Monet at the Savoy Hotel and the London fogs 1899-1901

by

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SYNOPSIS:

Monet painted his 'London Series' of 95 images between 1899 and 1902 and this study examines in detail the geometry, meteorology and the content of eight paintings of Waterloo Bridge and one painting of Charing Cross Bridge. A method based on solar geometry is used to estimate the exact date of these nine paintings. All nine paintings either contain a clear representation of the sun within the scene, or the position of the sun can be clearly inferred. This study shows that although Monet reworked the content of these images on subsequent days when the sun was in a similar position, he did not change the position of the sun. Monet resided at the Savoy Hotel during his stays in 1900 and 1901, painting his scenes from a suite located on the fifth floor - which this study identifies for the first time. Letters to Monet's wife and contemporary weather data are used to verify the probable dates. This analysis confirms that Monet painted what he saw and that his London Series can be utilised as a pictorial 'weather diary' of typical Victorian London fogs.

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I would like to take this opportunity to thank my family and friends for all of the support they have given me over the last three years. Their help and understanding has got me to where I am today.

I would like to extend my gratitude to my supervisors, Professor John Thornes and Dr Jacob Baker, who have helped and encouraged me throughout my PhD. And I would also like to thank Professor Andy Baker and Dr Lloyd Jenkins, who always managed to make the undergraduate Geography fieldtrips fun and very memorable, and have always been there whenever I needed their advice.

CHAPTER 1: Introduction

1.1. Abstract

Over the past decade, there has been an ever increasing interest in the relationship between weather and climate and how they are portrayed artistically. The representations of skies, atmosphere, weather, climate and climate change through a variety of artistic media have been considered thus far (Eliasson 2003; Olson et al 2004; Thornes 1999, 2008, Khan et al 2009). Furthermore, there have been a number of studies that have contemplated the use of environmental art as a form of proxy data for past weather, air pollution and climate change (Lamb 1967; Neuberger 1970; Brimblecombe and Ogden 1977, Baker and Thornes 2006 and Zerefos et al 2007). Monet's series paintings can be considered as another example of art representing aspects of the weather, for example, when Monet painted his scenes of London, he would include the sun when it was visible or a representation of the sun when it was obscured, trying to illustrate the atmosphere, and thus the weather, in his paintings. Monet was also known to rework many of his canvases with the intention of reflecting how the atmosphere appeared on specific days from year to year.

For this reason, the opportunity to deconstruct Monet's representations of the skies in his London Series (1899-1901) could not have come at a better time.

1.2. Brief introduction of the research area

Claude Monet, was one of the most prominent Impressionist painters of the nineteenth century, painting numerous scenes of London at the turn of the twentieth century, his main motifs were the Houses of Parliament, Waterloo Bridge and Charing Cross Bridge. Monet wanted to capture the atmosphere, which he fondly referred to as 'l'enveloppe' in all of his paintings. This is what made Monet's paintings an ideal series to analyse with respect to his representations of the London fogs.

Between the years 1899 and 1901 Monet resided at the Savoy Hotel in London for approximately six months in total. During his stays in 1900 and 1901, Monet wrote many letters to his wife, Alice, who remained at the family home in Giverny, France, and also to some of his other acquaintances. Within these letters, Monet included detailed accounts of the weather, particularly observations of the fog. A source of information, that will enable the analysis of Monet's paintings are the weather observations recorded at Chiswick, in West London, and collated by the Royal Horticultural Society in the form of weather diaries. Another source of data has been retrieved from the Meteorological Office Archives in Exeter and consists of reports for weather stations at Westminster, Brixton and Kew.

The contents of Monet's letters can be used in conjunction with the observations logged in the Royal Horticultural Society's weather diaries as well as the weather reports for Westminster, Brixton and Kew, to help determine the accuracy of Monet's portrayal of the London fogs at the turn of the twentieth century.

According to convention the main user group that would study nineteenth century paintings, such as Monet's London Series, would be art historians. Therefore, as this study is being conducted from an environmental scientist's point of view, it will hopefully broaden the existing knowledge base that is available with respect to the artistic representations of skies.

If this study proves that Monet's London Series is an accurate representation of the London skies for 1899-1901, then it could be suggested that there is a ready made pictorial as well as numerical representation of the 'London fogs' in the form of a weather diary. The construction of which is one on the main objectives of this study.

The advent of the Industrial Revolution brought about a definite shift in the motifs being studied by nineteenth century artists. Claude Monet, as a forerunner of the French Impressionist movement, saw a variety of changes during the nineteenth century. Initially he would paint in areas where he was living at that particular point in his life, yet during the 1880s Monet chose to travel in an attempt to grasp foreign scenes of nature and their consequential effects (House, 1986). Monet had always been entranced by the atmosphere and the various effects of light, yet it was not until 1890 that this area of interest came to the forefront and the physical objects became subordinate (House, 1986). This change saw Monet become more captivated by the overall effect of a scene, with the possibility of painting nature at its purest, as opposed to the individual aspects within the scene.

Monet was not the only artist that tried to accurately depict the atmosphere in his paintings. In 1967, Professor Hans Neuberger examined a total of 12,000 paintings each portraying a representation of the climate from 1400 through to 1967. Just as Neuberger's study attempted to prove that the various paintings were a record of the changing climate of Europe, this study aims to prove that Monet's London Series will provide an accurate depiction of London's weather at the turn of the twentieth century.

Prior to this study, the content of Monet's paintings of the Houses of Parliament were analysed by Baker and Thornes (2006), where a selection of the paintings were dated according to the position of the sun in each painting. Figure 1.1 shows an example of a painting of the Houses of Parliament that Baker and Thornes superimposed solar tracks over in order to determine a range of possible dates for the production of the painting.

Figure 1.1 London, Houses of Parliament, Effects of Sun in the Fog

However, the solar positions for the remaining paintings in the London Series, those of Waterloo Bridge and Charing Cross Bridge, still need to be derived, which is the main drive for this particular study.

The previous work carried out by Baker and Thornes has been an inspirational factor in the instigation of this report, but many of the paintings of Waterloo Bridge and Charing Cross Bridge contain only what can be considered as inferred representations of the sun, so the analysis of these paintings has required a slightly different approach to those of the Houses of Parliament.

The research required for the purpose of this study falls into two very separate categories; science and art. The scientific side of this study consists of the geometrical analysis of Monet's Waterloo Bridge and Charing Cross Bridge paintings from his London Series; all with respect to Monet's viewing position at the Savoy Hotel. This analysis will aid in the use of the definitive solar geometry required to approximately date these paintings. As aforementioned, analysis of synoptic meteorological data and the information contained in nineteenth century weather diaries will also be considered, in order to draw a comparison between 'real' data and Monet's own representations. The artistic side of this study will include understanding the traditional analysis of Monet's art and the contribution of his work to Impressionism and nineteenth century art as a whole. By developing a comprehensive understanding of nineteenth century art and the impact of the visual, the relationship between art and science can be explored.

The value of this research can only be hypothesised at this stage. However, if successful in proving that Monet's London Series is an accurate representation of the London fogs, during 1899-1901, then this study may sit amongst the others previously mentioned that work to bridge the gap between science and art.

There are many other forms of proxy data that can be retrieved from sources other than paintings and works of art. Some examples of these data sources are pollen samples, tree rings, ice cores and ships logs. A brief review of the work conducted using this last example as proxy data will be explored in this section of the report, as originally the information held in a selection of ships logs were being considered as another data source for this study. However, after careful deliberation, it was concluded that the distance between the ship ports and Monet at the Savoy Hotel was too great for any substantial findings, thus this data set was removed from the final analysis. Nevertheless, this area of research is vast, with experts within the UK, and internationally, managing to compile huge amounts of data from the logs of ships sailing during 1750 to 1850 (Universidad Complutense Madrid [UCM], 2003). The information collated from the logs makes up the Climatological Database for the World's Oceans (CLIWOC). The data collection for this project came to an end in 2003; yet work has continued to produce a database of detailed observations for over 250,000 days which is readily available and updated regularly. CLIWOC was the first attempt made by scientists to explore using logbooks as a resource to understand the climatic changes over the world's oceans during the pre-instrumental period. The ship's logs that were used for analysis were retrieved from the National Maritime Museum, in London, and archives in the Netherlands, France and Spain. The logbooks span a one hundred year period, from 1750 to 1850, so they can provide significant information about the recovery from the Little Ice Age. It also marks a time when changes in the climate cannot be viewed as a consequence of world-wide industrialisation and the consequential release of greenhouse gases into the atmosphere (National Maritime Museum [NMM], 2008).

This brief review of the proxy data that can be retrieved from sources, such as logbooks, helps to highlight the main advantage and disadvantage of using visual data, such as paintings. Whilst the entries of the logbooks are very technical and scientific, describing the weather situation experienced at the time of recording, it could be concluded that the information collated from a painting is only as reliable as the artist painting it. Artistic license plays an enormous part in the majority of paintings, so using the content of for example, landscape paintings, may be limited as a consequence of this. On the other hand, tabulated data may be considered to be quite hard to visualise, especially when faced with pages and pages of numbers and figures. Considering this form of data emphasises the advantage of the visual information held within paintings, representing a pictorial history ready for analysis.

1.3. General research outline

The aim of this study is to determine the accuracy of Monet's depiction of the London fogs, in his London Series (1899-1901), at the turn of the twentieth century.

The program of work that will be undertaken, will take the form of three objectives.

- To critically review the evolution of the symbolism of skies in landscape art as well as the background to London's climate and fogs at the turn of the twentieth century together with an analytical appraisal of the context of Monet's life and artistic representations of 'l'enveloppe' in his London Series.
- Definition of a solar geometry method that will enable the derivation of the dates and times of production of Monet's paintings of Waterloo Bridge and Charing Cross Bridge.
- Investigation of information included in Monet's letters of correspondence as well as data from the Royal Horticultural Society's weather diaries and weather reports

from three weather stations in London. This should help in the construction of a weather diary that will describe the 'London fogs'.

1.4. Outline of thesis

The following chapters will endeavour to accurately examine Monet's London Series using geometrical and content analysis of his paintings of Waterloo Bridge and Charing Cross Bridge.

Chapter 2 will provide the theoretical framework for this thesis by discussing the development of landscape art, environmental art and the artistic representation of skies over time. This chapter will also introduce the scientific theory behind the fogs.

Chapter 3 should help to contextualise Monet's paintings in the huge array of work that was produced during the nineteenth century. Therefore this chapter will cover important developments in Impressionism and other genres of painting, as well as the ever-increasing popularity of photography that existed at this time. Monet's series will also be put into context with respect to his life, his previous work and his paintings.

The methodology of the thesis will be covered in Chapter 4. This chapter will offer the quantitative approaches utilised in conducting this study. The geometry, meteorology and the content of the paintings will be analysed. Another quantitative approach that will be employed is solar geometry. This method will help in the derivation of approximate dates and times of production for each painting. Though the work in this area is still very new and highly theoretical, the analytical techniques being used will offer stable ground to base conclusions on.

Chapter 5 will be dedicated to the analysis of Monet's paintings depicted from the Savoy Hotel. This chapter will also include analyses of the Waterloo Bridge paintings and Charing Cross Bridge paintings with respect to Monet's viewing positions at the Savoy Hotel.

Chapter 6 will explore the climate of London towards the end of the nineteenth century and into the beginning of the twentieth century. The records that will be utilised here will be the Royal Horticultural Society's nineteenth century weather diaries, synoptic meteorological data for several locations in urban London and letters of correspondence that Monet wrote which include details of fog observations.

A comparison between Monet's paintings and the 'real' data will then be considered. The aim of this chapter is to develop a better understanding of the weather, particularly the fogs, experienced in Victorian London.

Finally, Chapter 7 will present the key findings from the thesis as well as empirical and theoretical evidence that Monet's London Series may be confidently used as proxy meteorological data.

CHAPTER 2: Theoretical framework

2.1. Introduction

As discussed earlier, there has been a growing fascination, during recent years, in subject areas of geography crossing the divide between art and science (Cosgrove and Daniels 1988; Wylie 2007; Thornes 2008). Such an interest has resulted in the development of various factions associated with landscape and geography, some of which are explored in this chapter.

The aim of this chapter is to investigate the links between nature and how aspects such as the sky are represented in art. Since the London fogs are such an integral part to this study, a brief analysis of the fogs from a scientific point of view will also been conducted within this chapter.

2.2. Geographical context

Tayler (1964) maintains that the relationship between nature and art can be both cooperative and antagonistic. Nature can be viewed as a raw wilderness, encompassing the deformed and uncontrollably prolific face of the fallen world. Alternatively, nature can also be seen as representing a form of perfection, the ideal order. Consequently, Renaissance thinkers were steered towards one of two interpretations of the division; either nature and art as complementary or nature and art as opposed. The notion of nature incorporating the forces and energy that encourage growth and decay as well as movement and change, seems to challenge the idea of landscape being a fixed and stable arrangement of natural forms organised by the artist (Andrews, 1999). Perhaps this concept was influential in Turner's method of landscape painting, choosing to experience nature directly in order to capture his scenes with certain authenticity. Criticised for what some called 'bad painting', Turner defended his work by declaring that it was 'nature' (Andrews, 1999) which evidently changes from day to day.

2.3. The perception of art

The classical way of viewing art, in particular landscape art, is to admire the 'scenic beauty' of the image, with an innate appreciation of the aesthetic qualities of the landscape (Warnock and Brown, 1998). Paintings in the Renaissance period used landscape merely as a backdrop to the central human or divine focus of the scene. Thus, the landscape acquires a very low status in the scenic hierarchy dominated by the human presence (Andrews, 1999).

Clark was of the opinion that until the sixteenth century, artists were primarily interested in the landscape for its symbolic value; that is, for the picturesque view of nature and its untouched state (Andrews, 1999). For some artists, landscape was held as a cultural image, presenting a pictorial way to exhibit, structure and symbolise their surroundings (Cosgrove and Daniels, 1988).

The subject of nature was to have its greatest vogue during the Romanticism era in the early nineteenth century, when nature was ultimately viewed as pure, fine, good, and truly beautiful (Meinig, 1979). Conversely, just a century later, during the nineteenth century, the subject of 'nature' was to have a major impact on the sciences, leading to the formation of what is now known today as the ‘natural sciences’. This term refers to those fields that use a scientific method to study nature, and forms the basis for the applied sciences.

A painting of a landscape is given credit as being visually realistic and proportional to the landscape itself, thus the painting permits an impression of visual depth for the observer. This illusion of three-dimensional depth on a two-dimensional canvas is achieved using linear perspective, which works to organise the space within the painting around a vanishing point on the horizon (Wylie, 2007). Cosgrove (1985) states that one of the continual purposes of landscape painting was to produce a scene of order and proportional control, so much so, that he declared that there is an inherent conservatism within the landscape idea.

The interpretation of the term ‘landscape’ caused a few reverberations during the 1980s amongst human geographers, since many believed in the ‘purity’ and ‘authenticity’ of individual experience (Wylie, 2007). During this time, “a new cultural geography” emerged on account of Cosgrove and Daniels “In an area … between radical and humanistic geography” (Daniels, 1989). They both believed that “every study of a landscape further transforms its meaning, depositing yet another layer of cultural representation” (Cosgrove and Daniels, 1988).

It could be suggested that the current focus on global warming and climate change has meant that there has been an increase in representational art and non-representational/performative (in terms of audience participation) art encompassing the sky, atmosphere, weather, climate and climate change (Thornes, 2008). In recent years, the artist Olafur Eliasson pushed the boundaries with his work addressing the relationship between society and nature, stating that “The weather is ‘nature’ in the city” (Eliasson, 2003). Eliasson is a unique artist that brings modernism into his artistic representation of the weather. Eliasson appears to be fascinated with the effect of the weather on an environment and the effect of an environment on the weather; because of the fact that the weather itself remains an aspect of nature that can be experienced anywhere regardless of location. The motive behind his work is to encourage the viewer to experience “seeing yourself sensing”, in order to explore the relationship between the spectator and the object.

In 2008, Thornes concluded that representative environmental art began as early as the nineteenth century with artists such as Constable and Turner painting the real environment as opposed to an imagined landscape. Today, environmental artists seem to cross the divide between representational and non-representational environmental art. For this reason, it can be said that environmental artists have a host of differing approaches, methods and beliefs. These are generally: raising awareness about the fragility of the environment; using ‘green’ methods and natural materials to create their works and investigating how the environment works (Thornes, 2008).

At one time in the history of the visual arts, disciplines such as meteorology and botany, to name but a few, were key to the successful creation of the desired aesthetic effects

(Fuller, 1988). Artists such as Turner and Constable worked with this duality of art and science so that their paintings represented their total physical environment (Thornes, 2008). However, in today's academic environment, the visual arts and mathematics seem to be at completely opposite ends of the spectrum. Yet, disregarding the aesthetic properties of landscape art, it is based on geometric laws of perspective and proportion (Wylie, 2007). Since perspective is a combined geometrical system of perception and representation, it "gives the eye absolute mastery over space" (Cosgrove, 1985). Therefore, in theory, the certainties of mathematics and geometry can be transferred to landscape imagery in order to assure clear and distinct topographical knowledge and command (Wylie, 2007).

Since landscape can be classed as a way of seeing, landscape can also be linked with the 'practical sciences' of cartography and navigation, thus connecting landscape gazes to observation and classification amongst the Western sciences (Wylie, 2007). During the nineteenth century, with the emergence of the life sciences and their consequential pictorial and classification impulses, landscape paintings were viewed as being accurate, reliable and trustworthy (MacKenzie 1990, Pratt 1992, Driver and Martins 2005).

Unfortunately, the perspective of the painted landscape could not effectively encompass the expanding metropolis of nineteenth century London. This may be the reason that maps and aerial views of the city became so popular during this time, as they permitted necessary in-depth observations (Andrews, 1999). This spread of urbanisation into the countryside induced the start of a reverse process in which nature attempted to reclaim territory in the greening of ruins (Andrews, 1999). With the dawn of the nineteenth century came the concept of open-air painting, which provided an enormous progress in geographical understanding. The advent of photography was also developed in this period, after much work and refinement by Louis Daguerre in 1839 the term ‘photograph’ was coined by Sir John Herschel during the same year, and eventually became the primary instrument for pictorial naturalism as the century progressed. Despite these technological advances, some still believed that a photograph was not an adequate representation of the subjective relationship between an observer and the natural scene neither was it able to convey the sense of nature as a living process (Andrews, 1999).

An influential figure of nineteenth century London was the art critic, John Ruskin. His main aim was to produce an objective, scientific, visible framework whereby he could examine and compare paintings. Yet, Ruskin also urged that form was more important than process and that the moral meaning of art was significantly more important than its scientific truth (Thornes 1999). This of course created a paradox. Ruskin had an overwhelming vision of the sky, which he voiced in his writings and drawings, yet he seemed to lack scientific insight. Ruskin made few attempts to correlate his findings statistically, and his attempts at scientific explanation were usually wrong or confused (Thornes, 1999). It seems that Ruskin viewed landscape as a form of text, searching for a reassurance of order in the face of the apparent chaos of industrialising Britain (Cosgrove, 1979).

2.4. The evolution of skies in art

It is important to state at this point that throughout the many centuries of landscape painting, replicating the sky directly from nature was often not the aim. Instead, the sky was used as a backdrop for the subject of the paintings, the landscape. Nevertheless, there were a handful of artists who were unconventional when they painted elements of the sky.

John Constable discussed what he thought were the earliest representations of skies, in landscape paintings, during his lecture at Hampstead in June 1833. Constable credits thirteenth century Italian artists Cenni di Pepo Cimabue and Giotto di Bondone as the first landscape artists that portrayed changing skies in their scenes (Thornes, 1999).

The American meteorologist, Stanley Gedzelman, recognises that a variety of cloud types have been used in landscape paintings between 1425 and 1675. Gedzelman identifies 'The Crucifixion' by Flemish painter Jan van Eyck that appears to show an accurate representation of cumulus, altocumulus lenticularis, cirrus uncinus and cirrocumulus lacunosis clouds (Thornes, 1999). Conversely, Kurt Badt believes that the seventeenth century Dutch artists Aelbert Cuyp and Jacob van Ruisdael were the first to do this, claiming that the work of their fifteenth and sixteenth century predecessors (Albrecht Durer, Leonardo da Vinci and Sir Peter Paul Rubens, to name a few) painted clouds as isolated formations (Badt, 1950). Cuyp painted many scenes that were dominated by skies reflecting representations of real weather. Ruisdael would also paint landscapes dedicated to the sky, atmosphere and diffuse light (Thornes, 1999). Ruisdael was a rarity, as was Constable, in that the weather could be inferred from his paintings. Nevertheless, Ruisdael's skies could still be considered unrealistic, despite their grandeur, yet Constable was able to paint his skies true to nature (Thornes, 1999).

Interestingly, Leonardo da Vinci was thought to be quite experimental for his time declaring that clouds could inspire new ideas for landscapes (Thornes, 1999).

Constable also discussed the later work of Rubens during his lecture in 1833. At this point in his career Rubens had started to take an interest in painting skies, showing "the freshness and dewy light". Constable went on to comment that "Rubens delighted in phenomena – rainbows upon a stormy sky, – bursts of sunshine" (Leslie, 1845).

During the seventeenth century, Rembrandt was a well renowned artist; but he is not so well-known for his landscape paintings. Yet Kenneth Clark notes that "In his landscape drawing of the 1650s, every dot and scribble contributes to an effect of space and light" (Clark, 1976). This is simply echoed in the 1994 edition of 'The Thames and Hudson Dictionary of Art and Artists' which states Rembrandt's "preference for 'nature' above artistic tradition".

Throughout the eighteenth century, there were many English painters that would include representations of the sky in their landscape paintings. The painting by Alexander Cozens 'The Rain' incorporates the natural colour of the sky, the brightness of the sunlight on the cloud edges, the dark fragmented stratus overhead and the beauty of the atmosphere (Thornes, 1999). The artist Thomas Girtin, painted his skies in watercolours, and in 1794 he conducted a study purely based on clouds. Joseph Mallord William Turner produced many sketches and paintings of nature during his career in the nineteenth century. In fact, Turner dedicated a sketchbook solely to skies in 1818/19. The skies that Turner would paint were usually stormy which he seemed to use to reflect the power of nature. Turner was infatuated with the relationship between the atmosphere and sunlight and how he could utilise this to enhance the effects of his landscapes and seascapes (Thornes, 1999).

Turner painted his scenes of London during the first half of the nineteenth century, before the London fogs had started to become progressively worse. However, Monet was painting in London during 1899-1901, which was actually whilst the fogs were starting to lessen over the city. Interestingly, Whistler also spent some time in London, between these two periods, during what is now known to be the peak of the London fogs. Therefore, for the purpose of this study, scenes of London painted by Turner and Whistler will be analysed in order to determine the encroachment of the London fogs during the nineteenth century.

2.5. The deconstruction of Monet's London Series

Monet's surviving London Series is made up of ninety four paintings in total; nineteen of the Houses of Parliament, forty one of Waterloo Bridge and thirty four of Charing Cross Bridge. The aim of this study is to determine whether a selection of paintings of Waterloo Bridge and Charing Cross Bridge, taken from the London Series, can be successfully used as a form of proxy data for the fogs in London at the turn of the twentieth century.

The analysis is comprised of different quantitative approaches, which will be applied to this selection of paintings from Monet's London Series. The geometry, meteorology, and the content of the paintings will be analysed.

The geometry of the paintings will be assessed with respect to a) the geometry of the landscape portrayed within each painting; and b) the geometrical positioning of the sun in each painting. The method utilised for deriving the solar geometry for the Waterloo Bridge and Charing Cross Bridge paintings is based on the work conducted by Baker and Thornes in 2006, and has been refined with respect to input and advice from Prof. Donald W. Olson of Texas State University. This method will produce hypothetical dates and times for the production of each painting.

Prof. Donald W. Olson and his team have also worked on paintings by the artists Vincent van Gogh and Edvard Munch. The first obstacle that they had to overcome was to decipher whether the celestial object that was to be analysed within each scene was the sun or the moon. In the papers 'Dating van Gogh's Moonrise' and 'Reflections on Edvard Munch's Girls on the Pier', Olson et al (2003, 2006) were able to determine that the celestial object in question was in fact the moon. During the analysis of both paintings, Olson and his team used the altitude and azimuth of certain aspects within each scene, for example the altitude and azimuth of the pier in the painting 'Girls on the Pier' by Munch was used to determine the altitude and azimuth of the 'yellow disk' within the scene.

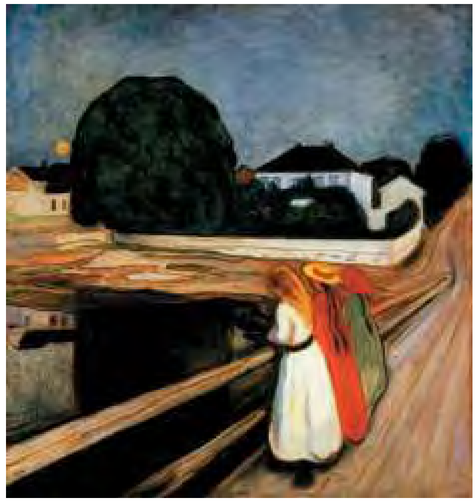

Figure 2.1 Girls on the Pier

Using these angles in conjunction with the known latitude of Åsgårdstrand, possible declinations of the 'yellow disk' could be derived. These were consistent with declinations for the moon. A computer program, similar to the one that will be used in the solar geometry section of this study, was utilised to determine dates for when these lunar declinations occurred. The dating process was then further refined using Munch's letters of correspondence that he penned whilst residing in Åsgårdstrand. Olson and his team were then able to pinpoint accurately the date on which Munch painted this particular scene. This is just one example of a method utilising the position of a celestial object within a painting to successfully date the production of the scene. The strengths and weaknesses of this method will be similar to those encountered during the study of Monet's paintings. The main weakness is due to working from a reproduction of a painting which can lead to errors in measurements. However the strengths lie with using known heights of structures depicted within the paintings in conjunction with an accurate computer program, which should help to alleviate some of these errors. Also, utilising the letters of the artist in question, adds another dimension of analysis with respect to the content of the paintings.

Once the possible dates and times of production for Monet's paintings of Waterloo Bridge and Charing Cross Bridge have been determined, the next stage of the quantitative approach is the analysis of the meteorology depicted in each painting as well as the content of the said painting. Weather conditions recorded by various authorities will be used in conjunction with the meteorological analysis of the paintings in order to refine the dates and times produced in the solar geometry section of the analysis. Finally, the content of the paintings will be assessed with respect to Monet's letters of correspondence, in order to determine the accuracy of what Monet was trying to depict.

2.6. Scientific context – Introduction to the London fogs

During the nineteenth century the urbanisation of London began to increase so rapidly that by the 1840s the population density had reached approximately 50,000 per square mile (Mosley, 2003). Many authoritative figures spoke out regarding the ever decreasing space for an ever growing population leading to an increasing threat to the health of the city's inhabitants. Sinclair (1964) and Mogridge et al. (1997) present maps that show the expansion of London from 1800-1958. There are six maps in total, showing the built-up area of London for the years 1800, 1850, 1880, 1914, 1939 and 1958. For the purpose of this study, only the maps of London for 1880 and 1914 have been selected, which will hopefully show the change in the city at the turn of the twentieth century.

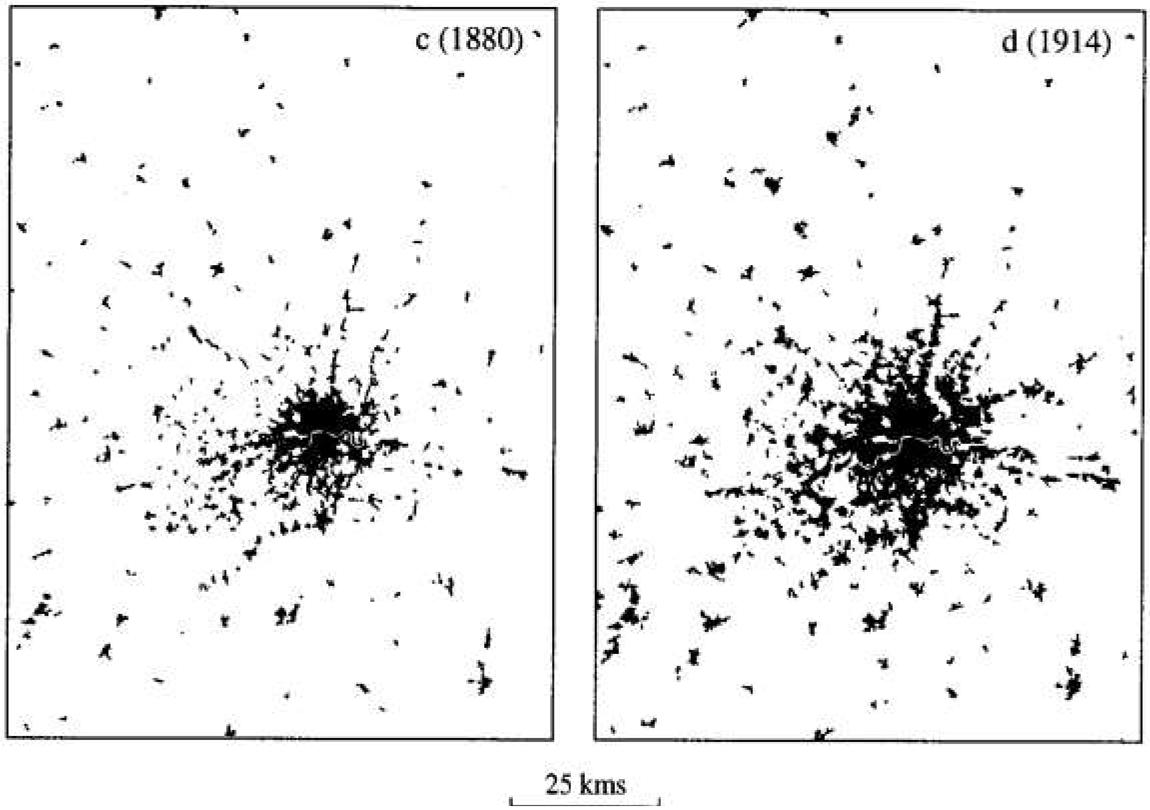

Figure 2.2 Built-up area of London in 1880 (c) and 1914 (d) (Mogridge and Parr, 1997).

By 1880, the central built-up areas had begun to grow beyond the pre-existing boundaries. The map also shows that a substantial suburban development already existed. During the next three decades, by 1914, the metropolis had grown extensively along with the urban areas located at various distances from the centre. The expansion of London can be attributed to the development of the suburban transport networks during the nineteenth century, which ultimately meant that the growing population of London along with the coal-burning activities of the city's inhabitants were dispersed over a greater area.

The amount of smoke present in London during the nineteenth century meant that there was subsequently a call for the introduction of an air pollution abatement act. After the Smoke Nuisance Abatement Act was established in 1853, there were also smoke clauses defined in the Sanitary Acts of 1858 and 1866, as well as in the Public Health Act of 1875 (Brimblecombe, 1987). Nevertheless, by the 1880s a lot of the previous interest in smoke abatement had disappeared. The most likely reason for this decline in interest was the lack of an air pollution monitoring network within London. Documents processed by the early inspectors show that they assessed progress by counting the number of times smoke was observed each year, instead of trying to determine the concentration of the air pollutants (Brimblecombe, 2004). Since the inspectors were only relying on visual observation, the inhabitants of London were unaware of the true amount of air pollution present in the city air (Brimblecombe, 1987). The pollution problem in London was closely related to the alkali industry owing to the production of sodium sulphate, which was much needed in the manufacture of glass, along with the production of alkalis such as sodium carbonate and sodium hydroxide (Brimblecombe, 1987). The method utilised by the industry involved the reaction of common salt with sulphuric acid which can be represented by the equation: $2NaCl + H_2SO_4 \rightarrow 2HCl + Na_2\ SO_4$

The formula shows that the process produced hydrogen chloride as a by-product, yet as it was regarded as having little significance it was released directly into the air. With the growth of the alkali industry, the volumes of hydrogen chloride produced also increased, with devastating environmental consequences (Brimblecombe, 1987). However, soon pollution levels could no longer be ignored, as the fogs on the River Thames started to become much more noticeable. It is now known that high levels of pollution aid in the formation of fog, and since the levels of air pollution were particularly high during this time the fogs naturally became thicker, more frequent, and different in colour than those of the past.

Even towards the end of the nineteenth century, the inhabitants of London were still unsure of the cause or the effects of the pollution that was being continuously pumped into the atmosphere. An account written by John Ruskin in 1884 reflects this lack of conviction when addressing the creation of the 'plague-winds', "It looks partly as if it were made of poisonous smoke;" (Ruskin 1884:46). Ironically, Ruskin was correct in his diagnosis, since the fogs were predominantly as a consequence of the high levels of smoke that industrial London was producing.

However, in mid-nineteenth century London, the government established the 'Select Committee on Smoke Prevention' (Whitehead, 2009). The purpose of creating such a Committee in 1843 was to consider the atmospheric problems facing industrial Britain during this time. Throughout this period many members of parliament and scientists began to place great importance on the effect the fogs were having on parks and plants, in spite of the uncertainty surrounding the effects they were having on human health (Luckin, 2002). Nevertheless, the launch of this Committee in 1843 was seen as the first attempt made by the government to try to build relations with British scientists in order to work together against the air pollution problem (Whitehead, 2009). The advent of the scientific analysis of air pollution in 1843 could be pinpointed as a turning point in the history of the air pollution systems of nineteenth century Britain. Despite this, there was still great concern about the contamination of rainfall and river water with respect to the Alkali Act of 1863. Fortunately, the first Chief Alkali Inspector, Robert Angus Smith, who was responsible for many of the early chemical analyses of rain and air, took his role very seriously and would conduct work above and beyond the requirements of the act

(Brimblecombe, 2004). Nonetheless, there still remained a shortage of air pollution measurements, and it was not until 1910 that air pollution monitoring networks were established, which was entirely as a result of the development of deposit gauges inspired by the work of 'The Lancet' (Brimblecombe, 2004). Another possible method to estimate the concentration of air pollutants would be modelling. The simple models that have been used, in recent studies, suggest that the concentration of air pollutants was high at the end of the nineteenth century, an idea supported by the strong correlation between London's fog frequency and the modelled pollution load. As previously discussed, particulates from activities such as coal burning have been linked to increased fog formation, so this finding was to be expected.

Brimblecombe (1987) 'The Big Smoke' contains figures regarding the number of days in the second half of the nineteenth century that encountered fog.

Years	**Number of days with fog in London**
1871-5	51 ± 15
1876-80	58 ± 15
1881-5	62 ± 7
1886-90	74 ± 11

Table 2.1 Number of days experiencing fog in London 1871-1890

Just by looking at Table 2.1 above, it can be concluded that the frequency of the fogs seemed to reach a peak between the years 1886-1890. Mossman (1897) 'The non-instrumental meteorology of London 1713-1896' and Lamb (1982) 'Climate, History, and the Modern World' also contain figures regarding the average number of days with fog and dense fog throughout the nineteenth century.

Years	Average yearly number of days with fog	Average yearly number of days with dense fog
1811-20	19	2.4
1821-30	19	2.5
1831-40	26	5.2
1841-50	22	3.9
1851-60	33	7.6
1861-70	39	8.1
1871-80	49	9.0
1881-90	55	9.3

Table 2.2 Number of days experiencing fog and dense fog 1811-1890

Table 2.2 also shows that there was another peak in the fogs during 1831-40, after which the frequency saw a brief downturn before the number of fogs and dense fogs rose to a maximum in 1881-90. Nevertheless, the fogs did continue into the twentieth century which prompted the London Fog Inquiry of 1901-1902. Coincidentally, just as the inquiry got under way, the frequency of the fogs seemed to lessen. The rise and fall of the fogs between 1871 and 1890 were observed and recorded by the meteorologist F. J. Brodie (1892, 1905). He believed that the decrease in fogs was because of the founding of the Coal Smoke Abatement Society in 1899, as they had pushed for the enforcement of the laws that required factories to consume their own smoke (Brimblecombe, 1987). However, private chimneys were not included in any of the legislations passed regarding smoke emissions until the Clean Air Act of 1956. The reason that private chimneys were not initially included in these laws was on account of the weariness of Victorian and Edwardian governments to interfere with London's inhabitants' 'right' to enjoy the luxury of an open coal fire (Mosley, 2003). Many Victorians viewed their coal fires with a certain amount of sentimentality and ironically believed that an open hearth would aid in the ventilation of the home (Mosley, 2003). It is well-known that Londoners in the nineteenth century would fill their open fires with bituminous coal without realising that the smoke they produced would intensify the fog. For many centuries, London had been covered by a canopy of smoke; but this was much enhanced during the nineteenth century by the factories, railway engines, steam-powered machinery in the docks and steamers of the River Thames (Bernstein, 1975). Table 2.3 displays London's coal supply for the period 1830-89 (Making the Modern World, 2004).

Years	**Seabourne (1000's of tons, averages per year)**	**Railbourne (1000's of tons, averages per year)**
1830-9	2288	-
1840-4	2664	-
1845-9	3279	19
1850-4	3379	451
1855-9	3167	1195
1860-4	3407	1750
1865-9	3001	3064
1870-4	2940	4609
1875-9	3257	5559
1880-4	3952	6701
1885-9	4768	7424

Table 2.3 London's coal supply for 1830-1889

Owing to this, improvements in London's air quality seem not to have come from the adoption of legislation, but instead as a consequence of the persistent pressure applied to industry. Prior to the implementation of the Clean Air Act, in 1956, the sale of coal in London had dropped to 3,227 thousand tons and continued falling (United Kingdom, Ministry of Fuel and Power, 1962).

The annual average of dense fogs, that is when fogs over a widespread area reduce the visibility to ¼ of a mile or less, rose from 2.4 to 9.3 for the decades 1811-20 and 1881-90, respectively. Sir Douglas Strutt Galton, a sanitary reformer of military barracks and hospitals, claimed that the "great prevalence of fog-forming matter in our London air … and the enormous amount of smoke" was the cause of the darkness hanging over London.

Luke Howard, the renowned meteorologist, conducted a study of the temperature in urban and rural London during the early nineteenth century, to determine the 'urban heat island'. He concluded that inner London had an 'artificial excess of heat' causing an overall heating effect which saw an increase in the city's temperature by two degrees Fahrenheit during the winter months (Brimblecombe, 1987). Howard reported that he thought the heating was a result of combined fuel consumption and increased absorption of radiation by urban surfaces. He believed that all of the chimneys in London played a major role in the production of the 'fuliginous cloud' that frequently hung over the city. By the end of the nineteenth century, the fogs had become so severe that in stagnant atmospheric conditions, the city was barely habitable (Brimblecombe, 1987).

Much of the smoke reduction in London during the twentieth century was attributed to the smoke control zones assigned to local areas of the city. However, before these had been put into place, coal burning in London had diminished (Bernstein, 1975). Strutt Galton advised the people of London that "We must cook by gas and we must sacrifice open fireplaces" (Strutt Galton, 1888), and whether they took heed to this or not, it seems that many Londoners started to use modern central heating systems which ran on fuels such as gas, electricity or oil. These new systems replaced the more labour intensive coal fires that required constant cleaning of dusty grates and refilling of heavy coal scuttles. In addition to this, the ‘penny-in-the-slot gas-meter’ was introduced to the working classes in the 1890s, thus vastly reducing the amount of coal used in the home.

In 1901 Captain Carpenter collaborated with Captain Lionel de Latour Wells in order to arrange for systematic fog observations to be recorded at thirty fire stations spread throughout London. Other stations also contributed observations so that a widespread network had been established within a couple of weeks, which not only covered London, but adjacent heights and the Thames Estuary as well. This network of observational stations operated for two winters, incurring a minimal cost (MPMC, 1901). This investigation was called The London Fog Inquiry. “The contamination of the air by smoke” was observed and recorded by Captain Carpenter when he ascended Victoria Tower and St Paul’s Cathedral on ten separate occasions between 20th December 1901 and 17th January 1902. None of these days were foggy, with several of the days having “great visibility in the country”, yet the visibility from the towers ranged from half a mile to one and a quarter miles. Despite the noted clarity of these days, Captain Carpenter observed that “St Paul’s has not yet been seen from Westminster nor Westminster from St Paul’s, although their distance apart is but 1½ miles” (MPMC, 1902). The London Fog Inquiry established that the London fogs were produced in London, and had it not been for the mixture of smoke particles, then they would not have assumed the density of the thickest black or yellow fog (Bernstein, 1975).

The fogs within London did appear to have had some locality, as one could pass from thick darkness into the clear light of day within a few yards, leaving many agreeing that the best thing to do would be to abolish the fogs altogether (Bernstein, 1975). However, just as the London Fog Inquiry was collating these results, the frequency of the fogs appeared to be decreasing. Less than twenty fogs were recorded in 1900, which made it the least foggy year since 1871, yet over forty fogs were recorded in 1901, forty fogs were again reported in 1902, and less than thirty fogs were recorded in 1903 (Bernstein, 1975).

W. N. Shaw deduced from the results of the London Fog Inquiry that the Coal Smoke Abatement Society dealt with approximately 20% of the London fogs, whilst the remainder of the fogs depended on physical processes "which are not within our control" (Shaw, 1906). Bernstein (1975) drew his own conclusion that the economic 'progress' in London had contributed roughly 70% to the smoke reduction and fog banishment, whilst the Clean Air Act had contributed the remaining 30%.

In 1904, Brodie announced that the foggiest months in the twenty year period 1871-90 were December, October, January and March, in descending order; and in the thirty-three year period 1871-1903 the foggiest months were December, November, January and October (Bernstein 1975). The reduction in fog frequency continued into the twentieth century, undoubtedly aided by the decreased emissions released in London, tighter industrial laws, together with the fact that the use of coal became unfashionable as the use of new fuels became more widespread. However, it was not until the 'Great Smog' of 1952 had claimed the lives of 4,000 Londoners that people were truly willing to give up the open coal fire (Mosley, 2003).

In 1954, London was the first local authority in the country to obtain parliamentary powers to declare the whole city a smokeless zone. Between 1958 and 1969, the smoke concentrations over London had declined by 80% (Scarrow, 1972), which seemed to coincide with the less frequent appearance of fogs (Jenkins, 1971).

2.7. Meteorological optics

The effects of smoke are now quite extensively known because of their visibility to the naked eye, for example vegetation damage as well as the reduction of visibility and solar radiation. Visibility reduction is caused by the scattering and absorption of light by molecules in the air. Scattered light works to decrease the contrast between an object and the background sky, which results in a reduction of visibility (Pauly Hyslop, 2009). Over urban areas, blankets of particles work to reduce the direct and scattered solar radiation, thus decreasing the amount of sunlight that reaches the ground level. In Victorian London these particles would have been present as a result of the increased levels of pollution at the time. It was these polluted scenes that Monet wished to capture in his depiction of the London ‘landscape’.

As discussed earlier, during the nineteenth century, coal smoke characterised the urban atmosphere and affected the lives of every city dweller regardless of their social status. However the composition of the smoke surrounding them was never considered. The majority of coal contains between 85-90 % carbon (Alloway and Ayres, 1993), with smaller amounts of oxygen, hydrogen, nitrogen and sulphur. In fact, the complete combustion of coal does not produce any smoke. It is only when the coal is not completely burned that the small particles of carbonaceous matter – smoke and soot – are produced (Mosley, 2001).

The seasons were thought to have had an effect on the fogs, and even though the fogs did not disappear altogether during the summer months, they did seem to lessen somewhat. Nevertheless, in January 1855, *The Times* newspaper published the following about London's air quality during the summer;

> Smoke we have always with us. If we look out on a fine summer's day … for a view of the great metropolis, we naturally exclaim, "I see it; there is the smoke;" … any picture of London without its dim canopy of soot would be as unrecognizable as would a portrait of Pope, Hogarth, or Cowper without their well-known headgear (The Times, 1855).

Conversely in 1894, *Pall Mall Magazine* had the following account from Ernest Hamilton;

> London in June is hardly recognisable as the same place where six months before we were coughing and wheezing and groping our grimy way through the gaslit streets. In June the trees are in the full zenith of their short-lived verdure, the young grass fresh and green, the parks bright with flowers, and the exhalations of domestic chimneys have ceased for a time to obscure the heavens. In short, everything looks its best and brightest, and only the houses stand as gloomy, silent witnesses that the truce with the powers of darkness is only temporary … So it is year after year. We grumble in winter, and we forget in summer (Hamilton, 1894).

It has been documented that smoke particles, resulting from activities such as coal burning, alter the electrical properties of air. For example, an increase in smoke particle concentration causes a decrease in the electrical conductivity of air but an increase in the Potential Gradient (PG). A potential gradient is defined as the local space rate of change of electric potential; that is, the amount of work that would be required to move a unit of electrical charge from a reference point to a specific point against an electric field.

Early twentieth century smoke concentrations at monthly resolution have been found for Kew Observatory, as well as calibrated PG data from 1898 and air conductivity measurements for the years between 1909 and 1979 are available for Kew. Since there are existing automated smoke observations for this site from 1921, an absolute calibration to smoke concentration was possible, highlighting that late nineteenth century winter smoke concentrations at Kew were roughly 100 times greater than current winter smoke concentrations (Harrison, 2006). The previously discussed sensitivity of atmospheric electrical parameters to smoke particles, along with the extensive availability of PG measurements for locations all over Europe from the mid-nineteenth century onwards (Harrison, 2004), enables the reconstruction of past urban smoke concentrations for Kew, London in the 1860s (Harrison and Aplin, 2002).

Figure 2.3 Monthly smoke concentrations for London in 1863

The frequency of fog formation is higher in cities when compared to the countryside, despite the fact that cities have higher temperatures and lower humidity than in the country. Therefore it has been concluded that the explanation lies in the mechanism of fog formation (Seinfeld, 1986). When fog forms over cities, where the air is usually polluted, the fog is often thicker than any fog forming over an ocean. City air contains a plethora of available condensation nuclei, such as dust, that water vapour can condense on to produce lots of fog droplets which thus increases the possible thickness of the fog layer resulting in reduced visibility. Since the air in most cities is polluted to some degree, the fog can turn acidic as the tiny liquid droplets merge with gaseous impurities, posing a threat to human health.

The official definitions of fog, as determined by the Met Office, is as follows. ‘Fog’ is when visibility is reduced to below one kilometre, which is thought to be an appropriate limit for aviation purposes. As far as the general public and motorists are concerned, the upper limit for visibility in fog is 200 metres, and is referred to as ‘thick fog’. The third situation is ‘dense fog’ and this is when visibility falls below 50 metres, causing severe disruption to transport (Met Office, 2007). Mist has also been defined by the Met Office. This term is used for conditions when the atmosphere is obscured by suspended microscopic water droplets or wet hygroscopic particles, resulting in a visibility of one kilometre or more (Met Office, 2007).

It was reported that the visibility in London at the height of the fogs was extremely low (MPMC, 1902), with many Londoners experiencing difficulty when simply trying to navigate their way around the city. Since the fogs of nineteenth century London would settle over the city for days at a time, they would have most certainly posed a threat to the health of London’s inhabitants and its visitors.

Once a fog layer has formed it is easily preserved by new fog droplets which continuously form on the available nuclei as long as the air maintains its degree of saturation. This is possible by either a continual cooling or by the evaporation and mixing of water vapour into the air (Ahrens, 2000).

Even though the fogs of London peaked during the 1880s, Monet depicted the continually occurring fog layer in his paintings of London during his stays in 1899, 1900 and 1901.

The variety of colours that he employed in order to portray each foggy scene could surely be interpreted as evidence of the effects that the pollution levels had on the atmospheric properties and thus the weather of London.

2.8. The colour of the fog

The colour of the London fogs was not frequently noted in early reports, but as the fogs became more prevalent so too did the observations.

In 1908, Beale wrote in his book, 'Recollections of a Spinster Aunt', that 1850s London seldom experienced yellow fogs. However, the frequency of the fogs and the variety of the colours seemed to increase greatly, which is evident from the following excerpt.

> A sudden draught apparently had swept across the sky, and where before the thick black curtain had been opaquely stretched, there came sudden rents and illuminations. Swirls of orange-coloured vapour were momentarily mixed with the black, as if the celestial artist was trying the effects of some mixing of colours on his sky palate …. the commotion among the battling vapours grew ever more intense: blackness returned to one quarter, but in another all shades from the deepest orange to the pale gray of dawn succeeded on another (Benson, 1905).

It was not only the 'celestial artist' that was experimenting with colours, as landscape artists began to change the colours they were using when depicting the skies they observed. The blue skies that were initially dominant became secondary to skies of pink and shades of yellow-brown (Lamb, 1982).

The colouration of the London fogs still requires further exploration. Novakov and Novakov (2006) speculate what chromatic effects certain industrial processes had on the atmosphere during the nineteenth century. They suggest that tars from low temperature coal combustion would give morning fogs a yellow hue, on account of the relative soluble properties. However as the working day progressed, industrial emissions as well as exhaust from steam trains and ships would darken the fogs. This change in colour to dark brown was attributable to tar being produced at higher temperatures. In addition to this, one of the most important chemical activities during this time was manufacturing 'alkali', which was primarily made up of sodium carbonate and sodium hydroxide. Industry of this kind would release huge volumes of hydrochloric acid into the atmosphere.

The hypothesis of Novakov and Novakov is rooted in two kinds of evidence. Firstly, a large percentage of the airborne particles consisted of low temperature tar; and secondly, the chemical reactions consequently produced colourful dyes. Since coal tar is a complex organic material it consists of many constituents such as aniline and phenols. When these react with acids, which were provided in abundance by the 'alkali' factories, salts are produced. These salts are water-soluble, and thus may pass on various colours to their aqueous solutions. The colouration of the atmosphere and thus fogs could also be a consequence of the absorption of certain wavelengths of light by the air molecules and fog droplets. Everything is dependent on the size of the droplets present in the air. Fog will usually appear white since it is illuminated by the scattered and transmitted rays of sunlight. The scattered light usually makes up approximately 99% of the incident light, thus appearing white as a whole even though each element of light may show a preference for scattering blue (Minnaert, 1974). Nevertheless, the fogs in London during the nineteenth century appear to have formed because of a variety of consequences, thus the colouration of those fogs are very likely to be the result of the complexities of the compounds produced in the industrial processes as detailed by Novakov and Novakov. Thus, an in-depth analysis of the content of Monet's London Series, with reference to his letters and various meteorological records, may provide a better understanding of the severity of London's pollution and its resulting effect on the production of fog.

If nothing else, the fogs caused a stir among many regarding their aesthetic qualities. Early descriptions by the French writer James Morier in 1849 claimed that the fogs "…covered all things with an eternal mourning". However, as the century progressed, visitors to London started to view the fogs as an "aesthetic effect" of the atmosphere (House, 2005); and in 1867, the French novelist Edmond Duranty described the docks as being "…astonishing … particularly in grey foggy weather". Nonetheless, the majority of England's natives were in agreement with Morier, that indeed London was hideous to look at, but would be less hideous without its smoke (Russell, 1880). Monet was one of the visitors to London who held the satmospheric changes in great esteem, commonly referring to them as 'l'enveloppe'. After completing his series, Monet told René Gimpel "What I like most of all in London is the fog" (Gimpel 1963 sited House 1986). It was during his fourth trip to London in 1901, whilst he was continuing with the work on his London Series, that Monet commented on the diversity of colours that the fogs displayed:

> There are black, brown, yellow, green, purple fogs and the interest in painting is to get the objects as seen through all these fogs (Bullet, 1901).

Monet tried to depict all of the colours of the fogs in his many scenes of London. It was in fact during the nineteenth century, in particular, that artists began to formulate colour with increasing intensity using a combination of artistic and scientific theories (Kemp, 1990).

2.9. Visual Culture

In 2005, Thornes suggested that rather than a 'visual turn' occurring there seemed to be a 'visual return' to geography taking place. This would require a visual literacy to be established across the whole geographical field, using images as a tool of explanation rather than words or equations, in order for human geographers and physical geographers to share and revise their visual methodologies accordingly. Working together in this way would help to teach geographers the importance of visual skills, so that they know how to deconstruct images before they even start to create their own (Thornes, 2005). Until recently, many geographers have been in a state of visual denial, as a result of the fabricated reputation that geographers 'colour in' maps. This obviously slowed down the 'visual return' to geography.

In England during the 1950s, a cultural turn occurred which introduced physical geography to culture, thus producing 'cultural physical geography' (Gregory, 2000). The theory of visual culture reached the US in the 1970s, incorporating a plethora of methodologies in its understanding. A few of these methodologies included; The Gaze, semiotics, iconography, psycho analysis, discourse analysis and content analysis. Expansion of this subject resulted in the new discipline of 'visual studies' which was fully developed in the 1990s.

The need for visual literacy within the social sciences requires an expansion of visual culture and visual studies (Elkins, 2003). A visual 'return' has already been experienced by human geographers, resulting in a complete 'theory of pictures' to aid in the understanding and deconstruction of images (Rose, 2001). The physical sciences intend to modernise techniques in visualisation, modelling, imaging and analysis (Thornes, 2005). The visual 'return' to physical geography has been predominantly interested in 'picturing theory', relating to the visualisation of processes (Thornes, 2005).

2.10. Visual Studies

The title 'visual studies' seems to encompass three fields within this subject area; cultural studies, visual culture, and finally visual studies.

The field of 'cultural studies' gained knowledge from a variety of disciplines such as art history, anthropology, sociology, art criticism, and film studies, to name but a few (Elkins, 2003). However, it was not until the 1970s that this study area seemed to spread throughout the 'red-brick universities'. A decade later, in the 1980s, 'cultural studies' became international, reaching America, Australia, Canada and India.

Conversely, ‘visual culture’ was an American study area which took hold in the 1990s (Baxandall, 1972), but it was “a narrower area of cultural studies” (Crimp, 1999), focusing primarily on the visual. Finally, ‘visual studies’ was a term coined by Mitchell in 1995, to join the fields of art history, cultural studies and literary theory. Mitchell called this connection the ‘pictorial turn’, a sequel to the ‘cultural turn’ experienced some 35 years earlier that had then produced the field of ‘cultural studies’ (Mitchell, 1995).

In 2002, Mitchell discussed vision as a cultural construction, that it is experienced and nurtured, rather than being simply given by nature. He also specified that ‘visual culture’ encompassed the field and its content, with the context to clarifying the meaning. The example that Mitchell gave was of aesthetics and art history, as they work together in a complementary fashion. Together, aesthetics and art history provide completeness, since the theory of visual experience is dealt with by aesthetics, whilst the history of visual images is dealt with in art history (Mitchell, 2002). Therefore it seems only natural that a ‘sub discipline’ halfway between aesthetics and art history would develop, concerning visuality and addressing problems such as light, optics, visual apparatuses and experience, the eye as a perceptual organ, and the scopic drive, amongst other things (Mitchell, 2002). Hence, it is not just aesthetics and art history that fall into this arena, but scientific and technical fields such as physical optics. Ancient optical theory treated vision as a comprehensively tactile and material process (Mitchell, 2005). In his publication, ‘A New Theory of Vision’, Bishop Berkeley states that vision is not simply an optical process but in fact requires a coordination of optical and tactile impressions that will work together to create a coherent and stable visual field (Mitchell, 2005). This concept was echoed in

2002 when Jay professed that any new field cannot emerge in its entirety without being indebted to the fields that preceded it. Therefore it follows that these new fields will naturally borrow a selection of matters and methods from a variety of neighbouring or antecedent disciplines. Ultimately, sometimes complementary and sometimes contradictory approaches are required in order to develop a full understanding of the 'visual culture' (Jay, 2002).

CHAPTER 3: Context of Monet and his work

In order to be able to understand Monet's role in Impressionism and in nineteenth century art, as a whole, this chapter will initially attempt to explore Monet's work with respect to that of other contemporary artists. The chapter will finish with an analysis of the catalogue of Monet's career, paying particular attention to his series paintings.

3.1. The founding of Impressionism

The Impressionist movement developed in France during the late nineteenth century and into the early twentieth century, with Impressionist painting consisting of the work produced between 1867 and 1886 (Pioch, 2006). Enthusiasts of the Impressionist movement viewed this style of painting as a different way of seeing. They were predominantly concerned with the general impression of a scene or object which was conveyed with the use of unmixed primary colours and small strokes to simulate the reflected light (Pioch, 2006).

Levinson (1997) suggested that the Impressionist movement was started as a reaction to the introduction of photography. To begin with, paintings of both portraits and landscapes were thought to be unrealistic whereas photography "produced life like images much more efficiently and reliably" (Levinson, 1997). The aim of the Impressionists was to portray their own experiences of nature and not merely to create direct reflections as photographs would. In fact, it seems that photography encouraged the artists to exploit certain aspects of the painting medium, like colour; so they were the "first to consciously offer a subjective alternative to the photograph" (Levinson, 1997).

3.2. Photographs of London c. 1900

At the same time that Impressionism was becoming an established art movement, photography was another artistic medium that was gaining significant recognition. During this period photographs were also called 'impressions' on account of the long exposure cameras that were used. Since the photographs were taken using this instrumentation, they captured the speed at that cities moved at as a blur, which was very similar to how Monet and the Impressionists would paint figures on their canvases.

Art photographers working towards the end of the nineteenth century and into the beginning of the twentieth century were renowned for including visual metaphors in their photographs. These metaphors were based heavily in the pictorial, for example; patterns, shapes, smoke, reflections on the surface of water, plus effects created by steam and lighting.

Interestingly, there exists the perception that the content of photographs can be considered to be true and believable since they have been captured using a machine. Yet the accuracy of the content of a painting is deemed to be questionable as it is susceptible to the artist painting the scene, that is, their artistic licence. However, Alvin Langdon Coburn is a brilliant example of a photographer who would rework his photographs in order to emphasis certain elements of a scene. Coburn's work was unique in that during the photographic printing process, he would hand-work his images in order to minimise detail in favour of how the atmosphere was portrayed. The end result was to give the photograph a painterly aspect (Museum of London, 2006), thus proving that the content of a photograph is not always reliably accurate.

At the beginning of the twentieth century, Coburn produced a series of photographs of London dated 1900 to 1913. A selection of these photographs will be chosen for analysis in order to draw a comparison between Coburn's view of London and Monet's depictions of the capital. Out of the twenty Coburn photographs available in the Museum of London archives, five have been chosen because of the proximity of their locations to where Monet painted his London Series.

Figure 3.1 Westminster Abbey

This photograph (Figure 3.1) was taken from a point on Westminster Bridge, with a view of Westminster Abbey in the distance behind some trees. The bridge lanterns in the foreground of the photograph are almost in focus, though the trees and the Abbey beyond are quite hazy. The haziness of the photograph could be as a result of either Coburn's printing process or possibly the atmospheric conditions experienced at the time. Since the focus of the photograph lessens with distance from Coburn's viewing position, it may be fair to assume that the degradation in visual range could quite possibly be the result of atmospheric properties that Coburn had simply tried to highlight when printing the image.

Figure 3.2 Waterloo Bridge

The clarity of this photograph (Figure 3.2) is relatively good with extended visibility under the arches of the Waterloo Bridge showing the embankment on the opposite side of the Thames. The calmness of the river means that the reflections of sunlight off the water and the shadows cast by the bridge have been captured perfectly within the photograph. Therefore it seems possible that this photograph was taken on a bright and clear day. As discussed earlier, Coburn would alter his images to emphasise the appearance of the atmosphere in his photographs, so it may be fair to assume that since no 'real' atmosphere is detectable in this photograph, this may have been how the scene appeared at the time.

Figure 3.3 From Westminster Bridge

This photograph (Figure 3.3) is very dark, but in spite of this; the clarity of the lantern in the foreground of the image is surprisingly good. The recognisable outline of the Parliament buildings is somewhat hazy in the background of the photograph, and the sky beyond the buildings could be described as looking turbulent. Nevertheless, the windows of the Parliament buildings are relatively clear, so it could be concluded that the overall haziness of the photograph is the result of Coburn's printing process rather than any atmospheric situation.

Figure 3.4 On the Embankment

The most important aspect of this photograph (Figure 3.4) is that Coburn seems to have captured the Savoy Hotel in the background of the scene. The haziness of the Savoy Hotel may be because of fog, though the sphinx in the foreground of the image is relatively clear.

Figure 3.5 Houses of Parliament

Victoria Tower is clearly visible in the background of the photograph (Figure 3.5), and it is reflected in the surface of the Thames. The rest of the Parliament buildings are comparatively hazy as they are further away. The sky beyond the buildings seems clear, yet towards the top of the photograph, the sky appears to darken significantly. This image is very reminiscent of one of Monet’s Houses of Parliament paintings from his London Series; so it seems entirely plausible that Coburn could have styled this photograph on one of these paintings.

3.3. Paintings of London c. 1900

An analysis of Monet’s London Series will help to develop an understanding of how Monet worked and what elements he felt were important to include in his scene of London. However, ideally a comparison between Monet’s London Series and the work of other artists, that painted scenes of London during the nineteenth century, would mean that the accuracy of Monet's depictions of London could also be assessed. Fortunately, the nineteenth century saw many artists travelling to London in order to paint its many vistas. Of these artists, two in particular have been chosen on account of their prominence and contributions made to nineteenth century art. These two artists are Joseph Mallord William Turner and James Abbott McNeill Whistler, and their representations of London will be compared to Monet's.

As previously discussed, the artists Turner, Whistler and Monet, all painted in London at quite significant stages of the severity of the fogs. Turner was painting his scenes of London prior to the fogs, Whistler painted London during the peak of the fogs, whereas Monet was painting London during the decline of the fogs. For this reason, comparing the scenes of London by all three artists will hopefully provide an overall view of the differing intensities of the fogs during the nineteenth century.

In 1789, at the age of fourteen, Joseph Mallord William Turner was accepted into the schools at the Royal Academy. Turner's work initially consisted of drawings and watercolours. However, nearly a decade after joining the Royal Academy, Turner started to produce his oil paintings.

Turner visited Paris in 1802, and was inspired by the works of Claude Lorrain as well as the Dutch seascapes displayed in the Louvre. Turner began to portray the atmospheric effects of light in his watercolours and oils, producing many representations of nature and the forces at work within nature. Turner travelled throughout England, Scotland, Ireland and the Continent painting such representations. The following paintings are a couple of scenes that Turner painted whilst in London.

Figure 3.6 London (1809)

This painting (Figure 3.6) by Turner was created ninety years before Monet started his London Series, and as the fog occurrences peaked towards the end of the nineteenth century, it seems fair that the climate of London would have been very different from that which Monet observed. The position of Turner when he painted this scene is unknown, yet all aspects of the landscape are easily discernable, which could be the result of blue sky conditions depicted within the painting.

Figure 3.7 The Burning of the Houses of Lords and Commons (1834)

Almost all of the left hand side of this painting (Figure 3.7) has been dedicated to depicting the fire that engulfed the House of Lords and the House of Commons. However the top half of the right side of the canvas depicts quite a gloomy sky, which may be in part because of the smoke wafting from the fire or possibly that the canvas was painted at night. Nevertheless, the dark blue of the sky is still visible, thus regardless of the fire; the day on which this scene was painted was likely to be somewhat overcast and dim.

Figure 3.8 The Fighting Temeraire tugged to her last Berth to be broken up (1838)

This painting (Figure 3.8) by Turner depicts the *HMS Temeraire* being towed, after playing its role in the Battle of Trafalgar, to its final berth in East London where it was destined for the scrap yard. Turner seems to cleverly juxtapose the sad event of a once revered battleship being 'taken out to pasture' with the phenomenal sunset casting wonderful pink and orange tones amidst an azure sky which is all reflected in the surface of the Thames.

Looking at the three paintings by Turner, it seems fair to disregard Figure 3.7 as it depicts a scene full of fire and smoke. However, the remaining two paintings (Figures 3.6 and 3.8) show London with blue skies and crisp white clouds, which would correspond well with the fact that they were painted during the first half of the nineteenth century, before the London fogs had begun to set in. Therefore, it may be concluded that Turner's paintings depict fair representations of London's weather during this time.

The second artist to be compared to Monet is James Abbott McNeill Whistler who was born in Lowell, Massachusetts in the United States in 1834. After succeeding in drawing during his time at the military academy, West Point, Whistler travelled to Paris in 1855 to become an artist. Prior to enrolling at the studio of Charles-Gabriel Gleyre, Whistler had studied for some time at the École Impériale et Spéciale de Dessin.

Whistler made a series of etchings before starting his first painting in 1859. And nearly two decades later, in 1877, Whistler began to paint a series of views of the River Thames at night. This series was entitled 'Nocturnes'.

Figure 3.9 Nocturne in Blue and Silver; Chelsea (1871)

Chelsea is approximately three to four miles away from the Savoy Hotel, thus this scene (Figure 3.9) of Chelsea painted by Whistler may be compared to Monet's own representations of the River Thames. Unfortunately, Whistler's exact position in Chelsea is unknown; but it is possible to deduce that Whistler would have been positioned on the same side of the Thames that Monet was, looking towards either Battersea or South Lambeth. The most obvious disparity between this painting and any of Monet's paintings of London is the time of day that the scene was created. Monet's painting routine has been well documented; he would paint Waterloo Bridge during the early morning, and Charing Cross Bridge from midday into the early afternoon, hence trying to assess the weather situation portrayed in each scene can be a relatively straightforward exercise. Nevertheless, the lack of sunlight in the scene 'Nocturne on Blue and Green; Chelsea' has been made up for by the moonlight which shows an evening so clear that the embankment on the far side of the Thames is obviously discernable.

Figure 3.10 Symphony in Gray: Early Morning Thames (c. 1871)

As this scene (Figure 3.10) was painted during the early morning, it can be compared somewhat to Monet's paintings of the Waterloo Bridge. Unfortunately, the exact position of Whistler when he painted this scene is unknown, so only the representations of the sky within this painting can be compared to Monet's skies. The canvas has clearly been divided into four parts, the nearside embankment, the River Thames, the far side embankment, and the sky. The majority of the canvas has been dedicated to the Thames, whilst the sky has the smallest share of the canvas. Nevertheless, it is possible to see that as the title states the sky is slightly gray and hazy, which could also describe some of the skies painted by Monet in his scenes of Waterloo Bridge.

Figure 3.11 Nocturne: Grey and Gold - Westminster Bridge (1871-74)

If the location of the scene (Figure 3.11) had not been stated in the title of this painting, only Whistler would have known the true answer. However, despite the darkness of the scene, blue fragments of sky are visible on the horizon amid clouds that seem to exude a pinkish hue. As a result of this apparent visibility, it seems fair to suggest that the weather was fair, if a little cloudy, on this particular day.

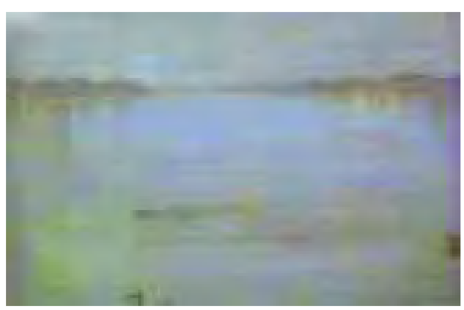

Figure 3.12 Nocturne: Blue and Silver – Cremorne Lights (1872)

From the relative brightness of this scene (Figure 3.12), one could easily think that this painting was produced during the day; even the structures in the far distance seem to be reflected in the surface of the Thames. However, as this painting is one of Whistler's 'Nocturnes', then it must have been painted on an extremely clear night when the moonlight was intense enough to produce reflections on the river.

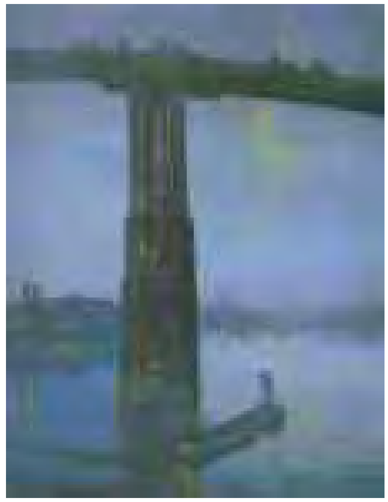

Figure 3.13 Nocturne in Blue and
Gold - Old Battersea Bridge (1872-75)

Just as with 'Nocturne: Blue and Silver – Cremorne Lights', this painting (Figure 3.13) by Whistler also seems to have been produced on a remarkably clear night when the moon is shining brightly. Old Battersea Bridge in the forefront of the painting is clearly discernable, as are the structures in the background which also appear to be reflected in the surface of the Thames. The presence of the word 'gold' in the title of the painting may be referring to the gold hues of the light within the scene, specifically in the sky just below the bridge as well as ascents of gold on the structures and in the reflections.

Figure 3.14 London Bridge (1885)

London Bridge is only approximately one to two miles from the Savoy Hotel, thus comparing this scene (Figure 3.14) of the Thames to the scenes painted by Monet seems to be fairly reasonable. The most striking aspect of this painting is the monochromatic tones that Whistler has used in his depiction. The sky and the river can only be distinguished as separate elements on account of the boats on the surface of the Thames. As the greyness of the sky has been reflected in the surface of the water, it seems fair to conclude that the air was either thick with fog or smoke, or a mixture of both. In addition, it has been documented that the severity of the fog occurrences reached a peak during the 1880s, and as this painting was produced in 1885 it seems to reflect this situation entirely.

From the analysis of the six paintings of London by Whistler, four of the paintings (Figures 3.9, 3.11, 3.12 and 3.13) are from his 'Nocturnes' series which suggests that they were actually painted after dark. For this reason, it may be advisable to disregard them at this stage and concentrate on the remaining two paintings; Figures 3.10 and 3.14. Both of these paintings are decidedly grey in their depiction, so it is only the structures within each respective scene which enables the observer to differentiate between where the sky finishes and the River Thames begins. Since Whistler was residing in London at a time when the fogs had reached their peak, it seems reasonable to conclude that his paintings of London reflect this situation.

3.4. Monet's life

Claude Monet was born in Paris in 1840, but by the time that he was five years old, he and his family had moved to Le Havre on the Seine estuary (House, 1986). Monet's mother died in 1857, so he spent a lot of his time with his aunt, Marie-Jeanne Lecadre, who, unlike his father, seemed to understand his artistic interests.

Monet served with the Chasseurs d'Afrique in Algeria from 1861-2, which appears to have helped to encourage him with his ambitions to become a landscapist (House, 1986). After this military service, Monet moved to Paris to study painting with the renowned academic teacher Charles-Gabriel Gleyre who had previously taught Whistler. During this time, Monet was being supported financially by his father, an arrangement which seems to be entirely thanks to his aunt's persuasion (House, 1986).

Monet met Camille Doncieux in 1865, and in 1867 they had their first child, Jean. Monet and his new family battled with poverty for several years, but he was eventually able to marry Camille in 1870. However, shortly after the beginning of their honeymoon, Monet fled to London in order to avoid conscription for the Franco-Prussian War (House, 1986). Despite this, Monet's financial situation appears to have picked up over the following years, on account of the sales of his work to art dealer Paul Durand-Ruel.

In the mid 1870s, Monet developed a close relationship with business man, Ernest Hoschedé, and his wife Alice. However in 1877, Hoschedé went bankrupt, which led to both families pooling their resources (H.Adhémar, 1984). Camille Monet died a while later in the September of 1879 because of a longstanding disease of the womb. Shortly afterwards, Ernest Hoschedé left his family to pursue the life of a bachelor in Paris. This left Monet and Alice Hoschedé to look after her six children and Monet's two (House, 1986). This living situation seems to have caused quite a stir and was the reason that Monet was isolated by his colleagues in 1880 (Wildenstein, 1974). The two families moved to Giverny in 1883, yet Monet and Alice still managed to live technically separate lives (House, 1986). However, with Ernest Hoschedé's death is 1891 the couple were permitted to marry a year later.

On account of Monet's increasing success, the family in Giverny eventually "acquired the image of a prosperous bourgeois ménage" (House, 1986). Alice Monet passed away in 1911, and Monet died much later in 1926 at the age of 86.

Throughout most of his life Monet primarily painted scenes in close proximity to where he was living at that time. This was the case when he began to paint what was to become his Grain Stacks Series. The stacks are believed to have been located in a field near to where he lived in Giverny.

It was later on during the 1880s that Monet decided to travel to various locations in an attempt to observe and understand differing scenes of nature and their resulting effects

(House, 1986). During this time, Monet became a more experienced artist and his style and technique underwent a variety of changes. It is also possible to pinpoint moments in Monet's career when he began to focus his time and efforts on different subjects.

At the beginning of Monet's career in 1870, he would tend to paint groups of related but separate works (Seiberling, 1988). He initially focused his efforts on man-made landscapes, being fascinated by the contemporary elements of the scenes themselves.

He started to concentrate primarily on the open air from around 1870, painting small scale canvases which made up the majority of the work exhibited by the Impressionists from 1874 onwards (House, 1986). Monet launched his studio boat in 1873 (Thiebault-Sisson, 1927) which appears to be the clearest indication of Monet's commitment to his outdoor work of the 1870s. It was during the 1880s, that the Impressionists gained infamy as a group of artists whose methods were based primarily on outdoor painting (House, 1986). By 1880 there was a distinctive shift in Monet's focus, when he began to view raw nature as a subject worth painting (House, 1986), trying to capture it in its entirety.

Mirbeau, a friend of Monet's, wrote an essay in 1889 to catalogue his accounts. Monet was aware of the instantaneity of the atmospheric and lighting effects since each "effect lasts for barely thirty minutes" so that "Every day at the same hour, for the same number of minutes, in the same light…he would come back to his *motif*". From observing Monet's techniques, Mirbeau concluded that "The open air is his only studio" (Mirbeau, 1889).

Monet took great pleasure in relaying the hardships that he had endured in order to paint his outdoor scenes. Geffroy observed Monet painting in oilskins with his easel fastened to the rocks on Belle-Isle in 1886, and after watching him wrote "The painter goes to his work as if going into battle" (Geffroy, 1897). Thus, whilst working outdoors, Monet was at the mercy of the transitory effects of the elements (House, 1986). Monet would wait for the disappearing effects to reappear, "halting his brush when the scene before him changed, placing the uncompleted canvas at his feet" (Le Roux, 1889).

Reputation and pride meant a great deal to Monet, and so he profusely maintained that he was an artist who began and finished his work in front of the subject (House, 1986). However, the multitude of problems that he faced whilst trying to complete his paintings left him no choice but to alter his methods from those which he professed (House, 1986).

During the 1880s, Monet would still try to finish his work outdoors, yet he increasingly began to 'look over' and even rework some of his canvases at home before exhibiting them (House, 1986). However, this retouching was not a new development, as some may think, as he wrote to de Bellio of a painting that he sold to him in the December of 1877;

> I told you that I wanted to retouch it before giving it to you, and since then I've been bothered by so many things that I have not found a moment's quiet to do this little task (Wildenstein, 1974).

Therefore, based on this, it seems fair to assume that Monet conducted reworkings in his studio throughout the 1870s, primarily when outdoor conditions prevented him from completing his work on the spot (House, 1986). In addition, there are paintings from the

1870s with surfaces that have been obviously reworked. This would imply that they had been elaborated or revised in some way, which suggests that some alterations took place in the studio (Le Roux, 1889).

The atmosphere and the effects of light had always fascinated Monet, but it was only in 1890 that this particular subject matter took precedence over physical objects (House, 1986). All of the physical objects that he chose were absorbed into and transformed by the surrounding atmosphere (Taylor, 1995). At this point in his career Monet became obsessed with trying to capture the effect that the whole scene created. It was around this time that he also began to work increasingly on several versions of the same image, which meant that he was working nearly exclusively on series of paintings by the 1890s.

3.5. Monet's series paintings

	Grain Stacks Series	Rouen Cathedral Series	London Series
Number of paintings	15	30	94
Years of production	1890-1891	1892-1894	1899-1905

Table 3.1 Monet's series paintings

The series of the Grain Stacks as well as Rouen Cathedral present a sequence from sunrise to sunset, showing the variations of light and its effects on the forms of the stacks and the cathedral.

During the 1890s, Monet began to regularly date his paintings with the year of completion. The fifteen scenes that constitute the Grain Stacks Series were all dated 1891 (House, 1986), even though the summer effects among them were all begun during the year before their final exhibition in May 1891. In the same way, the Rouen Cathedral Series were all dated 1894, when in actual fact they were started during Monet's visits to Rouen in 1892 and 1893. What's more, the majority of the London Series were dated 1902, 1903 and 1904, yet Monet actually only visited London in 1899, 1900 and 1901 (House, 1986).

As discussed earlier, when exhibiting his series paintings, the date of the exhibitions were normally delayed by at least one year owing to Monet's continual retouching and reworking of the paintings.

3.5.1. Grain Stacks Series

Monet was inspired to paint the grain stacks by a chance observation of the consistently changing sunlight over the field near his Giverny studio.

Figure 3.15 Grain Stacks, End of Summer, Morning Effect (1891)

Monet began to paint the series in October 1890 and continued to work on them throughout the winter, which in fact explains why some of the scenes actually depict snow-covered stacks.

Figure 3.16 Grain Stacks, Snow (1891)

The grain stacks within each scene provide the foundation for the continuously changing effects of light and colour, and Monet’s obsession lay in trying to capture the “weather, atmosphere and ambience” within each of these scenes (letter to Geffroy 21/07/1890, W letter 1066; House 1986).

Monet tried to keep a degree of flatness to the canvases by painting the grain stacks against the hills in the background, which worked to further simplify the scenes. It was with this series that the colours Monet employed began to gain increasing autonomy (House, 1986).

As with the majority of his series paintings, Monet experienced difficulties in finishing the Grain Stacks Series, trying to keep up with the transitory effects of the atmosphere that he desired to capture so perfectly. Thus he inevitably continued a lot of the painting in his studio, retouching the canvases sometimes even after their exhibition, which obviously altered the painting schemes of many of the scenes.

The importance of displaying the Grain Stacks as a series was emphasised by Monet himself, as he believed that the paintings would "only acquire their value by the comparison and succession of the entire series" (Bijvanck, 1892).

The work that Monet carried out during the 1890s can be traced back to experiments he conducted with the use of colour, tone and texture during the 1880s. As Monet's series paintings were primarily concerned with capturing the colour variations within the same scene under different lighting conditions, Monet appeared to become progressively more analytical towards the application of colour in his paintings (Kemp, 1990). Yet all of this experimentation did not completely prepare him for the immense task that he undertook by making the atmosphere the focus of all of his paintings.

3.5.2. Rouen Cathedral Series

Monet first visited Rouen in order to organise his half sister's estate after she died very suddenly. However, it was whilst he was staying in Rouen that Monet discovered the cathedral; inspiring him to return to Rouen in order to paint two panoramic views of the scene, neither of which he managed to finish.

As with most of the painting he conducted away from home, Monet kept his wife, Alice, regularly informed of his progress with the series. The content of the letters that he sent to Alice ranged from elation at having found a subject to paint, through to complaints about the weather during his stay. These changes in the weather were actually quite beneficial to Monet, as during the grey days he was able to concentrate on his grey-toned paintings, just as during the sunny days he was able to work on his brighter scenes (Taylor, 1995).

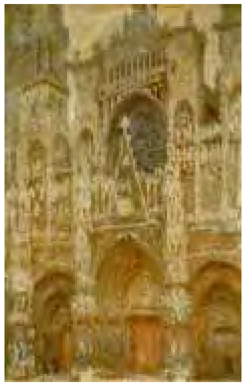

Figure 3.17 Rouen Cathedral, the West Portal, Dull Weather (dated 1894, painted (1892))

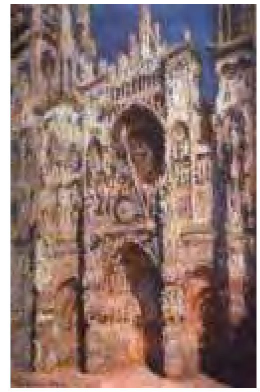

Figure 3.18 Rouen Cathedral: Full Sunlight (1894)

As a consequence of several inevitable changes with accommodation arrangements whilst staying from February to April in 1892 and 1893, Monet ended up painting the cathedral from three different first floor properties spanning the cathedral square. After his second stay in Rouen, Monet returned to Giverny where compelled by fear of failure he began to order his series. In 1894 he completed this task and he signed and dated twenty six of his paintings, signed a further three, but left the remaining canvas unsigned and undated (Taylor, 1995).

Monet's interest in Rouen Cathedral is comparable to his interest in the London skyline, since the objects themselves gave off no real distinct colour, allowing them to be easily manipulated by atmospheric effects. By choosing a single dominant figure for his series, Monet was able to focus on complex silhouettes, such as the fretwork of Rouen Cathedral as well as the complex architecture of London (House, 1986).

Monet also faced problems when trying to complete his Rouen Cathedral Series, which he discussed with Theodore Robinson by explaining that he was attempting “to do architecture without using lines or contours” (Robinson, Diary 23 May 1892; Daudet 1927; House 1986). For this reason, he had no choice but to paint the rigid structure of the cathedral using full-bodied layers of paint, which drew away from the actual architecture of the building and emphasised the atmospheric effects that surrounded it.

The Rouen Cathedral Series was eventually exhibited in 1895 but Monet’s final visit to Rouen was in 1893. This postponement of the exhibition was on account of the problems that Monet encountered when trying to finish the series, yet it seems probable that Monet’s alterations were actually extensions of the spirit of the original, amplifying and enriching the initial stimulus from the natural scene (House, 1986). The Rouen Cathedral Series was exhibited alongside eight paintings from a trip he had taken to Norway. This juxtaposition of working directly from nature and paintings worked up over a period of years shows the conflict that Monet experienced when constructing direct records in comparison to evolving ambitious calculated scenes (House, 1986).

3.5.3. London Series

Monet first visited London in 1870-1, when he attempted to avoid conscription during the Franco-Prussian war. During this time he painted depictions of two sites on the Thames; the first was of the Pool of London, and the second was of the new Embankment.

It is thought that Monet's living conditions in London in 1870-1 must have been fairly meagre, and that he was quite possibly living on the outskirts of the city, just like his fellow friend Pissarro had when he boarded in Norwood during his visit to England (Taylor, 1995).

After his first visit, Monet planned to return to London to continue his painting; but he did not manage this return trip until the autumn of 1899. This is when he began his London Series. It was over thirty years after Monet had started his painting career that he approached his painting style in a slightly different way, starting with this particular series. Jules-Antoine Castagnary described Monet's new technique of painting as painting "not the landscape but the sensation produced by the landscape" (Castagnary, 1874).

On his return to London, Monet was a much more affluent artist, and thus could afford to travel and lodge in luxury. Nothing made this more apparent than Monet's stay at the Savoy Hotel, which was then regarded as one of the most luxurious hotels in the world (Taylor, 1995).

In 1899, Monet started to paint scenes of Charing Cross Bridge. He included Cleopatra's Needle in two of his earlier sketches; but he failed to include it in the remainder of his paintings. It is thought that Monet may have felt that the needle actually split the scene in two (Reed, 1998). As Monet was staying in the Savoy Hotel, he painted views looking east across Waterloo Bridge and the South Bank, as well as south towards Charing Cross Bridge and the Houses of Parliament.

Monet then returned to London for the third time in 1900, and as he began work on February 11th, he had in mind to stick to a strict painting regime. Daily work was to start from the Savoy Hotel concentrating on Waterloo Bridge in the early morning sun, moving on to work on Charing Cross Bridge in the midday to early afternoon sun. Monet then moved his viewing position to St. Thomas's Hospital to paint the Houses of Parliament at sunset (Thornes and Metherell, 2003). In Monet's images of Waterloo Bridge he chose to include the vast industrialised area east of the bridge, in his scenes, as he enjoyed the smoke produced by the factories, and would often complain when they did not produce it (Reed, 1998). When Monet began to study the Houses of Parliament, he would always paint in the afternoon to ensure that the scenes were as misty as they could possibly be, as well as being able to incorporate the setting sun behind the buildings. The mist levels during the afternoon could be attributed to the amalgamation of the smoke pumped out by all of the factories since opening that morning.

In 1901, Monet made his fourth and final trip to London to continue work on his series, commenting on the "black, brown, yellow, green, purple fogs" (Bullet, 1901). As previously discussed, it was London's mist and fog which Monet commonly referred to as 'l'enveloppe' that he fondly remembered London for. It was for this reason that Monet only seemed to paint in London during the winter months, as it was only through these winter fogs that Monet viewed London as "a beautiful city" (Gimpel, 1963).

From studying Monet's various paintings of London, it is apparent that he found it difficult to depict the scenes in just one or two scenes. Since the subject that Monet was trying to capture was so variable, he was unable to successfully paint them directly which greatly frustrated him. For example, Monet would begin to paint a scene of the Houses of Parliament during the afternoon, and come the next day the weather conditions would have changed so considerably that he would not be able to continue to work on that particular painting. Since this was the case with so many of the scenes that Monet began, he retrieved the canvases that he had started in 1900 on the same day during the following visit in 1901, in the hope that the position of the sun and atmospheric conditions would be similar enough to continue work on some of them. Hence, even though painting in London was planned in advance, it was nevertheless postponed on many occasions because of the weather.

It is known that Monet would write letters to his wife almost every day, each containing meticulous details regarding the weather in London and how this weather would in turn affect his work schedule. As well as writing with such regularity to his wife, Monet also bestowed many letters upon his friends, such as Paul Durand-Ruel and Gustave Geffroy, which also contained various descriptions of the weather.

The main objective for Monet's London Series was to try and capture the effects of the fogs and mist. Therefore these scenes were regarded as *contre-jour*, which translates into 'against the light', with the sun only visible through the fogs. This ultimately filled the atmosphere with colour and thus reduced the forms of silhouettes in the paintings (House, 1986). Approaching his work in this way shows that Monet tried to capture the meteorological situation of London, and possibly also tried to capture some degree of the climatological condition of London as well. Whether he did this inadvertently or intentionally, only further research will show.

Monet eventually completed his London Series, producing 94 paintings in total; 34 of Charing Cross Bridge, 41 of Waterloo Bridge and 19 of the Houses of Parliament (Reed, 1998).

CHAPTER 4: Methods

4.1. Introduction

Of the ninety four paintings that make up Monet's London Series, only fourteen paintings have the sun directly depicted in the scene. This selection of paintings consists of nine paintings of the Houses of Parliament, four of Waterloo Bridge and one of Charing Cross Bridge. These paintings of Waterloo Bridge and Charing Cross Bridge, along with another three paintings of Charing Cross Bridge where the position of the sun has been inferred within the scene, have been analysed within this study.

The method that is being employed for the purpose of this study incorporates quantitative approaches. The content, geometry and meteorological representations of Monet's London Series will be investigated. In order to complete this analytical approach, the solar position of the Waterloo Bridge and Charing Cross Bridge paintings will be established which in turn will enable the derivation of the dates and times of the execution of these paintings.

4.2. Research design

The purpose of the quantitative analysis is to deconstruct Monet's London Series through examining the content, geometry and meteorology contained within each painting. The final part of the quantitative analysis will introduce work previously conducted by Baker and Thornes (2006) with respect to the solar geometry of the Houses of Parliament paintings from Monet's London Series. This section is in essence a continuation of the work started in 2006 to include paintings of Waterloo Bridge and Charing Cross Bridge.

A method derived with the help of Prof. Donald W. Olson is also being utilised in the quantitative analysis of the paintings. A step-by-step guide of this method is given below.

1. Select the paintings that have a direct representation of the sun or one that can be inferred within the scene.
2. Identify the structures that are visible within each painting, and measure their heights directly from the reproductions in Wildenstein (1974-1985).
3. Measure the distances between the Savoy Hotel and the respective structures from the 1897 map of London (Figure 5.3).
4. Measure the azimuthal angle clockwise from the Savoy Hotel to each pier of the respective bridge of the scene being analysed.
5. Use the position of the sun in the painting with respect to the piers of the bridge, the azimuthal angle of the sun is determined.
6. Use the derived height of Monet on the fifth floor of the Savoy Hotel (see Section 5.3. 'Waterloo Bridge'), the height of a structure within the scene and the distance between the Savoy Hotel and the structure, the elevation of the structure above Monet's viewing position is determined.
7. Repeat this for each visible structure within the painting.
8. Use the derived angles of elevation along with the measured heights of the structures in the painting to determine a vertical degree to millimetre ratio for each structure.
9. Use the azimuthal angles of the bridge piers with the measured distances between the piers in the painting to determine a horizontal degree to millimetre ratio for each pier.
10. Calculate an average using all ratios within the scene.

11. Measure the distance of the sun above a structure in the painting and use the averaged ratio to determine the elevation of the sun above the structure. Add this elevation to the known elevation of the structure.
12. Repeat this for all visible structures within the painting.
13. Calculate an average using all solar elevations within the scene.
14. The average solar elevation and solar azimuth (see step 5) are entered into a computer program and the output is the 'best fit' elevations and azimuths with corresponding dates and times.

This method can be employed for all of the selected Waterloo Bridge and Charing Cross Bridge paintings; hence the date and time that Monet painted each scene can be estimated. This is the ultimate goal for the methodology mentioned so far.

4.3. Quantitative approaches – solar geometry

In 2006, Baker and Thornes conducted a study primarily focusing on Monet's paintings of the Houses of Parliament from his London Series. Therefore, the solar positions have already been determined for these paintings. Yet, as discussed earlier, the solar positions for the remaining Waterloo Bridge and Charing Cross Bridge paintings are still unknown, hence this is one of the goals for this study.

In order to determine the dates and times of production for Monet's paintings of Waterloo Bridge and Charing Cross Bridge, the position of the sun within the painting is very important. As the solar elevation and solar azimuthal angles are specific for certain days, or a series of days, paintings of Waterloo Bridge and Charing Cross Bridge that contain a direct or indirect representation of the sun will only be considered in this section.

4.3.1. Waterloo Bridge

For the analysis of the sun's position in Monet's Waterloo Bridge paintings, there are eight images that can be used, with most containing numerous structures that can also be used to give an indication of the elevation within each painting.

Reproductions of the paintings have been retrieved from Wildenstein (1974-1985) 'Claude Monet : biographie et catalogue raisonné 1840-1926', and his numbering system has been utilised for identifying the images. The most promising scenes of Waterloo Bridge, because of the position of sun, which can be accurately inferred within each painting; are W1555 (Figure 5.8), W1563 (Figure 5.9), W1565 (Figure 5.10), W1567 (Figure 5.11), W1572 (Figure 5.4), W1573 (Figure 5.5), W1574 (Figure 5.6) and W1575 (Figure 5.7).

The initial scale was derived using the calculated lengths of the piers as a height scale, which was then combined with the measured heights of the piers in order to produce a much more refined scale. The known heights of the Watts Shot Tower and the chimney of the City Sewers were also used in conjunction with the measured heights of the towers taken from the painting. The average water level of the River Thames at Waterloo Bridge can be determined to be 1.37 metres from a sounding conducted by the Thames Conservancy Board for 1895-1901. The locations of the points for which the depths were measured were all along the ‘near side’ of Waterloo Bridge that is the side of the bridge which can be identified as the nearest side to the Savoy Hotel. Using this value for the water level, the average amount of bridge that would have been visible was 13.57 metres. Combining the ratio derived using this bridge height compared to the measured heights at each visible pier of Waterloo Bridge along with the heights for the Watts Shot Tower and the City Sewers, the heights from the top of Waterloo Bridge to the middle of the sun can be determined.

An azimuthal scale for each painting can be produced by determining the angles, along the horizontal plane, from the position of the Savoy Hotel round to the respective positions of the piers of the bridge included in each scene. A great deal of care is required when measuring the angles to the bridge piers, as Monet’s exact position at the Savoy Hotel comes with an error, thus this will produce an array of angles for each pier with respect to each painting.

4.3.2. Charing Cross Bridge

There are four paintings of Charing Cross Bridge that appear to depict a representation of the sun. These paintings are labelled as W1532 (Figure 5.25), W1536 (Figure 5.28), W1537 (Figure 5.31) and W1554 (Figure 5.22) by Wildenstein, and the sun either appears to be partially or completely included in these scenes. The majority of these paintings contain depictions of Charing Cross Bridge, Westminster Bridge, Big Ben and Victoria Tower, which will all be used to help determine an elevation scale. Three different scales can be derived using the heights of Westminster Bridge, Big Ben and Victoria Tower, respectively, and will be combined to produce a much more refined scale.

The average water level at Westminster Bridge was again determined to be 1.37 metres from the 1895-1901 sounding. Hence the average amount of bridge that would have been visible was 9.60 metres. The ratio derived using the bridge height compared to the measured height of the bridge in the painting will be used in conjunction with the scales derived using the relative heights of Big Ben and Victoria Tower, thus the heights from the top of Westminster Bridge to the middle of the sun can be determined.

An azimuthal scale for each painting of Charing Cross Bridge can be produced by determining the angles, along the horizontal plane, from the position of the Savoy Hotel round to the respective positions of the piers of the bridge included in the scene. As with the paintings of Waterloo Bridge, a great deal of care is required when measuring the angles to the bridge piers, on account of the error that comes with Monet's position at the Savoy Hotel, so this will result in an array of angles for each pier with respect to each painting.

During this study, a mutual working relationship with Prof. Donald W. Olson and his team at Texas State University has developed. Prof. Donald W. Olson recommended a method that can be used in conjunction with the previously discussed scaling methods for the Waterloo Bridge and Charing Cross Bridge paintings. Ultimately a much more refined method for deriving the dates and times of production for Monet's paintings has been achieved.

4.3.3. Waterloo Bridge

The method designed by Prof. Donald W. Olson is going to be used with respect to the eight paintings of Waterloo Bridge; W1555 (Figure 5.18), W1563 (Figure 5.19), W1565 (Figure 5.20), W1567 (Figure 5.21), W1572 (Figure 5.12), W1573 (Figure 5.15), W1574 (Figure 5.16) and W1575 (Figure 5.17).

The landmarks visible within the Waterloo Bridge scenes are Waterloo Bridge, the Watts Shot Tower, the City Sewers Tower and the Waterloo Flour Mill. The structures will be utilised for this method, and the elevations from Monet on the fifth floor of the Savoy Hotel to the respective visible landmarks will be calculated. The azimuthal angles for the location of the Watts Shot Tower, the City Sewers Tower and the Waterloo Flour Mill will also be derived. These sets of angles can be used to establish a scale, which will then be used to convert the height of the sun, measured above Waterloo Bridge and above the City Sewers Tower, to give an average altitude.

As previously mentioned, the azimuthal scale for the painting is produced by determining the angles from the Savoy Hotel round to the identified piers of Waterloo Bridge, the Watts Shot Tower, the chimney of the City Sewers and the Waterloo Flour Mill.

4.3.4. Charing Cross Bridge

It will be shown that a true representation of the sun is not visible in the paintings labelled W1532 (Figure 5.25), W1536 (Figure 5.28) and W1537 (Figure 5.31), only what seems to be the outer edges of the sun's glow. Therefore, the precise location and thus elevation of the sun cannot be determined for these three paintings. A program from the Astronomical Applications Department of the U.S. Naval Observatory (http://aa.usno.navy.mil/data/docs/AltAz.php) will be employed to determine the solar elevation and azimuth for the dates that Monet was residing in London.

Fortunately, the painting of Charing Cross Bridge labelled as W1554 (Figure 5.22), clearly shows a representation of the sun. This painting also shows the tower of the Lead Works and the Lion Brewery, so these landmarks can be used to derive a scale which in turn will be used to derive the solar elevation for this scene.

The azimuthal angle of the speculated position of the sun will be estimated for each painting; and the angles can be used as a reference point for finding the solar elevation.

4.4. Limitations of research

The main limitation, with respect to the methods employed for the analysis of Monet's Waterloo Bridge and Charing Cross Bridge paintings, is the clarity of the reproductions of the paintings. Of the eight Waterloo Bridge paintings, only four contain clear representations of the sun, whilst the sun is only visible in one of the four Charing Cross Bridge paintings. For the paintings where the exact position of the sun is unclear, a certain degree of assumption and approximation is required for the analyses. Finally, at the beginning of the analysis, it was thought that the unknown date of production for all of the paintings would be a limitation, but through the quantitative methods employed; approximate dates and times for each painting can be derived.

4.5. Summary and final comments

Throughout his career, Monet painted most of his scenes for himself, trying to capture the beauty of the moment that he had seen and that had initially inspired him. When Monet first saw the Grain Stacks and the continuously changing effects of the light and colour, his obsession with trying to capture the “weather, atmosphere and ambience” began (letter to Geffroy 21/07/1890, W letter 1066; House 1986).

The second stage of analysis was with respect to the solar elevations depicted in the eight chosen paintings of Waterloo Bridge and the four paintings of Charing Cross Bridge. Once the position of the sun was determined within each painting, an approximate date and time of production could be derived. Dates were estimated for the paintings using a two pronged approach. Firstly, the position of the sun was estimated for each painting with respect to the average water level of the River Thames. Then secondly the known elevations of the landmarks depicted within each scene were used to estimate the elevation of the sun in the paintings.

Monet stayed in London for a number of months each year, from 1899 to 1901, whilst he was painting his London Series. His three visits were as follows.

1899: Monet left France on or about September 15th (Wildenstein, 1985), and stayed in London until the end of October or early November. During this time Monet stayed in a sixth floor suite at the Savoy Hotel.

1900: Monet started work on February 11th with the intention to keep to a rigid painting regime. As aforementioned, Monet would start to work in the early morning on canvases of Waterloo Bridge, and then at midday he would turn his attention to Charing Cross Bridge. Later on Monet would move from the Savoy Hotel to St. Thomas's Hospital in order to paint the Houses of Parliament at sunset (Thornes and Metherell, 2003). Monet set off for his return to France in early April. During this stay, and again in 1901, Monet resided in a fifth floor suite at the Savoy Hotel.

1901: Monet left for England on January 23rd. But it is documented that he had to wait for his crates of paintings to arrive, and so did not start to work on his series until February. However, during this wait, Monet began working on a few pastel drawings, which he could have later turned into painted canvases. On March 10th, Monet started to show signs of illness, which placed a major hindrance on his work until he left England at the end of March (Wildenstein, 1985).

CHAPTER 5: The Savoy Hotel

5.1. Monet's residence at the Savoy Hotel

Monet resided in the much revered Savoy Hotel during his trips to London in 1899, 1900 and 1901. The view from Monet's position on the sixth floor of the Savoy Hotel, had Waterloo Bridge to the left, downstream, and Charing Cross Bridge to the right, upstream. In the distance beyond Charing Cross Bridge, the Houses of Parliament were visible. However, it was not until Monet's return to London in the February of 1900, that he decided to include the Houses of Parliament as another motif in his London Series (Seiberling, 1988). On his return in 1900, Monet discovered that the entire sixth floor of the hotel had been dedicated to soldiers of the Boer War, as per Princess Louise's request (Wildenstein, 1974-85). Therefore, during this visit and again in 1901, Monet continued work on his series from a suite on the fifth floor. After painting from this vantage point for some time, Monet managed to negotiate permission to paint from a viewing position at St Thomas's Hospital (Taylor, 1995), in order to be able to paint the Houses of Parliament in more detail. Monet began sketching on that very spot on February 13th (Wildenstein, 1974-85) and continued working from St Thomas's Hospital until the end of March 1901.

There have been differing opinions regarding Monet's precise viewing position on the sixth and fifth floors of the Savoy Hotel during his stays in 1899, 1900 and 1901. Many art historians believe that Monet resided in the same suite as Whistler did in 1896, which would imply that both artists stayed in the corner suite on the sixth floor.

Figure 5.1 Savoy Pigeons (1896)

By simply looking at the façade of the Savoy Hotel, it can be ascertained that pillars are only present up to and including the fifth floor of the hotel. Whistler's viewing position can be ascertained from his painting 'Savoy Pigeons' (Figure 5.1) since the corner of the balcony is clearly visible without any pillars. Therefore it can be concluded that Whistler was painting from the corner suite of the sixth floor during his stay at the Savoy Hotel.

Another way of demonstrating that Whistler was painting from a suite on the sixth floor of the Savoy Hotel, whilst Monet was painting from a suite located on the fifth floor, is by looking at the stretch of the Thames visible between Waterloo Bridge and the opposite Embankment. For this analysis, Whistler's painting 'Evening, Little Waterloo Bridge' (Figure 5.2) can be compared to the eight paintings of Waterloo Bridge, by Monet, that have been selected for this study.

Figure 5.2 Evening, Little Waterloo Bridge (1896)

For each painting, the maximum visible distance between Waterloo Bridge and the Embankment will be measured along with the maximum height of Waterloo Bridge. The measurements will be made from a reproduction of Whistler's painting taken from the 'Monet's London' catalogue published by the Museum of Fine Arts, and reproductions of Monet's paintings published by Wildenstein (1974-1985).

Of Monet's eight paintings of Waterloo Bridge (W1555, W1563, W1565, W1567, W1572, W1573, W1574 and W1575), only four can be analysed with respect to this section, as the other four paintings do not show even the slightest portion of the River Thames between Waterloo Bridge and the Embankment. Therefore, these paintings (W1567, W1572, W1573 and W1574) will be disregarded. The ratios of the maximum distance of the Thames visible to the maximum heights of Waterloo Bridge can be determined for the four remaining paintings of Waterloo Bridge (W1555, W1563, W1565 and W1575) as well as Whistler's painting, and are listed in Table 5.1.

Painting	Thames visible (mm)	Waterloo Bridge (mm)	Ratio	Ratio in %
W1555	7.5	32.0	1 : 4.3	23.44
W1563	3.0	19.0	1 : 6.3	15.79
W1565	4.0	18.0	1 : 4.5	22.22
W1575	2.0	13.0	1 : 6.5	15.38
Whistler	7.5	18.0	1 : 2.4	41.66

Table 5.1 Ratios of the depths of the River Thames to the heights of Waterloo Bridge

As can be seen from Table 5.1, the ratios for Whistler's painting are almost double the values derived for Monet's paintings of Waterloo Bridge. That is Whistler was able to see a greater amount of the Thames from his position at the Savoy Hotel than Monet could. It is also worth recalling at this stage that Whistler was in fact painting from a corner suite on the sixth floor, but had he been situated in a suite more central to the façade of the hotel, similar to the position that Monet had occupied, Whistler's view of the Thames between Waterloo Bridge and the Embankment would have been even greater.

During a trip to the Savoy Hotel on 31st October 2006, Susan Scott, the hotel's curator, divulged some very interesting information regarding Monet's viewing position in 1900 and 1901. Susan Scott adamantly stated that Monet stayed in a suite in the middle of the fifth floor and it is thought that he slept in room 510 and painted in room 511. An alteration in the numbering system of the rooms at the Savoy Hotel has resulted in the sequence of increasing room numbers changing from one direction to the other.

Since the Savoy Hotel played such an important role in Monet's visits to London it seems appropriate to investigate the area of Westminster surrounding the hotel and the bridges.

The aim of this chapter is to analyse Monet's paintings to determine if they contain any quantitative information that can be verified, and thus assess their value as potential observational records. Geometrical and content analysis of each painting could help to determine the accuracy of Monet's depiction of the fogs at the turn of the twentieth century.

5.2. Quantitative approaches

5.2.1. Geometrical analysis

The initial stage of the analysis of Monet's Waterloo Bridge and Charing Cross Bridge scenes is the geometrical analysis of the paintings. Research in this area has already been conducted in 2006 by Julia Wells. In her dissertation entitled 'An Investigation into the Potential for Claude Monet's London Series to Portray Atmospheric Stability', Wells analysed a variety of historic maps and pictures ranging from ordnance survey maps through to historic pictures of Westminster. Wells also analysed some of Monet's depictions of Waterloo Bridge, especially the clear paintings where the features of the industrial region beyond the bridge were distinctly identifiable. The work conducted by Wells in this section of the dissertation may be utilised for the purpose of drawing a comparison with this study.

The predominant illustration of the area of Westminster, surrounding the River Thames, which is used in this study, is a scale map printed in 1897 and can be seen in Figure 5.3.

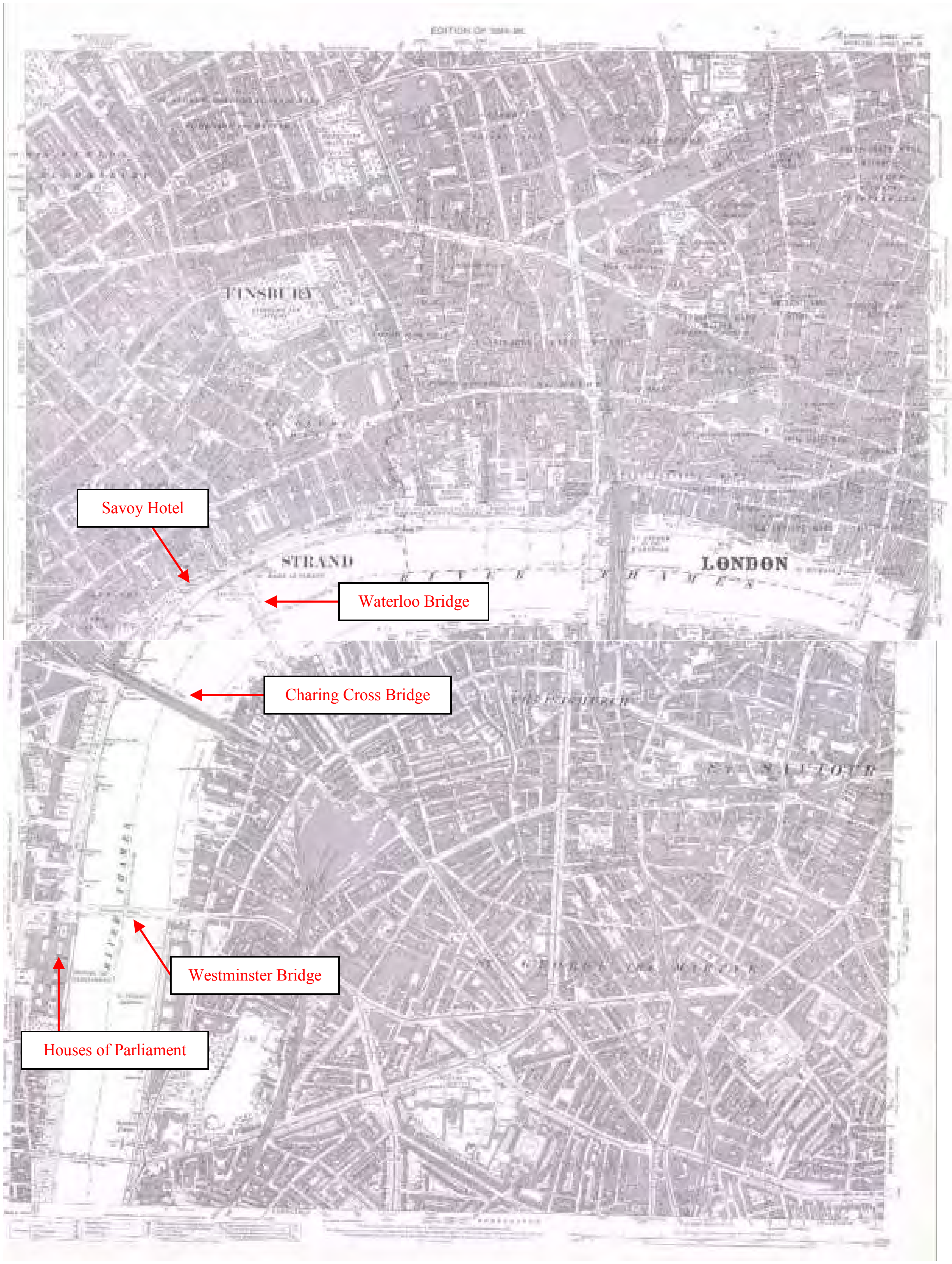

Figure 5.3 1897 map of London

The horizontal scale for Figure 5.3 is printed on the map and showed that 500 feet was equivalent to 1.6875 inches. The conversion of metres to feet is 1 metre equals approximately 3 feet and 3 inches i.e. 3.25 feet. Since 1 inch on the map is roughly equal to (500/1.6875) feet, then 1 inch is also equal to ((500/1.6875)/3.25) metres which equates to 91.17 metres[1]. The heights stated on the map have all been measured with respect to the Ordnance Datum level. For the period 1844-1921, the Ordnance Datum for the British Isles was measured from the level of Victoria Dock in Liverpool. Therefore, the heights of the Embankment and the bridges, used in this study, are all measured relative to this level.

The map can be utilised to determine the distances from a point approximately a third of the way across the façade of the Savoy Hotel to the midpoint on each of the individual bridges on the map. These distances will be referred to as the viewing distances between the Savoy Hotel and each respective bridge. The reason for choosing this particular point on the Savoy Hotel as a reference point is to work in conjunction with Monet's viewing position from the suites on the fifth and sixth floors of the Savoy Hotel. During his stay in 1899, Monet resided in a suite on the six floor of the Savoy Hotel. However, upon his return in 1900 and 1901, Monet continued to work on his London Series from a suite on the fifth floor. The suites on the fifth and sixth floors of the Savoy Hotel consisted of two rooms, a bedroom (rooms 610 and 510) and a sitting room (rooms 611 and 511) which Monet used as a studio. These suites are depicted on Figure 5.4.

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[1] For the purpose of this section, a 6.25% uncertainty level will be assumed, as an uncertainty of 0.0625 inches i.e. a 1/6th of an inch, is a fair approximation for a measurement of 1 inch.

Figure 5.4 The Savoy Hotel and rooms occupied by Monet in 1899 (6th floor) and in 1900 and 1901 (5th floor)

The exact place where Monet stood his easel on the balconies remains unknown and it is possible that he may have changed his position when facing Charing Cross Bridge to when he turned towards Waterloo Bridge. Nonetheless, these positions would only have been within a few metres of each other.

The approximate location of Monet at the Savoy Hotel is required so that the azimuthal angles measured from Monet's viewing position, at the Savoy Hotel, to a variety of locations identified from the Waterloo Bridge and Charing Cross Bridge paintings, can to be determined. Figure 5.5 is a magnified section of the previous map (Figure 5.3), with all of the azimuthal angles highlighted. These angles will be utilised in the analysis of the paintings selected for the purpose of this study.

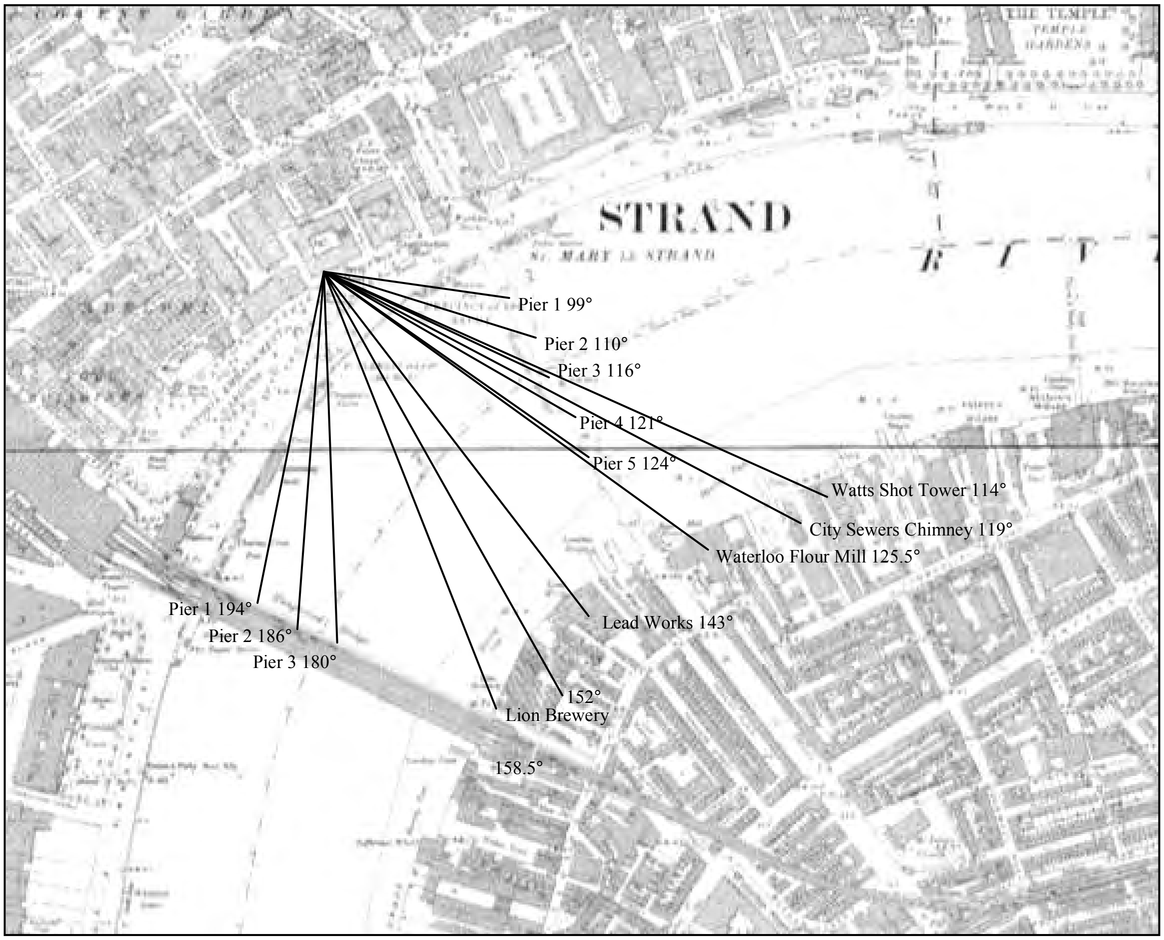


Figure 5.5 Azimuthal angles of landmarks in Westminster

5.2.2. Waterloo Bridge

By studying the bridge in Figure 5.3 it can be assumed that Waterloo Bridge was approximately flat in 1897, since three points along the bridge are labelled as 49 feet. The conversion between feet and meters, is 1 foot equals 0.3048 meters, so this height can be converted to give 49*0.3048 = 14.9352 meters = 14.94 meters (2 d. p.) The distance from the Savoy Hotel to the midpoint of Waterloo Bridge is (233.62 ± 5.70) metres.

5.2.3. Charing Cross Bridge

Charing Cross Bridge (now more commonly known as Hungerford Bridge) has been extensively altered since 1899/1901 but the original bridge piers are still in place. The structure that Monet would have seen was a railway bridge that had been opened in 1864 comprising nine spans made of wrought iron lattice girders. Unfortunately, the height of Charing Cross Bridge is not stated on the map, so for this reason, the Board of Trade plan of Charing Cross Bridge from 1884 has been used to estimate the height as 12.6 metres. This plan is included in Appendix 1. The distance from the Savoy Hotel to the midpoint of Charing Cross Bridge has been determined as (364.68 ± 5.70) metres.

These derived values for the heights of Waterloo Bridge and Charing Cross Bridge will be used to determine the angle between Monet's viewing position on the fifth and sixth floor of the Savoy Hotel, respectively, and the top of Waterloo Bridge and Charing Cross Bridge, respectively.

5.2.4. Westminster Bridge

Westminster Bridge was opened in 1862 as a seven-arch wrought iron bridge. The bridge height has been estimated, from Figure 5.3, to be 36 feet (10.97 metres). The distance from the Savoy Hotel to the midpoint of Westminster Bridge is (945.89 ± 5.70) metres.

The water levels of the River Thames can be found for the period that Monet was residing in London. A sounding of the river which was resounded under the direction of the Thames Conservancy Board for 1895-1901, is held in the archives at the National

Maritime Museum. The depths of the River Thames recorded for the sounding are stated to be the deepest possible depths for the river at the time of recording. The soundings are in feet, so need to be converted into metres so that the depths can be compared to the heights of Waterloo Bridge, Charing Cross Bridge and Westminster Bridge.

The locations of the depths to be used for the purpose of this study are taken as the depths recorded on the near side of the bridges with respect to the Savoy Hotel. Minimum and maximum water levels are available for each location along the River Thames; so average water levels can be determined for each of the locations.

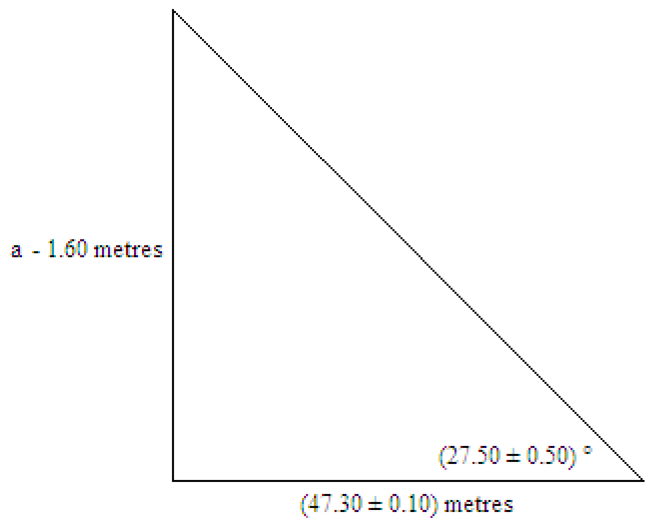
5.3. Waterloo Bridge

The geometrical analysis of Monet's Waterloo Bridge paintings has only been considered with respect to the fifth floor of the Savoy Hotel. This decision was made since it is thought Monet began work on Waterloo Bridge in 1900, whilst residing in a fifth floor suite at the hotel. Monet continued to work on the Waterloo Bridge paintings in 1901, again from a viewpoint on the fifth floor.

5.3.1. Fifth floor

In order to begin the geometrical analysis of Monet's paintings, the angle of elevation from ground-level to the fifth floor of the Savoy Hotel needs to be determined. An abney level was employed to measure the angle from eye level to the window ledge on the fifth floor of the Savoy Hotel and is determined to be $(27.50 \pm 0.50)°$. The horizontal distance from the Savoy Hotel to the chosen viewing position was also measured and is equal to

(47.30 ± 0.10) metres. The height to eye level (1.60 metres) can be taken into consideration, so that the height from the ground-level to the window ledge of the fifth floor can also be ascertained.



Using trigonometry, tan (27.50 ± 0.50) = (a – 1.60) / (47.30 ± 0.10), so a = ((24.62 ± 0.58) + 1.60) metres. Therefore, a = (26.22 ± 0.58) metres.

Monet's height also has to be considered at this stage. Even though Monet's exact height is not documented, it is thought that he was a man of small stature, so it has been estimated that the height of Monet's eye level was 5 foot and 4 inches. Since the distance to the window ledge on the fifth floor has already been calculated, and the window ledge is approximately 1 foot and 6 inches above the floor, then only the difference between Monet's height and the window ledge is used. This height needs to be converted into metres before it can be included in the calculations, thus 3 foot and 10 inches (3and 5/6 feet) is equal to (3 and 5/6 * 0.3048) = 1.1684 metres. Consequently, this allows the distance from the ground-level to Monet on the fifth floor to be calculated → (a + (3 foot 10 inches ± 1 inch)) → (26.22 ± 0.58) + (1.1684 ± 0.0254) = (27.39 ± 0.61) metres.

From Figure 5.3, the benchmark printed on the Embankment directly in front of the Savoy Hotel is 17 feet, which is equivalent to 5.1816 metres. Since the height to Monet's eye level on the fifth floor of the Savoy Hotel, above this point, has been determined, the total height to Monet above the Ordnance Datum Liverpool level is (27.39 ± 0.61) + 5.1816 = (32.57 ± 0.61) metres.

The angle of elevation from the top of Waterloo Bridge to Monet's viewing position on the fifth floor is determined using trigonometry. Once this angle is determined, the viewing distance to Waterloo Bridge from Monet's suite can also be derived.

Average river level

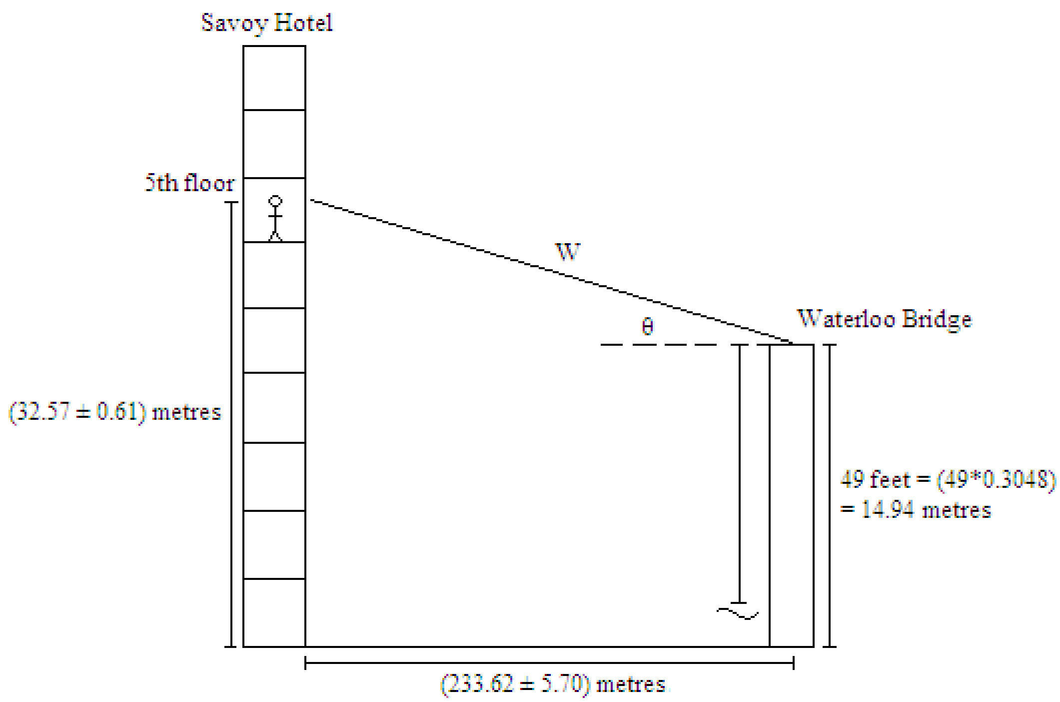


Figure 5.6 Angle of elevation and viewing distance from Waterloo Bridge to Monet on the fifth floor of the Savoy Hotel

Bridge	Angle of elevation (°)	Viewing distance (m)
Waterloo	$\theta = 4.65 \pm 0.26$	234.39 ± 5.63

Table 5.2 Fifth floor elevation and viewing distance for Waterloo Bridge

5.4. Charing Cross Bridge and Westminster Bridge

The geometrical analysis of Monet's Charing Cross Bridge paintings will be separated according to Monet's position on the fifth floor and sixth floor of the Savoy Hotel. Monet painted scenes of Charing Cross Bridge between 1899 and 1901, whilst residing in a suite on the fifth and sixth floors of the hotel, therefore the angles of elevation from the top of Charing Cross Bridge to the respective floors of the Savoy Hotel will be determined.

5.4.1. Fifth floor

As discussed earlier, the angle from eye level to the window ledge on the fifth floor of the Savoy Hotel was determined to be $(27.50 \pm 0.50)°$ whilst the horizontal distance from the Savoy Hotel to the chosen viewing position was measured to be (47.30 ± 0.10) metres. The height to eye level (1.60 metres) was taken into consideration in order to determine the height from the ground-level to the window ledge of the fifth floor.

The angles of elevation from the top of Charing Cross Bridge and Westminster Bridge to Monet's viewing position on the fifth floor are determined using trigonometry. Using these angles the viewing distances to Charing Cross Bridge and Westminster Bridge from Monet's suite can also be derived.

Average river level

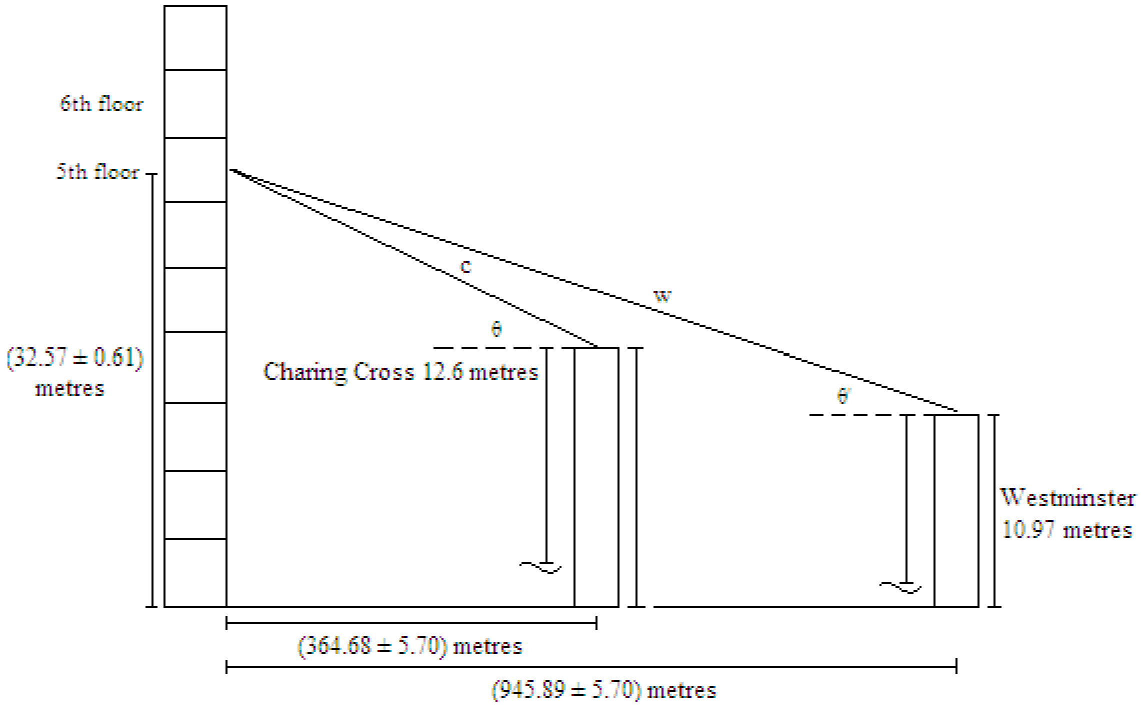


Figure 5.7 Angles of elevation and viewing distances from Charing Cross Bridge and Westminster Bridge to Monet on the fifth floor of the Savoy Hotel

Bridge	**Angle of elevation (°)**	**Viewing distance (m)**
Charing Cross	$\theta = 3.35 \pm 0.15$	$c = 365.30 \pm 5.65$
Westminster	$\theta' = 1.39 \pm 0.05$	$w = 946.17 \pm 5.68$

Table 5.3 Fifth floor elevations and viewing distances for Charing Cross Bridge and Westminster Bridge

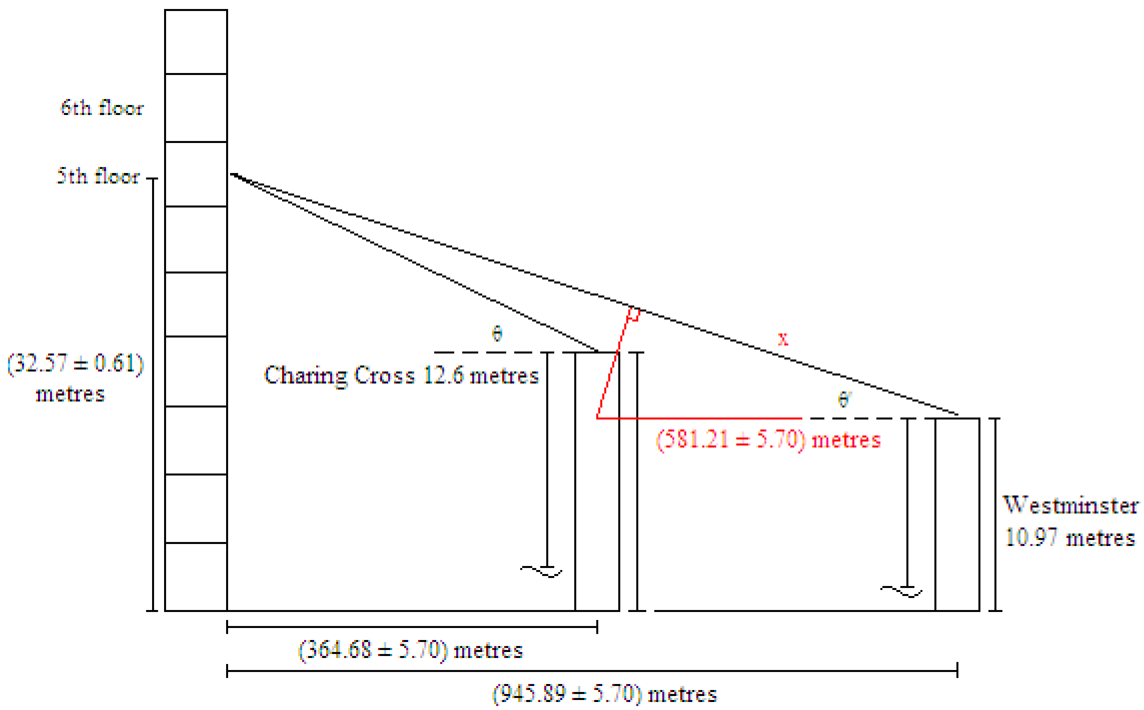


Figure 5.8 Distance between Charing Cross Bridge and Westminster Bridge as viewed by Monet on the fifth floor of the Savoy Hotel

Bridges	**Distance (m)**
Charing Cross → Westminster	x = 581.38 ± 5.69

Table 5.4 Fifth floor viewing distance between Charing Cross Bridge and Westminster Bridge

5.4.2. Sixth floor

As previously mentioned, the angle from eye level to the window ledge on the sixth floor of the Savoy Hotel was determined to be (31.50 ± 0.50)° and the horizontal distance from the Savoy Hotel to the chosen viewing position was measured to be (47.30 ± 0.10) metres. The height to eye level (1.60 metres) was taken into consideration when estimating the height from the ground-level to the window ledge of the sixth floor. The angles of elevation from the top of Charing Cross Bridge and Westminster Bridge to Monet's viewing position on the sixth floor were again determined using trigonometry. Once these angles had been determined, the viewing distances to Charing Cross Bridge and Westminster Bridge from Monet's suite could also be derived.

Average river level

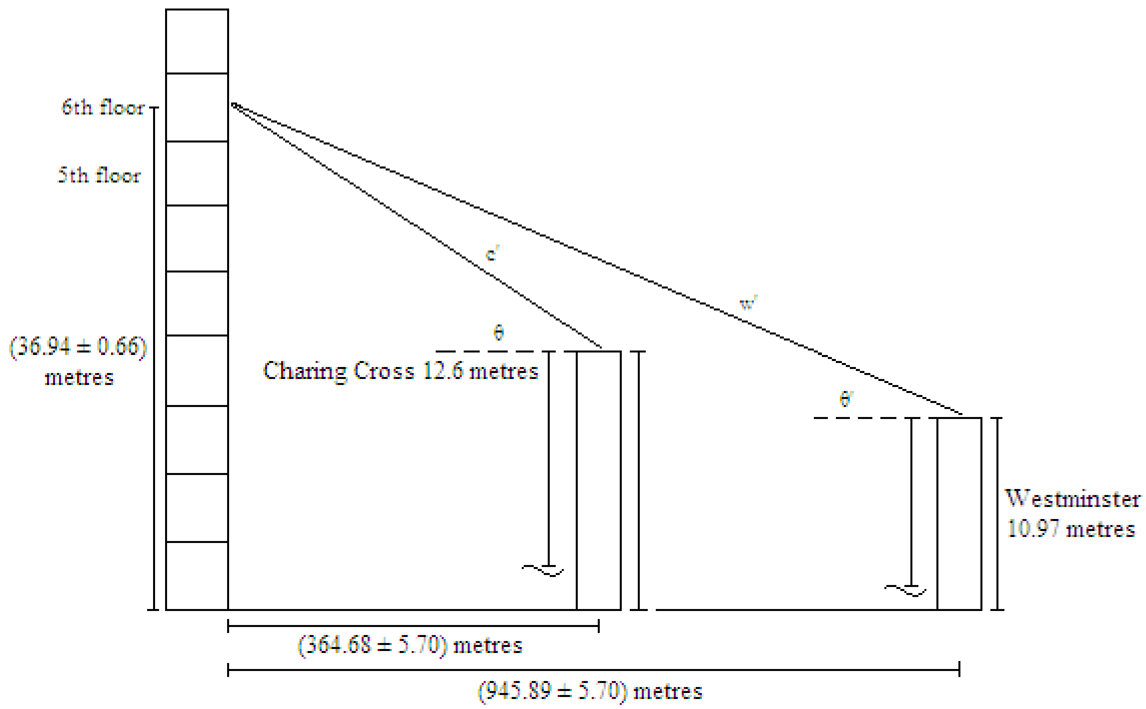


Figure 5.9 Angles of elevation and viewing distances from Charing Cross Bridge and Westminster Bridge to Monet on the sixth floor of the Savoy Hotel

Bridge	Angle of elevation (°)	Viewing distance (m)
Charing Cross	θ = 4.03 ± 0.17	c' = 365.58 ± 5.64
Westminster	θ' = 1.66 ± 0.05	w' = 946.29 ± 5.68

Table 5.5 Sixth floor elevations and viewing distances for Charing Cross Bridge and Westminster Bridge

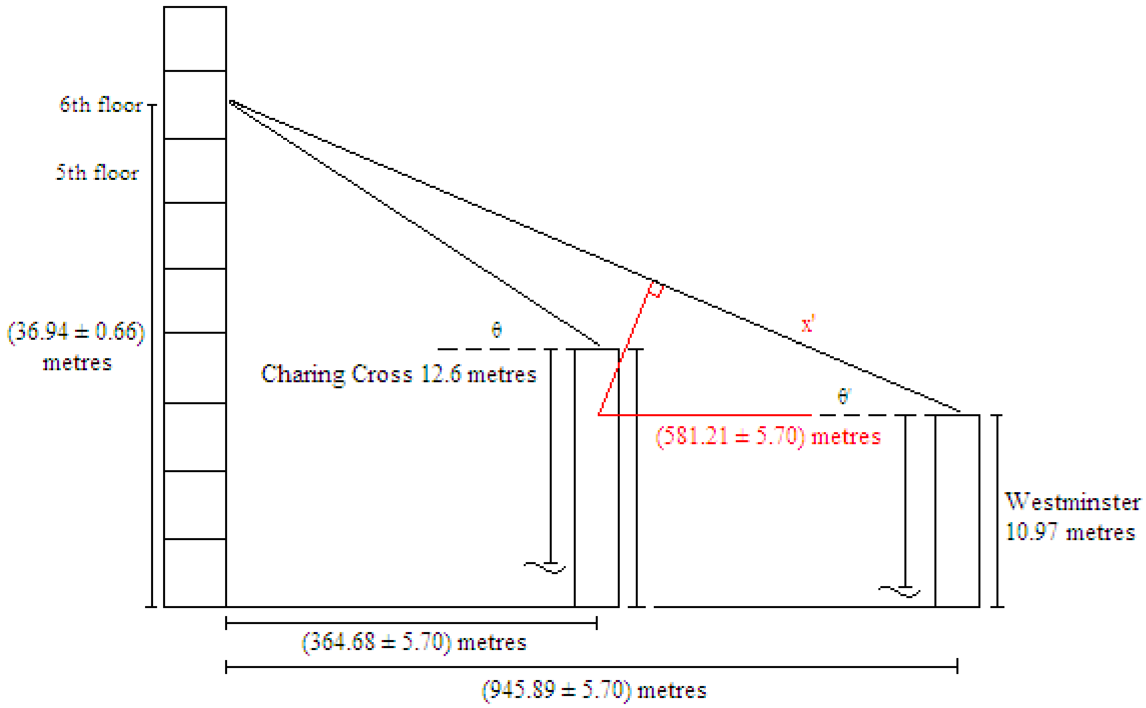


Figure 5.10 Distance between Charing Cross Bridge and Westminster Bridge as viewed by Monet on the sixth floor of the Savoy Hotel

Bridges	**Distance (m)**
Charing Cross → Westminster	x' = 581.45 ± 5.69

Table 5.6 Sixth floor viewing distance between Charing Cross Bridge and Westminster Bridge

The geometrical analysis of Monet's depictions of Waterloo Bridge and Charing Cross Bridge has shown that the angles of elevation from the sixth floor of the Savoy Hotel are greater than those viewed from the fifth floor. The distances viewed from the sixth floor suite of the Savoy Hotel to Waterloo Bridge, Charing Cross Bridge and Westminster Bridge, respectively, were also larger than those distances as viewed from the fifth floor. Therefore, correspondingly, the distance visible between Charing Cross Bridge and Westminster Bridge from the sixth floor was greater than the distance visible from the fifth floor of the Savoy Hotel. All of these findings were to be expected on account of the simple laws of geometry along with the heights of the structures included in the analysis.

5.5. Solar geometry analysis

The eight paintings of Waterloo Bridge will be divided into two groups for the solar geometry analysis; one group consisting of four paintings (W1572, W1573, W1574 and W1575) that clearly show the sun within the scene, whilst the second group consists of four paintings (W1555, W1563, W1565 and W1567) where the position of the sun has to be inferred. In order to determine an internal scale within the paintings of Waterloo Bridge, several landmarks on the South Bank will be utilised; namely, the Watts Shot Tower, the City Sewers Tower and the Waterloo Flour Mill. The heights of these features have been determined by Prof. Donald W. Olson, taking into consideration the Liverpool Ordnance Datum which was measured with respect to the tidal pole at Victoria Dock. The respective elevations for these landmarks can be determined using their known heights along with the known height of Monet on the fifth floor of the Savoy Hotel and the horizontal distance between the Savoy Hotel and each individual feature e.g.
$\tan^{-1}$[(height of the Watts Shot Tower - height of Monet on the fifth floor of the Savoy Hotel)/(distance from the Savoy Hotel to the Watts Shot Tower)].

The four paintings of Charing Cross Bridge will also be divided into two groups with respect to the representation of the sun. One painting, W1554, shows the sun clearly in the image, whilst the position of the sun has to be inferred in the remaining three paintings (W1532, W1536 and W1537). The landmarks that can be employed in the analysis of the Charing Cross Bridge paintings are the tower of the Lead Works and the Lion Brewery. The elevations for both landmarks can be determined using the same method as before e.g. $\tan^{-1}$[(height of the Lead Works Tower - height of Monet on the fifth floor of the Savoy Hotel)/(distance from the Savoy Hotel to the Lead Works Tower)].

5.6. Geometrical analysis of Waterloo Bridge paintings sun visible

5.6.1. WB Painting 1: 'Waterloo Bridge, le soleil dans le brouillard' (W1572)

The first painting is entitled 'Waterloo Bridge, le soleil dans le brouillard' (effect of sunlight in the fog) and has been identified by Wildenstein as W1572.

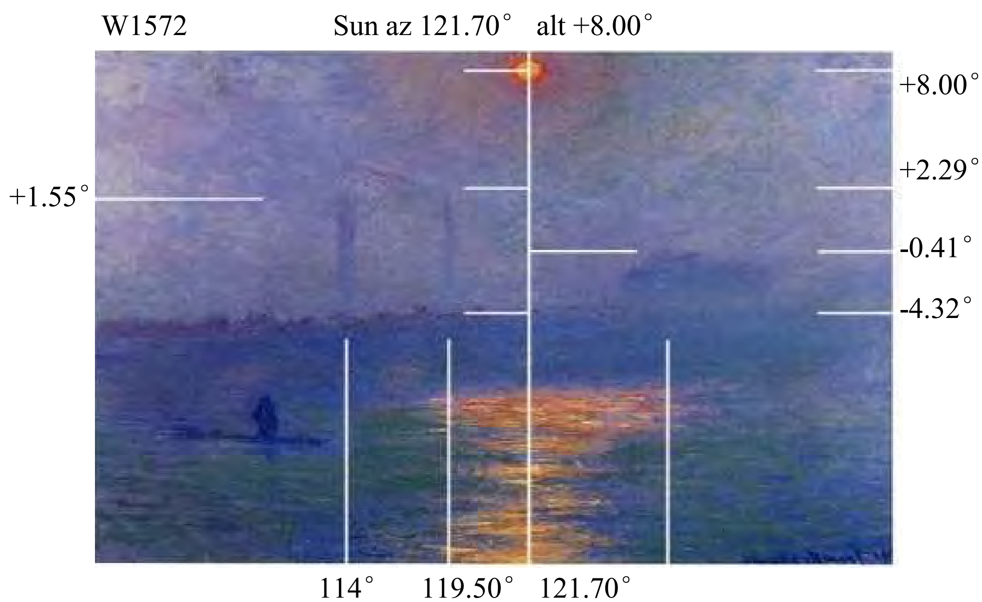


Figure 5.11 Waterloo Bridge, le soleil dans le brouillard

Using this version of the reproduction, the towers, the bridge and the mill are all visible, thus the horizontal distances that will be measured are; the Watts Shot Tower to the City Sewers Tower (AB), from the City Sewers Tower to the Waterloo Flour Mill (BC), and the total distance from the Watts Shot Tower to the Waterloo Flour Mill (AC). A vertical distance will be measured from the top of the Waterloo Flour Mill to the top of Waterloo Bridge (EF).

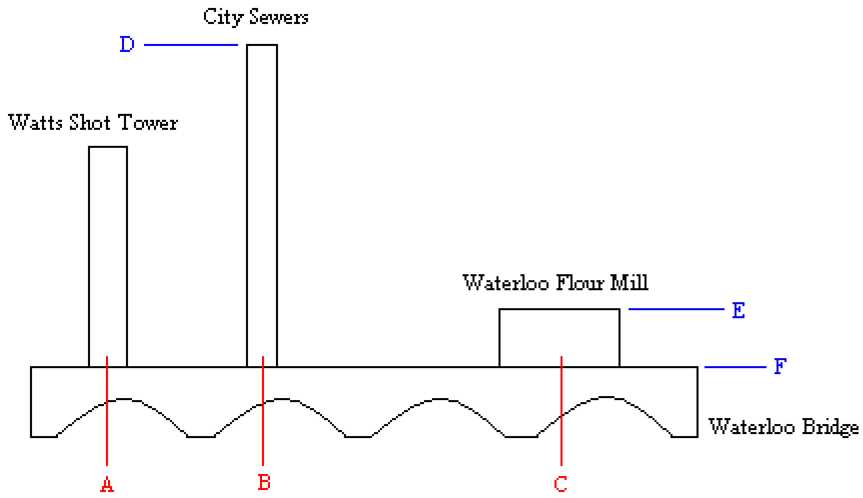


Figure 5.12 Landmarks on the South Bank visible in the Waterloo Bridge paintings

The corresponding horizontal and vertical elevations can be determined, which will aid in the derivation of a degree to millimetre ratio.

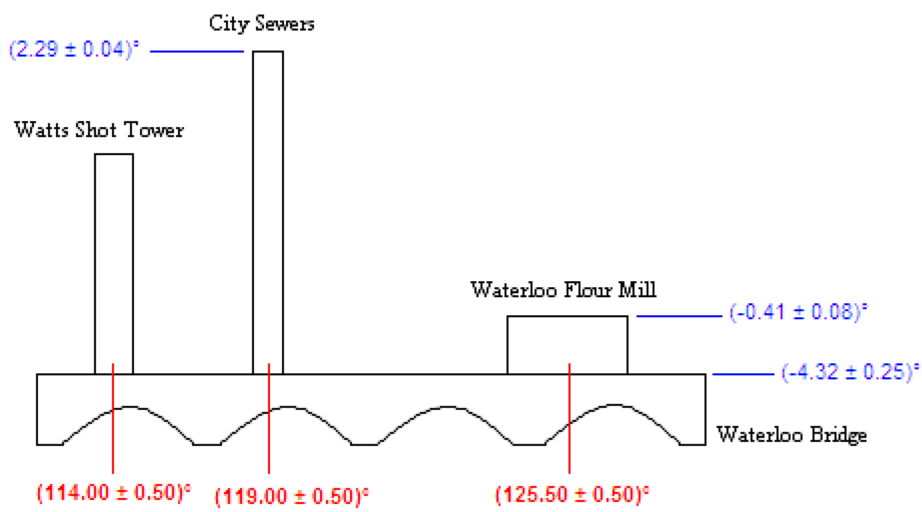


Figure 5.13 Azimuthal and elevation angles of landmarks on the South Bank visible in the Waterloo Bridge paintings

The height to the middle of the sun from the top of Waterloo Bridge is measured and used in conjunction with the degree to millimetre ratio to determine the elevation of the sun with respect to the elevations of Waterloo Bridge.

	Angle (°)	Distance (mm)	Ratio (°/mm)
Solar Azimuth	121.70 ± 0.50	-	-
AB	5.00 ± 0.50	30.50	0.164 ± 0.019
BC	6.50 ± 0.50	65.00	0.100 ± 0.009
AC	11.50 ± 0.50	95.50	0.120 ± 0.006
DE	2.70 ± 0.12	23.00	0.117 ± 0.005
EF	3.91 ± 0.33	22.50	0.174 ± 0.015
DF	6.61 ± 0.29	45.50	0.145 ± 0.006

Table 5.7 Degree to millimetre ratios for the landmarks on the South Bank visible in the Waterloo Bridge paintings

Average degree to millimetre ratio: (0.137 ± 0.010)°/mm

	Distance (mm)	Elevation above structure (°)	Elevation of structure (°)	Elevation of sun (°)
Sun above Waterloo Bridge	88.50 ± 0.50	12.13 ± 0.95	-4.32 ± 0.25	7.81 ± 0.70
Sun above City Sewers	43.00 ± 0.50	5.89 ± 0.50	2.29 ± 0.04	8.18 ± 0.54

Table 5.8 Distances and angles to the sun

Average elevation to the sun: (8.00 ± 0.62)°

Fifth floor solar elevation → February 17th at 8:16

Range of possible dates: February 16th – February 18th at 8:13 – 8:19am

This painting could have been painted in either 1900 or 1901.

Using the program from the Astronomical Applications Department of the U.S. Naval Observatory (http://aa.usno.navy.mil/data/docs/AltAz.php), the azimuthal angle and elevation angle of the sun within W1572 may be used to retrieve further estimates for the date of production. The dates produced using the solar geometry method can be utilised in conjunction with the azimuthal angle of the sun (121.70°) and the solar elevation (8.00°), to output the following information.

Altitude and azimuth of the sun for February 16th 1901 for London

hh:mm	Altitude	Azimuth (E of N)
08:16	8.00	121.70

Table 5.9 Altitude and azimuth for February 16th 1901

Monet wrote to Alice on February 17th 1900: "une brume exquise, et un splendide coucher de soleil; aujourd'hui, pluie et brouillard" which translates to "an exquisite fog, and a splendid sunset; today, rain and fog" (Wildenstein 1996b, p342). In 1901, Monet wrote to Alice on February 17th: "des bourrasques de neige, puis du soleil, du brouillard et du temps noir" which translates to "flurries of snow, then sun, fog and black weather" (Wildenstein 1996b, p353).

The weather observations recorded for London do not report any fog or mist on February 16th 1900 but 'mist' was recorded at Westminster and Brixton on February 17th 1900. There was no mention of mist or fog on February 16th and 17th in 1901.

Therefore it can be concluded that Monet painted 'Waterloo Bridge, le soleil dans le brouillard' in either 1900 or 1901, or alternatively that perhaps he started to paint the scene on February 17th in 1900 and worked on the painting again on February 17th 1901.

The tables for the rest of the Waterloo Bridge paintings are displayed in Appendix 2.

5.6.2. WB Painting 2: 'Waterloo Bridge, soleil dans le brouillard' (W1573)

The painting identified as W1573 by Wildenstein and entitled 'Waterloo Bridge, soleil dans le brouillard' (effect of sunlight in the fog), has a depiction of the entire sphere of the sun within the scene.

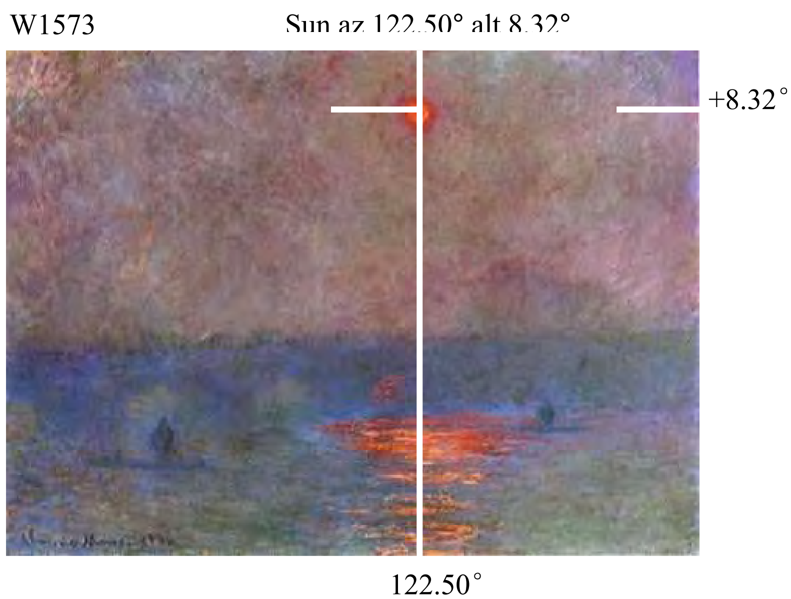


Figure 5.14 Waterloo Bridge, soleil dans le brouillard

The positions of the Watts Shot Tower and the City Sewers are only just visible in this painting, so the heights of the towers cannot be used but their azimuthal angles can be. Since this is the case, only the height of the Waterloo Flour Mill can be used for this painting.

Fifth floor solar elevation → February 16th at 8:19

Range of possible dates: February 15th – February 18th at 8:16 – 8:23am

The date for this painting corresponds to either of Monet's visits in 1900 or 1901.

The dates produced from the solar geometry method will be used along with the azimuthal angle of the sun (122.50°) and the solar elevation (8.32°), to generate the following information.

Altitude and azimuth of the sun for February 15th 1900 for London

hh:mm	Altitude	Azimuth (E of N)
08:19	8.20	122.50
08:20	8.30	122.70

Table 5.10 Altitude and azimuth for February 15th 1900

Monet wrote to Alice on February 17th 1900: "une brume exquise, et un splendide coucher de soleil; aujourd'hui, pluie et brouillard" which translates to "an exquisite fog, and a splendid sunset; today, rain and fog" (Wildenstein 1996b, p342). In 1901, Monet wrote to Alice on February 17th: "des bourrasques de neige, puis du soleil, du brouillard et du temps noir" which translates to "flurries of snow, then sun, fog and black weather" (Wildenstein 1996b, p353).

'Mist' was reported at Kew on February 15th 1900. However the weather observations recorded for London do not report any fog or mist on February 16th 1900 but 'mist' was also recorded at Westminster and Brixton on February 17th 1900. There was no mention of mist or fog on February 16th and 17th in 1901 but 'mist' was recorded on February 15th 1901 at Westminster and again on Februarys 18th 1901 at Brixton and Kew.

Therefore it can be concluded that Monet painted 'Waterloo Bridge, le soleil dans le brouillard' in either 1900 or 1901, or alternatively that perhaps he started to paint the scene on February 15th in 1900 and worked on the painting again on February 17th 1900 and also again on February 15th and February 18th in 1901.

5.6.3. WB Painting 3: 'Waterloo Bridge' (W1574)

Monet has used large brushstrokes to comprise this particularly impressionist representation of Waterloo Bridge. The bridge and the Waterloo Flour Mill beyond are vaguely discernible. The Waterloo Flour Mill is the only decipherable landmark, apart from Waterloo Bridge, in this painting. However, the globe of the sun is clearly apparent, so only the height of the mill and the distance from Waterloo Bridge to the middle of the sun can be used to determine the elevation of the sun within this scene.

W1574 Sun az 118.50° alt 7.91°

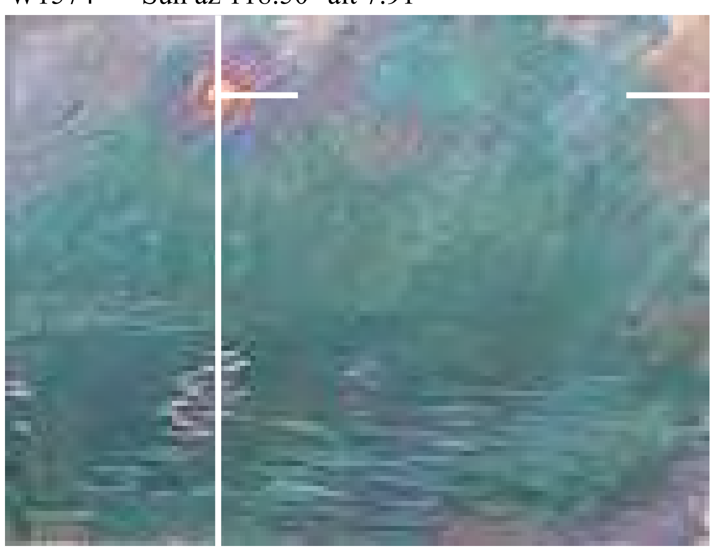


Figure 5.15 Waterloo Bridge

Fifth floor solar elevation → February 22nd at 8:04

Range of possible dates: February 20th – February 23rd at 8:01 – 8: 08am

The dates suggest that this painting may have been painted either during 1900 or 1901.

The program from the Astronomical Applications Department of the U.S. Naval Observatory can utilise the azimuthal angle and elevation angle of the sun within W1574 to determine another estimate for the date of production.

Altitude and azimuth of the sun for February 21st 1901 for London

hh:mm	Altitude	Azimuth (E of N)
08:04	7.90	118.40

Table 5.11 Altitude and azimuth for February 21st 1901

Unfortunately, Monet did not write to Alice on any of the selected dates in February during 1900 or 1901.

Fog was not recorded on any of the dates in 1900. However, during the following year, 'mist' was reported in Kew on February 20th 1901 and in Brixton on February 21st 1901.

Therefore, it seems reasonable to suggest that Monet started to paint 'Waterloo Bridge' on February 20th 1901 and continued to work on the scene the next day on February 21st 1901.

5.6.4. WB Painting 4: 'Waterloo Bridge, brouillard' (W1575)

The final painting is entitled 'Waterloo Bridge, brouillard' (fog) and has been identified by Wildenstein as W1575. Monet's brush strokes in this particular painting are quite abstract in their appearance. The Watts Shot Tower, the chimney of the City Sewers and the Waterloo Flour Mill are all visible enough to be used for the analysis of this painting. The sun is visible as a red sphere in the sky.

W1575 Sun az 113° alt 7.00°

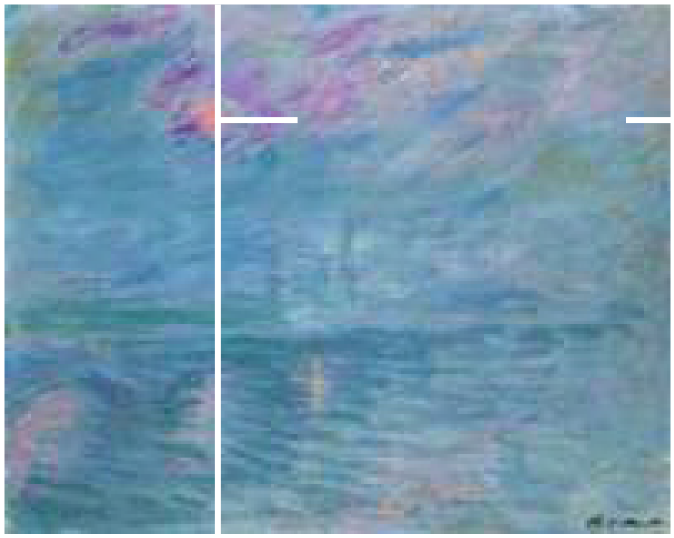


Figure 5.16 Waterloo Bridge, brouillard

Fifth floor solar elevation → February 28th at 8:43

Range of possible dates: February 27th – March 1st at 8:40 – 8:46am

Monet could have painted this scene during either of his visits in 1900 or 1901. Monet did not write on any of these dates in 1900 or 1901.

The azimuthal angle and elevation angle of the sun within W1575 can be used in conjunction with the dates produced using the solar geometry method to retrieve further estimates for the date of production.

Altitude and azimuth of the sun for February 27th 1900 for London

hh:mm	Altitude	Azimuth (E of N)
07:43	7.00	112.90

Table 5.12 Altitude and azimuth for February 27th 1900

Altitude and azimuth of the sun for February 27th 1901 for London

hh:mm	Altitude	Azimuth (E of N)
07:43	6.90	113.00
07:44	7.00	113.20

Table 5.13 Altitude and azimuth for February 27th 1901

The weather observations recorded in London report ‘fog’ in Brixton and ‘mist’ in Kew on February 27th 1900. ‘Mist’ is also reported in Chiswick, Brixton and Kew on the following day, February 28th 1900.

Therefore using these observations, it could be suggested that Monet painted ‘Waterloo Bridge, brouillard’ on both February 27th and February 28th in 1900.

5.7. Geometrical analysis of Waterloo Bridge paintings sun position inferred

5.7.1. WB Painting 5: ‘Londres, Waterloo Bridge’ (W1555)

In the painting identified as W1555 by Wildenstein and entitled ‘Londres, Waterloo Bridge’ (London, Waterloo Bridge), Monet has also included the Watts Shot Tower and the chimney of the City Sewers. The sun can be inferred at the top right of the scene, with sunlight being reflected in the surface of the River Thames.

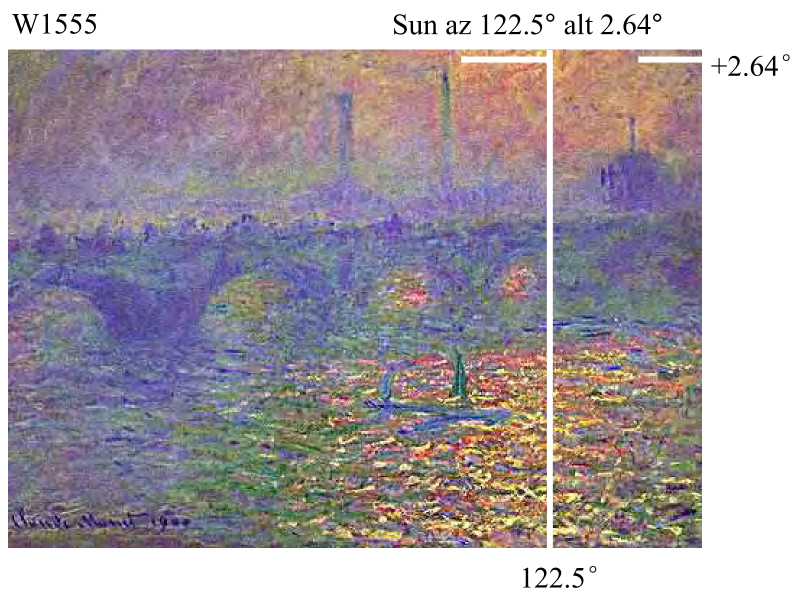


Figure 5.17 Londres, Waterloo Bridge

The height of the Watts Shot Tower is determined to be 154 feet (46.94 metres); the chimney belonging to the City Sewers is 174 feet (53.04 metres), whilst the height of the Waterloo Flour Mill is 96 feet (29.26 metres).

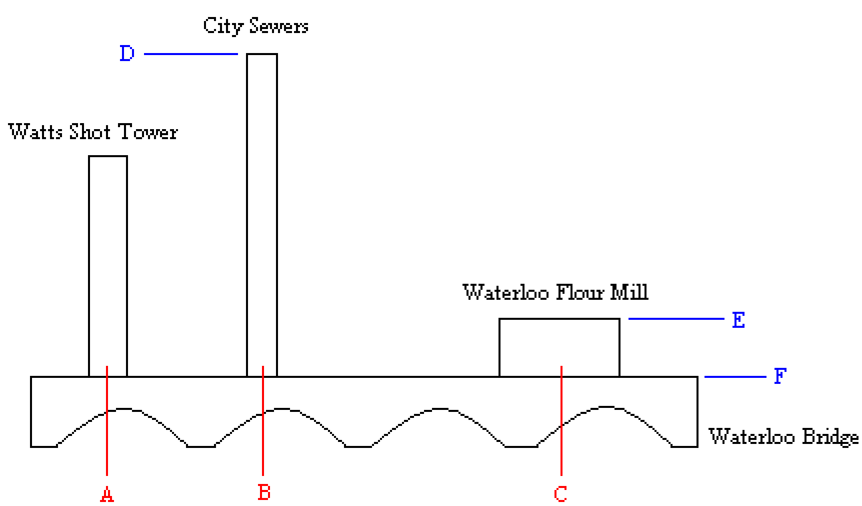


Figure 5.12 Landmarks on the South Bank visible in the Waterloo Bridge paintings

The horizontal distances measured are; the Watts Shot Tower to the City Sewers Tower (AB), from the City Sewers Tower to the Waterloo Flour Mill (BC), and the total distance from the Watts Shot Tower to the Waterloo Flour Mill (AC). The vertical distances measured are; from the top of the City Sewers Tower to the top of the Waterloo Flour Mill (DE), from the top of the Waterloo Flour Mill to the top of Waterloo Bridge (EF), and then the total height from the top of the City Sewers Tower to the top of the bridge (DF).

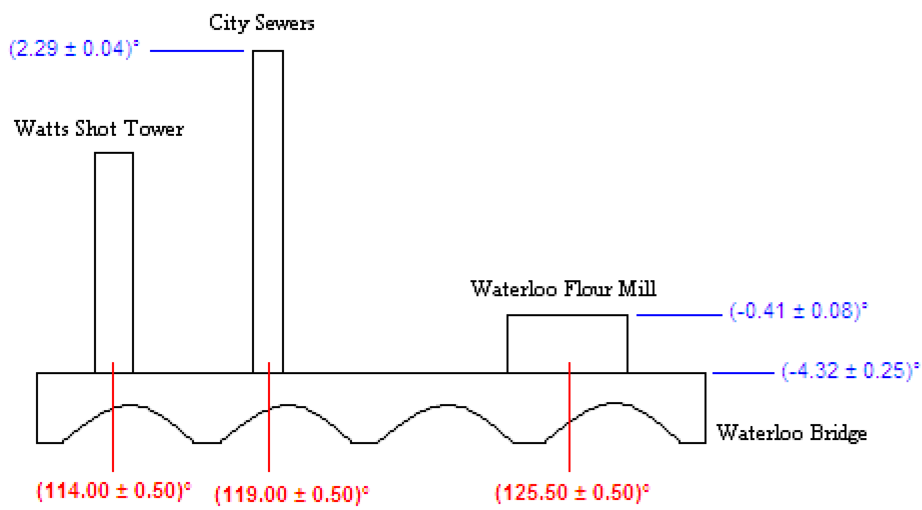


Figure 5.13 Azimuthal and elevation angles of landmarks on the South Bank visible in the Waterloo Bridge paintings

The heights to the middle of the sun from the top of the City Sewers Tower and from the top of Waterloo Bridge are then measured and can be used in conjunction with the degree to millimetre ratio to determine the elevation of the sun with respect to the elevations of the chimney of the City Sewers and Waterloo Bridge.

	Angle (°)	Distance (mm)	Ratio (°/mm)
Solar Azimuth	122.50 ± 0.50	-	-
AB	5.00 ± 0.50	29.00	0.172 ± 0.020
BC	6.50 ± 0.50	54.00	0.120 ± 0.010
AC	11.50 ± 0.50	83.00	0.139 ± 0.007
DE	2.70 ± 0.12	25.00	0.108 ± 0.005
EF	3.91 ± 0.33	19.00	0.206 ± 0.017
DF	6.61 ± 0.29	44.00	0.150 ± 0.007

Table 5.14 Degree to millimetre ratios for the landmarks on the South Bank visible in the Waterloo Bridge paintings

Average degree to millimetre ratio: (0.149 ± 0.011)°/mm

	Distance (mm)	Elevation above structure (°)	Elevation of structure (°)	Elevation of sun (°)
Sun above Waterloo Bridge	47.00 ± 0.50	7.00 ± 0.45	-4.32 ± 0.25	2.68 ± 0.34
Sun above City Sewers	2.00 ± 0.50	0.30 ± 0.09	2.29 ± 0.04	2.59 ± 0.14

Table 5.15 Distances and angles to the sun

Average elevation to the sun: (2.64 ± 0.24)°

Fifth floor solar elevation → February 1st at 8:06

Range of possible dates: February 1st – February 2nd at 8:04 – 8:08am

The date for this painting corresponds to Monet's final visit in 1901.

The program from the Astronomical Applications Department of the U.S. Naval Observatory (http://aa.usno.navy.mil/data/docs/AltAz.php) produces the following information with the use of the derived azimuthal angle and elevation angle of the sun within W1555.

Altitude and azimuth of the sun for February 1st 1901 for London

hh:mm	Altitude	Azimuth (E of N)
08:04	2.70	122.00

Table 5.16 Altitude and azimuth for February 1st 1901

Monet wrote to Alice on February 2nd 1901 with the following: "un léger brouillard" which translates to "a slight fog" (Wildenstein 1996b, p351).

'Mist' was recorded in Chiswick and Westminster on February 1st 1901. 'Mist' was also reported on February 2nd 1901 at Kew.

Therefore, it seems reasonable to suggest that Monet could have painted 'London, Waterloo Bridge' on either day in 1901. Alternatively, Monet may have started to work on the canvas on February 1st and completed the scene on February 2nd 1901.

The tables for the rest of the Waterloo Bridge paintings are displayed in Appendix 2.

5.7.2. WB Painting 6: 'Waterloo Bridge, temps couvert' (W1563)

The next painting that will be analysed is identified by Wildenstein as W1563 and is entitled 'Waterloo Bridge, temps couvert' (overcast weather). The Watts Shot Tower, the chimney of the City Sewers and the Waterloo Flour Mill are all decipherable, with the sun visible to the left of the image with reflections on the water behind Waterloo Bridge.

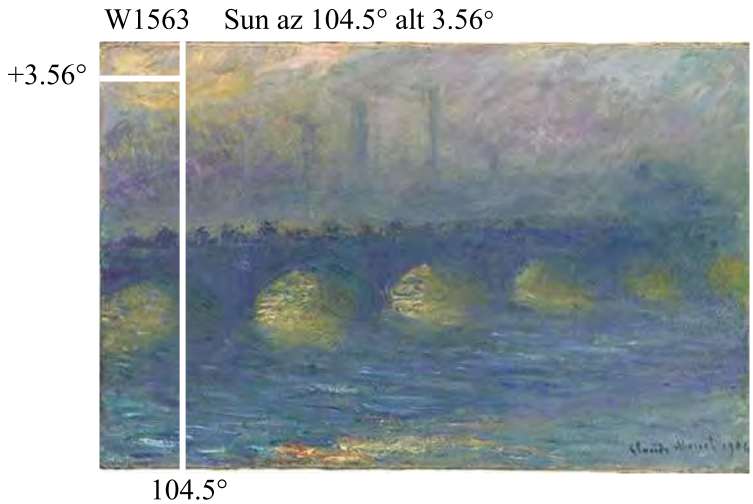


Figure 5.18 Waterloo Bridge, temps couvert

Fifth floor solar elevation → March 6th at 7:06

Range of possible dates: March 6th at 7:04 – 7:09am

This painting could have been painted in either 1900 or 1901.

The azimuthal angle and elevation angle of the sun within W1563 can be used to retrieve further estimates for the date of production. The dates produced using the solar geometry method can be utilised in conjunction with the azimuthal angle of the sun (104.50°) and the solar elevation (3.56°), to output the following information.

Altitude and azimuth of the sun for March 6th 1901 for London

hh:mm	Altitude	Azimuth (E of N)
07:04	3.60	103.90

Table 5.17 Altitude and azimuth for March 6th 1901

Monet did not write to Alice on any of the dates on March during either 1900 or 1901.

The title of the painting, ‘Waterloo Bridge, temps couvert’, suggests that Monet painted this scene during overcast conditions. ‘Overcast’ conditions were recorded at Brixton on March 6th 1900 and again at Chiswick on March 6th 1901.

Hence it may be concluded that Monet painted ‘Waterloo Bridge, temps couvert’ on either March 6th 1900 or March 6th 1901. On the other hand, Monet could have started to paint the scene on March 6th in 1900 and worked on the painting again on March 6th 1901.

5.7.3. WB Painting 7: ‘Waterloo Bridge, effet de soleil’ (W1565)

The painting labelled as W1565 by Wildenstein is entitled ‘Waterloo Bridge, effet de soleil’ (sunlight effect). The Watts Shot Tower and the chimney of the City Sewers are visible in the background of the painting. A faint representation of the Waterloo Flour Mill is also discernible. The sun is visible at the top of the canvas and the sunlight is significantly reflected by the Thames. Boats are also visible in the forefront of this painting and the angle of view has moved to the right to capture the full reflection of the sun on the Thames.

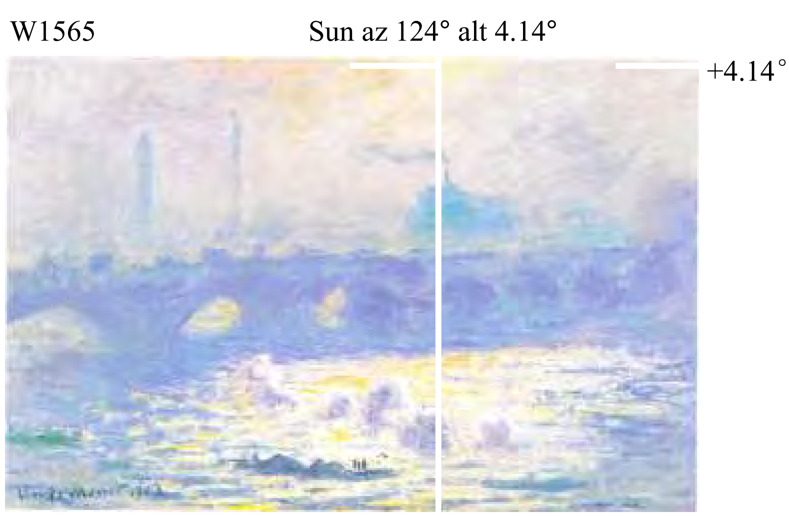


Figure 5.19 Waterloo Bridge, effet de soleil

Fifth floor solar elevation → February 3rd at 8:15

Range of possible dates: February 2nd – February 3rd at 8:13 – 8:17am

Monet could have painted this scene during his last visit to London in 1901.

The program from the Astronomical Applications Department of the U.S. Naval Observatory can utilise the azimuthal angle and elevation angle of the sun within W1565 to determine another estimate for the date of production.

Altitude and azimuth of the sun for February 2nd 1901 for London

hh:mm	Altitude	Azimuth (E of N)
08:14	4.10	123.80
08:15	4.20	124.00

Table 5.18 Altitude and azimuth for February 2nd 1901

Monet wrote to Alice on February 2nd 1901: “un léger brouillard” which translates to “a slight fog”. Monet also wrote to his wife on February 3rd 1901: “Grâce aux fumées, la brume est venue, puis des nuages,” - “Through the smoke, the fog came, then the clouds” (Wildenstein 1996b p 351).

The weather observations recorded in London report ‘mist’ in Kew on February 2nd in 1901. On February 3rd 1901, ‘mist’ was recorded in Chiswick and Brixton.

Using these observations in conjunction with Monet’s letters, it may be concluded that Monet began to paint ‘Waterloo Bridge, effet de soleil’ on February 2nd 1901 and worked on it again on February 3rd 1901.

5.7.4. WB Painting 8: ‘Waterloo Bridge, effet de soleil’ (W1567)

In the painting identified as W1567 by Wildenstein and entitled ‘Waterloo Bridge, effet de soleil’ (sunlight effect), the Watts Shot Tower and the City Sewers are visible along with the Waterloo Flour Mill. The sun can be inferred at the top right of the scene, with sunlight being reflected in the surface of the Thames.

W1567 Sun az 130° alt 5.74°

+5.74°

130°

Figure 5.20 Waterloo Bridge, effet de soleil

Fifth floor solar elevation → January 27th at 8:39

Range of possible dates: January 27th – January 28th at 8:36 – 8:42am

Monet could have painted this scene during his final visit in 1901.

The azimuthal angle and elevation angle of the sun within W1567 may be used to retrieve further estimates for the date of production. The dates produced using the solar geometry method can be utilised in conjunction with the azimuthal angle of the sun (130.00°) and the solar elevation (5.74°), to output the following information.

Altitude and azimuth of the sun for January 27th 1901 for London

hh:mm	Altitude	Azimuth (E of N)
08:37	5.70	129.60
08:38	5.80	129.80
08:39	5.90	130.00

Table 5.19 Altitude and azimuth for January 27th 1901

Monet did not write to Alice on any of the dates in January 1901.

Also, fog, mist or haze was not reported at any of the weather stations during the selected dates. However, since the painting seems to depict dull or overcast conditions, these have been retrieved from the weather reports. ‘Overcast’ conditions were reported in Westminster on January 27th 1901. ‘Dull’ conditions were reported in Chiswick on January 28th 1901, whilst ‘overcast’ conditions were recorded at Brixton on the same day.

Therefore, it may be concluded that Monet either worked on ‘Waterloo Bridge, effet de soleil’ on January 27th 1901 or January 28th 1901. Alternatively, Monet may have started to work on this painting on January 27th 1901 and continued to work on the canvas on January 28th 1901.

5.8. Geometrical analysis of Charing Cross Bridge paintings sun visible

5.8.1. CCB Painting 1: ‘Charing Cross Bridge, brouillard sur la Tamise’ (W1554)

This painting of Charing Cross Bridge was labelled as W1554 by Wildenstein and entitled ‘Charing Cross Bridge, brouillard sur la Tamise’ (fog on the Thames). The sun is visible at the top left of the scene as an orange-red sphere. Charing Cross Bridge, the tower of the Lead Works and an outline of the Lion Brewery are the only structures visible within the scene.

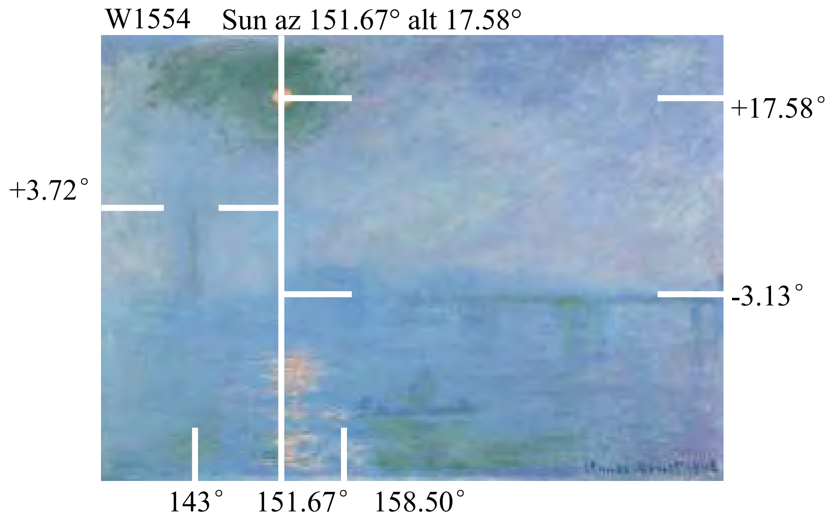


Figure 5.21 Charing Cross Bridge, brouillard sur la Tamise

An azimuthal scale for the painting is produced by determining the angles from the Savoy Hotel round to the tower of the Lead Works and the Lion Brewery.

The height of the tower of the Lead Works is 198 feet (60.35 metres) and the height of Charing Cross Bridge is 12.6 metres.

The horizontal distance measured is from the tower of the Lead Works to the Lion Brewery (AB), whilst the vertical distance measured is from the top of Charing Cross Bridge to the top of the Lead Works tower (CD).

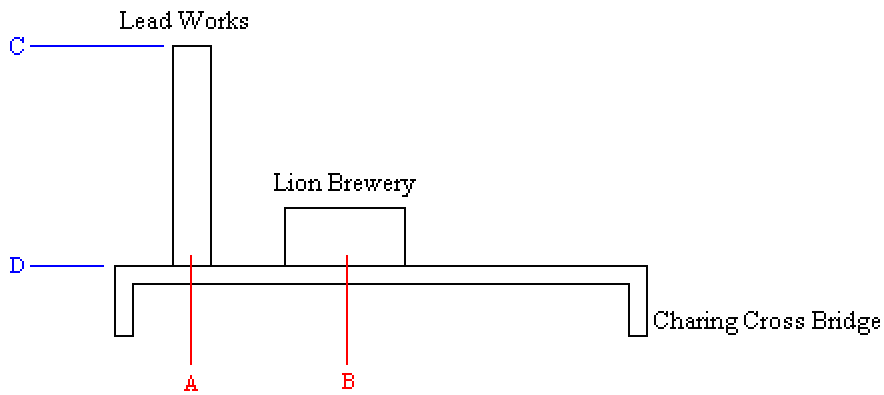


Figure 5.22 Landmarks on the South Bank visible in the Charing Cross Bridge paintings

As with the paintings of Waterloo Bridge, the horizontal and vertical elevations can be determined and used to derive a degree to millimetre ratio.

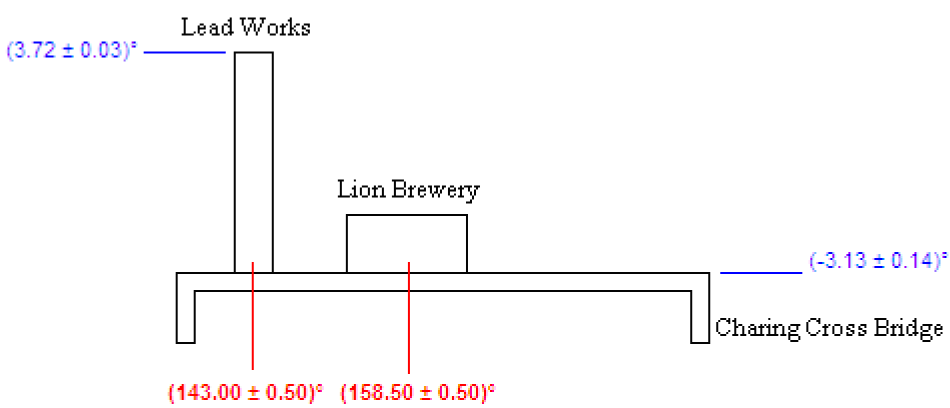


Figure 5.23 Azimuthal and elevation angles of landmarks on the South Bank visible in the Charing Cross Bridge paintings

The height to the middle of the sun from the top of the Lead Works tower and from the top of Charing Cross Bridge, are then measured and used in conjunction with the degree to millimetre ratio to determine the elevation of the sun with respect to the elevations of the tower of the Lead Works and Charing Cross Bridge.

	Angle (°)	Distance (mm)	Ratio (°/mm)
Solar Azimuth	151.67 ± 0.50	-	-
AB	15.50 ± 0.50	41	0.378 ± 0.017
BC	6.85 ± 0.11	33	0.208 ± 0.003

Table 5.20 Degree to millimetre ratios for the landmarks on the South Bank visible in the Charing Cross Bridge paintings

Average degree to millimetre ratio: (0.293 ± 0.010)°/mm

	Distance (mm)	Elevation above structure (°)	Elevation of structure (°)	Elevation of sun (°)
Sun above Lead Works	45.00 ± 0.50	13.19 ± 0.60	3.72 ± 0.03	16.91 ± 0.63
Sun above Charing Cross Bridge	73.00 ± 0.50	21.39 ± 0.88	-3.13 ± 0.14	18.26 ± 0.74

Table 5.21 Distances and angles to the sun

Average elevation to the sun: (17.58 ± 0.68)°

Fifth floor solar elevation → February 4th at 10:22

Range of possible dates: February 1st – February 6th at 10:18 – 10:24am

Using the program from the aforementioned Astronomical Applications Department of the U.S. Naval Observatory (http://aa.usno.navy.mil/data/docs/AltAz.php), the azimuthal angle and elevation angle of the sun within W1554 may be used to retrieve further estimates for the date of production. The dates produced using the solar geometry method can be utilised in conjunction with the azimuthal angle of the sun (151.67°) and the solar elevation (17.58°), to output the following information.

Altitude and azimuth of the sun for February 3rd 1901 for London

hh:mm	Altitude	Azimuth (E of N)
10:22	17.60	151.80

Table 5.22 Altitude and azimuth for February 3rd 1901

Monet could only have painted this scene during his visit in 1901. Monet wrote to Alice on February 2nd 1901: “un léger brouillard” which translates to “a slight fog”. Monet also wrote to his wife on February 3rd 1901: “Grâce aux fumées, la brume est venue, puis des nuages,” - “Through the smoke, the fog came, then the clouds” (Wildenstein 1996b p 351). In a letter to Alice dated February 5th 1901, Monet wrote “le brouillard s'est épaissi assez pour dissimuler la neige” - “the mist thickened enough to hide snow”. Monet also wrote to Alice on February 6th 1901: “Il y avait bien un peu trop de brouillard le matin, mais le joli ballon rouge n’a pas été long à se montrer et avec lui une succession d’effets étonnants” - “There was a little too much fog this morning, but the pretty red balloon was not long to be shown and with him a succession of astonishing effects” (Wildenstein 1996b, p352).

The weather observations recorded in London report ‘mist’ in Chiswick and Westminster on February 1st 1901. On February 2nd 1901, ‘mist’ was recorded at Kew, whilst ‘mist’ was reported in Chiswick and Brixton on February 3rd 1901. ‘Mist’ was also reported in Chiswick, Westminster, Brixton and Kew on February 4th 1901, whilst ‘mist’ was recorded at Westminster on February 5th 1901.

Therefore using these observations in conjunction with Monet's letters, it is most likely that Monet started to paint 'Charing Cross Bridge, brouillard sur la Tamise' on February 1st 1901 and possibly worked on it again until February 6th 1901.

5.9. Geometrical analysis of Charing Cross Bridge paintings sun position inferred

5.9.1. CCB Painting 2: 'Charing Cross Bridge, reflets sur la Tamise' (W1532)

The first painting is identified as W1532 by Wildenstein and is entitled 'Charing Cross Bridge, reflets sur la Tamise' (reflections on the Thames). The glow of the sun is visible to the left of the centre at the very top of the scene. Westminster Bridge, Victoria Tower, Big Ben and the Parliament buildings are all visible beyond Charing Cross Bridge.

Figure 5.24 Charing Cross Bridge, reflets sur la Tamise

The azimuthal angle of the speculated position of the sun is estimated to be 183.00°, and this can be used as a reference point for finding the solar elevation.

The earliest date that Monet was in London, in one year, was January 25th in 1900. This date, in conjunction with the solar azimuthal angle of 183.00°, produced the smallest solar elevation of 19.50°. A segment of the angles computed by the program from the Astronomical Applications Department is displayed below.

Altitude and azimuth of the sun for January 25th 1900 for London

hh:mm	Altitude	Azimuth (E of N)
12:24	19.50	182.80
12:25	19.50	183.10
12:26	19.50	183.30

Table 5.23 Altitude and azimuth for January 25th 1900

Figure 5.25 shows the elevation of the sun relative to the elevations of Westminster Bridge, Victoria Tower and Big Ben.

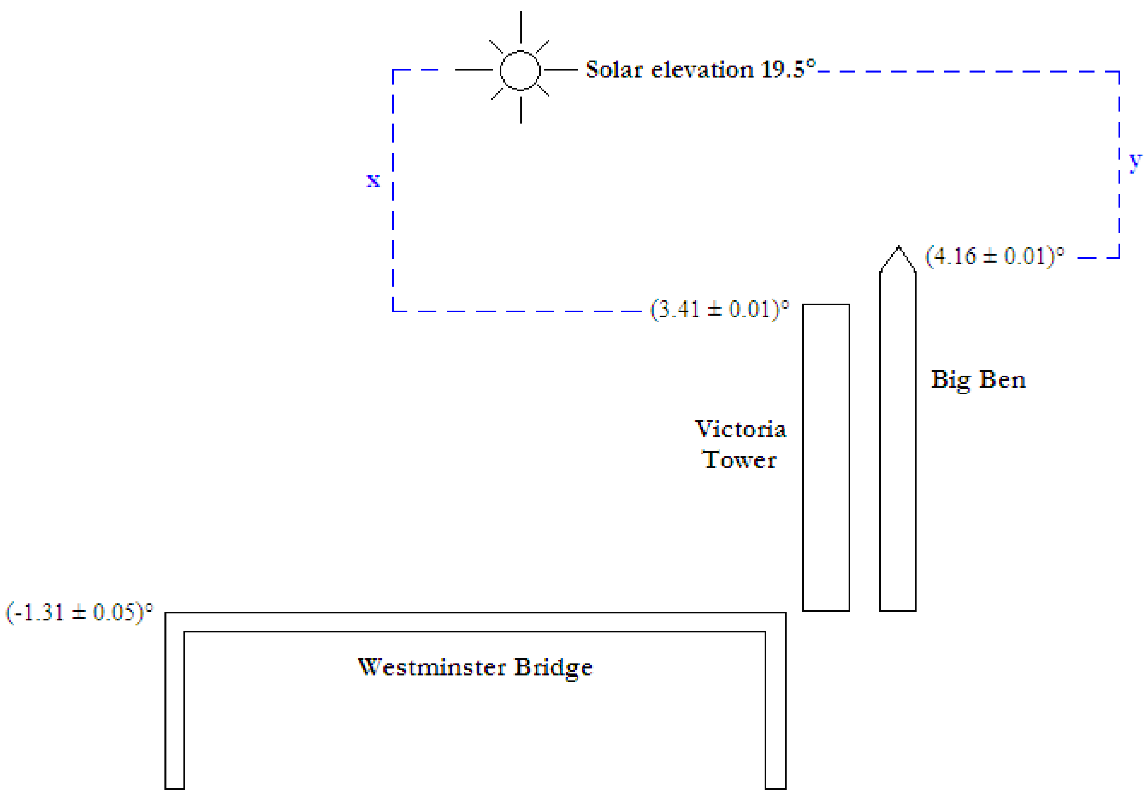


Figure 5.25 Elevation of the sun

The elevations of Victoria Tower and Big Ben have can be compared to their measured heights, in the painting, in order to determine a degree to millimetre ratio for each building. These ratios are then multiplied by the relative difference between the elevation of the sun and the elevations of the towers, which produce two respective heights, x and y, (in millimetres) to the estimated position of the sun. These heights are depicted in Figure 5.26.

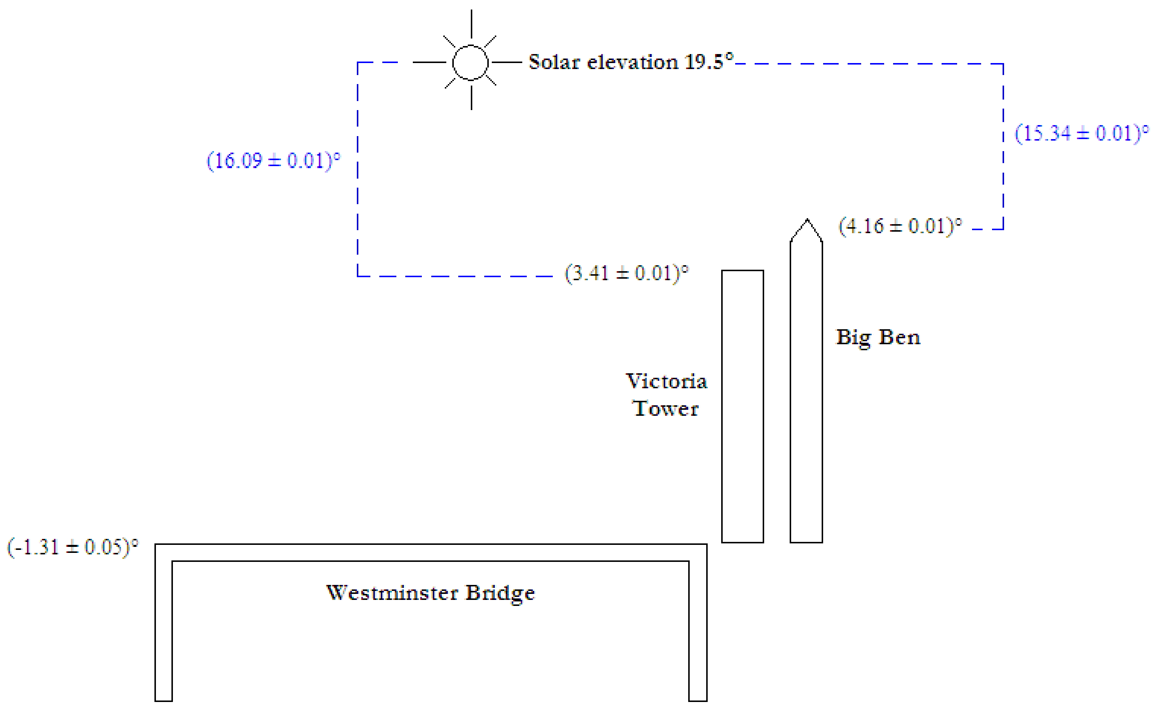


Figure 5.26 Revised elevation of the sun

The heights below have been measured directly from the reproduction of W1532 ‘Charing Cross Bridge, reflets sur la Tamise’ in Wildenstein’s Volume III.

The height to the top of Victoria Tower above Westminster Bridge is measured to be 47mm which is equivalent to $(3.41 \pm 0.01)° + (1.31 \pm 0.05)° = (4.72 \pm 0.06)°$. The degree to millimetre ratio for Victoria Tower can then be determined to be (0.100 ± 0.001)

degree/mm. Since the difference between the elevation of Victoria Tower to the elevation of the sun is $(16.09 \pm 0.01)°$, the height of the sun above Victoria Tower is (160.90 ± 1.51) mm.

The height of Big Ben above Westminster Bridge is 44mm which is also equal to $(4.16 \pm 0.01)° + (1.31 \pm 0.05)° = (5.47 \pm 0.06)°$. The degree to millimetre ratio for Big Ben is (0.124 ± 0.001) degree/mm. Since the difference between the elevation of Big Ben to the elevation of the sun is $(15.34 \pm 0.01)°$, then the height of the sun above Big Ben is (123.71 ± 1.08) mm.

From these measurements it has been shown that the position of the sun can be estimated to be approximately 16cm above Victoria Tower and 12.4cm above Big Ben. Looking at the reproduction of the painting, there is approximately 1.5cm from the top of Victoria Tower and Big Ben to the top edge of the canvas. Therefore it seems quite reasonable to estimate that the location of the sun would need to be a further 11-14cm above the top of the canvas reproduced by Wildenstein (1974-1985). This is an extremely important finding, as it shows that Monet conducted a degree of vertical stretching whilst painting this scene.

5.9.2. CCB Painting 3: 'Charing Cross Bridge, la Tamise' (W1536)

The next painting has been labelled as W1536 by Wildenstein and entitled 'Charing Cross Bridge, la Tamise' (The Thames). The outer glow of the sun is visible at the top of the scene as an orange-red glow, and Westminster Bridge, Victoria Tower and Big Ben are all visible beyond Charing Cross Bridge.

Figure 5.27 Charing Cross Bridge, la Tamise

As with W1532, the azimuthal angle of the estimated position of the sun is estimated for this painting as being 190.00°, so this can be used as a reference point for finding the solar elevation.

As previously discussed, the earliest date that Monet was in London, during one year, was January 25th in 1900. This date was used in conjunction with the solar azimuthal angle of 190.00°, to produce the smallest solar elevation of 19.00°. The program from the Astronomical Applications Department was used again to produce the table below.

Altitude and azimuth of the sun for January 25th 1900 for London

hh:mm	Altitude	Azimuth (E of N)
12:52	19.00	189.80
12:53	19.00	190.00
12:54	18.90	190.30

Table 5.24 Altitude and azimuth for January 25th 1900

Figure 5.28 shows the elevation of the sun relative to the elevations of Westminster Bridge, Victoria Tower and Big Ben.

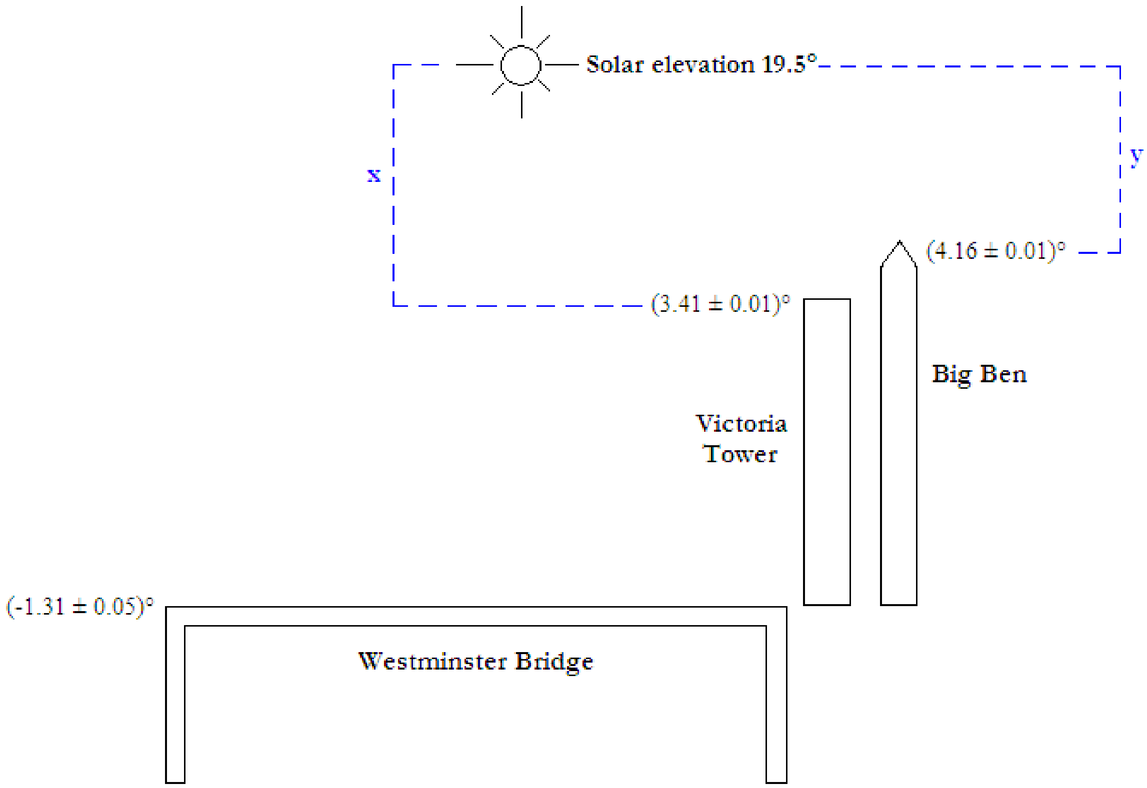


Figure 5.28 Elevation of the sun

The elevations of Victoria Tower and Big Ben can be compared to their measured heights, in the painting, in order to determine a degree to millimetre ratio for each building. These ratios are then multiplied by the relative difference between the elevation of the sun and the elevations of the towers, which produces two respective heights, x and y, (in millimetres) to the estimated position of the sun. These heights have been depicted in Figure 5.29.

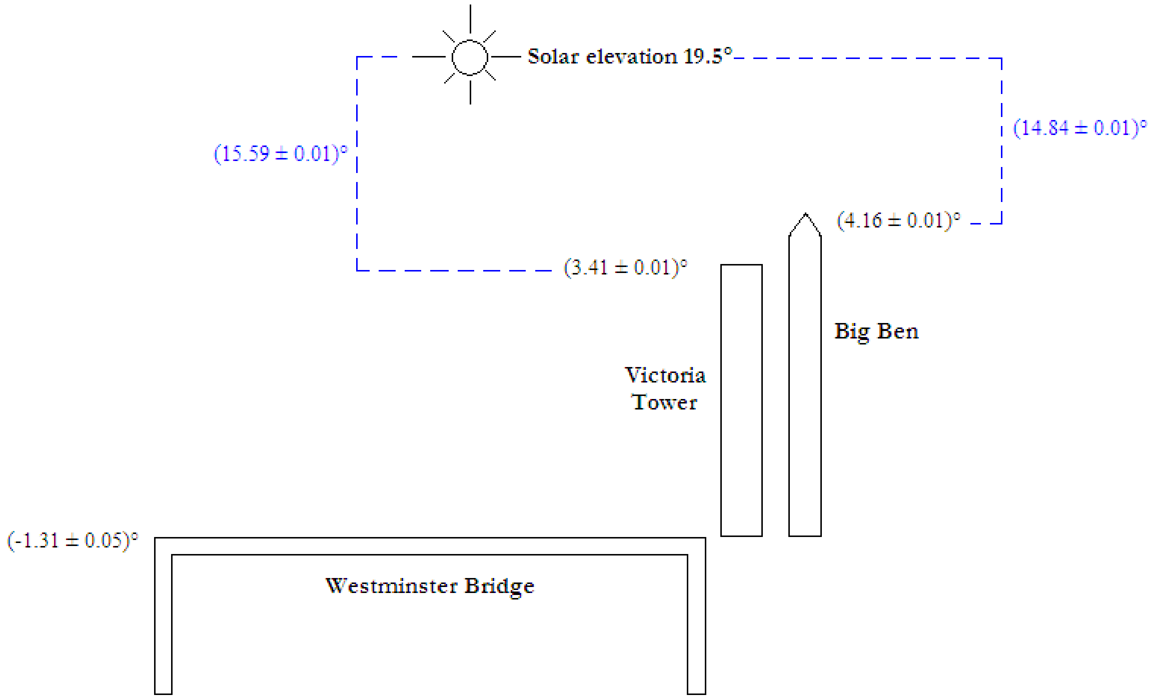


Figure 5.29 Revised elevation of the sun

The heights below can be measured directly from the reproduction of W1536 'Charing Cross Bridge' in Wildenstein's Volume III.

The height to the top of Victoria Tower above Westminster Bridge is 51mm which corresponds to (3.41 ± 0.01)° + (1.31 ± 0.05)° = (4.72 ± 0.06)°. The degree to millimetre ratio for Victoria Tower is (0.093 ± 0.001) degree/mm. Since the difference between the elevation of Victoria Tower to the elevation of the sun is (15.59 ± 0.01)°, the height of the sun above Victoria Tower is (167.63 ± 1.91) mm.

The height to the top of Big Ben above Westminster Bridge is 48mm which is equal to (4.16 ± 0.01)° + (1.31 ± 0.05)° = (5.47 ± 0.06)°. The degree to millimetre ratio for Big Ben is (0.114 ± 0.001) degree/mm. Since the difference between the elevations of Big

Ben to that of the sun is (14.84 ± 0.01)°, the height of the sun above Big Ben is (130.18 ± 1.23) mm.

From these measurements the position of the sun can be estimated as being approximately 17cm above Victoria Tower and 13cm above Big Ben. Looking at the reproduction of the painting, there is approximately 3.5cm from the top of Victoria Tower and Big Ben to the top edge of the canvas. Therefore it seems fair to estimate that the location of the sun would need to be a further 10-13cm above the top of the canvas reproduced by Wildenstein (1974-1985). As with W1532 'Charing Cross Bridge, reflets sur la Tamise' this result is hugely significant as it again shows that Monet used vertical stretching in some of his paintings.

5.9.3. CCB Painting 4: 'Charing Cross Bridge, la Tamise' (W1537)

This painting has been labelled as W1537 by Wildenstein and entitled 'Charing Cross Bridge, la Tamise' (The Thames). Like the previous two paintings, the outer edges of the sun are visible, just as Westminster Bridge, Victoria Tower and Big Ben are.

Figure 5.30 Charing Cross Bridge, la Tamise

The azimuthal angle for this painting is 190.00°, the same as that for W1536; but the heights can be measured directly from the reproduction of W1537 'Charing Cross Bridge' in Wildenstein's Volume III.

The height to the top of Victoria Tower above Westminster Bridge is 52mm which is equal to $(3.41 \pm 0.01)° + (1.31 \pm 0.05)° = (4.72 \pm 0.06)°$. The degree to millimetre ratio for Victoria Tower is (0.091 ± 0.001) degree/mm. Since the difference between the elevation of Victoria Tower to the elevation of the sun is $(15.59 \pm 0.01)°$, the height of the sun above Victoria Tower is (171.32 ± 1.99) mm.

The height to the top of Big Ben above Westminster Bridge is 46mm which corresponds to $(4.16 \pm 0.01)° + (1.31 \pm 0.05)° = (5.47 \pm 0.06)°$. The degree to millimetre ratio for Big Ben is (0.119 ± 0.001) degree/mm. Since the difference between the elevation of Big Ben to the elevation of the sun is $(14.84 \pm 0.01)°$, the height of the sun above Big Ben is (124.71 ± 1.13) mm.

From these measurements the position of the sun can be estimated as being approximately 17cm above Victoria Tower and 12.5cm above Big Ben. Looking at the reproduction of the painting, there is approximately 3.5-4cm from the top of Victoria Tower and Big Ben to the top edge of the canvas. Therefore it seems fair to estimate that the location of the sun would need to be a further 8.5-13.5cm above the top of the canvas reproduced by Wildenstein (1974-1985). As with the previous two paintings, W1532 'Charing Cross Bridge, reflets sur la Tamise' nad W1536 'Charing Cross Bridge, la

Tamise', this painting reinforces that Monet stretched some of his scenes vertically when depicting them on the canvases.

The dates, derived using the solar geometry, have been compared to the information included within Monet's letters along with the data retrieved from the weather diaries and the weather reports. For the eight paintings of Waterloo Bridge and the one painting of Charing Cross Bridge, the synoptic data sets have reinforced the dates determined with the solar geometry, which has thus reinforced the perceived accuracy of Monet's depictions of London during 1900 and 1901. There were three paintings of Charing Cross Bridge that the solar geometry method could not be applied to because of the estimated height of the sun within each scene. The sun within each of these three paintings was approximated to be between a minimum of 8.5cm and a maximum of 14cm above the top of the canvas. Baker et al. (2009) discusses the idea that Monet stretched his paintings in the vertical direction, working to emphasise the skyline and the atmosphere within each scene. However, Monet did not repeat this stretching in the horizontal direction, and he still managed to accurately depict the relative positioning of the structures within each painting (Baker et al. 2009). This vertical stretching could be the reason that the speculated solar position for the three paintings (W1532, W1536 and W1537) is so far off the top of each canvas.

The strengths and weaknesses of the solar geometry method have been considered and are listed in Table 5.25.

Solar geometry

Strengths	Weaknesses
Derives dates and times of the paintings with respect to the position of the sun	Not all of the paintings depict clear representations of the sun, resulting in a degree of assumption and approximation
Works with internal scales determined using the known heights of the structures included in the paintings	Working from reproductions of the paintings, so the clarity of each scene is questionable
	The date of production for all of the paintings are unknown
	Possible vertical stretching in some of Monet's scenes means that the sun is omitted from the paintings

Table 5.25 Strengths and weaknesses of the solar geometry method

CHAPTER 6: London's climate 1899-1901

6.1. Introduction

In this chapter, the information retrieved from the weather data have been compared to the dates derived for Monet's paintings of Waterloo Bridge and Charing Cross Bridge. The dates for the weather data have also been cross-compared to the dates from Monet's letters in an attempt to further refine the dates determined for the paintings.

6.2. Introduction to London's changing climate

According to one of the latest version of the Köppen-Geiger Climate classification (Figure 6.1; 2006) London lies in the middle of a warm temperate - fully humid - warm summer climate (Cfb). The climate experienced in London, as well as the whole of the British Isles, does not encounter any extremes in temperature, but does experience rain during every month of the year (Met Office, 2007); with mild, wet summers and cool, wet winters.

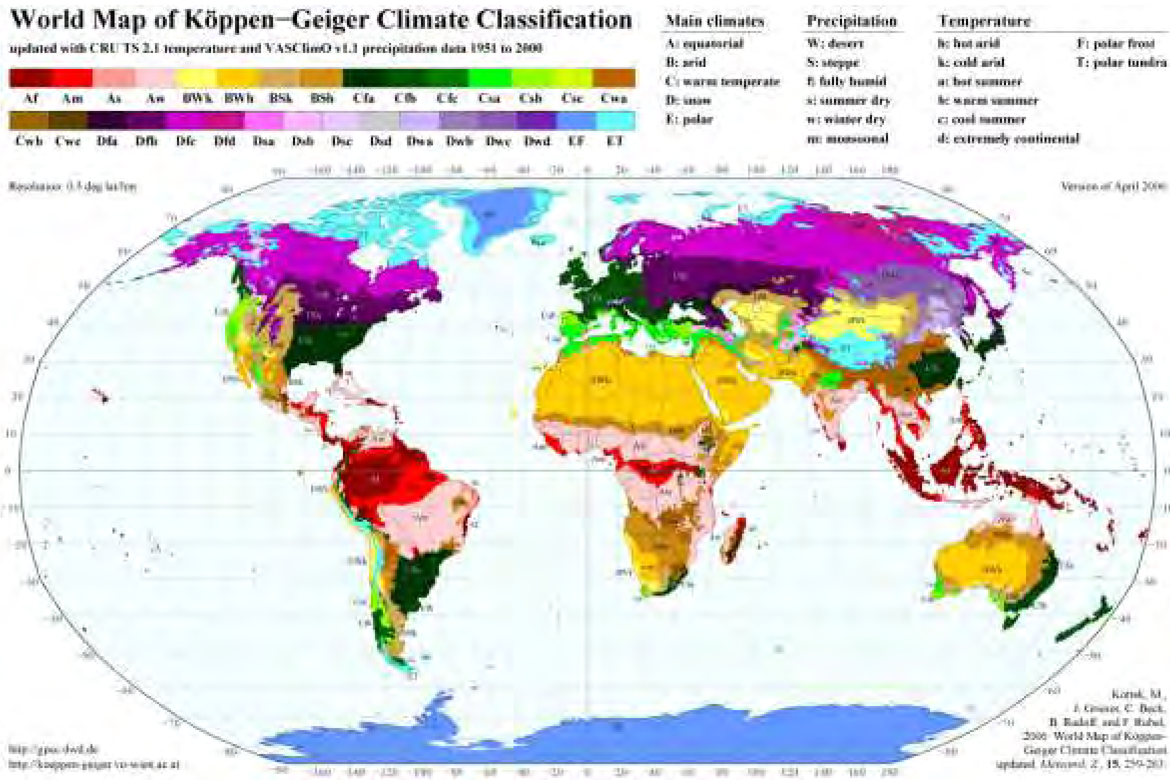


Figure 6.1 Köppen-Geiger Climate classification

The climate of London has seen several changes since the turn of the twentieth century, when Monet was residing in the city. Most of these changes can be attributed to a reduction of smoke levels and a corresponding increase in visibility and sunshine.

The method of measuring smoke levels, until 1960, consisted of drawing comparisons between the darkness of a stain formed by air passing through a filter with a series of standard, calibrated stains (Chandler, 1965). This process was open to a variety of errors and was therefore replaced by more up-to-date photo-electric methods.

Smoke concentrations for Kew have been recorded for a period spanning a total of twenty two years within the time frame 1935 to 1962 (1935-1952 and 1957-1962). The mean winter concentrations decreased considerably between the two periods, whereas the summer concentrations still showed some similarity (Chandler, 1965). The tables below highlight these situations.

	Mean
Winter (October-March)	217
Summer (April-September)	62

Table 6.1 Average smoke concentrations in Kew $\mu g/m^3$ 1932-52 (Chandler, 1965)

	Mean
Winter (October-March)	147
Summer (April-September)	61

Table 6.2 Average smoke concentrations in Kew $\mu g/m^3$ 1957-62 (Chandler, 1965)

The decrease in emissions can be partially accredited to smoke control regulations which encouraged the use of more efficient fuels by industries and domestic consumers, such as oil and electricity (Chandler, 1965).

Figure 6.2 demonstrates the likely changes in air pollution that has London experienced since the seventeenth century.

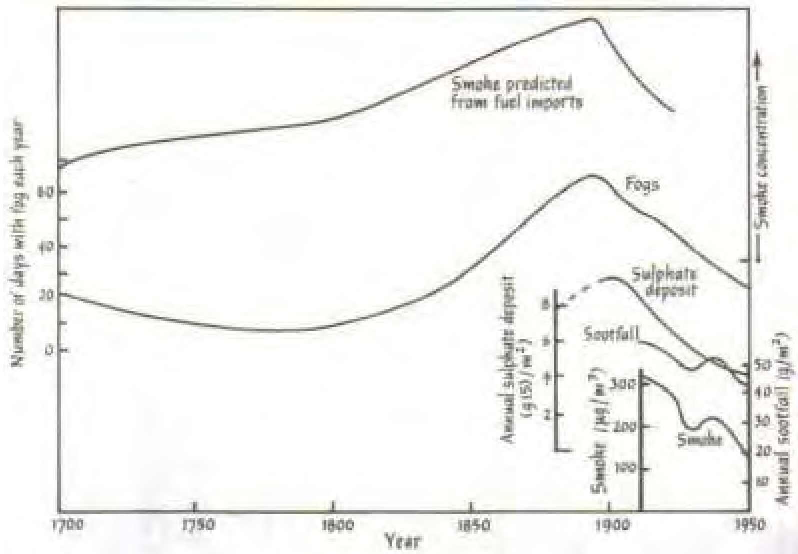


Figure 6.2 Air pollution in London, 1700-1950 (Brimblecombe, 1987)

Smoke concentrations in London fell from approximately 300 μg/m^3 (micrograms per cubic metre) in around 1910 to under 150 μg/m^3 by 1950 (Brimblecombe, 1987).

After the Great Smog of 1952 (smoke levels of greater than 3000 μg/m^3) and the Clean Air Act of 1956, the overall smoke emissions in London decreased by 37%, from approximately 141,000 tons in 1952 to 89,000 tons in 1960 (Chandler, 1965).

Present day emissions of PM10 particulates are recorded daily for the whole of London as part of the London Air Quality Network established by King's College London. The values for the site at Westminster (Marylebone Road) have been extracted for the time period January 1st 2009 to January 1st 2010. The daily mean concentrations, during this time period, range from approximately 10 μg/m^3 to nearly 80 μg/m^3. This shows how pollution levels have declined in the last century, falling from 300 μg/m^3 to just 10 μg/m^3.

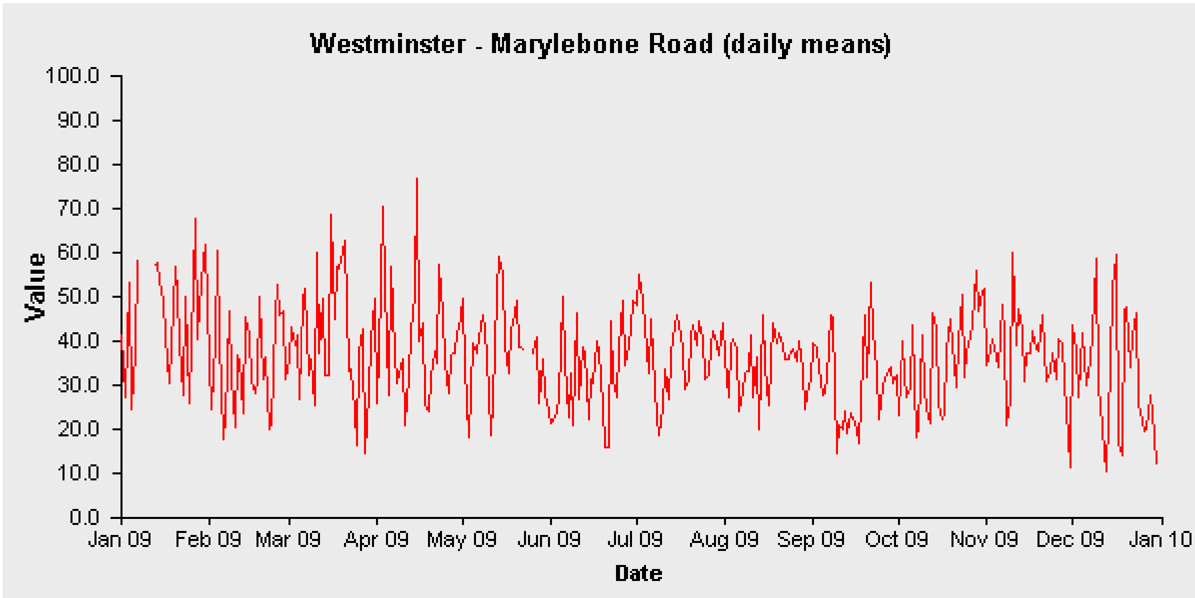


Figure 6.3 Daily means of PM10 particulate s (μg/m^3) at Westminster (Marylebone Road), January 1st 2009- January 1st 2010

As the climate of London at the beginning of the twentieth century would have greatly affected Monet's perception of the landscape, it seems appropriate to compare the change in climatic variables of London during Monet's visits (1899-1901) to the current climate of London (1971-2000). In order to do this, the monthly values of maximum temperature, minimum temperature, rainfall and hours of sunshine will be compared for the two time periods.

The data that are contained in Appendix 3 gives the maximum and minimum temperature, rainfall and hours of sunshine on a daily basis for four locations in London; Chiswick, Westminster, Brixton and Kew. Monthly values for the current climate (1971-2000) are retrievable from the Met Office website (Met Office, 2009) for the weather station at Greenwich. The values for the maximum and minimum temperatures are given in degrees Celsius; so these measurements have been converted into degrees Fahrenheit for comparison. Similarly, the values for rainfall are given in millimetres which have been converted into inches, again for comparison.

The available data for Monet's three visits to London are September, October and November in 1899; February, March and April in 1900; and January, February, March and April in 1901. Therefore this will be compared to the measurements for January, February, March, April, September, October and November from the 1971-2000 data set. Since daily readings are available from the synoptic data for 1899-1901, monthly averages need to be derived for each site, which can then be used to determine an overall average for each month.

The locations of the four data sources for 1899-1901 have been plotted with respect to the location for the 1971-2000 data set using Google Earth, and are displayed below in Figure 6.4.

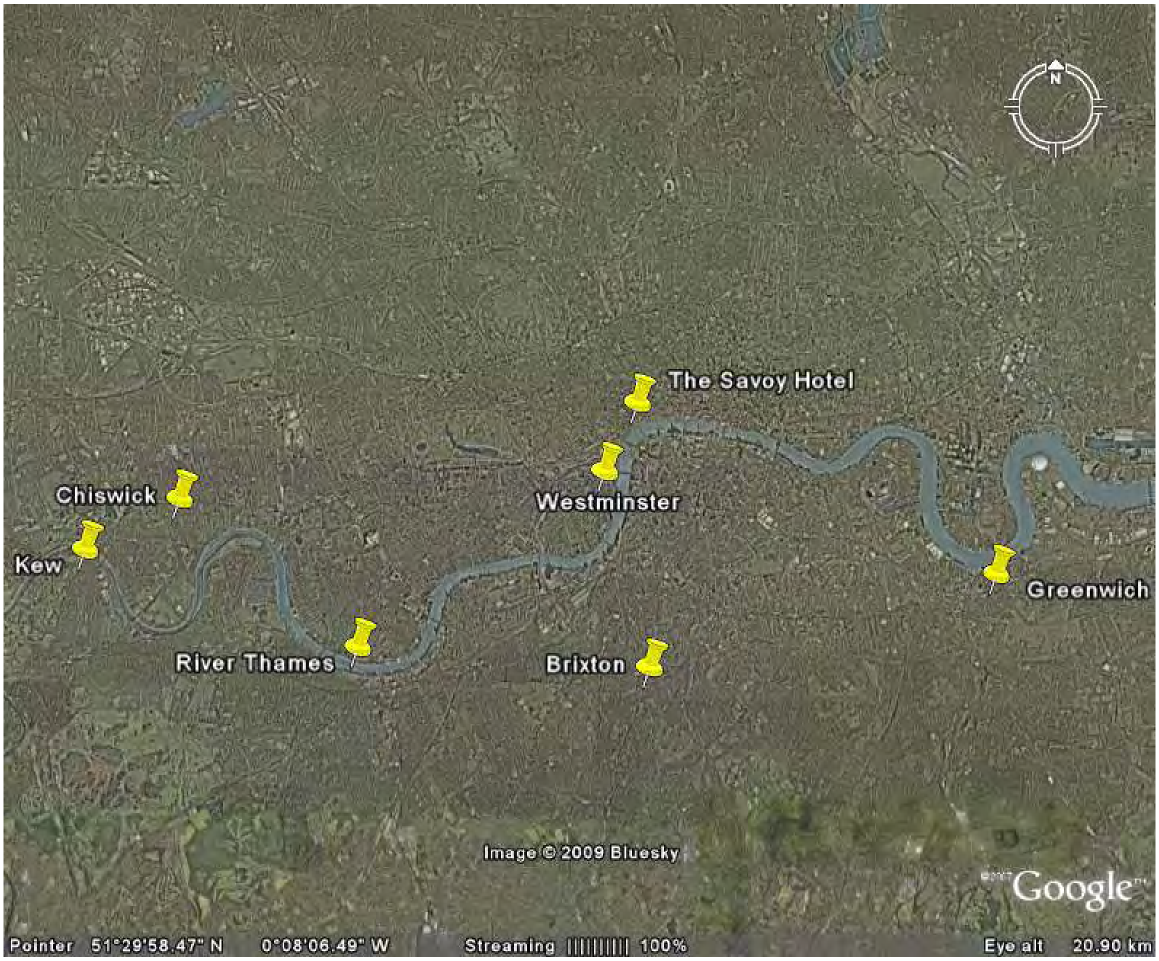


Figure 6.4 Locations of the Westminster, Brixton, Chiswick, Kew and Greenwich with respect to the Savoy Hotel

This map shows the proximity of the data sources, with Greenwich being only 5.24 miles (8.43 km) east of the Savoy Hotel. Therefore it can be assumed to be reasonable to compare the information gathered from all of the data sources in question.

The general trends for the maximum and minimum temperatures, between the two time frames show that the climate in 1971-2000 was generally warmer than the meteorological situation experienced whilst Monet was residing in London. Nevertheless, the temperatures for November in 1899 were higher than those for the thirty year period, 1971-2000.

On the whole, the rainfall amounts show that the climate in London during 1971-2000 was drier than the situation during Monet's stay, at the turn of the twentieth century. However, the amount of rainfall experienced in January 1901 was exactly the same amount recorded for the time period 1971-2000.

Finally, the hours of sunshine reported during the thirty year time period are more than those reported in 1899-1901, with the exception of September and November in 1899 which experienced slightly more sun than the same months in the 1971-2000 data set.

The main reason for the hours of sunshine being lower, during the majority of the months analysed in the period 1899-1901, is predominantly the result of the levels of smoke and fog present at the turn of the twentieth century.

The slight anomaly for hours of sunshine recorded in September and November 1899 may be a feature of the averaging process required to determine the monthly amount of sunshine for these months. On closer inspection, the hours of sunshine for September 1899 range from a minimum of 0.3 hours to a maximum of 9 hours. The difference between the average hours of sunshine for the two time periods (1899 and 1971-2000) is only 0.16 hours greater for September 1899. Therefore it is reasonable to look at the number of days when the hours of sunshine are above and below the average value for

1971-2000, which is 4.64 hours. In September 1899, there are an equal amount of days when sunshine levels are less than or greater than 4.64 hours. This supports the hypothesis that the average hours of sunshine in September 1899 are greater than September during 1971-2000 because of the averaging process. Similarly, for November 1899, the hours of sunshine range from a minimum of 0 hours to a maximum of 7.1 hours. The difference between the average hours of sunshine for November 1899 is 0.48 hours greater than November in 1971-2000. Hence, it is fair to look at the number of days when the sunshine levels are above or below the average value for November 1971-2000, which is 2.02 hours. During this particular month, there is approximately the same number of occasions that experienced hours of sunshine above or below this figure. This again highlights that the averaging process resulted in a greater value for sunshine levels in November 1899 when compared to the same month during 1971-2000.

Overall, it seems that the climatic variables that Monet encountered during his three stays in London were colder and wetter than the climate during 1971-2000. It also appears, that Monet would have experienced less sunshine when he was in London, compared to the values of the 1971-2000 data set. Since Monet was in London to paint the fogs, it seems that the weather conditions during the time that Monet was residing in London would have been much more favourable to him rather than the warmer and drier conditions experienced in 1971-2000. Recordings of fog/mist for the two time periods can be found in Appendix 3 and Appendix 4.

Another factor that may be of interest here is the microclimate of London, which will affect the temperatures measured in the city compared to those measured in the nearby rural locations (Jones and Lister, 2009). This effect is known as the Urban Heat Island (UHI). In 2009, Jones and Lister conducted a study of the urban heat island (UHI) experienced by locations in Central London and the surrounding areas, during the time frame 1900-2006. They found that the UHIs and urban-related warming observed increases at two of the suburban sites; Heathrow and Kew. However, the sites within Central London experienced constant UHIs and thus did not see any overall urban-related warming trends. Using the temperature readings for St James's Park and the London Weather Centre, (sites in Central London), Jones and Lister concluded that the UHI for Central London must have occurred before the beginning of the twentieth century.

Another element of this chapter is to compare the data sets selected for this study. The analysed data falls into either artistic or scientific categories, so this study is a true case of art versus science.

By painting his London Series, Monet produced many artistic representations of the London fogs at the turn of the twentieth century. As previously discussed, Monet wrote numerous letters to his wife, Alice, and other acquaintances which contained many observations of the weather that he experienced during his stays. For this reason, Monet's letters are going to be used as another source of information regarding the London fogs. Whilst visiting London in 1900, Monet wrote a total of forty six letters, eight of which contained observations of fog. During the following year, in 1901, Monet wrote about the fogs in ten letters out of a total of forty nine.

The scientific data that were retrieved and considered are the Royal Horticultural Society's weather diaries along with the weather reports for Westminster, Brixton and Kew. The data that has been retrieved from these four sources has also been cross-referenced with respect to four pairings of the locations in an attempt to determine the spatial variation of the fogs around London at the turn of the twentieth century.

The concept of comparing artistic representations to 'real' synoptic data will hopefully aid in demonstrating that information collated from artistic and scientific fields can be used concurrently as well as independently.

6.3. Observed weather data for the periods Monet was in London 1899-1901

The term 'meteorological data' covers a wide range of data criterion. For the purpose of this investigation, two types of data are being employed. Firstly, the meteorological observations recorded in the Royal Horticultural Society's weather diaries will undergo analysis. The second criteria of meteorological data that will be used are weather reports from various weather stations around London. These weather stations provided a base for meteorologists to collate information that would then be used in the production of daily weather reports. The Royal Horticultural Society's weather diaries and the weather reports are all held at the Meteorological Office Archives in Exeter.

The entries of the diaries can be examined with respect to Monet's London Series as well as his letters. The content of Monet's eight paintings of Waterloo Bridge and one painting of Charing Cross Bridge, for 1900 and 1901, can be compared to the information collated from the Royal Horticultural Society's weather diaries as well as the weather reports for the same time period. The paintings were split into two groups for analysis; those dated as being produced in either 1900 or 1901, and those dated as 1901 only. The dates of the corresponding observations from the weather diaries are displayed in Appendix 10.

Monet's letters of correspondence, that he wrote whilst residing in London from 1899 to 1901, have been translated and studied, and the letters that include any details about the fogs of London have been selected for analysis. Monet wrote of occasions when there was either too little or too much fog, both of which were useless to him. On the one hand, too little fog meant that Monet could not capture any atmospheric effects in his paintings, and on the other hand, too much fog meant that the whole scene would be obscured and again Monet would not be able to portray the atmospheric effects. Monet was waiting for the occasions when the fog reached an optimal depth that could be depicted within his London Series.

6.3.1. Comparison

The information contained in Monet's letters can be compared to the data collected from the various synoptic sources mentioned previously. The dates that Monet wrote his letters are given at the beginning of each letter, so it was a simple case of selecting the letters from the known periods that Monet was in London and reading each letter to determine which ones contained information about the London fogs. The synoptic data can also be studied in order to determine the dates, within each data set, when fog, mist or haze was reported. Dates when fog occurrences are reported in either one of Monet's letters, the Royal Horticultural Society's weather diaries, or one of the weather reports from Westminster, Brixton or Kew; during 1900 or 1901, were noted and listed for comparison in Appendix 9.

1900

Data sources	N$^{o.}$ of dates	Dates
Letter + 1 synoptic source	5	Feb: 12th, 13th, 17th 25th, 26th
At least 1 synoptic source	22	Feb: 7th-10th, 12th-13th, 15th, 17th, 25th-28th Mar: 3rd, 10th-11th, 21st, 29th-31st Apr: 1st-3rd
At least 2 synoptic sources	12	Feb: 7th-9th, 12th-13th, 25th-28th Mar: 11th, 21st, 30th

Table 6.3 Dates of fog occurrences in 1900

1901

Data sources	N$^{o.}$ of dates	Dates
Letter + 1 synoptic source	7	Feb: 2nd-3rd, 5th, 8th-9th, 11th, 19th
At least 1 synoptic source	23	Jan: 23rd-24th, 31st Feb: 1st-5th, 7th-11th, 13th, 15th, 18th-21st Mar: 10th-12th, 17th
At least 2 synoptic sources	10	Jan: 23rd, 31st Feb: 1st, 3rd-4th, 7th-9th, 11th, 18th

Table 6.4 Dates of fog occurrences in 1901

6.4. A comparison of the observed weather data and the calculated dates of Monet's paintings

The meteorological observations recorded by the Royal Horticultural Society were taken at their gardens in Chiswick, west London. The location of these gardens with respect to

Monet's viewing position at the Savoy Hotel can be determined using Google Earth, and is displayed in Figure 6.5. This map hopefully provides some perspective of the scale of London. However, even though Chiswick appears to be quite some distance from the Savoy Hotel, there is in fact only 6.09 miles (9.80 km) between the two locations.

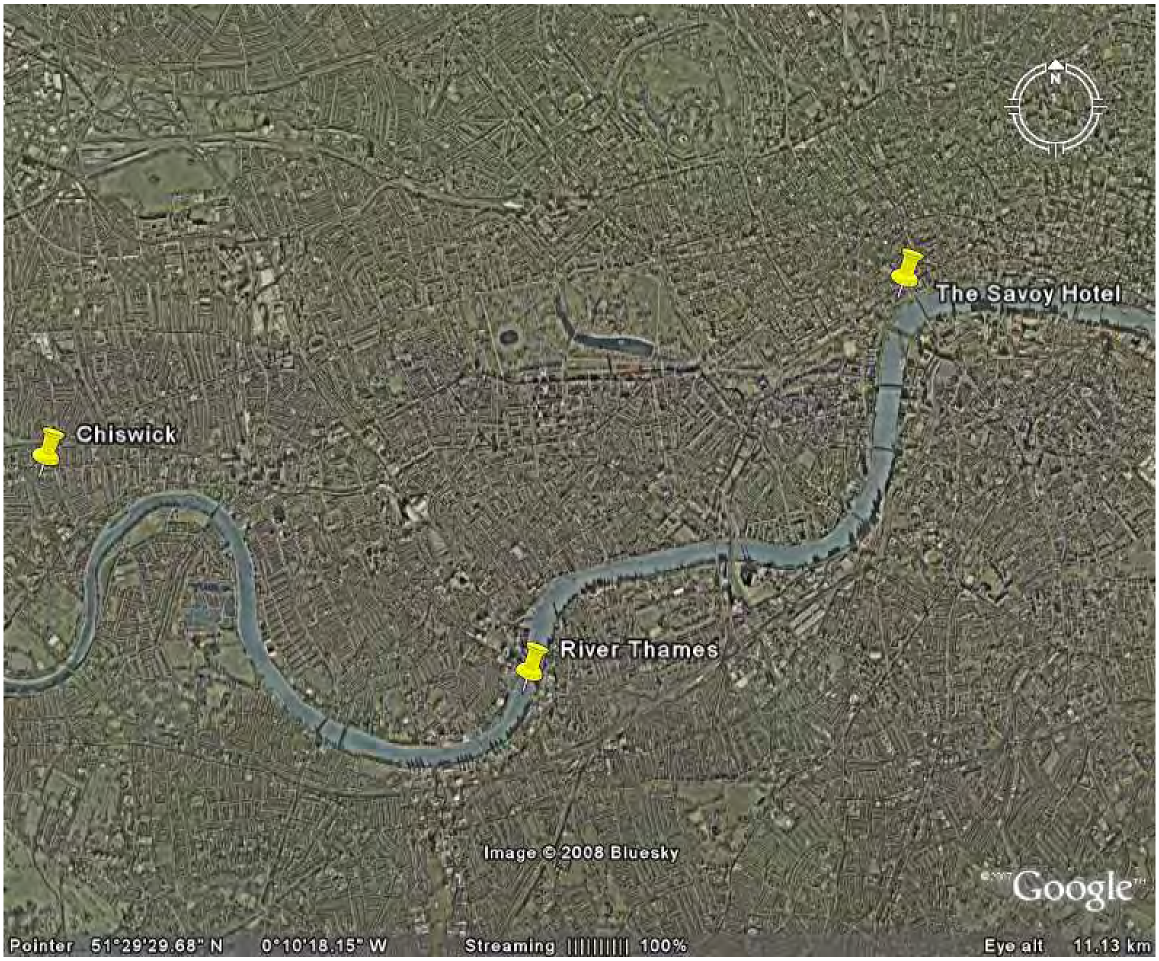


Figure 6.5 Location of Chiswick with respect to the Savoy Hotel

The meteorological information recorded by the Royal Horticultural Society includes: mean relative humidity of the air at 9am; dry bulb air temperature; wet bulb air temperature; maximum day air temperature; minimum night air temperature; rain amount (inches); soil temperature at 9am at a depth of 1 foot, 2 foot, and four foot; lowest temperature on grass; wind direction; and finally, any general observations. These particular weather diaries contain information for the years 1899 to 1903, so there is significant information held for the periods that Monet was residing in London. There are also weather reports that have been analysed in this chapter. The data recorded in these reports give observations for the south of England, Westminster and Brixton. Google Earth has again been used to show the position of Westminster and Brixton compared to Chiswick and the Savoy Hotel.

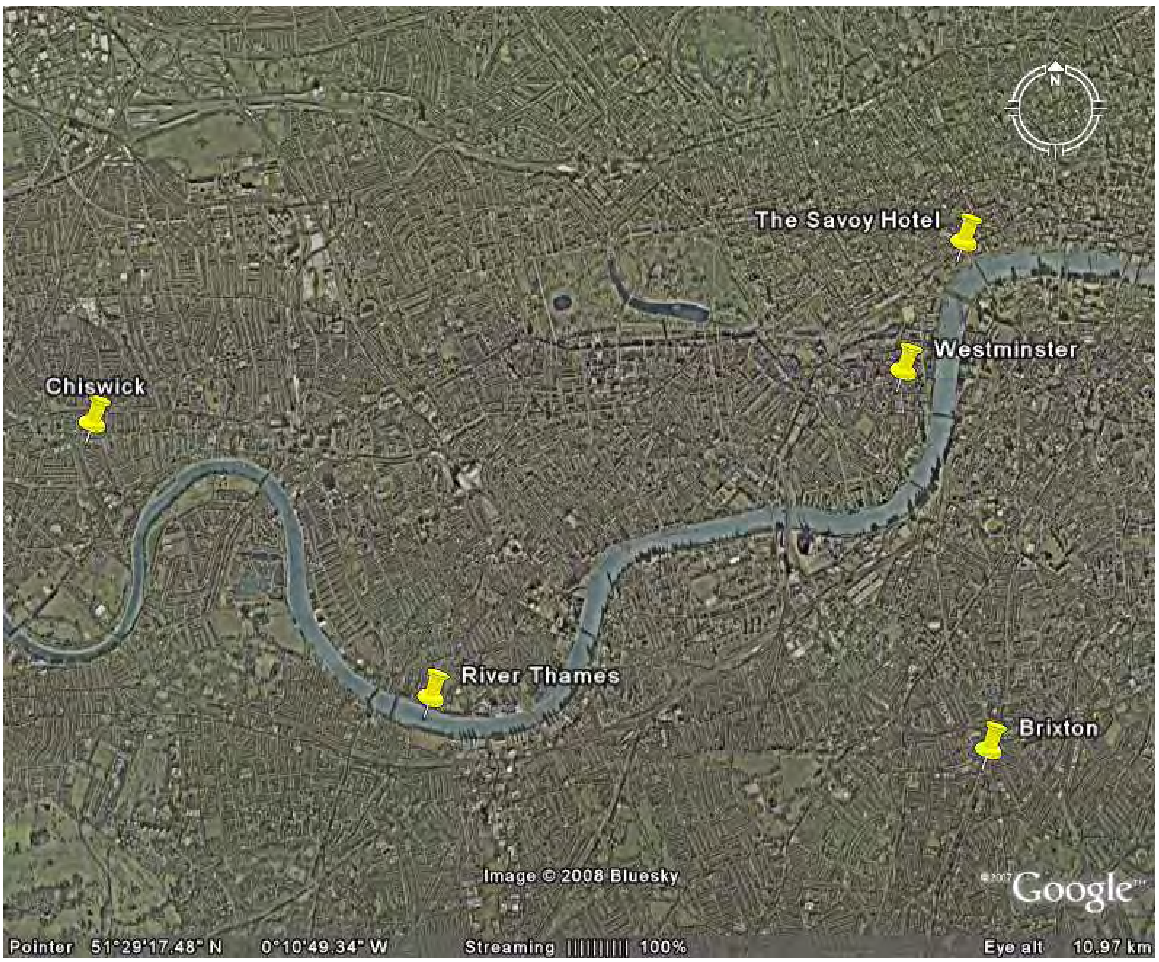


Figure 6.6 Locations of Westminster, Brixton and Chiswick with respect to the Savoy Hotel

The information contained in the weather reports has been divided into three main categories which are as follows: forecasts for the south of England for the 24 hours ending at noon on the day of the report; today's 2pm reports for Westminster, London;

and the daily weather reports for Brixton, London. These three categories contain much more information about the weather than the titles state.

- Forecasts for the south of England for the 24 hours ending at noon on the day of the report → wind direction and strength, observations.
- Today's 2pm reports for Westminster, London → barometer reading, dry bulb temperature, wet bulb temperature, wind direction, wind force, observations.
- Daily weather reports for Brixton, London → Yesterday evening: barometer reading, dry bulb temperature, wind direction and force, weather. This morning: barometer reading, change in barometer reading since yesterday, dry bulb temperature, wet bulb temperature, change in dry bulb temperature since yesterday, wind direction and force, weather, sea. Past 24 hours: weather, hours of bright sunshine (recorded on the Tower of the Wesleyan Training College, Westminster), maximum temperature, minimum temperature, rainfall amount (inches).

These particular weather reports cover the time period July 1st – December 31st 1899 and January 1st – June 30th 1900, hence Monet's first and second visits to London can be analysed with respect to these reports. As Monet's last visit is not covered by these weather reports, it seemed beneficial to use some alternative weather reports as well.

The information retrieved from the Royal Horticultural Society's weather diaries and the various other weather reports can be found in Appendix 3.

There are another set of weather observations for Brixton and Kew, covering the following time periods; September to November in 1899, February 1900, as well as January and February in 1901. The daily observations from Brixton weather station are divided into three time frames: 8am → dry bulb temperature, wet bulb temperature, maximum temperature, minimum temperature, wind direction and weather; 2pm → dry bulb temperature, wet bulb temperature, wind direction and weather; 6pm → dry bulb temperature, wet bulb temperature, wind direction, weather and remarks. Two hourly observations were taken at Kew weather station, from 10am to 10pm, with any additional remarks also logged.

The location of Kew has been added to the Google Earth image which highlights all of the locations that meteorological information was available for.

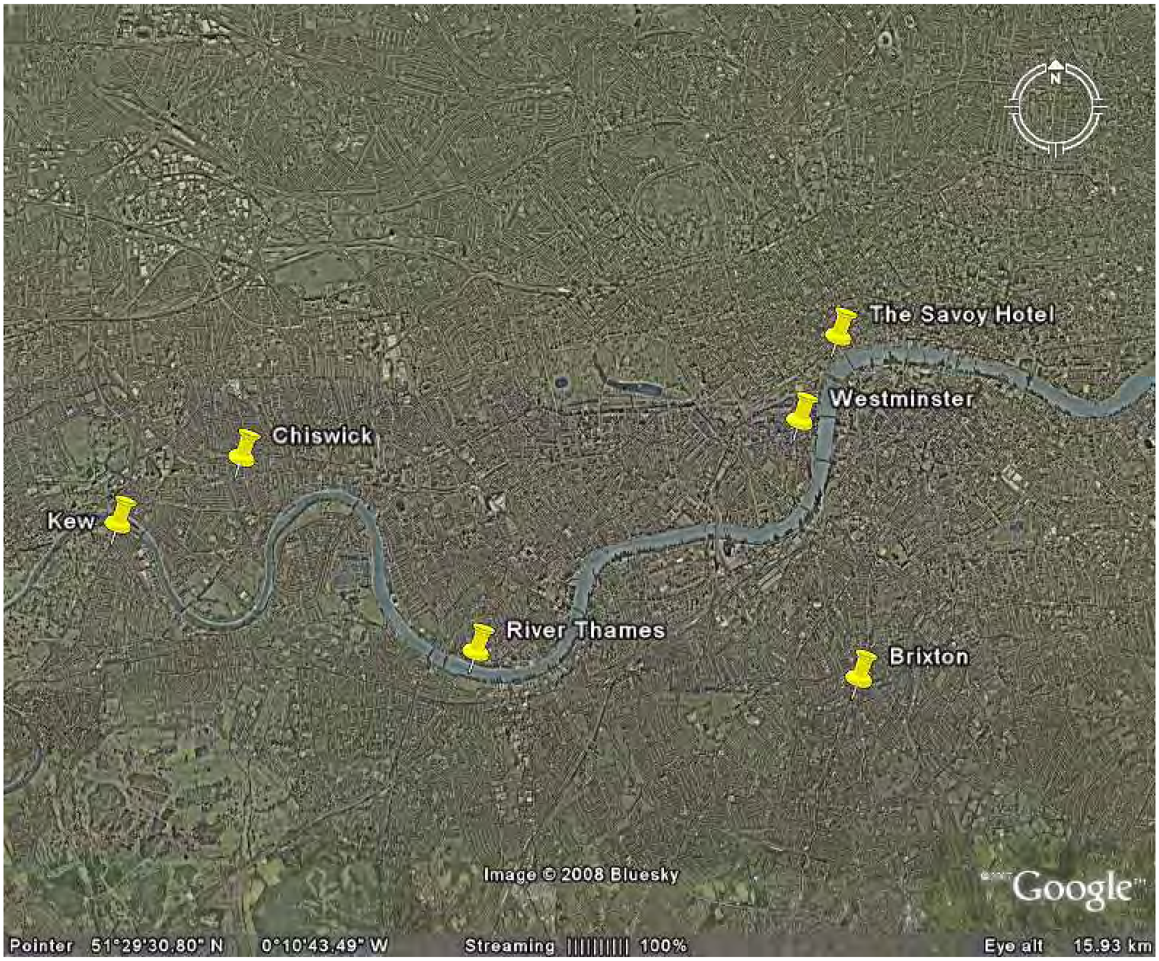


Figure 6.7 Locations of Westminster, Brixton, Chiswick and Kew with respect to the Savoy Hotel

Retrieving data for the four locations, shown in Figure 6.7, will help to produce an overall picture of the weather conditions experienced in London when Monet was painting his series.

An analysis of the localities of Chiswick, Westminster, Brixton and Kew, may help to show the spatial variation of the mists and fogs that occurred in London during the periods that Monet was residing in the city. Figure 6.7 shows the four locations with respect to the Savoy Hotel.

The likelihood of fog occurring can also be determined from the value of relative humidity. This is given as a percentage and is a measure of the ratio of the actual moisture content of the air to the potential moisture content. The relative humidity can be determined from psychometric charts if both the dry bulb temperature and wet bulb temperature are known. For the purpose of this study, a relative humidity calculator will be utilised from the following website http://www.ringbell.co.uk/info/humid.htm. The dry bulb temperatures and wet bulb temperatures for the observations recorded at Chiswick, Westminster and Brixton will be entered into the calculator in order to determine a relative humidity for each reading.

It has been stated that fog normally occurs at a relative humidity near 100% (Gleissman, 2007), mist at a relative humidity of 95% or greater, and haze at a relative humidity below 95%. Therefore, the dates that will be selected are those when mist, fog or haze has been reported on that day, or alternatively when the derived relative humidity is greater than or equal to 90%. The calculated values for the relative humidity are given with the other values of observations in Appendix 6.

September 1899

Dates	Sites	Weather observation	RH (%)
18th	Westminster	Fog	Brixton ≥ 90%
20th	Westminster	Fog	
29th	Chiswick & Brixton	Mist	≥ 90%
30th	Chiswick & Brixton		≥ 90%

Table 6.5 Dates in September 1899 when mist, fog or a RH ≥ 90% were reported at Chiswick, Westminster, Brixton or Kew

Of the four dates in September 1899 when mist/fog or a relative humidity greater than or equal to 90% was reported at one of the weather stations, there are two dates when mist/fog and a relative humidity ≥ 90% was reported at two stations simultaneously.

October 1899

Dates	Sites	Weather observation	RH (%)
1st	Brixton		≥ 90%
2nd	Chiswick & Brixton		≥ 90%
4th	Chiswick, Westminster, Brixton & Kew	Mist	Chiswick ≥ 90%
5th	Kew	Mist	
6th	Chiswick, Westminster, Brixton & Kew	Mist	
7th	Chiswick; Brixton	Mist; Fog	Brixton ≥ 90%
8th	Chiswick; Brixton	Mist & Fog; Fog	≥ 90%
9th	Chiswick & Kew; Westminster; Brixton	Fog; Mist; Fog & Mist	Chiswick & Brixton ≥ 90%
10th	Chiswick; Westminster & Kew; Brixton	Fog; Mist; Fog & Mist	Chiswick & Brixton ≥ 90%
11th	Chiswick; Westminster & Kew; Brixton	Fog; Mist; Fog & Mist	Chiswick & Brixton ≥ 90%
12th	Chiswick; Kew	Fog; Mist	Chiswick & Brixton ≥ 90%
14th	Chiswick	Mist	Chiswick & Brixton ≥ 90%
16th	Chiswick & Kew	Mist	Brixton ≥ 90%
17th	Chiswick; Westminster & Kew; Brixton	Fog; Mist; Mist	Chiswick & Brixton ≥ 90%
18th	Chiswick; Westminster; Brixton & Kew	Fog; Mist; Fog & Mist	Chiswick & Brixton ≥ 90%
19th	Chiswick, Brixton & Kew	Fog	Chiswick & Brixton ≥ 90%
20th	Chiswick & Kew; Westminster; Brixton	Fog; Mist; Fog & Mist	Chiswick & Brixton ≥ 90%
21st	Chiswick, Westminster, Brixton & Kew	Fog	Chiswick & Brixton ≥ 90%
22nd	Chiswick, Brixton & Kew	Fog	Chiswick & Brixton ≥ 90%
23rd	Chiswick, Westminster & Brixton; Kew	Fog; Mist	Chiswick & Brixton ≥ 90%
24th	Chiswick & Brixton	Fog	≥ 90%
25th	Chiswick; Brixton & Kew	Fog; Mist	Brixton ≥ 90%

Dates	Sites	Weather observation	RH (%)
26th	Brixton		≥ 90%
27th	Brixton		≥ 90%
28th	Chiswick & Brixton		≥ 90%
30th	Chiswick & Brixton		≥ 90%

Table 6.6 Dates in October 1899 when mist, fog or a RH ≥ 90% were reported at Chiswick, Westminster, Brixton or Kew

In October 1899 there were twenty six dates in total when either mist/fog or a relative humidity greater than or equal to 90% was recorded at one of the sites. Of these dates, there were twenty one days when mist/fog and a relative humidity ≥ 90% were reported at more than one of the sites.

November 1899

Dates	Sites	Weather observation	RH (%)
2nd	Chiswick & Brixton		≥ 90%
4th	Chiswick & Brixton		≥ 90%
5th	Chiswick & Brixton		≥ 90%
6th	Westminster, Brixton & Kew	Mist	Chiswick & Brixton ≥ 90%
7th	Chiswick		≥ 90%

Table 6.7 Dates in November 1899 when mist, fog or a RH ≥ 90% were reported at Chiswick, Westminster, Brixton or Kew

Of the five dates selected from November 1899, there is just one day when mist and a relative humidity greater than or equal to 90% was reported at more than one site simultaneously.

February 1900

Dates	Sites	Weather observation	RH (%)	Paintings
7th	Westminster & Brixton	Mist		
8th	Westminster & Brixton	Mist		
9th	Chiswick, Westminster & Brixton	Fog	Chiswick ≥ 90%	
10th	Kew	Mist		
12th	Chiswick; Brixton; Kew	Fog & Haze; Mist; Mist & Fog	Chiswick ≥ 90%	
13th	Chiswick; Westminster; Brixton & Kew	Fog; Mist; Fog & Mist	Chiswick ≥ 90%	
14th	Brixton		≥ 90%	
15th	Kew	Mist	Chiswick ≥ 90%	
16th				W1573
17th	Westminster & Brixton	Mist	Brixton ≥ 90%	W1572
18th	Brixton		≥ 90%	
19th	Chiswick		≥ 90%	
22nd				W1574
23rd	Chiswick & Brixton		≥ 90%	
24th	Brixton		≥ 90%	
25th	Chiswick & Kew	Mist	Chiswick & Brixton ≥ 90%	
26th	Chiswick, Brixton & Kew	Mist	Chiswick & Brixton ≥ 90%	
27th	Brixton; Kew	Fog; Mist	Chiswick, Westminster & Brixton ≥ 90%	
28th	Chiswick, Brixton & Kew	Mist	Chiswick, Westminster & Brixton ≥ 90%	W1575

Table 6.8 Dates in February 1900 when mist, fog or a RH ≥ 90% were reported at Chiswick, Westminster, Brixton or Kew

There were nineteen dates in February 1900 when mist/fog or a relative humidity greater than or equal to 90% was reported at one of the weather stations, and on ten of these days mist/fog and a relative humidity ≥ 90% was reported at two stations simultaneously. The dates of production derived for two of Monet's paintings (W1572 and W1575) also correspond to two of the dates when mist/fog and a relative humidity ≥ 90% were reported.

March 1900

Dates	Sites	Weather observation	RH (%)	Paintings
3rd	Chiswick	Mist		
6th				W1563
10th	Chiswick	Mist	Brixton ≥ 90%	
11th	Chiswick & Brixton	Mist		
16th	Brixton		≥ 90%	
19th	Chiswick & Brixton		≥ 90%	
21st	Chiswick; Brixton	Mist; Fog	Brixton ≥ 90%	
23rd	Chiswick		≥ 90%	
29th	Chiswick	Fog		
30th	Chiswick & Brixton	Fog	Brixton ≥ 90%	
31st	Chiswick	Mist		

Table 6.9 Dates in March 1900 when mist, fog or a RH ≥ 90% were reported at Chiswick, Westminster, Brixton or Kew

Of the eleven dates in March 1900 when mist/fog or a relative humidity greater than or equal to 90% was reported at one of the weather stations, there are four dates when mist/fog and a relative humidity ≥ 90% was reported at two stations simultaneously.

April 1900

Dates	Sites	Weather observation	RH (%)	Paintings
1st	Chiswick	Mist		
2nd	Chiswick	Mist	Brixton ≥ 90%	
3rd	Chiswick	Mist	≥ 90%	

Table 6.10 Dates in April 1900 when mist, fog or a RH ≥ 90% were reported at Chiswick, Westminster, Brixton or Kew

In April 1900 there were three dates in total when either mist/fog or a relative humidity greater than or equal to 90% was recorded at one of the sites. Of these dates, there was only one day when mist/fog and a relative humidity ≥ 90% were reported at more than one of the sites.

January 1901

Dates	Sites	Weather observation	RH (%)	Paintings
21st	Brixton	Mist		
23rd	Chiswick; Brixton & Kew	Mist; Fog & Mist	Chiswick & Brixton ≥ 90%	
24th	Brixton	Mist	Chiswick & Brixton ≥ 90%	
27th				W1567
28th	Brixton		≥ 90%	
30th	Brixton		≥ 90%	
31st	Chiswick & Westminster	Mist	Brixton ≥ 90%	

Table 6.11 Dates in January 1901 when mist, fog or a RH ≥ 90% were reported at Chiswick, Westminster, Brixton or Kew

Of the seven dates selected from January 1901, there were three days when mist and a relative humidity greater than or equal to 90% was reported at more than one site simultaneously.

February 1901

Dates	Sites	Weather observation	RH (%)	Paintings
1st	Chiswick, Westminster & Brixton	Mist	Chiswick ≥ 90%	W1555
2nd	Kew	Mist		
3rd	Chiswick & Brixton	Mist		W1565
4th	Chiswick, Westminster, Brixton & Kew	Mist	Chiswick ≥ 90%	W1554

Dates	Sites	Weather observation	RH (%)	Paintings
5th	Westminster & Brixton	Mist	Brixton ≥ 90%	
6th	Brixton		≥ 90%	
7th	Westminster, Brixton & Kew	Mist		
8th	Chiswick, Westminster, Brixton & Kew	Mist	Chiswick & Brixton ≥ 90%	
9th	Chiswick, Westminster, Brixton & Kew	Mist	Chiswick & Brixton ≥ 90%	
10th	Kew	Mist	Chiswick ≥ 90%	
11th	Westminster, Brixton & Kew	Mist		
13th	Kew	Mist	Brixton ≥ 90%	
14th	Westminster & Brixton		≥ 90%	
15th	Westminster & Brixton	Mist		
16th	Chiswick		≥ 90%	W1573
17th	Brixton		≥ 90%	W1572
18th	Brixton & Kew	Mist		
19th	Westminster	Fog	Chiswick & Brixton ≥ 90%	
20th	Kew	Mist		
21st	Brixton	Mist		
22nd	Chiswick & Brixton		≥ 90%	W1574
24th	Brixton		≥ 90%	
25th	Brixton		≥ 90%	
27th	Brixton		≥ 90%	
28th	Chiswick & Brixton		≥ 90%	W1575

Table 6.12 Dates in February 1901 when mist, fog or a RH ≥ 90% were reported at Chiswick, Westminster, Brixton or Kew

There were twenty five dates in February 1901 when mist/fog or a relative humidity greater than or equal to 90% was reported at one of the weather stations, and on eleven of these days mist/fog and a relative humidity ≥ 90% was reported at two stations simultaneously. The dates of production derived for four of Monet’s paintings (W1555, W1554, W1574 and W1575) also correspond to four of the dates when mist/fog and a relative humidity ≥ 90% were reported.

March 1901

Dates	Sites	Weather observation	RH (%)	Paintings
1st	Chiswick		≥ 90%	
2nd	Chiswick		≥ 90%	
4th	Chiswick		≥ 90%	
5th	Chiswick		≥ 90%	
6th				W1563
10th	Chiswick	Mist	≥ 90%	
11th	Chiswick	Mist		
12th	Chiswick	Mist	≥ 90%	
13th	Chiswick		≥ 90%	
16th	Chiswick		≥ 90%	
17th	Chiswick	Mist		
25th	Chiswick		≥ 90%	
26th	Chiswick		≥ 90%	
31st	Chiswick		≥ 90%	

Table 6.13 Dates in March 1901 when mist, fog or a RH ≥ 90% were reported at Chiswick, Westminster, Brixton or Kew

Of the fourteen dates in March 1901 when mist/fog or a relative humidity greater than or equal to 90% was reported at one of the weather stations, there were no occasions when mist/fog and a relative humidity ≥ 90% was reported at two stations simultaneously.

April 1901

Dates	Sites	Weather observation	RH (%)	Paintings
6th	Chiswick		≥ 90%	

Table 6.14 Dates in April 1901 when mist, fog or a RH ≥ 90% were reported at Chiswick, Westminster, Brixton or Kew

In April 1901 there was only one day when either mist/fog or a relative humidity greater than or equal to 90% was recorded at one of the sites. However, mist/fog and a relative humidity ≥ 90% was only reported at Chiswick on this particular day.

Mist, fog and haze observations recorded by the Royal Horticultural Society at Chiswick and the weather stations based at Westminster, Brixton and Kew, have been analysed with respect to each other in order to determine any relationships that exist between the four locations in London. The data sources with the greatest distances between them have been separated into four pairings. These are Chiswick and Westminster, Chiswick and Brixton, Kew and Westminster, and Kew and Brixton.

Chiswick and Westminster

Year	Total no. days when mist/fog/haze reported	No. days mist/fog/haze reported by both stations
1899	23	10
1900	20	2
1901	19	5
Total	**62**	**17**

Table 6.15 Dates when mist/fog/haze was recorded by Chiswick and Westminster in 1899-1901

Out of a total of sixty two dates in 1899-1901, there were seventeen occasions when Chiswick and Westminster reported mist or fog on the same day; which is approximately equivalent to one observation every four days. There are 5.53 miles (8.90 km) between Chiswick and Westminster, which is the shortest distance between any of the observation sites. Still they have the least amount of dates in common, out of the four pairings, with respect to reports of mist or fog occurrences.

Chiswick and Brixton

Year	Total no. days when mist/fog/haze reported	No. days mist/fog/haze reported by both stations
1899	21	17
1900	20	8
1901	19	6
Total	**60**	**31**

Table 6.16 Dates when mist/fog/haze was recorded by Chiswick and Brixton in 1899-1901

From a total of sixty dates in 1899-1901, there were thirty one instances when Chiswick and Brixton reported mist, fog or haze on the same date; which is approximately equal to one observation every two days. There are 6.49 miles (10.44 km) between Chiswick and Brixton, making them the second closest pairing of observation sites. The records for these sites have the most dates in common with respect to reports of mist, fog or haze.

Kew and Westminster

Year	Total no. days when mist/fog/haze reported	No. days mist/fog/haze reported by both stations
1899	23	11
1900	15	1
1901	19	5
Total	**57**	**17**

Table 6.17 Dates when mist/fog/haze was recorded by Kew and Westminster in 1899-1901

Out of a total of fifty seven dates in 1899-1901, there were seventeen occasions when Kew and Westminster reported mist or fog on the same day; which approximately corresponds to one observation every three days. There are 6.83 miles (10.99 km) between Kew and Westminster, and they have the third largest amount of dates when mist or fog was experienced on the same date.

Kew and Brixton

Year	Total no. days when mist/fog/haze reported	No. days mist/fog/haze reported by both stations
1899	21	14
1900	15	5
1901	18	7
Total	**54**	**26**

Table 6.18 Dates when mist/fog/haze was recorded by Kew and Brixton in 1899-1901

From a total of fifty four dates in 1899-1901, there were twenty six instances when Kew and Brixton reported mist or fog on the same date; which is approximately equivalent to one observation every two days. There are 7.50 miles (12.07 km) between Kew and Brixton, which is the greatest distance between the four observation sites. Yet the reports for these sites have the second largest amount of observations of mist or fog in common.

The spatial variation of the mist and fog in London can be estimated by looking at the differences between the reports from the sites which are the furthest away from the Savoy Hotel. These sites are Chiswick and Kew. Chiswick is 6.09 miles (9.80 km) due West of the Savoy Hotel and Kew is 7.45 miles (11.98 km) due West of the Savoy Hotel. Since Westminster is 0.97 miles (1.56 km) South South West of the Savoy Hotel, comparing the observations recorded at Westminster to those for Chiswick and Kew will aid in determining the distribution of mist and fog around London. For Chiswick and Kew, mist or fog was reported at both sites approximately once every four days. Whilst for Kew and Westminster, mist or fog was observed at both sites approximately once every three days.

A comparison between the dates when mist or fog was reported at the sites from the two pairings, Chiswick-Westminster and Kew-Westminster, will highlight any similarities between the locations.

In 1899, mist or fog was reported by both Chiswick and Westminster a total of ten times and these dates were echoed by the observations from the pairing of Kew and Westminster on all occasions. There was only one other date when mist or fog was reported by both Kew and Westminster that was not also reported by Chiswick. During 1900, Chiswick and Westminster reported similar observations of mist or fog on two days, one of which was also recorded by Kew. Finally in 1901, both pairings, Chiswick-Westminster and Kew-Westminster, recorded mist or fog observations on five dates in total. Of these five dates, observations at Chiswick, Westminster and Kew were in agreement on three days.

Looking at the observations for the three years draws attention to a significant similarity in the observations recorded at the three sites depicted in Figure 6.8. This shows that the distribution of mist/fog around this particular area of London experienced a certain degree of homogeneity.

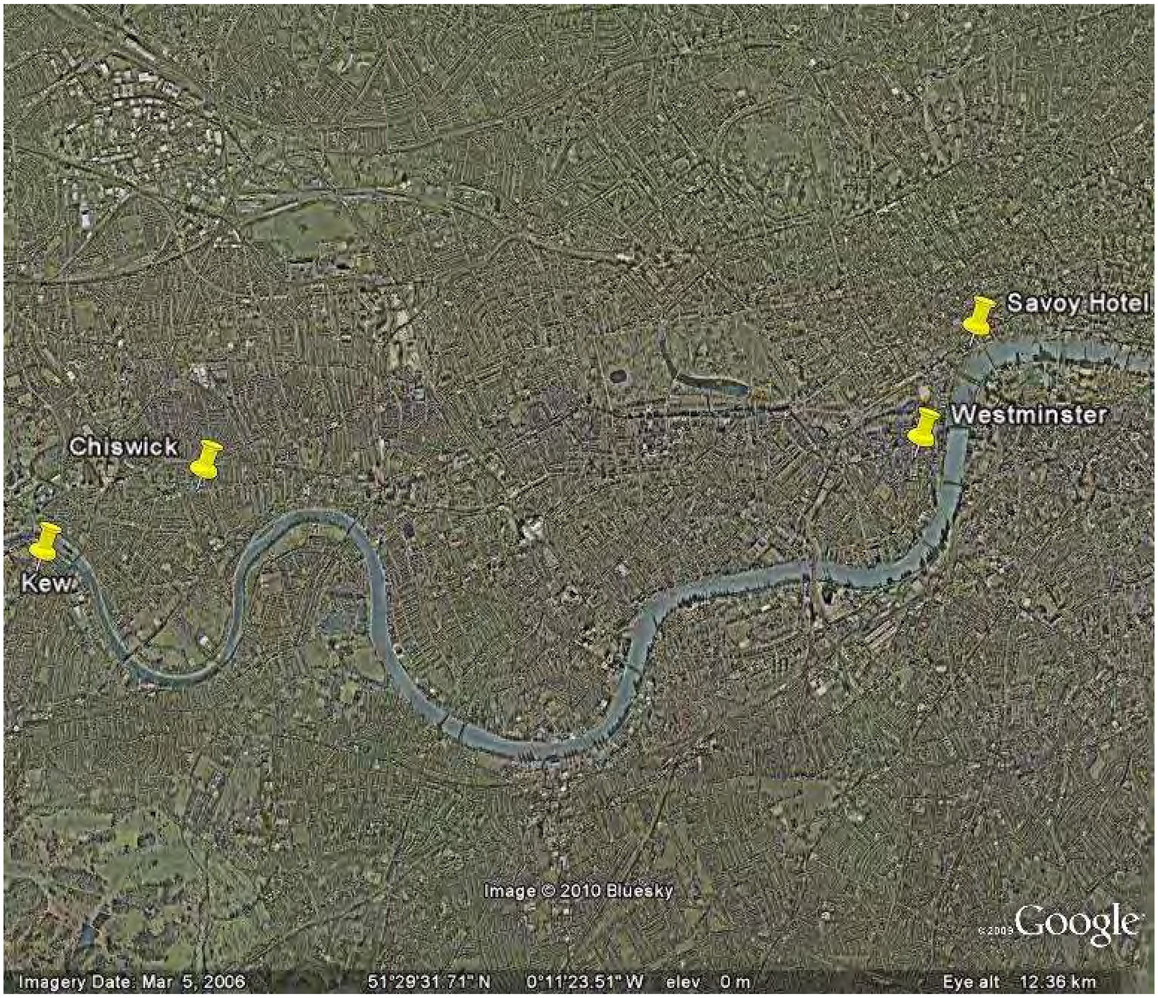


Figure 6.8 Locations of Chiswick, Westminster and Brixton with respect to the Savoy Hotel

6.5. Weather data from Monet's letters

Throughout this chapter, the content of Monet's letters are compared to the synoptic information contained within the two data sets; the Royal Horticultural Society's weather diaries and the weather reports from the stations at Westminster, Brixton and Kew.

The first letter that Monet wrote when he visited London in 1900 is dated February 10th 1900. The letter before that is dated February 5th 1900 and is postmarked Giverny. Of a possible nineteen dates in February 1900, Monet wrote eighteen letters in a total of fifteen days as on three occasions he wrote two letters in the duration of one day. Monet included observations of fog in seven of his letters that he wrote in February 1900. The relevant excerpts of these letters, complete with translations, are as follows.

1505 London, Monday 12th February 1900 to Alice Monet

"il y a un brouillard des plus épais" → there is a very thick fog

1506 London, Tuesday 13th February 1900 to Alice Monet

"Ce matin et hier, brouillard à ne rien voir" → This morning and yesterday, nothing to see but fog

1507 London, Wednesday 14th February 1900 to Alice Monet

"lorsque ce n'est pas un brouillard à ne rien voir" → when there is a fog nothing is is to be seen

1509 London, Saturday 17th February 1900 to Alice Monet

"une brume exquise, et un splendide coucher de soleil; aujourd'hui, pluie et brouillard" → an exquisite fog, and a splendid sunset; today, rain and fog

1517 London, Saturday 24th February 1900 at 10 o'clock to Alice Monet

"un brouillard superbe" → the fog is superb

1518 London, Sunday 25th February 1900 at 4:30 in the evening to Alice Monet

"beaucoup de brouillard" → lots of fog

1519 London, Monday morning at 10 o'clock 26th February 1900 to Alice Monet

"Je profile du brouillard très épais" → I benefit from very thick fog have taken advantage

"Ce matin au petit jour, il y a eu un brouillard extraordinaire" → This morning, at daybreak, there was an extraordinary fog

"Hélas! Le brouillard ne veut pas se dissiper" → Alas! The fog does not want to recede

During the whole of March in 1900, Monet wrote twenty six letters in twenty one days, where on five occasions he wrote twice a day. However, only one letter that Monet wrote in March 1900 contained any information regarding the fogs. An extract from this letter is given below.

1531 London, 17th March to Alice Monet

"moments très beau avec un brouillard délicieux" → very beautiful moments with a delicious fog

And in April 1900, Monet wrote two letters, one on each day that he was still in London, as he left England during this period. Unfortunately, neither of these letters included an observation of the fog. Monet's next letter of correspondence is dated April 10th 1900 and has a Giverny postmark.

During the following year, in 1901, Monet's first letter is dated January 25th 1901. The letter before that one is dated January 18th 1901 and has a Giverny postmark. Out of a possible seven dates in January 1901, Monet wrote four letters in a total of four days. In February 1901, Monet wrote twenty six letters in twenty two days, where on two occasions he wrote twice a day and once he wrote three letters in one day. Of these letters that he wrote in February 1901, Monet enclosed details of the London fogs in ten. Passages from these letters are listed below.

1592 London, Saturday 2nd February 1901 to Alice Monet

"un léger brouillard" → a light fog

1593 London, Sunday 3rd February 1901 to Alice Monet

"Grâce aux fumées, la brume est venue, puis des nuages" → Through the smoke, the fog came, then clouds

1596 London, Tuesday 5th February 1901 to Alice Monet

"le brouillard s'est épaissi assez pour dissimuler la neige" → the mist thickened enough to hide snow

1597 London, Wednesday 6th February 1901 to Alice Monet

"Il y avait bien un peu trop de brouillard le matin, mais le joli ballon rouge n'a pas été long à se montrer et avec lui une succession d'effets étonnants" → There was a little too much fog this morning, but the pretty red balloon was not long to be shown and with him a succession of astonishing effects

1598 London, Friday 8th February 1901 to Alice Monet

"beau temps, mais obstrué par le brouillard" → beautiful weather, but obstructed by fog

1599 London, Saturday 9th February 1901 to Alice Monet

"Encore une journée de brouillard complet " → Again a day of complete fog

1601 London, Monday 11th February 1901 to Alice Monet

"les effets variables au possible à cause de cette brume merveilleuse" → variable effects are possible because of this marvellous fog

1604 London, Thursday 14th February 1901 to Alice Monet

"c'est le brouillard qui s'est levé en augmentant d'intensité" → it is the fog which rose with increasing intensity

1606a London, Sunday 17th February 1901 to Alice Monet

"des bourrasques de neige, puis du soleil, du brouillard et du temps noir" → flurries of snow, then sun, fog and black weather

1608a London, Tuesday morning 19th February 1901 to Alice Monet

"à chaque pas je voyais de belles choses justement à cause de ce grand brouillard" → with each step I precisely saw beautiful things because of this thick fog

Monet wrote his last letter in London on March 30th 1901, and out of a thirty possible dates Monet wrote nineteen letters on seventeen days, on one occasion writing three letters in one day. Observations of fog were not included in any of the letters that Monet wrote in March 1901. Monet's next letter of correspondence is dated April 8th 1901 and is postmarked Giverny.

6.6. A comparison of Monet's letters, the observed weather data and the calculated dates of Monet's paintings

The information contained within Monet's letters, regarding fog occurrences, can be compared to the dates when fog, mist or haze was reported by any of the synoptic data sets. Firstly, Monet's letters were compared to the data collated from the weather stations; after which the letters were also compared to the entries of the Royal Horticultural Society's weather diaries.

1900

Data sources	N$^{o.}$ of dates	Dates
Letter + Westminster/Brixton/Kew	5	Feb: 12th-13th, 17th, 25th-26th

Table 6.19 Dates of fog occurrences recorded by Monet and a weather station in 1900

Data sources	N$^{o.}$ of dates	Dates
Letter + RHS weather diary + Westminster/Brixton/Kew	4	Feb: 12th-13th, 25th-26th

Table 6.20 Dates of fog occurrences recorded by Monet, the RHS and a weather station in 1900

1901

Data sources	N$^{o.}$ of dates	Dates
Letter + Westminster/Brixton/Kew	7	Feb: 2nd-3rd, 5th, 8th-9th, 11th, 19th

Table 6.21 Dates of fog occurrences recorded by Monet and a weather station in 1901

Data sources	N$^{o.}$ of dates	Dates
Letter + RHS weather diary + Westminster/Brixton/Kew	3	Feb: 3rd, 8th-9th

Table 6.22 Dates of fog occurrences recorded by Monet, the RHS and a weather station in 1901

The strengths and weaknesses of using the data from the Royal Horticultural Society's weather diaries and the weather reports for Westminster, Brixton and Kew have been considered and are listed below.

Royal Horticultural Society's weather diaries

Strengths	Weaknesses
On-site weather observations	Only one observation recorded daily at 9am
	Weather observations can be subjective to the observer

Table 6.23 Strengths and weaknesses of the Royal Horticultural Society's weather diaries

Weather reports for Westminster

Strengths	Weaknesses
On-site weather observations	Only one observation recorded daily at 2pm
	No observations recorded for March 1900 or 1901
	Weather observations can be subjective to the observer

Table 6.24 Strengths and weaknesses of the weather reports for Westminster

Weather reports for Brixton

Strengths	Weaknesses
On-site weather observations	No observations recorded for March 1901
Two observations recorded at Brixton	Two observations for Brixton recorded 'this morning', so exact time of observation remains unknown
	Weather observations can be subjective to the observer

Table 6.25 Strengths and weaknesses of the weather reports for Brixton

Weather reports for Kew

Strengths	Weaknesses
On-site weather observations	No observations recorded for March 1900 or 1901
Observations recorded at two hourly intervals	No early morning observation recorded
	Weather observations can be subjective to the observer

Table 6.26 Strengths and weaknesses of the weather reports for Kew

6.7. Discussion

6.7.1. Royal Horticultural Society weather diaries

The gardens of the Royal Horticultural Society are located in Chiswick, west London, which is almost directly west of Westminster and the Savoy Hotel. For this reason, dates when a wind blows from west to east, known as a westerly wind, are of interest here. The corresponding dates can be found in Appendix 7. The weather conditions detected on these dates can all be identified in one of Monet's paintings from his London Series.

Dull and cloudy conditions, as well as mist, fog, rain and snow, all reduce the visibility of a scene to some degree, which could have been the inspiration for some of Monet's hazy depictions of London, for example W1567 'Waterloo Bridge effet de soleil' (sunlight effect). On the other hand, bright and clear conditions could equally have been the inspiration for Monet's light and colourful portrayals of the city, such as W1532 'Charing Cross Bridge, reflets sur la Tamise' (reflections on the Thames).

6.7.2. Weather reports – south of England, Westminster and Brixton

The observations in these reports consist of 'forecasts for 24 hours ending at noon on the day of the report' for the south of England, 'today's 2pm reports' for Westminster, and 'daily weather reports' for Brixton. Since the precise location for the south of England observations is unknown, any conditions that obscure visibility have been considered and are contained in Appendix 7. The meteorological conditions experienced are primarily changeable, cloudy, dull, overcast, foggy, misty or unsettled. The changeable, cloudy, dull and unsettled conditions, with mist, fog and rain, all work to reduce the visibility of a scene. These conditions have been identified in some of Monet's paintings of London, for example W1573 'Waterloo Bridge, soleil dans le brouillard' (effect of sunlight in the fog) and W1574 'Waterloo Bridge'. As depicted on the maps previously, Brixton is to the south of Westminster and the Savoy Hotel. So any observations with a southerly wind, that is a wind that blows from south to north, recorded in the 'daily weather reports' may be significant here. The daily observations are recorded for 'yesterday evening', 'this morning' and for the 'past 24 hours', so dates have been selected with respect to these three time frames and can again be found in Appendix 7.

The overcast, cloudy, misty and foggy conditions experienced would all reduce visibility. As aforementioned, these conditions have been identified in some of Monet's paintings of London. Equally, the observations of blue sky have also been identified in Monet's brighter depictions of the city.

6.7.3. Weather reports – Brixton and Kew

The observations were recorded for weather stations posted at Brixton and Kew. The reports for Brixton were recorded at three times throughout the day; 8am, 2pm and 6pm. As Monet started his scenes of Waterloo Bridge in the morning and worked on his paintings of Charing Cross Bridge after noon and into the early afternoon sun, only the 8am and 2pm observations are relevant here. Again, Brixton is to the south of Westminster and the Savoy Hotel, so observations that corresponded to southerly winds are important. The corresponding dates can be found in Appendix 7.

The recorded meteorological observations are visible in Monet's depictions of London. For example, overcast conditions would work to reduce the vibrancy of light within a scene and W1563 'Waterloo Bridge, temps couvert' (overcast weather) is a painting that clearly reflects this. The reports from Kew weather station consist of two hourly observations from 10am to 10pm, along with any other daily remarks, so the morning to early afternoon observations are important here. Kew is to the west of Westminster, but since the wind directions are not detailed in these particular reports the dates that have conditions that will compromise visibility will be used here. As with the dates for Brixton weather station, the dates recorded by Kew weather station have also been included in Appendix 7. The weather conditions reported would result in a reduction in visibility, and is recognisable in many of Monet's representations of London at the turn of the twentieth century. A couple of example of such depictions are W1554 'Charing Cross Bridge, brouillard sur la Tamise' (fog on the Thames) and W1575 'Waterloo Bridge, brouillard' (fog).

6.7.4. Fog frequency and spatial variation

The frequency of the fogs observed at Brixton was recorded by the Meteorological Office for the time period 1871-1903. The measurements showed that the highest total of foggy days was eighty six in 1886, whilst the lowest was thirteen days in 1900 (Thornes and Metherell, 2003). Figure 6.9 shows the results published by Marriot for fog occurrences observed at Brixton and West Norwood, for the years 1878 to 1903.

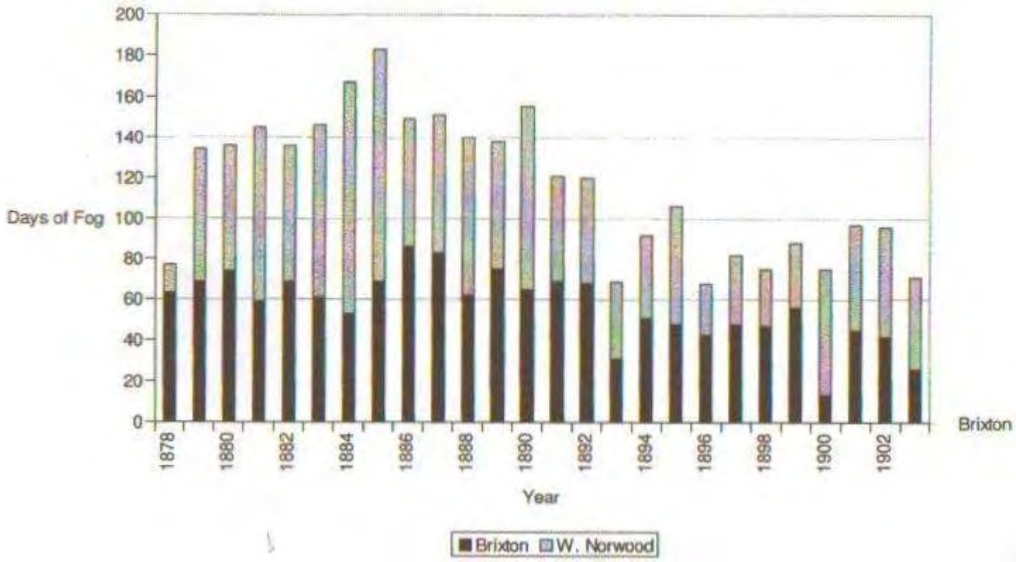


Figure 6.9 Days fog was observed at Brixton and West Norwood, 1878-1903 (Thornes and Metherell, 2003)

There are three miles between these sites, so the distribution of fogs could also be assessed. During this period, Brixton had an average of fifty seven days of fog compared to one hundred and sixteen days at West Norwood. In spite of the spatial distribution of the fogs experienced in London, the differences observed between the two sites are possibly due to the varying definition of 'fog' (Thornes and Metherell, 2003). Captain Carpenter established definition for 'light fog', 'moderate fog' and 'thick fog' during The London Fog Inquiry 1901/2. However, problems with these definitions were encountered due to the narrow streets of the city, as they did not present clear views (Thornes and Metherell, 2003). Therefore another definition was then determined (Bernstein 1975:199).

> Thin Fog or Mist was defined as visibility of objects at 200 yards or more, slightly hindering traffic by rail and river but not by road. Moderately Thick Fog was taken to mean that observers were unable to discern a man by day more than 100 yards away, a house at 200 yards, or a street light by night at

440 yards. Dense Fog meant inability to discern objects across the road by day or lights of street lamps 60 yards distant by night.

6.7.5. Fog observations – Brixton, Kew, *The Times* newspaper

As discussed earlier, the fog observations have been recorded by three independent bodies; Brixton weather station, Kew weather station, and *The Times* newspaper. The occasions when fog occurred and was reported by one of the sources mentioned above, have been noted in Appendix 7.

6.7.6. Fog observations – relative humidity

The values of relative humidity were calculated for the observation sites at Chiswick, Westminster and Brixton, for 1899-1901, in order to compare the likelihood of mist/fog/haze occurrences to actual observations of mist/fog/haze. The relative humidity figures calculated for these sites are listed in Appendix 6 and have been discussed in Section 6.4. 'A comparison of the observed weather data and the calculated dates of Monet's paintings'

6.7.7. Monet's letters

In total, Monet wrote ninety five letters to Alice and various other contacts during both his visits to London in 1900-01. Of those ninety five letters, only eighteen contained comments about the fogs that he experienced whilst painting his subjects. Excerpts of these letters have been detailed in Section 6.3. 'Weather data from Monet's letters' and are also displayed in Appendix 8.

6.7.8. Summary

The strengths and weaknesses of the meteorological data that has been considered are listed in Table 6.27.

Meteorological data

Strengths	Weaknesses
Lots of data is available for the required time periods	All observations recorded are open to human error
Different site locations shows the spatial variation of London's fogs	Errors are involved with averaging the daily weather measurements for 1899-1901 to derive monthly values
	Techniques for measuring smoke levels was limited until 1960
	The definition of 'fog' leads to differing results

Table 6.27 Strengths and weaknesses of the meteorological data

Taking the strengths and weaknesses of the meteorological data into account, it can be concluded that London's emissions saw a definite decline during the twentieth century. In a hundred years, (1910-2010), pollution levels fell by nearly 97% from 300 $\mu g/m^3$ to 10 $\mu g/m^3$. During this time, weather data shows that the meteorological situation in London also saw changes; becoming drier and warmer with increased levels of sunshine. The conditions experienced in London at the turn of the twentieth century are also clearly depicted in Monet's paintings of the city, along with his letters of correspondence.

CHAPTER 7: Conclusions

7.1. Introduction

The aim of this chapter is to conclude the study of Monet's London Series as a whole; with the intention of answering the all important question "can Monet's London Series be used as proxy data for the London fogs occurring at the turn of the twentieth century?"

In order to answer this question entirely, the key findings determined when investigating the three objectives outlined in Chapter 1, will be collated into two main categories; 'empirical contributions' and 'theoretical contributions'. Both of these terms are umbrella headings which will cover the majority of the work that has been conducted throughout this investigation. The three objectives were as follows;

- To critically review the evolution of the symbolism of skies in landscape art as well as the background to London's climate and fogs at the turn of the twentieth century together with an analytical appraisal of the context of Monet's life and artistic representations of 'l'enveloppe' in his London Series.
- Definition of a solar geometry method that will enable the derivation of the dates and times of production of Monet's paintings of Waterloo Bridge and Charing Cross Bridge.
- Investigation of information included in Monet's letters of correspondence as well data from the Royal Horticultural Society's weather diaries and weather reports from three weather stations in London.

The 'empirical contributions' to the key findings consisted of two of the three main objectives. Firstly, the geometrical analysis of Westminster, encompassing the whole region from the Savoy Hotel to Waterloo Bridge, Charing Cross Bridge and the Houses of Parliament, respectively. The solar geometry work carried out for the paintings selected from Monet's London Series has also been considered in this section; as the dates that have been derived using the methods highlighted in Chapter 5, were fundamental in the overall conclusion of this thesis. Secondly, the collation of the data from the various meteorological sources, the calculated values of relative humidity for the observation sites and the content of Monet's letters of correspondence (all discussed in Chapter 6), contributed significantly to the 'empirical contributions' within this study. And finally, the comparative analysis of all of the data exhibited in Chapter 6 in conjunction with the analysis of Monet's paintings on Waterloo Bridge and Charing Cross Bridge (also in Chapter 6) forms the remainder of the 'empirical contributions' section.

The 'theoretical contributions' to this investigation covers one of the three objectives stated at the beginning of this study. The aim of the research presented in the literature review (Chapter 2) was to introduce the reader to the subject area and to provide background information to aid in their understanding. This began with an introduction to previous work conducted within a similar context; covering topics such as landscape art, the portrayal of skies within paintings, and finally the intended deconstruction of Monet's London Series. The literature review also covered more scientific theory that was involved in trying to analyse the London fogs, as well as their cause and effect. Finally, the 'theoretical contributions' addressed the various media used in the depictions of London during the nineteenth century and Monet's development as an artist during this time.

By evaluating all of the contributions in this way, an informed decision regarding the question that underpins this study, can be made.

7.2. Key findings

The 'empirical contributions' to this study can be condensed into three main categories;

- the geometrical analysis of Westminster,
- the solar geometry analysis to derive the dates and times of production for each painting,
- the comparative analysis between Monet's paintings, letters and the synoptic data sets

These analyses were carried out with the intention of determining Monet's accuracy in depicting the fogs in his London Series.

A geometrical analysis of Westminster was conducted to aid with the visualisation of the area of London that Monet resided in and painted. In addition to this, the analysis of the structures within Monet's paintings means that an internal scale could be derived thus providing the necessary information that was required for the solar geometry analysis.

The dates derived using the solar geometry method, for the twelve initially selected paintings, were consistent with the periods that Monet visited London, in 1899-1901, for all but three paintings (W1532, W1536 and W1537). The reason for this is that the position of the sun within these three paintings is too far above the top of the canvas to allow an accurate analysis of the solar geometry. Consequently, any dates that could be derived would be erroneous and misleading. Nevertheless, the other nine paintings were successfully dated. Five paintings of Waterloo Bridge were dated as being produced in either 1900 or 1901, and the remaining four paintings, one of Charing Cross Bridge and three of Waterloo Bridge, were dated with 1901 as being the only possible year of production. The derivation of these dates meant that the content of the Monet's paintings and thus his representations of the meteorological situation could be compared to the synoptic data gathered from the Royal Horticultural Society's weather diaries, and the weather reports from Westminster, Brixton and Kew. These data sources were used to further refine the derived dates to produce 'new dates' for each painting. The dates for the Waterloo Bridge and Charing Cross Bridge paintings are displayed overleaf along with the dates that Baker and Thornes derived in 2006 for Monet's Houses of Parliament paintings. These tables are also displayed in Appendix 9.

The dates for the Waterloo Bridge and Charing Cross Bridge paintings are displayed in Appendix 9, along with the dates that Baker and Thornes derived in 2006 for Monet's Houses of Parliament paintings. From this data, the dates derived for the paintings of Waterloo Bridge and Charing Cross Bridge, that are consistent with observations recorded in the weather reports, weather diaries or Monet's letters, have been selected in an attempt to determine more specific dates for each painting. This has meant that the tables of dates for April 1900, January 1901 and March 1901 have been eliminated since the dates of paintings did not tally with the data or vice versa. All of these table are still shown in full in Appendix 9.

February 1900

Date	Letter	RHS weather diary	Westminster weather report	Brixton weather report	Kew weather report	Dates– solar geometry	New dates
10					✓	W1573, W1607	W1573
12	✓	✓		✓	✓	W1573, W1605, W1607, W1610	W1573
13	✓	✓	✓	✓	✓	W1573, W1599, W1605, W1607, W1610	W1573
14	✓					W1573, W1599, W1605, W1607, W1610	W1573, W1599, W1605, W1607, W1610
15					✓	W1572, W1573, W1599, W1605, W1610	W1572, W1573, W1599, W1605, W1610
17	✓		✓			W1572, W1599, W1602, W1605, W1610	W1572
24	✓					W1574, W1604, W1606	W1574, W1604, W1606

Date	Letter	RHS weather diary	Westminster weather report	Brixton weather report	Kew weather report	Dates– solar geometry	New dates
25	✓	✓			✓	W1575, W1604, W1606	W1575
26	✓	✓		✓	✓	W1575, W1604, W1606	W1575, W1606
27				✓	✓	W1575	W1575
28		✓		✓	✓	W1575	W1575

Table 7.1 Fog/Mist/Haze events in London from sources used in this thesis for February 1900

March 1900

Date	Letter	RHS weather diary	Westminster weather report	Brixton weather report	Kew weather report	Dates – solar geometry	New dates
21		✓		✓		W1597	W1597

Table 7.2 Fog/Mist/Haze events in London from sources used in this thesis for March 1900

February 1901

Date	Letter	RHS weather diary	Westminster weather report	Brixton weather report	Kew weather report	Dates – solar geometry	New dates
1		✓	✓		✓	W1554, W1555	W1554, W1555
2	✓				✓	W1554, W1555, W1565	W1554, W1555, W1565
3	✓	✓		✓		W1554, W1565	W1554, W1565
4		✓	✓	✓	✓	W1554, W1565	W1554, W1565
5	✓		✓			W1554	W1554
6	✓					W1554	W1554
7			✓	✓	✓	W1554	W1554

Date	Letter	RHS weather diary	Westminster weather report	Brixton weather report	Kew weather report	Dates – solar geometry	New dates
10					✓	W1573, W1607	W1573
11	✓		✓		✓	W1573, W1605, W1607	W1573, W1605, W1607
13					✓	W1573, W1599, W1605, W1607, W1610	W1573, W1599, W1605, W1607, W1610
14	✓					W1573, W1599, W1605, W1607, W1610	W1573, W1599, W1605, W1607, W1610
15			✓			W1572, W1573, W1599, W1605, W1610	W1572, W1573
17	✓					W1572, W1599, W1602, W1605, W1610	W1572
18				✓	✓	W1572, W1574, W1599, W1602, W1605, W1610	W1574
19	✓		✓			W1572, W1574, W1599, W1602, W1605, W1606	W1574
20					✓	W1574, W1599, W1606	W1574

Date	Letter	RHS weather diary	Westminster weather report	Brixton weather report	Kew weather report	Dates – solar geometry	New dates
21				✓		W1574, W1599, W1606	W1574

Table 7.3 Fog/Mist/Haze events in London from sources used in this thesis for February 1901

Monet also wrote many letters during his stays in London, which would often contain observations of the weather. These letters provided support to the theory that Monet had painted the canvases on the particular dates that were derived using the solar geometry. As discussed earlier in this chapter, with the use of the information contained in the various sources of synoptic data, along with Monet's letters, the initial dates derived for each painting using the solar geometry, were refined further still. These two sets of dates are displayed in a table, for comparison, in Appendix 11.

The 'theoretical contributions' to this study have come largely from the literature review that was conducted at the beginning of this investigation (Chapter 2). The literature review provided an introduction to the research area. The motivation behind this investigation is based on the work conducted by previous studies that used art as a form of proxy data for the weather and climate. A number of these studies explored the relationship between elements such as the sky, atmosphere, weather, climate and climate change, and how they are represented through an artistic medium. The aim of this investigation was to utilise some of the principles of these past studies in order to examine Monet's London Series accurately.

Another key study that inspired this work was that of Baker and Thornes (2006) when they analysed Monet's paintings of the Houses of Parliament from his London Series. Baker and Thornes used solar geometry in order to determine the dates and times of production for these paintings. Therefore, this new study could be viewed as a continuation of the Baker and Thornes report with the intention of incorporating the analysis of the Waterloo Bridge and Charing Cross Bridge paintings from the same series.

7.3. Future work

Given more time, work within this research area could have progressed in a number of directions. Firstly, the scientific analysis of Monet's London Series could have been developed to include an investigation of the visual range within the selected paintings, as well as a deeper analysis of the colour and content of the London fogs. The other area of development that could be pursued would fall under the artistic side of this research, as it would incorporate studying a wider range of paintings of London produced during the nineteenth century. This would ultimately create a kind of pictorial catalogue of events tracking the rise and decline of the London fogs.

These are just a couple of suggestions for the continuation of this study; however there are probably a plethora of other avenues that could also be explored.

7.4. Final words

The main driving force at the start of this study was to try to show that Monet produced accurate representations of the London skies in his paintings of Waterloo Bridge and

Charing Cross Bridge. Now that the analysis of Monet's depictions of Waterloo Bridge and Charing Cross Bridge, with respect to various sources of data, has come to fruition, it is fair to conclude that Monet did in fact paint accurate representations of London on a number of occasions during his visits at the turn of the twentieth century. Since this is the case, the hypothesis at the very beginning of the investigation that, if successful, this work could provide a ready made pictorial as well as a numerical representation of the London fogs, has been achieved.

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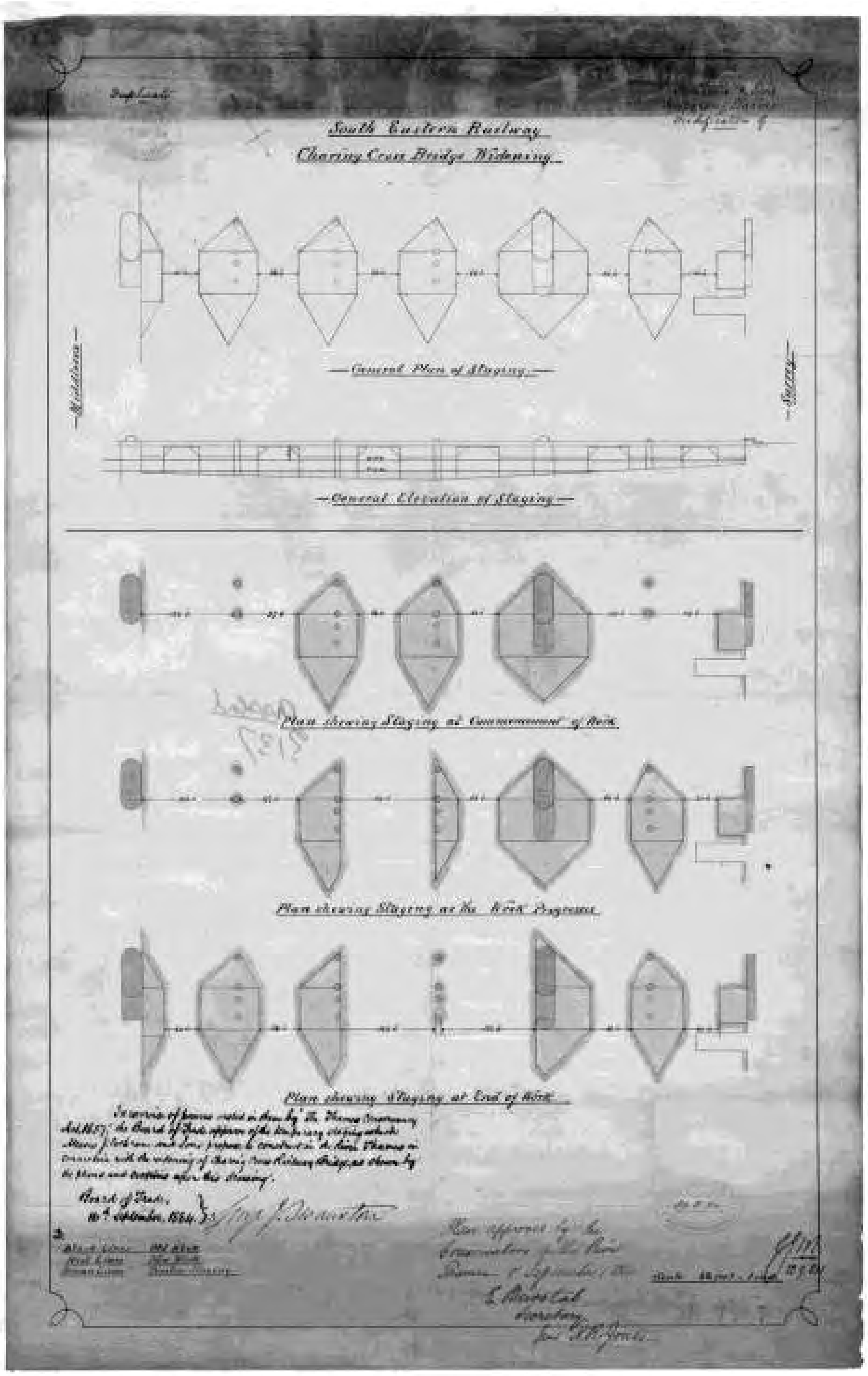
APPENDIX 1: Board of Trade plan of Charing Cross Bridge for 1884



APPENDIX 2: Geometrical analysis of the Waterloo Bridge paintings

Geometrical analysis of Waterloo Bridge paintings sun visible

WB Painting 2: 'Waterloo Bridge, soleil dans le brouillard' (W1573)

	Angle (°)	Distance (mm)	Ratio (°/mm)
Solar Azimuth	122.50 ± 0.50	-	-
AB	7.00 ± 0.50	25.00	0.280 ± 0.026
BC	5.00 ± 0.50	23.50	0.213 ± 0.026
AC	12.00 ± 0.50	48.50	0.247 ± 0.013
DE	2.70 ± 0.16	-	-
EF	3.86 ± 0.05	13.00	0.297 ± 0.015
DF	6.56 ± 0.11	-	-

Average degree to millimetre ratio: (0.259 ± 0.020) °/mm

	Distance (mm)	Angle (°)
Sun above Waterloo Bridge	42.00 ± 0.50	6.648 ± 1.000
Sun above City Sewers	-	-

Average elevation to the sun: (6.65 ± 1.00) °

WB Painting 3: 'Waterloo Bridge' (W1574)

	Angle (°)	Distance (mm)	Ratio (°/mm)
Solar Azimuth	118.50 ± 0.50	-	-
AB	-	-	-
BC	-	-	-
AC	-	-	-
DE	2.70 ± 0.16	-	-
EF	3.86 ± 0.05	8.00	0.483 ± 0.037
DF	6.56 ± 0.11	-	-

Average degree to millimetre ratio: (0.483 ± 0.037) °/mm

	Distance (mm)	Angle (°)
Sun above Waterloo Bridge	25.00 ± 0.50	7.845 ± 1.196
Sun above City Sewers	-	-

Average elevation to the sun: (7.85 ± 1.20) °

WB Painting 4: 'Waterloo Bridge, brouillard' (W1575)

	Angle (°)	Distance (mm)	Ratio (°/mm)
Solar Azimuth	113.00 ± 0.50	-	-
AB	4.00 ± 0.50	8.00	0.500 ± 0.094
BC	7.00 ± 0.50	16.00	0.438 ± 0.045
AC	11.00 ± 0.50	24.00	0.458 ± 0.030
DE	2.70 ± 0.16	8.00	0.338 ± 0.041
EF	3.86 ± 0.05	6.00	0.643 ± 0.062
DF	6.56 ± 0.11	15.00	0.437 ± 0.022

Average degree to millimetre ratio: (0.469 ± 0.040) °/mm

	Distance (mm)	Angle (°)
Sun above Waterloo Bridge	22.00 ± 0.50	6.088 ± 1.085
Sun above City Sewers	10.00 ± 0.50	7.020 ± 0.725

Average elevation to the sun: (6.55 ± 0.91) °

Geometrical analysis of Waterloo Bridge paintings sun inferred

WB Painting 2: 'Waterloo Bridge, temps couvert' (W1563)

	Angle (°)	Distance (mm)	Ratio (°/mm)
Solar Azimuth	104.50 ± 0.50	-	-
AB	4.00 ± 0.50	15.00	0.267 ± 0.042
BC	7.00 ± 0.50	47.50	0.147 ± 0.012
AC	11.00 ± 0.50	62.50	0.176 ± 0.009
DE	2.70 ± 0.16	15.00	0.180 ± 0.011
EF	3.86 ± 0.05	13.00	0.297 ± 0.004
DF	6.56 ± 0.11	28.00	0.234 ± 0.004

Average degree to millimetre ratio: (0.217 ± 0.014) °/mm

	Distance (mm)	Angle (°)
Sun above Waterloo Bridge	37.00 ± 0.50	3.799 ± 0.597
Sun above City Sewers	5.00 ± 0.50	3.415 ± 0.269

Average elevation to the sun: (3.61 ± 0.43) °

WB Painting 3: 'Waterloo Bridge, effet de soleil' (W1565)

	Angle (°)	Distance (mm)	Ratio (°/mm)
Solar Azimuth	124.00 ± 0.50	-	-
AB	4.00 ± 0.50	17.50	0.229 ± 0.035
BC	7.00 ± 0.50	43.00	0.163 ± 0.014
AC	11.00 ± 0.50	60.50	0.182 ± 0.010
DE	2.70 ± 0.16	13.00	0.208 ± 0.012
EF	3.86 ± 0.05	12.00	0.322 ± 0.004
DF	6.56 ± 0.11	25.00	0.262 ± 0.004

Average degree to millimetre ratio: (0.228 ± 0.013) °/mm

	Distance (mm)	Angle (°)
Sun above Waterloo Bridge	35.00 ± 0.50	3.750 ± 0.539
Sun above City Sewers	10.00 ± 0.50	4.610 ± 0.334

Average elevation to the sun: (4.18 ± 0.44) °

WB Painting 4: 'Waterloo Bridge, effet de soleil' (W1567)

	Angle (°)	Distance (mm)	Ratio (°/mm)
Solar Azimuth	130.00 ± 0.50	-	-
AB	4.00 ± 0.50	28.00	0.143 ± 0.020
BC	7.00 ± 0.50	66.00	0.106 ± 0.008
AC	11.00 ± 0.50	94.00	0.117 ± 0.006
DE	2.70 ± 0.16	15.00	0.180 ± 0.011
EF	3.86 ± 0.05	19.00	0.203 ± 0.003
DF	6.56 ± 0.11	34.00	0.193 ± 0.003

Average degree to millimetre ratio: (0.157 ± 0.009) °/mm

	Distance (mm)	Angle (°)
Sun above Waterloo Bridge	59.00 ± 0.50	5.033 ± 0.580
Sun above City Sewers	26.50 ± 0.50	6.491 ± 0.407

Average elevation to the sun: (5.76 ± 0.49) °

APPENDIX 3: Royal Horticultural Society's weather diaries and weather reports for Westminster, Brixton and Kew

b = blue sky
bc = partly cloudy
c = cloudy (detached opening clouds)
d = drizzling rain
f = fog
g = gale
h = hail
l = lightning
m = mist
o = overcast (the whole sky is covered with one impervious cloud)
p = shower (passing showers)
q = squally
r = rain (continuous rain)
rs = sleet
s = snow
t = thunder
v = visibility of distant objects whether sky cloudy
w = dew deposit

Royal Horticultural Society

September 1899

Mean Relative Humidity at 9am = 72%

Date	Dry bulb T	Wet bulb T	Max T (day)	Min T (night)	Rain (inches)	Soil T @ 1ft	Soil T @ 2ft	Soil T @ 4ft	Min T (grass)	Wind dir	Weather observations
15	58.5	51.8	67.1	42.8	0.19	59.9	61.5	60.7	32.7	NNW	Bright & clear. Wind cool
16	58.9	53.5	63.1	54.0	0.04	60.8	61.1	60.6	48.2	WNW	Cloudy, strong wind, thunderstorms during the day
17	58.5	54.7	68.9	48.9	-	59.1	60.9	60.5	39.5	WSW	Cloudy. Wind moderate & fresh
18	57.9	52.6	63.2	51.8	0.08	59.1	60.6	60.4	43.9	WSW	Very cloudy, wind cold
19	56.2	50.8	62.7	54.0	0.21	58.3	60.2	60.2	46.9	WSW	Very dull, wind cold
20	54.9	48.9	59.3	49.3	-	57.8	59.8	60.1	42.8	WSW	Cloudy, wind very cold
21	52.4	47.3	62.8	40.9	0.15	55.3	59.2	59.9	29.8	WSW	Bright & clear. Wind very cold
22	55.1	46.8	59.9	51.0	-	57.1	58.8	59.6	44.7	WNW	Bright & clear, wind strong & cold
23	53.3	47.6	58.9	40.5	0.02	54.8	58.5	59.5	28.5	WSW	Dull & cloudy, wind cold, rain in evening
24	54.0	47.9	60.9	45.7	0.02	54.5	58.1	59.2	38.3	WNW	Bright & clear, wind strong & cold
25	58.0	52.8	61.1	51.5	0.01	55.9	57.7	59.0	48.8	WSW	Bright & clear
26	58.1	51.9	61.7	48.4	-	57.1	58.1	58.9	40.3	WSW	Bright & clear, wind strong & cold
27	54.5	50.6	60.2	47.9	0.11	55.6	58.1	58.6	40.2	SW	Dull, cloudy & raining slightly. Thunderstorm in evening
28	47.5	44.3	58.8	36.6	-	53.9	57.6	58.4	28.1	WSW	Bright, clear & calm
29	45.0	44.1	57.3	32.9	0.98	52.1	57.1	58.2	24.4	SSW	Cloudy & misty
30	47.2	45.9	55.8	44.9	0.02	53.9	56.3	58.1	35.6	SSW	Dull. Cold & raining slightly. Much lightning in evening

October 1899

Mean Relative Humidity at 9am = 88%

Date	Dry bulb T	Wet bulb T	Max T (day)	Min T (night)	Rain (inches)	Soil T @ 1ft	Soil T @ 2ft	Soil T @ 4ft	Min T (grass)	Wind dir	Weather observations
1	51.9	50.0	63.2	42.5	0.17	52.1	55.8	57.8	32.4	ESE	Raining. Wind cold
2	51.8	50.7	52.7	50.8	-	53.2	55.6	57.5	42.1	WSW	Dull, cloudy & cold
3	52.9	49.1	61.6	37.4	0.05	51.2	55.3	57.2	27.1	WSW	Clear & bright, wind cool
4	51.2	50.6	51.9	50.9	0.15	54.1	55.1	56.9	50.4	NNE	Misty & raining
5	51.1	47.0	52.6	47.5	-	53.5	55.3	56.9	47.5	ENE	Dull & overcast, wind moderate & fresh
6	48.6	45.4	53.3	37.5	-	51.8	55.1	56.9	27.5	ENE	Misty, fine, wind cool
7	45.6	44.0	56.1	34.9	-	50.2	54.6	56.7	26.2	SSE	Misty, fine, wind cool
8	36.6	36.2	51.1	32.4	-	49.2	54.1	55.4	25.4	NNW	Very misty or white fog, cold
9	40.1	40.0	59.7	31.7	-	48.3	53.3	56.1	25.9	ESE	Dense fog
10	36.1	35.6	60.2	32.1	-	48.2	52.9	55.9	24.9	ESE	Dense fog
11	41.0	40.3	63.7	34.6	-	48.2	52.5	55.6	27.1	SE	Dense fog
12	51.2	50.6	62.9	40.5	0.07	49.6	52.5	55.4	33.2	SE	Slight fog
13	47.8	43.5	53.6	41.2	-	50.5	52.8	55.1	32.8	WSW	Bright & clear wind fresh
14	41.0	39.7	52.5	29.0	-	47.9	52.6	54.9	20.2	NNE	Slightly misty
15	49.9	44.7	52.2	39.3	-	47.3	51.8	54.9	26.1	ESE	Bright & clear, wind strong & cold
16	47.9	44.0	56.1	42.9	-	47.3	51.3	54.6	33.7	ENE	Slightly misty, strong & cold wind
17	44.8	44.2	59.1	42.0	-	47.8	51.3	54.4	32.0	ENE	Thick fog
18	40.0	40.0	61.7	34.0	-	47.1	51.2	54.3	25.6	ENE	Thick fog
19	43.9	43.7	57.7	36.1	-	46.8	50.9	53.9	25.5	ENE	Dense fog
20	40.8	40.6	52.6	35.0	-	46.2	50.5	53.8	26.5	ENE	Dense fog
21	40.0	40.0	43.2	33.9	-	45.6	49.9	53.5	25.8	ENE	Dense fog
22	43.1	42.9	53.3	39.9	-	46.4	49.9	53.3	39.0	ENE	Dense fog, so dense at night impossible to see anything

Date	Dry bulb T	Wet bulb T	Max T (day)	Min T (night)	Rain (inches)	Soil T @ 1ft	Soil T @ 2ft	Soil T @ 4ft	Min T (grass)	Wind dir	Weather observations
23	43.8	43.8	54.0	39.1	-	46.9	49.9	53.1	36.4	NW	Slight fog
24	47.5	47.5	59.9	42.5	-	47.1	50.2	52.9	33.1	WNW	Slight fog
25	49.7	47.9	59.7	39.8	-	49.1	50.5	52.9	34.9	ESE	Slight fog
26	55.1	52.6	57.2	44.9	0.21	49.7	50.9	52.8	33.9	SSW	Bright & clear, rain later
27	57.8	56.3	60.2	53.9	1.08	51.8	51.3	52.8	51.5	SW	Dull & cloudy, heavy rain later
28	58.5	57.2	62.7	57.1	-	54.2	52.1	52.8	51.9	SSW	Cloudy to clear, fine day
29	58.2	55.8	60.5	50.5	0.27	54.7	52.9	52.9	43.9	SSW	Dull & cloudy, rain in the evening
30	48.2	47.5	51.1	47.9	0.02	54.4	53.2	53.1	47.8	NNW	Overcast & raining slightly
31	47.0	43.7	55.5	35.9	-	50.8	53.2	53.3	35.9	WSW	Clear & bright

November 1899

Mean Relative Humidity = 86%

Date	Dry bulb T	Wet bulb T	Max T (day)	Min T (night)	Rain (inches)	Soil T @ 1ft	Soil T @ 2ft	Soil T @ 4ft	Min T (grass)	Wind dir	Weather observations
1	51.9	48.8	63.3	34.5	0.04	48.5	52.3	53.4	26.4	SSE	Bright & clear
2	58.9	57.5	60.0	48.5	0.32	48.5	51.5	53.3	35.9	SSE	Dull, very mild and raining
3	56.8	51.6	59.0	52.5	1.33	51.6	51.8	53.2	44.5	SW	Clear & bright at first, rain later
4	59.2	58.4	60.9	48.9	0.31	51.9	52.2	53.1	48.1	SW	Cloudy & raining, wind strong
5	55.1	53.8	61.2	54.0	1.25	54.1	52.7	53.1	52.5	SW	Cloudy & raining, calmer, thorough wet day
6	49.5	48.4	52.5	48.8	0.02	53.3	53.2	53.1	47.5	ENE	Overcast & raining
7	50.2	48.8	55.7	35.3	0.32	50.2	53.1	53.3	28.9	SSW	Clear & bright at first, rain later

February 1900

Mean Relative Humidity at 9am = 88%

Date	Dry bulb T	Wet bulb T	Max T (day)	Min T (night)	Rain (inches)	Soil T @ 1ft	Soil T @ 2ft	Soil T @ 4ft	Min T (grass)	Wind dir	Weather observations
7	28.4	26.1	34.9	24.9	-	36.1	39.5	43.2	15.9	NNE	Bright & clear, cold sunny day
8	25.0	23.3	33.9	24.9	-	35.3	39.2	43.1	9.0	NNE	Bright & clear at first, dull & cold later
9	18.3	18.1	31.1	15.7	-	34.8	39.1	42.9	8.9	ENE	Slightly foggy, dull cold day
10	27.8	26.7	36.5	16.8	0.40	34.3	38.6	42.9	7.5	ESE	Clear at first, dull & cold later, snowstorm in evening
11	33.1	31.9	36.1	27.6	-	34.5	38.4	42.7	26.8	NNW	Cold partial thaw about 4 inches snow, sunny part of day
12	23.8	23.6	38.8	15.0	-	34.0	38.1	42.5	6.2	ESE	Slightly foggy, dull hazy cold day
13	28.7	28.4	37.1	21.7	0.55	34.1	38.1	42.3	11.5	ESE	Foggy at first, gale and snow later
14	34.9	33.3	38.5	28.8	0.07	34.1	37.9	42.1	28.1	NNW	Snowing at first, sunny but cold day
15	35.9	35.0	47.0	24.7	0.40	33.8	37.5	41.9	17.7	SE	Cold wet day
16	39.7	37.5	47.9	34.4	0.08	33.4	35.1	40.3	30.5	SW	Bright sunny day, wind cold
17	46.5	43.4	47.6	39.5	0.17	34.0	36.1	40.9	33.1	SSW	Bright morning, stormy afternoon, wind cold
18	39.0	37.7	51.4	32.8	0.08	34.4	36.3	40.9	23.4	SW	Bright, fine sunny day, rain at night
19	51.6	50.2	52.2	38.9	0.20	38.3	37.1	40.9	37.2	SW	Rain at intervals, strong wind
20	43.9	40.7	47.3	37.7	0.03	39.8	38.7	41.4	31.2	SW	Cloudy, showers at first, fine later, strong wind
21	36.2	32.9	46.0	32.8	0.08	38.2	39.5	41.3	26.1	WNW	Bright sunny morning, very fine day
22	46.3	44.8	54.2	35.8	0.10	38.4	39.5	41.6	27.2	SSW	Dull & cloudy at first, fine with sun later
23	51.1	50.1	56.4	38.4	0.03	40.5	39.9	41.8	29.5	SSW	Dull & cloudy at first, fine day, showers in evening
24	53.3	51.1	56.3	50.6	0.09	43.8	41.4	41.9	47.0	SSW	Dull & showery
25	50.8	50.3	55.6	49.1	0.07	45.5	42.3	42.1	45.0	SSW	Dull & misty, dull fine day
26	47.2	46.9	57.7	44.8	0.28	46.1	43.5	42.6	44.1	SE	Misty showery day
27	47.4	46.9	49.5	46.6	0.13	46.3	44.1	42.9	41.9	NW	Showers during day
28	42.4	41.4	42.5	41.9	0.04	46.3	44.5	43.5	40.2	NE	Misty showery day

March 1900

Mean Relative Humidity at 9am = 79%

Date	Dry bulb T	Wet bulb T	Max T (day)	Min T (night)	Rain (inches)	Soil T @ 1ft	Soil T @ 2ft	Soil T @ 4ft	Min T (grass)	Wind dir	Weather observations
1	38.8	35.0	41.7	36.7	0.01	43.7	44.5	43.8	33.5	NE	Dull fine day, wind cold
2	38.1	36.5	42.2	31.8	0.02	41.2	43.6	44.1	22.6	NNW	Dull & cold
3	38.9	36.8	43.0	35.9	0.01	41.0	42.9	44.1	30.4	NW	Misty, dull & cold
4	36.6	34.4	39.6	35.3	0.01	40.9	42.7	44.1	33.8	NE	Dull cold day
5	38.0	35.8	39.6	35.2	-	40.5	42.4	44.1	31.1	NE	Dull cold day
6	38.4	36.0	39.4	37.6	-	40.4	42.2	44.0	35.3	NE	Very dull cold day
7	36.9	33.9	42.0	34.8	-	39.8	42.1	43.9	32.9	NW	Very dull cold day
8	39.8	34.8	41.5	37.1	-	40.5	42.1	43.9	34.5	ENE	Very dull cold day
9	40.4	36.7	46.2	37.2	-	40.0	41.9	43.9	33.3	ESE	Very dull cold day
10	43.8	41.0	55.5	38.8	-	40.4	41.9	43.9	32.9	ENE	Misty at first, bright sunshine later
11	42.8	40.7	52.2	37.5	-	41.2	42.2	43.9	29.2	ENE	Dull & misty
12	39.7	37.2	56.9	32.9	-	41.2	42.4	43.9	23.6	NNW	Bright morning, very fine day
13	45.8	42.8	46.6	36.6	-	42.1	42.8	43.9	26.5	NNW	Dull & cloudy, no sun
14	44.2	41.6	52.4	31.9	-	40.6	42.6	43.9	22.3	NNW	Dull & cloudy, flashes of sunshine
15	46.2	42.5	49.4	42.2	0.06	42.4	43.1	43.9	38.5	W	Dull cold day
16	38.9	36.9	43.6	36.7	-	42.6	43.1	43.9	33.9	WNW	Dull and cloudy flashes of sunshine
17	33.8	30.5	41.0	25.6	-	40.4	43.1	43.9	16.5	WNW	Dull with cold sleet showers
18	38.0	32.9	41.6	21.7	0.37	39.0	42.4	44.1	14.4	ENE	Bright & clear at first, sleet showers later
19	36.2	35.8	45.3	32.9	0.18	38.8	41.9	44.1	31.3	SSE	Dull at first, fine with sun later
20	44.4	40.5	51.5	36.1	-	40.4	41.9	43.9	27.6	SSW	Bright & clear, fine bright day throughout
21	39.1	37.7	47.5	33.4	0.11	40.4	42.2	43.9	21.6	ENE	Misty cold day, rain at night
22	43.8	41.7	45.7	38.9	-	41.1	42.2	43.9	36.9	ENE	Dull cold day

Date	Dry bulb T	Wet bulb T	Max T (day)	Min T (night)	Rain (inches)	Soil T @ 1ft	Soil T @ 2ft	Soil T @ 4ft	Min T (grass)	Wind dir	Weather observations
23	41.1	39.8	46.0	40.5	-	42.0	42.4	43.9	39.8	NE	Dull day with cold black wind
24	38.9	36.1	41.5	35.6	-	40.7	42.5	43.9	33.9	ENE	Dull cold day
25	38.5	33.2	42.0	34.7	-	39.8	42.2	43.9	30.4	ENE	Cloudy, fine day with some sun
26	35.2	33.6	42.0	31.7	-	39.8	42.1	43.9	22.6	ENE	Dull & cloudy, snow at night
27	35.0	32.8	41.2	31.5	0.15	39.3	41.8	43.9	22.0	NNW	Dull & wet, some sun later
28	38.1	37.0	42.3	31.3	-	39.6	41.8	43.9	22.6	SW	Bright, clear & cold
29	36.7	34.3	45.6	29.8	-	39.4	41.8	43.8	20.5	NNE	Fog at first, fine & bright later
30	33.2	31.9	47.4	25.8	-	39.1	41.8	43.7	18.1	ENE	Slight fog, fine but cold day
31	36.1	33.8	48.0	28.5	-	38.6	41.5	43.7	19.6	ENE	Misty, dull cold day

April 1900

Mean Relative Humidity = 71%

Date	Dry bulb T	Wet bulb T	Max T (day)	Min T (night)	Rain (inches)	Soil T @ 1ft	Soil T @ 2ft	Soil T @ 4ft	Min T (grass)	Wind dir	Weather observations
1	40.7	36.9	43.2	27.5	-	38.4	41.2	43.5	18.3	ESE	Misty dull cold day
2	36.2	32.2	49.4	25.3	0.01	37.5	40.9	43.5	17.5	WSW	Misty, wind cold, fine spring-like day
3	39.8	39.4	52.2	30.0	0.39	39.1	40.9	43.5	22.0	WSW	Misty, showers with hail
4	48.4	44.8	55.2	39.9	0.07	41.8	41.5	43.4	37.2	WNW	Cloudy at first, fine spring-like day
5	44.9	41.8	49.7	36.4	0.10	45.0	42.5	43.3	27.9	WNW	Overcast, dull showery day
6	44.2	40.1	53.4	30.9	0.02	43.0	43.1	43.5	23.1	WNW	Bright & clear, fine spring day
7	43.8	41.2	48.5	39.8	0.01	44.1	43.5	43.6	29.8	ESE	Dull & cloudy. Cold day

January 1901

Mean Relative Humidity = 88%

Date	Dry bulb T	Wet bulb T	Max T (day)	Min T (night)	Rain (inches)	Soil T @ 1ft	Soil T @ 2ft	Soil T @ 4ft	Min T (grass)	Wind dir	Weather observations
21	48.8	46.8	52.9	39.0	-	42.7	43.2	45.3	34.0	SSW	Dull & overcast, dull but fine day
22	48.2	46.0	50.3	47.8	-	44.4	43.8	45.5	45.5	SW	Dull & threatening, dull all day
23	31.6	31.2	45.0	30.5	-	43.7	44.4	45.5	22.0	NE	Misty & dull day
24	42.8	41.8	47.5	31.0	0.05	42.4	44.1	45.6	24.6	SSE	Dull & overcast, fine day, rain at night
25	40.2	37.0	47.7	37.3	0.10	42.6	44.0	45.8	28.8	WSW	Bright & clear, wind very cold, rain in afternoon
26	39.9	36.5	52.1	37.6	0.01	41.8	44.0	45.8	30.5	WNW	Bright & clear, wind rough & cold, fine day rather dull
27	51.9	47.9	54.6	39.3	0.17	42.0	43.8	45.8	32.5	SW	Fine with rough wind at first which freshened to a gale later
28	36.5	35.3	40.6	36.2	0.03	42.2	44.1	45.8	31.3	SW	Wind abated, dull, snowstorm afternoon
29	34.6	31.2	38.6	30.5	-	40.2	43.7	45.9	23.3	WNW	Bright & clear, wind cold, very cold day
30	34.9	32.8	40.7	33.4	-	38.7	43.0	45.8	25.4	WSW	Bright & clear, fine day wind cold
31	32.4	31.3	37.6	29.9	-	38.1	42.3	45.8	22.4	WSW	Slightly misty, fine but dull

February 1901

Mean Relative Humidity = 85%

Date	Dry bulb T	Wet bulb T	Max T (day)	Min T (night)	Rain (inches)	Soil T @ 1ft	Soil T @ 2ft	Soil T @ 4ft	Min T (grass)	Wind dir	Weather observations
1	32.1	31.2	40.1	28.0	-	37.6	41.8	45.5	19.4	WSW	Slightly misty at first, fine day with sun afternoon
2	35.7	33.8	42.4	29.7	-	37.0	41.3	45.3	20.7	SE	Dull & cloudy fine but dull all day
3	36.2	34.5	39.0	35.2	-	38.0	41.2	45.1	30.0	ENE	Dull cold & misty, fine day but dull
4	30.8	30.2	36.9	23.8	0.48	37.6	41.2	44.9	16.3	ENE	Misty, snow showers afternoon & evening
5	33.0	31.8	35.2	30.3	-	37.3	40.8	44.7	30.5	NNE	Snow & rain had fallen during the night, about 2 inches laying
6	35.4	34.2	38.0	31.5	-	37.3	40.6	44.7	26.2	NNE	Cloudy, fine but dull day, cold
7	30.9	29.4	39.3	30.2	-	37.1	40.5	44.4	22.4	NNW	Bright, fine day, cold
8	34.0	32.9	39.6	29.8	-	36.8	40.3	44.2	22.3	SE	Misty, fine but dull day
9	36.8	36.2	41.3	34.0	-	38.0	40.3	44.2	33.1	WNW	Dull & misty. Dull & cold all day
10	39.0	37.8	43.1	35.6	-	38.4	40.5	44.1	25.1	NNE	Dull & cloudy, dull day
11	36.7	34.6	38.6	36.2	-	39.2	41.0	43.9	33.6	NNE	Dull & overcast fine day
12	31.1	28.0	37.9	25.1	-	37.8	41.0	43.9	16.7	NNW	Bright, fine day with some sunshine
13	33.1	32.0	36.2	30.6	-	36.4	40.5	43.9	23.6	NNW	Cloudy, fine day but dull
14	28.0	25.7	33.9	20.7	-	35.8	40.1	43.9	14.6	NNW	Bright, fine day, cold wind
15	32.0	30.2	34.5	28.7	-	35.4	39.5	43.6	17.9	WSW	Bright, fine day, wind cold
16	34.0	32.9	43.1	25.1	0.07	35.3	39.4	43.6	17.9	WSW	Bright at first, rain in afternoon
17	36.8	34.5	41.1	33.9	0.02	35.3	39.2	43.3	29.7	NW	Bright, snow showers at intervals
18	35.7	33.5	36.4	31.3	-	35.5	39.2	43.2	24.1	NNE	Cloudy, fine day, dull
19	33.0	32.0	35.0	29.5	0.05	35.7	39.2	43.0	21.4	WNW	Slight snow showers, very dark afternoon
20	33.5	30.7	35.0	32.4	-	35.9	39.2	43.0	29.2	ENE	Dark dull day
21	30.5	29.2	39.4	24.1	0.07	35.7	39.2	42.9	16.2	NNE	Bright at first, rain and snow later

Date	Dry bulb T	Wet bulb T	Max T (day)	Min T (night)	Rain (inches)	Soil T @ 1ft	Soil T @ 2ft	Soil T @ 4ft	Min T (grass)	Wind dir	Weather observations
22	39.3	38.2	45.1	30.5	-	36.0	39.0	42.8	30.5	ENE	Dull and overcast, fine day
23	40.4	37.9	46.1	37.4	-	37.9	39.4	42.8	30.7	W	Fine but dull day
24	41.1	39.1	46.2	39.5	-	39.3	40.0	42.6	34.2	WSW	Fine but dull day
25	41.4	39.8	49.3	37.5	-	39.9	40.5	42.8	30.5	WSW	Bright fine day
26	42.9	40.1	44.9	39.0	0.30	40.4	41.0	42.8	29.2	WSW	Dull, rain afternoon
27	44.8	43.7	48.7	41.0	-	41.1	41.3	43.0	39.0	WSW	Cloudy, dull day
28	43.3	41.7	51.6	38.5	0.16	41.4	41.9	43.2	28.2	WSW	Bright, fine day, rain at night

March 1901

Mean Relative Humidity = 84%

Date	Dry bulb T	Wet bulb T	Max T (day)	Min T (night)	Rain (inches)	Soil T @ 1ft	Soil T @ 2ft	Soil T @ 4ft	Min T (grass)	Wind dir	Weather obs.
1	47.6	46.1	53.3	37.3	-	42.1	42.2	43.2	26.2	SSW	Dull & cloudy, fine day
2	44.7	43.7	53.6	35.6	0.21	42.0	42.5	43.3	26.2	SSW	Dull, rain at times
3	39.9	34.8	48.6	37.9	0.07	42.0	42.8	43.5	29.5	SSW	Bright & clear, hail afternoon
4	41.7	40.5	53.9	35.2	0.15	41.0	42.7	43.6	26.4	SSW	Raining morning, afternoon fine
5	49.9	48.7	55.1	41.5	0.04	43.1	42.7	43.9	40.0	SSW	Raining, heavy showers
6	46.9	42.7	47.4	40.2	0.23	42.7	43.2	43.9	33.0	SSW	Dull & overcast, storms of hail
7	41.8	40.0	48.0	40.1	0.12	42.0	43.0	44.0	34.0	SSW	Dull & overcast, hail & rain
8	41.6	39.8	45.4	36.8	0.08	42.4	43.1	44.1	34.9	NNE	Dull, wind cold, rain at times
9	38.3	36.7	43.6	35.0	-	42.1	43.3	44.1	29.3	NNE	Dull & cold, fine but dull
10	34.0	33.3	42.9	30.0	-	41.2	43.0	44.2	23.1	NNE	Slightly misty, fine but dull

Date	Dry bulb T	Wet bulb T	Max T (day)	Min T (night)	Rain (inches)	Soil T @ 1ft	Soil T @ 2ft	Soil T @ 4ft	Min T (grass)	Wind dir	Weather obs.
11	32.3	30.6	45.1	30.0	-	40.0	42.8	44.2	21.8	NNE	Slightly misty, fine but dull
12	40.9	39.9	53.3	31.9	-	40.3	42.5	44.2	30.2	NNE	Slightly misty, fine but dull
13	37.5	36.3	42.1	31.5	-	41.6	42.9	44.2	24.3	NNE	Overcast, fine, dull & cold
14	40.2	38.8	47.3	36.7	-	41.0	42.7	44.2	30.5	ENE	Dull day, wind cold
15	39.9	37.9	42.1	37.7	0.09	41.5	42.8	44.2	36.3	E	Very dull all day, rain at night
16	38.2	37.6	45.1	36.8	-	41.5	42.8	44.2	36.2	NE	Raining morning, fine bright afternoon
17	42.2	39.1	47.6	33.8	-	41.6	42.8	44.2	26.0	ENE	Misty, fine day
18	39.7	37.7	41.6	39.4	-	41.2	43.0	44.2	38.2	ENE	Dull cold day
19	38.7	34.6	41.6	35.3	0.27	41.2	42.9	44.2	33.0	ENE	Bright. Wind cold, sleet showers
20	38.6	37.2	41.3	34.6	0.12	41.2	42.9	44.2	33.4	ENE	Raining, wet cold day
21	39.2	35.1	43.1	36.7	-	40.5	42.5	44.2	32.7	ENE	Dull, wind very cold
22	38.0	33.8	43.3	31.5	-	39.8	42.3	44.2	24.9	ENE	Dull, wind cold, fine day. Gale
23	39.7	37.2	42.4	36.1	-	40.2	42.1	44.2	31.0	ENE	Dull, fine day
24	38.0	35.7	44.5	32.8	-	40.3	42.2	44.2	23.4	NE	Dull at first, bright afternoon, wind cold
25	35.5	34.6	38.0	31.3	0.03	39.8	42.2	44.2	22.1	ENE	Dull, snow at intervals
26	32.7	32.0	38.3	27.0	-	38.7	42.0	44.2	22.0	NW	Bright & clear, fine bright day, snow evening
27	34.2	32.0	38.3	27.0	-	38.2	41.5	44.0	19.5	NW	Bright & clear, very fine day, wind cold
28	33.5	31.8	39.4	25.3	-	37.8	41.3	43.9	19.1	N	Cloudy, dull cold day
29	35.0	30.9	43.2	24.1	0.07	37.4	40.9	43.9	16.0	WNW	Bright & clear, fine day
30	43.3	41.4	50.5	34.9	0.49	38.8	40.9	43.7	33.2	SSW	Heavy gale with rain
31	43.9	43.2	50.9	42.1	-	40.8	41.2	43.5	37.3	SSW	Raining at first, fine bright afternoon

April 1901

Mean Relative Humidity = 65%

Date	Dry bulb T	Wet bulb T	Max T (day)	Min T (night)	Rain (inches)	Soil T @ 1ft	Soil T @ 2ft	Soil T @ 4ft	Min T (grass)	Wind dir	Weather obs.
1	44.1	39.9	50.4	35.2	-	41.9	42.1	43.5	24.8	W	Cloudy at first, fine bright day
2	45.2	41.8	54.0	27.9	0.02	41.2	42.5	43.5	20.1	SSW	Bright, fine day, cold
3	51.9	50.0	56.7	45.7	0.58	43.9	42.8	43.7	40.8	SSW	Dull, wind strong, rain evening
4	44.8	40.9	58.2	41.7	-	45.6	43.7	43.9	40.0	WNW	Dull at first, fine & bright later
5	40.1	38.4	46.6	32.2	0.02	44.5	44.4	44.0	27.2	SE	Dull cold day
6	42.2	41.5	55.3	29.7	0.13	42.4	44.2	44.2	21.5	SE	Raining at first, fine afternoon
7	51.8	49.9	60.3	42.2	0.10	44.5	43.9	44.3	41.5	SW	Dull, showers at intervals

<u>Weather Reports</u>

Forecasts for 24 hours ending at noon

Location: South England

September 1899

Date	Observations
15	Westerly to Northerly breezes; cloudy; rain at times
16	Rather unsettled
17	North-Westerly winds, strong to fresh, squally, showery, cooler, moderating
18	-
19	Strong & squally winds from NW, passing showers, cool
20	Westerly (SW to NW) winds, very changeable, unsettled weather, occasional rain
21	North-Westerly winds, strong but moderating; cool, with passing showers in most places
22	North-Westerly to North-Easterly winds, light, fine at first, uncertain later
23	North-Westerly winds, very fresh & gusty, some rain at times
24	Westerly winds, veering to NW and increasing greatly in force, with cold showers, squally
25	-
26	Wind back from W to SW, increasing, becoming showery again
27	South-Westerly to Westerly winds, strong, showery
28	South-Westerly winds, fresh, showery – then veering to NW, colder, drier
29	North-Westerly winds, light, fine – then South-Westerly and less fair
30	Varying SE to SW winds, dull rainy

October 1899

Date	Observations
1	South-Westerly to North-Westerly winds, unsettled, some rain
2	-
3	Westerly to North-Westerly winds, strong & squally, but moderating, rainy to fair
4	South-Westerly to Westerly winds, freshening; fair at first, some rain later
5	South-Westerly to Westerly winds, strong to a gale on coasts; dull at first, with some rain, improving later
6	North-Westerly winds, light; local showers at first, then fair; frost inland at night
7	Easterly to North-Easterly winds, light or moderate, fair generally, frosty at night, with local fogs
8	Northerly to North-Easterly winds, light, fair generally, frosty & foggy at night
9	-
10	Southerly & South-Westerly winds, light, fine generally but local fogs at night
11	Light breezes chiefly South-Westerly, fair generally, local fogs at night
12	Southerly winds, light or moderate, fine at first, cloudy later probably some rain
13	Southerly to Westerly winds, moderate, cloudy, some rain, cooler
14	North-Westerly winds, fresh or strong at first, moderating later, fair generally, but local showers, frost inland at night
15	Northerly to North-Easterly winds, light or moderate; fine generally, local fogs at night
16	-
17	Easterly to South-Easterly winds, fresh, fair at first, cloudy later, possibly some rain
18	Easterly to South-Easterly winds, light or moderate, fine generally, local fogs at night
19	Easterly winds, light, fine generally but local fogs at night
20	Easterly to South-Easterly winds, light, fair generally, but local fogs at night
21	Variable to Easterly airs, fair in places, but mostly foggy or misty
22	Variable to Easterly airs, fair in places, but mostly foggy or misty
23	-
24	Variable or Westerly airs, foggy or misty in most places
25	North-Westerly or North-Easterly breezes, very light, fair, but cooler & foggy

Date	Observations
26	Southerly and South-Westerly winds, light to moderate, changeable, fair milder
27	South-Westerly & Westerly winds, light, slight showers, then colder & finer
28	South-Westerly & Southerly winds, light; rainy then cooler
29	Varying light breezes between SW & NW; weather very changeable, rain at times
30	-
31	North-Westerly to South-Westerly winds, temperatures finer, not settled

November 1899

Date	Observations
1	Westerly & South-Westerly winds, moderate, fair, cool
2	Southerly & South-Westerly winds, freshening, fine at first, cloudy later, probably some rain
3	Southerly winds, strong in places, mild, changeable, some showers, with bright intervals
4	South-Westerly winds, strong to a gale, fine at first, some rain later
5	South-Westerly to Southerly winds, increasing to a gale, fair at first, some rain later
6	-
7	Light variable breezes, dull & misty at first; with rain in places, improving temperatures later

February 1900

Date	Observations
7	Northerly to North-Easterly winds; moderate, fine at first, snow showers later
8	Northerly to North-Easterly winds, fine at first, fog in places, cloudy later, probably some snow
9	North-Easterly winds, light, fair generally, foggy or misty in places
10	Easterly & South-Easterly winds, light, fine at first, cloudy later, possibly snow becoming milder
11	Southerly winds increasing in force, gale in places, squally, some snow
12	-
13	Easterly winds increasing in force, cloudy, squally, some snow
14	Calms & South-Easterly winds, freshening, milder
15	Northerly winds light, finer, very cold tonight, South-Westerly light, mild after fog
16	South-Easterly to North-Easterly gales, rain and snow. Colder again
17	Westerly winds, strong to moderate, fair to showery
18	Southerly to Easterly strong winds & gales, rain perhaps snow, colder
19	-
20	South-Westerly & Westerly winds, strong to a gale at times, rainy to fair & colder
21	South-Westerly to North-Westerly winds, moderate to fresh, changeable, some showers
22	North-Westerly to South-Westerly winds freshening, fine at first, cloudy later with some rain or sleet
23	South-Westerly to Westerly winds, strong, squally, showery
24	South-Westerly winds, strong in places, mild, changeable, some rain
25	Southerly winds moderate, mild, changeable, showery
26	-
27	Easterly to South-Easterly winds moderate, rainy at first, improving temperatures later
28	Wind becoming Northerly generally and weather improving slowly

March 1900

Date	Observations
1	Easterly to North-Easterly winds, moderate to fresh, colder, rainy, dull
2	North-Easterly winds moderate, fair, dry, cold
3	North-Westerly to Westerly winds moderate to fresh. Fair & milder then cold showers
4	Varying Westerly to Northerly winds, some rain in most places, unsettled
5	-
6	North-Easterly & Northerly winds. Light to moderate. Cold, fair generally
7	Northerly to North-Westerly winds light dull misty or foggy in places
8	Northerly to North-Westerly winds light. Weather becoming brighter, but local showers probable
9	Variable or North-Easterly airs. Cloudy. Some mist or fog
10	Easterly winds moderate. Cloudy misty, slight rain locally
11	Easterly & South-Easterly winds, light, fair generally, warmer
12	-
13	Light Northerly breezes fine generally frosty at night. Local fogs
14	North-Westerly & Northerly winds. Fresh to moderate. Very slight showers. Colder
15	North-Westerly winds. Moderate. Fine at first. Some showers later
16	Westerly & North-Westerly winds. Fresh. Squally & showery then colder
17	Westerly & Northerly winds. Moderate. Few cold showers then finer. Frost at night
18	Northerly & North-Westerly winds light, cold shift to SW milder, rainy, unsettled
19	-
20	Southerly & South-Westerly winds, fresh to strong. Much rain at times. Milder
21	Southerly winds. Moderate or fresh. Changeable, some showers
22	Easterly winds. Moderate to fresh. Fair cold
23	Easterly & North-Easterly winds strong in places, changeable, some rain
24	North-Easterly winds strong, cloudy, slight rain locally
25	Northerly & North-Easterly winds moderate or fresh. Fair generally but rain or sleet locally

Date	Observations
26	-
27	North-Westerly winds freshening, changeable, some snow showers
28	Northerly winds backing W. Light fine, milder, not settled
29	South-Westerly to North-Westerly & Northerly winds colder some slight cold showers
30	Northerly airs & calms then South-Westerly & Southerly & milder weather
31	Calm, fine, foggy in places, very cold tonight

April 1900

Date	Observations
1	Variable & Southerly airs, fine, hazy at times, very little milder
2	-
3	Varying & North-Easterly airs, hazy, cloudy
4	South-Westerly winds, moderate or fresh, cloudy, some rain
5	South-Westerly & Southerly winds freshening. Rain at times. Milder
6	North-Westerly winds. Light or moderate fair generally but perhaps local showers
7	Southerly & South-Westerly winds becoming strong & squally, showery, milder, unsettled

Today's 2pm reports

Location: Westminster, London

September 1899

Date	Barometer	Dry bulb T	Wet bulb T	Wind dir	Wind F	Observations
15	29.96	67	59	WSW	3	c
16	29.60	63	57	NNW	3	bc
17	-	-	-	-	-	-
18	29.71	63	55	NW	4	cf
19	29.71	63	57	WNW	3	c
20	29.67	60	52	NW	5	cf
21	29.89	63	54	WNW	3	bc
22	29.82	60	49	WNW	4	c
23	29.95	61	53	W	3	o
24	-	-	-	-	-	-
25	29.75	67	58	WSW	3	o
26	29.52	63	55	W	3	bc
27	29.45	60	56	W	4	c
28	29.72	58	51	W	2	bc
29	29.67	54	51	SSW	2	od
30	29.32	56	50	SW	3	o

October 1899

Date	Barometer	Dry bulb T	Wet bulb T	Wind dir	Wind F	Observations
1	-	-	-	-	-	-
2	29.70	54	50	NW	5	o
3	29.96	62	53	WSW	4	o
4	29.88	54	52	SE	2	omg
5	30.11	54	50	NE	2	og
6	30.17	53	50	E	1	om
7	30.23	57	50	NW	2	bc
8	-	-	-	-	-	-
9	30.29	59	50	S	1	bm
10	30.24	61	53	SSW	1	bm
11	29.89	64	58	SSW	2	bm
12	29.52	62	58	WSW	2	c
13	29.92	55	47	NW	5	bcq
14	30.16	52	46	Z	0	c
15	-	-	-	-	-	-
16	29.91	56	51	E	3	b
17	30.10	60	53	E	1	bm
18	30.34	63	55	ENE	1	bm
19	30.39	59	51	ESE	2	b
20	30.34	60	51	E	2	bm
21	30.40	47	45	Z	0	f
22	-	-	-	-	-	-
23	30.22	55	52	NW	1	bf
24	30.33	59	53	WSW	2	o
25	30.28	61	54	S	2	o

Date	Barometer	Dry bulb T	Wet bulb T	Wind dir	Wind F	Observations
26	29.92	58	55	SW	3	or
27	29.76	61	59	SSW	3	or
28	29.83	62	58	WSW	2	o
29	-	-	-	-	-	-
30	29.80	57	47	NW	3	bc
31	30.10	57	50	WSW	3	c

November 1899

Date	Barometer	Dry bulb T	Wet bulb T	Wind dir	Wind F	Observations
1	29.89	56	49	S	4	bc
2	29.56	61	59	SW	3	ogd
3	29.48	60	53	SW	6	o
4	29.64	62	60	SW	4	o
5	-	-	-	-	-	-
6	29.91	53	50	NNW	2	om
7	29.98	54	49	S	4	o

February 1900

Date	Barometer	Dry bulb T	Wet bulb T	Wind dir	Wind F	Observations
7	29.86	36	32	NW	3	bm
8	29.99	36	32	NE	2	bm
9	29.98	37	32	ESE	2	f
10	29.64	38	34	SSE	4	o
11	-	-	-	-	-	-
12	29.38	40	36	ESE	2	o
13	29.46	38	35	ESE	2	m
14	29.90	38	35	N	5	c
15	29.62	39	37	SSE	7	or
16	29.35	48	43	WNW	5	bc
17	29.11	47	46	SSW	1	ogm
18	-	-	-	-	-	-
19	28.62	53	51	SW	6	cr
20	28.75	48	44	WSW	6	cp
21	29.60	46	40	WNW	3	bc
22	29.41	54	50	SW	2	o
23	29.62	56	52	WSW	3	c
24	29.73	57	53	S	3	c
25	-	-	-	-	-	-
26	29.56	55	51	SSE	3	c
27	29.51	50	50	WNW	1	ogd
28	29.95	43	42	ENE	3	og

January 1901

Date	Barometer	Dry bulb T	Wet bulb T	Wind dir	Wind F	Observations
25	30.07	49	43	WSW	4	c
26	29.91	46	41	WNW	4	c
27	-	-	-	-	-	-
28	29.44	41	38	W	2	c
29	29.48	40	36	NW	3	c
30	29.37	41	38	NW	3	c
31	29.48	39	36	WNW	1	ogm

February 1901

Date	Barometer	Dry bulb T	Wet bulb T	Wind dir	Wind F	Observations
1	29.75	40	37	NW	2	bcm
2	29.52	42	39	S	3	og
3	-	-	-	-	-	-
4	29.43	38	35	WSW	2	cm
5	29.42	36	34	N	3	om
6	30.01	39	36	NNE	3	og
7	30.25	40	36	NW	3	bcm
8	30.33	41	39	W	1	om
9	30.36	43	41	NW	1	ogm
10	-	-	-	-	-	-
11	30.33	38	34	N	2	cm
12	30.22	38	33	NNW	3	bc

Date	Barometer	Dry bulb T	Wet bulb T	Wind dir	Wind F	Observations
13	30.33	36	33	E	3	os
14	30.49	33	32	NNW	2	c
15	30.57	35	33	NE	2	om
16	30.37	42	39	NNW	3	od
17	-	-	-	-	-	-
18	30.40	37	33	NNE	1	og
19	30.23	37	36	Z	0	fg
20	30.29	35	32	E	3	o
21	30.29	37	33	W	1	o
22	30.24	44	41	NNE	1	c
23	30.12	47	43	NNW	1	o
24	-	-	-	-	-	-
25	29.68	50	45	SW	2	o
26	29.50	45	40	SSW	3	o
27	29.35	48	44	W	2	o
28	29.50	52	46	WNW	2	br

Daily weather reports

Location: Brixton

September 1899

Yesterday evening

Date	Barometer	Dry bulb T	Wind dir	Wind F	Observations
15	30.04	62	NNW	1	b
16	29.86	62	SW	2	o
17	29.69	59	NNW	3	b
18	29.76	65	W	2	c
19	29.74	59	NW	3	bc
20	29.64	61	WSW	3	c
21	29.75	55	WNW	3	b
22	29.82	55	SW	2	c
23	29.89	55	NW	2	b
24	29.88	54	W	4	bc
25	29.96	57	WSW	2	o
26	29.68	59	WSW	2	o
27	29.53	55	W	3	o
28	29.45	55	WSW	2	c
29	29.78	51	NNW	2	c
30	29.55	49	SE	2	r

This morning

Date	Barometer	Δ yesterday	Dry bulb T	Wet bulb T	Δ yesterday	Wind dir	Wind F	Observations	Sea
15	30.11	+0.05	54	51	-5	NW	1	b	*
16	28.57	-0.54	59	54	+5	NW	4	cq	*
17	29.83	+0.26	56	52	-3	WSW	2	o	*
18	29.71	-0.12	56	57	0	NW	4	c	*
19	29.78	+0.07	54	49	-2	WSW	4	o	*
20	29.66	-0.12	53	48	-1	WNW	5	bc	*
21	29.95	+0.29	49	45	-4	NW	3	bc	*
22	29.72	-0.23	53	47	+4	WNW	5	bc	*
23	30.05	+0.33	49	45	-4	WSW	2	bc	*
24	29.94	-0.11	51	45	+2	WNW	5	bq	*
25	29.83	-0.11	55	51	+4	WNW	2	c	*
26	29.63	-0.20	54	50	-1	W	3	b	*
27	29.58	-0.05	54	50	0	SW	2	o	*
28	29.68	+0.10	45	43	-9	NW	2	bw	*
29	29.78	+0.10	45	44	0	SW	1	om	*
30	29.29	-0.49	47	46	+2	S	1	o	*

Past 24 hours

Date	Weather	Hours of bright sunshine	T(max)	T(min)	Rainfall (inches)
15	b.bm	4.0	69	46	-
16	bc.oqp	6.1	70	53	0.20
17	cpt.b	4.1	65	50	0.07
18	c.b	2.8	69	51	-

Date	Weather	Hours of bright sunshine	T(max)	T(min)	Rainfall (inches)
19	q p bc o	5.2	64	53	0.12
20	c.op.b	0.3	63	49	0.10
21	bc.b	9.0	61	40	-
22	bc.oqr	7.2	65	48	0.18
23	bc.b	8.8	61	41	-
24	bc.op	2.8	61	45	0.03
25	b.c.od	8.8	62	51	0.02
26	bc.or	4.6	68	48	0.01
27	c.ol.b	5.2	63	47	-
28	o.tlp.b	2.1	63	39	0.44
29	cph.blw	6.0	61	37	0.01
30	o.r	0.5	57	45	0.99

October 1899

Yesterday evening

Date	Barometer	Dry bulb T	Wind dir	Wind F	Observations
1	29.40	51	S	3	b
2	29.17	58	SSW	3	c
3	29.90	52	NNW	2	om
4	29.92	57	WSW	3	c
5	29.92	51	ESE	1	ogm
6	30.15	52	E	3	o
7	30.16	51	E	3	o

Date	Barometer	Dry bulb T	Wind dir	Wind F	Observations
8	30.28	46	Z	0	m
9	30.38	52	NE	1	bcm
10	30.29	49	SW	1	bcm
11	30.22	50	Z	0	m
12	29.84	55	S	1	bm
13	29.48	58	W	3	op
14	30.02	48	WNW	2	cm
15	30.18	46	NE	1	o
16	30.06	45	E	5	bq
17	29.92	51	ESE	1	om
18	30.16	53	E	1	b
19	30.40	53	SE	1	b
20	30.37	50	SE	1	b
21	30.35	49	SE	1	bm
22	30.42	42	Z	0	f
23	30.33	44	Z	0	f
24	30.23	51	NW	1	cm
25	30.36	50	NW	1	om
26	30.24	55	SSW	1	o
27	29.88	55	SW	2	or
28	29.77	60	SW	2	od
29	29.92	55	W	2	bc
30	29.84	55	SW	4	o
31	29.89	46	NW	2	b

This morning

Date	Barometer	Δ yesterday	Dry bulb T	Wet bulb T	Δ yesterday	Wind dir	Wind F	Observations	Sea
1	29.42	+0.13	51	50	+4	SE	3	ogq	*
2	29.38	-0.04	52	51	+1	W	3	og	*
3	30.07	+0.69	51	48	-1	SW	2	b	*
4	29.82	-0.25	58	56	+7	SW	2	o	*
5	30.07	+0.25	49	47	-9	E	2	og	*
6	30.21	+0.14	47	45	-2	E	1	bw	*
7	30.22	+0.01	37	37	-10	Z	0	f	*
8	30.38	+0.16	39	39	+2	Z	0	fw	*
9	30.36	-0.02	42	41	+3	NE	1	bfw	*
10	30.28	-0.08	35	35	-7	Z	0	f	*
11	30.02	-0.26	41	41	+6	Z	0	f	*
12	29.61	-0.41	51	50	+10	Z	0	c	*
13	29.80	+0.19	43	41	-8	WNW	3	bc	*
14	30.16	+0.36	38	37	-5	W	1	c	*
15	30.20	+0.04	45	42	+7	E	4	b	*
16	29.96	-0.24	43	42	-2	E	3	b	*
17	30.04	+0.08	46	45	+3	E	1	bm	*
18	30.33	+0.29	41	41	-5	E	1	f	*
19	30.42	+0.09	41	41	0	Z	0	f	*
20	30.39	-0.03	41	40	0	Z	0	f	*
21	30.35	-0.04	41	41	0	Z	0	f	*
22	30.43	+0.08	44	44	+3	Z	0	f	*
23	30.28	-0.15	41	41	-3	W	1	of	*
24	30.33	+0.05	47	47	+6	W	1	cf	*
25	30.37	+0.04	48	47	+1	ENE	1	cm	*

Date	Barometer	Δ yesterday	Dry bulb T	Wet bulb T	Δ yesterday	Wind dir	Wind F	Observations	Sea
26	30.01	-0.36	53	522	+5	S	2	o	*
27	29.83	-0.18	57	56	+4	SW	1	od	*
28	29.81	-0.02	58	57	+1	WSW	1	c	*
29	30.00	-0.19	56	54	-2	SW	2	oc	*
30	29.63	-0.37	51	40	-5	NNW	3	o	*
31	30.06	+0.43	45	43	-6	WSW	3	b	*

Past 24 hours

Date	Weather	Hours of bright sunshine	T(max)	T(min)	Rainfall (inches)
1	cp.o.bl	1.5	57	45	0.01
2	orq.c.or	0.2	63	50	0.17
3	od.om.b	0.0	52	40	-
4	bc.oq.p	5.0	64	51	0.01
5	opdm	0.0	59	47	0.23
6	od.mw	0.0	53	42	0.02
7	op.o.bw	0.3	55	35	-
8	bc.fw	3.4	55	35	-
9	bf.c.bw	2.5	62	35	-
10	b.bfw	6.5	62	33	-
11	b.bm.bw	3.5	62	35	-
12	b.m.bw	4.8	65	40	-
13	c.op.b	1.2	64	40	0.07
14	b.bmw	7.3	55	33	-
15	c.b	0.5	51	37	-
16	bq	8.1	56	40	-

Date	Weather	Hours of bright sunshine	T(max)	T(min)	Rainfall (inches)
17	bm.om.b	5.5	59	43	-
18	bv.fw	5.2	64	40	-
19	f.b.bw	4.0	66	40	-
20	bm.fw	4.3	60	39	-
21	f.bm.fw	1.0	60	40	-
22	fg	0.0	44	41	-
23	fg	0.0	50	39	0.01
24	gf.mw	0.0	54	40	-
25	cm.o	0.0	60	46	-
26	cm.o.d	1.5	62	46	-
27	or.b	0.0	62	53	0.26
28	or	0.0	60	49	1.06
29	bc	2.9	64	50	-
30	c.oq.r	0.7	61	51	0.31
31	gr.o.bw	0.7	51	39	0.08

November 1899

Yesterday evening

Date	Barometer	Dry bulb T	Wind dir	Wind F	Observations
1	30.15	48	WSW	2	bc
2	29.80	48	S	2	b
3	29.55	56	SW	2	o
4	29.47	56	SW	7	rq

Date	Barometer	Dry bulb T	Wind dir	Wind F	Observations
5	29.68	61	SSW	5	odr
6	29.86	53	S	1	o
7	30.00	48	Z	0	bm

<u>This morning</u>

Date	Barometer	Δ yesterday	Dry bulb T	Wet bulb T	Δ yesterday	Wind dir	Wind F	Observations	Sea
1	30.08	+0.02	49	47	+4	S	2	b	*
2	29.62	-0.46	59	58	+10	S	4	or	*
3	29.63	+0.01	54	51	-5	SSW	4	b	*
4	29.64	+0.01	58	58	+4	SSW	4	c	*
5	29.74	+0.10	54	53	-4	S	3	or	*
6	29.86	+0.11	49	49	-5	SE	1	ogr	*
7	30.09	+0.24	47	45	-2	S	3	bc	*

<u>Past 24 hours</u>

Date	Weather	Hours of bright sunshine	T(max)	T(min)	Rainfall (inches)
1	c.o.bw	7.0	56	43	-
2	bc.b.od	7.1	59	47	0.01
3	or.cqp.b	0.0	62	52	0.56
4	cp.orq	3.4	60	49	1.14
5	od.oqr	0.0	62	54	0.20
6	ogr	0.0	55	48	1.44
7	or.c.bm	0.0	51	42	0.06

February 1900

Yesterday evening

Date	Barometer	Dry bulb T	Wind dir	Wind F	Observations
7	29.83	36	NNE	3	bc
8	29,87	30	NNW	1	bm
9	30.02	32	NNE	1	bm
10	29.97	32	SSE	1	m
11	29.49	34	SSE	5	s
12	29.47	31	W	4	b
13	29.40	35	ENE	2	om
14	29.29	33	SE	5	os
15	30.06	34	NNE	1	bm
16	29.38	39	S	8	oqd
17	29.47	45	W	4	bc
18	29.04	42	SE	1	org
19	29.25	44	SSW	3	o
20	28.56	48	SW	6	opq
21	28.94	40	NNW	3	b
22	29.62	39	SW	2	c
23	29.43	49	NW	2	bc
24	29.67	52	SSW	3	c
25	29.77	54	S	2	c
26	29.80	52	NW	1	m
27	29.56	53	SSW	2	cp
28	29.57	49	S	1	ogd

This morning

Date	Barometer	Δ yesterday	Dry bulb T	Wet bulb T	Δ yesterday	Wind dir	Wind F	Observations	Sea
7	29.91	+0.19	27	25	-7	NE	2	bm	*
8	29.96	+0.05	24	23	-3	NE	1	bm	*
9	30.03	+0.07	18	16	-6	Z	0	f	*
10	29.82	-0.21	29	26	+11	SSE	1	bc	*
11	29.19	-0.63	32	30	+3	W	5	o	*
12	29.44	+0.25	23	21	-9	E	1	m	*
13	29.63	+0.19	26	24	+3	Z	0	f	*
14	29.55	-0.08	34	33	+8	NNW	6	s	*
15	29.96	+0.41	37	35	+3	SSE	6	rq	*
16	29.19	-0.77	38	35	+1	SW	4	bc	*
17	29.27	+0.08	43	41	+5	SW	3	b	*
18	29.33	+0.06	36	35	-7	WSW	3	b	*
19	28.81	-0.52	51	49	+15	SSW	6	odq	*
20	28.82	+0.01	40	38	-11	SSW	3	bc	*
21	29.46	+0.64	33	31	-7	WNW	3	b	*
22	29.40	-0.06	45	43	+12	SW	2	c	*
23	29.56	+0.16	50	50	+5	SSW	2	o	*
24	29.71	+0.15	51	50	+1	S	2	c	*
25	29.76	+0.05	50	49	-1	WSW	1	o	*
26	29.63	-0.13	45	44	-5	ESE	2	omd	*
27	29.47	-0.16	48	47	+3	N	1	fgr	*
28	29.83	+0.36	43	42	-5	ENE	3	ogmd	*

Past 24 hours

Date	Weather	Hours of bright sunshine	T(max)	T(min)	Rainfall (inches)	Comments
7	bc.b	3.5	40	27	-	
8	bm.o	1.0	35	23	-	
9	bm.o	0.1	35	18	-	
10	bm.b	0.4	39	18	-	
11	o.s.r	0.0	37	29	0.39	
12	o.bc.b	3.6	37	20	-	
13	om.f	0.0	40	22	-	
14	of.srq	0.0	40	25	0.26	Locally varying
15	bm.b.o	1.0	38	28	0.09	
16	orq.o	0.0	49	34	0.49	
17	bc.b.oqp	6.1	48	38	0.07	
18	ogr	0.9	48	33	0.27	
19	bc.o.qr	4.3	51	36	0.05	
20	oqr.o	0.0	52	37	0.28	
21	op.c.b	1.4	48	32	0.03	
22	b.oqp	7.0	45	33	0.03	
23	c.o.r	2.0	55	43	0.06	
24	cp.c.od	0.4	57	49	0.02	
25	o.m.r	0.3	57	49	0.06	
26	o.m.b.d	0.0	56	44	0.01	
27	bc.m.or	1.2	58	44	0.37	
28	ogrm.og	0.0	50	43	0.09	

March 1900

Yesterday evening

Date	Barometer	Dry bulb T	Wind dir	Wind F	Observations
1	30.02	41	NE	4	o
2	30.30	37	NE	2	b
3	30.25	40	NNW	3	bmd
4	30.18	42	NNW	1	og
5	30.15	38	NNE	2	o
6	30.27	40	N	2	o
7	30.30	37	NE	3	o
8	30.28	41	NNW	1	og
9	30.23	40	E	2	o
10	30.23	41	ESE	3	bc
11	30.27	48	E	2	b
12	30.26	49	NE	2	c
13	30.45	53	NW	3	b
14	30.57	42	N	5	bc
15	30.51	49	NNW	3	o
16	29.91	45	W	3	og
17	29.54	38	NW	3	b
18	29.51	34	Z	0	m
19	29.39	37	SSE	5	ors
20	29.36	42	SE	2	bc
21	29.76	46	SE	2	b
22	29.69	43	NE	4	b
23	29.53	46	E	3	o

Date	Barometer	Dry bulb T	Wind dir	Wind F	Observations
24	29.89	39	NE	5	o
25	29.93	39	NE	3	bc
26	29.79	39	NNW	3	o
27	29.66	37	NW	1	bm
28	29.66	38	W	2	bm
29	29.70	39	NNE	4	c
30	29.94	42	N	1	b
31	30.15	43	NE	2	bm

<u>This morning</u>

Date	Barometer	Δ yesterday	Dry bulb T	Wet bulb T	Δ yesterday	Wind dir	Wind F	Observations	Sea
1	30.16	+0.33	37	35	-6	ENE	3	o	*
2	30.29	+0.13	37	35	0	NNW	3	o	*
3	30.21	-0.08	38	36	+1	WNW	1	og	*
4	30.16	-0.05	36	33	-2	N	2	c	*
5	30.18	+0.02	38	36	+2	NE	2	c	*
6	30.31	+0.13	38	35	0	NNE	2	og	*
7	30.29	-0.02	36	33	-2	NW	1	og	*
8	30.27	-0.02	38	36	+2	NE	1	og	*
9	30.24	-0.03	39	37	+1	E	2	c	*
10	30.30	+0.06	40	39	+1	E	3	b	*
11	30.25	-0.05	40	38	0	ENE	1	om	*
12	30.43	+0.18	38	36	-2	NE	1	b	*
13	30.44	+0.01	46	43	+8	NW	3	o	*
14	30.59	+0.15	40	38	-6	NW	1	o	*

Date	Barometer	Δ yesterday	Dry bulb T	Wet bulb T	Δ yesterday	Wind dir	Wind F	Observations	Sea
15	30.24	-0.35	43	40	+3	W	3	o	*
16	29.60	-0.64	37	36	-6	NW	3	o	*
17	29.52	-0.08	30	29	-7	NNW	1	bcsp	*
18	29.52	0.00	37	33	+7	SE	1	b	*
19	29.25	-0.27	33	33	-4	SW	1	o	*
20	29.60	+0.35	43	40	+10	SW	3	b	*
21	29.81	+0.21	36	35	-7	E	1	bf	*
22	29.50	-0.31	43	41	+7	NE	4	og	*
23	29.78	+0.28	41	39	-2	NE	6	og	*
24	29.92	+0.14	37	35	-4	NNE	3	og	*
25	29.94	+0.02	36	32	-1	NE	3	o	*
26	29.71	-0.23	34	32	-2	NW	2	c	*
27	29.71	0.00	34	32	0	NW	1	og	*
28	29.56	-0.15	38	37	+4	W	1	od	*
29	29.92	+0.36	34	32	-4	NE	1	c	*
30	30.07	+0.15	33	32	-1	ESE	1	bf	*
31	30.37	+0.30	34	31	+1	E	2	bc	*

Past 24 hours

Date	Weather	Hours of bright sunshine	T(max)	T(min)	Rainfall (inches)
1	ogr.o	0.0	44	36	0.07
2	c.b.od	1.5	44	34	-
3	odp.r	0.1	42	36	0.02
4	og.o	0.0	44	36	-
5	c.o	1.5	41	36	-

Date	Weather	Hours of bright sunshine	T(max)	T(min)	Rainfall (inches)
6	og	0.3	40	37	-
7	og	0.0	40	35	-
8	og	0.0	42	35	-
9	o.op	0.0	45	37	-
10	bc.c.bw.g	0.0	48	37	-
11	bm.o	4.0	56	38	-
12	om.bc.cm	0.0	51	34	-
13	bm.b	1.3	56	37	-
14	ogq.b	0.0	46	34	-
15	c.o	0.5	52	40	-
16	og.rq	0.1	50	37	0.06
17	c.b	0.7	44	27	-
18	cm	-	40	23	-
19	b.or.rs	2.5	42	33	0.50
20	cp.bc.b	2.6	45	33	0.01
21	bc.b	6.1	52	32	-
22	bcm.orq	0.2	48	35	0.11
23	og.ogq	0.0	46	40	-
24	og	0.0	42	36	-
25	og.bc.o	0.0	42	35	-
26	bc.ps.og	1.2	41	32	-
27	o.phs.bm	0.4	42	32	-
28	o.bm	0.0	42	33	0.12
29	o.b.bc	0.0	43	30	-
30	c.b.f	2.6	44	28	-
31	bc.b	2.0	48	29	-

April 1900

Yesterday evening

Date	Barometer	Dry bulb T	Wind dir	Wind F	Observations
1	30.36	46	SE	2	bm
2	30.18	42	SE	1	b
3	29.99	46	NW	1	bcm
4	29.55	43	S	3	or
5	29.41	50	W	1	b
6	29.71	44	W	2	c
7	29.80	45	SW	2	c

This morning

Date	Barometer	Δ yesterday	Dry bulb T	Wet bulb T	Δ yesterday	Wind dir	Wind F	Observations	Sea
1	30.33	-0.04	37	34	+3	E	2	b	*
2	30.13	-0.20	34	31	-3	WSW	1	c	*
3	29.83	-0.30	38	37	+4	SW	1	o	*
4	29.31	-0.52	47	45	+9	W	4	bc	*
5	29.55	+0.24	44	42	-3	NNW	1	og	*
6	29.92	+0.37	40	38	-4	W	2	b	*
7	29.71	-0.21	44	41	+4	E	1	od	*

Past 24 hours

Date	Weather	Hours of bright sunshine	T(max)	T(min)	Rainfall (inches)
1	b	0.1	49	31	-
2	o.b.m	0.8	45	27	-
3	c.bv.od	0.0	49	31	-
4	cpd.or	0.3	52	37	0.25
5	cp.bv.op	5.8	56	40	0.05
6	cp.or.bc	0.0	49	34	0.04
7	c.b.o	8.0	54	40	0.01

Brixton Weather Station Data

September 1899

Time = 8am

Date	Dry bulb T	Wet bulb T	Max T	Min T	Wind dir	Weather
15	54	51	70	46	NW	b
16	59	54	65	53	NW	cq
17	56	52	69	50	WSW	o
18	56	51	64	51	NW	c
19	54	49	63	53	WSW	o
20	53	48	61	49	WNW	bc
21	49	45	65	40	NW	b
22	53	47	61	48	WNW	b
23	49	45	61	41	WSW	bc

Date	Dry bulb T	Wet bulb T	Max T	Min T	Wind dir	Weather
24	51	45	62	45	WNW	bq
25	55	51	68	51	WNW	c
26	54	50	63	48	W	b
27	54	50	63	47	SW	o
28	45	43	61	39	NW	bw
29	45	44	57	37	SW	om
30	47	46	57	45	S	o

Time = 2pm

Date	Dry bulb T	Wet bulb T	Wind dir	Weather
15	67	59	WSW	c
16	63	57	NNW	bc
17	-	-	-	-
18	63	55	NW	cp
19	63	57	WNW	c
20	60	52	NW	p
21	63	54	WNW	bc
22	60	49	WNW	c
23	61	53	W	o
24	-	-	-	-
25	67	58	WSW	o
26	63	55	W	bc
27	60	56	W	c
28	58	51	W	bc
29	54	51	SSW	od
30	56	50	SW	o

Time = 6pm

Date	Dry bulb T	Wet bulb T	Wind dir	Weather	Remarks
15	62	-	SW	o	
16	59	-	N	b	Thunder in several parts
17	65	-	W	c	
18	59	-	NW	bc	
19	61	-	WSW	c	
20	55	-	WNW	b	
21	55	-	SW	c	
22	55	-	NW	b	
23	54	-	W	bc	
24	57	-	WSW	o	
25	59	-	WSW	o	
26	55	-	W	o	
27	55	-	WSW	c	Thunderstorms 3pm and 5:45pm
28	51	-	NNW	c	
29	49	-	SE	r	
30	51	-	S	b	

October 1899

Time = 8am

Date	Dry bulb T	Wet bulb T	Max T	Min T	Wind dir	Weather
1	51	50	63	45	SE	ogq
2	52	51	52	50	W	og
3	51	48	64	40	SW	b

Date	Dry bulb T	Wet bulb T	Max T	Min T	Wind dir	Weather
4	58	56	59	51	SW	o
5	49	47	53	47	E	og
6	47	45	55	42	E	bw
7	37	37	55	35	Z	f
8	39	39	62	35	Z	fw
9	42	41	62	35	NE	bfw
10	35	35	62	33	Z	f
11	41	41	65	35	Z	f
12	51	50	64	40	Z	c
13	43	41	55	40	WNW	bc
14	38	37	51	33	W	b
15	45	42	56	3?	E	b
16	43	42	59	40	E	b
17	46	45	64	43	E	bm
18	41	41	66	40	E	f
19	41	41	60	40	Z	f
20	41	40	60	39	Z	f
21	41	41	44	40	Z	f
22	44	44	50	41	Z	f
23	41	41	54	39	W	of
24	47	47	60	40	W	cf
25	48	47	62	46	ENE	cm
26	53	52	62	46	S	o
27	57	56	60	53	SW	od
28	58	57	64	49	WSW	c
29	56	54	61	50	SW	o
30	51	50	51	51	NNW	o
31	45	43	56	39	WSW	b

Time = 2pm

Date	Dry bulb T	Wet bulb T	Wind dir	Weather
1	-	-	-	-
2	54	50	NW	o
3	62	53	WSW	o
4	54	52	SE	omg
5	54	50	NE	og
6	53	50	E	om
7	57	50	NW	bc
8	-	-	-	-
9	59	50	S	bm
10	61	53	SSW	bm
11	64	58	SSW	bm
12	62	58	WSW	c
13	55	47	NW	bcq
14	52	46	Z	c
15	-	-	-	-
16	56	51	E	b
17	60	53	E	bm
18	63	55	ENE	bm
19	59	51	ESE	b
20	60	51	E	bm
21	47	45	Z	f
22	-	-	-	-
23	55	52	NW	bf
24	59	53	WSW	o
25	61	54	S	o
26	58	55	SW	or

Date	Dry bulb T	Wet bulb T	Wind dir	Weather
27	61	59	SSW	or
28	62	58	WSW	o
29	-	-	-	-
30	51	47	NE	bc
31	57	50	WSW	c

Time = 6pm

Date	Dry bulb T	Wet bulb T	Wind dir	Weather
1	58		SSW	c
2	52		NNW	om
3	57		WSW	c
4	51		ESE	ogm
5	52		E	b
6	51		E	o
7	46		Z	m
8	52		NE	bcm
9	49		SW	bcm
10	50		Z	m
11	55		S	bm
12	58		W	op
13	48		WNW	cm
14	46		NE	o
15	45		E	bq
16	51		ESE	om
17	51		E	b
18	53		SE	b

Date	Dry bulb T	Wet bulb T	Wind dir	Weather
19	50		SE	b
20	49		SE	bm
21	42		Z	f
22	44		Z	f
23	51		NW	cm
24	50		NW	om
25	55		SSW	o
26	55		SW	or
27	60		SW	od
28	55		W	bc
29	55		SW	o
30	46		NW	b
31	48		WSW	bc

November 1899

Time = 8am

Date	Dry bulb T	Wet bulb T	Max T	Min T	Wind dir	Weather
1	49	47	59	43	S	b
2	59	58	62	47	S	or
3	54	51	60	52	SSW	b
4	58	58	62	49	SSW	c
5	54	53	55	54	S	or
6	49	48	51	48	SE	ogr
7	47	45	57	42	S	bc

Time = 2pm

Date	Dry bulb T	Wet bulb T	Wind dir	Weather
1	56	49	S	bc
2	61	59	SW	ogd
3	60	53	SW	o
4	62	60	SW	o
5	-	-	-	-
6	53	50	NNW	om
7	54	49	S	o

Time = 6pm

Date	Dry bulb T	Wet bulb T	Wind dir	Weather
1	48		S	b
2	56		SW	o
3	56		SW	rq
4	61		SSW	odw
5	53		S	o
6	48		Z	bm
7	52		S	o

February 1900

Time = 8am

Date	Dry bulb T	Wet bulb T	Max T	Min T	Wind dir	Weather
7	27	25	35	27	NE	bm
8	24	23	35	23	NE	bm
9	18	16	39	18	Z	f
10	29	26	37	18	SSE	bc
11	32	30	37	29	W	o
12	23	21	40	20	E	m
13	26	24	40	22	Z	f
14	34	33	38	25	NNW	s
15	37	35	49	28	SSE	rq
16	38	35	48	34	SW	bc
17	43	41	48	38	SW	b
18	36	35	51	33	WSW	b
19	51	49	52	36	SSW	odq
20	40	38	48	37	SSW	bc
21	33	31	45	32	WNW	b
22	45	43	55	33	SW	c
23	50	50	57	43	SSW	o
24	51	50	57	49	S	c
25	50	49	56	49	WSW	o
26	45	44	58	44	ESE	omd
27	48	47	50	44	N	fgr
28	43	42	44	43	ENE	ogmd

Time = 2pm

Date	Dry bulb T	Wet bulb T	Wind dir	Weather
7	36	32	NW	bm
8	36	32	NE	bm
9	37	32	ESE	f
10	38	34	SSE	o
11	-	-	-	-
12	40	36	ESE	o
13	38	35	ESE	m
14	38	35	N	c
15	39	37	SSE	or
16	48	43	WNW	bc
17	47	46	SSW	ogm
18	-	-	-	-
19	53	51	SW	cr
20	48	44	WSW	cp
21	46	40	WNW	bc
22	54	50	SW	o
23	56	52	WSW	c
24	57	53	S	c
25	-	-	-	-
26	55	51	SSE	c
27	50	50	WNW	ogd
28	43	42	ENE	og

Time = 6pm

Date	Dry bulb T	Wet bulb T	Wind dir	Weather	Remarks
7	30		NNW	bm	
8	32		NNE	bm	
9	32		SSE	m	
10	34		SSE	r	
11	31		W	b	Snow
12	35		ENE	om	
13	33		SE	os	
14	34		NNE	bm	
15	39		S	oqd	Snow
16	45		W	bc	
17	42		SE	org	
18	44		SSW	o	
19	48		SW	opq	
20	40		NNW	b	
21	39		SW	c	
22	49		NW	bc	
23	52		SSW	c	
24	54		S	c	
25	52		NW	m	
26	53		SSW	cp	
27	49		S	ogd	
28	41		NE	o	

January 1901

Time = 8am

Date	Dry bulb T	Wet bulb T	Max T	Min T	Wind dir	Weather
21	48	46	53	42	SW	c
22	48	46	51	47	WSW	og
23	36	35	46	36	E	fg
24	42	41	47	36	SE	ogm
25	38	36	48	37	WSW	b
26	38	36	52	37	WNW	b
27	52	49	55	38	W	c
28	36	35	41	36	SW	op
29	30	29	39	29	W	b
30	33	32	40	29	WSW	bc
31	31	30	37	29	W	bc

Time = 2pm

Date	Dry bulb T	Wet bulb T	Wind dir	Weather
21	53	51	WSW	om
22	51	47	SW	og
23	47	41	ESE	mg
24	46	45	SSW	om
25	49	43	WSW	c
26	46	41	WNW	c
27	-	-	-	-
28	41	38	W	c
29	40	36	NW	c

Date	Dry bulb T	Wet bulb T	Wind dir	Weather
30	41	38	NW	c
31	39	36	WNW	ogm

Time = 6pm

Date	Dry bulb T	Wet bulb T	Wind dir	Weather	Remarks
21	52		SW	o	
22	51		W	o	
23	42		ENE	o	
24	46		WSW	od	
25	48		W	bc	
26	44		SW	opd	
27	46		W	cqp	
28	37		WNW	opds	Hail. Snow
29	37		NNW	b	
30	36		NW	bc	
31	34		NNW	b	

February 1901

Time = 8am

Date	Dry bulb T	Wet bulb T	Max T	Min T	Wind dir	Weather
1	31	29	40	28	NW	bc
2	36	34	45	30	SW	o
3	36	34	40	34	ESE	ogm

Date	Dry bulb T	Wet bulb T	Max T	Min T	Wind dir	Weather
4	27	25	37	25	NE	ogm
5	33	32	36	27	NE	o
6	35	34	39	32	NE	og
7	32	30	40	32	WNW	bcmg
8	33	32	41	29	Z	c
9	37	37	42	33	W	om
10	40	38	42	36	NW	og
11	37	35	39	36	NE	og
12	26	24	38	25	W	b
13	32	32	36	26	NW	og
14	23	22	35	21	W	b
15	30	28	36	22	NE	bc
16	30	28	43	25	W	bc
17	36	35	40	30	N	osp
18	33	32	37	32	NE	bm
19	32	31	35	29	SW	os
20	33	30	37	29	NE	c
21	27	25	40	27	NW	m
22	39	38	45	27	NE	og
23	39	37	46	37	WNW	o
24	40	39	46	39	W	og
25	39	38	49	39	WSW	c
26	43	41	45	38	SE	o
27	44	43	48	41	SW	op
28	41	40	52	40	SW	b

Time = 2pm

Date	Dry bulb T	Wet bulb T	Wind dir	Weather
1	40	37	NW	bcm
2	42	39	S	og
3	-	-	-	-
4	38	35	WSW	cm
5	36	34	N	om
6	39	36	NNE	og
7	40	36	NW	bcm
8	41	39	W	om
9	43	41	NW	ogm
10	-	-	-	-
11	38	34	N	cm
12	38	33	NNW	bc
13	36	33	E	os
14	33	32	NNW	c
15	35	33	NE	om
16	42	39	NNW	od
17	-	-	-	-
18	37	33	NNE	og
19	37	36	Z	fg
20	35	32	E	o
21	37	33	W	o
22	44	41	NNE	c
23	47	43	NNW	o
24	-	-	-	-
25	50	45	SW	o
26	45	40	SSW	o

Date	Dry bulb T	Wet bulb T	Wind dir	Weather
27	48	44	W	o
28	52	46	WNW	br

Time = 6pm

Date	Dry bulb T	Wet bulb T	Wind dir	Weather	Remarks
1	35		W	bm	
2	40		SSE	om	
3	36		E	bc	
4	34		SW	odrs	Snow
5	35		NNE	o	
6	37		NNE	bc	
7	35		NW	bc	
8	38		WSW	o	
9	41		NW	o	
10	40		NW	og	High fog
11	35		W	bc	
12	35		NNE	bc	Snow
13	31		E	bm	Snow
14	34		NNW	b	
15	32		N	c	Snow
16	41		N	om	
17	35		NNE	c	Snow
18	35		N	o	
19	34		Z	sf	Snow
20	32		E	o	
21	32		N	os	Snow

Date	Dry bulb T	Wet bulb T	Wind dir	Weather	Remarks
22	42		NNE	om	
23	45		NW	ogm	
24	43		W	o	
25	47		SW	o	
26	42		SSW	od	
27	46		W	o	
28	48		SSW	o	

<u>Kew Weather Station Data</u>

September 1899

Date	10am	12pm	2pm	4pm	6pm	8pm	10pm	Remarks
15								
16								
17								Cloudy and dull all day
18								
19								
20								
21								
22								
23								
24								
25								
26								

Date	10am	12pm	2pm	4pm	6pm	8pm	10pm	Remarks
27								
28								
29								
30								

October 1899

Date	10am	12pm	2pm	4pm	6pm	8pm	10pm	Remarks
1								
2								Overcast and gloomy all day
3								
4								Overcast and misty all day
5								Overcast and misty all day
6								Dull and misty all day
7							Fog	
8								Thick wet fog after sunset
9	Fog						Thick wet fog	
10							Thick wet fog	Fine but misty all day
11							Thick wet fog	Fine but misty all day
12								Fine but misty all day
13								
14								
15								
16								Fine but misty all day
17								Fine but misty all day

Date	10am	12pm	2pm	4pm	6pm	8pm	10pm	Remarks
18	Fog							Fine but misty all day
19	Fog	Fine	Fine	Fine	Fine	Fine	Fine	
20								Fog nearly all day
21								Foggy all day. Very damp
22	Fog							Thick fog during the evening
23								Dull and misty all day
24								
25								Fine but misty through the day
26								
27								
28								
29								
30								
31								

November 1899

Date	10am	12pm	2pm	4pm	6pm	8pm	10pm	Remarks
1								
2								Overcast all day, rain at times
3								
4								Dull all day
5								
6								Overcast and misty till approx. 3:30pm
7								

February 1900

Date	10am	12pm	2pm	4pm	6pm	8pm	10pm	Remarks
7								
8								
9								
10	o, m							7 inches of snow
11								
12	o, f		o, m	o, m	o, m	o, m		Fog or mist all day
13	Fog		o, m	o, m	o, m	o, m		Fog with thick mist
14								
15	o, m							
16								
17								
18								
19								
20								
21								
22								
23								
24								
25	o, m							
26	o, m							
27	o, m	o, m	o, m					Dull and misty all day
28	o, m	o, m	o, m					Overcast with mist all day

January 1901

Date	10am	12pm	2pm	4pm	6pm	8pm	10pm	Remarks
21								
22								
23	Fog	Fog	Fog					Dull and misty
24								
25								
26								
27								
28								
29								
30								
31								

February 1901

Date	10am	12pm	2pm	4pm	6pm	8pm	10pm	Remarks
1								
2								Rather dull and misty
3								Overcast and dull
4								Sun shining through thin clouds. Misty
5								
6								
7								Misty
8								Misty, fair and dull later

Date	10am	12pm	2pm	4pm	6pm	8pm	10pm	Remarks
9								Dull and misty
10								Dull, misty and overcast
11	Mist							Dull
12								
13								Dull and misty
14								
15								
16								
17								
18								Dull and misty
19								
20								Dull and misty
21								
22								
23								
24								
25								
26								
27								
28								

APPENDIX 4: Climate of London for 1971-2000

Month	Max temp (F)	Min temp (F)	Rainfall (inches)	Sunshine (hours)
January	46.2	36.3	2.04	1.53
February	46.8	36.0	1.34	2.20
March	51.6	38.8	1.65	3.44
April	55.9	41.4	1.78	4.90
September	66.7	51.6	2.24	4.64
October	59.4	46.4	2.42	3.66
November	51.6	40.6	2.06	2.02

APPENDIX 5: Fog observations from Brixton weather station, Kew weather station and *The Times* newspaper

Fog Observations

October 1899

Brixton	Kew	The Times
7 (am)	7 (pm)	7 (Fog)
8 (am)	8 (Thick wet fog after sunset)	8 (Fog)
9 (am)	9 (am) (Thick wet fog)	9 (Fog)
10 (am)	10 (pm) (Thick wet fog)	10 (Fog)
11 (am)	11 (pm) (Thick wet fog)	11 (Fog)
18 (am)	18 (am)	
19 (am)	19 (am)	19 (Fog)
20 (am)	20 (Fog nearly all day)	20 (Fog)
21 (am)	21 (Foggy all day)	21 (Fog)
22 (am-pm)	22 (am) (Thick fog during the evening)	
23 (am-pm)		
24 (am)		

November 1899

Brixton	Kew	The Times
	14 (pm) (Ground fog)	
15 (am)	15 (am) (Thick fog)	15 (Fog)
16 (am)		
	17 (Foggy throughout the day)	
18 (am)		
	19 (Foggy early)	
29 (am)	29 (Foggy all day)	29 (Fog)
30 (am-pm)	30 (Foggy all day)	30 (Fog)

February 1900

Brixton	Kew	The Times
	4 (am)	
9 (am-pm)		
	12 (am) (Fog or mist all day)	
13 (am)	13 (am) (Fog with thick mist)	13 (Fog)
27 (am)		

January 1901

Brixton	Kew	The Times
1 (pm)		
2 (am-pm)	2 (Fine but misty and foggy)	2 (Fog)
3 (am-pm)	3 (Thick fog all day)	3 (Fog)
	4 (Fog)	
5 (am)	5 (Fog)	5 (Fog)
	6 (Fog)	
9 (pm)		
11 (am)		
12 (am-pm)		
15 (am)		
	16 (Fog all day)	
	17 (am) (Fog dispersed soon after noon)	
23 (am)		
	24 (Fog)	

February 1901

Brixton	Kew	The Times
10 (High fog)		
19 (pm)		

APPENDIX 6: Relative humidity calculations

Royal Horticultural Society

September 1899

Date	Dry bulb T	Wet bulb T	RH (%)	Weather observations
29	45.0	44.1	93.3	Cloudy & misty
30	47.2	45.9	90.8	Dull. Cold & raining slightly. Much lightning in evening

October 1899

Date	Dry bulb T	Wet bulb T	RH (%)	Weather observations
2	51.8	50.7	92.9	Dull, cloudy & cold
4	51.2	50.6	96.0	Misty & raining
6	48.6	45.4	78.3	Misty, fine, wind cool
7	45.6	44.0	88.3	Misty, fine, wind cool
8	36.6	36.2	96.4	Very misty or white fog, cold
9	40.1	40.0	99.2	Dense fog
10	36.1	35.6	95.5	Dense fog
11	41.0	40.3	94.3	Dense fog
12	51.2	50.6	96.0	Slight fog
14	41.0	39.7	89.5	Slightly misty
16	47.9	44.0	73.4	Slightly misty, strong & cold wind
17	44.8	44.2	95.5	Thick fog
18	40.0	40.0	100.0	Thick fog
19	43.9	43.7	98.5	Dense fog
20	40.8	40.6	98.4	Dense fog
21	40.0	40.0	100.0	Dense fog
22	43.1	42.9	98.4	Dense fog, so dense at night impossible to see anything
23	43.8	43.8	100.0	Slight fog
24	46.5	47.5	100.0	Slight fog
25	49.7	47.9	87.9	Slight fog
28	58.5	57.2	92.5	Cloudy to clear, fine day
30	48.2	47.5	95.1	Overcast & raining slightly

November 1899

Date	Dry bulb T	Wet bulb T	RH (%)	Weather observations
2	58.9	57.5	92.0	Dull, very mild and raining
4	59.2	58.4	95.4	Cloudy & raining, wind strong
5	55.1	53.8	92.1	Cloudy & raining, calmer, thorough wet day
6	49.5	48.4	92.5	Overcast & raining
7	50.2	48.8	90.7	Clear & bright at first, rain later

February 1900

Date	Dry bulb T	Wet bulb T	RH (%)	Weather observations
9	18.3	18.1	97.0	Slightly foggy, dull cold day
12	23.8	23.6	97.5	Slightly foggy, dull hazy cold day
13	28.7	28.4	96.7	Foggy at first, gale and snow later
15	35.9	35.0	91.8	Cold wet day
19	51.6	50.2	90.9	Rain at intervals, strong wind
23	51.1	50.1	93.4	Dull & cloudy at first, fine day, showers in evening
25	50.8	50.3	96.7	Dull & misty, dull fine day
26	47.2	46.9	97.9	Misty showery day
27	47.4	46.9	96.5	Showers during day
28	42.4	41.4	92.2	Misty showery day

March 1900

Date	Dry bulb T	Wet bulb T	RH (%)	Weather observations
3	38.9	36.8	82.4	Misty, dull & cold
10	43.8	41.0	79.0	Misty at first, bright sunshine later
11	42.8	40.7	83.8	Dull & misty
19	36.2	35.8	96.4	Dull at first, fine with sun later
21	39.1	37.7	88.2	Misty cold day, rain at night
23	41.1	39.8	89.5	Dull day with cold black wind
28	38.1	37.0	90.5	Bright, clear & cold
29	36.7	34.3	78.8	Fog at first, fine & bright later
30	33.2	31.9	87.4	Slight fog, fine but cold day
31	36.1	33.8	79.4	Misty, dull cold day

April 1900

Date	Dry bulb T	Wet bulb T	RH (%)	Weather observations
1	40.7	36.9	69.8	Misty dull cold day
2	36.2	32.2	64.7	Misty, wind cold, fine spring-like day
3	39.8	39.4	96.7	Misty, showers with hail

January 1901

Date	Dry bulb T	Wet bulb T	RH (%)	Weather observations
23	31.6	31.2	95.9	Misty & dull day
24	42.8	41.8	92.2	Dull & overcast, fine day, rain at night
31	32.4	31.3	89.1	Slightly misty, fine but dull

February 1901

Date	Dry bulb T	Wet bulb T	RH (%)	Weather observations
1	32.1	31.2	91.0	Slightly misty at first, fine day with sun afternoon
3	36.2	34.5	84.7	Dull cold & misty, fine day but dull
4	30.8	30.2	93.8	Misty, snow showers afternoon & evening
8	34.0	32.9	89.5	Misty, fine but dull day
9	36.8	36.2	94.6	Dull & misty. Dull & cold all day
10	39.0	37.8	89.9	Dull & cloudy, dull day
16	34.0	32.9	89.5	Bright at first, rain in afternoon
19	33.0	32.9	90.2	Slight snow showers, very dark afternoon
22	39.3	38.2	90.8	Dull and overcast, fine day
27	44.8	43.7	91.8	Cloudy, dull day

March 1901

Date	Dry bulb T	Wet bulb T	RH (%)	Weather obs.
1	47.6	46.1	89.5	Dull & cloudy, fine day
2	44.7	43.7	92.5	Dull, rain at times
4	41.7	40.5	90.5	Raining morning, afternoon fine
5	49.9	48.7	91.9	Raining, heavy showers
10	34.0	33.3	93.3	Slightly misty, fine but dull
11	32.3	30.6	83.2	Slightly misty, fine but dull
12	40.9	39.9	91.9	Slightly misty, fine but dull
13	37.5	36.3	89.5	Overcast, fine, dull & cold
16	38.2	37.6	94.8	Raining morning, fine bright afternoon
17	42.2	39.1	76.0	Misty, fine day
25	35.5	34.6	91.7	Dull, snow at intervals
26	32.7	32.0	93.1	Bright & clear, fine bright day, snow evening
31	43.9	43.2	94.7	Raining at first, fine bright afternoon

April 1901

Date	Dry bulb T	Wet bulb T	RH (%)	Weather obs.
6	42.2	41.5	94.5	Raining at first, fine afternoon

Westminster – 2pm

September 1899

Date	Dry bulb T	Wet bulb T	RH (%)	Observations
18	63	55	59.8	cf
20	60	52	57.8	cf

October 1899

Date	Dry bulb T	Wet bulb T	RH (%)	Observations
4	54	52	87.6	omg
6	53	50	81.3	om
9	59	50	52.2	bm

Date	Dry bulb T	Wet bulb T	RH (%)	Observations
10	61	53	58.5	bm
11	64	58	69.7	bm
17	60	53	62.7	bm
18	63	55	59.8	bm
20	60	51	53.0	bm
21	47	45	85.9	f
23	55	52	81.9	bf

November 1899

Date	Dry bulb T	Wet bulb T	RH (%)	Observations
6	53	50	81.3	om

February 1900

Date	Dry bulb T	Wet bulb T	RH (%)	Observations
7	36	32	64.5	bm
8	36	32	64.5	bm
9	37	32	57.0	f
13	38	35	74.4	m
17	47	46	92.9	ogm
27	50	50	100	ogd
28	43	42	92.3	og

January 1901

Date	Dry bulb T	Wet bulb T	RH (%)	Observations
31	39	36	75.0	ogm

February 1901

Date	Dry bulb T	Wet bulb T	Wind F	Observations
1	40	37	75.6	bcm
4	38	35	74.4	cm
5	36	34	82.0	om
7	40	36	67.7	bcm
8	41	39	84.0	om
9	43	41	84.7	ogm
11	38	34	66.2	cm
14	33	32	90.2	c
15	35	33	81.5	om
19	37	36	91.1	fg

Brixton – This morning

September 1899

Date	Dry bulb T	Wet bulb T	RH (%)	Observations
18	57	56	94.1	c
29	45	44	92.6	om
30	47	46	92.9	o

October 1899

Date	Dry bulb T	Wet bulb T	RH (%)	Observations
1	51	50	93.4	ogq
2	52	51	93.5	og
7	37	37	100	f
8	39	39	100	fw
9	42	41	92.1	bfw
10	35	35	100	f
11	41	41	100	f
12	51	50	93.4	c
14	38	37	91.3	c
16	43	42	92.3	b
17	46	45	92.7	bm
18	41	41	100	f
19	41	41	100	f

Date	Dry bulb T	Wet bulb T	RH (%)	Observations
20	41	40	91.9	f
21	41	41	100	f
22	44	44	100	f
23	41	41	100	of
24	47	47	100	cf
25	48	47	93.0	cm
26	53	52	93.6	o
27	57	56	94.1	od
28	58	57	94.2	c

November 1899

Date	Dry bulb T	Wet bulb T	RH (%)	Observations
2	59	58	94.3	or
4	58	58	100	c
5	54	53	93.8	or
6	49	49	100	ogr

February 1900

Date	Dry bulb T	Wet bulb T	RH (%)	Observations
7	27	25	77.2	bm
8	24	23	87.5	bm
9	18	16	70.2	f
12	23	21	74.4	m
13	26	24	76.6	f
14	34	33	90.5	s
18	36	35	90.9	b
23	50	50	100	o
25	50	49	93.3	o
26	45	44	92.6	omd
27	48	47	93.0	fgr
28	43	42	92.3	ogmd

March 1900

Date	Dry bulb T	Wet bulb T	RH (%)	Observations
10	40	39	91.7	b
11	40	38	83.6	om
16	37	36	91.1	o
19	33	33	100	o
21	36	35	90.9	bf
28	38	37	91.3	od
30	33	32	90.2	bf

April 1900

Date	Dry bulb T	Wet bulb T	RH (%)	Observations
3	38	37	91.3	o

Brixton

September 1899

Time = 8am

Date	Dry bulb T	Wet bulb T	RH (%)	Weather
29	45	44	92.6	om
30	47	46	92.9	o

Time = 2pm

No dates

October 1899

Time = 8am

Date	Dry bulb T	Wet bulb T	RH (%)	Weather
1	51	50	93.4	ogq
2	52	51	93.5	og
7	37	37	100	f
8	39	39	100	fw

Date	Dry bulb T	Wet bulb T	RH (%)	Weather
9	42	41	92.1	bfw
10	35	35	100	f
11	41	41	100	f
17	46	45	92.7	bm
18	41	41	100	f
19	41	41	100	f
20	41	40	91.9	f
21	41	41	100	f
22	44	44	100	f
23	41	41	100	of
24	47	47	100	cf
25	48	47	93.0	cm
26	53	52	93.6	o
27	57	56	94.1	od
28	58	57	94.2	c
30	51	50	93.4	o

Time = 2pm

Date	Dry bulb T	Wet bulb T	RH (%)	Weather
4	54	52	87.6	omg
6	53	50	81.3	om
9	59	50	52.2	bm
10	61	53	58.5	bm
11	64	58	69.7	bm
17	60	53	62.7	bm
18	63	55	59.8	bm
20	60	51	53.0	bm
21	47	45	85.9	f
23	55	52	81.9	bf

November 1899

Time = 8am

Date	Dry bulb T	Wet bulb T	RH (%)	Weather
4	58	58	100	c
5	54	53	93.8	or
6	49	48	93.2	ogr

Time = 2pm

Date	Dry bulb T	Wet bulb T	RH (%)	Weather
6	53	50	81.3	om

February 1900

Time = 8am

Date	Dry bulb T	Wet bulb T	RH (%)	Weather
7	27	25	77.2	bm
8	24	23	87.5	bm
9	18	16	70.2	f
12	23	21	74.4	m
13	26	24	76.6	f
14	34	33	90.5	s
18	36	35	90.9	b
23	50	50	100	o
24	51	50	93.4	c
25	50	49	93.3	o
26	45	44	92.6	omd
27	48	47	93.0	fgr
28	43	42	92.3	ogmd

Time = 2pm

Date	Dry bulb T	Wet bulb T	RH (%)	Weather
7	36	32	64.5	bm
8	36	32	64.5	bm
9	37	32	57.0	f
13	38	35	74.4	m
17	47	46	92.9	ogm
27	50	50	100	ogd
28	43	42	92.3	og

January 1901

Time = 8am

Date	Dry bulb T	Wet bulb T	RH (%)	Weather
23	36	35	90.9	fg
24	42	41	92.1	ogm
28	36	35	90.9	op
30	33	32	90.2	bc
31	31	30	89.7	bc

Time = 2pm

Date	Dry bulb T	Wet bulb T	RH (%)	Weather
21	53	51	87.4	om
23	47	41	59.1	mg
24	46	45	92.7	om
31	39	36	75.0	ogm

February 1901

Time = 8am

Date	Dry bulb T	Wet bulb T	RH (%)	Weather
3	36	34	82.0	ogm
4	27	25	77.2	ogm
5	33	32	90.2	o
6	35	34	90.7	og
7	32	30	80.1	bcmg
8	33	32	90.2	c
9	37	37	100	om
13	32	32	100	og
17	36	35	90.9	osp
18	33	32	90.2	bm
19	32	31	90.0	os
21	27	25	77.2	m
22	39	38	91.5	og
24	40	39	91.7	og
25	39	38	91.5	c
27	44	43	92.4	op
28	41	40	91.9	b

Time = 2pm

Date	Dry bulb T	Wet bulb T	RH (%)	Weather
1	40	37	75.6	bcm
4	38	35	74.4	cm
5	36	34	82.0	om
7	40	36	67.7	bcm
8	41	39	84.0	om
9	43	41	84.7	ogm
11	38	34	66.2	cm
14	33	32	90.2	c
15	35	33	81.5	om
18	37	33	65.4	og
19	37	36	91.1	fg

APPENDIX 7: Analysis of Monet's paintings with respect to the Royal Horticultural Society's weather diaries and weather reports for Westminster, Brixton and Kew

Royal Horticultural Society weather diary

September 1899

Date	Wind dir	Weather obs.
16	WNW	Cloudy, strong wind, thunderstorms during the day
17	WSW	Cloudy. Wind moderate & fresh
18	WSW	Very cloudy, wind cold
19	WSW	Very dull, wind cold
20	WSW	Cloudy, wind very cold
21	WSW	Bright & clear. Wind very cold
22	WNW	Bright & clear, wind strong & cold
23	WSW	Dull & cloudy, wind cold, rain in evening
24	WNW	Bright & clear, wind strong & cold
25	WSW	Bright & clear
26	WSW	Bright & clear, wind strong & cold
27	SW	Dull, cloudy & raining slightly. Thunderstorm in evening
28	WSW	Bright, clear & calm

October 1899

Date	Wind dir	Weather obs.
2	WSW	Dull, cloudy & cold
3	WSW	Clear & bright, wind cool
13	WSW	Bright & clear wind fresh
24	WNW	Slight fog
31	WSW	Clear & bright

February 1900

Date	Wind dir	Weather obs.
21	WNW	Bright sunny morning, very fine day

March 1900

Date	Wind dir	Weather obs.
16	WNW	Dull and cloudy flashes of sunshine
17	WNW	Dull with cold sleet showers

April 1900

Date	Wind dir	Weather obs.
2	WSW	Misty, wind cold, fine spring-like day
3	WSW	Misty, showers with hail
4	WNW	Cloudy at first, fine spring-like day
5	WNW	Overcast, dull showery day
6	WNW	Bright & clear, fine spring day

<u>Weather reports – south of England, Westminster and Brixton</u>

Forecasts for 24 hours ending at noon, Location: South England

September 1899

Date	Observations
15	Westerly to Northerly breezes; cloudy; rain at times
16	Rather unsettled
18	-
19	Strong & squally winds from NW, passing showers, cool
20	Westerly (SW to NW) winds, very changeable, unsettled weather, occasional rain
21	North-Westerly winds, strong but moderating; cool, with passing showers in most places

Date	Observations
22	North-Westerly to North-Easterly winds, light, fine at first, uncertain later
23	North-Westerly winds, very fresh & gusty, some rain at times
24	Westerly winds, veering to NW increasing greatly in force, with cold showers, squally
25	-
26	Wind back from W to SW, increasing, becoming showery again
27	South-Westerly to Westerly winds, strong, showery
28	South-Westerly winds, fresh, showery – then veering to NW, colder, drier
29	North-Westerly winds, light, fine – then South-Westerly and less fair
30	Varying SE to SW winds, dull rainy

October 1899

Date	Observations
1	South-Westerly to North-Westerly winds, unsettled, some rain
4	South-Westerly to Westerly winds, freshening; fair at first, some rain later
5	South-Westerly to Westerly winds, strong to a gale on coasts; dull at first, with some rain, improving later
6	North-Westerly winds, light; local showers at first, then fair; frost inland at night
7	Easterly to North-Easterly winds, light or moderate, fair generally, frosty at night, with local fogs
8	Northerly to North-Easterly winds, light, fair generally, frosty & foggy at night
9	-
10	Southerly & South-Westerly winds, light, fine generally but local fogs at night
11	Light breezes chiefly South-Westerly, fair generally, local fogs at night
12	Southerly winds, light or moderate, fine at first, cloudy later probably some rain
13	Southerly to Westerly winds, moderate, cloudy, some rain, cooler
14	North-Westerly winds, fresh or strong at first, moderating later, fair generally, but local showers, frost inland at night
17	Easterly to South-Easterly winds, fresh, fair at first, cloudy later, possibly some rain
18	Easterly to South-Easterly winds, light or moderate, fine generally, local fogs at night
19	Easterly winds, light, fine generally but local fogs at night
20	Easterly to South-Easterly winds, light, fair generally, but local fogs at night
21	Variable to Easterly airs, fair in places, but mostly foggy or misty
22	Variable to Easterly airs, fair in places, but mostly foggy or misty
23	-
24	Variable or Westerly airs, foggy or misty in most places
25	North-Westerly or North-Easterly breezes, very light, fair, but cooler & foggy

Date	Observations
26	Southerly and South-Westerly winds, light to moderate, changeable, fair milder
27	South-Westerly & Westerly winds, light, slight showers, then colder & finer
28	South-Westerly & Southerly winds, light; rainy then cooler
29	Varying light breezes between SW & NW; weather very changeable, rain at times
30	-
31	North-Westerly to South-Westerly winds, temperatures finer, not settled

November 1899

Date	Observations
1	Westerly & South-Westerly winds, moderate, fair, cool
2	Southerly & South-Westerly winds, freshening, fine at first, cloudy later, probably some rain
3	Southerly winds, strong in places, mild, changeable, some showers, with bright intervals
4	South-Westerly winds, strong to a gale, fine at first, some rain later
6	-
7	Light variable breezes, dull & misty at first; with rain in places, improving temperatures later

February 1900

Date	Observations
7	Northerly to North-Easterly winds; moderate, fine at first, snow showers later
8	Northerly to North-Easterly winds, fine at first, fog in places, cloudy later, probably some snow
9	North-Easterly winds, light, fair generally, foggy or misty in places
10	Easterly & South-Easterly winds, light, fine at first, cloudy later, possibly snow becoming milder
12	-
13	Easterly winds increasing in force, cloudy, squally, some snow
14	Calms & South-Easterly winds, freshening, milder
16	South-Easterly to North-Easterly gales, rain and snow. Colder again
17	Westerly winds, strong to moderate, fair to showery
19	-
20	South-Westerly & Westerly winds, strong to a gale at times, rainy to fair & colder

Date	Observations
21	South-Westerly to North-Westerly winds, moderate to fresh, changeable, some showers
22	North-Westerly to South-Westerly winds freshening, fine at first, cloudy later with some rain or sleet
23	South-Westerly to Westerly winds, strong, squally, showery
24	South-Westerly winds, strong in places, mild, changeable, some rain
25	Southerly winds moderate, mild, changeable, showery
26	-
27	Easterly to South-Easterly winds moderate, rainy at first, improving temperatures later
28	Wind becoming Northerly generally and weather improving slowly

March 1900

Date	Observations
1	Easterly to North-Easterly winds, moderate to fresh, colder, rainy, dull
4	Varying Westerly to Northerly winds, some rain in most places, unsettled
5	-
7	Northerly to North-Westerly winds light dull misty or foggy in places
9	Variable or North-Easterly airs. Cloudy. Some mist or fog
10	Easterly winds moderate. Cloudy misty, slight rain locally
11	Easterly & South-Easterly winds, light, fair generally, warmer
17	Westerly & Northerly winds. Moderate. Few cold showers then finer. Frost at night
21	Southerly winds. Moderate or fresh. Changeable, some showers
23	Easterly & North-Easterly winds strong in places, changeable, some rain
24	North-Easterly winds strong, cloudy, slight rain locally
26	-
27	North-Westerly winds freshening, changeable, some snow showers
28	Northerly winds backing W. Light fine, milder, not settled
29	South-Westerly to North-Westerly & Northerly winds colder some slight cold showers
30	Northerly airs & calms then South-Westerly & Southerly & milder weather
31	Calm, fine, foggy in places, very cold tonight

April 1900

Date	Observations
1	Variable & Southerly airs, fine, hazy at times, very little milder
2	-
3	Varying & North-Easterly airs, hazy, cloudy
4	South-Westerly winds, moderate or fresh, cloudy, some rain
7	Southerly & South-Westerly winds becoming strong & squally, showery, milder, unsettled

Today's 2pm reports, Location: Westminster, London

September 1899

Date	Wind dir	Observations
18	NW	cf
20	NW	cf

October 1899

Date	Wind dir	Observations
4	SE	omg
6	E	om
9	S	bm
10	SSW	bm
11	SSW	bm
17	E	bm
18	ENE	bm
20	E	bm
21	Z	f
23	NW	bf

November 1899

Date	Wind dir	Observations
6	NNW	om

February 1900

Date	Wind dir	Observations
7	NW	bm
8	NE	bm
9	ESE	f
13	ESE	m
14	N	c
15	SSE	or
16	WNW	bc
17	SSW	ogm

January 1901

Date	Wind dir	Observations
31	WNW	ogm

February 1901

Date	Wind dir	Observations
1	NW	bcm
4	WSW	cm
5	N	om
7	NW	bcm
8	W	om
9	NW	ogm
11	N	cm
15	NE	om
19	Z	fg

Daily weather reports

Location: Brixton

Yesterday evening

September 1899

Date	Wind dir	Observations
16	SW	o
22	SW	c
30	SE	r

October 1899

Date	Wind dir	Observations
1	S	b
2	SSW	c
10	SW	bcm
12	S	bm
19	SE	b
20	SE	b
21	SE	bm
26	SSW	o
27	SW	or
28	SW	od
30	SW	o

November 1899

Date	Wind dir	Observations
2	S	b
3	SW	o
4	SW	rq
5	SSW	odr
6	S	o

February 1900

Date	Wind dir	Observations
10	SSE	m
11	SSE	s
14	SE	os
16	S	oqd
18	SE	org
19	SSW	o
20	SW	opq
22	SW	c
24	SSW	c
25	S	c
27	SSW	cp
28	S	ogd

March 1900

Date	Wind dir	Observations
19	SSE	ors
20	SE	bc
21	SE	b

April 1900

Date	Wind dir	Observations
1	SE	bm
2	SE	b
4	S	or
7	SW	c

This morning

September 1899

Date	Wind dir	Observations
27	SW	o
29	SW	om
30	S	o

October 1899

Date	Wind dir	Observations
1	SE	ogq
3	SW	b
4	SW	o
26	S	o
27	SW	od
29	SW	oc

November 1899

Date	Wind dir	Observations
1	S	b
2	S	or
3	SSW	b
4	SSW	c
5	S	or
6	SE	ogr
7	S	bc

February 1900

Date	Wind dir	Observations
10	SSE	bc
15	SSE	rq
16	SW	bc
17	SW	b

Date	Wind dir	Observations
19	SSW	odq
20	SSW	bc
22	SW	c
23	SSW	o
24	S	c

March 1900

Date	Wind dir	Observations
19	SW	o
20	SW	b
21	E	bf

April 1900

Date	Wind dir	Observations
3	SW	o

<u>Past 24 hours</u>

September 1899

Date	Weather
15	b.bm

October 1899

Date	Weather
3	od.om.b
5	opdm
6	od.mw
8	bc.fw
9	bf.c.bw
10	b.bfw

Date	Weather
11	b.bm.bw
12	b.m.bw
14	b.bmw
17	bm.om.b
18	bv.fw
19	f.b.bw
20	bm.fw
21	f.bm.fw
22	fg
23	fg
24	gf.mw
25	cm.o
26	cm.o.d

November 1899

Date	Weather
7	or.c.bm

February 1900

Date	Weather
8	bm.o
9	bm.o
10	bm.b
13	om.f
14	of.srq
15	bm.b.o
25	o.m.r
26	o.m.b.d
27	bc.m.or
28	ogrm.og

March 1900

Date	Weather
11	bm.o
12	om.bc.cm
13	bm.b
18	cm
22	bcm.orq
27	o.phs.bm
28	o.bm

April 1900

Date	Weather
2	o.b.m

<u>Brixton Weather Station Data</u>

September 1899

Time = 8am

Date	Wind dir	Weather
27	SW	o
29	SW	om
30	S	o

Time = 2pm

Date	Wind dir	Weather
29	SSW	od
30	SW	o

October 1899

Time = 8am

Date	Wind dir	Weather
1	SE	ogq
3	SW	b

Date	Wind dir	Weather
4	SW	o
26	S	o
27	SW	od
29	SW	o

Time = 2pm

Date	Wind dir	Weather
4	SE	omg
9	S	bm
10	SSW	bm
11	SSW	bm
25	S	o
26	SW	or
27	SSW	or

November 1899

Time = 8am

Date	Wind dir	Weather
1	S	b
2	S	or
3	SSW	b
4	SSW	c
5	S	or
6	SE	ogr
7	S	bc

Time = 2pm

Date	Wind dir	Weather
1	S	bc
2	SW	ogd
3	SW	o
4	SW	o
7	S	o

February 1900

Time = 8am

Date	Wind dir	Weather
10	SSE	bc
15	SSE	rq
16	SW	bc
17	SW	b
19	SSW	odq
20	SSW	bc
22	SW	c
23	SSW	o
24	S	c

Time = 2pm

Date	Wind dir	Weather
10	SSE	o
15	SSE	or
17	SSW	ogm
19	SW	cr
22	SW	o
24	S	c
26	SSE	c

January 1901

Time = 8am

Date	Wind dir	Weather
21	SW	c
24	SE	ogm
28	SW	op

Time = 2pm

Date	Wind dir	Weather
22	SW	og
24	SSW	om

February 1901

Time = 8am

Date	Wind dir	Weather
2	SW	o
19	SW	os
26	SE	o
27	SW	op
28	SW	b

Time = 2pm

Date	Wind dir	Weather
2	S	og
25	SW	o
26	SSW	o

Kew Weather Station Data

September 1899

Date	10am	12pm	2pm	4pm	6pm	8pm	10pm	Remarks
17								Cloudy and dull all day

October 1899

Date	10am	12pm	2pm	4pm	6pm	8pm	10pm	Remarks
2								Overcast and gloomy all day
4								Overcast and misty all day
5								Overcast and misty all day
6								Dull and misty all day
9	Fog						Thick wet fog	
10							Thick wet fog	Fine but misty all day

Date	10am	12pm	2pm	4pm	6pm	8pm	10pm	Remarks
11							Thick wet fog	Fine but misty all day
12								Fine but misty all day
16								Fine but misty all day
17								Fine but misty all day
18	Fog							Fine but misty all day
19	Fog	Fine	Fine	Fine	Fine	Fine	Fine	
20								Fog nearly all day
21								Foggy all day. Very damp
22	Fog							Thick fog during the evening
23								Dull and misty all day
25								Fine but misty through the day

November 1899

Date	10am	12pm	2pm	4pm	6pm	8pm	10pm	Remarks
2								Overcast all day, rain at times
4								Dull all day
6								Overcast and misty till approx. 3:30pm

February 1900

Date	10am	12pm	2pm	4pm	6pm	8pm	10pm	Remarks
10	o, m							7 inches of snow
12	o, f		o, m	o, m	o, m	o, m		Fog or mist all day

Date	10am	12pm	2pm	4pm	6pm	8pm	10pm	Remarks
13	Fog		o, m	o, m	o, m	o, m		Fog with thick mist
15	o, m							
25	o, m							
26	o, m							
27	o, m	o, m	o, m					Dull and misty all day
28	o, m	o, m	o, m					Overcast with mist all day

January 1901

Date	10am	12pm	2pm	4pm	6pm	8pm	10pm	Remarks
23	Fog	Fog	Fog					Dull and misty

February 1901

Date	10am	12pm	2pm	4pm	6pm	8pm	10pm	Remarks
2								Rather dull and misty
3								Overcast and dull
4								Sun shining through thin clouds. Misty
7								Misty
8								Misty, fair and dull later
9								Dull and misty
10								Dull, misty and overcast
11	Mist							Dull
13								Dull and misty
18								Dull and misty
20								Dull and misty

Fog Observations

October 1899

Brixton	Kew	The Times
9 (am)	9 (am) (Thick wet fog)	9 (Fog)
18 (am)	18 (am)	
19 (am)	19 (am)	19 (Fog)
20 (am)	20 (Fog nearly all day)	20 (Fog)
21 (am)	21 (Foggy all day)	21 (Fog)
23 (am-pm)		
24 (am)		

November 1899

Brixton	Kew	The Times
15 (am)	15 (am) (Thick fog)	15 (Fog)
16 (am)		
	17 (Foggy throughout the day)	
18 (am)		
	19 (Foggy early)	
29 (am)	29 (Foggy all day)	29 (Fog)
30 (am-pm)	30 (Foggy all day)	30 (Fog)

February 1900

Brixton	Kew	The Times
	4 (am)	
9 (am-pm)		
	12 (am) (Fog or mist all day)	
13 (am)	13 (am) (Fog with thick mist)	13 (Fog)
27 (am)		

January 1901

Brixton	Kew	The Times
2 (am-pm)	2 (Fine but misty and foggy)	2 (Fog)
3 (am-pm)	3 (Thick fog all day)	3 (Fog)
	4 (Fog)	
5 (am)	5 (Fog)	5 (Fog)
	6 (Fog)	
11 (am)		
12 (am-pm)		
15 (am)		
	16 (Fog all day)	
	17 (am) (Fog dispersed soon after noon)	
23 (am)		
	24 (Fog)	

February 1901

Brixton	Kew	The Times
10 (High fog)		

APPENDIX 8: Monet's letters

<u>Monet's second visit in 1900</u>

Monet's letters

1505 London, Monday 12th February 1900 to Alice Monet

"il y a un brouillard des plus épais" → there is a very thick fog

1506 London, Tuesday 13th February 1900 to Alice Monet

"Ce matin et hier, brouillard à ne rien voir" → This morning and yesterday, nothing to see but fog

1507 London, Wednesday 14th February 1900 to Alice Monet

"lorsque ce n'est pas un brouillard à ne rien voir" → when there is a fog nothing is is to be seen

1509 London, Saturday 17th February 1900 to Alice Monet

"une brume exquise, et un splendide coucher de soleil; aujourd'hui, pluie et brouillard" → an exquisite fog, and a splendid sunset; today, rain and fog

1517 London, Saturday 24th February 1900 at 10 o'clock to Alice Monet

"un brouillard superbe" → the fog is superb

1518 London, Sunday 25th February 1900 at 4:30 in the evening to Alice Monet

“beaucoup de brouillard” → lots of fog

1519 London, Monday morning at 10 o’clock 26th February 1900 to Alice Monet

“Je profile du brouillard très épais” → I benefit from very thick fog have taken advantage

“Ce matin au petit jour, il y a eu un brouillard extraordinaire” → This morning, at daybreak, there was an extraordinary fog

“Hélas! Le brouillard ne veut pas se dissiper” → Alas! The fog does not want to recede

1531 London, 17th March to Alice Monet

“moments très beau avec un brouillard délicieux” → very beautiful moments with a delicious fog

<u>Monet’s final visit in 1901</u>

Monet’s letters

1592 London, Saturday 2nd February 1901 to Alice Monet

“un léger brouillard” → a light fog

1593 London, Sunday 3rd February 1901 to Alice Monet

“Grâce aux fumées, la brume est venue, puis des nuages” → Through the smoke, the fog came, then clouds

1596 London, Tuesday 5th February 1901 to Alice Monet

“le brouillard s'est épaissi assez pour dissimuler la neige” → the mist thickened enough to hide snow

1597 London, Wednesday 6th February 1901 to Alice Monet

“Il y avait bien un peu trop de brouillard le matin, mais le joli ballon rouge n’a pas été long à se montrer et avec lui une succession d’effets étonnants” → There was a little too much fog this morning, but the pretty red balloon was not long to be shown and with him a succession of astonishing effects

1598 London, Friday 8th February 1901 to Alice Monet

“beau temps, mais obstrué par le brouillard” → beautiful weather, but obstructed by fog

1599 London, Saturday 9th February 1901 to Alice Monet

“Encore une journée de brouillard complet ” → Again a day of complete fog

1601 London, Monday 11th February 1901 to Alice Monet

“les effets variables au possible à cause de cette brume merveilleuse” → variable effects are possible because of this marvellous fog

1604 London, Thursday 14th February 1901 to Alice Monet

“c’est le brouillard qui s’est levé en augmentant d’intensité” → it is the fog which rose with increasing intensity

1606a London, Sunday 17th February 1901 to Alice Monet

“des bourrasques de neige, puis du soleil, du brouillard et du temps noir” → flurries of snow, then sun, fog and black weather

1608a London, Tuesday morning 19th February 1901 to Alice Monet

“à chaque pas je voyais de belles choses justement à cause de ce grand brouillard” → with each step I precisely saw beautiful things because of this thick fog

APPENDIX 9: Diary of fog/mist/haze events in London from sources used in this thesis

Fog/ Mist/ Haze

February 1900

Date	Letter	RHS weather diary	Westminster weather report	Brixton weather report	Kew weather report	Dates– solar geometry	New dates
9		✓	✓	✓			
10					✓	W1573, W1607	W1573
11						W1573, W1605, W1607	
12	✓	✓		✓	✓	W1573, W1605, W1607, W1610	W1573
13	✓	✓	✓	✓	✓	W1573, W1599, W1605, W1607, W1610	W1573
14	✓					W1573, W1599, W1605, W1607, W1610	W1573, W1599, W1605, W1607, W1610
15					✓	W1572, W1573, W1599, W1605, W1610	W1572, W1573, W1599, W1605, W1610
16						W1572, W1599, W1602, W1605, W1610	W1599, W1602, W1605, W1610

Date	Letter	RHS weather diary	Westminster weather report	Brixton weather report	Kew weather report	Dates– solar geometry	New dates
17	✓		✓			W1572, W1599, W1602, W1605, W1610	W1572
18						W1572, W1574, W1599, W1602, W1605, W1610	
19						W1572, W1574, W1599, W1602, W1605, W1606	W1599, W1602, W1605, W1606
20						W1574, W1599, W1606	W1599, W1606
21						W1574, W1599, W1606	W1599, W1606
22						W1574, W1604, W1606	W1604, W1606
23						W1574, W1604, W1606	W1604, W1606
24	✓					W1574, W1604, W1606	W1574, W1604, W1606
25	✓	✓			✓	W1575, W1604, W1606	W1575
26	✓	✓		✓	✓	W1575, W1604, W1606	W1575, W1606
27				✓	✓	W1575	W1575
28		✓		✓	✓	W1575	W1575

March 1900

Date	Letter	RHS weather diary	Westminster weather report	Brixton weather report	Kew weather report	Dates – solar geometry	New dates
1						W1575	
3		✓					
5						W1563	
6						W1563, W1596	
7						W1563, W1596	
8						W1596	
9							W1596
10		✓					
11		✓		✓			
17	✓						
20						W1597	W1597
21		✓		✓		W1597	W1597
22						W1597	
23						W1597	
24						W1597	W1597
25						W1597	
29		✓					
30		✓		✓			
31		✓					

April 1900

Date	Letter	RHS weather diary	Westminster weather report	Brixton weather report	Kew weather report	Dates – solar geometry	New dates
1		✓					
2		✓					
3		✓					

January 1901

Date	Letter	RHS weather diary	Westminster weather report	Brixton weather report	Kew weather report	Dates – solar geometry	New dates
23		✓		✓	✓		
24				✓			
26						W1567	
27						W1567	
28						W1567	
29						W1567	
31		✓					

February 1901

Date	Letter	RHS weather diary	Westminster weather report	Brixton weather report	Kew weather report	Dates – solar geometry	New dates
1		✓	✓		✓	W1554, W1555	W1554, W1555
2	✓				✓	W1554, W1555, W1565	W1554, W1555, W1565
3	✓	✓		✓		W1554, W1565	W1554, W1565
4		✓	✓	✓	✓	W1554, W1565	W1554, W1565
5	✓		✓			W1554	W1554
6	✓					W1554	W1554
7			✓	✓	✓	W1554	W1554
8	✓	✓			✓		
9	✓	✓		✓	✓		
10					✓	W1573, W1607	W1573
11	✓		✓		✓	W1573, W1605, W1607	W1573, W1605, W1607
12						W1573, W1605, W1607, W1610	W1605, W1607, W1610

Date	Letter	RHS weather diary	Westminster weather report	Brixton weather report	Kew weather report	Dates – solar geometry	New dates
13					✓	W1573, W1599, W1605, W1607, W1610	W1573, W1599, W1605, W1607, W1610
14	✓					W1573, W1599, W1605, W1607, W1610	W1573, W1599, W1605, W1607, W1610
15			✓			W1572, W1573, W1599, W1605, W1610	W1572, W1573
16						W1572, W1599, W1602, W1605, W1610	
17	✓					W1572, W1599, W1602, W1605, W1610	W1572
18				✓	✓	W1572, W1574, W1599, W1602, W1605, W1610	W1574
19	✓		✓			W1572, W1574, W1599, W1602, W1605, W1606	W1574
20					✓	W1574, W1599, W1606	W1574

Date	Letter	RHS weather diary	Westminster weather report	Brixton weather report	Kew weather report	Dates – solar geometry	New dates
21				✓		W1574, W1599, W1606	W1574
22						W1574, W1604, W1606	
23						W1574, W1604, W1606	
24						W1574, W1604, W1606	
25						W1575, W1604, W1606	
26						W1575, W1604, W1606	
27						W1575	
28						W1575	

March 1901

Date	Letter	RHS weather diary	Westminster weather report	Brixton weather report	Kew weather report	Dates – solar geometry	New dates
1						W1575	
5						W1563	
6						W1563, W1596	
7						W1563, W1596	
8						W1596	
20						W1597	
21						W1597	
22						W1597	
23						W1597	
24						W1597	

Date	Letter	RHS weather diary	Westminster weather report	Brixton weather report	Kew weather report	Dates – solar geometry	New dates
25						W1597	

Monet's paintings vs. Royal Horticultural Society's weather diaries

February 1900

Date	Painting
22	W1574 d
23	W1574 d
28	W1575

March 1900

Date	Painting
1	W1575 d
6	W1563 d

January 1901

Date	Painting
28	W1567 d

February 1901

Date	Painting
1	W1554, W1555
2	W1554 d, W1555 d, W1565 d
3	W1554 d, W1565
4	W1554
6	W1554 d
18	W1572 d, W1573 d
20	W1574 d
22	W1574 d
23	W1574 d

Date	Painting
27	W1575 d

March 1901

Date	Painting
1	W1575 d
6	W1563 d

<u>Monet's paintings vs. weather reports</u>

February 1900

Date	Painting
15	W1573
17	W1572, W1573
22	W1574 o
27	W1575
28	W1575

March 1900

Date	Painting
1	W1575 o
6	W1565 o g

January 1901

Date	Painting
28	W1567 o

February 1901

Date	Painting
1	W1554, W1555
2	W1554, W1555, W1565
3	W1554, W1565
4	W1554
5	W1554
6	W1554 o g
15	W1573
16	W1572 o d, W1573 o d
17	W1573 o
18	W1572, W1573
20	W1574
21	W1574
22	W1574 o g
23	W1574 o
27	W1575 o

APPENDIX 10: Comparative analysis of Monet's paintings

Conclusions: Monet's paintings vs. weather diaries and weather reports

February 1900

Date	Painting
15	W1573
17	W1572, W1573
22	W1574 o d
23	W1574 d
27	W1575
28	W1575

March 1900

Date	Painting
1	W1575 o d
6	W1563 o d

January 1901

Date	Painting
27	W1567 o
28	W1567 o d

February 1901

Date	Painting
1	W1554, W1555
2	W1554, W1554 d, W1555, W1555 d, W1565, W1565 d
3	W1554, W1554 d, W1565
4	W1554
5	W1554
6	W1554 o g d
16	W1572 o d, W1573 o d

Date	Painting
17	W1573 o
18	W1572 d, W1573 d
20	W1574 d
22	W1574 o g d
23	W1574 o d
27	W1575 o d

March 1901

Date	Painting
1	W1575 d
6	W1563 o d

APPENDIX 11: Dates for Waterloo Bridge and Charing Cross Bridge paintings

Table of dates for the Waterloo Bridge paintings

Paintings	**Solar geometry dates**	**New dates**
W1555 'Londres, Waterloo Bridge'	February 1st – 2nd 1901	February 1st – 2nd 1901
W1563 'Waterloo Bridge, temps couvert'	March 5th – 7th 1900/1901	X
W1565 'Waterloo Bridge, effet de soleil'	February 2nd – 4th 1901	February 2nd – 4th 1901
W1567 'Waterloo Bridge, effet de soleil'.	January 26th – 29th 1901	X
W1572 'Waterloo Bridge, le soleil dans le brouillard'	February 15th – 19th 1900/1901	1900: February 15th, 17th 1901: February 15th, 17th – 19th
W1573 'Waterloo Bridge, soleil dans le brouillard',	February 10th – 15th 1900/1901	1900: February 10th, 12th – 15th 1901: February 10th, 11th, 13th – 15th
W1574 'Waterloo Bridge'	February 18th – 24th 1900/1901	1900: February 24th 1901: February 18th – 21st
W1575 'Waterloo Bridge, brouillard'	February 25th – March 1st 1900/1901	1900: February 25th – 28th 1901: X

<u>Table of dates for the Charing Cross Bridge painting</u>

Paintings	Solar geometry dates	New dates
W1554 ‘Charing Cross Bridge, brouillard sur la Tamise’	February 1st – 7th 1901	February 1st – 7th 1901

APPENDIX 12: Monet at the Savoy

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Monet at the Savoy

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Solar geometry is used to accurately date the four paintings of Waterloo Bridge and one painting of Charing Cross Bridge, from Monet's London Series, that have the sun clearly visible within the image. Monet reworked the 'enveloppe' within these images on subsequent days when the sun was in a similar position but did not change the position of the sun. Letters to Monet's wife and contemporary weather data verify the probable dates. This confirms that Monet painted what he saw and that we can cautiously use his London Series as a pictorial 'weather diary' of typical Victorian London fogs. Monet painted these images from the Savoy Hotel during stays in 1900 and/or 1901 and the fifth floor balcony he used has now been located for the first time.

Key words: *Victorian fogs, London Series, solar geometry, climate change*

Introduction

Over the last decade there has been an ever increasing interest in the representation of skies, atmosphere, weather and climate in a variety of artistic media (Eliasson 2003; Olson *et al.* 2003 2005 2007; Kunz *et al.* 2005; Thornes 1999 2000 2008a 2008b). Indeed a number of studies have contemplated the use of environmental art as a form of proxy data for past weather, air pollution and climate change (Lamb 1967; Neuberger 1970; Brimblecombe and Ogden 1977; Thornes and Metherell 2003; Baker and Thornes 2006; Zerefos *et al.* 2007). However, there is some conjecture about the validity of using artists' images of the environment in this way and one has to be very careful in choosing which artists provide accurate representations and which use their artistic licence to exaggerate or invent a theme.

Baker and Thornes (2006) were able to accurately date nine of Monet's paintings from his London Series using solar geometry. The solar positions were calculated for images that had a clear representation of the sun setting over the Houses of Parliament. The likely dates and times for the paintings were derived and confirmed by cross referencing with Monet's letters to his wife Alice and dealer Durand-Ruel. Figure 1 shows the solar tracks superimposed over Monet's 'London, Houses of Parliament, Effects of Sun in the Fog'. Monet probably reworked the depicted atmosphere and fog, represented within the canvases, but the outline of the Houses of Parliament and the position of the sun remained constant. It is probable that Monet had already pre-drawn outlines of the Houses of Parliament on his canvases and the sun was the first item he painted into the images. Solar geometry was also used to derive the exact balcony that Monet must have used, at St Thomas's hospital across the Thames, to paint these images. The success of the use of solar geometry in this way suggests that Monet did attempt to paint exactly what he saw and therefore we can treat these images as faithful pictorial representations of the infamous London fogs.

Claude Monet first visited London in 1870–1, when he was exiled from France during the Franco-Prussian war and was more than likely living on the outskirts of the city due to a lack of funds. Nevertheless, it was during this visit to London that Monet fell in love with the city, the London fog and the atmospheric effects

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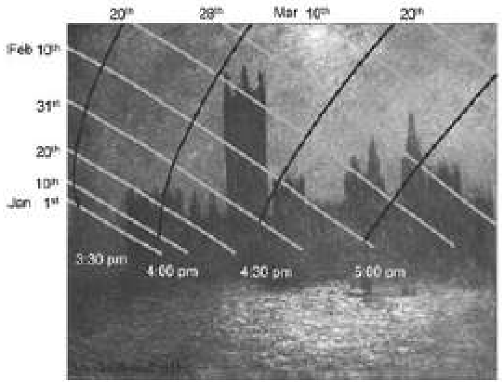

Figure 1 Solar geometry overlaid on Monet's 'London, Houses of Parliament, Effects of Sun in the Fog', giving a date and time of 7 March at 16:17 pm

that he called the 'enveloppe' – the atmosphere between the artist and the motifs (House 1986, 220). Monet was determined to return to London to produce another Series but it wasn't until 1899, when he was more affluent, that he could afford to travel and lodge in luxury at the Savoy, which was then regarded as one of the most luxurious hotels in the world (Taylor 1995). The Savoy Hotel had opened to much acclaim in 1889 and was recommended to Monet by his friend and fellow artist Whistler. Whistler had stayed on the sixth floor of the Savoy in 1896 and produced a number of sketches of the Thames.

Monet's *London Series* consists of 94 surviving oil paintings and many more that were started but never completed between 1899 and 1905.[1] Nearly all of the images were further worked upon when Monet returned home to Giverny between and after his visits to London. The known existing works are composed of 19 representations of the Houses of Parliament, 41 of Waterloo Bridge and 34 of Charing Cross Bridge. Thornes and Metherell (2003) discuss Monet's typical daily routine in 1900 and 1901 working on Waterloo Bridge paintings in the morning, Charing Cross Bridge paintings around lunch time and the Houses of Parliament in the afternoon – following the sun. This paper is concerned with four representations of Waterloo Bridge and one of Charing Cross Bridge in which the sun's disc is clearly visible. These will be dated using solar geometry and where possible the dates will be verified using Monet's letters and also contemporary weather data. Firstly it is necessary to establish which rooms Monet occupied at the Savoy during his three visits in 1899, 1900 and 1901.

Monet's rooms at the Savoy

Monet's three visits to the Savoy Hotel were from mid-September to the end of October/early November in 1899, 9 February to 5 April in 1900, and 25 January until the end of March in 1901. There is some uncertainty in these dates, but in all Monet spent nearly six months in London during this 18-month period, which shows his determination to complete his remarkable *London Series*.

The view from Monet's rooms in 1899, on the sixth floor of the Savoy Hotel overlooking The Thames, had Waterloo Bridge to the left, downstream, and Charing Cross Bridge to the right, upstream. In the distance behind Charing Cross Bridge, the Houses of Parliament were visible. When Monet returned to London in 1900, he discovered that the entire sixth floor of the hotel had been dedicated to injured soldiers of the Boer War, as per Princess Louise's request (Wildenstein 1996a, cited Seiberling 1988). Therefore, during this visit and again in 1901, Monet continued work on his *London Series* from a suite on the fifth floor. In those days a suite consisted of two rooms: a bedroom and a sitting room, both facing the river.

The established literature (Patin 1994; Shanes 1994) assumes that in 1899 Monet stayed in the corner suite that Whistler had previously occupied and recommended because the balcony view was so felicitous (Bennett 2005): 'For his first campaign, in September 1899, Monet took the sixth-floor corner suite at the Savoy that Whistler had occupied in 1896' (Shanes 1994, 120).

Whistler's room and viewing position can be ascertained from his lithographs 'Savoy Pigeons' (Lochnan 2005, 182) and 'Evening – Little Waterloo Bridge' (Lochnan 2005, 185), both produced in 1896 when he resided at the Savoy for several weeks to give comfort to his wife, Trixie, who was dying of cancer. The pigeons in 'Savoy Pigeons' can be seen on the corner balcony with no pillars to the left. As these pillars are only present up to and including the fifth floor of the hotel (see Figure 2), then it can indeed be confirmed that Whistler was painting from the corner suite of the sixth floor of the Savoy Hotel.

Also note that in 'Waterloo Bridge' (Lochnan 2005, 185) Whistler, sketching from the sixth floor (Room 608), clearly shows that a large triangular stretch of the Thames can be seen beyond Waterloo Bridge in front of the south bank. However, none of Monet's representations of Waterloo Bridge show such a large stretch of the Thames beyond the Bridge, which suggests that all of Monet's representations of Waterloo Bridge were

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Figure 2 The Savoy Hotel and rooms occupied by Monet in 1899 (6th floor) and in 1900 and 1901 (5th floor)

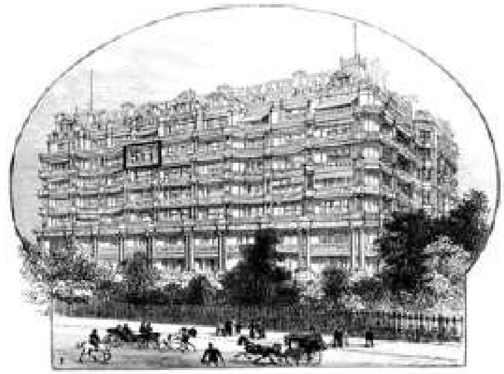

Figure 3 An artist's impression of the Savoy frontage

painted from the fifth floor. Wildenstein, to the contrary, suggests that: 'Although no painting of this motif (Waterloo Bridge) is dated 1899, it may be supposed that Monet began work on this important series during his first stay' (1996a, 676).

House (2005, 32) also suggests that Monet painted views of Waterloo Bridge in 1899. Simple geometry shows that this is unlikely to be true and we can assume that all of the Waterloo Bridge pictures were painted either in 1900 or 1901 from the fifth floor.

Monet included Cleopatra's Needle in the foreground of two of his representations of Charing Cross Bridge, and the geometry of the Needle's alignment with the bridge piers implies that Monet was in fact staying in the suite comprising rooms 610 and 611 in 1899 (as shown in Figure 2) and the suite directly below (rooms 510 and 511) in 1900 and 1901. Both suites had a bedroom (610 and 510) and a sitting room (611 and 511) that he used as a studio. An alteration in the numbering system of the rooms at the Savoy Hotel since Monet's time has added to the confusion of previous authors. The original room numbers of the current rooms are as follows: 610 (old 642); 611 (old 641); 510 (old 542); 511 (old 541). As of 2008, the Savoy has been closed for renovations of the riverside rooms – perhaps the room numbers will be changed again? Interestingly, before restoration in 2008, the Savoy Hotel mistakenly marketed rooms 512 and 513 as the 'Monet Suite'

Each room had an accessible balcony overlooking the Thames. Figure 3 shows that the balconies in front of rooms 511 and 611 protruded further out towards the river than the balconies of rooms 510 and 610, and would have offered ideal locations for Monet to paint. Although it is not possible to know exactly where Monet stood his easel on the balconies, and he may have used slightly different positions when facing towards Charing Cross Bridge compared with when he painted Waterloo Bridge, the likely locations are within a few metres of each other.

The solar geometry of the Waterloo Bridge and Charing Cross images

Having established which balconies Monet used to paint his views of Waterloo and Charing Cross bridges, it is now possible to use solar geometry to date those images that have a representation of the sun within them. In order to determine the likely dates that Monet first painted these images, it is necessary to calculate two angles: the solar azimuth and the solar elevation. The solar azimuth is the compass angle of the sun from where Monet was standing, measured from the north, such that at midday the solar azimuth would be 180 degrees, i.e. South. The solar elevation is the vertical angle to the sun from where Monet was standing. The sun's position in the sky varies with time of day and season and was essentially the same on a given date and time in 1899–1901 as it is today. In order to calculate these two angles for each painting, the geometry of the painting has to be scaled up to the real geometry of the Savoy Hotel and the bridges.

An Ordnance Survey map of London dated 1897 (County Series 1 : 2500) has been used to calculate the distances and angles from the Savoy Hotel to the bridges and other features. Charing Cross Bridge (now more commonly known as Hungerford Bridge) has

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been extensively altered since 1899/1901 but the original bridge piers are still in place. The structure that Monet would have seen was a railway bridge that had been opened in 1864 comprising nine spans made of wrought iron lattice girders. The first Waterloo Bridge was built as a toll bridge and opened in 1817. The bridge was built of granite and had nine arches, each of 120 feet (36.6 metres) span, separated by double Grecian-Doric stone columns. The toll was removed in 1878. Due to structural problems the bridge was replaced during the Second World War and the current bridge was opened in 1945. Westminster Bridge was opened in 1862 as a seven-arch wrought iron bridge and survives today much as it was in Monet's time.

The Savoy Hotel frontage has changed since Monet's day, but the height of the floors is unchanged. The balconies were removed to make way for bathrooms and the rooms were extended to the front edge of the balconies a decade later. Today when looking out of the windows of rooms 611 and 511, one is standing where Monet would have stood on the balcony.

The Waterloo Bridge paintings

The view from the Savoy across Waterloo Bridge was very different in Monet's day. The sun, having risen behind the industrial landscape, was visible through the smoke pollution generated by the industrial south bank of the Thames. Figure 4 shows the features on the South Bank used in the analysis. Wildenstein (1996a) identifies 41 images of Waterloo Bridge which he numbers as best he can in date order. Wildenstein groups the images according to the perceived time of day. Images W1555–W1581 show morning light, with the sun low in the sky in the image. Images W1582–W1595 are different as they are lit with the sun to the south, and hence the sun is not visible in any of these images. Four Waterloo Bridge paintings have been chosen for analysis from the first group W1555–W1581, in which the sun is directly visible. Firstly, it is assumed that all four of these images must have been painted in 1900 or 1901 as they represent the view from the fifth floor as discussed above. Secondly, the inferred dates will be checked against Monet's known time of stay at the Savoy, his letters and the reported weather conditions on those dates. During his visits to London in 1900 and 1901, Monet wrote with great frequency to his wife, Alice (Wildenstein 1996b). In his letters Monet wrote about his progress with his work, as well as detailed observations of the weather that he experienced day to day.

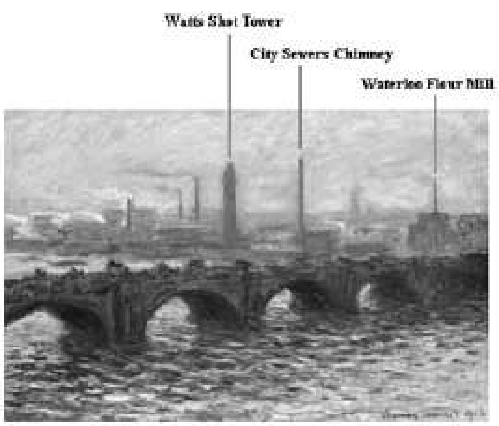

Figure 4 Features on the South Bank used in the analysis

The elevations from Monet on the fifth floor of the Savoy Hotel to distinctive landmarks visible within the Waterloo Bridge paintings were calculated. These landmarks are Waterloo Bridge, the Watts Shot Tower, the City Sewers Chimney and the Waterloo Flour Mill. The azimuthal angles for the location of the Watts Shot Tower, the City Sewers Chimney and the Waterloo Flour Mill were derived from the Ordnance Survey map. These sets of angles were used to establish an average 'degree to millimetre' scale, in both the horizontal and vertical directions, which could then be used to convert the height of the sun, measured above Waterloo Bridge and above the City Sewers Chimney, to an average altitude. The calculated dates were then derived using internet software from the Astronomical Applications Department of the US Naval Observatory (United States Naval Observatory 2009).

Solar elevations: Waterloo Bridge paintings

Each of the four paintings considered has a unique Wildenstein (1996a) number which will be used below. Reproductions of the paintings in Wildenstein have been used for analysis as the originals belong to galleries and private collections all over the world. Any distortion or stretching in the images used is taken into account by averaging the azimuth and altitude 'degree to millimetre' scales for each image. Note that only the years 1900 and 1901 are being considered because we know that these paintings were made from the fifth

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floor, therefore only dates after the 21 December equinox are calculated, i.e. in January, February and March.

W1572: 'Waterloo Bridge, le soleil dans le brouillard' (the sun in the fog) Private Collection, London 73 × 92 cm

Monet wrote to Alice on 17 February 1900: 'une brume exquise, et un splendide coucher de soleil; aujourd'hui, pluie et brouillard', which translates to 'an exquisite fog, and a splendid sunset; today, rain and fog' (Wildenstein 1996b, 342). In 1901, Monet wrote to Alice on 17 February: 'des bourrasques de neige, puis du soleil, du brouillard et du temps noir', which translates to 'flurries of snow, then sun, fog and black weather' (Wildenstein 1996b, 353). Monet also wrote to Alice on 19 February 1901: 'à chaque pas je voyais de belles choses justement à cause de ce grand brouillard' – 'with each step I saw such beautiful things, thanks, quite simply, to the thick fog' (Wildenstein 1996b, 354).

'Mist' was reported at Kew on 15 February 1900. However, the weather observations recorded for London do not report any fog or mist on 16 February 1900, but 'mist' was also recorded at Westminster and Brixton on 17 February 1900. There was no mention of mist or fog on 16 and 17 February in 1901, but 'mist' was recorded on 15 February 1901 at Westminster and 'fog' was recorded in Westminster on 19 February 1901.

Therefore, it can be concluded from available evidence that Monet painted 'Waterloo Bridge, le soleil dans le brouillard' in either 1900 or 1901, or alternatively that he started to paint the scene on 15 February 1900 and worked on the painting again on 17 February 1900 and also again on 15 and 19 February 1901.

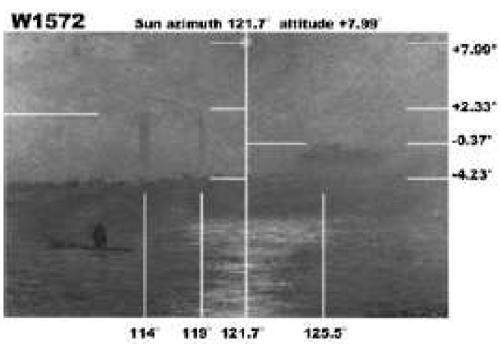

Figure 5 The towers, the bridge and the mill are all visible. Range of possible dates: 15 February–19 February at 8:14–8:17 am. This painting could therefore have been painted in either 1900 or 1901

W1573: 'Waterloo Bridge, soleil dans le brouillard' (effect of sunlight in the fog) National Gallery of Canada, Ottawa, 73 × 100 cm

Monet wrote to Alice on 12 February 1900: 'il y a un brouillard des plus épais', which translates to 'there is a very thick fog' and on 13 February 1900: 'Ce matin et hier, brouillard à ne rien voir' – 'This morning and yesterday, nothing to be seen but fog' and on 14 February 1900: 'lorsque ce n'est pas un brouillard à ne rien voir' – 'when there is a fog nothing is to be seen' (Wildenstein 1996b, 342). Monet also wrote to Alice on 14 February 1901: 'Mais c'est le brouillard qui s'est levé en augmentant d'intensité' – 'But it is the fog which rose with increasing intensity'. 'Mist' was recorded at Kew on 10 February 1900. 'Fog' was also reported in Chiswick and Kew on 12 February, whilst 'mist' was recorded in Brixton on the same day. 'Fog' was reported in Chiswick, Brixton and Kew, and 'mist' at Westminster, Brixton and Kew on 13 February 1900. 'Mist' was also recorded at Kew on 15 February 1900.

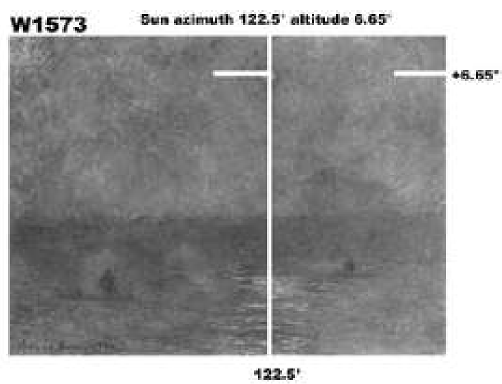

Figure 6 The positions of the Watts Shot Tower and the city sewers are only just visible in this painting and therefore the heights of the towers cannot be used but their azimuthal angles can be used. Since this is the case, only the height of the Waterloo Flour Mill has been used for the dating of this painting. Range of possible dates: 10 February–15 February at 8:14–8:18 am. The date for this painting corresponds to either of Monet's visits in 1900 or 1901

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During the following year, 'mist' was recorded on 10 February in Kew, 11 February in Westminster and Kew, 13 February in Kew, and again in Westminster on 15 February 1901.

Therefore, it seems reasonable to suggest that Monet could have painted 'Waterloo Bridge, soleil dans le brouillard' in 1900 or 1901. More likely Monet may have started to work on the canvas on 10 February 1900 and reworked the image in February 1901.

W1574: 'Waterloo Bridge' Private Collection 65 × 81 cm

Monet has used large brushstrokes to produce this particularly impressionist representation of Waterloo Bridge (Figure 7). The bridge and the Waterloo Flour Mill beyond are vaguely discernible. The globe of the sun, however, is clearly apparent, therefore only the height of the mill and the distance from Waterloo Bridge to the middle of the sun can be used to determine the elevation of the sun within this scene.

Monet wrote to Alice on 24 February 1900: 'un brouillard superbe' – 'a superb fog' (Wildenstein 1996b, 343). In a letter to Alice dated 19 February 1901, Monet wrote 'à chaque pas je voyais de belles choses justement à cause de ce grand brouillard' – 'with each step I saw such beautiful things, thanks, quite simply, to the thick fog' (Wildenstein 1996b, 354).

Fog was not recorded on any of the dates in 1900; however, 'dull' conditions were reported in Chiswick on 24 February 1900. The weather observations recorded for London reported 'mist' in Kew on 18 February 1901, and a 'very dark afternoon' in Chiswick and 'fog' in Westminster on 19 February 1901. 'Mist' was also recorded in Kew on 20 February 1901, whilst 'dull' conditions were also reported in Chiswick for 24 February 1901. Therefore the available evidence suggests that Monet started to paint 'Waterloo Bridge' on 24 February 1900 and may have reworked the image between 18 February 1901 and 24 February 1901.

W1575: 'Waterloo Bridge, brouillard' (in the fog) Private Collection 65 × 81 cm

Monet's brush strokes give this particular painting (Figure 8) a less distinct appearance. The Watts Shot Tower, the chimney of the City Sewers and the Waterloo Flour Mill are all visible enough to be used for analysis. The sun is visible as a red sphere in the sky.

Monet wrote to Alice on 25 February 1900: 'Aujourd'hui, beau temps, beaucoup de brouillard', which translates to 'Today, good weather, lots of fog'. Monet also wrote a letter to Alice on 26 February 1900: 'Je profite du brouillard très épais' – 'I benefit from a very thick fog', 'Ce matin au petit jour, il y a eu un brouillard extraordinaire' – 'This morning, at daybreak, there was an extraordinary fog' and 'Hélas! Le brouillard ne veut pas se dissiper' – 'Alas! The fog does not want to recede' (Wildenstein 1996b, 343).

The weather observations recorded in London report 'mist' in Chiswick and Kew on 25 February in 1900.

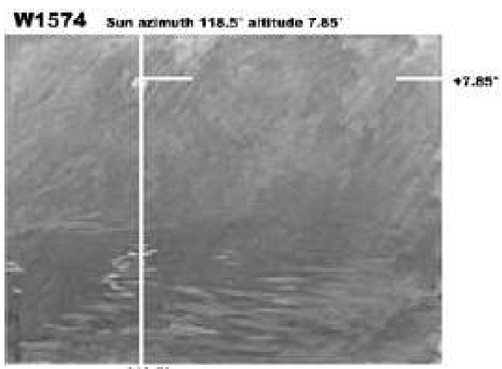

Figure 7 Waterloo Bridge. Range of possible dates: 18 February–24 February at 8:02–8:07 am. The dates suggest that this painting may have been painted either during 1900 or 1901

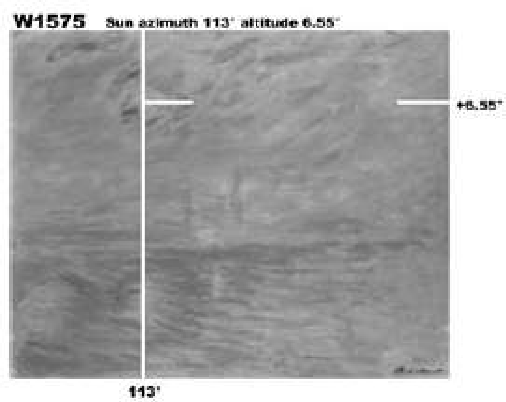

Figure 8 Waterloo Bridge. Range of possible dates: 25 February–1 March at 7:41–7:44 am. Monet could have painted this scene during either of his visits in 1900 or 1901

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Table 1 Solar positions and corresponding dates and times for the four paintings. Azimuth and solar elev are the solar azimuthal and elevation angles in degrees, respectively, for the depicted sun

Painting	Azimuth (°)	± (°)	Solar elev (°)	± (°)	Date	± day	Time	± min
W1573	122.5	0.5/0.5	6.65	1.00/1.00	12 Feb	2/+3	8:16	−2/+2
W1572	121.7	0.5/0.5	7.99	0.72/0.72	17 Feb	−2/+2	8:16	−2/+1
W1574	118.5	0.5/0.5	7.85	1.20/1.20	21 Feb	−3/+3	8:04	−2/+3
W1575	113.0	0.5/0.5	6.55	0.91/0.91	27 Feb	−2/+2	7:42	−1/+3

On 26 February 1900, 'mist' was recorded in Chiswick, Brixton and Kew. 'Fog' was recorded in Brixton on 27 February 1900, whilst 'mist' was reported in Kew. On 28 February 1900, 'mist' was recorded in Chiswick, Brixton and Kew. 'Dull' conditions were recorded in Chiswick on 1 March 1900 and on the same date in 1901. However, mist and fog was not recorded for any location on 1 March 1900 or any of the dates in 1901. Therefore using these observations in conjunction with Monet's letters, it could be suggested that Monet painted 'Waterloo Bridge, brouillard' on any day between 25 February to 1 March 1900, with possible reworking on 1 March 1901.

Waterloo Bridge paintings date order

Table 1 displays the solar azimuthal and elevation angles together with the corresponding dates and times for the four Waterloo Bridge paintings. The paintings have been ordered according to the derived dates, with the dates ranging from the end of January through to early March.

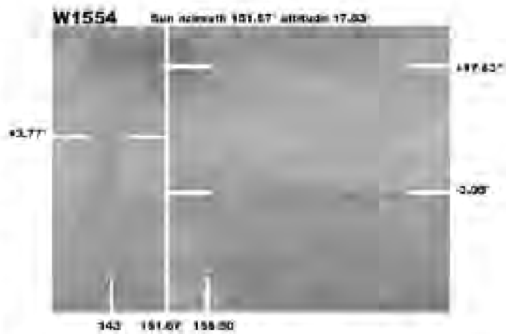

Figure 9 The sun is visible at the top left of the scene as an orange-red sphere. Charing Cross Bridge, a lead works tower and the outline of the Lion Brewery are the only identifiable structures visible within the scene. The azimuthal scale for the painting has been produced by determining the angles from the Savoy Hotel round to the tower of the lead works and the Lion Brewery. Range of possible dates: 1 February–7 February at 10:20–10:23 am

Charing Cross Bridge

The Charing Cross Bridge paintings are looking south from the Savoy and relate to times close to midday. Consequently the sun is at its maximum height in the sky and is generally well beyond the top of the canvases. However, there is one image that is suitable for analysis, W1554, which represents a different view to most of the other Charing Cross Bridge images.

W1554: 'Charing Cross Bridge, brouillard sur la Tamise' (fog on the Thames) Fogg Art Museum, Harvard University Art Museums, Cambridge, Massachusetts, USA, 73 × 92 cm

From the known dates when Monet was in London, he could only have painted this scene (Figure 9) during his visit in 1901. Monet wrote to Alice on 2 February 1901: 'un léger brouillard', which translates to 'a slight fog'. Monet also wrote to his wife on 3 February 1901: 'Grâce aux fumées, la brume est venue, puis des nuages' – 'Through the smoke, the fog came, then the clouds' (Wildenstein 1996b, 351). In a letter to Alice dated 6 February 1901, Monet wrote 'Il y avait bien un peu trop de brouillard le matin, mais le joli ballon rouge n'a pas été long à se montrer et avec lui une succession d'effets étonnants' – 'There was a little too much fog this morning, but the pretty red balloon was not long to be shown and with it a succession of astonishing effects' (Wildenstein 1996b, 352).

The weather observations recorded in London report 'mist' in Chiswick and Westminster on 1 February 1901. On 2 February 1901, 'mist' was recorded at Kew, whilst 'mist' was reported in Chiswick on 3 February 1901. 'Mist' was also reported in Chiswick, Westminster and Kew on 4 February 1901, whilst 'mist' was recorded at Westminster on 5 February 1901. 'Dull' conditions were reported in Chiswick on

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Table 2 Solar positions and corresponding dates and times for W1554 with respect to the fifth floor suite of the Savoy Hotel. Azimuth and solar elev are the solar azimuthal and elevation angles in degrees, respectively, for the depicted sun

Painting	Azimuth (°)	± (°)	Solar elev (°)	± (°)	Date	± day	Time	± min
W1554	151.67	0.5/0.5	17.63	0.81/0.81	4 Feb	–3/+3	10:22	–2/+1

6 February 1901, whilst 'mist' was reported in Westminster and Kew on 7 February 1901.

Therefore, using these observations in conjunction with Monet's letters, it is most likely that Monet started to paint 'Charing Cross Bridge, brouillard sur la Tamise' on 1 February 1901 and possibly worked on it again until 7 February 1901.

Table 2 displays the solar azimuthal and elevation angles for W1554 'Charing Cross Bridge, brouillard sur la Tamise' together with the corresponding dates and times for the painting with respect to the fifth floor suite of the Savoy Hotel.

Conclusions

Monet faithfully represented the London fogs in his *London Series*. Both this paper and Baker and Thornes (2006) have shown that it is possible to corroborate dates calculated using solar geometry with comments made by Monet in letters to his wife, Alice. Also this paper has used historical weather data to help select the day and the year that Monet began particular paintings. Having established the accuracy that Monet displays in positioning the sun and features of the bridges and buildings in his *London Series*, further research is now underway to assess the accuracy of the colours of the fogs. House (2005) believes that colour was central to Monet's vision of London. Monet told an interviewer in 1901: 'The fog in London assumes all sorts of colours; there are black, brown, yellow, green and purple fogs, and the interest in painting is to get the objects as seen through all these fogs' (House 2005, 32).

The fact that Monet reworked many of the paintings in the *London Series* suggests that they represent the climate of London as much as the weather. Monet would not paint if the fog was too thick or too thin and hence the *London Series* represents those days when the visibility was such that the bridges could be seen. The mean visibility in London in winter at that time was less than two kilometres. Thornes and Metherell (2003) show that the mean visibility of the 34 Charing Cross Bridge paintings is 1127 metres, which is very close to the visibilities recorded in the London Fog Inquiry carried out between 1902 and 1904 (Bernstein 1975). It is clear that Monet has given us a faithful representation of central London weather and climate at that time, and it is also clear how much the air quality and climate has changed for the better.

All 14 paintings of the *London Series* with the sun visible in the image have now been accurately dated using solar geometry. Further research is required to examine the implied solar geometry in the remaining paintings where the position of the sun can be indirectly inferred. It should be possible, for example, to infer the time of day – from shadows and sun reflection in the Thames. The use of solar/lunar geometry and historical weather data to help date works of art is directly applicable to other landscape artists where landscape features can be mapped accurately. Research by the authors on historical dating apart from Monet include Constable (Thornes 1999), Munch (Olson *et al.* 2007), Van Gogh (Olson *et al.* 2003), Ansel Adams (Olson *et al.* 2005) and Caesar's invasion of Britain (Olson and Doescher 2008).

This opens up an exciting new form of content analysis for geographers and environmental historians who are trying to deconstruct the past environments represented in art works as well as understand the working habits of the artists.

This paper can be seen as a contribution to the new genre of cultural climatology (Thornes and McGregor 2003; Thornes 2008a) with its interdisciplinary approach that cuts across both human and physical geography. This provides a deeper insight into both the physical climate and the social climate of London's 'peasoupers' at the turn of the twentieth century. The paper also provides art historians and environmental historians with hard empirical evidence for the dating of parts of the *London Series* and the location of the Savoy balcony from where Monet created this legendary environmental art.

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Earth and Environmental Sciences at the University of Birmingham.

Note

1 Only 14 of the *Series* have the sun's disc clearly represented in the image: nine of the Houses of Parliament, four of Waterloo Bridge and one of Charing Cross Bridge.

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