**Colonial private diaries and their potential for reconstructing historical climate in Bombay, 1799-1828**

**Introduction**

As Richard Grove and others have shown, the servants of the East India Company carried a preoccupation with the recording and classification of natural environments[[1]](#endnote-1). This is particularly true of weather and climate. During the early-mid nineteenth century the East India Company established the first systematic meteorological observatories in several territories under their control, including (in chronological order of opening) Madras, Calcutta, St Helena, Bombay and Singapore. However, the tradition of recording meteorological observations extended back significantly further than this, with weather chronologies of a shorter duration available in numerous archives around the world. These derived from medical observations, travel writings, military records, ships logs and a variety of personal diaries and correspondences. New territories were assessed for their suitability for European habitation. Likewise, travel ‘tours’ to new trading regions incorporated meteorological readings to assess the likely crop yields and their responses to droughts and floods[[2]](#endnote-2). East India Company naturalists corresponding about a series of global droughts in the 1790s arguably discovered El Niño teleconnections some 130 years before Gilbert Walker first defined the Southern Oscillation[[3]](#endnote-3).

Several interlinking narratives governed this passion for the recording of climate. By the late eighteenth century, the high disease incidence and low life expectancy experienced by colonists in India and elsewhere had transformed early optimism regarding the ‘salubriousness’ of the subcontinent into fear and trepidation[[4]](#endnote-4). Hippocratic medical beliefs equating ill health with ‘miasmas’ were resurgent with the spread of scientific enquiry during the Enlightenment[[5]](#endnote-5). The migration of the East India Company from a trading company to a territorial organisation resulted in the exploration of new localities (and hence new climates) and raised the possibility of permanent settlement of Europeans in India. This was thought to be perilous to the health of colonists, and it was also feared that the new climate would threaten their racial superiority by limiting their energy levels, intellectual ability, and moral character[[6]](#endnote-6). Sites were therefore sought with climates that were as similar as possible to those of northern Europe, resulting in substantial monitoring and recording of meteorological data, much of which still survives[[7]](#endnote-7).

At the same time as the official recording, Europeans in the employment of the East India Company undertook substantial recording of climate on an *ad hoc* basis within private diaries and correspondence. Jan Golinski has previously drawn attention to the importance of weather monitoring amongst the intellectual elite of the eighteenth century, and this was still true in the early decades of the nineteenth[[8]](#endnote-8). Scientific endeavour raised the middle and upper classes above the ‘vulgar superstitions’ of the proletariat[[9]](#endnote-9). This created a fashion for the keeping of weather diaries, the incorporation of instrumental observations elevating the endeavour even further[[10]](#endnote-10). The recording of meteorological conditions was particularly prevalent amongst the largely educated colonial elite within tropical regions, where the general British fascination with the weather was accentuated by the novelty of the climates in which colonists inhabited[[11]](#endnote-11). After the turn of the nineteenth century, medical writings also started to recommend intellectual activity as a way to combat the detrimental influence of tropical climates[[12]](#endnote-12). The study and recording of extremes of heat and humidity therefore offered a method to counter their supposedly destructive effects.

Although some work has been undertaken to analyse meteorological information within colonial diaries for the history of meteorology[[13]](#endnote-13) and colonial climatic discourse[[14]](#endnote-14), the significance of these observations for the study of climatology has been generally overlooked[[15]](#endnote-15). This chapter concerns the meteorological information contained within private diaries kept by four British colonists resident in Bombay (Mumbai) between 1799 and 1828. Two were direct employees of the East India Company: Lieutenant General Sir Jasper Nicolls (then Lieutenant/Captain) who served in the Bombay Army during the Second Anglo-Maratha War of 1803-1805, and The Hon. Mountstuart Elphinstone, Governor of Bombay from 1819 to 1827. A third, Sir James McGrigor, was a military surgeon serving with the 88th Regiment of Foot, stationed in Bombay periodically between 1799 and 1803. The final diary was kept by Lady Lucretia West, wife of Sir Edward West, the Chief Justice of Bombay from 1823-1828. Apart from McGrigor’s, all are personal diaries, and McGrigor’s volumes are casebooks rather than systematic weather diaries. Nevertheless, all contain a large amount of meteorological information.

The early nineteenth century is an important period for meteorological re-analysis. The national instrumental meteorological network in India was established in 1871. Before this date data are sparse, particularly before 1850. In western India, the first regular long record of precipitation began in Bombay in 1817 with the publication of monthly totals of rainfall during the monsoon months (June to October) in the English language periodicals the *Bombay Courier* and *Bombay Gazette.* However, these are non-standardised and potentially unreliable. Standardised meteorological readings did not begin until the 1847 at the Colaba Observatory, with the exception of a brief period from 1816 to 1822 during which daily temperature and pressure observations were published in the *Bombay Courier.* Information from personal weather diaries can therefore be used both to extend the published meteorological record and assess early instrumental records for reliability and homogeneity[[16]](#endnote-16).

The generation of long records is vital for the study of climatology today. The climatology of South Asia is affected by a number of territorial, oceanic, and atmospheric factors, particularly sea surface temperature[[17]](#endnote-17). Changes in the relative location of warm- and cold-water regions in the major oceans can affect the areas where evaporation occurs, and hence the location of low- and high-pressure systems. In South Asia, where rainfall is seasonal and reliant on pressure systems that prevail for several weeks at a time, a change in their position can have severe consequences. The central Pacific is the location for one particularly important sea-surface temperature phenomenon, the El Niño Southern Oscillation (ENSO). This is the movement of a warm water pool from the east to the central Pacific, which has implications for weather across the globe, including South Asia. An El Niño event, in which warm water moves to the central Pacific, is associated with cooler summer temperatures in India and, importantly, reduced summer monsoon rainfall[[18]](#endnote-18). A similar system is situated in the Indian Ocean, known as the Indian Ocean Dipole (IOD). In this system the warm water pool moves from the eastern to the western Indian Ocean, with an easterly warm pool associated with deficient monsoon rainfall[[19]](#endnote-19). The Indian Ocean also affects monsoon rainfall at a shorter timescale. Rainfall is generally more intense when the seas are warmer as this creates heavier evaporation; heavy monsoon rainfall will cool the Indian Ocean and cause weaker rainfall the following season. This results in a two-year cycle of heavier and weaker monsoons, referred to as the Tropospheric Biennial Oscillation[[20]](#endnote-20).

These large-scale dipoles and oscillations themselves exhibit variability over the timescale of several years. ENSO, for example, has been show to oscillate in intensity with a wavelength of approximately 55-60 years. The relationship between monsoon rainfall and ENSO also appears to oscillate in intensity with a periodicity of approximately 70 years[[21]](#endnote-21). Quantifying these long-term variations is clearly important for long-term forecasting of both temperature and rainfall over the subcontinent, both of which can profoundly impact upon livelihoods. However, accurately diagnosing climatic variation on the timescale of several decades is problematic when the available data spans only a century and a half.

This chapter adds to existing work by the author to extend the climatic record for western India using documentary sources. In doing so, it will not only benefit the modern study of climatology, but will also illustrate the value of the scientific observations collected by the East India Company. The chapter focuses on the potential of individual diaries for reconstructing temperature and precipitation variability with a high temporal density. This includes monthly temperature maxima, precipitation variability, and the occurrence of notable or extreme climatic events[[22]](#endnote-22). The sources analysed are described below.

**Diaries Analysed**

The Case Books of James McGrigor

James McGrigor was a Scottish surgeon serving in the British Army with the 88th Regiment of Foot. The Regiment were stationed in Bombay from 3 September 1799 to 28 February 1803, during which time McGrigor and his deputies maintained detailed medical records. The nine ‘casebooks’ relating to Bombay catalogued in the archives of the Aberdeen Medico-Chirurgical Society date from 3 September 1799 to 28 February 1803[[23]](#endnote-23). McGrigor was absent from Bombay from December 1800 serving with the 88th in Alexandria[[24]](#endnote-24); no records are therefore available from 9 December 1800. However, a casebook was kept by a deputy from July 1801, which was continued by McGrigor on his return in June 1802. Later correspondence by McGrigor suggests that deputies also occasionally kept the casebooks at other times. From September 1799 to October 1800 the books refer to a barracks on Colaba (then an island). After this date McGrigor transferred to a hospital in Bombay Fort, and from August 1801 to an unspecified location in Bombay ‘bazaar’.

The entries within the casebooks predominantly comprise of daily notes on the progress of patients within the hospitals, interspersed with detailed weekly summaries of the progress of patients. A total of 117 of these weekly summaries include meteorological observations, amounting to 78% of the total weekly records in the casebooks. The observations comprise descriptions of general meteorological conditions through the week, including remarks on temperature, rainfall, and prevailing wind direction. A total of 81 of the weekly summaries contain maximum temperature observations for the week; 71 also include minima, although the time of day recorded is not specified.

The following two quotations exemplify the meteorological summaries contained within the casebooks:

The Monsoon draws near a very little rain has fallen there has been much lightning the sun is hot & sultry, thermometer for some days 93 & the Wind variable tho generally S and SW.[[25]](#endnote-25)

We had a remarkable change in the weather during the past week after a clouded & hazy sky & a very sultry day, in the afternoon of the 24th, we had much loud Thunder with frequent flashes of lightning, & in the night a very considerable quantity of rain fell. On the two following days we had a little distant thunder & some lightning The extreme range of the thermometer has been from 73° to 82°.[[26]](#endnote-26)

The Diaries of Jasper Nicolls

Jasper Nicolls arrived in Bombay in September 1802 and left in February 1805. Like James McGrigor, he spent some of this period away on a military posting, fighting in the Deccan in the Second Anglo-Maratha War from September 1803 to April 1804. From his arrival, Nicolls’ diaries display a strong preoccupation with climate, including detailed observations both on meteorological conditions and on the responses of the Indian and European populations to climatic variability. Nicolls’ diaries are a particularly strong source of information regarding the famine of 1803-04 and measures to combat its effects. However, the diary was not kept daily and meteorological information within it is sparser than that contained in McGrigor’s casebooks. A total of 63 entries contain meteorological information out of 16 months that Nicolls spent in Bombay, averaging approximately one entry every 10 days. Meteorological observations mainly describe rainfall during the monsoon and storm events during the remainder of the year, with less information on temperature.

Nicolls' diaries also contain summaries of meteorological observations for monthly, and later seasonal and yearly periods. The first of these was written on 30 September 1802. This includes only general descriptions of the weather during the past month:

This month has been showery; in the morning there has been but very little wind it springs up about 10, and blows refreshingly in general for the remainder, between 5 and 6 in the evening it is a very pleasant air.[[27]](#endnote-27)

By November, however, the summary had been extended to include average temperature readings for 'Morning', 'Noon', and 'Night', maximum and minimum temperatures recorded during the month, and fairly detailed descriptions of wind conditions and rainfall[[28]](#endnote-28).

I have this month noted down daily the changes of the wind, which comes alternately from the land and sea; About 12 or near 1 OClock p.m. the sea breeze sets in, and blows between W.N.W. and N.N.W., about 8 or 9 pm - The land breeze succeeds and continues until the following noon to blow from N by E, to E.N.E.: but upon average to the N of the latter point.[[29]](#endnote-29)

Regular monthly observations are more sporadic during the first half of 1803, ascribed by Nicolls to the warmth of the morning preventing observations and 'the time for an evenings walk exactly interfering with our dinner hour'[[30]](#endnote-30). However, in July 1803, Nicolls included a detailed summary of conditions during the last 6 months. This included thrice-daily average monthly temperatures, maxima, and minima of temperature, 'general' averages for each third of the month and qualitative descriptions of wind and rainfall. A similar meteorological abstract was included in an entry of 20 July 1804, covering the period 1 July 1803 to 30 June 1804 and including all of the aforementioned observations with the exception of the thrice-monthly temperature averages. These, Nicolls stated, were taking from the 'General's daily account', with the thermometer placed somewhere in the interior of a house in Bombay 'where it could not be very materially affected by either the cooling sea breezes, or the violence of the sun's heat, which would have been the case, had it been hung in any verandah, or other exposed place'[[31]](#endnote-31). It can be reasonably assumed that the General in this case refers to Major General Arthur Wellesley, although some observations must have been collected by a deputy as Wellesley and Nicolls were absent from Bombay from September 1803 to April 1804.

In January 1805 Nicolls’ diary includes a summary of monthly temperature variations for the whole of 1804, which included days of 'heavy' and 'slight' rain, although no notes on wind direction. Significantly, on 22 January, Nicolls also included a facsimile of a paper he presented that day to the first meeting of the Bombay Literary Society. This was eventually published in the first edition of the *Transactions of the Literary Society of Bombay*[[32]](#endnote-32). The paper comprises of a synthesis of the temperature observations recorded in Nicolls' diaries for 1803 and 1804, together with days of 'heavy rain' and 'showers' in each month. The paper also contains further information on the temperature readings. Morning observations were made between 6:00 and 8:00 a.m., afternoon from 12:00 to 4:00 p.m., and evening between 9:30 p.m. and midnight. The house in which the thermometer was contained was exposed to the West, but surrounded by buildings to the East and South. From 24 March 1803 readings were taken from several thermometers so as to ensure continuity.

The thermometers were suspended against a wall, two feet in thickness, within a few inches of the angel formed by the junction of another wall of nearly equal thickness: the room itself spacious and lofty ... On three sides also they have not been exposed to any improper influence, or current of the air, on one being sheltered by a door, which, being kept open, forms a channel for the air from the other. The height at which the instruments were suspended is about 23 feet above the level of the high water mark.[[33]](#endnote-33)

The Diaries of Mountstuart Elphinstone

The Hon. Mountstuart Elphinstone arrived in India in 1796 and held several posts within the East India Company, including Envoy to Kabul and Resident at Poona (Pune). He served under General Wellesley in the Second Anglo-Maratha War and was briefly resident in Bombay in 1802-03 (and thus likely having made the acquaintance of Jasper Nicolls). However, his principal posting in Bombay occurred when he was awarded the Governorship of Bombay in late October 1819, a position that he retained until he left India on 15 November 1827. Elphinstone's diary entries display a preoccupation with climate, particularly the influence of climate on his health[[34]](#endnote-34). He was a reader of academic papers for pleasure, particularly those relating to meteorology[[35]](#endnote-35). He was also President of the Literary Society of Bombay when the first issue of the *Transactions* was released, and he quotes Nicolls' paper in his diary:

To day the glass has been at 88°, 3° higher than it has been since I came to Parell & as high as it was at any time during the whole year 1804 as appears by the Trans'c Liti Soci[[36]](#endnote-36)

Elphinstone's diary was not kept daily. However, between 1819 and 1827, 315 entries mentioned meteorological conditions, with approximately one entry every nine days. These were *ad hoc* observations; however, they were regular and are relatively detailed. Heat was noted regularly, generally connected to a complaint Elphinstone referred to as the 'languor of the hot weather'. Rainfall (‘the weariness & nervousness of the rains’[[37]](#endnote-37)) and wind direction (‘the southerly winds famous among Bombay people for bringing drowsiness & prickly heat’[[38]](#endnote-38)) were also noted frequently. From 7 December 1821, 115 entries include thermometer observations, although not all of these were collected in Bombay. Elphinstone spent the late monsoons of 1822 and 1826 in Pune, and 1823 and 1824 at the Hill Station of Khandala. The winters of 1820 and 1821 were also spent visiting territories in Gujarat. However, the majority of entries referred to Bombay, either at the Governor's main residence on Parel Island or at Elphinstone's summer residence at Malabar Point, where he generally resided from April to June.

The weather has been hot for three days, today the wind is hot & the thermometer 88° but there is yet no languor. On the contrary I still enjoy the effects of our fortnight of cold weather & scarcely recollect the depression & lassitude of the rains.[[39]](#endnote-39)

The Diaries of Lucretia West

Lady Lucretia West was resident in Bombay from February 1823 until July 1828, dying shortly afterwards in Poona. She arrived in Bombay as the wife of the Chief Justice, Sir Edward West. Sir West was not a direct employee of the East India Company; the position of Chief Justice was created by the British Government to investigate supposed abuses of power by the Company at a time when the British Government were becoming increasingly concerned about its position as a trader and administrator. This role brought Edward West into conflict with Mountstuart Elphinstone, with West eventually accusing Elphinstone of having drunkenly challenged him to a duel, an accusation which Elphinstone denied[[40]](#endnote-40).

Lady West's diaries are generally concerned with the social life of Bombay. However, 653 of her diary entries in Bombay include meteorological observations, representing approximately one entry every two days[[41]](#endnote-41). These are generally brief, announcing the weather to be 'hot' or 'quite cool', or detailing rainfall events:

Rather a hot day little breeze, Ther. 86[[42]](#endnote-42)

It rains so violently it is almost dark.[[43]](#endnote-43)

I have been to the school meeting and found it very hot; yesterday & today are a little warm in the middle of the day - but quite cool Morng and Eveg Ther. at 2 O'clock 84[[44]](#endnote-44).

Thermometer readings are presented throughout the diary, including in earlier entries that West kept whilst at sea before she arrived in Bombay. A total of 212 daily observations are available, generally recording the daily maximum temperature. Both West and Elphinstone also recorded unusual or extreme events, particularly storms and periods of unusual cold or warmth. The contemporaneity of the two diaries allows these extreme events to be verified, meaning that detailed reconstruction of climatic conditions from the diaries is possible. It is to this that this chapter will now turn.

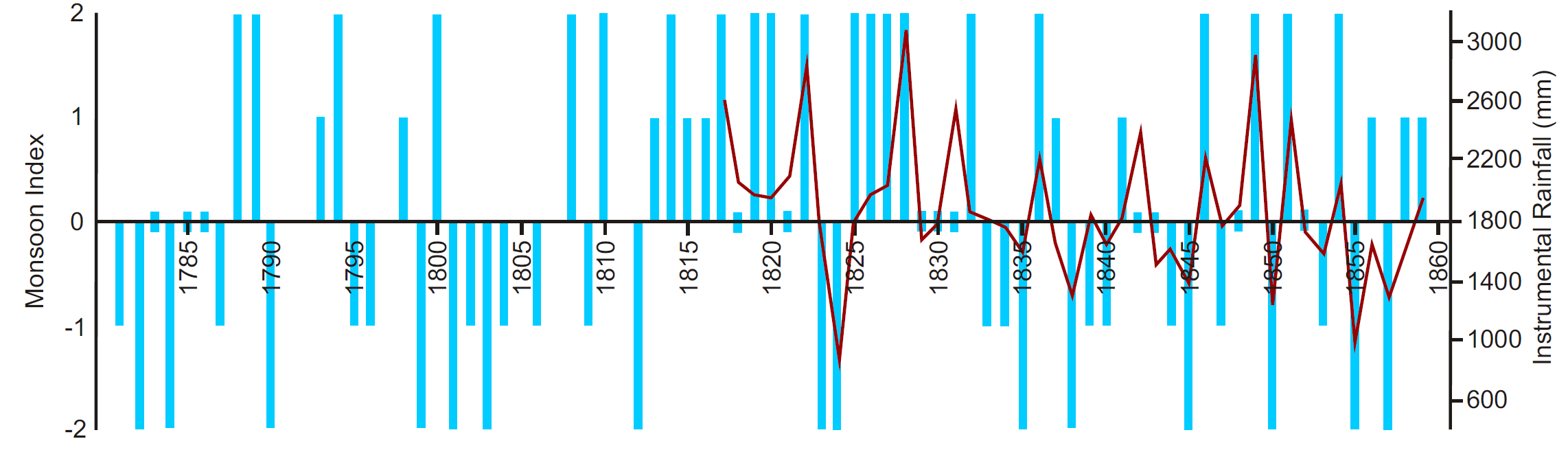
**Meteorological Analysis**

Precipitation

Precipitation information included within the diaries analysed here is fragmentary and in variable forms. Nicolls' diaries contain the most readily quantifiable information in the form of the paper presented to the Literary Society of Bombay. This includes days with 'light' and 'heavy' rainfall throughout 1803 and 1804. However, in the absence of any instrumental comparison it is not possible to determine the exact quantities of rain associated with these terms. The discovery of other contemporaneous records may allow this in the future, particularly if the original 'General's daily account' can be uncovered.

One technique commonly adopted in historical climatology that can allow quantification of qualitative and anecdotal information is content analysis. This is a process whereby key terms (e.g. 'pleasant temperature', 'heavy rain', 'showers', 'quite cool') and meteorological phenomena (such as the occurrence of droughts, floods, snowfall, etc) are used to derive semi-quantitative reconstructions of climatic conditions. This commonly consists of a five- or seven-point climatic index, running from extreme heat/drought through to extreme cold/floods[[45]](#endnote-45). This technique requires a complete or near-complete temporal dataset, and ideally a crossover instrumental period to allow terminology to be compared with instrumental observations. The four diaries analysed here would therefore require supplemental archival materials to extend the precipitation record into a continuous time series.

Such a technique has been previously adopted by this author together with David Nash, using these four diaries combined with contemporary newspapers and government reports. These combined materials were used to generate a 5-point semi-quantitative reconstruction of monsoon rainfall from 1781 to 1860, calibrated against instrumental rainfall observations from the Colaba Observatory (Figure 6.1). The monsoon rainfall index generated spans -2 (scanty monsoon rainfall) to +2 (excess monsoon), with 0 (normal monsoon) corresponding to the 1847-1950 instrumental rainfall average[[46]](#endnote-46). The exact methodology adopted will not be repeated here, but can be found within the references detailed. However, it is significant to note that the reconstructed index indicates a sustained drought period from 1799-1805, with the exception of 1800 which experienced a heavy monsoon. The period 1819-1828 was conversely associated with generally heavy rainfall, with 'excess' monsoon rainfall (the highest rainfall category) experienced in most years, excepting 1821 (average rainfall) and 1823-24, which experienced severe drought[[47]](#endnote-47).



*Figure 6.1* Semi-quantitative monsoon rainfall reconstruction for Bombay from East India Company diaries, government reports and contemporary newspapers. Continuous lines represent instrumental observations from the Colaba Observatory (1847-1859) and Bombay newspapers (1817-1846). See Adamson and Nash (2014)[[48]](#endnote-48).

Extreme Events

Several categories of extreme events are recorded within the diaries, including droughts, extreme heat and cold and periods of rainfall at unusual periods (Table 6.1). For example, on 10 February 1825, during a month that usually experiences rainfall once every ten years[[49]](#endnote-49), Lucretia West recorded 'a cold gloomy blowing Morning and rather a heavy shower of rain an extraordinary appearance & events at this Season of the year.'[[50]](#endnote-50) Likewise on 23 December 1826 West noted:

'Quite a phenomenon last night we had a deluge of rain & to day has been as cold & gloomy as days usually are in England in November & so damp, the Ther. 72, yesterday it was 86 that one really finds it wretchedly cold and longs for a fire... We have had rain again to day'[[51]](#endnote-51)

*Table 6.1* Chronology of extreme or unusual climatic events. ● heavy rainfall; ≡ flooding; □ drought; ◊ storm/cyclone; 🞧 thunderstorm; 🡅 unusual heat; 🡇 unusual cold

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| 1799 |  |  |  |  |  | [● | ●(◊) | ●] |  |  | ◊ |  |
| 1800 |  |  |  |  |  |  |  |  |  | ◊ |  |  |
| 1801 |  |  |  |  |  |  |  |  |  |  | ◊ |  |
| 1802 |  |  |  |  |  |  |  |  |  |  |  |  |
| 1803 |  |  | ◊ |  |  | [□ | □ | □ | □] |  |  |  |
| 1804 |  |  |  |  |  | 🞧● | [□ | □] | ●≡ |  | 🡅 |  |
| 1805 |  | ◊ |  |  |  |  |  |  |  |  |  |  |
| 1820 |  | ◊🡇 |  |  |  |  |  |  |  |  |  |  |
| 1821 |  |  |  |  |  |  |  |  |  |  |  |  |
| 1822 | 🡅 |  |  |  |  |  |  |  |  |  |  |  |
| 1823 |  | 🡇 |  |  |  |  |  |  |  | 🡅 |  |  |
| 1824 |  |  |  | 🡅🞧● |  | [□ | □ | □ | □] |  |  |  |
| 1825 |  | ●[🡇 | 🡇] |  |  | 🞧●≡ |  |  |  |  | 🡇 |  |
| 1826 |  | ◊ |  |  | 🡇 |  |  |  |  |  |  | 🞧●🡇 |
| 1827 |  |  |  | ◊[🡅 | 🡅] |  |  |  |  |  | ◊● |  |

Periods of extreme cold were also recorded in February 1820, February 1823, November 1825, May 1826 and January 1827. 'An unusually long & pleasant cold season'[[52]](#endnote-52) was reported by both Mountstuart Elphinstone and Lucretia West during the winter of 1825. Conversely, extreme heat was recorded in January 1822, October 1823 and during the hot season (April-May) of 1827, noted to be the hottest since 1780[[53]](#endnote-53). On 2 April 1824, there was recorded a temperature of 94°F (34.4°C), documented by Elphinstone as 'the highest I ever saw in Bombay'[[54]](#endnote-54). This was superseded on 8 April 1827 with Elphinstone recording 96°F (35.5°C)[[55]](#endnote-55), which was exceeded elsewhere: 'The heat of Sunday has been a general theme At Colonel Scott's at Colaba it was 100° & at Mr Tanqueray's on the esplanade 105° in the sun it was 135.[[56]](#endnote-56)

Ther. 89 on the Esplanade on Sunday 98 & 100 at Malabar Point[[57]](#endnote-57)

The year 1800 was described by James McGrigor as having an 'unusually rainy and severe monsoon'[[58]](#endnote-58). On 9 June 1825, West described a flooding event, with 'the Esplanade under water'[[59]](#endnote-59). Droughts were also mentioned regularly; on 6 April 1804 Jasper Nicolls noted a 'famine occasioned by the failure of the rains of last year, and the insufficiency of the fall in 1802.' On 10 August 1804 he commented that 'we have had the most uncommonly mild monsoon hitherto'[[60]](#endnote-60), although this was terminated in September with heavy rainfall and water '2 feet high in the streets'[[61]](#endnote-61). During the monsoon of 1824 Lucretia West's diary entries contain regular reports of 'no regular Monsoon'[[62]](#endnote-62) or 'no rain'[[63]](#endnote-63). On 12 August she recorded:

'The weather is very cool and pleasant & rain of a night, but not enough to be of any essential use, the Governor begins to be alarmed & consulted Edward as to what government could do in the event of a famine, which we now begin to dread.'[[64]](#endnote-64)

The reports in Elphinstone's diaries are even starker:

The weather is itself agreeable but as we have had only one shower near once a day of mild rain we are threatened with famine, the most horrible of evils even pestilence is not so dreadful as it falls on all souls & is so evidently beyond human power In famine you blame yourself for not affording sufficient relief & feel your own exemption from the general calamity a fool of reproach.[[65]](#endnote-65)

All four diarists reported particularly violent thunderstorms, and the occurrence of windstorms or cyclones. Windstorms were described as 'hurricanes' (McGrigor), 'gales' (Nicolls, Elphinstone) or 'storms' (Nicolls, Elphinstone, West) and were generally associated with pre-monsoon cyclonic disturbances[[66]](#endnote-66) or with the post-monsoon northerly 'Elephanta' wind. One further ‘hurricane’ was described by Jame McGrigor in July 1800, likely to be associated with monsoonal cyclonic systems. Thunderstorms were generally reported during the onset of the monsoon, although some were associated with pre-monsoonal or post-monsoonal systems. The details of windstorms reported are provided in Table 6.2.

*Table 6.2* Details of windstorm/cyclone events listed within the diaries consulted

|  |  |  |
| --- | --- | --- |
| Date | Description | Diary entry |
| 4 November 1799 | 'Destructive wind' | The wind has been stronger – an uncommon phenomenon at this season, in its appearance, on the 4th November we had a considerable fall of rain not less than [blank] inches with a high & destructive Wind[[67]](#endnote-67) |
| 30-31 October 1800 | 'Hurricane' | The Wind has been rather variable. There has been 3 days of rain - on the night of 30 and morning of 31st it blew a hurricane and the rain was very heavy.[[68]](#endnote-68) |
| 23-24 March 1804 | 'Equinorial gale' | Blew very hard last night, an equinorial gale.[[69]](#endnote-69) |
| 10-11 February 1804 | 'Storm' | This morning there was some slight rain, to the Northward it was much heavier, during the night there was much thunder and lightning, today a little; about 3 P.M. the breeze was very fresh indeed, and the clouds of dust very frequently raised to such a degree, as to be extremely disagreeable... the coachman stopped the carriage for a minute or two to allow one of these clouds to pass, a proper precaution in a crowded street.[[70]](#endnote-70)  It continues to blow pretty fresh still, the wind is variable blowing sometimes from the Southward with much violence; it is now known that this is the tail of a storm which has done much injury at Ceylon; the Shurness 44 has been destroyed by it in the inner road of Tuncomalee, two country vessels are on shore, and the barracks and houses of all Kinds in that neighbourhood have been blown down.[[71]](#endnote-71) |
| 2 February 1820 | 'Gale' | Last night it blew a gale Walter & I sat up late talking... & could not sleep afterwards for the noise of the sea this morning is really cold at 10[[72]](#endnote-72) |
| 1 February 1826 | 'Storm' | The weather quite cold it blows a storm.[[73]](#endnote-73) |
| 19 April 1827 | 'Storm' | This evening a storm of wind and threatening of rain.[[74]](#endnote-74) |
| 27-28 November 1828 | 'Violent storm' | We have had a complete Monsoon, night, such a violent Storm of wind & rain & so unexpected every thing was knocking about.[[75]](#endnote-75)  The loss of lives, in the Storm have been dreadful, Bunder Boats, Patna's going to Surat, one especially laden with People going to the Marriage of a High Priest it is said 100's have perished.[[76]](#endnote-76)  We have just heard the most deplorable a story as I think I ever heard, the death of Mrs Lewis her Infant and Ayah - She was coming to Bombay for the marriage of Miss Bouchain and her husband put her into a Boat at Rhatnagherry & in a few hour's she hope to be here, they were overtaken by the Storm & her & her child & Servant have all been picked up & no one hardly knows anything more there was I fear no other European & it is said 7 Natives were saved, what must have been her agony and her sufferings of mind as well as body, with her helpless infant & no one near her but common Natives ­­­- she was young & healthy & death in so horrible a way is quite lamentable.[[77]](#endnote-77) |

With a few exceptions, little information is provided in the diaries on the effects of the storms. However, if combined with information on societal impacts the reports may facilitate reconstruction of cyclone pathway and impacts, as has happened elsewhere in the world[[78]](#endnote-78). This would allow further analysis of the path and strength of cyclones through history, improving both forecasting and disaster management. Newspaper reports would be suitable for this purpose, as would pre-colonial records such as the court records of the Maratha *Paishwa's*[[79]](#endnote-79)*.*

Temperature

Each of the diaries analysed contain regular instrumental temperature observations. These therefore provide potentially very accurate measures of climate during the period. However, the only diary within which these observations are systematic is that of Jasper Nicolls, which includes observations collected at 'morning' (6:00 am to 8:00 am), 'noon' (12:00 pm to 4:00 pm) and 'night' (9:00pm to 12:00 am). However, even these relatively systematic observations do not reach the rigorous levels of standardisation required for modern instrumental meteorological observations, which Nicolls himself recognised:

The daily observations of the height of the thermometer, from which the following remarks and accompanying Charts have been framed, were not originally intended to form the basis of a very minute enquiry into the variations of the climate; but they have been continued with so much care and punctuality that they may possibly afford a result, which tho' not scrupulously accurate, may not be uninteresting.[[80]](#endnote-80)

The predominant issue with temperature observations within the diaries concerns the location of the thermometers and time of observations. Most thermometers were located indoors; Nicolls' within a 'spacious and lofty room' with a constantly open door, Elphinstone's within his 'tiffen room'[[81]](#endnote-81) and West's in her 'drawing room'[[82]](#endnote-82). These indoor locations followed the advice of the period, as specified in the *Philosophical Transactions of the Royal Society* by James Jurin in 1723[[83]](#endnote-83). However, such readings may be affected by microclimatic conditions within the buildings, and may differ from those collected outside. The only thermometer located outside was that used by James McGrigor. This was located 'in the shade' 'near the barrack' while he was in Colaba[[84]](#endnote-84), and after moving to Bombay bazaar 'suspended about 8 1/2 feet from the ground and in a slight shelter'[[85]](#endnote-85). Nicolls’ thermometer in Bombay is therefore that which is in the most similar situation to the Stevenson Screens used today. Some kind of measurement verification can, however, be attempted between McGrigor's and Nicolls' temperature observations, as they were both recording observations from November 1802 to February 1803. McGrigor's thermometer was in a similar situation to those of today, and Nicolls' observations can be verified for accuracy due to the use of multiple thermometers (although only after March 1803). The most suitable measurement for analysis is the daily maxima. These were recorded at periods that the observers deemed to be the hottest part of the day (usually between 12:00 and 16:00) so should be comparable. Recorded minima are also available in both diaries, although these suffer from variations in the time in the morning in which they were recorded.

In order to facilitate comparison between the two sets of observations, those recorded by Nicolls have been transferred to monthly maxima. The comparable observations are listed in Table 6.3.

*Table 6.3* Monthly temperature maxima recorded by James McGrigor and Jasper Nicolls from October 1802 to February 1803. All observations have been converted from the Fahrenheit to Celsius scale.

|  |  |  |
| --- | --- | --- |
| Month | James McGrigor | Jasper Nicolls |
| October 1802 | 31.1 | 29.4 |
| November 1802 | 29.4 | 30.7 |
| December 1802 | 27.8 | 28.9 |
| January 1803 | 28.3 | 27.8 |
| February 1803 | 26.1 | 27.8 |

McGrigor's observations display a mean of 28.5°, which is slightly smaller than the mean of 28.9° displayed in Nicolls’ observations. This may be a result of the heat island effect caused by neighbouring buildings around that in which Nicolls’ thermometer was placed. Nicolls recognised this limitation:

The part of the house runs nearly North & South, opening to the West towards the sea, and distant 375 yards from high water mark: It is wholly exposed to the Westward, partly so to the Northward, but to the E. and S. the neighbouring buildings either obstruct the free passage of air, or, from their low roofs, reflect a considerable portion of heat.[[86]](#endnote-86)

The differences between the two averages are minimal, however, and a student's t-test finds no significant difference. Furthermore, the greatest temperature (31.1° in October 1802) was recorded by McGrigor, and McGrigor's observations display a greater standard deviation, 1.86 to Nicolls' 1.22. However, the Fisher f-test suggests no difference in variance between the two samples. These statistics suggest that McGrigor's and Nicolls' observations come from the same population, and can be considered concurrent, with the exception of small microclimatic variations that would be expected with all temperature observations. They are therefore likely to accurately represent ‘average’ conditions in Bombay.

The data collected by Elphinstone and West (1822-1828) is more difficult to verify as the observations were collected *ad hoc*. However, other contemporary data is available for comparison. From December 1816 to August 1822 the *Bombay Courier* printed monthly meteorological tables, collected in the rooms of the Bombay Literary Society[[87]](#endnote-87). These comprised of daily temperature observations throughout the year, collected at 11:00 am, 1:00 pm and 4:00 pm, together with pressure readings collected at 11:00 am and 4:00 pm. These were also apparently collected indoors, and no information is available regarding the location or make of the instruments used. However, as they were collected systematically, they allow for comparison with the data collected by Elphinstone and West in order to determine whether or not the *ad hoc* observations recorded in the diaries record the true extremes in temperature.

The annual average monthly maxima recorded within Elphinstone and West's diaries is 30.4°. In comparison, the average 1816-1822 temperature recorded in the *Bombay Courier* is 29.8°. The values are similar enough to be attributed to variations between years rather than any systematic bias in observations. Moreover, a student’s t-test finds no significant difference between the values. Significantly, the f-test finds no difference between variances, suggesting that the spread of monthly maxima is the same between the newspaper observations and the diary observations. This strongly suggests that Elphinstone and West’s diaries did record the highest temperatures for the month.

The full dataset of monthly temperature maxima recorded in the diaries of McGrigor, Nicolls, Elphinstone, and West are presented in Table 6.4. To account for gaps in daily observations between observers, where monthly data are replicated the highest value has been chosen.

*Table 6.4* Monthly temperature maxima within observations recorded by James McGrigor, Jasper Nicolls, Mountstuart Elphinstone and Lucretia West. All observations have been converted to Celsius scale.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **1799** | **1800** | **1801** | **1802** | **1803** | **1804** | **1822** | **1823** | **1824** | **1825** | **1826** | **1827** | **1828** | **Avg.** |
| **Jan** |  |  |  | 29.4 | 29.4 | 27.5 | 31.1 |  | 28.9 |  | 31.1 |  | 27.2 | 29.2 |
| **Feb** |  |  |  | 27.8 | 27.8 | 27.8 |  | 27.8 | 28.9 | 27.8 | 30.0 | 30.6 | 26.7 | 28.3 |
| **Mar** |  |  |  | 31.7 | 31.7 | 29.4 | 31.7 | 31.7 | 31.1 | 32.2 | 30.0 | 31.1 | 33.3 | 31.4 |
| **Apr** |  |  |  | 32.2 | 32.2 | 31.7 | 32.2 | 33.3 | 34.4 | 31.7 | 31.1 | 35.6 |  | 32.7 |
| **May** |  | 33.9 |  | 32.3 | 32.8 | 31.1 | 31.7 | 31.1 | 31.1 | 33.9 | 30.6 | 30.6 | 33.3 | 32.0 |
| **Jun** |  | 33.3 |  | 29.0 | 31.4 | 31.1 |  | 31.1 | 31.7 | 33.3 | 27.8 |  | 31.7 | 31.2 |
| **Jul** |  | 28.6 | 29.4 | 28.9 | 29.3 | 30.0 |  | 28.3 | 26.7 | 30.0 | 25.6 |  |  | 28.5 |
| **Aug** |  | 29.4 | 28.6 |  | 28.1 | 28.8 |  | 27.8 | 26.7 | 30.0 | 27.8 |  |  | 28.4 |
| **Sep** | 28.3 | 30.0 | 29.4 | 30.0 | 29.3 | 28.2 |  | 27.8 | 31.7 | 30.0 | 32.2 |  |  | 29.7 |
| **Oct** | 30.8 | 32.2 | 31.7 | 31.1 | 31.1 | 29.7 |  | 32.2 | 31.7 | 31.7 | 31.7 |  |  | 31.4 |
| **Nov** | 30.0 |  | 28.9 | 30.6 | 30.6 | 28.9 |  | 26.7 | 31.1 |  | 32.8 |  |  | 29.9 |
| **Dec** | 27.8 |  | 25.6 | 29.0 | 29.0 |  |  |  |  |  | 31.1 |  |  | 28.5 |

Comparison with recent records

Detailed daily and monthly temperature observations, collected at the Satacruz Observatory in Mumbai, are available for 1973 to 2013. This allows for comparison between recent temperature observations and the temperature readings collected from the East India Company diaries analysed in this chapter. This is presented in Table 6.5. The average monthly maximum collected from the four diaries analysed is 30.1°C. This decreases to 30.0°C when the temperature data from 1816-1822 printed in the *Bombay Courier* are included. In contrast, the average monthly maximum recorded between 1973 and 2013 is 35.0°, representing a difference of 5°C. The reason for this variation is likely to be a heat-island effect caused by the rapid urbanisation that occurred in the city during the nineteenth and twentieth centuries. This finding that is consistent with other studies looking at twentieth-century warming in Mumbai/Bombay[[88]](#endnote-88). Global warming caused by anthropogenic releases of CO2 is also likely to have a role in this warming[[89]](#endnote-89). However, it is also possible that there is a systematic under-recording of temperature in *all* thermometers used in Bombay in the early nineteenth century. This will require experimental verification.

*Table 6.5* Monthly temperature maxima from East India Company diaries, compared with the 1973-2013 average. Column 3 uses diaries only; column 3 incorporates observations presented in the *Bombay Courier*, collected in the rooms of the Literary Society of Bombay. All temperatures in °C.

|  |  |  |  |
| --- | --- | --- | --- |
| Month | 1973-2013 | 1799-1828 from East India Company diaries | 1799-1828 including 1816-1821 from *Bombay Courier* |
| January | 34.8 | 29.2 | 28.6 |
| February | 36.1 | 28.3 | 28.8 |
| March | 37.9 | 31.4 | 31.0 |
| April | 37.0 | 32.7 | 32.4 |
| May | 36.0 | 32.0 | 31.8 |
| June | 34.8 | 31.2 | 31.2 |
| July | 32.4 | 28.5 | 28.7 |
| August | 31.5 | 28.4 | 28.4 |
| September | 33.1 | 29.7 | 29.6 |
| October | 36.1 | 31.4 | 31.1 |
| November | 35.8 | 29.9 | 30.0 |
| December | 34.8 | 28.5 | 28.5 |
| **Average** | **35.0** | **30.1** | **30.0** |

**Discussion**

It is not necessary to inform our readers at the Presidency that early on Tuesday morning the rain fell pretty freely, accompanied with some lightning and thunder; and that there has been some severe showers since: we mention, however, the circumstances of this early commencement of the South West Monsoon, by way of record.[[90]](#endnote-90)

The above quote is a short article presented in the *Bombay Courier* on 1 June 1822[[91]](#endnote-91). That these 'records' are continuing to inform the study of climatology is testament to the East India Company and its associates in India in recording, measuring and cataloguing natural phenomena. Other chapters in this volume have highlighted the Company's role in botany and plant transfer, natural history medicine and resource management. This chapter has focussed on meteorological recording. It highlights not only the Company’s contemporary scientific endeavours, but also their continuing importance for the study of climatology. Whilst the original reasons for data collection may not have been philanthropic (having as much to do with racial and class superiority as with scientific exploration)[[92]](#endnote-92), the measurements can now inform the global issue of climate change, regularly referred to as the greatest challenge facing humanity.

In terms of the contribution to climate science, this chapter has demonstrated that temperature in Bombay around the turn of the nineteenth century was around 5°C cooler than today. This is likely to be predominantly the result of huge urbanisation in the region, the population of Bombay in 1800 being around 150,000[[93]](#endnote-93), compared to around 20 million in 2013. Anthropogenic global warming also likely has a role to play, although further research is needed to determine whether any bias existed in the thermometers used during the period. The precipitation reconstructions over western India described earlier in this chapter are also shedding further light on the relationship between the Indian monsoon and ENSO, suggesting that the strength of the relationship may be affected by Indonesian volcanic eruptions[[94]](#endnote-94). This has potentially significant implications for forecasting. Previous research using East India Company materials to reconstruct monsoon onset date has demonstrated a delay in monsoon onset over Mumbai in the last 50 years, relative to the previous 170 years[[95]](#endnote-95).

This chapter has demonstrated the viability of temperature observations within diaries that were not intended as systematic weather journals in assessing historical climatic conditions. Although thermometer readings analysed from these diaries were collected in a largely *ad hoc* manner, they show no significant difference to methodical temperature observations also collected during the period. This is significant as it opens up new, previously unused observations into historical climatology, which may be particularly useful elsewhere in India. It should be noted, however, that these personal *ad hoc* observations may only be a viable representation of daily temperature maxima in regions such as Mumbai where the temperature has a small variation, and where a hot climate means the temperature maxima are likely to be a significant event for individuals. In temperature regions where the diurnal variation is higher and where climatic conditions can change markedly through a day there is a far greater chance that the daily maximum temperature will be missed. However, personal observations of temperature minima may be a viable source for colder regions. It is unlikely that personal diaries will prove a viable source for average temperatures, although this will be worth exploring.

This study has also highlighted the viability of personal diaries in cataloguing meteorological extremes. This approach has benefits for the incorporation of natural disasters into the study of history[[96]](#endnote-96). It also allows for the identification climatic events such as cyclones, which may be studied in greater detail in the future. This approach of cataloguing extreme events from personal diaries has only been attempted once before in India, using Danish missionary records for the eighteenth-century Coromandel Coast[[97]](#endnote-97). There is great potential for extending this, using both European and Indian language-records. The extensive East India Company archives of the Bengal Presidency have, for example, not been explored for this purpose. Neither have English-language observations for South India, despite knowledge of the existence of detailed weather diaries such as that kept by William Roxburgh[[98]](#endnote-98). Furthermore, the significance pre-colonial documents cannot be stressed strongly enough.

It is hoped that this study will spark further exploration of Indian language records to extend the climatic record in India back further, potentially including Maratha, Tamil, Persian and Sanskrit materials[[99]](#endnote-99).

1. R.H. Grove (1997) *Ecology, Climate and Empire* (Cambridge: The White Horse Press), p 124-146; R. H. Grove (1998) ‘The East India Company, the Raj and the El Niño: The Critical Role Played by Colonial Scientists in Establishing the Mechanisms of Global Climate Teleconnections 1779-1930’ in R.H. Grove, V. Damodaran and S. Sangwan (eds.) *Nature and the Orient: The Environmental History of South and Southeast Asia* (Oxford, New York: Oxford University Press), p. 301-323; S. Sangwan (1998) ‘From Gentlemen Amateurs to Professionals: Reassessing the Natural Science Tradition in Colonial India 1780-1840’ in R.H. Grove, V. Damodaran and S. Sangwan (eds.) *Nature and the Orient: The Environmental History of South and Southeast Asia* (Oxford, New York: Oxford University Press), p. 301-323; M. Harrison, M (1999) *Climates and Constitutions: Health, Race, Environment and British Imperialism in India 1600-1850* (Oxford: Oxford University Press); J. Golinski (2007) *British Weather and the Climate of the Enlightenment* (Chicago, London: University of Chicago Press); R. H. Grove (2007) ‘The Great El Niño of 1789-93 and its Global Consequences: Reconstructing an Extreme Climate Event in World Environmental History’, *The Medieval History Journal* X,75-98; G.C.D. Adamson (2012) ‘”The languor of the hot weather”: everyday perspectives on weather and climate in colonial Bombay’, 1819-1827, *Journal of Historical Geography*, XXXVIII, 143-154. [↑](#endnote-ref-1)
2. See, for example, A.P. Hove (1855) *Tours for scientific and economical research, made in Guzerat-Kattiawar, and the Conkuns, in 1787–1788* (Bombay: Government of Bombay). [↑](#endnote-ref-2)
3. G.T. Walker (1924) ‘Correlation in seasonal variations of weather, IX. A further study of world weather’,*Memoirs of the India Meteorological Department* XXIV 275-333; Grove, The East India Company, the Raj and El Niño. [↑](#endnote-ref-3)
4. Harrison, *Climates and Constitutions* [↑](#endnote-ref-4)
5. Harrison, *Climates and Constitutions* [↑](#endnote-ref-5)
6. D.N. Livingstone (2002) Race, space and moral climatology: notes towards a geneology, *Journal of Historical Geography*, XXVIII, 159-180 [↑](#endnote-ref-6)
7. The predominant archives are those of the India Office at the British Library, St Pancras, and the archives of the Bombay, Bengal and Madras Presidencies at Mumbai, Kolkata and Chennai. Other materials are known to exist in the National Archives of India and the National Library of Scotland, as well, potentially, as several other archives worldwide. [↑](#endnote-ref-7)
8. J. Golinski (2003) ‘Time, talk and the weather in eighteenth-century Britain’ in S. Strauss and B.S. Orlove (eds.) *Weather, Climate, Culture* (Oxford, New York: Berg), p. 17-38; Golinksi, *British Weather and the Climate of the Enlightenment*. Chapter in *Weather, Climate, Culture* [↑](#endnote-ref-8)
9. Golinski, Time, talk and the weather. [↑](#endnote-ref-9)
10. Golinski, Time, Talk and the weather. [↑](#endnote-ref-10)
11. T. Harley (2003) ‘Nice weather for the time of year: the British obsession with the weather’ in S. Strauss and B.S. Orlove (eds.) *Weather, Climate, Culture* (Oxford, New York: Berg), p. 103-120; Golinski, Time, Talk and the Weather. [↑](#endnote-ref-11)
12. J. Johnson (1818) *The Influence of Tropical Climates on European Constitutions*, 2nd edn (London). [↑](#endnote-ref-12)
13. Grove, *Ecology, Climate and Empire*; Grove, ‘The East India Company, the Raj and the El Niño’; Grove, ‘The Great El Niño of 1789-93 and its Global Consequences’. [↑](#endnote-ref-13)
14. Grove, *Ecology, Climate and Empire*; G.H. Endfield and D.J. Nash (2002) ‘Missionaries and Morals: Climatic Discourse in Nineteenth-Century Southern Africa’, *Annals of the Association of American Geographers*,XCIV, 727-742; Adamson, ‘The languor of the hot weather’. [↑](#endnote-ref-14)
15. Notable exceptions to this are: G.C.D. Adamson and D.J. Nash (2013) Long-term variability in the date of monsoon onset over western India’, *Climate Dynamics* XL 2589-1603; and, G.C.D. Adamson and D.J. Nash (2014) ‘Documentary reconstruction of monsoon rainfall variability over western India, 1781-1860’, *Climate Dynamics* XLII749-769. These will be discussed further later. A few other studies have been attempted using colonial missionary records, see: R. Glaser, S. Militzer, and R.P.D. Walsh (1991) ‘Weather and climate at Madras, India, in the years 1732–1737 based upon an analysis of the weather diary of the German missionary Geisler’, *Würzburger Geographische Arbeiten*, LXXX, 45-86; R.P.D. Walsh, R. Glaser and S. Militzer (1999) ‘The climate of Madras during the eighteenth century’, *International Journal of Climatology*, XIX,1025-104; D.J. Nash and G.H. Endfield (2002) ‘A 19th Century Climate Chronology for the Kalahari Region of Central Southern Africa Derived From Missionary Correspondence’, *International Journal of Climatology*, XXII,821-841; D.J. Nash and G.H. Endfield (2008) ‘“Splendid rains have fallen”: links between El Niño and rainfall variability in the Kalihari, 1840-1900’, *Climatic Change*,LXXVI,257-290; D.J. Nash and S.W. Grab (2010) ‘“A sky of brass and burning winds”: documentary evidence of rainfall variability in the Kingdom of Lesotho, Southern Africa, 1824-1900’, *Climatic Change*, CI,617-653; S. Grab and D. Nash (2010) ‘Documentary evidence of climate variability during cold seasons in Lesotho, southern Africa, 1833 – 1900’, *Climate Dynamics*, XXXIV, 473-499. [↑](#endnote-ref-15)
16. Adamson and Nash, Documentary reconstruction of monsoon rainfall variability over western India [↑](#endnote-ref-16)
17. For a review of Indian monsoon dynamics, see: S. Gadgil (2003) ‘The Indian monsoon and its variability’, *Annual Review of Earth and Planetary Science*,XXXI,429-467; Y. Ding (2007) ‘The variability of the Asian summer monsoon’, *Journal of the Meteorological Society of Japan*, LXXXV,21-54. [↑](#endnote-ref-17)
18. V. Krishnamurthy and B.N. Goswami (2000) ‘Indian monsoon-ENSO relationship on interdecadal timescales’, *Journal of Climate*, XIII,579-595; Gadgil, The Indian monsoon and its variability; Ding, The variability of the Asian summer monsoon. [↑](#endnote-ref-18)
19. N.H. Saji, B.N. Goswami, P.H. Vinayachandran and T. Yamagata (1999) ‘A dipole mode in the tropical Indian Ocean’, *Nature*, CDI 360–363; K. Ashok and N.H. Saji (2007) ‘Impacts of ENSO and Indian Ocean Dipole events on the sub-regional Indian summer monsoon rainfall’, *Journal of Natural Hazards*,XLII, 273-285. For the role of ENSO in the Indian Ocean Dipole system see also R. Allan, D. Chambers, W. Drosdowsky, H. Hendon, M. Latif, N. Nicholls, I. Smith, R. Stone and Y. Tourre (2001) ‘Is there an Indian Ocean Dipole, and is it independent of the El Niño – Southern Oscillation?’, *CLIVAR Exchanges*,VI, 18-22 [↑](#endnote-ref-19)
20. G.A. Meehl (1994) ‘Coupled land-ocean-atmosphere processes and South Asian monsoon variability’, *Science*, CCLVVI,263-267; Ding, The variability of the Asian summer monsoon. [↑](#endnote-ref-20)
21. Adamson and Nash, Documentary reconstruction of monsoon rainfall variability over western India. [↑](#endnote-ref-21)
22. The cataloguing of notable climatic events is a technique adapted from a study of climatic information contained within eighteenth-century Danish missionary records pertaining to the Coromandel Coast. See Walsh et al., The climate of Madras during the eighteenth century. [↑](#endnote-ref-22)
23. Available online at digitool.abdn.ac.uk [↑](#endnote-ref-23)
24. J. McGrigor (1804) *Medical sketches of the expedition to Egypt from India* (London: John Murray; Edinburgh: Bell and Bradfute; Dublin: Gilbert and Hodges). [↑](#endnote-ref-24)
25. UAL GB0817 AMCS 4/1/4/17 Casebook of James McGrigor 1 June 1800, University of Aberdeen Library (available online) [↑](#endnote-ref-25)
26. UAL GB0817 AMCS 4/1/4/23 27 November 1802 [↑](#endnote-ref-26)
27. BL MSS Eur F175/2 Diary of Jasper Nichols 30 September 1802, British Library [↑](#endnote-ref-27)
28. BL MSS Eur F175/2 30 November 1802 [↑](#endnote-ref-28)
29. BL MSS Eur F175/230 November 1802 [↑](#endnote-ref-29)
30. BL MSS Eur F175/3 31 May 1803 [↑](#endnote-ref-30)
31. BL MSS Eur F175/4 20 July 1804 [↑](#endnote-ref-31)
32. J. Nicolls (1819) ‘Remarks on the temperature of the Island of Bombay during the years 1803 and 1804’, *Transactions of the Literary Society of Bombay*,I,6-11. [↑](#endnote-ref-32)
33. Nicolls, Remarks of the temperature of the Island of Bombay; BL MSS Eur F175/9 22 January 1805 [↑](#endnote-ref-33)
34. Adamson, ‘The languor of the hot weather’, p. 146-147 [↑](#endnote-ref-34)
35. Adamson, ‘The languor of the hot weather’, p. 147 [↑](#endnote-ref-35)
36. BL MSS Eur F88/425 Diary of Mountstuart Elphinstone 15 January 1822, British Library [↑](#endnote-ref-36)
37. BL MSS Eur F88/425 26 March 1822 [↑](#endnote-ref-37)
38. BL MSS Eur F88/426 10 June 1823 [↑](#endnote-ref-38)
39. BL MSS Eur F88/425 1 March 1822 [↑](#endnote-ref-39)
40. S. Banks (2010) *A polite exchange of bullets: the duel and the English gentleman* (Woodbridge: Boydell Press), p. 104-105. [↑](#endnote-ref-40)
41. The monsoon of 1827 and 1828 were spent in Pune and December 1823, 1824 and 1825 spent travelling, in the Deccan, Goa and at the Hill Station of 'Lanowlie' (Lonavala) respectively. [↑](#endnote-ref-41)
42. BL MSS Eur D888/1 Diary of Lucretia West 23 August 1825, British Library [↑](#endnote-ref-42)
43. BL MSS Eur D888/1 24 June 1823 [↑](#endnote-ref-43)
44. BL MSS Eur D888/1 5 May 1826 [↑](#endnote-ref-44)
45. D.W. Moodie and A.J.W. Catchpole (1976) ‘Valid climatological data from historical sources by content analysis’, *Science*, CXCIII,52-53; C. Pfister (1992) ‘Monthly temperature and precipitation in central Europe from 1525-1979: quantifying documentary evidence on weather and its effects’ in R.S. Bradley and P.D. Jones (1992) *Climate Since A.D. 1500* (London and New York: Routledge), p. 118-142; R. Brázdil, C. Pfister, H. Wanner, H. von Storch and J. Luterbacher (2005) Historical climatology in Europe – the state of the art, *Climatic Change*, LXX,363-430. [↑](#endnote-ref-45)
46. Adamson and Nash, Documentary reconstruction of monsoon rainfall variability over western India. [↑](#endnote-ref-46)
47. Adamson and Nash, Documentary reconstruction of monsoon rainfall variability over western India, p. 14. [↑](#endnote-ref-47)
48. Adamson and Nash, Documentary reconstruction of monsoon rainfall variability over western India, p. 14. [↑](#endnote-ref-48)
49. National Oceanic and Atmospheric Administration (2012) Global Historical Climatology Network, http://www.ncdc.noaa.gov/ghcnm/ (home page), date accessed January 2012. [↑](#endnote-ref-49)
50. BL MSS Eur D888/1 10 February 1825 [↑](#endnote-ref-50)
51. BL MSS Eur D888/1 23 December 1826 [↑](#endnote-ref-51)
52. BL MSS Eur F88/426 25 March 1825 [↑](#endnote-ref-52)
53. 'A fine wind to day but Ther. 90, the Natives say there has not been so hot a Season since 1780.' BL MSS Eur D888/1 19 May 1827 [↑](#endnote-ref-53)
54. BL MSS Eur F88/426 2 April 1824 [↑](#endnote-ref-54)
55. BL MSS Eur F88/426 8 April 1827 [↑](#endnote-ref-55)
56. BL MSS Eur F88/426 11 April 1827 [↑](#endnote-ref-56)
57. BL MSS Eur D888/1 11 April 1827 [↑](#endnote-ref-57)
58. UAL GB0817 AMCS 4/1/4/17 19 July 1800 [↑](#endnote-ref-58)
59. BL MSS Eur D888/1 9 June 1825 [↑](#endnote-ref-59)
60. BL MSS Eur F175/8 10 August 1804 [↑](#endnote-ref-60)
61. BL MSS Eur F175/8 6 September 1824 [↑](#endnote-ref-61)
62. BL MSS Eur D888/1 22 June 1824 [↑](#endnote-ref-62)
63. BL MSS Eur D888/1 9 July 1824, 11 July 1824, 18 July 1824, 20 July 1824, 26 September 1824 [↑](#endnote-ref-63)
64. BL MSS Eur D888/1 12 August 1824 [↑](#endnote-ref-64)
65. BL MSS Eur F88/426 15 August 1824 [↑](#endnote-ref-65)
66. Krishnamurti, T.N., Ardanuy, P., Ramanthan, Y. and Pasch, R. (1981) On the onset vortex of the summer monsoon. *Monthly Weather Review* **109** 344-362 [↑](#endnote-ref-66)
67. UAL GB0817 AMCS 4/1/4/16 9 November 1799 [↑](#endnote-ref-67)
68. UAL GB0817 AMCS 4/1/4/18 1 November 1800 [↑](#endnote-ref-68)
69. BL MSS Eur F175/3 24 March 1803 [↑](#endnote-ref-69)
70. BL MSS Eur F175/9 10 February 1805 [↑](#endnote-ref-70)
71. BL MSS Eur F175/9 11 February 1805 [↑](#endnote-ref-71)
72. BL MSS Eur F88/363 3 February 1820 [↑](#endnote-ref-72)
73. BL MSS Eur D888/1 1 February 1826 [↑](#endnote-ref-73)
74. BL MSS Eur F88/426 19 April 1820 [↑](#endnote-ref-74)
75. BL MSS Eur D888/1 28 November 1827 [↑](#endnote-ref-75)
76. BL MSS Eur D888/1 2 December 1827 [↑](#endnote-ref-76)
77. BL MSS Eur D888/1 3 December 1827 [↑](#endnote-ref-77)
78. R.J. Murnane, R.J. K.B. Liu (eds) (2004) *Hurricanes and Typhoons: Past, Present and*

    612 *Future* (New York: Columbia University Press); L.-A. Dupigny-Giroux and C.J. Mock (eds.) (2009): *Historical Climate Variability and Impacts in North America* (New York: Springer). [↑](#endnote-ref-78)
79. Rulers of much of the Deccan during the eighteenth and early-nineteenth centuries, based at Poona (Pune). [↑](#endnote-ref-79)
80. BL MSS Eur F175/9 22 January 1805; Nicolls, Remarks upon the temperature of the island of Bombay, p. 6 [↑](#endnote-ref-80)
81. BL MSS Eur F88/425 7 December 1821 [↑](#endnote-ref-81)
82. BL MSS Eur D888/1 16 April 1823 [↑](#endnote-ref-82)
83. J. Jurin (1720) ‘Invitatio ad Observationes Meteorologicas communi consilio instituendas’, *Philosophical Transactions*, XXXII, 422-427. [↑](#endnote-ref-83)
84. UAL GB0817 AMCS 4/1/4/18 4 October 1800 [↑](#endnote-ref-84)
85. UAL GB0817 AMCS 4/1/4/21 12 December 1801 [↑](#endnote-ref-85)
86. BL MSS Eur F175/9 22 January 1805 [↑](#endnote-ref-86)
87. BLNC MC1112 *Bombay Courier*, issues January 1817 to September 1822, British Library Newspaper Collections. The originals of these observations have not been located. [↑](#endnote-ref-87)
88. K. Rupa Kumar and L.S. Hingane (1988) ‘Long-term variations of surface air temperature at major industrial cities of India’, *Climatic Change*, XIII, 287-307; A. Dhorde, A. Dhorde and A. S. Gadgil (2009) Long-term temperature trends at four largest cities of India during the twentieth century, *Journal of the Indian Geophysical Union*, XIII, 85-97. [↑](#endnote-ref-88)
89. D.R. Kothawale and K. Rupa Kumar (2005) ‘On the recent changes in surface temperature trends over India’, *Geophysical Research Letters*, XXXII (XIII); G. Alory, S. Wijffels and G. Meyers (2007) ‘Observed temperature trends in the Indian Ocean over 1960–1999 and associated mechanisms’, *Geophysical Research Letters* XXXIV (II) [↑](#endnote-ref-89)
90. BLNC MC1112 *Bombay Courier*, 1 June 1822. [↑](#endnote-ref-90)
91. Mountstuart Elphinstone also recorded the monsoon onset at this date in 1822, writing on 3 June 'we still have rains no doubt the monsoon' BL MSS Eur F88/425 3 June 1822 [↑](#endnote-ref-91)
92. See Harrison, *Climates and Constitutions*, Golinski, *British Weather and the Climate of the Enlightenment*. For a fuller discussion of wider colonial climatic discourse within the diaries of Elphinstone and West see Adamson, ‘The languor of the hot weather’. [↑](#endnote-ref-92)
93. S.M. Edwardes and J. Campbell (1909) *The gazetter of Bombay city and island* (Government of the Bombay Presidency: Bombay). [↑](#endnote-ref-93)
94. Adamson and Nash, Documentary reconstruction of monsoon rainfall variability over western India [↑](#endnote-ref-94)
95. Adamson and Nash, Long-term variability in the date of monsoon onset over Mumbai. [↑](#endnote-ref-95)
96. For a fuller discussion of the importance of natural disasters in Indian history see T. Roy (2012) *Oxford Short Introductions: Natural Disasters in Indian History* (New Delhi: Oxford University Press) [↑](#endnote-ref-96)
97. Walsh et al., The climate of Madras during the eighteenth century. [↑](#endnote-ref-97)
98. Grove, The East India Company, the Raj and the El Niño. [↑](#endnote-ref-98)
99. A brief overview of Indian climate variability over the last millennium has been attempted, although this used secondary sources only and did not generate a chronology. See G.B. Pant, K. Rupa Kumar, N.A. Sontakke and H.P. Borgaonkar (1993) ‘Climate variability over India on century and longer time scales’ in R.N. Keshavamurty and P.C. Joshi (eds.) *Advances in Tropical Meteorology* (New Delhi: Tata McGraw-Hill Publishing Company), p. 71-84. [↑](#endnote-ref-99)