BAMS Article

The Late-Eighteenth-Century Climate of Cape Town, South Africa, Based on the Dutch East India Company "Day Registers" (1773–91)

Stefan Grab and Mark Williams

ABSTRACT: We introduce the Dutch East India Company "day registers" as one of the world's longest known pre-nineteenth-century corporate chronicles (1652–1791) containing near-continuous, systematic, noninstrumental daily weather information for Cape Town, South Africa. This transcript provides the longest-known continuous seventeenth- to eighteenth-century daily weather record for Africa and the Southern Hemisphere. An 18-yr (1773–91) climate chronology from this record is presented, thus providing unique insight to the late-eighteenth-century climate of Cape Town. Extraction of daily weather information for basic statistical analysis includes precipitation, wind, sky conditions, and accounts of storms, drought, and floods. From this, we provide monthly and annual number of rain days, a rain index (relative rainfall amount), hot and cold days, and occurrence of storm-strength winds. Results show extreme weather and climate variability in Cape Town during the mid- to late 1780s.

KEYWORDS: Cape Town, Eighteenth century, Climate, Documentary sources

https://doi.org/10.1175/BAMS-D-21-0127.1
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In final form 4 May 2022

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Developing an improved understanding of recent (~last two millennia) climate change depends largely on reliable historical meteorological data and refined high-precision climate modeling. With such endeavors, climate data are obtained from either "archives of nature" (e.g., sediment cores, tree rings, coral records, speleothem records) or "archives of society" (instrumental, documentary, and iconographic data sources). Natural proxies have the clear advantage of providing data into the deep past (some proxies potentially to several hundred thousand years BP), while human-engineered data have a much narrower temporal coverage, generally confined to the last two millennia. However, instrumental and documentary-based climate data achieve much higher spatial and temporal (to subdaily) resolution than natural proxies, and thus offer the best opportunities for high-precision reconstructions of past climate where such data are available.

In the absence of instrumental data, or to complement instrumental-based climate series, a wide variety of documentary records offer an alternate means of constructing high-resolution (annual to subdaily) climate chronologies for given localities or regions (e.g., Nash and Adamson 2014; Pfister and White 2018; Nash et al. 2019). The quality of such documentary-based weather and climate reconstructions is highly variable and depends largely on data density (ability to triangulate and corroborate) for a given time period, reliability (subjectivity) of the data source, the type of detail provided (e.g., date, locality, particulars on anomalies), and the ability to calibrate against an overlapping period of instrumental records. An added value of documentary records is that they often contain details on human and environmental consequences and associated human responses.

Although the world's earliest-known written weather records are those engraved on ox bones during the Shang dynasty (~eighteenth–twelfth century BC), these were sporadic and isolated in extent (Wang and Zhang 1988). Nonetheless, Chinese documentary records containing past weather or climate information for the last two millennia are exceptionally voluminous (Wang and Zhang 1988; Ge et al. 2018; Chen et al. 2020). In the eastern Mediterranean and Middle Eastern regions, written sources go back at least to AD 300, providing insights to past climatic anomalies (Telelis 2008). Nearly contemporaneous textual sources from Venice (Italy) going back to around AD 604 have assisted in establishing past winter severity based on lagoon-freezing phenomena (Camuffo et al. 2017). Records such as these have helped ensure that there is now a substantial volume of known, documentary-based material that details climate anomalies for much of Europe, covering the past several centuries (for syntheses, see Brázdil et al. 2010; Pfister et al. 2018; Rohr et al. 2018).

In contrast, documentary records for North and Latin America, parts of Asia, sub-Saharan Africa, and Australasia are largely limited to the late-modern era, and in most cases begin with periods of initial and expanding European colonization. The longest Southern Hemisphere (SH) documentary-based climate records provide El Niño–Southern Oscillation (ENSO) signals based on hydric variability over northern Argentina, dating back to the late sixteenth century (Prieto and Rojas 2015). However, for the most part, documentary-based data density only permits annually resolved climate variability assessment during the course of the eighteenth century for some parts of South America (e.g., Prieto and Herrera 2002; Deschamps et al. 2014) and daily chronologies seem absent prior to the nineteenth century. In southern Africa and Australia, the few (mostly discontinuous) nineteenth-century instrumental meteorological records have been complemented with documentary records, mainly to provide relatively long annual to seasonal rainfall chronologies, starting as early as 1788 in the case of Australia (Fenby and Gergis 2013; Gergis and Ashcroft 2013). Recent work has compared and consolidated documentary-derived nineteenth-century rainfall patterns across much of the African subcontinent, and has identified ENSO as the primary driver (e.g., Neukom et al. 2014; Nash et al. 2016, 2018; Grab and Zumthurm 2018; Nicholson et al. 2018). Notwithstanding the value of this work, such climate reconstructions are limited to annual or seasonal resolution in the absence of chronicles containing longer daily records. In addition, data density and spatial coverage substantially diminishes prior to the mid-1830s. To this end, any earlier chronicle containing daily weather records over multiple years would be of enormous value to extend annually to seasonally resolved climate chronologies prior to the nineteenth century.

It is in this wider context that we aim to 1) introduce the Dutch East India Company [“*Vereenigde Oost-Indische Compagnie*” (VOC)] day registers (Dutch = “*daghregisters*”) as one of the world’s longest known pre-nineteenth-century corporate chronicles containing near-continuous, systematic, noninstrumental daily weather information, and 2) provide insight to the late-eighteenth-century weather and climate of Cape Town (South Africa).

Contemporary climatic context of Cape Town

Cape Town, located in the southwestern most portion of the African subcontinent, is surrounded by the Atlantic Ocean and mountainous coastal topography exceeding 1,000 m MSL (Fig. 1). The Castle (“*Kasteel*”), from where seventeenth- and eighteenth-century weather observations were made by the VOC, is located in central Cape Town at latitude 33°55′12″S, longitude 18°25′40″E, and 5 m MSL (Fig. 1).

The contemporary Mediterranean climate of Cape Town is primarily driven by 1) the overpass of midlatitude cyclones/storms (“cold fronts”), which bring wet, cool weather dominated by NW winds during austral winter, and 2) the South Atlantic high pressure system, which provides for dry warm/hot weather dominated by SE winds during summer (Tadross et al. 2012; Mahlalela et al. 2019; Ndebele et al. 2020). Coastal low pressure systems occasionally develop along the west coast, initially causing hot, dry offshore airflow (“berg winds”) and subsequent moist onshore flow, typically during late winter or early spring (Tadross et al. 2012). The most severe weather conditions (excessive rain, gale force winds, storm surges, exceptional cold) over Cape Town are associated with slow moving “cutoff lows” (CoLs), which provide as much as 11% of annual precipitation to the region (Abba Omar and Abiodun 2020).

Mean long-term (1841–2016) annual precipitation at the South African Astronomical Observatory is 619 mm, of which ~70% falls between late autumn and early spring (May–September) (Ndebele et al. 2020). Thunderstorms and hail are infrequent to Cape Town but known in the region even during summer due to convective activity. Marine fog is a more regular occurrence over Cape Town, especially during autumn mornings due to moist air transported over the cold Atlantic from the west (Tadross et al. 2012).

The VOC day registers at the Cape of Good Hope

Trade and associated VOC shipping was established between the Netherlands (United Provinces, Dutch Republic) and southeast Asia through Indian Ocean trade routes at the end of the sixteenth century. By the mid-seventeenth century, it was realized that a permanent reprovisioning and resting station was required, for which Table Bay at the Cape was deemed the most suitable. Jan van Riebeeck was subsequently commissioned to establish the

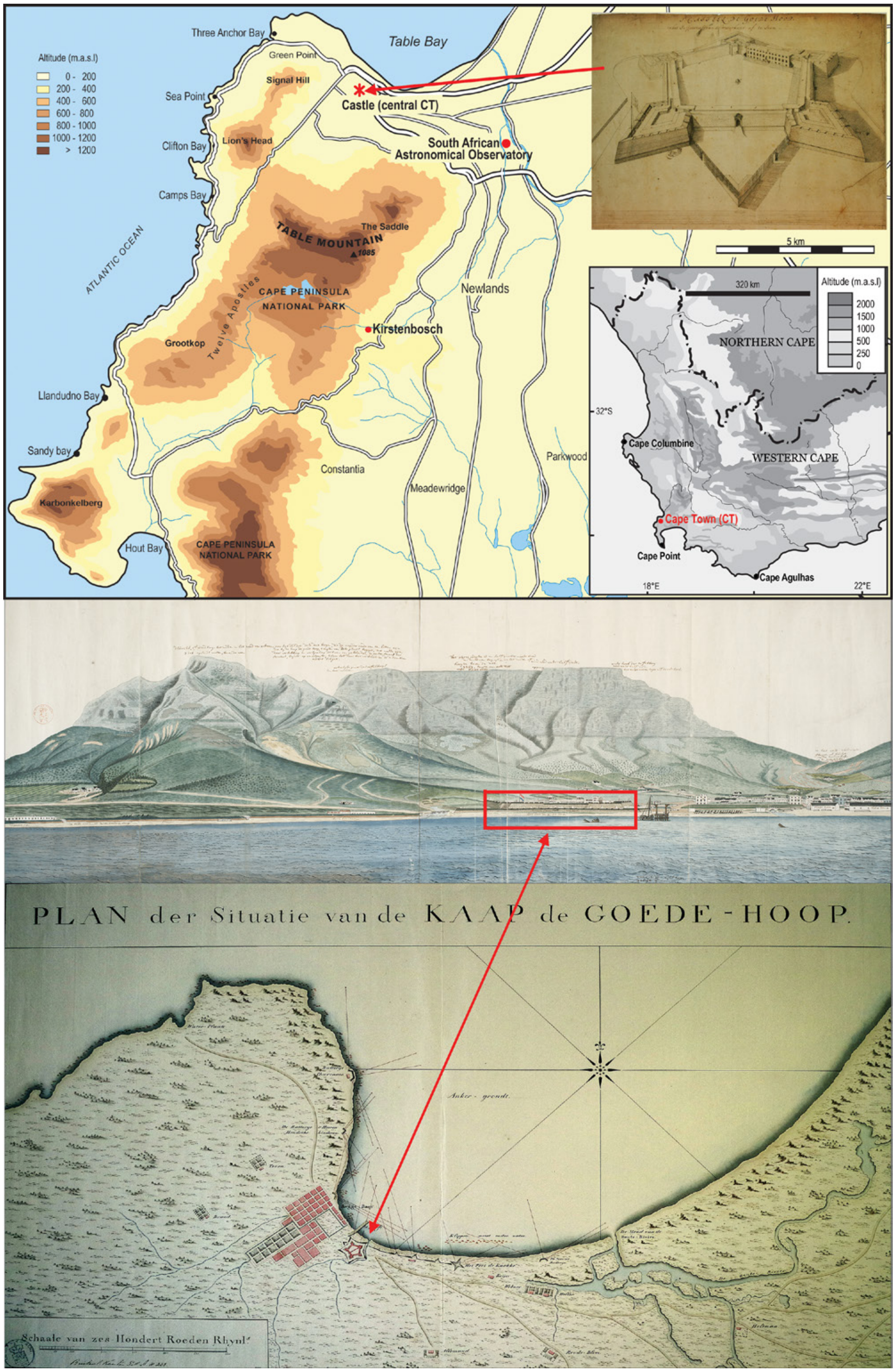

Fig. 1. (top left) Location of Cape Town and the Castle (where weather observations were made for the day registers). (top right) A "Perspective of the Castle of Good Hope, as seen from the Waterfront" by Jan Wittebol, ~1680 (source: Comprehensive Atlas, p. 26: Nationaal Archief, 4 VEL Record No. 830). (middel) A panorama of Cape Town and its surroundings as seen from the sea (by Robert Jacob Gordon, 1778; source: Rijksmuseum online digital resource library). (bottom) A plan view dated to ~1760–89 (cartographer unknown; source: Comprehensive Atlas, p. 103. Nationaal Archief, 4, TOPO 15.72).

settlement, build a fortress (the *Kasteel*), and develop company gardens as the first governor at the Cape in AD 1652.

Early navigation practices brought about the first day registers to be kept while at sea. These initially recorded the time, speed, and progress of the voyage but gradually expanded to include "the passing of other fleets, news from the crew, etc." (Delmas 2012, p. 103). By the time of van Riebeeck's colonization of the Cape, the writing of these day registers began to incorporate land-based considerations with strict guidelines as to their content.

A "residual effect" (Delmas 2012, p. 107) of this move on land from navigational record-keeping was a continuation of climate recording. Although recording daily weather conditions was not part of the initial instruction at the Cape Colony, van Riebeeck took a personal interest in understanding the Cape climate and its implications for local shipping, and hence requested that daily weather also be included in the day registers. Not only did this become the first regular item in the daily entries, but it became so entrenched that daily weather was included in the contents of all registers (AD 1652–1791) at the Cape until the demise of the VOC. These immediately became valuable to the VOC's archiving practices: the first "*daghregister*" was sent from the Cape to Holland in April 1652, and to Batavia shortly thereafter, beginning a practice that would see three copies dispatched to Europe and Asia yearly and certified as *Copijen* (copies) (Delmas 2012, 108–109).

Of particular importance and value is the consistency and systematic manner in which record keeping was undertaken through the decades. Daily weather observations were made and written into the registers (Fig. 2) by scribes appointed through the secretaries of various sections of government. During the period assessed in this article (1773–91), this secretarial role was occupied predominantly by two men: secretaries Rönnenkamp and Horak, both of whom account for the first 12 years of the period (Fig. 1). This lends a remarkable degree of consistency to the record-keeping practices within a set of documents already structured through habit and institutional priority around continuity and the discouraging of variation. While successive observers may have experienced daily weather differently on an individual basis, the record-keeping practices of the VOC demanded that this terminology was inherited and consistent from one clerk to the next to ensure its functionality. This made both the observation of weather and recording of entries at the Castle (Fig. 1) a daily ritual with global implications for company trade.

Descriptions of daily weather in the registers vary from a brief overview for the entire day (e.g., "Once again enjoyed a pleasant day with light variable winds from both the sea and land" for 8 January 1786) to the more usual detailed and systematic accounts that include subdaily (including nighttime) changes in wind direction and strength, cloud cover, and the duration/type/strength of precipitation. Particular detail is provided for wind and changes in wind direction/force during the day, which would have been important to the VOC in the context of shipping safety, arrivals, and departures.

Methodology

Original registers available at the National Archives, Den Haag (Netherlands) and the Western Cape Archives, Cape Town (South Africa) were photographed and subsequently transcribed by the Tracing History Trust (THT), which comprises several full-time professional staff trained as transcribers, editors, historians, and translators. All transcribed work was double checked and edited against original texts to ensure accuracy. The process was led by Helena Liebenberg, a specialist transcriber and Dutch language historian. A total of 22,859 images (or 3.33 million words) have been transcribed. In this paper, we present the first phase of completed transcriptions and weather data extraction (1773–91), which also represents the most recent period from the full chronicle record. The original text is written and transcribed verbatim in seventeenth- and eighteenth-century Dutch and includes Gothic text in the earliest years.

All daily weather information was extracted and translated into English and captured on spreadsheets. Categories include descriptions of rain (strength, duration, time of day); descriptions of the sky; wind direction and strength (usually including subdaily changes); warm or hot days; cool or cold days; occurrence of mist or fog; and general descriptions of the weather

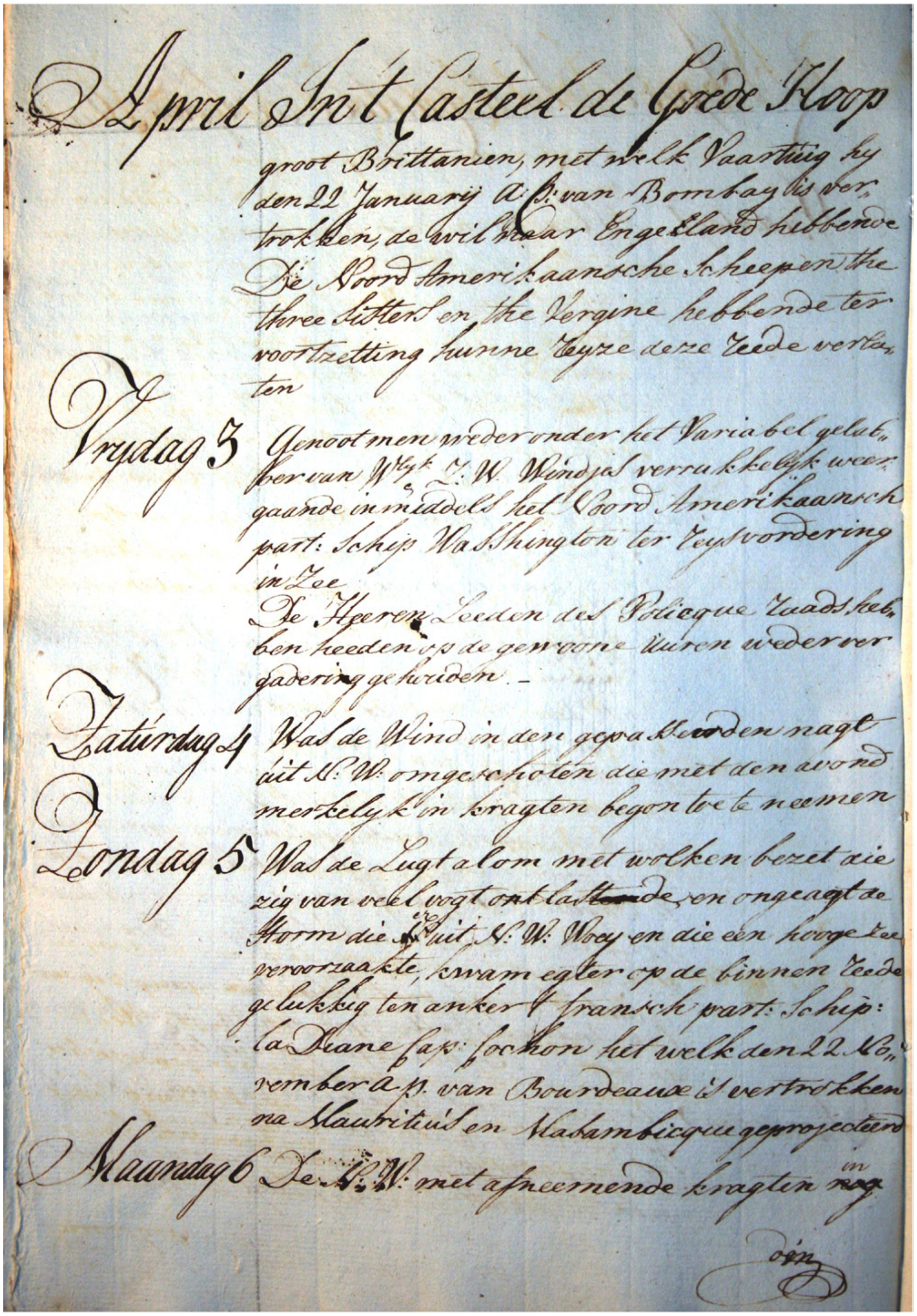

Fig. 2. Example of an original *Daghregister* page providing daily weather information for 4–6 Apr 1789.

and sea (e.g., hail, lightning, thunder, heavy swells, rough seas). From this, basic statistical values were calculated, such as monthly and annual number of rain days, days of hail, warm or hot days, cool or cold days, days of mist or fog, and thunder and/or lightning days. Additional variables calculated include maximum consecutive rain days per month and year, and total number of 1-, 2-, and ≥3-day wet spells per rain season (April–October), the latter two referring to consecutive rain days. We also include the longest dry spell length (consecutive days without precipitation) during each rain season. These results are then compared to those calculated for the nineteenth, twentieth, and early-twenty-first centuries. For more recent times of rain gauged data, which were shared by Ndebele et al. (2020), a rain day is one where rainfall amount is ≥1 mm, based on the assumption that anything less than 1 mm is easily lost through ground cover and/or evaporation, and is thus relatively insignificant. Similarly, it is possible that the calculated number of rain days for the late eighteenth century may miss reporting of events that would equate to less than 1 mm, particularly nighttime events.

There is no universal single system for converting qualitative rainfall information into quantitative data (see Harvey-Fishenden and Macdonald 2021), largely because the quality and characteristics of such information differs across documentary source types. It is thus important to develop quantitative rainfall data (e.g., rainfall index or rainfall classification system) that best suit the source type but also achieve the highest possible quality of quantitative outputs. Although number of rain days provides some indication of wetness, a potentially more accurate indication of *relative* rainfall amount is provided through a calculated rainfall index. This is possible given that attributes of rainfall intensity, timing and duration are provided. The uniqueness of the registers is that even the slightest drizzle or dampness was reported and that accounts were at subdaily resolution. Even overnight precipitation was reported on in detail, such as for example "much rain" having fallen during "the previous night" (e.g., 11 May 1782). Adjectives such as "steady," "continuous," "intermittent," and "on and off" were added to those describing the force of rainfall, such as "hard," "moderate," "light," and "downpours," "showers," "drizzle," among others. In cases where overnight precipitation was not directly observed, comments were made on the dampness of the ground and assumed as light overnight drizzle. Given such extraordinarily high levels of detail, we have developed a rainfall index which combines relative rainfall duration and intensity. In this case intensity is a measure of continuity plus force (relative amount per unit of time), based on daily qualitative accounts. Please refer to Table 1 for further details on how we calculate the rainfall index. This is not an indication of *absolute* rainfall quantity, but rather offers a measure for *relative* rainfall amounts between months and years investigated.

Despite no specific details on how qualitative judgments of daily wind direction and force were made, it is likely that directional descriptions were based on flag-flutter (a flag was permanently hoisted at the Castle). Dutch wind force terminology was closely linked to sailing practice, based on the amount of sail carried. There was a well-defined order of the many Dutch wind force terms, which were identical to the ones later used when the Beaufort wind force scale was introduced (García-Herrera et al. 2003). This offers a unique opportunity to translate the daily Dutch wind force terms to Beaufort-scale values, and thus to quantify daily maximum wind force reached in Cape Town [for further methodological details, please see Wheeler and Wilkinson (2005)]. Although it is not possible to calculate *absolute* mean daily wind force given that force changed throughout the day and at times varied greatly (e.g., from a still morning to gale force in the late afternoon), descriptions of

Table 1. Details on calculating the rainfall index (RI). The daily rainfall index is then calculated as (rainfall duration index value) × (rainfall intensity index value). A further four index points are added where flooding is reported due to exceptionally heavy rainfall.

Rainfall index	Index value
Rainfall duration	
"Short," "brief," "early morning," "before noon," "at midday," "after noon," "evening"	1
Half day *or* half the night—Continuous	2
Half day *or* half the night on and off	1.5
Full day *or* all night—Continuous	4
Full day *or* all night on and off	3
Full day and night—Continuous	8
Full day and night on and off	6
All night and half the day—Continuous	6
All day and half the night—Continuous	6
All night and half the day on and off	4.5
All day and half the night on and off	4.5
Rainfall intensity	
"Light," "drizzle"	1
"Rain," "showers"	2
"Heavy rain," "downpours"	3
Reports of floods due to heavy rain	4

maximum daily to subdaily (morning/afternoon/evening/night) wind force are typically included. The maximum force reached each day was then assigned a Beaufort-scale value, from which an indication of *relative* mean monthly/annual maximum wind force was calculated. Wind direction was provided according to cardinal, intercardinal, and secondary intercardinal directions. We calculate wind directional frequency based on the number of days wind blowing in a given direction is reported per month. This is then expressed as a percentage of days per month. *Relative* wind frequency in this historical analysis thus represents percentage daily *occurrence* rather *duration*. Unfortunately, there was not always an interannual consistency in providing subdaily wind directional detail, thus rendering it unsuitable to make direct comparison between years. Given that the prominent topography (e.g., Table Mountain) surrounding central Cape Town has significant impact on wind direction and strength (Kruger et al. 2014), any historical wind patterns thus reflect local rather than regional conditions.

Table 2. Days without weather reporting at the Castle of Good Hope, indicating both the annual number of missing days, and maximum number of missing days in any given month per annum.

Year	Total days	Percentage of days	Max days missing in a given month
1773	1	0.3	1 (Dec)
1774	0	0.0	–
1775	0	0.0	–
1776	1	0.3	1 (Apr)
1777	1	0.3	1 (Dec)
1778	0	0.0	–
1779	8	2.2	2 (Jan, Mar, Apr)
1780	6	1.6	2 (Apr)
1781	7	1.9	3 (Mar)
1782	6	1.6	2 (Dec)
1783	4	1.1	2 (Mar)
1784	11	3.0	3 (Jan)
1785	6	1.6	2 (Jan, Mar)
1786	3	0.8	2 (Dec)
1787	12	3.3	3 (Feb, Apr)
1788	5	1.4	2 (Nov)
1789	0	0.0	–
1790	365	100.0	Entire year missing
1791	32	8.8	31 (Dec)*

* December 1791 = missing data and we undertook data infilling to acquire a full rain record for this year.

Please note the unavailability of daily registers for 1790 and December of 1791. For December 1791, we impute mean December values (n = 17 years; 1773–89) for calculated monthly variables, which is feasible given that December is a typically dry month, and thus has no significant impact on the rain day counts for 1791. Such imputation techniques are common practice where data are missing (e.g., Addi et al. 2022). During the 18 years (excluding missing registers for 1790 and December 1891), 1.1% of days have unrecorded weather observations (Table 2). This typically varies from 0% (1774, 1775, 1778, 1789) to 3.3% (1787) of days. Although 1791 has 32 days (8.8% of days) on which no weather is reported, this is owing to the entire month of December being missing. Where there were days without weather reporting, days prior to and after such missing daily reports were carefully examined in terms of wind direction and likely rainfall. This was to establish the most likely conditions on the day of missing information. However, in this context, we did not find any occasion where it was deemed necessary to impute "possible" missing rain days.

Weather and climate of Cape Town: 1773–91

This section provides a summary of weather conditions in Cape Town over the period 1773–91, and where possible, places these in context of mean conditions during more recent times. This broadly encompasses occurrences and characteristics associated with precipitation, storminess, temperature, and wind.

Table 3. Statistical data on rainfall (1773–2018) for Cape Town at the Castle of Good Hope and Royal Astronomical Observatory.

	Late eighteenth century (1773–91)	Nineteenth century (1841–99)	Twentieth century (1900–99)	Early twenty-first century (2000–18)	Last ~178 years (1841–2018)
Mean annual rainfall (mm)	Not available	646.4	604	574.4	613.3
Mean annual No. of rain days	83	76	75	67	75
Max annual No. of rain days (year recorded)	121 (1787)	101 (1883)	101 (1902)	86 (2013)	101 (1883, 1902)
Min annual No. of rain days (year recorded)	53 (1789)	51 (1880)	55 (1973)	52 (2000)	51 (1880)
Wet season (Apr–Oct)					
Annual No. of 1-day wet spells	13.3	17.3	15.9	17.3	16.5
Annual No. of 2-day wet spells	7.5	8.9	8.6	8.5	8.7
Annual No. of ≥3-day wet spells	8.3	6	6.3	4.5	6
Absolute max wet spell length: Days (year recorded)	16 (1787)	14 (1888)	10 (1968)	9 (2010)	14 (1888)
Mean max wet spell length per season: Days	6.9	5.5	5.3	4.6	5.3
Absolute max dry spell length: Days (year recorded)	34 (1789)	37 (1894)	42 (1991)	33 (2006)	42 (1991)
Mean max dry spell length per season: Days	19	17.7	19.7	19.8	19

Rain. The mean number of rain days per annum for the period 1773–91 (83) was higher than that during more recent periods (Table 3; Fig. 3). Fewest rain days occurred in 1789 (53 days), which ranks as having one of the lowest number of rain days in the last ~245 years (Table 3). In contrast, the years 1786/87 had the highest recorded numbers of rain days over the last ~245 years. The mean monthly distribution of rain days over the period 1773–91 follows an almost identical seasonal pattern as that for more recent times since 1841 (Fig. 3). For the period 1773–91, 61% of annual total rain days occurred from May to September, while only 18% occurred over the summer months of November–February. Noteworthy is the progressive decline in rain days for autumn (April and May) from the period 1773–91 (average = 6.6 and 9.8 days, respectively) to most recent times 2000–18 (average = 4.2 and 8.3 days, respectively) (Table 3). The period 1773–91 experienced considerably higher numbers of rain days during spring and early summer than times since then, with a general trend of ongoing decline over the last century (see also Ndebele et al. 2020).

Generally, the period 1773–91 had fewer short (1–2 days) wet spell lengths, but had more long (≥3 days) wet spell lengths than times since the mid-nineteenth century (Table 3). Mean annual maximum wet spell lengths have progressively decreased over the period 1773–2018. The longest wet spell for the period 1773–91 was 16 days in 1787. By contrast, the longest recorded wet spell during the nineteenth/twentieth centuries was 14 days in 1888, and that during the most recent two decades was 9 days in 2010.

Our rainfall index (RI) is used to compare monthly and annual rainfall amounts during the period 1773–91 only. Driest years were 1776 (RI = 393), 1788 (RI = 454), and 1777 (RI = 462) (Table 3; Fig. 3). Other commentary in the registers supports this dryness. During the second half of November to early December 1777, the weather was described as "very warm [hot] throughout the day" (17 November 1777) and as "burning heat" (30 November 1777). The summary for the year reported that the grain harvest was meager in quantity owing to extraordinary little rainfall and great drought (31 December 1777). The year 1787 (RI = 865) stands out as an anomalously wet one, largely owing to extreme high precipitation values in June and July (rain days = 23, RI = 212/rain days = 20, RI = 194, respectively). The entry for 26 June summarizes these conditions: "Continual, copious rains have taken the upper hand of this winter season." On 13 July it is reported that "the accumulated rainfall has exceeded that noted during all previous winter seasons at this locality." This is followed by another noteworthy entry on 18 July: "It cannot be

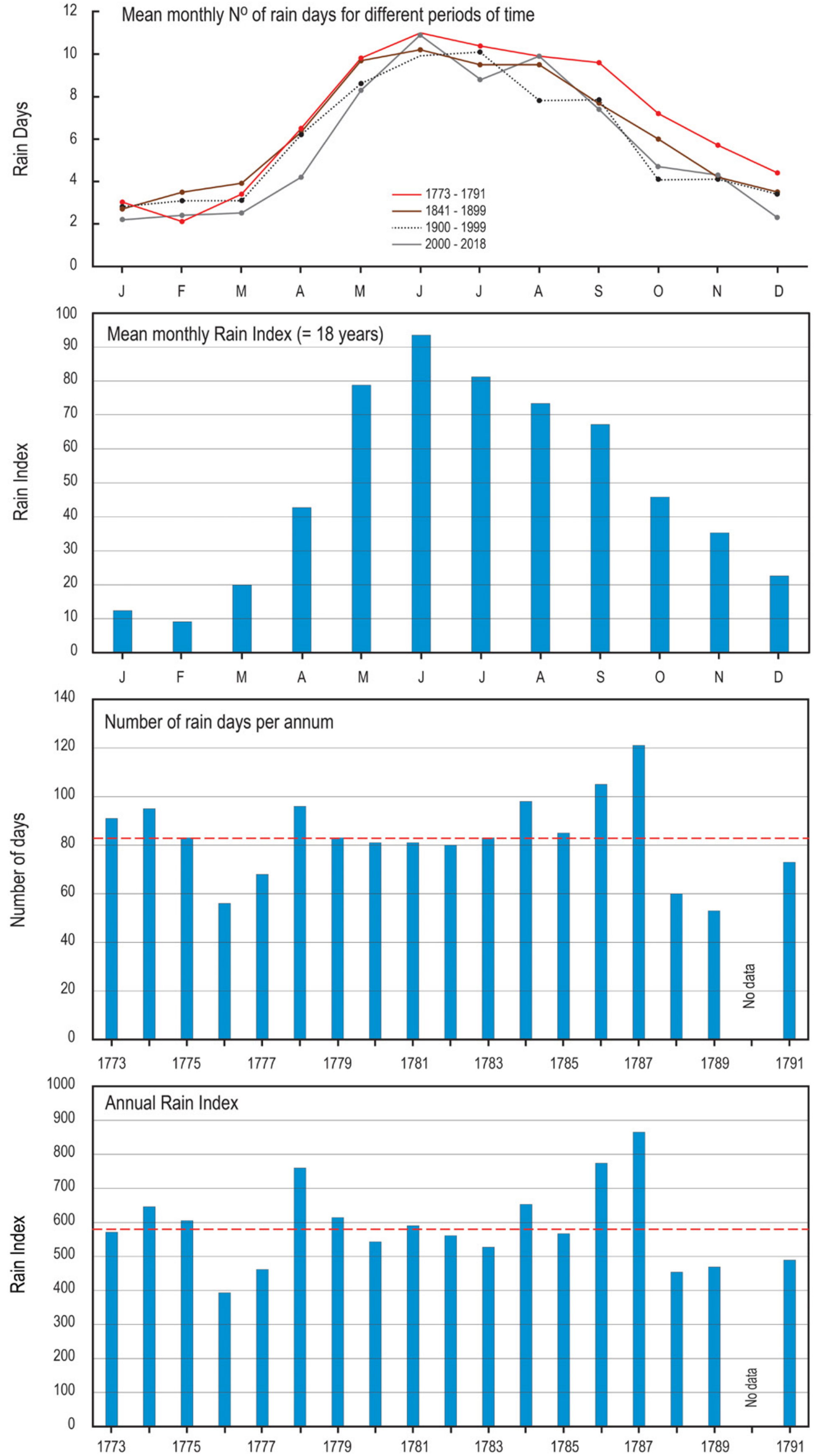

Fig. 3. (top) Mean number of rain days over different periods of time between 1773 and 2018. (bottom three panels) Monthly and annual rain day/rain index (RI) values for Cape Town over the period 1773–91. Red dotted lines indicate the mean annual value for the period 1773–91.

recalled in human memory, at least not since a long time in years, of such excessive rains that have almost flooded the countryside, and of such cold northwest winds."

Thunder, lightning, and hail. Thunder and/or lightning was infrequently reported over Cape Town during the period 1773–91 (on average 3.1 times per year). Years with the highest number of days with reported lightning were 1791 (10 days) and then 1777 and 1782 (7 days each) (Fig. 4). Interestingly, such higher reported occurrences were during drier (drought) years. Hail was even more rarely reported (0.7 events per year); in fact no hail was reported during 11 of the 18 years. The exception was 3 days of hail in July and one day in August of 1787. The entry of 18 July 1787 notes the "abundant hail showers which have remarkably covered the entire Table Mountain, and through the considerable cold remained over a great portion [of the mountain for assumedly 3 days] until midday [of the third day], before it suddenly started to melt."

Mist and fog. On average, 16.5 days of mist or fog were reported per annum over the period 1773–91 (Fig. 4). This varied from only 3 days in 1774 to as many as 45 days in 1783. The years 1782–1786 had distinctly high annual mist and fog occurrences averaging 35 days per year. Although variability between months was low, highest reported frequency was during autumn and winter, and lowest during spring (Fig. 4).

Temperature. Given the absence of instrumental temperature measurements and the somewhat subjective nature of our data (i.e., impacted by the observer's lived experience), results on thermal conditions need to be used with caution. Notably, thermal conditions are only mentioned on ~5% of days, and thus such commentary would have been relative to other days experienced at the Cape. Lived experiences of "normal" or "average" thermal conditions never earned mention, but rather it was days which felt particularly warm to hot or cool to cold during a given season that received mention, and so some periods stand out as exceptionally hot or cold (Fig. 5). The usage of the Dutch word "*warm*" in the registers implies temperature conditions that would usually be associated in the English language as a "hot" day. The word "*heet*" was infrequently used to describe exceptionally hot conditions. The average number of reported heat days = 10 times per year, with highest occurrences in 1786 (31 days) and 1787 (26 days). The mean number of heat days reported during austral summers (December–February) was 5 per season. Most notable is that no such days are mentioned for the summers of 1782/83 to 1784/85, but then is followed by anomalously high numbers reported during the summers of 1785/86 (19 days) and 1786/87 (18 days). Very few cold days are ever reported during summers, the exception being in January of 1787 (4 days). The average number of reported cold days = 9.5 times per year, with an exceptionally high reporting in 1787 (52 days). An average of 7 cold days were reported per austral winter (May–September), but such a value is largely due to the outstandingly cold winter season of 1787 (48 reported cold days).

Wind. The most frequently reported wind direction over the period 1773–91 was southeasterlies (SE: ~38.6% of days times per year), particularly over the warmer months (October–March: av ~48.7% of days) and peaking in February (58.9% of days) (Fig. 6). This is a likely underrepresentation (as are winds reported from other directions) considering that contemporary SE are said to blow >70% of the time between November and March in parts of Cape Town (Schumann and Martin 1991). Nevertheless, the typical seasonal occurrence is distinct with SE reaching a minimum in June and July (~22.5% of days), as is also the case nowadays (Fig. 6). Northwesterlies (NW) were the second most commonly reported winds (25.8% of days times per year) over the period 1773–91, also with a distinctly seasonal

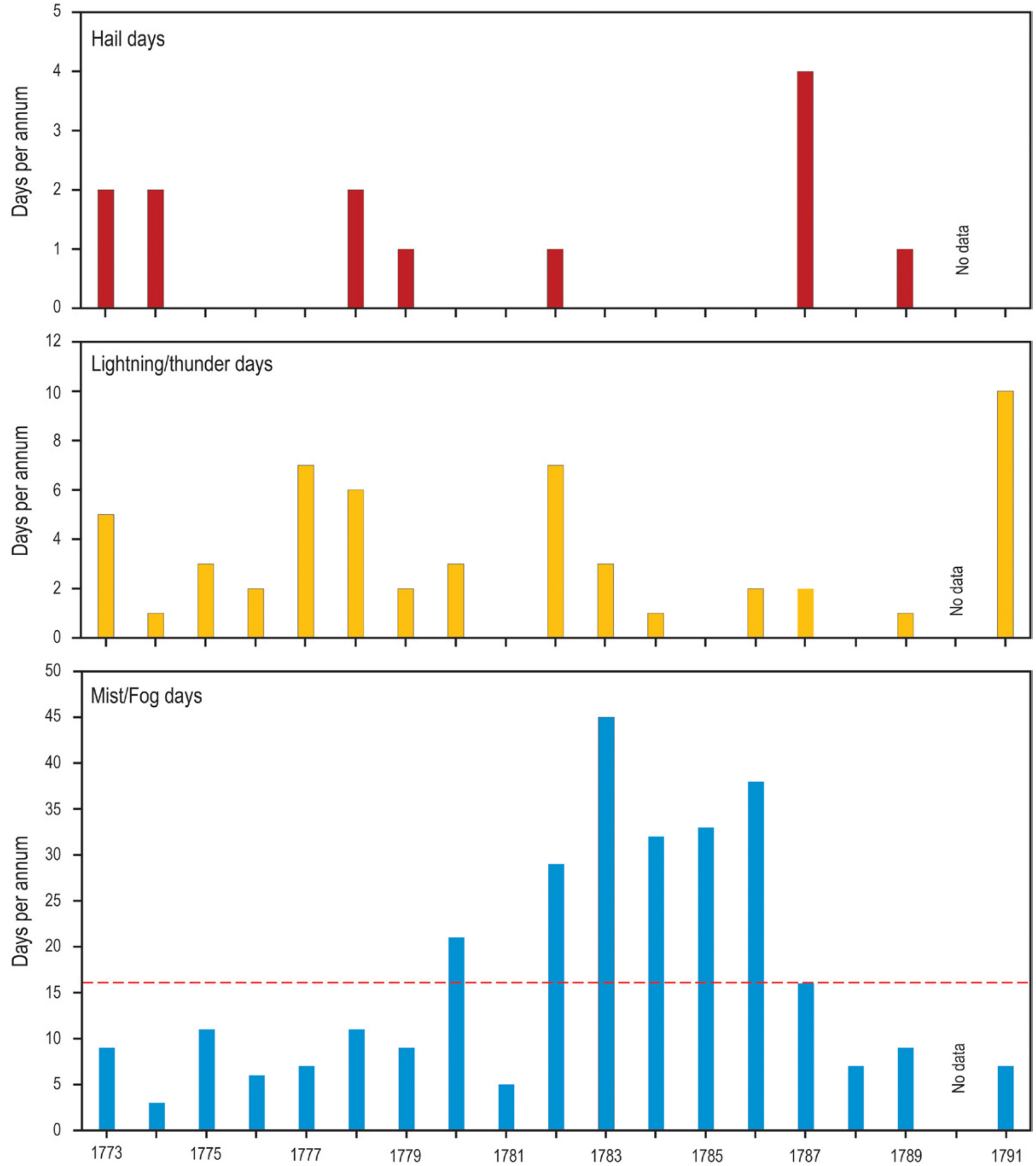

Fig. 4. Number of specific annual weather (related) anomalies for Cape Town over the period 1773–91. Red dotted line indicates the mean annual value for the period 1773–91.

pattern reaching highest reporting between May and September (~33.8% of days) and lowest over December to March (~15.1% of days). The most notable enhanced occurrence of SE occurs over the years 1785–88 (1786 being most outstanding with an occurrence of 51.8% of days). The years 1883 and 1886 stand out as those with highest reported occurrence of NW (38.6% and 40.8% of days, respectively).

Mean *relative* daily maximum wind force reached over the period 1773–91 was 3.6 on the Beaufort scale (i.e., gentle to moderate breeze) (Fig. 6). This varied from 4.0 (moderate breeze) during summer (November–February) to 3.4 (somewhat gentler breeze) during autumn and winter (March–August). Highest *relative* daily maximum wind force is calculated for January (average = 4.1) and lowest for April (average = 3.2). Years with highest *relative* daily maximum wind force were 1788 and 1789 (both years average = 4.52; moderate to fresh), while those with lowest force were 1773 (average = 2.74) and 1780 (average = 2.8).

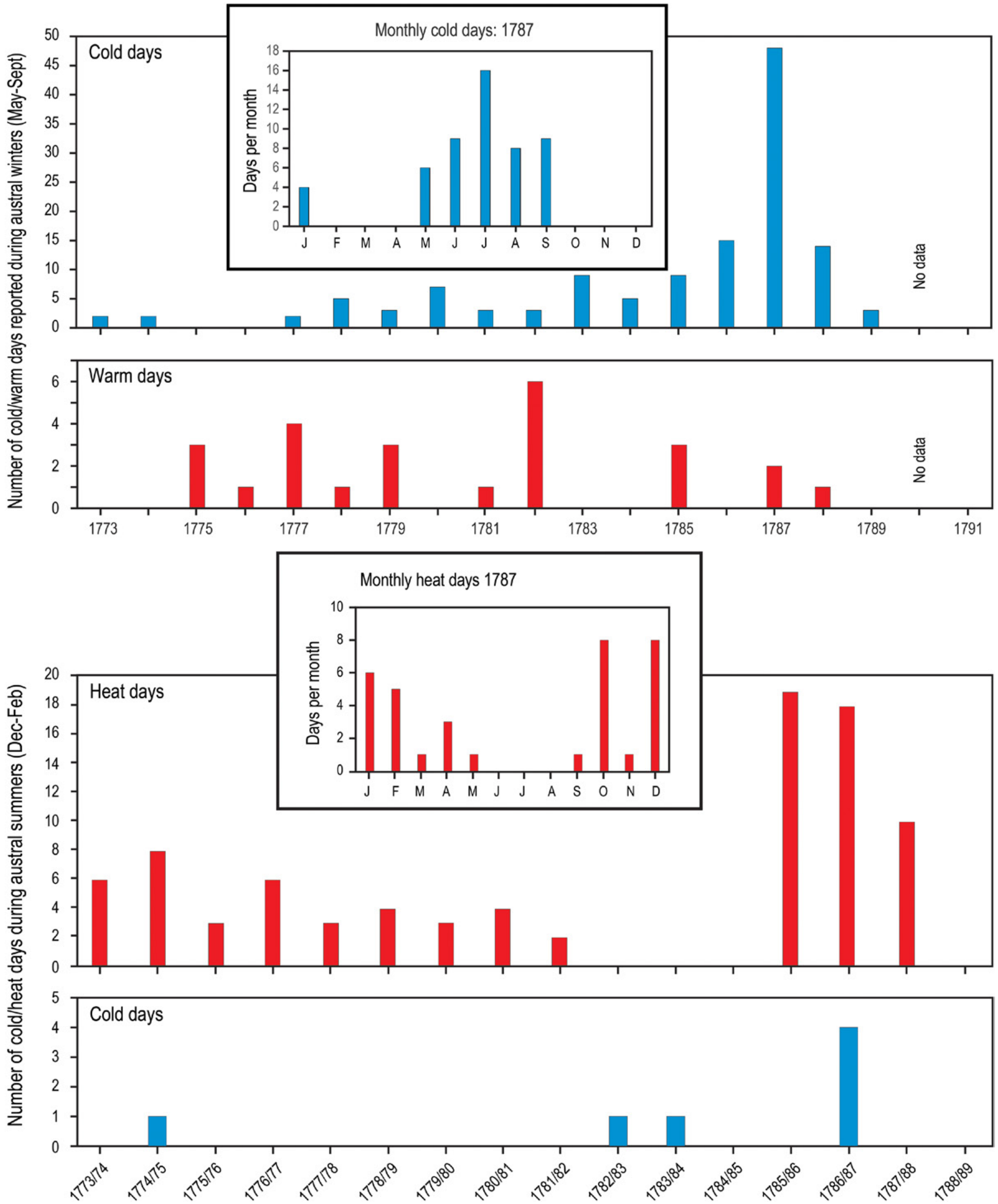

Fig. 5. Annual cold and heat days for Cape Town during austral winters (May–September) and summers (December–February) over the period 1773–89. Inset graphs are monthly cold and heat days for the anomalous year: 1787.

The period 1785–91 stands out as that with the highest *relative* daily maximum wind force (average = 4.1). During this period, summer winds were notably strong, and averaged 6.1 (strong breeze) in January 1787 and 5.93 in February 1788. On average, gale to storm-strength winds (Beaufort scale ≥ 8) occurred on 16.4 days per annum, and varied from as few as 2 days in 1778 to as many as 55 days in 1788. The period 1785–91 had particularly high occurrence of gale and storm-strength winds (average = 30.7 days per year). Overall, 76% of gale and storm-strength winds were SE, primarily as summer gales and storms, while 24% were NW (including westerlies and west-northwesterlies), primarily as autumn–winter–spring gales and storms.

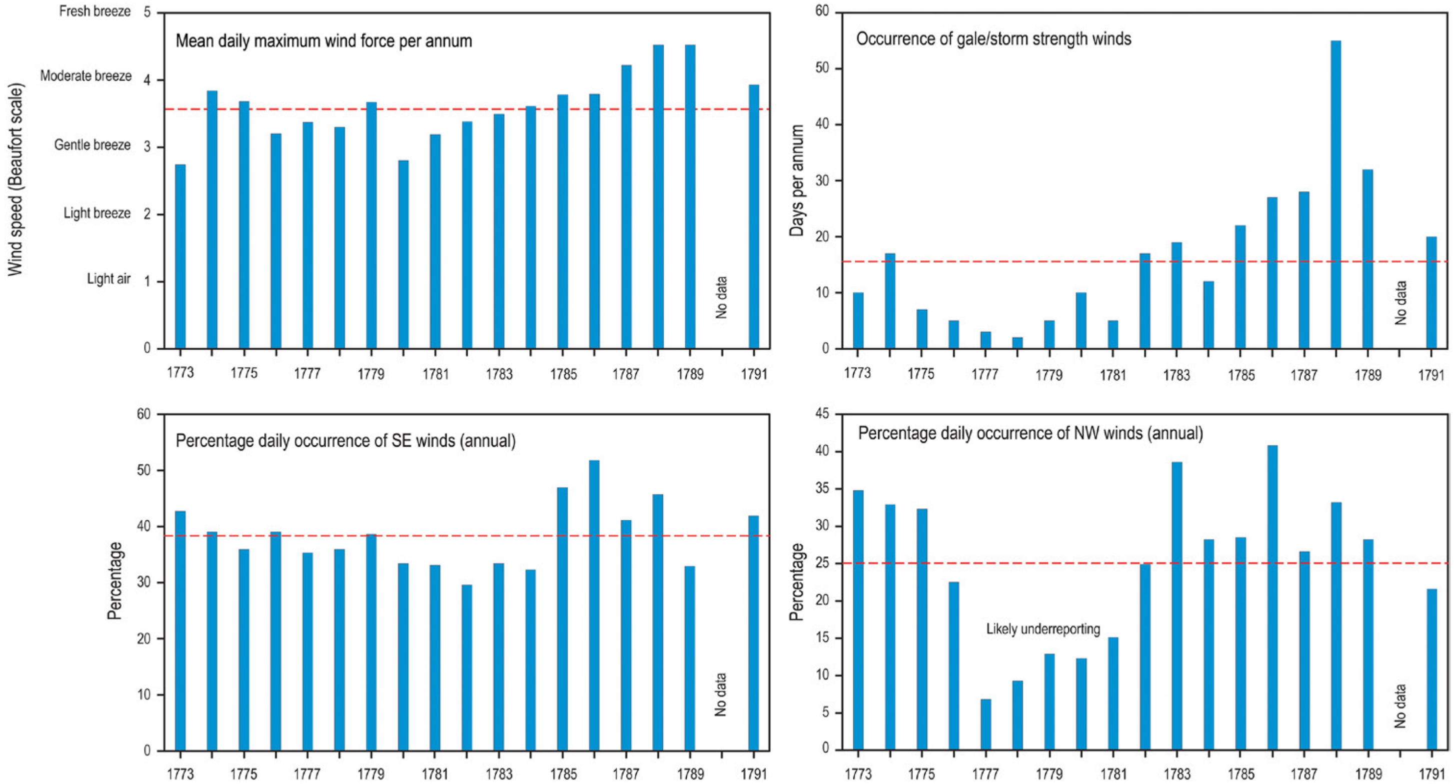

Fig. 6. Wind anomalies for Cape Town over the period 1773–91: (top) force and (bottom) direction. Red dotted lines indicate the mean annual value for the period 1773–91.

Closing remarks

The VOC day registers with their daily to subdaily weather entries for Cape Town during the seventeenth/eighteenth century are of climatological value to both the African subcontinent and SH, as they fill a spatiotemporal data gap. The paper presents the first 18-yr (1773–91) climate chronology from this record. Daily weather accounts (wind direction and strength, rain, etc.) have not only enabled the identification of wetter and drier seasons and years, but also the quantification of relative wetness and wind directional frequency, occurrence of extreme wind force events, and establishment of particularly cold/warm/hot periods, ranging from daily to interannual temporal scales. The data richness is sufficient to, in the future, compare against other regional and hemispheric proxy data for purposes of confirmation and improving our understanding of the SH climate at the time.

Overall, our data show extreme weather and climate (variability) in Cape Town during the mid- to late 1780s, at a time when the notable 1783/84 Lakagígar eruption impacted climates across the NH (e.g., Brázdil et al. 2010; Zheng et al. 2021). In so doing, the findings of anomalously wet and cold winters, hot summers, high occurrence of mist/fog days and strong winds during the later 1780s, raises important research questions that require further investigation, such as whether past major explosive volcanic forcing at high northern latitudes (in this case Lakagígar) might be capable of impacting midlatitude climates of the SH (e.g., mid- to late 1780s). More broadly, the high temporal resolution of the VOC day registers serves as an invaluable source of information to help "plug" the SH climatological information gap prior to the nineteenth century.

Acknowledgments. We acknowledge funding received from Embassy of the Netherlands, Pretoria; Newton Fund, United Kingdom; and University of the Witwatersrand, Johannesburg. We thank the Cape Town Archives and Nationaal Archief in Den Haag for access to original materials. Great appreciation goes to Helena Liebenberg and the Tracing History Trust for photography, transcriptions, and translations. Three anonymous referees and the BAMS editors are thanked for their valuable insights and constructive comments.

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