The weather of the First Fleet voyage to Botany Bay, 1787–1788

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Culturally significant weather records

Our understanding of recent climate change hinges on the quality and length of historical weather observations. In the best-observed regions of the world around 150 years of direct instrumental observations are available for climate research, but in large parts of the Southern Hemisphere records only cover the past 50–100 years. This is despite the fact that weather observations were routinely recorded by exploration, naval and merchant ship crews travelling the world during the eighteenth and nineteenth centuries (Garcia Herrera *et al.*, 2005; Brohan *et al.*, 2009). Although there have been recent efforts to digitise marine observations from some logbooks (Garcia Herrera *et al.*, 2005; Brohan *et al.*, 2009), millions of observations lie buried within the ship logbooks and diaries of early European voyages, written decades before official meteorological stations were established. Recovering these weather measurements provides us with an opportunity to improve the quality of our historical climate record further back in time.

Researchers from the University of Melbourne recently stumbled upon a culturally priceless ship's logbook containing the weather conditions experienced during the British First Fleet's voyage to Botany Bay in 1787–1788 (Figure 1). The logbook charts the journey taken by the 11 ships which set sail from Portsmouth, England on 13 May 1787 bound for a virtually unknown shore half a world away. After an eight-month journey riddled with death and disease, the fleet arrived in Botany Bay on 19 January 1788 to develop the first British colony in Australia. The shipping of convicts to Australia was the largest single migration the world had seen at the time (Hill, 2008).

Aboard the First Fleet's flagship *HMS Sirius* was a young marine, William Bradley, who kept a daily logbook of weather observations including temperature, barometric pressure and winds (Figure 2). We have compared each eighteenth-century temperature and pressure reading against a modern climatology for each day's position, given by the ship's latitude and longitude, throughout the eight-month journey (Figure 3). Comparisons with accounts written by diarists on board provide a fascinating insight into the conditions faced by the British as they sailed towards an isolated outpost in the Southern Ocean.

An epic journey begins

The course of the First Fleet voyage from England to Australia reflects the knowledge of winds and ocean currents by mariners in the eighteenth century (most of the detail in this section is taken from Kington (1997) and Hill (2008)). Voyages were planned taking into account major atmospheric and oceanic circulation systems and stops at established supply ports along the way. According to Kington, the fleet left British waters in the boreal spring of 1787 to take advantage of the annual decline in the westerlies around late April to early June.

On leaving the English Channel, the ships sailed south past Spain and northwest Africa into the latitudes of the northeast trade winds and the Canary Current. After refreshing at Tenerife in the Canary Islands in June 1787, the fleet entered the Doldrums in the Atlantic Narrows. After it crossed the Equator in serene conditions, the weather became hot and humid as the fleet encountered some squally tropical weather that led to a woman convict being crushed to death and one man from the *Sirius* being thrown overboard and drowned. Figure 4 shows the typically warm equatorial air the crews must have sweated through coming from a cool English climate. Once through this zone of light and variable winds, the ships progressed south and southwest in the Brazil

Figure 1. The original copy of William Bradley's journal, titled A voyage to New South Wales, December 1786–May 1792, *held at the State Library of New South Wales in Sydney. (Reproduced with permission from the State Library of New South Wales, Australia.)*

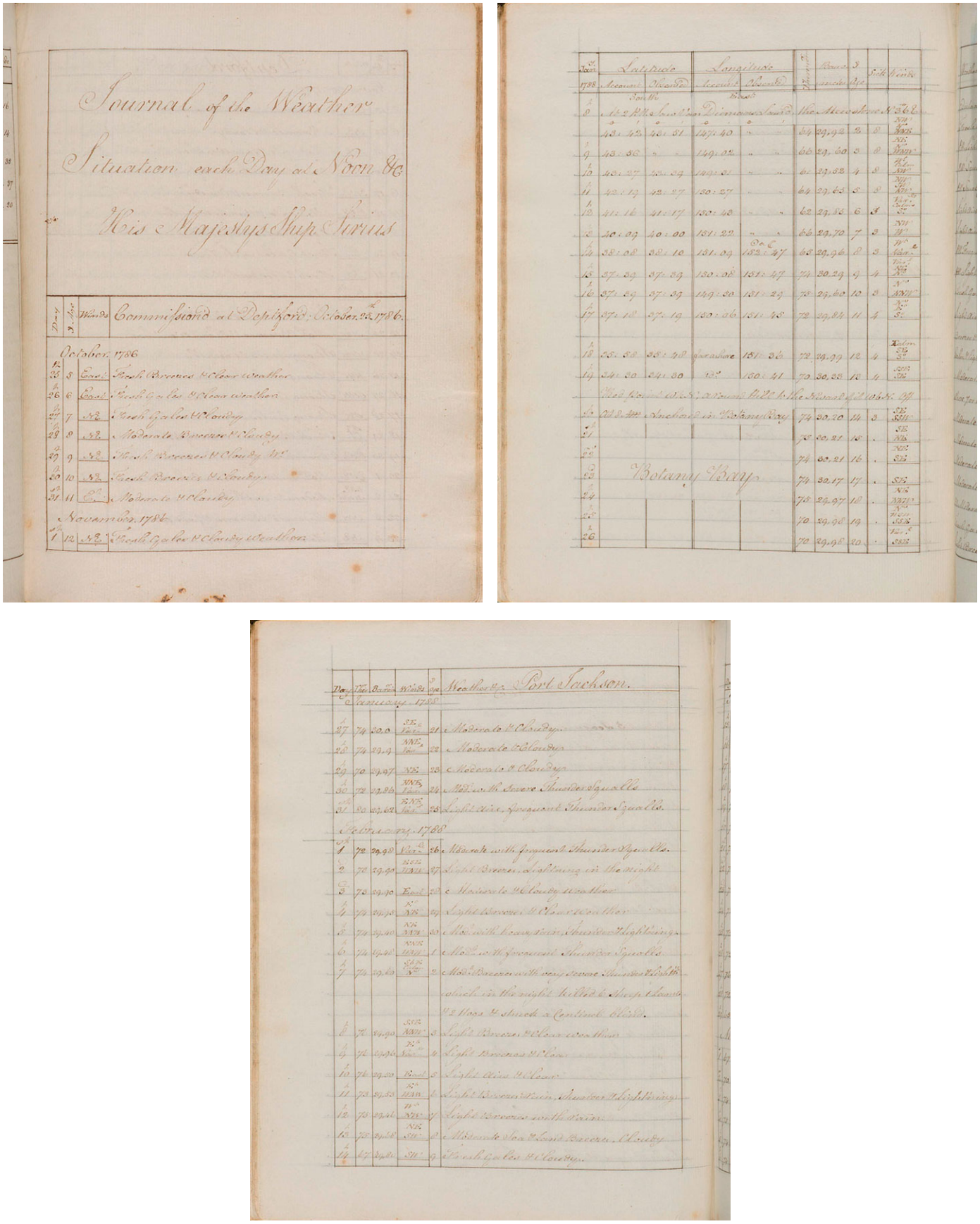

Figure 2. Pages from one of Australia's first meteorological records kept by William Bradley aboard HMS Sirius, *January 1788, in his journal titled* A voyage to New South Wales, December 1786–May 1792. *(Reproduced with permission from the State Library of New South Wales, Australia.)*

Current and southeast trade winds to Rio de Janeiro where they anchored in August 1787.

After replenishing its supplies in Rio de Janeiro, the fleet hitched a ride on the westerlies south towards the Cape of Good Hope, South Africa. It took more than five weeks for the fleet to complete the crossing from Rio to the Cape. Land was sighted early on the morning of 13 October, and by dark all 11 ships were anchored in Table Bay. They stayed at the Cape for a month, preparing for the final and longest leg of the voyage to Botany Bay, which they began on 13 November

Figure 3. Route taken by HMS Sirius, *the flagship of the British First Fleet, 13 May 1787–26 January 1788. The voyage from England to Australia took 252 days, covering over 24 000 kilometres. The red points are (predominately) recorded at daily intervals, so as well as showing the route of the fleet, the separation between each point gives an indication of the speed of travel. The fast sailing in the Roaring Forties and slow progress in the Doldrums are both clear.*

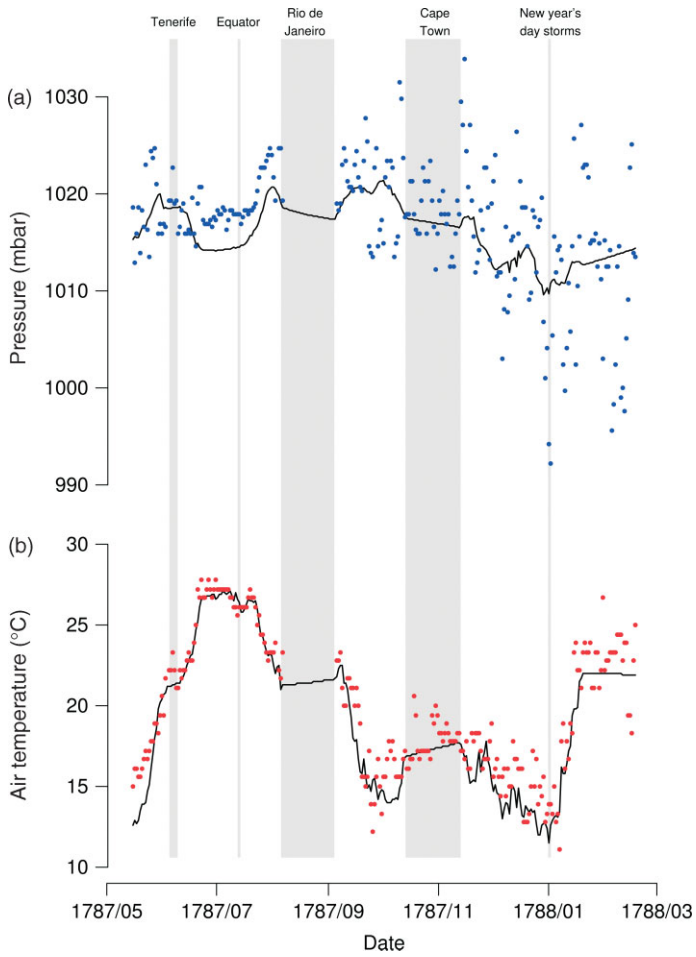

Figure 4. Bradley's pressure (a) and temperature (b) measurements compared with the values expected based on modern (1961–1990) climatologies (HadDAT2 and HadSLP2). As well as identifying periods of extreme weather (e.g. the storms of New Year's Day 1788), Bradley's observations track the expected climatological variations (e.g. the transitions between the subtropical high and the equatorial low), showing that these observations from over 200 years ago are good enough for useful comparison with modern observations. However, such comparisons must be done with care: the limitations of early instrument and non-standard observing practices will introduce some biases into the observed temperatures and pressures. These observations have not been adjusted to remove such biases.

sailing into the westerly winds and tremendous swell of the Southern Ocean. The voyage from Cape Town to Botany Bay took about eight weeks. The fleet left Cape Town in quiet conditions before the weather turned stormy with vessels being blown off course sailing in the Roaring Forties.

The treacherous Roaring Forties

The most evocative passages found in a number of journals kept by the ships' crews were recorded as ferocious weather battered the First Fleet as it made its way through the Roaring Forties in the Southern Ocean between November and December 1787. Although strong westerly winds were favourable for sailing, conditions on the overcrowded ships were miserable. Aboard the *HMS Supply*, Lieutenant Philip Gidley King described the violent summer storms experienced across the vast stretch of ocean between Africa and Australia in 1787: *Very strong gales…with a very heavy sea running which keeps this vessel almost constantly under water and renders the situation of everyone on board her, truly uncomfortable* (Hunter, 1793). Unable to go on deck in the rough seas, the convicts remained cold and wet in the cramped hulls.

As Christmas of 1787 approached, Lieutenant Gidley King noticed the surprisingly chilly conditions: *The cold is in the extreme here as in England at this time of year, although it is the height of summer here* (Hunter, 1793). A close inspection of Figure 4 shows that, indeed, the temperatures were probably the lowest they experienced since leaving England. Aboard the *Sirius*, the crew tried to celebrate Christmas in *mountains high* seas, to no avail (Hill, 2008). Bradley's barometer measurements indicate clearly the storms that struck at the turn of the year (Figure 4). On New Year's Day 1788, Arthur Bowes Smyth (1979) described how the sea poured into his cabin:

> *Just as we had dined, a most tremendous sea broke in at the weather scuttle of the great cabin and ran with a great stream all across the cabin, and as the door of my cabin not to be quite closed shut the water half filled it, the sheets and the blankets being all on a flow. The water ran from the quarterdeck nearly into the great cabin, and struck against the main and missen chains with such a force as at first alarmed us all greatly, but particularly me, as I believed [the] ship was drove in pieces. No sleep this night.*

In a letter to his father, crew member Newton Fowell described the terrible weather that greeted the new year: *This year began with very bad tempestuous weather, it blew much harder than any wind we have had since our leaving England* (Irvine, 1988). As the violent weather continued, the First Fleet was forced to slow down to prevent the ships' sails from tearing. Earlier in December, the *Prince of Wales* had already lost its topsail and a man overboard in what a sailor on the *Scarborough* described as *the heaviest sea as ever I saw* (Hill, 2008). Captain of *HMS Sirius,* John Hunter (1793) described how the rough seas made life very difficult for the animals on board:

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The rolling and labouring of our ship exceedingly distressed the cattle, which were now in a very weak state, and the great quantities of water which we shipped during the gale, very much aggravated their distress. The poor animals were frequently thrown with much violence off their legs and exceedingly bruised by their falls.

On their knees at prayers

It was not until the first week of January 1788 that the majority of the First Fleet sailed past the southeast corner of Van Diemen's Land (Tasmania). They ran into a violent thunderstorm squall as they sailed along the Tasmanian coast (Figure 5), and were surprised to see small patches of snow at the height of summer as they passed the coastline. Newton Fowell (Irvine, 1988) describes how they began the thousand-kilometre struggle north up the coast of New South Wales to Botany Bay against a strong headwind and the East Australian current:

The wind variable and weather dark and gloomy, with a very troublesome high sea. About two o'clock p.m. we had one of the most sudden gusts of wind I ever remember to have known. In an instant it split our main-sail; and but for the activity shewn by the sailors, in letting fly the sheets and lowering the top-sails, the masts must have gone over the side. The Prince of Wales, *who was close to us, had her main yard carried away in the slings. Fortunately for us the squall was of short duration, otherwise the ships must have suffered considerably from the uncommon cross sea that was running; which we had found to be the case ever since we reached this coast.*

Faced with a *greater swell than at any other period during the voyage* many of the ships were damaged, as were seedlings needed to supply the new colony with food. Figure 4 shows the low pressure associated with a severe storm centred on 10 January 1788. Arthur Bowes Smyth (1979) describes the conditions experienced on the day in his diary:

The sky blackened, the wind arose and in half an hour more it blew a perfect hurricane, accompanied with thunder, lightening and rain…I never before saw a sea in such a rage, it was all over as white as snow…every other ship in the fleet except the Sirius sustained some damage…during the storm the convict women in our ship were so terrified that most of them were down on their knees at prayers.

Then finally, after eight endless months at sea, on 19 January 1788 the last ships of the First Fleet arrived in Botany Bay. After just three days there, Governor Arthur Phillip realised that the site was unfit for settlement.

Figure 5. HMS Sirius *weathering a storm near Tasman's Head, Tasmania, by George Raper, 1791. (Reproduced with permission from the State Library of New South Wales, Australia.)*

It had poor soil, insufficient fresh water and was exposed to the strong southerly and easterly winds. With all the cargo and 1400 starving convicts still anchored in Botany Bay, Arthur Phillip and a small party quickly set off to find an alternative place to settle (Hill, 2008).

Twelve kilometres to the north they found Port Jackson (modern-day Sydney Harbour), which James Cook had observed, but never visited, during his voyage to New South Wales some 18 years earlier. They found it a much better anchorage, according to Surgeon White, Port Jackson was *without exception, the finest and most extensive harbour in the universe* (Hill, 2008), and on the second day of their exploration of it Governor Phillip and his party discovered a sheltered bay within Port Jackson with a fresh water stream. They decided it was here, not Botany Bay, that would be their new home. They named the bay, where the Harbour Bridge and Opera House are today, 'Sydney Cove' after Lord Sydney, the Home Secretary of England at that time.

On 23 January 1788, Phillip and his party returned to Botany Bay and gave orders for the entire fleet to set sail immediately for Port Jackson. But on the morning of 24 January strong headwinds were blowing, preventing the ships from leaving the harbour. On 25 January, Lieutenant Philip Gidley King, a naval officer on the *Supply*, writes: *The wind blowing strong from the NNE prevented…our getting out…[o]n the 25th…we were obliged…to wait for the ebb tide and at noon we weighed and turned out of the harbour* (Hunter, 1793). In the meantime the rest of the fleet was still trying to sail out of Botany Bay as: *The wind continued to blow strong all this day…in the evening there was a good deal of thunder and lightening* (Hunter, 1793). The low barometric pressure readings recorded in the ship logbook between 24 and 26 January 1788 (Figure 2) are also seen on the far right in Figure 4.

As Surgeon Worgan writes: *Friday 25th…the wind coming to blow hard, right in to the bay, the Sirius and the transports could not possibly get out* (Worgan, 1978). A huge sea rolling into the bay continued to buffet the ships causing ripped sails and a lost boom as the ships were blown dangerously close to the rocky coastline. According to Lieutenant Ralph Clark:

If it had not been by the greatest good luck, we should have been both on the shore on the rocks, and the ships must most have been all lost, and the greater part, if not the whole on board drowned, for we should have gone to pieces in less than half of an hour (Clark, 1981).

Finally, as Bowes Smyth (1979) describes it, it was: *With the utmost difficulty and danger with many hairbredth escapes got out of the harbour's mouth…it was next to a miracle that some of the ships were not lost, the danger was so very great*. By 3 o'clock on 26 January 1788 all the ships of the First Fleet had safely arrived in Port Jackson. Meanwhile, earlier that morning while waiting for the others to arrive, Governor Phillip and a small party from the *Supply* had rowed ashore and planted a Union Jack at their landing place, marking the beginning of European settlement in Australia. After what had been one of the great sea voyages of British naval history, the ordeal was washed away with a swig of rum (Hill, 2008).

Salvaging sunken treasure

It is remarkable that culturally significant materials describing the weather conditions that influenced the historic journey of the first European settlement of Australia are only being recovered in these early years of the twenty-first century. As very few instrumental weather observations have survived from 1787, Bradley's measurements provide a unique insight into eighteenth-century weather, especially from the Southern

Hemisphere. With increasing concern about climatic change, variability and extremes, there is a growing demand for reliable, high-quality instrumental observations of past weather conditions. Although a single record covering a relatively short period of time is insufficient for assessing absolute changes in past weather and climate variability, such records are important for providing information of relative variability from a period where limited data are currently available. The recovery of early weather data, especially in regions of the Southern Hemisphere, is essential for building the database available for describing the global climate system during pre-twentieth-century times. This paper is illustrative of one of a growing number of historical marine voyages, expeditions and surveys from which instrumental weather observations are being recovered, digitised, quality controlled and brought into major climate databases under coordinated international activities.

To make full use of recovered early weather data, we need to archive it in standard format, so it is readily available for scientific use and preserved for future analyses. For marine data like the First Fleet observations, this means including it in the International Comprehensive Ocean–Atmosphere DataSet (ICOADS) (Worley *et al.*, 2005; Woodruff *et al.*, 2010). Visualisations of the data, showing comparisons of the observed weather changes in space and time, with present-day values, are also invaluable in identifying and understanding changes in climate. Google Earth is a powerful tool for making such comparisons, and a Google Earth visualisation of the First Fleet data, along with the observations in the standard ICOADS format, can be obtained from the website http://www.oldweather.org/examples/the-first-fleet.

To better understand climate variability, large amounts of historical observational data have been collected by researchers all over the world. Even so, equally large sources of valuable climate data remain untapped. In fact, there are considerable terrestrial and marine data around the world that are still in hard copy form and have not been digitised and stored in international climate data banks (Page *et al.*, 2004; Brohan *et al.*, 2009). Many countries, particularly in the developing world, are not aware of the extent of colonial observations made in their territories or do not have the finances, personnel or infrastructure to digitise data.

In an attempt to address this issue, and to use the data being recovered to reconstruct global historical weather conditions, an international 'data rescue' initiative, Atmospheric Circulation Reconstructions over the Earth (ACRE), is now underway (http://www.met-acre.org/). ACRE aims to provide historical daily and sub-daily (sometimes hourly) terrestrial and marine observations (Brohan *et al.*, 2009) for a series of pioneering surface data reanalyses covering the past 250 years (Compo *et al.*, 2006). The weather products produced by these reanalyses can then be used for myriad purposes including climate research, applications, impacts, and risk models, serving communities of researchers, educators, students and the general public.

In 2002, the Australian Bureau of Meteorology completed the Computerising the Australian Climate Archive (CLIMARC) project, which digitised historical daily and hourly climate data for 64 sites at 51 key climate locations across Australia (Page *et al.*, 2004).Yet despite this major effort, copious amounts of early Australian weather data are yet to be digitised and archived.

To help address this research gap, researchers at the University of Melbourne are using early Australian instrumental data, colonial documentary records and paleoclimatic records to compile a record of climate conditions since the first European settlement of Australia in 1788 (www.climatehistory.com.au). In doing so, we can better understand climate variability in a key location of the Southern Hemisphere, while shedding light on the culturally significant period of Australia's first European settlement. Given the large number of extreme climate events Australia has recently been experiencing, further research in this area will provide timely context for understanding recent climate variability in the Australian region.

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