Deliberate Confusions

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Climate's very complexities have been manna from heaven for climate change deniers. Reports of global atmospheric warming, the increasing of carbon dioxide in the atmosphere and record after record tumbling on continent after continent have met with a common refrain from the international chorus of deniers – 'the climate has always changed'. But this is a deliberate confusion. It is myth number one on the *Skeptical Science* web site, expressed in the phlegmatic claim 'the climate has changed before'.[1] It is a staple of climate change denial. The issue, however, is not change versus stasis; it relates instead to magnitude, rates of change and tipping points. Nevertheless, this spurious assertion has been effective in confusing the issue of anthropogenic global warming, at least in Australia. While a clear majority there understand that human activity causes global warming, this confusion has weakened the impetus for change and provided an alibi for business as usual from government and many (though not all) in the corporate and industrial sectors.[2] Confusion has, for the time being, defused this issue. This is partly because many people know little about the intricacies of climate but know vaguely about climate change on geological time scales. More importantly, as Chapter Three of Mike Hulme's *Why We Disagree about Climate Change* explains, the broader public both understands that disagreement is integral to science yet it does not grasp the robustness of the methods, data quality, and conclusions underlying scientific consensus.[3] So, claims by deniers fall into this template of claim and counterclaim, which is widely seen as scientific debate. To some consensus looks more political than scientific.

This paper considers another crucial set of factors that has enabled these ideas to make sense in Australasia at this historical moment. Until recently, the inherent variability of Australasia's climate has been invisible in the formal scientific study of weather and climate. Yet such variability is an experiential hallmark of life throughout Australasia. One only has to live for several years in any part of Australia to experience seasons so different from one year to the next that they impress themselves on people's memories. Usually tied to the drought/flood cycles of the El Niño Southern Oscillation (ENSO), this variability affects communities, regions and usually leaves visible marks on the economy of the entire Commonwealth of Australia. This variability creates individual memories; it shapes collective memories and spurs art, literature, and myth.

Poems such as Dorothea Mackellar's *My Country* (1908) and paintings like W.C. Piguenit's *Flood on the Darling 1890* (1895) long resonated with lived experience in a manner that science tried for so long to do but could not. Farmers across Australia also understood this quirk of the continent's climates. Only in 1969, when Jacob Bjerknes began to elucidate the interactions between sea and sky across the Pacific and Australasia, did it become possible to conceive of a rigorous, scientifically valid mechanism to explain what people across Australasia experienced. These ideas did not permeate to the broader public until long after the lethal 1982/83 El Niño and its monumental droughts and fires in south-eastern Australia. Both the concepts and the physical dynamics sparked intense interest among Australian climatologists, but as Australian environmental historian Don Garden has frankly noted, even he did not grasp the significance of ENSO until the mid-1990s.[4] Knowledge about ENSO has slowly spread to the broader population since then. Indeed, Garden's 2009 opus would have illuminated many still grappling with this complex atmospheric and oceanic flux.

Variability has come back into sight with anthropogenic global warming. Studying aspects of the Dutch colonial encounter with the atmosphere above Indonesia and British efforts at deciphering atmospheric fluxes above northern Australia, this paper sketches how variability became invisible. After discussing implications of the 'rediscovery of variability' and its ready, deliberate confusing with global warming, I will outline how a thorough understanding of historic variability will help signpost a greater variety of consequences of climate change. Far from confusing the issue, variability, at least in Australasia, can clarify.

Seasons and Climates of Northern Australia

A startling reality about northern Australia is that people in any locale experience common weather, but two climates and two seasonal regimes. In the tens of thousands of years that Aboriginal people have lived on, tended to and made home the vast lands of tropical Australia, they have developed elaborate concepts of climate and seasons. They link constellations of events on the land, in the skies and, where appropriate, in the waters. These ideas are comprehensive, nuanced and linked to particular places. In Indigenous cosmologies north Australia has a multitude of climates and seasonal patterns. Through extensive field work in the 1980s cultural anthropologist Deborah Bird Rose gleaned that rain is the kernel of Yarralin concepts about season and climate. *Yipu* is the generic term for rain among the Yarralin people of the Victoria River district of Australia's Northern Territory. Living in what western science classifies as a monsoonal climate, about 100 kilometres from the coast, they use a set of words to distinguish phenomena related to common kinds of rain in the region: hot weather rain, cold weather rain, the first rain after extended periods of heat, even the smell of the first rains.[5] In Indigenous cosmologies seasons are linked to ecological happenings, not the calendar. The Yarralin can reliably predict therefore when crocodiles will start to lay eggs, and associated weather, not from the time of year, but from observing the arrival of March flies.[6]

Where rain is at the centre of Yarralin notions of season, the Gidjingarli, along the middle of Australia's northern coastline, define the seasons according to their dominant winds.[7] Geographer Stephen Davis has identified that Aboriginal people in far northern Australia typically recognise six major seasons each year. But the particular concepts of each season vary from one locale to another. Gupapuyngu speakers among the Yolngu, live along the coast of north eastern parts of the Northern Territory in and around

Milingimbi. They classify their six seasons as: *Dhuludur*, the pre-wet season; *Barra mirri*, the growth season; *Mayaltha*, the flowering season; *Midawarr*, the fruiting season; *Dharratharramirri*, the early dry and birth time of sharks and sting rays; and *Rarraandharr*, the main dry season.[8] Living across Bathurst and Melville Islands, ranging from 400 to 600 kilometres west of Milingimbi, the Tiwi experience a very similar climate and also recognise six annual seasons. Their seasons however comprise three different seasons of *Jamutakari*, identified by the predominant type of rain of each season; two seasons of *Yirriwinari*, one a part of the dry where cold weather and morning fog frequently recur, the other when large-scale burning is undertaken; and *Tiyari*, when humidity builds and thunderstorms begin.[9]

Perhaps the most accessible account of Indigenous Australian seasons for northern hemisphere readers appears in Ben Orlove's chapter 'How People Name Seasons', in his 2003 collection edited with Sarah Strauss, *Weather, Climate, Culture.* Two things strike the reader from his account of the six seasons reckoned by speakers of Gundjeihmi, in the western part of coastal Arnhem Land. First, the seasons are not of equal duration. Second, seasons are a recurrence of particular sequences in which constellations of certain kinds of weather and related ecological phenomena occur.[10] This account, however, evinces a widespread problem in Western discussion of Indigenous seasons and the calendars they relate to. Each of the seasons is drawn as coming at the same time each year, going at the same time each year and so always being of the same duration. Yet indigenous concepts of season allow for differing times of arrival and departure, some also include periods of transition between seasons. In their critique of Western-produced Indigenous seasonal calendars, linguists Robert Hoogenraad and George Jampijinpa Robinson observed that these calendars of Aboriginal knowledge typically, and erroneously, used the European month as an organising framework. These charts therefore risk forcing one system of knowledge into the parameters of another system – in this case traditional Aboriginal knowledge into European conceptualisations of time, season, and climate.[11] That this has happened so commonly attests to the ontological force of western notions of season and weather linked to precise calendrical time and in particular, the calendar month.[12]

When the British invaded north Australia in the nineteenth century, they imported their clockwork climate. Simply put, this is an understanding linked to calendrical time and bound up in millennia-old Western European ideas of nature as regular and orderly. Although there is ever-increasing documentation of the British learning much about the land from Aboriginal people,[13] there is no evidence of Indigenous concepts or knowledge shaping European ideas about weather and climate in Australia. Even if small groups of newcomers are, in the future, found to have taken on Indigenous knowledge, this did not shape broader, authoritative, scientific understandings. Across northern Australia the parallel epistemologies of Indigenous knowledge and the European clockwork-climate have existed in parallel since Europe washed up on its shores.

This clockwork-climate is the Wet/Dry dichotomy that typifies tropical regions in western knowledge. Darwin-based weather observer *par excellence* J.A.G. Little encapsulated this when he described (many times) the region's climate as rhythmic such that 'the changes of these seasons are so uniform that they may be predicted to almost a day'.[14] Little's quote not only featured in contemporaneous guides to the Northern Territory at the turn of the twentieth century, but also by distinguished geographer

Griffith Taylor in his authoritative work of 1918, *The Australian Environment (Especially as Controlled by Rainfall)*. This idea of a wet/dry seasonal dyad regularly 'flipping' in tropical Australia has a long pedigree dating to the late seventeenth century and Edmund Halley in British thinking. This concept was reinforced by William Dampier's *Discourse on Winds*, which from 1699 accompanied the widely read narrative of his explorations – *A New Voyage around the World*. Outlining the winds of the Indian Ocean tropics, Dampier gives a strong sense of a mechanical regularity when he notes that:

> All shift in the shifting seasons, which are April and September, at one and the same time and to their opposite points…these shifting winds in the East Indies are called monsoons; one is called the East-Monsoon, the other the West-Monsoon.[15]

This understanding pervaded eighteenth-and nineteenth-century British sailors' guides and nautical manuals.[16] Descriptions of the climate of Darwin and its hinterland in almanacs commonly identified the turning from wet to dry as March 31 and the reverse as October 1. During the early decades of the twentieth century, April 30 and November 1 were more frequently identified as the dates the seasons flipped. This may well be an implicit acknowledgement of the region's temporal variability, yet scientists, officials, and many European newcomers clung to the idea of a timely clockwork-climate, that seasons switched on a particular date.

Seasons and Climates of the Maritime Continent

For the Indonesian Maritime Continent, the difference between Indigenous and non-Indigenous knowledge is a little less stark. This is not to dispute that there is a wealth of place-based Indigenous knowledge across this archipelago of nearly twenty thousand islands. But many Indonesian coastal locales traded with each other, as well as Arab and Chinese mariners long before the Portuguese arrived. Some 250 language groups have been identified throughout the archipelago; Malay was adopted as a lingua franca around 1400. We would be remiss not to allow for exchanges and modifications of knowledge. With this rich history of encounters it is difficult to untangle long held indigenous understandings of people of a particular locale from those influenced by Arab, Chinese or indeed indigenous seafarers from other parts of the archipelago. Certainly, a trove of knowledge greeted the Portuguese in the early 1500s. By the time the Dutch and, to a much lesser extent, the English came, the Dutch already had detailed knowledge of the maritime routes and the weather and climate of the Maritime Continent.

John Huyghen van Linschoten was an official in Portuguese Goa for five years in the late sixteenth century. Today, he seems somewhat like a late Renaissance/Early Modern Edward Snowden or Bradley Manning. Early European traders and later, the English and Dutch East India Companies, meticulously recorded details of ocean and weather conditions during their voyages. To best their competitors they jealously guarded the data they amassed - it was secret. This information could only be accessed by those who could use it to the financial betterment of the organisation that had accrued these archives. Even by the 1590s, a decade or so before the formation of the English and Dutch East India Companies, the Portuguese had acquired invaluable knowledge about wind and seasonal patterns across the Indian Ocean and the waters embracing the archipelago we now know as Indonesia.

Over the century since Da Gama's voyage, Portuguese had learned much about the monsoons on an oceanic scale. Before Arab pilots guided da Gama across the Indian Ocean, rather than around its shores, European knowledge of the winds and seasons was confined to the Indian Ocean littoral. The Portuguese traded out of Malacca (on the west coast of the Malay Peninsula) from 1511, and Ambon and Ternate during the following decade. During the 1550s the Portuguese presence on Timor, just a few hundred kilometres from present day Darwin, became decisive. Steadily and very quietly, van Linschoten copied many of the charts the Portuguese had drawn based on decades of voyages. He also took copious notes about the different sailing routes. Back in Holland he began publishing the four parts of his then famous, if now forgotten, *Itinerario* in 1595. Successive Dutch editions were published in 1596, 1604, 1614, 1623 and 1644; the first English translation came in 1598, and there were multiple translations into French and Latin.[17] The secrets were well and truly out. With this knowledge, the Dutch bypassed Goa and the contingencies of the monsoons; they went to Malacca or Java instead, taking advantage of more consistent wind regimes.

Itinerario transmitted Portuguese knowledge of Indian Ocean climate and seasons – along its shores and over its waters. This became Dutch and European knowledge. Indeed, a fascinating question arises as to just how much this was to influence Halley's thinking. Shaped by the needs of maritime travel and trade, *Itinerario* and its content likely provided a framework within which subsequent experience and knowledge has been interpreted – one in which seasons are seen as regular and operating to time. Let me cite one example of this knowledge. Outlining trade between the Mozambique and India, Van Linschoten remarks:

> They sayle from thence to India but once every year in the month of August till half September, because that throughout (the whole countries of India) they must sail with the Monssoyns, that is with the tides of the year, which they name by the windes, which blow certain months in the yeare, whereby they make their account to goe and come from the one place to the other, and the time that men commonly sayle between Mossambique and India is 30 days, little more or less, and then they stay in India till the month of April when the winde or Monssoyne commeth again for Mossambique.[18]

This is a climate working to time. At this point, 'India' included what we now call Indonesia and so the reference to sailing with Monssoyns throughout the countries of India might be among the earliest references of this idea of climate for the Maritime Continent.

John Splinter Stavorinus held the same idea of climate and seasons for the Indonesian Archipelago on the cusp of the nineteenth century. Stavorinus' characterisation of the seasons there is conceptually identical. Given the nearly 200 years' experience the Dutch had accumulated throughout the Maritime Continent; given the volumes of data and personal accounts that had circulated back to the Netherlands, it is not unreasonable to consider that Stavorinus reflected prevailing Dutch thinking, as well as his own experiences. References to monsoons, good monsoons, bad monsoons, and departures timed for particular monsoons, abound in his 1798 opus *Voyages to the East Indies*. British sailors' guides of the time (Capper, Horsburg etc.) draw on the same lexicon and evince an identical conceptual repertoire. In a piece that captures both general and local Dutch knowledge he states about the Southern Celebes that:

> The seasons, known here, as throughout the east, by the denomination of monsoons are the same as at Java; the southeast monsoon being called the good and the northwest the bad one, the first always brings (at least in the country west of the mountain range) a clear sky and dry weather; the last is accompanied with violent winds and continual heavy rain; but to the eastward of the ridge, the exact contrary takes place … so that the different seasons of summer and winter are felt, at the same time, at no more than eight Dutch miles distant from each other.[19]

Dutch and indeed, European knowledge was extensive. During the eighteenth century intricate interactions between land, sea, and sky came to be understood across vast swathes of Indonesia's seas and coasts. Place came to matter. Expectation was not based upon latitude, as would be the case for Australia for at least a century. We see this in Stavorinus' discussion of Amboyna. Latitude would decree a climate and seasonal regime identical to that of Java. Topography, however, has bequeathed monsoons that 'are exactly contrary here, to what they are along the islands of Java, Borneo, Bali, Lombok, Sumbawa, the west coast of the Celebes'.[20] An interesting set of questions for future investigation arises: did the Dutch discover this themselves? Did this come from the Portuguese? Did Europeans learn this from Indigenous mariners of the region? Certainly the Dutch had experienced the climate long enough to discern these patterns. But this does not preclude knowledge exchange with other mariners across the archipelago.

This idea of a climate with two timely annual seasons is very tidy, perhaps a little too tidy. Even the locales recognised as different are a mirror of what predominates throughout the region. Conceptually though, these understandings of climate are identical – the same framework, the same parameters, the same elements, the same inextricable link to the western calendar. This was not just the Dutch, or the British or the Portuguese notion of the Maritime Continent's climate. This was the European idea of climate and seasons in the tropics. Symmetry, opposites, dualities, binaries; all of these suggest deep, potent cultural influences so taken for granted that they scarcely visible.

Colonial Weather Watching

Fortunately, we can test the concept against data. Modern, quality controlled meteorological data was routinely gathered at both Batavia (Jakarta) and Darwin from the 1860s. Meteorology was a high priority for the colonial invaders of Australia. Indeed, as Richard Grove has shown, this was the case throughout India, the Caribbean, and the entire 'colonial periphery'.[21] The first observatory in Sydney was established by the first of the British colonisers in 1788, just two years after the English East India Company established the observatory at Madras (Chennai). A number of observatories were established and disbanded in Sydney and other Australian colonies, but by the late 1850s observatories had been permanently established in Sydney, Melbourne and Adelaide. Darwin's observatory began systematic weather watching in March 1869. Operating to British practices, with reliable equipment they set about casting a net of observatories, strung together by telegraph wire, across as much of the continent as possible. Until Federation in 1901, 'Australia' was a collection of separate British colonies. Until Australia's Commonwealth Bureau of Meteorology was established in 1908, each colony (later, state) had its own network of weather and astronomical observatories. This is not to say that standards changed at colonial and state borders and that data from one jurisdiction was incompatible with that from others. During three vital meetings between 1879 and 1888 the heads of Australia's major colonial observatories set down common standards and practices for the observation of weather, the reliable measurement of weather elements, and the organisation and analysis of data. Much of this was settled at the First Intercolonial Meteorological Conference in 1879.[22] Participants also agreed to systematic and regular sharing of weather data. The establishment of international standards for observing and recording weather in 1876 no doubt aided standardisation across the Australian continent and ensured that Australia's then fledgling observatories operated to international, scientific standards.

From 1863 till 1911 the Northern Territory was administered by South Australia. Under the assiduous command of Charles Todd of Adelaide Observatory, Darwin was linked to both southern Australia and Java by 1871. Todd was both head of the observatory as well the body that created, maintained, and extended its network: Post and Telegraphs. It was these telegraphic lines between southern Australia and Java that tied Darwin in place. As these networks were being created for local knowledge and the colonial purposes of mastering new lands, interest among European scientists about larger regional, even global tropical dynamics also grew - an interest that cut across empires.

With the establishment of observatories in Australia and on the Indian subcontinent no less a man of science than Alexander von Humboldt had written to the government of Netherlands India in 1856 urging the establishment of an observatory at Batavia to 'promote our knowledge of the meteorological phenomena between the tropics' and its use in conjunction with the meteorological and magnetic observatories of British India and Australia.[23] Records began there in 1864. According to the Badan Meteorologi, Klimatologi dan Geofisika (BMKG) – In donesia's chief agency for the observation and study of weather and climate – Batavia's observatory was not the locus of Java's first systematic weather observations. These began in 1841, when the chief of Bogor Hospital started his weather observations there.[24] By 1878 there were 55 stations recording rain on Java, 22 on Sumatra, 2 on Bangka, 8 on Borneo, 4 on Celebes, 4 on Amboyna, 1 on Banda and 1 on Ternate.[25] As a first grade observatory, Batavia recorded rainfall, wind, temperature, humidity, atmospheric pressure, atmospheric tension, magnetic readings, and lunar observations at every hour of the day. Observations were recorded accordingly. In Darwin observations were taken and recorded at three hourly intervals.

This region was the locus of the one apparent nineteenth-century challenge to the concept of the clockwork climate ticking to the calendar year: the cyclical climate. Interest in this partly explains the assiduous interest in regular systematic weather observation throughout Australasia and India. So too does an interest in trans-colonial atmospheric dynamics. Both are an important aspect of the proliferation of observatories there during the mid- and late nineteenth century. When Swiss astronomer Rudolf Wolf identified an eleven-year sunspot cycle in 1852, climatic cycles appeared to have gained an explanatory mechanism. At the same time, William Stanley Jevons recognised and wrote explicitly of Australia's many variable climates.[26] By the 1870s numerous British scientists proposed links between sunspot cycles, the frequency of Indian Ocean tropical cyclones, the scale and intensity of the Indian summer monsoon, and cycles of drought and flood. By then Jevons was arguing that sunspot activity not only shaped Indian and Chinese agriculture, but also powered the global business cycle.[27] According to his logic, sunspots not only drove cycles of drought, famine, and flood – they also accounted for fluctuations in the global economy. In Australia, colonial meteorologists such as Charles Egeson and H.C. Russell recognised climate variability and proposed various astronomically-driven weather cycles.[28] On reflection, this was more a modification of the idea of the clockwork climate than a direct challenge to it. The cycles they proposed were exact. Although these concepts of cycle undermined the understanding of weather repeating very similar patterns, year after year, the cycles, conceptually, still posited a distinct regularity the weather and climate. They were orderly. They allowed for prediction. They ultimately even allowed for the distant possibility of control.

Decades earlier, weather watchers had actually observed synchronicity in weather cycles across different parts of the globe. Richard Grove has shown that by the 1810s, awareness had developed of simultaneous drought in India, the Caribbean, and the then embryonic colony of Sydney in 1791.[29] Curiosity about a possible mechanism emerged. Following the 1877-79 drought in India, the Director of the newly established Indian Meteorological Office (IMO), Henry Blanford became interested in the possibility of simultaneous, anomalous weather elsewhere. Charles Todd was among the meteorologists who responded to Blandford's request for weather data, especially barometric pressure observations. Again drought in India and drought in Australia had happened at the same time. As Mike Davis demonstrated in *Late Victorian Holocausts*, this drought was far more widespread and global drought happened again in the late 1880s and between 1896 and 1903.[30] Todd and his colleagues in NSW and Victoria – H.C. Russell and R.J. Ellery – had had concluded by 1888 that there is a climatic teleconnection between Australia and India, at least in respect to atmospheric pressure and cycles of drought and flood. Such thinking was not merely the province of science. It found a much wider audience in a very detailed and lucid discussion in the Australian press.

Often referred to, an 1888 article in the *Australasian* with Todd, Russell and Ellery is most revealing. This was a detailed delineation of their understanding of drought cycles and synchronicity with other parts of the world. Here, Australia's top three weathermen endeavoured to explain Australia's climate, its variability, and relationship to the broader region. Moreover, they were doing so to the broader public. Written during the drought of the late 1880s, all three men explained Australian drought in terms of larger, more regional, even global dynamics. Although Ellery did not discuss India, a section of his contribution dealt with 'drought cycles'.[31] Under this very heading he dismissed the idea that droughts had an identifiable periodicity, but conceded a relationship between the earth's atmosphere and sunspot activity, which is cyclical. Ellery also averred that 'heat at the equatorial regions' influenced atmospheric fluxes above Australia.[32] Russell likewise linked droughts in Australia to the failure of the monsoon over northern Australia.[33] Later he spoke of how the development of 'the meteorological system of Australasia' will help elucidate questions about drought in Australia.[34] Like Henry Blanford in India, Russell concludes that the relationship between 'a continuous high barometer' and 'very little rain' is strong in Australia.[35] Although he avowedly disputes links between drought and Wolf's 11-year sunspot cycle, Russell reiterates his own proposal of a 19-year climate cycle in Australia, first circulated in 1876. Accordingly, he implicitly acknowledges Australia's climate as inherently variable.

Todd likewise discusses the periodicity of droughts.[36] He, however, draws no firm conclusions. His contribution is distinguished by the attention he gives to the synchronicity of droughts in Australia and India – indeed one whole section of Todd's piece appears under the title 'Australian and Indian weather'. Todd's conclusion about this teleconnection is worth quoting in full:

> Comparing our records with those of India I find a close correspondence or similarity of seasons with regard to the prevalence of drought, and there can be little or no doubt that severe droughts occur as a rule simultaneously over the two countries. The most remarkable instance of this was the disastrous drought of 1876, the year of the great Indian famine. This drought, it is said, has been traced from 30 deg. south in Australia to 60 deg. north, over 90 degrees of latitude and 100 degrees of longitude.[37]

This is meteorology writ large. It goes beyond colonial borders. It far transcends the shores of the Australian continent. Todd's scope encompasses not just the broader region but much of the tropical and temperate girdles of the world. Moreover, Todd's global vision was being transmitted to the broader Australian public who otherwise would have no reason to conceive of simultaneous patterns of drought between Australia, India and far flung places such as Mauritius. Colonial meteorological networks were far from merely physical. This did not only apply to networks within the British Empire. Todd used weather data from Banjoewangie (far eastern Java) and Jakarta to place the Australian drought in context. For the former he noted that the north-west monsoon had been late in 1888, resulting in a 10 inch (250mm) deficit in rainfall for the calendar year. Similarly Jakarta's 1888 rainfall was 14 inches or 350mm below the annual average.[38] Humboldt's vision – to some extent - was being fulfilled.

Ordering Colonial Meteorology

This affords a great opportunity. With the region's seasons defined as Wet and Dry, in accordance with the different monsoons, and presence of this reliable and self-consciously systematic network, we can use rainfall data to test the concept against reality. Average rainfall figures for Darwin tell a story that fits the concept almost perfectly: annual drought, followed by linear increase to deluge, then a linear decline to drought, crossing thresholds of wet and dry in between (see Fig. 4.1). As Fig. 4.2 illustrates, data for Batavia fits this pattern, albeit not as ideally. My work on Darwin is more advanced hence the disparity of the data sets; Java research is in progress. However, this data set for Batavia is lengthy enough for the purposes of this paper. Although I am using weather data and climate statistics, my analysis is historical, rather than statistical. Moreover, this was what people interested in Indonesia's climate at the time had to think with. Unlike Darwin, Batavia does not experience annual cycles of drought. The middle of the year is drier than the rest, but rain – sometimes heavy – usually still falls.[39] Between 1864 and 1882 the mean number of rain days between July and September was under eight; for January and February, it was over 20. So these 'Dry' months would have seemed much drier, relative to 'Wet' months.

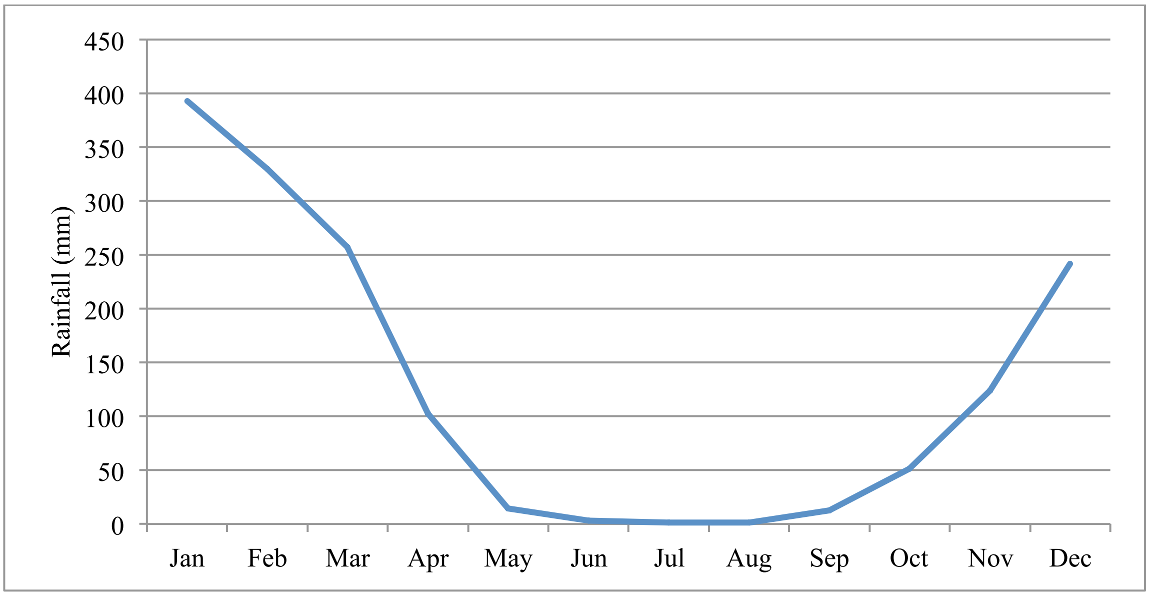

Fig. 4.1. Mean Monthly Rainfall, Darwin Post Office, 1869 – 1942.

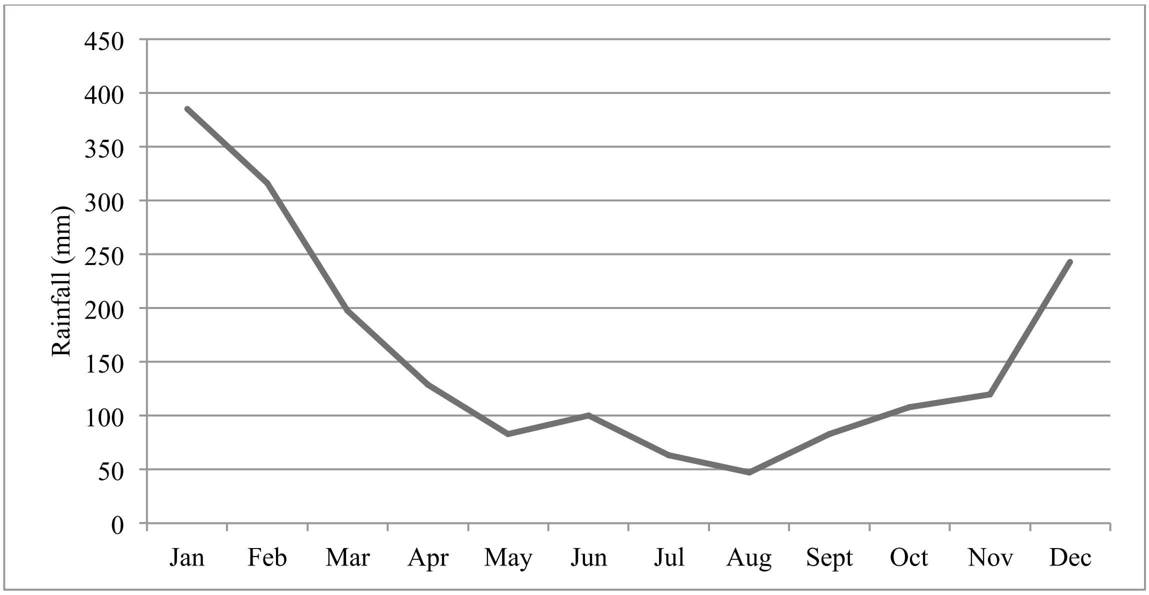

Fig. 4.2. Mean Monthly Rainfall, Batavia, 1864 – 1882.

Means, crucially, were the grammar of weather narratives at the time. This has continued in Australasia until relatively recently, and continues among quasi-scientific lay approaches to weather and climate. The average is the essential value. The organising of the Batavia data in the earliest publications of the Observatory indicates just how intently this was so. Volume VI of Batavia Observatory's observations, published in 1885, contains upwards of 180 tables of enumerated data.[40] The overwhelming majority of these are tables of means of various weather phenomena for each month, for times of day, for times of each month. To give a sense of just how meticulous the observing was, and how diligently data were arranged, allow me to cite a number of the less obvious titles: Table 60 shows the 'Relative Humidity of the Air and Mean Change from Hour to Hour'; Table 71 the 'Mean Degree of Relative Humidity, Corresponding to 16 Points of the Compass'; Table 50 reflects the lunar preoccupations of the period – 'Mean Temperature of the 24 Hours on 8 different Moon Phases'. Similarly, data were organised and distributed according to monthly means of different weather phenomena. Means then and since, have been the kernel of weather data and the discerning of climates. By the time meteorology emerged as a distinct discipline, averages and distributions of numerical values had acquired particular meanings. As Stephen Stigler has noted, with the work of Belgian astronomer Quetelet in the 1820s and 30s, the average came to be widely understood as normal. Above and below values were deviations from the norm – variations but not signifiers of variability.[41] As weather and seasons were understood to repeat each year, the issue of variability between years and patterns on decadal rather than yearly scales made little sense. Variation was read as deviation, abnormality, and freak weather. Averages, as philosopher Ian Hacking has concluded, were not just values but a powerful episteme.[42] For a long time they were a principal instrument of how science understood the atmosphere.

As meteorology became more systematic, more statistical and more numerical, variability became invisible in Australasian science. The cycles proposed for both global and local weather collapsed. They failed because reality did not bare them out. With meteorology becoming more numerical, oceans of data from across the continent and region were collected. Basic statistical calculations helped order this immensity and provided knowledge that ministered to many queries and needs. Even the tele-connections identified by Sir Gilbert Walker, the conceptual forerunner of ENSO, became peripheral. Science had become blind to climatic variability in Australasia.

Histories from Numbers

Why does this matter? Consider these rainfall graphs from Darwin and Batavia (Figures 4.3 to 4.10).[43]

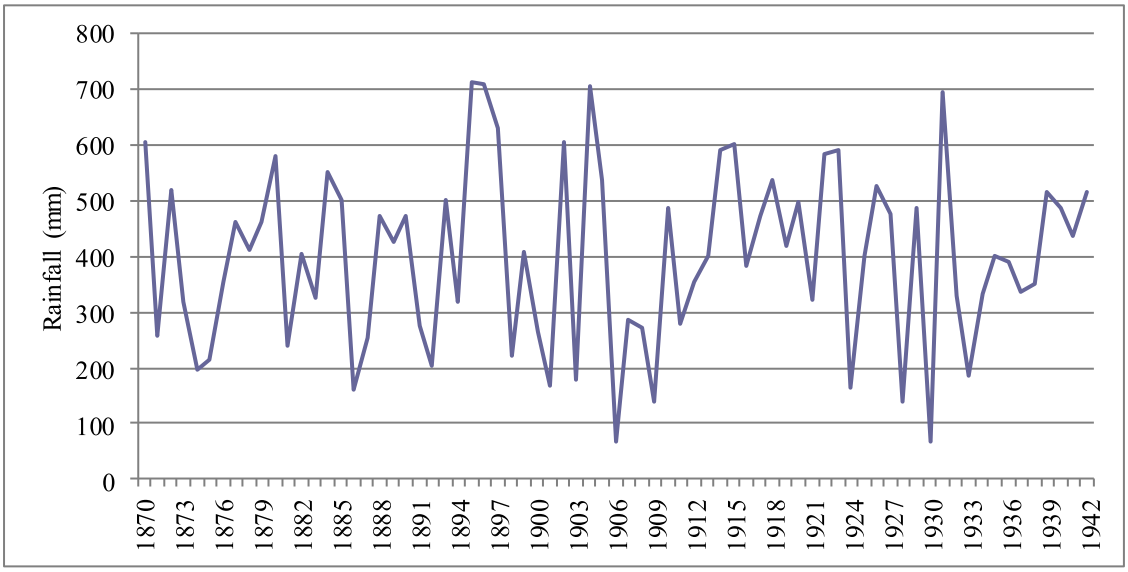

Fig. 4.3. January Rainfall, Darwin Post Office, 1869 – 1941.

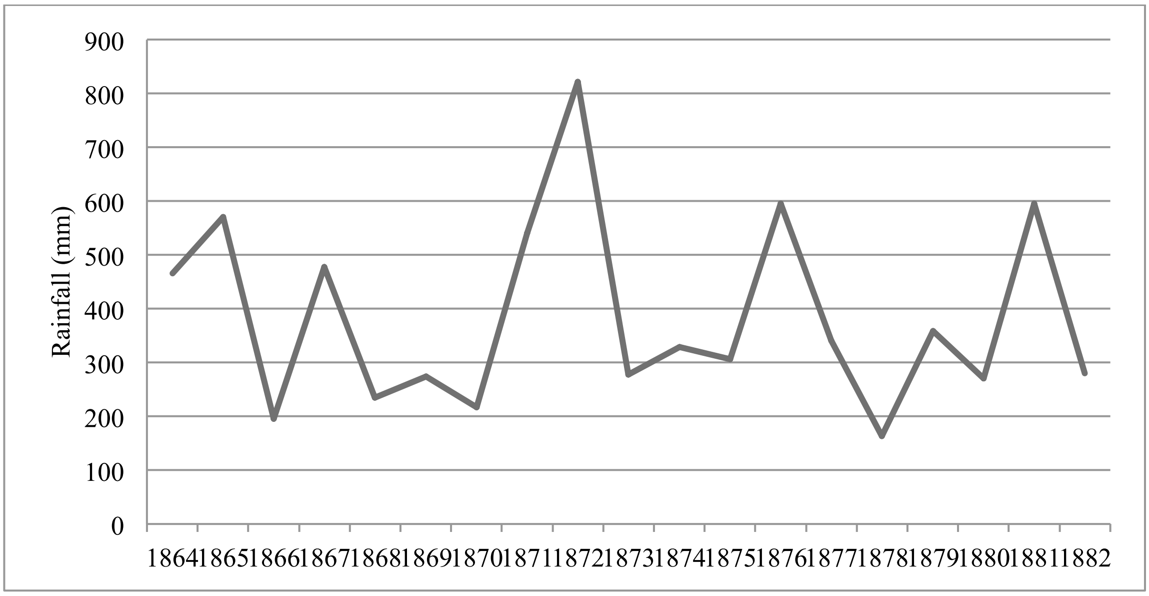

Fig. 4.4. January Rainfall, Batavia, 1864 – 1882.

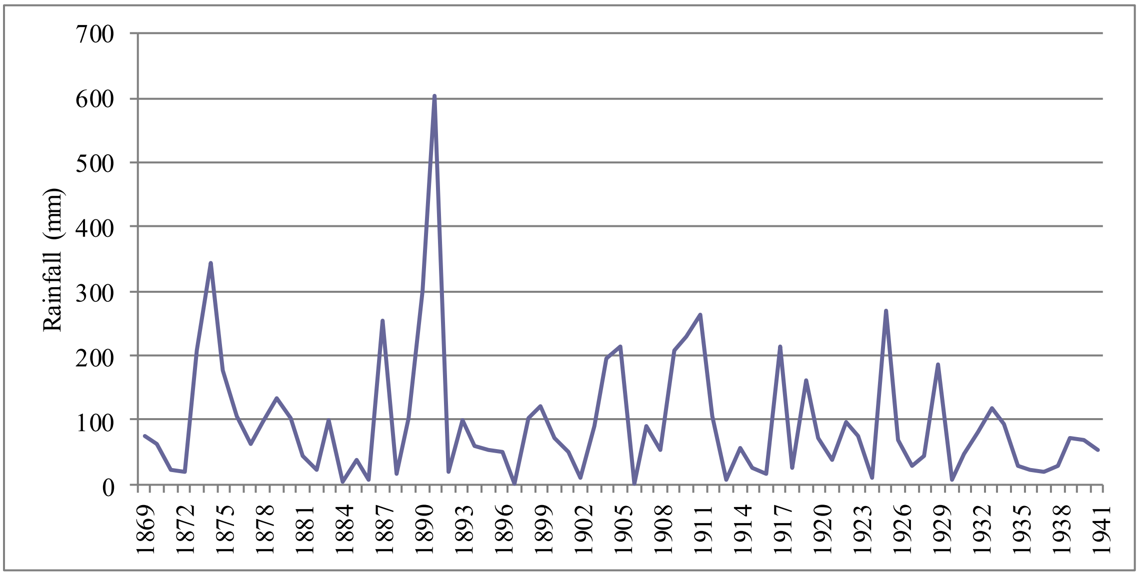

Fig. 4.5. April Rainfall, Darwin Post Office, 1869 – 1941.

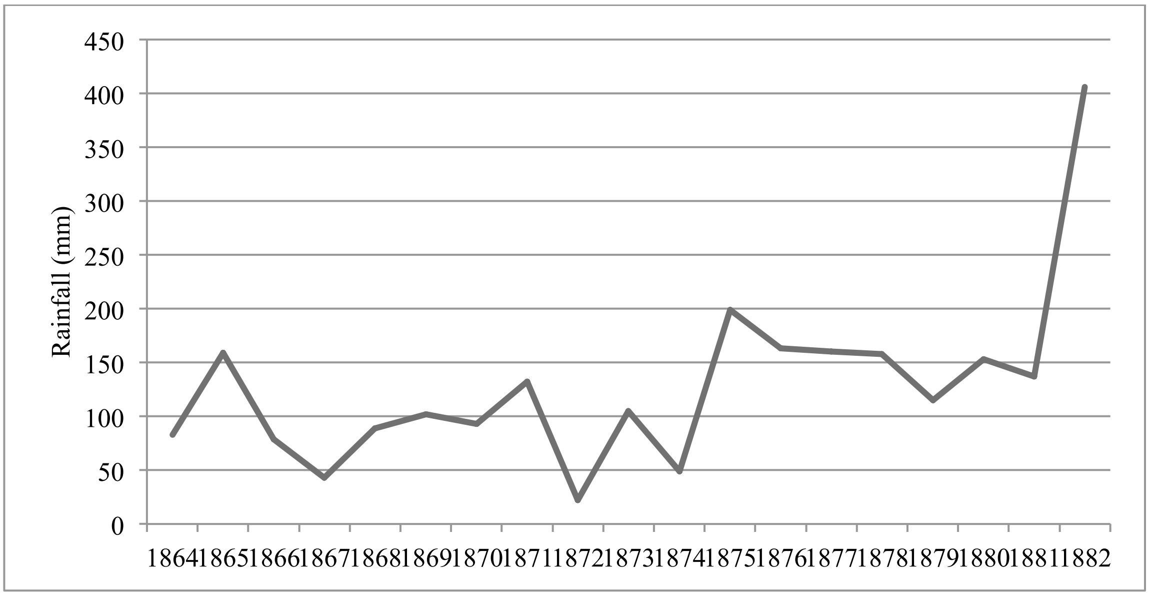

Fig. 4.6. April Rainfall, Batavia, 1864 – 1882.

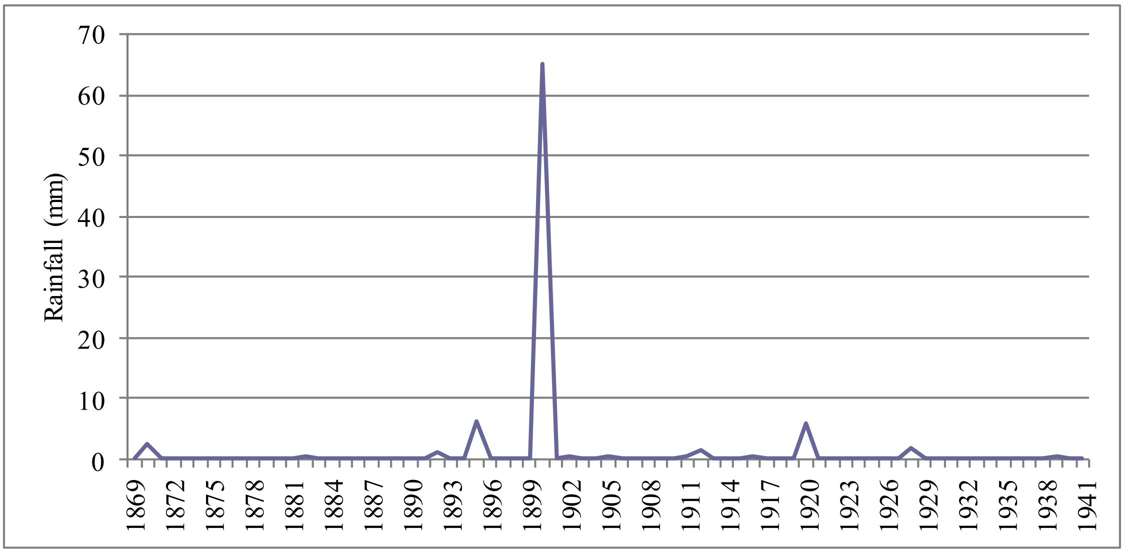

Fig. 4.7. July Rainfall, Darwin, 1869 – 1941.

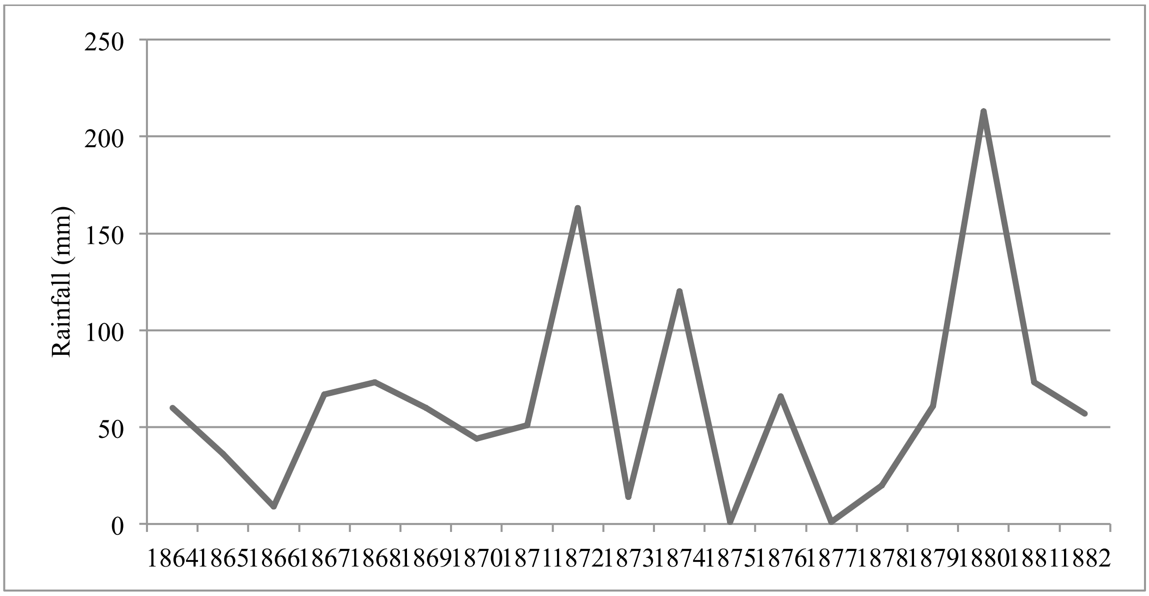

Fig. 4.8. July Rainfall, Batavia, 1864 – 1882.

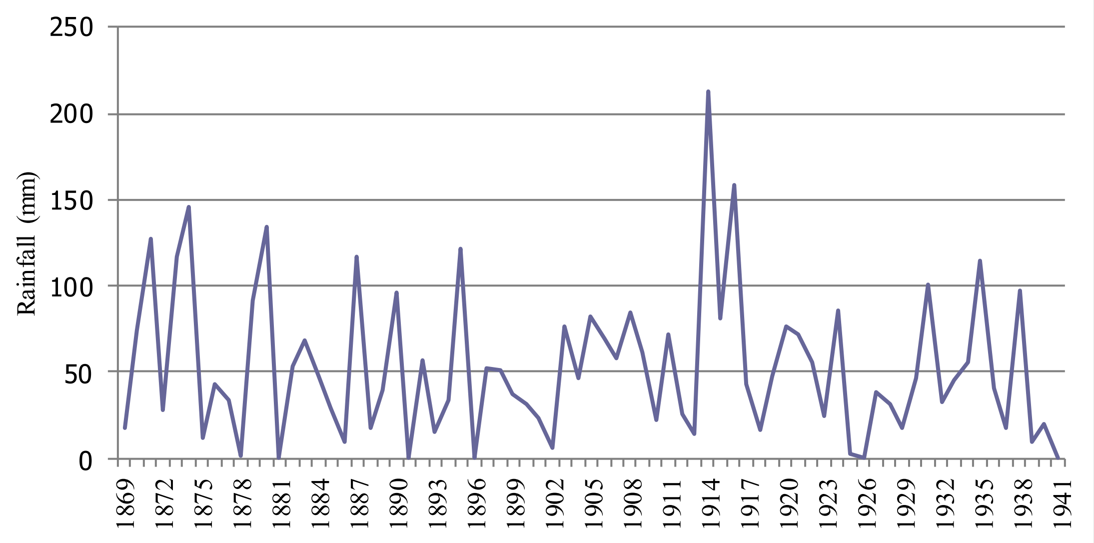

Fig. 4.9. October Rainfall, Darwin Post Office, 1869 – 1941.

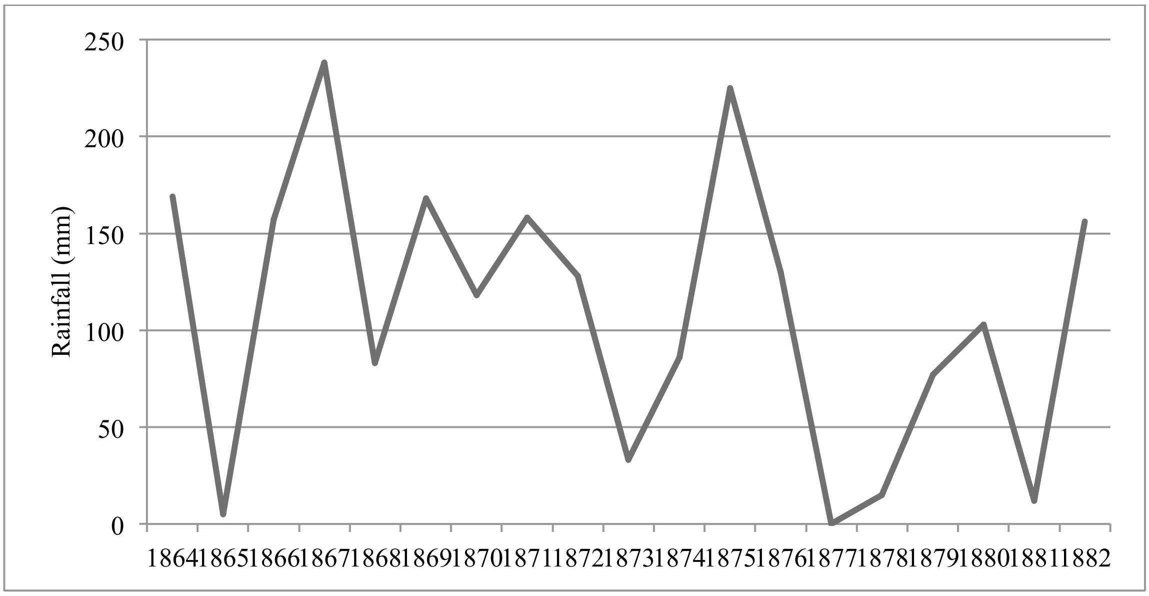

Fig. 4.10. October Rainfall Batavia, 1864 – 1882.

Historically, rainfall has been enormously variable from one year to another in both locales. The range in volumes for January, April and October in Darwin and for all months in Batavia is staggering – so much so that it is obvious that in both centres, Aprils and Octobers can be in one season one year; another the next. Using 50mm as a threshold between wet and dry, there were 23 dry Aprils and 39 dry Octobers in Darwin between 1869 and 1942. Or, about one in three Aprils and three in five Octobers qualified as dry. Between 1864 and 1882 in Batavia three, or one in six Aprils were dry and five, or one in three Octobers were dry. The April range during these respective periods was 1.3mm (1897) to 603mm (1891) for Darwin and 22mm (1872) to 406mm (1882) for Batavia. Octobers ranged from 0.0mm (1891, 1896, 1926 and 1941) to 213.4mm (1914) in Darwin and from 0mm (1877) to 238mm (1867) in Batavia. Even deep into 'The Wet' both centres recorded large variations in historical monthly rainfall: Januaries in Darwin between 1869 and 1942 ranged from 68mm in 1908 to 711.3mm in 1895. During the driest January from 1864 to 1882 – 1878 – 163mm was recorded in Batavia; 822mm fell during the wettest January of this period (1872). But it is around the middle of the year when differences between the two are most stark. Most obviously, Darwin's driest months on average are June, July and August and Batavia's are July, August and September. More importantly, drought does occur around Darwin in about 95% of years lasting between 4 to 6weeks on both sides of the southern Winter Solstice. Only twice during the 73 years from 1869 did at least one of the three driest months record over 50mm of rain in Darwin. In contrast, during the 18 years from 1864, this only failed to happen on one single occasion in Batavia.

Averages cannot show this, only histories of various weather elements. As shown above, such histories draw out different patterns between places with seemingly similar climates. Of course, variability is not just an issue of volumes or quantities: timing is vital too. Daily records for Darwin from 1870 to 1942 demonstrate a climate at odds with the received understanding of two six-month periods of Wet and Dry each year. Twice rain fell each calendar month. On another six occasions, it fell during 11 calendar months of its respective year.[44] Yet in 1896 no rain was recorded from 24 April until 16 November; 1925 likewise saw one of the only other six- month periods without rain. In 1925 rain was light, occasional and sporadic until December. The year 1926 seems to have experienced two "dries", one from 10 May till 10 September, the other from late September till early November. Moreover, daily records show that in many years rainfall does not increase and decrease in the steady, linear fashion that monthly means suggest.

My research on Batavia has not advanced to analysis of daily weather data, yet. However, the monthly data set I have been using here yields worthwhile information about temporal patterns of rain.[45] Between 1864 and 1882 there was just one year, the infamous global drought year of 1877, when no rain fell for at least three months. 1881 was the only other year when rain was not recorded in a calendar month and in 1875 two months recorded just 1mm each. Only three of these nineteen years experienced three consecutive months with less 50mm of rain. Although July and August had by far the two lowest monthly rainfall means there were still five years when over 100mm fell in either July or August. Similarly, there were six years in which at least 25mm was recorded each month and two on which over 50mm were recorded. A sample of 19 years is too small from which to extrapolate definite cycles. But it is enough to show that historical reality is significantly at variance with the dominant concepts of weather, climate, and season. Continuing research on Batavia's weather history should give better shape to the nature of these differences and to the intricacies of the region's atmospheric fluxes. In the early 1980s climatologists such as Neville Nicholls and John McBride began studying variability in Australasia. Until then a bizarre situation had developed such that data spoke of regularity, while the evolution of suggested variability. Now, amidst debates about climate change variability and other complexities, Australia's climates are yet to be understood – and climate change can and will change the very variability of variable climates.

Concluding Thoughts

Variability re-emerged in Australasia as the world has been grappling with anthropogenic climate change. For a time this enabled the deliberate confusing of the two. Sorting out the confusions, however, is an opportunity for remarkable clarification. One cause of confusion is the imported understandings of the colonisers. New concepts of seasons for different locales across the region can be identified through study of historical data. For Darwin, this, unsurprisingly, would largely match the nuanced concepts and patterns discerned through the millennia long empirical observations of the locale's Aboriginal peoples. With a better understanding of seasons and their turning we have many more signifiers of climate change: are seasons earlier, later, of different lengths? Are some seasons becoming more frequent or less frequent on decadal scales? Have some seasons acquired a different quality? We not only learn more about climate change but about the patterns that constitute climate itself. Data about quantities such as rain volume, temperature and humidity are vital in identifying both change and variability; but both happen across time, on various timescales. Indeed knowing about long term mechanisms of variability such as ENSO we can now, in the long term, look to see whether global warming is changing the dynamics, scale and timing of this mechanism.

Common to understanding both Australasia's climate cycles and global warming is the need for this rigorous, empirically based reconceptualising of seasons. Our received ideas of season fail to account for much of what we experience. Also, climate change will alter the nature and timing of these seasons anyway. This re-think demands considering seasons as not merely anchored to annual cycles of Earth's tilting on its axis, but also to the decadal scale fluxes in the great ocean of air we call our atmosphere. Finally in the West, we need to uncouple the seasons from calendar. or at the very least, integrate events in the physical world into our reckoning. In some places circumstances might even demand that we acknowledge that some seasons do not occur every year and, conversely, that some years do not include every season.

The diligence of observers in the past has given us a treasure trove of meteorological material. With this we can learn so much more about weather, climate, and the relationships between them. Other cultures offer other ways of knowing about the dynamics of the atmosphere and, sometimes, their relationships to various ecological events. It is up to us to ask new and revealing questions to combat the confusions others would foist upon us for personal or political gain.

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[44] Adelaide Observatory and Commonwealth Bureau of Meteorology, *Daily Rainfall, Darwin Post Office, 1869-1942.* Unless otherwise cited, all data in this paragraph comes from this source.

[45] All data here comes from *Observations made at…Batavia, VI*, op. cit., p. 280.