foreseechange

forecasting and futures consultants
foreseechange pty ltd acn 094 521 614

22 April 2009

Submission to the House of Representatives Industry, Science and Innovation Committee enquiry into long-term meteorological forecasting in Australia

I am pleased to make this submission to the committee. The submission demonstrates that long-term forecasting of rainfall is feasible in at least some regions of Australia.

I have analysed rainfall data for Melbourne and also for the Murray Darling Basin. The Melbourne data has been chosen for analysis because it is the longest time series available in Australia and because Melbourne is in its 13th year of below average rainfall. I have found that there is a cycle in Melbourne's rainfall which appears to be influenced by the 18.6 year lunar nodal cycle. This does not explain all variation, in particular the years 2006, 2007, 2008, and 2009 so far during which the drought has intensified. However, even this is not unprecedented and further research is likely to be able to explain and predict this sort of aberration.

The signature of the 18.6 year lunar nodal cycle is also evident in rainfall data for the Murray Darling Basin and my analysis suggests improved rainfall over the next few years.

These results are potentially valuable for farmers, who may be able to vary crops to suit expected rainfall patterns; to water management authorities; for the forestry industry; and for gardeners. Ultimately, this line of research may also be valuable as an input to bushfire risk mitigation strategy.

While mot a meteorologist or climate scientist, I have a B.Sc. degree majoring in Statistics. I am able to understand the science and have many years experience in forecasting time series, in particular discovering patterns and identifying causal factors. More information about my professional skills can be read at www.charlienelson.com/professional.htm.

Charlie Nelson
Managing Director

PO Box 401, Brunswick, Victoria 3056, Australia
website: www.foreseechange.com; email: charlien@bigpond.com
area code 03; international code 613; phone 9386 4841; fax 9383 2609

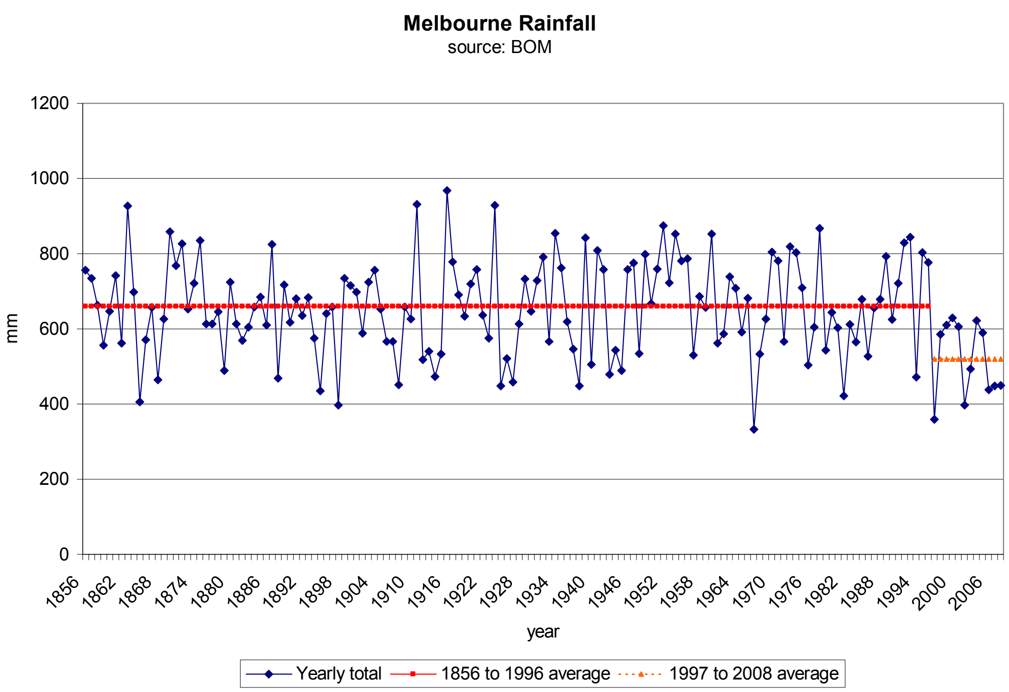
Overview of Melbourne's rainfall data

By the end of 2002, Melbourne had simultaneously endured both its driest six years on record and it's hottest. My 2003 analysis of this data can be read at www.foreseechange.com/melbourne.htm. Since then, the drought has intensified and temperatures have also risen.

Unfortunately, this prepared the bush land around Melbourne for the tragic fires of 7 February 2009. It has also caused losses to farmers in much of Victoria and led to urgent action to secure water supplies as Melbourne's dams reach record lows.

Melbourne's rainfall seems to have suffered an abrupt drop (of 21%) from 1997 and again (by 32%) from 2006 (Chart 1).

Chart 1

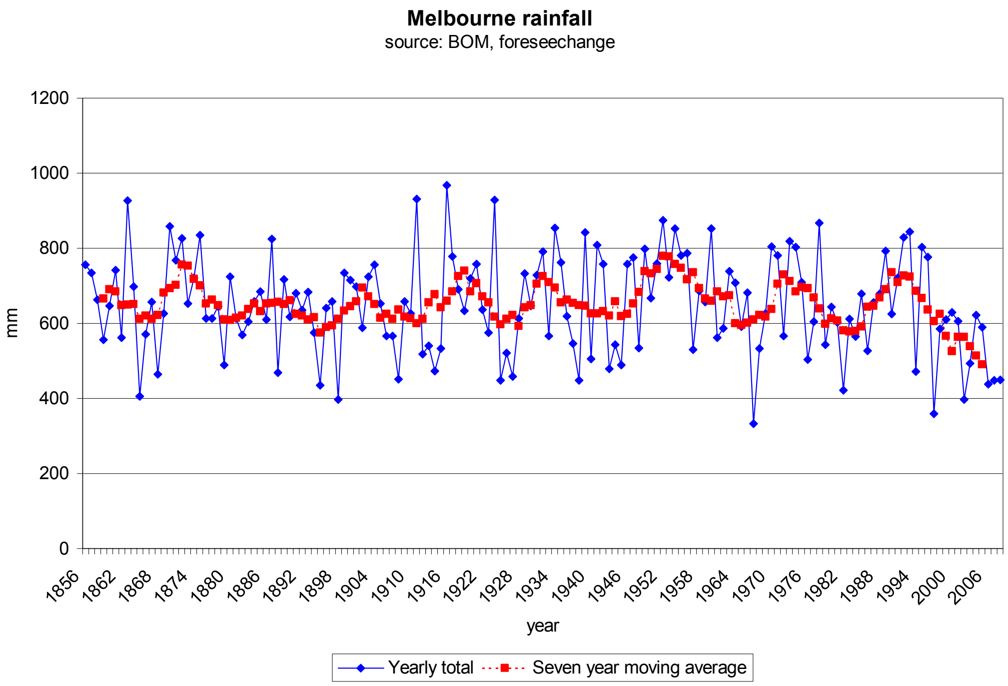


PO Box 401, Brunswick, Victoria 3056, Australia
website: www.foreseechange.com; email: charlien@bigpond.com
area code 03; international code 613; phone 9386 4841; fax 9383 2609

A cyclical pattern in Melbourne's rainfall

There is a cycle in Melbourne's rainfall. This is apparent by looking at moving average data as illustrated in Chart 2.

Chart 2



The period of the cycle appears to be about 19 years. The amplitude varies and there are individual years which vary substantially from the cycle. Also, there are a small number of periods of three or four years which are not synchronized with the cycle. However, it may be possible to explain, and in some cases predict, some of these variations.

Statistical analysis confirms that there is a significant cycle of about 18 years. These technical details (autocorrelation and spectrum analysis) have been omitted in the interests of brevity.

But what causes the cycle?

The lunar nodal cycle

The Sun's declination changes from +23.5° to -23.5° between the solstices due to the Earth's rotational axis being tilted at about 23.5° from the axis of orbital motion around the sun (the ecliptic). The Moon also changes in declination by the same average amount over a period of four weeks, the period of the Moon's orbit around the Earth. But unlike the Sun, the maximum and minimum declination of the moon varies because the Moon's orbit around the Earth is inclined at 5° to the plane of the

Earth's orbit around the Sun. Thus, the maximum declination varies between 18.5° and 28.5°.

The two points at which the Moon's path crosses the ecliptic are known as the nodes. These nodes slowly move around the ecliptic, taking 18.6 years to complete one cycle.

At a minor standstill, which last occurred in 1997, the declination of the moon varies from -18.5° to +18.5° over its month. At a major standstill, which last occurred in 2006, the declination of the Moon varies from -28.5° to +28.5° over its month.

This means that the Moon swings both further south and further north of the equator at a major standstill and its swings are closer to the equator at a minor standstill.

These variations are easily observed and have been known about since ancient times. The correlation of the lunar node cycle, and other lunisolar cycles, with variations in the weather has been suggested many times (see, for example, Charles D. Keeling and Timothy P. Whorf in "The 1,800-year oceanic tidal cycle: A possible cause of rapid climate change", Proceedings of the National Academy of Science USA, March 21 2000).

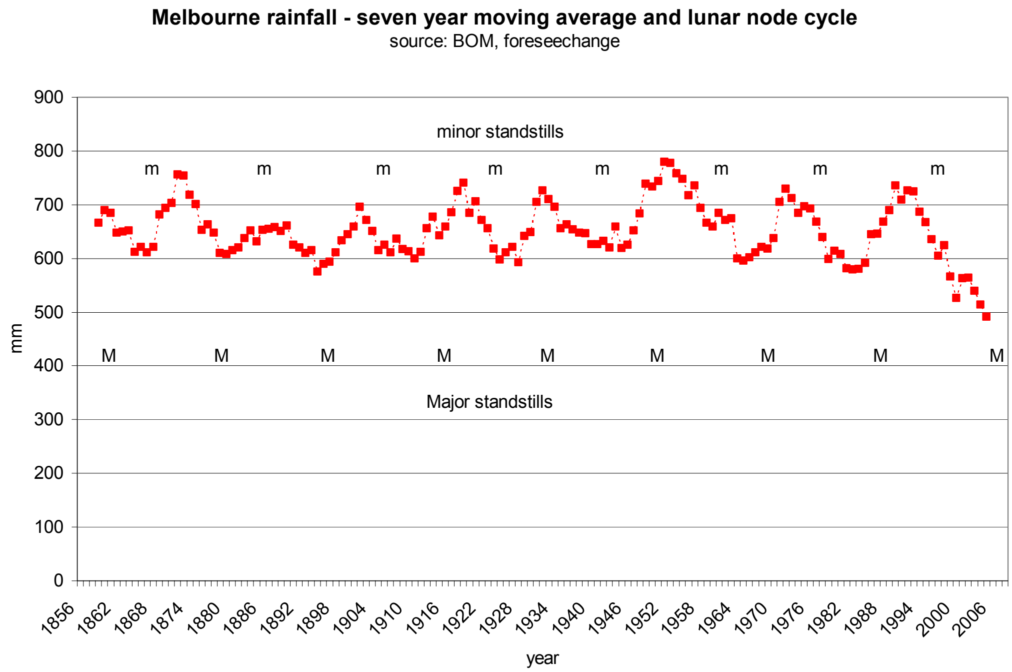
The lunar node cycle means that the Moon, which on average, swings as far south as the tropic of Capricorn (just south of Exmouth on the Western Australian coast) has periods when it doesn't reach Port Hedland and others when it is overhead as far south as Geraldton. During the nine years before a major standstill, it is presumably dragging warm water further south and during the nine years before a minor standstill, it would be pulling cool water further north.

This, or some other mechanism such as variations in vertical mixing of water of different temperatures, could impact on the temperature and moisture of the air over the coast of Western Australia, thus affecting rainfall in Melbourne and elsewhere in the continent.

So is the 18.6 year lunar node cycle synchronized with the observed cycle in Melbourne's rainfall?

Chart 3 shows the moving average rainfall line against the major (M) and minor (m) standstills.

Chart 3

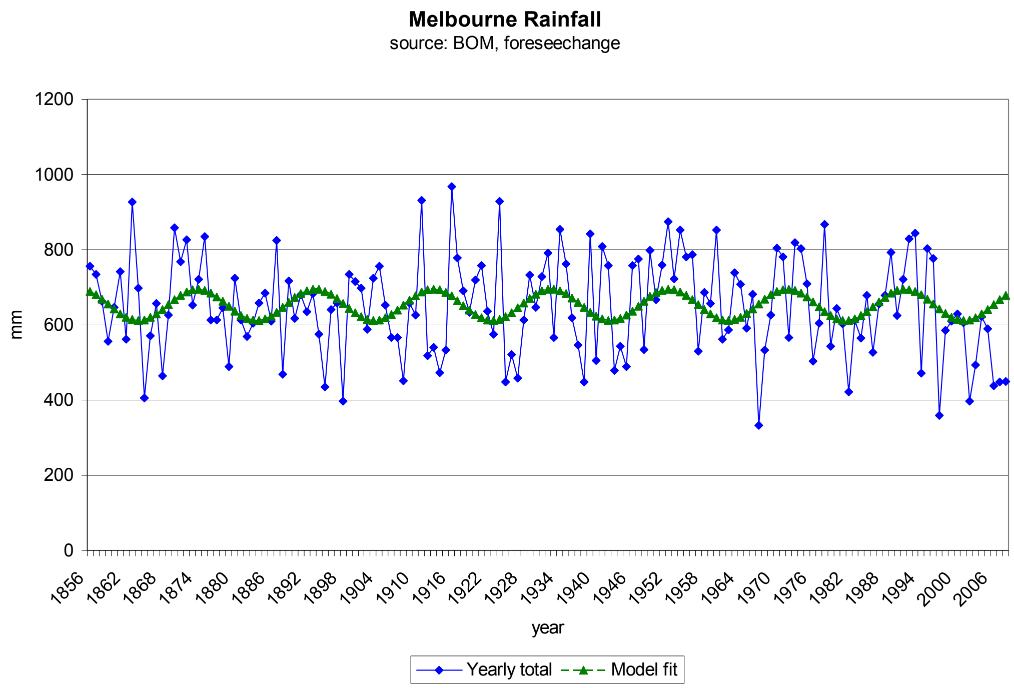


Wet periods, relative to the average, occur between the Major and minor standstills while dry periods occur between the minor and Major standstills. In other words, a switch towards dryer periods occurs after a minor standstill and a switch towards wetter periods occurs after a Major standstill (which is after the Moon is swinging most widely around the equator).

Lunar node cycle model of Melbourne Rainfall

Regression analysis shows that there is a statistically significant relationship between actual rainfall and a model constructed from the lunar node cycle, as illustrated in Chart 4.

Chart 4



The model indicates that rainfall varies by an average of 83mm from the peak to the trough of the cycle. There are large deviations from the model and these are of two types.

First, there are large variations in individual years and these are unlikely to be predictable long in advance because they are caused by short-term random events. For example, the driest year on record is 1967 and it is unlikely that a cause can be assigned, or if it can that it was predictable.

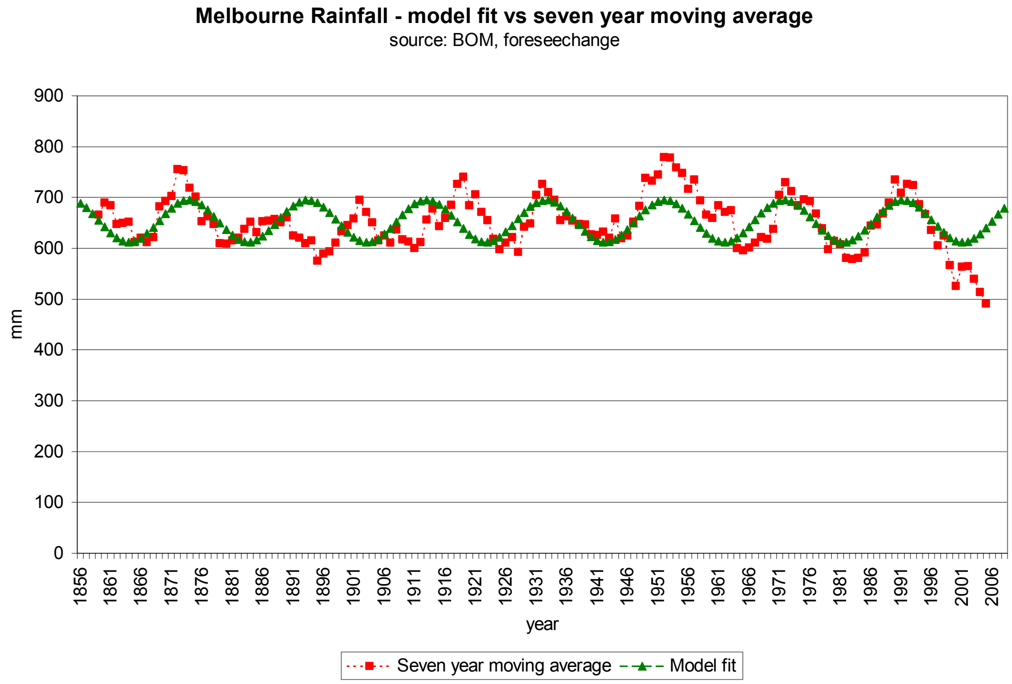
Second, there are a few periods of several consecutive years where the model fits the data poorly. These include the period 2006 to 2008 and 1912 to 1915 which was also much drier than expected although 1911 and 1916 were very wet and compensated. A period much like the recent years is 1925 to 1927 when rainfall did not pick up early in the cycle, although it was back to the cycle by 1928 and thereafter. The period 1899 to 2004 had five years out of six which were at variance with the cycle.

It is analysis of the second type of deviation which will most likely lead to the identification of other factors which will improve the predictive accuracy of the model. These factors could be other components of the lunisolar cycles. There is, for example, a 90 year component.

The model fit is shown against the seven year moving average in Chart 5. The fit is quite good apart from the period 1891 to 1922 when the cycles moved out of phase although there were still cycles. It was as if the cycle was delayed by six years before re-synchronizing. We need to understand the cause of this, because we may be entering another such period. The other period was from 1949 to 1963, when the cycles were synchronized but rainfall was much higher than expected than at any other time. Again, understanding this may lead to the ability to predict another such event or an opposite event – when rainfall follows the cycle but is much lower than expected.

Most of the historic variations from the model can be attributed to spring rainfall, which may narrow the search, but the latest dry period is observable in all seasons except perhaps summer.

Chart 5

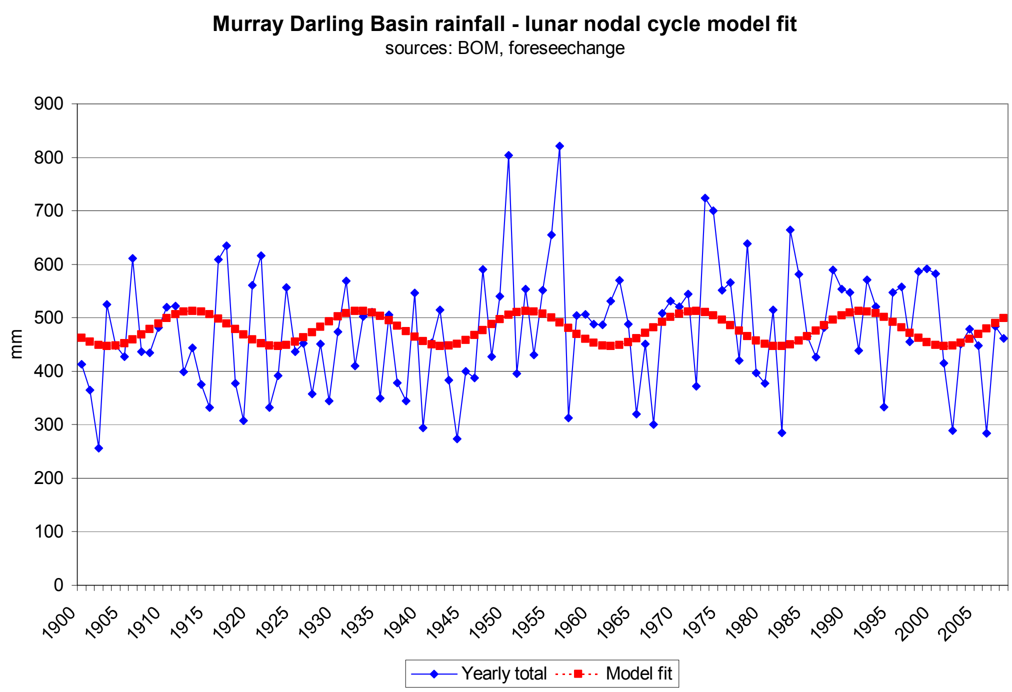


PO Box 401, Brunswick, Victoria 3056, Australia
website: www.foreseechange.com; email: charlien@bigpond.com
area code 03; international code 613; phone 9386 4841; fax 9383 2609

Applicability to the Murray Darling Basin

Rainfall in the Murray Darling basin is also correlated with the lunar node cycle (Chart 6) and in this case the swing around the mean averages 33mm above and below. As with Melbourne, there are periods of poor fit, such as the period 1912 to 1915. There are also periods, such as the 1960's, where the model is a poor fit for the Murray Darling basin but not for Melbourne. Encouragingly, the rainfall over the past two years has not been inconsistent with the model and it is to be hoped that rainfall continues to rise over the next few years as predicted by the model.

Chart 6



Directions for further research

There are two streams of research needed in order to improve the reliability of rainfall forecasts based on my models.

One, it is necessary to establish the physical mechanism connecting the lunar nodal cycle and rainfall over Melbourne, central Victoria, much of the Murray Darling Basin, and other areas. This will be via analysis of ocean water temperatures, tidal heights, and perhaps other data. This would validate the correlations observed.

Two, reasons for variations from the model must be identified. These could include:

- Other dimensions of the lunisolar forces. This includes distances and alignments between the Sun, Moon, and Earth.

- The influence of other planets such as Jupiter, which has had some close alignments with the Moon over recent years, including an eclipse. The tidal influence of Jupiter is very small but there may be a threshold effect or possibly non-tidal effects such as focusing the solar wind.
- The influence of the Asian brown haze, which has been intensified recently by forest fires in Borneo. 1997, 2002, and 2006 were bad years for fires and were dry years in Melbourne. The Asian brown haze reportedly reduces solar energy reaching the Earth's surface by up to 15%, altering the Asian monsoon (New Scientist, August 12, 2002). If this proves to be an important factor, it would make sense for the Australian and Victorian governments to invest in preventing forest fires in Indonesia and extinguishing them if they start.
- The Indian Ocean Dipole. A recent Australian paper by Ummenhofer et al. ("What causes southeast Australia's worst droughts?" Geophysical Research Letters, Vol 36, 2009) claims that the Indian Ocean Dipole (IOD) is a major driver of rainfall over southeast Australia. I am not convinced that this is a major factor. For example, there was a long sequence of years before 1890 without a negative dipole event but rainfall was average, while there has been a similarly long sequence of years recently without a negative dipole event and yet there is a severe drought. Furthermore, the IOD is currently not able to be predicted a few months ahead, while lunar cycles can be predicted long in to the future.

Conclusions

I have demonstrated that there are long periods, in particular from the mid-1920's to the late 1990's, where the lunar node cycle is a very good (long-term) predictor of rainfall in Melbourne and wide areas of Australia. We need to understand the causes of divergences from the model in order to increase the reliability of predictions.