

The Oceans' Role in Seasonal and Longer Term Climate

Why the recent cooling is likely just the start

Although, I believe ultimately the sun is the primary driver for the changes to global climate, the oceans may provide the mechanisms for the changes on year-to-year to multidecadal time scales. In a prior analysis, we had shown how the sun and oceans correlated better with US temperature changes than carbon dioxide over the last century. The oceans had the strongest correlation. In this analysis, we will present evidence for how and why the oceans affect temperatures.

Thermal Property Differences between Land and Water

The oceans warm and cool much slower than land for a number of reasons.

- (1) The sun is able to warm only the thin upper surface of the land directly while it may penetrate many meters into the ocean
- (2) The ocean like the air but unlike land is subject to vertical mixing and convective movements.
- (3) The thermal capacity of the oceans is much higher because the water is considerably denser and has roughly four times the specific heat (the amount of heat required to warm a given volume 1 degree Celsius) as most land surfaces.

This is why land warms more and much faster than the ocean in the spring and cools more and faster in the fall.

One consequence of the ocean's ability to absorb more heat is that when an area of ocean becomes warmer or cooler than usual, it takes much longer for that area to revert to "normal" than it would for a land area.

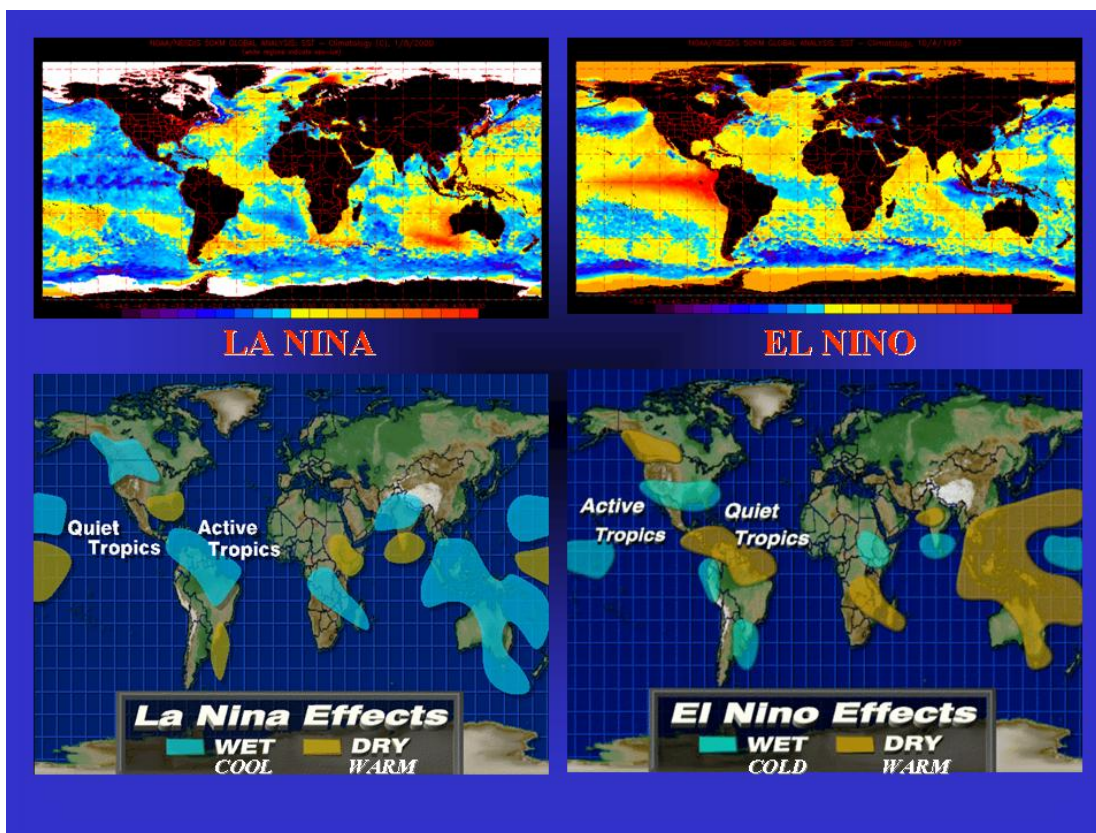
Also because of the huge discrepancy in volumetric thermal capacities, the influence of water on air is very much greater and more immediate than air on water. A change in atmospheric temperatures might take decades to affect the oceans, but the flip of an anomaly of an ocean pool of water has an almost immediate effect on the air.

Major Oscillations and Their Effects

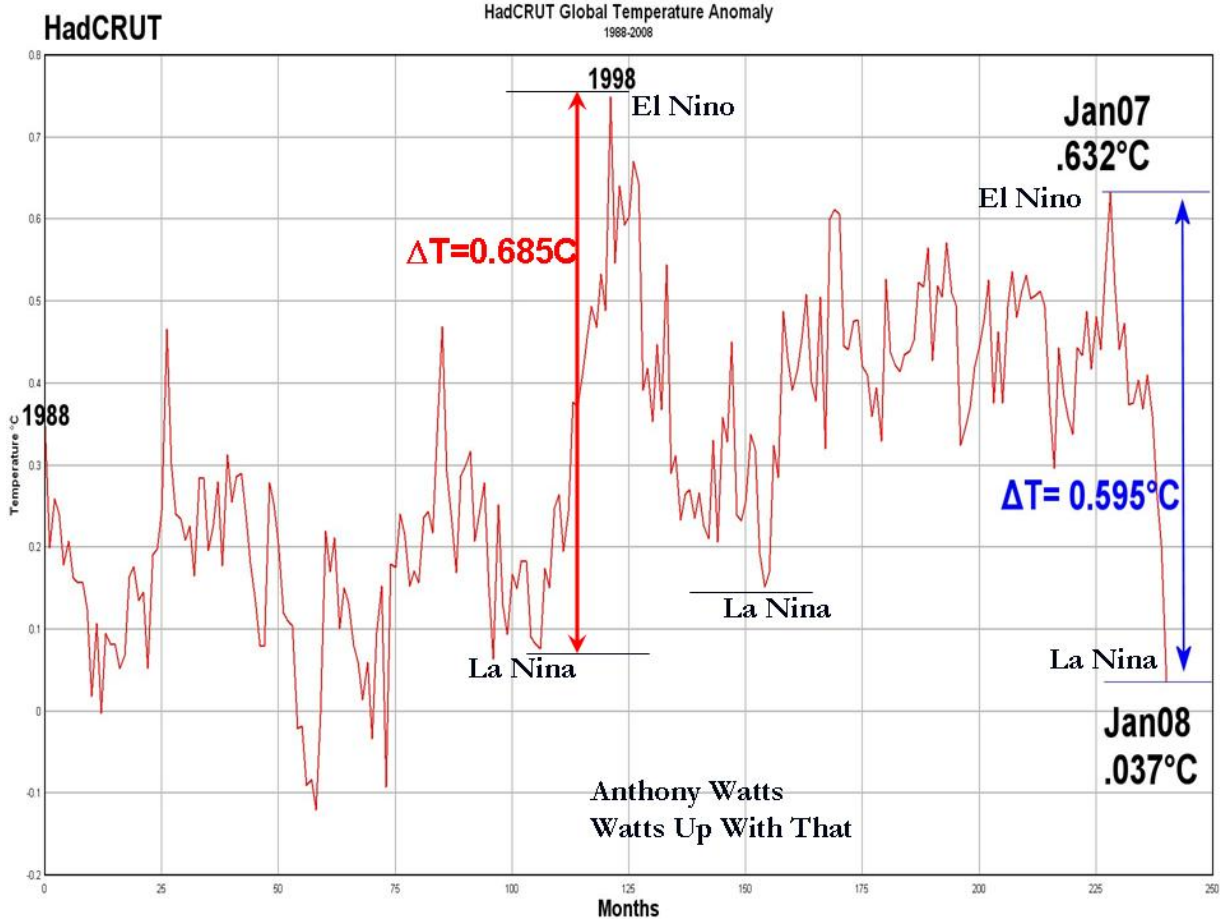
Although ocean temperature anomalies tend to persist for long periods, there are oscillations or flip-flops that take place on scales of a few years to multiple decades. Both types have profound effect of global temperatures.

El Nino and La Nina

The term El Niño refers to the large-scale ocean-atmosphere climate phenomenon linked to a periodic warming in sea-surface temperatures across the central and east-central equatorial Pacific (between approximately the date line and 120°W). El Niño represents the warm phase of the El Niño/Southern Oscillation (ENSO) cycle, and is sometimes referred to as a Pacific warm episode. La Niña refers to the periodic cooling of ocean surface temperatures in the central and east-central equatorial Pacific. La Niña represents the cool phase of the El Niño/Southern Oscillation (ENSO) cycle, and is sometimes referred to as a Pacific cold episode. During an El Niño or La Niña, the changes in Pacific Ocean temperatures affect the patterns of tropical rainfall from Indonesia to the west coast of South America, a distance covering approximately one-half way around the world. These changes in tropical rainfall affect weather patterns throughout the world.



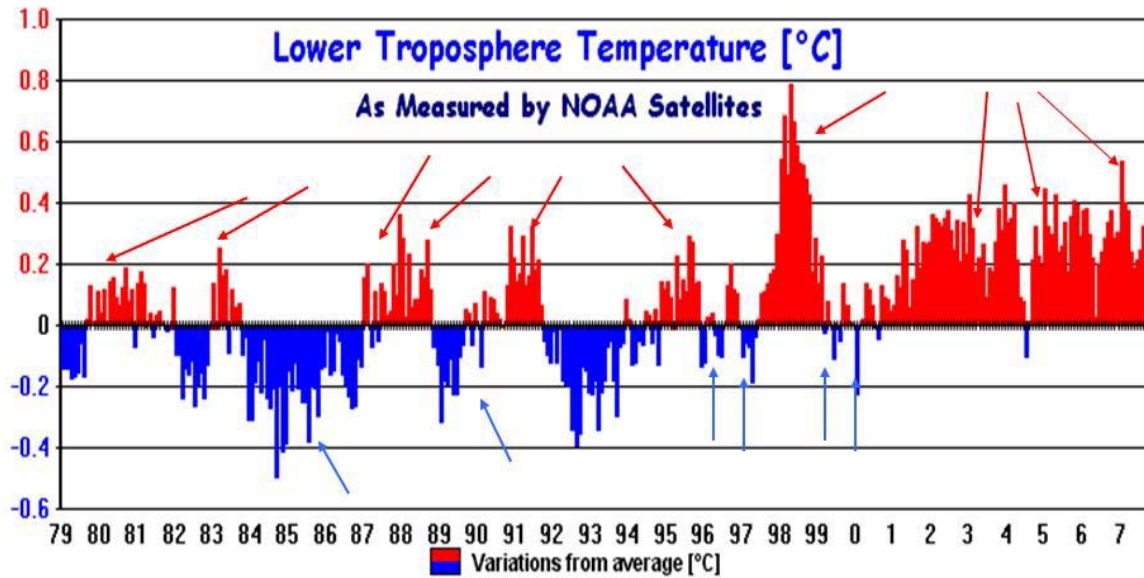
In general, an El Niño leads to global scale warming while a La Niña global scale cooling. This can be seen from both the global land and sea temperature pattern from the UK Hadley Centre and from the satellite-derived lower tropospheric temperatures from the University of Alabama, Huntsville since 1979.



Note the rapid global warming as we moved from a La Nina in 1996/97 to a major El Nino followed by almost as much cooling as we moved to the La Ninas of 1999 and 2000.

We started 2007 with a moderate El Nino but ended the year with a moderate to strong La Nina. Again this led to a strong cooling (over 1 F).

In the longer satellite record of global lower tropospheric temperatures from Spencer and Christy at UAH, we see El Ninos are invariably warm and La Ninas cool. The enhanced cooling of the early 1980s and 1990s was related to the volcanic eruptions of El Chichon and Mt. St. Helens and the Pinatubo and Cerro Hudson.



El Ninos lead to global warming and La Ninas to cooling



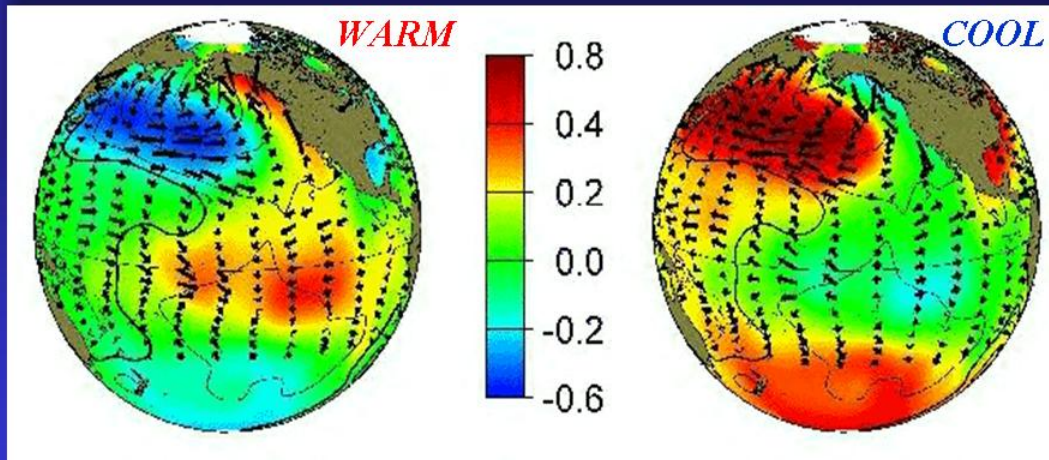
You may notice a tendency for more El Ninos than La Nina since 1979. This by itself would suggest a net warming effect (more warm years than cool). That is where the Multidecadal Oscillation comes in.

Pacific Decadal Oscillation

Researchers at the University of Washington and JPL found a tendency for the ocean temperatures in the Pacific to assume one of two virtually opposite configurations and to persist in these modes for decades at a time. They termed this oscillation the [Pacific Decadal Oscillation](#). Changes from one phase to the other appeared to occur rapidly. The IPCC described these oscillations as natural and resulting from changes in the thermohaline circulation and ocean gyres and circulation centers (Aleutian low).

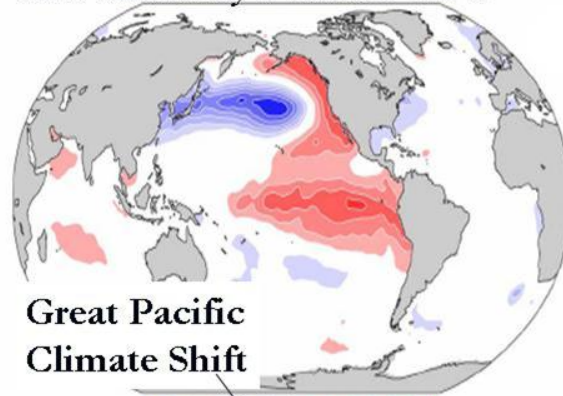
Pacific Decadal Oscillation

University of Washington and JPL scientists
(*Mantua, etal*) found an apparent decadal scale
oscillation in the Pacific they call the PDO.

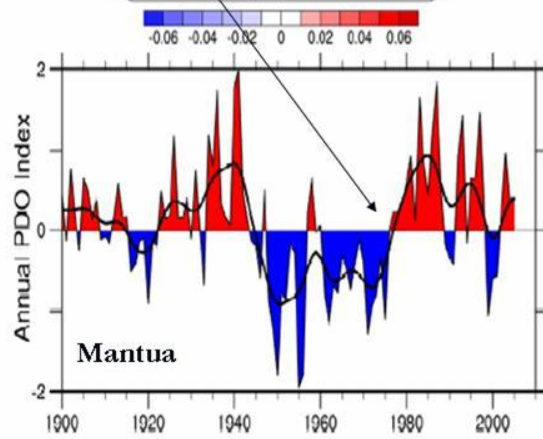


In the positive mode of the PDO, there is a tendency for the oceans to be warmer than normal in the eastern Pacific near North America and along the equatorial Pacific and cold in the northwestern Pacific. Note the cold mode is very nearly opposite. Note in the following IPCC chart the warm mode dominated after the Great Pacific Climate Shift in 1979.

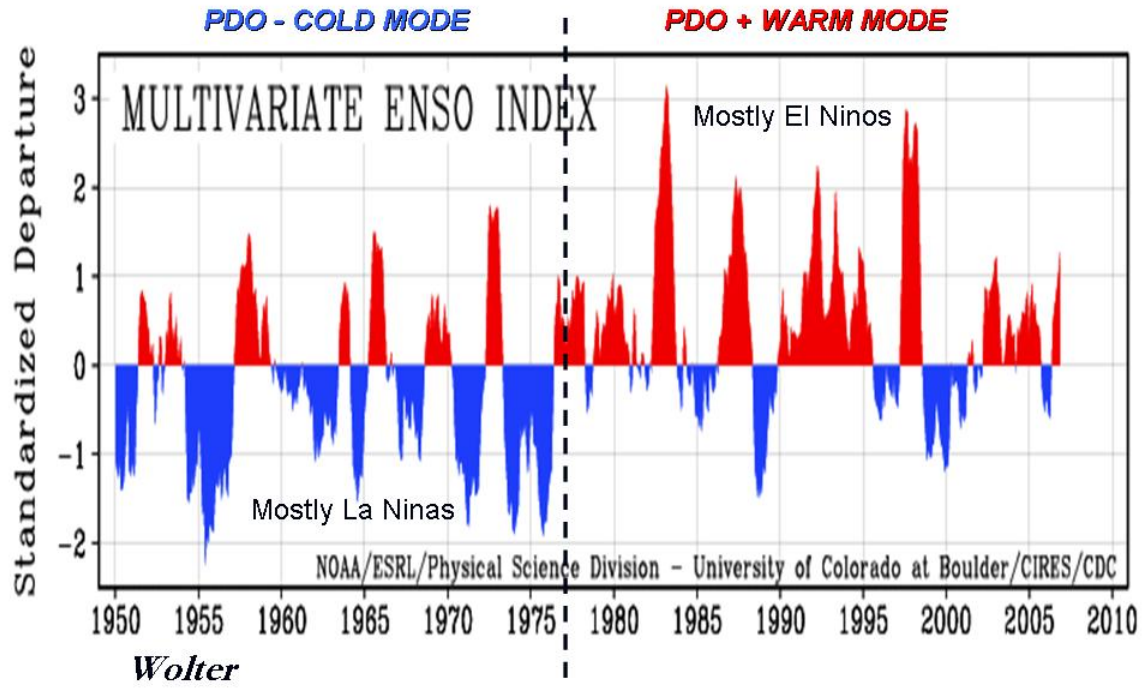
SST Anomaly Positive PDO



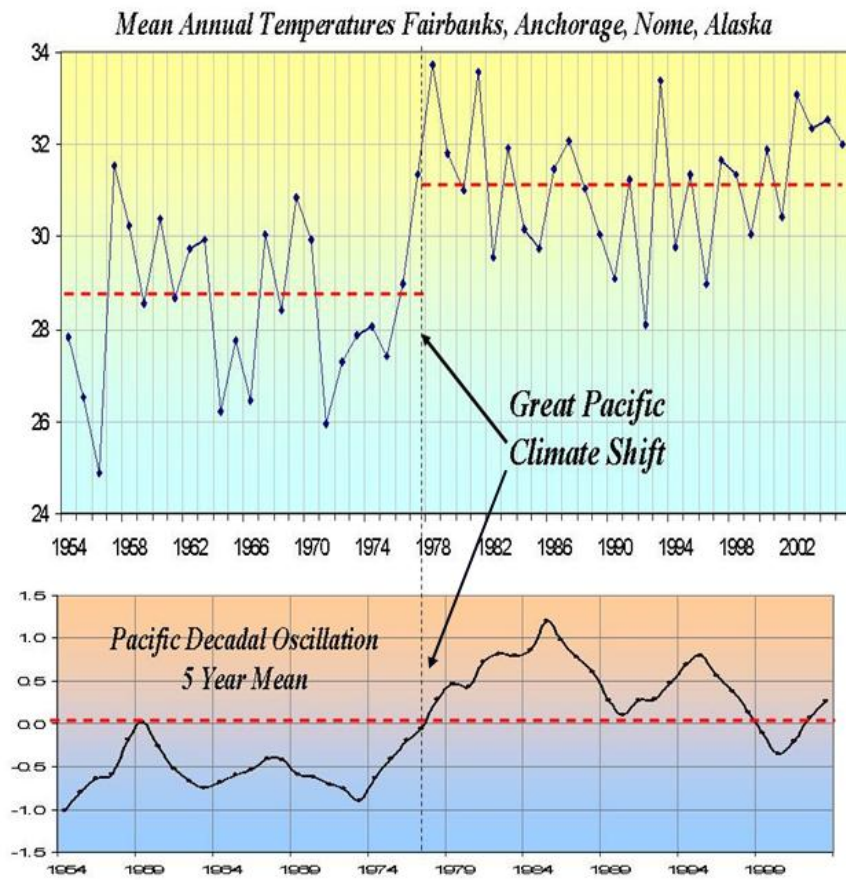
**Great Pacific
Climate Shift**



Notice how indeed the number of El Ninos suddenly increased after that transition, reversing the tendency for La Ninas that had characterized the cold phase from 1947 to 1977.

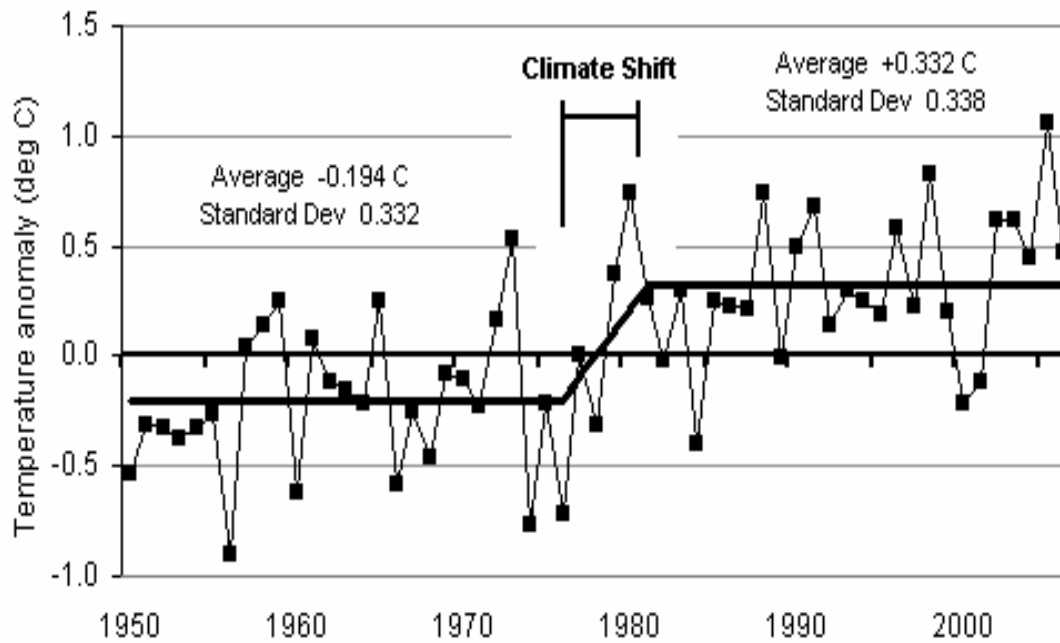


Notice also the instant warming that took place when the 'regimes' changed.



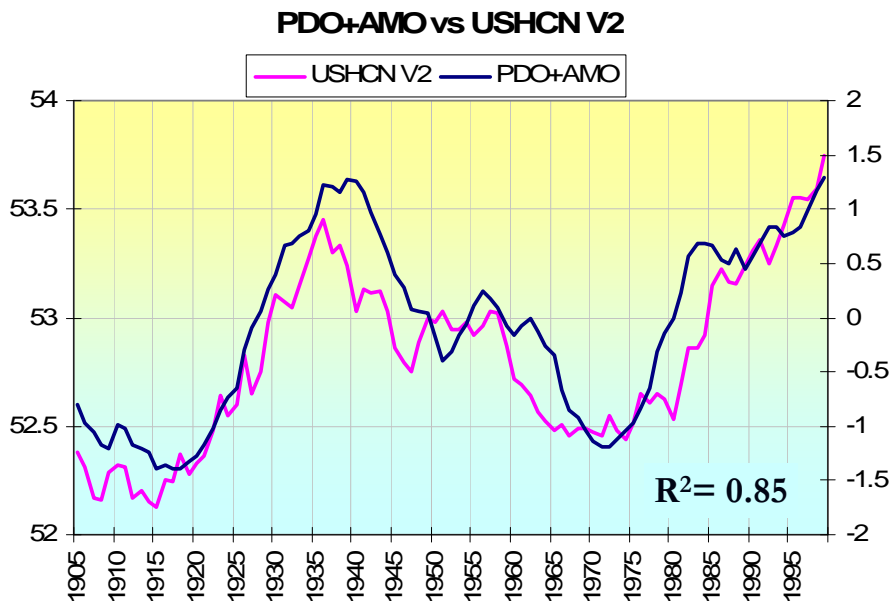
The above is for the cities of Fairbanks, Anchorage and Nome in Alaska. The following for Australian cities from John McLean.

Annual average temperature anomaly 1950-2006



Oceans: The Flywheel of The Climate System?

We showed in an earlier blog how well the US temperatures correlated with the multidecadal ocean changes.



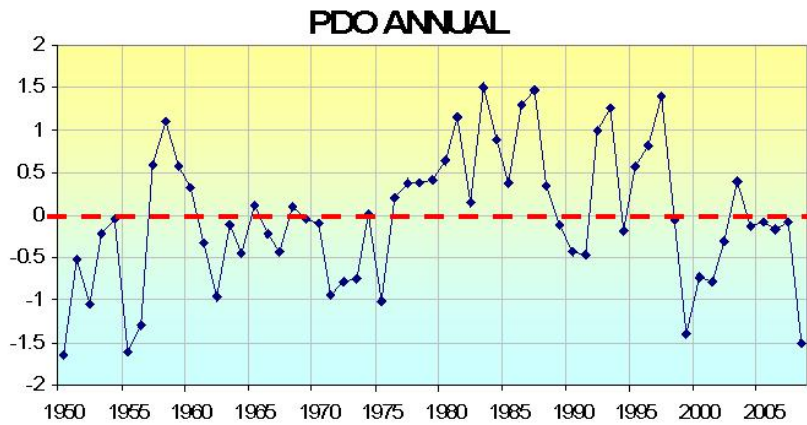
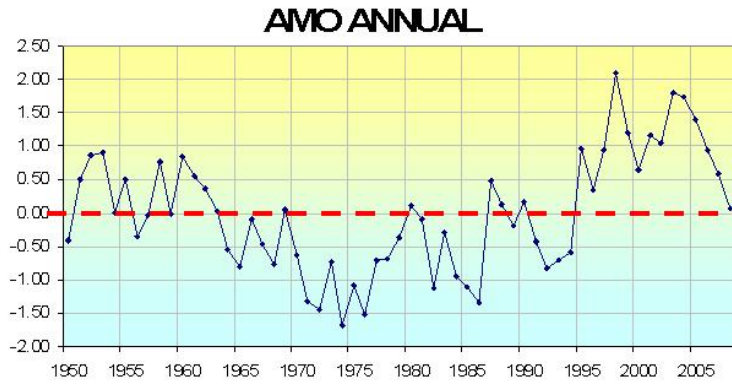
The ocean indices and the Total Solar Irradiance correlated better than CO₂ for the last century. The correlation of temperatures with CO₂ vanished in the last decade.

Factor	Years	Correlation Pearson Coefficient	Correlation Strength (r-squared)
Carbon Dioxide	1895-2007	0.66	0.44
Total Solar Irradiance	1900-2004	0.76	0.57
Ocean Warming (PDO and AMO)	1900-2007	0.92	0.85
Carbon Dioxide Last Decade	1998-2007	-0.14	0.02

Though the sun may be the ultimate driver of climate cycles and change, it may be that the oceans act as the flywheel of the climate system, providing the mechanisms to bring about the changes. For example, when too much heat builds in the tropical oceans as solar activity increases, the oceans may flip into their warm mode, which in the Pacific is the positive PDO favoring more El Ninos which transport excess heat poleward. A while later, the Atlantic warms and transports warm water and air to the higher latitudes and the arctic. This sequence happened in the 1930s and 1940s and again the 1980s into the early 2000s.

The Great Pacific Climate Change II ?

The PDO has turned negative and the AMO has diminished



With the decline in solar activity also forecast by more and more solar scientists as this cycle lingers, it would appear likely, a further cooling is ahead of us.