## *More on The Great Pacific Climate Shift and the Relationship of Oceans to Temperatures and Arctic Ice*

By Joseph D'Aleo, CCM

In a recent guest blog, John McLean explained how Australia's CSIRO and Bureau of Meteorology (Power and Smith) respectively were reporting a period of unprecedented El Niño dominance the last 30 years, which they blamed on human activity. Last year in May it was Vecchi who told us there was a just 1% probability that this was due to natural events.

On The Weather Channel blogs, meteorologist Stu Ostro, also found a similar continuity shift in weather pattern starting 30 years ago. Blog comments back to Stu and John McLean's blog here showed how the change had precious little to do with anthropogenic factors but was a large scale cyclical climate shift known for decades as the Great Pacific Climate Shift.

Later on it was shown to be the latest change in a cyclical regime change given the name Pacific Decadal Oscillation by Mantua et al. This followed research showing decadal like ENSO variability by Zhang et al. in 1993/

They found the Pacific Ocean temperature regime and overlying pressure patterns tended to persist in one mode for two or three decades and then flip to very nearly the opposite mode for a similar period.

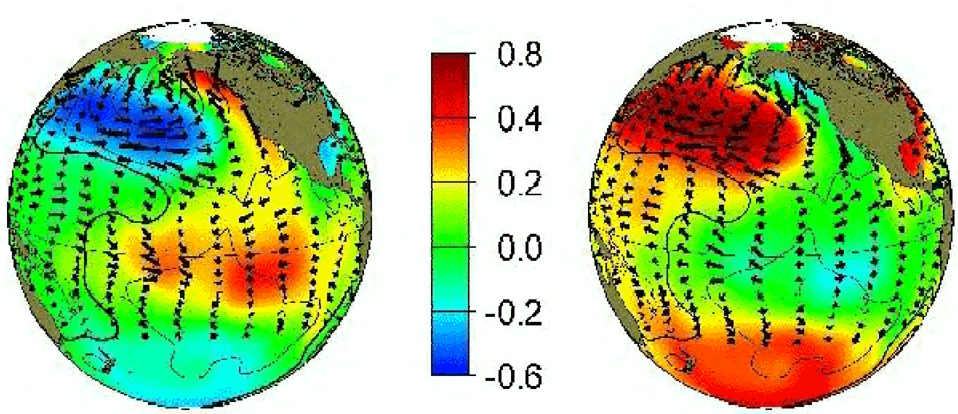



*Figure 1: Mantua's PDO warm phase (left) and cold phase (right)*

They discovered that in the 20th century, the PDO tended to be predominantly positive from 1922 to 1947 and negative from 1947 to 1977 and then positive most of the time since 1977.

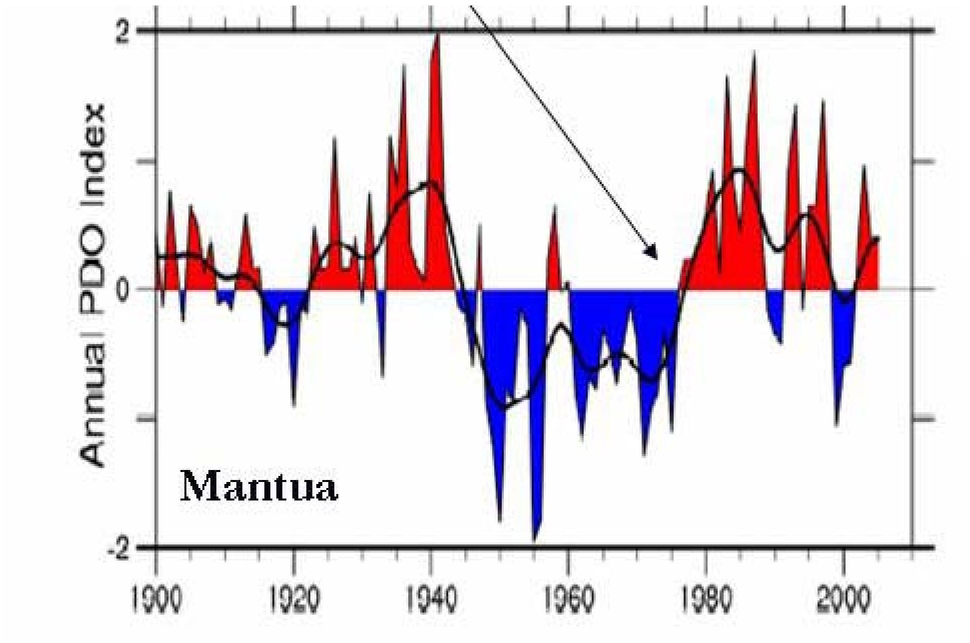



*Figure 2: The PDO since 1900. Note the dominant warm regime from 1922 to 1947, cold from 1947 to 1977 and then mainly warm from 1997 to 2006. The arrow points to the Great Pacific Climate Shift around 1977.*

Temperatures during the warm mode tend to be above normal in the tropical Pacific and along the west coast of North America to Alaska but cooler than normal in the southeast United States.

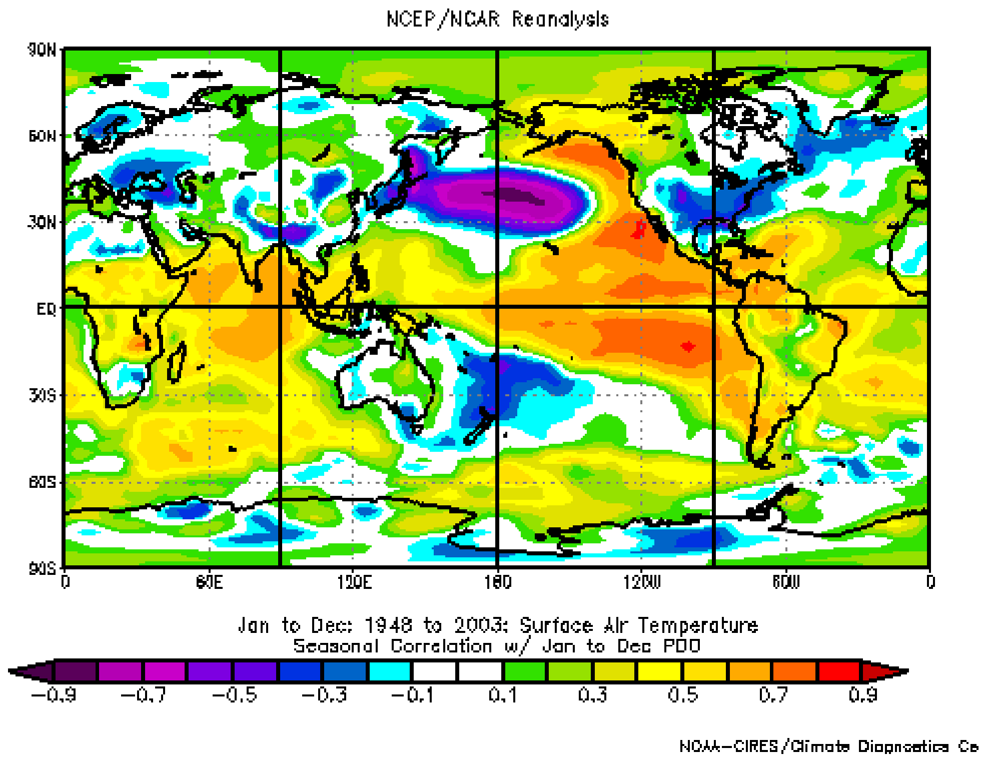



*Figure 3: The global temperature regimes during the warm phase of the PDO as provided by NOAA CIRES CDC. Note the tendency for a warm tropical Pacific, warmth in Alaska but a cool southeast United States.*

Actual average temperatures since the Great Pacifci Climate Shift match this pattern very well.

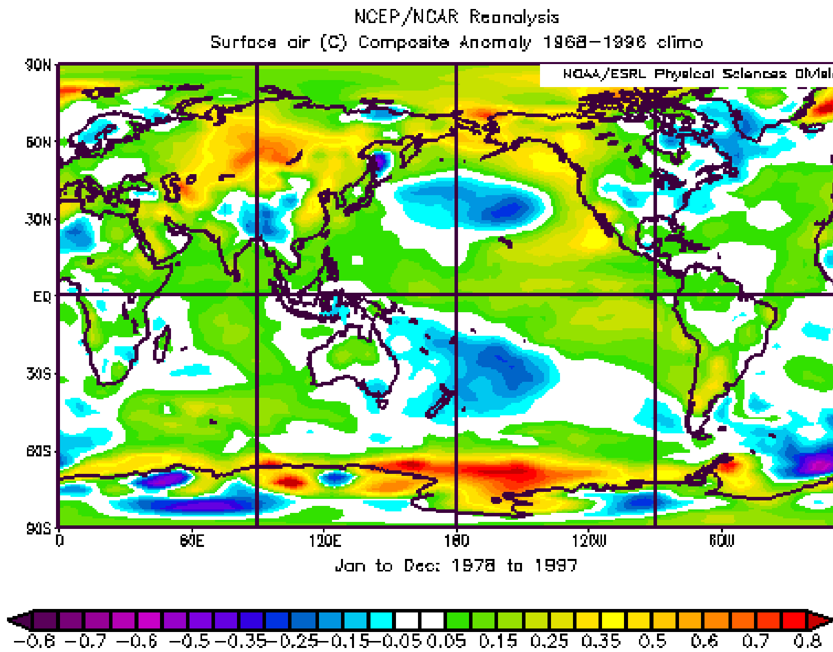



*Figure 4: Actual annual global temperature anomalies since the Great Pacific Climate Shift in 1977. Note the warm tropical Pacific and Alaska as well as the tendency for cooler than normal conditions in the southeast United States.*

John Mclean noted how the upwelling of cold water off the South American Coast was shown by McPhaden and Zhang to have decreased by about 25%, from 47 sverdrups in the 1970s to 35 sverdrups in the 1990s (1 sverdrup = 264 million US gallons per second). It is that upwelling of cold water that generates the plume of cold water along the equator in the La Ninas.

The IPCC showed how during the positive phase of the PDO, the sea surface temperature pattern suggested more warmth in the eastern tropical Pacific (thus more El Ninos).

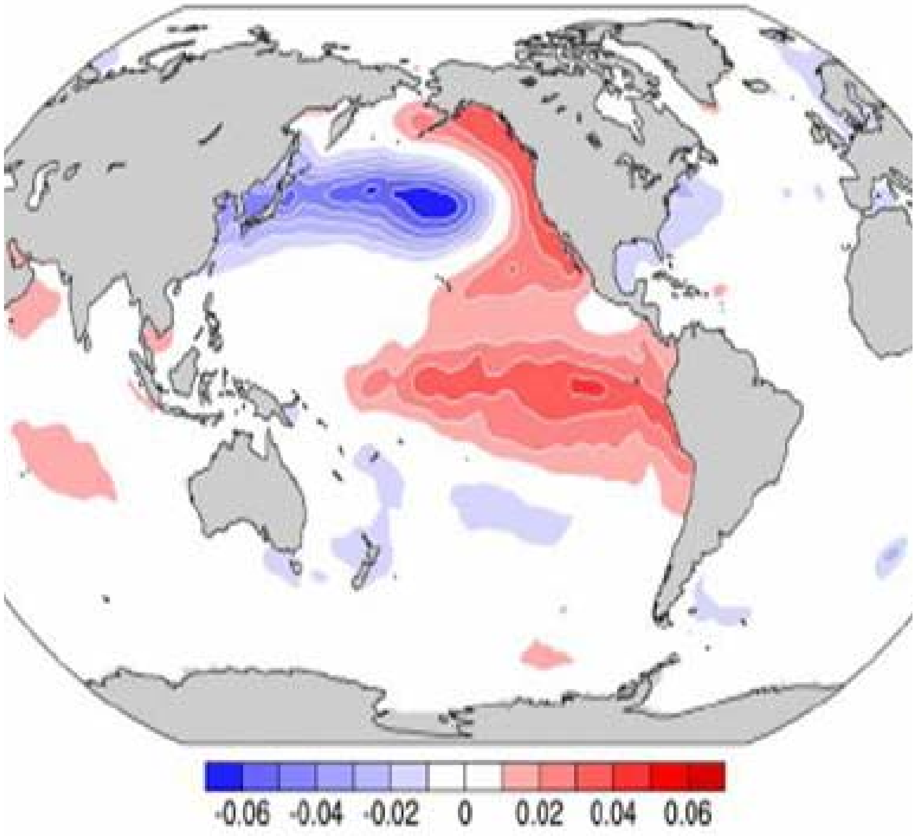



*Figure 5: IPCC AR4 analysis of sea surface temperature anomalies during the warm phase of the PDO. Note the tendency for warmth in the eastern tropical Pacific, implying more El Ninos.*

Wolter's Multicariate ENSO Index indeed shows a greater frequency of El Ninos during the warm phase and the opposite, more La Ninas in the cold phase, when the reverse of the sea surface anomaly pattern above dominates.

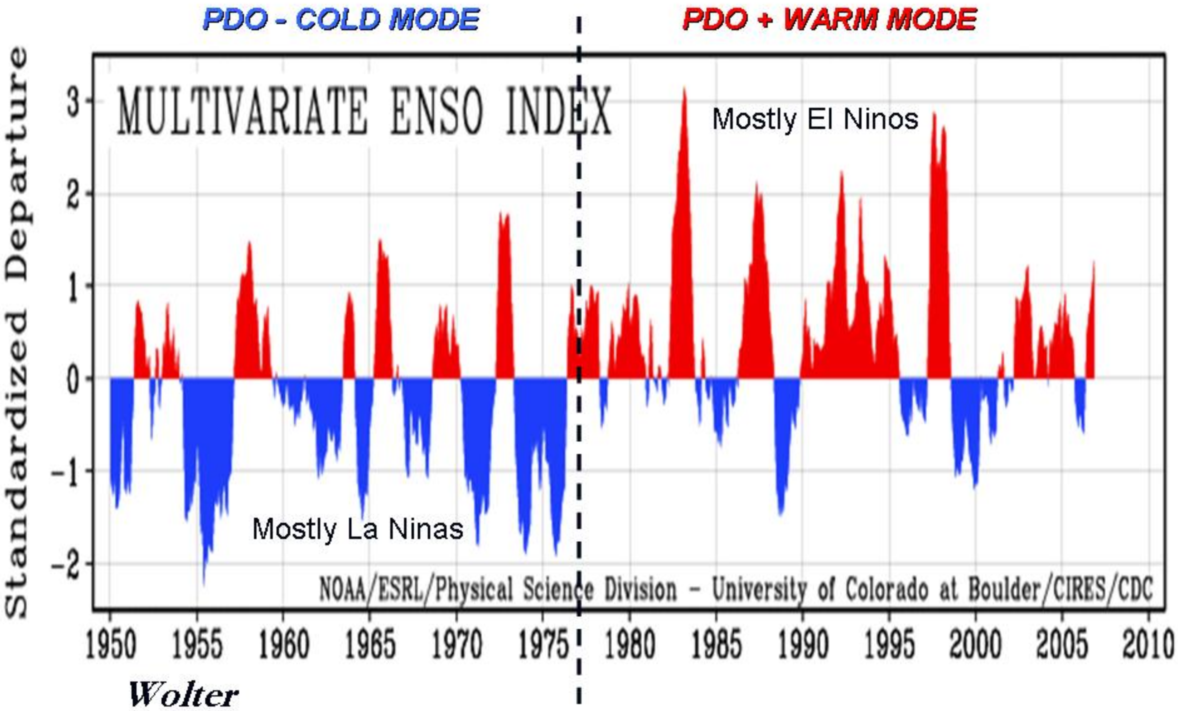



*Figure 6: Wolter's Multivariate ENSO Index (MEI) plotted since 1950. Cold phase of the PDO lasted until 1976 followed by the warm phase. The more significant positive spikes (red) are El Ninos and negative (blue) La Nina*

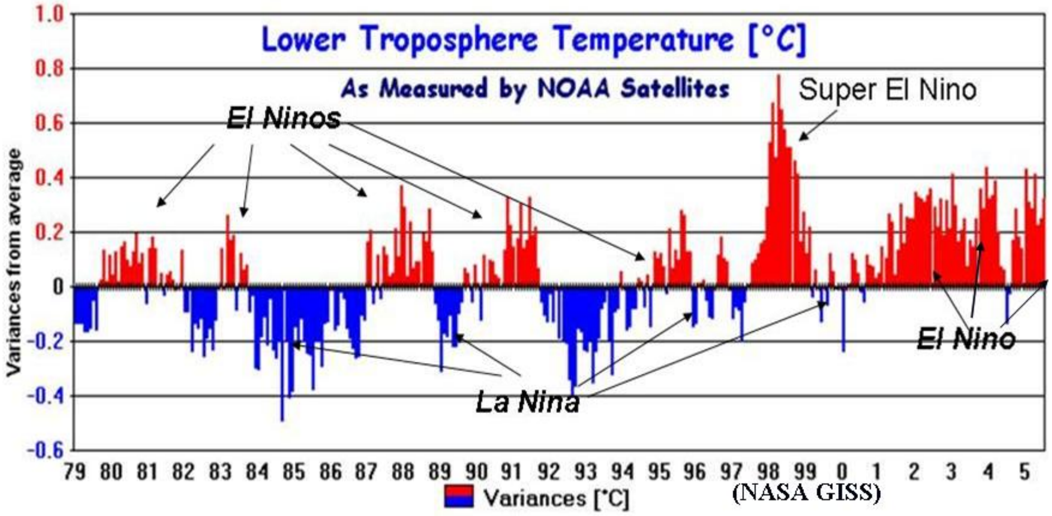
This shows about twice as many El Ninos as La Ninas during the positive PDO and nearly three times as many strong El Ninos and La Ninas. The opposite occurred during the prior cold PDO regime.

| # Years | Cold PDO 1947-1976 | Warm PDO 1977-2006 |
|---|---|---|
| **El Nino** | | |
| **Strong** | 3 | **8** |
| **All** | 7 | **13** |
| **La Nina** | | |
| **Strong** | **8** | 3 |
| **All** | **13** | 7 |

During the cold PDO phase, La Ninas arev very nearly twice as likely as El Ninos and almost three times as many are strong.

The opposite happens during the warm PDO pgase with twice as many El Ninos as La Ninas and almost three times as many are strong

It is well know that El Ninos with their large expanse of warm tropical waters leads to global warmth and La Ninas global cooling. This can be seen in the Spence and Christy's satellite derived temperature plot available only during the warm mode since 1979. The two prolonged cold spells in the early 1980s and 1990s were related to major volcanic activity (Mt. St. Helens/El Chichon and Pinatubo/Cerro Hudson).




*El Ninos lead to global warming and La Ninas to cooling*

*MSU satellite derived data Spencer and Christy*

***THE ATLANTIC MULTIDECADAL OSCILLATION***

The Atlantic too undergoes multidecadal shifts. The Atlantic Multidecadal Oscillation (AMO) produces a warming that peaks about every 70 years as seen below. The AMO turned warm in the late 1980s but then backed of when Pinatubo exploded and led to global cooling. It resumed its climb and turned has been warm since 1995.

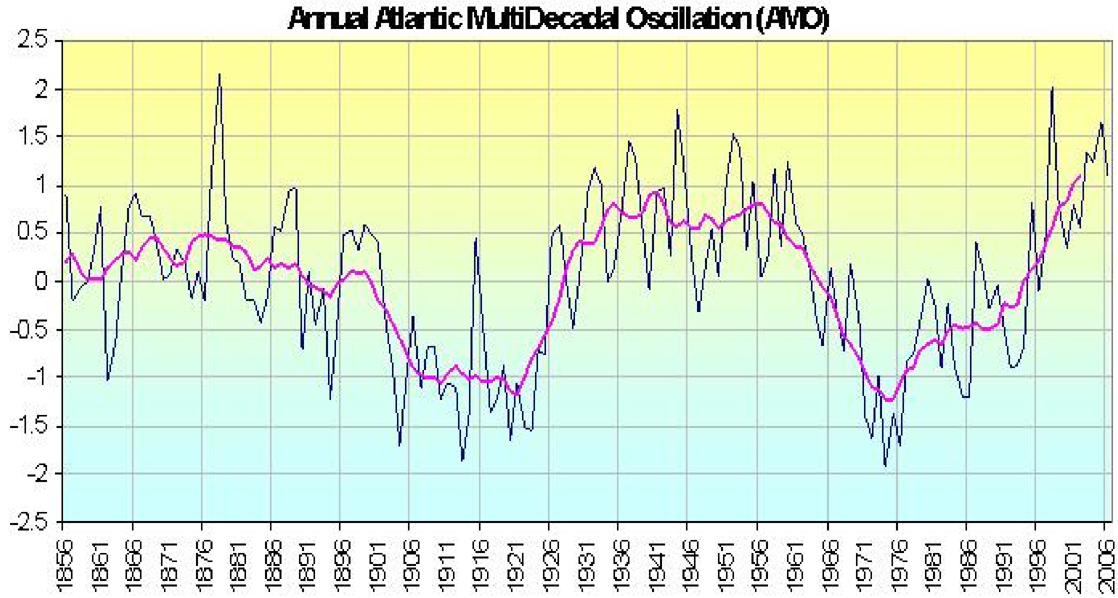
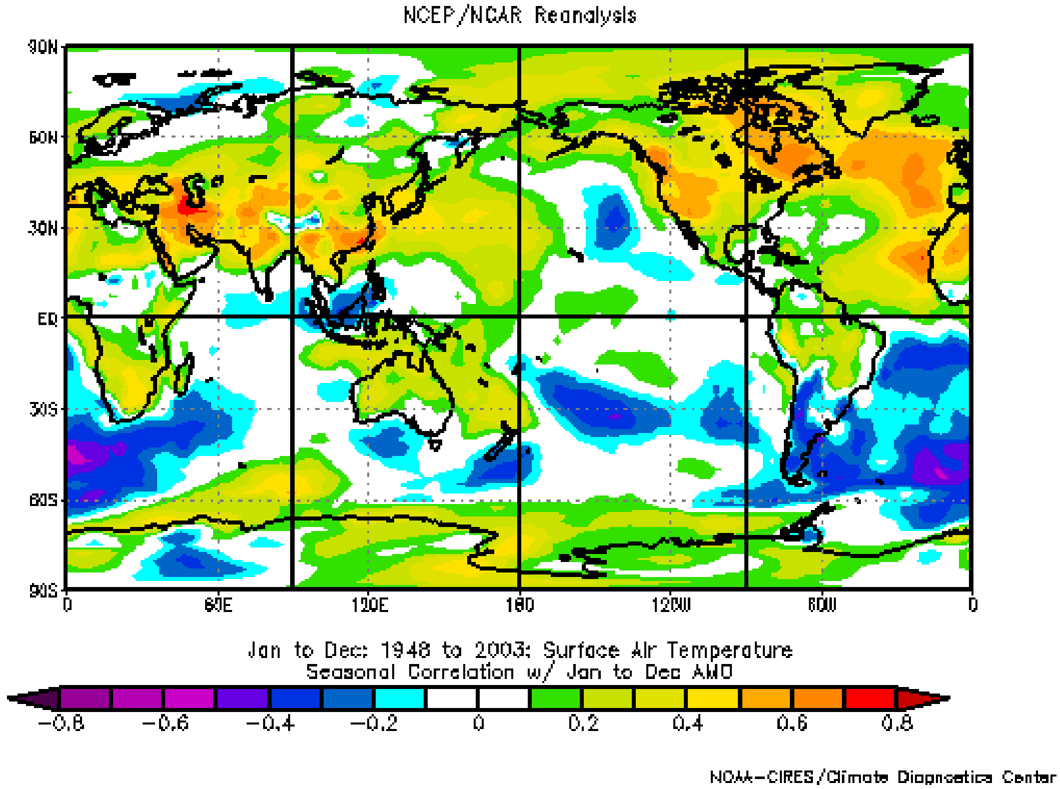



*Figure 7; Atlantic Multidecadal oscillation (AMO) from NOAA CDC. Noite the 70 year cyclical behavior extending back into the mid 1800s.*

We know when the AMO is in its warm mode there is an increase in tropical activity in the Atlantic basin, its cold marks a period of relative quiet. On a global scale, the AMO leads to general warmth especially in the northern hemisphere.




***A COMBINED OCEAN WARMING INDEX AND TEMPERATURES***

Since the warm PDO leads to more El Ninos and El Ninos lead to warmth and the positive AMO leads to general warmth, the sum of the two may be useful as a tool for assessing global warmth potential. I standardized both CDC data sets and then added them.

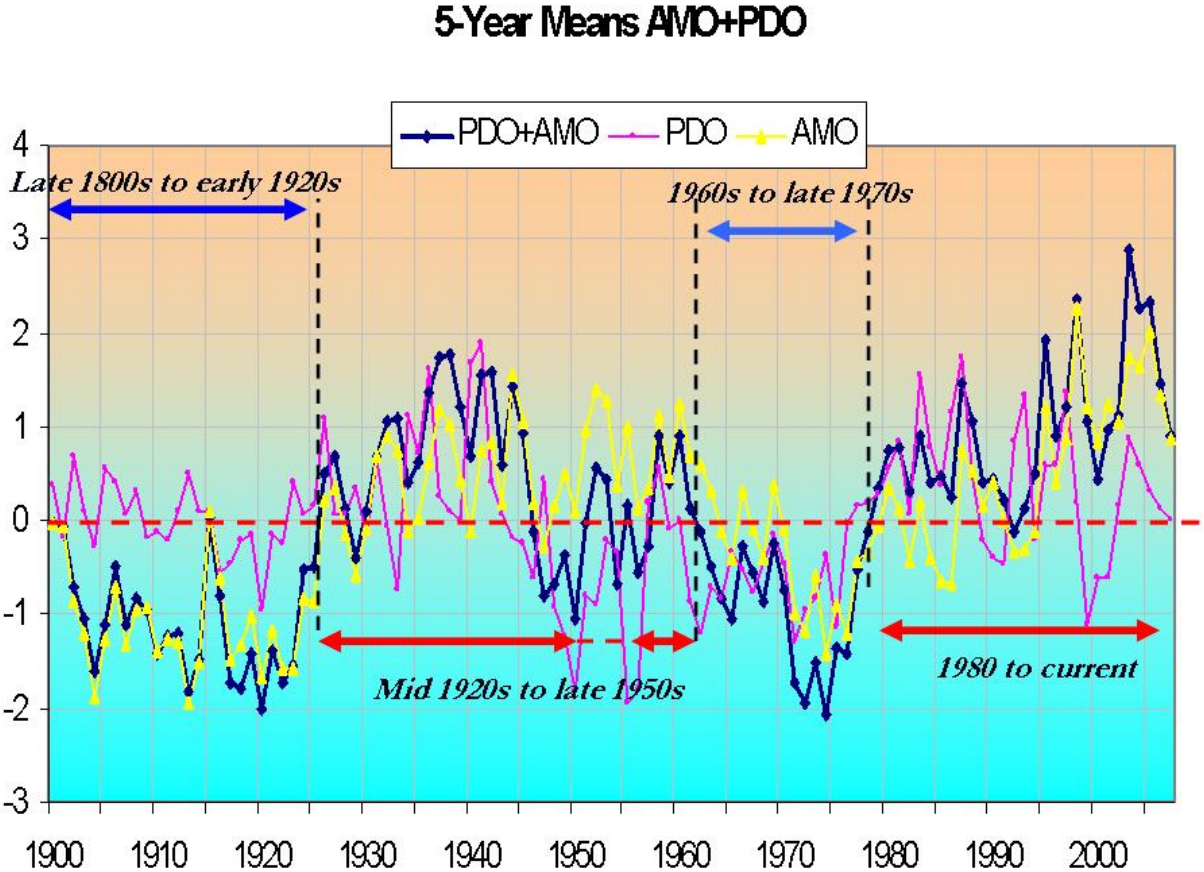



*Figure 8: The AMO, PDO and total AMO+PDO. I found a tendency for negative (favoring cool) from late 1800s to the early 1920s and again from 1960s to the late 1970s. There was a tendency for positive (favoring warm) from the mid 1920s the late 1950s and again after 1980.*

This agrees very well with the NASA GISS US Annual Mean temperatures recently adjusted.

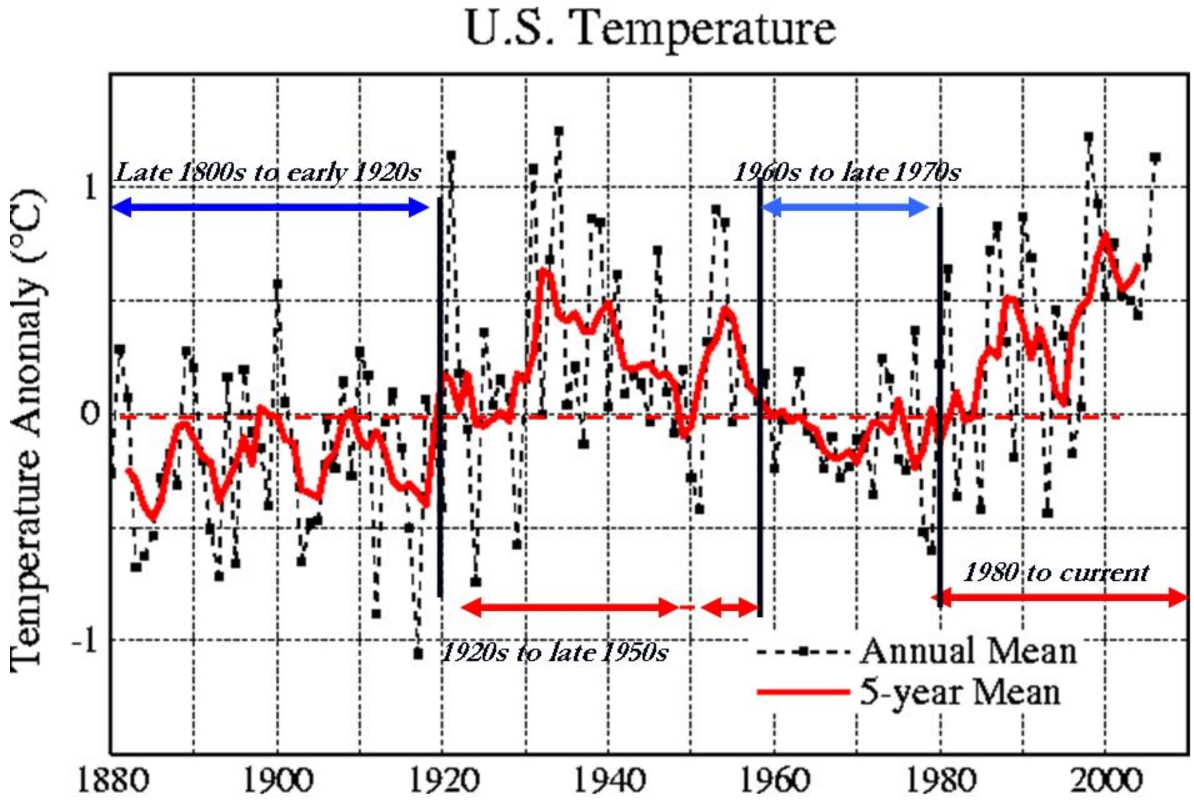



***Figure 9: The NASA GISS USHCN annual Mean Temperatures. Superimposed are the cold and warm ocean periods. Note the excellent agreement.***

I smoothed the temperatures and the sum and did a correlation. I found an r-squared correlation of 0.86!

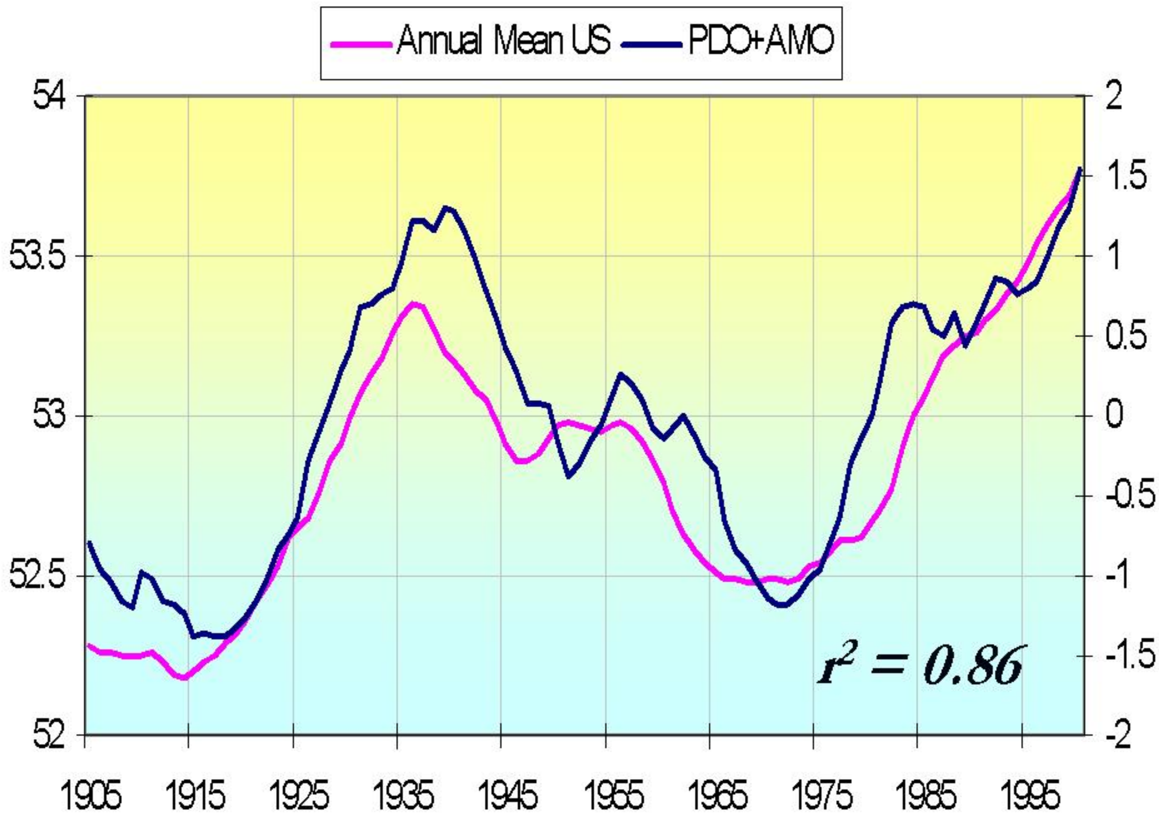



***Figure 9: Smoothed PDO+AMO and USHCN data showing an r-squared correlation of 0.86!***

***THE ARCTIC AND THE OCEAN CYCLES***

Similarly the PDO and AMO are very well correlated with arctic temperatures as warm Pacific water is know to enter the arctic through the Bering Straits and warm north Atlantic water from the Barents Sea. As NSIDC (National Snow and Ice data Center) stated in their blog

**"**One prominent researcher, Igor Polyakov at the University of Fairbanks, Alaska, points out that pulses of unusually warm water have been entering the Arctic Ocean from the Atlantic, which several years later are seen in the ocean north of Siberia. These pulses of water are helping to heat the upper Arctic Ocean, contributing to summer ice melt and helping to reduce winter ice growth.

Another scientist, Koji Shimada of the Japan Agency for Marine–Earth Science and Technology, reports evidence of changes in ocean circulation in the Pacific side of the Arctic Ocean. Through a complex interaction with declining sea ice, warm water entering the Arctic Ocean through Bering Strait in summer is being shunted from the Alaskan coast into the Arctic Ocean, where it fosters further ice loss."

"Many questions still remain to be answered, but these changes in ocean circulation may be important keys for understanding the observed loss of Arctic sea ice."

Dmitrenko and Polyokov (2003) observed that warm Atlantic water in the early 2000s from the warm AMO that developed in the middle 1990s had made its way under the ice to off of the arctic coast of Siberia where it thinned the ice by 30% much as it did when it happened in the last warm AMO period from the 1880s to 1930s

Jennifer Francis of Rutgers University detailed in a recent issue of the journal *Geophysical Research Letters* that the warming waters in the Barents Sea—which have risen about 3 degrees Celsius since 1980—are to blame for the reduction in winter ice cover. "Two factors contribute to the warming of the Barents Sea: warming Atlantic waters funneled in by the Gulf Stream and solar heating of the open ocean as ice melts in the summer, both of which make it harder for new ice to form in the winter.

The latter factor, known as the ice-albedo (reflectance) feedback works like this: As ice melts in the summer, the open ocean warms up as it absorbs the solar radiation that the ice would normally reflect back to space; as global temperatures rise, more ice melts, so the ocean absorbs more heat, and less ice re-forms the next winter, which just keeps the cycle going."

This research supports the notion that the natural cyclical warming Atlantic is partially responsible for the ice loss. How did that warm water get to the Barent's sea? Well it was the natural thermohaline circulation cycling that warmed it in the last decade after cooling down the area for the previous 3 decades. In other words, the Atlantic Multidecadal Oscillation. And Jennifer is exactly right, once the ice melts there is some positive feedback through that albedo effect.

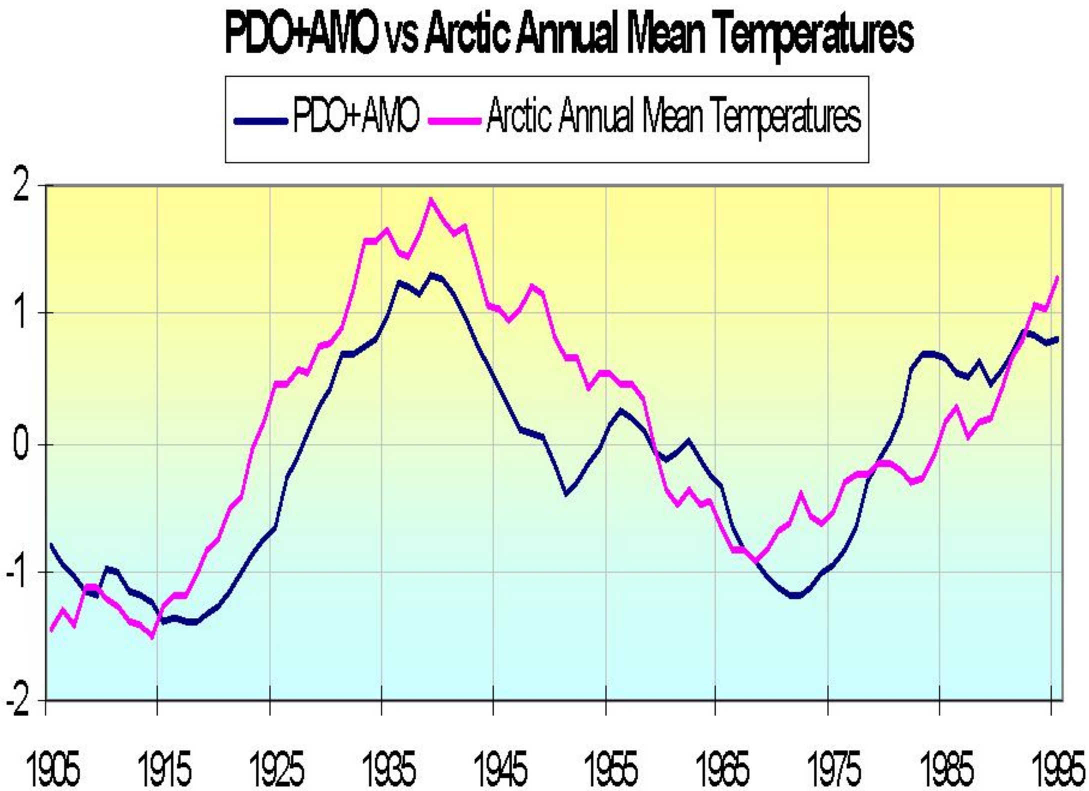



*Figure 10: Smoothed PDO+AMO versus arctic annual mean temperatures from Polyakov (r-squared of 0.73)*

Willie Soon showed in a paper in the GRL how the arctic temperature cycle very well with solar irradiance and how the correlation with carbon dioxide was a poor 0.22 r-squared.

***SUMMARY***

Though recent studies have rediscovered natural variability in the Pacific and attributed the changes to global warming, we have shown how these are simply changes resulting from  multidecadal oscillations that have repeated for many decades and likely centuries. In addition we showed how these cycles correlate extremely well with temperatures in the United States and the arctic. These cycles likely also are responsible for the recent decline in arctic ice as was previously observed in the 1930s and 1940s when arctic temperatures last peaked.

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