I. Background Information

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This comment is meant to address the unproven attribution of climate change to man-made influences, specifically from key finding #1:

"1. Human-induced climate change and its impacts are apparent now throughout the United States.
• *Global warming is unequivocal and is due primarily to human-induced emissions of heat-trapping gases and other pollutants"*

This statement can not be supported when looking at the facts and must be removed. We will show how by process of elimination the greenhouse component must be a very minor one.

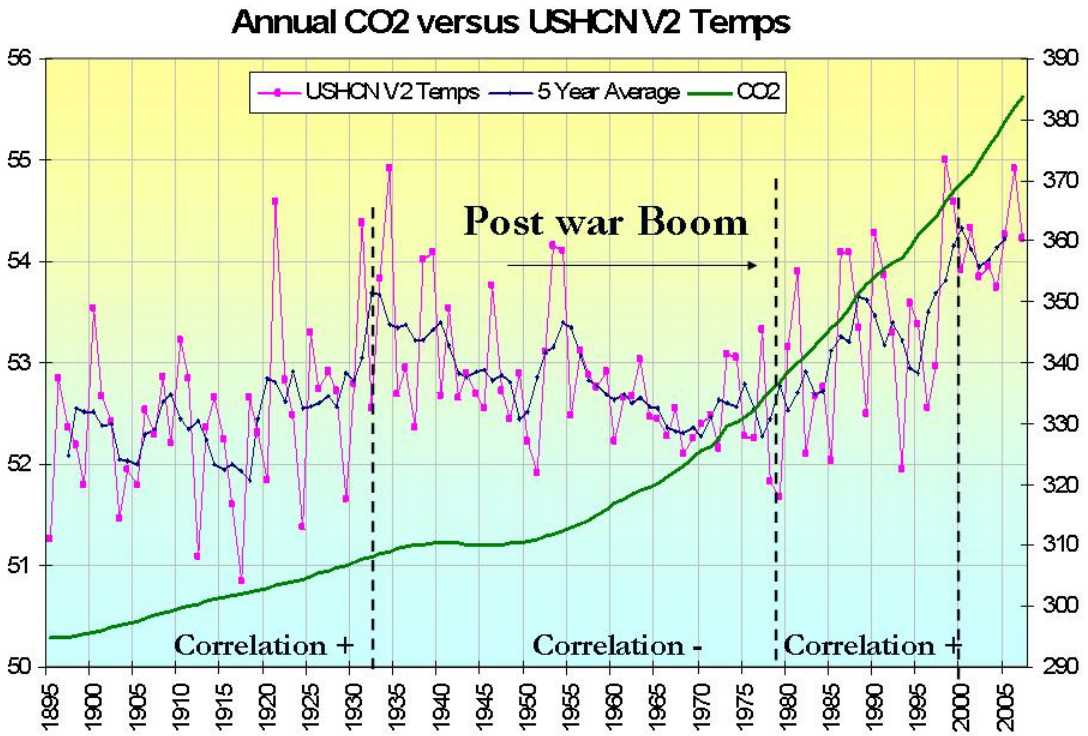
CO2 has generally been portrayed as increasing over the past century based on direct measurements spliced with ice core estimates. I will not get into the claims by atmospheric physicists, chemists and geologists (Jaworowski, Segalstad, Beck) that ice core data is fraught with errors and uncertainty and may be very different prior to 1958 but assume that depiction is correct for the purpose of this analysis.

In addition the CCSP ignores all the other man made localized effects as I discussed in a prior comment and other commenters have addressed like insufficient adjustment for urbanization, land use changes and siting issues which are more important than greenhouse gases.

The CCSP dismisses any natural factors that are present. This document will compare the CO2 temperature correlations with the correlations with natural factors and show that natural factors can not be ignored and use of historical cycles to predict the future states and adaption are the only sensible solutions.

CO2 AND US TEMPERATURES SINCE 1895

If we plot the USHCN version 2 annual mean US temperatures since 1895

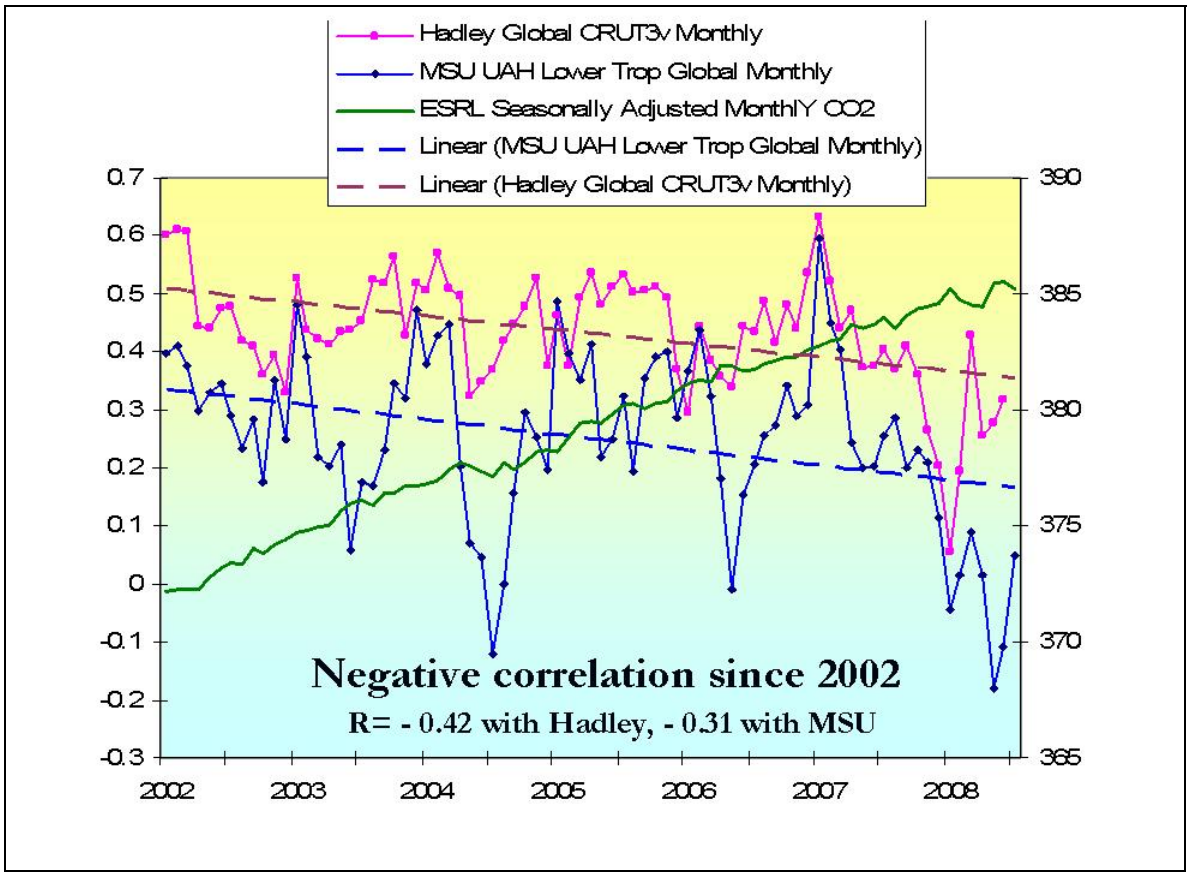


The correlation between CO2 and temperatures was positive from the start of the plot to 1930s. It was negative from the mid 1930s to the late 1970s. It was positive then from 1979 to around 1998.

Temperatures which stopped rising in 1998, began falling in 2002 accelerating in 2008. From 1998 to 2007, the CO2 correlation of the annual USHCN V2 with CO2 was -0.14.

The correlation of the monthly global data bases from Hadley (CRUT3v) and UAH MSU lower troposphere with the ESRL seasonally adjusted monthly CO2 value turned flat in 1998 and then after 2002 significantly negative. Since 2002, CO2 continued to rise, about 3.5%.

The temperature fell in both data bases since 2002 was more than 0.3F. The correlation with CO2 of the Hadley data was a negative 0.42, with the UAH MSU a negative 0.31.



Monthly global temperature anomalies degrees C from Hadley CRUT3v and UAHMSU lower troposphere versus ESRL seasonally adjusted monthly CO2.

This on again (52% of the years), off again (48% of the years) correlation of CO2 with temperatures suggest CO2 is not the primary driver for global and regional long term and cyclical climate changes.

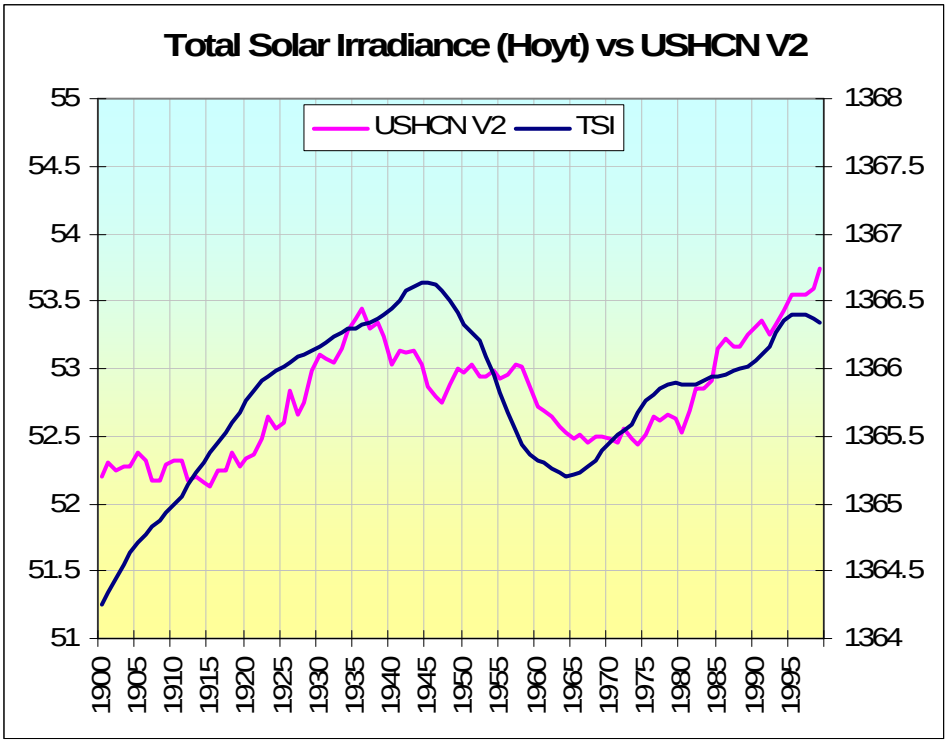
THE SUN AND THE USHCN DATA

The sun was dismissed as a factor in the CCSP in recent years because of the cooling in the stratosphere. In the IPCC report it was dismissed with a single flawed last minute paper from Wang and Lean that led the IPCC to downplay solar forcing by a factor of 7 even though much recent peer review literature argued the solar was an important factor through direct and indirect means.

Despite the CCSP's and IPPC's flimsy reasons to dismiss it, the sun is a major factor in climate change over time. The sun has effects both direct and indirect on temperatures. The earth's temperatures have been shown to correlate with changes in solar brightness or irradiance (Soon, Hoyt/Schatten, Scafetta/West), UV warming through ozone chemistry high up in low and mid latitudes (Shindell, Labitzke), solar wind variances (Boberg and Lundstedt), and geomagnetic storms that warm high latitudes (Labitzke, Pyche et al), and through the effects of an active sun on low cloudiness by diffusion

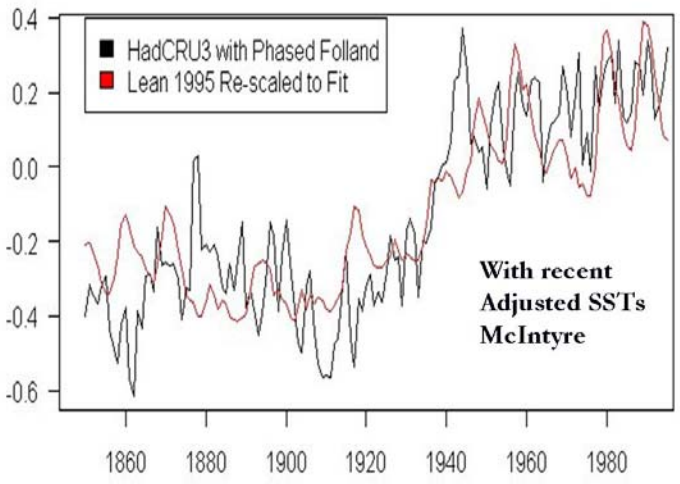
cloud nucleating cosmic rays (Svensmark, Bago and Butler, Tinsley/Yu, Shaviv, many others).

Scafetta and West (2007) have shown in a phenomenological approach how the total solar irradiance, used as a proxy for the total (direct and indirect) solar effect, could account for as much as 69% of the changes since 1900 depending on the TSI reconstruction used. The following shows an 11 year smoothed total solar irradiance from Hoyt and Schatten with USHCN V2, similarly smoothed. This is done to filter out the 11 year variations related to the 11 year cycle.



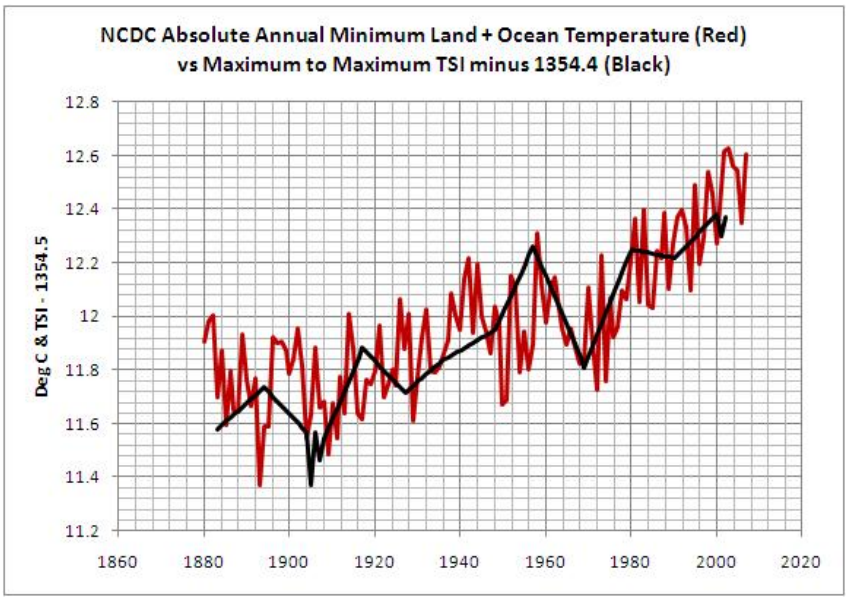
The correlation (r or Pearson) was 0.77 (r-squared of 0.59) for the TSI with this data set.

Steve McIntyre on Climate Audit showed an excellent fit of Lean TSI with the Folland adjusted HADCRU3 data.



Bob Tisdale has taken the NCDC Absolute Annual Global Land + Ocean 1880 to 2007 and compared to the maximum TSI (-1354.4 for scaling to same plot).

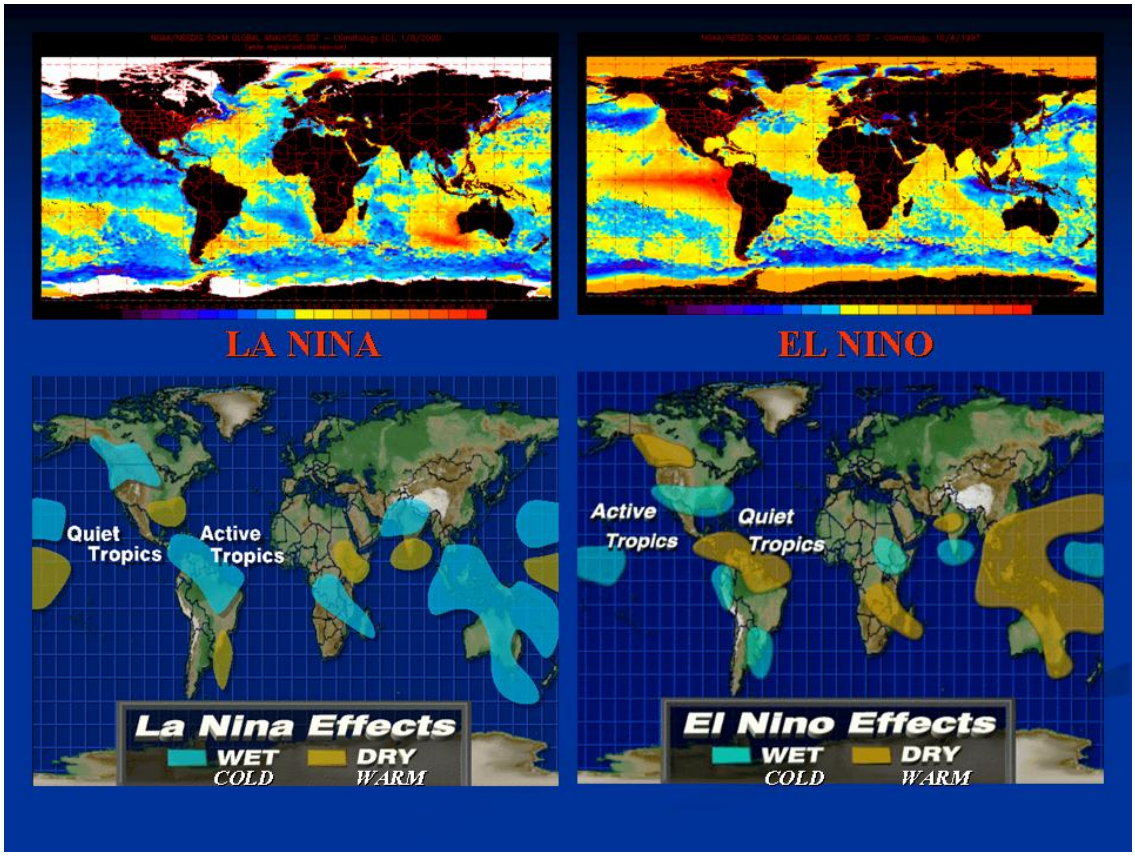
The correlation of the two curves appears to infer that minimum annual global temperature is a function of maximum TSI, or a derivative thereof.



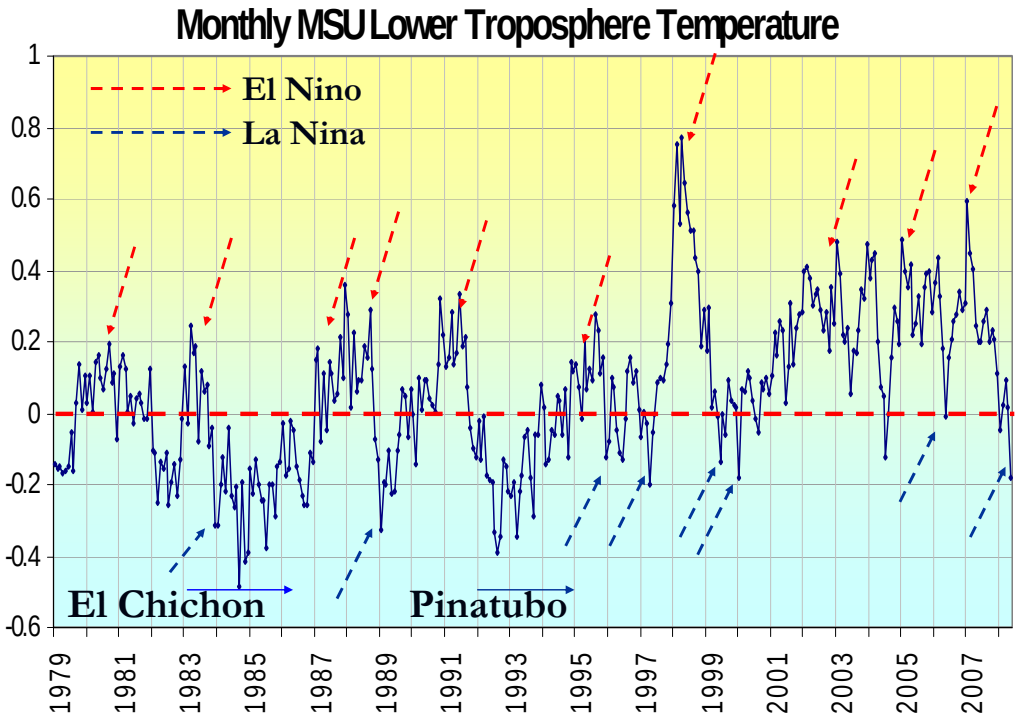
These plots suggest you cannot rule out the solar influence. Good science would have us investigate any and all possible solar contributions to climate change with an open mind.

ENSO AND THE MULTIDECADAL CYCLES IN THE OCEANS

Following the Super El Nino of 1982/83, research into the global effects of El Ninos and La Ninos began. In 1986, the first is the series of landmark papers, Ropelewski and Halpert showed statistically significant connections between ENSO and global temperature and precipitation patterns. The series showed the following tendencies.



In general more of the earth is cold during La Nina and warm during El Ninos. This can be clearly on this plot of global temperatures from UAH MSU temperatures since 1979. Each El Nino produces a warm spike, each La Nina a cool dip. The cooling due to the global cooling from major volcanoes in the early 1980s and early 1990s is also shown.



The frequency of El Nino and La Nina has varied on multidecadal scales.

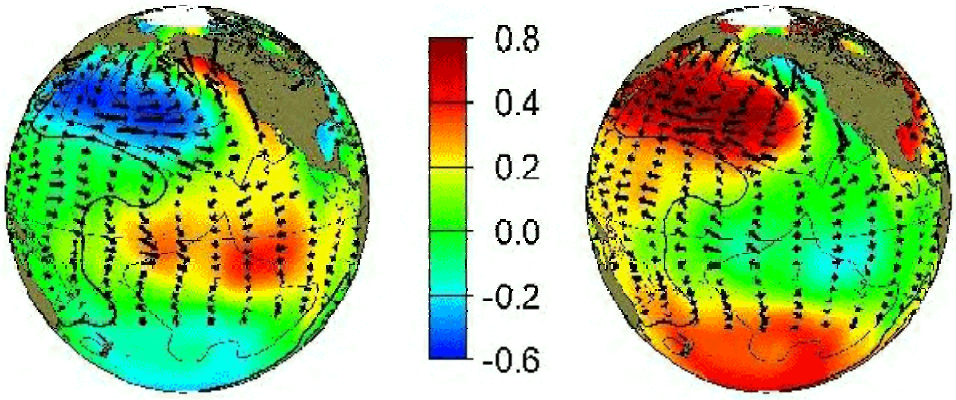
John McLean in a paper here reported Australia's CSIRO and Bureau of Meteorology (Power and Smith 2007) argued the recent period of unprecedented El Niño dominance the last 30 years was due to human activity. Vecchi (2006, 2007) speculated there was a just 1% probability that this was due to natural events. They are very wrong.

THE PACIFIC DECADAL OSCILLATION

McLean's paper and the following discussion will show how the change had precious little to do with anthropogenic factors but was the result of a natural large scale cyclical climate flip-flop known now as the Pacific Decadal Oscillation.

The first hint of a basin wide cycle was a recognition of a major regime change in the Pacific in 1977 among climatologists that became known as the Great Pacific Climate Shift. Later on this shift was shown to be part of a cyclical regime change given the name Pacific Decadal Oscillation by Mantua (1997). This followed research first showing decadal like ENSO variability by Zhang in 1993.

Mantua found the Pacific Ocean temperature regime and overlying pressure patterns tended to persist in one mode (in terms of ocean temperature anomalies and overlying pressure and wind patterns) for two or three decades and then flip to very nearly the opposite mode for a similar period.



Mantua's PDO positive warm phase (left) and negative cold phase (right). Colors represent sea surface temperature anomalies (reds are warmer than normal, blues colder than normal). Note a tendency for El Ninos in the positive warm phase and La Ninas in the negative cold phase.

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.

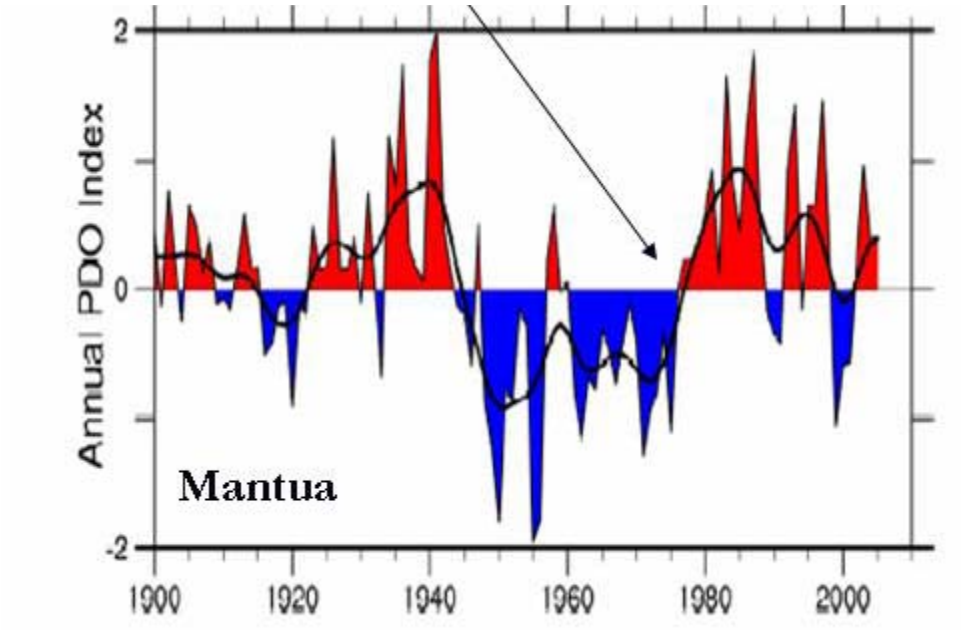
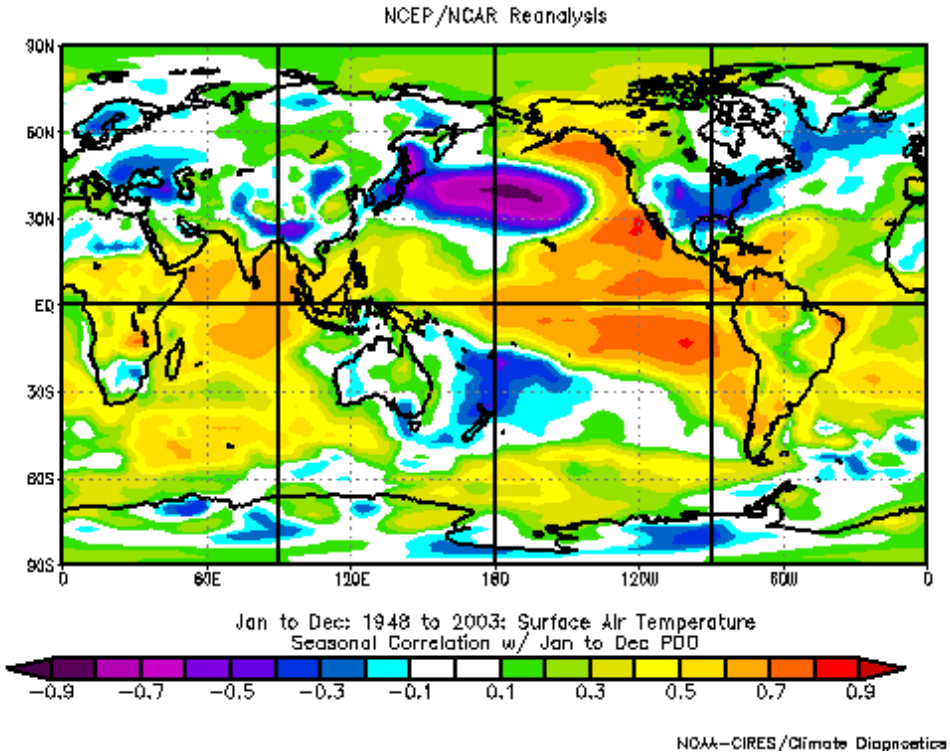


Figure 2: The PDO since 1900. Note the dominant warm regime from 1922 to 1947, cold from 1947 to 1977 and then mainly warm from 1997 to 2006. The arrow points to the Great Pacific Climate Shift around 1977.

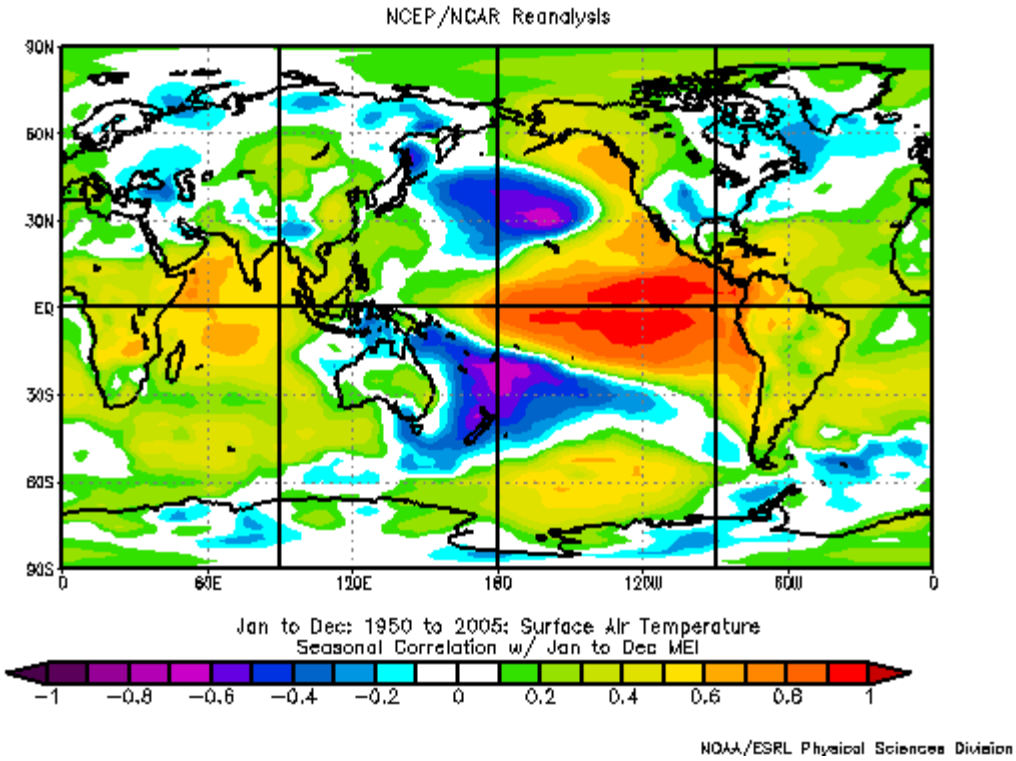
Temperatures during the positive warm mode tend to be above normal in the tropical Pacific and along the west coast of North America to Alaska but cooler than normal in the southeast United States. The opposite occurs in the negative cold mode. This can be

clearly seen using Climate Diagnostics Center Reanalysis data correlations. For the positive mode, yellows and reds show abnormal warmth, blues and purples, coolness.



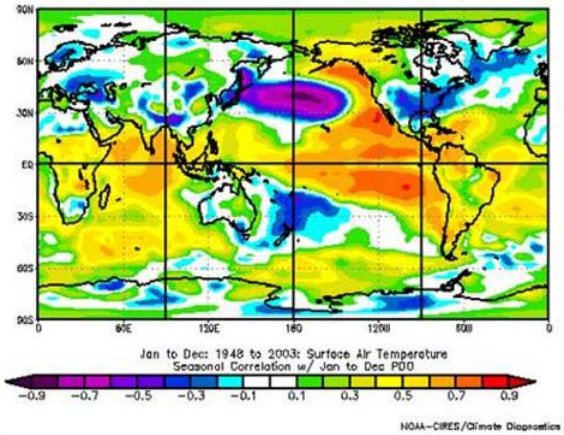
The global temperature regimes during the warm phase of the PDO as provided by NOAA CIRES CDC. Note the tendency for a warm tropical Pacific (El Nino, warmth in Alaska but a cool southeast United States.

This by the way is very similar to the global correlation to El Ninos.

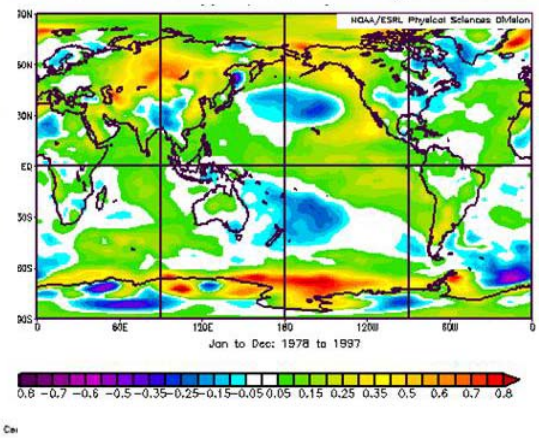


Global temperatures have followed this El Nino signal and PDO cycle very well. It warmed during the warm mode from 1922 to 1947, cooled during the cold mode after a few years till a few years after the Great Pacific Climate Shift in 1977, warmed after a few years into the warm PDO mode after 1980. The following CDC reanalysis shows ACTUAL temperature anomalies on an annual basis for the warm mode from 1978 to 1998, a very close match to the correlation shown.

Positive PDO Correlation Temps

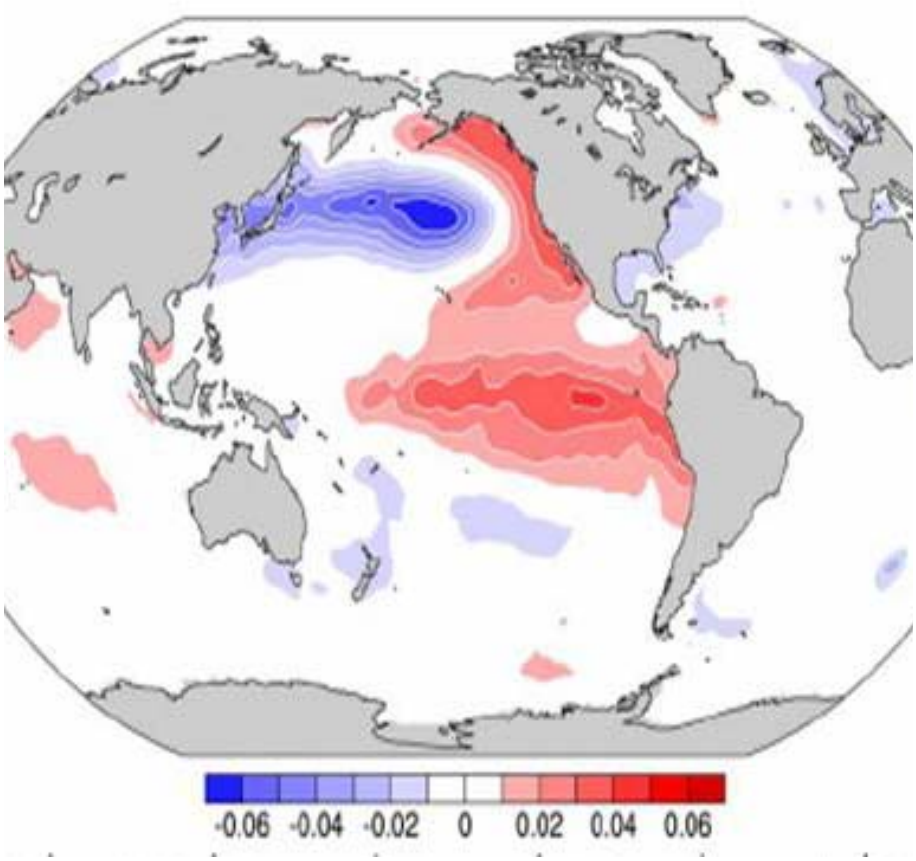


Actual Mean Annual Anomaly 1978-1997



Actual annual global temperature anomalies after the Great Pacific Climate Shift in the PDO warm era from1978 to 1997. Note the warm tropical Pacific and Alaska as well as the tendency for cooler than normal conditions in the southeast United States as the corrrelation with PDO and El Ninos suggested.

The IPCC (2007) also 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).

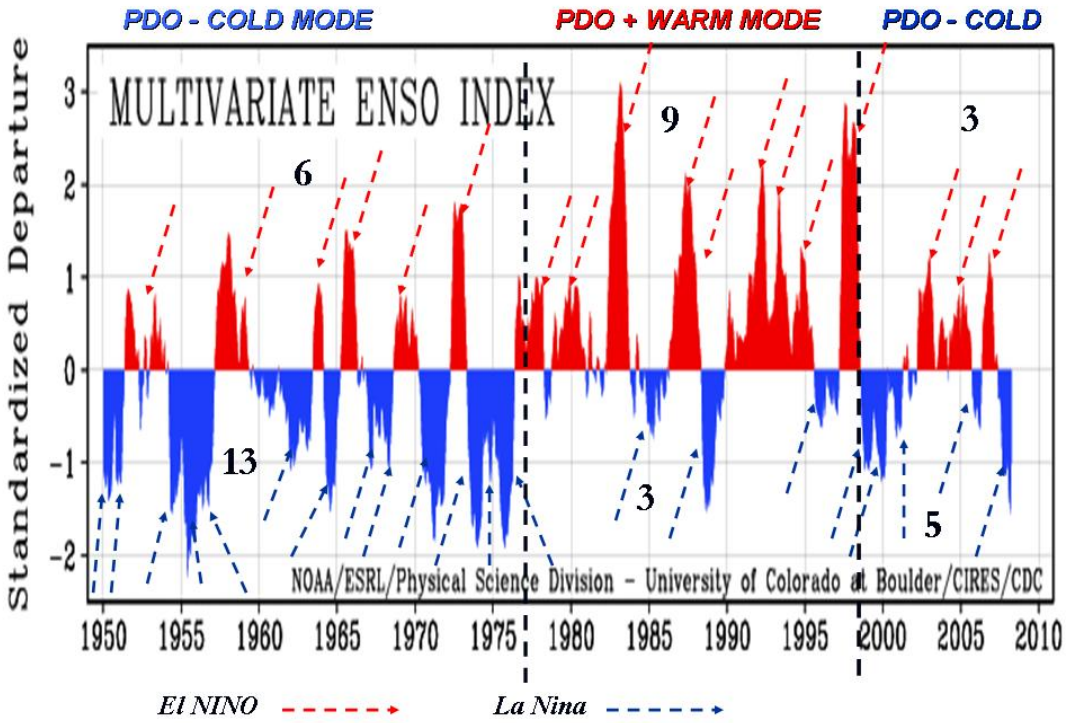


IPCC AR4 analysis of sea surface temperature anomalies during the warm phase of the PDO. Note the tendency for warmth in the eastern tropical Pacific, implying more El Ninos.

There are three principal measures of ENSO, one official. I have chosen to use Wolter's Multivariate ENSO Index (explained here). You can see clearly the predisposition for more and stronger La Ninas and fewer weaker El Ninos during the cold phase of the PDO and more and stronger El Ninos and fewer cooler La Ninas.

I have chosen the MEI because it is relatively stable month-to-month because it includes a combination of the ocean and atmospheric parameters. The SOI (Southern Oscillation Index measure the atmospheric pressure differences (Darwin to Tahiti) which are subject

to both the ENSO state and the Madden Julian Oscillation and thus bounces around more week-to-week, even day-to-day.

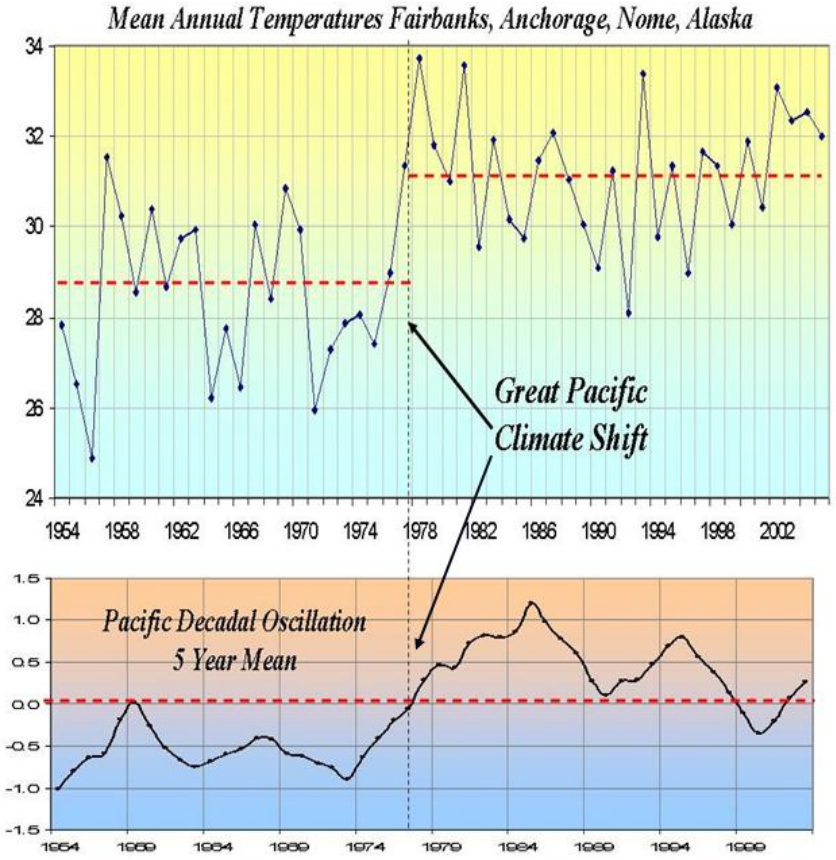


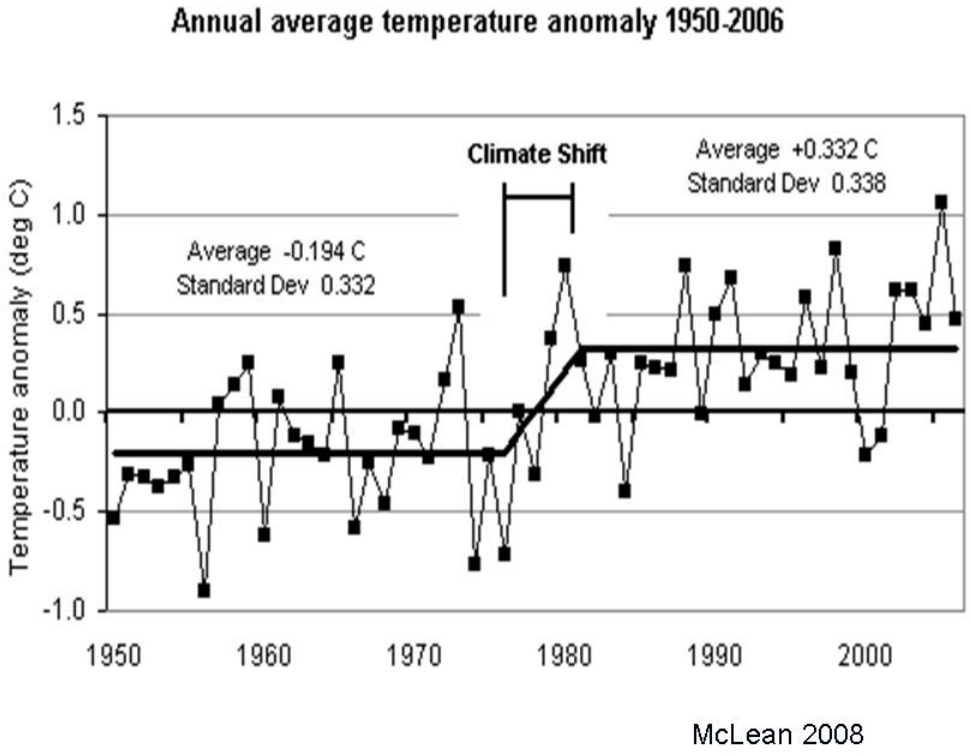
Wolter's Multivariate ENSO Index indeed shows a greater frequency and relative strength of El Ninos (positive MEI values in red) during the warm phase and the opposite, more and stronger La Ninas in the cold phase (negative MEI values in blue), when the reverse of the sea surface anomaly pattern above dominates.

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.

It has been shown 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 MSU 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 in early 1980s and Pinatubo/Cerro Hudson in early 1990s).

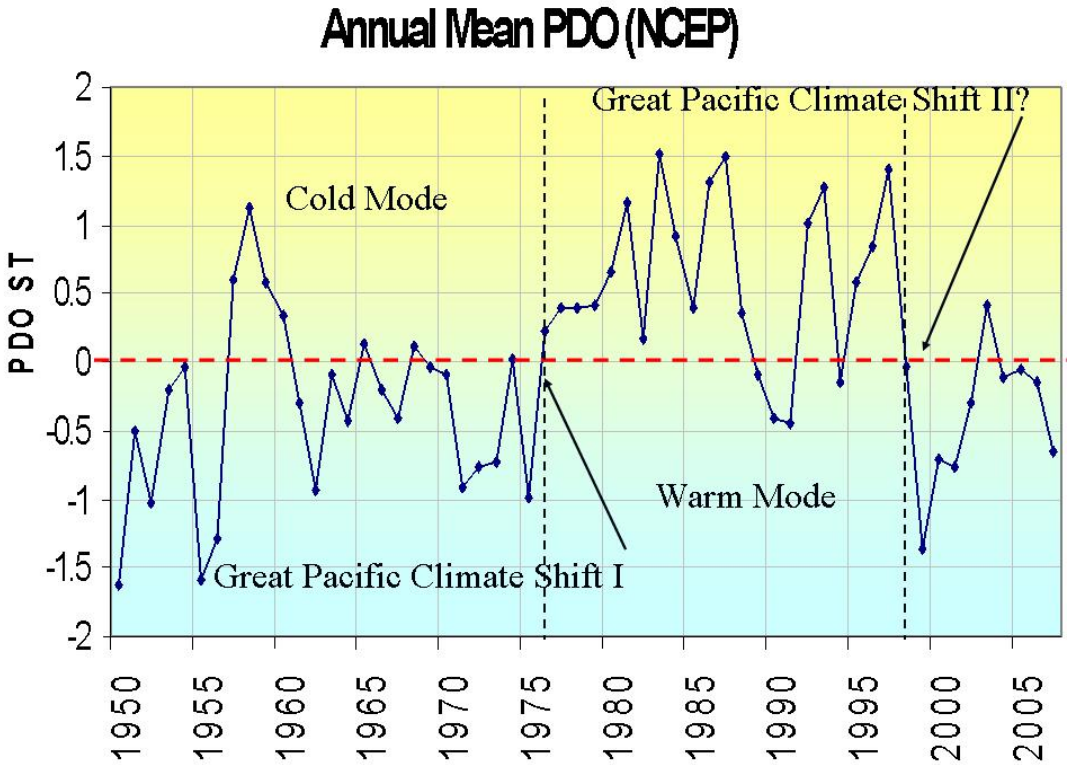
Changes with flips of the PDO occur rapidly and in step ladder form. This can be seen for Alaskan cities and by McLean for global temperatures.


Mean Annual Temperatures Fairbanks, Anchorage, Nome, Alaska
34
32
30
28
26
24
1954
1958
1962
1966
1970
1974
1978
1982
1986
1990
1994
1998
2002
Great Pacific
Climate Shift
Pacific Decadal Oscillation
5 Year Mean
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5



HAVE WE EXPERIENCED GREAT PACIFIC CLIMATE SHIFT II – A REGIME CHANGE IN PDO?

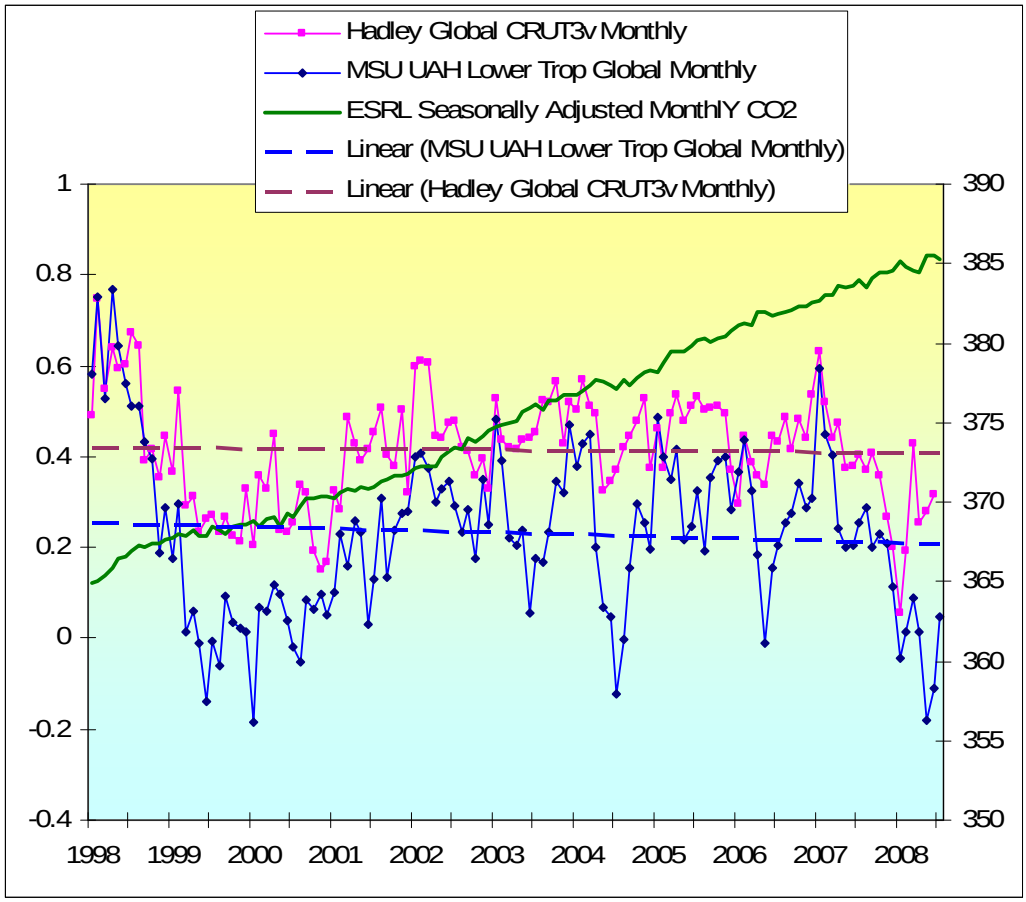
The PDO appears to have changed back to the cold mode in 1998 following the Super El Nino of 1997/98. Three straight years of La Nina followed. PDO bounced some during the early 2000s but this year dropped off dramatically again this past year as a strong La Nina developed. It has been running almost 2 STD negative thus far in 2008. Since it is 30 years since the last climate shift, it appears likely this negative mode should continue.



NCEP PDO annual average (standardized), Note the cold mode until 1977, warm mode after 1978 to 1998. After 1998, we have been mostly neutral to negative

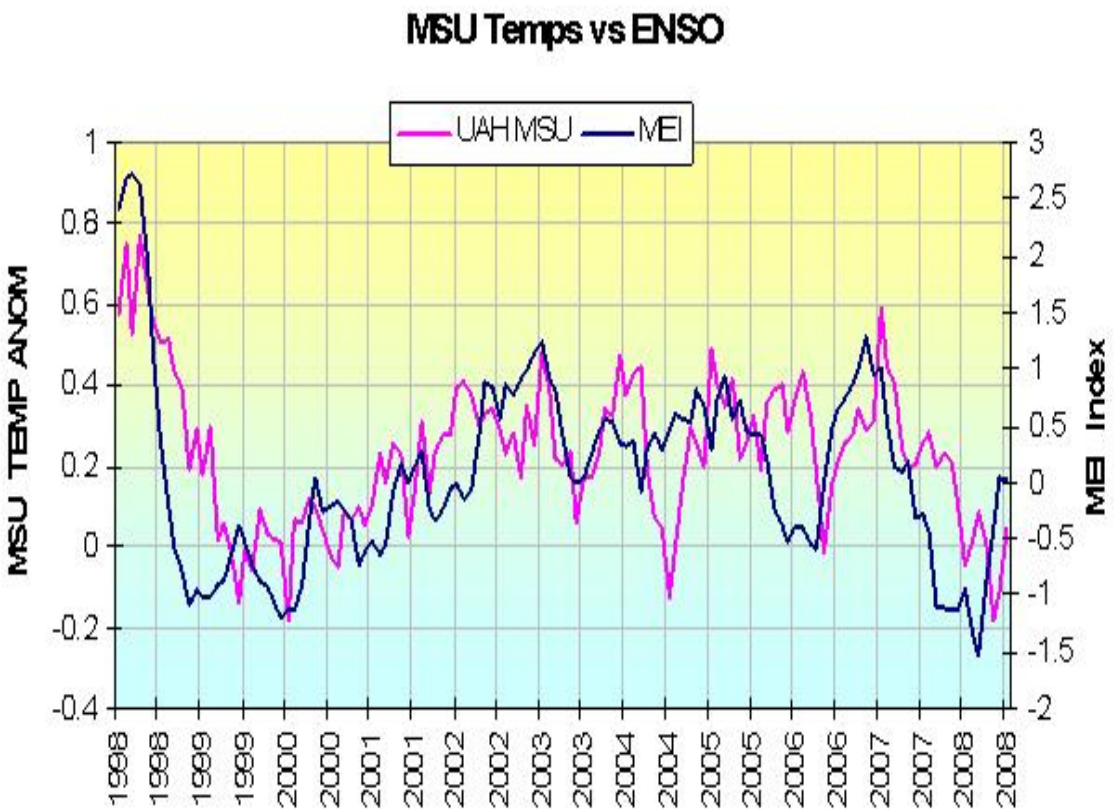
If this regime change has indeed taken place, this would mean there would be more, stronger La Ninas and fewer, mainly weaker El Ninos in the next few decades. This would imply a cooling of global temperatures much as we saw in the last cool negative PDO phase from 1947 to 1977. Temperatures have not warmed since 1998 globally.

Note the similarity of the global temperature trends to this pattern with a spike in 1998 with the super El Nino, a big dip in the late 1990s to 2001 with a drop of PDO and moderately strong La Ninas, followed by a rise again with a PDO bounce and three El Ninos in the early 2000s until the La Nino and drop in PDO again this past year.



University of Alabama MSU satellite derived lower tropospheric temperatures variations from average. Hadley Center CRU land and ocean global temperature anomalies and ESRL seasonally adjusted CO2 .

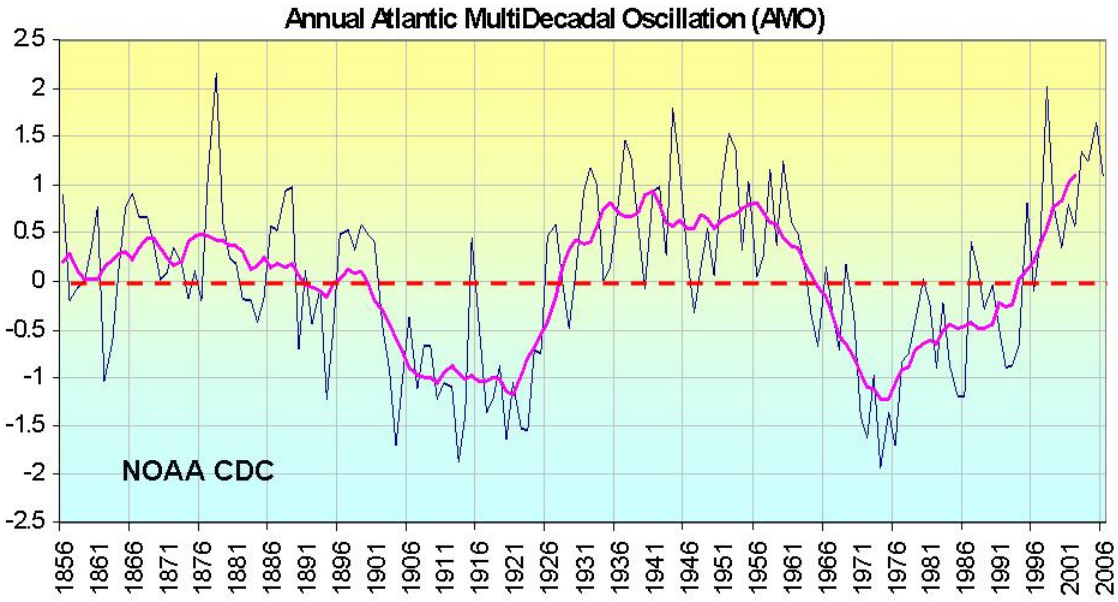
See how well the temperatures did correlate well with the El Ninos and La Ninas during that decade.



The PDO is clearly a driver in global (and regional) climate corresponding with changes in the relative frequency of El Nino and La Nina and through that, global temperatures (and as we will show in a future blog storm track and precipitation). ENSO clearly correlates with global temperatures, with rising global temperatures in decades when El Nino dominate and falling temperatures when La Ninas dominate.

THE ATLANTIC MULTIDECADAL OSCILLATION (AMO)

A similar multidecadal cycle is observed in the Atlantic, as suggested by the IPCC related to variations in the strength of the Thermohaline circulation. The cycles average 65 to 75 years in length and extend back hundreds of years. The measure used by CPC is the annual mean temperatures from 0 to 70N standardized.

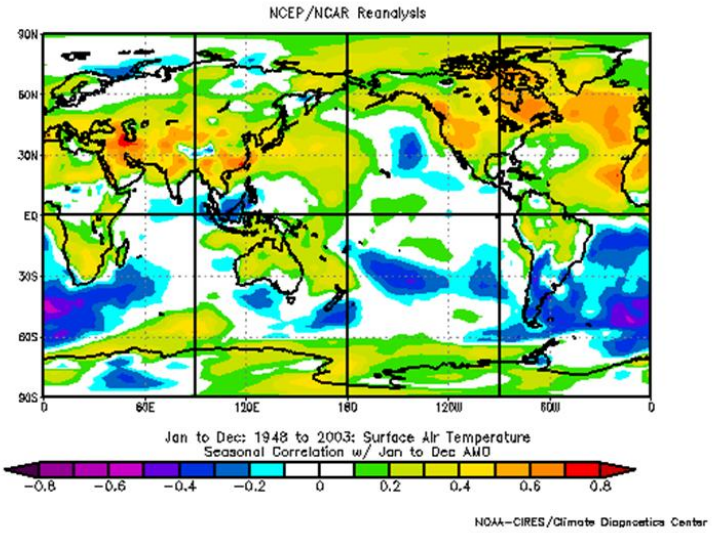


Mean ocean temperature anomalies in the Atlantic from 0 to 70N

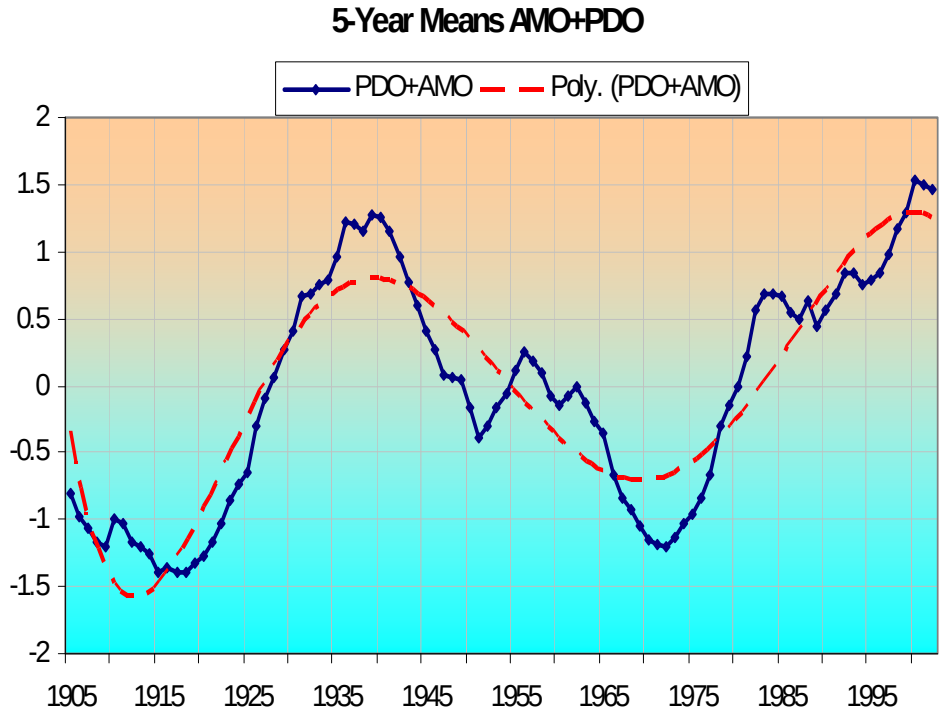
When the Atlantic is in its warm mode, there is a tendency for warmth across the Northern Hemispheric continental areas on an annual basis, although blocking in winter can make for spells of extreme cold.

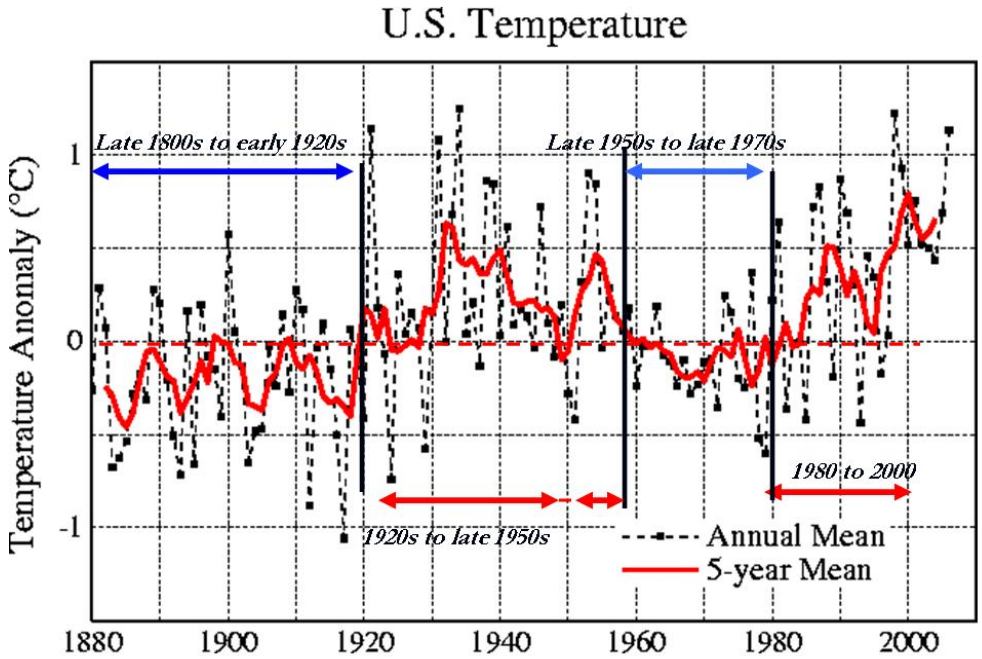
Atlantic Multidecadal Oscillation

Correlates with general warmth, statistically significant in places

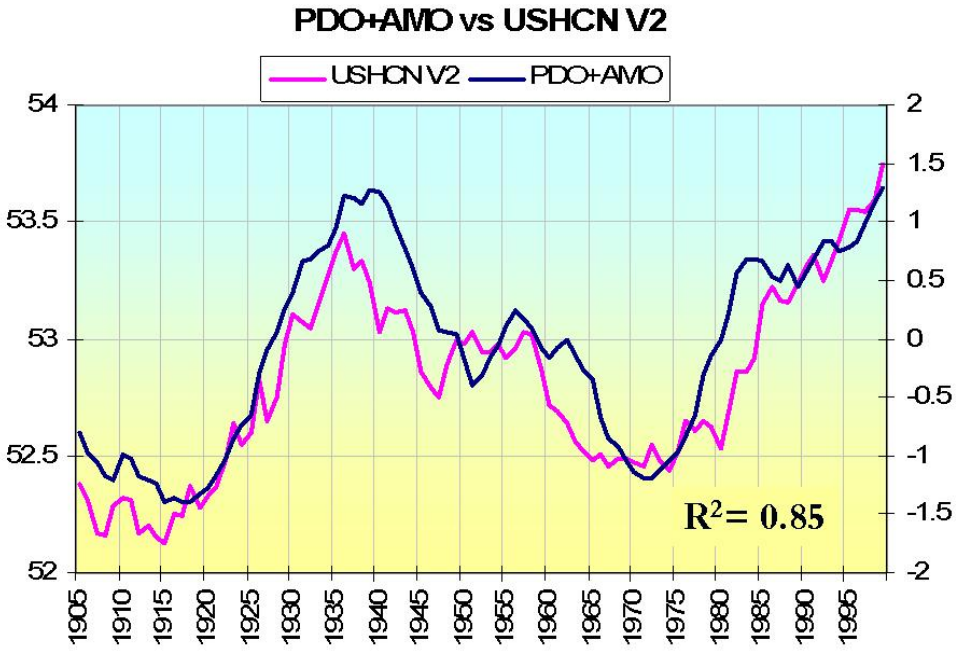


If + PDO relates to more El Ninos which lead to global warming, and if +AMO relates to general global warmth, the sum of the two may be useful in identifying warm periods (and when negative cold periods).

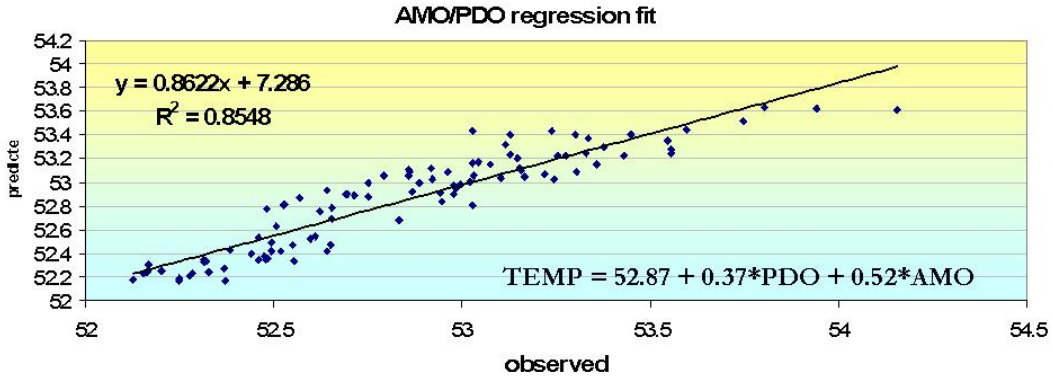


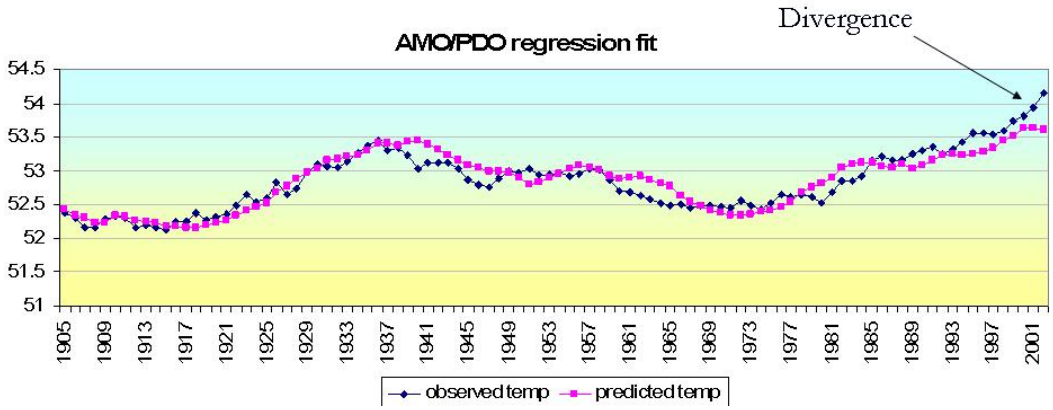


As you can see very clearly this matches USHCN annual mean temperatures as plotted by NASA from USHCN. Positive net AMO and PDO are warm eras, negative cold periods.



The three data sets were then fit using multiple regression. The correlation here was shown to be impressive (r-squared of 0.85).





The slight divergence at the end was not there when the same thing was done with USHCN V1. The divergence may be due to the removal of the urban adjustment and the introduction of questionable methodology for finding and adjusting for local change and urban signals in the data. The data changes from USHCN version 1 with the urban and known siting adjustments to version 2 with a change point detection algorithm approach are odd and highly suspect.

SUMMARY

Correlations of temperature data with CO2 and solar and ocean cycles shows that natural variability can not be dismissed. The on again off again correlation of temperatures with CO2 suggest this may not be an important climate driver though largely due to population increases globally from 1.5 to 6.5 billion in 100 years, man plays some role in observed temperature rises. Strong consistent correlation of temperatures with solar and ocean cycles suggest these are the primary drivers in decadal scale changes. They are likely not independent. The sun has a significant effect on global and especially tropical oceans and may itself the ocean cycles. Research into these factors is sorely needed. The cycles further offer an opportunity to anticipate and forecast forward in time much more accurately than we can with the climate models. Our own Climate Prediction Center is an example of that. 15 years ago, they were proclaiming their new climate models was the method of choice but found their skill was limited and moved to statistical methods focusing mainly on ENSO.

CORRECTION REQUESTED

The first key finding needs rewriting and the following document changes changed to reflect it.

"1. Climate Change is unequivocal as the only constant in nature is change. *Changes are in part due to man through urbanization, land use changes, the introduction of aerosols and gases. Natural factors like the sun and oceans play important roles in global and regional changes.*

Recommendations should be made that much of the wasted research money now funneled to modeling and global warming impact studies be redirected towards a better understanding of these real climate drivers and that the cycles be used to project future climate changes with recommendations for adaption to those changes.

I will address the regional issue in a separate comment.

REFERENCES

SOLAR

Boberg, F. and H. Lundstedt, 2002: Solar wind variations related to fluctuations of the North Atlantic Oscillation, Geophys. Res. Lett., 29, doi:10.1029/2002GL014903.

Coughlin, K.T., and Tung K.K., 2003: 11-Year solar cycle in the stratosphere extracted by the empirical mode decomposition method, Advances in Space Research doi:10.1016/j.asr.2003.02.045

Fröhlich, C., and J. Lean, The sun's total irradiance: Cycles, trends, and related climate change uncertainties since 1976, Geophys. Res. Lett., 25, 4377–4380, 1998.

Gleissberg, W.: (1958), the 80-year sunspot cycle, Journal of British Astronomy Association 68, pg 150

Hoyt, D.V. and Schatten, K.H. (1997): The role of the sun in climate change, New York Oxford, Oxford University Press, 1997

Hoyt, D.V. (1979): Variations in sunspot structure and climate, Climate Change, 2, pp 79-92

Labitzke, K., The global signal of the 11-year sunspot cycle in the stratosphere: Differences between solar maxima and minima, Meteorol. Zeitschift, 10, 83–90, 2001.

Moberg, A., et al. (2005), Highly variable Northern Hemisphere temperatures

reconstructed from low- and high-resolution proxy data, Nature, 433,613– 617.

Palle Bago, E., and Butler, C.J. (2000): The influence of cosmic rays on terrestrial clouds and global warming, Astron. Geophysics, 41, 4.18-4.22

Palle Bago, E., and Butler, C.J. (2001): Sunshine records from Ireland: Cloud factors and possible links to solar activity and cosmic rays, International Journal of Climatology 21, 709-729

Scafetta, N., and B. J. West (2005), Estimated solar contribution to the global surface warming using the ACRIM TSI satellite composite, Geophys.Res. Lett., 32, L18713, doi:10.1029/2005GL023849.

Scafetta, N., and B. J. West (2006a), Phenomenological solar contribution to the 1900 – 2000 global surface warming, Geophys. Res. Lett., 33,L05708, doi:10.1029/2005GL025539.

Scafetta, N., and B. J. West (2006b), Reply to comment by J. L. Lean on ‘‘Estimated solar contribution to the global surface warming using the ACRIM TSI satellite composite’’, Geophys. Res. Lett., 33, L15702 doi:10.1029/2006GL025668.

Scafetta, N., and B. J. West (2006c), Phenomenological solar signature in 400 years of reconstructed Northern Hemisphere temperature, Geophys. Res. Lett., 33, L17718, doi:10.1029/2006GL027142.

Scafetta, N., and B.J. West (2007) Phenomenological reconstructions of the solar signature in the Northern Hemisphere surface temperature records since 1600, Journal of Geophysical Research, Vol. 112, D24S03, doi:10.1029/2007JD008437,

Schatten, K.H. and W.K.Tobiska 2003, Solar Activity Heading for a Maunder Minimum?, *Bulletin of the American Astronomical Society*, 35 (3), 6.03

Shaviv, N.J., (2002). The Spiral Structure of the Milky Way, Cosmic Rays, and Ice Age Epochs on Earth, New Astronomy, 8, pp 39-77

Shaviv, N.J. (2005). On climate response to changes in cosmic ray flux and radiative budget, Journal of Geophysical Research 110,

Shindell, D.T., D. Rind, N. Balachandran, J. Lean, and P. Lonergan, Solar cycle variability, ozone, and climate, Science, 284, 305–308, 1999a.

Soon, W., Baliunas, S., Idso, S. B., Kondratyev, K. Ya., Posmentier, E. S. (2001). Modeling climatic effects of anthropogenic carbon dioxide emissions: Unknowns and uncertainties. Climate Research, 18, 259 – 275.

Soon, W.H., Posmentier, E., Baliunas, S.L. (1996), Inference of solar irradiance variability from terrestrial temperature changes 1880-1993: an astrophysical application of the sun-climate relationship. Astrophysical Journal 472, pp 891-902

Svenmark, H, Friis-Christensen, E.: (1997):Variation of cosmic ray flux and global cloud cover- a missing link in solar -climate relationships, Journal of Atmospheric and Solar-Terrestrial Physics, 59, pp 1125-32

Svensmark, H. (2007), Cosmoclimatology, Astron. Geophys, 48, 18– 24.

Theijl, P. and Lassen, K. (2000): Solar forcing of the northern hemisphere land air temperature, Journal Atmospheric Solar Terrestrial Physics, 62, pp 1207-1213

Tinsley, B.A., and Yu, F. (2002): Atmospheric ionization and clouds as links between solar activity and climate. In AGU monograph Solar Variability and its effects on the earth’s atmosphere and climate system.

Veizer, J., Godderis, Y.,François, L.M. (2000). Evidence for decoupling of atmospheric CO2 and global climate during the Phanerozoic eon. Nature, 408

Willson, R. (1997) Total solar irradiance trend during solar cycles 21 and 22: Science 277, pp 1963-1965

Willson, Richard C. and Mordvinov, Alexander V., 2003. Secular total solar irradiance trend during solar cycles 21–23. GRL Vol. 30, No 5, 1199,

Willson, R.C., Hudson, H.S., (1988), Solar Luminosity Variations in Solar Cycle 21, Nature, 332,pp. 810 -12

Delworth, T.L. ,and M.E. Mann, 2000: Observed and simulated multidecadal variability in the Northern Hemisphere. Climate Dyn., 16, 661–676.

Drinkwater, K.F. 2006. The regime shift of the 1920s and 1930s in the North Atlantic. Progress in Oceanography ***68****: 134-151.*

Gray, S.T., et al., 2004: A tree-ring based reconstruction of the Atlantic Multidecadal Oscillation since 1567 A.D. Geophys. Res. Lett., 31, L12205, doi:10.1029/2004GL019932

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Kerr, R. A., A North Atlantic climate pacemaker for the centuries,
Science, 288 (5473), 984-1986, 2000.

Latif, M. and T.P. Barnett, 1994: Causes of decadal climate variability over the North Pacific and North America. Science 266, 634-637.

Mantua, N.J. and S.R. Hare, Y. Zhang, J.M. Wallace, and R.C. Francis,1997: Pacific interdecadal climate oscillation with impacts on salmon production. Bulletin of the American Meteorological Society, 78, pp. 1069-1079.

McPhaden, M.J and D. Zhang (2002), "Slowdown of the meridional overturning circulation in the upper Pacific Ocean", Nature, 415(7), 603–608 (2002).

Miller, A.J., D.R. Cayan, T.P. Barnett, N.E. Graham and J.M. Oberhuber, 1994: The 1976-77 climate shift of the Pacific Ocean. Oceanography 7, 21-26.

Minobe, S. 1997: A 50-70 year climatic oscillation over the North Pacific and North America. Geophysical Research Letters, Vol 24, pp 683-686.

Power, S.B. and I.N. Smith (2007), "Weakening of the Walker Circulation and apparent dominance of El Niño both reach record levels, but has ENSO really changed?" Geophysical Research Letters, vol. 34, L18702, doi:10.1029/2007GL030854, 2007

Ropelewski, C. F., and M. S. Halpert, 1986: North American precipitation and temperature patterns associated with the El Nino/ Southern Oscillation (ENSO). Mon. Wea. Rev., 114, 2352-2362.

Ropelewski, C. F., and M. S. Halpert ,1987: Global and regional scale precipitation patterns associated with the El Nino/ Southern Oscillation. Mon. Wea. Rev., 115, 1606-1626.

Ropelewski, C.F. and P.D. Jones, 1987: An extension of the Tahiti-Darwin Southern Oscillation Index. Mon. Wea. Rev, 115, 2161-2165.

Ropelewski, C. F., and M. S. Halpert, 1989: Precipitation patterns associated with the high index phase of the Southern Oscillation. J. Climate, 2, 268-284.

Ropelewski, C. F., and M. S. Halpert, 1996: Quantifying Southern Oscillation-precipitation relationships. J. Climate, 9, 1043-1059.

Trenberth, K.E., and J.W. Hurrell, 1999: Decadal atmosphere-ocean variations in the Pacific. Clim. Dyn., 9, 303-319.

Vecchi, G.A., B Soden, A.T. Wittenberg, I. M. Held, A. Leetmaa, and M. J. Harrison (2006), "Weakening of Tropical Pacific Atmospheric Circulation Due to Anthropogenic Forcing", Nature, 441, 73–76 (4 May 2006).

Vecchi, G.A. and B Soden (2007), "Global Warming and the Weakening of the Tropical Circulation", Journal of Climate, Vol. 20, (Sep 2007), pp 4316-4340

Venegas, S.A., Mysak, L.A., 2000: Is There a Dominant Time scale of Natural Climate Variability in the Arctic, Journal of Climate, October 2000,13, 3412-3424

Wolter, K., and M.S. Timlin, 1993: Monitoring ENSO in COADS with a seasonally adjusted principal component index. Proc. of the 17th Climate Diagnostics Workshop, Norman, OK, NOAA/N MC/CAC, NSSL, Oklahoma Clim. Survey, CIMMS and the School of Meteor., Univ. of Oklahoma, 52-57.

Zhang, Y., J.M. Wallace, D.S. Battisti, 1997: ENSO-like interdecadal variability: 1900-93. Journal of Climate, 10, 1004-1020