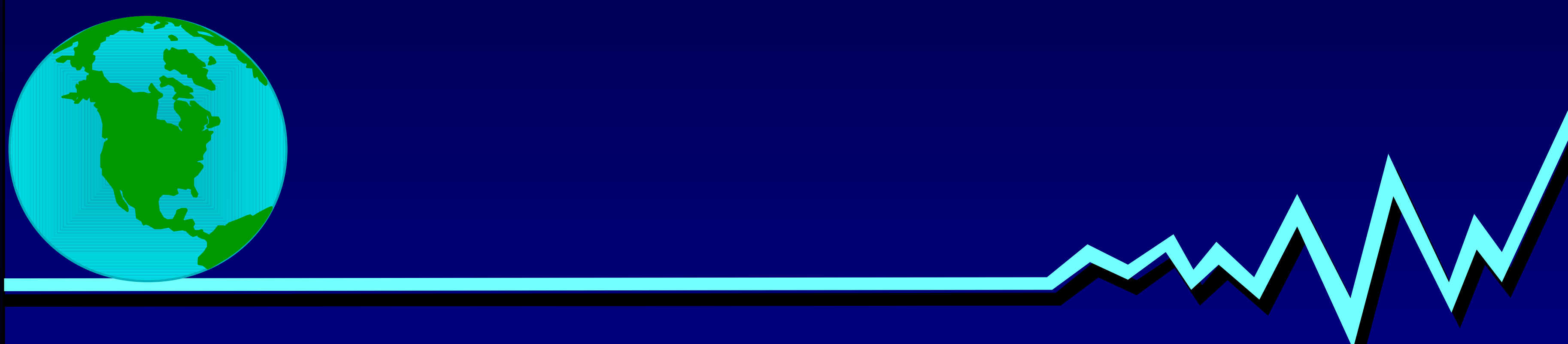
FUTURE OF GLOBAL CLIMATE CHANGE

Fiction and Facts

INTRODUCTION

For decades scientists and politicians have debated the issue of climate change. Unfortunately, international politics and energy policies have been the main driving force. A select international group has attempted to cut off debate by declaring a consensus has been reached and that they know what action should be taken immediately to prevent a future catastrophe. Their conclusions, however, are based on several erroneous assumptions. Thus, the debate goes on among many scientists that were excluded in the decision making process. To get the truth, I have critically analysed the data upon which decisions have been made. These data include carbon dioxide concentrations, ice cores, sea surface temperatures, solar activity, and polar sea ice cyclical melts and thaws. All are available for download off the Internet.



DATA

All the data that I have evaluated is readily available on the Internet in the form that is easily downloaded or cut and pasted into Lotus or Excel worksheets.

The primary sources are Scripps Institute,
http://scrippsco2.ucsd.edu/data/atmospheric_co2.html,

NOAA's World Data Center for Palio Climatology,
http://hurricane.ncdc.noaa.gov/pls/paleo/fm_createpages.icecore,

National Snow and Ice Data Center,,
ftp://sidads.colorado.edu/DATASETS/NOAA/G02135

Climate Prediction Center,
http://www.cdc.noaa.gov/data/climateindices/list/#Tropicaleof , and
http://www.cpc.ncep.noaa.gov/data/indices/

Plots of the data as a function of time reveal a common yet distinctive characteristic. Each set of data presents a cyclical distinctive, but not unique wave form. Wave forms can be digitally generated using a mathematical infinite series and can be approximated by the first few harmonic terms. The mathematical technique most often used to analyse physical relationships is the normal statistics least squares fit. This works well when the independent variables are truly fixed (accurately measured) and not functionally related to each other. In the real world of researching global climate change with so many possible variables that must be considered, it is unrealistic to expect that a relationship so calculated establishes cause and effect. At best it is an indicator and at worst it is literally lunacy (like relating abnormal human behaviour to the phases of the moon). The most accurate data with respect to both time and space are the Scripps data. The least accurate are the ice core data. We have modellers and measurers in many different fields doing global climate research. Will we ever make enough accurate measurements to validate models or will we ever produce models that realistically establish cause-effect relationships? To be more specific, is burning of fossil fuel contributing significantly to global warming? The answer to the first question is possibly never. To the second,   however, I believe I have found an answer.

ATMOSPHERIC CARBON DIOXIDE

Scripps Institute has carbon dioxide monitoring sites around the Pacific from Alert Station, Canada, to the South Pole. The data have been collected daily from some sites since 1958. Each of their sites was selected to have a minimum influence from man made sources of carbon dioxide. They are intended to be background sites. Concentrations in cities and near industrial sources are often several times background levels. Plots of the raw daily flask data reveal some spikes in concentration indicating influence of local sources that are not representative of background. These data are flagged and not included in daily or monthly averages.

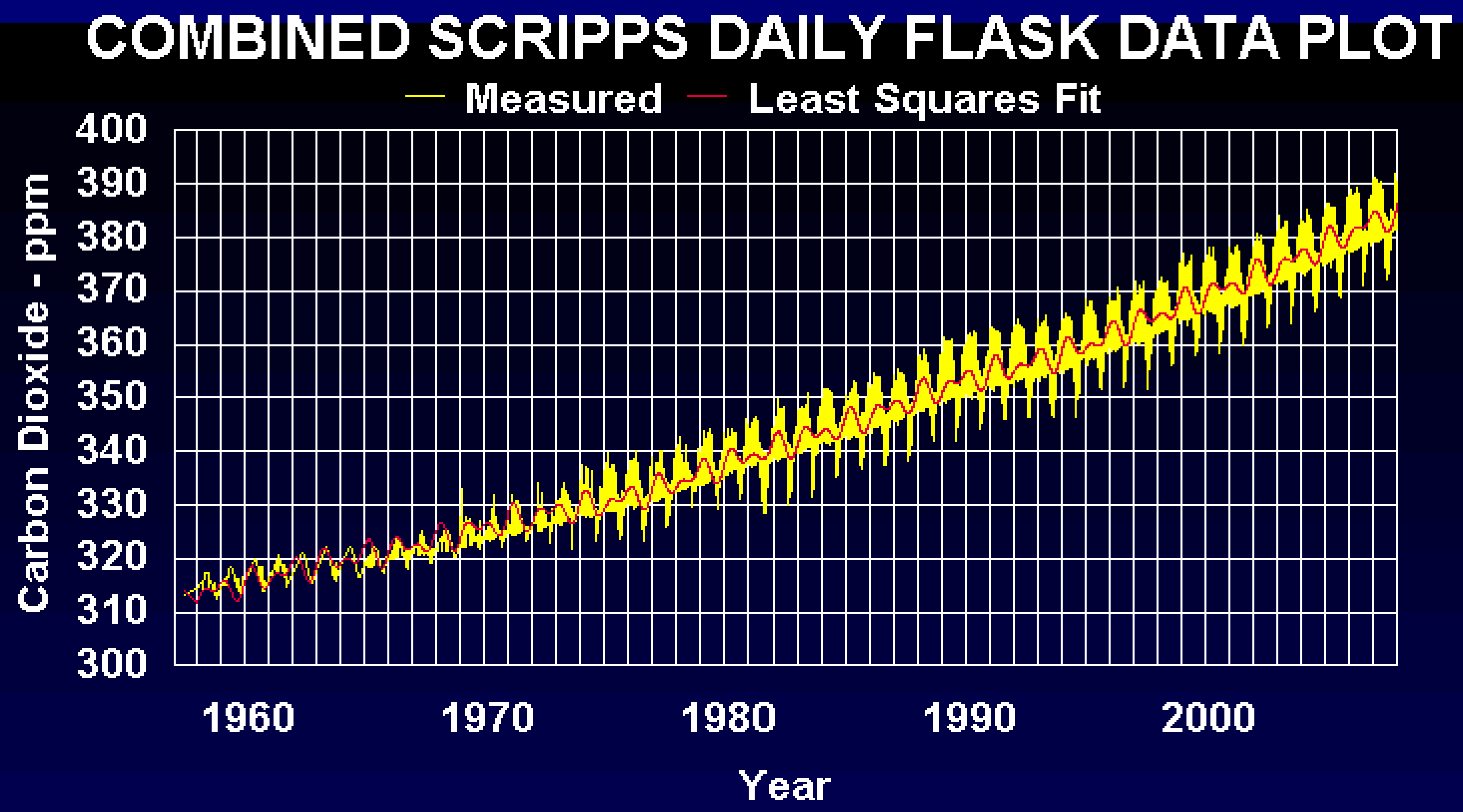
The locations of the eleven sites are given in the following table. Data from all of the sites show regular annual cycles. Both the magnitude and phase of this cyclical variation is latitude dependent. The greatest magnitude variation occurs in the most northern latitudes and decreases as you go South to Samoa (14 S) where it is the least. The magnitude then increases slightly as you go to the South Pole but with an opposite phase reflecting the seasonal difference between hemispheres. A minimum annual variation at 14 S rather than at the equator indicates that the northern hemisphere has the greater seasonal effect on background levels of carbon dioxide.

SCRIPPS SITE LOCATIONS		
SITE	LONGITUDE	LATITUDE
South Pole	0 E	90 S
New Zealand	175 E	41 S
Kermadec Island	178 W	29 S
Samoa	151 W	14 S
Christmas Island	157 W	2 N
Mauna Loa, Hawaii	156 W	20 N
Cape Kumukahi, Hawaii	155 W	20 N
Baja, Mexico	110 W	24 N
La Jolla, California	117 W	33 N
Pt. Barrow, Alaska	157 W	71 N
Alert Station, Canada	62 W	82 N

This seasonal variation has been attributed to the cyclical respiration of the terrestrial biosphere. It is more likely related to the oceans as sources and sinks for both organic and inorganic carbon dioxide. Oceans cover most of the earth and are the greatest reservoir of carbon. Fluxes in and out of the sea surface are temperature change dependent, which is seasonal.

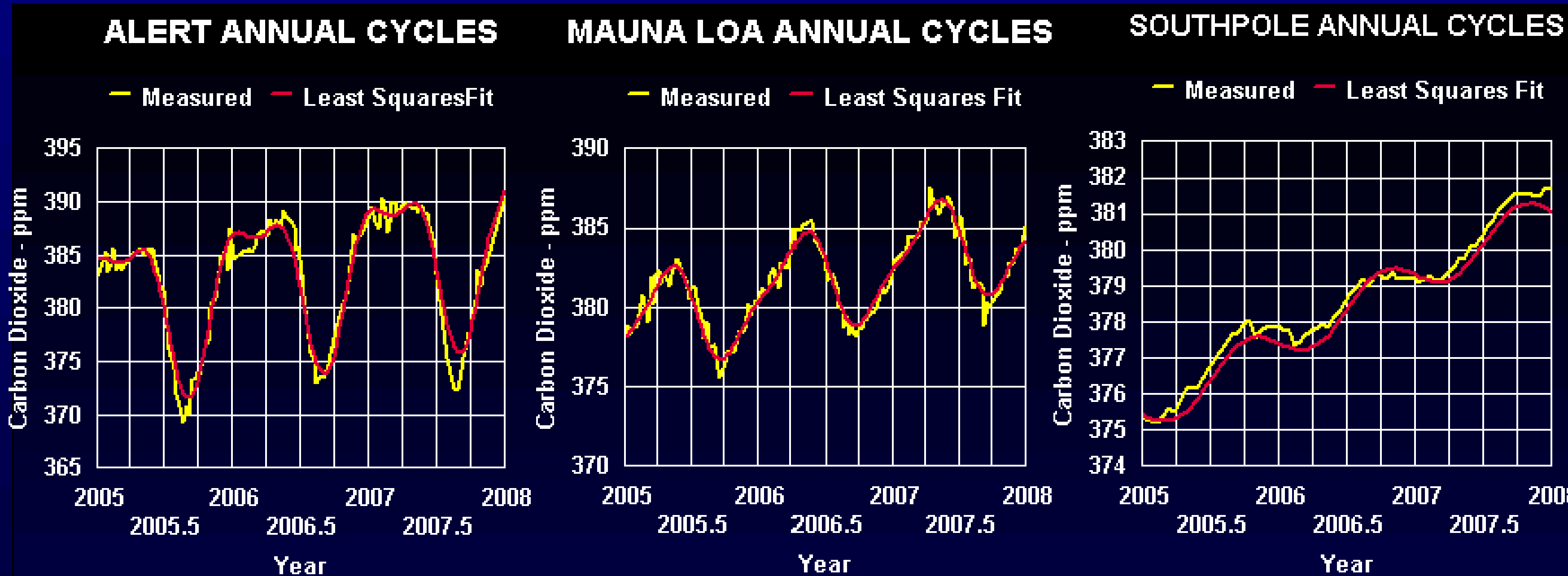
Lumping and plotting all the accepted data indicates that with the exception of seasonal variations, the sites do not differ significantly in what they are measuring. Thus, the global atmosphere is well mixed and transfer rates between water and air are relatively fast.

The lumped data set consists of 8310 acceptable daily flask measurements to which I have applied a trial and error least squares curve fitting technique. The best fit I found was a multi-linear regression on four sine functions. Besides the obvious annual cycle, a nine year, a 20 year, and a 308 year cycle are statistically significant. The 308 year cycle is highly significant and fits the “hockey stick” shape of the long term curve better than an exponential form which has been attributed to anthropogenic emissions.



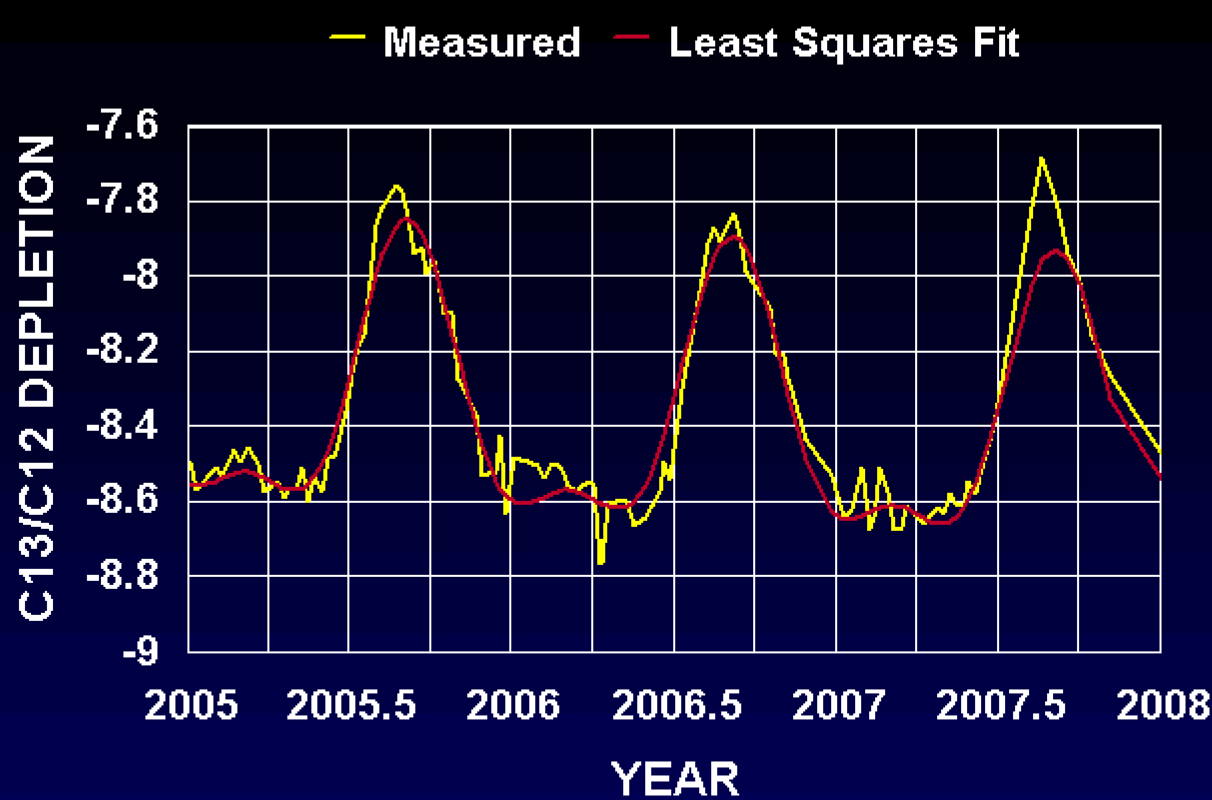
This fit of all the data accounts for 96% of the variability. Fits for individual sites adjusting the parameters for the annual cycle can account for more than 99%.

A simple sine function ($\sin(x+a)$ where $x=2*PI*years$ and a is a constant) is sufficient to fit the annual cycles in the southern hemisphere. The Arctic sites annual cycles have a modified triangular wave form with flattened tops. The remaining northern hemisphere sites show annual saw tooth wave forms. This form is approximated with $\sin(x+a)-\sin(2*(x+a))/b$. The constants a and b are determined by trial and error to get a least squares fit with the other cyclic parameters included in the regression. The wave form for the Arctic sites is approximated with $\cos(x+a)+\cos(2*(x+a))/b$.



These plots illustrate the wave forms and degree of fit for the annual cycles of different site locations. Note that the minimums for the Northern hemisphere are in the third quarter while the minimums at the south pole are in the first quarter. These times correspond to when sea ice is at its minimum in respective hemispheres.

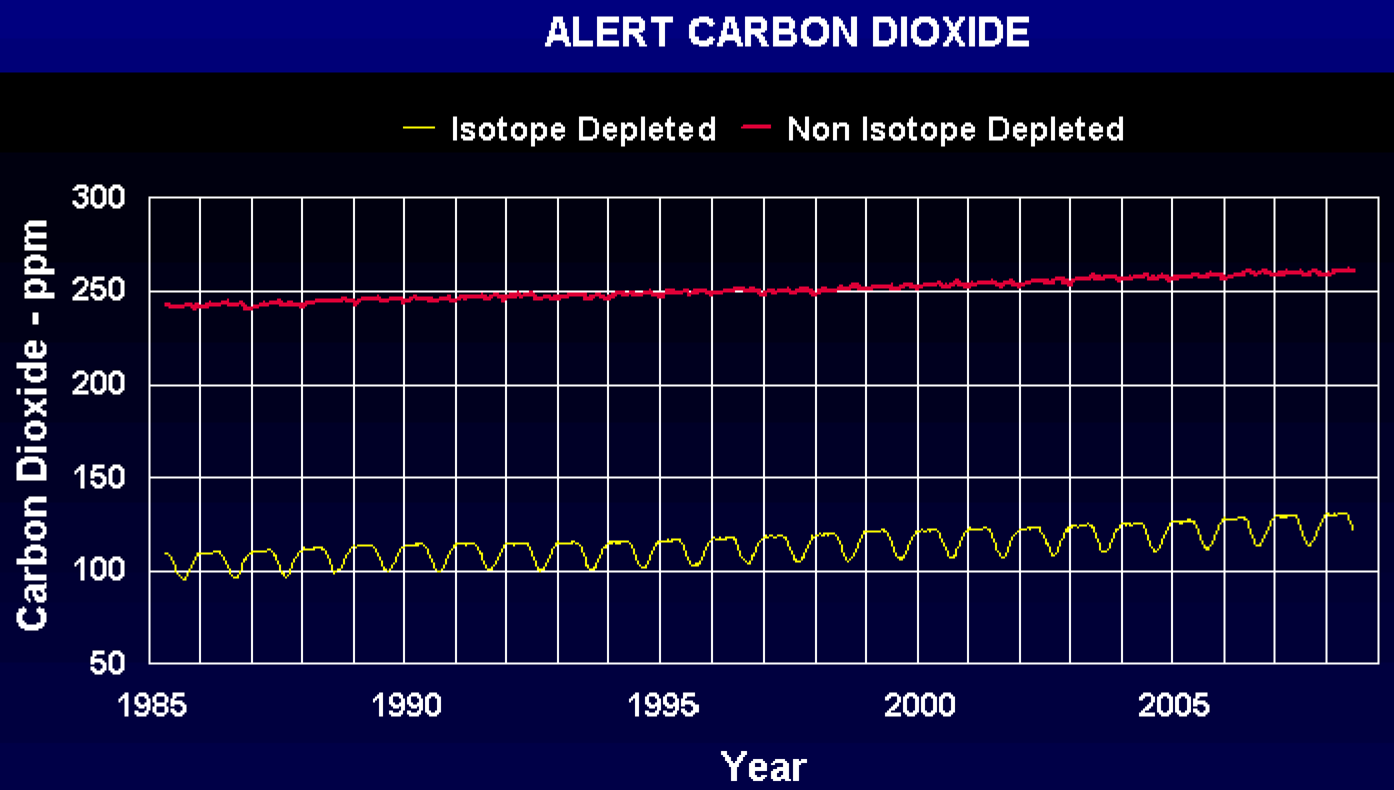
ALERT CARBON ISOTOPE DEPLETION



Plots of isotope depletion are mirror images of concentration plots and the same cyclic parameters produce the best statistical fits. The above plot shows the annual wave form and degree of fit.

With the isotope depletion data and the NIS Standards for PDB and graphite it is possible to calculate the fractional contributions of potential sources to the total concentration of atmospheric carbon dioxide. With the exception of a small contribution from cement manufacturing, the non-depleted fraction can be assumed to be from natural sources. The depleted fraction includes burned fossil fuel as well as natural sources.

I performed these calculations for each of the Scripps sites with results that require some explanation.



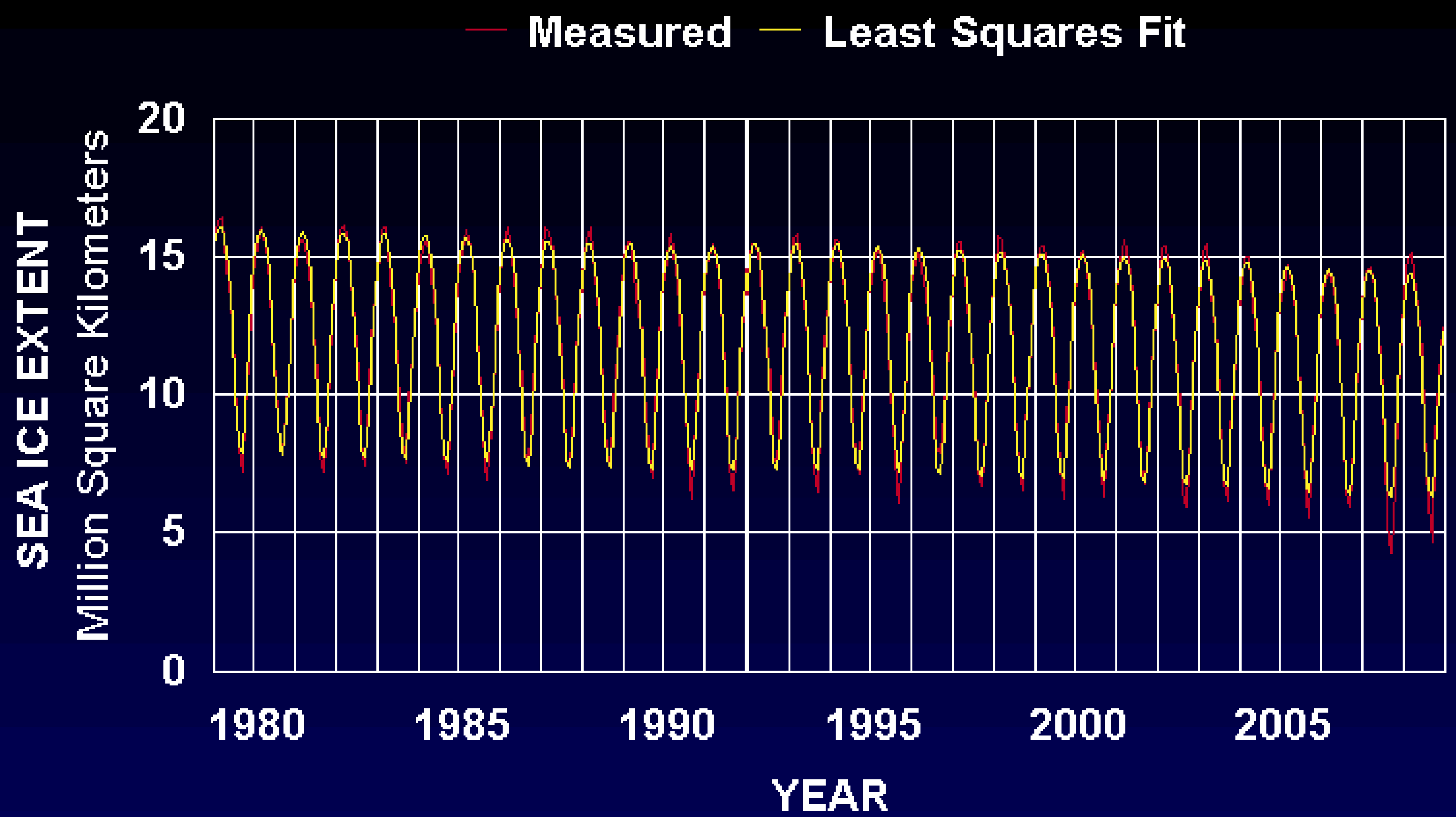
This plot shows that only the isotope depleted portion is affected by seasonal variations and the long term behavior for both portions are similar. The concentration of the non-depleted portion is about two and a half times that of the depleted portion. Plots of the other sites show similar behavior.

EFFECT OF LATITUDE ON SEASONAL VARIATION

Hemisphere	Southern				Northern						
Latitude	90	41.4	29.2	14.2	2.0	19.5	19.5	23.3	32.9	71.3	82.3
Change-ppm	0.58	0.46	0.35	0.30	1.25	3.57	2.97	3.18	4.46	7.21	6.92

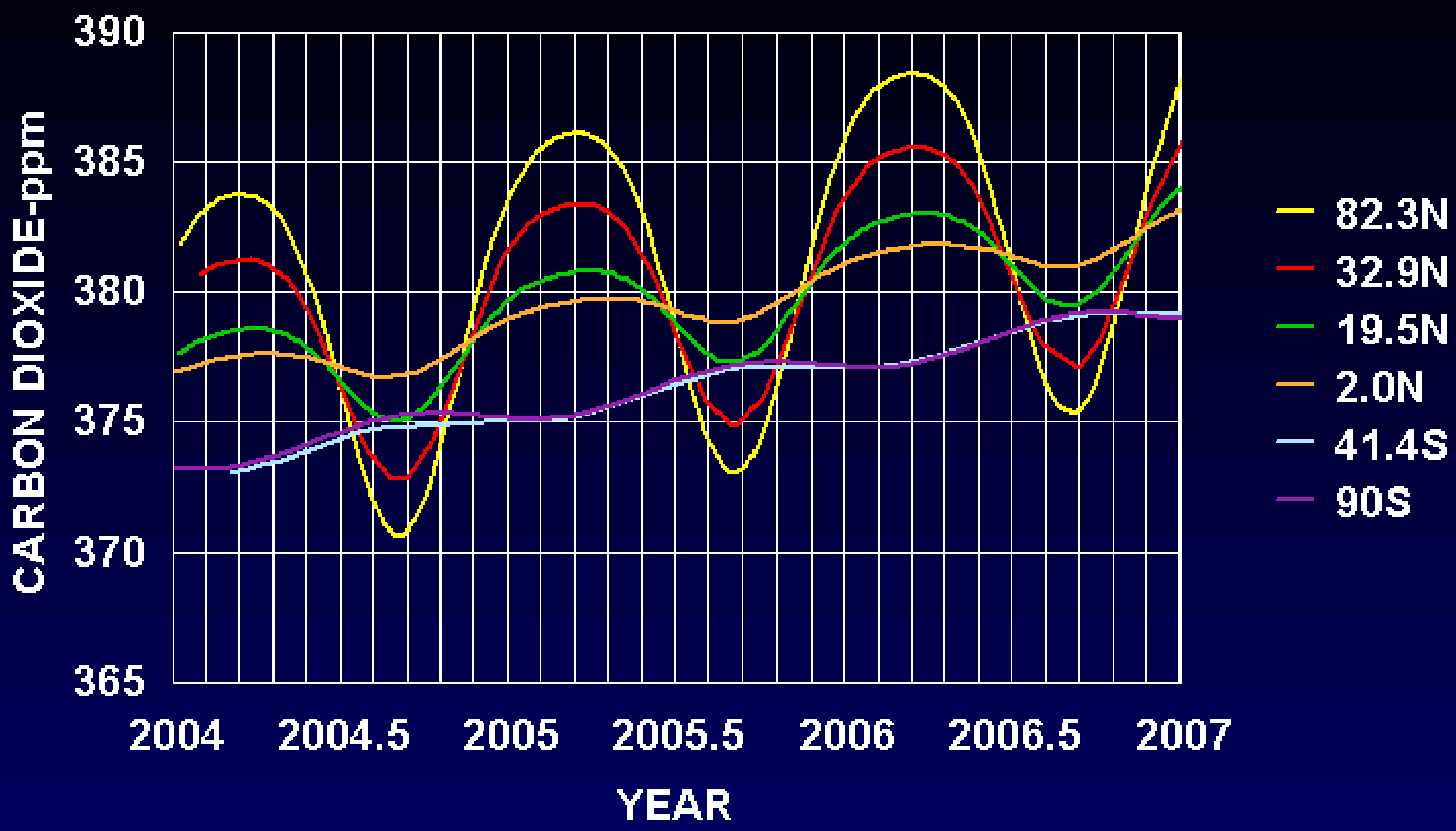
As observed previously, the magnitude of the seasonal variation is the greatest for the two northern sites and the least at the Samoa site (14.2S). This is consistent with the southern tropics being the greatest source of carbon dioxide and the Arctic ocean being the greatest sink. I believe the mechanism that effects the depletion portion and not the non-depletion portion is similar to the mechanism that allows one to estimate prehistoric sea surface temperatures from measuring depletion of stable oxygen and hydrogen isotopes in ice cores. The differences in partial pressure between lighter and heavier molecules causes the separation. The separation is amplified by multiple evaporation and condensation processes. The greater the distance between the source and sink, the greater the number of evaporation and condensation cycles can amplify the measured signal. The mechanism is similar for the carbon isotopes. Carbon dioxide is continually being adsorbed by condensed moisture in clouds and released as those droplets evaporate as they fall through warmer air. The observed depletion is probably a better proxy measure of atmospheric dew point temperature than it is for SST.

ARCTIC SEA ICE EXTENT



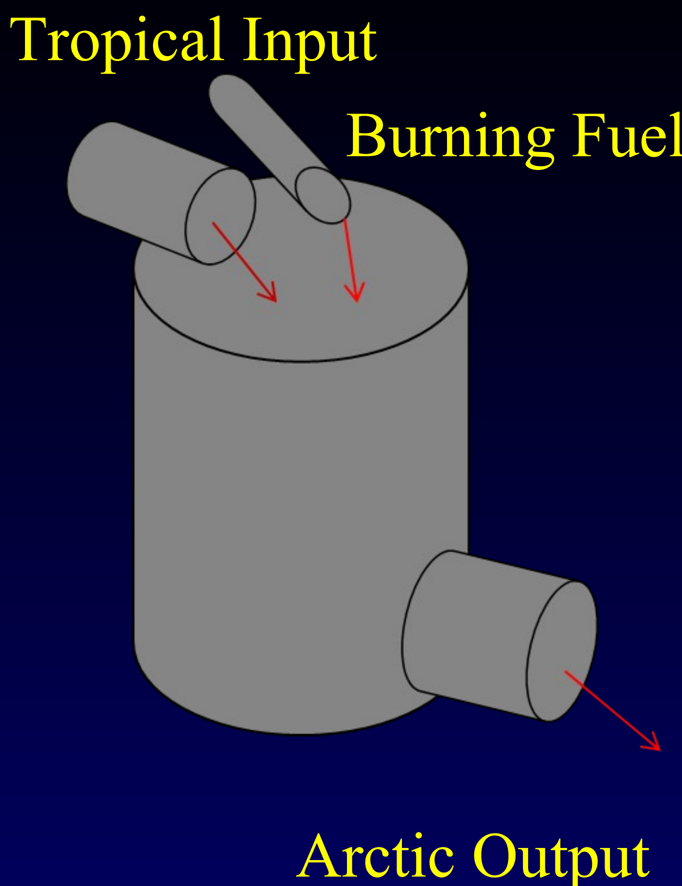
The shapes of the Arctic carbon dioxide curves are very similar to the Arctic sea ice extent curve. The same parameters give excellent fits to both curves. The above plot shows the degree of fit. The Southern hemisphere sites have a similar but weaker relationship with Antarctic sea ice extent. Thus, freezing and thawing of sea ice is the factor that causes the observed seasonal variation in carbon dioxide concentrations.

EFFECT OF LATITUDE ON SEASONAL VARIATION



I performed least squares fits for each of the Scripps sites data using best fit sea ice extent as the seasonal variation parameter. The above plot shows the increasing effect of latitude in the Northern hemisphere. The effect in the Southern hemisphere is much less.

BASIC INPUT/OUTPUT MODEL



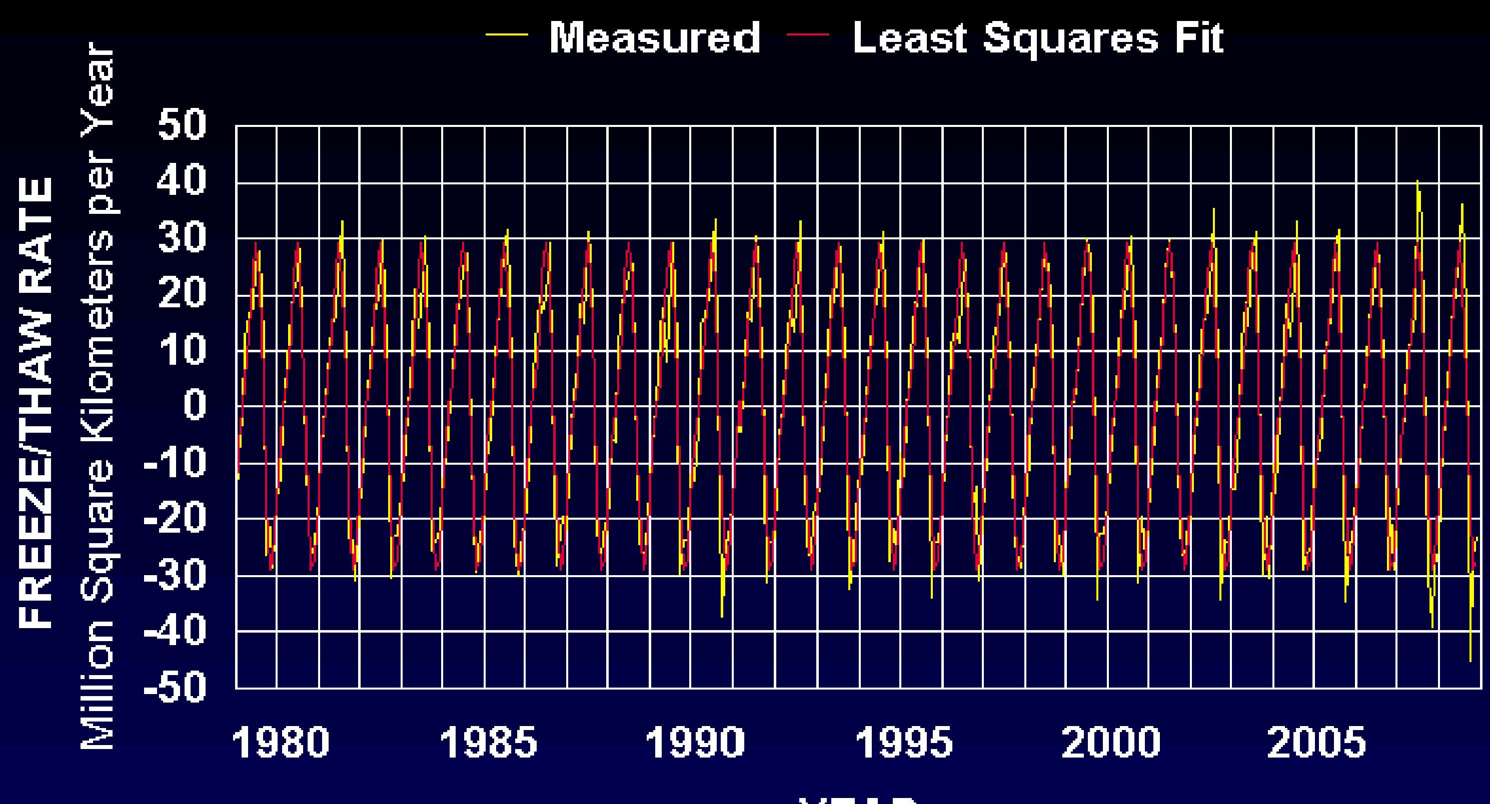
Input-output equals accumulation. It has been assumed that natural exchanges of carbon dioxide in and out of the atmosphere remain relatively balanced and burning fossil fuels thus contributes to the accumulation. In fact, the natural exchange rates change with changes in sea surface temperatures. These rates can be an order of magnitude greater than the increased emissions from anthropogenic sources.

GLOBAL SIGNIFICANCE OF SEA ICE DATA

The Arctic freeze/thaw cycle is the pump that drives the global oceanic conveyor belt. As the cold sea water freezes, it concentrates salts in the unfrozen water, increasing it's density. The heavier brine sinks and flows toward the equator. Dissolved carbon dioxide, calcium carbonate, and carbonate ions are part of the mixture that sinks to the bottom. The cold sea water of the Arctic is a strong sequester of carbon dioxide. When sea ice forms it covers the water which then can no longer absorb carbon dioxide. Conversely, when it thaws, absorption resumes. The rate of absorption decreases with increases in arctic sea surface temperature. The observed year to year increase in measured atmospheric carbon dioxide is very likely the result of increases in Arctic SST. The year to year decreases in sea ice is evidence the sea surface temperatures have been rising in the Arctic. A set of Bering Sea buoy data confirms this fact. These are natural processes that are not related to the rate of burning fossil fuels.

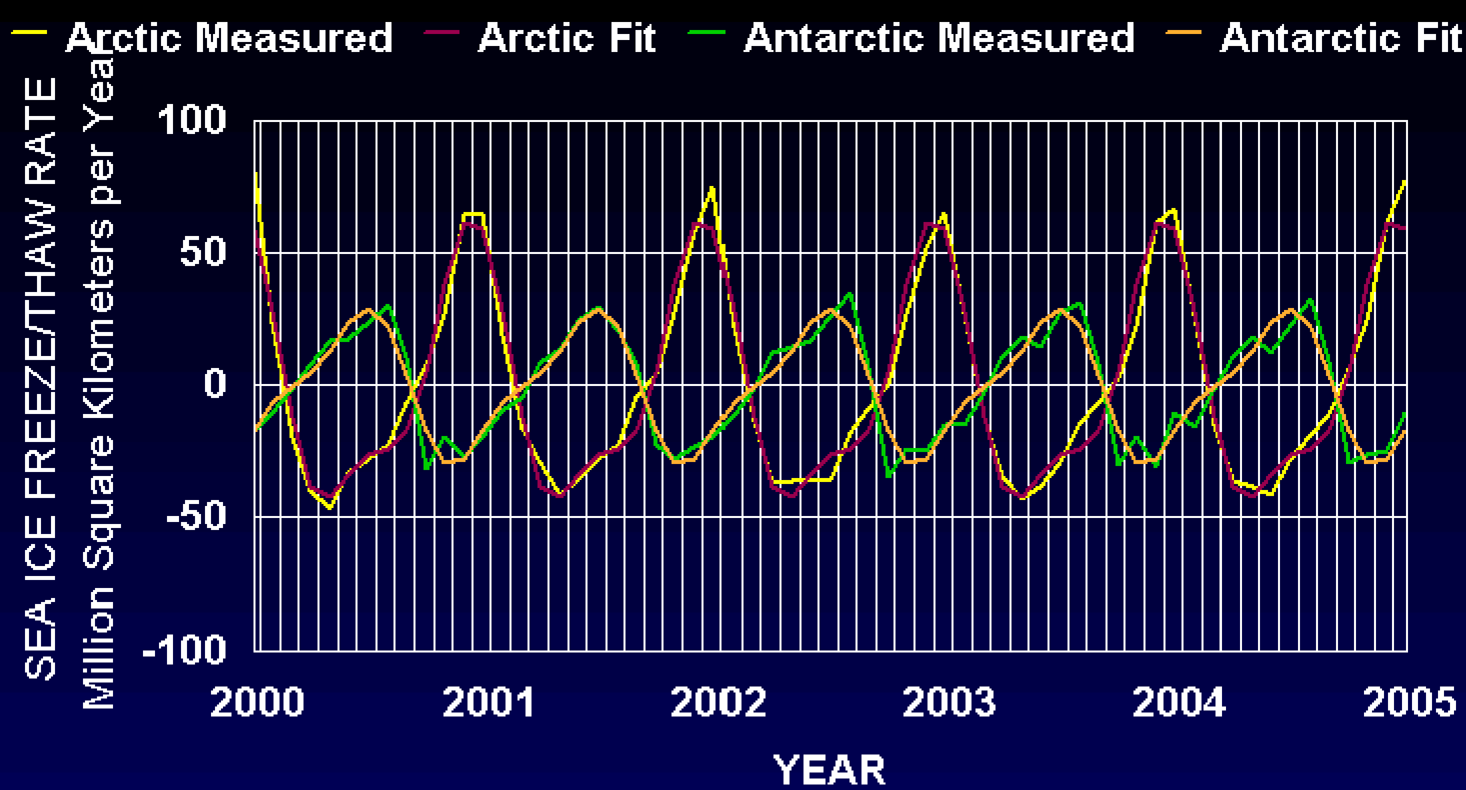
The rate of freeze/thaw is a fairly good measure of the net energy flux in and out of the Arctic. When it is dark, there is no solar influx. What little influx there may be is delivered by ocean currents and wind. During the time of the midnight sun, solar influx is at its maximum. Radiation out to space occurs day and night. The driving force is the difference between the surface of the earth and outer space to the fourth power. Exposed Arctic ocean is warmer than frozen sea ice and outbound flux from water is greater than from ice. Because thermal conductivity of ice is less than radiant transfer, ice serves as an insulator for the arctic ocean and thus slows the rate of global cooling. Heat must conduct through the ice before it can be radiated to space.

ARCTIC SEA ICE FREEZE/THAW RATES



Both measured and fit values are calculated from month to month differences. A plot of the Antarctic values are similar. Long term changes in rates for both indicate slight increases in net heat inputs that are not statistically significant. Those inputs are probably the result of the influx of warmer ocean currents rather than a decrease in radiant outbound flux.

SEA ICE FREEZE/THAW CYCLES



This plot shows the cyclic behavior and degree of fit for freeze/thaw rates in the Arctic and Antarctic. Positive indicates heat gain and negative heat loss.

CARBON DIOXIDE – SEA SURFACE TEMPERATURE

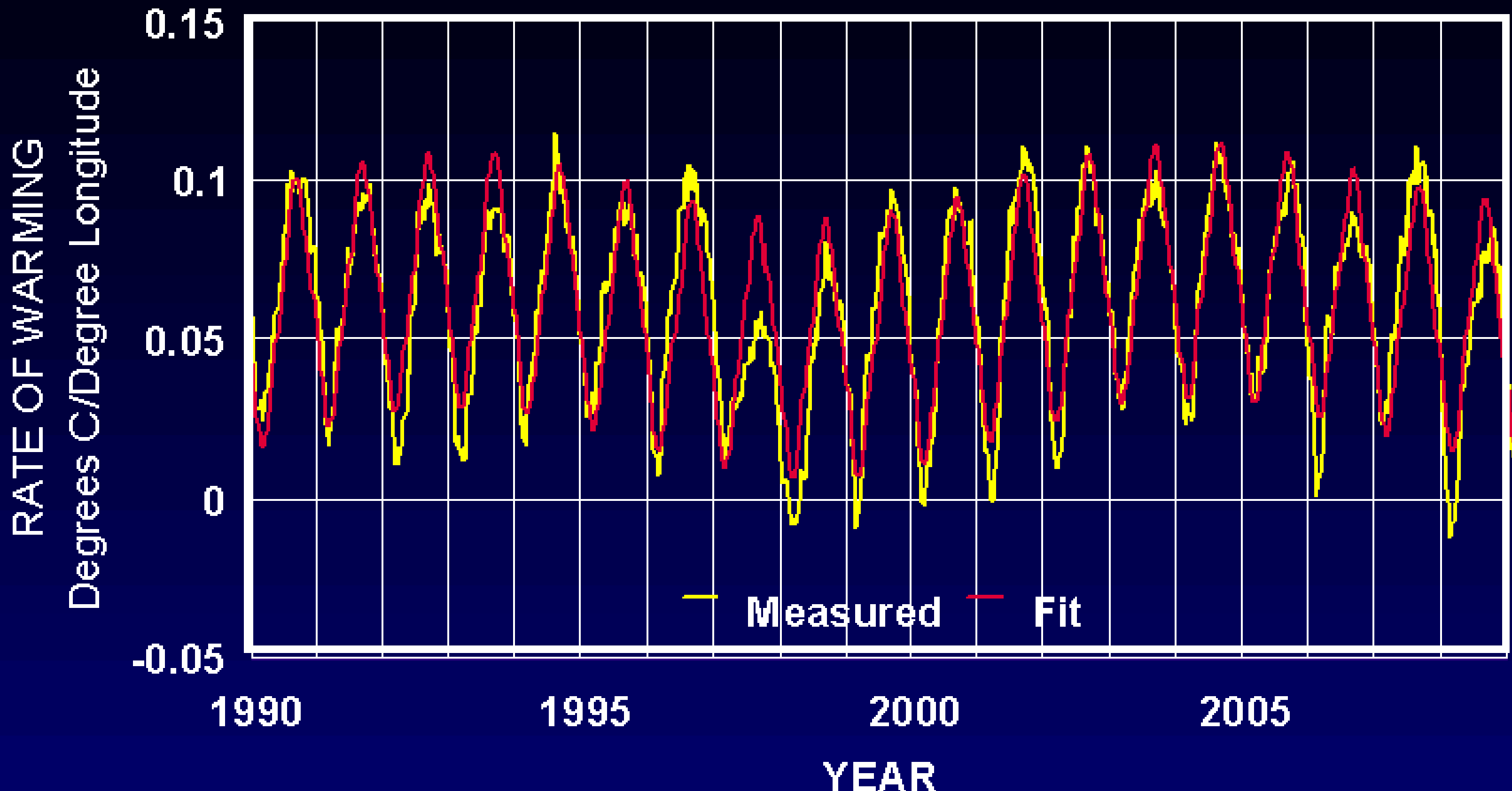
Most of the solar energy the earth receives is absorbed by the oceans in the tropics during daylight hours. Heat energy is lost to space from all surfaces both day and night. This constant cyclical exchange drives changes in weather and climate. It affects sea surface temperature, (SST), wind, atmospheric moisture, ocean currents, biological activity, ocean chemistry, and atmospheric carbon dioxide concentration.

Surface currents in the Pacific northern hemisphere flow clockwise. They flow from east to west in the tropics, increasing in temperature as they go. Then as it flows toward the Arctic, SST decreases as more heat is lost to space than is gained from the sun. As it returns to the eastern tropics, SST again increases. Very near the surface, atmospheric dew point temperature is close to SST. The higher the dew point, the more moisture there is in the atmosphere. This is how hurricanes and typhoons are fed. Heat energy is converted into kinetic energy.

The sea surface is a source of carbon dioxide when the vapor pressure of dissolved carbon dioxide exceeds the partial pressure of carbon dioxide in the atmosphere. When the atmospheric partial pressure exceeds the dissolved vapor pressure, the sea surface is a sink. If SST remained constant, there would be no exchange.

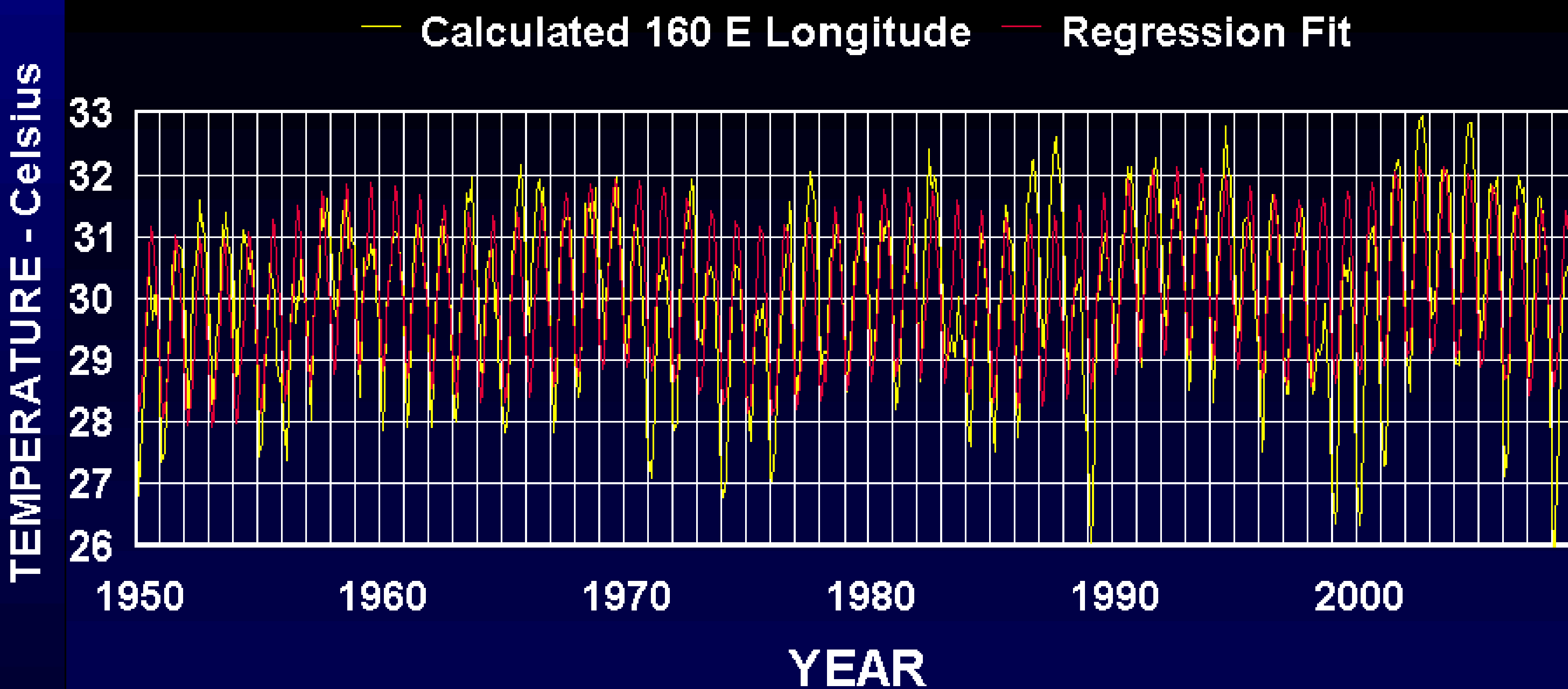
The vapor pressure of carbon dioxide is a function of the thermodynamics of sea water containing carbonate ions, dissolved carbonates, their solids, as well as dissolved carbon dioxide. Decaying organic matter is another source of carbon dioxide in sea water. There is a lot more of it in the oceans than there is on land. The sea becomes a source when SST rises and a sink when it falls. The rate of emission or absorption depends on the rate and direction of temperature change. That rate is constantly changing with space and time. A good example of this is illustrated by the four SST data sets of the Nino regions across the tropical Pacific. The temperature rises as the water goes from East to West across the Pacific. The rise is linear and the rate of rise varies seasonally and is not constant from year to year. The seasonal variation is associated with the northern Pacific circulation. Besides the seasonal variation there are two other statistically significant cycles. One at 11 years is stronger than one at 176 years. Nearly all the rates are positive and vary by an order of magnitude within six months. Thus, the tropics are nearly always a source of carbon dioxide and the strength of that source changes by an order of magnitude within a relatively short time.

RATE OF WARMING ACROSS THE TROPICAL PACIFIC



Two factors moderate the effect of SST increases on measured carbon dioxide concentrations in the tropics. First, the amount of moisture in the atmosphere increases with increasing temperature. During the day, water vapor rises and condenses in clouds as a result of adiabatic cooling(PV=NRT) as well as heat loss due to radiation. At night, fog forms as heat is lost due to radiation. These cool water droplets readily adsorb carbon dioxide to approach equilibrium with atmospheric concentrations. At present background levels, the pH of clean rain is around 5. Most of the atmospheric carbon dioxide is being transported by water droplets. Some will rise in clouds to the stratosphere were water freezes and it is released. Some falls in rain. As rain falls and evaporates in warmer air, carbon dioxide is released. That which isn't, is returned to the ocean. The second factor is ocean chemistry. Sea water is basic with a pH of around 8, primarily a function of dissolved basic salts. Dissolved carbon dioxide is neutralized by these basic salts to form carbonates. Calcium carbonate solubility decreases with increasing temperature. As the surface ocean water becomes saturated with calcium carbonate, it will precipitate out and fall into colder subsurface water. Conversely, upwelling of cold subsurface water can be a source of carbon dioxide.

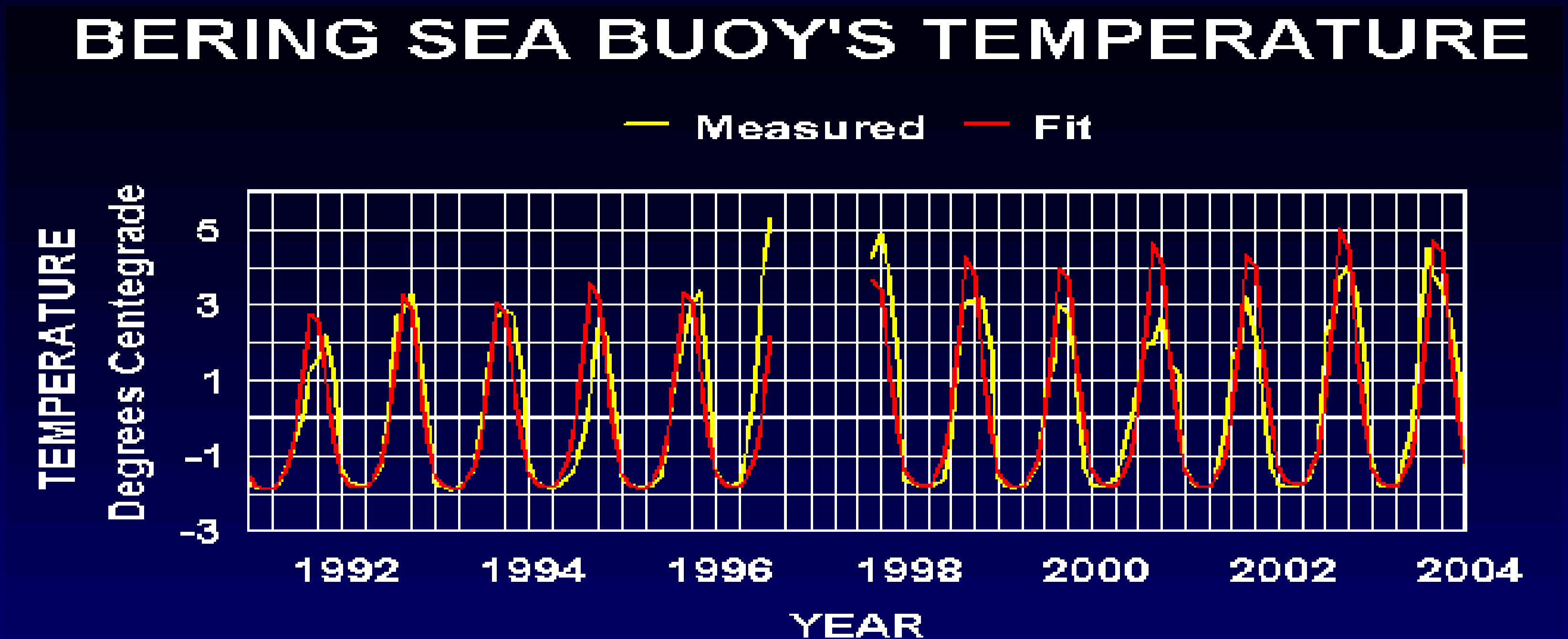
WESTERN EQUITORIAL PACIFIC SST



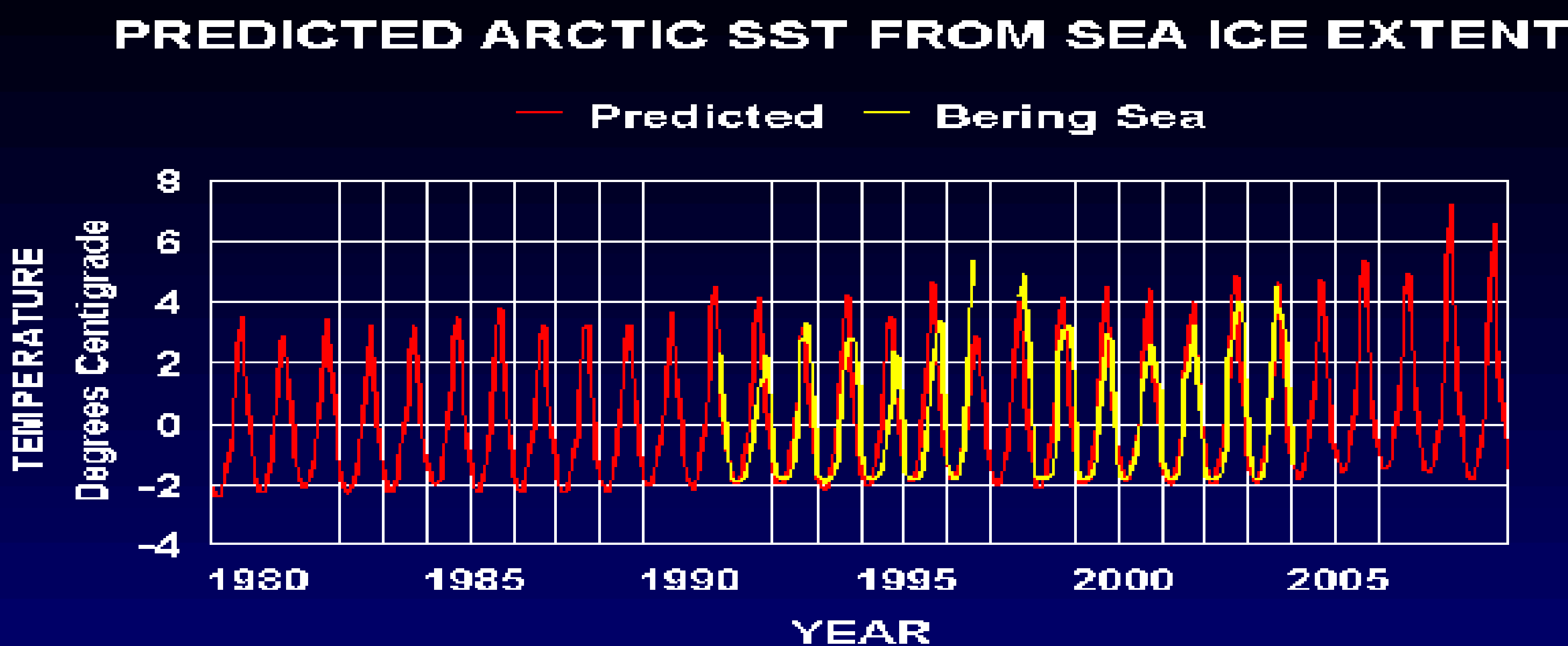
The warmest part of the Pacific is around the western equator. I calculated SST for 160 East using the Nino rate of warming data. Least squares regressions on these data yield four statistically significant natural cycles. The annual cycles are approximated by a triangle wave form with one harmonic (cos(x)+cos(3x)/9). The three other cycles are sine waves with lengths of 11.11, 39.05, and 79.01 years. The regression accounts for nearly 60% of the variability.

ARTIC SEA SURFACE TEMPERATURE

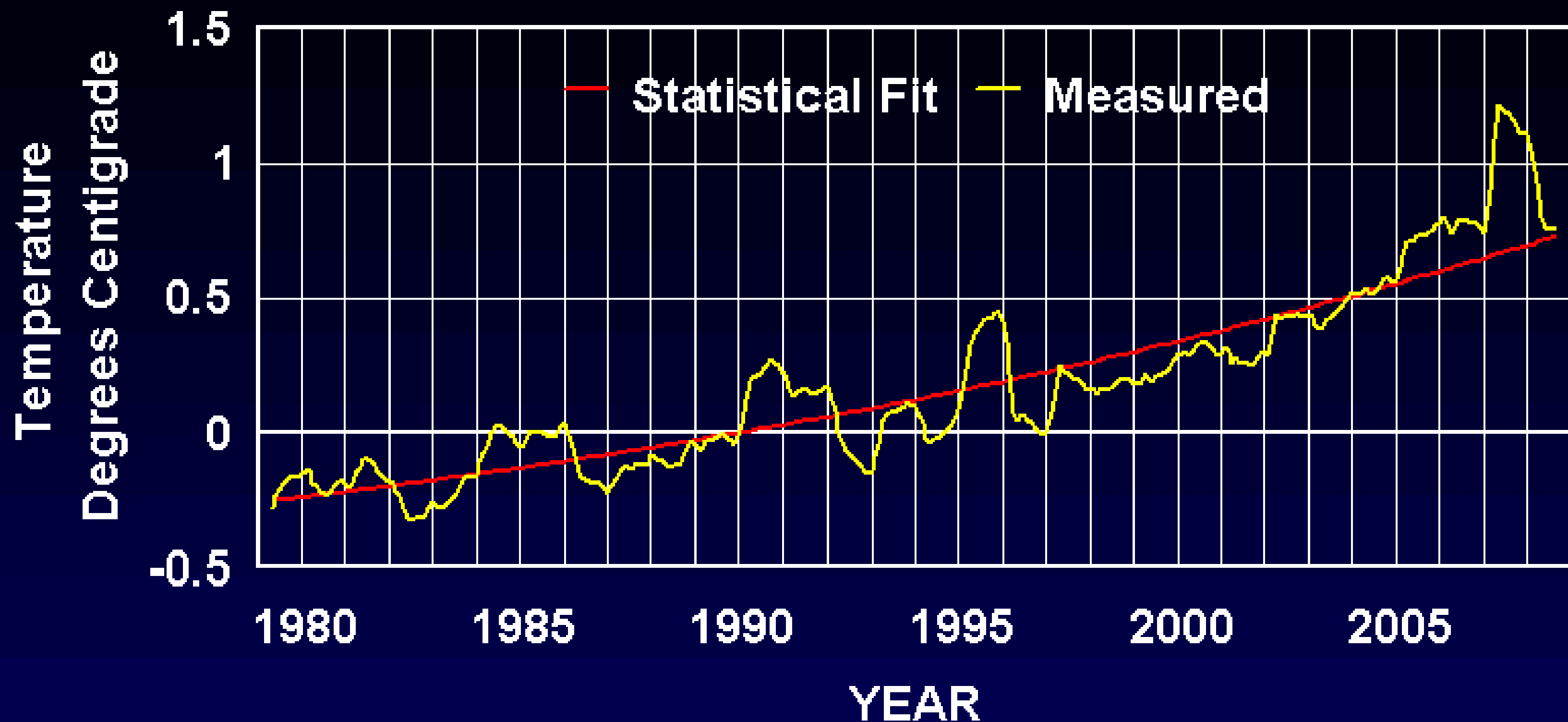
In the Arctic, atmospheric carbon dioxide concentration, isotope depletion, and sea ice extent are closely related to SST. Bering Sea buoy data is representative of Arctic SST. The temperature never gets below the freezing temperature of sea water and varies cyclically from year to year. This plot shows the statistical fit of the measured data. The dependent variable ln(SST+2.08) is regressed on two sine functions; an annual cycle and a 308 year cycle. The fit accounts for 88% of the variability.



A statistical relationship between sea ice extent and SST can account for 95% of the variability. The function is SST=17.7-7.18*ln(E) where E is measured monthly Arctic ice extent. The following plot compares predicted SST to Bering Sea buoy data.



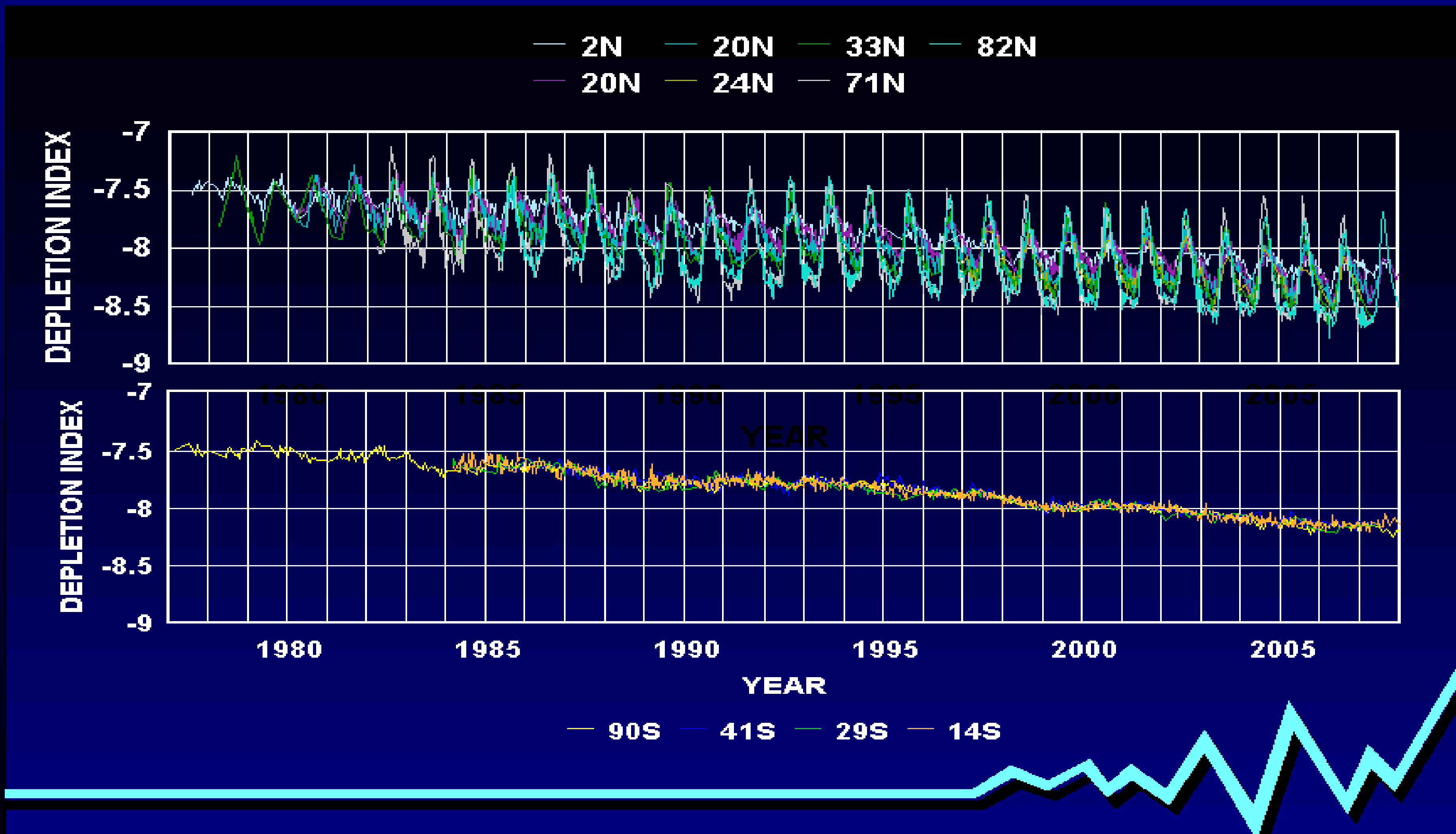
TWELVE MONTH RUNNING AVERAGE OF ARCTIC SST
CALCULATED FROM SEA ICE EXTENT



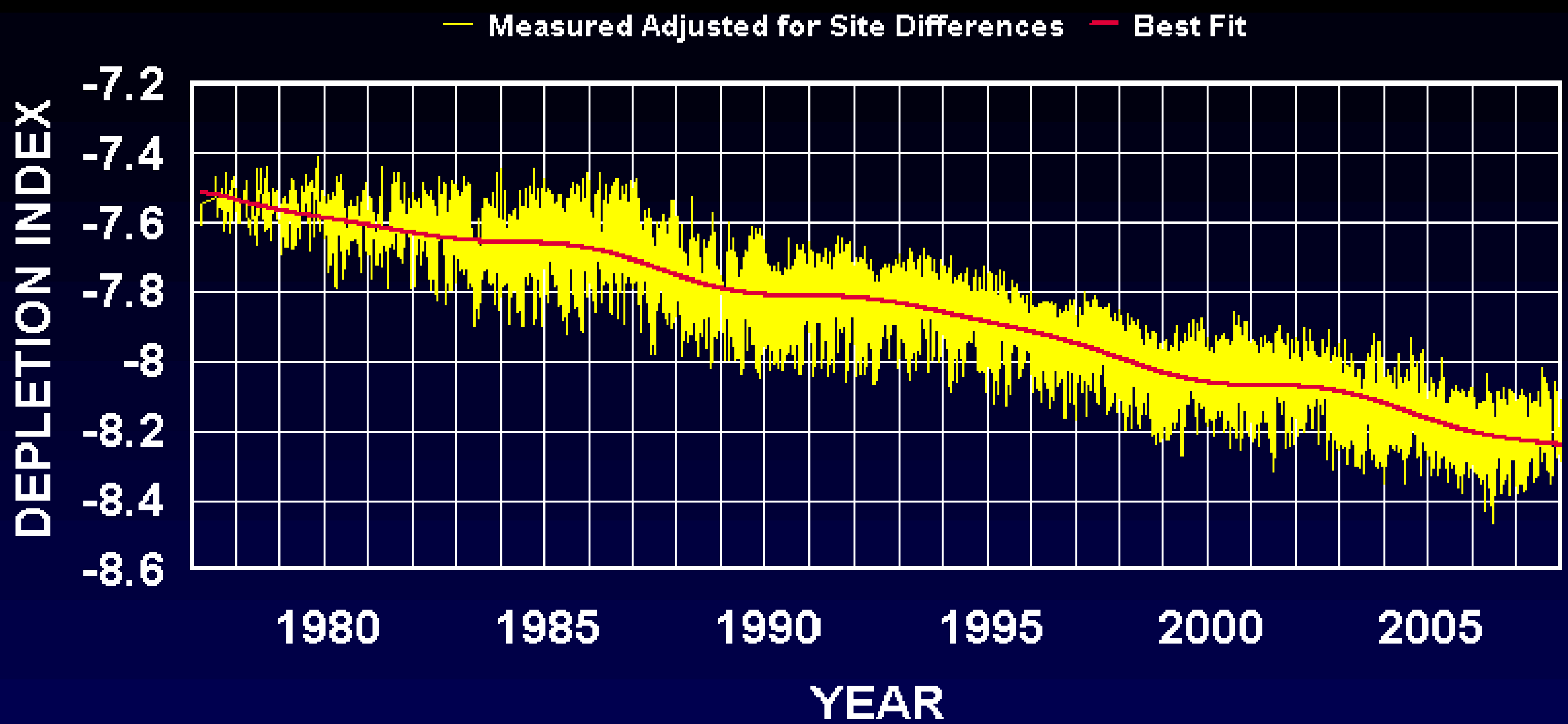
The smooth fit data depicts the long term 308 year cycle that is common to all the carbon dioxide data as well as the sea ice extent data. It is evidence that the decreasing solubility in the Arctic ocean is the primary, if not the only cause of accumulation in atmospheric carbon dioxide. It affects organic and inorganic sources similarly.

This plot shows the effect of latitude on the Scripps measured isotope depletion. There is little, if any, seasonal effect in the Southern hemisphere. The seasonal effect in the Northern hemisphere increases with latitude. Latitude has no effect on the long term behavior in either hemisphere. The long term behavior is an indicator of the relative accumulation from organic sources, both natural and anthropogenic.

LATITUDE EFFECT ON C13/C12 DEPLETION INDEX

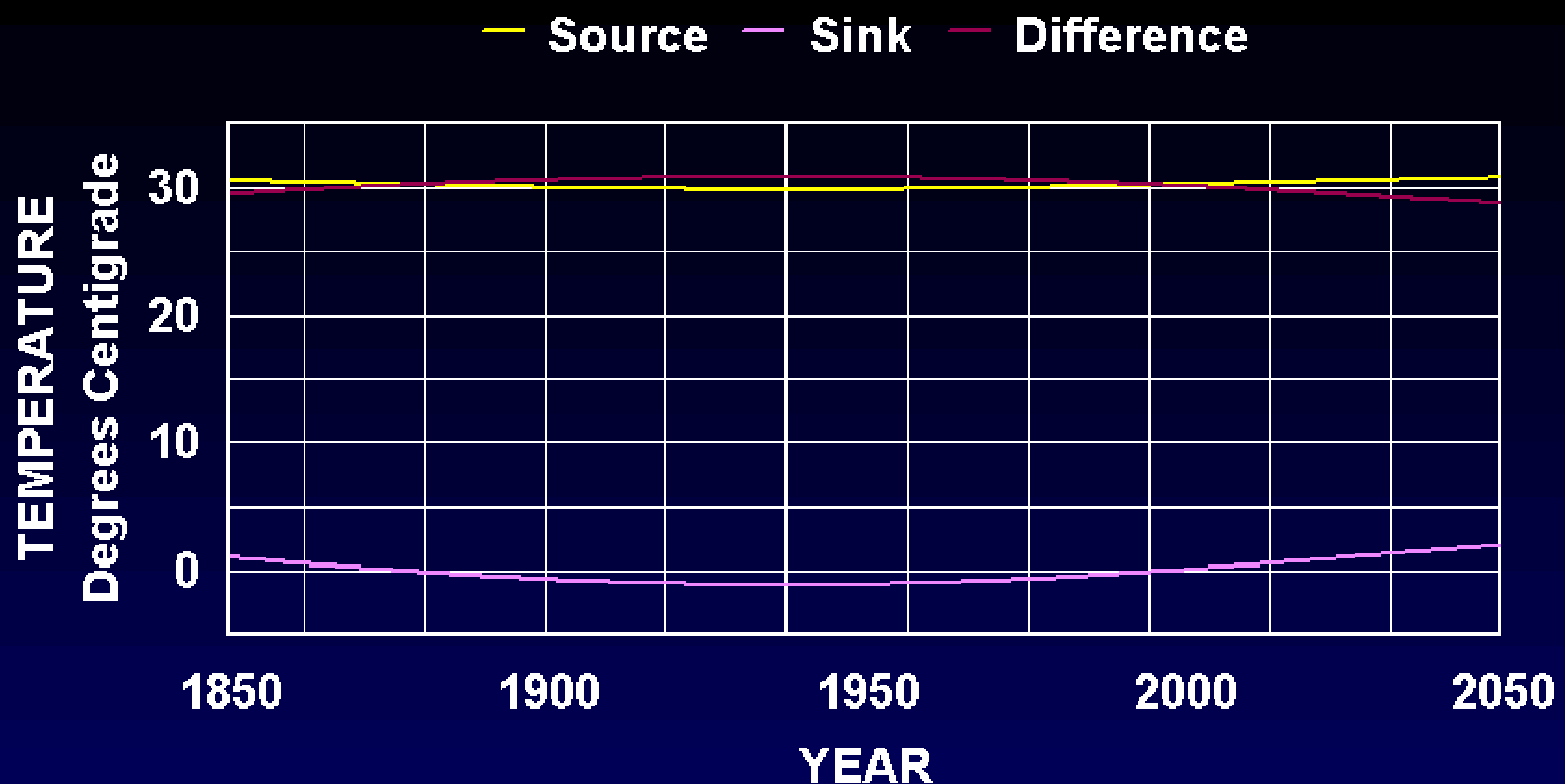


LONG TERM CHANGE IN C13/C12 DEPLETION INDEX



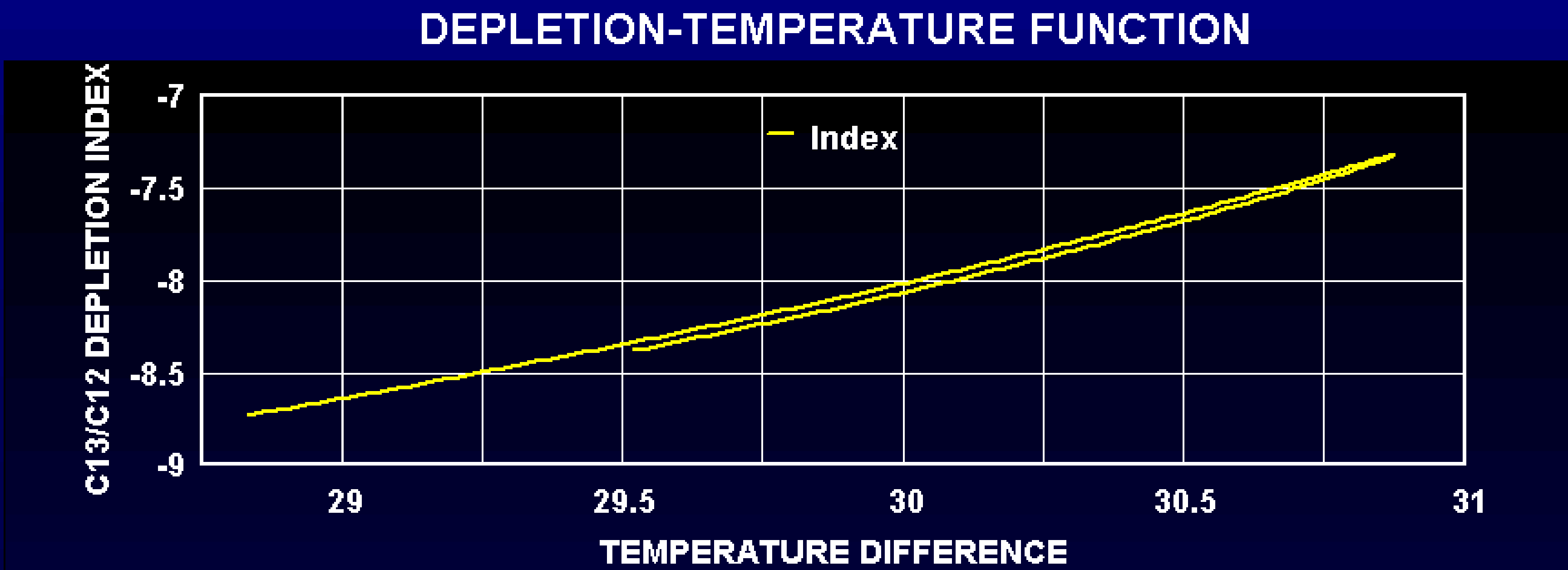
I adjusted the measured values by factoring out the seasonal effect and slight line displacements between sites. Five sine wave cycles are statistically significant, accounting for better than 84% of the variability. The standard deviation is 0.023. The cycles in the regression are 307.9. 88, 19.98, 9, and 5.5 years. Three of these cycles are common with regression fits for concentrations of carbon dioxide.

CALCULATED LONG TERM SST CYCLES



The isotope index is a function of the temperature difference between sources and sinks.

The above plots are calculated long term temperatures for the Arctic and equatorial sea surfaces around 160 E longitude.

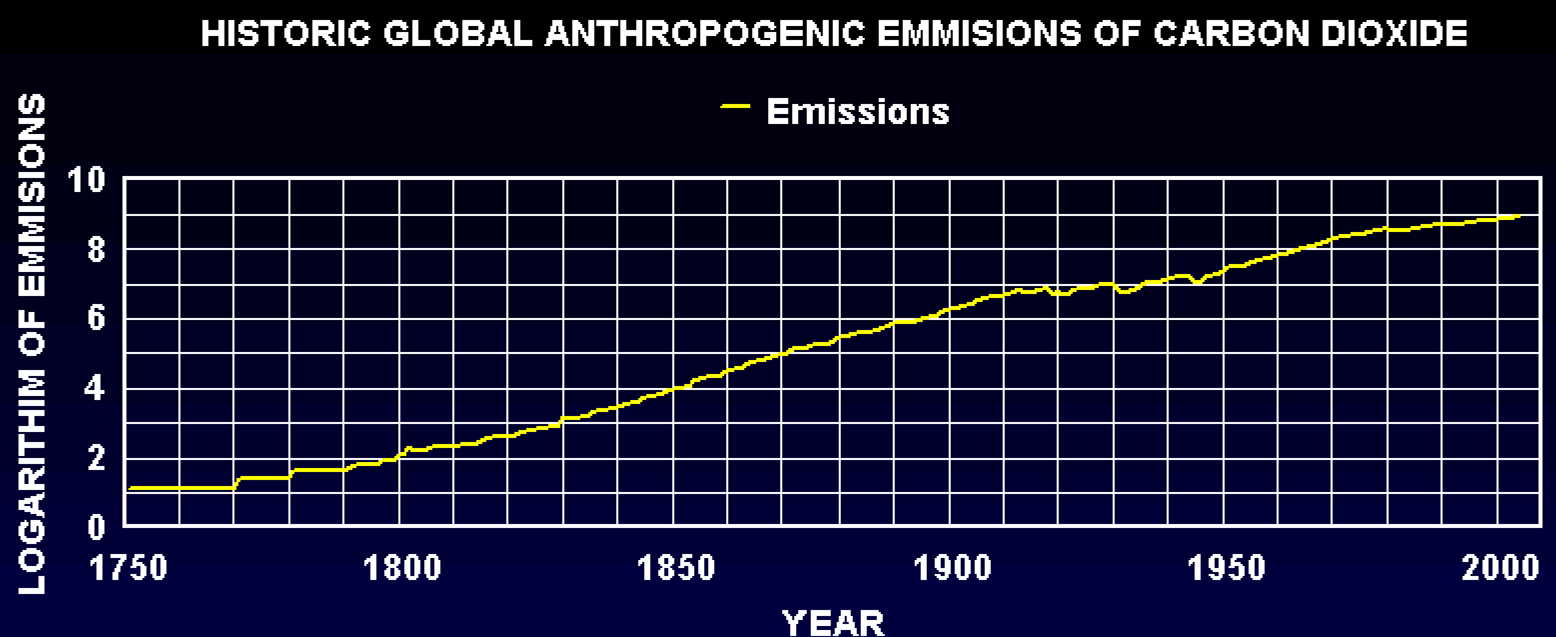


The source temperature was calculated based on Nino data from 1950 to present. The Arctic sink was calculated based on sea ice extent. All the data including depletion index were regressed on the common long term 308 and 9 year cycles. The plots are drawn using the respective regression coefficients for those two cycles. The above plot demonstrates the expected behavior with very little hysteresis associated with rising and falling temperature differences. This is strong evidence that the long term accumulation in atmospheric carbon dioxide (from both organic and inorganic sources) is a natural process.

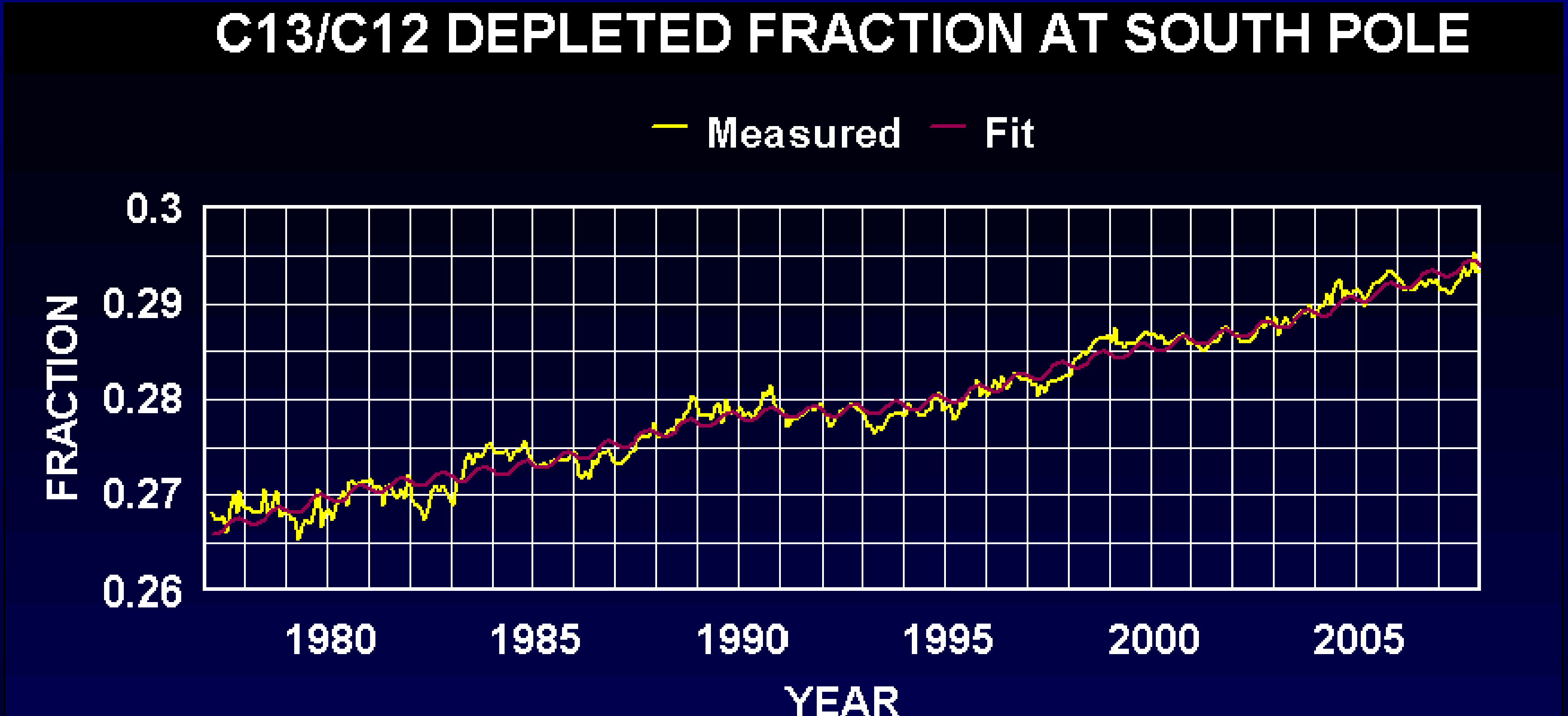
HOW MUCH DOES BURNING FOSSIL FUEL CONTRIBUTE TO THE ACCUMULATION OF CARBON DIOXIDE?

The increasing fraction of C13 depleted carbon dioxide has been given as evidence of the accumulation of the by-product of burned fossil fuel. The previous slide demonstrates that the depletion index from which the fraction is calculated is very closely related to the difference between source and sink SSTs. This is a natural process that affects equally the non-depleted fraction accumulation. The depleted fraction accounts for less than a third of the total accumulation. How much of that third comes from burning of fossil fuel? Is there a statistically significant relationship that would indicate cause and effect?

The following plot of the log of global emissions of carbon dioxide shows that four time periods have different exponential slopes. The period that corresponds to the depletion index is from 1975 to the present. A regression on time for that period yields the relationship emissions = exp(-24.19+0.0165years). This regression accounts for more than 97% of the variability during that period.



Scripps started collecting depletion index data at the south pole in 1977. I calculated the depleted fraction from the index and regressed it on the periods emissions data as well as the observed natural cycles. The natural cycles were annual, 9, 20, and 308 years. All of the natural cycles were statistically significant but emissions was not. The sign of its coefficient was negative and when included in the regression had the effect of reducing the significance of the 308 year cycle.



This plot shows rate of increase of the depleted fraction and the degree of fit with the four natural cycles that are associated with source-sink SST differences. The regression accounts for better than 97.4% of the variability and the standard error of fraction estimate is only 0.0012.

This analysis is strong evidence that anthropogenic emissions of carbon dioxide have not measurably contributed to accumulation in the atmosphere. The half life of any carbon dioxide in the atmosphere as a gas is short, a matter of days rather than years. It is readily adsorbed by an abundance of condensed moisture in clouds, fog, and dew. It readily reacts with basic materials such as limestone, slate, marble, concrete, and galvanized steel. It is returned to the atmosphere as a gas when moisture droplets evaporate. Much of it will go through many of these cycles before it returns to the ocean or reacts with some material on land. Of course plants consume carbon dioxide, but in a mature forest, they produce as much as they consume.

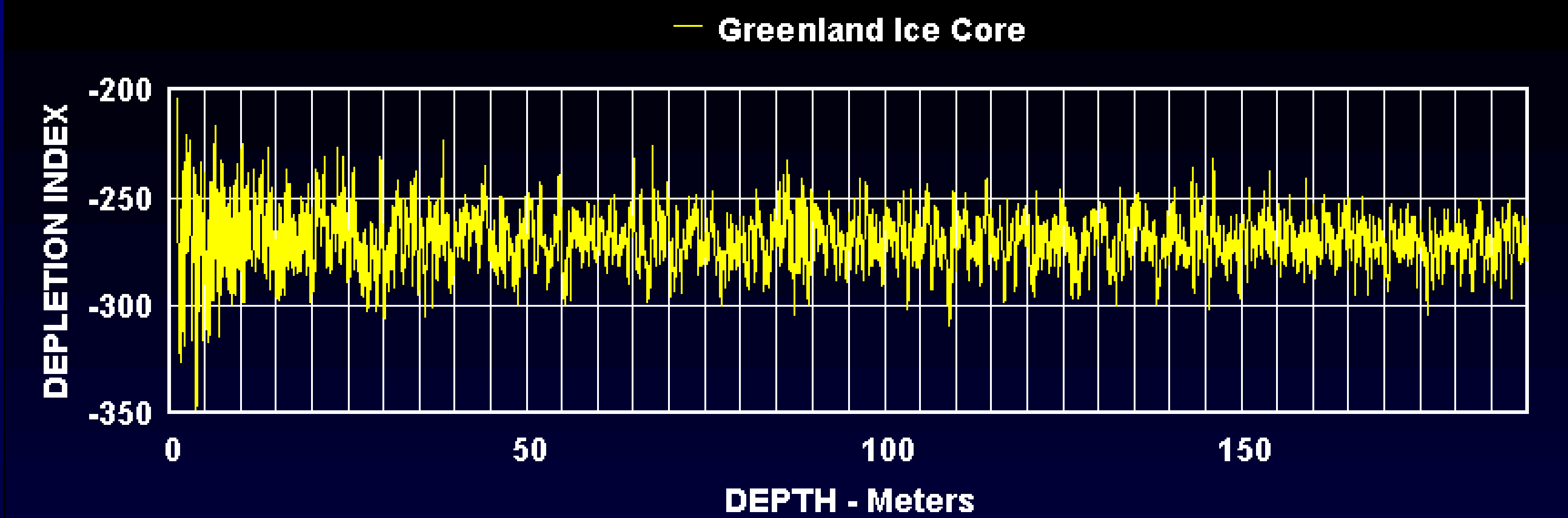
The driving force for weather and resulting climate change is the temperature differences between the equatorial latitudes and the poles. Heat flows from hot to cold via wind and ocean currents. Most of that heat is transported as evaporated moisture. It gives up that heat when it condenses. Condensed moisture transports carbon dioxide toward the poles where it is readily sequestered by frigid sea water. Thus, the accumulation of atmospheric carbon dioxide is a function of the integrated dew point (SSTs as proxies) differences between global sources and sinks. Ice core data, although inaccurate as to time and magnitude, strongly indicates that the relationship exists and is a natural process.

WHAT ABOUT THE ICE CORE DATA?

Both measured values and time to which they are associated are estimates of the true values. The statistics are bi-variant. The error of estimate is the difference between the measured and true value. Both the independent and dependent variables have estimates of error. With the ice core data, the magnitude of that error increases with depth because of physical processes that occur over time.

The most accurate set of ice core data is the high resolution deuterium depletion measurements from the Greenland ice sheet. Back engineering the reported data indicates that the core was sliced into 3 centimeter samples representing an average of 3.2 centimeters of depth. I estimate that good depletion measurements were made on around 99% of over 6000 slices. I have interpolated to fill in these few missing data to get a more accurate depth/depletion relationship.

EFFECT OF DEPTH ON DEUTERIUM DEPLETION

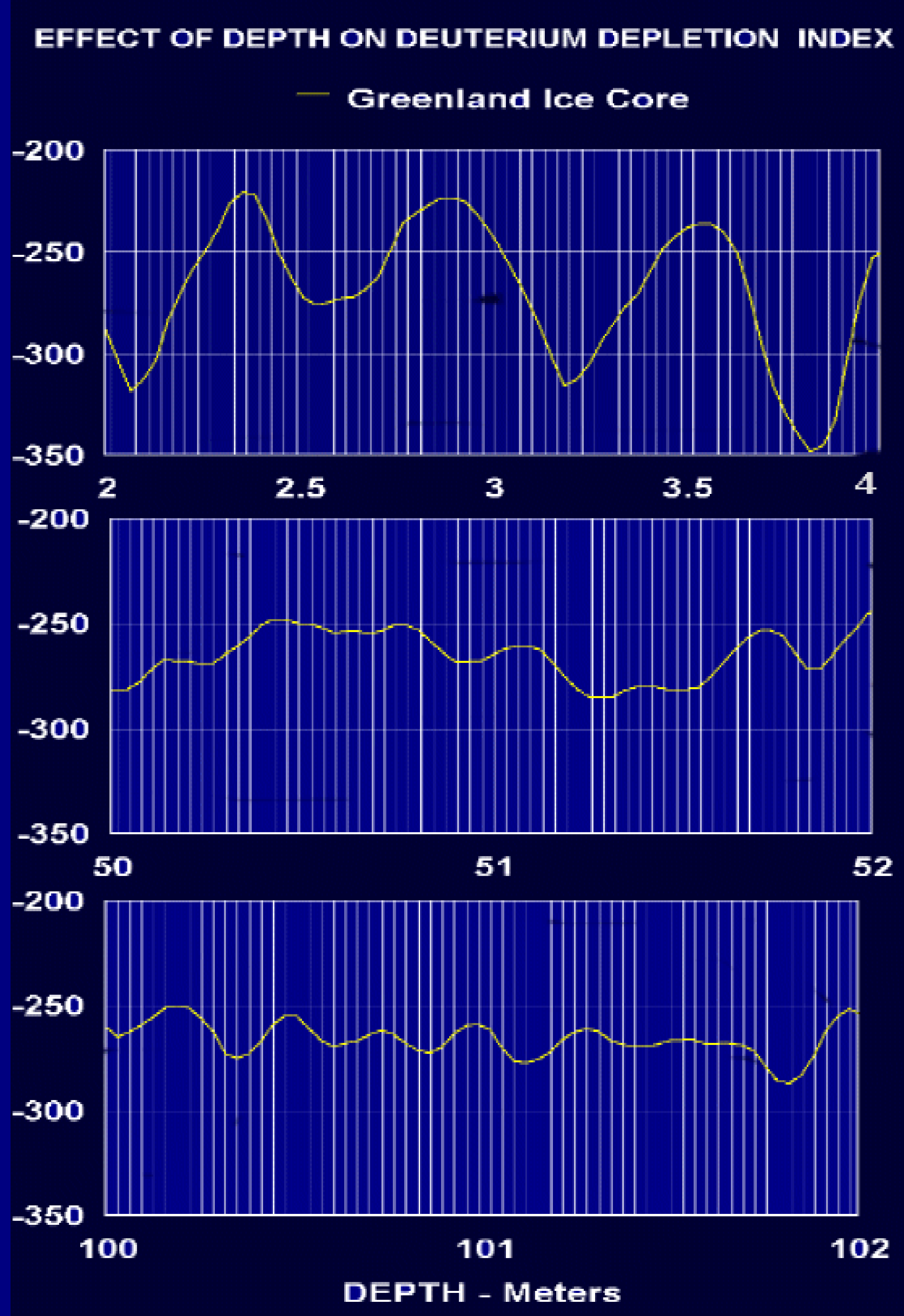


This is a plot of the reported data. A simple linear regression on the data indicates that, at the surface, the value of the average depletion index is -268 and decreases with depth at a rate of -0.0128 per meter. While this slope is not statistically significant, it indicates a temperature rise with later time of deposit. The plot also shows that the variability in the measured index decreases with depth and the rate of decrease is not linear. Expanding this plot clearly shows annual cycles upon which time of deposit of snow can be estimated.

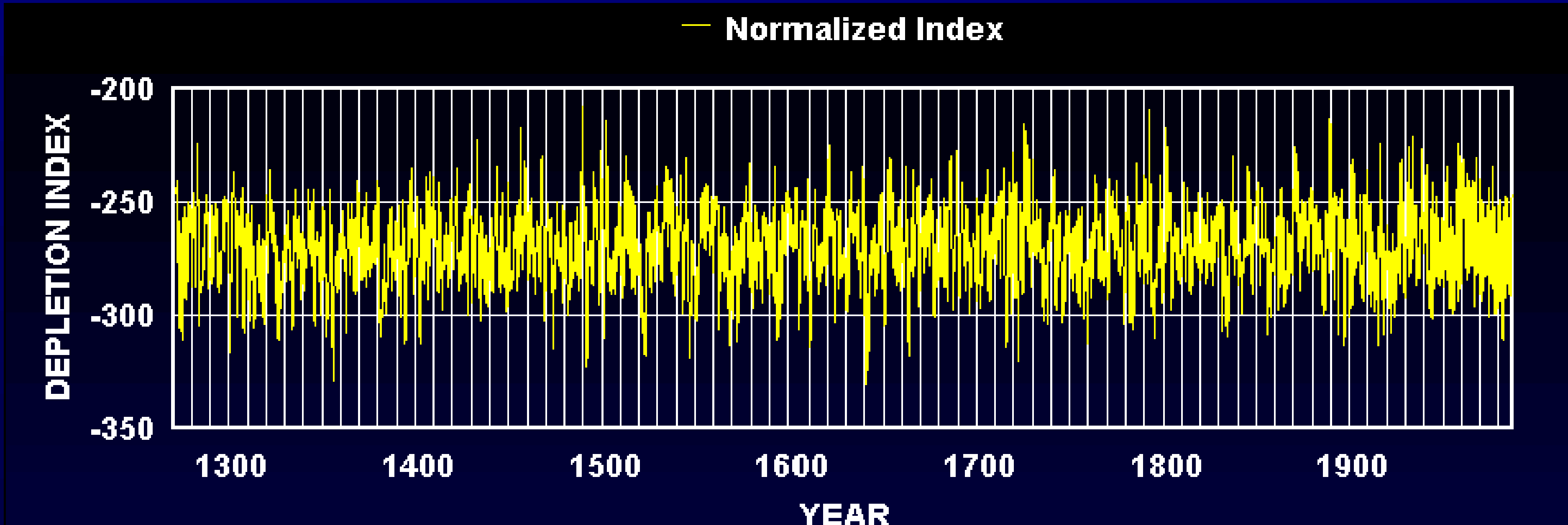
This plot demonstrates how physical processes such as compression, diffusion, and convection affect the measured depletion. Ice is not a crystal structure and is like glass in that it flows under pressure over long periods of time. Molecules diffuse in solids over long periods of time. The resulting effect is to average out the extremes as is shown by the decrease in variability with depth. The deeper you go, the more difficult it is to identify annual cycles.

The weight of accumulated snow compresses the ice sheet below and rate of accumulation is not constant. Therefore, we should not expect depth to be a linear proxy for time. The plot shows that the thickness of annual cycles varies from year to year and decreases with depth.

In order to critically analyze the data, I compensated for these effects by normalizing the standard deviation and fitting the individual cyclic annual minimums to late February.



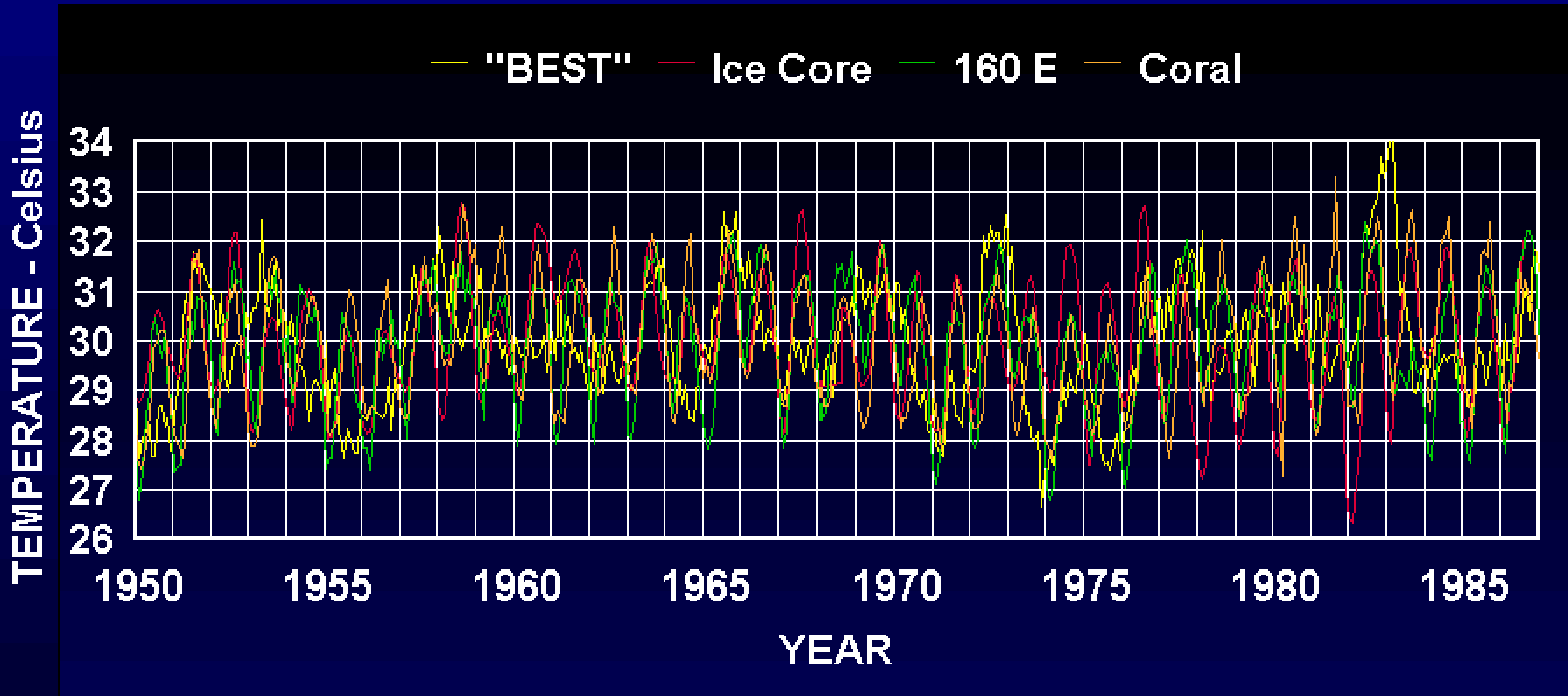
ADJUSTED DEUTERIUM DEPLETION INDEX/TIME FUNCTION



The results from these compensations are shown above. The accuracy of the time estimate decreases with depth. Annual cycles prior to 1900 are often obscured by year to year differences.

These values are expected to correlate with globally integrated source to sink differences in atmospheric dew point. The sink in this set of data is a point with a dew point around zero. The primary sources of moisture are the warmer areas of the oceans, the warmest being the south-western equatorial Pacific. The 160 E data calculated from Nino data sets are representative of this area. There are data in both sets for the period between 1950 and 1987. I analyzed these data to test their degree of correlation.

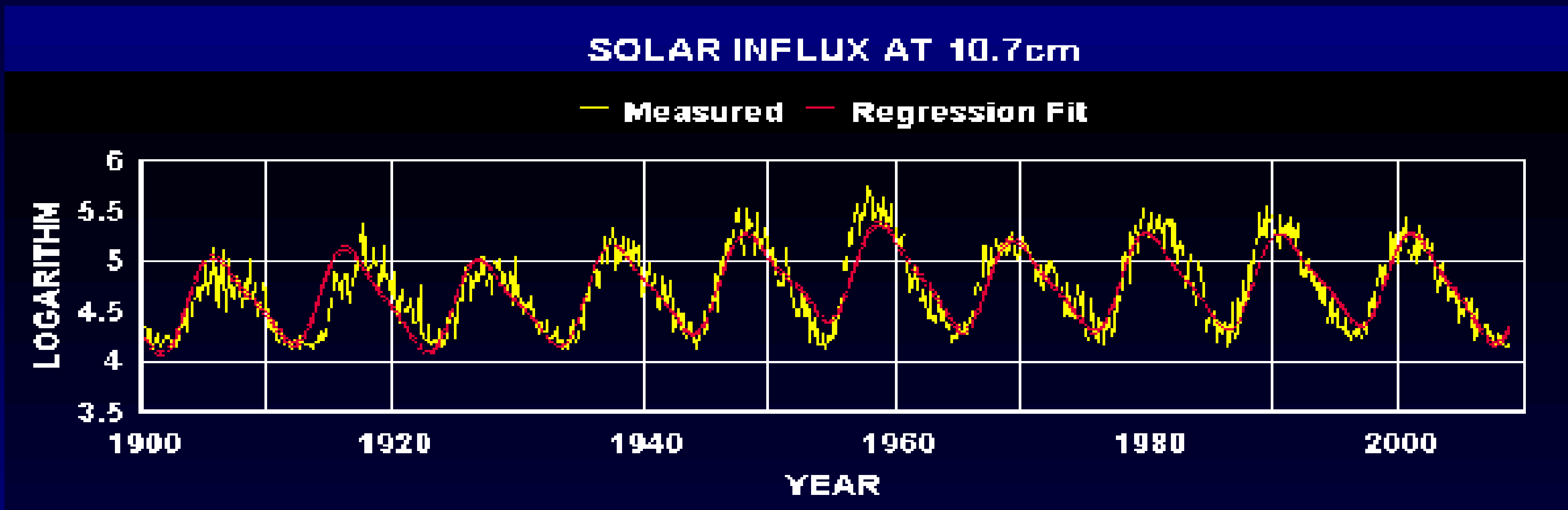
ESTIMATED WESTERN EQUATORIAL PACIFIC SST



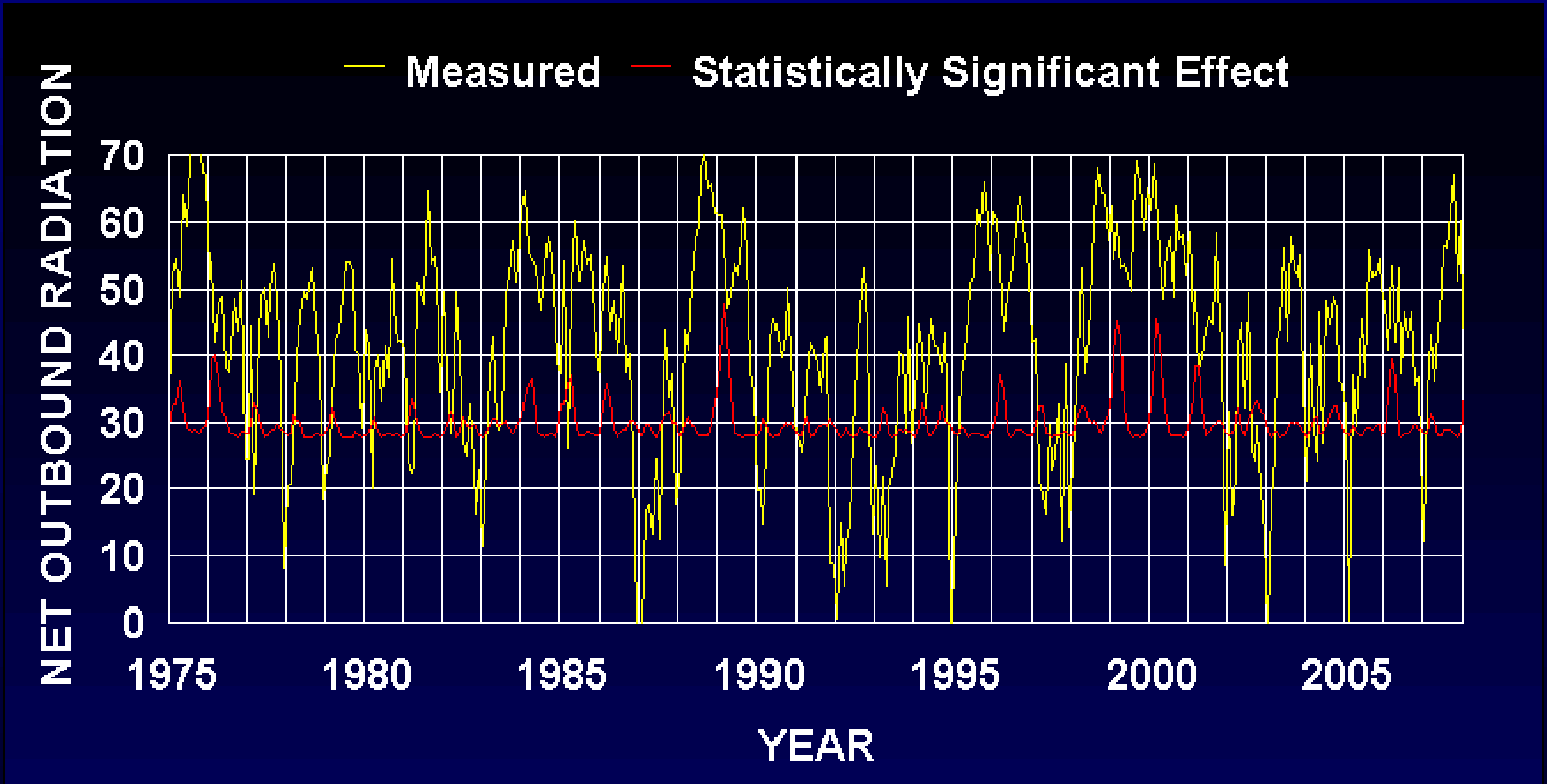
I converted three data sets to comparable 160 E temperatures by correlating the means and standard deviations for the common time period . This plot shows the annual cycles track well for all but the “BEST” data. The “Bi variant EnSo Time series” (BEST) is calculated using the Southern Oscillation Index (SOI) and the Hadley Center Nino 3.4 data set. It is calculated back to 1871. The Coral data are based on measurements of the annual variation in Sr/Ca and estimates time back to about 1750. The magnitudes of the “BEST” annual cycles are similar but the shapes and timing of the cycles are not. The “BEST” data is much more erratic. I believe the ice core data is a more reliable indicter of global climate change than the “BEST” data.

ENERGY FLUX AND SEA SURFACE TEMPERATURE

Most of earth's energy comes from the sun. SSTs are expected to be related to solar influx such as the reported 10.7 cm data. These data are linearly related to sun spot numbers that have been recorded as far back as 1750. I have calculated the logarithm of solar influx from sun spot numbers and determined the best statistical fit to data back to 1900 for three sine function cycles, each with one harmonic. These cycles are 10.6, 40.2, and 321.6 years. This regression accounts for nearly 88% of the variability. They are similar to the long term cycles calculated from the Greenland ice core data.



EFFECT OF SST AND MOISTURE ON NET LONG WAVE RADIATION



The measured Western Equatorial Pacific out bound long wave radiation expresses extreme variability. If there were no atmosphere, outbound radiation would be proportional to the absolute sea surface temperature to the fourth power. Clouds reflect heat back to the sea. Water vapor and carbon dioxide absorb some of it. I calculated the amount of water vapor at saturation for SSTs. I then regressed the data on SST, water vapor, and carbon dioxide concentrations at Christmas Island. The results are shown above. The linear slope is not significant and indicates a rise of less than 6% in 100 years. Carbon dioxide increased 16% during the 38 year period. The SST affect was significantly positive as expected. Water vapor was significantly negative as expected. CO2 was not significant and was slightly positive. This is evidence that carbon dioxide does not contributed significantly to a green house effect.

ESTIMATING PREHISTORY CLIMATE CHANGES FROM ICE CORES

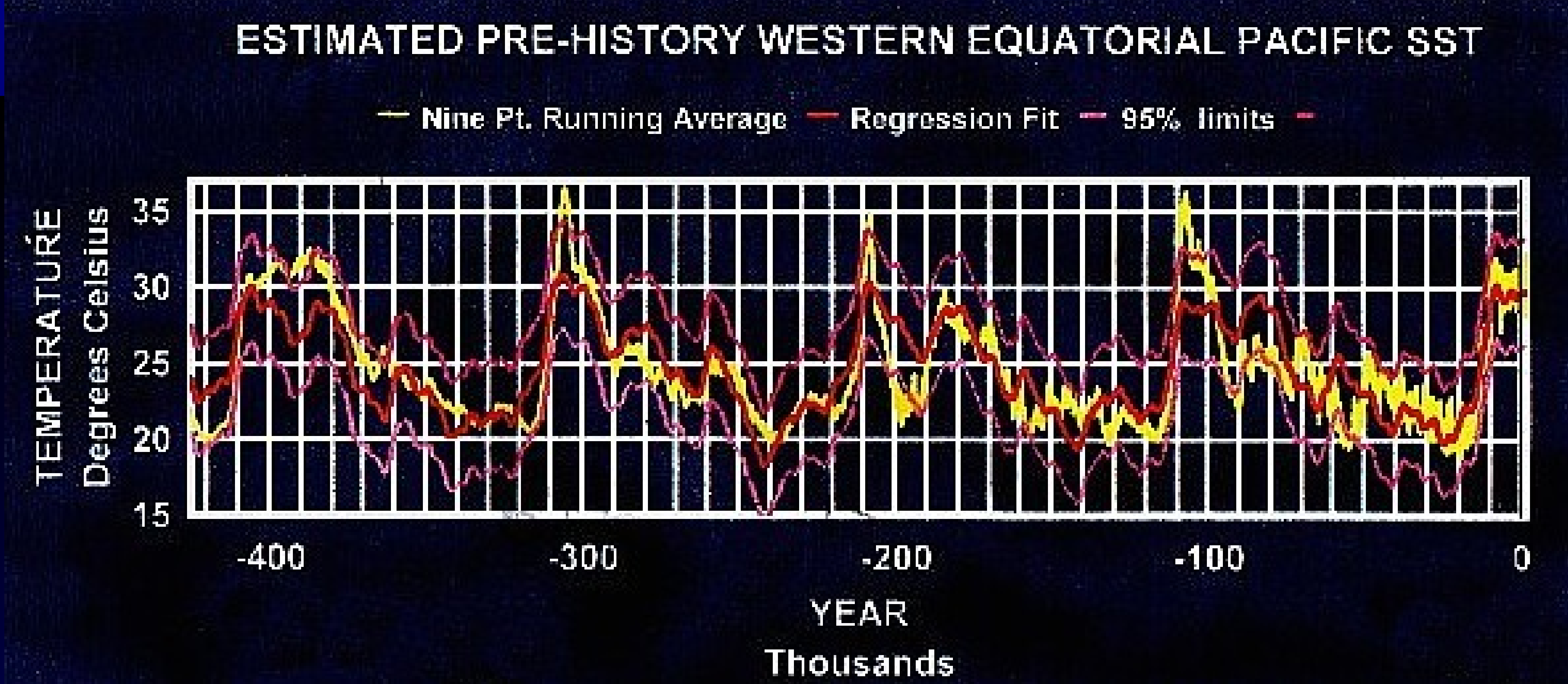
The deuterium and oxygen 18 depletion indexes are good indicators for estimating globally integrated SST differences. The signal is amplified proportional to the distance between the source of evaporation and the condensation sink. Thus, the South Pole ice cores provide data with the strongest signals. The deepest reported ice core (3000+ meters) is the European EPICA dome C. They measured depletion on 55cm samples and averaged the values for each 3.85 meters. At the top of the core a sample represents an average for around 70 years. At the bottom some of the reported averages cover over 4000 years. Their best estimates are based on 3000 year averages. This gives you a better estimate of long term trends but washes out the detail of relatively short term changes that produce a maximum or a minimum value.

Many other sets of depletion data have much better resolution but do not extend as far back. Eleven sites in Greenland, Canada, and the Antarctic have produced annual average data for isotope depletion. Several report results for multiple ice cores and others report both O 18 and deuterium.. While the magnitude of the signals differ from site to site, the trends and cycles are similar. One set of data extends back to around 1800 BC.

I converted all these high resolution data into time-temperature data using means and standard deviations for common time periods. The annual averages of these combined data are indicators of global source temperature changes. The time scales have been estimated in several ways and related to ice core depth. The depletion index can be used to estimate the time scale. The high resolution time scale should be fairly accurate.

For the long term, low resolution data,I have visually adjusted the reported time scales to an orbital time scale calibrated to the Younger Dryas event at 9620 BC and reflecting the Milankovitch 100,000 year cycle by synchronizing the inter-glacial peaks. Individual sets of depletion data were converted to temperature..

Running averages of the data reduces the potential for introducing conversion errors.

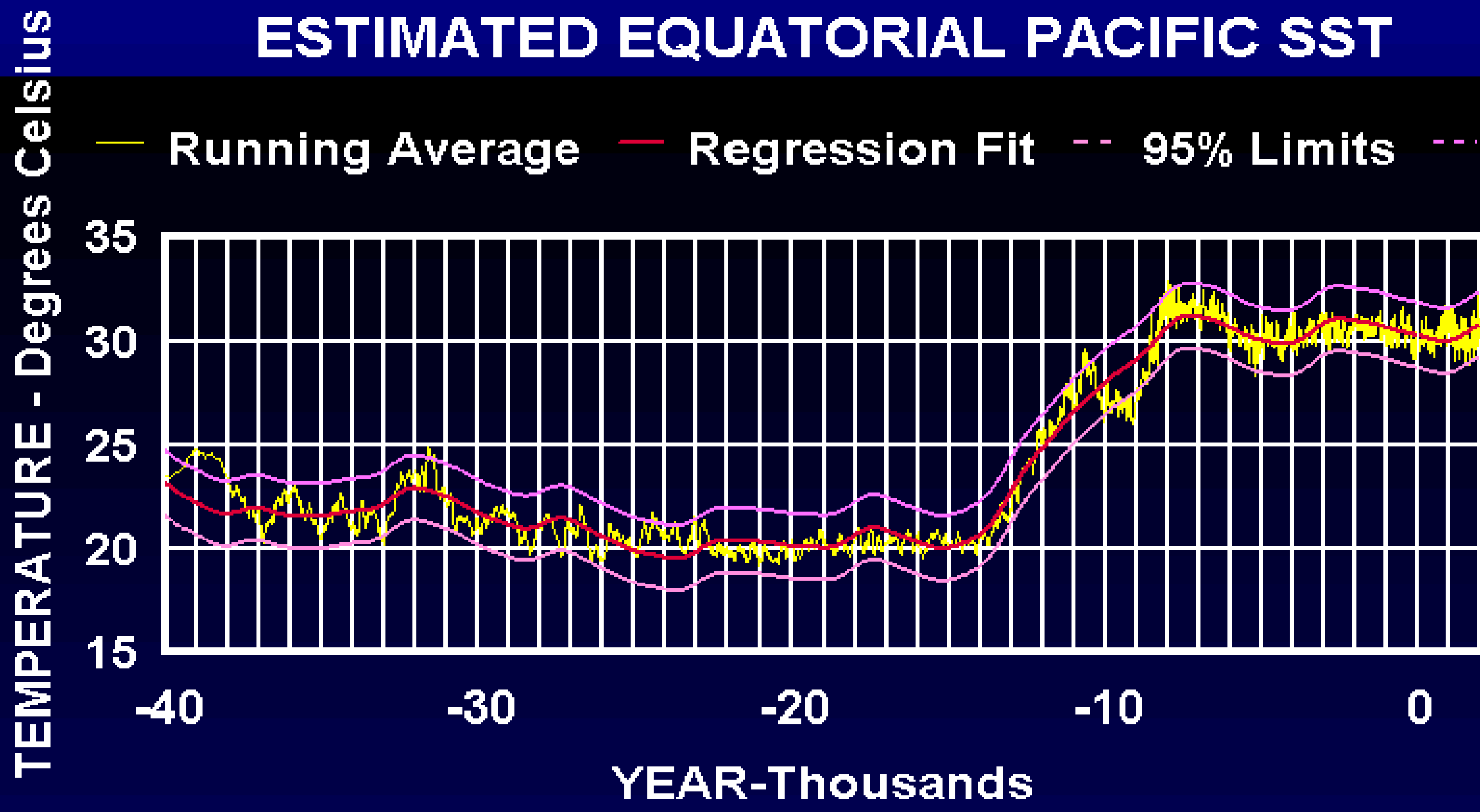


The results for the long term data are shown above. The shape of the cycles is a sawtooth wave form approximated by sine(x)-sine(2x)/4+sine(3x)/9 where x=2Πyears/b+a. The terms a and b are determined by trial and error in a multiple linear regression. The term b is the wave length and a is a positioning constant. I found five statistically significant wave lengths. They are 101,000, 43,050, 24,840, 9942, and 5014 years. The first three correspond to the Milankovitch cycles. The fit accounts for 80% of the variability in the data back to 400,000 BC.

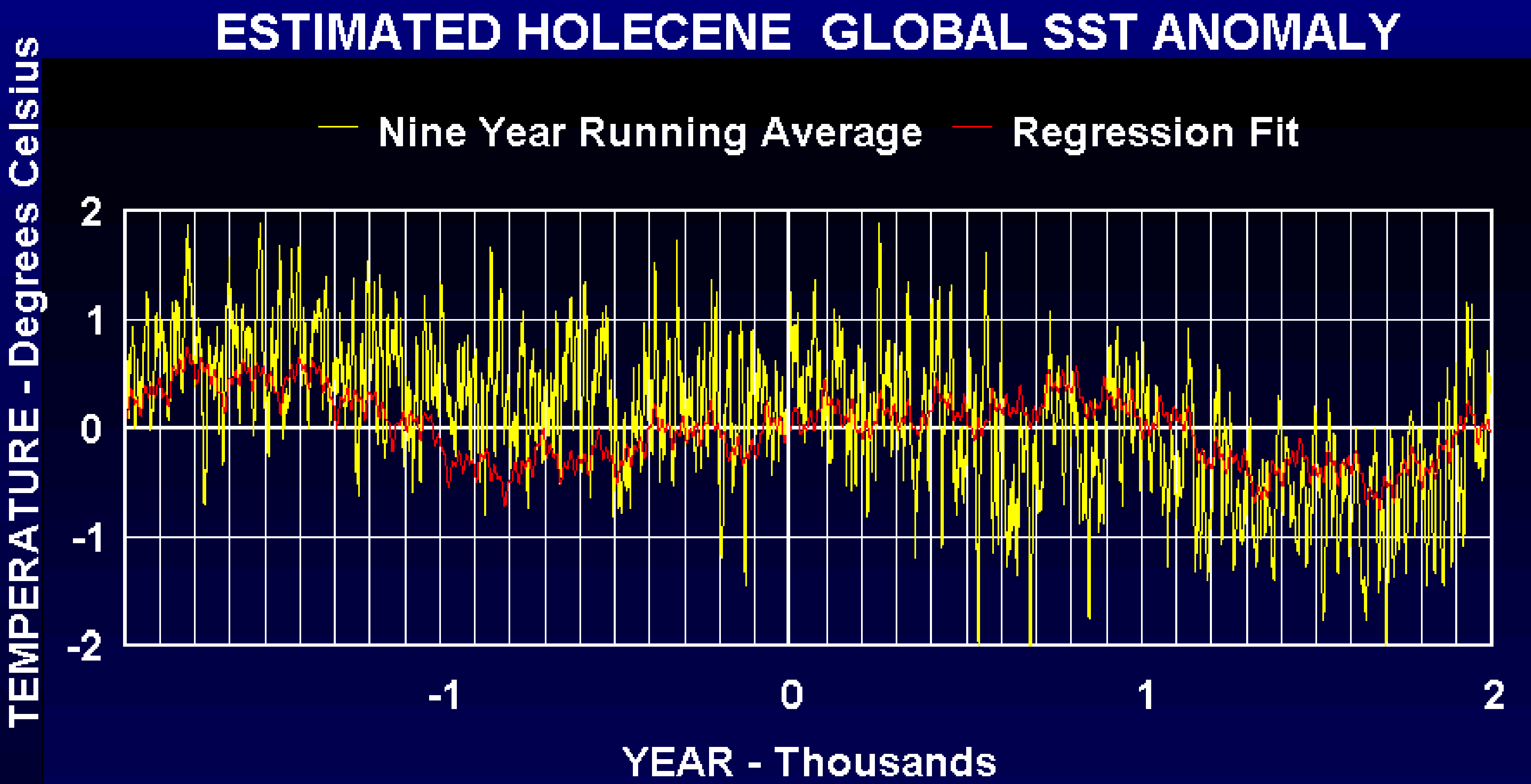
These major cycles are similar but not identical. The sawtooth wave form is indicative of a rather fast global energy charging followed by a slower loss or consumption of that energy . The earth is reacting to the sun's radiation as an energy capacitor. Water, in all its forms, is the factor affecting this process. It is the primary regulator of global temperature.

Our present interglacial period is unique in several ways. First, the maximum temperature 10,000 years ago was about five degrees less than the peak for the previous cycle. The unique Younger Dryas event may have contributed to this difference. Second, unlike previous interglacial periods, major temperature changes have been relatively mild and the period is longer, allowing civilization to develop.

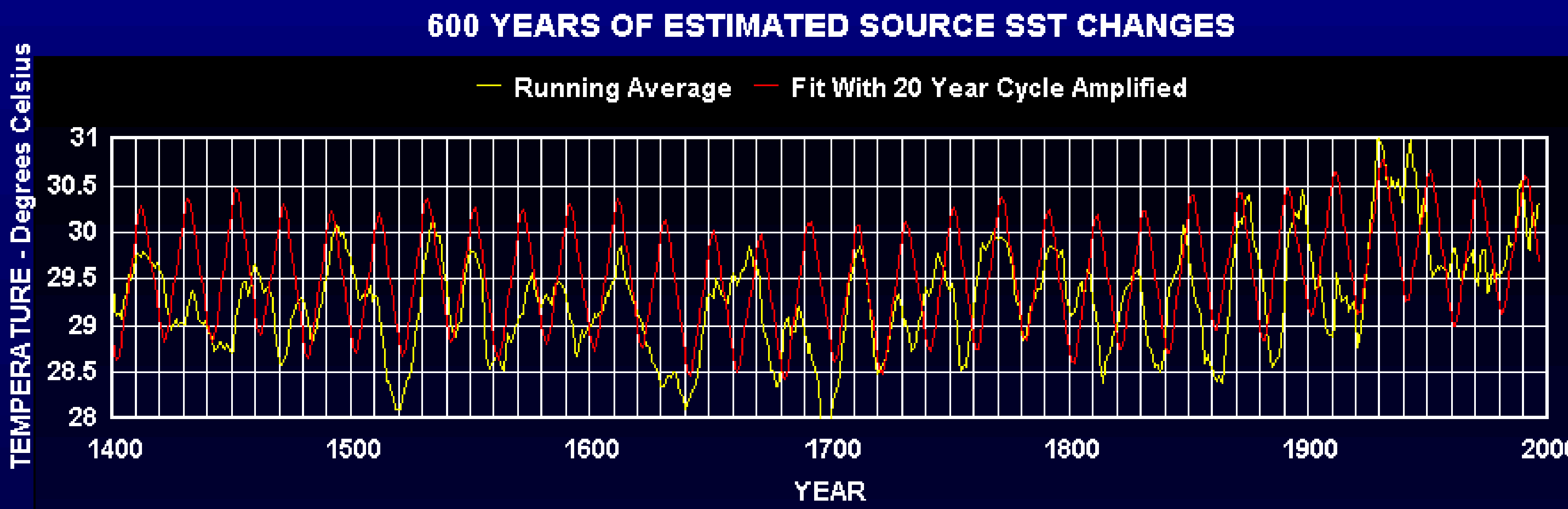
I have analyzed these differences by regressing these cycles on selected consistent data sets for the past 45,000 years. The selected seven sets of data all show the Younger Dryas event. The result is a very good fit accounting for 97% of the variability. The better fit shows an additional shorter cycle to be statistically significant. The wave lengths for these six sawtooth cycles are 101,000, 52,500, 23,500, 10,300, 4890, and 1,479 years The next plot illustrates the degree of fit.



Although these cycles show the long term trends that are expected to continue, the resolution isn't good enough to show shorter term natural changes. Also, they do not explain unique natural events such as the Younger Dryas. The high resolution depletion data yields many more statistically significant shorter term cycles.



I analyzed the annual averaged data as anomalies on the temperature predicted from the five long term cycles of 101,000, 43,050, 24,840, 9,942, and 5,014 years. Trial and error regression on the running average indicates eight statistically significant triangle shaped cycles:1,839 , 1,356, 653, 364, 165, 79.7, 40.2, and 19.97 years. The above plot shows our present rise in SST began in the little ice age, a couple of centuries before industrialization and is a natural cycle.



The regression value of the coefficient for the 20 year cycles is low because both wave length and amplification vary from year to year. I adjusted this coefficient so that it would more accurately reflect the observed amplification. The rate of temperature change in these cycles is around 0.14 Celsius degrees/year. The results are shown in the above plot.

Projecting this plot into the future indicates we will have fluctuations of about a degree and a half within ten year periods and the long term average will reach a maximum of about 0.8 degrees higher than today around the year 2250. An intermediate maximum 0f 0.5 degrees is expected around 2090. I expect we will experience a ten year decline in SST beginning within a couple of years.

Each regressed wave length coefficient has an estimate of error and the trial and error wave lengths and their placements have an undetermined degree of error. Thus, the projected times and magnitudes of maximums is uncertain. Based on the ratio of estimate of errors to coefficients, I estimate each wave length can vary by about 25%. The maximum temperatures are probably off by as much as a degree.

What the data reveal is that the long term trend for the last 10,000 years has been a consistent decline in temperature with thousands of relatively rapid perturbations in temperature of up to three degrees. The long term trend has been only a temperature drop of 1.14 degrees in 10,000 years. A trend line determined on a short term does not represent long term global climate changes. A temperature rise of more than a couple of degrees is very unlikely because there are natural forces that serve like a limiting thermostat causing triangular wave form swings.

WHAT ABOUT CARBON DIOXIDE IN ICE CORES

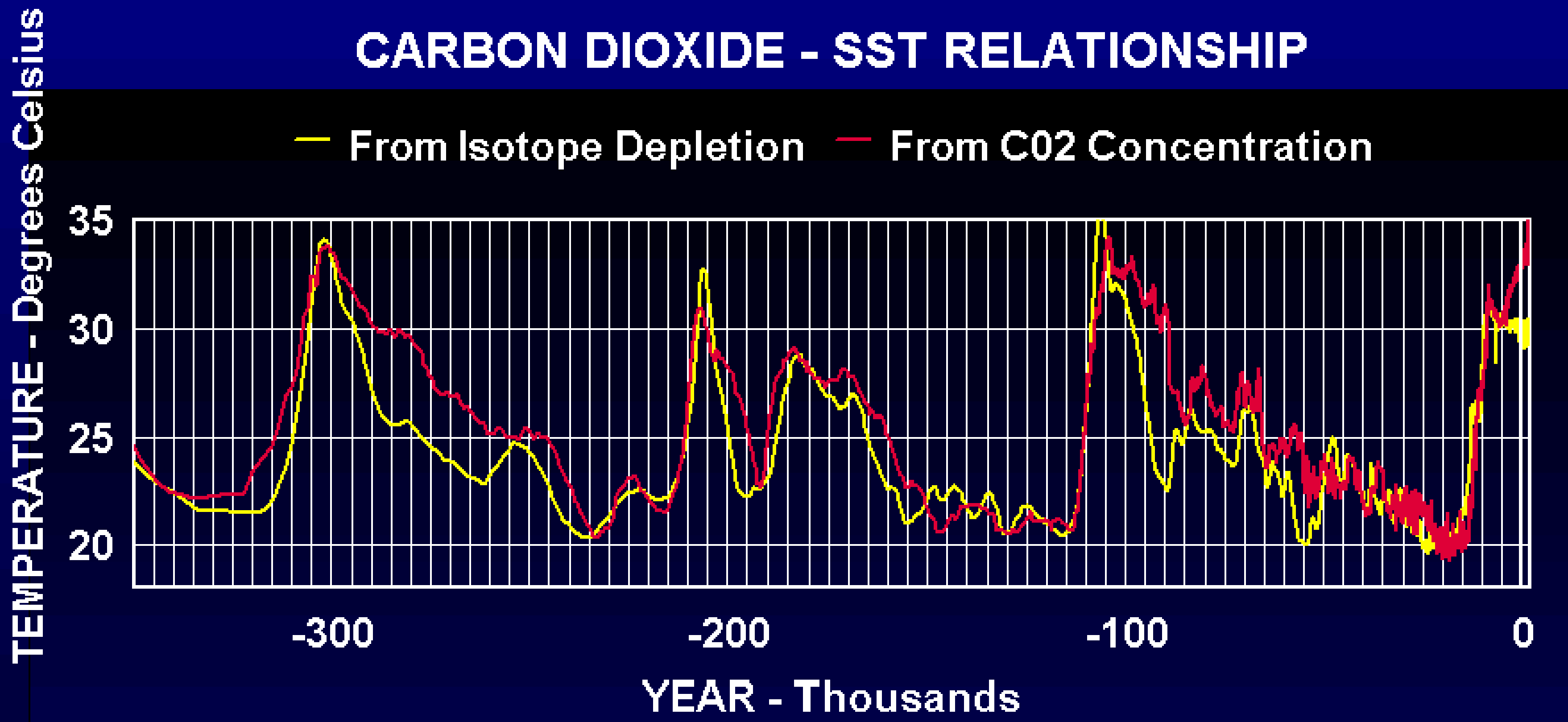
Statements have been made that the levels of atmospheric carbon dioxide are higher now than they ever have been. They are comparing Scripps measured data with carbon dioxide measured in air extracted from ice cores and disregarding atmospheric wet chemistry measurements as too inaccurate or misleading. The truth is that the ice core data is misleading because it is not a direct measure of the carbon dioxide trapped in the ice thousands of years ago. There are several limitations to the accuracy of these measurements as indicators of atmospheric carbon changes with time. The first is the limits to time resolution. The length of the ice core sample has to be large enough to be able to extract a measurable air sample. The length of the core samples represents from about 100 to 3000 years depending on depth. Thus, individual samples are measures of the averages over the represented time period. This physical averaging factors out the highs and lows that occur within each period. Second, the trapped air is not a gas at the temperatures and pressures at a depth of more than around 100 meters. Most of the molecules of oxygen, nitrogen, and carbon dioxide are encased in clathrate hydrates which can remain relatively stable when the pressure is remove as the core is extracted. Third, during the acclimatization period after core extraction, expanding air produces micro-cracks in the ice into which modern air diffuses.

The mixing of the modern air with the trapped air causes the apparent age of the air to be up to 3000 years younger than the ice in which it is trapped. Carbon 14 found in deep ice cores confirms that this mixing has taken place. Carbon 14 should not be detectable at the ages of these deep cores.

The ice core data is a very good indicator of a strong relationship between background atmospheric carbon dioxide and global SST. The measured concentrations do not vary significantly from site to site. I have combined several CO2-time data sets adjusting each time scale to the same orbital time scale as used with the isotope depletion data. I used means and standard deviations for comparable time periods around the Younger Dryas event to convert the CO2 concentrations to SST.

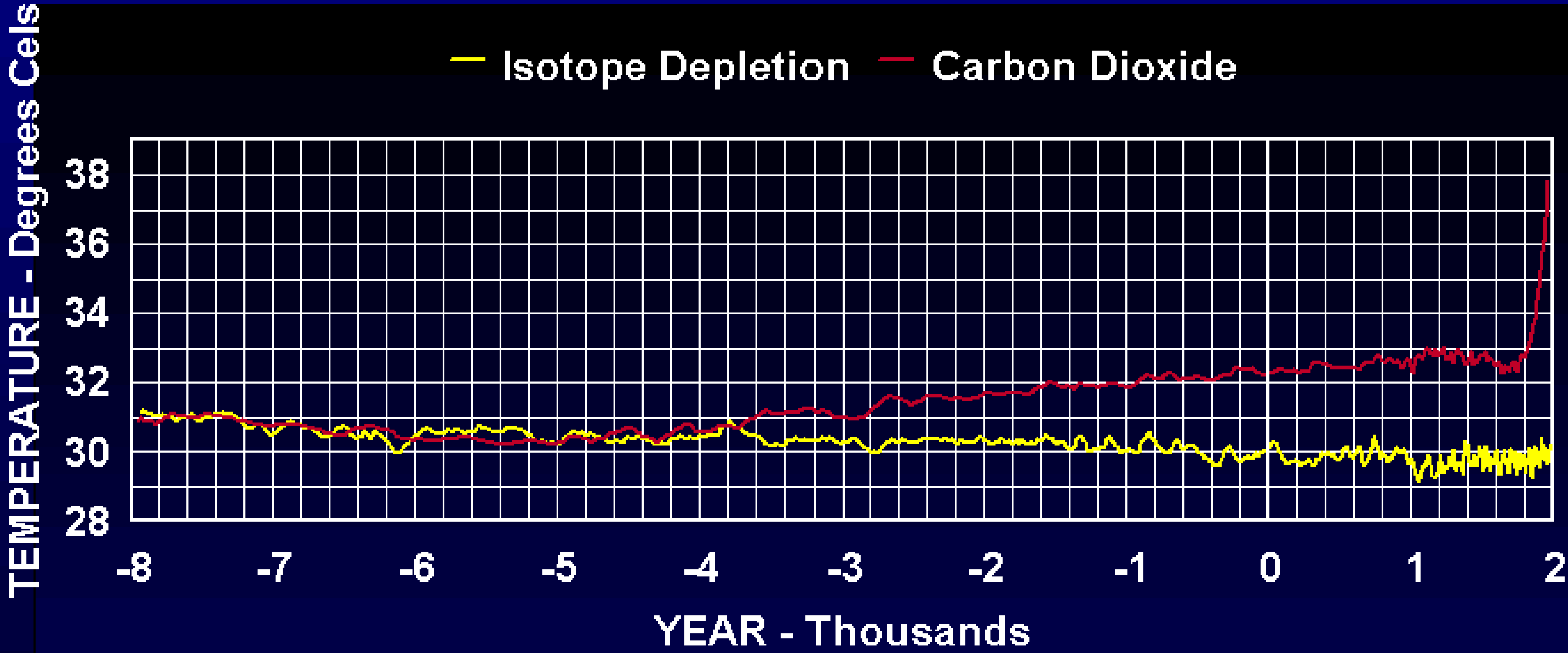
There are much more depletion data than CO2 data giving that set better time resolution and related cycle amplitudes. For comparison purposes, I averaged the depletion data to produce a set with a comparable number of data points with the CO2 set. Each set was then smoothed to filter out spikes by doing a running average of nine points. The results are shown in the next plot. The calculated linear relationship between temperature and CO2 concentration is

$$\text{Temperature} = -8.57 + 0.15 * \text{CO2}$$



Note that both the upward and downward slopes from the CO2 data are generally not as steep as those from the depletion data. This indicates that a rise in CO2 naturally follows a rise in SST. Also, the CO2 is slower in being absorbed as the SST cools. This relationship follows fairly closely up until around 4000 BC where there is a distinct departure of the two lines.

PREDICTED SST FROM ICE CORE DATA



This plot shows the departure of the carbon dioxide predictions from those of the isotope depletion. The latter closely agrees with the last centuries measured values while the “hockey stick” predictions of the CO2 relationship are extremely high. Apparently, below depths equivalent to older than 4000 BC, significant amounts of carbon dioxide are retained in stable clathrate hydrates when the trapped air is extracted for measurement.

Also, oxygen and nitrogen may be retained in clathrate hydrates but in different fractions, thus, complicating carbon dioxide concentration measurements. The three degree difference in predicted temperature around 1500 is equal to a CO2 concentration difference of 20 ppm. Above a depth equivalent to about 1800, the ice has not firmed and most of the air is not trapped so that the concentration values more closely reflect ambient conditions. The eight degree difference at the maximum deviation is equivalent to 53 ppm.. This indicates that ice cores below a depth equivalent to older than 4000 BC could be retaining as much as 17% of the trapped carbon dioxide in stable clathrate hydrates. Because SST was higher 10,000 years ago than today, carbon dioxide was very likely higher as well. The maximum temperature for the previous interglacial period was significantly higher than today so CO2 concentrations would also be higher.

CONCLUSIONS

> We are in a long term period of declining temperatures that started at a peak about 10,000 years ago.

> Thousands of natural temperature cycles with swings of around two degrees deviate from this declining trend. A statistically significant twenty year cycle tends to dominate SST change rates of about 0.14 degrees/year. We are presently on an upswing and can expect a downswing within a couple of years.

>The observed rise in background levels of carbon dioxide is globally uniform and is primarily the result of rising temperatures of the arctic ocean sink and not from increases in anthropogenic emissions.

>The condensation, evaporation, freezing, and thawing of water is the thermostat that moderates our atmospheric temperature and allows life to exist. The effect on temperature by carbon dioxide's absorption of long wave radiation is not detectable compared to the effects of water. It takes a whole lot more energy to evaporate a mole of water at a constant temperature than it does to raise a mole of carbon dioxide by a degree or two. There is a lot more water vapor in the air than carbon dioxide.

>Carbon dioxide tends to equilibrate with condensed moisture in clouds and fog and thus moderating the effects of SST rises that cause it's emission from equatorial sources. Also, clouds transport dissolved CO2 toward the poles where it is sequestered by frigid ocean sinks.

>Carbon dioxide extracted from ice cores is an indicator but not an accurate measure of prehistoric atmospheric concentrations. Long term averaging filters out peaks and valleys of natural cyclic swings. Stable clathrate hydrates retain significant amounts of carbon dioxide in the extraction process. Atmospheric concentrations were significantly higher than indicated by the extracted measurements.

>Changes in atmospheric carbon dioxide follow changes in SST and the rates of change are slower producing a moderating effect. This is a natural process that has occurred for over 400,000 years. There have been no tipping points caused by high carbon dioxide concentrations.

FINALLY, THE BOTTOM LINE!

* Anthropogenic emissions of carbon dioxide have not caused a rise in background levels of carbon dioxide. A green house effect of carbon dioxide is not causing global warming. Thus, carbon dioxide is not a pollutant!

* Lowering emissions of carbon dioxide will have no effect on natural climate changes including our present global warming. Attempting to control emissions of CO2 will waste energy when we need to be using it more efficiently!

Sincerely,

Fred H. Haynie

Retired Environmental Scientist