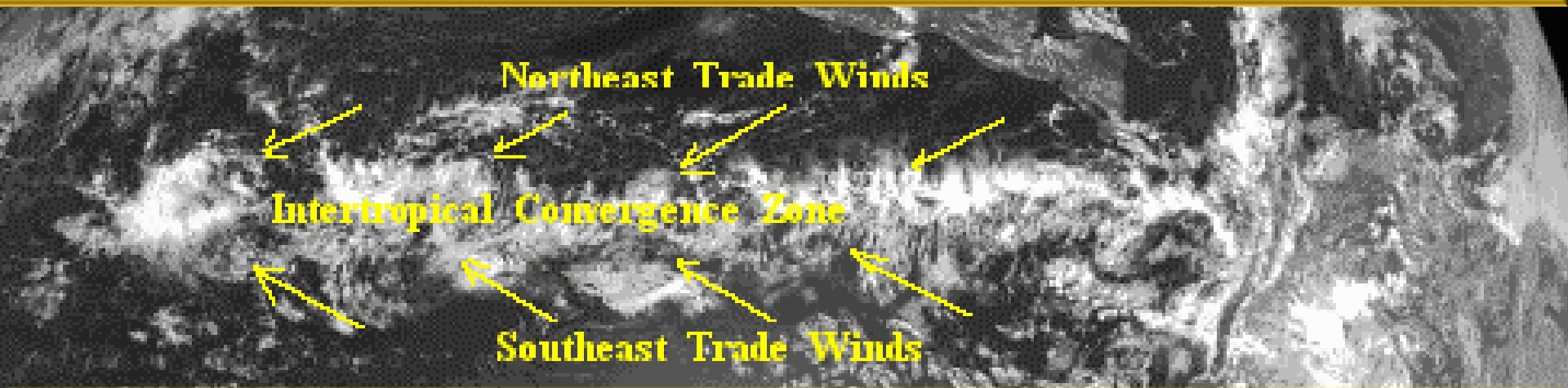


# Weather, Climate, and Climate Change...

## What the Data Say

### Climate History and El Nino (ENSO)



**Bob Endlich**

**[bendlich@msn.com](mailto:bendlich@msn.com)**

**3 Oct 2017**

**<http://casf.diskstation.me/wordpress/>**

**Apologies--continued web page Technical Difficulties.**

The following several slides are editorial in nature,  
but begin with real stories taken from the “news”  
pages of the Washington Post.

# Scientists have a new way to calculate what global warming costs. Trump's team isn't going to like it.

By Chelsea Harvey

How we view the costs of future climate change, and more importantly how we quantify them, may soon be changing. A much-anticipated [new report](#), just released by the National Academy of Sciences, recommends major updates to a federal metric known as the “social cost of carbon” — and its suggestions could help address a growing scientific concern that we’re underestimating the damages global warming will cause.

**The social cost of carbon is an Obama-era metric first addressed by a federal working group in 2009.**

The basic premise is simple: Scientists agree that climate change will have all kinds of impacts on human societies, including natural disasters and effects on human health, productivity and agricultural output, all of which have economic consequences.

[https://www.washingtonpost.com/news/energy-environment/wp/2017/01/12/scientists-have-a-new-way-to-calculate-what-global-warming-costs-trumps-team-isnt-going-to-like-it/?utm\\_term=.a6e0ad0f2](https://www.washingtonpost.com/news/energy-environment/wp/2017/01/12/scientists-have-a-new-way-to-calculate-what-global-warming-costs-trumps-team-isnt-going-to-like-it/?utm_term=.a6e0ad0f2)

# After Maria, the misery deepens

In isolated mountains of Puerto Rico, residents are running out of basics

The Washington Post 25 Sep 2017 [+6 more](#) BY SAMANTHA SCHMIDT AND JOEL ACHENBACH

Juncos, puerto rico — In the heat and humidity here in the central mountains, Meryanne Aldea fanned her bedridden mother with a piece of cardboard Sunday as the ailing woman lay on her side, relieving a large ulcer in her back.

The 63-year-old mother, Maria Dolores Hernandez, had cotton stuffed in her ears to keep flies out, since her now screenless windows were letting all sorts of bugs in. The gray-haired di-

abetic woman spoke with her daughter about her worries: that she would run out of prescription drugs, that they were almost out of generator fuel to keep her insulin refrigerated and to run the fans at night. With all the heat, she feared that her ulcer would become infected.



# Editorial

The Washington Post is schizoid:

They approvingly proclaim that the **social costs of carbon** need to be attached to use of energy.

Yet, they whine when non-availability of electricity harms poor people.

Their solution is to use renewables:

Subsidized Wind and Solar

How is that working out in Puerto Rico?

The next slides have an answer:

I think this is from a storm chasing small business called Live Storms Media; they put this up on YouTube as **\*\*\*NOT FOR BROADCAST\*\*\*** hoping to be paid for the video by markets which can afford to pay the fees.

9-22-17 Puerto Rico Wind - Solar - Cellular Structures Destroyed ...



**\*\*\*NOT FOR BROADCAST\*\*\***

MORE VIDEOS

FOR LICENSING CONTACT  
brett@livesstorms.com

0:26 / 1:21



YouTube



# Puerto Rico Wind/Solar Destroyed By Maria <https://youtu.be/1AAHJs-j3uw>

Posted on September 27, 2017 by tonyheller



<https://realclimatescience.com/2017/09/puerto-rico-windsolar-destroyed-by-maria/>

Green energy is worthless. If Puerto Rico had to depend on it, they would be back to the Dark Ages.

# Halfway through class

Daily and Weekly changes (so far) in the Annual Cycle

Controls on the Annual Cycle in the El Paso Area

Hurricane Harvey Data: Harvey was NOT CO<sub>2</sub>-Enhanced  
2016 Baton Rouge Floods: NOT CO<sub>2</sub>-Enhanced

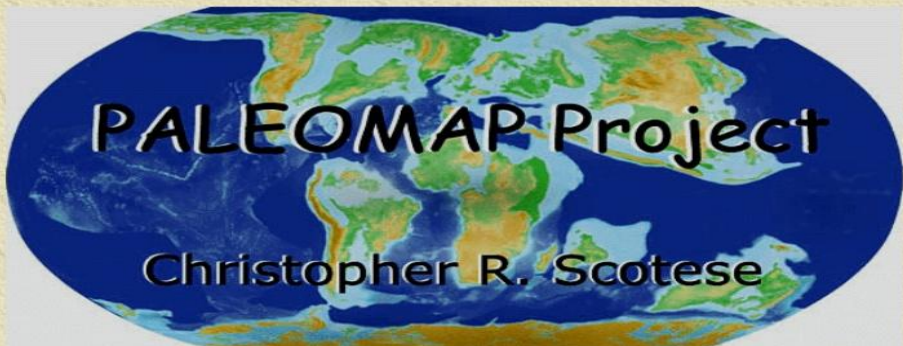
We Shift Gears: **Earth Climate History:**

Geological Time Scale, last 600 Million Years

Within the past 500,000 years (part of Pleistocene)

Within the past 10,000 years (Holocene)

Discussion of **El Nino, La Nina, ENSO Neutral**



PALEOMAP Project  
Christopher R. Scotese

---

Sci/Tech Web Awards 2001  
SCIENTIFICAMERICAN.COM

Selected by Science Educators  
SCILINKS  
From NSTA

SCIENTIFIC AMERICAN  
2002  
SCI-TECH  
WEB AWARDS

[Site Map](#)  
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[Climate History](#)  
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**Goal of the PALEOMAP Project**

✦ The goal of the PALEOMAP Project is to illustrate the plate tectonic development of the ocean basins and continents, as well as the changing distribution of land and sea during the past 1100 million years.

[AMERICAN JOURNAL OF SCIENCE, VOL. 301, FEBRUARY, 2001, P. 182-204]

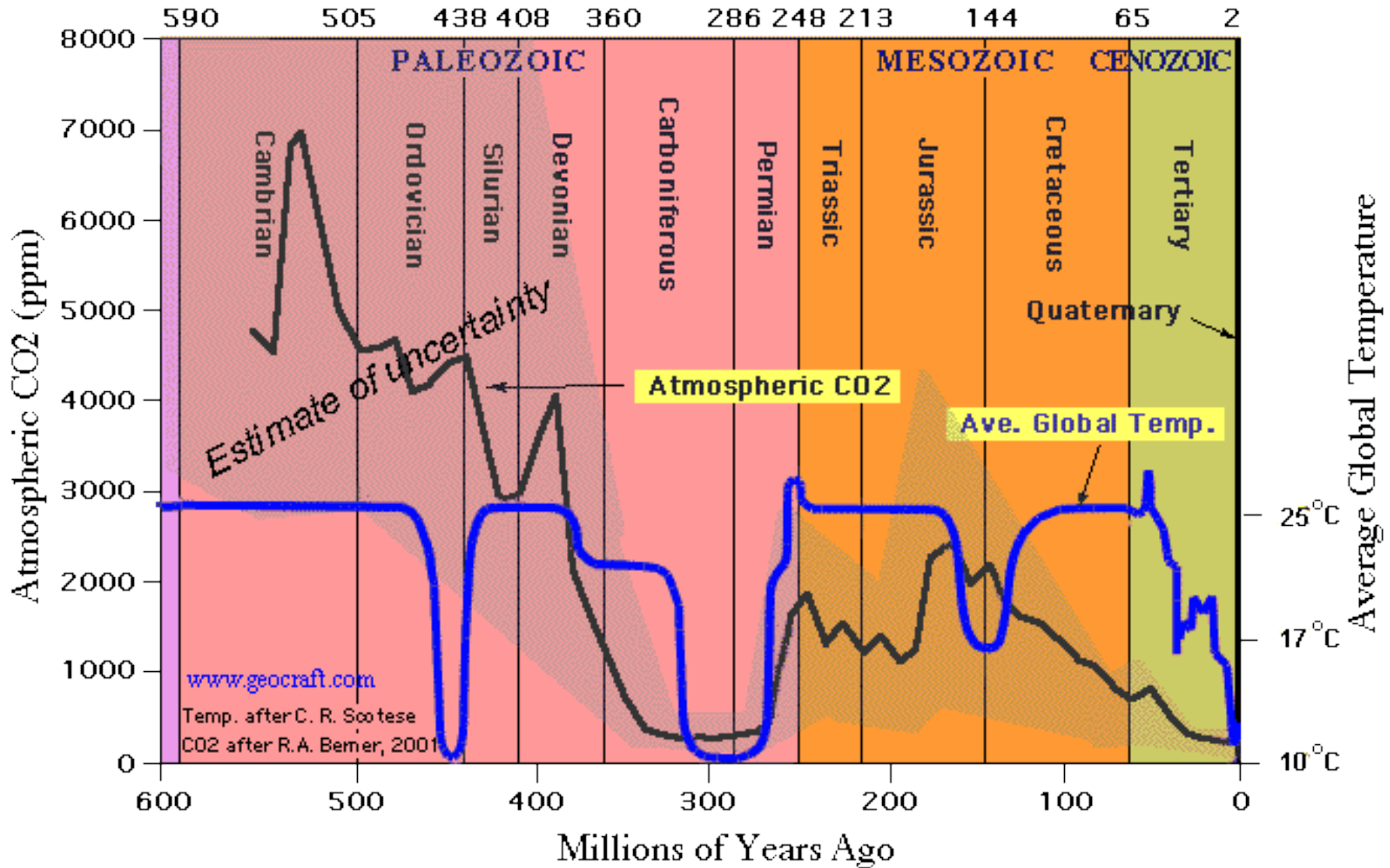
## GEOCARB III: A REVISED MODEL OF ATMOSPHERIC CO<sub>2</sub> OVER PHANEROZOIC TIME

ROBERT A. BERNER and ZAVARETH KOTHAVALA

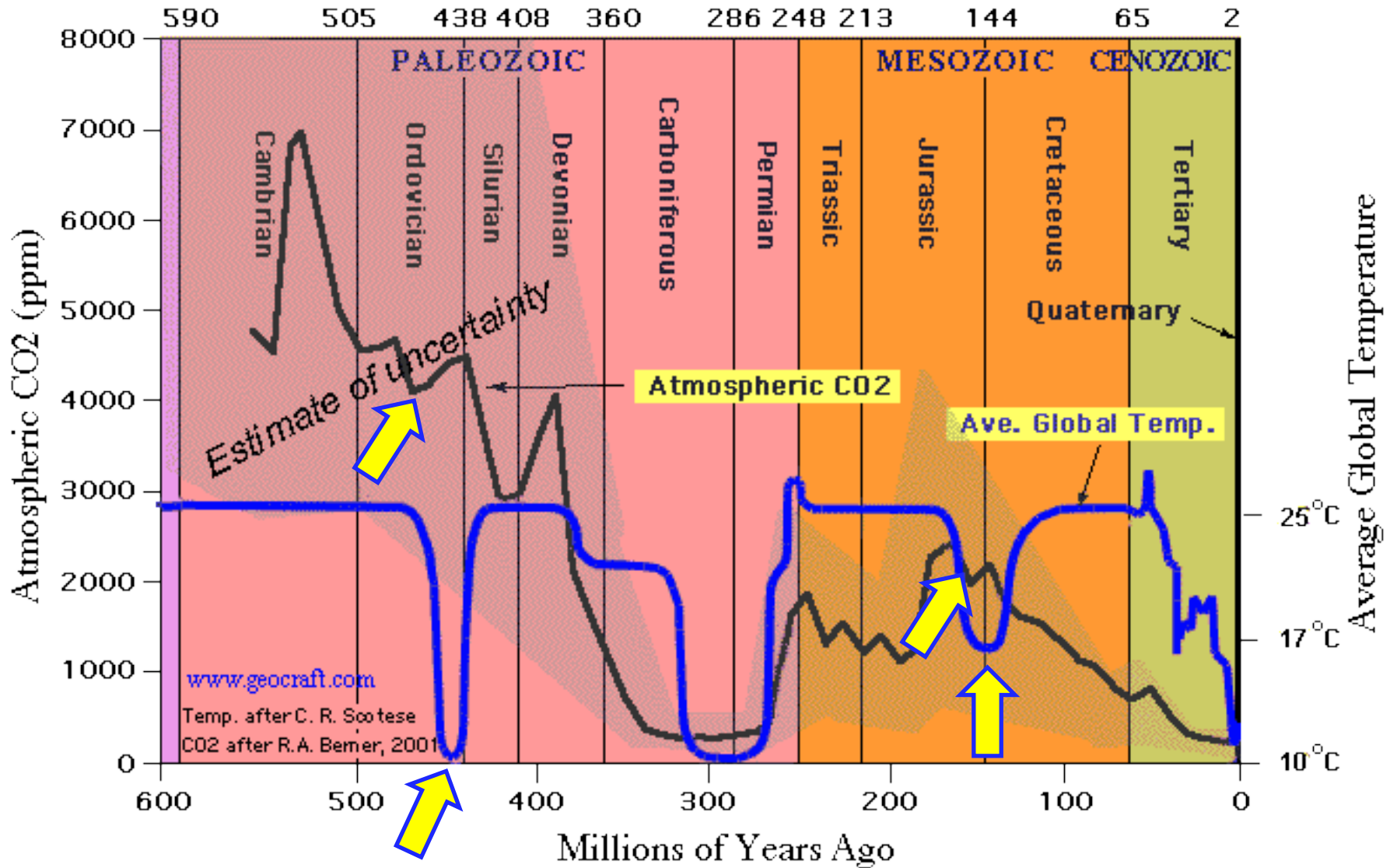
Department of Geology and Geophysics, Yale University,  
New Haven, Connecticut 06520-8109

**ABSTRACT.** Revision of the GEOCARB model (Berner, 1991, 1994) for paleolevels of atmospheric CO<sub>2</sub>, has been made with emphasis on factors affecting CO<sub>2</sub> uptake by continental weathering. This includes: (1) new GCM (general circulation model)





**X-Axis Time:** Cambrian 600 MY ago Left Present on Right  
**Y-Axis Blue Average Global Temperature,** Scotese Paleomap Project [Climate](#) Tab  
**Y-Axis Black Atmospheric <CO<sub>2</sub>>** Berner & Kothavala, Am J. Sci., 2001, p 182-204



If atmospheric <CO<sub>2</sub>> effect has such a great effect on Temperature and the feedbacks are so strong, why, at the end of the Ordovician, 450M years BP, did temperatures fall so precipitously, when <CO<sub>2</sub>> INCREASED from 4100 to 4500 PPM.? Similar effect in at end of Jurassic. Yellow Arrows.

# Proxies for Temperature

Liquid-in-glass thermometer record available, at best, since 1800s

Proxies for temperature: Objects in the physical record dependent on temperature during their creation -- used to determine temperature history.

Example: Ice Core Data.

Water consists of H<sub>2</sub>O. Oxygen consists of isotopes of O<sub>16</sub> and O<sub>18</sub>. The O<sub>16</sub>/O<sub>18</sub> ratio can be used to determine temperature of the water substance which became snow... then ice after burial...hundreds...thousands of years.

“The heavier [isotope](#) (<sup>18</sup>O) condenses more readily as [temperatures](#) decrease and falls as [precipitation](#), while the lighter isotope (<sup>16</sup>O) can fall in even colder conditions. The farther [north](#) elevated levels of an <sup>18</sup>O isotope are detected signals a warming over time.<sup>[8]</sup>”

Often written in the technical literature as  $\delta^{18}\text{O}$ .

Typically used for Greenland Ice Cores

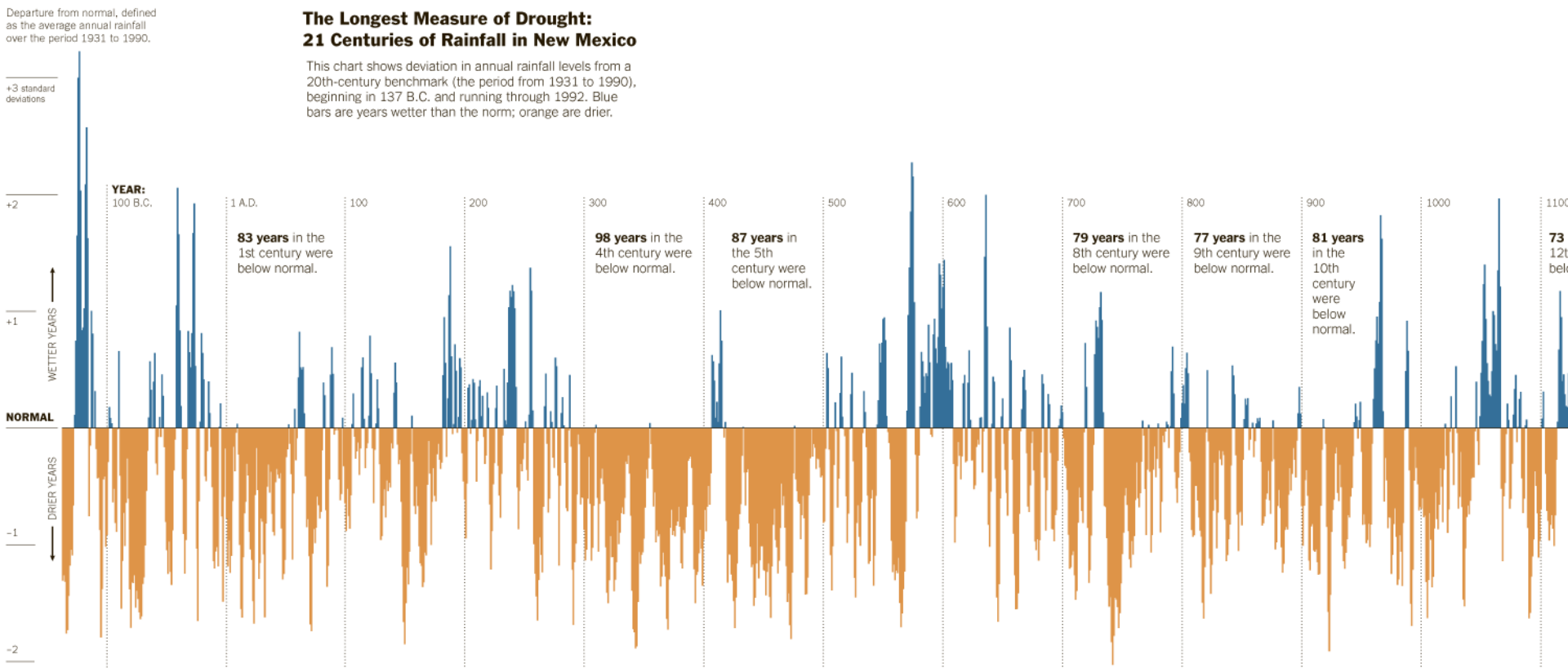


# Other Proxies for Temperature

**Tree Rings**, pioneered by the University of Arizona Tree Ring Laboratory.

“Dendroclimatology is the science of determining past climates from trees, primarily from properties of the annual [tree rings](#).”

Tree rings...wider when conditions favor growth, narrower when times are difficult.”



## Other Proxies for Temperatures

### **Boreholes:**

"Boreholes have a great advantage over many other proxies in that no calibration is required: they are actual temperatures.

However, they record surface (ground) temperature not the near-surface temperature (1.5 meter) used for most "surface" weather observations."

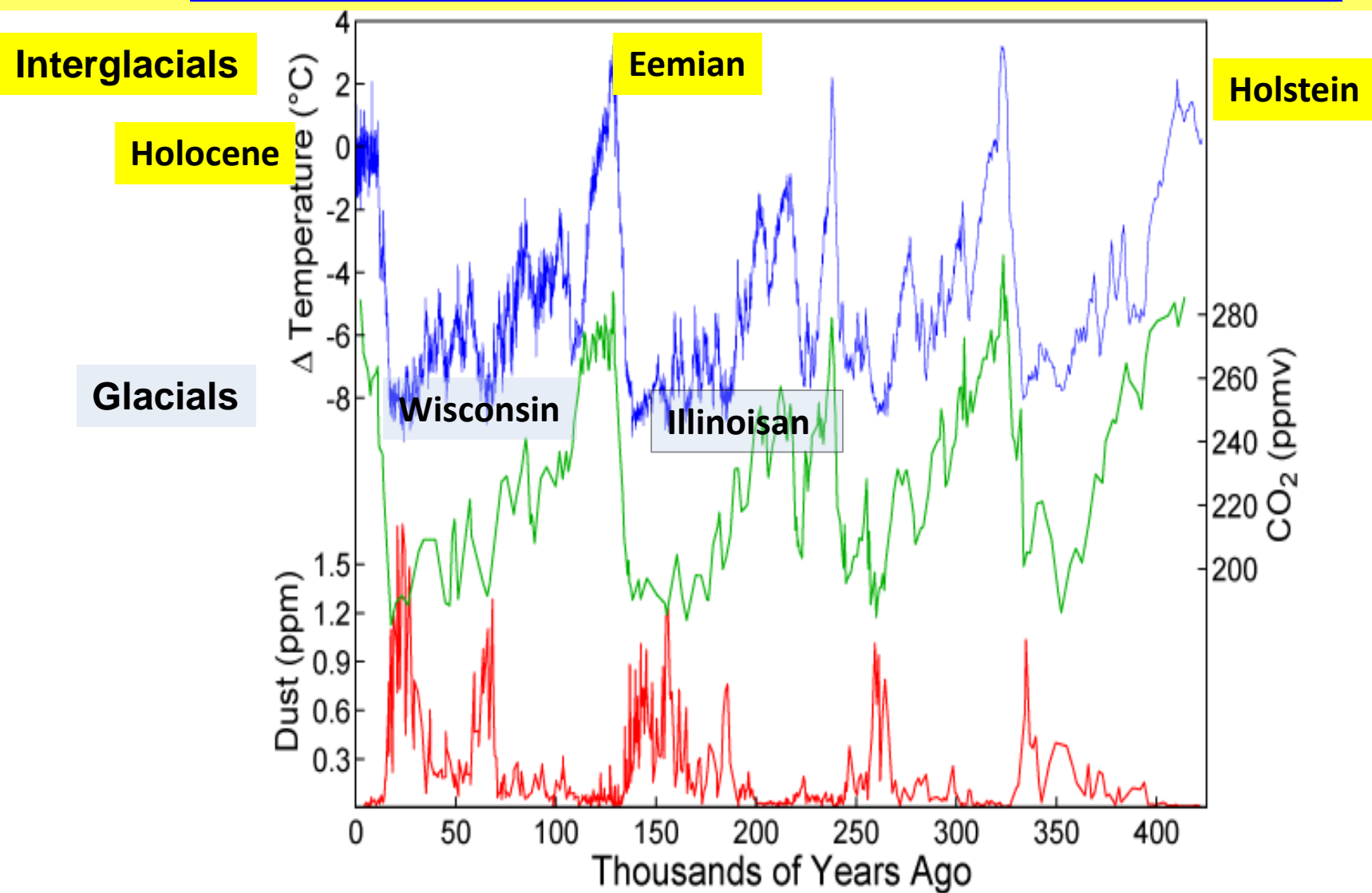
"Central Greenland borehole temperatures show "a warming over the last 150 years of approximately  $1^{\circ}\text{C} \pm 0.2^{\circ}\text{C}$  preceded by a few centuries of cool conditions.

Preceding this was a warm period centered around A.D. 1000, which was warmer than the late 20th century by approximately  $1^{\circ}\text{C}$ ."

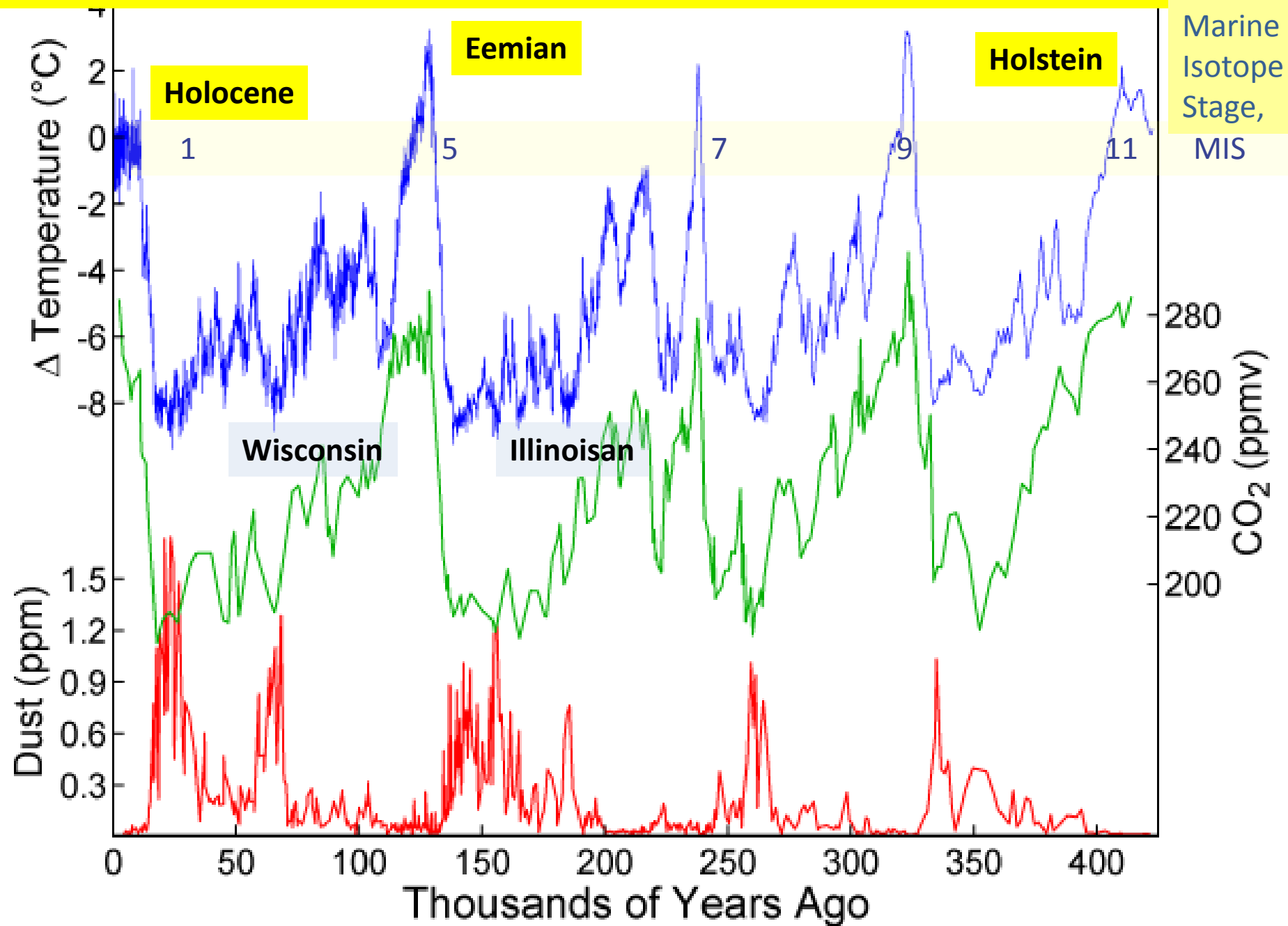
A borehole in the Antarctica icecap shows that the "temperature at A.D. 1 [was] approximately  $1^{\circ}\text{C}$  warmer than the late 20th century".<sup>[14]</sup>"

**How did "Wikipedia's Climate Doctor" allow this one to escape deletion?**

<http://casf.diskstation.me/wordpress/wp-content/uploads/2017/04/Wikipedias-Climate-Doctor-by-Lawrence-Soloman.pdf>



**X-Axis Time** Present Time, Left 450,000 years BP, Right  
**Y-Axis Blue Temperature** difference “anomaly” from mean, last 10K yrs  
**Y-Axis Green, Scale on Right, atmospheric  $\text{CO}_2$**



Letter <http://www.nature.com/nature/journal/v462/n7271/abs/nature08564.html>

*Nature* **462**, 342–345 (19 November 2009) | doi:10.1038/nature08564; Received 9 October 2008;  
Accepted 5 October 2009

## Evidence for warmer interglacials in East Antarctic ice cores

L. C. Sime<sup>1</sup>, E. W. Wolff<sup>1</sup>, K. I. C. Oliver<sup>2,4</sup> & J. C. Tindall<sup>3</sup>

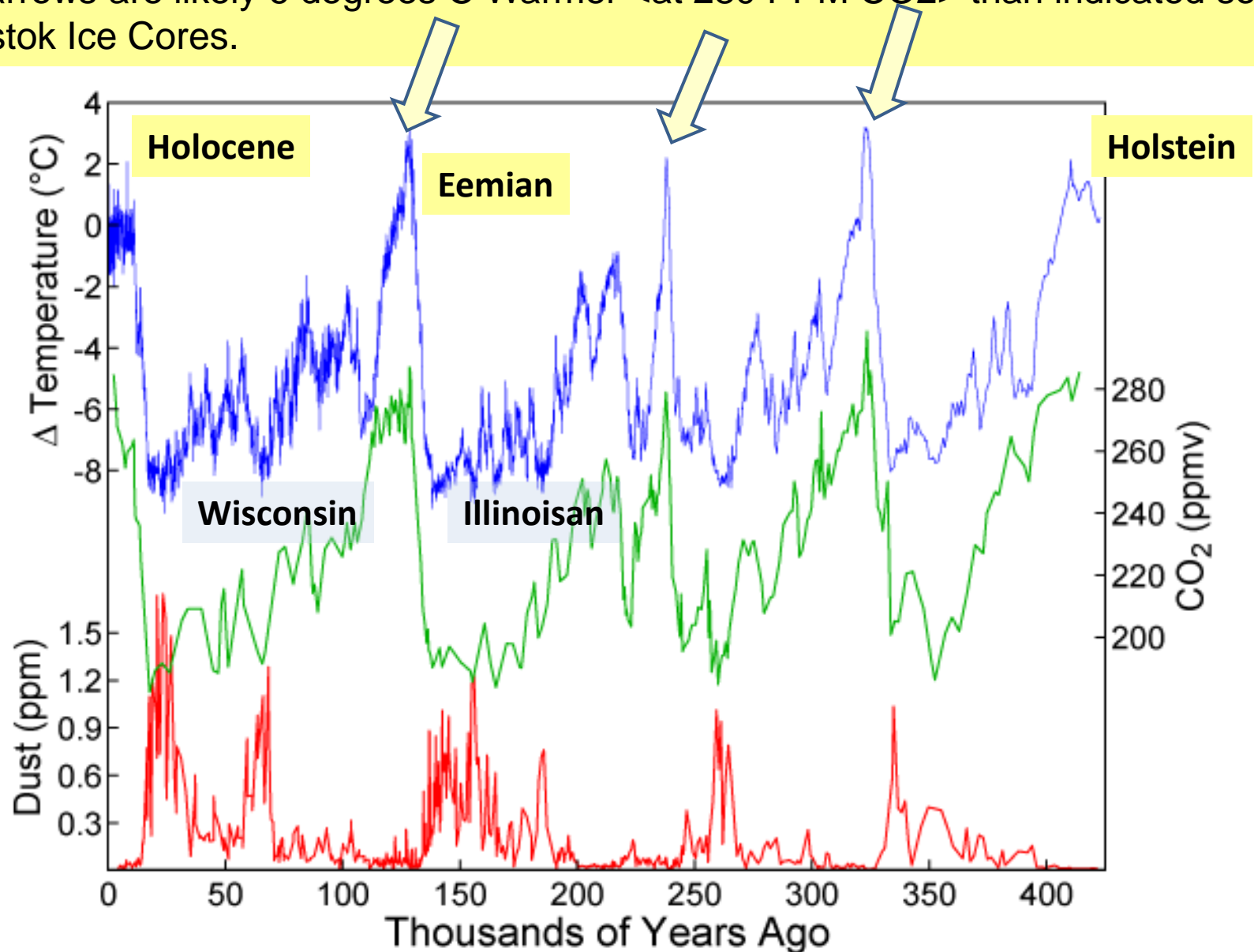
**Three East Antarctica Ice Cores from the past 340,000 years.**

**“We conclude that previous temperature estimates from interglacial climates are likely to be too low.**

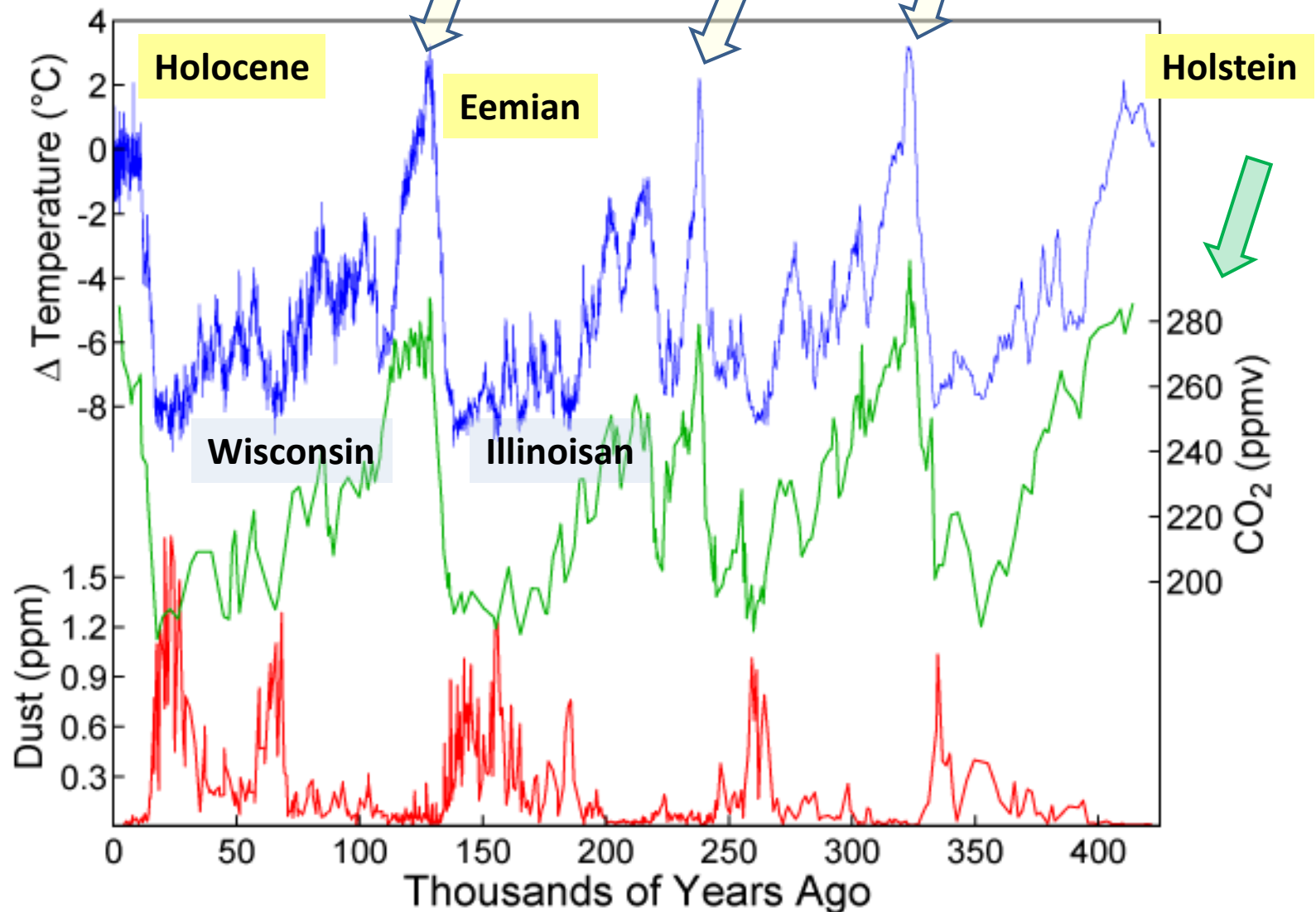
**The available evidence is consistent with a peak Antarctic interglacial temperature that was at least 6 K higher than that of the present day**

**—approximately double the widely quoted 3–1.5 K (refs [5](#), [6](#)).”**

Previous Nature Letter says there is evidence that the three interglacials shown with yellow arrows are likely 6 degrees C Warmer <at 280 PPM CO<sub>2</sub>> than indicated solely by the Vostok Ice Cores.



Present  $\langle \text{CO}_2 \rangle$  is ~406 PPM, which on the green  $\text{CO}_2$  scale on the right would be **Off Scale High**. If  $\text{CO}_2$  controlled temperature, then this would be the warmest of the five interglacials. It is the coldest. Therefore,  $\text{CO}_2$  does not control temperature.



[Article](#)[Talk](#)<http://en.wikipedia.org/wiki/Eemian>[Read](#)[Edit](#)[View history](#)

## Eemian

Previous Interglacial, 130,000 years ago.

From Wikipedia, the free encyclopedia

**Temperature:** perhaps 6C (10F) warmer than mean of the Holocene

**CO2:** 280 PPM

**Sea Level** 4 to 6 m higher than present Sea Level

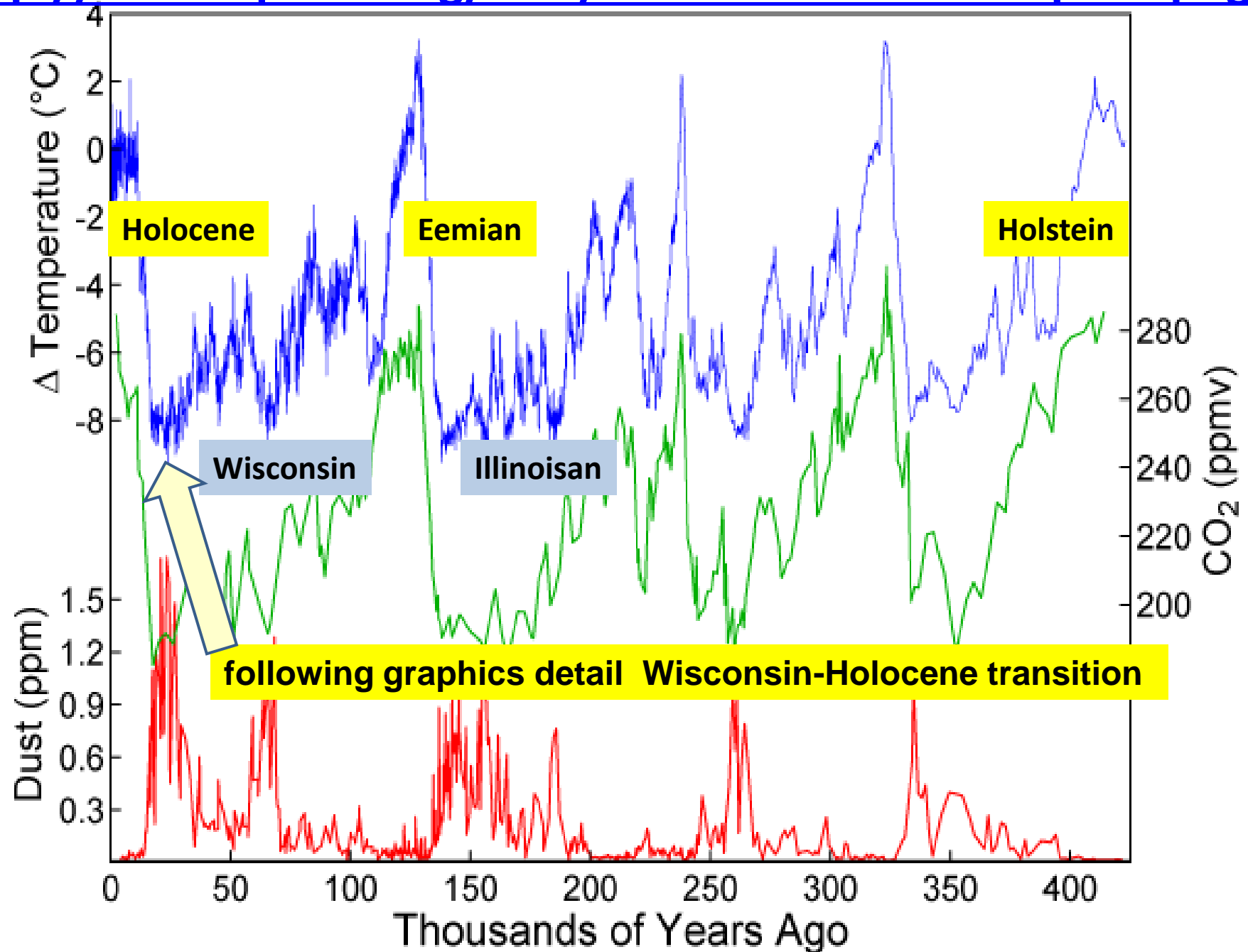
**Features:** The [hippopotamus](#) was distributed as far north as the rivers [Rhine](#) and [Thames](#)

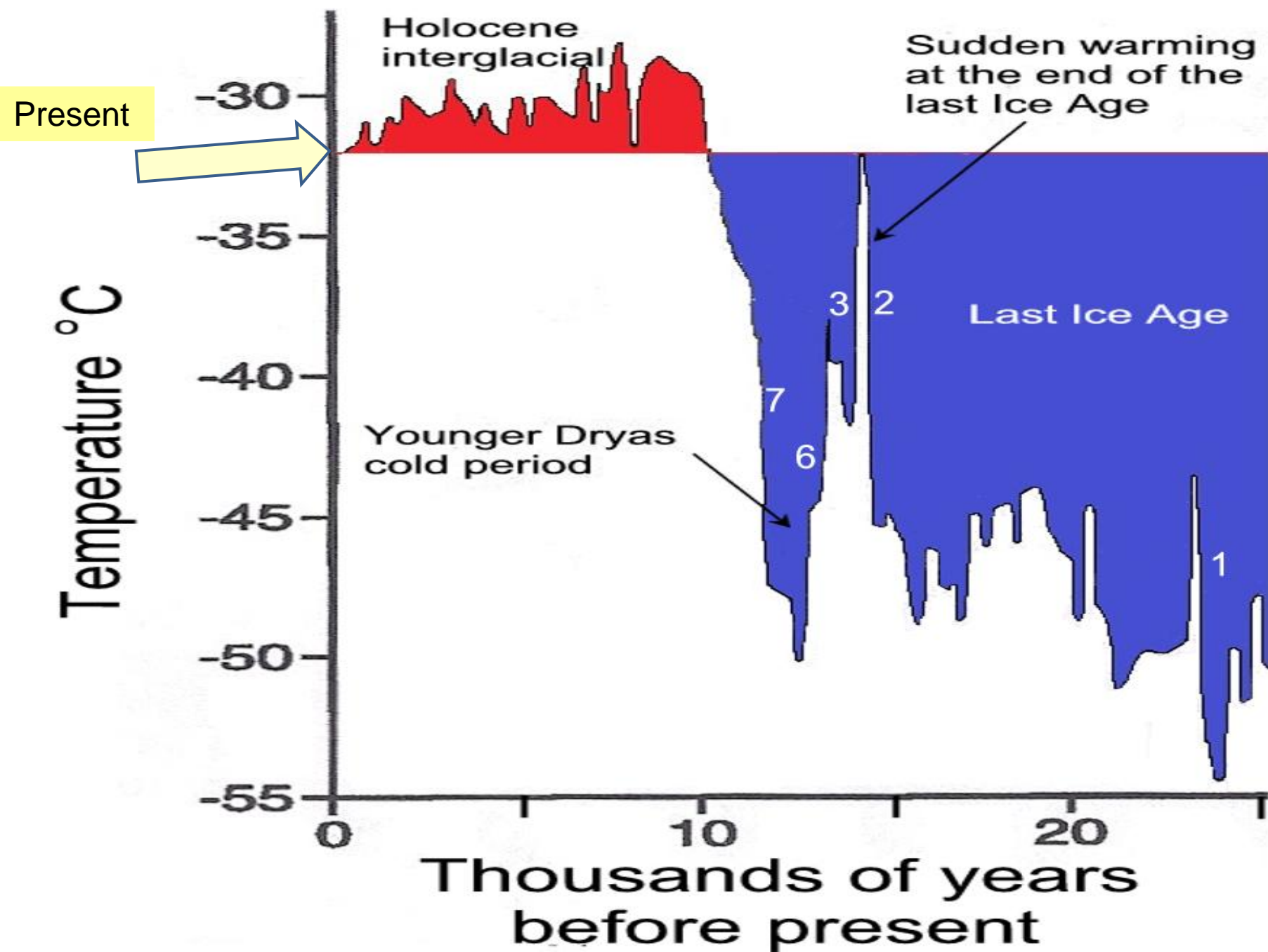
Forests reached as far north as [North Cape, Norway](#) (which is now [tundra](#)) well above the Arctic Circle.

Greenland ice core site [Dye 3](#) was glaciated during the Eemian,<sup>[5]</sup> implies Greenland could have contributed at most 2 m (6.6 ft) to [sea level rise](#).<sup>[6][7]</sup>

[Scandinavia](#) was an island due to the inundation of vast areas of [northern Europe](#) and the [West Siberian Plain](#).

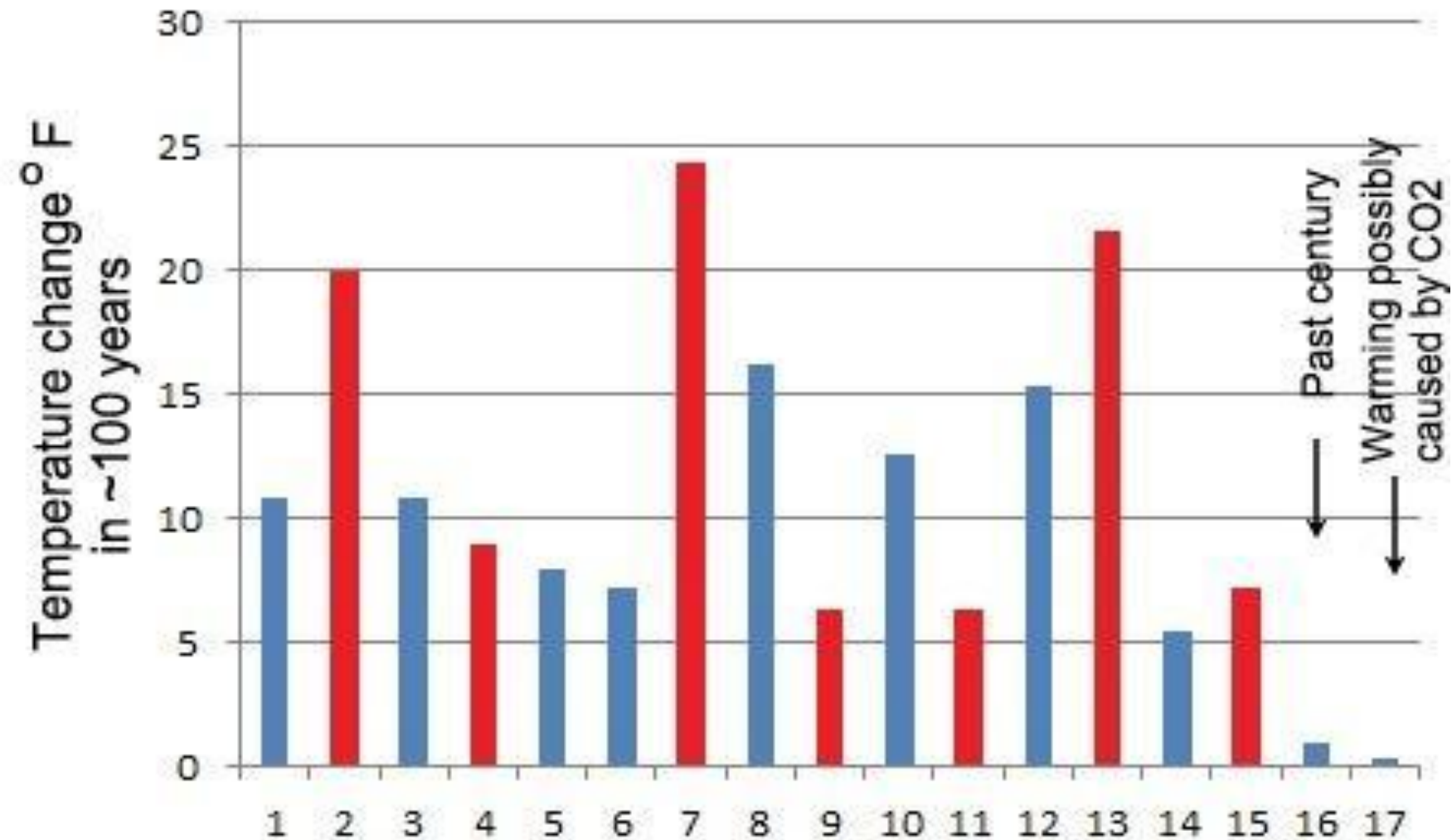




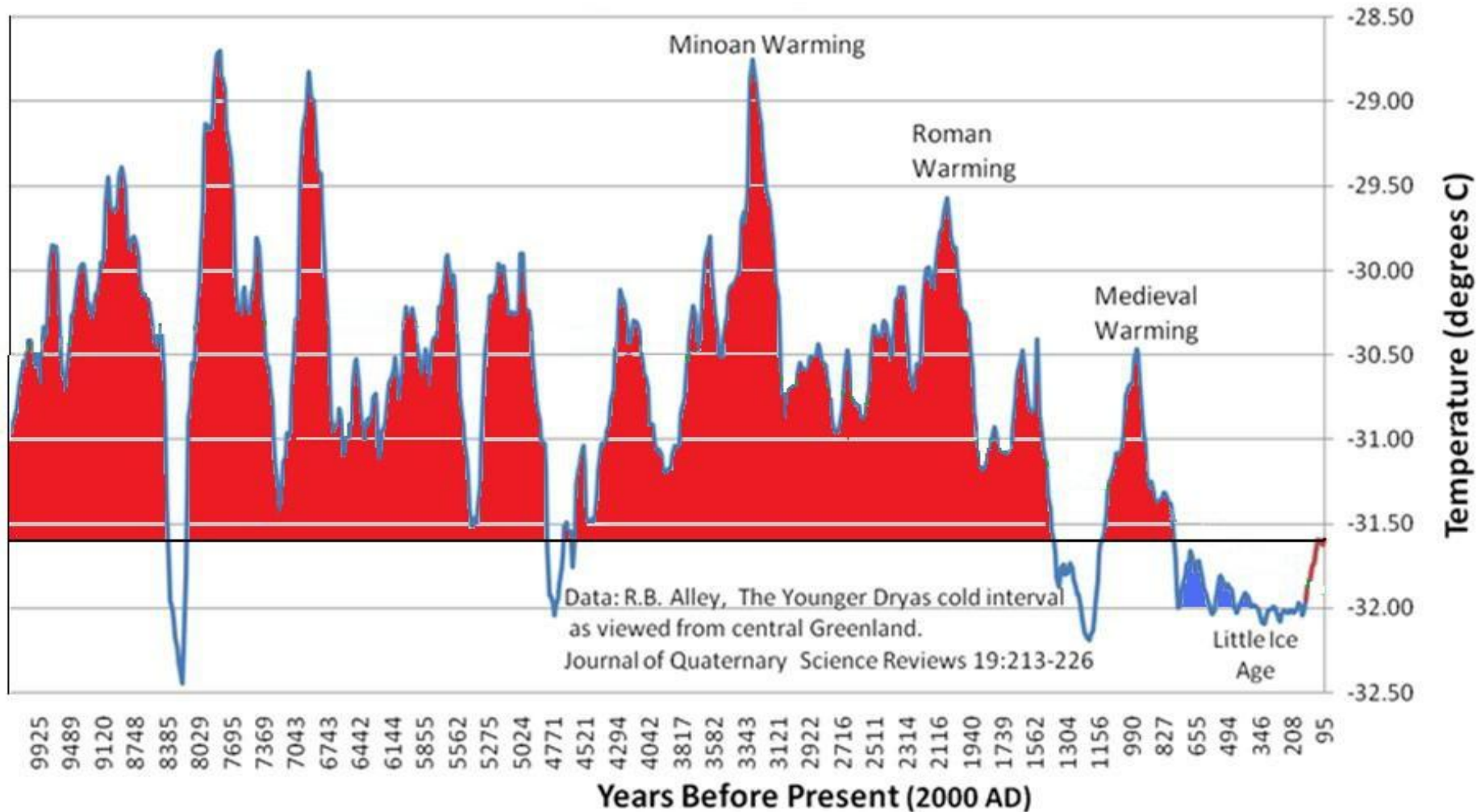


Seventeen Sets positive (red), negative (blue)      Temperature change Deg F / 100 years  
Dr Don Easterbrook's analysis of GISP2 proxy temperatures.

**Highest rate: +14F in 40 years (younger Dryas)**



# Greenland GISP2 Ice Core - Temperature Last 10,000 Years



**X-Axis, Time**

Oldest on Left,

Present on Right

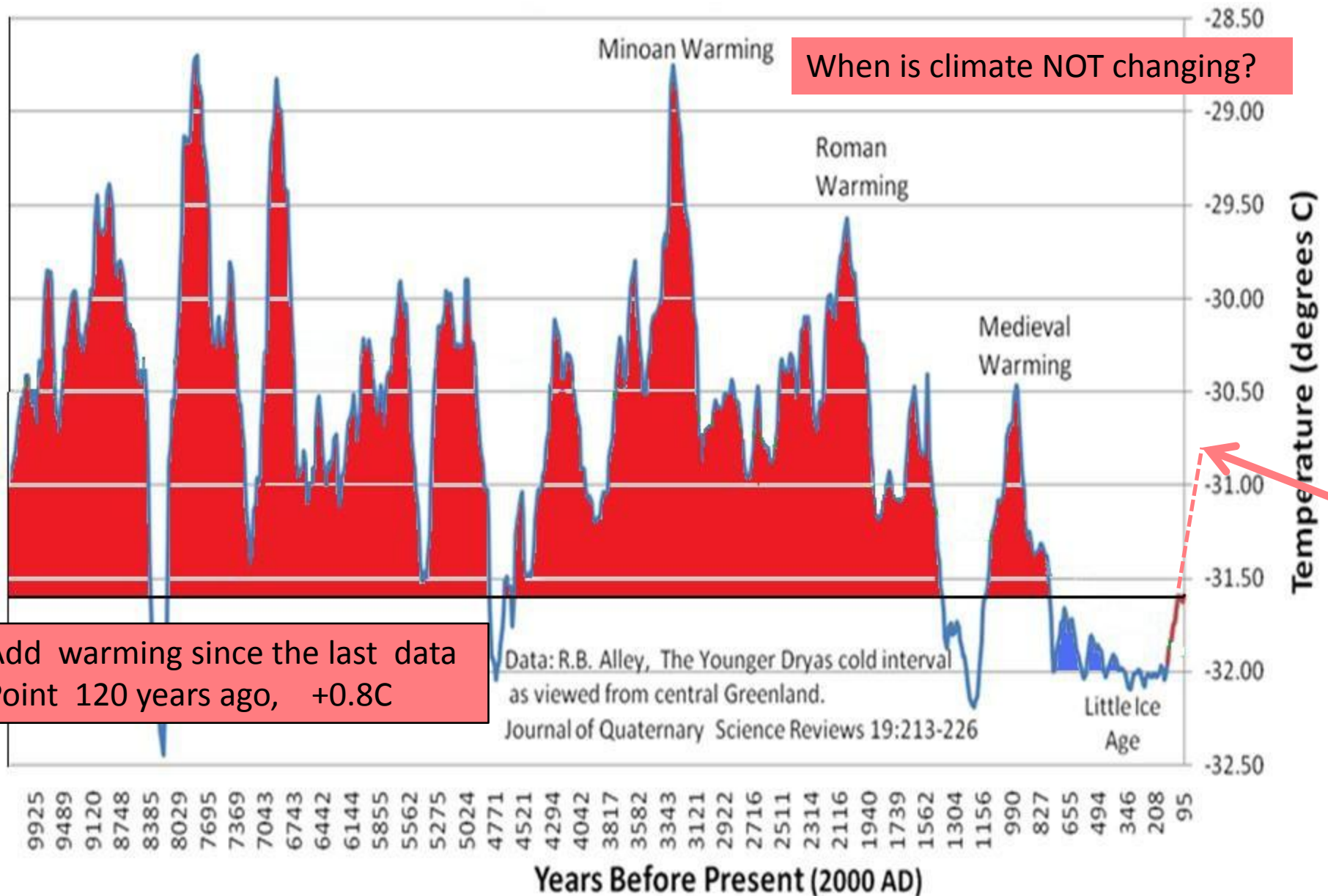
**Y-Axis, Temperature**

from the O16/O18 ratio , Greenland GISP2 Ice Core

Coldest Down, Warmer Up.

# Greenland GISP2 Ice Core - Temperature Last 10,000 Years

<http://wattsupwiththat.files.wordpress.com/2013/03/gisp2-ice-core-temperatures.jpg?w=960&h=720>



## **Minoan, Roman, Medieval Warm Periods**

The past 3500 years shows a distinct “1000-1500” year periodicity in temperatures

### **Show of hands**

Have you heard of “Bond Cycles” of climate fluctuations?

Have you heard of the 1000-1500 year periodicity of temperatures?

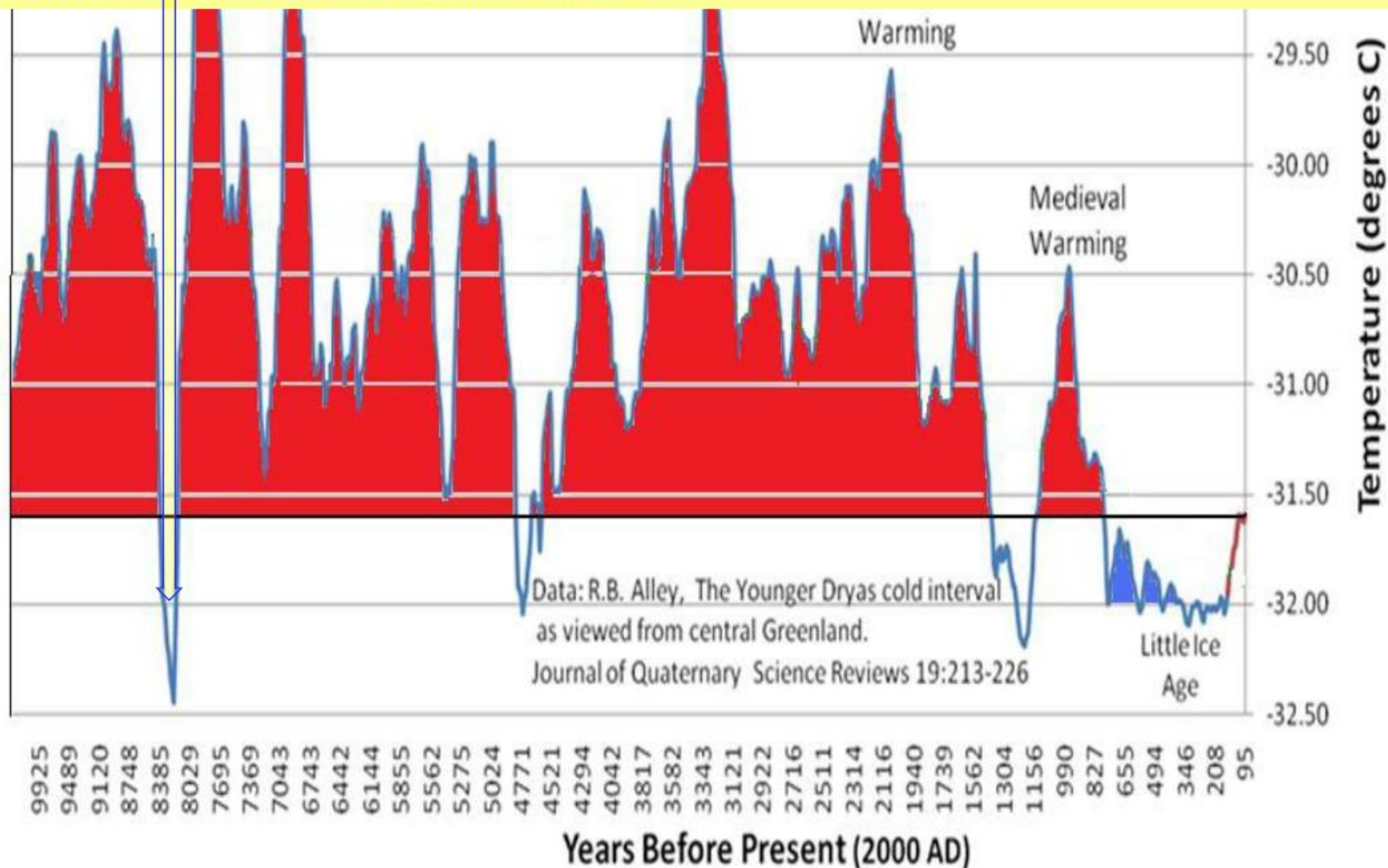
Have you heard that it was distinctly warmer 3500, 2000, and 1000 yrs ago?

If not, then, “Why not?”



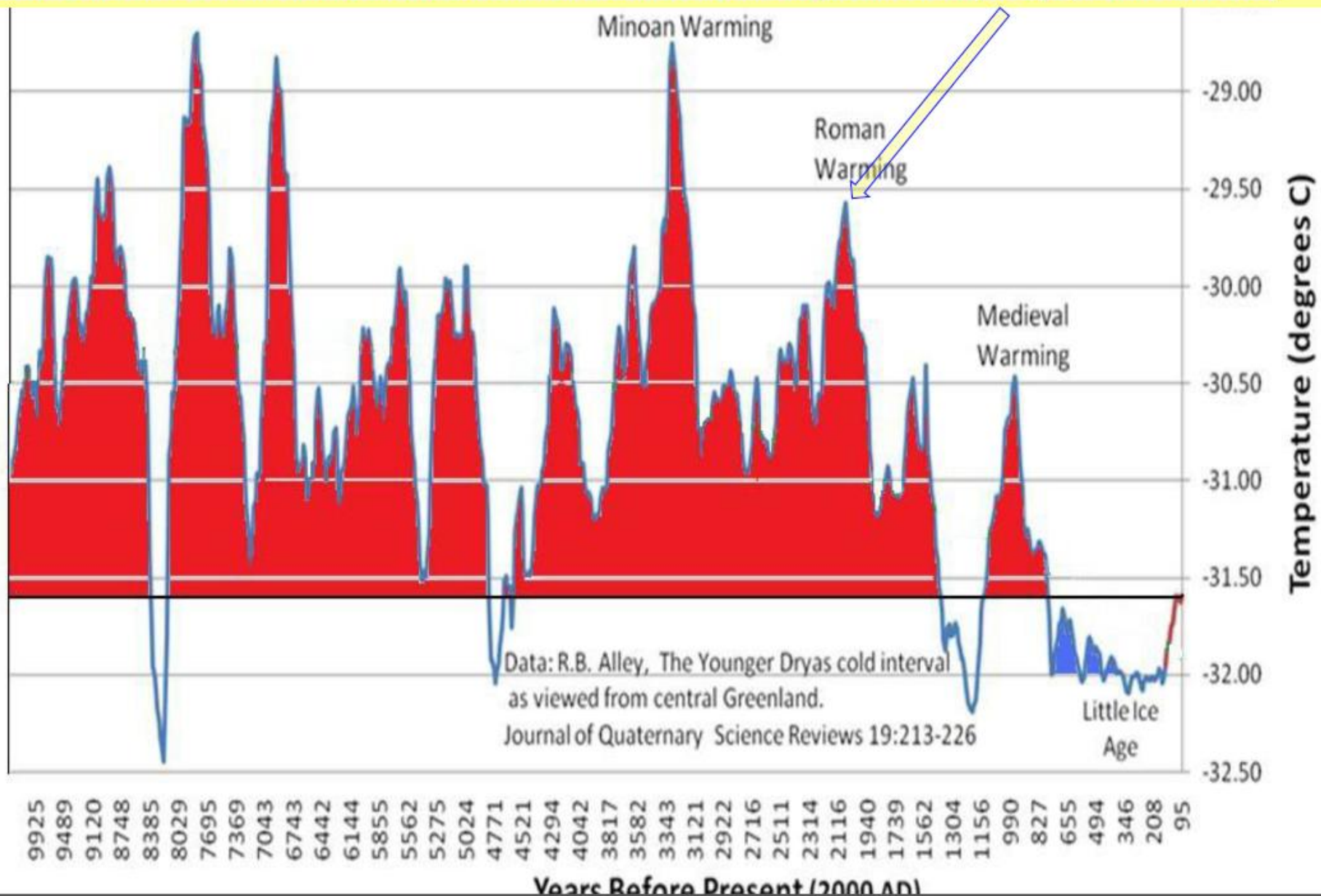
**6181 BC: Sudden cooling kills numerous trees, trunks of which are found by Swiss Geologist Christian Schluchter at the base of the Mont Mine' Glacier, Switzerland, about 5 miles north of the Italian border and 10 miles west of Zermatt.**

<http://notrickszone.com/2014/06/09/giant-of-geologyglaciology-christian-schluechter-refutes-co2-feature-interview-throws-climate-science-into-disarray/>



“the forest line was much higher than it is today; there were hardly any glaciers. Nowhere in the detailed travel accounts from Roman times are glaciers mentioned.”

<http://notrickszone.com/2014/06/09/giant-of-geologyglaciology-christian-schluechter-refutes-co2-feature-interview-throws-climate-science-into-disarray/#sthash.z6pKzqtQ.zWfPF60s.dpuf>

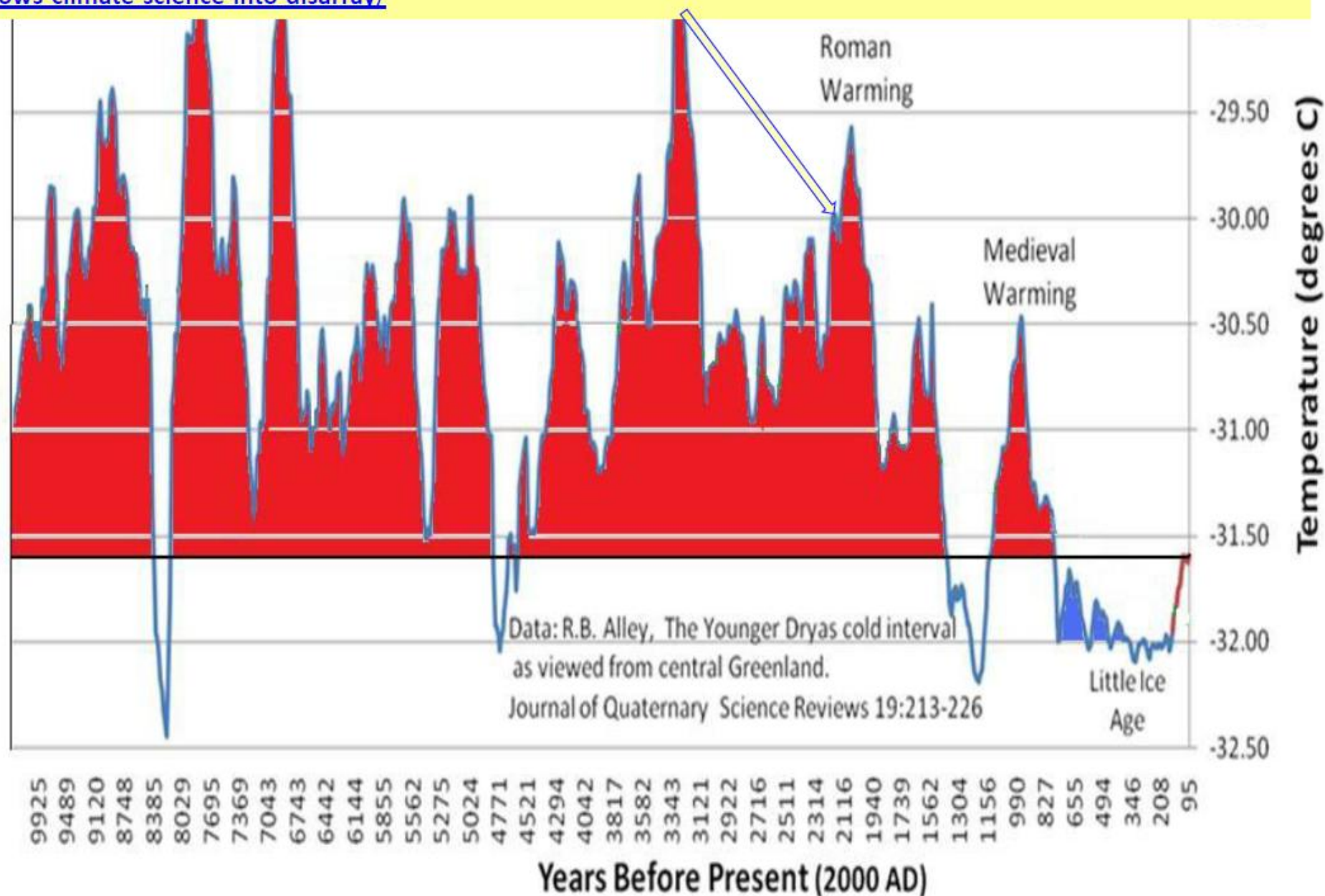




218 BC: Hannibal crosses the Alps but does not encounter glaciers, reportedly only nuisance snows.

<http://www.derbund.ch/wissen/natur/Unsere-Gesellschaft-ist-grundsatzlich-unehrlich/story/24948853>

<http://notrickszone.com/2014/06/09/giant-of-geologyglaciology-christian-schluechter-refutes-co2-feature-interview-throws-climate-science-into-disarray/>



## **Persistent solar influence on North Atlantic climate during the holocene**

Gerard Bond; Bernd Kromer; Juerg Beer; Raimund Muscheler; et al

*Science*; Dec 7, 2001; 294, 5549; Research Library Core

pg. 2130

# **Persistent Solar Influence on North Atlantic Climate During the Holocene**

**Paper on Bond Cycles**

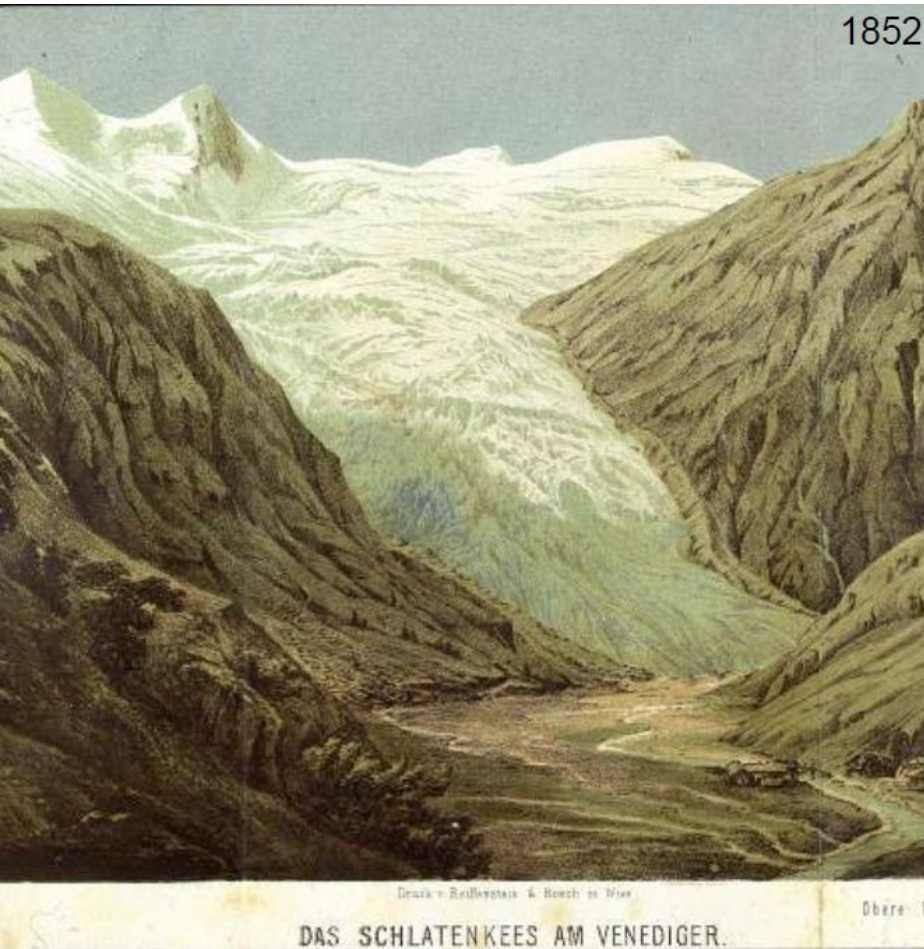
**Gerard Bond,<sup>1\*</sup> Bernd Kromer,<sup>2</sup> Juerg Beer,<sup>3</sup>  
Raimund Muscheler,<sup>3</sup> Michael N. Evans,<sup>4</sup> William Showers,<sup>5</sup>  
Sharon Hoffmann,<sup>1</sup> Rusty Lotti-Bond,<sup>1</sup> Irka Hajdas,<sup>6</sup> Georges Bonani<sup>6</sup>**

Surface winds and surface ocean hydrography in the subpolar North Atlantic appear to have been influenced by variations in solar output through the entire Holocene. The evidence comes from a close correlation between inferred changes in production rates of the cosmogenic nuclides carbon-14 and beryllium-10 and centennial to millennial time scale changes in proxies of drift ice measured in deep-sea sediment cores. A solar forcing mechanism therefore may underlie at least the Holocene segment of the North Atlantic's "1500-year" cycle. The surface hydrographic changes may have affected production of North Atlantic Deep Water, potentially providing an additional mechanism for amplifying the solar signals and transmitting them globally.



# Glaciers as Climate Witness, Gletcher als Klimazeugen

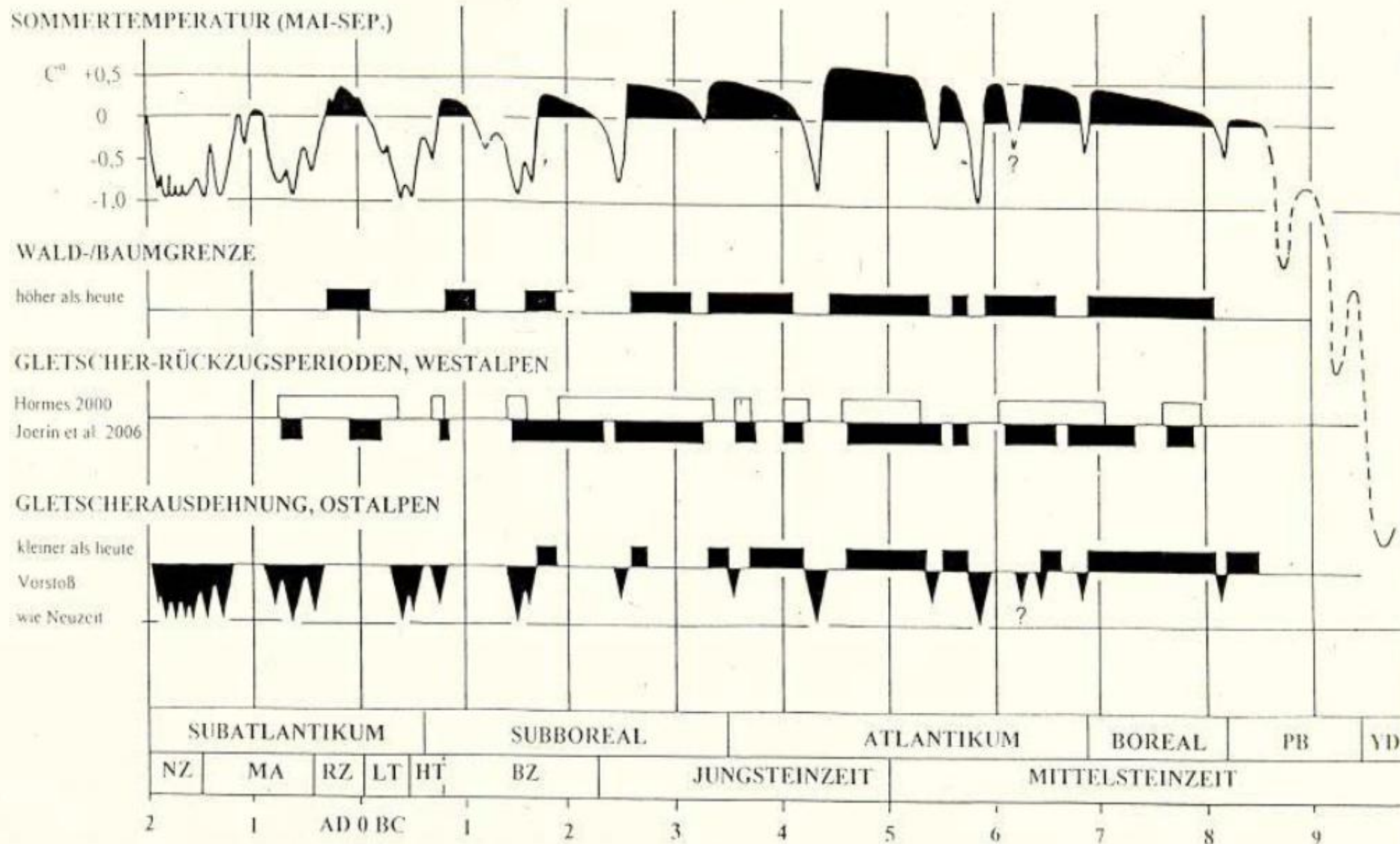
[http://www.iuf-berlin.org/wm\\_files/wm\\_pdf/prof.\\_patzelt\\_berlin\\_4.12.2009.pdf](http://www.iuf-berlin.org/wm_files/wm_pdf/prof._patzelt_berlin_4.12.2009.pdf)



These images in the Austrian Alps shows glacial retreat from 1852-1995. This is the sort of information that alarmists like to show as proof of man-caused Global Warming. Has this happened before?

# Glaciers as Climate Witness, Gletcher als Klimazeugen

[http://www.iuf-berlin.org/wm\\_files/wm\\_pdf/prof.\\_patzelt\\_berlin\\_4.12.2009.pdf](http://www.iuf-berlin.org/wm_files/wm_pdf/prof._patzelt_berlin_4.12.2009.pdf)



## Think of it:

Ice Cores from Greenland show ~12 warm periods last 10,000 years. <O16/O18 ratio>  
**Present Warm Period Notably Weaker** than past such periods.

Ice Cores show dramatic cooling, “8.2 K year” event, [https://en.wikipedia.org/wiki/8.2\\_kiloyear\\_event](https://en.wikipedia.org/wiki/8.2_kiloyear_event)

Christian Schluchter shows same cooling event...jumble of trees Mt Mine' Switzerland

Ice cores match up with Roman Warm Period and Hannibal's crossing of Alps

Ice Cores match up with Medieval Warm Period

History of England and Europe

Ice Cores match up with borehole data set from Greenland.

Austrian Alps Dendrochronology also shows ~12 Warm Periods last 10,000 years

**Present Warm Period Notably Weaker** than past such events

**Fundamentally Different Proxies** show the same pattern, but separated by  
Thousands of Kilometers.

**Do the data send a distinct message?**

# **El Nino, a basic description**



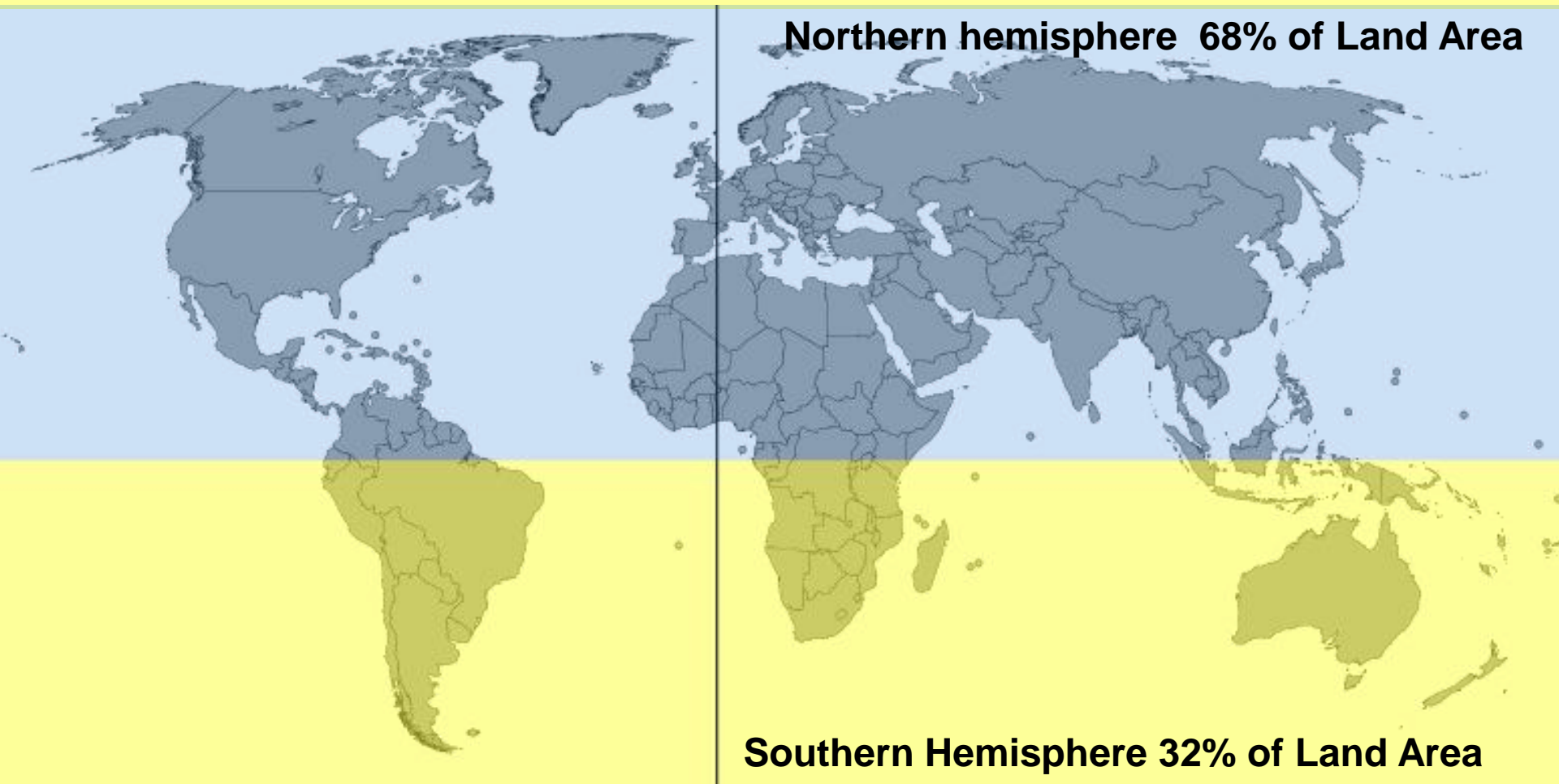
## Origins of the name, *El Niño*

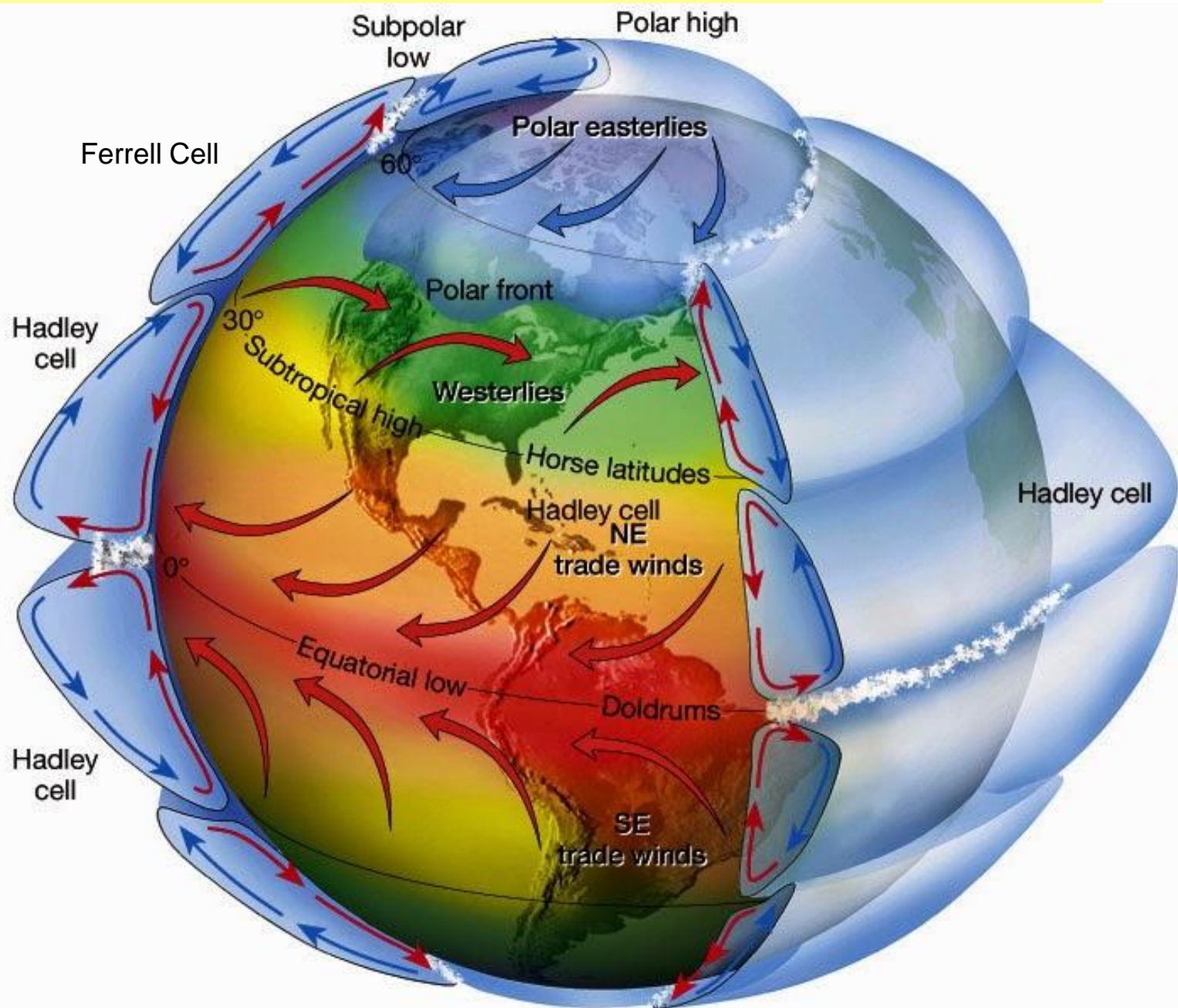
**El Niño**... originally recognized by fisherman off the coast of South America as appearance of **unusually warm water in the Pacific Ocean**, occurring ~beginning of the year.

El Niño means *The Little Boy* or *Christ child* in Spanish.

This name was used for the tendency of the phenomenon to arrive around Christmas...

...the Northern Hemisphere's Winter Solstice

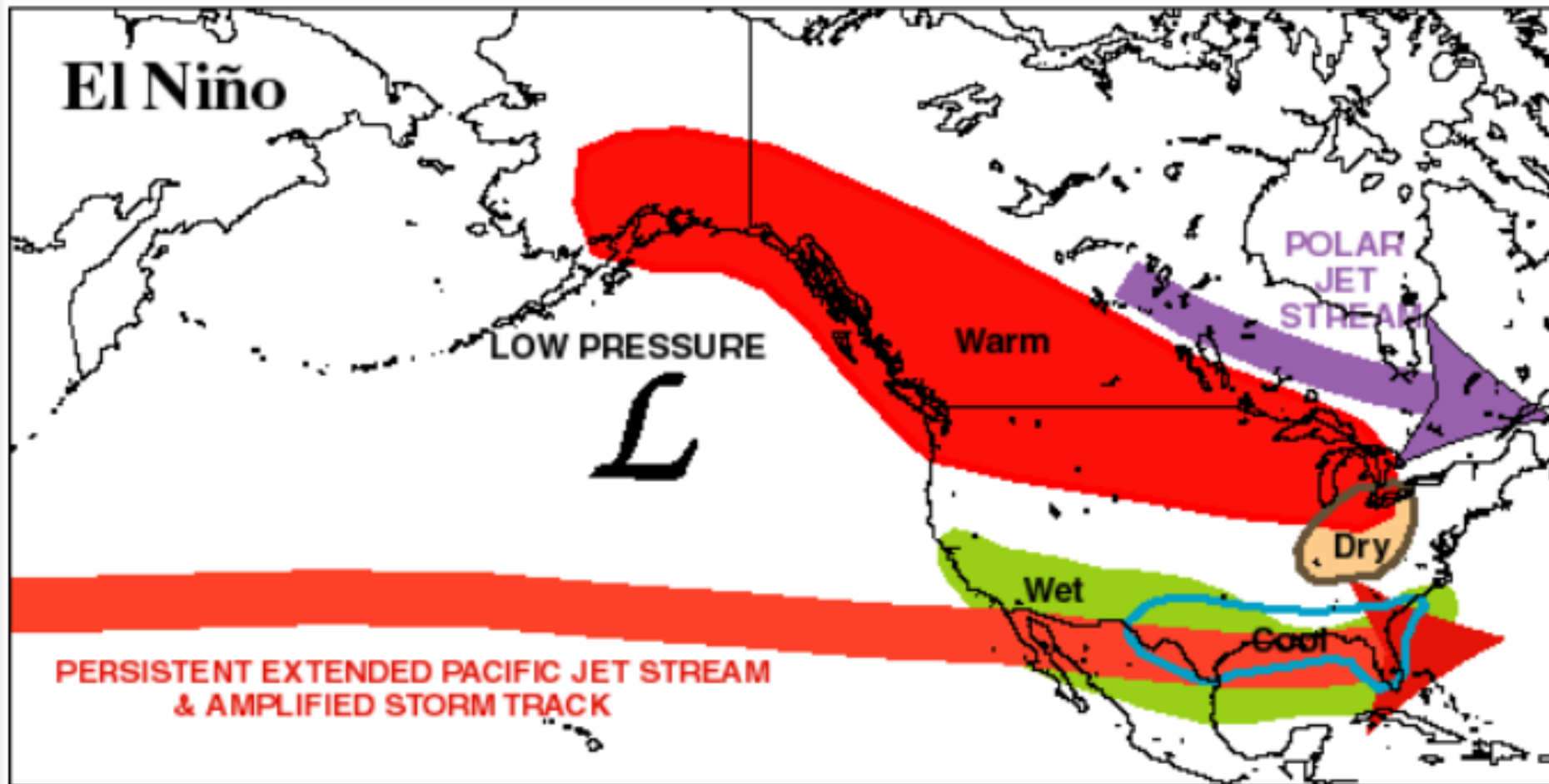




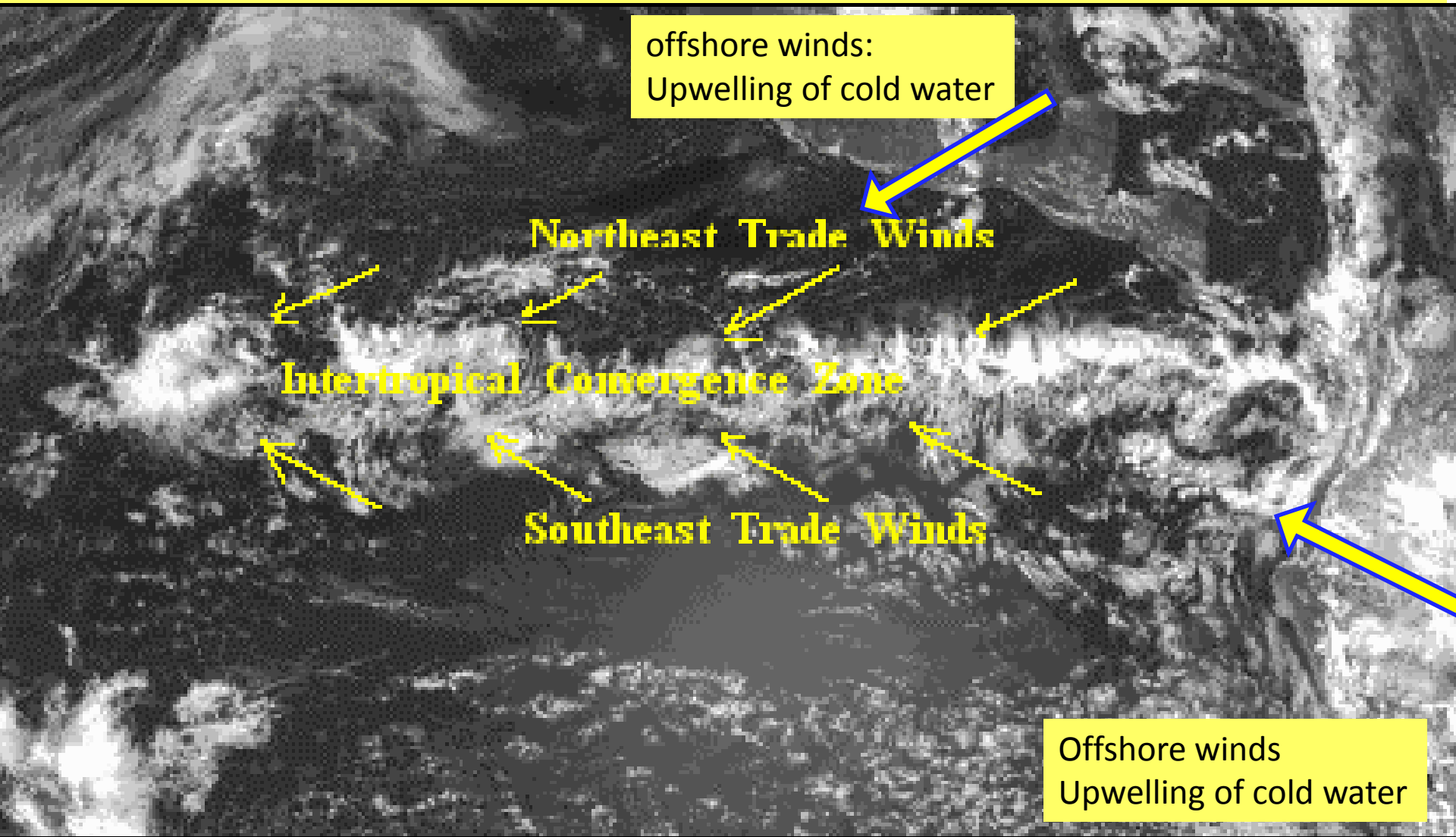


**El Niño** pattern: Brings wet from California to New Mexico to East Coast

Huge Warm Pattern from Gulf of Alaska all the way to Michigan!



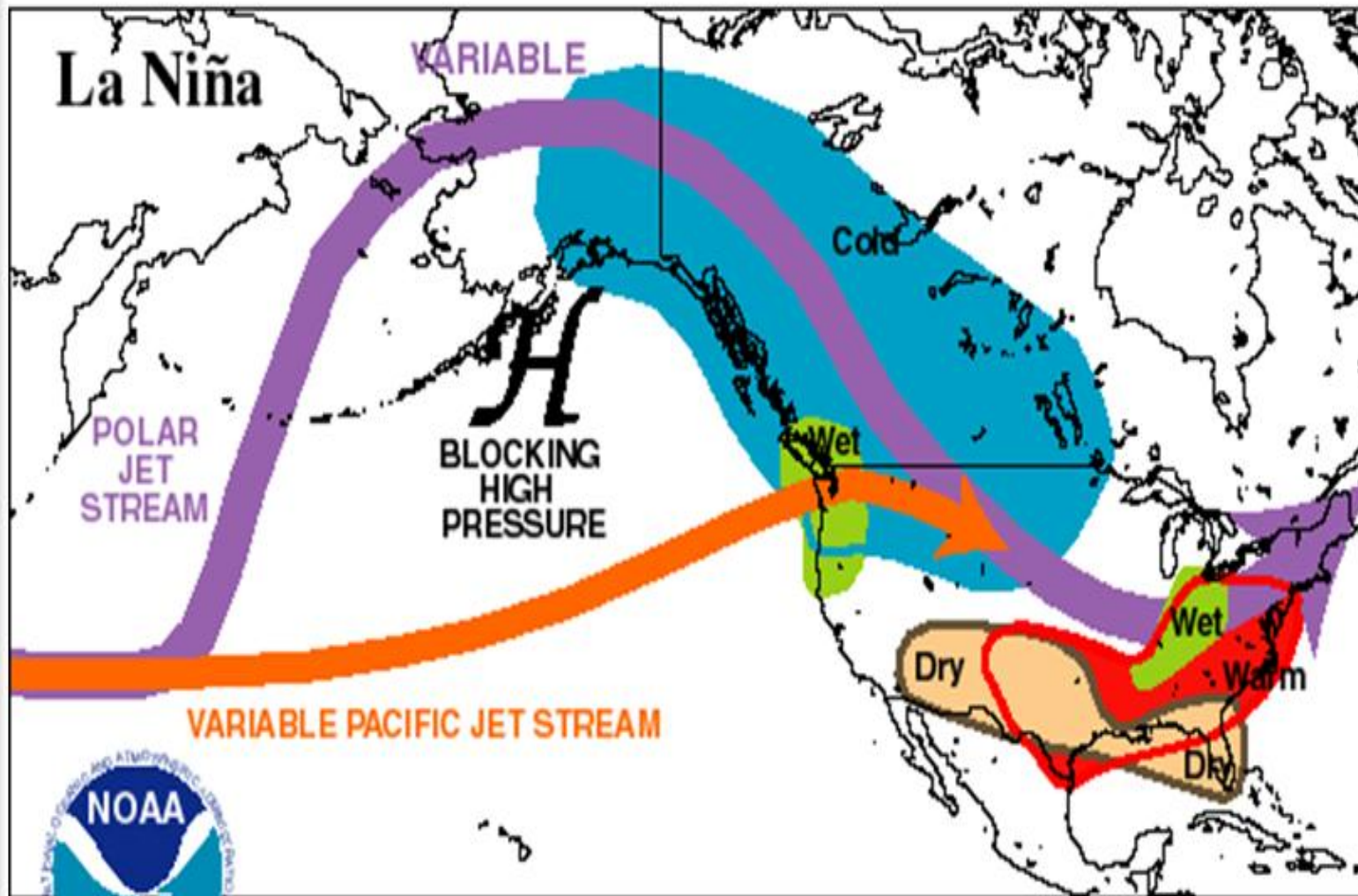
The Northeasterly Trade Winds are very prevalent, stronger in La Nina years. Visitors to Hawaii usually encounter the steady from the northeast Trade Winds



But EL NINO is caused by a disruption of this pattern, which allows warm water to flow from Indonesia/Western Pacific across the entire Pacific Ocean.

**La Nina** pattern, brings dry/drought from Arizona to Florida

[http://www.cpc.ncep.noaa.gov/products/analysis\\_monitoring/ensocycle/nawinter.shtml](http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensocycle/nawinter.shtml)

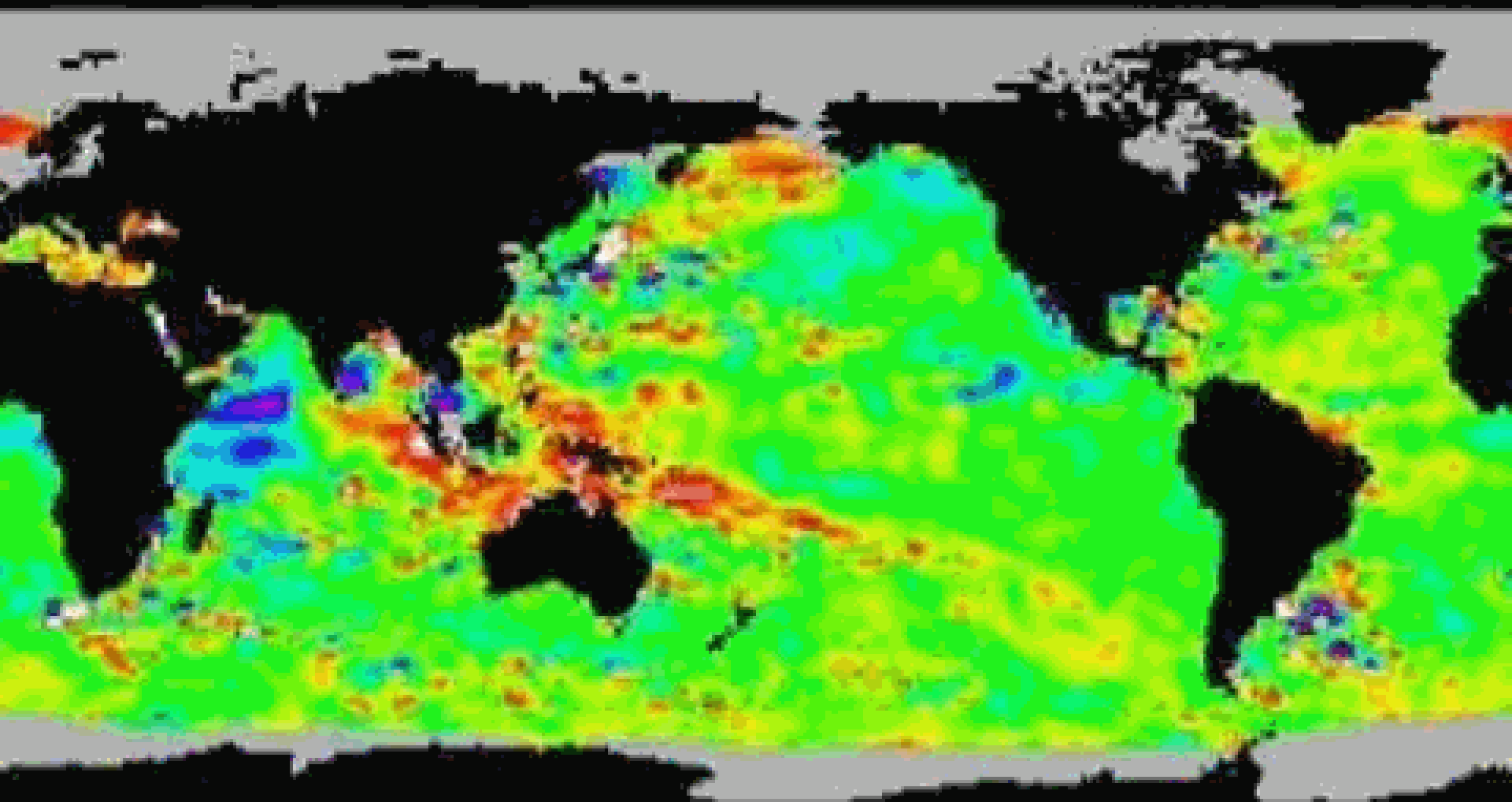


**Climate Prediction Center/NCEP/NWS**

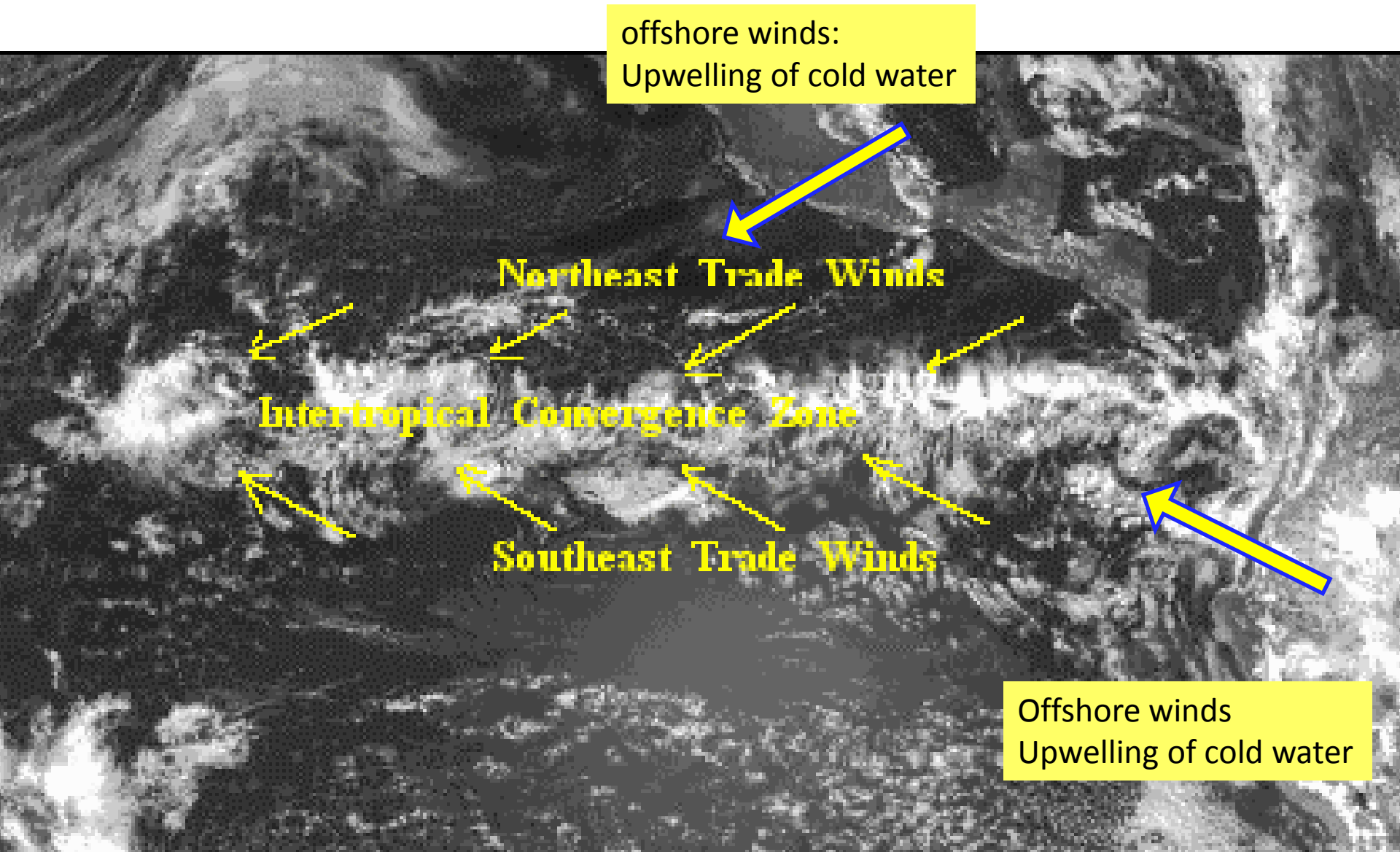
**Next graphics show animations of El Nino, and then La Nina**

START

DEC 16 1996



The Northeasterly Trade Winds are very prevalent, stronger in La Nina years. Visitors to Hawaii usually encounter steady from the northeast Trade Winds



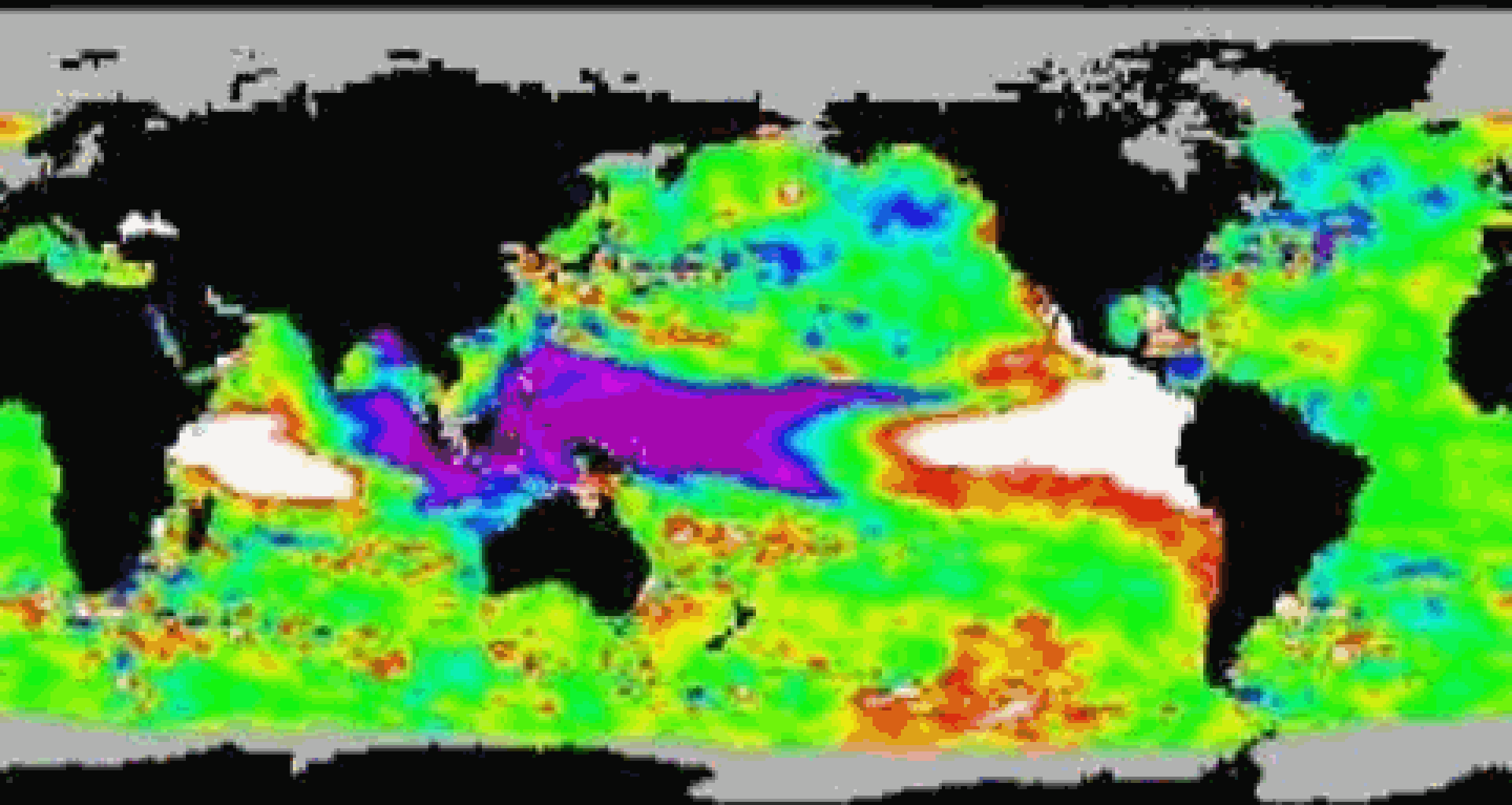


**Animation of La Nina beginning on 31 Jan 1998**

**<https://bobtisdale.files.wordpress.com/2012/06/animation-3-1.gif>**

START

DEC 31 1997



# IMPORTANT POINT!

WATER TEMPERATURE OF OCEAN OFFSHORE NORTH AMERICA  
DETERMINES RAINFALL/DROUGHT in (especially) Western North America

What determines that water temperature?

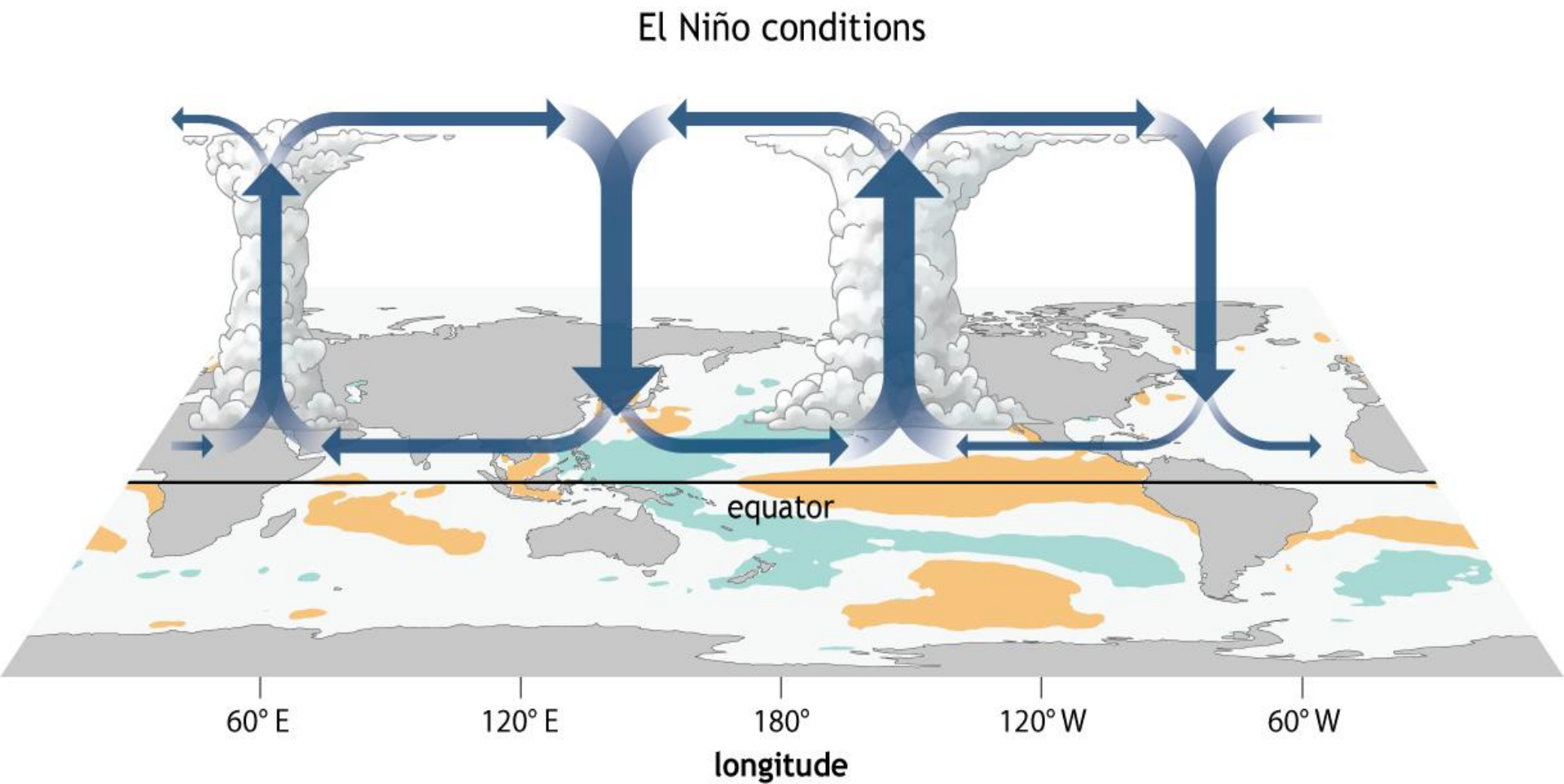
That Multi-year weather pattern called EL NINO

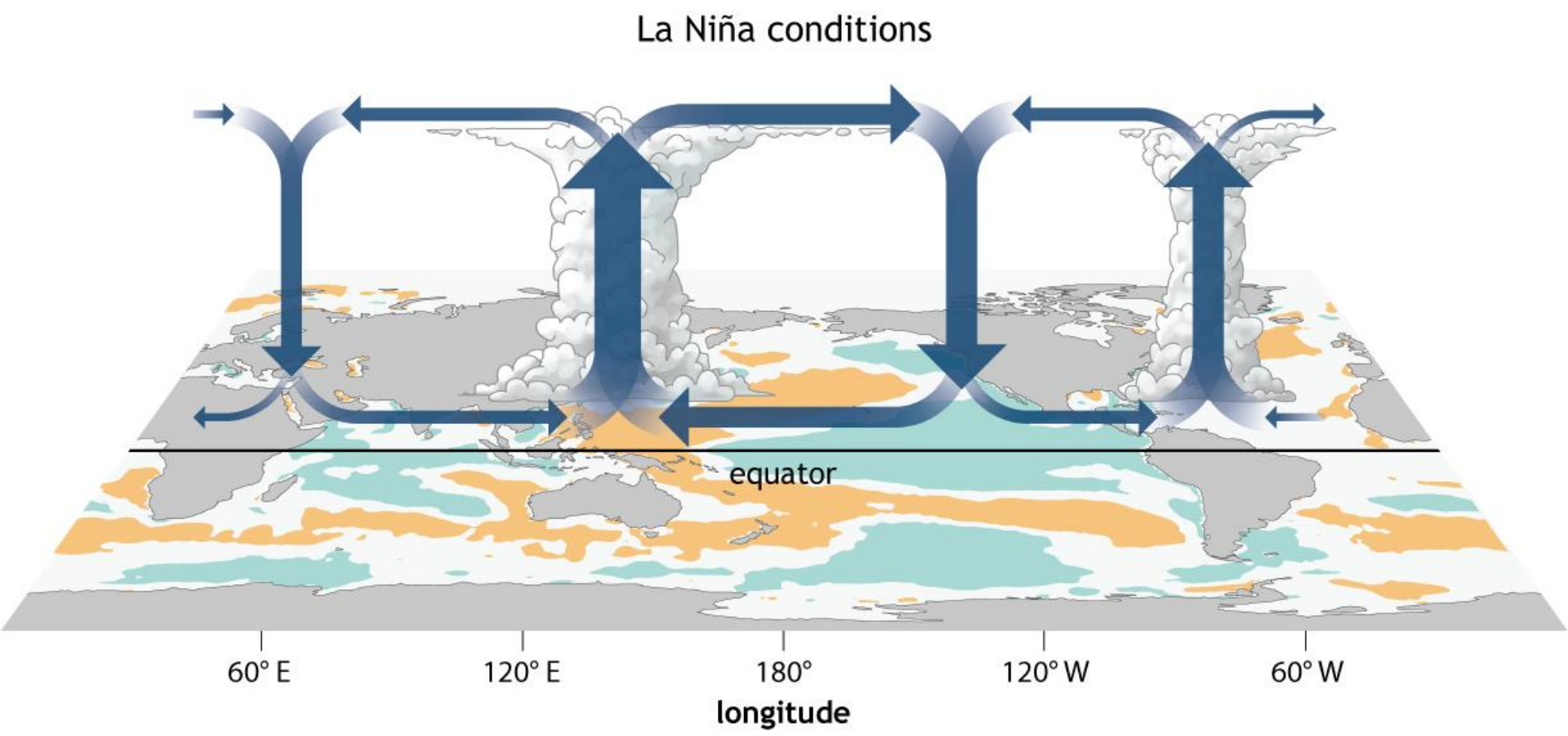
also, El Nino-Southern Oscillation “ENSO”

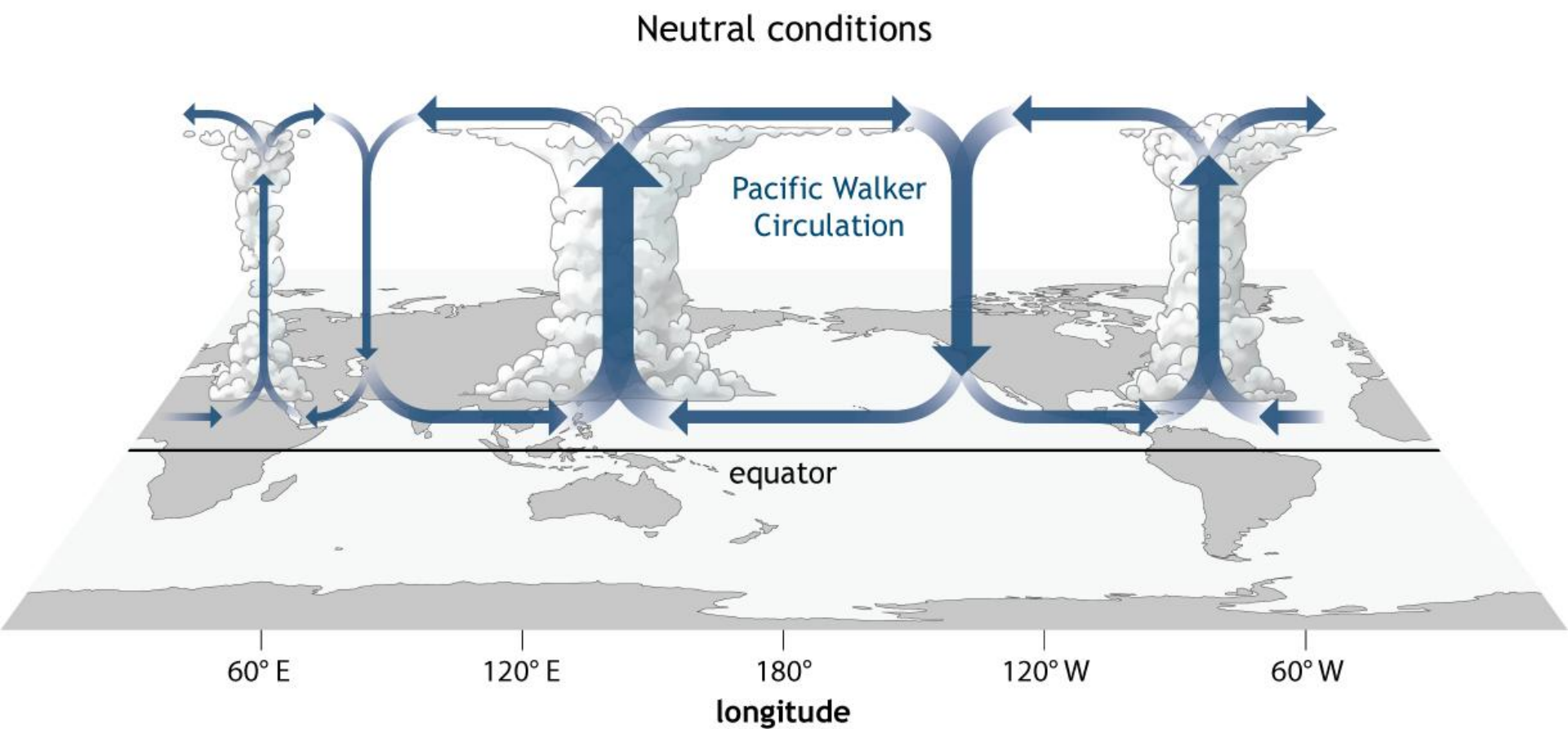
Later, we'll study a 60-year pattern

PACIFIC DECADAL OSCILLATION or “PDO”

30 years MORE EL NINOS, and  
30 years FEWER EL NINOS.









# Nino 3.4 region: area bounded from 5N to 5S and from 120W to 160E



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ENVIRONMENTAL INFORMATION  
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION



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[Home](#) > [Climate Monitoring](#) > [Equatorial Pacific Sea Surface Temperatures](#)

July Global Release: Thu, 20 Aug 2015, 11:00 AM EDT

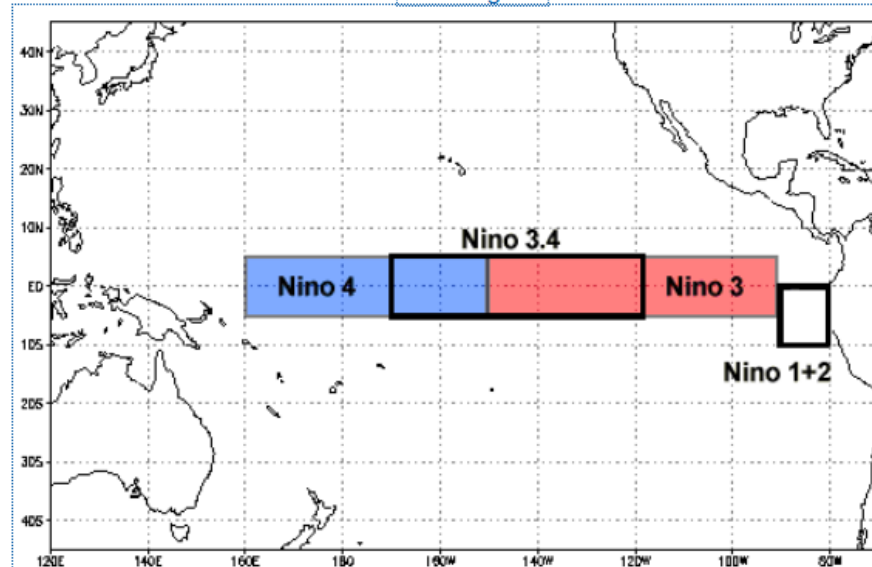
## Equatorial Pacific Sea Surface Temperatures

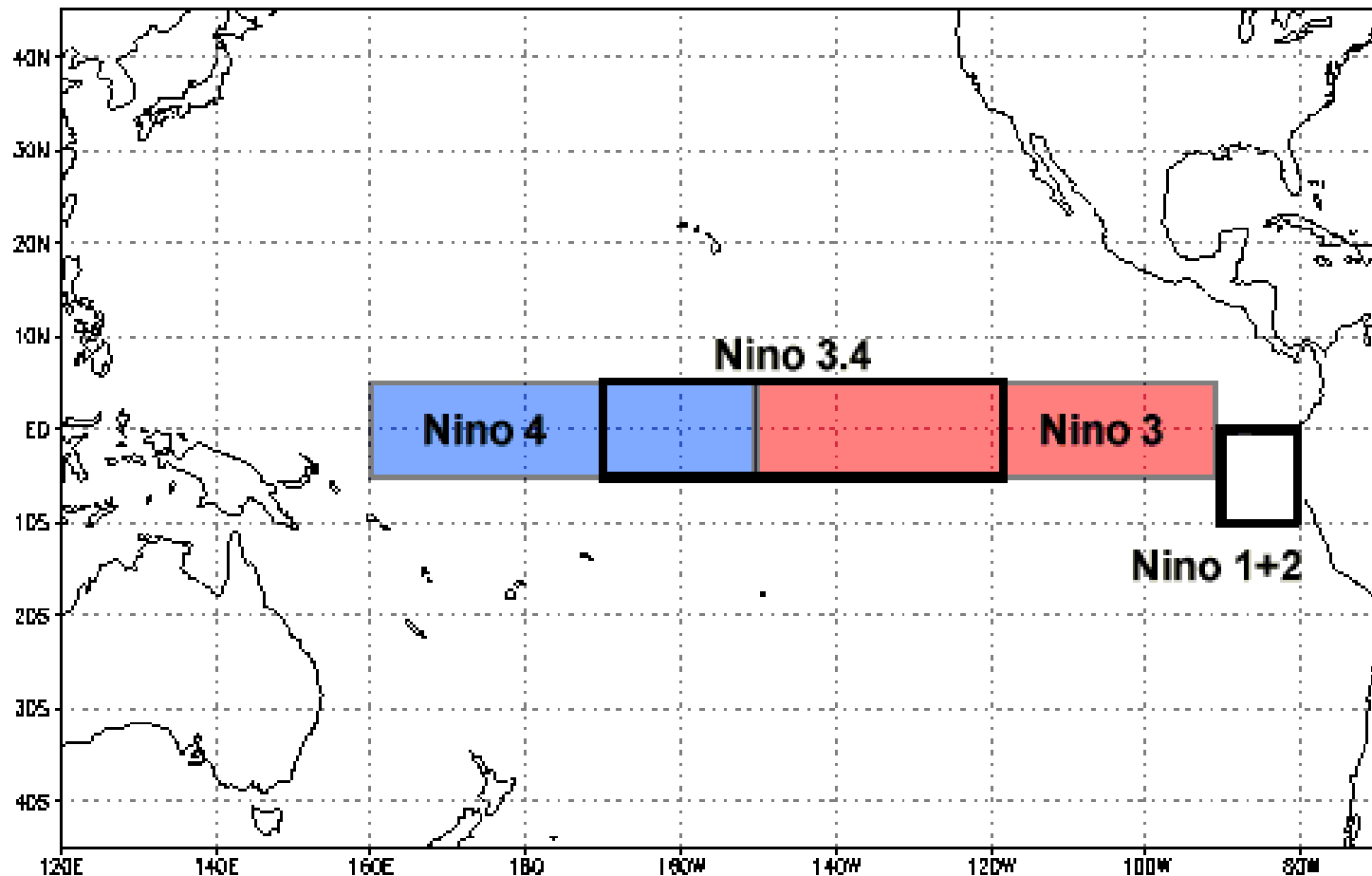
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[BAMS State of the Climate](#)  
[Temp, Precip, and Drought](#)  
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[GHCN Monthly](#)  
[Monitoring References](#)

[ENSO](#) | [Zonal Winds](#) | [SSTs](#) | [Sea Temps](#) | [SST Anomalies](#) | [OLR](#) | [SOI](#)

El Niño (La Niña) is a phenomenon in the equatorial Pacific Ocean characterized by a five consecutive 3-month running mean of sea surface temperature (SST) anomalies in the [Niño 3.4 region](#) that is above (below) the threshold of  $+0.5^{\circ}\text{C}$  ( $-0.5^{\circ}\text{C}$ ). This standard of measure is known as the [Oceanic Niño Index \(ONI\)](#).

Niño Regions





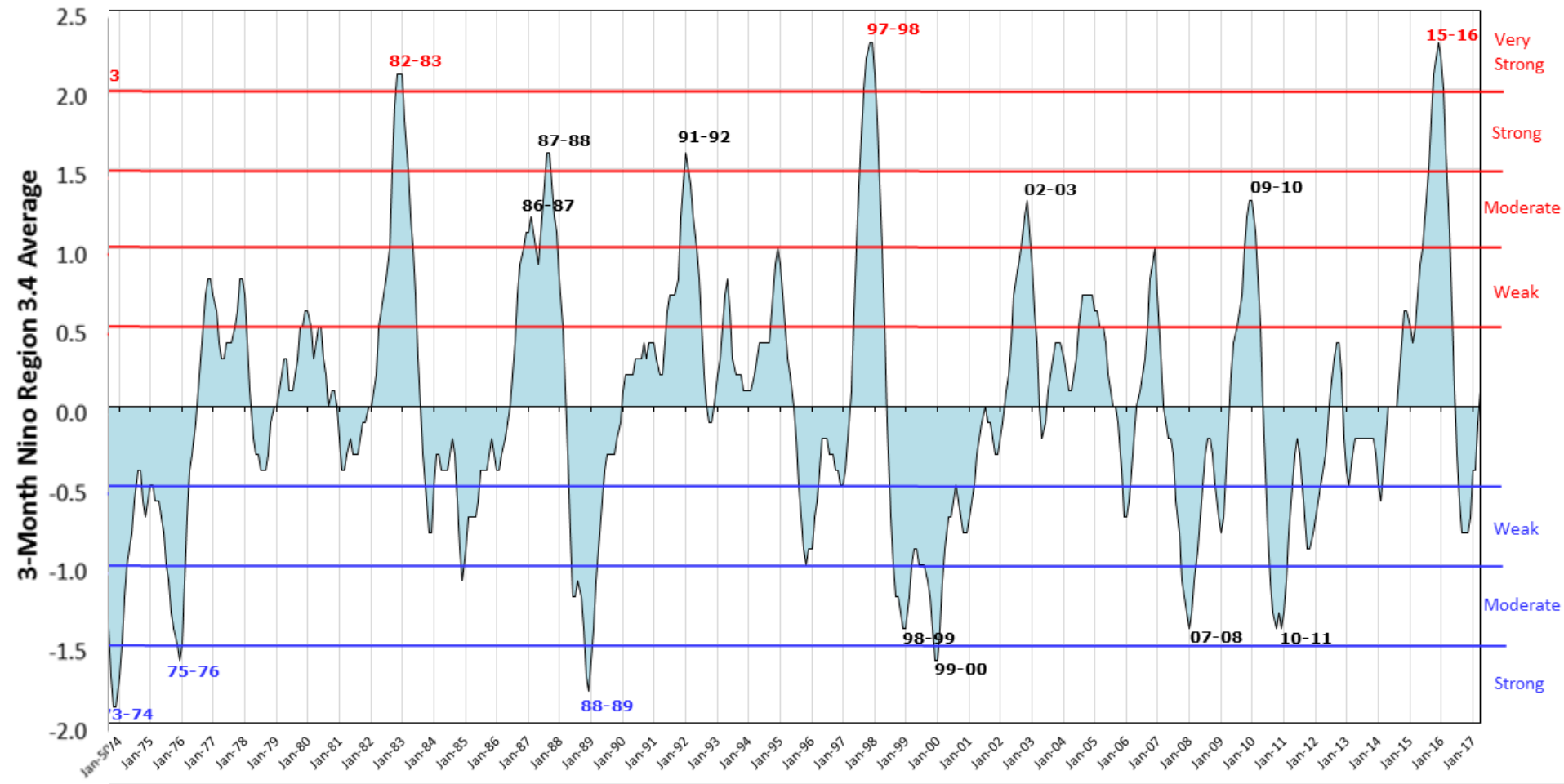
The **Oceanic Nino Index**: (ONI) is one of the primary **indices** used to monitor the El **Nino**-Southern Oscillation (ENSO). The ONI is calculated by averaging sea surface temperature anomalies in an area of the east-central equatorial Pacific **Ocean**, which is called the **Nino 3.4 region** (5S to 5N; 170W to 120W).

Golden Gate Weather Services, Jan Null, used with permission

Red = Strong El Niño  
Blue = Strong La Niña  
Black = Moderate (either)

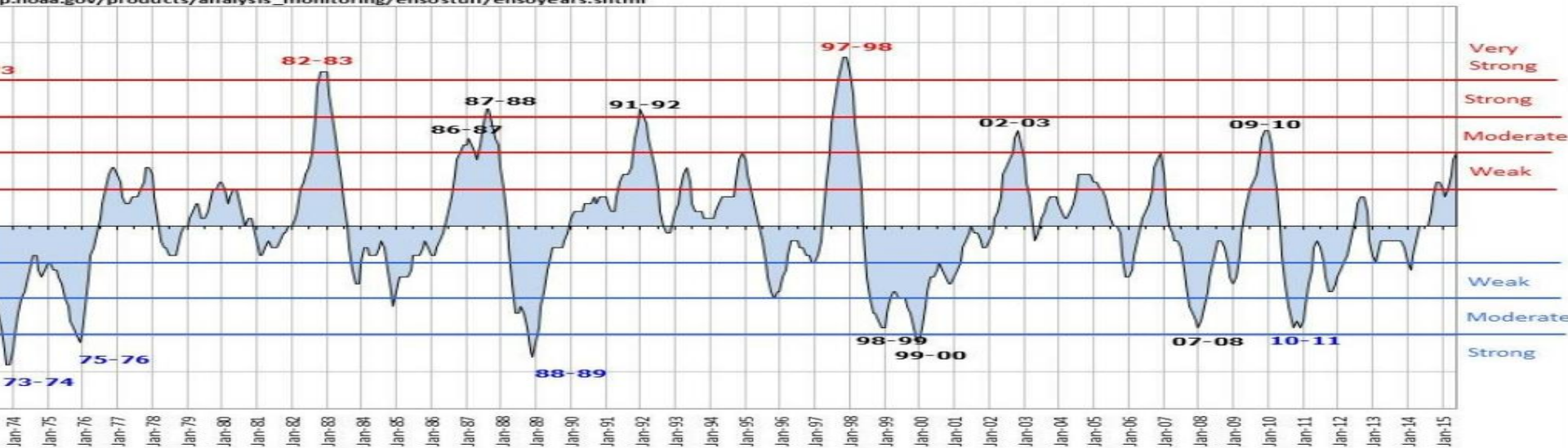
## Oceanic Niño Index (ONI)

[http://www.cpc.ncep.noaa.gov/products/analysis\\_monitoring/enso\\_stuff/ensoyears.shtml](http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_stuff/ensoyears.shtml)



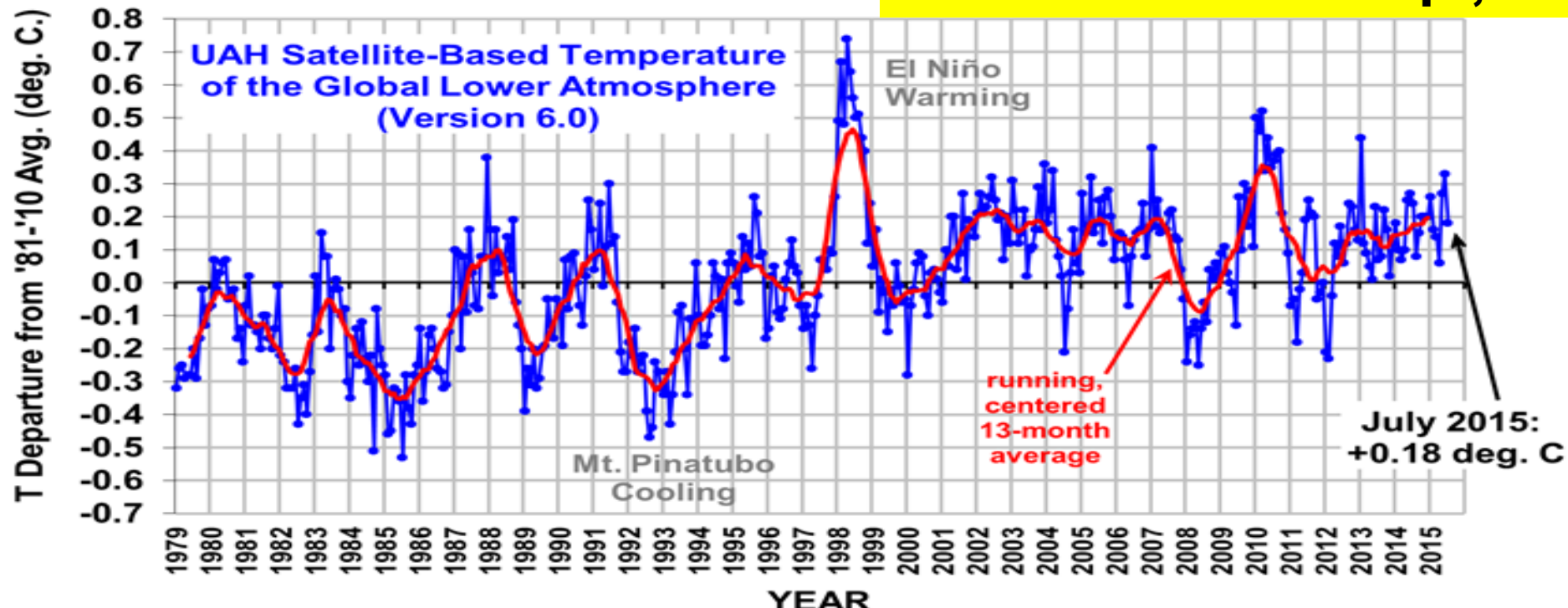
# Niño Niño Index (ONI)

[p.noaa.gov/products/analysis\\_monitoring/ensostuff/ensoyears.shtml](http://p.noaa.gov/products/analysis_monitoring/ensostuff/ensoyears.shtml)



Running 3-Month Mean ONI values

## Global Greenhouse Temps, TLT

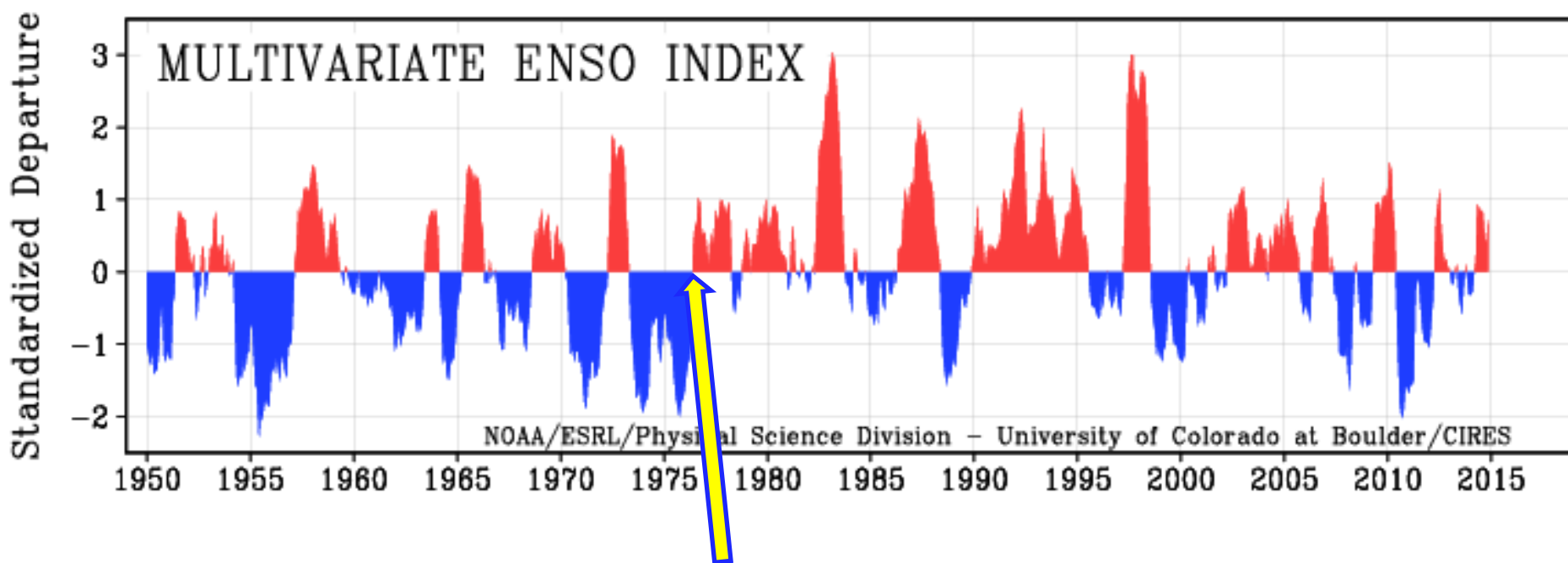




# Earth System Research Laboratory

## Physical Sciences Division

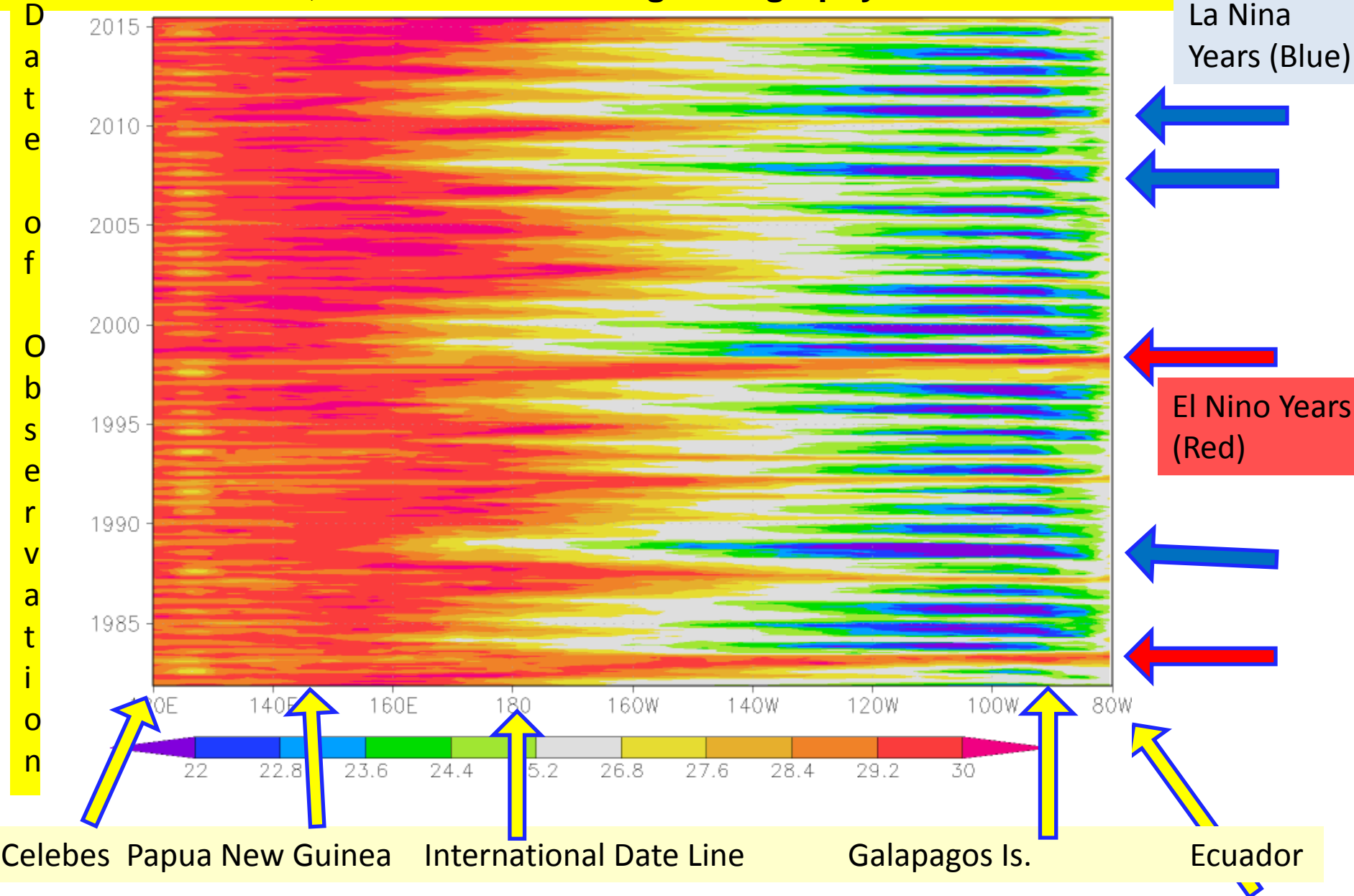
<http://www.esrl.noaa.gov/psd/enso/mei/>



**Notice the Great Climatic Shift of 1976, when the number of El Ninos per decade increased dramatically.**

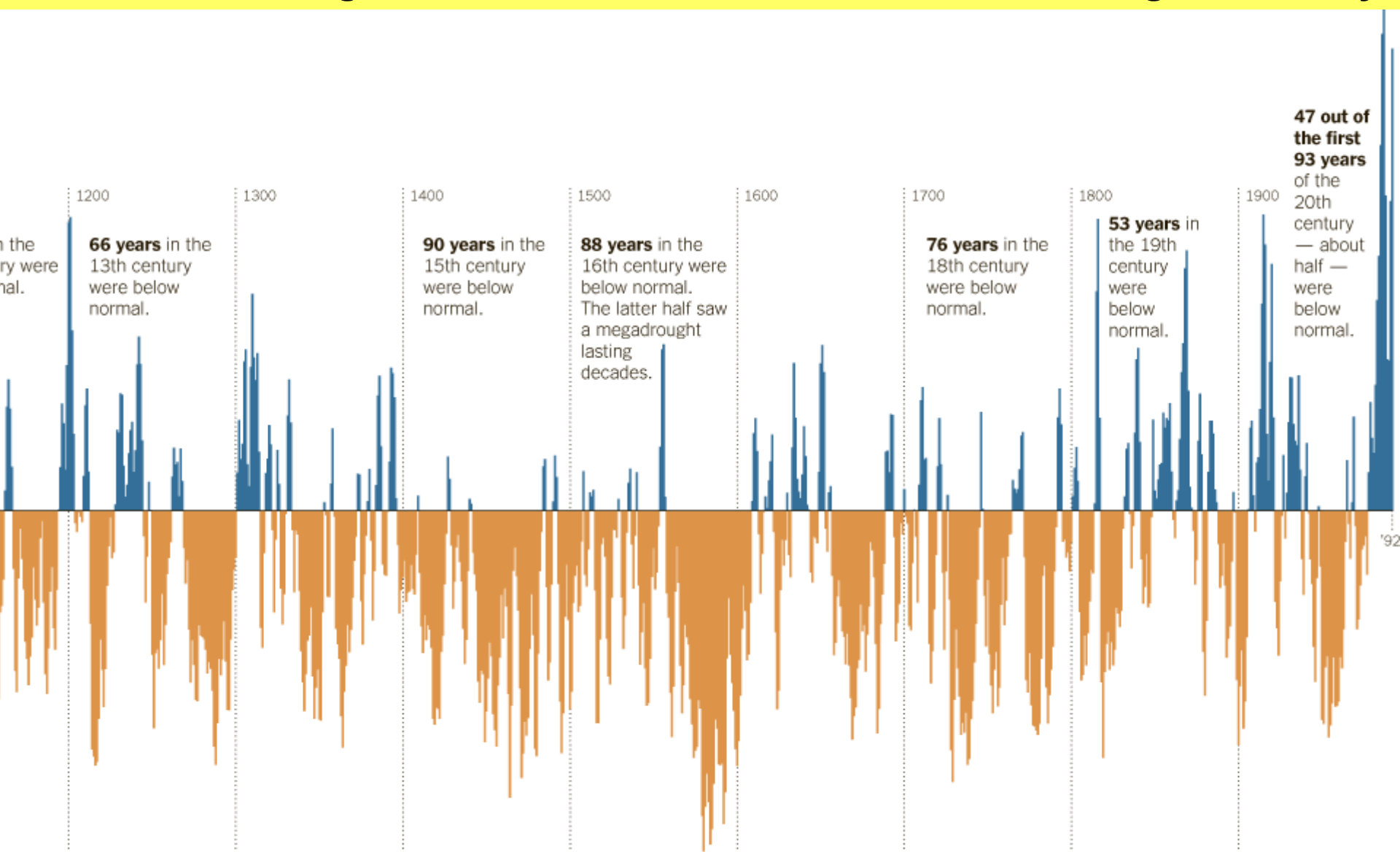
**Bob Tisdale's Hovemuller diagram. Equator Sea Surface Temperature (Longitude)**

**SSTs , not anomalies. Rough Geography –Yellow arrows**





# Rainfall and Drought Chart: New York Times...U of A Tree Ring Laboratory



**X-Axis Time: 1200s on LEFT -- present on RIGHT**

**Y-Axis: Rainfall (Blue, above Axis) Drought (Brown, Below Axis)**

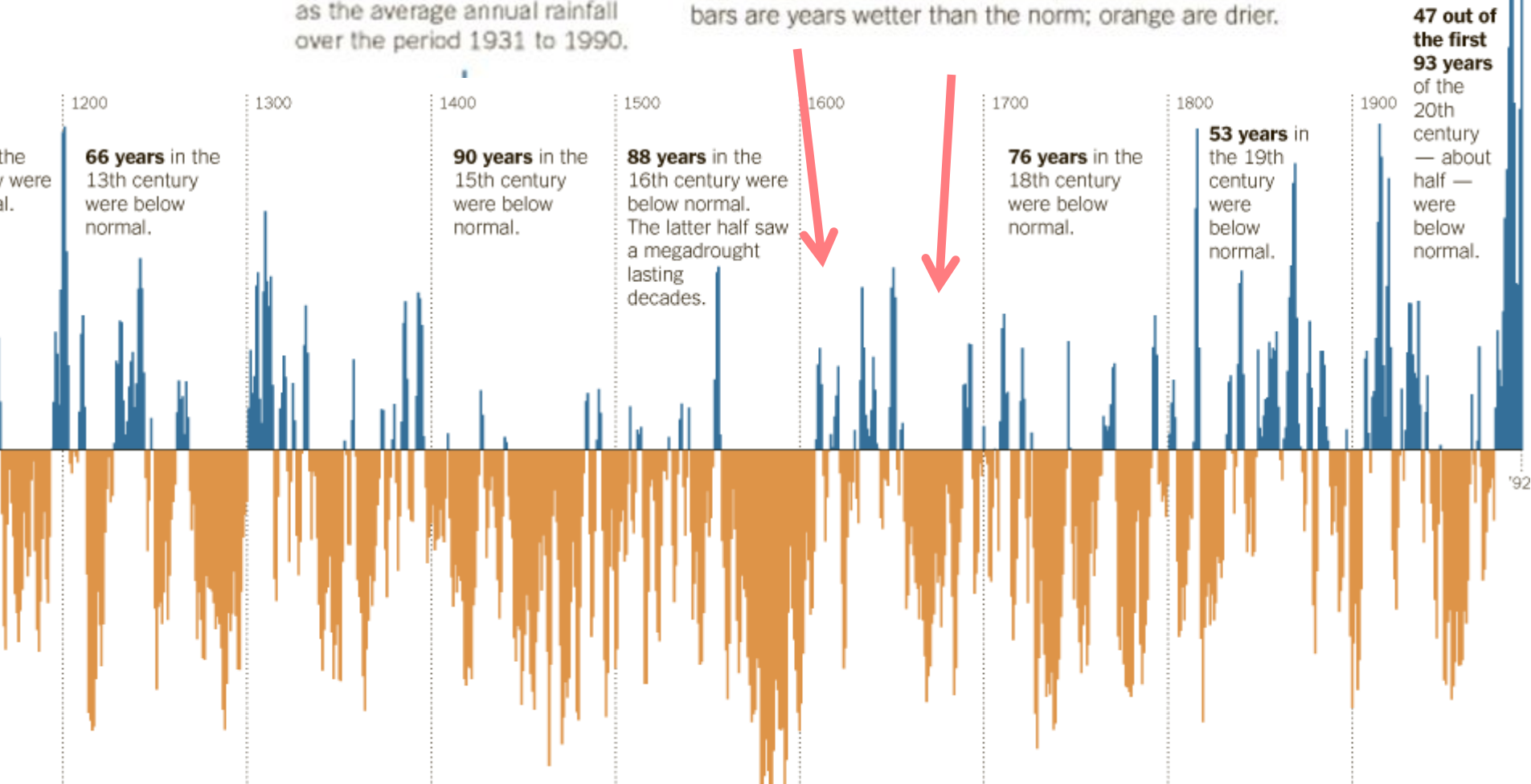
**Axis = 20<sup>th</sup> Century Avg 1900-1993**

The New York Times

## The Longest Measure of Drought: 21 Centuries of Rainfall in New Mexico

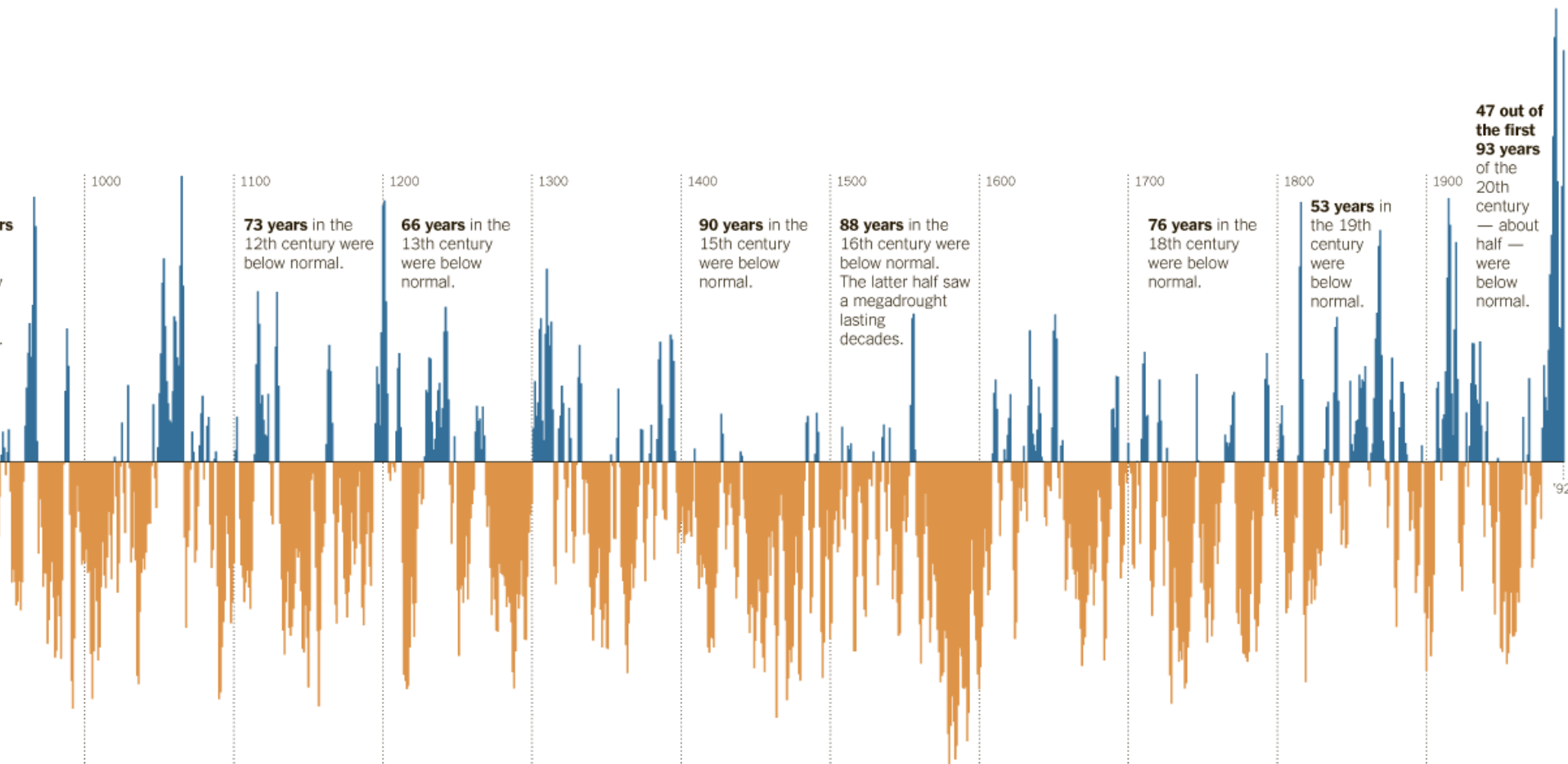
Departure from normal, defined as the average annual rainfall over the period 1931 to 1990.

This chart shows deviation in annual rainfall levels from a 20th-century benchmark (the period from 1931 to 1990), beginning in 137 B.C. and running through 1992. Blue bars are years wetter than the norm; orange are drier.



**Late 20<sup>th</sup> Century wettest in 2000 years.** Abo' Mission, Mountainair: founded 1620 re-roofed, 1640, abandoned because of drought ~1675.

## El Nino/ENSO helps explain dramatic changes from Wet to Dry in New Mexico



# Repeat of this IMPORTANT POINT!

WATER TEMPERATURE OF OCEAN OFFSHORE NORTH AMERICA  
DETERMINES RAINFALL/DROUGHT in (especially) Western North America

What determines that water temperature?

The Multi-year weather pattern called EL NINO

El Nino Southern Oscillation “ENSO”

Later, we'll study a 60-year pattern

PACIFIC DECADAL OSCILLATION or “PDO”

30 years MORE EL NINOS, and  
30 years FEWER EL NINOS.

Now to discuss the variability of rainfall here based on weather records.

**It's not necessary to resort to human-caused CO2-fueled climate change,  
only to understand the climate we have here naturally.**

**The variability of the monsoon rainfall in Tucson is from driest, 1.59" to wettest, 13.84," or 12.25 inches.**

**In El Paso, the variability of the monsoon rainfall is from driest 0.23" to wettest, 15.28," or 15.05 inches.**



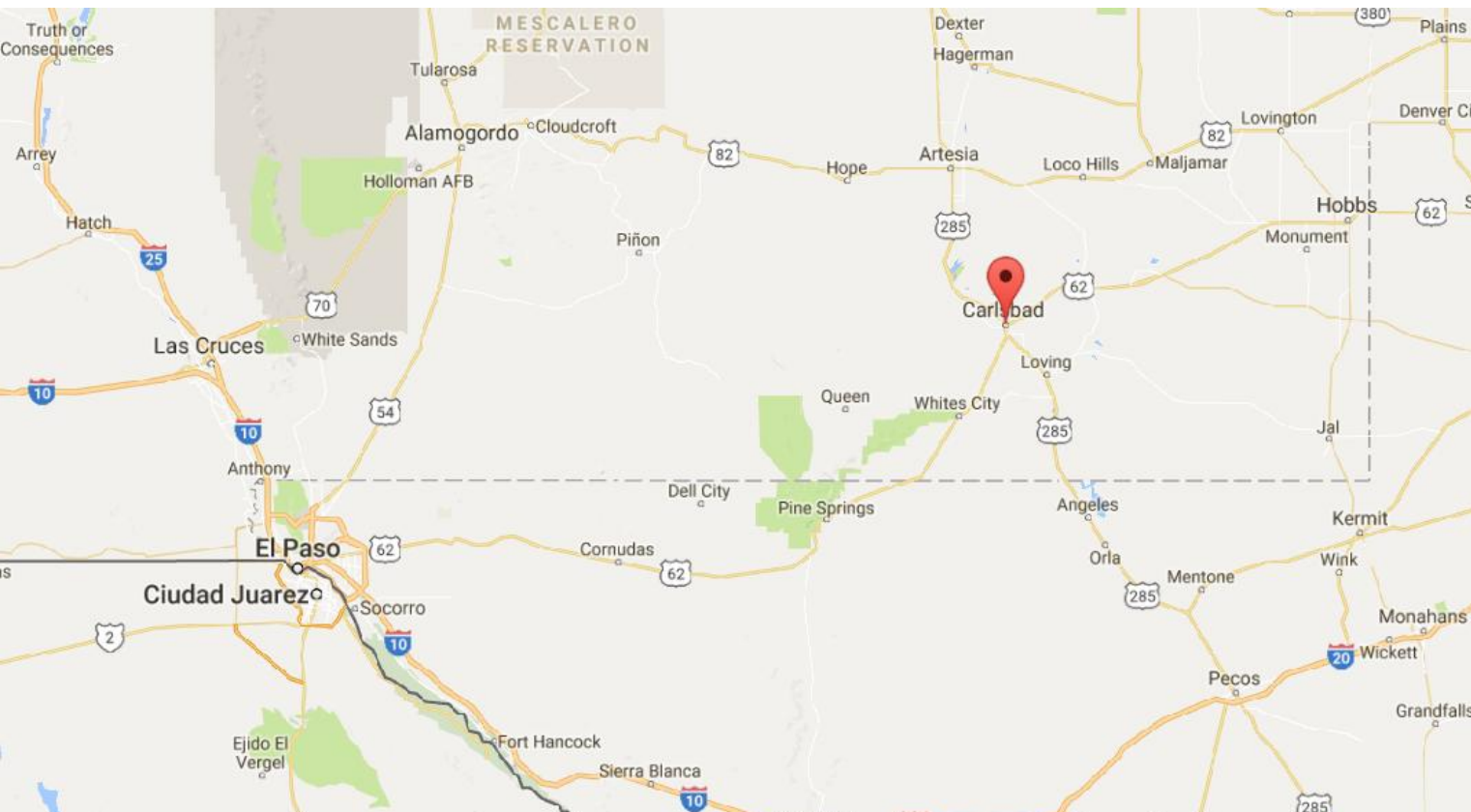
Extremes in precipitation, Carlsbad, New Mexico

1924: with 2.93 inches of Rain

1941: with 33.94 inches of Rain

**Think of it: 30 inches difference between wettest and driest years  
a factor of Ten Times—difference between the two.  
And, 1941 stands out as the wettest year, by far.**

**What about 1941 caused so much rain?**



# The global climate anomaly 1940–1942

<http://onlinelibrary.wiley.com/doi/10.1256/wea.248.04/pdf>

Weather – December 2005, Vol. 60, No. 12

## Stefan Brönnimann

*Institute for Atmospheric and Climate Sciences, ETH, Zürich, Switzerland*

In summer 1941, German troops were advancing into the Soviet Union, starting the Eastern Front. In the beginning the troops progressed rapidly, but then an exceptionally harsh winter stopped the assault:

"1942: The winter comes with full strength, hardly a way left to advance without missing winter equipment. Even the winter clothing is missing. ( midnight the temperature dropped to a new reported low point. On 24 January 1942,  $-56^{\circ}\text{C}$  was measured at our division observation post." (from the diary of Otto Geipel (Geipel 1997), see also Fig. 1).

"Strong, Long-Lasting El Niño"

338

R MET S  
ROYAL METEOROLOGICAL SOCIETY

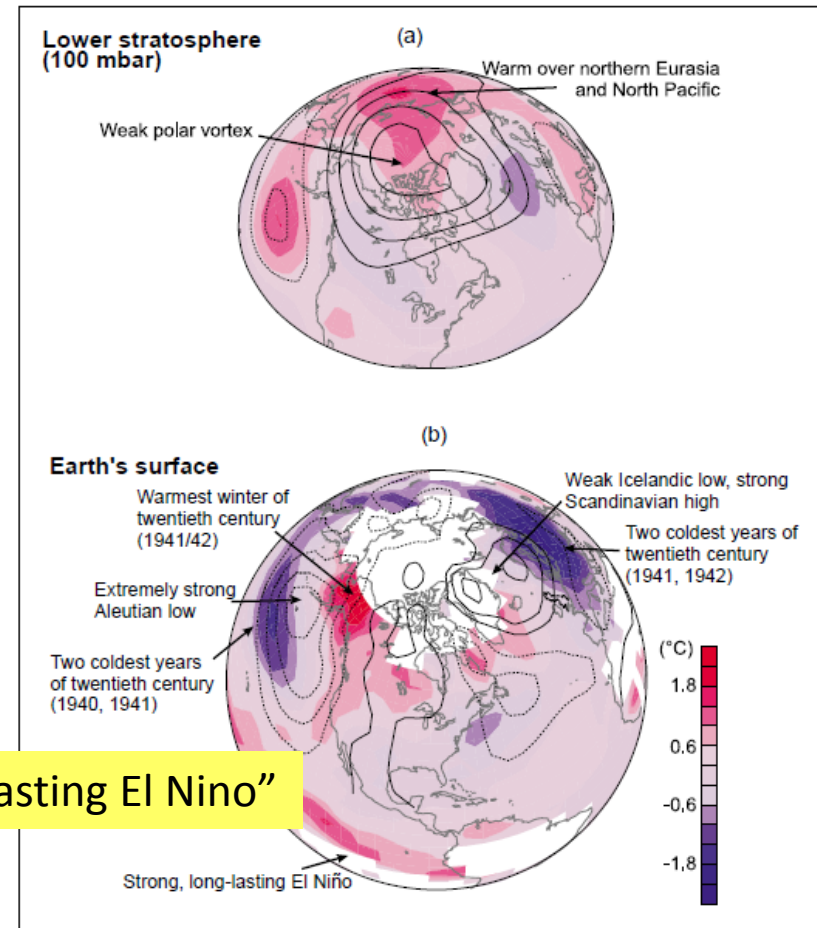
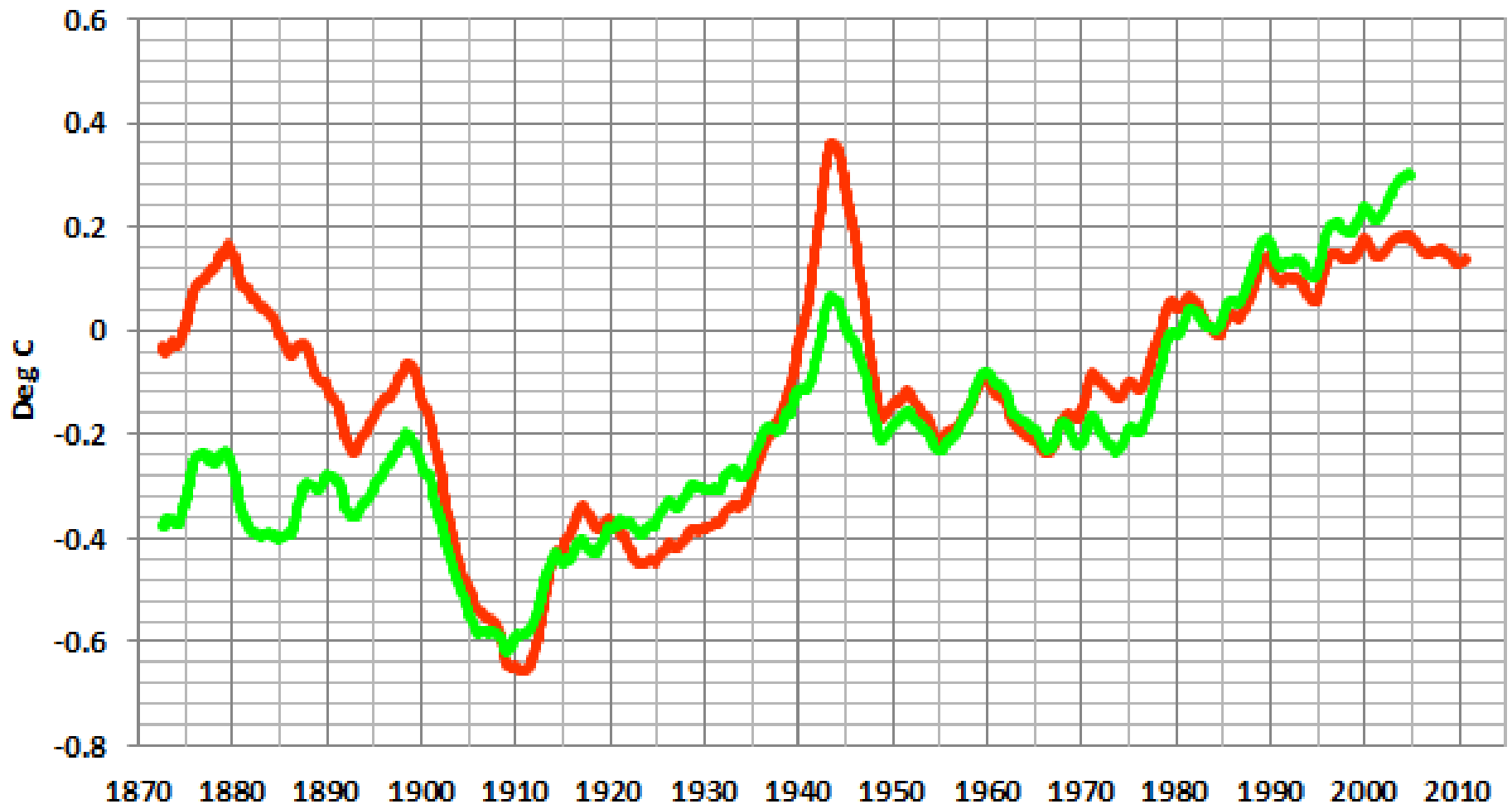


Fig. 7 Averaged anomaly fields (with respect to 1961–1990) from January 1940 to February 1942 of (a) temperature and geopotential height (contours, interval 20 gpm, zero contour not shown) at 100 mbar and (b) surface temperature (HadCRUT2v, Jones and Moberg 2003) and SLP (contours, interval 1 mbar, zero contour not shown, Trenberth and Paolino 1980).

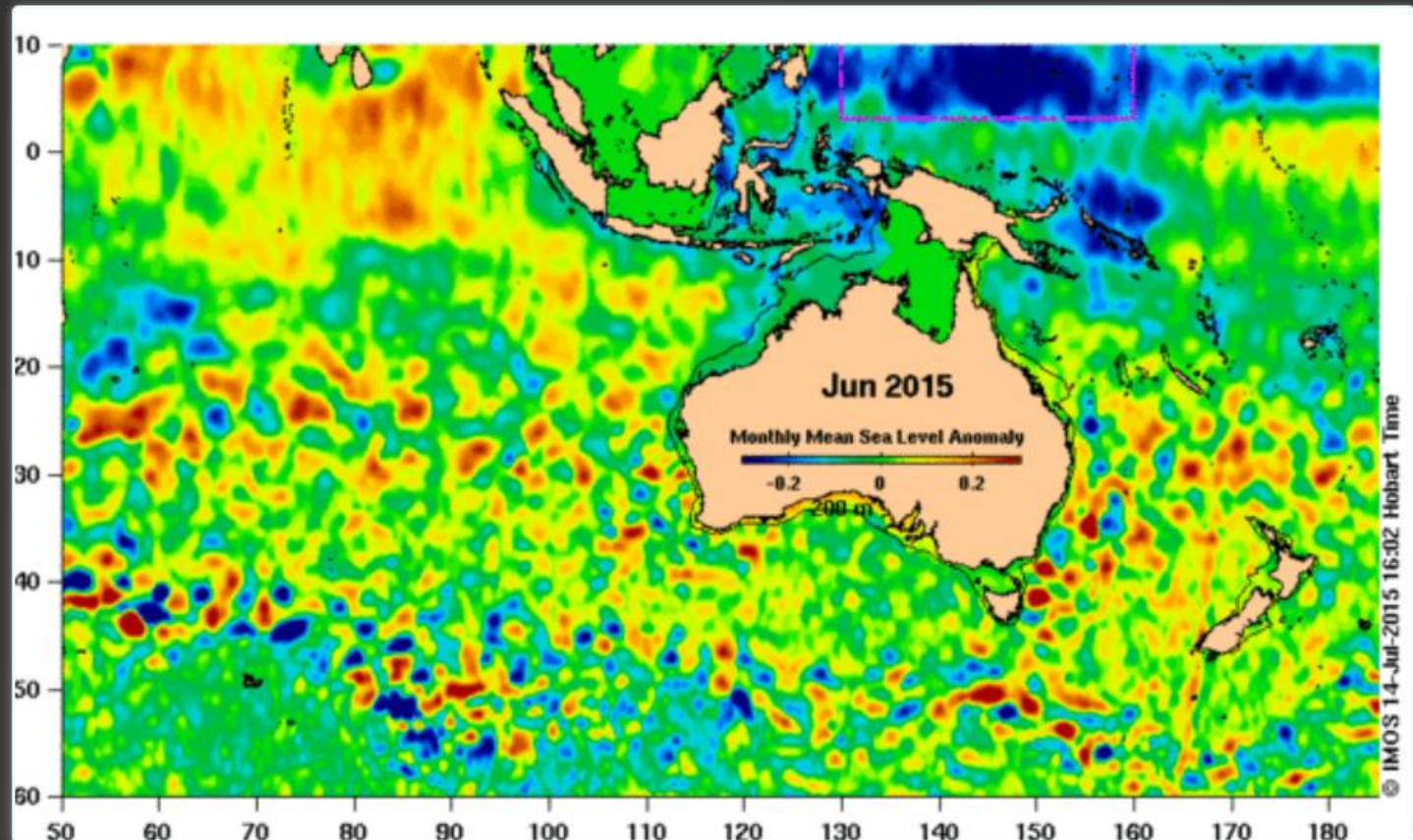
**Global Marine Air Temperature Anomalies (ICOADS)**  
**Global Night Marine Air Temperature Anomalies (MOHMAT)**  
**Jan 1870 to Jan 2013 / Mar 2007 (Base Years = 1955-2010)**



<http://www.aviso.altimetry.fr/en/news/idm/2015/jul-2015-el-ninos-return-west-side-story.html>

# EL NIÑO'S RETURN, WEST SIDE STORY

*Image of the Month - July 2015*





SPOTTING AN EL NIÑO



TEMPERATURES

in the tropical Pacific Ocean warm, both at the surface and below



SURFACE PRESSURE

changes across the Pacific; higher in the west, lower in the east



TRADE WINDS

weaken, and sometimes reverse



CLOUD

increases near the Date Line

WHEN DO THEY OCCUR?

USUALLY EL NIÑO DEVELOPS IN **AUTUMN TO WINTER** AND STARTS TO DECAY IN SUMMER

EL NIÑO EVENTS CAN LAST FOR AS LITTLE AS

**6 MONTHS** OR AS LONG AS **2 YEARS**

ON AVERAGE THEY OCCUR EVERY **3 TO 5 YEARS**

THE LAST **EL NIÑO** WAS IN **2009-10**

TYPICAL IMPACTS ON OUR CLIMATE

↓ **RAINFALL** DECREASES IN EASTERN AUSTRALIA

↑ **TEMPERATURE** INCREASES IN SOUTHERN AUSTRALIA (DAYTIME TEMPERATURES)



GLOBALLY, **7 OUT OF 10**

OF THE HOTTEST YEARS ON RECORD WERE IN AN EL NIÑO YEAR OR THE YEAR FOLLOWING

OTHER IMPACTS

INCREASED BUSHFIRE RISK

FEWER TROPICAL CYCLONES

LATER START TO NORTHERN WET SEASON

MORE HEATWAVES

LONGER FROST RISK SEASON

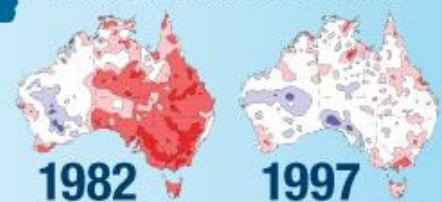
REDUCED CHANCE OF WIDESPREAD FLOODS

LESS CHANCE OF INDIAN OCEAN HEATWAVES

STRONGER SEABREEZES

EVERY EL NIÑO IS DIFFERENT

EL NIÑO WINTER AND SPRING RAINFALL



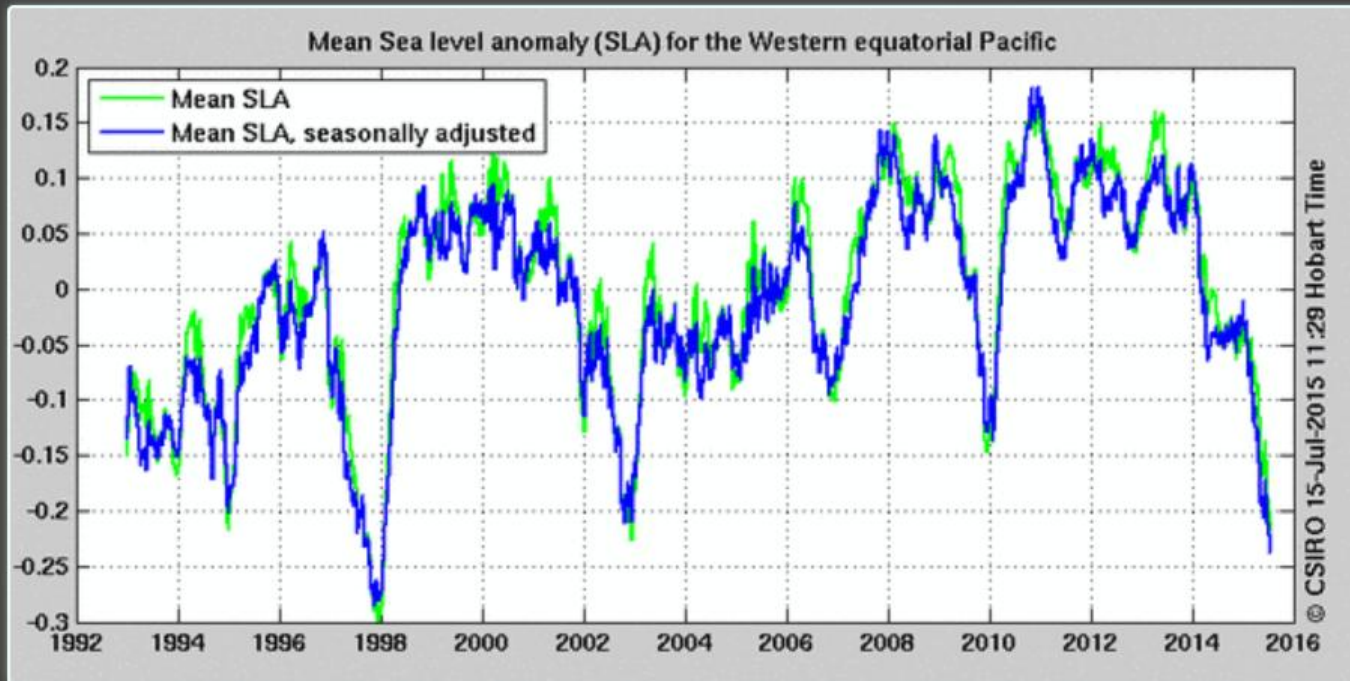
RED = DRIER THAN NORMAL BLUE = WETTER THAN NORMAL

THERE HAVE BEEN **26** EL NIÑO EVENTS SINCE 1900 **17** HAVE BROUGHT WIDESPREAD DROUGHT

**7** OF AUSTRALIA'S 10 DRIEST YEARS ON RECORD WERE DURING EL NIÑO

<http://www.bom.gov.au/climate/enso/>

<http://www.aviso.altimetry.fr/en/news/idm/2015/jul-2015-el-ninos-return-west-side-story.html>



*June monthly Mean Sea Level Anomaly around Australia (top), and the spatial mean SLA of the region (boxed in map) North of New Guinea (bottom) (Credits IMOS/CSIRO)*

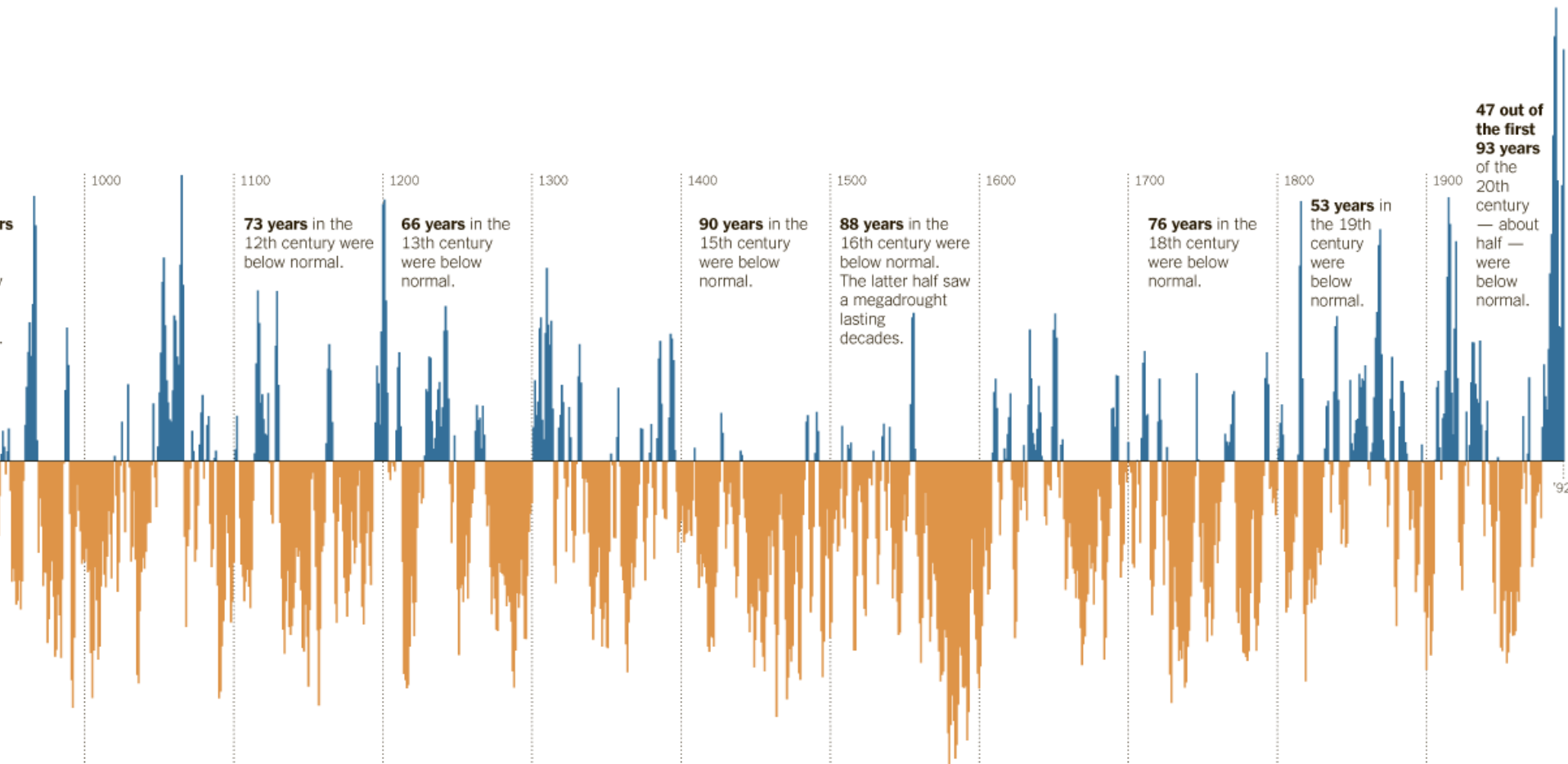
El Niño's name comes from South America. However, this phenomenon impacts the whole Pacific, the Western part no less than the Eastern, though in opposite ways. While on the Peruvian coasts El Niño means heavy rainfalls, higher-than-usual sea levels and temperatures, along the Australian, Papuan and Indonesian coasts it means drought and lower sea levels and temperatures. This being as much a problem as the reverse. In 1997 in particular, a lot of forest fires devastated Indonesia.



<http://www.bloomberg.com/news/articles/2015-08-12/worst-el-nino-in-30-years-pounds-south-american-economies-polls>



## El Nino/ENSO helps explain dramatic changes from Wet to Dry in New Mexico

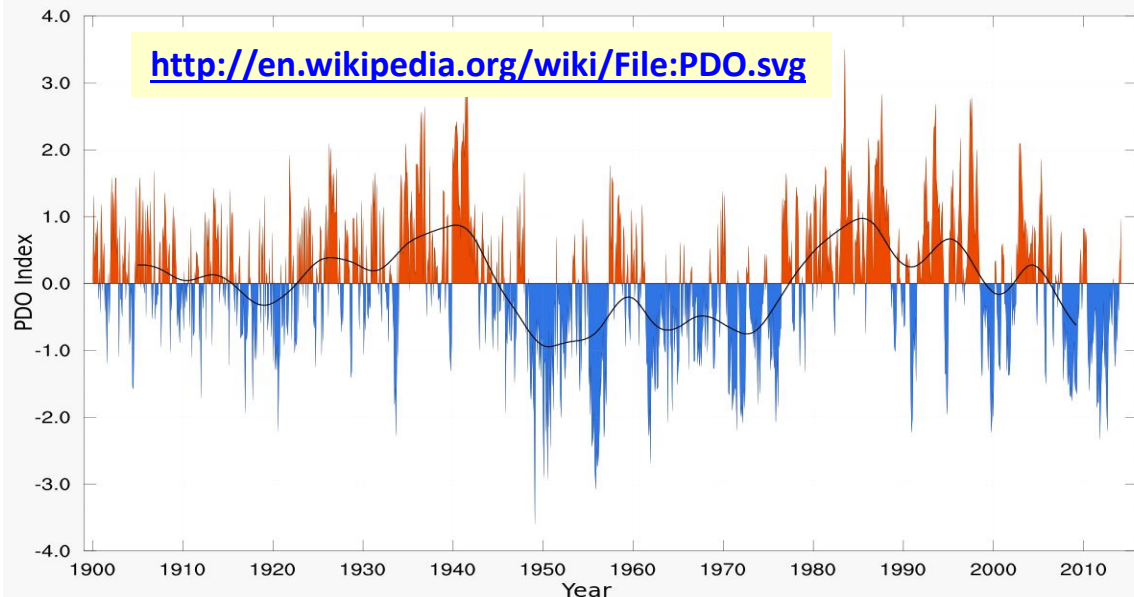


# Pacific Decadal Oscillation

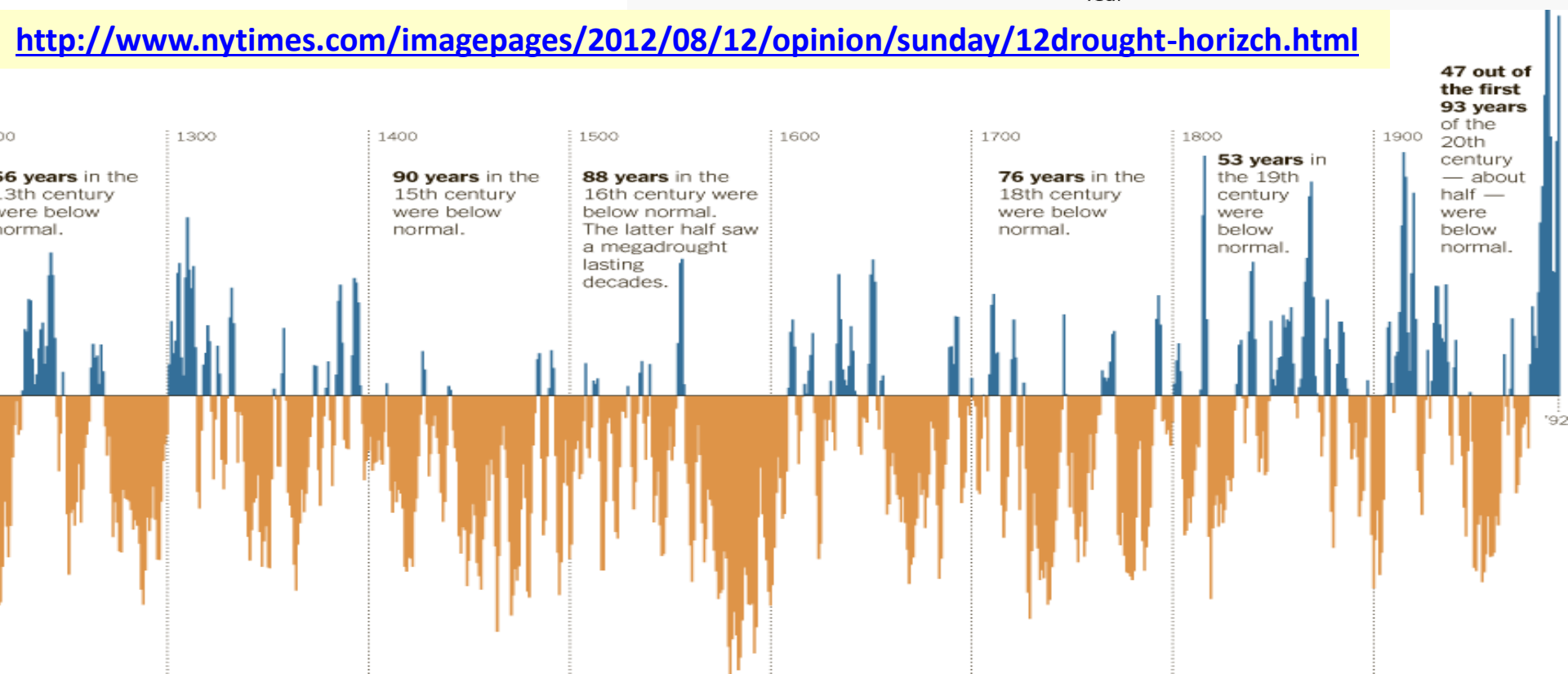
Natural change in  
offshore

Water Temperature  
Pattern

Off North America

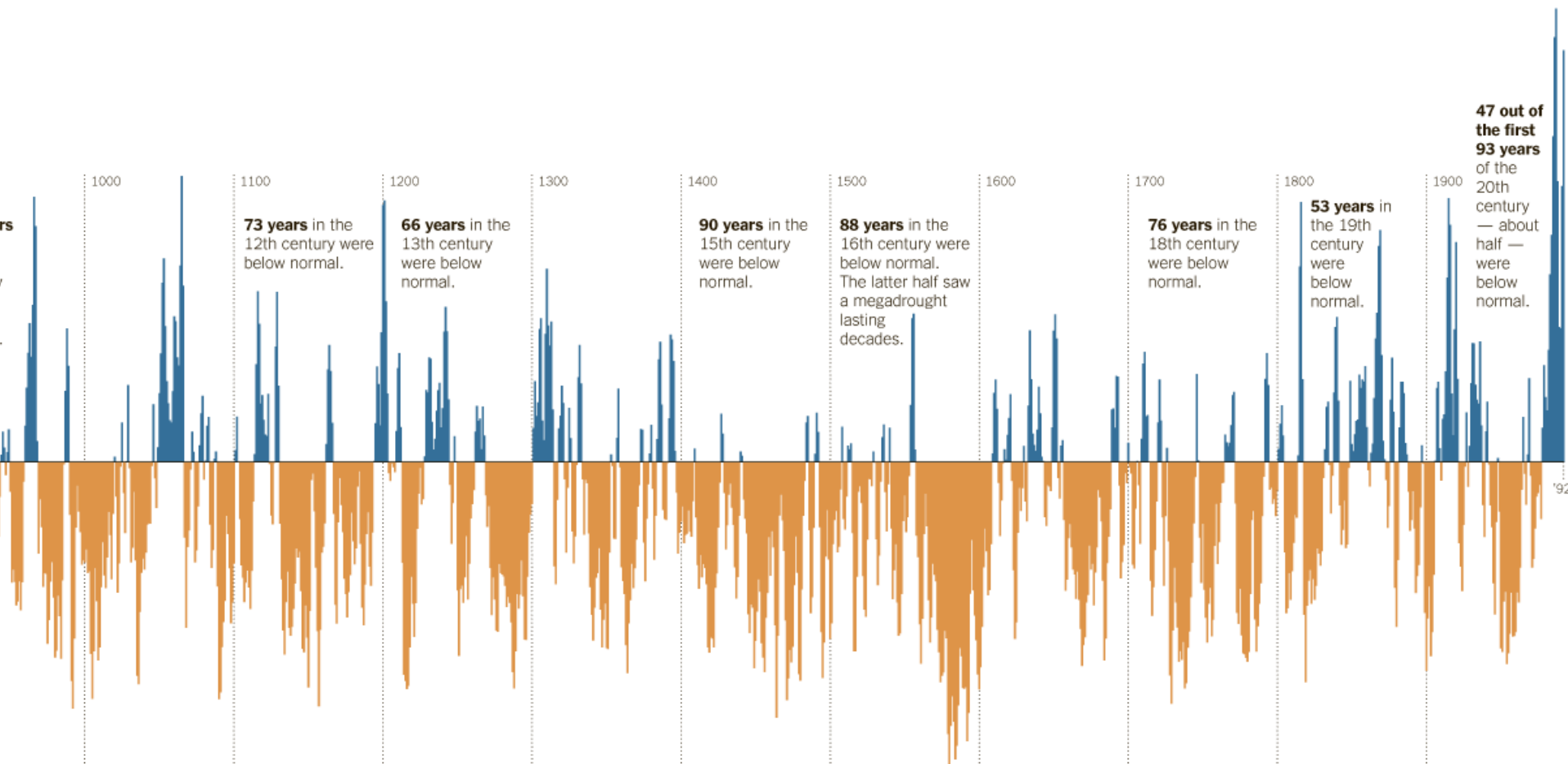


<http://www.nytimes.com/imagepages/2012/08/12/opinion/sunday/12drought-horizch.html>



## El Nino/ENSO helps explain dramatic changes from Wet to Dry in New Mexico

### 60-year Pacific Decadal Oscillation helps explain Rainfall and Drought in NM



[http://www.wrh.noaa.gov/twc/monsoon/monsoon\\_variability.php](http://www.wrh.noaa.gov/twc/monsoon/monsoon_variability.php)

## Climate Change and the Monsoon

A question of concern is how the North American Monsoon will be altered in the future as a result of climate change. Global warming projections are given by numerical computer models, such as those documented by the Intergovernmental Panel on Climate Change. Unfortunately the IPCC models poorly represent the North American Monsoon in the Southwest. Hence this question does not have an accurate answer at this time.

Here we have a presumably mid-level professional employee of the NWS, trying to provide good technical information on a complex subject, the variability of the North American Monsoon of the southwestern USA, and this employee blurts out the truth:

The Intergovernmental Panel on Climate Change, or IPCC, models “poorly represent the North American Monsoon in the Southwest.”

**Who else has noticed that the IPCC models do poorly?**



# Climate Science: Roger Pielke Sr.

[HOME](#)

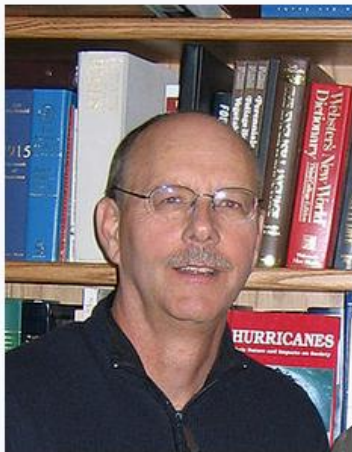
[MAIN CONCLUSIONS](#)

[MESSAGE FROM R.A. PIELKE SR.](#)

## Pielke Research Group: News and Commentary



**Roger A. Pielke Sr.**



**Born** October 22, 1946 (age 70)  
[United States](#)

**Fields** [Meteorology](#), [Climatology](#), [Earth System Science](#)

**Institutions** [University of Colorado Boulder](#),  
[Colorado State University](#), [Duke University](#), [University of Virginia](#),  
[NOAA Experimental Meteorology Lab](#)

**Alma mater** [Towson State College](#) (B.A., 1968), [Pennsylvania State University](#) (M.S., 1969; Ph.D., 1973)



# Climate Science: Roger Pielke Sr.

HOME

MAIN CONCLUSIONS

MESSAGE FROM R.A. PIELKE SR.

## Pielke Research Group: News and Commentary

BY RPIELKE | OCTOBER 9, 2012 · 7:00 AM

### Quotes From Peer Reviewed Paper That Document That Skillful Multi-Decadal Regional Climate Predictions Do Not Yet Exist



#### [The Huge Waste Of Research Money In Providing Multi-Decadal Climate Projections For The New IPCC Report](#)

there is an enormous amount of money being spent to provide multi-decadal regional climate forecasts to the impacts communities. In this post, I select just a few quotes from peer reviewed papers to document that the climate models do not have this skill. There are more detailed on this post also (e.g. [see](#)).

As the first example, from

Dawson A., T. N. Palmer and S. Corti: 2012: [Simulating Regime Structures in Weather and Climate Prediction Models](#). Geophysical Research Letters. doi:10.1029/2012GL053284 In press.

We have shown that a low resolution atmospheric model, with horizontal resolution typical of CMIP5 models, is not capable of simulating the statistically significant regimes seen in reanalysis, .....It is therefore likely that the embedded regional model may represent an unrealistic realization of regional climate and variability.

Other examples, include

Taylor et al, 2012: [Afternoon rain more likely over drier soils](#). Nature.  
doi:10.1038/nature11377. Received 19 March 2012 Accepted 29 June  
2012 Published online 12 September 2012

“...the erroneous sensitivity of convection schemes demonstrated here is likely to contribute to a tendency for large-scale models to ‘lock-in’ dry conditions, extending droughts unrealistically, and potentially exaggerating the role of soil moisture feedbacks in the climate system.”

Driscoll, S., A. Bozzo, L. J. Gray, A. Robock, and G. Stenchikov (2012), [Coupled Model Intercomparison Project 5 \(CMIP5\) simulations of climate following volcanic eruptions](#), J. Geophys. Res., 117, D17105, doi:10.1029/2012JD017607. published 6 September 2012.

The study confirms previous similar evaluations and raises concern for the ability of current climate models to simulate the response of a major mode of global circulation variability to external forcings.

Fyfe, J. C., W. J. Merryfield, V. Kharin, G. J. Boer, W.-S. Lee, and K. von Salzen (2011), [Skillful predictions of decadal trends in global mean surface temperature](#), Geophys. Res. Lett., 38, L22801, doi:10.1029/2011GL049508

”...for longer term decadal hindcasts a linear trend correction may be required if the model does not reproduce long-term trends. For this reason, we correct for systematic long-term trend biases.”

Xu, Zhongfeng and Zong-Liang Yang, 2012: [An improved dynamical downscaling method with GCM bias corrections and its validation with 30 years of climate simulations](#). Journal of Climate 2012 doi: <http://dx.doi.org/10.1175/JCLI-D-12-00005.1>

”...the traditional dynamic downscaling (TDD) [i.e. without tuning] overestimates precipitation by 0.5-1.5 mm d<sup>-1</sup>.....The 2-year return level of summer daily maximum temperature simulated by the TDD is underestimated by 2-6°C over the central United States-Canada region.”



A highly-recommended  
E-book.

This book is the source  
for the excellent  
graphics I used later  
in this section.

# **WHO TURNED ON THE HEAT?**

**THE UNSUSPECTED GLOBAL  
WARMING CULPRIT,  
EL NIÑO-SOUTHERN OSCILLATION**

**BY BOB TISDALE**

**El Nino, basics on how  
it develops and works...**

**The entire phenomenon is called**

**ENSO: El Nino Southern  
Oscillation**



## 1.2 The ENSO Annotated Illustrations

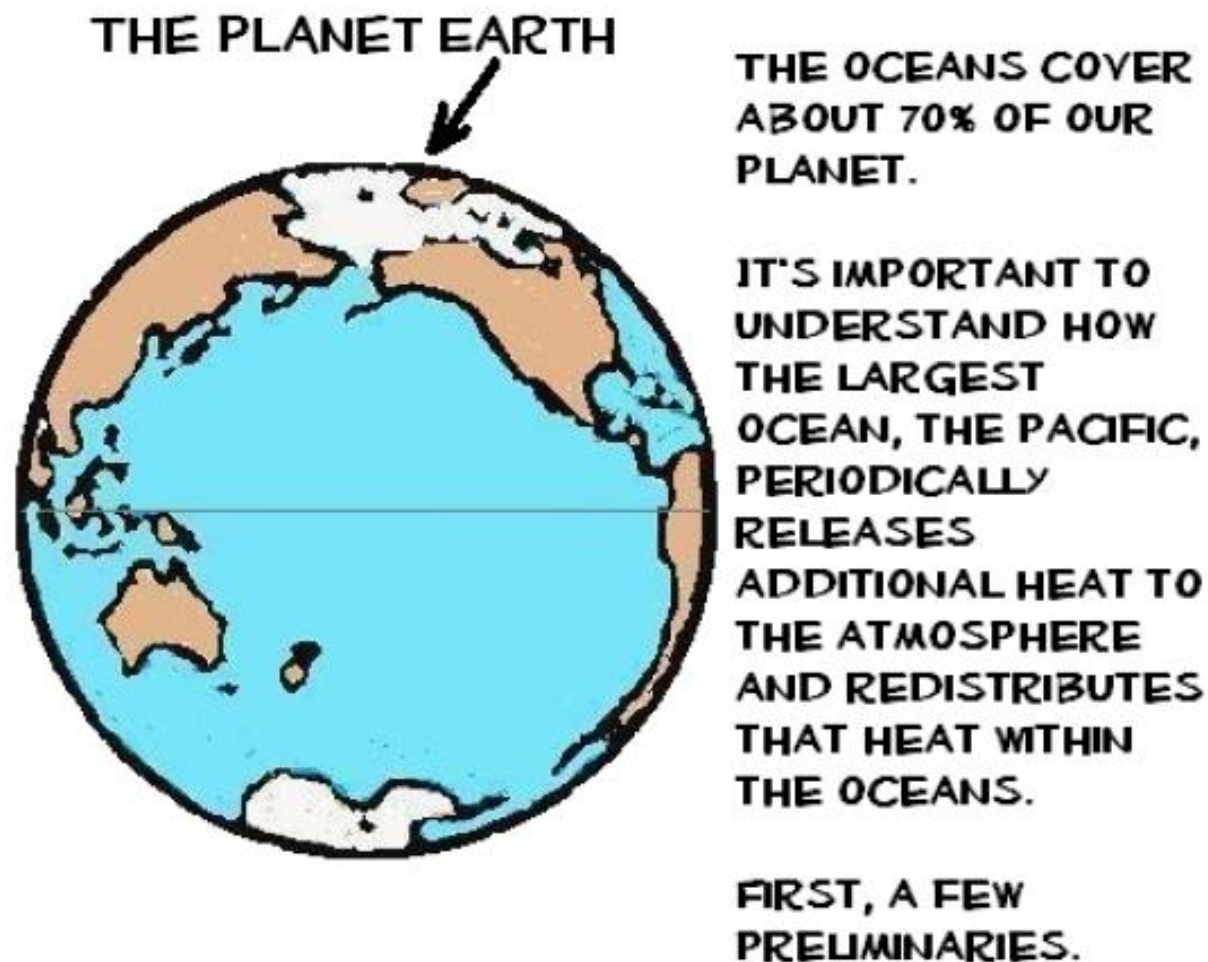
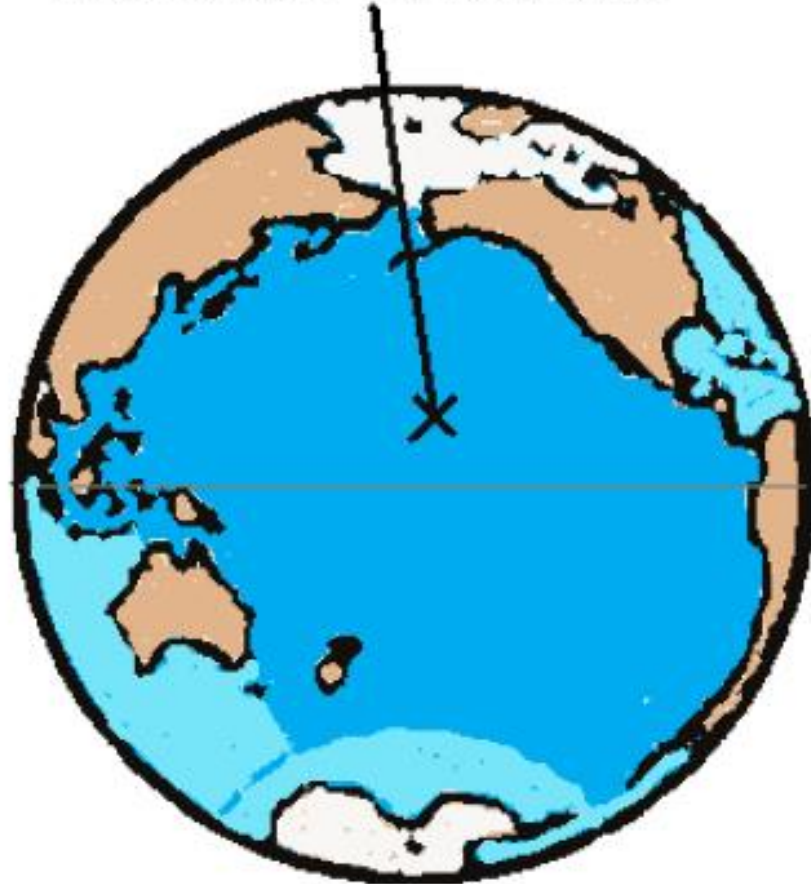


Figure 1-1

Bob Tisdale

HHH

## THE PACIFIC OCEAN



THE PACIFIC OCEAN  
STRETCHES ALMOST  
HALFWAY AROUND THE  
GLOBE AT THE EQUATOR.

IT COVERS THE SURFACE OF  
THE PLANET FROM ASIA TO  
NORTH AMERICA AND FROM  
AUSTRALIA TO SOUTH  
AMERICA.

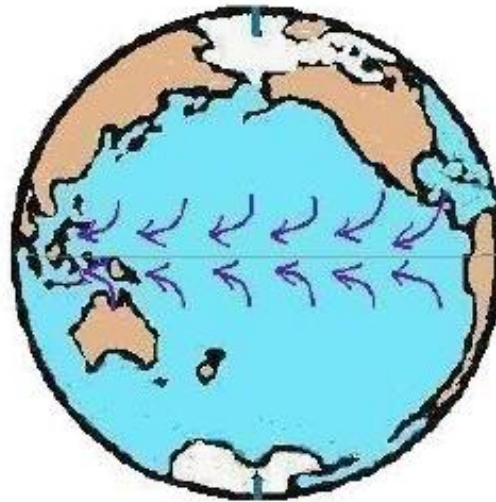
IT REACHES FROM THE  
BERING STRAIT NEAR THE  
ARCTIC OCEAN TO THE  
IMAGINARY BORDER WITH  
THE SOUTHERN OCEAN THAT  
SURROUNDS ANTARCTICA.

Figure 1-2

Bob Tisdale

HHH

## TRADE WINDS



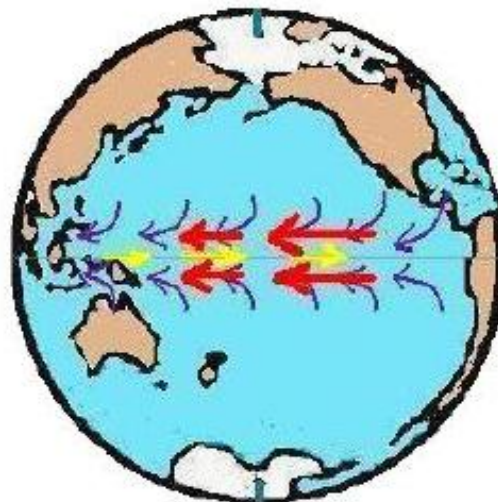
THE TRADE WINDS BLOW ACROSS THE SURFACE OF THE TROPICAL PACIFIC, FROM THE NORTHEAST TO THE SOUTHWEST IN THE NORTHERN HEMISPHERE AND FROM THE SOUTHEAST TO THE NORTHWEST IN THE SOUTHERN HEMISPHERE.

Figure 1.3

Bob Tisdale

HHH

## OCEAN CURRENTS



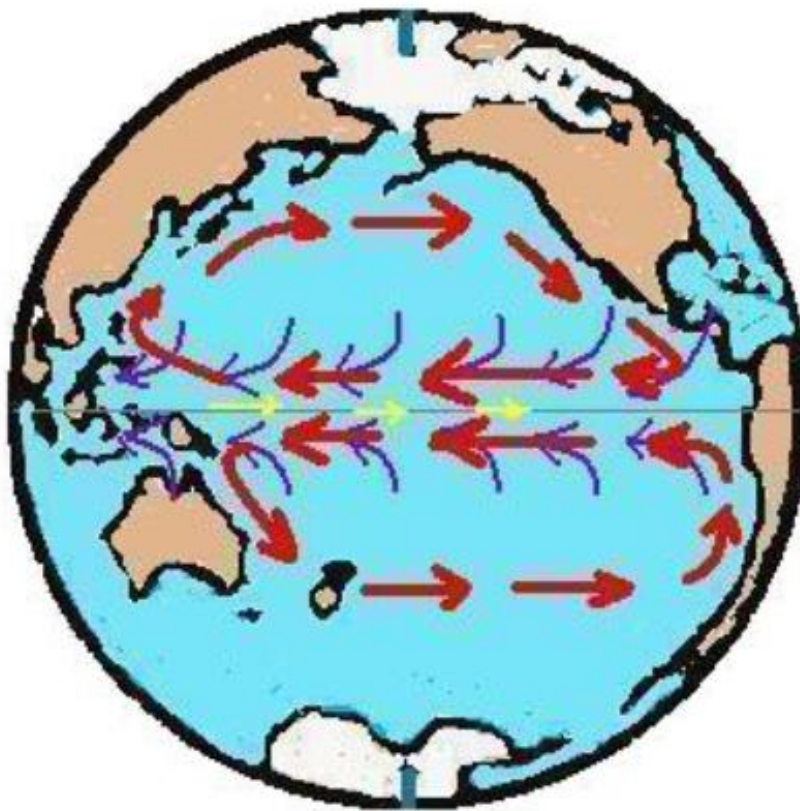
THE OCEAN CURRENTS IN THE TROPICAL PACIFIC ARE DRIVEN BY THE TRADE WINDS.

THE CURRENTS NEAR THE EQUATOR ARE CALLED THE NORTH AND SOUTH EQUATORIAL CURRENTS. THEY CARRY WATER FROM EAST TO WEST.

THERE'S ALSO A (NORMALLY) SMALLER CURRENT THAT RUNS BETWEEN THEM CALLED THE EQUATORIAL COUNTER CURRENT.



## OCEAN CURRENTS

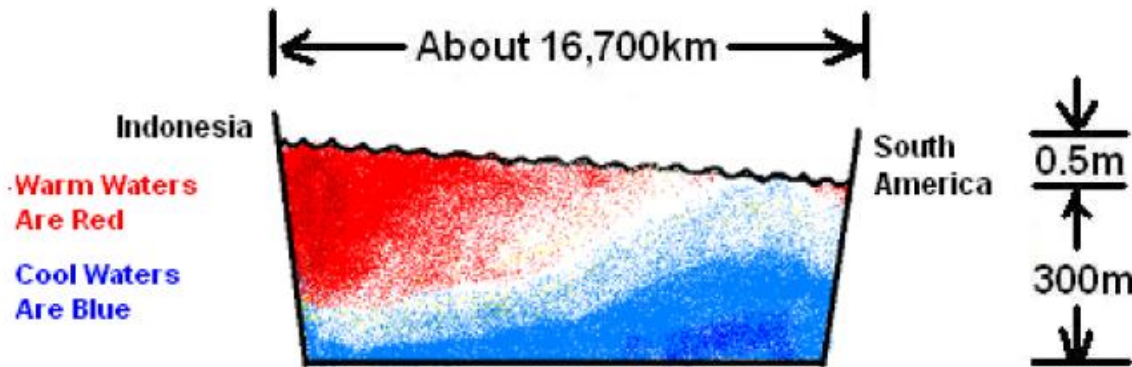


**THE TRADE WIND-DRIVEN  
WATERS COLLIDE WITH  
LAND SO THEY ARE  
FORCED TO HEAD TOWARD  
THE POLES.**

**THEY THEN CIRCLE  
AROUND AND FORM WHAT  
ARE CALLED THE NORTH  
AND SOUTH PACIFIC  
GYRES.**

Figure 1-5

**INTRODUCTION TO THE CROSS SECTION OF THE  
EQUATORIAL PACIFIC OCEAN  
USED IN MANY OF THE GRAPHICS THAT FOLLOW**



**THE DIMENSIONS OF THE CROSS SECTION ARE SKEWED. BUT KNOWING THE SEA LEVEL IS ABOUT 0.5 METERS HIGHER IN THE WEST THAN IN THE EAST UNDER "NORMAL" CONDITIONS IS IMPORTANT.**

**THE VARIATIONS IN TEMPERATURES BELOW THE SURFACE ARE ALSO IMPORTANT, BUT THEY TAKE PLACE IN THE TOP 300 METERS.**

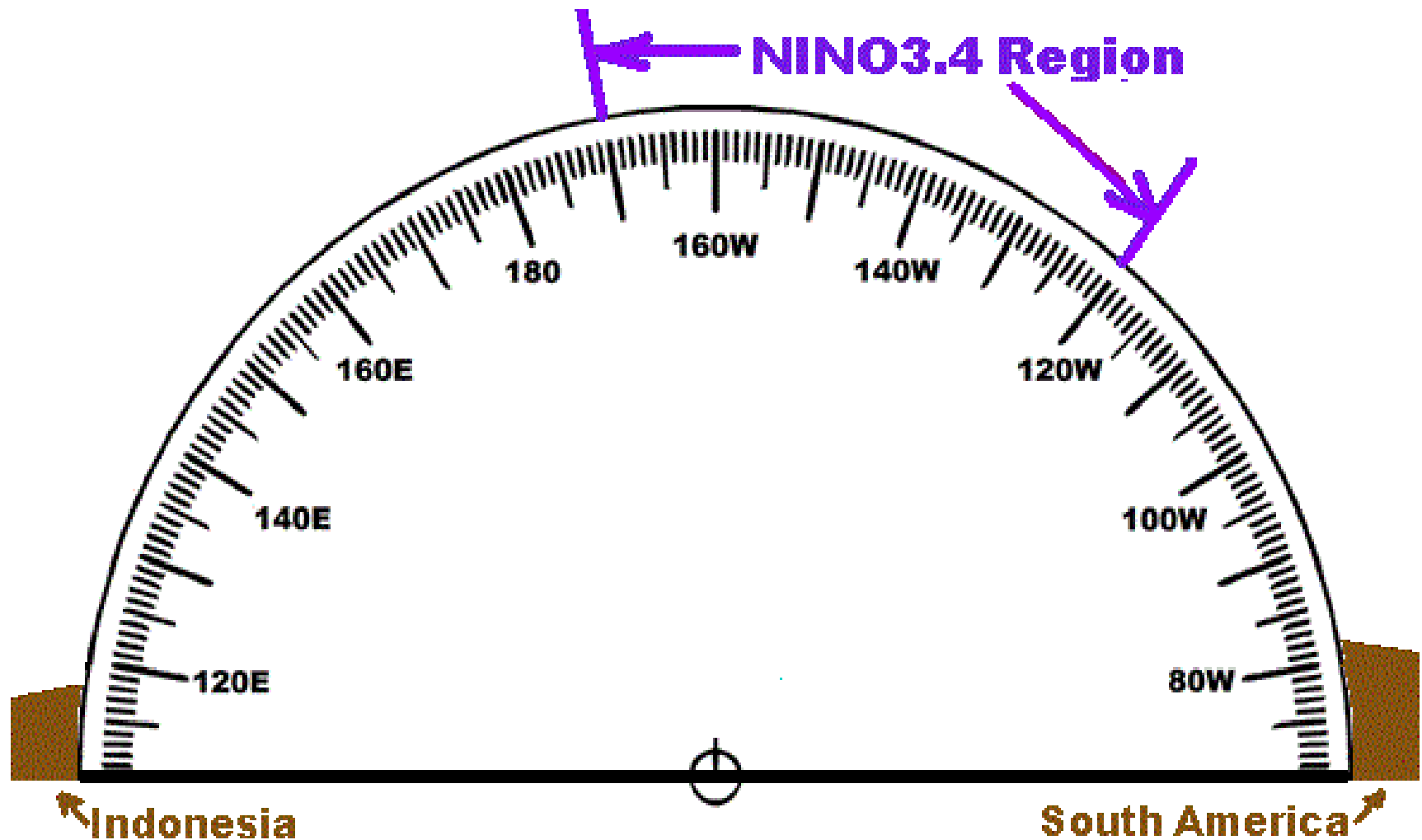
**AND THE OVERALL WIDTH OF THE TROPICAL PACIFIC MUST BE KEPT IN MIND.--ALMOST HALFWAY AROUND THE GLOBE.**

Figure 1-6

Bob Tisdale

## EQUATORIAL PACIFIC

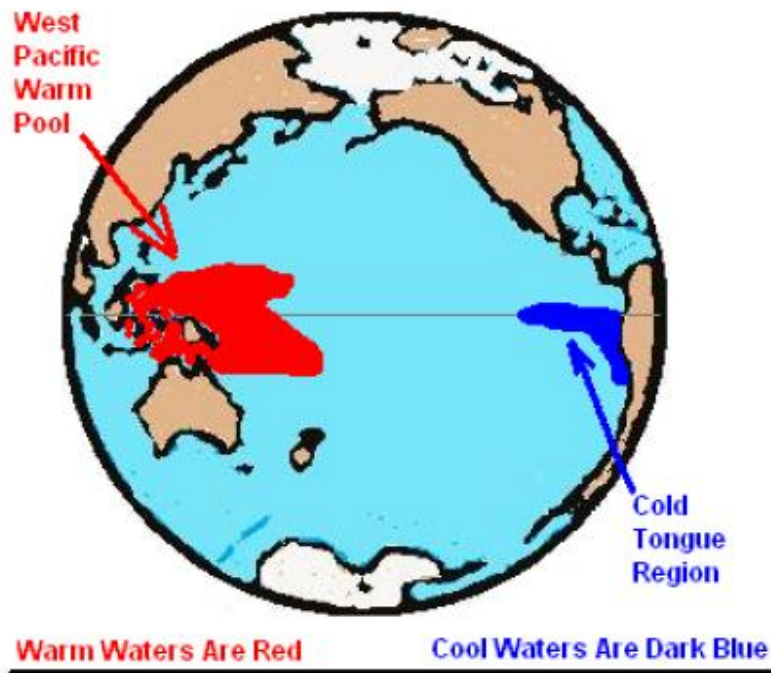
### A Different Perspective of Its Surface





# NORMAL OR "ENSO-NEUTRAL" CONDITIONS (A)

(NOT AN EL NIÑO AND NOT A LA NIÑA)



THE TRADE WINDS PUSH THE SUN-WARMED WATER TO THE WEST AND IT ACCUMULATES IN AN AREA CALLED THE WEST PACIFIC WARM POOL, REACHING DEPTHS OF ALMOST 300 METERS.

THE TRADE WINDS ALSO DRAW COOL WATERS FROM BELOW THE SURFACE OF THE EASTERN EQUATORIAL PACIFIC IN A PROCESS KNOWN AS UPWELLING.

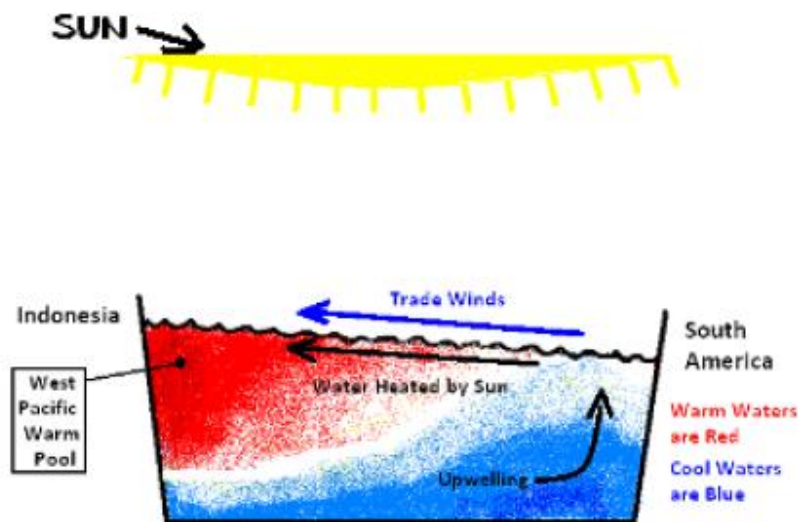
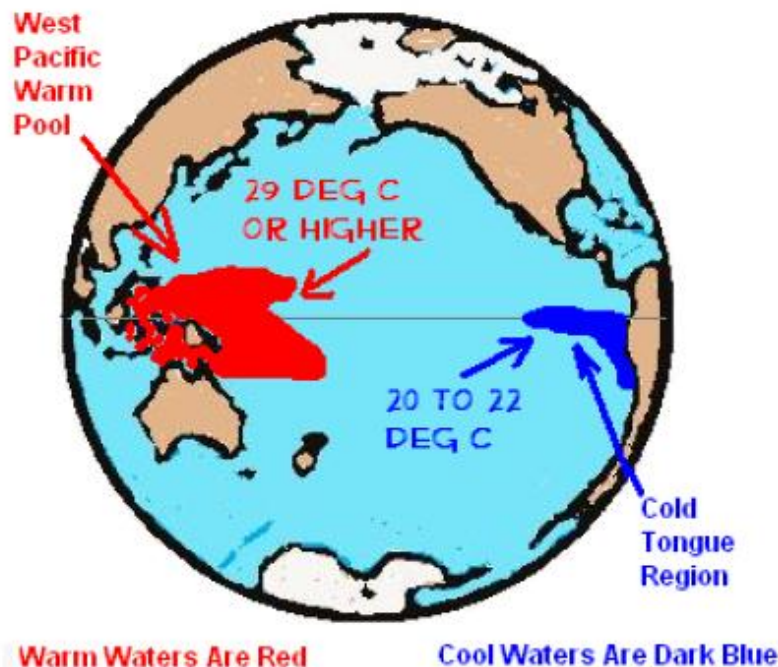


Figure 1-7

# NORMAL OR "ENSO-NEUTRAL" CONDITIONS (B) (NOT AN EL NIÑO AND NOT A LA NIÑA)



AS A RESULT, THE SEA SURFACE TEMPERATURE IN THE WEST PACIFIC WARM POOL CAN BE 8 TO 10 DEG C WARMER THAN IN THE COLD TONGUE REGION IN THE EAST.

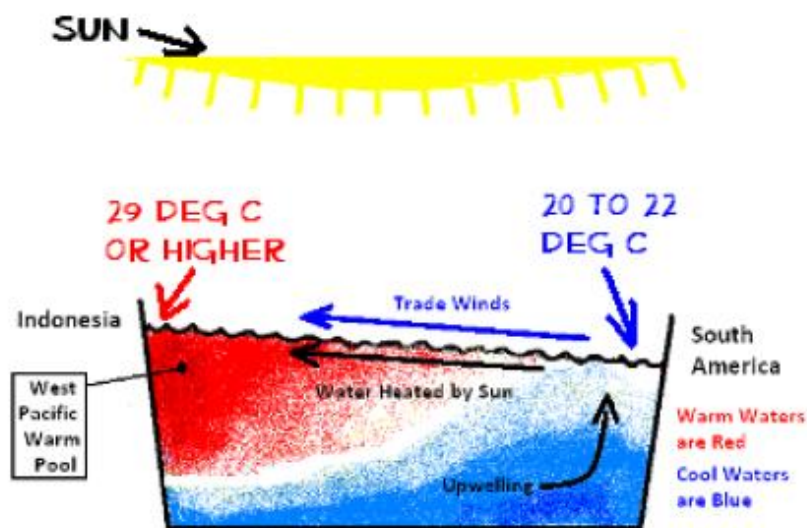
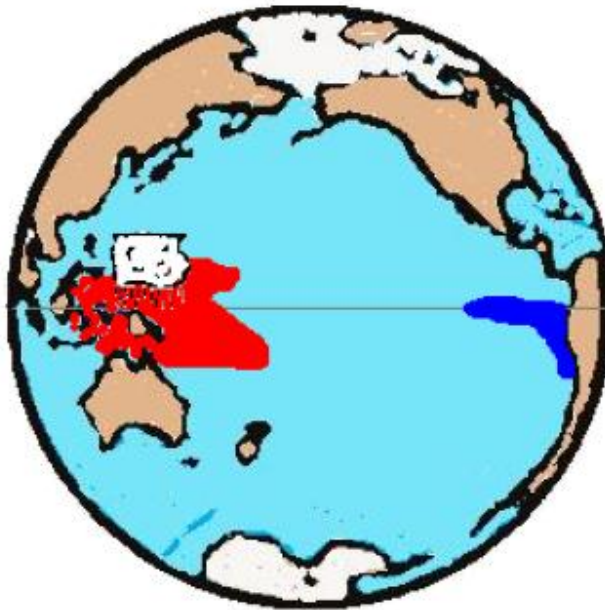


Figure 1-8

## NORMAL OR "ENSO-NEUTRAL" CONDITIONS (C)

(NOT AN EL NIÑO AND NOT A LA NIÑA)



Warm Waters Are Red

Cool Waters Are Dark Blue

THE OCEANS RELEASE  
HEAT PRIMARILY  
THROUGH  
EVAPORATION.

AS THE WARM, MOIST  
AIR OVER THE PACIFIC  
WARM POOL RISES, IT  
COOLS.

AS IT CONTINUES TO  
RISE AND COOL, THE  
AIR CAN HOLD LESS  
OF THE MOISTURE,  
AND IT COMES OUT AS  
RAIN.

IN DOING SO, IT  
RELEASES THE HEAT  
FROM THE SUN THAT  
WAS USED TO  
EVAPORATE IT.

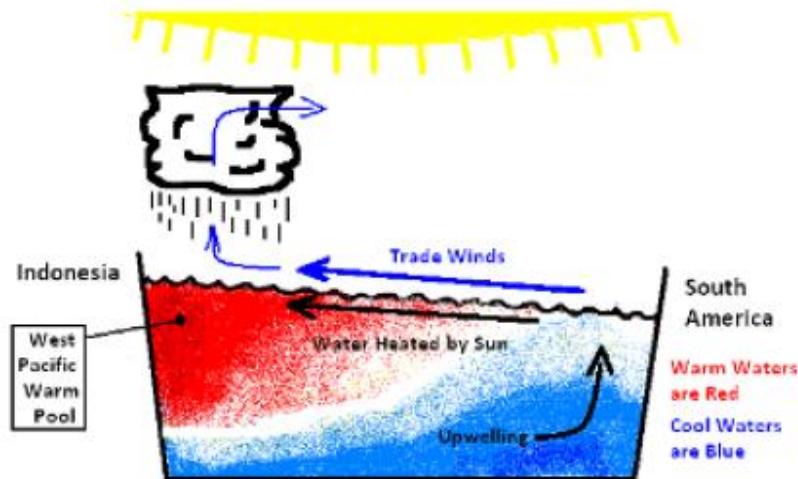
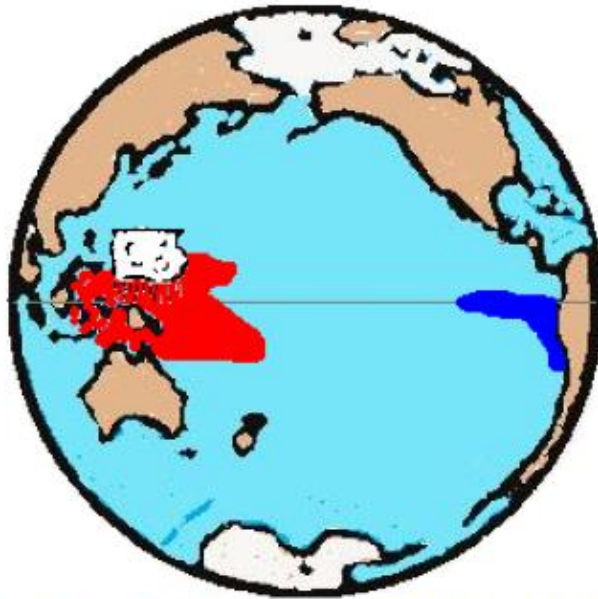


Figure 1-9



**NORMAL OR "ENSO-NEUTRAL" CONDITIONS (D)**  
(NOT AN EL NIÑO AND NOT A LA NIÑA)



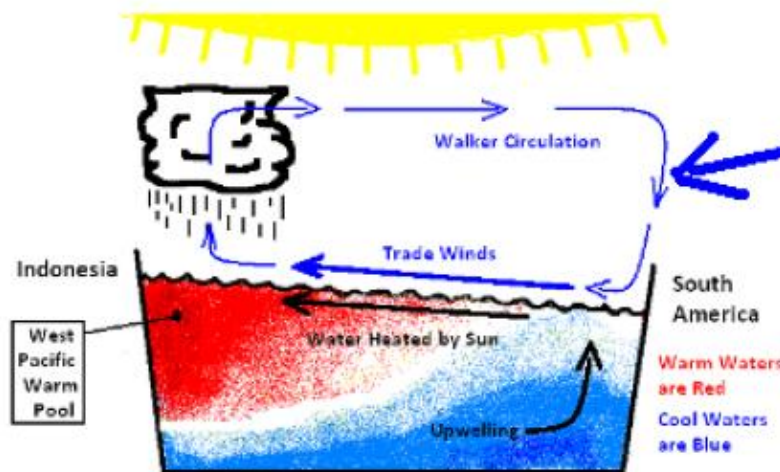
Warm Waters Are Red

Cool Waters Are Dark Blue

THE TRADE WINDS  
REPLACE THE RISING  
AIR IN THE WEST.

THE AIR SINKS IN THE  
EAST.

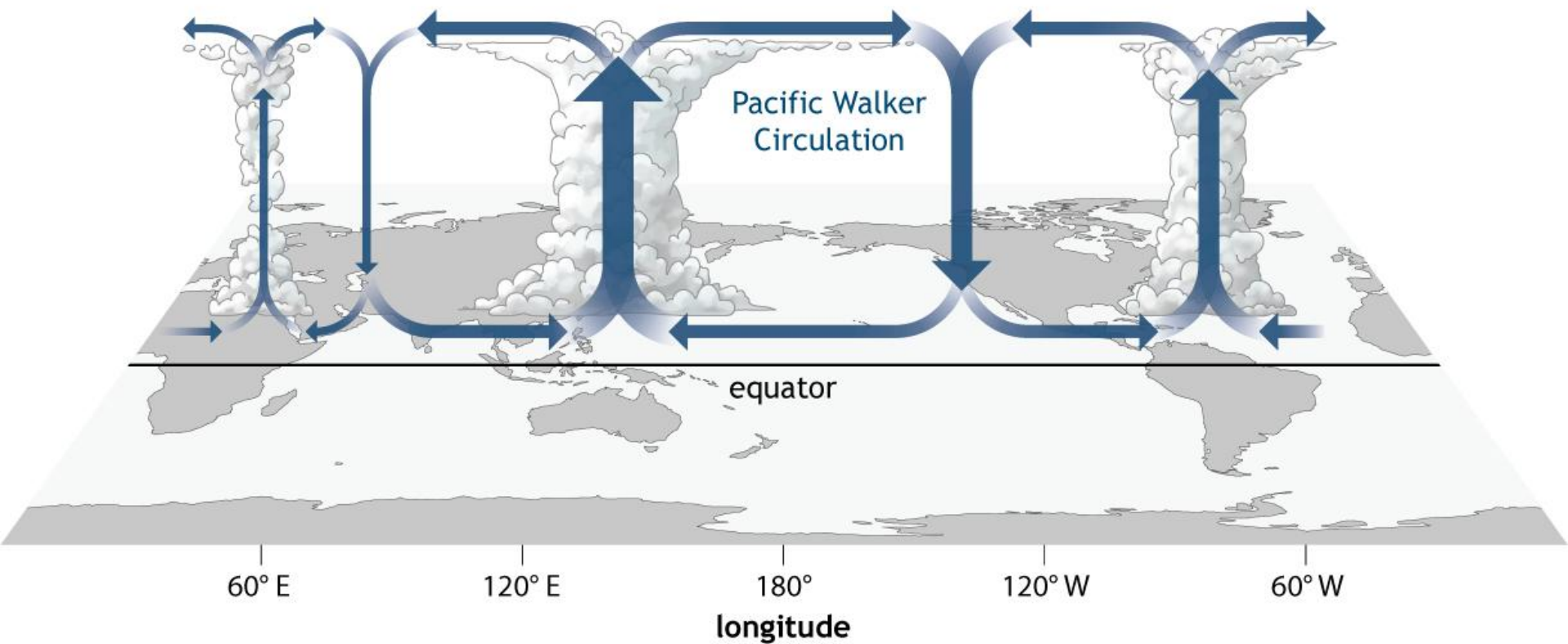
AND THE  
EASTWARD UPPER  
WINDS AND WESTWARD  
TRADE WINDS  
CONNECT THEM.



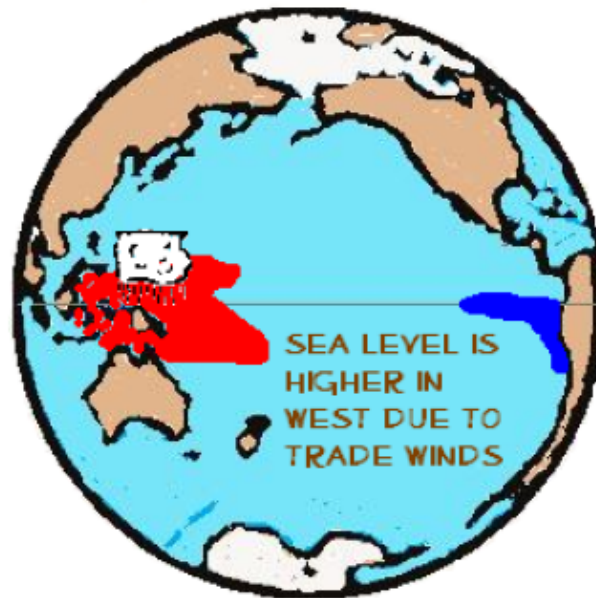
THIS IS KNOWN AS  
WALKER CIRCULATION  
OR A WALKER CELL,  
JUST IN CASE YOU  
WERE WONDERING.

Figure 1-10

Neutral conditions



# NORMAL OR "ENSO-NEUTRAL" CONDITIONS (E) (NOT AN EL NIÑO AND NOT A LA NIÑA)

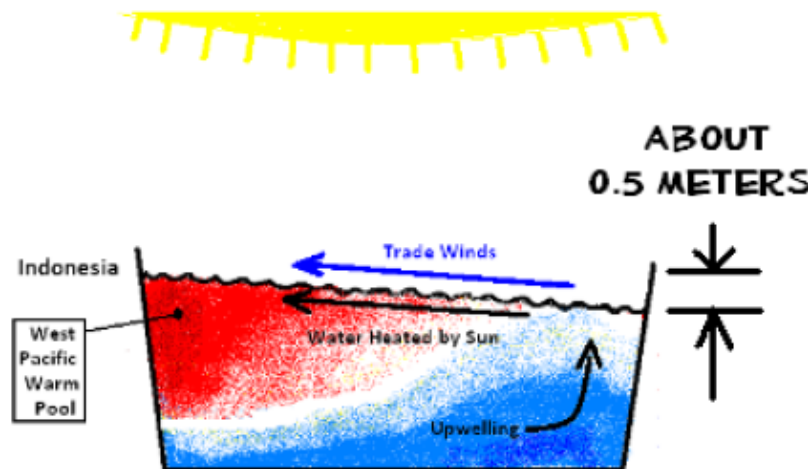


Warm Waters Are Red

Cool Waters Are Dark Blue

BECAUSE THE  
TRADE WINDS ARE  
PUSHING THE WATER  
TO THE WEST, IT  
PILES UP THERE.

IT IS ABOUT 1/2  
METER HIGHER IN  
THE WEST PACIFIC  
WARM POOL THAN IT  
IS IN THE COLD  
TONGUE REGION IN  
THE EAST.

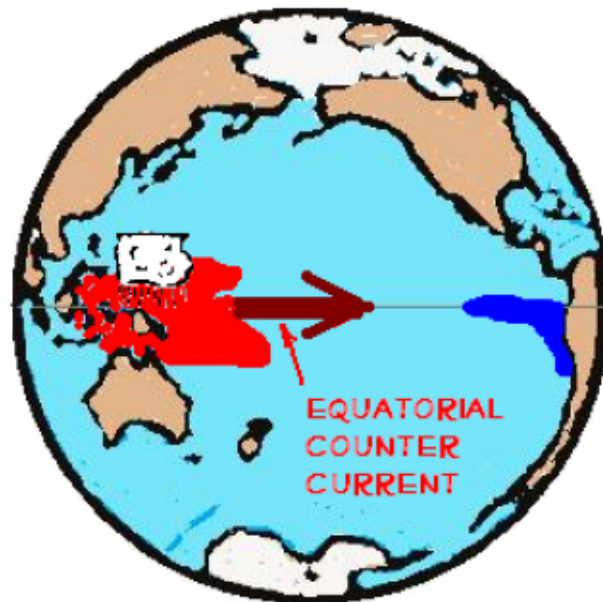


GRAVITY WOULD LIKE  
IT TO BE LEVEL,  
BUT THE TRADE  
WINDS ARE HOLDING  
THE WARM WATER IN  
PLACE IN THE WEST.

Figure 1-11



## WHAT DO YOU SUPPOSE HAPPENS WHEN THE TRADE WINDS DECIDE TO RELAX?



Warm Waters Are Red

Cool Waters Are Dark Blue

WHEN THE TRADE WINDS WEAKEN, GRAVITY TAKES OVER AND TRIES TO LEVEL THE SEA SURFACE HEIGHT OF THE EQUATORIAL PACIFIC.

THE EQUATORIAL COUNTER CURRENT GETS MUCH LARGER AND WARM WATER FROM THE PACIFIC WARM POOL SLOSHES TO THE EAST.

GRAVITY TAKES OVER WHEN THE TRADE WINDS WEAKEN AND TRIES TO LEVEL THE HEIGHT OF THE OCEAN



AND THAT'S  
HOW AN EL NIÑO  
STARTS!!!!

Figure 1-12

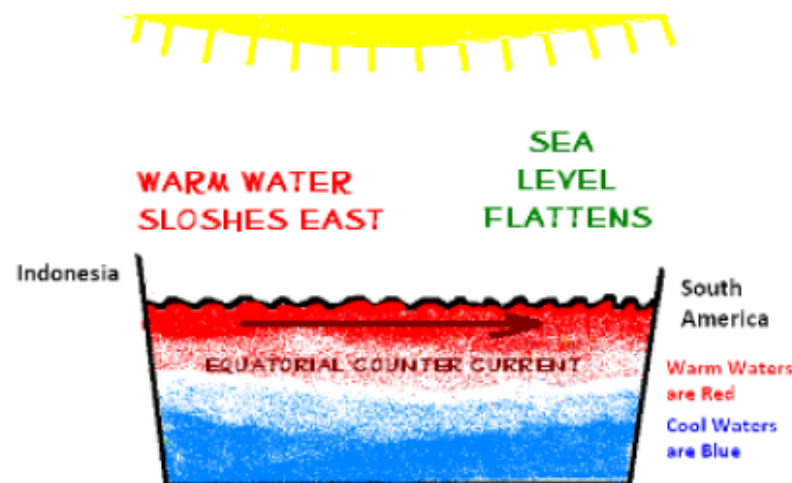
# EL NIÑO CONDITIONS (A)



Warm Waters Are Red

Cool Waters Are Dark Blue

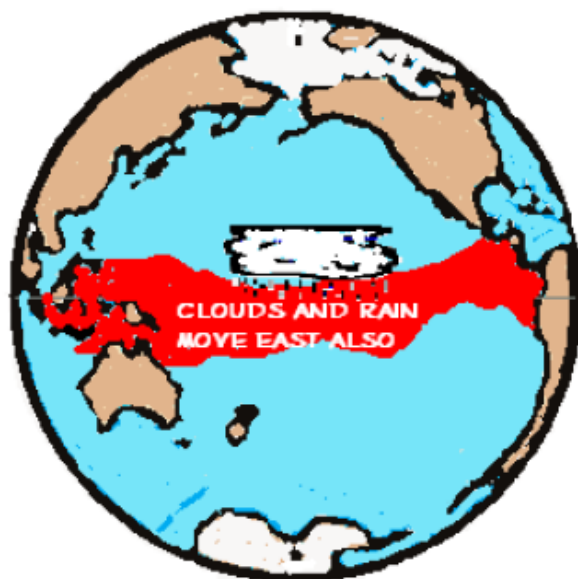
DURING AN EL NIÑO, WARM WATER FROM THE SURFACE AND BELOW THE SURFACE OF THE PACIFIC WARM POOL IS CARRIED EAST AND SPREAD ACROSS THE SURFACE OF THE CENTRAL AND EASTERN TROPICAL PACIFIC, SOMETIMES AS FAR AS THE AMERICAS.



THE WARMER WATER COVERS MORE OF THE SURFACE, AND THAT INCREASES THE SEA SURFACE TEMPERATURE OF THE TROPICAL PACIFIC.

Figure 1-13

## EL NIÑO CONDITIONS (B)

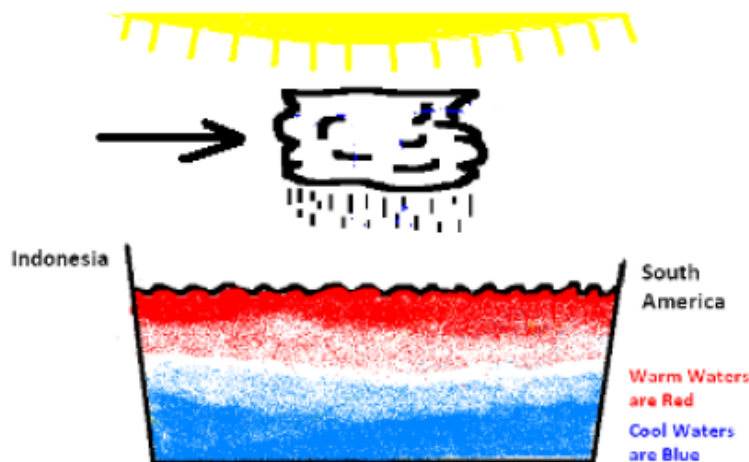


Warm Waters Are Red

Cool Waters Are Dark Blue

THE CLOUDS AND RAIN  
ACCOMPANY THE WARM  
WATER TO THE EAST.

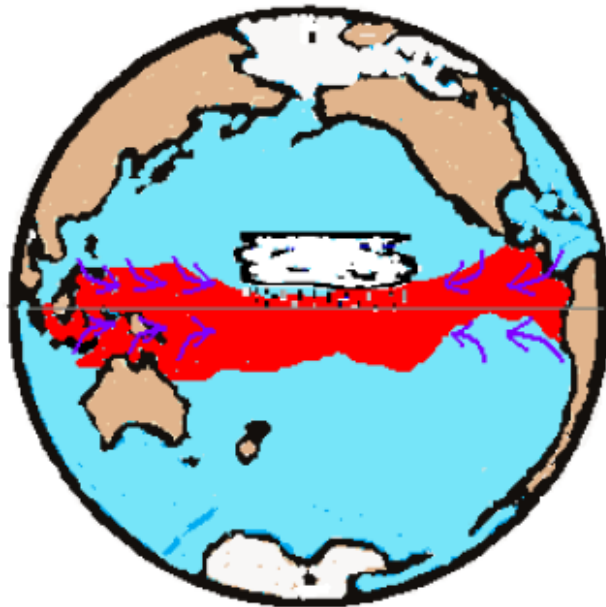
BECAUSE THE WARM  
WATER COVERS A  
GREATER SURFACE  
AREA, THERE IS MORE  
EVAPORATION, MORE  
CLOUDS AND MORE  
RAIN.



AS A RESULT, MORE  
HEAT THAN NORMAL IS  
DISCHARGED FROM  
THE TROPICAL PACIFIC  
OCEAN TO THE  
ATMOSPHERE.

Figure 1-14

# EL NIÑO CONDITIONS (c)



Warm Waters Are Red

Cool Waters Are Dark Blue

TO FEED THE RISING AIR THAT HAS NOW TRAVELED EAST, THE TRADE WINDS IN THE WESTERN TROPICAL PACIFIC REVERSE DIRECTION AND BECOME WESTERLIES.

THE TRADE WINDS IN THE EASTERN PACIFIC WEAKEN



Figure 1-15

**Some Lessons from Bob Tisdale's data set:**

**ENSO is not a true oscillations.**

**El Ninos are not regular occurrence.**

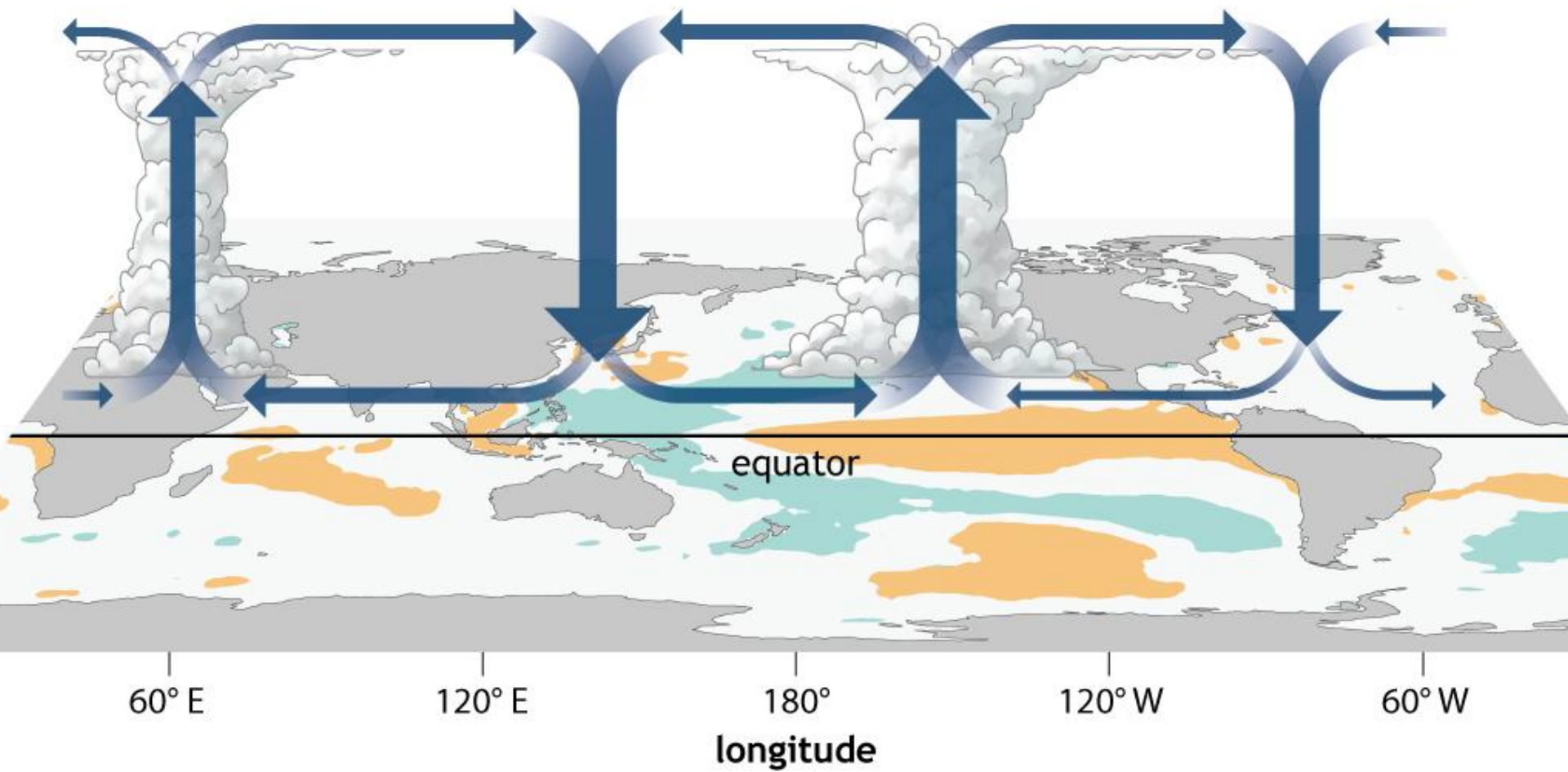
**Some El Ninos last a year, some two years, some, almost 3 years long.**

**La Nina is not the “Opposite” of El Nino**

**La Ninas are periods when there are strong trade winds and strong upwelling from the Americas' west coasts.**

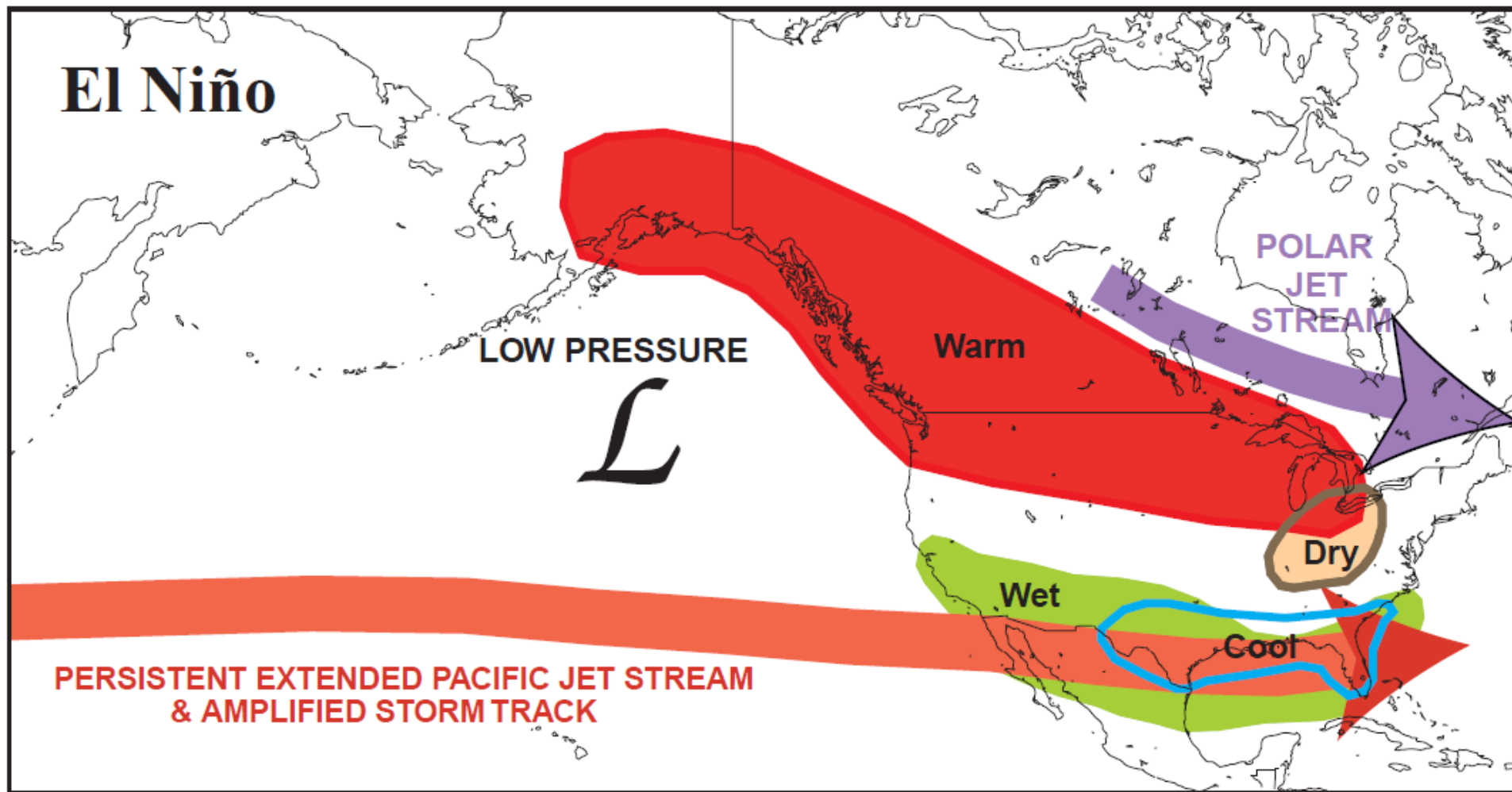


## El Niño conditions



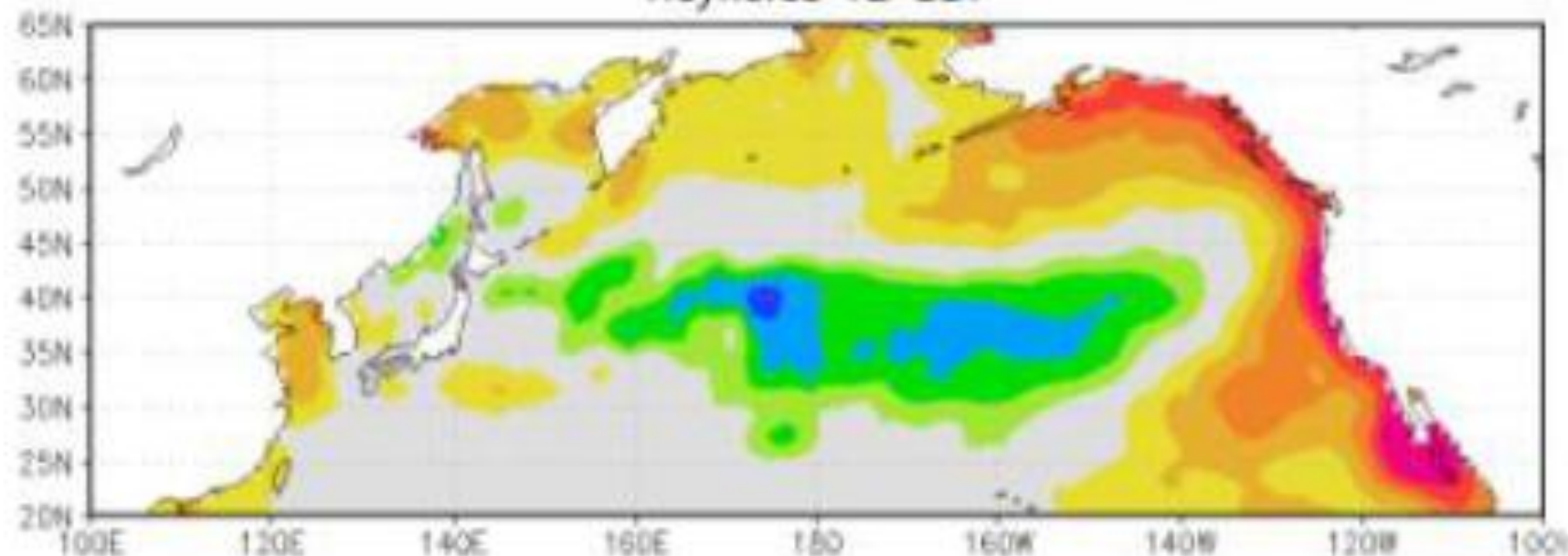
## El Niño's effects on Northern Hemisphere Weather Patterns

[http://www.cpc.ncep.noaa.gov/products/analysis\\_monitoring/ensocycle/nawinter.shtml](http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensocycle/nawinter.shtml)



## El Niño Sea Surface Temperature Anomaly Pattern In The North Pacific

sst-clim8209 May-Mar1998  
Reynolds v2 SST



## EAST PACIFIC EL NIÑO EVENTS



Warm Waters Are Red

Cool Waters Are Dark Blue

DURING EAST PACIFIC EL NIÑO EVENTS, THE WARM WATER REACHES THE COASTS OF THE AMERICAS.

EAST PACIFIC EL NIÑO EVENTS ARE TYPICALLY STRONGER THAN CENTRAL PACIFIC EL NIÑO—SO STRONG, THEY CAN RAISE EASTERN PACIFIC SEA SURFACE TEMPERATURES AS MUCH AS 5 DEG C (9 DEG F) IN SOME PLACES.



DURING SOME MAJOR EAST PACIFIC EL NIÑO EVENTS, THERE CAN BE MORE WARM WATER BELOW THE SURFACE IN THE EAST THAN THE WEST



DURING A VERY STRONG EL NIÑO, THERE CAN BE MORE WARM WATER BELOW THE SURFACE IN THE EASTERN PACIFIC THAN IN THE WEST.

Figure 1-17

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Bob Tisdale

## TRANSITION FROM EL NIÑO TO ENSO-NEUTRAL (A)



Warm Waters Are Red

Cool Waters Are Dark Blue

EL NIÑO EVENTS  
TYPICALLY PEAK IN  
DECEMBER AND  
JANUARY.

AS THE TROPICAL PACIFIC  
TRANSITIONS FROM EL  
NIÑO TO ENSO-NEUTRAL  
STATES, THE TRADE  
WINDS RESUME THEIR  
NORMAL EAST TO WEST  
DIRECTION.



ANY WARM SURFACE  
WATERS LEFT OVER FROM  
THE EL NIÑO ARE  
RETURNED TO THE  
WESTERN TROPICAL  
PACIFIC BY THE TRADE  
WINDS.

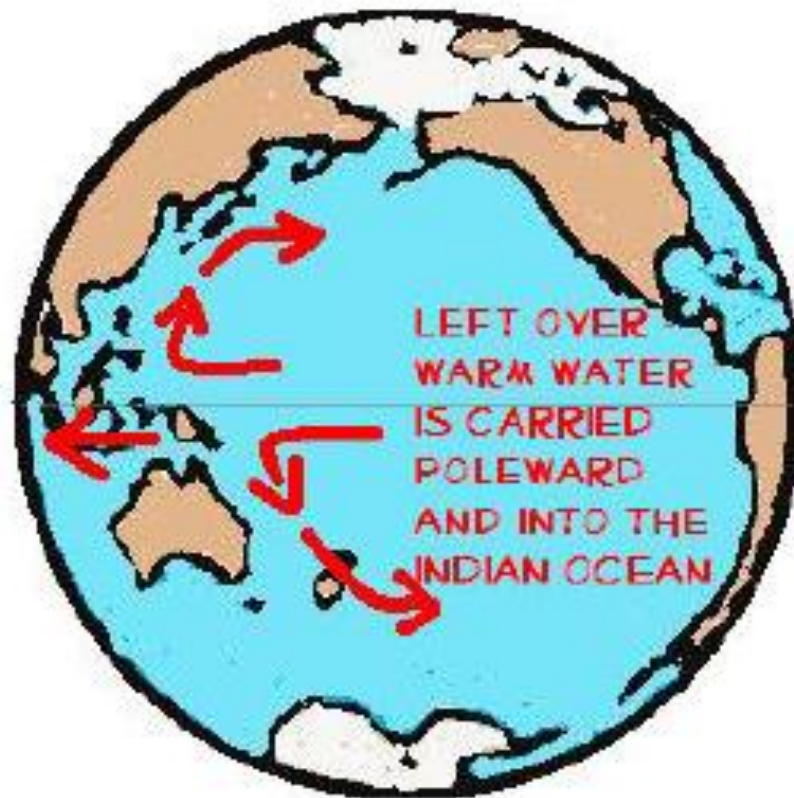
Figure 1-18

Bob Tisdale

HHH



## TRANSITION FROM EL NIÑO TO ENSO-NEUTRAL (C)



SOME OF THE WARM WATER LEFT OVER FROM THE EL NIÑO HELPS TO RECHARGE THE PACIFIC WARM POOL FOR THE NEXT EL NIÑO.

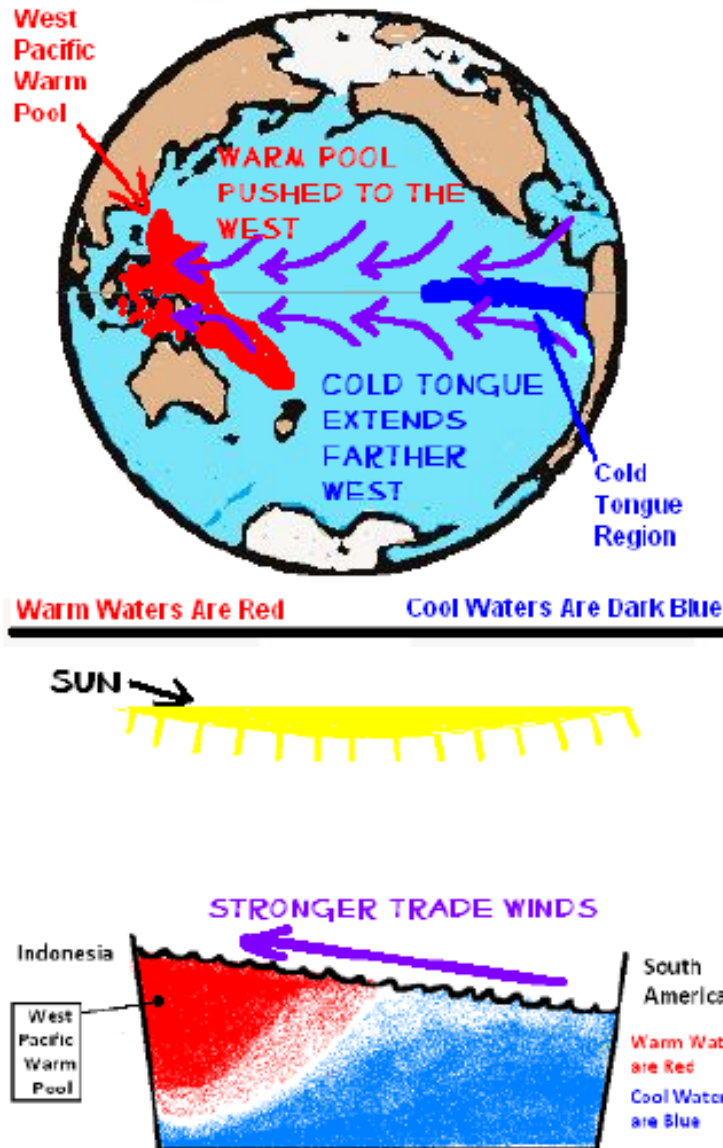
THE REMAINDER IS CARRIED POLEWARD AND INTO THE INDIAN OCEAN.

Figure 1-20

HHH

Bob Tisdale

## LA NIÑA CONDITIONS (A)



TRADE WINDS ARE STRONGER THAN NORMAL DURING A LA NIÑA.

THE STRONGER TRADE WINDS PUSH THE WARM WATERS FARTHER TO THE WEST IN THE TROPICAL PACIFIC.

AND THE COLD TONGUE IN THE EAST EXTENDS FARTHER TO THE WEST, TOO.

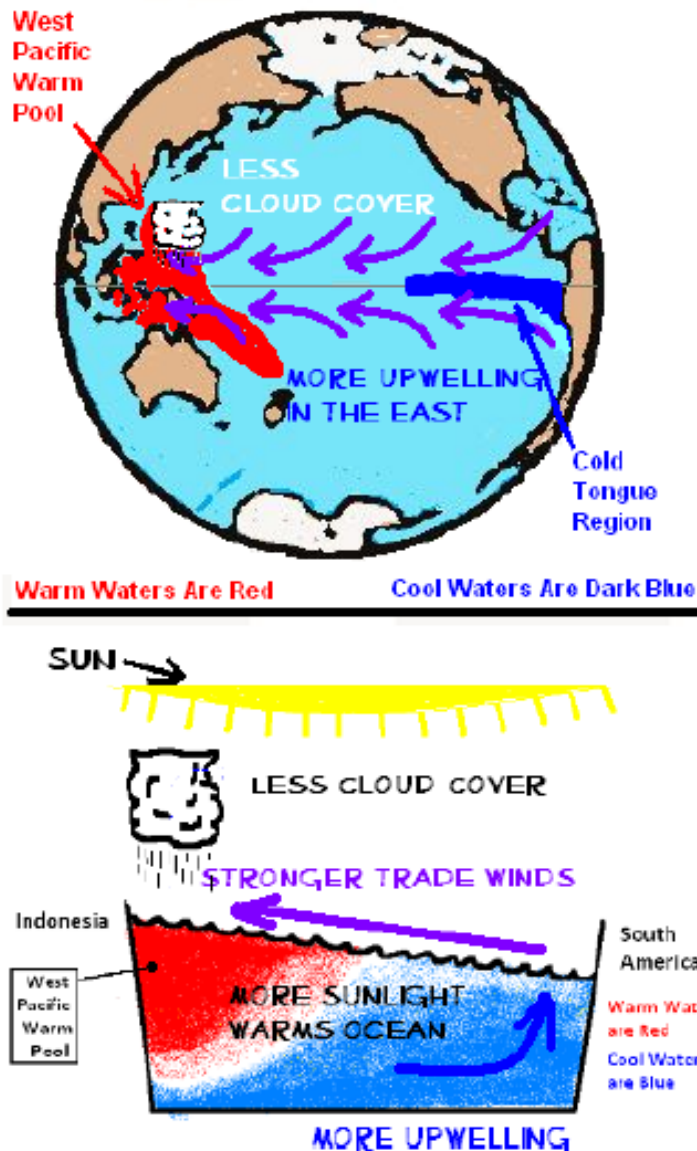
LA NIÑA EVENTS ARE BASICALLY AN EXAGGERATED ENSO-NEUTRAL STATE.

BUT THEY ARE IMPORTANT.

Figure 1-21  
HHH

Bob Tisdale

## LA NIÑA CONDITIONS (B)



THE STRONGER TRADE WINDS CAUSE MORE COOL SUBSURFACE WATER TO BE DRAWN TO THE SURFACE IN THE EAST (MORE UPWELLING).

AND THE STRONGER TRADE WINDS RESULT IN LESS CLOUD COVER.

WITH LESS CLOUD COVER, MORE VISIBLE SUNLIGHT (DOWNWARD SHORTWAVE RADIATION) REACHES THE SURFACE OF THE TROPICAL PACIFIC. SUNLIGHT PENETRATES AS DEEP AS 100 METERS, DECREASING IN STRENGTH WITH DEPTH.

THE ADDITIONAL SUNLIGHT WARMS THE TROPICAL PACIFIC MORE THAN NORMAL.

You heard the words,  
“Sunlight penetrates  
the ocean water”  
in the first lesson...

Figure 1-22

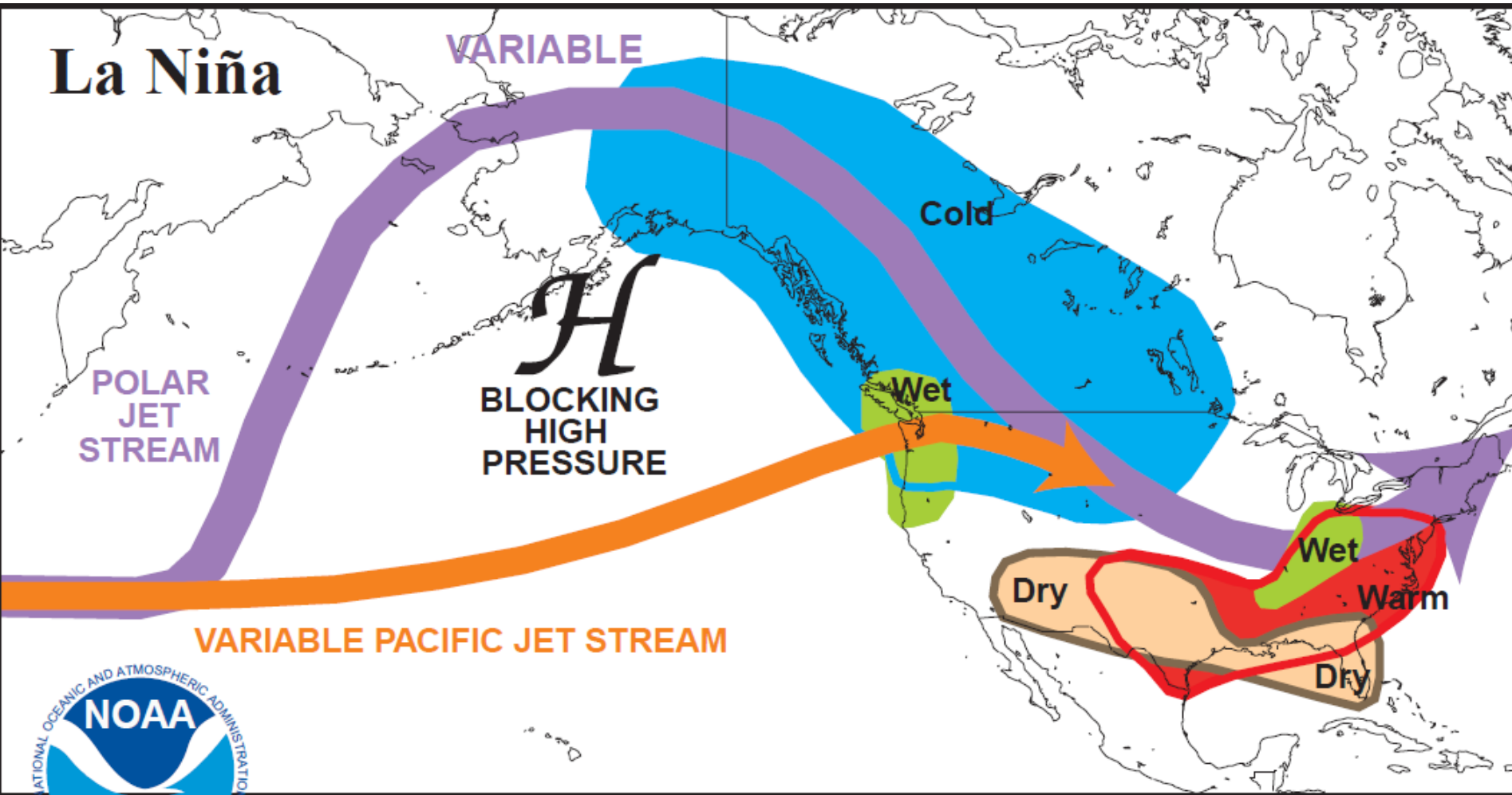
HHH

Bob Tisdale

El Nino's counterpart is La Nina.

[http://www.cpc.ncep.noaa.gov/products/analysis\\_monitoring/ensocycle/nawinter.shtml](http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensocycle/nawinter.shtml)

La Nina results in dry from Arizona to Florida

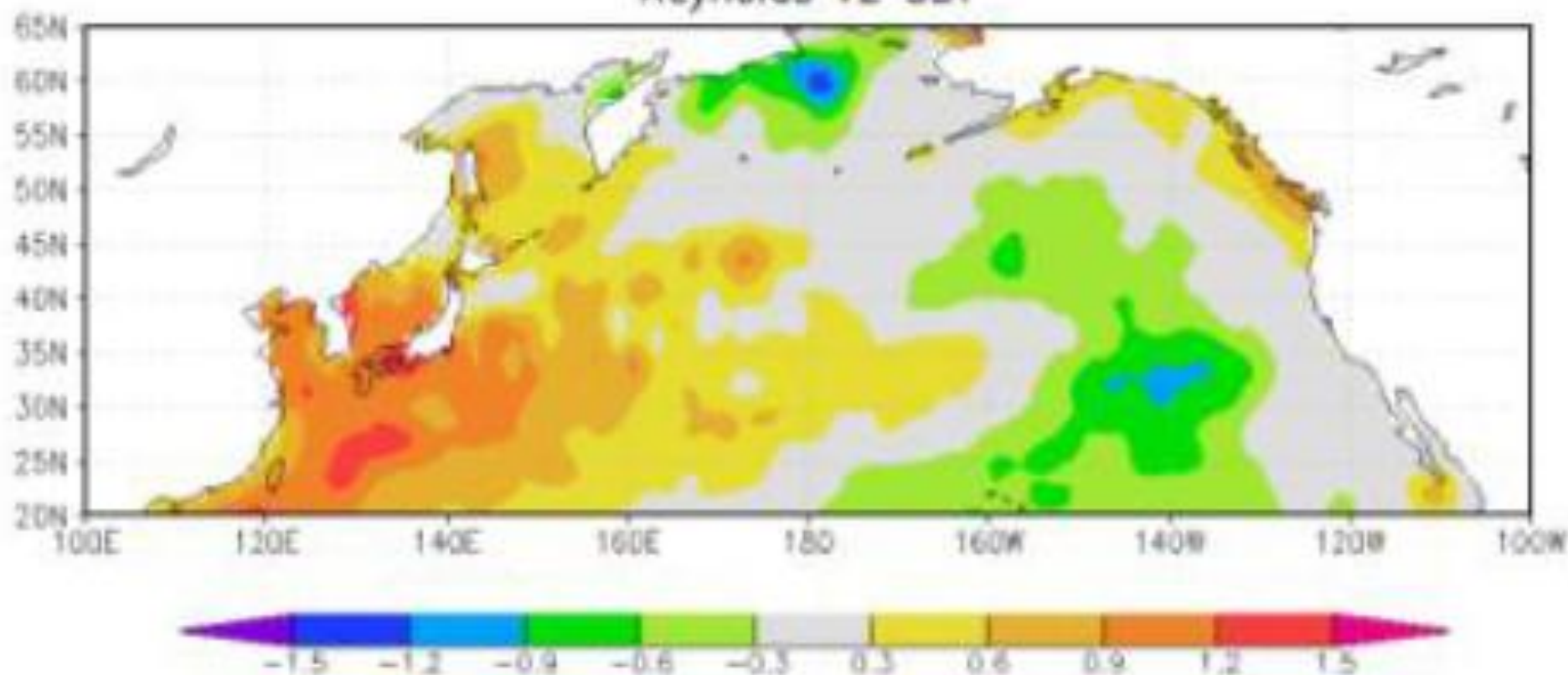


Climate Prediction Center/NCEP/NWS



# La Niña Sea Surface Temperature Anomaly Pattern In The North Pacific

sst-clim8209 Mar-Jan1999  
Reynolds v2 SST



Maps Created at KIMI Climate Explorer

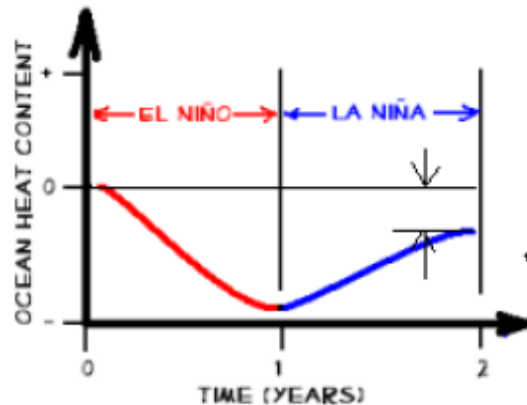
Figure 4-73

Bob Tisdale



# LA NIÑA RECHARGES THE HEAT DISCHARGED BY THE EL NIÑO

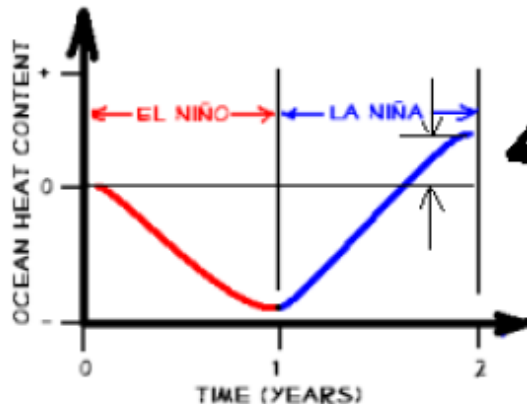
TROPICAL PACIFIC OCEAN HEAT CONTENT



BECAUSE MORE SUNLIGHT REACHES AND WARMS THE TROPICAL PACIFIC DURING THE LA NIÑA, OCEAN HEAT CONTENT THERE INCREASES, REPLACING THE HEAT GIVEN OFF DURING THE EL NIÑO.

MOST TIMES, LESS HEAT IS SUPPLIED DURING THE LA NIÑA THAN WAS DISCHARGED DURING THE EL NIÑO.

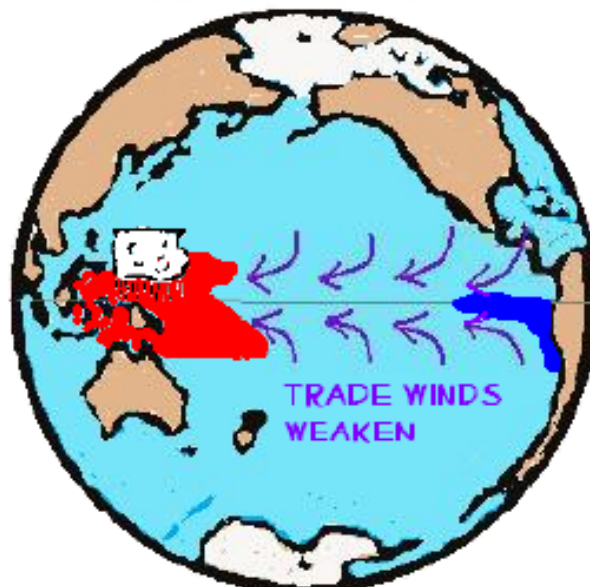
TROPICAL PACIFIC OCEAN HEAT CONTENT



OCCASIONALLY, THE LA NIÑA SUPPLIES MORE HEAT THAN WAS DISCHARGED BY THE EL NIÑO.

THAT "OVERCHARGING" OCCURRED DURING THE 1973/74/75/76 AND 1995/96 LA NIÑA EVENTS!

# TRANSITION FROM LA NIÑA TO ENSO-NEUTRAL



Warm Waters Are Red

Cool Waters Are Dark Blue

LA NIÑA EVENTS ALSO  
TYPICALLY PEAK IN  
DECEMBER AND  
JANUARY.

AS THE TROPICAL PACIFIC  
TRANSITIONS FROM LA  
NIÑA TO ENSO-NEUTRAL  
STATES, THE TRADE  
WINDS WEAKEN TO THEIR  
NORMAL STRENGTH.



UPWELLING IN THE EAST  
DECREASES AND THE  
SEA SURFACE  
TEMPERATURES WARM IN  
THE CENTRAL AND  
EASTERN EQUATORIAL  
PACIFIC, ALL RETURNING  
TO NORMAL CONDITIONS.

Figure 1-24

HHH

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## LA NIÑA IS NOT THE OPPOSITE OF EL NIÑO

### BEFORE EL NIÑO



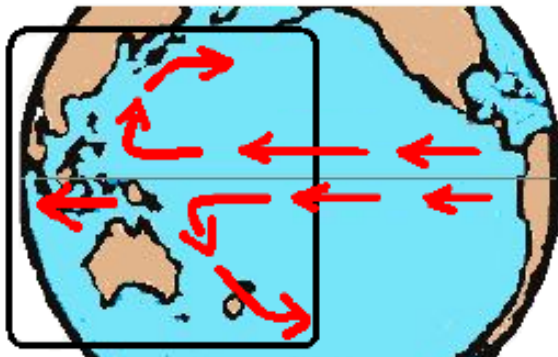
BEFORE THE EL NIÑO, MOST OF THE WARM WATER THAT WILL BE RELEASED BY THE EL NIÑO IS BELOW THE SURFACE AND EXCLUDED FROM SURFACE TEMPERATURE MEASUREMENTS.

### DURING EL NIÑO



DURING THE EL NIÑO, THE WARM WATER FROM BELOW THE SURFACE OF THE PACIFIC WARM POOL THAT HAD BEEN EXCLUDED FROM THE SURFACE TEMPERATURE RECORD IS NOW SPREAD ACROSS THE SURFACE AND INCLUDED IN THE SURFACE TEMPERATURE RECORD.

### AFTER EL NIÑO



AFTER THE EL NIÑO, THE WARM WATER IS RETURNED TO THE WEST WHEN FLOW RETURNS TO ITS NORMAL DIRECTION. MUCH OF THE WARM WATER REMAINS ON THE SURFACE AND CONTINUES TO BE INCLUDED IN THE SURFACE TEMPERATURE RECORD.

Figure 1-25

Bob Tisdale

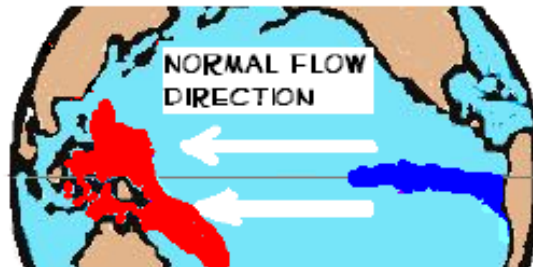
## LA NIÑA IS NOT THE OPPOSITE OF EL NIÑO

### BEFORE LA NIÑA



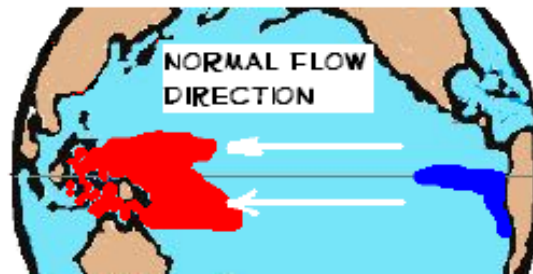
BEFORE THE LA NIÑA, THE SEA SURFACE TEMPERATURE IN THE EASTERN EQUATORIAL PACIFIC IS DICTATED BY THE TEMPERATURE OF THE UPWELLED WATERS.

### DURING LA NIÑA



DURING THE LA NIÑA, STRONGER TRADE WINDS INCREASE THE AMOUNT OF UPWELLING, WHICH EXPANDS THE SURFACE AREA OF COOLER WATERS IN THE EAST. THE WARM POOL IS PUSHED TO THE WEST. THE FLOW IS IN THE NORMAL DIRECTION.

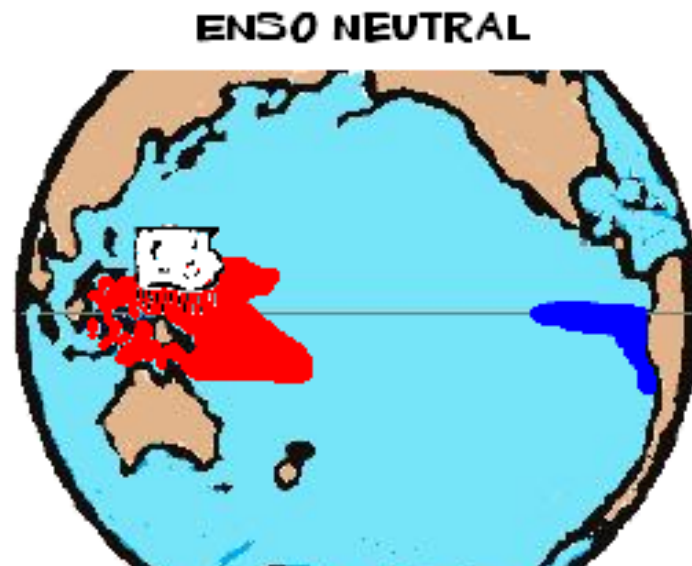
### AFTER LA NIÑA



AFTER THE LA NIÑA, THE TRADE WINDS RELAX BACK TO THEIR NORMAL STRENGTH. THE UPWELLING OF COOL WATER SLOWS. THE WARM POOL EXPANDS EAST.

UNLIKE AN EL NIÑO, THERE ARE NO "LEFTOVER" COOL SURFACE WATERS IN THE EASTERN TROPICAL PACIFIC THAT NEED TO BE RETURNED TO THE WEST. THE TRADE WINDS HAVE BEEN PUSHING THE WATER FROM EAST TO WEST ALL ALONG, THROUGH THE ENSO-NEUTRAL AND LA NIÑA PHASES.

## WHY GLOBAL SURFACE TEMPERATURES WARM DURING AN EL NIÑO (A)



AN EL NIÑO RELEASES  
HEAT INTO THE  
ATMOSPHERE. BUT THAT  
IS NOT WHY GLOBAL  
SURFACE TEMPERATURES  
WARM IN RESPONSE TO  
THE EL NIÑO.

BECAUSE THE PACIFIC  
WARM POOL IS SO WARM, A  
LOT OF MOISTURE IS  
PUMPED INTO THE  
ATMOSPHERE THERE.

BECAUSE THE PACIFIC  
WARM POOL IS ALSO SO  
LARGE, IT IS ONE OF THE  
DRIVING FORCES OF  
GLOBAL CLIMATE.

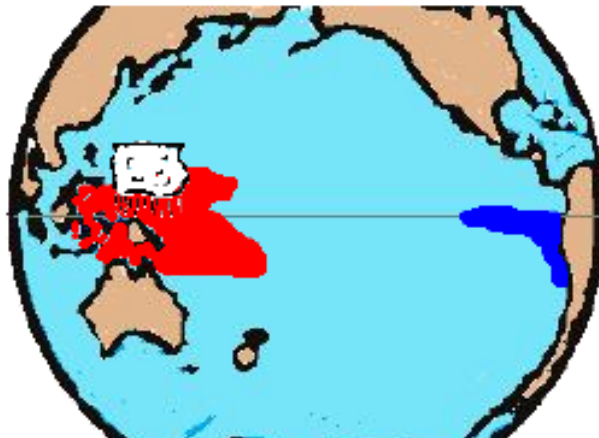
Figure 1-27

Bob Tisdale



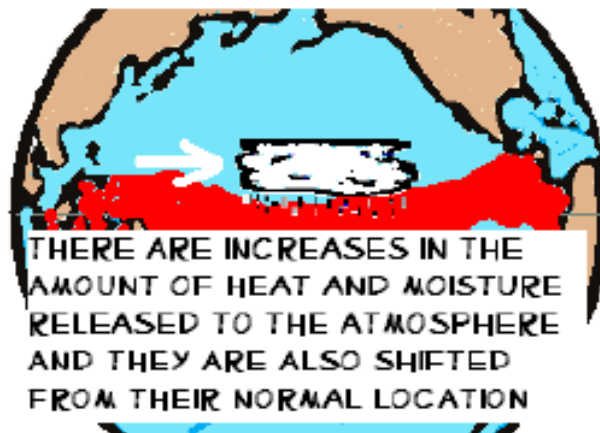
# WHY GLOBAL SURFACE TEMPERATURES WARM DURING AN EL NIÑO

## ENSO NEUTRAL



THE "NORMAL" STATE OF GLOBAL CLIMATE IS IN PART DEPENDENT ON THE LOCATION OF ALL OF THE MOISTURE AND HEAT BEING RELEASED FROM THE WESTERN TROPICAL PACIFIC.

## EL NIÑO



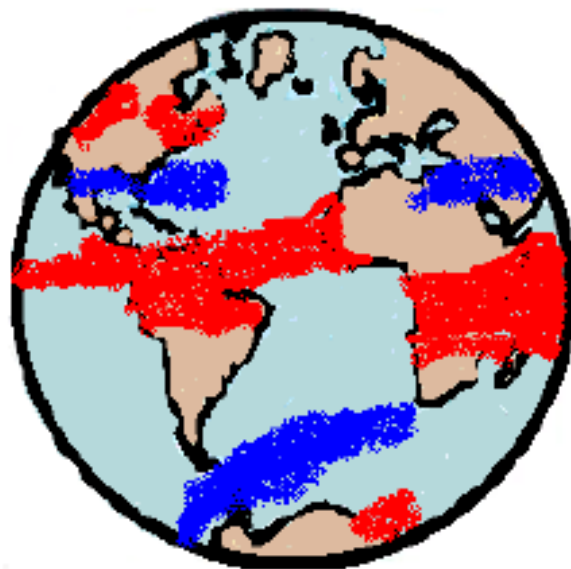
THEN, DURING THE EL NIÑO, NOT ONLY IS MORE HEAT AND MOISTURE BEING RELEASED TO THE ATMOSPHERE, BUT THAT RELEASE OF HEAT AND MOISTURE HAS BEEN SHIFTED ABOUT A QUARTER OF THE WAY (OR MORE) AROUND THE GLOBE.

Figure 1-28

HHH

# WHY GLOBAL SURFACE TEMPERATURES WARM DURING AN EL NIÑO

CORRELATION OF SURFACE  
TEMPERATURE WITH ENSO INDEX  
(3-MONTH LAG)



RESPONSE DURING EL NIÑO

RED --> AREAS THAT WARM

BLUE--> AREAS THAT COOL

THE INCREASED RELEASE OF HEAT AND MOISTURE AND THEIR RELOCATION DURING AN EL NIÑO CAUSE CHANGES IN ATMOSPHERIC CIRCULATION PATTERNS.

IT IS THOSE CHANGES IN ATMOSPHERIC CIRCULATION DURING AN EL NIÑO THAT CAUSE SURFACE TEMPERATURES OUTSIDE OF THE EASTERN TROPICAL PACIFIC TO WARM IN SOME PLACES AND TO COOL IN OTHERS.

SINCE THE AREAS THAT WARM ARE GREATER THAN THOSE THAT COOL, GLOBAL SURFACE TEMPERATURES RISE DURING AN EL NIÑO.

MORE AREAS AROUND THE GLOBE COOL THAN WARM DURING A LA NIÑA SO GLOBAL SURFACE TEMPERATURES COOL.

Why we use anomalies or departures from a mean to help describe weather and climate variations.

Global Sea Surface Temperatures (Reynolds OI.v2)  
Nov 1981 to Nov 2011

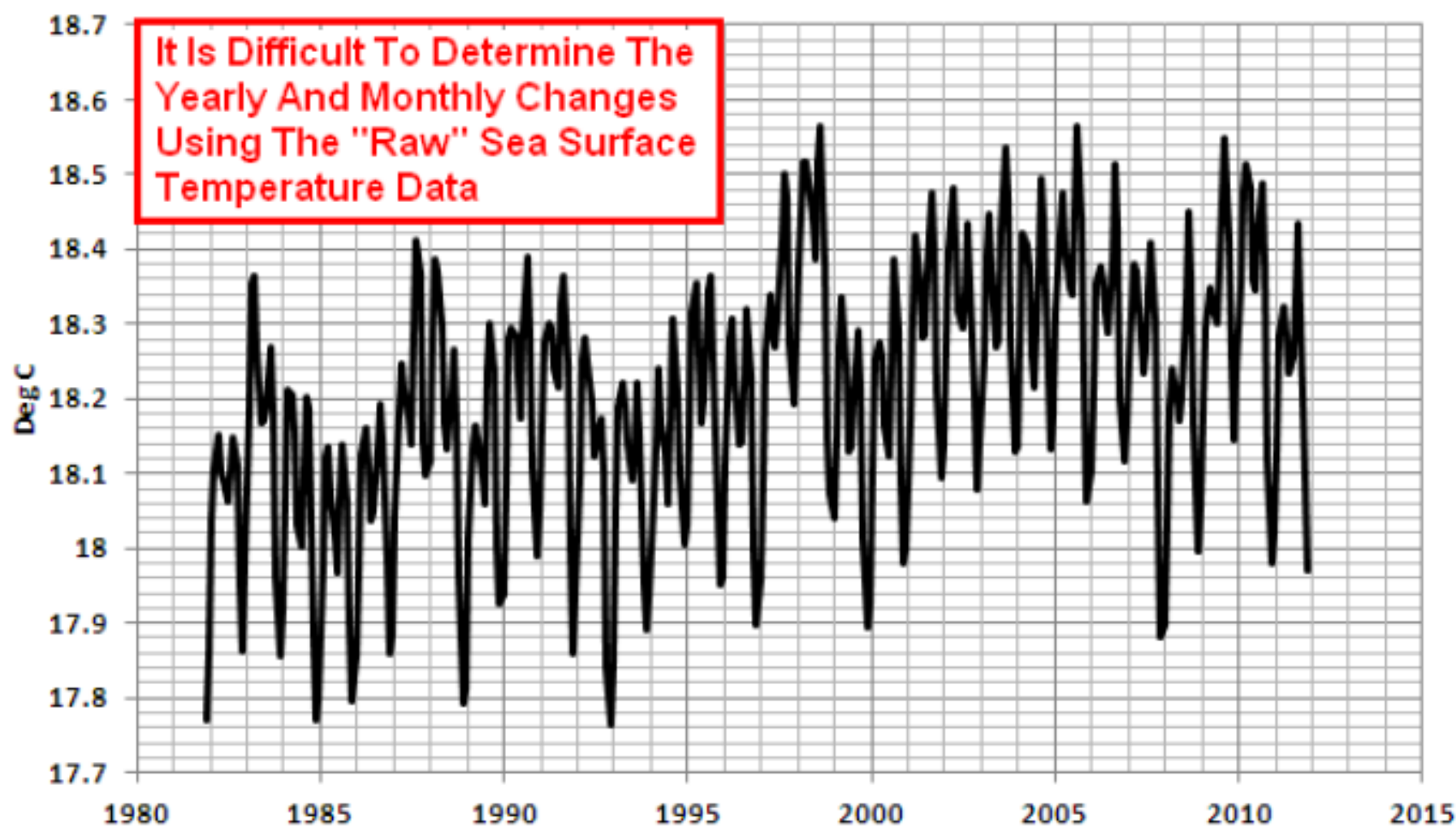


Figure 2-17

## Sea Surface Temperature Comparison (Reynolds OI.v2)

Northern Hemisphere, Southern Hemisphere

Nov 1982 to Nov 2011

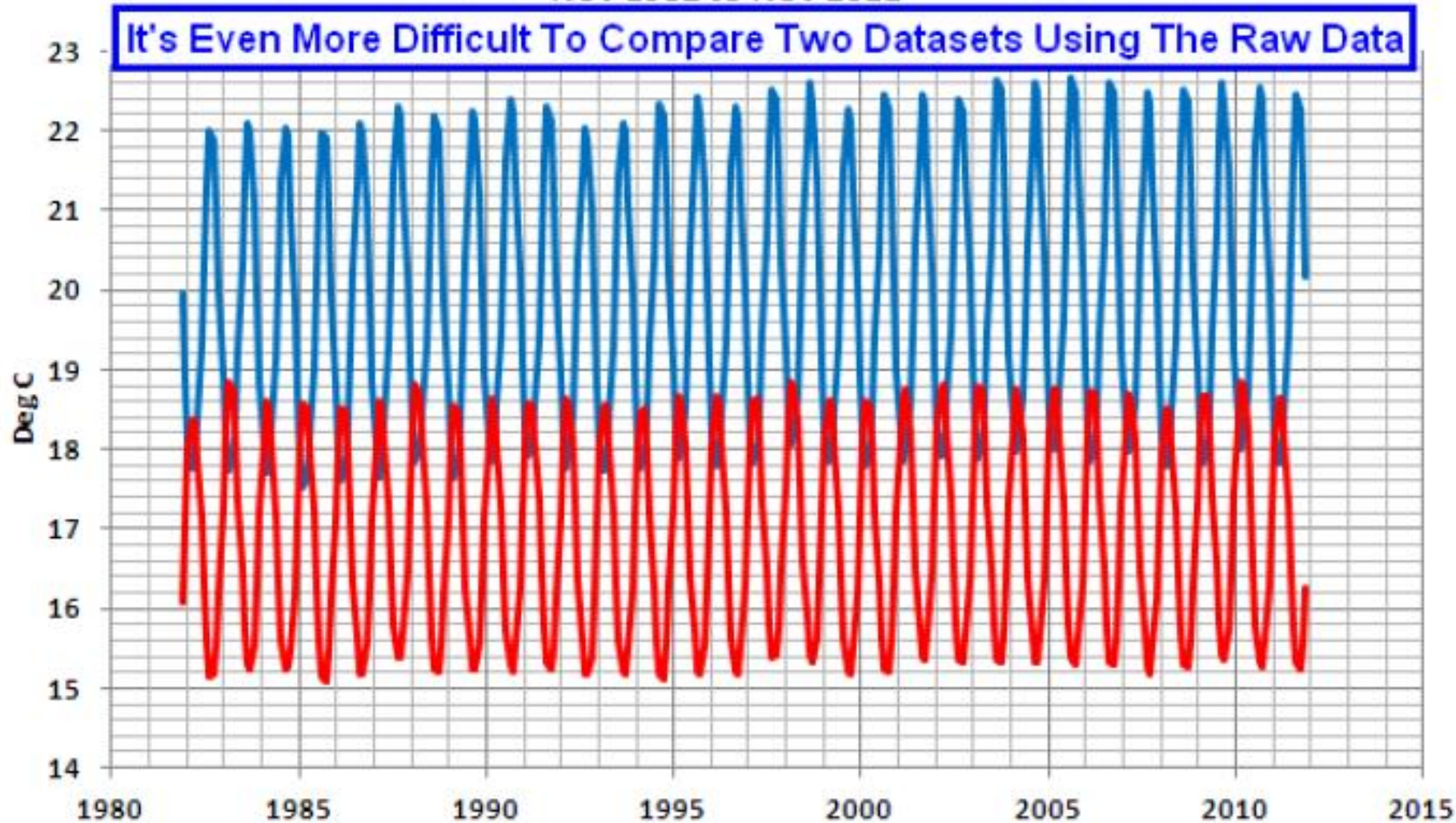


Figure 2-18



## Sea Surface Temperature Anomaly Comparison (Reynolds OI.v2)

Northern Hemisphere, Southern Hemisphere

Nov 1981 to Nov 2011

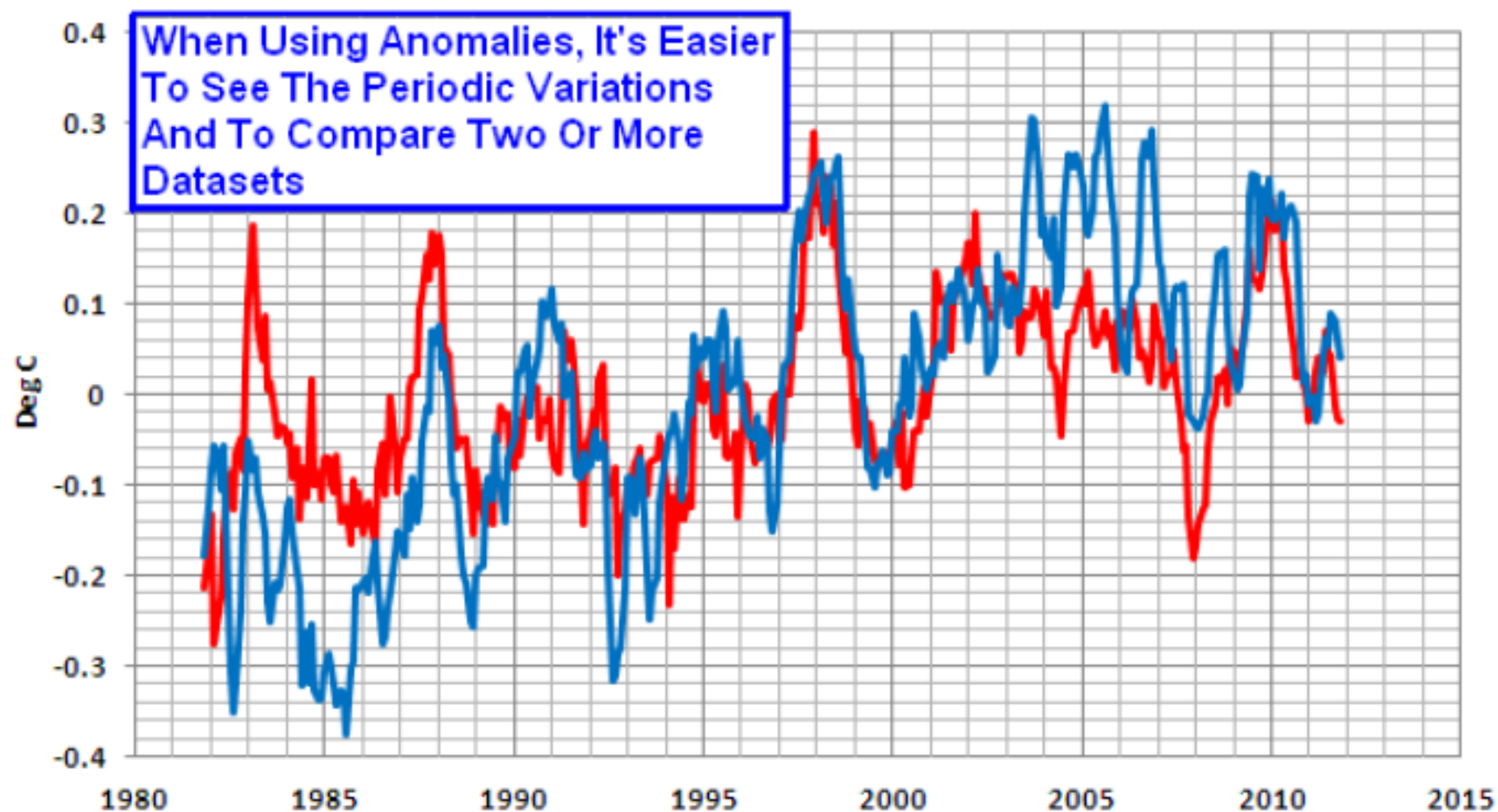


Figure 2-19

Reynolds OI.v2 NINO3.4 Region (5S-5N, 170W-120W)

Sea Surface Temperature & Base Period Average Sea Surface Temperature

Jan 1995 to Jan 2005

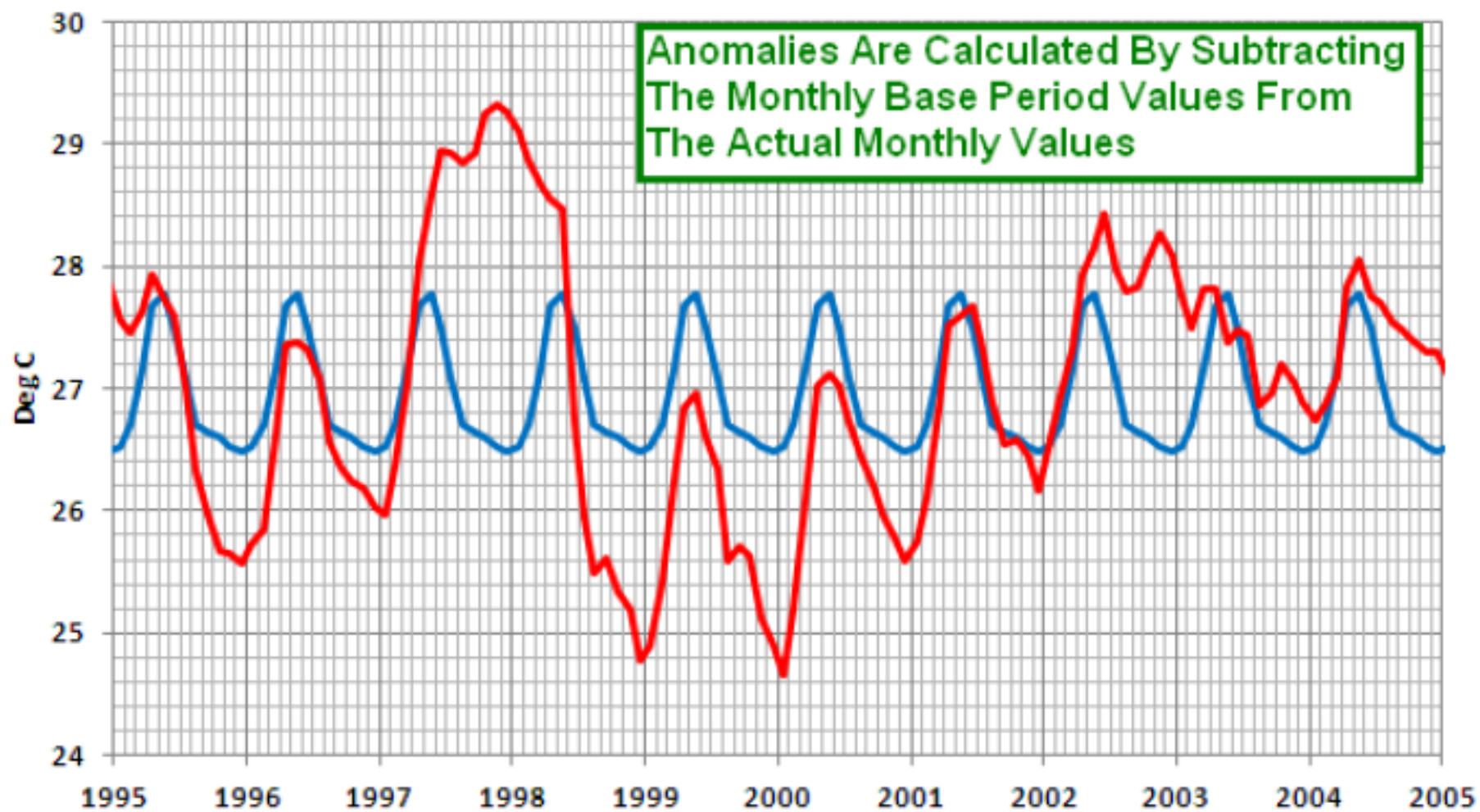


Figure 2-20

**NINO3.4 Sea Surface Temperature Anomalies**  
**Jan 1995 to Jan 2005**

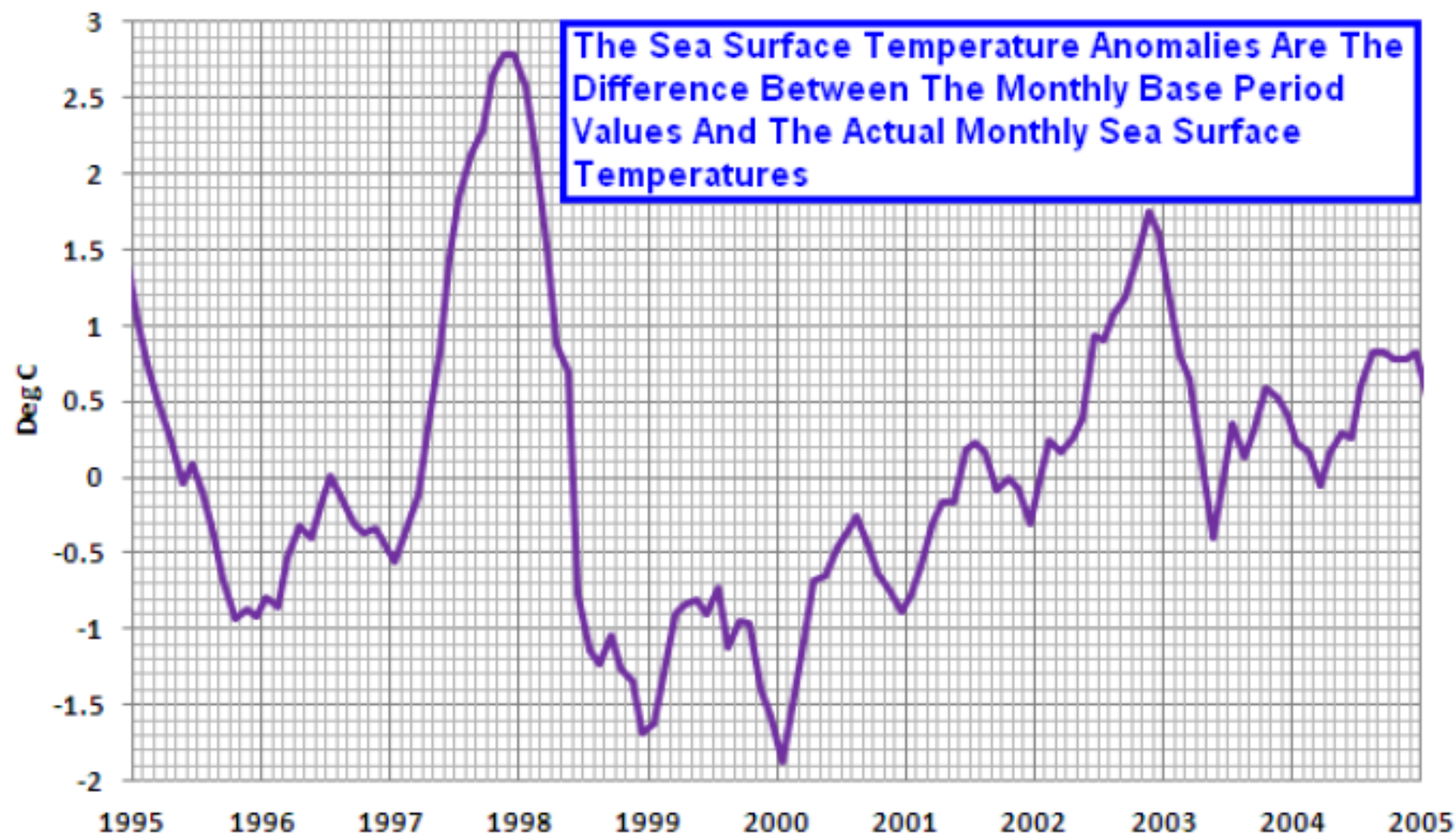


Figure 2-21

Bob Tisdale

Annual Cycle In Base Year Sea Surface Temperatures  
Global, Northern Hemisphere, Southern Hemisphere

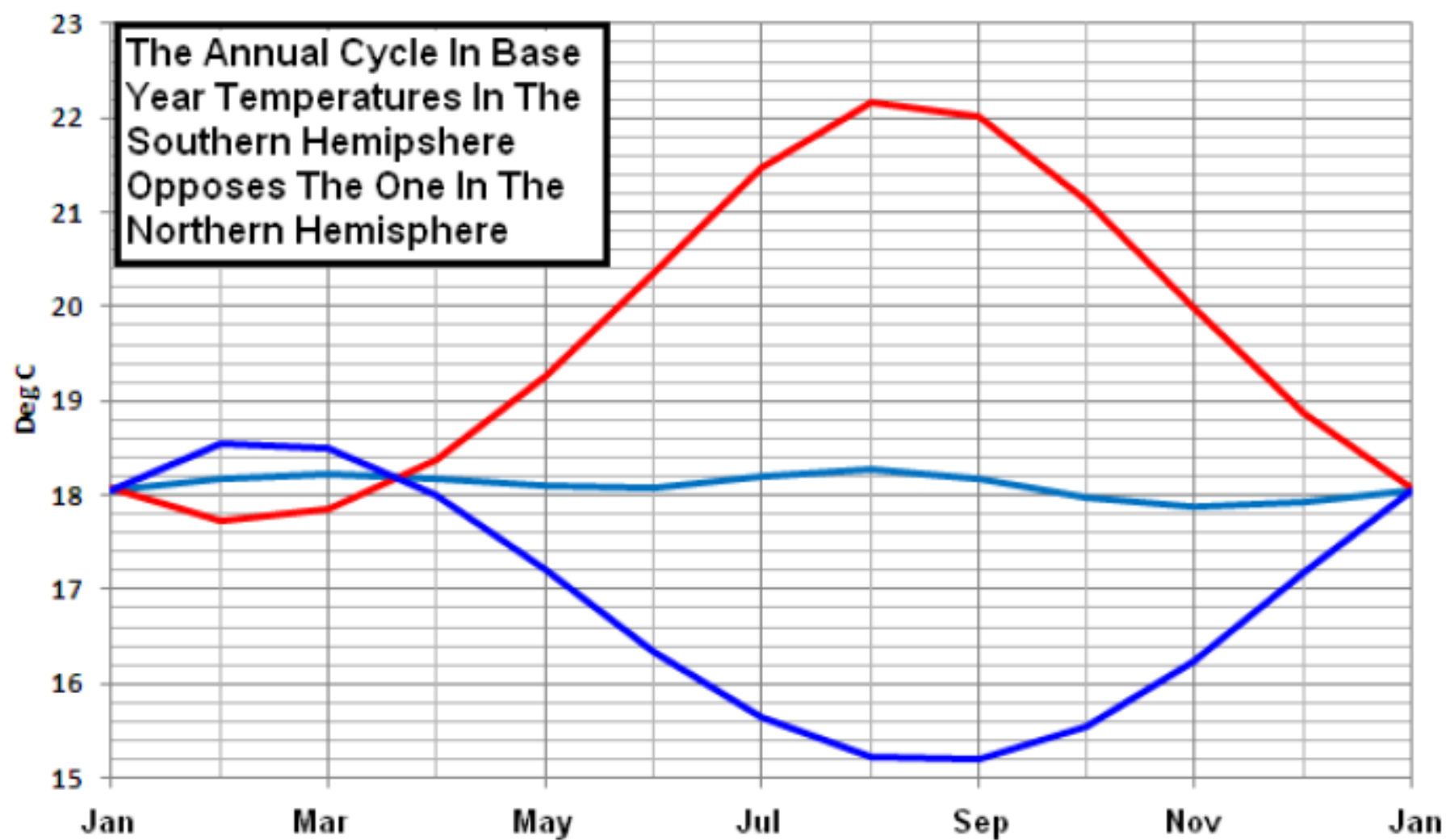


Figure 2-22

### Annual Cycle In Base Year Sea Surface Temperatures

NINO 3.4 Region (5S-5N, 170W-120W),

Pacific Warm Pool (20S-20N, 120E-180E)

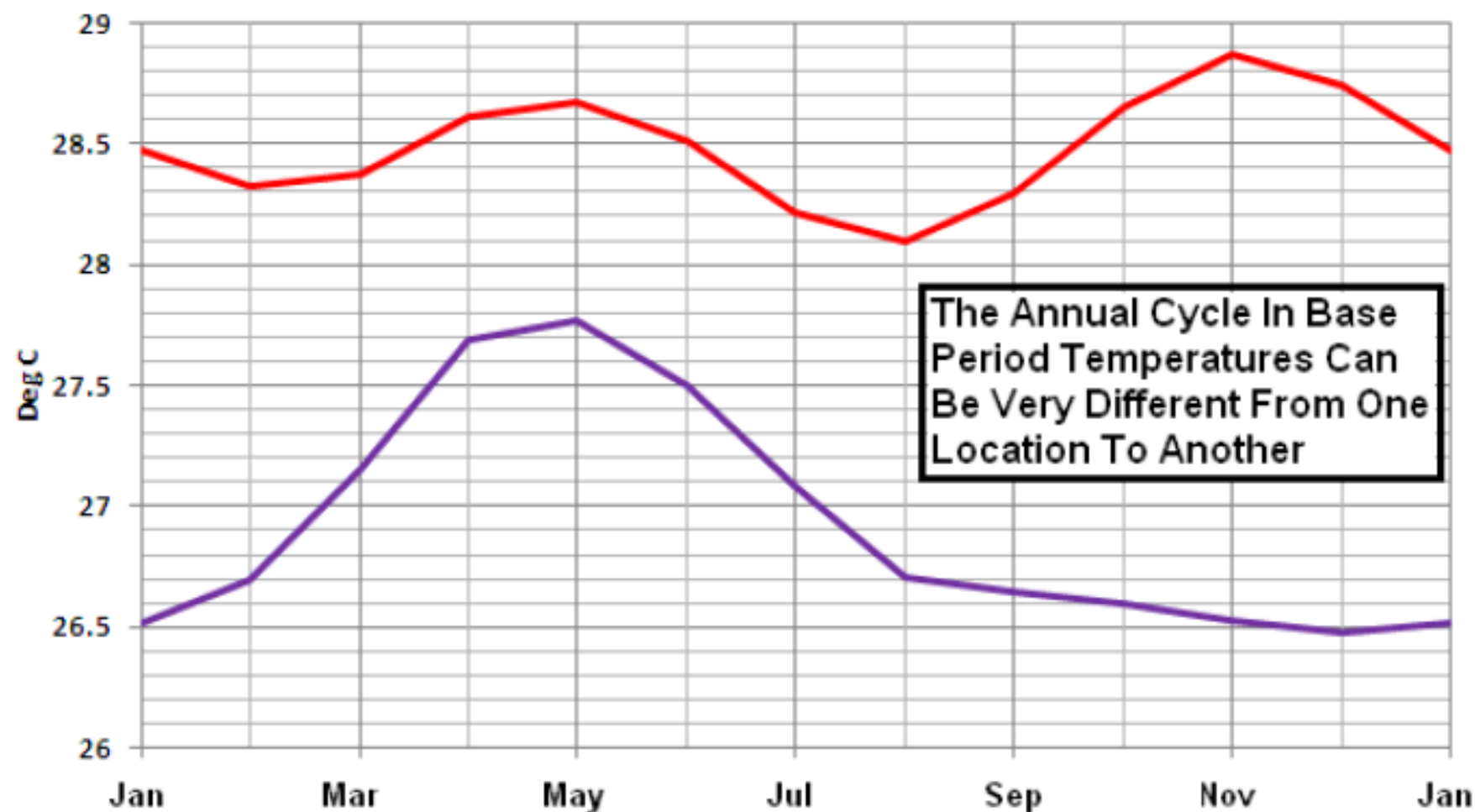


Figure 2-23

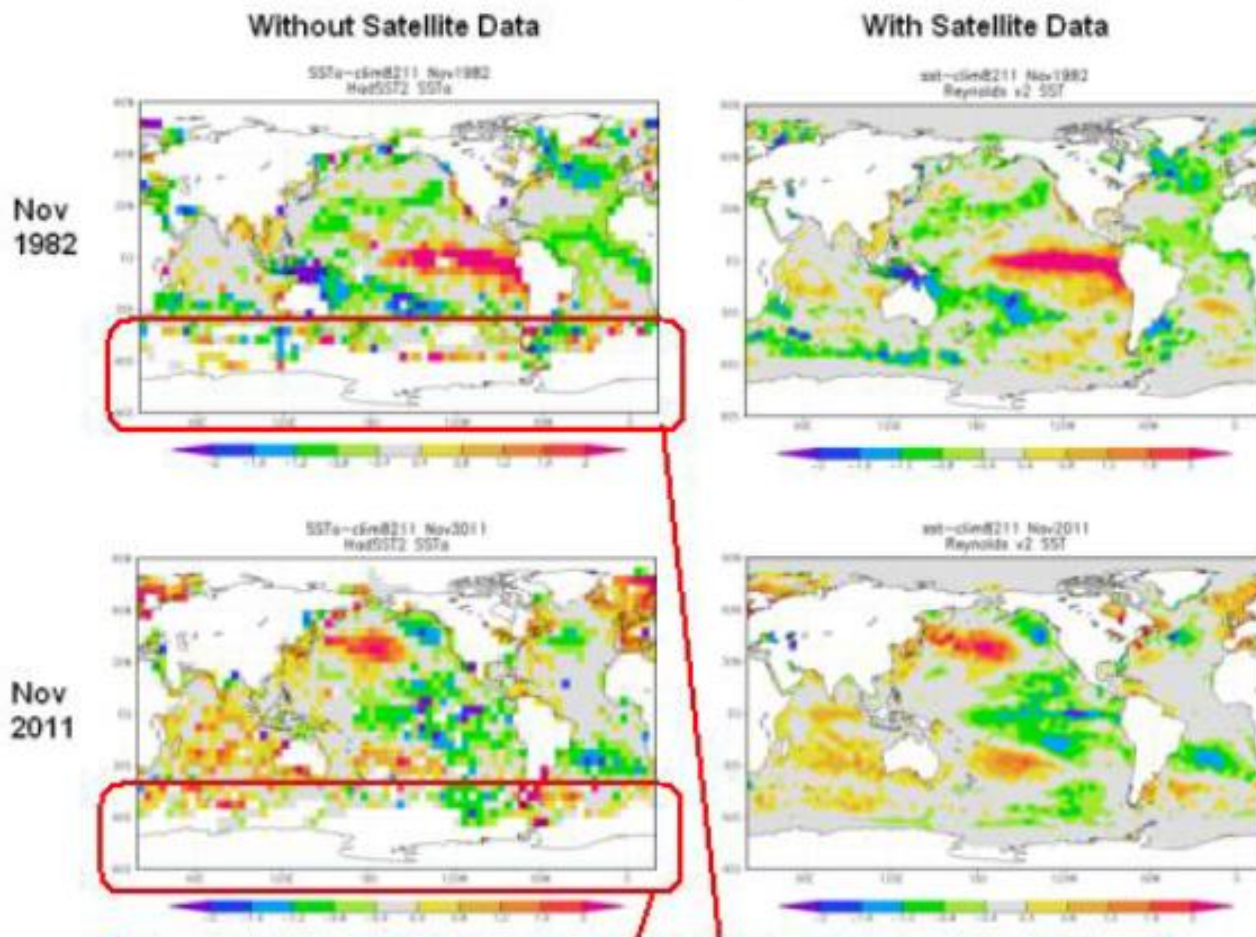
Bob Tisdale



Next Slide...

Why do they do this?

## Global Sea Surface Temperature Coverage - Datasets With and Without Satellite-Based Measurements



Sea Surface Temperature Datasets Like HADSST2 And HADSST3 Exclude Major Portions Of The Southern Ocean, Which Has Cooled Since 1982. That Causes A Bias Toward Warming In Global Data.

Maps Created At KIMI Climate Explorer

Figure 2-25

Bob Tisdale