

# Uncertainty in Climate Science

Good  
Decisions...

Most of the problems  
in life are because  
of two reasons:

We act  
*without thinking or*  
We keep thinking  
*without acting.*

Require Good  
Evidence...

By

Marcia Glaze Wyatt

# Seeing is Believing



August 20, 2015

Marcia Glaze Wyatt

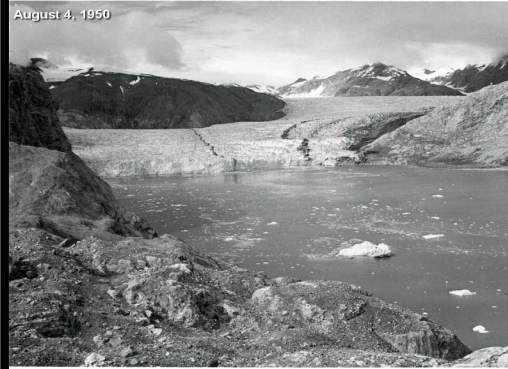
2

# Or Uncertainty:

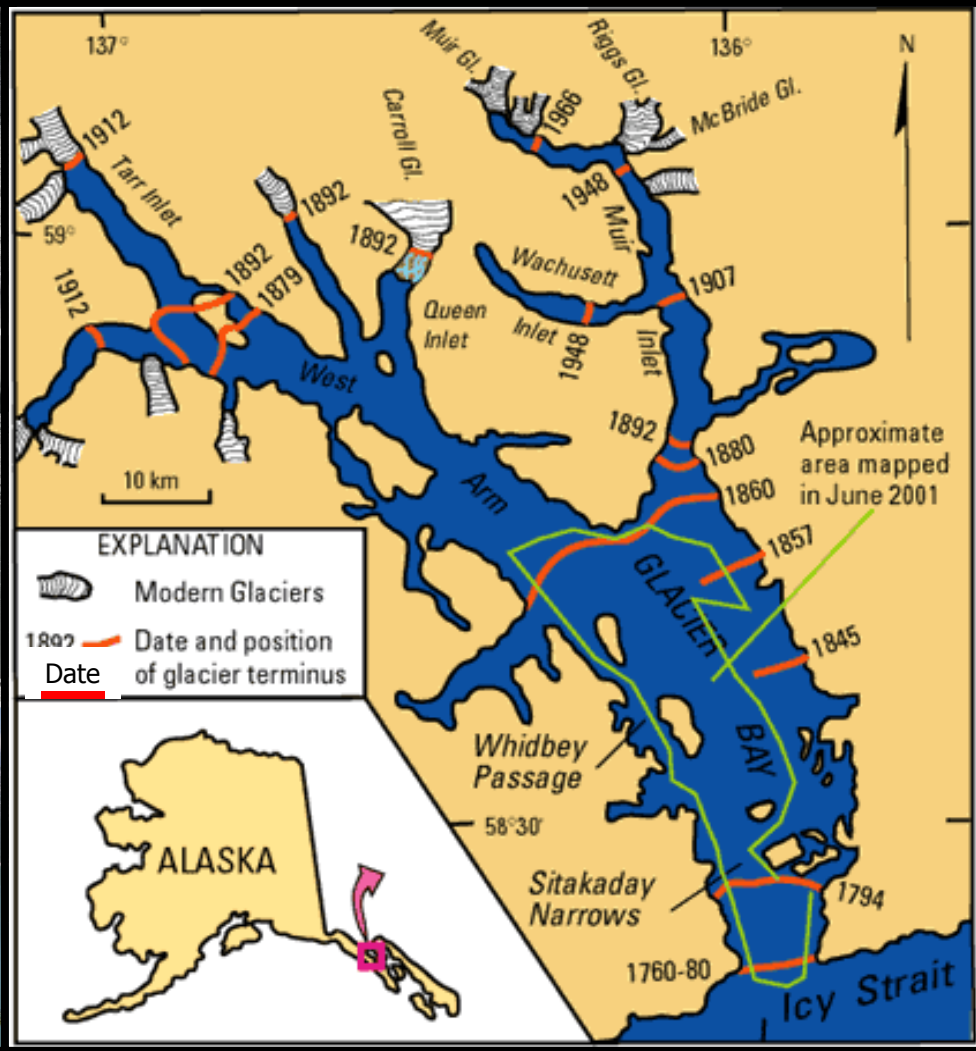
August 1941



August 1950



August 2004



August 20, 2015

Marcia Glaze Wyatt

References: WUWT discussion; USGS maps and descriptions



# Seeing is Believing



# Or Uncertainty:



“Experts” differ on conclusions

# And the Experts Say



**THE SCIENTIFIC DEBATE  
ON GLOBAL WARMING  
IS OVER.**

The most comprehensive study to date has found

**97%**

of published climate papers with a position  
on human-caused global warming **AGREE:**

**GLOBAL WARMING IS REAL,  
AND WE ARE THE CAUSE.**

TheConsensusProject.com

 the  
consensus  
project

# Which Experts?



“Experts” differ on conclusions

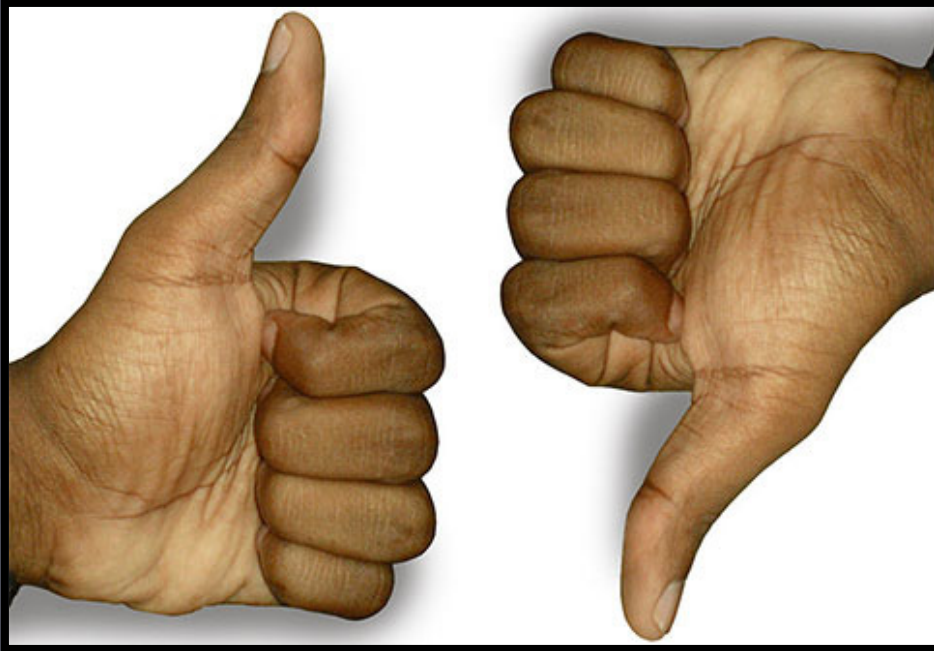
# Scientists Agree:



- Temperatures have increased since 1850
  - CO<sub>2</sub> has increased since 1850
  - CO<sub>2</sub> is an infrared warmer
- With no +/- feedbacks, 2x CO<sub>2</sub> → 1.1°C increase (~2°F)



# But They Disagree On:



- If there really is a problem
- Consequences of proposed solutions

- How much T has risen
- T increase due to CO<sub>2</sub>
- T increase due to urbanization
- Climate sensitivity
- Nature's Influence
- Earth's intrinsic dynamics
- Extreme-weather correlation
- Model Representation
- Integrity of Data
- Projected Warming Trend

# Let's Pull Back the Curtain

## The "Oz" of Uncertainty



Fear Thrives on Credulity  
And Retreats into Proper Proportion with Scrutiny

# What is the Evidence?

Homework Assignment: Find it!

CATASTROPHIC ANTHROPOGENIC  
GLOBAL WARMING EVIDENCE

Before I "act",  
I want  
evidence...

Your  
assignment:  
*find* some!



?

# Hard Evidence Must Exist!



"The science is settled"

"Climate change is happening, humans are causing it, and I think this is perhaps the most serious environmental issue facing us."

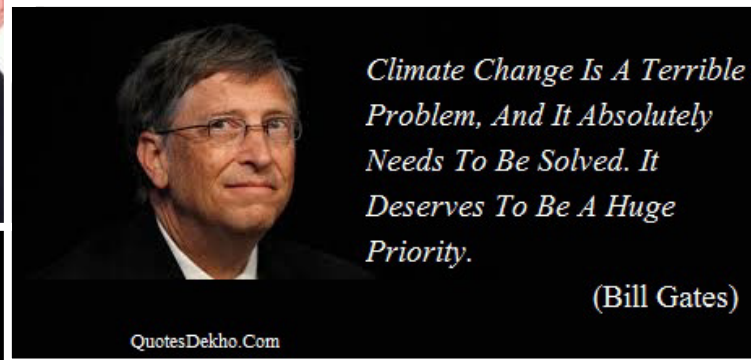
-Bill Nye



*Climate Change Is A Terrible Problem, And It Absolutely Needs To Be Solved. It Deserves To Be A Huge Priority.*

(Bill Gates)

QuotesDekho.Com



POPE FRANCIS HAS A MESSAGE TO THE WORLD LEADERS ABOUT CLIMATE CHANGE:

THE TIME TO FIND GLOBAL SOLUTIONS IS RUNNING OUT.

THERE IS THEREFORE A CLEAR, DEFINITE AND URGENT ETHICAL IMPERATIVE TO ACT.

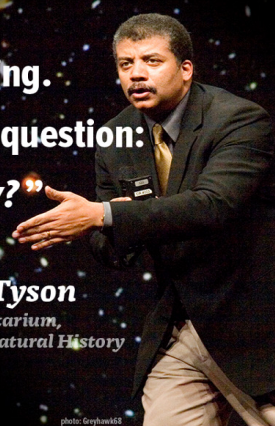


**"I'm often asked whether I believe in global warming. I now just reply with the question: Do you believe in gravity?"**

-Neil deGrasse Tyson

Director, Hayden Planetarium,  
American Museum of Natural History

photo: Greyhawk83



No challenge poses a greater threat to future generations than climate change.

~ President Obama

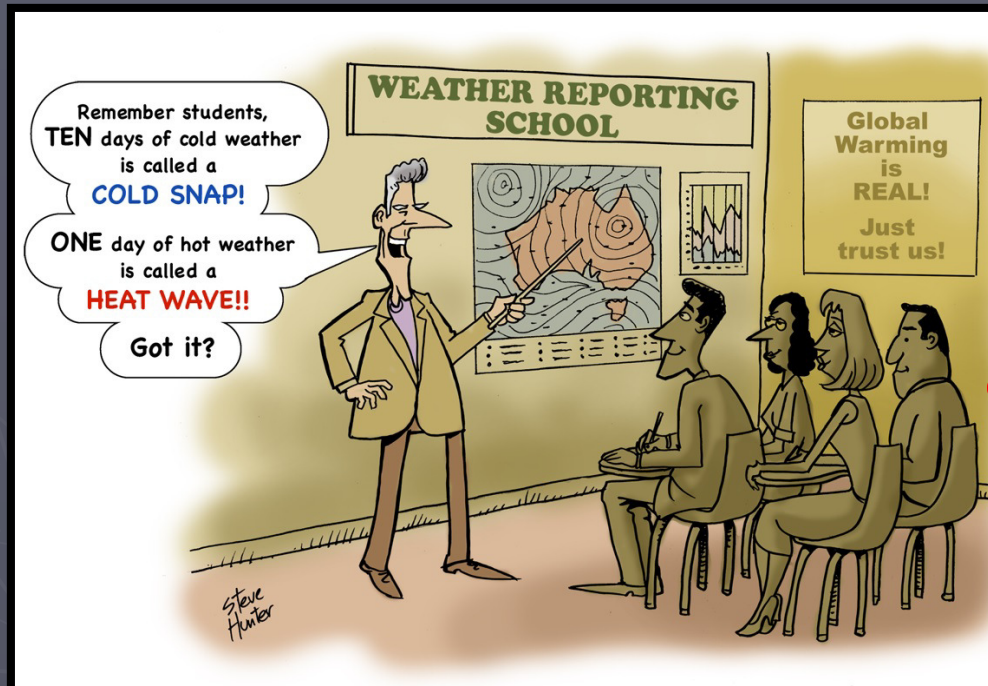
Photo: Pete Souza

TheGreenDivas.com



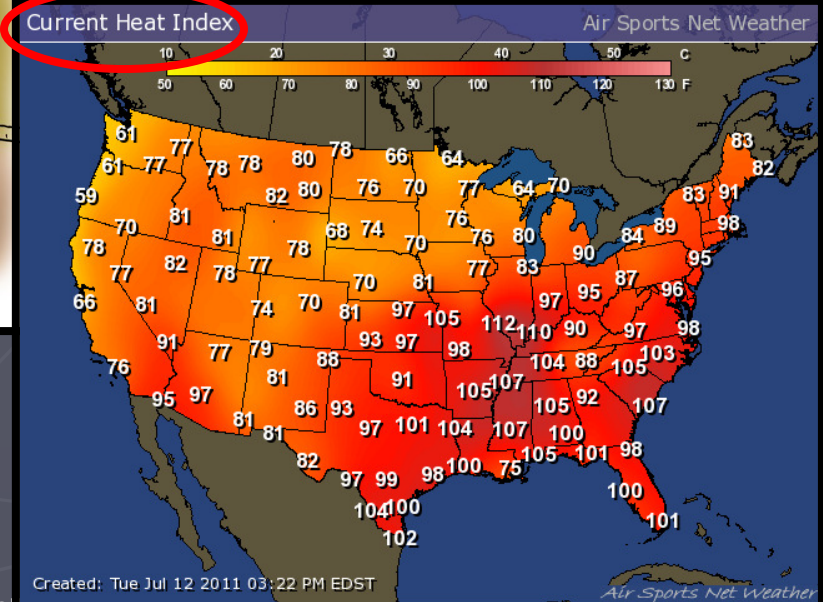


# Media Supply "Evidence"



## How climate change makes Sandy worse:

1. The Atlantic ocean is 5° F warmer than average. Warm water = stronger storms, further north.
2. Warmer water = more evaporation, heavier rains.
3. Higher sea levels = higher storm surges.



Perception Creates Reality!

# Let's Dig Deeper

Scrutinize the Following:

*CATASTROPHIC ANTHROPOGENIC  
GLOBAL WARMING EVIDENCE*

- The Hypotheses
  - The Models
  - The Data
  - The History
  - Consensus

That should  
keep you  
busy!

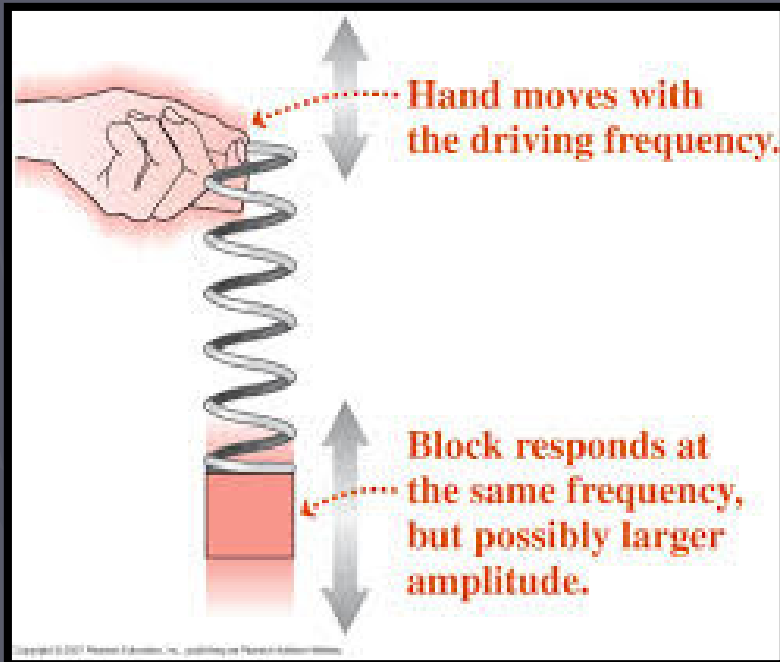


Step 1:  
Examine Hypotheses

# How *Might* Climate Work?

Consensus Hypothesis:

Internal Dynamics: Minor Role



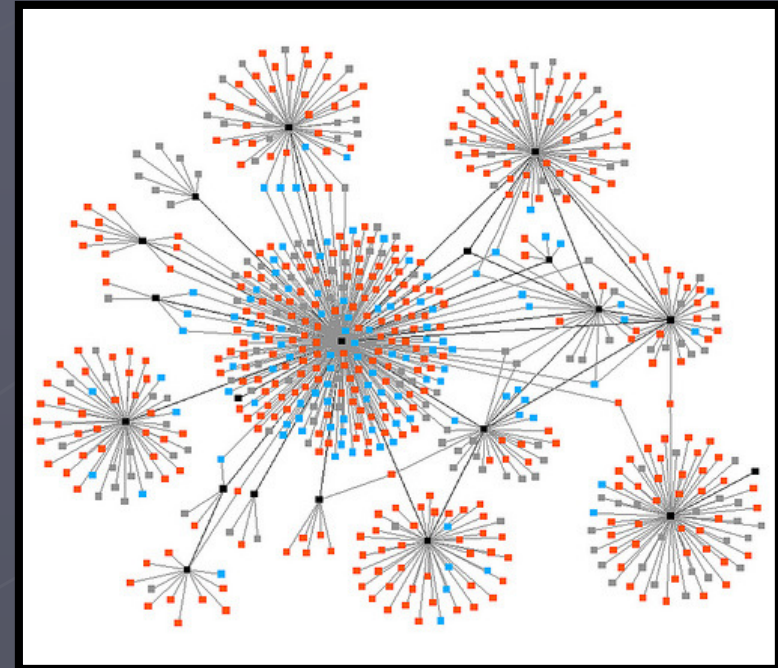
**External Forcing Directly Controls**

System Passively Responds

"Parts" Behave Independently

Alternate Hypothesis:

Internal Dynamics: Major Role



OR

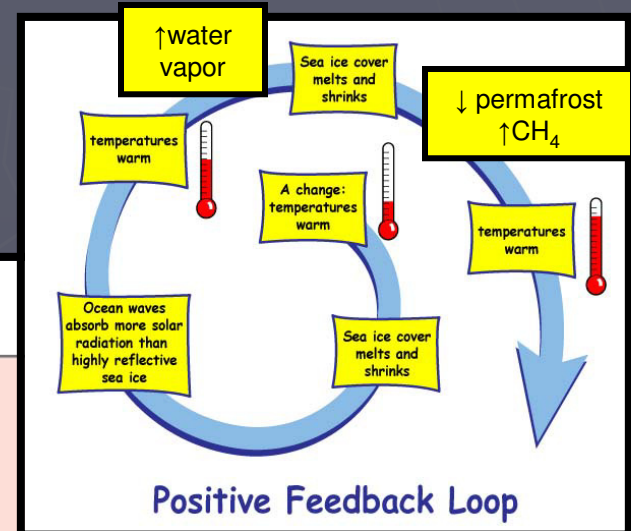
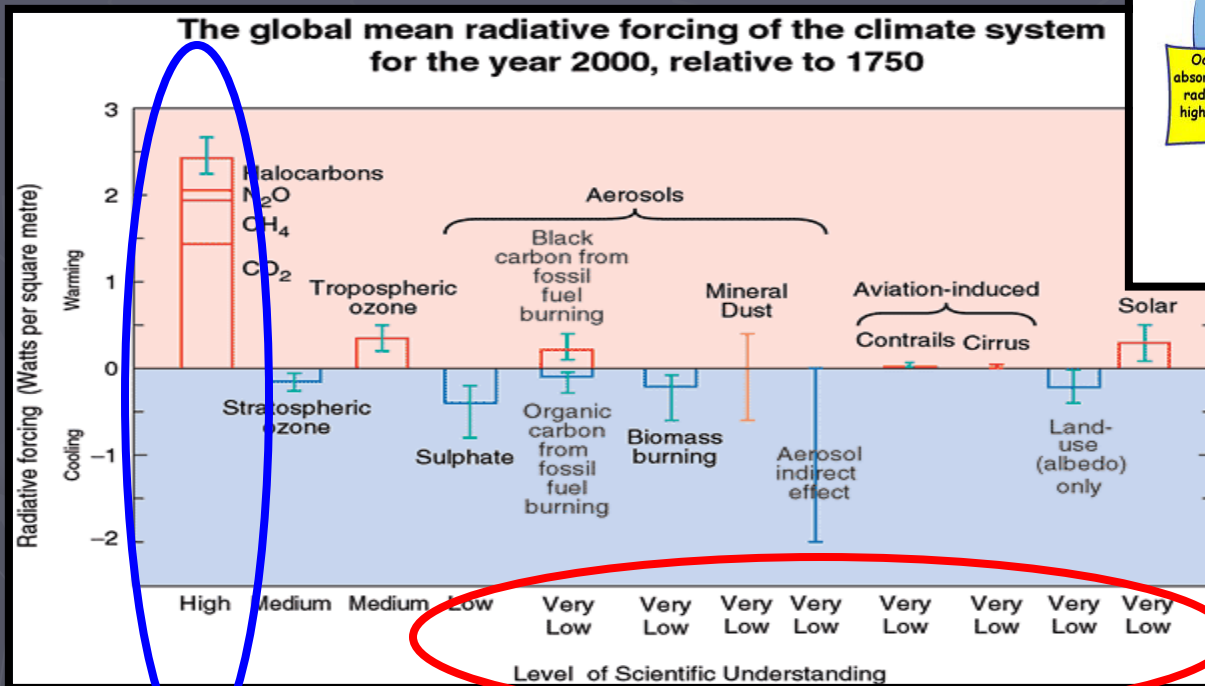
**External Forcing Supplies Energy**

Network "Parts" Couple: Communicate

Self-Organized Collective Behavior

# "Consensus" Hypothesis

External Forcing Dominates  
Climate Signature



Positive feedbacks *assumed* will occur create the projected extreme warming.

Note: Low to Very Low Understanding for all Negative Feedbacks!



# Alternate Hypothesis : Networks

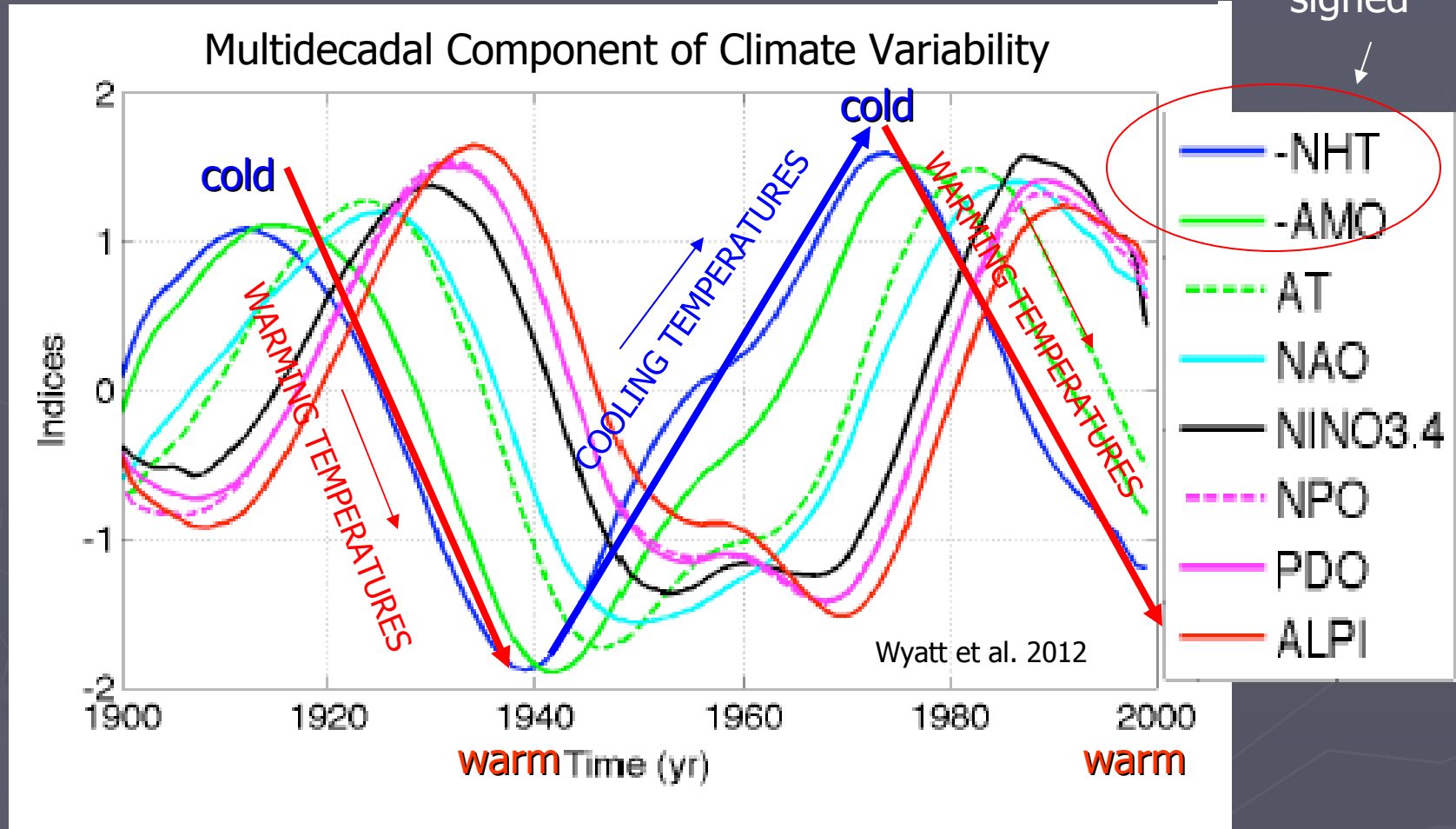
Internal Dynamics Key!

## “Stadium-Wave Signal”

Local Coupling within Network → Signal Propagation



# “Stadium Wave”

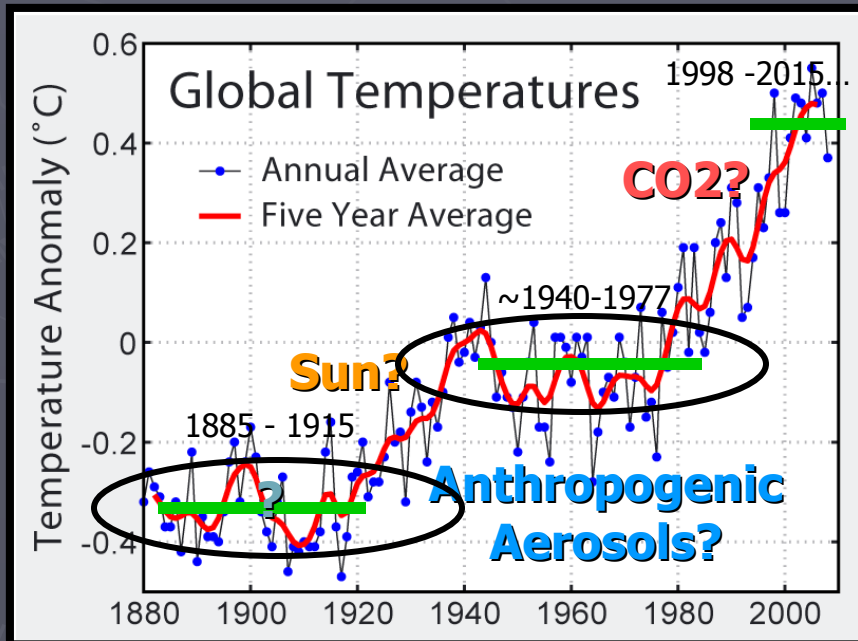


Cold Atlantic → ↑ Arctic ice → ↑ polar-equator T gradient → ↑ W-E wind flow → ↑ warm-air to higher latitudes → Δ Pacific oc/air circ → ↑ Arctic and NH Temps → warming Atlantic → ↓ Arctic ice → ↓ W-E winds → ↓ warm air to higher latitudes → ↓ Ts ...

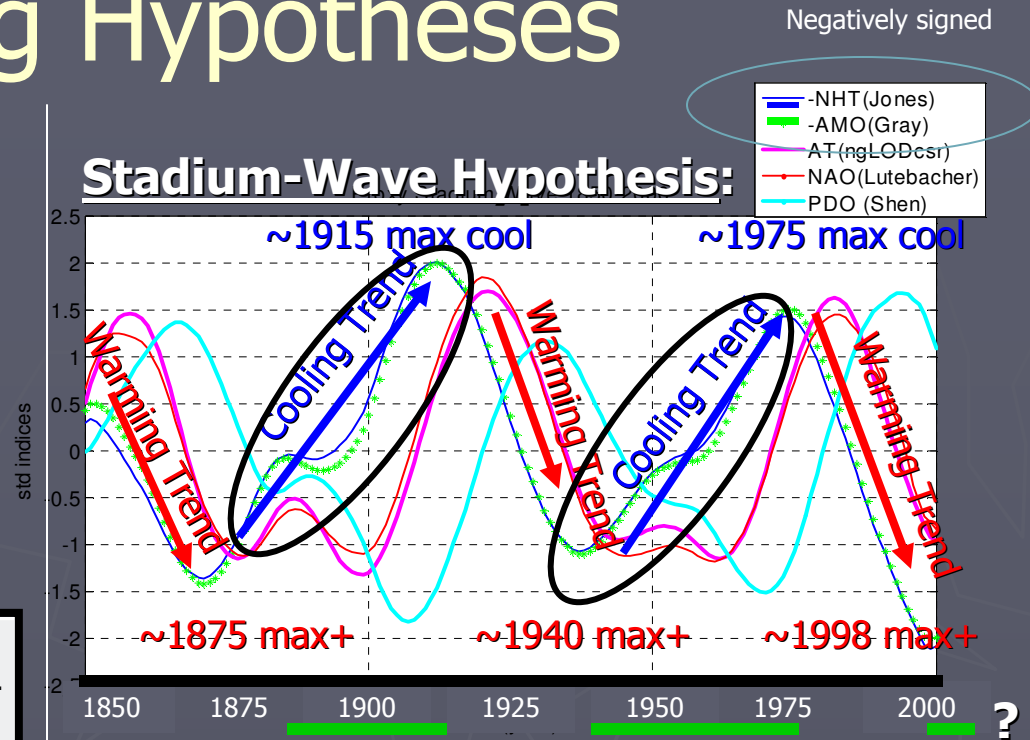
# Comparing Hypotheses

## Consensus Hypothesis (CO<sub>2</sub>):

- Forcing "recipes" vary to explain "wiggles" on T-trend: (Guesses)
- Model input: est. F and sensitivity
- Hypothesis not directly testable
- Hypothesis "test" is model



## Stadium-Wave Hypothesis:

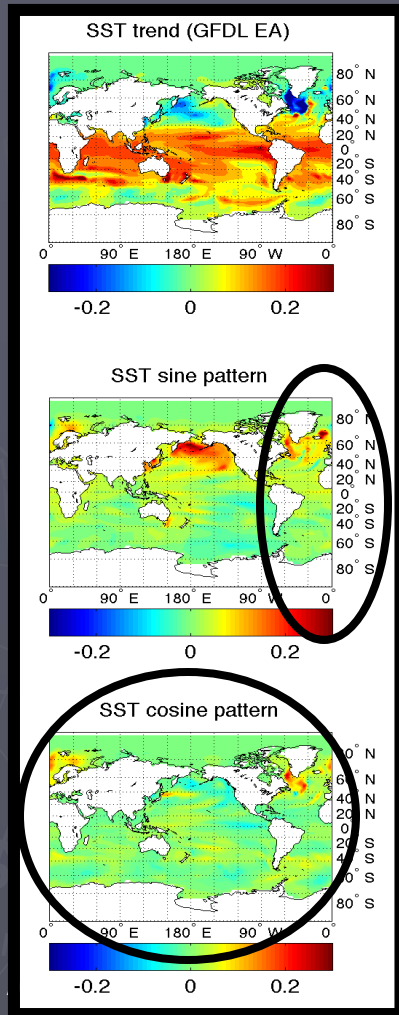


- Consistent with T-trend "wiggles"
- Cooling MD trends ≈ "pauses" on T-trend
- Hypothesis directly testable (with time)
- Observed T & climate index data capture
- Not mutually exclusive w/ external F

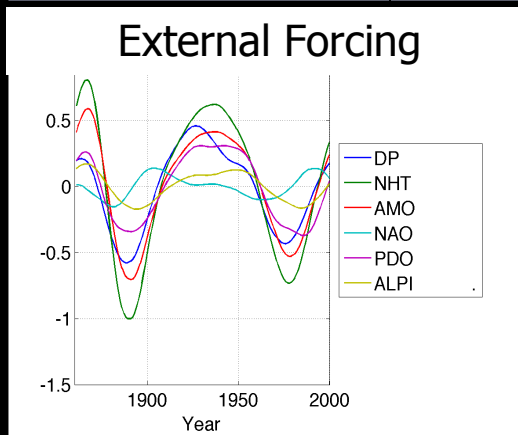
# Modeled vs. Observational Data

Modeled Data Do Not Capture Network Behavior; Observational Data Do!!!

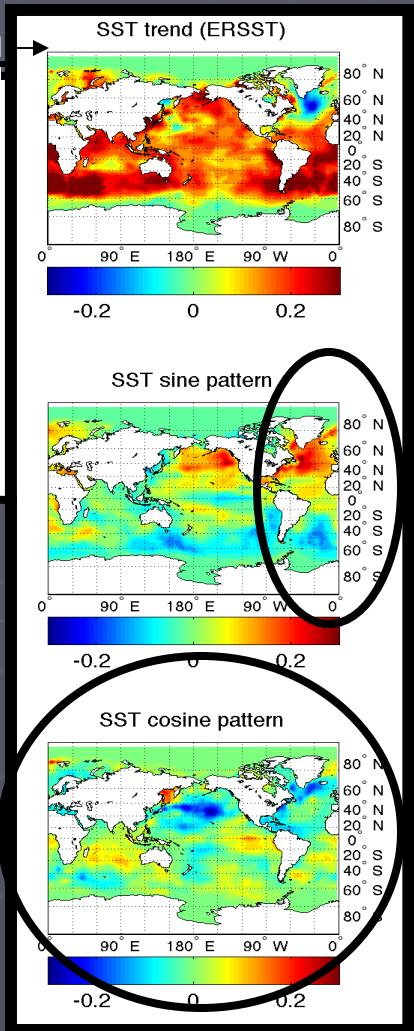
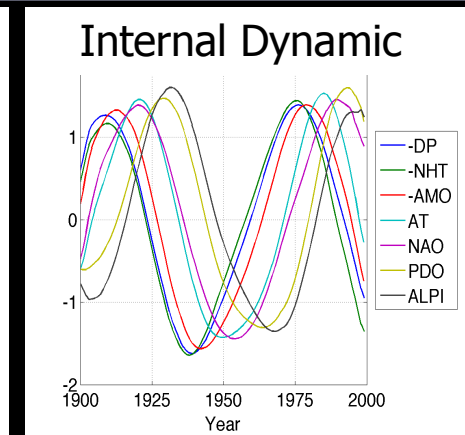
Are key climate dynamics missing, or poorly represented, in model designs???



← **Model Data**



**Observational Data** →



Difference between these Views:  
**Relative Roles of External vs. Internal**

Kravtsov, Wyatt, Tsonis, Curry 2014

Marcia Glaze Wyatt



# What You Learned :

## About Hypotheses of Climate Variability

### CATASTROPHIC ANTHROPOGENIC GLOBAL WARMING EVIDENCE

- More than one hypothesis can explain observations.
- Contrasting views exist over the relative roles of external forcings & internal dynamics.
- Modeled data support strong external forcing; observational data support greater role for internal dynamics.

There's more than one hypothesis!!!!

One hypothesis, the models support; the other, the observations support...



**Step 2:  
Review Climate  
Models...**

# Model Forecasts & Limitations

Input differs for each model design

Goal 1: Reconstruct T History  
Goal 2: Project T Future

Estimated Parameterizations

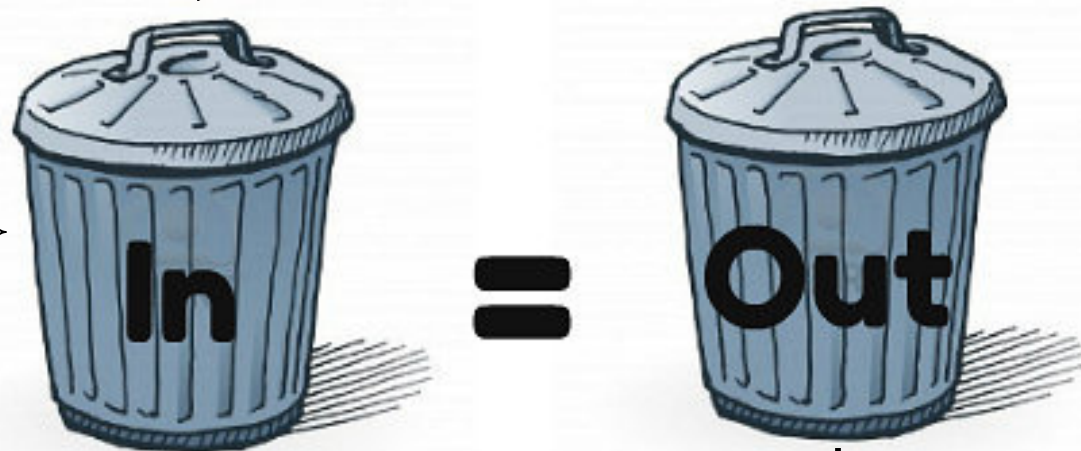
Assumed Forcing

Basic Physics

Assumed Climate Sensitivity

Hypothesized Dynamics

Data



Results depend upon:

Input

Beginning conditions

Model design

Results compared to historical observed data.  
Tweak...

# What You Learned :

## About Climate Models

### CATASTROPHIC ANTHROPOGENIC GLOBAL WARMING EVIDENCE

- Input based on what we *think* we know.
- Model design: physical laws, parameterizations, data.
  - Parameterizations  $\neq$  physical laws, just *assumed* behavior based on observations
- Output *never* same, even for same model design.
- Different outputs averaged together  $\rightarrow$  T projection

$\uparrow$ precision

$\neq$   $\uparrow$ accuracy



Jostlitz

You mean models are hypotheses?  
You mean we use hypotheses to test hypotheses???

Sounds circular!  
No?

**Step 3:  
Investigate Data...**

But first,  
what is  
temperature?

# What is Temperature?



With one  
thermometer, one  
can know.

With two, one can  
never be sure...

Earth's temperature field is infinite; measurements are limited.

Temperature describes a condition; it is NOT heat!

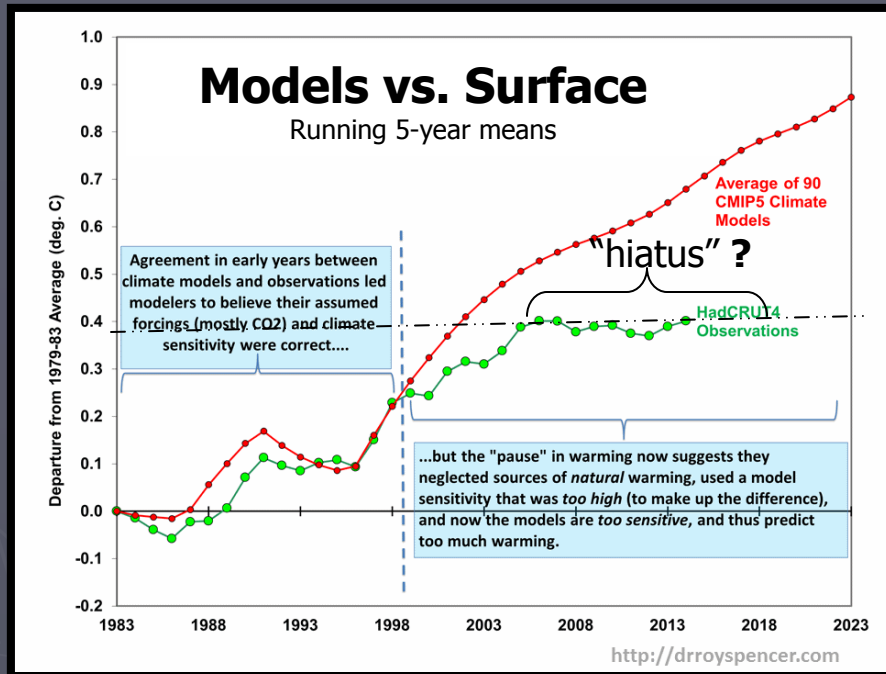
Averaged Temperature describes nothing. It is a statistic!

Heat is constantly re-distributed.

Ts, alone, don't tell that story well.



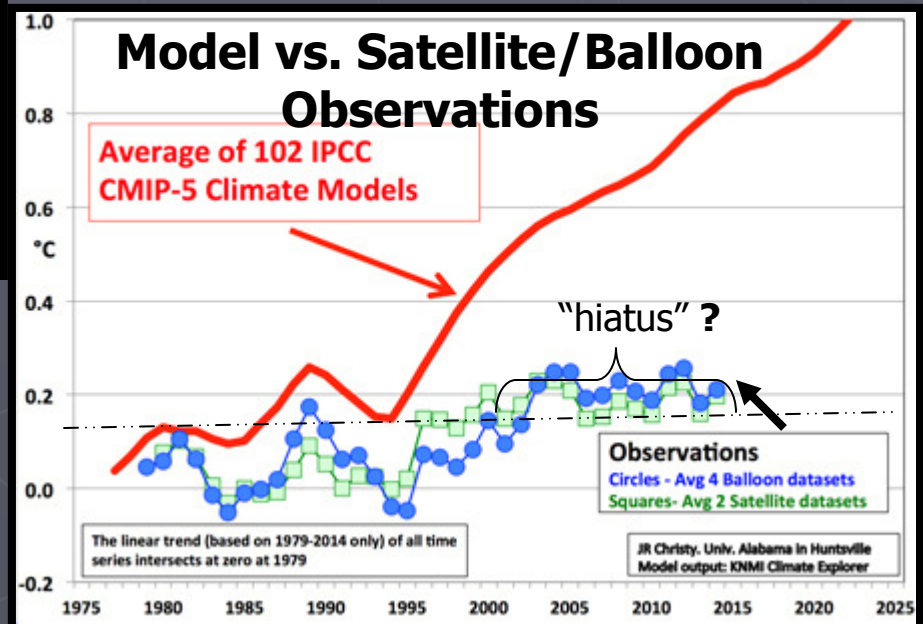
# Comparing Data: Model vs. Surface & Troposphere



## Modeled "Average" T-trend Different from all other T records

← Divergence between model and observed T anomalies (Ta)

Divergence between satellite-derived and surface T anomalies



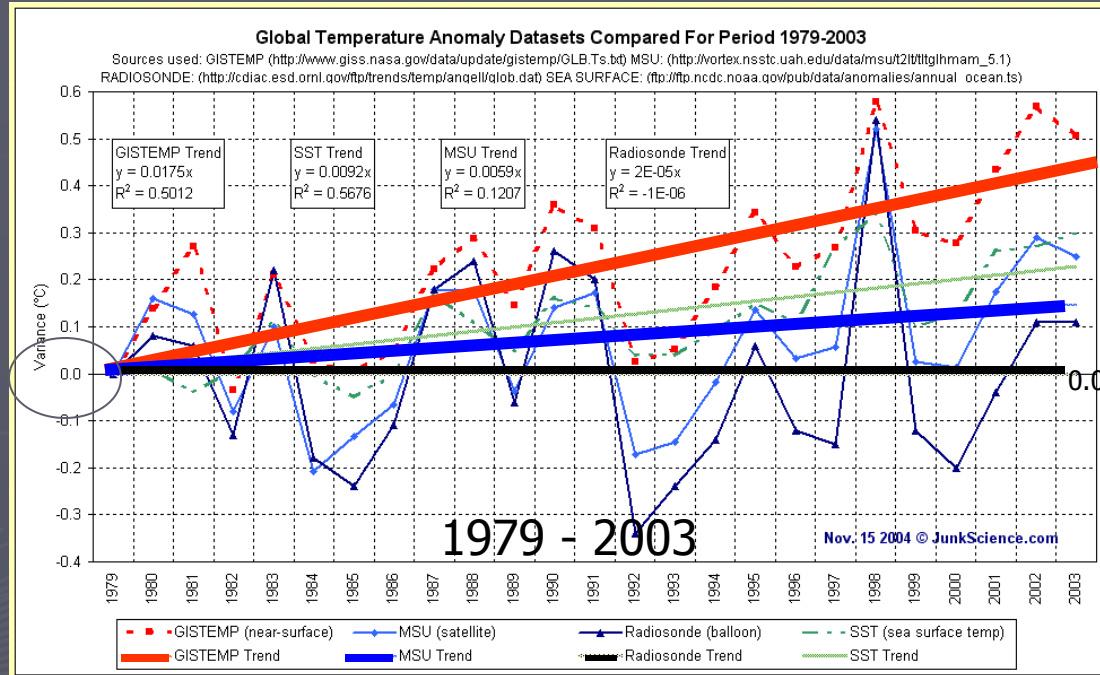
# And How About Other Data?

Surface ≠ Satellite/Balloon

Surface T ≠  
Satellite T

Surface T ≠  
Balloon T

Satellite T =  
Balloon T



Surface Ta

Satellite Ta

Balloon Ta

Ta: T anomalies

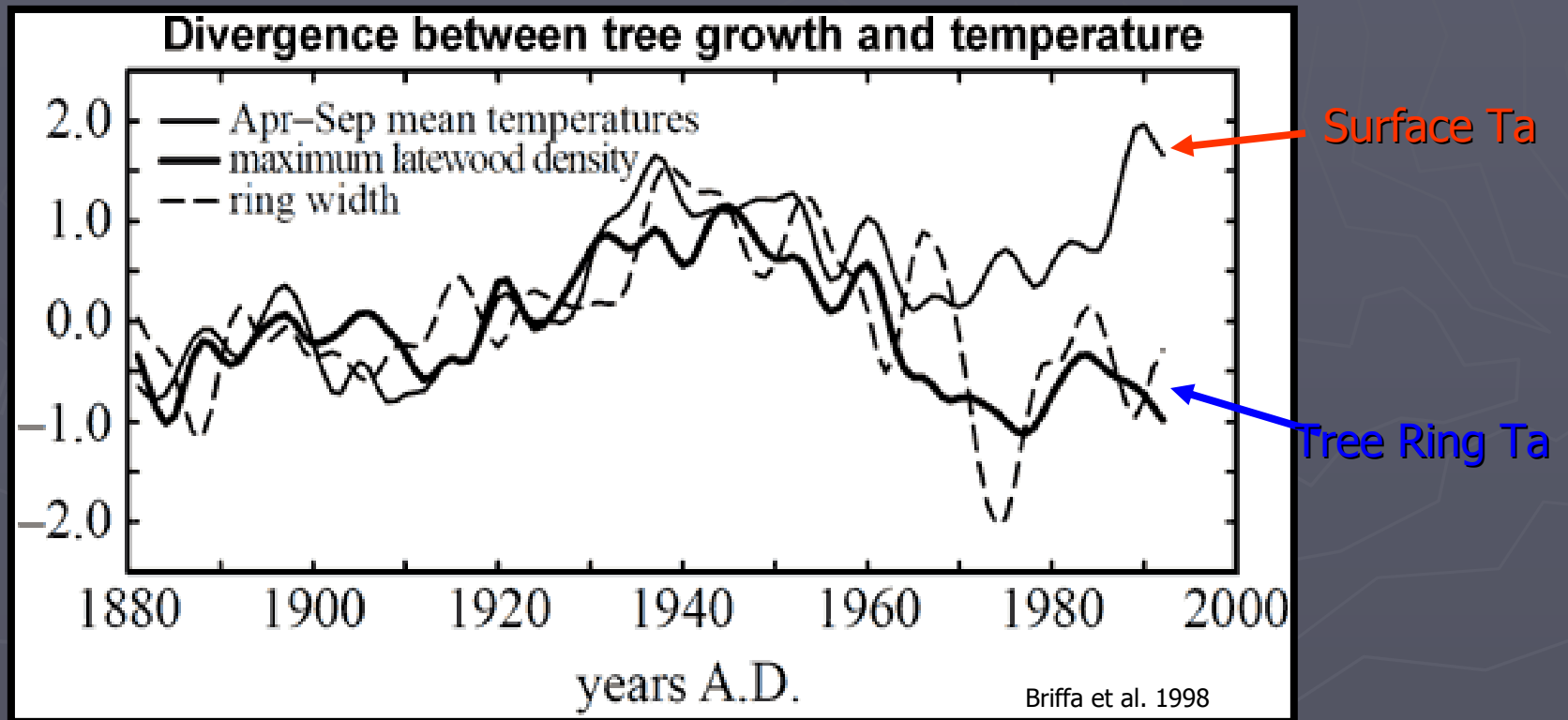
Satellite and balloon data reflect little long-term T trend in lower troposphere.

Theory of Greenhouse-Gas Warming argues for greater increase in lower troposphere temperatures than in surface temperatures.

Not what we see.

# Surface T $\neq$ Tree-Ring Data :

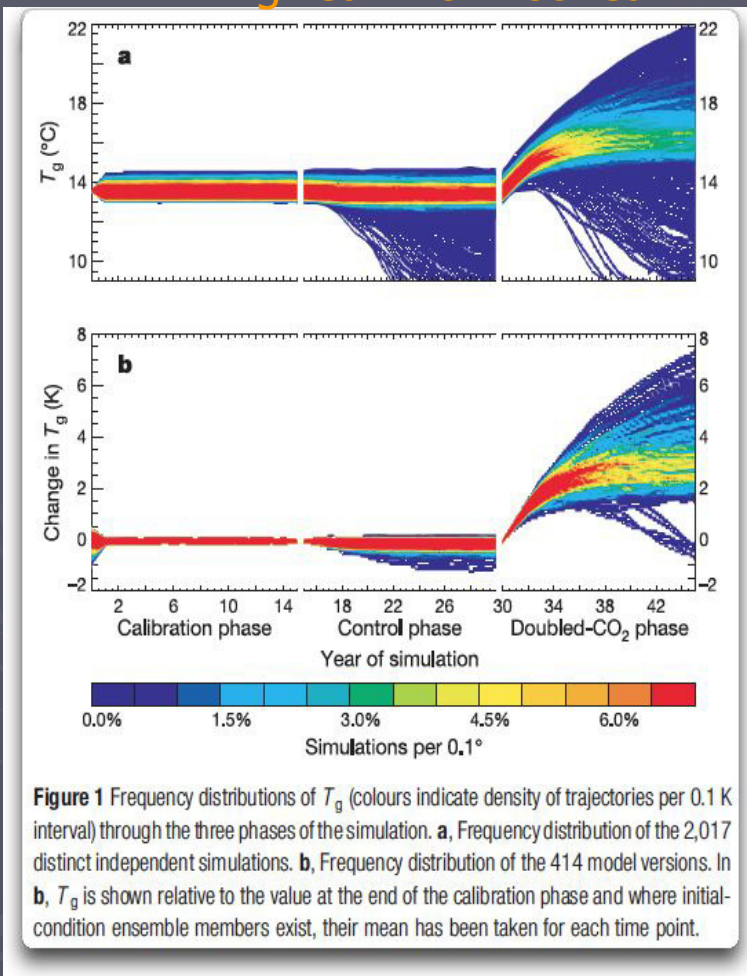
Summer temperatures



Ta = temperature anomalies

# Reanalysis "Data": packaged mix!

Mixing real with not-real



From Willis Eschenbach post WUWT (May 10, 2013)

Purpose:

- Used to fill in data

Method:

- Use best-guess algorithm to fill in holes
- Best-guess algorithm from inverse-modeling
  - Data → Model parameters → Data

Problems:

- Quality of data input
- Accumulated errors
- Never same result
- How to distinguish good from bad
- Sometimes represented as real "data"
- Sometimes used in place of real data.



# Mixing "Real" with "Modeled":

Mixing Data Sets: real w/ not-real



To Consider:

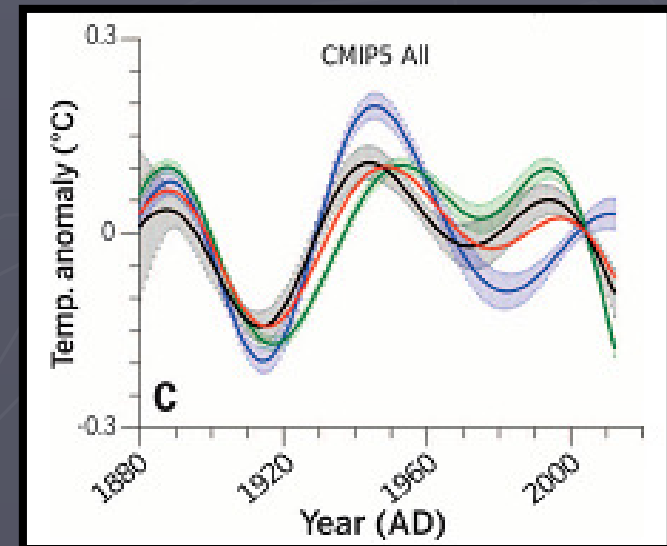
Is Forced-Signal "recipe" right?

Are internal dynamics represented by model?

Can results be considered "real"???

Semi-empirical method

- Assumption-based forcing "recipe"
- Model "Forced Signature" (FS)
- (Observed Data) – (Model FS)



From Steinman et al. (2015) challenging (unsuccessfully) stadium wave.

# What You Learned :

You say we have 4 ways to measure avg T - *whatever avg T is* - and none match the models, and surface avg Ts don't match any others either???

And sometimes we fill in (or substitute) "real" data with model output. Other times we mix "real" data with "modeled" output.

Oh my!!!

## About Temperature and T Data Records

### CATASTROPHIC ANTHROPOGENIC GLOBAL WARMING EVIDENCE

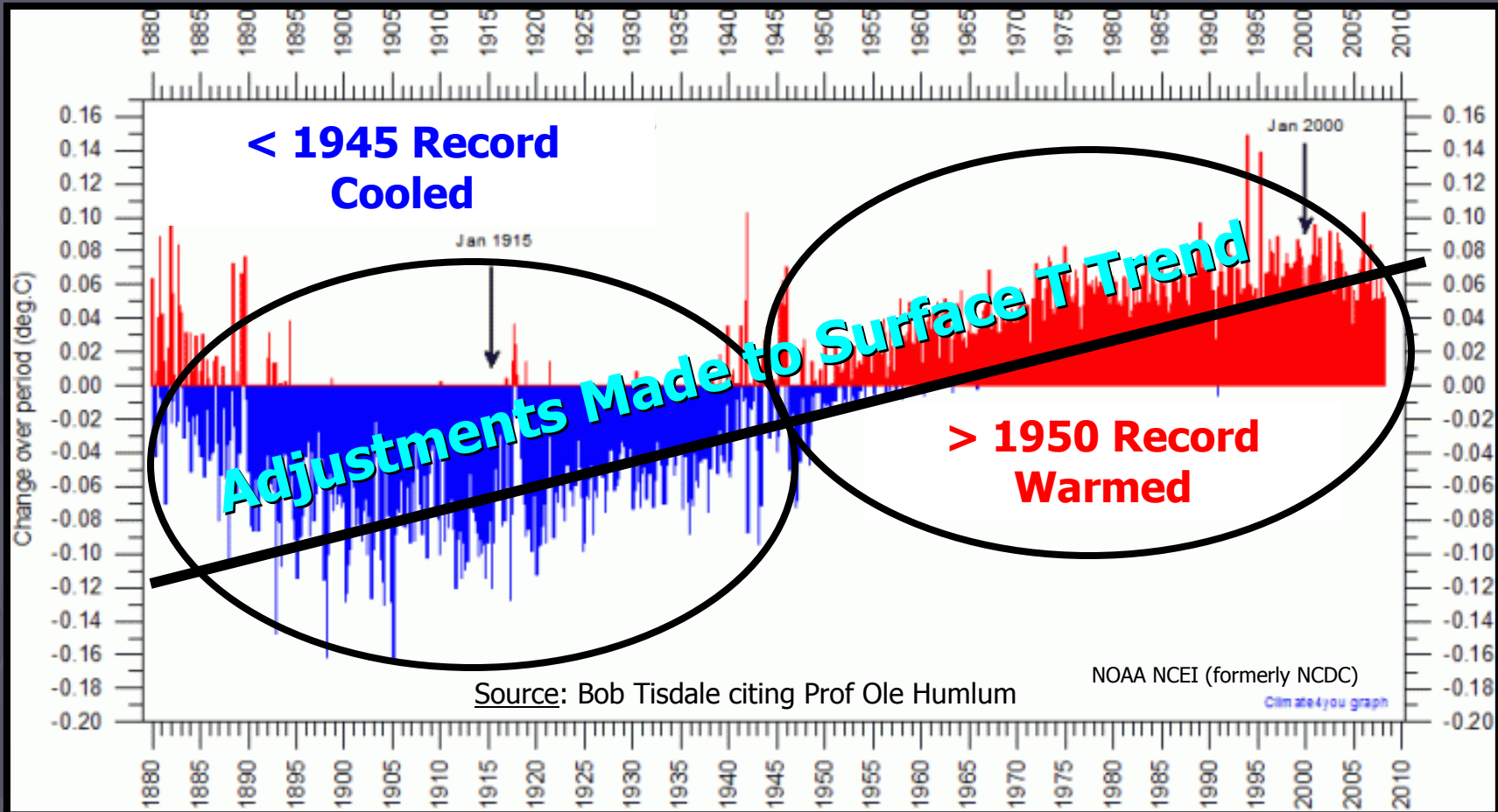
- Temp is not heat; it is a local condition, not a quantity.
  - Average Temperature is no more than a *statistic*.
- Four categories of T: surface, satellite, balloon, proxy.
  - Modeled Ts match none! Surface Ts match none!
- Models fill in data "holes"; we pick and chose results.
  - Sometimes scientists mix modeled with "real"!



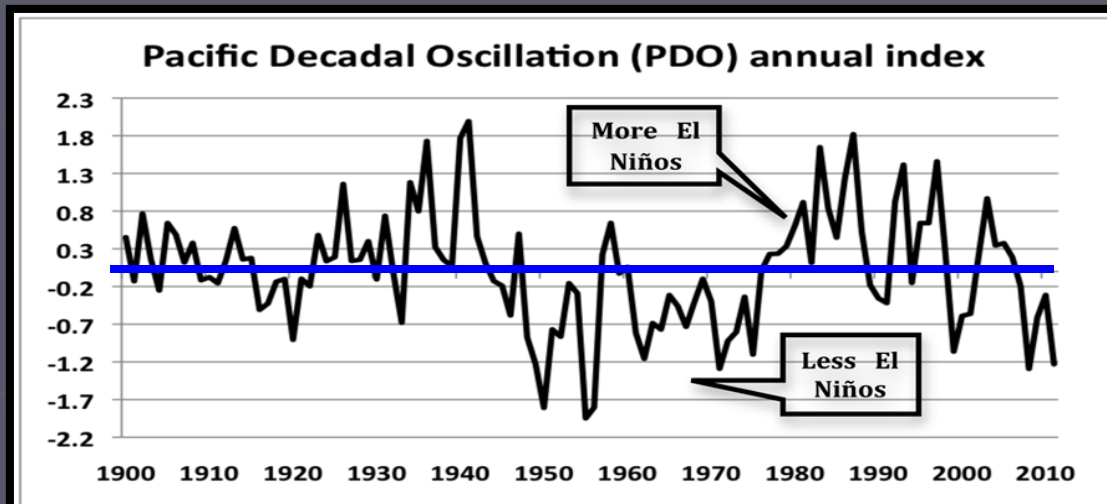
**Step 4:**  
Take a closer look  
at surface-T data

# If trends don't match, change them!

Changes made to Surface T Record applied between 2008 and 2015:  
For record: 1880 to 2010



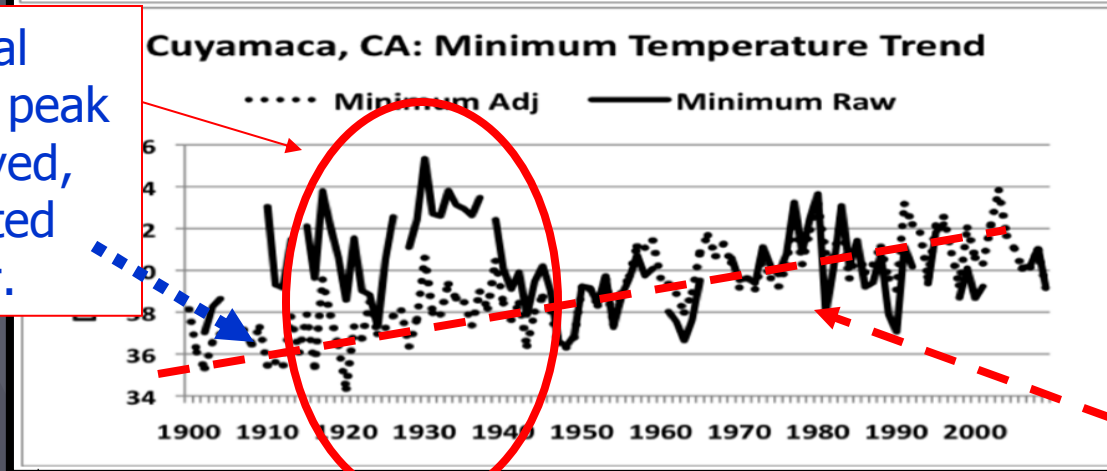
# Assumed Climate Behavior:



Natural Influence on Temperatures: PDO

Pacific Decadal Oscillation (PDO) influences frequency and intensity of El Niño events, thereby exerting influence on T

Natural warm peak removed, adjusted cooler.

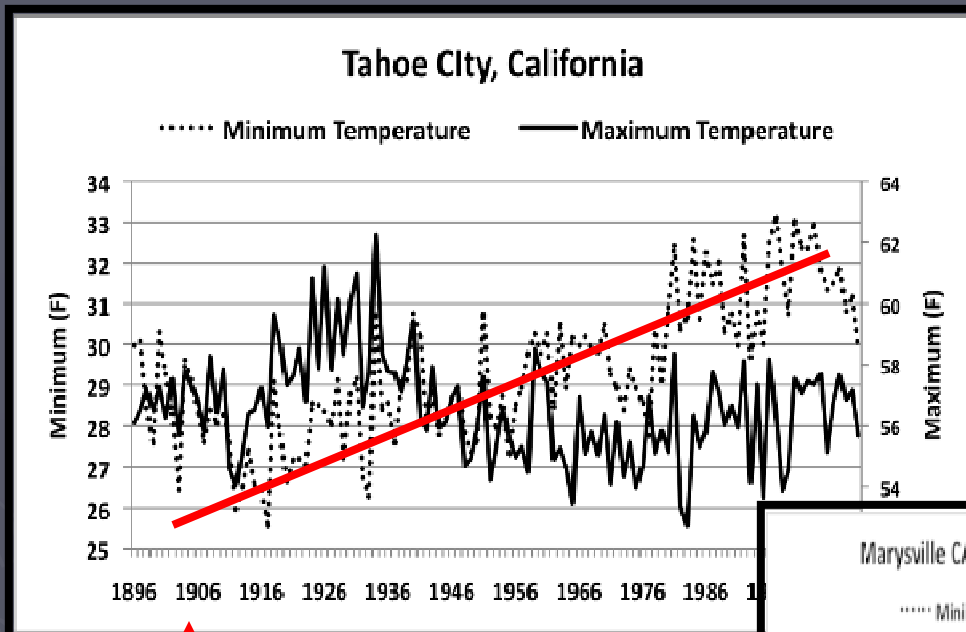


With 1930s "cooled", century-scale trend of increasing warmth steeper and blends with neighbors (trends steep due to UHI end-of-century).

Source: Jim Steele - Landscapes and Cycles



# Homogenization: Blending Trends

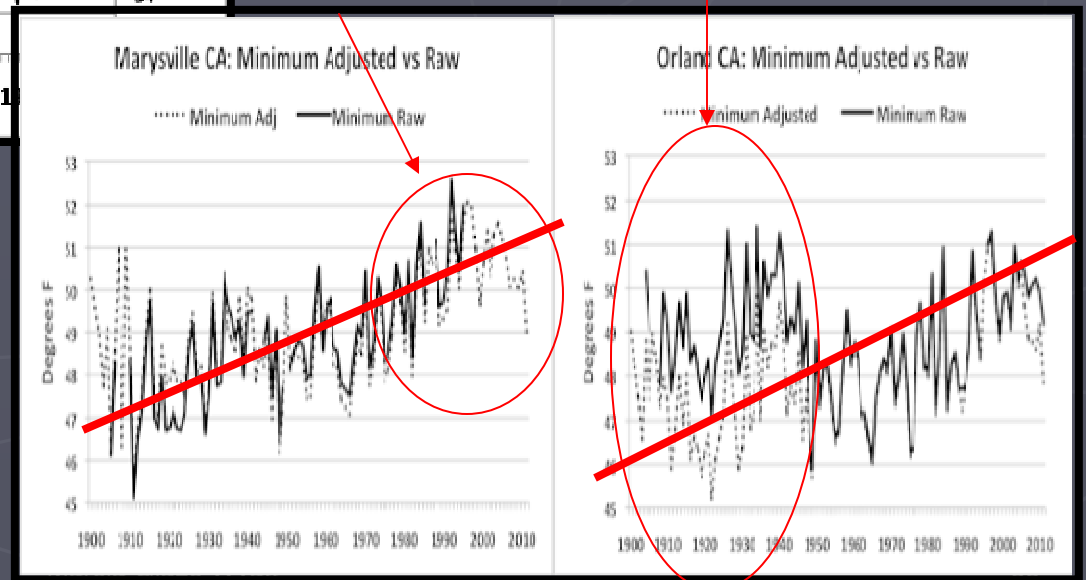


Trend due to high Ts later years caused by UHI.

No UHI trend late 1900s. To homogenize trends, early years cooled (although those were natural due to PDO).

Urban-heat-island (UHI) effect:

Minimum Ts rise > than Maximum Ts



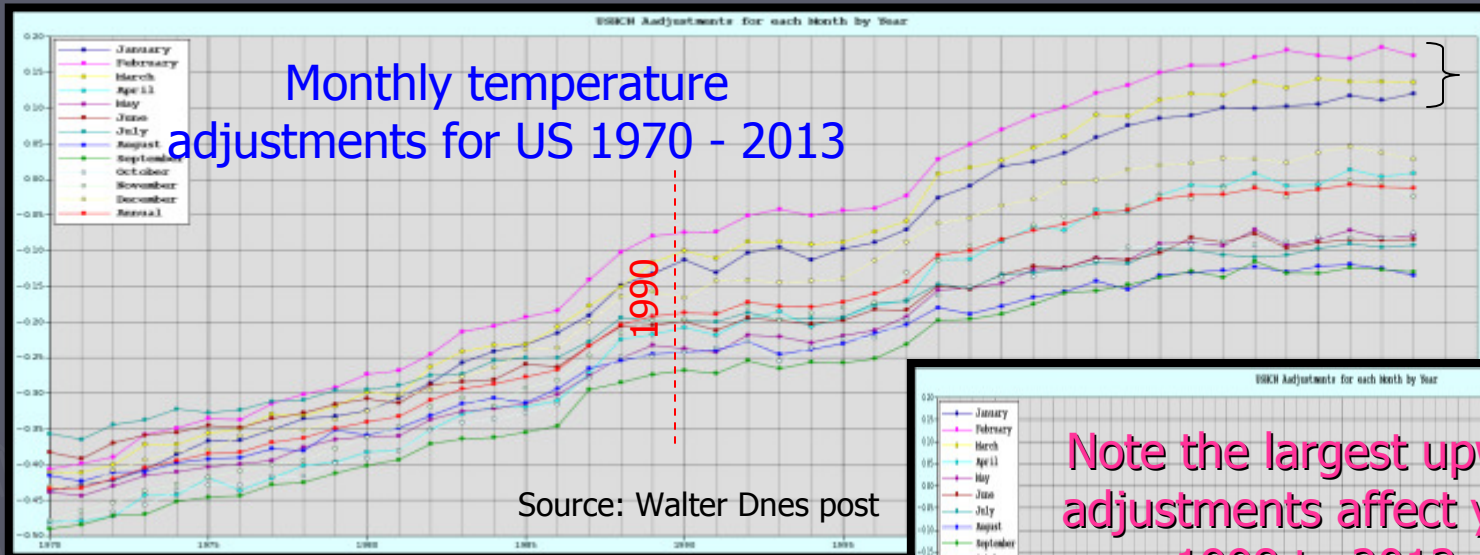
August 20, 2015

Plots from Jim Steele Landscapes and Cycles

30

# Monthly Bias in U.S. Adjustments

USHCN temperature adjustments

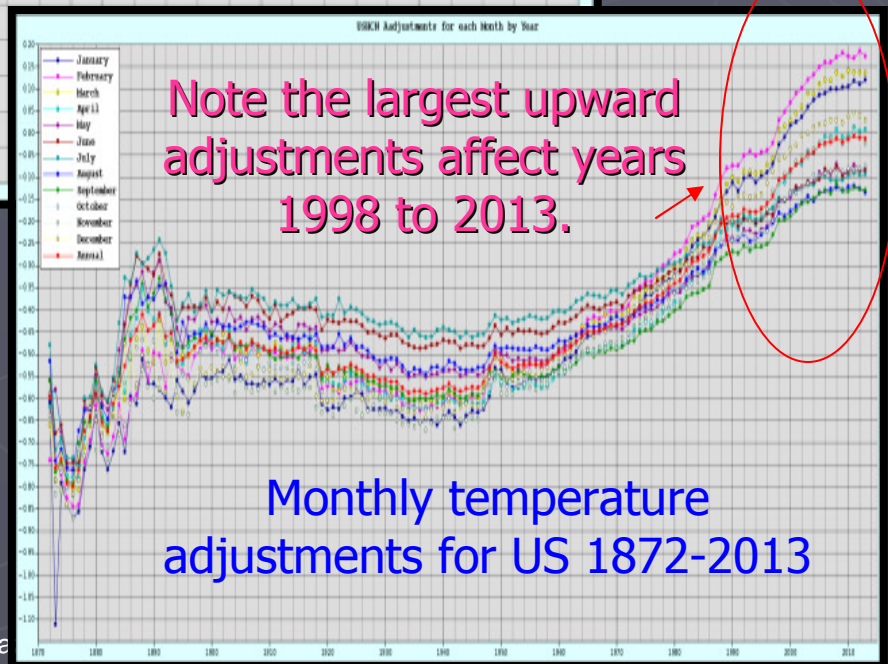


February  
March  
January

Cold months adjusted upward more than warm months.

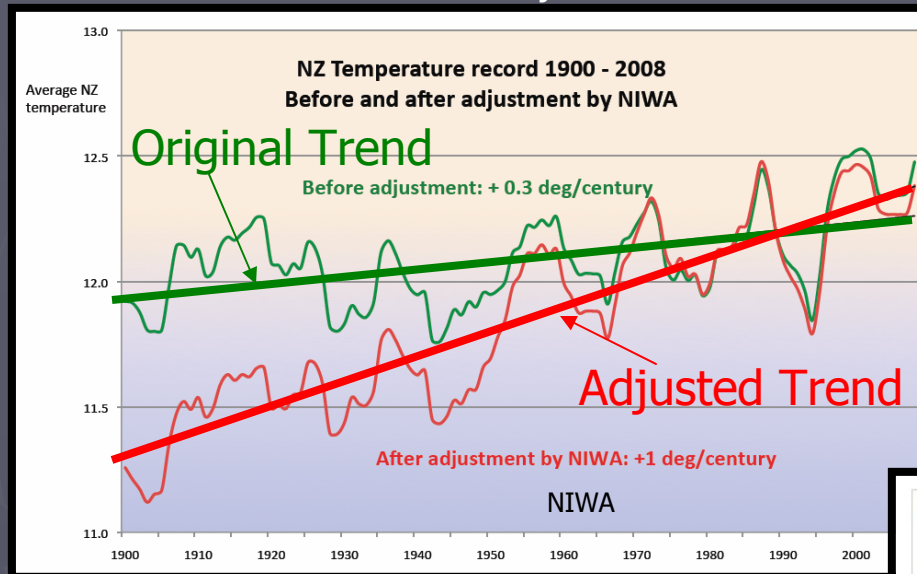
GHG warming supposed to manifest in warmer winters.

Increasingly larger adjustments > 1990



# Down-Under Adjusts Similarly!

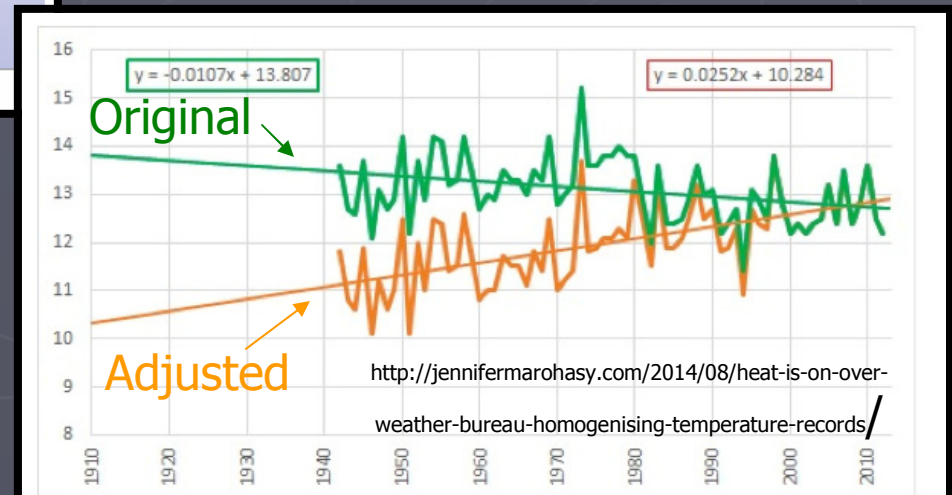
New Zealand Average T: 1900 – 2008  
before and after adjustments:



Graphs depicting each plot curve: <http://joannenova.com.au/2012/08/dont-mention-the-peer-review-new-zealands-niwa-bury-the-australian-review/>

“Down Under” adjustments tend to cool the record prior to 1971 and warm it after.

Amberley, Queensland Australia Minimum T: 1910-2014  
before and after adjustments:



<http://jennifermarohasy.com/2014/08/heat-is-on-over-weather-bureau-homogenising-temperature-records/>

**Figure 1.** The Bureau of Meteorology has changed the minima temperature for Amberley, Queensland. The green line is a plot of original data, while the orange line is the temperature trend in ACORN-SAT.

# What You Learned :

Model Ts don't match any instrumental record. Model Ts are always much higher. But now, we are changing the instrumental surface data and they are starting to look more like the modeled data!

Oy vey!!!

## About Data Quality and Making it "Better"

### *CATASTROPHIC ANTHROPOGENIC GLOBAL WARMING EVIDENCE*

- The data are a mess.
- Station numbers, locations, distributions: a mess.
- Temperature-measuring techniques: a mess.
- Disentangling UHI from natural: a mess.
- So we adjust. We assume and adjust.
- We've cooled the past and warmed the present.



Jostlitz

**Step 5:  
Looking at T-  
trends and  
hiatuses**

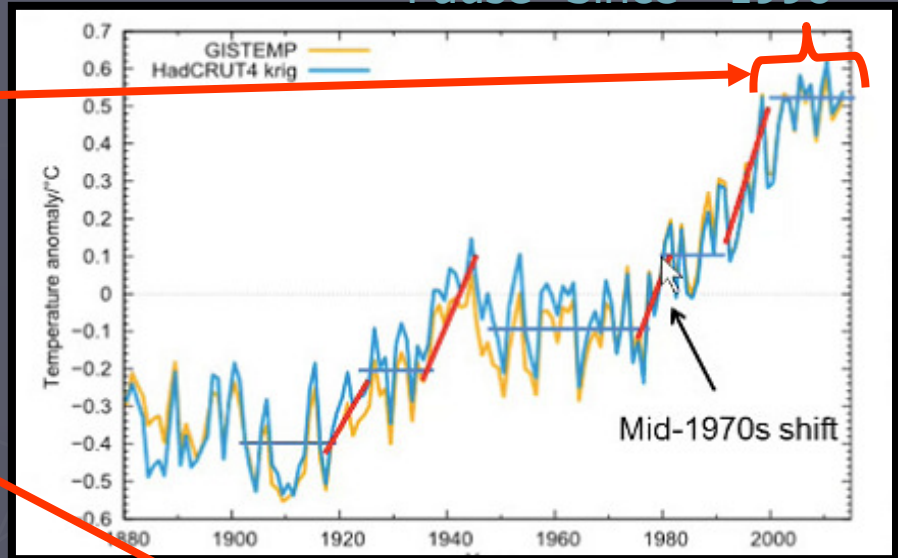


# Did the Warming Pause? 1998 – 2015...

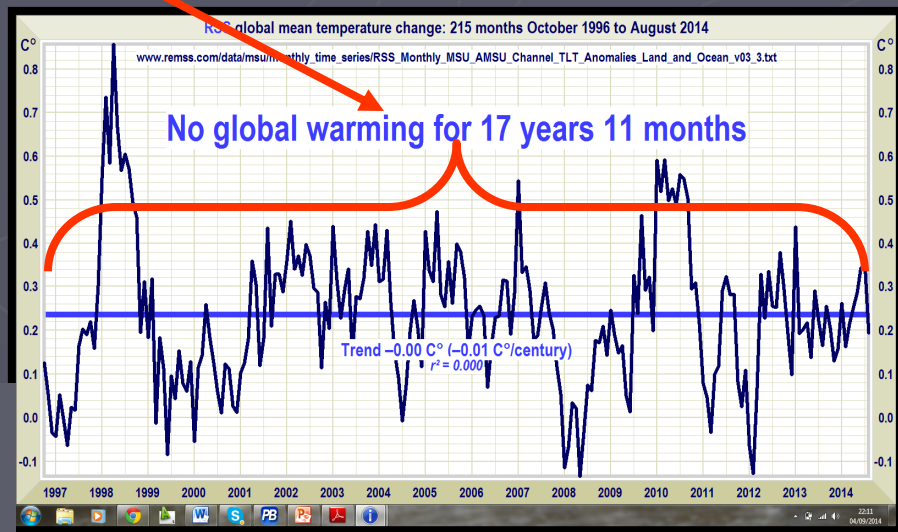
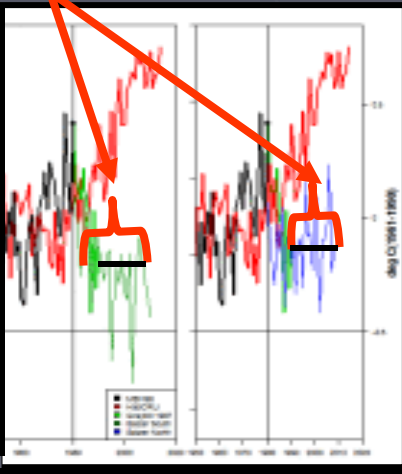
As of 2014, "hiatus" in:

- Surface Record
- Satellite Record
- Balloon Record
- Proxy Records (?)

"Pause" Since ~1998



From Steve McIntyre (ClimateAudit 12/4/14): compares NH T data from: MBH(98) multi proxy (black); HadCRU instrumental (red); Graybill (87) bristlecone proxy (bold green); Salazar et al. (2014) bristle cone proxy NF (thin green left plot) & SF (blue right plot). Note: plot here is truncated to highlight recent trends. Shown: 1950 to 2020 (longest proxy record to 2014). HadCRU scale chosen to match mean & SD for calibration period 1902-1980.

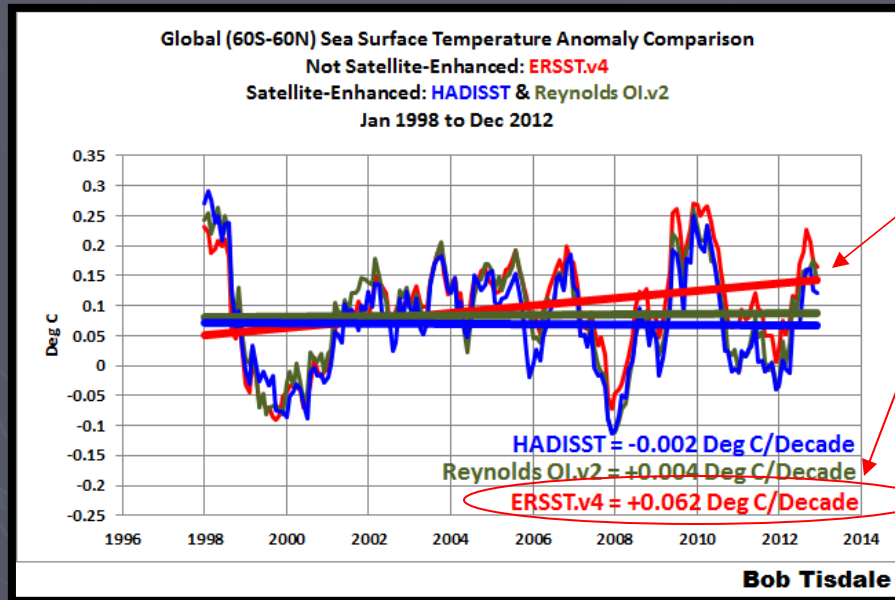


Note: No trend is evident in the proxy data plots from the end of the 1980s to 2014. Proxy data are highly controversial and arguments from both sides are valuable. Regardless of controversy, the question remains: why the dramatic differences between surface instrumentation, satellite retrievals, and proxy data?

# Maybe We Can Adjust Some More:

Extra changes made to 1998 to 2014!

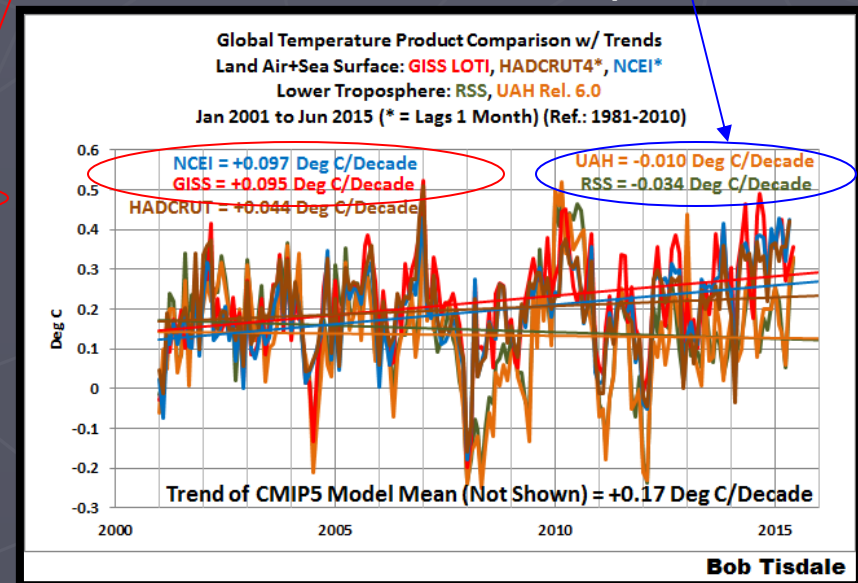
## Sea Surface Temperatures



Satellite record (lower right-side plot):  
 minimal trend

Satellite data were removed.

## Land & Sea Surface Temperatures



NCEI: data removed "hiatus"

Two main changes:

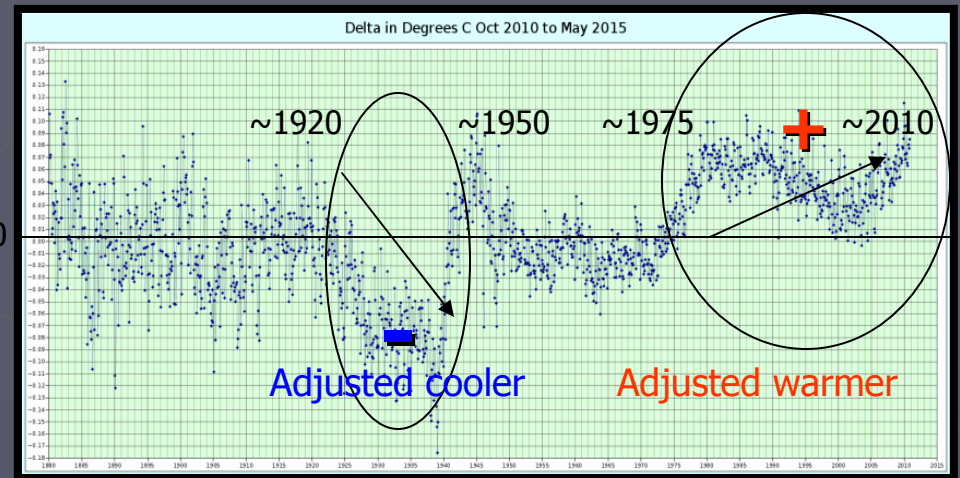
SSTs

Arctic Ts

# Hiatus "Disappears" from Surface T

As of 2015 "hiatus" in:

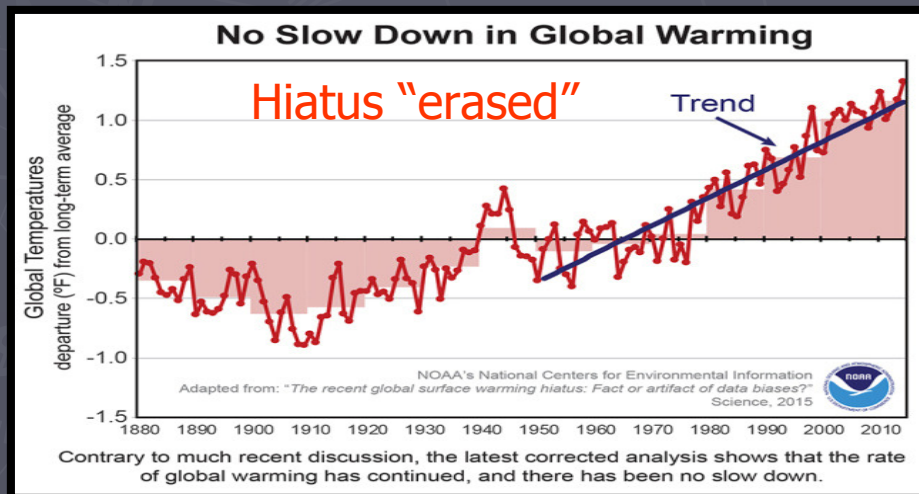
- ~~Surface Record~~
- Satellite Record
- Balloon Record
- Tree-Ring Record



Adjustments Made b/n October 2010 & May 2015  
Most made b/n April and May 2015

Walter Dynes post WUWT July 2015

Adjusted Surface T now looks  
more like modeled T



Contrary to much recent discussion, the latest corrected analysis shows that the rate of global warming has continued, and there has been no slow down.

Wyatt

# What You Learned :

We thought warming had slowed over the last 18 years.

No model output can simulate an 18-y pause.

But wait! You say just a few more data adjustments were needed. And the pause in surface T is gone.

*Seriously!*

## About The Temperature Trend

### CATASTROPHIC ANTHROPOGENIC GLOBAL WARMING EVIDENCE

- Data adjustments have been made.
- Documented changes “fix” the real issues.
- “Undocumented” changes “fix” the *assumed* issues.
- Now surface T data look more like modeled data.
- The 1998-2014 slowdown of warming is erased.
- History is changing!



**Step 6:  
Examine Temperature  
history**



# They Said it Was Hot :

1920s-1940s

Washington Post 11/2/1922 –

The Arctic Ocean is warming up, icebergs are growing scarcer and in some places the seals are finding the water too hot.... Reports from fishermen, seal hunters and explorers all point to a radical change in climate conditions and hitherto unheard-of temperatures in the Arctic zone... Great masses of ice have been replaced by moraines of earth and stones. At many points well-known glaciers have entirely disappeared. Very few seals and no white fish are found in the eastern Arctic, while vast shoals of herring and smelts, which have never before ventured so far north, are being encountered in the old seal fishing grounds.

New York Times 3/27/1933 –

America in longest warm spell since 1776; temperature line records a 25 year rise.

New York Times May 30, 1947 -

A mysterious warming of the climate is slowly manifesting itself in the Arctic, engendering a "serious international problem," -

# Then They Said it Was Cold:

1970s

- ▶ New York Times – July 18, 1970 :

The United States and the Soviet Union are mounting large-scale investigations to determine why the **Arctic climate is becoming more frigid**, why parts of the **Arctic sea ice** have recently become **ominously thicker** and whether the extent of that ice cover contributes to the **onset of ice ages**.

- ▶ Fortune Magazine – February 1974:

"There is **very important climatic change (Global Cooling)** going on right now, and it's not merely something of academic interest. It is something that, if it continues, **will affect the whole human occupation of the earth** – like a **billion people starving**. The effects are already showing up in a rather drastic way."

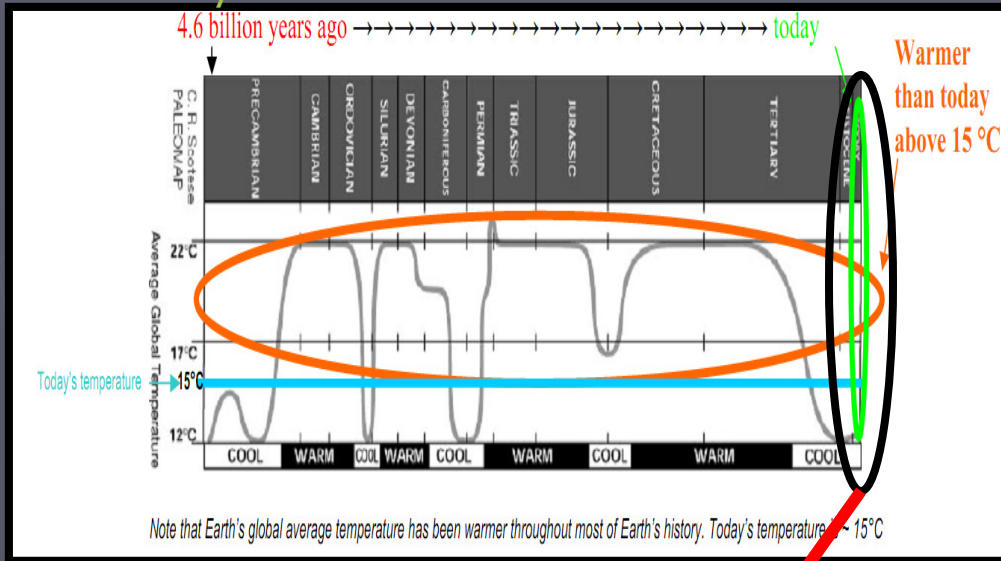
- ▶ Lowell Ponte (science writer: The Cooling 1976):

Consensus: Global cooling is upon us... It is a cold fact: that **global cooling presents humankind with the most important social, political, and adaptive challenge we have had to deal with for 10,000 years.**"

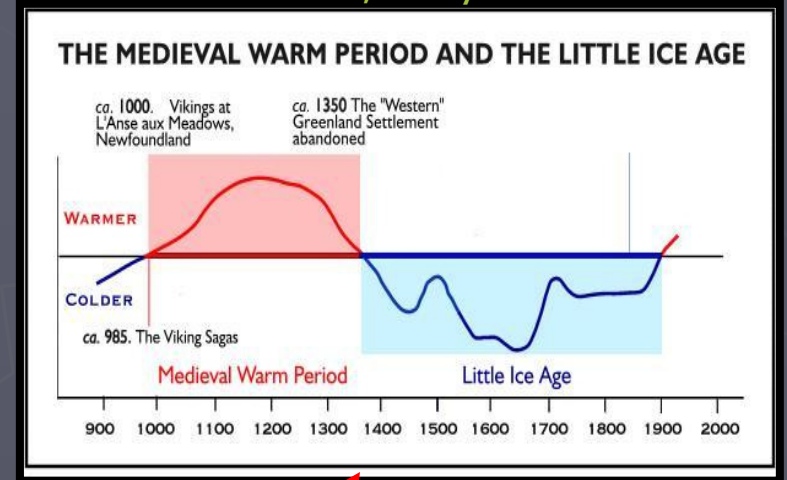
# And Here's the Long-held View:

## On Climate's History

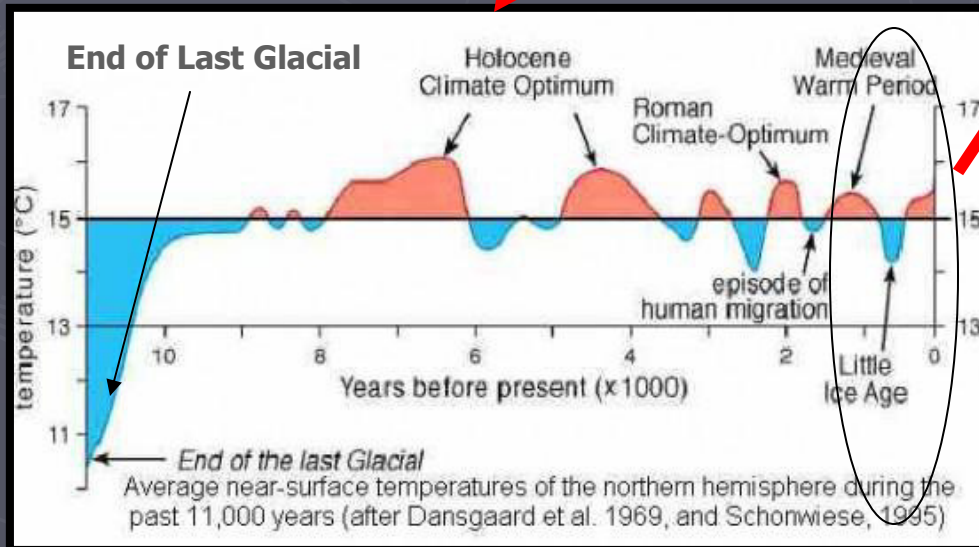
4.6 billion years of climate



1,000 years of climate



10,000 years of climate

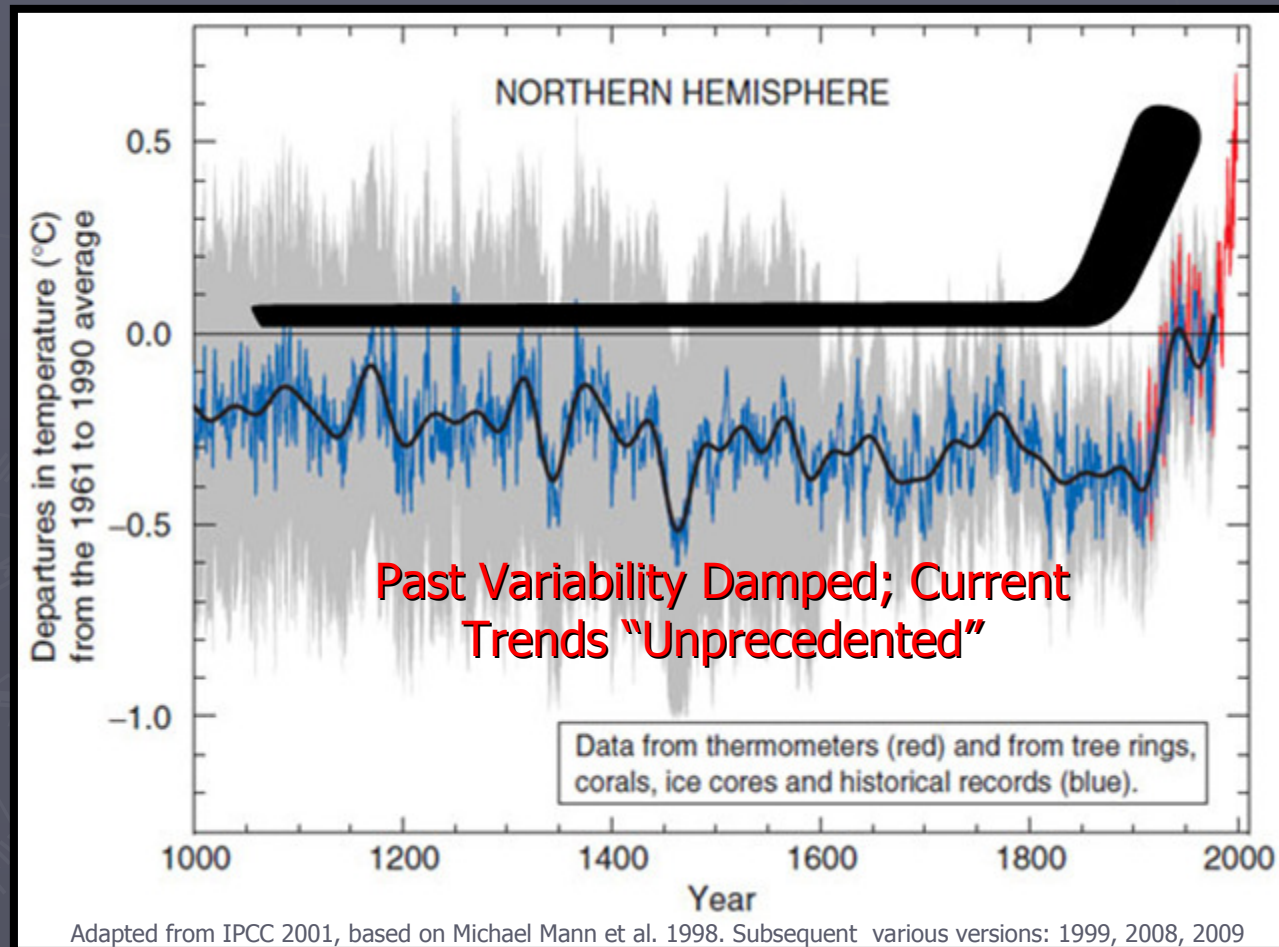


History supports climate variability, not climate instability.

See Notes Page for plot citations

# But Adjustments Changed That!

Controversial and debunked; yet lives on...





# What You Learned :

For decades and centuries, archival and proxy evidence told us of extreme warmth in the 1930s; a thousand years ago; 2000; 3500; and 7500 years ago – apparently 100s of researchers were mistaken. *There!*

Settled science!  
Amazing!

## About Climate History

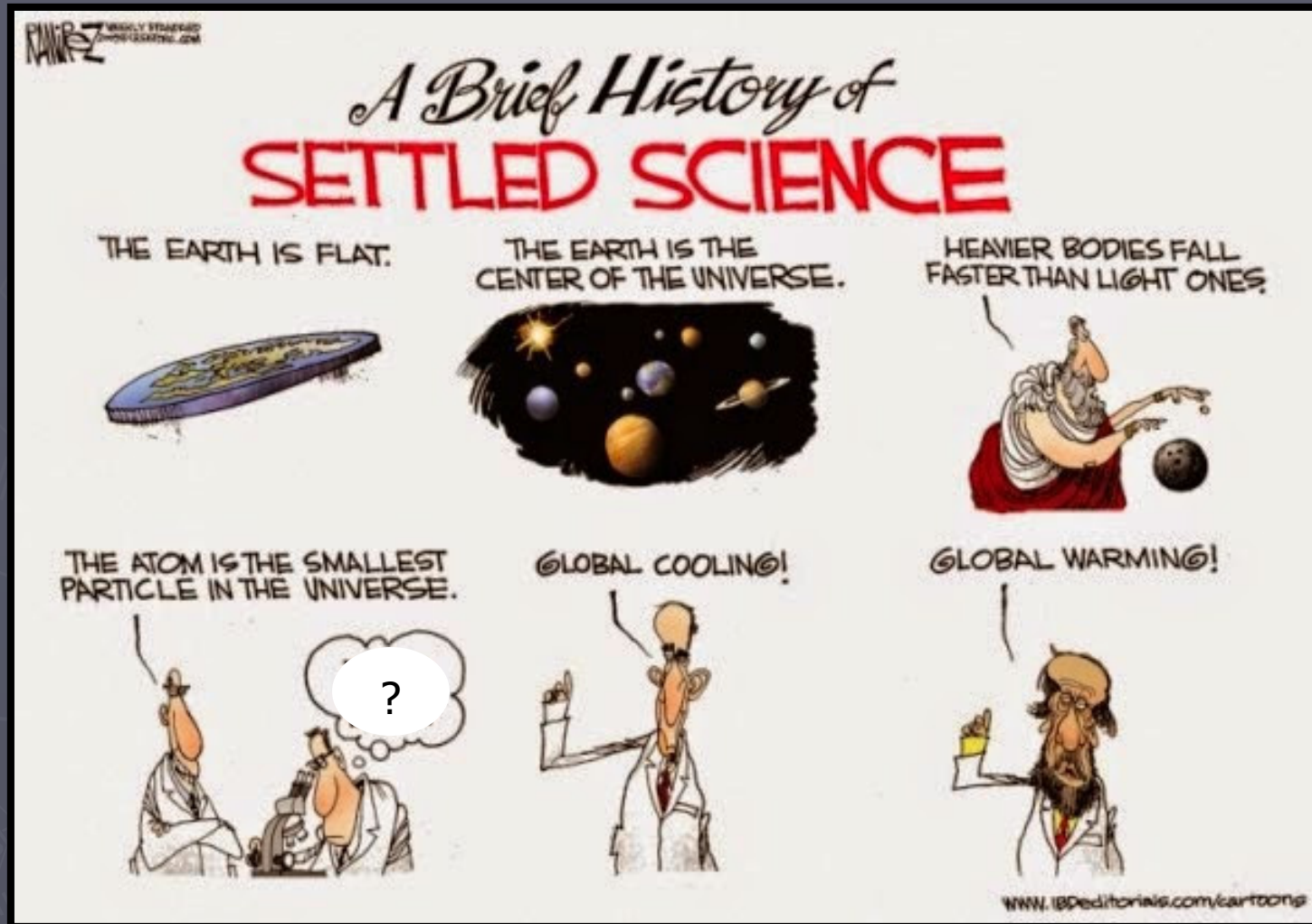
### CATASTROPHIC ANTHROPOGENIC GLOBAL WARMING EVIDENCE

- Apparently we aren't the first to see change!
- But we are special – *our* change appears extreme.
  - All it took were a few well-chosen proxies.
  - And a few more adjustments.
- The present is *now* the warmest in 1000s of years!
- The magic of adjustments

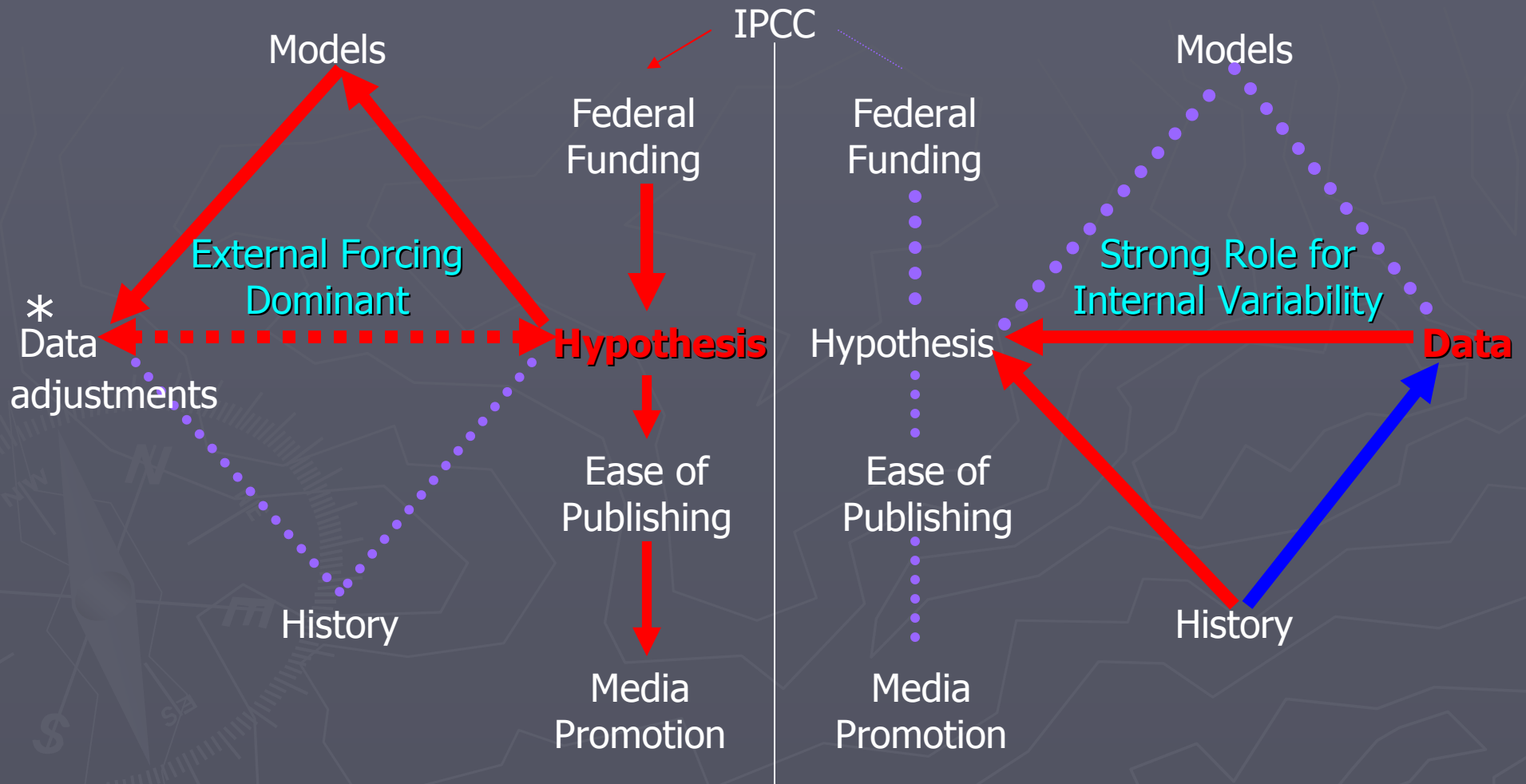


**Step 7:  
Explore Roots of  
Consensus**

# "Consensus": Often Wrong :



# How Today's Consensus Evolved:



# Charisma Spreads Consensus

## And memories are short...



*“...we are not just scientists, but human beings...”*

*“...we have to offer up scary scenarios, make simplified, dramatic statements, and make little mention of any doubts we might have...”*

*Stephen Schneider, NCAR, Stanford 1989 interview with *Discover Magazine**

*“We should not talk to the politicians about our doubt or the uncertainties of our model output; we should keep that among ourselves, when we are talking to other scientists. It is our moral duty to express certainty.”*

*as quoted from a well-known NCAR scientist presenting at a class of mine on the deficiencies of computer modeling being done for the IPCC. (2007)*



# What You Learned :

I see that "science" has been *thought* to be settled before, and for a much longer time than global warming has been "settled".

Lack of technology (& filters & funding) can perpetuate false hypotheses.

It can be hard to step back and see the big picture.

## About Consensus in Science

### CATASTROPHIC ANTHROPOGENIC GLOBAL WARMING EVIDENCE

- Root of consensus: good intentions, ego, filters (seeing what expect to see), funding.
- "Adjustments" appended to keep paradigm alive.
- Hypothesis drives models, data & handling of history.
- Peer-review, publication, media exposure impacted.



**Step 8:  
What Does  
Nature Say?**

# Signs of Doom?

- ▶ Extreme weather
- ▶ Sea level
- ▶ Melting glaciers
- ▶ Migrating species



August 20, 2015

Marcia Glaze Wyatt

# What You Learned :

You tell me that things aren't always as they appear; we tend to assume simplistic correlations that fuel our paradigm.

There are always the complexities and inconsistencies that mess up a good theory!

## About Nature's Climate-Related Behavior

### CATASTROPHIC ANTHROPOGENIC GLOBAL WARMING EVIDENCE

- Things aren't as simple as they appear.
- Just because it appears obvious doesn't mean it is!!!
- Some studies present results misleadingly.
- Pictures do not always tell an accurate story.



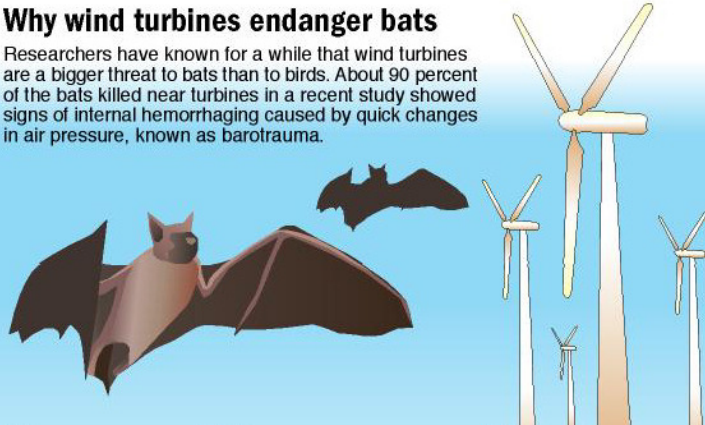
What if we just  
"Do *something*"  
!!!



# Do We Act “Just in Case”?

## Why wind turbines endanger bats

Researchers have known for a while that wind turbines are a bigger threat to bats than to birds. About 90 percent of the bats killed near turbines in a recent study showed signs of internal hemorrhaging caused by quick changes in air pressure, known as barotrauma.



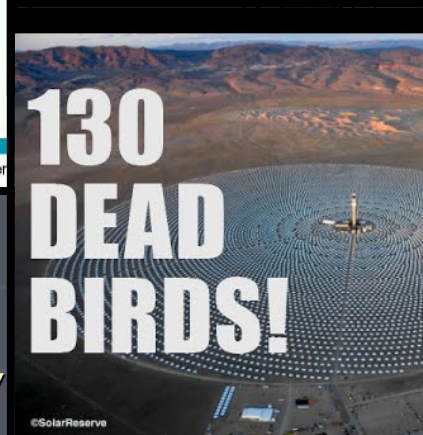
**1.** Bats should be able to avoid the blades of turbines using echolocation. In the study, only half of the dead bats had been hit by blades, and they may have been hit after they hemorrhaged.

**2.** Turning turbines create low-pressure areas near the tips of the blades. When a bat flies into these areas, the air in its lungs is at a higher pressure than the surrounding air. It expands and can rupture tiny vessels around the lungs. In effect, the bat's lungs explode.

**3.** The effect is similar to a scuba diver who gets the bends when the air pressure in his lungs has not had a chance to equalize with the pressure at the surface. Birds do not have the same problems. Their lungs are different than those of mammals.

Sources: Current Biology, National Geographic, Science Daily

Press graphic by Tim Fahren



Good Intentions  
Unintended Consequences  
Trade-offs come with all “Solutions”



# What You Learned :

I'm really tired.  
And I'm really  
confused.

I prefer easy and  
simple. I guess  
that's what usually  
gets us in trouble,  
huh?

I'm ready for your  
summary.

## About the Risk of Good Intentions

### CATASTROPHIC ANTHROPOGENIC GLOBAL WARMING EVIDENCE

- Every action taken has consequences.
- We trade one set of problems for another.
  - Good intentions can backfire.
- “*Just do something!*” may be ill-advised.
  - Especially when uncertainty lurks...



Summary

*Finally!*

# What You Learned :

So you're saying that  
"It ain't so much the  
things we don't know  
that get us into  
trouble. It's the  
things we *do* know  
that just ain't so!!!"

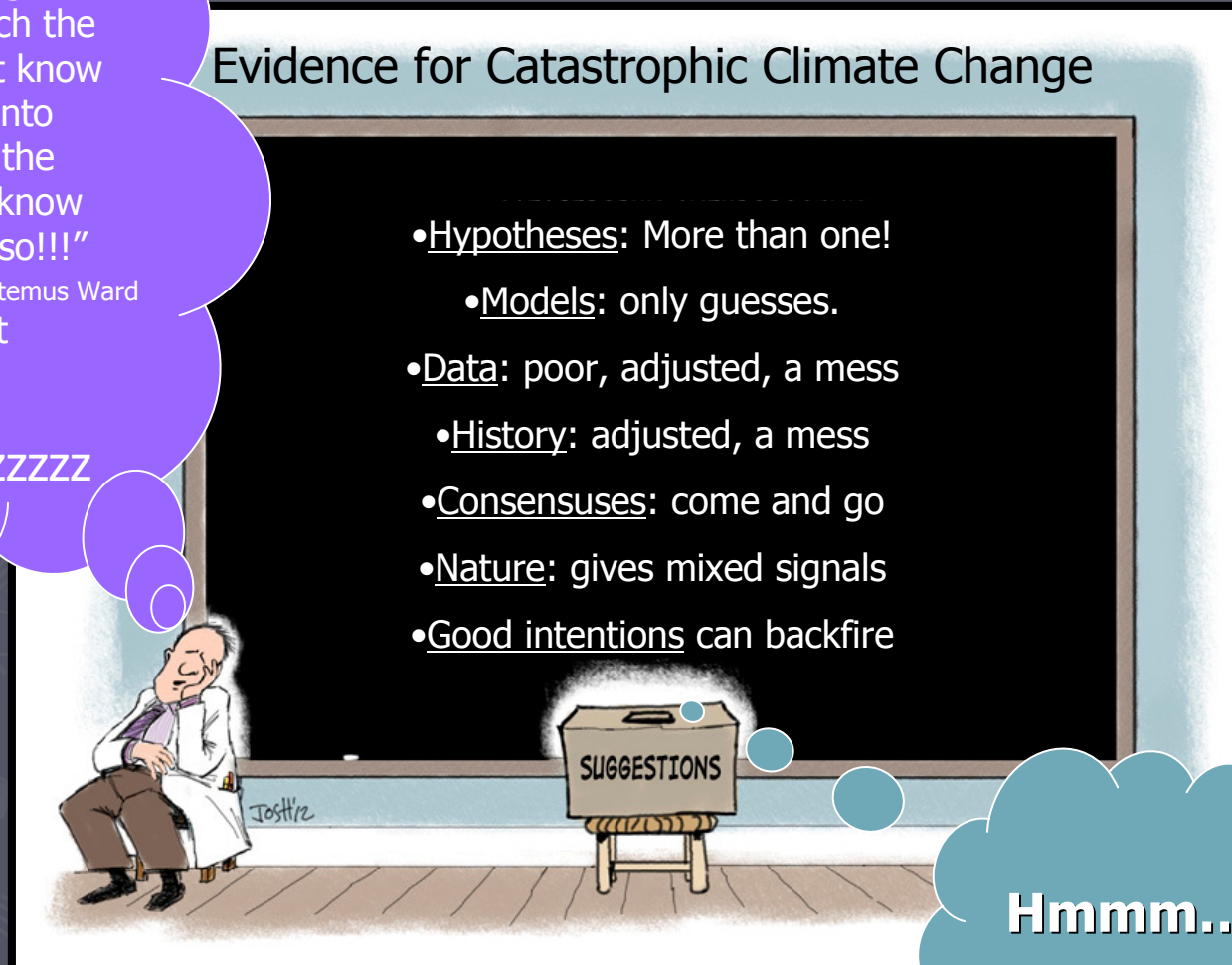
Artemus Ward

It's all most  
*certainly*  
uncertain!

..ZZZZZ

## Evidence for Catastrophic Climate Change

- Hypotheses: More than one!
  - Models: only guesses.
- Data: poor, adjusted, a mess
  - History: adjusted, a mess
- Consensuses: come and go
- Nature: gives mixed signals
- Good intentions can backfire



Hmmm...



CONSENSUS: It “seems” right

SCIENCE: Just because it *seems* right doesn’t mean it necessarily *is*!!!

Not everyone who eats ice cream is fat.

Not everyone who is fat eats ice cream.

Few systems are so simple...



The End