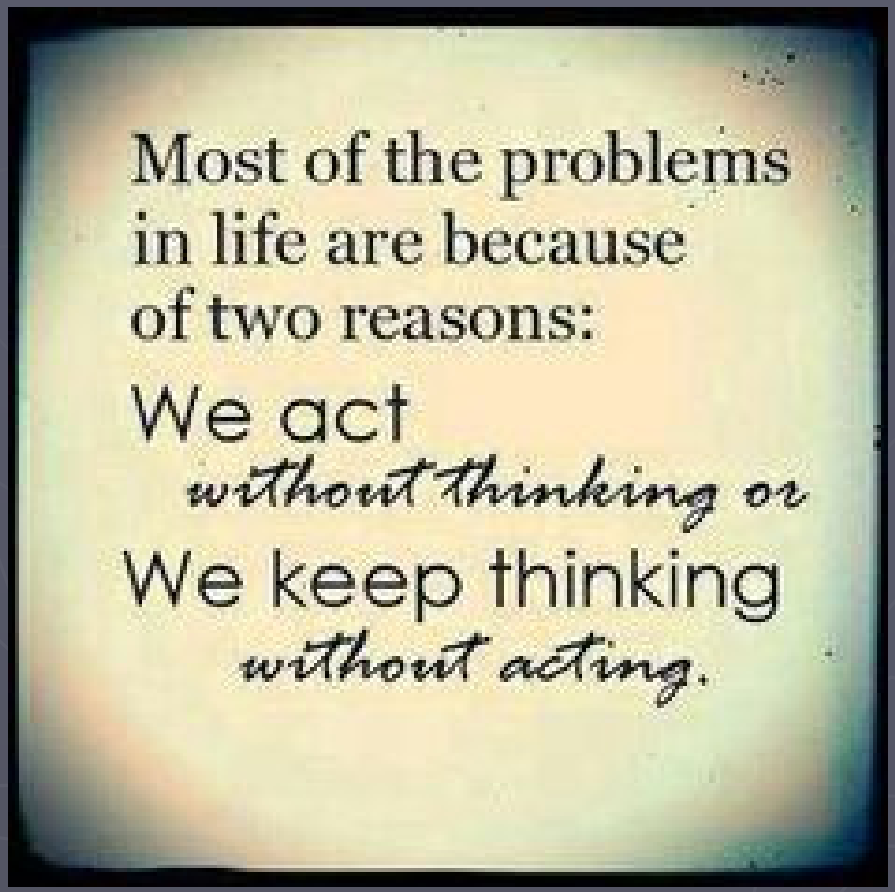
Uncertainty in Climate Science

Good Decisions…



Require Good Evidence…

By

Marcia Glaze Wyatt

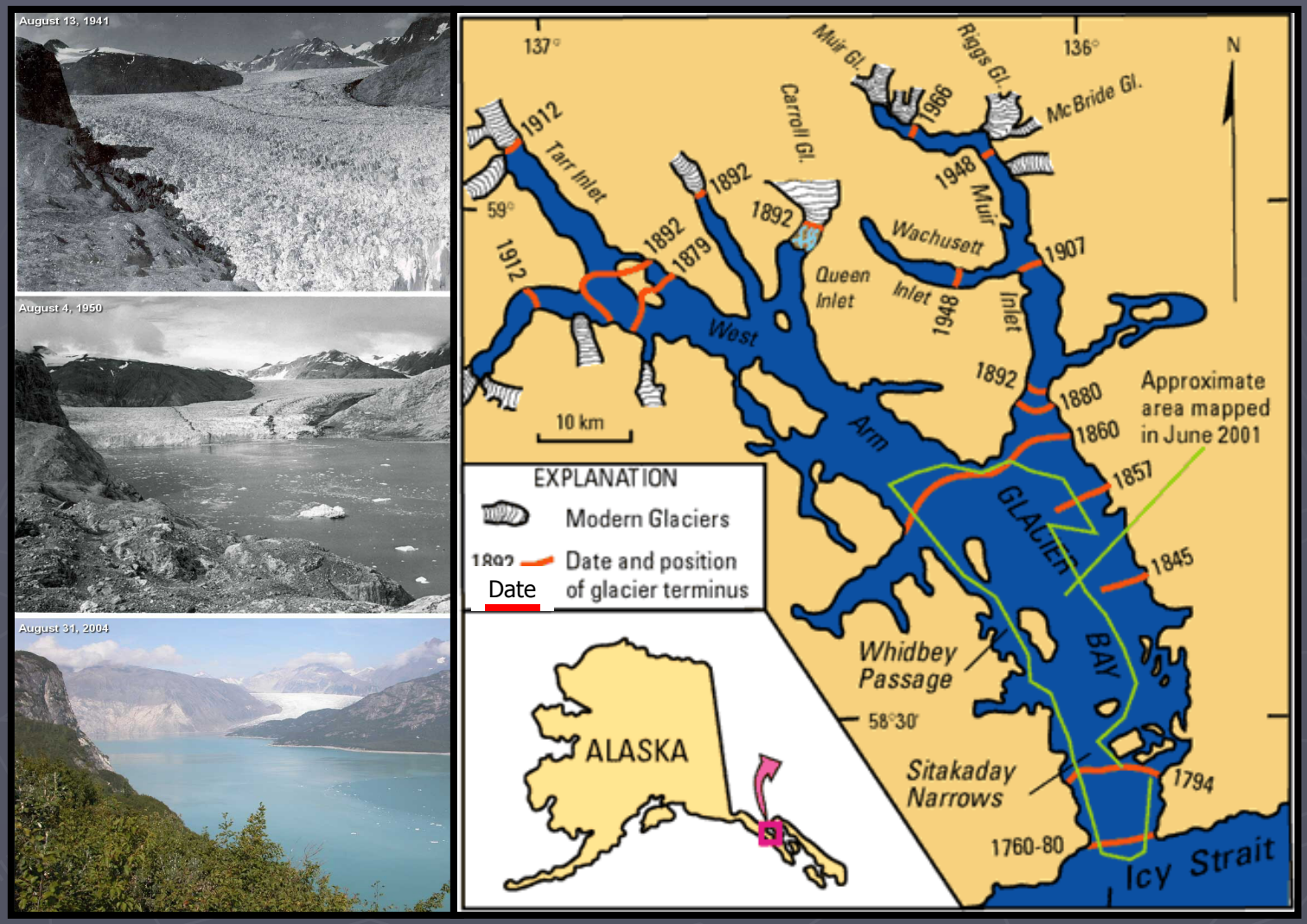
Seeing is Believing

Or Uncertainty:

August 1941

August 1950

August 2004



References: WUWT discussion; USGS maps and descriptions

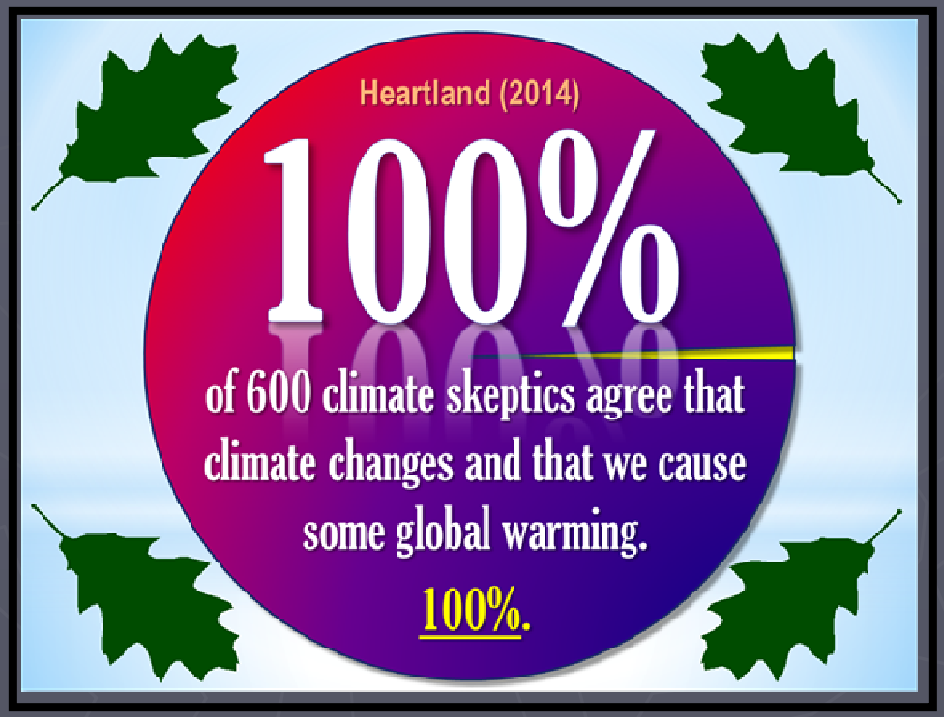
Seeing is Believing

Or Uncertainty:

"Experts" differ on conclusions

And the Experts Say

Which Experts?

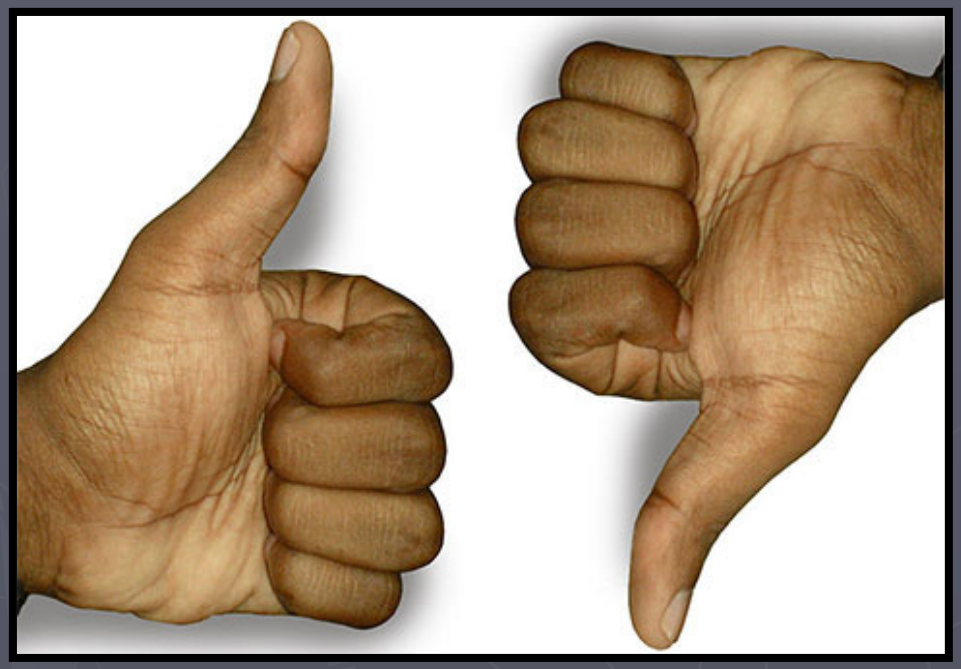


"Experts" differ on conclusions

Scientists Agree:

- Temperatures have increased since 1850
- CO_2 has increased since 1850
- CO_2 is an infrared warmer
- With no +/- feedbacks, 2x CO_2 → 1.1°C increase (~2°F)

But They Disagree On:

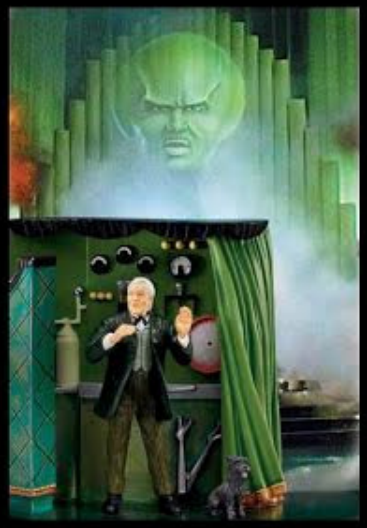


- If there really is a problem
- Consequences of proposed solutions

- How much T has risen
- T increase due to CO2
- 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

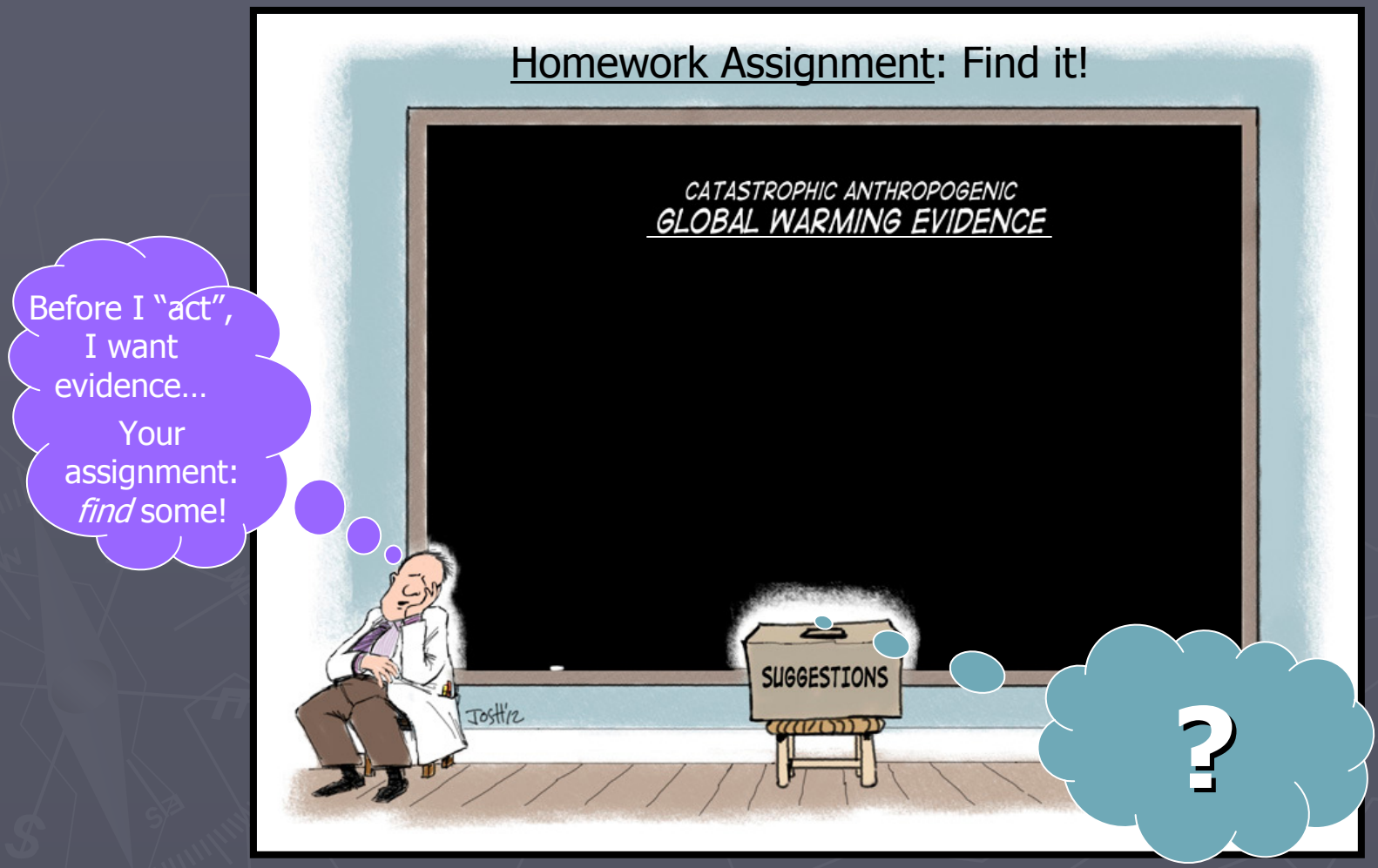
The "Oz" of Uncertainty



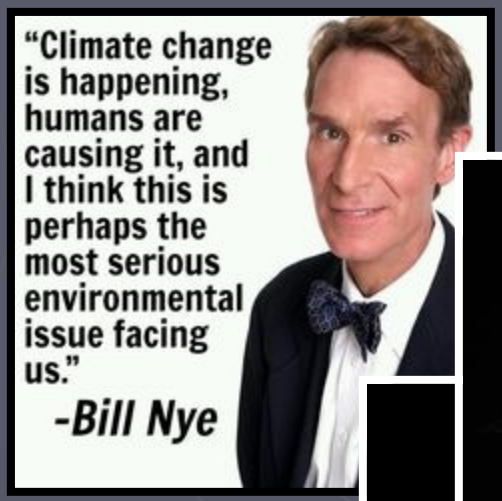
Fear Thrives on Credulity

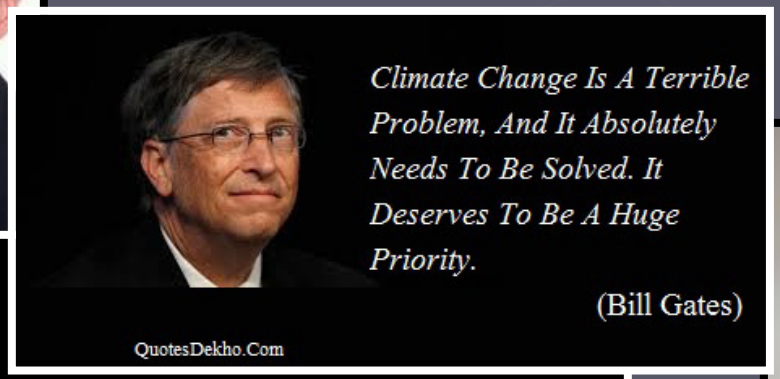
And Retreats into Proper Proportion with Scrutiny

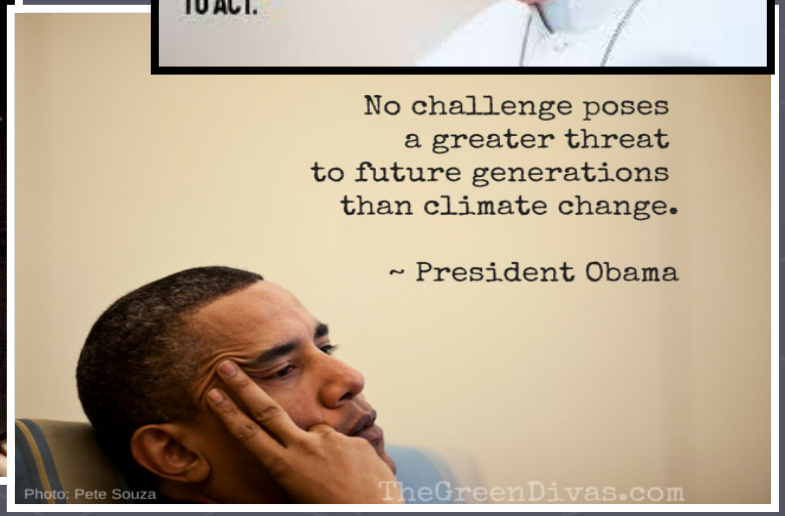
What is the Evidence?



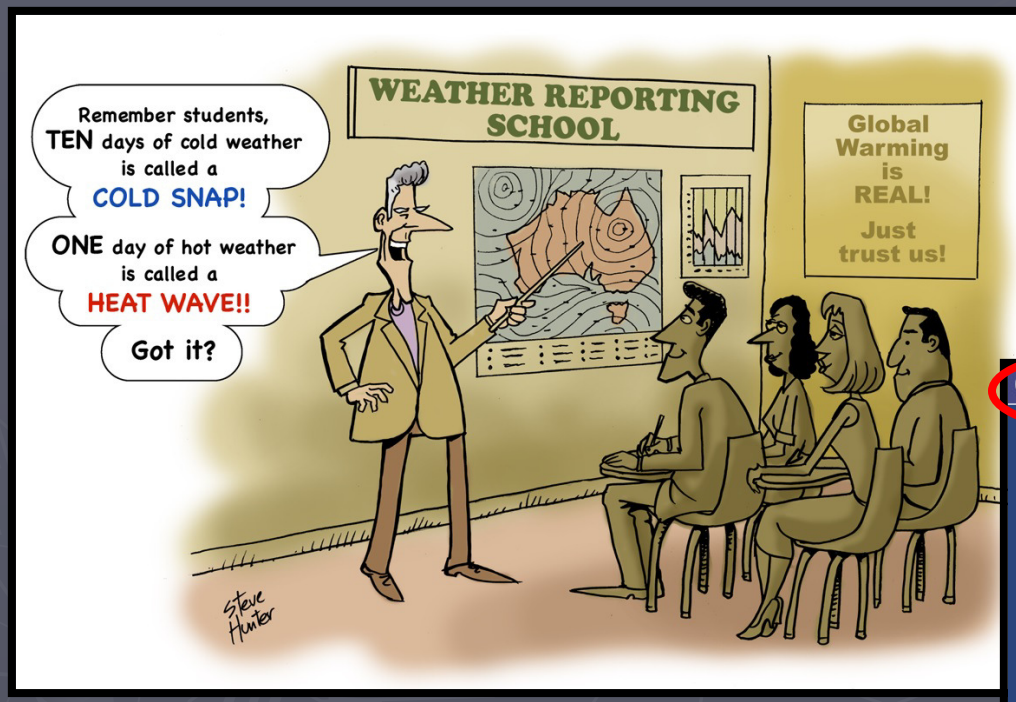
Hard Evidence Must Exist!

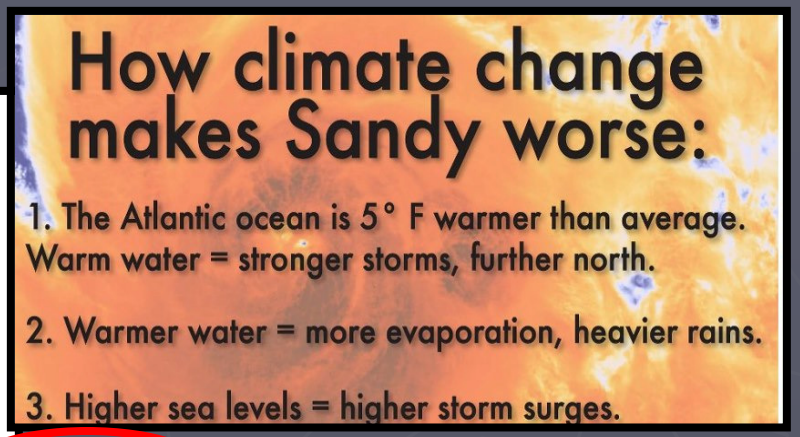


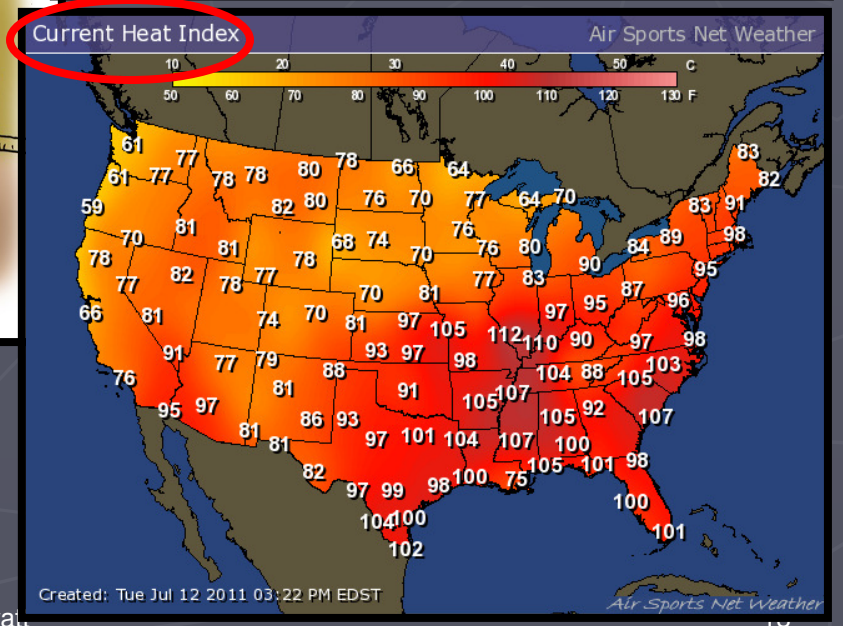




Media Supply "Evidence"

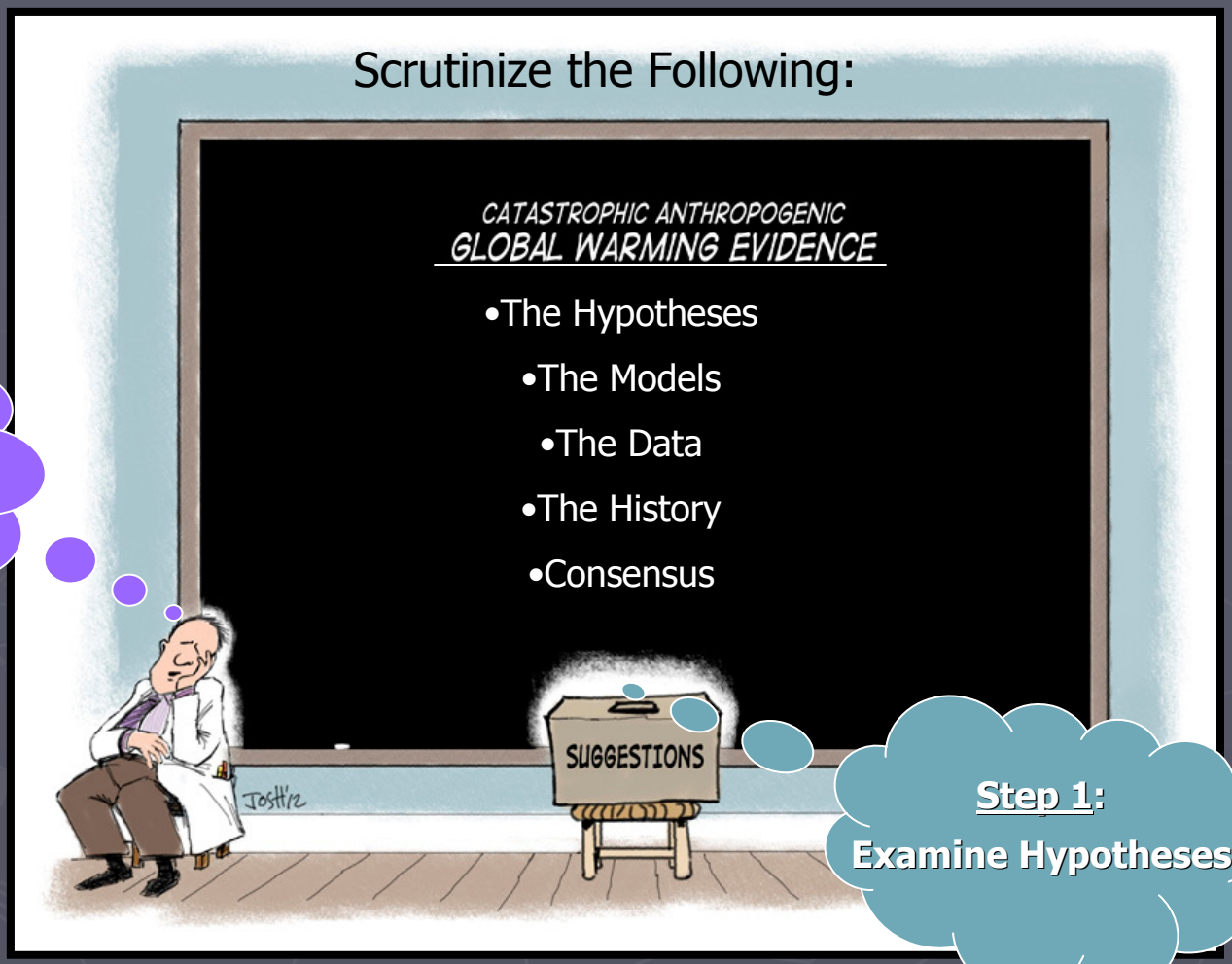






Perception Creates Reality!

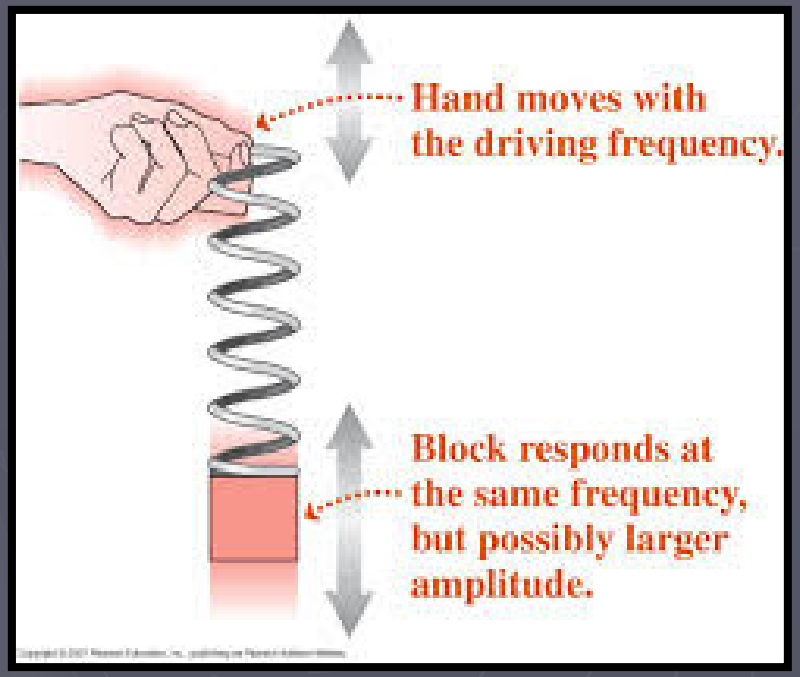
Let's Dig Deeper



How *Might* Climate Work?

Consensus Hypothesis:

Internal Dynamics: Minor Role



External Forcing Directly Controls

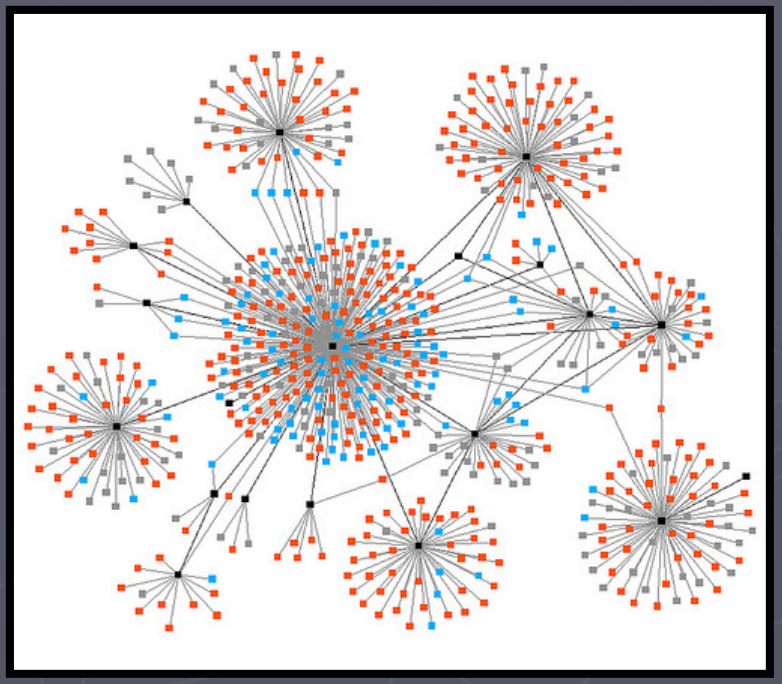
System Passively Responds

"Parts" Behave Independently

OR

Alternate Hypothesis:

Internal Dynamics: Major Role



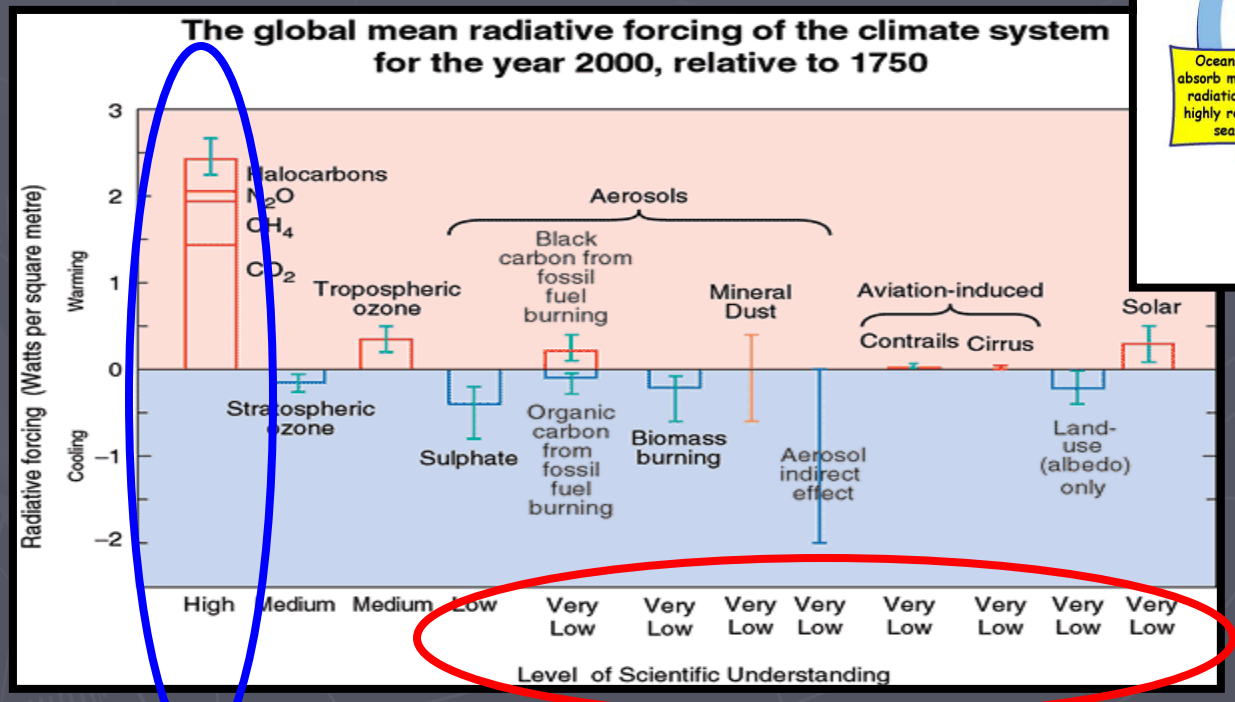
External Forcing Supplies Energy

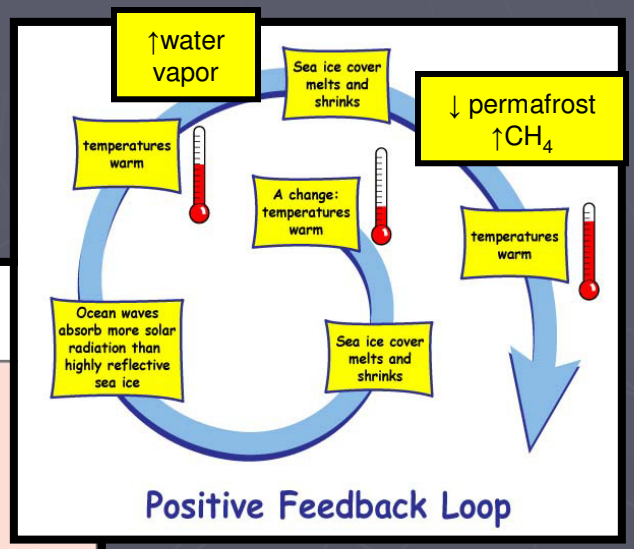
Network "Parts" Couple: Communicate

Self-Organized Collective Behavior

"Consensus" Hypothesis

External Forcing Dominates Climate Signature





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

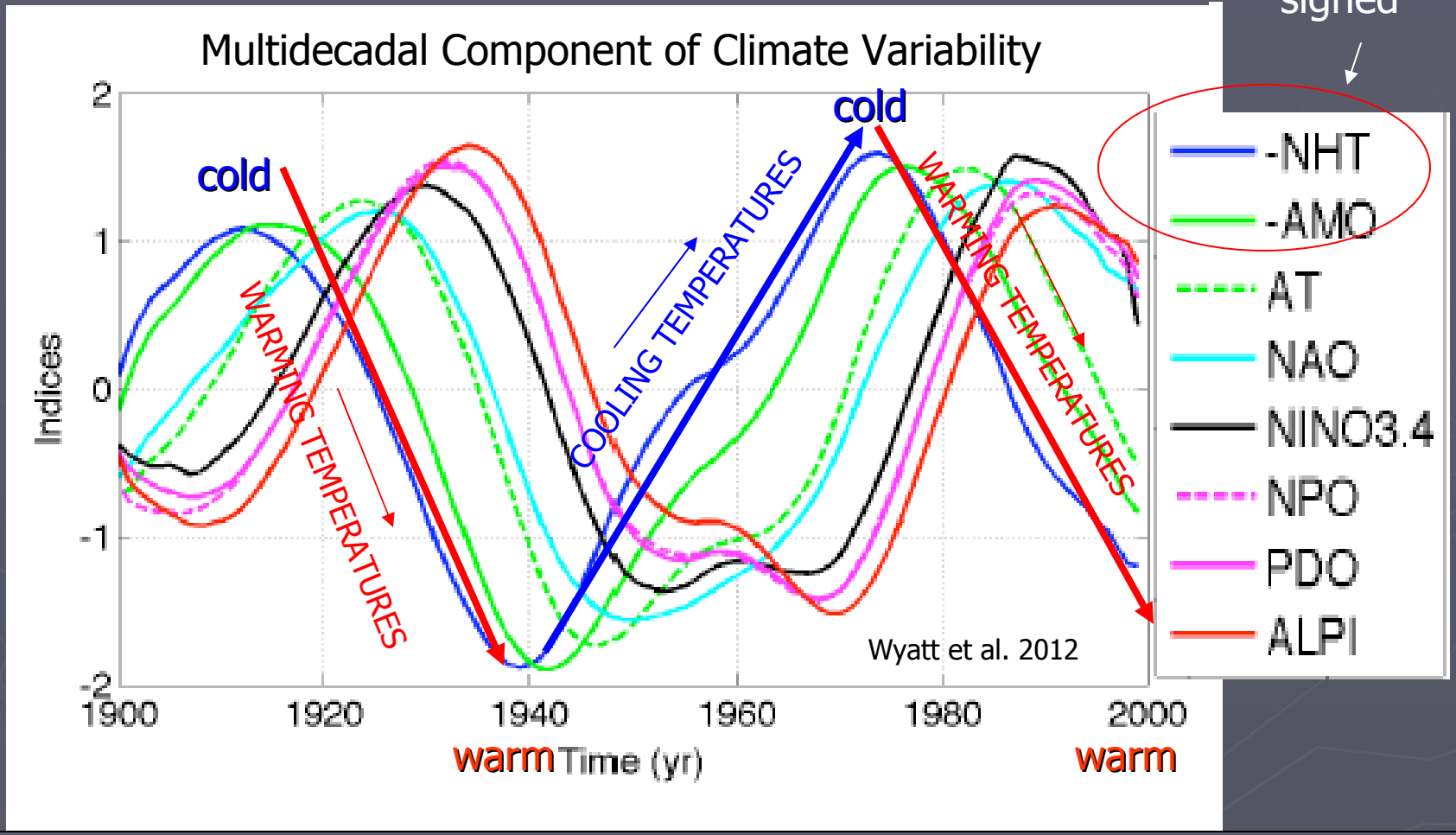
Note: Low to Very Low Understanding for all Negative Feedbacks!

Alternate Hypothesis : Networks

Internal Dynamics Key!

"Stadium Wave"

On plot: Negatively signed

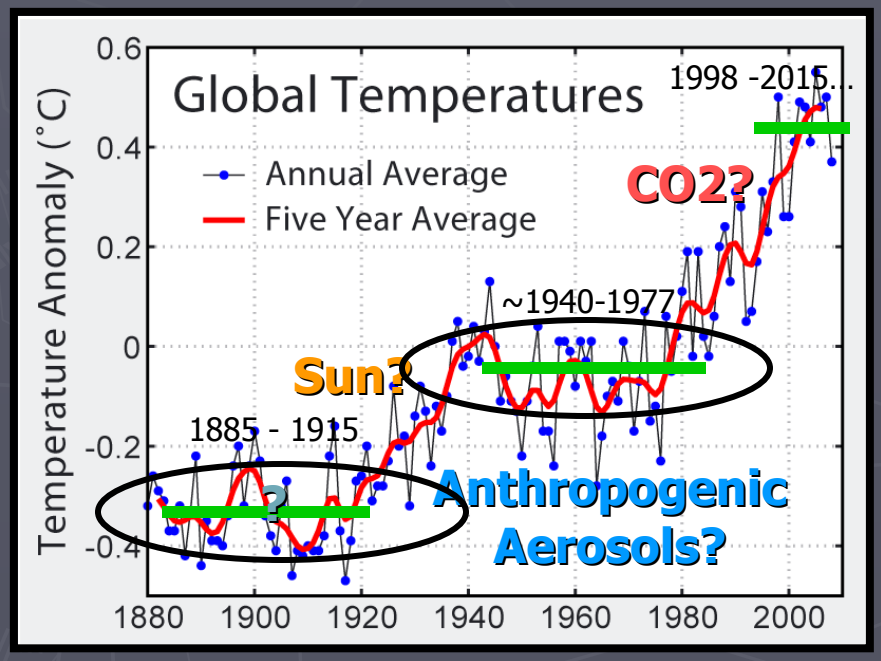


Cold Atlantic → ↑ Arctic ice → ↑ polar-equator T gradient → ↑ W-E wind flow → ↑ warm-air to higher latitudes → Δ Pacific oc/air circ → ↑ Arctic and NH Temps → warming Atlantic → ↓ Arctic ice → ↓ W-E winds → ↓ warm air to higher latitudes → ↓Ts …

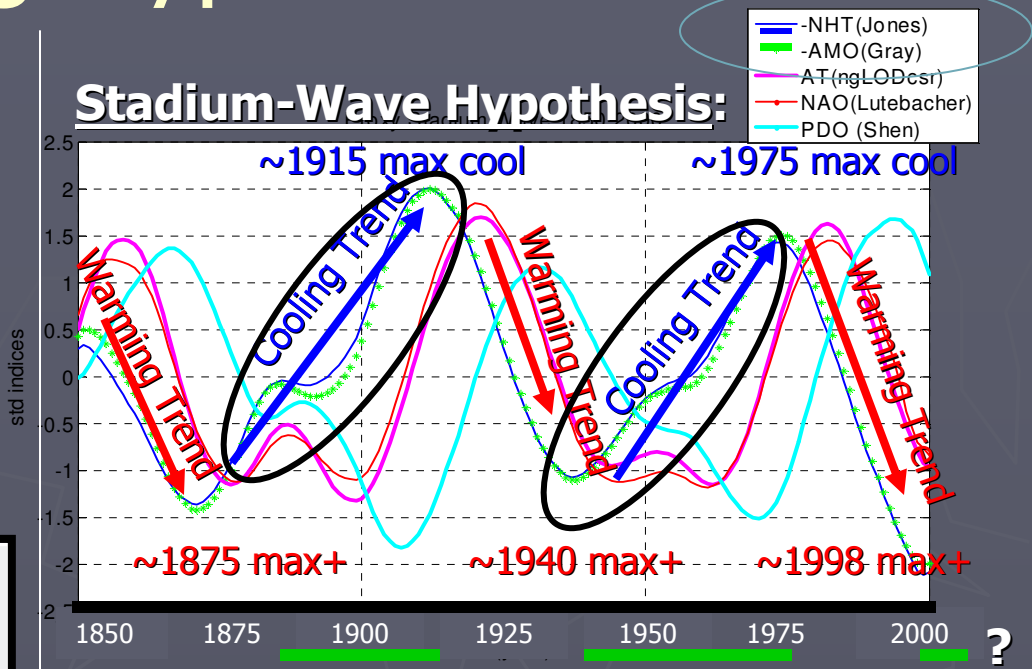
Comparing Hypotheses

Consensus Hypothesis (CO2):

- 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:



?

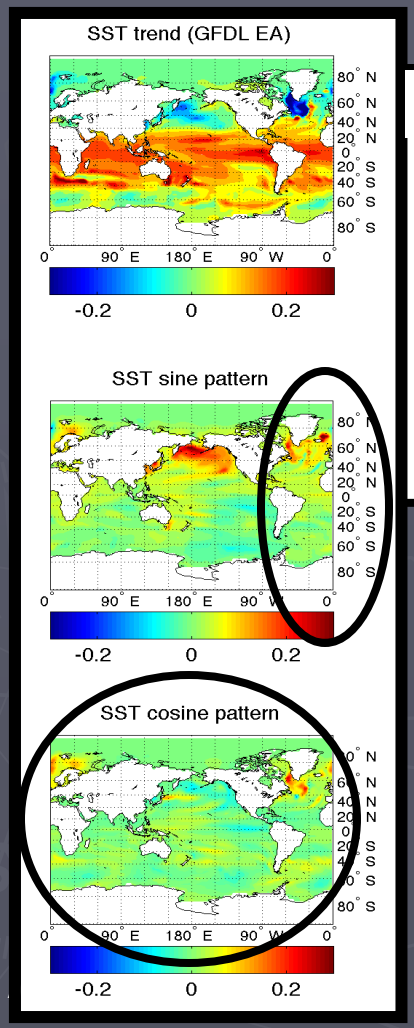
- Consistent with T-trend "wiggles"
- Cooling MD trends ≈ "pauses" on T-trend
- Hypothesis directly testable (with time)
- Observed T & climate index data capture
- Not mutually exclusive w/ external F

pauses

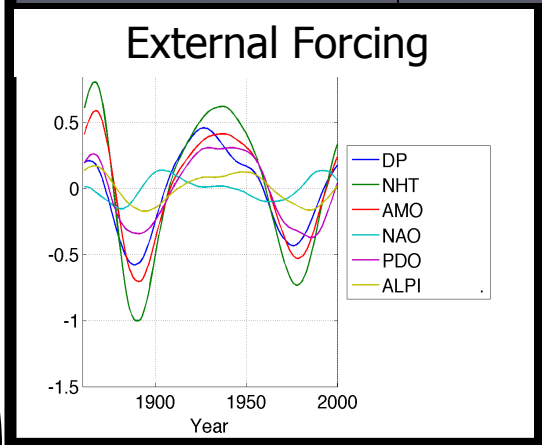
Modeled vs. Observational Data

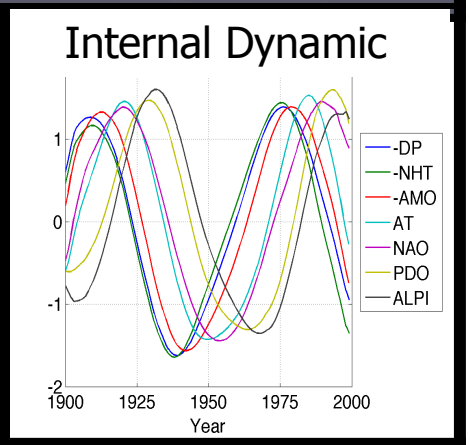
Modeled Data Do Not Capture Network Behavior; Observational Data Do!!!

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



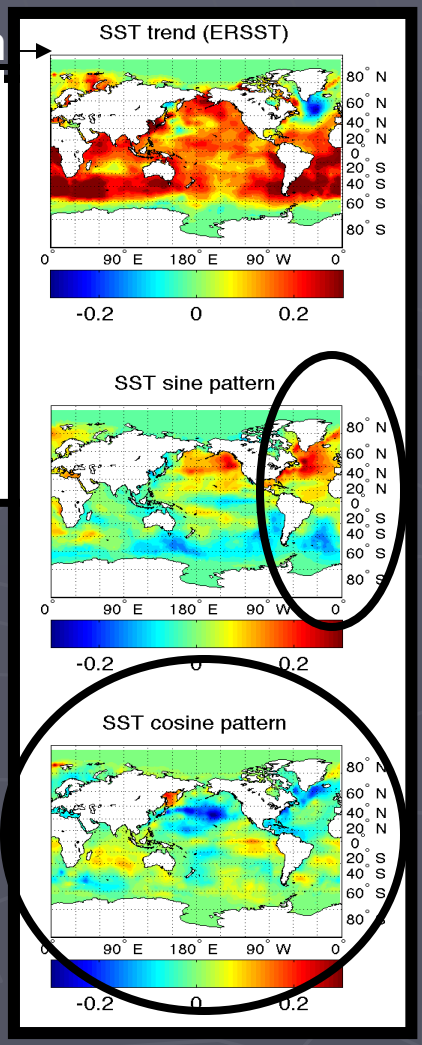
← **Model Data** **Observational Data**





no propagation

propagation



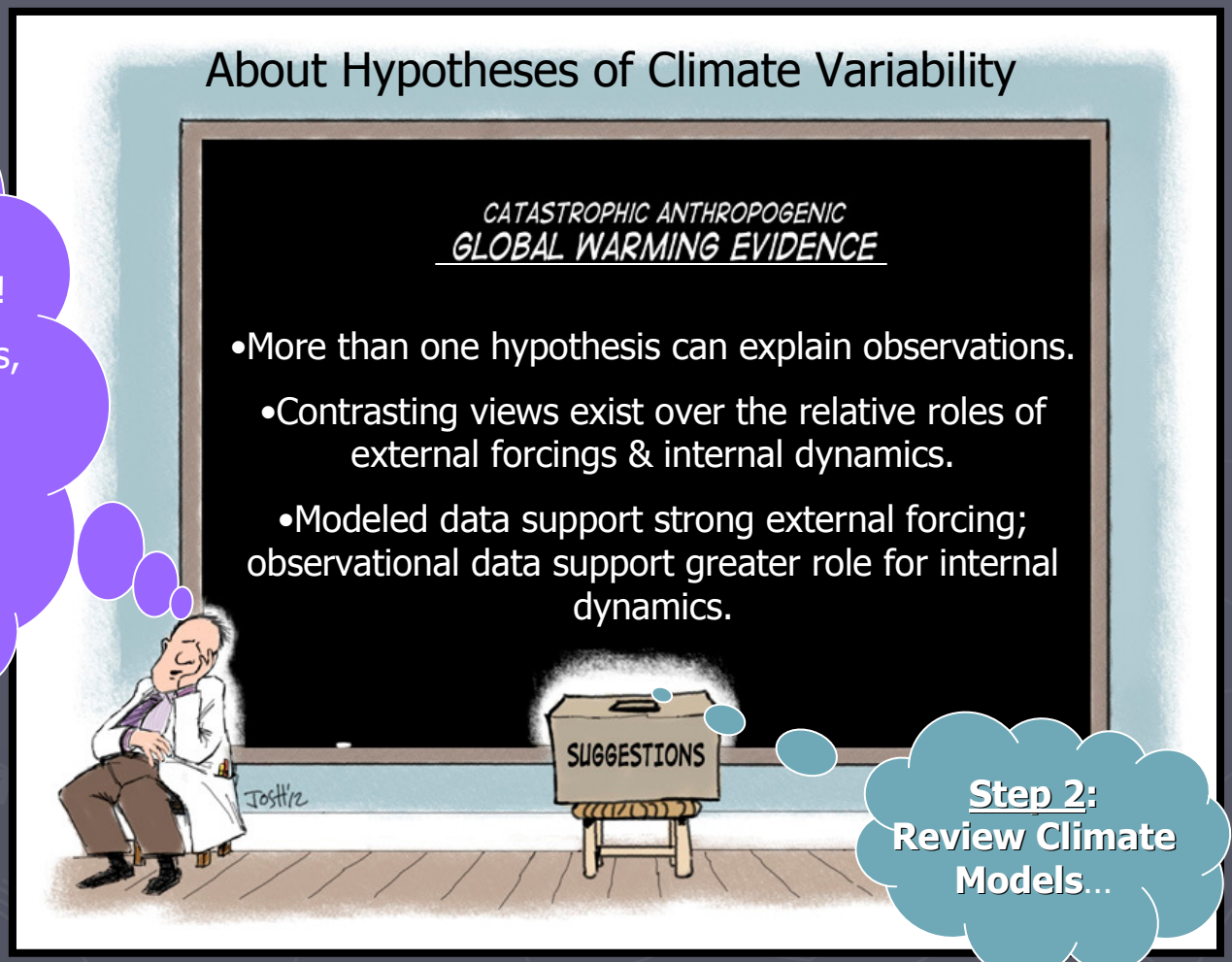
Difference between these Views:

Relative Roles of External vs. Internal

Kravtsov, Wyatt, Tsonis, Curry 2014

Marcia Glaze Wyatt

What You Learned :



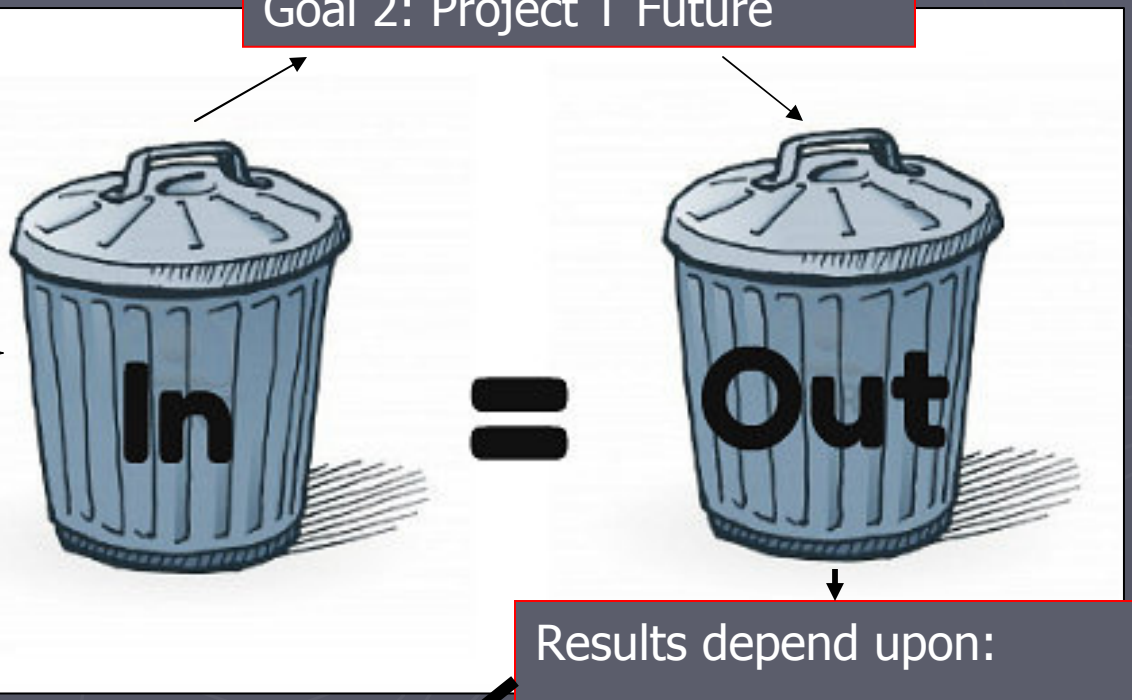
Model Forecasts & Limitations

Input differs for each model design

- Estimated Parameterizations
- Assumed Forcing
- Basic Physics
- Assumed Climate Sensitivity
- Hypothesized Dynamics
- Data

Goal 1: Reconstruct T History

Goal 2: Project T Future



Results depend upon:

Input

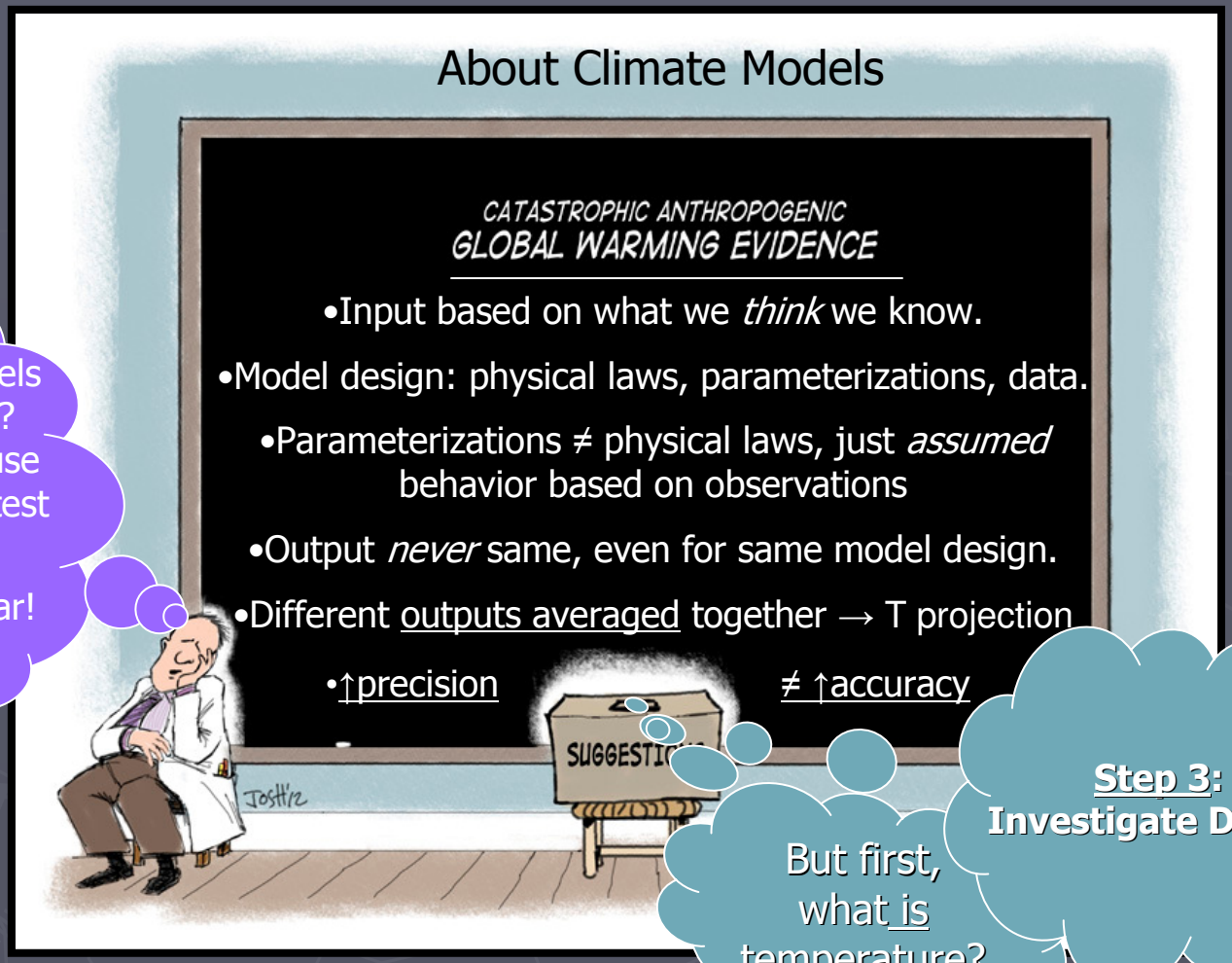
Beginning conditions

Model design

Results compared to historical observed data.

Tweak…

What You Learned :



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.

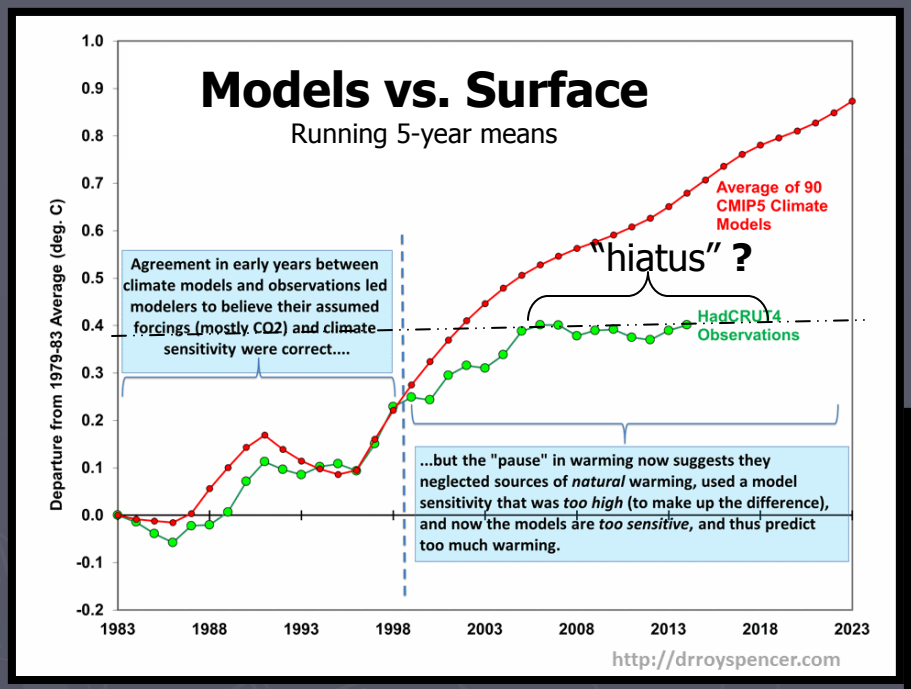
Temperature describes a condition; it is NOT heat!

Averaged Temperature describes nothing. It is a statistic!

Heat is constantly re-distributed.

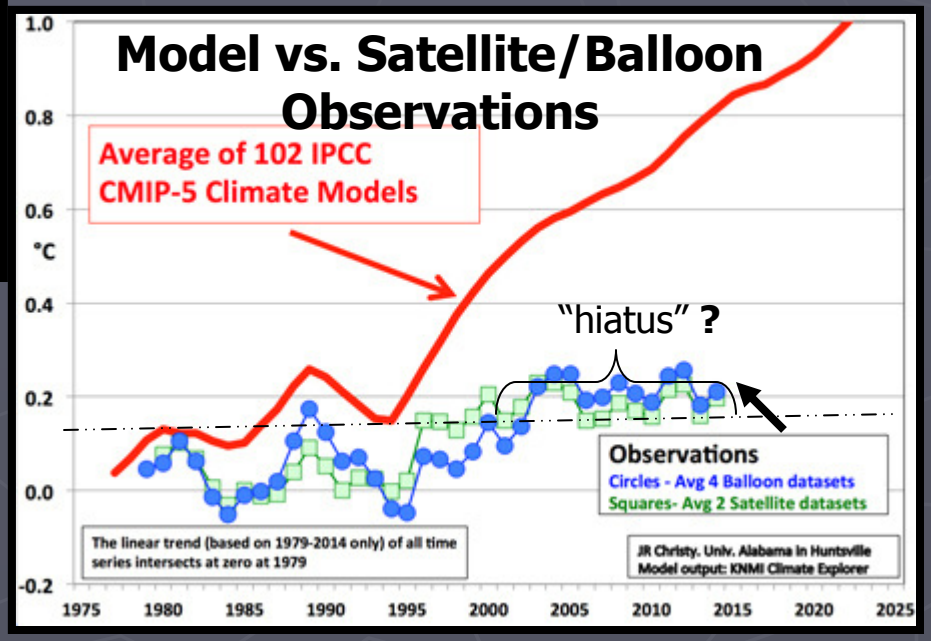
Ts, alone, don't tell that story well.

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

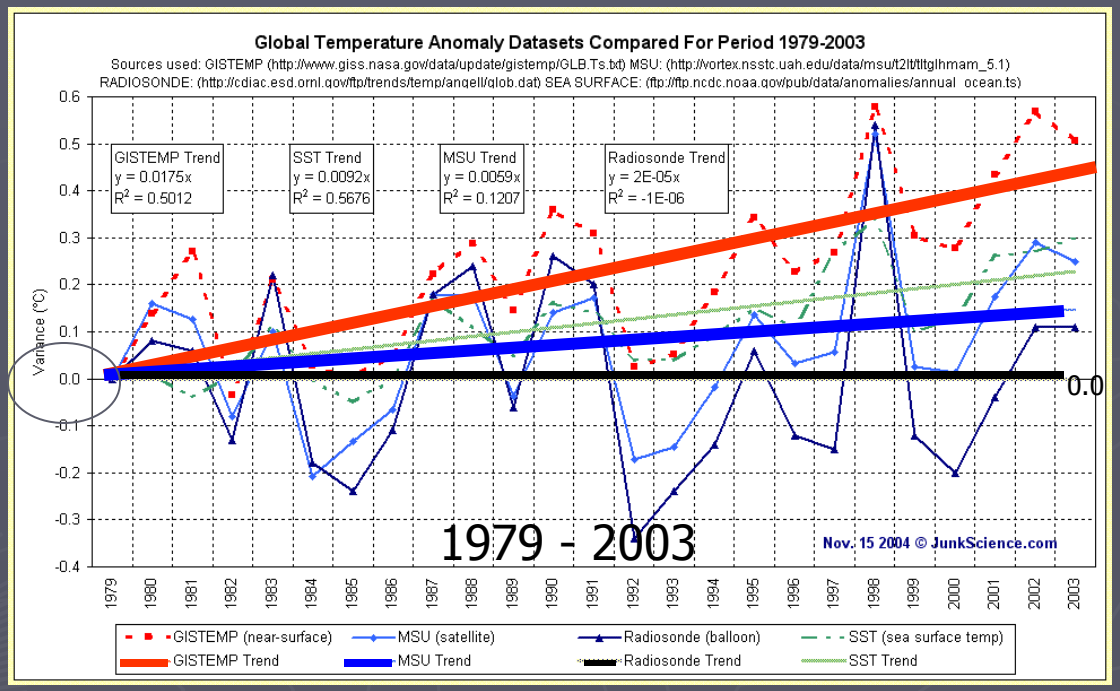
And How About Other Data?

Surface ≠ Satellite/Balloon

Surface T ≠ Satellite T

Surface T ≠ Balloon T

Satellite T = Balloon T



Surface Ta

Satellite Ta

Balloon Ta

Ta: T anomalies

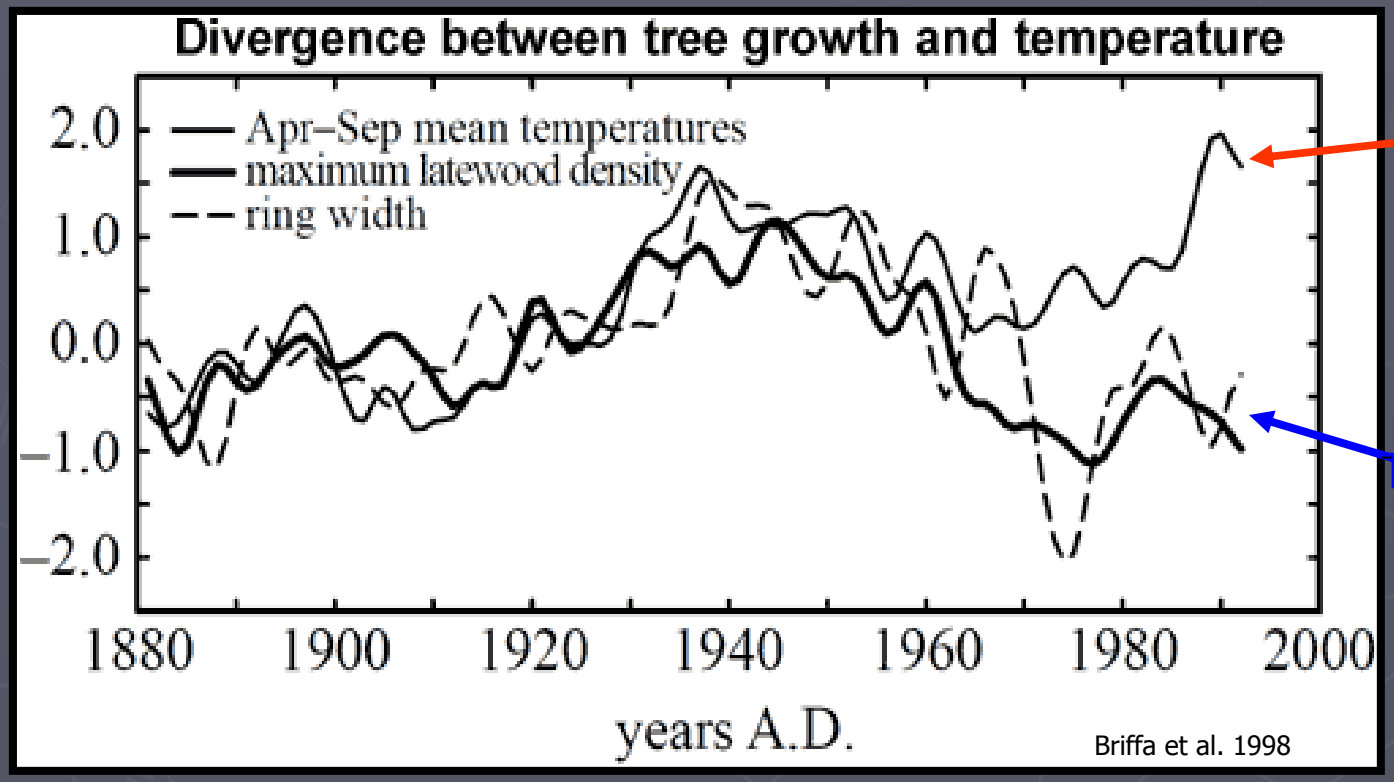
Satellite and balloon data reflect little long-term T trend in lower troposphere.

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

Not what we see.

Surface T ≠ Tree-Ring Data :

Summer temperatures



Surface Ta

Tree Ring Ta

Ta = temperature anomalies

Reanalysis "Data": packaged mix!

Mixing real with not-real

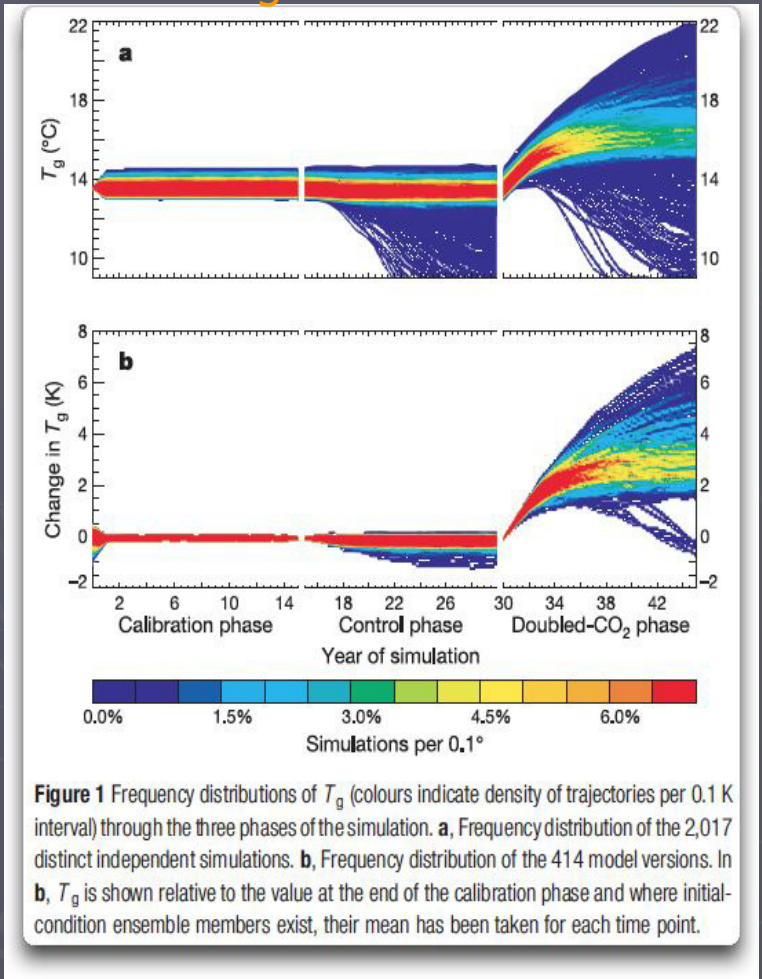


Figure 1 Frequency distributions of T_g (colours indicate density of trajectories per 0.1 K interval) through the three phases of the simulation. **a**, Frequency distribution of the 2,017 distinct independent simulations. **b**, Frequency distribution of the 414 model versions. In **b**, T_g is shown relative to the value at the end of the calibration phase and where initial-condition ensemble members exist, their mean has been taken for each time point.

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:

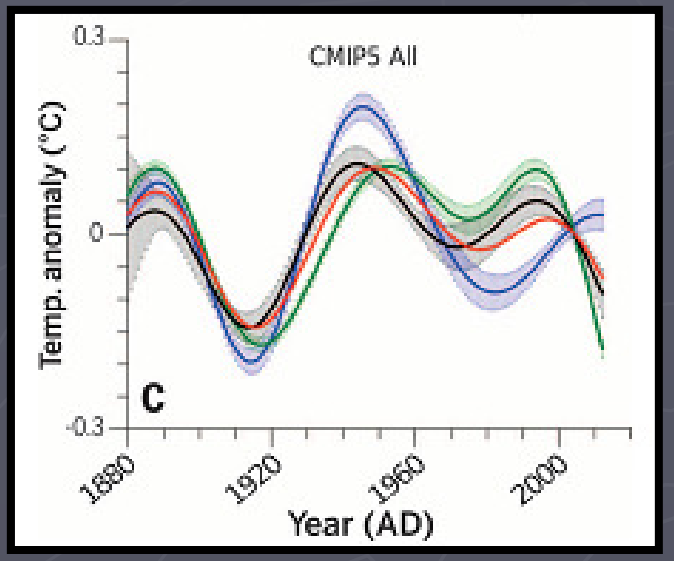
Is Forced-Signal "recipe" right?

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???

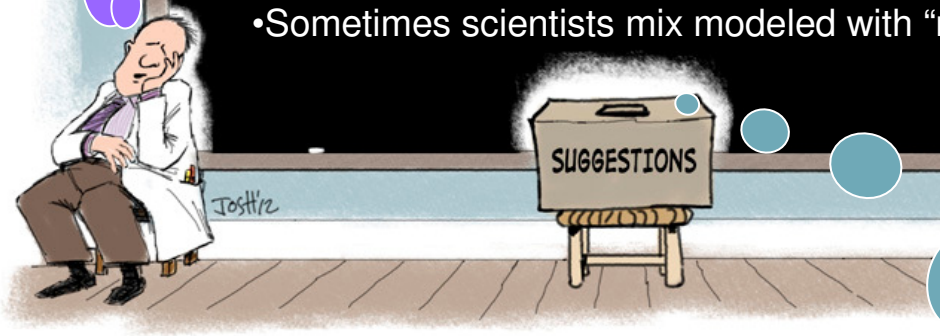
And sometimes we fill in (or substitute) "real" data with model output. Other times we mix "real" data with "modeled" output.

Oh my!!!

About Temperature and T Data Records

CATASTROPHIC ANTHROPOGENIC
GLOBAL WARMING EVIDENCE

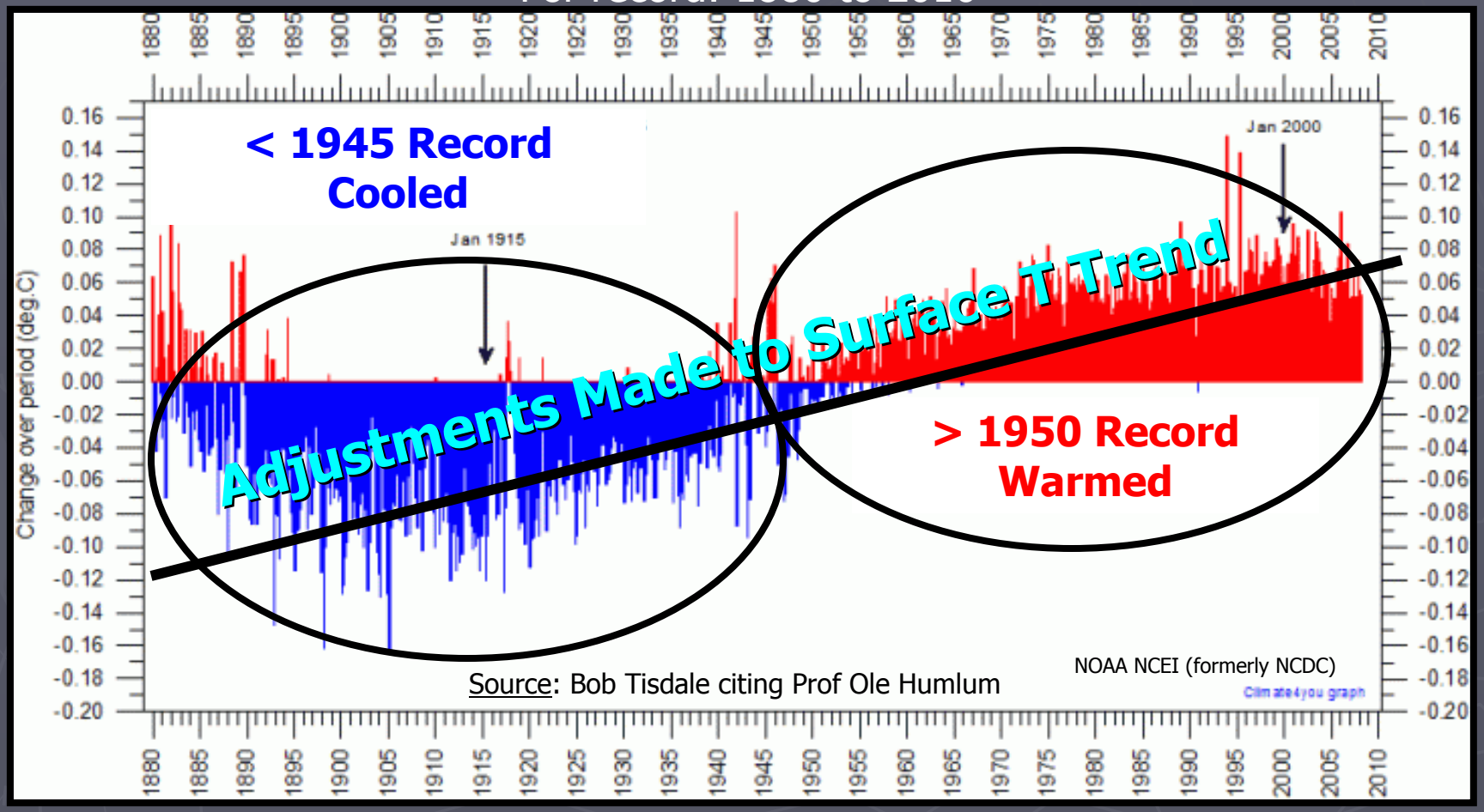
- Temp is not heat; it is a local condition, not a quantity.
- *Average* Temperature is no more than a *statistic*.
- Four categories of T: surface, satellite, balloon, proxy.
- Modeled Ts match none! Surface Ts match none!
- Models fill in data "holes"; we pick and chose results.
- Sometimes scientists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



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

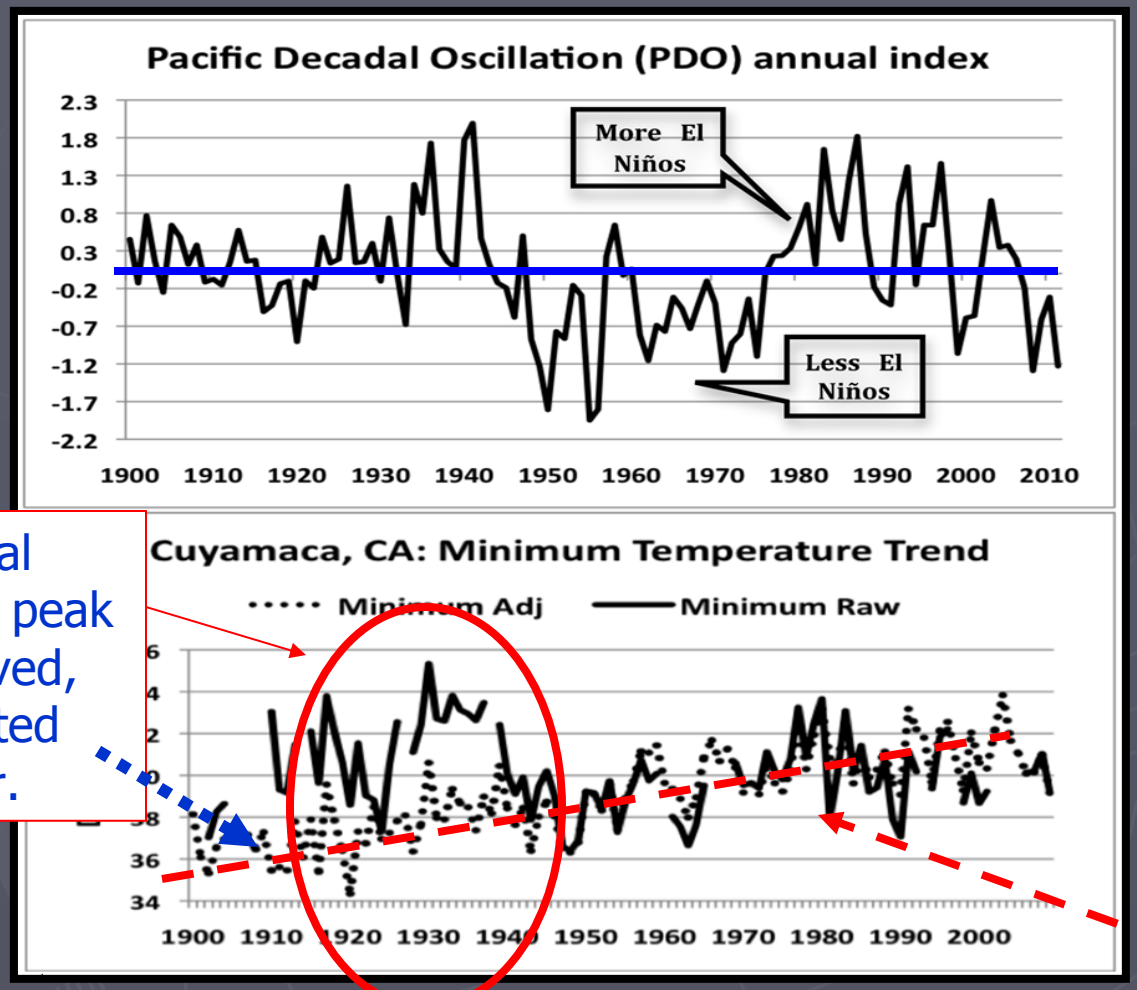
If trends don't match, change them!

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



Source: Bob Tisdale citing Prof Ole Humlum

Assumed Climate Behavior:



Natural warm peak removed, adjusted cooler.

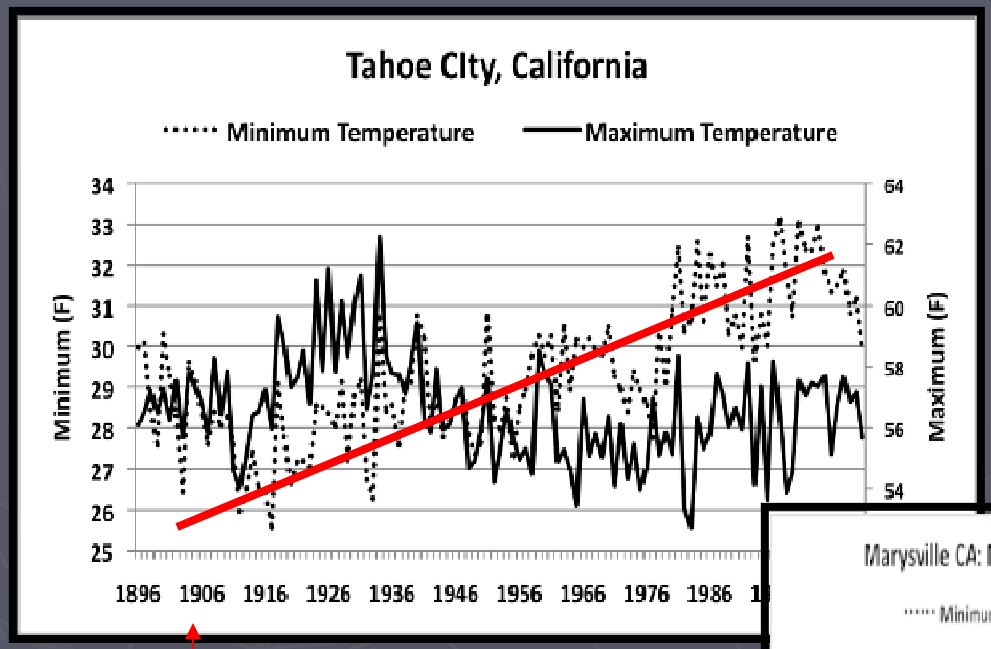
Source: Jim Steele - Landscapes and Cycles

Natural Influence on Temperatures: PDO

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

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

Homogenization: Blending Trends

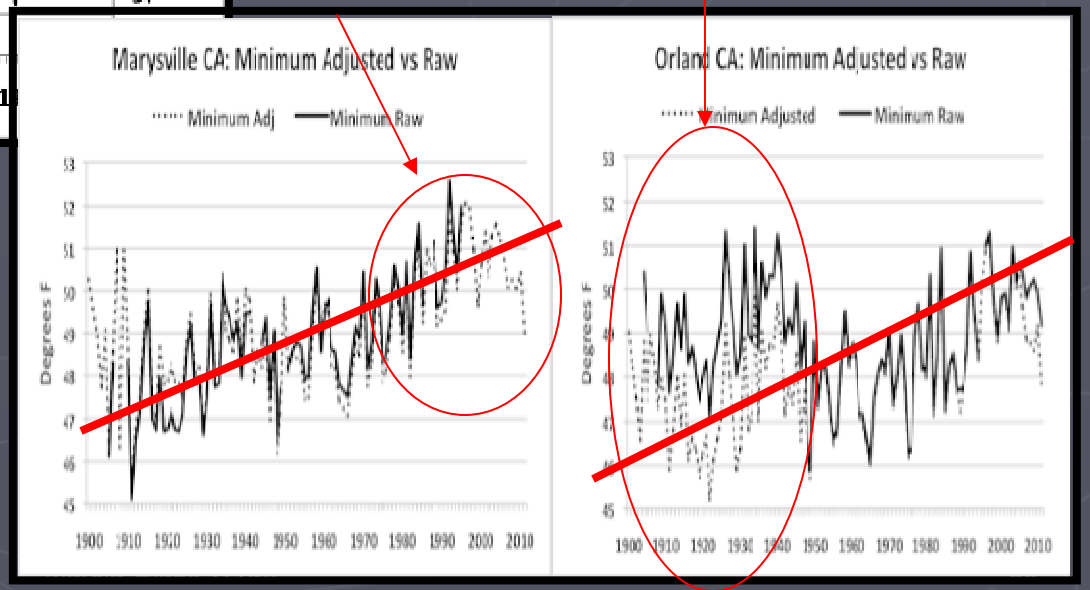


Urban-heat-island (UHI) effect:

Minimum Ts rise > than Maximum Ts

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).

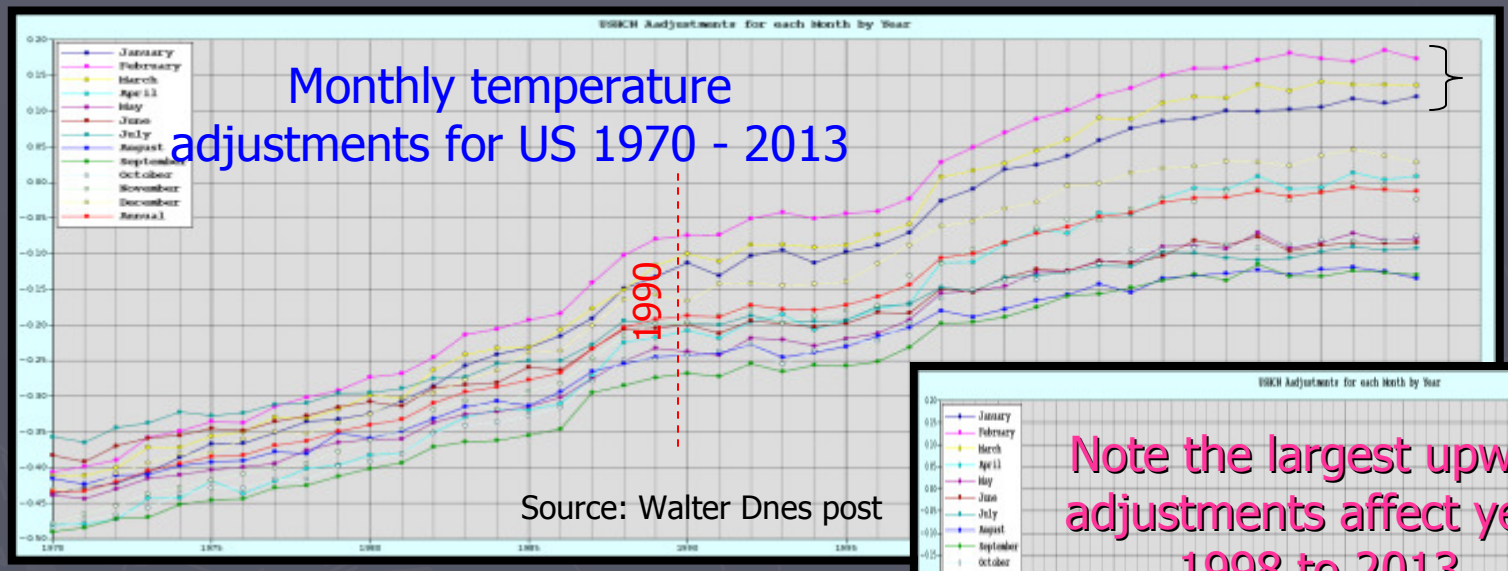


August 20, 2015

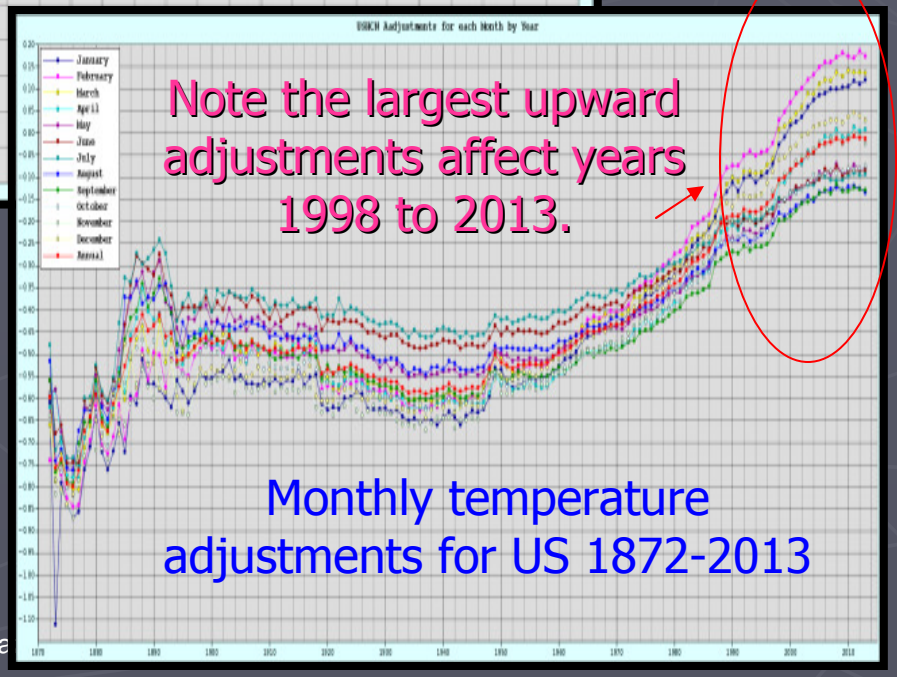
Plots from Jim Steele Landscapes and Cycles

Monthly Bias in U.S. Adjustments

USHCN temperature adjustments



February
March
January



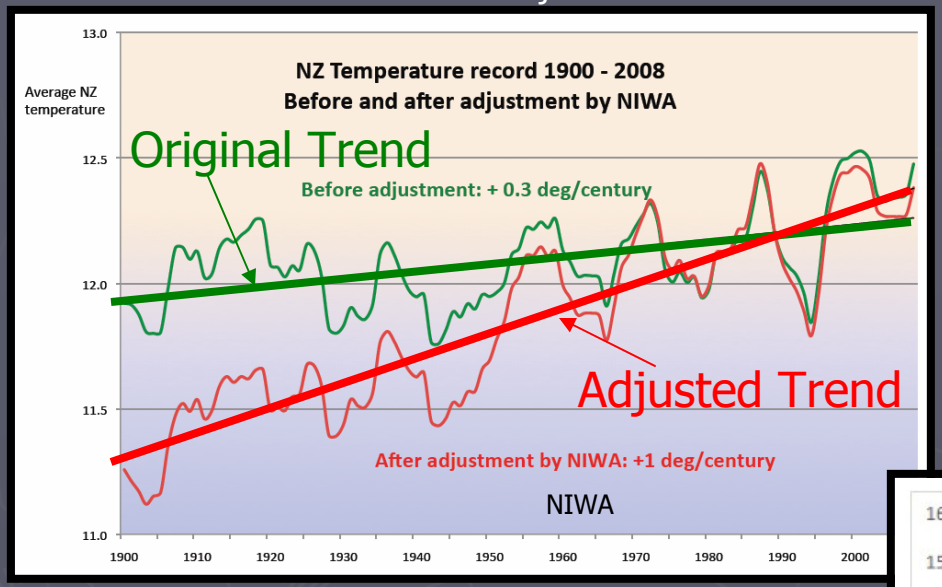
Cold months adjusted upward more than warm months.

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:

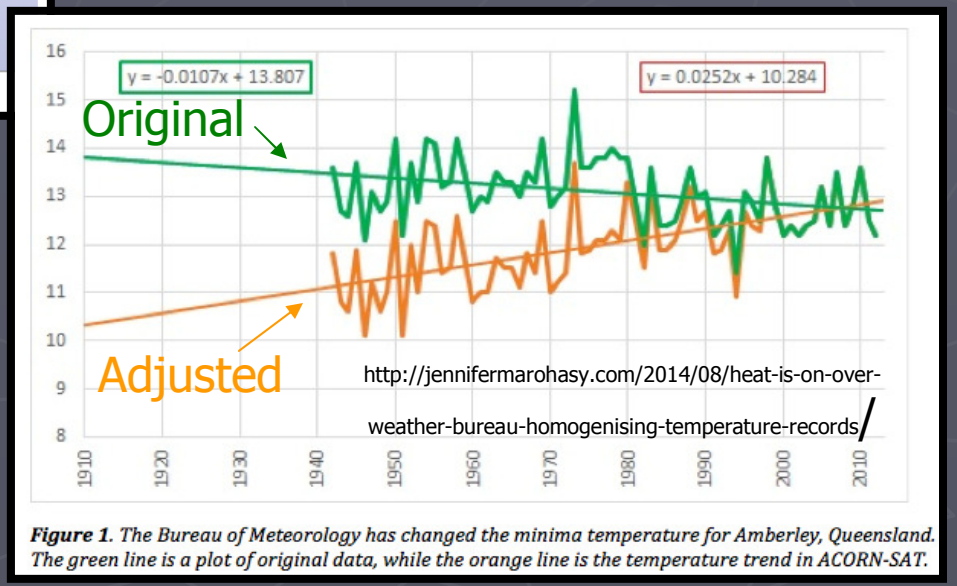
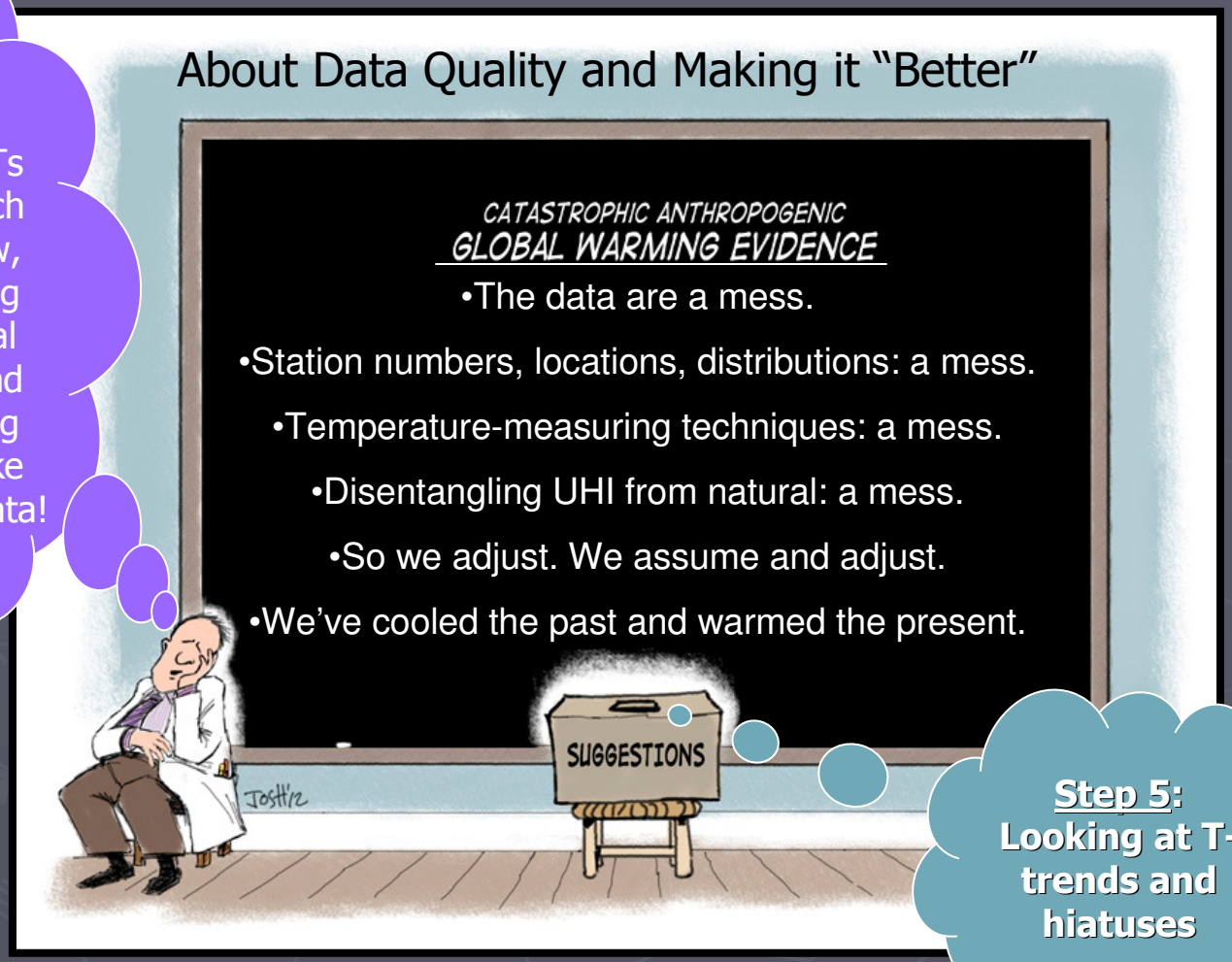


Figure 1. *The Bureau of Meteorology has changed the minima temperature for Amberley, Queensland. The green line is a plot of original data, while the orange line is the temperature trend in ACORN-SAT.*

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!!!



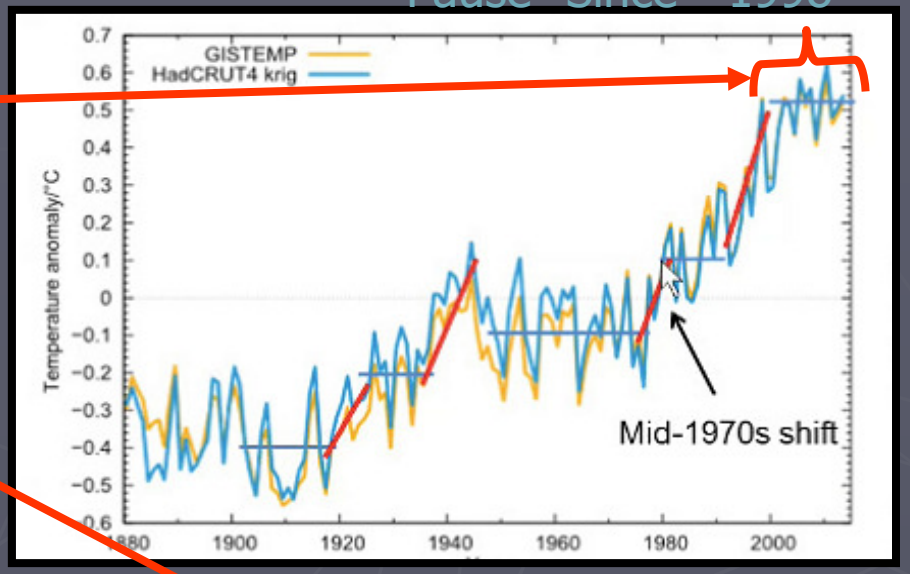
Step 5: Looking at T-trends and hiatuses

Did the Warming Pause? 1998 – 2015…

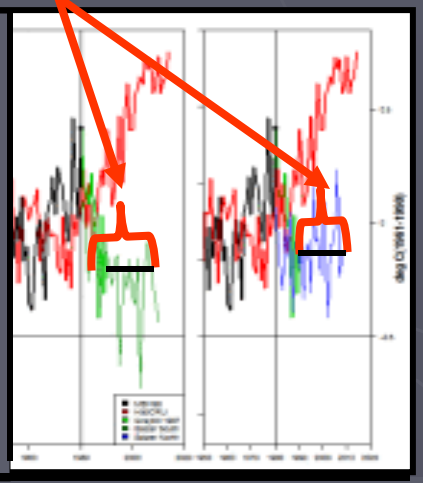
As of 2014, "hiatus" in:

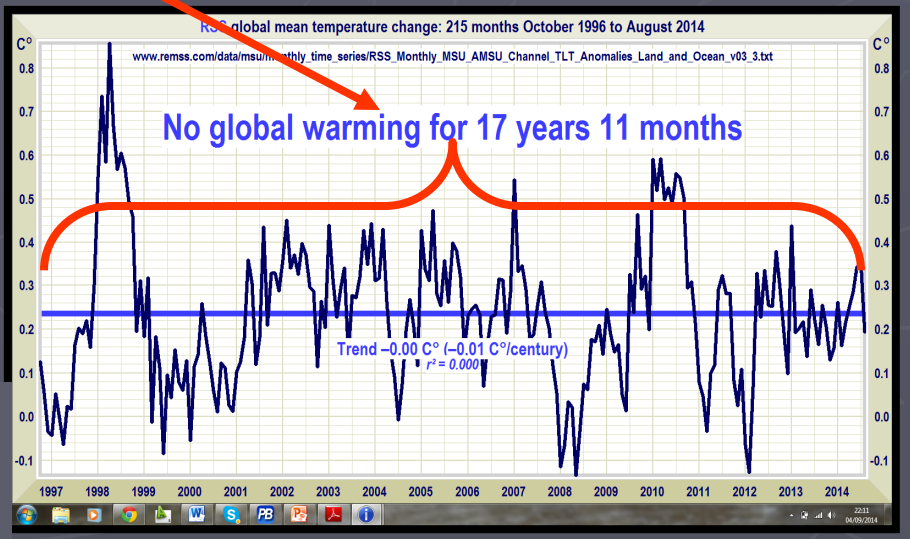
- Surface Record
- Satellite Record
- Balloon Record
- Proxy Records (?)

"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.



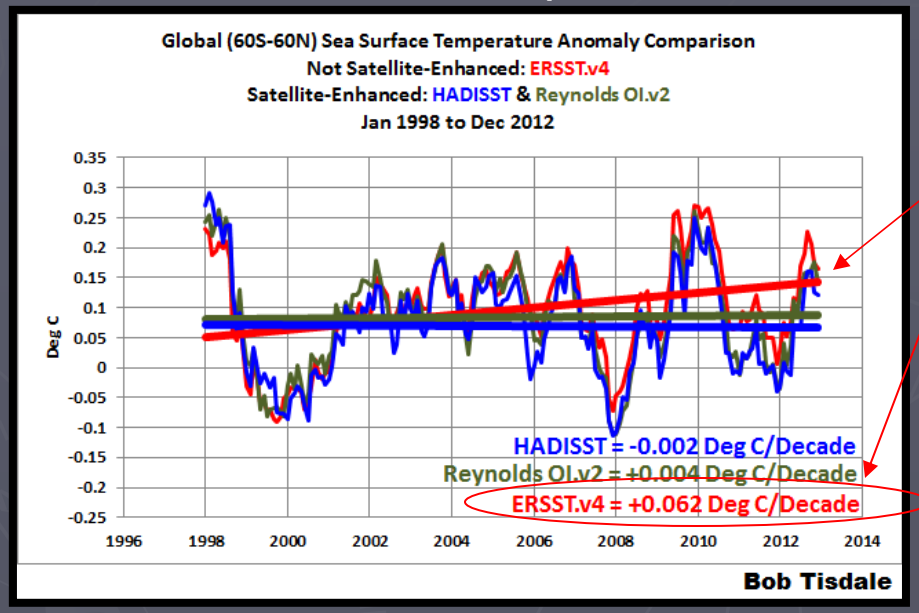


Note: No trend is evident in the proxy data plots from the end of the 1980s to 2014. Proxy data are highly controversial and arguments from both sides are valuable. Regardless of controversy, the question remains: why the dramatic differences between surface instrumentation, satellite retrievals, and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

Maybe We Can Adjust Some More:

Extra changes made to 1998 to 2014!

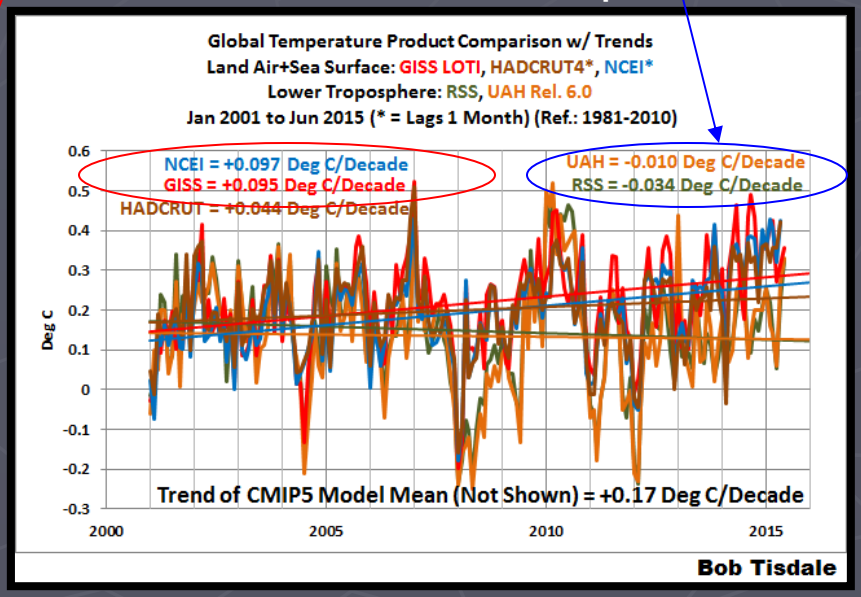
Sea Surface Temperatures



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

Satellite data were removed.

Land & Sea Surface Temperatures



NCEI: data removed "hiatus"

Two main changes:

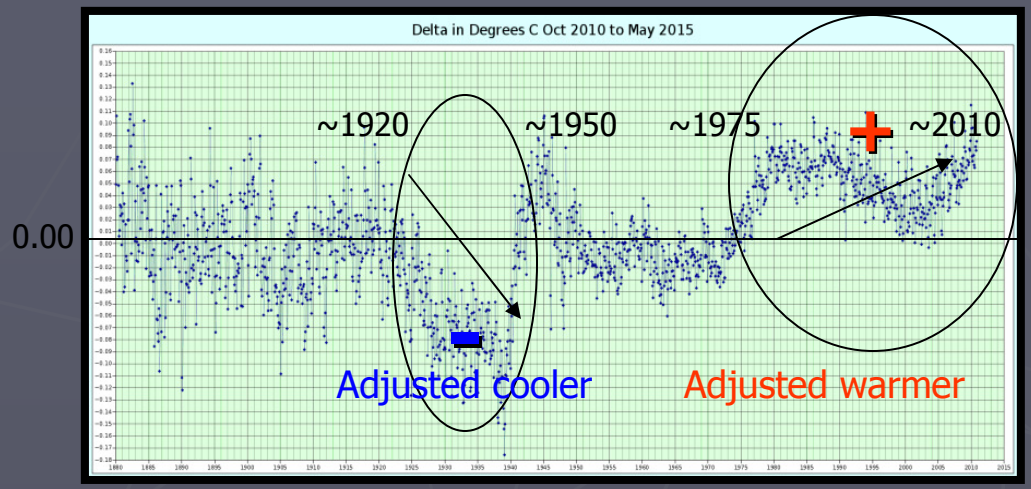
SSTs

Arctic Ts

Hiatus "Disappears" from Surface T

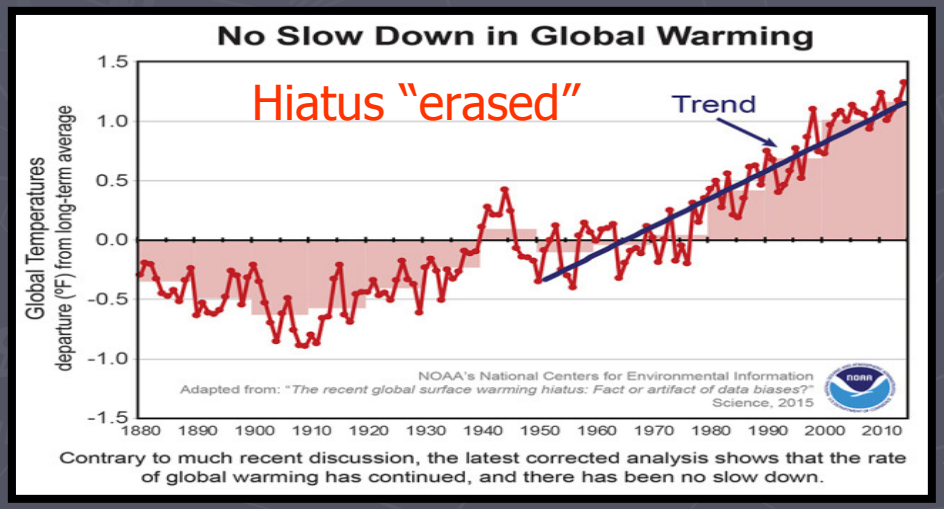
As of 2015 "hiatus" in:

- ~~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

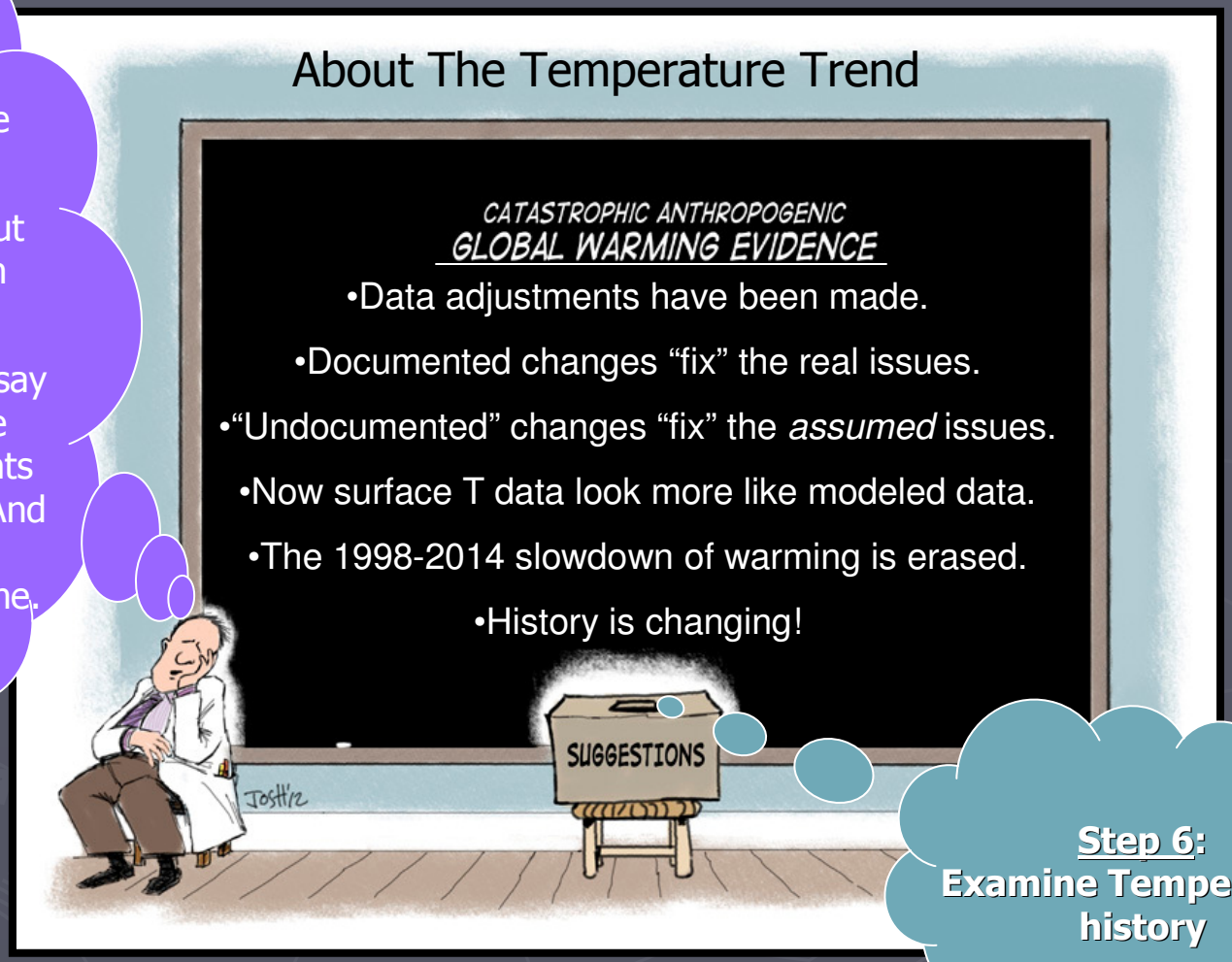
What You Learned :

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!



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."

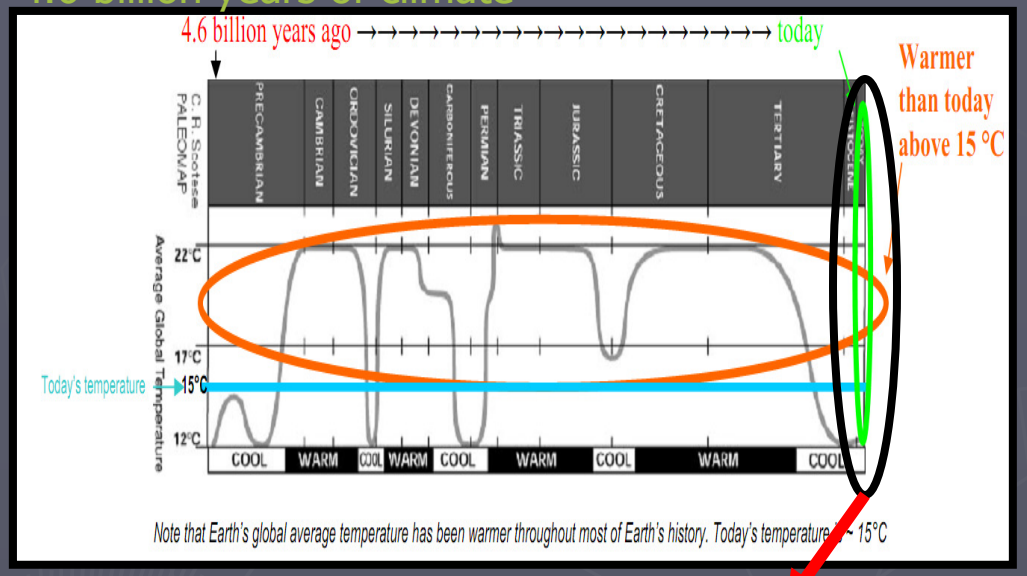
- Lowell Ponte (science writer: The Cooling 1976):

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."

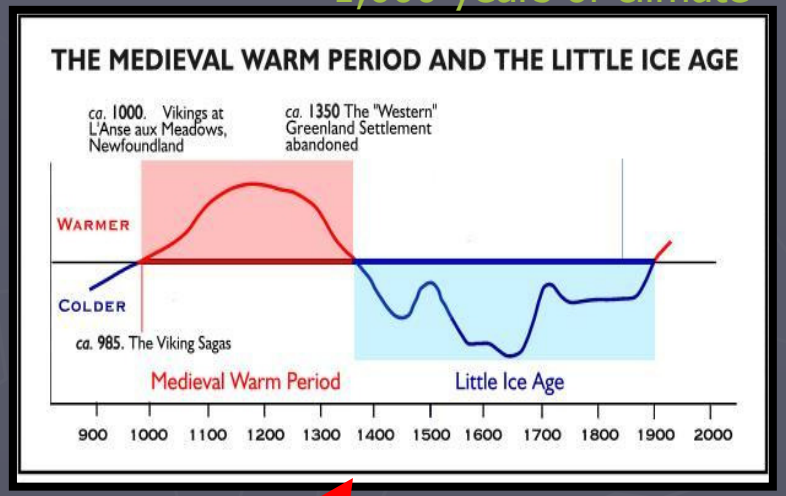
And Here's the Long-held View:

On Climate's History

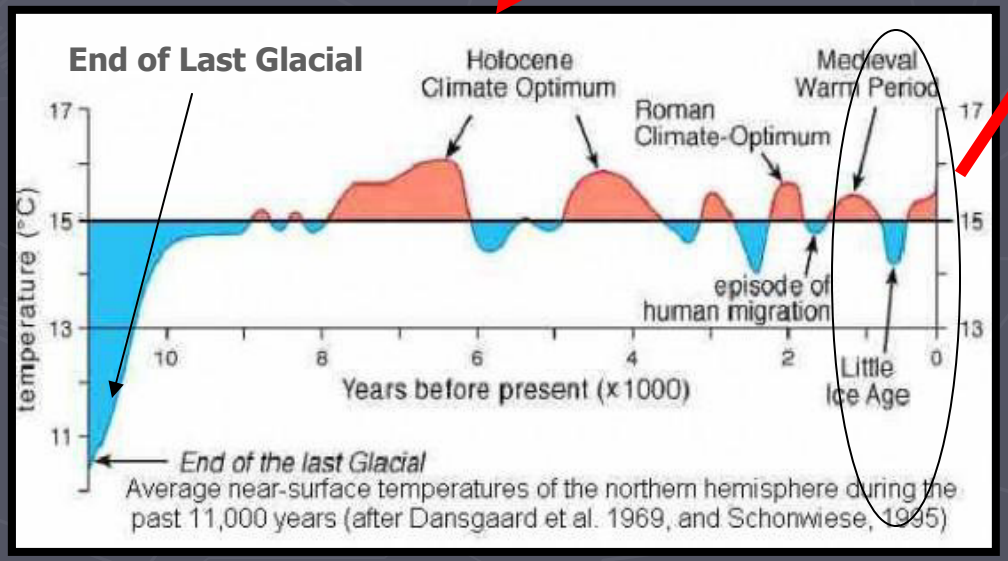
4.6 billion years of climate



1,000 years of climate



10,000 years of climate

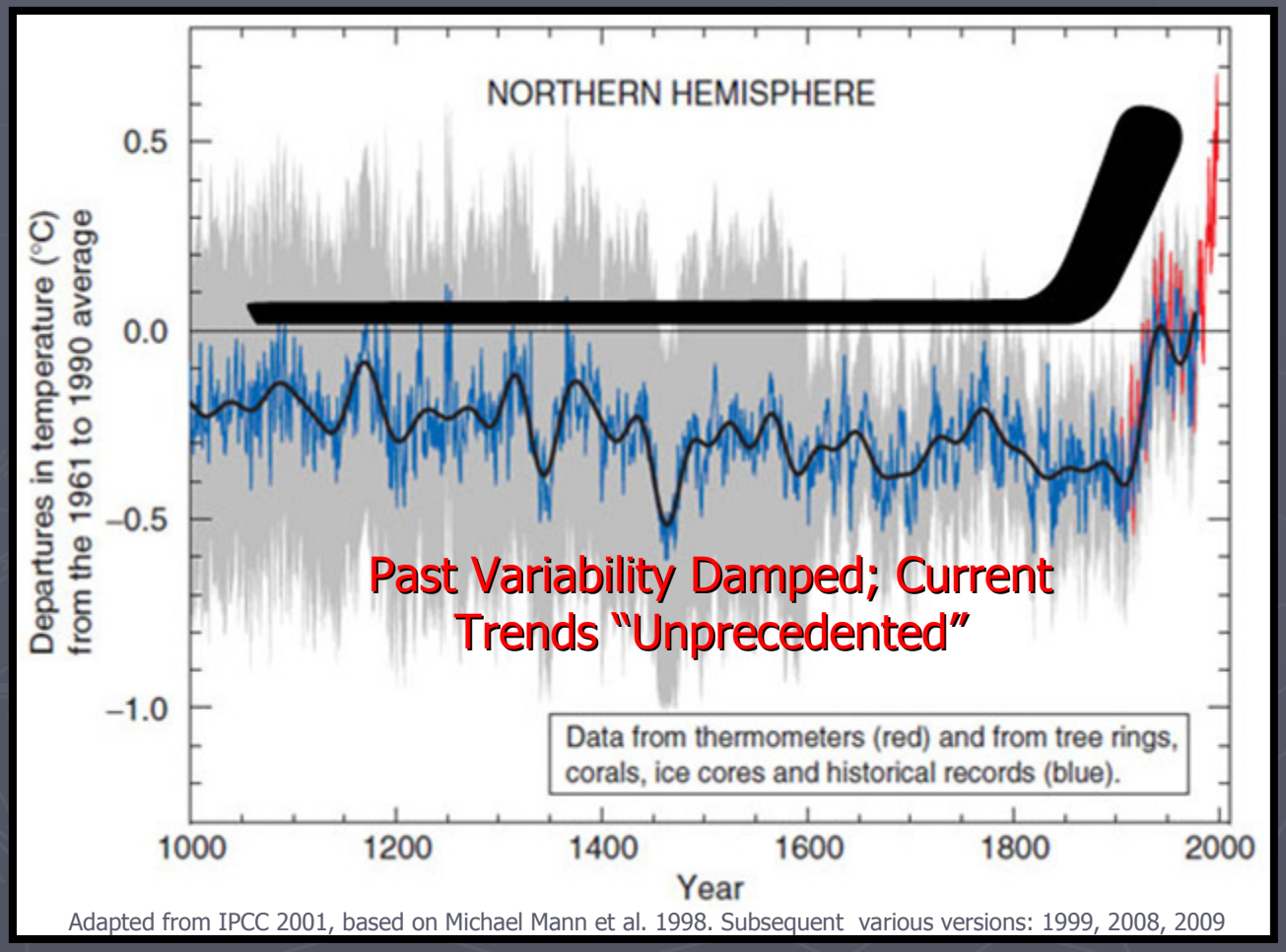


History supports climate variability, not climate instability.

See Notes Page for plot citations

But Adjustments Changed That!

Controversial and debunked; yet lives on…



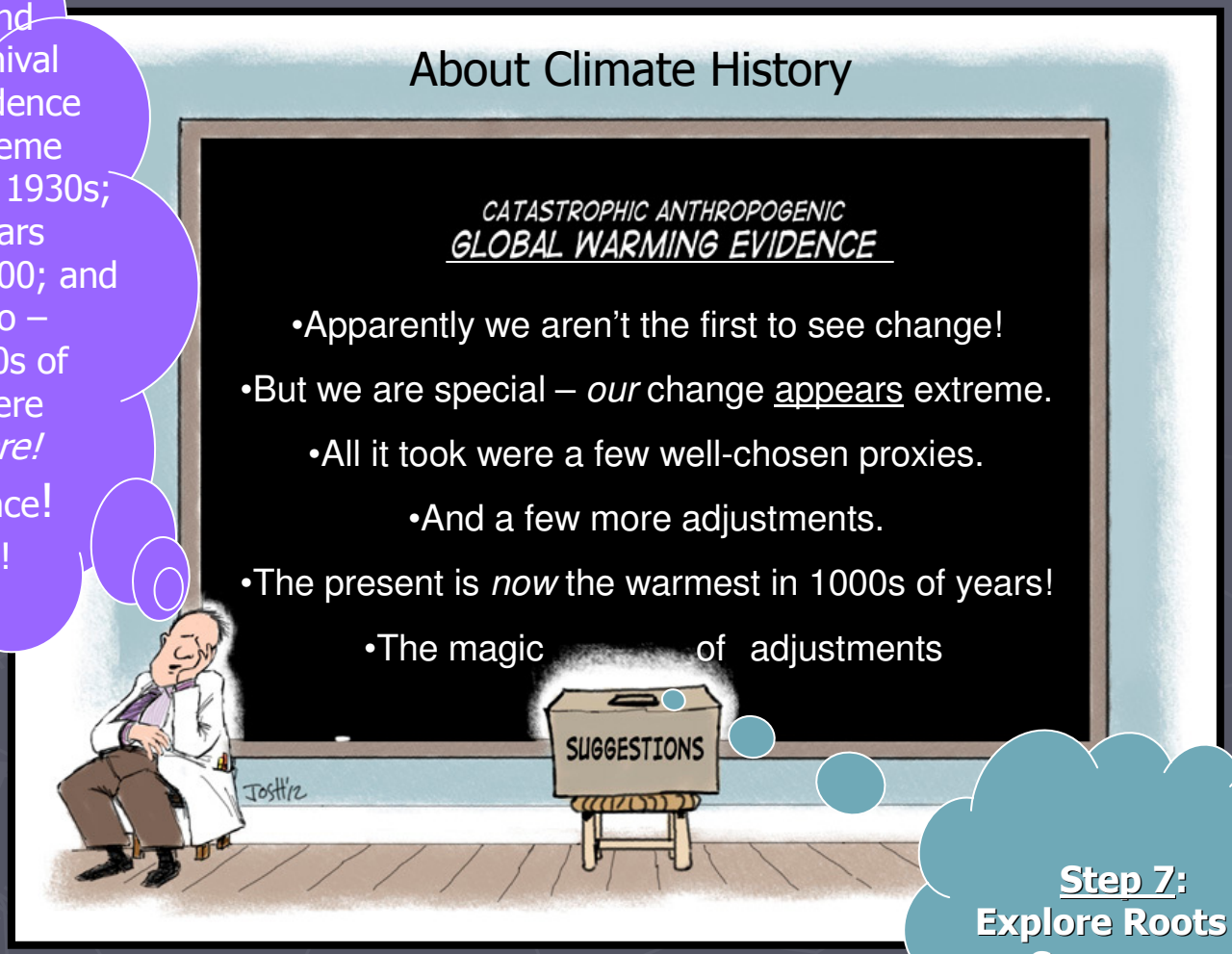
Adapted from IPCC 2001, based on Michael Mann et al. 1998. Subsequent various versions: 1999, 2008, 2009

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!*

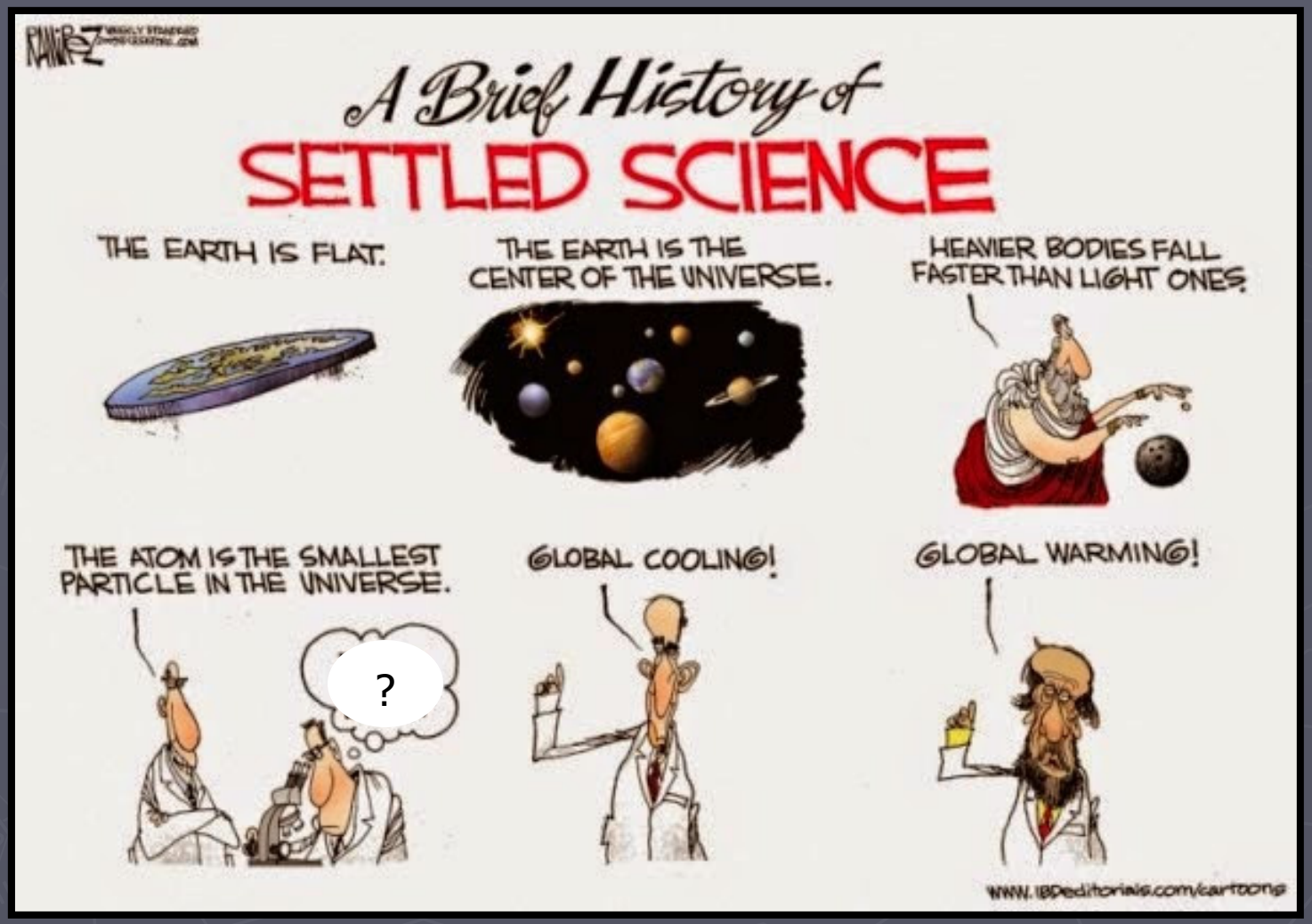
Settled science!

Amazing!

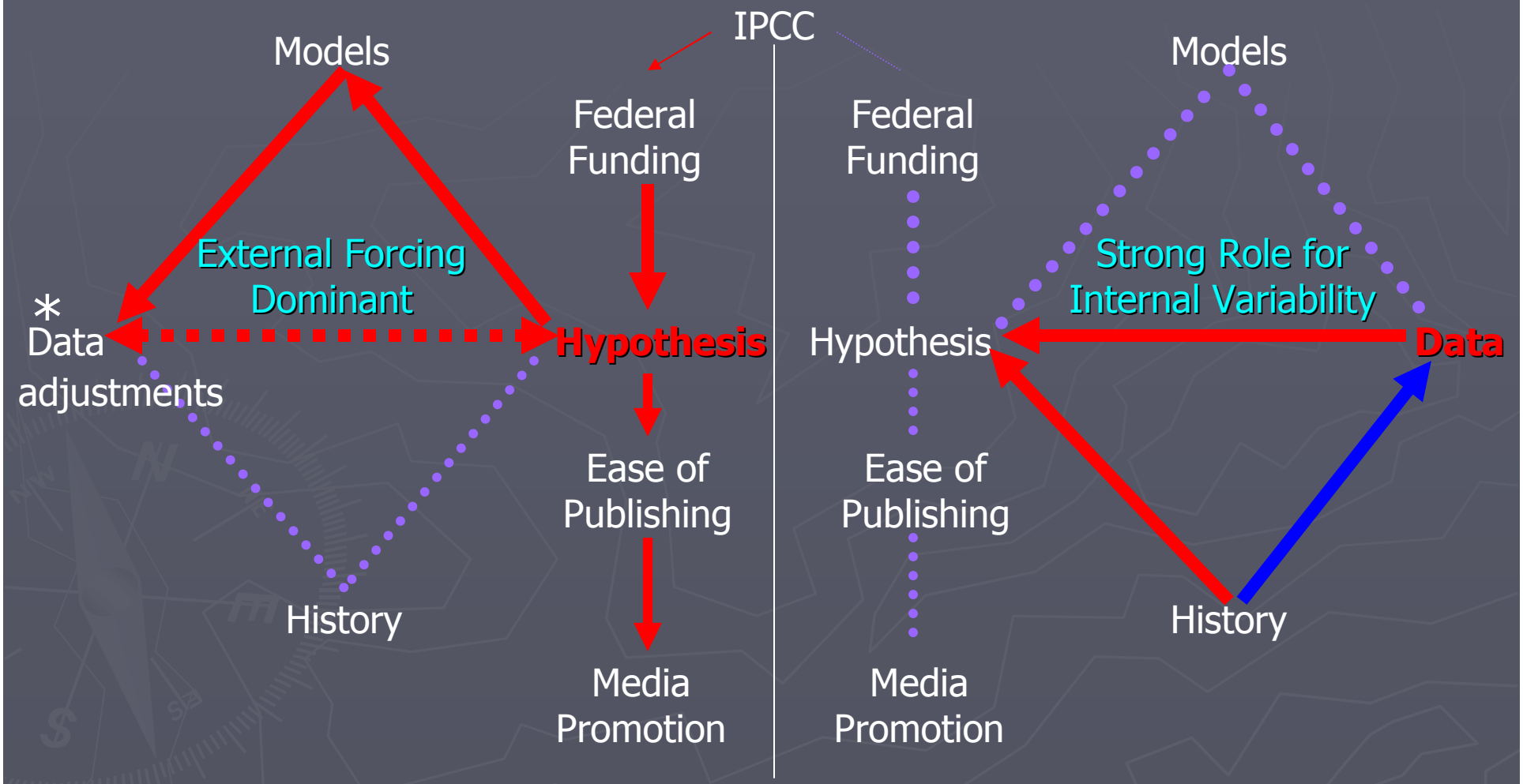


Step 7: Explore Roots of Consensus

"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."

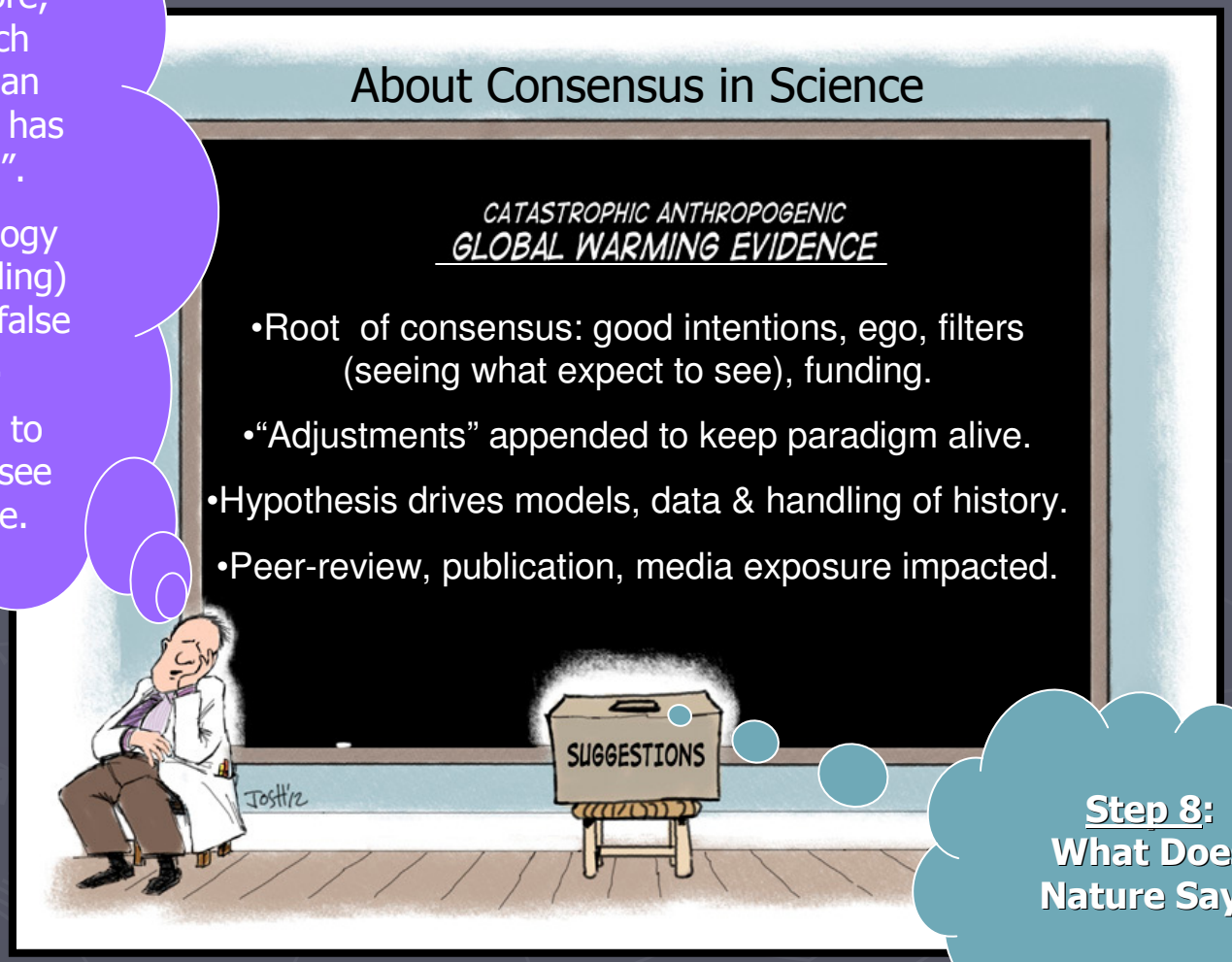
as quoted from a well-known NCAR scientist presenting at a class of mine on the deficiencies of computer modeling being done for the IPCC. (2007)

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.



Step 8: What Does Nature Say?

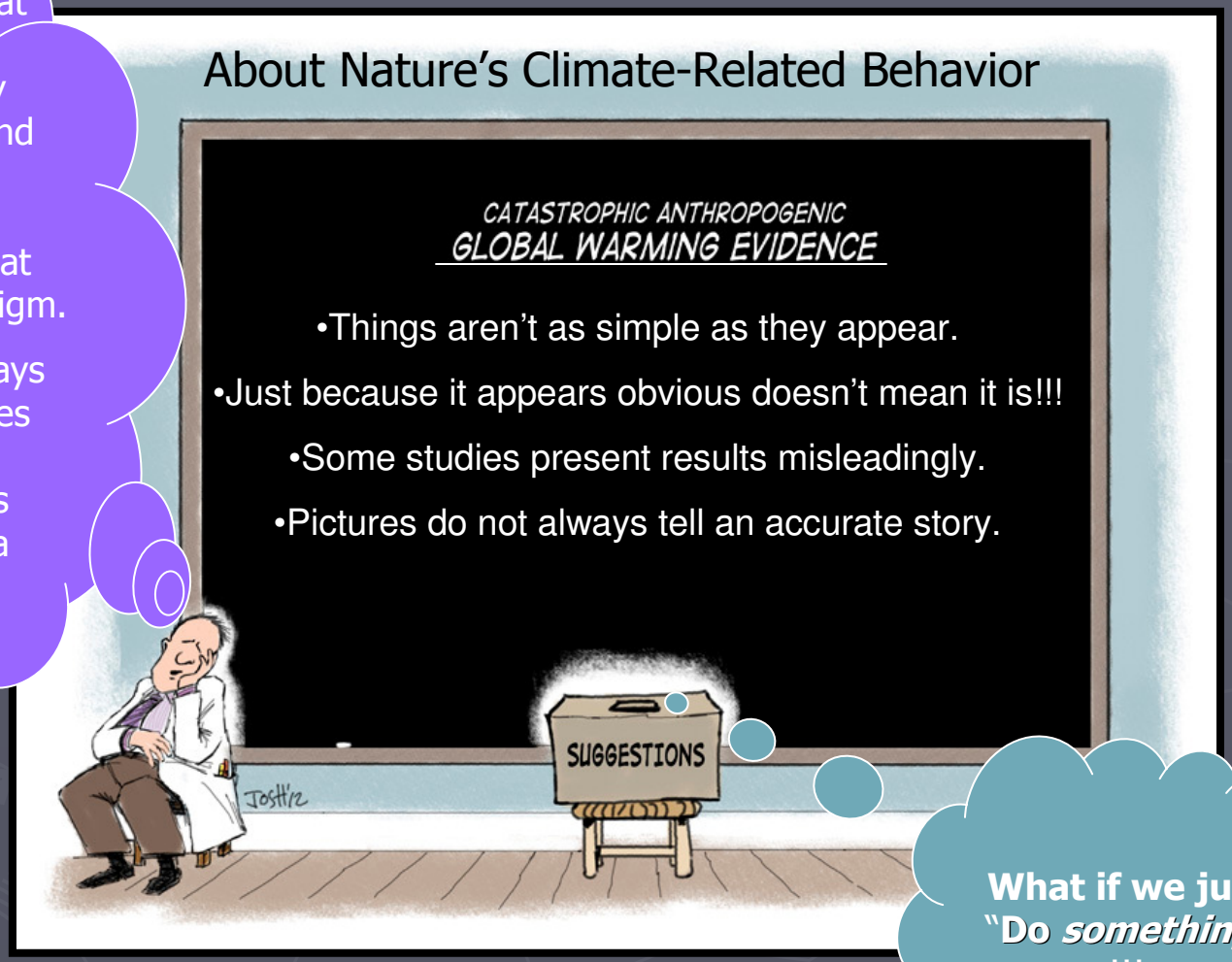
Signs of Doom?

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

What You Learned :

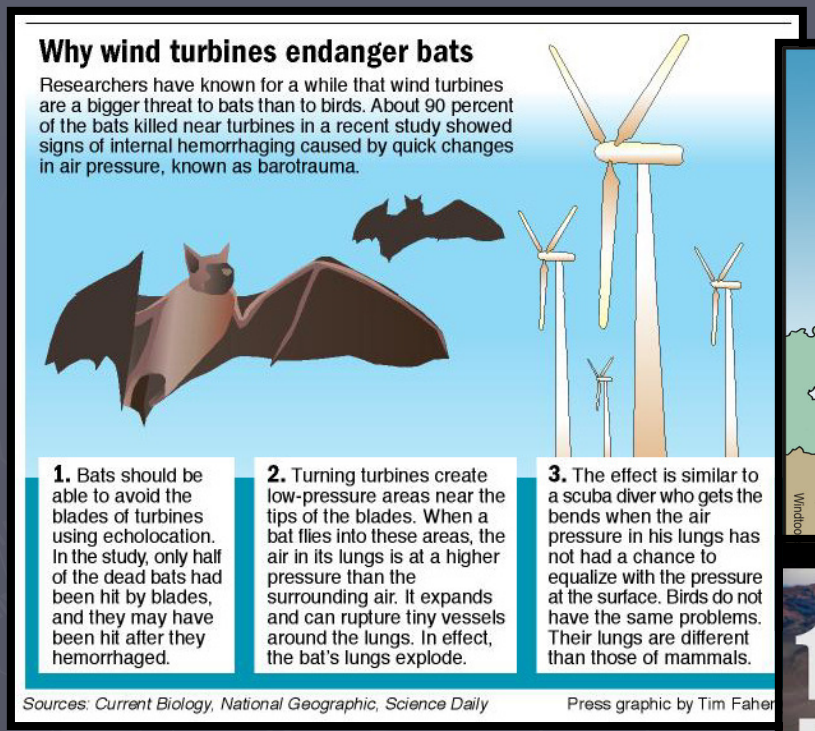
You tell me that things aren't always as they appear; we tend to assume simplistic correlations that fuel our paradigm.

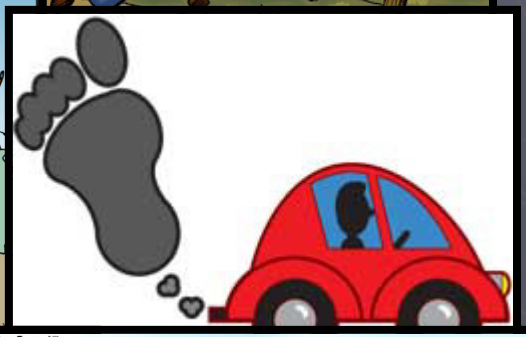
There are always the complexities and inconsistencies that mess up a good theory!

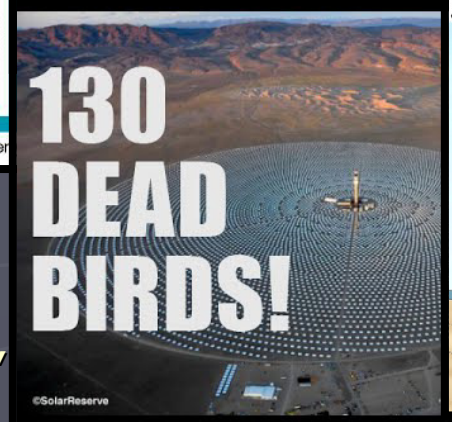


What if we just "Do *something*" !!!

Do We Act "Just in Case"?







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.

Summary

Finally!

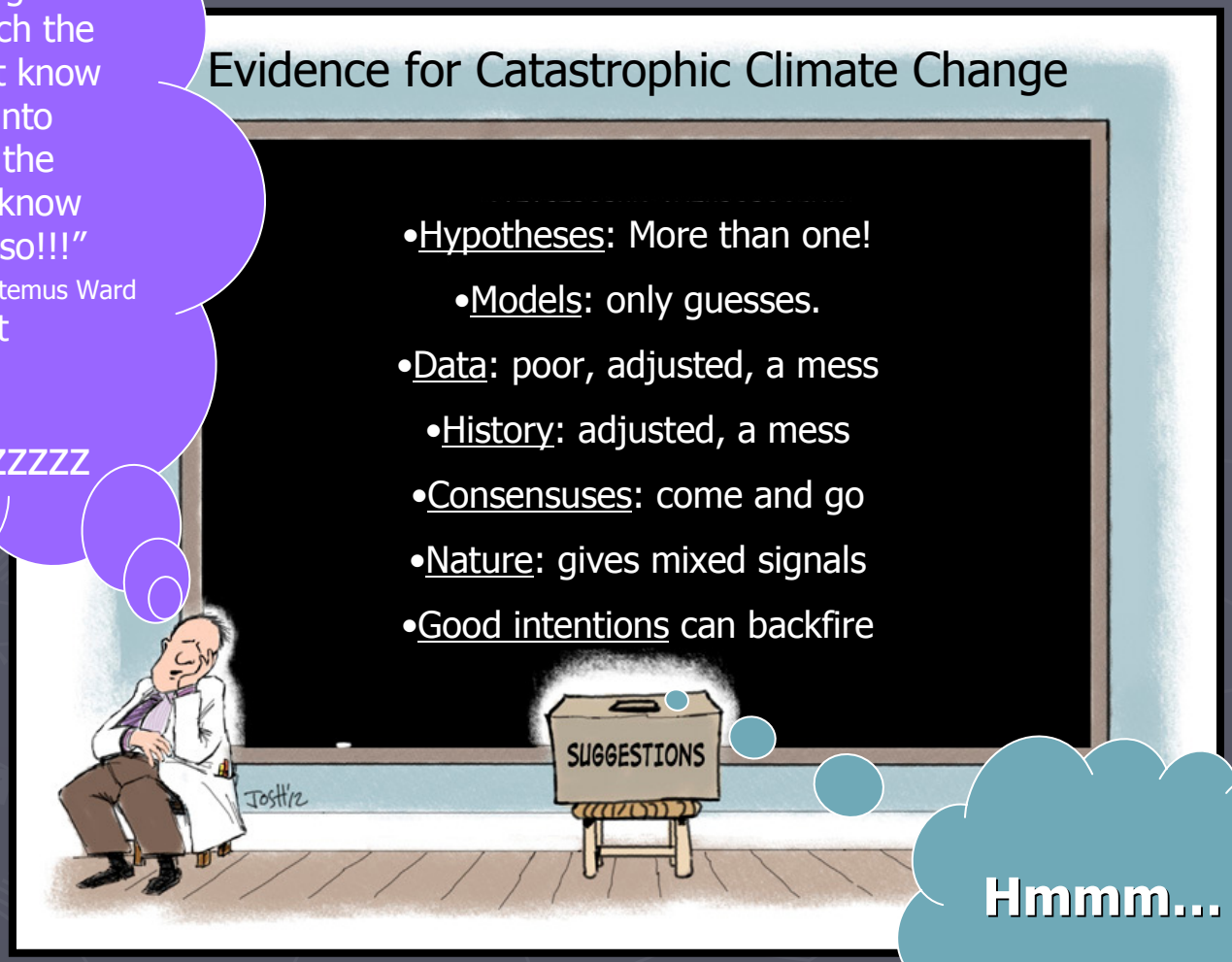
What You Learned :

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



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