

**A NEW PARADIGM FOR
ASSESSING THE ROLE OF
HUMANITY IN THE CLIMATE
SYSTEM AND IN CLIMATE
CHANGE**

Weiqing Han's Class

Feb 20, 2017

University of Colorado at Boulder

The Commonly Presented View of Climate Change

The focus is on CO₂ and a few other greenhouse gases as the primary driver of changes in regional and global climate



“Human-caused increases in greenhouse gases are responsible for most of the observed global average surface warming of roughly 0.8°C (1.5°F) over the past 140 years”



“Climate models predict that global temperatures will continue to rise, with the amount of warming primarily determined by the level of emissions”



“Actions that could diminish the threats posed by climate change to society and ecosystems include substantial emissions cuts to reduce the magnitude of climate change”..

An Important Underemphasized Caveat

“Climate change is not expected to be uniform over space or time. Deforestation, urbanization, and particulate pollution can have complex geographical, seasonal, and longer-term effects on temperature, precipitation, and cloud properties. In addition, human-induced climate change may alter atmospheric circulation, dislocating historical patterns of natural variability and storminess.”

Climate Change Risk Management – AMS Report 2014

<http://www2.ametsoc.org/ams/index.cfm/policy/studies-analysis/climate-change-risk-management/>

Climate change risk management approaches generally fall into four broad categories:

- 1) mitigation—efforts to reduce greenhouse gas emissions;
- 2) adaptation—increasing society's capacity to cope with changes in climate;
- 3) geoengineering or climate engineering—additional, deliberate manipulation of the earth system that is intended to counteract at least some of the impacts of greenhouse gas emissions; and
- 4) knowledge-base expansion—efforts to learn and understand more about the climate system, which can help support proactive risk management.



"Climate change - caused by carbon pollution - is one of the most significant public health threats of our time,"

Environmental Protection Agency Head - Gina
McCarthy

<http://www.bbc.co.uk/news/business-24181341>

Obama states "changing climate" is more of a threat than "terrorism, instability, inequality, disease" [<http://t.co/5gEdLwkEMI>]



Donald Trump Still Thinks Climate Change Is 'A Bunch Of Bunk'

http://www.huffingtonpost.com/entry/donald-trump-climate-change_us_583b16e3e4b000af95ee85dd



FIRST: HOW ARE THE IPCC MULTI- DECADAL PREDICTIONS (PROJECTIONS) PERFORMING?

**THIS IS AN INDEPENDENT QUESTION
FROM WHAT SHOULD BE DONE
ABOUT ADDED CO₂ EMISSIONS**



TWO DISTINCT HYPOTHESES

Hypothesis #1 The skill of initial value multi-decadal regional predictions of changes in climate statistics provide an upper bound on what is achievable using multi-decadal climate projections based on external forcings from added CO₂ and other human climate forcings.

Hypothesis #2 Skill at projecting changes in regional climate statistics emerges on time period beyond a decade when the external forcings from added CO₂ and other human climate forcings dominate over natural variability and initial value conditions.

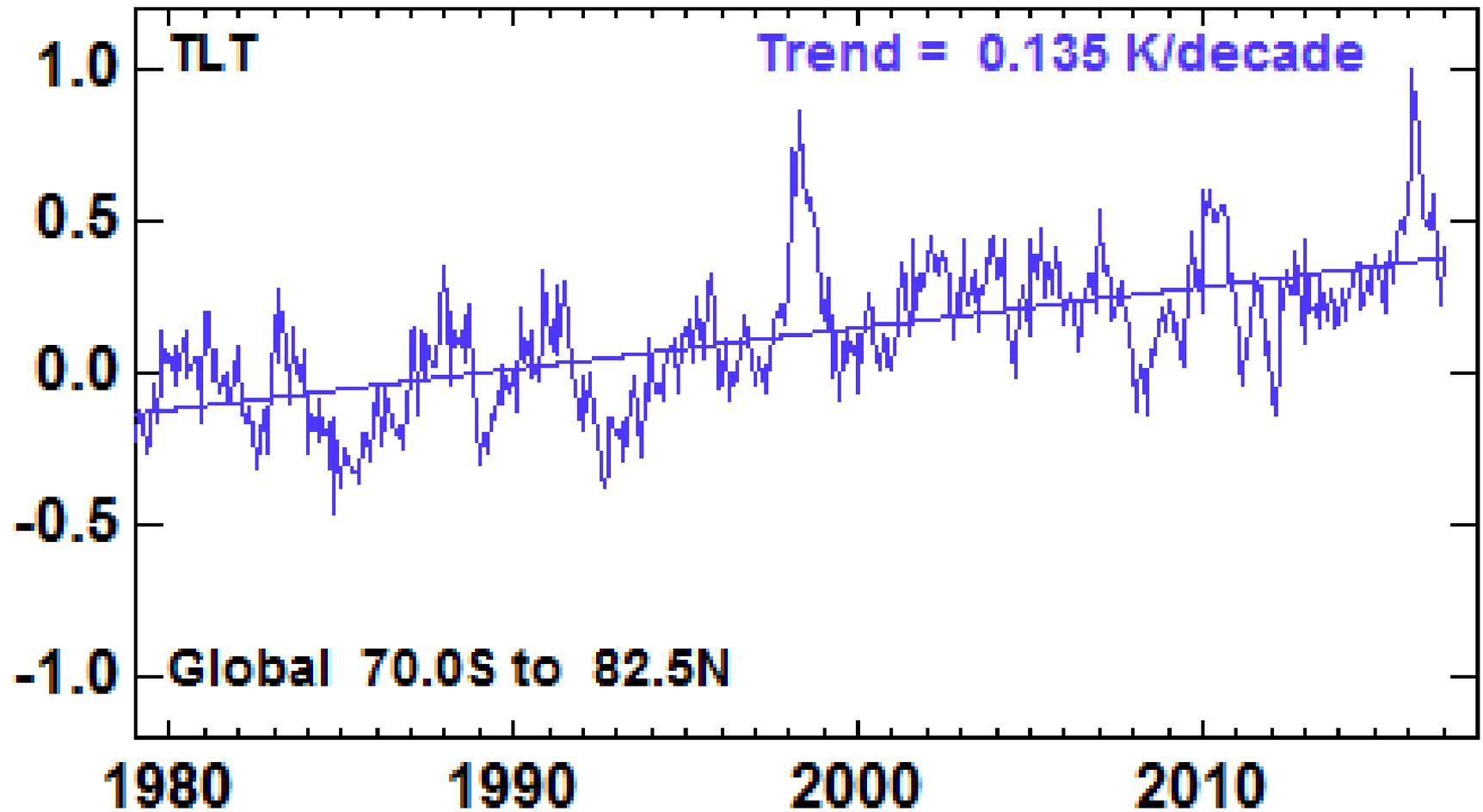
Testing of these two hypotheses must be accomplished using hindcasts.

Necessary Conditions For Skillful Multi-Decadal Predictions of Extreme Events

In hindcast runs (the last several decades), skillful predictions must be demonstrated which include:

1. *The average (annual, monthly, etc.) global, regional and local climate.*
2. *The changes in these averages over the past several decades*
3. *The statistics of extreme weather events*
4. *The changes in the probabilities of these extremes over the last several decades.*

<http://www.remss.com/measurements/upper-air-temperature>

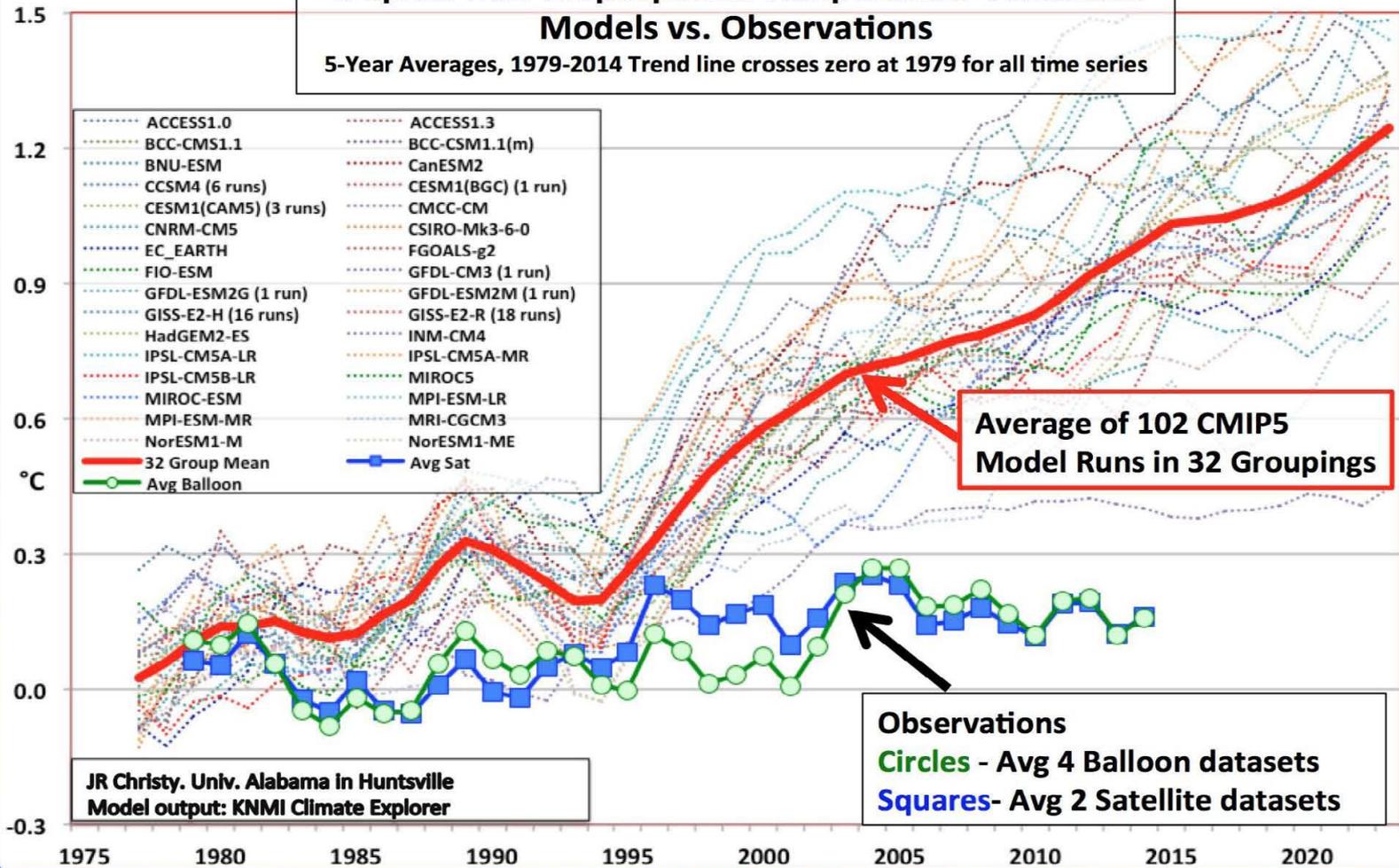


Citation for the following two slides

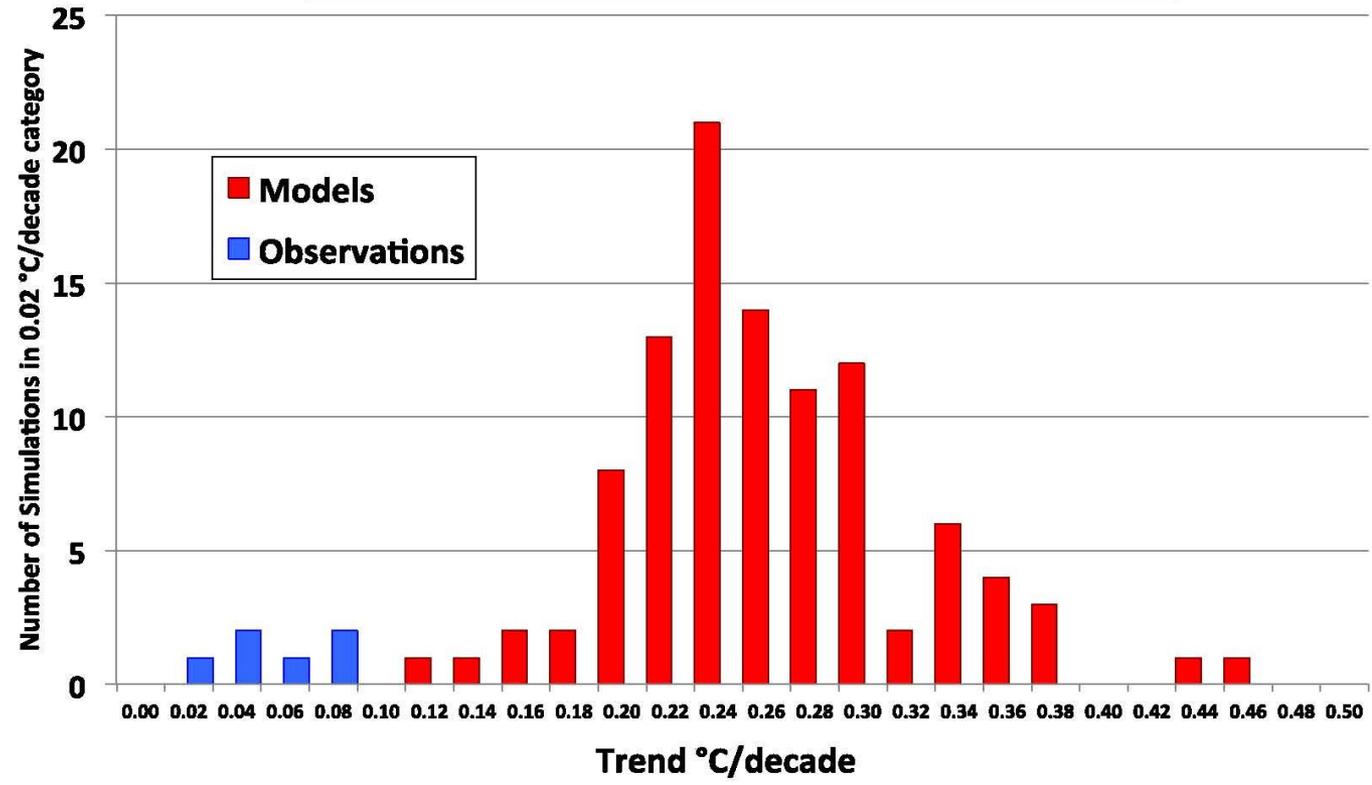
Pressure level temperature data provided through KNMI Climate Explorer. Calculation of satellite layer temperatures and plotting performed by J Christy, UA Huntsville.

Tropical Mid-Tropospheric Temperature Variations Models vs. Observations

5-Year Averages, 1979-2014 Trend line crosses zero at 1979 for all time series

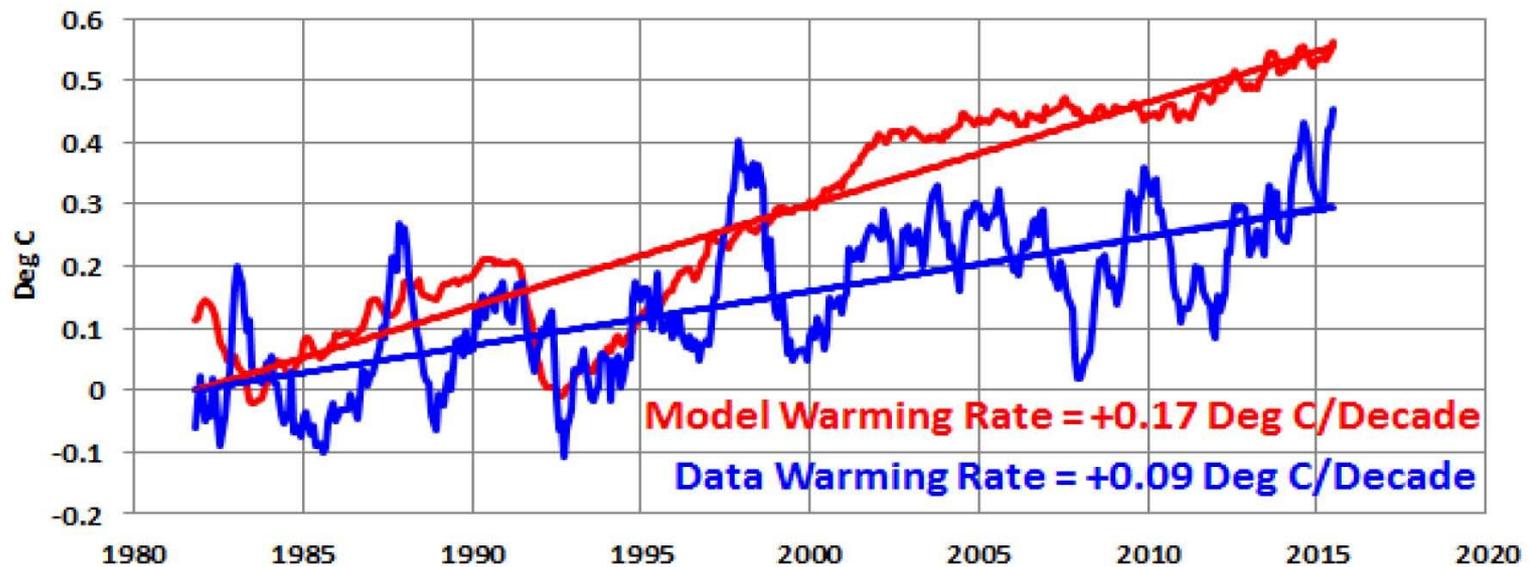


Distribution of Tropical Tropospheric Trends 1979-2013 102 RCP4.5 CMIP-5 Model Runs

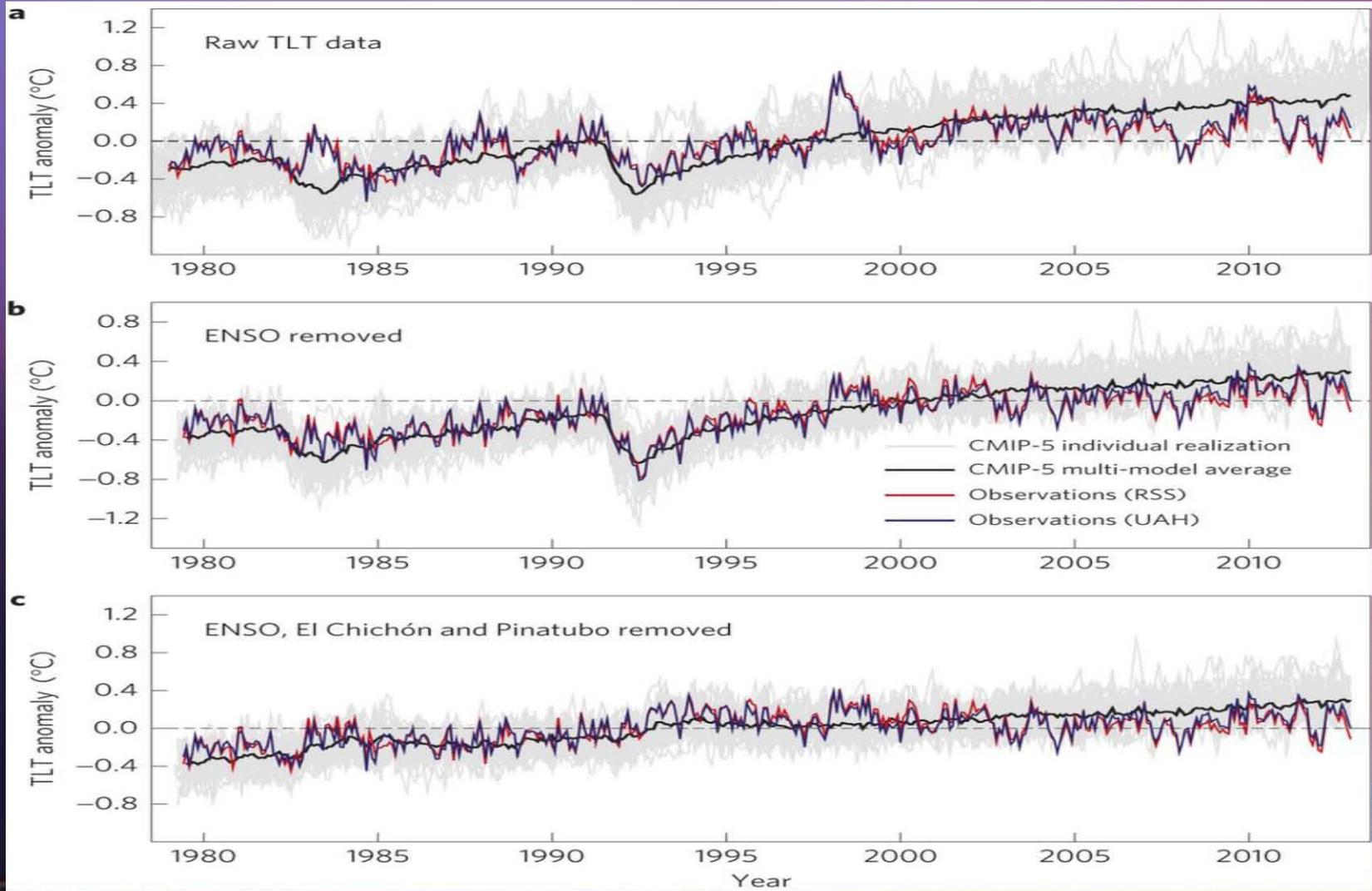


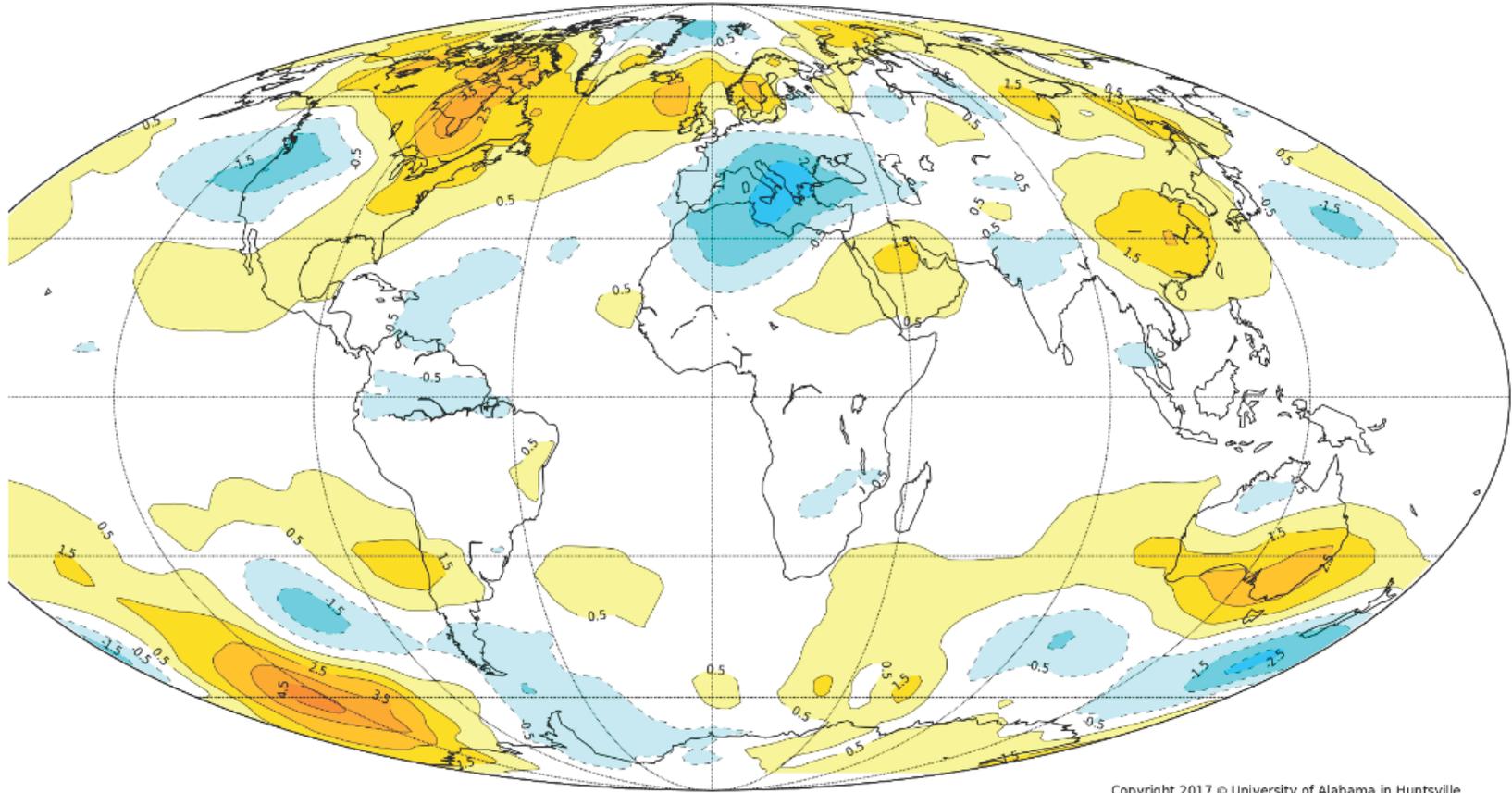
Model-Data Comparison
Global Sea Surface Temperature Anomalies
Models: CMIP5 (IPCC AR5) Multimodel Ensemble Mean (TOS)
Historic/RCP6.0
Data: Reynolds OI.v2

Nov 1981 to Jul 2015 (Data & Models Shifted to Zero the Trends at Start)

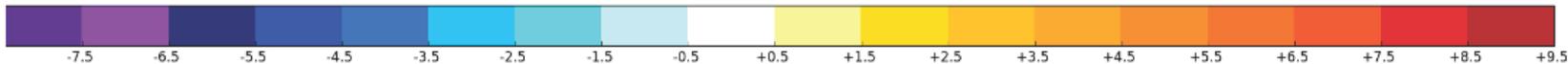


Bob Tisdale



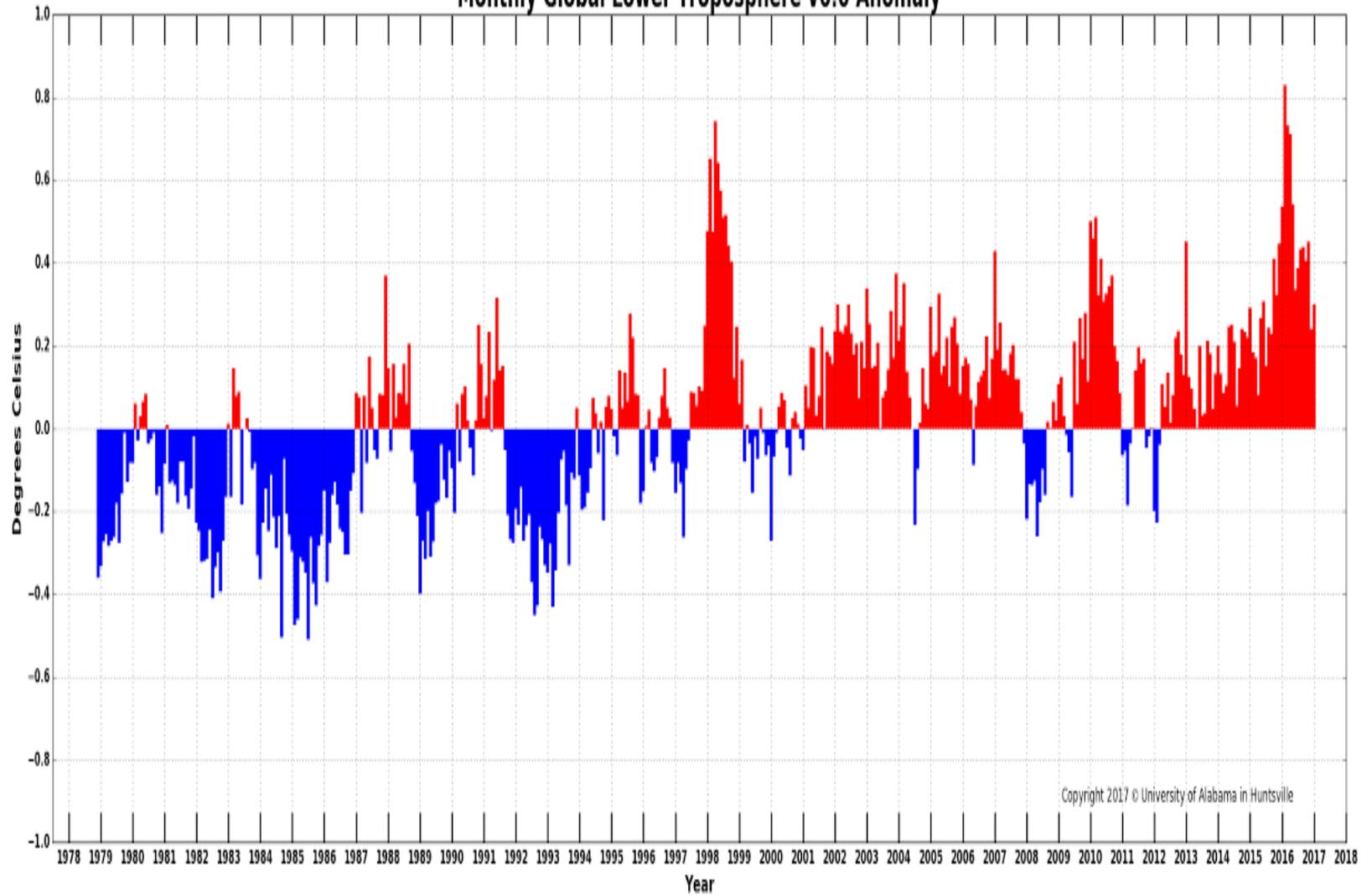


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Broken lines outline areas that were cooler than seasonal norms. Each contour represents one degree Celsius, starting at -0.5 and +0.5 degrees C. Solid lines outline areas that were warmer than seasonal norms.

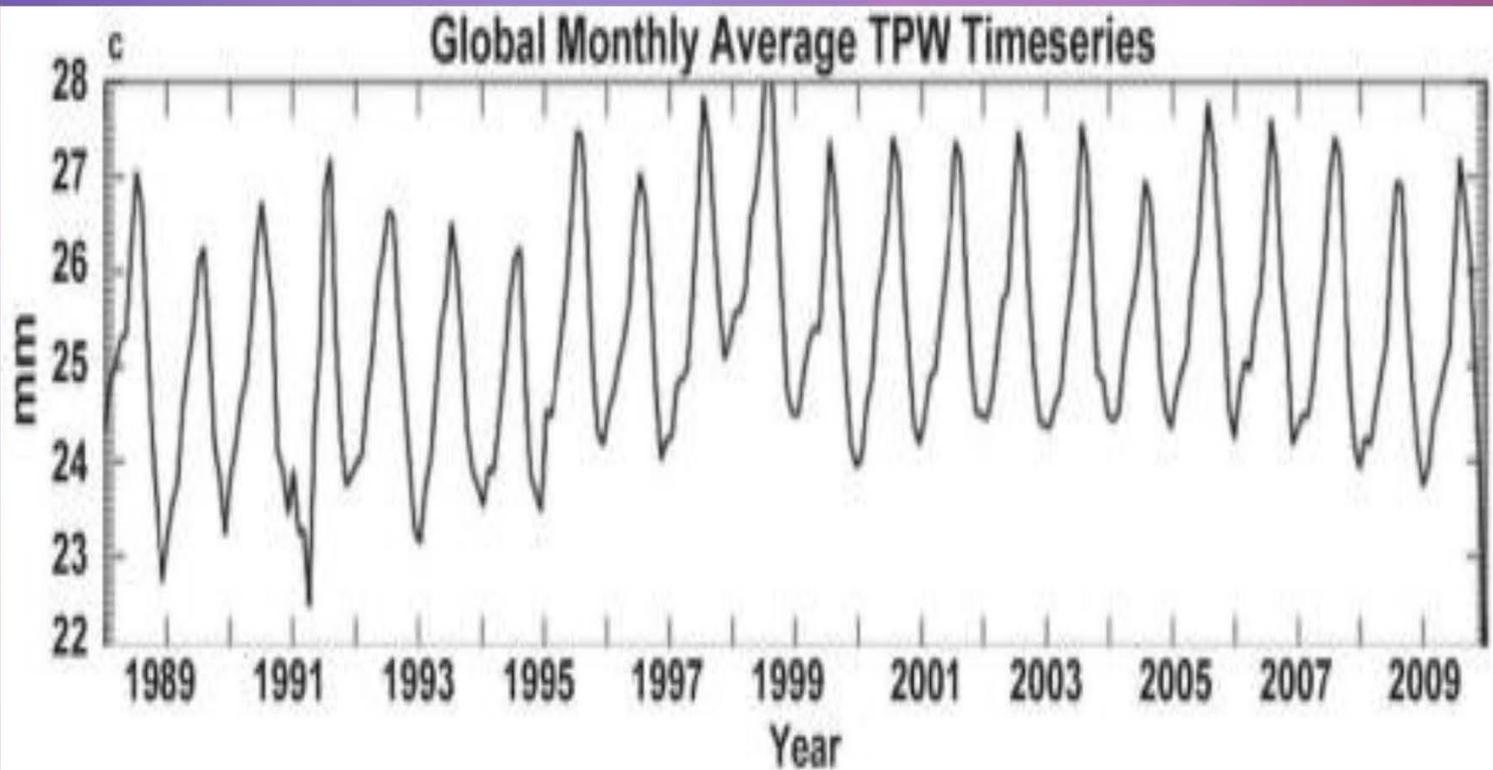
Monthly Global Lower Troposphere v6.0 Anomaly



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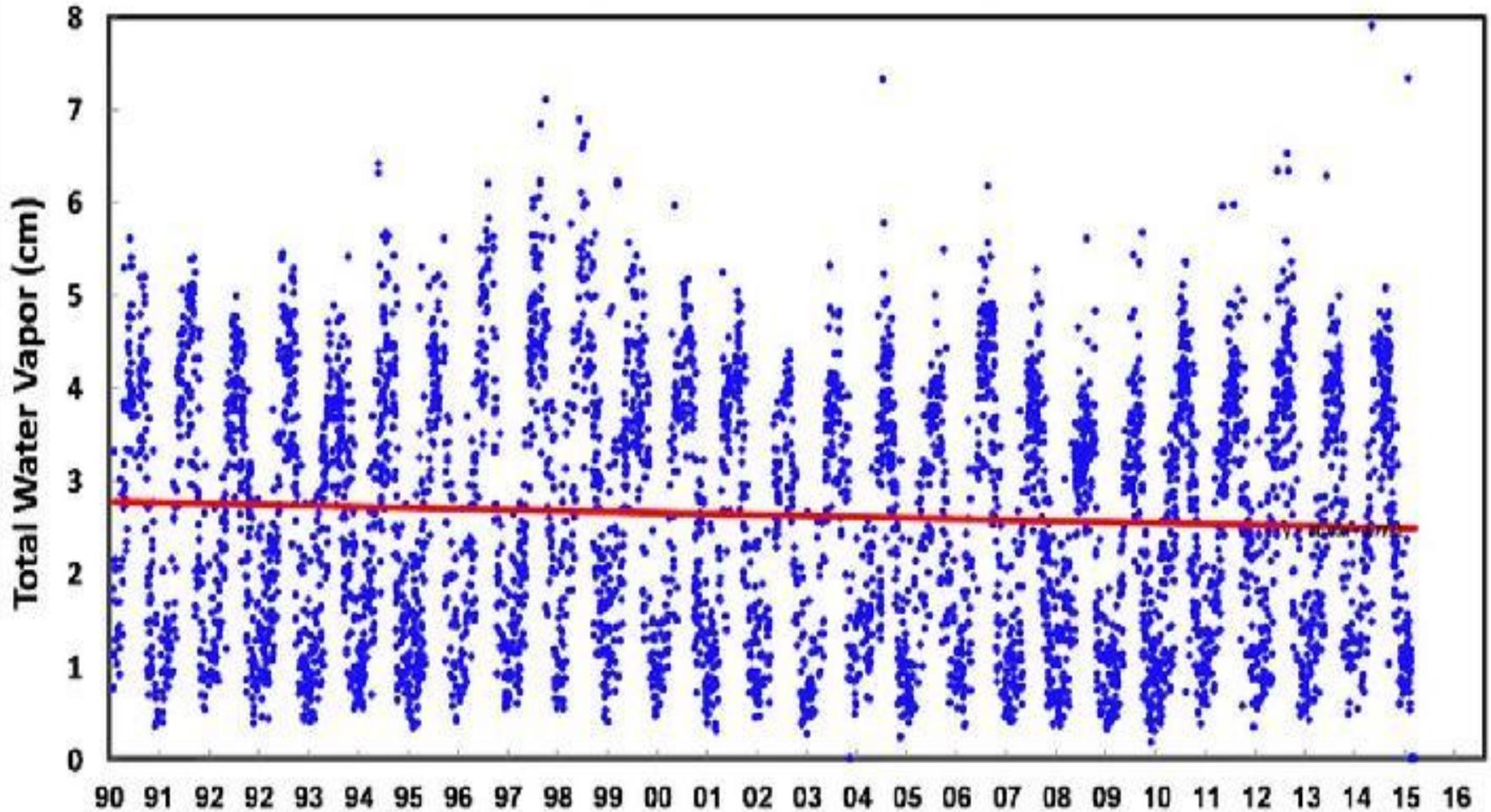
December 1978 to January 2017

Vonder Haar, T. H., J. Bytheway, and J. M. Forsythe (2012), Weather and climate analyses using improved global water vapor observations, *Geophys. Res. Lett.*,doi:10.1029/2012GL052094.

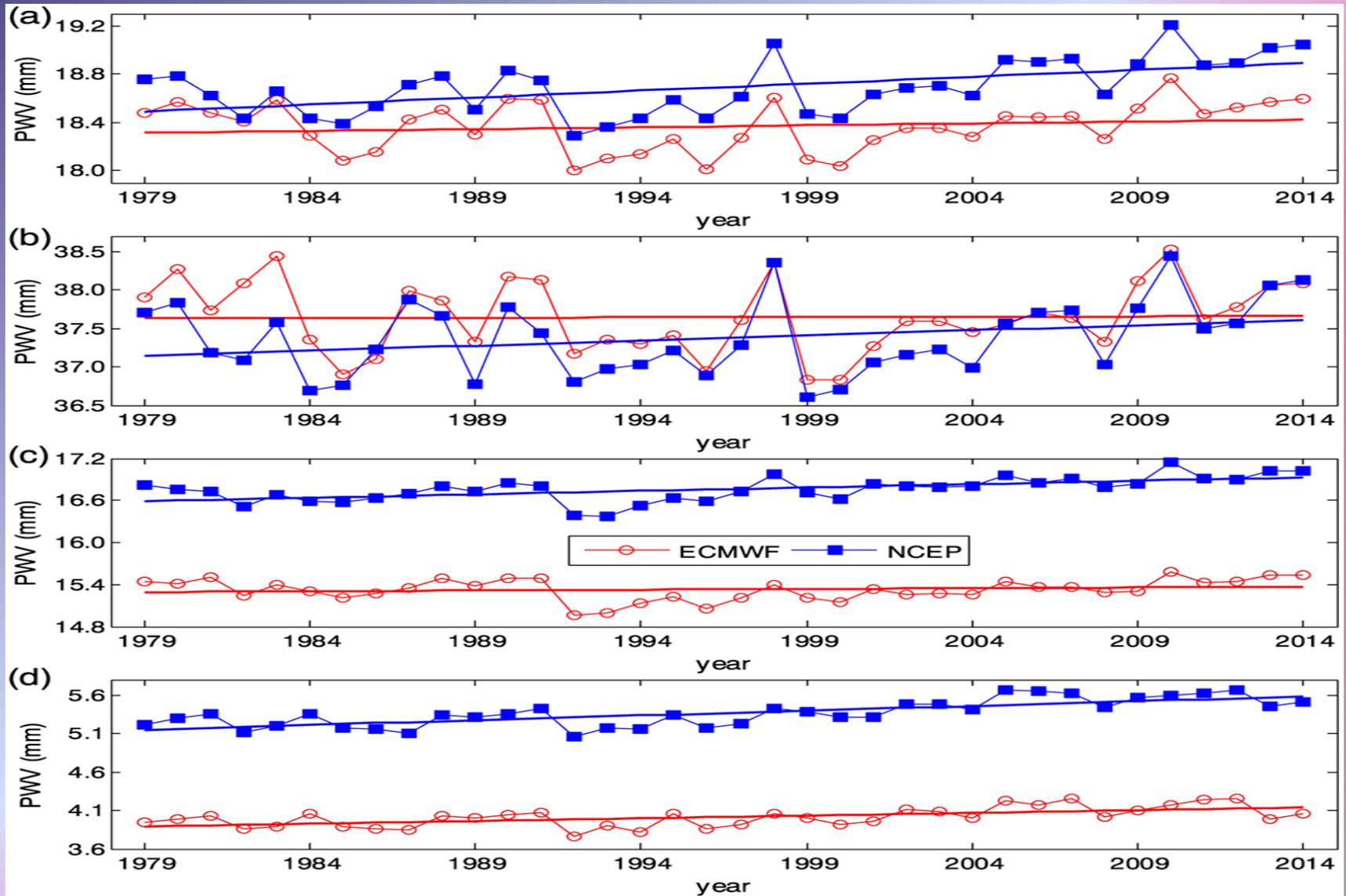


<http://forrestmims.org/sciencedata.html>

Total Water Vapor at Solar Noon, Seguin, Texas



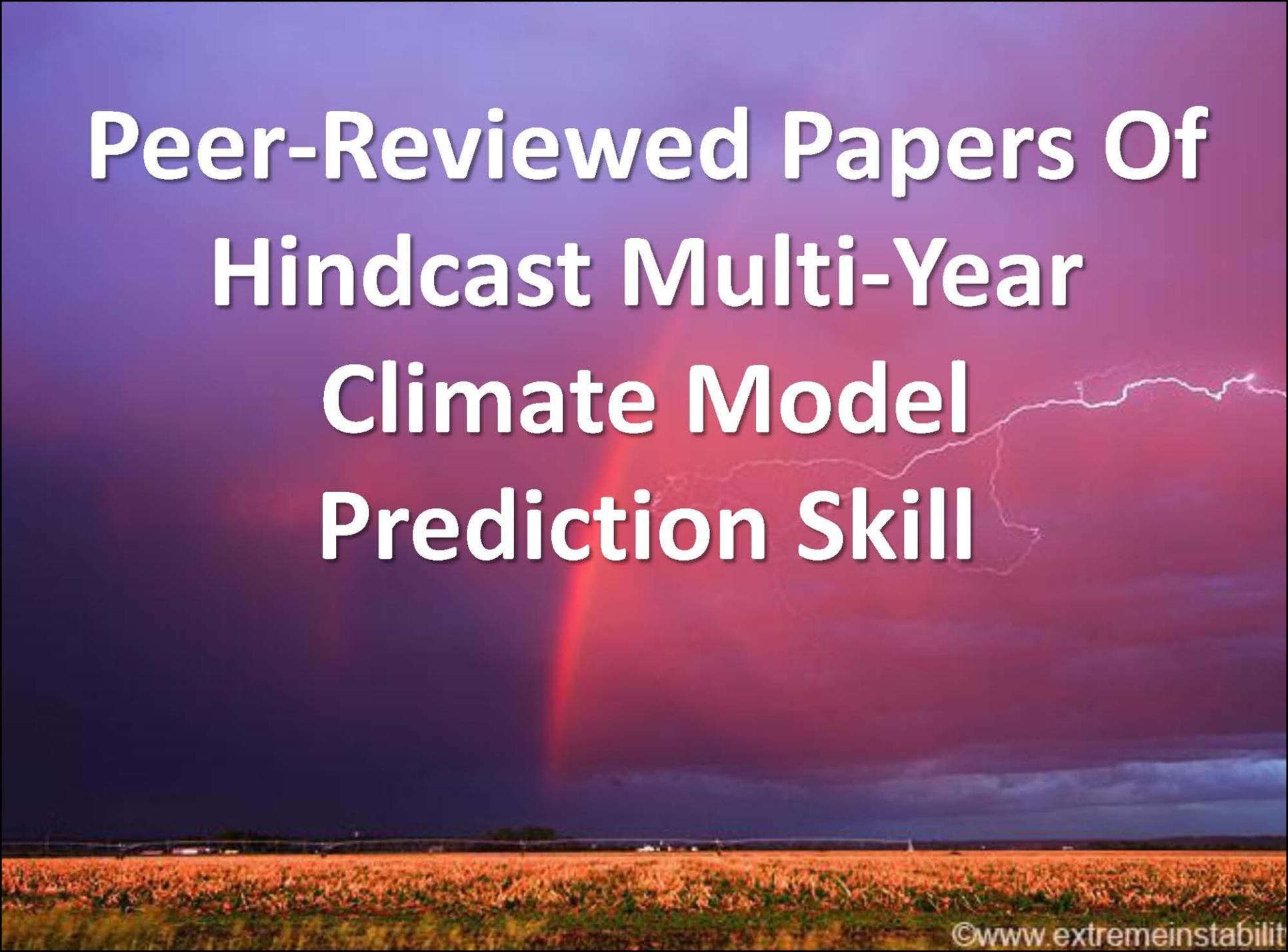
ECMWF and NCEP PWV time series averaged over (a) global, (b) tropical, (c) temperate, and (d) polar regions during the period 1979–2014. Chen and Liu (2016 -JGR Atmosphere



<http://onlinelibrary.wiley.com/doi/10.1002/2016JD024917/abstract>

Global water vapor variability and trend from the latest 36 year (1979 to 2014) data of ECMWF and NCEP reanalyses, radiosonde, GPS, and microwave satellite Chen and Liu, 2016 JGR-Atmosphere

- Positive global PWV trends, defined as percentage normalized by annual average, of $0.61 \pm 0.33\%$ decade⁻¹, $0.57 \pm 0.28\%$ decade⁻¹, and $0.17 \pm 0.35\%$ decade⁻¹, have been derived from the NCEP, radiosonde, and ECMWF, respectively, for the period 1979–2014.
- 1992–2014 and 2000–2014. The linear relationship between PWV and surface temperature is positive over most oceans and the polar region.
- Based on the 36 year (1979–2014) ERA-Interim reanalysis data set, the simulation of Clausius-Clapeyron relation shows that global PWV should increase in the range of 6%–13% K⁻¹ accordingly with air temperature increase... Global PWV-temperature regression slopes of $2.4 \pm 1.7\%$ K⁻¹ and $4.5 \pm 1.4\%$ K⁻¹ are obtained for the period 1979–2014 from ECMWF and NCEP, respectively.
- The regression slopes grow rapidly in the recent years 2000–2014, and slopes of $10.1 \pm 2.7\%$ K⁻¹ and $11.4 \pm 2.9\%$ K⁻¹ are yielded from the ECMWF and NCEP, respectively.
- Like the PWV, surface temperature trends estimated from NCEP are larger than those derived from ECMWF. However, the surface temperature trends derived from both reanalyses indicate global surface warming slowdown in the recent period 2000–2014.

A dramatic sky with a rainbow and lightning over a field. The sky is dark purple and blue, with a bright rainbow arching across the middle. A lightning bolt is visible on the right side. The foreground is a field of golden-brown crops, likely corn, under a dark, stormy sky.

Peer-Reviewed Papers Of Hindcast Multi-Year Climate Model Prediction Skill

Ronald van Haren, Geert Jan van Oldenborgh, Geert Lenderink, Matthew Collins, and Wilco Hazeleger, 2012: SST and circulation trend biases cause an underestimation of European precipitation trends
Climate Dynamics, DOI: 10.1007/s00382-012-1401-5

“To conclude, modeled atmospheric circulation and SST trends over the past century are significantly different from the observed ones. These mismatches are responsible for a large part of the misrepresentation of precipitation trends in climate models. The causes of the large trends in atmospheric circulation and summer SST are not known.”

Anagnostopoulos, G. G., Koutsoyiannis, D., Christofides, A., Efstratiadis, A. & Mamassis, N. 2010: A comparison of local and aggregated climate model outputs with observed data. Hydrol. Sci. J. 55(7), 1094–1110

"... local projections do not correlate well with observed measurements. Furthermore, we found that the correlation at a large spatial scale, i.e. the contiguous USA, is [even] worse than at the local scale."

Sun, Z., J. Liu, X. Zeng, and H. Liang, 2012:
Parameterization of instantaneous global horizontal
irradiance at the surface. Part II: Cloudy-sky component,
J. Geophys. Res., doi:10.1029/2012JD017557

“Radiation calculations in global numerical weather prediction (NWP) and climate models are usually performed in 3-hourly time intervals in order to reduce the computational cost. This treatment can lead to an incorrect Global Horizontal Irradiance (GHI) at the Earth’s surface, which could be one of the error sources in modelled convection and precipitation. An important application of the scheme is in global climate models....It is found that these errors are very large, exceeding 800 W m⁻² at many non-radiation time steps due to ignoring the effects of clouds....”

Stephens, G. L., T. L'Ecuyer, R. Forbes, A. Gettleman, J.-C. Golaz, A. Bodas-Salcedo, K. Suzuki, P. Gabriel, and J. Haynes, 2010: Dreary state of precipitation in global models, J. Geophys. Res., 115, D24211, doi:10.1029/2010JD014532.

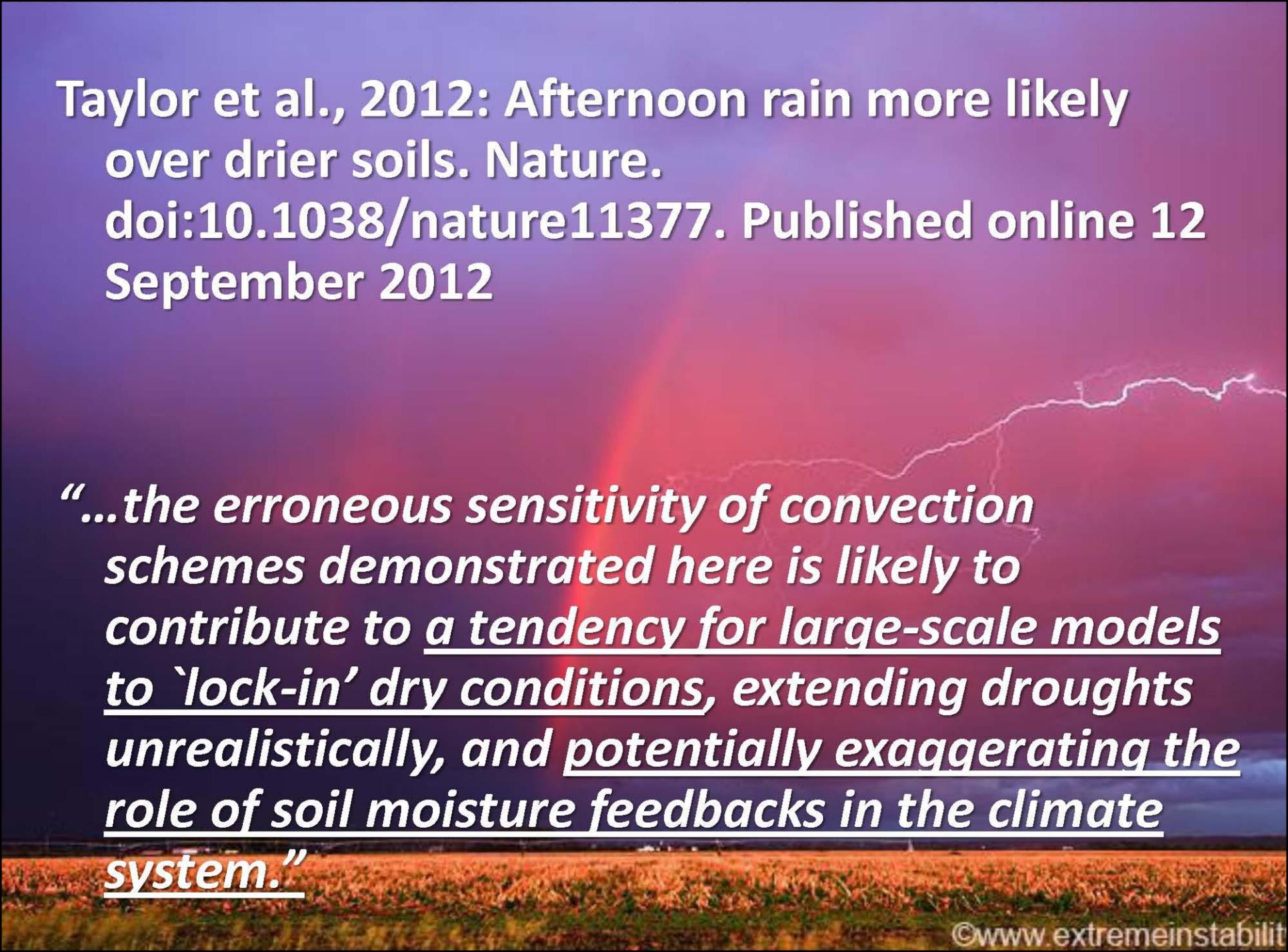
"...models produce precipitation approximately twice as often as that observed and make rainfall far too lightly....The differences in the character of model precipitation are systemic and have a number of important implications for modeling the coupled Earth systemlittle skill in precipitation [is] calculated at individual grid points, and thus applications involving downscaling of grid point precipitation to yet even finer-scale resolution has little foundation and relevance to the real Earth system."

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⁻¹.....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".

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.”

A dramatic sky with a rainbow and lightning over a field. The sky is a mix of purple, blue, and red, with a bright rainbow arching across it. A jagged lightning bolt strikes from the right side. Below the sky is a field of golden-brown crops, possibly corn, under a dark horizon.

Taylor et al., 2012: Afternoon rain more likely over drier soils. Nature.
doi:10.1038/nature11377. 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.

“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.”

None of these papers are cited and commented on in the CMIP5 model assessment paper!

Miller et al. 2014: CMIP5 historical simulations (1850–2012) with GISS ModelE2. Journal of Advances in Modeling Earth Systems. 10.1002/2013MS000266 Pg 441- 477.



Stephens, G. L., D. O'Brien, P. J. Webster, P. Pilewski, S. Kato, and J.-I. Li (2015), The albedo of Earth, *Rev. Geophys.*, 53, doi:10.1002/2014RG000449.

<http://webster.eas.gatech.edu/Papers/albedo2015.pdf>

“Climate models fail to reproduce the observed annual cycle in all components of the albedo with any realism, although they broadly capture the correct proportions of surface and atmospheric contributions to the TOA albedo. A high model bias of albedo has also persisted since the time of CMIP3, mostly during the boreal summer season. Perhaps more importantly, models fail to produce the same degree of interannual constraint on the albedo variability nor do they reproduce the same degree of hemispheric symmetry.”

Is the Earth's climate system constrained?

“models energy balance is not similarly constrained”

“Models don't have the same behavior as the observed Earth – they lack the same degree of regulation and symmetry. Does this really matter? It seems so.”

http://wind.mit.edu/~emanuel/Lorenz/Lorenz_Workshop_Talks/Stephens.pdf

“We can’t use present models to test ideas because they are neither balanced nor in steady state (e.g. as in control). The hemispheric differences of models (historical) exceed that observed.”

- Here are Judy Curry's conclusions
- [<http://judithcurry.com/2015/03/10/the-albedo-of-earth/>]

"The implications of this paper strike me as profound. Planetary albedo is a fundamental element of the Earth's climate. This paper implies the presence of a stabilizing feedback between atmosphere/ocean circulations, clouds and radiation. Climate models do not capture this stabilizing feedback."

"The failure of models to reproduce this hemisphere synchronicity raises interesting implications regarding the fidelity of climate model-derived sensitivity to CO2."

Necessary Conditions For Skillful Multi-Decadal Predictions of Extreme Events

In hindcast runs (the last several decades), skillful predictions must be demonstrated which include:

1. The average (annual, monthly, etc.) global, regional and local climate. **POOR PERFORMANCE**
2. The changes in these averages over the past several decades. **POOR PERFORMANCE**
3. **The statistics of extreme weather events. NOT DONE YET?**
4. **The changes in these extremes over the last several decades NOT DONE YET?**

Hypothesis #1 The skill of initial value multi-decadal regional predictions of changes in climate statistics provide an upper bound on what is achievable using multi-decadal climate projections based on external forcings from added CO2 and other human climate forcings. NEEDED REGIONAL SKILL LACKING

Hypothesis #2 Skill at projecting changes in regional climate statistics emerges on time period beyond a decade when the external forcings from added CO2 and other human climate forcings dominate over natural variability and initial value conditions. NOT SHOWN TO HAVE SKILL

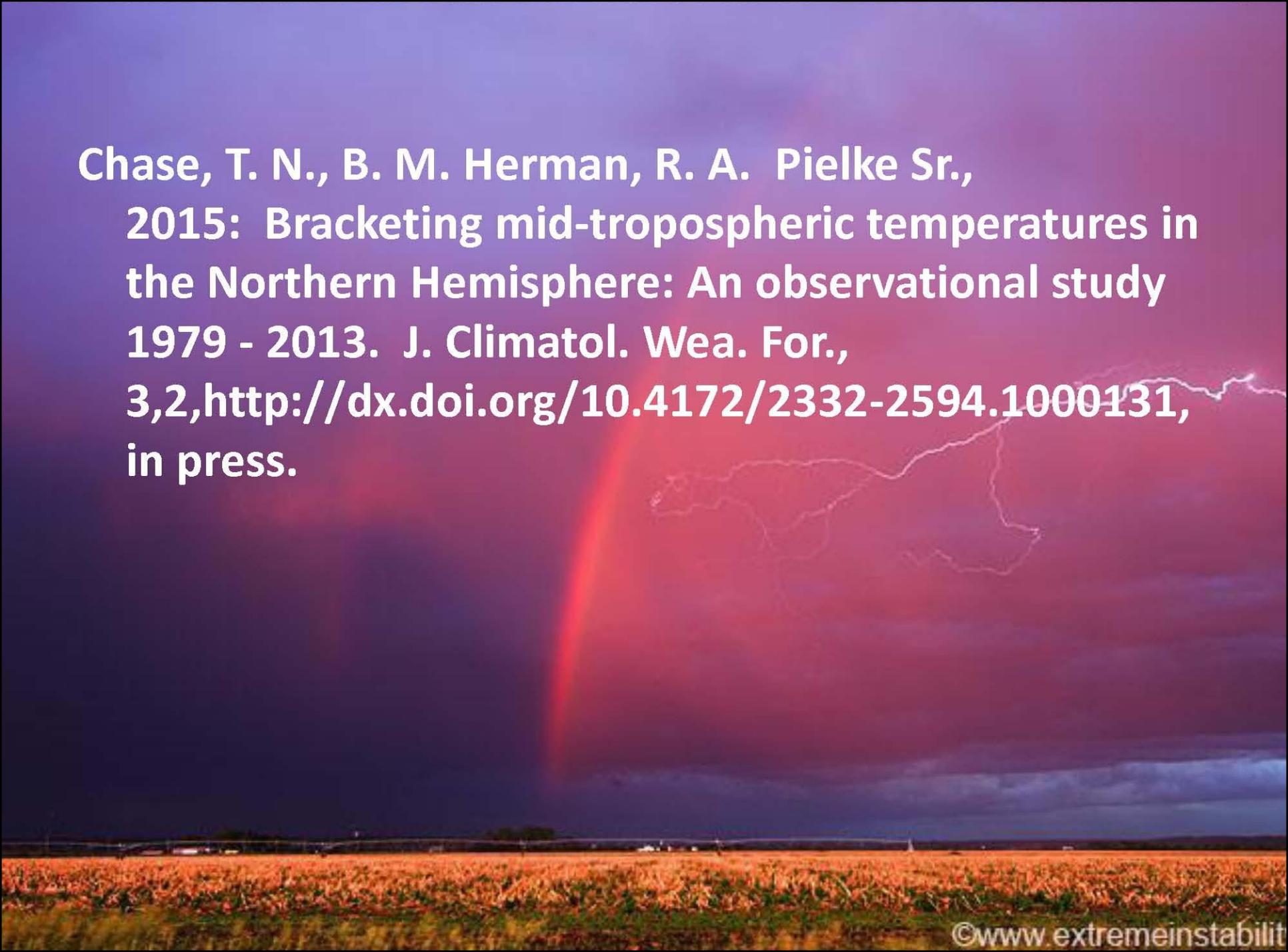
Testing of these two hypotheses must be accomplished using hindcasts.

Self Regulation by the Climate System

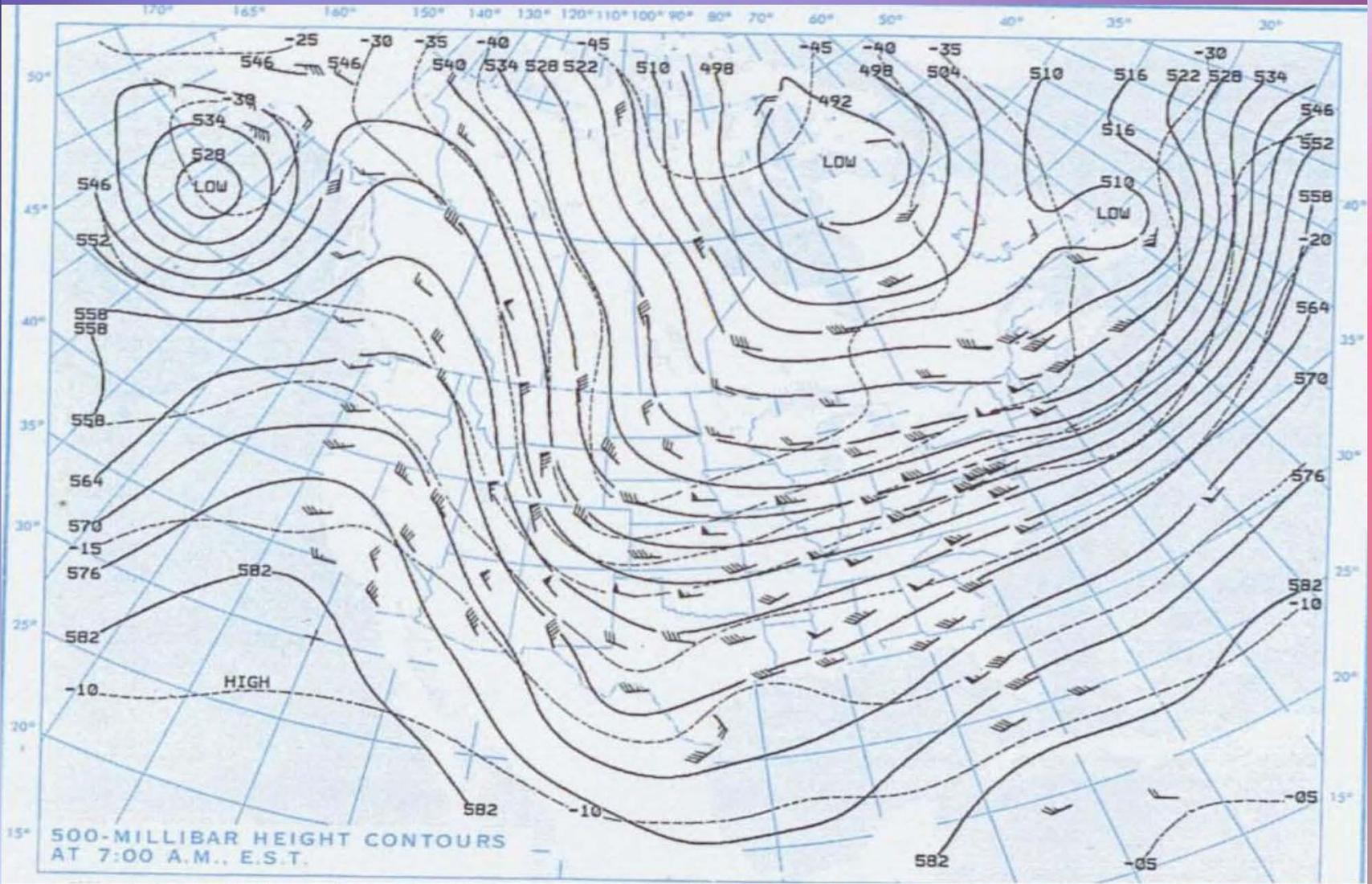


http://wind.mit.edu/~emanuel/Lorenz/Lorenz_Workshop_Talks/Stephens.pdf

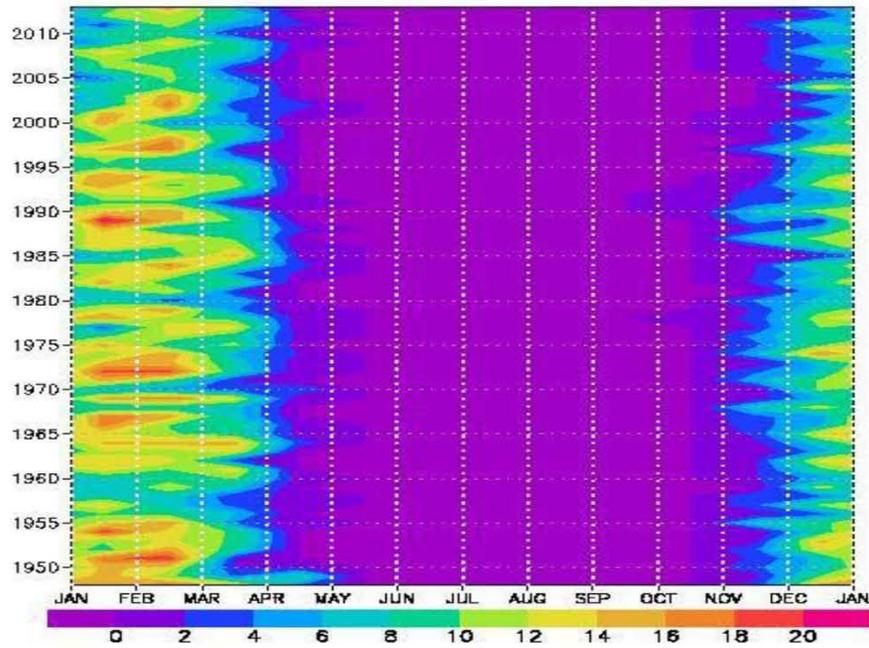
“The reflected energy from Earth is highly regulated & this regulation by clouds. The most dramatic example of this appears in hemispheric symmetry of reflected solar radiation – Hemispheric OLR also appears regulated by clouds”

A dramatic sky with a rainbow and lightning over a field. The sky is dark and stormy, with a bright rainbow arching across the left side. Several bright lightning bolts are visible in the dark clouds. The foreground shows a field of golden-brown crops, likely corn, under a dark, overcast sky.

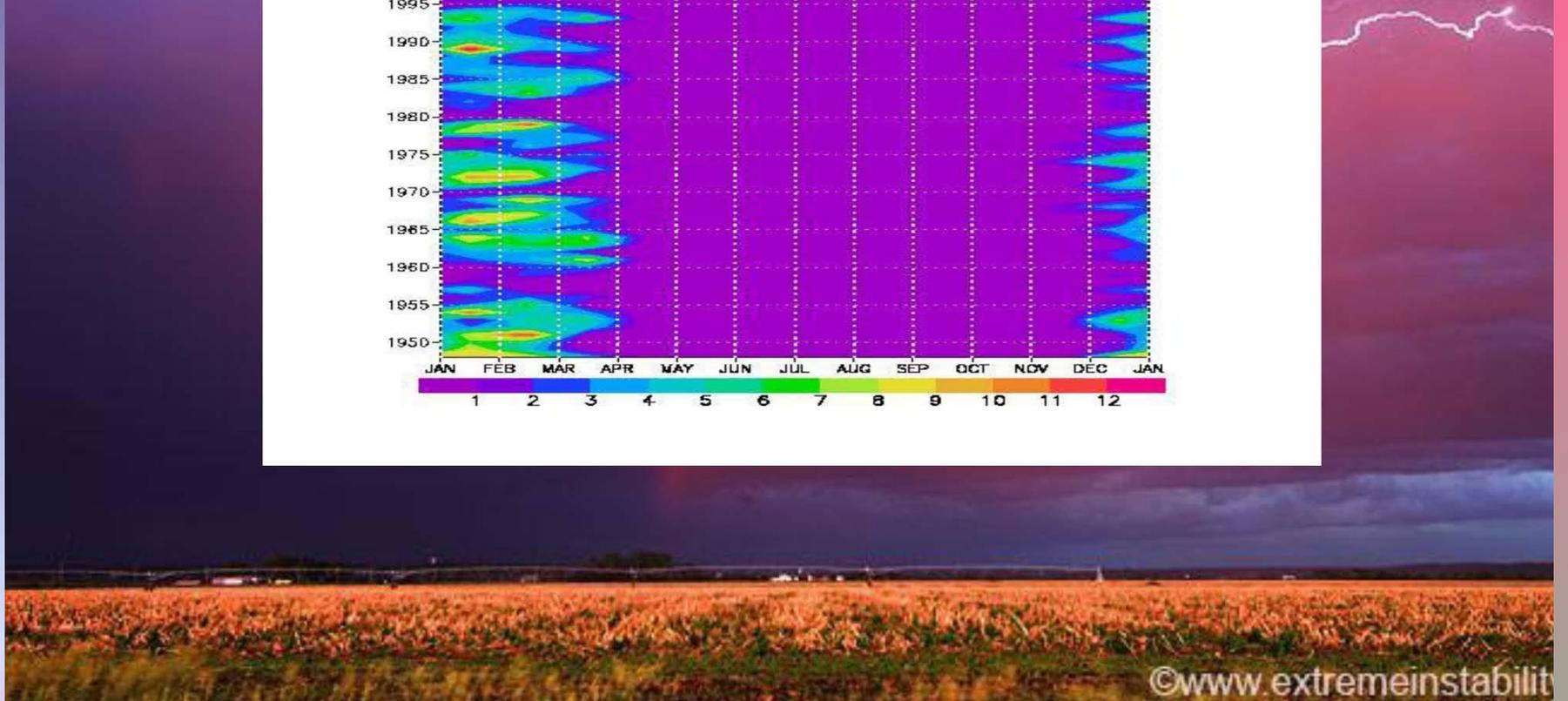
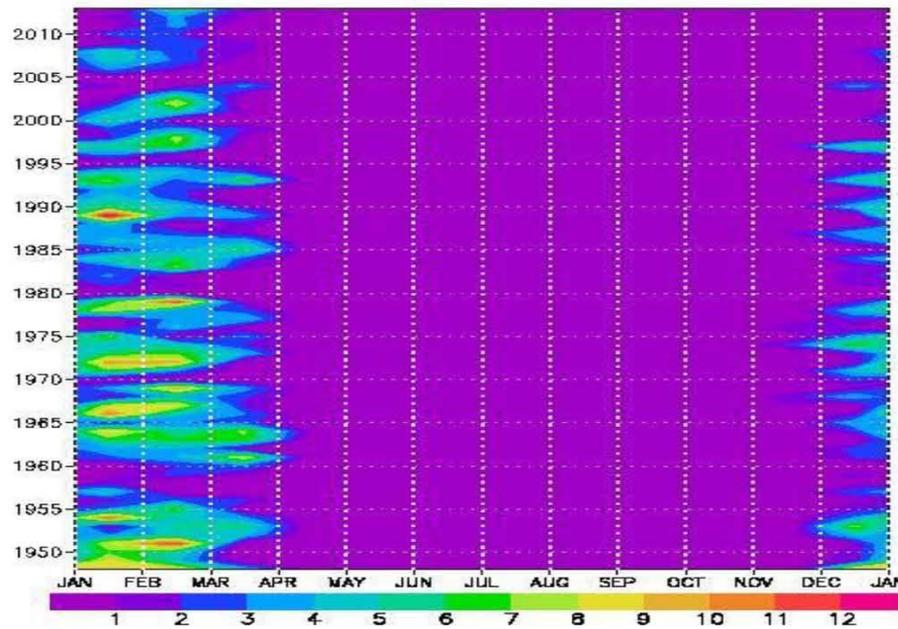
**Chase, T. N., B. M. Herman, R. A. Pielke Sr.,
2015: Bracketing mid-tropospheric temperatures in
the Northern Hemisphere: An observational study
1979 - 2013. J. Climatol. Wea. For.,
3,2,<http://dx.doi.org/10.4172/2332-2594.1000131>,
in press.**



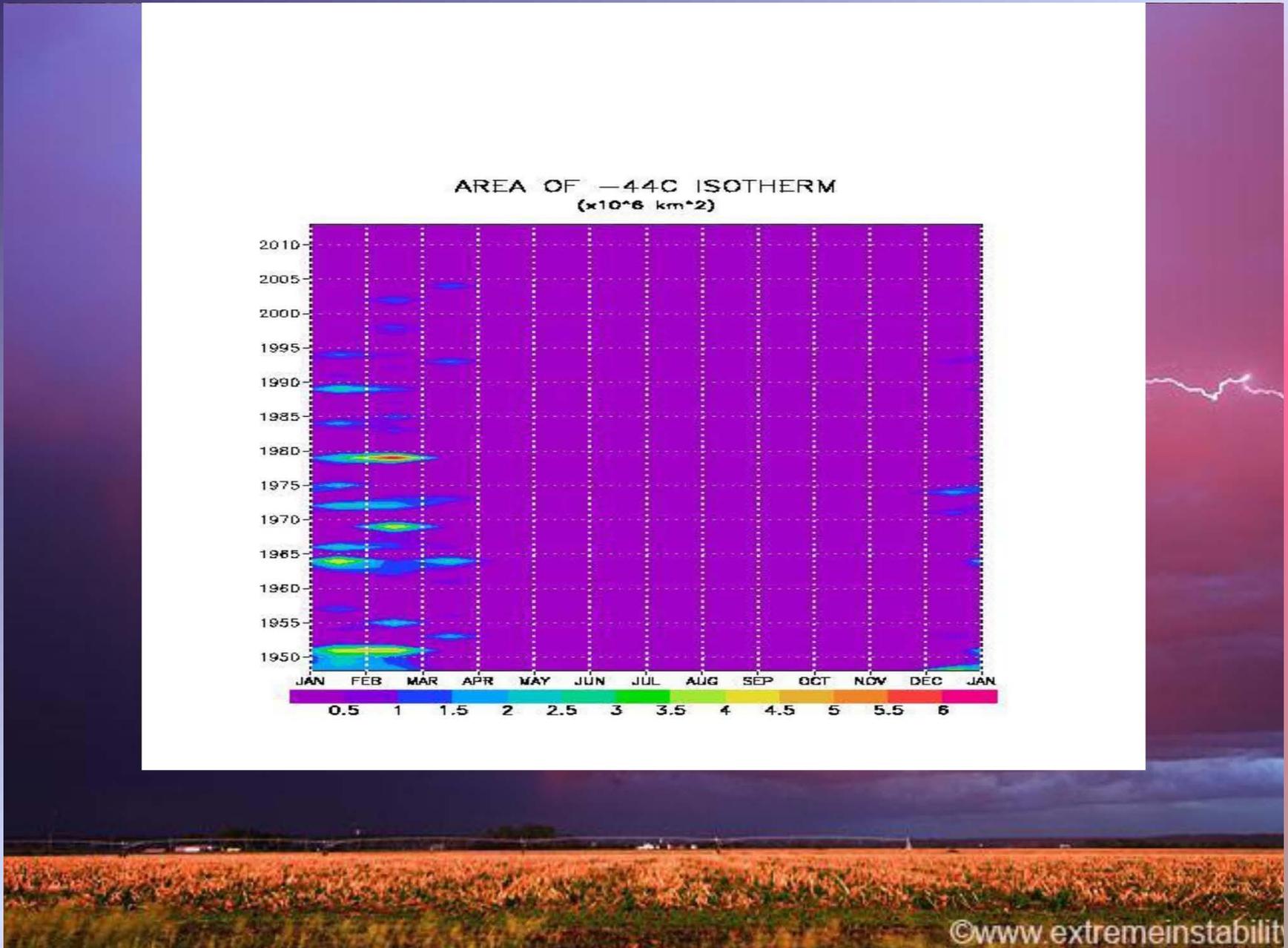
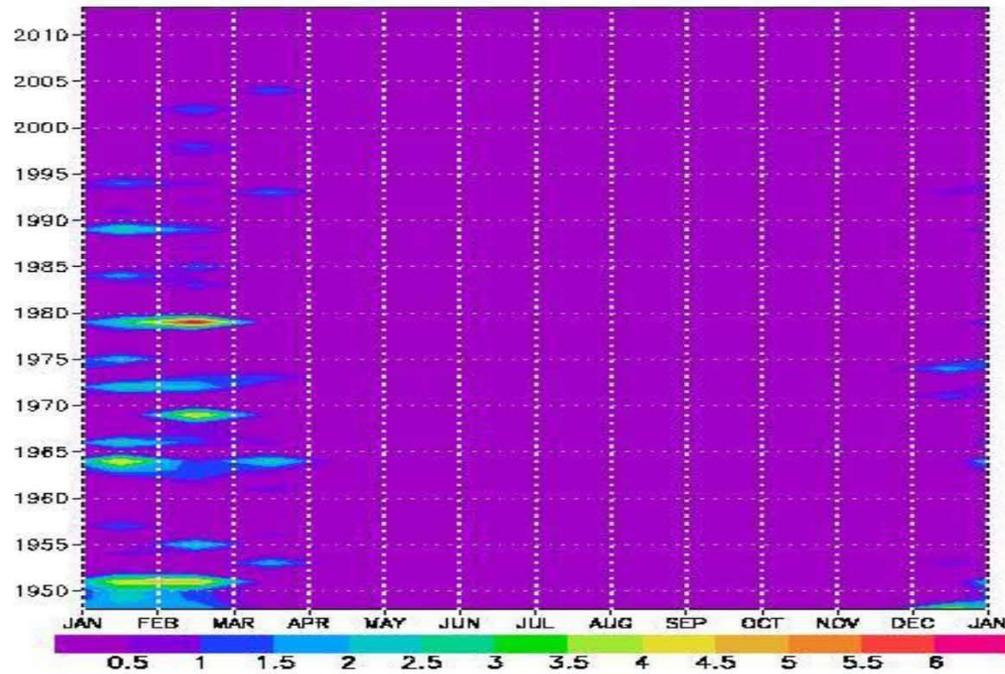
AREA OF -40C ISOTHERM
($\times 10^6 \text{ km}^2$)



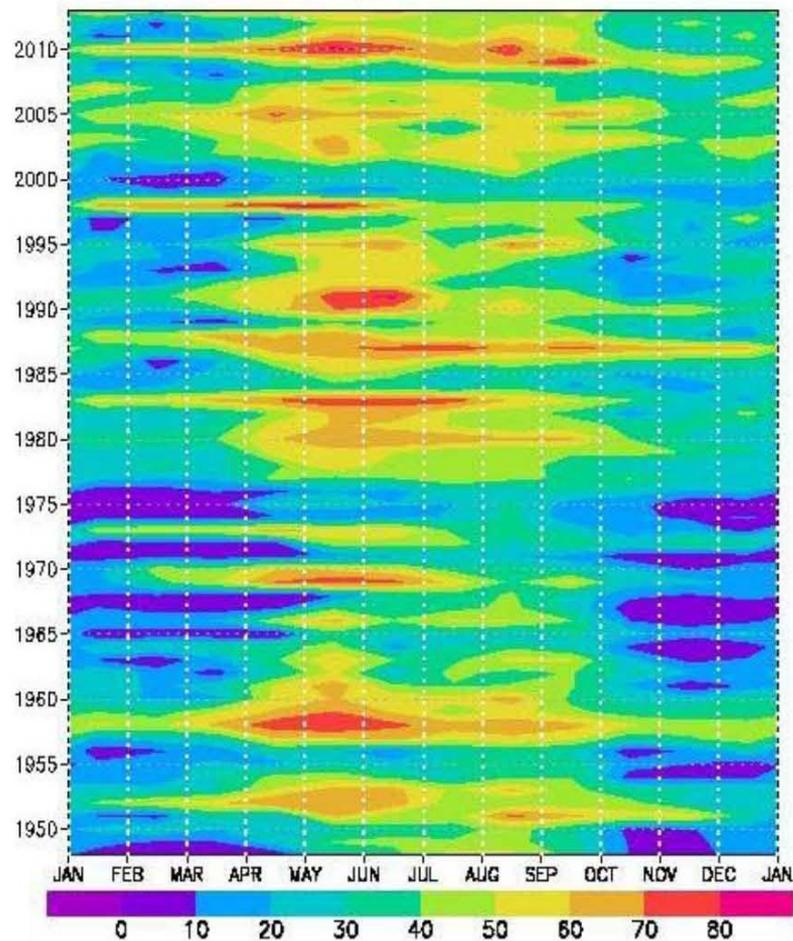
AREA OF -42°C ISOTHERM
($\times 10^6 \text{ km}^2$)



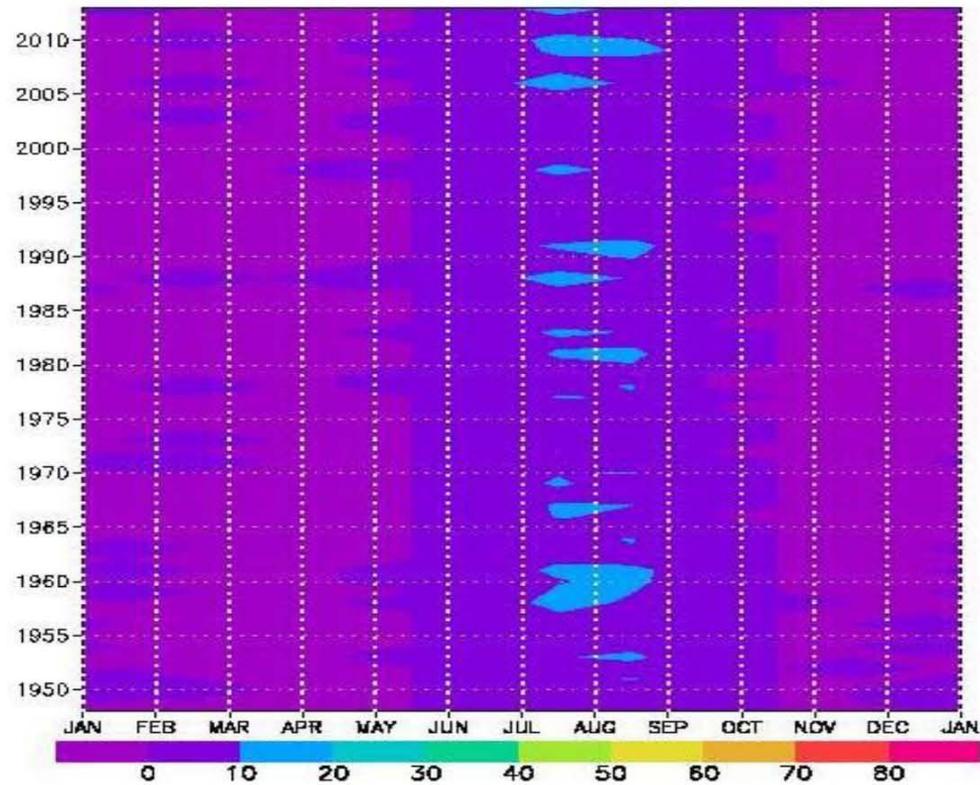
AREA OF -44C ISOOTHERM
($\times 10^6 \text{ km}^2$)



AREA OF -5°C ISOTHERM in NH
($\times 10^6 \text{ km}^2$)



AREA OF -3°C ISOTHERM in NH
($\times 10^6 \text{ km}^2$)



Conclusion - There are self regulations in the climate system that are not properly handled by the models.



Next, Let's Look At "Climate Change"

Global Warming << "Climate Change"

But lets look at Global Warming since that is where so much attention has been concentrated.



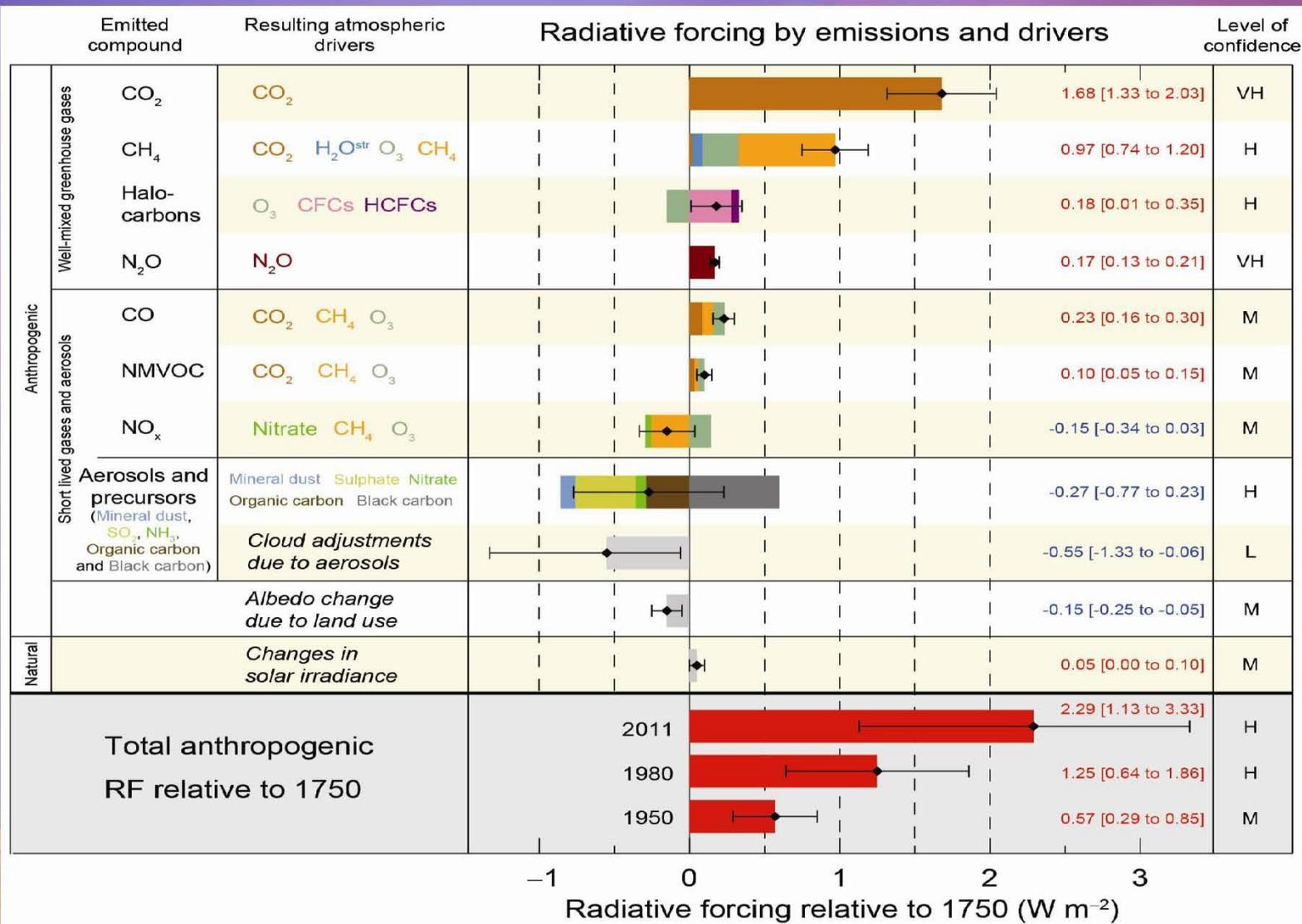
Global Warming/Cooling

Global warming involves the accumulation of heat in Joules within the components of the climate system.

This accumulation is dominated by the heating and cooling within the upper layers of the oceans.

The global average surface temperature trend is an inadequate metric to diagnose this warming/cooling





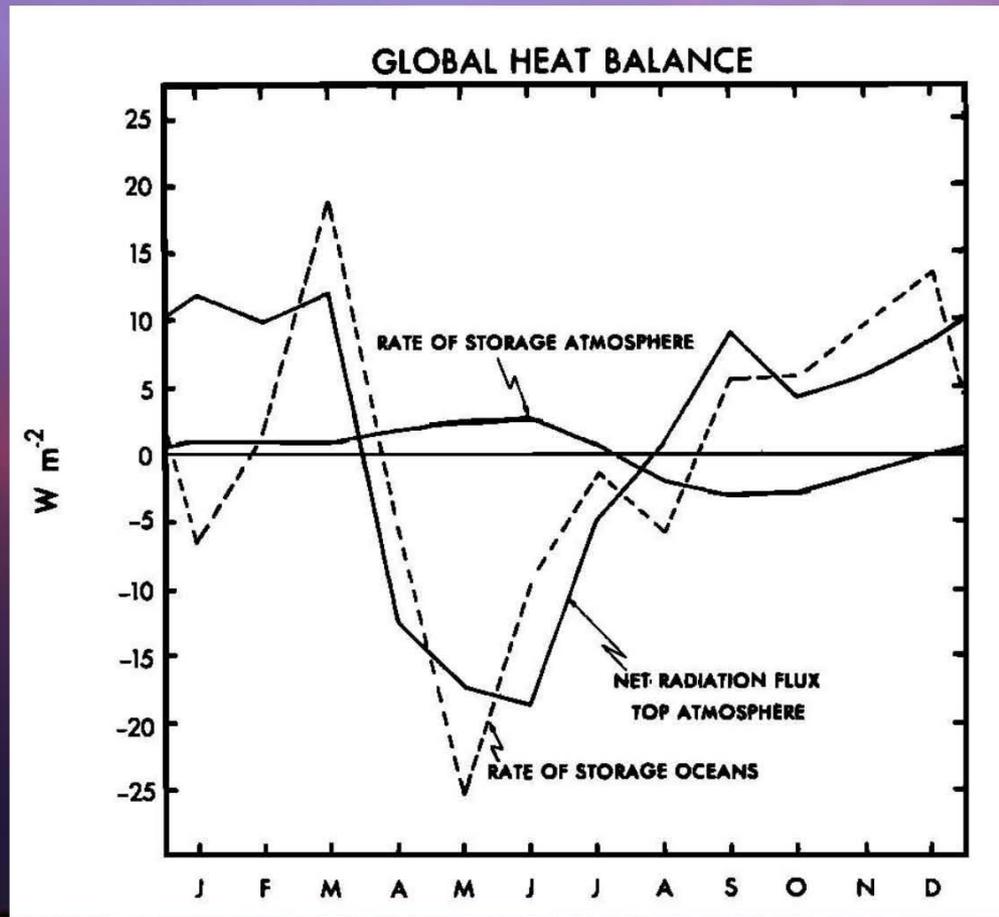
Palmer et al. 2015: Ocean heat content variability and change in an ensemble of ocean reanalyses. *Climate Dynamics*

“Accurate knowledge of the location and magnitude of ocean heat content (OHC) variability and change is essential for understanding the processes that govern decadal variations in surface temperature, quantifying changes in the planetary energy budget, and developing constraints on the transient climate response to external forcings.”

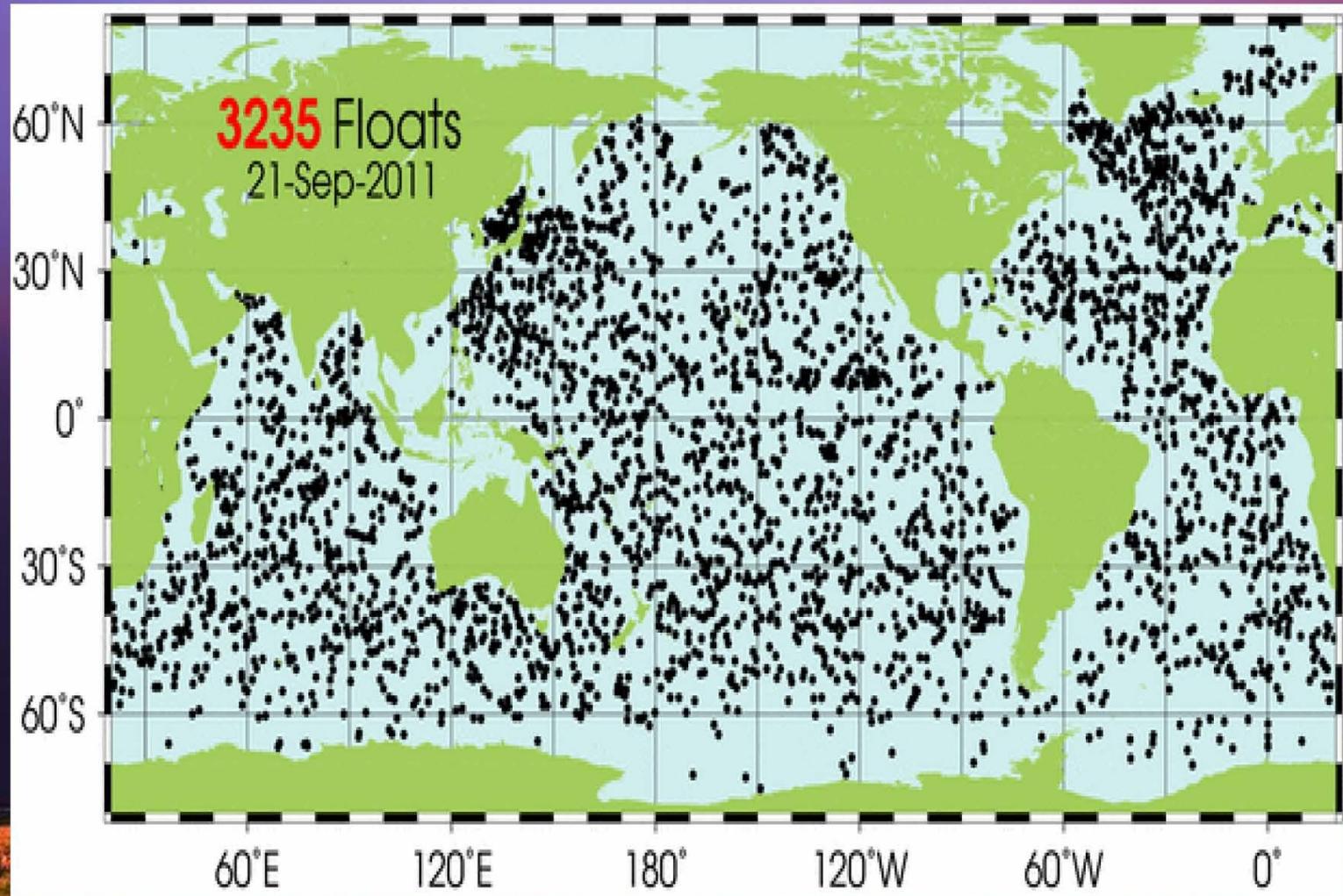
Finally accepts what is written in

Pielke Sr., R.A., 2003: Heat storage within the Earth system. *Bull. Amer. Meteor. Soc.*, 84, 331-335.

Seminal paper on this subject: Ellis . J.S., T.H. Vonder Haar, S. Levitus, and A.H. Oort
1978: The annual variation in the global heat balance of the Earth. J. Geophys. Res.,
83, 1958-1962.

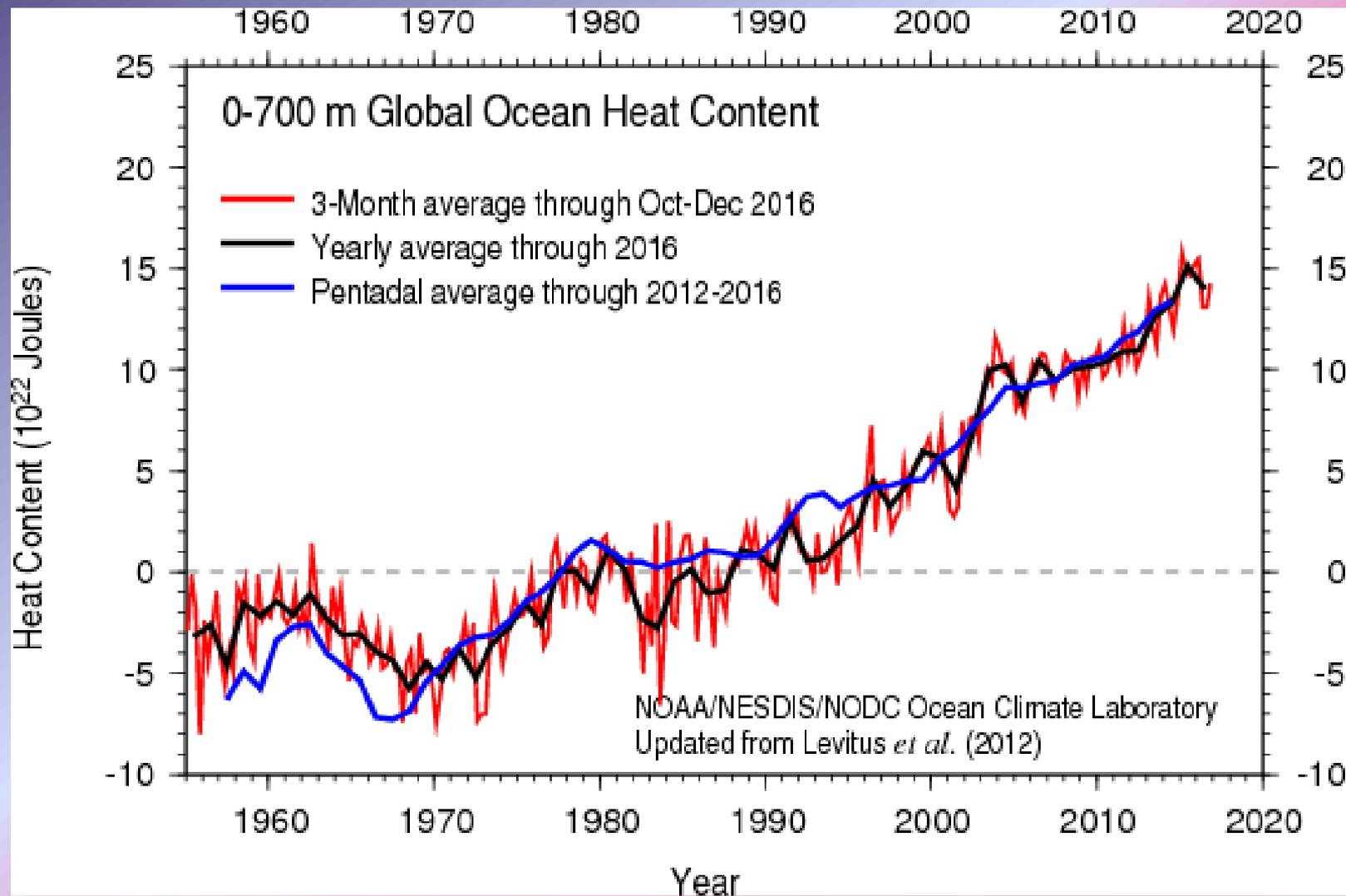


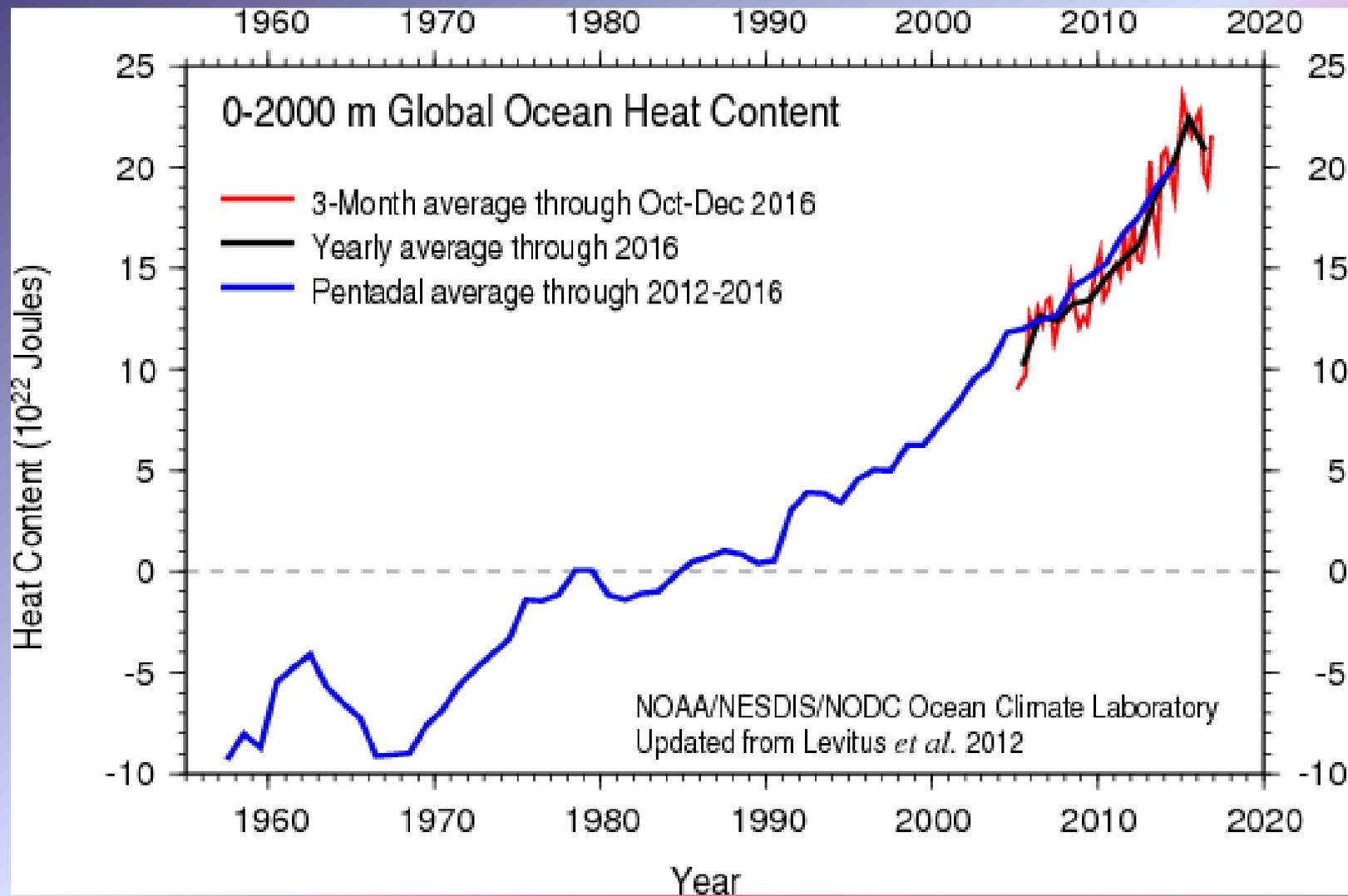
Argo Network

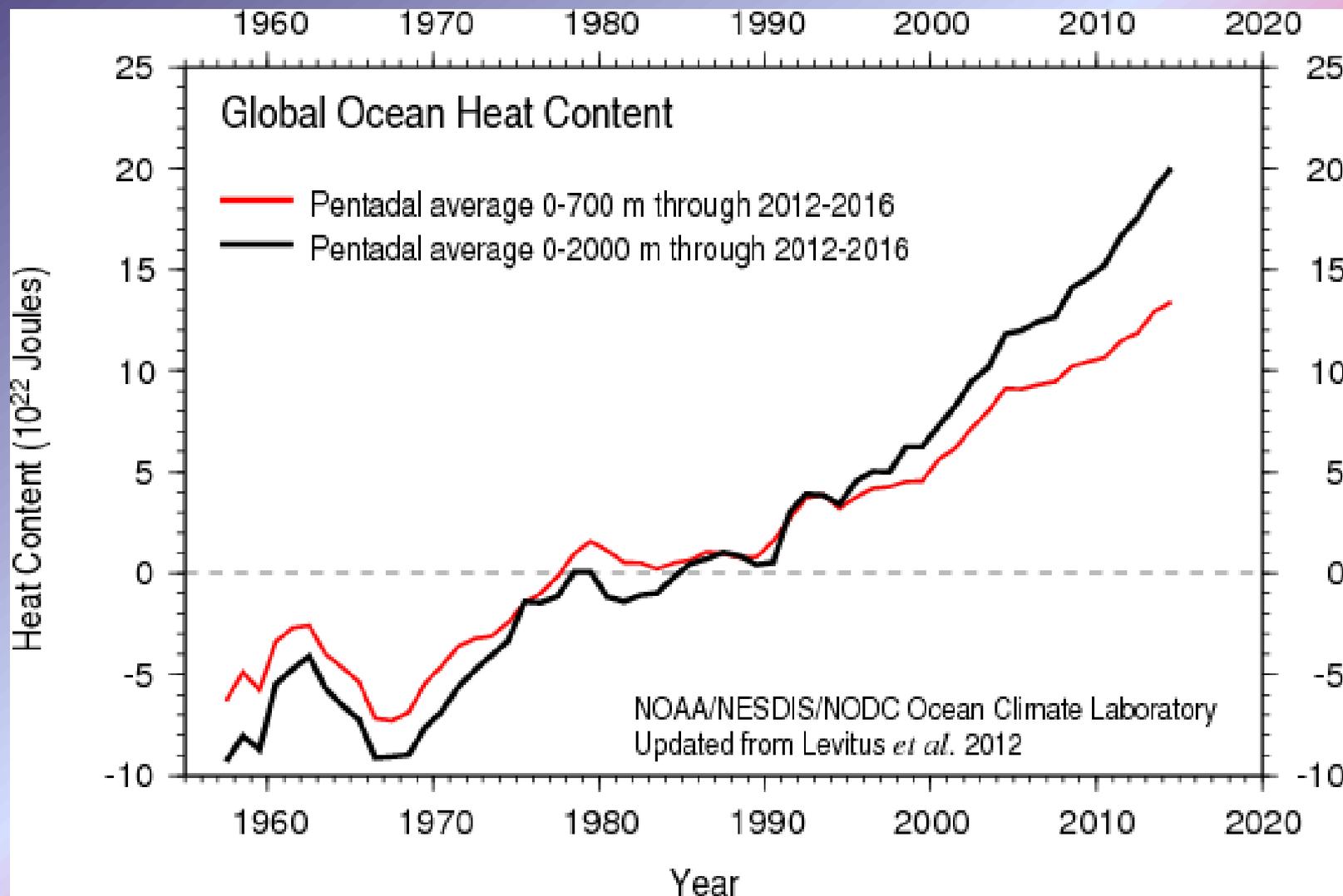


Next three slides

https://www.nodc.noaa.gov/OC5/3M_HEAT_CONTENT/







Global Radiative Imbalance [Most Accurately Diagnosed from
OHC changes] = Global Radiative Forcings + Global Radiative
Feedbacks

Better reconciling the two terms on
the right is needed

Magnitude Of Global Warming

“0.85 W/m² is the imbalance at the end of the decade [end of the 1990s]” Jim Hansen

“The net warming of the ocean implies an energy imbalance for the Earth of 0.64 ± 0.44 W m⁻² from 2005 to 2013.” Llovel et al 2014

“the [global]1955-2010 warming rate is 0.43 W m⁻² ± 0.031 W m⁻²” Levitus et al 2012

“a fairly steady mean global rate of 0.9 ± 0.8 W m⁻² for the period 1995–2002 that drops to 0.2 ± 0.6 W m⁻² for the period 2004–2006” Palmer et al 2015

Real world data also shows a more complex behavior than is commonly communicated by the media and in professional society statements.



Moreover, climate change is much more than global warming



However, what is “climate change”?

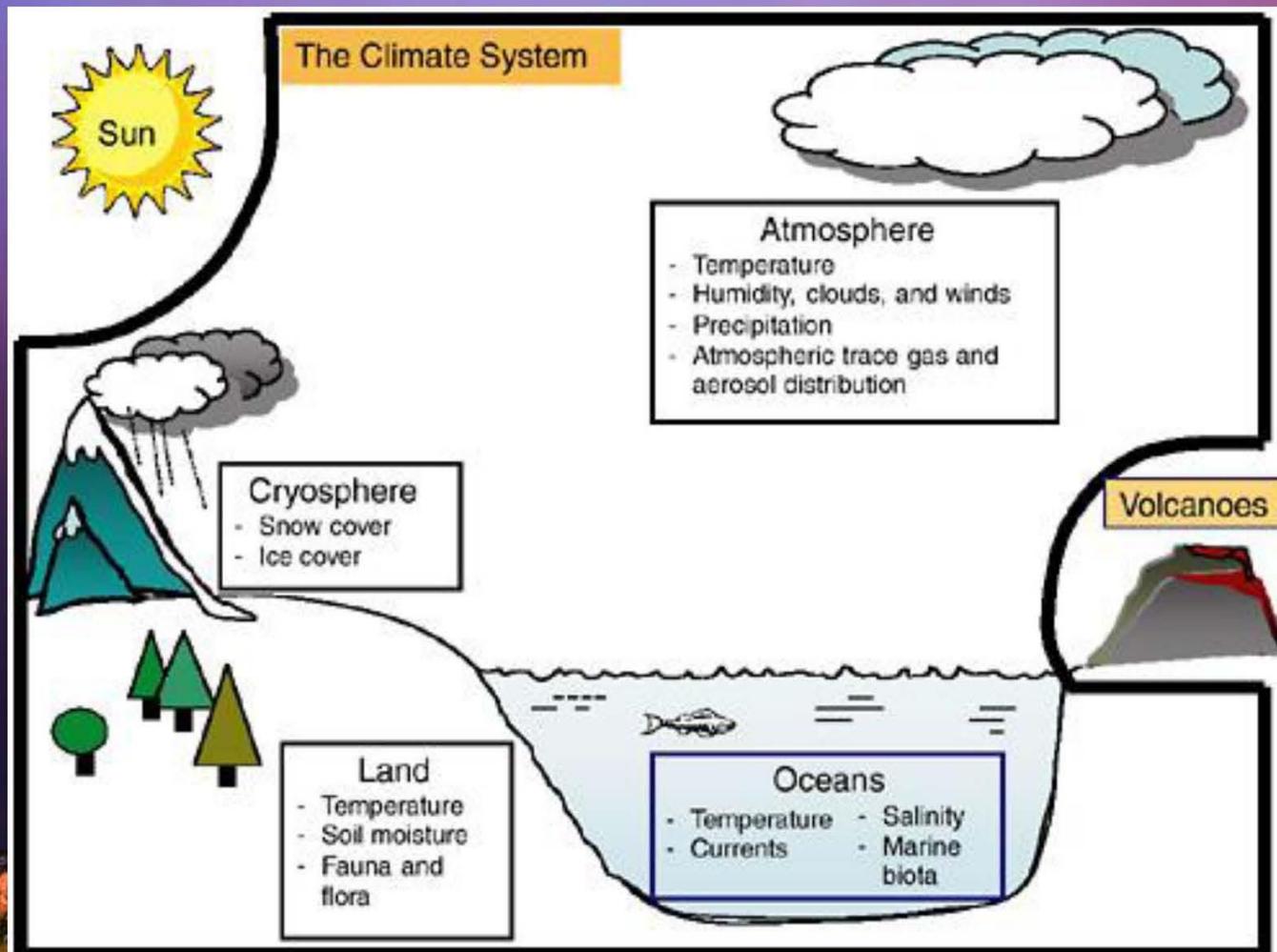
Climate Change is any multi-decadal or longer alteration in one or more physical, chemical and/or biological components of the climate system.

Climate change includes, for example, changes in fauna and flora, snow cover, etc which persist for decades and longer. Climate variability can then be defined as changes which occur on shorter time periods.

Also Climate Is Much More Than Climate Change.

Indeed, the addition of the word “Change” is redundant. Climate is always changing, just like the weather.

Source: National Research Council, 2005: Radiative forcing of climate change: Expanding the concept and addressing uncertainties.



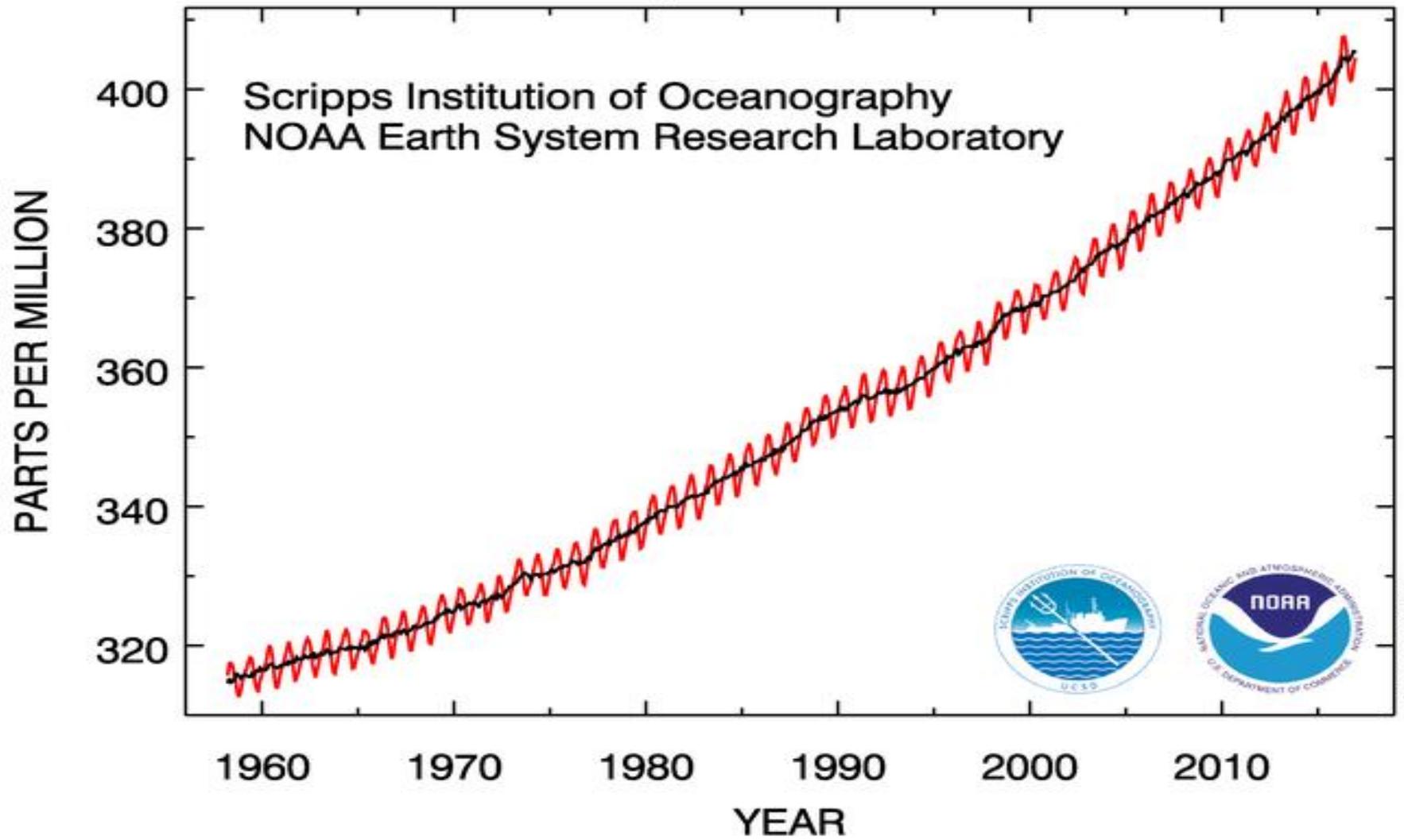
Human Climate Forcings



Human Climate Forcings

- The influence of the human input of CO₂ and other greenhouse gases on regional and global radiative heating
- The influence of human-caused aerosols on regional (and global) radiative heating
- The effect of aerosols on clouds and precipitation
- The influence of aerosol deposition (e.g. soot; nitrogen) on climate
- The effect of land cover/ land use on climate
- The biogeochemical effect of added atmospheric CO₂

Atmospheric CO₂ at Mauna Loa Observatory



EPA Criteria Pollutants -

<http://www.epa.gov/air/criteria.html>

Ozone

Particulate Matter – PM10 and PM 2.5

Carbon Monoxide

Nitrogen Oxides

Sulfur Dioxide

Lead

There are no benefits for these criteria pollutants at EPA standards levels. CO2 does at levels being discussed to limit to in the atmosphere. Not all are positive but some are (some plants like enriched CO2).

Thus, calling added CO2 a pollutant rather than a climate forcing is scientifically misleading even though politicians use the label.

CO2 is not an air pollutant. It is a climate forcing.

Cochran, L.S., R.A. Pielke, and E. Kovacs, 1992: Selected international receptor based air quality standards. J. Air Waste Mgt. Assoc., 42, 1567-1572.

<http://pielkeclimatesci.files.wordpress.com/2012/01/r-167.pdf>

on page 1571

"Need to Know" Versus "Right to Know"

In compiling this information, we found it easier to access the regulations from some countries as opposed to others. There is a major political difference between public rights to air quality information. In the United States, for example, the federal law mandates a "right to know," while the Seveso Directive (#67/548) of the European community permits access based on a "need to know." This fundamental difference provides further impetus for an ambient based standard, in addition to emission based standards, since the public and other interested parties could monitor air quality."

Thus in terms of modeling of the effect of air pollution that is used to determine a regulatory response by the EPA, there is a right to know in the USA. Since CO₂ has been labeled as a "pollutant", the rule should apply to the modeling of the effects from added CO₂.

An Aside: The CO2 part of climate change

- Instead of a tax on carbon, I recommend taxes on emissions into the atmosphere of pollutants such as mercury, lead, SO₂, etc where reductions in CO₂ would be a co-benefit.
- This may be a way to move forward to limit CO₂ emissions with a broader group of support.

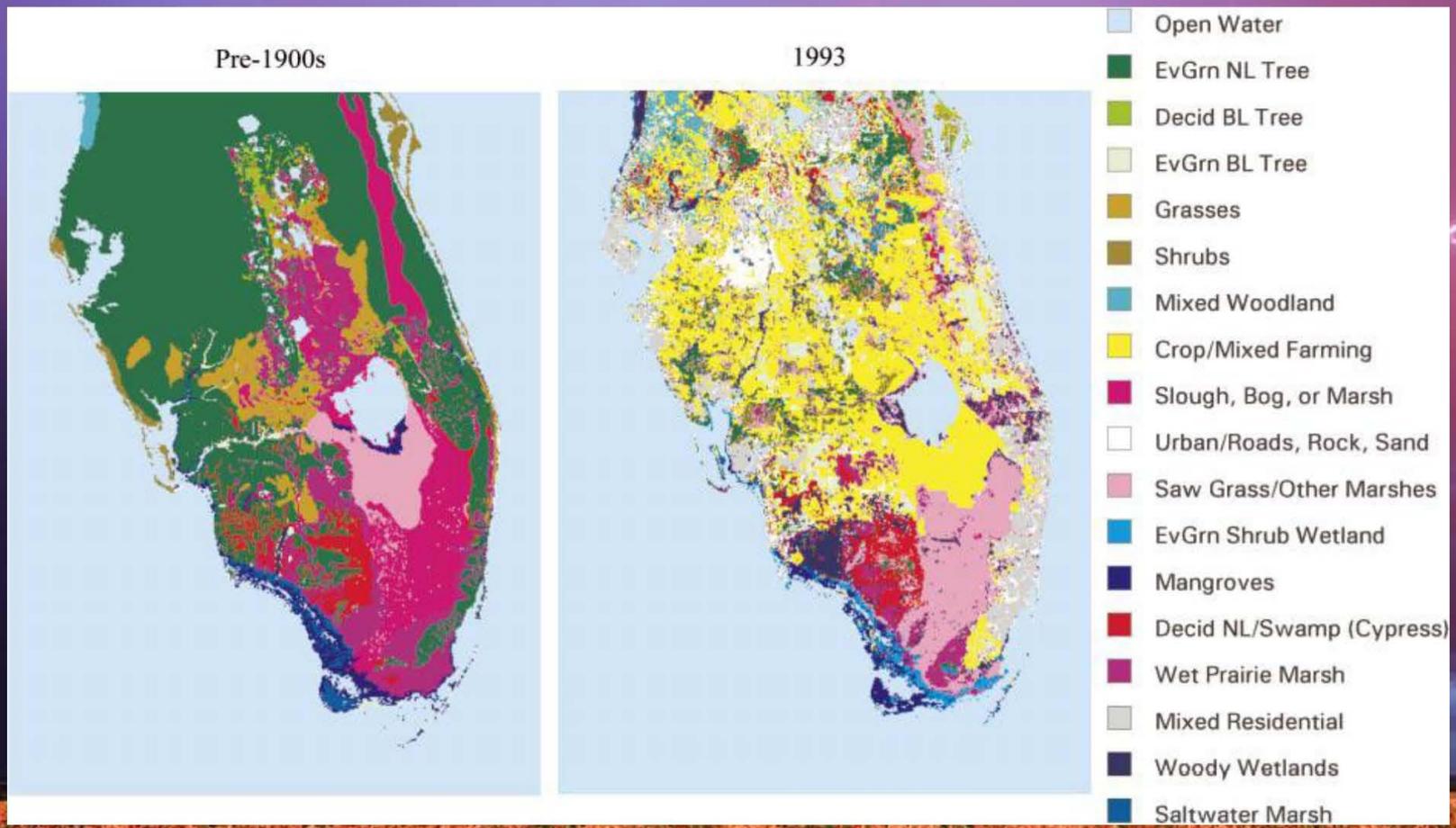


LAND USE/LAND COVER CHANGE





From Marshall et al. 2004



Alter et al: 2015: Rainfall consistently enhanced around the Gezira Scheme in East Africa owing to irrigation. Nature Geosciences Sept 7 2015

“Land-use and land-cover changes have significantly modified regional climate patterns around the world”



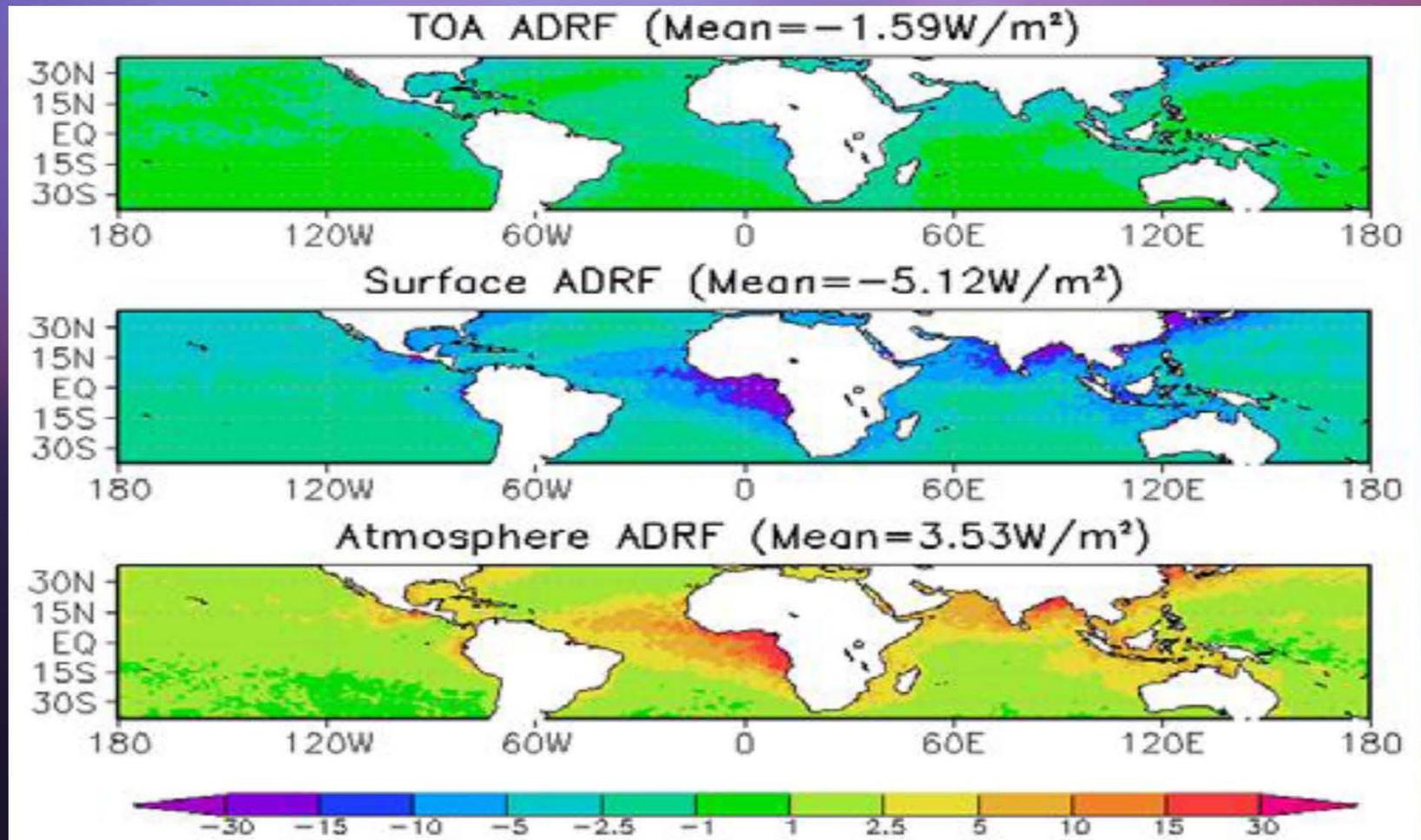
Aerosols



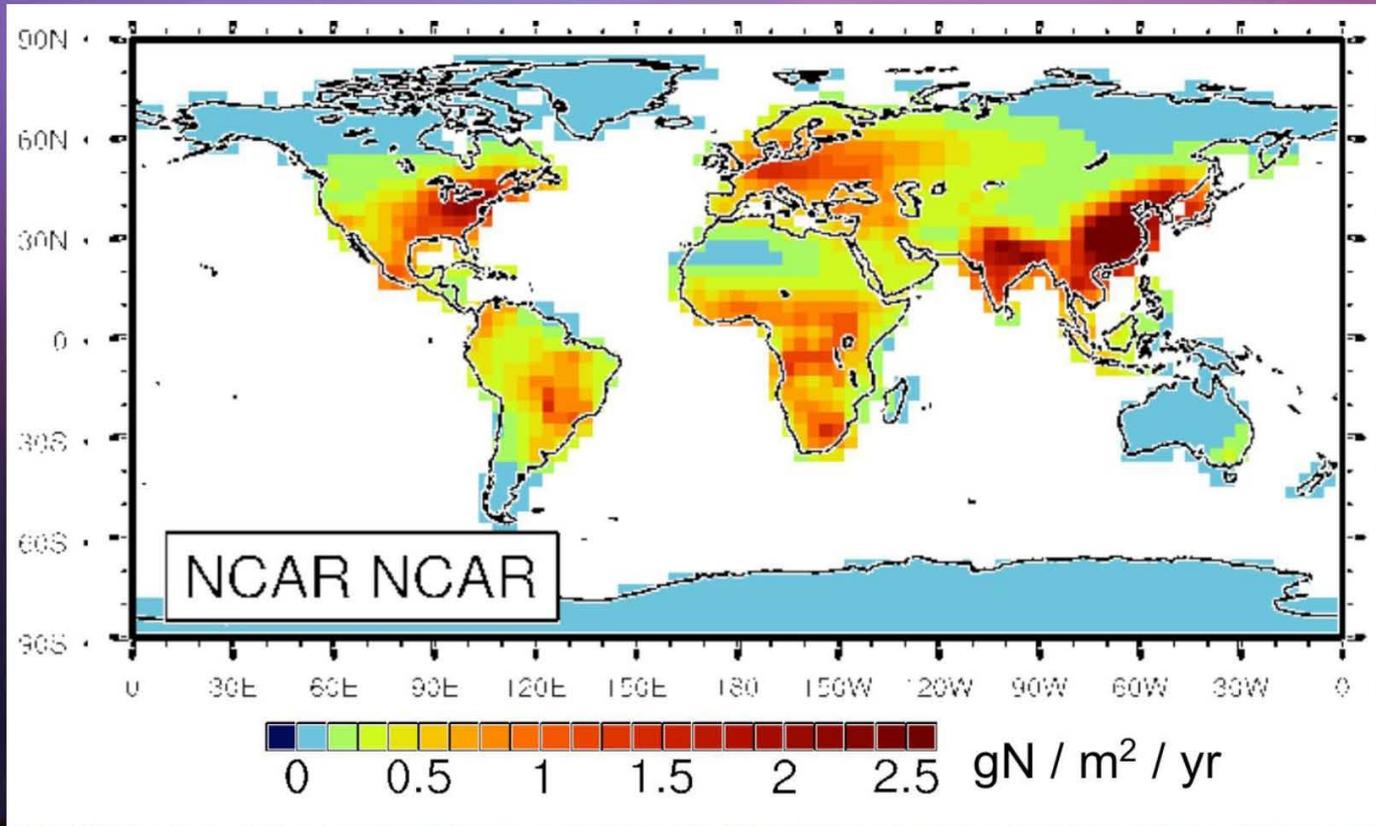


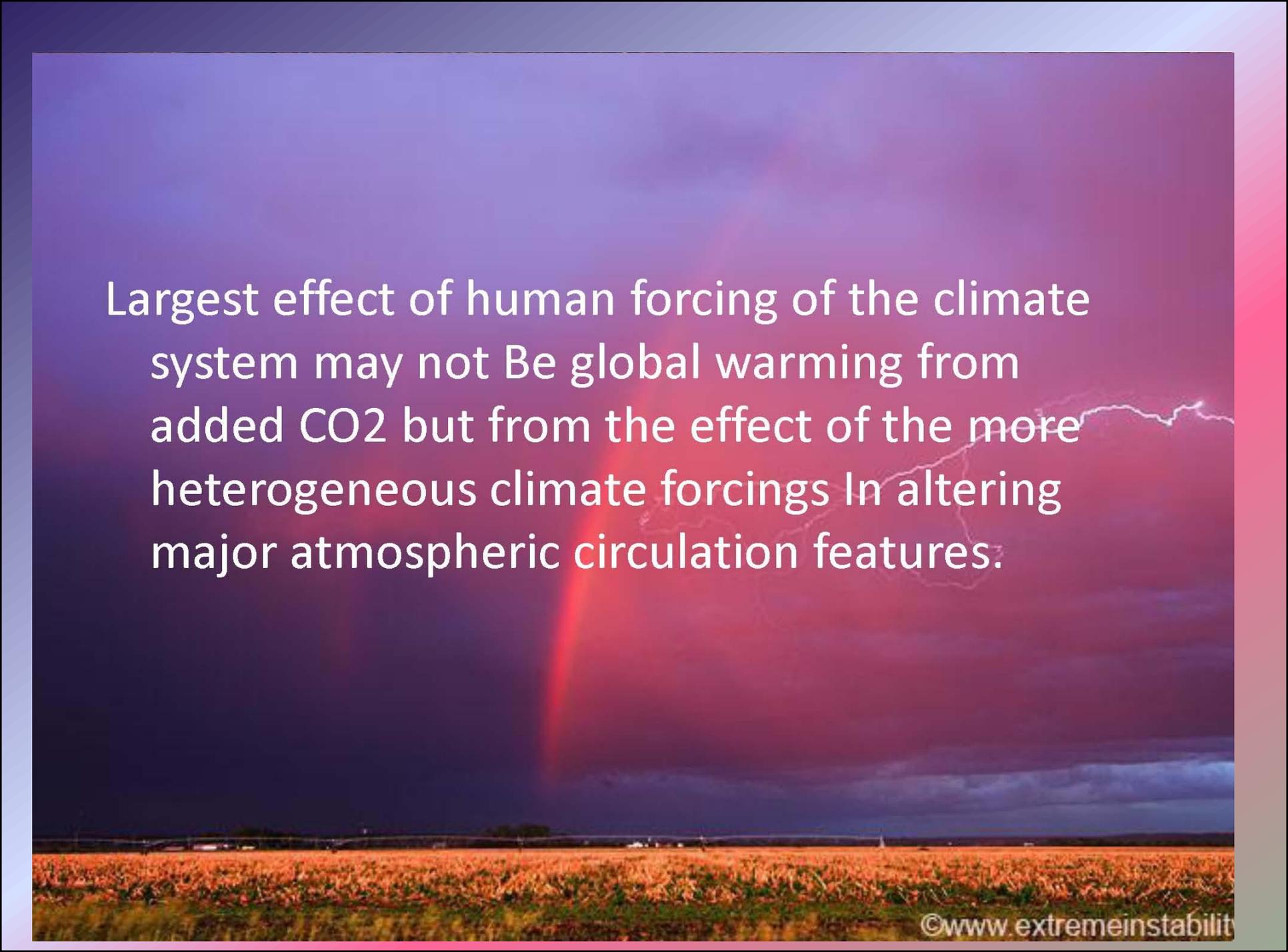


Matsui, T., and R.A. Pielke Sr., 2006: Measurement-based estimation of the spatial gradient of aerosol radiative forcing. Geophys. Res. Letts., 33, L11813, doi:10.1029/2006GL025974.



Nitrogen Deposition





Largest effect of human forcing of the climate system may not be global warming from added CO₂ but from the effect of the more heterogeneous climate forcings in altering major atmospheric circulation features.

A dramatic sky with a rainbow and lightning over a field of golden wheat. The sky is a mix of purple, blue, and red, with a bright rainbow arching across it. A lightning bolt is visible on the right side. The foreground is a field of golden wheat.

**The Human Influence on Climate is
Everywhere!**
**The IPCC and other assessments have
failed to properly assess these
influences.**

And Then There Are The Natural Climate Forcings

- Solar
- Volcanic
- Internal atmospheric/ocean circulation variability [PDO, NAO, ENSO, etc]
- Other



Three Hypotheses

- Hypothesis 1: Human influence on climate variability and change is of minimal importance, and natural causes dominate climate variations and changes on all time scales. In coming decades, the human influence will continue to be minimal.
- Hypothesis 2a: Although the natural causes of climate variations and changes are undoubtedly important, the human influences are significant and involve a diverse range of first- order climate forcings, including, but not limited to, the human input of carbon dioxide (CO₂). Most, if not all, of these human influences on regional and global climate will continue to be of concern during the coming decades.
- Hypothesis 2b: Although the natural causes of climate variations and changes are undoubtedly important, the human influences are significant and are dominated by the emissions into the atmosphere of greenhouse gases, the most important of which is CO₂. The adverse impact of these gases on regional and global climate constitutes the primary climate issue for the coming decades. [IPCC]



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REJECTED

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REJECTED



As Mike Hulme of the University of East Anglia writes of two views:

1) “The overwhelming scientific evidence tells us that human greenhouse gas emissions are resulting in climate changes that cannot be explained by natural causes. Climate change is real, we are causing it, and it is happening right now.”

or

2) “The overwhelming scientific evidence tells us that human greenhouse gas emissions, land use changes and aerosol pollution are all contributing to regional and global climate changes, which exacerbate the changes and variability in climates brought about by natural causes. Because humans are contributing to climate change, it is happening now and in the future for a much more complex set of reasons than in previous human history.”

As Mike Hulme writes

”....these two different provocations – two different framings of climate change – open up the possibility of very different forms of public and policy engagement with the issue. They shape the response.

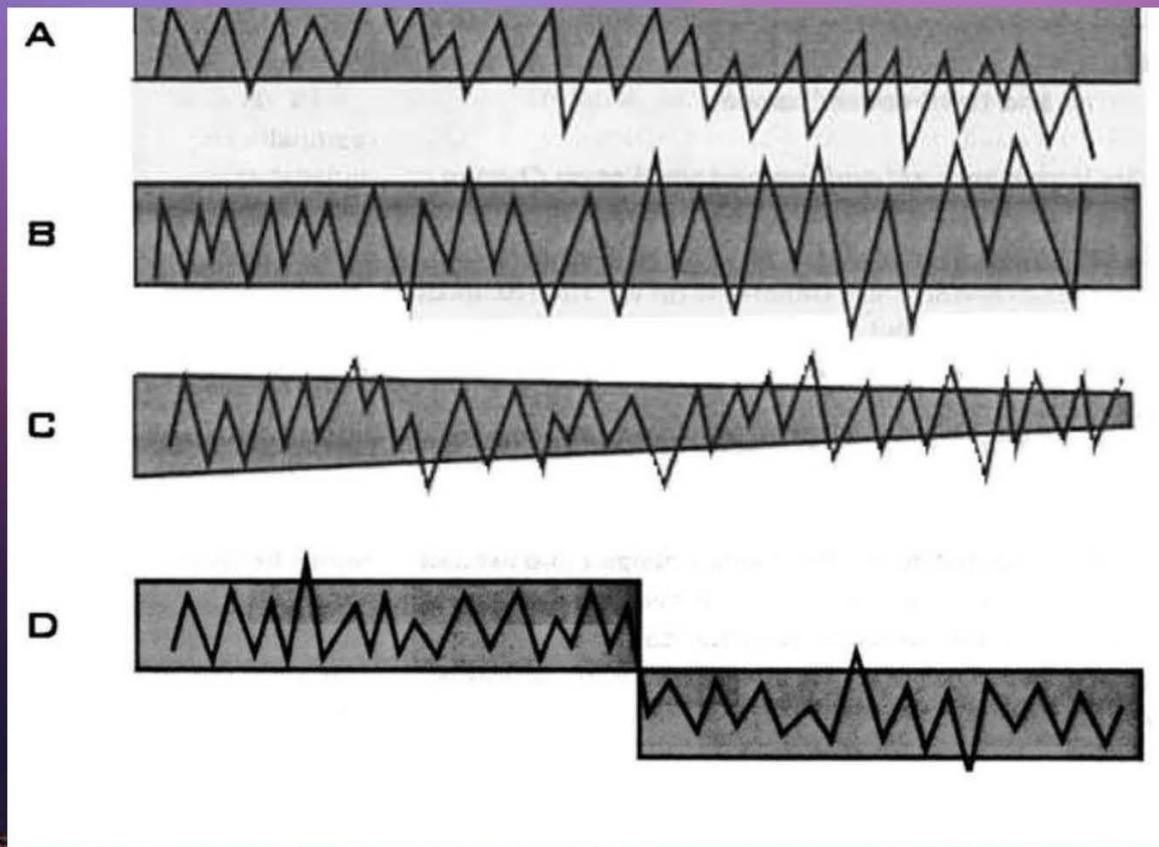
<http://theconversation.edu.au/youve-been-framed-six-new-ways-to-understand-climate-change-2119>

A New Approach Is Needed!

**We Need To Replace The IPCC Top-Down Approach To Predict
Future Environmental And Social Risk With A Bottom-Up
Resource-Based Assessment of Vulnerability**

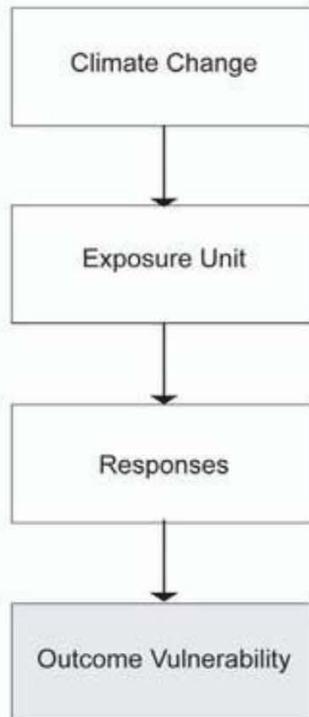
**Our Key Resources Are Water, Food, Energy, Ecosystem
Function and Human Health**

How Vulnerability Can Change Over Time



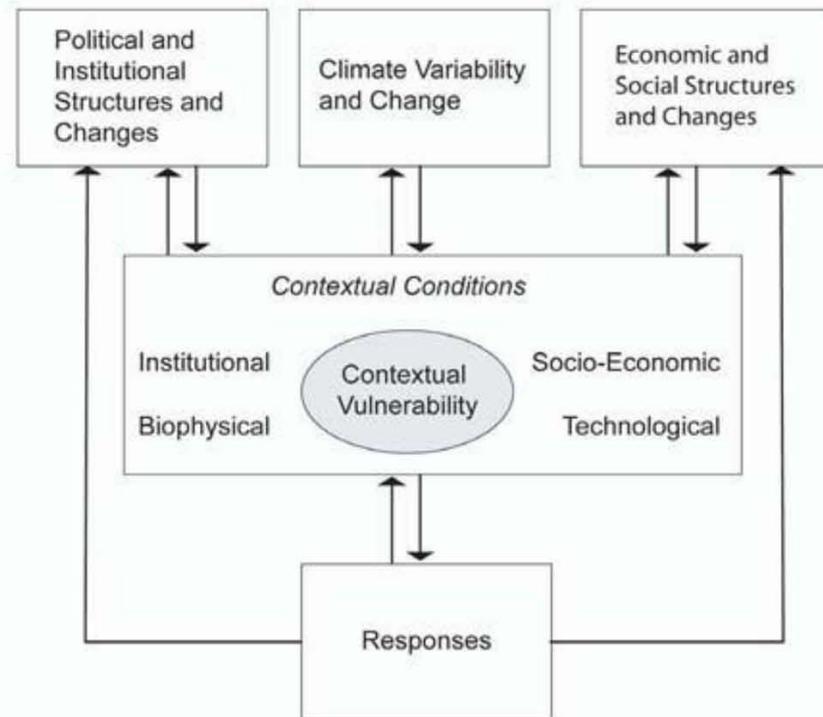
O'Brien et al., 2007: Why different interpretations of vulnerability matter in climate change discourses. *Climate Policy* 7 (1): 73–88

1a Outcome Vulnerability



1b

Contextual Vulnerability



Climate Vulnerability

Understanding and Addressing Threats to Essential Resources

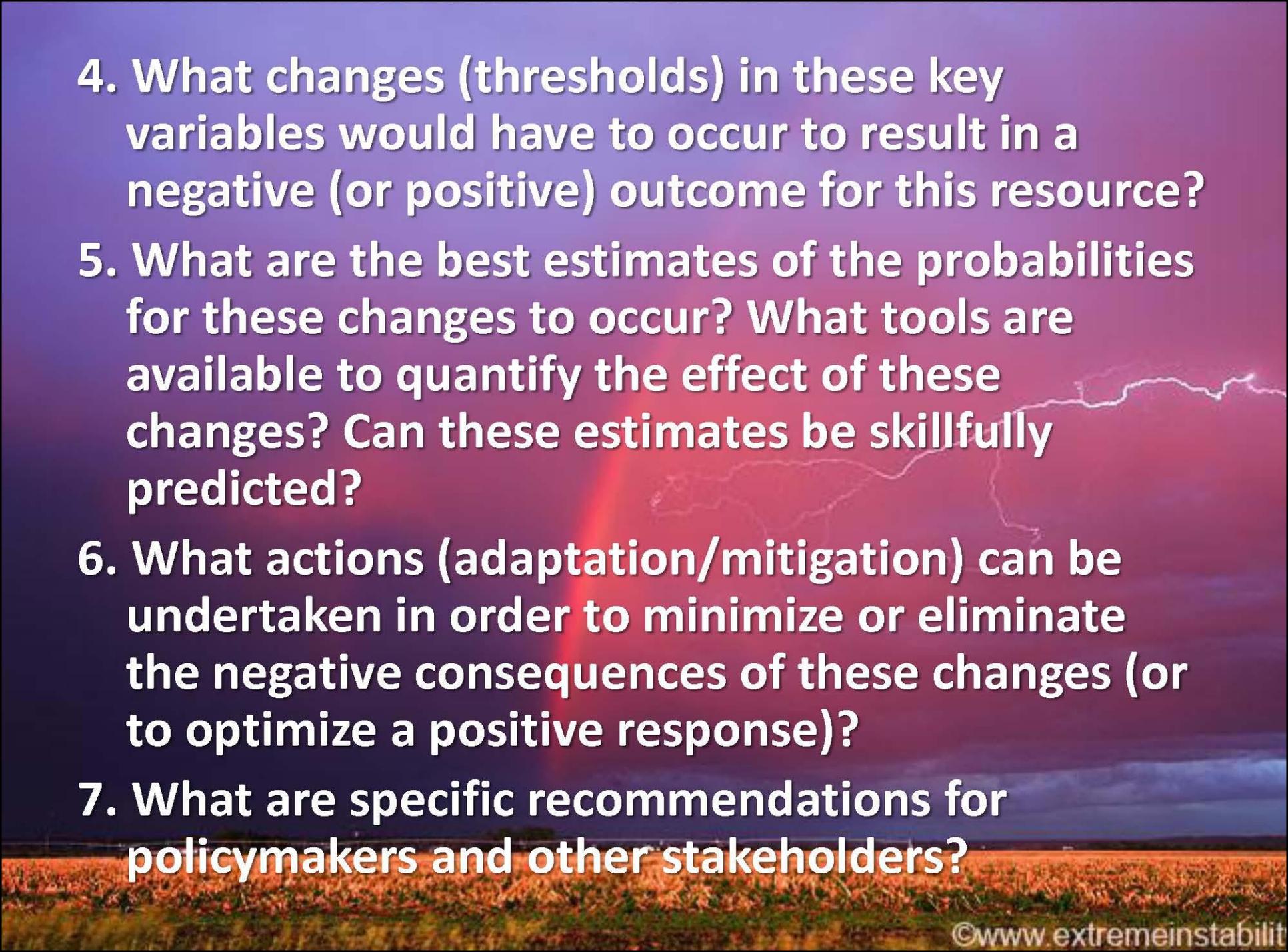


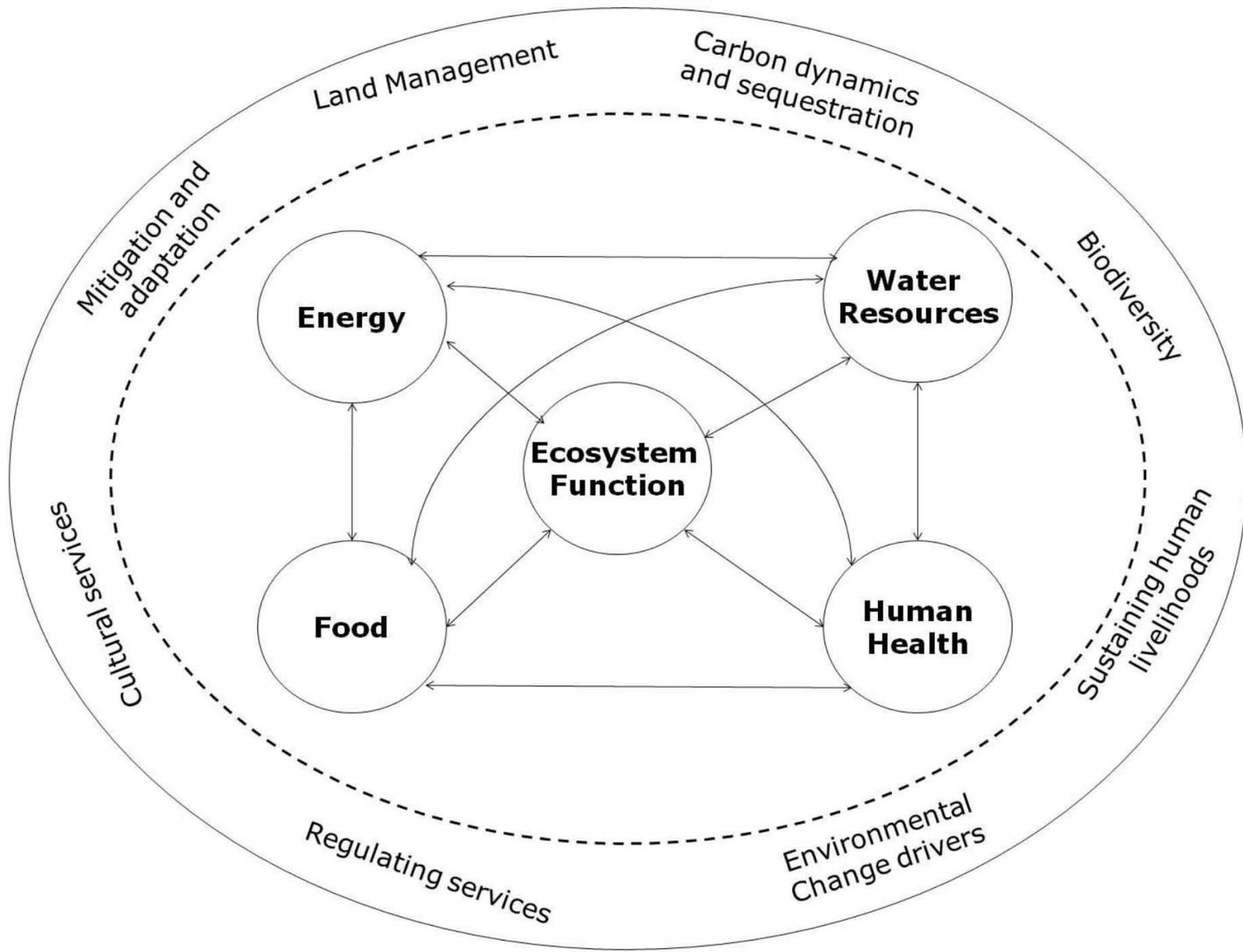
Editor:
Roger A. Pielke, Sr.

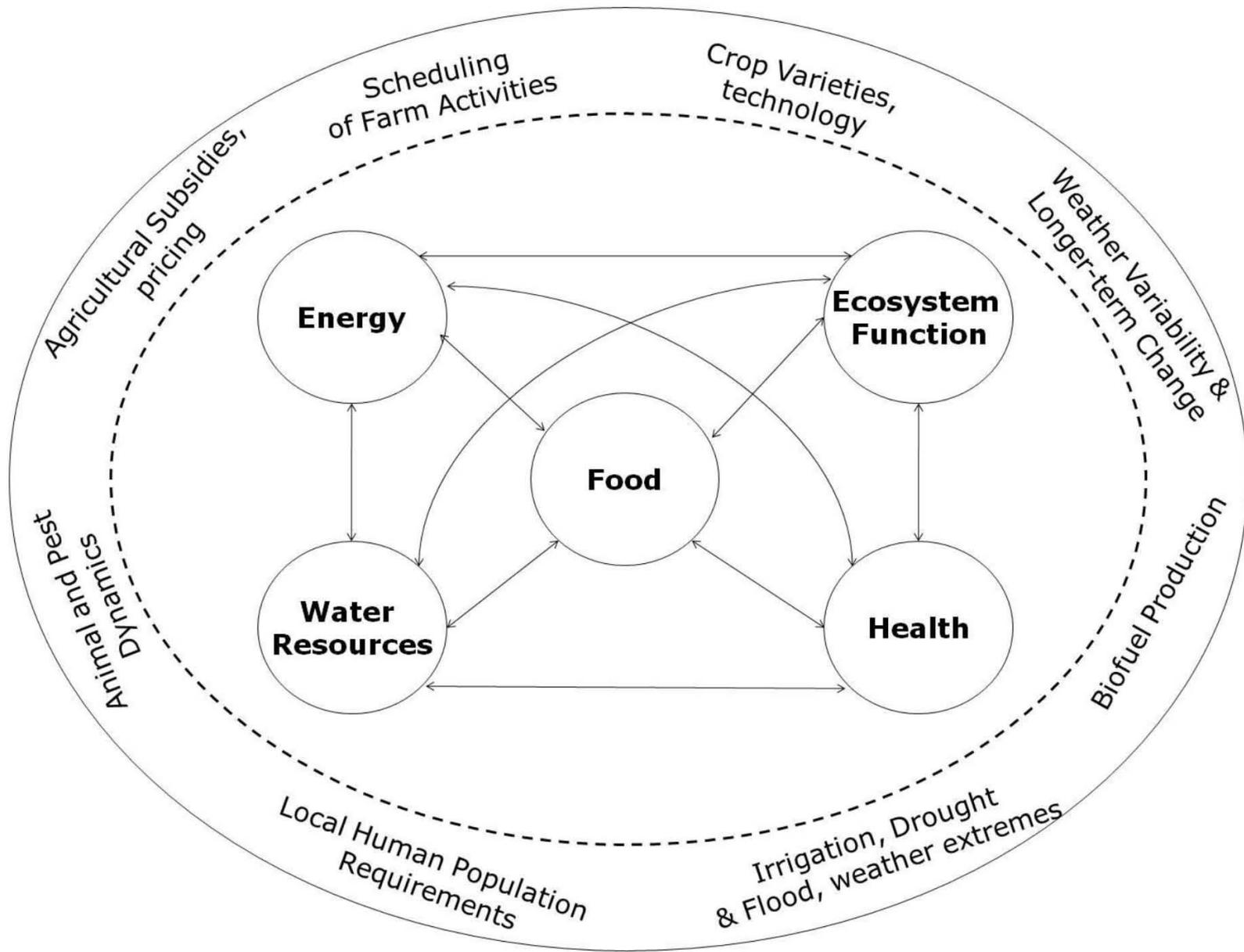


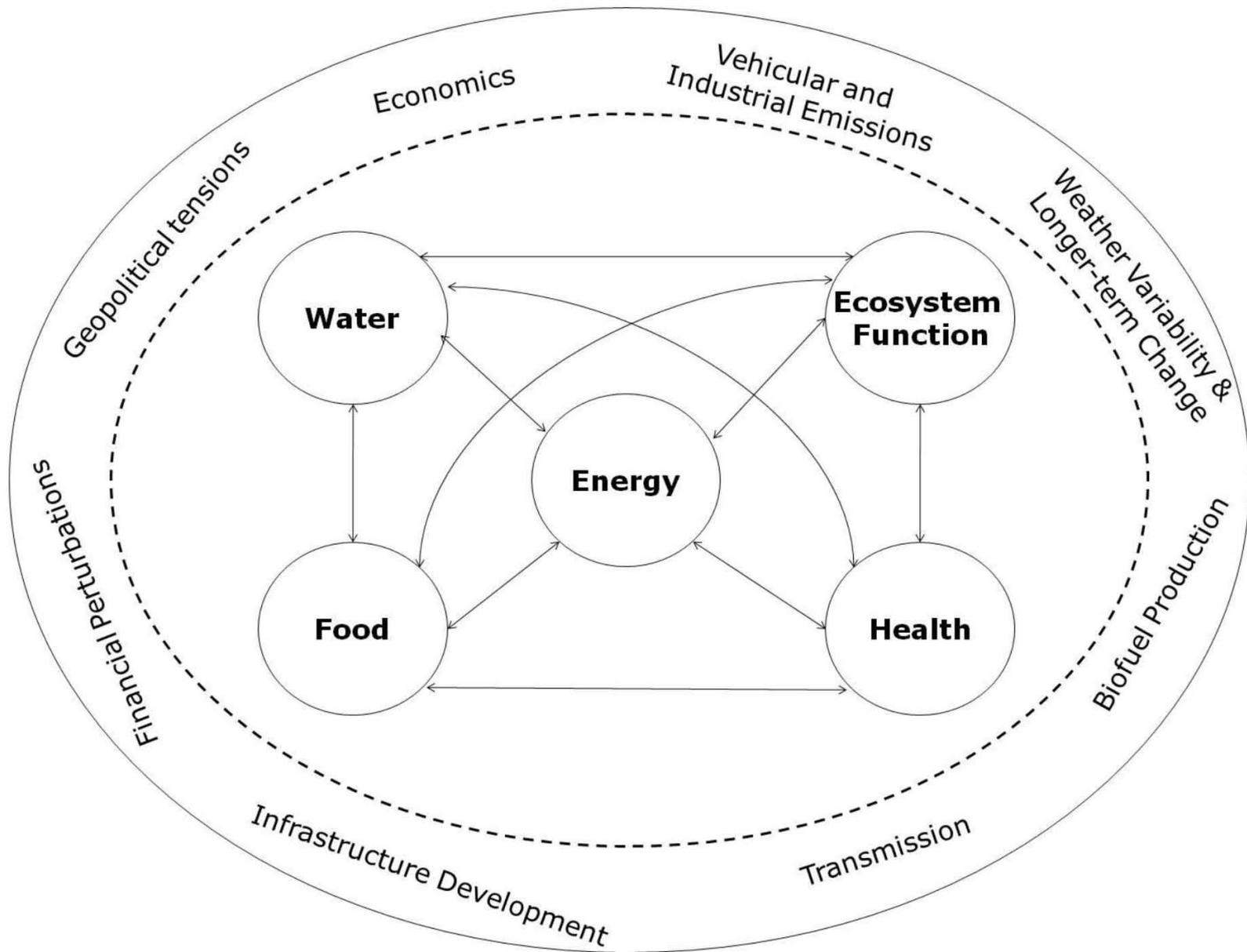
Questions For Stakeholders On The Bottom-Up Approach

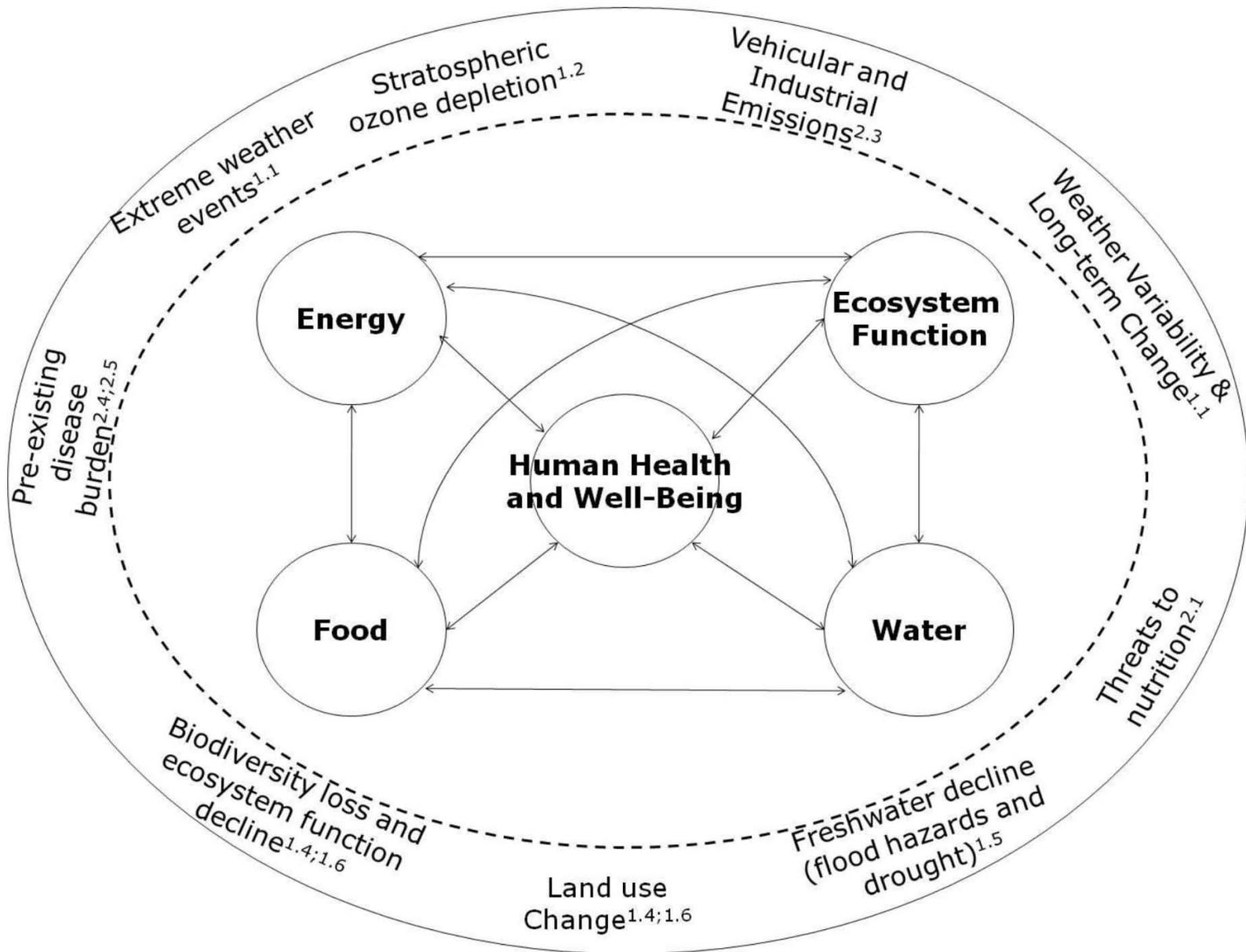
1. Why is this resource important? How is it used? To what stakeholders is it valuable?
2. What are the key environmental and social variables that influence this resource?
3. What is the sensitivity of this resource to changes in each of these key variables? (This may include but is not limited to, the sensitivity of the resource to climate variations and change on short (days); medium (seasons) and long (multi-decadal) time scales).

- 
- A dramatic sky with a rainbow and lightning over a field of golden wheat. The sky is dark with a bright rainbow arching across it, and several lightning bolts are visible. The foreground shows a field of golden wheat.
4. What changes (thresholds) in these key variables would have to occur to result in a negative (or positive) outcome for this resource?
 5. What are the best estimates of the probabilities for these changes to occur? What tools are available to quantify the effect of these changes? Can these estimates be skillfully predicted?
 6. What actions (adaptation/mitigation) can be undertaken in order to minimize or eliminate the negative consequences of these changes (or to optimize a positive response)?
 7. What are specific recommendations for policymakers and other stakeholders?







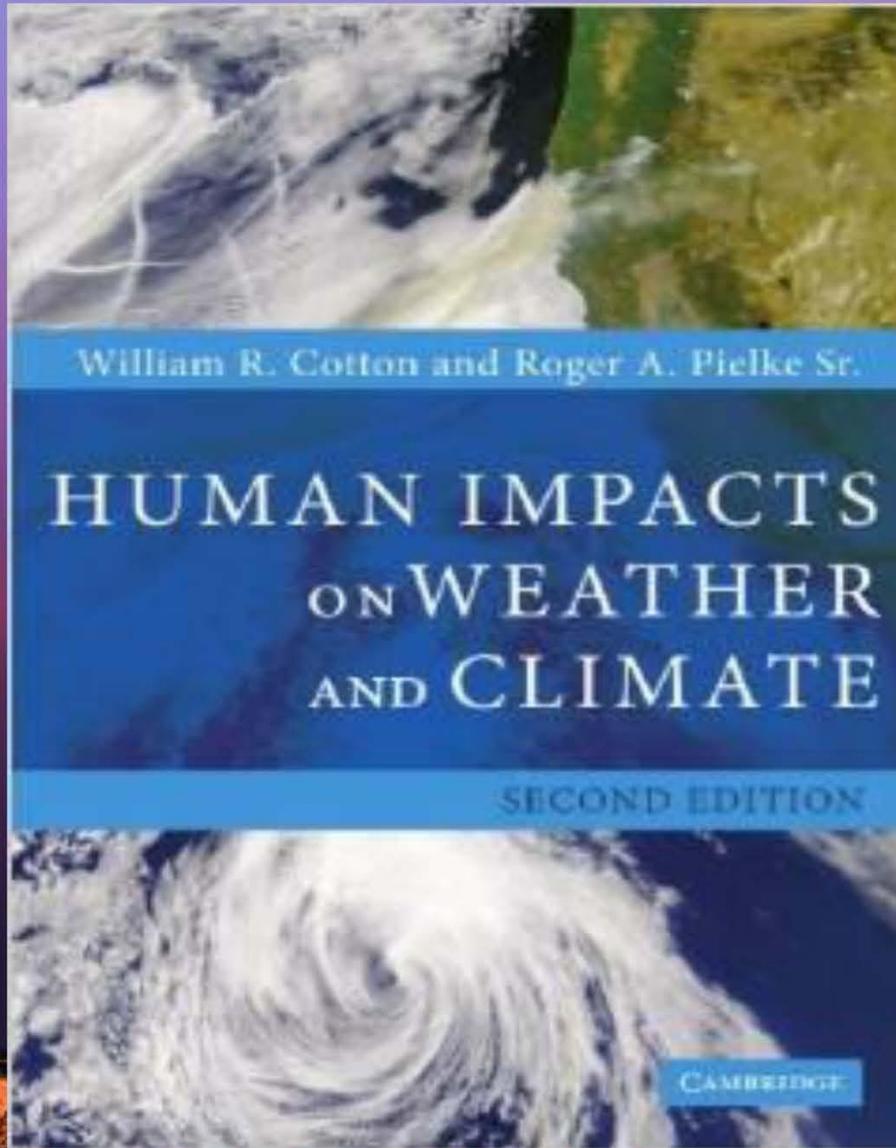


A bottom-up vulnerability perspective concept permits the determination of the major threats to local and regional water, food, energy, human health, and ecosystem function resources from extreme events including climate, but also from other social and environmental issues. After these threats are identified for each resource, then the relative risks can be compared with other risks in order to adopt optimal preferred mitigation/adaptation strategies.



Summary

1. Climate models have not demonstrated skill at predicting changes in regional climate statistics on multi decadal time scales.
2. Climate is much more than climate change which is much more than global warming.
3. The climate system has self regulation mechanisms that are not properly simulated in the models.
4. A number of observed climate trends are not being properly predicted by the global models even in their global averages.
5. The regulation of CO₂ and a few other greenhouse gases is much more than just about climate. It is a framework that is being used for a range of other policy and political actions including with respect to energy.
6. Added CO₂ is just one of a diverse spectrum of human climate forcings.



William R. Cotton and Roger A. Pielke Sr.

HUMAN IMPACTS ON WEATHER AND CLIMATE

SECOND EDITION

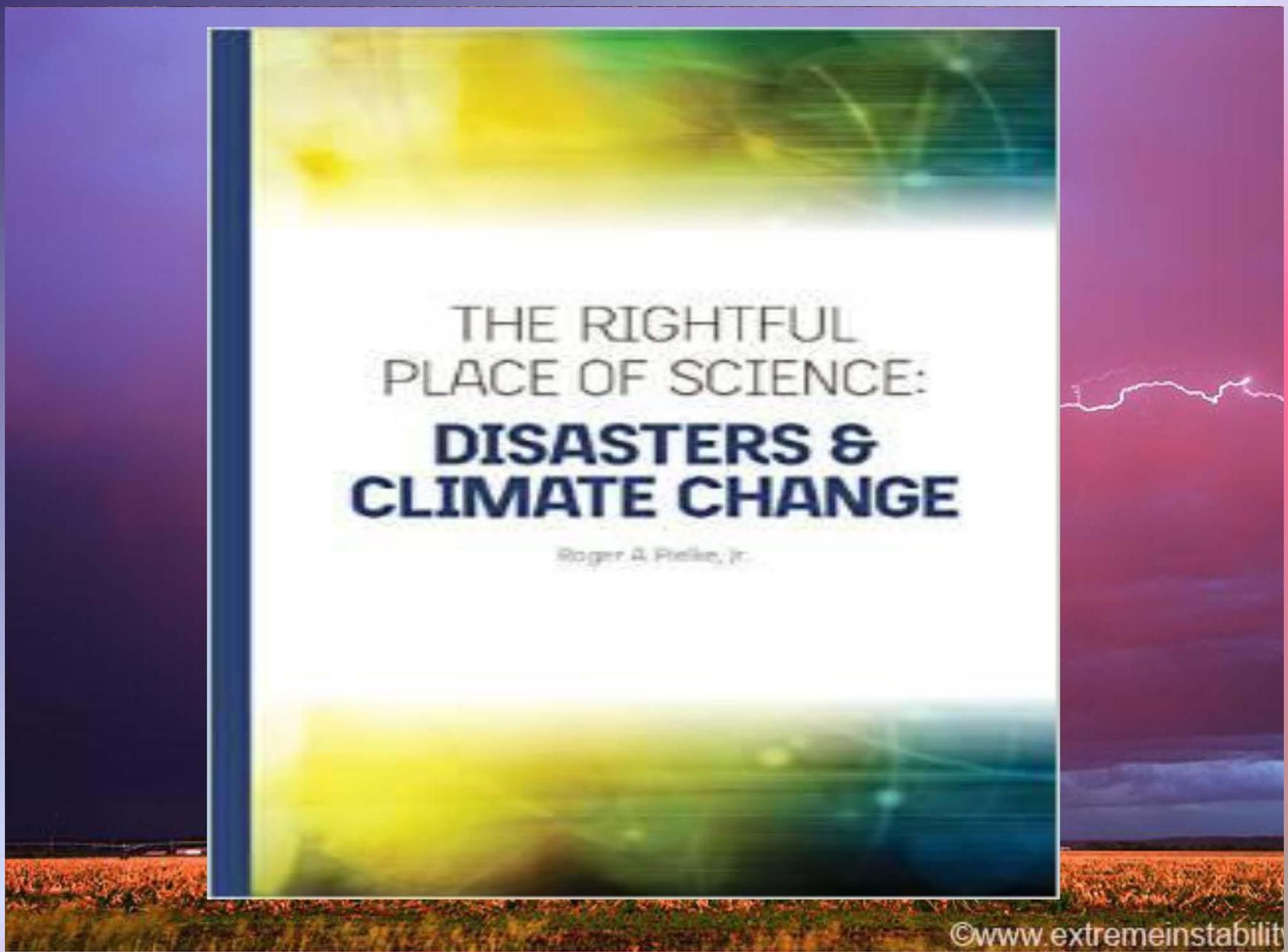
CAMBRIDGE

WHAT SCIENTISTS and POLITICIANS WON'T TELL
YOU ABOUT GLOBAL WARMING



The Climate Fix

ROGER PIELKE, JR.



THE RIGHTFUL
PLACE OF SCIENCE:
**DISASTERS &
CLIMATE CHANGE**

Roger A. Pielke, Jr.

- Joanne Simpson said
<https://pielkeclimatesci.files.wordpress.com/2010/03/ppr-250.pdf>
- “It is a delight and stimulation for me to interact with these brilliant young people and to provide leadership and a quasi-academic atmosphere in order that they may develop their talents freely and fully. I have fought like an alley cat to secure them advancement and honors and have figuratively spilled my blood on the ground to shield them from the nightmare of the bureaucratic and political quagmire until they acquire the maturity and toughness to share this burden with me...” *“Develop a thick skin toward being disliked by some – even many – people. This is bound to happen if you are successful.”*
- I was reminded of her quotes as I just completed reading the AMS autobiography of Bob Simpson -
http://www.amazon.com/Hurricane-Pioneer-Memoirs-Bob-Simpson/dp/1935704753/ref=sr_1_1?s=books&ie=UTF8&qid=1440172839&sr=1-1&keywords=robert+h+simpson



Our websites

<http://cires.colorado.edu/science/groups/pielke/>

<http://pielkeclimatesci.wordpress.com/>

Thanks, as usual, to Dallas Staley in the preparation of the PowerPoint slides!