

# Climate Threats: A More Inclusive Assessment Is Needed

For Weiqing Han's Class ATOC on Climate Issues and Policy

By

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# The Commonly Presented View of Climate Change

The focus is on CO<sub>2</sub> and a few other greenhouse gases as the primary driver of changes in regional and global climate



The Climate Issue has become very politicalized  
and polarized.

# AGU Statement On Climate Change – 2013 –

<http://onlinelibrary.wiley.com/doi/10.1002/2013EO340006/pdf>

Amy Clement, Rosenstiel School of Marine and Atmospheric  
Science, University of Miami

John Farrington, Woods Hole Oceanographic Institute

Susan Joy Hassol, Climate Communication

Robert Hirsch, U.S. Geological Survey

Peter Huybers, Harvard University

Peter Lemke, Alfred Wegener Institute

Gerald North, Texas A&M University (panel chair)

Michael Oppenheimer, Princeton University

Roger Pielke Sr., University of Colorado at Boulder

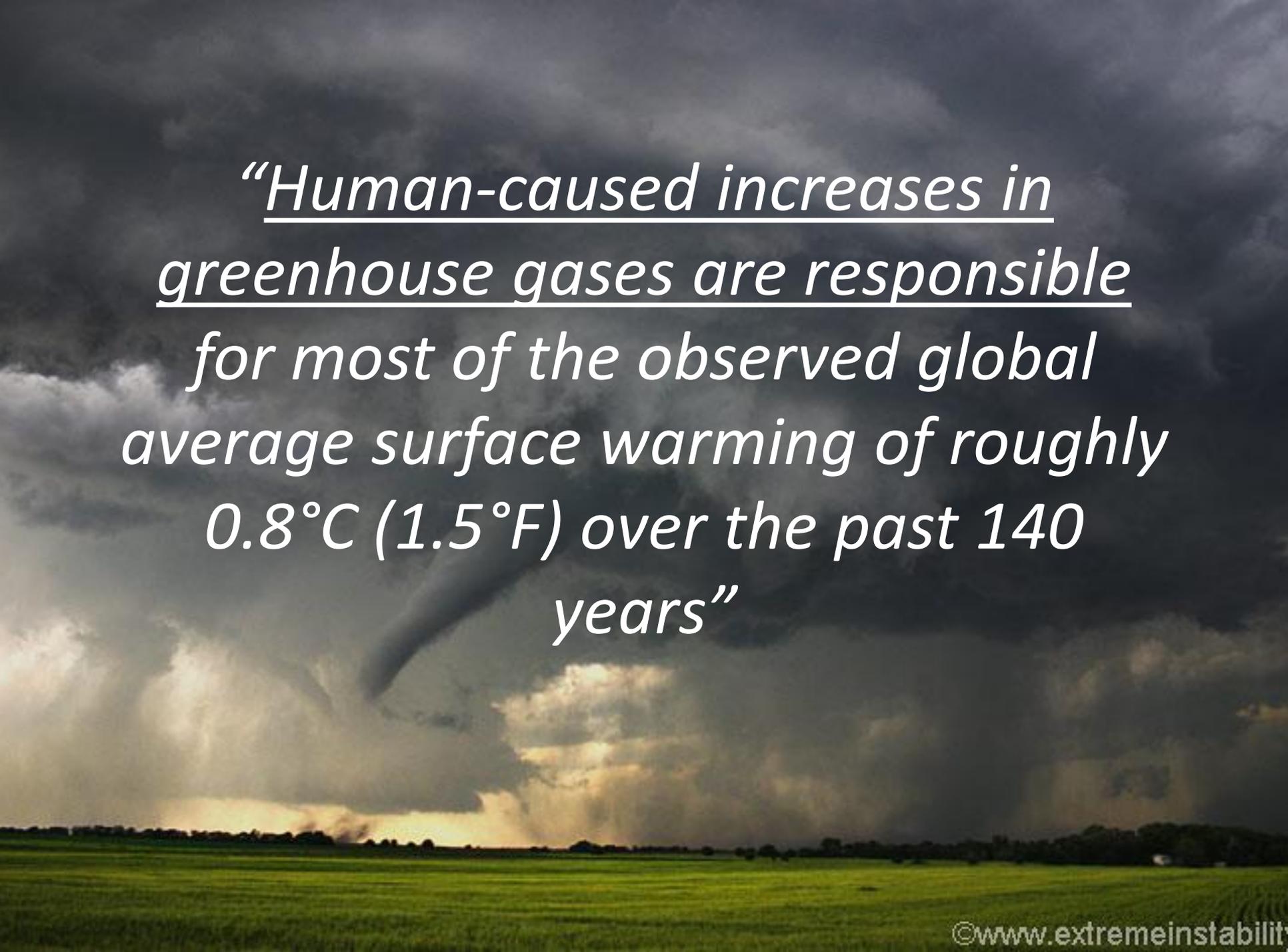
Ben Santer, Lawrence Livermore National Laboratory

Gavin Schmidt, Goddard Institute for Space Studies, NASA

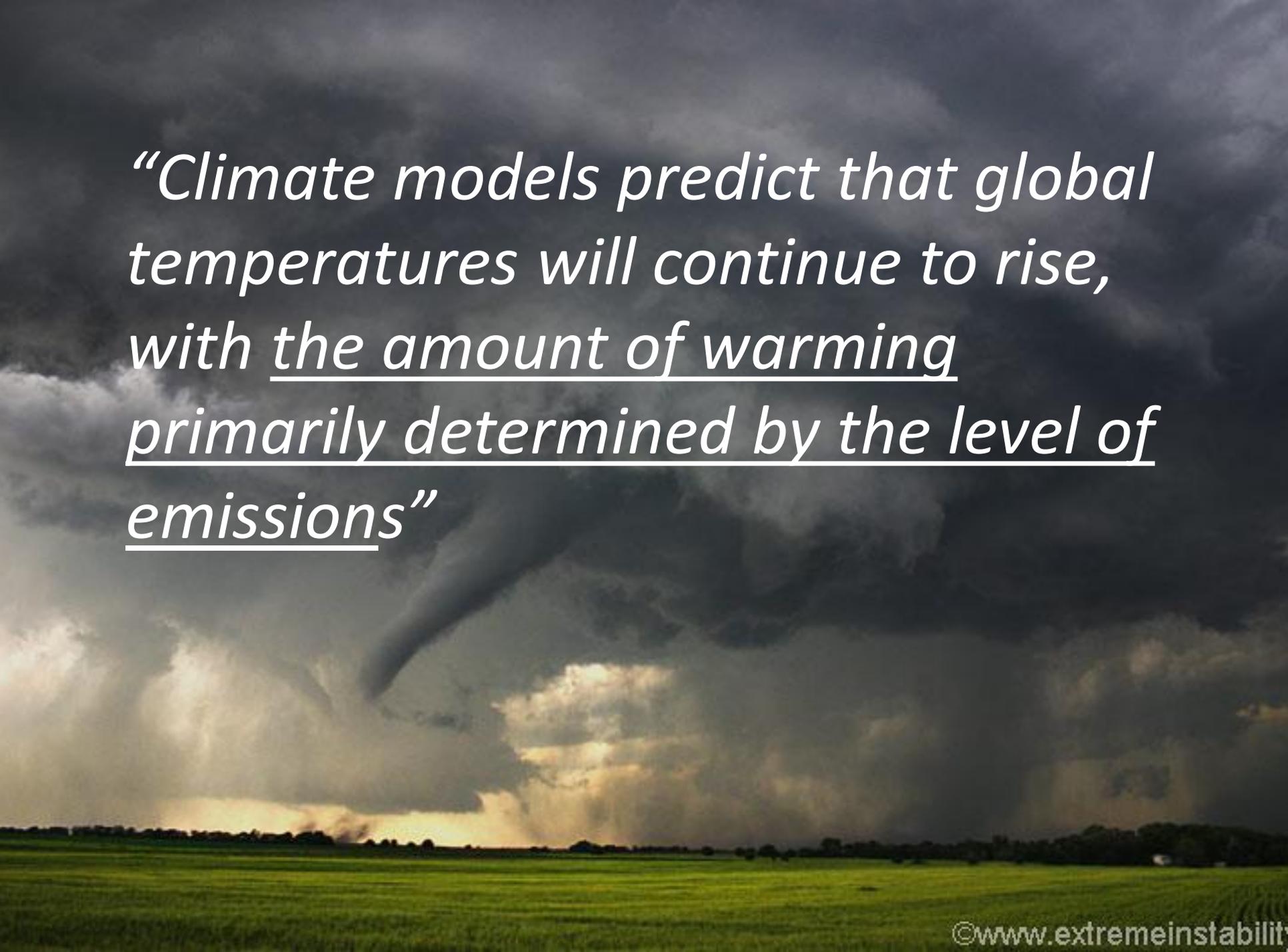
Leonard A. Smith, London School of Economics

Eric Sundquist, U.S. Geological Survey

Pieter Tans, National Oceanic and Atmospheric Administration



*“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>]



# This Changes Everything: Capitalism vs. The Climate

## by Naomi Klein

*The most important book yet from the author of the international bestseller The Shock Doctrine, a brilliant explanation of why the climate crisis challenges us to abandon the core “free market” ideology of our time, restructure the global economy, and remake our political systems.*

*In short, either we embrace radical change ourselves or radical changes will be visited upon our physical world. The status quo is no longer an option.*

*...\_Klein meticulously builds the case for how massively reducing our greenhouse emissions is our best chance to simultaneously reduce gaping inequalities, re-imagine our broken democracies, and rebuild our gutted local economies.*

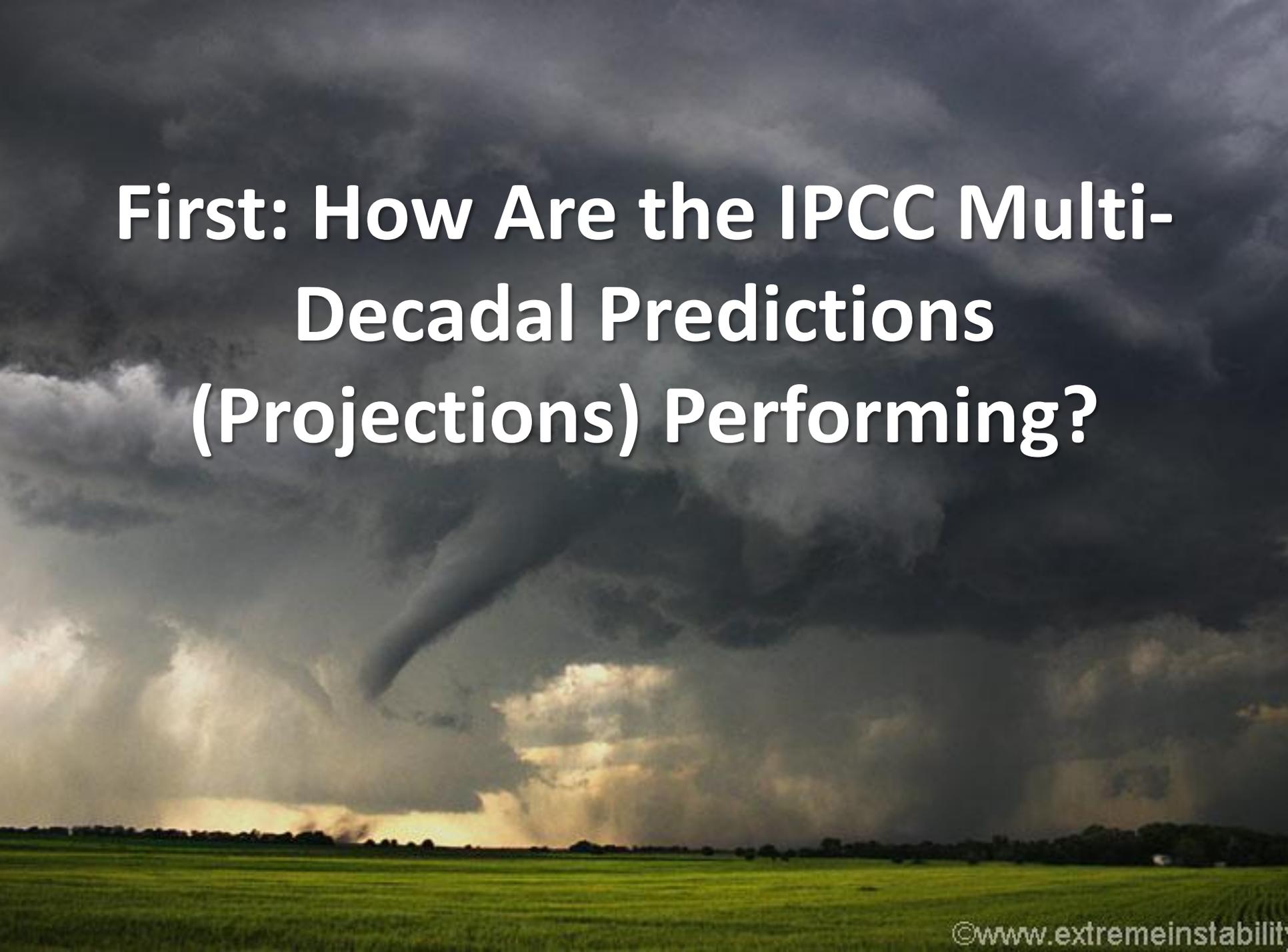
[http://www.amazon.com/This-Changes-Everything-Capitalism-Climate/dp/1451697384/ref=sr\\_1\\_cc\\_1?s=aps&ie=UTF8&qid=1413385756&sr=1-1-catcorr&keywords=naomi+klein](http://www.amazon.com/This-Changes-Everything-Capitalism-Climate/dp/1451697384/ref=sr_1_cc_1?s=aps&ie=UTF8&qid=1413385756&sr=1-1-catcorr&keywords=naomi+klein)



It's about greenhouse gas emissions particularly CO<sub>2</sub> as the “catalyst”.

We need, however, to more robustly  
address uncertainties

Where are we in our ability to assess the role of human climate forcings in climate and on predicting changes in the coming decades?



# First: How Are the IPCC Multi-Decadal Predictions (Projections) Performing?

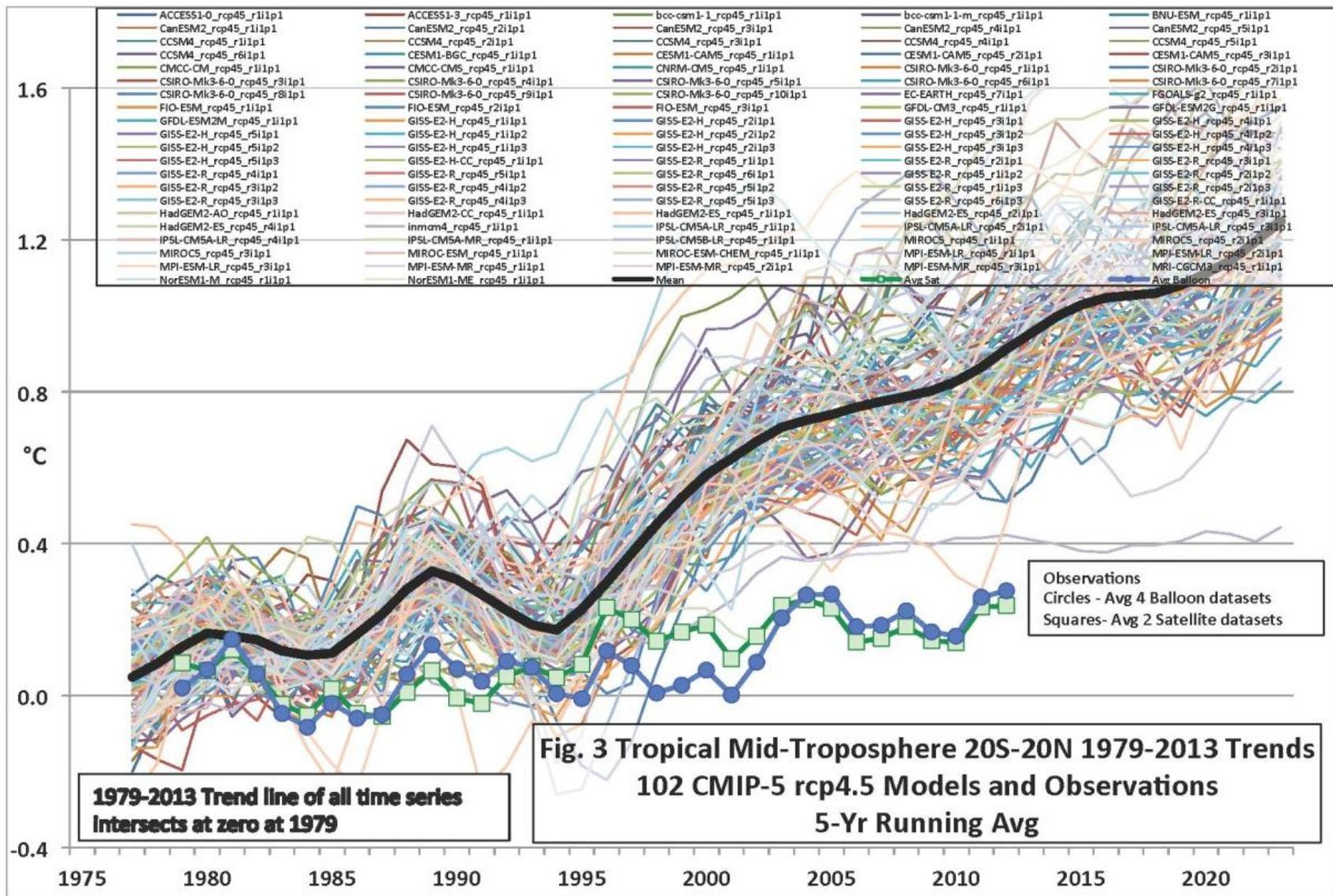
# Necessary Conditions For Skillful Multi-Decadal Predictions of Extreme Events

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

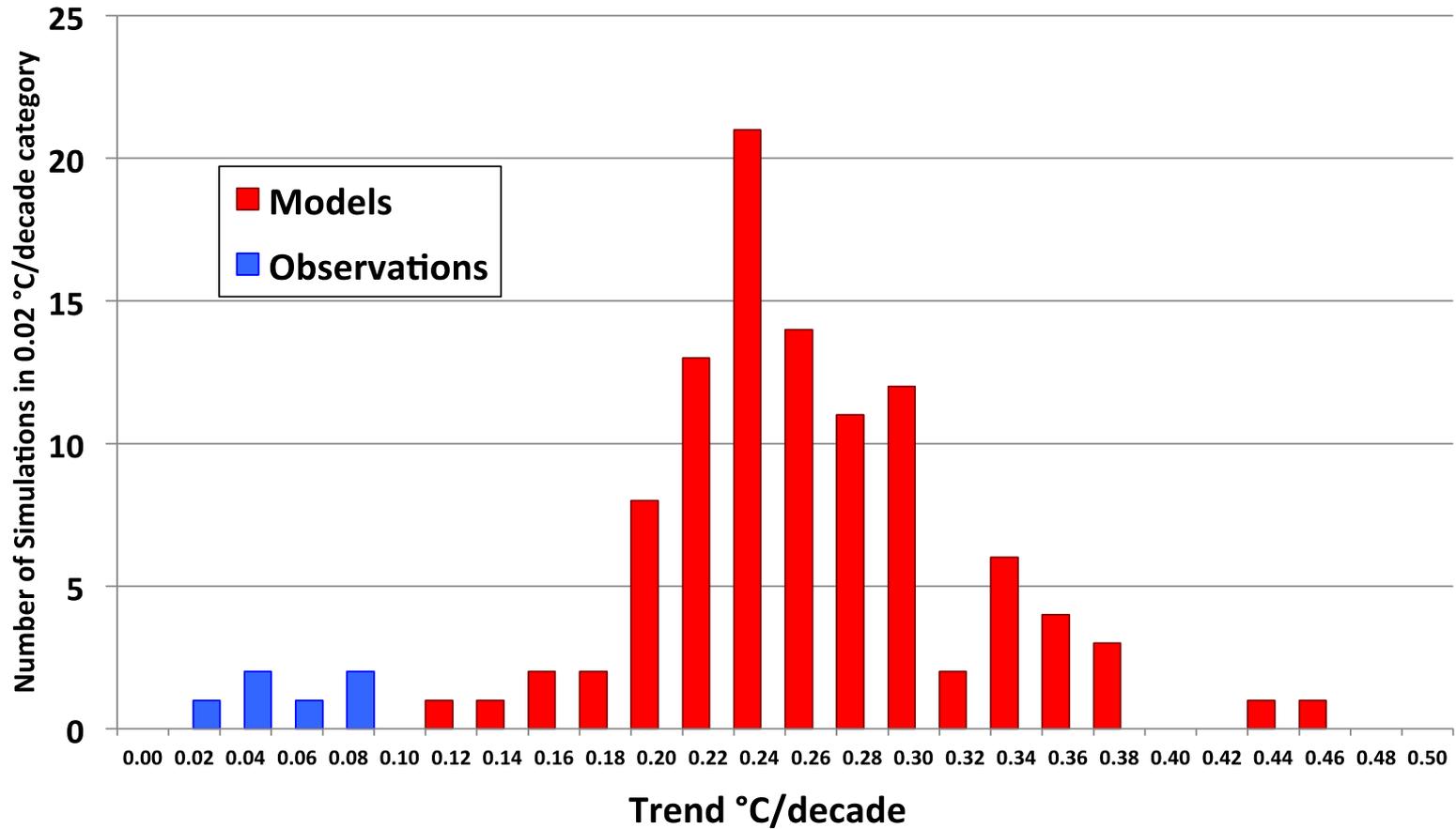
- 1. The average (annual, monthly, etc.) global, regional and local climate.*
- 2. The changes in these averages over the past several decades*
- 3. The statistics of extreme weather events*
- 4. The changes in these extremes over the last several decades.*

# 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.



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

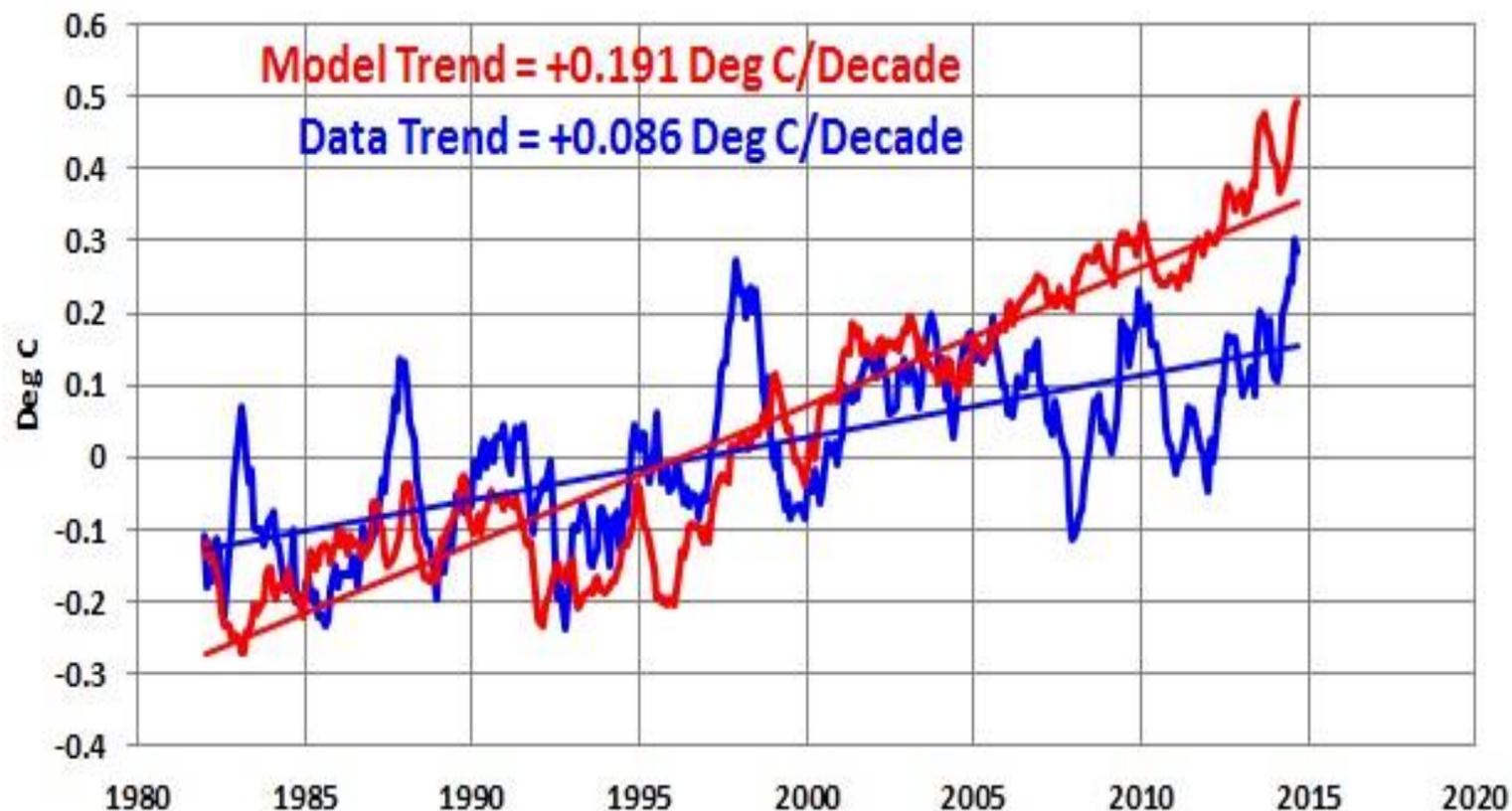


**Model-Data Comparison**  
**Global (90S-90N) Sea Surface Temperature Anomalies**

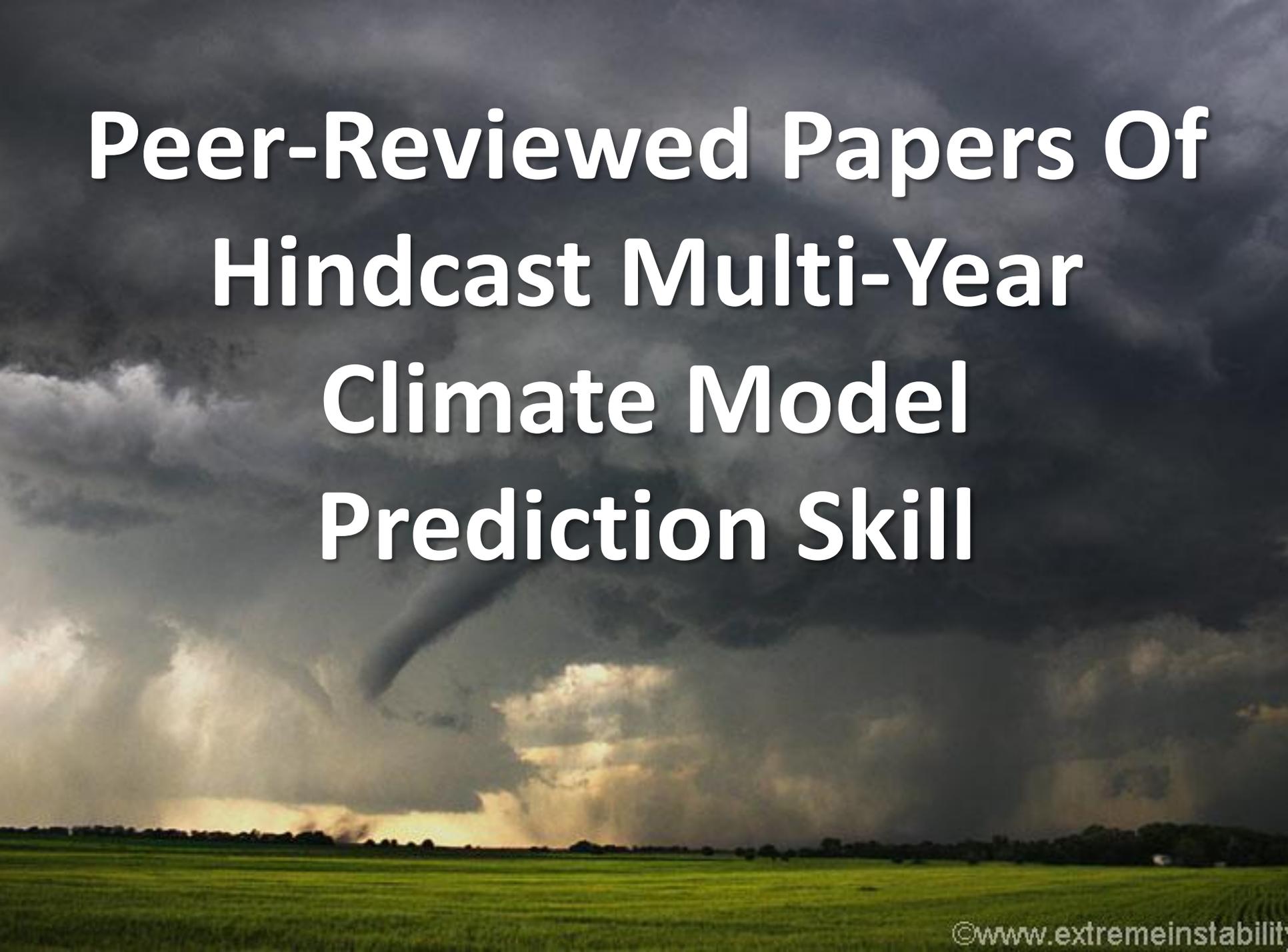
**Model Mean: HADGEM2-ES Historic/RCP6.0**

**Data: Reynolds OI.v2**

**Jan 1982 to Sep 2014**



**Bob Tisdale**



# 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<sup>-2</sup> 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 system .....little 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<sup>-1</sup>.....The 2-year return level of summer daily maximum temperature simulated by the TDD is underestimated by 2-6°C over the central United States-Canada region”.*

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.”*

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 new 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.

# 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.*
4. *The changes in these extremes over the last several decades.*

# Conclusion on Multi-decadal Climate Model Predictive Skill

*Clearly the models do not pass the first two requirements required of hindcast predictions.*

*Without the models being constrained by real world observations, they cannot accurately even predict most aspects of regional and local climate in hindcast predictions, much less changes in climate including of extreme weather events.*

# A Paradigm Shift?

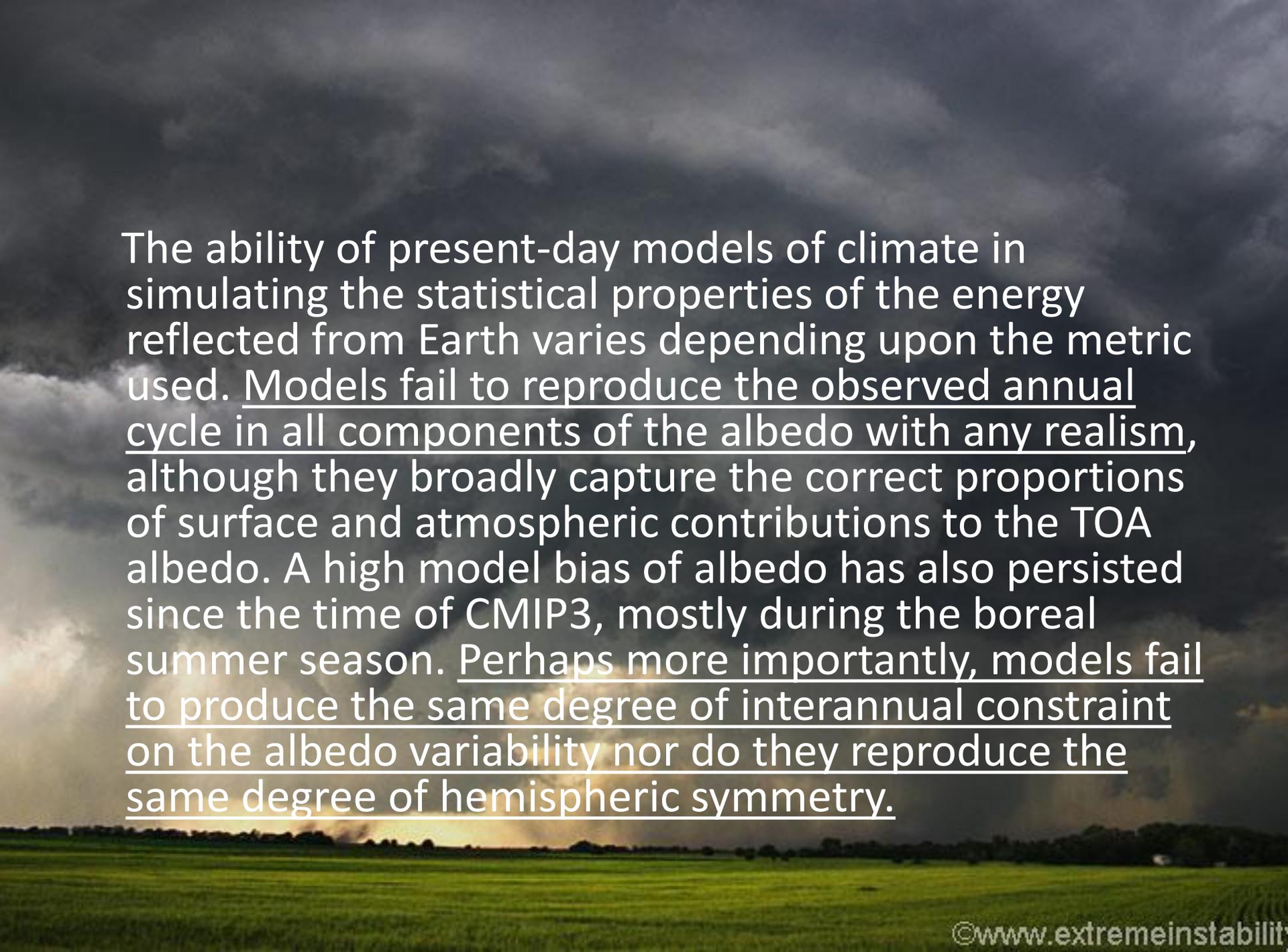




**The albedo of Earth:** Graeme L. Stephens, Denis O'Brien, Peter J. Webster, Peter Pilewski, Seiji Kato, and Jui-lin Li, 2015: *Reviews of Geophysics*  
<http://webster.eas.gatech.edu/Papers/albedo2015.pdf>

## MAJOR NEW FINDING

The albedo of Earth appears to be highly buffered on hemispheric and global scales as highlighted by both the hemispheric symmetry and a remarkably small interannual variability of reflected solar flux ( $\sim 0.2\%$  of the annual mean flux). We show how clouds provide the necessary degrees of freedom to modulate the Earth's albedo setting the hemispheric symmetry. We also show that current climate models lack this same degree of hemispheric symmetry and regulation by clouds.



The ability of present-day models of climate in simulating the statistical properties of the energy reflected from Earth varies depending upon the metric used. 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.

# Next, Let's Look At "Climate Change"

Global Warming << "Climate Change"

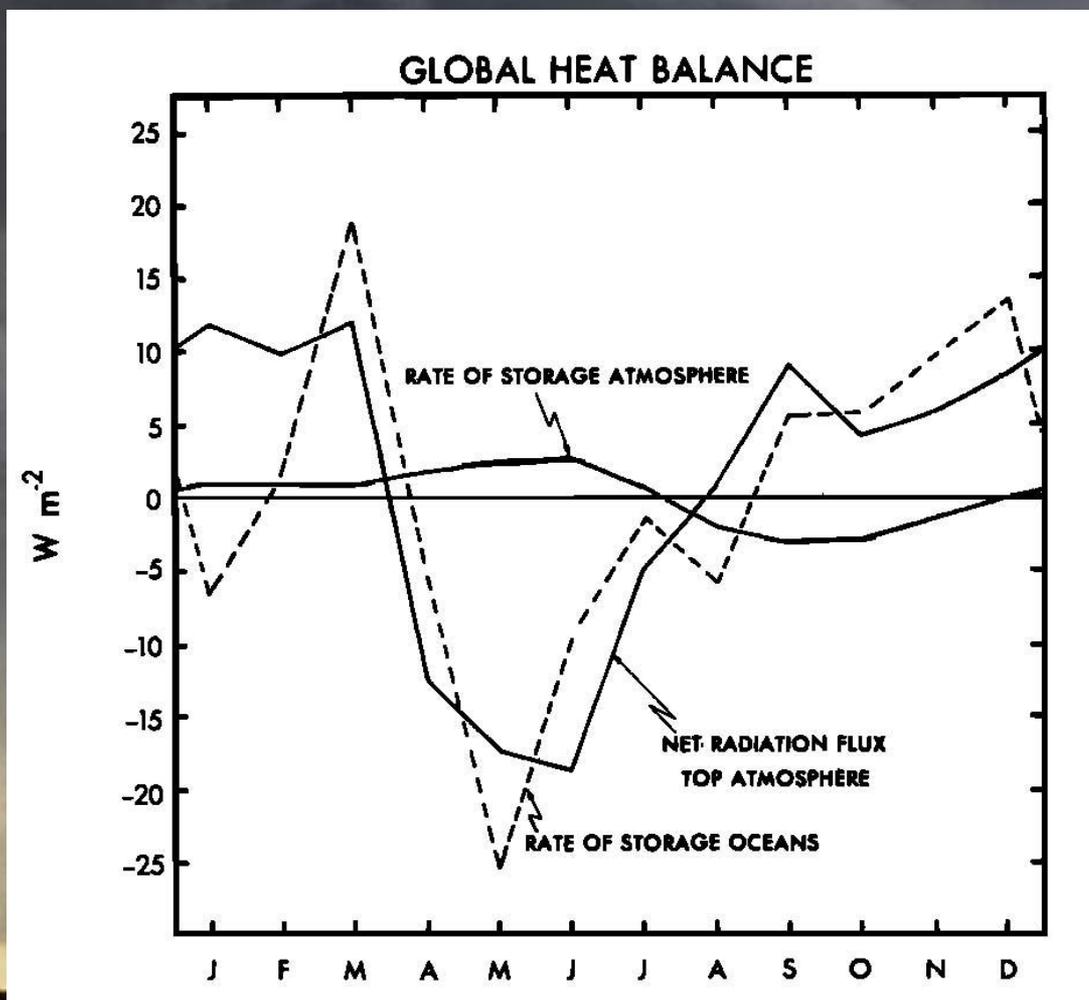
But lets look at Global Warming since that is where so much attention has been concentrated.

# 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.

# From Ellis et al. 1979



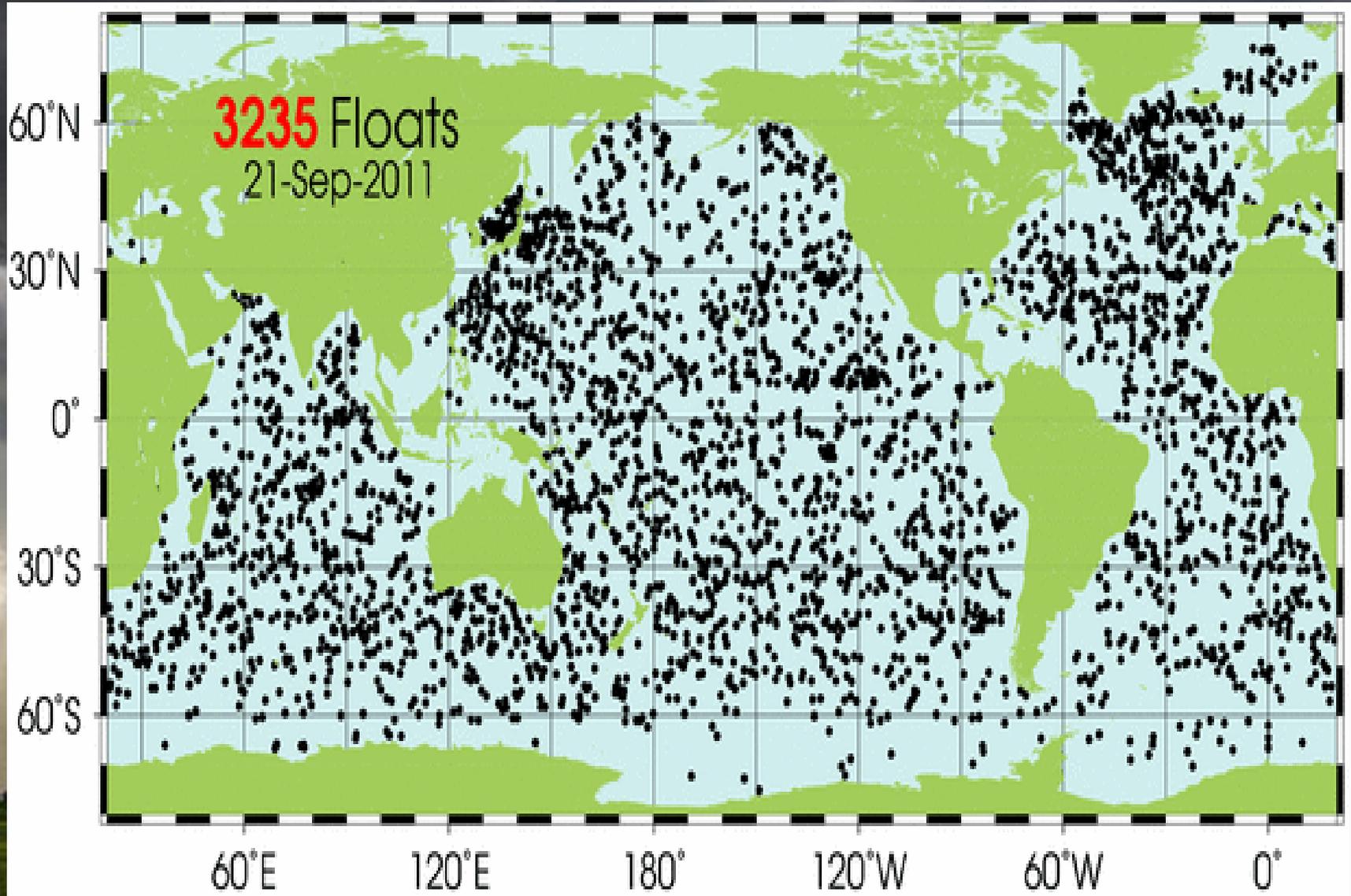
## Statement by Jim Hansen

“Our simulated 1993-2003 heat storage rate was  $0.6 \text{ W/m}^2$  in the upper 750 m of the ocean. The decadal mean planetary energy imbalance,  $0.75 \text{ W/m}^2$ , includes heat storage in the deeper ocean and energy used to melt ice and warm the air and land.  $0.85 \text{ W/m}^2$  is the imbalance at the end of the decade [end of the 1990s]”.

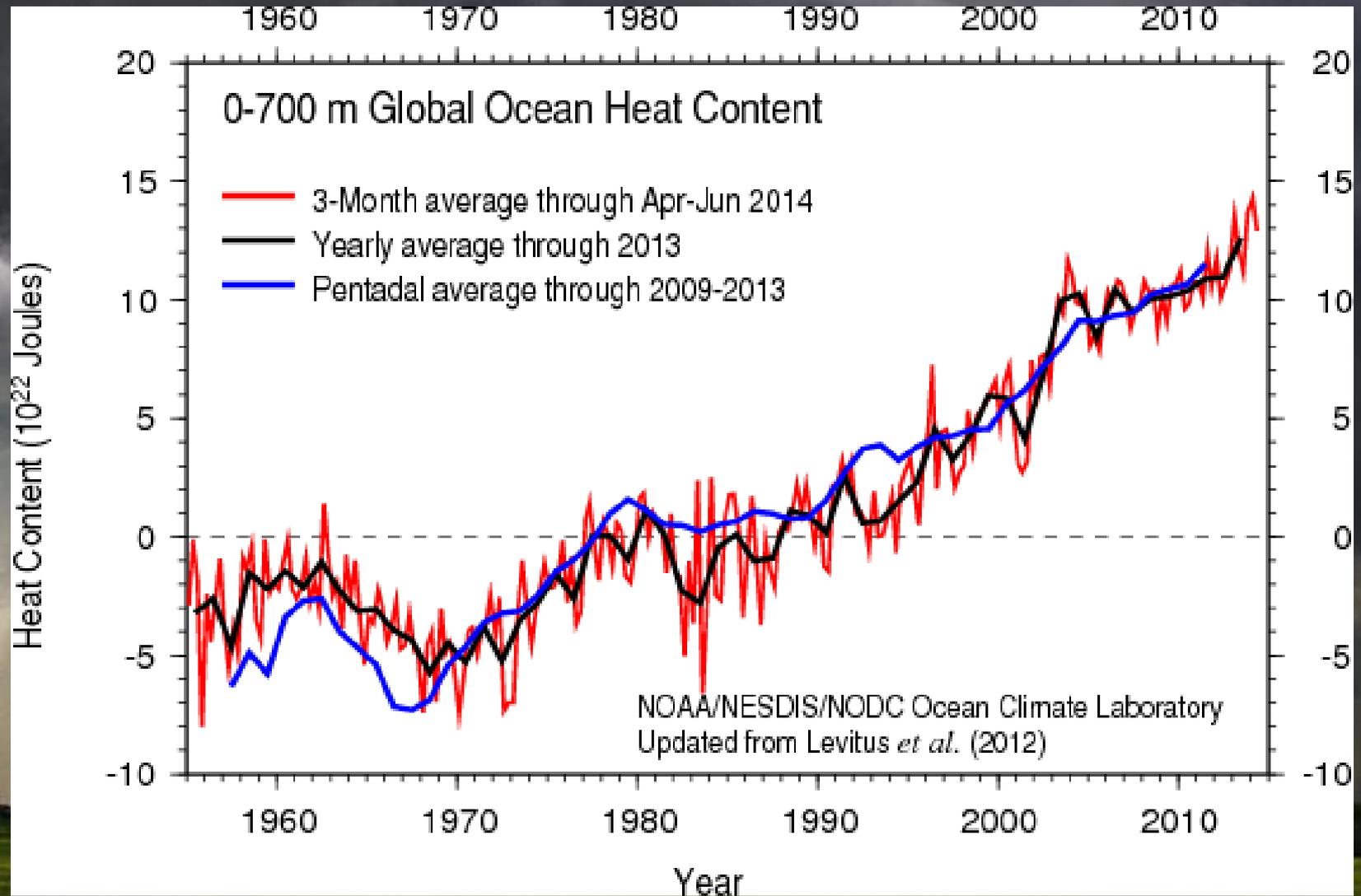
From Jim Hansen, 2005

[<http://pielkeclimatesci.files.wordpress.com/2009/09/1116592hansen.pdf>]

# Argo Network



[http://www.nodc.noaa.gov/OC5/3M\\_HEAT\\_CONTENT/](http://www.nodc.noaa.gov/OC5/3M_HEAT_CONTENT/)



“The net warming of the ocean implies an energy imbalance for the Earth of  $0.64 \pm 0.44$   $\text{W m}^{-2}$  from 2005 to 2013.”

“the deep ocean (below 2,000 m) contributes  
..... $-0.08 \pm 0.43$   $\text{W m}^{-2}$  to Earth’s energy  
balance

Llovel et al. 2014

Deep-ocean contribution to sea level and energy budget not detectable over the past decade  
Nature Climate Change (2014) doi:10.1038/nclimate2387 Received 27 June 2014 Accepted 26  
August 2014 Published online 05 October 2014: <http://oceans.pmel.noaa.gov/>

Levitus et al. (2012) reported that since 1955, the layer from the surface to 2000 m depth had a warming rate of  $0.39 \text{ W m}^{-2} \pm 0.031 \text{ W m}^{-2}$  per unit area of the Earth's surface which accounts for approximately 90% of the warming of the climate system. Thus, if we add the 10%, the 1955-2010 warming rate is  $0.43 \text{ W m}^{-2} \pm 0.031 \text{ W m}^{-2}$ .

Levitus, S., J. I. Antonov, T. P. Boyer, O. K. Baranova, H. E. Garcia, R. A. Locarnini, A. V. Mishonov, J. Reagan, D. Seidov, E. S. Yarosh, M. M. Zweng (2012), World ocean heat content and thermosteric sea level change (0-2000), 1955-2010, Geophys. Res.

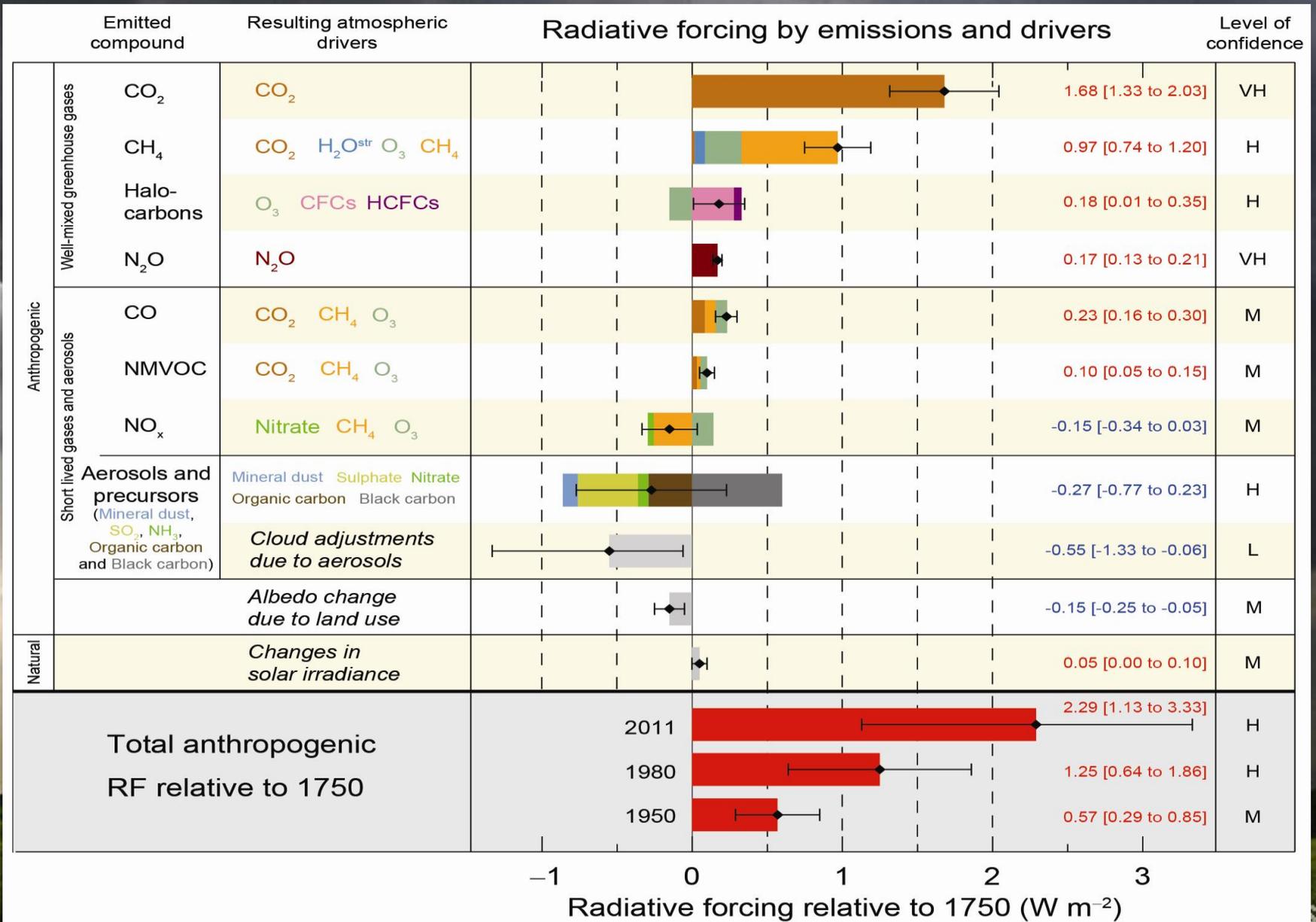


Global Radiative Imbalance = Global  
Radiative Forcings + Global Radiative  
Feedbacks

Radiative Forcing and Feedbacks are  
defined here as Radiative Flux  
Divergences on All Time Scales.



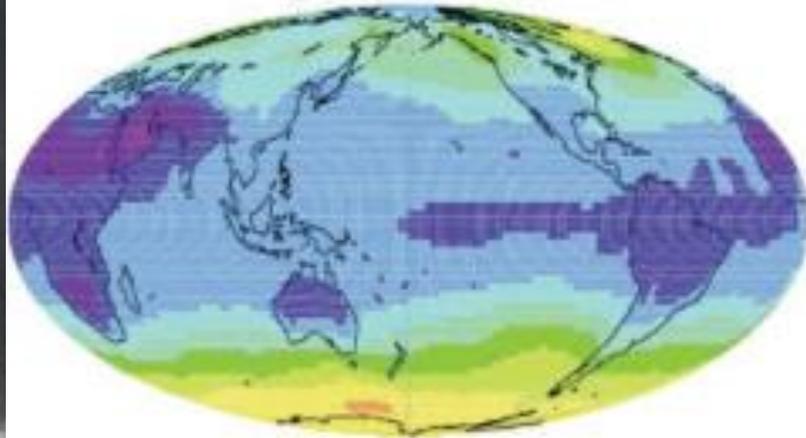
# The Global Averaged Radiative Forcings



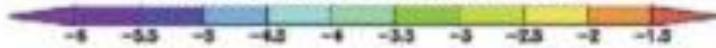
Next Figure – on climate model ensemble decadal mean feedbacks from

Wielicki, Bruce A., and D. F. Young , and M. G. Mlynczak, K. J. Thome, S. Leroy, J. Corliss, J. G. Anderson, C. O. Ao, R. Bantges, F. Best, K. Bowman, H. Brindley, J. J. Butler, W. Collins, J. A. Dykema, D. R. Doelling, D. R. Feldman, N. Fox, X. Huang, R. Holz, Y. Huang, Z. Jin, D. Jennings, D. G. Johnson, K. Jucks, S. Kato, D. B. Kirk-Davidoff, R. Knuteson, G. Kopp, D. P. Kratz , X. Liu , and C. Lukashin, A. J. Mannucci, N. Phojanamongkolkij, P. Pilewskie, V. Ramaswamy, H. Revercomb, J. Rice, Y. Roberts, C. M. Roithmayr, F. Rose, S. Sandford, E. L. Shirley, W. L. Smith Sr., B. Soden, P. W. Speth, W. Sun, P. C. Taylor, D. Tobin, and X. Xiong, (2013), Achieving climate change absolute accuracy in orbit. Bull. Amer. Meteor. Soc., 94, 1519–1539, doi: <http://dx.doi.org/10.1175/BAMS-D-12-00149.1>

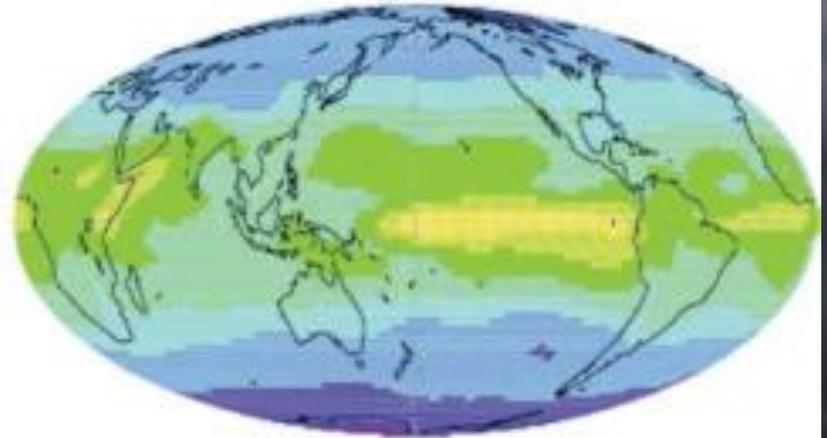
**Temperature Feedback**



**Global Mean =  $-4.2 \text{ W/m}^2/\text{K}$**



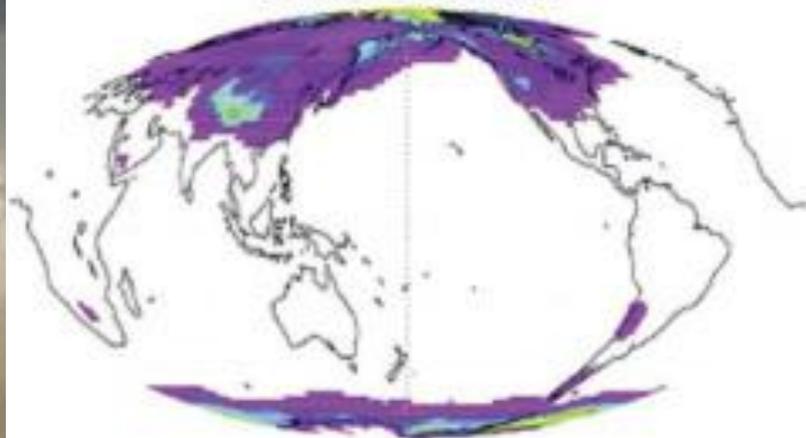
**Water Vapor Feedback**



**Global Mean =  $1.9 \text{ W/m}^2/\text{K}$**



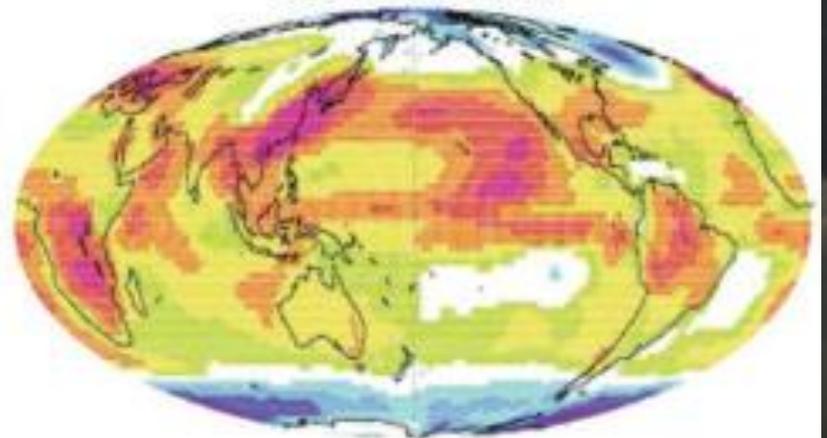
**Albedo Feedback**



**Global Mean =  $0.30 \text{ W/m}^2/\text{K}$**

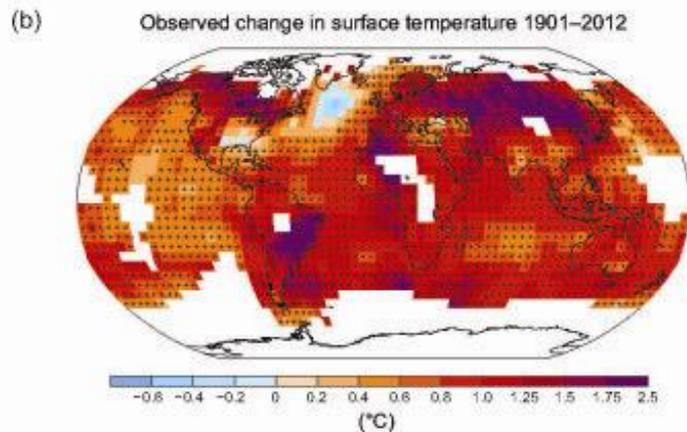
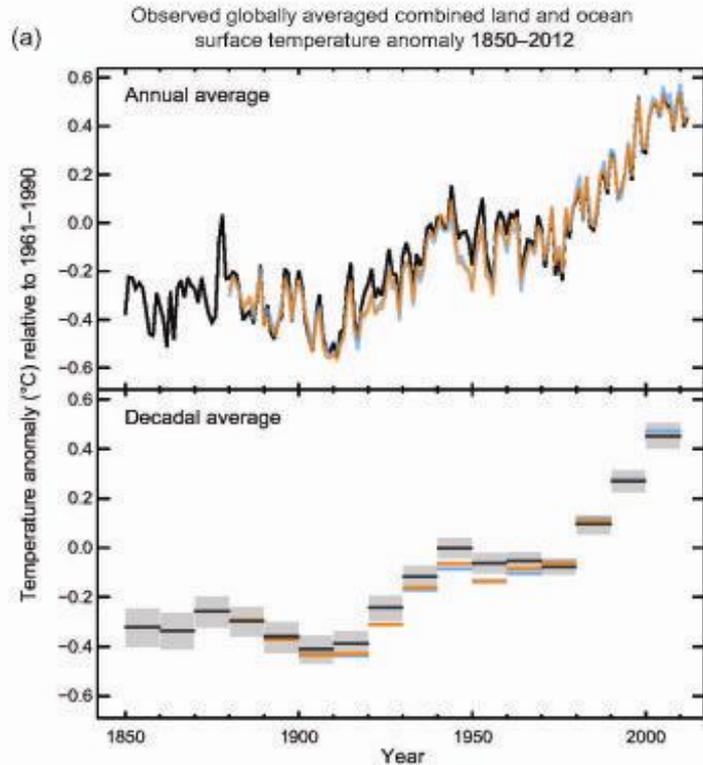


**Cloud Feedback**



**Global Mean =  $0.79 \text{ W/m}^2/\text{K}$**





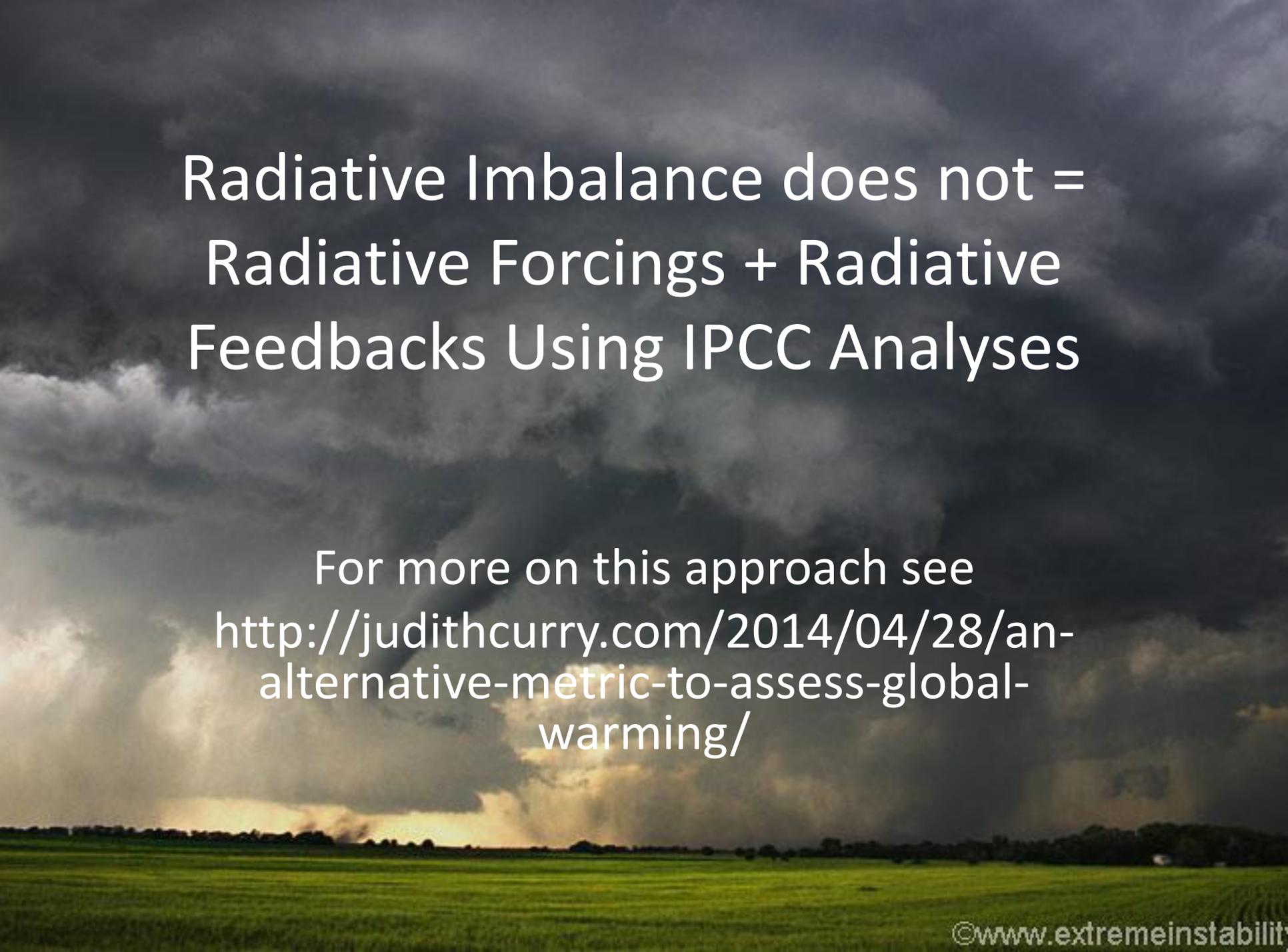
**Figure SPM.1 |** (a) Observed global mean combined land and ocean surface temperature anomalies, from 1850 to 2012 from three data sets. Top panel: annual mean values. Bottom panel: decadal mean values including the estimate of uncertainty for one dataset (black). Anomalies are relative to the mean of 1961–1990. (b) Map of the observed surface temperature change from 1901 to 2012 derived from temperature trends determined by linear regression from one dataset (orange line in panel a). Trends have been calculated where data availability permits a robust estimate (i.e., only for grid boxes with greater than 70% complete records and more than 20% data availability in the first and last 10% of the time period). Other areas are white. Grid boxes where the trend is significant at the 10% level are indicated by a + sign. For a listing of the datasets and further technical details see the Technical Summary Supplementary Material. (Figures 2.19–2.21, Figure TS.2)

# What are the estimated Radiative Feedbacks?

1. Temperature Feedback -  $-4.2 \text{ W m}^{-2} \text{ K}^{-1}$
2. Water Vapor Feedback +  $1.9 \text{ W m}^{-2} \text{ K}^{-1}$
3. Albedo Feedback +  $0.3 \text{ W m}^{-2} \text{ K}^{-1}$
4. Cloud Feedback  $0.79 \text{ W m}^{-2} \text{ K}^{-1}$
5. Others?

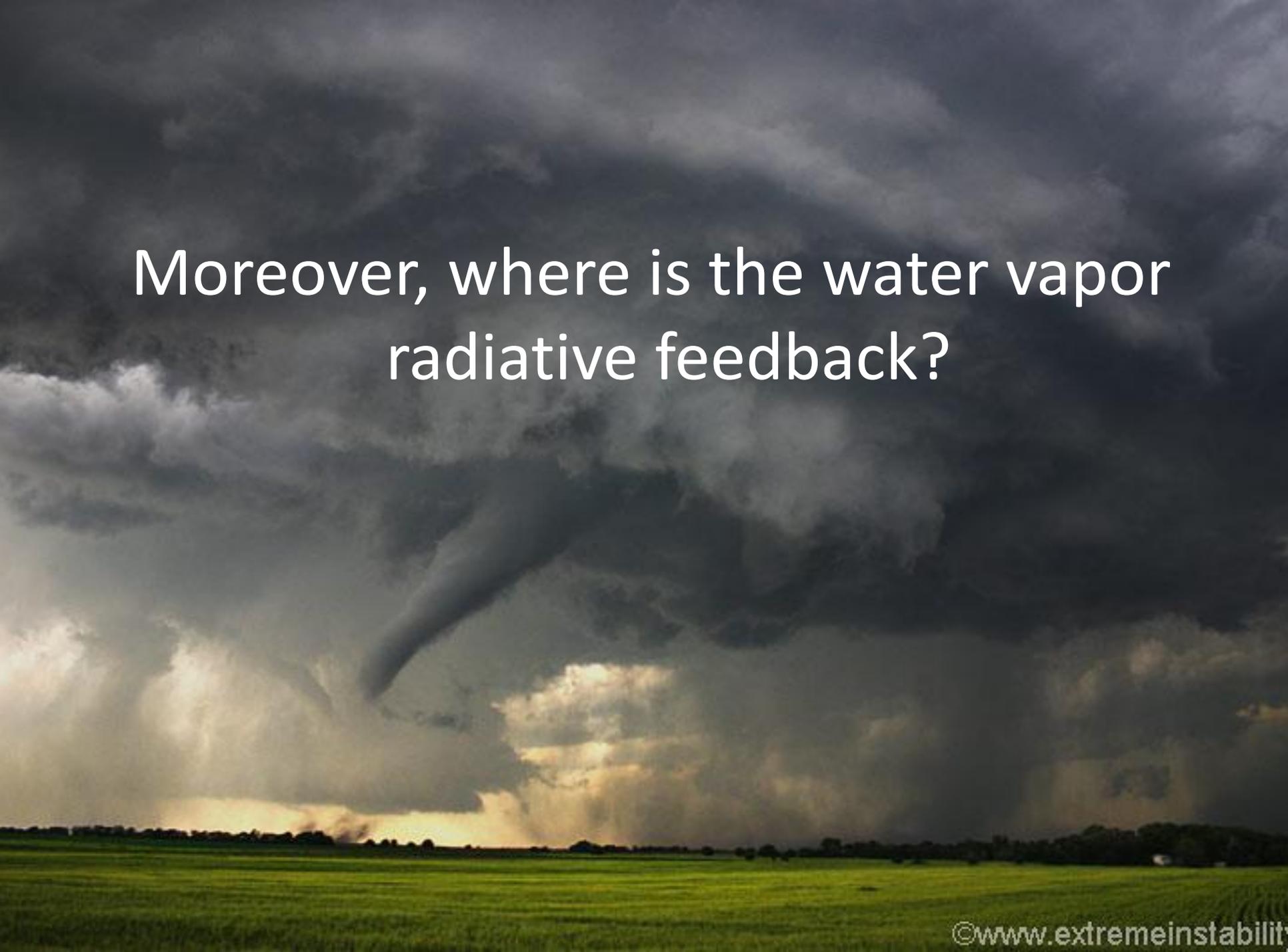
- The net warming of the ocean implies a Radiative Imbalance for the Earth of 0.64 [1.08 to 0.2] W m<sup>-2</sup> from 2005 to 2013. Other studies - e.g. Levitus et al 2012 provide a smaller Radiative Imbalance for the period 1955 to 2000 of 0.43 W m<sup>-2</sup> ± 0.031 W m<sup>-2</sup>
- IPCC SPM presents the Total Anthropogenic Radiative Forcing Relative to 1750 as 2.29 [1.13 to 3.33] W m<sup>-2</sup>. The claim is made that this is the current (2014) Forcing]
- The Radiative Feedback =  $0.64 \text{ W m}^{-2} - 2.29 \text{ W m}^{-2} = -1.65 \text{ W m}^{-2}$
- Yet the sum of the feedbacks estimated by the models is -1.21 W m<sup>-2</sup> K<sup>-1</sup>
- To illustrate, for a 0.5 C increase of the global averaged temperature, the Net Global Radiative Feedback is only -0.60 W m<sup>-2</sup> K<sup>-1</sup>

They do not match up.



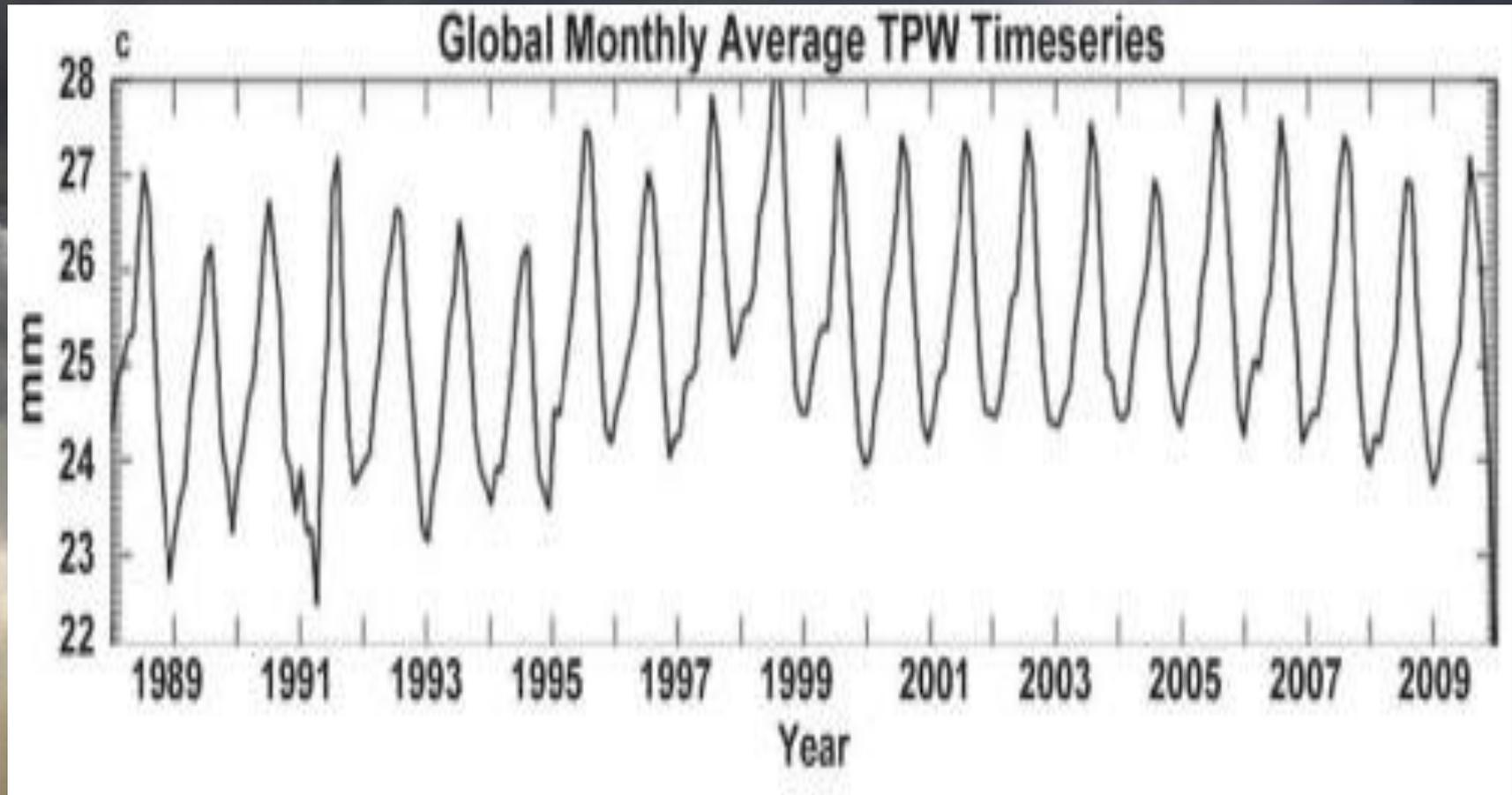
# Radiative Imbalance does not = Radiative Forcings + Radiative Feedbacks Using IPCC Analyses

For more on this approach see  
<http://judithcurry.com/2014/04/28/an-alternative-metric-to-assess-global-warming/>

A dramatic sky with dark, heavy clouds and a bright light source near the horizon, casting a glow over a green field.

Moreover, where is the water vapor  
radiative feedback?

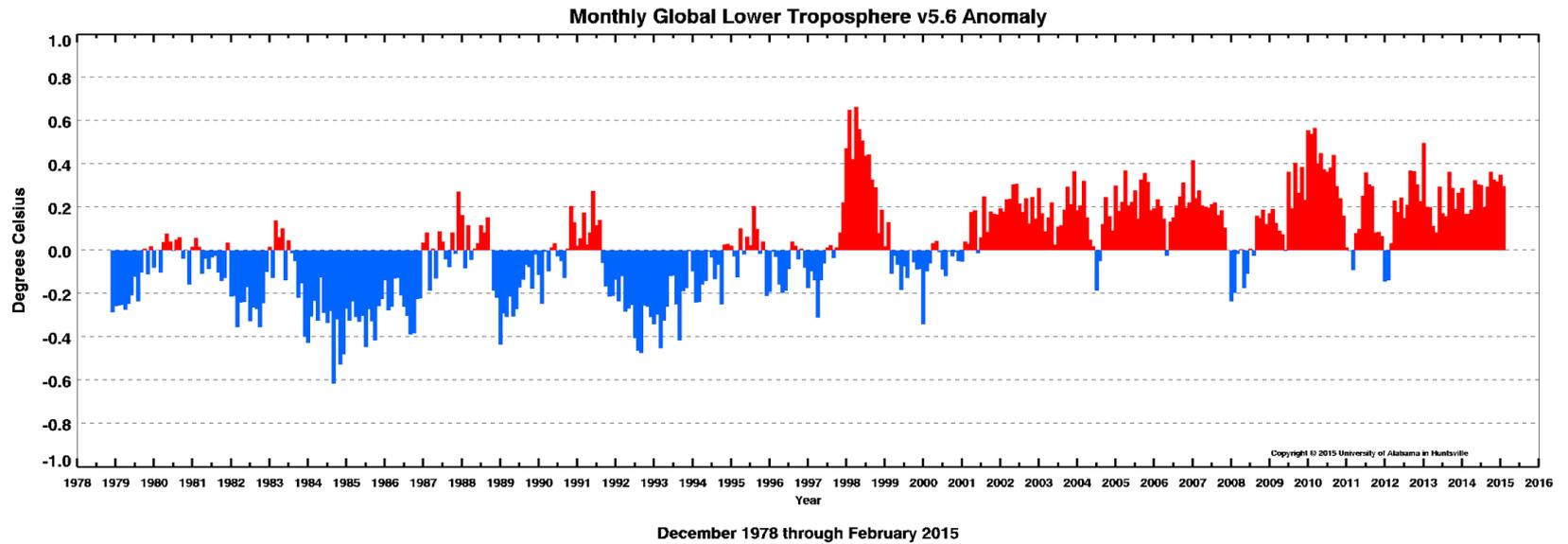
Vonder Haar, T. H., J. Bytheway, and J. M. Forsythe (2012), Weather and climate analyses using improved global water vapor observations, *Geophys. Res. Lett.*,doi:10.1029/2012GL052094.



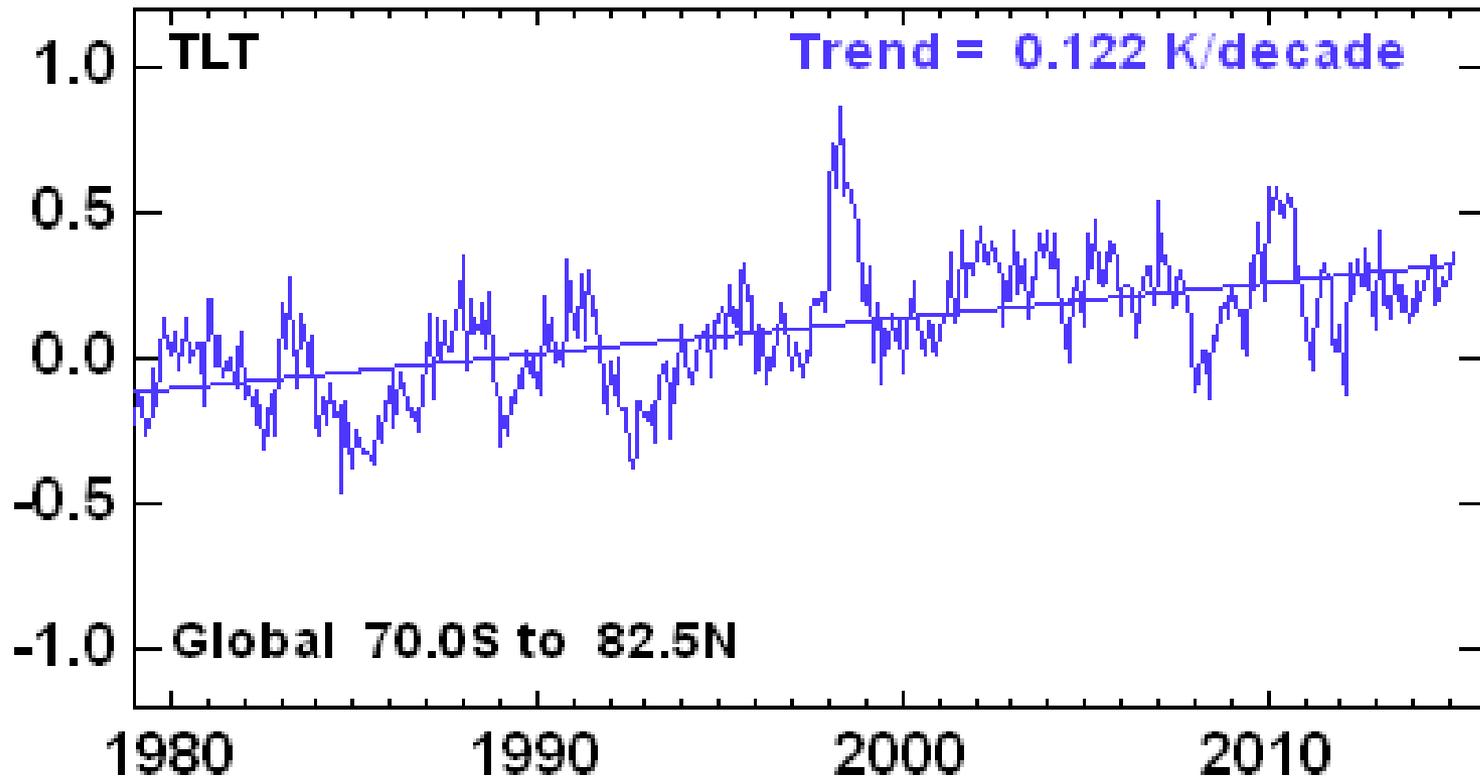


Real world data also shows a more complex behavior than is commonly communicated by the media and in professional society statements.

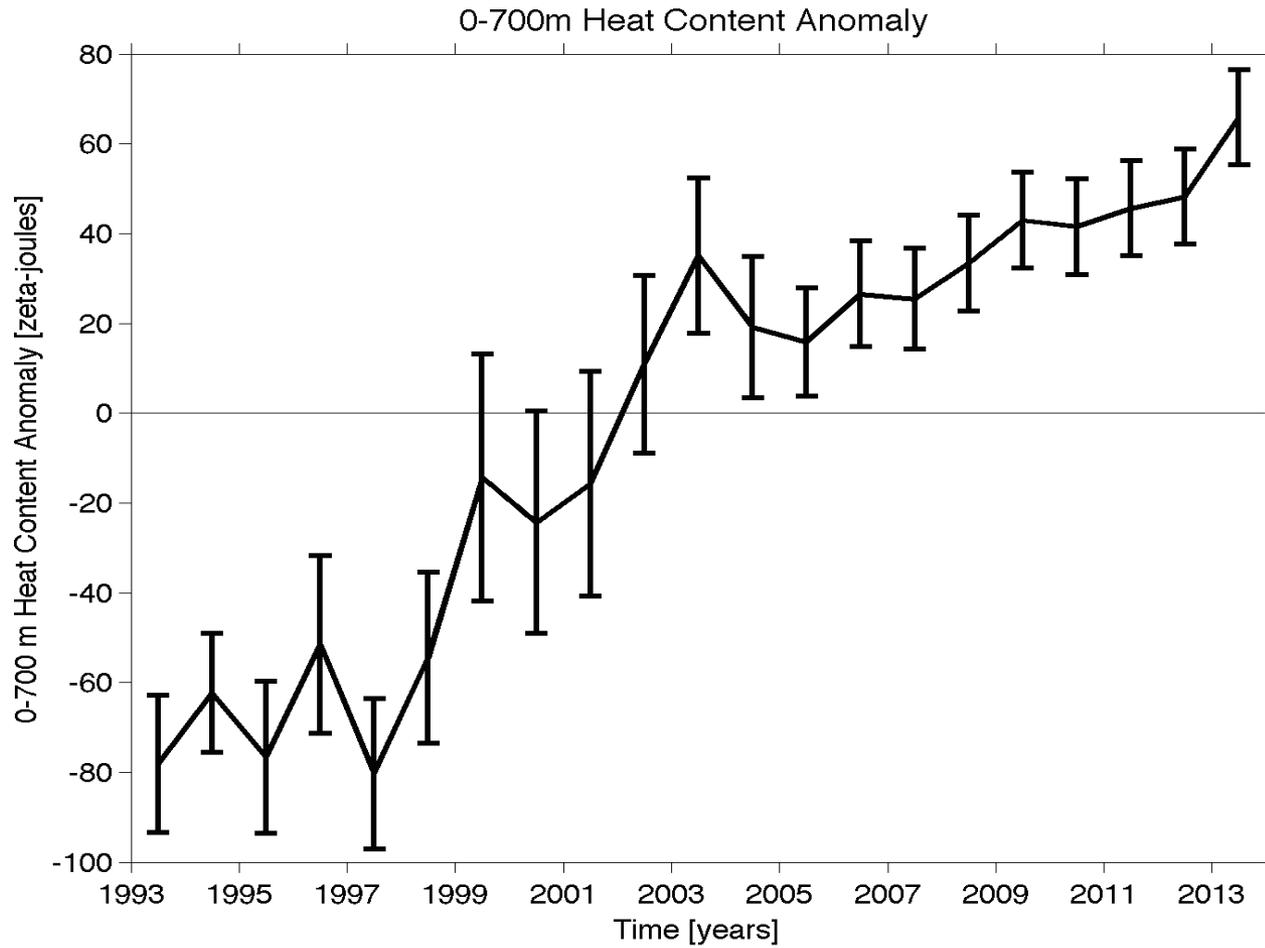
# UAH LTT



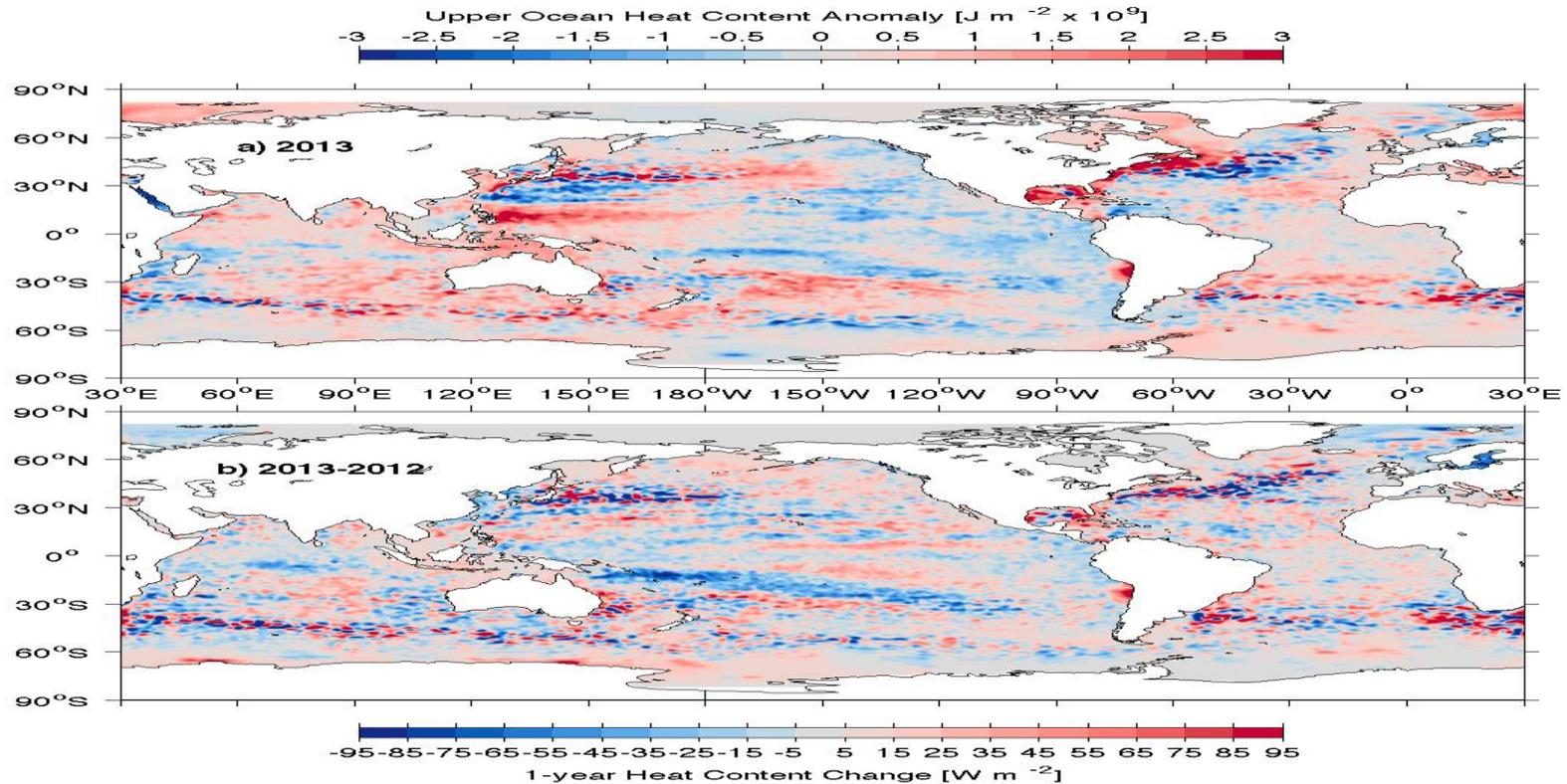
[http://images.remss.com/msu/msu\\_time\\_series.html](http://images.remss.com/msu/msu_time_series.html)



<http://oceans.pmel.noaa.gov/>



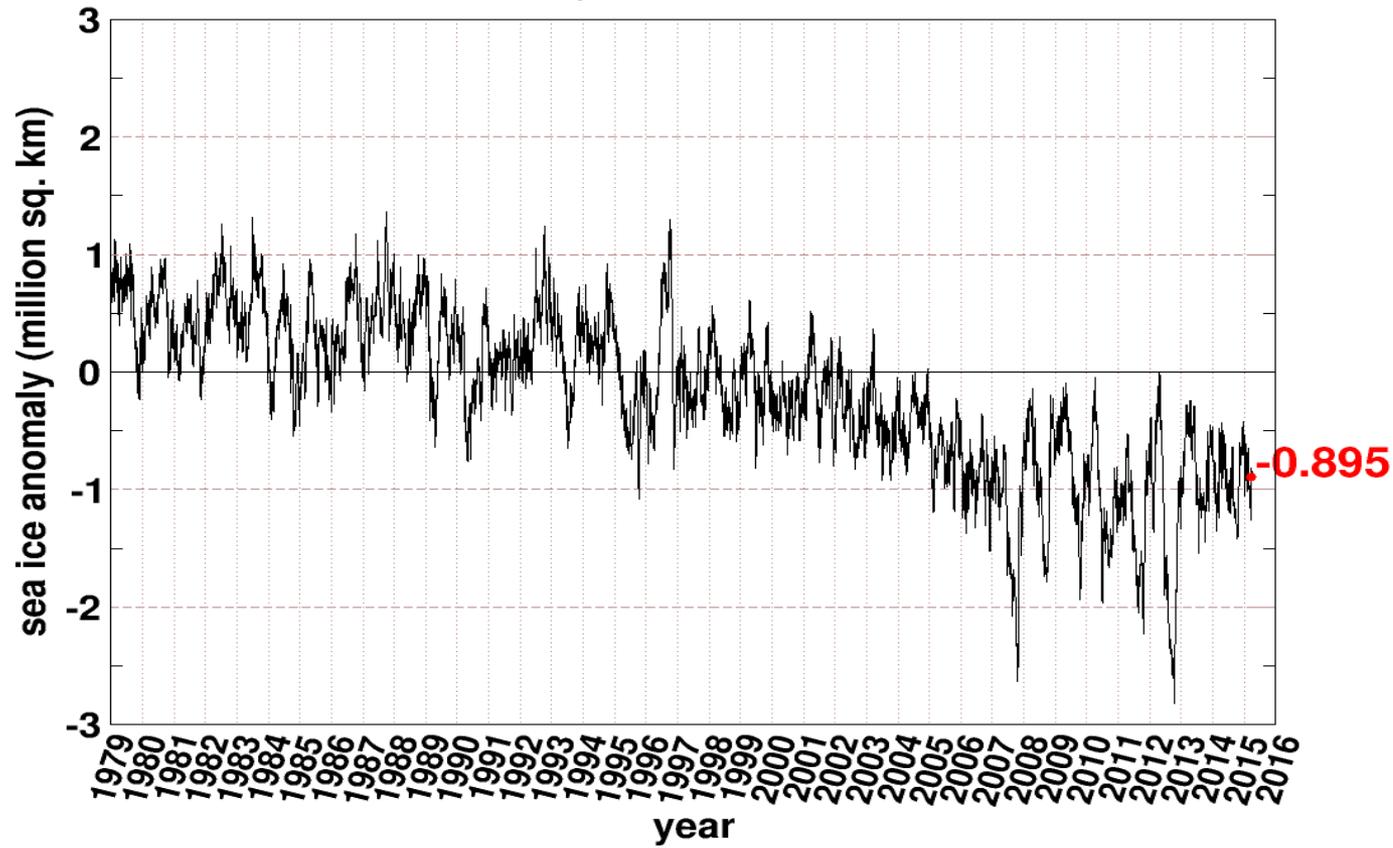
<http://oceans.pmel.noaa.gov/uohca-plots.html>



<http://arctic.atmos.uiuc.edu/cryosphere/IMAGES/seaice.anomaly.arctic.png>

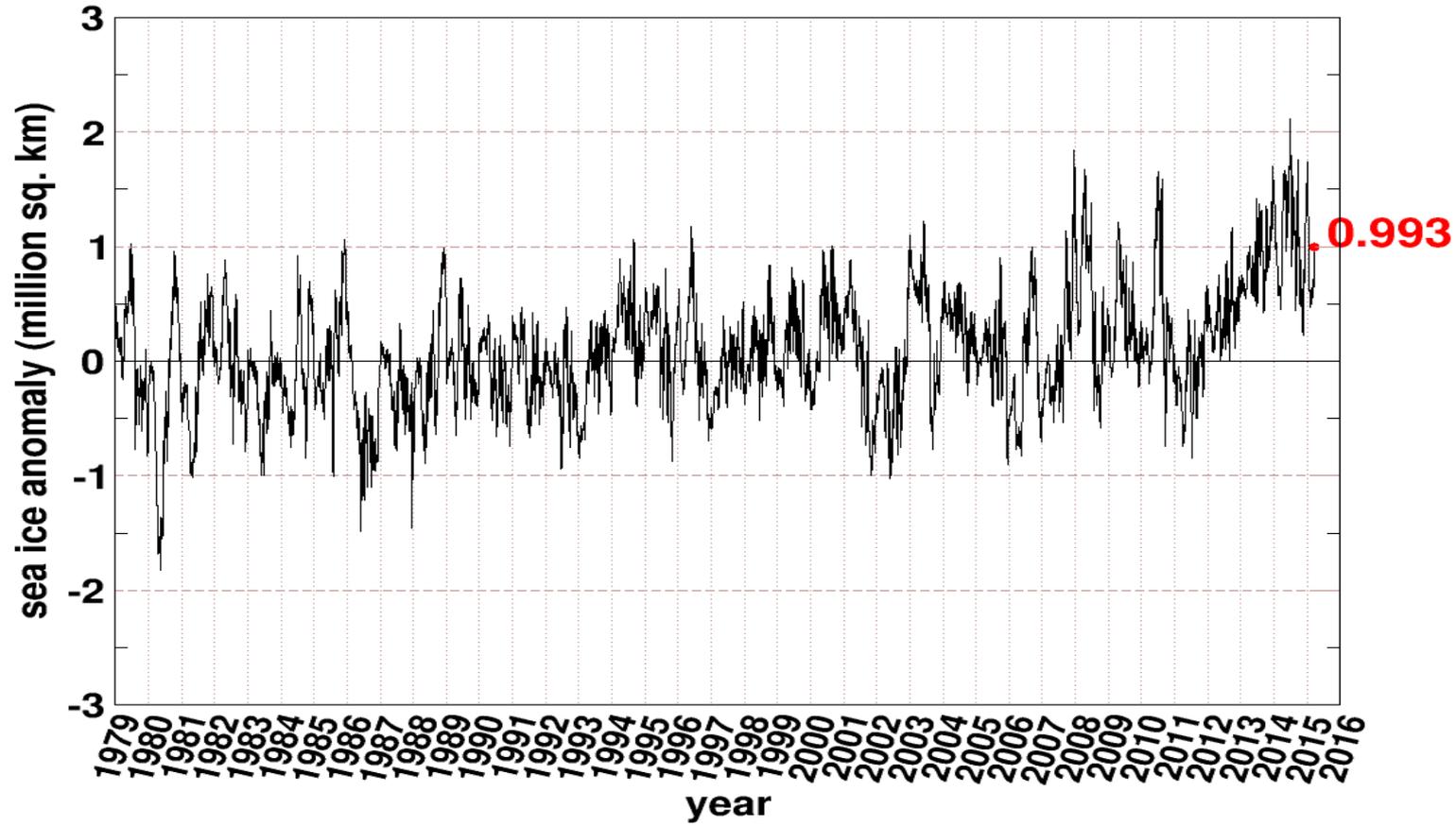
## Northern Hemisphere Sea Ice Anomaly

Anomaly from 1979-2008 mean

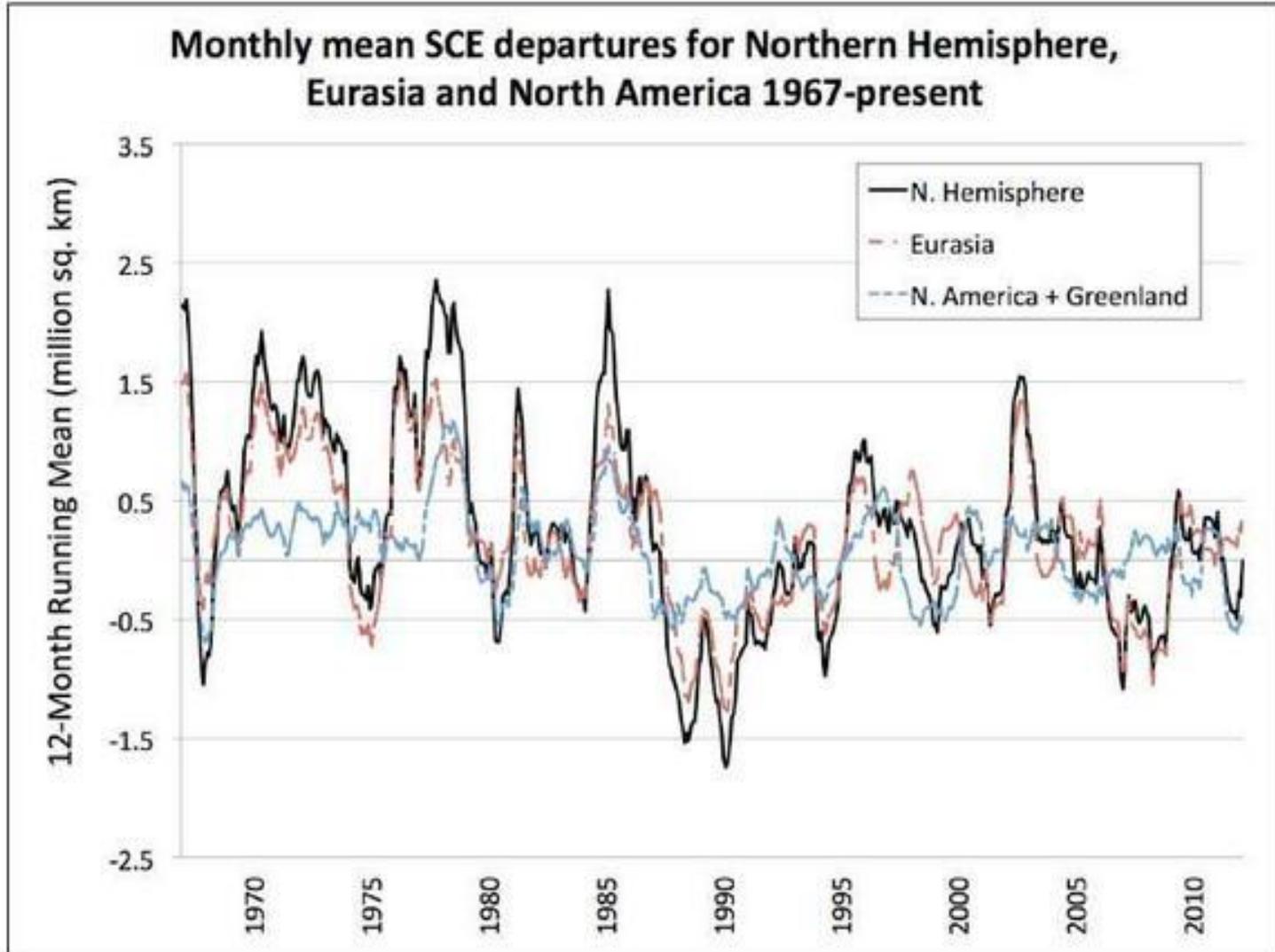


## Southern Hemisphere Sea Ice Anomaly

Anomaly from 1979-2008 mean



h/t Chris Beale 2013 annual NHem SCE report - Snow Cover





Moreover, climate change is much more than global warming

# However, what is “climate change”?

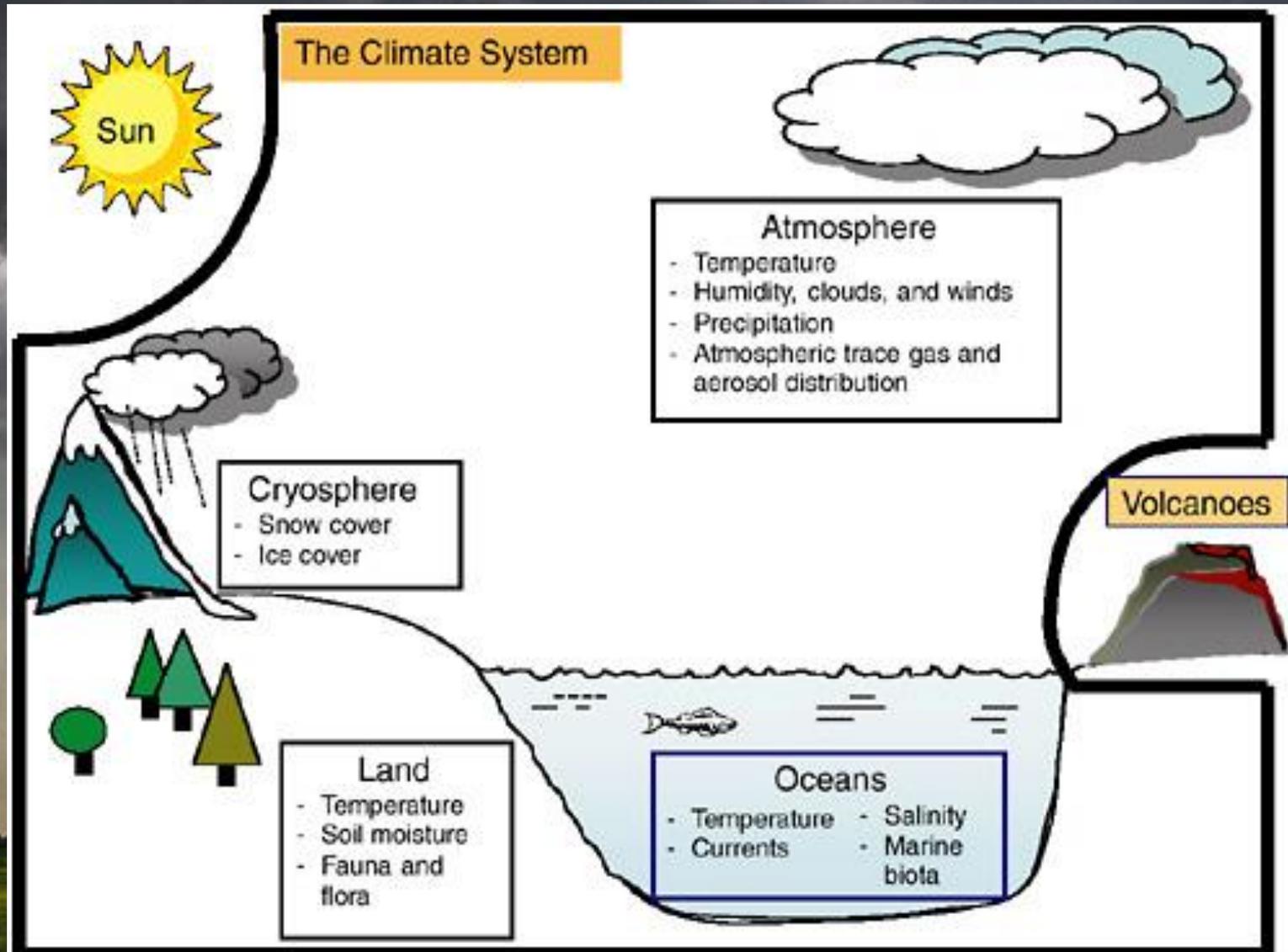
Climate Change is any multi-decadal or longer alteration in one or more physical, chemical and/or biological components of the climate system.

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.



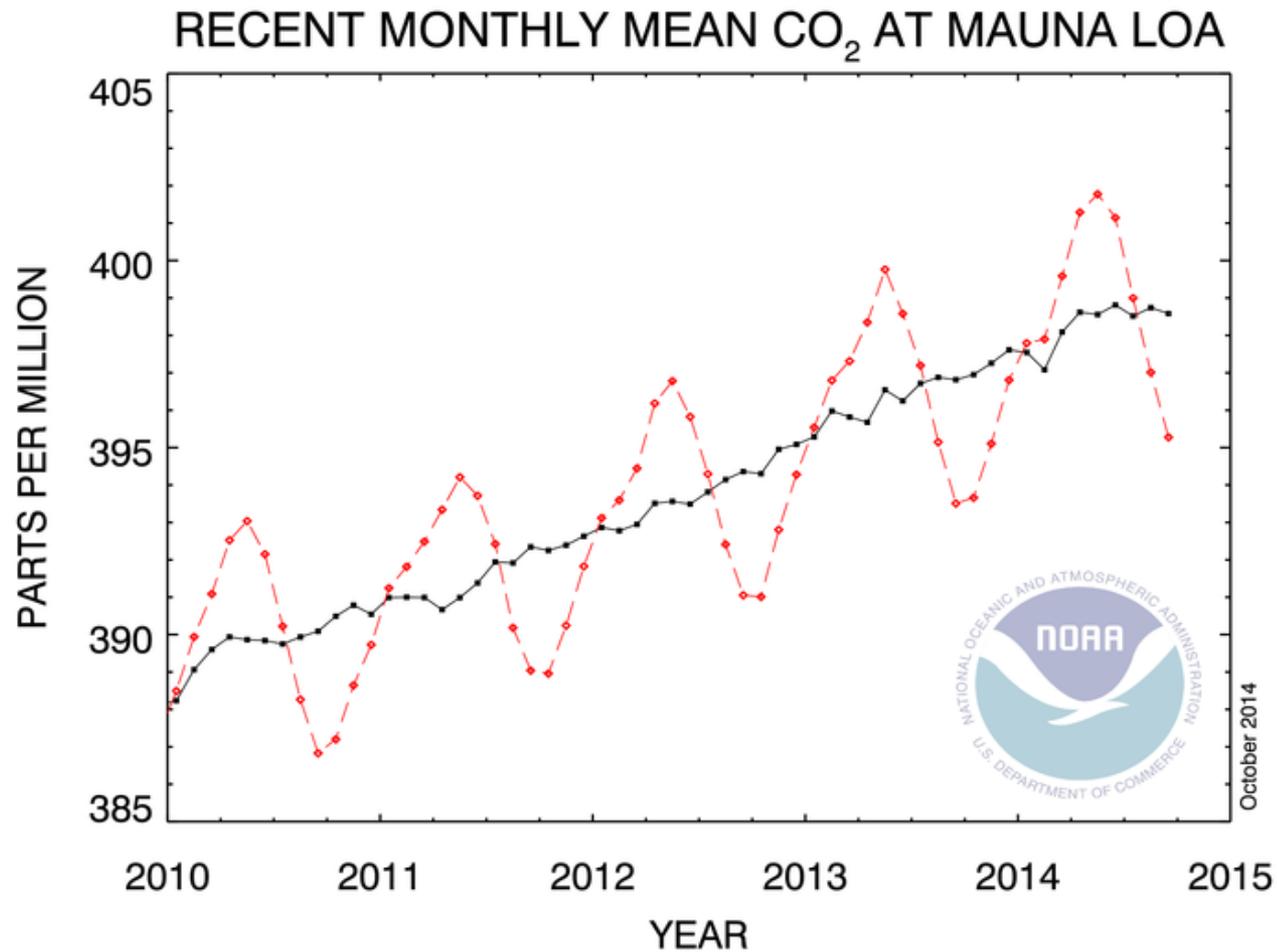
# Human Climate Forcings

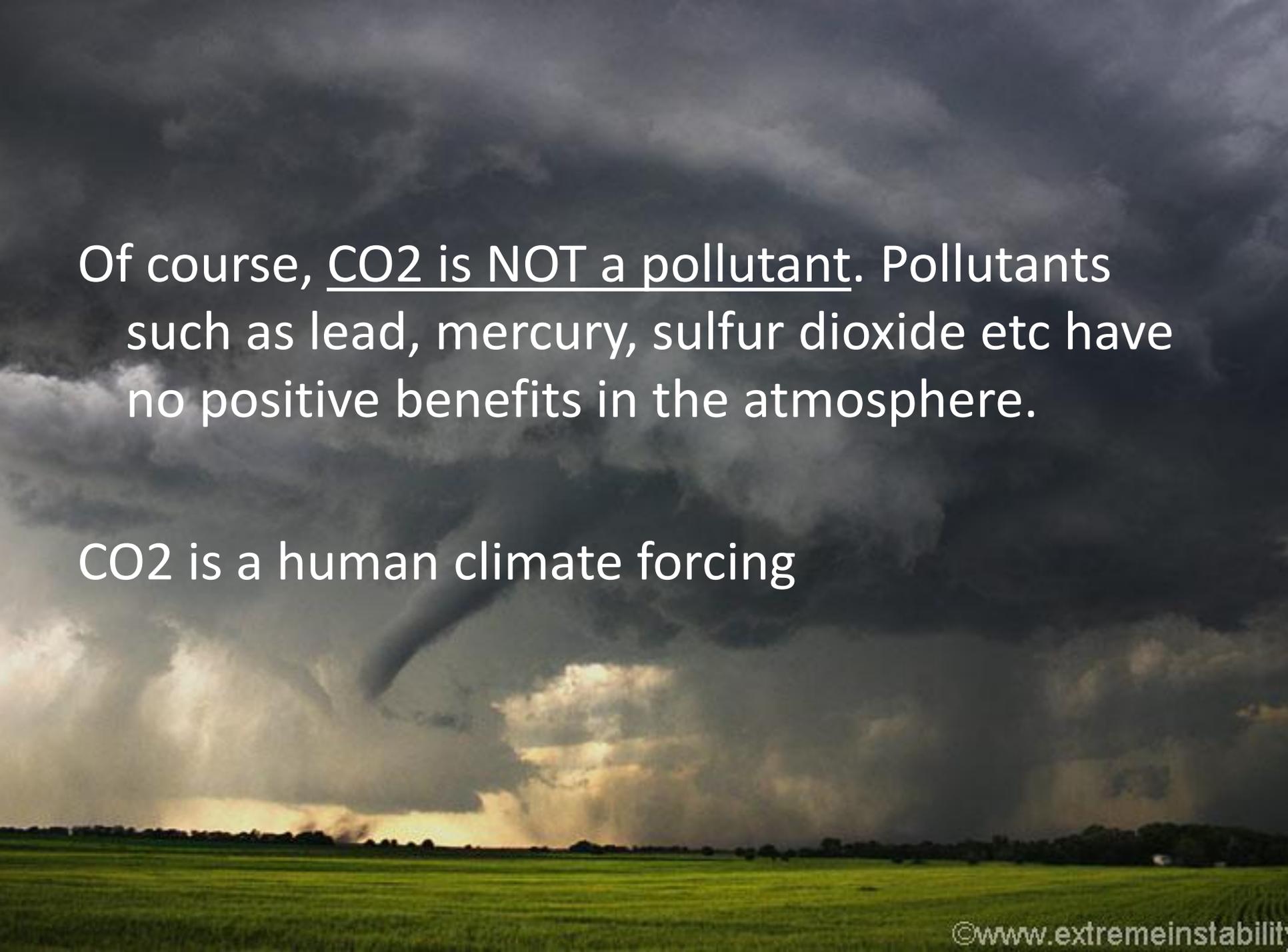


# Human Climate Forcings

- The influence of the human input of CO<sub>2</sub> 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 CO<sub>2</sub>

<http://www.esrl.noaa.gov/gmd/ccgg/trends/>





Of course, CO2 is NOT a pollutant. Pollutants such as lead, mercury, sulfur dioxide etc have no positive benefits in the atmosphere.

CO2 is a human climate forcing

# 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

# An Aside: The CO<sub>2</sub> part of climate change

- Instead of a tax on carbon, I recommend taxes on emissions into the atmosphere of pollutants such as mercury, lead, SO<sub>2</sub>, etc where reductions in CO<sub>2</sub> would be a co-benefit.
- This may be a way to move forward to limit CO<sub>2</sub> emissions with a broader group of support.

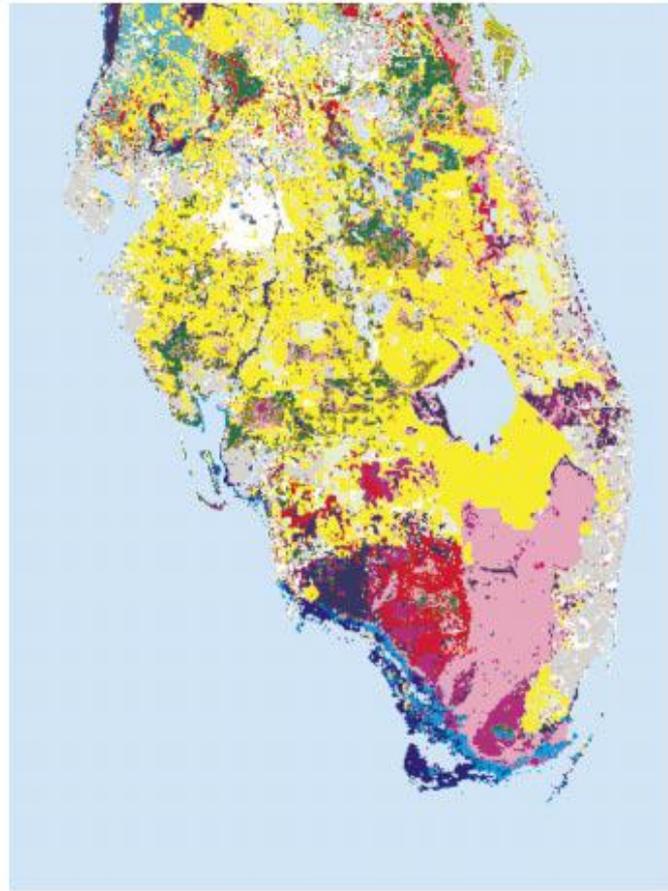
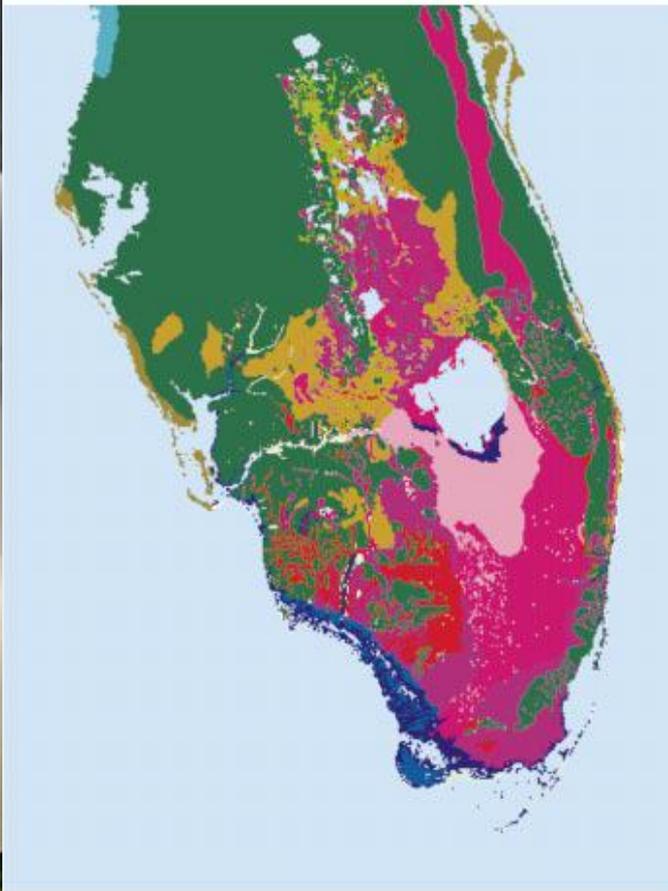
# LAND USE/LAND COVER CHANGE



# From Marshall et al. 2004

Pre-1900s

1993



- Open Water
- EvGrn NL Tree
- Decid BL Tree
- EvGrn BL Tree
- Grasses
- Shrubs
- Mixed Woodland
- Crop/Mixed Farming
- Slough, Bog, or Marsh
- Urban/Roads, Rock, Sand
- Saw Grass/Other Marshes
- EvGrn Shrub Wetland
- Mangroves
- Decid NL/Swamp (Cypress)
- Wet Prairie Marsh
- Mixed Residential
- Woody Wetlands
- Saltwater Marsh

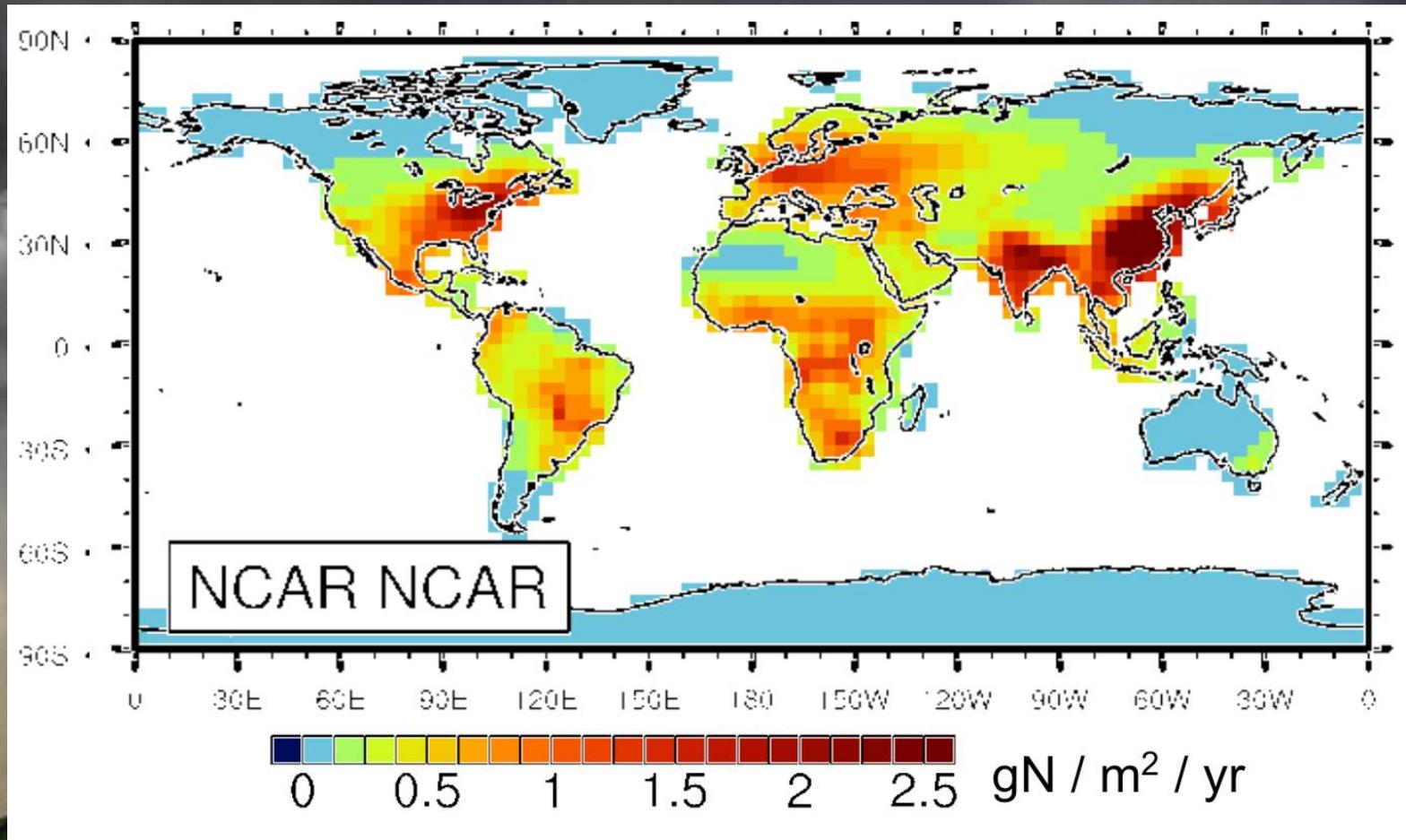
# Aerosols

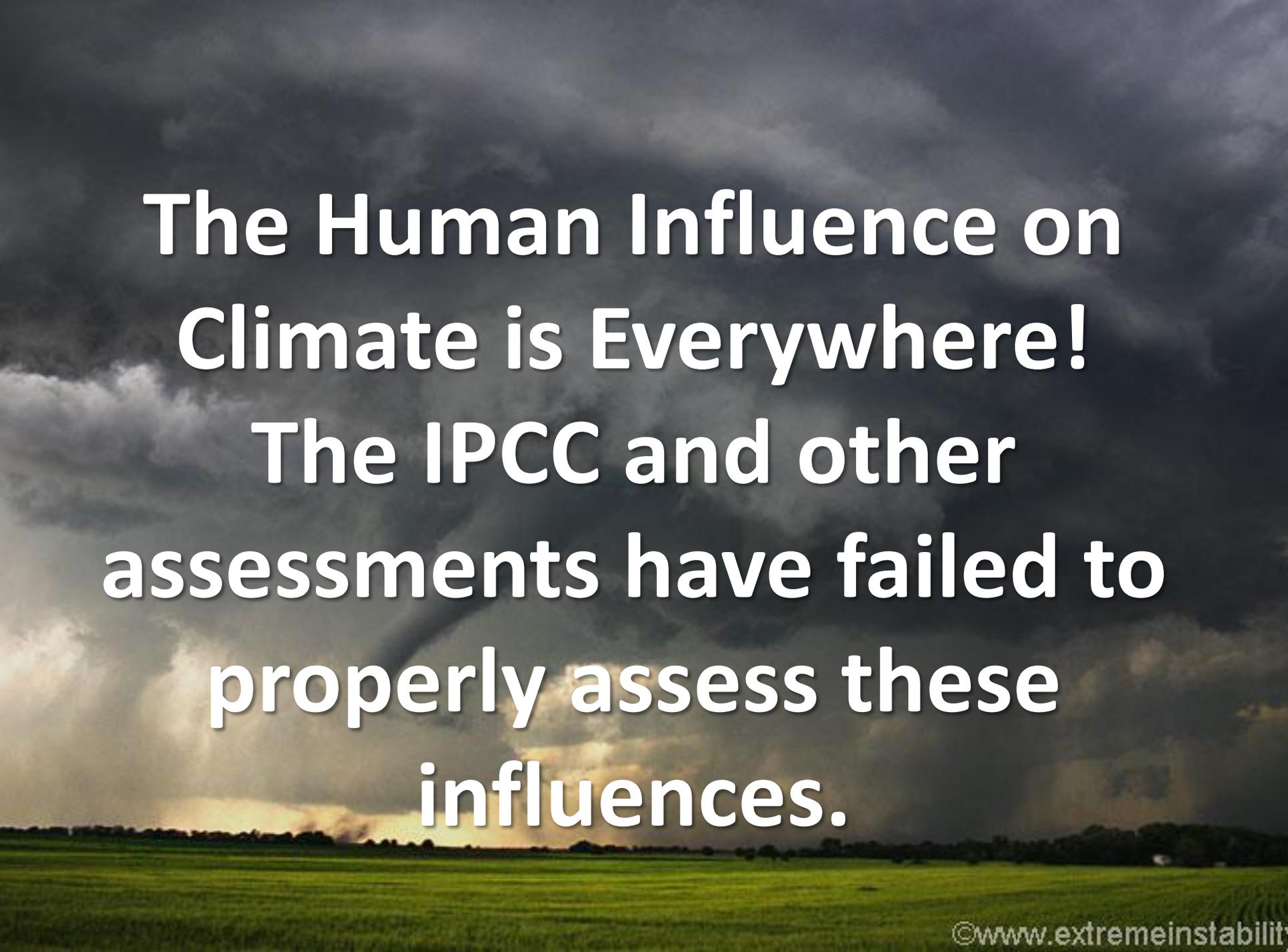
A dramatic landscape photograph featuring a vast green field in the foreground. The sky is filled with dark, heavy, and textured clouds, with a bright, glowing area near the horizon suggesting a sunset or sunrise. The overall mood is intense and atmospheric.





# Nitrogen Deposition





**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

- ~~• 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 (CO<sub>2</sub>). 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 CO<sub>2</sub>. The adverse impact of these gases on regional and global climate constitutes the primary climate issue for the coming decades. [IPCC]~~

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.

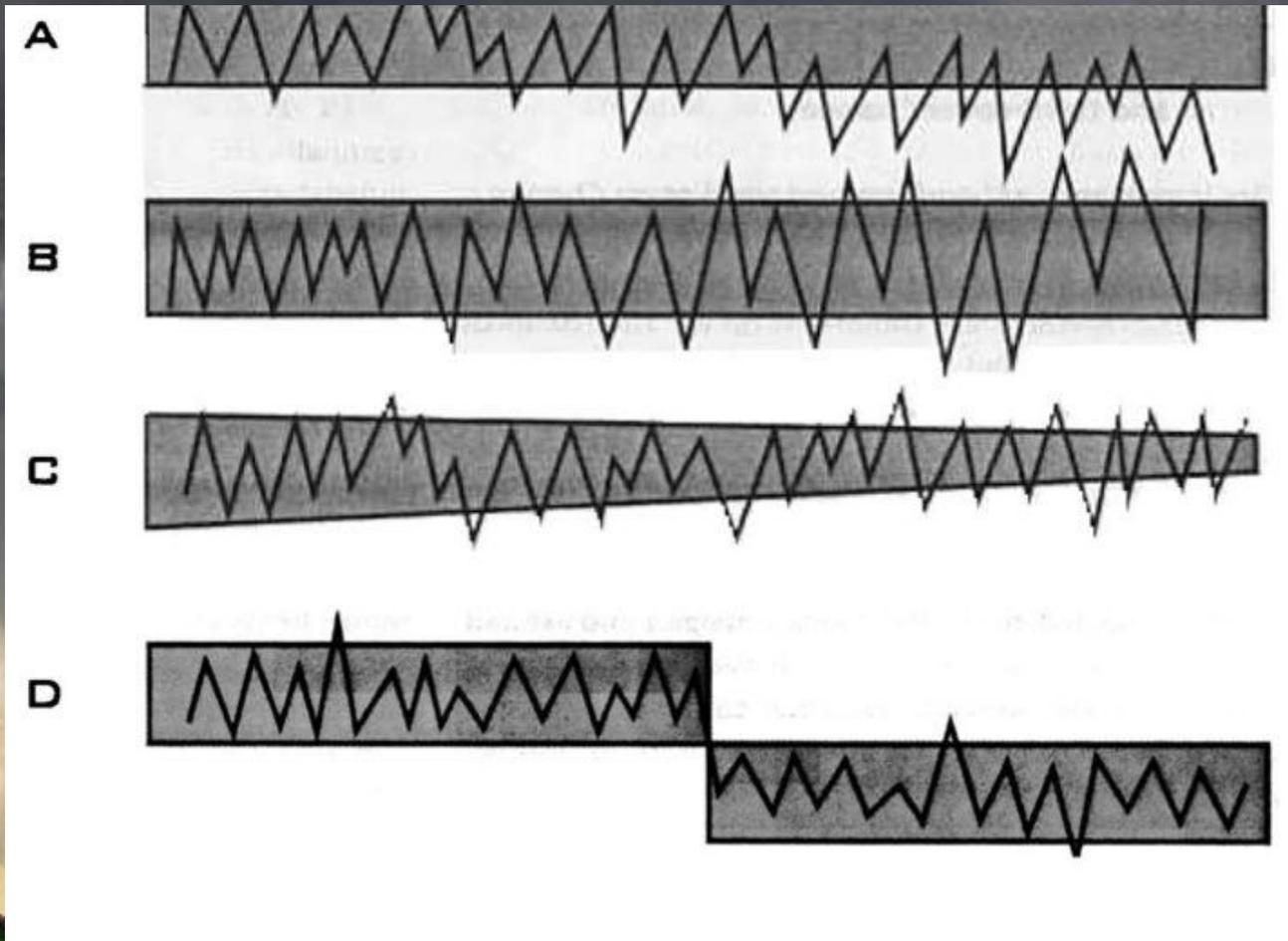
<http://theconversation.edu.au/youve-been-framed-six-new-ways-to-understand-climate-change-2119>

# **A New Approach Is Needed!**

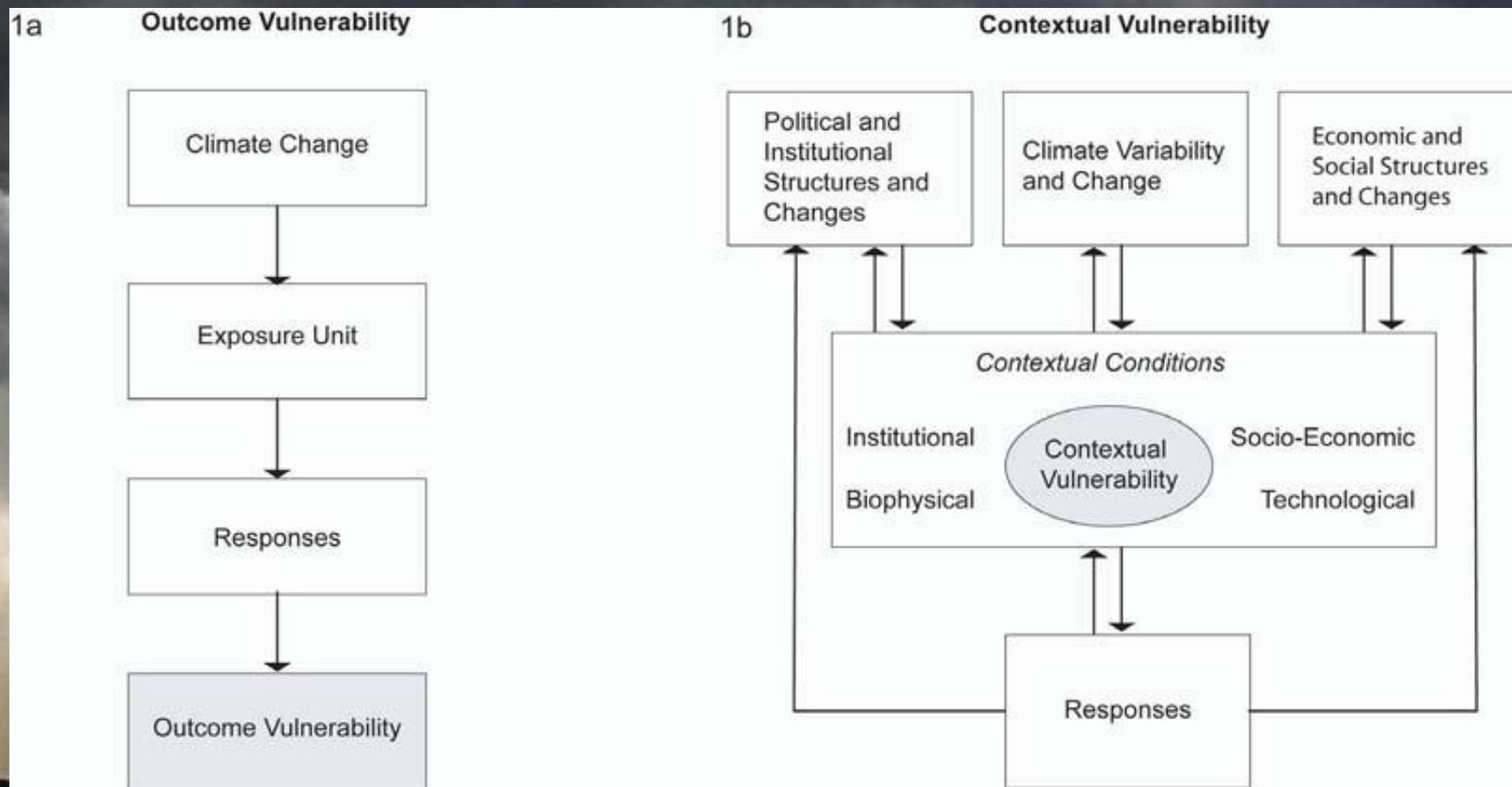
**We Need To Replace The IPCC Top-Down Approach To Predict Future Environmental And Social Risk With A Bottom-Up Resource-Based Assessment of Vulnerability**

**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



# Climate Vulnerability

Understanding and Addressing Threats to Essential Resources



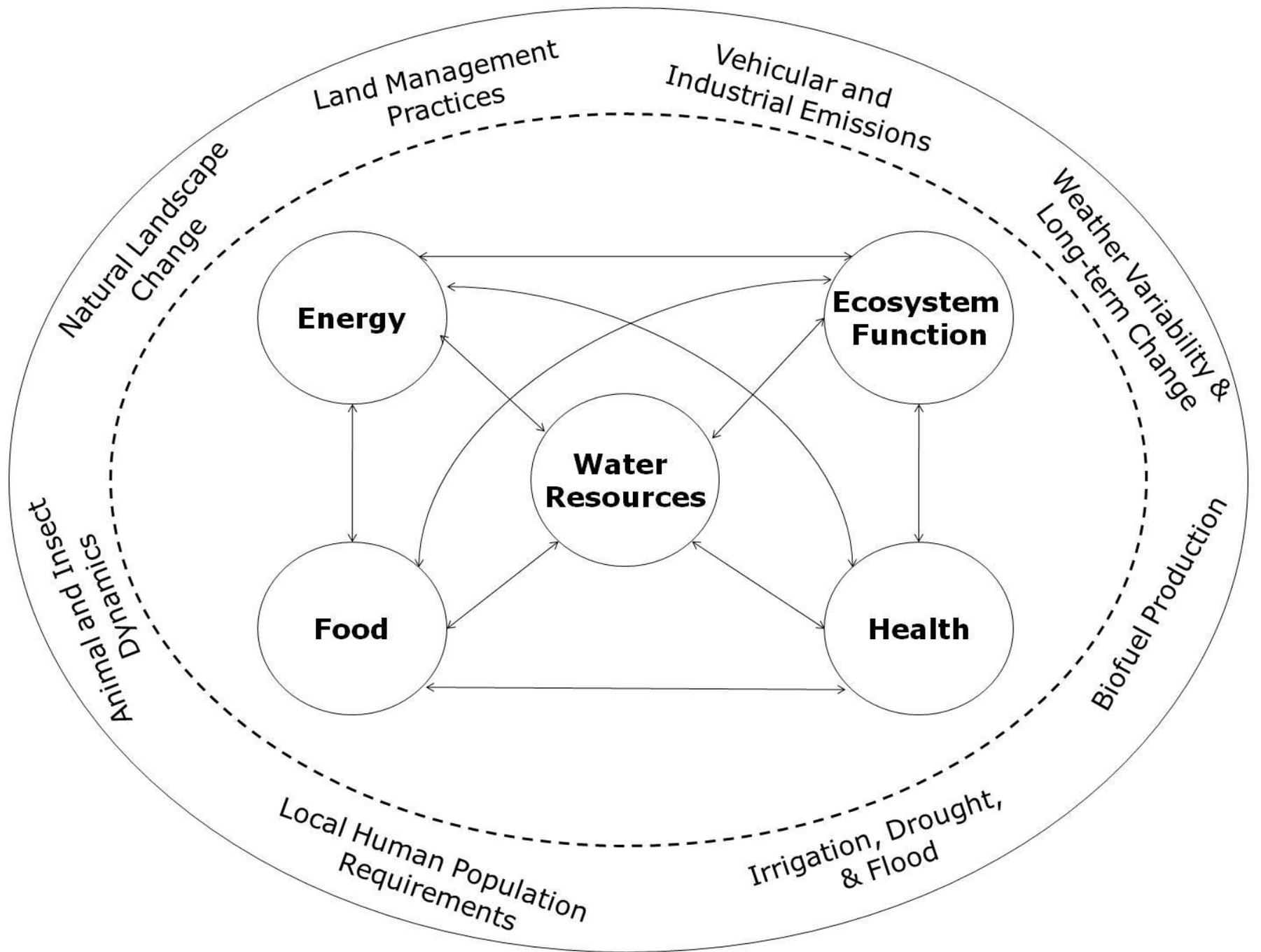
Editor:  
Roger A. Pielke, Sr.

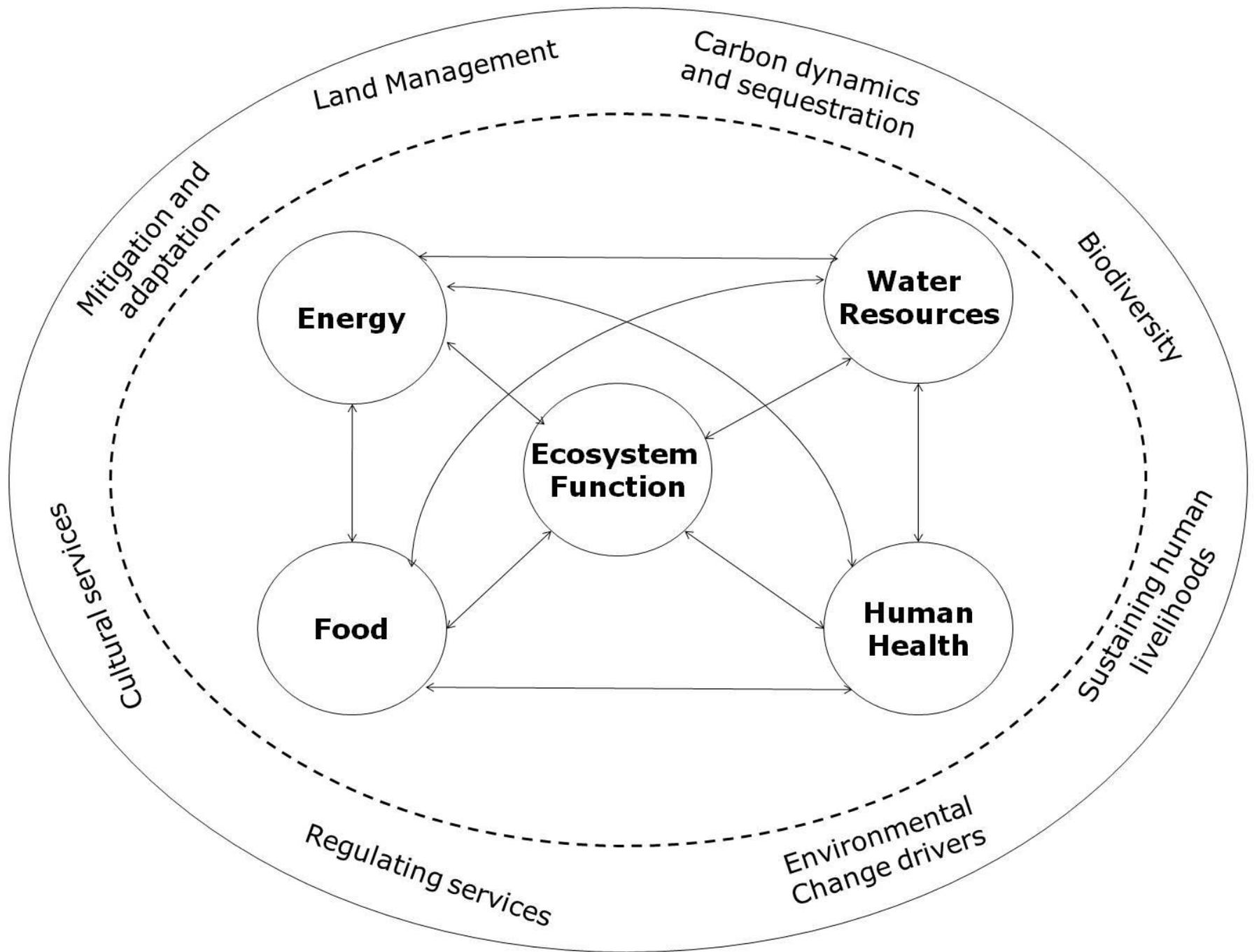


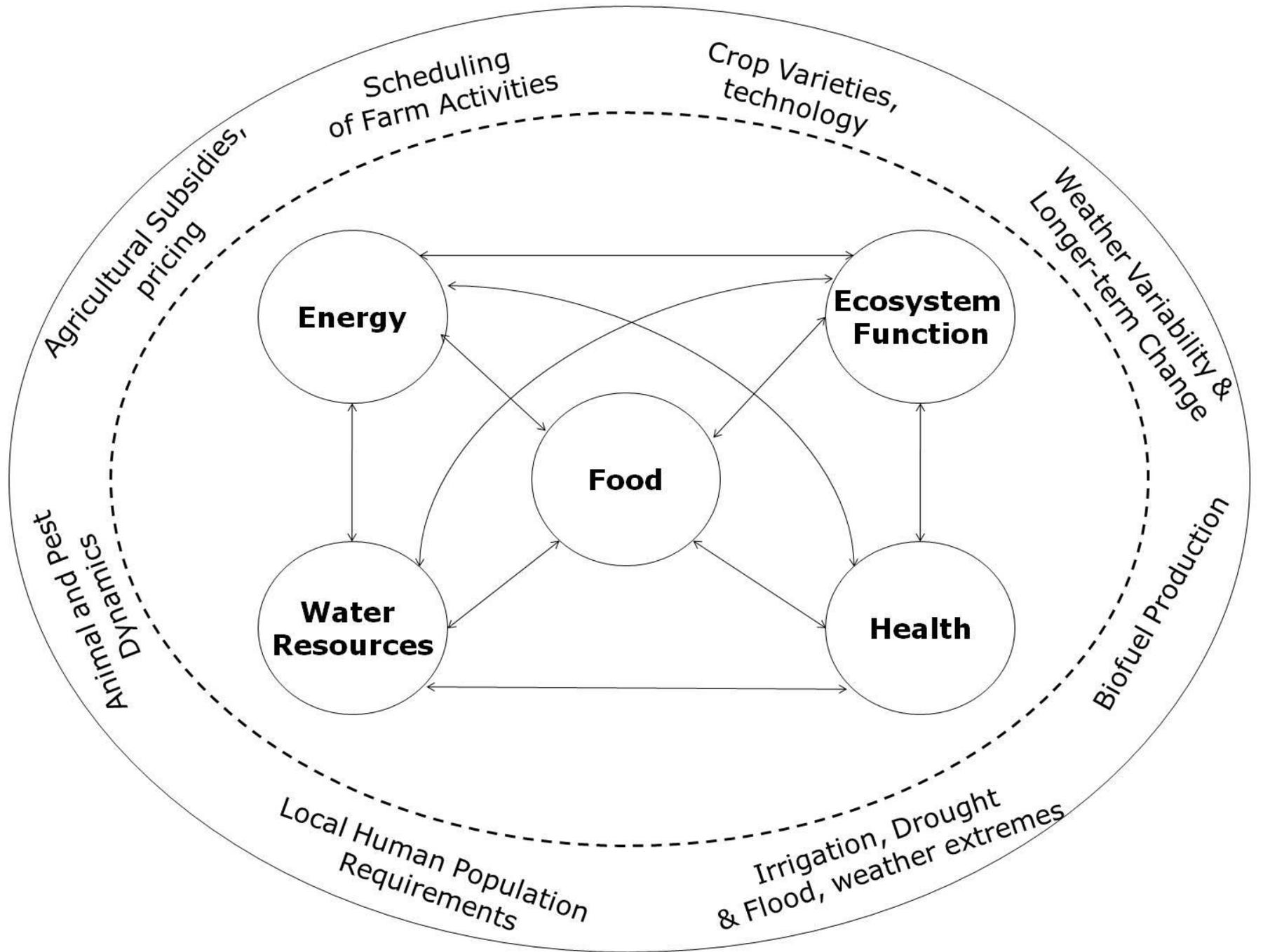
# Questions For Stakeholders On The Bottom-Up Approach

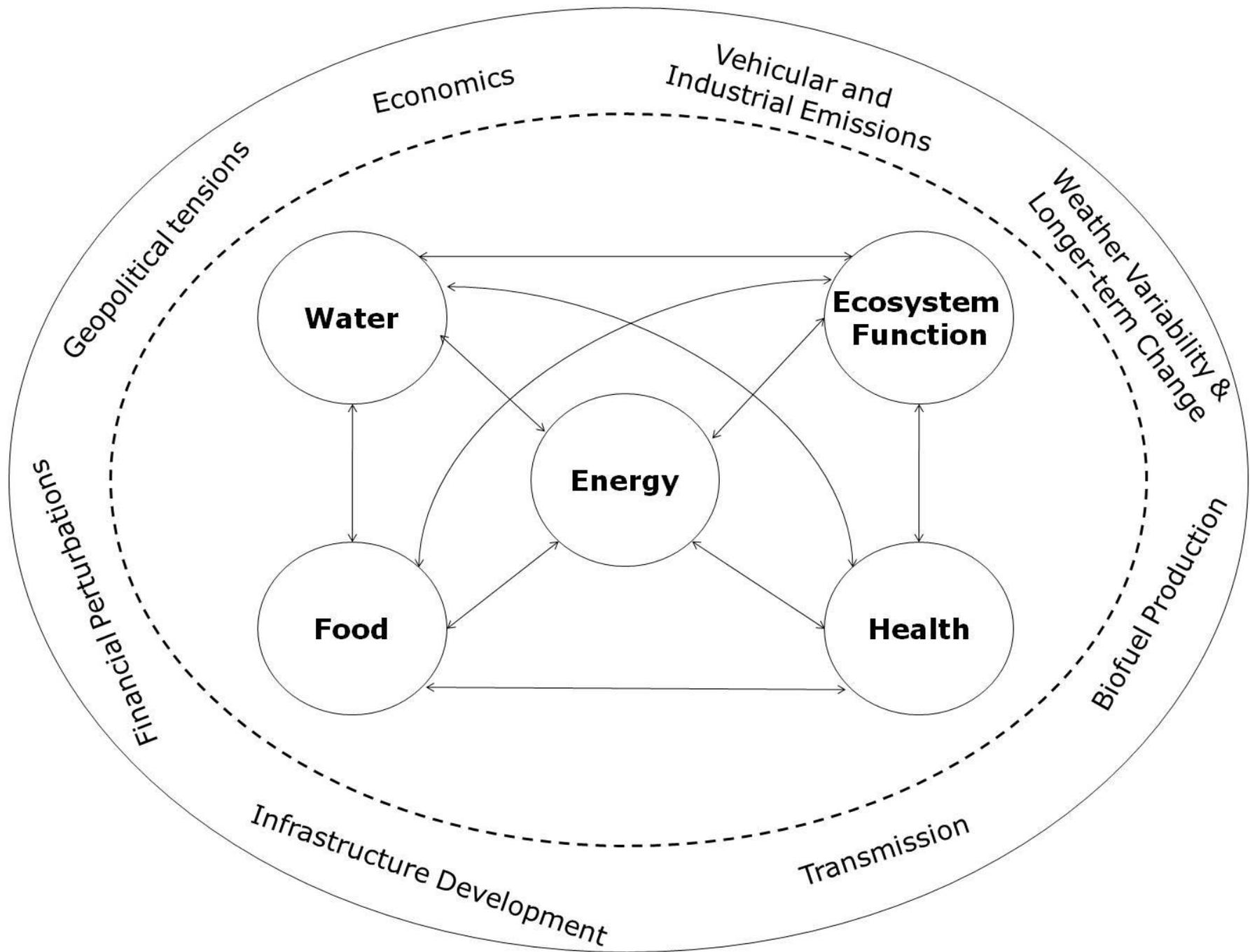
1. Why is this resource important? How is it used? To what stakeholders is it valuable?
2. What are the key environmental and social variables that influence this resource?
3. What is the sensitivity of this resource to changes in each of these key variables? (This may include but is not limited to,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

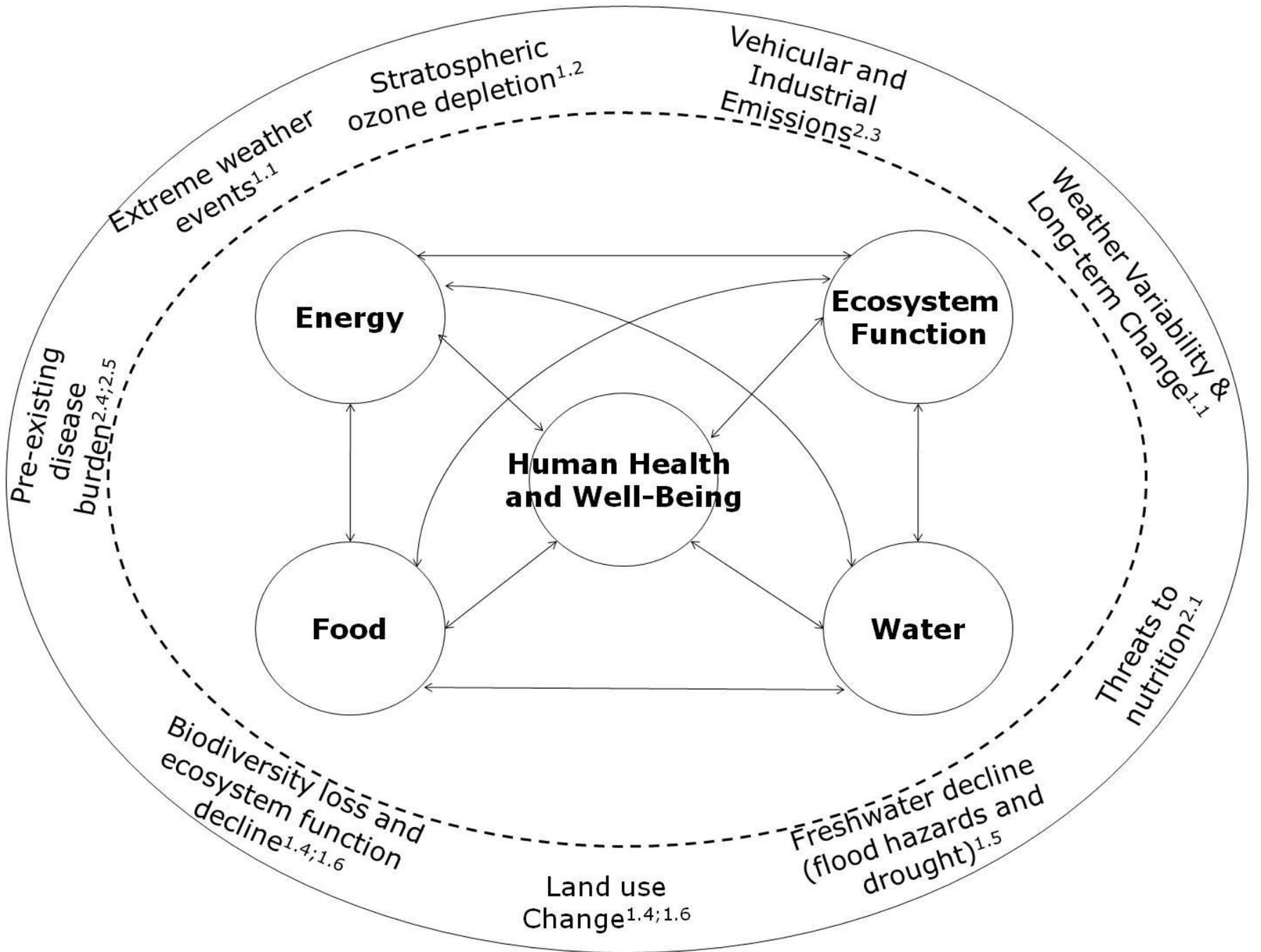
4. What changes (thresholds) in these key variables would have to occur to result in a negative (or positive) outcome for this resource?
5. What are the best estimates of the probabilities for these changes to occur? What tools are available to quantify the effect of these changes? Can these estimates 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?



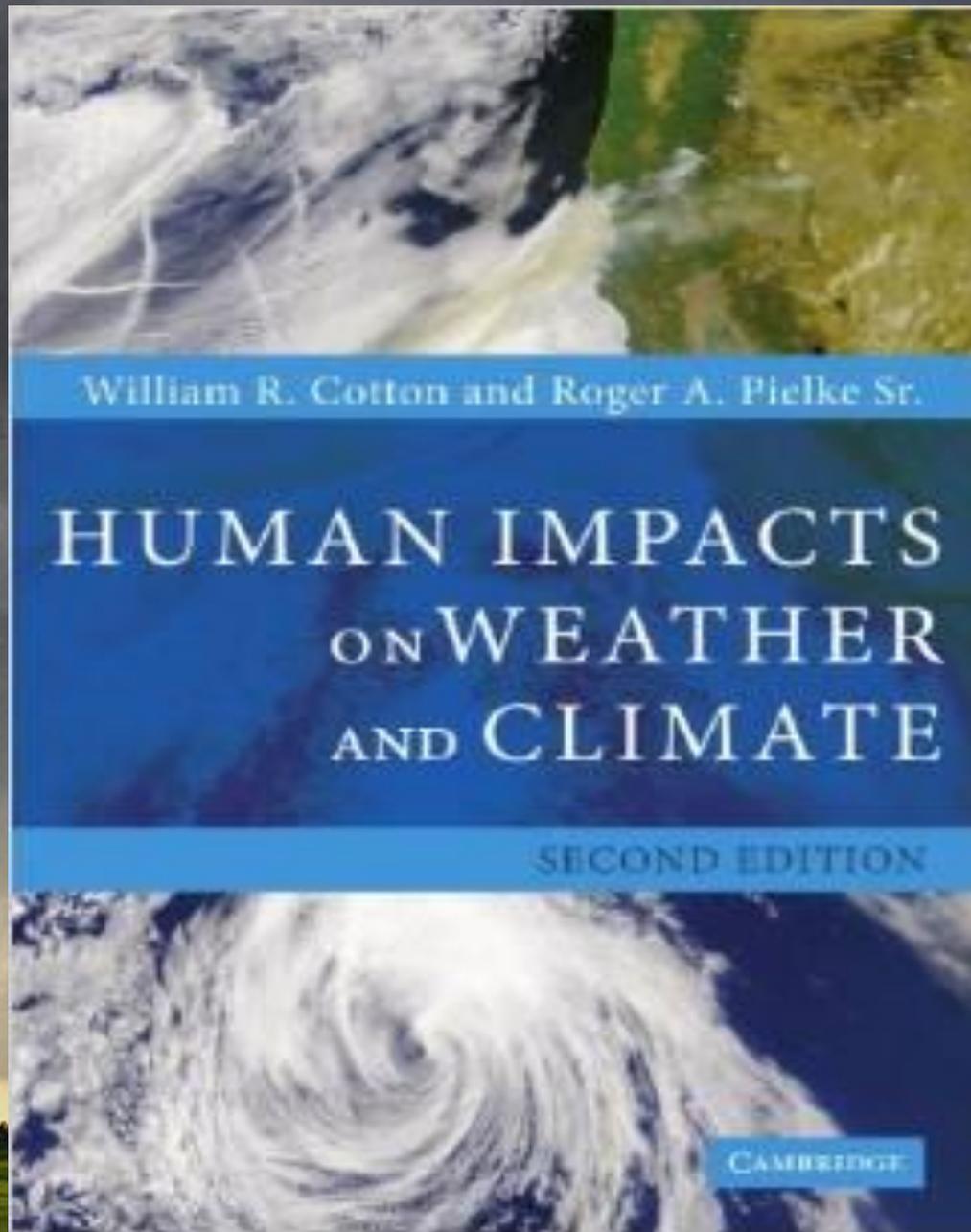








A bottom-up vulnerability perspective concept permits the determination of the major threats to local and regional water, food, energy, human health, and ecosystem function resources from extreme events including climate, but also from other social and environmental issues. After these threats are identified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



William R. Cotton and Roger A. Pielke Sr.

# HUMAN IMPACTS ON WEATHER AND CLIMATE

SECOND EDITION

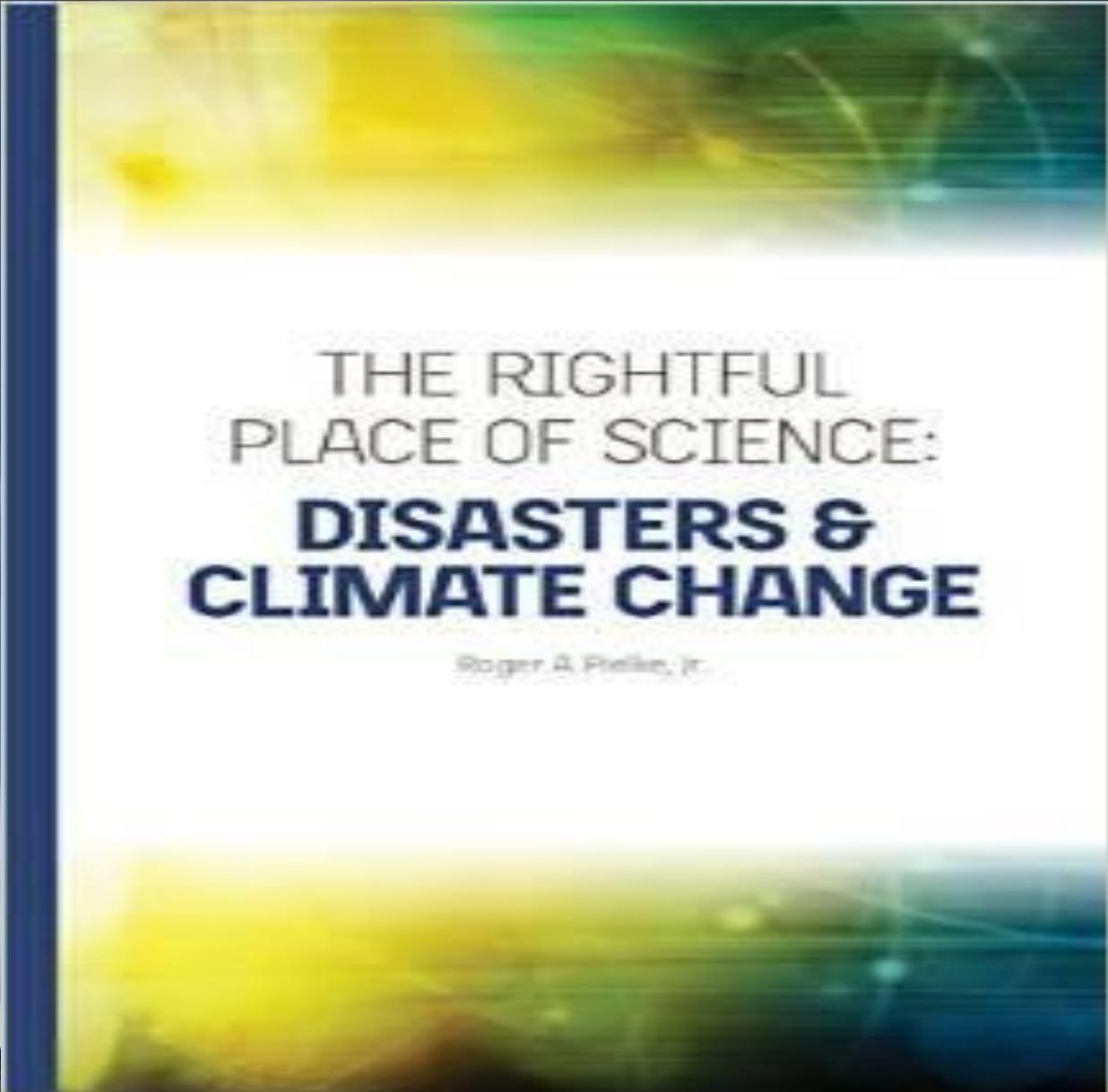
CAMBRIDGE

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.

# 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!