

“CLIMATE: What is it, is it changing, and
why?...Its not just CO2”

Nov 21, 2019

Roger A Pielke

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Research Scientist at University of Colorado, Boulder

Presented to the Saddlebrook Ranch Community, Tucson, AZ

Climate Vulnerability

Understanding and Addressing Threats to Essential Resources



Editor:
Roger A. Pielke, Sr.





William R. Cotton and Roger A. Pielke Sr.

HUMAN IMPACTS ON WEATHER AND CLIMATE

SECOND EDITION



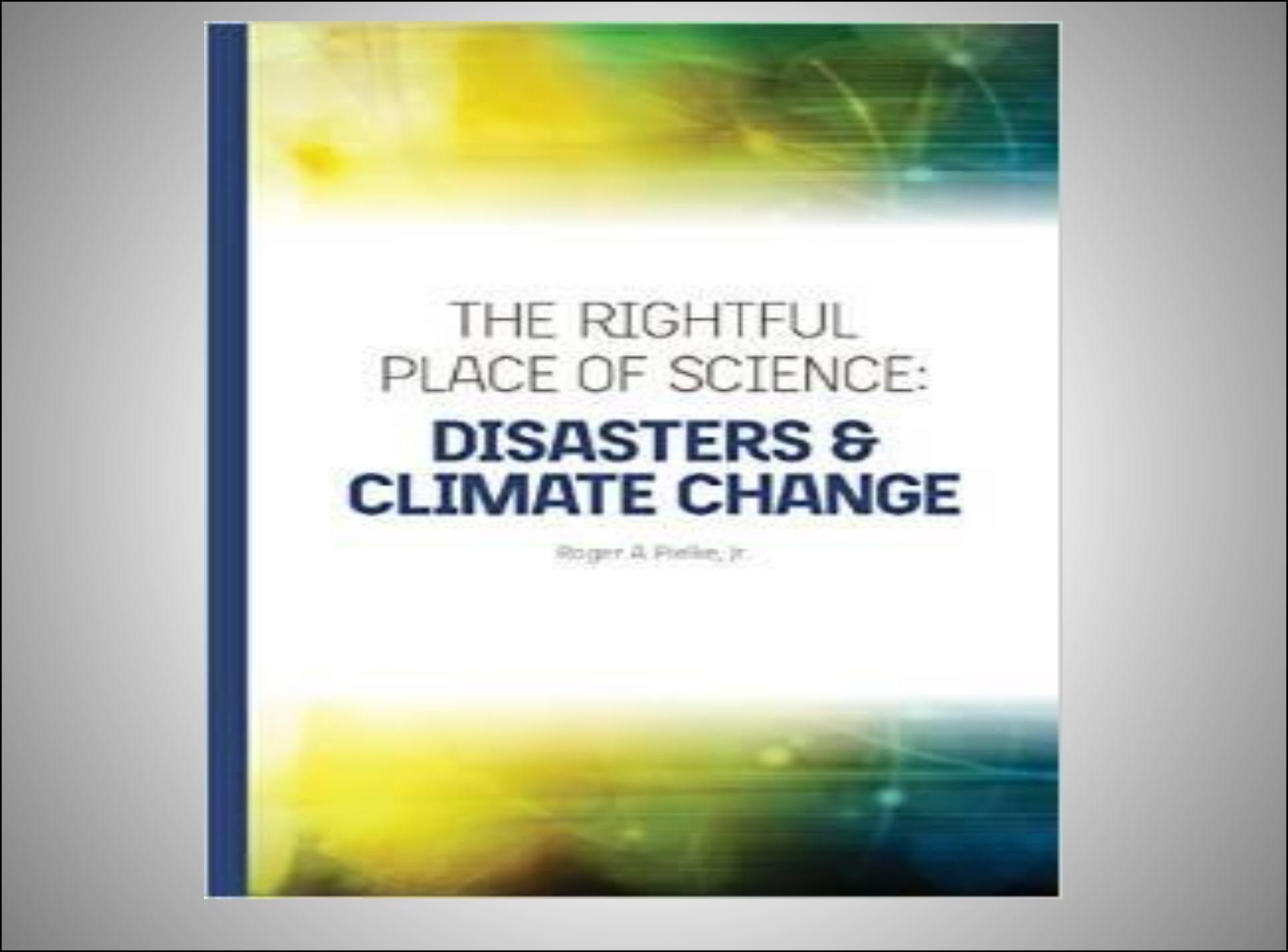
CAMBRIDGE

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**

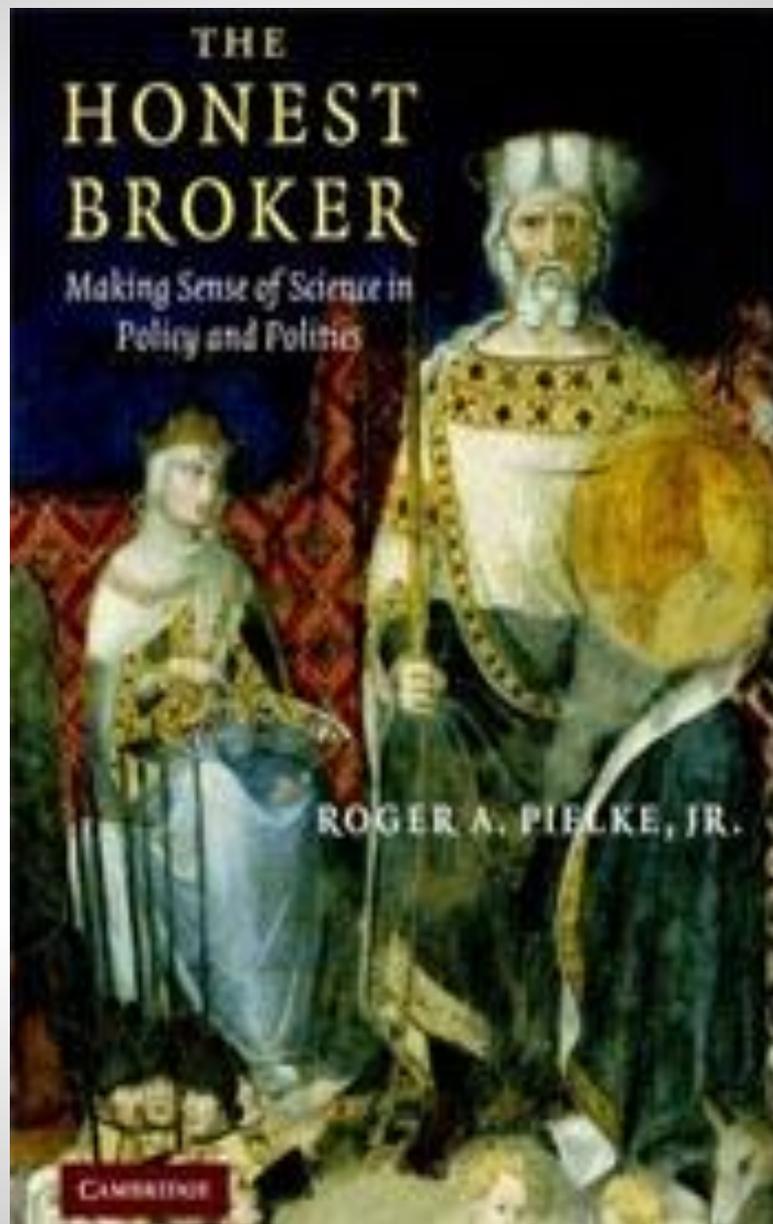
Roger A. Pielke, Jr.

THE
HONEST
BROKER

*Making Sense of Science in
Policy and Politics*

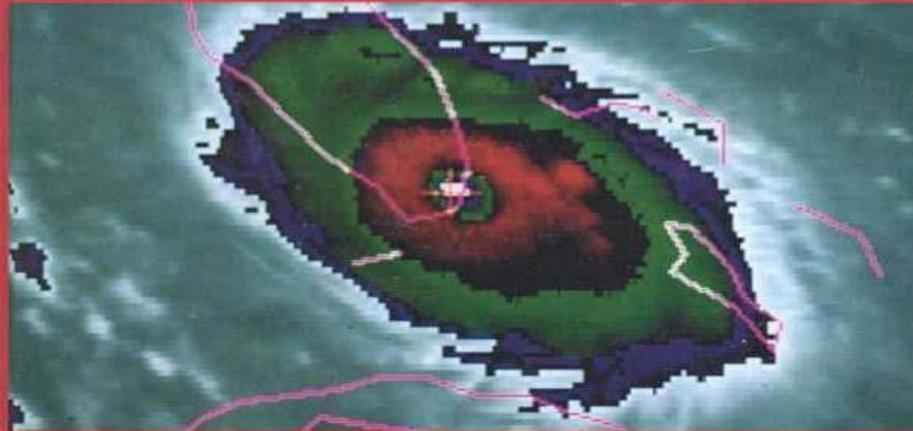
ROGER A. PIELKE, JR.

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HURRICANES

their Nature and Impacts on Society



Roger A. Pielke Jr.
AND
Roger A. Pielke Sr.

 WILEY

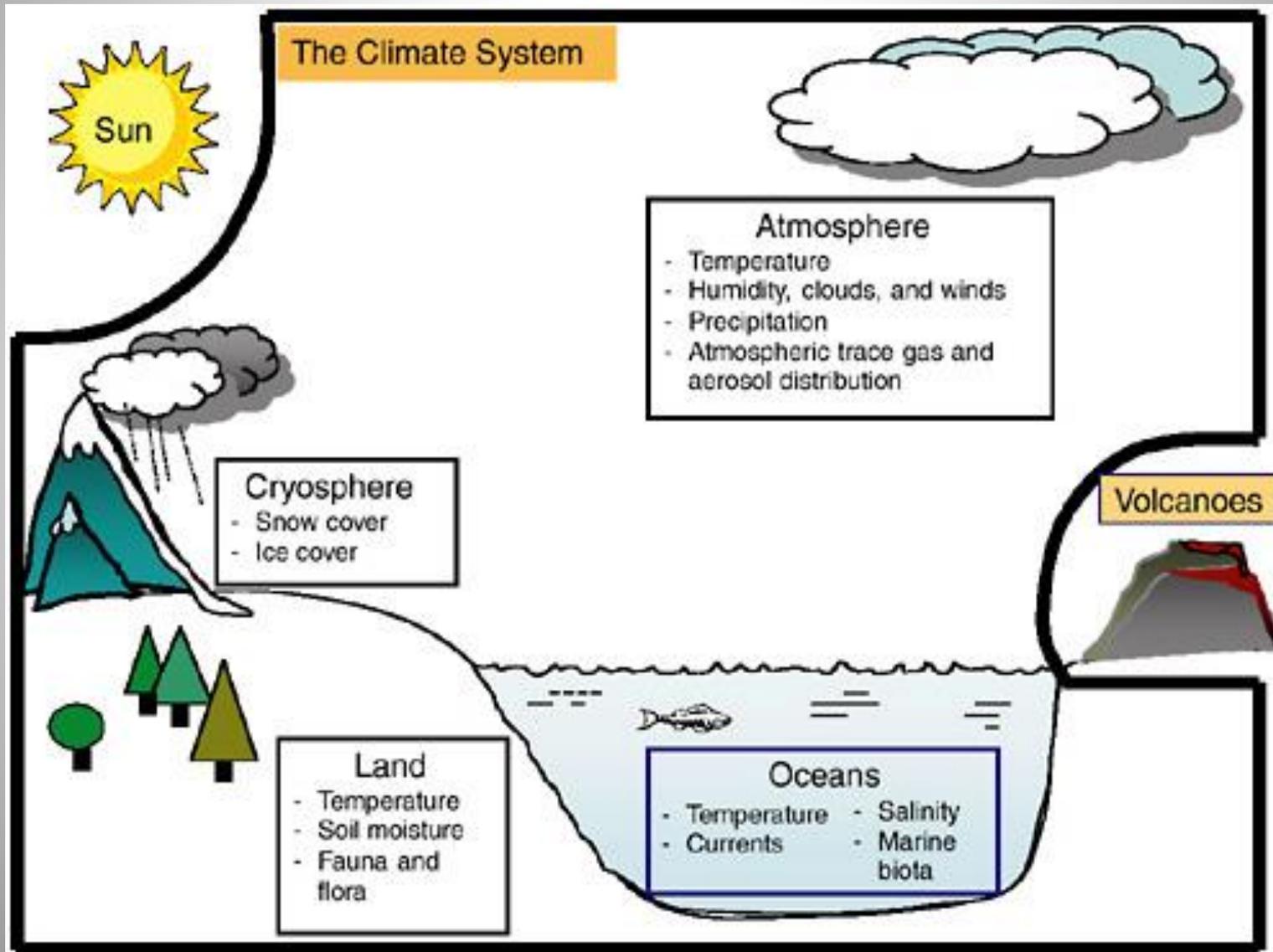
What is “climate change”?

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.

The use of the word “Change” is redundant, of course.
Climate is always changing, just like the weather.

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

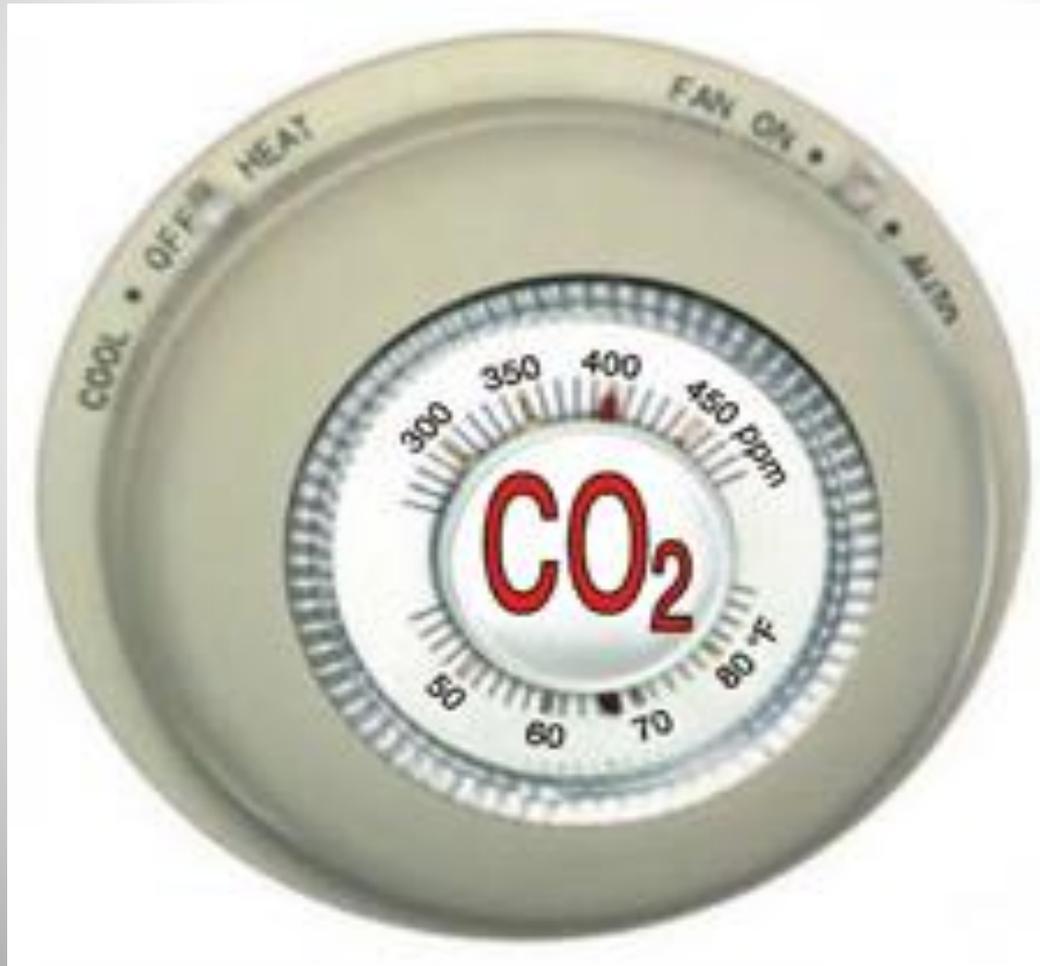


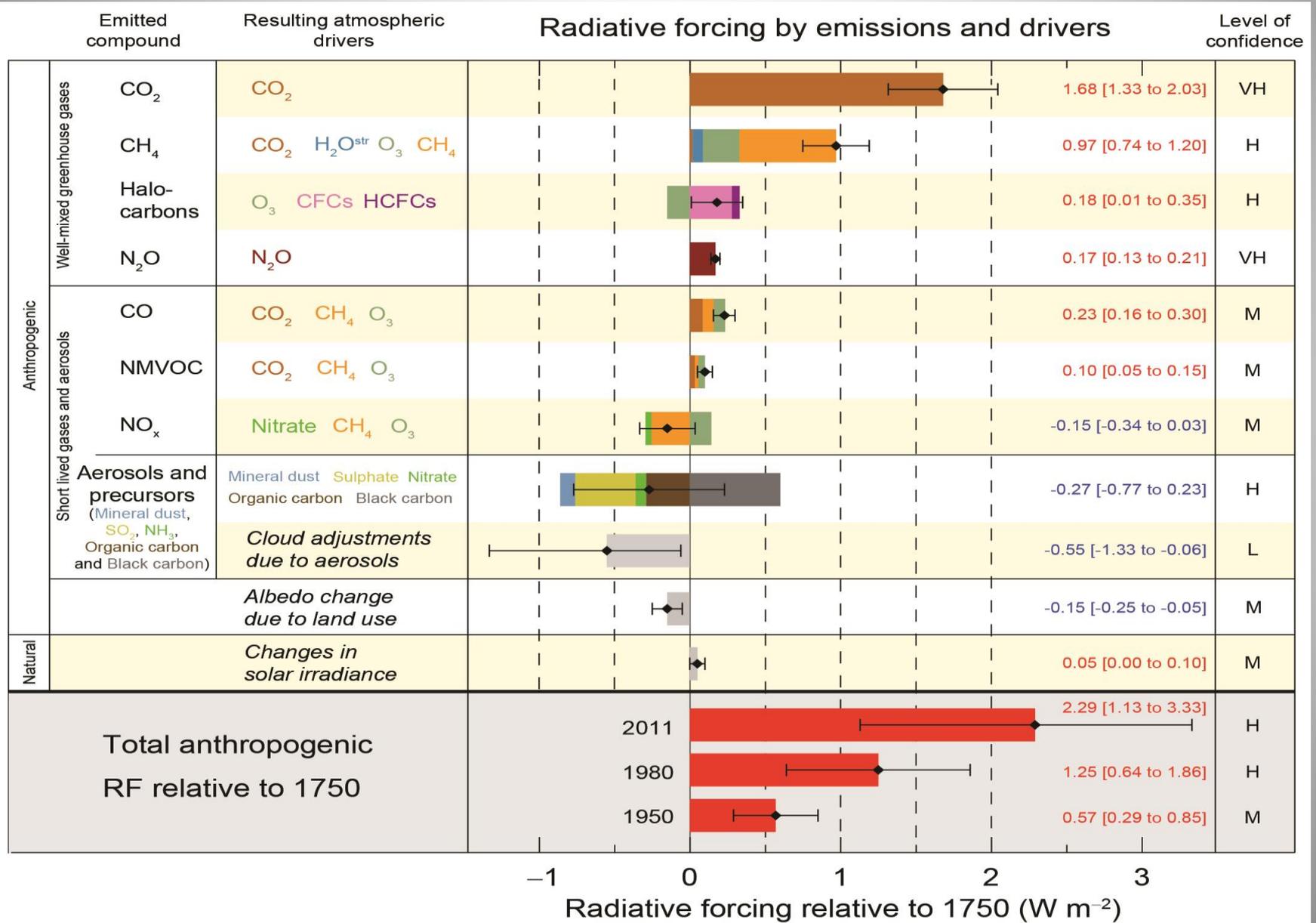
The View
of Climate Change In The IPCC and Other Assessments,
and in the MSM

CO2 and a few other greenhouse gases are the primary driver of changes of changes in regional and global climate

How Carbon Dioxide Controls Earth's Temperature

<https://www.giss.nasa.gov/research/news/20101014/> NASA GISS





United Nations : <https://unfccc.int/topics/action-on-climate-and-sdgs/action-on-climate-and-sdgs>

Climate change presents the single biggest threat to sustainable development everywhere and its widespread, unprecedented impacts disproportionately burden the poorest and most vulnerable

Urgent action to halt climate change and deal with its impacts is integral to successfully achieving all Sustainable Development Goals (SDGs).

Collectively, the three post-2015 agendas for action – the Paris Agreement, the 2030 Agenda for Sustainable Development and the Sendai Framework for Disaster Risk Reduction - provide the foundation for sustainable, low-carbon and resilient development under a changing climate

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

What is “Climate Change”?

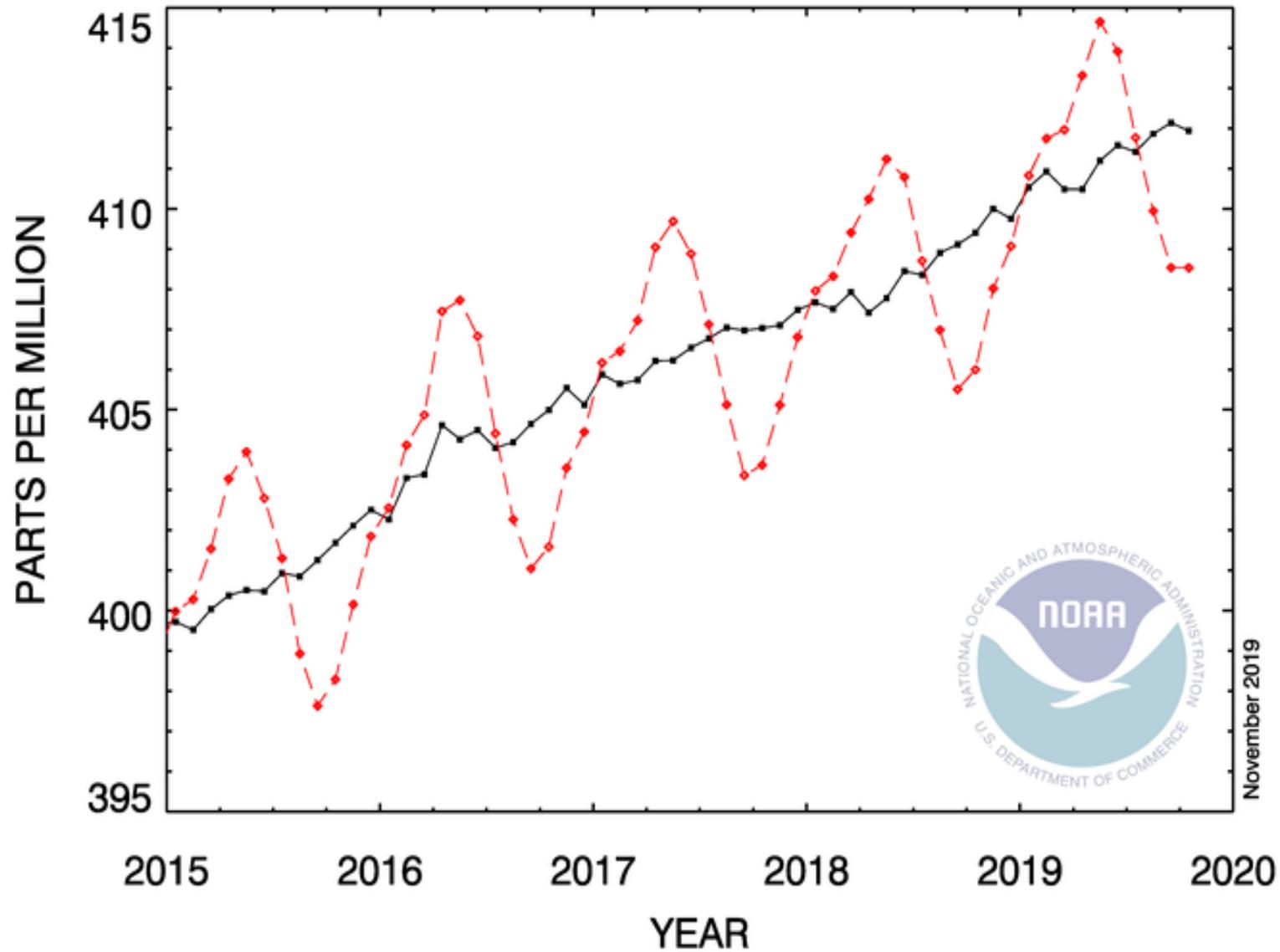
Global Warming << “Climate Change”

Human Climate Forcings

- The influence of the human input of CO₂ and other greenhouse gases on regional and global radiative heating [Focus of IPCC]
- The influence of human-caused aerosols on regional (and global) radiative heating [Included in IPCC]
- 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

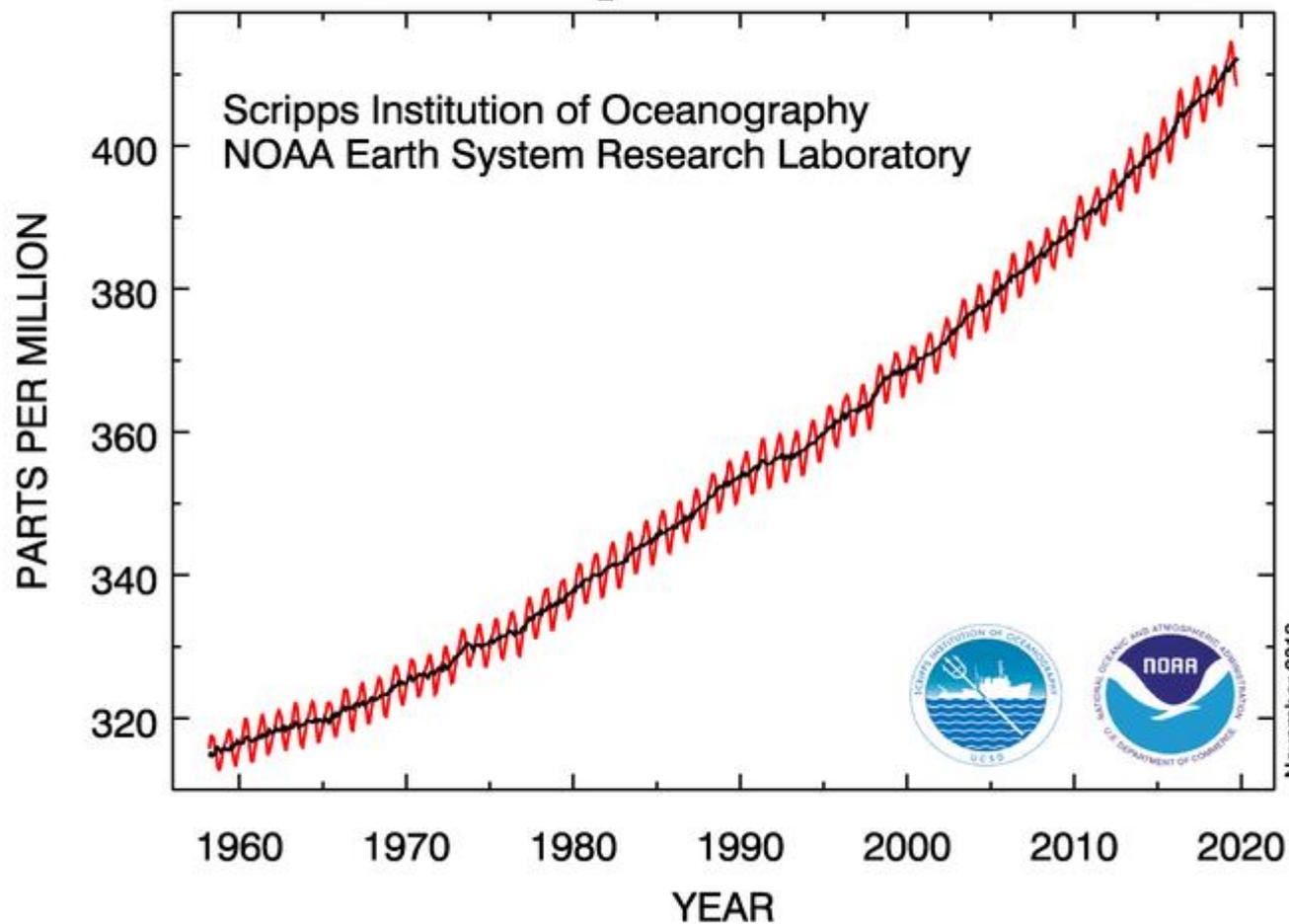
What Does The Observed Data Tell Us About Changes in the Climate System?

RECENT MONTHLY MEAN CO₂ AT MAUNA LOA



November 2019

Atmospheric CO₂ at Mauna Loa Observatory



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

CO2 is a human climate forcing

EPA Criteria Pollutants -

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

Ozone

Particulate Matter – PM10 and PM
2.5

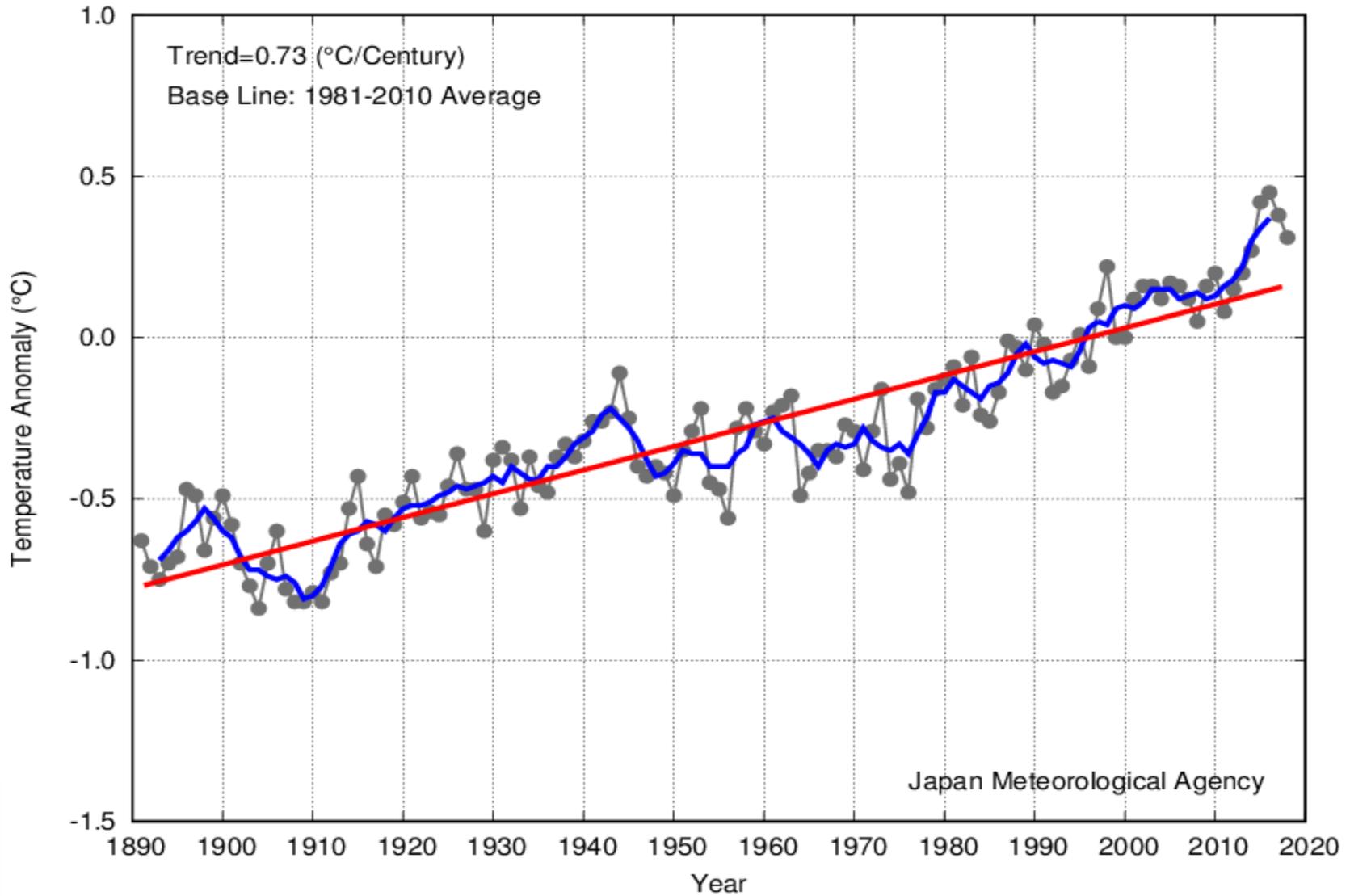
Carbon Monoxide

Nitrogen Oxides

Sulfur Dioxide

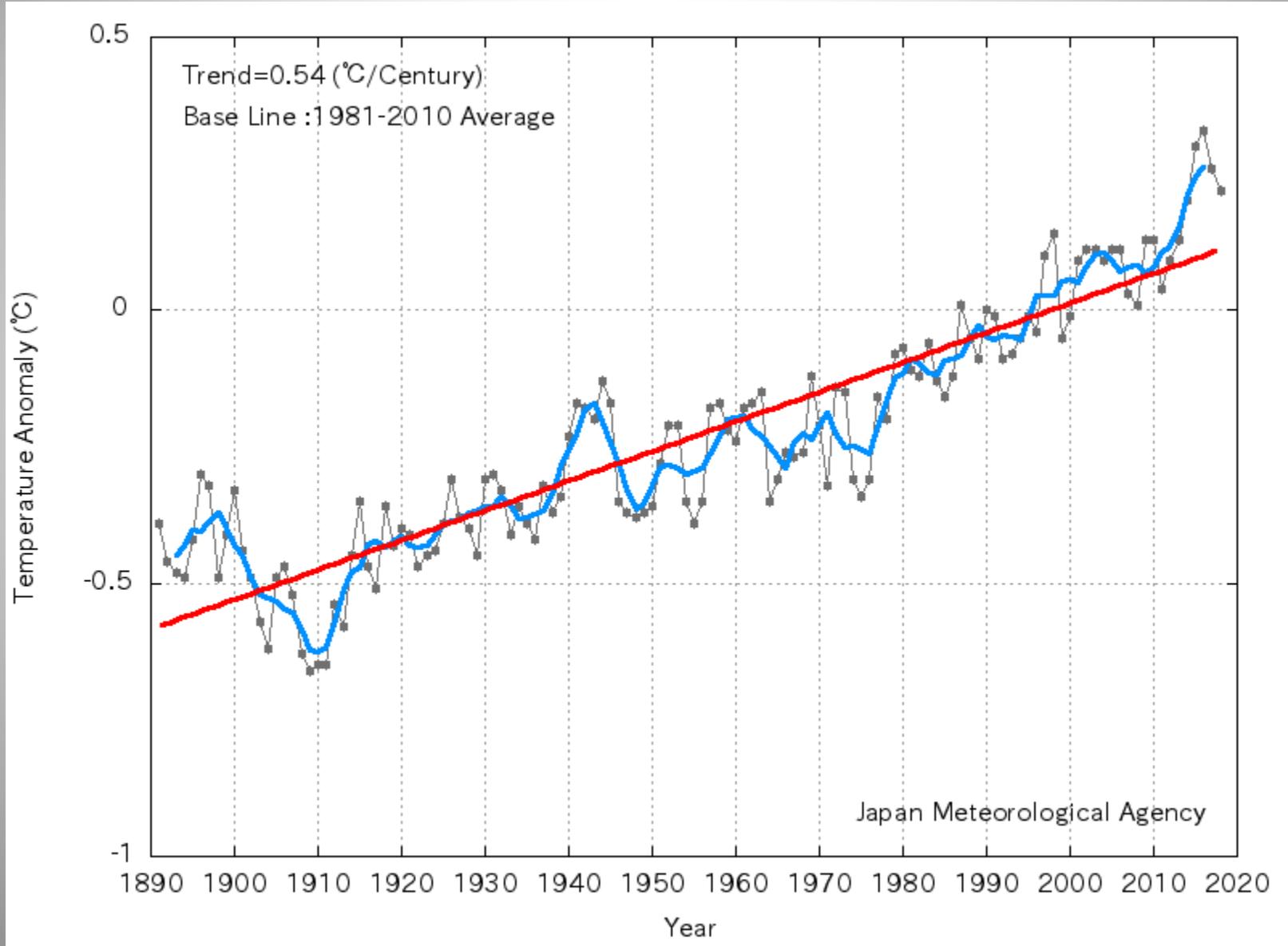
Lead

Annual Global Average Temperature



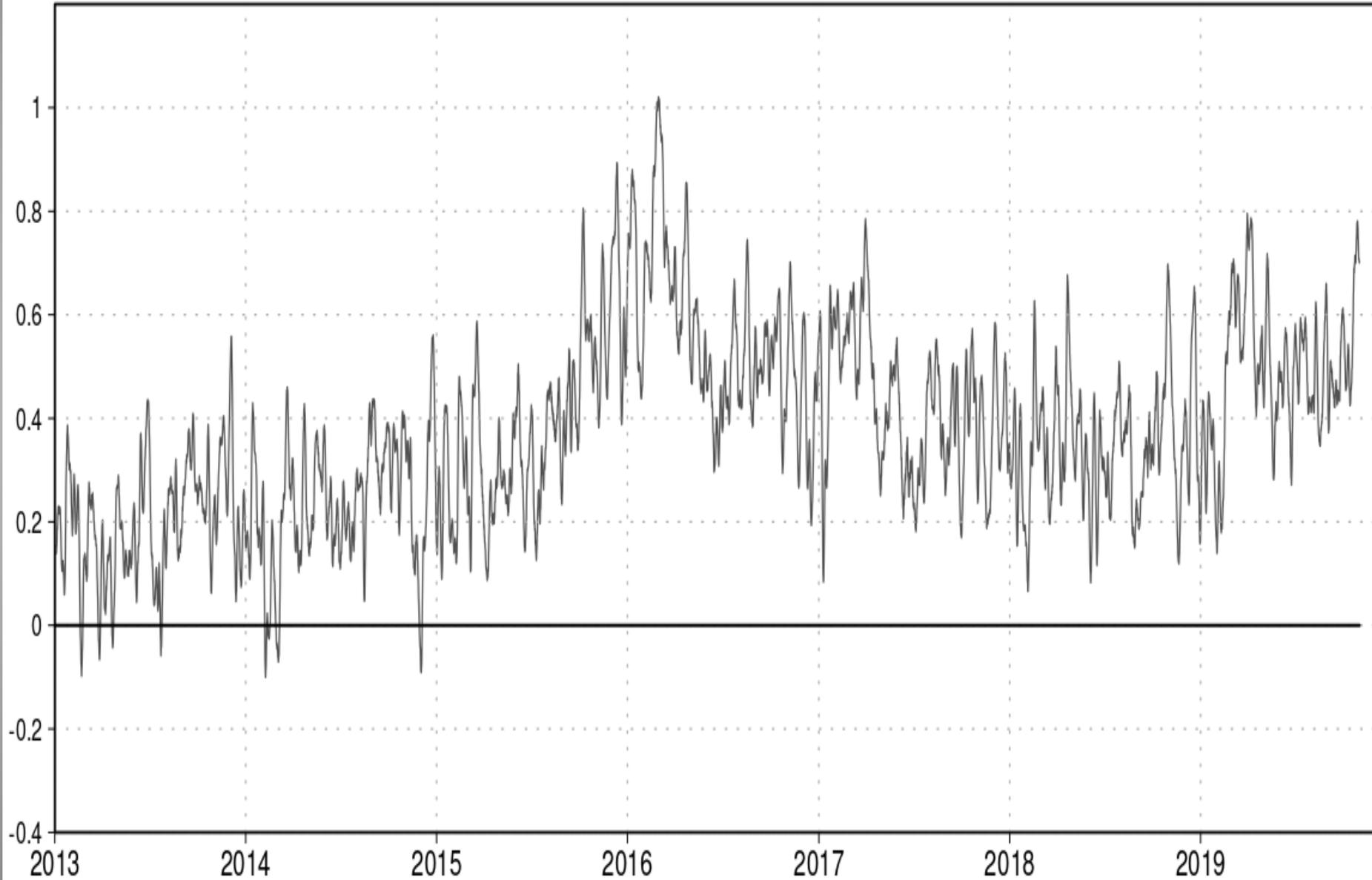
Annual global sea surface temperature anomalies

https://www.data.jma.go.jp/gmd/kaiyou/english/long_term_sst_global/glb_warm_e.html



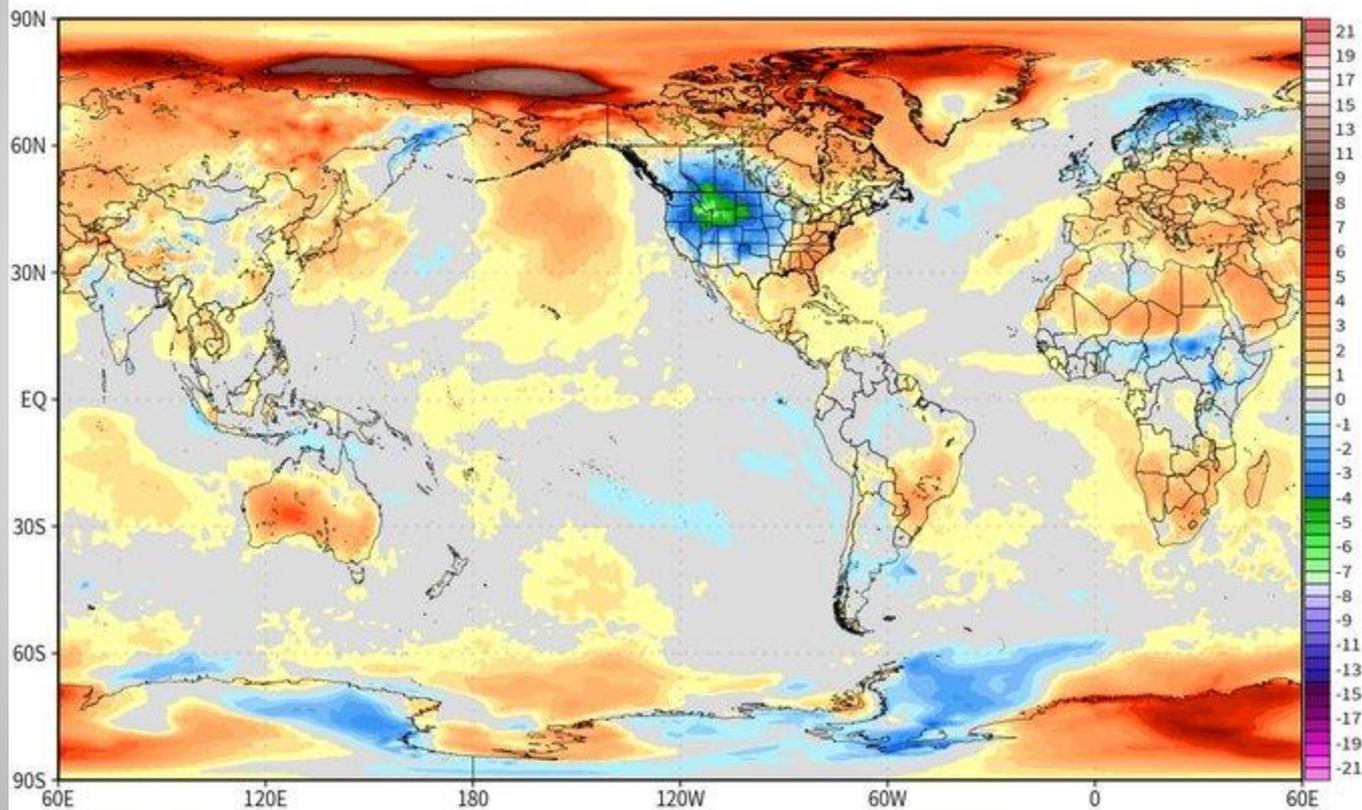
JRA-55 2-meter Temperature Anomaly [°C] Global
1981-2010 Climatology | @RyanMaue | climatlas.com

2019 YTD: 0.50 °C | MTD: 0.59 °C
Thru: 18Z31OCT2019



ERA5 Global Temperature Anomaly [°C] October 2019

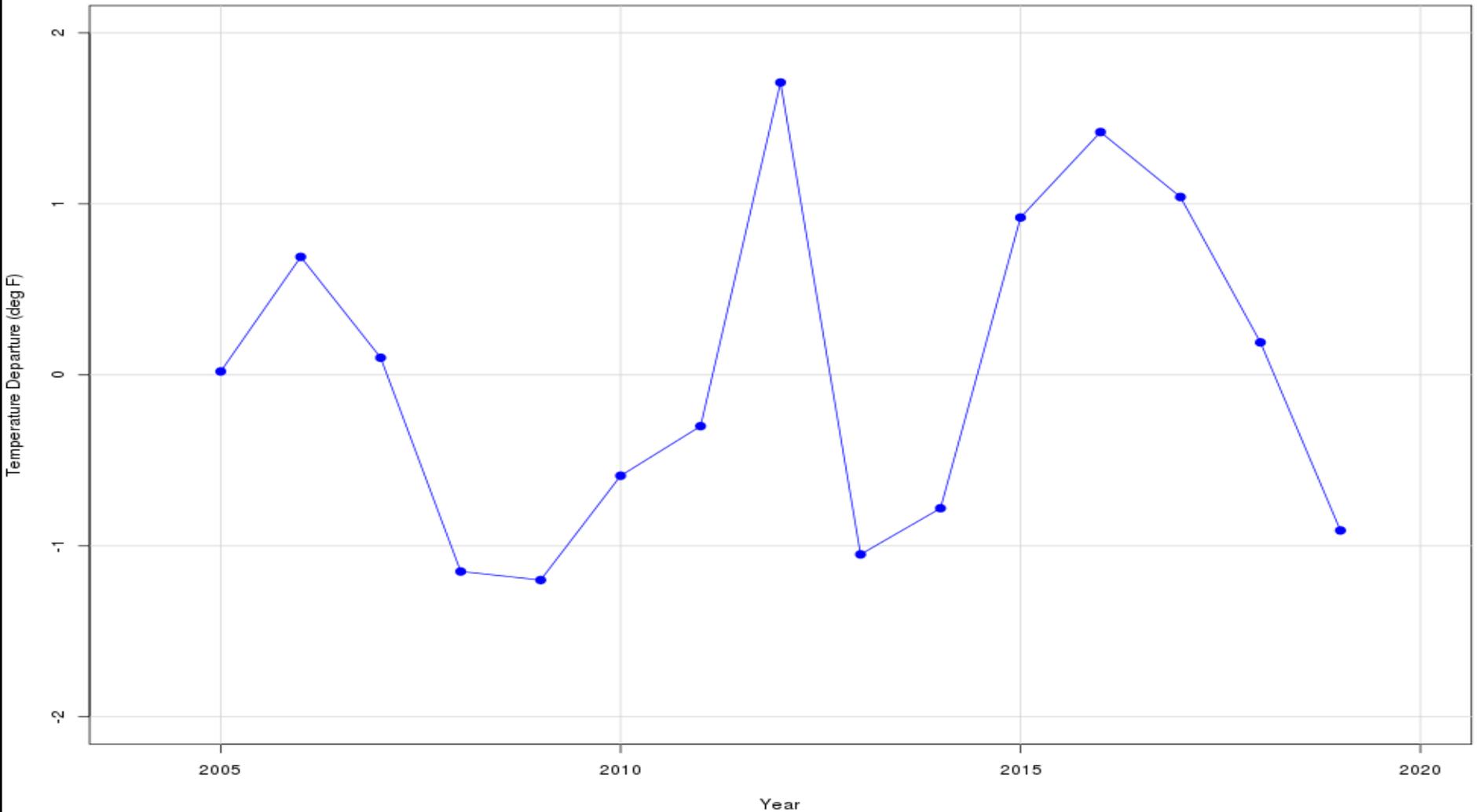
ANALYSIS T: 14.90°C
ANOMALY T: 0.69°C



ERA5 1981-2010 Climatology | @RyanMaue | climatlas.com

Prepared by Mark Albright - CRN Average over USA48

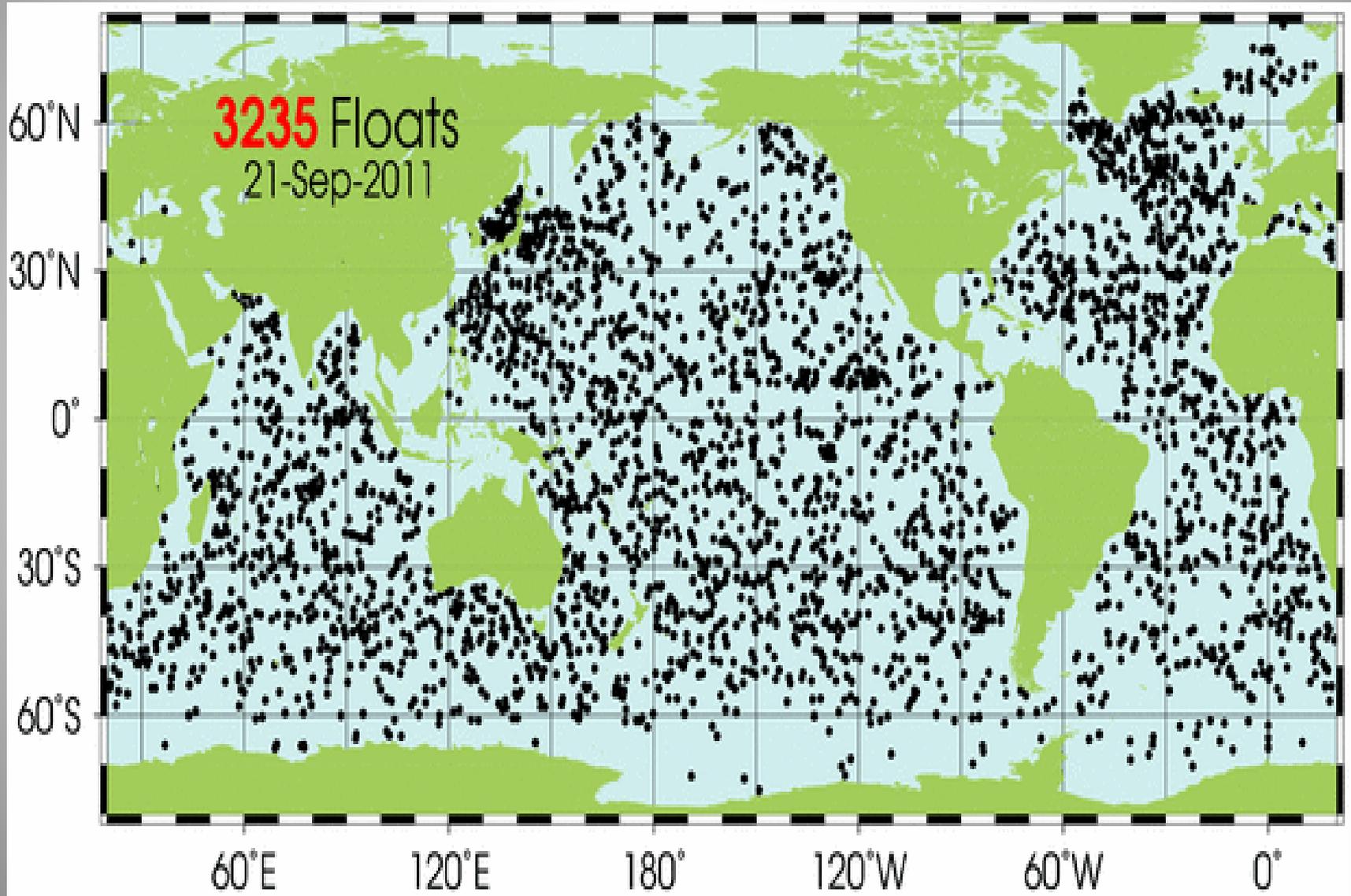
2005 - 2019, USA48 Temperature Departure from Climatology



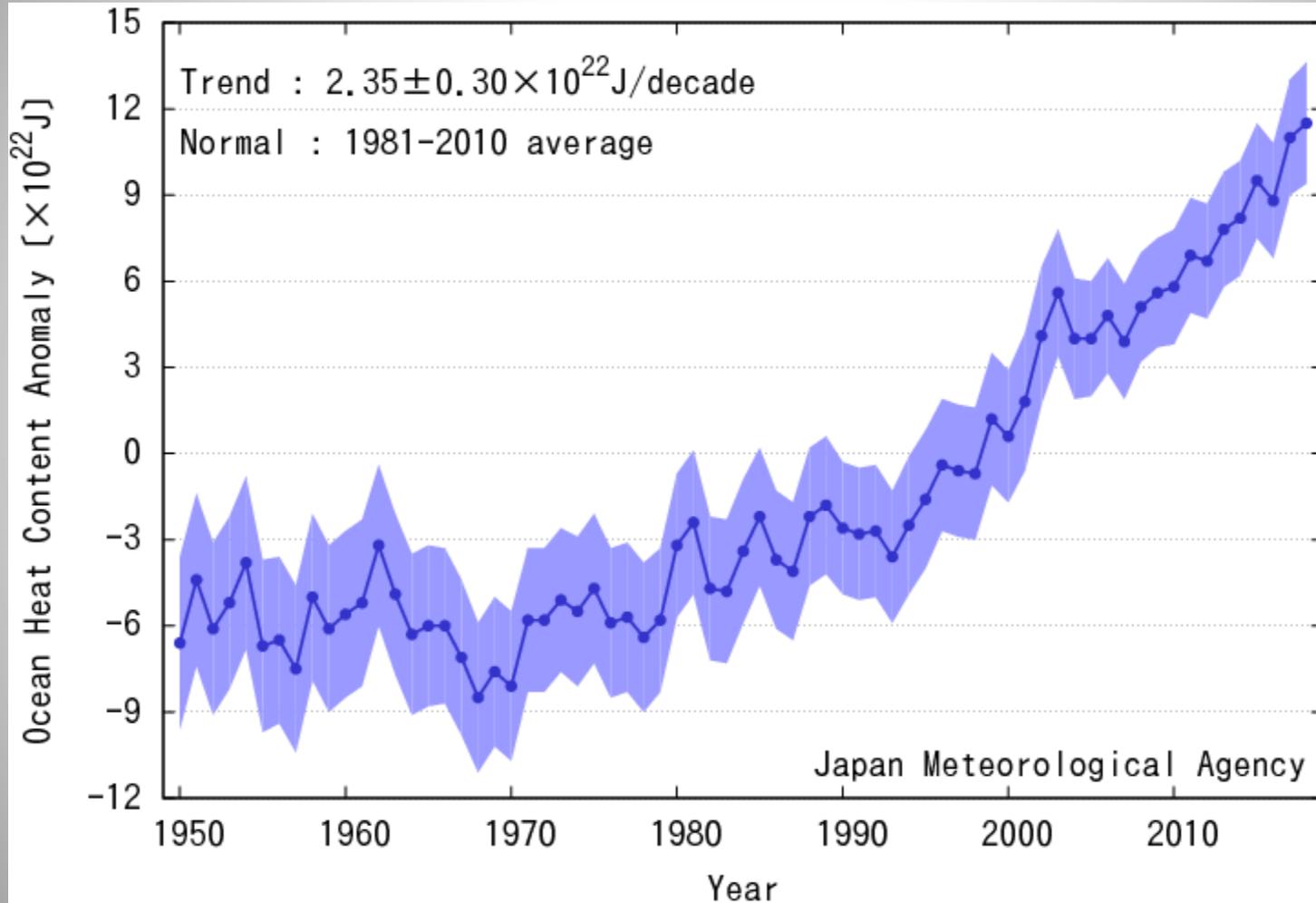
On Global Warming

Global Warming Can Be Most Accurately Estimated Using Changes in Ocean Heat Content.

Argo Network



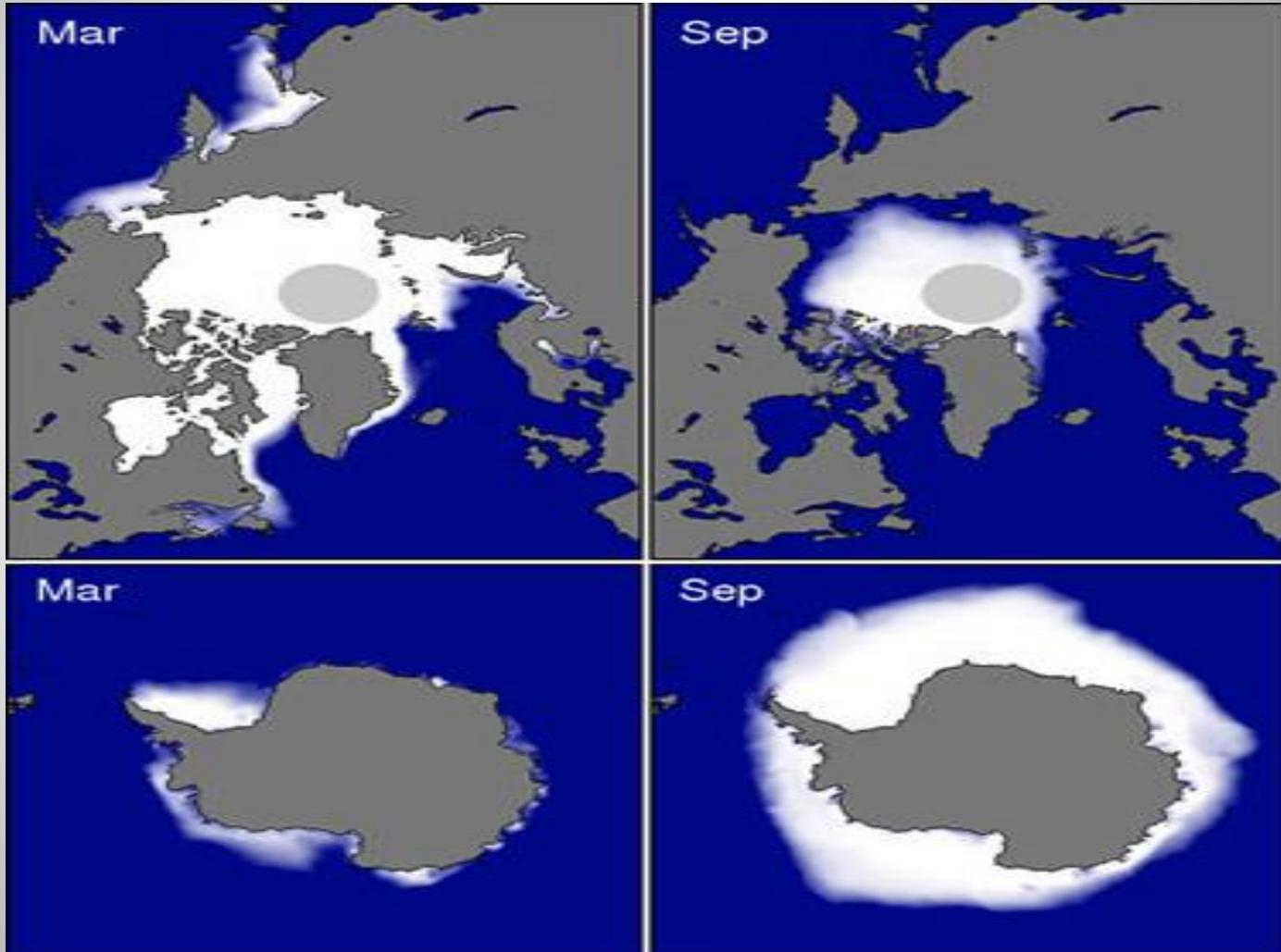
Globally integrated upper (0 – 700 m) ocean heat content anomaly
https://www.data.jma.go.jp/gmd/kaiyou/english/ohc/ohc_global_en.html



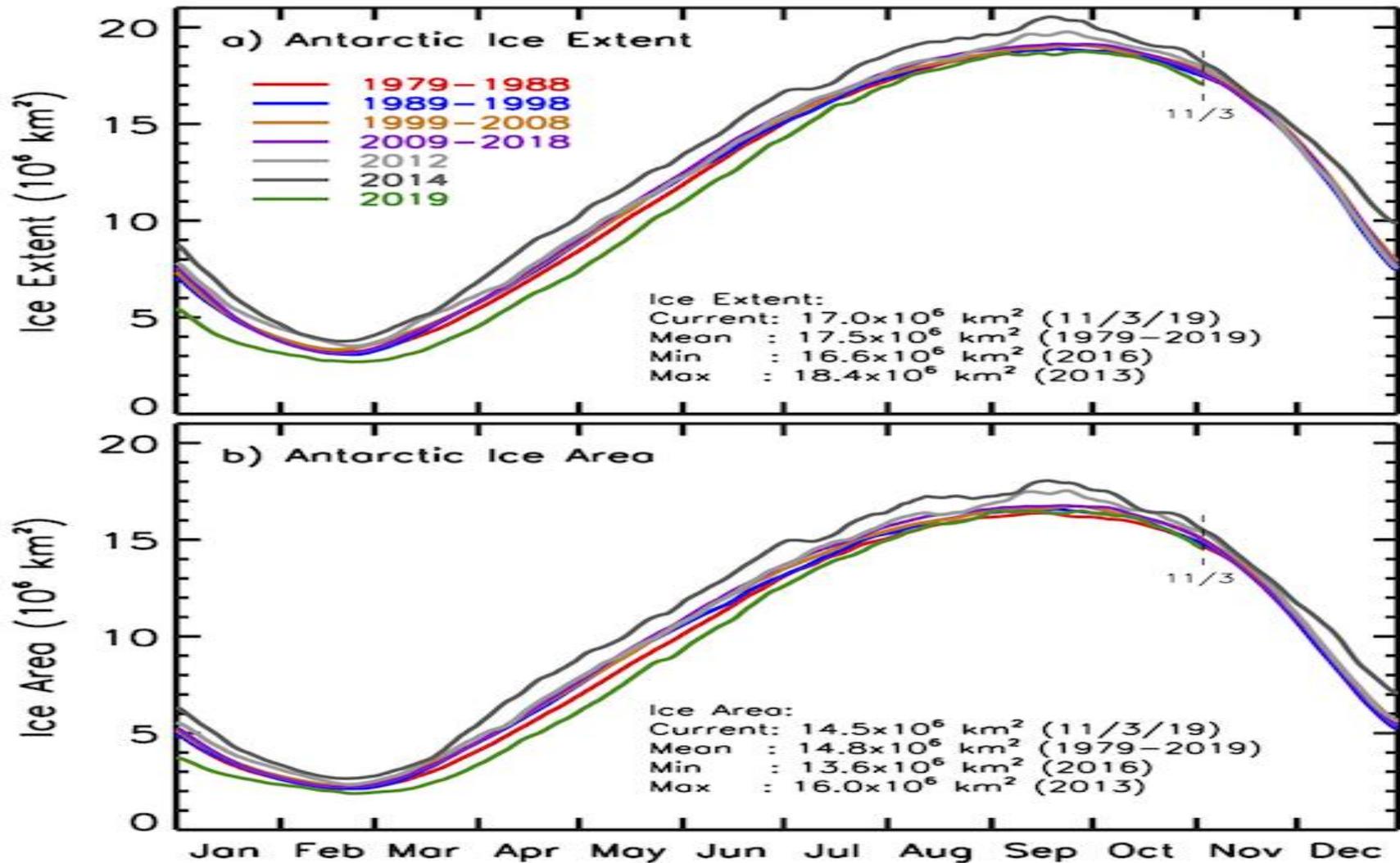
https://www.data.jma.go.jp/gmd/kaiyou/english/ohc/ohc_global_en.html

A rise of **$0.025 \pm 0.003^{\circ}\text{C}$ per decade** in the globally averaged upper ocean (0 – 700 m) temperature accompanied the OHC increase.

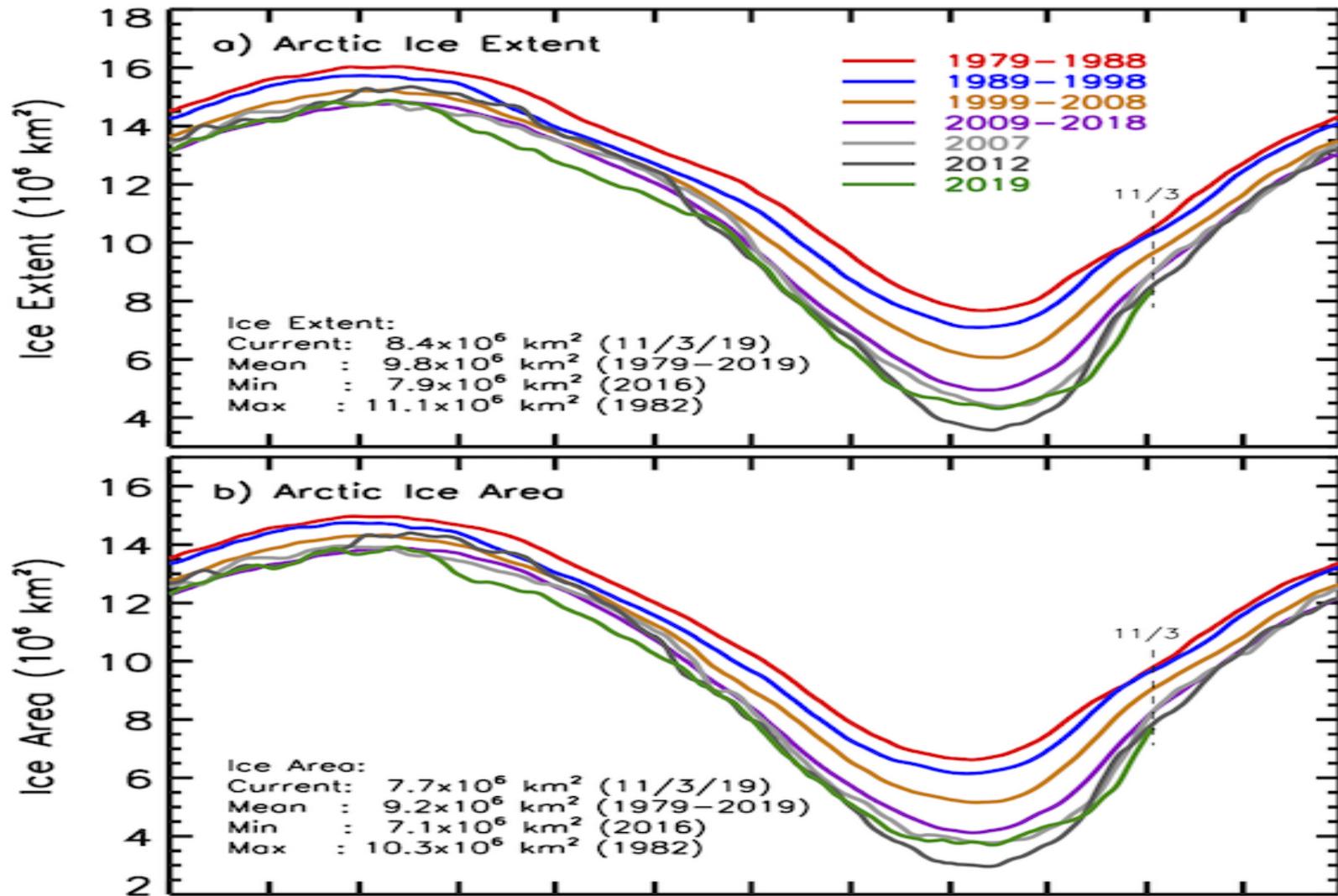
<https://nsidc.org/cryosphere/seaice/characteristics/difference.html>



<https://neptune.gsfc.nasa.gov/csb/index.php?section=234>

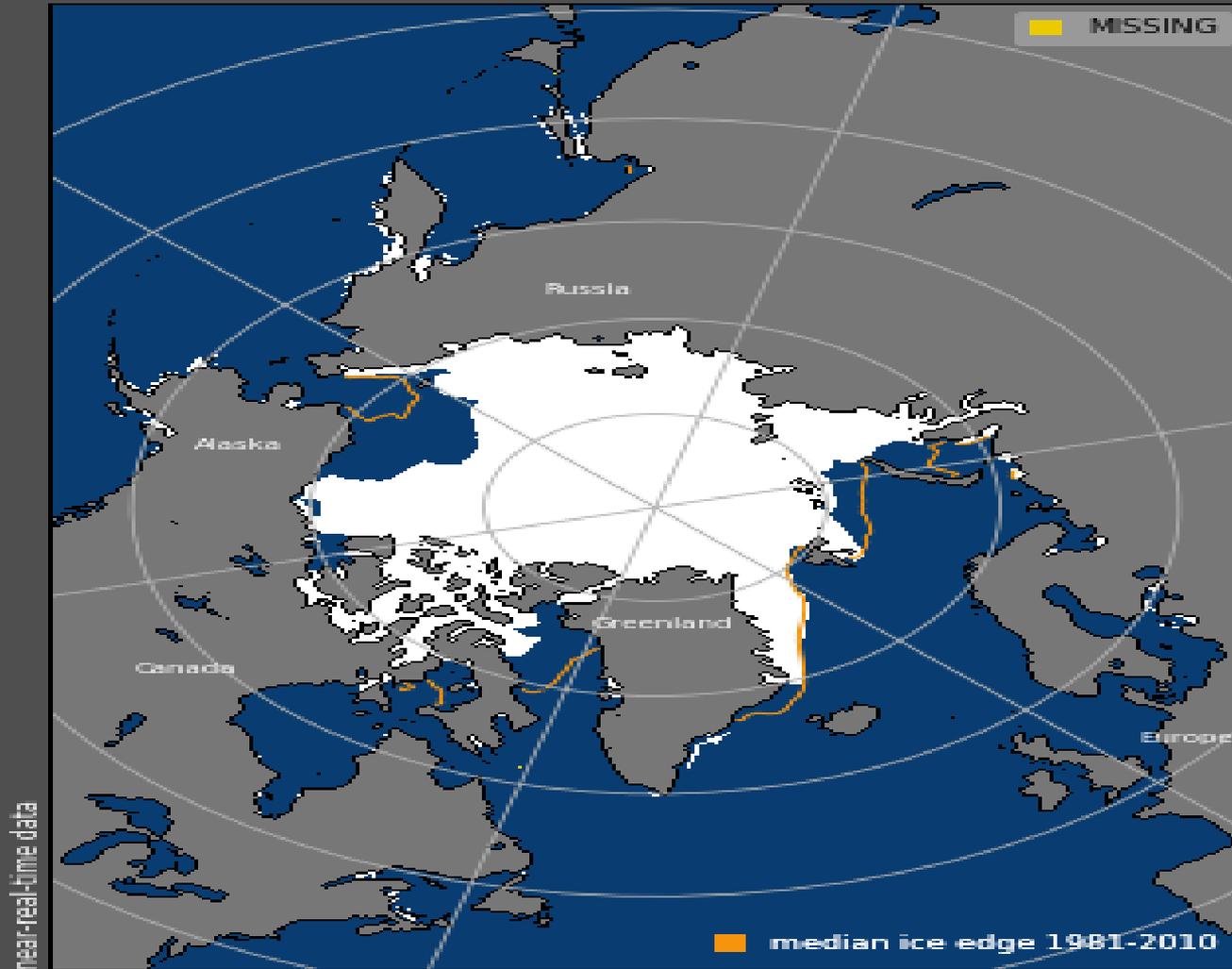


<https://neptune.gsfc.nasa.gov/csb/index.php?section=234>

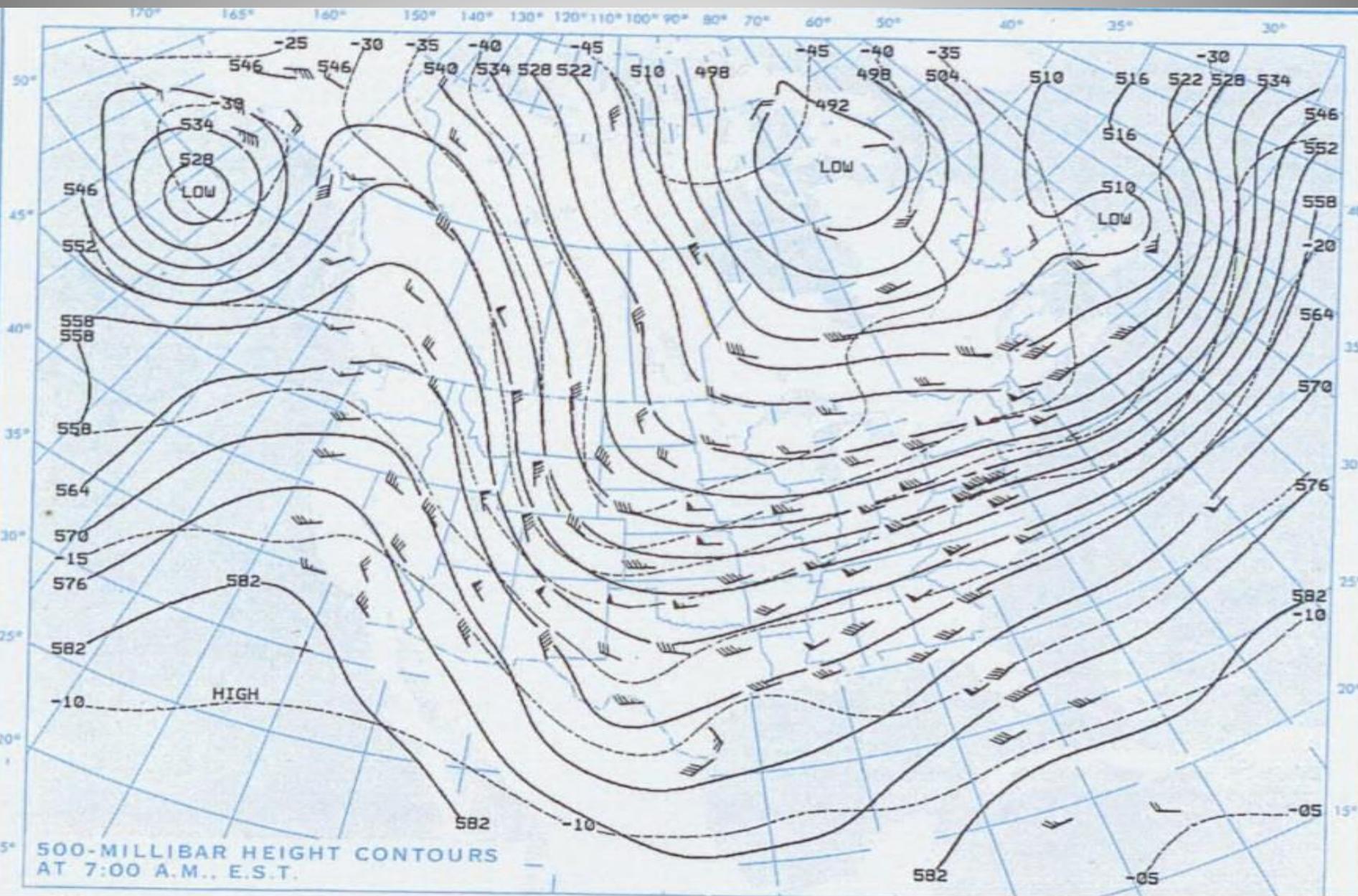


<http://nsidc.org/arcticseaicenews/>

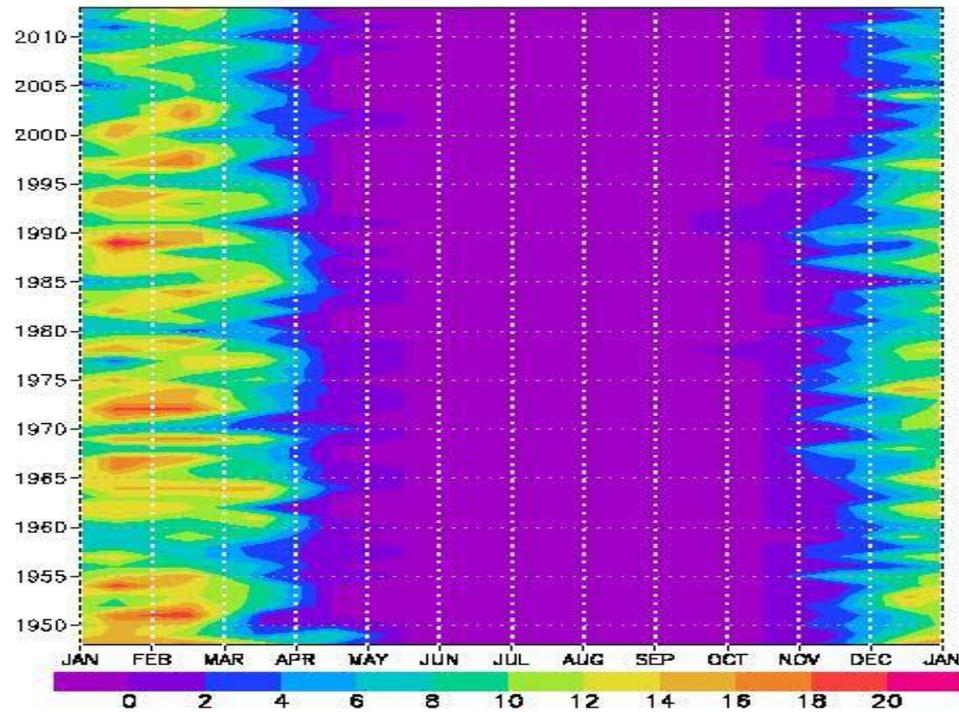
Sea Ice Extent, 05 Nov 2019



National Snow and Ice Data Center, University of Colorado Boulder



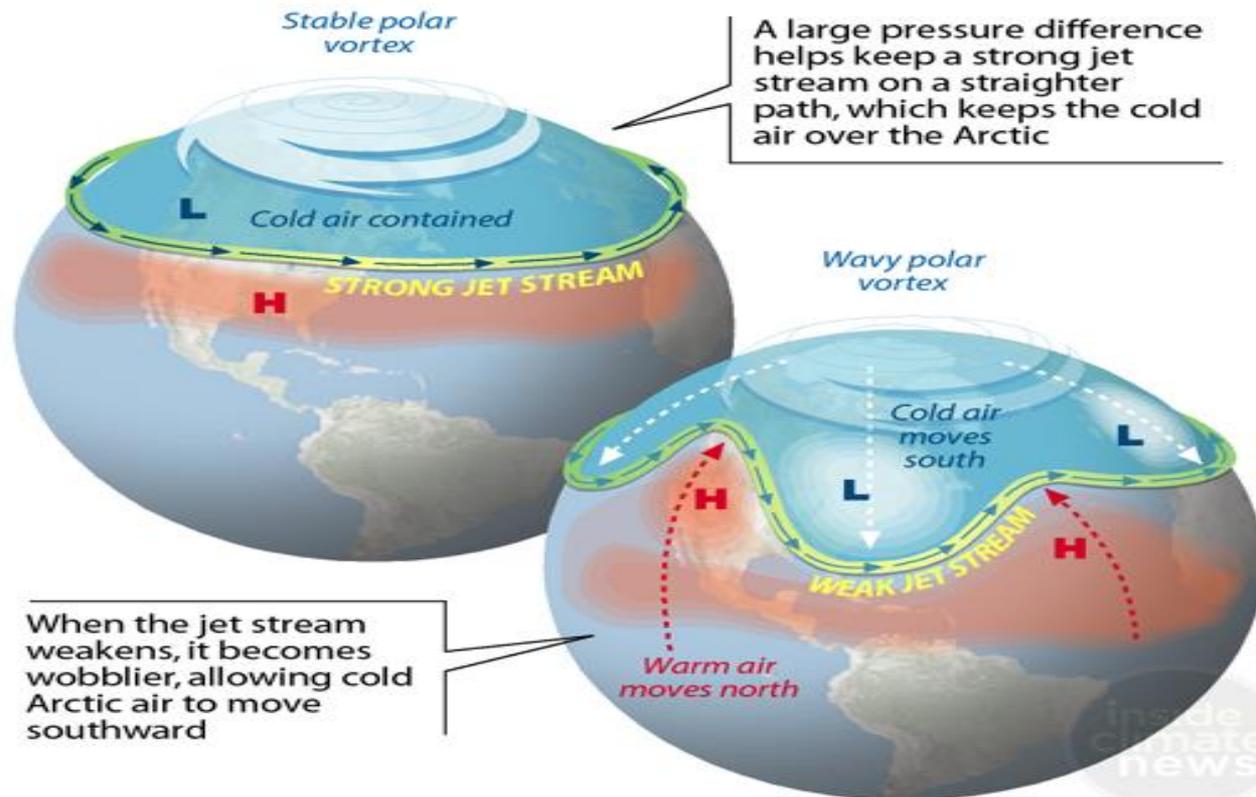
AREA OF -40C ISOTHERM
($\times 10^6 \text{ km}^2$)



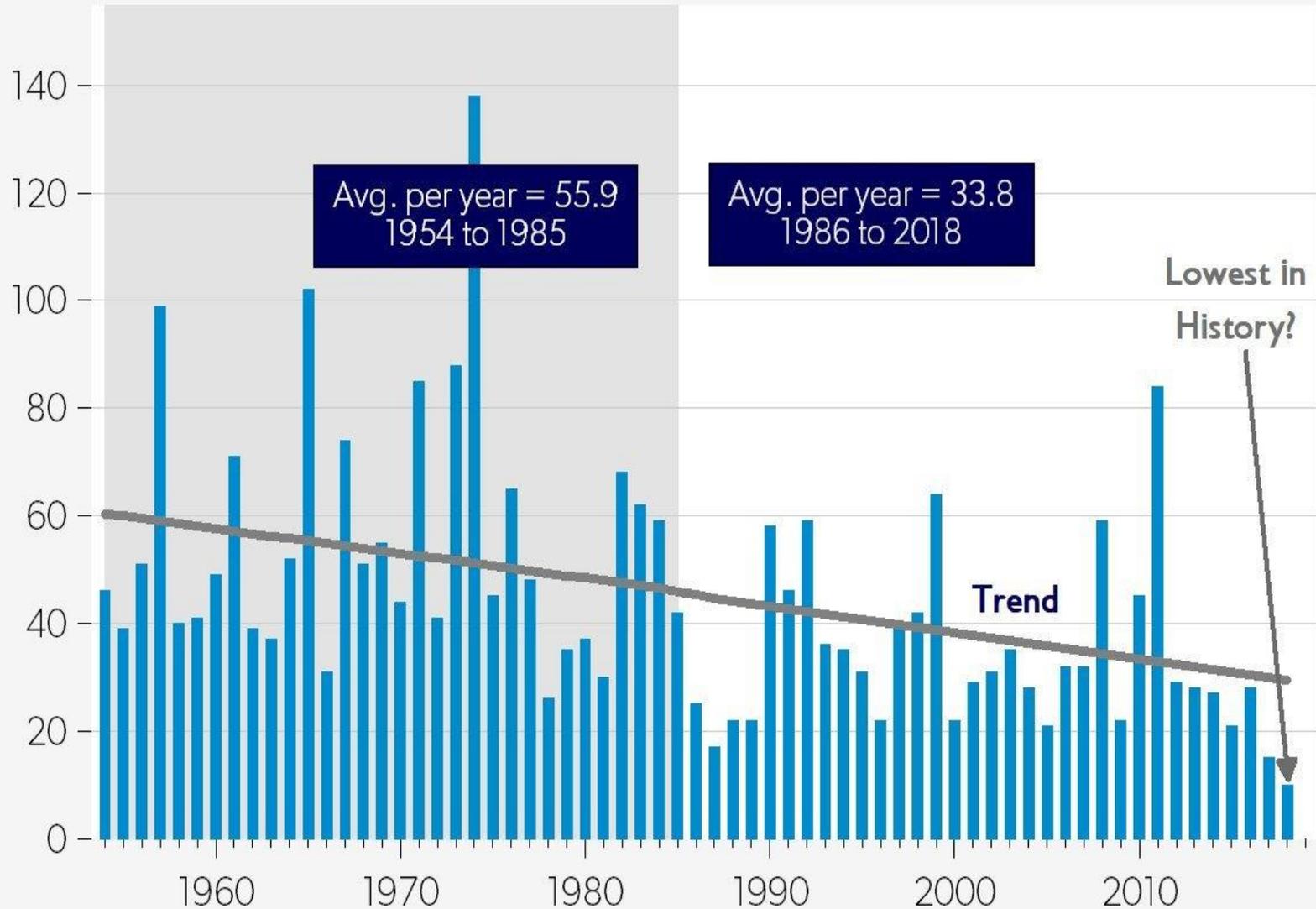
Erroneous Claim: Strong Polar Jet Confines Cold Air To Arctic

Polar Vortex Explained

The polar vortex is a large area of low pressure and cold air over Earth's North and South Poles. When the jet stream weakens, it becomes wavier, allowing that cold air to dip southward in places while warmer air pushes northward elsewhere.



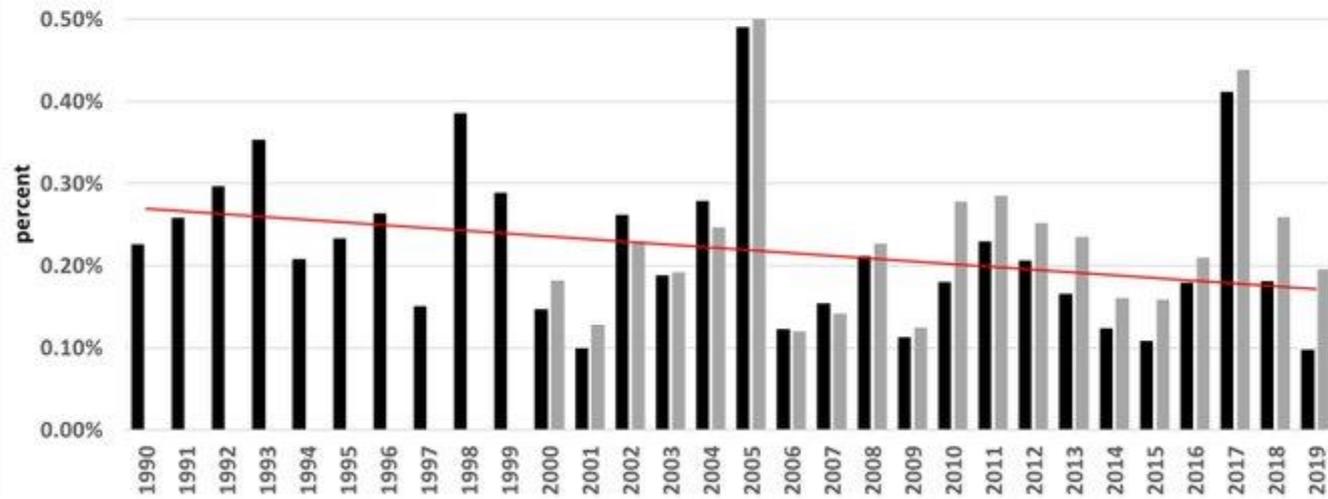
Strong to Violent Tornadoes (F3+) in the US, 1954 to 2018



Source: National Oceanic and Atmospheric Administration

Source: Updated from Pielke (2019)
@Forbes
31 Oct 2019

Global Weather Losses as Percent of Global GDP: 1990-2019
(2019 losses are 1H annualized)



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

In Other Words How Are the IPCC Multi-Decadal Predictions
(Projections) Performing?

This is an independent question from what should be done
about added CO2 emissions

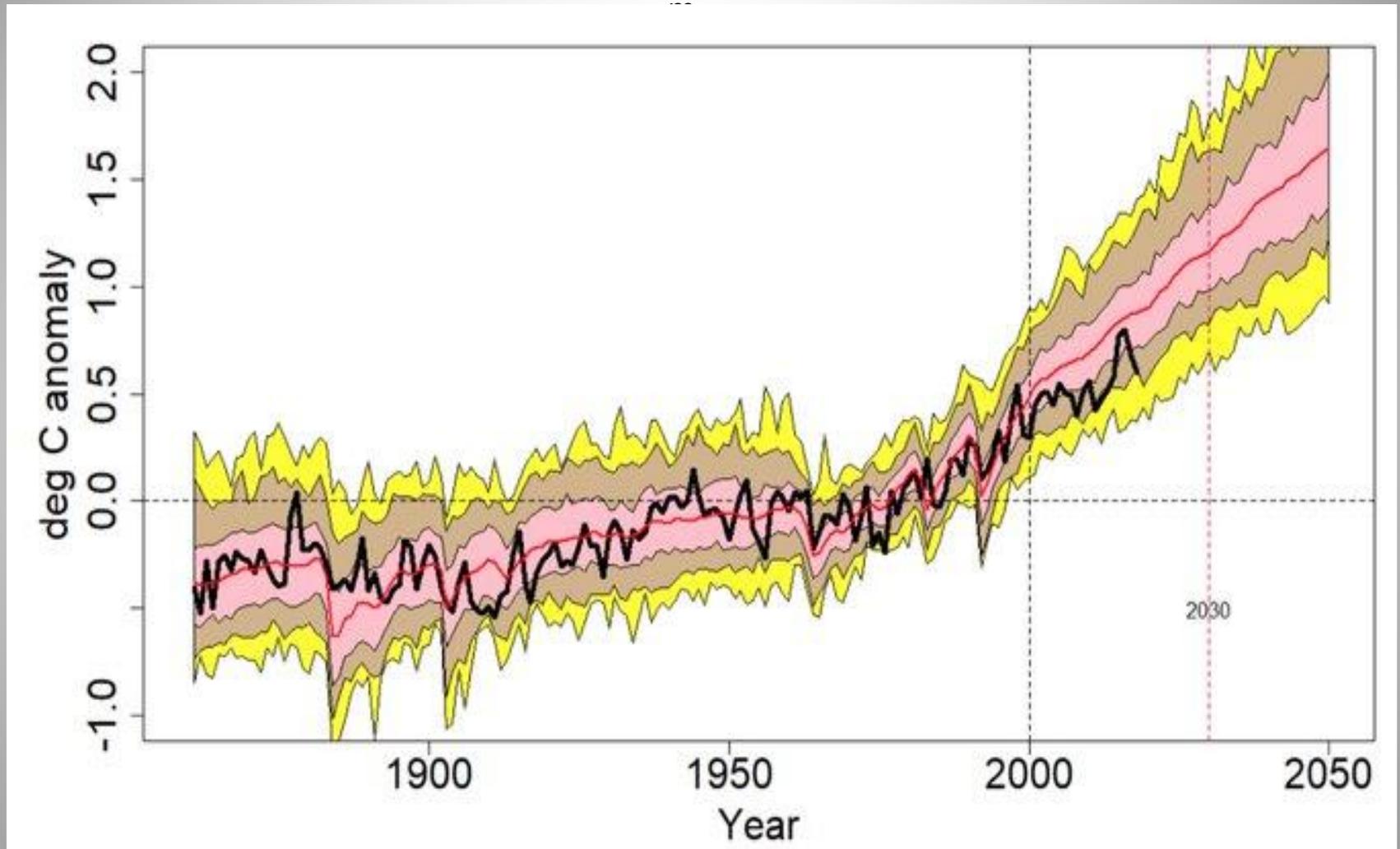
Necessary Conditions For Skillful Multi-Decadal Predictions of Extreme Events

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.

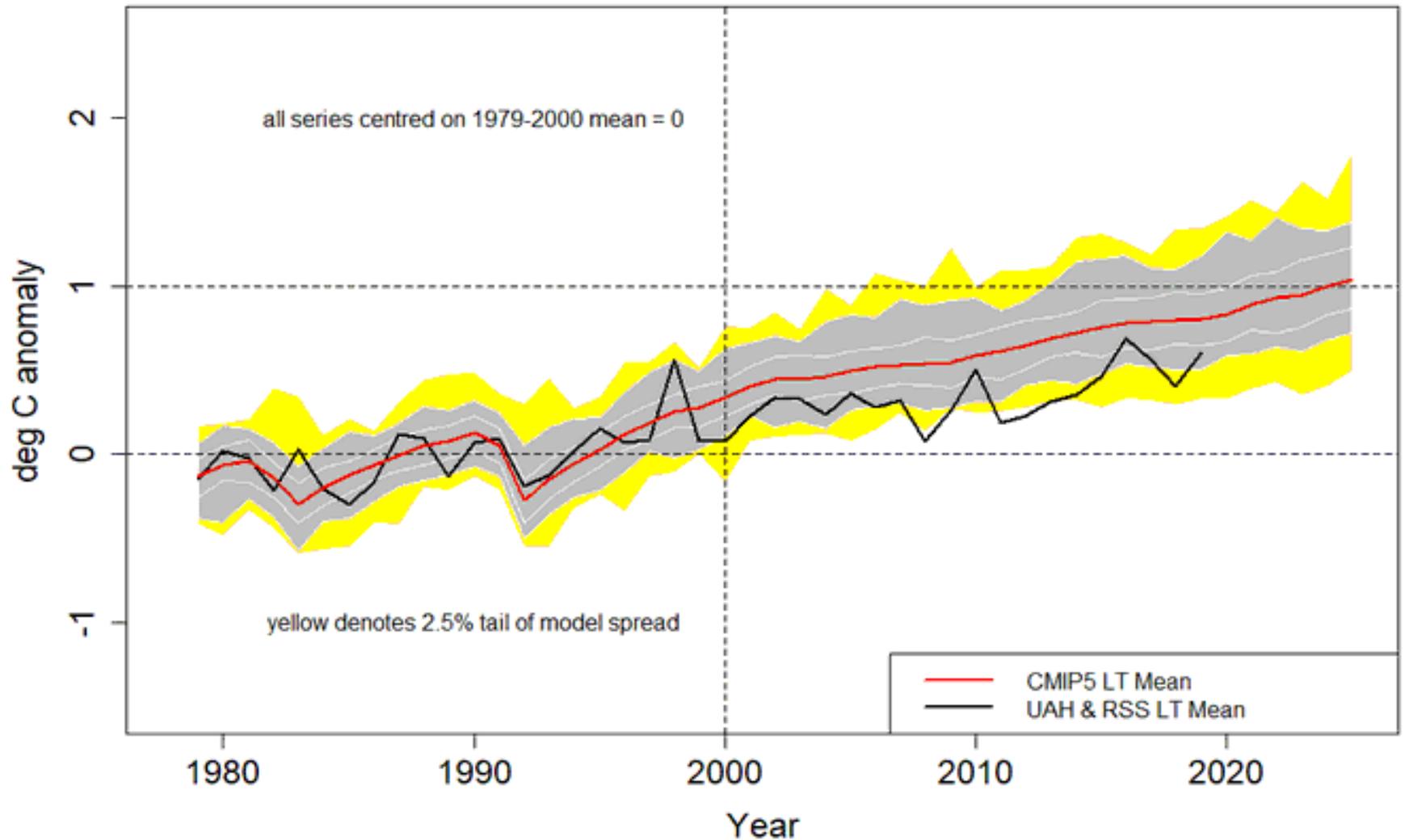
https://www.rossmckitrick.com/uploads/4/8/0/8/4808045/model_obs_comp_nov_2019.pdf

HadCRUT4 series versus CMIP5 climate model predictions of sfc T using RCP4.5 scenario



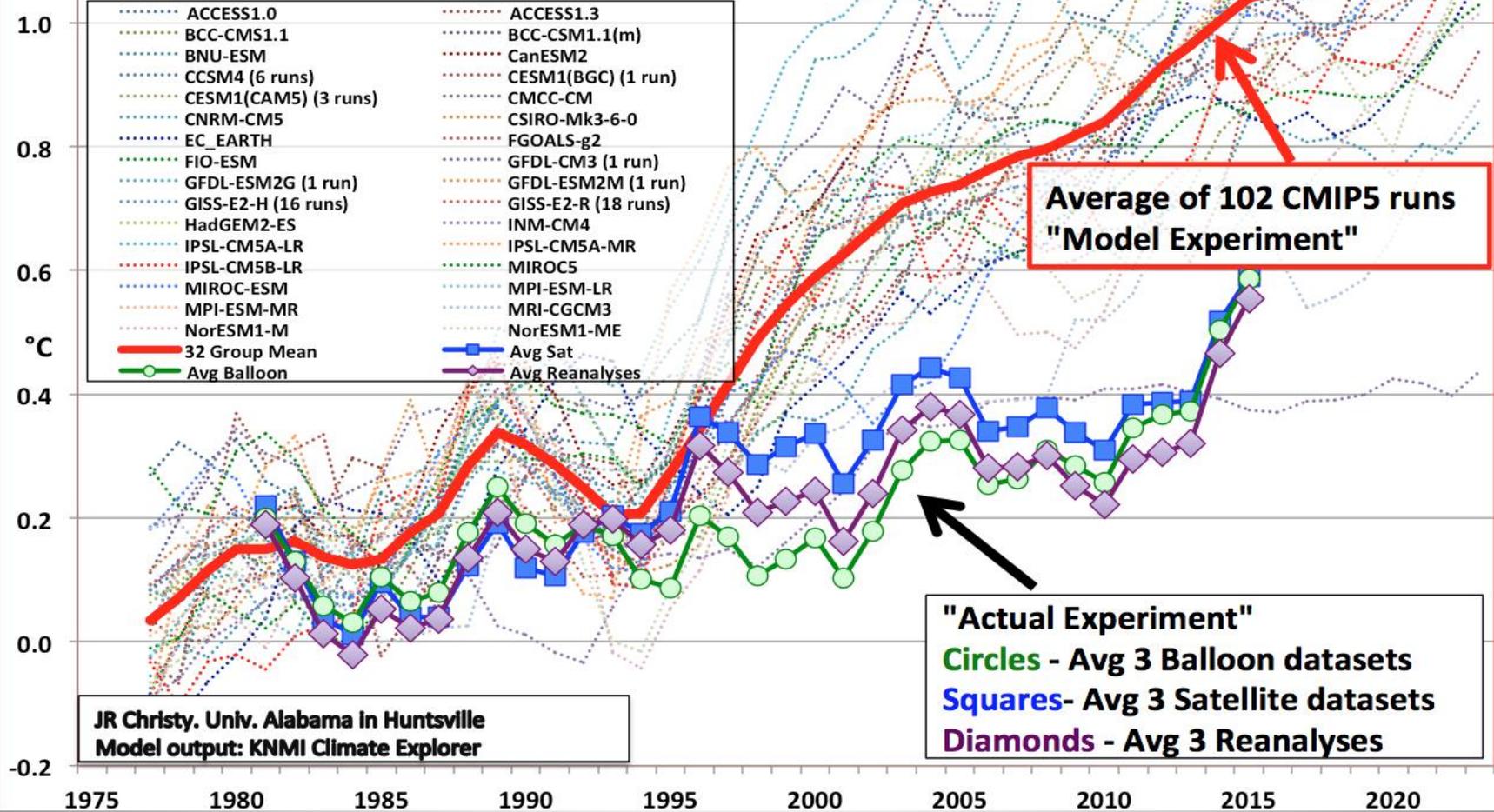
<https://twitter.com/rossmckitrick/status/1194770455229607936?s=12>

Lower Troposphere Comparison (Global)



Tropical Mid-Tropospheric Temperature Variations Models vs. Observations

5-Year Averages, 1979-2017 Trend line crosses zero at 1979 for all time series



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

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.**"

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?**

Real world data also shows a more complex behavior than is commonly communicated by the media, in professional society statements and in international assessments such as the IPCC reports.

Human Climate Forcings

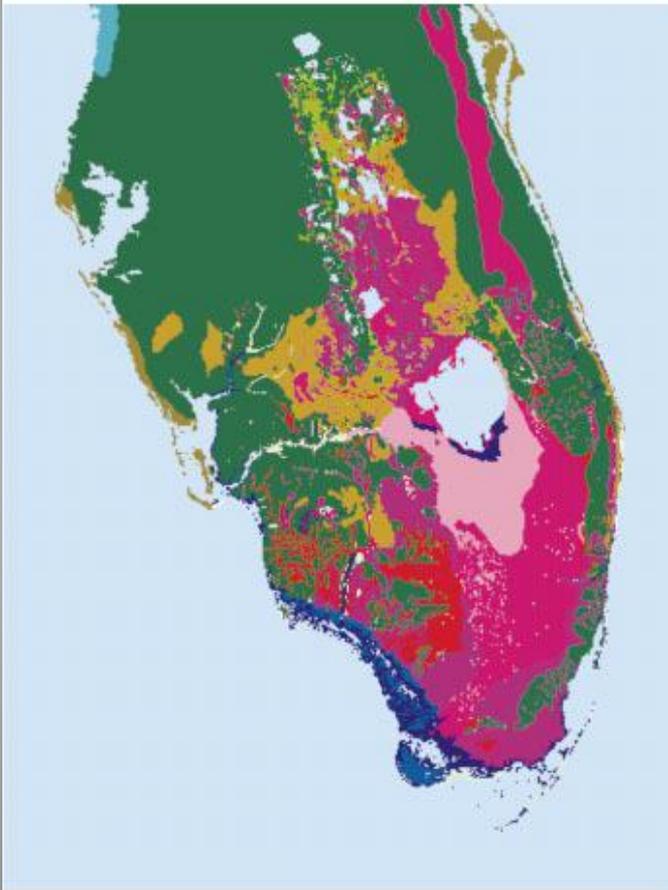
- The influence of the human input of CO₂ and other greenhouse gases on regional and global radiative heating [Focus of IPCC]
- The influence of human-caused aerosols on regional (and global) radiative heating [Included in IPCC]
- The effect of aerosols on clouds and precipitation
- The influence of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

LAND USE/LAND COVER CHANGE

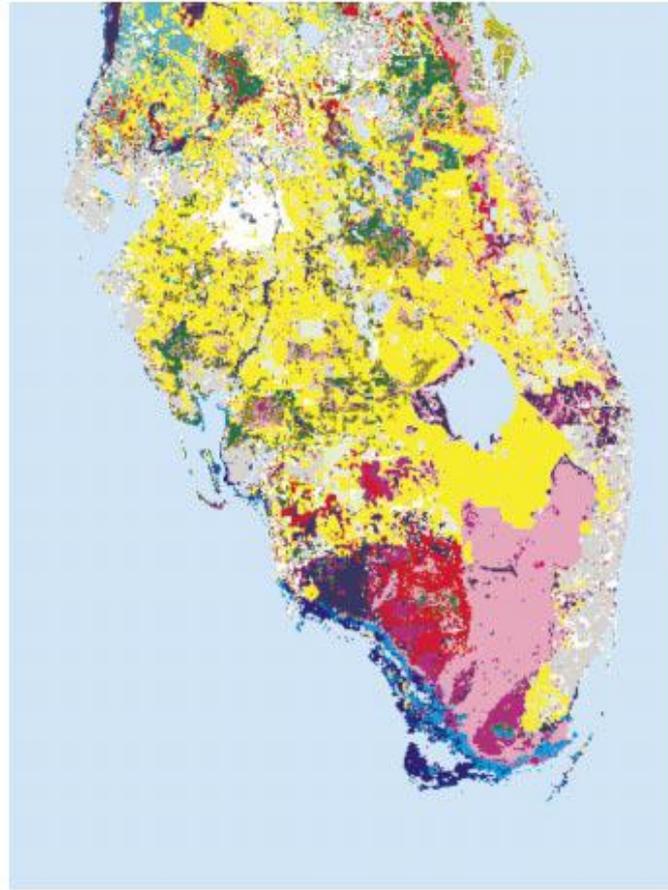


From Marshall et al. 2004

Pre-1900s



1993



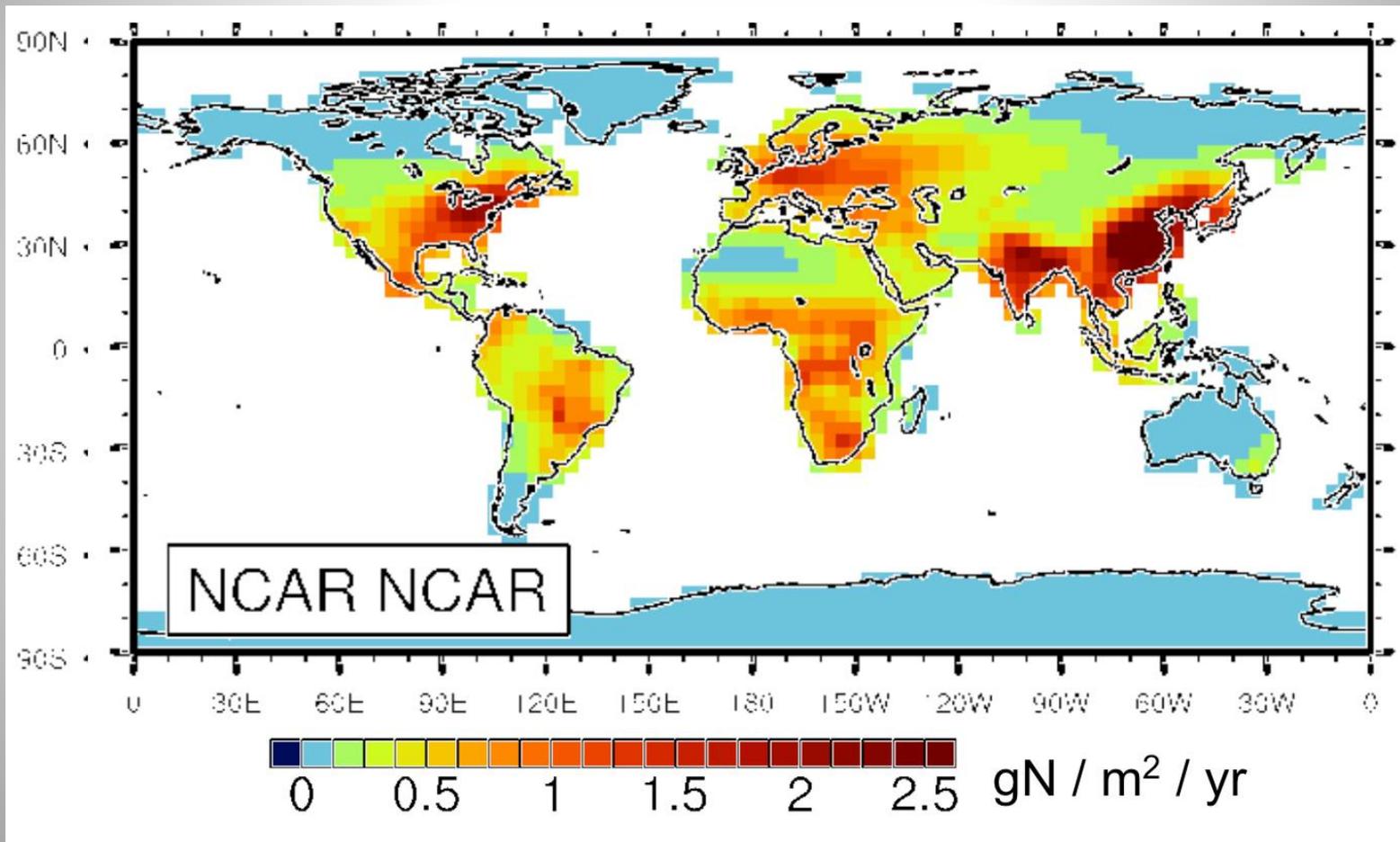
- Open Water
- EvGrn NL Tree
- Decid BL Tree
- EvGrn BL Tree
- Grasses
- Shrubs
- Mixed Woodland
- Crop/Mixed Farming
- Slough, Bog, or Marsh
- Urban/Roads, Rock, Sand
- Saw Grass/Other Marshes
- EvGrn Shrub Wetland
- Mangroves
- Decid NL/Swamp (Cypress)
- Wet Prairie Marsh
- Mixed Residential
- Woody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

Aerosols





Nitrogen Deposition



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] [MSM] [AMS][AGU] etc**

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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.” [IPCC; MSM; AMS; AGU etc]

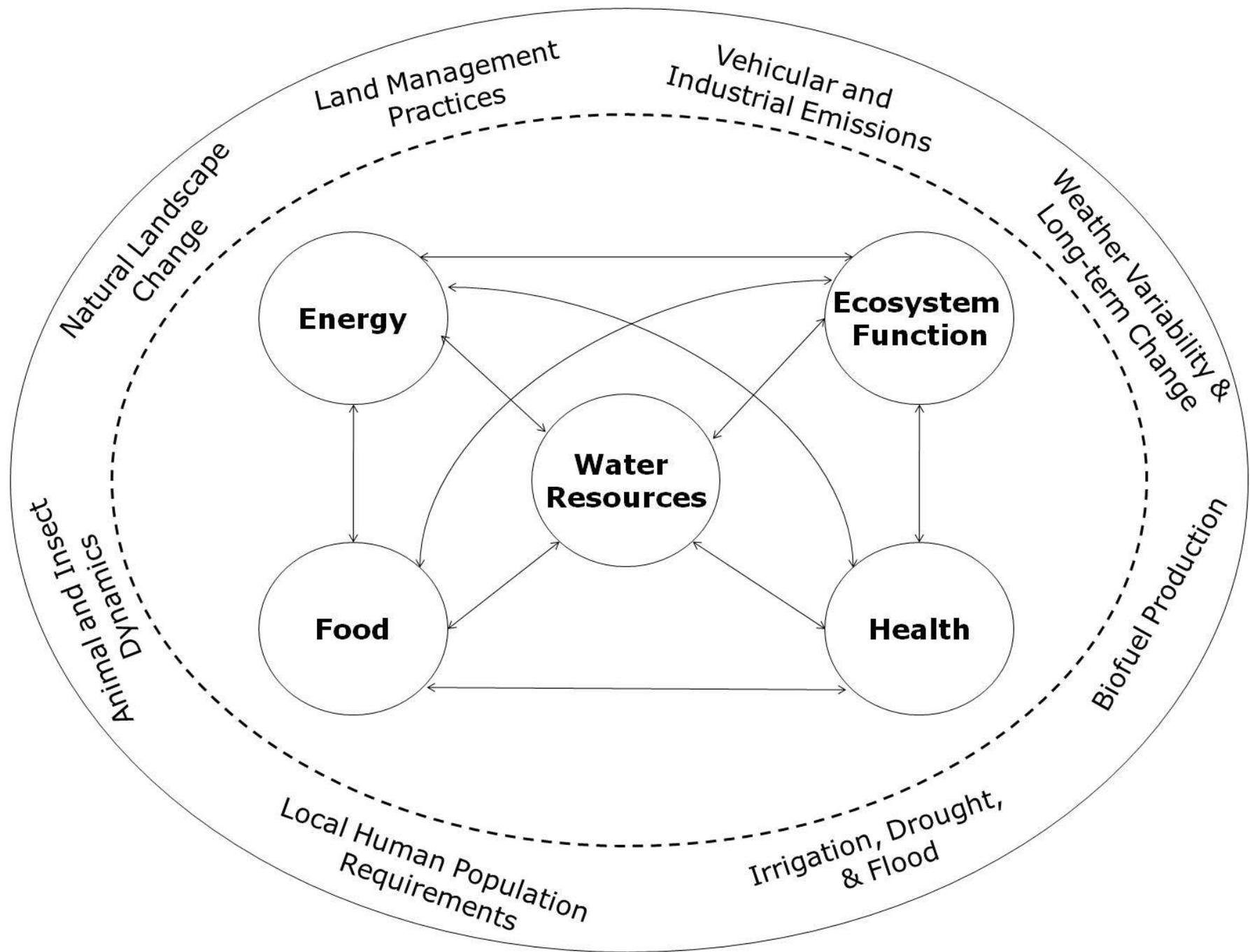
or

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>



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.

Thank You for the Opportunity
to Present!

Enjoy the Holidays!



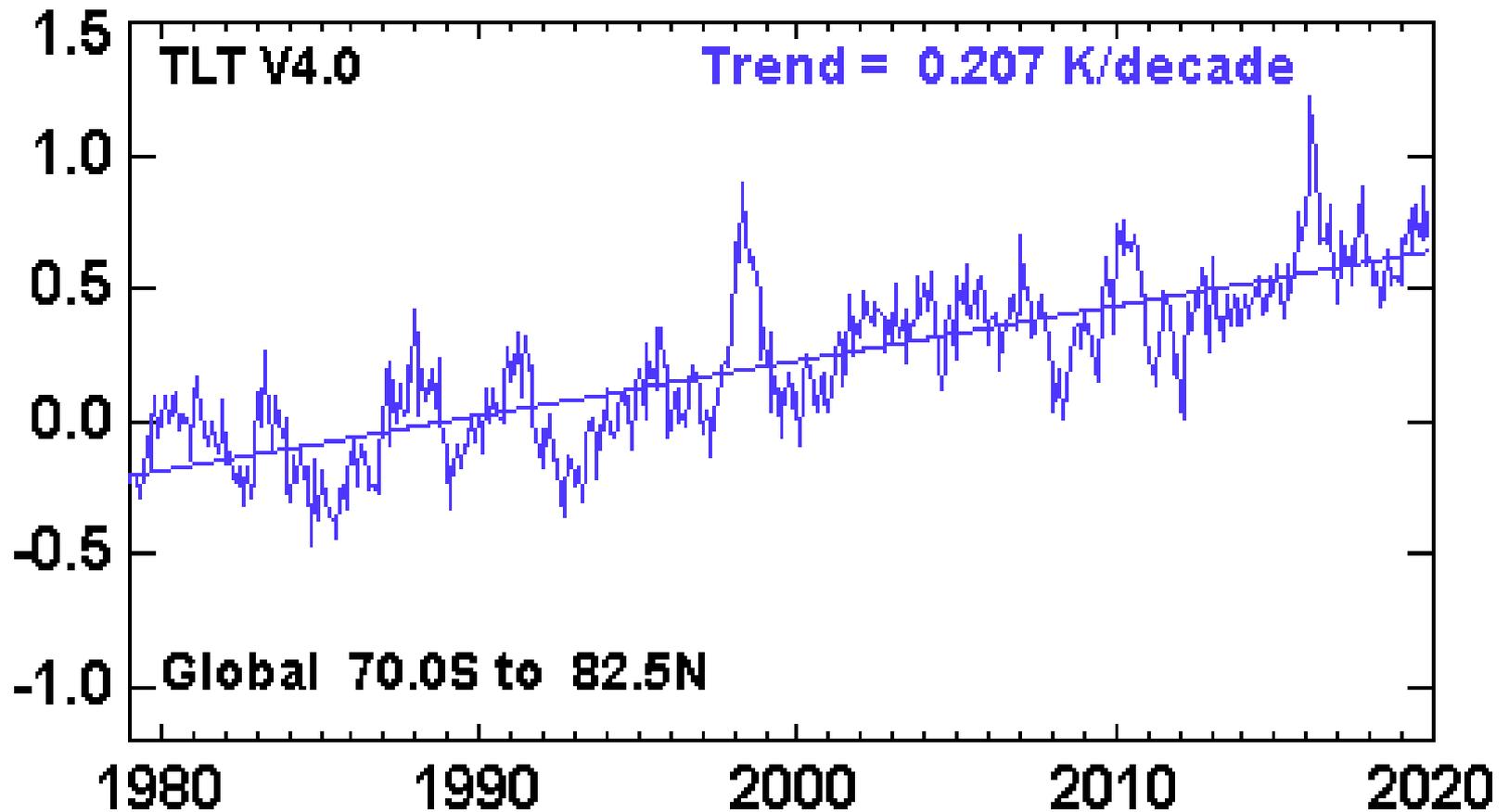
Our websites

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

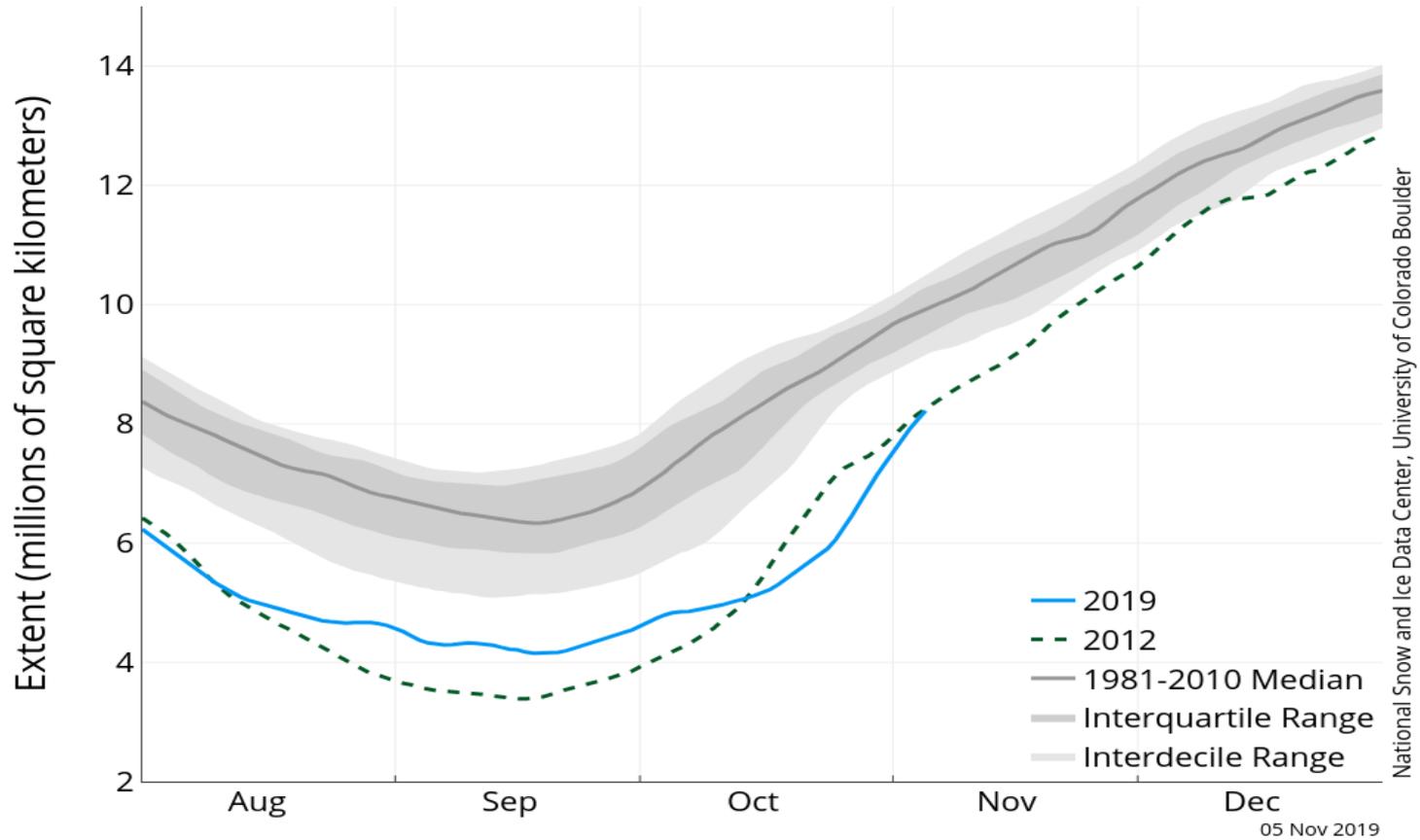
<http://pielkeclimatesci.wordpress.com/>

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

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

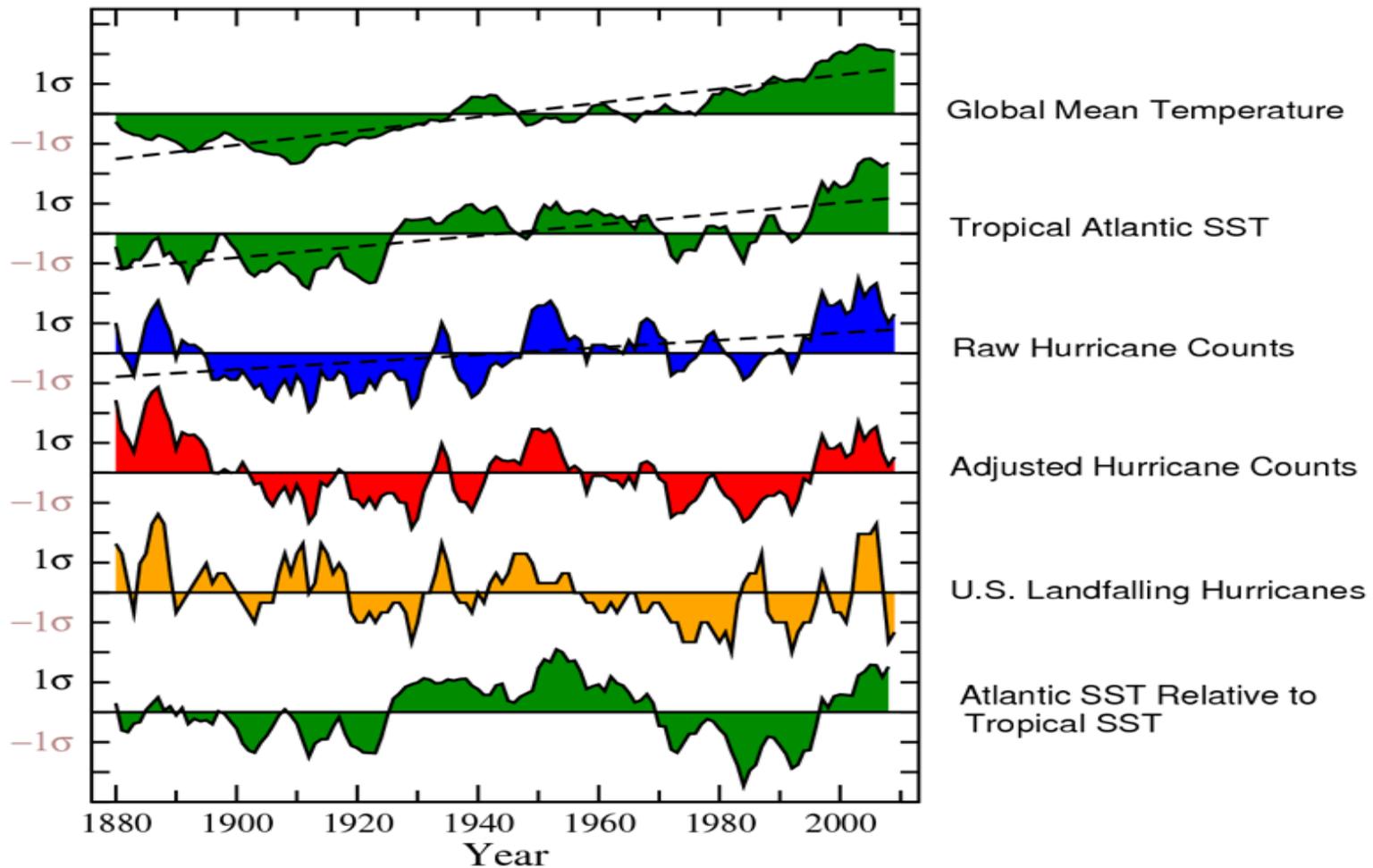


Arctic Sea Ice Extent (Area of ocean with at least 15% sea ice)

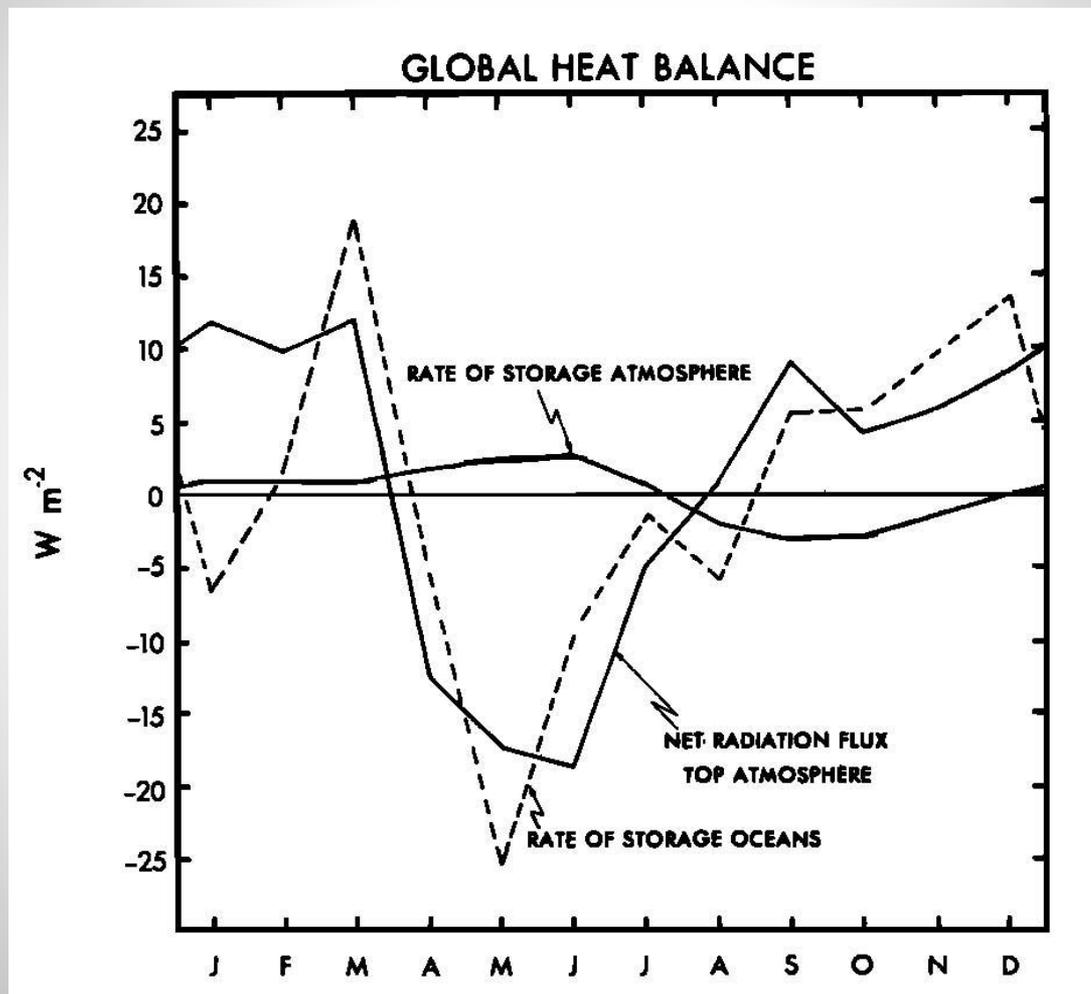


https://www.gfdl.noaa.gov/wp-content/uploads/pix/user_images/tk/global_warm_hurr/6stack_NOAA_FACT_Sheet_2012_crop.png

Normalized Tropical Atlantic Indices



**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.**



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.”

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.**”

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.”

- 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."

My Conclusion

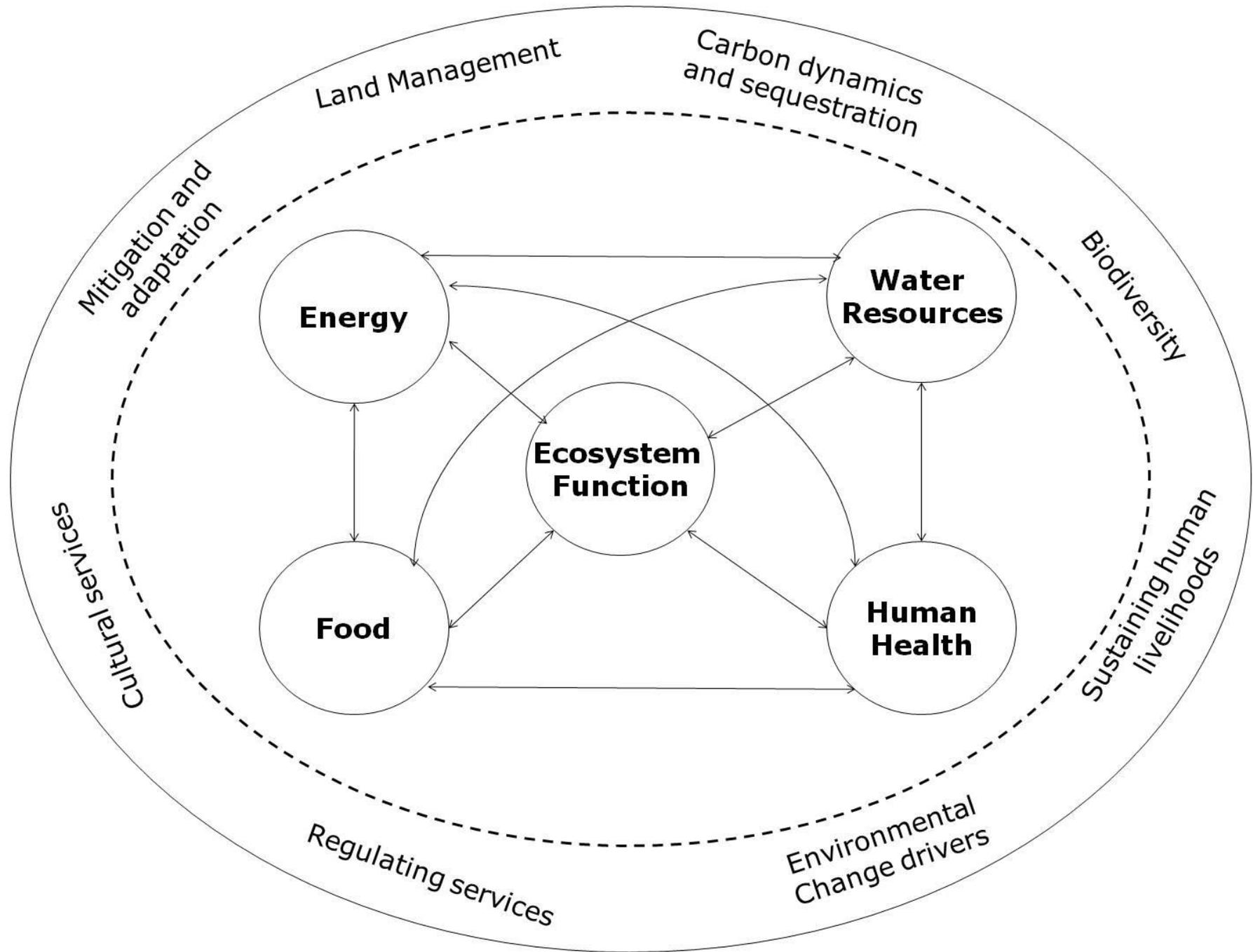
TWO APPROACHES TO WG1 OF THE IPCC REPORT

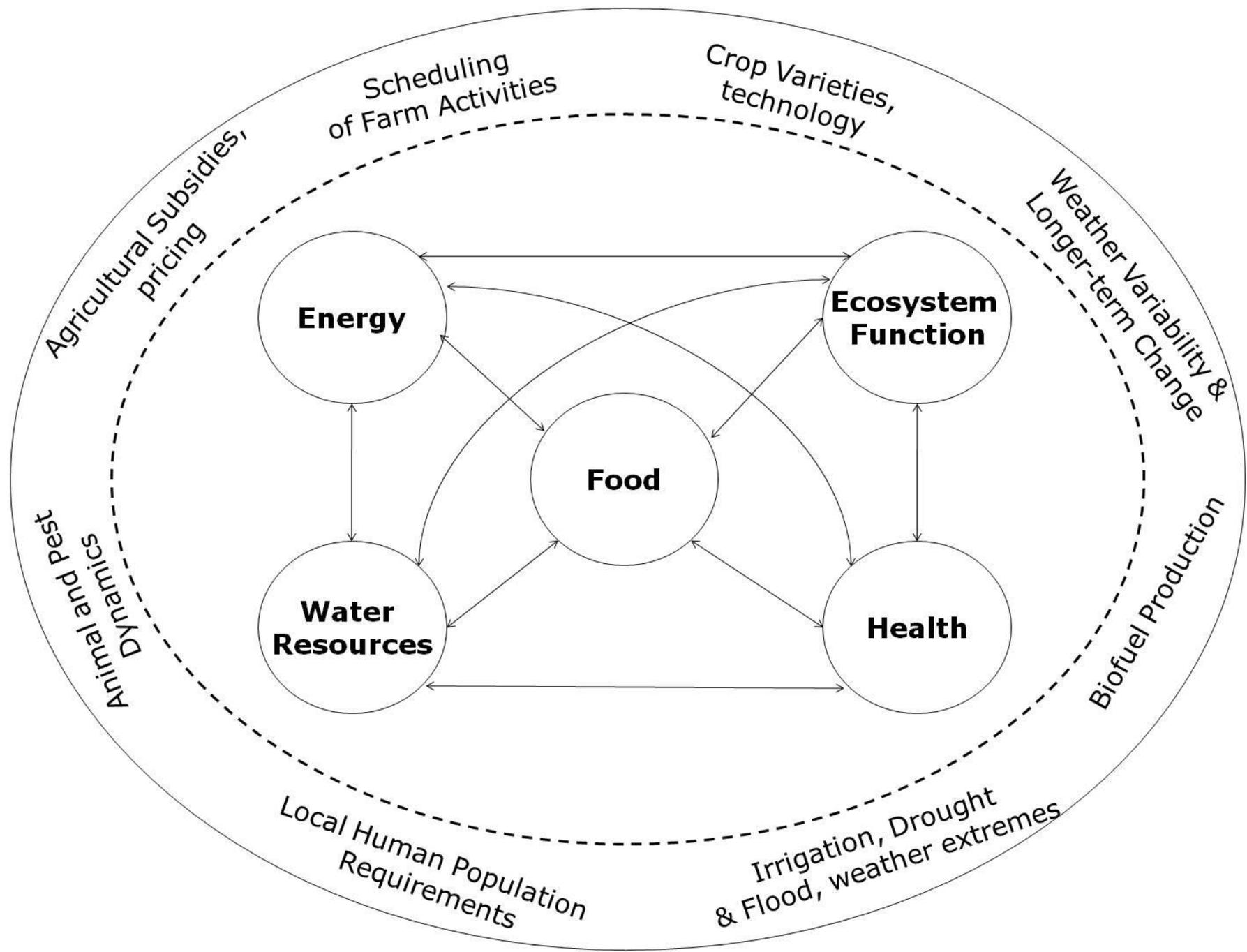
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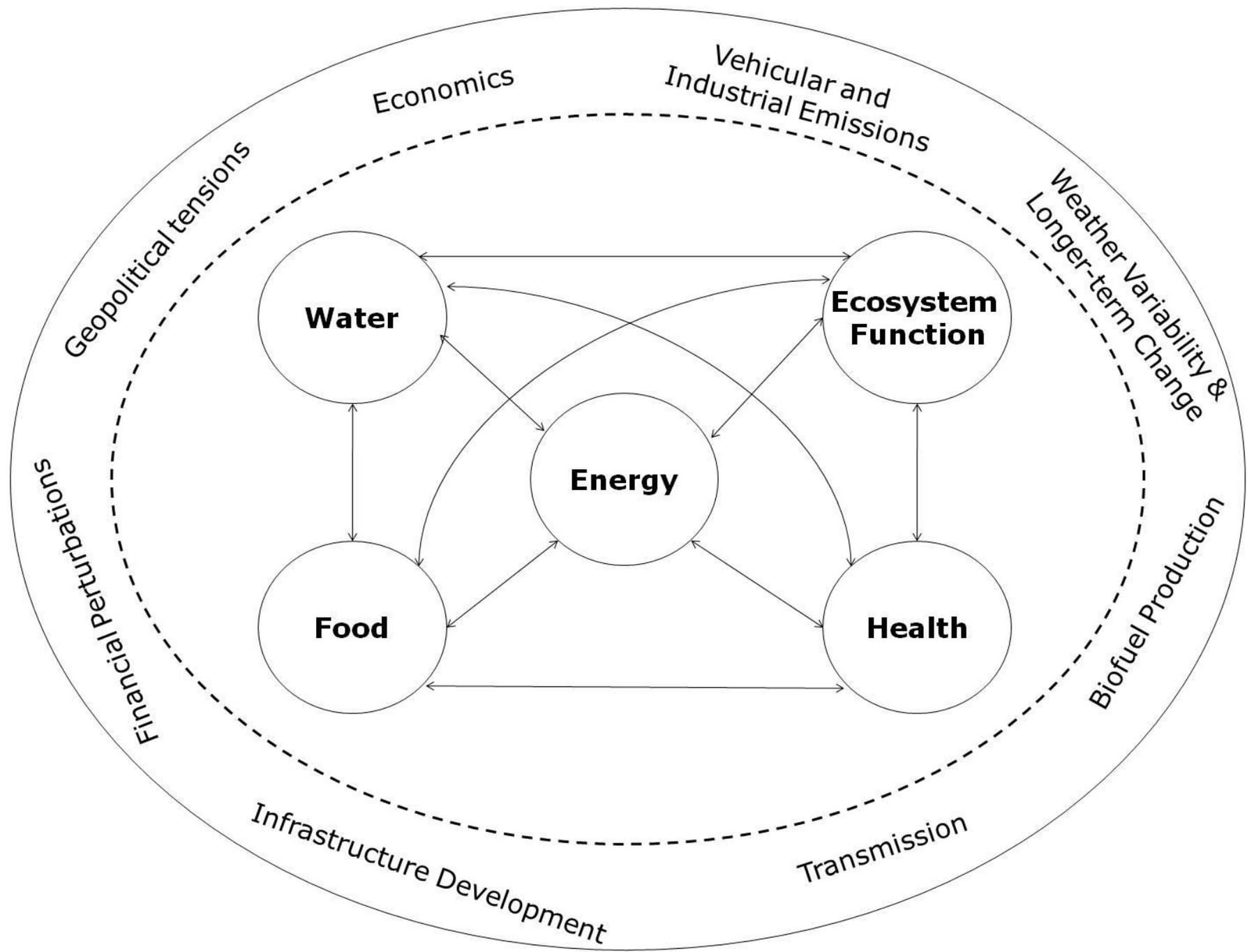
- 2) "The overwhelming scientific evidence tells us that human greenhouse gas emissions, land use changes and aerosol pollution are all contributing to regional and global climate changes, which exacerbate the changes and variability in climates brought about by natural causes. Because humans are contributing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

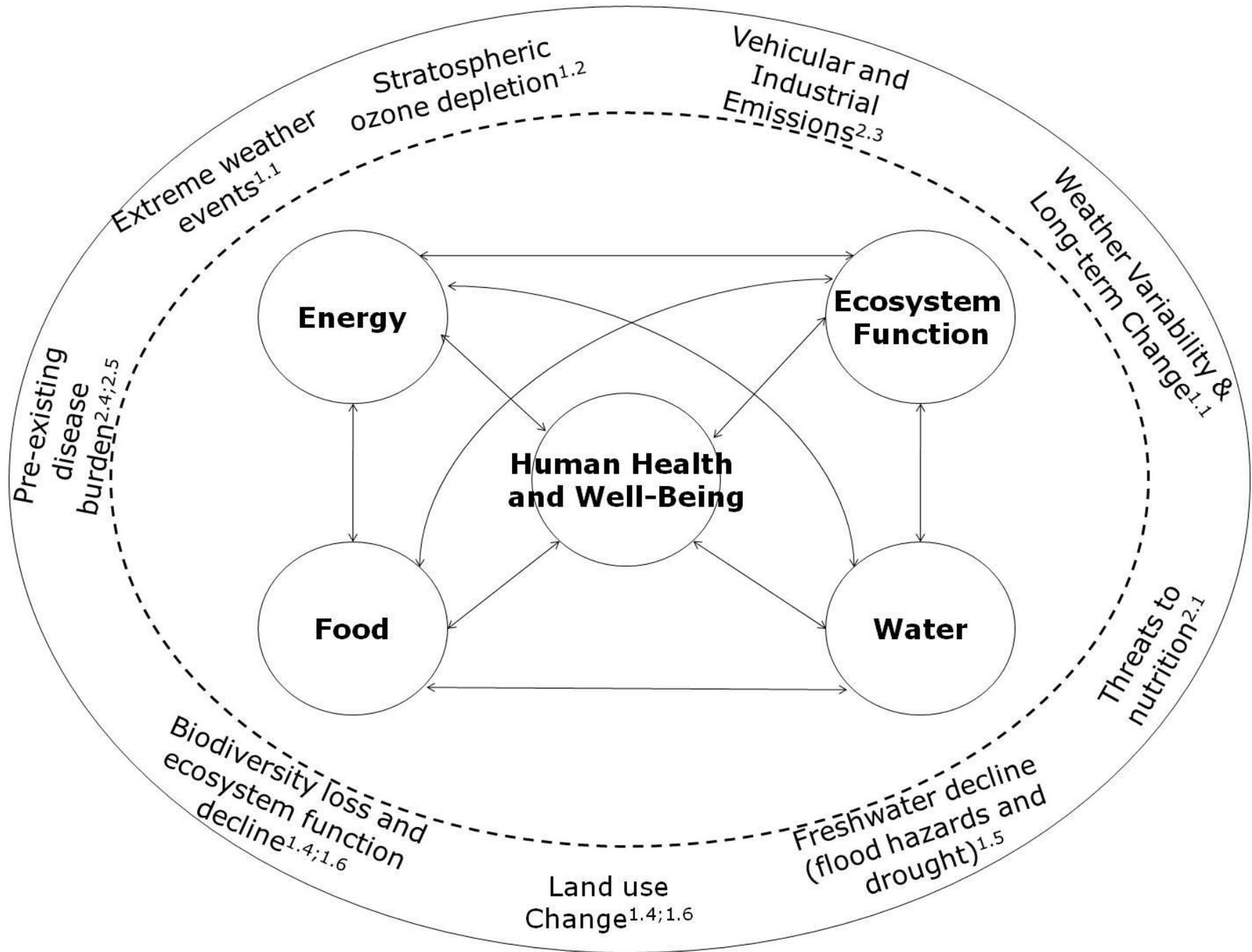
As Mike Hulme writes "....these two different provocations – two different framings of climate change – open up the possibility of very different forms of public and policy engagement with the issue. They shape the response.

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









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.