

Charles Stanier charles-stanier@uiowa.edu

Critical Issues in Climate Change Science and Advocacy





How can climate scientists claim that the changes we are seeing are manmade?



Impacts of 2°C (3.6°F) and larger increases?

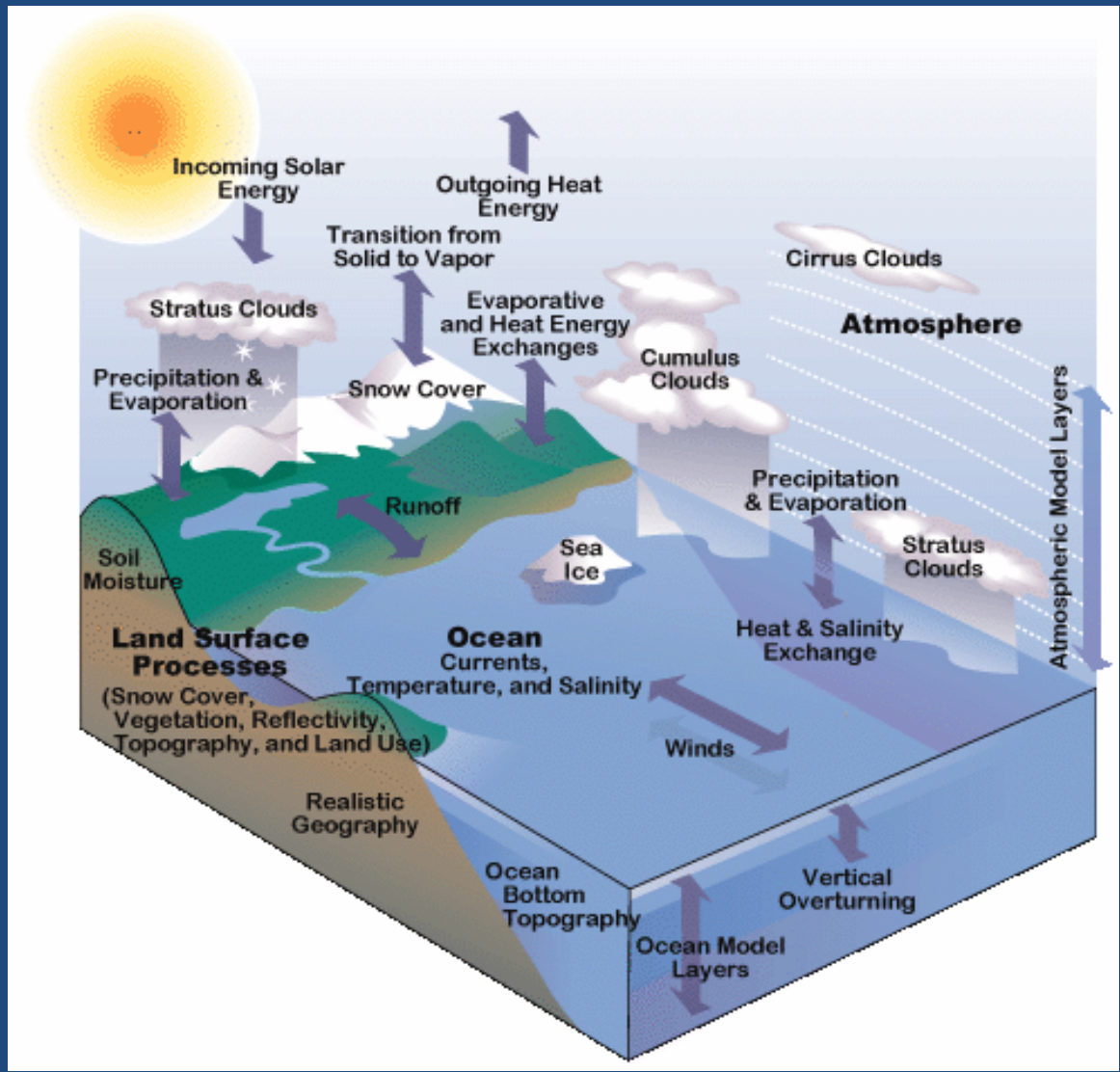


Knowledge ≠ Power?
Solutions?



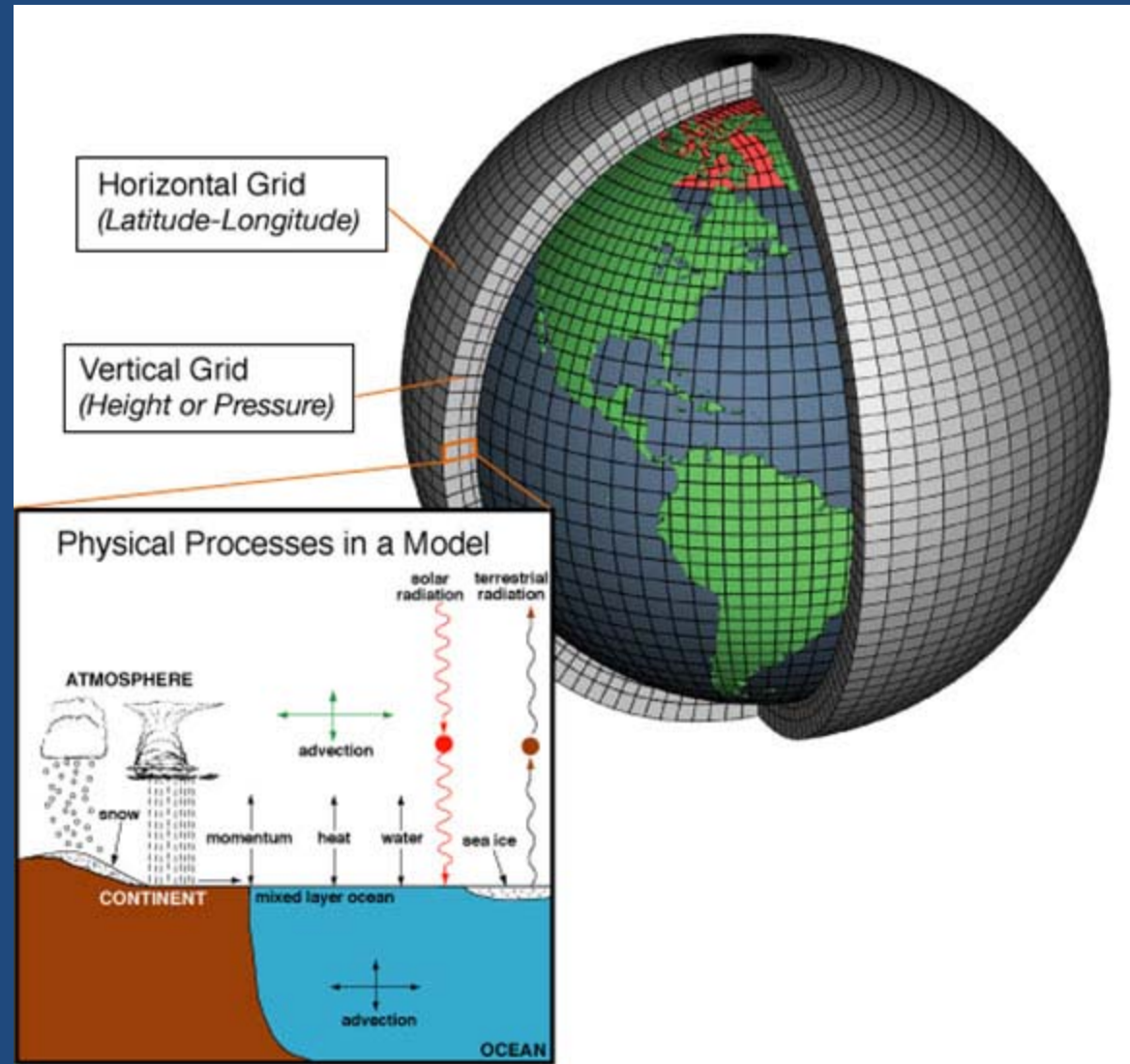
There is a “weight of evidence” where many scientific observations in nature can only be explained by accounting for the physics of greenhouse gases in the atmosphere

We inspect observations of the earth system such as temperatures and atmospheric radiation. We then ask if they make more sense when we account for manmade changes like increases in CO₂



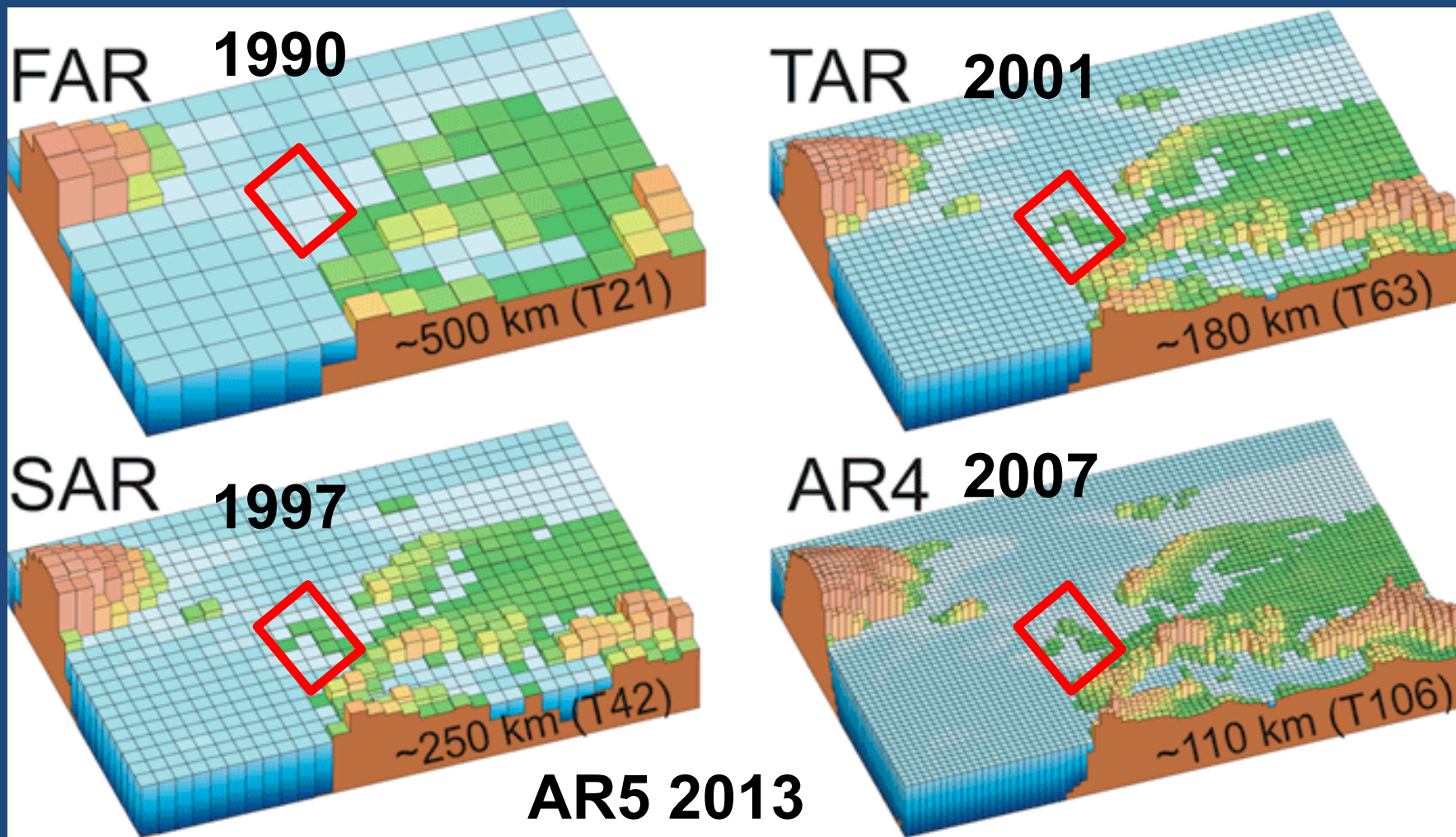
Source: NCAR
Community Climate
Model

The most comprehensive models we have are earth system models

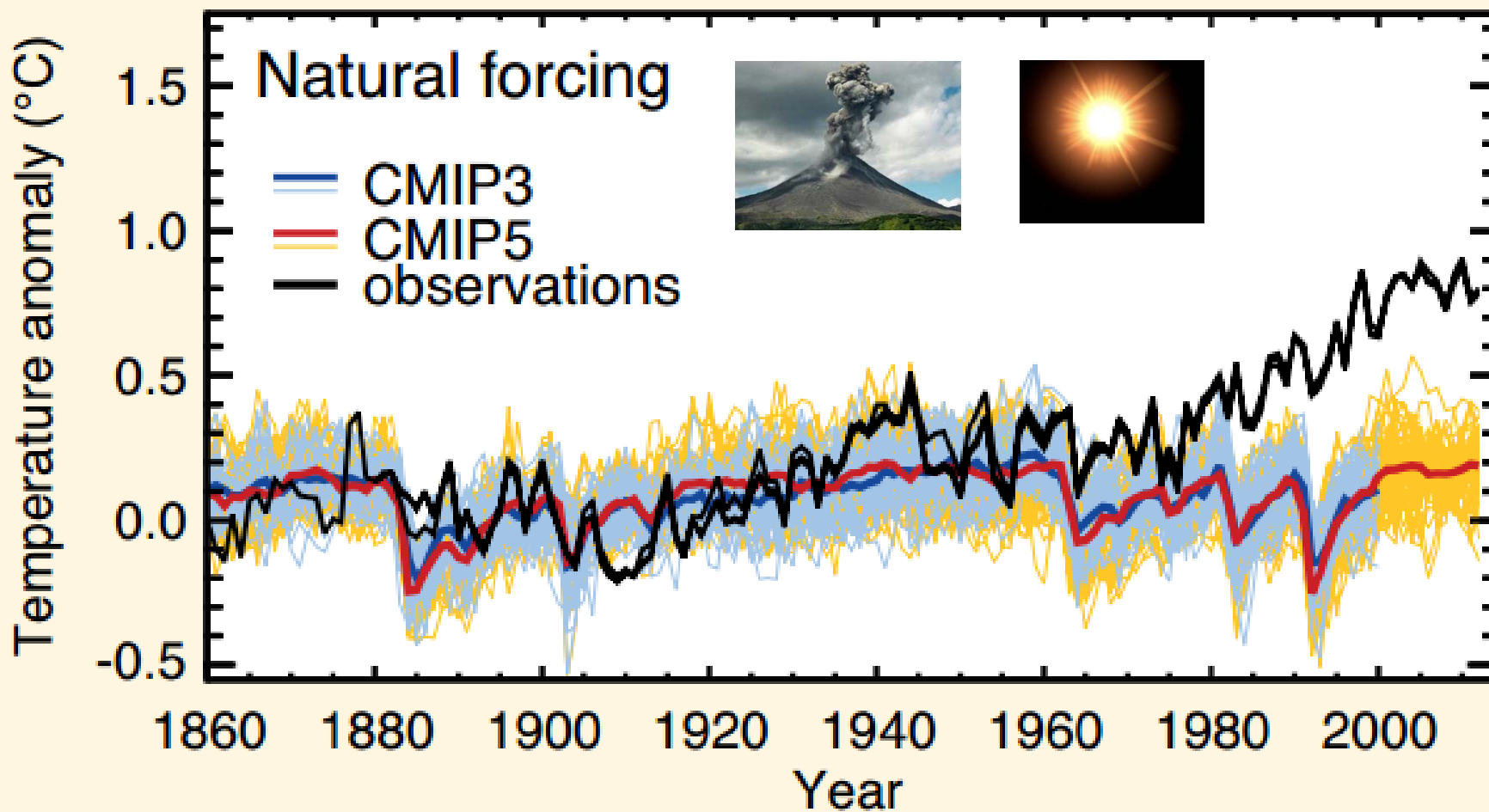


Source: NOAA
http://celebrating200years.noaa.gov/breakthroughs/climate_model/welcome.html

The physics of greenhouse gases are included in increasingly sophisticated simulations of past and future climate.



Simulations with all known NATURAL effects on climate do not reproduce the global temperature record.



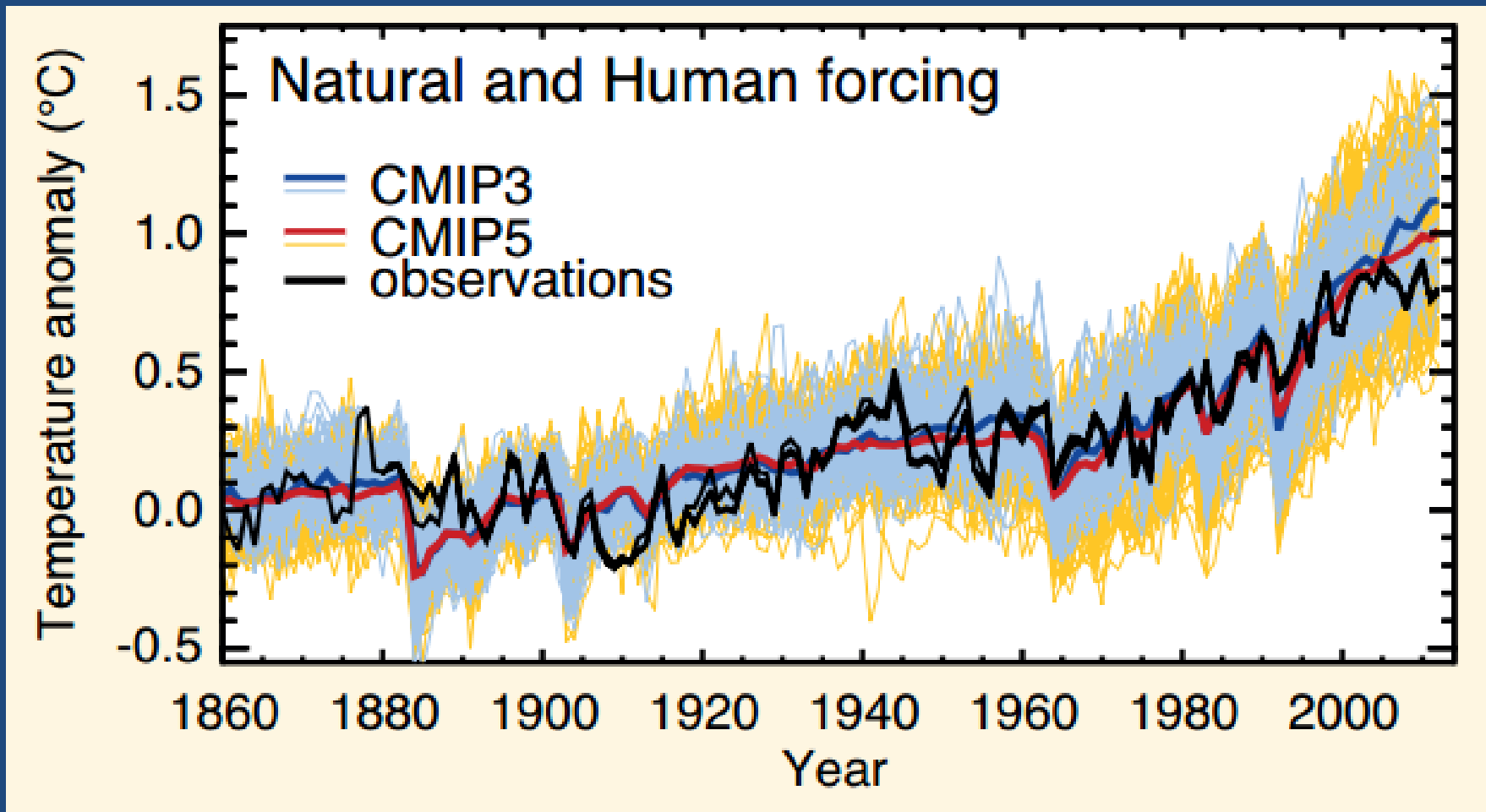
Krakatoa

CMIP5: 27 models from research centers in the US (NASA, Princeton, NCAR) and centers in China, Canada, Italy, France, Australia, UK, Russia, France, Japan, Germany & Norway

El Chichon

Pinatubo

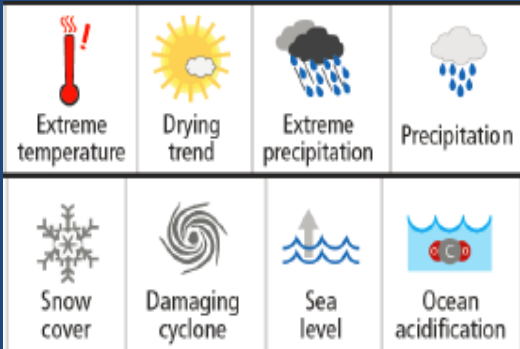
Simulations with all known NATURAL and MANMADE effects on climate DO reproduce the global temperature record.





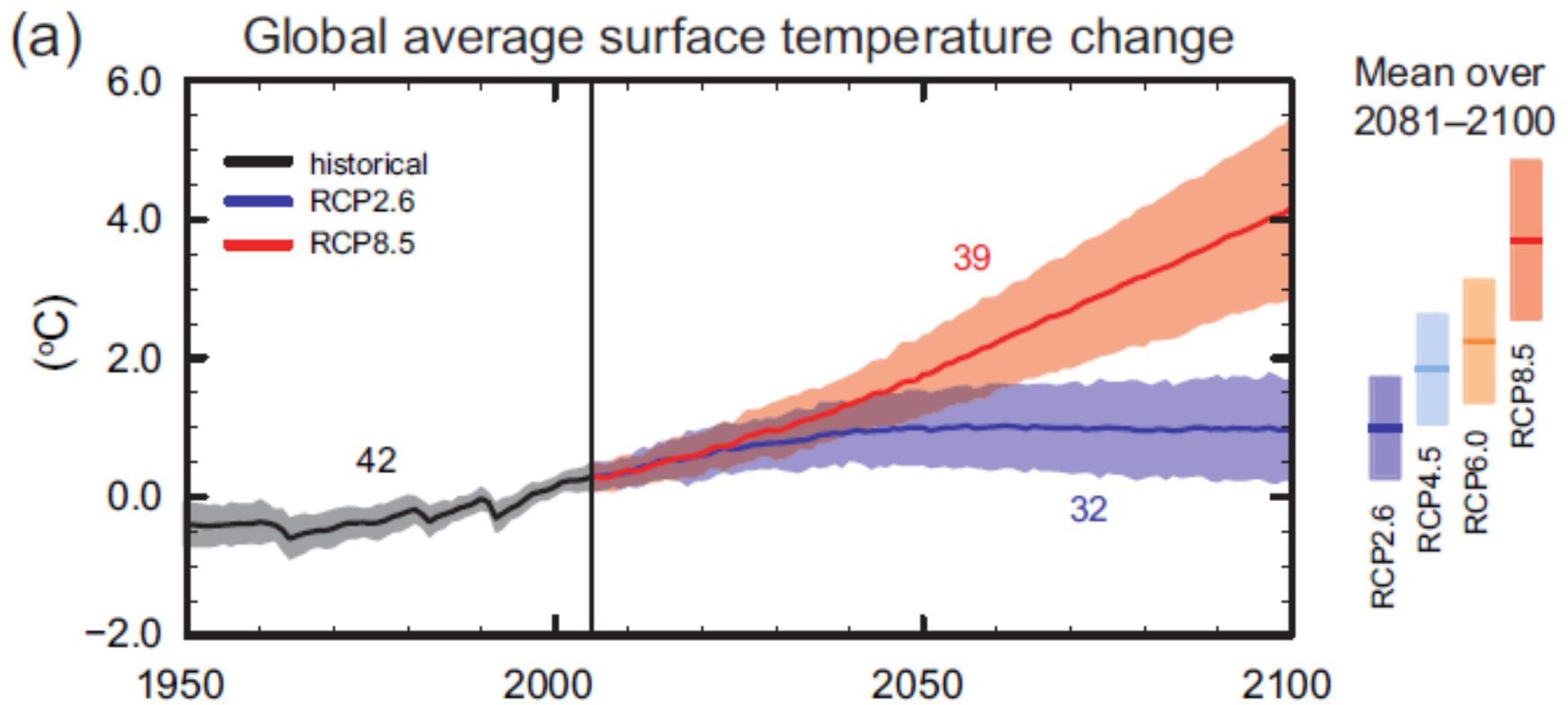
There is a “weight of evidence” where many scientific observations in nature can only be explained by accounting for the physics of greenhouse gases in the atmosphere

- Ocean heat content
- Which continents have warmed the most
- Pattern of ocean changes in temp, salt, acidity
- Vertical changes in atmospheric temperature and water
- Patterns of changes in ice cover, rain amount, and rain intensity
- Radiation as function of time, place, elevation, and wavelength

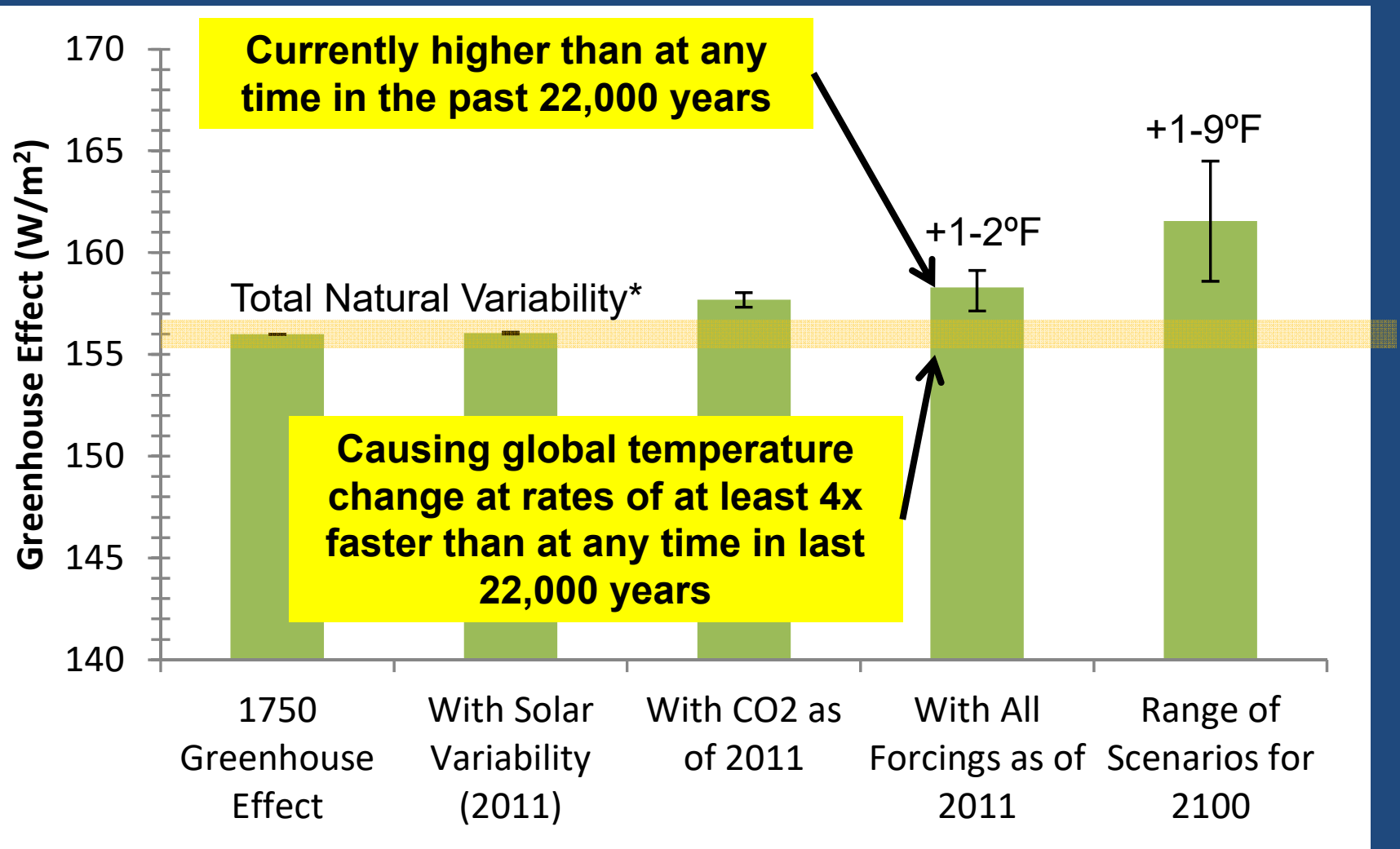


What's the big deal?

Impacts of 2°C (3.6°F) and larger increases?

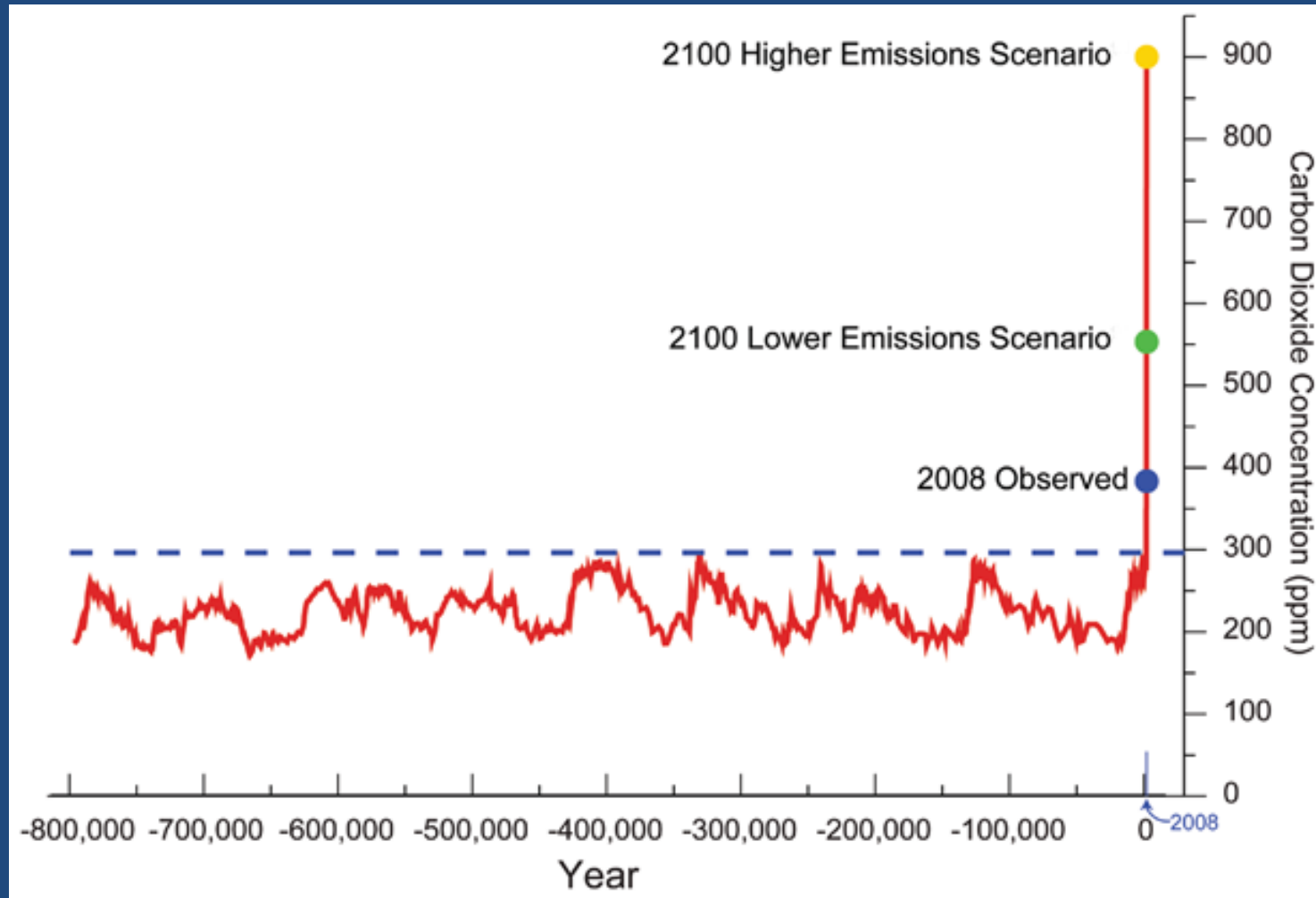


Atmosphere and climate are changing now faster than any time in the last 20 centuries.



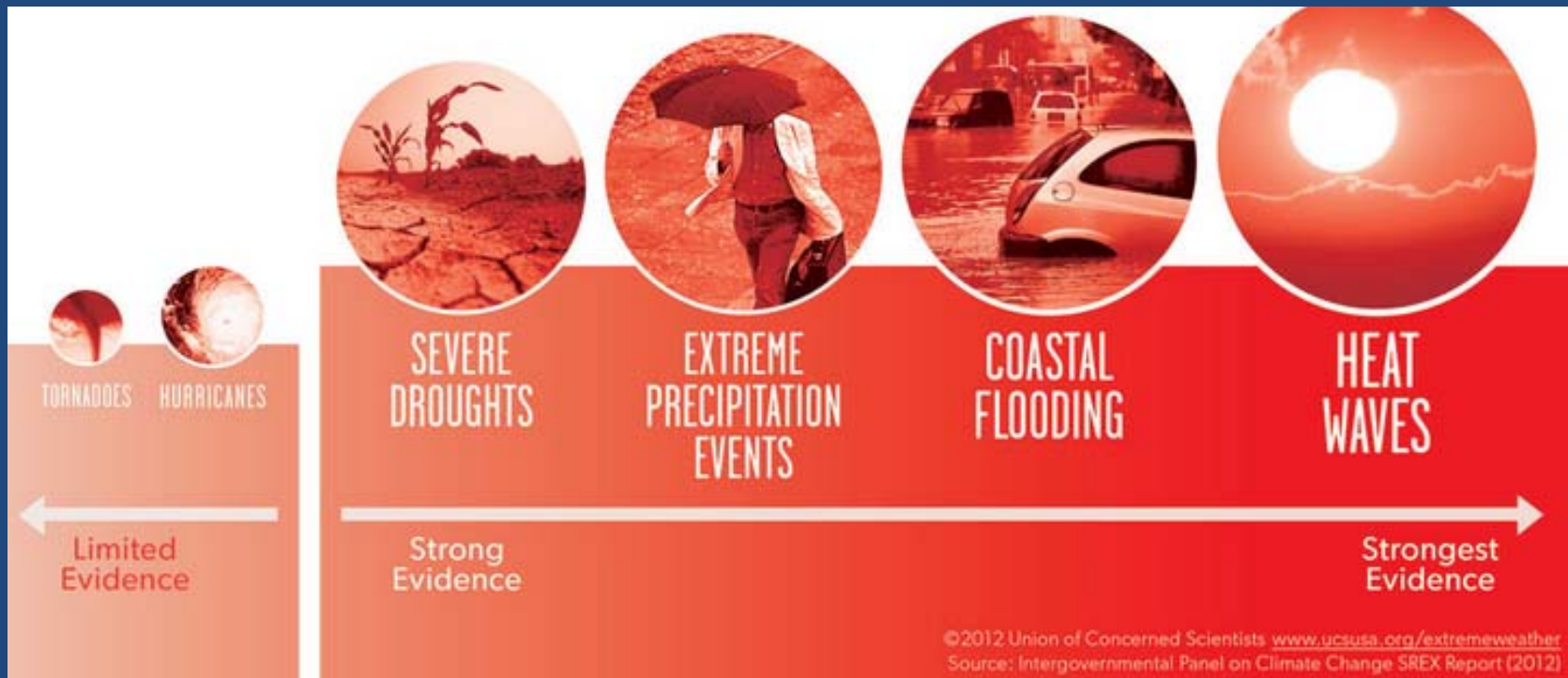
*Estimated based on AR5 Chapter 5, FAQ 5.1, Covers from 1870 and excludes volcanic eruptions

The levels of atmospheric influence on climate we are headed for have not been seen for millions of years.



Source: US Global Change Program

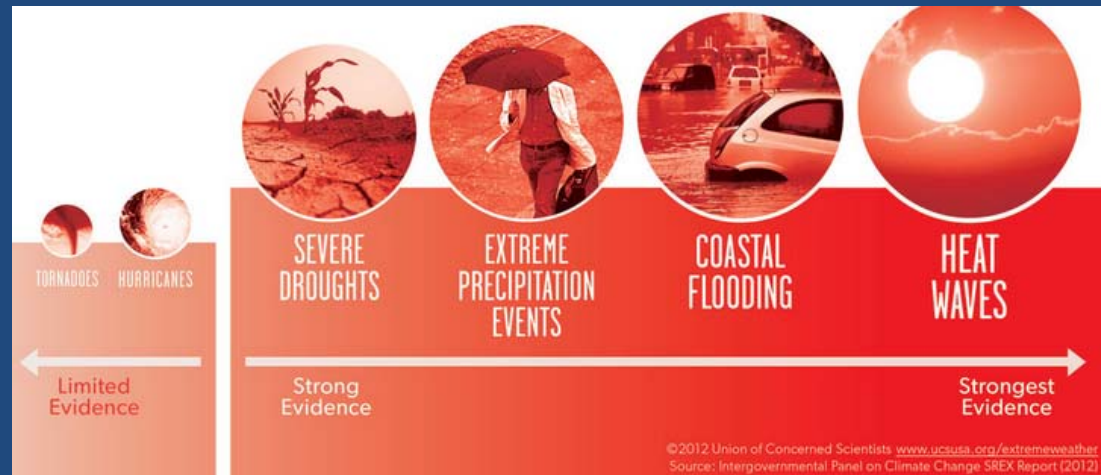
The following impacts are have a high or very high risk of occurrence on at least one continent or ocean basin



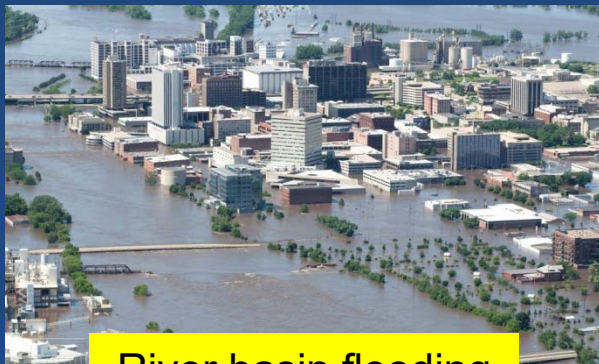
The following impacts are have a high or very high risk of occurrence on at least one continent or ocean basin



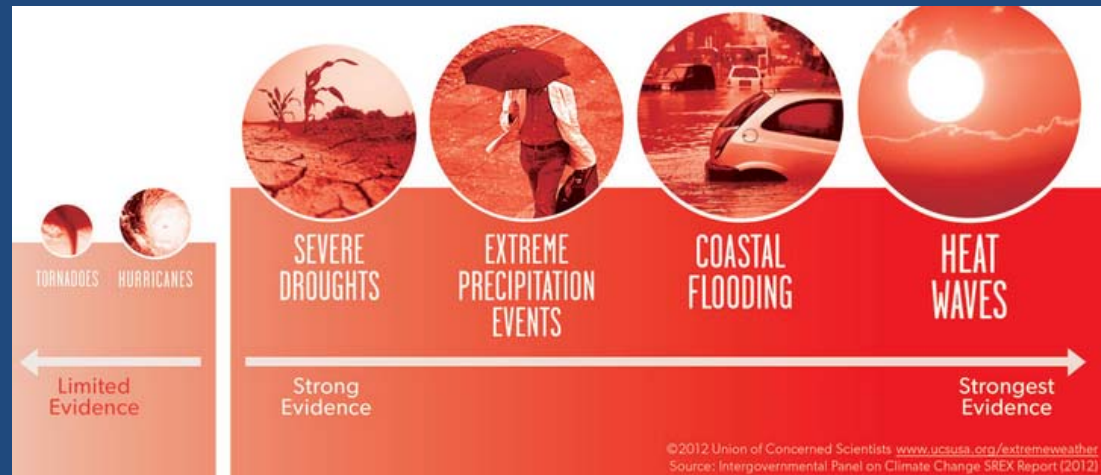
Insect-borne disease impacts



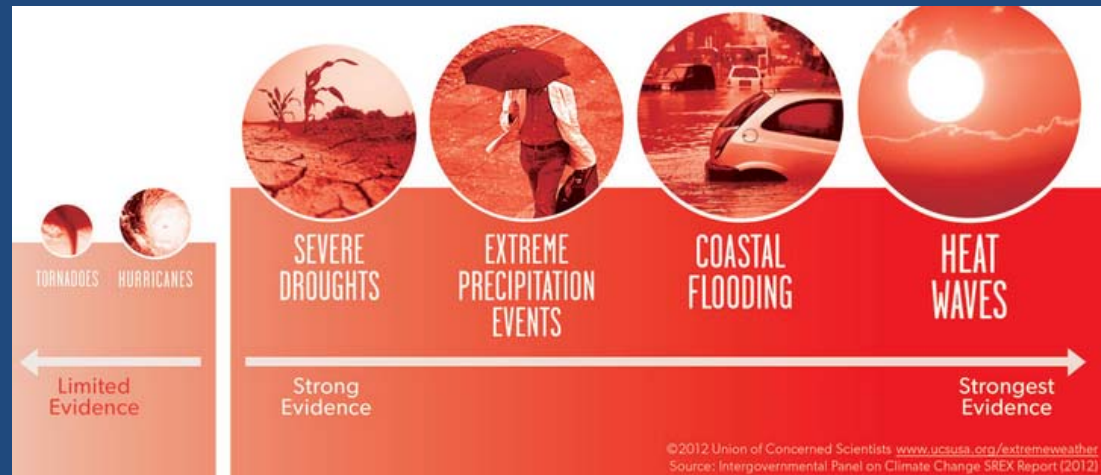
The following impacts are have a high or very high risk of occurrence on at least one continent or ocean basin



River basin flooding

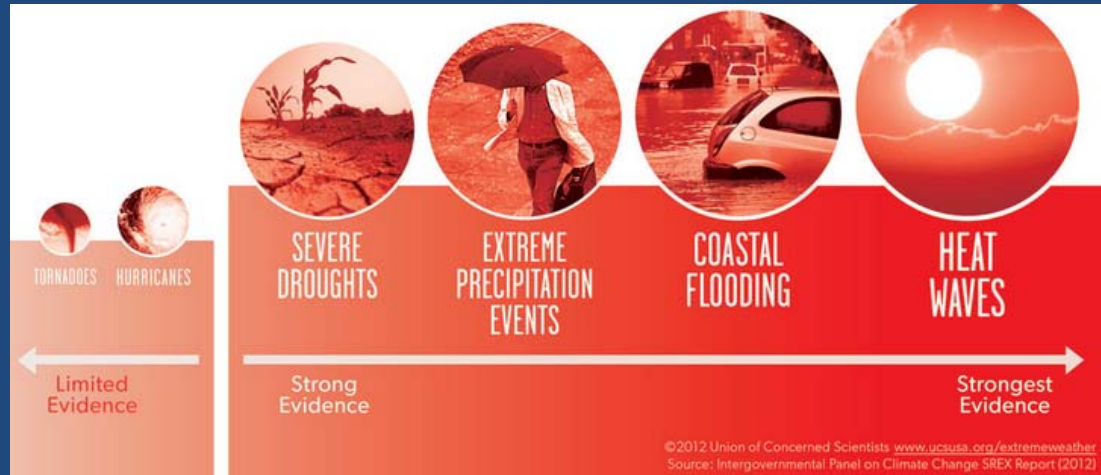


The following impacts are have a high or very high risk of occurrence on at least one continent or ocean basin



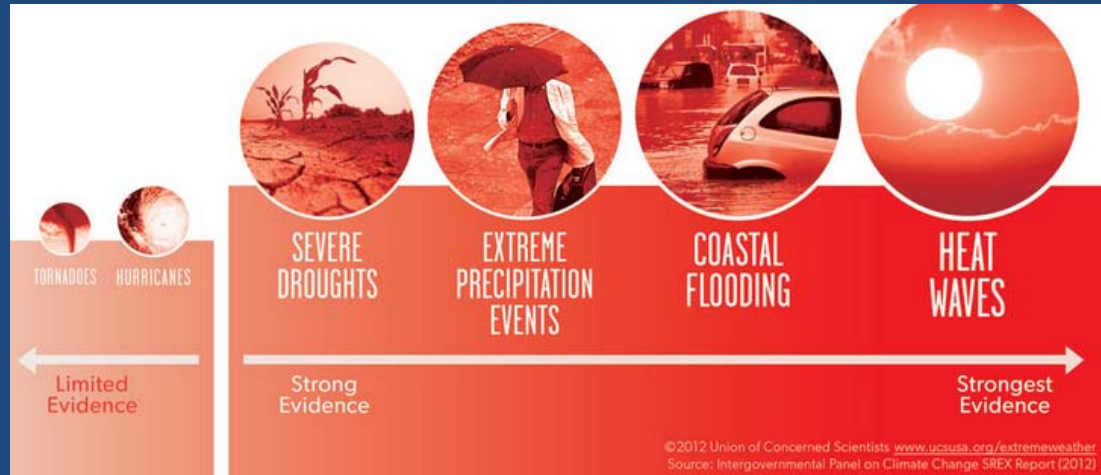
Anticipated net losses to agriculture

The following impacts are have a high or very high risk of occurrence on at least one continent or ocean basin



Coral reef ecosystem damage

The following impacts are have a high or very high risk of occurrence on at least one continent or ocean basin



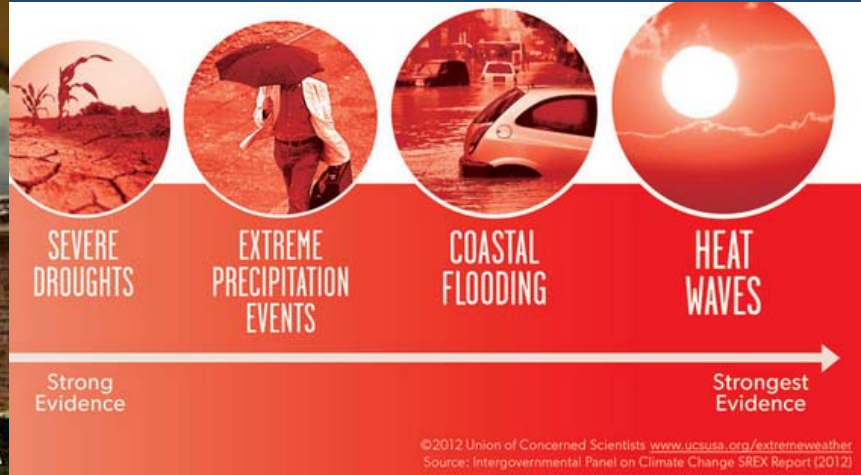
Loss of ecosystem integrity due to shifting ranges, degraded habitat, imbalanced predator-prey dynamics, and more frequent and intense ecosystem disturbances (droughts, wind-storms, fires, and pest outbreaks)



The following impacts are have a high or very high risk of occurrence on at least one continent or ocean basin



Property loss, illness and mortality from wildfire ↑



Loss of ecosystem integrity due to shifting ranges, degraded habitat, imbalanced predator-prey dynamics, and more frequent and intense ecosystem disturbances (droughts, wind-storms, fires, and pest outbreaks)



The following impacts are have a high or very high risk of occurrence on at least one continent or ocean basin



SEVERE DROUGHTS EXTREME PRECIPITATION EVENTS COASTAL FLOODING HEAT WAVES

Strong Evidence Strongest Evidence

©2012 Union of Concerned Scientists www.ucsusa.org/extremeweather
Source: Intergovernmental Panel on Climate Change SREX Report (2012)



OF CROP LOSS
DROUGHT
EXCESS MOISTURE
HAIL
WIND
DISEASE
FLOOD
INSECTS
OTHER



Flash flooding from intense rain
 (droughts, wind-storms, fires, and pest outbreaks)

ing ranges,
 prey dynamics,
 em disturbances

The following impacts are have a high or very high risk of occurrence on at least one continent or ocean basin



Dead zones are rapidly increasing

- They are caused by excess nutrients
- The zones can suffocate fish, squid
- There are more than 400 ocean dead zones
- Waters around Tasmania and near the list.

Coastal, estuary, and river mouth dead zone ↑

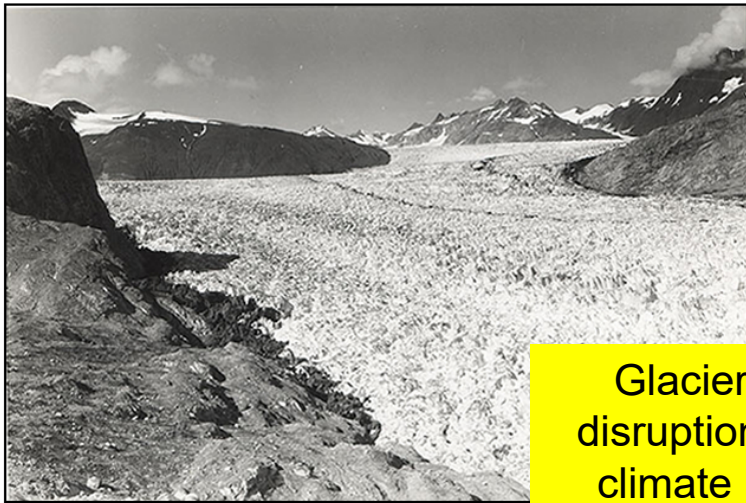


OF C
ROUGH
EXCESS MOISTURE
ROST/FREEZE
AIL
IND
SEASE
OOD
SECTS
THER



Long ranges, prey dynamics, and disturbances (droughts, wind-storms, fires, and pest outbreaks)

The following impacts are have a high or very high risk of occurrence on at least one continent or ocean basin



Glacier loss & disruption of cold-climate habitats



- The zones can suffocate fish, squid and other marine life.
- There are more than 400 ocean dead zones in the world's seas.
- Waters around Tasmania and near Perth were recently included on the list.



Low...
de...
an...
(droughts, wind-storms, fires, and pest outbreaks)



The following impacts are have a high or very high risk of occurrence on at least one continent or ocean basin



- The zones can suffocate fish, squid and other marine life.
- There are more than 400 ocean dead zones in the world's seas.
- Waters around Tasmania and near Perth were recently included on the list.

OF C
ROUGH
ACCESS MOISTURE
ROST/FREEZE
A
S
O
S
THER

Water resources impact

SERIOUS DROUGHT
HELP SAVE WATER



Lo
de
an
(droughts, wind-storms, fires, and pest outb



The following impacts are have a high or very high risk of occurrence on at least one continent or ocean basin

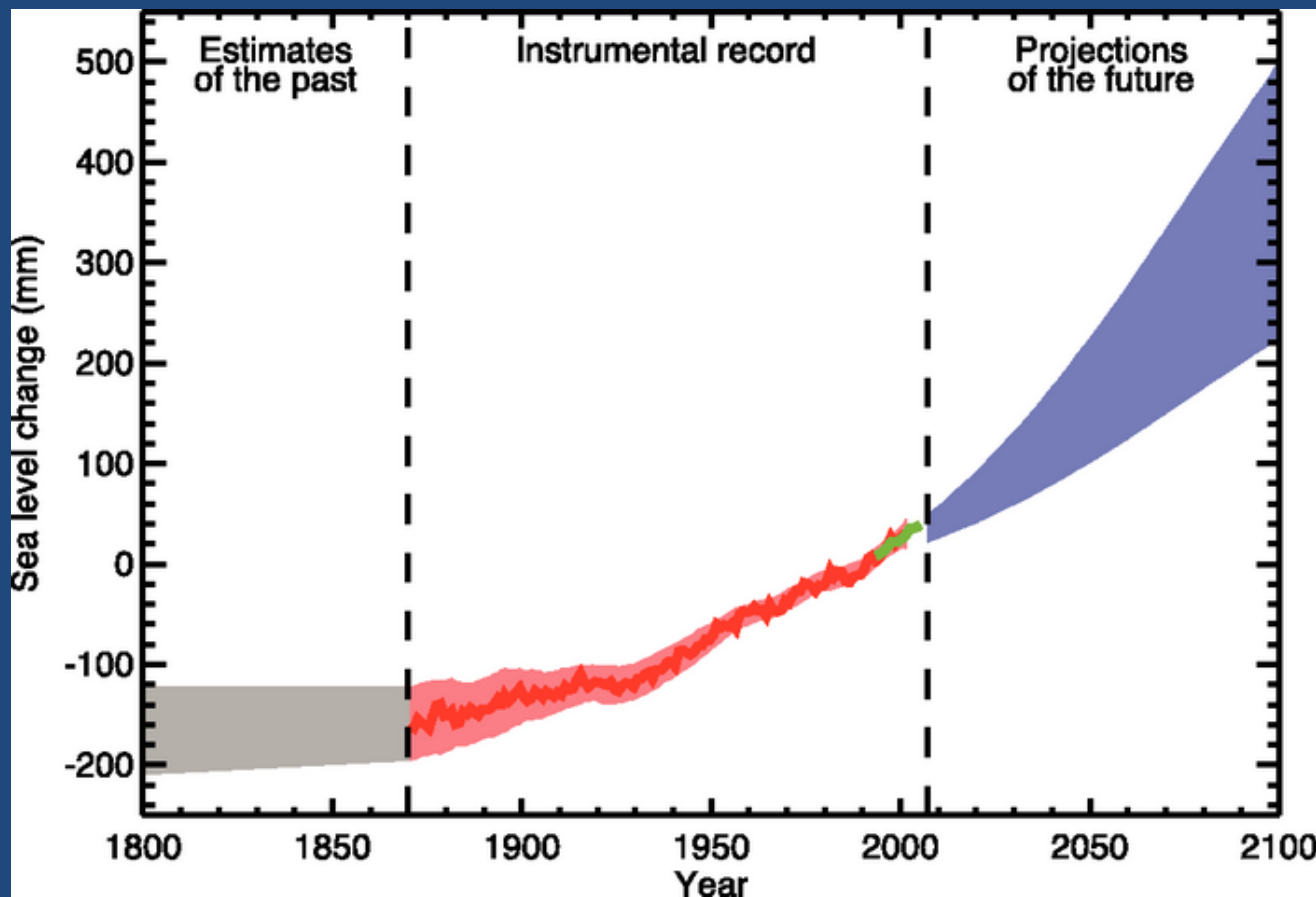


Fisheries decline predicted in 4°C scenario



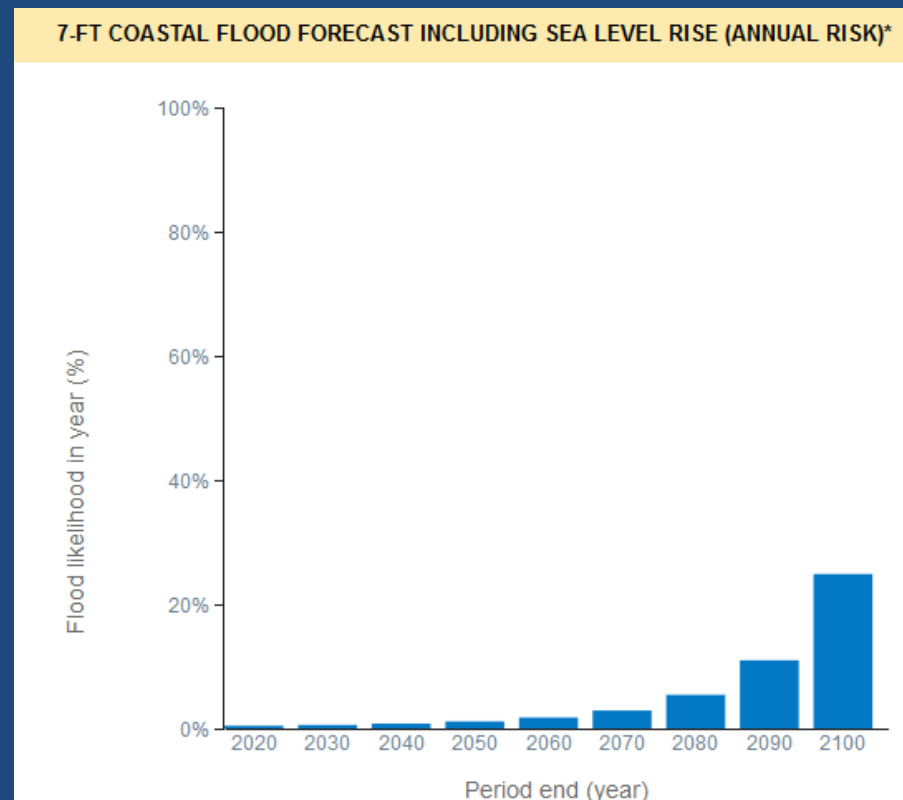
Low...
de...
an...
(droughts, wind-storms, fires, and pest outb

Sea level rise is 25 cm (0.8 ft) over 100 years so far with 40-100 cm (1.3-3.3 ft) more coming over next 100 years and up to up to 7 meters (23 feet) in the long term



Coastal flooding estimates are greater than sea level rise estimates due to storm surge.

- Probability of a 7 foot coastal flood in New York City is currently 0.6% per year – will increase to 25% chance per year by 2100 (Sandy was 10 ft)



Visualizing a 10 foot coastal flood in New York



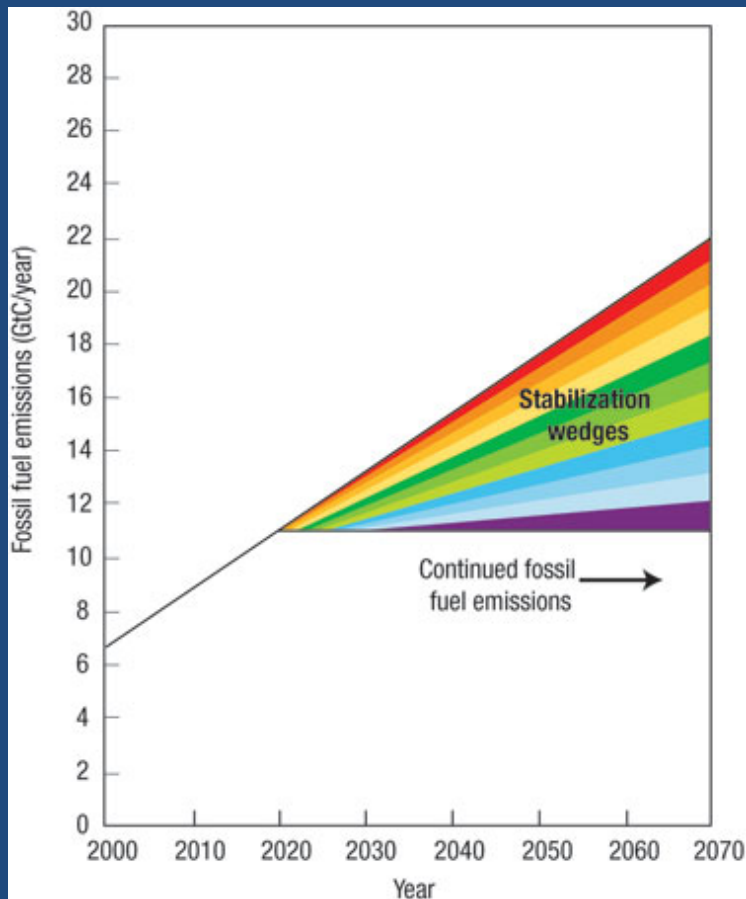
Climate Central calculates the risk of this 4 ft flood in Miami as 0.3% per year now, and 100% chance per year in 2100





There are many viable technical solutions to reducing greenhouse gas emissions

For example, Princeton Carbon Mitigation Institute "Stabilization Wedges: Solving the Climate Problem for the next 50 Years with Current Technologies," S. Pacala and R. Socolow, *Science*, August 13, 2004.



- Coal-fired elec. & carbon capture
- Fuel switching (coal to gas)
- Fossil-derived H₂ electricity & C capture
- Nuclear power
- Solar power
- Wind-generated hydrogen
- Efficient buildings
- Efficient industry
- Wind power
- Vehicle efficiency
- Biofuels
- Forest storage
- Soil carbon storage
- Travel fewer miles and/or rideshare

Additional solutions

- To the 15 carbon stabilization wedges we should add
- Plant-based diet (Weber & Matthews ES&T 2008)
- Control of potent warming agents called “Short-Lived Climate Forcers”
 - Black carbon aerosols
 - Ozone
 - Hydrofluorocarbons
 - Methane
- There are significant co-benefits to these reductions in addition to climate, like lives saved from air pollution (for black carbon), and \$\$ savings (for stopping methane leaks)
- See for example
http://web.unep.org/dewa/Portals/67/pdf/Black_Carbon.pdf

There are many equitable policy frameworks to decrease greenhouse gas emissions.

- Binding schedule of emission targets for all countries
- A portfolio of international treaties – each taking on a specific region and/or economic sector
- Any of these can include a mixture of “cap-and-trade” and (revenue neutral) carbon taxation policies.

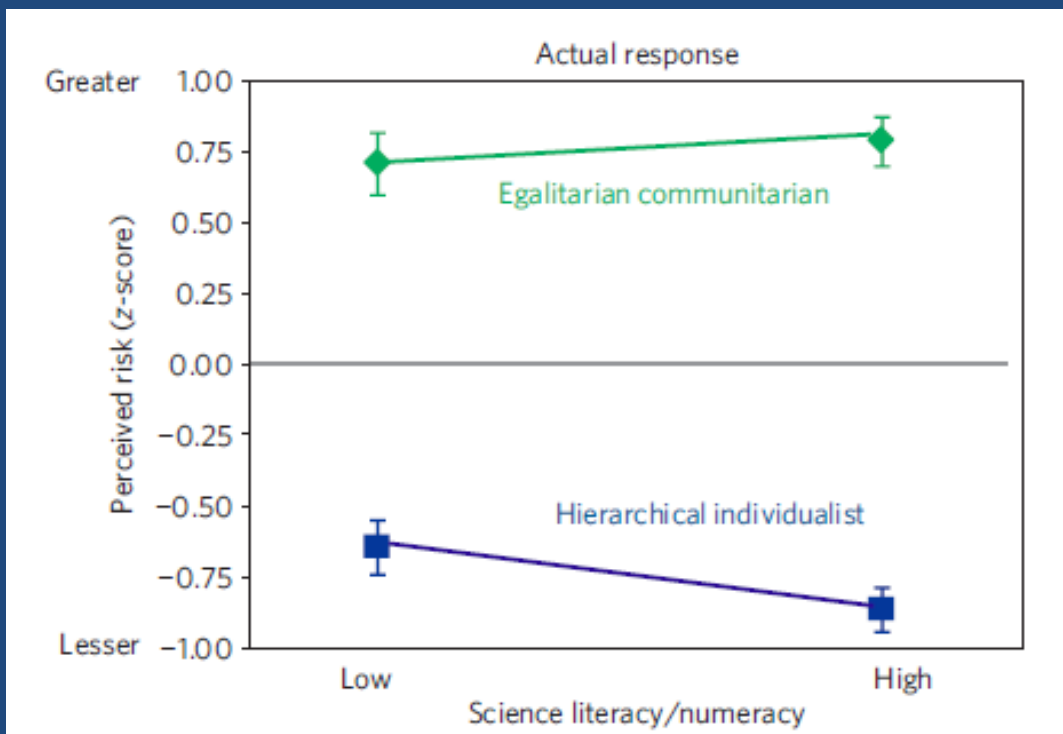
The public knows too little science (and therefore is apathetic about climate change).
We tested this and **found no support for it.**

The polarizing impact of science literacy and numeracy on perceived climate change risks by Kahan et al. (2012). Nature Climate Change.

The public knows too little science (and therefore is apathetic about climate change).
We tested this and found no support for it.

The polarizing impact of science literacy and numeracy on perceived climate change risks by Kahan et al. (2012). Nature Climate Change.

How much risk do you believe climate change poses to human health, safety or prosperity?



Hierarchical individualists: tie authority to conspicuous social rankings; eschews collective interference with the decisions of individuals possessing such authority

Boomerangs versus Javelins: How Polarization Constrains Communication on Climate Change

Jack Zhou

To cite this article: Jack Zhou (2016) Boomerangs versus Javelins: How Polarization Constrains Communication on Climate Change, *Environmental Politics*, 25:5, 788-811, DOI: [10.1080/09644016.2016.1166602](https://doi.org/10.1080/09644016.2016.1166602)

To link to this article: <http://dx.doi.org/10.1080/09644016.2016.1166602>

- Treatments of moral justice, natural disaster, national security, and economics

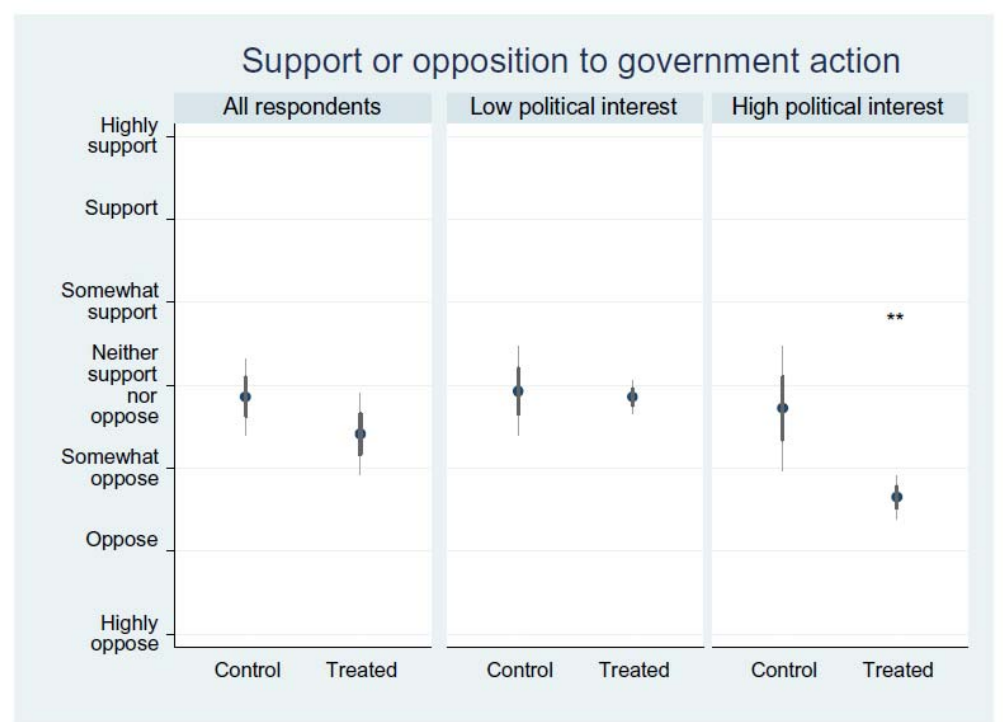


Figure 1. Support or opposition for governmental action among treated respondents. *Note.* Left side: effects among all respondents; center: effects among politically uninterested; right side: effects among politically interested. Darker lines indicate 68% confidence interval; lighter lines indicate 95% confidence interval.

- Honest and effective communication and dialogue about climate change should acknowledge that climate change is (Supran & Oreskes, ERL, 2017):
 - Real
 - Human-caused
 - Serious
 - Solvable
- Furthermore, it should genuinely recognize that people hold different world views. (Climate science: Why the world won't listen” – New Scientist, Sept 26, 2013)

Sources and additional readings

- “Climate Change and Global Warming: A Briefing from the Hadley Centre”
 - a collection of 60 slides with notes, containing up-to-date knowledge of the state of the climate and projections for the future.
 - https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=0ahUKEwjX38Ci04TXAhXn6oMKHdq_DtgQFggMAE&url=https%3A%2F%2Fwww.reefrelief.org%2Fwp-content%2Fuploads%2Fclimate_greenhouse2.pdf&usg=AOvVaw3Q3GaQIGwvvgx1YReK2j2MI
- Intergovernmental Panel on Climate Change (IPCC) Working Group I, 5th Assessment
 - Also known as IPCC 2013:WG1-AR5
- U.S. Global Change Program
- Jim Hansen. Global Warming: Can We Avoid Dangerous Climate Change?
 - Download at <http://www.columbia.edu/~jeh1/>
- Gavin Schmidt TED talk on climate models
 - https://www.ted.com/talks/gavin_schmidt_the_emergent_patterns_of_climate_change
- Climate Stabilization Wedges
 - <http://cmi.princeton.edu/wedges/>
- Berkeley Cool Climate Calculator (Carbon Footprints)
 - <http://coolclimate.berkeley.edu/calculator>