# Main Points

**1) The scientific evidence for human-induced climate change**
- **-- history and prehistory of climate trends**
- **-- the greenhouse effect**
- **-- the politicalization of climate change**
- **-- warning: Jake's opinions may creep into this lecture**

**2) Alternative Stable States (ASS): unfortunate acronym, important concept**
- **-- boundary shifts and thresholds**

**3) Q&A session for HW #3**

**Pre-reading: Thursday 22 October = Gilbert and Chalfoun**
**Tuesday 27 October = NA**

**Thursday 22 October = HW #3 due to Jake as a .doc by 5pm.**

**Tuesday 27 October = Debate #2. Evaluators, print out different group evaluations and bring to class. *Please label these "pro-mitigation.doc" or "anti-mitigation.doc" for full credit.* Presenters are (again) encouraged to see Jake and go through their outline.**

**Terms: greenhouse gas, carbon sink, carbon source, resistance, resilience**

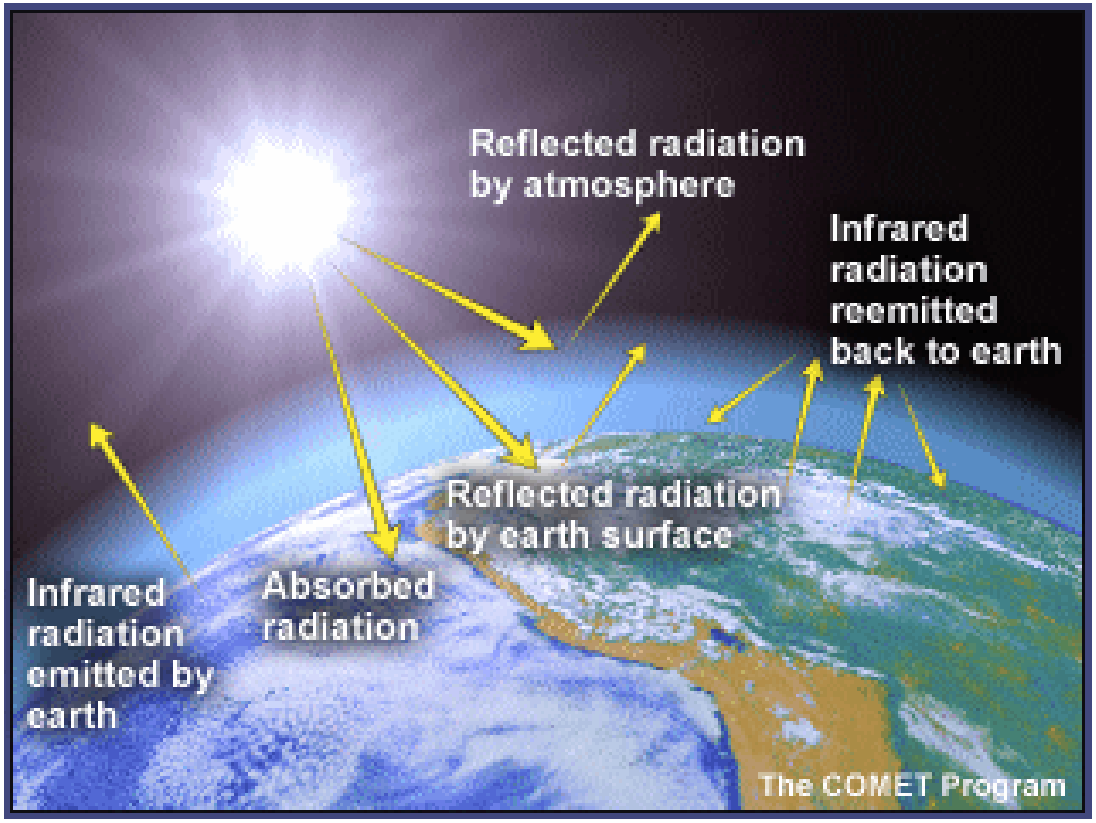
# Scientific basis of climate change

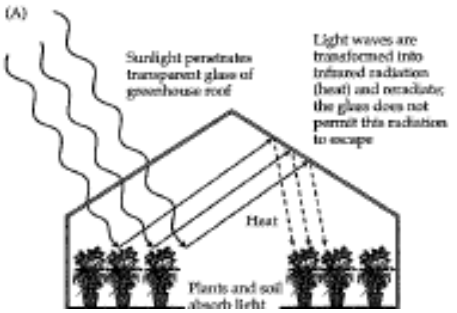
- **“Climate change is the one threat that exists everywhere, cannot be reversed by local actions, and will continue even if all nations come to agreement to tackle the problem”**

  **—C. Parmesan 2006.**

# Scientific basis of climate change

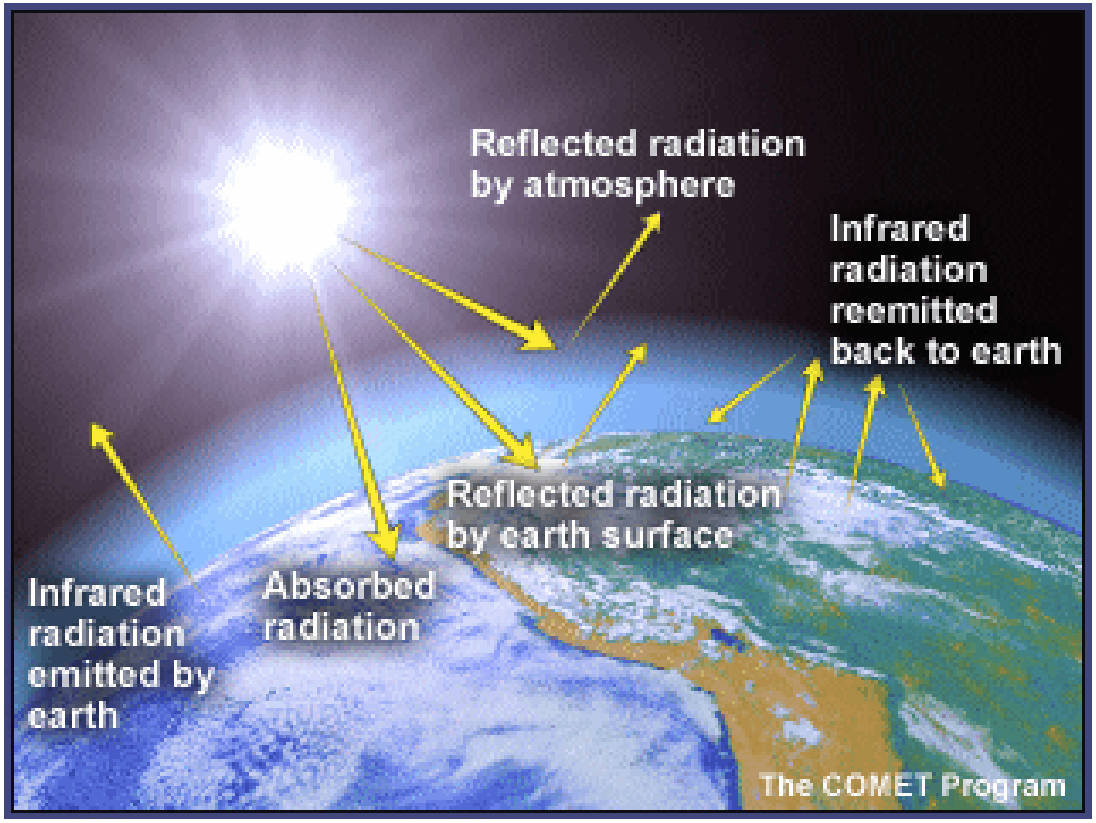
- **<u>greenhouse effect</u> = the transformation of short-wave (UV) to long-wave (IR) energy that is subsequently prevented from dissipating back into space.**

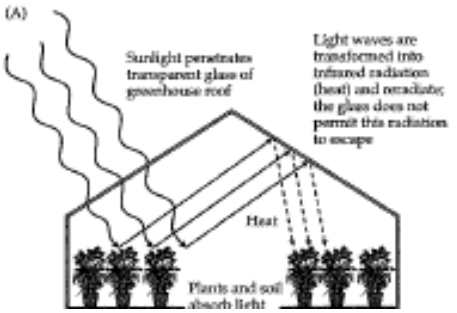


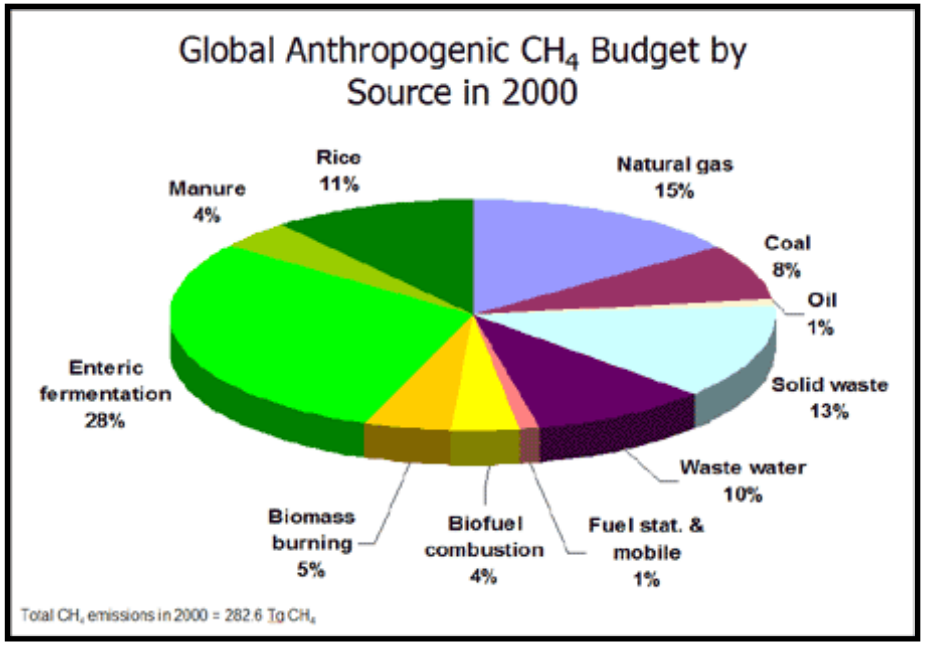
# Scientific basis of climate change

- **greenhouse gasses (CO2, methane, nitrous oxide, etc) trap heat re-radiated from the Earth's surface, causing temperatures to warm.**

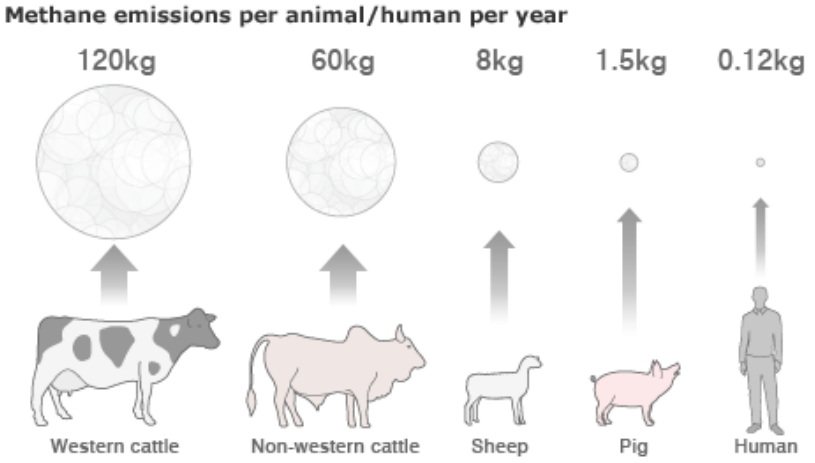


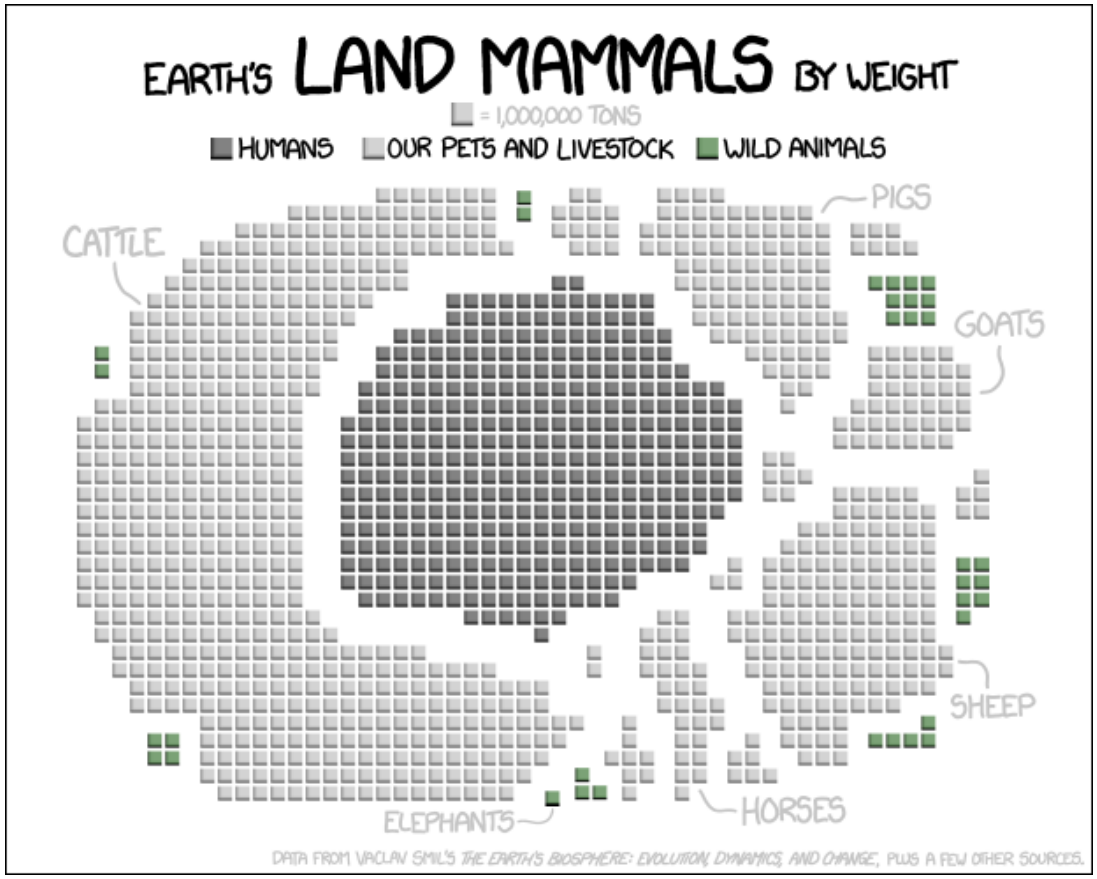



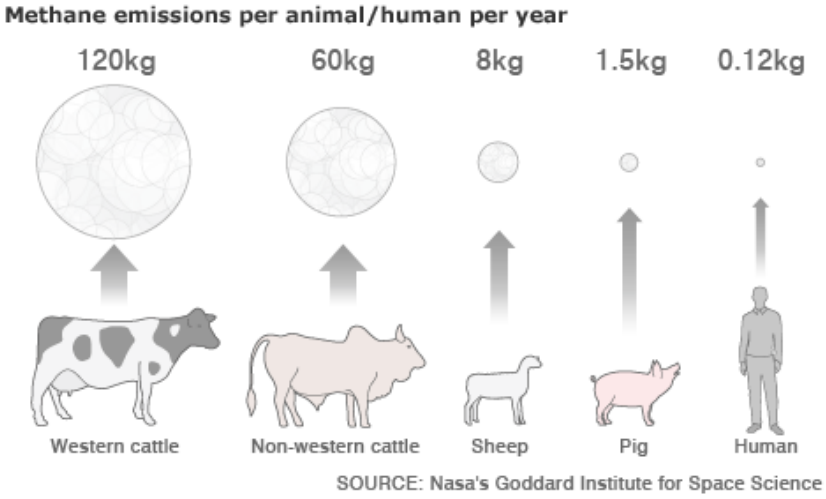
# Scientific basis of climate change








EARTH'S LAND MAMMALS BY WEIGHT
= 1,000,000 TONS
HUMANS
OUR PETS AND LIVESTOCK
WILD ANIMALS
CATTLE
PIGS
GOATS
SHEEP
HORSES
ELEPHANTS
DATA FROM VACLAV SMIL'S THE EARTH'S BIOSPHERE: EVOLUTION, DYNAMICS, AND CHANGE, PLUS A FEW OTHER SOURCES.


Methane emissions per animal/human per year
120kg
60kg
8kg
1.5kg
0.12kg
Western cattle
Non-western cattle
Sheep
Pig
Human
SOURCE: Nasa's Goddard Institute for Space Science

# Scientific basis of climate change

- **Since 1860s, burning of coal, oil, and natural gas has increased greenhouse gases by 30%, leading to a 0.6 C increase.**

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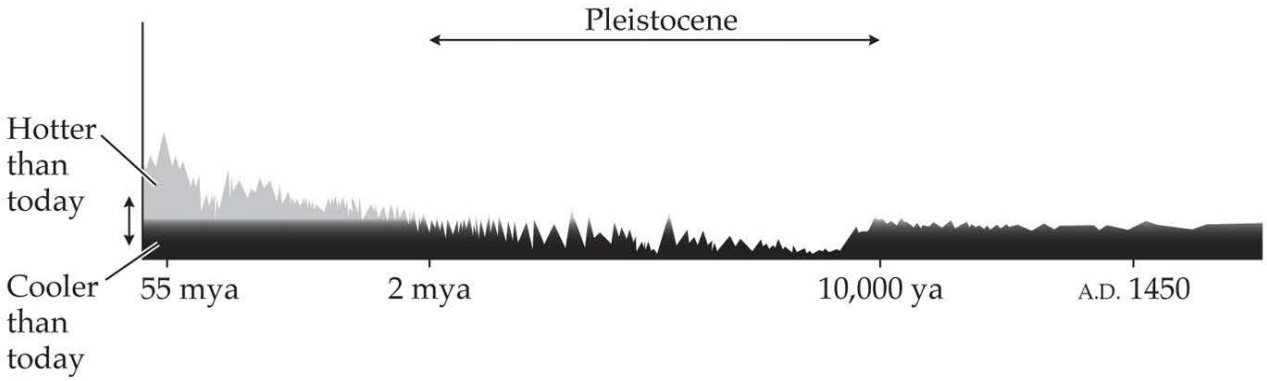
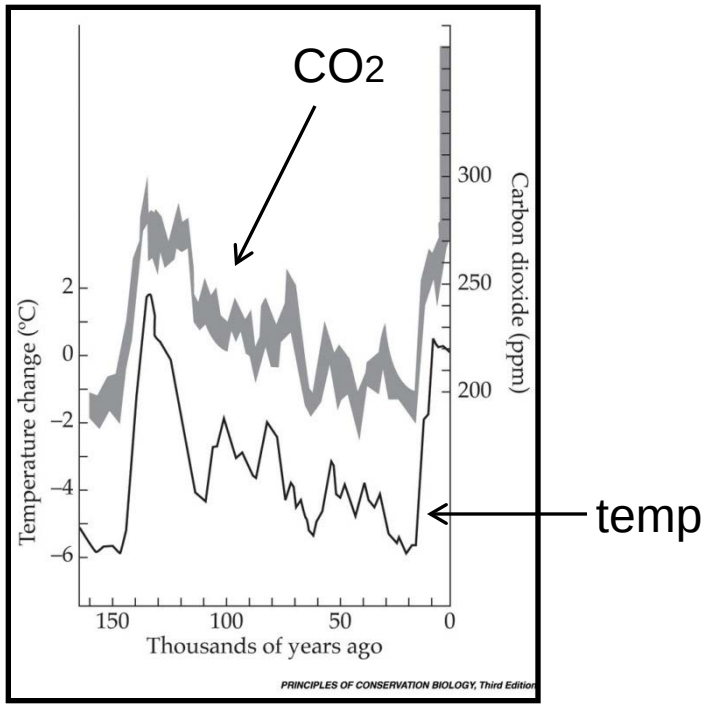
- **Global climate varies based on the observer's time scale; temperatures have been cooling over the past 50-60 million years.**

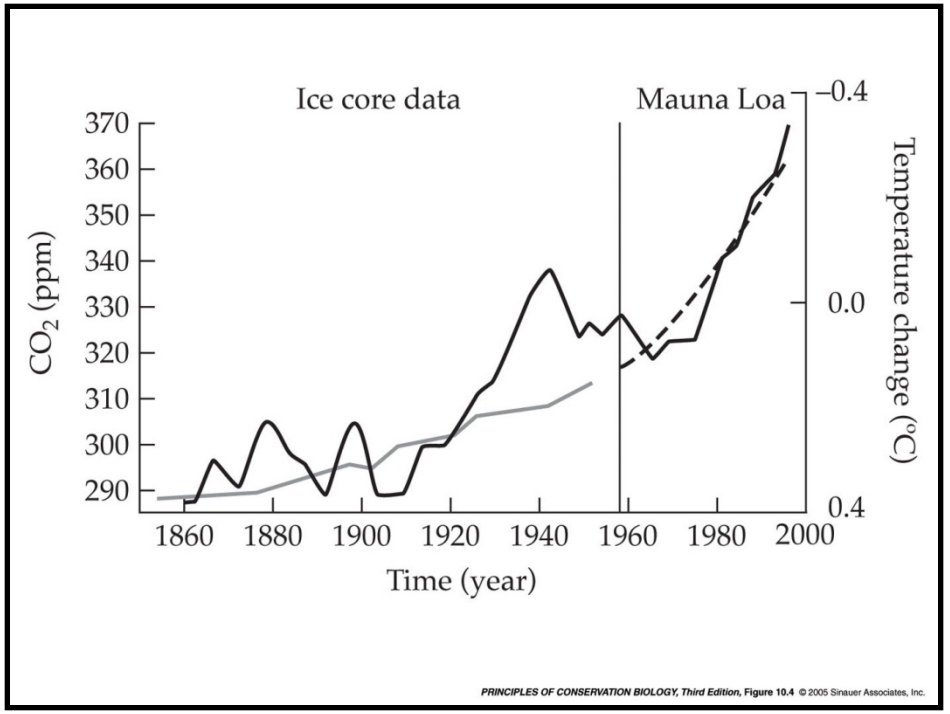


# Scientific basis of climate change

- **Data from oxygen isotope ratios in ice cores demonstrates a positive correlation between temperature change and carbon dioxide.**

- **Atmospheric carbon dioxide levels rose 36% since 1910—from 280-380 ppm.**



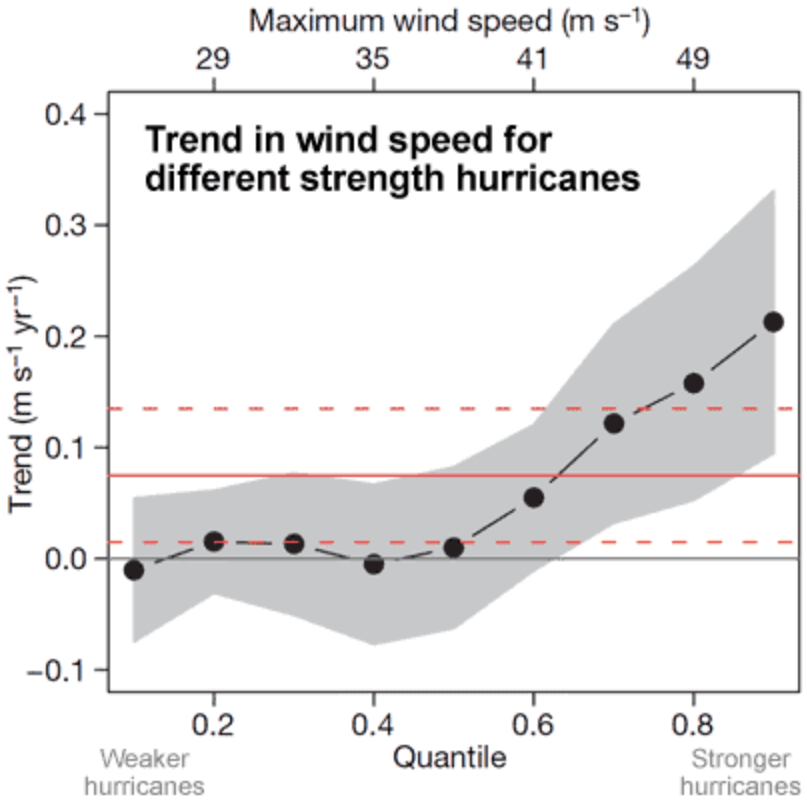



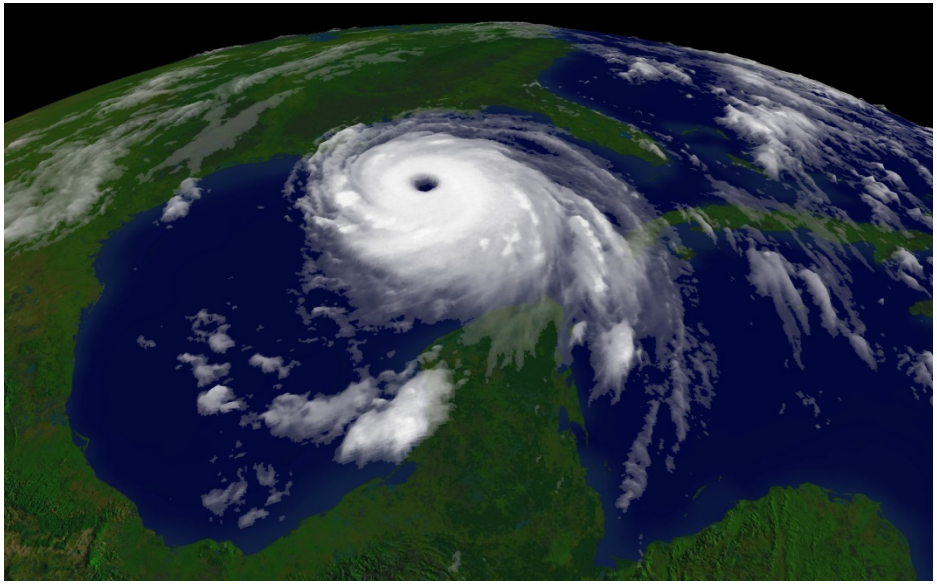
# Scientific basis of climate change

- **carbon sink = a process that removes carbon from atmospheric circulation (e.g., growth of forests).**

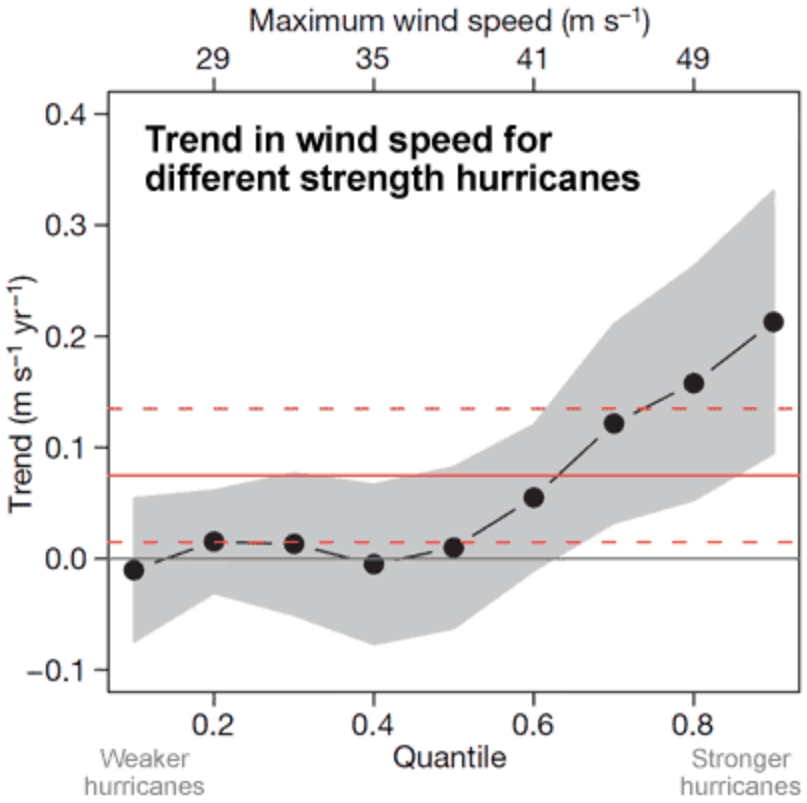
- **carbon source = a process that releases stored carbon into the atmosphere (e.g., elevated industrial activity).**

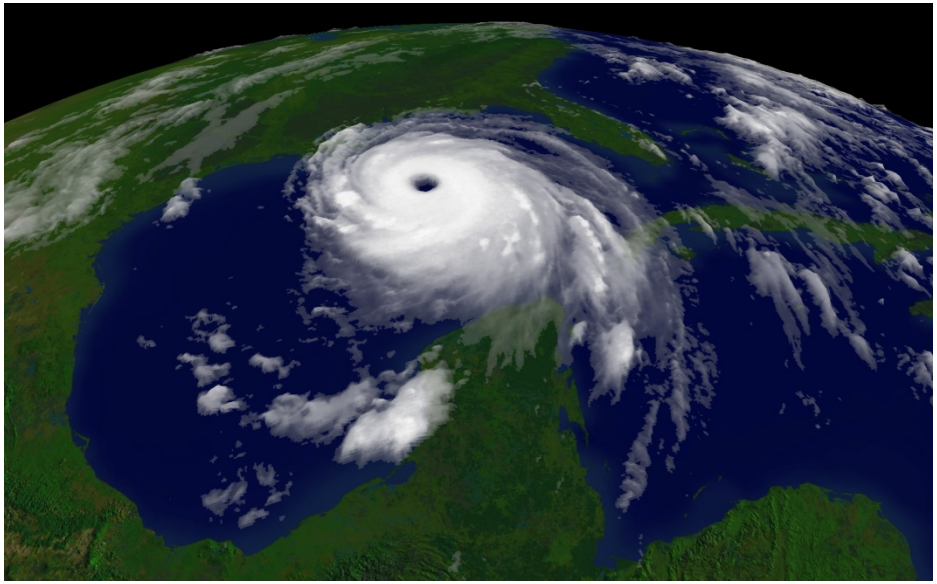
- **# Americans killed by domestic terrorism since 2001 = 2997**



- **# Americans killed by hurricanes, tornados, and floods since 2001 = 2772**



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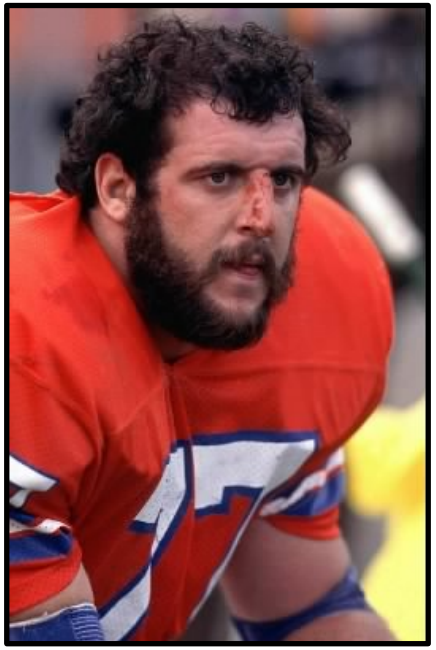
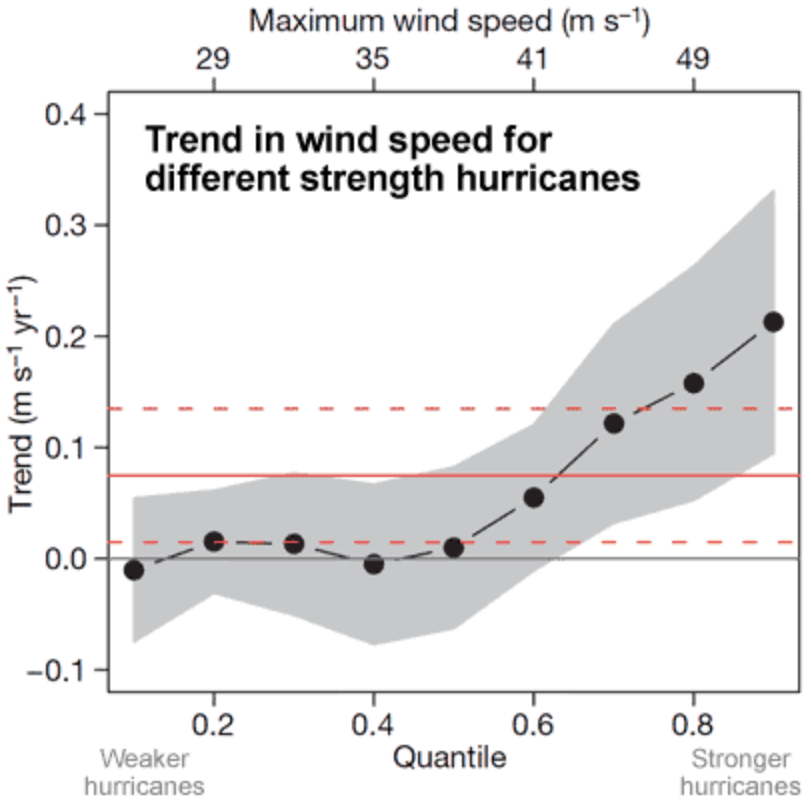
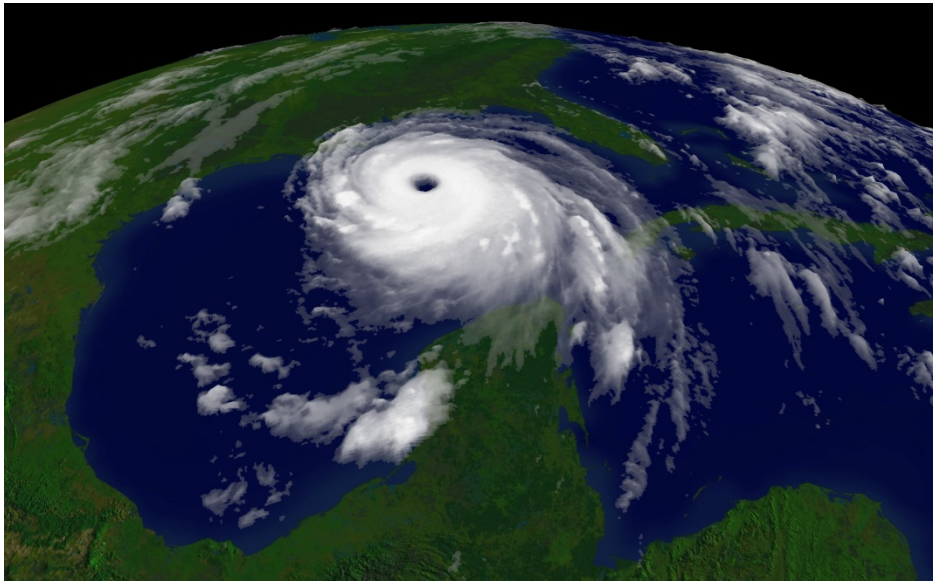
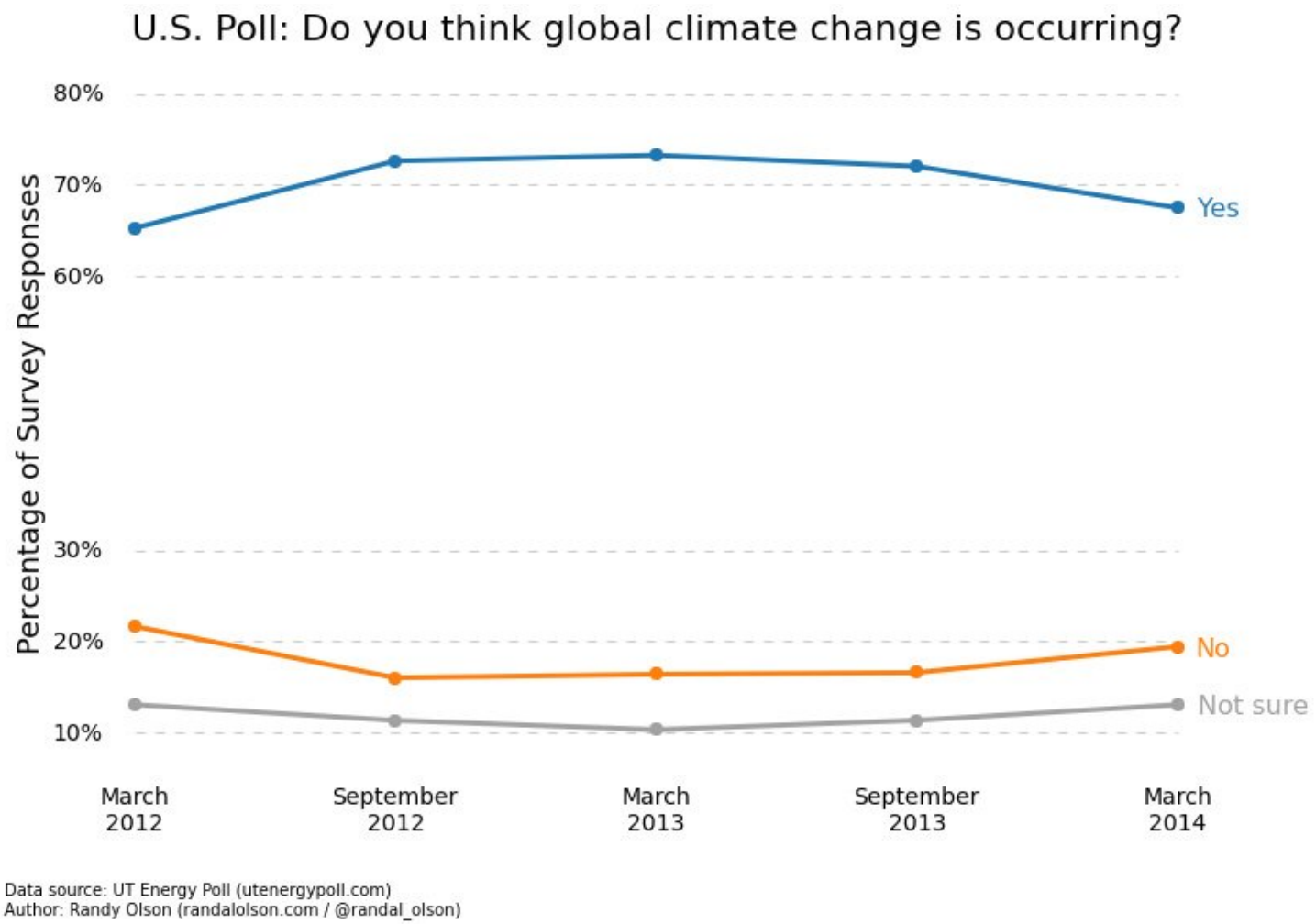




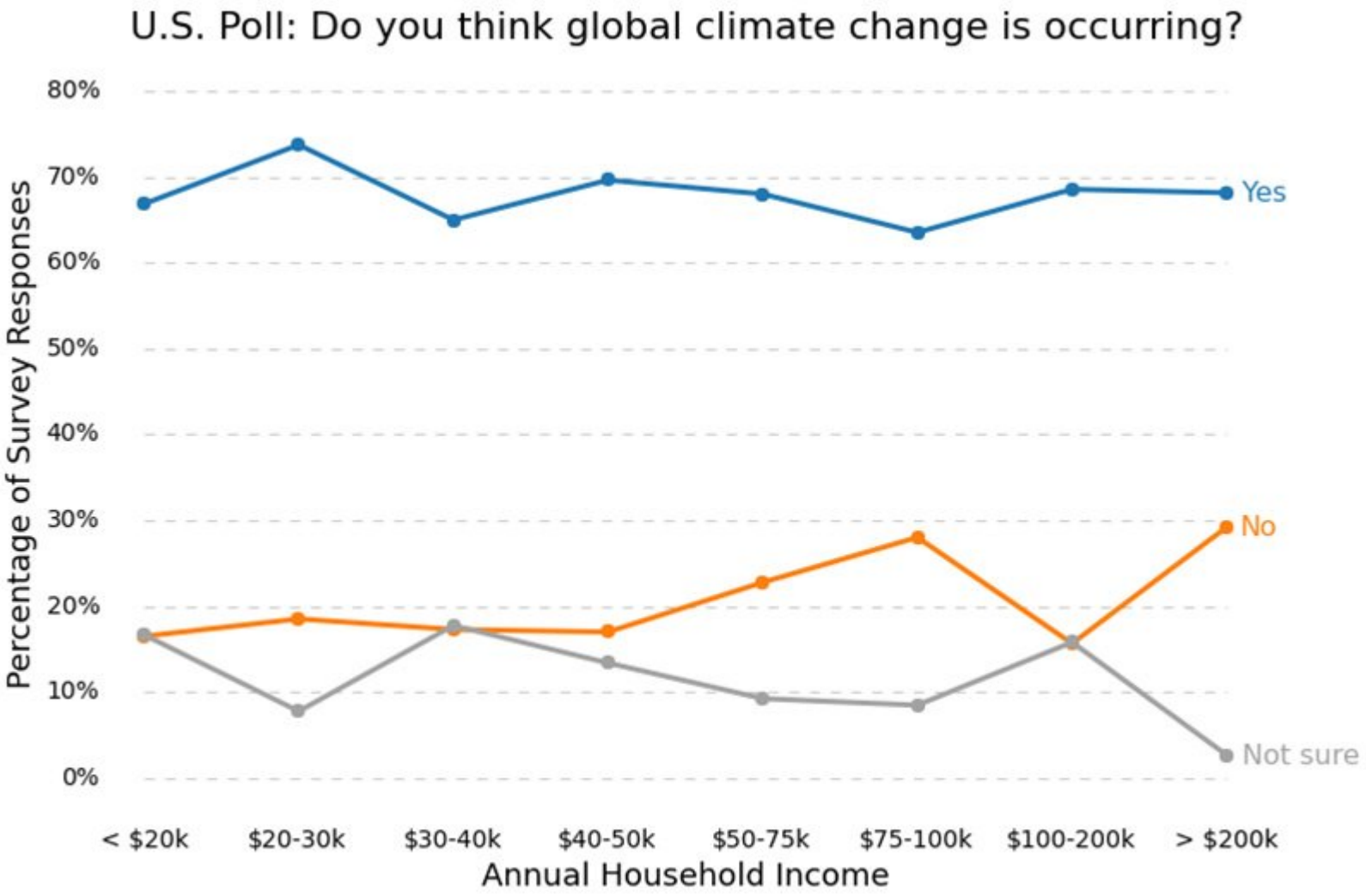



# Politics and climate change



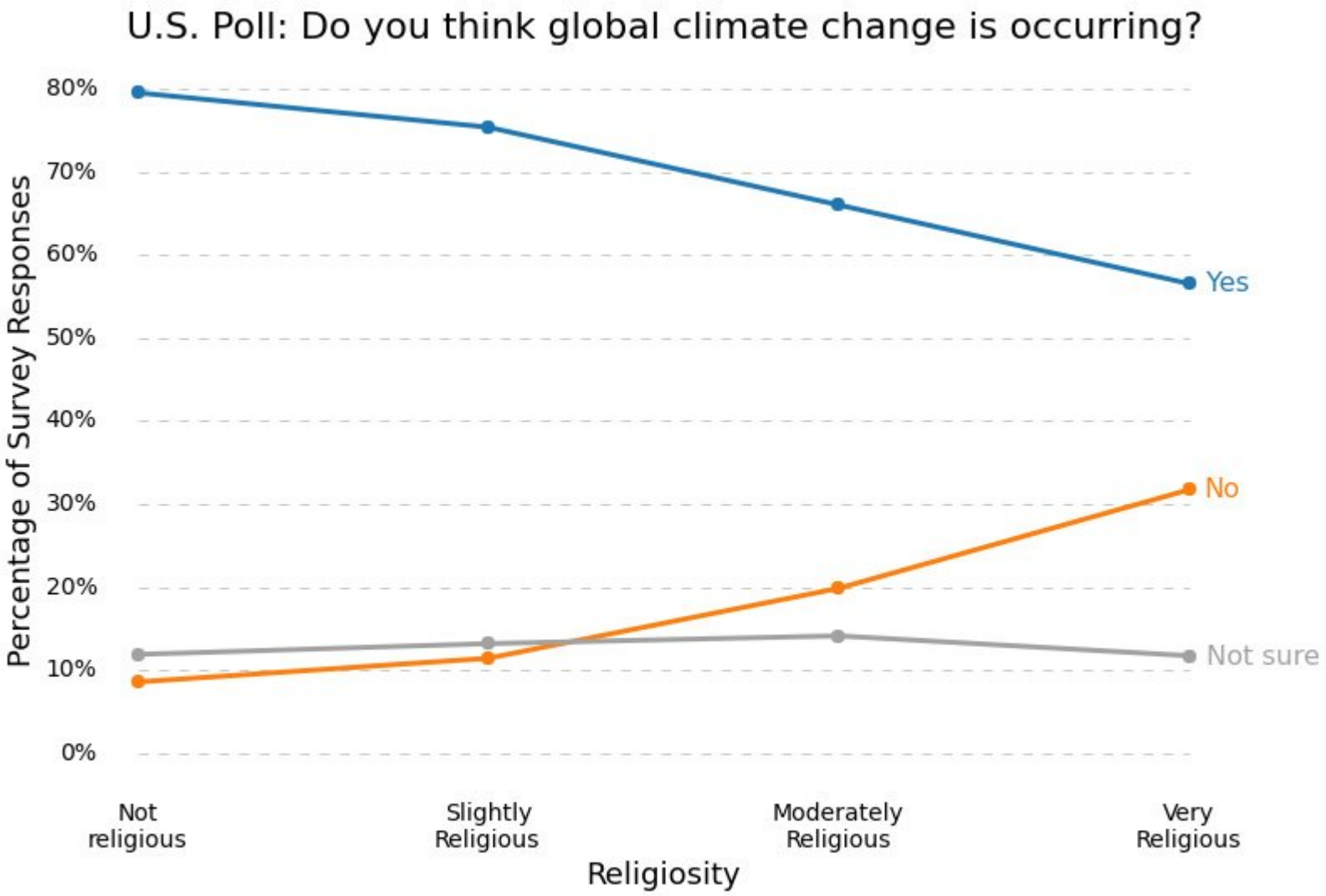

Data source: UT Energy Poll (utenergypoll.com)
Author: Randy Olson (randalolson.com / @randal_olson)

# Politics and climate change




Data source: UT Energy Poll (utenergypoll.com), Wave 6 (March 2014)
Author: Randy Olson (randalolson.com / @randal_olson)

# Politics and climate change

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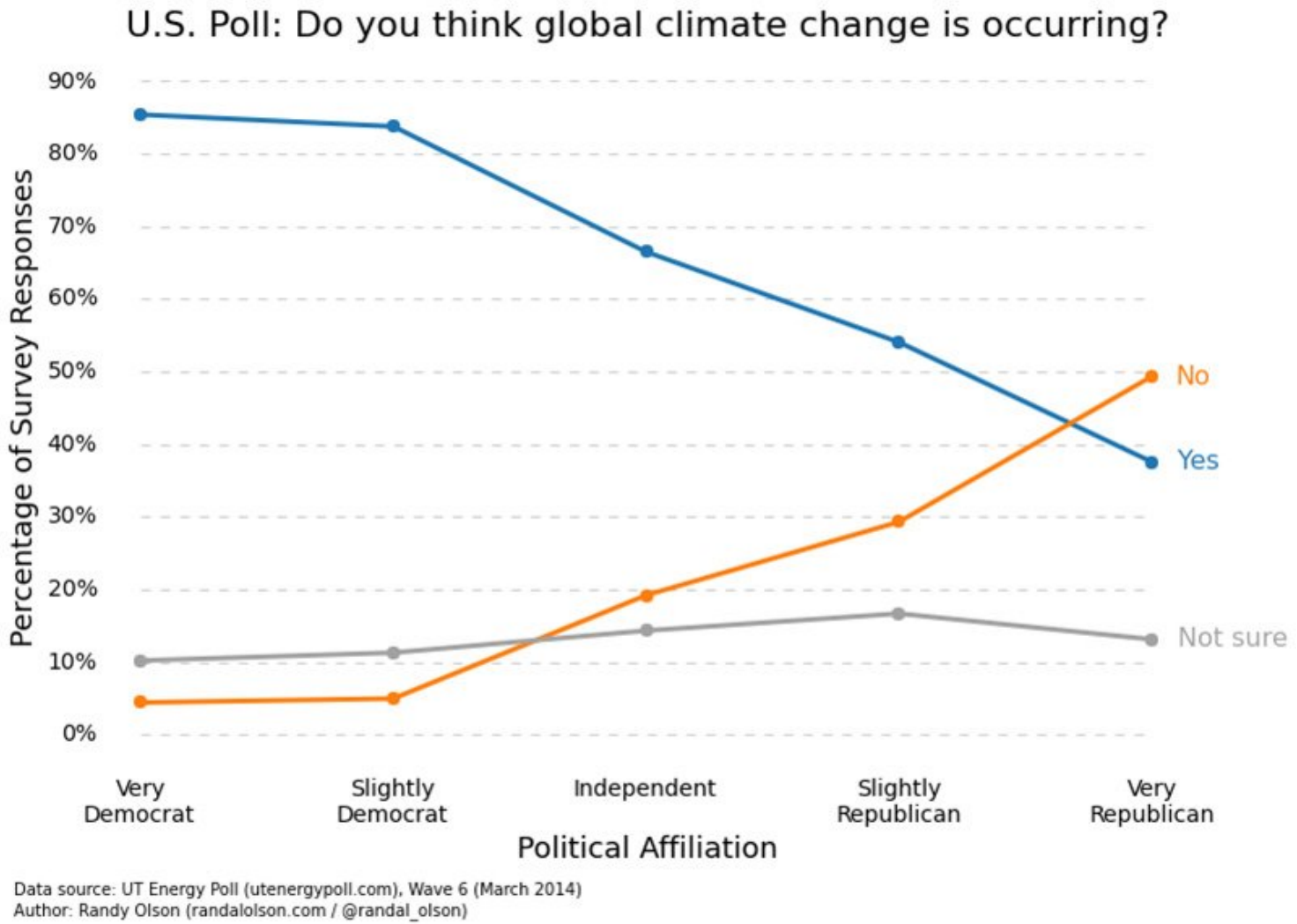


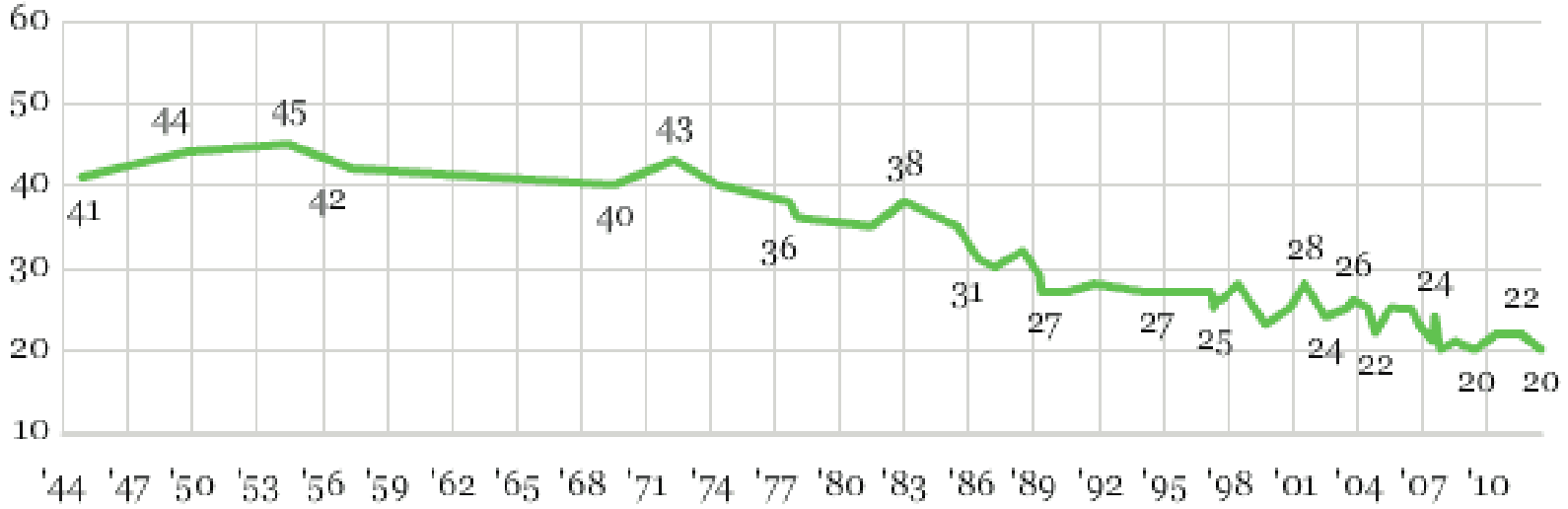
# Climate change, denial, and cultural shifts

# Climate change, denial, and cultural shifts




*Percentage of U.S. Adults Who Smoke Cigarettes, 1944-2012*

Have you, yourself, smoked any cigarettes in the past week? (% yes shown)




GALLUP

# Why has climate change become a cultural/political issue?

# <u>Why</u> has climate change become a cultural/political issue?


1) **The "figureheads" for climate change are mostly democrats.**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# Why has climate change become a cultural/political issue?


**2) Admitting humans are at the root of climate change may force economically-costly action**

# Why has climate change become a cultural/political issue?

Wyoming Schools Won't T...

7/3412131/wyoming-rejects-ngss/

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CLIMATE

## Wyoming Schools Won't Teach Kids About The Reality Of Climate Change

BY KATIE VALENTINE MAR 17, 2014 2:04PM

CREDIT: AP PHOTO/STEVE RUARK

Share 1,495 Tweet 282

Wyoming has become the first state to reject new national science education standards, a decision based in part on some Wyoming lawmakers' concerns that the standards teach climate change as a scientifically-accepted phenomenon.

**2) Admitting humans are at the root of climate change may force economically-costly action**

**"the standards handle global warming as settled science"—Rep. Matt Teeters (R)**

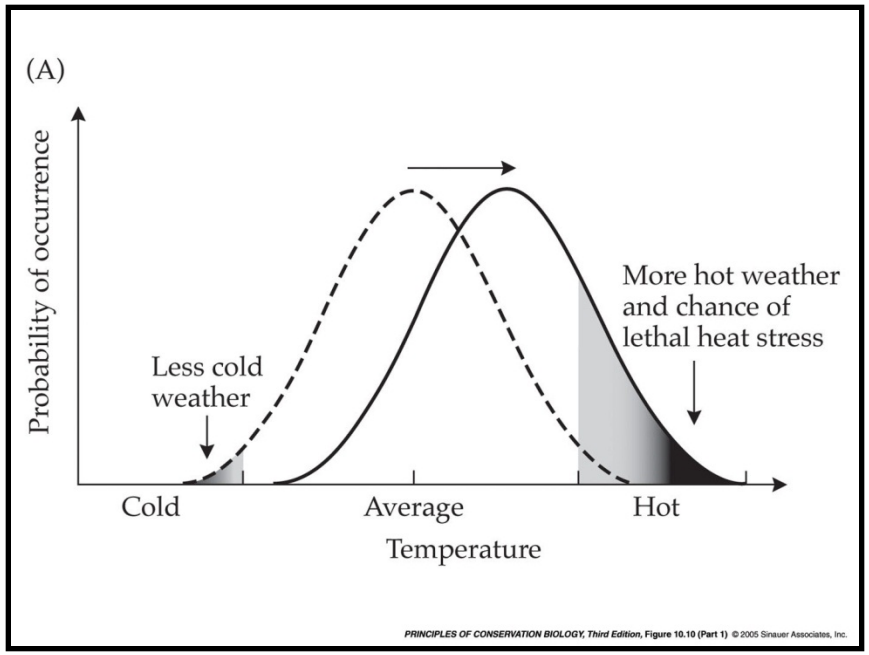
**"I don't accept, personally, that climate change is a fact. The standards are very prejudiced in my opinion against fossil-fuel development"—State Board of Education Chair Ron Micheli**

# Why has climate change become a cultural/political issue?


**3) Economically-costly action will require strong, federal interventions, taxation, and public adaptation. IOW "big government".**


# Thresholds and responses to extreme weather

- **many biological processes undergo sudden shifts at particular thresholds (e.g., upper lethal temperatures, frost tolerances, etc).**





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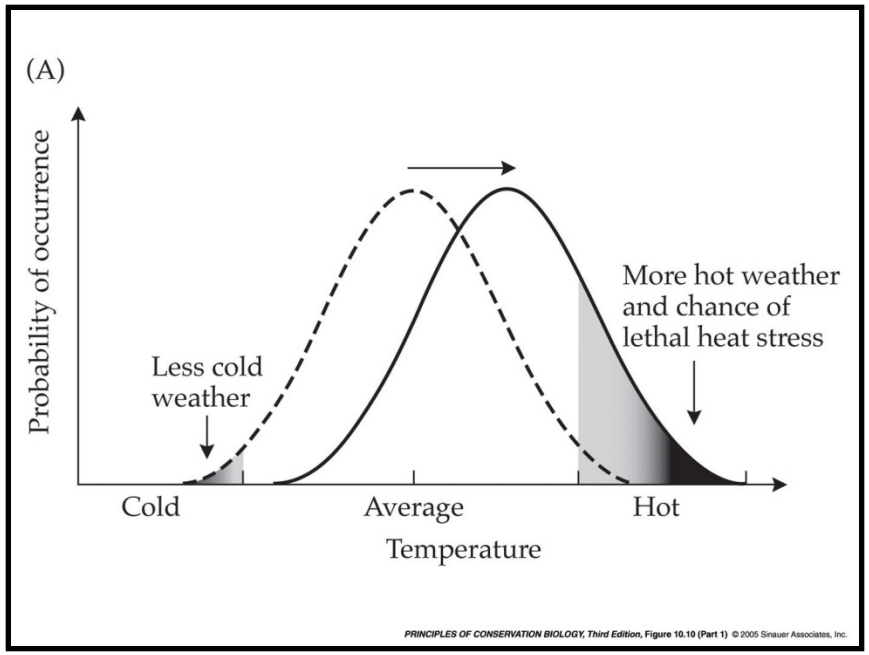


- Increase in mean temp leads to more record hot weather, greater heat stress, and more lethal events due to heat.


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# Thresholds and responses to extreme weather

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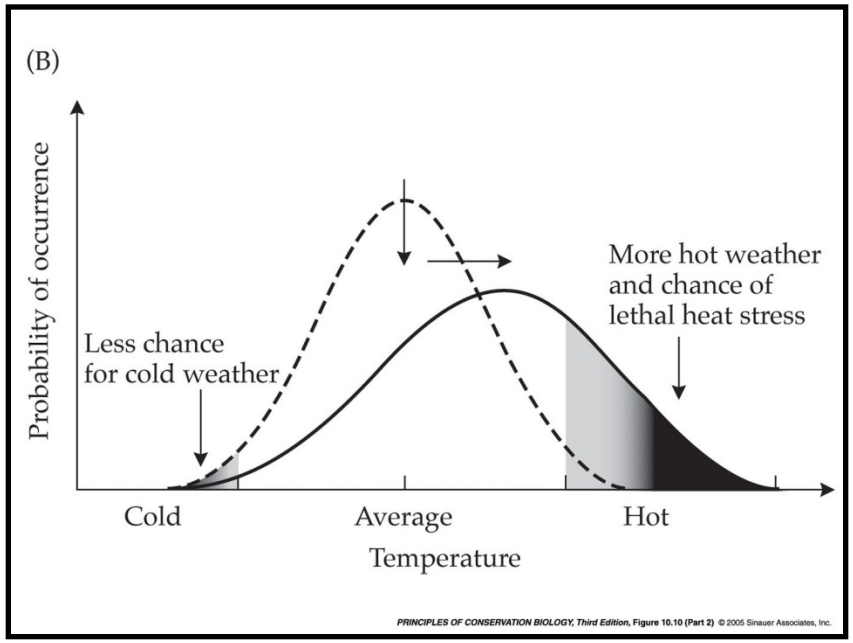



- Increase in temp mean and variance leads to much greater heat stress and even more lethal events.


27

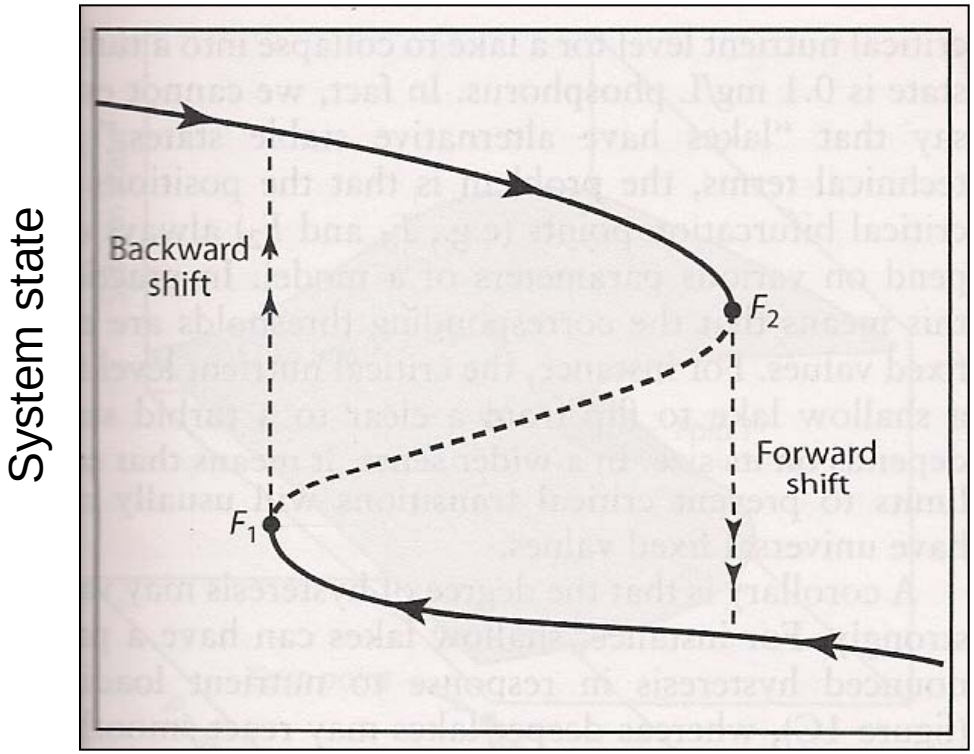
# Thresholds and responses to extreme weather

- **mass die-offs of budgerigars and zebra finches in western Australia in response to record (45° C) temps for ~10 days.**

# Alternative Stable States Defined

- **abrupt, irreversible shifts that occur once a threshold (or "tipping point") is crossed.**

- **different stable states (e.g., woodland/grassland) that can exist under the same external conditions**



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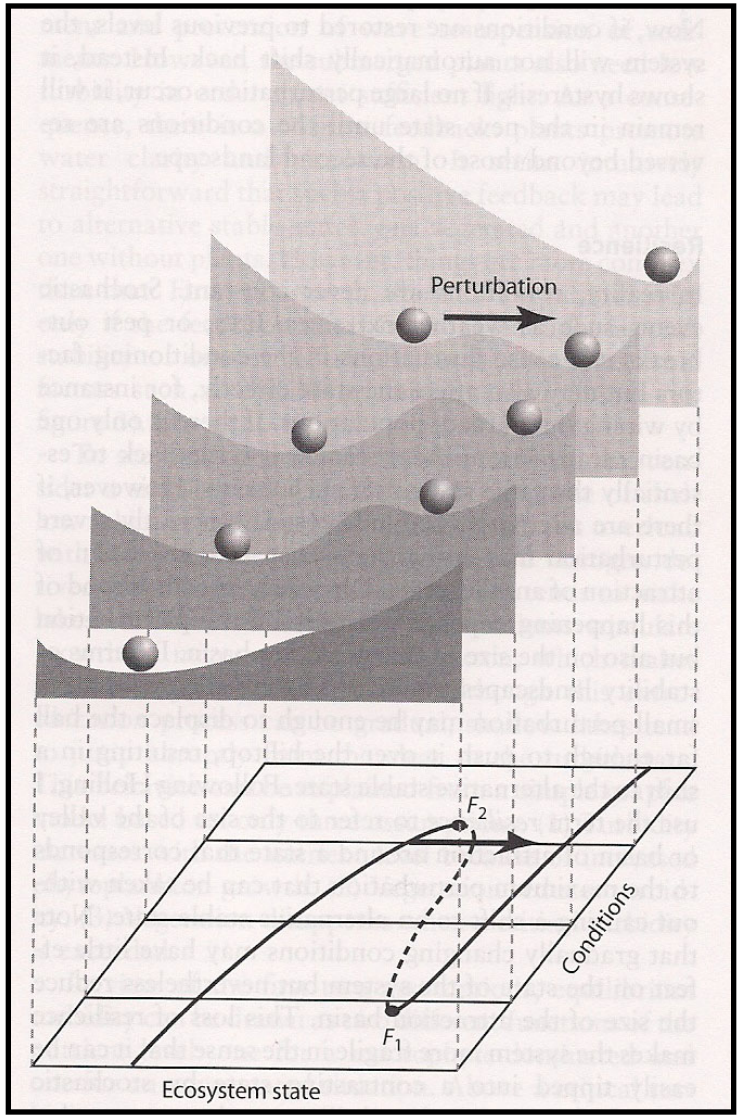


- **<u>resilience</u> is the tendency of an ecosystem to return to a previous state; refers to the size of the "valley" around a state**

- **<u>resistence</u> is the maximum perturbation that a system (usually community, sometimes ecosystem) can withstand without shifting to an alternative stable state**

**Discussion Q: Given we know alternative stable states have existed in Earth's biosphere in the past, why should we exercise caution in extrapolating the effects of climatic conditions from climate change into the future?**