Tribal Climate Change Webinar Series

June-July 2013

Hosted by
Institute for Tribal Environmental Professionals
Northern Arizona University
http://www4.nau.edu/itep/

Tribal Climate Change Webinar Series

- June 13: Climate Change—What it is and why it's important
- June 18: Indicators of Climate Change
- June 25: Climate Change Impacts on Tribes
- July 12: Climate Change Outreach and Education

For more information about the webinars:

http://www4.nau.edu/itep/climatechange/tcc_webinars.asp

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For more information about ITEP, please visit our website:
http://www4.nau.edu/itep/

Climate Change – The Basics

CLIMAS
Climate Assessment for the Southwest

Zack Guido

Research Staff Scientist

Climate Assessment for the Southwest (CLIMAS)

Climate Change 101(+):

An overview of the climate system, observations & projections

ITEP Climate Change Webinar Series (part 1)
June 13

Zack Guido
Climate Assessment for the Southwest (CLIMAS)

ARIZONA

Institute of the Environment

CLIMAS
Climate Assessment for the Southwest

Big Picture Outline

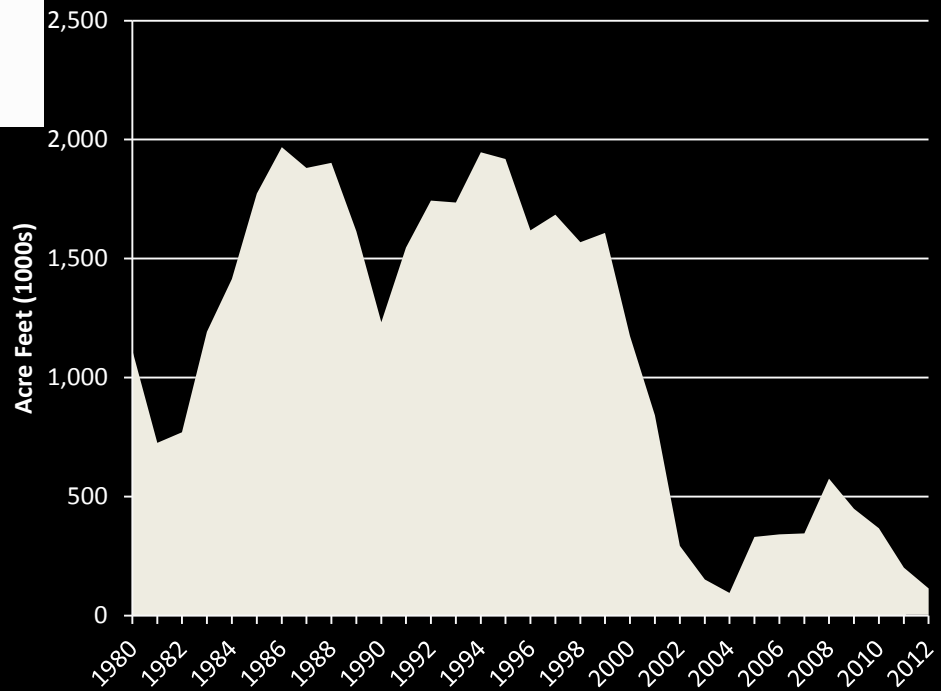
1. **The Climate System** (20 mins + 5 for Q&A)
2. **Observations** (15 mins + 5 for Q&A)
3. **Projections** (15 mins + 10 for Q&A)

In the Next 20 mins…

1. Why we care
2. How the climate system works
3. Energy Balance
4. Paleoclimate
5. Greenhouse gasses

The Rio Grande

The Rio Grande



The Rio Grande

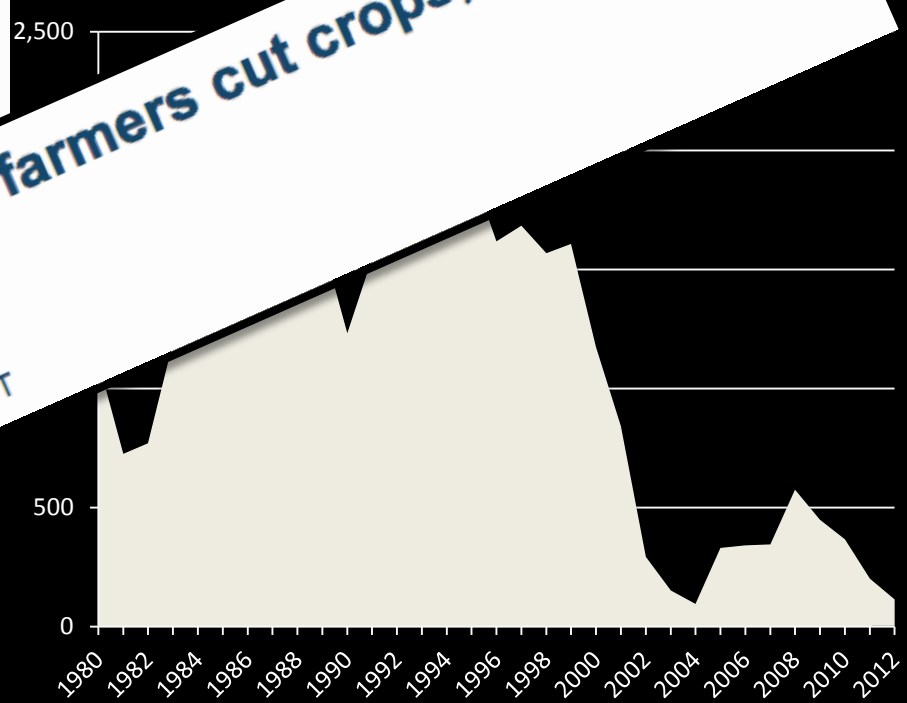
New Mexico Farmers Seek 'Priority Call' as Drought Persists

NY Times

By FELICITY BARRINGER
Published: March 26, 2013

New Mexico, El Paso farmers cut crops, use wells in drought

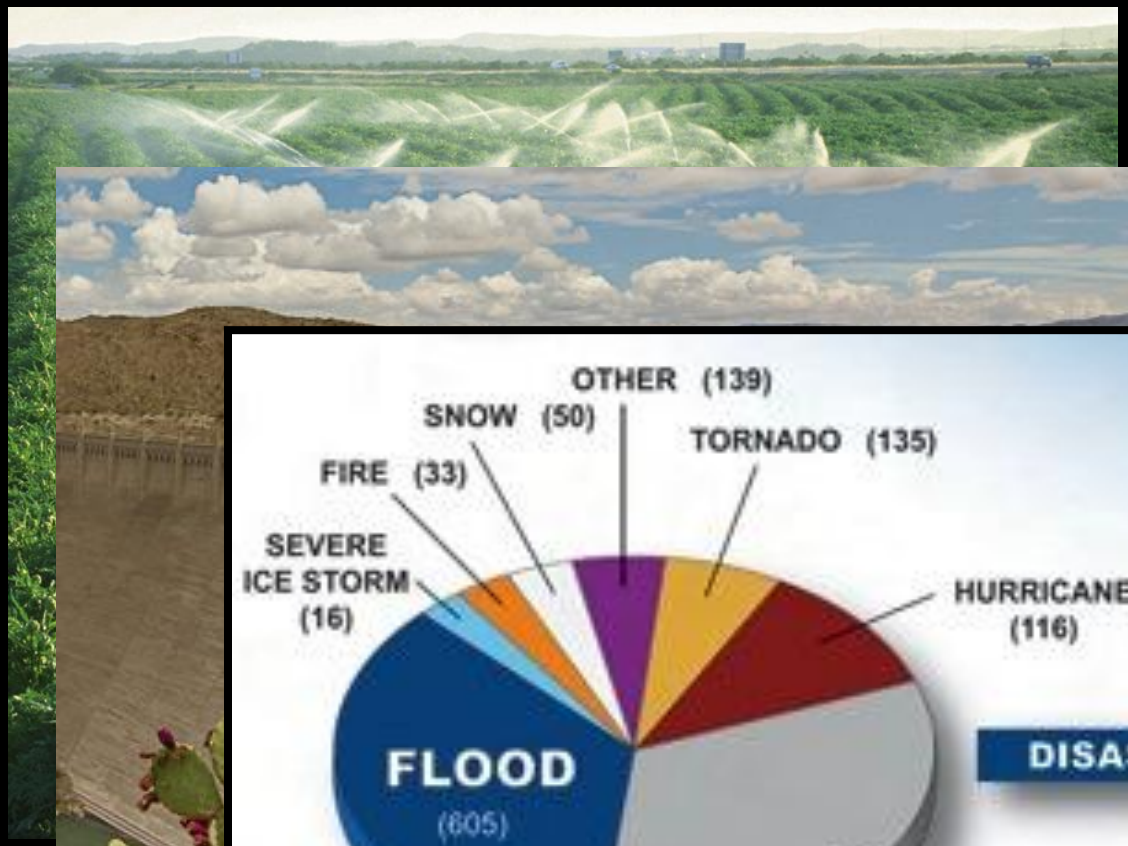
By Ramón Rentería \ El Paso Times
Posted: 05/06/2013 12:12:49 AM MDT



Food supply

Food supply

Water supply

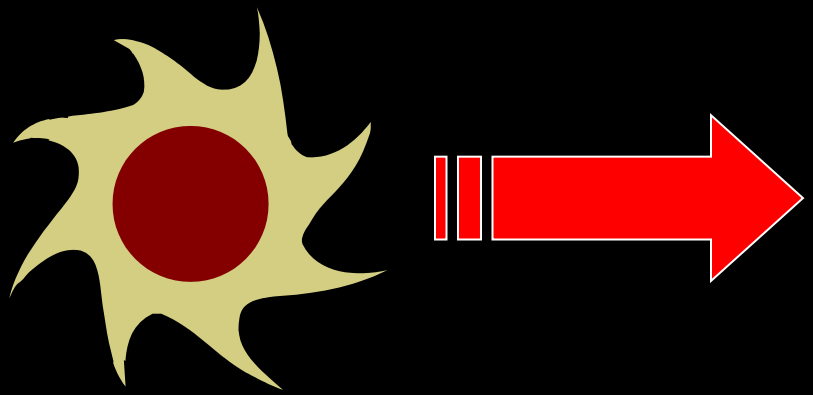


Food supply

Water supply

Disasters

Sun Drives Circulation



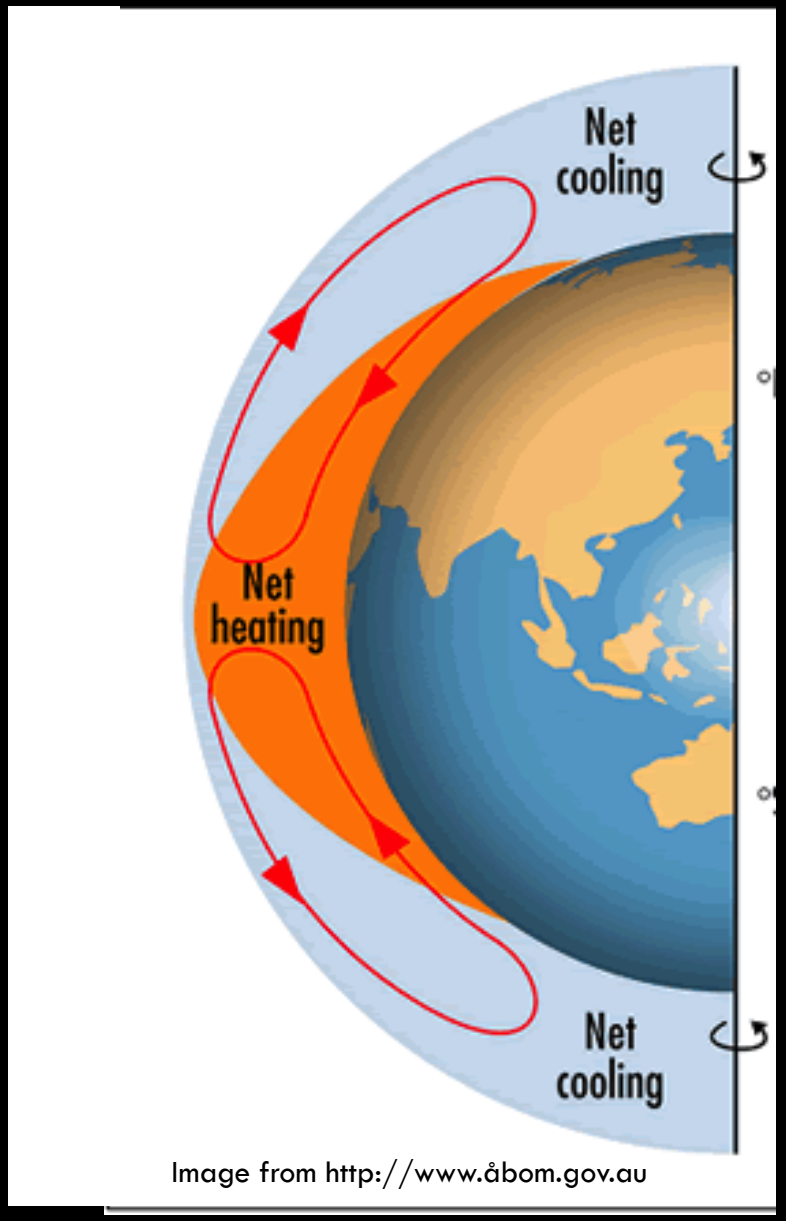
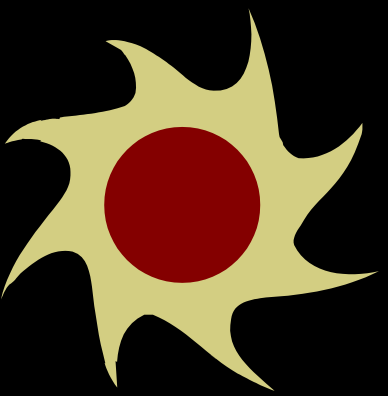


Image from http://www.åbom.gov.au

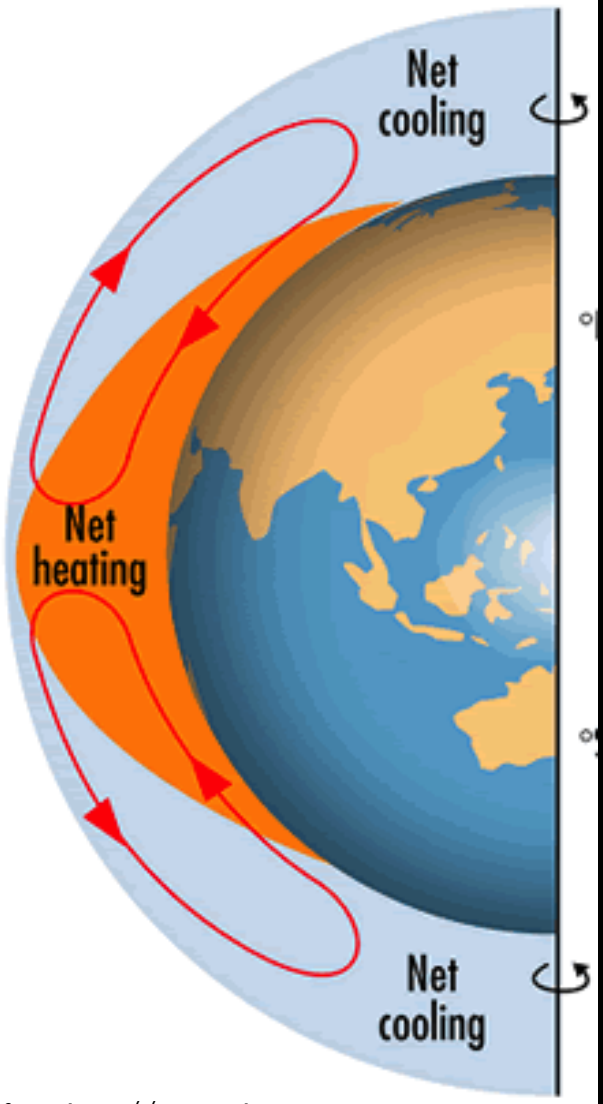
Energy Balance



Solar Constant =

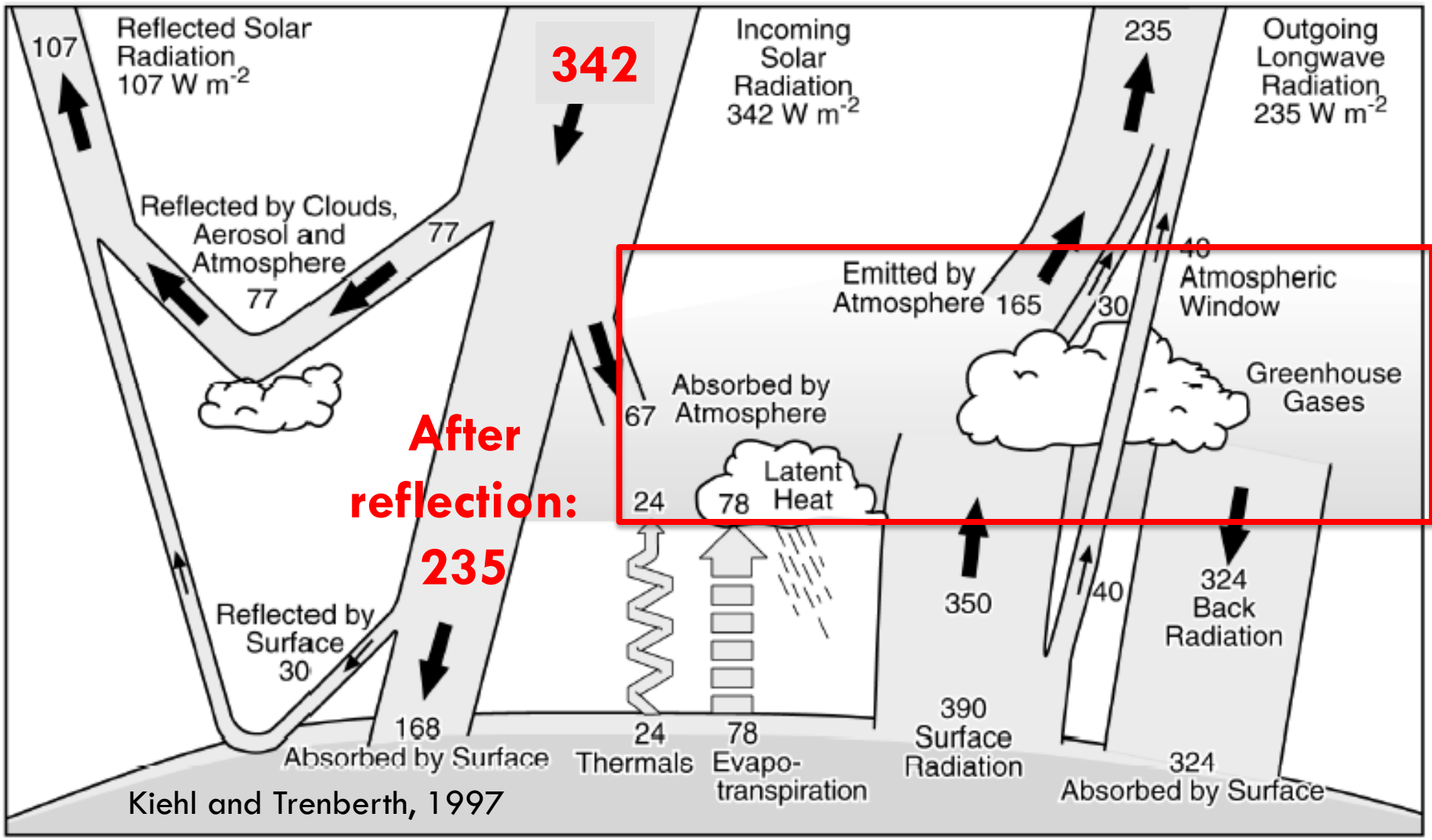
1370 W/m^2

342 W/m2



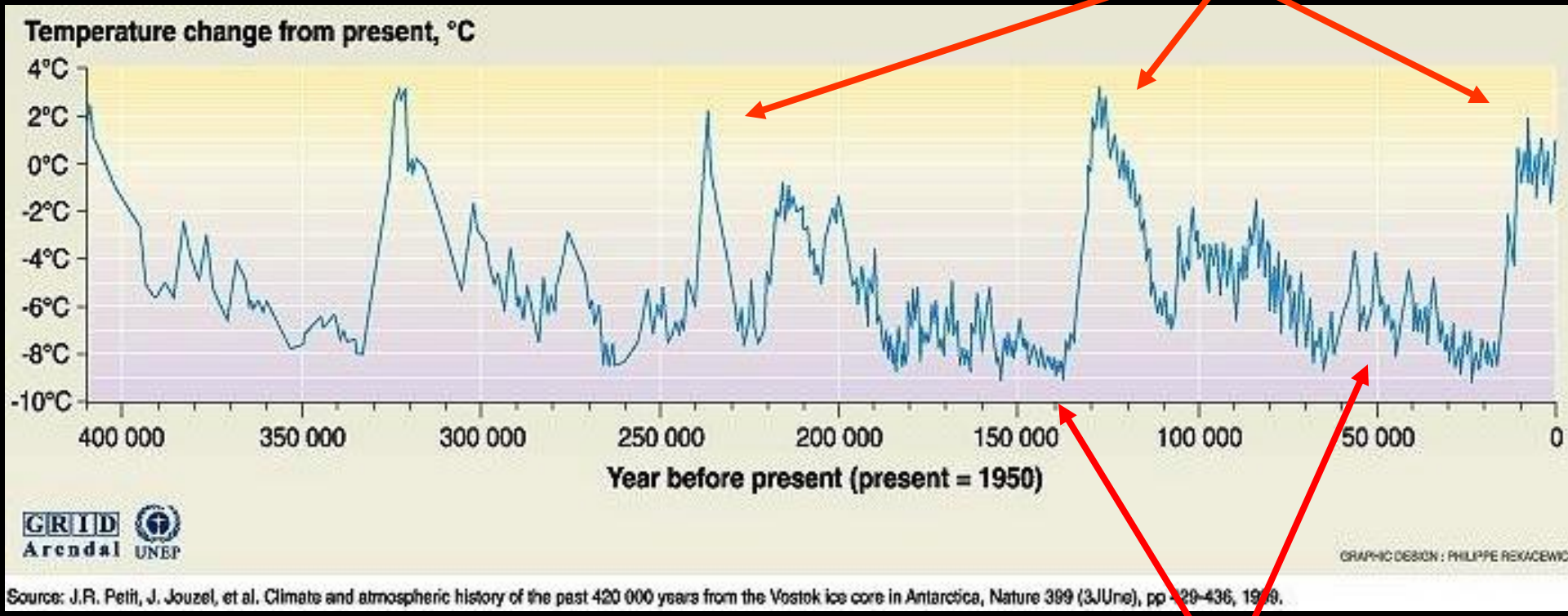
age from http://www.åbom.gov.au

Energy Balance:
Sun drives the climate system and is moderated by GHG



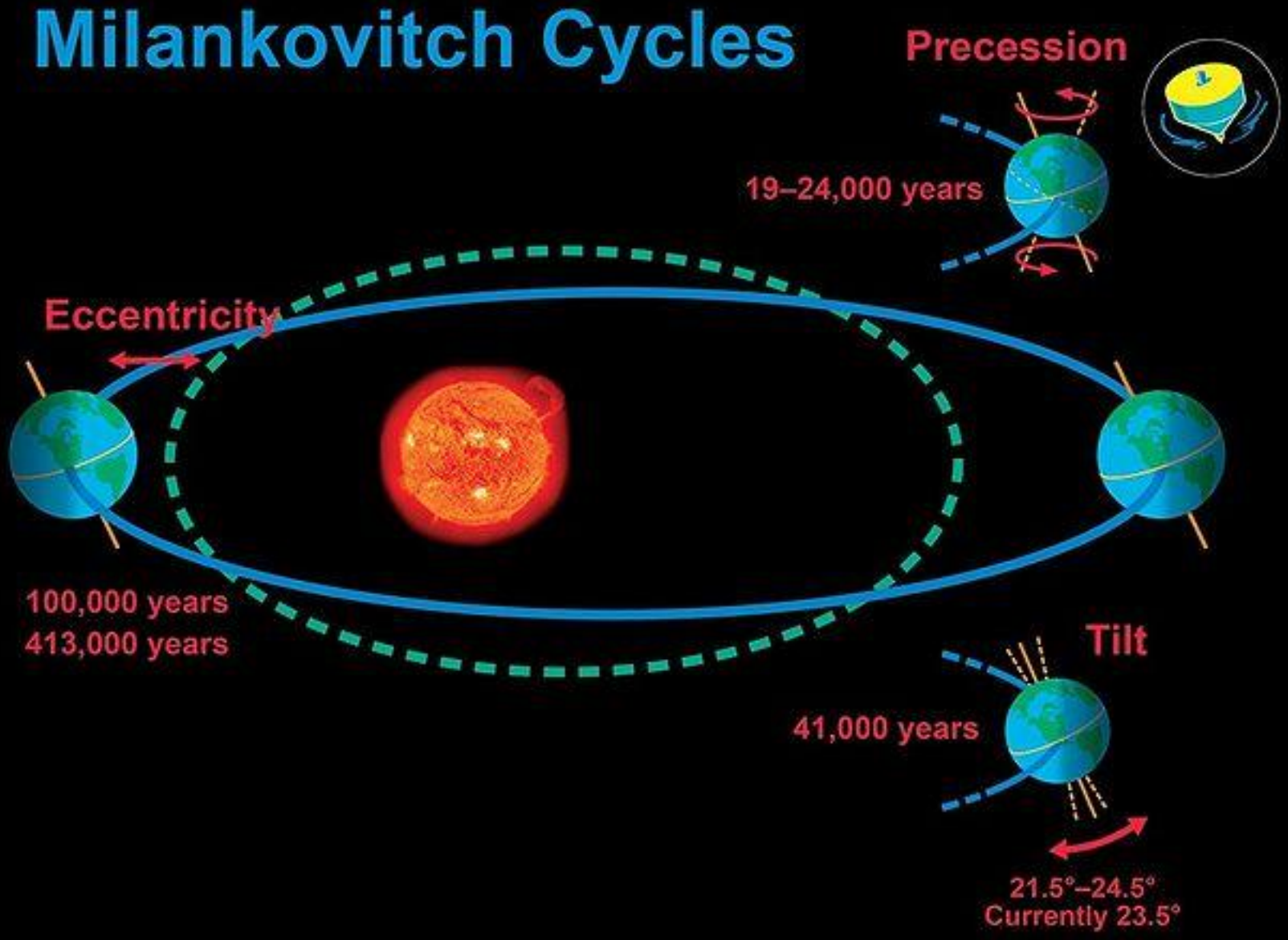
Kiehl and Trenberth, 1997

Warmer Climates;
High Solar Radiation

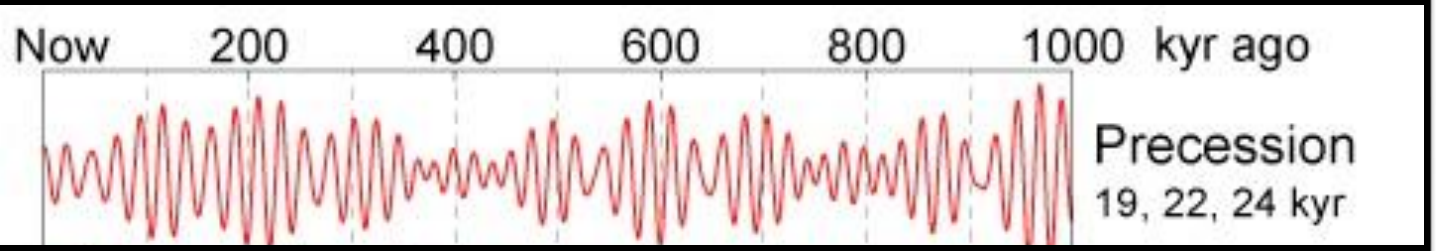


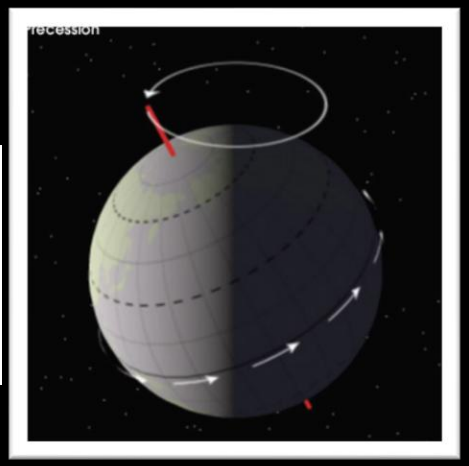
Glaciation;
Low Solar Radiation

Petit et al. 1999; Siegenthaler et al. 2005


Milankovitch Cycles
Precession
19–24,000 years
Eccentricity
100,000 years
413,000 years
Tilt
41,000 years
21.5°–24.5°
Currently 23.5°

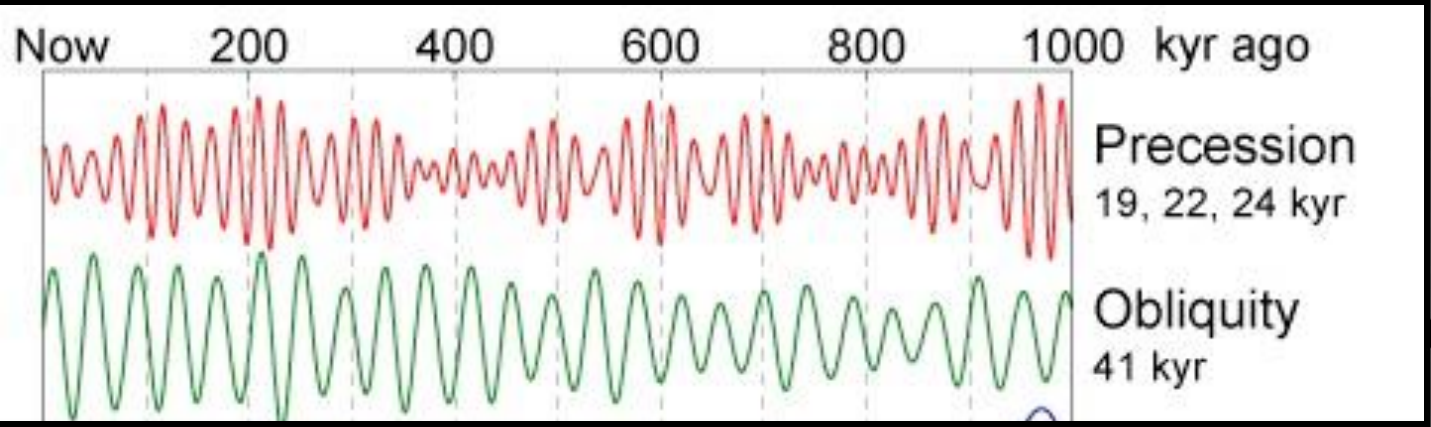
Orbital changes

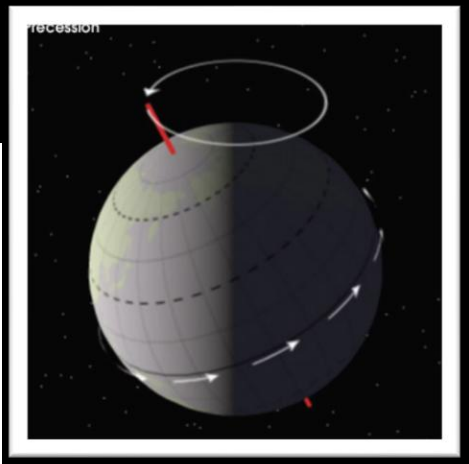


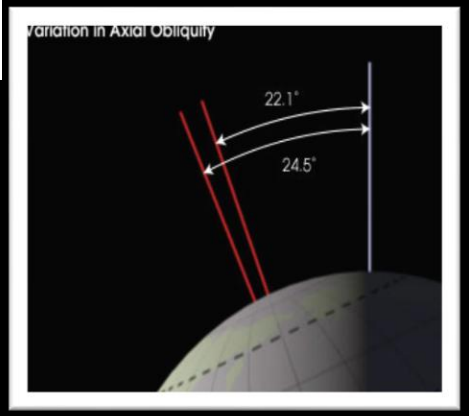


Images obtained from: www.wikipedia.org

Orbital changes

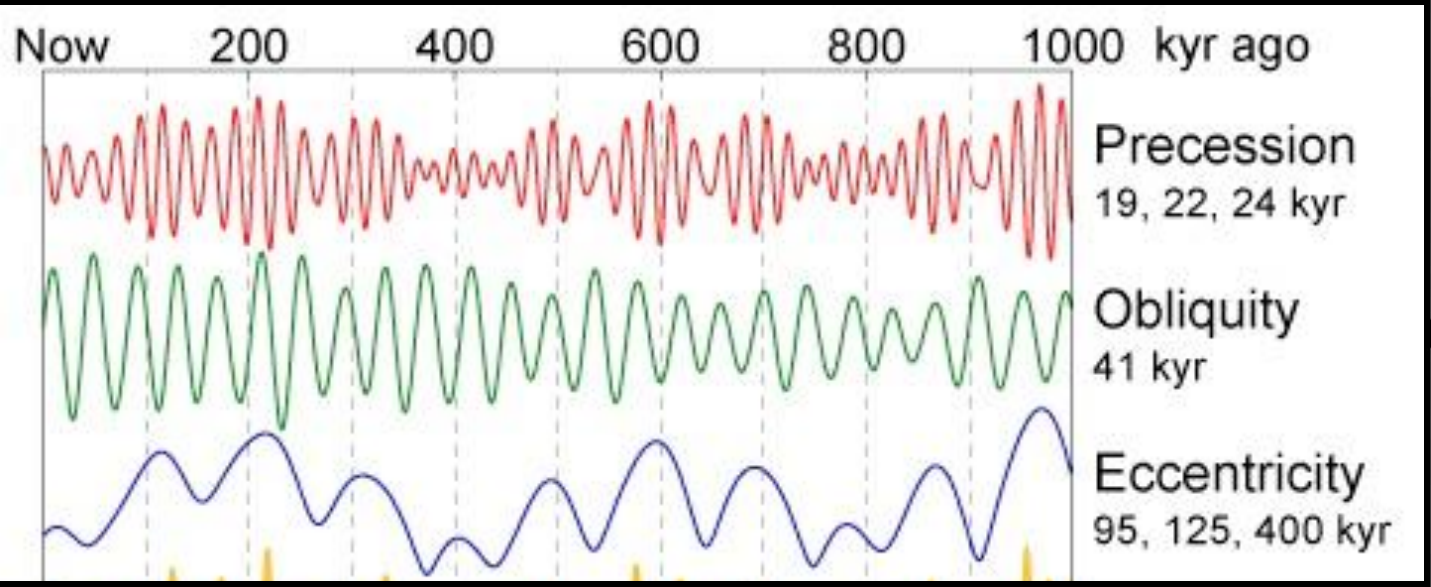


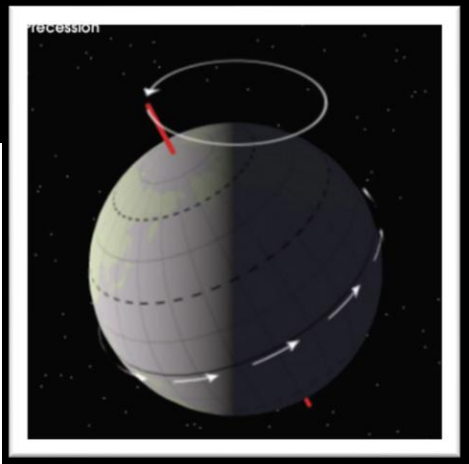


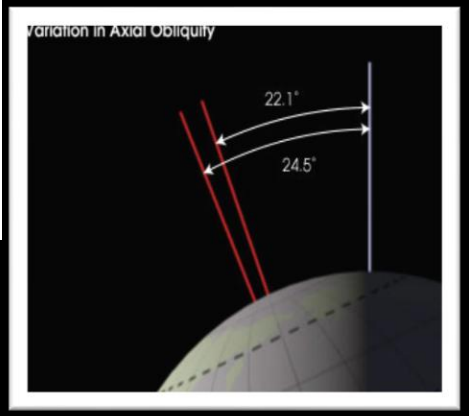


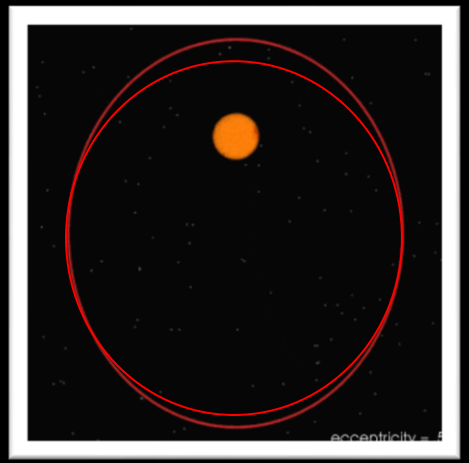
Images obtained from: www.wikipedia.org

Orbital changes



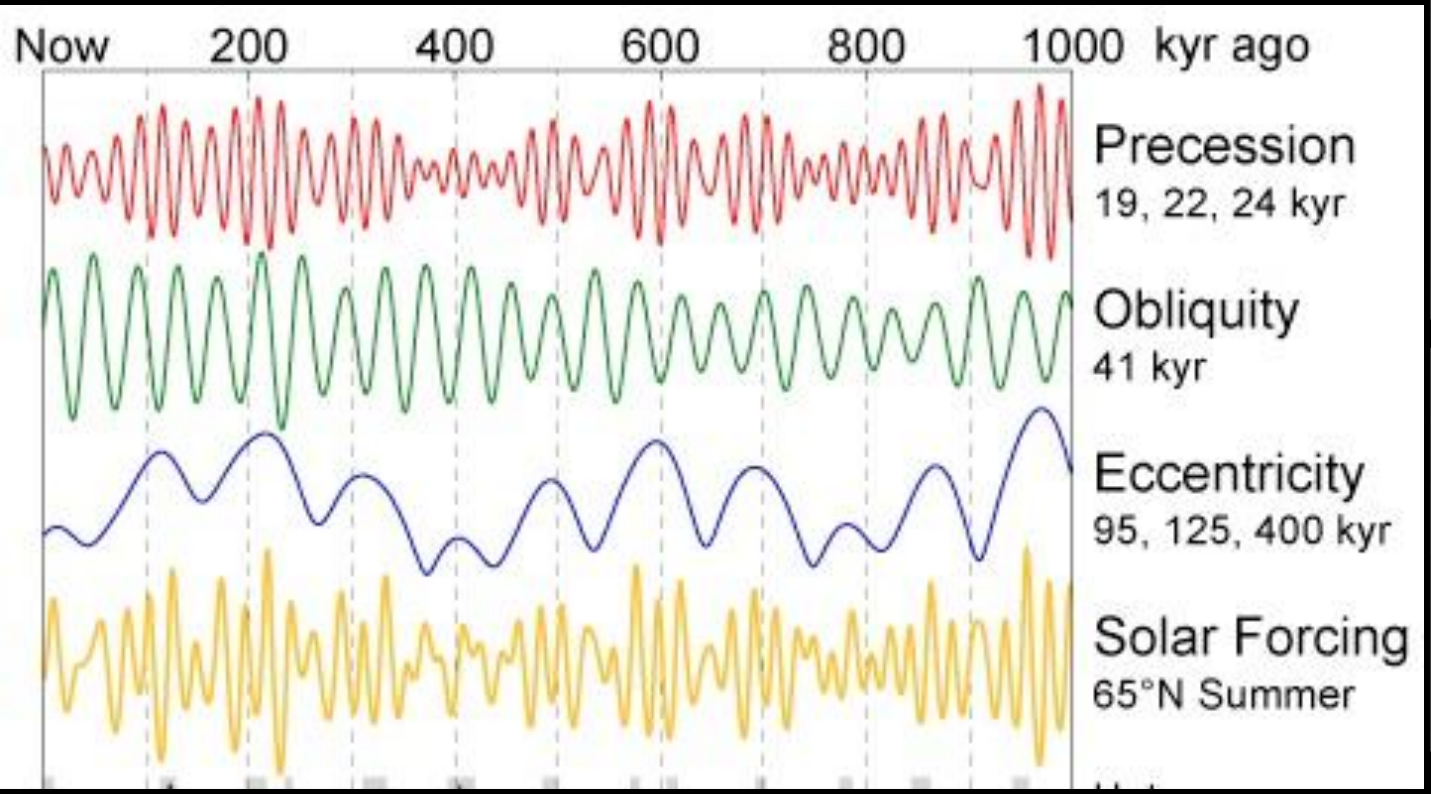


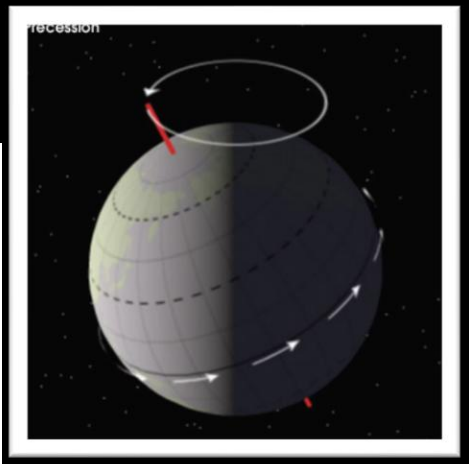


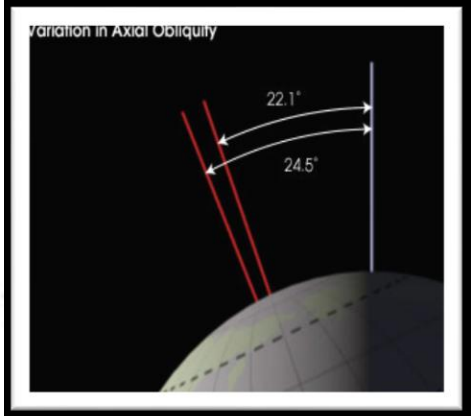


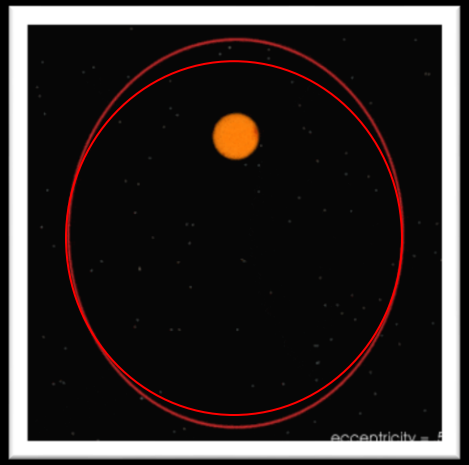
Images obtained from: www.wikipedia.org

Orbital changes



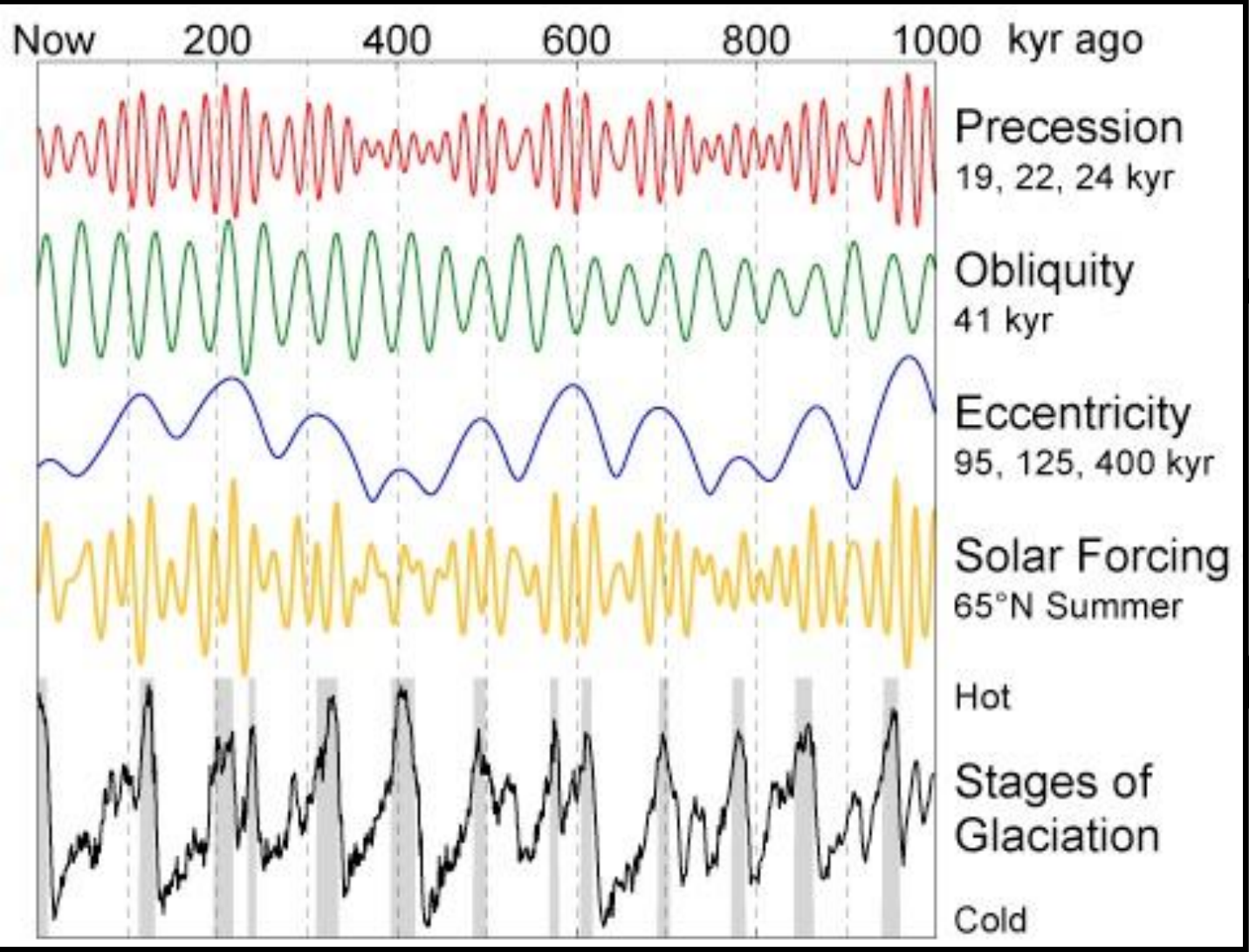


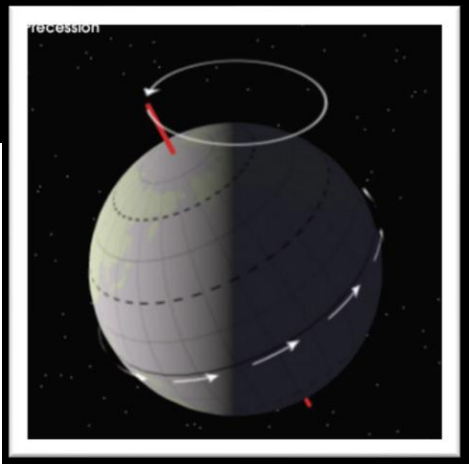


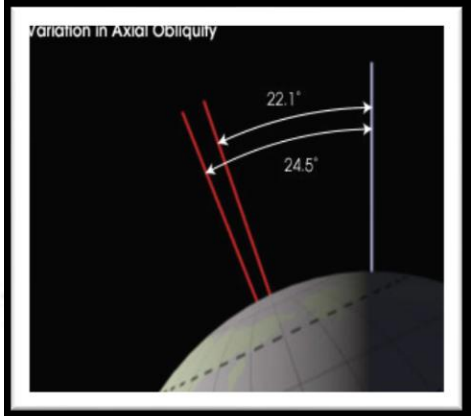


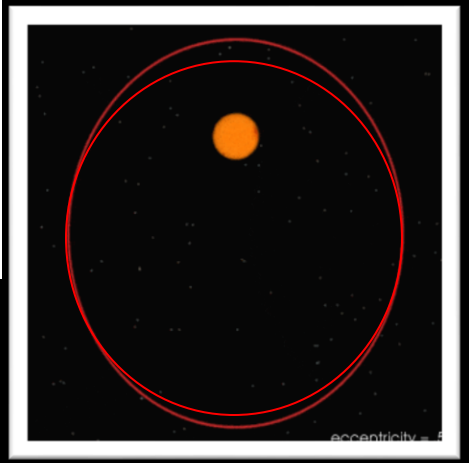
Images obtained from: www.wikipedia.org

Orbital changes



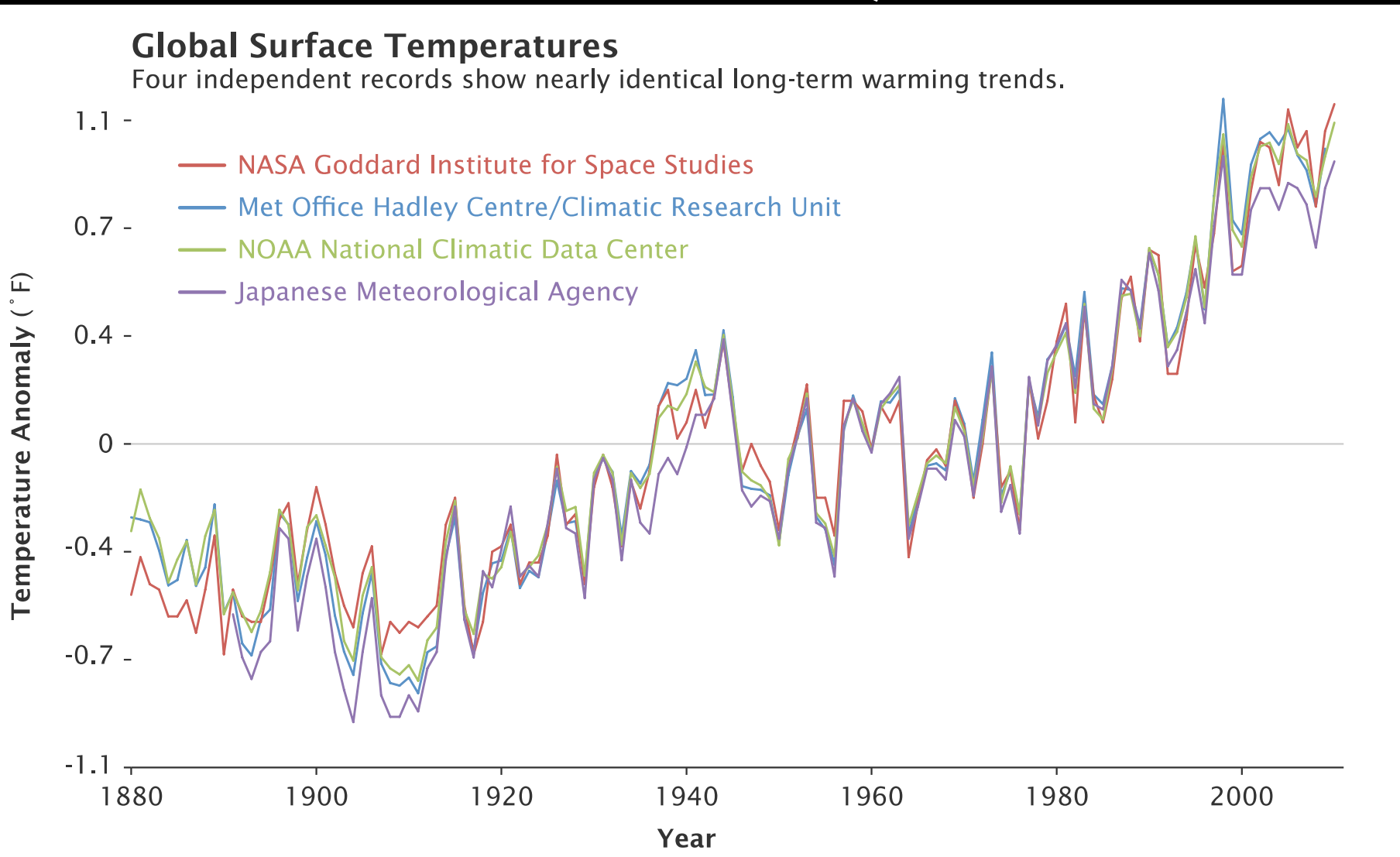






Images obtained from: www.wikipedia.org

"2010 ties 2005 as the warmest year in the 131-year instrumental record"—*NASA, Jan 2011*



Credit: NASA Earth Observatory/Robert Simmon

http://www.giss.nasa.gov/research/news/20110113/

Data Sources: NASA Goddard Institute for Space Studies, NOAA National Climatic Data Center, Met Office Hadley Centre/Climatic Research Unit, and the Japanese Meteorological Agency.

Temperature and CO_2 in lockstep

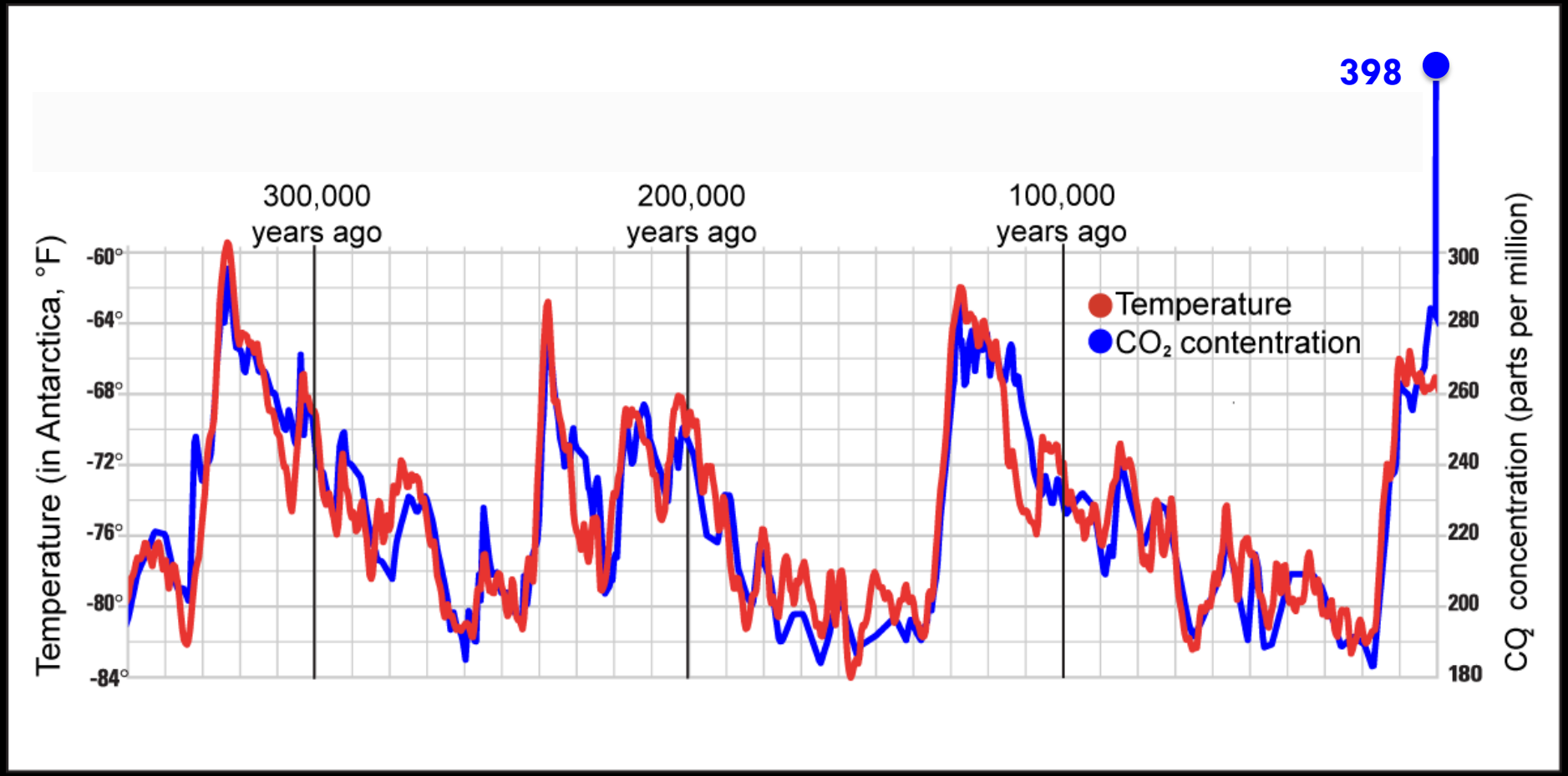
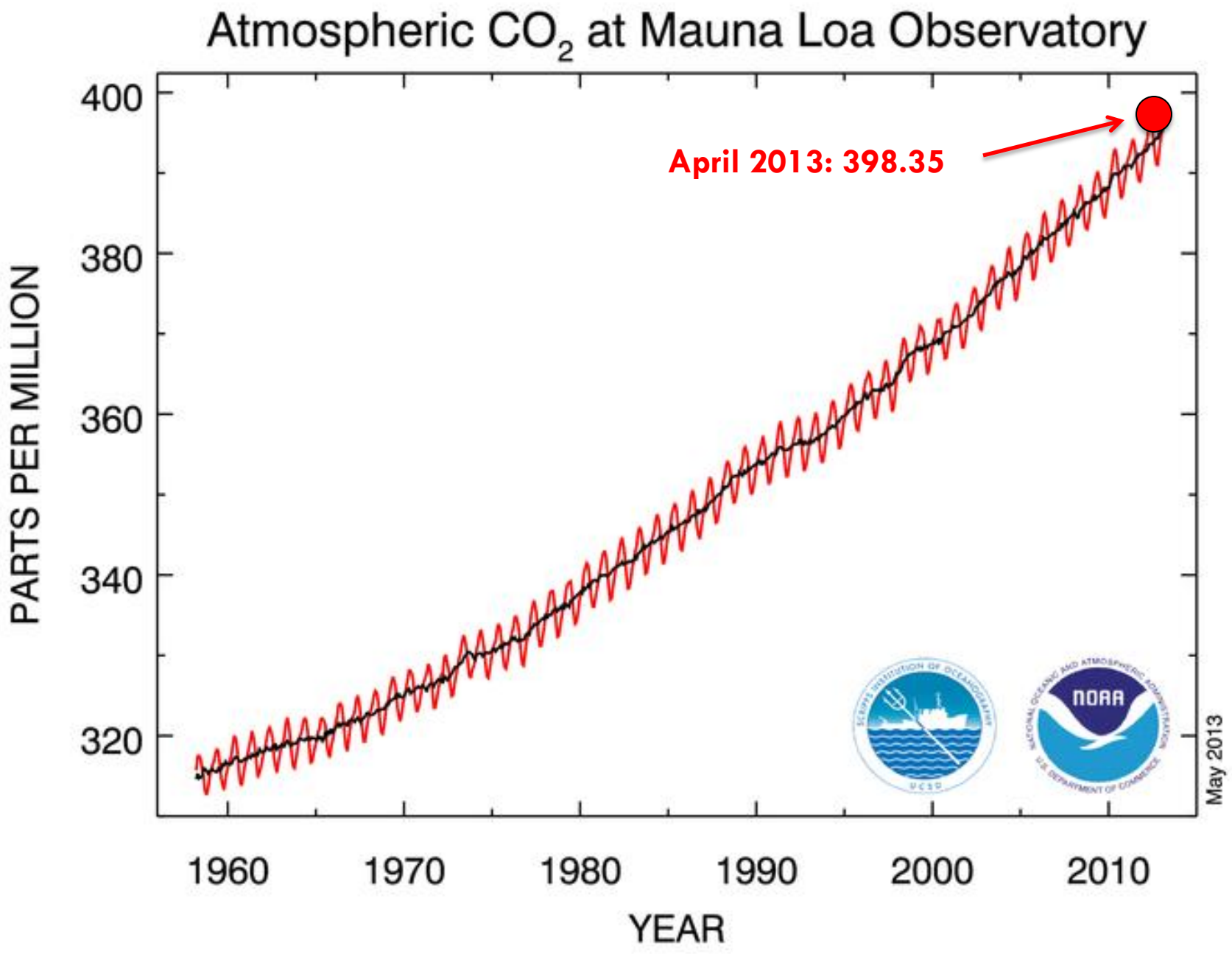
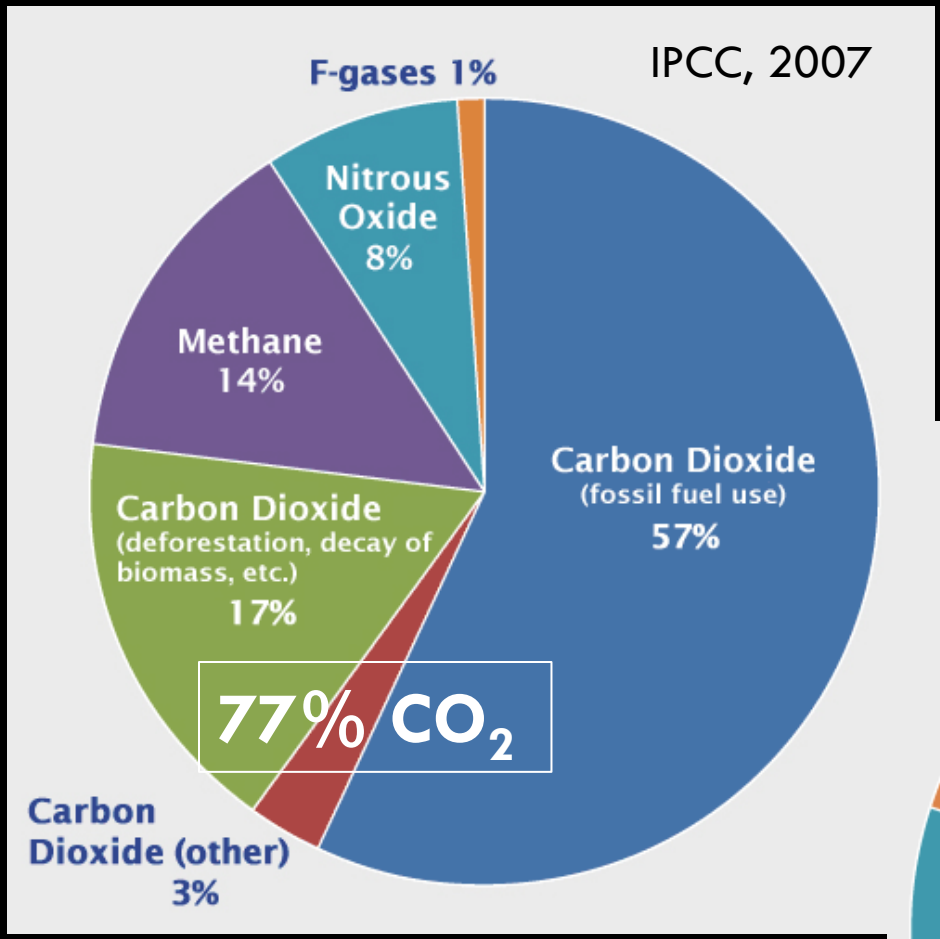
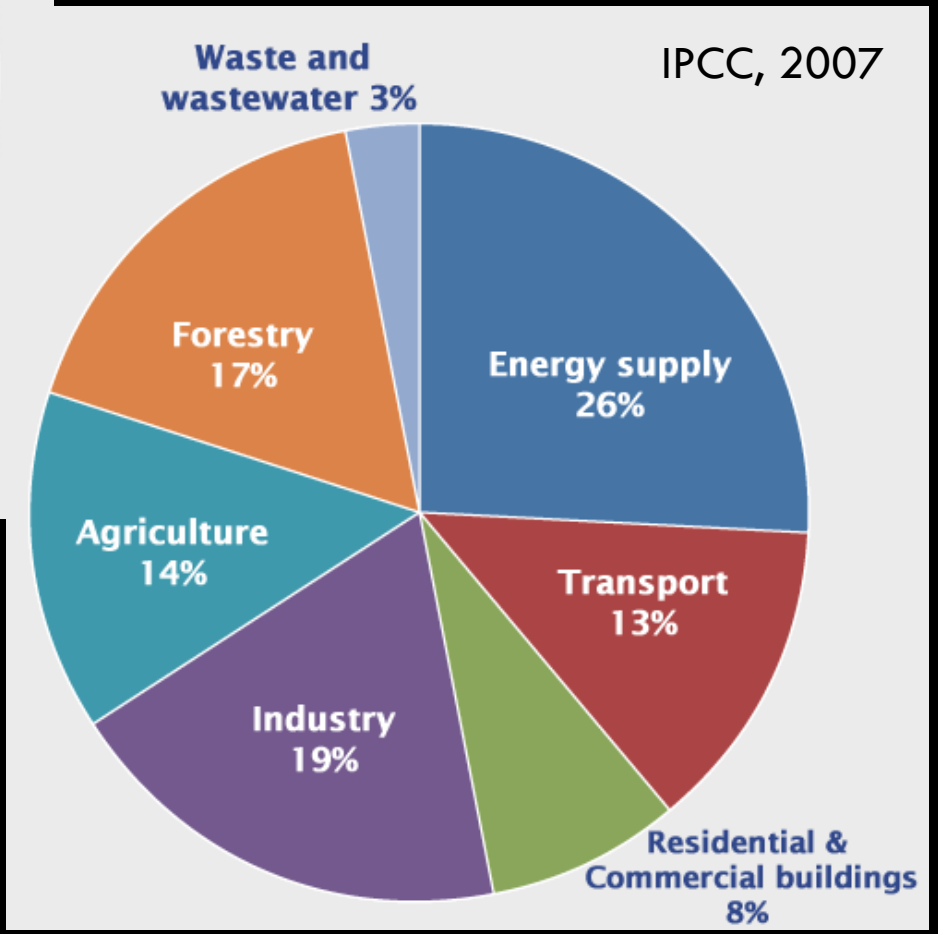


Image courtesy of Marian Koshland Science Museum of the National Academy of Science

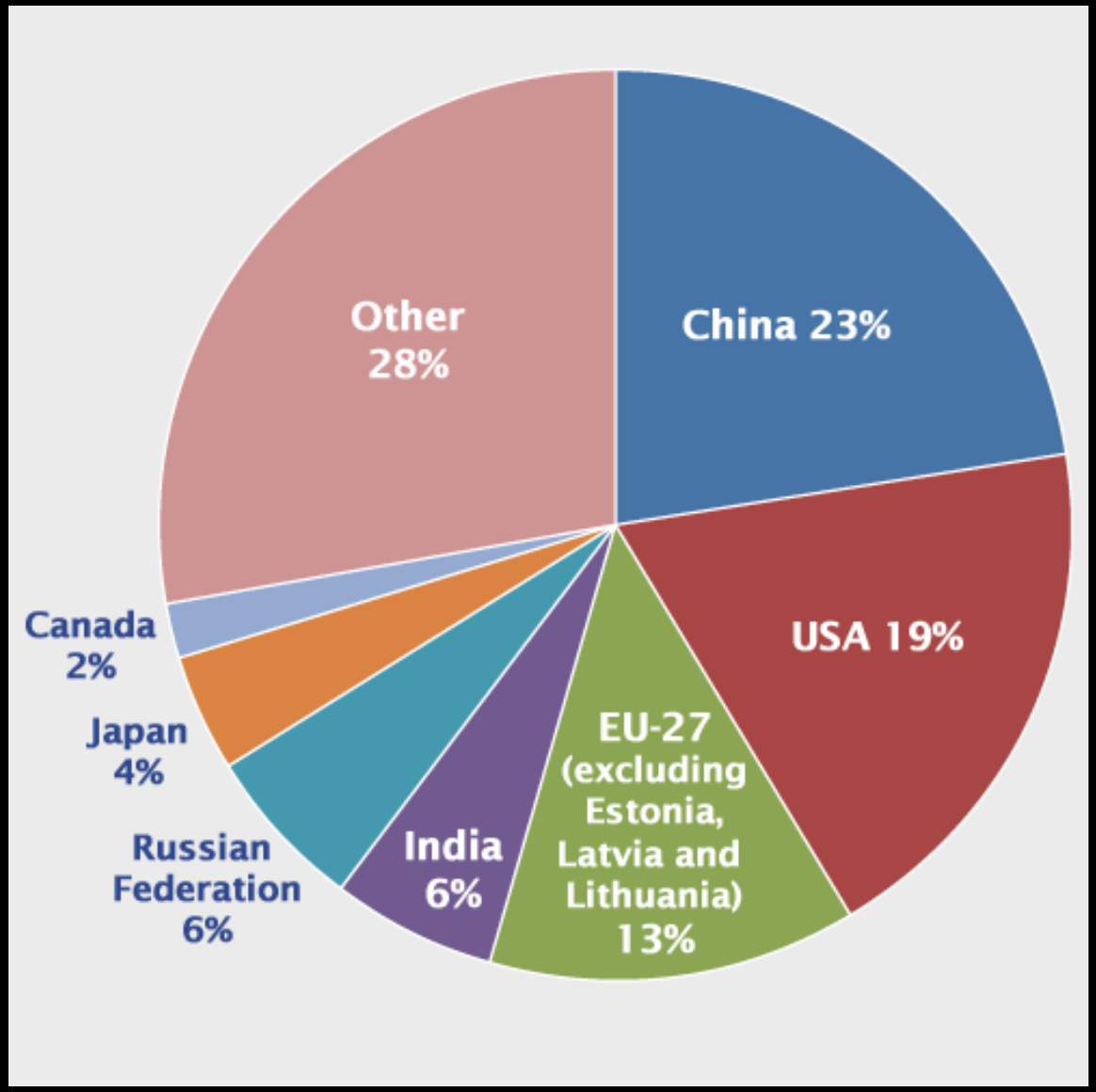

Atmospheric CO_2 at Mauna Loa Observatory
April 2013: 398.35
PARTS PER MILLION
400
380
360
340
320
1960
1970
1980
1990
2000
2010
YEAR
NOAA
May 2013

GHG emitted by humans (data for 2004)





In 2008


Other
28%
China 23%
USA 19%
EU-27
(excluding
Estonia,
Latvia and
Lithuania)
13%
India
6%
Russian
Federation
6%
Japan
4%
Canada
2%

Fate of Anthropogenic CO_2 Emissions (2002-2011 ave)

8.3 ± 0.4 GtC/yr 90%

1.0 ± 0.5 GtC/yr 10%

+

4.3 ± 0.1 GtC/yr
46%

2.6 ± 0.8 GtC/yr
28%

Calculated as the residual of all other flux components

2.5 ± 0.5 GtC/yr
26%

Summary

- Sun’s energy sets up atmospheric circulation
- GHG moderate the energy within our atmosphere
- Climate changes over longer timescales influenced by orbital changes
- Over periods important to humans, GHG play major role

In the next 15 mins: Observations

1. Temp
2. Feedbacks
3. Impacts
4. Extreme events

Some definitions

What's the difference between **weather** & **climate**?

Weather is the conditions of the atmosphere over a short period of time

Climate is how the atmosphere "behaves" over relatively long periods of time. - NASA

Some definitions

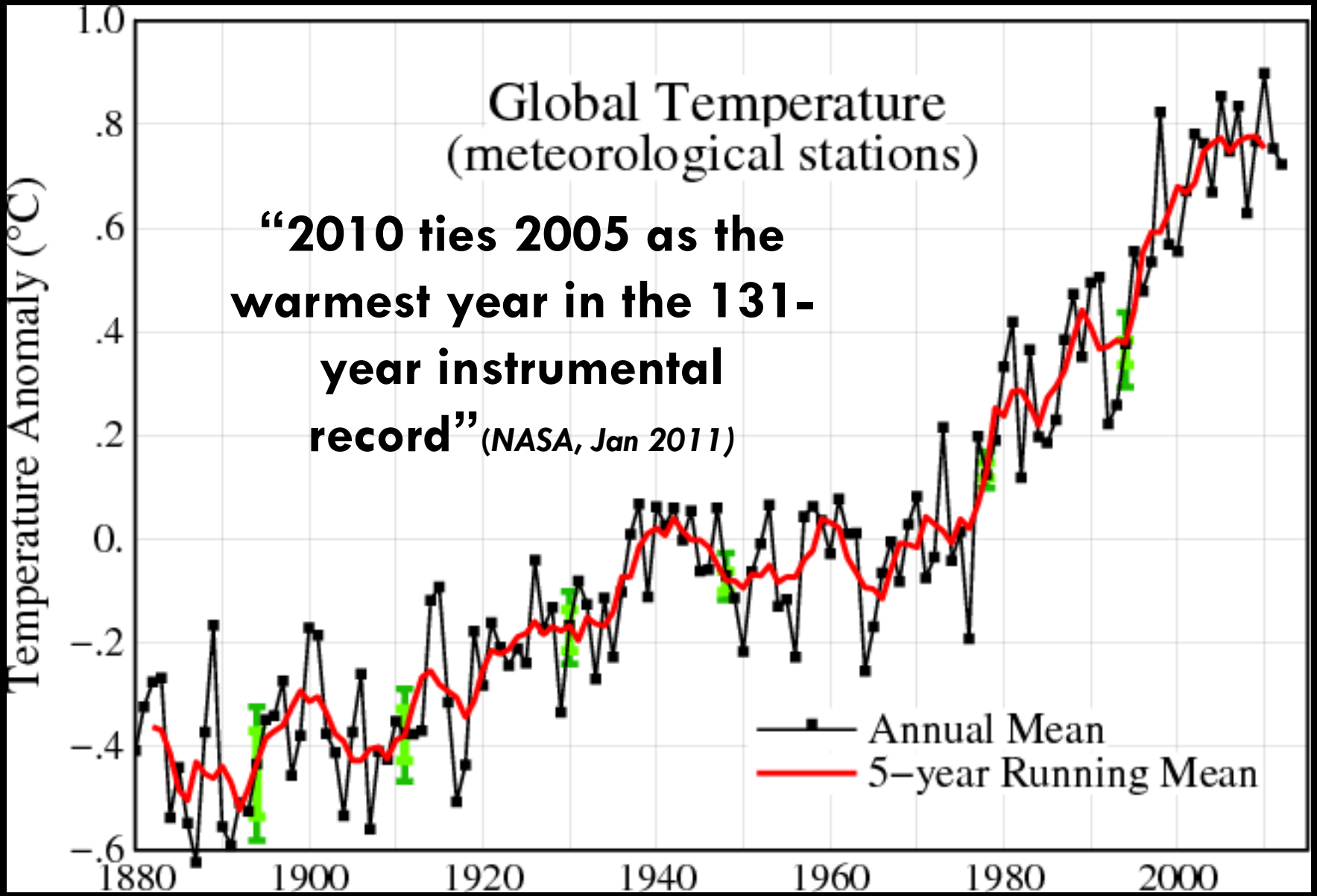
What's the difference between **weather** & **climate**?

Weather is the conditions of the atmosphere over a short period of time

Climate is how the atmosphere "behaves" over relatively long periods of time. - NASA

Isn't climate just made up of a whole bunch of tiny weathers? – Stephen Colbert

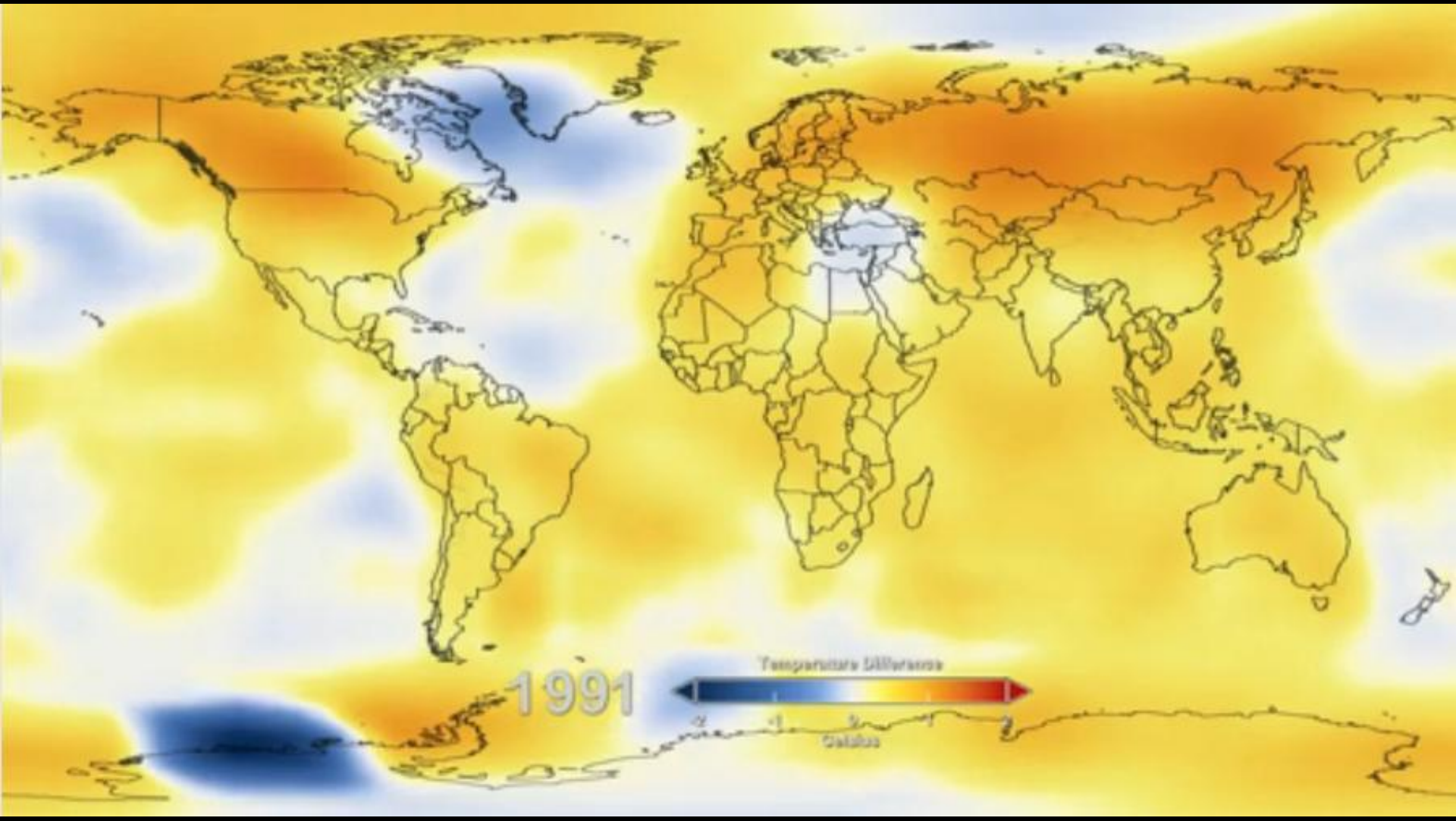
~ 1.33 F (~0.7 C) global temperature rise in last century



NASA, GISS

Global Temperature Movie:

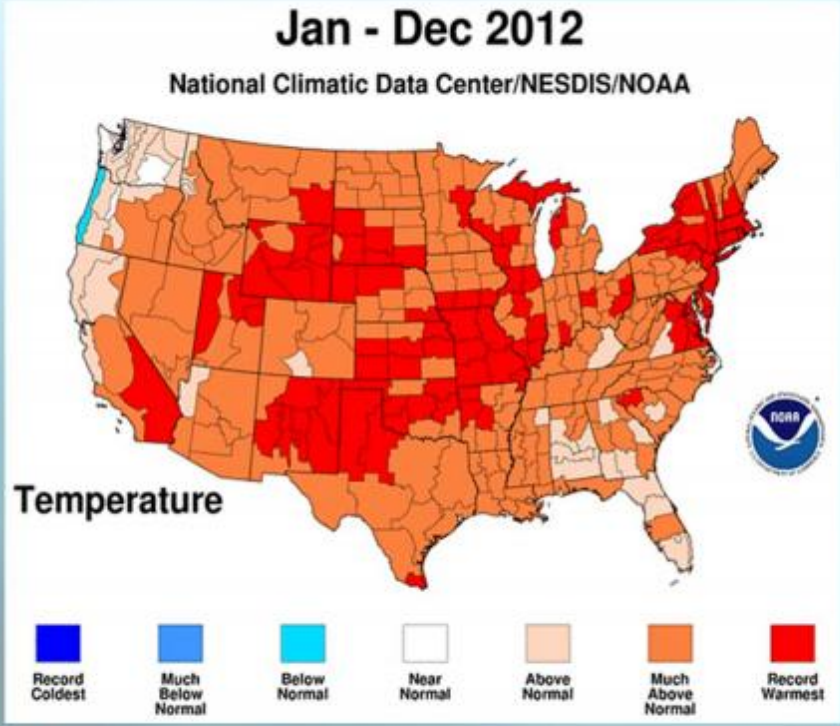
http://www.nasa.gov/topics/earth/features/2012-temps.html

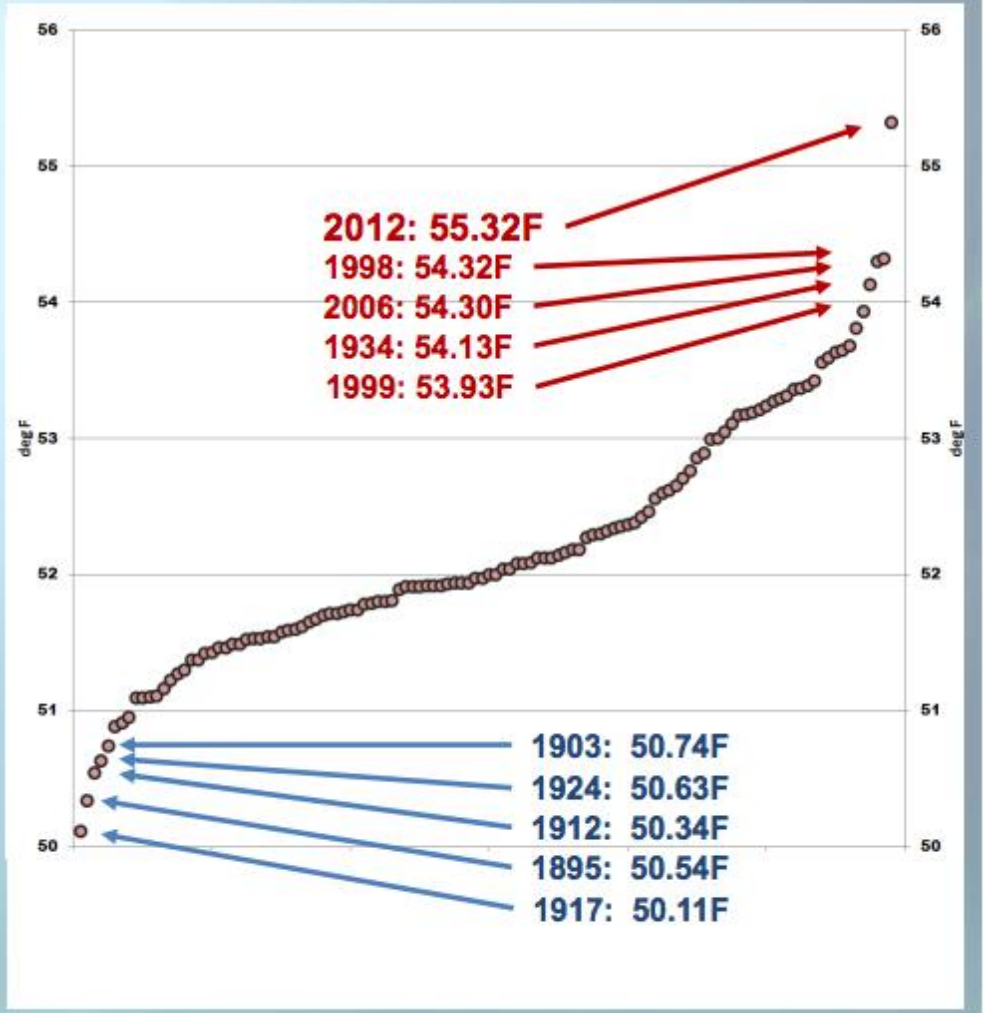


Warmest Year on Record for the Continental U.S.

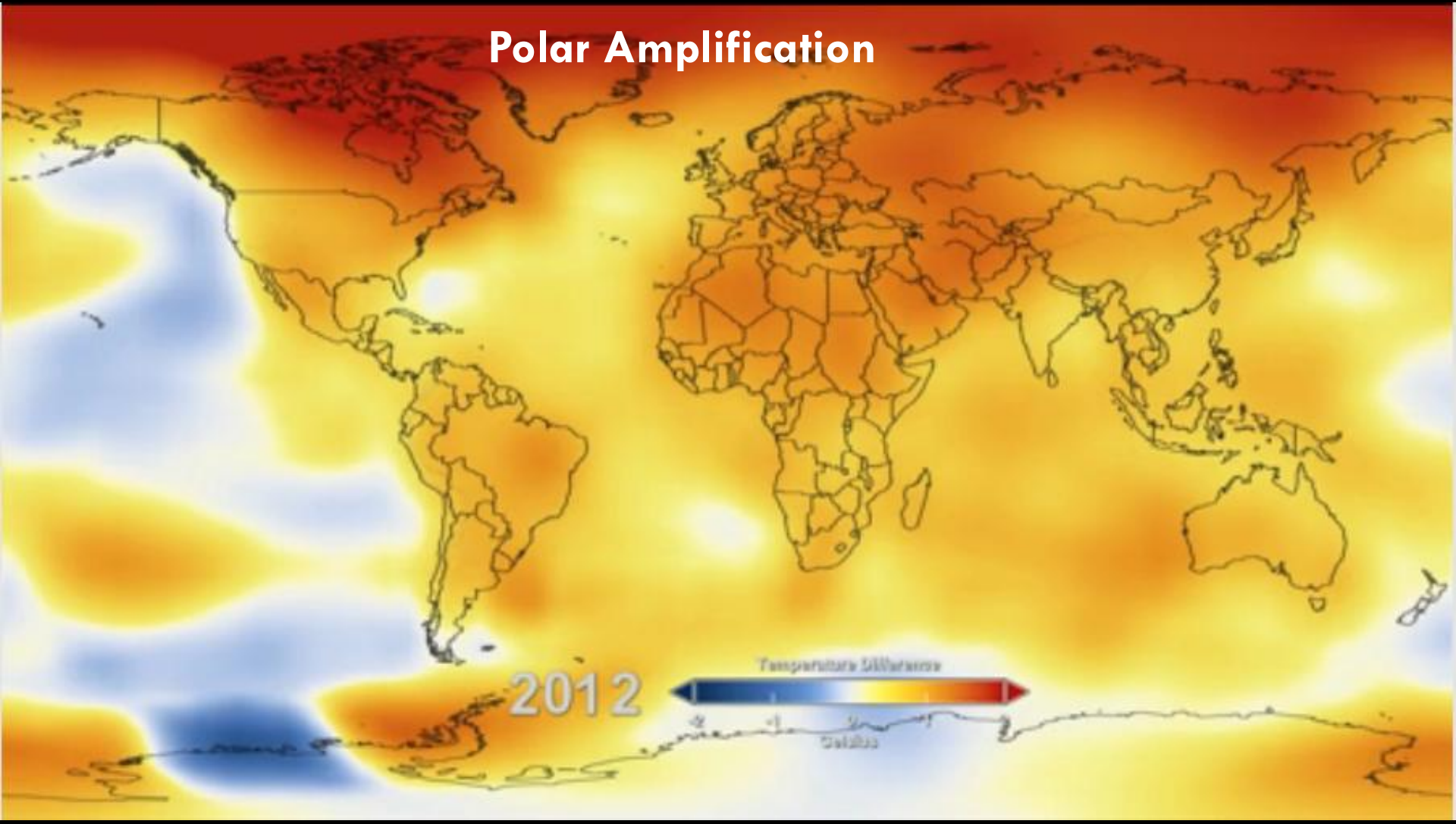
NOAA

- **3.25F** above 20th Century average





Temperature changes are not same across geographies



Why Polar Amplification? “Feedbacks”

Positive Feedback:

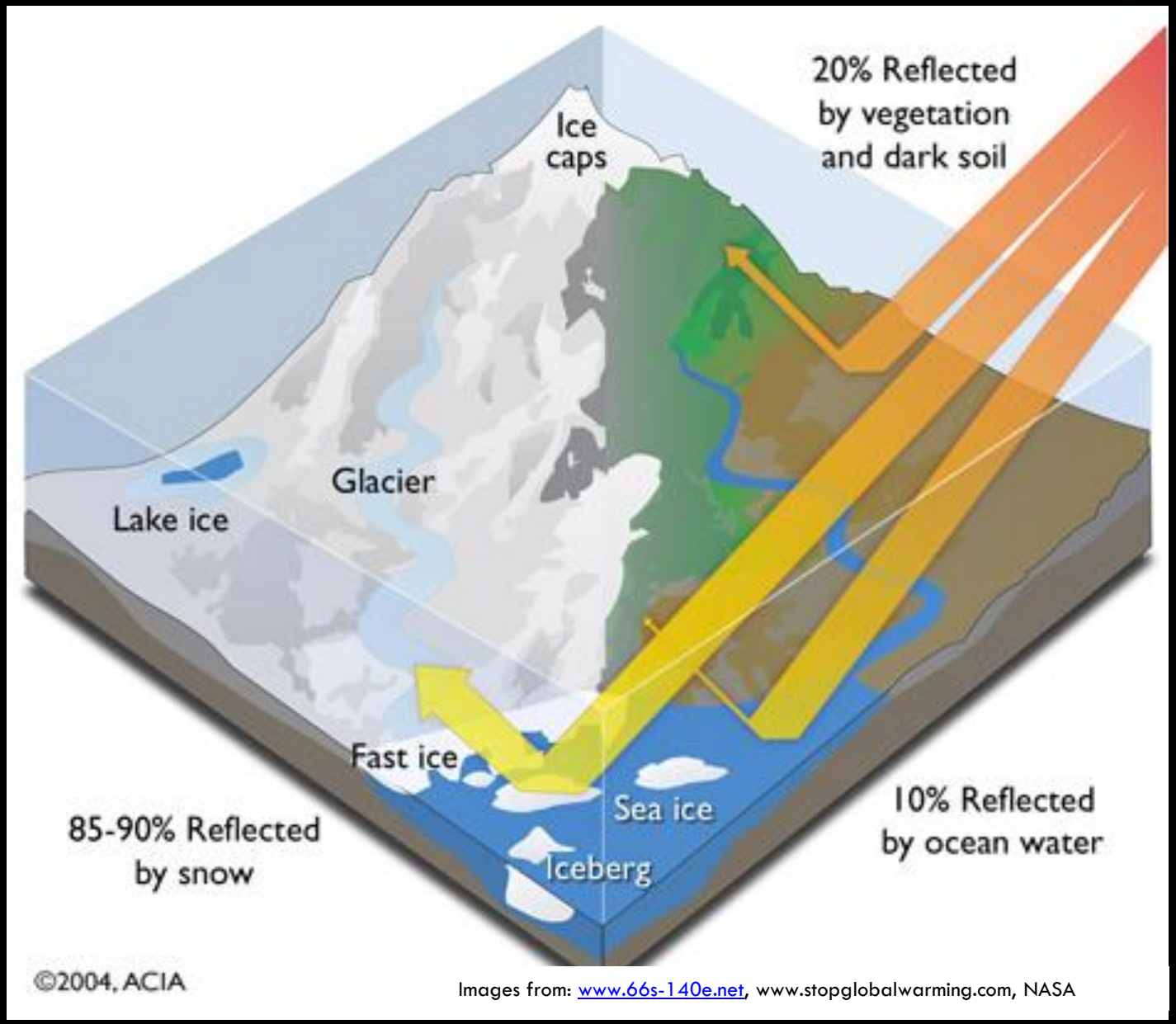
Stock market decline → more selling → more stock declines

Why Polar Amplification? "Feedbacks"

Negative Feedback:

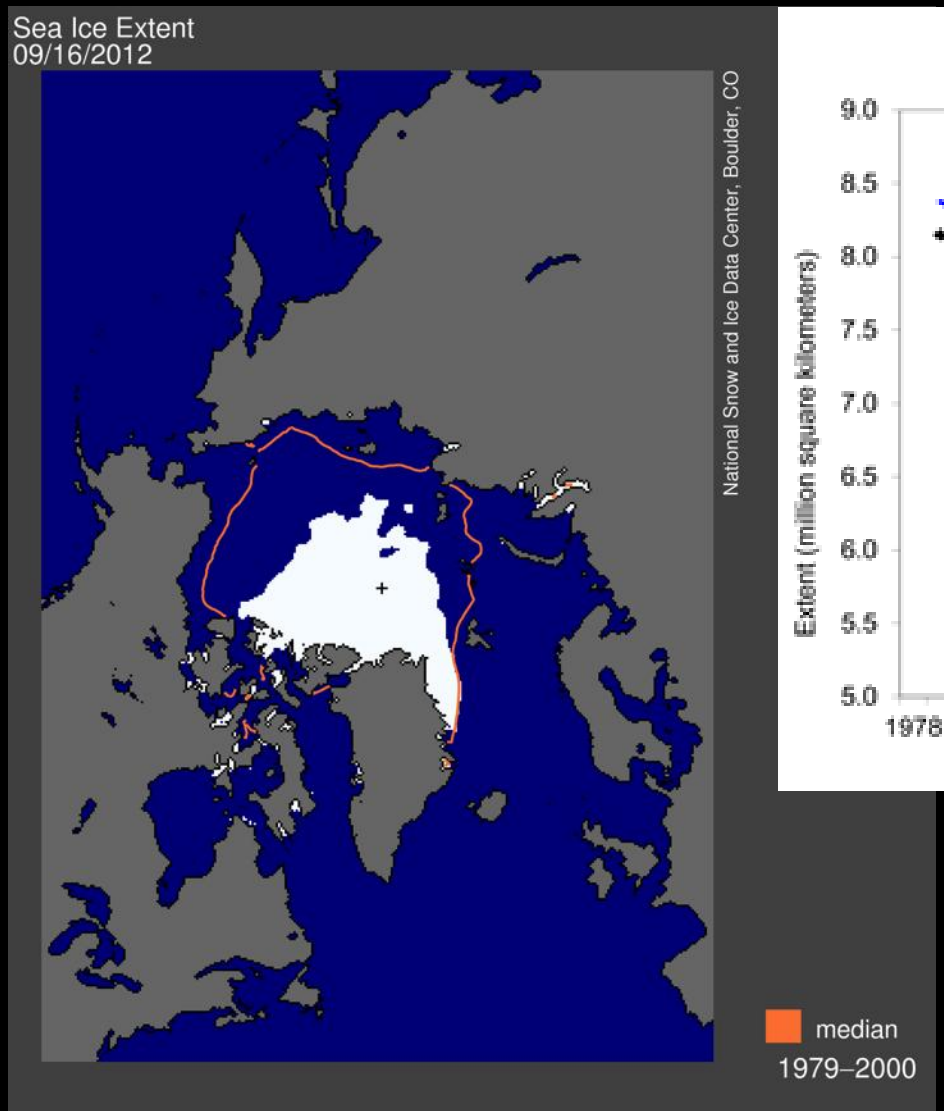
Stock market decline → good opportunity to buy→ stocks stabilize

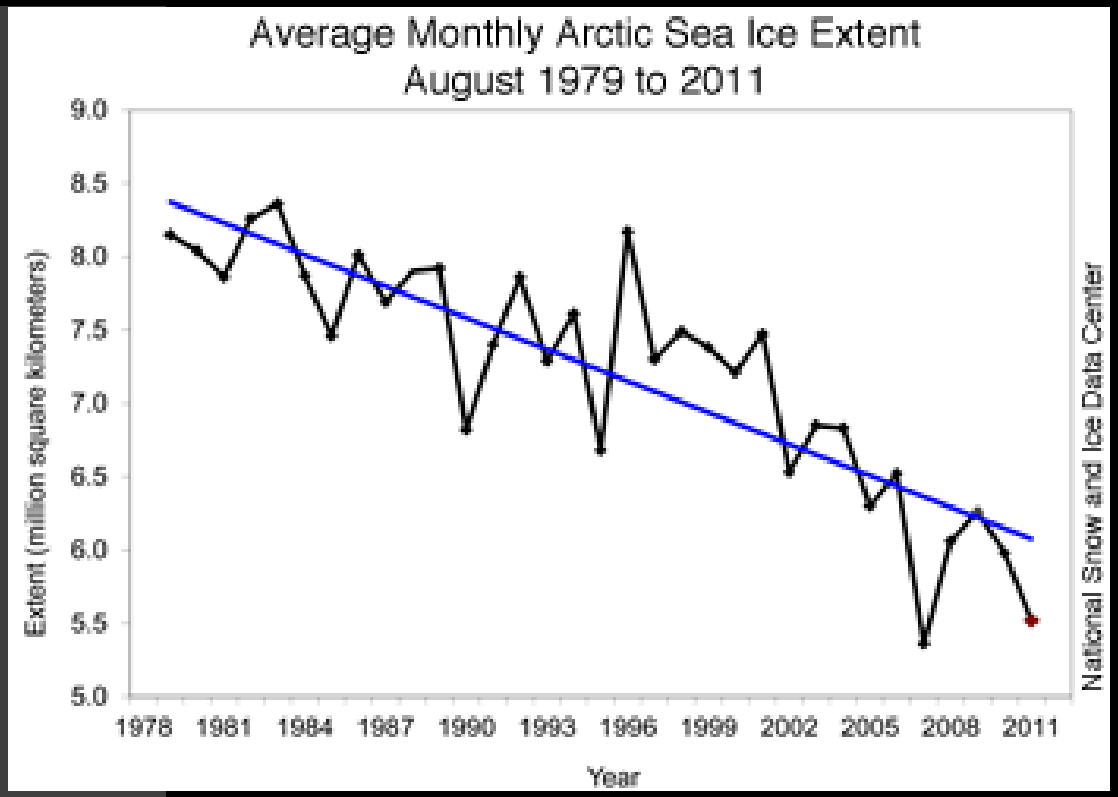
Reflectivity (Albedo)



Images from: www.66s-140e.net, www.stopglobalwarming.com, NASA

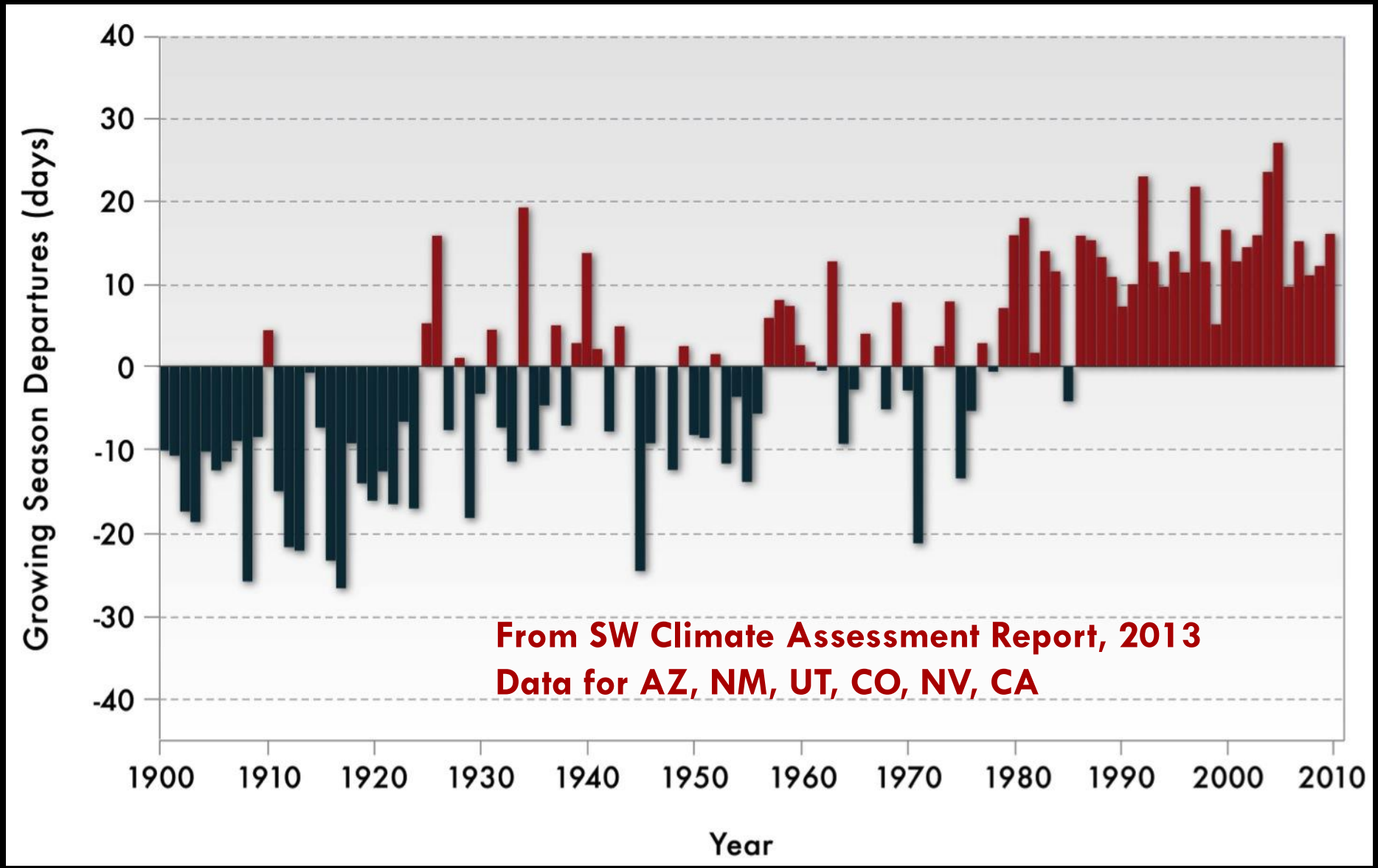
Arctic Sea Ice on the decline:





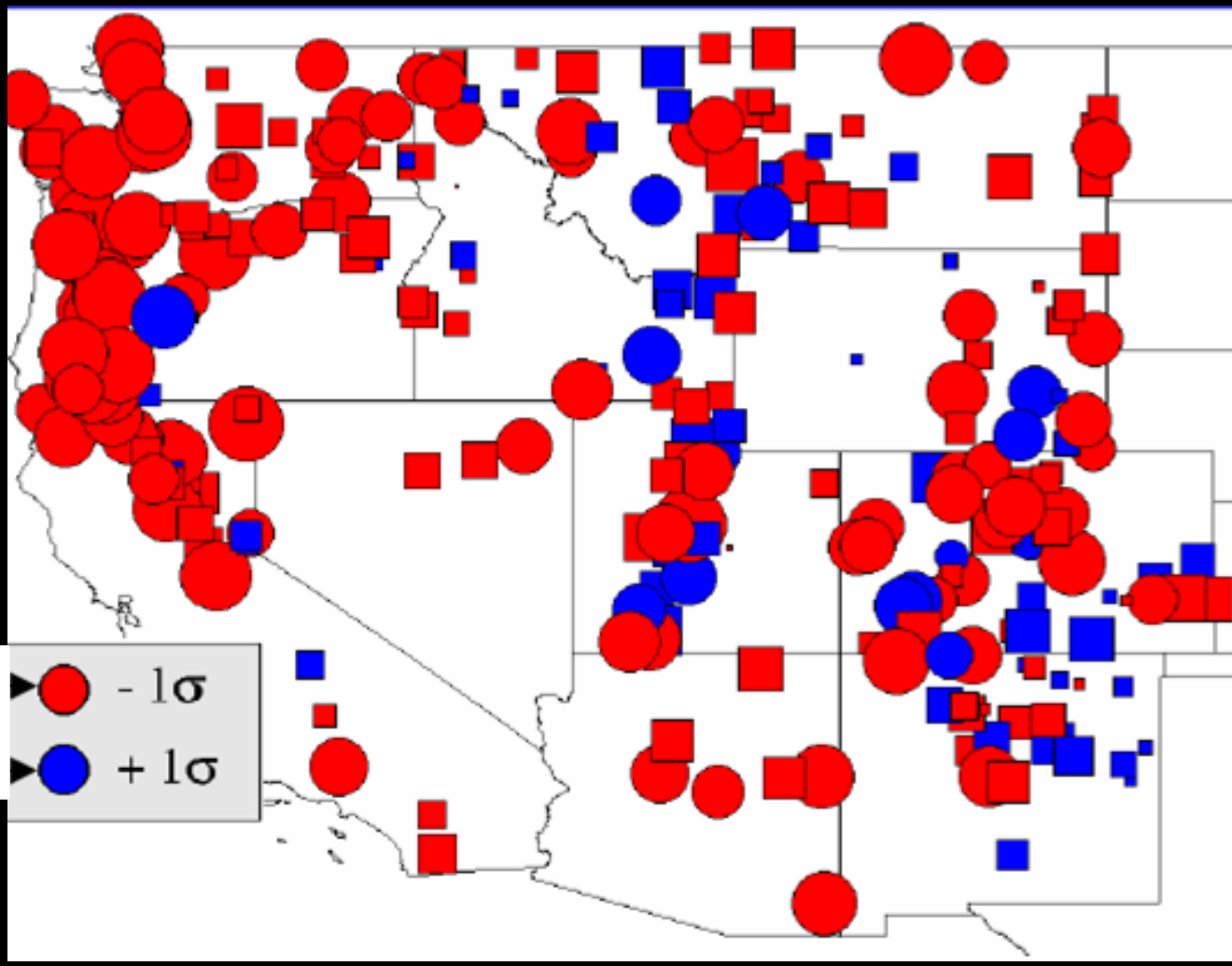
NSIDC: www.nsidc.org/arcticseaicenews/2012/08

Growing season for SW increased ~7% (17 days) during 2001–2010 compared to 20th century ave.



Winter Trends: Less Snow, More Rain

Most important at low-to-mid elevations (<8,500)



More Rain, Less Snow
More Snow, Less Rain

Data: NOAA Co-op Network

Courtesy of Noah Knowles, USGS

Water Supply

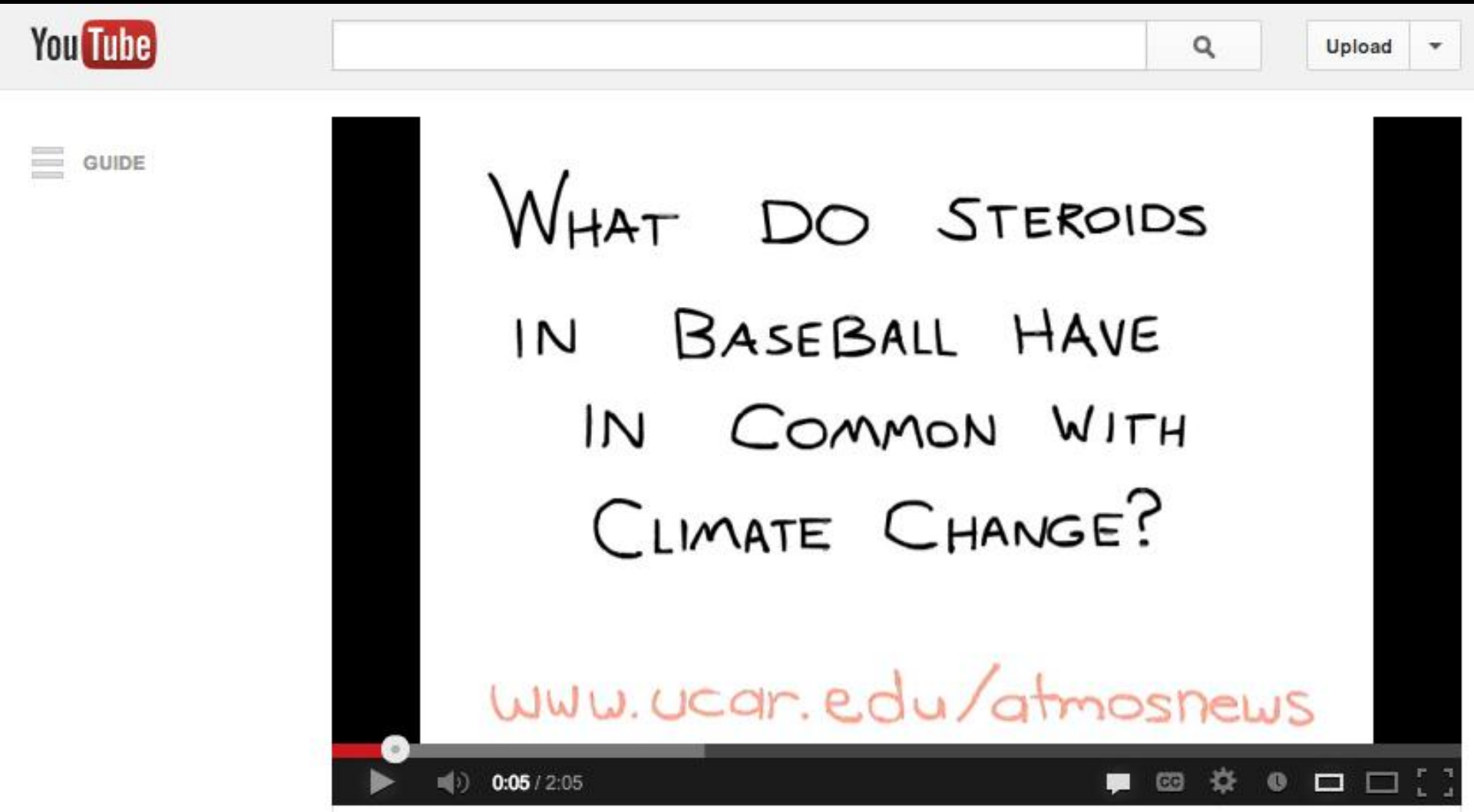
Fire

People matter: impacts emerge from interaction of people and climate

http://randallsisland.org/events/ing-new-york-city-marathon/

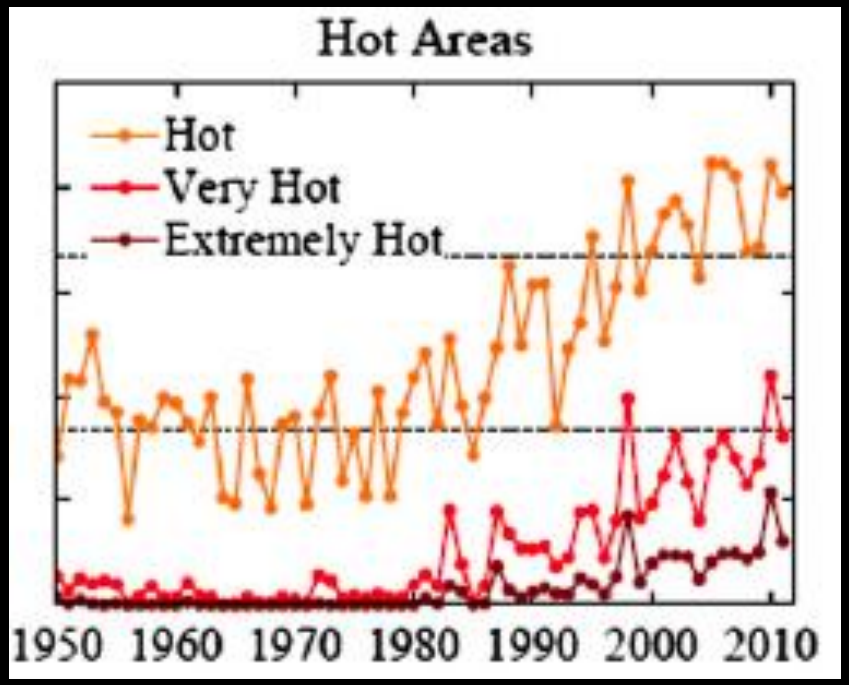
What about Extreme Events?

MOVIE
Steriods and Climate



Extremes getting Extremer:

Jun-Aug temp anomalies over NH Land



Hansen et al., 2012, PNAS

Summary

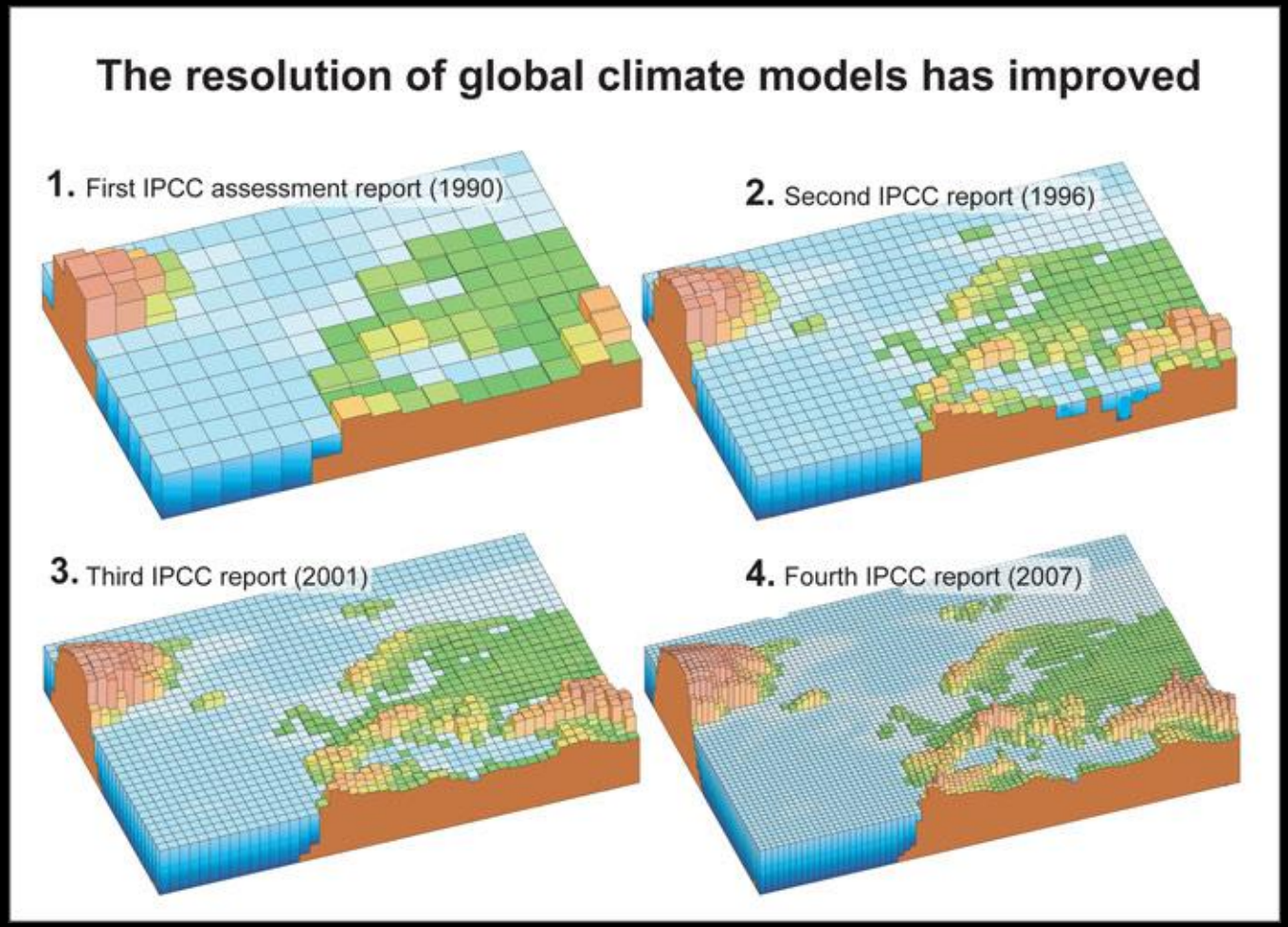
- Temperature on the rise: global increase ~1.33 F
- Feedbacks can amplify or dampen change
- Impacts across many sectors, including agr, snow packs, etc.
- Some evidence for increasing extreme events, most notably in temperatures

In the next 15 mins: Projections

1. Models
2. Temperature & Precipitation
3. Extreme events
4. Impacts

Models:

Imperfect representations of reality, but useful for some things

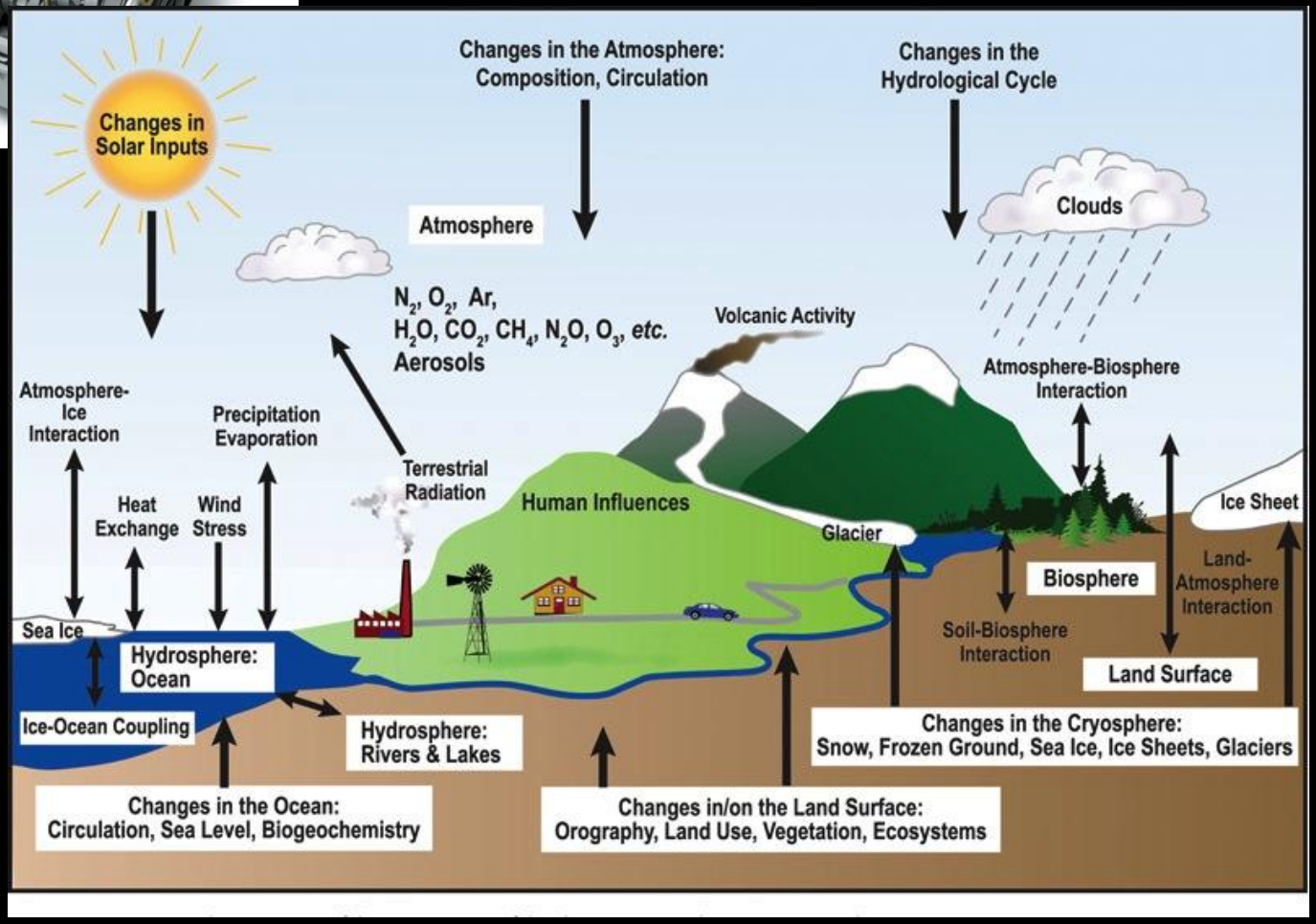


How Climate Models Work

Physical processes

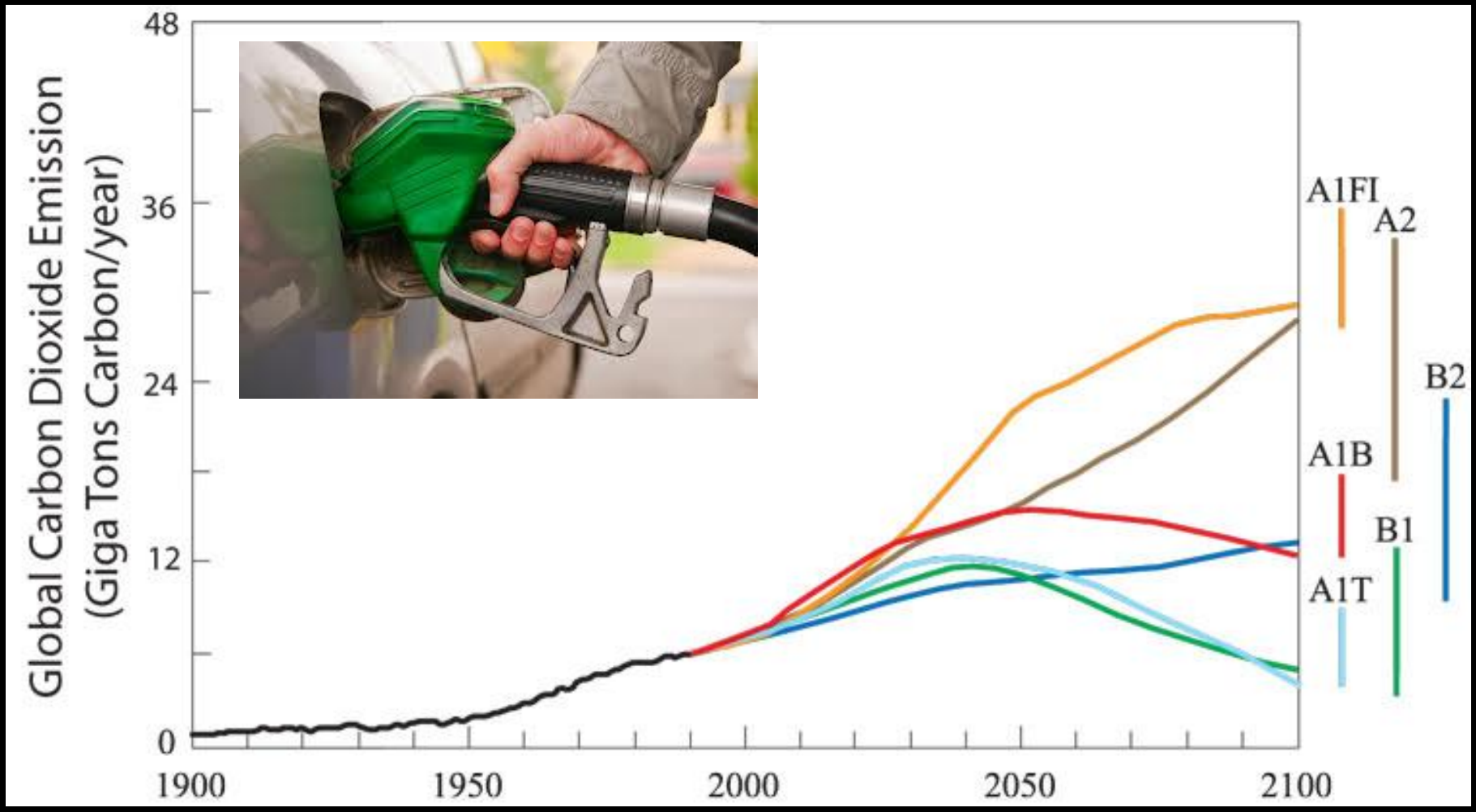
Energy Balance

The moving parts



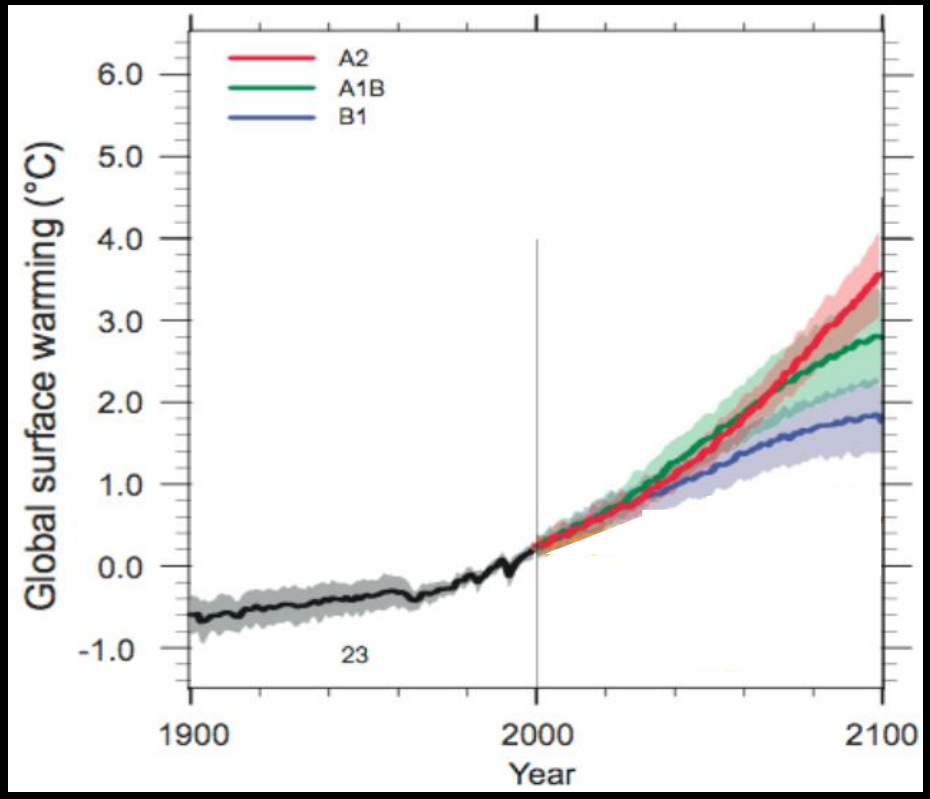
IPCC, 2007

GHG Trajectories



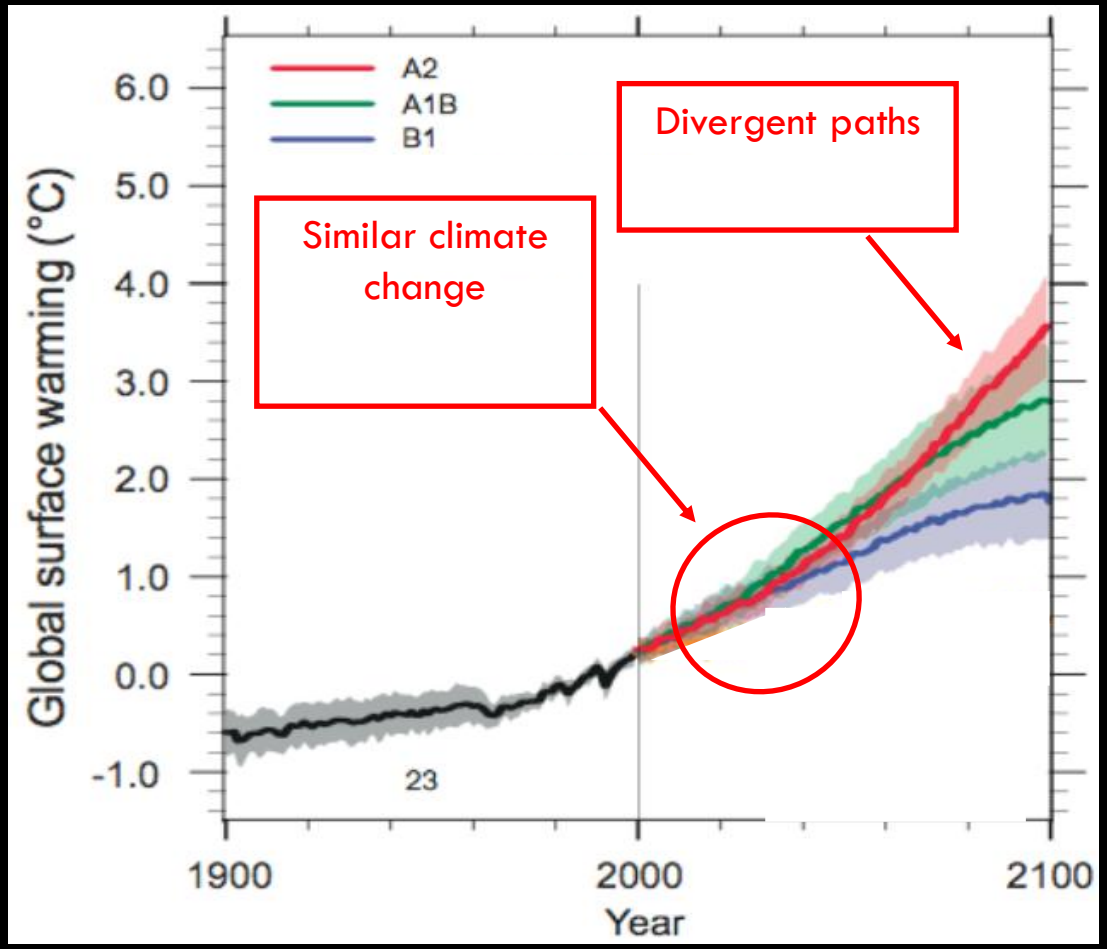
SRES, IPCC 2007

Temperature Projection

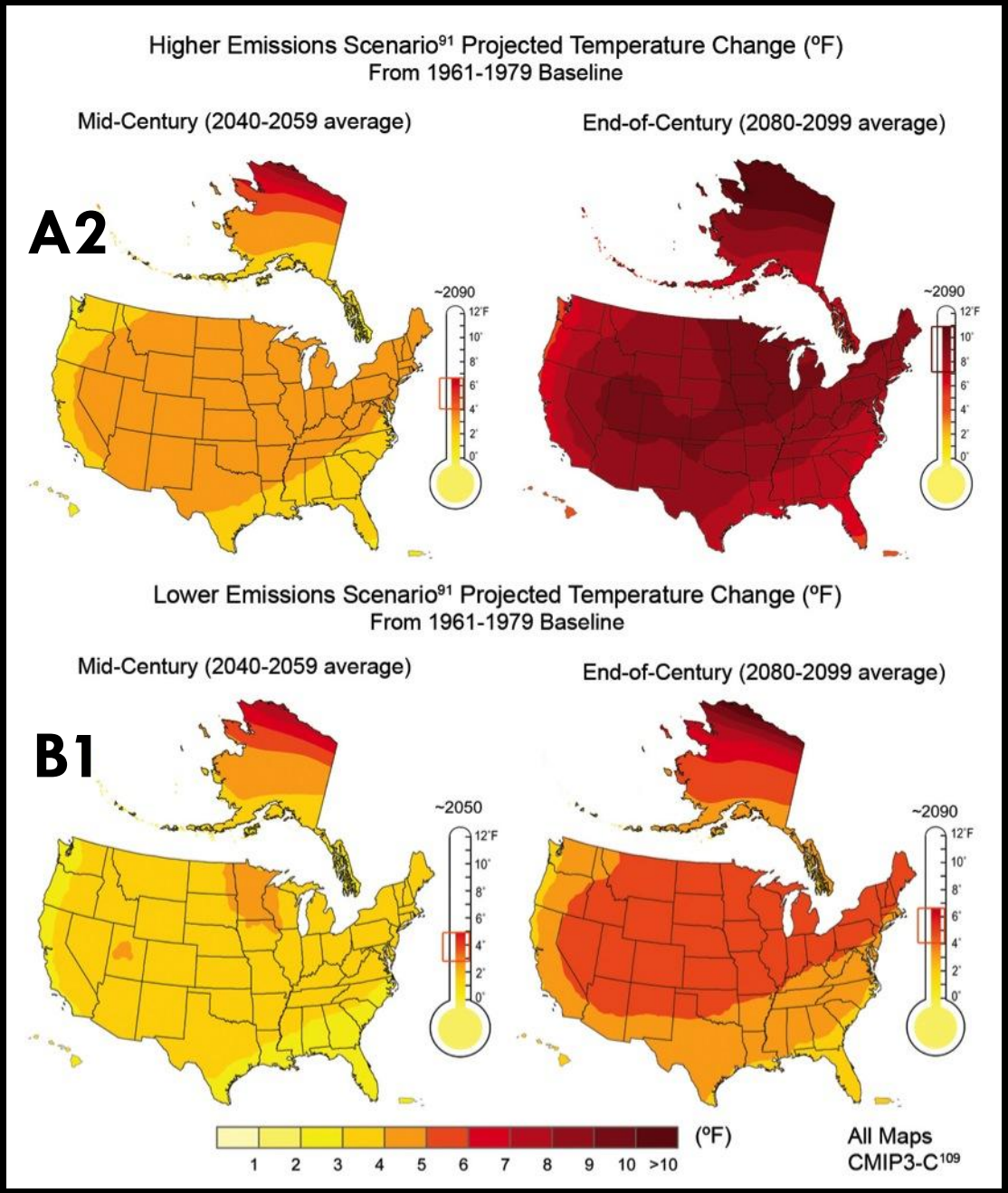


Annual average temperature projections relative to 1980-1999 baseline (IPCC 2007)

Temperature Projection



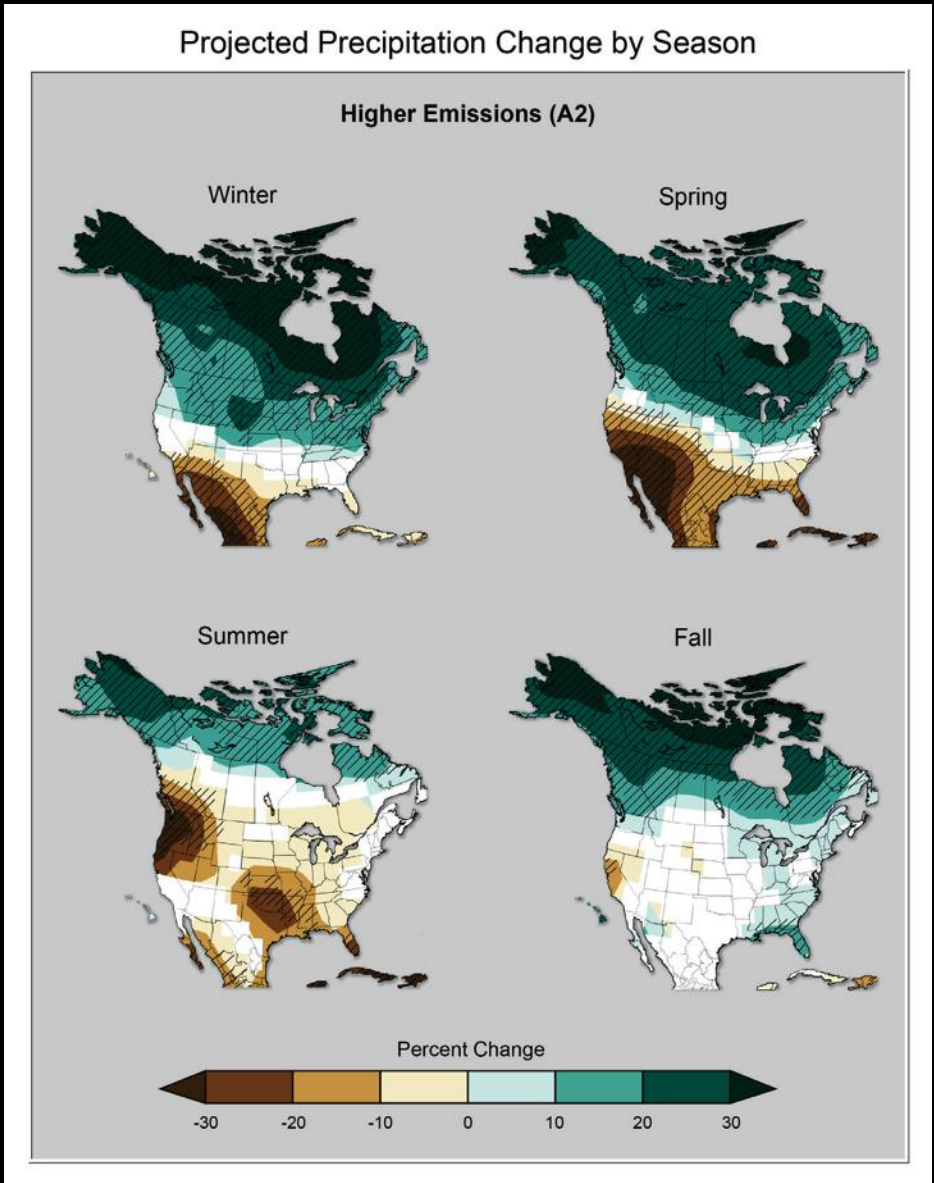
Annual average temperature projections relative to 1980-1999 baseline (IPCC 2007)



mid- and late-century warming over the US under higher (A2) and lower (B1) scenarios

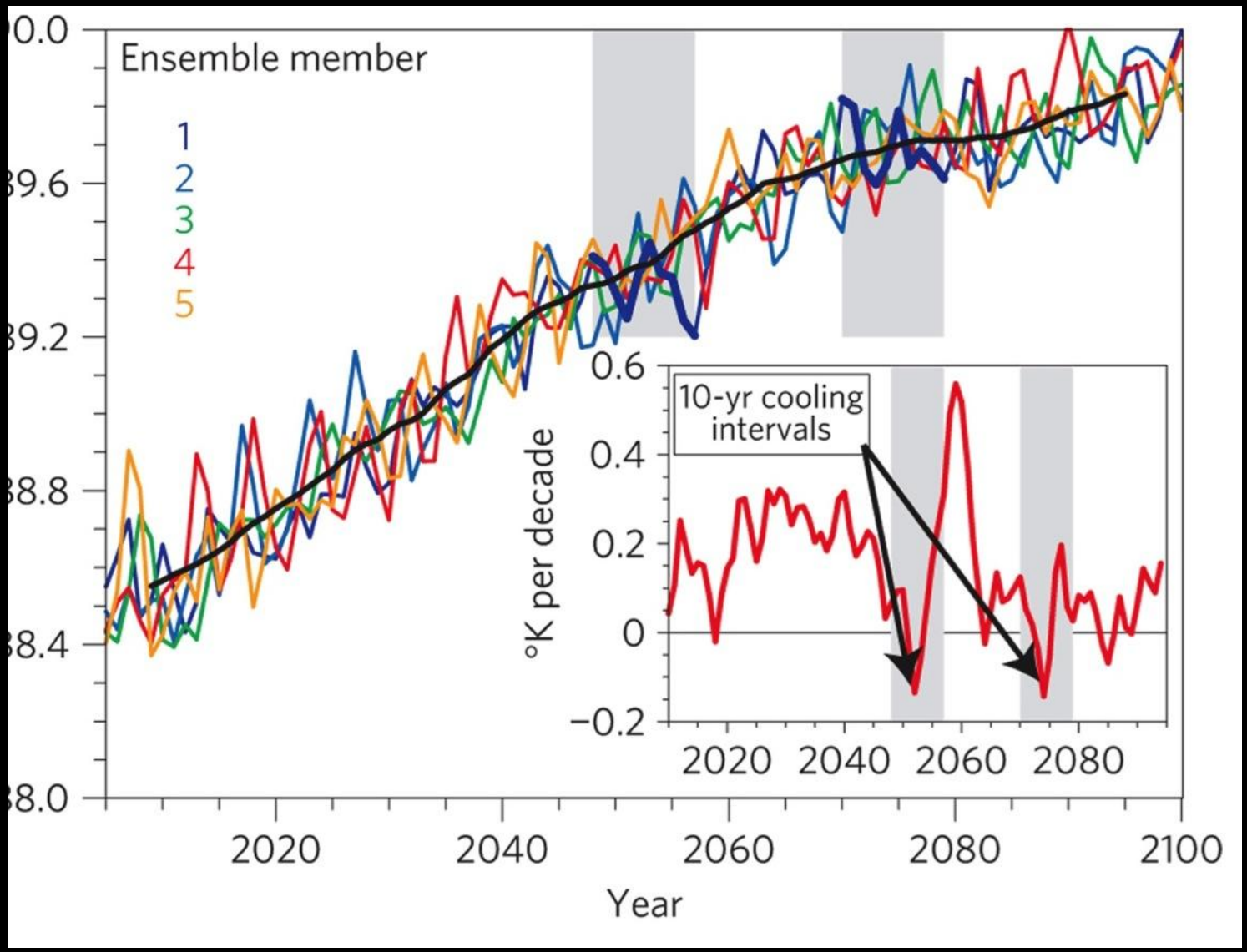
Karl, T. R., J. M. Melillo, and T. C. Peterson, 2009: Global Climate Change Impacts in the United States. Cambridge University Press.

Precipitation



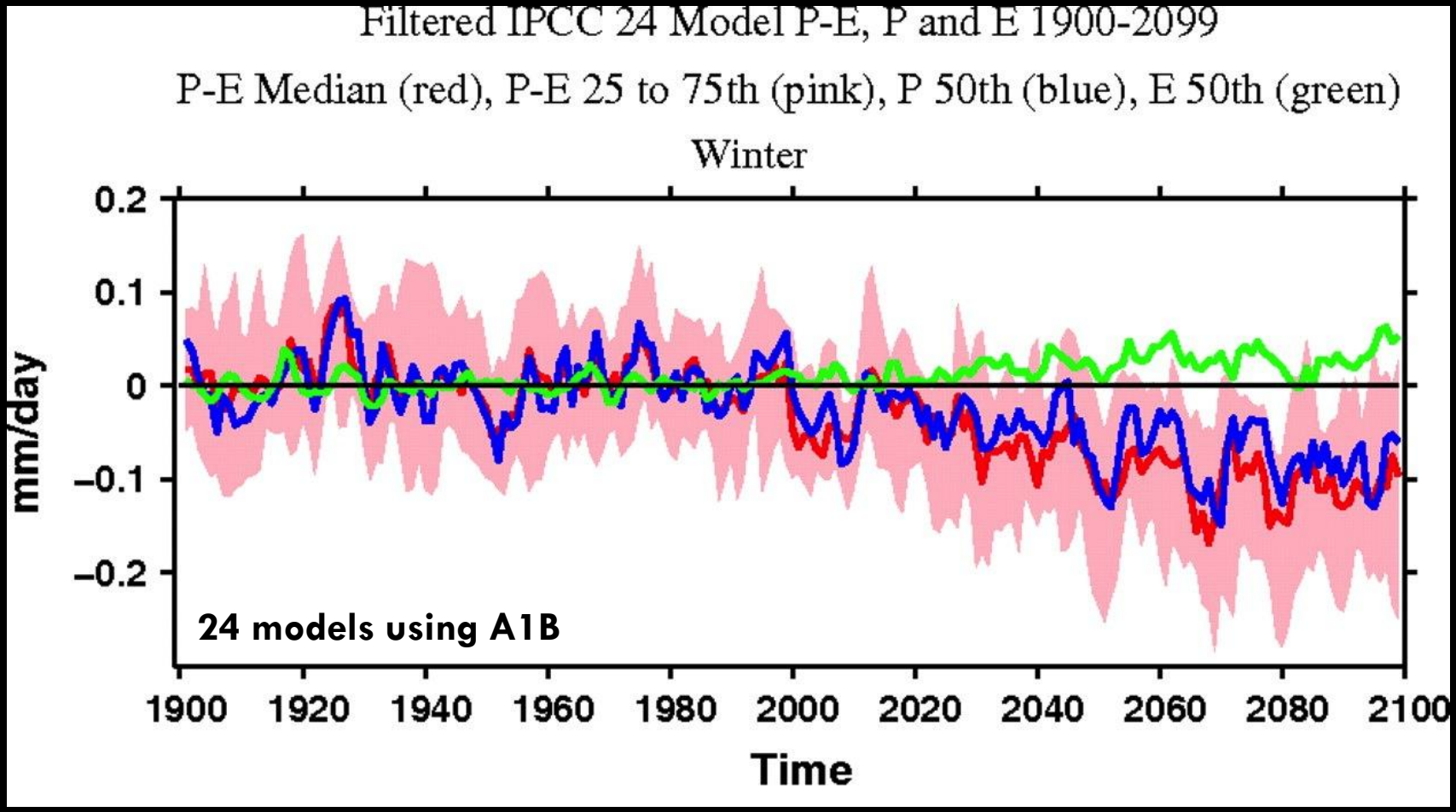
SW Climate Assess. Report, 2013

Cooler periods within warming trend



Meehl, 2011, Nature Climate Change

Winter (Oct-Mar) Drying in Southwest



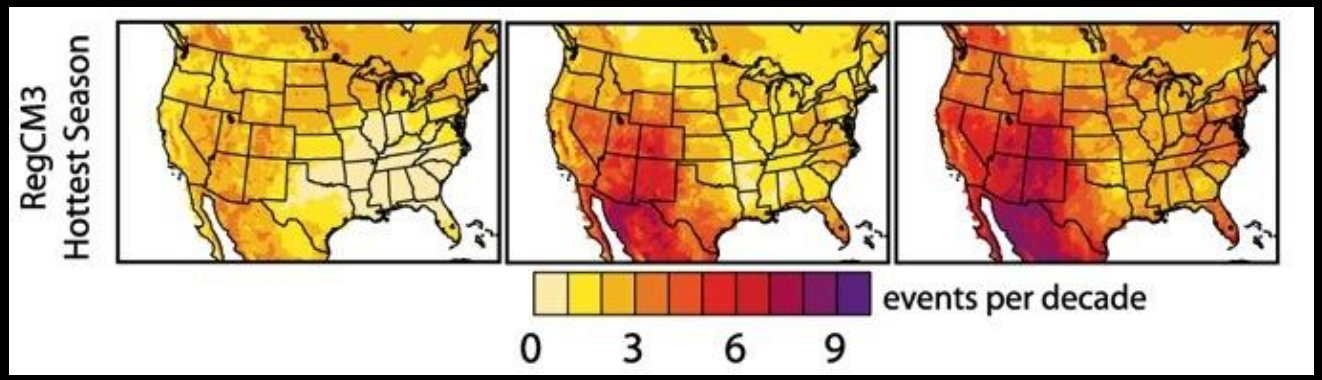
Seager R , Vecchi G A PNAS 2010;107:21277-21282

Intensification of hot Extremes

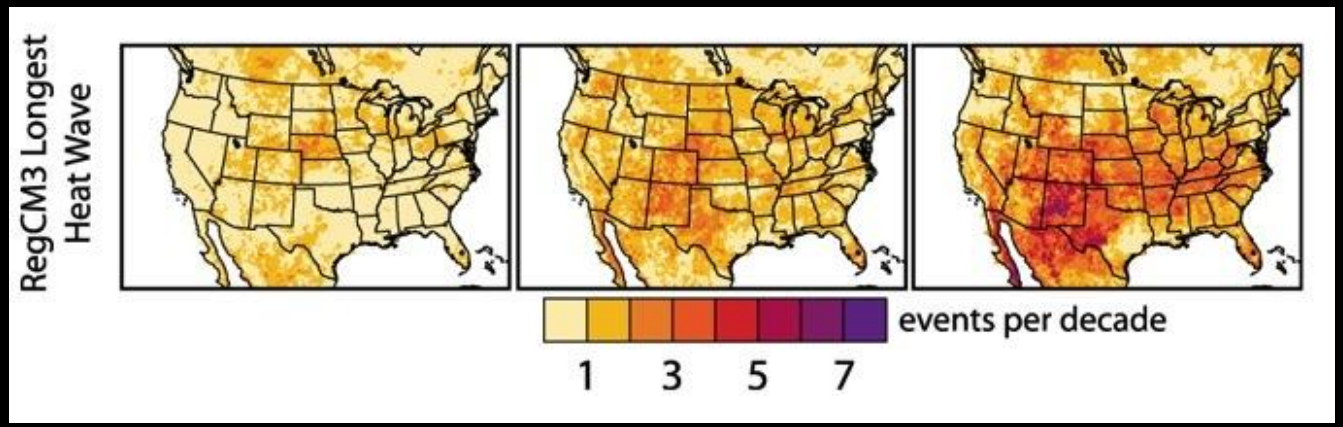
Diffenbaugh and Ashfaq, 2010, GRL

A1B Scenario

2010-2019 **2020-2029** **2030-2039**



HOTTEST SUMMER =
hottest summer between 1951-99



HEAT WAVE =
Longest heat wave in 1951-1999 period


Water Supply


Drought


Fire

Summary

- Models are imperfect but do some things well
- Temperatures very likely to increase
- Dry places get drier and wet places wetter
- Extreme events will likely increase in frequency, intensity, and/or both

Questions?

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