Climate change and variations:

From the IPCC to Vermont

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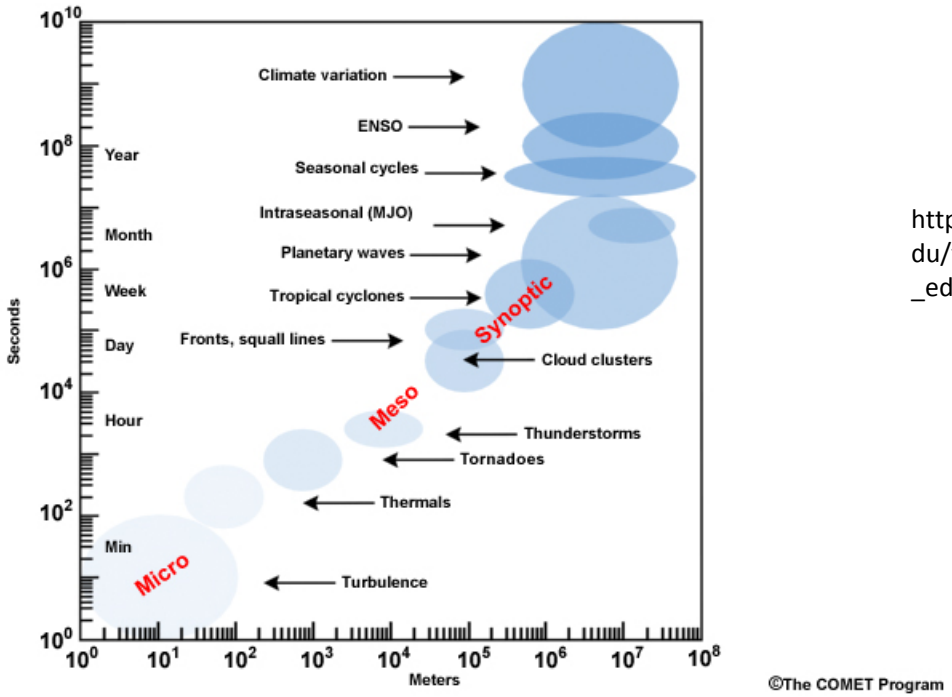
UVM – Geography Department
VT State Climatologist

RACC Workshop – Sheraton – 13 November, 2012

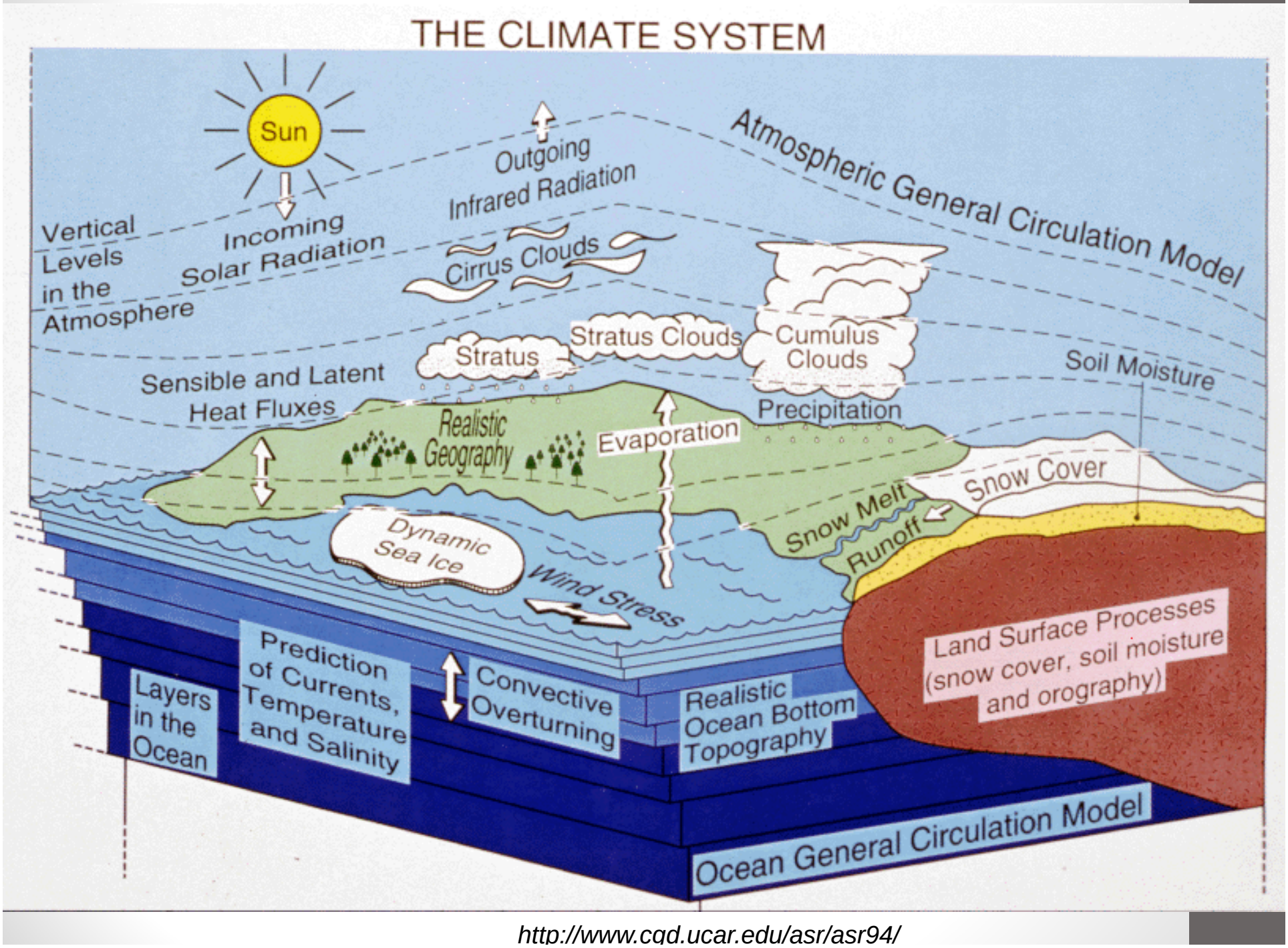
1. Weather - climate continuum



http://www.meted.ucar.edu/tropical/textbook_2nd_edition/print_1.htm

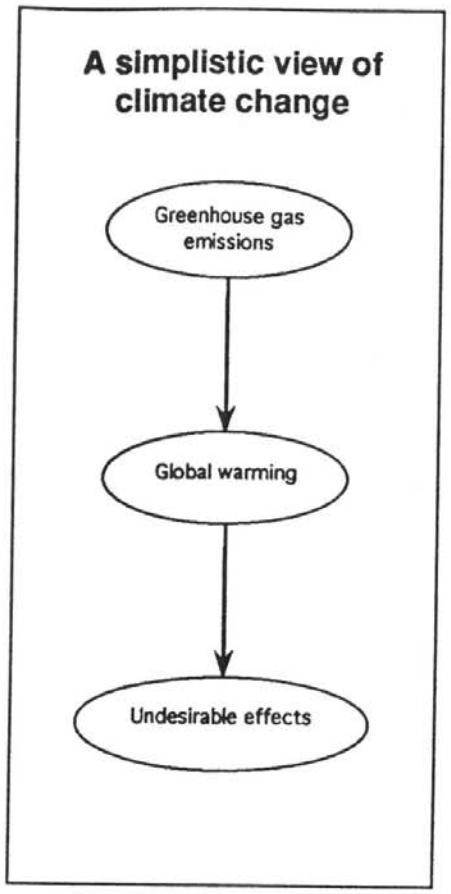
- Weather = state of the atmosphere at some place & time
  - described as temperature, cloudiness, precipitation, wind speed & direction

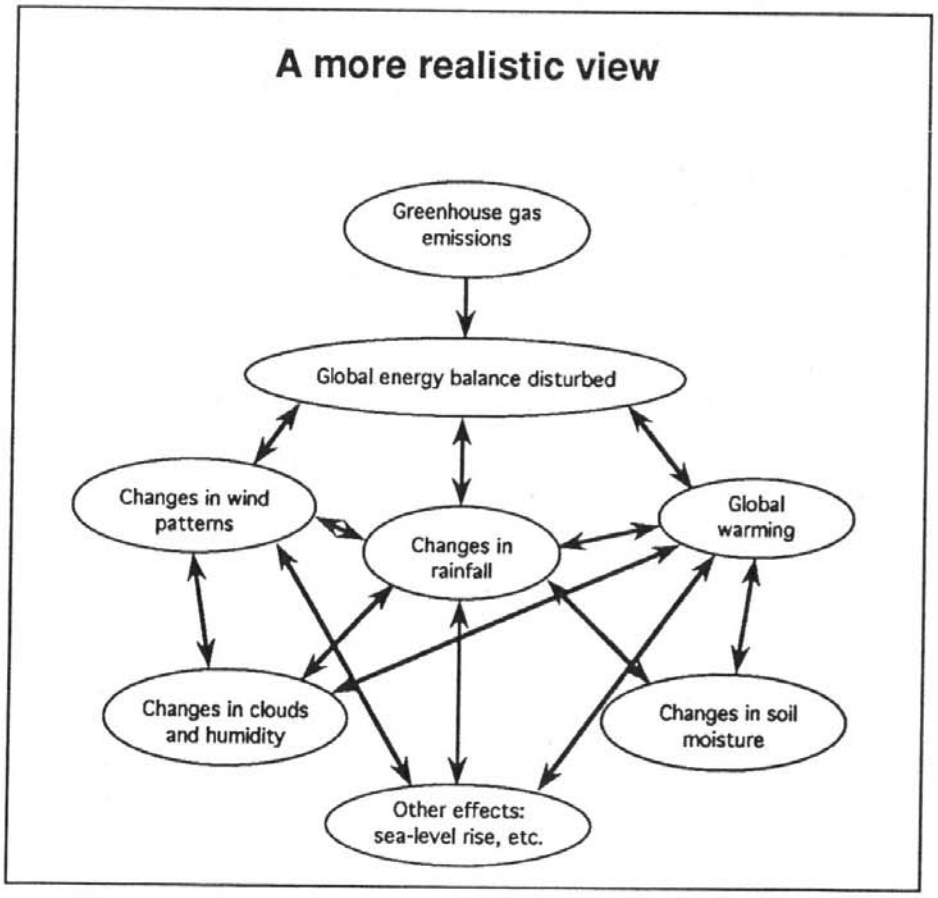
- Climate = weather conditions at some locality averaged over a specified time period



http://www.cgd.ucar.edu/asr/asr94/

2. Climate change as a system



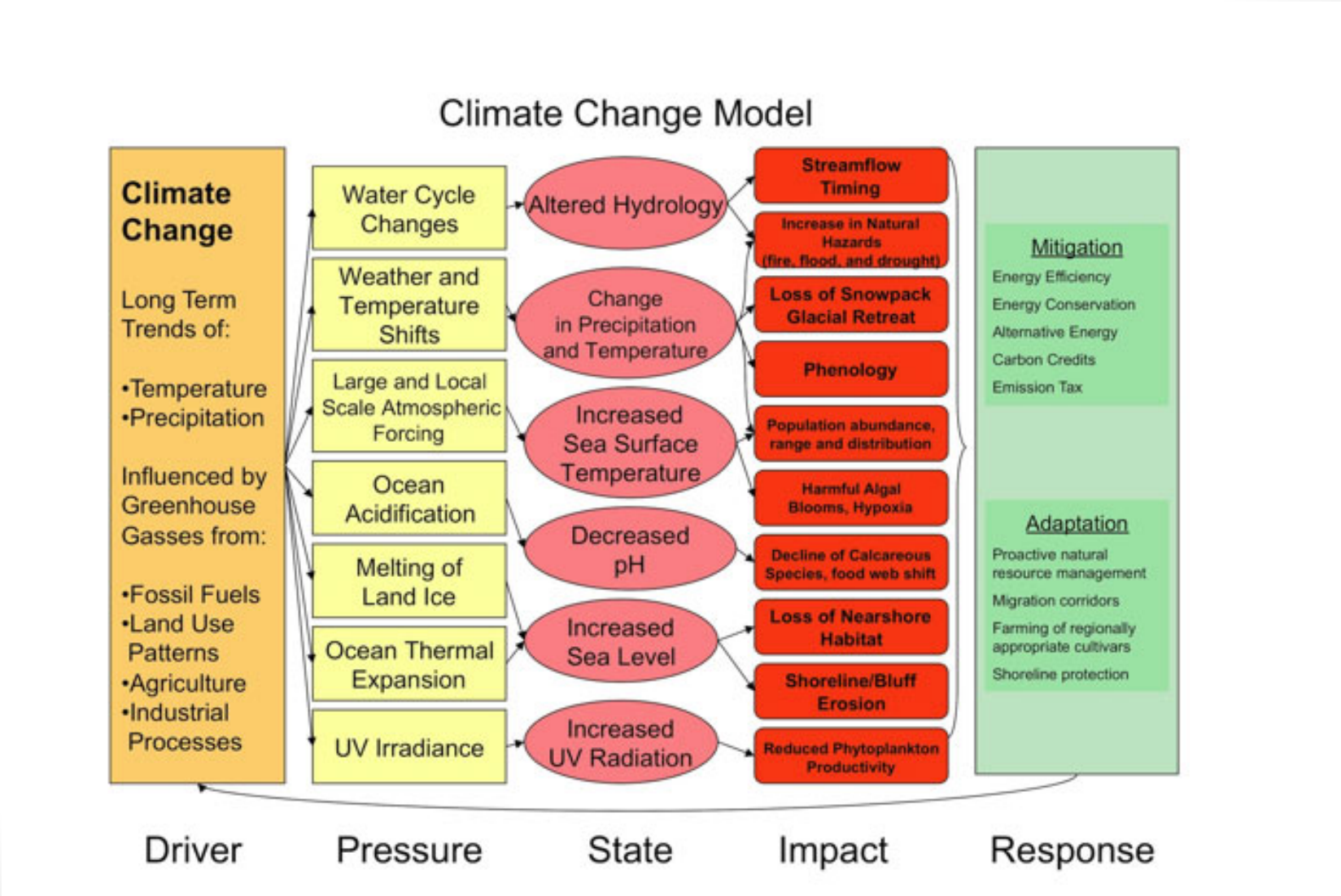


UNEP

3. Three aspects of climate change

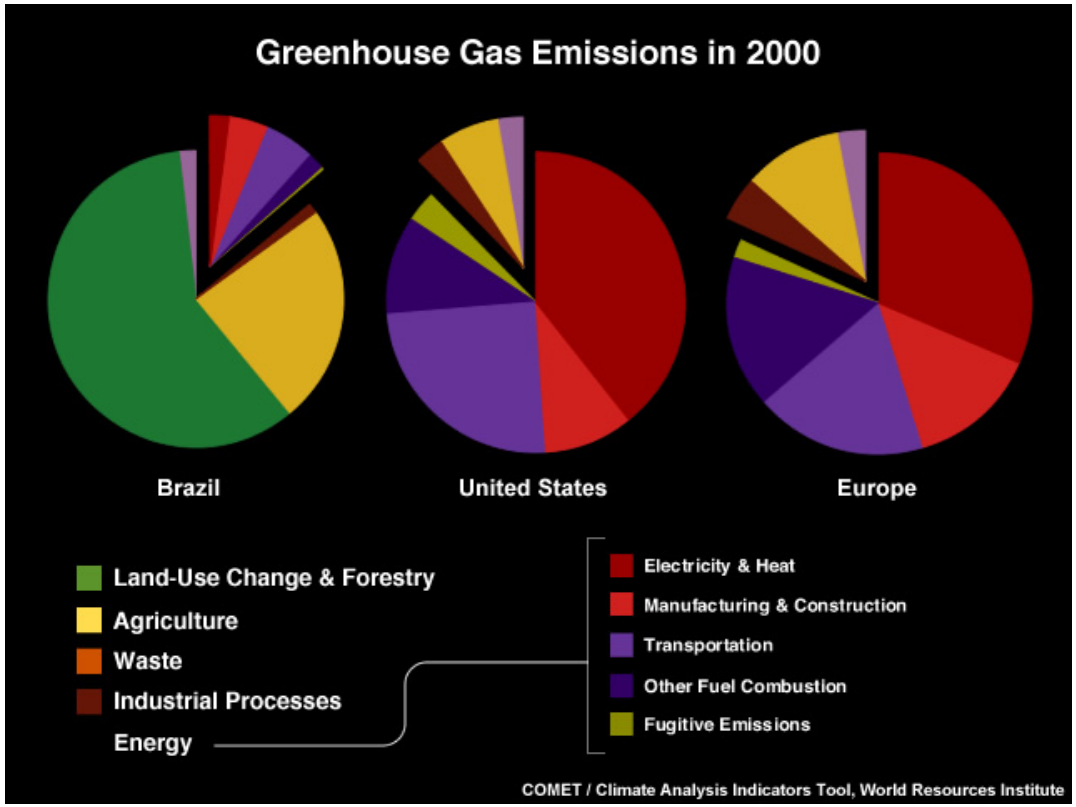
- process
- impacts
- strategies for adaptation & mitigation

Process, impact, strategies



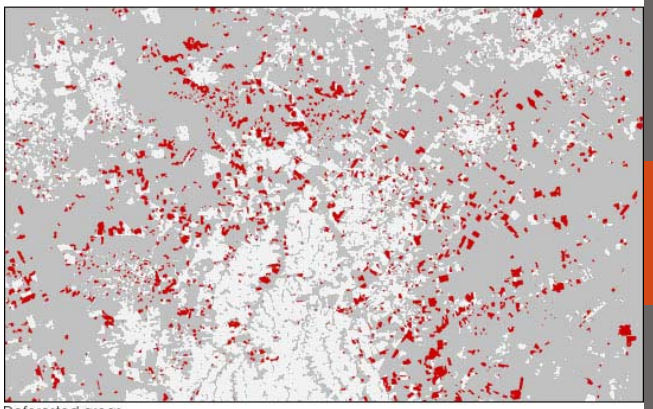
http://pugetsoundscienceupdate.com/pmwiki.php?n=Chapter3.Section2

4. Human (anthropogenic) influences on climate



June 28, 2006


June 17, 2002


Deforested areas

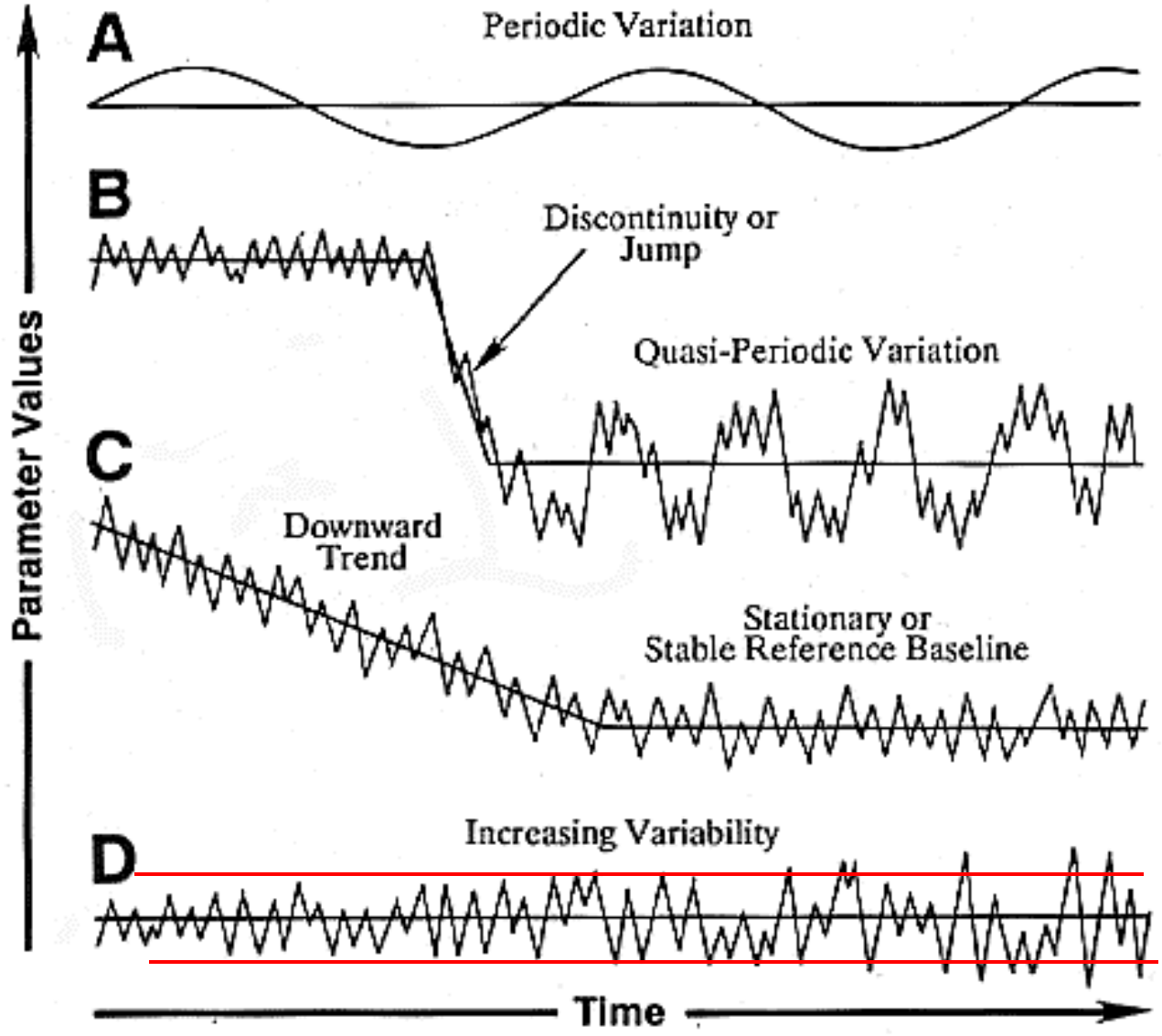
NASA Earth Observatory

- deforestation
- agricultural overuse
- creation of artificial lakes
- urbanization

  - act to change the surface albedo, temperature and climate

5. IPCC definition of climate change

"Climate change in IPCC usage refers to a change in the state of the climate that can be identified (e.g. using statistical tests) by **changes in the mean and/or the variability of its properties**, and that persists for an extended period, typically decades or longer. It refers to **any change in climate** over time, whether due to **natural variability or as a result of human activity**. This usage differs from that in the United Nations Framework Convention on Climate Change (UNFCCC), where climate change refers to a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods."

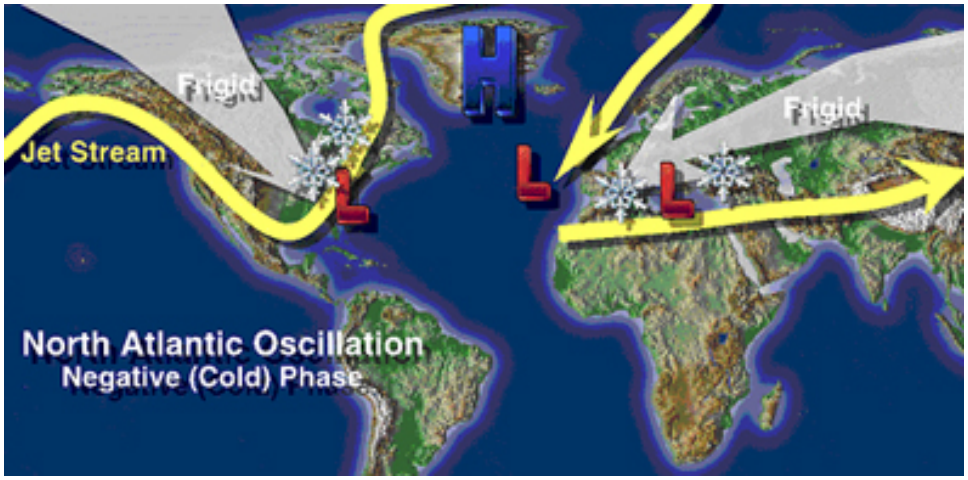


Types of climatic variation

Increased human vulnerability

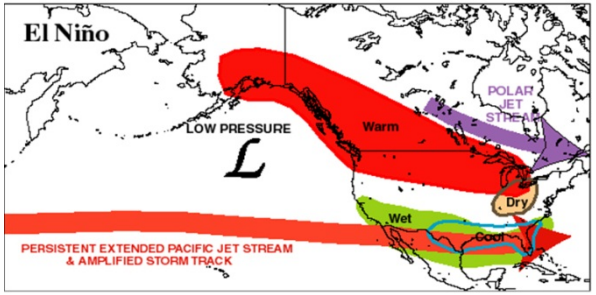
Credit: David Robinson, NJSC

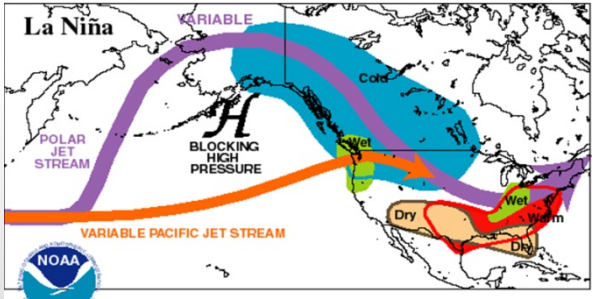
6. What is climate variability?



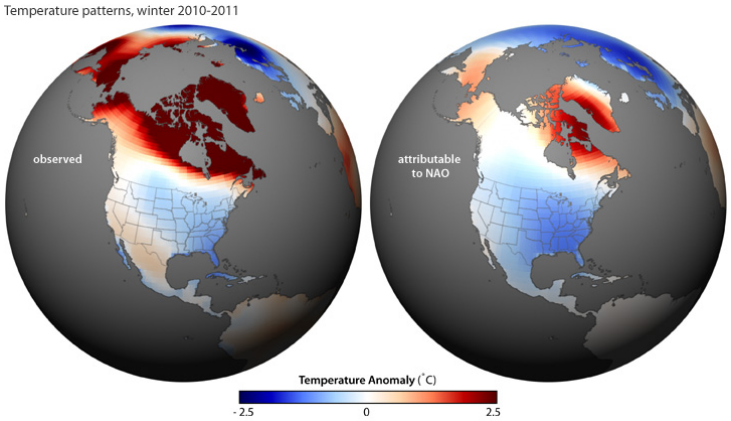
Jack Creilson

- "The temporal variations of the atmosphere– ocean system around a mean state. Typically, this term is used for timescales longer than those associated with synoptic weather events (i.e., months to millennia and longer). The term "natural climate variability" is further used to identify climate variations that are not attributable to or influenced by any activity related to humans." AMS Glossary





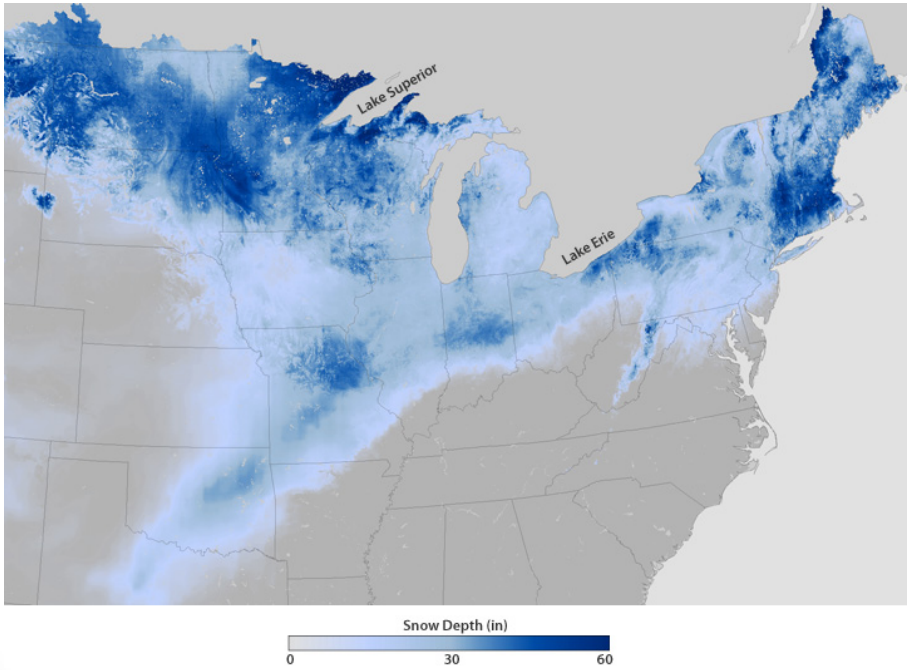
Climate Prediction Center/NCEP/NWS



NOAA

Observing climate variability

Snow depths on 2 February 2011

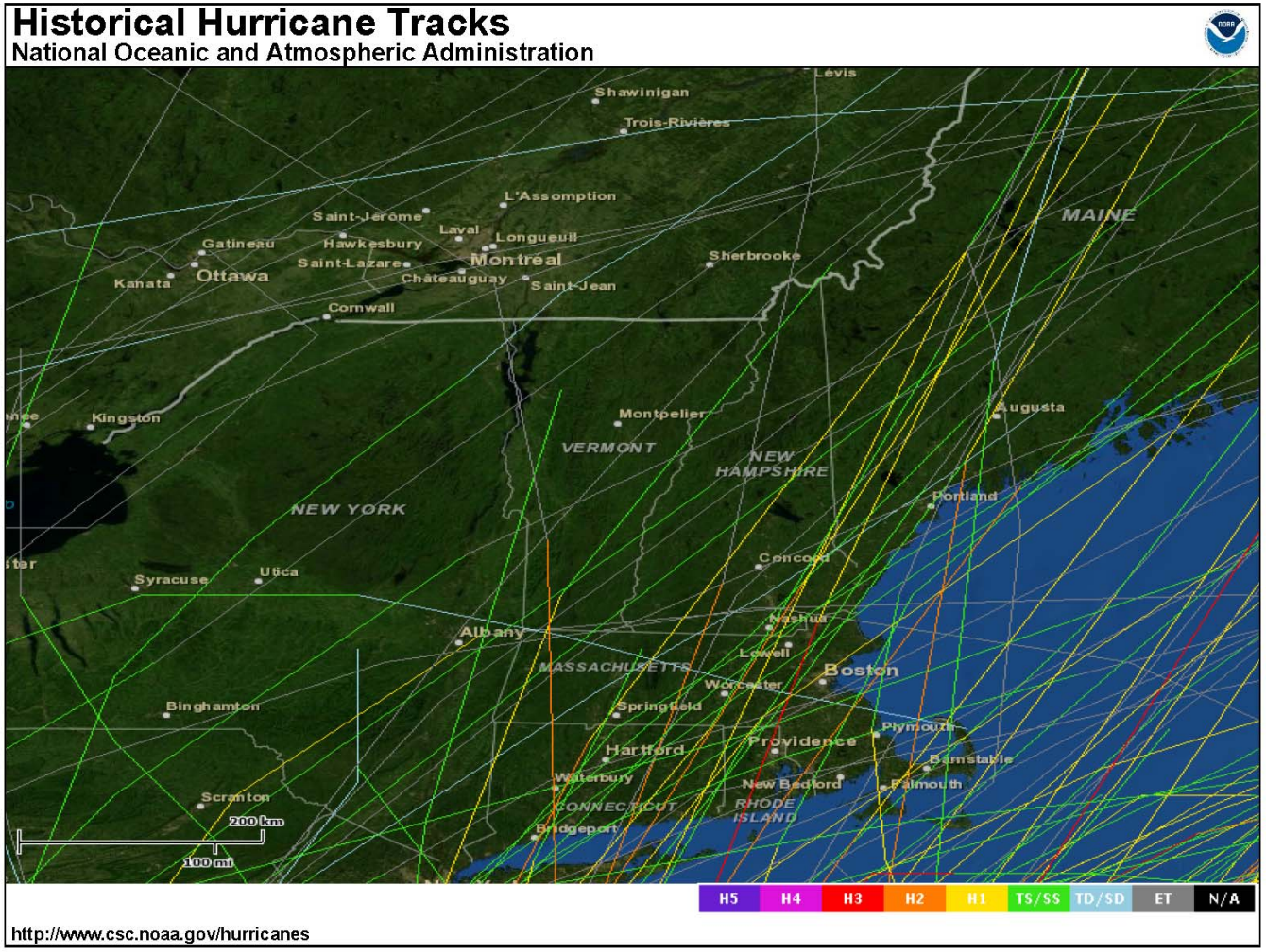


http://www.climatewatch.noaa.gov/2011/articles/another-wintry-winter-for-the-eastern-u-s

Backward seasons (2010, 2012)

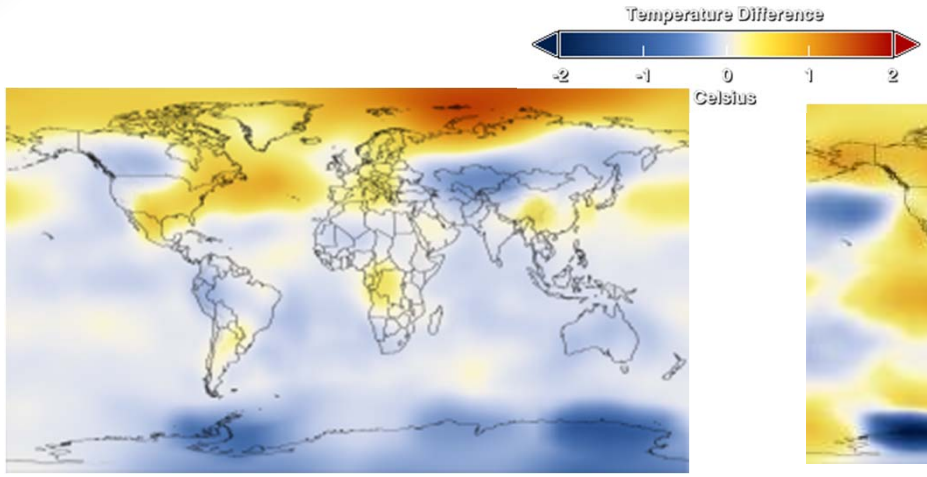
Photo credit: L-A. Dupigny-Giroux

Tropical cyclones (including hurricanes) 1850-2011

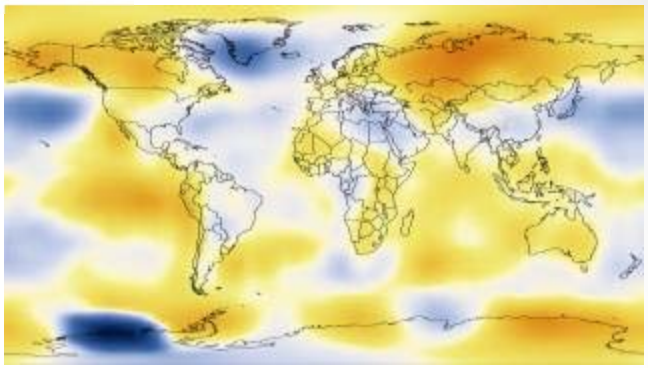


7. Temperature anomalies

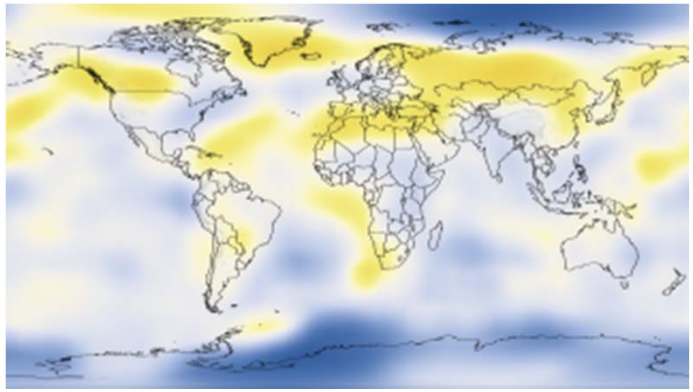
Global temperature anomalies (1951-1980 base period)
NASA
SVS



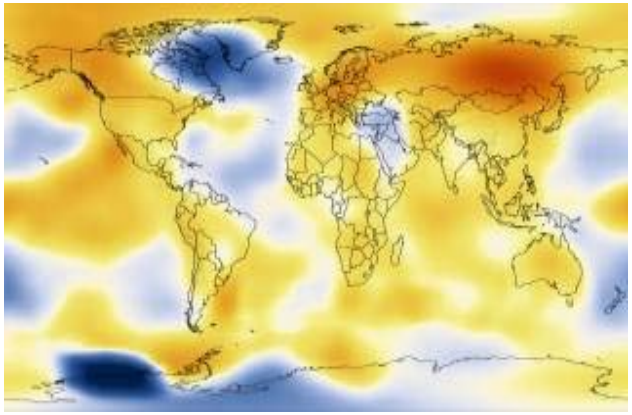
1950-1954



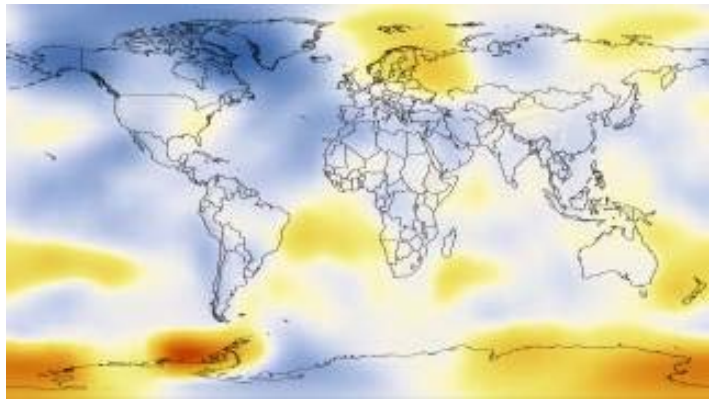
1980-1984



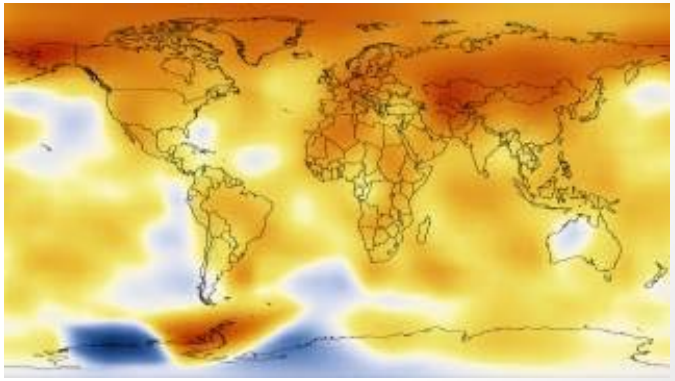
1960-1964



1990-1994

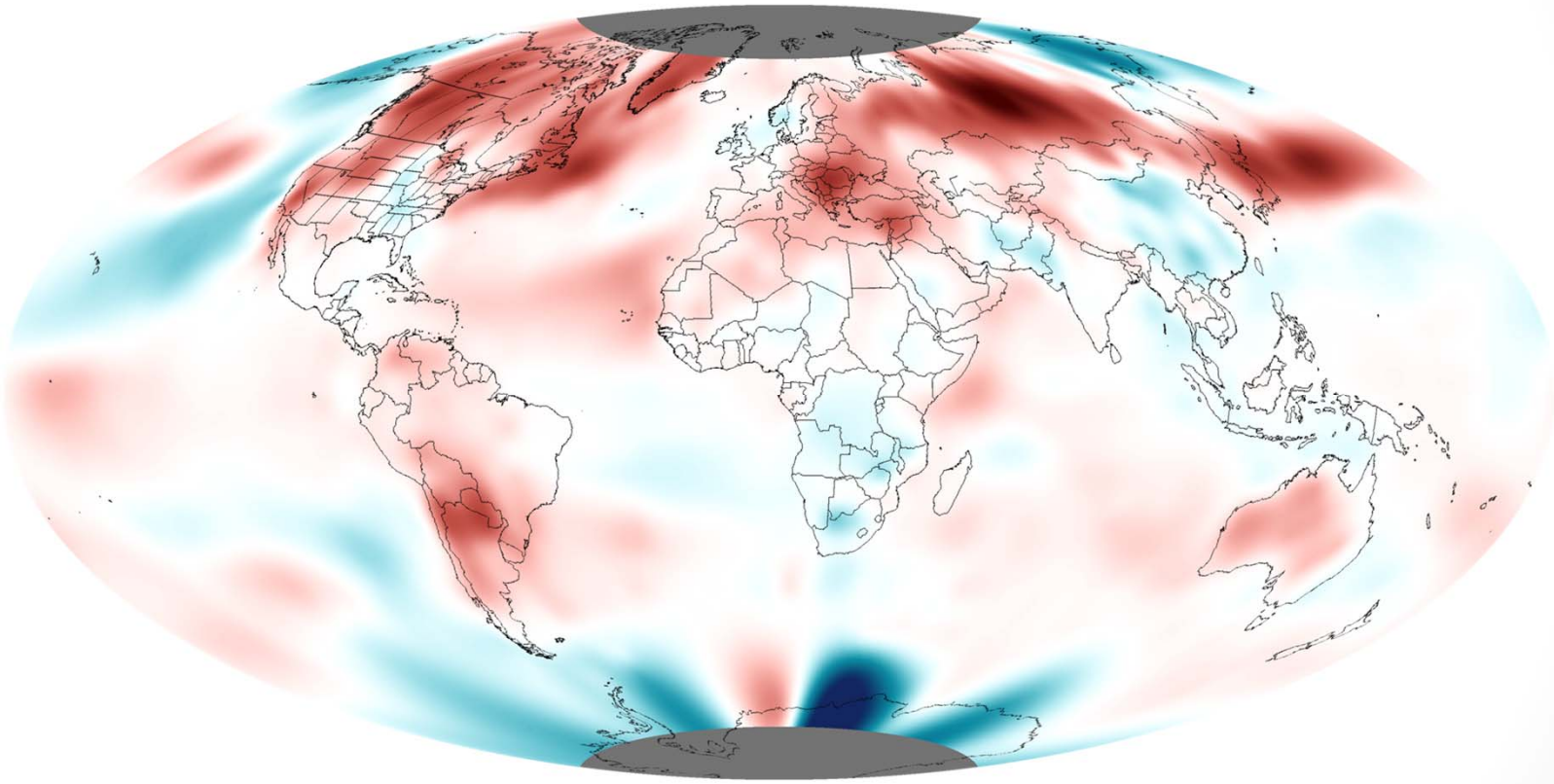


1970-1974

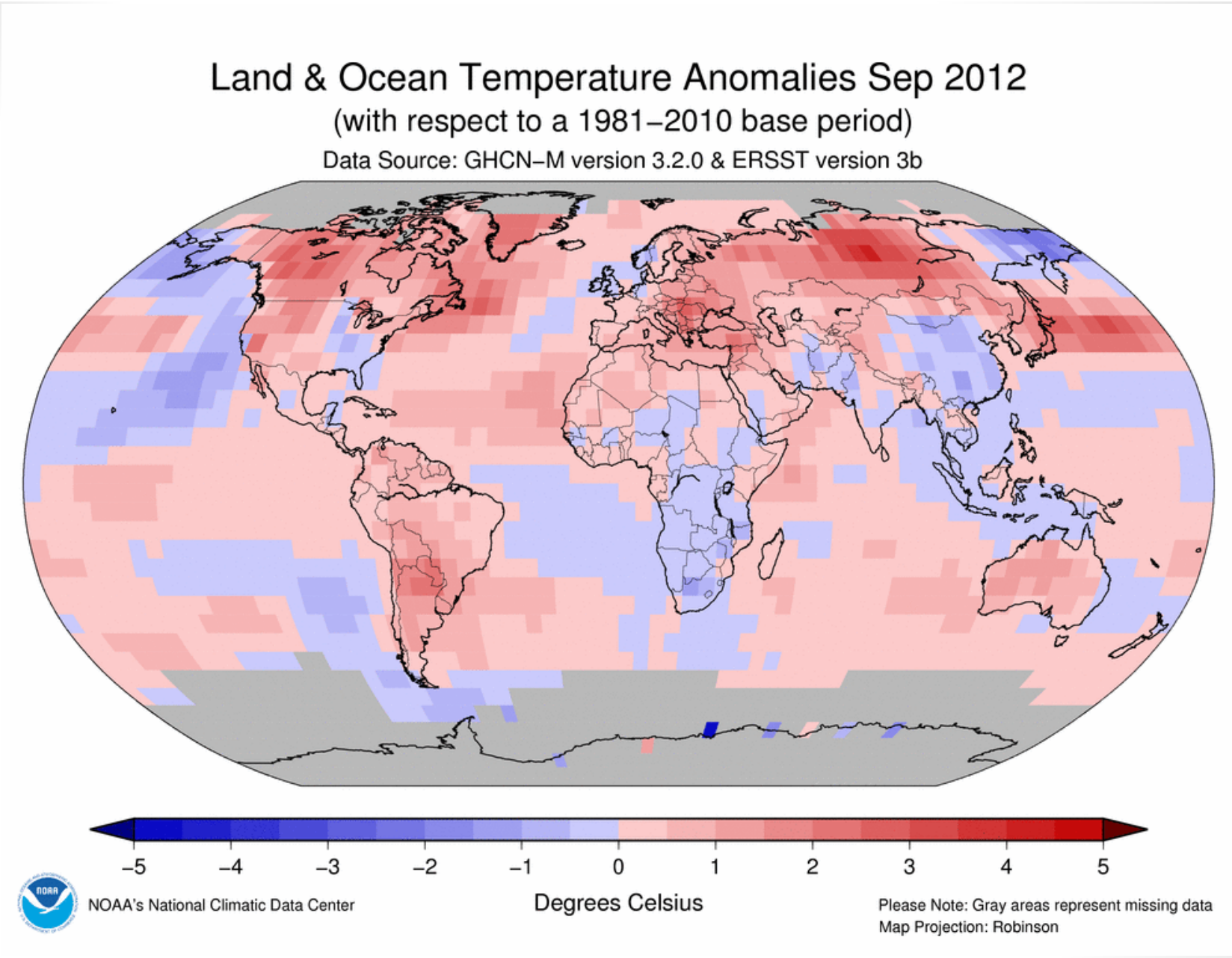


2000-2004

2012 - global temperature ties with 2005 as record highest for September



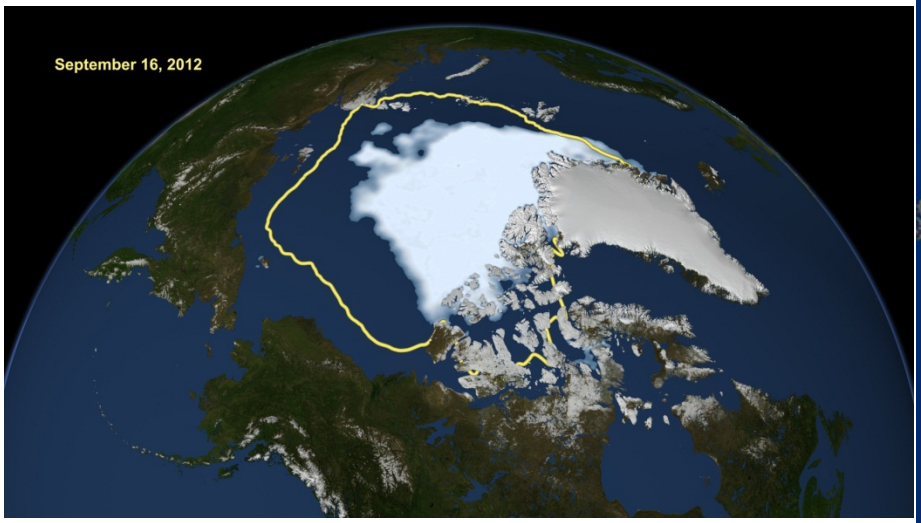
http://www.nnvl.noaa.gov/MediaDetail2.php?MediaID=1209&MediaTypeID=1



http://www.ncdc.noaa.gov/sotc/service/global/map-blended-mntp/201209.gif

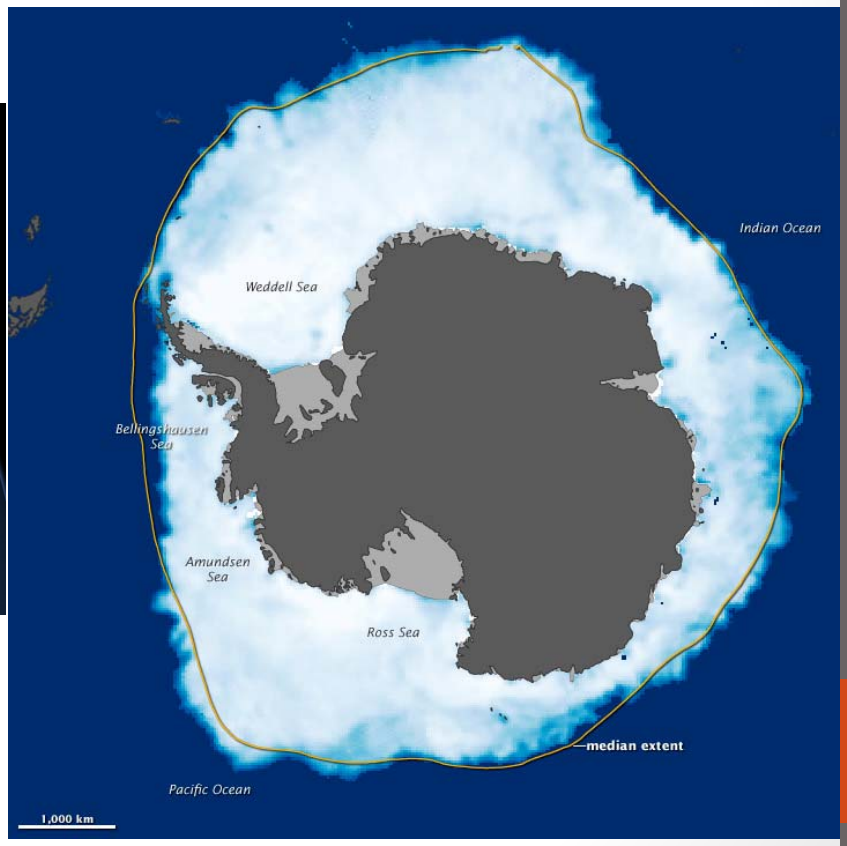
Polar sea ice extent – Sep 2012

Arctic sea ice minimum in satellite era



http://www.nasa.gov/images/content/689574main_MinSeaIce_20120916-orig_full.jpg

Antarctic sea ice maximum – 26 September



http://earthobservatory.nasa.gov/IOTD/view.php?id=79369

8. Radiative forcing (IPCC, 2007)

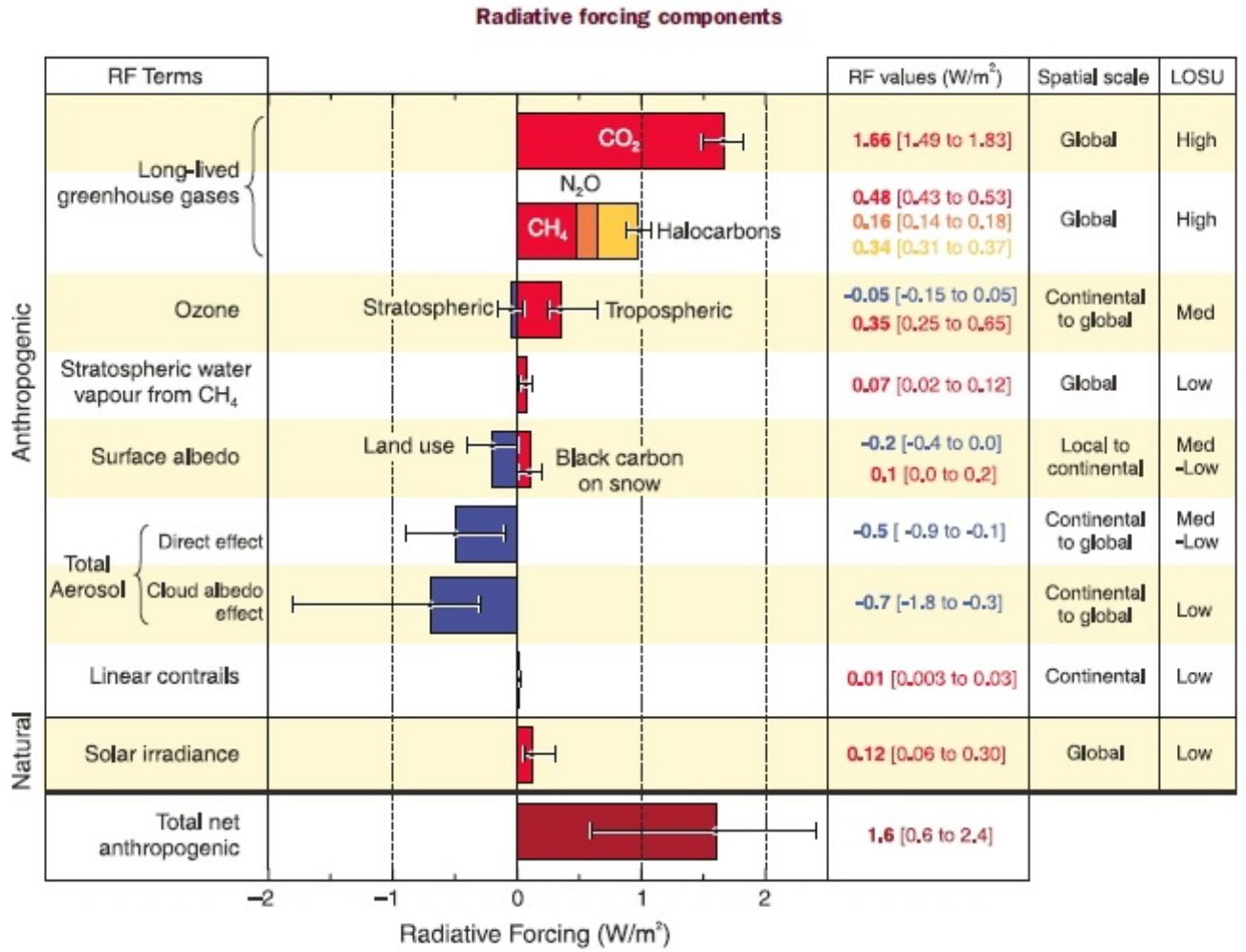
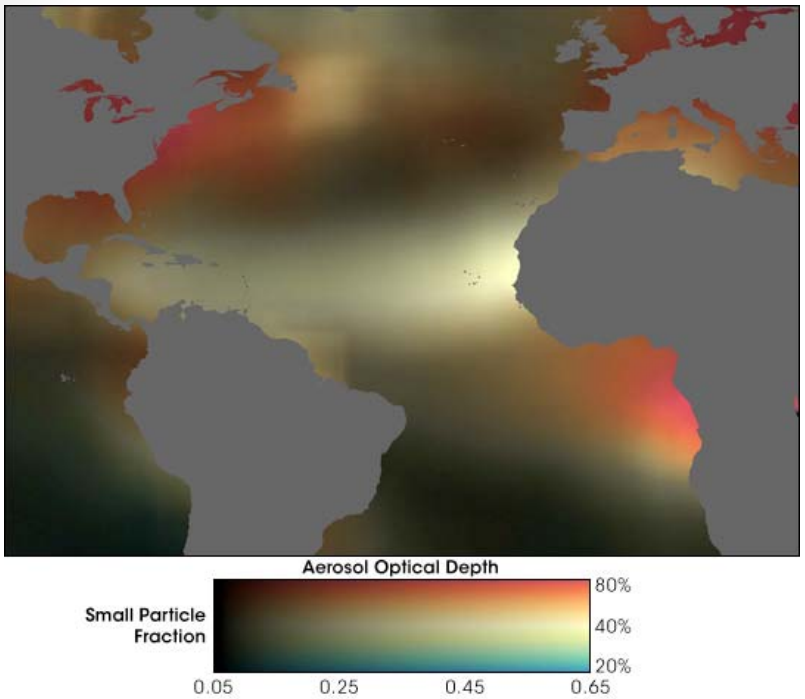
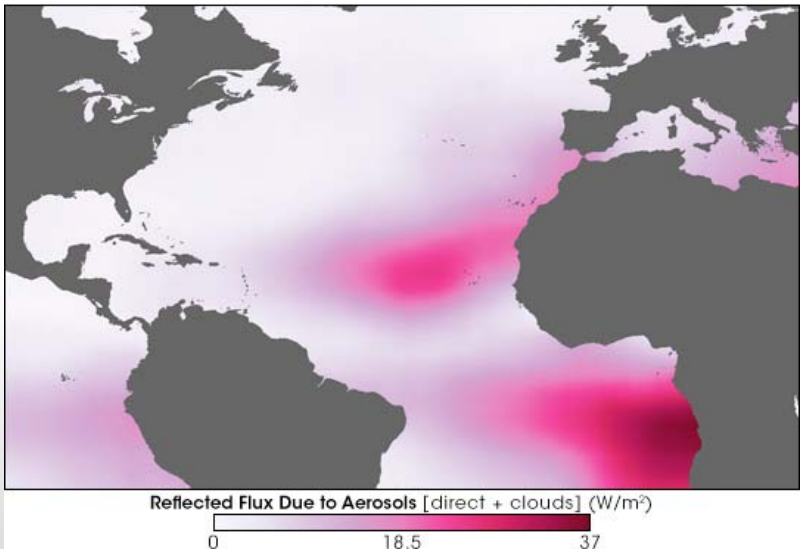


Figure 2.4. Global average radiative forcing (RF) in 2005 (best estimates and 5 to 95% uncertainty ranges) with respect to 1750 for CO_2, CH_4, N_2O and other important agents and mechanisms, together with the typical geographical extent (spatial scale) of the forcing and the assessed level of scientific understanding (LOSU). Aerosols from explosive volcanic eruptions contribute an additional episodic cooling term for a few years following an eruption. The range for linear contrails does not include other possible effects of aviation on cloudiness. {WGI Figure SPM.2}

Role of aerosols



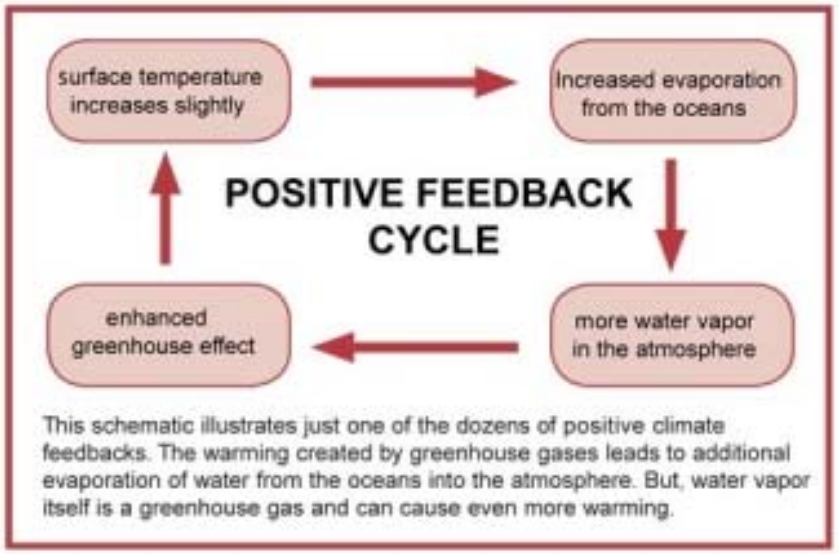


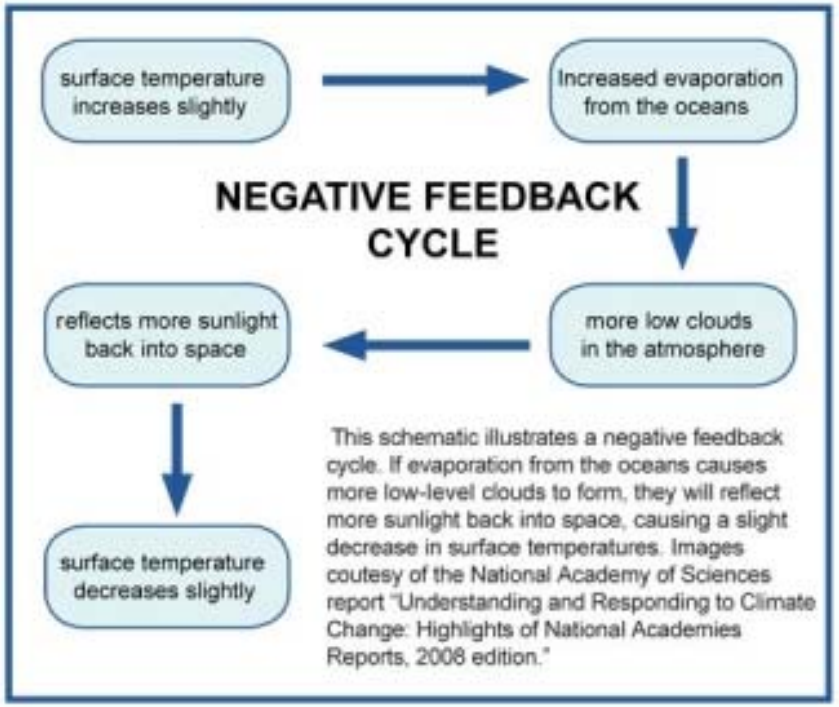
- light colored ones reflect radiation (cooling)
- dark aerosols (soot) inhibit cloud formation
- large aerosols (yellow)
- small aerosols (red)

- sources
  - urban pollution (30-60°N)
  - Saharan dust (5-25°N)
  - fires
  - sea salt

NASA

Types of feedbacks



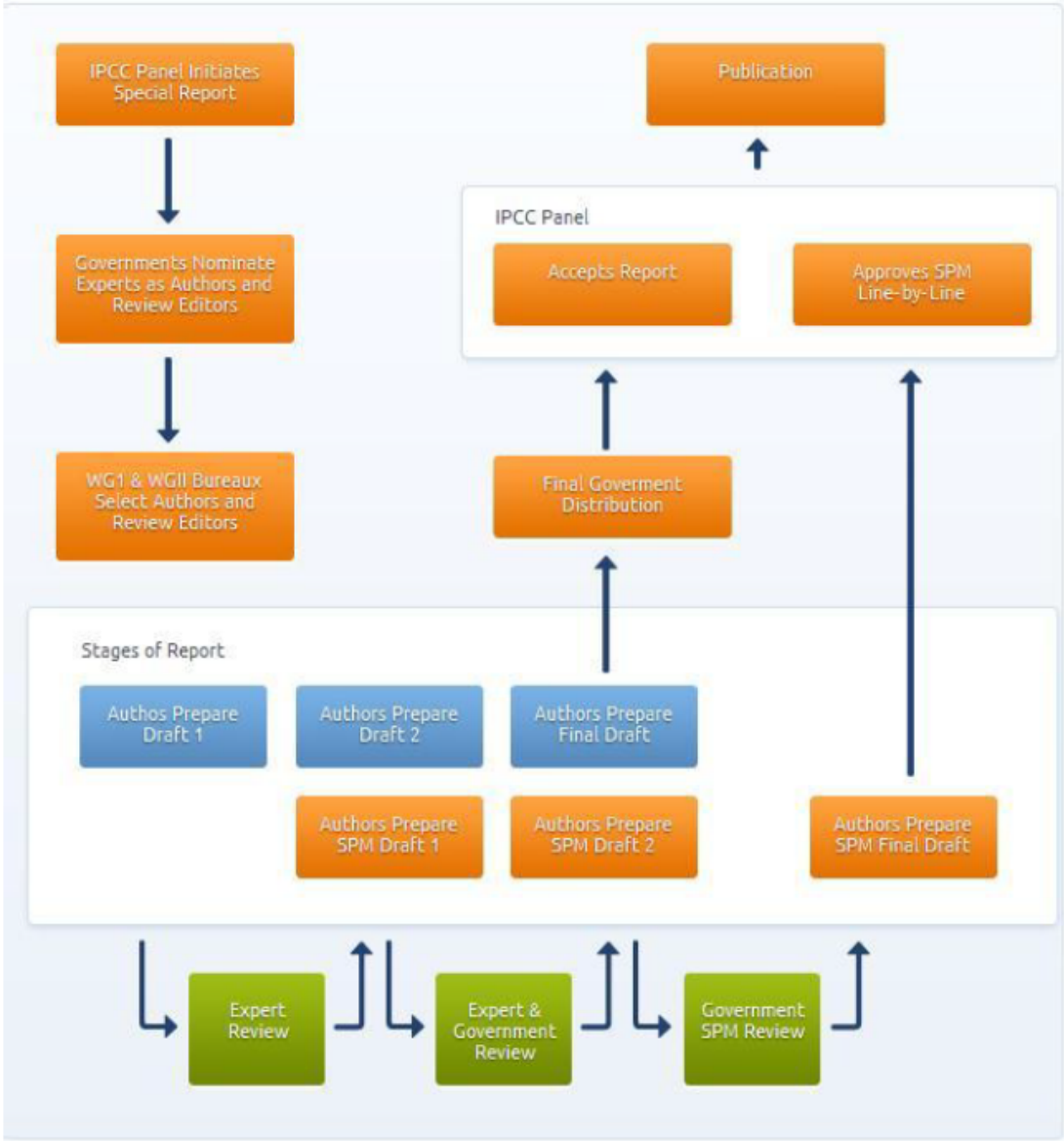


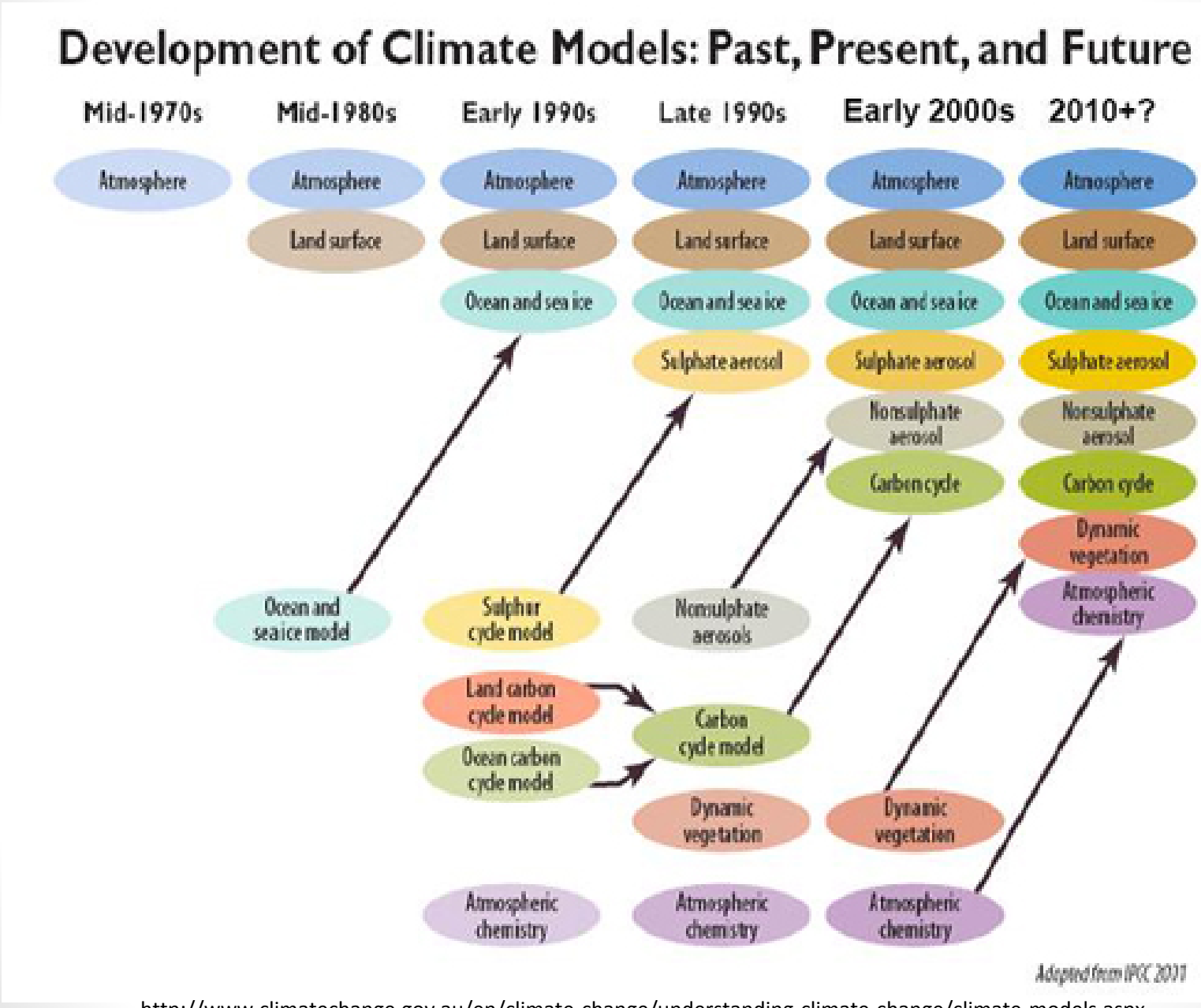
Positive and Negative Feedback Cycles: Feedbacks are important drivers of climate change as well as sources of uncertainty for projected changes.
Credit: Figure courtesy of the National Academies, 2008.
http://www.nationalacademies.org/

http://www.southwestclimatechange.org/figures/feedback_cycles

9. Models & the IPCC process

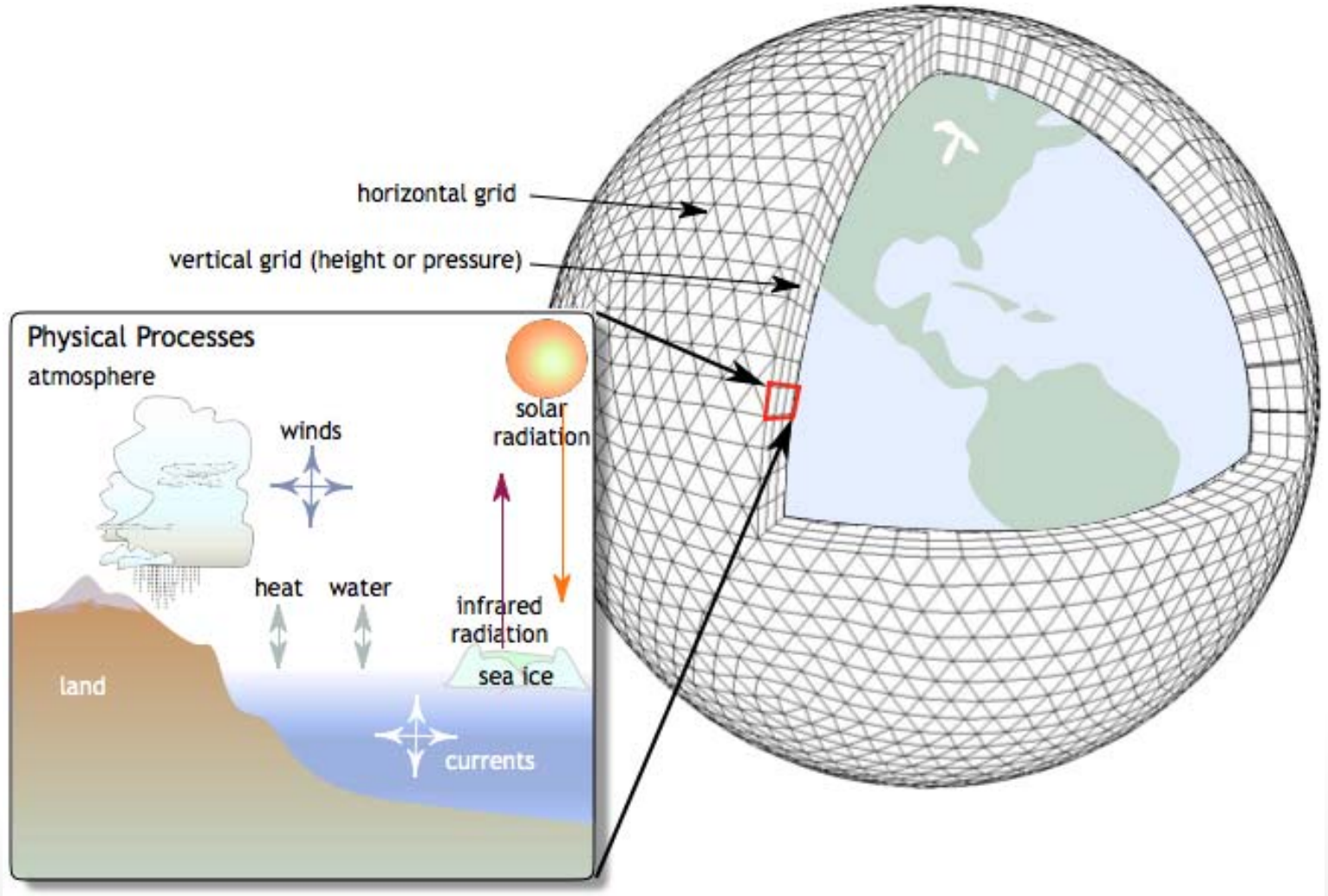
IPCC Assessment Reports: The Process





http://www.climatechange.gov.au/en/climate-change/understanding-climate-change/climate-models.aspx

Global climate model (GCM)



http://www.cmmap.org/learn/modeling/whatIs2.html

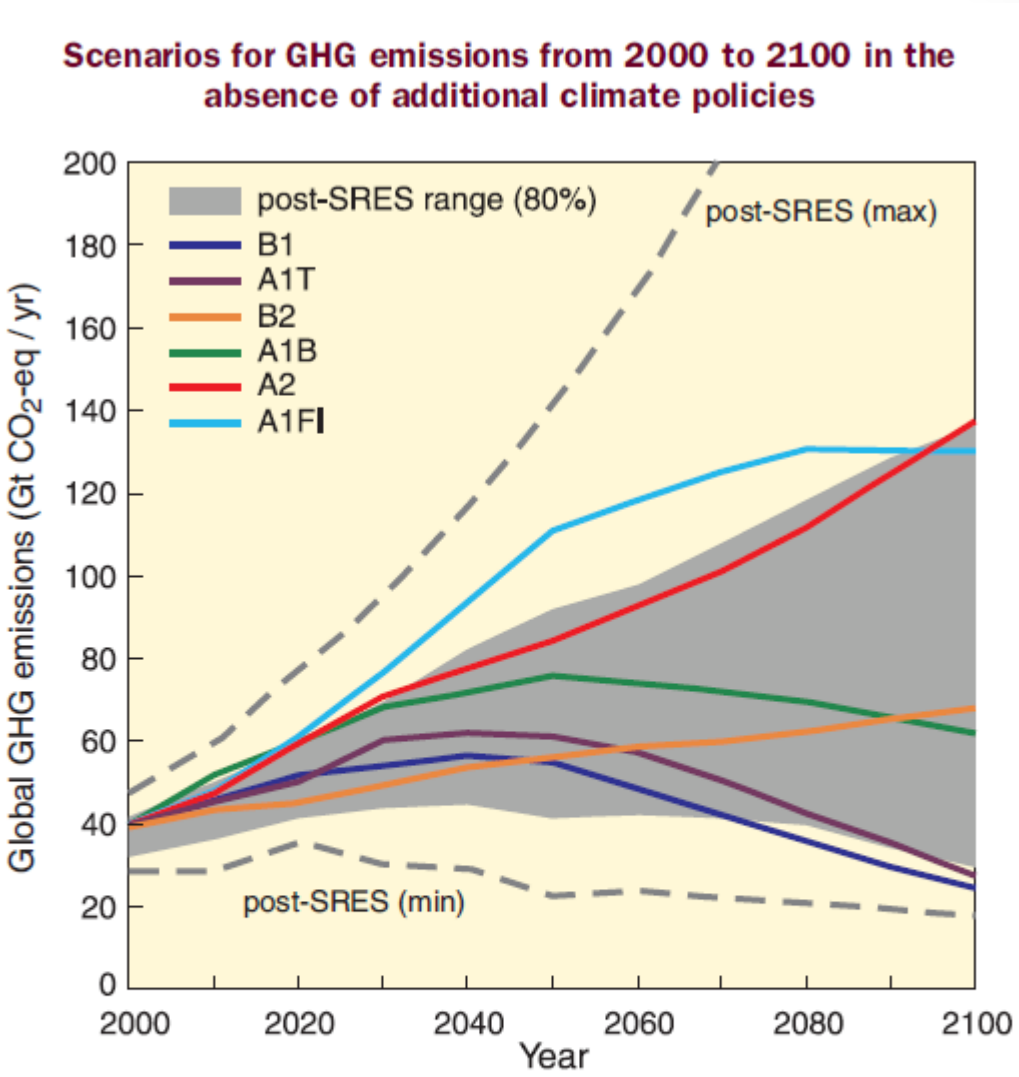
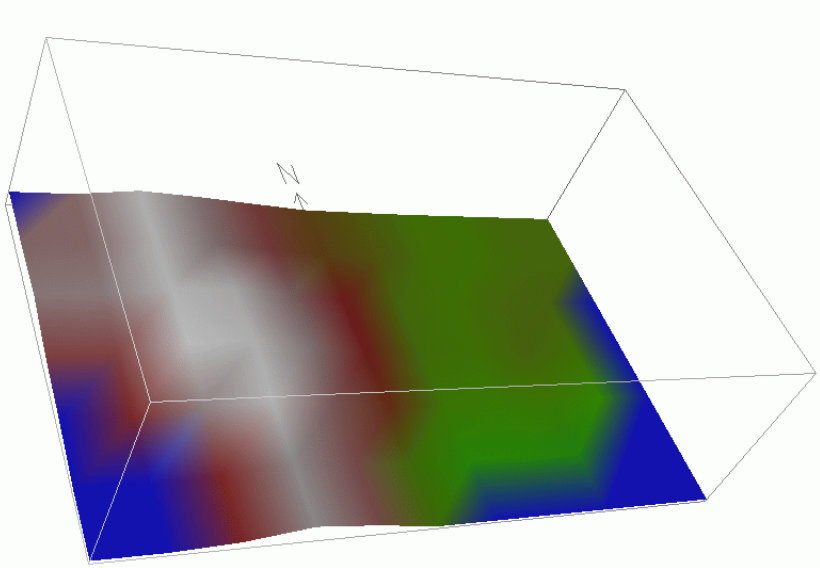
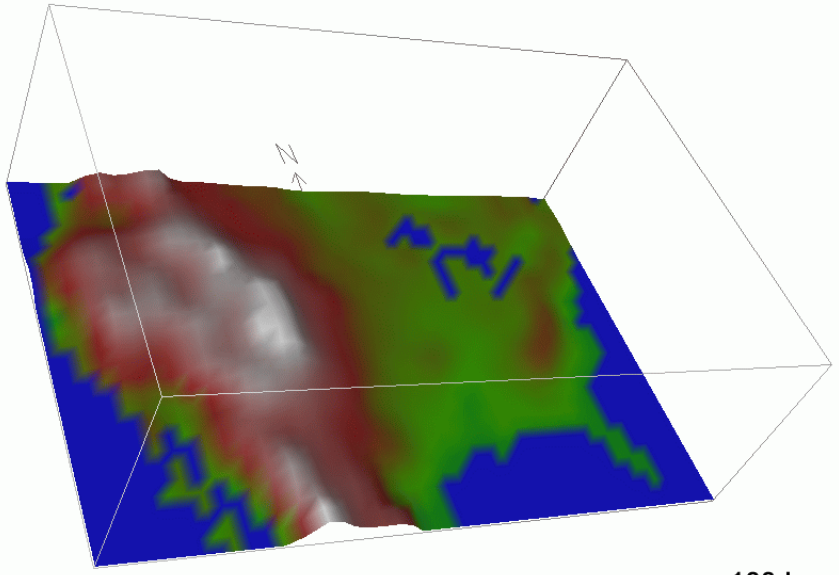


Figure 3.1. *Global GHG emissions (in $GtCO_2$-eq per year) in the absence of additional climate policies: six illustrative SRES marker scenarios (coloured lines) and 80th percentile range of recent scenarios published since SRES (post-SRES) (gray shaded area). Dashed lines show the full range of post-SRES scenarios. The emissions include CO_2, CH_4, N_2O and F-gases. {WGIII 1.3, 3.2, Figure SPM.4}*

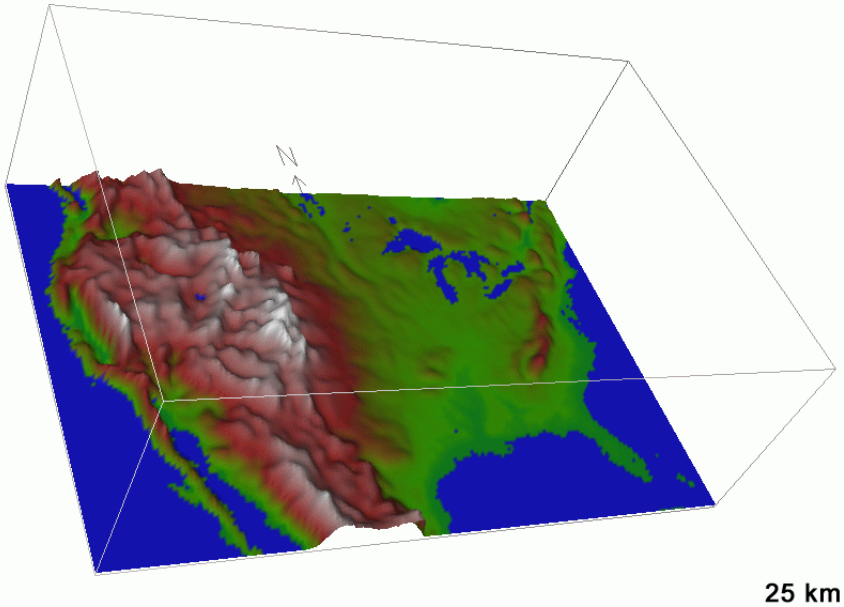
IPCC Fourth Assessment Report: Climate Change 2007

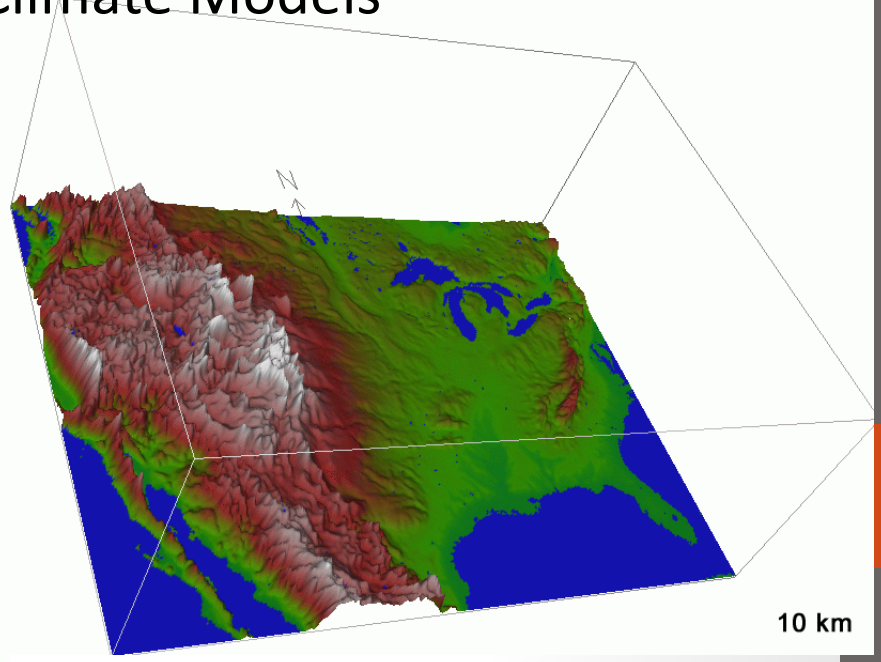
Global Climate Models





Regional Climate Models



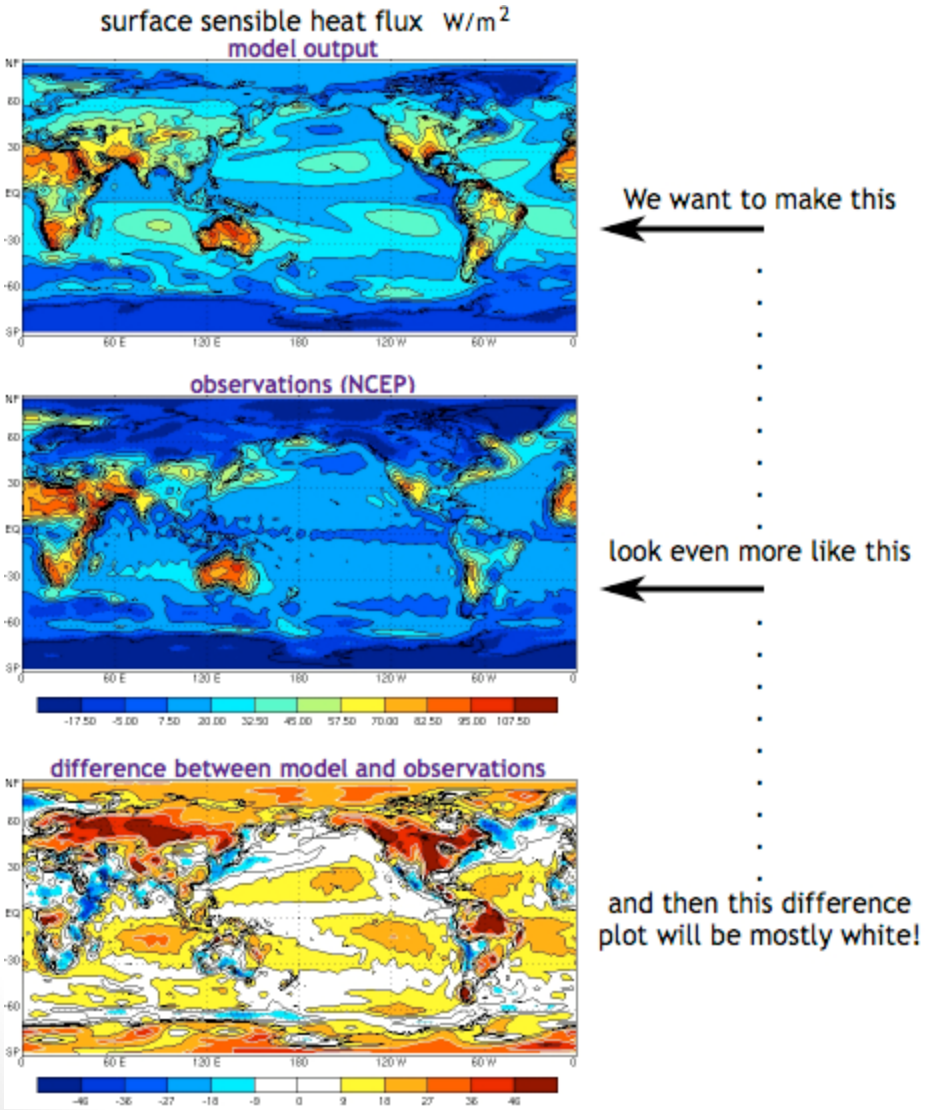


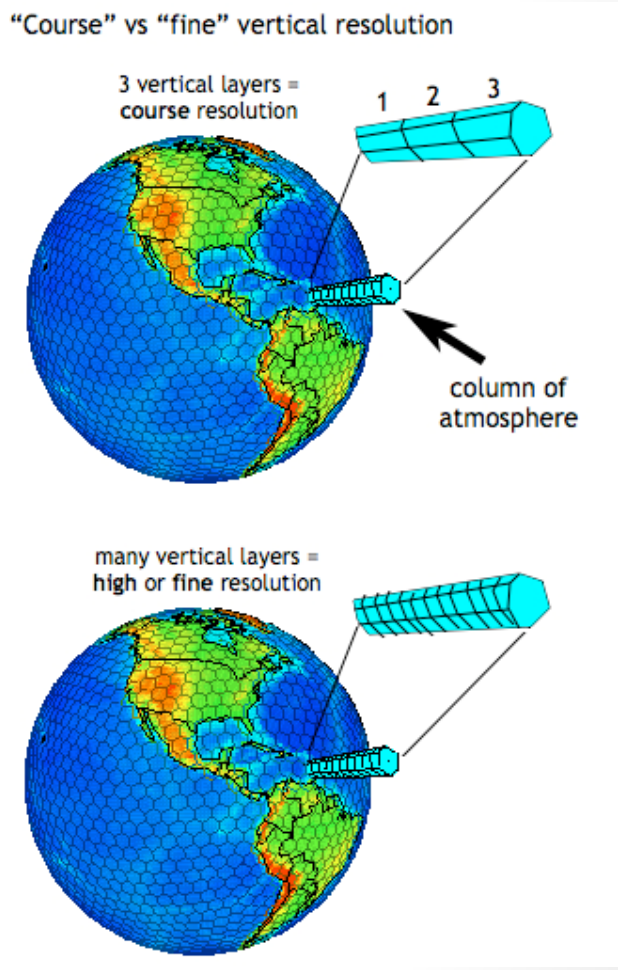
Dr. Rick Anthes

Role of topography

NASA MODIS image
12 Sept. 2012

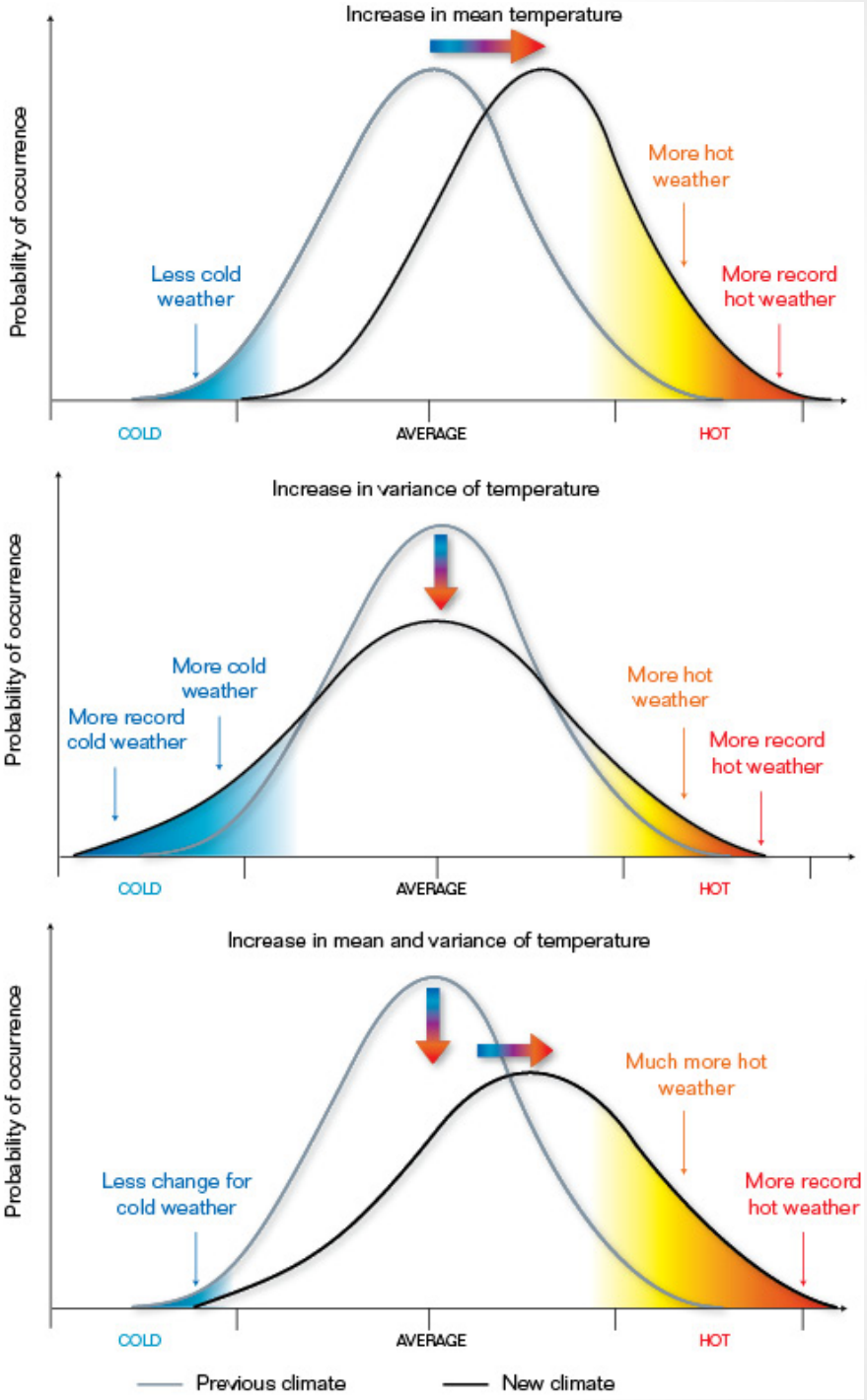
Model improvements





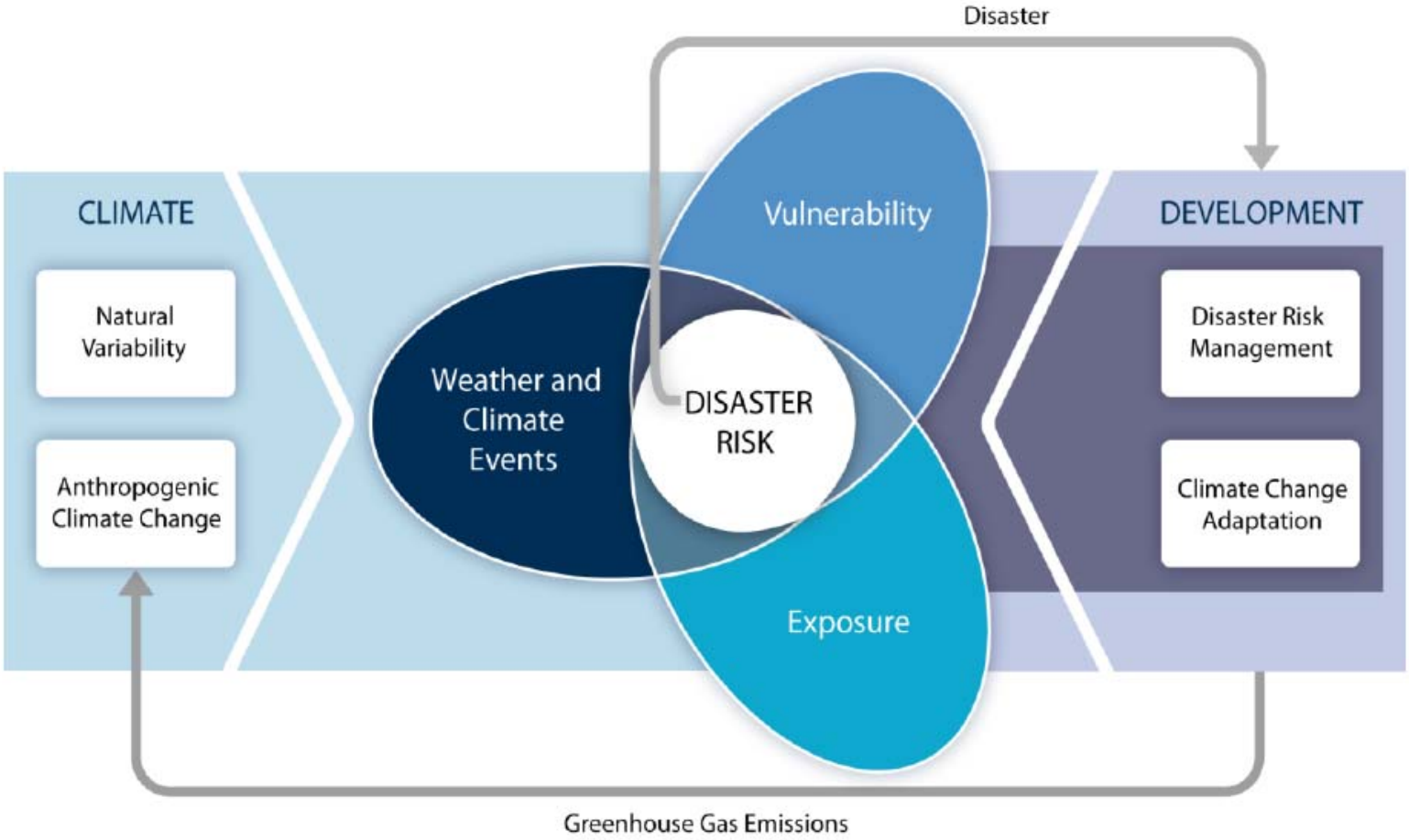
http://www.cmmap.org/learn/modeling/improvements1.html

Figure 2.5 Effect on extremes of temperature from an increase in mean temperature, an increase in variance, and an increase in both mean temperature and variance



http://www.garnautreview.org.au/chp2.htm

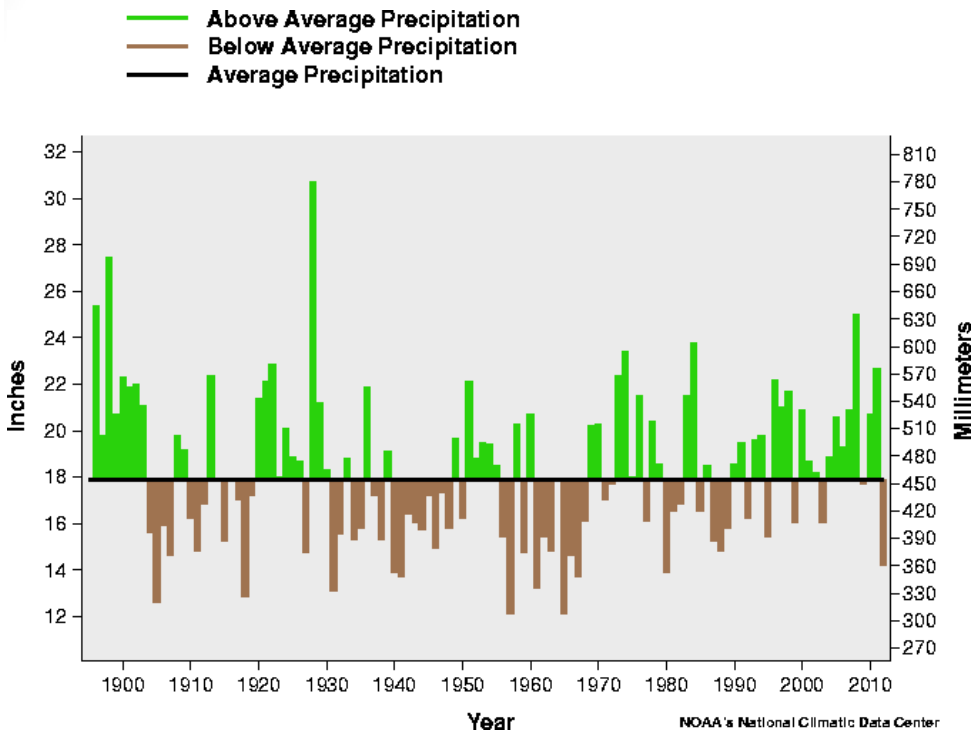
Increasing vulnerability, exposure, or severity and frequency of climate events increases disaster risk



*Disaster risk management and climate change adaptation can influence the degree to which **extreme events translate into impacts** and **disasters***

The local conversation

November – April comparison for Vermont



2011- 2012

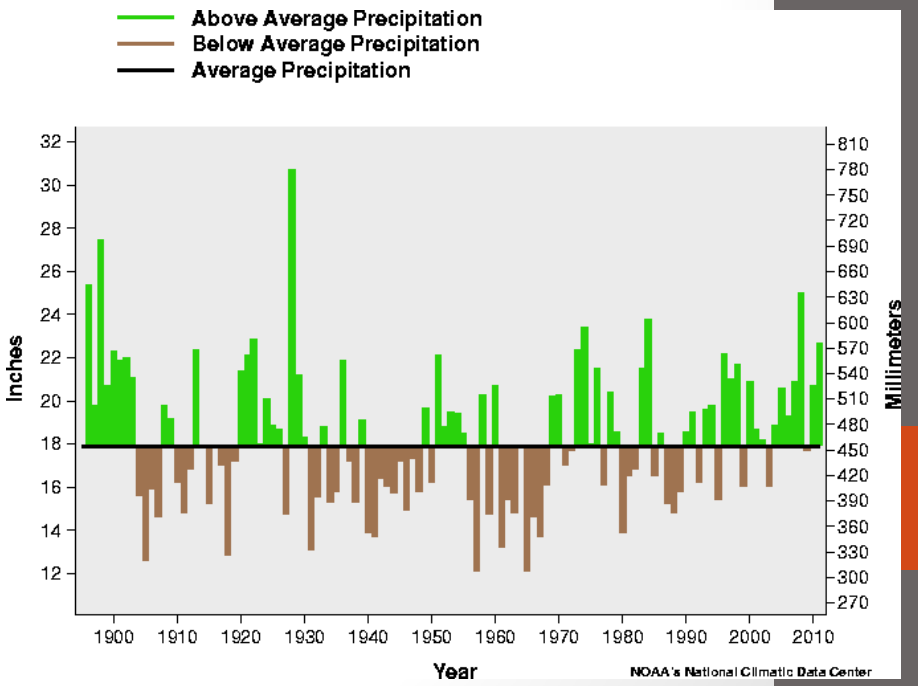
11th driest since 1895

1895 - 2012 Trend = -0.01 Inches / Decade

2010- 2011

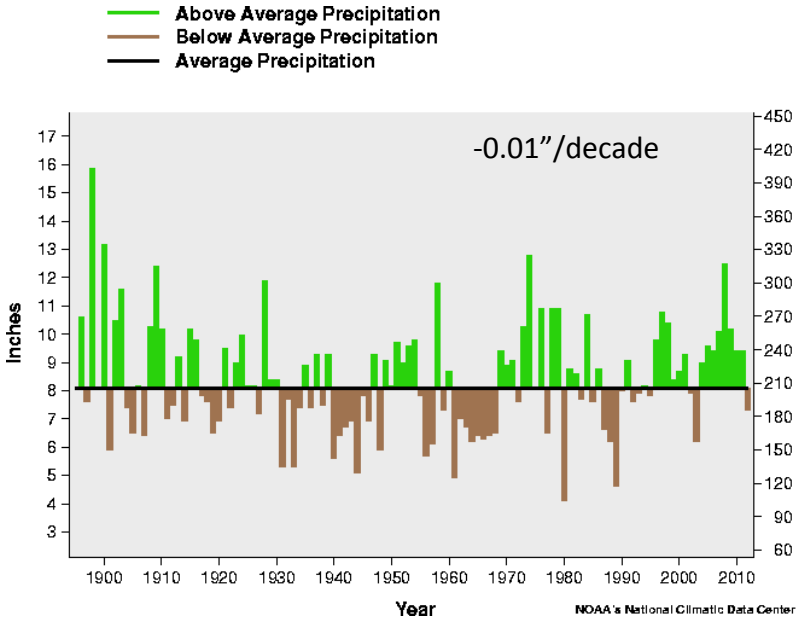
6th wettest since 1895

1895 - 2012 Trend = 0.00 Inches / Decade

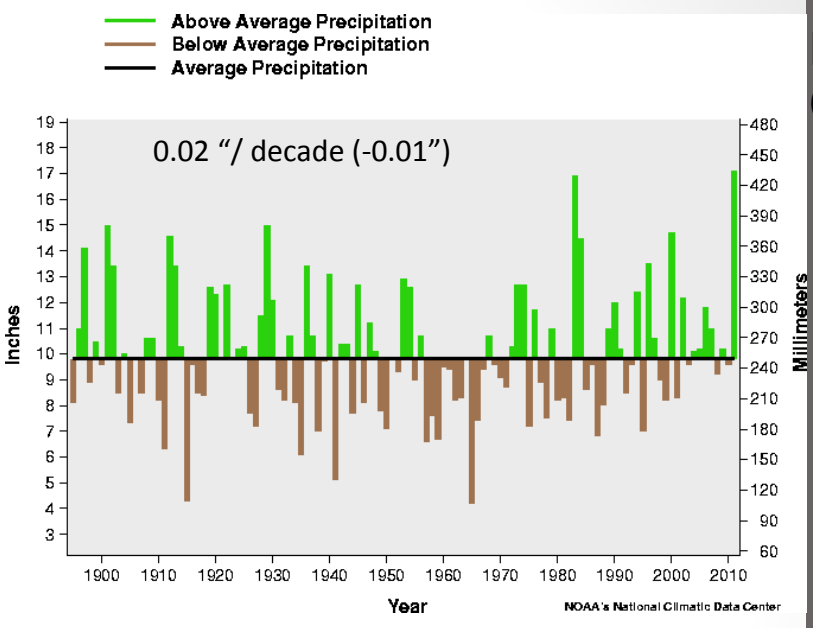


Seasonal changes observed across Vermont – 1895- 2011

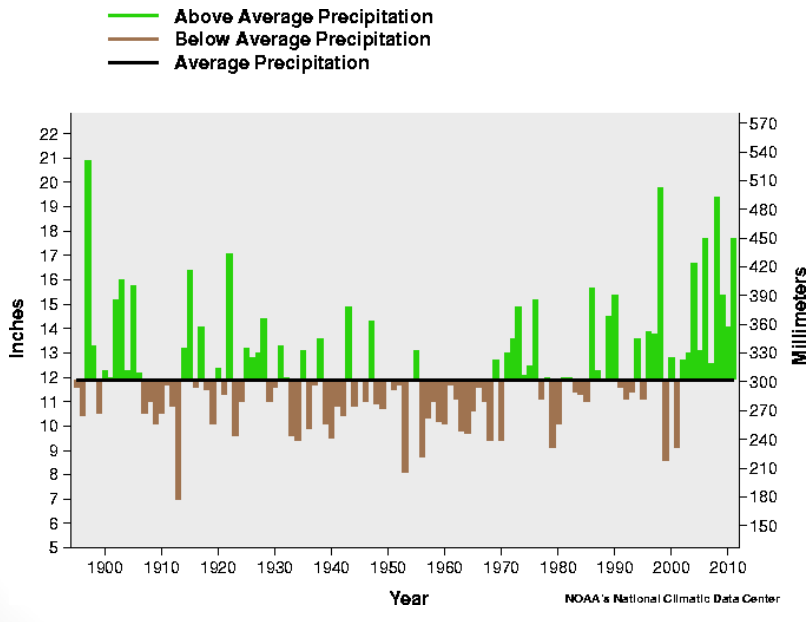
DJF
(winter)



MAM
(spring)

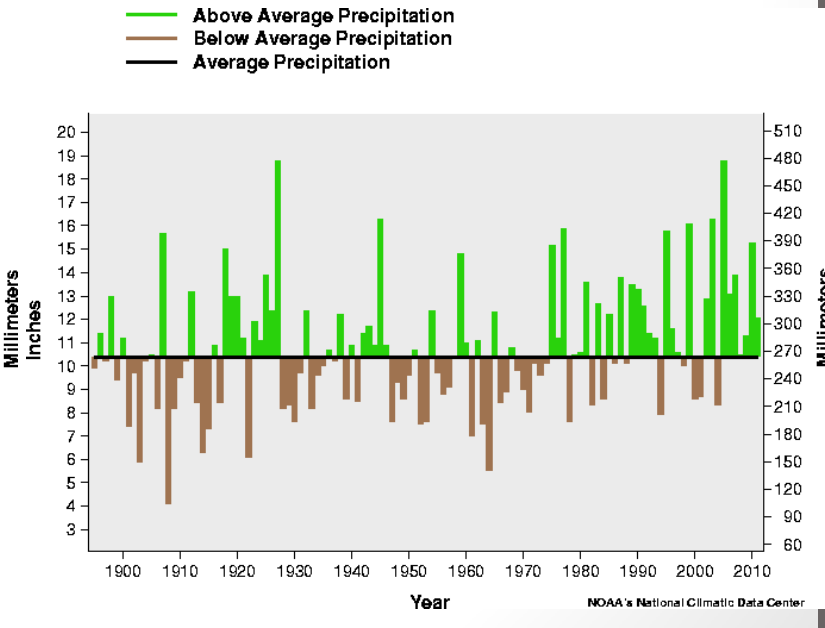


JJA
(summer)



0.11”/decade (0.09”)

SON
(fall)



0.20”/decade

Take-home message

- spatial & temporal scales of analysis are critically important
- systems approach
- role of non-linearities
- identifying vulnerability in the natural & human environment
- adaptation to reduce the vulnerability of natural and human systems

Thank you!

For more information contact:

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656-2146