Climate change 101

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1. Weather, climate and climate change are not interchangeable

Weather vs. climate

- Weather = state of the atmosphere at some place & time
  - described as temperature, cloudiness, precipitation, wind speed & direction
- Meteorology = study of the atmosphere & processes that cause weather
- Climate = weather conditions at some locality averaged over a specified time period
- Climatology = study of climate, its controls & variability

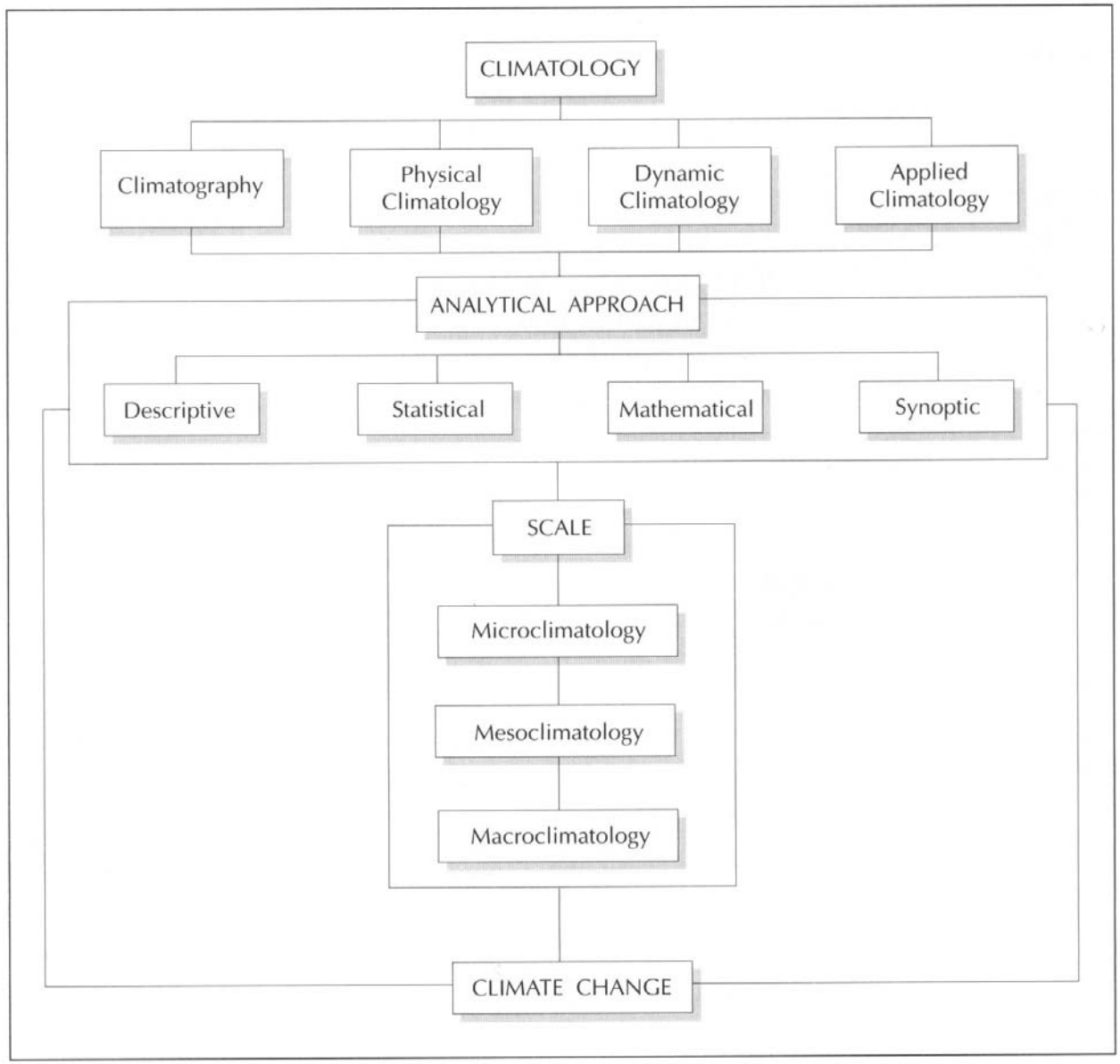
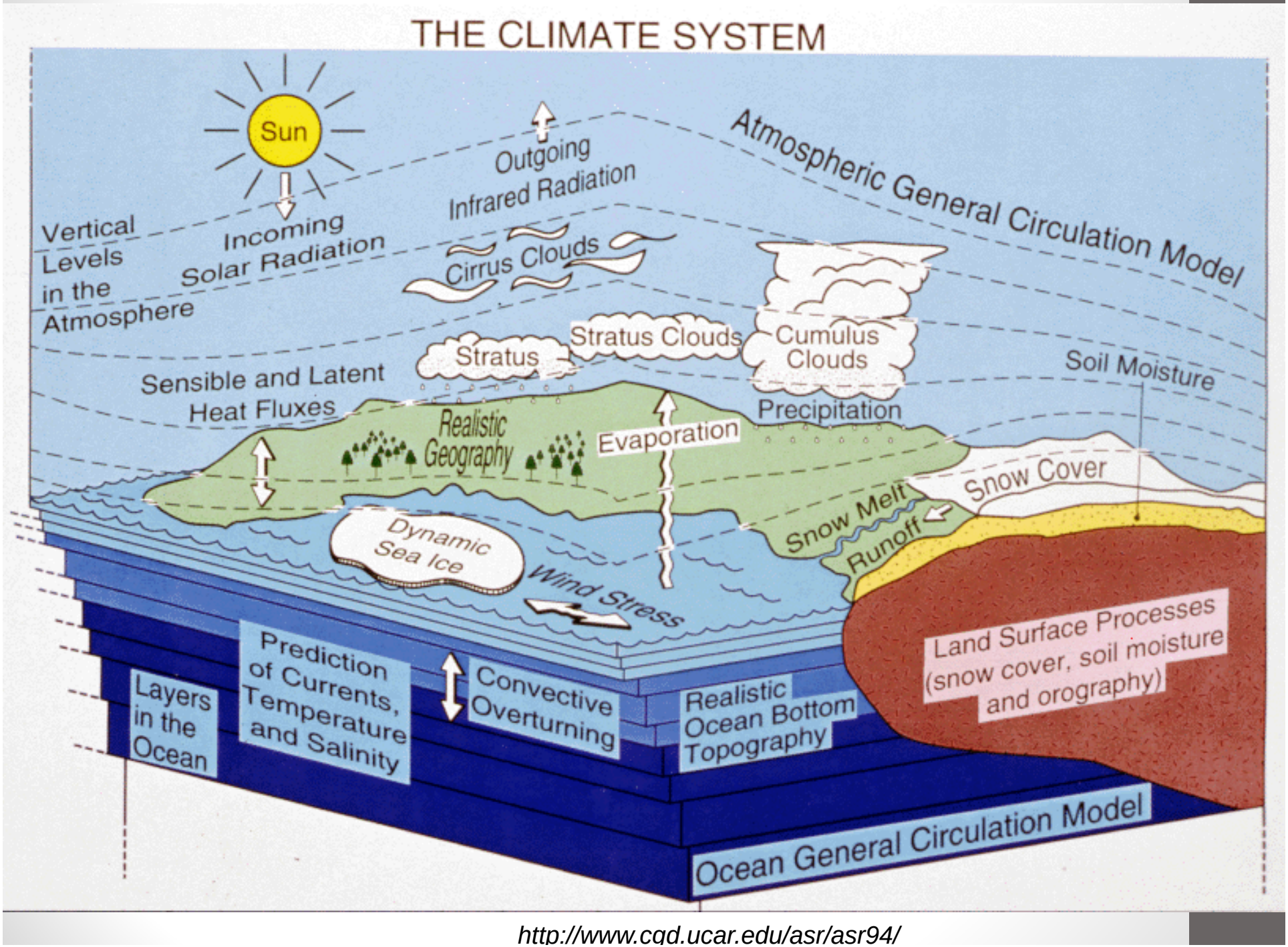


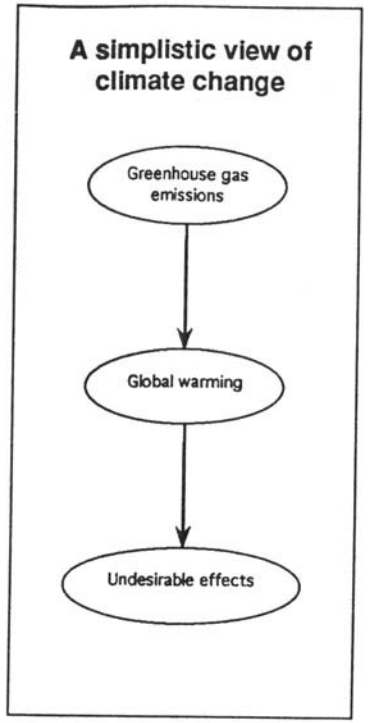
Figure 1.1
Subgroups, analytic methods, and scales of climate study (from Oliver J.E., *Climatology: Selected Applications*, © 1981, John Wiley and Sons, New York).

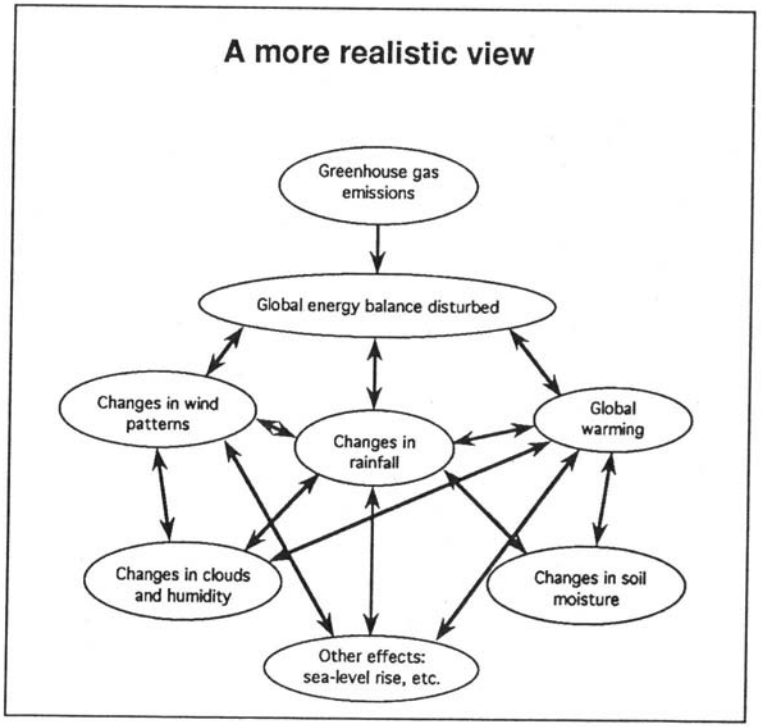
2. Systems approach



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

Climate change as a system



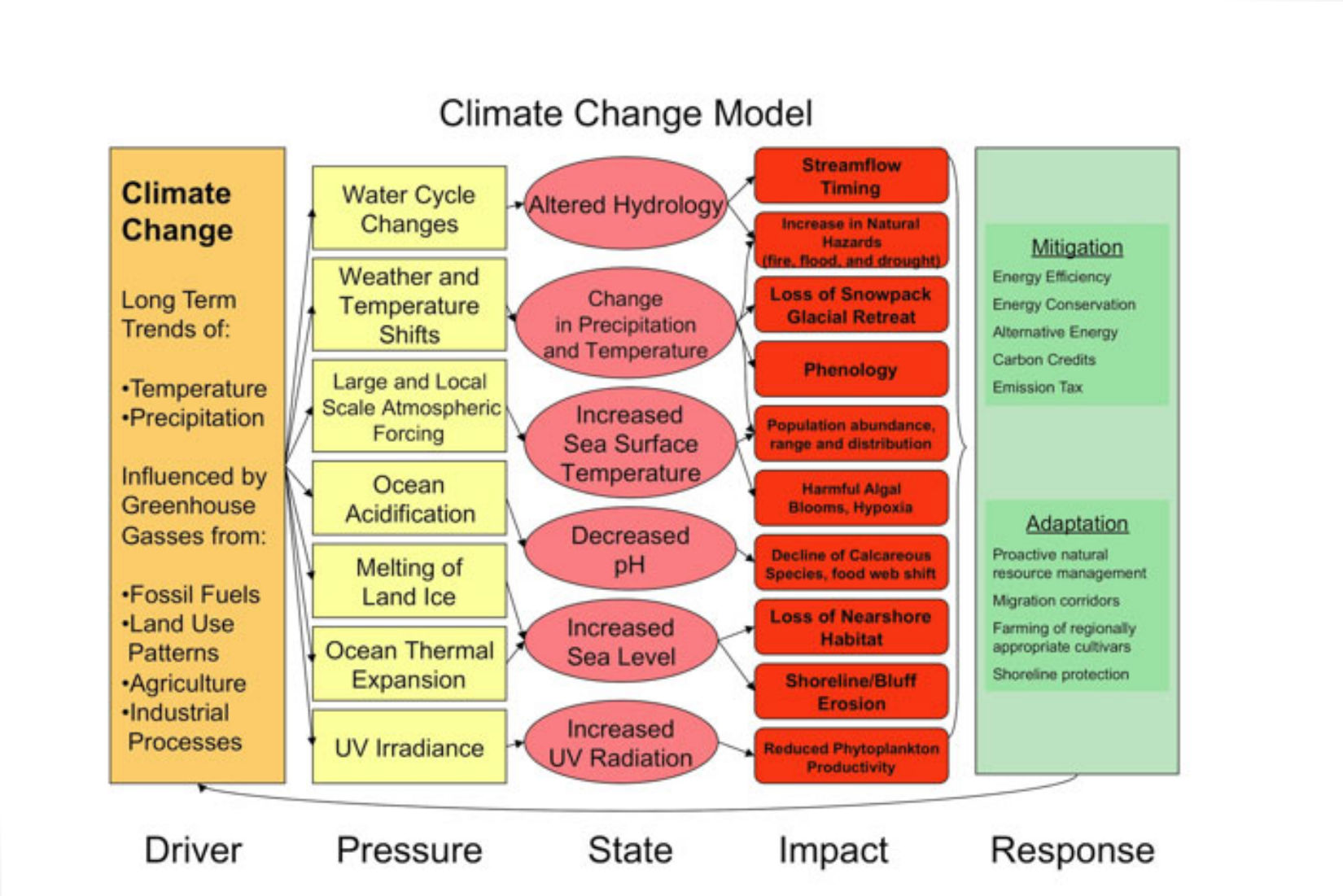


UNEP

3. The three aspects of climate change

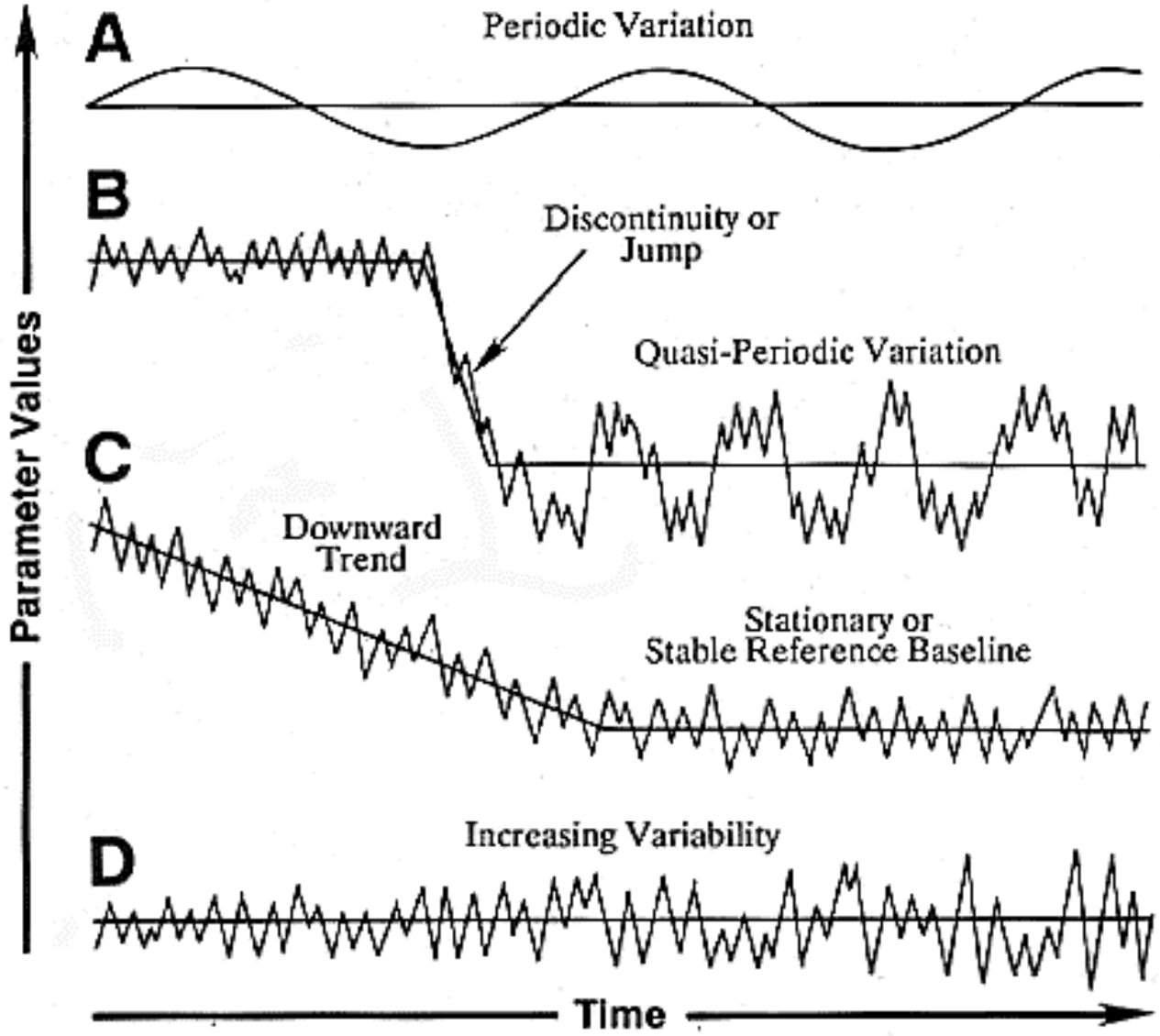
- process
- impacts
- strategies for mitigation & adaptation

Process, impact, strategies



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

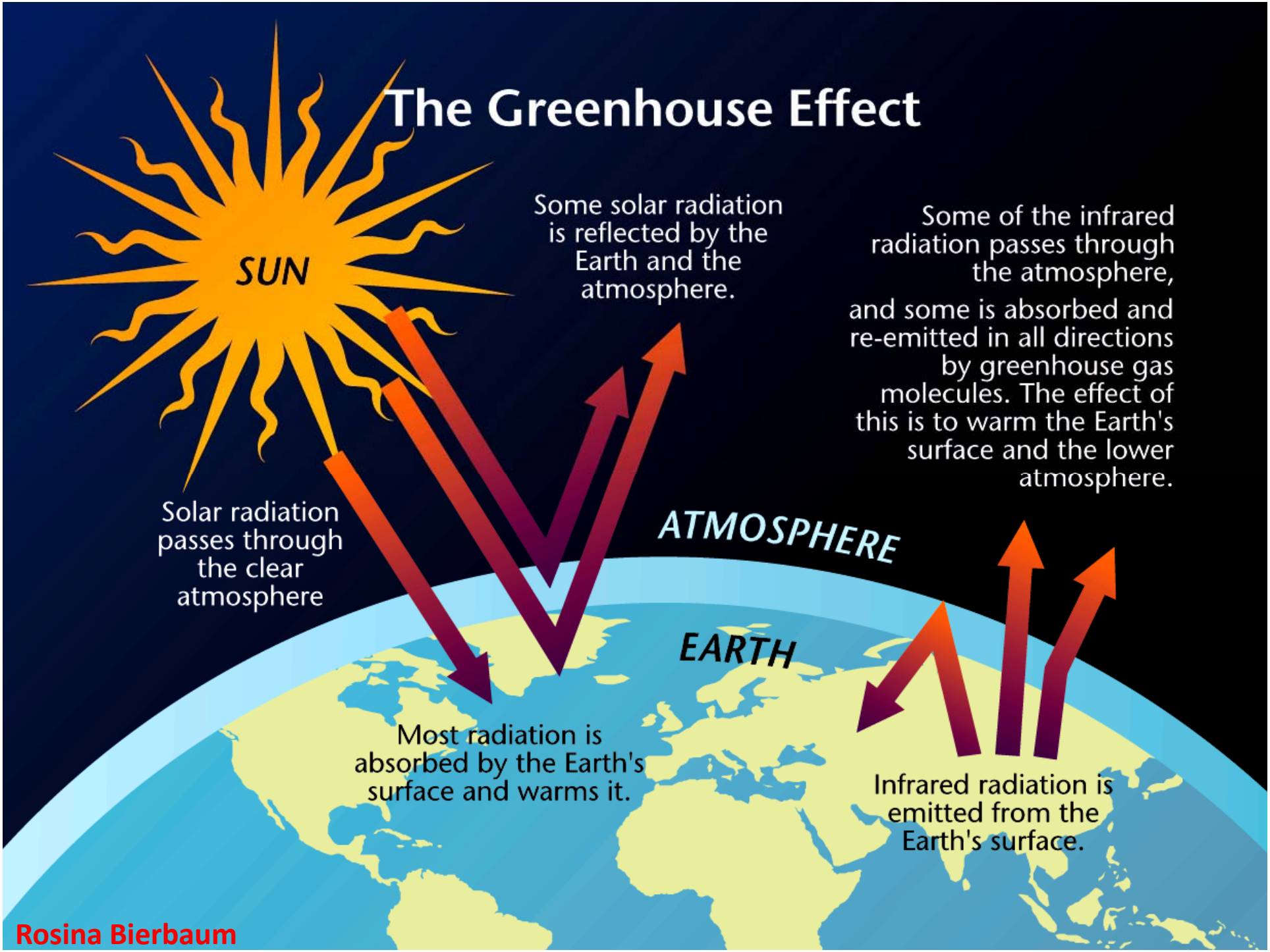
4. Identifying the process of climate change



Types of climatic variation

Credit: David Robinson, NJSC

5. Global warming differs from climate change


The Greenhouse Effect
SUN
Some solar radiation is reflected by the Earth and the atmosphere.
Some of the infrared radiation passes through the atmosphere,
and some is absorbed and re-emitted in all directions by greenhouse gas molecules. The effect of this is to warm the Earth's surface and the lower atmosphere.
Solar radiation passes through the clear atmosphere
ATMOSPHERE
EARTH
Most radiation is absorbed by the Earth's surface and warms it.
Infrared radiation is emitted from the Earth's surface.
Rosina Bierbaum

The main greenhouse gases

Greenhouse gases	Chemical formula	Pre-industrial concentration	Concentration in 1994	Atmospheric lifetime (years)***	Anthropogenic sources	Global warming potential (GWP) *
Carbon-dioxide	CO_2	278 000 ppbv	358 000 ppbv	Variable	Fossil fuel combustion Land use conversion Cement production	1
Methane	CH_4	700 ppbv	1721 ppbv	12,2 +/- 3	Fossil fuels Rice paddies Waste dumps Livestock	21 **
Nitrous oxide	N_2O	275 ppbv	311 ppbv	120	Fertilizer industrial processes combustion	310
CFC-12	CCl_2F_2	0	0,503 ppbv	102	Liquid coolants. Foams	6200-7100 ****
HCFC-22	$CHClF_2$	0	0,105 ppbv	12,1	Liquid coolants	1300-1400 ****
Perfluoromethane	CF_4	0	0,070 ppbv	50 000	Production of aluminium	6 500
Sulphur hexa-fluoride	SF_6	0	0,032 ppbv	3 200	Dielectric fluid	23 900

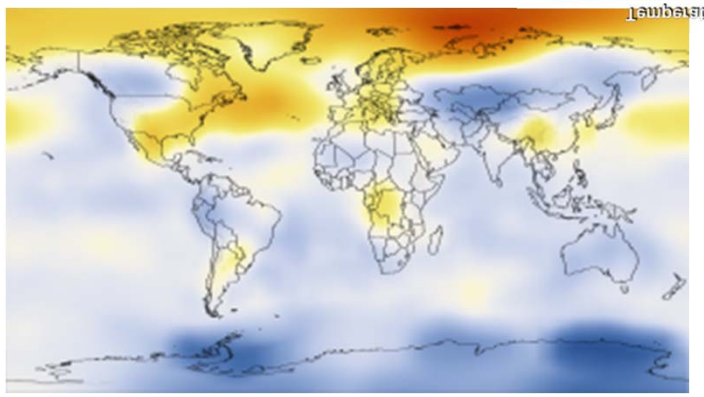
Note : pptv= 1 part per trillion by volume; ppbv= 1 part per billion by volume, ppm v= 1 part per million by volume

* GWP for 100 year time horizon. ** Includes indirect effects of tropospheric ozone production and stratospheric water vapour production. *** On page 15 of the IPCC SAR. No single lifetime for CO_2 can be defined because of the different rates of uptake by different sink processes.**** Net global warming potential (i.e., including the indirect effect due to ozone depletion).

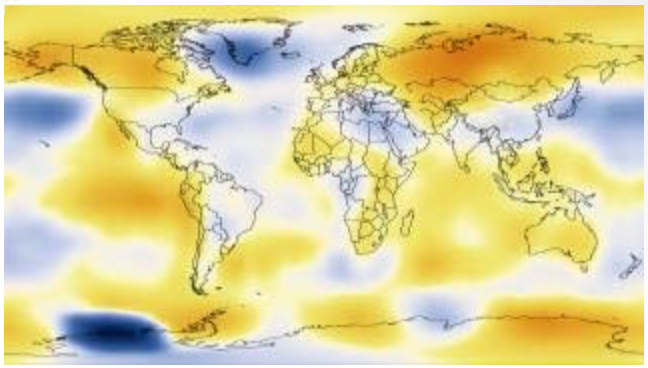
GRID Arendal UNEP

Source: IPCC radiative forcing report , Climate change 1995, The science of climate change, contribution of working groupe 1 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge press university, 1996.

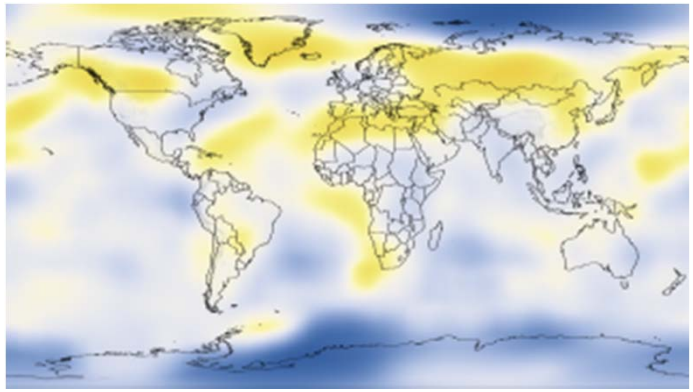
NASA
SVS



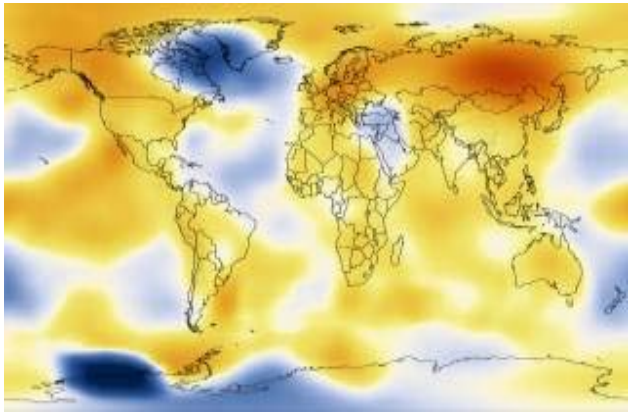
1950-1954



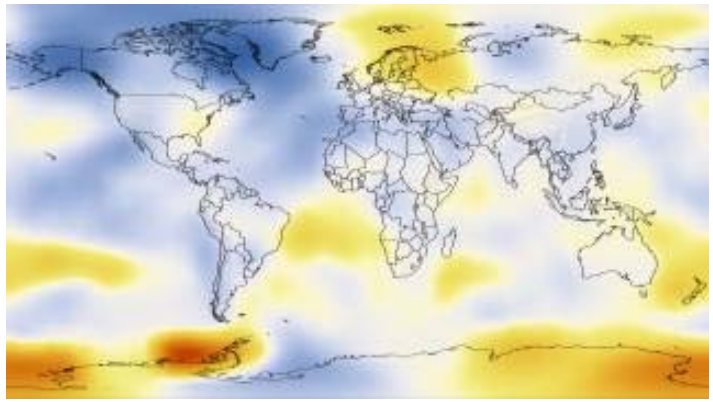
1980-1984



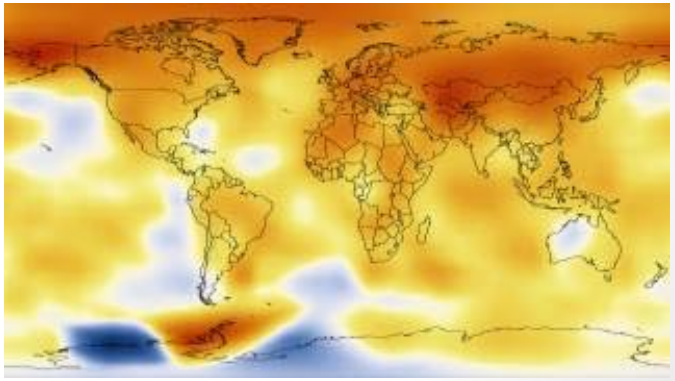
1960-1964



1990-1994



1970-1974



2000-2004

6. What is climate change?

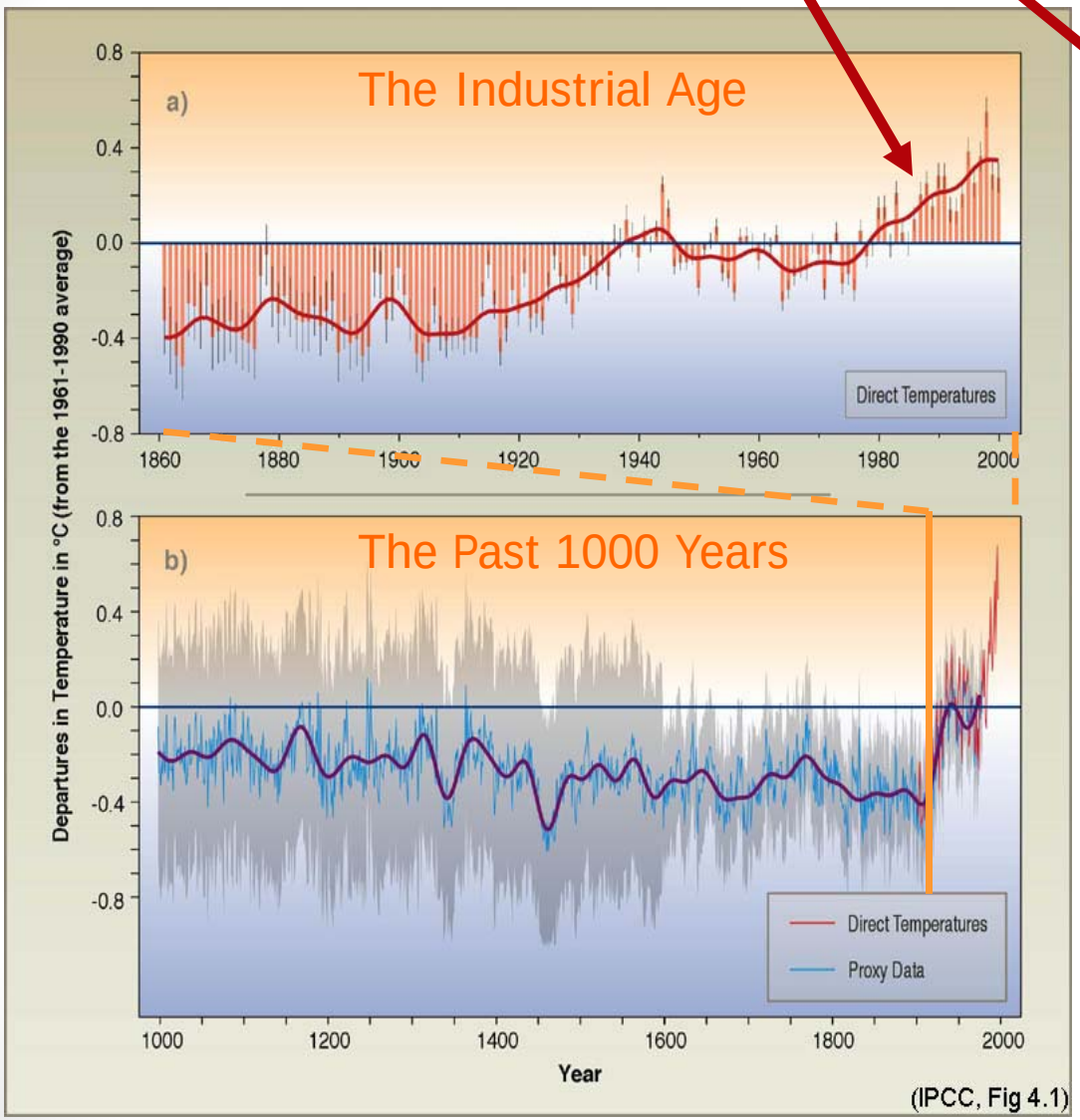
IPCC (2007) definition

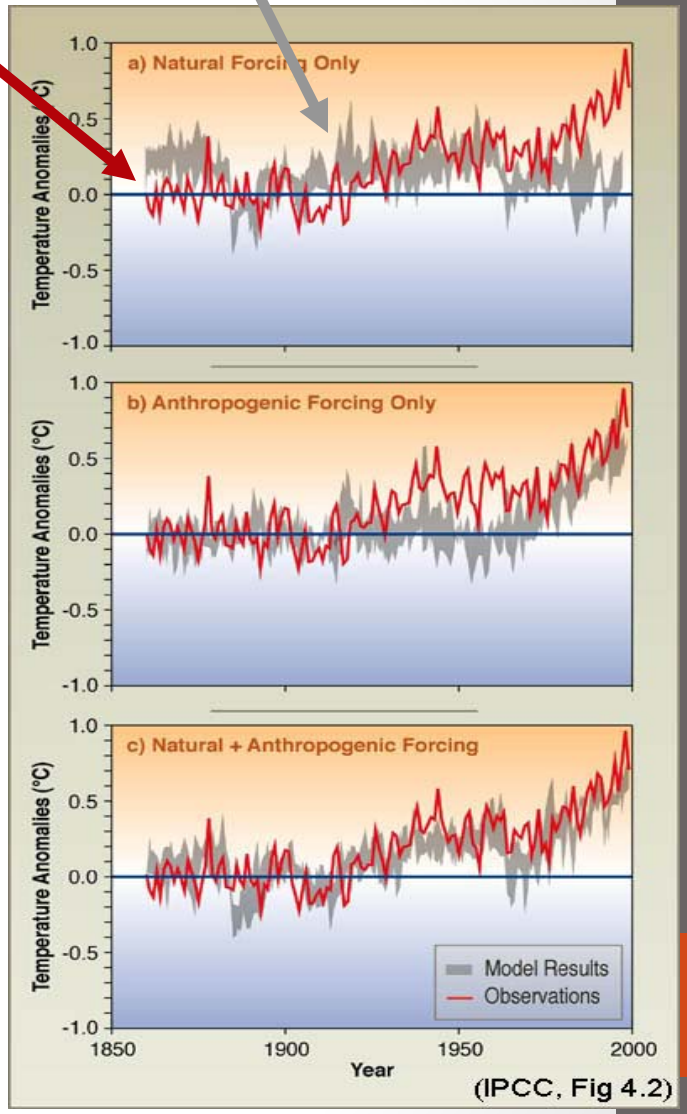
"Climate change in IPCC usage refers to a change in the state of the climate that can be identified (e.g. using statistical tests) by **changes in the mean and/or the variability of its properties**, and that persists for an extended period, typically decades or longer. It refers to **any change in climate** 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."

Natural vs. human-induced climate impacts.

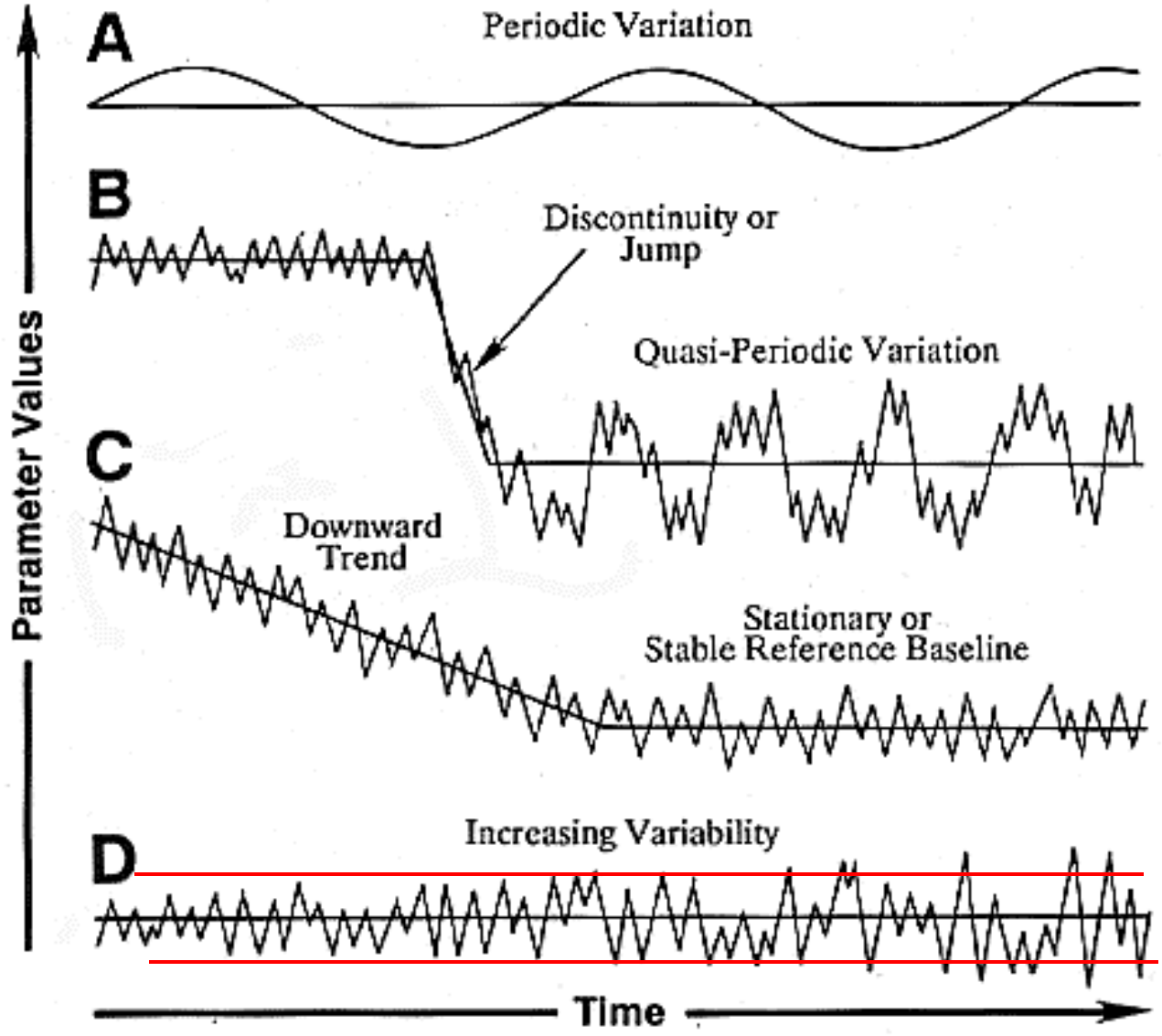
Observed Climate Changes

Climate Model





Recent changes are due to natural + human-induced effects.



Types of climatic variation

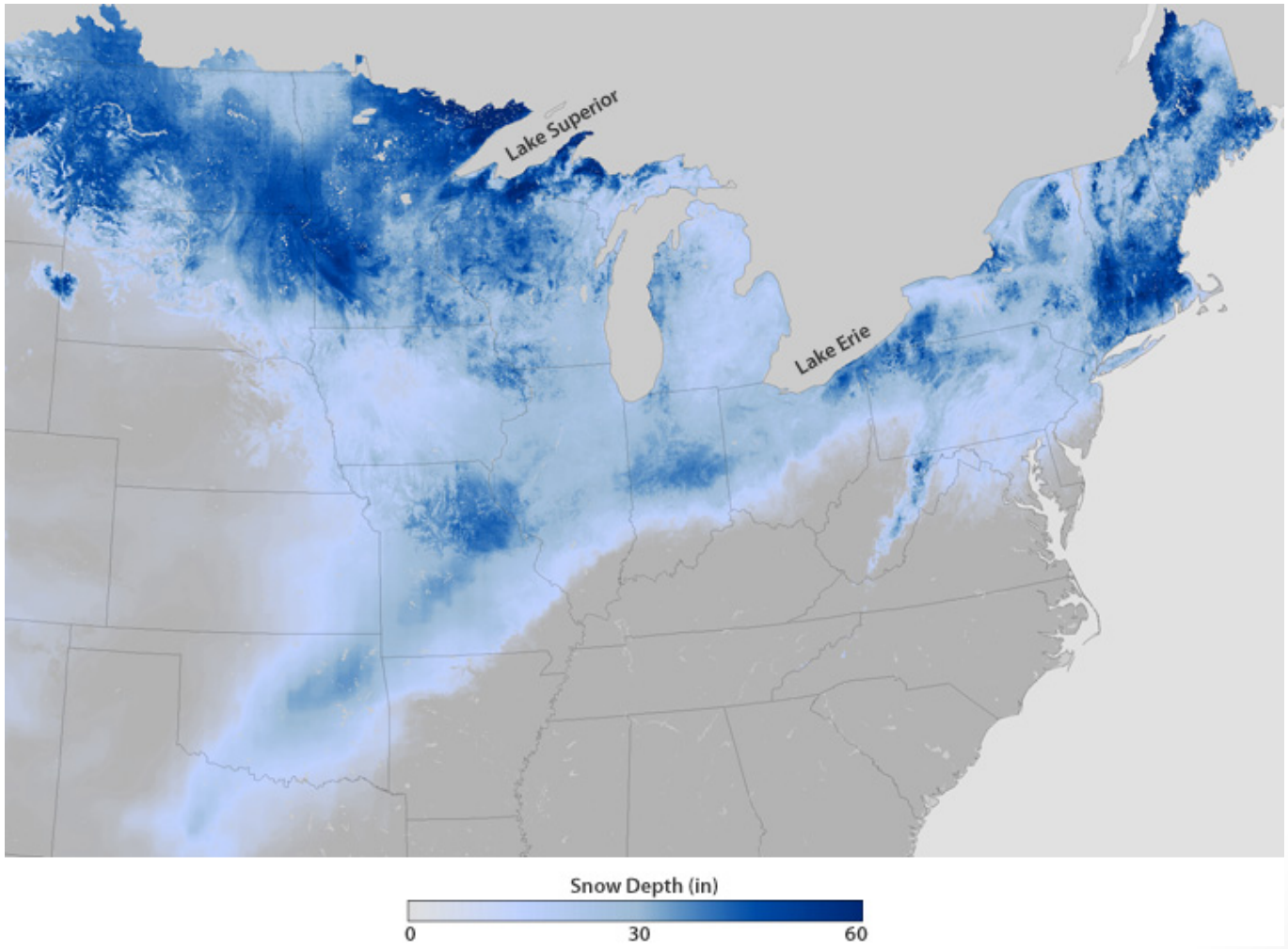
Increased human vulnerability

Credit: David Robinson, NJSC

What is climate variability?

- Climate variability refers to the inherent fluctuations that occur in precipitation and temperature patterns, storm tracks and frequency as well as other hydroclimatological variables at a number of time scales (annual, decadal, centennial and even millenial). Such naturally occurring variations make it difficult to distinguish long term trends in the climate record.

2 February 2011 – snow depths



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

Backward spring 2010

Photo credit: L-A. Dupigny-Giroux

- low temperatures in January – June
- land-locked stations colder
- winter freeze/thaw cycles – predictor
- snow, freezing rain – April to June
- summer killing frosts
- summer drought
- NW flow

7. Warming & cooling factors (IPCC, 2007)

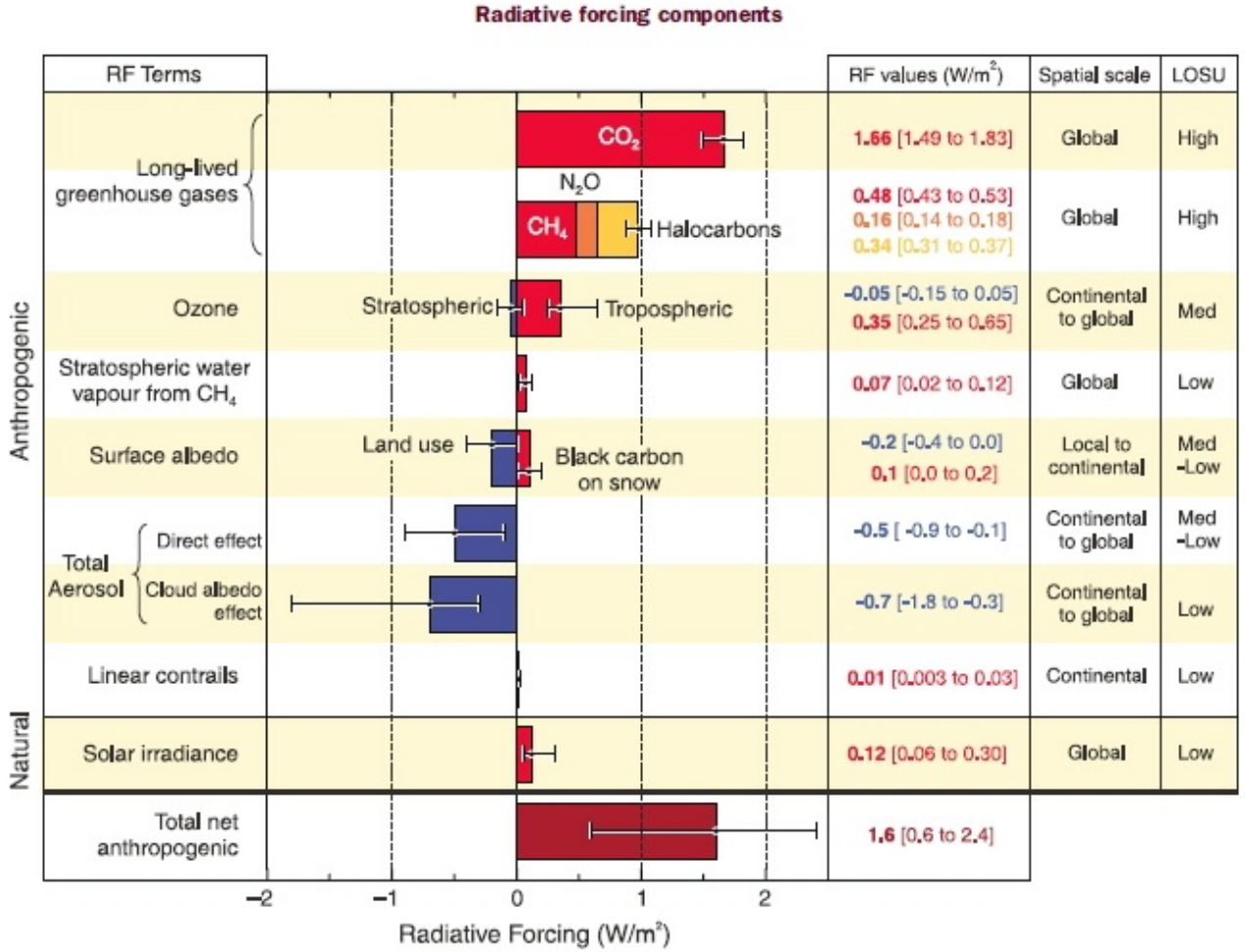
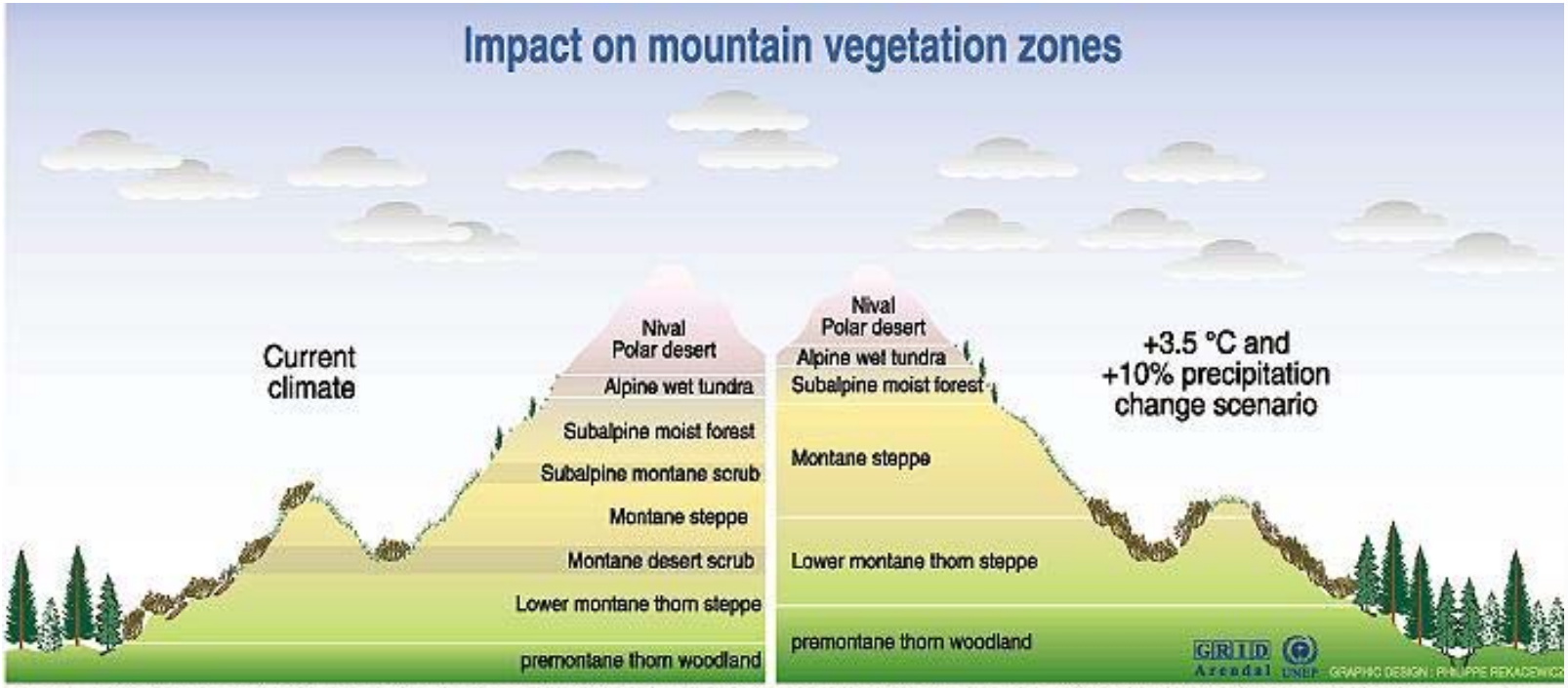


Figure 2.4. Global average radiative forcing (RF) in 2005 (best estimates and 5 to 95% uncertainty ranges) with respect to 1750 for CO_2, CH_4, N_2O and other important agents and mechanisms, together with the typical geographical extent (spatial scale) of the forcing and the assessed level of scientific 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}

The local conversation

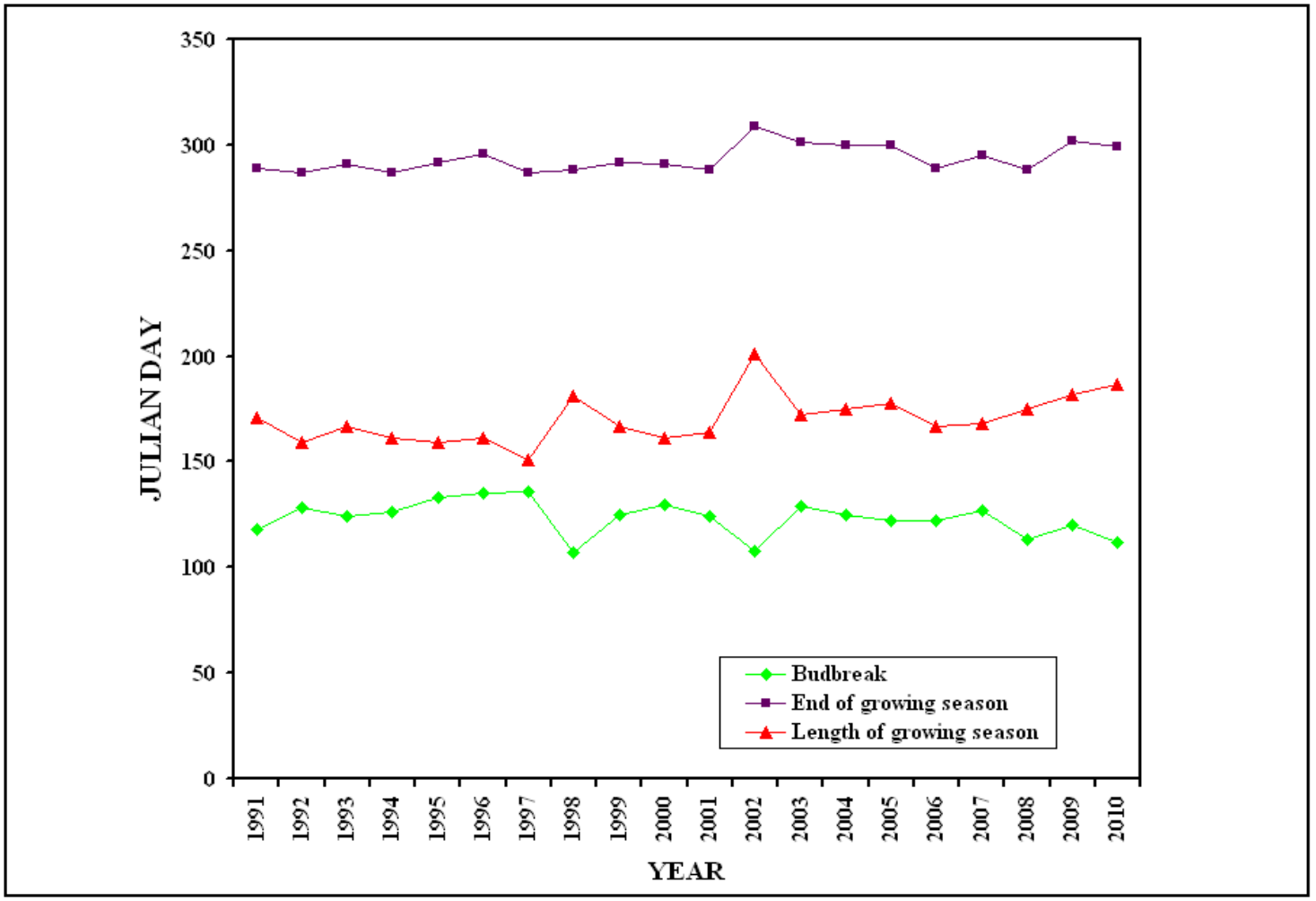

Vulnerabilities & Consequences of Climate Change
Agriculture
Forests
Water
Coastal
Ecosystems
Health
Communities
Energy
Commerce
Atmosphere (Greenhouse Gases)
Temperature
Precipitation
Sea Level
Glacial Melting
Extreme Events

Ecotone shifts have been observed



Sources: Martin Benitson, Mountain environments in changing climates, Routledge, London, 1994; Climate change 1995, Impacts, adaptations and migration of climate change, contribution of working group 2 to the second assessment report of the intergovernmental panel on climate change (IPCC), UNEP and WMO, Cambridge press university, 1996.

Proctor Maple Research Center – sugar maple phenology



Data courtesy: Tom Simmons & Sandy Wilmot – VT ANR/FPR

Thank you!

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