Class-7

Climate system - Impact

18th September 2023

Climate

- *The scope of climatology*
  Derived from Greek terms: klima + logos
  slope (reflecting the early idea that distance from the equator alone drove climate) + study

- *Study physical aspects of the interaction of the atmosphere with other spheres (lithosphere, hydrosphere, cryosphere, and biosphere); focusing on large scale (1000-km or above).*

Weather versus Climate

W: The condition of atmosphere <u>at a given time and place</u>

C: Defined as the average state of the atmosphere over a finite time period and over a geographic region (space).

Climate is what you expect and weather is what you get.
Climate tells what clothes to buy, but weather tells you what clothes to wear

Climatic Controls

The world's many climates are controlled by the same factors affecting weather,

a) intensity of sunshine and its variation with latitude,

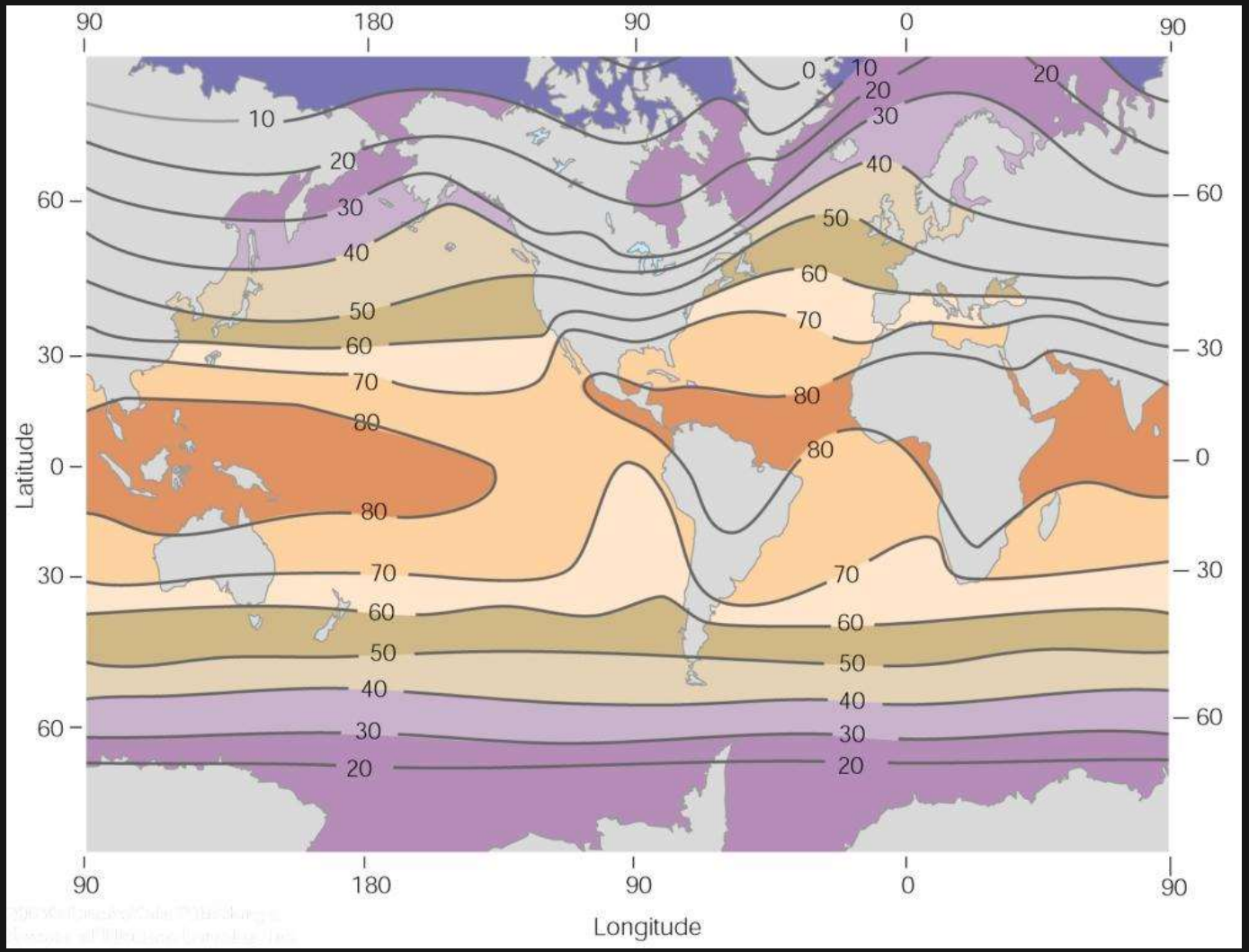
b) distribution of land and water,

c) ocean temperature and currents,

d) mountain barriers,

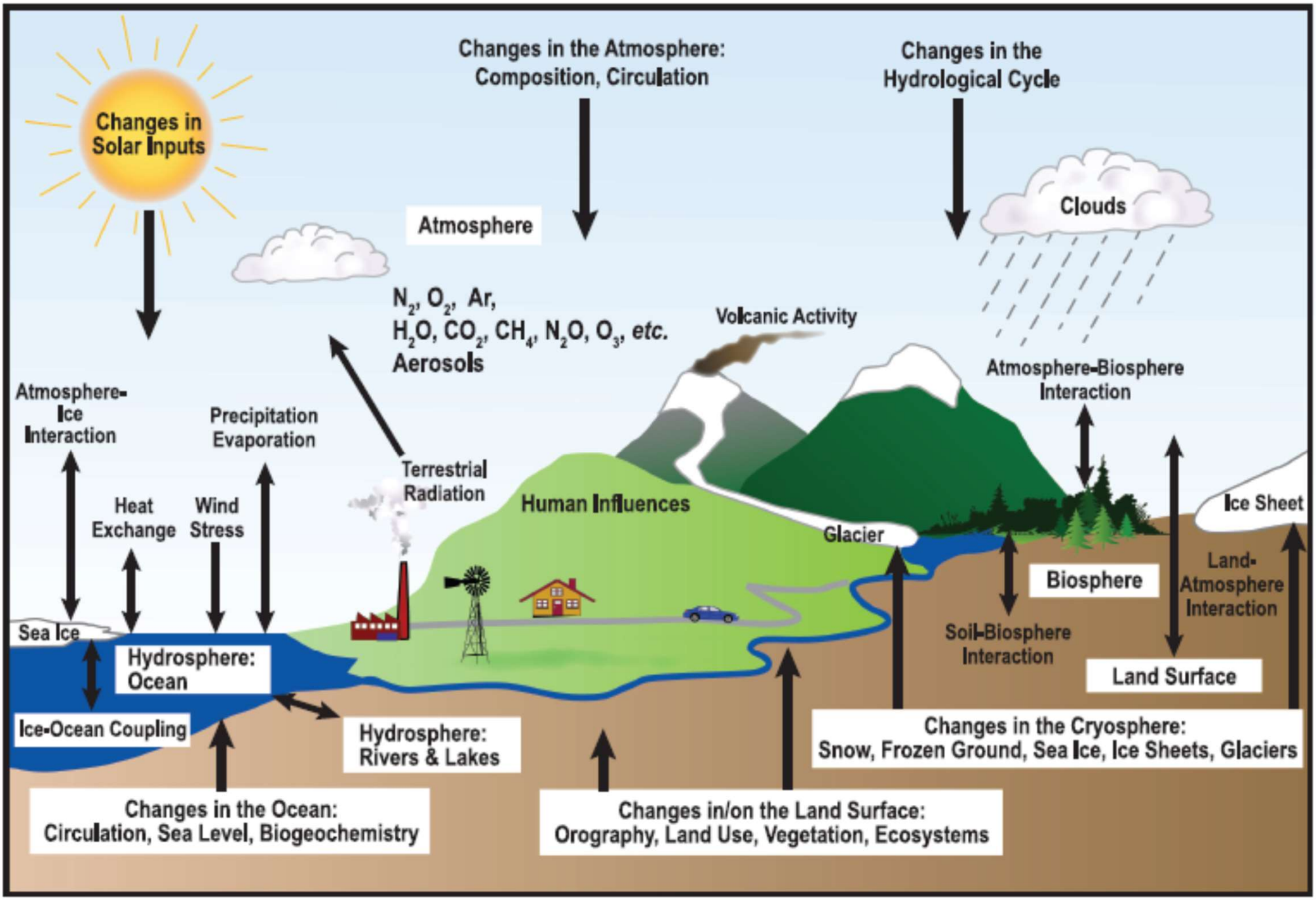
e) land cover,

f) atmospheric composition.

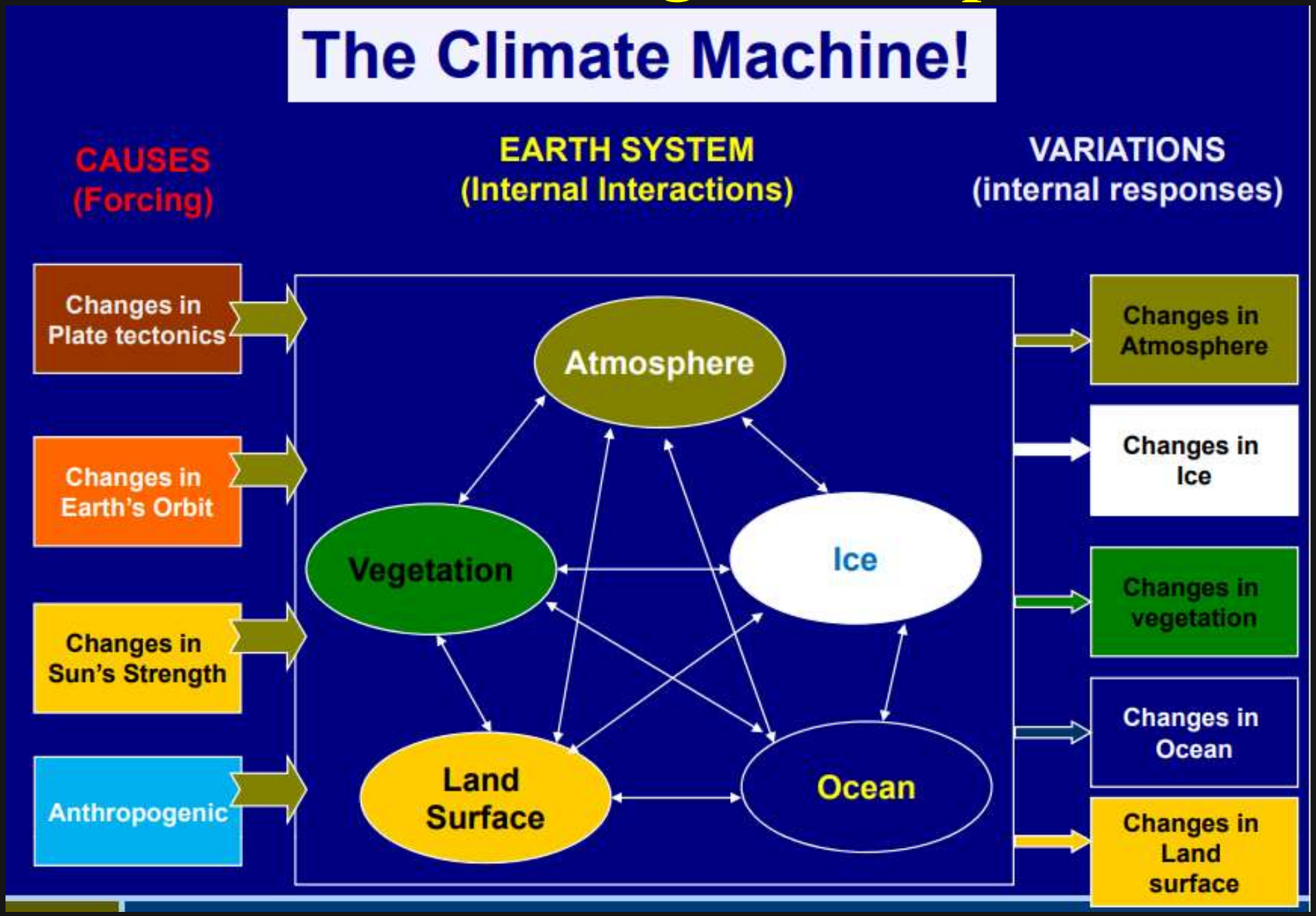


This map shows sea-level temperatures (° F).

The Climate System Components



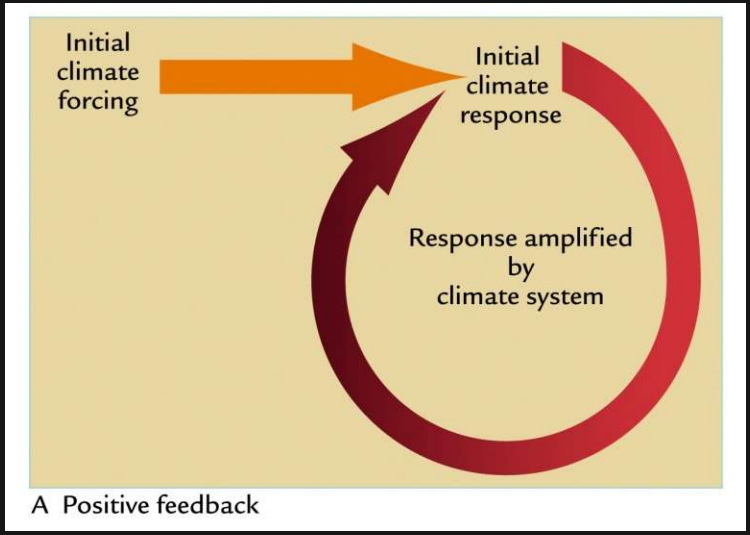
Climate: Forcing and Response



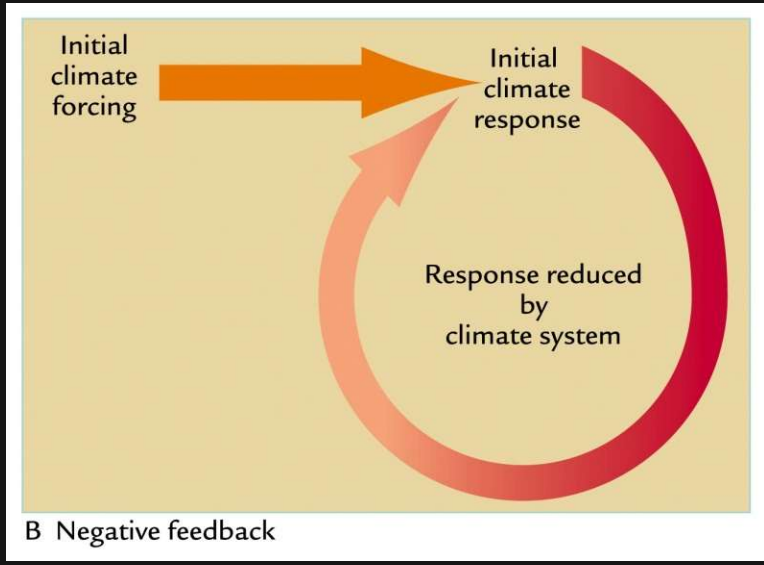
Feedbacks

A feedback is a mechanism whereby an initial change in a process will tend to either reinforce the change (positive feedback)

or weaken the change (negative feedback).



A Positive feedback



B Negative feedback

Example of a positive feedback

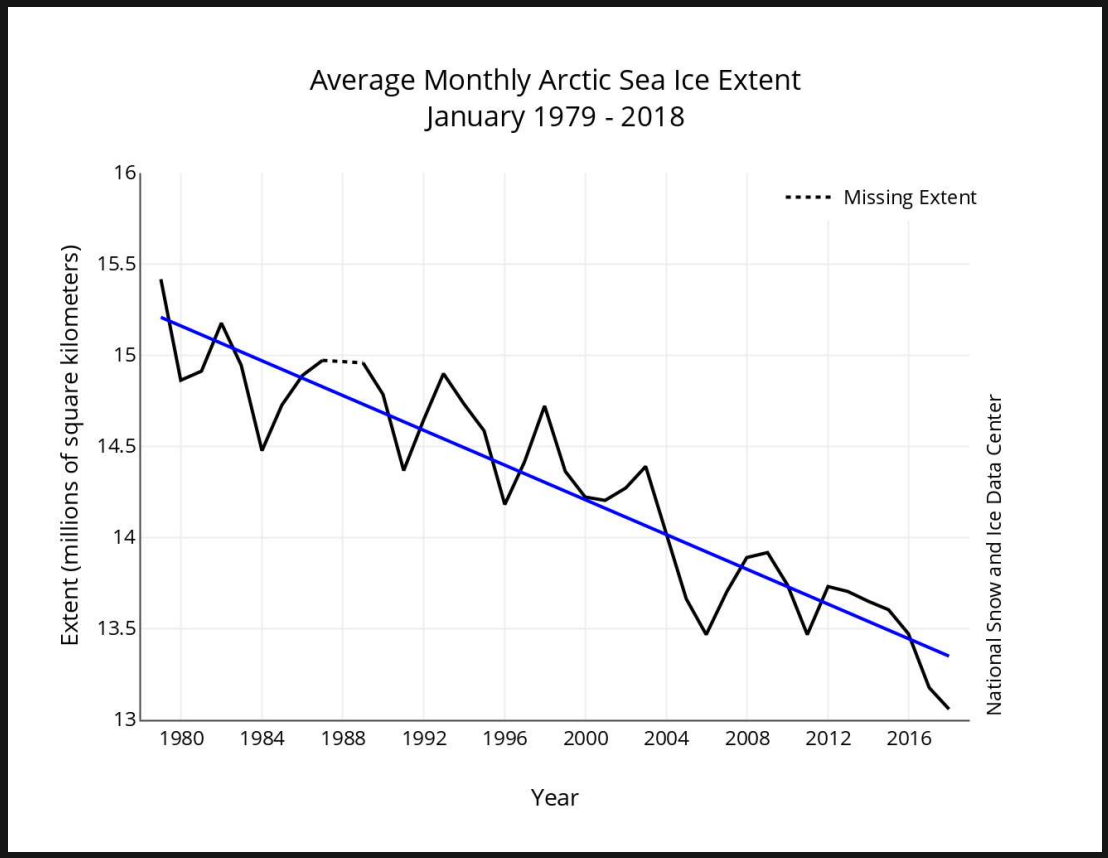
More energy retained in system

Warm temperatures

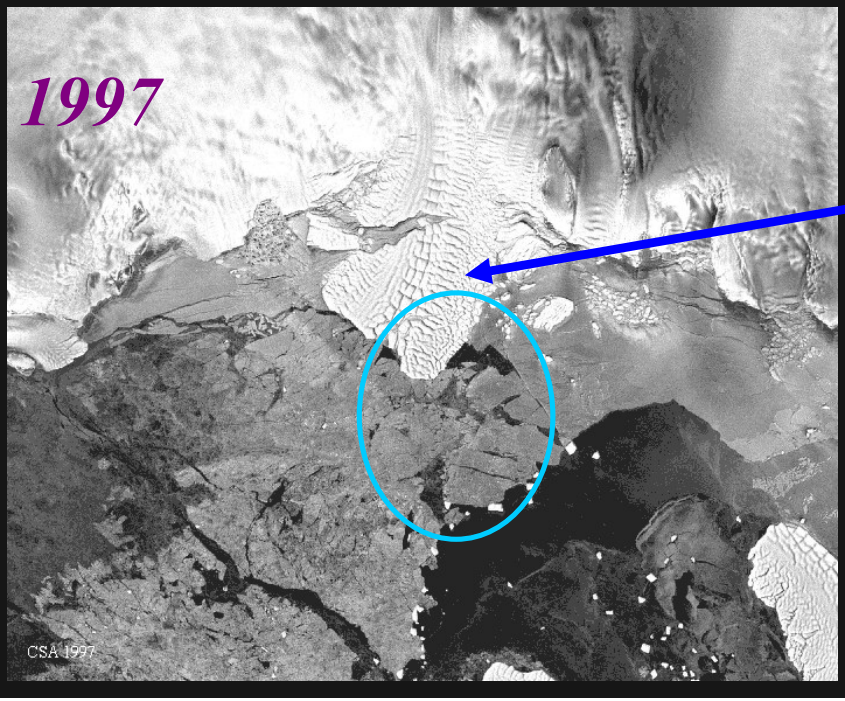
Ice and snow melt

Albedo decreases
Less solar energy reflected

If this were the only mechanism acting, we'd get a runaway temperature increase

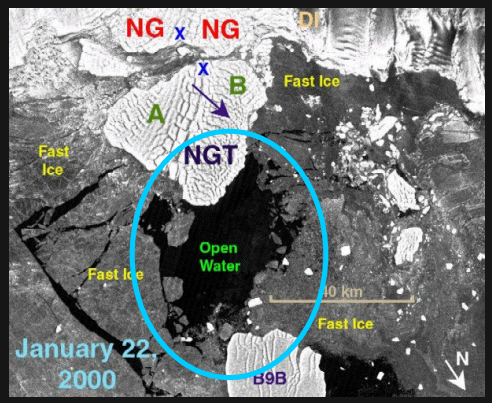


Snow and ice albedo feedbacks in the polar regions are to blame for the large changes already observed.



Ninnis Glacier Tongue Antarctica

2000



Example of a negative feedback

More energy retained in system

Warm temperatures

More evaporation
More clouds

Albedo decreases
Less solar energy reflected

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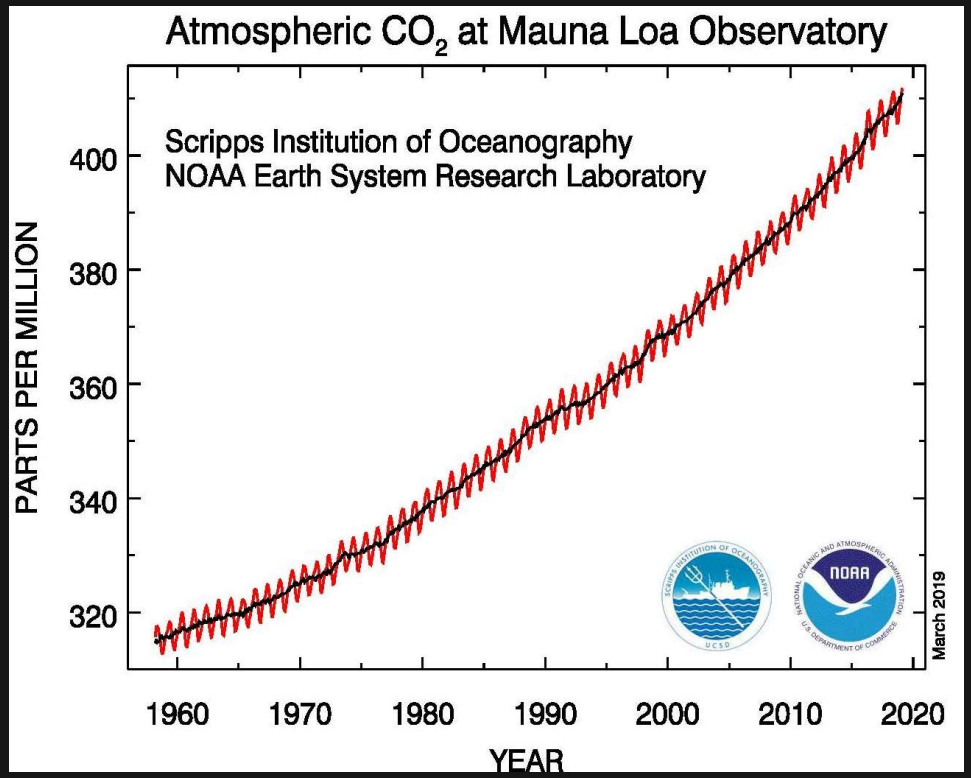
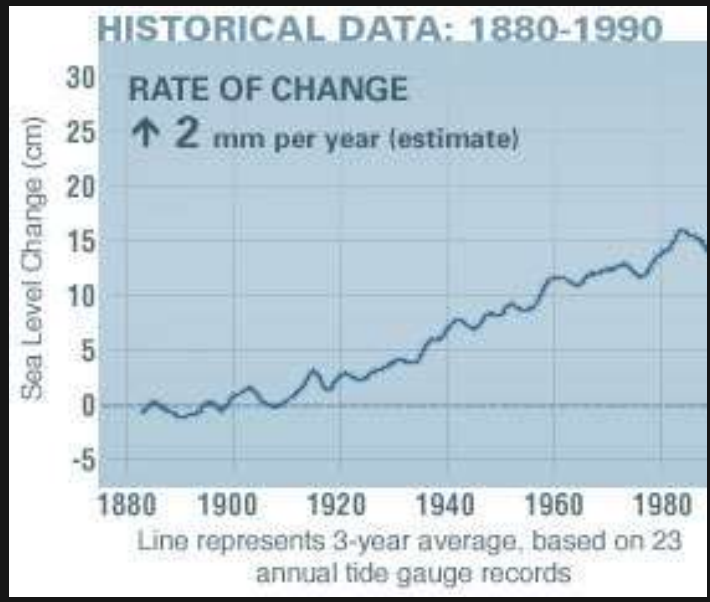
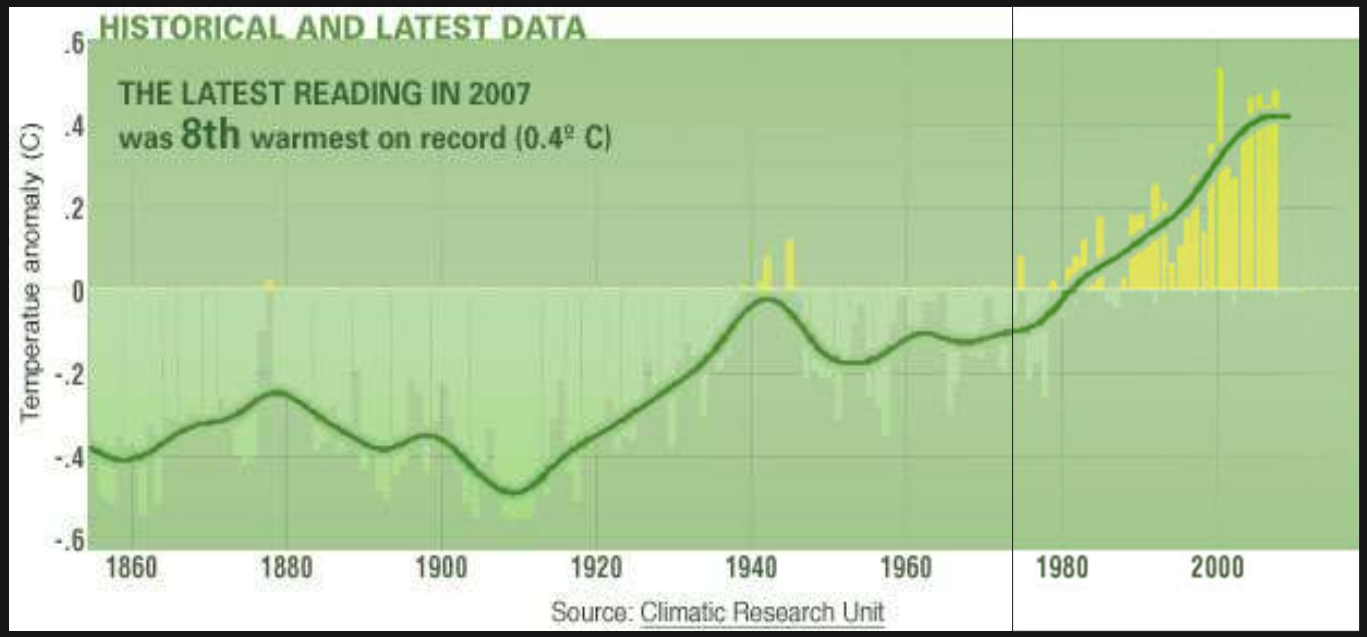
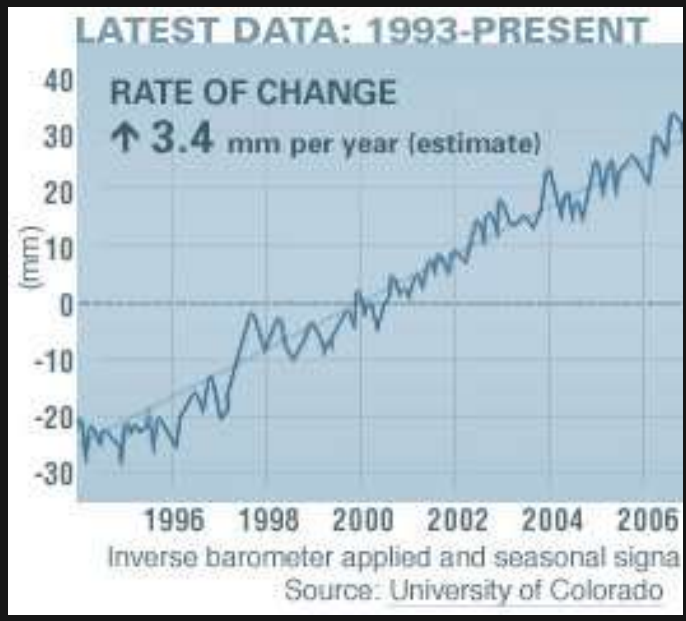
Climate Change

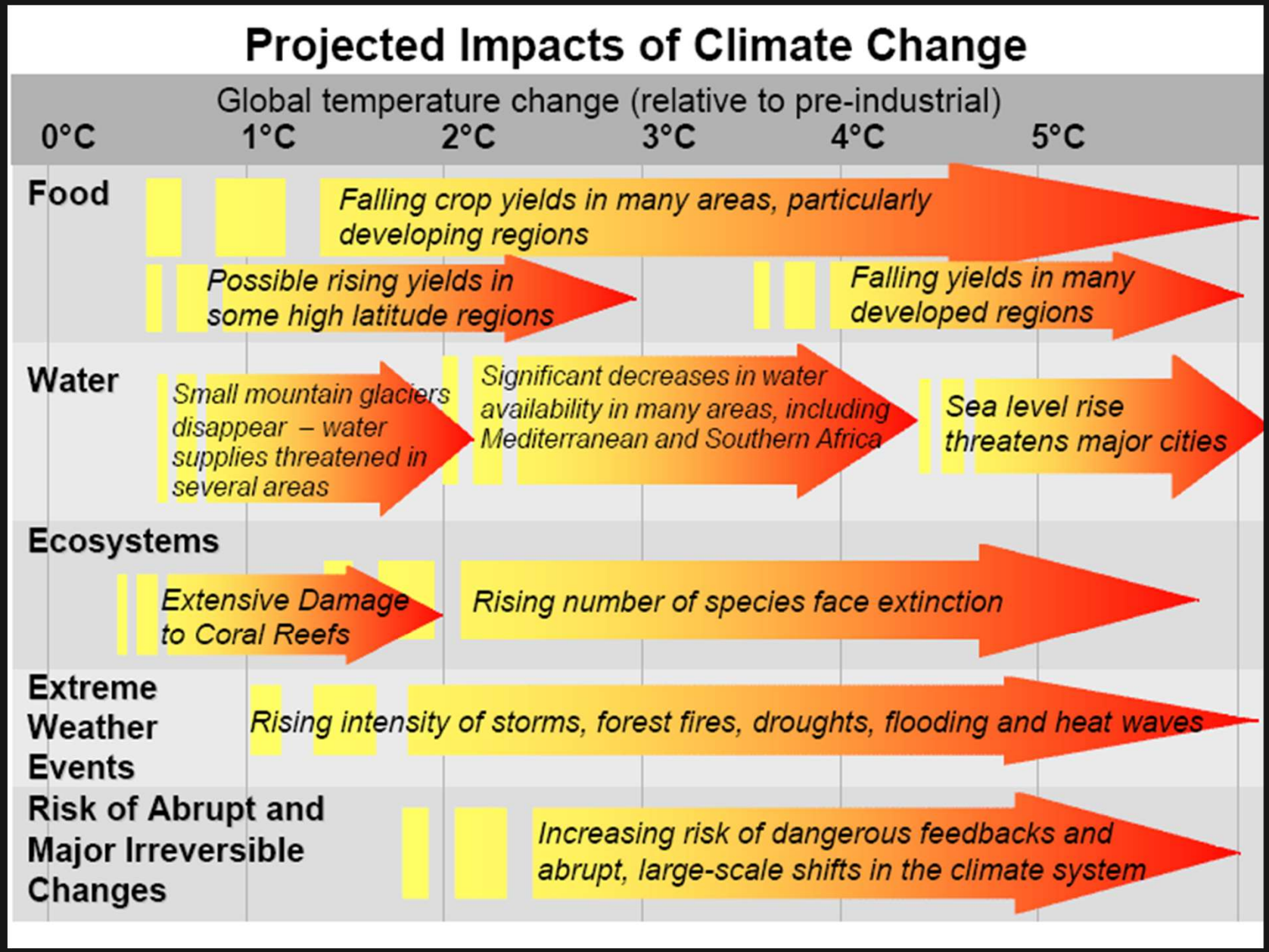






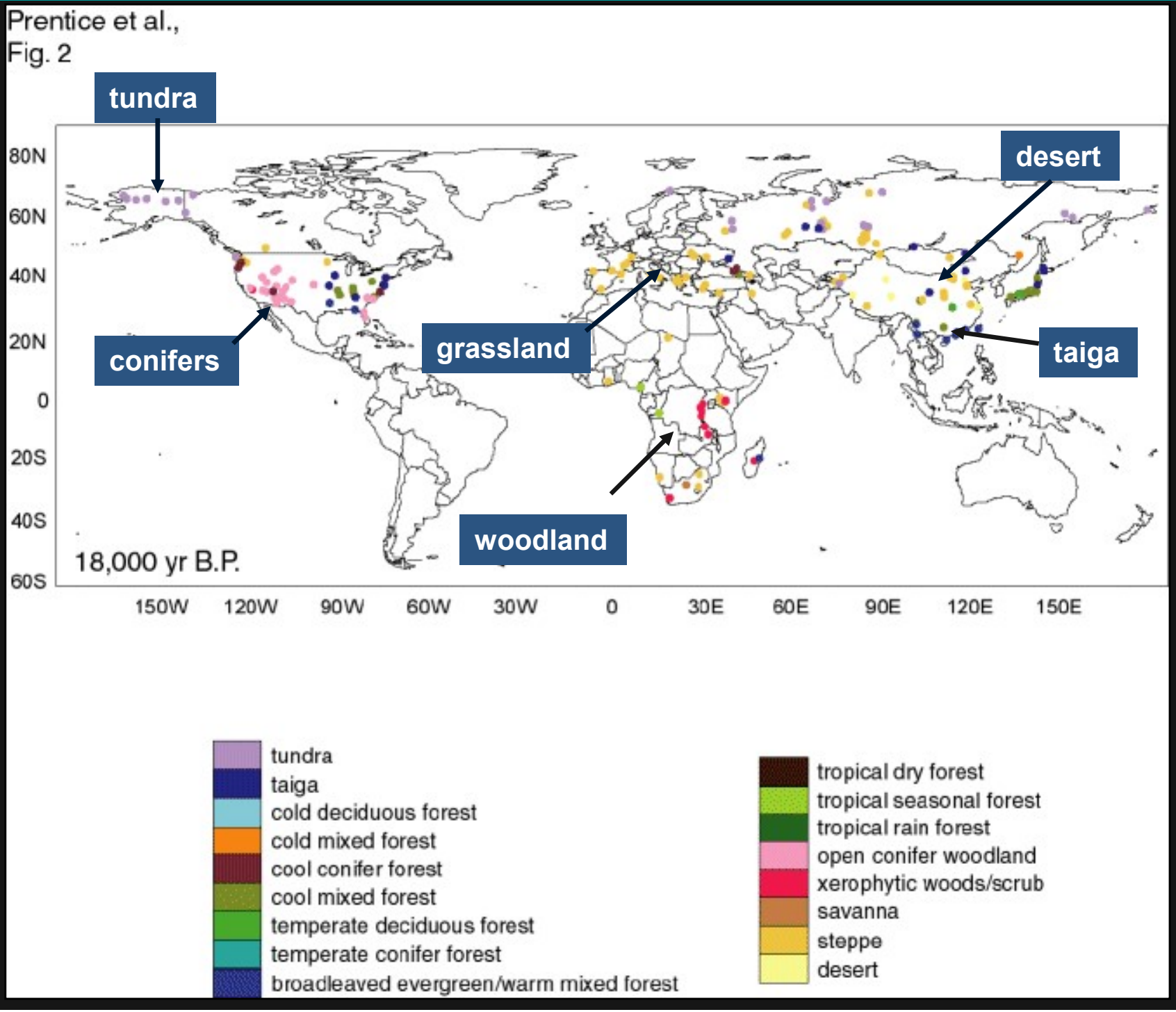


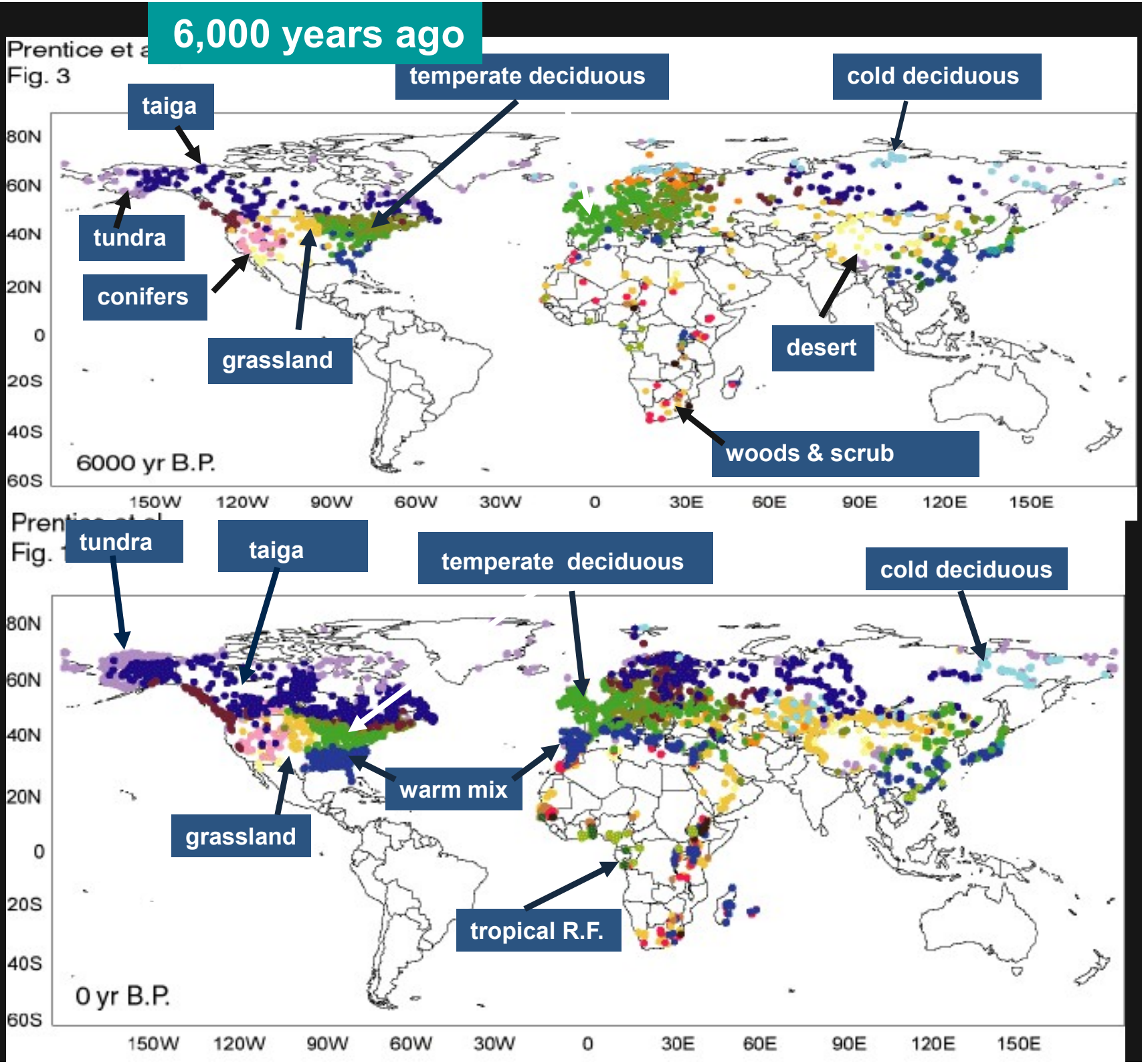
Climate Change – and dealing with it



Source: Stern Review on the Economics of Climate Change, 2006

Global Distribution of Vegetation 18,000 years ago

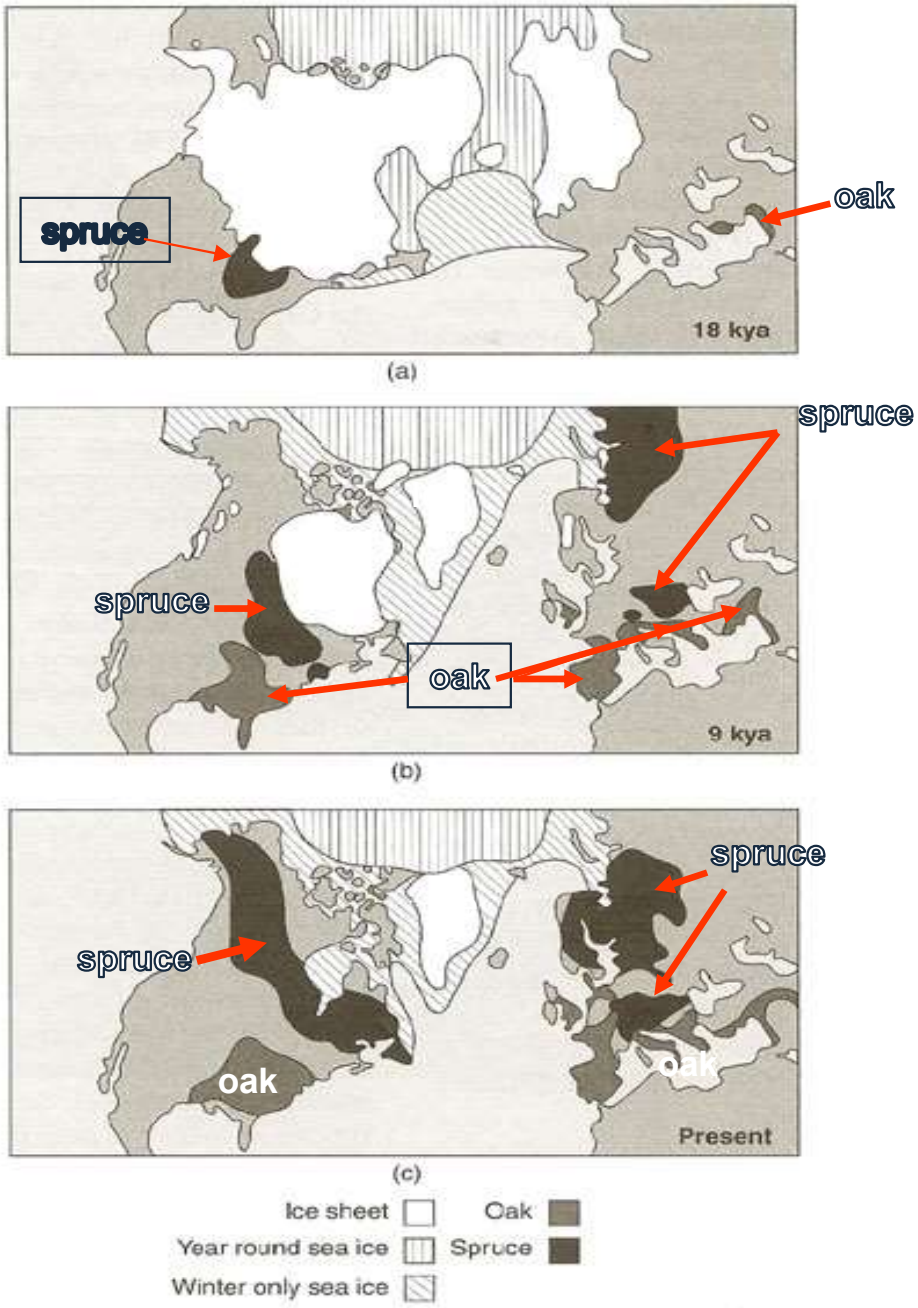



6,000 years ago
Prentice et a
Fig. 3
taiga
temperate deciduous
cold deciduous
tundra
conifers
grassland
desert
woods & scrub
6000 yr B.P.
80N
60N
40N
20N
0
20S
40S
60S
150W
120W
90W
60W
30W
0
30E
60E
90E
120E
150E
Prenti
Fig.
tundra
taiga
temperate deciduous
cold deciduous
warm mix
grassland
tropical R.F.
0 yr B.P.

Shifts in Terrestrial Habitat

- *18,000 years ago Spruce trees and oak trees filled small pockets of habitat – as climates warmed Spruce trees migrated into the Northern Hemispheres and the Oak trees expanded in to Southeastern U.S., Western Europe and Southern Europe*

- *Shifts in vegetation occur slowly tree species were able to successfully expand into favorable regions*



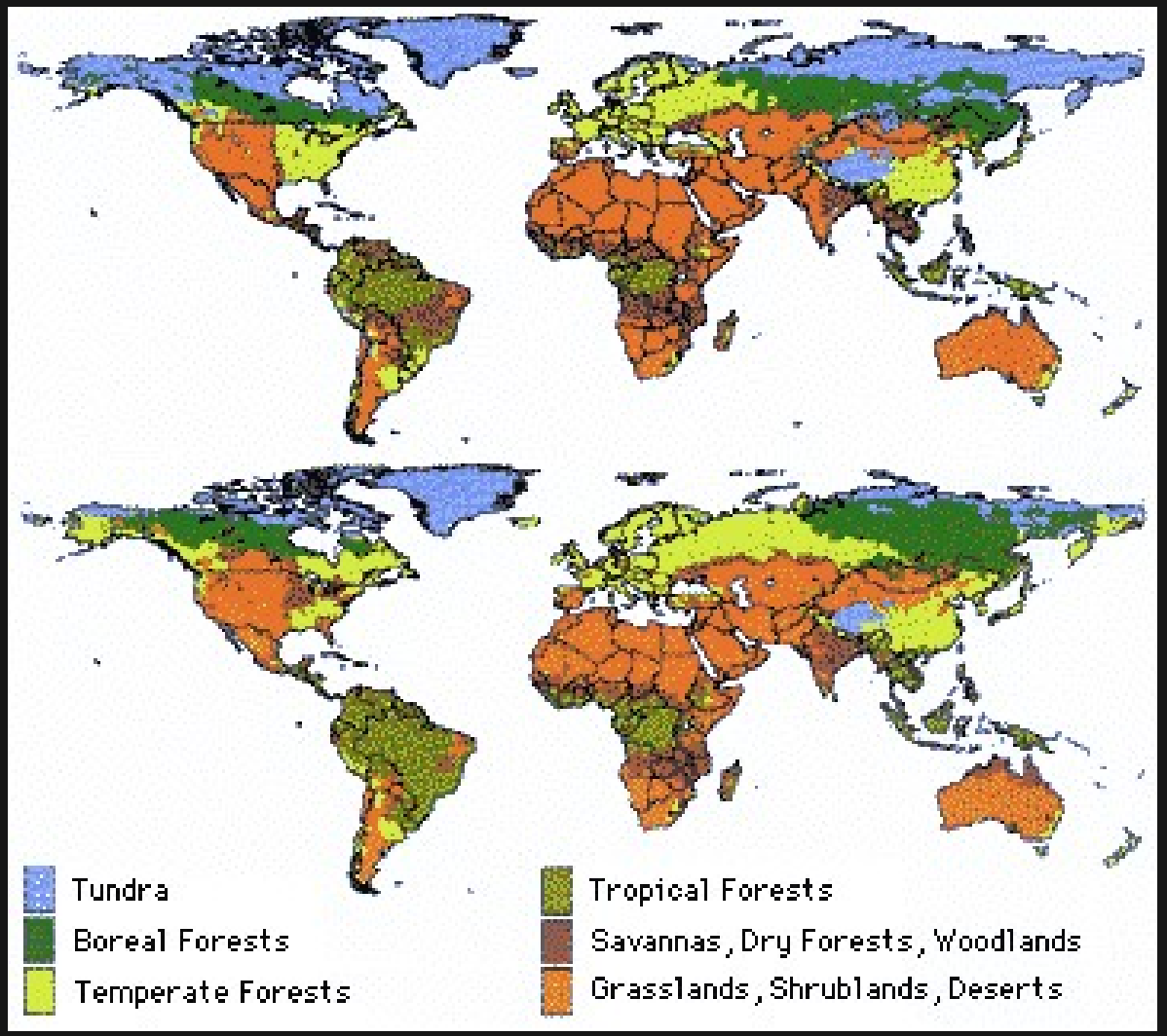
Distribution of spruce and oak forests in Northern Hemisphere since the glacial period 18,000 kya

Shifts in Terrestrial Habitat

It is predicted that at the end of this century there will be large scale shifts in the global distribution of vegetation in response to anthropogenic climate change.

With man doubling the amount of carbon dioxide entering into the atmosphere the climate is changing more rapidly then plant migration can keep up.

Potential distribution of the major world biomes under current climate conditions



Projected distribution of the major world biomes by simulating the effects of 2xCO2-equivalent concentrations

Observations

As climate warms we expect northern and mountain regions to become greener, to photosynthesize more rapidly and to grow faster

We expect that in the north especially, there will be widespread changes in the distribution of plants, as the length of the 'growing season' increases

Height growth had increased in the northern plants since the 1970s, so that the northern trees were growing almost as well as the southern trees

Photosynthesis responds strongly to changes in humidity, as leaves tend to close their stomata in dry air

Effects on species' distributions

Lenoir et al. 2008, plants in western Europe

Studied forest plants in six mountain ranges in Europe, from sea level to 2600 m

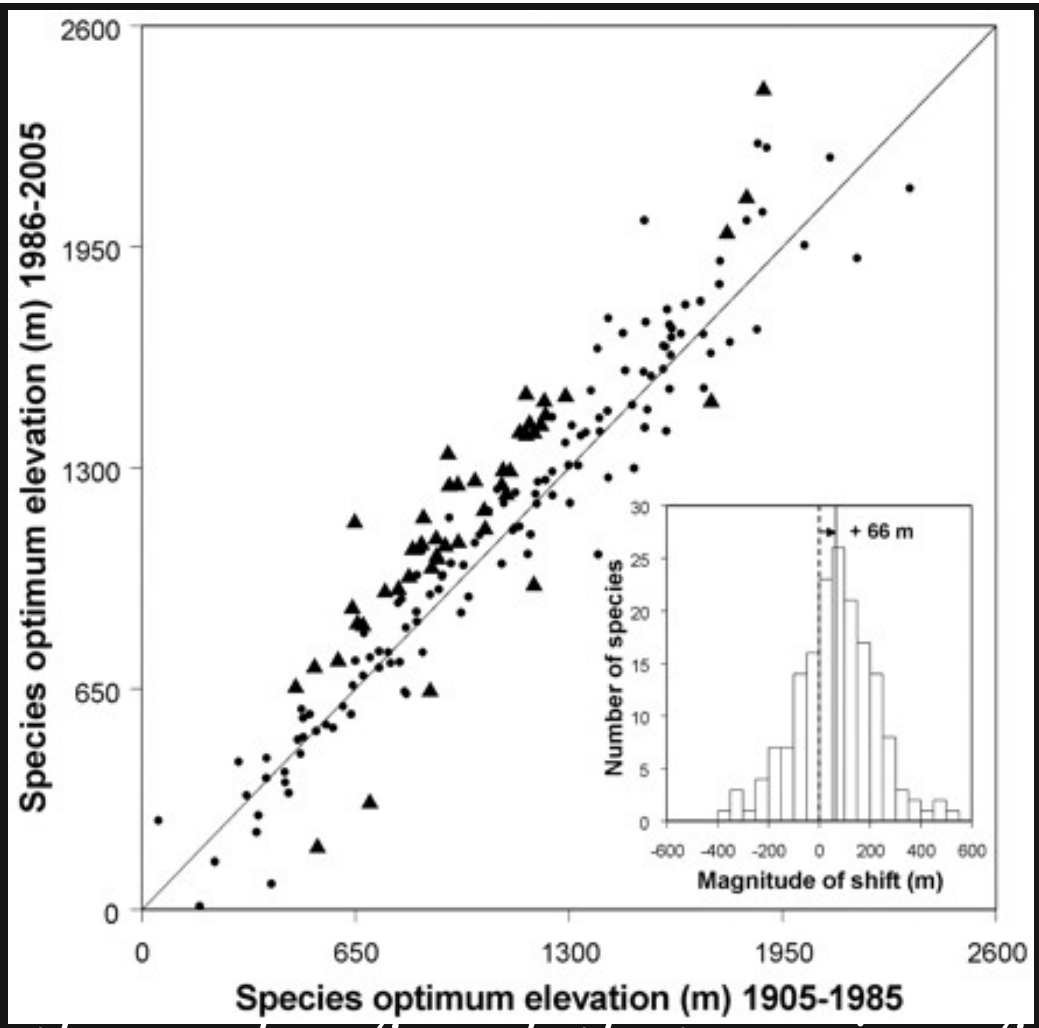
Used data from surveys conducted from 1905 through 1985 (early surveys) and compared these data to data from surveys conducted between 1986 and 2005 (late surveys)

Question— Do species shift their optimal elevational range upward when the climate is warming?

Question 2—Do species with particular life history traits have greater responses to climate change?

Based on how many times each plant species was detected at particular elevations during the early surveys and the late surveys, scientists calculated the "optimal elevation" for the earlier and later time periods

There was a significant upward shift in optimal elevation for 2/3 of the plant species. The mean shift was 64.8 meters between the two time periods.



Authors also found that species of higher elevation (mountainous areas) and species with shorter life cycles (i.e. faster rates of reproduction) showed the greatest upward shifts

CLIMATE CHANGE – SPECIES DIVERSITY

Effects on Plant Diversity

Species 'left behind' as they are unable to change distribution fast enough. Species with long life cycles and/or slow dispersal are particularly vulnerable.

Some isolated or disjunct species are particularly vulnerable, as they may have 'nowhere to go'. These include Arctic and alpine species, and Island endemics

Coastal species which will be 'squeezed' between human settlements and rising sea levels.

Plant genetic composition may change in response to the selection pressure of climate change.

Some plant communities or species associations may be lost as species move and adapt at different rates.

Increased invasions by alien species may occur, as conditions become more suitable for exotic species whilst native species become less well suited to their environment. This is especially true given human interventions which have deliberately and accidentally facilitated the spread of species across the globe.

Many plant communities act as 'sinks' (store carbon), which helps to offset carbon emissions. However, over the next 70 years, the effects of climate change on plants mean many terrestrial sinks may become sources