

Class-7

Climate system - Impact

13th September 2022

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 at a given time and place

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

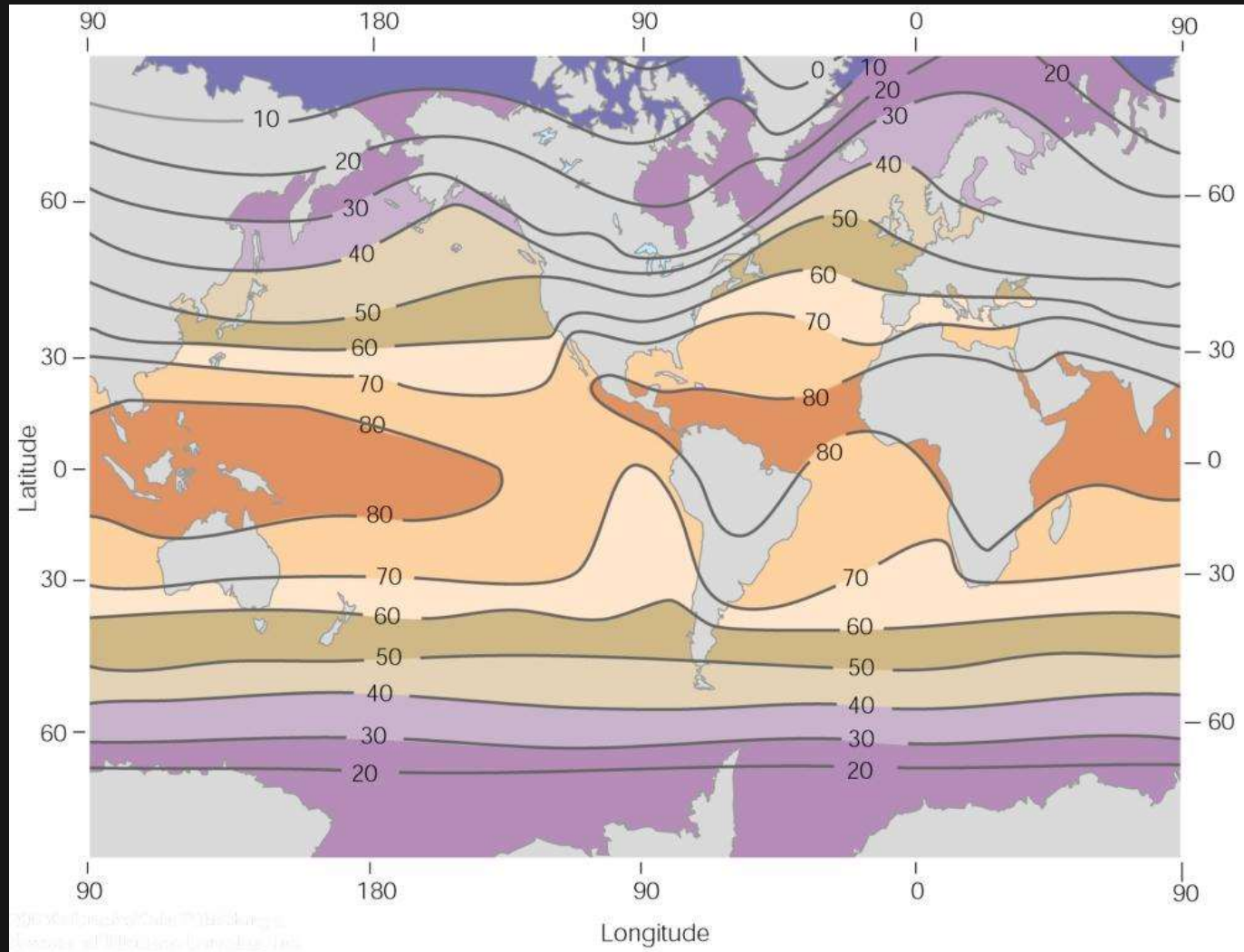
Climate is what you expect and weather is what you get.

Climate tells what clothes to buy, but weather tells you what clothes to wear

Climatic Controls

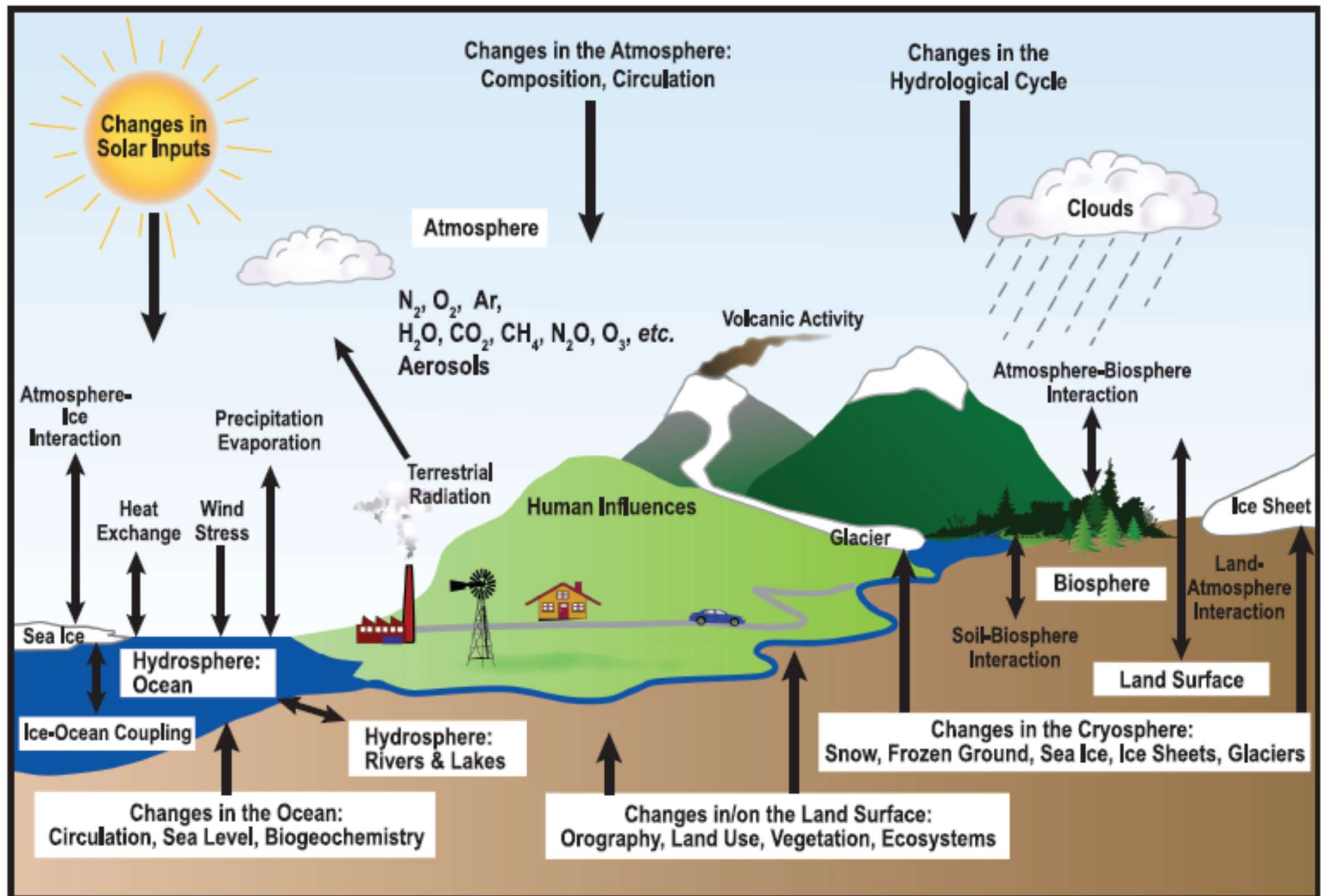
The world's many climates are controlled by the same factors affecting weather,

- 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.*



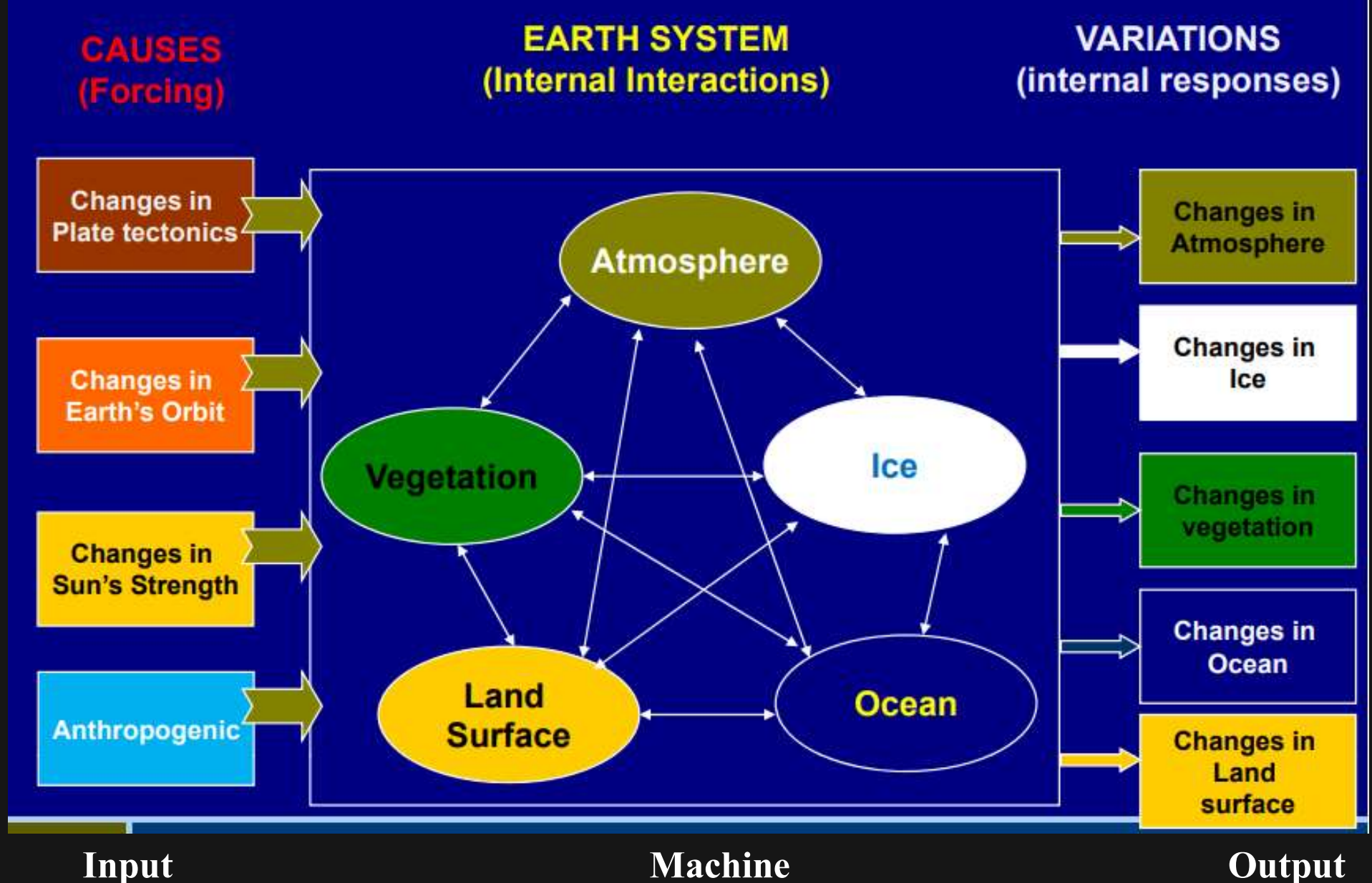
This map shows sea-level temperatures ($^{\circ}$ F).

The Climate System Components



Climate: Forcing and Response

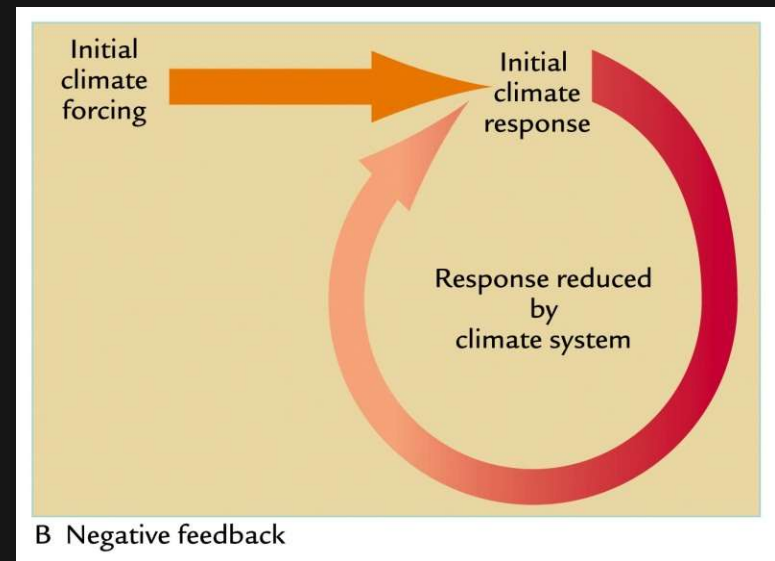
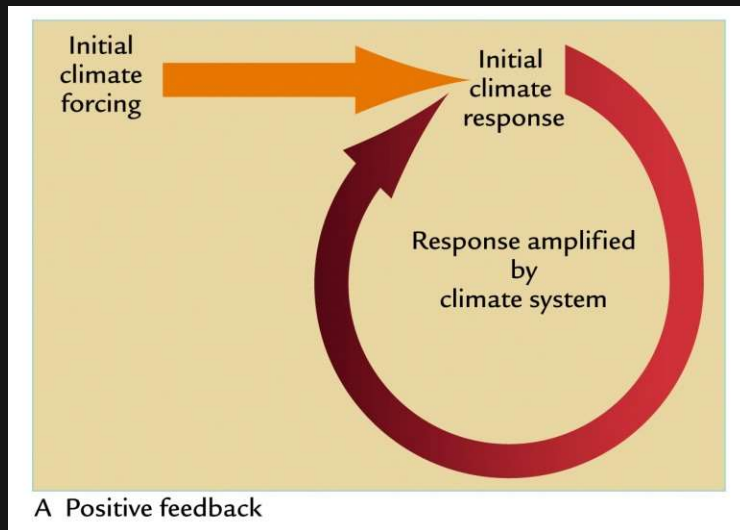
The Climate Machine!



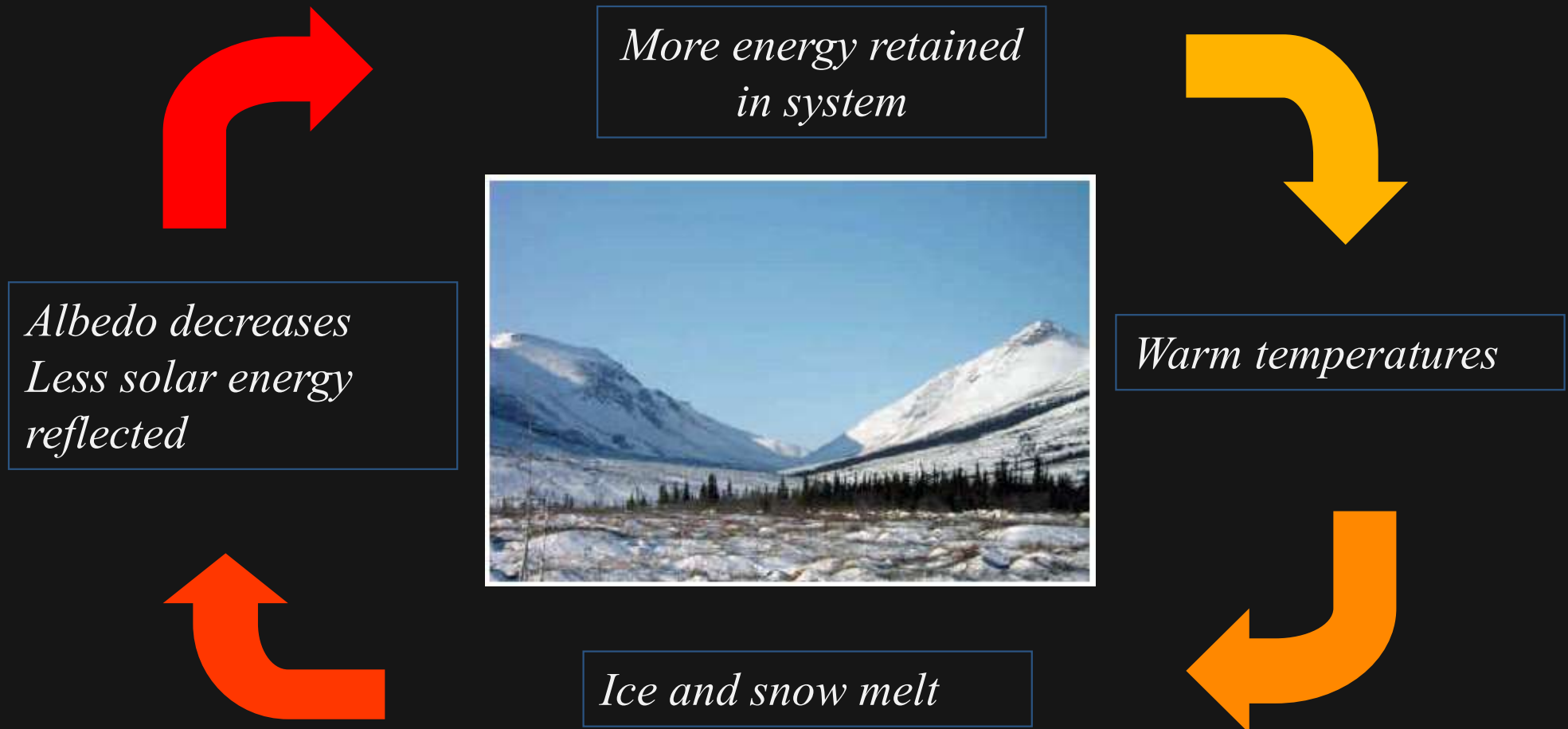
Feedbacks

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).

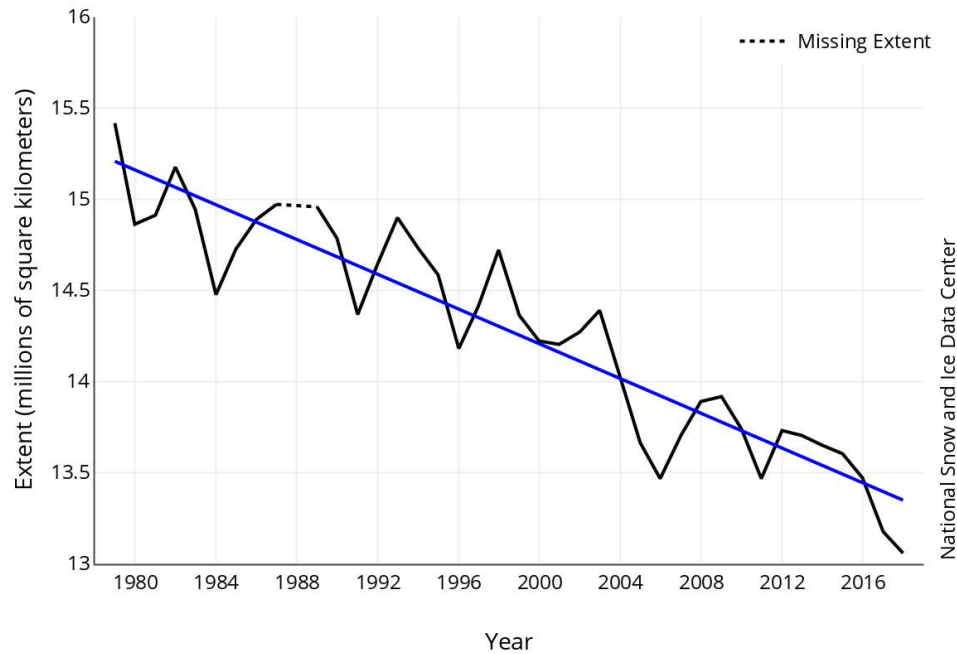


*Example of a **positive** feedback*

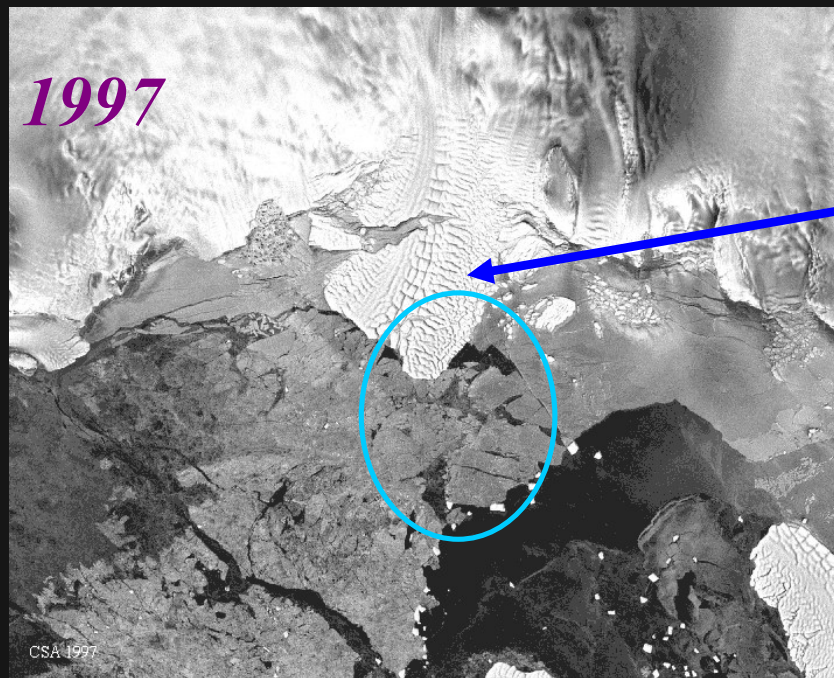


If this were the only mechanism acting, we'd get a runaway temperature increase

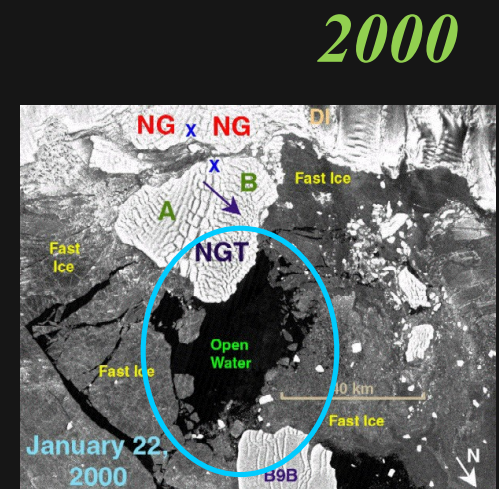
Average Monthly Arctic Sea Ice Extent
January 1979 - 2018



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



*Ninnis Glacier Tongue
Antarctica*



Example of a **negative** feedback

More energy retained
in system



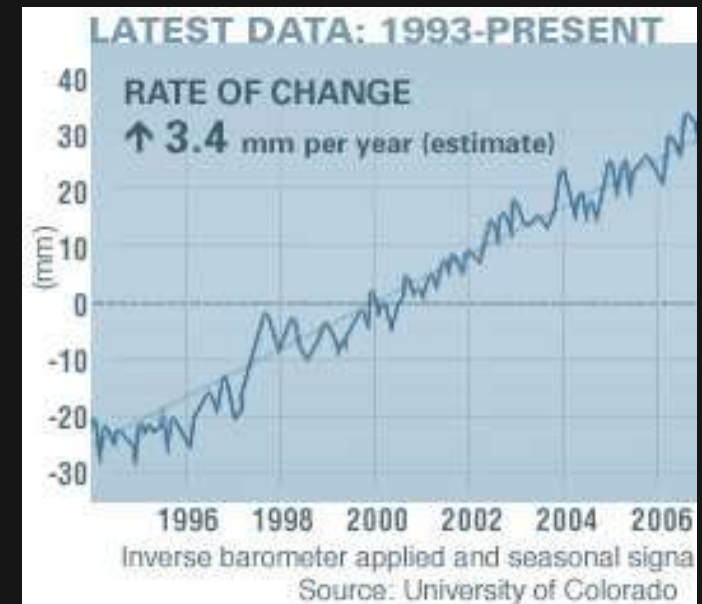
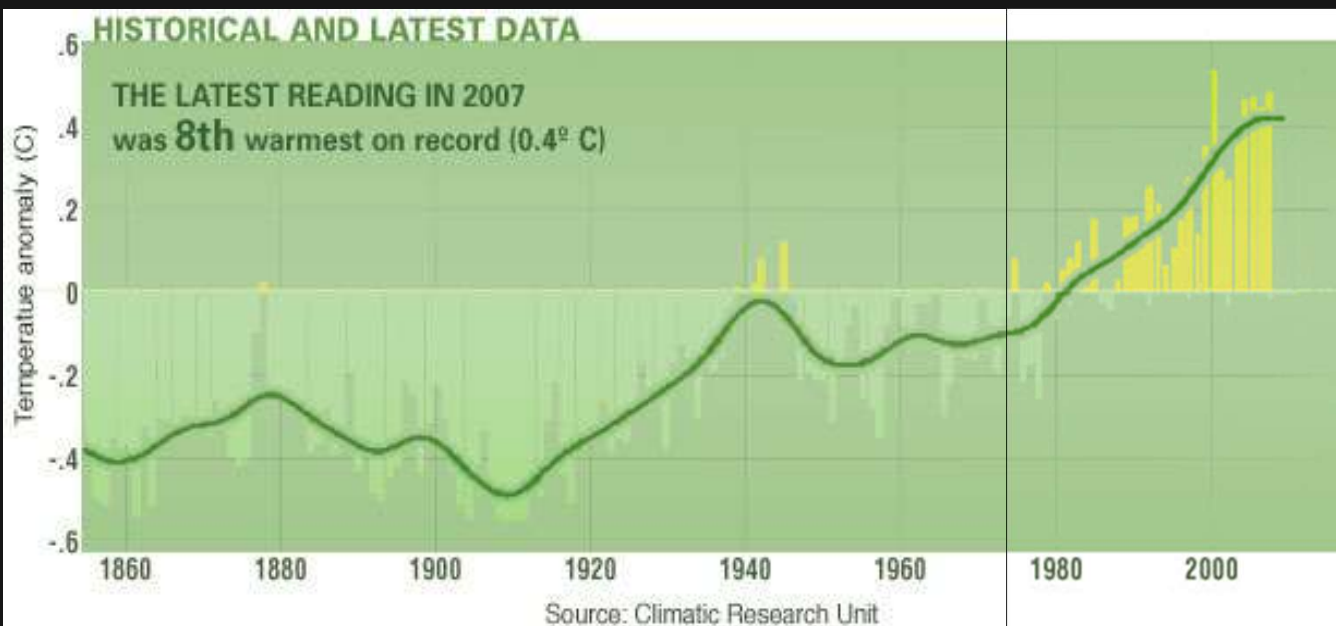
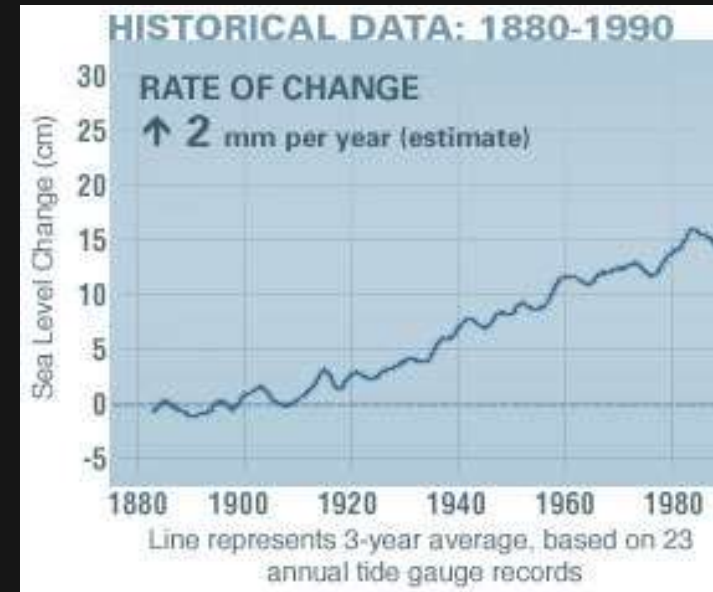
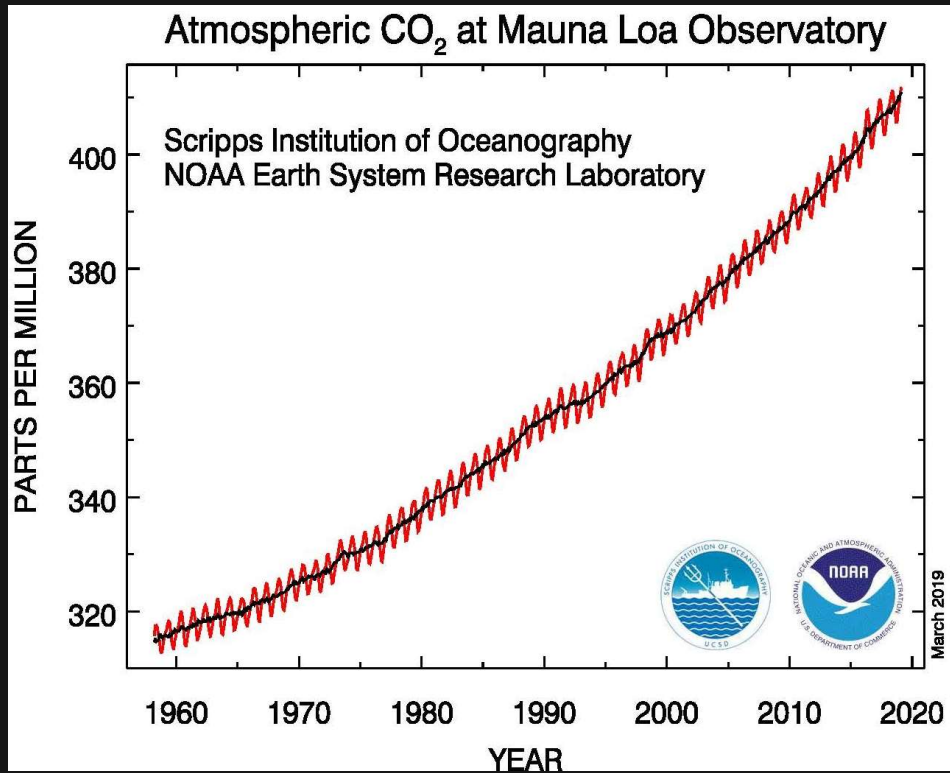
Albedo decreases
Less solar energy
reflected

Warm temperatures

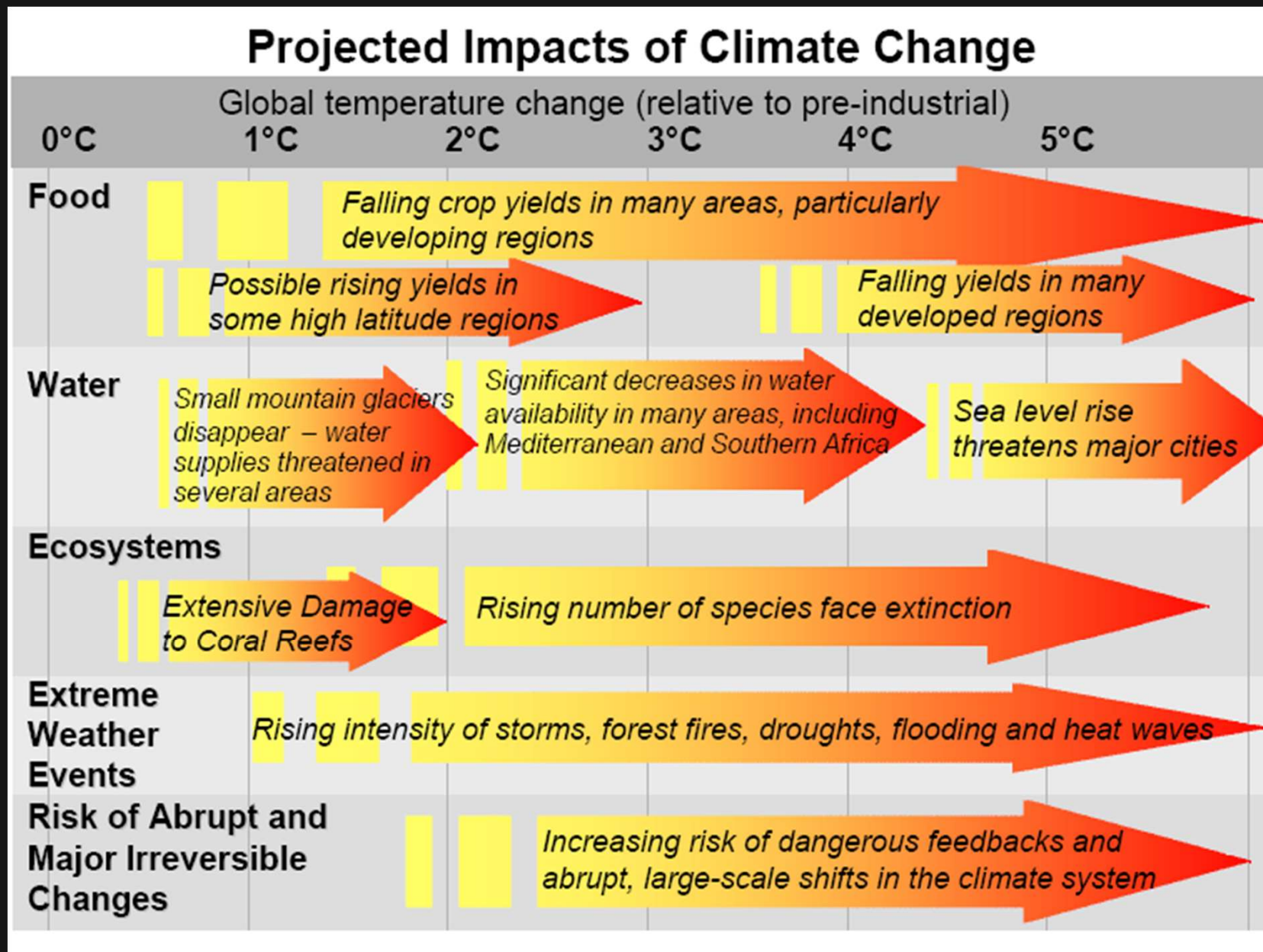
More evaporation
More clouds

?????

Climate Change

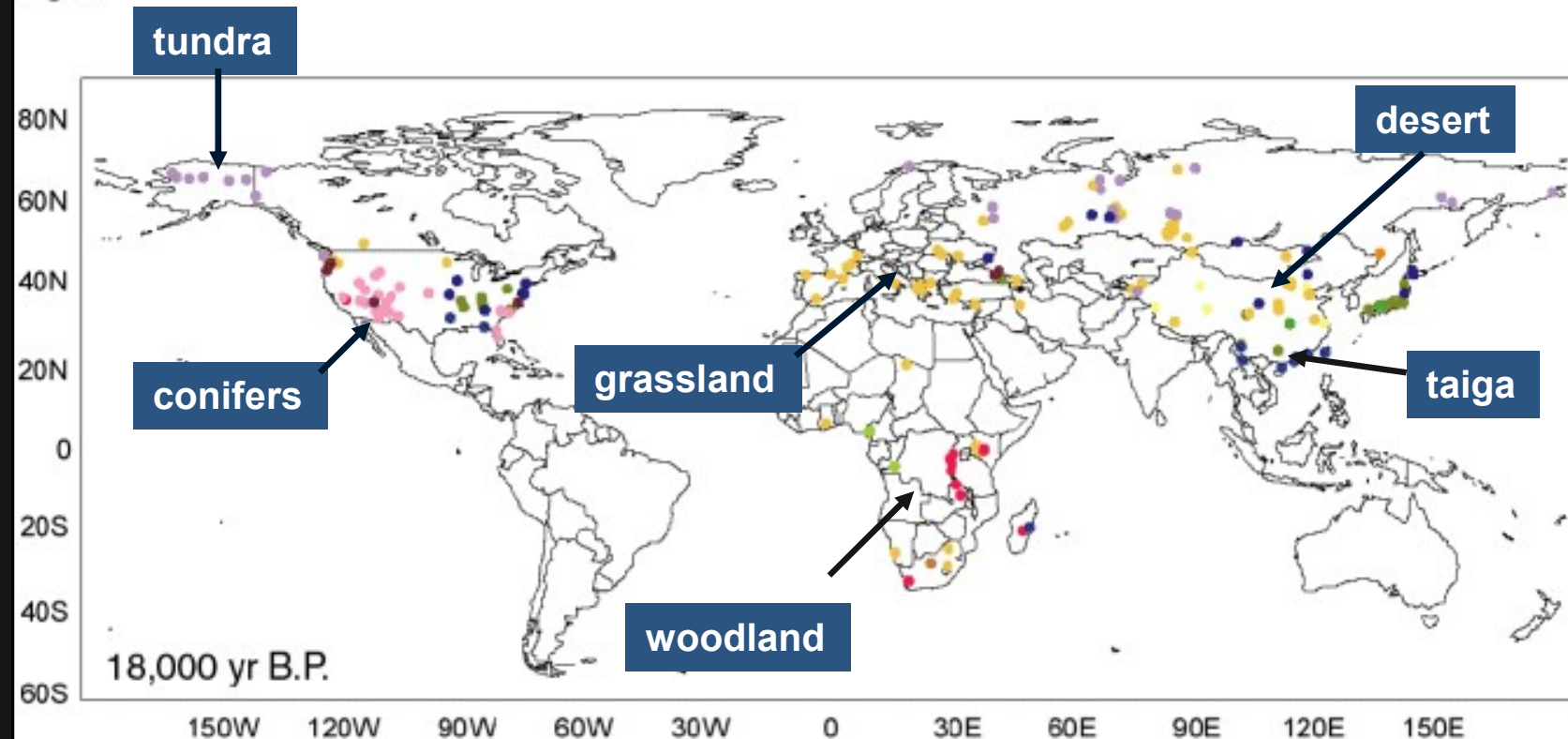


Climate Change – and dealing with it



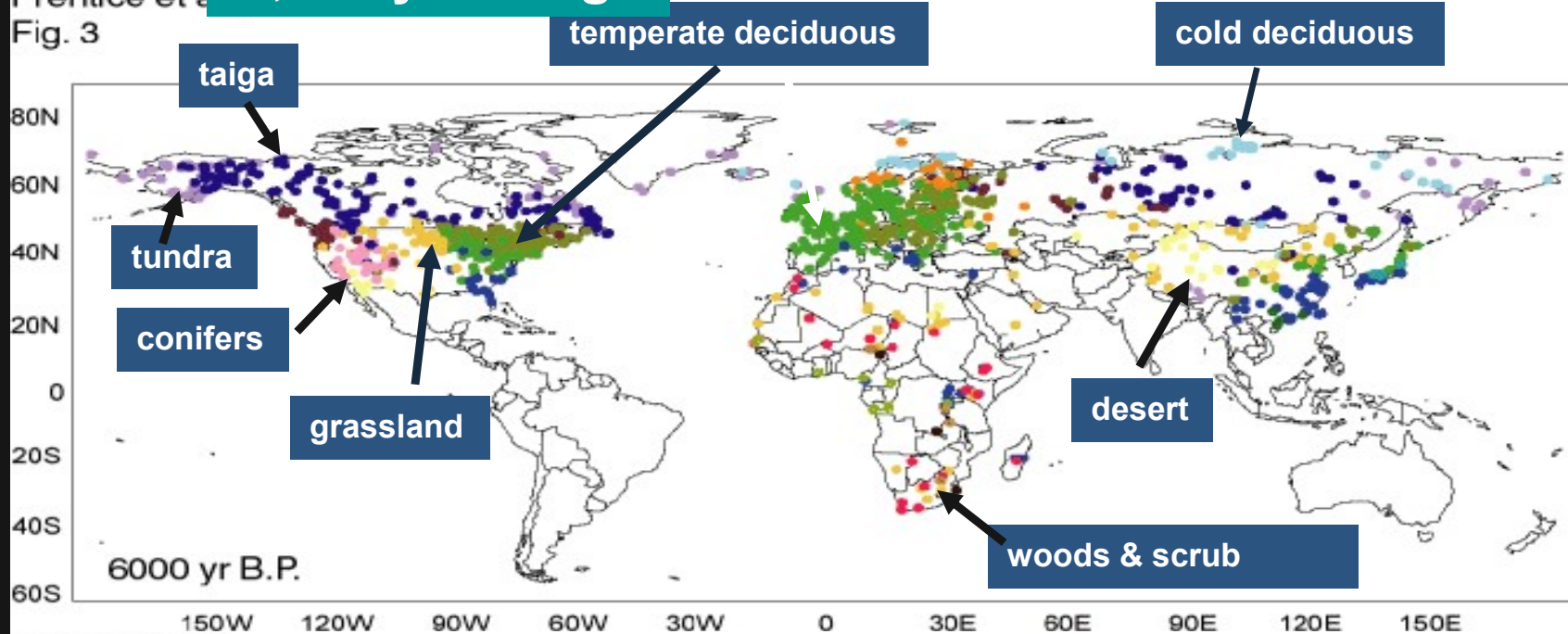
Global Distribution of Vegetation 18,000 years ago

Prentice et al.,
Fig. 2

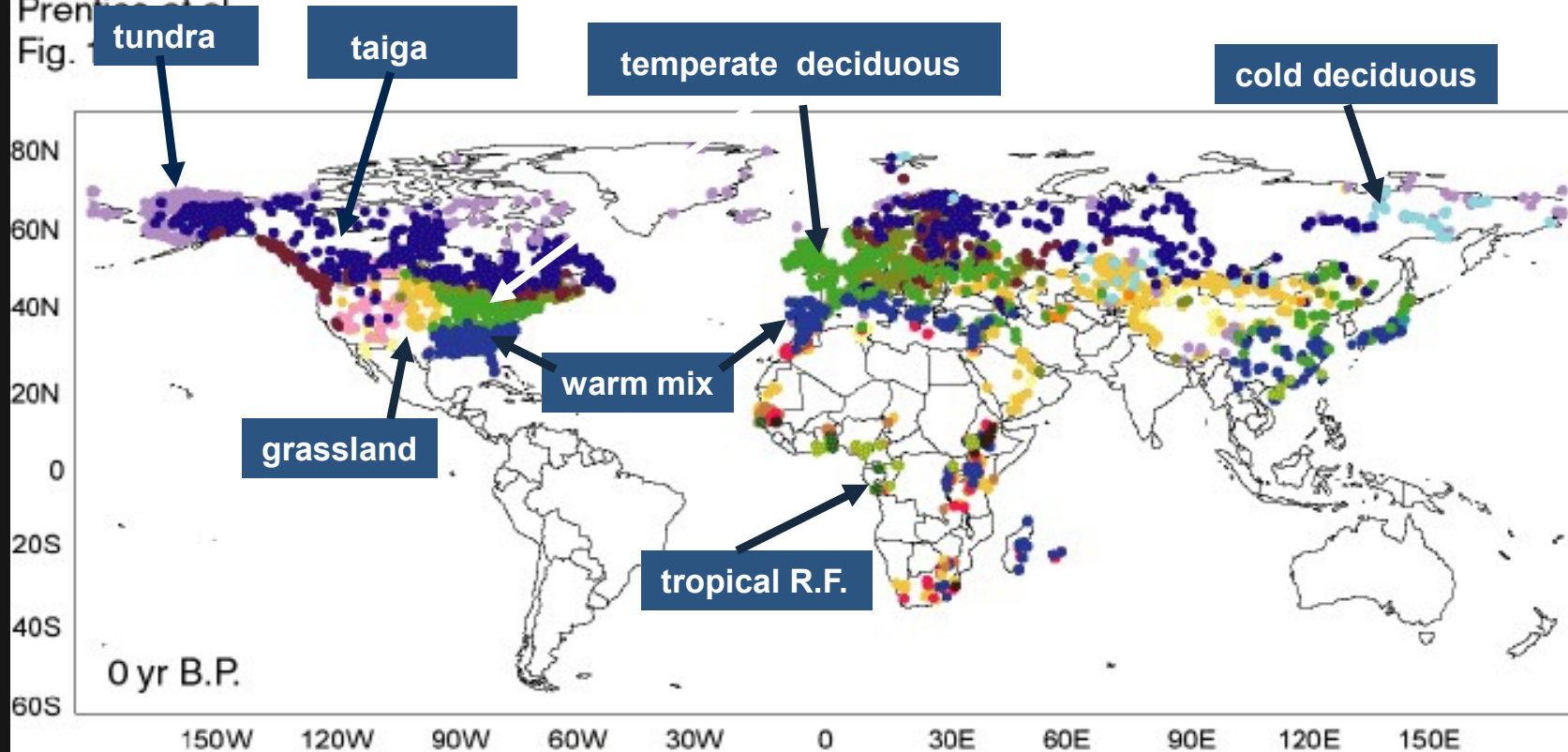


6,000 years ago

Prentice et al.
Fig. 3

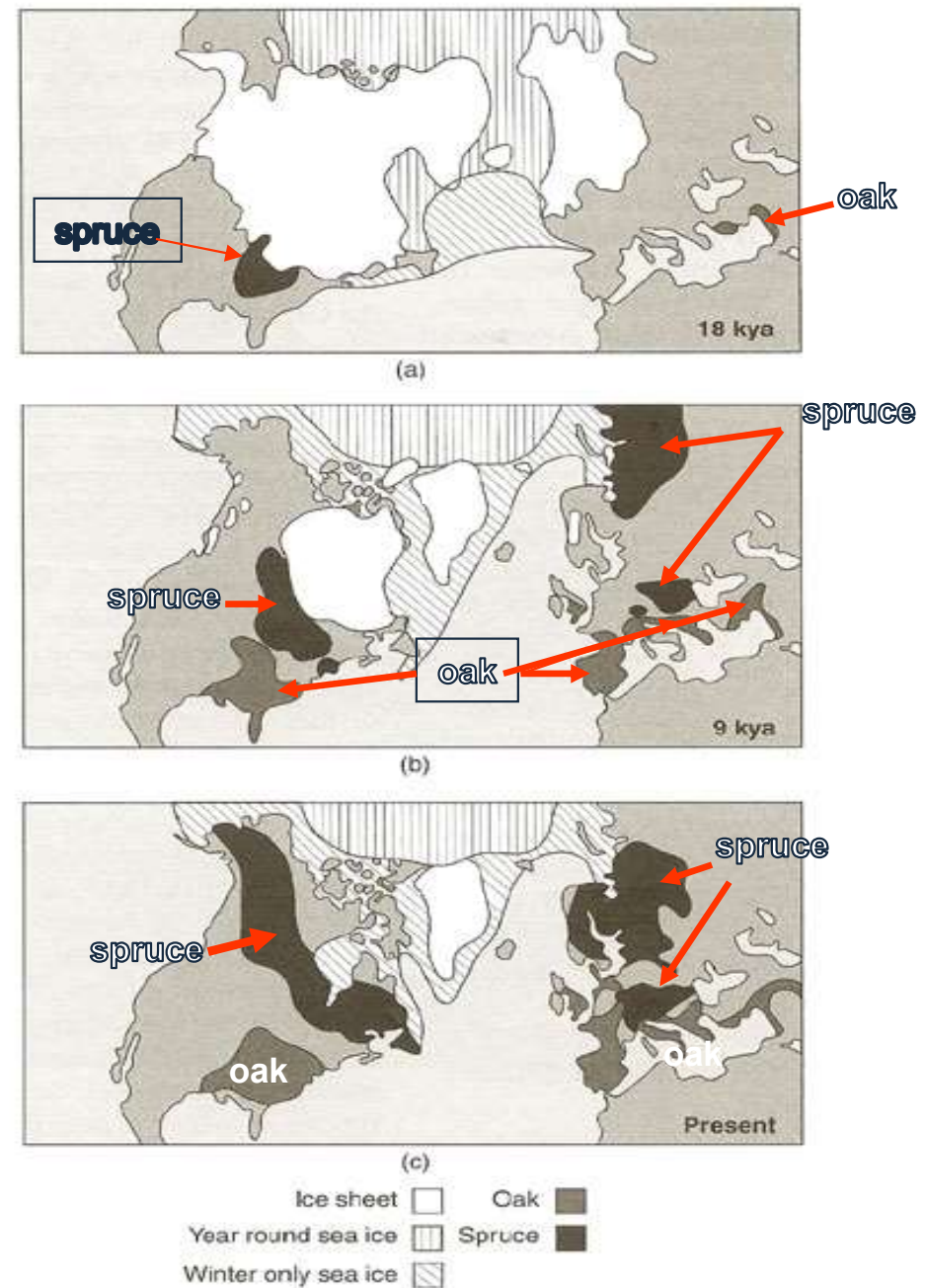


Prentice et al.
Fig. 3



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



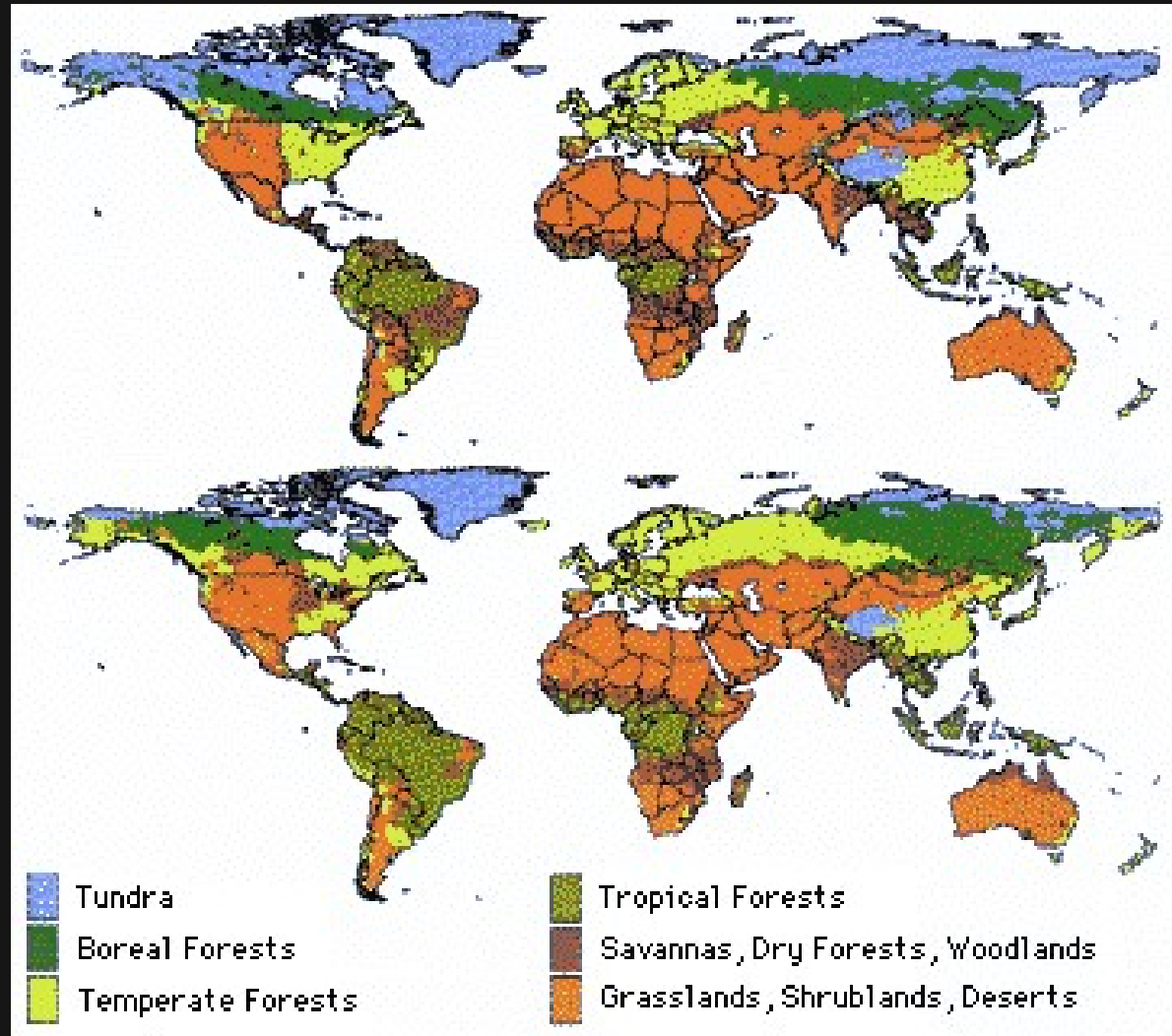
Distribution of spruce and oak forests in Northern Hemisphere since the glacial period 18,000 kya

Shifts in Terrestrial Habitat

Potential distribution of the major world biomes under current climate conditions

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 than plant migration can keep up.



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

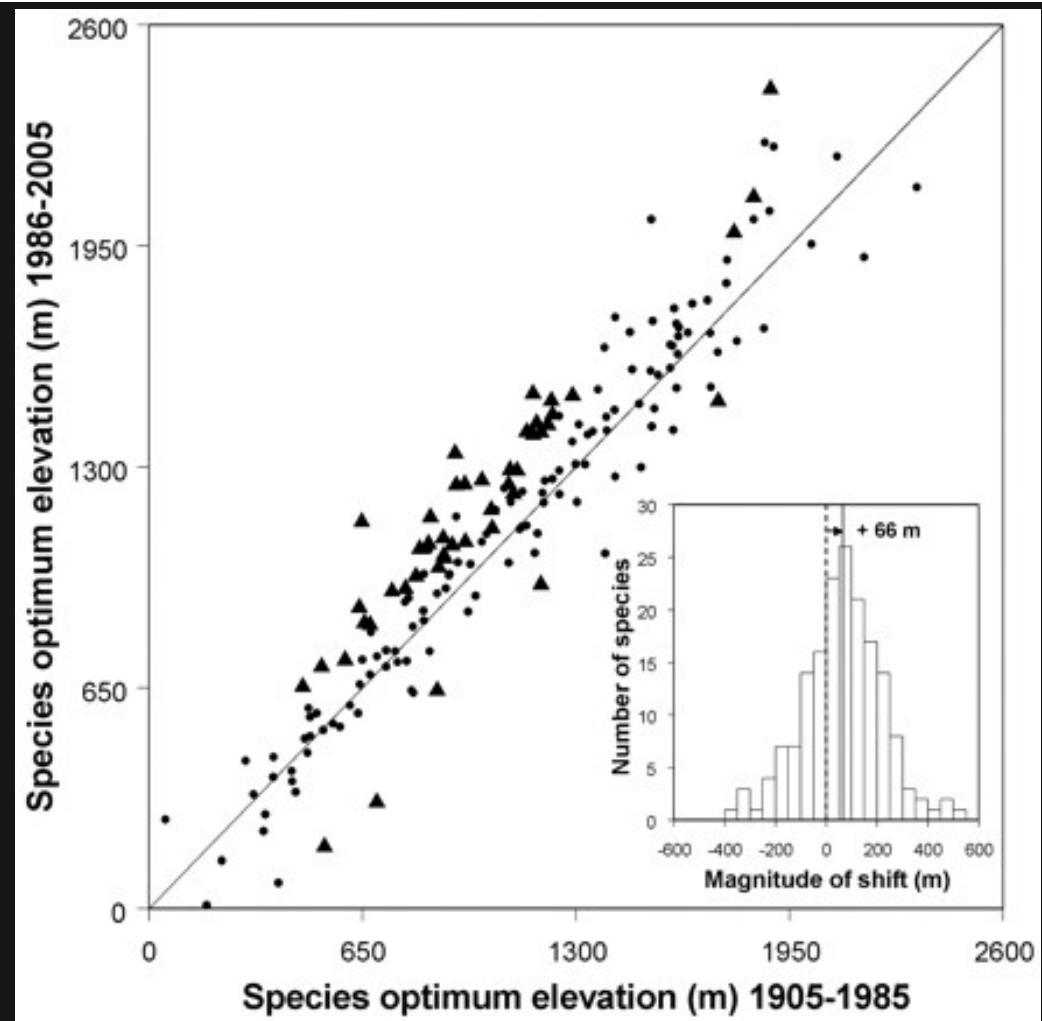
Used data from surveys conducted from 1905 through 1985 (early surveys) and compared these data to data from surveys conducted between 1986 and 2005 (late surveys)

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

PROBABLE IMPACT ON BIODIVERSITY OF SUNDERBANS DUE TO SEA LEVEL RISE



“Royal Bengal Tigers may go extinct by turn of century - reveals study” says a report by prominent English daily THE DAILY STAR, on 1st March’2010. The report also said, “The Royal Bengal Tigers, one of the world’s largest big cat populations, could disappear by the end of this century as rising sea levels caused by climate change destroy their habitat along the Sundarbans coast.”

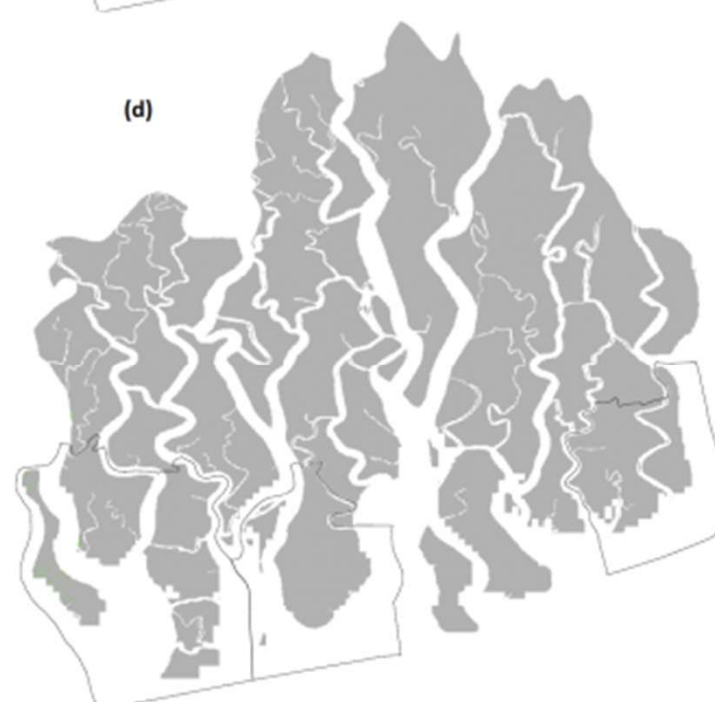
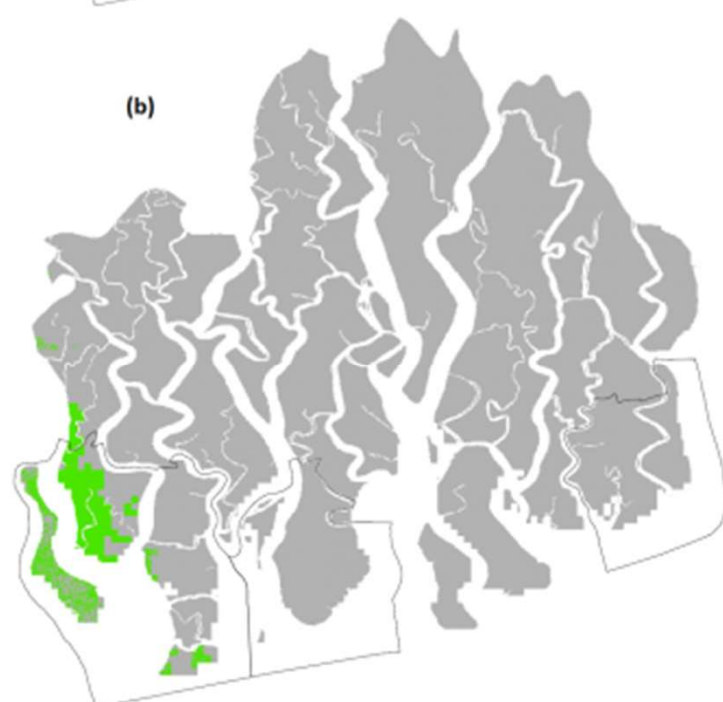
the Bangladesh and Indian portion of the forest are listed in the UNESCO world heritage list separately as the Sundarban i.e.the “beautiful forest” and Sundarban National Park respectively, though they are simply parts of the same forest.

The Sundarbans, its wildlife and the natural resources that sustain millions of people may disappear within 50 to 90 years.



2050

2070

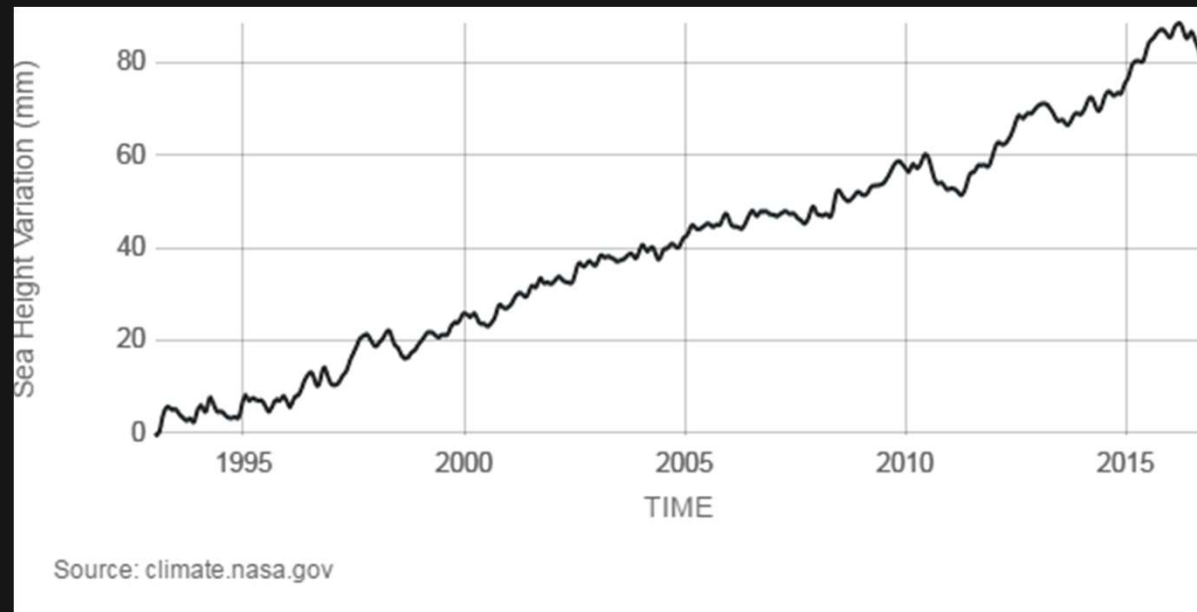
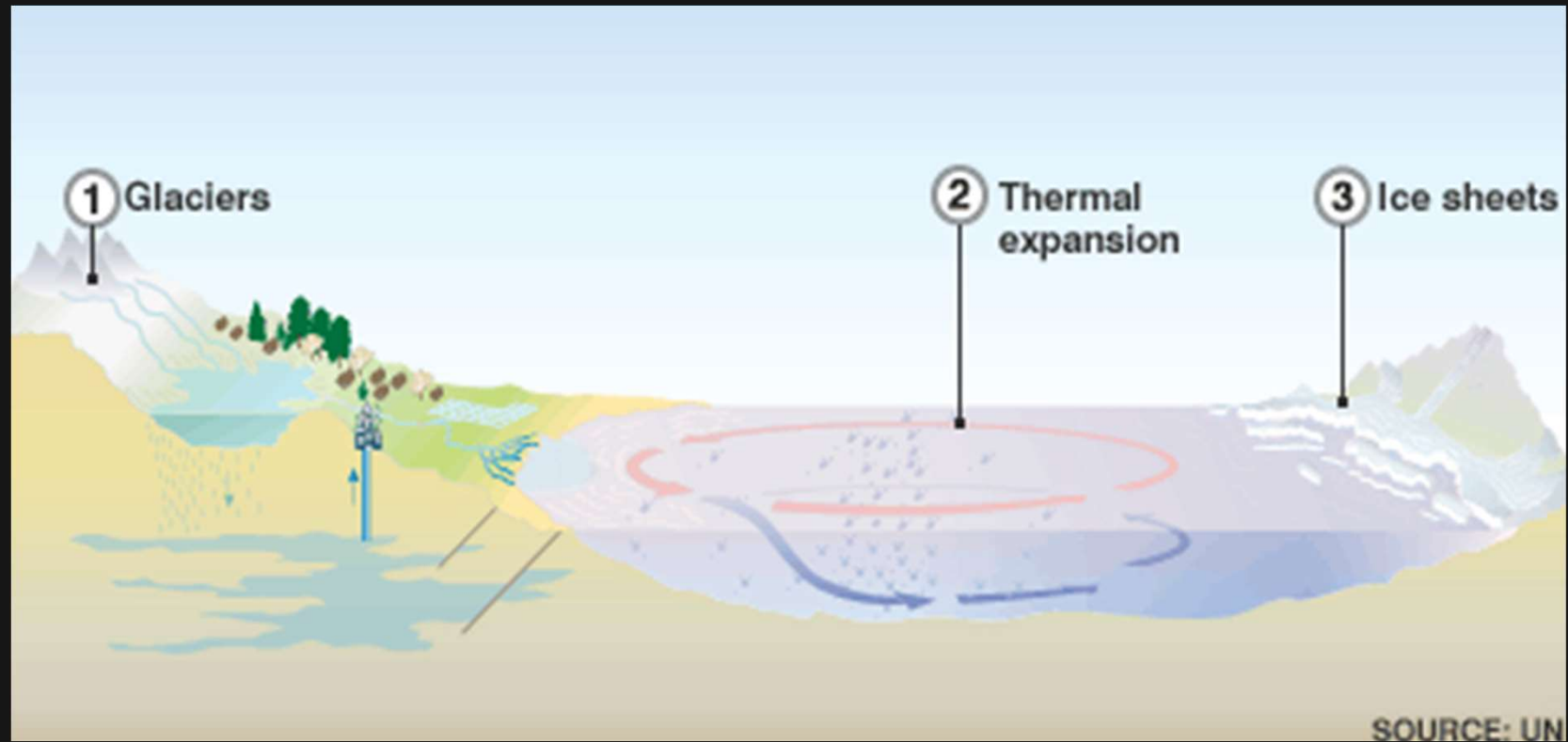


Lost Protection

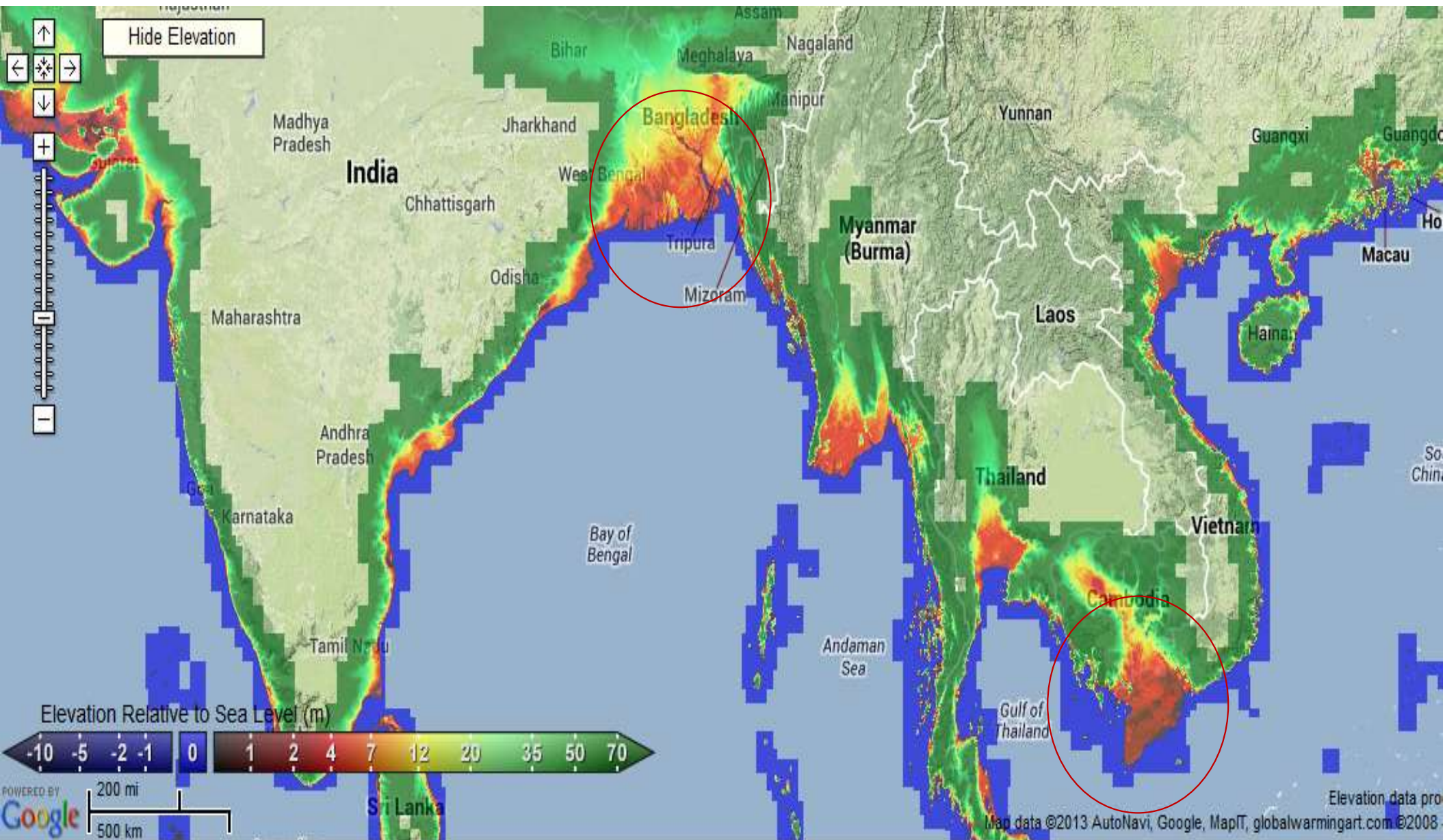
The Sundarbans spans nearly 10360 km² of India and Bangladesh along the Bay of Bengal. The world's largest continuous mangrove forest, it's home to a wide variety of species. For the 7.5 million people who live in the region, the forest is a natural barrier against tides and cyclones. But as people cut the trees and rising seas bring saline waters, the forest and the land itself are shrinking. More than a million coastal residents have already migrated north.



Causes of Sea Level Rise



Sea Level Change in India, Bangladesh & Vietnam



Sea Level Rise in Bangladesh



Sources: Dacca University; Intergovernmental Panel on Climate Change (IPCC).

Sea level rise

Sea level rise in Bangladesh and its potential impacts

Year	2020	2050	2100
Sea level rise	10 cm	25 cm	1 m (high end estimate)
Land below SLR	2 % of land (2,500 km ²)	4 % of land (6,300 km ²)	17.5% of land (25,000 km ²)
Ecosystem	Inundates 15% of the Sundarbans.	Inundates 40% of the Sundarbans.	The Sundarbans would be lost.
Salinity	Increase	Increase	Increase

Sea level rise	Potential impacts
10 cm	will inundate 15% of the Sundarbans
25 cm	will inundate 40% of the Sundarbans
45 cm	will inundate 75% of the Sundarbans
60 cm	will inundate the whole Sundarbans
1 metre	□ will destroy the whole Sundarbans

Impacts due to sea level rise:

The main impact of sea level rise on water resources is the reduction of fresh water available due to salinity intrusion. Both water and soil salinity along the coast will be increased with the rise in sea level

Increased salinity will change the habitat pattern of the forest. Sundari, the most typical kind of tree in the Sundarbans is thought to suffer from top dyeing disease because of increased salinity (Kausher et al., 1993).

The resultant increase in salinisation and accretion of sediments may alter vegetation composition.

Eventually the species offering dense canopy cover would be replaced by non-woody shrubs and bushes, while the overall forest productivity would decline significantly. The degradation of forest quality might cause a gradual depletion of rich diversity of the forest flora and fauna of the Sundarbans ecosystem

Natural habitat will be destroyed due to inundation

Bengal tiger could go extinct as Sundarban habitats entirely vanish by 2070 because of climate change

The reasons behind so many species of tigers dying out are:

Habitat loss

Poaching

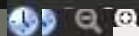
Effects of climate change

Drastic reduction in breeding among different tiger populations as per genomic evidence

"Beyond climate change, the Sundarbans are under growing pressure from industrial developments, new roads, and greater poaching

So, tigers are getting a double whammy -- greater human encroachment on the one hand and a worsening climate and associated sea-level rises on the other,





2006



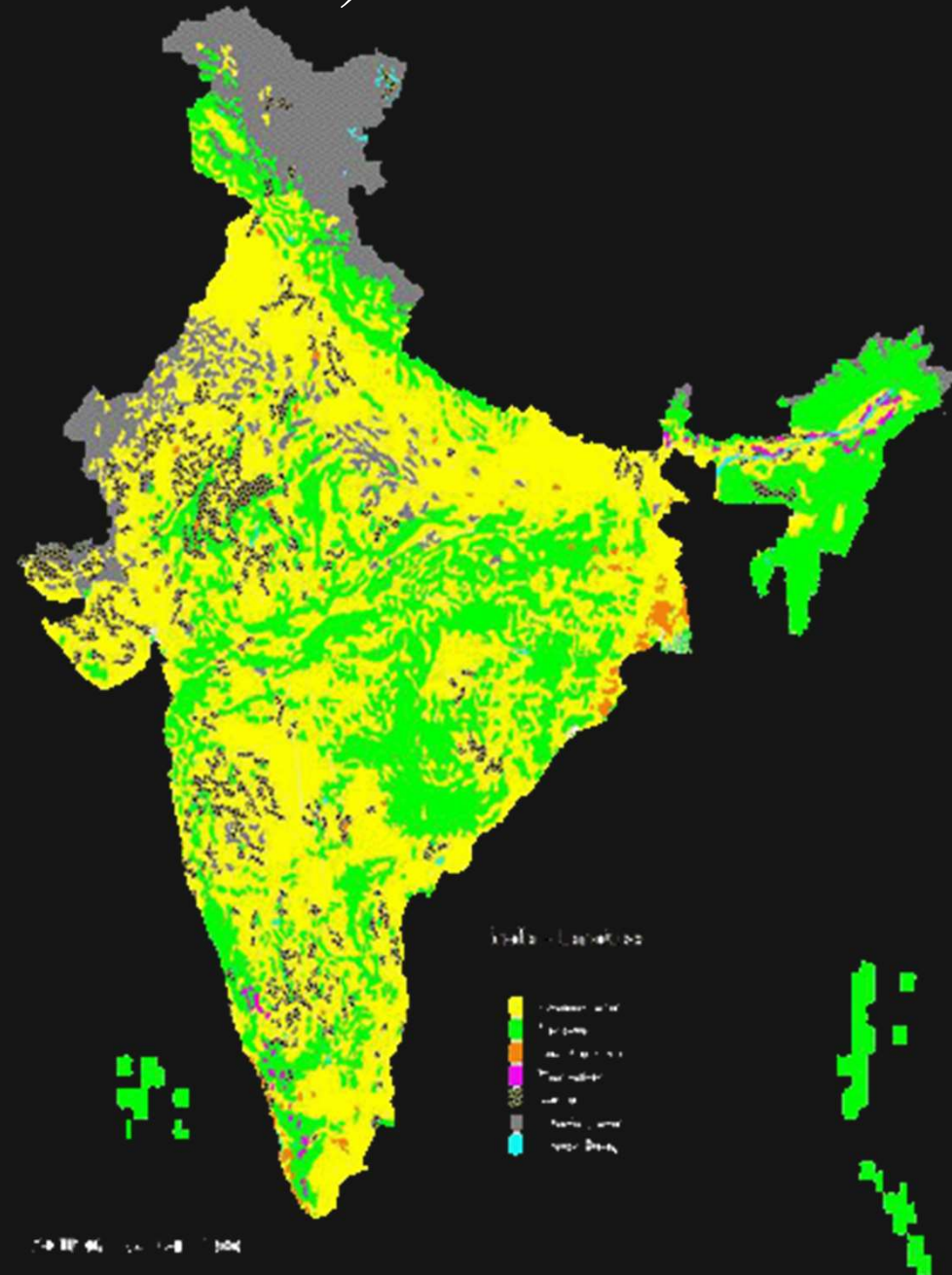
Climate change on Forests of India (Sukumar & Ravindran 1995)

*Shift in vegetation type boundaries
i.e in Western Ghats the moist
forest species are shifting
eastward.*

*Species of lower altitude migrating
to higher altitude.*

*Mountain forests of Western Ghats
would change into grasslands.*

*Increase in dry season length
would increase the risk of forest
fires in moist and dry deciduous
forests.*



Impact of climate change on biodiversity of India MoEF Study

Adverse effect on agriculture, health, forestry and infrastructure.

Temperature rise by 3° C to 4°C towards the end of 21st century.

Reduction in wheat and rice yields.

Rainfall patterns and quantities in periods of drought in some regions, more rainfall in central India and reduced rain in the north-east, leading to changes in forestry and vegetation.

70% of vegetation vulnerable to change.

Adverse impact on wildlife and other biological species.



<https://www.excavate.in/indiaclimatedialogue-nilgiris-threatened-by-climate-change/>

https://www.youtube.com/watch?v=9BP2XV-_1V8

<https://www.youtube.com/watch?v=S2gesipk7lY>

<https://www.youtube.com/watch?v=OuHUx5Y6mK0>