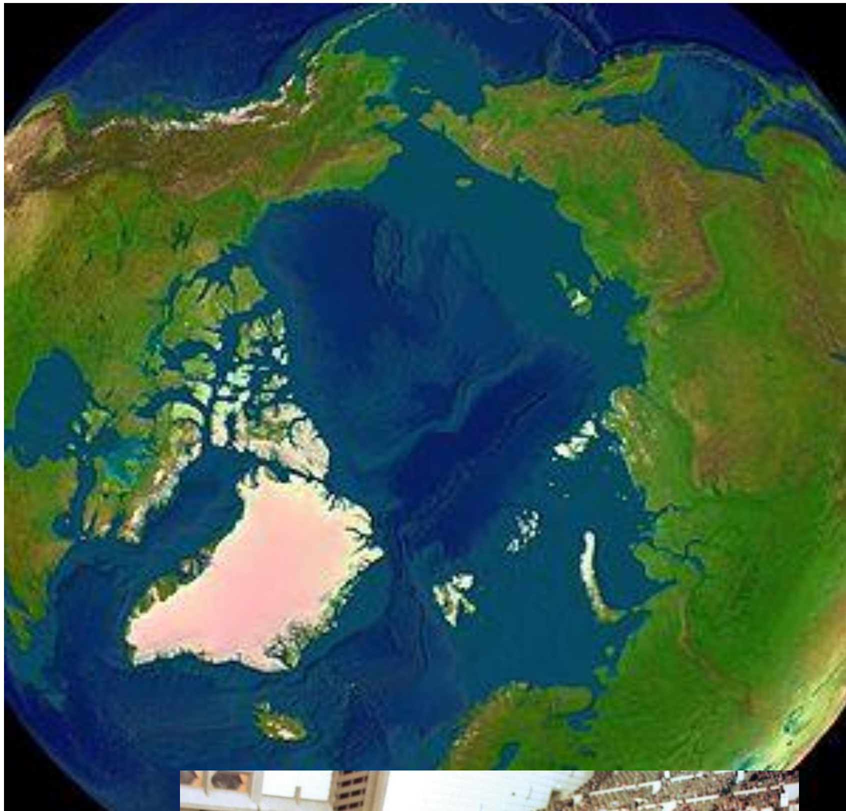

Climate Change and the Arctic

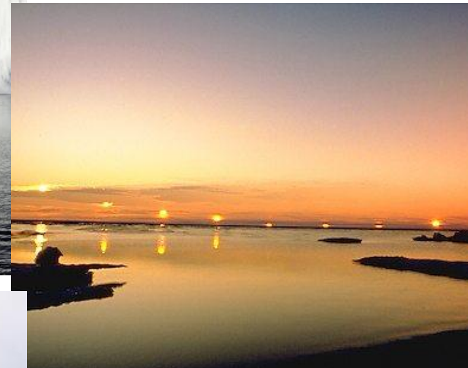
From last week……

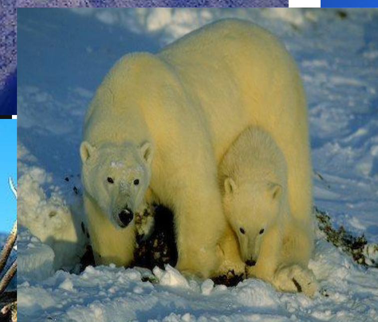


Today’s Menu

- What is the Arctic, exactly?
- What are the signs of warming in the Arctic?
- What causes that Warming?
- What are some of the Arctic effects?

What is the Arctic?





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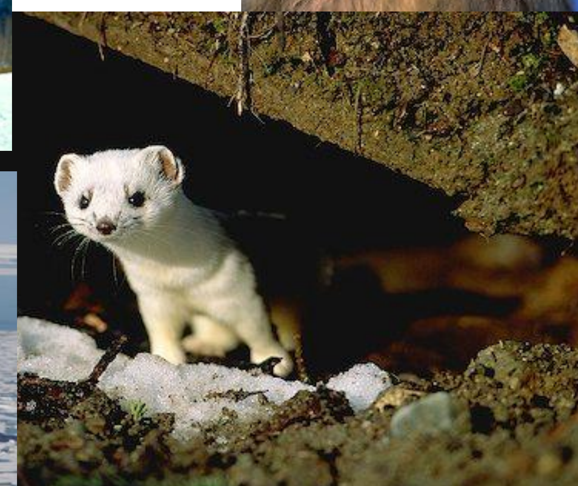
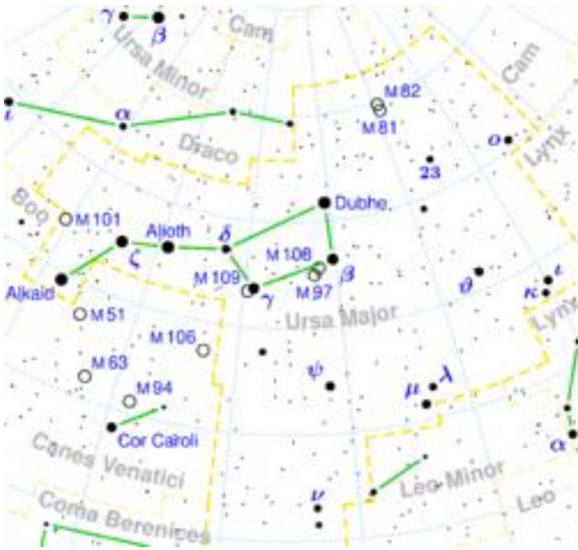
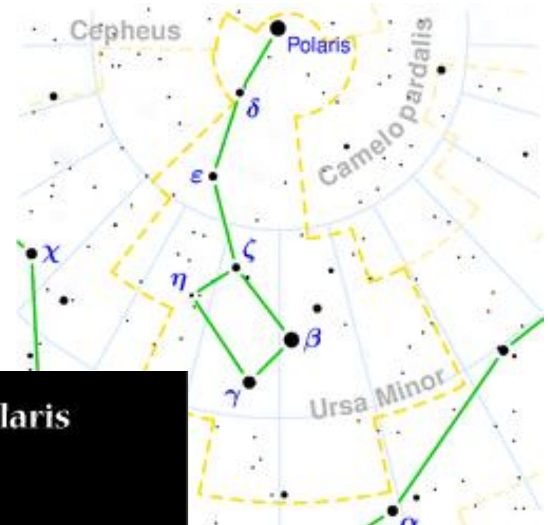
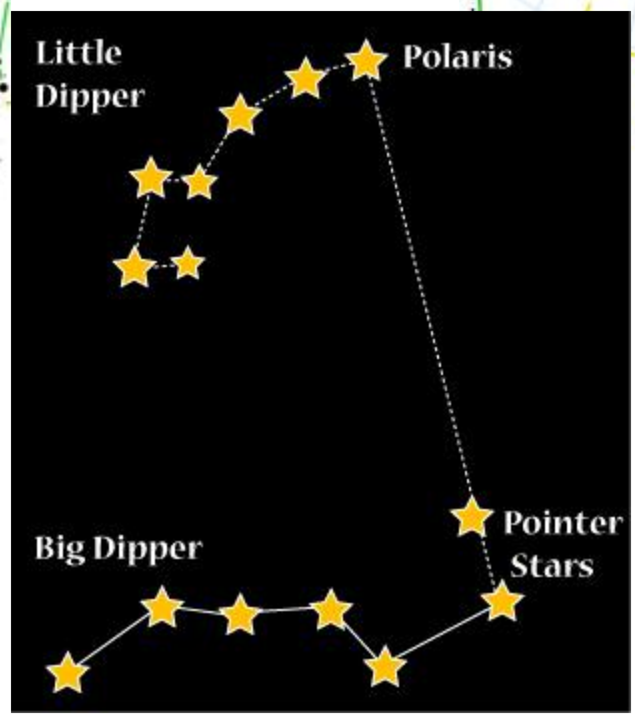


Polaris….the North Star

Arctic means “Country of the great bear”





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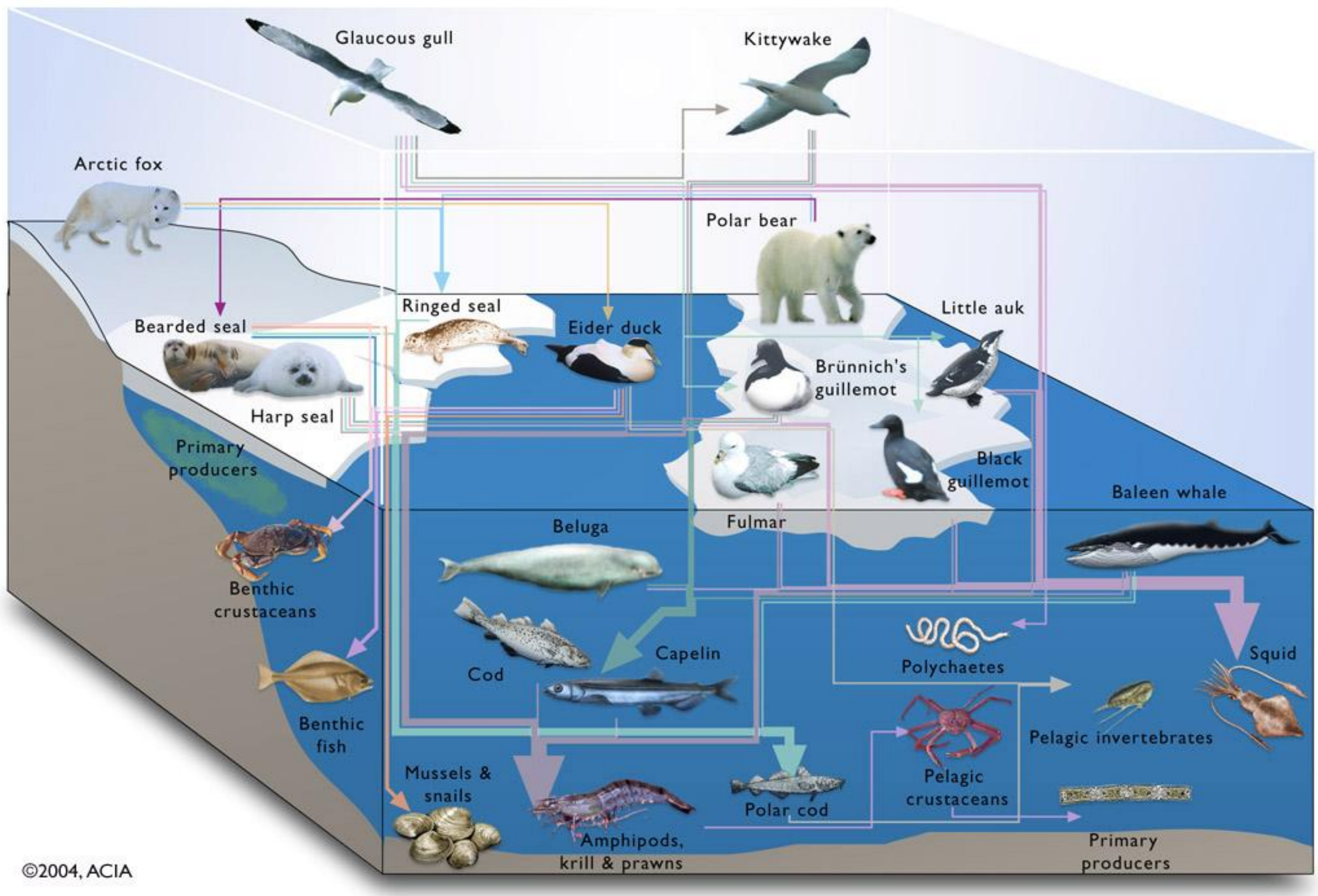
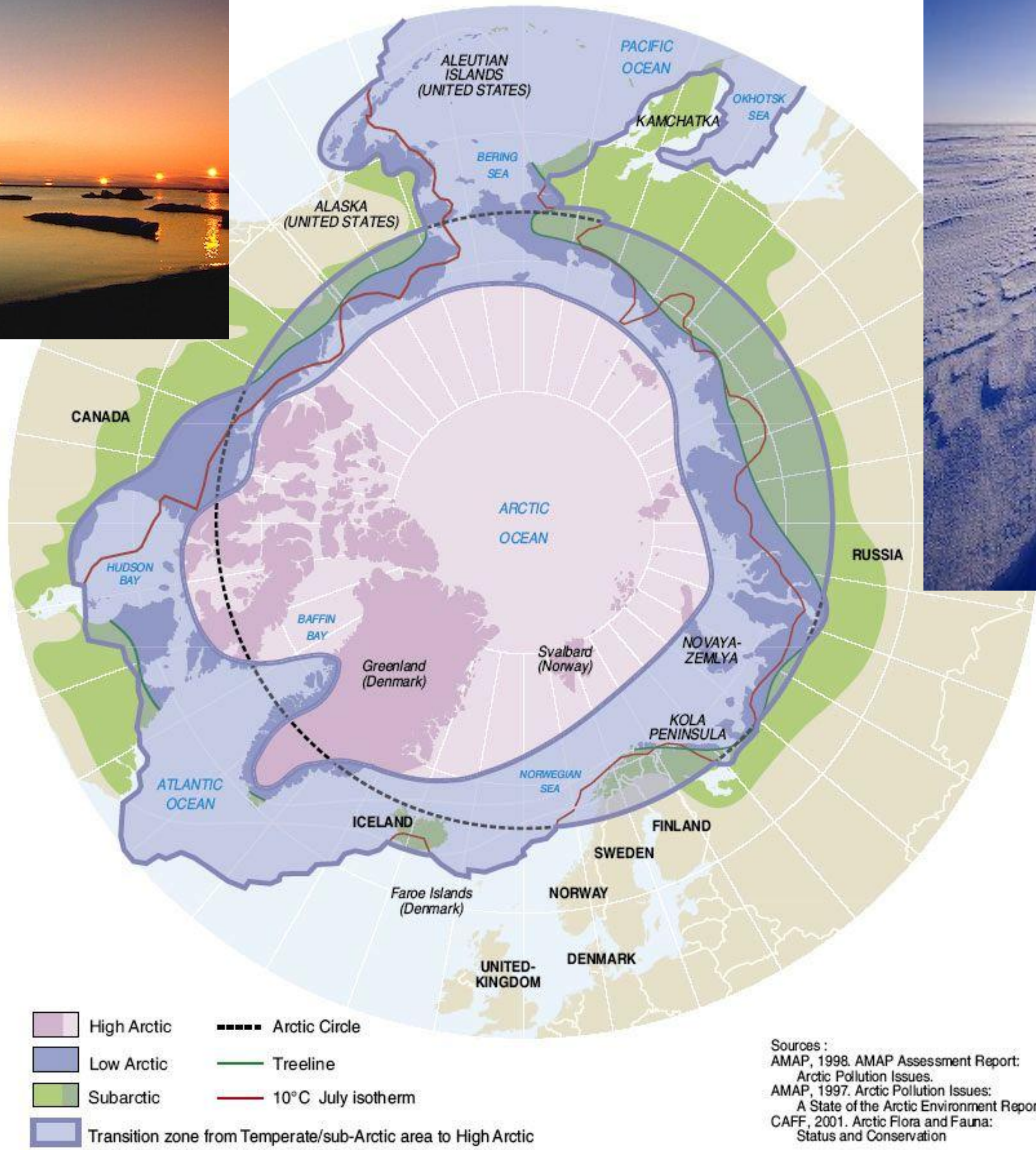
Arctic wildlife

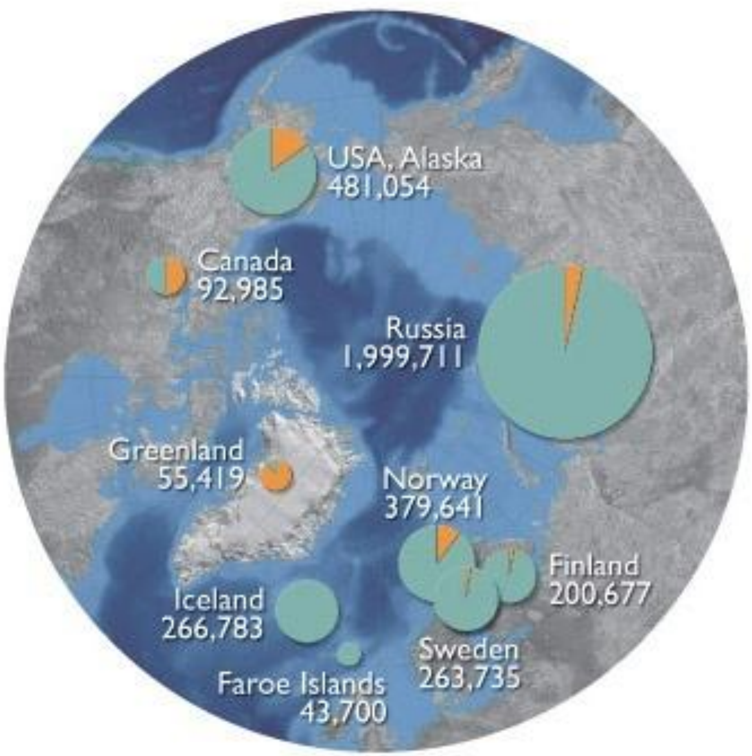




ALEUTIAN ISLANDS (UNITED STATES)
PACIFIC OCEAN
OKHOTSK SEA
KAMCHATKA
BERING SEA
ALASKA (UNITED STATES)
CANADA
HUDSON BAY
BAFFIN BAY
ARCTIC OCEAN
RUSSIA
Greenland (Denmark)
Svalbard (Norway)
NOVAYA-ZEMLYA
KOLA PENINSULA
NORWEGIAN SEA
ATLANTIC OCEAN
ICELAND
FINLAND
SWEDEN
NORWAY
Faroe Islands (Denmark)
UNITED-KINGDOM
DENMARK
High Arctic
Low Arctic
Subarctic
Arctic Circle
Treeline
10°C July isotherm
Transition zone from Temperate/sub-Arctic area to High Arctic
Sources :
AMAP, 1998. AMAP Assessment Report: Arctic Pollution Issues.
AMAP, 1997. Arctic Pollution Issues: A State of the Arctic Environment Report.
CAFF, 2001. Arctic Flora and Fauna: Status and Conservation

Arctic Circle

People of the Arctic



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Saami Council (SC)
Russian Association of Indigenous Peoples of the North (RAIPON)
Aleut International Association (AIA)
Inuit Circumpolar Conference (ICC)
Gwich'in Council International (GCI)
Arctic Athabaskan Council (AAC)

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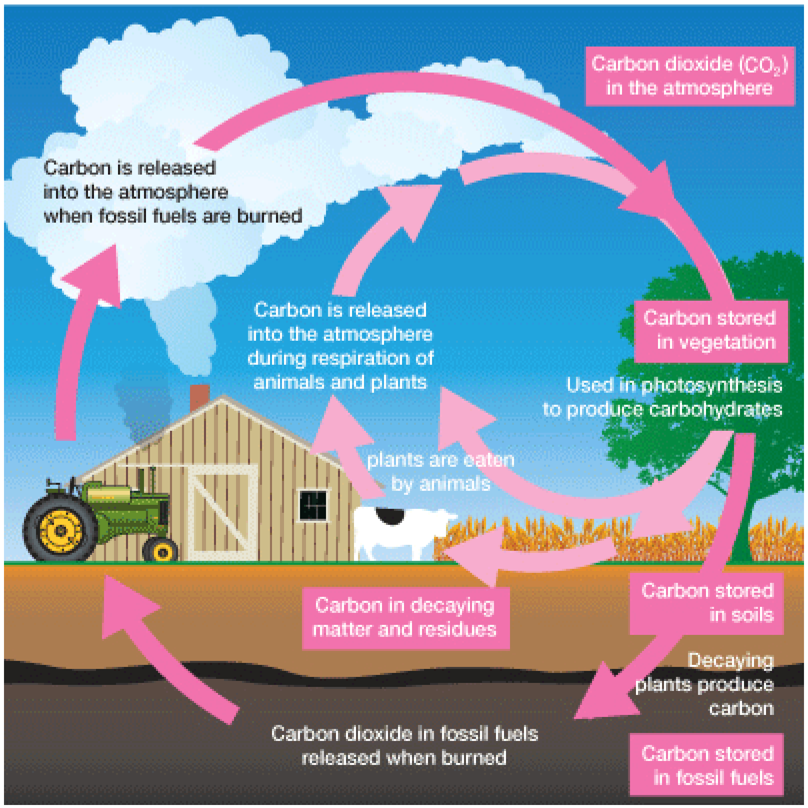
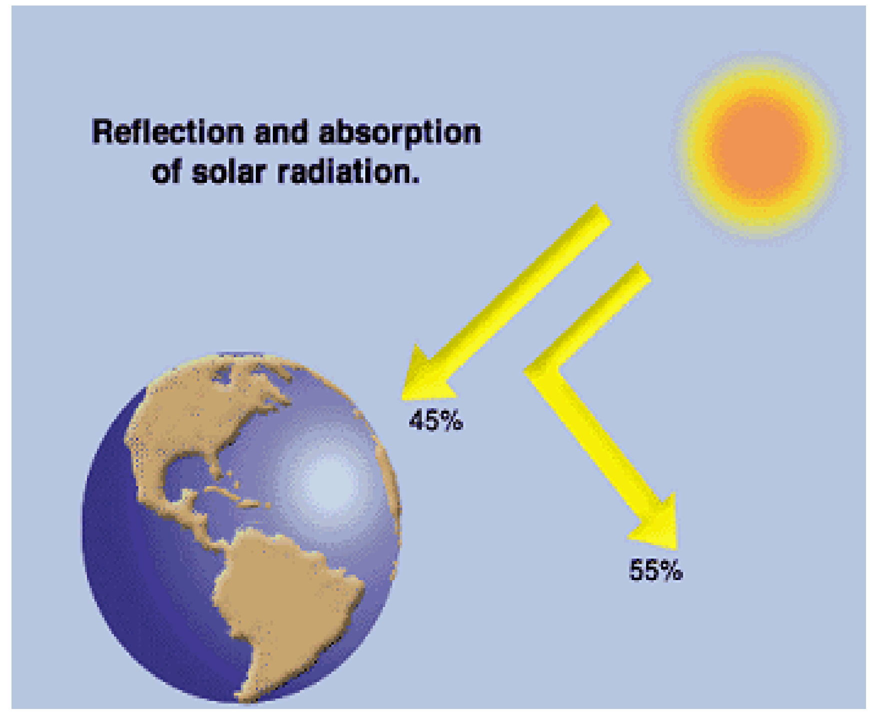
Life in the Arctic: Both Vulnerable and Resilient

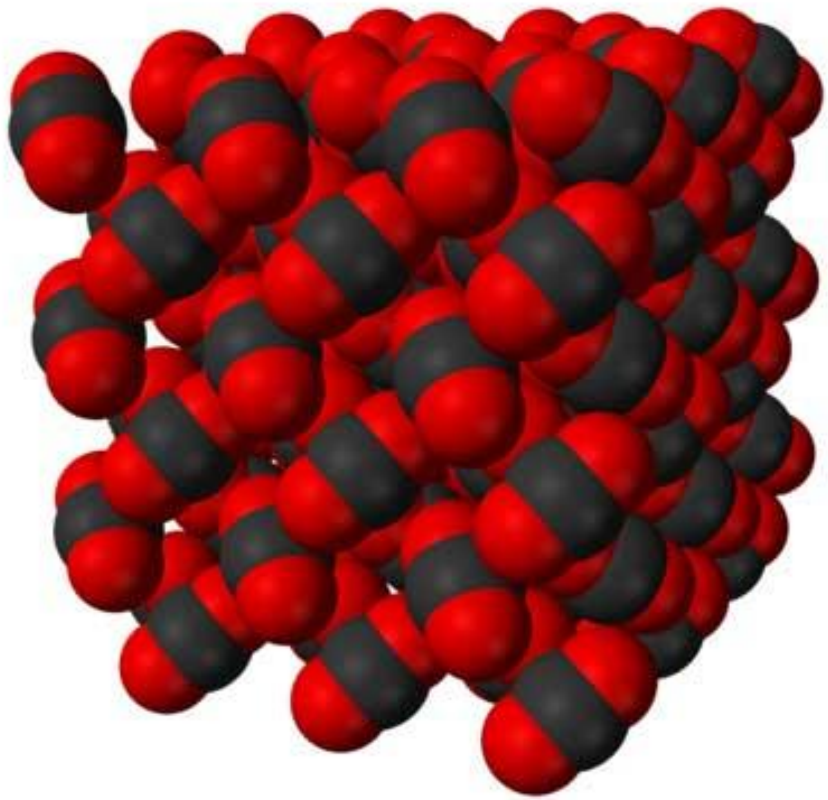
Climate Change as a challenge to resilience…

Two systems are important in understanding climate change: The carbon cycle and solar radiation

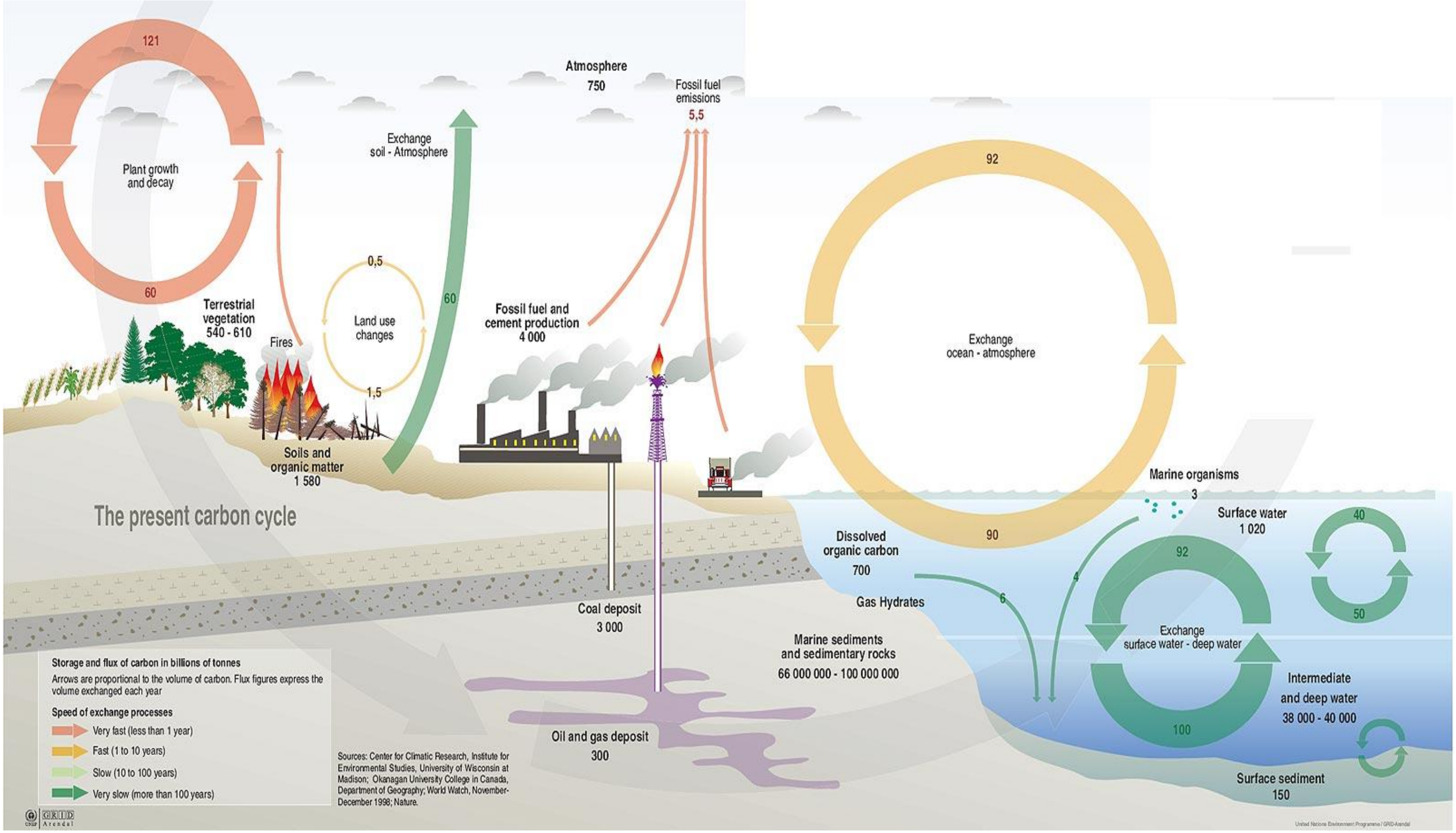




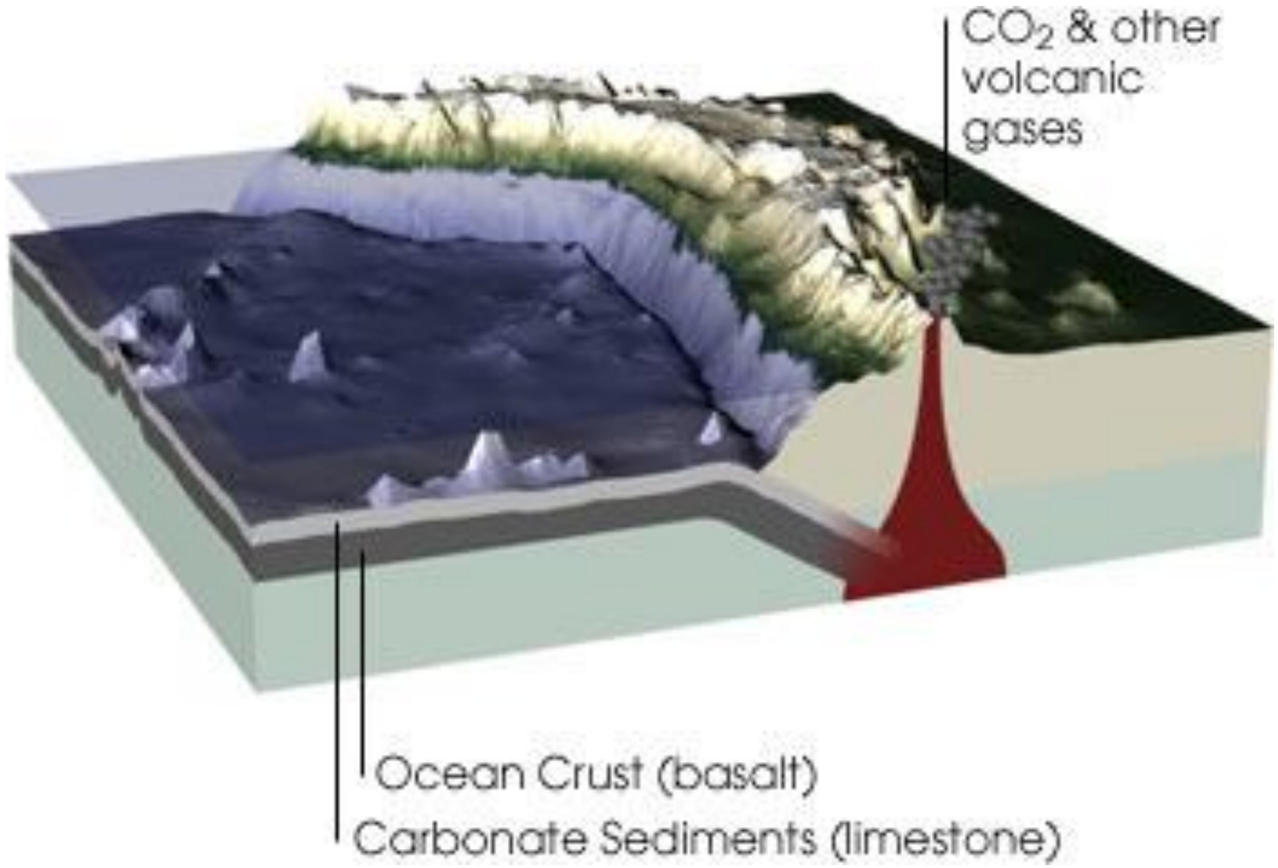
For understanding climate change we need to understand the role of Carbon dioxide. In the atmosphere, carbon combines with oxygen to produce the gas, CO_2



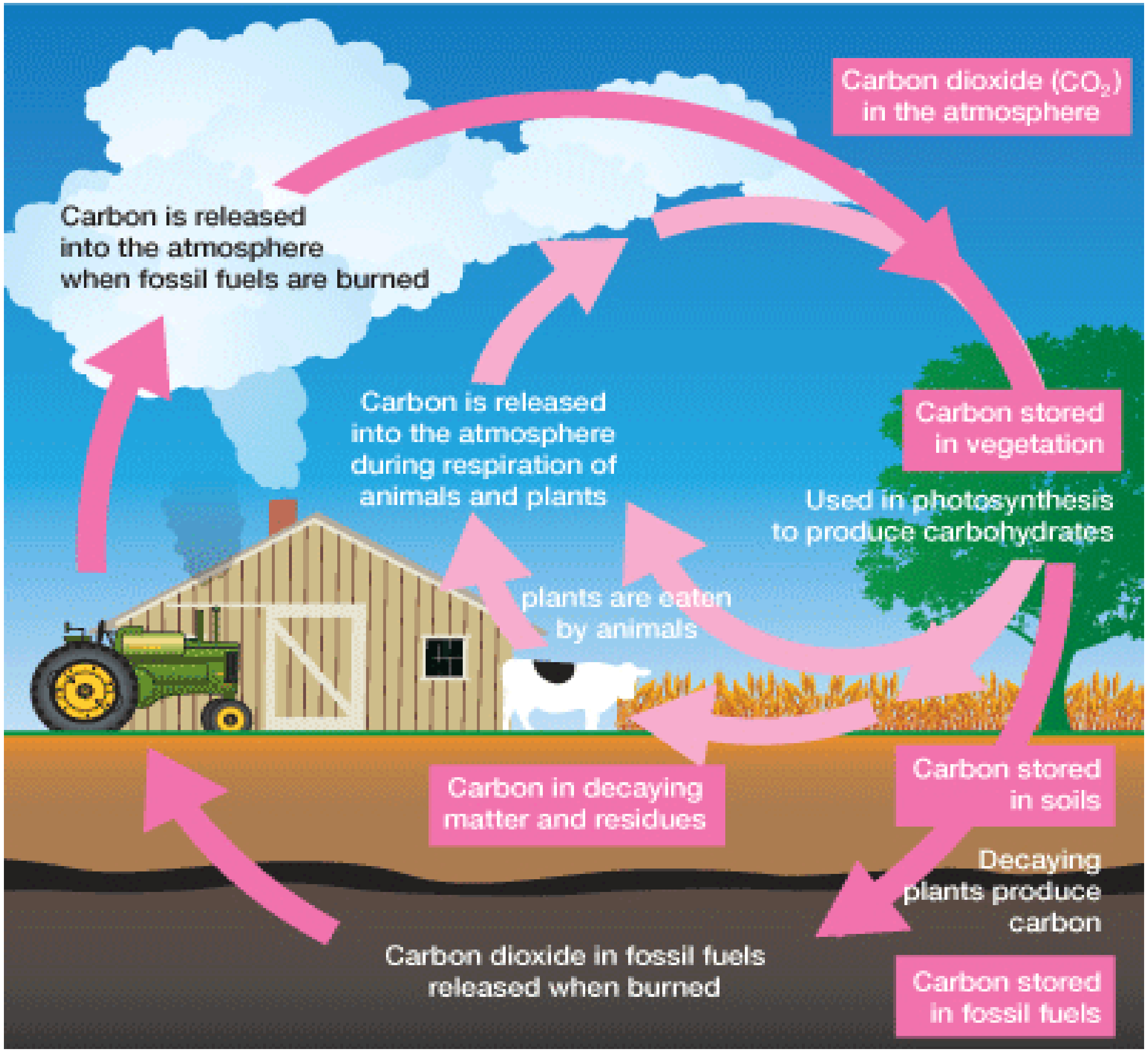
The Carbon cycle The transfer of carbon dioxide from the land to the atmosphere: The Carbon Cycle: long (geological) and short (biological):



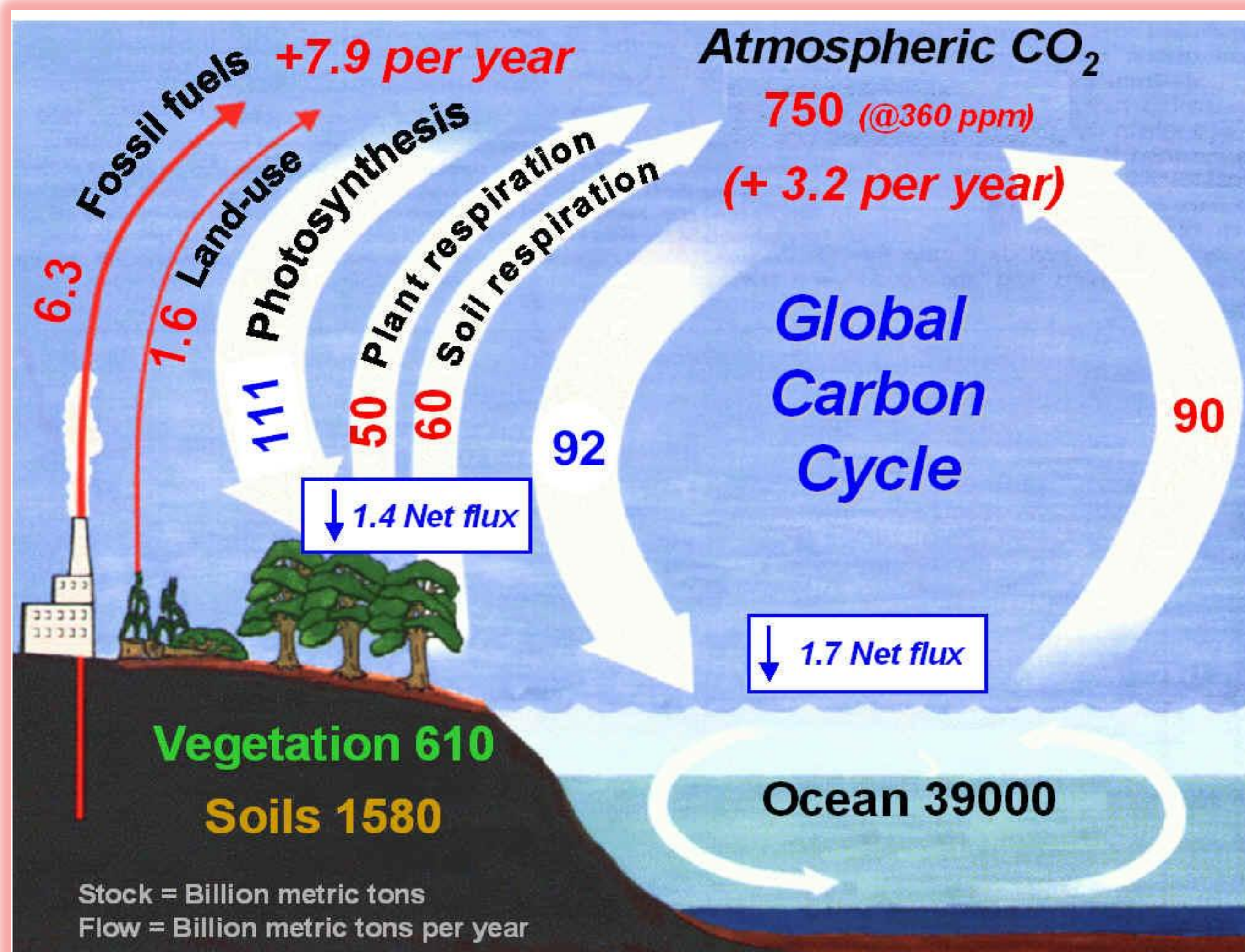
The Geological Carbon cycle: From Carbon to CO_2 and back again



The biological carbon cycle: From Carbon to CO_2 and back again

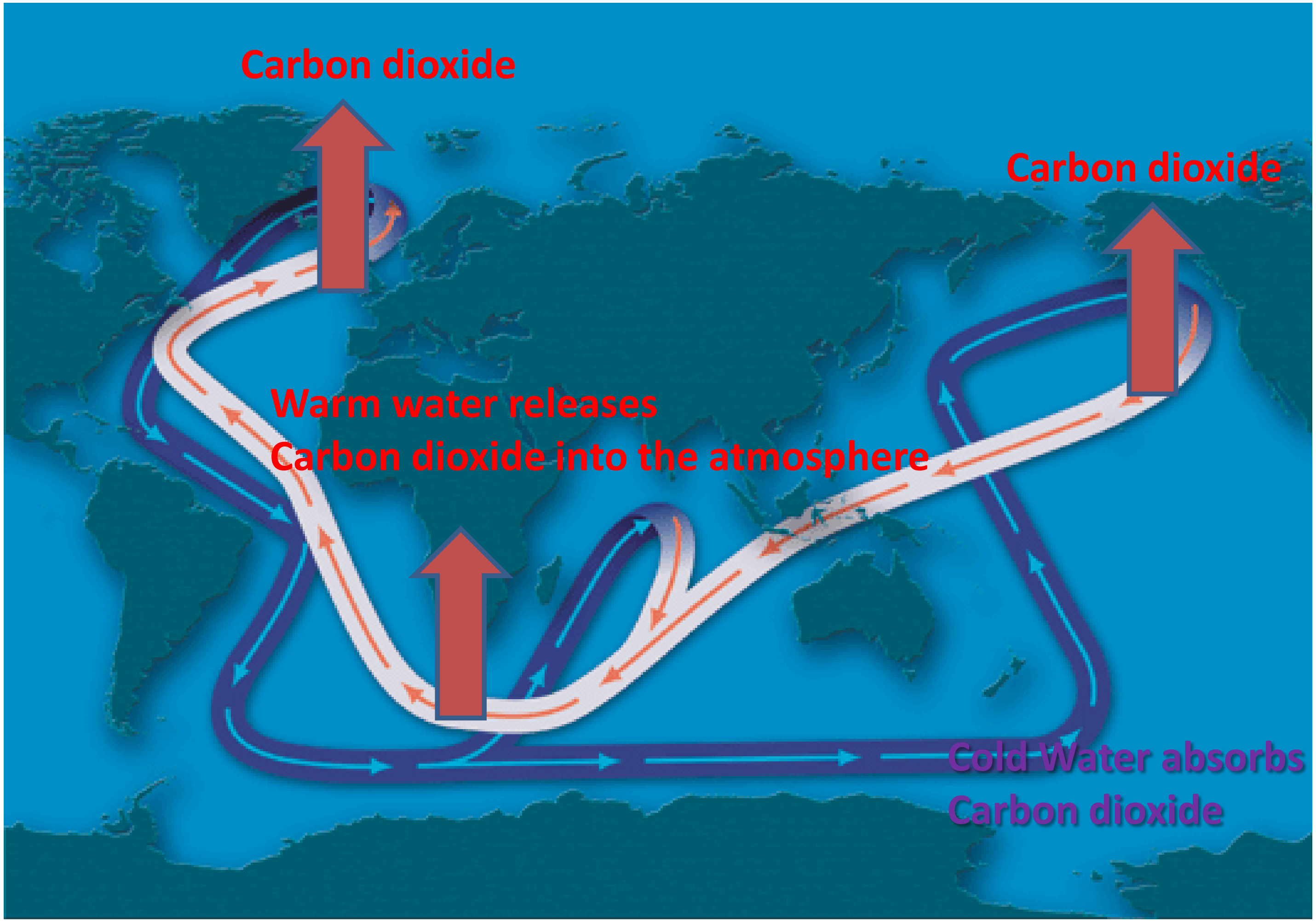


Biological cycle has much more impact on carbon exchange than fossile fuel burning but much of the carbon dioxide released by fossile fuels stays in the atmosphere……

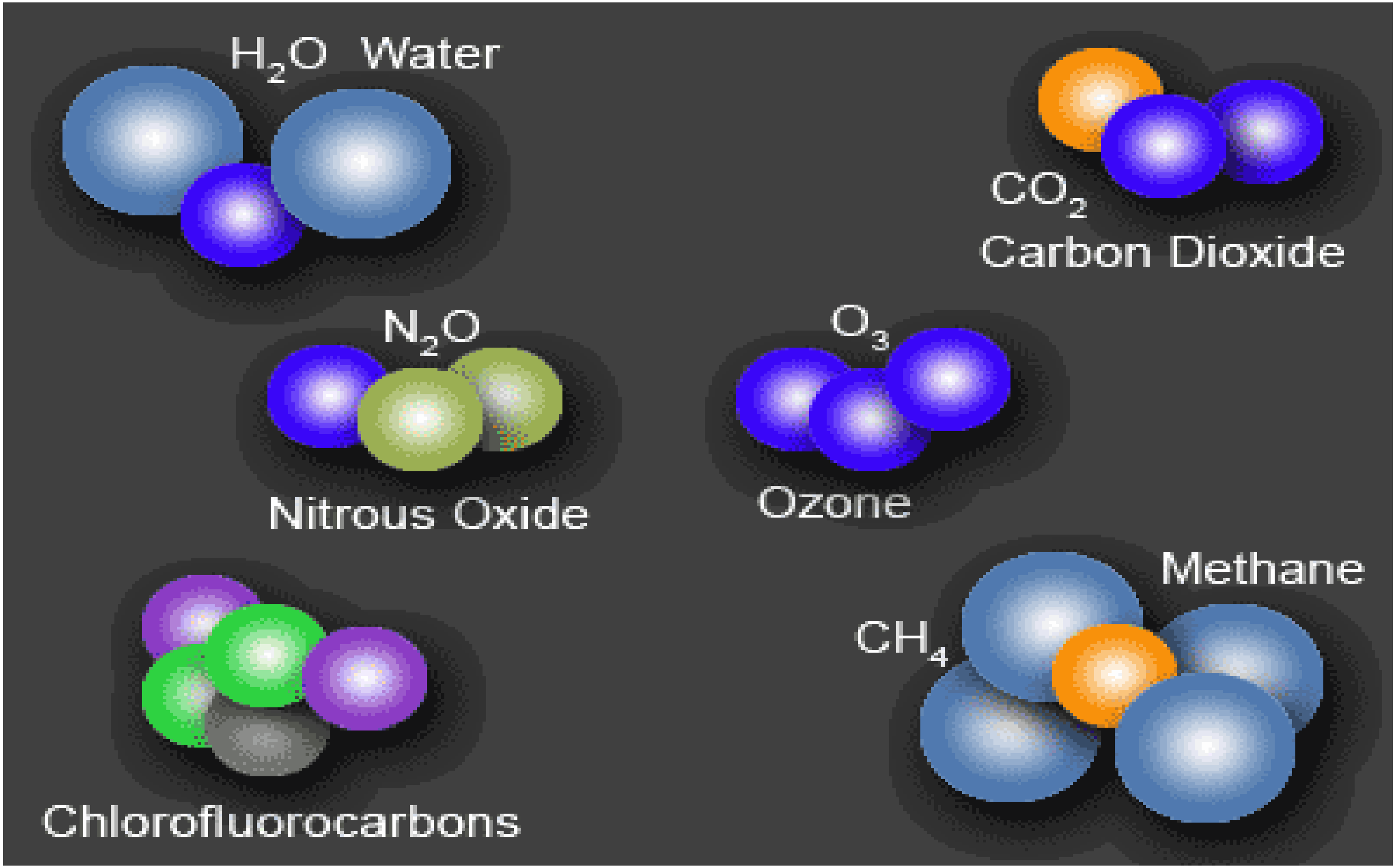


Fire

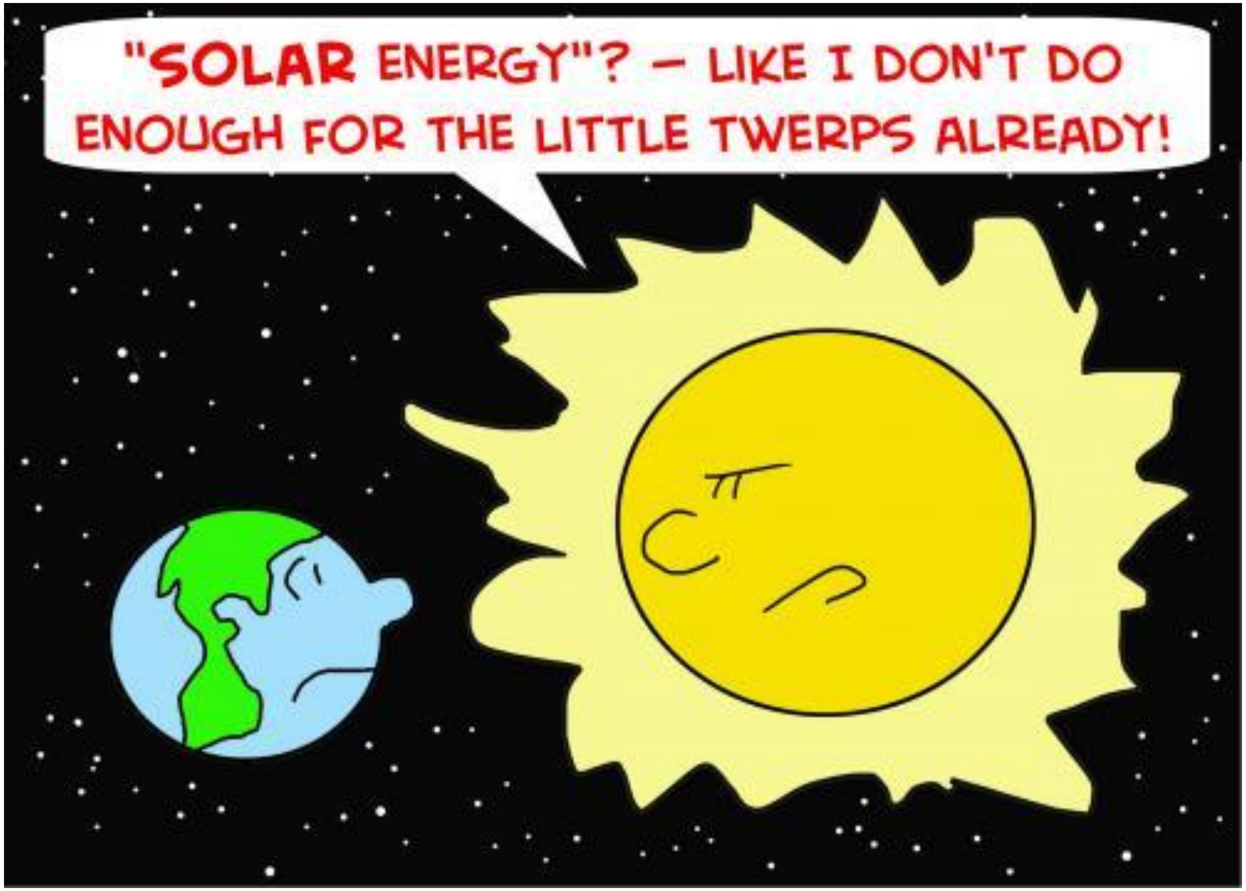
Warm and cold ocean water



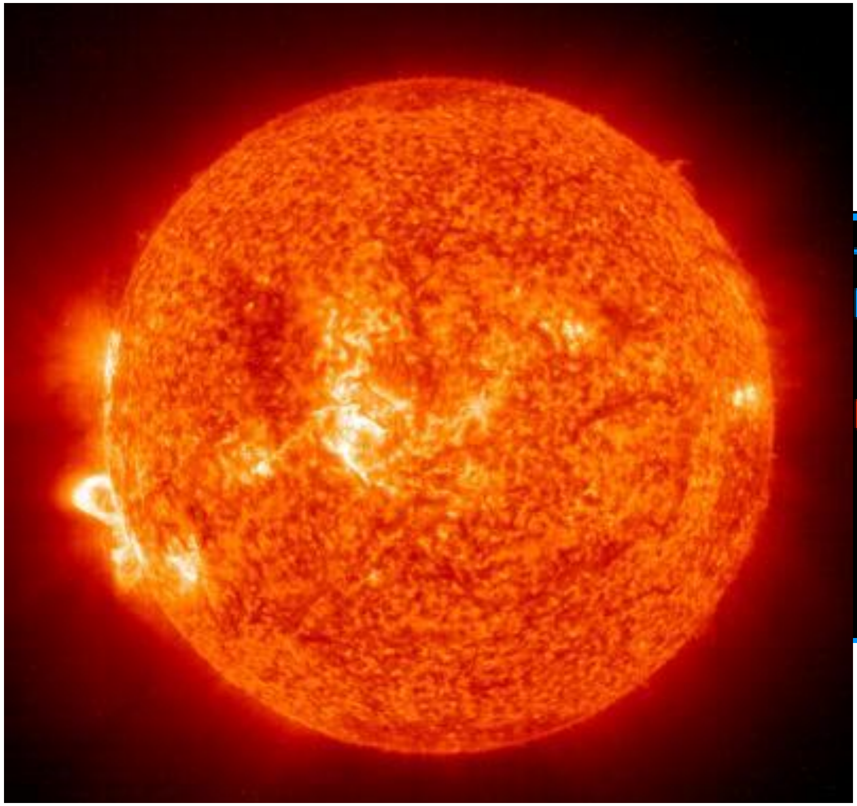
In the atmosphere, some of the CO_2 is concentrated and becomes a greenhouse gas

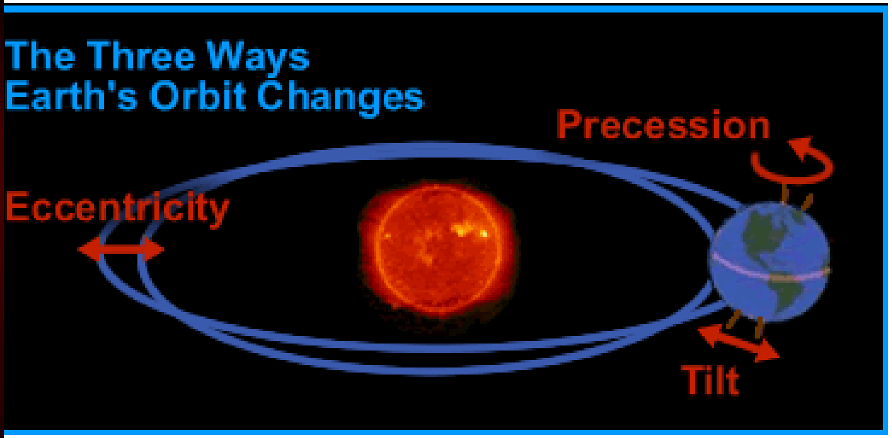


Now…here comes the sun. Solar radiation powers the climate system



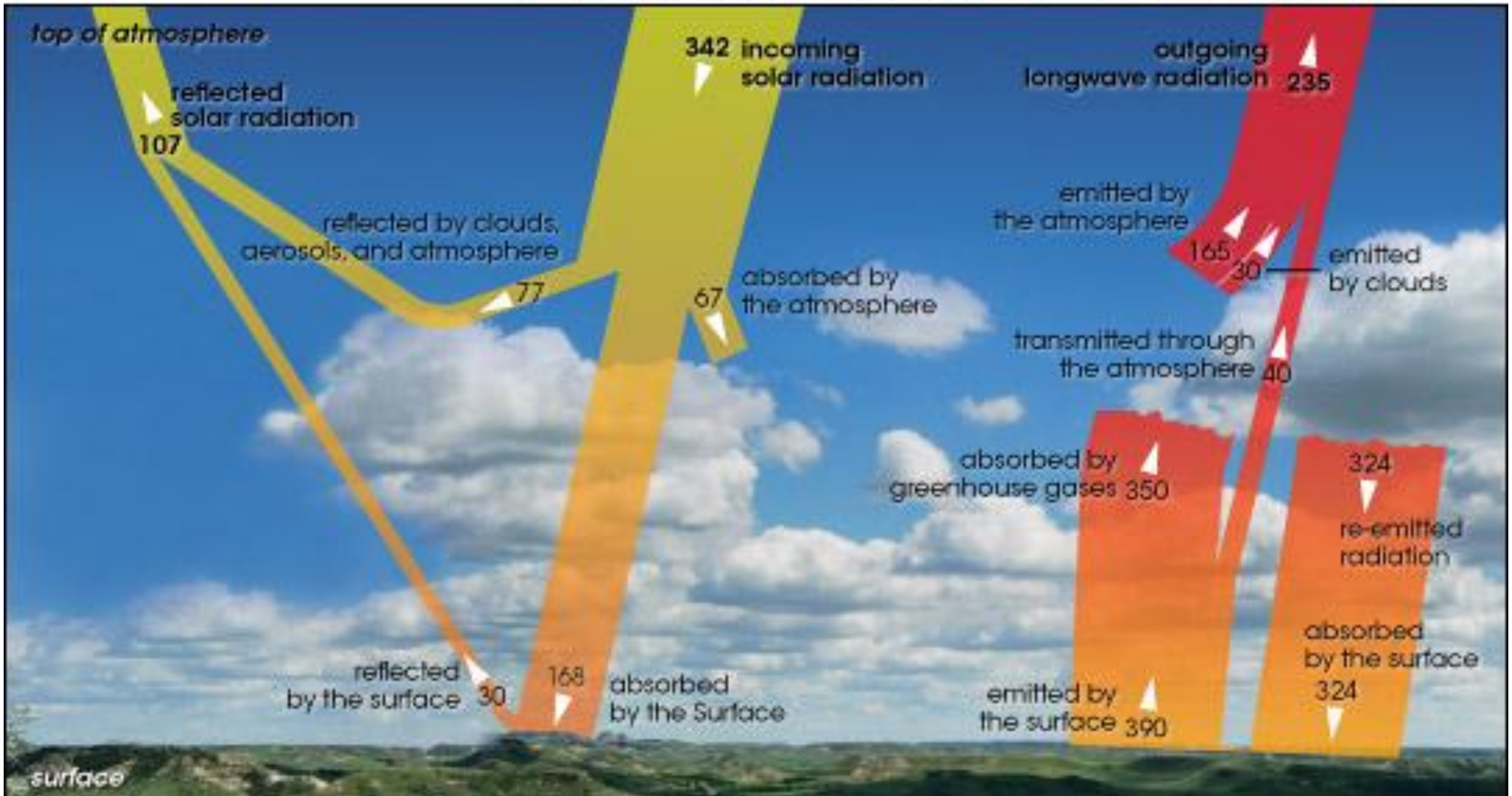
Changes in the sun and changes in the Earth's orbit: warming and cooling factors





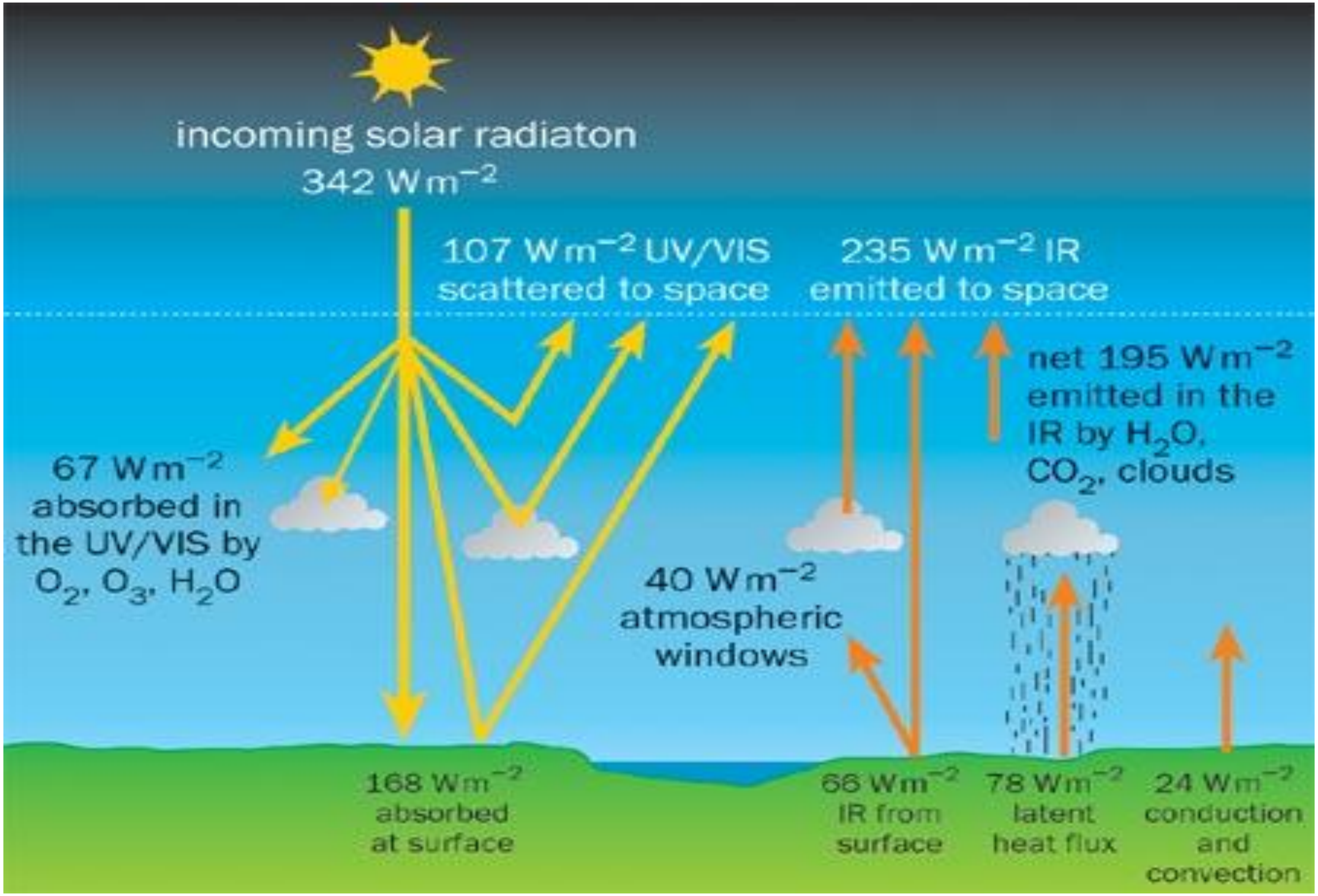
Once [the Sun's energy]() reaches the Earth, [Three things can happen]().

energy received from the Sun | energy emitted by the Earth

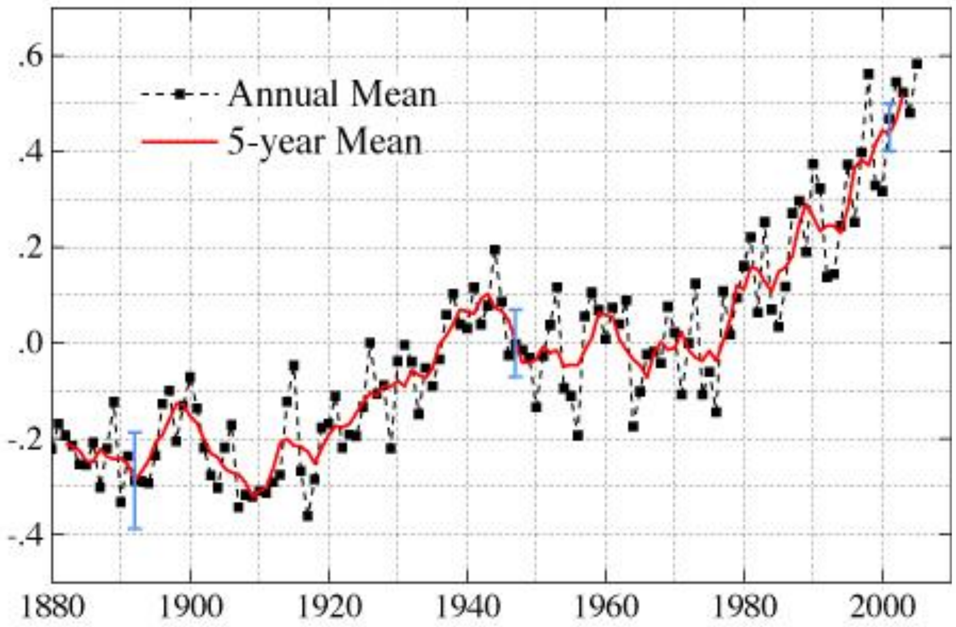


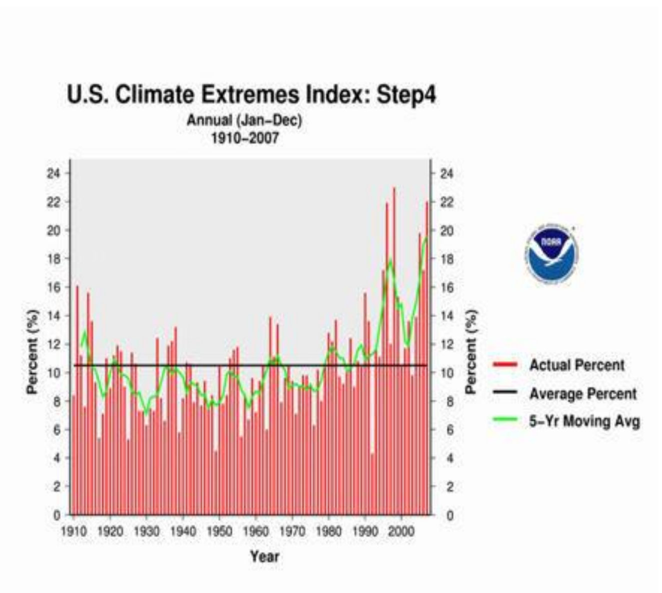
energy flux in Watts per square meter

climate is determined by balance between radiation and absorption

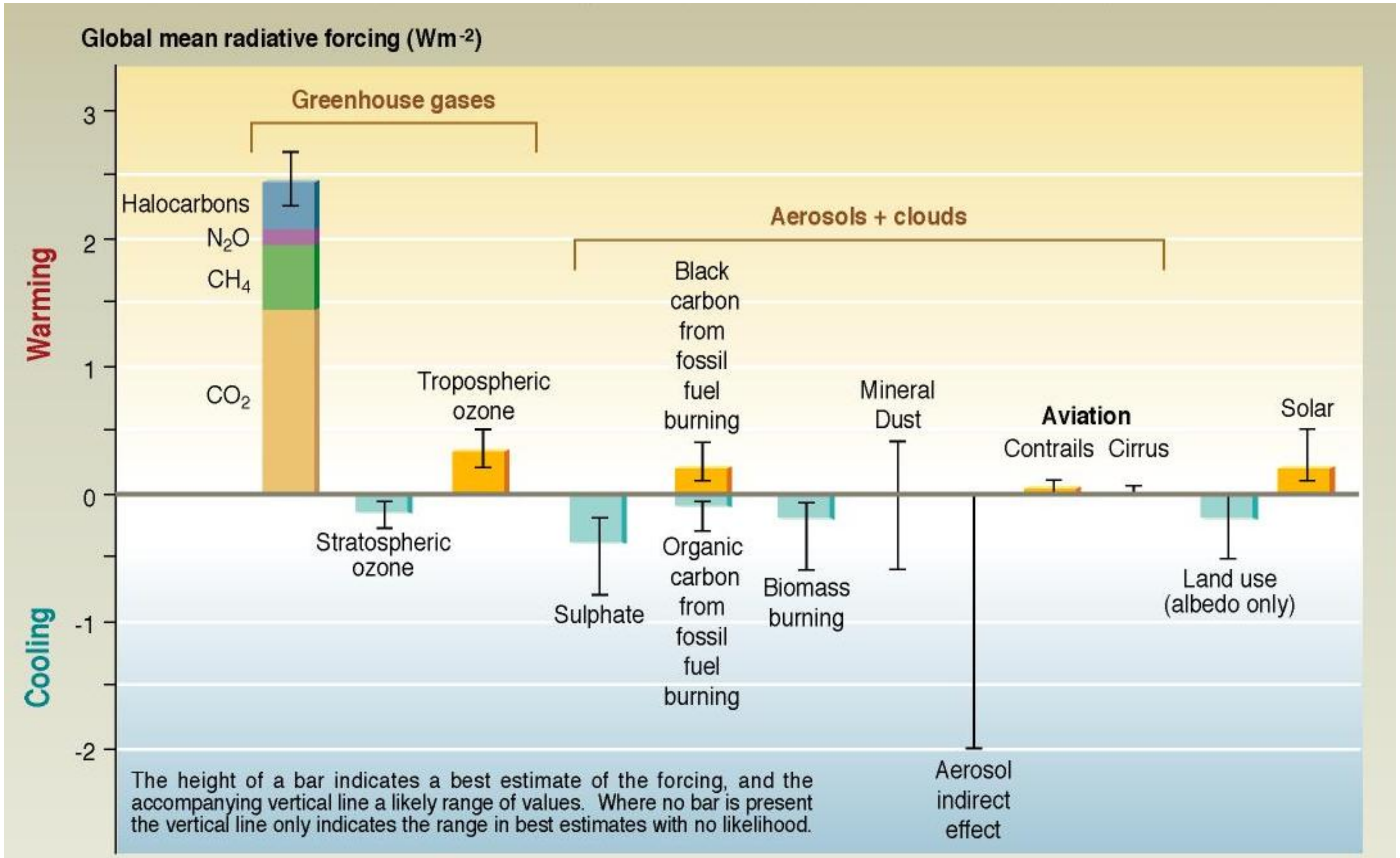


Global Warming: Balance between warm and cold is disturbed

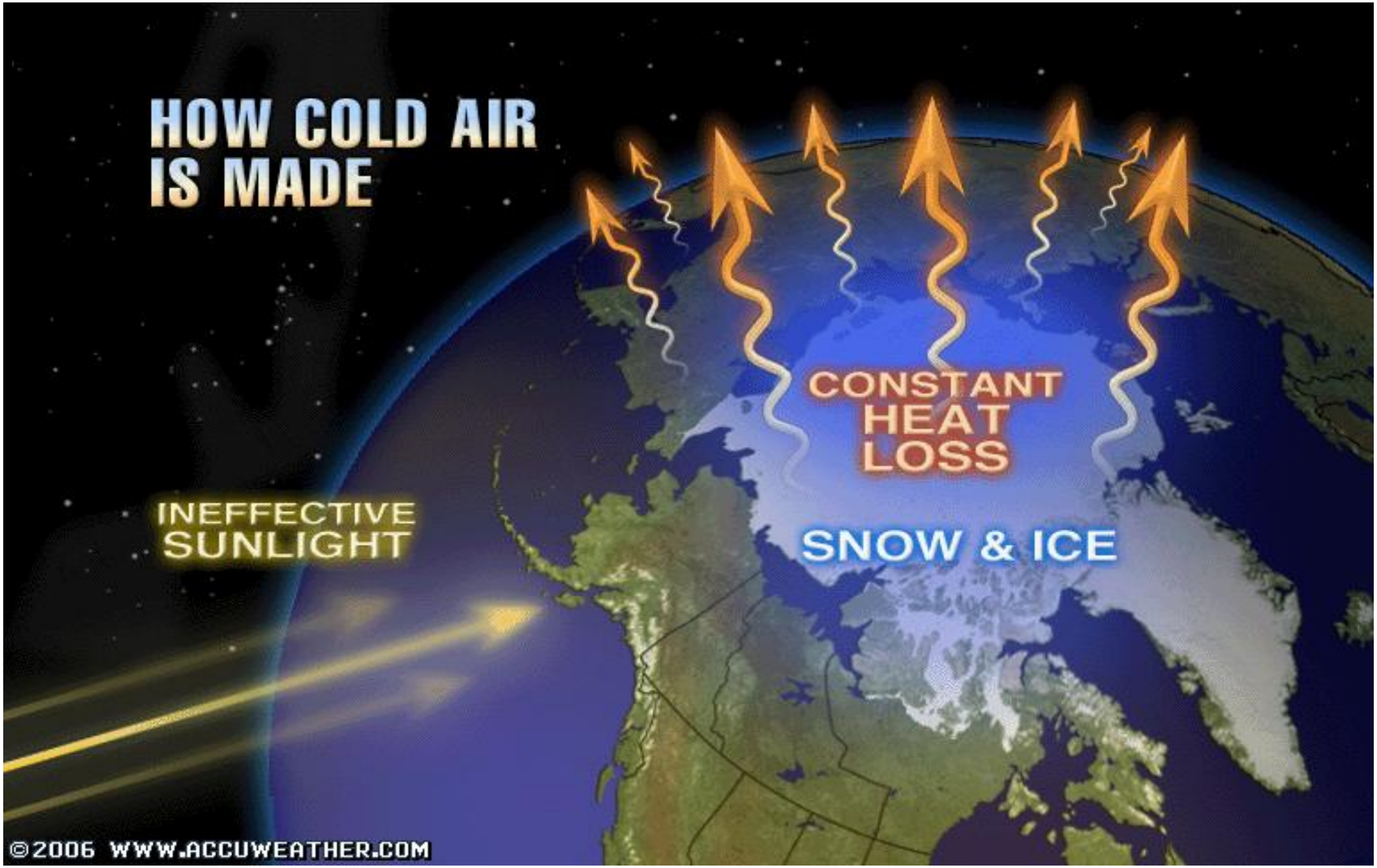




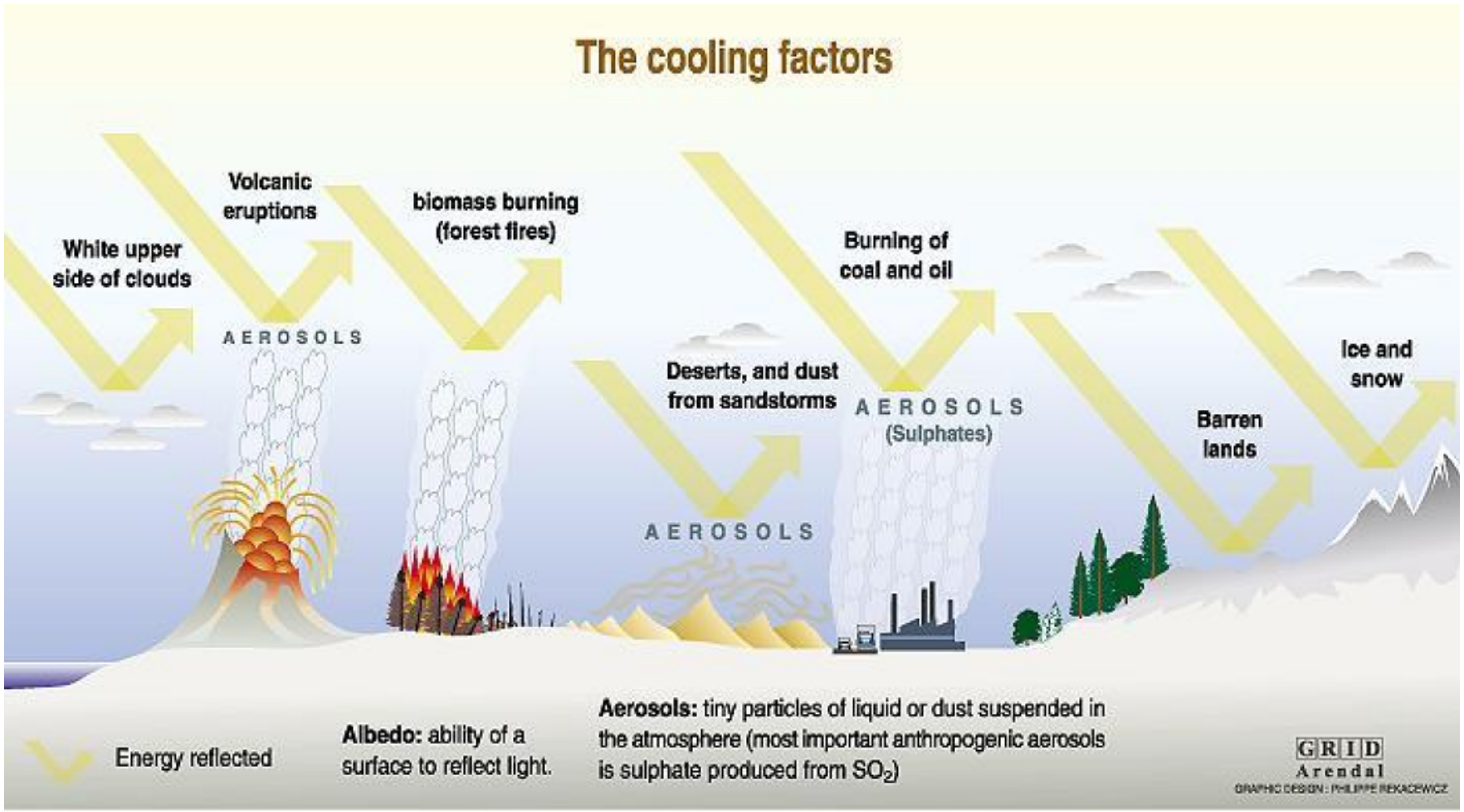
“Forcings”: Volcanos, sunspots, fossile fuel burning



Cooling factors: albedo…..

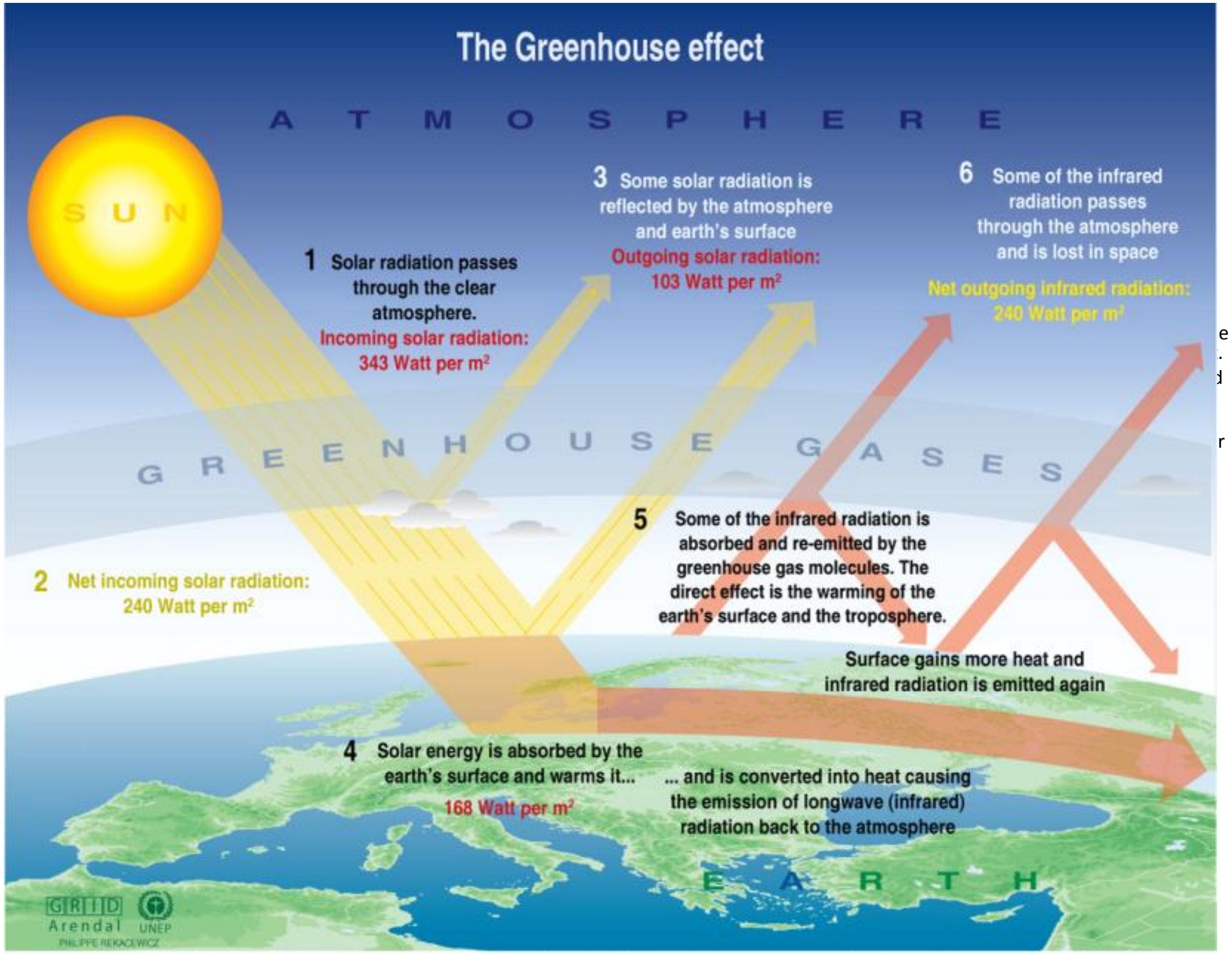


Reflected Solar radiation: cooling factors (forcings)



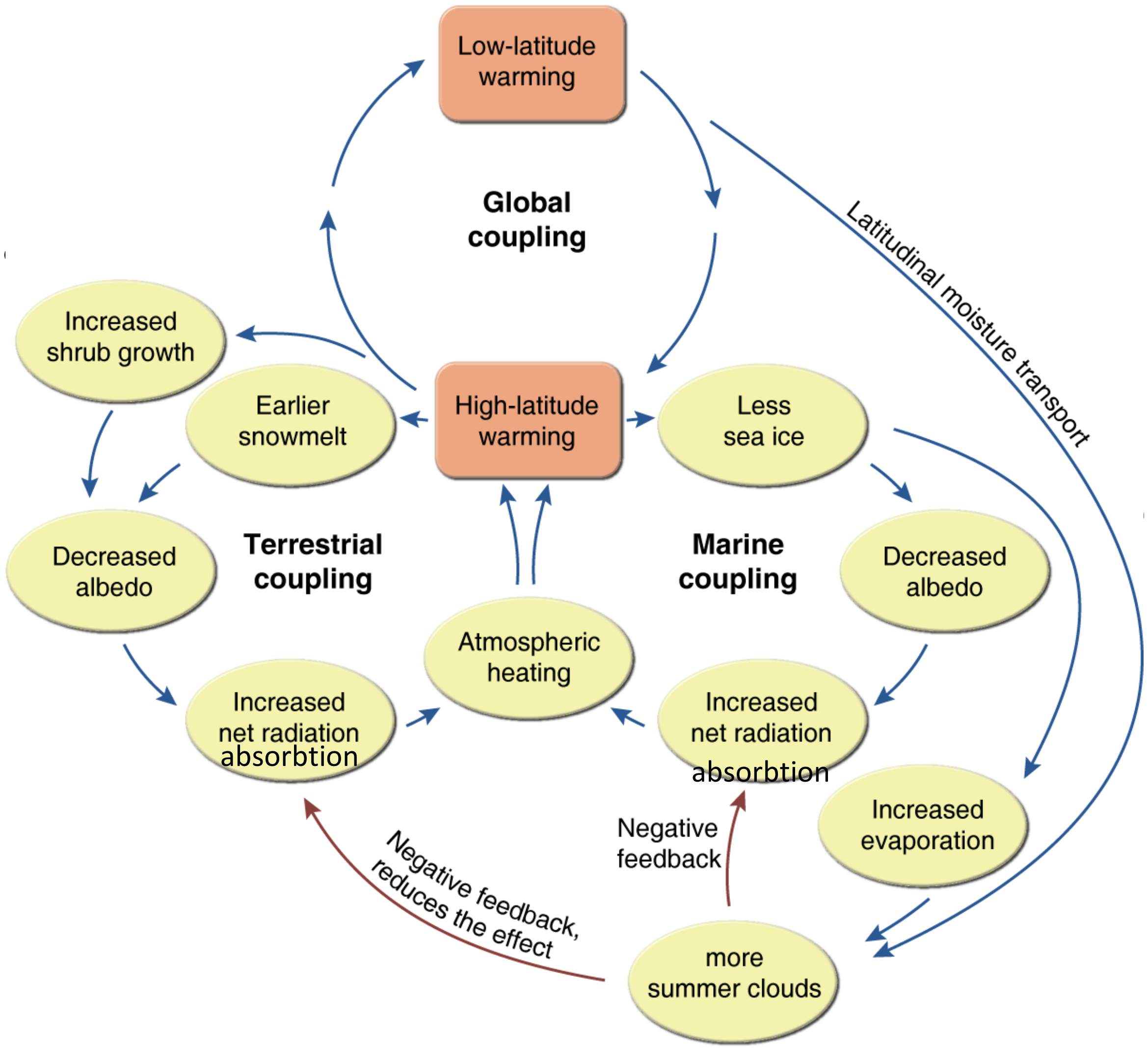
Sources: Radiative forcing of climate change, the 1994 report of the scientific assessment working group of IPCC, summary for policymakers, WMO, UNEP; L.D. Danny Harvey, Climate and global environmental change, Prentice Hall, pearson Education, Harlow, United Kingdom, 2000.

Warming factors: direct absorbtion and heat trapped by greenhouse gases-- The carbon cycle meets solar radiation



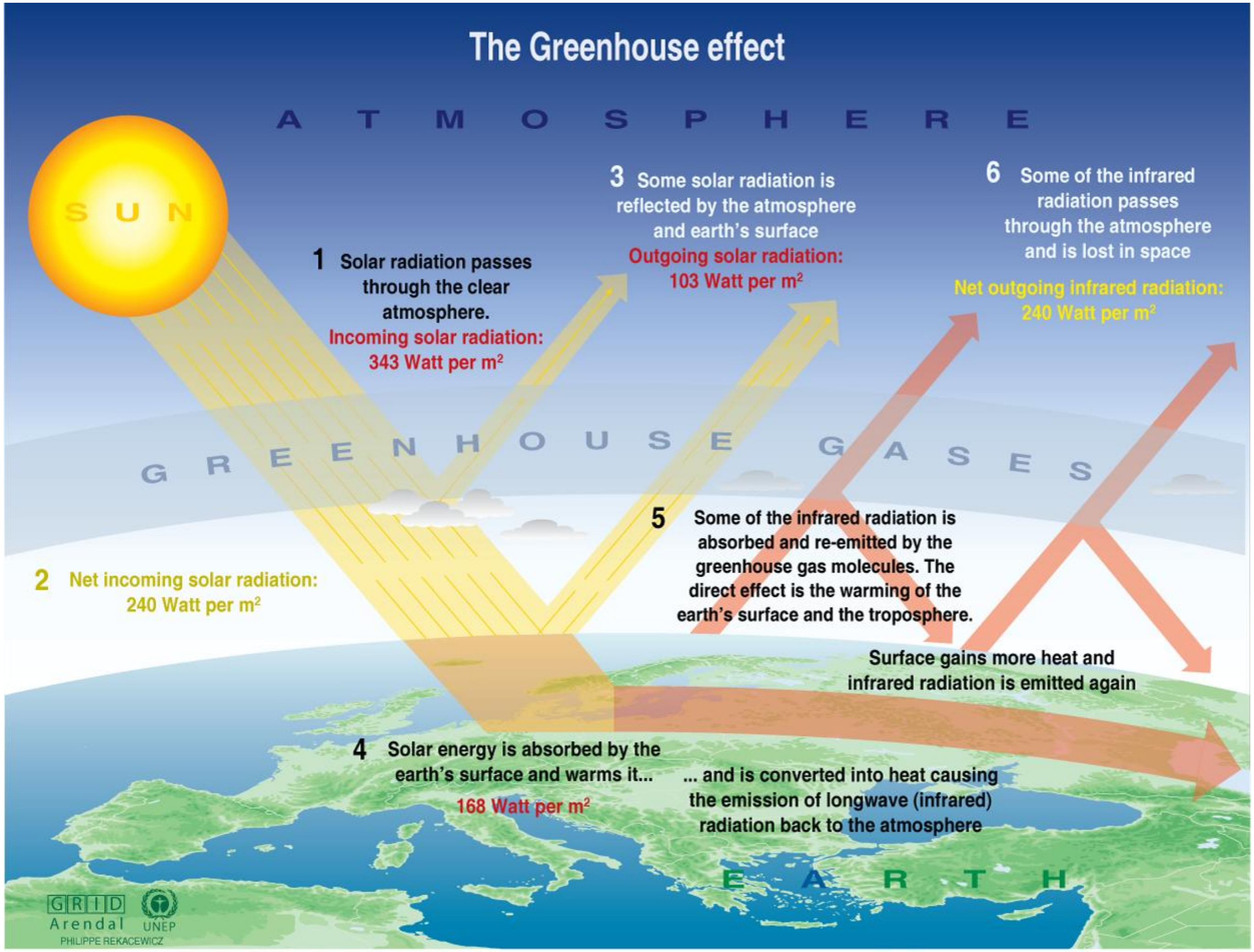
Sources: Okanagan university college in Canada, Department of geography, University of Oxford, school of geography; United States Environmental Protection Agency (EPA), Washington; Climate change 1995, The science of climate change, contribution of working group 1 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge university press, 1996.

Feedback



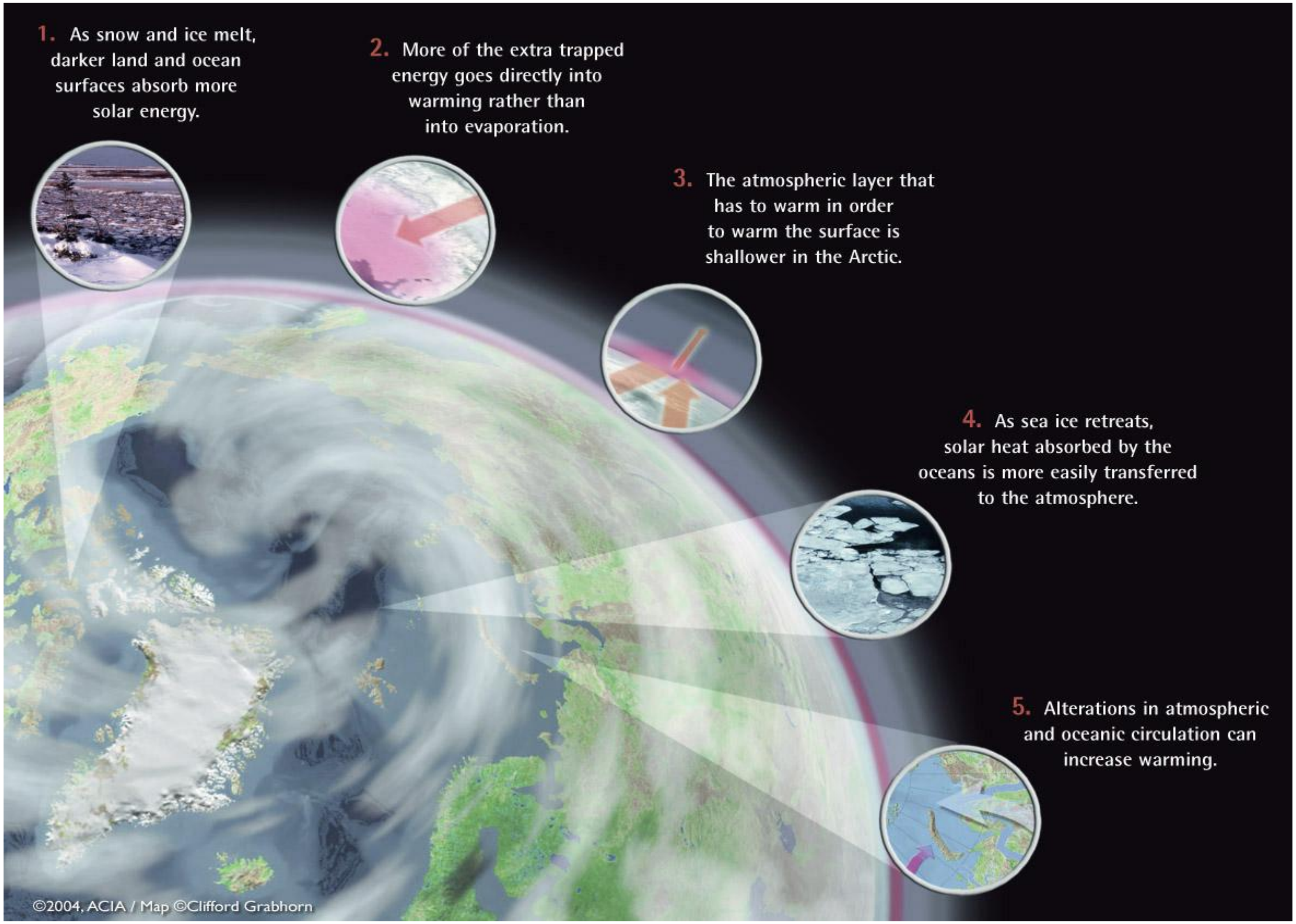
Low-latitude warming
Global coupling
Latitudinal moisture transport
Increased shrub growth
Earlier snowmelt
High-latitude warming
Less sea ice
Decreased albedo
Terrestrial coupling
Marine coupling
Decreased albedo
Atmospheric heating
Increased net radiation absorbtion
Increased net radiation absorbtion
Increased evaporation
Negative feedback
Negative feedback, reduces the effect
more summer clouds

Feedback Mechanisms



Sources: Okanagan university college in Canada, Department of geography, University of Oxford, school of geography; United States Environmental Protection Agency (EPA), Washington; Climate change 1995, The science of climate change, contribution of working group 1 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge university press, 1996.

One reason the arctic is so important:The Ice-Albedo feedback



Ice Albedo feedback

Ice Albedo effect

Greenhouse effect is natural……

The Greenhouse Effect

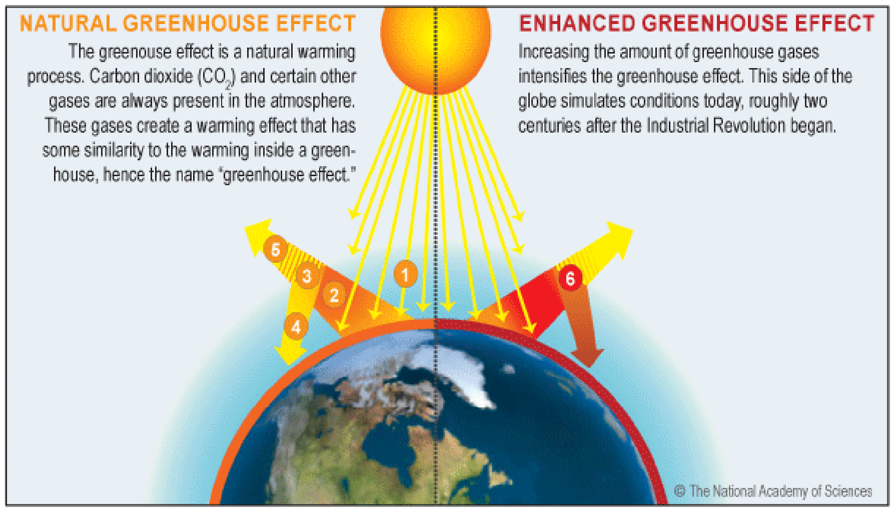
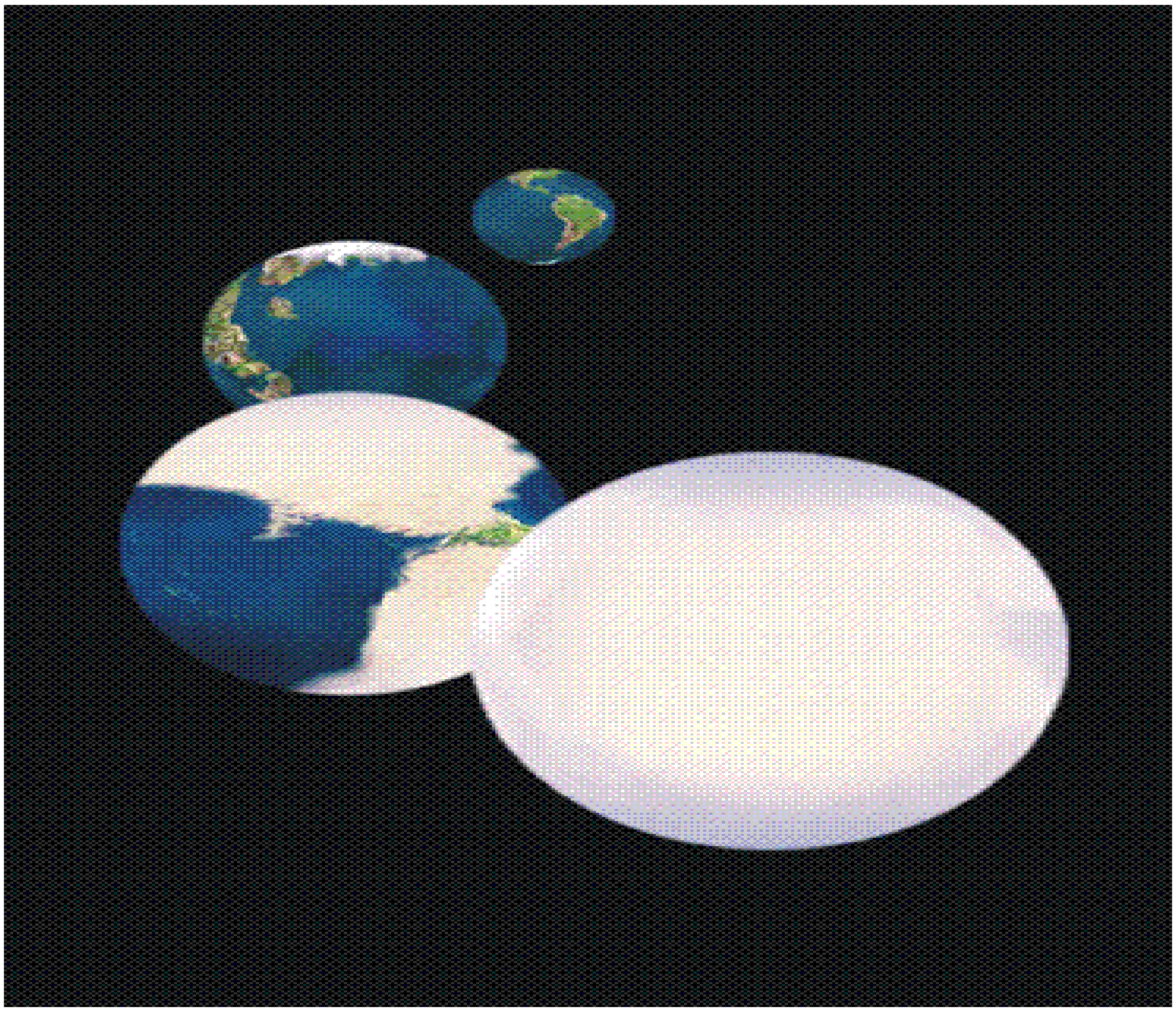


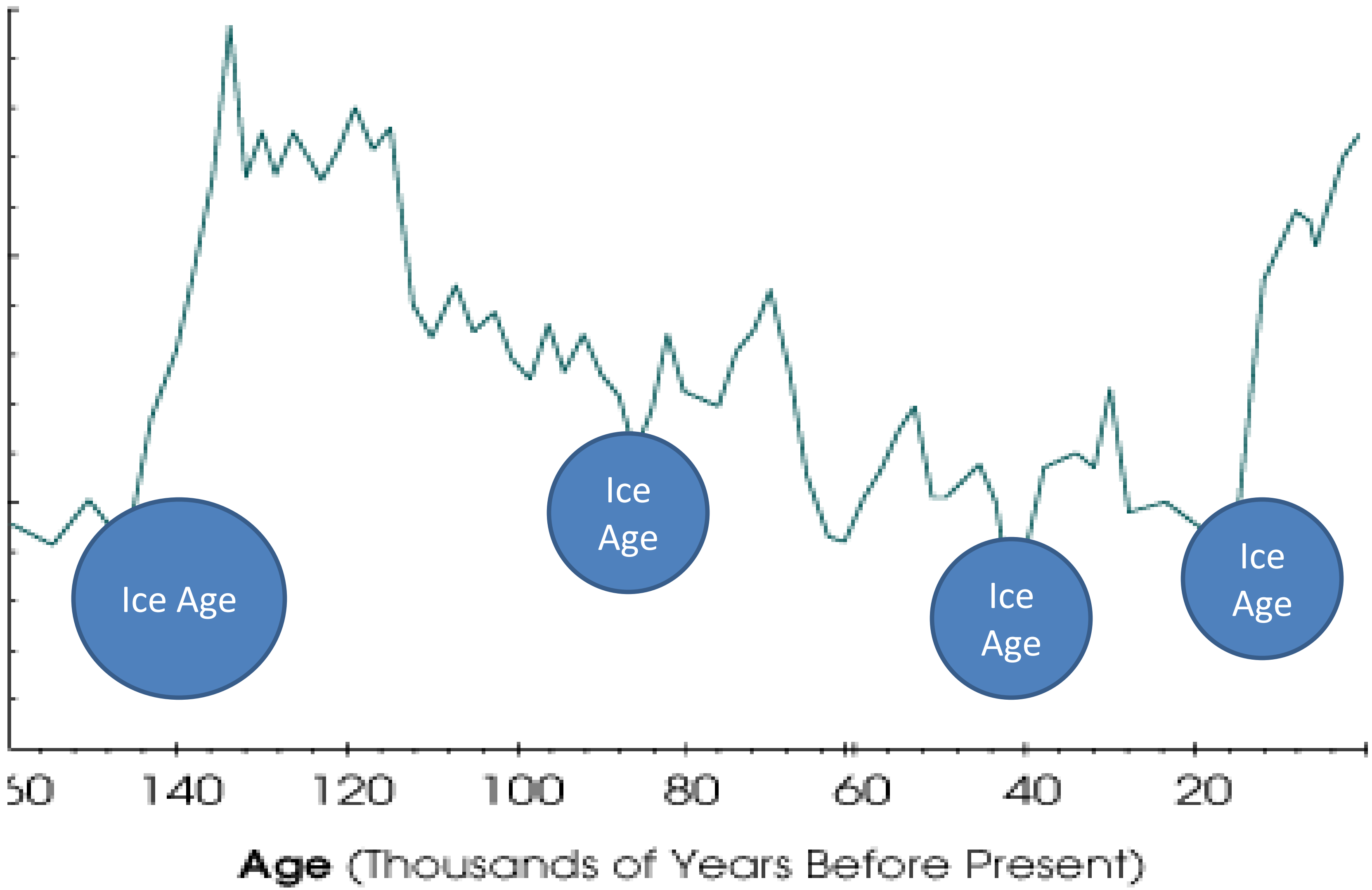
Illustration of the greenhouse effect (courtesy of the Marion Koshland Science Museum of the National Academy of Sciences). Visible sunlight passes through the atmosphere without being absorbed. Some of the sunlight striking the earth $\boxed{1}$ is absorbed and converted to heat, which warms the surface. The surface $\boxed{2}$ emits infrared radiation to the atmosphere, where some of it $\boxed{3}$ is absorbed by greenhouse gases and $\boxed{4}$ re-emitted toward the surface; some of the heat is not trapped by greenhouse gases and $\boxed{5}$ escapes into space. Human activities that emit additional greenhouse gases to the atmosphere $\boxed{6}$ increase the amount of infrared radiation that gets absorbed before escaping into space, thus enhancing the greenhouse effect and amplifying the warming of the earth.

Image Source: The National Academy of Sciences

Climate change is not new and it can be abrupt

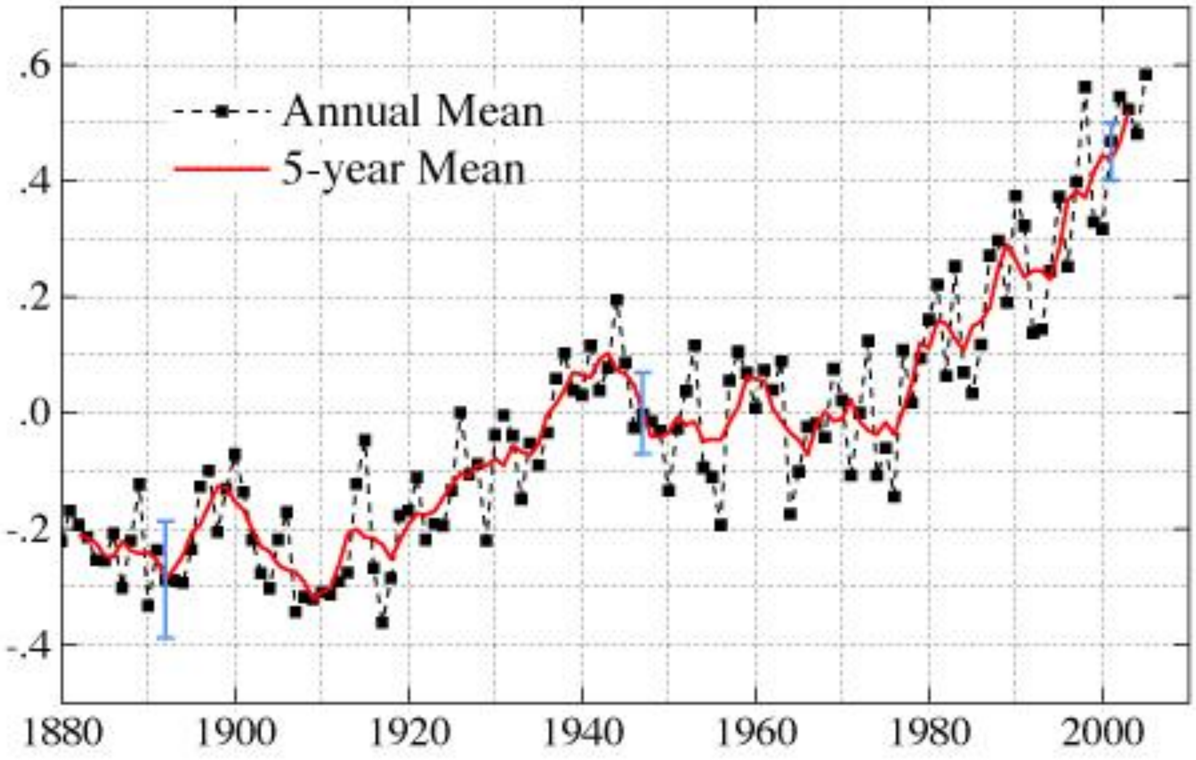


The amount of greenhouse gas fluctuates

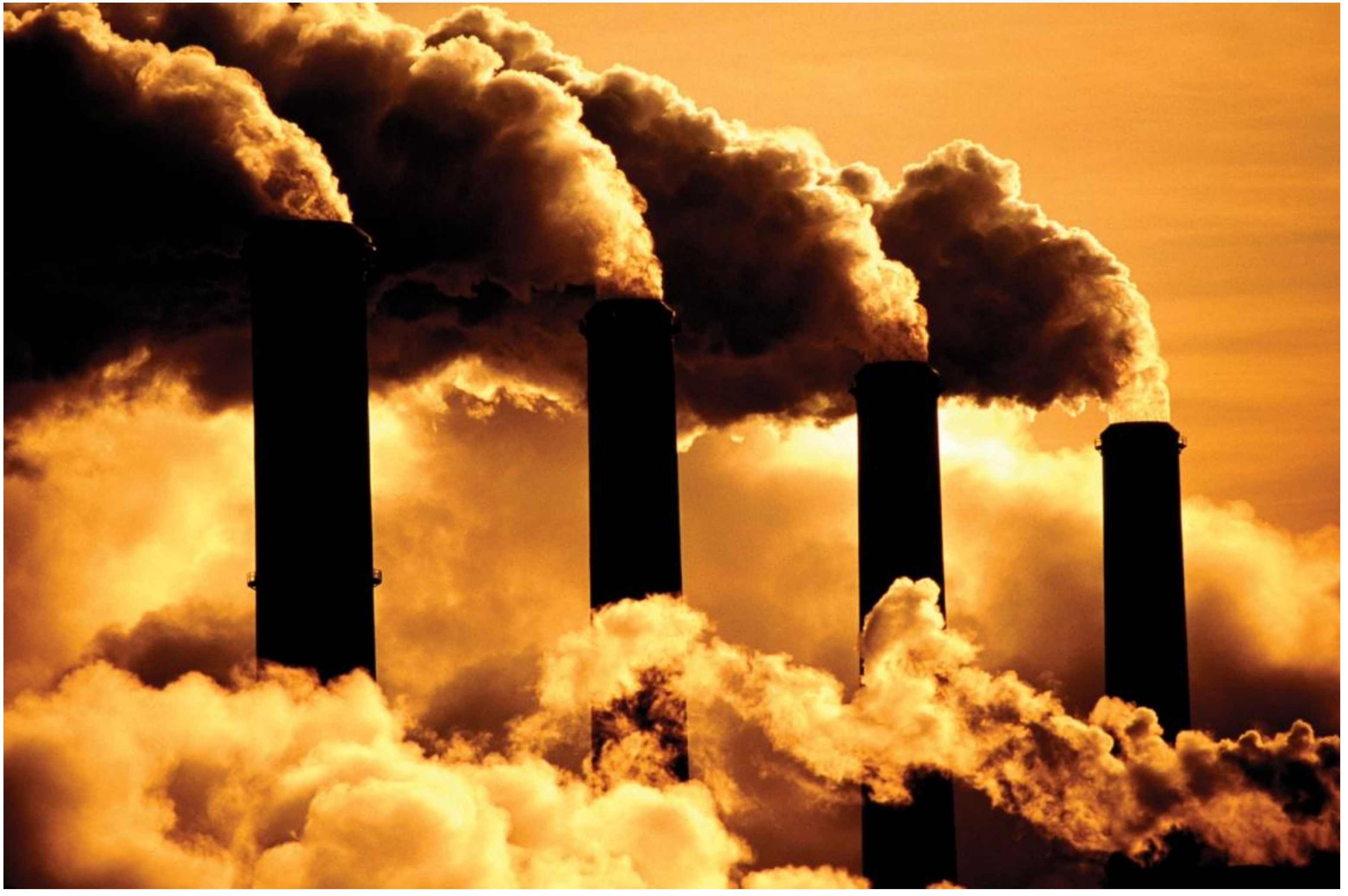
- 

The last ice age ended 10,000 to 20,000 years ago, as carbon dioxide levels rose from below 200 parts per million to about 280 parts per million.

Current atmospheric carbon dioxide levels are above 370 parts per million

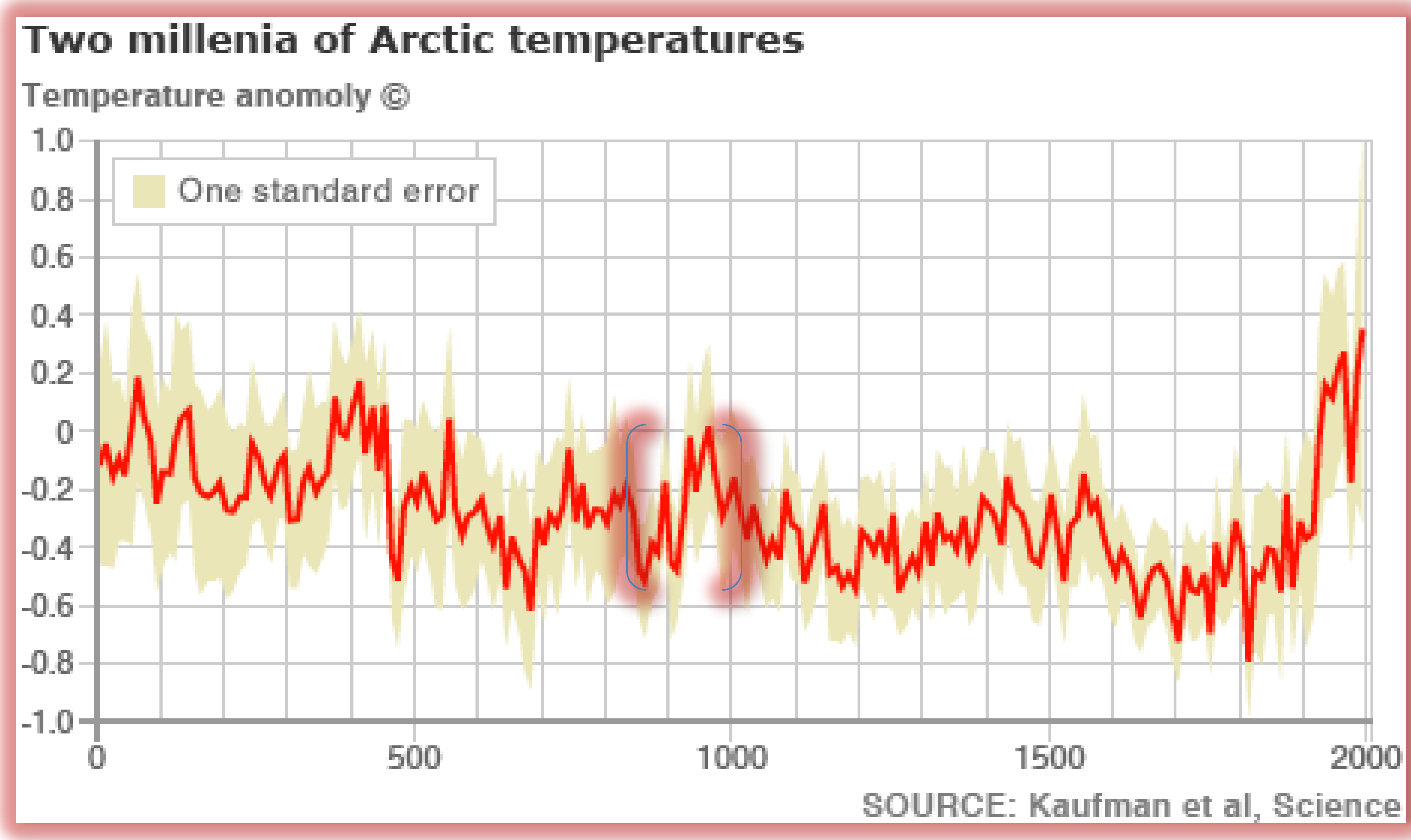


The Human Role

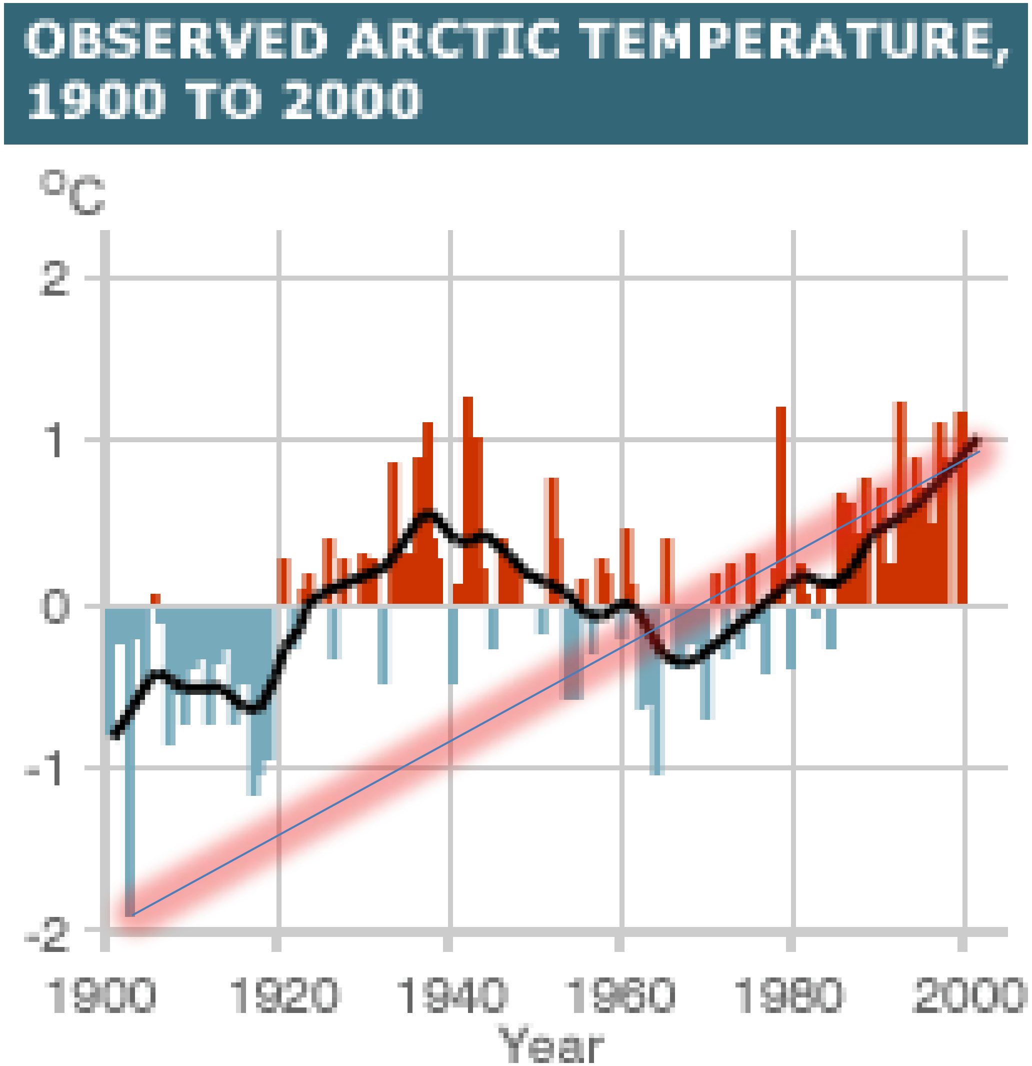


Arctic Climate Trends

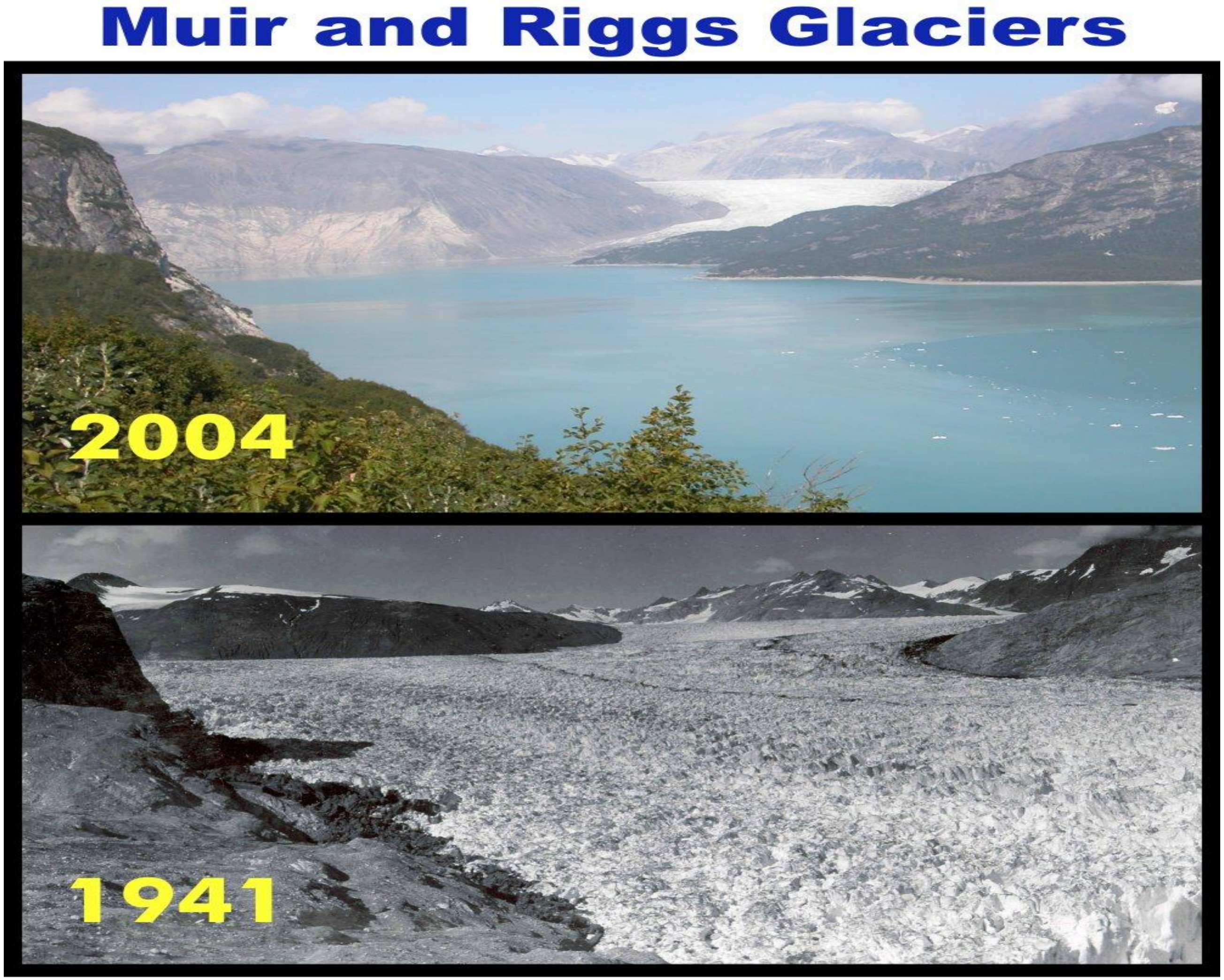
Rising Temperatures (Celsius)



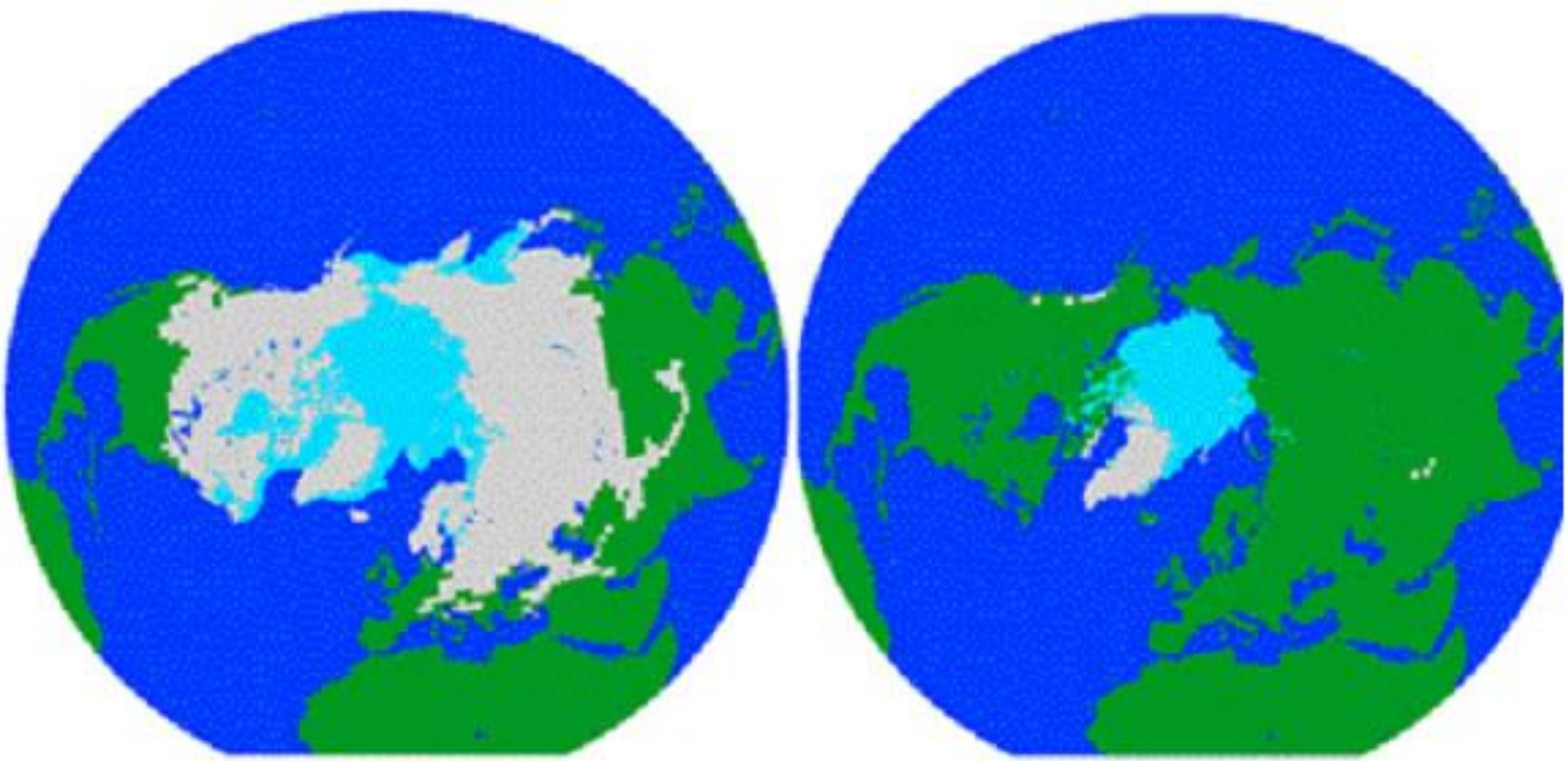
The last half-century is the warmest of the 2,000-year temperature record, and the last 10 years have been especially dramatic



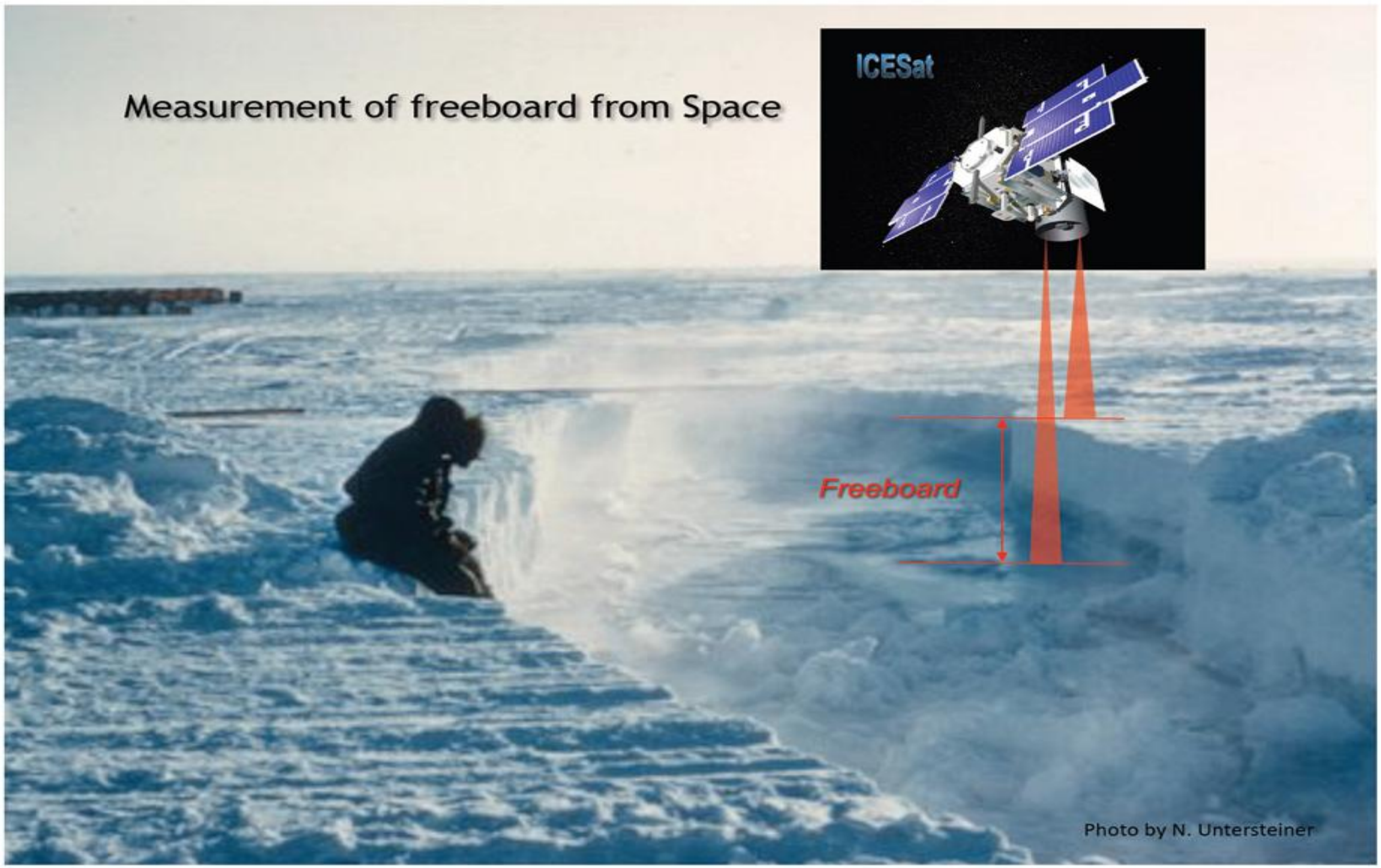
Melting glaciers



Decline of the snow cover



Melting snow…….

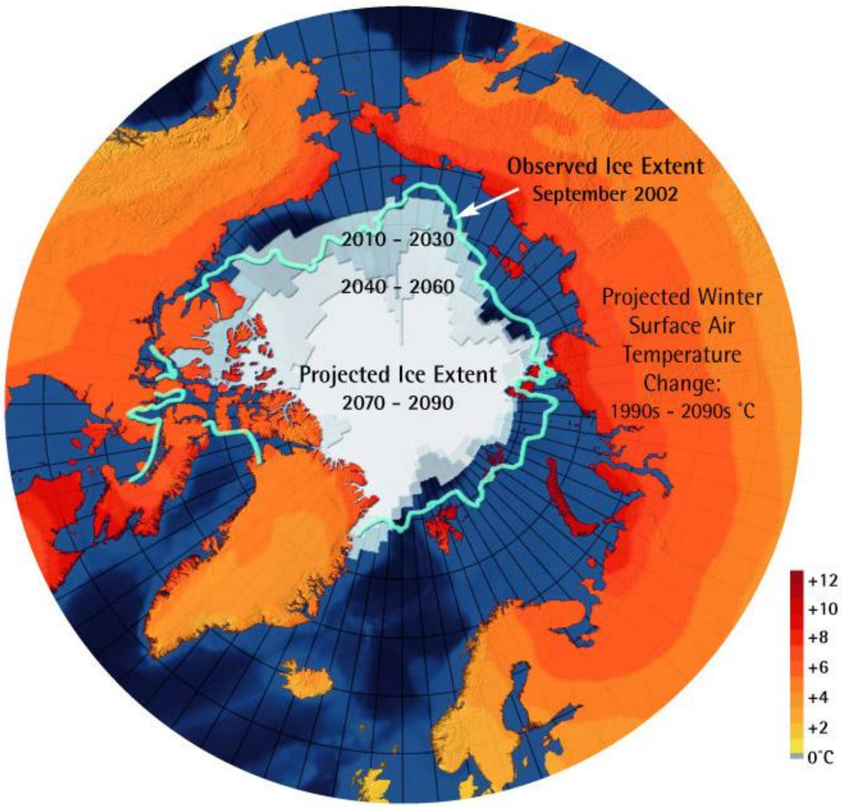


Increasing precipitation

Projected precipitation

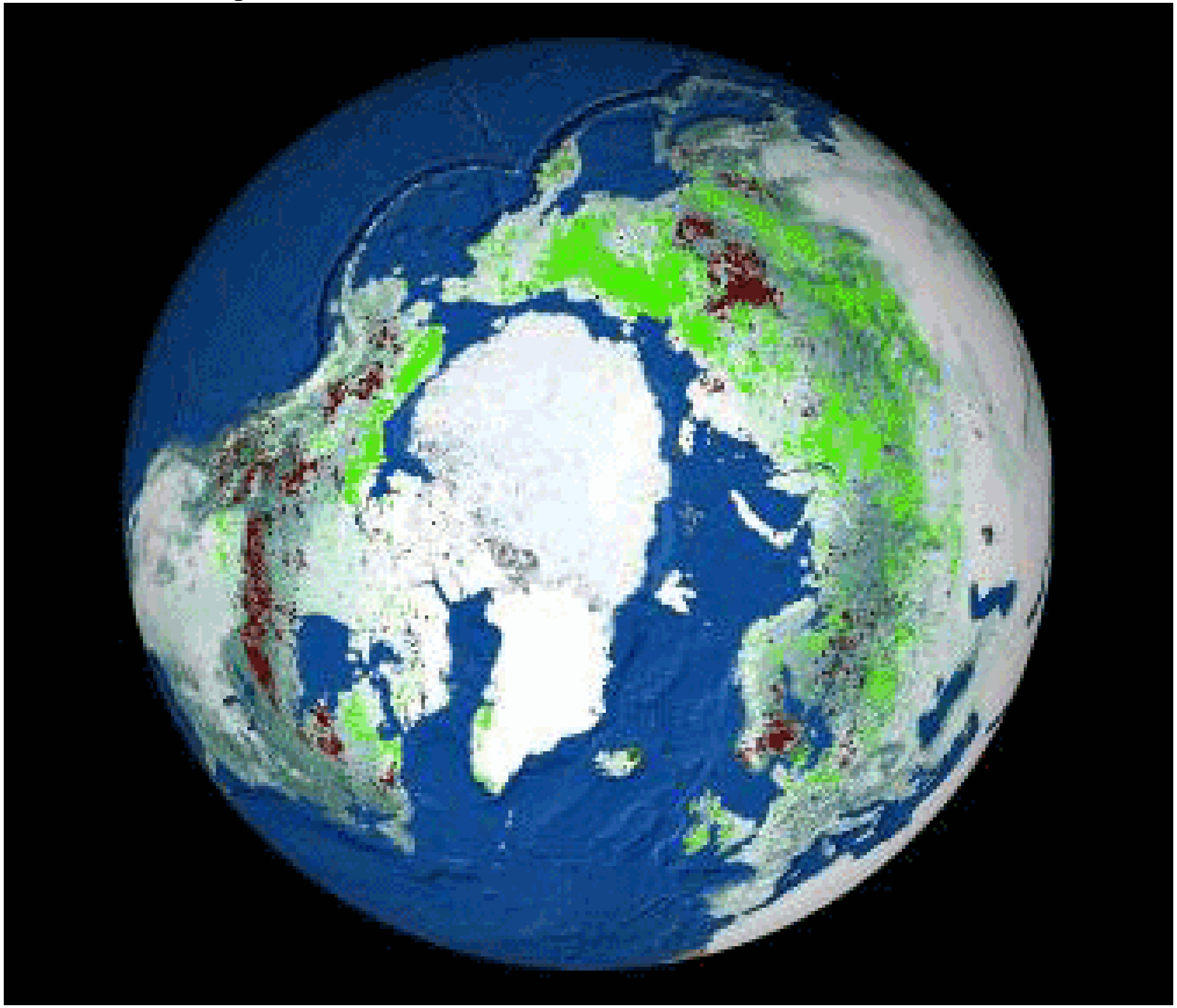
Melting sea ice

Projected sea ice decline

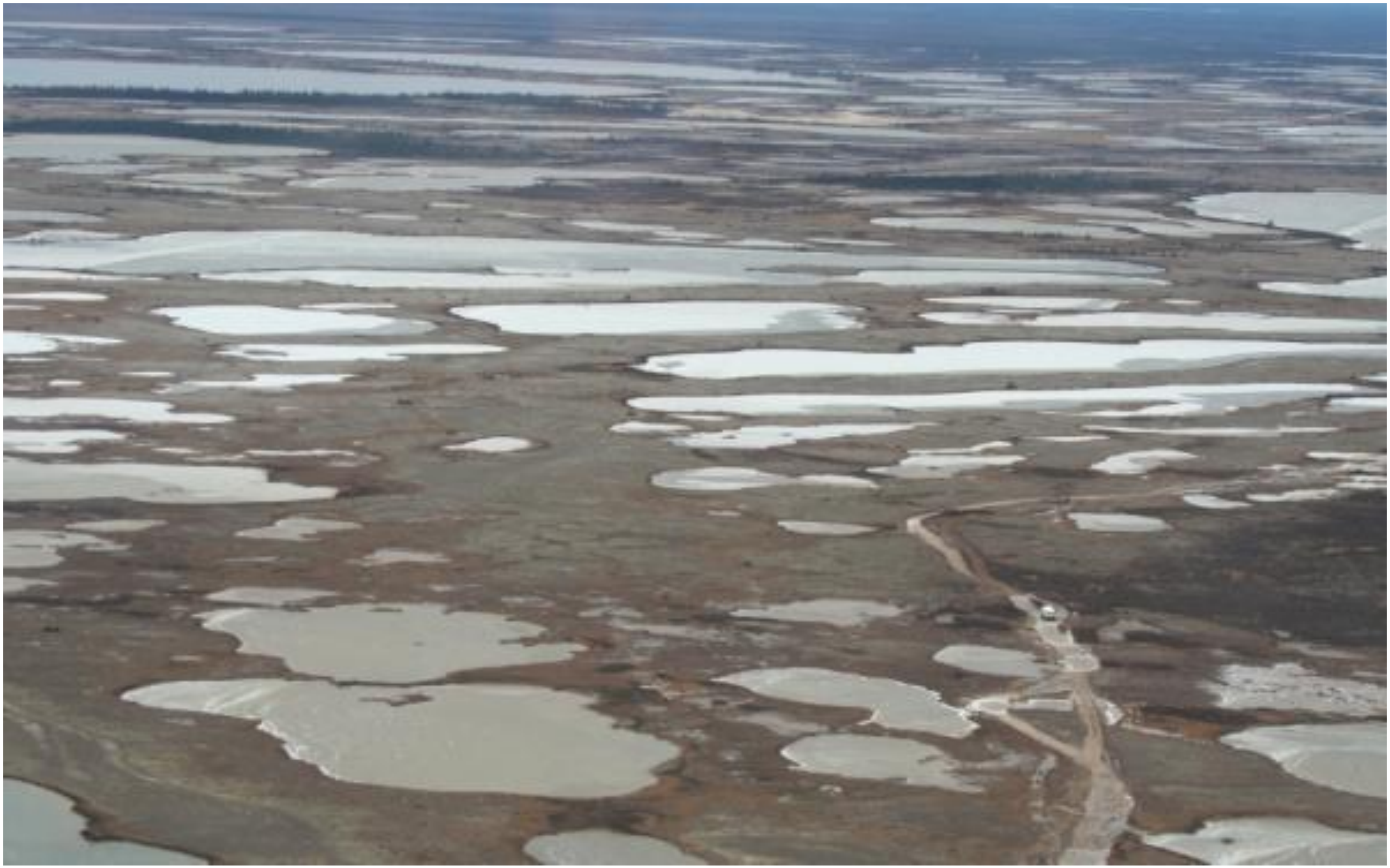


Rising sea level…

Expansion of forests



Thawing permafrost



Increase in Methane


EXTREME
ICE
An acclaimed photographer teams up
with scientists to document the runaway
melting of arctic glaciers.