Human Impact on the Environment: Part I

The late Alan Gregg pointed out that human population growth within the ecosystem was closely analogous to the growth of malignant tumor cells, that man was acting like a cancer on the biosphere. The growth of human numbers certainly seems wild and uncontrolled. Four million a month -- the equivalent of the population of Chicago. We seem to be doing all right at the moment; but if you could ask cancer cells, I suspect they would think they were doing fine. But when the organism dies, so do they; and for our own, selfish, practical, utilitarian reasons, I think we should be careful about how we influence the rest of the ecosystem.

Marston Bates

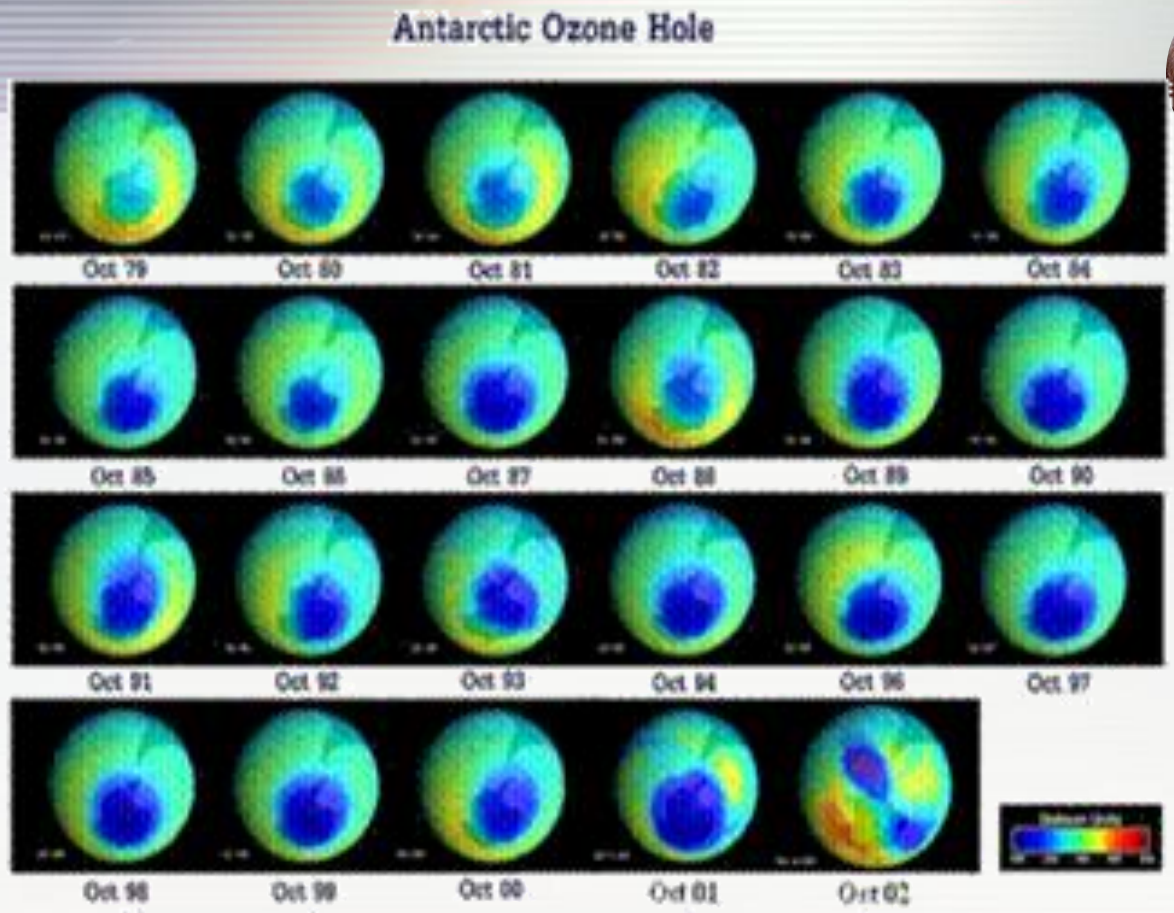
Human Activity

Over-Population, destruction of habitats for agriculture and mining, pollution from industry and transportation, and many other activities all contribute to the damage of the environment.

Human Activity

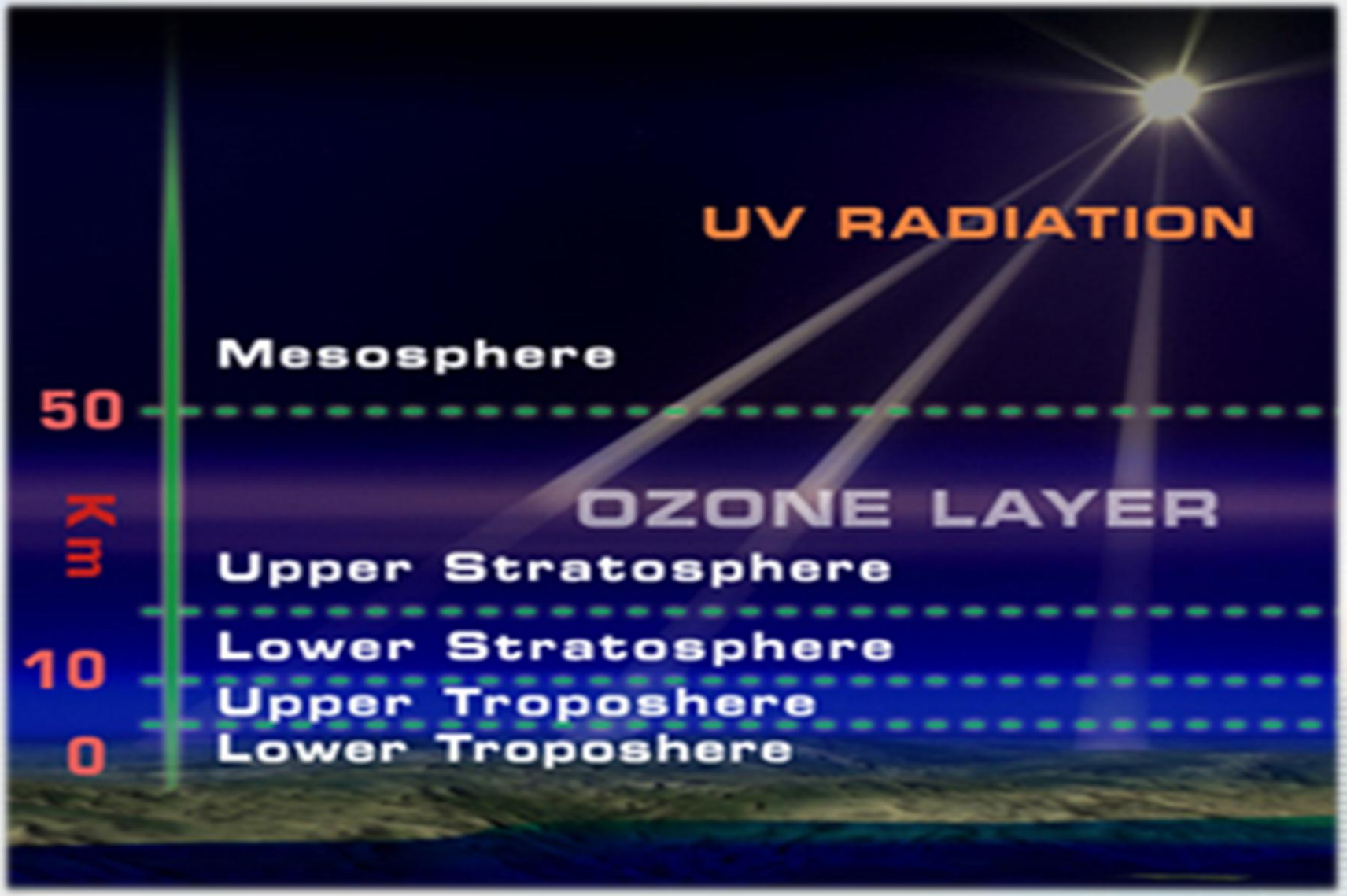
Some of the destructive consequences of human activity are:

1. Ozone depletion
2. Rise in global temperature
3. Global sea level rise
4. Acid rain
5. Pollution – land, air, water
6. Biodiversity loss
7. Desertification
8. Deforestation
9. Overuse of resources



1. OZONE DEPLETION

Ozone Depletion



Ozone Depletion

The Damage to the Ozone Layer

Ozone is a molecule composed of:

three atoms of oxygen.

- The ozone in the upper atmosphere:

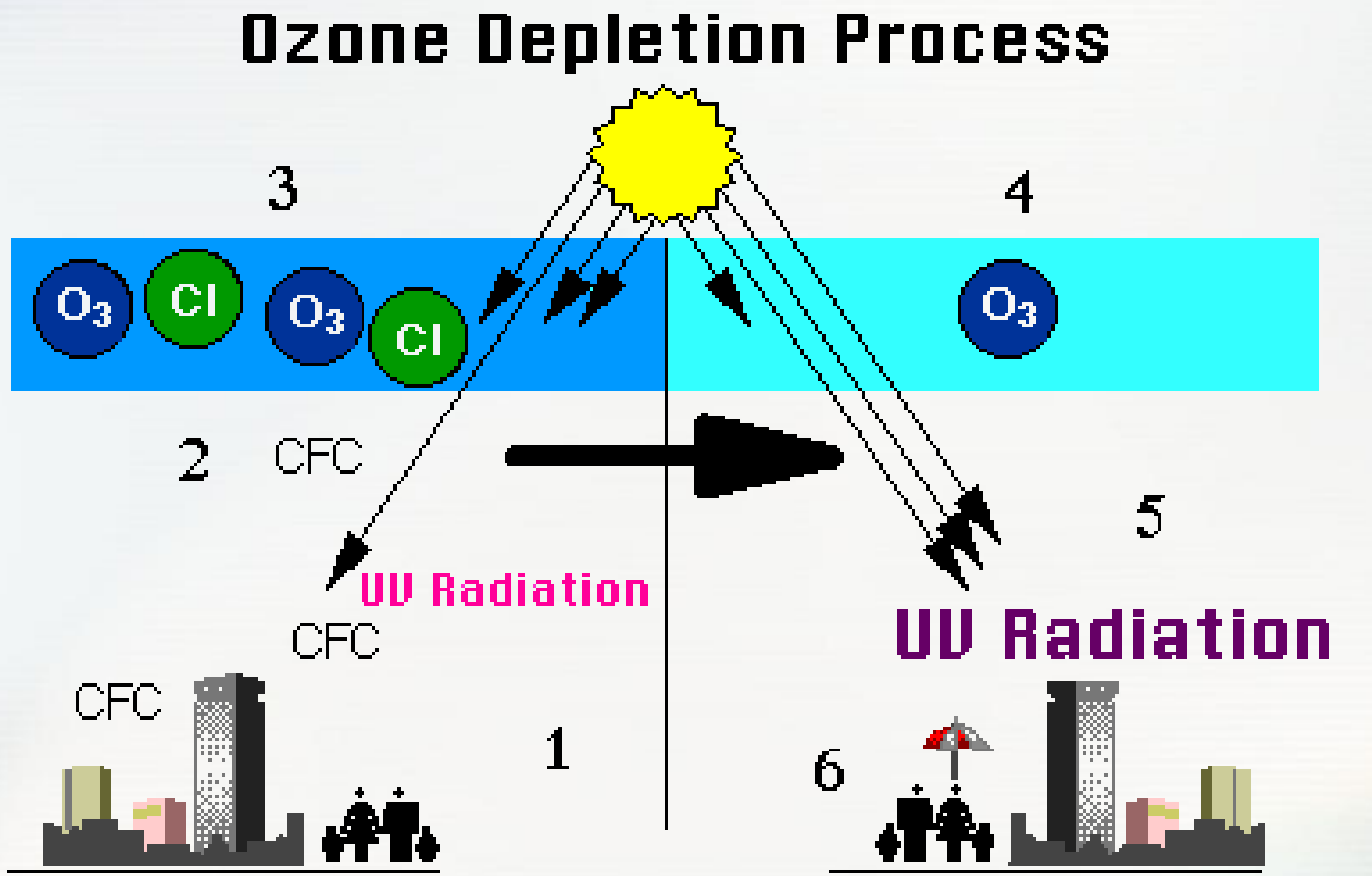
protects and shields the organisms on Earth from ultraviolet radiation from the sun.

An abundance of chlorofluorocarbons (CFC's) is causing damage to this protective layer of ozone.

Ozone Depletion

- The ozone layer forms in the upper atmosphere when UV radiation reacts with oxygen (O_2) to form ozone (O_3).
- The ozone absorbs UV radiation and thus prevents it from reaching the surface of the earth where it would damage the DNA of plants and animals.
- Various air pollutants, such as chlorofluorocarbons (CFCs), enter the upper atmosphere and break down ozone molecules.
- CFCs have been used as refrigerants, as propellants in aerosol sprays and in the manufacture of plastic foams.
- When ozone breaks down, the ozone layer thins, allowing UV radiation to penetrate and reach the surface of the earth.
- Areas of major ozone thinning, called **ozone holes**, appear regularly over Antarctica, the Arctic and northern Eurasia.

Ozone Depletion



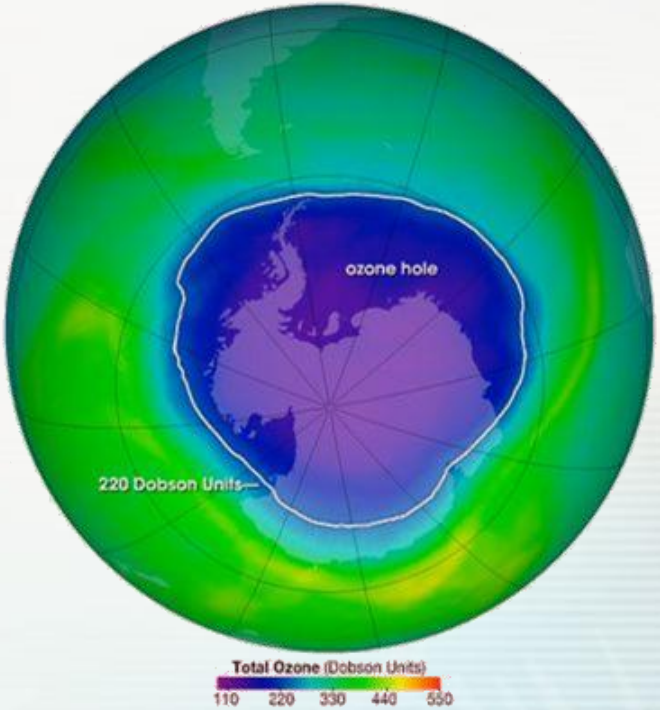
1 - CFCs released
2 - CFCs rise into ozone layer
3 - UV releases Cl from CFCs

4 - Cl destroys ozone
5 - Depleted ozone -> more UV
6 - More UV -> more skin cancer

Ozone Depletion

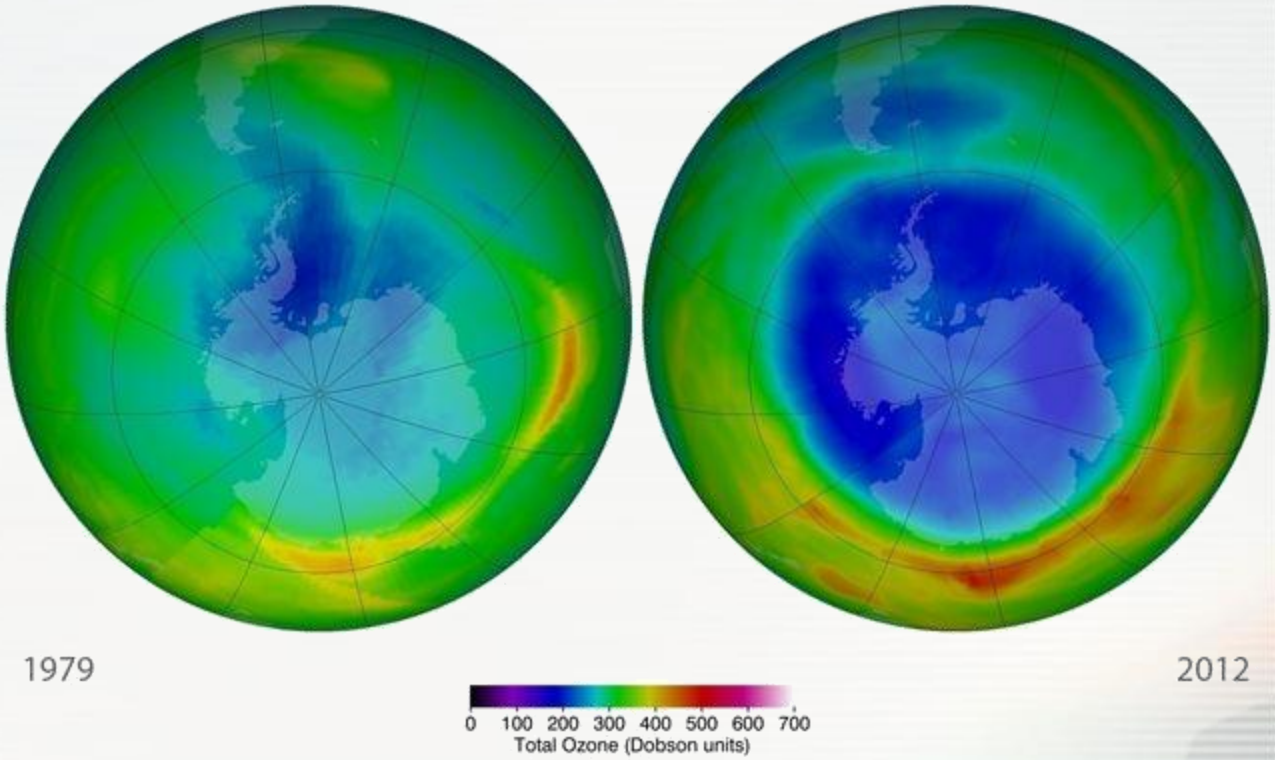
The annual ozone "hole“ over Antarctica has occurred during the Antarctic Spring (October) since the early 1980s.

Rather than being an actual hole through the layer, the ozone hole is a large area with extremely low amounts of ozone. Ozone levels fall by over 60% during the worst years.



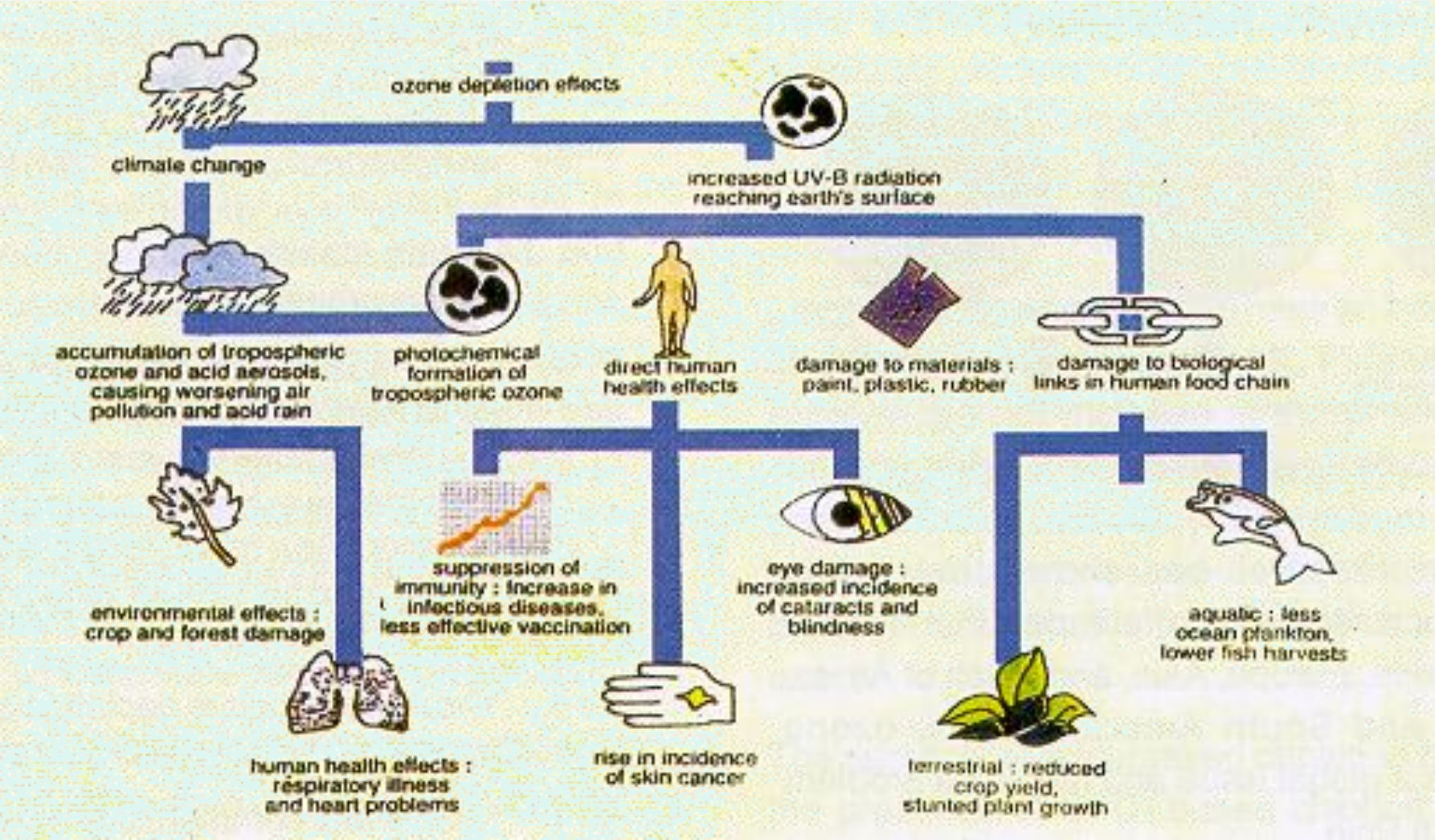
Ozone Depletion

These images of the ozone hole were taken by NASA in September 1979 and September 2012.



Ozone Depletion

The effects of ozone depletion include:



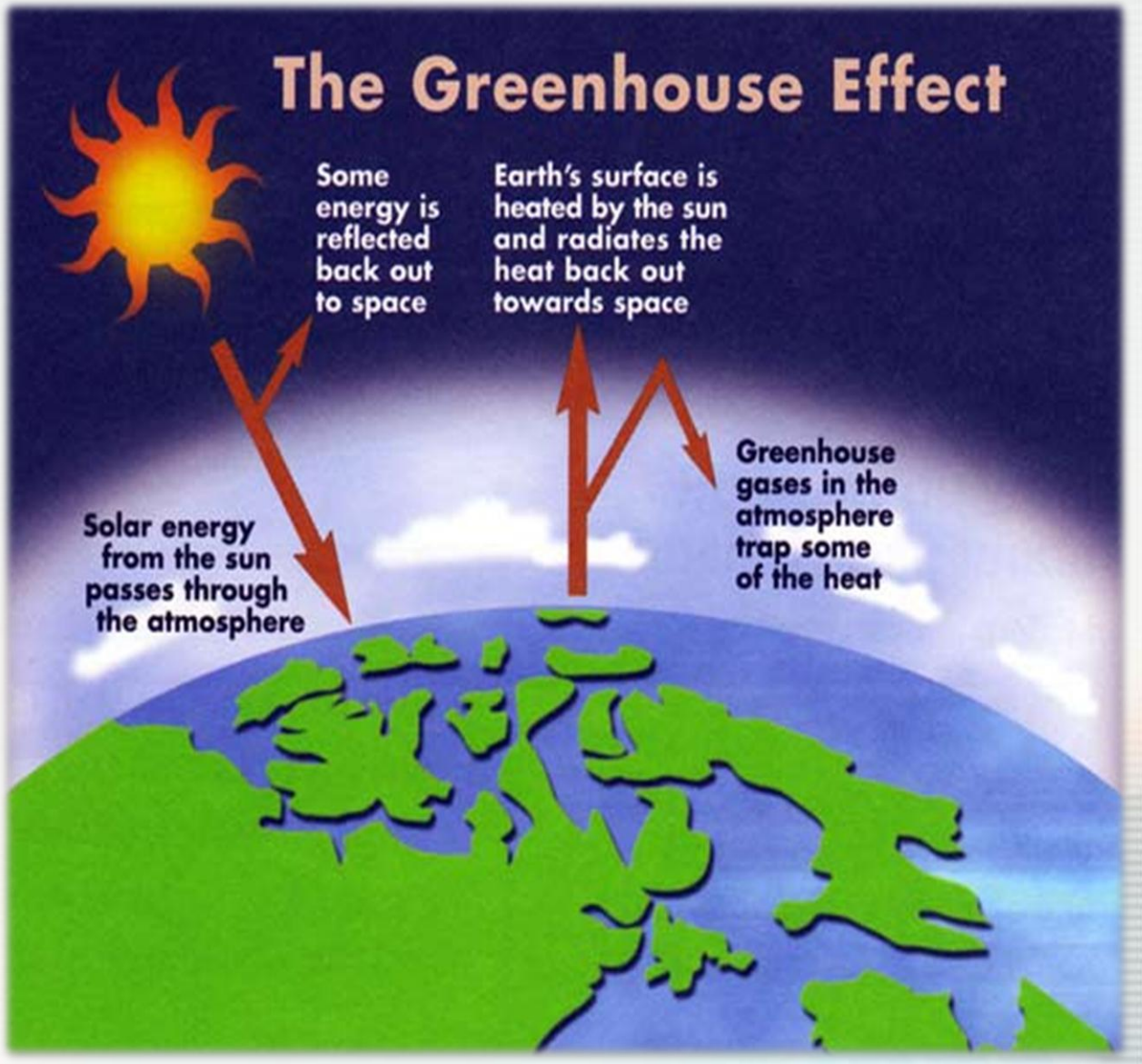
2. RISE IN GLOBAL TEMPERATURE

Rise in Global Temperature

- The **greenhouse effect** helps to regulate the temperature of our planet. It is essential for life on Earth and is one of Earth's natural processes.
- It is the result of heat absorption by certain gases in the atmosphere (called greenhouse gases) and re-radiation downward of some of that heat.
- Water vapor is the most abundant greenhouse gas, followed by carbon dioxide and other trace gases.
- Without a natural greenhouse effect, the temperature of the Earth would be about zero degrees F instead of its present 57°F.

Rise in Global Temperature

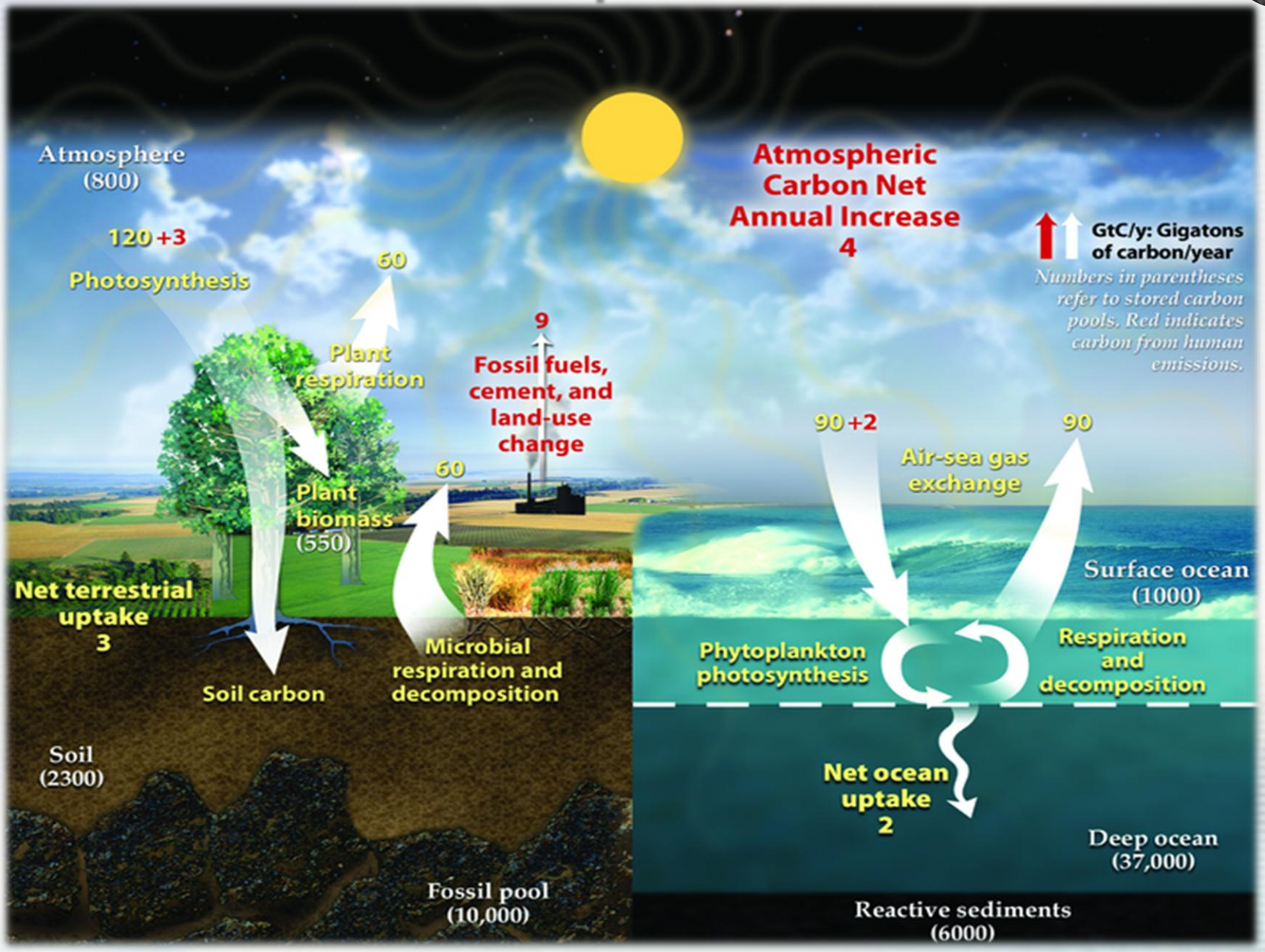
- The burning of fossil fuels increases CO_2 in the atmosphere.
- Increases in CO_2 cause more heat to be trapped in the earth's atmosphere.
- As a result, global temperatures rise.



Rise in Global Temperature

- The concern is not with the fact that we have a greenhouse effect, but whether human activities are leading to an enhancement of the greenhouse effect.
- Human activity has been increasing the concentration of greenhouse gases in the atmosphere (mostly carbon dioxide from combustion of coal, oil and gas).
- Pre-industrial levels of carbon dioxide were about 280 parts per million by volume (ppmv). Current levels are greater than 380 ppmv and increasing at a rate of 1.9 ppm yr^{-} since 2000.
- The global concentration of CO_2 in our atmosphere today far exceeds the natural range over the last 650,000 years of 180 to 300 ppmv.
- By the end of the 21st century, we could expect to see carbon dioxide concentrations of anywhere from 490 to 1260 ppm (75%-350% above the pre-industrial concentration).

Rise in Global Temperature



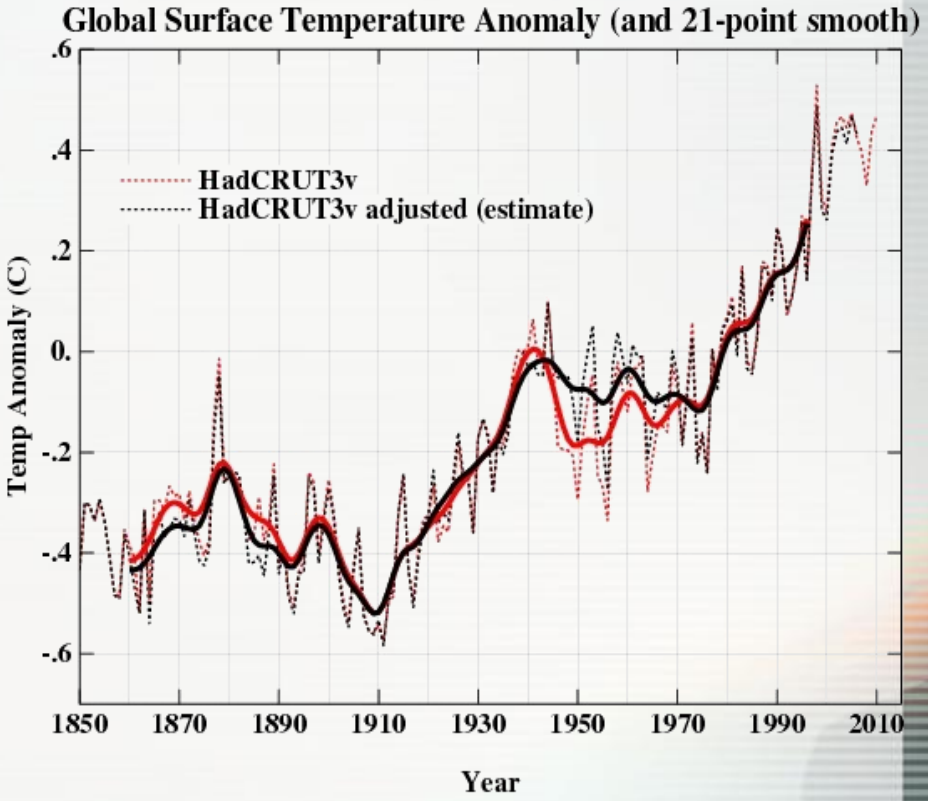
Rise in Global Temperature

In January 2015:

- Much warmer-than-average temperatures were observed across central to eastern Asia, Europe, parts of western North America and southern North America stretching through Central America into northern and eastern South America.
- The global land surface temperature was 1.43°C (2.57°F) above average.
- The Northern Hemisphere was third warmest for the month over land, while the Southern Hemisphere had its 19th highest January land temperature.
- Some areas in southern Siberia and Far East Russia were more than 5°C (9°F) warmer than their long-term monthly averages.

Rise in Global Temperature

- Seawater temperatures rose during the last half of the 20th century, causing significant reductions in the extent of sea ice.
- During January 2015:
  - The globally-averaged ocean temperature anomaly of +0.53°C (+0.95°F) was the third highest on record for January.
  - Scattered regions of record warmth combined with many areas that were much warmer than average led to the warmest January sea surface temperatures on record for the Northern Hemisphere.

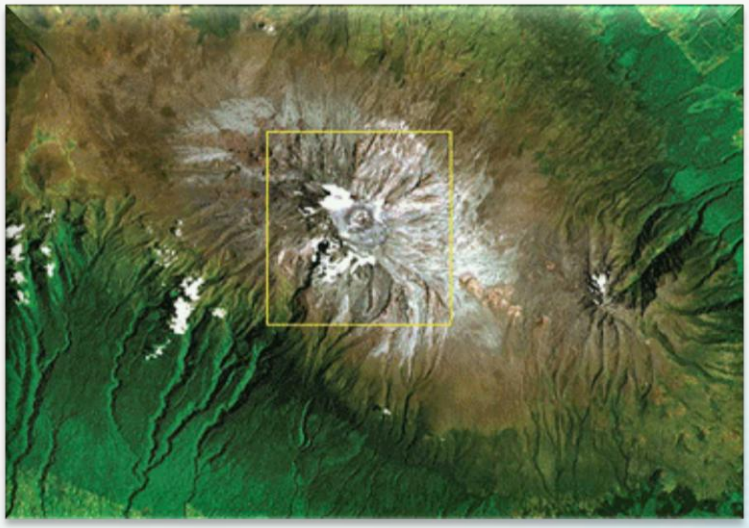


- By the end of the 21st century, seawater temperatures are expected to be much higher, and Arctic sea ice may be absent for most of the year.

Rise in Global Temperature

- Greenland glacier melting around exterior, accumulating inland (higher precipitation).

- Melting glaciers on Japan's Mount Kilimanjaro.



Rise in Global Temperature

For Northern Hemisphere temperatures, recent decades appear to be the warmest since at least about 1000 AD, and the warming since the late 19th century is unprecedented over the last 1000 years.

Northern Hemisphere average annual snow cover has declined in recent decades. This pattern is consistent with warmer global temperatures. Some of the largest declines have been observed in the spring and summer months.

Experts predict that by the middle of the 21st century, the Rocky Mountains, Cascades, and Glacier National Park will have lost almost all their ice.

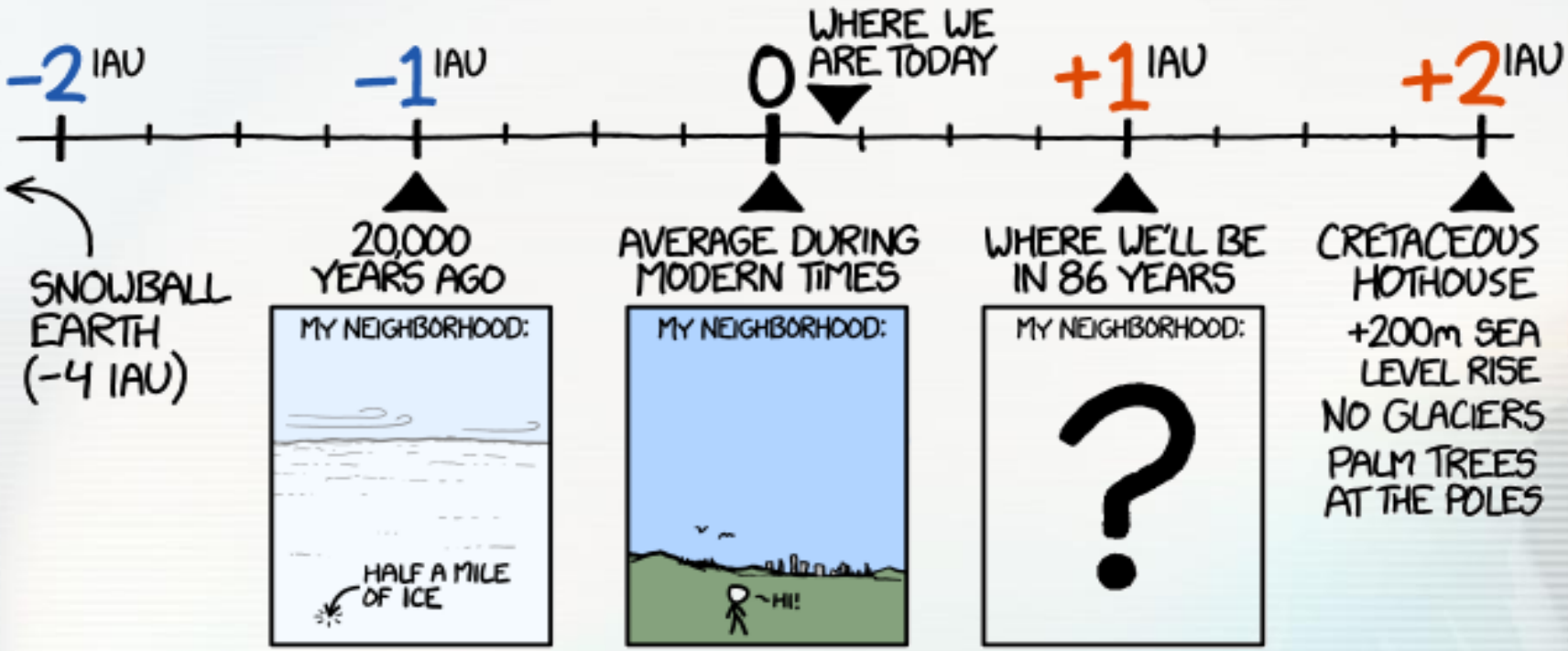
Rise in Global Temperature

WITHOUT PROMPT, AGGRESSIVE LIMITS ON CO_2 EMISSIONS, THE EARTH WILL LIKELY WARM BY AN AVERAGE OF 4°–5°C BY THE CENTURY'S END.

HOW BIG A CHANGE IS THAT?

IN THE COLDEST PART OF THE LAST ICE AGE, EARTH'S AVERAGE TEMPERATURE WAS 4.5°C BELOW THE 20TH CENTURY NORM.

LET'S CALL A 4.5°C DIFFERENCE ONE "ICE AGE UNIT."



Rise in Global Temperature

The effects of higher global temperatures include:

- the dramatic alteration of many marine ecosystems and deadly stress to organisms such as corals that live in habitats where temperatures are already near lethal levels
- the possible extinction of polar bears and other species that depend upon an arctic sea ice habitat
- alteration of the flow of the Gulf Stream, causing major air temperature alterations in the North Atlantic and colder climates in western European countries that are presently warmed by the Gulf Stream
- higher risk of forest fires
- decreased crop yields
- increased competition for water

Rise in Global Temperature

The effects of higher global temperatures include (continued):

- the amplification of drought in certain midcontinental areas due to changes in climate variability and extremes resulting from global warming
- wetter conditions, at least in the short term, due to an intensification of the hydrologic cycle associated with warmer sea surface temperatures
- fresh water supplies jeopardized by saltwater intrusion

Rise in Global Temperature

The effects of higher global temperatures include (continued):

- increased wind speed and rainfall in hurricanes and increased impacts of storm surges
- more severe hurricane damage to human communities and greater disturbance in and stress to coastal ecosystems
- significant changes in runoff and river flows, which will affect the influx of chemicals and sediments to estuaries and coastal waters, alter freshwater flows and cause stress to organisms and communities that depend on them
- increased irrigation demands

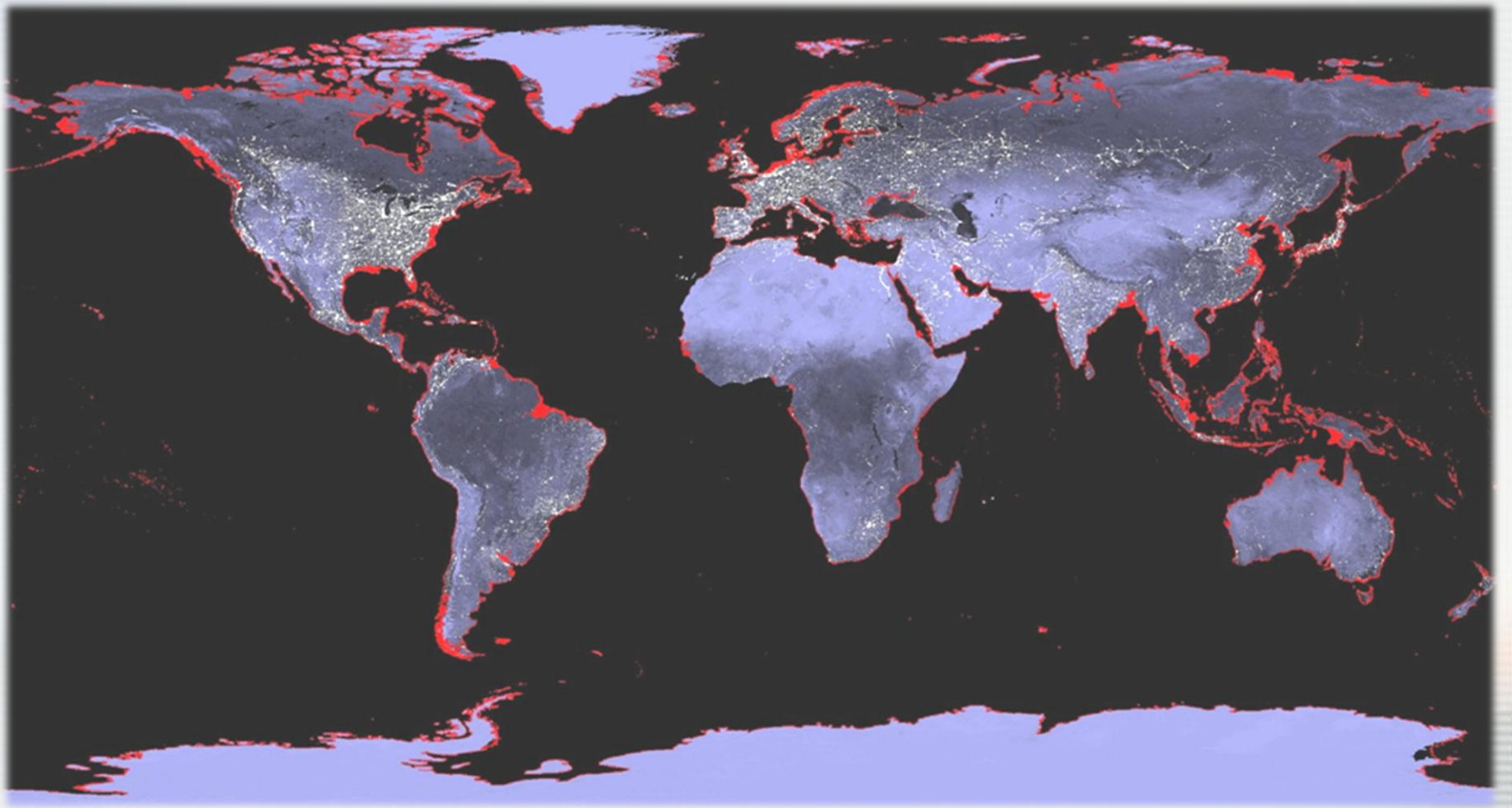

Tuvaluan kids hang out as extra high tide floods neighborhood.

3. GLOBAL SEA LEVEL RISE

Global Sea Level Rise

- Global mean sea level has been rising at an average rate of 1.7 mm/year over the past 100 years, which is significantly larger than the rate averaged over the last several thousand years.
- Much of the sea level rise to date is a result of increasing heat of the ocean causing it to expand. It is expected that melting land ice (e.g. from Greenland and mountain glaciers) will play a more significant role in contributing to future sea level rise.
- The rate of change is increasing, and the rise of global sea levels is expected to be several times larger during the 21st century.
- In areas where land is sinking (such as Louisiana and Texas), the relative change in sea level may be as much as 20-40 inches.

Global Sea Level Rise



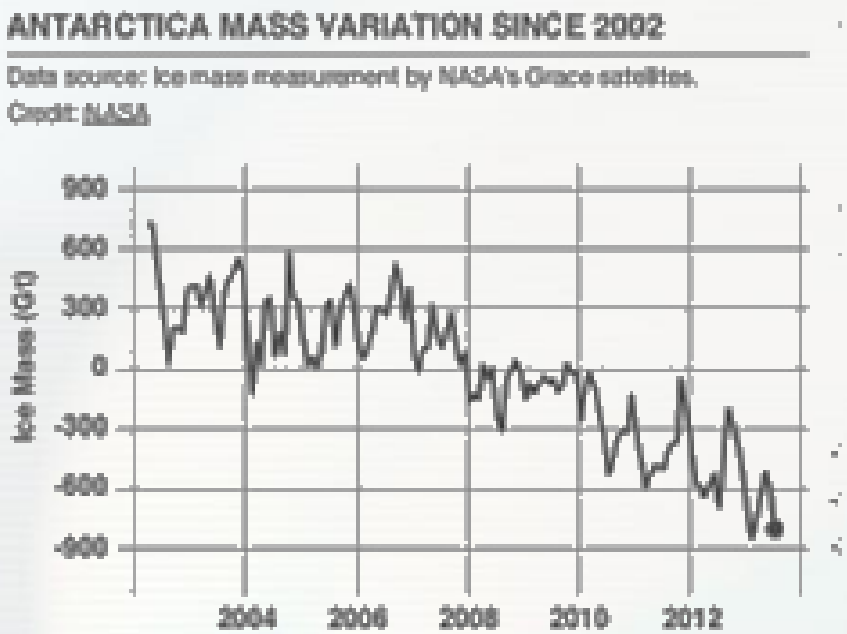
Earth with a sea level rise of six meters. Research finds that human activity is responsible for 87% of sea level rise since 1970.

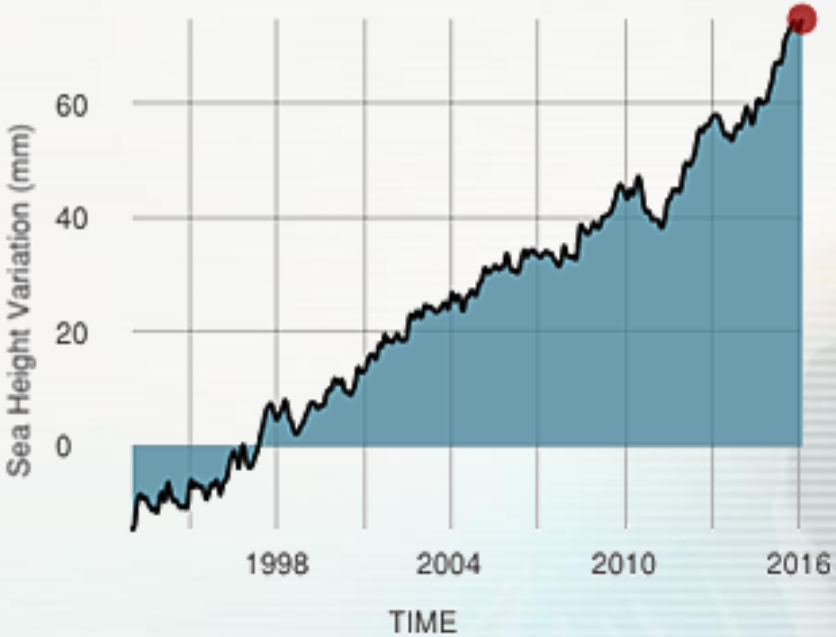
Global Sea Level Rise

- The total volume of glaciers on Earth is declining sharply.
- Most of Earth's 160,000 glaciers have been melting during the last century, but the rate of melting has accelerated dramatically since the mid-1990s.
- Only a few glaciers are actually advancing (in locations that were well below freezing, and where increased precipitation has outpaced melting).
- The progressive disappearance of glaciers has implications for a rising global sea level.

Global Sea Level Rise

- Satellite observations confirmed Antarctic melting.
- Recent estimates by NASA indicate that Arctic sea ice is melting at a rate of 9% per decade.
- Satellite measurements found Antarctic melting is equivalent to a sea level rise of 0.4 mm per year.





Global Sea Level Rise

The effects of higher sea levels include:

- increased coastal erosion
- disappearance of many coastal habitats and their associated natural resources
- intrusion of saltwater into drinking water supplies and freshwater ecosystems
- decreased supply and quality of fresh water
- increased competition for water
- increased risk of infectious diseases
- inundation of coastal lands
- cost of protecting coastal communities
- possibility of loss of homeland for island cultures

Continued in Human Impact on the Environment Part II