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Global warming and Climate Change



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- What is Global Warming and Climate Change?
- Global warming and climate change refer to an increase in average global temperatures. Natural events and human activities are believed to be contributing to an increase in average global temperatures. This is caused primarily by increases in greenhouse gases such as Carbon Dioxide (CO₂).



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- A warming planet thus leads to a change in climate which can affect weather in various ways, as discussed further below.



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Ten indicators for a warming world, [Past Decade Warmest on Record According to Scientists in 48 Countries](#)



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Seven indicators are rising:

1. Air temperature over land,
2. Sea-surface temperature
3. Air temperature over oceans,
4. Sea level
5. Ocean heat
6. Humidity
7. Troposphere temperature in the “active-weather” layer of the atmosphere closest to the Earth’s surface



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Three indicators are declining

- Arctic sea ice
- Glaciers
- Spring snow cover in the Northern hemisphere



Green house gasses

- Six main greenhouse gases are carbon dioxide (CO_2), methane (CH_4) (which is 20 times as potent a greenhouse gas as carbon dioxide) and nitrous oxide (N_2O), plus three fluorinated industrial gases: hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6). Water vapor is also considered a greenhouse gas.



Green house gasses

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- The Greenhouse effect is natural. What do we have to do with it?
- Many of these greenhouse gases are actually life-enabling, for without them, heat would escape back into space and the Earth's average temperature would be a lot colder.
- However, if the greenhouse effect becomes stronger, then more heat gets trapped than needed, and the Earth might become less habitable for humans, plants and animals.
- Carbon dioxide, though not the most potent of greenhouse gases, is the most significant one. Human activity has caused an imbalance in the natural cycle of the greenhouse effect and related processes. NASA's Earth Observatory is worth quoting the effect human activity is having on the natural carbon cycle, for example:



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Green house gasses

- In addition to the natural fluxes of carbon through the Earth system, anthropogenic (human) activities, particularly fossil fuel burning and deforestation, are also releasing carbon dioxide into the atmosphere.
- When we mine coal and extract oil from the Earth's crust, and then burn these fossil fuels for transportation, heating, cooking, electricity, and manufacturing, we are effectively moving carbon more rapidly into the atmosphere than is being removed naturally through the sedimentation of carbon, ultimately causing atmospheric carbon dioxide concentrations to increase.
- Also, by clearing forests to support agriculture, we are transferring carbon from living biomass into the atmosphere (dry wood is about 50 percent carbon).
- The result is that humans are adding ever-increasing amounts of extra carbon dioxide into the atmosphere. Because of this, atmospheric carbon dioxide concentrations are higher today than they have been over the last half-million years or longer.



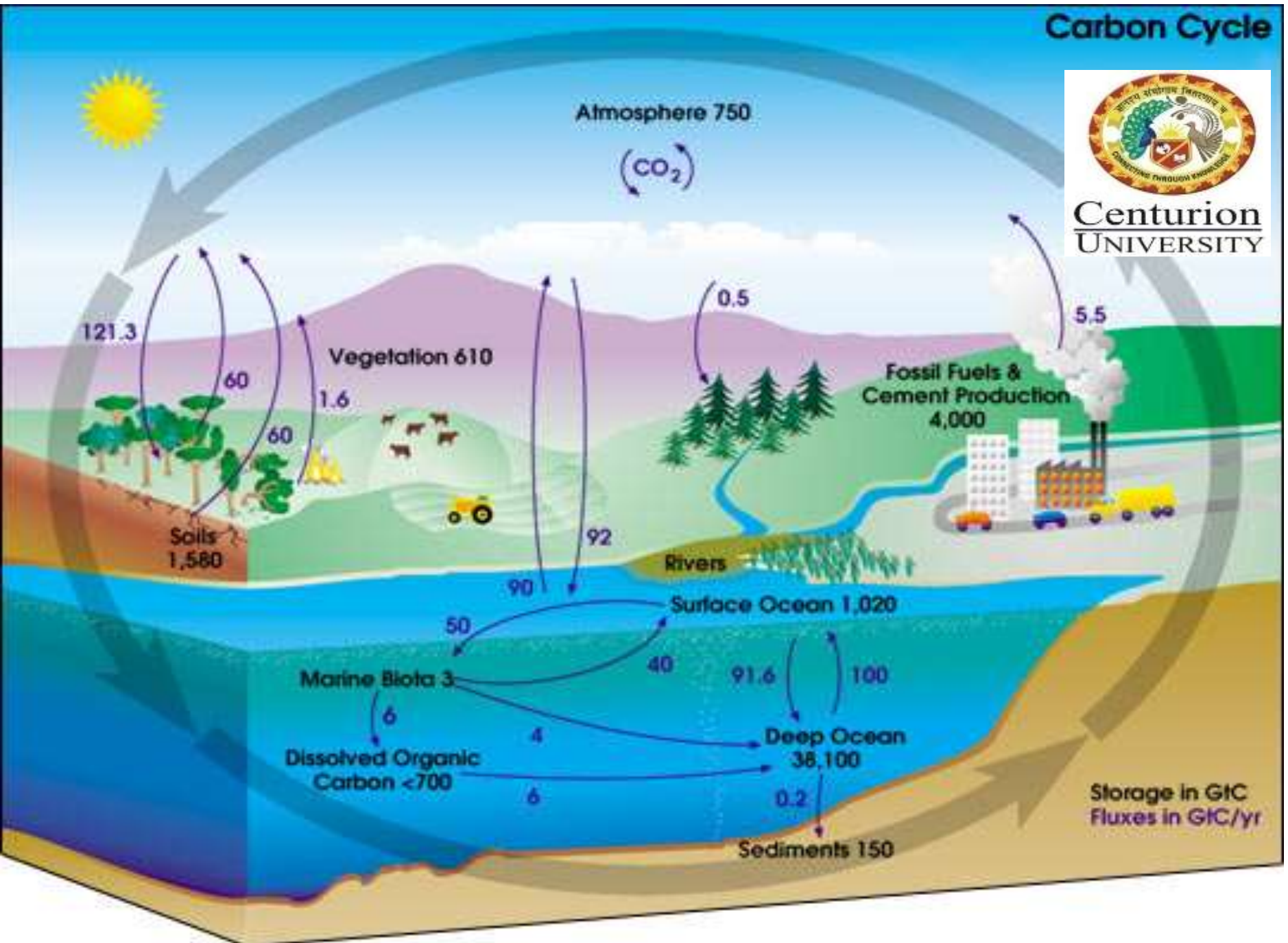
Green house gasses

- Another way of looking at this is with a simple analogy: consider salt and human health:
- A small amount of salt is essential for human life;
- Slightly more salt in our diet often makes food tastier;
- Too much salt can be harmful to our health.
- In a similar way, greenhouse gases are essential for our planet; the planet may be able to deal with slightly increased levels of such gases, but too much will affect the health of the whole planet.

Carbon Cycle



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Key warming facts

- Sea surface temperature, ocean heat content, sea level rise, melting of glaciers and ice sheets, CO₂ emissions and atmospheric concentrations are increasing at an accelerating rate with significant consequences for humanity and the marine species and ecosystems of the ocean.



Impact

- There is likely to be an increase in mean global ocean temperature of 1-4o C by 2100. The greatest ocean warming overall is occurring in the Southern Hemisphere and is contributing to the subsurface melting of Antarctic ice shelves. Since the 1990s the atmosphere in the polar regions has been warming at about twice the average rate of global warming.



Impact

- There is likely to be Arctic warming and ice loss, and possibly the essential removal, in some years, of the summer Arctic sea ice within the next few decades. In the Antarctic the extent of the sea ice has been growing at a rate of $\sim 1.3\%$ per decade, although there is strong inter-annual variability.



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Impact

- Over the last 20 years there has been an intensification and distinct change in the El Niño events, with a shift of the mean location of sea surface temperature anomalies towards the central Pacific



Impact

- Currently 2.5 Gt of frozen methane hydrate are stored in the sea floor at water depths of 200 – 2000 m. Increasing water temperature could release this source of carbon into the ocean and ultimately into the atmosphere.



- The other difference between the natural carbon cycle and human-induced climate change is that the latter is *rapid*. This means that ecosystems have less chance of adapting to the changes that will result and so the effects felt will be worse and more dramatic if things continue along the current trajectory.



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The climate has always varied in the past.
How is this any different?

- Throughout Earth's history the climate has varied, sometimes considerably. Past warming does not automatically mean that today's warming is therefore also natural. Recent warming has been shown to be due to human industrialization processes.
- John Cook, writing the popular Skeptical Science blog, summarizes the key indicators of a human finger print on climate change:



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- This graph, based on the comparison of atmospheric samples contained in ice cores and more recent direct measurements, provides evidence that atmospheric CO₂ has increased since the Industrial Revolution:
<http://www.globalissues.org/article/233/climate-change-and-global-warming-introduction#WhatisGlobalWarmingandClimateChange> eased since the Industrial Revolution: