

CLIMATE CHANGE:

A Silent Threat

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I. THE CLIMATE SYSTEM



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The Climate System: A brief summary

The climate system is governed by numerous interactions between closed loop systems. A modification of one aspect of these systems, such as the carbon cycle, can influence the overall climate system and lead to change...

- **Weather:** Refers to the changes taking place in the atmosphere at present over short periods of time (the science of meteorology)
- **Climate:** Defines the tendency of the weather over long periods of time (the science of climatology)

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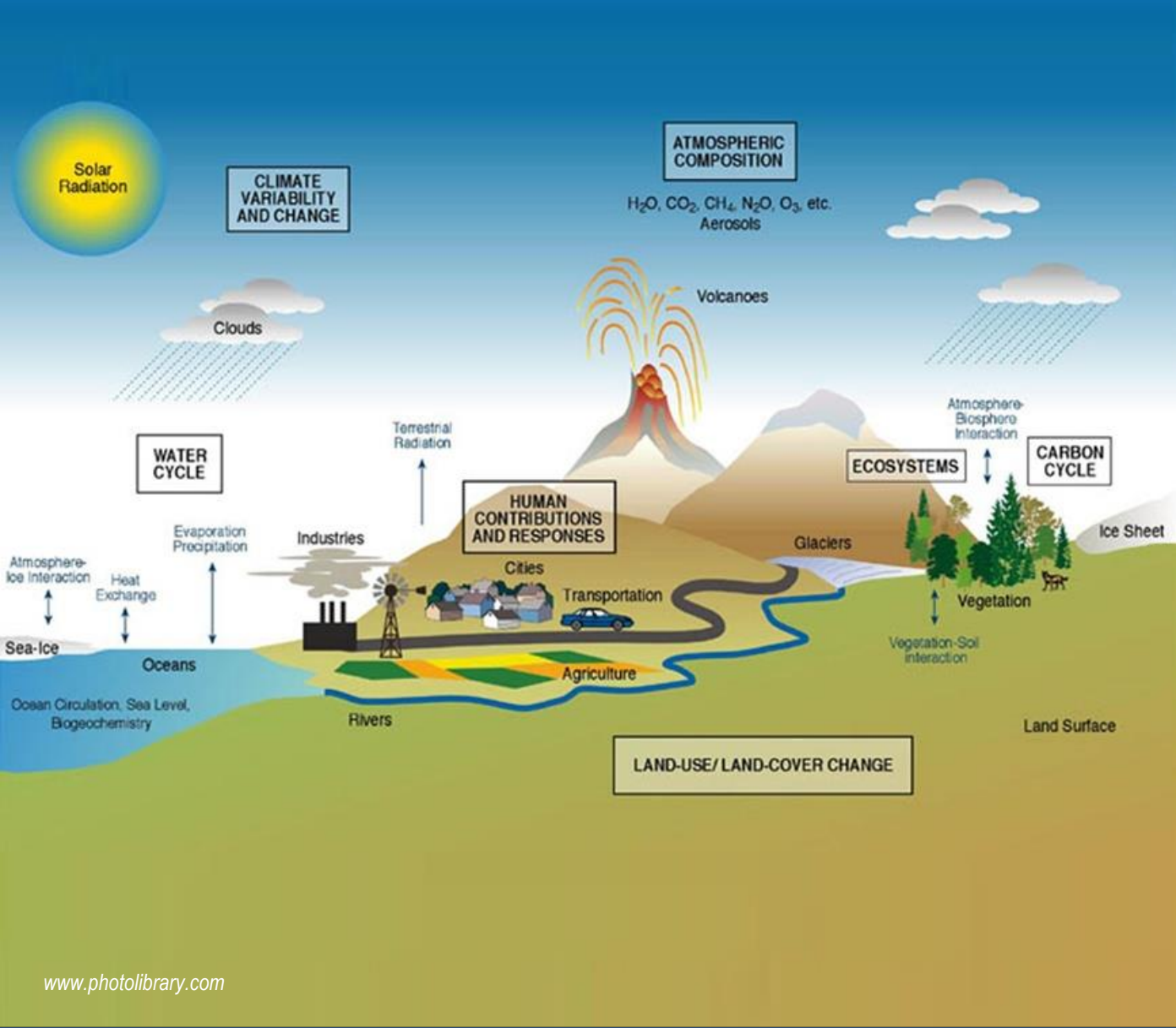
The Climate System: A brief summary

The major factors that determine the patterns of climate on earth can be explained in terms of⁸:

- the strength of the incident radiation from the sun, which determines the overall planetary temperature of the earth;
- the spherical shape of the earth and the orientation of its axis;
- the greenhouse effect of water vapour and other radiatively active trace gases;
- the various physical, chemical and biological processes that take place within the atmosphere-geosphere-biosphere climate system, in particular:
 - the global energy balance,
 - the global water cycle,
 - the global carbon cycle and other biogeochemical cycles;
- the rotation of the earth, which substantially modifies the large-scale thermally-driven circulation patterns of the atmosphere and ocean; and
- the distribution of continents and oceans.

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The Global Climate System:

- The climate system is driven by a close interaction between the Atmosphere, the Geosphere (Lithosphere, Hydrosphere, Cryosphere) and space
- Human activities can affect/modify these interactions

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Atmospheric circulation transfers a small proportion of the heat around the planet



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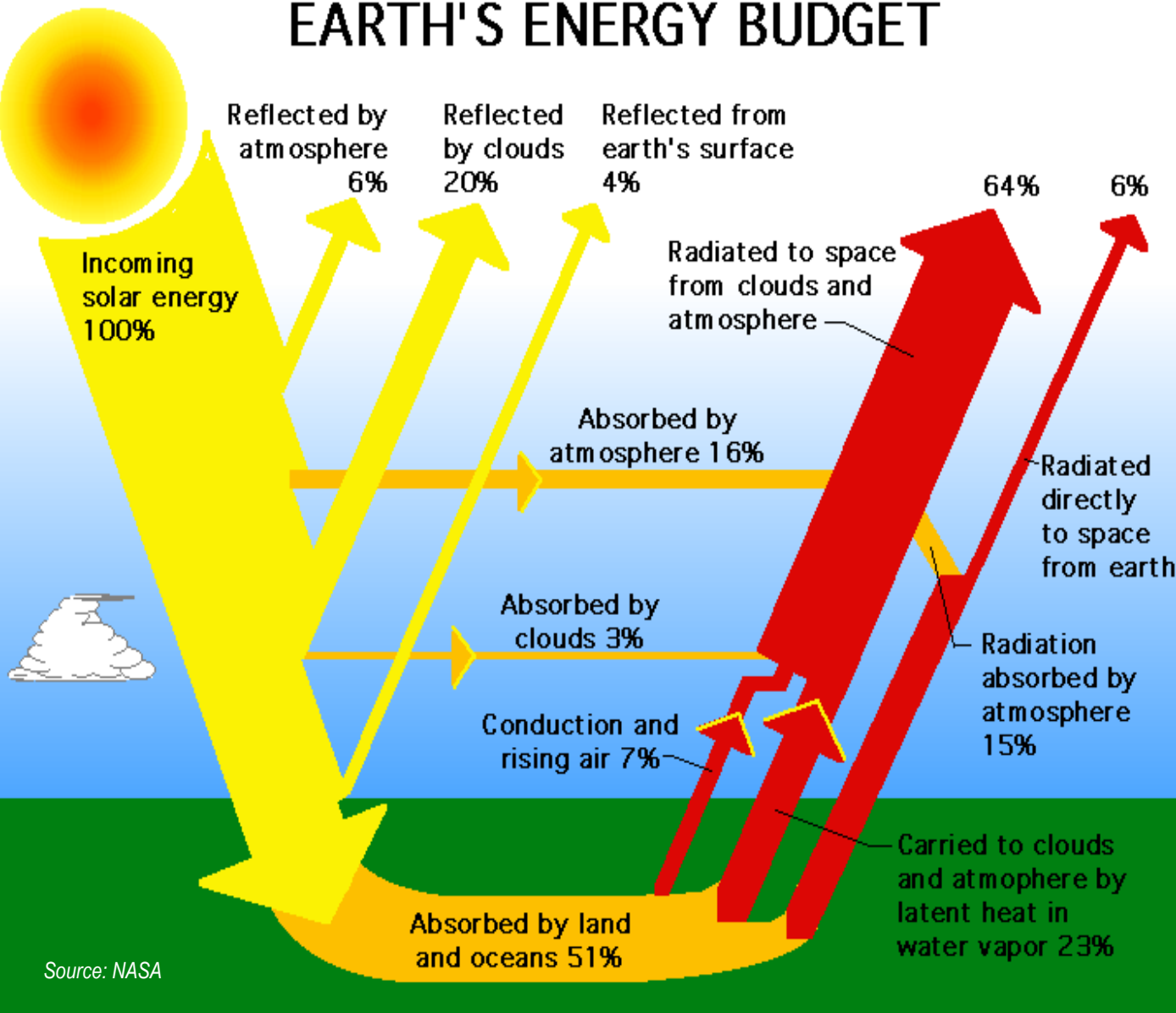
Oceanic circulation (currents) is by far the main medium for heat transfer around the planet. The general oceanic circulation is known as the oceanic conveyor belt or the thermohaline system

The Climate System: Heat Transfer

- There are constant heat exchanges occurring on the planet between the cold poles and the warm equatorial latitudes
- The earth receives energy from the sun equal to approximately 1360 W m^{-2} (as an annual average) and has an approximate albedo (reflectivity) of 0.3 . As such, without any atmosphere the average temperature of the earth would be approximately $-18 \text{ deg C}^{\circ}$
- There are two main systems by which temperatures are distributed around the planet which affect the weather:
 - The atmospheric air circulations
 - The oceanic currents
- The transfer of heat is derived from solar energy and from the motion of the earth around its axis
- The global temperature of the planet and how it is distributed has an important impact on the behaviour of the climate system
- Climate change is changing this temperature distribution which is expected to have major repercussions on our climate and weather system



EARTH'S ENERGY BUDGET



Source: NASA

- The global energy balance is the balance between incoming energy from the sun and outgoing heat from the earth

- The global energy balance regulates the state of the earth's climate and modifications to it, as a result of natural and man-made climate-forcing, is causing the global climate to change

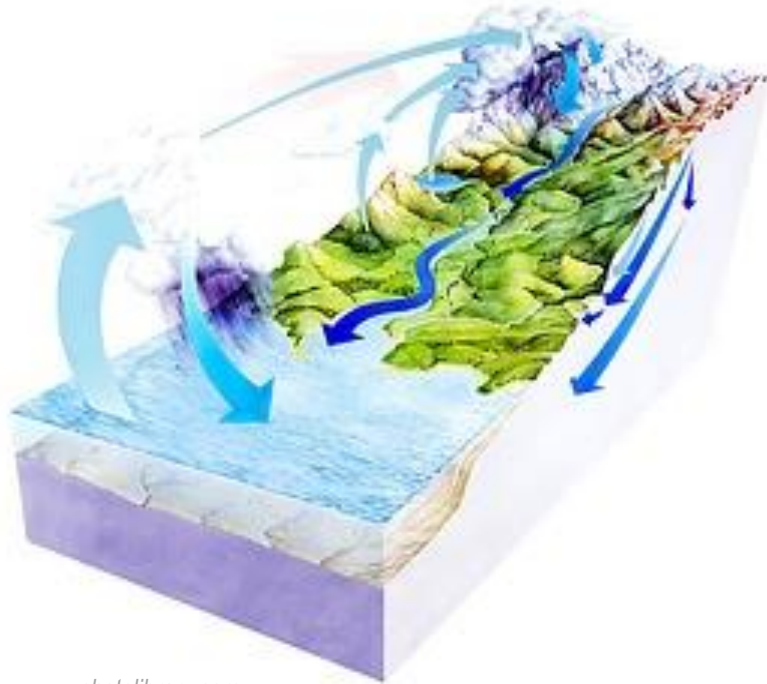


The Climate System: The Global Water Cycle (1a)

Water (H₂O) is stored in different phases on the planet and passes from one phase to another through a cycle referred to as the global water cycle:

There are 16 main elements of the water cycle:

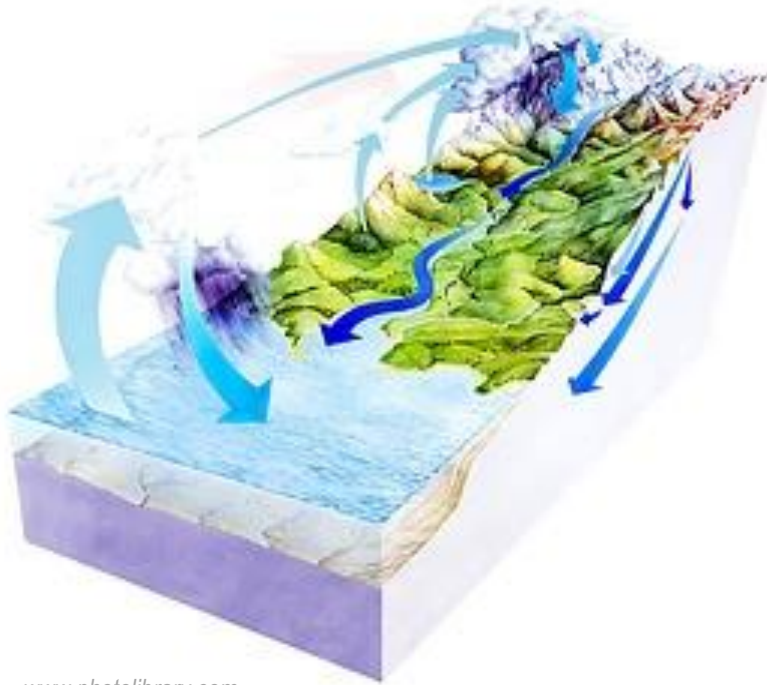
- *Water storage in oceans*
- *Evaporation*
- *Sublimation*
- *Evapotranspiration*
- *Water in the atmosphere*
- *Condensation*
- *Precipitation*
- *Water storage in ice and snow*
- *Snowmelt runoff to streams*
- *Surface runoff*
- *Streamflow*
- *Freshwater storage*
- *Infiltration*
- *Ground-water storage*
- *Ground-water discharge*
- *Springs*
- *Global water distribution*



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The Climate System: The Global Water Cycle (1b)

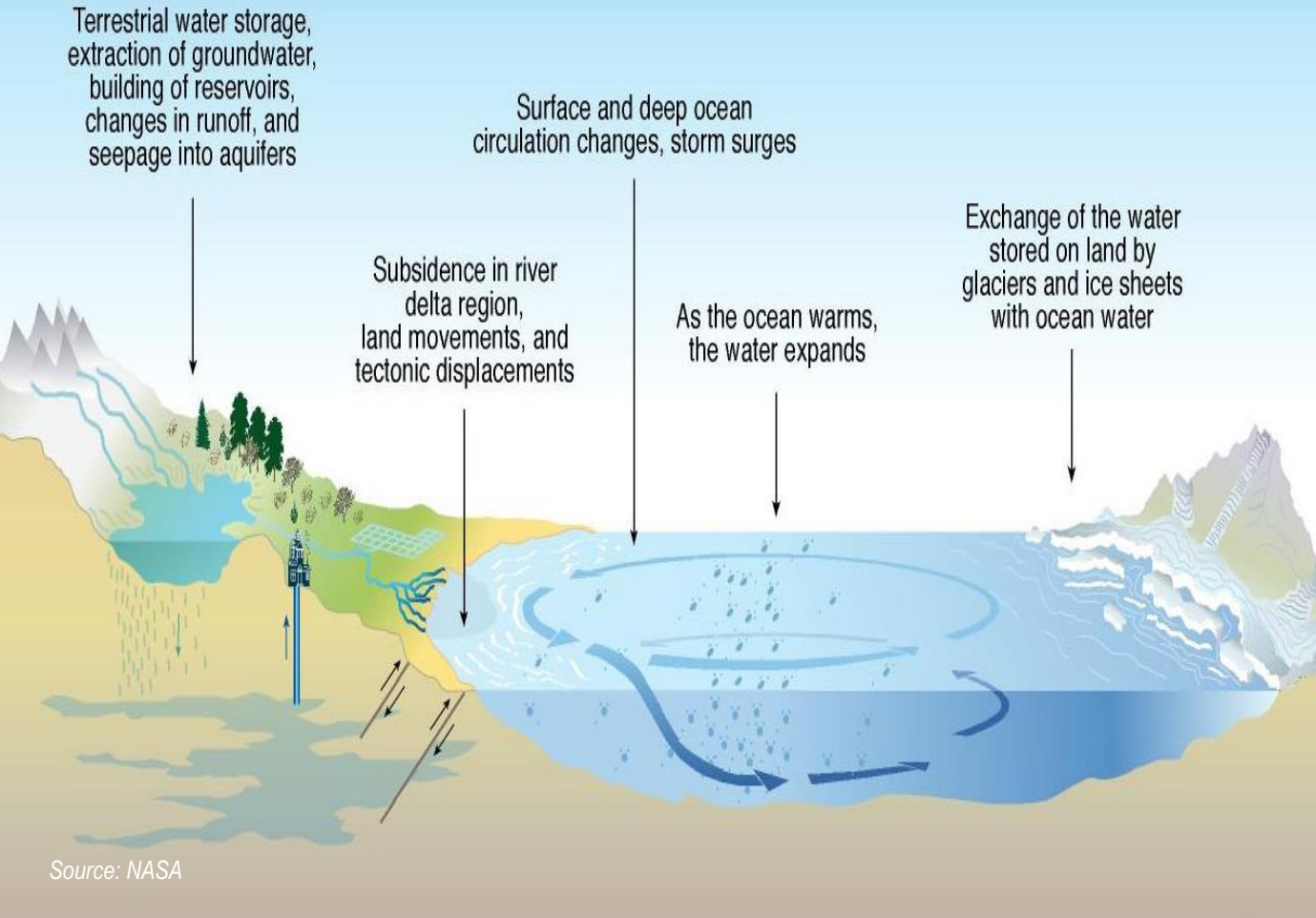


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- The water cycle plays an important role in regulating the earth climate
- Vice versa, a change in the climate system will significantly influence and modify the water cycle and how water is distributed on the planet
- The transport of atmospheric moisture from the oceans, which cover more than two-thirds of the globe, to the continents plays a vital role to balance the discharge from rivers and groundwater to the oceans⁸
- Water vapour is the most important of the greenhouse gases, in terms of its influence on the climate⁸



What causes the sea level to change?

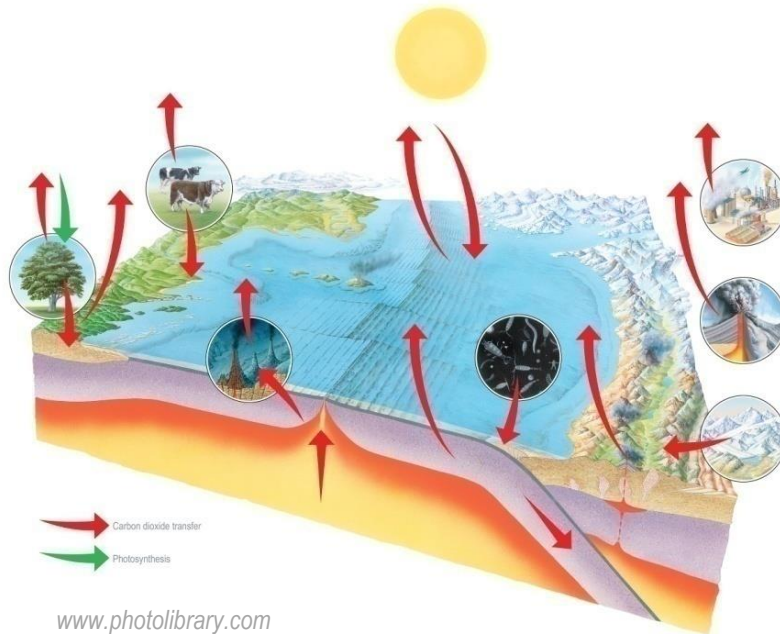


The Climate System: The Global Water Cycle (3)

- By modifying the water cycle, we are also impacting global sea level. The main cause of sea level rise is due to thermal expansion of the water body as temperature rises. The second main cause of global sea level rise is ice melt from land ice
- There are also seasonal variations in sea level and during storm events as a result of change in atmospheric pressure



The Climate System: The Global Carbon Cycle



- The carbon cycle refers to the movement of carbon, in its many forms, between the Biosphere, Atmosphere, Hydrosphere and the Geosphere
- There are many ways in which carbon can be stored for long periods of time on our planet. These are referred to as carbon sinks (ex: oceans, forests, trees...)
- Plants absorb CO₂ from the atmosphere during photosynthesis, also called primary production, and release CO₂ back in to the atmosphere during respiration
- Another major exchange of CO₂ occurs between the oceans and the atmosphere. The dissolved CO₂ in the oceans is used by marine biota in photosynthesis
- However, since the industrial revolution human activity has influenced the carbon cycle by changing land use and has released huge amounts of CO₂ into the atmosphere
- Fossil fuel burning is increasing the atmosphere's store of carbon by **6.1 Giga tones each year**
- Humans have created an imbalance in the carbon cycle significantly influencing the earth's climate system



Vulnerability Of The Climate System

- Our climate is bonded by a series on complex interactions between several interlocking systems
- A modification of one of these system could trigger a destabilization of our climate
- There are many unknowns about the behavior of the climate system and how it will react to change
- Humans are modifying the carbon cycle to the extent that noticeable changes in the climate system are already starting to take place
- Evidences from the past shows that sometimes the climate suddenly changes when pressures pass a certain point. Continuing to modify the carbon cycle at the current rate by releasing large amounts of carbon dioxide (CO₂) and other Greenhouse gases into the atmosphere is posing some serious risks to the stability of our climate
- If our climate was to suddenly change it would be impossible to reverse with adaptation as the only alternative

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II. WHAT IS CLIMATE CHANGE?



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What is Climate Change? (1a)

The Intergovernmental Panel on **climate change** (IPCC) refers to climate change as a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity⁶

The United Nations Framework Convention on climate change (UNFCCC), refers to climate change as a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods¹²

More commonly, climate change is a shift in long-term average weather patterns

The international scientific community agrees that there has been a significant change in global climate in recent years, particularly in the polar areas⁶



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