Ulisses

CLIMATE SYSTEM, CIRCULATION PATTERNS AND CARBON CYCLE

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THE CLIMATE SYSTEM

Our planet receives more energy from the Sun at the equator than at the poles. Consequently, hot air rises and builds up in the tropics, pushing toward the cooler poles. In the poles, the air masses cool, descend, and eventually return to the tropics, making a giant loop.

Such heat movement (also known as heat transport) originates large-scale and regular patterns of atmosphere circulation.

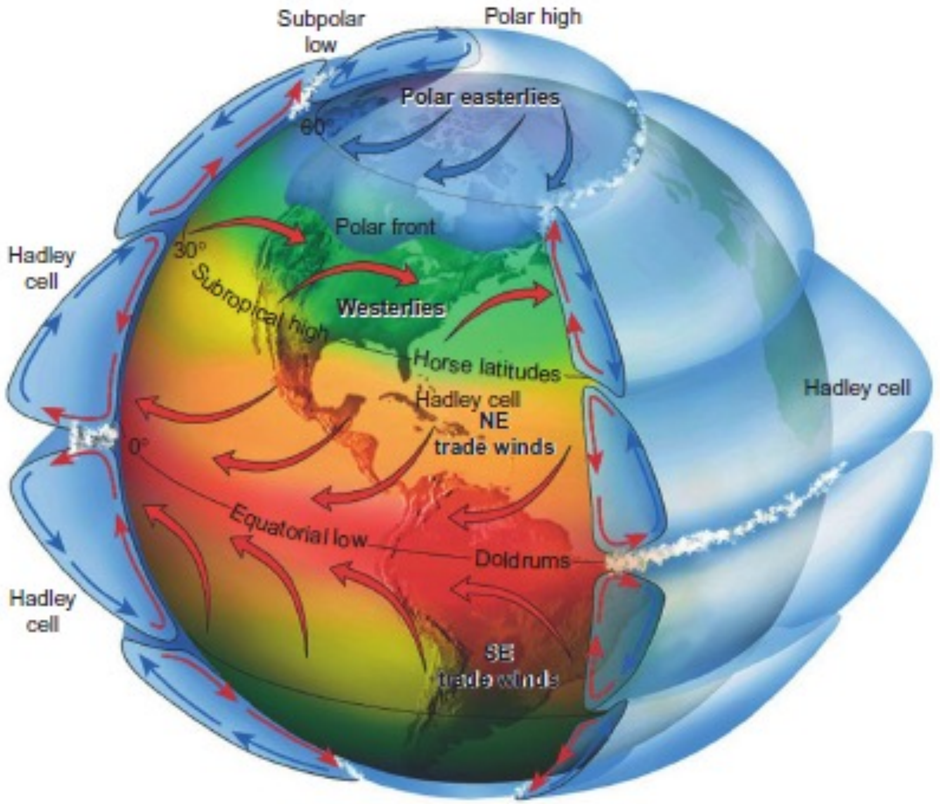

FIGURE 2.11 Hadley Cells.
Warm air rises in the atmosphere, cools, and descends. This phenomenon results in the formation of major vertical circulation features in the atmosphere known as Hadley cells. *Reproduced with permission from Pearson Publishers.*

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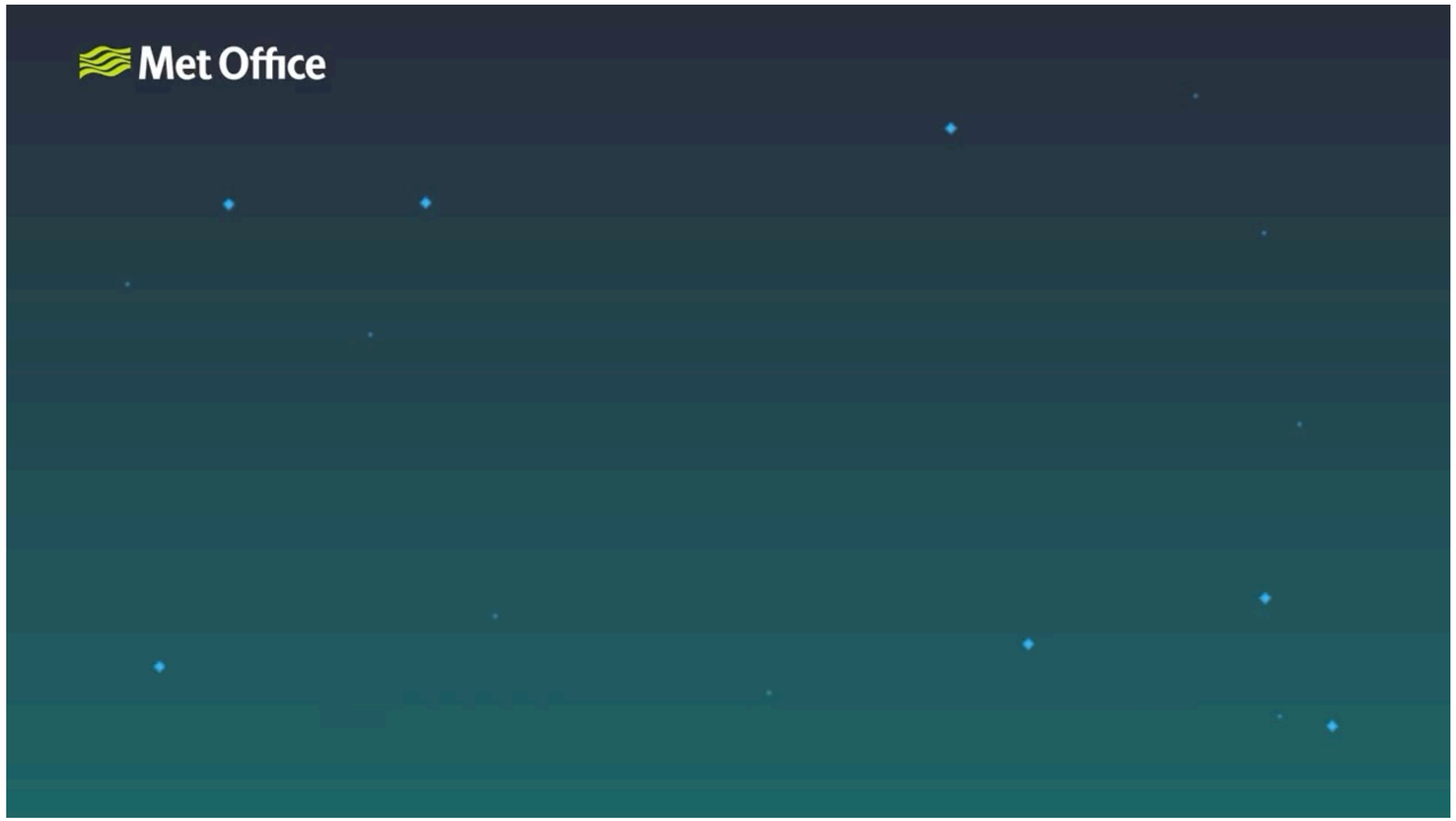
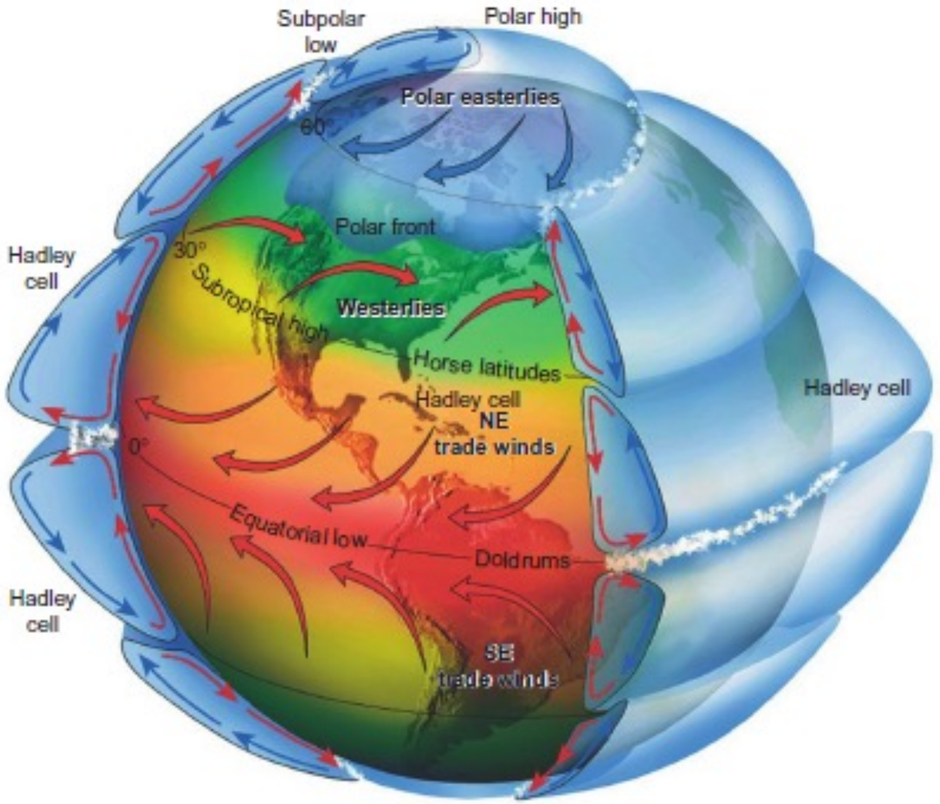
MOVIE - **What is global circulation? | Part One | Differential heating**



https://www.youtube.com/watch?v=7fd03fBRsuU

THE CLIMATE SYSTEM

These circulation patterns are known as the **Hadley cells** – and that there are two of them between the equator and each pole.



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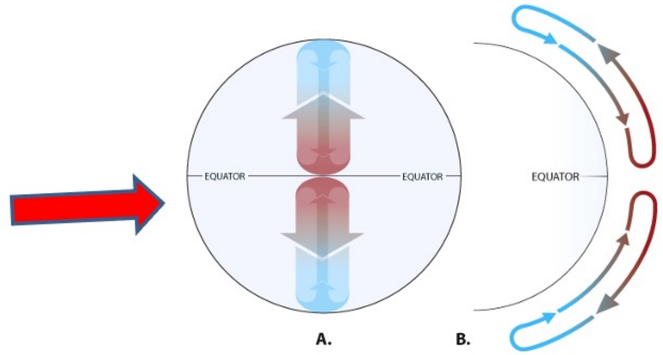
MOVIE - **What is global circulation? | Part Two | The three cells**

https://www.youtube.com/watch?v=xqM83_og1Fc&t=2s

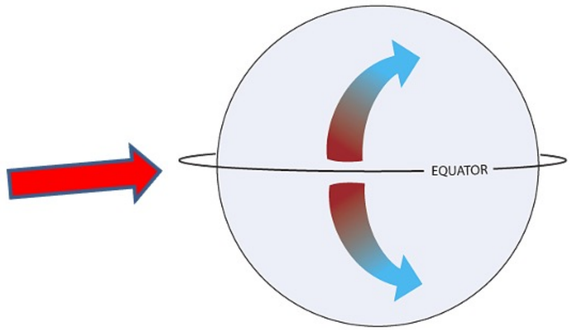
THE CLIMATE SYSTEM

Moreover, Hadley cells have both vertical and horizontal structures. Regarding the latter one, the circulation is clockwise because the air is redirected by the Coriolis effect induced by Earth's rotation.

If the Earth did not rotate and remained stationary, the atmosphere would circulate between the poles (high pressure areas) and the equator (a low pressure area) in a simple back-and-forth pattern.



But because the Earth rotates, circulating air is deflected. Instead of circulating in a straight pattern, the air deflects toward the right in the Northern Hemisphere and toward the left in the Southern Hemisphere, resulting in curved paths. **This deflection is called the Coriolis effect.**



MOVIE - **What is global circulation? | Part Three | The Coriolis effect and winds**

https://www.youtube.com/watch?v=PDEcAxfSYaI&t=79s

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THE CLIMATE SYSTEM

In the tropical regions, alongside the Hadley cells, there are East–West-oriented circulation cells. These circulation patterns arise when pressure differences across ocean basins drive surface winds in one direction, balanced by transfers upward in the opposite direction. Within the Pacific Ocean, the circulation is known as Walker cell circulation or the “Southern Oscillation”, and its breakdown results in an **El Niño event**.

MOVIE - **El Niño**

https://www.youtube.com/watch?v=WPA-KpldDVc&t=14s

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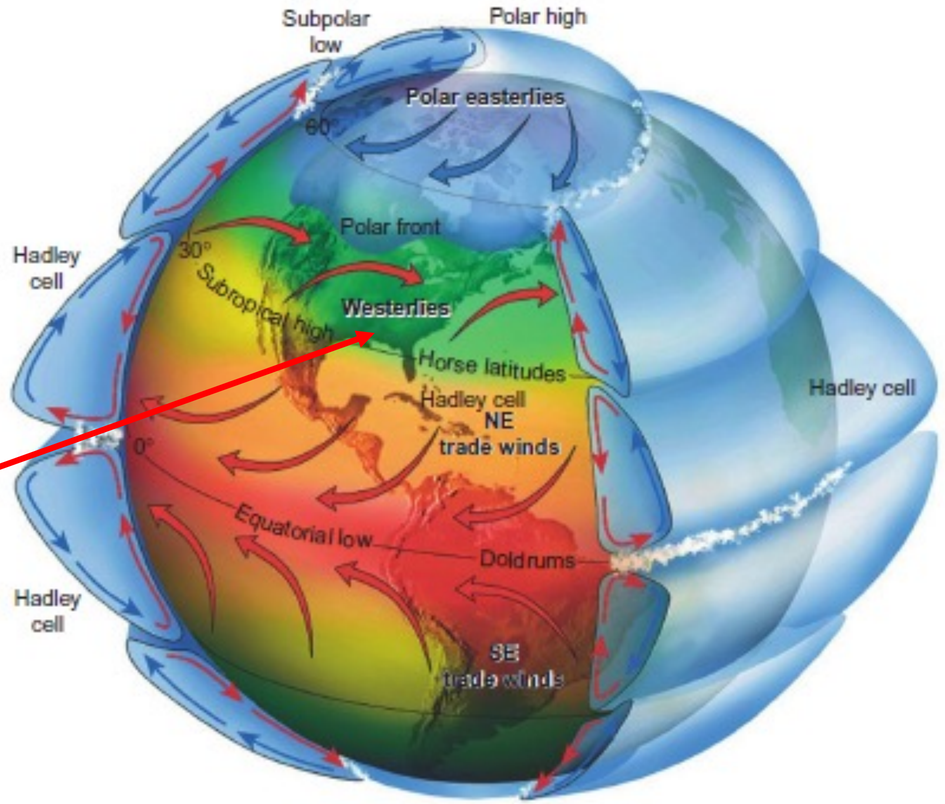
The trade winds are easterly (i.e., blow from the east) and move westward along the equator (in both the Northern and the Southern Hemisphere). The place where the trade winds converge creates a zone of uplift and cloud formation - also known as the Intertropical Convergence Zone. Such circulation pattern is balanced by west-to-east winds in the mid-latitudes - also known as the westerlies.



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CIRCULATION PATTERNS

Ocean circulation patterns

Winds drive ocean currents in the upper 100 meters of the ocean's surface. However, ocean currents also flow thousands of meters below the surface.

these deep-ocean currents are driven by differences in the water's density, which is controlled by temperature (*thermo*) and salinity (*haline*). This process is known as **thermohaline circulation**.

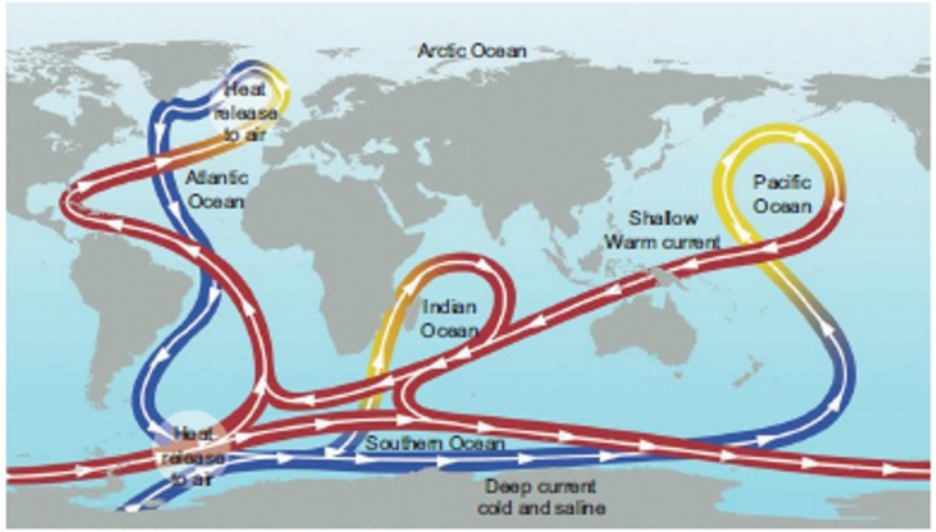

FIGURE 2.13 Thermohaline Circulation.
Major circulation features in the oceans are established when seawater warms at the equator, evaporating and becoming more saline, and then moves near the surface (red) toward the poles, where it cools and sinks. It then moves near the bottom (blue) back to the equator, to rise and begin the process anew on timescales of hundreds of years. Because it involves both temperature and salinity, this feature is termed thermohaline circulation. *Reproduced with permission from Yale University Press.*

MOVIE – **How do currents work?**

https://www.youtube.com/watch?v=p4pWafuvdrY

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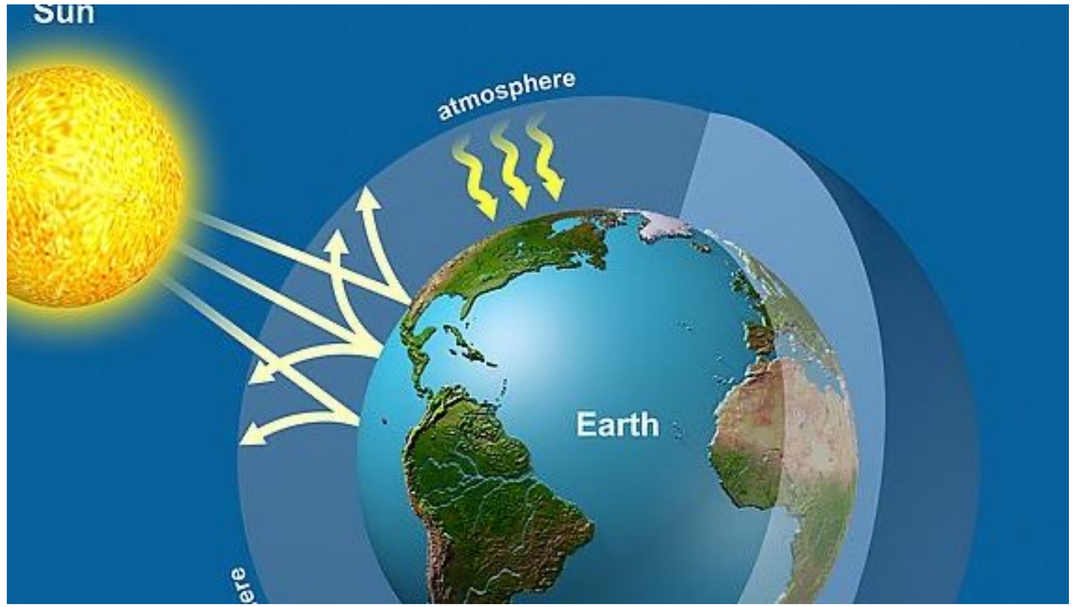
CARBON CYCLE

Global carbon cycle

Carbon dioxide (CO_2) is the most important of the greenhouse gases, and its concentration is significantly increasing in the atmosphere due to human activities. It has been estimated that such increase has contributed about 72% of the enhanced greenhouse effect. Alongside, methane (CH_4) contributed about 21% and nitrous oxide (N_2O) about 7%. CO_2 is the dominant mean through which carbon is transferred in Earth between some natural carbon reservoirs (namely atmosphere, ocean, soil and biota) – a process known as the carbon cycle.



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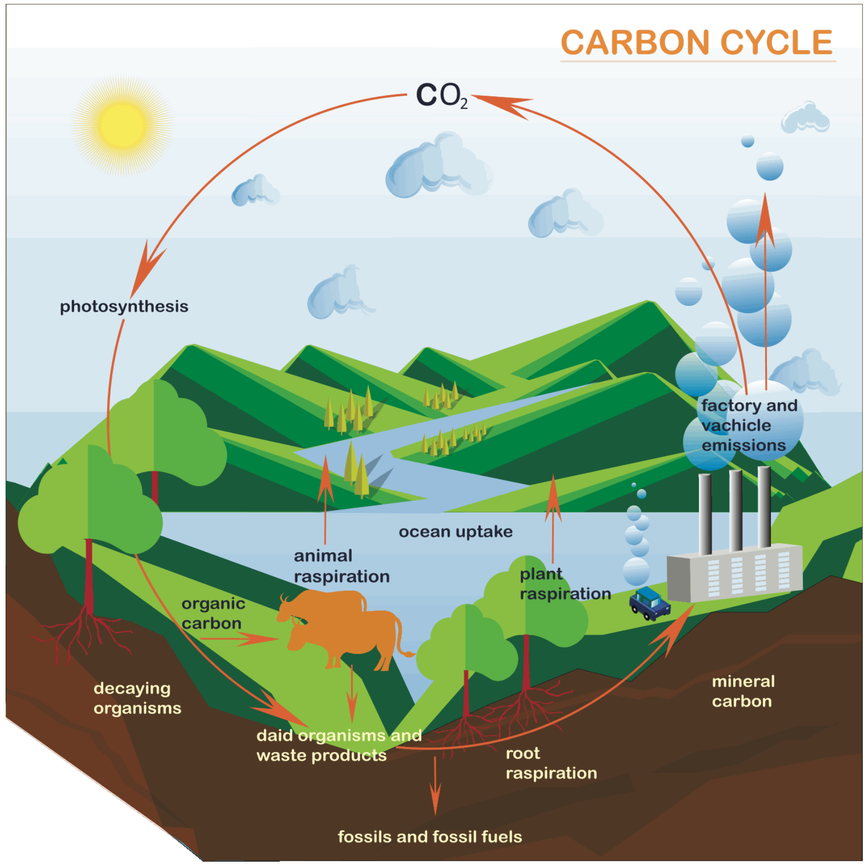
CARBON CYCLE

In terms of carbon stock, both the land (~2500 Gigatonnes; Gt) and ocean (~39000 Gt) reservoirs are much larger than the amount in the atmosphere (~760 Gt). This implies that small changes in these former reservoirs could, therefore, have a tremendous effect on the atmospheric concentration. The release of only 2% of the carbon stored in the oceans could double the amount of atmospheric CO_2. This gas is not destroyed but redistributed among the various carbon reservoirs, and therefore, it is different from other greenhouse gases that are destroyed by chemical action in the atmosphere.



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MOVIE – What is the carbon cycle?

https://www.youtube.com/watch?v=0-DtXqr-gPQ

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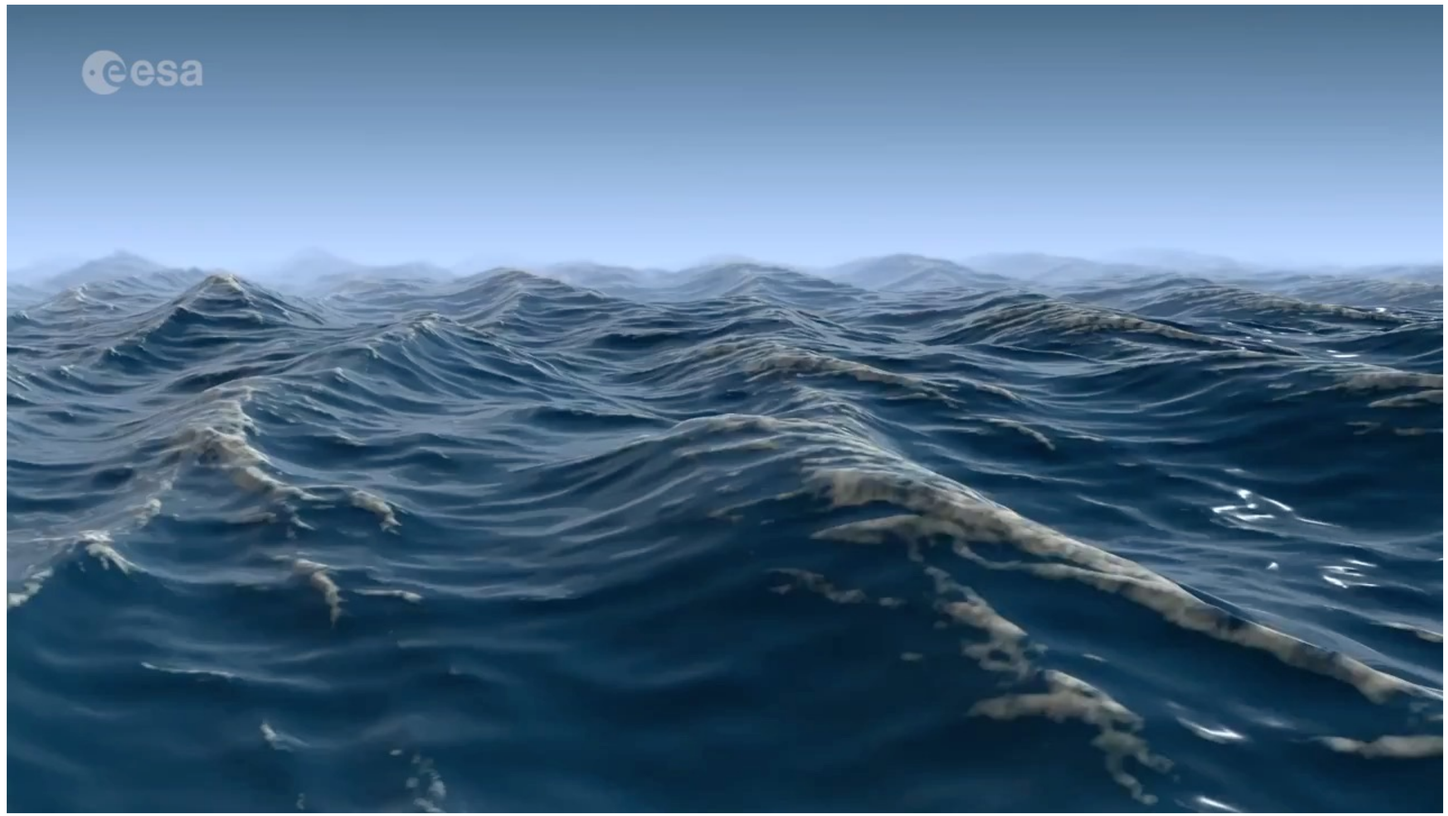
MOVIE – CO2, ocean monitoring and climate modelling



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