Bund für Umwelt und Naturschutz Deutschland

BUND

FRIENDS OF THE EARTH GERMANY

THE BLUE CLIMATE MIRACLE IN CRISIS

BUND „OCEAN & CLIMATE“ FACT CHECK SERIES – PART 1

The ocean is the central pacemaker of our climate system – and at the same time our greatest ally in the current climate crisis. It removes huge amounts of carbon dioxide (CO_2) from the atmosphere and absorbs the lion's share of extra heat trapped by the anthropogenic greenhouse effect. A true marvel that mitigates global climate change.

But the seemingly unlimited ability to absorb CO_2 and heat is deceptive. For it is dependent on the health of our marine ecosystems. The consequences of the global climate crisis along with overexploitation by us humans continue to weaken the ocean's function as a climate buffer. And without countermeasures, the air for our blue climate miracle is getting thin.

Numbers & Facts

- ✓ As a large natural carbon sink, the ocean absorbs more than a quarter of global anthropogenic CO_2 emissions - thus significantly slowing down climate change.
- ✓ Since the beginning of industrialisation, the ocean has already become almost 30 percent more acidic due to the constant uptake of anthropogenic CO_2. This reduces the solubility of the greenhouse gas in seawater and thus the absorption capacity of the ocean.
- ✓ Since the 1970s, the ocean has absorbed 90 percent of the excess heat from human emissions, significantly mitigating global warming in the process.
- ✓ The increasingly rapid warming of seawater is weakening its global circulation system and thus its natural function as a carbon sink.

Assembly line work for our climate

The ocean holds an estimated 97 percent of the world's water. Its huge body of saltwater covers more than 70 percent of the Earth's surface. Naturally, this entails a considerable impact on our weather and temperature. It comes to no surprise that the vast expanses of the ocean take up most of the solar radiation reaching our planet. In the uppermost layers of the ocean, this solar energy is converted into heat. What is special about this conversion is that the high heat capacity of seawater prevents a synchronous sharp rise in water temperature. In combination with an effective mixing, this ensures that the ocean heats up – and cools down – only slowly and evenly.

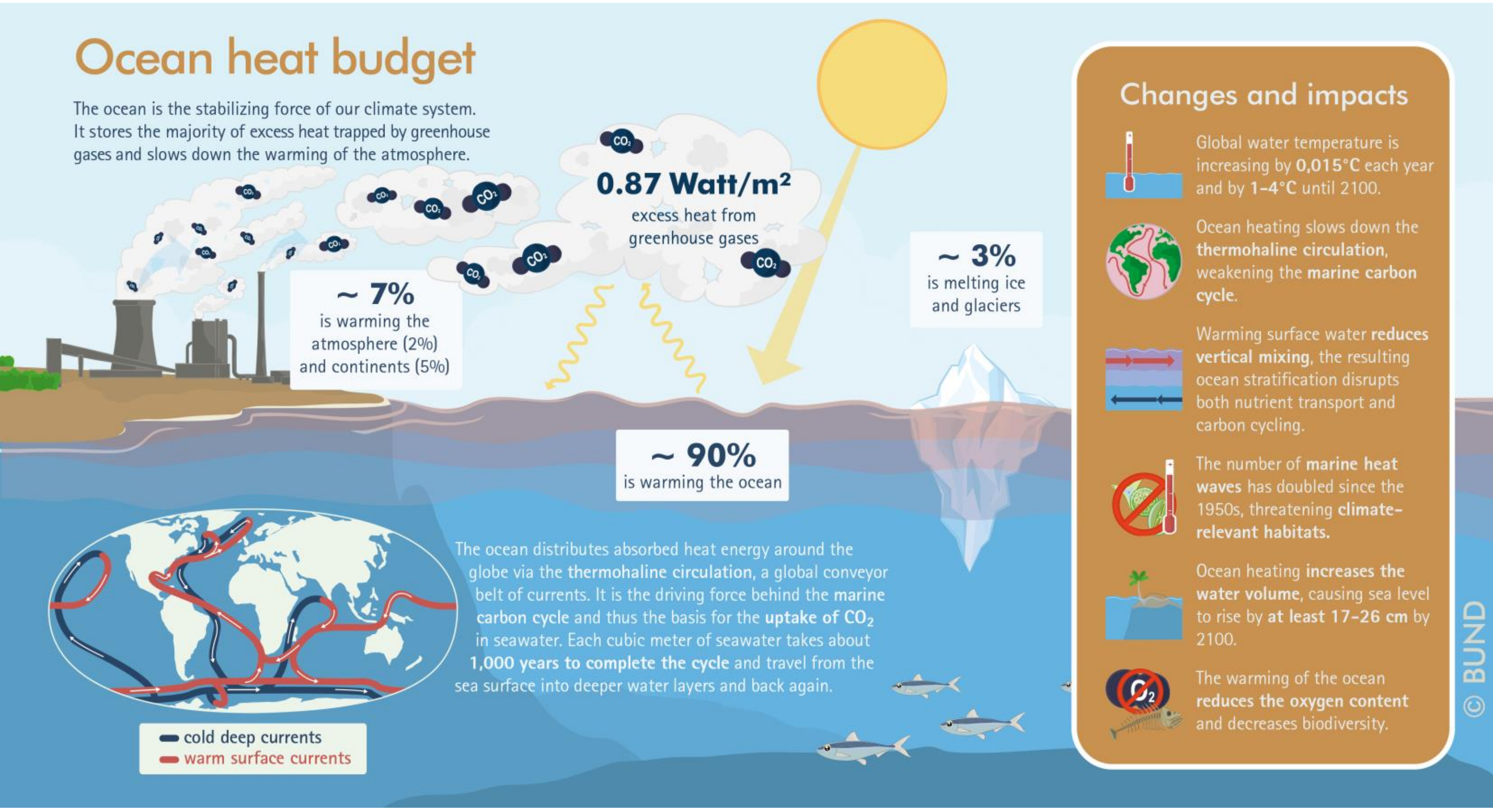
This enormous capability gives the blue wonder a stabilising role in the Earth's climate system. It balances out seasonal temperature fluctuations of the atmosphere and can partially absorb longer-term climatic changes. At the same time, the ocean dampens the rise in atmospheric temperature associated with the dramatic increase in our CO_2 emissions. This is because it takes up most of the heat generated by the greenhouse effect – about 90 percent!

Without this enormous heat storage capactiy, our atmosphere would warm up much faster than it currently does. However, the buffer function comes to a high price: even without a further increase in atmospheric CO_2 concentrations, the ocean will continue to warm up for centuries. This shows its immense importance for our climate system.

However, the ocean not only absorbs gigantic amounts of heat. It also transports the thermal energy over great distances. Huge ocean currents constantly distribute warm and cold water masses around the Earth like giant conveyor belts. Since these currents are driven by winds as well as differences in salinity and temperature of the seawater, this phenomenon is called the "thermohaline circulation". Warm surface water constantly flows from the equator towards the poles and cools down in the process. At the poles, the formation of sea ice increases the salinity and thus the density of the surrounding water. Cold and dense seawater then sinks to greater depths. Along the ocean floor, it finally spreads out again towards the equator, where it resurfaces. It takes a single drop of water about 1,000 years to complete its journey through this cycle. In this way, the blue wonder also regulates temperatures and weather on the continents. In Northern Europe, for example, it would be about 10 degrees colder without this influx of heat.

The ocean, a carbon reservoir: from the atmosphere to the deep sea

The great importance of the ocean in our climate system also becomes apparent when we take a closer look at one of the most important elements on our planet – carbon. Carbon is the chemical backbone of all life on Earth. Without it, there would be neither proteins nor DNA. Hence no living beings either. In the form of carbon dioxide, however, carbon is linked to one of the greatest challenges of our time – climate change. Since the industrialisation, the concentration of the greenhouse gas in our atmosphere has risen from 278 to over 410 ppm (parts per million). A steep increase of no less than 50 percent. And that is only part of the story: in spite of all scientific warnings and political declarations of intent, our greenhouse gas emissions continue to increase even further. Today, CO_2 concentrations in the atmosphere are rising at unprecedented rates of over 2 ppm per year. Compared to the 1950s, this means that the global rate has almost quadrupled. We are already experiencing the catastrophic and cascading effects of global warming set in motion by this anthropogenic impact. The progressive rise in sea level or the drastic increase in extreme weather events are unfortunately only the tip of the (melting) iceberg.

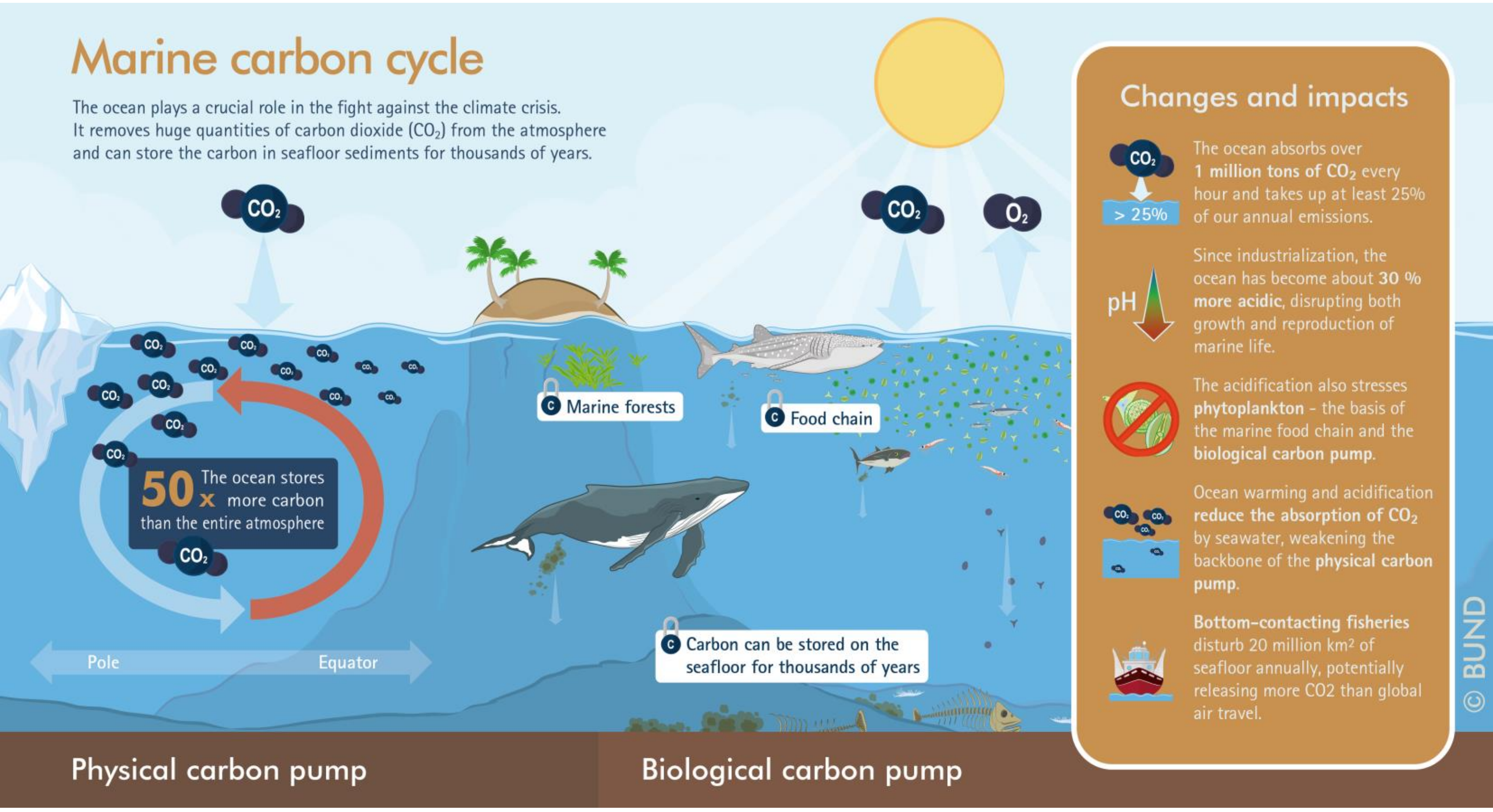


ABOVE – *The ocean absorbs 90 percent of the excess energy from human greenhouse gas emissions. It is an effective buffer against climate change and slows down the warming of our atmosphere. The other side of the coin: in the long term, the accelerating warming of the ocean threatens its global circulation system as well as climate-relevant ecosystems and their organisms – and thus also the ability of the ocean to absorb heat and CO_2.*

Here, too, the blue climate miracle helps us by actively working against the cause of the greenhouse effect. Over a quarter of anthropogenic CO_2 emissions are absorbed by the ocean. That is up to 30 million tonnes. Every day. This gigantic achievement makes the ocean one of the largest natural carbon sinks on our planet and slows down climate change.

But how does it work, how can the ocean absorb CO_2? The main driver is a constant interaction between the elements water and air, coupled with the gigantic circulation processes of seawater and the continuous activities of marine animals and plants alike. Together they drive a process that ensures the uptake of CO_2, its redistribution to the deep ocean and its long-term storage on the seafloor – the marine carbon cycle:

- At the boundary between the elements air and water, the ocean takes up atmospheric CO_2 by chemically dissolving the greenhouse gas in its surface water. For this to work CO_2 pressure in the air must be higher than that in the water – the effect is similar to the production of sparkling water. In addition, the absorption of the greenhouse gas by seawater strongly depends on the temperature of the latter. Colder water (e.g., in polar regions) naturally can take up more CO_2 than warmer water (e.g., in tropical regions).
- The physical carbon pump uses the global system of ocean currents, the thermohaline circulation, to transport CO_2 dissolved in the surface water towards the depths of the ocean. There it accumulates over time and slowly migrates over the seafloor towards the equator, where it finally returns to the surface. A correspondingly lengthy process, the effects of which will only gradually become apparent in the future.
- In the biological carbon pump, marine plants and animals fix CO_2 by building up biomass. Comparable to forests on land, marine plants absorb the gas through the process of photosynthesis. This happens in the light-rich zones of the surface waters in the open ocean (primarily through microscopic phytoplankton) as well as in coastal regions (e.g., seagrass and large algae). At least 50 percent of the oxygen that is vital for human life originates from the photosynthetic activities of these marine plants. At the same time, the organisms form the food basis for many marine animals. If plants and animals die or excrete substances, the organic mass sinks to the seafloor. There it decays and can be bound in the sediments over thousands of years. Without this vertical pump, the CO_2 content in our atmosphere would be around 150-200 ppm higher today.



ABOVE – *The marine carbon cycle ensures that the ocean can absorb CO_2 from the atmosphere and store it on the seafloor in the long term. While the physical carbon pump chemically dissolves the greenhouse gas in the surface water and transports it to greater ocean depths via the global circulation system, the biological carbon pump is largely responsible for the vertical transport of organic carbon and its storage on the seafloor.*

SOS:
when stores turn into sources

Just as the ocean exerts an immense influence on our climate system, it is in turn affected by climate change. The dramatic consequences of the climate crisis do not stop at the buffer functions of the ocean and its ecosystems.

Over the last 200 years, absorption of anthropogenic CO_2 has reduced the ocean's pH value from 8.2 to 8.1. What may not look like much corresponds to a drop in acidity by almost 30 percent due to the logarithmic pH scale. By 2100, the ocean is expected to become another 100 to 150 percent more acidic. The consequences? A reduced solubility of CO_2 in seawater, hence a lower uptake by the ocean. More and more greenhouse gas remains in the atmosphere, amplifying the climate crisis. At the same time, the ongoing ocean acidification weakens phytoplankton species with calcareous shells – and thus saws away the very foundations of the biological carbon pump. In more acidic water, their shells become thinner and thus lighter, disrupting transport to the depths. As a result, significantly less carbon could be sequestered on the seafloor in the future.

But acidification is not the only consequence of climate change that negatively impacts the ocean as a carbon sink. Heat poses another problem, as the warming of surface waters by about 0,015°C per year lowers the ocean's capacity to absorb CO_2. At the same time, it reduces the vertical mixing of seawater. The increasing ocean stratification disrupts nutrient transport that is essential for phytoplankton productivity. Marine heat waves also repeatedly threaten climate-relevant habitats and their organisms. Since the 1950s, these extreme events have doubled in frequency. And the progressive sea level rise associated with global warming endangers the effective carbon reservoirs of coastal regions, such as seagrass meadows or salt marshes.

Taken together, these climate impacts could even lead to the ocean releasing more CO_2 than it absorbs in the future. It would make the blue climate miracle itself a source of greenhouse gas emissions, thus contributing to global warming. Against this background, the consequences of human activities in the ocean also gain considerable importance. By destroying and polluting marine ecosystems, we humans are dramatically impairing their ability to sequester CO_2 – and at the same time release carbon that has already been locked away. In view of the global climate crisis, it is therefore essential to preserve and further strengthen the natural climate functions of the ocean. Only a healthy ocean with thriving ecosystems can provide the functions that are so important for life on our planet. For this to happen, however, marine nature conservation must finally become a mainstay of climate protection.

The BUND demands

- Consideration of the natural climate functions of the ocean in all relevant political processes and decisions at regional, national and European level.
- Renaturation of carbon sinks native to the North and Baltic Sea, such as seagrass beds and salt marshes, to at least half their original extent.
- Integration of climate-relevant ecosystems into protected area management and marine spatial planning.
- At least 50% strictly protected (=no-take) zones in marine protected areas.
- Consistent reduction of harmful subsidies (e.g., fossil fuels or fisheries).

Selected literature

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APOC
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