

THE ROLE OF THE OCEAN IN THE EARTH AND CLIMATE SYSTEM

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Oceans are an integral part of Earth; they are intimately linked to atmosphere and land. Unraveling the links and feedbacks between the different components of the Earth's system is not only scientifically challenging; it is also essential to understand the future of our planet. Another aspect is the vast biodiversity in the ocean. Humankind relies on marine life not only for food but also for natural materials and many ecosystem services. Last but not least, exploring the depths of the oceans opens up an unknown world of trenches, mountains and endless plains and we only have just begun to understand this part of the Earth System.

Global climate models started in the 1970s without taking oceans into account, but step by step a more complex ocean was included in climate models. Now, the next big step will be to integrate marine life in the models in order to arrive at better predictions for CO₂ uptake in the ocean and future climate changes.

Increasing CO₂ in the atmosphere acidifies the ocean, an effect that is independent from other climate change issues. Acidification alters several chemical and biological processes in the ocean, and our understanding of life in a more acidic ocean is still scarce. So far, the largest effects are predicted for the cold polar waters.

Warming of the ocean has numerous effects on ocean currents, stratification, heat transport and distribution of organisms. Particularly obvious is the observed increase in melting of sea ice and glacial ice sheets that lead to shifts in polar eco-systems and sea level rise. Major future problems will therefore arise to a large extent from changes in the polar regions, both Arctic and Antarctic.

The Arctic is warming up twice as fast as the global average; it is therefore an issue of deep concern for the global climate and a topic of intense research. We can consider the Arctic as an early warning indicator for global change. The sea ice cover of the Arctic Ocean has decreased dramatically during the last decades. This development is likely to trigger large changes in physical and biological processes in the Arctic Ocean and to influence global climate. For this reason it is of utmost importance to observe the 'Atlantification' of the Arctic Ocean, monitor changes in sea ice volume and model its future development. Measurements at a long-term deep-sea observation station between Greenland and Spitzbergen show that retreat of sea ice is even felt at the deep-sea floor.

The ocean is not only an essential part of the Earth System, but also of utmost importance for the future of human society. Untapped resources in the ocean are now becoming a target of exploitation. We need to use these resources in a responsible and sustainable way. This is one of the prime tasks of future ocean research.