Ocean acidification and the Southern Ocean

What is ocean acidification?

About half of the carbon dioxide (CO_2) emitted from human activities, such as burning fossil fuels, land clearing and cement production, has dissolved in the ocean, altering its chemistry and making the water more acidic.

How does the water change?

When (CO_2) dissolves in water (H_2O) it forms carbonic acid (H_2CO_3) – the same weak acid found in carbonated drinks. Increasing levels of carbonic acid interfere with the formation of calcium carbonate ($CaCO_3$), a major structural component of the shells of many important planktonic organisms (free-floating marine plants, animals and microbes ranging in size from microscopic to several centimetres). Increasing acidity also affects the availability of nutrients in the ocean.

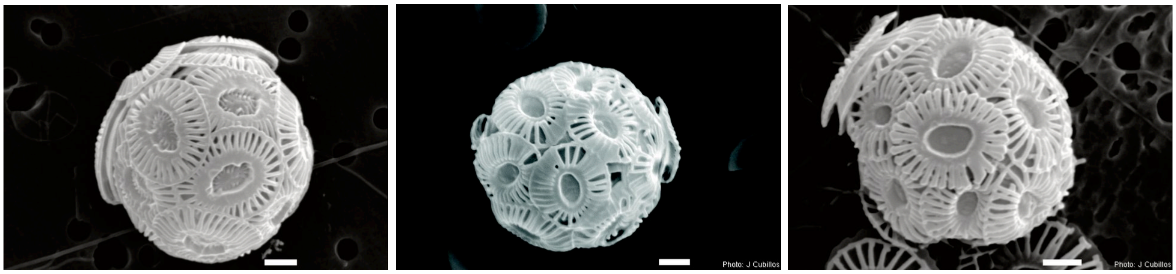
The pteropod *Cavolinia uncinate* will be affected by ocean acidification.
Photo: Russ Hopcroft.

What effect will ocean acidification have?

As it becomes more difficult for calcium carbonate to form, it will become more difficult for some planktonic organisms to form shells. If their shells are thinner and/or deformed, the organisms may be unable to function properly. Many of these organisms are key components of the food chain – important in the diets of krill, fish, squid, penguins, seals and whales. They are also important in the removal of carbon from surface waters to the deep ocean and the release of oxygen into the air. Important metabolic processes, such as respiration in fish, may also be impaired by the acidity, as lowering the pH reduces the efficiency of oxygen exchange in their gills.

What organisms will be affected?

In the Southern Ocean and other open-ocean ecosystems, calcifying organisms affected will include snail-like molluscs called 'pteropods', abundant, single-celled algae called 'coccolithophorids' and protozoan 'foraminifera'. Changes in microbial populations are likely to flow on to dependent species throughout the food chain. In tropical coastal ecosystems coral reefs, comprised of colonies of small animals that secrete calcium carbonate skeletons, are also at risk.



Left to right: Healthy shell structure of the coccolithophorid *Emiliania huxleyi;* incomplete shell growth as acidity increases; malformed shell plates under more acidic conditions. Photos: J Cubillos

How acidic will the oceans get?

The pH of seawater has historically remained at about 8.2, which is slightly alkaline (pure water is neutral - pH 7). However, CO_2 from human activities has caused the pH of ocean surface waters to drop by 0.11 pH units. This might not sound like much, but it is equivalent to a 30% increase in acidity. Unless CO_2 emissions are curbed, the pH is expected to fall by 0.5 pH units by 2100, a 320% increase in acidity.

How can we stop it?

Even if all carbon emissions stopped today, we are committed to a further drop of 0.1—0.2 pH units and it will take thousands of years for the oceans to recover. However, action now can prevent conditions, that are corrosive to calcifying organisms, from becoming more widespread.

What research is being done?

Scientists at the Australian Antarctic Division and the Antarctic Climate and Ecosystems Cooperative Research Centre, based in Hobart, are conducting a range of experiments on plankton and sediments from the Southern Ocean, to determine the effect of increasing CO_2 on marine organisms and the impacts this will have on the ecosystem. A research voyages in 2007, the *Sub-Antarctic Zone Sensitivity to Environmental Change* conducted ship-board experiments and brought back samples for laboratory analysis.

Why is Southern Ocean research so important?

The Southern Ocean contains more CO_2 than other oceans because cooler water absorbs more CO_2 than warmer water. Thus, the impacts of ocean acidification will appear first in the Southern Ocean.