Media release

**Scientists produce first Australian maps of our acidifying oceans**

Scientists have taken the first steps towards mapping ocean chemistry change and hotspots in the Australian region as the ocean responds to rising global levels of atmospheric carbon dioxide.

The research explores how ocean acidification in the regional Indian, Pacific and Southern Oceans and the Tasman Sea is changing, how it is likely to continue in the future and explores adaptation options.

Ocean acidification is likely to impact the entire marine ecosystem – from microbial communities to top predators; through changes in reproductive health, organism growth and physiology, species composition and distributions, food web structure, and nutrient availability.

The new studies will benefit marine planners, environmental managers and primary producers in coastal waters and estuaries, such as shellfish farms.

The research coincides with the first studies evaluating the benefits of seaweed farms in buffering coral reefs and the ecosystems they support around Heron Island on the Great Barrier Reef against the impacts of acidification. The project found the most extensive seaweed farm can only delay the impact of acidification by between seven and 21 years, and is dependent on future global carbon emissions.

“These are significant research outcomes for Australia as carbon emissions rise,” says CSIRO’s Dr Andrew Lenton.

“The next step is to correlate past, present and likely future influences on the marine ecosystem and extend our studies into risk and mitigation options, particularly where there are social, economic and environmental interests at the coasts and in our iconic marine parks,” Dr Lenton said.

The three studies, published in February, come on the eve of the first international symposium on ocean acidification to be held in the Southern Hemisphere.

*The Oceans in a High CO2 World Symposium* is being held in Hobart from May 3-6, supported by a cluster of Australian research institutions led by the Antarctic Gateway Partnership, the US National Science Foundation, NASA and the National Oceanic and Atmospheric Administration. It is expected to attract 400 scientists from more than 30 countries.

Dr Lenton said that with rising levels of carbon dioxide, and the growing awareness of the environmental, social and economic impacts of ocean acidification this has become a significant area of science, paralleling climate change science. It is often referred to as the *evil twin of global warming.*

“The two fields of research go hand in hand with the oceans playing a critical role slowing the rate of climate change by taking up and sequestering around one third of the carbon emitted annually into the atmosphere.

“In this context, understanding the relationship between climate change and the marine environment is critical for the future management of the world’s marine resources,” he said.

“For many organisms it will be a trade-off between ocean acidification and warming. For example, some organisms that migrate southward may experience conditions that are more favourable in terms of ocean temperature but less attractive in terms of ocean pH. For other organisms such as seagrasses there is potential to do better in the future due to ocean acidification but worse under ocean warming,” Dr Lenton said.

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**Background**

Once absorbed into the ocean through biological and physical processes, CO2 reacts with seawater, leading to changing ocean chemistry (through decreases in pH and dissolved carbonate ion concentration), these changes being collectively referred to as ocean acidification. Over the past 200 years, it is estimated that there has been a 0.1 unit reduction in the ocean’s surface pH, or a 26% increase in the concentration of hydrogen ions in seawater.

In the Australian region there has been both similar decreases in pH and aragonite saturation state (a measure of the carbonate ion concentration) since the preindustrial period.

The availability of carbonate ions in the marine environment is important as many marine organisms use carbonate ions, along with calcium, to form hard calcium carbonate shells and skeletons. There are two primary forms of calcium carbonate used by organisms: aragonite and calcite. Aragonite is the primary form of calcium carbonate used by corals to form hard reef structures and by other invertebrate organisms such as oysters, clams, lobsters, crabs and starfish and some plankton e.g. pteropods. Calcite is primarily used by marine phytoplankton such as coccolithophores and foraminifera and is more chemically stable than aragonite.

The oceans are projected to continue acidifying, with these changes persisting for many millennia. Within the marine environment, ocean acidification has the potential to impact the entire marine ecosystem, from microbial communities to top predators. These impacts include organism growth, reproductive health, and physiology, species composition and distributions, food web structure and nutrient availability.

* **Marine Projections of Warming and Ocean Acidification in the Australasian Region** http://www.bom.gov.au/amm/docs/2015/lenton.pdf

Ocean warming and acidification are considered two of the key stressors in the marine environment. These are very likely to have significant implications for the health, longer-term sustainability and biodiversity of marine environments in the Australian region. It is likely that these changes will impact on the important ecosystem services that these marine environments provide such as fisheries, tourism, coastal protection and food security. In this context, projecting and understanding how Australia’s climate may change, together with its potential impact on Australia’s marine environment, is critical for the management of marine resources now and into the future.

The study investigates and quantifies how Australia’s marine environment may change in response to different emissions scenarios. The magnitude and rate of these changes is strongly tied to the emissions trajectory followed.

* **Historical reconstruction of ocean acidification in the Australian region** - <http://www.biogeosciences.net/13/1753/2016/>

In response to increasing carbon dioxide (CO2) emissions the oceans have become warmer and more acidic. The oceans have also played a critical role in limiting the rate of global warming by absorbing 30% of CO2 emissions since the preindustrial period.

This reconstruction assesses the ability of Earth system models to simulate observed temperature and ocean acidification around Australia, and then how it will change in future.

Under a set of different emission scenarios relevant to the extent that emissions grow, the oceans around Australia exhibit warming and continued acidification. However, these changes are quite variable, with increases projected in areas such as the Tasman Sea. The paper concludes that the projected changes in sea surface temperature, and chemical change through aragonite saturation state and pH are likely to profoundly impact marine ecosystems, and the ecosystem services that they provide in the Australasian region.

* **Optimising reef-scale CO2 removal by seaweed to buffer ocean acidification** - <http://iopscience.iop.org/article/10.1088/1748-9326/11/3/034023/meta>

Coral reefs and the ecosystems they support are regarded as one of the most vulnerable ecosystems to ocean acidification, threatening their long-term viability. In response to this threat, different strategies for buffering the impact of ocean acidification have been proposed. While many schemes to buffer these changes have been proposed, the efficacy of these buffering strategies remains largely unknown.

Here we assess the feasibility and potential efficacy of a reef-scale (a few kilometres) carbon removal strategy, through the addition of seaweed farms within the southern Great Barrier Reef at the Heron Island reef, one of the most studied reefs on the GBR

For a reef-scale ocean-acidification buffering project to proceed, many environmental, social and economic considerations will need to be met. Before these more complicated issues should even be considered scientists must investigate at what scale and how efficiently ocean acidification can be locally mitigated.

Therefore, despite considerable cost, the 1.9 ${\mathrm{km}}^{2}$ farm only has the ability to buffer the majority of the Heron Island reef from ocean acidification for a period of 7–21 years (up to 40 years, in small localised areas downstream of the farm). This highlights the importance of mitigation of anthropogenic carbon emissions to reduce the impacts of ocean acidification on the marine ecosystem.