# #22-23 – January-February 2016

News

NZOA website is [launched](http://nzoac.nz/#new-zealand-ocean-acidification-community).

Thanks to all the hard work of Victoria Metcalf. If you have any ideas of things that should be on the website or comments please get in touch with Victoria [victoria.metcalf@gmail.com](mailto:victoria.metcalf@gmail.com). We also have a facebook page – search for “New Zealand Ocean Acidification Community”. The committee have also produced some NZOAC postcards to promote the work that we are doing. If you would like some to distribute some at an upcoming event please get in touch with [Abby.Smith@otago.ac.nz](mailto:Abby.Smith@otago.ac.nz).

**Expertise database**

Don’t forget to send Victoria your details and expertise for the NZOA database of OA researchers for the website.

**CARIM**

The Ministry for Business Innovation and Employment (MBIE) funded CARIM (Coastal Acidification: Rate, Impacts and Management) project is now underway. A general article about the project can be found at <https://www.niwa.co.nz/news/investigating-ocean-acidification>. A new website will be launched soon and we will provide a link to it in upcoming newsletters so you can keep up to date with the activities and results.

## Upcoming events

**4th International Symposium on the Ocean in a High-CO2 World**    
Will be held at the Hotel Grand Chancellor in Hobart, Tasmania, Australia, from 3 to 6 May 2016. <http://www.highco2-iv.org/>. There are a number of Open Workshops aligned with the conference – deadlines to register for these are closing soon.

* [Coral reefs in a high CO2 world – Heron Island (27 – 30 April 2016)](http://www.highco2-iv.org/workshop-coral-reefs)
* [xFOCE systems: present status and future developments workshop (29 April 2016)](http://www.highco2-iv.org/workshop-xfoce)
* [Chemical, biological, and statistical considerations for ocean acidification experiments (28, 29 April and 2 May 2016)](http://www.highco2-iv.org/workshop-chemical)
* [Global Ocean Acidification Observing Network (GOA-ON) Workshop (8-10 May 2016)](http://www.highco2-iv.org/workshop-goa-on)
* [Multiple stressors and marine biota (9-11 May 2016)](http://www.highco2-iv.org/workshop-stressors)

**Sharing Ocean Resources Now and in the Future** New Zealand Marine Sciences Society (NZMSS) and Australian Marine Sciences Association (AMSA) joint 2016 Conference ***–*** 4-7th July 2016, Victoria University, Wellington [Website](https://innovators.eventsair.com/QuickEventWebsitePortal/nzmss-amsa-2016/home)

Abstracts are now open, deadline for abstracts is 7th April. We encourage NZOA members to attend and present their Ocean Acidification studies in Session 3.4 (see description below). This session will be held on the last day of the conference (to allow for our 9th Annual NZOA workshop to follow on the 8th July – see below).

**Session 3.4:** Preparing for climate change:it is one thing to understand what changes are taking place in the ocean in response to climate change but marine decision-makers continue to be daunted by what can be done to mitigate and prepare for changes in their own EEZ. Scope of presentations sought: Effects of climate change on resource management; the positives and negatives of climate change and ocean acidification on marine industry and other sector interests and obligations. Biosecurity in a changing ocean environment.

**9th Annual NZOA workshop**   
Will be held on the 8th July, 2016, at Victoria University, Wellington.

The 9th NZOA workshop will be held the day after the joint NZMSS and AMSA conference. As there will be an OA session on the final day of the NZMSS conference, the OA workshop will only be one day this year. The format will also differ, with fewer science presentations, and more time for OA project updates and discussion and debate. The committee would appreciate feedback from policy makers, stakeholders and scientists on what topics they would like to discuss at the workshop. Please submit ideas to [Helen.Bostock@niwa.co.nz](mailto:Helen.Bostock@niwa.co.nz) by the 31st March 2016.  
  
International News

**OA-ICC**   
The Ocean Acidification International Coordination Centre has produced it latest [summary](https://oceanacidification.files.wordpress.com/2016/02/oa-icc-highlights-october-december-2015-new-version.pdf) of activities from Oct-Dec 2015.

**Global Ocean Health**   
New [edition](http://globaloceanhealth.cmail20.com/t/ViewEmail/d/47E77D99560D492E/E755DA03CBDE2B310F8C96E86323F7F9) of the “Ocean Acidification Report”. The January 2016 edition centers around the UNFCCC COP21 held in Paris on 30 November – 10 December 2015.

#### **The Lemon Sea Project** <http://lemonsea.org/> for some fun resources to teach about OA. LEMONSEA was created in 2014 by a group of students passionate about the protection of the environment and more precisely by ocean preservation. Considering that Ocean Acidification is at the root of many of the issues that ocean conservation faces, we believe in the necessity of awareness raising in order to tackle the main drivers of acidification in a holistic approach.

* to create innovative educational tools to popularize and facilitate the science on issues linked to Ocean Acidification
* to contribute to the dissemination of knowledge by sharing relevant content on Ocean Acidification
* to work with organizations or individuals committed to research and advocacy on Ocean Acidification issues

The group are looking for new energetic members and scientific advisors.

Selection of recent papers from the SW Pacific and beyond

Special Issue in Journal of Marine Sciences - Towards a broader perspective on Ocean Acidification research. Volume 73, wide selection of papers <http://icesjms.oxfordjournals.org/content/73/3.toc>

**Incorporating benthic community changes into hydrochemical-based projections of coral reef calcium carbonate production under ocean acidification.** The existence of coral reefs is dependent on the production and maintenance of calcium carbonate (CaCO3) framework that is produced through calcification. The net production of CaCO3 will likely decline in the future, from both declining net calcification rates (decreasing calcification and increasing dissolution) and shifts in benthic community composition from calcifying organisms to non-calcifying organisms. Here, we present a framework for hydrochemical studies that allows both declining net calcification rates and changes in benthic community composition to be incorporated into projections of coral reef CaCO3 production. The framework involves upscaling net calcification rates for each benthic community type using mapped proportional cover of the benthic communities. This upscaling process was applied to the reef flats at One Tree and Lady Elliot reefs (Great Barrier Reef) and Shiraho Reef (Okinawa), and compared to existing data. Future CaCO3 budgets were projected for Lady Elliot Reef, predicting a decline of 53 % from the present value by end-century (800 ppm CO2) without any changes to benthic community composition. A further 5.7 % decline in net CaCO3 production is expected for each 10 % decline in calcifier cover, and net dissolution is predicted by end-century if calcifier cover drops below 18 % of the present extent. These results show the combined negative effect of both declining net calcification rates and changing benthic community composition on reefs and the importance of considering both processes for determining future reef CaCO3 production. Shaw E. C., et al., in press. *Coral Reefs.* [Article](http://dx.doi.org/10.1007/s00338-016-1407-2) (subscription required).

**Data compilation on the biological response to ocean acidification: an update.** The exponential growth of studies on the biological response to ocean acidification over the last few decades has generated a large amount of data. To facilitate data comparison, a data compilation hosted at the data publisher PANGAEA was initiated in 2008 and is updated on a regular basis (doi:10.1594/PANGAEA.149999). By January 2015, a total of 581 data sets (over 4 000 000 data points) from 539 papers had been archived. Here we present the developments of this data compilation 5 years since its first description by Nisumaa et al. (2010). Most of the study sites from which data have been archived are in the Northern Hemisphere and the number of archived data from studies from the Southern Hemisphere and polar oceans is still relatively low. Data from 60 studies that investigated the response of a mix of organisms or natural communities were all added after 2010, indicating a welcome shift from the study of individual organisms to communities and ecosystems. The initial imbalance of considerably more data archived on calcification and primary production than on other processes has improved. There is also a clear tendency towards more data archived from multifactorial studies after 2010. For easier and more effective access to ocean acidification data, the ocean acidification community is strongly encouraged to contribute to the data archiving effort, and help develop standard vocabularies describing the variables and define best practices for archiving ocean acidification data. Yang Y., et al., 2016. *Earth System Science Data* 8:79-87. [Article.](http://dx.doi.org/10.5194/essd-8-79-2016)

**Urchins in a high CO2 world: partitioned effects of body-size, ocean warming and acidification on metabolic rate.** Body-size and temperature are the major factors explaining metabolic rate, and the additional factor of pH is a major driver at the biochemical level. These three factors have frequently been found to interact, complicating the formulation of broad models predicting metabolic rates and hence ecological functioning. In this first study of the effects of warming and ocean acidification, and their potential interaction, on metabolic rate across a broad body-size range (two-to-three orders of magnitude difference in body mass) we addressed the impact of climate change on the sea urchin *Heliocidaris erythrogramma* in context with climate projections for east Australia, an ocean warming hotspot. Urchins were gradually introduced to two temperatures (18 and 23 °C) and two pH (7.5 and 8.0), and maintained for two months. That a new physiological steady-state had been reached, otherwise known as acclimation, was validated through identical experimental trials separated by several weeks. The relationship between body-size, temperature and acidification on the metabolic rate of *H. erythrogramma* was strikingly stable. Both stressors caused increases in metabolic rate; 20% for temperature and 19% for pH. Combined effects were additive; a 44% increase in metabolism. Body-size had a highly stable relationship with metabolic rate regardless of temperature or pH. None of these diverse drivers of metabolism interacted or modulated the effects of the others, highlighting the partitioned nature of how each influences metabolic rate, and the importance of achieving a full acclimation state. Despite these increases in energetic demand there was very limited capacity for compensatory modulating of feeding rate; food consumption increased only in the very smallest specimens, and only in response to temperature, and not pH. Our data show that warming, acidification and body-size all substantially affect metabolism and are highly consistent and partitioned in their effects, and for *H. erythrogramma* near-future climate change will incur a substantial energetic cost. Carey N., et al., in press. *Journal of Experimental Biology.* [Article](http://dx.doi.org/10.1242/jeb.136101) (subscription required).

**Deep-Sea DuraFET: A pressure tolerant pH sensor designed for global sensor networks.** Increasing atmospheric carbon dioxide is driving a long-term decrease in ocean pH which is superimposed on daily to seasonal variability. These changes impact ecosystem processes and they serve as a record of ecosystem metabolism. However, the temporal variability in pH is observed at only a few locations in the ocean because a ship is required to support pH observations of sufficient precision and accuracy. This paper describes a pressure tolerant Ion Sensitive Field Effect Transistor pH sensor that is based on the Honeywell Durafet® ISFET die. When combined with a AgCl pseudo-reference sensor that is immersed directly in seawater, the system is capable of operating for years at a time on platforms that cycle from depths of several km to the surface. The paper also describes the calibration scheme developed to allow calibrated pH measurements to be derived from the activity of HCl reported by the sensor system over the range of ocean pressure and temperature. Deployments on vertical profiling platforms enable self-calibration in deep waters where pH values are stable. Measurements with the sensor indicate that it is capable of reporting pH with an accuracy of 0.01 or better on the total proton scale and a precision over multi-year periods of 0.005. This system enables a global ocean observing system for ocean pH. Johnson K. S., et al., in press. *Analytical Chemistry*. [Article](http://dx.doi.org/10.1021/acs.analchem.5b04653) (subscription required).

**The exposure of the Great Barrier Reef to ocean acidification**. The Great Barrier Reef (GBR) is founded on reef-building corals. Corals build their exoskeleton with aragonite, but ocean acidification is lowering the aragonite saturation state of seawater (Ωa). The downscaling of ocean acidification projections from global to GBR scales requires the set of regional drivers controlling Ωa to be resolved. Here we use a regional coupled circulation–biogeochemical model and observations to estimate the Ωa experienced by the 3,581 reefs of the GBR, and to apportion the contributions of the hydrological cycle, regional hydrodynamics and metabolism on Ωa variability. We find more detail, and a greater range (1.43), than previously compiled coarse maps of Ωa of the region (0.4), or in observations (1.0). Most of the variability in Ωa is due to processes upstream of the reef in question. As a result, future decline in Ωa is likely to be steeper on the GBR than currently projected by the IPCC assessment report. Mongin M., et al., in press.. *Nature Communications*. [Article.](http://dx.doi.org/10.1038/ncomms10732)

**Coastal-ocean uptake of anthropogenic carbon** Anthropogenic changes in atmosphere-ocean and atmosphere-land CO2 fluxes have been quantified extensively, but few studies have addressed the connection between land and ocean. In this transition zone, the coastal ocean, spatial and temporal data coverage is inadequate to assess its global budget. Thus we use a global ocean biogeochemical model to assess the coastal ocean’s global inventory of anthropogenic CO2 and its spatial variability. We used an intermediate resolution, eddying version of the NEMO-PISCES model (ORCA05), varying from 20 to 50 km horizontally, i.e., coarse enough to allow multiple century-scale simulations but finer than coarse resolution models (~ 200 km), to begin to better resolve coastal bathymetry. Simulated results indicated that the global ocean absorbed 2.3 Pg C yr−1 of anthropogenic carbon during 1993–2012, consistent with previous estimates. Yet only 4.5 % of that (0.10 Pg C yr−1) is absorbed by the global coastal ocean, i.e., less than its 7.5 % proportion of the global ocean surface area. Coastal uptake is weakened due to a bottleneck in offshore transport, which is inadequate to reduce the mean anthropogenic carbon concentration of coastal waters to the mean level found in the open-ocean mixed layer. Bourgeois T., et al., 2016. *Biogeosciences Discussions.* [Article](http://dx.doi.org/10.5194/bg-2016-57).

**Reversal of ocean acidification enhances net coral reef calcification.** Laboratory and field studies2, 3 have shown that calcification rates of many organisms decrease with declining pH, [CO32−], and Ω. Coral reefs are widely regarded as one of the most vulnerable marine ecosystems to ocean acidification, in part because the very architecture of the ecosystem is reliant on carbonate-secreting organisms4. Acidification-induced reductions in calcification are projected to shift coral reefs from a state of net accretion to one of net dissolution this century5. While retrospective studies show large-scale declines in coral, and community, calcification over recent decades, determining the contribution of ocean acidification to these changes is difficult, if not impossible, owing to the confounding effects of other environmental factors such as temperature. Here we quantify the net calcification response of a coral reef flat to alkalinity enrichment, and show that, when ocean chemistry is restored closer to pre-industrial conditions, net community calcification increases. In providing results from the first seawater chemistry manipulation experiment of a natural coral reef community, we provide evidence that net community calcification is depressed compared with values expected for pre-industrial conditions, indicating that ocean acidification may already be impairing coral reef growth. Albright R et al.,  *Nature.*[Article](http://dx.doi.org/10.1038/nature17155) (subscription required). Video discussing this article https://www.youtube.com/watch?v=TF60YAQxStA&app=desktop

**Differences in the responses of three scleractinians and the hydrocoral Millepora platyphylla to ocean acidification.** We tested the hypothesis that taxonomically diverse cnidarians display dissimilar responses to ocean acidification (OA), and did so by comparing the individual responses to OA of one hydrocoral and three scleractinians. The hydrocoral *Millepora platyphylla* and the scleractinians massive *Porites spp.,* *Acropora pulchra* and *Pocillopora meandrina* provided a contrast of three clades of calcifying cnidarian (Milleporidae, Robusta, and Complexa). Corals were collected from the shallow back reef of Moorea, French Polynesia, and were incubated under orthogonal contrasts of 408 and 913 μatm pCO2, and 28.0 and 30.1 °C. After 19 days in these treatments, calcification of *P. meandrina* was reduced 55 % at 913 μatm pCO2 and 30.1 °C, but the calcification of the other three taxa was unaffected by high pCO2 at 30.1 °C; the calcification of all taxa was unaffected by high pCO2 at 28.0 °C. These results show that *P. meandrina* (Robusta) was strongly and negatively affected by OA, whereas *A. pulchra* and massive *Porites spp.* (Complexa) and *M. platyphylla* (milleporine) were unaffected by OA. The assignment of these taxa to different clades suggests that evolutionary constraints could play a role in determining the sensitivity of cnidarian calcification to OA. Brown D. & Edmunds P. J., 2016. Marine Biology 163:62. [Article](http://dx.doi.org/10.1007/s00227-016-2837-7) (subscription required).