AMOS submission to the Senate inquiry into the impacts of climate change on marine fisheries and biodiversity (Environment and Communications Reference Committee)

Monday 14 November 2016

The Australian Meteorological and Oceanographic Society (AMOS, http://www.amos.org.au) is an independent professional society representing the fields of meteorology (weather and climate), oceanography (including ocean chemistry), and climate change science. Our membership includes science professionals employed at CSIRO, Bureau of Meteorology, and the University sector.

This submission for the "Inquiry into the impacts of climate change on marine fisheries and biodiversity" has been prepared to represent the views of the members of AMOS.

In this capacity we would like to address the first TOR: **The current and future impacts of climate change on marine fisheries and biodiversity, including recent and projected changes in ocean temperatures, currents and chemistry associated with climate change**, noting that the emphasis of our submission is on the changes in the ocean environment rather than quantifying how marine fisheries and biodiversity will respond to climate change.

Climate change, particularly in local Australian waters, is clearly evidenced and well documented[1]. These changes primarily take the form of warming sea surface temperatures including increased incidence of extreme warm temperature episodes, changes to ocean currents, and acidification of the waters. Over recent decades:

- In Australian waters acidification has been occurring -- the pH has reduced by nearly 0.1 units, which corresponds to an increase of almost 30% in hydrogen ion content[2] [3] ;
- Sea Surface temperatures have risen on average by 0.5 °C;
- Waters off SE Australia have warmed 2-3 times faster than the global average as a result of a southward intensification of the East Australian Current (EAC)[4];
- Intensification of the EAC (attributed in part to anthropogenic climate change) has facilitated the movement of species southward to Tasmania with significant effects on local ecosystems[5];

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[1] Bureau of Meteorology and CSIRO (2016) State of the Climate 2016. ISBN: 978-0-642-70678-2 http://www.bom.gov.au/state-of-the-climate/

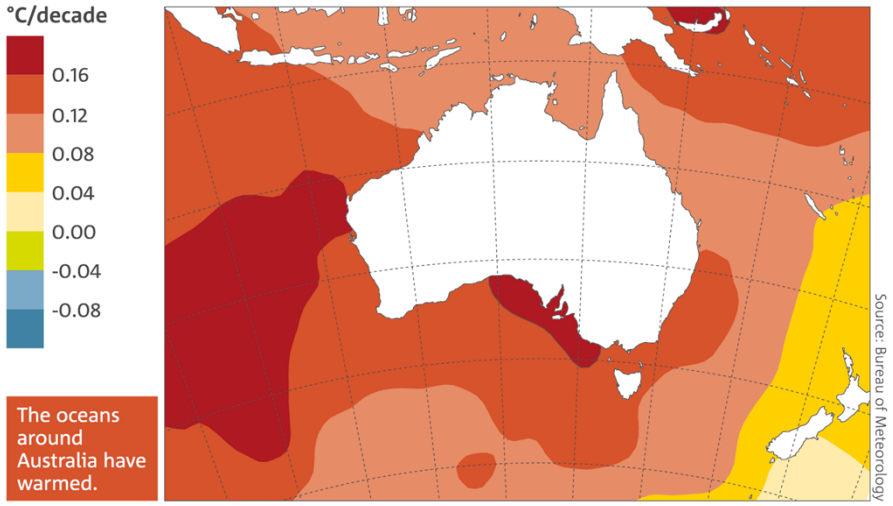
[2] Raven J., Caldeira K., Elderfield H., Hoegh-Guldberg O., Liss P., Riebesell U. (2005). Ocean acidification due to increasing atmospheric carbon dioxide, The Royal Society, Policy Document, London, UK.

[3] Lenton, A., McInnes, K. L., O'Grady, J. G. (2015). Marine Projections of Warming and Ocean Acidification in the Australasian Region. Australian Meteorological and Oceanographic Journal 65(1): 1-28.

[4] Wu, L., et al. (2012), Enhanced warming over the global subtropical western boundary currents, Nat. Clim. Change, 2(3), 161–166, doi: 10.1038/NCLIMATE1353.

[5] Ling S.D., Johnson, C.R., Ridgway, K.R., Hobday, A.J. and Haddon, M. (2008) Climate change drives range extension of a sea urchin: Informing future patterns by analysis of recent population dynamics, Global Change Biology, 14, doi: 10.1111/j.1365-2486.2008.01734

- The combined influence of long-term ocean warming and natural variability (particularly associated with ENSO[6]) is leading to unprecedented marine heatwaves, including the "Ningaloo Nino" in 2011[7], extreme temperatures in the Tasman Sea in 2015/16 and marine heatwaves across the Great Barrier Reef in 1998 and 2016. These latest marine heatwaves have led to mass coral bleaching and mortality on both sides of Australia.



Trends in sea surface temperature in the Australian region from 1950 to 2015. These are calculated from the National Oceanic and Atmospheric Administration (NOAA) Extended Reconstructed Sea Surface Temperature Version 4 (ERSST v4) data, from www.esrl.noaa.gov/psd/. Figure from State of the Climate, BoM and CSIRO, 2016 (http://www.bom.gov.au/state-of-the-climate/)

State-of-the-art climate models and extensive research shows that, under scenarios of increasing greenhouse gas emissions, these trends will continue into the future. It is estimated that over the next century:

- sea surface temperatures will continue to warm (a lower warming of about 1°C even with strong mitigation; while under business as usual emission increases around 3°C warming might occur);
- A combination of ocean warming and natural climate variability will lead to increased frequency and intensity of extreme warm marine temperature episodes. Such episodes are likely to put the viability of coral reef systems under severe risk[8];
- Without strong mitigation, acidification levels and associated aragonite concentrations are expected to drop to levels that may severely impact coral reef systems and other marine species;

[6] El Nino-Southern Oscillation
[7] Feng, M., McPhaden, M. J., Xie, S. & Hafner, J. (2013) La Niña forces unprecedented Leeuwin Current warming in 2011. Sci. Rep. 3, 1–9.
[8] Frieler K., Meinshausen M., Golly A., Mengel M., Lebek K., Donner S.D., Hoegh-Guldberg O. (2013). Limiting global warming to 2 degrees C is unlikely to save most coral reefs. Nature Climate Change. 3:165-170. DOI: 10.1038/Nclimate1674.

- Climate models project a further intensification of the southern portion of the East Australian Current[9] causing amplified warming of the Tasman Sea and greater risk of species invasion.

We note that these trends may not occur as uniform smooth changes but more likely as sharp jumps in the system that would challenge the natural ability of marine ecosystems to adapt[10].

These oceanic changes are coupled to the emissions trajectory of greenhouse gases over coming decades. A lower emissions target may keep many of these oceanic environmental factors at survivable levels for marine ecosystems and biodiversity[11].

Submitted on behalf of the Australian Meteorological and Oceanographic Society (AMOS), by

Mary Voice (President)

[9] Gupta, Sen, A., McGregor, S., Sebille, E., Ganachaud, A., Brown, J.N., & Santoso, A. (2016). Future changes to the Indonesian Throughflow and Pacific circulation: The differing role of wind and deep circulation changes. Geophysical Research Letters. http://doi.org/10.1002/2016GL067757

[10] Gupta, Sen, A., Brown, J.N., van Sebille, E., Ganachaud, A. Verges, A. (2015) Episodic and non-uniform migration of thermal habitats in a warming ocean. Deep Sea Research Part II: Topical Studies in Oceanography 113(59-72).

[11] Lenton, A., McInnes, K. L., O'Grady, J. G. (2015). Marine Projections of Warming and Ocean Acidification in the Australasian Region. Australian Meteorological and Oceanographic Journal 65(1): 1-28.