Voyage ss2013_t03

Microbially-mediated biogeochemistry of northern Australia

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Contribution to Australia's national benefit:

The accumulation of fossil-fuel-derived CO2 in the sea and associated shifts in ocean temperature, circulation, stratification, nutrient input and oxygen content, is leading to major changes in the functioning of globally important biogeochemical cycles that sustain life on Earth (Riebesell et al. 2000; Hutchins et al. 2009). Given the enormous ecosystem services we derive from the global ocean (estimated at $8.4 trillion per year; Costanza et al. (1997) and that the ocean contributes approximately $42 billion to the Australian economy (The AIMS index of marine industry (2011)), this research is significant.

Microbes are central players in the Earth's biogeochemical cycles, with small changes in function having potentially large consequences for the Earth-climate system (Taucher and Oschlies 2011). The outcomes of this research will have significant impact because it will increase the accuracy of predictions on the future delivery of ecosystem services, critical information that can be used to inform decision making about the sustainable use of Australia's ocean resources, aligning directly with goals of the Priority goal of " Responding to climate change and variability" and "Sustainable use of Australia's biodiversity" with the National Research Priority "An environmentally sustainable Australia".

As a result of this voyage:

1. We have a better understanding of:
   - The rates of nitrogen fixation around north-eastern Australia, and the microbes responsible.
   - Rates of photosynthesis and carbon fixation and the stock of dissolved and particulate carbon, including transparent exopolymeric substances that have the potential to form marine snow.
   - The abundance of diatoms and the degree of silica incorporation into cells.
   - The abundance and identity of key groups of photoheterotrophic bacteria that use light energy to break down organic matter, and subseqeuntly have a significant influence on ocean carbon cycling.
   - Velocity and direction of surface currents in the Arafura Sea – Gulf of Carpentaria region, and the abundance of greenhouse gases in the atmosphere.
2. We have found:
   - Little evidence of the nitrogen fixing cyanobacterium Trichodesmium erythraeum in surface waters during the transit, likely due to strong wind-induced mixing.
   - Variable rates of primary productivity (carbon fixation) and dissolved organic carbon production.
   - Relatively low incidence of marine aggregate formation (only 2 of 11 roller tank experiments).
3. We have mapped about 66% of the Great Barrier Reef (GBR) shelf break from Torres Strait to the Swains Reefs along the 100 m contour, thereby extending the known southern limit of the GBR submerged (drowned) reefs along the shelf break to about 1000 km in distance. We have also mapped the distribution of greenhouse gases and ozone in the coastal atmosphere.
4. We have commenced a program to understand the microbially-mediated biogeochemical transformations in waters around Australia, helping to inform biogeochemical and ecosystem models to help predict future changes in ecosystem function.

> Voyage track ss2013_t03