How is the marine nitrogen cycle responding to physical climate change at the Antarctic Peninsula?

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The nitrogen (N) cycle of the west Antarctic Peninsula (WAP) is susceptible to global change. Close coupling of the polar marine N and carbon cycles dictates that changes in N biogeochemistry can modulate air-sea CO_2 exchange and therefore exert a direct ocean-climate feedback. Recent atmospheric and ocean warming, sea ice declines and glacial retreat are impacting on the chemical and biological systems of the WAP in complex non-linear ways, with both advantageous and deleterious effects.

Unlike the high nutrient low chlorophyll (HNLC) open Southern Ocean, the WAP continental shelf experiences high chlorophyll concentrations and substantial nutrient drawdown in summer, particularly in coastal regions. We used a suite of biogeochemical and isotopic data gathered over a five year time-series in the WAP coastal ocean to examine changes in the seasonal cycling of N and other nutrients in response to ongoing climate change. Annual changes in N cycle processes were compared to sea ice, physical oceanographic and biological changes to elucidate the controls on and consequences of N cycle changes in the WAP coastal ocean.

We found that N exhibits distinct seasonality dominated by new nitrate-based production during a short yet intense summer growing season facilitated by favourable light and iron conditions, and subsequent remineralisation and export of organic matter. This seasonal cycle, also demonstrated by P and Si, is closely linked to sea ice dynamics and their effect on upper ocean stratification, as well as variability in the Circumpolar Deep Water nutrient source. Marked interannual variability in N cycle processes was consistent with sea ice changes, and suggests that low ice conditions can lead to reduced nutrient utilisation and organic matter production. This has the potential to modify nutrient budgets both regionally and further afield via large-scale ocean circulation.

In light of the predicted continuation of sea ice declines at the WAP, the findings of this study give important insights into future climate-induced changes in polar marine nutrient cycles, ecosystem functioning and CO_2 uptake. Ongoing work will quantify these changes as they occur and unravel the complex mechanisms that are crucial to predicting future interactions between key physical, chemical and biological changes underway in this climatically-sensitive region.