Macronutrient cycling on the Antarctic Peninsula shelf

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Biogeochemical cycling of nutrients in the Southern Ocean plays an important role in regulating climate under contemporary global change and over glacial-interglacial timescales. The west Antarctic Peninsula (WAP) shelf is a region of high primary productivity and intense macronutrient cycling, fuelled by upwelling of nutrient-rich circumpolar deep waters on to the shelf and mixing into the productive surface ocean. The WAP is also a region of rapid climate change and large interannual variability, having experienced significant atmospheric and oceanic warming, sea ice losses and glacial retreat in the last half century. These physical changes can be expected to exert a strong influence on nutrient biogeochemistry in the region.

The objective of this study was to examine the sources, sinks and cycling of nitrogen (N), silicon (Si) and carbon (C) over the WAP shelf during austral summer, and to investigate the coupling and decoupling of the N and Si cycles by biological and physical factors. To do this, we measured the concentration and stable isotope composition of nitrate, silicic acid, particulate organic carbon, nitrogen and biogenic silica in seawater, sediment and pore water samples collected in December 2015, alongside a suite of ancillary biological and physical oceanographic data.

We find that the upper ocean drawdown of macronutrients (N, P and Si), in response to primary production in the euphotic zone, is regulated by sea ice cover, and that organic matter undergoes intense remineralisation as it is exported to depth in the water column. Sediment and pore water data provide evidence for further remineralisation at and just below the sediment-water interface, and with depth in the seafloor. Stable isotope approaches are employed to resolve the key remineralisation processes at work, in particular those that decouple the cycling of N and Si in Antarctic seafloor sediments.

The findings of this study reveal important information on the modern processes influencing biological carbon drawdown and marine productivity, as well as the sources and sinks of N, Si and C in Antarctic shelf environments. At the broader scale, these results have implications for the budgets of these bio-essential nutrients in both polar oceans, and their ecological and climatic consequences.