Palmer Station Nitrate Uptake

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Project
» Quantifying Processes Driving Interannual Variability in the Biological Carbon Pump in the Western Antarctic Peninsula (WAP Carbon export)

Contributors	Affiliation	Role
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Methods & Sampling

We conducted 12-h nitrate uptake experiments in on-land incubators. Each incubator was cooled with flow-through seawater. Nitrate uptake rates were typically conducted on 1-L samples collected from 0, 5, 10, 20, and 65 m. Samples were placed in polycarbonate bottles and spiked with 15-N labeled nitrate, then placed in mesh shading to approximate 100% surface irradiance (0 m), 50% surface irradiance (5 m), 25% surface irradiance (10 m), 10% surface irradiance (20 m), and dark (65 m). These light levels were chosen to match Palmer LTER net primary production depths and light levels and are close to the seasonal average light levels at these depths, although actual light varied substantially throughout the season (see Stukel et al. 2015). At the end of the 24-hour incubation, bottles were immediately vacuum filtered onto pre-combusted 25-mm GF/F filters. Filters were rinsed with filtered seawater, wrapped in foil and stored at 80°C. On land, samples were fumigated with HCl vapor to remove inorganic carbon, dried, and placed inside a tin cup for C/N and isotopic analysis at the UC Davis stable isotope facility. NO3- uptake rates in each incubation bottle (and associated uncertainties) were determined using equations in Dugdale and Wilkerson (1986). For additional details see Stukel et al. (2015).

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Related Publications

Dugdale, R. C., & Wilkerson, F. P. (1986). The use of 15 N to measure nitrogen uptake in eutrophic oceans; experimental considerations1,2. Limnology and Oceanography, 31(4), 673–689. Portico. https://doi.org/10.4319/lo.1986.31.4.0673
Methods

Stukel, M. R., Asher, E., Couto, N., Schofield, O., Strebel, S., Tortell, P., & Ducklow, H. W. (2015). The imbalance of new and export production in the western Antarctic Peninsula, a potentially “leaky” ecosystem. Global Biogeochemical Cycles, 29(9), 1400–1420. Portico. https://doi.org/10.1002/2015gb005211 https://doi.org/10.1002/2015GB005211
Methods

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Parameters

Parameters for this dataset have not yet been identified

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Project Information

Quantifying Processes Driving Interannual Variability in the Biological Carbon Pump in the Western Antarctic Peninsula (WAP Carbon export)

Coverage: Western Antarctic Peninsula (Palmer LTER Study Region)

NSF abstract:

Algae in the surface ocean convert carbon dioxide into organic carbon through photosynthesis. The biological carbon pump transports this organic carbon from the atmosphere to the deep ocean where it can be stored for tens to hundreds of years. Annually, the amount transported is similar to that humans are currently emitting by burning fossil fuels. However, at present we cannot predict how this important process will change with a warming ocean. These investigators plan to develop a 15+ year time-series of vertical carbon transfer for the Western Antarctic Peninsula; a highly productive Antarctic ecosystem. This region is also rapid transition to warmer temperatures leading to reduced sea ice coverage. This work will help researchers better understand how the carbon cycle in the Western Antarctic Peninsula will respond to climate change. The researchers will develop the first large-scale time-series of carbon flux anywhere in the ocean. This research will also support the education and training of a graduate student and support the integration of concepts in Antarctic research into two undergraduate courses designed for non-science majors and advanced earth science students. The researchers will also develop educational modules for introducing elementary and middle-school age students to important concepts such as gross and net primary productivity, feedbacks in the marine and atmospheric systems, and the differences between correlation and causation. Results from this proposal will also be incorporated into a children's book, "Plankton do the Strangest Things", that is targeted at 5-7 year olds and is designed to introduce them to the incredible diversity and fascinating adaptations of microscopic marine organisms.

This research seeks to leverage 6 years (2015-2020) of 234Th samples collected on Palmer LTER program, 5 years of prior measurements (2009-2010, 2012-2014), and upcoming cruises (2021-2023) to develop a time-series of summertime particle flux in the WAP that stretches for 15 years. The 238U-234Th disequilibrium approach utilizes changes in the activity of the particle-active radio-isotope 234Th relative to its parent nuclide 238U to quantify the flux of sinking carbon out of the surface ocean (over a time-scale of ~one month). This proposal will fund 234Th analyses from nine years' worth of cruises (2015-2023) and extensive analyses designed to investigate the processes driving inter-annual variability in the BCP. These include: 1) physical modeling to quantify the importance of advection and diffusion in the 234Th budget, 2) time-series analyses of particle flux, and 3) statistical modeling of the relationships between particle flux and multiple presumed drivers (biological, chemical, physical, and climate indices) measured by collaborators in the Palmer LTER program. This multi-faceted approach is critical for linking the measurements to models and for predicting responses to climate change. It will also test the hypothesis that export flux is decreasing in the northern WAP, increasing in the southern WAP, and increasing when integrated over the entire region as a result of earlier sea ice retreat and a larger ice-free zone. The project will also investigate relationships between carbon export and multiple potentially controlling factors including: primary productivity, algal biomass and taxonomic composition, biological oxygen saturation, zooplankton biomass and taxonomic composition, bacterial production, temperature, wintertime sea ice extent, date of sea ice retreat, and climate modes.

This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

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Funding

Funding Source	Award
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