Trends in metal limitation of phytoplankton and coccolithophores along the “Great Calcite Belt” in the Southern Ocean

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Abstract

Satellite observations have shown particulate inorganic carbon (PIC) concentrations to be elevated in a “Great Calcite Belt” that encircles the Southern Ocean between approximately 40°S and 60°S. We participated in cruises to the Atlantic and Indian Ocean sectors of this belt to investigate the potential control of phytoplankton— and coccolithophores, in particular—by trace metal availability. Incubation experiments were conducted at 8 stations along the belt. Iron limitation of the bulk phytoplankton community (assessed by increases in chlorophyll) was observed in the Indian sector but not the Atlantic sector of the belt, nor was iron limitation found north of the tropical front. This zonal trend matches modeled dust deposition to the Southern Ocean and broad regional trends in surface dissolved iron. Iron stimulated coccolithophores growth (assessed by increases in PIC) 40% more than it stimulated growth of the bulk phytoplankton community at one station, and additions of zinc or cobalt resulted in approximately 2-fold higher PIC/Chl ratios, relative to controls, at the same station. It appears that coccolithophores in some parts of the belt are poised to preferentially respond to added metals.

Great Calcite Belt

The “Great Calcite Belt” is a broad region of elevated particulate inorganic carbon (PIC) first observed with MODIS/SeaWiFS. The Great Belt appears south of ~38°S and extends southwards to ~60°S. One quarter of all suspended PIC in the global ocean is found between 40 and 60°S.

Nutrient distributions across the Great Belt

Surface nutrient concentrations [μM] at CTD stations across both cruises. Incubation locations indicated by numbers.

Conclusions

• Spatial trends in metal limitation of phytoplankton community broadly match modeled dust deposition to the Southern Ocean and broad regional gradients in surface dissolved Fe.
• PIC accumulation was significantly enhanced by Fe in the incubation started near the Crozet Islands in the Indian Sector. Fe stimulated coccolithophores growth about 40% more than it stimulated growth of the bulk phytoplankton community.
• Zn or Co resulted in ~2 fold higher PIC/Chl ratios, relative to controls, at the Crozet station.
• Coccolithophores in parts of the Great Belt appear poised to preferentially respond to added metals.

Acknowledgements

This work was supported by a grant from the National Science Foundation (OCE 0961660) to BST as part of a collaborative project with Barney Balch, Phoebe Lam and Nick Bates. Sampling assistance was provided by Whitney King and Jason Hopkins.