Patagonian Shelf coccolithophores: ecological factors regulating the southern hemisphere's largest recurring coccolithophore bloom

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Intellectual merit of the proposed activity- This is a proposal to study coccolithophores, at the fringes of the Southern Ocean, on the Patagonian Shelf (PS), east of Argentina. WMB has been invited to join a team of U.K. investigators to visit the PS in November 2008 aboard a British research vessel. Some of the most extensive coccolithophore blooms in the world occur on the PS but the remoteness of the region has impeded their study. In this part of the southern ocean, we lack the most basic knowledge about a) the relationships between coccolithophores and other species of phytoplankton, b) the impact of coccolithophores on the carbon cycle and c) how environmental changes affect bloom taxonomy and function. This will be the first multi-disciplinary ship-based investigation of these mesoscale blooms; it will build on our understanding of coccolithophore ecology derived almost exclusively from northern hemisphere bloom studies. The team objectives are to describe the recurring coccolithophore blooms in the PS and the impact of ocean acidification on these coccolithophores.

This is a stand-alone proposal to allow WMB's participation in the UK study. One goal of the WMB component is to document the factors regulating the spatial-temporal distribution of the coccolithophore blooms, using a combination of underway, satellite and discrete sampling. Satellite measurements will provide quantitative estimates of particulate inorganic carbon (PIC) and particulate organic carbon (POC) in coccolithophore blooms while underway hydrographic and optical sampling will allow real-time evaluation of coccolithophores in both bloom and surrounding non-bloom waters. Vertical casts across the shelf front will provide depth resolved coccolithophore abundance as well as estimates of phytoplankton species richness.

Another goal of the WMB component is to examine the effects of ocean acidification on algal optical properties, coccolithophore concentrations and PIC concentrations (to be determined from deck experiments). Moreover, dilution experiments will provide key estimates on phytoplankton growth rates, coccolithophore growth rates and calcification rates, plus the intrinsic loss rates (i.e. phytoplankton grazing, coccolithophore grazing and dissolution associated with zooplankton grazing). The examination of PIC in dilution experiments has not been addressed heretofore.

The proposed work will yield fundamental insights into a) our understanding of coccolithophore ecology (not just *Emiliania huxleyi*) and b) the utility of the "functional group" concept to describe coccolithophore variability over the PS. Such knowledge is critical for modeling complex biogeochemical processes that regulate phytoplankton production and the biological pump. It is also worthy of note that the PS coccolithophore populations are at the western edge of a southern hemisphere belt of enhanced coccolithophores (this band is thought to extend from the southern tip of South America to waters south of Australia, (~180^{o} of longitude). This study will provide the first detailed analysis of the coccolithophores in this enormous band of high suspended calcite water.

Broader impacts resulting from the proposed activity- The burning of fossil fuels is predicted to increase atmospheric CO_2 to 750 p.p.m.v. or more under various future scenarios. As a large fraction of the anthropogenic CO_2 diffuses into seawater, the ocean is becoming more acidic, and it is predicted that the pH of the surface ocean will drop by up to 0.7 units by year 2300, a 5-fold increase in the proton concentration. A major goal of the NERC study (as well as this NSF component) is to examine the effects of ocean acidification on coccolithophores, in a region of low calcite saturation. The results of these experiments will be highly relevant to our basic understanding of the marine carbon cycle. For fulfillment of Criterion II activities, this project includes funds for an REU student from a Maine university or college to work at Bigelow Laboratory and to attend a national scientific meeting each year. Participation of undergraduate students from Maine colleges builds capacity in our rural coastal state and helps thwart the serious issue of "brain-drain", in which the best students are leaving Maine to seek opportunity in more populated states. The project includes a teacher-training component to be run by a new educational/outreach coordinator at Bigelow who will develop learning modules for teachers about such areas as coccolithophores, calcification and climate change.