PI Name : **William Balch**	NASA Proposal Number
Organization Name : **BIGELOW LABORATORY FOR OCEAN SCIENCES**	**TBD on Submit**

Proposal Title : **Coccolithophores of the Beaufort and Chukchi Seas: Harbingers of a polar biogeochemical province in transition?**

SECTION VII - Project Summary

I propose a series of biological and bio-optical observations to address the role of calcifiers in the Arctic Ocean (AO). The biogeochemical province that includes the Chukchi and Beaufort Seas is expected to undergo fundamental changes as the ice cap melts, affecting both the biota (increased abundance of coccolithophores) and the bio-optical properties of the water mass (due to increased abundance of highly-scattering calcium carbonate coccoliths). I am proposing a series of measurements to be done on the two NASA cruises to the Chukchi and Beaufort Seas, falling into "discrete" and "underway" sampling. The discrete measurements will determine: calcification rate (using the 14C micro-diffusion method which also estimates total primary productivity), concentrations of the two major sea water ballast minerals (particulate inorganic carbon (PIC) plus biogenic silica (BSi)) and coccolithophore/phytoplankton abundance (using polarized microscopy plus a Flow-cam). Automated underway measurements will be made for: inherent optical properties (spectral absorption and attenuation [dissolved and particulate], backscattering, acid-labile backscattering, chlorophyll fluorescence, all sampled from the ship's seawater system) plus apparent optical properties (spectral upwelling radiance, sky radiance and downwelling irradiance as measured from bow-mounted radiometers). The latter measurements will provide critical matchups for satellite measurements, as well as radiometry for use in real time estimates of chlorophyll and PIC when clouds obscure the satellite view. In the latter two years of the project, the ship data will be used for regional calibration and validation of PIC and calcification algorithms so that we can use the historical data base of satellite ocean color to examine for long-term changes in coccolithophore abundance in the AO.

This work will provide fundamental, new knowledge on the standing stocks and production rates of calcium carbonate by coccolithophores, in the Chukchi and Beaufort Seas. These proposed measurements will be the first-ever, direct 14C measurements of coccolithophore calcification in the AO, as opposed to indirect estimates based on carbonate system parameters or ocean color. Why is this important? First, PIC represents the most important ballast material responsible for sinking POC, which drives the biological pump. Indeed, the future of calcification and PIC production represents the future of the ocean's biological pump. Moreover, even at typical, non-bloom concentrations, coccolith PIC is a significant contributor to the ocean albedo. In summer, they likely have even greater impact in the AO when extensive coccolithophore blooms form. Second, global climate change and ocean acidification are bringing unprecedented changes to the AO by a) melting the seasonal plus permanent sea ice cover, and b) slowly decreasing the pH over the next century. Decreasing sea ice cover will likely bring about a major biological shift in the Boreal Polar biogeochemical province (Longhurst et al., 1995), making it more Sub-Arctic in character. This is hypothesized to be allowing the current invasion of coccolithophores to the AO over the last decade. Less sea ice cover may also allow more air-sea influx of anthropogenic CO2, the cause of ocean acidification; this is expected to have the largest negative impact on calcifiers at high latitudes due to lower calcite and aragonite saturation states there. Our bio-optical measurements will allow critical revisions to PIC and calcification algorithms for the AO, technically impossible to do now due to a paucity of ship data. Armed with these validated algorithms, our proposed retrospective investigation of ocean color imagery for PIC and calcification in the AO will be critical to discern long time-scale changes in AO calcifiers associated with climate change.