Amundsen Sea Polynya International Research Expedition (ASPIRE)

This project brings together experienced US and Swedish investigators (trace metal and carbon chemists, phytoplankton physiologists, microbial and zooplankton ecologists, and physical oceanographers) to investigate climate controls on carbon uptake by one of the most productive ecosystems in the Antarctic. The Amundsen Sea Polynya is the most productive Antarctic polynya per m^2, and exhibits higher chlorophyll levels during peak bloom and greater interannual variability than the better-studied Ross Sea Polynya ecosystem. Polynyas, or recurring areas of seasonally open water surrounded by ice, are foci for energy and material transfer between the atmosphere, polar surface ocean, and deep sea. These polar ecosystems are characterized by high productivity and intense biogeochemical cycling. Polynyas may be the key to understanding the future of polar regions since their extent is expected to increase with anthropogenic warming. Regional reductions or growth in sea-ice over the past decade have been extensive and are coupled to climate-sensitive global cycles such as ENSO and the Southern Annular Mode. Without a long time series of measurements, this regional and interannual variability is our best present-day indication for what controls or "forces" these critical polar ecosystems and their sensitivity to future change. Variability in the productivity of Antarctic polynyas is high for reasons we do not currently understand. The supply of trace metals such as iron is thought to determine phytoplankton community structure and production in the Southern Ocean, particularly in conjunction with mixed-layer depth controls on light limitation. A key question is whether regional or interannual variability is driven by these two climate-sensitive factors, and whether we can expect climate-sensitive shifts in ecosystem function and carbon flux in the future. Understanding critical feedbacks between climate and the marine biosphere becomes increasingly urgent as we project rates of change into the future.

We hypothesize that 1) sources of iron to the Amundsen Sea Polynya will vary according to climate forcing, 2) phytoplankton community structure will shift with changing iron supply and mixed-layer depths, 3) the efficiency of the biological pump of carbon to depth will depend on phytoplankton physiology and community structure, zooplankton grazing, and bacterial remineralization, and 4) the net flux of carbon from the atmosphere to the deep will vary interannually according to climate and micronutrient forcing. The biogeochemical cycling of the Amundsen was entirely unknown until members of this team visited it briefly in 2007. The planned NBP/*Oden* cruises for 2010-11 afford an important and unique opportunity to investigate climate-sensitive biogeochemical cycling in this poorly studied region of the Antarctic, accessible during peak bloom periods only by an icebreaker with *Oden's* capabilities. Our proposed plans include linking our results for the Amundsen Sea to existing data synthesis and modeling efforts for the Palmer LTER and Ross Sea.