

Processes Regulating Iron Supply at the Mesoscale in the Ross Sea (PRISM-RS)

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Introduction

The Ross Sea continental shelf is the single most productive area in the Southern Ocean, and may comprise a significant but unaccounted for oceanic CO₂ sink, largely driven by phytoplankton production. However, the processes that control the magnitude of primary production in this region are not well understood. During summer, an observed abundance of macronutrients and scarcity of dissolved iron are consistent with iron limitation of phytoplankton growth in the Ross Sea polynya, as is further suggested by shipboard bioassay experiments. Field observations and model simulations indicate four potential sources of dissolved iron to surface waters of the Ross Sea: (H₁) circumpolar deep water intruding from the shelf edge; (H₂) sediments on shallow banks and nearshore areas; (H₃) melting sea ice around the perimeter of the polynya; and (H₄) glacial meltwater from the Ross Ice Shelf. These potential iron sources are isolated, either laterally or vertically, from the surface waters of the Ross Sea for much of the growing season. We hypothesize that hydrodynamic transport via mesoscale currents, fronts, and eddies facilitate the supply of dissolved iron from these four sources to the surface waters of the Ross Sea polynya. Our cruise plan was designed to accomplish two distinct objectives: (A) regional-scale, high-resolution transects to characterize the hypothesized source regions of iron, and (B) mini-process studies to examine selected mesoscale features in detail.



Figure 1. PRISM-RS science party and Raytheon Polar Services Corporation support staff.

Cruise overview

Voyage #12-01 of the RVIB Nathaniel B. Palmer was a 49 day journey from Punta Arenas Chile to McMurdo Station, Antarctica. Shortly after departure on 24 December 2011, we took the opportunity to test two of our towed instrument platforms, the Moving Vessel Profiler (MVP) and the Video Plankton Recorder (VPR). These systems were then stowed away for the transit to the Ross Sea. In transit, we began to address PRISM objectives with an opportunistic process study in and around a band of sea ice in the Antarctic Circumpolar Current (H_3). We entered the eastern Ross Sea on January 9, and with the aid of a recently acquired MODIS image sampled two eddies. Shortly after beginning a detailed survey of Eddy 2, we broke off from science operations to respond to a distress call from F/V *Jung Woo 2*. The rescue mission was completed on January 11 with the evacuation of seven injured fishermen to McMurdo Station. Science operations were recommenced in the Western Ross Sea, starting with a zonal transect at $76^\circ 40'$ followed by detailed studies of a cyclonic eddy (including deployment of SeaHorse, a profiling instrument package) and the frontal region between high- and low-biomass areas of the zonal transect (H_3). We then proceeded to Ross Bank for surveys and deployment of the SeaHorse in a moored configuration (H_2). Next on our agenda was the Ross Ice Shelf, where we sampled Ice Shelf Water and a cyclonic eddy moving northward from the ice edge (H_4). From there we transited back to Ross Bank for recovery of the SeaHorse and then proceeded to Joides Trough to sample Modified Circumpolar Deep Water coming up onto the shelf (H_1). The last phase of the cruise, we revisited the Western Ross Sea with re-occupation of the $76^\circ 40'$ line, study of an eddy near the ice edge, sampling of a suspected hydrothermal vent site near Franklin Island, a north-south transect along 169°E , detailed survey of a frontal region between 169°E and 170°E , and an extension of the $76^\circ 40'$ line (actually at $76^\circ 45'$) into the far western Ross Sea previously covered with ice (H_2 , H_3). A cruise blog aimed toward middle-school students is available at <http://www.steminaction.org/blog/>.

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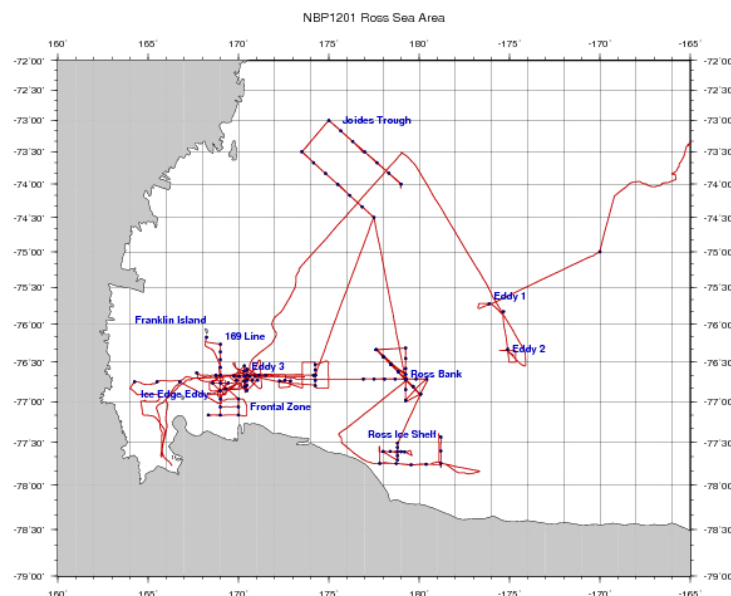


Figure 2. Cruise track of the RVIB Nathaniel B. Palmer, voyage 12-01.