ARCTIC GEOTRACES: Radionuclide and Stable Isotope Analyses of Water Transport from the Pacific to the Arctic Ocean

Lee Cooper & Jacqueline Grebmeier, University of Maryland Center for Environ. Sci., Solomons, MD 20688
Wieslaw Maslowski & Jaclyn Clement Kinney, Naval Postgraduate School, Monterey, CA 93943

The nuclear accident at the Fukushima-Daiichi power plant in 2011 has introduced the single largest point-source addition of ^{137}Cs to the world ocean. Model projections indicate arrival of this conservative, water-borne plume in the Bering Sea and into the Arctic Ocean by the time of the planned Arctic Geotraces cruise in 2015. This tracer, as it moves northward, could provide important new insights on how Pacific-origin waters mix, spread and contribute to Arctic Ocean surface and sub-surface waters, including the mixing that occurs between the Anadyr Current versus Alaska Coastal Water. The oxygen isotope composition of Alaska Coastal Water in the Bering and Chukchi seas suggests continuity with surface waters flowing westward along the Gulf of Alaska, while more nutrient-rich Anadyr waters are advected onto the Bering and Chukchi shelves from depths of ~200 m. Given high-density sampling that can be expected to continue in the North Pacific and existing data from the Arctic that tracks transport of the Sellafield and La Hague signals from Atlantic sources, prudent sampling in the Bering Strait and in the western Arctic will provide important insights on the fate of this significant point source of ^{137}Cs. We propose a shipboard based collection program for ^{137}Cs together with determinations of stable isotope ratios of $^{18}O/^{16}O$ to assess the impacts of runoff, brine injection and melted sea ice on the point source signal. In addition to the planned NSF-supported Healy cruise, we will use complementary programs such as the NOAA-supported RUSALCA (Russian American Long-term Census of the Arctic) to facilitate collection of samples across Bering Strait.

This effort will be coupled to modeling that will complement sampling and facilitate synthesis and integration of data from this and possibly other Arctic GEOTRACES projects. A hierarchy of coupled models, including stand alone ice-ocean and fully coupled Arctic System model configurations at increasing resolution will be used to simulate multiple passive tracers (i.e. not altering water density) with point sources in the North Pacific, Bering Strait and river mouths and their distribution, mixing and residence times in the Arctic. This high-resolution (up to 2.4 km) approach will resolve details of local bathymetry and coastline as well as enhance capabilities to simulate important processes such as mesoscale eddies, coastal currents, and shelf-basin exchange. Model results will be validated and synthesized with published and new observations and together they will provide a state-of-the-art representation of flow through the narrow straits and passageways, ocean currents and air-sea-ice interactions. Using improved versions of our prior published models, we plan to quantify the contribution of eddies to the on-shelf transport through canyons along the Bering Slope and through Barrow Canyon, across the Bering/Chukchi shelves and along the slopes. Due to the pan-Arctic domain and long simulation time (~50 years), model results will augment the observational dataset by providing a temporal context and will allow us to trace inputs of particles/^{137}Cs not only at present but also at different climate regimes that have occurred in recent decades. This work will contribute to the GEOTRACES goal of understanding mechanisms for Pacific exchange with the Atlantic through the Arctic. Other program contributions include tracing (both via observations and modeling) riverine and sea ice formation/melt impacts in surface waters of the Arctic. This will be possible because the north Pacific signal of ^{137}Cs will result in significant differences from other relatively fresh Arctic surface waters.