cANIMIDA – Spring Runoff and Under Ice Flow

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John Trefry, Bob Trocine, Debra Woodall, Matt Alkire, Florida Institute of Technology
Mark Savoie, Gary Lawley, Kinnetic Laboratories, Inc.
Rob Rember, IARC, University of Alaska Fairbanks
Alex Mansfield, Battelle

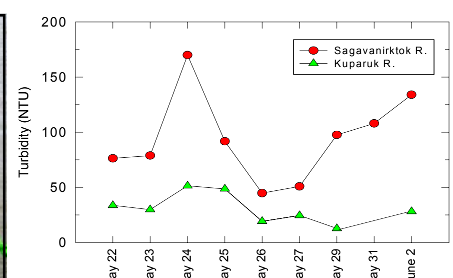
cANIMIDA is off to a great start. We had two weeks of ideal conditions to highlight our study of the spring 2004 melt water event and the under ice transport of river runoff more than 10 miles offshore into the coastal Beaufort Sea. We sampled rivers daily and sampled through the ice at 28 different locations for a total of 58 separate under-ice deployments, including two to four times at many locations. We made numerous field measurements and collected samples of river water, snow, ice and water under the ice. The parameters being investigated include the following: salinity, temperature, current speed and direction, turbidity, dissolved oxygen, pH, dissolved silica, phosphate and nitrate, dissolved barium and other trace metals, total suspended solids, particulate metals, dissolved and particulate organic carbon, $\partial^{18}O$, ∂D, and $^{87}Sr/^{86}Sr$. Samples also were collected for dissolved and particulate petroleum hydrocarbons from three area rivers.

The spring study was designed to delineate and quantify the offshore dispersion of river runoff and suspended sediment during the spring melt. More than 90% of the annual input of suspended sediment by local rivers occurs during the brief one- to three-week period of the spring flood. What is the role of spring inputs of freshwater to biogeochemical cycles of organic carbon, nutrients and other chemicals in the coastal Beaufort Sea? How are river water and suspended sediment dispersed seaward under the ice? By better understanding the natural processes and movement of water and suspended sediment at this dynamic time of year, we may be able to predict and model the behavior of any spilled or otherwise introduced anthropogenic chemicals more accurately.

We began sampling on May 22, 2004 in the Kuparuk and Sagavanirktok rivers. Once again, flow patterns were different than in previous years. Flow in the Kuparuk River was steady from May 24 through June 3 relative to the more common 2-3 day flood event that usually covers the bridges and often washes out a portion of the road. In a somewhat similar fashion, flow in the Sagavanirktok River was steady with only minor highs and lows as shown by the plot for turbidity below. Concentrations of total suspended solids in mg/L are about double values for turbidity in NTU shown on the graph.

Kuparuk River, May 22, 2004.

Sampling the Sagavanirktok River.



Turbidity in area rivers.

Ice coring.

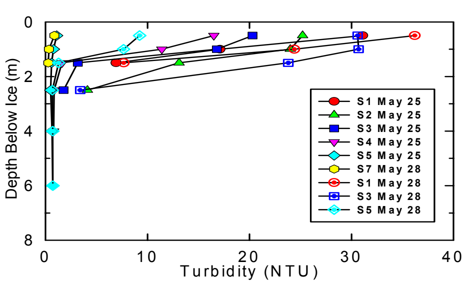
Ten miles offshore in the Beaufort Sea.

Deploying instruments.

The seaward flow of river water over and under the ice in the coastal Beaufort Sea is an amazing phenomenon. Imagine being 10 miles offshore and out of sight of the shoreline. Then, you drill a hole through six feet of ice and up flows turbid, yellowish river water. This year, we were able to follow the flows of the Kuparuk and Sagavanirktok rivers in both time and space. It was exciting to sample an offshore location and find clear ocean water on one day and come back a couple of days later to find a 2-4 foot thick layer of river water overlying seawater. Both the freshwater and seawater layers appear to be forced offshore by the inflowing river water.

The layer of river water under the ice diminishes in thickness and turbidity with increasing distance offshore. The profiles of turbidity in water under the ice, as shown below, track offshore movement of water from the Sagavanirktok River. The graph shows increased turbidity at sites S1 and S3 over time and only a slight indication of any river water flow at site S7 (farthest offshore) on May 28. Many other variables such as pH, concentrations of dissolved nutrients and organic carbon also track turbidity in a similar fashion. In some cases, we could distinguish between the two rivers in areas where the source river was not obvious. For example, the pH of water in the Kuparuk River averaged ~7.35 relative to ~7.95 in the Sagavanirktok River (i.e., about four times more H^+ in the Kuparuk River than the Sagavanirktok River). The pH values of river water-seawater mixtures collected under the ice clearly reflect this difference and provide one of several possible tracers of seaward movement of freshwater from each river.

We are very excited about the success of our Spring 2004 field effort and feel very fortunate to be able to experience the spring melt and under ice flow first hand. We thank Minerals Management Service (MMS), U.S. Department of Interior, for funding this study and especially Dick Prentki of MMS for continued support and scientific collaboration. We thank British Petroleum (BP) for logistical support and accommodations on the North Slope and the staff of the Seawater Treatment Plant at West Dock for their interest in our work and use of their laboratory facilities.



Turbidity under ice in the Beaufort Sea.

Sampling snow.

Getting hot (1°C), time to go home.