Marginal Ice Zone Processes Observation
From Unmanned Aerial Systems

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Recent years have seen extreme changes in the Arctic. Marginal ice zones (MIZ), or areas where the "ice-albedo feedback" driven by solar warming is highest and ice melt is extensive, may provide insights into the extent of these changes.

Measurements from unmanned aerial systems (UAS) in the marginal ice zone were made during 2 experiments: 1) North of Oliktok Point AK in the Beaufort Sea were made during the Marginal Ice Zone Ocean and Ice Observations and Processes EXperiment (MIZOPEX) in July-August 2013 and 2) Fram Strait and Greenland Sea northwest of Ny-Ålesund, Svalbard, Norway during the Air-Sea-Ice Physics and Biogeochemistry Experiment (ASIBEX) April – May 2015.

Airborne remote sensing, in particular InfraRed (IR), offers a unique opportunity to observe physical processes at sea-ice margins. It permits monitoring the ice extent and coverage, the ice and ocean temperature variability. It can also be used for derivation of surface flow field allowing investigation of turbulence and mixing at the ice-ocean interface. Visible and IR imagery of melting ice floes clearly defines the scale of the ice floes. The IR imagery show distinct cooling of the skin sea surface temperature (SST) as well as an intricate circulation and mixing pattern that depends on the surface current, wind speed, and near-surface vertical temperature/salinity structure. Individual ice floes develop turbulent wakes as they drift and cause transient mixing of an influx of colder surface (fresh) melt water. We capture a melting and mixing event that explains the changing pattern observed in skin SST and is substantiated using laboratory experiments. The data suggest turbulence due to increased floe concentration enhances the mixing of skin SST variability and erases gradients generated by ice melt. These results suggest that sea ice concentration enhances mixing and the sea ice melt enhances near-surface gradients. We hypothesize that ΔT first decreases with floe concentration up to a certain point where the ice concentration starts inhibiting turbulence and melt processes dominate. Similarly, the same mixing and surface turbulence that affects SST variability will affect gas transfer.

Bio: Christopher received his Ph.D in Civil and Environmental Engineering at the University of Washington. He is currently the Doherty Associate Research Scientist in the Ocean and Climate Physics Division at Lamont Doherty Earth Observatory (LDEO), at Columbia University. His area of research interest is air-sea interaction, wave dynamics and wave breaking, effect of near-surface turbulence on heat, gas and momentum transport, infrared remote sensing, upper-ocean process, coastal and estuarine processes. In 2004 he received the Office of Naval Research Young Investigator Award.