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Local effects of ice floes and leads on skin sea surface temperature, mixing and gas transfer in the marginal ice zone

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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. Furthermore, MIZ play a central role in setting the air-sea CO_2 balance making them a critical component of the global carbon cycle. Incomplete understanding of how the sea-ice modulates gas fluxes renders it difficult to estimate the carbon budget in MIZ. Here, we investigate the turbulent mechanisms driving gas exchange in leads, polynyas and in the presence of ice floes using both field and laboratory measurements.
Here, we present measurements of visible and IR imagery of melting ice floes in the marginal ice zone north of Oliktok Point AK in the Beaufort Sea made during the Marginal Ice Zone Ocean and Ice Observations and Processes EXperiment (MIZOPEX) in July-August 2013. The visible and IR imagery were taken from the unmanned airborne vehicle (UAV) ScanEagle. The visible imagery 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 Gas Transfer through Polar Sea Ice experiment was performed at the US Army Cold Regions Research and Engineering Laboratory (Hanover, NH) under varying ice coverage, winds speed, fetch and currents. Supporting measurements were made of air and water temperature, humidity, salinity and wave height. Air-side profiling provided momentum, heat, and CO_2 fluxes. Transfer velocities are also estimated via the active controlled flux technique. Surface turbulence statistics derived from PIV and optical flow applied to infrared imagery are linked to subsurface turbulence and used to investigate how turbulent mechanisms at the ice-water boundary including shear and buoyancy contribute to the magnitude of the transfer. Gas exchange variability with lead size and enhancement near floes will be examined.
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