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Turbulent surface exchange during the Arctic Ocean 2018 expedition

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Turbulence-driven air-sea and air-ice exchanges of momentum, heat, moisture and trace gases in sea-ice regions are key boundary layer processes. Turbulent heat fluxes are important for the surface energy budget and determine the interactions between sea ice, the atmospheric boundary layer and clouds. Atmosphere-ice/ocean momentum exchange in the presence of sea ice is determined from surface drag, or roughness. Both drag and heat flux coefficients are prescribed in numerical weather prediction, climate and Earth system models as functions of stability. In addition, sea ice acts as a near-impermeable lid to air-sea gas exchange, but is also hypothesised to enhance gas transfer rates in open water areas (e.g. leads) through physical processes such as increased surface-ocean turbulence from ice-water shear and ice-edge form drag. There are few direct observations of turbulence-driven surface exchange from which to develop parameterisations, particularly in the High (> 85N) Arctic. Recent rapid changes to sea-ice conditions in the region also make older observations less applicable.
Here we present direct eddy covariance measurements of surface momentum, heat, moisture, CO_2 and CH4 exchange from the Arctic Ocean 2018 expedition. The expedition, on the icebreaker Oden, began on August 1, 2018 and lasted 7 weeks. Oden transited from Svalbard to the High Arctic, close to the North Pole. There it moored to a 1.5-by-0.7 km^2 large ice floe and drifted with the ice for a period of four weeks before returning to Svalbard. A wide variety of direct and remotely sensed atmospheric and oceanographic measurements were made both onboard Oden and from equipment deployed on the floe. Turbulence exchange measurements were made during the transits and the ice camp from Oden's 20 m foremast. During the ice camp, turbulent exchange measurements were also made on the ice floe near Oden from a 15 m and a 2 m mast, and from a 2 m mast deployed on the far side of the floe from Oden at the ice edge, adjacent to a lead that remained open through the majority of the ice camp.
The extensive data set spans a range of surface conditions during the Arctic summer and autumn, and includes measurements during both ice melt and freeze up periods. Atmospheric conditions during the ice camp were variable with extensive periods of low cloud and fog as well as clear sky periods. Air temperature ranged from -13°C to 0°C, while wind speeds ranged from calm to 19 m/s. The surface water in the open lead was heavily undersaturated with respect to CO_2, with pCO_2 around 300 μatm. The turbulent flux measurements and a preliminary analysis will be described. The measurements will be compared with both ship-based and on-ice measurements made on previous Oden Arctic expeditions.