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Boundary layer dependence of atmosphere-ocean coupling in operational weather forecast models over the marginal ice zone

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Arctic cyclones are the dominant type of hazardous weather system affecting the Arctic environment in summer. They can also have critical impacts on sea-ice movement, sometimes resulting in 'Very Rapid Ice Loss Events' which present a major challenge to coupled forecasts of the Arctic environment from days out to a season ahead. In late summer the marginal ice zone is extensive and wind forcing can move the ice readily; in turn, the dynamic sea ice distribution is expected to feedback on the developing weather systems.

In summer 2022, in concert with ONR-THINICE, we aim to fly two research aircraft from Svalbard into Arctic cyclones passing over the marginal ice zone. We will measure the turbulent exchange fluxes, flying low above the interface between atmosphere and ice, at the same time as measuring the wind and cloud structure of the cyclones above and the properties of the ice below. Combining the observations with numerical modelling experiments using the Met Office NWP model, we aim to deduce the dominant physical processes acting and test theoretical mechanisms for the influence of sea ice on Arctic cyclone dynamics, with a particular focus on form drag and momentum exchange in the boundary layer.

Met Office and ECMWF forecasts that are coupled, or uncoupled, with a dynamic sea ice distribution have been investigated initially for systematic differences in the representation of boundary layer and surface fluxes, composited relative to the warm and cold sectors of Arctic cyclones and conditional on the surface beneath (ice, ocean, land). One of the key differences outlined resides in the increased strength of surface (10m) winds over ice, including marginal ice, in coupled Met Office forecasts when compared against their uncoupled counterparts. Initial analysis links this discrepancy with a difference in the degree of stability of the boundary layer. A more stable profile is observed in the coupled forecasts, associated with lower temperature at 1.5m and smaller wind rotation with height. These findings help us to focus the objectives of the research flights and measurements and, in consequence, inform the flight and observation plans for the field experiment.