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Retrieving sea ice drag parameters and turning angles from observations using an inverse modelling framework.

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Sea ice drifting on polar ocean can be described using a momentum balance of winds, ocean currents and Coriolis acceleration for the case of ice concentrations lower than 95%. When describing the transfer of momentum from the atmosphere to sea ice, and sea ice to ocean by two dimensional quadratic drag laws, two drag parameters and two turning angles are used. These four values as represented in the Nansen number and Rossby radius form a four dimensional inverse modelling problem. We build a inverse modelling framework to retrieve the key characteristics within this parameter space from remote sensing observations. We have developed a forward model that describes the physical system of free drifting sea ice. This forward model results in a non-linear, under constrained system so we use novel numerical methods to find optimal parameter values for multiple observational groups. The methodology is tested on buoy observations of Cole, et al (2017) who give a collection of coincident atmosphere, sea ice and ocean velocities for low sea ice concentration conditions from the Canada Basin from March through December 2014. Our inverse modelling framework allows us to show the development of the ocean stress turning angle over the depth of the Ekman spiral and in comparison to geostrophic currents. This has the potential to inform changes in the momentum budget over the polar regions with implications in the context of climate change for the spin up / down of the Beaufort Gyre and the Southern Ocean subpolar gyres. Our study shows the effectiveness of inverse modelling techniques in retrieving key physical parameter values in complex coupled geophysical systems.