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Modelling tidal and inertial variability in sea-ice drift and deformation

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Semidiurnal oscillations are a ubiquitous feature of Arctic (and Antarctic) sea ice drift and deformation. Over much of the Arctic Basin inertial and semi-diurnal tidal variability occur at the similar frequencies so their periodicity alone is typically inadequate to resolve the source. Also interplay of these two mechanisms renders interpretation by frequency along difficult. To investigate the relative roles of tidal and inertial variability in the Arctic, a barotropic ice ocean model with sea ice imbedded in an upper boundary layer is constructed and numerically investigated in light of hourly observed buoy drift at several location, and temporally dense RGPS observations of sea-ice deformation near the pole. A 'levitated' ice ocean model–as used in most coupled ice-ocean mdels for climate studies–is also examined to demonstrate some of the deleterious characteristics of this formulation. In 'levitated' models mechanical buoyancy effects of sea ice are neglected. In much of the analysis of the simulated and observed results rotary spectral techniques are utilized as the rotation sense of both sea ice dcrift and deformation at the semidiurnal period provides a useful disciminant between tidal and inertial effects over much of the Arctic Basin. Analysis of the results shows that levitated models yield an artificial resonance for the ice motion even in the absence of ice interaction whereas the imbedded model does not. With ice mechanics and the presence of wind forcing, however, the imbedded model demonstrates a strong amplification of the clockwise rotating inertial motion induced by wind variations and ice mechanics. This amplification, absent in levitated models, can amplify inertial power by a factor of 100 in near shore regions which is found to be in general agreement with buoy observations. This amplification is shown to be due to non linear ice mechanics and is not present for example in linear viscous sea ice models, and can be justified by a simple physical mechanical analog. The ramifications of this enhanced amplification on thickness characteristics is also investigated and discussed.