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Parameter calibration and uncertainty analysis for snow depths from the NASA Eulerian Snow On Sea Ice Model and derived sea ice thickness from ICESat-2

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Snow on Arctic sea ice plays many, sometimes contrasting roles in Arctic climate feedbacks. During the sea ice growth season, the presence of snow on sea ice can enhance ice growth by increasing the sea ice albedo, or conversely, inhibit sea ice growth by insulating the ice from the cold atmosphere. Furthermore, estimates of snow depth on Arctic sea ice are also a key input for deriving sea ice thickness from altimetry measurements, such as satellite lidar altimetry measurements from ICESat-2. Due to the logistical challenges of making measurements in as remote a region as the Arctic, snow depth on Arctic sea ice is difficult to observationally constrain.

The NASA Eulerian Snow On Sea Ice Model (NESOSIM) can be used to provide snow depth and density estimates over Arctic sea ice with pan-Arctic coverage within a relatively simple framework. The latest version of NESOSIM, version 1.1, is a 2-layer model with simple representations of the processes of accumulation, wind packing, loss due to blowing snow, and redistribution due to sea ice motion. Relative to version 1.0, NESOSIM 1.1 features an extended model domain, and reanalysis snowfall input scaled to observed snowfall retrieved from CloudSat satellite radar reflectivity measurements.

In this work, we present a systematic calibration, and an accompanying estimate in the uncertainty of the free parameters in NESOSIM, targeting airborne snow radar measurements from Operation IceBridge. We further investigate uncertainties in snow depth and the resulting uncertainties in derived sea ice thickness from ICESat-2 altimetry measurements using NESOSIM snow depths.