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Improved Northern Hemisphere Snow Water Equivalent product from passive microwave remote sensing and in situ data

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The European Space Agency Snow CCI+ project provides global homogenized long time series of daily snow extent and snow water equivalent (SWE). The Snow CCI SWE product is built on the Finish Meteorological Institute's GlobSnow algorithm, which combines passive microwave data with in situ snow depth information to estimate SWE. The CCI SWE product improves upon previous versions of GlobSnow through targeted changes to the spatial resolution, ancillary data, and snow density parameterization.

Previous GlobSnow SWE products used a constant snow density of 0.24 kg m^{-3} to convert snow depth to SWE. The CCI SWE product applies spatially and temporally varying density fields, derived by krigging in situ snow density information from historical snow transects to correct biases in estimated SWE. Grid spacing was improved from 25 km to 12.5 km by applying an enhanced spatial resolution microwave brightness temperature dataset. We assess step-wise how each of these targeted changes acts to improve or worsen the product by evaluating with snow transect measurements and comparing hemispheric snow mass and trend differences.

Together, when compared to GlobSnow v3, these changes improved RMSE by ~5 cm and correlation by ~0.1 against a suite of snow transect measurements from Canada, Finland, and Russia. Although the hemispheric snow mass anomalies of CCI SWE and GlobSnow v3 are similar, there are sizeable differences in the climatological SWE, most notably a one month delay in the timing of peak SWE and lower SWE during the accumulation season. These shifts were expected because the variable snow density is lower than the former fixed value of 0.24 kg m^{-3} early in the snow season, but then increases over the course of the snow season. We also examine intermediate products to determine the relative improvements attributable solely to the increased spatial resolution versus changes due to the snow density parameterizations. Such systematic evaluations are critical to directing future product development.