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Towards a multi-decadal snow on sea ice product: validation, inter-comparison and impacts on satellite retrievals and climate

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Retrieval of sea ice depth from satellites relies on knowledge of snow depth in the conversion of freeboard measurements to sea ice thickness. This remains the largest source of uncertainty in calculating sea ice thickness. In order to go beyond the use of a seasonal snow climatology in this radar processing chain we have developed as part of an ESA project several novel snow on sea ice pan-Arctic products, with the ultimate goal to resolve for the first time inter-annual and seasonal snow variability.

We explore ways to extend our snow products over several decades (1990-2017) using an array of laser and radar altimeter satellites (IceSat, Envisat, CryoSat-2, AltiKa) as well as hybrid model-observation dynamic snow load model combining Lagrangian drifting sea ice particles with existing reanalysis precipitation products.

Our products are inter-compared and calibrated with each other to guarantee multi-decadal continuity. In addition, we validate each snow product against independent in-situ data (IMBs, snow buoys, field measurements), airborne studies (e.g. Operation IceBridge), and remote sensing products from different instruments (e.g. AMSR-E, SMOS). Quality assessment and uncertainty estimates are provided at a gridded level and as a function of sea ice cover characteristics such as sea ice age, sea ice type, surface temperature and salinity.

Finally, we investigate the impact of the spatially and temporally varying snow products on current satellite estimates of sea ice thickness and provide an update on the sea ice thickness uncertainties. We pay particular attention to potential biases of the seasonal ice growth and inter-annual trends. These results will in turn inform and benefit from model studies that are run in parallel and where the impact of the snow cover on the physical processes of sea ice (growth, melt pond formation, form drag) can be identified.