# MuSA: The Multiscale Snow data Assimilation system.

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The snowpack has an influence on ecological and hydrological processes at multiples scales from the hillslope to the river basin. However, neither remote sensing observations or in situ measurements are sufficient to provide an accurate description of the snow cover across such a range of spatial scales. Recent advances in snow science suggest that the combination of multi-sensor remote sensing observations and numerical models is the path forward to estimate spatial distribution of relevant snow cover state variables. Hence, we have developed a new data assimilation toolbox, the Multiscale Snow data Assimilation system (MuSA). MuSA is designed to fuse distributed or point scale observations of different nature of the snow with simulations generated by the Flexible Snowpack Model (FSM2). MuSA is able to assimilate fractional snow cover, snow depth, SWE, albedo, surface temperature, latent and sensible heat fluxes retrievals of different spatio-temporal resolutions through different data assimilation algorithms, including the Particle Batch Smoother, Particle filter, Ensemble Kalman filter, and Kalman filter. The observations can be assimilated individually or simultaneously in a highly scalable and user-friendly way to develop snowpack reanalysis or deploy real time monitoring systems. Here we introduce the first real world applications of MuSA. We have used it to assimilate 5m spatial resolution snow depth retrievals from UAV Structure from Motion in the Izas catchment (Spanish central Pyrenees) and point scale AWS data. We show the performance of the different data assimilation algorithms using spatally-distributed snow depth and snow cover observations. MuSa is intended to be open source to foster the development of distributed snow simulations.