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Evaluation of a tool to simulate high resolution mountain SWE from global datasets

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Despite its significance, the snow water equivalent (SWE) is poorly characterized in many mountain regions due to i) a lack of in situ measurements and ii) the difficulty to measure the SWE directly from satellite observations.

We developed a tool to simulate the spatial distribution of SWE at high resolution (typically 100 m) in any region of interest using SnowModel (Liston and Elder, 2006a, 2006b), global meteorological data (ERA5) and satellite observations of the snow cover fraction (SCF). Satellite observations are used to mitigate errors in the model parameterization and the meteorological forcings using the particle batch smoother (Margulis et al., 2015). This method consists in computing N perturbed simulations on the whole hydrological season and transforming the simulated SWE in a simulated SCF. In this study, we used the formula linking the SWE and the SCF of the Noah Land Surface Model as the measurement operator. After that, the simulations are compared to remotely sensed SCF data and weighted according to their agreements with the observations.

We implemented this data assimilation method with both MODIS and Sentinel-2 SCF data. We are testing it on the Bassies catchment in the French Pyrenees, and on the Tuolumne River Catchment in the Sierra Nevada, USA. In the Bassies catchment, we compare the results with snow depth maps from Pléiade satellites. We perturbed the precipitations with a log-normal law and found a very good agreement between the posterior simulated SCF and the observed one in Bassies as expected. However, the simulated snow depths in this catchment do not match the Pléiades snow depths observations. We added the perturbation of the air temperature with a normal law and found similar results. We also found a very small sensitivity of the posterior snow depth on the empirical parameters of the measurement operator. These results suggest that the SWE-SCF relationship may not be sufficiently informative in the study site of Bassiès. We will present the extension of this work to the Tuolumne river basin where the Airborne Observatory provides SWE maps over a larger region.