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## CRAMPON: A Particle Filter to assimilate sparse snowpack observations into a semi-distributed geometry

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In mountainous areas, detailed snowpack models are essential to capture the high spatio-temporal variability of the snowpack. This task is highly challenging, and models suffer from large simulation errors. In these regions, in-situ observations are scarce, while remote sensing observations are generally patchy owing to complex physiographic features (steep slopes, forests, shadows,...) and weather conditions (clouds). This point is stressing the need for a spatially coherent data assimilation system able to propagate the informations into unobserved locations.

In this study, we present CRAMPON (CRocus with AssiMilation of snowPack ObservatioNs), an ensemble data assimilation system ingesting snowpack observations in a spatialized context. CRAMPON quantifies snowpack modelling uncertainties with an ensemble and reduces them using a Particle Filter. Stochastic perturbations of meteorological forcings and the multi-physical version of Crocus snowpack model (ESCROC) are used to build the ensemble. Two variants of the Sequential Importance Resampling Particle Filter (PF) were implemented to tackle the common PF degeneracy issue that arises when assimilating a large number of observations. In a first approach (so-called global approach), the observations information is spread across topographic conditions by looking for a global analysis. Degeneracy is mitigated by inflating the observation error covariance matrix, with the side effect of reducing the impact of the assimilation. In a second approach (klocal), we propagate the information and mitigate degeneracy by a localisation of the PF based on background correlation patterns between topographic conditions.

Here, we investigate the ability of CRAMPON to globally benefit from partial observations in a conceptual semi-distributed domain which accounts for the main features of topographic-induced snowpack variability. We compare simulations without assimilation with experiments assimilating synthetic observations of the Height of Snow and VIS/NIR reflectance. This setup demonstrates the ability of CRAMPON to spread the information of various snow observations into unobserved locations.