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Geoscientific Model Development Discussions

Interactive comment on "CrocO_v1.0 : a Particle Filter to assimilate snowpack observations in a spatialised framework" *by* Bertrand Cluzet et al.

Anonymous Referee #1

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In this study, the authors developed two variants of the particle filter (PF), named the global PF and the klocal PF, to assimilate snow depth and reflectance for snow water equivalent (SWE) estimation. The global PF assimilation all observations in the domain while the klocal PF is a localized PF that assimilate only a subset of observations. To prevent the degeneracy of PF, the global PF inflates the observation error covariance until a sufficient number of replicas are available, while the klocal approach applies the maximum of "k" observations to maintain a sufficiently large observation-state variable variation. Some notable assumptions include the observations are free of noise, error, and correlation in space and time, and the prior estimates and the observations are generated from the same model (identical twin). The results prove that the inflations and the k-localization effectively prevent the degeneracy, and the PF systems are able

to spread the observed snow signal to non-observed areas.

This is a nice contrition to the existing PF literature and has the potential to significantly extend the applicability of PF. The study fits the scope of the journal. I hope the authors consider the following comments in the revision:

1. The domain is divided into classes based on elevation band, aspect and slope, but there is no information regarding the geographic distribution of these classes. The PF's performance is generally good in high-elevation areas, but performance variations still exist among these areas. Could this be a result that the observation improve the more local classes more than the class that is farther away from the observation?

2. Some discussions on the assumption and the feasibility-testing nature of the system is needed in the abstract or be acknowledged in the introduction section. In addition to the assumptions mentioned above, the depth observation error is assumed to be 0.1m (error covariance is 1e-2mˆ2), which is quite a high-bar for existing observation techniques, especially when used on spaceborne platform for large-scale measurements.

3. Line 27: panel a of Figure 1 does not look like flat âĂŤ the surface does seem to make an angle with the level surface (the brown triangle)

4. Line 128: it would be useful to include more details of the perturbation for each key forcing variable, like what perturbation models and error statistics are used, and whether spatial correlations are considered.

5. Figure 2: how do the forcing particle (Fi) and the model particle (Mi) get paired? Is it random or does it follow some protocol?

6. Line 180: can posterior estimates form the klocal approach show spatial discontinuity, since each area is updated independently by different measurements?

7. Line 195: how are the 10% and 0.3 here determined? Are they from previous literature or are there sensitivity test?

8 Line 239: the PF performance with band4 and band5 observations are quite different (as in Figure 4), what could be the reason?

9. Line 279: Figure 3c

10. Line 367: remove one “because of”.

11. Figure 1: panel a is not “flat”, as it has an elevation gradient. Making c the same size with b so their slope difference is more clear.

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