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Hydrology and Earth System Sciences Discussions

Interactive comment on "A Bayesian spatial assimilation scheme for snow coverage observations in a gridded snow model" *by* S. Kolberg et al.

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On the significance of transformations

The authors appreciate the response from anonymous referee #2, and in particular acknowledge the need for more clear and precise presentation of the method. Full answers to all comments will be posted at this site at the end of the evaluation period, but some fundamental issues raised in the general comments from referee #2 are discussed here.

We are a bit surprised over the emphasis given by the reviewer to the transformations as the main innovation in the article. In our opinion, the innovation lies in the general reduction of spatial uniqueness, brought by both the use of global variables (by which we transform), and by the spatial models applied (in which the transformations increase the spatial dependency). It is these models of spatial dependency that reduce the effective dimensionality of our estimation problem, and thus enhance the informational value of the limited number of observations we have.

It is correct that we do not explore different methods of smoothing the spatial data. The surfaces we transform are simulated by a hydrological precipitation-runoff model (PRM) consisting of simplified deterministic equations for the governing physical processes. For most PRMs, these equations include a degree-day equation used in scaling temperature to snow melt intensity, and elevation gradients used in downscaling input data. Usually, these gradients dominate the small-scale spatial variability in the simulated data, because measuring stations tend to be absent at high altitude, and the station network is sparse compared to both the spatial scale of the terrain and the typical discretisation of a grid distributed PRM.

Thus, rather than looking among several transformations for the one which best smoothes our specific data, we have based our transformations on prior knowledge and common PRM practice. Hence, the transformations themselves are hardly our innovations, and in our opinion the original contribution from the current paper lies in the use of spatial models to enhance the informational value of satellite data. In this context, we fully agree that applying a spatio-temporal model as in Huang and Cressie (1996) instead of a purely spatial, would be a good idea, in particular for the accumulated melt depth. It is likely that we will pursue this idea in the future.

Regarding the effect of the spatial models and global variables (called for in rev. comment # 11, p1199-1200), the reader is referred to a preceding paper (Kolberg and Gottschalk, 2005). Here, the similar analysis was performed independently in each grid cell, without spatial models or global variables, leaving each observation with four variables to estimate. That paper is reviewed and accepted for publication in Hydrological Processes, but due to long production time it will not be available before late autumn 2005 (web) or early in 2006 (print).

In terms of reduction of variance from the prior to the posterior state, the inclusion of global variables and spatial models have greatly improved the results of the Bayesian assimilation technique. It is true that the changes in expected values are not unambiguously confirmed by estimates derived from observed discharge. Reasons for this are discussed in the text, in particular relating to estimating the elevation gradients when most high-altitude observations carry little information on mass balance, due to full snow coverage.

References:

Huang, H.-C. and Cressie, N. (1996): Spatio-Temporal Prediction of Snow Water Equivalent using the Kalman Filter. Computational Statistics and Data Analysis 22, p. 159-175.

Kolberg, S. and Gottschalk, L. (2005): Updating of Snow Depletion Curve with Remote Sensing Data. Hydrological Processes, in press.

Interactive comment on Hydrology and Earth System Sciences Discussions, 2, 1185, 2005.