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Satellite snow data in hydrological models

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In mountainous regions with a deep seasonal snow pack, the spring flood often persists for several weeks, and may contain half of the annual runoff. With melt runoff being the product of melt rate and snow coverage, adequate representation of the gradually diminishing snow coverage is important for estimating runoff during the melt period. Updating of uncertain model states with satellite observation of snow covered area could provide improved hydrological forecasts.

However, such improvements do not always occur, several authors report degraded performance when updating. This may be due to internal compensation of errors caused by traditional calibration to discharge measurements, being disturbed when an internal state is suddenly supplied independently. The current work investigates the connection between the calibration of snow related parameters, and a distributed snow melt model's response to added snow covered area information. Using a Bayesian technique for re-estimating a multi-dimensional model state, spatially distributed as well as regionally invariant parameters are adjusted to both satellite snow coverage information and distributed discharge measurements.

The analysis is based on MODIS data, from the seasons 2000 to 2005. Using the data product MOD09 Surface Reflectance, sub-pixel snow coverage maps are derived by a normalized index method. The Bayesian assimilation technique re-estimates both state variables and parameters in the model, the latter representing calibration of individual grid cells.

As accumulation of the information proceeds over several years, the prior variance of distributed parameters reduces. After four years of assimilating satellite data, the model is recalibrated using the adjusted map of distributed parameters, and the performance of the two calibrations during further updating is compared.