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Data assimilation with in situ soil moisture observations: what spatial configuration of the sensor network should be considered?

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Continuously monitoring soil moisture in a permanent in situ network can yield an interesting observation product for hydrological data assimilation. Those in situ observations can be characterised by some major advantages such as a fine temporal resolution, a large vertical extent, the small impact of land cover on the observation error, etc.

Because of the typical small integration volume of in situ measurements and the often large spacing between monitoring locations, only a small part of the modelling domain can be directly observed. Therefore a first important question to answer is whether spatially sparse in-situ soil moisture observations contain a sufficient data representativeness to successfully update the largely unobserved spatial extent of a distributed hydrological model.

Furthermore, the spatial configuration of the sensors remains unaltered through time. Consequently it is interesting to assess the sensitivity of the spatial configuration of the sensors regarding the data assimilation performance. This allows for answering a second question: is it possible to reduce the number of sensors by optimising the design of the in situ network whilst maintaining the same level of assimilation performance? To bring added value in practice, one should be able to identify optimal network configurations using prior available model input data and/or open loop statistics, i.e. statistics derived from a model run without data assimilation.

In this study the meso-scale catchment of the Bellebeek ($\pm$100 km^2) in Belgium is modelled. The abovementioned questions are addressed by means of a synthetic data assimilation framework using the ensemble Kalman filter. It can be concluded that the network configuration can indeed have a significant influence on the assimilation performance. Furthermore, preliminary results indicate that certain open loop statistics can be used as a network performance predictor. More in particular, it was examined whether the information content of the ensemble error covariance matrix could be exploited to identify representative locations within a catchment.