Sub-Optimal Ensemble Filters and distributed hydrologic modeling: a new challenge in flood forecasting

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Data assimilation techniques based on Ensemble Filtering are widely regarded as the best approachin solving forecast and calibration problems in geophysic models.

Often the implementation of statistical sub-optimal techniques, like the Ensemble Kalman Filter, is unfeasible because of the large amount of replicas used in each time step of the model for updating che error covariance matrix. Various sub-optimal techniques were tested in atmospheric and oceanographic models, some of them are based on the detection of a “null space”.

Distributed Hydrologic Models differ from the other geo-fluid-dynamics models in some fundamental aspects that make complex to understanding the relative efficiency of the different suboptimal techniques. Those aspects include threshold processes , preferential trajectories for convection and diffusion, low osservability of the main state variables and high parametric uncertainity.

This research study is focused on such topics and explore them through some numerical experiments on an continuous hydrologic model, MOBIDIC. This model include both water mass balance and surface energy balance, so it's able to assimilate a wide variety of datasets like traditional hydrometric “on ground” measurements or land surface temperature retrieval from sattelite.

The experiments that we present concern to a basin of 700 kmq in center Italy, with hourly dataset on a 8 months period that includes both drought and flood events, in this first set of experiment we worked on a low spatial resolution version of the hydrologic model (3.2 km).

In the experiments we implement with a P.O.D. Reduction from control theory, two different suboptimal filtering tecniques that are computationally less onerous then the complete Ensemble Kalman Filter: the first is a simple rank reduction of the complete filter error covariance and the second is a more exceed filter on a complementary reduced space. We compare the two different techniques and, for each technique, we resolve two different percentage of sub-space modes in the phase space .

Then the efficiency of the different techniques is weighed in term of hydrometric forecast accurancy in time intervals up to the corrivation time of the basin (about 8 hours).

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