Joint assimilation of streamflow and downscaled satellite soil moisture observations to improve large-scale hydrological modelling.

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Abstract

The coarse spatial resolution of global hydrological models (typically > 0.25^o) limits their ability to resolve key water balance processes for many river basins, especially when compared to locally-tunes river models. A possible solution to the problem may be to drive the coarse resolution models with high-resolution meteorological data as well as to assimilate ground-based and remotely-sensed observations. In this study, we investigated the impact that assimilating streamflow and satellite soil moisture observations have on hydrological model estimation, for the Murrumbidgee River in Australia.

The PCR-GLOBWB global hydrological model is forced with downscaled global climatological data (from 0.5^o downscaled to 0.1^o resolution) obtained from the WATCH Forcing Data and local high resolution gauging station based gridded datasets (0.05^o). Downscaled satellite derived soil moisture (0.1^o resolution) from AMSR-E and 23 discharge stations are assimilated using an ensemble Kalman filter.

Results show that the assimilation of soil moisture observations results in the largest improvement of the model estimates. The joint assimilation of both streamflow and downscaled soil moisture observations leads to further improvement in streamflow simulations (20% decrease in RMSE).

Results also show that the added contribution of data assimilation, for both soil moisture and streamflow, is more pronounced when the global meteorological data are used to force the models. This is caused by the higher uncertainty and coarser resolution of the global forcing.

We show that it is possible to improve hydrological simulations forced by coarse resolution meteorological data with downscaled satellite soil moisture and streamflow observations and bring them closer to a local hydrological model forced with local climatological data. These findings are important in light of the efforts that are currently done to go to global hyper-resolution modelling and high resolution soil moisture mapping.