Geophysical Research Abstracts
Vol. 17, EGU2015-8627, 2015
EGU General Assembly 2015

Improved large-scale hydrological modelling through the assimilation of streamflow and downscaled satellite soil moisture observations.

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The coarse spatial resolution of global hydrological models (typically $> 0.25^o$) often limits their ability to resolve key water balance processes for many river basins and thus compromises their suitability for water resources management, 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 of key water cycle variables. While this would improve the modelling resolution of the global model, the impact of prediction accuracy remains largely an open question. In this study we investigated the impact that assimilating streamflow and satellite soil moisture observations have on global hydrological model estimation, driven by coarse- and high-resolution meteorological observations, for the Murrumbidgee river basin 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 (WFDEI) and local high resolution gauging station based gridded datasets (0.05^o), sourced from the Australian Bureau of Meteorology. Downscaled satellite derived soil moisture (from 0.5^o downscaled to 0.1^o resolution) from AMSR-E and streamflow observations collected from 25 gauging stations are assimilated using an ensemble Kalman filter. Several scenarios are analysed to explore the added value of data assimilation considering both local and global climatological data.

Results show that the assimilation of streamflow observations result in the largest improvement of the model estimates. The joint assimilation of both streamflow and downscaled soil moisture observations leads to further improved in streamflow simulations (10% reduction in RMSE), mainly in the headwater catchments (up to 10,000 km^2).

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.

This study demonstrates 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 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 can significantly help to advance this research.