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Integrating SMOS brightness temperatures with a new conceptual spatially distributed hydrological model for improving flood and drought predictions at large scale.

Renaud Hostache (1), Dominik Rains (2), Marco Chini (1), Hans Lievens (2), Niko E.C. Verhoest (2), and Patrick Matgen (1)

(1) Luxembourg Institute of Science and Technology, Environmental Research and Innovation Department, Esch-sur-Alzette, Luxembourg., (2) Ghent University, Faculty of Bioscience Engineering, Laboratory of Hydrology and water Management, Ghent, Belgium.

Motivated by climate change and its impact on the scarcity or excess of water in many parts of the world, several agencies and research institutions have taken initiatives in monitoring and predicting the hydrologic cycle at a global scale. Such a monitoring/prediction effort is important for understanding the vulnerability to extreme hydrological events and for providing early warnings. This can be based on an optimal combination of hydro-meteorological models and remote sensing, in which satellite measurements can be used as forcing or calibration data or for regularly updating the model states or parameters. Many advances have been made in these domains and the near future will bring new opportunities with respect to remote sensing as a result of the increasing number of spaceborn sensors enabling the large scale monitoring of water resources. Besides of these advances, there is currently a tendency to refine and further complicate physically-based hydrologic models to better capture the hydrologic processes at hand. However, this may not necessarily be beneficial for large-scale hydrology, as computational efforts are therefore increasing significantly. As a matter of fact, a novel thematic science question that is to be investigated is whether a flexible conceptual model can match the performance of a complex physically-based model for hydrologic simulations at large scale.

In this context, the main objective of this study is to investigate how innovative techniques that allow for the estimation of soil moisture from satellite data can help in reducing errors and uncertainties in large scale conceptual hydro-meteorological modelling.

A spatially distributed conceptual hydrologic model has been set up based on recent developments of the SUPERFLEX modelling framework. As it requires limited computational efforts, this model enables early warnings for large areas. Using as forcings the ERA-Interim public dataset and coupled with the CMEM radiative transfer model, SUPERFLEX is capable of predicting runoff, soil moisture, and SMOS-like brightness temperature time series. Such a model is traditionally calibrated using only discharge measurements. In this study we designed a multi-objective calibration procedure based on both discharge measurements and SMOS-derived brightness temperature observations in order to evaluate the added value of remotely sensed soil moisture data in the calibration process.

As a test case we set up the SUPERFLEX model for the large scale Murray-Darling catchment in Australia ($\sim$ 1 Million km2). When compared to in situ soil moisture time series, model predictions show good agreement resulting in correlation coefficients exceeding 70 % and Root Mean Squared Errors below 1 %. When benchmarked with the physically based land surface model CLM, SUPERFLEX exhibits similar performance levels. By adapting the runoff routing function within the SUPERFLEX model, the predicted discharge results in a Nash Sutcliff Efficiency exceeding 0.7 over both the calibration and the validation periods.