Geophysical Research Abstracts,
Vol. 10, EGU2008-A-04329, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-04329
EGU General Assembly 2008

A new data assimilation approach for improving streamflow forecasting using remotely-sensed soil moisture retrievals

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A large number of recent studies have focused on improving rainfall/runoff and stream flow modeling via the assimilation of remotely sensed surface soil moisture retrievals into a hydrologic model. The vast majority of these approaches have viewed the problem from a state-estimation perspective – in which remotely sensed soil moisture estimates are assimilated to improve the characterization of antecedent moisture predictions by a hydrologic model, and consequently, its simulation of runoff response to future precipitation. Such an approach, however, neglects a potentially important source of information within remotely sensed surface soil moisture retrievals. Recent work has demonstrated how soil moisture retrievals can be interpreted to filter accumulation errors present in satellite-based rainfall products. This result demonstrates that soil moisture retrievals have potential benefit for both the characterization of antecedent moisture conditions (required to estimate subsequent rainfall runoff efficiencies) and the estimation of storm-scale precipitation totals (required to establish the total runoff volume). Efforts to exploit soil moisture remotely sensing for hydrologic forecasting applications should consider both sources of skill or risk a sub-optimal exploitation of forecasting information present in remotely sensed soil moisture retrieval products.

This work will present a new sequential data assimilation system that exploits remotely sensed surface soil moisture retrievals to improve estimates of both pre-storm soil moisture conditions *and* storm-scale rainfall accumulations. Our Ensemble

Kalman filter-based system is specifically designed to avoid the presence of cross-correlation between forecasting and observing errors that can arise from such a dual use of soil moisture retrievals (and potentially confound a sequential filter). Preliminary testing of the system, via a synthetic twin data assimilation experiment, demonstrates that our new approach is more efficient at improving stream flow estimates than a baseline strategy of assimilating retrievals to improve antecedent soil moisture conditions only (i.e. the typical state estimation-based strategy discussed above). Such improvements are likely to be the most profound in basins where rainfall is not accurately measured and/or runoff efficiency is not highly sensitivity to antecedent soil moisture conditions. The basis and implication of these sensitivities, and issues surrounding the selection of an appropriate sequential data assimilation filter, will be addressed.