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Open source data assimilation framework for hydrological modeling

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An open-source data assimilation framework is proposed for hydrological modeling. Data assimilation (DA) in hydrodynamic and hydrological forecasting systems has great potential to improve predictions and improve model result. The basic principle is to incorporate measurement information into a model with the aim to improve model results by error minimization. Great strides have been made to assimilate traditional in-situ measurements such as discharge, soil moisture, hydraulic head and snowpack into hydrologic models. More recently, remotely sensed data retrievals of soil moisture, snow water equivalent or snow cover area, surface water elevation, terrestrial water storage and land surface temperature have been successfully assimilated in hydrological models.
The assimilation algorithms have become increasingly sophisticated to manage measurement and model bias, non-linear systems, data sparsity (time & space) and undetermined system uncertainty. It is therefore useful to use a pre-existing DA toolbox such as OpenDA. OpenDA is an open interface standard for (and free implementation of) a set of tools to quickly implement DA and calibration for arbitrary numerical models. The basic design philosophy of OpenDA is to breakdown DA into a set of building blocks programmed in object oriented languages. To implement DA, a model must interact with OpenDA to create model instances, propagate the model, get/set variables (or parameters) and free the model once DA is completed. An open-source interface for hydrological models exists capable of all these tasks: OpenMI.
OpenMI is an open source standard interface already adopted by key hydrological model providers. It defines a universal approach to interact with hydrological models during simulation to exchange data during runtime, thus facilitating the interactions between models and data sources. The interface is flexible enough so that models can interact even if the model is coded in a different language, represent processes from a different domain or have different spatial and temporal resolutions.
An open source framework that bridges OpenMI and OpenDA is presented. The framework provides a generic and easy means for any OpenMI compliant model to assimilate observation measurements. An example test case will be presented using MikeSHE, and OpenMI compliant fully coupled integrated hydrological model that can accurately simulate the feedback dynamics of overland flow, unsaturated zone and saturated zone.