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Application of WRF - SWAT OpenMI 2.0 based models integration for real time hydrological modelling and forecasting

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Intake of deterministic distributed hydrological models into operational water management requires intensive collection and inputting of spatial distributed climatic information in a timely manner that is both time consuming and laborious. The lead time of the data pre-processing stage could be essentially reduced by coupling of hydrological and numerical weather prediction models. This is especially important for the regions such as the South of the Russian Far East where its geographical position combined with a monsoon climate affected by typhoons and extreme heavy rains caused rapid rising of the mountain rivers water level and led to the flash flooding and enormous damage.
The objective of this study is development of end-to-end workflow that executes, in a loosely coupled mode, an integrated modeling system comprised of Weather Research and Forecast (WRF) atmospheric model and Soil and Water Assessment Tool (SWAT 2012) hydrological model using OpenMI 2.0 and web-service technologies.
Migration SWAT into OpenMI compliant involves reorganization of the model into a separate initialization, performing timestep and finalization functions that can be accessed from outside. To save SWAT normal behavior, the source code was separated from OpenMI-specific implementation into the static library. Modified code was assembled into dynamic library and wrapped into C# class implemented the OpenMI ILinkableComponent interface.
Development of WRF OpenMI-compliant component based on the idea of the wrapping web-service clients into a linkable component and seamlessly access to output netCDF files without actual models connection. The weather state variables (precipitation, wind, solar radiation, air temperature and relative humidity) are processed by automatic input selection algorithm to single out the most relevant values used by SWAT model to yield climatic data at the subbasin scale. Spatial interpolation between the WRF regular grid and SWAT subbasins centroid (which are coinciding as virtual weather stations) realized as OpenMI AdaptedOutput. In order to make sure that SWAT-WRF integration technically sounds and preevaluate the impact of the climatic data resolution on the model parameters a number of test calculations were performed with different time-spatial aggregation of WRF output.
Numerical experiments were carried out for the period of 2012-2013 on the Komarovka river watershed (former Primorskaya water-balance station) located in the small mountains landscapes in the western part of the Khankaiskaya plain. The watershed outlet is equipped with the automatic water level and rain gauging stations of Primorie Hydrometeorological Agency (Prigidromet http://primgidromet.ru) observation network. Spatial structure of SWAT simulation realized by ArcSWAT 2012 with 10m DEM resolution and 1:50000 soils and landuse cover. Sensitivity analysis and calibration are performed with SWAT CUP. WRF-SWAT composition is assembled in the GUI OpenMI.
For the test basin in most cases the simulation results show that the predicted and measured water levels demonstrate acceptable agreement. Enforcing SWAT with WRF output avoids some semi-empirical model approximation, replaces a native weather generator for WRF forecast interval and improved upon the operational streamflow forecast. It is anticipated that leveraging direct use of the WRF variables (not only substituted standard SWAT input) will have good potential to make SWAT more physically sound.