Luis Samaniego and Rohini Kumar

Robust predictions of water fluxes on large scales.

Finding cost effective solutions to pressing environmental problems or reducing the vulnerability of socio-economic activities to extreme hydro-meteorological events require among other things to have the ability of monitoring and predicting the movement of water on the landscape at scales varying from 1 to 5 km. Limited data availability, on the other hand, imposes another grand challenge because most hydrological predictions would have to be done in ungauged locations. As a consequence of these requirements and limitations, land surface and distributed hydrological models are fraught with issues such as over-parameterization, parameter non-identifiability, non-transferability of parameters across calibration scales and locations, and demanding computational time.
One option to overcome these issues is to seek for efficient parameterization schemes that should allow existing models to exploit all kinds of physiographical, meteorological, and remotely sensed data available. In this study, the selection of the most efficient approach was carried out within a formal hypothesis testing framework. Specific goals were to investigate the effects of scale, transferability of parameters across scales and locations, parametric uncertainty, and sub-grid variability of parameters on model outputs such as streamflow, top soil water content, and groundwater recharge. These tests were carried out with the distributed mesoscale Hydrological Model (mHM) and two parameterization methods: the hydrologic (homogeneous) response units (HRU) and the multiscale parameter regionalization technique (MPR). The study domain comprised eight major river basins in Germany (Danube, Main, Weser, Neckar, Mulde, Ems, Saale, Rhine) and two large river basins in the USA (Red River and Ohio). In Germany, mHM is forced with (4 x 4) km daily precipitation and temperature fields interpolated from 5600 rain gauges and 1100 meteorological stations operated by the German Meteorological Service (DWD). In the USA, the model was forced with a recently developed meteorological data set available at 1/16_ spatial resolution (Livnehet al. 2010).
Results indicated that modeled water fluxes are extremely sensitive to the parameterization method employed as well as the sub-grid variability of the parameter fields. HRU is scale dependent whereas MPR is almost scale invariant. As a result, MPR, as compared to HRU, performed much better for all simulations carried out in Germany (Kumar et al. 2012). The efficiency of the MPR method was further supported by the possibility of transferring global model parameters estimated in German basins to those in the USA.