A WATERSHED SCALE GROUNDWATER-LAND-SURFACE MODEL

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Land surface models (LSMs) and groundwater models are important tools in studying the Earth's surface processes. However, subsurface waters are not well described in LSMs, and groundwater models tend to have relatively primitive land-surface schemes. Coupled models of the atmospheric boundary layer, land surface and subsurface, which incorporate groundwater components into LSMs and couple the deeper subsurface with the atmosphere, may yield significant improvements in both short-term climate forecasting and flood/drought forecasting.

A groundwater-land-surface model system has been developed from the Penn State Integrated Hydrologic Model (PIHM). The land-surface scheme is mainly adapted from the Noah LSM (Ek et al. 2003), which is widely used in mesoscale atmospheric models and has undergone extensive testing. Because PIHM is able to simulate lateral water flow and has deep groundwater, the new LSM is able to represent some of the land-surface heterogeneity caused by topography. At the same time, the robust land-surface scheme incorporated into PIHM provides accurate sensible heat flux and evapo-transpiration rates. The new model has been implemented for the Shale Hills watershed in central Pennsylvania and run from 0000 UTC 1 May to 0000 UTC 1 June 2009. The model is driven by North American Regional Reanalysis (NARR) atmospheric forcing data.

The model reproduces realistic topographically-induced distributions of water table, soil moisture, and skin temperature. The surface heat fluxes, soil temperature and skin temperature simulated by the new LSM compare well with the NARR data. The NARR-PIHM surface heat flux residuals are always less than 50 Wm^{-2}. The simulated water table depth shows reasonable agreement with the in-situ measurements. The sensible and latent heat fluxes and skin temperature are correlated with water table depth, which indicates the strong interaction between land surface and groundwater.

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