A Watershed-Scale Groundwater-Land-Surface Model

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Motivation

- Ignoring deep groundwater and lateral water flow
- Groundwater models: relatively simple evapotranspiration scheme

Model and data

- A land-surface module is incorporated into the Penn State Integrated Hydrologic Model or PIHM 2.0 (Kumar 2008)
  - Fully coupled surface water, groundwater, and land surface components
  - Land-surface scheme is mainly adapted from the Noah LSM (Ek et al. 2003)

- Shale Hills Watershed in central Pennsylvania (0.08 km²)
  - Shale Hills Critical Zone Observatory is a small-scale site for testing the theory with an array of land-surface and subsurface sensors.
  - 598 grids with an average grid size of 128 m²

Results

- Uniform soil and land-cover distribution
- Driven by North American Regional Reanalysis (NARR)
- Simulation from 00 UTC 1 May to 00 UTC 1 June 2009

Groundwater predictions

- Figure 3: Comparison of water table depth (the distance from land surface to water table) between the GWLSM simulation and measurements of Real-Time Hydrologic monitoring network (RTHnet) groundwater level sensor at Instrument Array 3 (Figure 2).
- Model is insensitive to small amounts of precipitation
- Results could be improved by:
  - Using more sophisticated hydrology (in development), and
  - Better optimization

Surface energy balance predictions

- Figure 5: The comparison of (a) sensible heat fluxes, (b) latent heat fluxes, and (c) ground heat fluxes between new GWLSM simulation and NARR data. The heat fluxes are averaged spatially over the whole domain.

Future Work

- Compare model with eddy-covariance measurements
- Incorporate data assimilation module into model and test the assimilation of eddy-covariance and sap flux measurements, surface temperature, water table depth, and channel flow
- Test on different spatial scales
- Evaluate impact of model on flood/drought prediction at scales up to the Juniata River Basin (~8800 km²)

Works Cited