Evaluating green infrastructure fluxes using Parflow.CLM

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Objectives

• Evaluate performance of Philadelphia GI projects at subwatershed and site scales
• Use the integrated hydrologic model ParFlow.CLM as an analysis tool
• Demonstrate the capabilities of this modeling approach
ParFlow.CLM

Common Land Model

NLDAS Primary forcing
(Precipitation, temperature, solar radiation, wind speed, land cover)

Soil moisture state

ParFlow

Surface-subsurface hydrology

Pressure head and saturation

Upper boundary condition fluxes
(Precipitation - Evapotranspiration)

Courtesy of A. Bhaskar
Wingohocking Model Domain
Model inputs

- DEM resampled to 40 m x 40 m resolution
- Vertical discretization 1 m
- Domain area of 32 km$^2$
- 70 m depth
- Burning of pipes based on invert elevation
Model inputs, cont’d

- Landcover data
  - CLM vegetation input
  - Impervious locations
- SSURGO soil data
  - Surface layer hydraulic properties
Model inputs, cont’d

- Geology – soil, saprolite, fractured rock
- Water supply leakage
- NLDAS meteorological forcing used to drive the model, 1/1/2004 to 2/1/2015
Model output: subsurface storage
Model output: depth to water table

- ParFlow (70 m depth)
- USGS Well PH 550 (Well depth 52 m)
- USGS Well PH 1043 (Well depth 5.7 m)
- ParFlow (70 m depth)
Model output

- Pressure head
  - Base flow during dry periods at pipe locations
- CLM variables
Evapotranspiration: Pervious vs Impervious
Surface Saturation: Pervious vs Impervious

![Graph showing the comparison between Pervious and Impervious surface saturation over time with precipitation levels.](image)
Pervious saturation through depth

Saturation (%) vs. Precipitation (mm/s)

- 8m below land surface
- 7m below land surface
- 2m below land surface
- Surface layer

Dates: 6/22/2014 to 2/22/2015
Pervious layer: Hydraulic head during storms

- Surface layer
- 1m below land surface
- 2m below land surface
- 3m below land surface

Precipitation (mm/hr)

Hydraulic Head (m)

Dates: 16-May to 5-Jun 2014
Advantages and challenges of using Parflow-CLM for modeling green infrastructure

• Advantages
  - Capability of simulating saturated and unsaturated conditions, as well as overland flow
  - Capability of simulating evapotranspiration for various landcover types classified by CLM
  - Spatially and temporally variable output

• Challenges
  - Computational resource requirements
Future Work

• Model site-scale subdomains using finer gridding
• Determine distribution of subsurface flow paths and travel times using particle tracking
• Evaluate aquifer response to infiltration