# Hydrological response of a South Carolina river basin to the 2015 extreme rainfall event: A simulation using WRF-hydro

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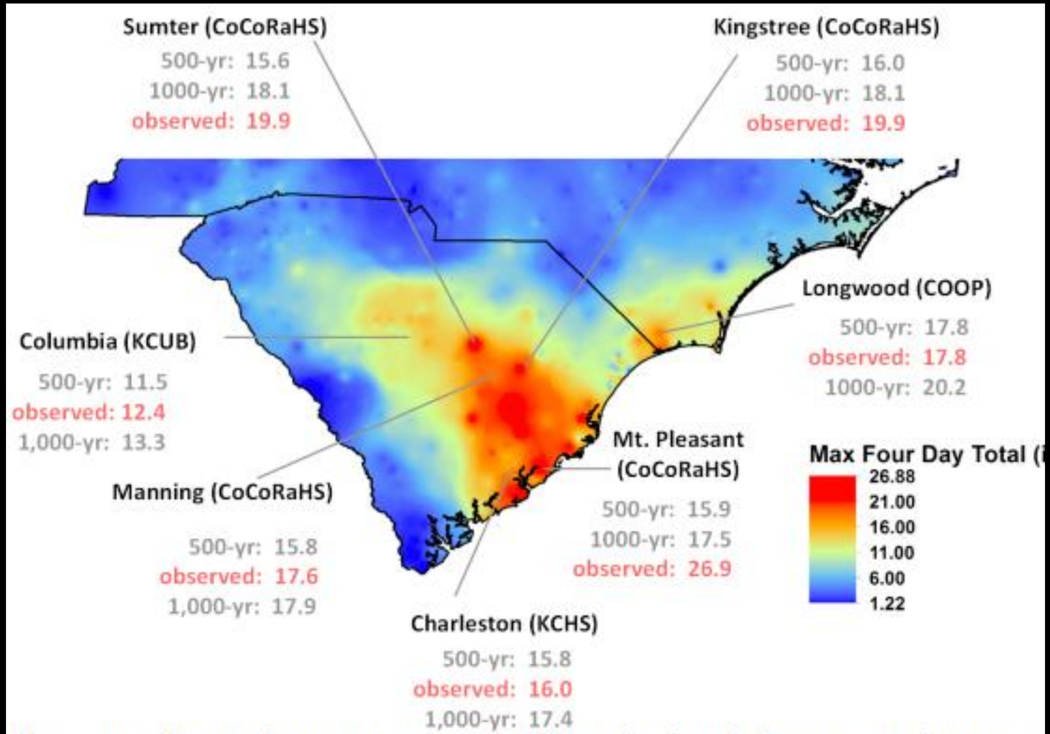
# 10/01/2015 – 10/05/2015

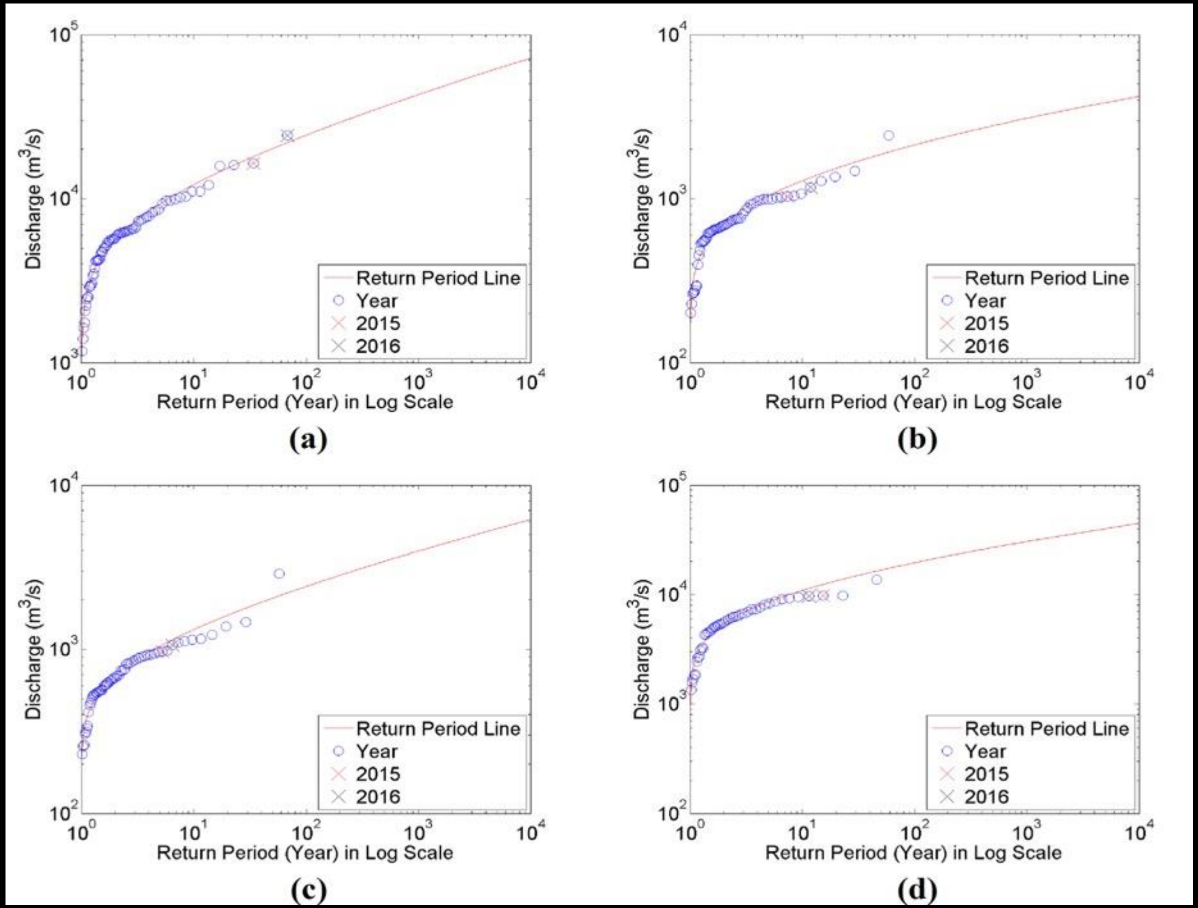
Rainfall : 1000-year



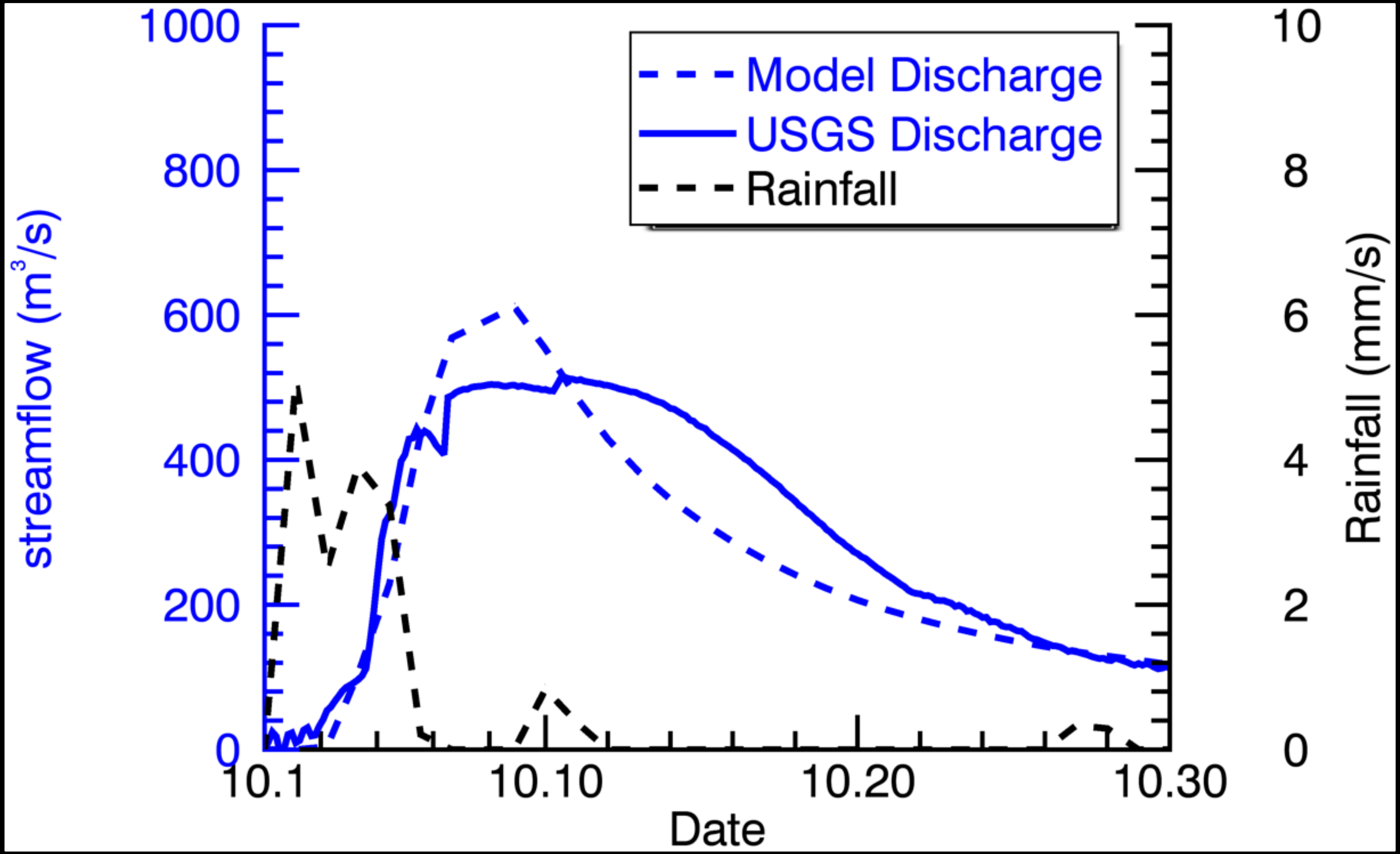

This map shows the maximum rainfall totals that fell over a 4-day perio during this event as well as data from weather stations where 500 an 1,000 year recurrence intervals were exceeded. The amount of rain was les than a 1,000 year event in some places and greater than that in others. M Pleasant, SC saw the highest recorded 4-day total (Oct 2-5) at 26.88 inche Map by Peng Gao.

*Source: USGS*

River discharge rate: 20-50 year

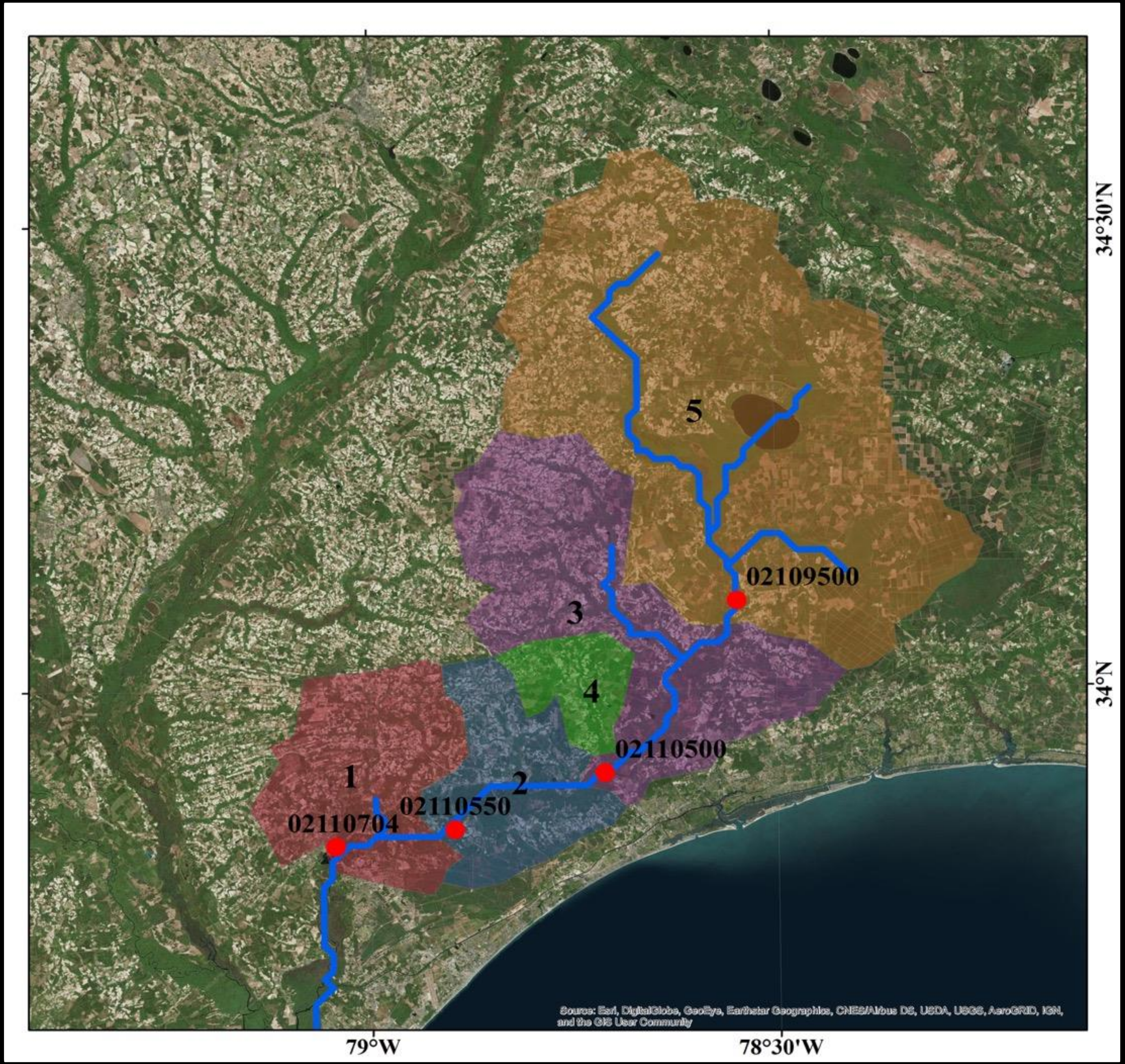


# River discharge lagged rainfall (Waccamaw River)



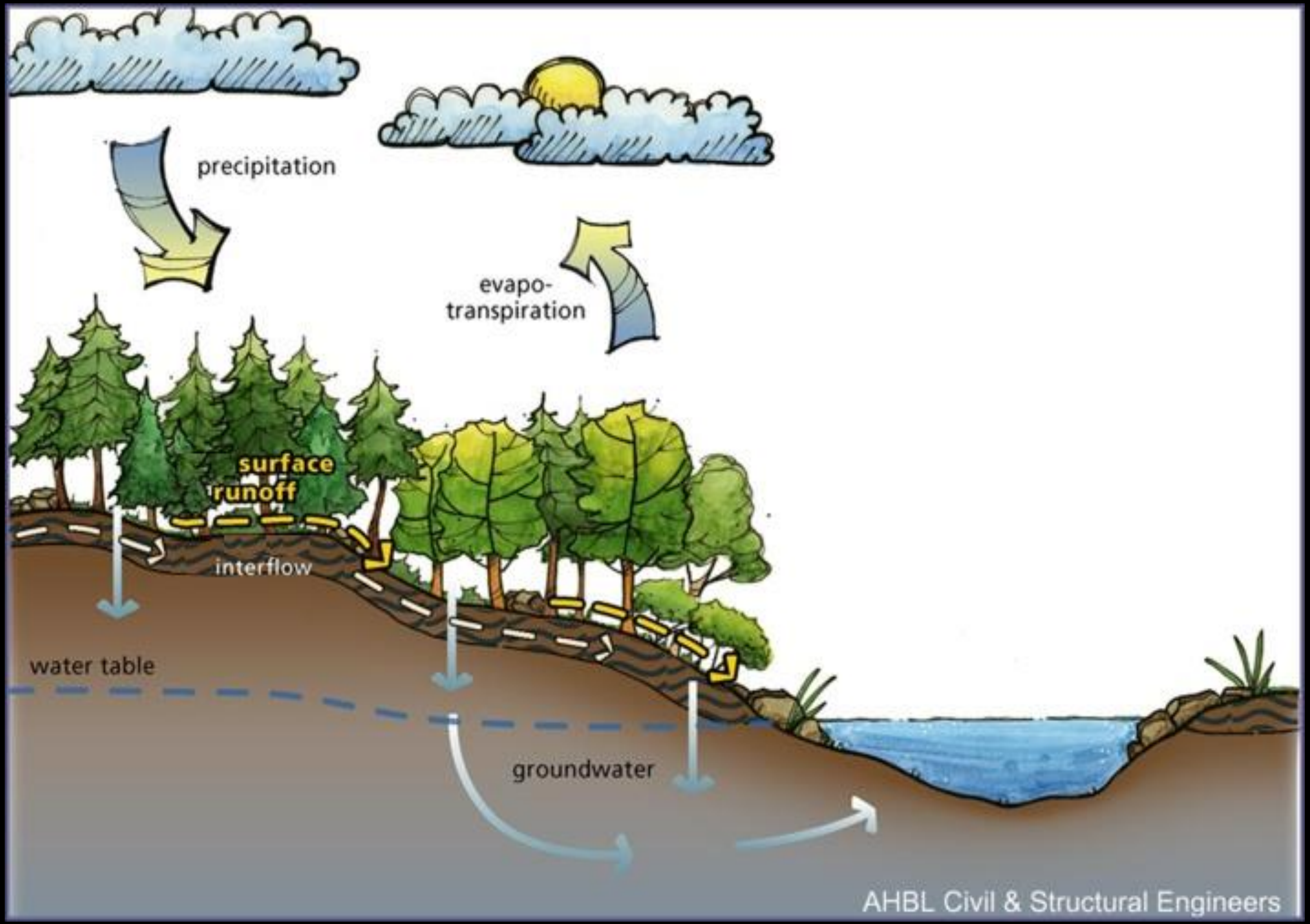
# Waccamaw River basin

- Typical river basin in the East US coast
- Low-lying outer coastal plain
- Wetlands with high infiltration



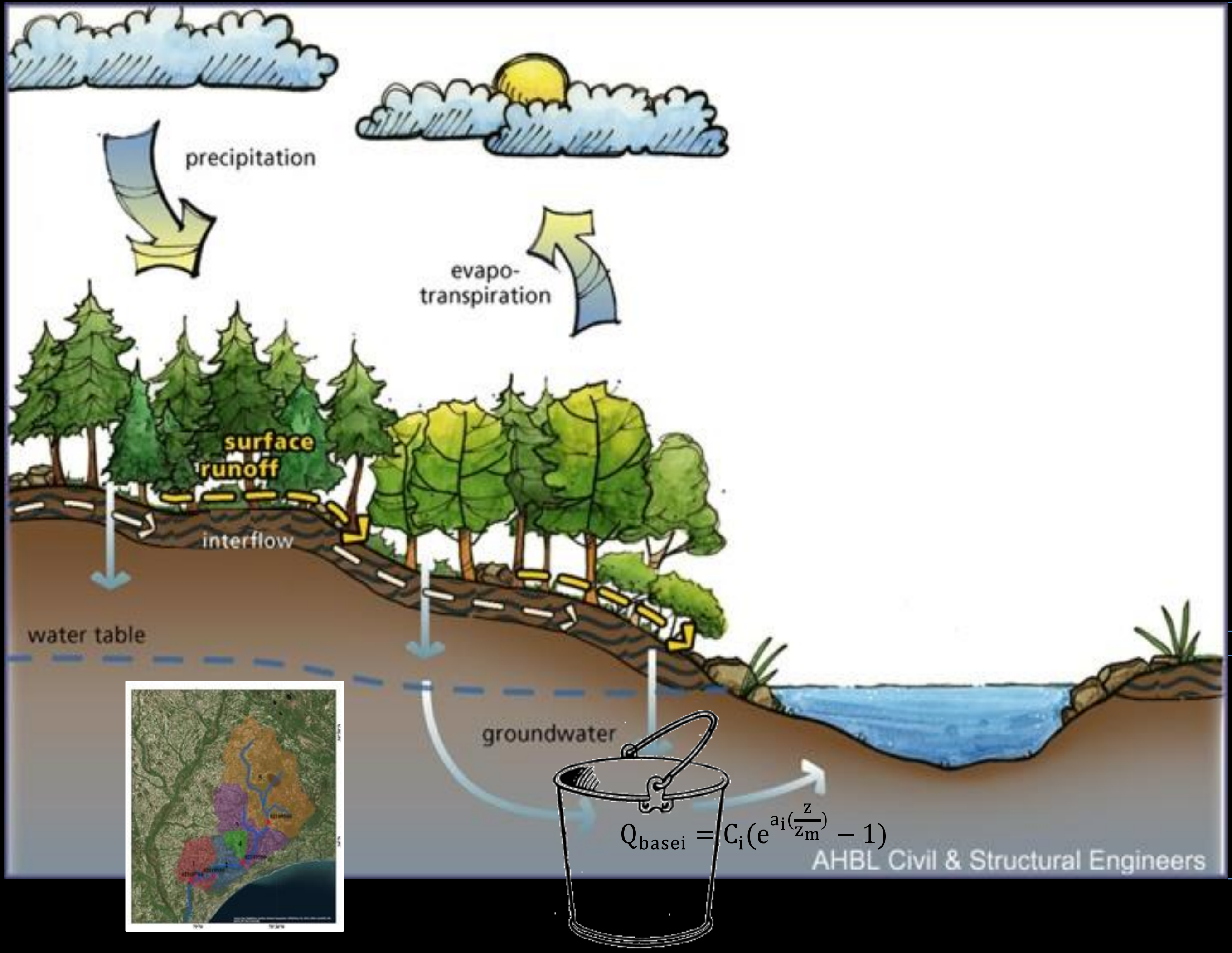
# Basic hydrologic processes

## Rain=Evaporation + direct runoff+ underground runoff + Storage




- Water balance
- Which is dominate: slow runoff or quick runoff?
- Why discharge lagged rainfall
- The role of land-surface

# WRF-hydro model

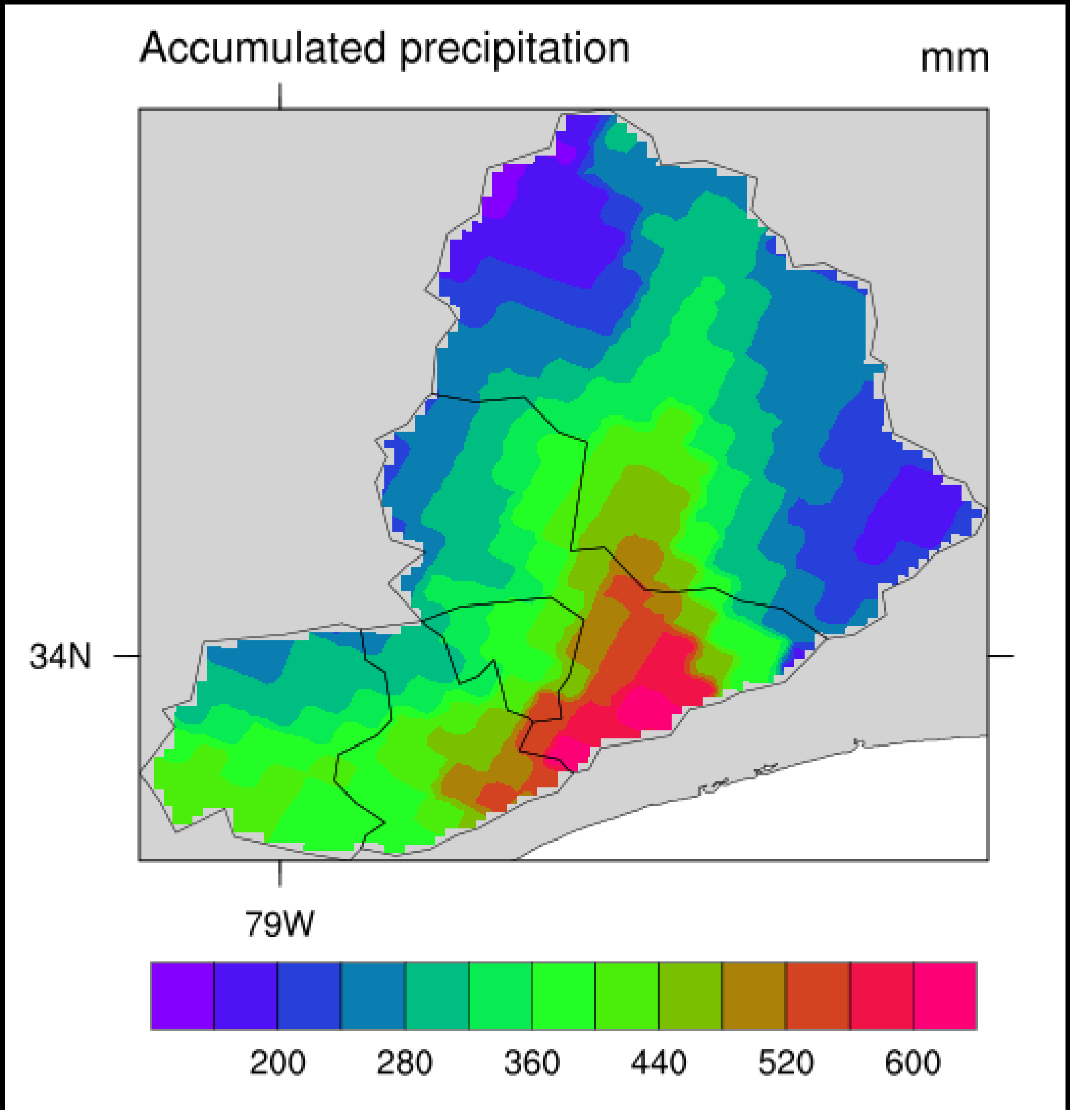


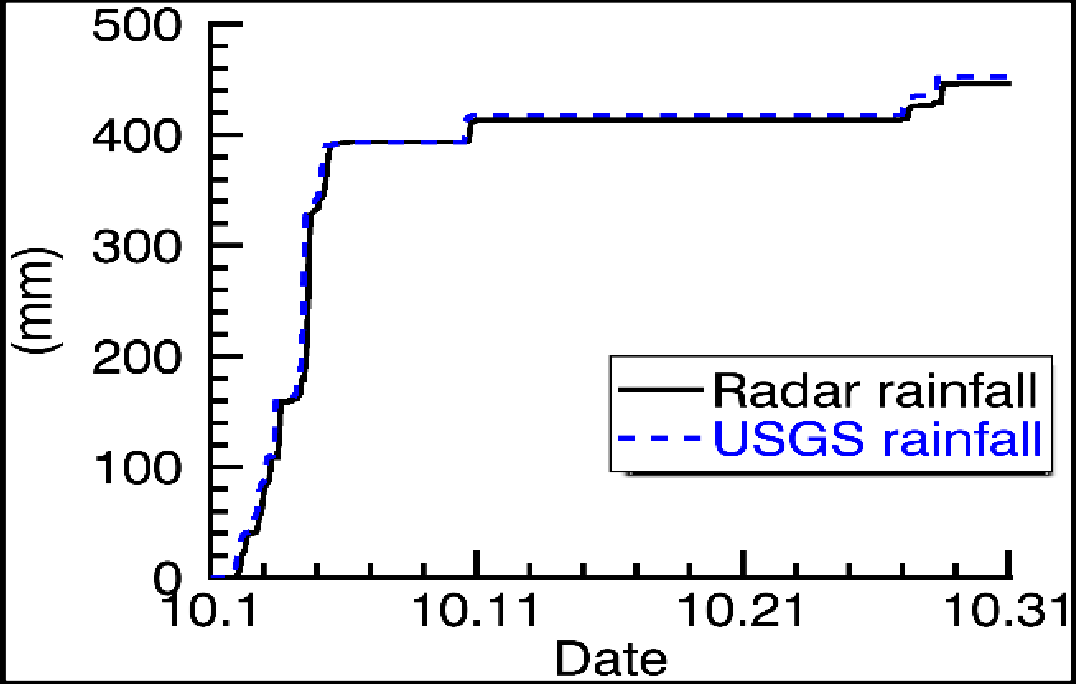

$$Q_{base_i} = C_i\left(e^{a_i\left(\frac{z}{z_m}\right)} - 1\right)$$

Distributed and Physics-Based

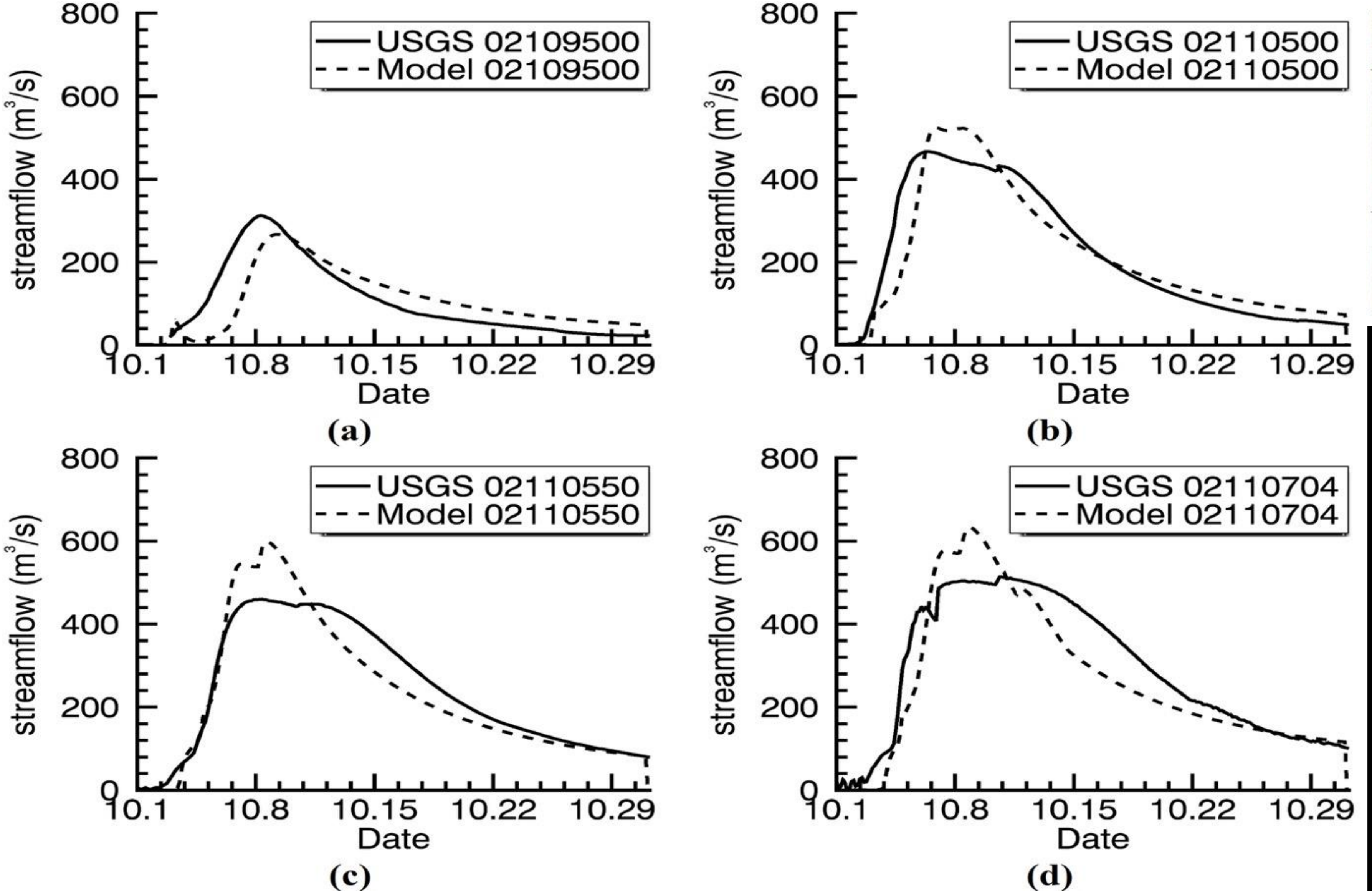
Conceptual bucket model

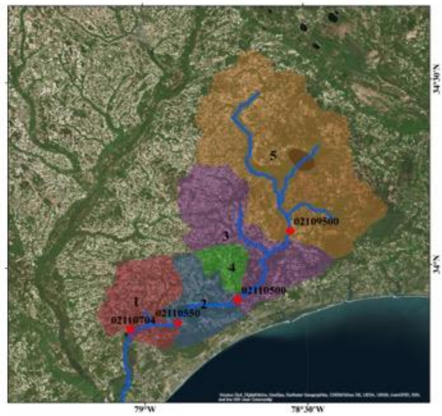
# Rainfall data : derived from radar reflectivity



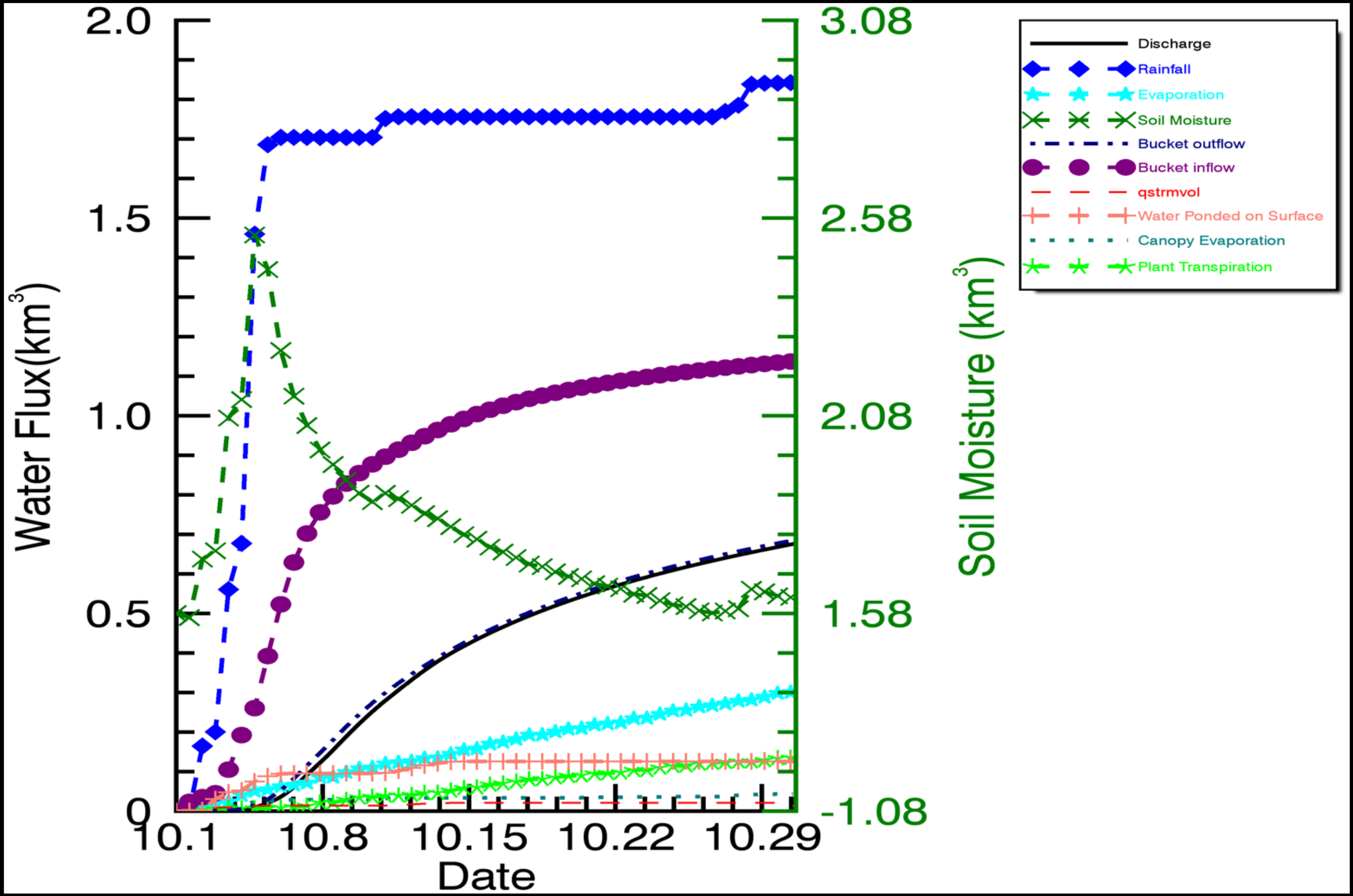



# simulated hydrograph

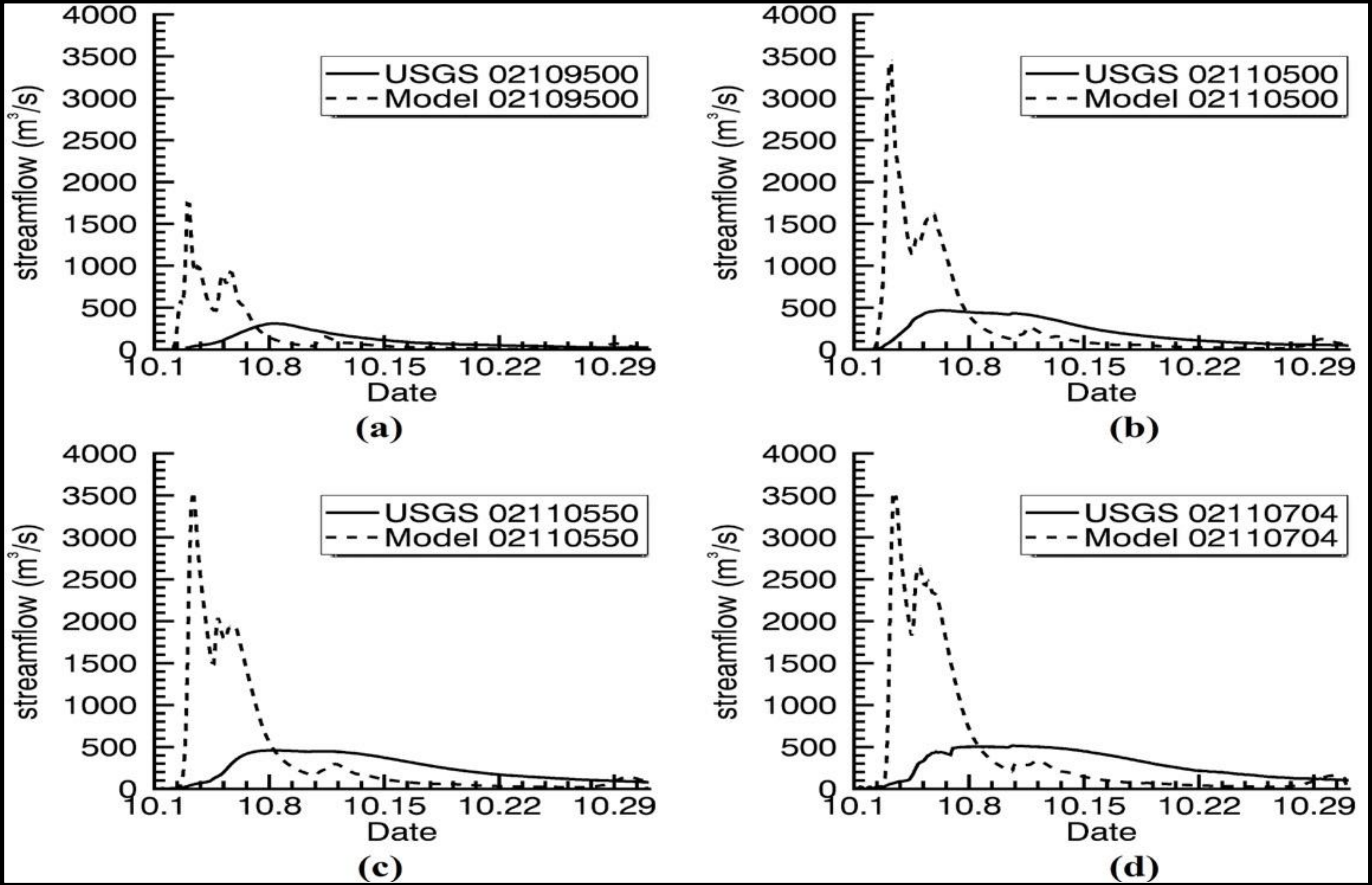


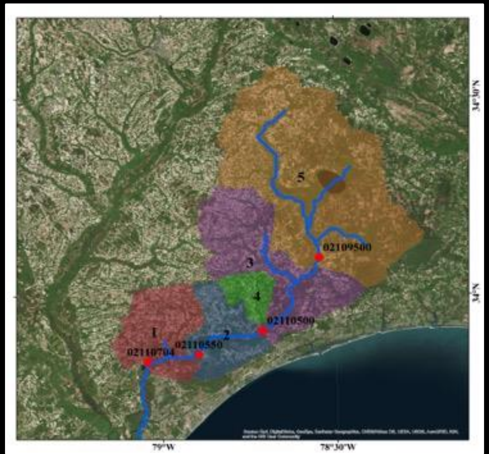



# Water balance

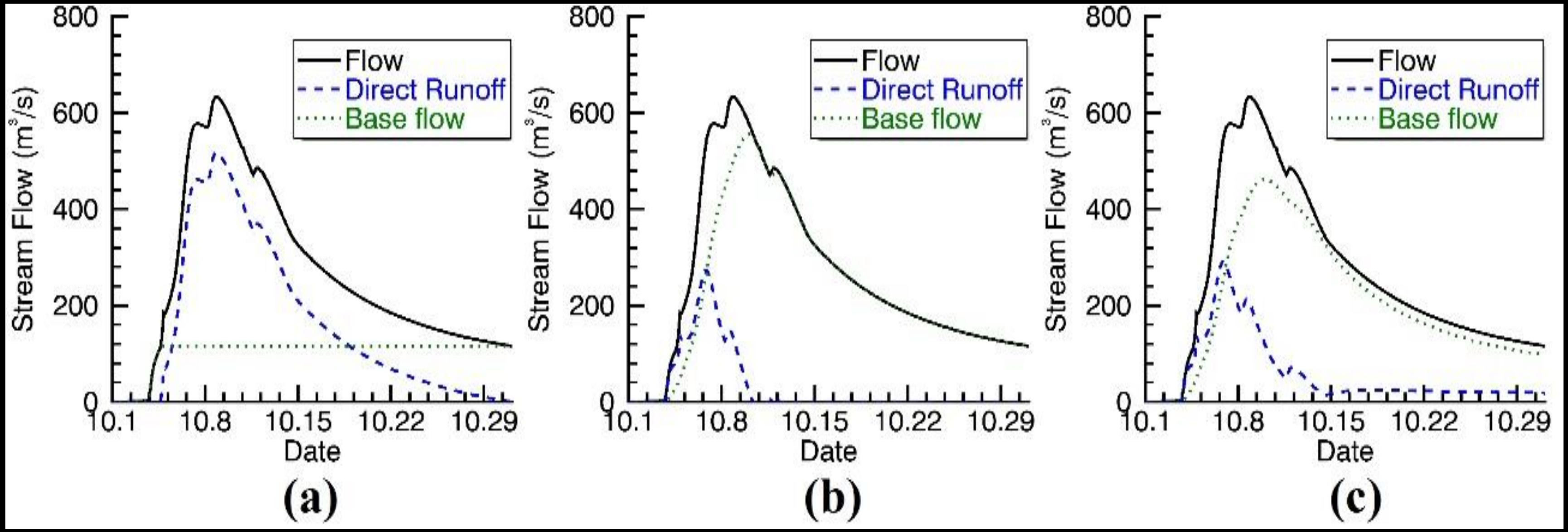


# If all land surface becomes impervious…



# Slow vs. fast: need to use distributed model




*(a) Local Minimum Method.* *(b) One Parameter Digital Filter* *(c) Recursive Digital Filter*

# Conclusion:

i. A physics based distributed hydrologic model with a conceptual underground baseflow process can reproduce the observed hydrographs during an extreme rainfall event in October 2015 in the Waccamaw River basin . The simulated features of delayed response, peak discharge rate and long and slow receding tails resemble the observed ones.
ii. Water budget balance is estimated during the rainfall event, which shows that 37% the rainfall is lost as river discharge, 24% of the rainfall to the underground aquifer recharge 27% to surface evaporation, canopy evaporation or plant transpiration, 7% of the rainfall is lost as the water ponded on surface, a small part of 2% of the soil moisture remained at the end of the simulation
iii. Most of the discharge was from the slow underground runoff, which can probably be attributed to the factors of land-use, low hydraulic gradient, underground aquifers and reservoirs.
iv. Traditional empirical methods to separate the quick direct overland runoff and slow underground runoff may be insufficient when the rainfall distribution and local conditions are not considered.
v. When the underground runoff is turned off, a fast responding hydrograph with a peak value that is seven times the observed one is simulated, highlighting the importance of slow underground runoff in mitigating extreme rainfall hazards in the Waccamaw River basin.