FRAMEWORK TO IMPROVE SIMULATION PROCESSES OF THE INTEGRATED HYDROLOGIC MODEL

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INTEGRATED HYDROLOGIC MODEL

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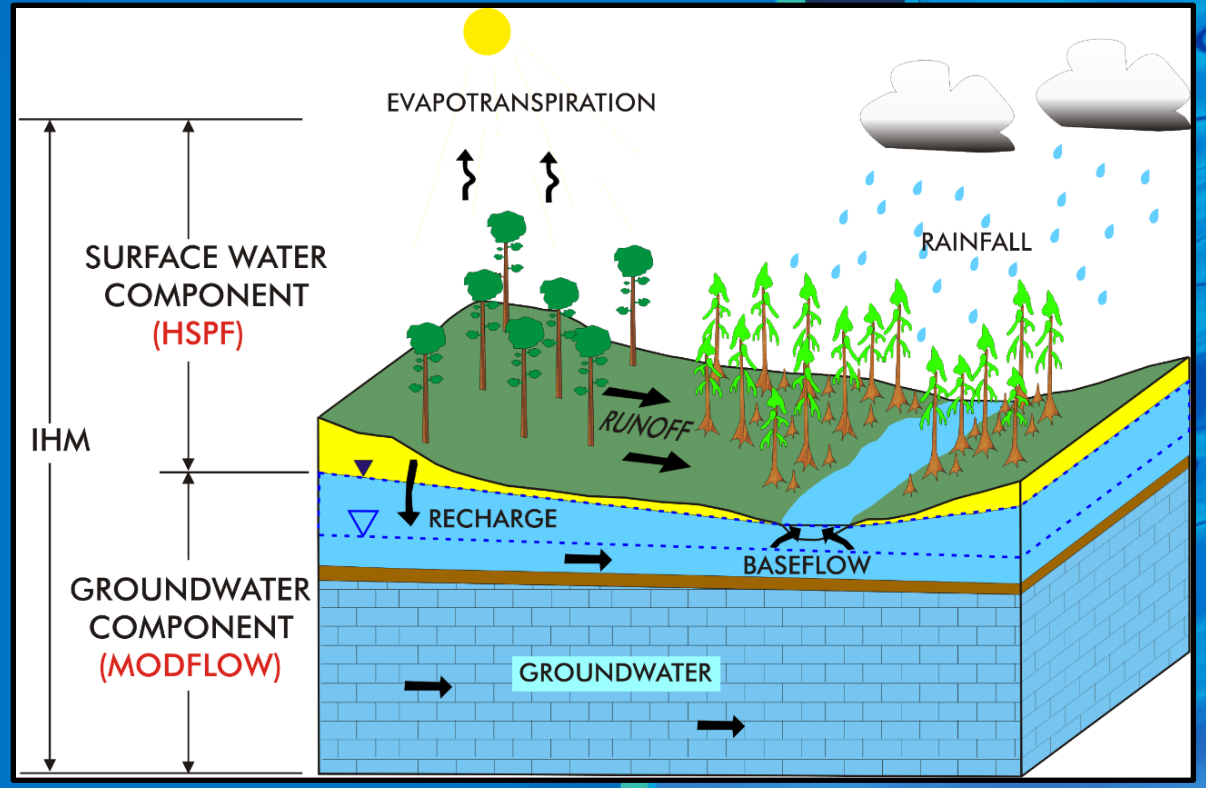
Motivation and Background

- IHM
- INTB
- Reduce simulation error for Streamflow and Recharge
- Reduce uncertainties in a functional management tool
- Peer Review Recommendations
- Future water management challenges



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HSPF-IHM Modifications

- New, multi-zone vadose storage model
- Potential for saturation-excess and more physically based infiltration
- Vadose zone fluxes, infiltration, percolation between zones, recharge for shallow & deep d_{WT}
- Recharge delay, especially for deep d_{WT}
- Vadose processes supported by dynamic depth to water table (d_{WT}) and variable specific yield (SY)
- Some ET distribution changes
- Improved segment/fragment water balance & handling
- Fragment-based variably-saturated areas (VSAs)

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New Soil Moisture Model & Deep Water Table Functions

Brooks and Corey (1964) Moisture & hydraulic conductivity:

$$\theta' = \frac{\theta - \theta_{wp}}{\theta_S - \theta_{wp}} \quad , \quad \theta' = \left(\frac{b'_{cf}}{z'}\right)^{\lambda}$$

$$K' = \theta'^{\left(\frac{2}{\lambda} + l + 2\right)} \quad , \quad k' = \frac{k(\theta)}{k_{S\,v}}$$

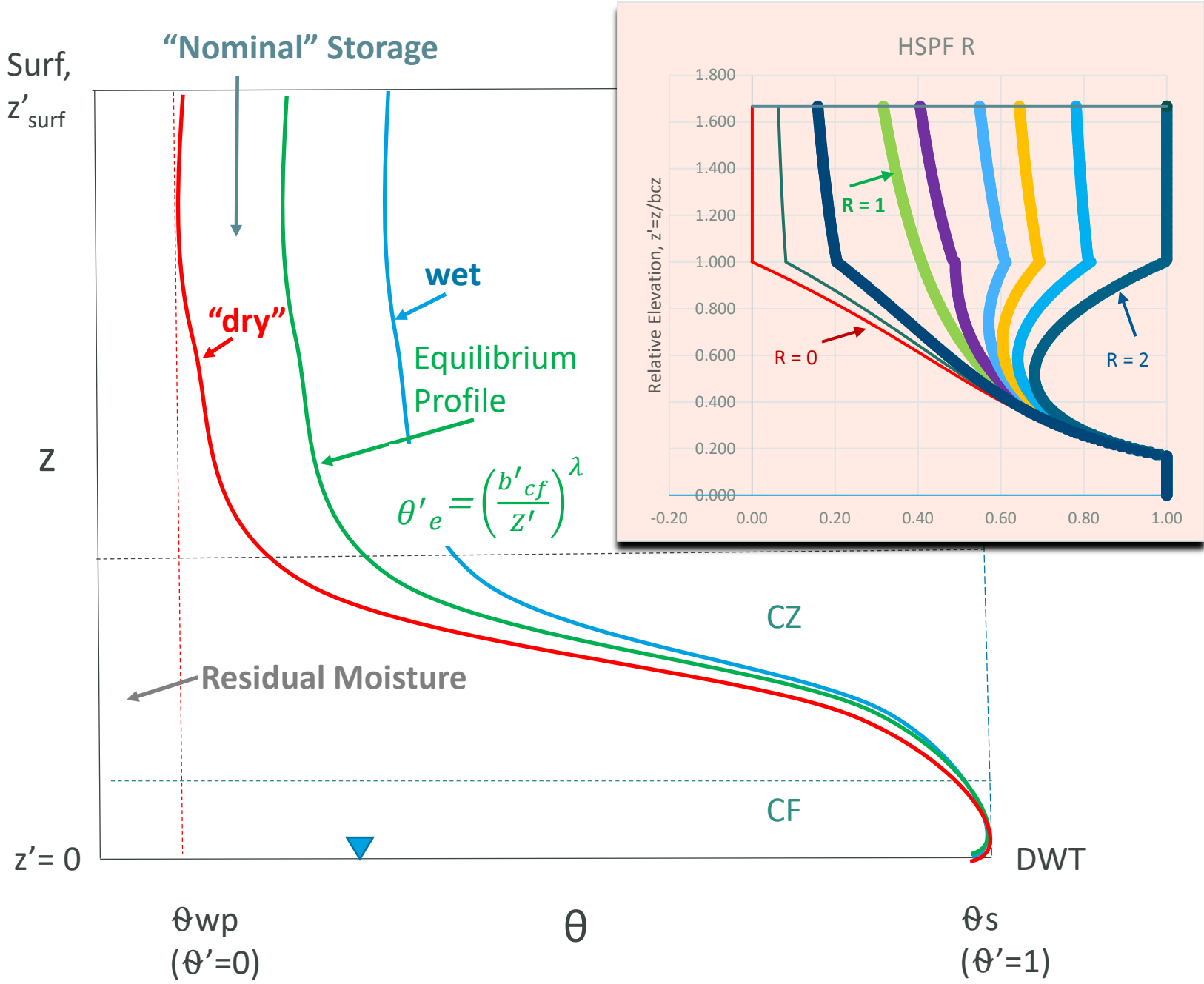
New Storage Condition (Ratio) for any d_{WT}:

$$0 \le R \le 2$$

R = 0, Extreme dry (wilting)

R = 1, Equilibrium

R = 2, Saturation



Vadose Zone Moisture Retention
HSPF Land Segment

- Improved soil discretization (7-layer soil zones)
- Dynamic water table depth, $d_{WT,}$ for segment
  - Allows soil saturation and explicit d_{wt} accounting
  - Allows Saturation-Excess runoff
  - Improved infiltration (new multi-layer G-A model)
  - Improved ET partitioning, uptake during Percolation
  - Improved magnitude & timing of recharge
- New relative moisture states, R, θ'
- More physical soil moisture retention & unsaturated hydraulic conductivity using Brooks & Corey relations

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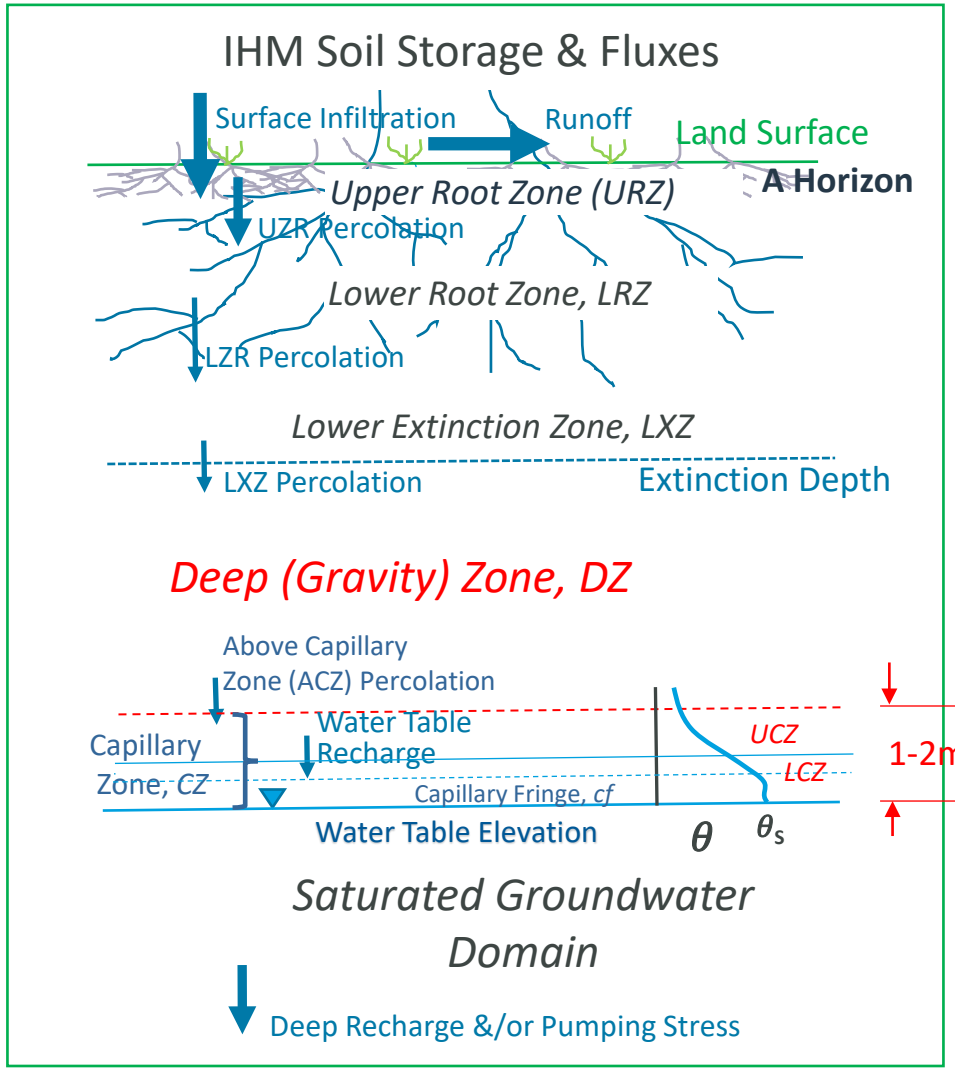
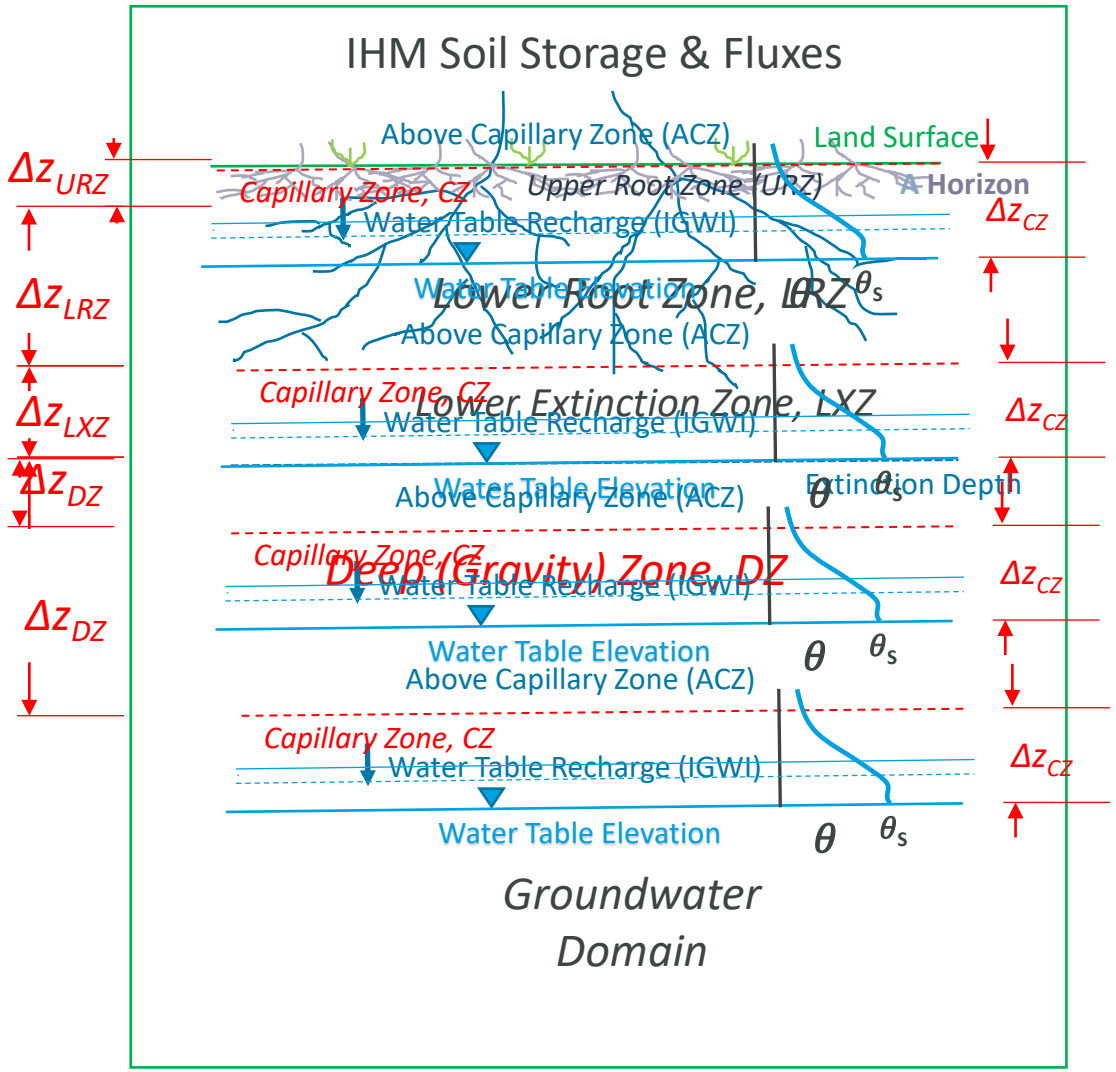
IHM & HSPF Vadose Zone Flux Improvements
Infiltration-Vadose Storage-Percolation-Recharge



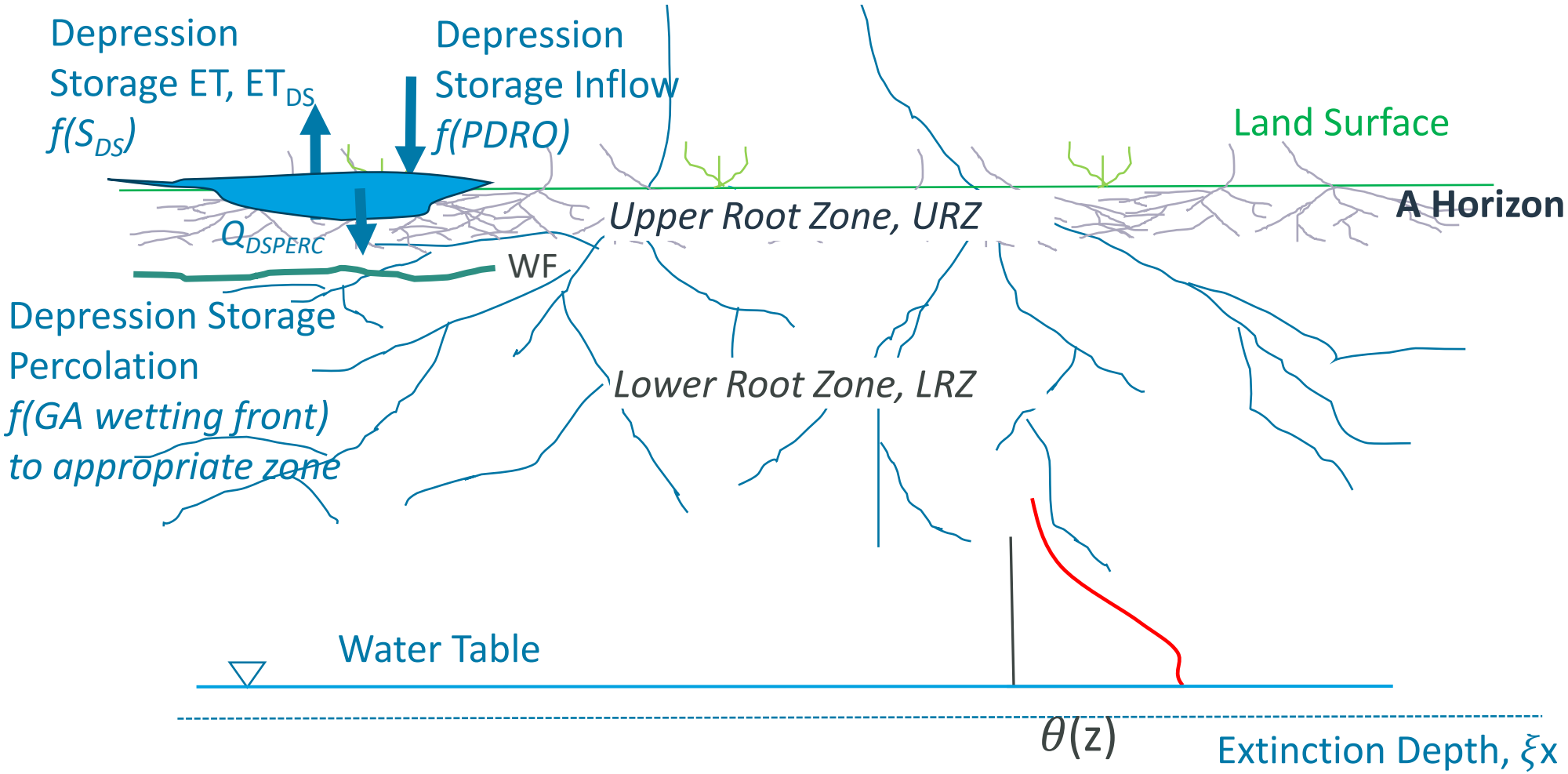
- 7 Soil Layers
- Dynamic d_{WT} from stresses: Recharge, ET, & Pumping
- Coupled *CZ*
- Brooks-Corey ϑ', $K(\vartheta')$
- G-A Infiltration
- Saturation, saturation-excess & Hortonian runoff
- Darcian Percolation between layers
- New recharge & *SY* model
- Deep flux, pumping

Capillary Zone, d_{WT} & Computational Cells

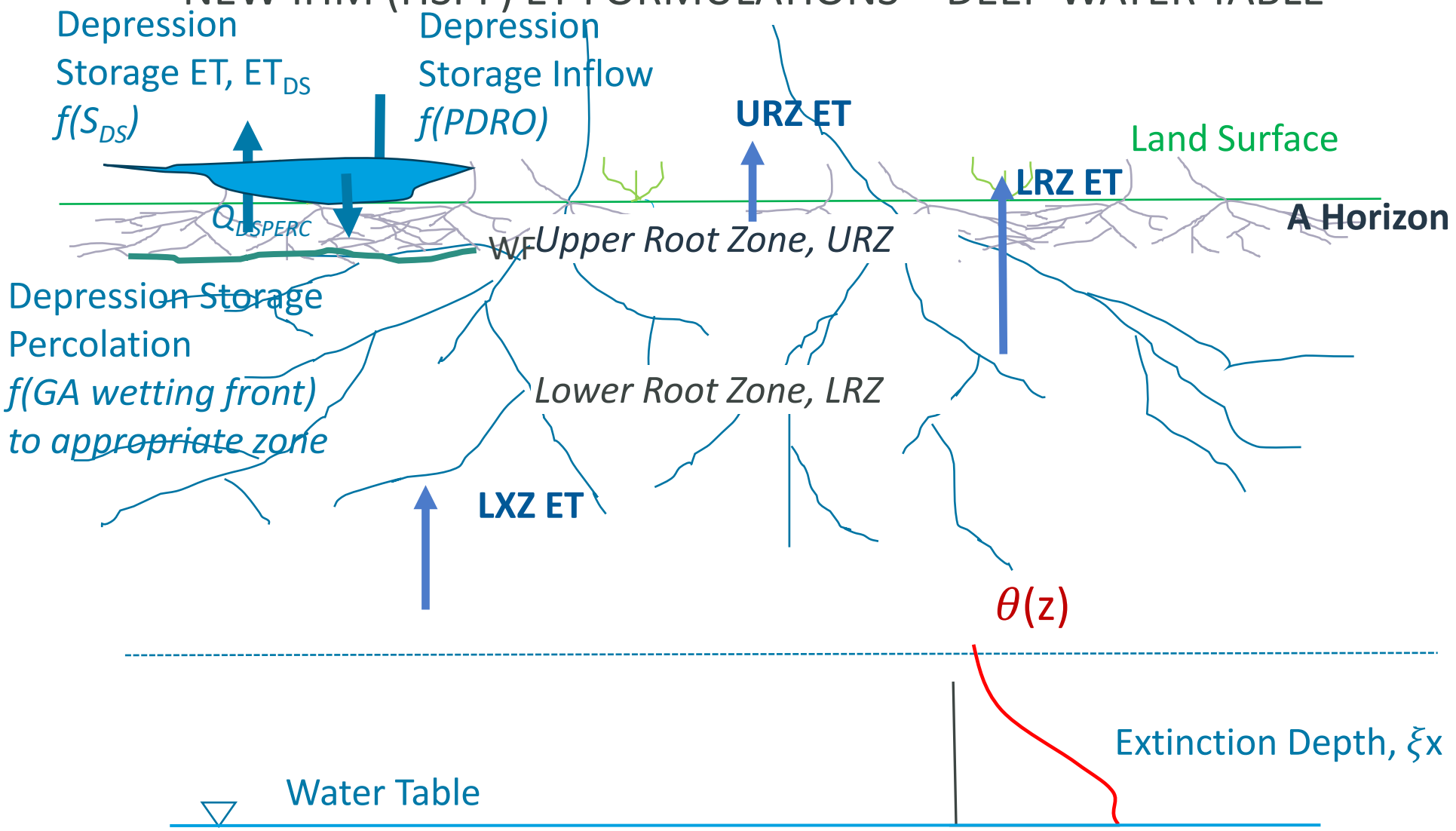


- Concept of “fixed capillary zone (CZ)”, Δ_{CZ} moving with d_{WT}
- New Recharge & SY model based on $\vartheta(z)$
- Darcian percolation within CZ is direct recharge
- Formulation allows d_{WT} movement due to recharge, ET, and pumping stresses
- Surface Saturation & Direct ET_{GW}

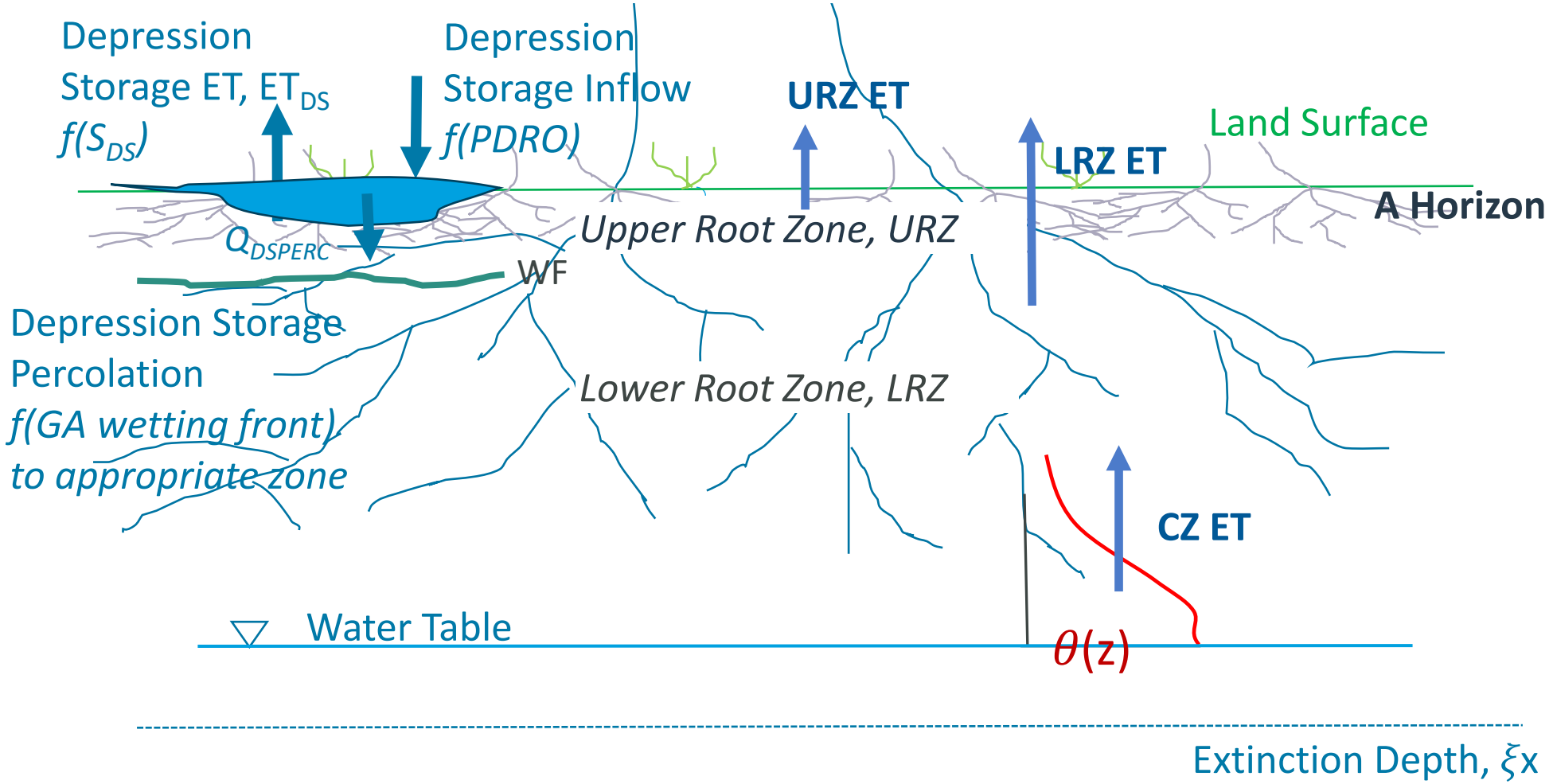
Proposed IHM (HSPF) Depression Storage, DS



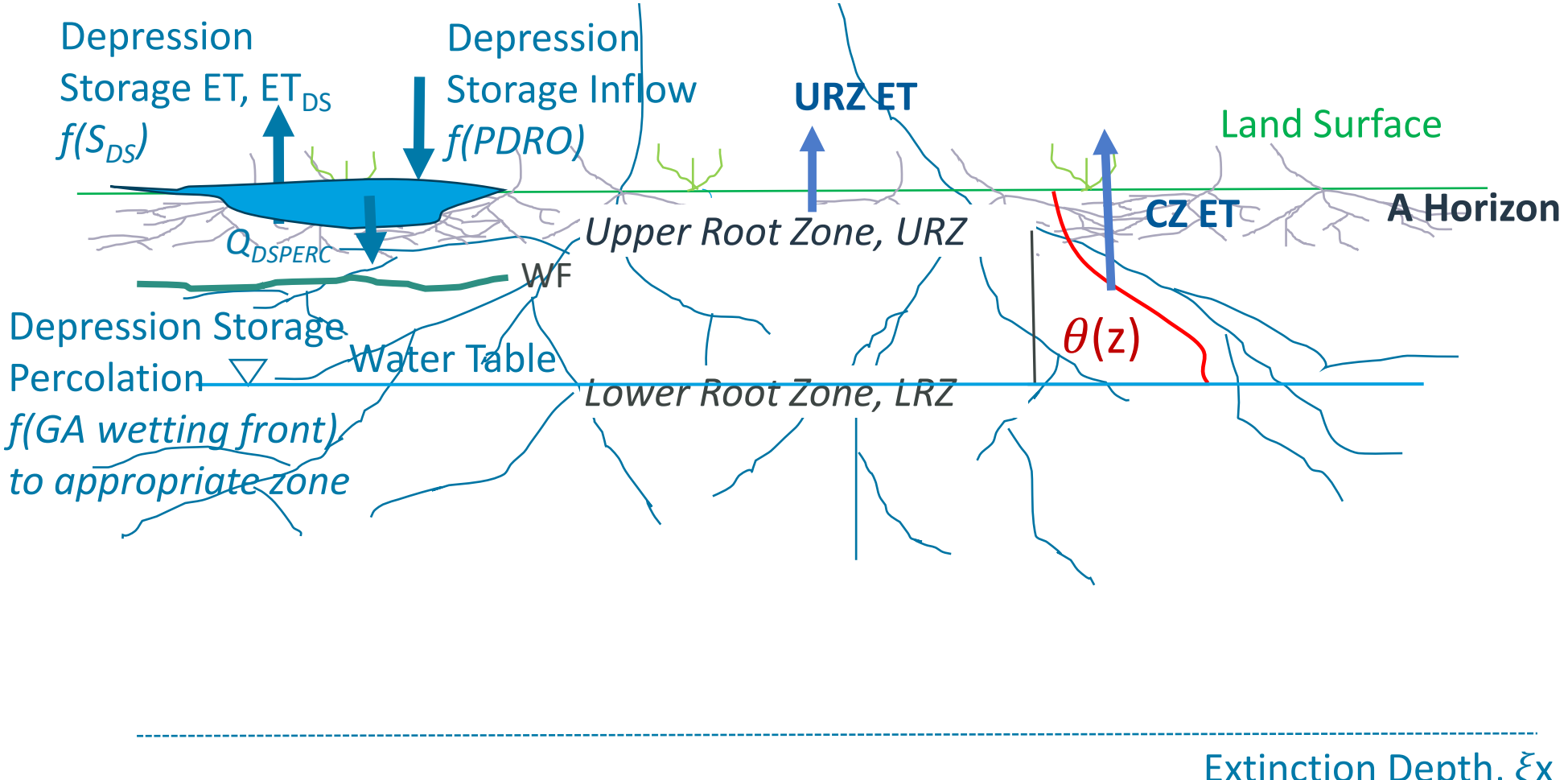
NEW IHM (HSPF) ET FORMULATIONS – DEEP WATER TABLE



NEW IHM (HSPF) ET FORMULATIONS – TRANSITIONAL WATER TABLE



NEW IHM (HSPF) ET FORMULATIONS – SHALLOW WATER TABLE



ET Hierarchy and Distribution

- Continues to use top to bottom ET hierarchy
- Full PET applied to Interception, then REMPET applied to each subsequent zone
- Depression storage ET is similar to existing HSPF
- Allows vertical root distribution to influence ET in the upper soil profile
- ET from soil zones is a function of relative moisture (R) and plant ET coefficient
- Allows ET extraction from below root zone for capillary zone top below the root zone bottom
- Allows ET extraction from the capillary zone and from water table

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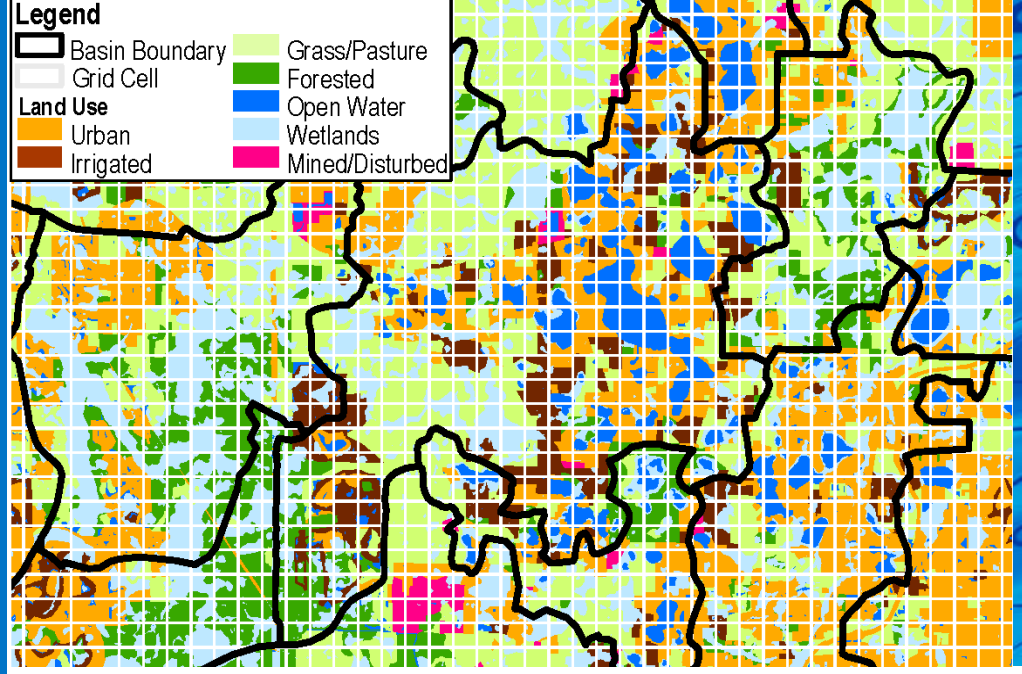
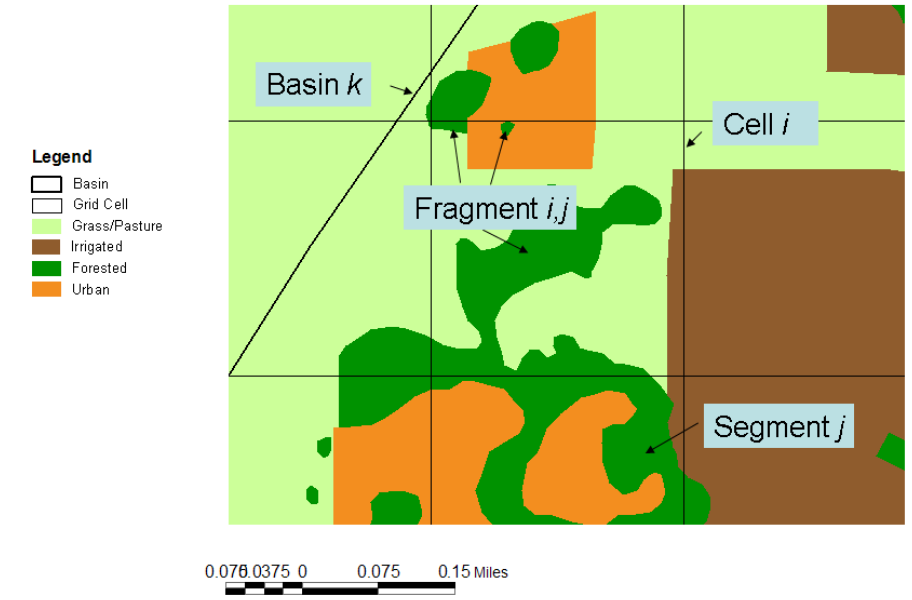
IHM Segment-Fragment Integration

- Fragments (*ij*) – Segment (*j*)
  - d_{wtij} (fragments) used to define d_{wtj} (segments)
  - Defines weighted moisture retention (B-C) parameters
  - Variable Saturated Areas (VSAs)
  - Defines ET Extinction for Segment
  - Defines Dry Moisture Retention
- Segments - Fragments
  - Moisture conditions for variable SY
  - REMPET stress for groundwater
  - Recharge



Basin Grid Reach Interaction



Summary

- Major re-write of the Vadose zone processes in HSPF (7-Layers including deep layers)
- Brooks & Corey Soil moisture description
- Included Darcian percolation and recharge
- Variable moisture conditions, partial and complete saturation of vadose zone
- More physical Infiltration to recharge fluxes & timing, better *dwt*, ET, runoff
- Improved vertical distribution of evapotranspiration
- Improved handling Segments-Fragments, Variable SY, fragment and segment (variably saturated areas, VSAs)

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Questions