Upscaling Strategies for Integrated Modeling in IP3

by

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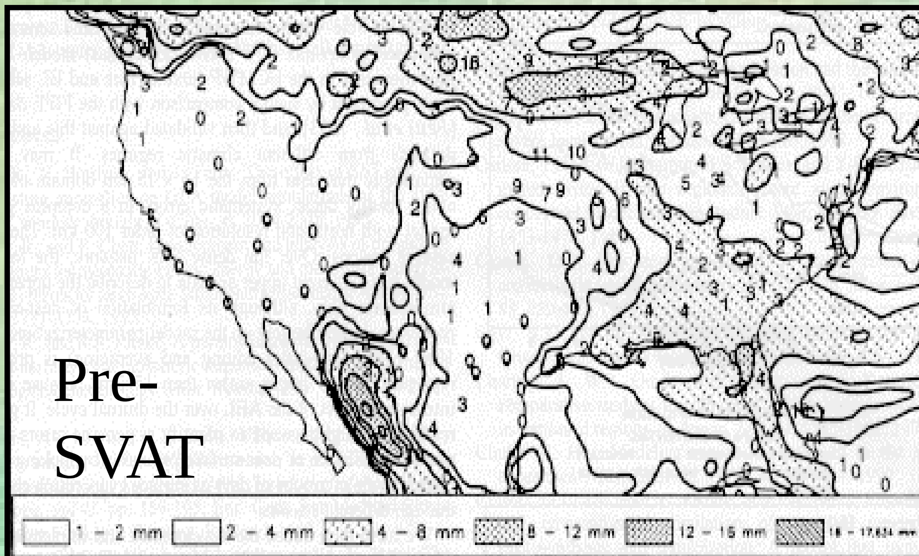
Acknowledgments

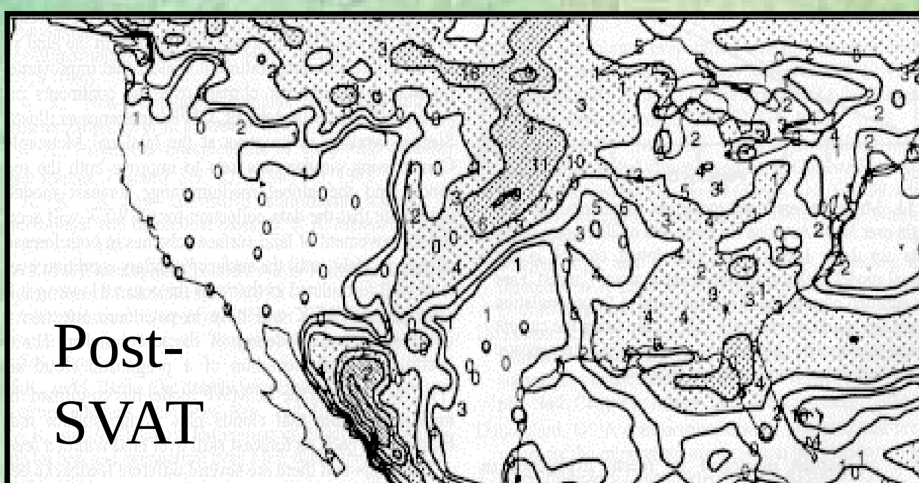
- Funding and patience
  - IP3 – John Pomeroy et al
  - MAGS – H. Woo et al
  - MSC/CRB - B. Goodison, D. Verseghy, R. Stewart
  - NWRI - A. Pietroniro, P. Marsh
  - NSERC Partnership Program
- Scientific help and guidance
  - D. Verseghy, A. Pietroniro, M. McKay
- Code, parameterizations and tests
  - K. Snelgrove, T. Whidden, S. Fassnacht

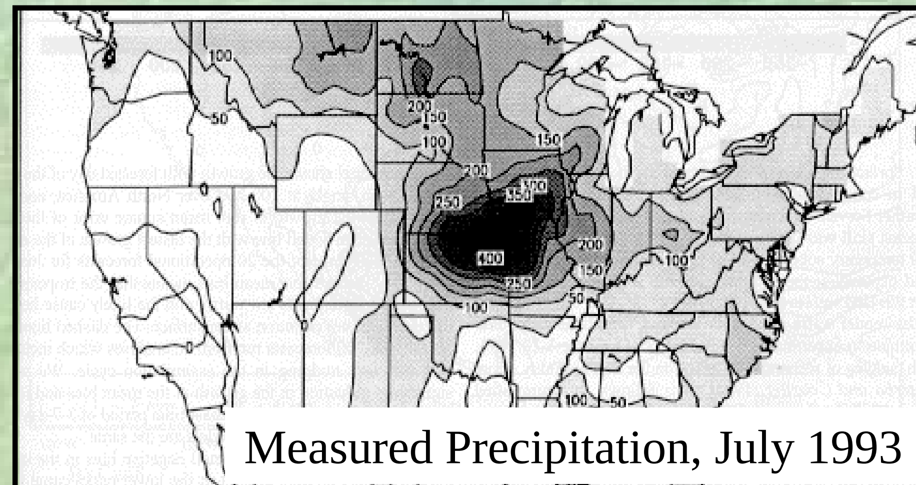
Outline

- Introduction
- MESH release
- MESH comparison with CRHM
- A few results from Scotty Creek

Mississippi Floods 1993



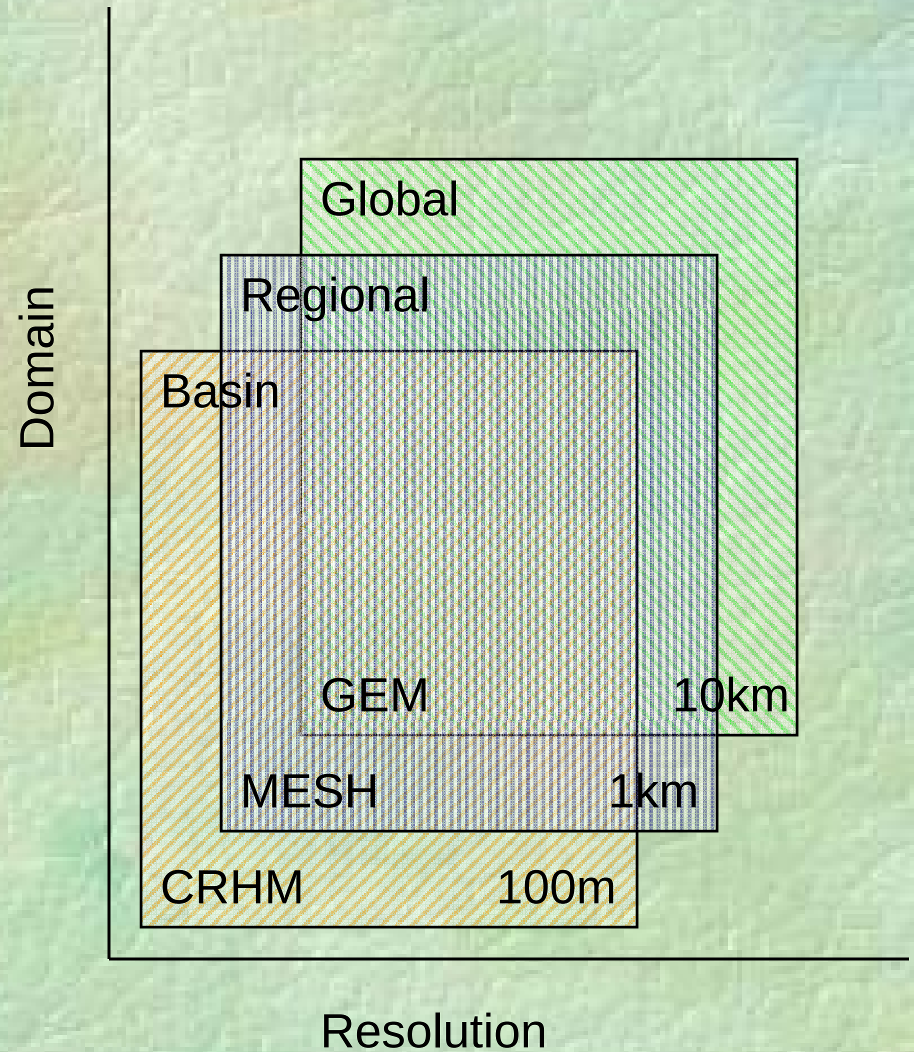




Measured Precipitation, July 1993

- Betts *et al.*, 1996

Model Hierarchy



Model Comparison

- All models are distributed
- All models are physically based
- Resolutions overlap
- Major difference is the application domain
  - (Basin, Regional, Global)
- Bookkeeping skill determines the domain

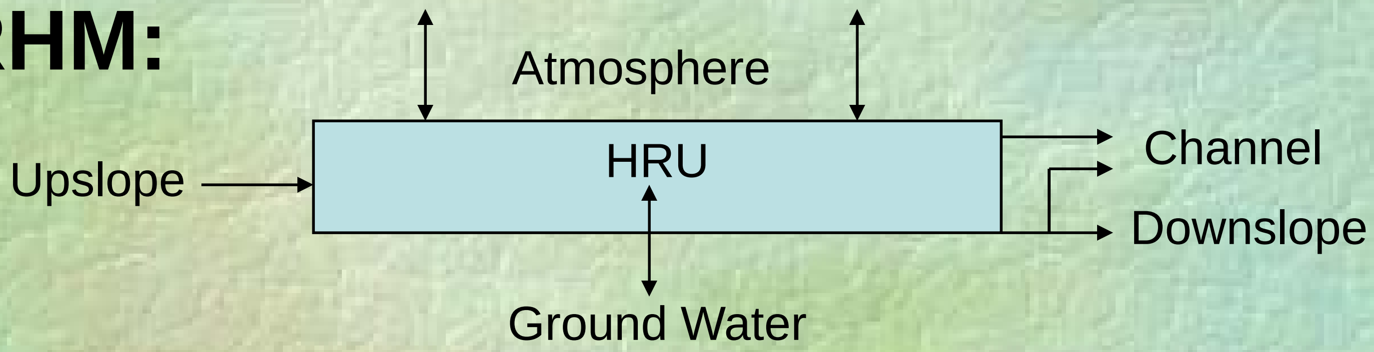
How To Extend Domain

- 1) Use generic algorithms

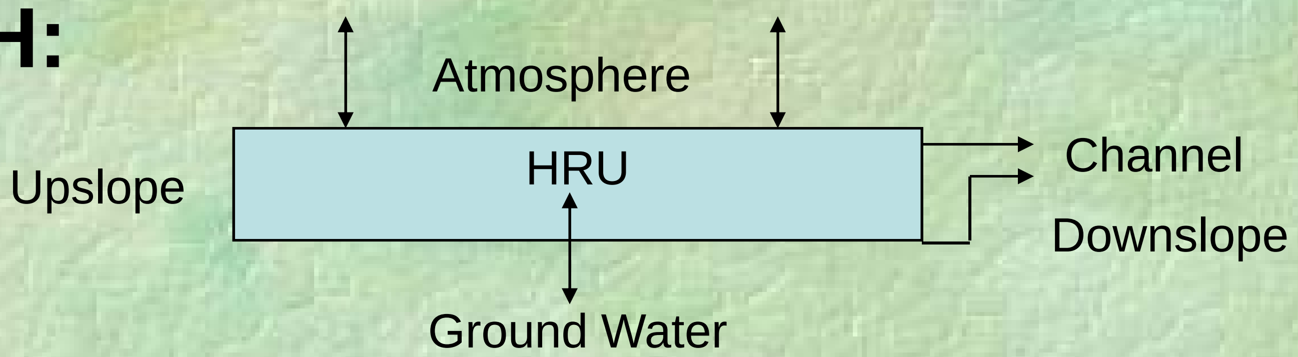
- CRHM typically treats HRUs individually
- MESH/GEM groups representative HRUs

InterHRU Transfers

CRHM:



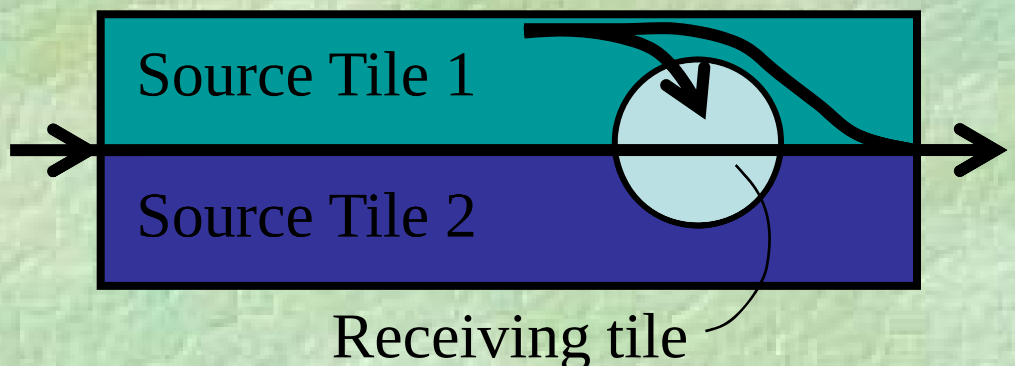
MESH:



Proposed Diversion Strategy

•can have one receiving class and two source classes
•transfer is based on the square-root of the ratio of the area of the receiving land class divided by that of the source land class

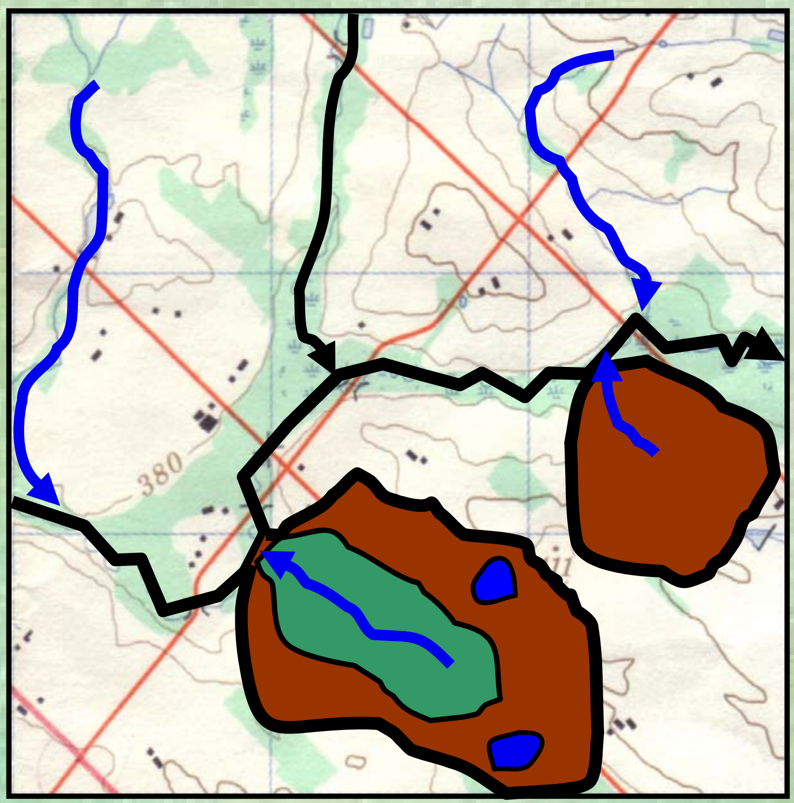
Grid element with tile diversion

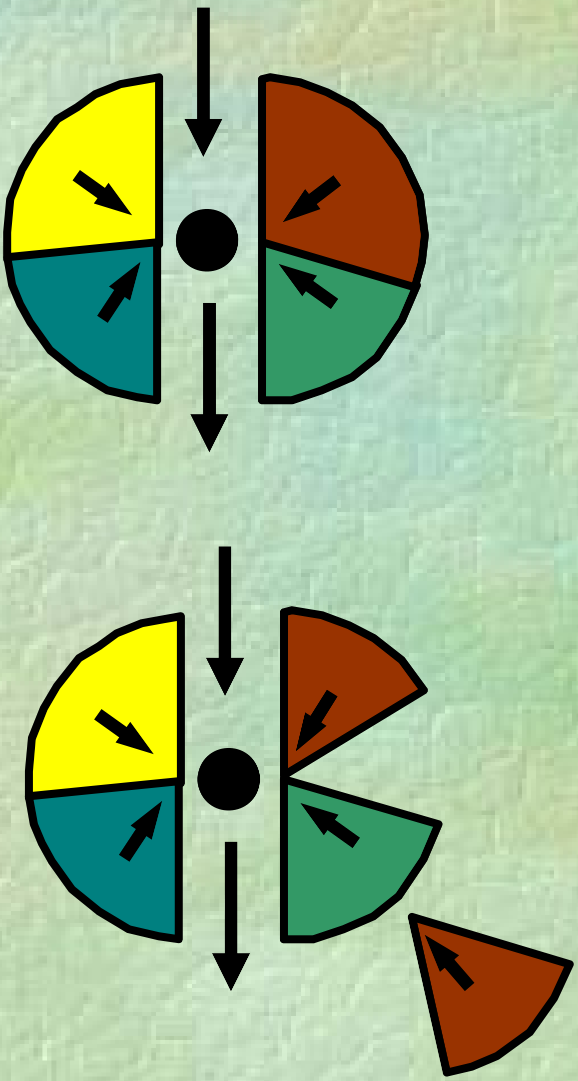


How To Extend Domain

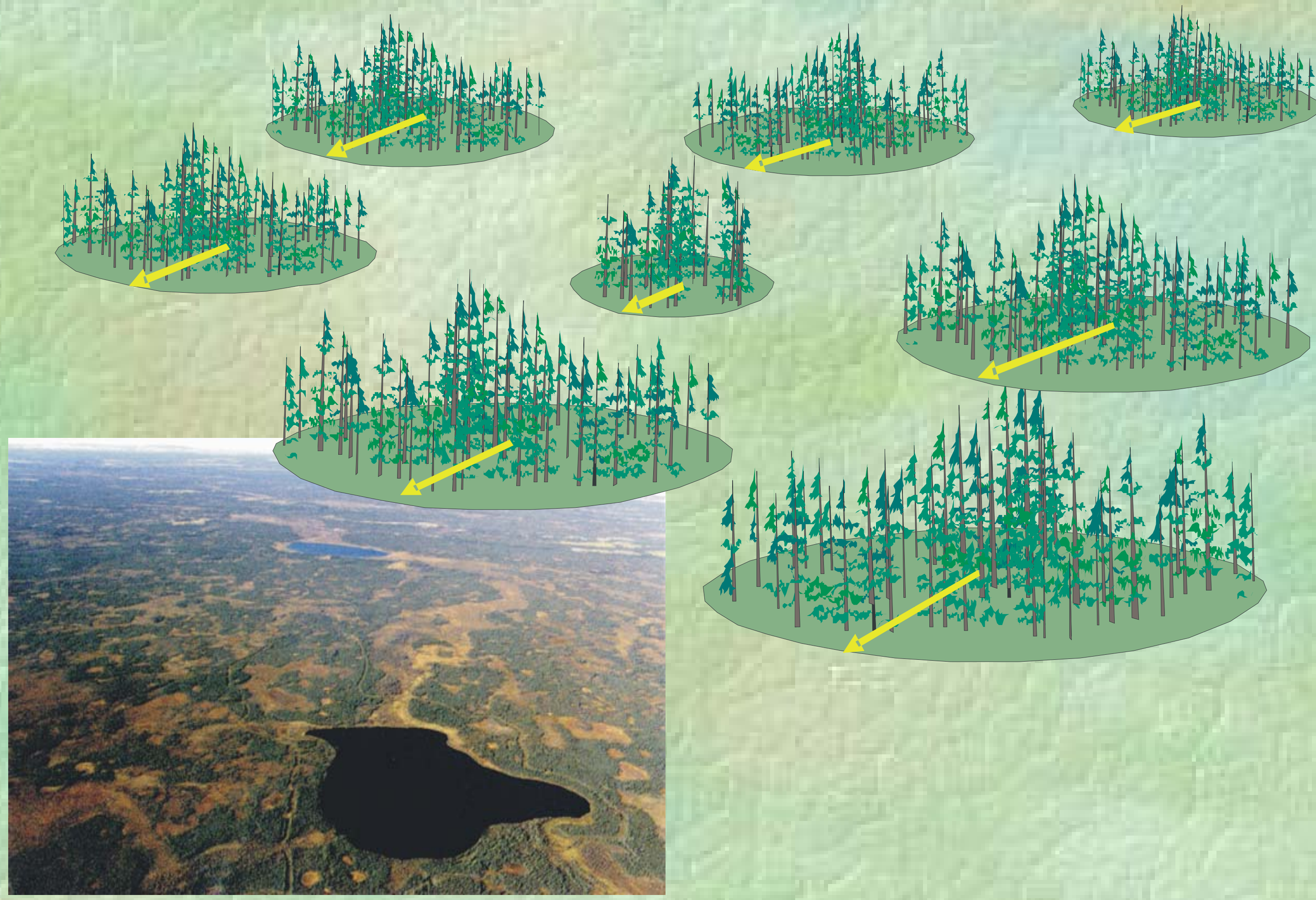
- 2) Use distribution based algorithms
  - sum fluxes by area
  - or use pdfs of important properties

IP3 Tile?

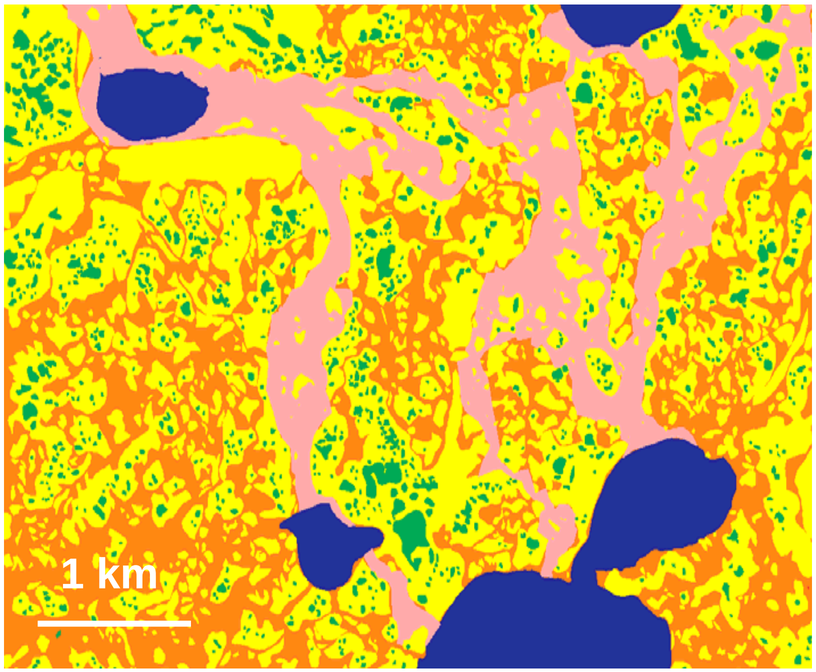




Disturbing Plateau Runoff



Site Distribution of Peat Plateaus



Lake

Isolated bog

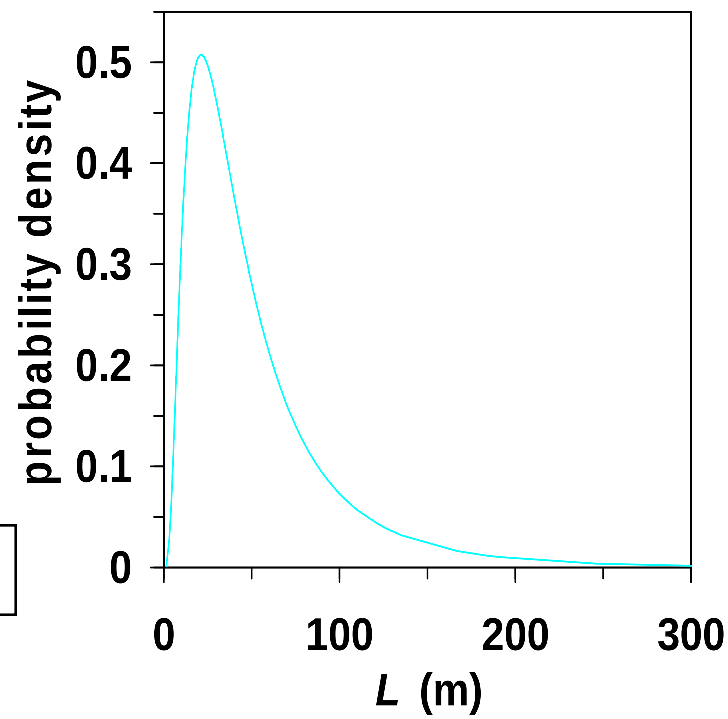
Connected bog

Peat plateau

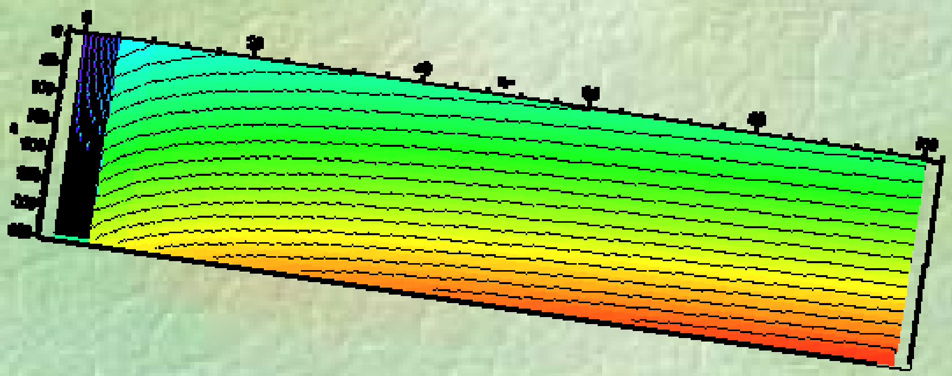
Fen

Hydraulic radius

L = 2 * area / perimeter



3) Embed More Physics in the Tile Algorithms



Class Landscape Unit (footprint)

← WATDRAIN (lateral processes)

WATFLOOD (routing)

MAGS Tile

Surface Runoff:
Manning's Equation

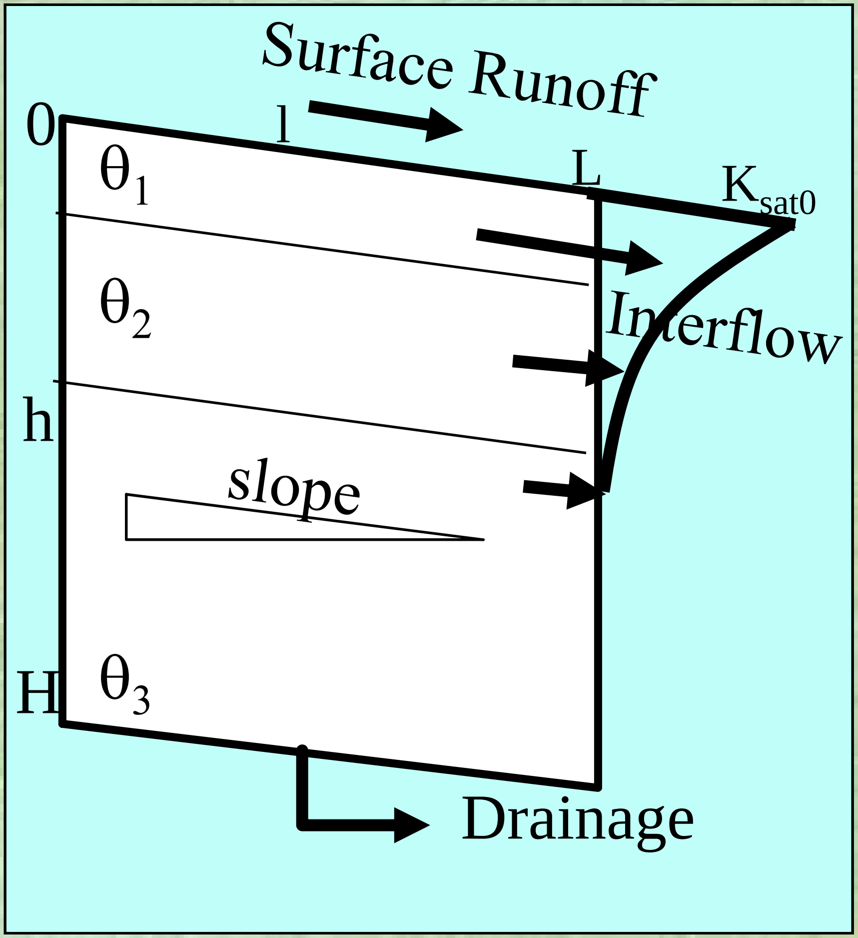
$$Q_{over} = \left(\frac{1}{n}\right) \cdot d_e^{\,5/3} \cdot \Lambda_I^{\,1/2} \cdot L_v$$

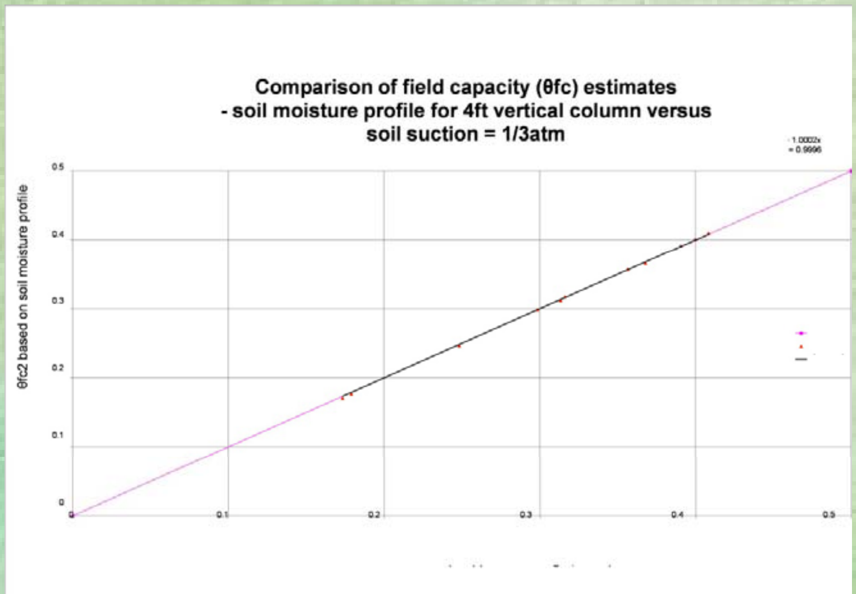
Infiltration redistribution interflow:
Richard's Equation

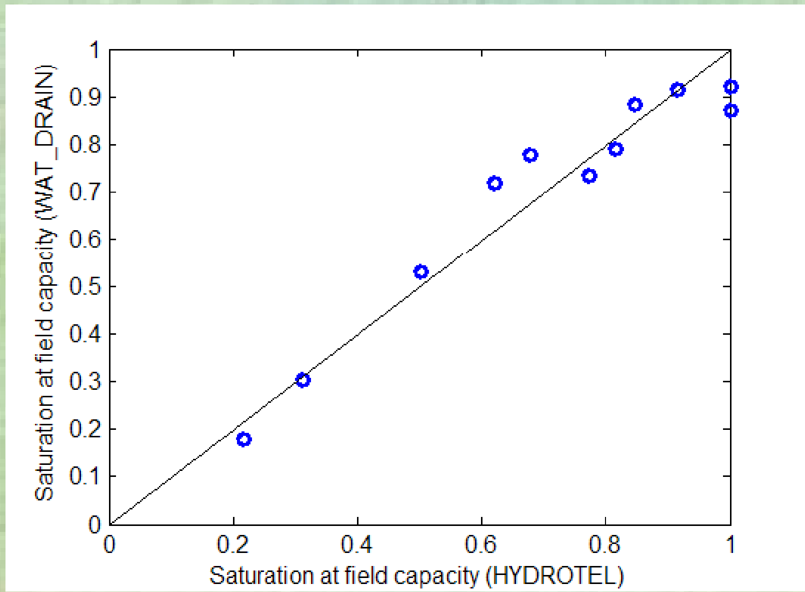
$$-\frac{\partial K_v(\theta)}{\partial z} + \frac{\partial}{\partial z}\left[K_v(\theta)\frac{\partial \psi(\theta)}{\partial z}\right] = \frac{\partial \theta}{\partial t}$$

Drainage or Recharge:
Darcy's Law

$$q_{drain} = K_{\mathrm{v}}(\theta_3)$$




Comparison of field capacity (θfc) estimates
- soil moisture profile for 4ft vertical column versus
soil suction = 1/3atm
θfc2 based on soil moisture profile


Saturation at field capacity (WAT_DRAIN)
Saturation at field capacity (HYDROTEL)

$$\Psi = (1 - f)\cdot[\overline{\Psi} + \sqrt{\frac{(\Psi - \Psi_0)^2}{4} + K}\,]$$

$$+ f \cdot[\overline{\Psi} + \sqrt{\frac{(\Psi - \Psi_1)^2}{4} + K}\,]$$

Where Ψ_0 and Ψ_1 are the end state suctions and f and κ are functions of distance, x and time, t.

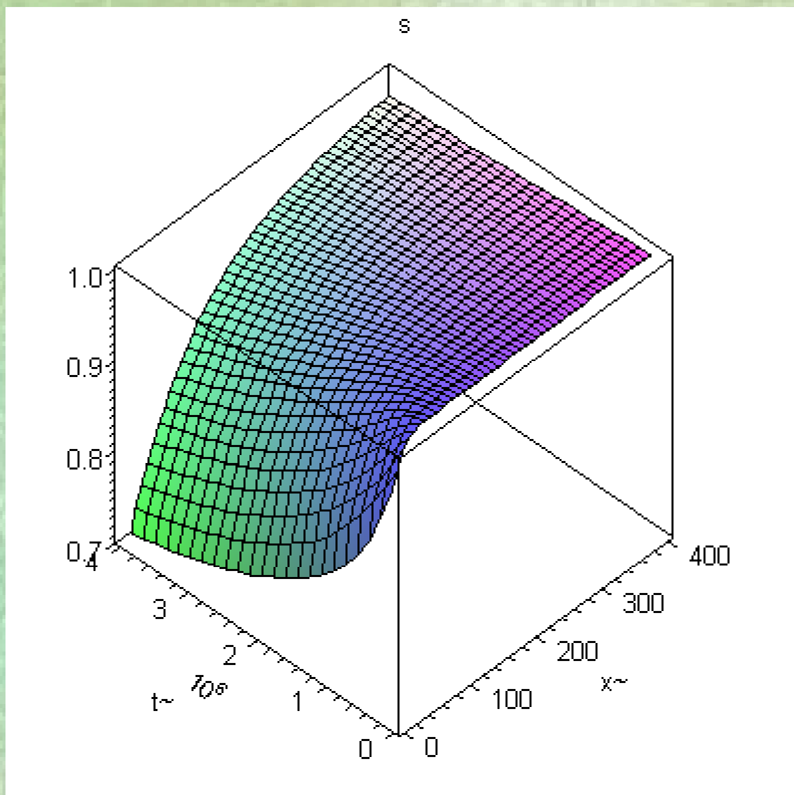
Richard's Equation

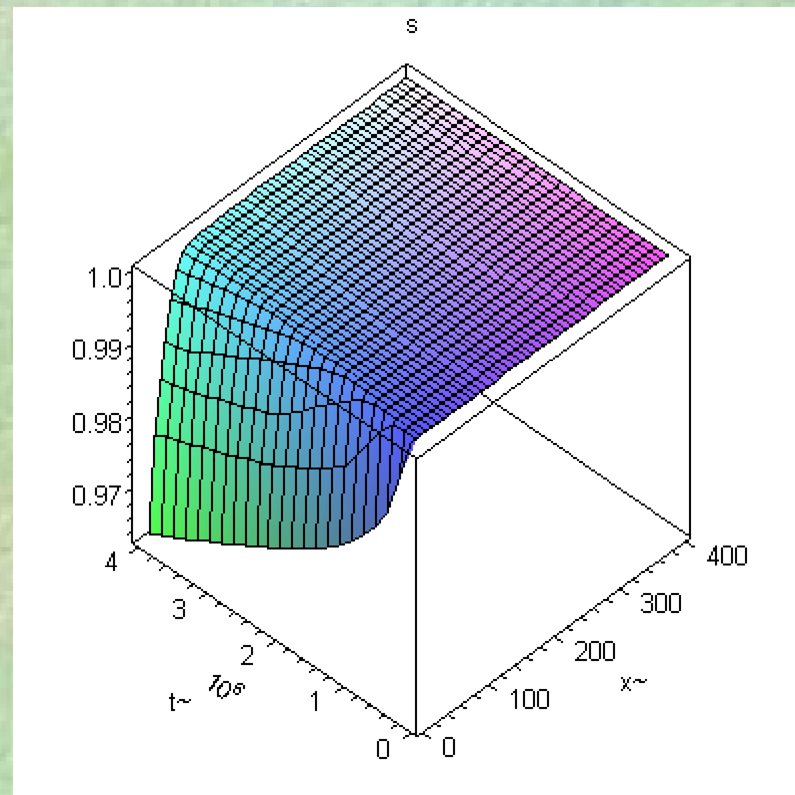
$$\frac{\partial \theta}{\partial t} = \frac{\partial}{\partial z}\left[K(\psi)\left(\frac{\partial \psi}{\partial z} + 1\right)\right]$$

where
K is the hydraulic conductivity, ψ is the pressure head, *z* is the elevation above a vertical datum, θ is the water content, and *t* is time

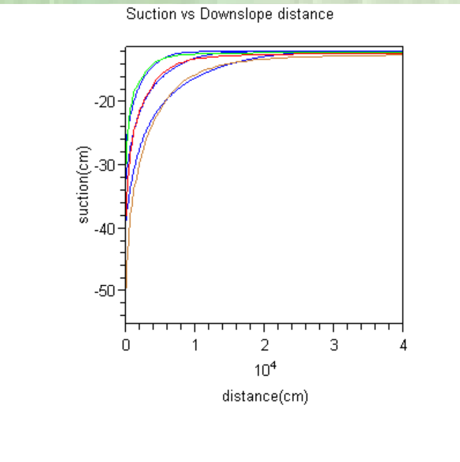
Drying Curves

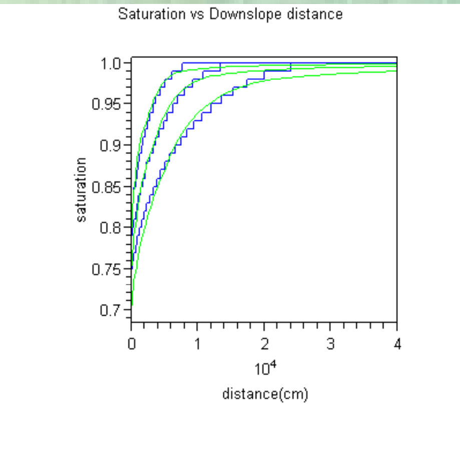
SAND AND LOAM



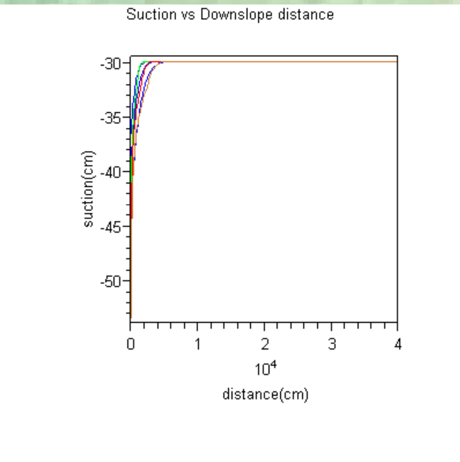


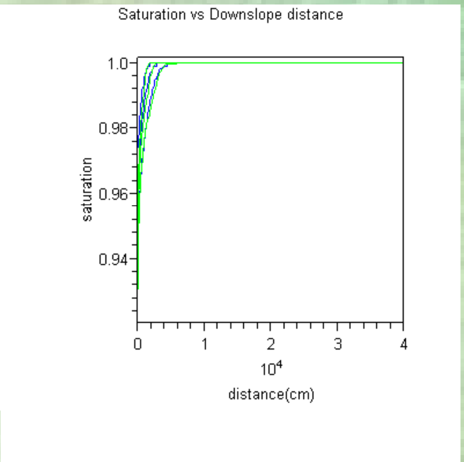
Meso/Micro Model Comparison





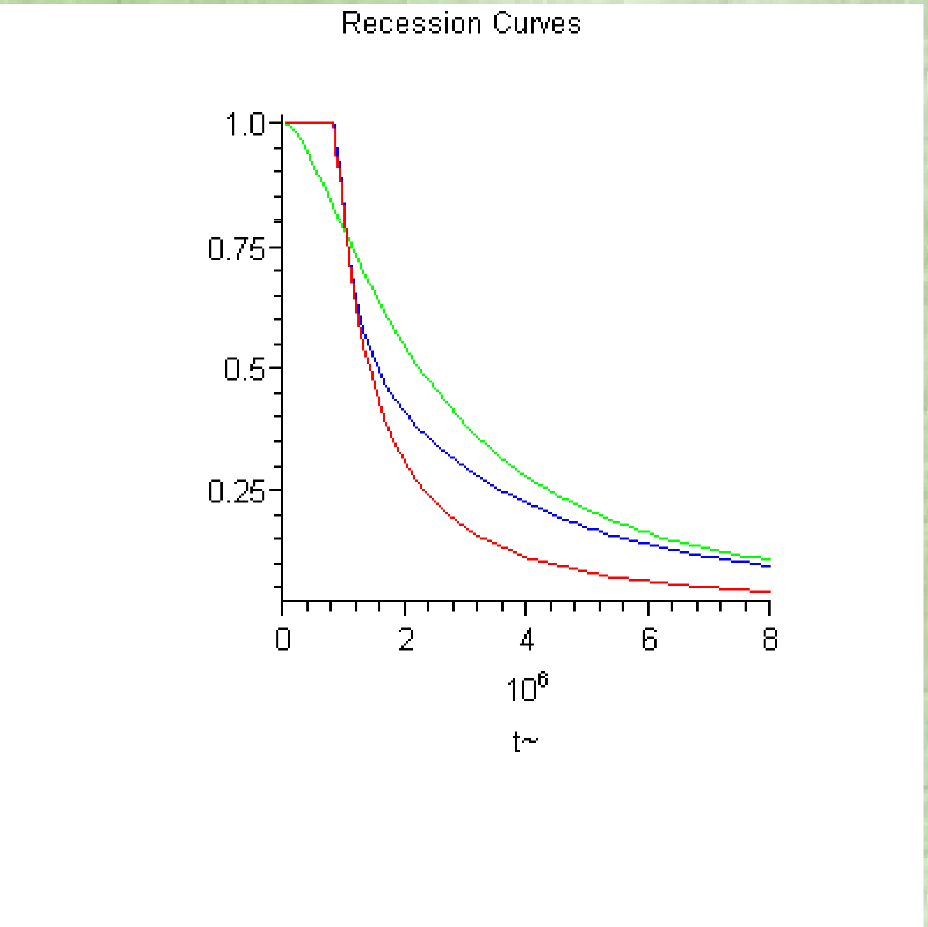
SAND





LOAM

Recession Curves Comparison



Red line is a typical gravity dominated curve. Green line is the corresponding suction dominated solution. WATDrainV2 uses an empirical blend of these. WATDrainV3 will use Equation (1) which is the blue line in Figure 3.

4) Some General Rules

- Do everything we can to minimize number of HRUs
- 2-4 HRUs per grid
- Modelling Scale 1/10th of target domain

Scotty Creek, DA = 177 km²
One grid with 2 tiles (peat plateau and fen),
20% of flow from peat plateau diverted to fen