



Canadian Foundation for Climate  
and Atmospheric Sciences (CFCAS)

Fondation canadienne pour les sciences  
du climat et de l'atmosphère (FCSCA)



# Groundwater Implications for Drought Research



By:

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For:

DRI Third Annual Workshop  
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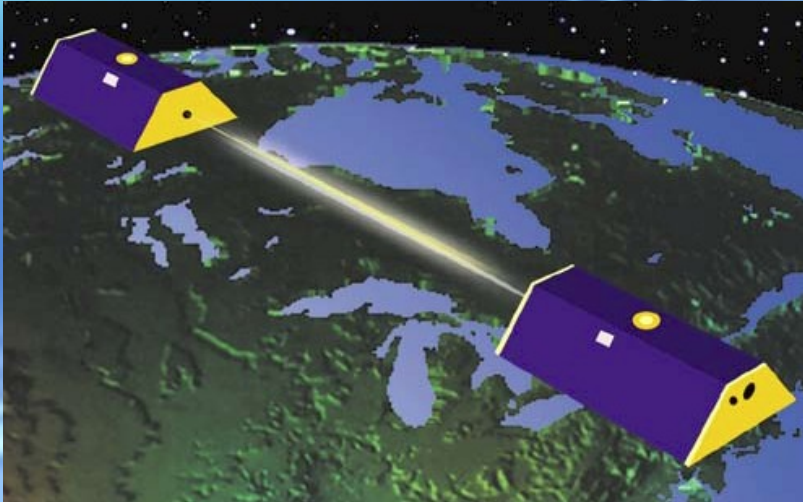
<http://www.southlandusa.com/news.php?month=08&year=2007>



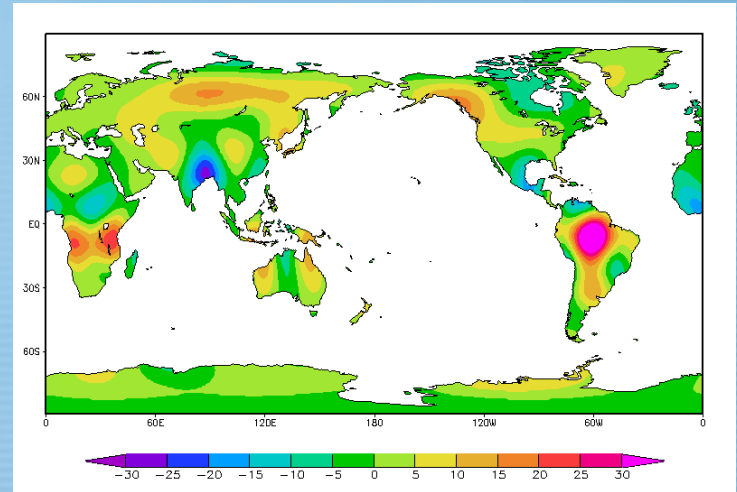
## Outline

- GRACE and Gravity
- ParFlow and SABAE-HW
- Larger Area Simulation Plans
- Conclusion

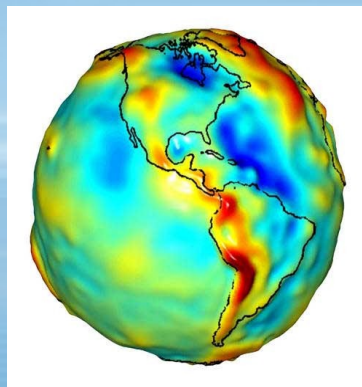
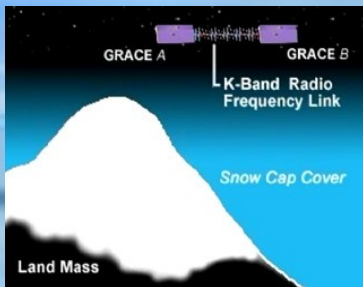
# GRACE & Gravity



GRACE Dual Satellites



Monthly Moisture Anomalies



Geopotential Expansion

~200 km Resolution

# GRACE & GOCE

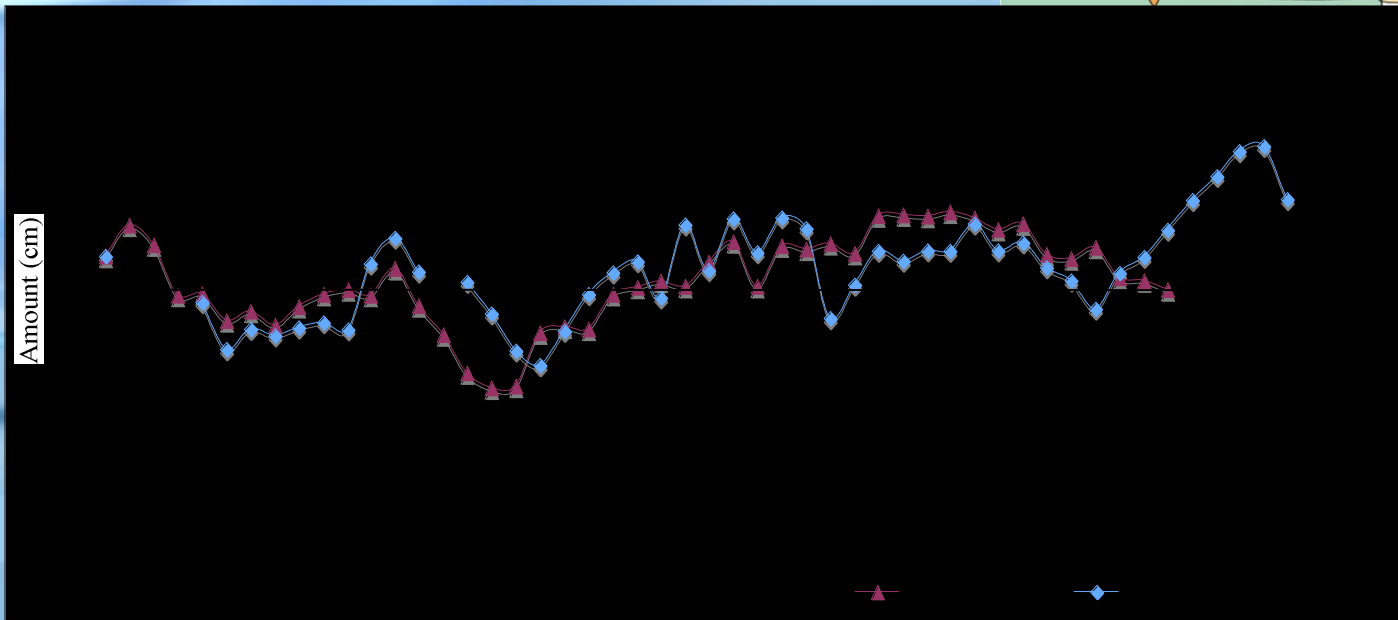
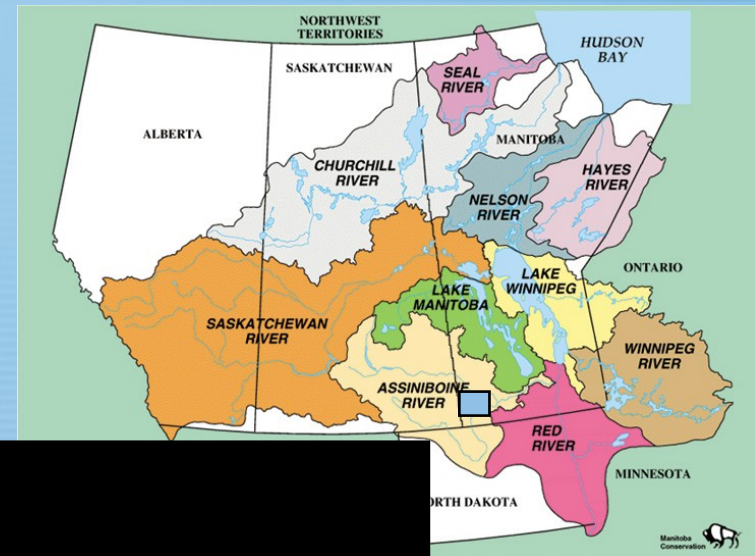


- Gravity and Ocean Circulation Explorer (GOCE)
- 10x Increase in Spatial Resolution
- 250 km Orbit
- Only 20 month Mission ☹️
- Launch Spring, 2008

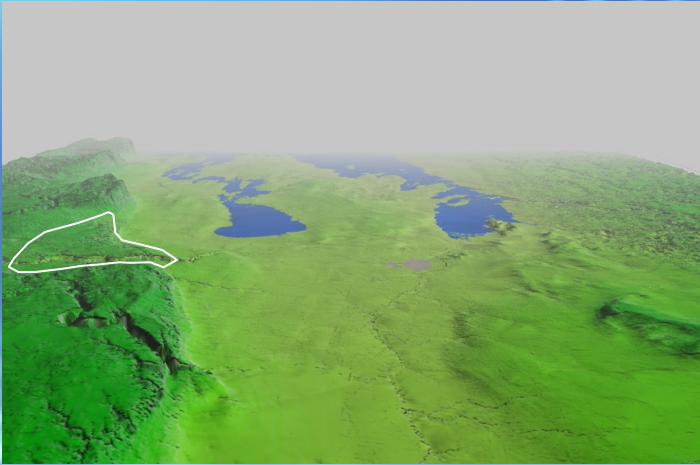


# GRACE & Gravity

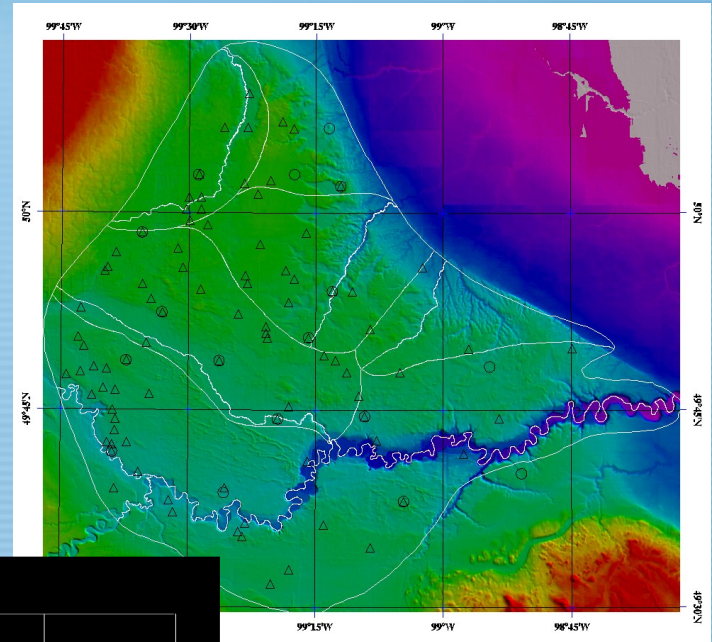
Prairie Water Storage from  
Gravity Measurement and GEM Analysis  
Saskatchewan Basin



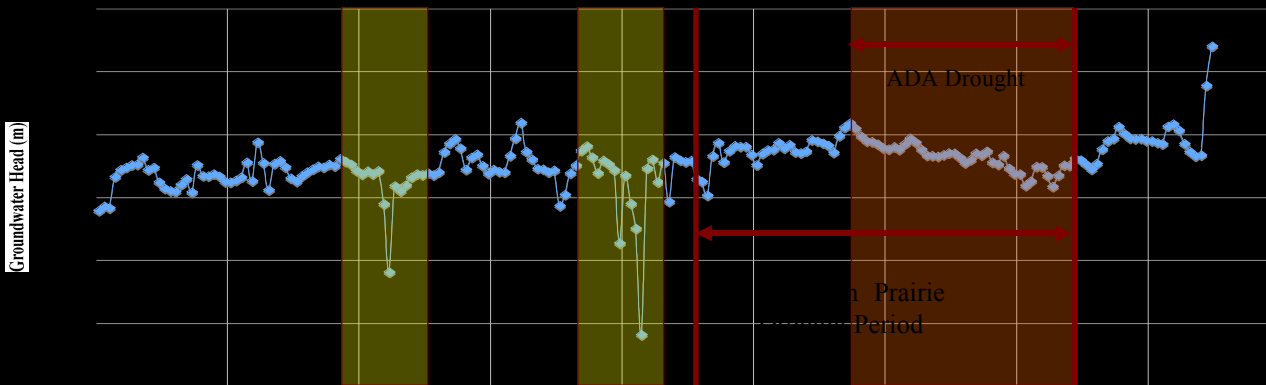
# GRACE & Gravity



Assiniboine Delta Aquifer

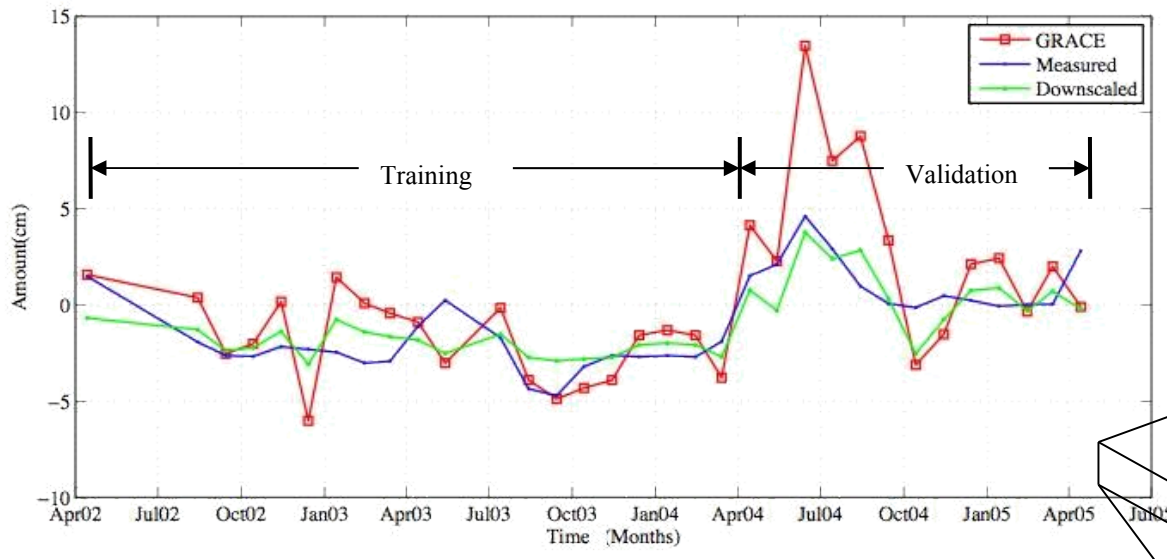


Observation Wells

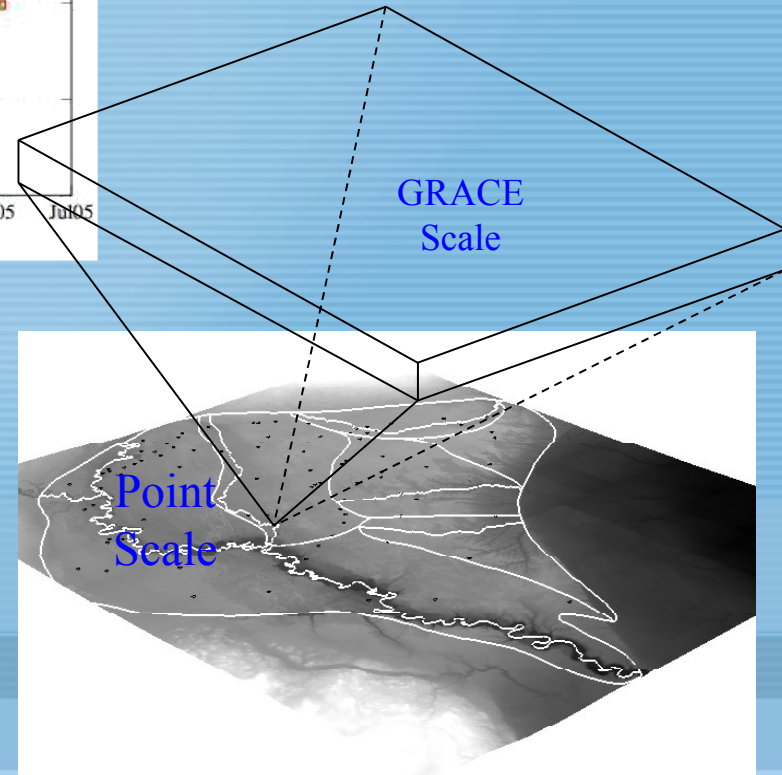


Average ADA Groundwater Storage

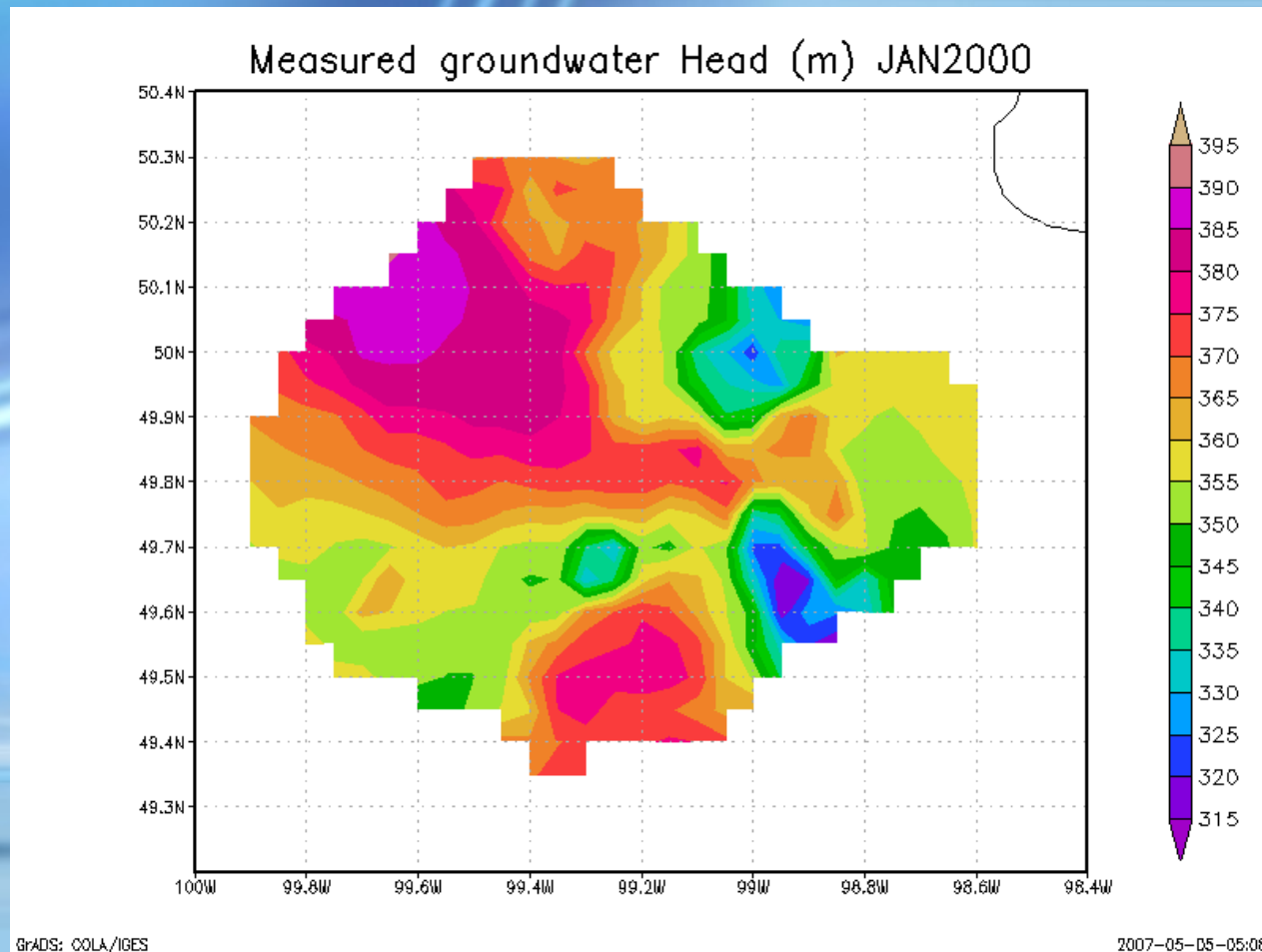
# GRACE & Gravity



Artificial Neural Network Downscaling



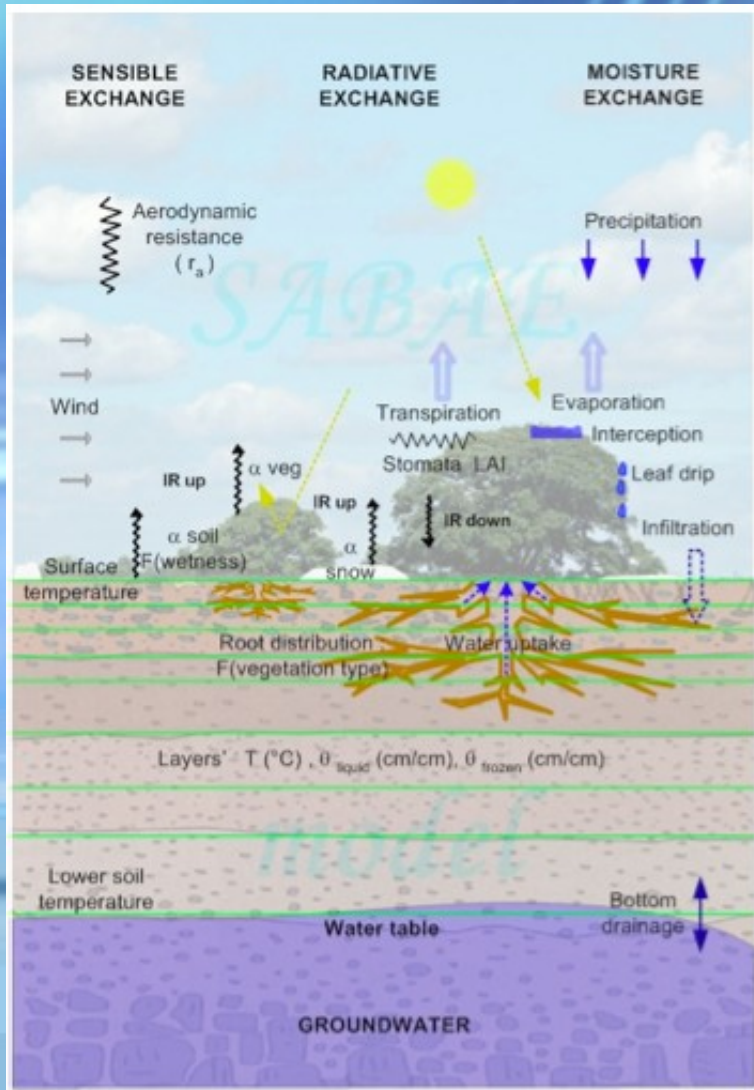
# GRACE & Gravity



Interpolated Groundwater Measurements for ADA



# SABEA HW & GW



## HW - Heat and Water

Built on CLASS

Extra Soil Layers to Impervious Surface

Efficient Implicit Energy Solution

Tests Against HYDRUS-1D and SHAW

## GW - Groundwater

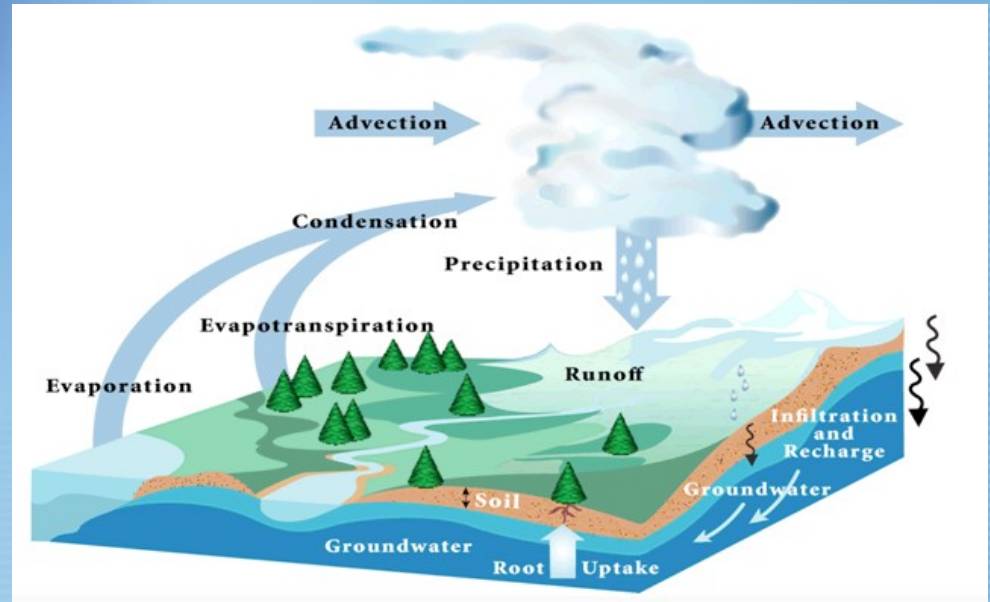
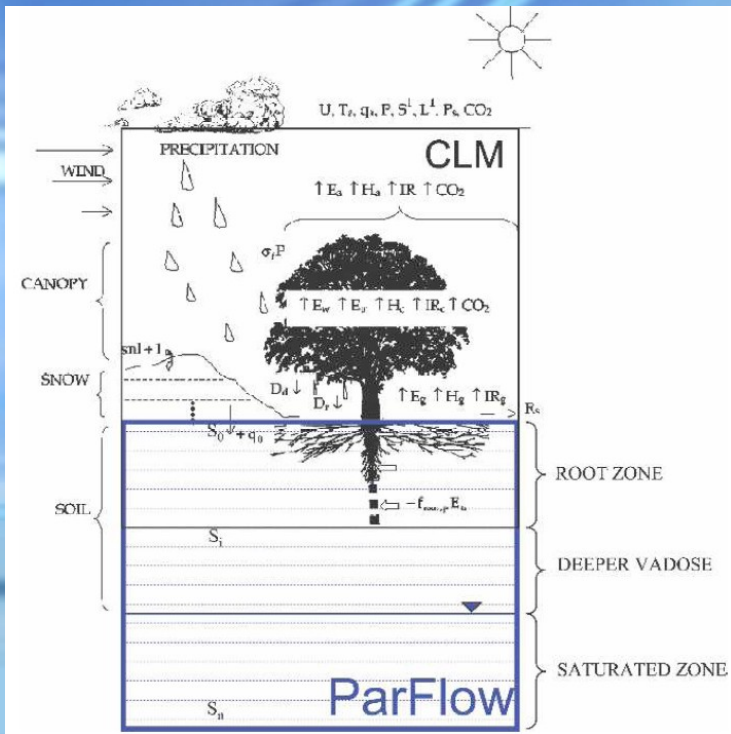
Quasi-3D Groundwater Solution

Less Costly than ParFlow

Development on-going

Testing on Assiniboine Delta Aquifer

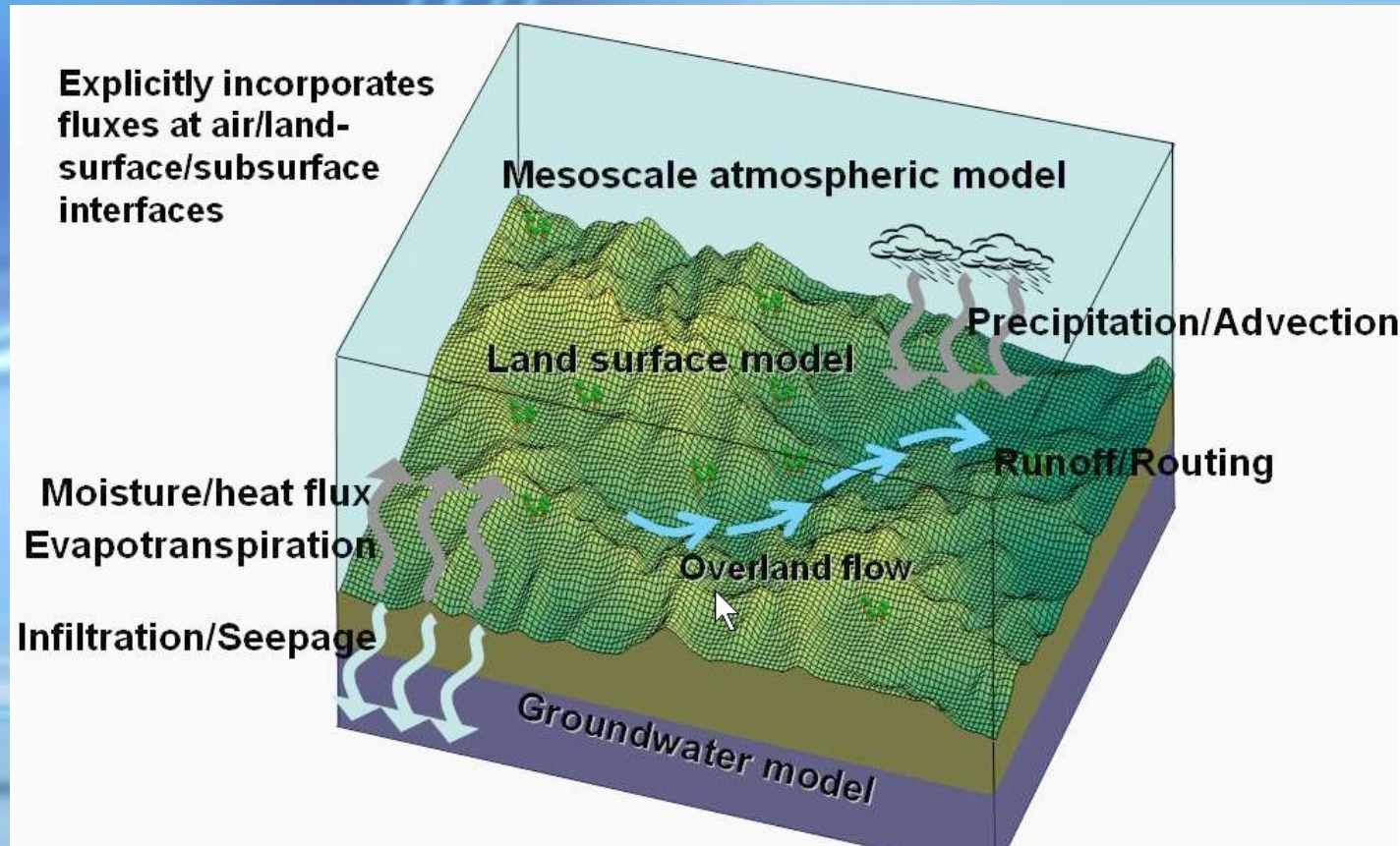
# Groundwater Modelling - ParFlow



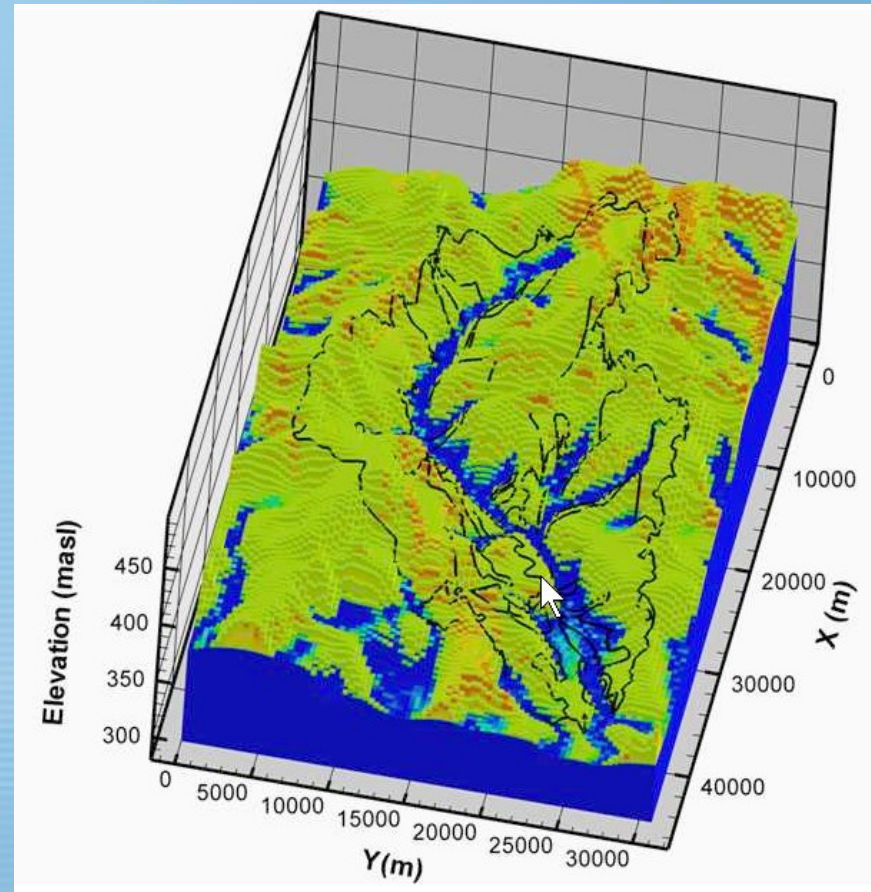
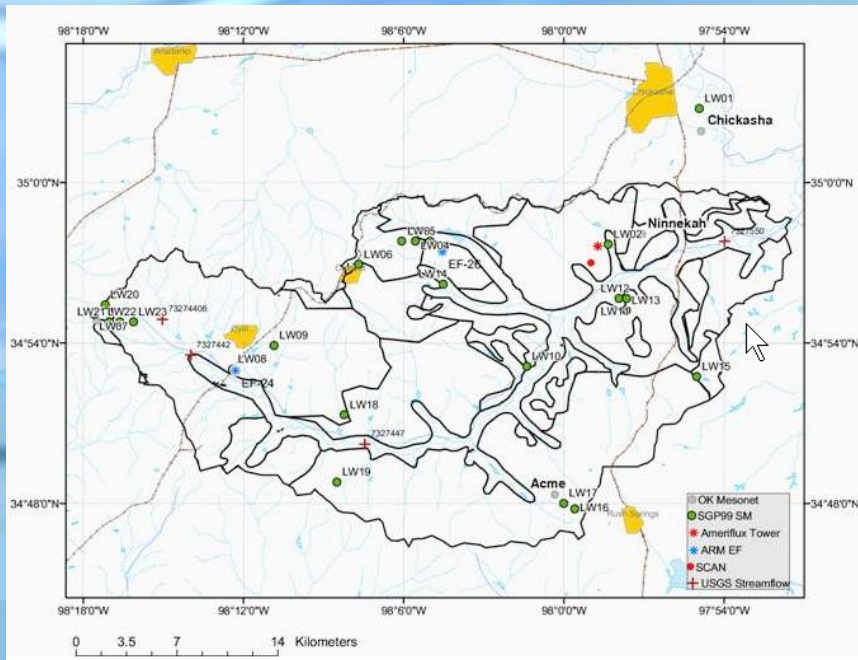
From:

Chow F.T., Kollet, S.J., Maxwell, R.M., and Duan, Q. (2006), Effects of soil moisture heterogeneity on boundary layer flow with coupled groundwater, land-surface, and mesoscale atmospheric modeling, AMS 17th Symposium on Boundary Layers and Turbulence, San Diego.

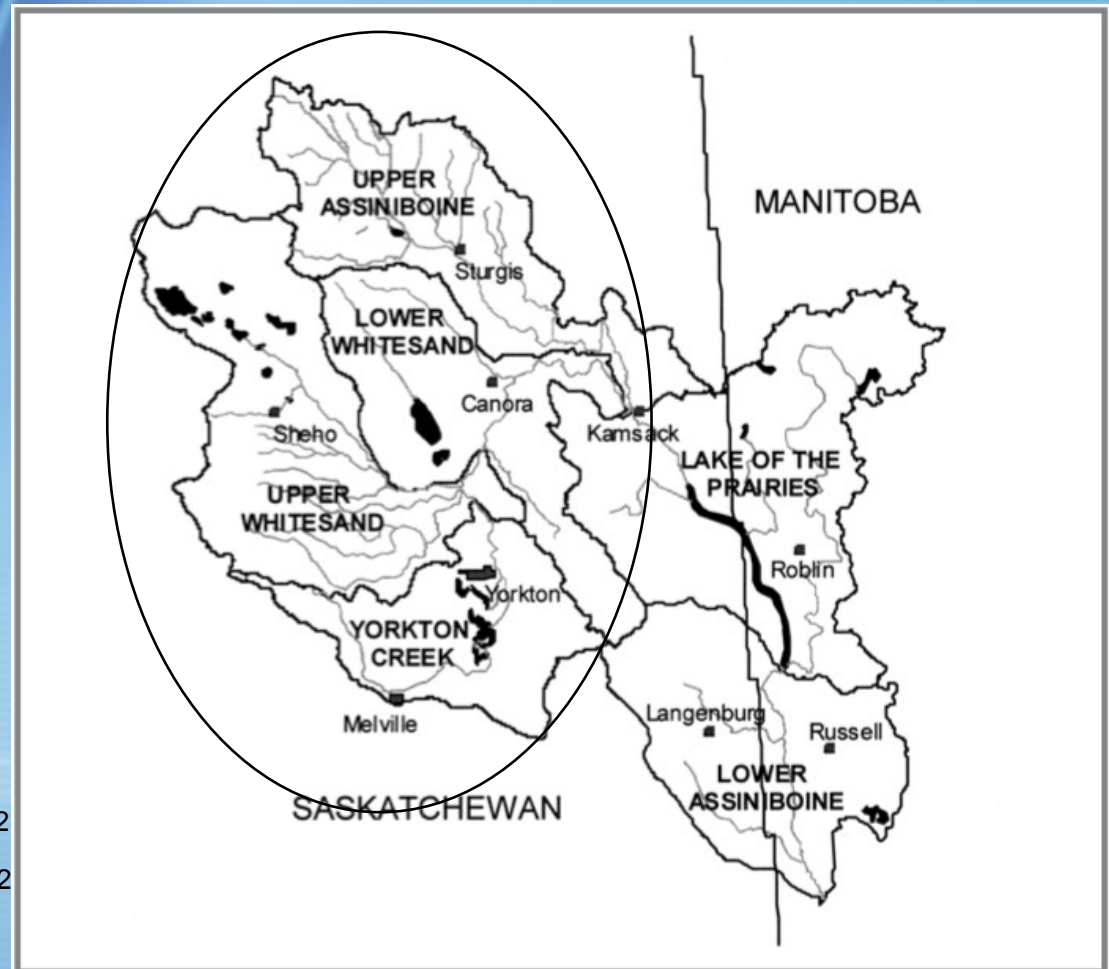
# ParFlow Coupled Model



# Little Washita Watershed Result



# Upper Assiniboine River Basin



Water Survey of Canada

Gauge 05MD004

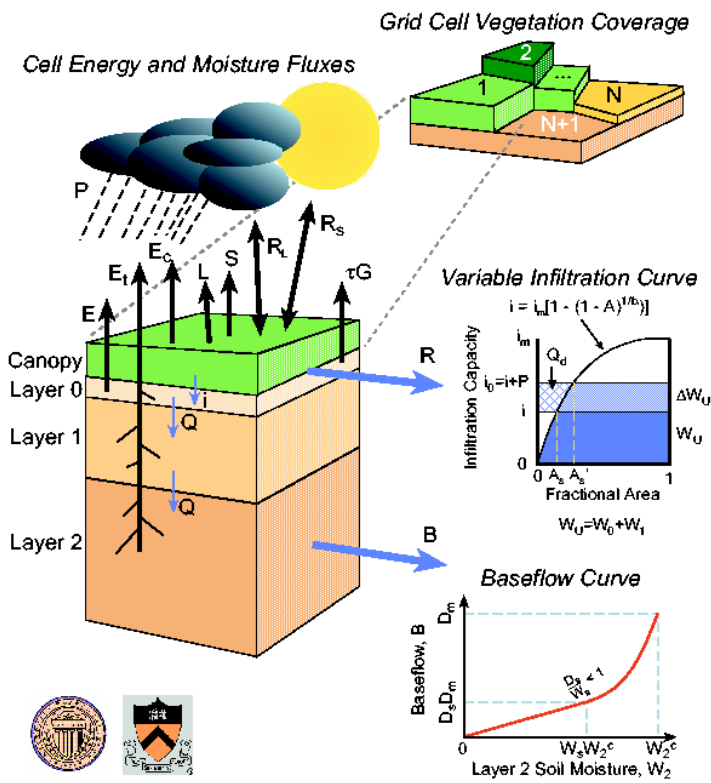
Assiniboine River at Kamsack

Gross Drainage Area = 13,000 km<sup>2</sup>

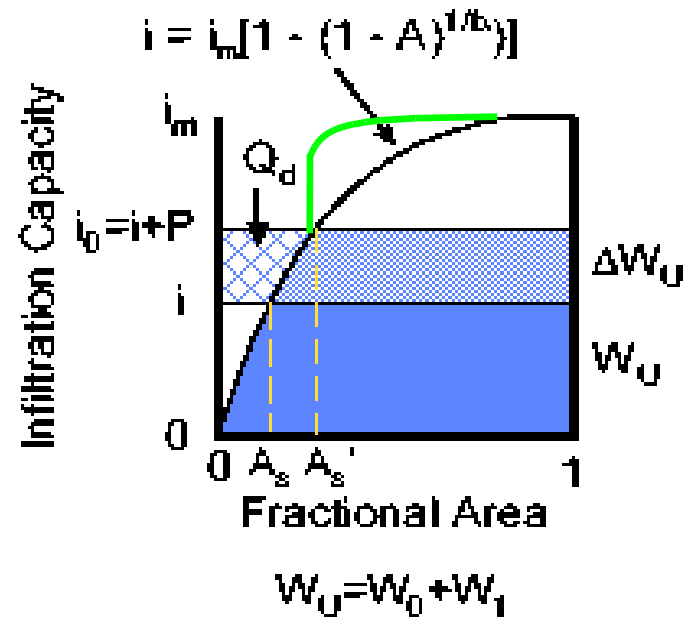
Effective Drainage Area = 4320 km<sup>2</sup>

# VIC Hydrologic Modelling

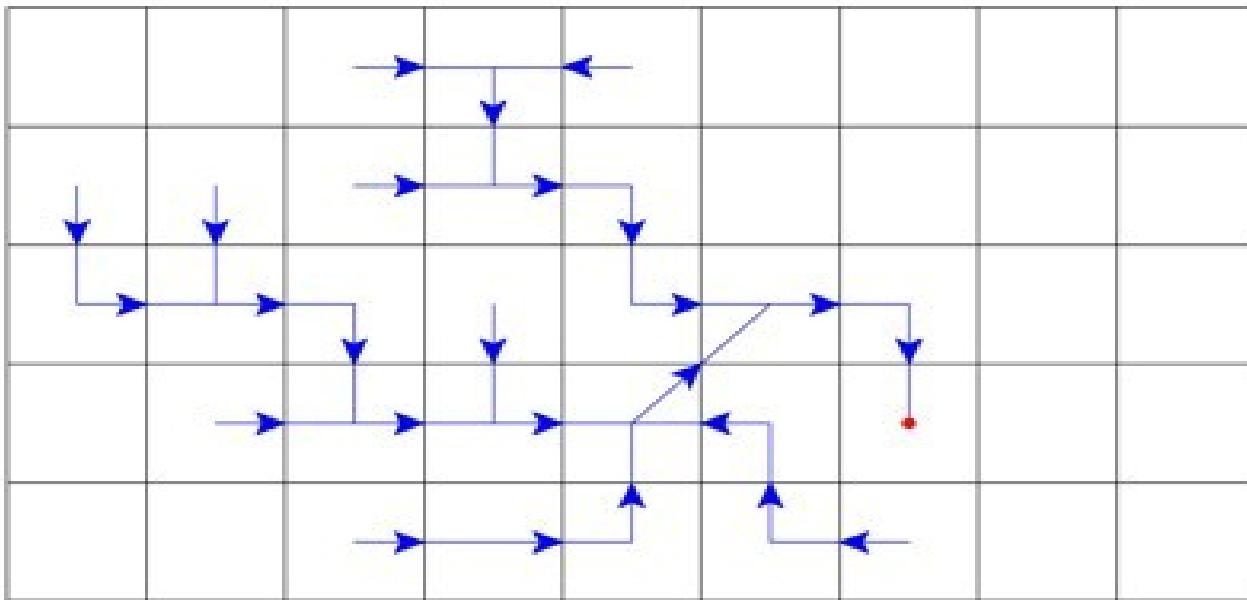
## Variable Infiltration Capacity (VIC) Macroscale Hydrologic Model



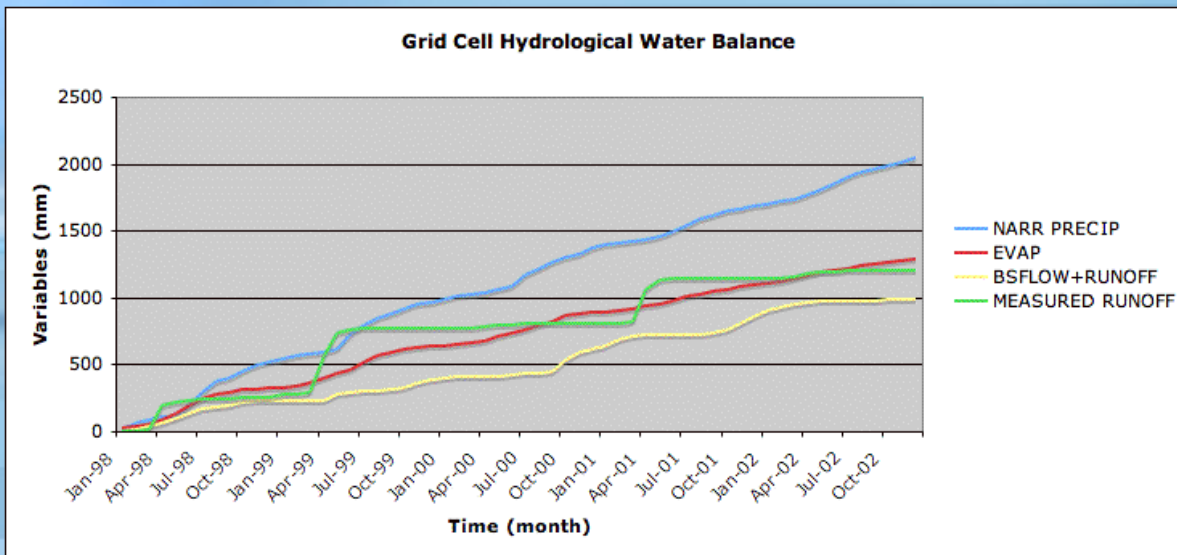
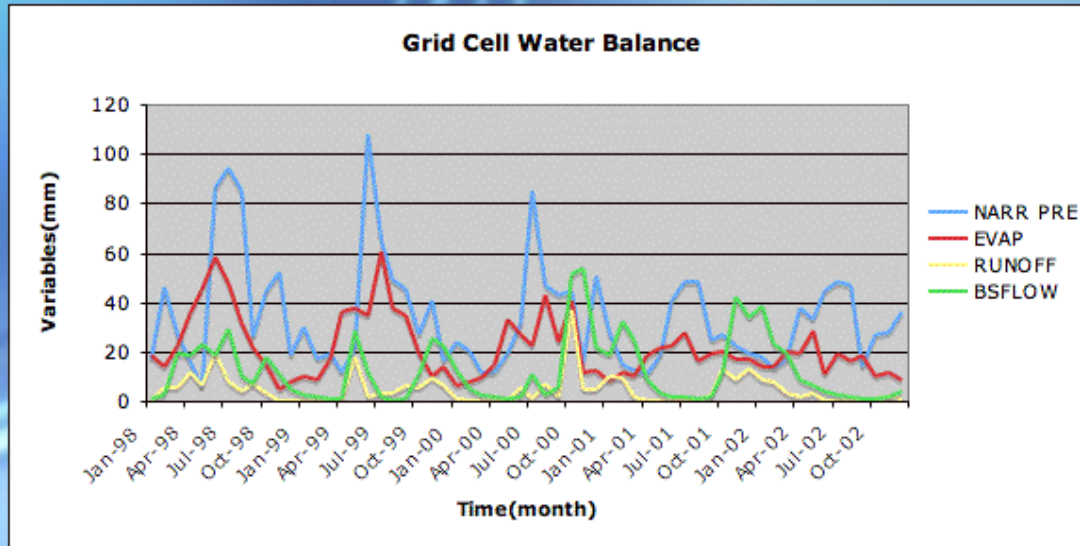
## Variable Infiltration Curve



# VIC Routing Modelling



# VIC Result







## Conclusion

- ◆ Gravity measurements can predict land surface storage on a variety of scales
- ◆ Coupled land surface and groundwater models required to describe drought
- ◆ ParFlow explicitly models GW and SW - COMPUTATIONALLY EXPENSIVE
- ◆ SABEA enhancement for CLASS will add GW connection
- ◆ Future testing on the Upper Assiniboine on for large area simulation.