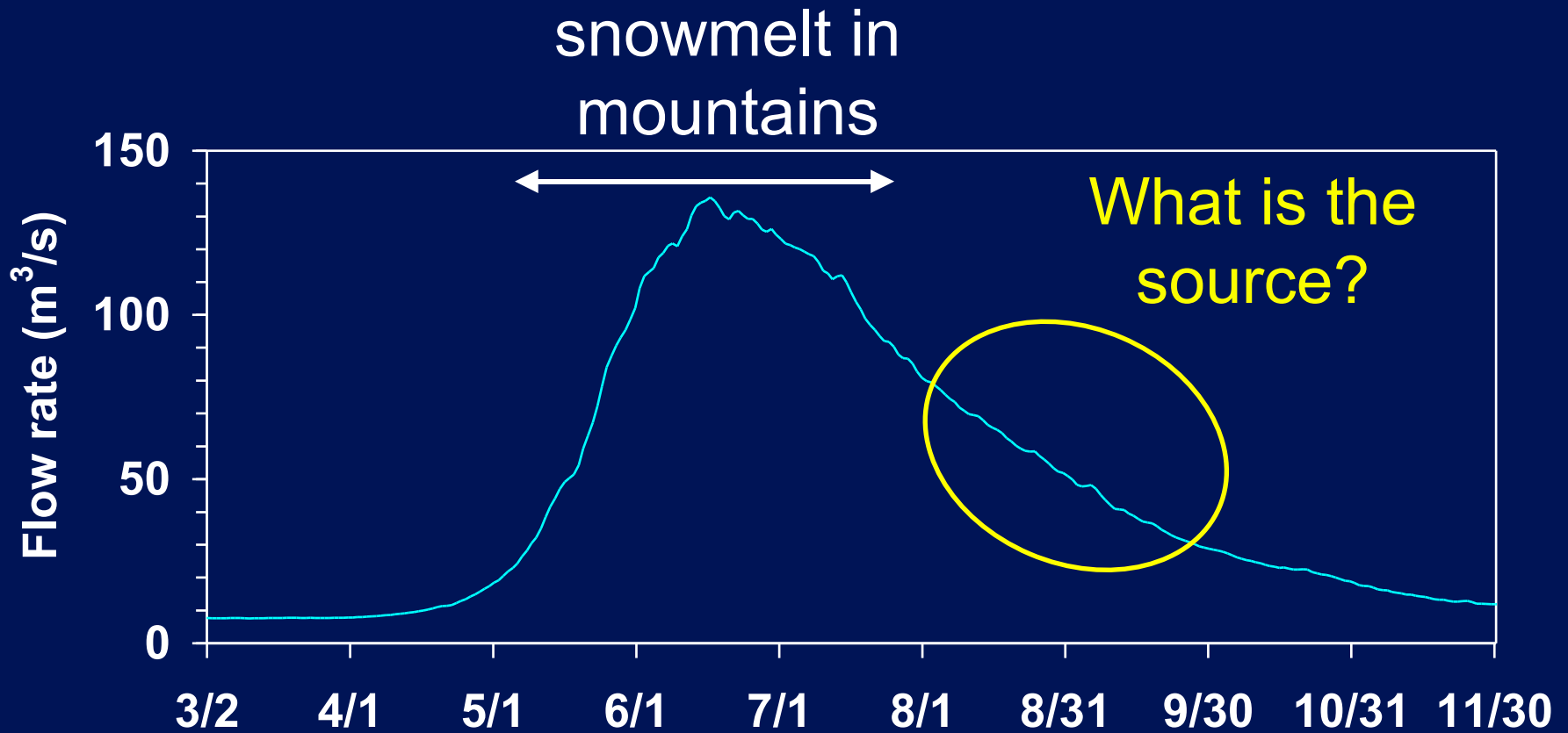


# Hydrological Storage and Pathways in Alpine Headwaters: Lake O'Hara Study Update

Masaki Hayashi, Jaime Hood, Greg Langston,  
Danika Muir, Alastair McClymont  
Dept. of Geoscience, Univ. of Calgary



# Average Flow in Bow River at Banff

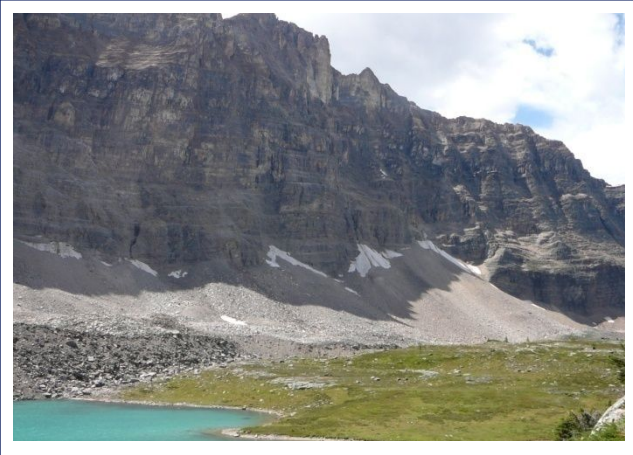


# Unanswered Questions in Alpine Hydrology

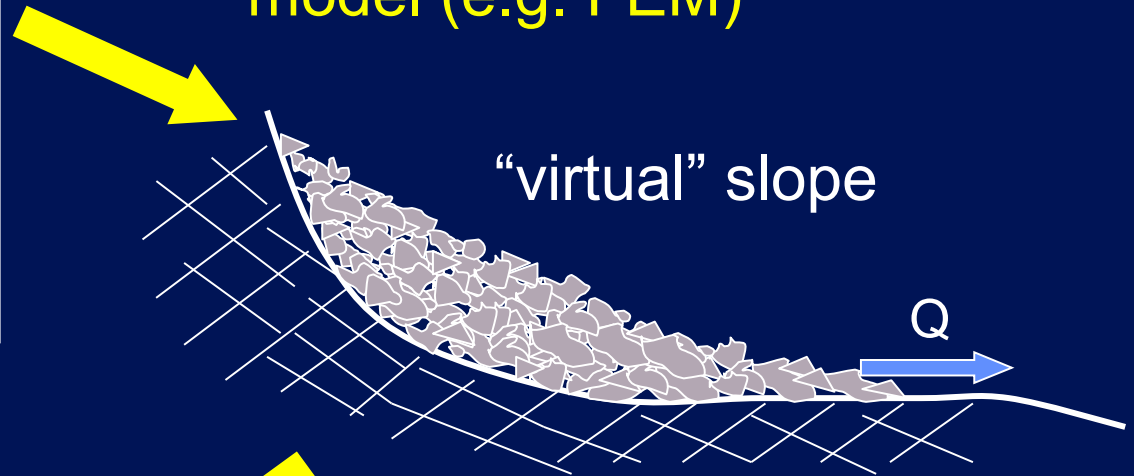
- Where is groundwater stored?
- How large is groundwater storage?  
10 mm? 100 mm?
- How long is groundwater stored?  
days? weeks? months?
- How can these be represented in basin hydrology models?  
e.g. MESH

# From Processes to Parameterization

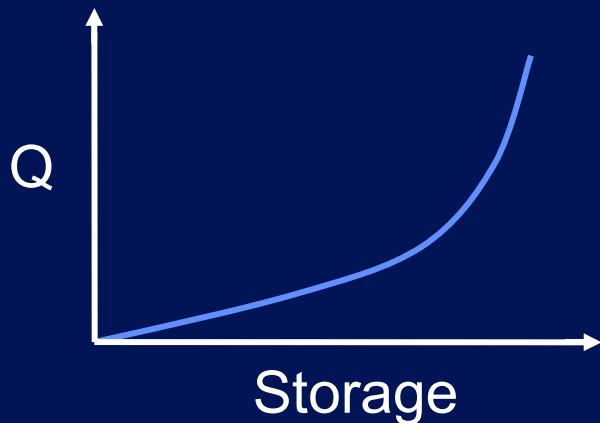
Field observation



physically-based  
model (e.g. FEM)



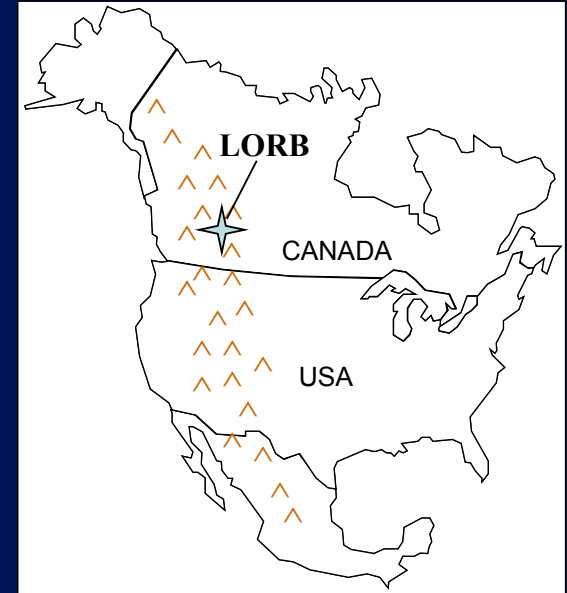
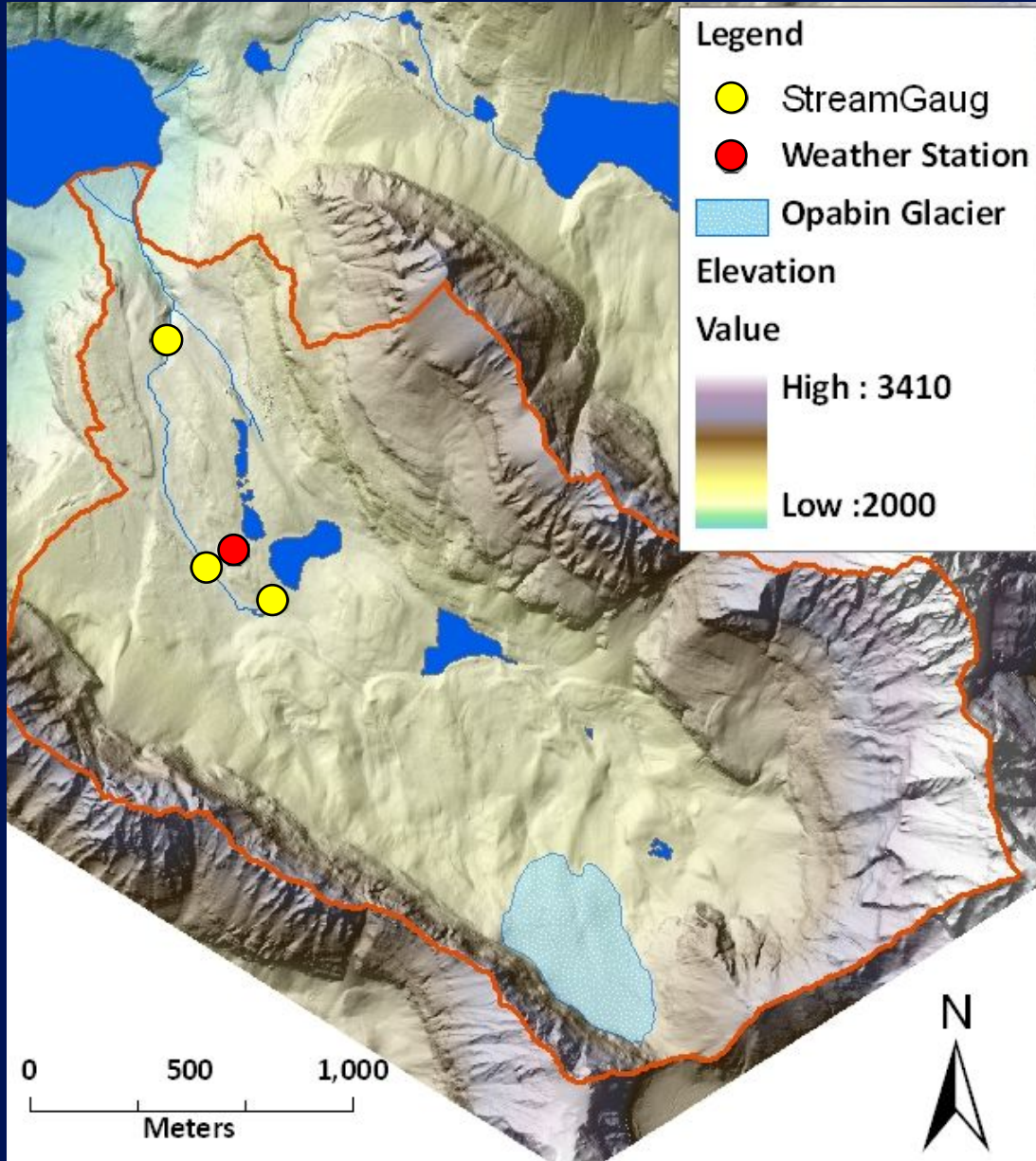
grid-scale function



simulation and  
sensitivity analysis

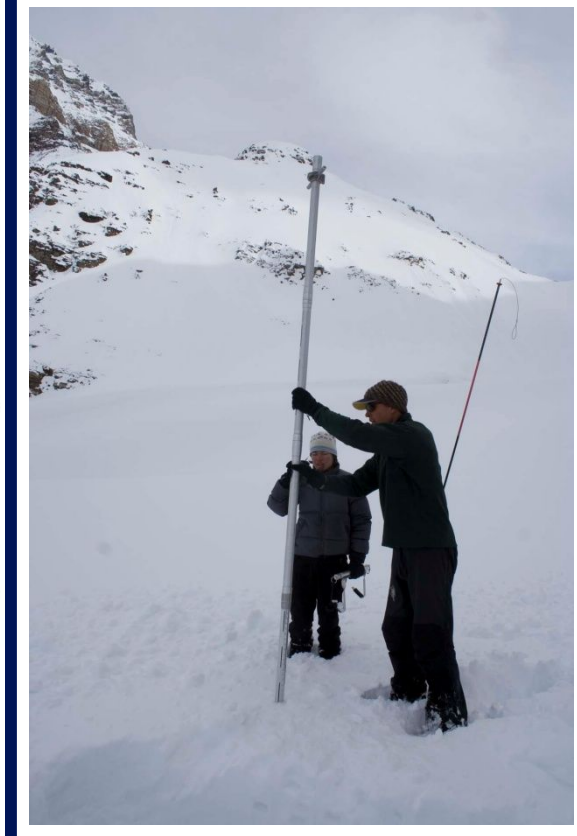
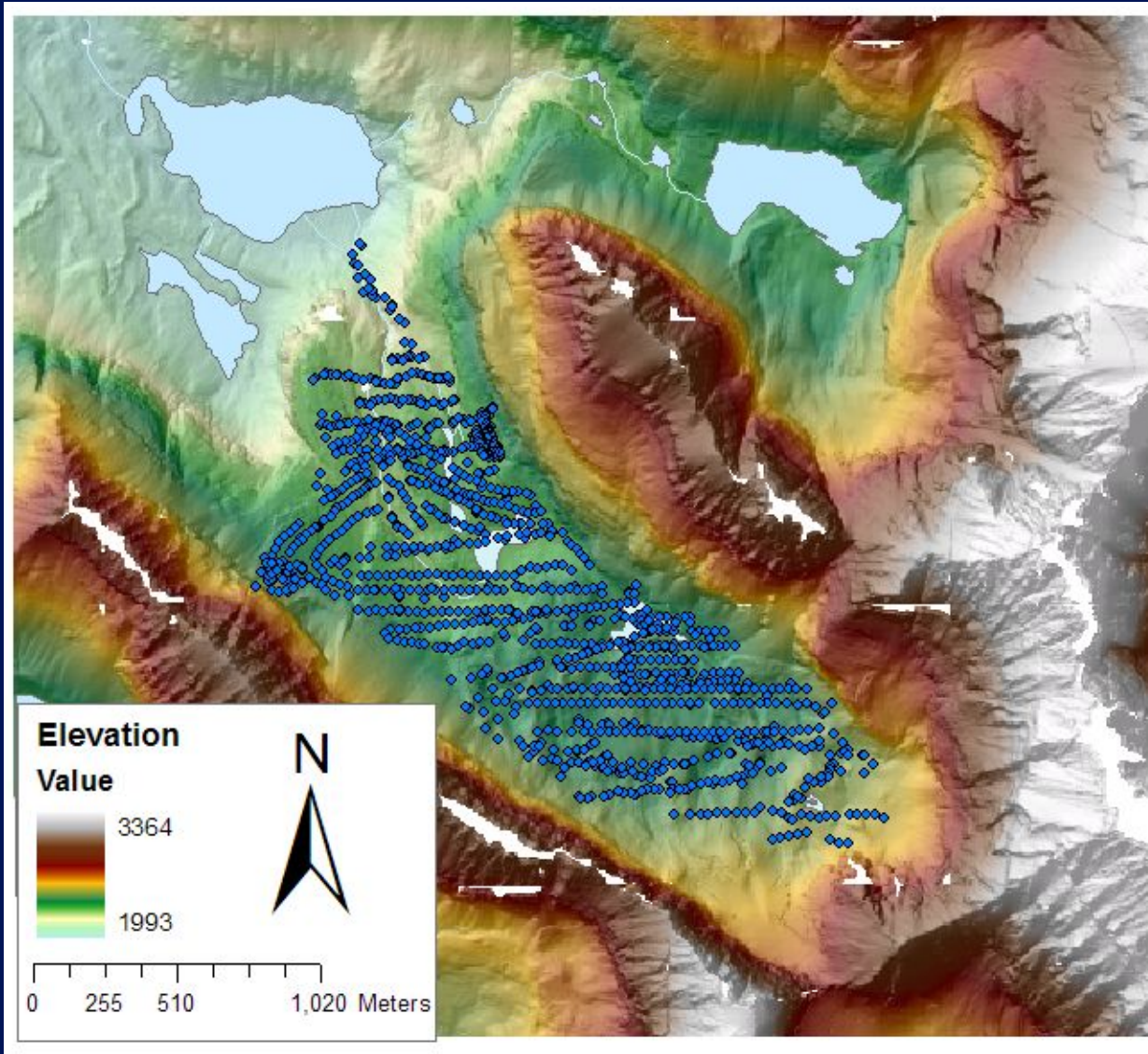


# Opabin Sub-Basin in Lake O'Hara Basin

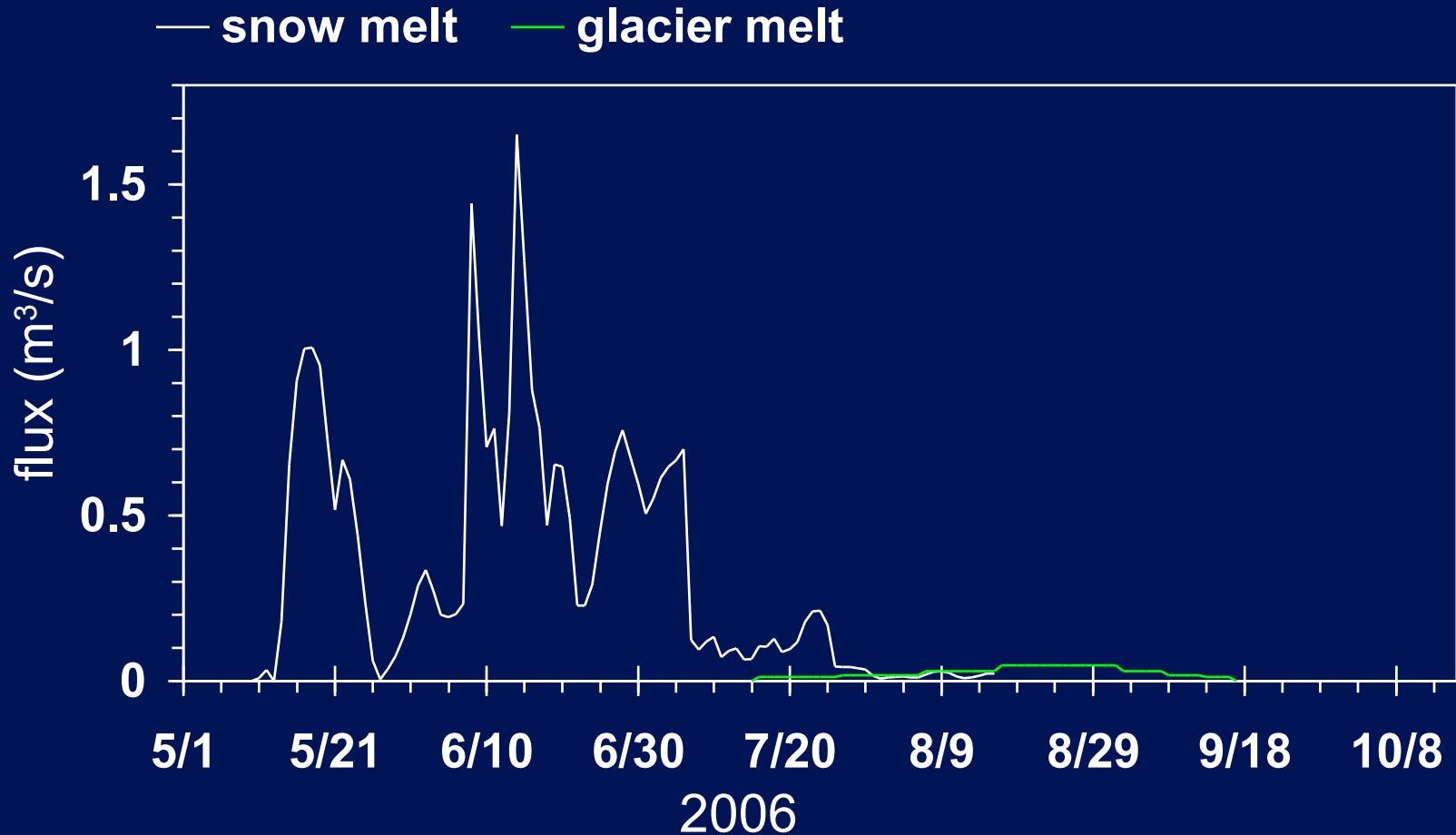




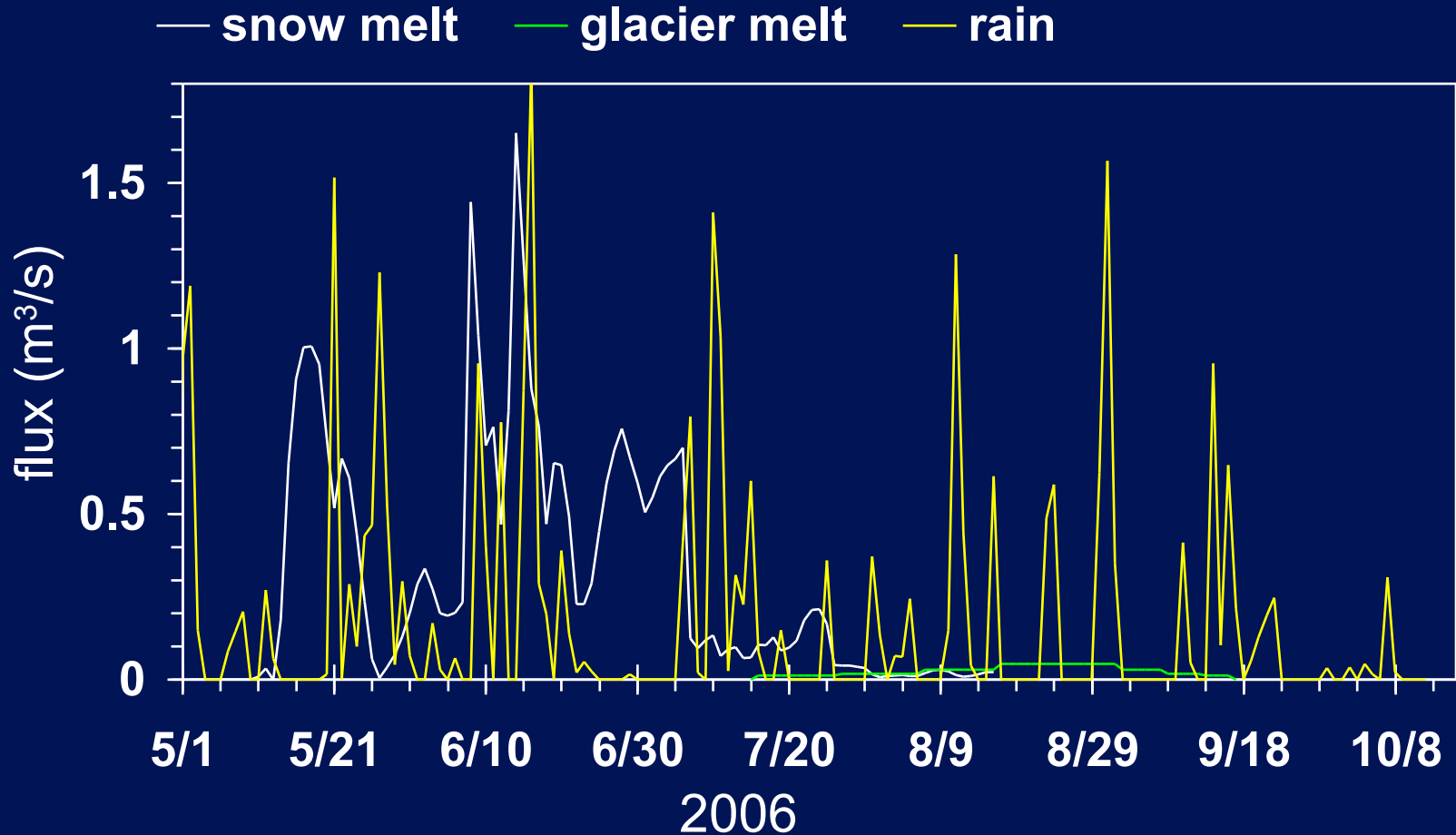
# Opabin Plateau Snow Survey, 2008



# Water Input to the Opabin Watershed

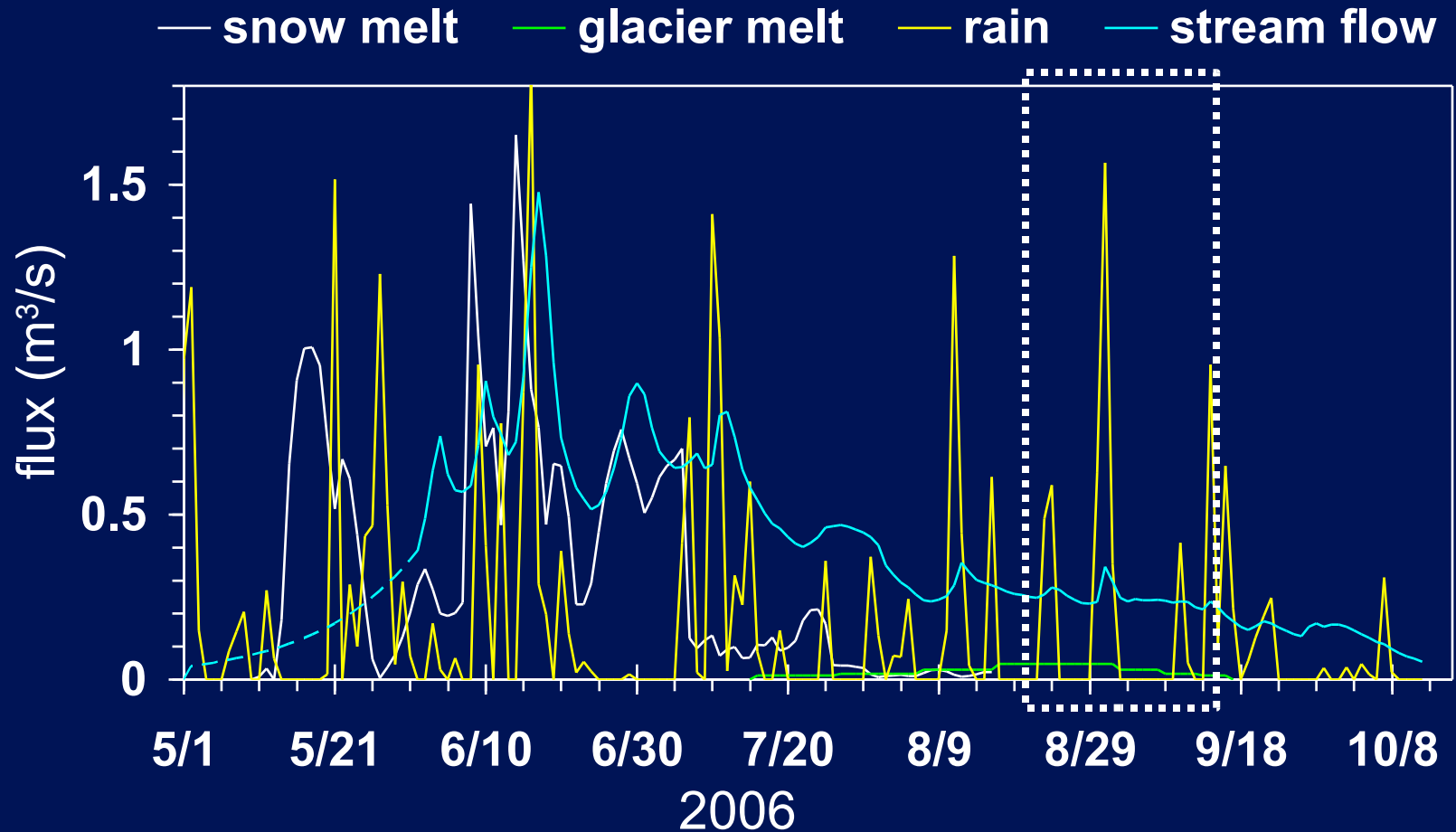


# Water Input to the Opabin Watershed

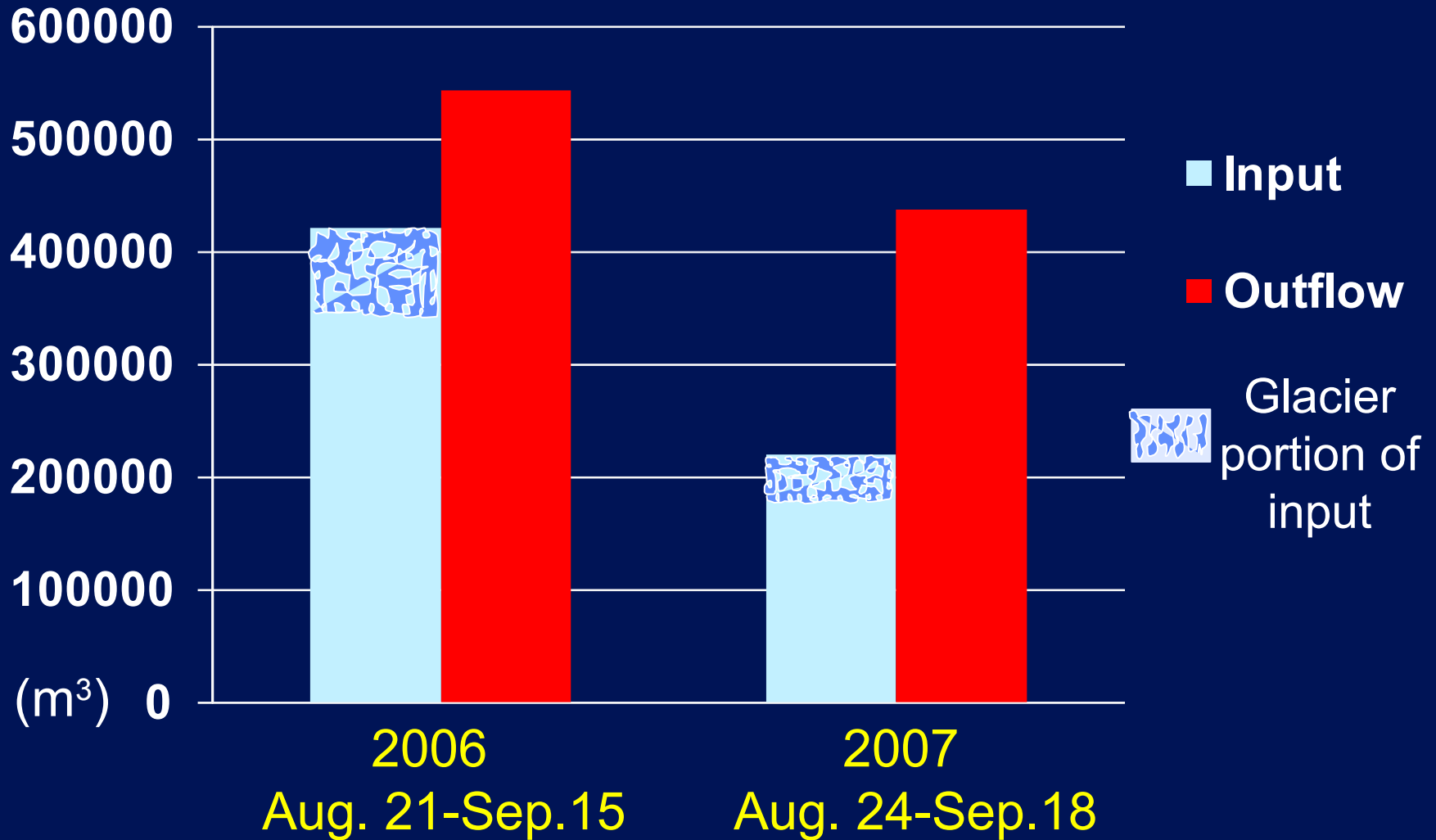




# Water Inputs and Output



# Total Inputs/Output in August-September



# Headwater of Opabin Creek

## Groundwater Springs





# 2008 Summer Geophysics Campaign

## Mapping Groundwater Pathways under the Moraine

### Ground Penetrating Radar



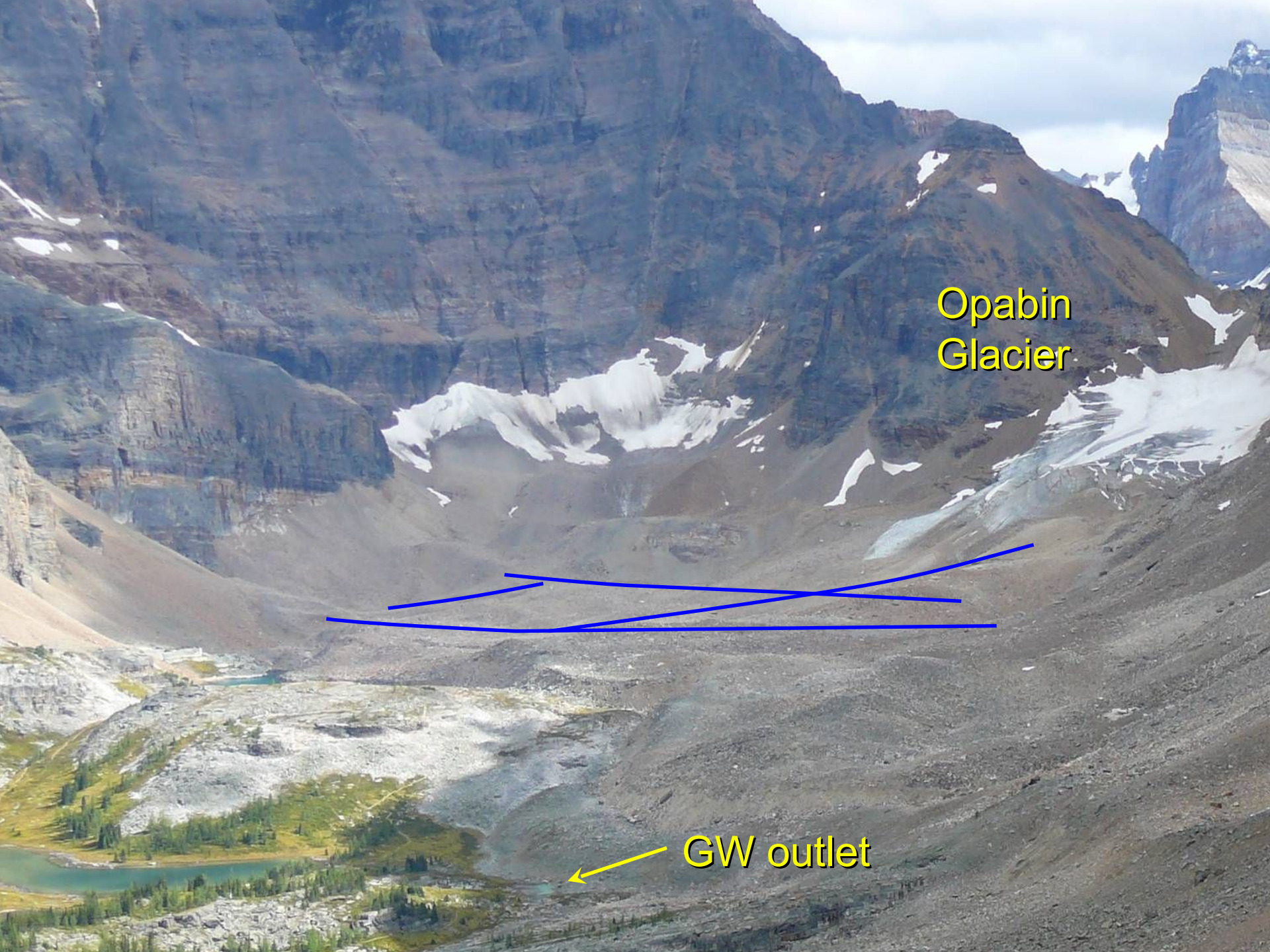
### Electrical Resistivity Imaging



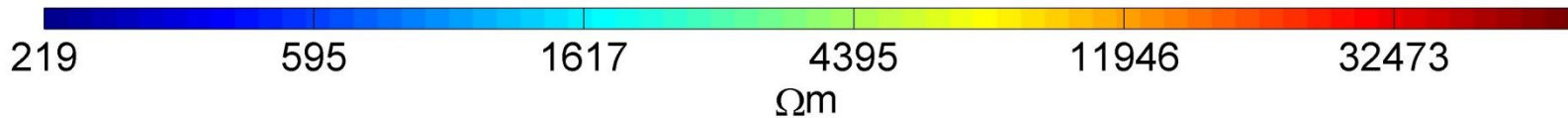
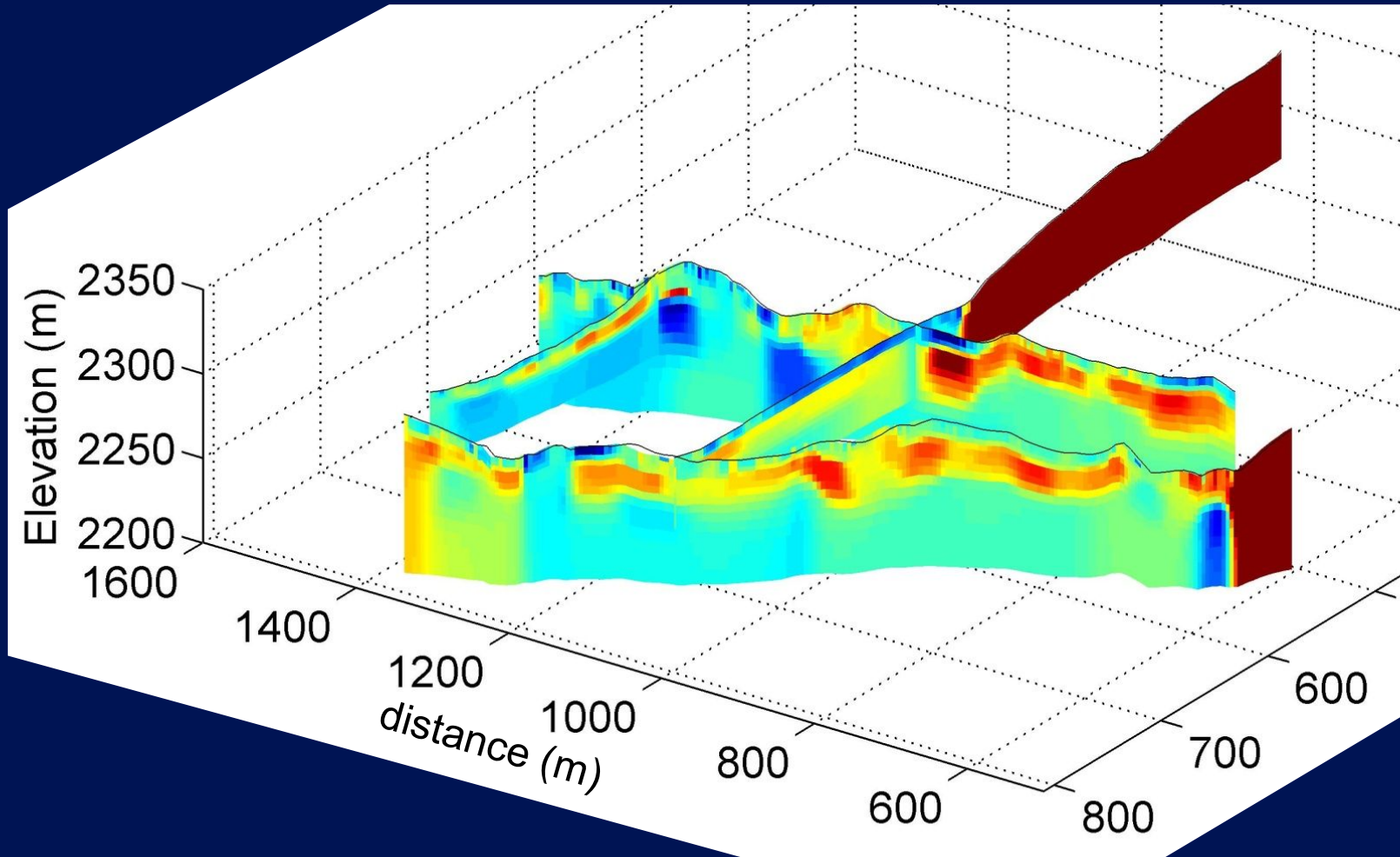


Opabin  
Glacier

GW outlet

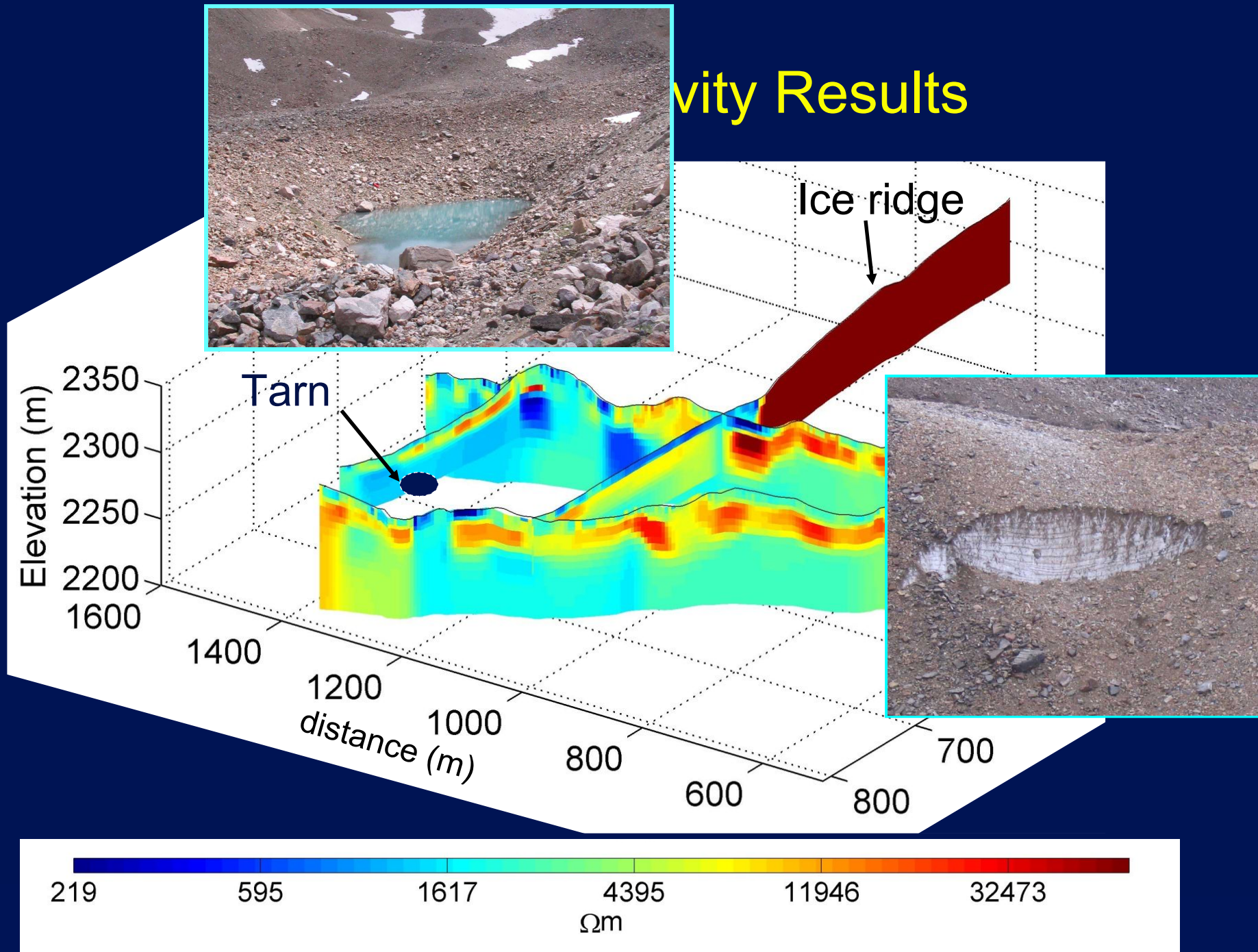


# Electrical Resistivity Results



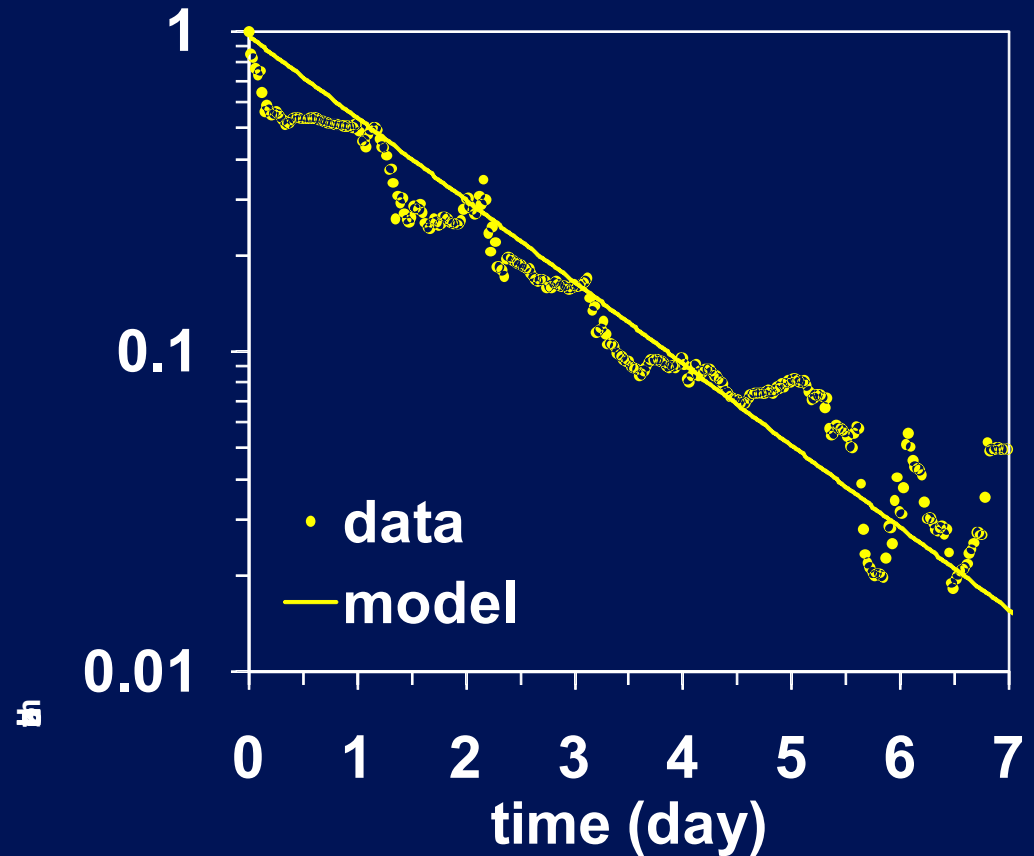


# Gravity Results



# Tracer Dilution Experiment, Aug. 2008

- 44 kg of NaCl released
- Slope of exponential decay proportional to flow rate  
 $\cong 400 \text{ m}^3/\text{d}$  flowing through





# Plans for 2009 and Beyond

- Hydrological field data collection tapering down
- Data analysis for processes
  - Proglacial moraine (Langston, M.Sc.)
  - Talus slopes (Muir, M.Sc.)
  - Spatial distribution (Hood, Ph.D.)
- Virtual model construction (Hayashi)
- MESH parameterization (Donnelly, M.Sc.)

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