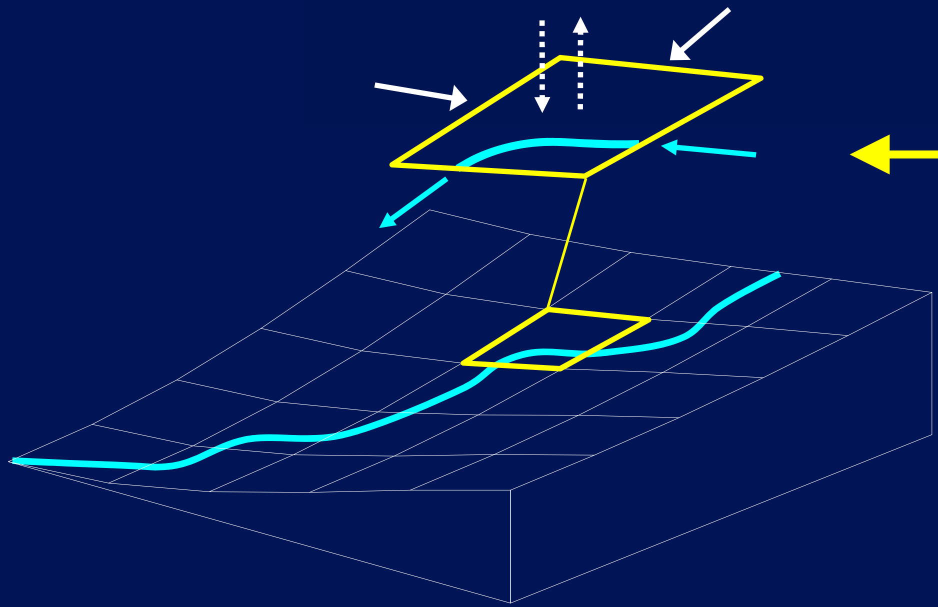
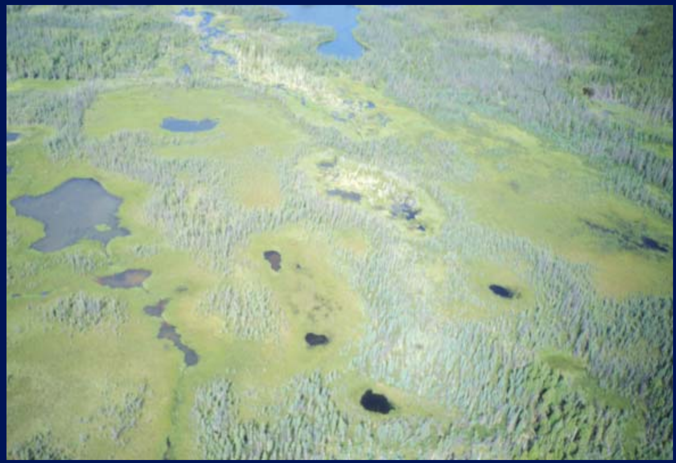
What is Hydrological Parameterization?





Scotty Creek Basin

Abstraction of complex processes into a model.
→ simplification, scaling up, “fitting” (fuzzy!)

The model must capture the ESSENSIAL FEATURE of physical processes.

How do we identify the <u>Essential Feature</u>?

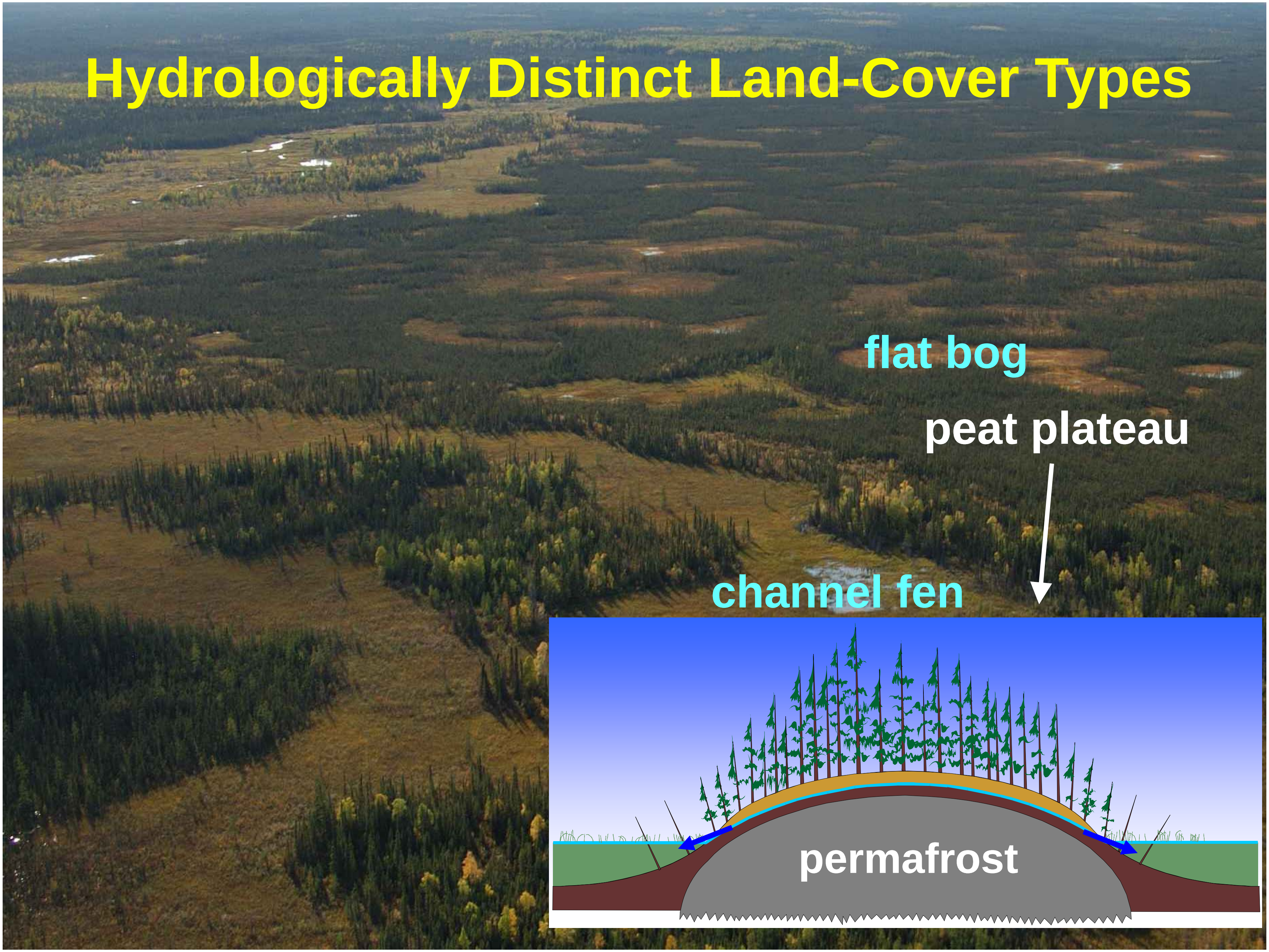
- Field ”intelligence” gathering

- Knowing what to look for
  → Hydrological process
  Equations and models

- Look at big <u>and</u> small picture

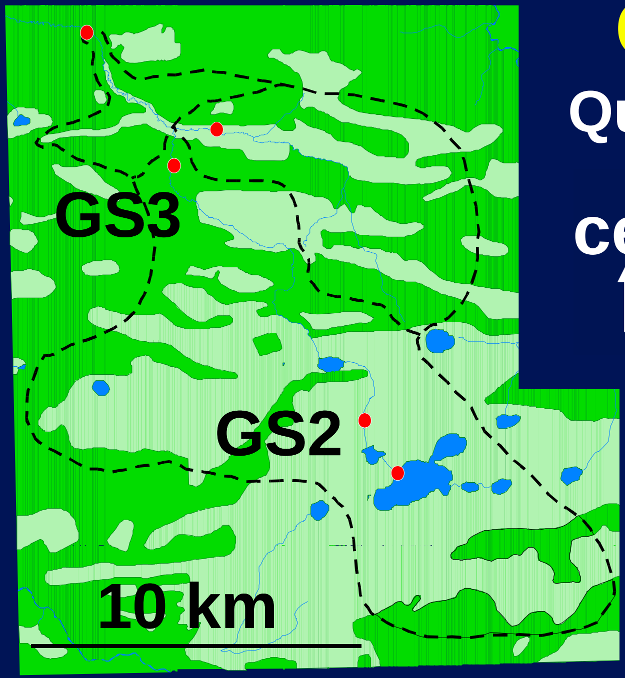
This is the best (and most fun) part of hydrological science!

Hydrologically Distinct Land-Cover Types



Channel Fen Parameterization

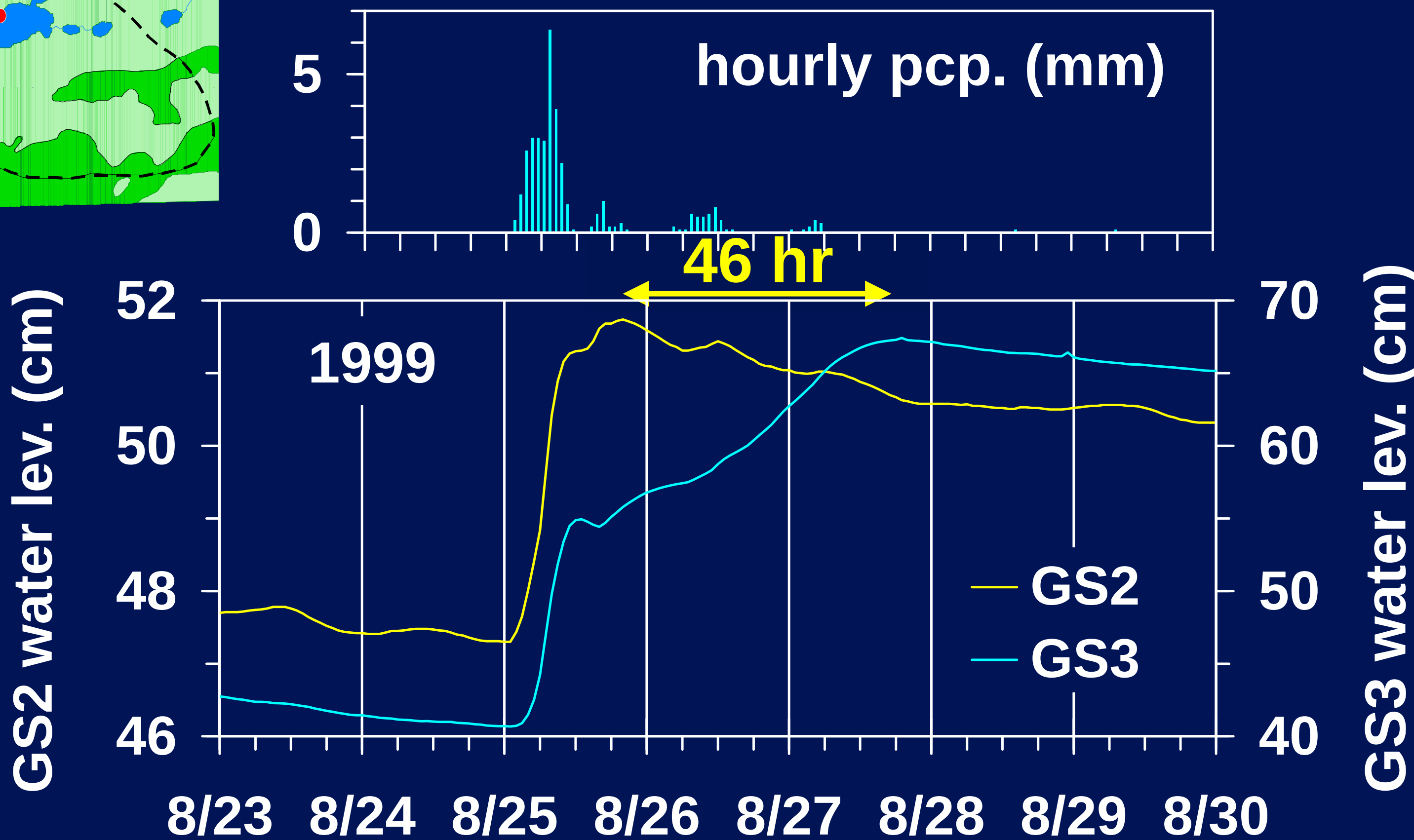
Quinton *et al* (2003. Hydrol. Proces. 17:3665)



celerity = 1.7 × (depth)$^{2/3}$ × (slope)$^{1/2}$ / *n*

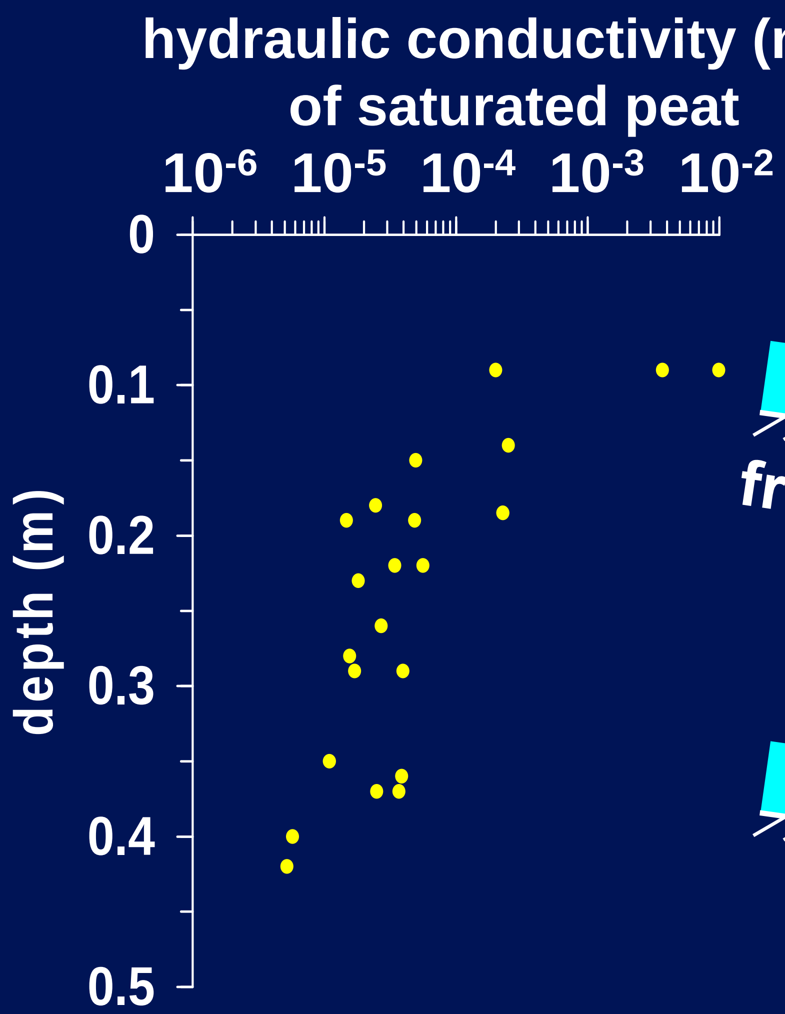
↑ wave propagation   Manning ↑

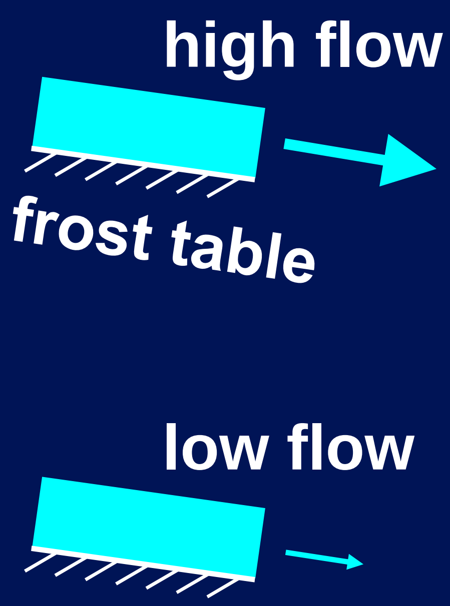
n = 0.13-0.17

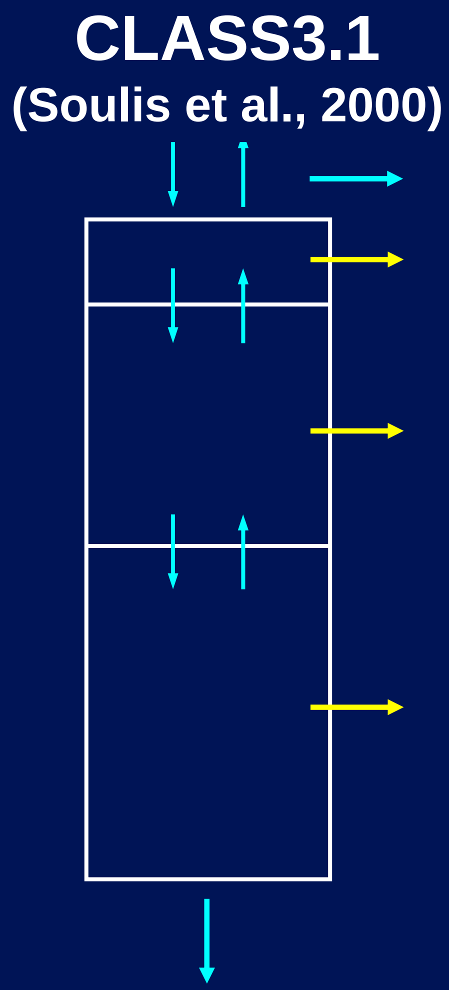


Peat Plateau Runoff Parameterization

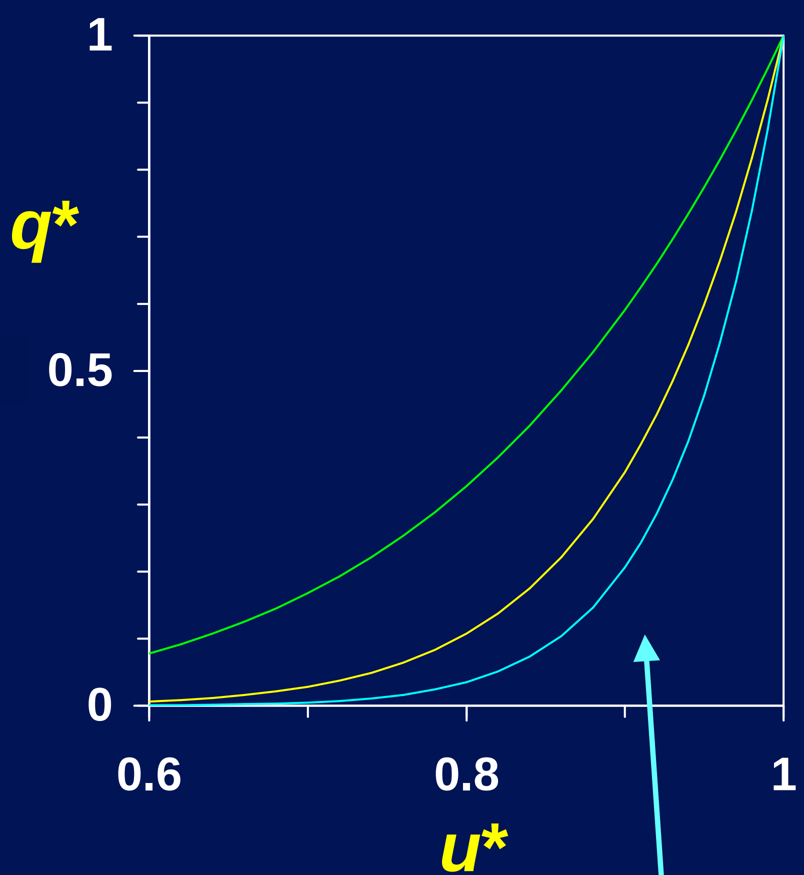
- Majority is subsurface, above the frost table
- Direction is lateral, not vertical drainage







Lateral Drainage in CLASS 3.1



Drainage flux per area, q

Maximum drainage, q_{max}
→ Complete saturation.
Depends on slope angle, hydraulic conductivity.

Average water storage, u

Maximum storage, u_{max}
→ Complete saturation.

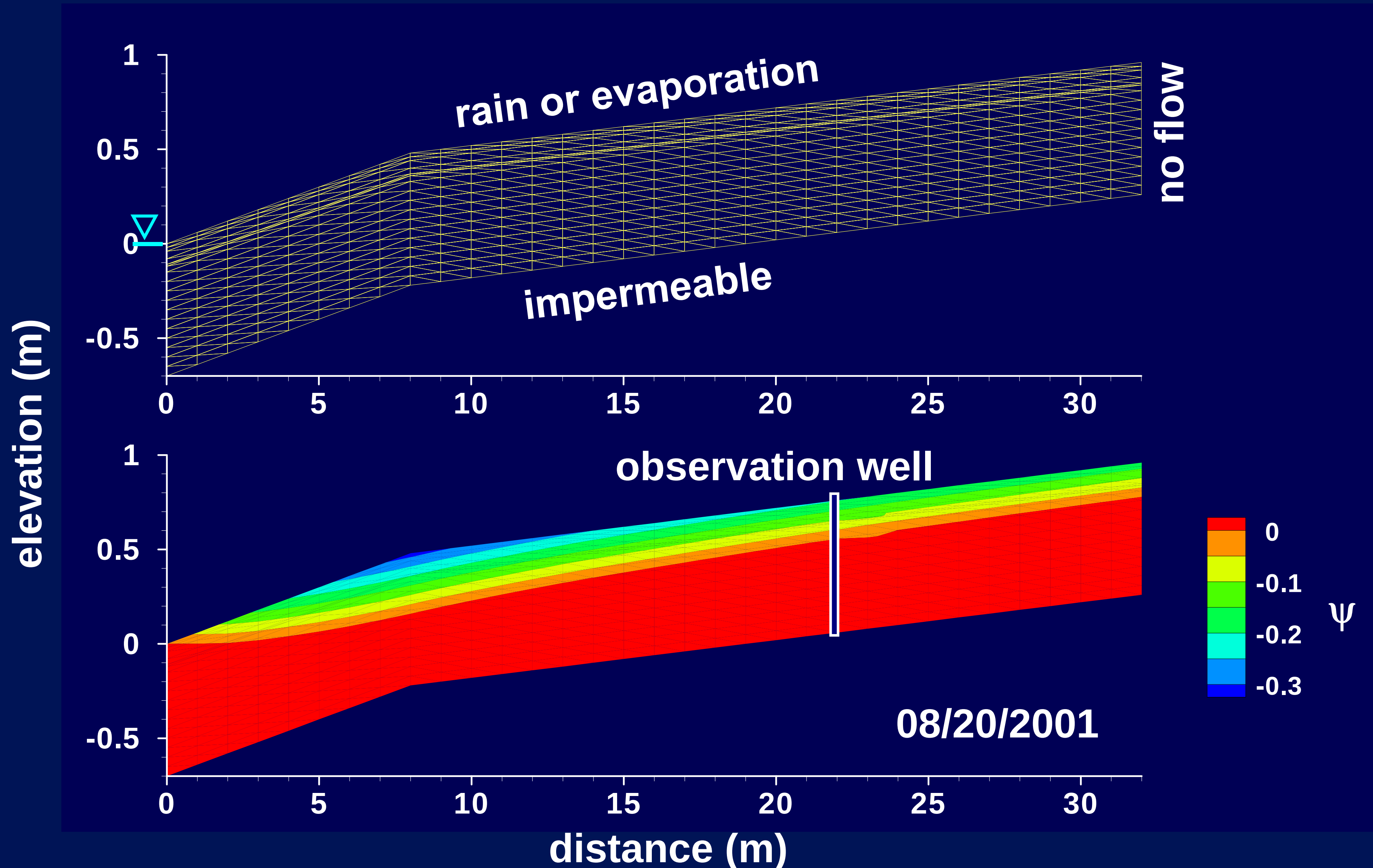
Normalized drainage $q^* = q/q_{max}$

Normalized storage $u^* = u/u_{max}$

Complex interplay of many processes

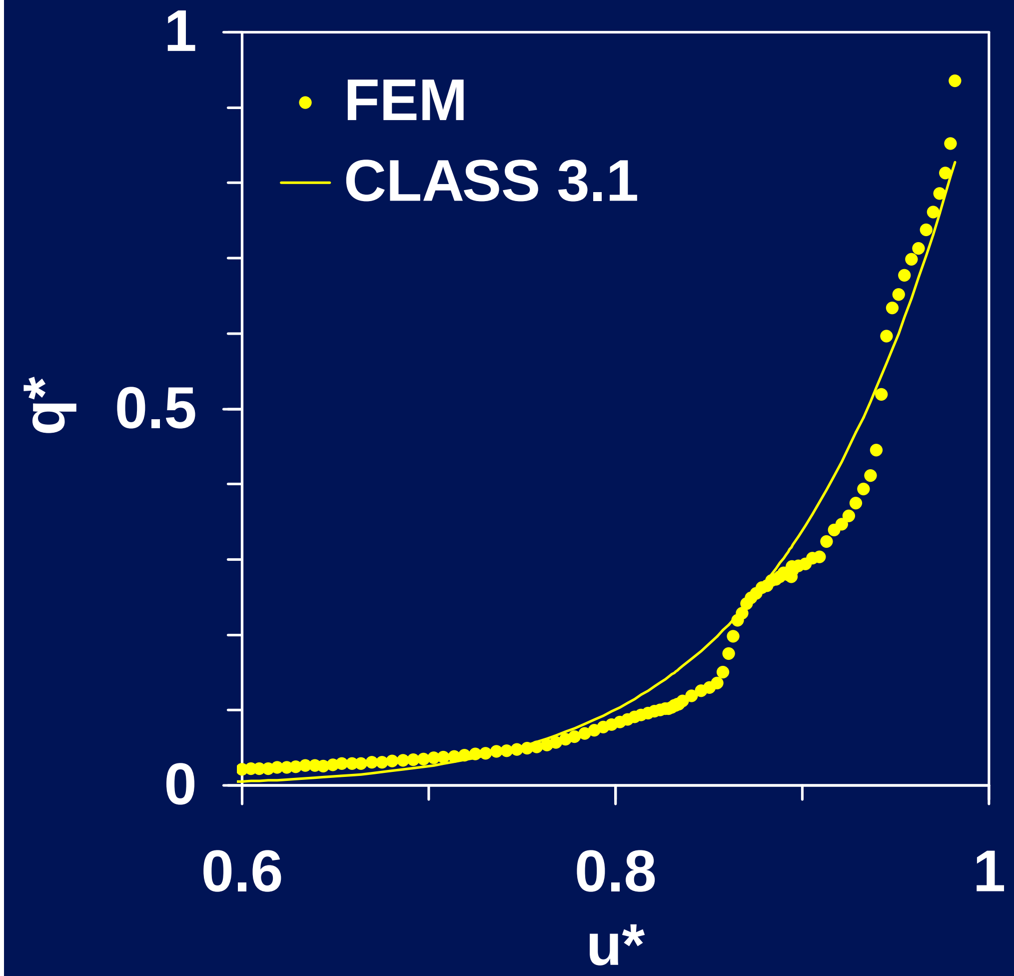
Finite Element Variably Saturated Flow Model

Princeton UNSAT-2D



Finite Element Model (FEM) as a Virtual Slope

- Verify the detailed slope model against field data.
- Then, use it to parameterize a basin model.



CLASS 3.1

Analytically derived *q*-u**.

FEM

1. Numerical drainage experiment.
2. Derive numerical *q*-u**.
3. Determine equivalent *q*-u** for CLASS 3.1.

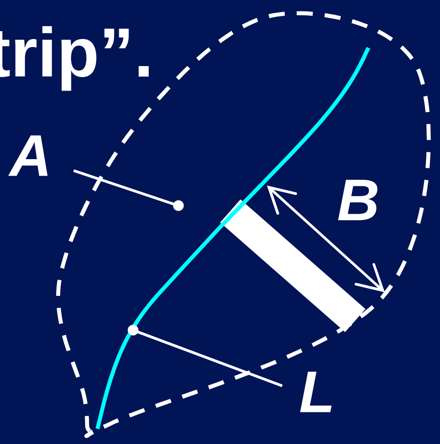
Marmot Creek Baseflow Parameterization

Analytical Solution of Brutsaert (2005. Hydrology)

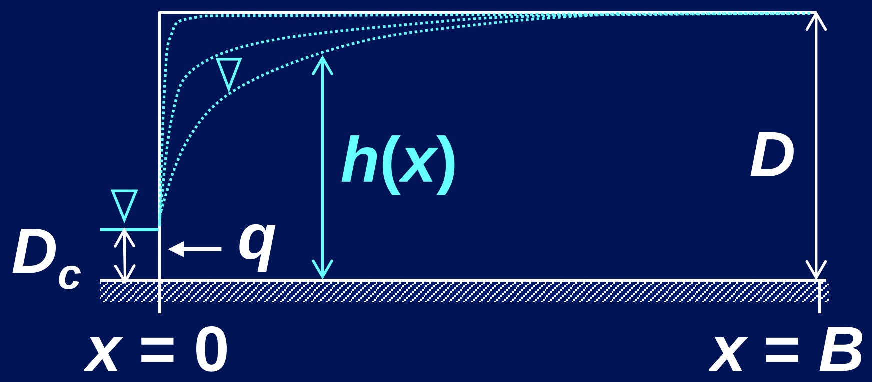
Boussinesq equation for a hillslope "strip".

$$\frac{\partial}{\partial x}\left(Kh\frac{\partial h}{\partial x}\right) = S_y \frac{\partial h}{\partial t}$$

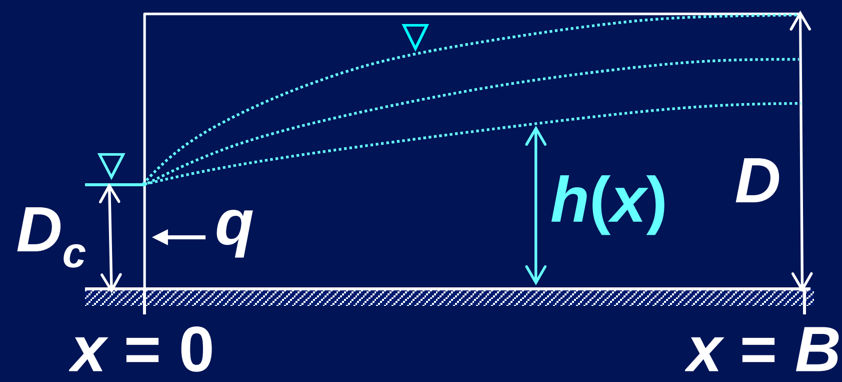
***K*: conductivity**
S_y: specific yield



early time solution



late time solution

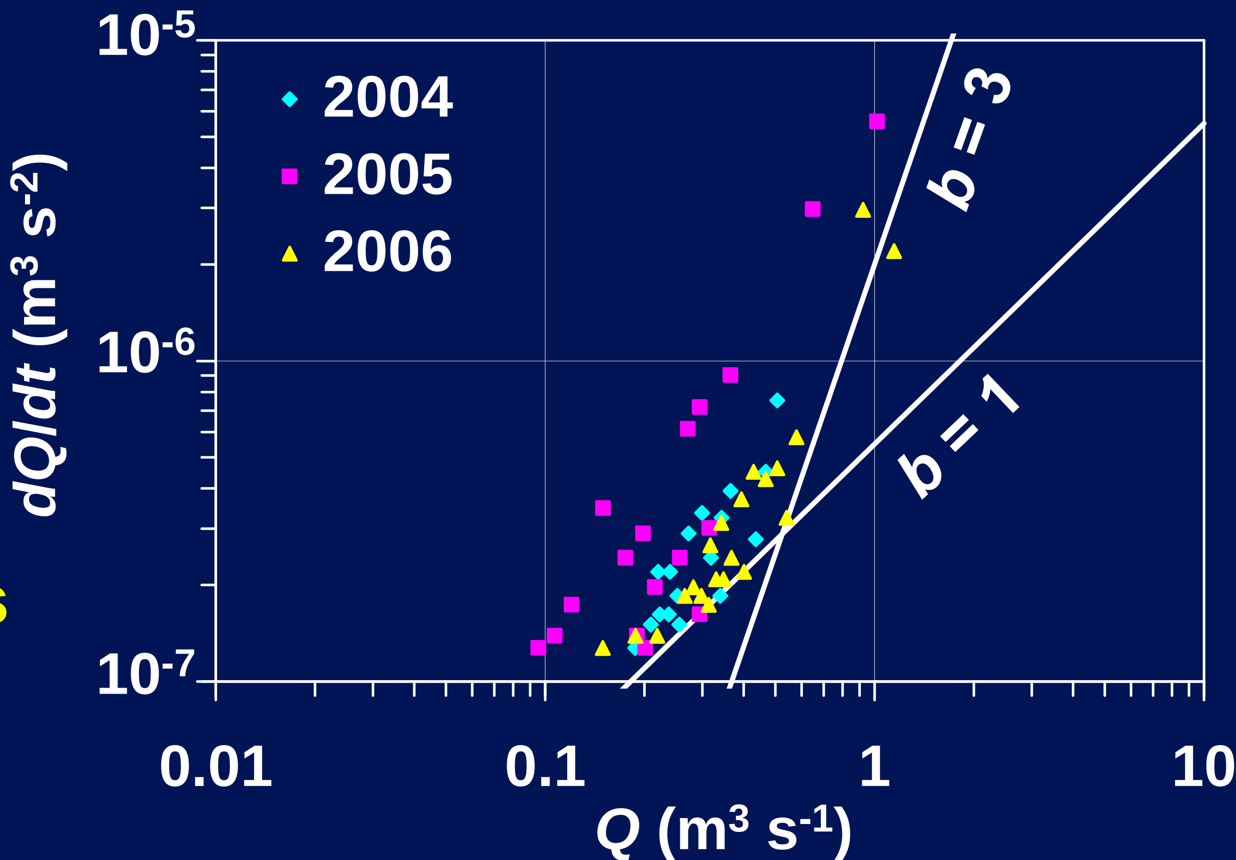


***q*: flow per shore length ($m^2\ s^{-1}$)**

$$\frac{dQ}{dt} = -aQ^b$$

Time derivative of baseflow discharge (Q) is proportional to Q^b.
→ b = 3 for early time, 1 for late time.

***K* can be determined from the intercepts of two envelope curves.**

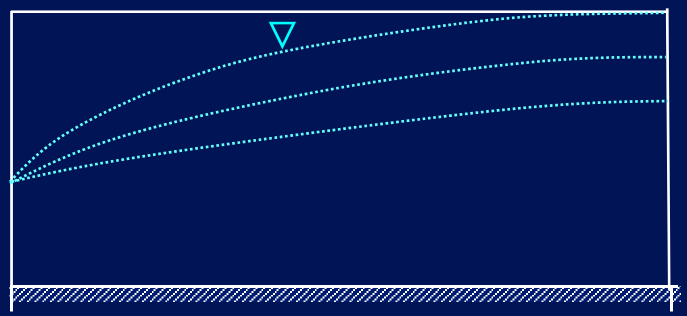


$K = 3 \times 10^{-3}$ m/s

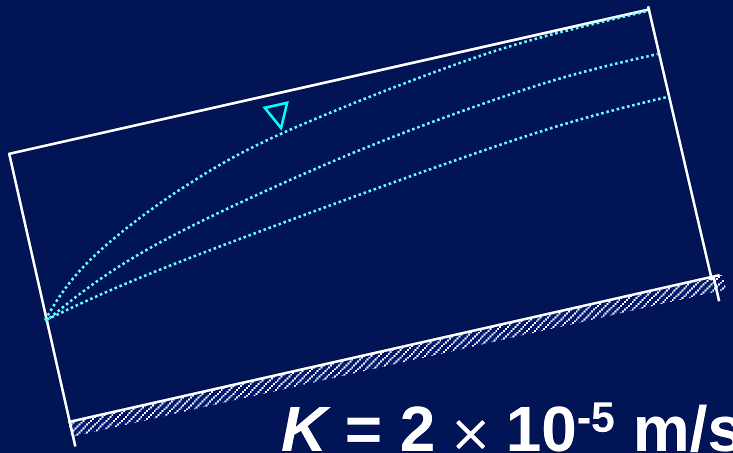
Reasonable??

Scale-Dependent Conductivity?

photo by J. Pomeroy



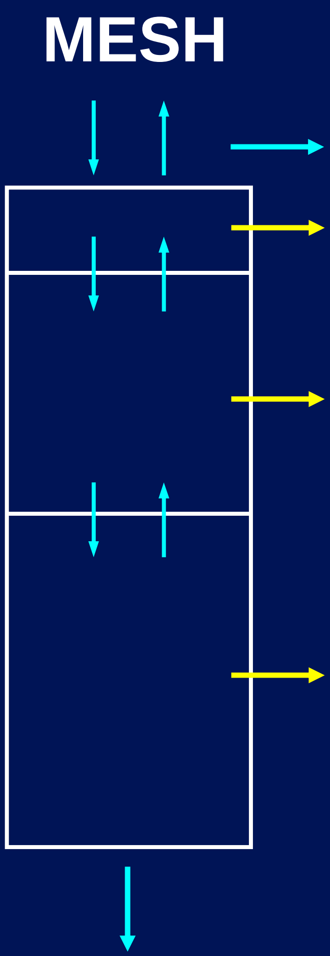
$K = 3 \times 10^{-3}$ m/s



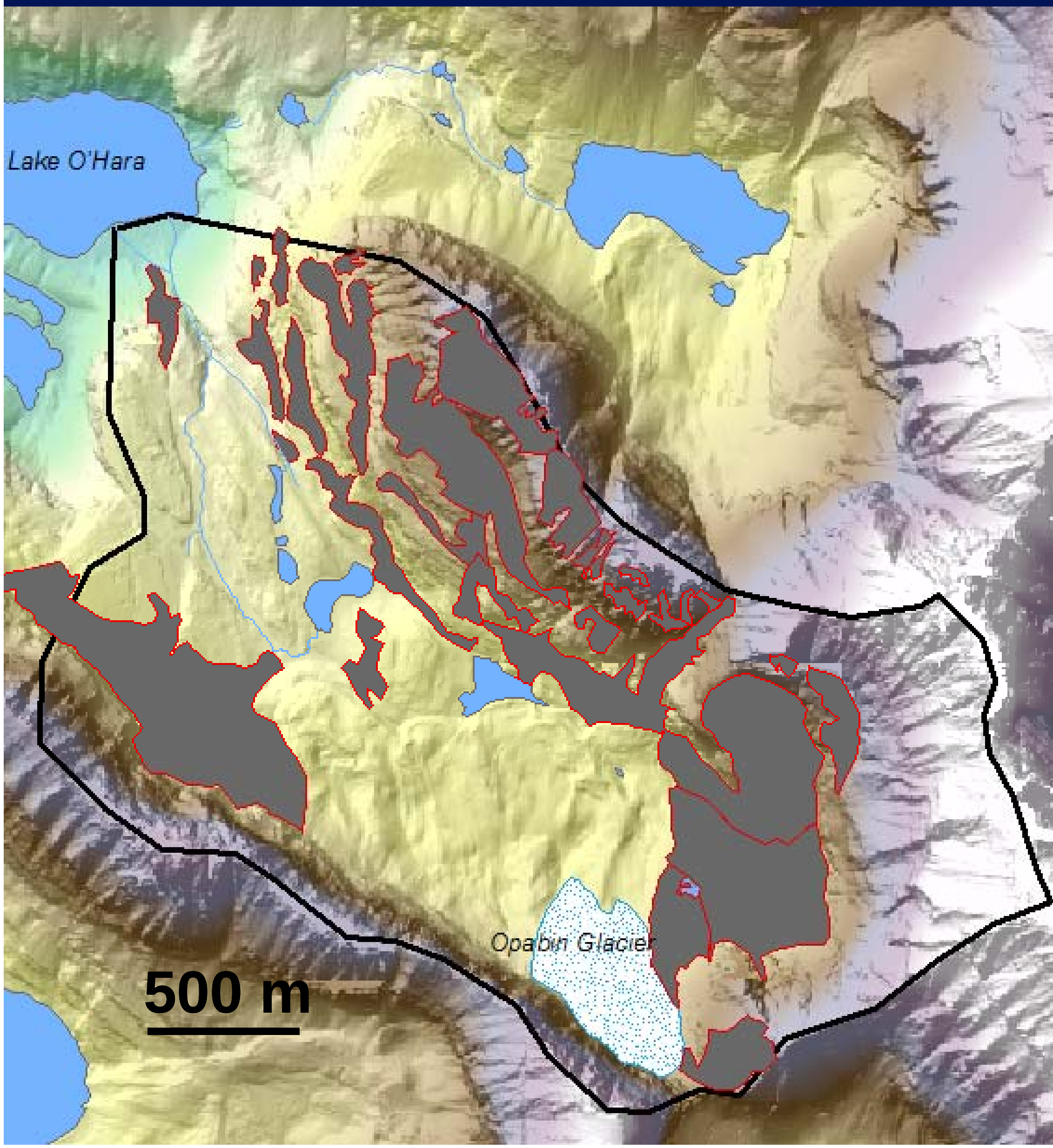
$K = 2 \times 10^{-5}$ m/s

No, it is “model-dependent” conductivity!

Lake O'Hara Research Basin
Parameterization? What? How?



Major Hydrological Land-Cover Types



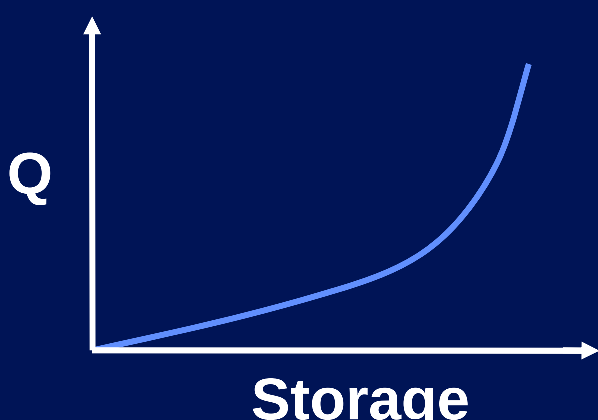
Example:
Talus slopes

From Processes to Parameterization

Field observation

physically-based model (e.g. FEM)

grid-scale function



simulation and sensitivity analysis

Take Home Messages

1. Parameterization by a detailed, “virtual” model.
2. Scale-dependent vs. model-dependent parameter.
3. Process people need to understand the equations and models VERY WELL.
4. Modellers need to make the algorithm transparent to process people:
   $\rightarrow$ Consistent with published papers.
   No arbitrary “tricks” in the code.