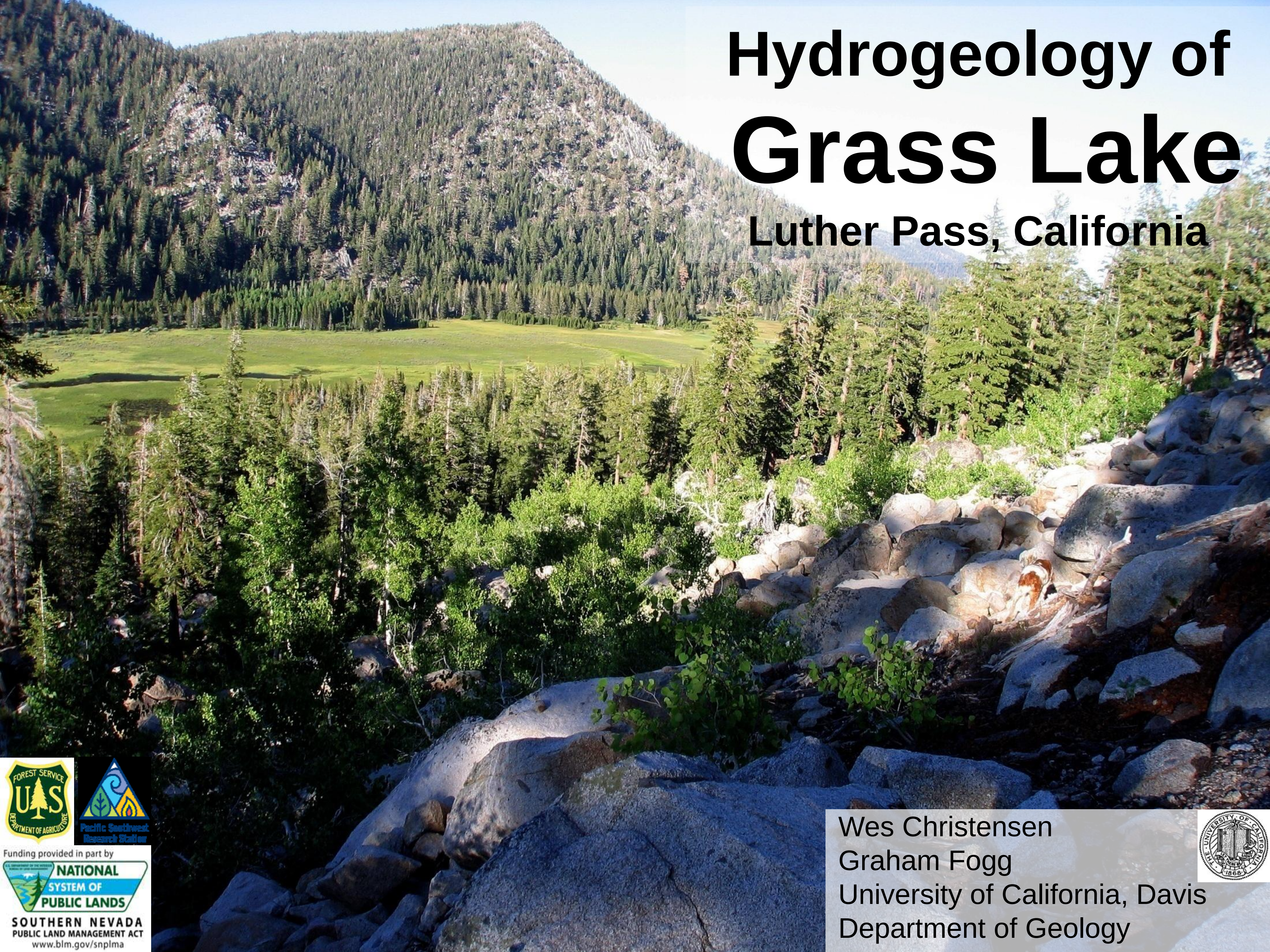

Hydrogeology of Grass Lake

Luther Pass, California

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Department of Geology

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NATIONAL SYSTEM OF PUBLIC LANDS
SOUTHERN NEVADA PUBLIC LAND MANAGEMENT ACT
www.blm.gov/snplma

Overview

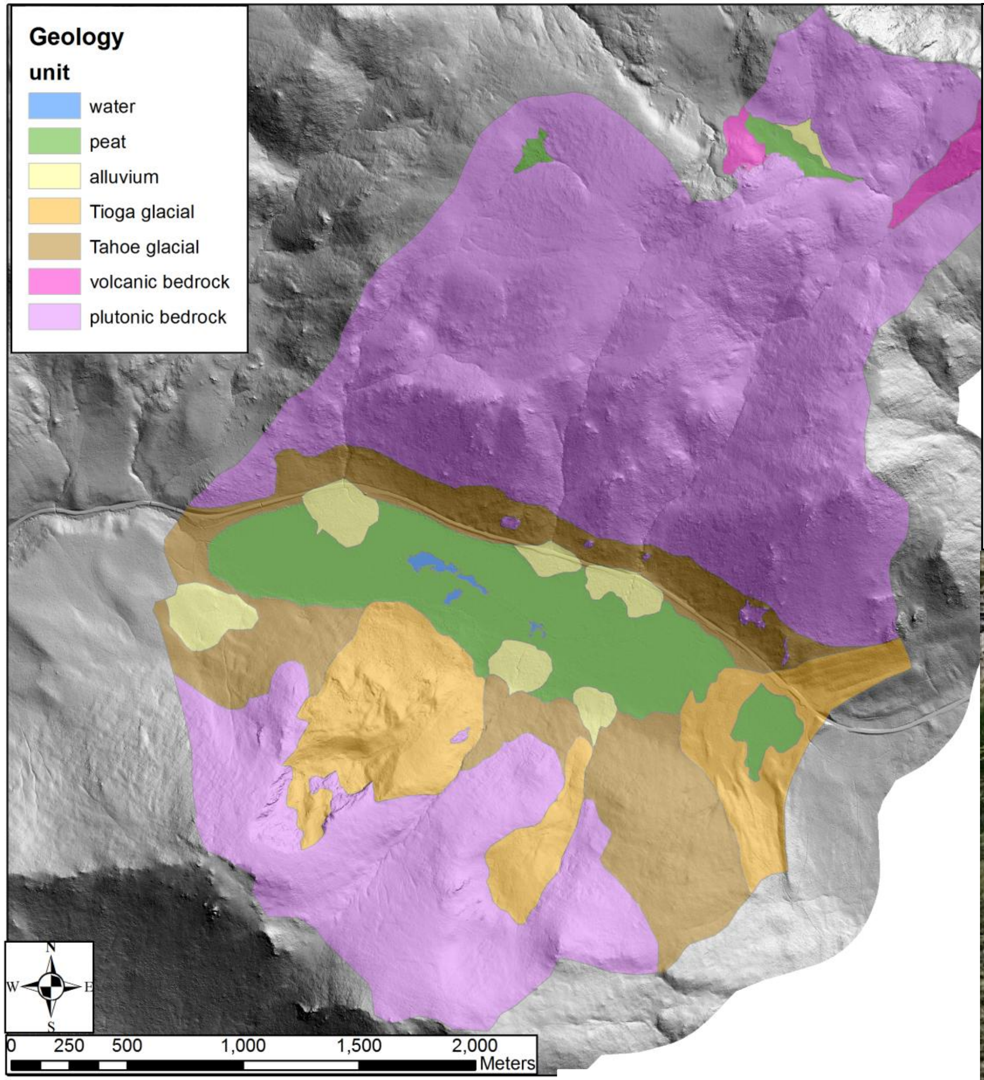
- Site description
  - Geology
  - Stream flows
  - Hydraulic gradients
  - Specific conductivity
- Modeling
  - Parameter estimations and measurements
  - Geomorphic basis for geologic unit thickness
- Watershed model

Physically Based Modeling

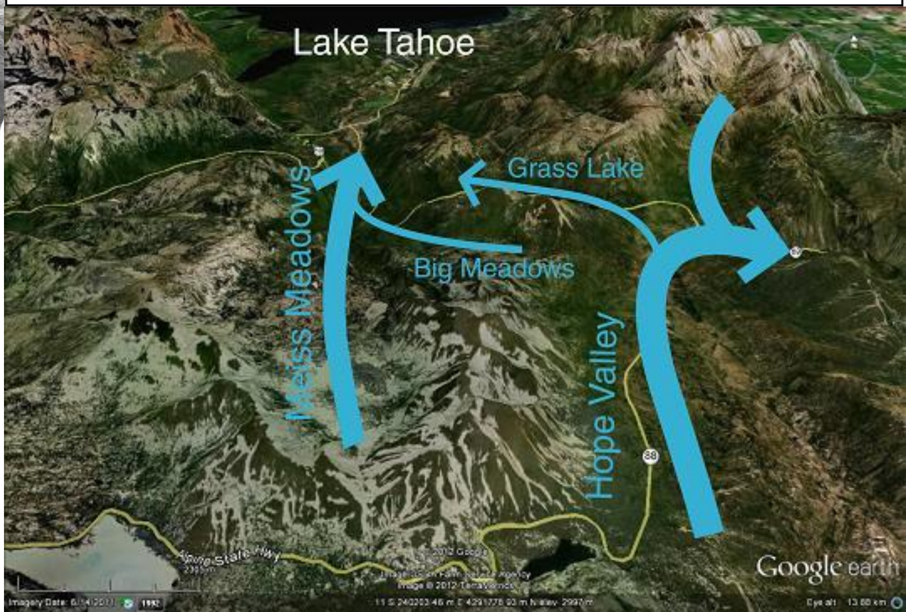
- Explore the potential response of a groundwater sustained peatland (Grass Lake) to predicted changes in climate
  - Earlier snow melt
  - Less snow, more rain on snow
- Small watershed scale (~10 km^2)
  - Local scale hydrology (~100 m^2)

- Physical parameters governing groundwater flow and storage
  - Hydraulic conductivity
  - Storage coefficients
  - Thicknesses of geologic units
- Protected "Research Natural Area"
  - NO tracer tests
  - NO pumping
  - Minimal disturbance
  - Natural T signal

Grass Lake Geology

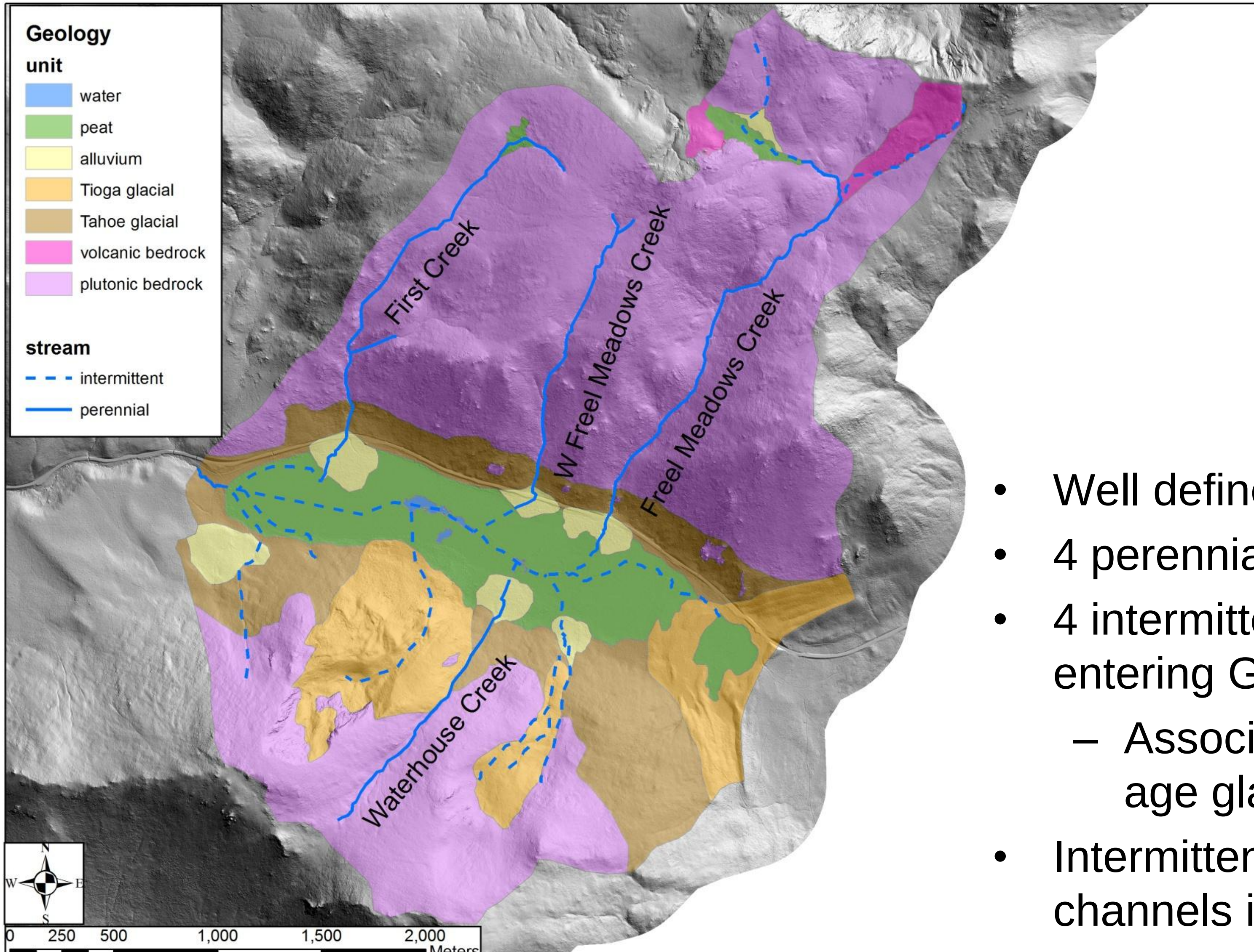


- Weathered granodiorite
- Tertiary volcanics
- Tahoe glaciation (145 ka)
  - Recessional and lateral moraines
- Tioga glaciation (19 ka)
  - Terminal and cirque moraines
- Alluvium
- Peat



Grass Lake

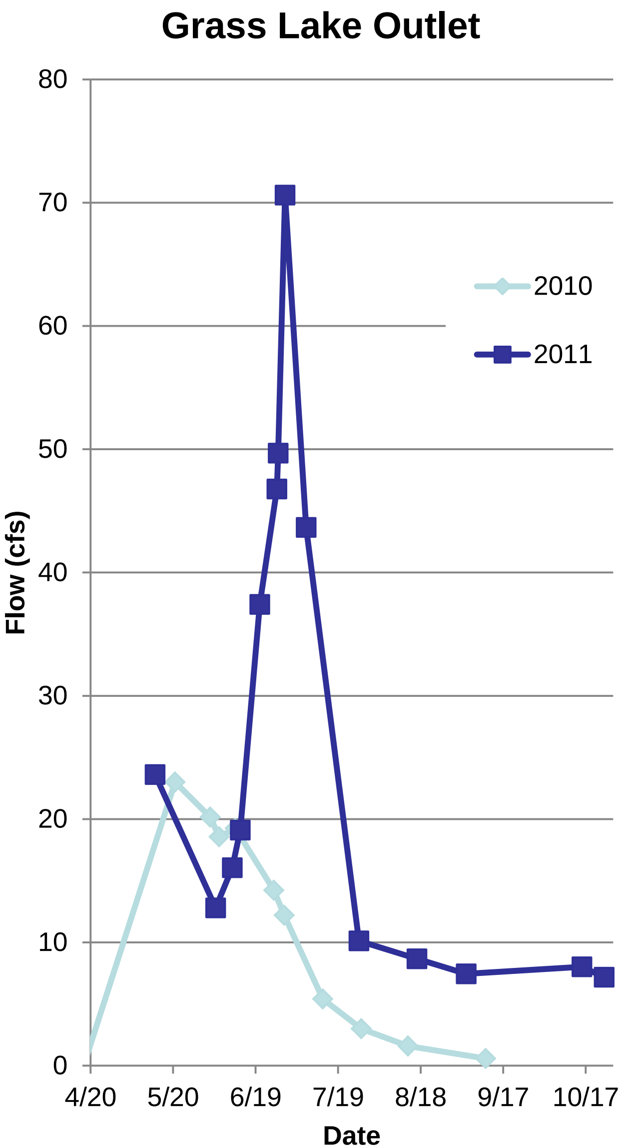
Streams

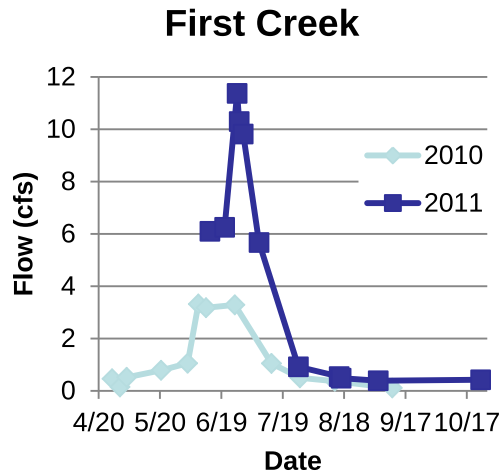


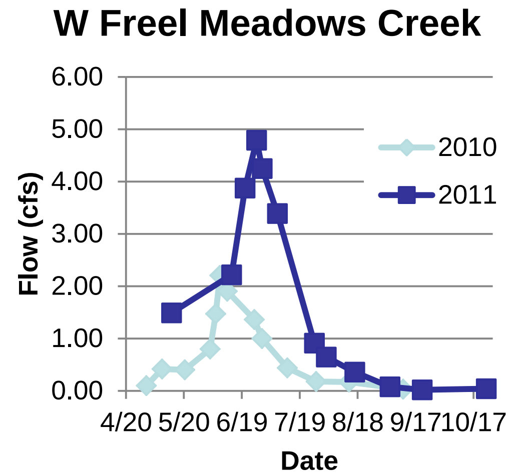
- Well defined outlet stream
- 4 perennial streams
- 4 intermittent streams entering Grass Lake
  - Associated with Tioga age glacial cirques
- Intermittent /ephemeral channels in upper WS

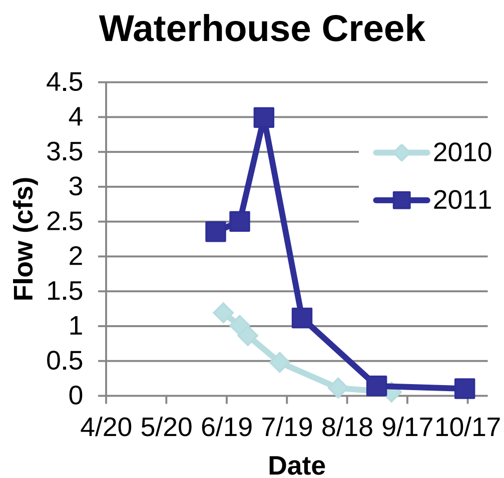
Stream Flow

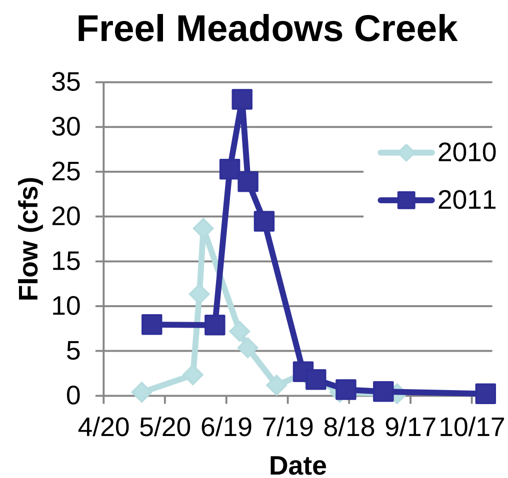
(y-axes different scale)







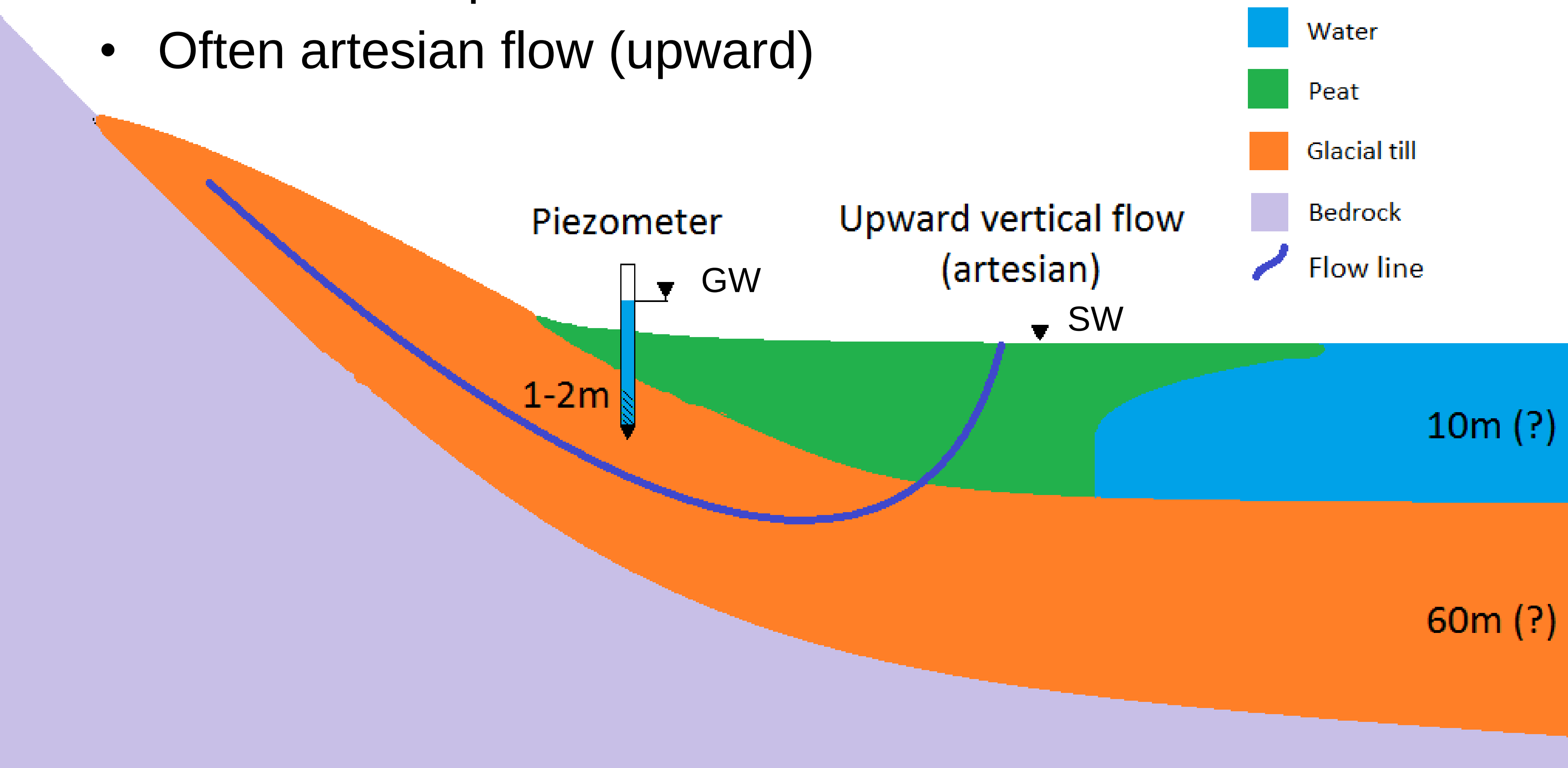




- Base flow ~ same in small creeks
  - WH Ck and WFM Ck slightly longer recession
- Outlet recession different for 2010 & 2011

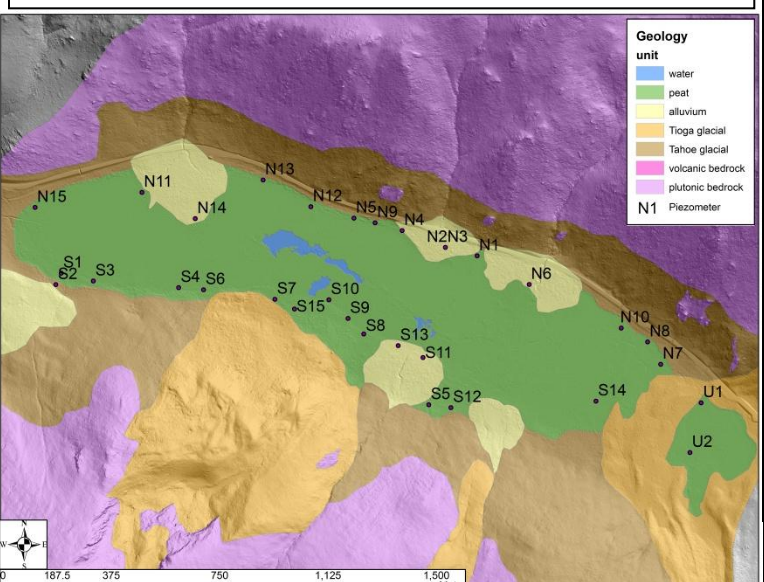
Groundwater

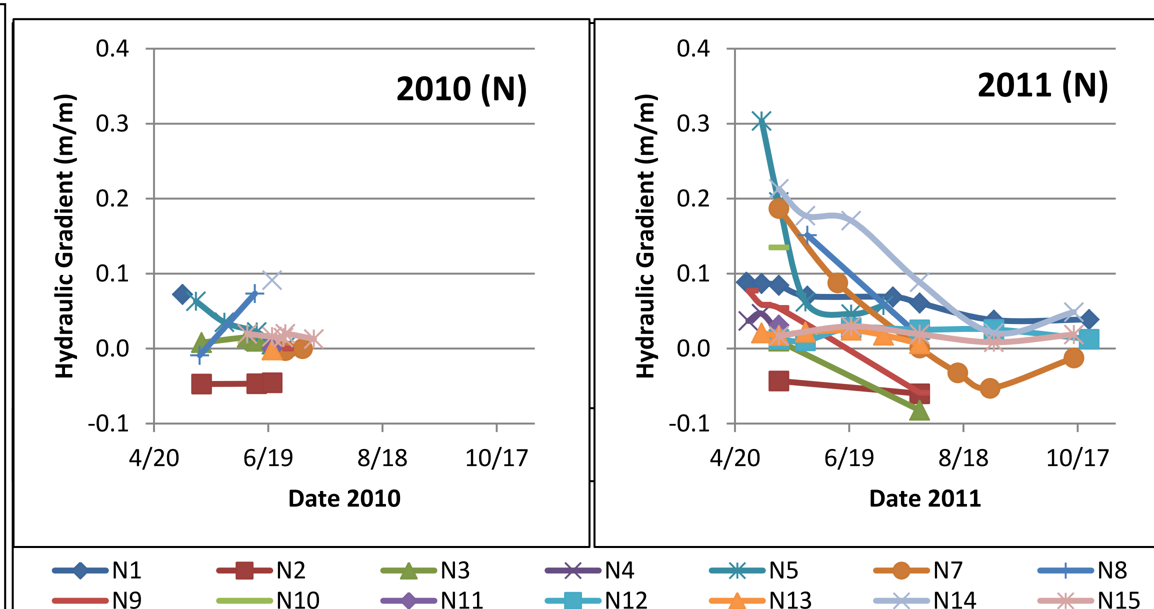
- 30 piezometers near shore
- Screened in sediment below peat
- Gradient = (GW-SW)/(DEPTH)
  - Limited to presence of SW
- Often artesian flow (upward)

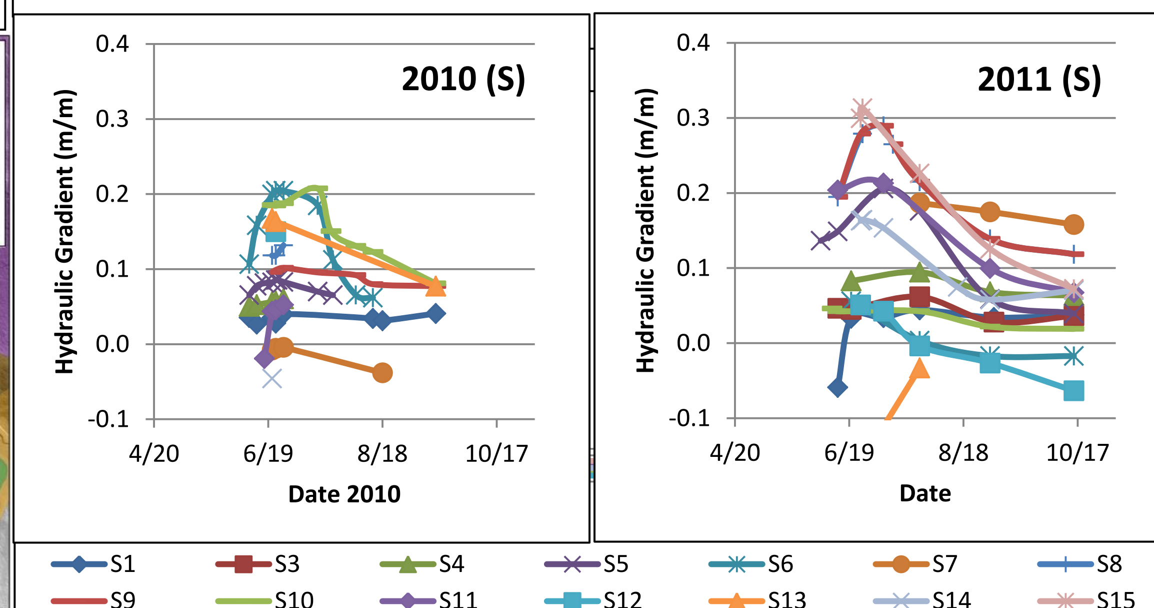


Vertical Hydraulic Gradients
(+ is upward flow)

- Gradient requires surf water
  - (GW-SW)/(DEPTH)
- High gradient over short vertical distances
- Gradient drives flow from hillslope/confined aquifer through the peat
- Gradient S > Gradient N
- N = road
- S = glacial deposits

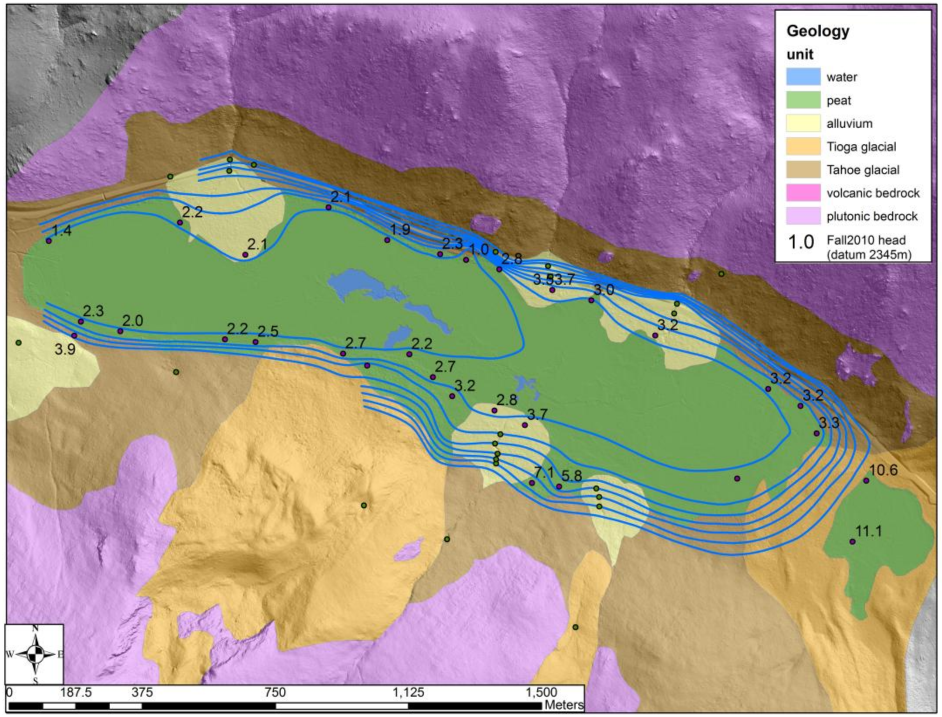




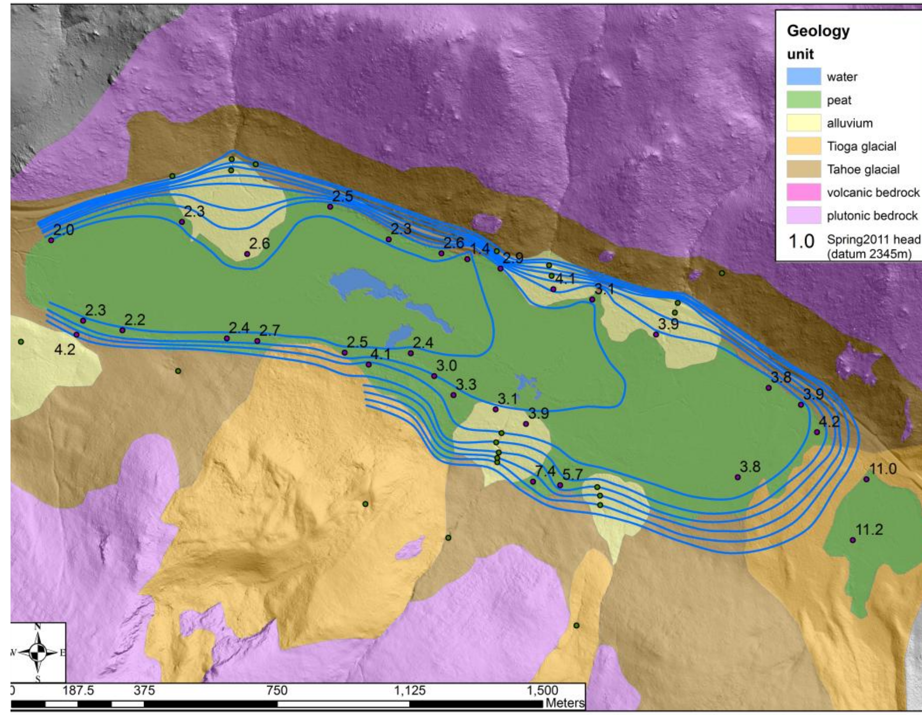


Confined Head Contours

Fall 2010 Piezometric Head



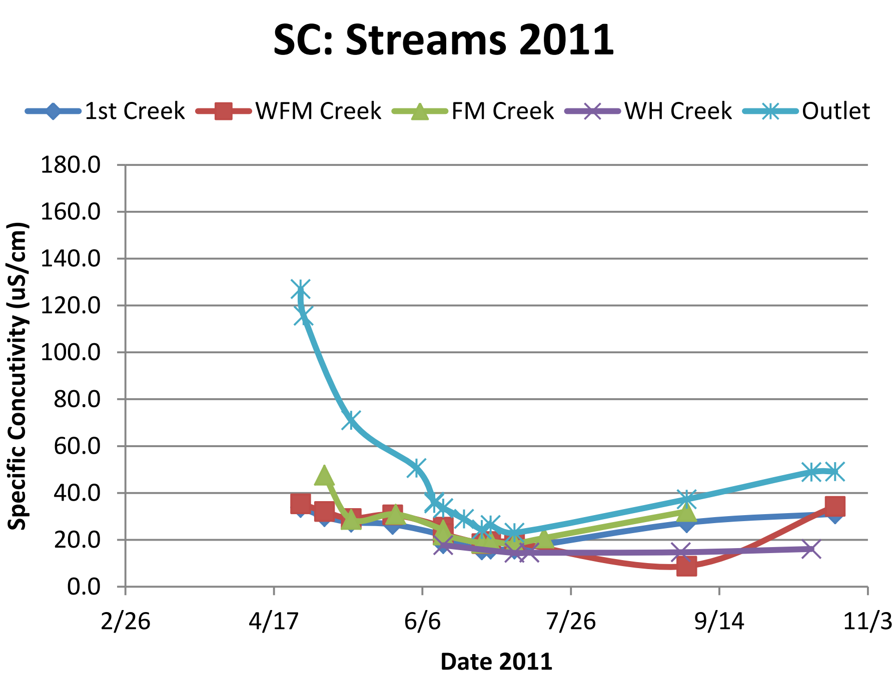
Spring 2011 Piezometric Head

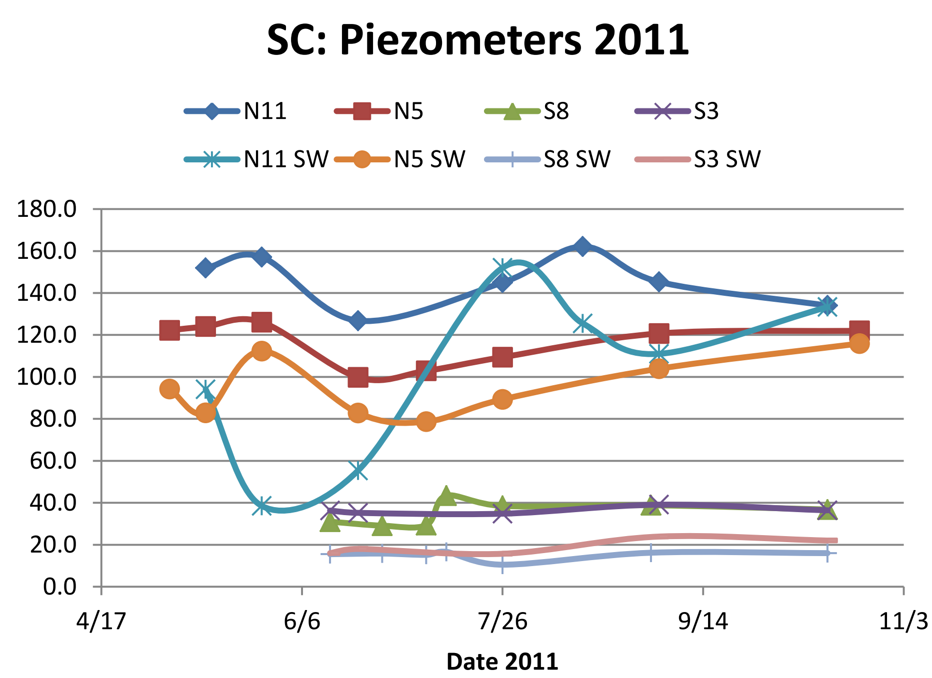


- “Shadow” effect from bedrock
- Stream influence
- Larger change along N than S
  - 0.1 to 0.9m change in N
  - 0.1 to 0.3m change in S

Specific Conductivity

- North GW >> (South GW ~ Streams)
- (South GW > South SW) ~ Streams
- Dilution of GW and SW from snowmelt

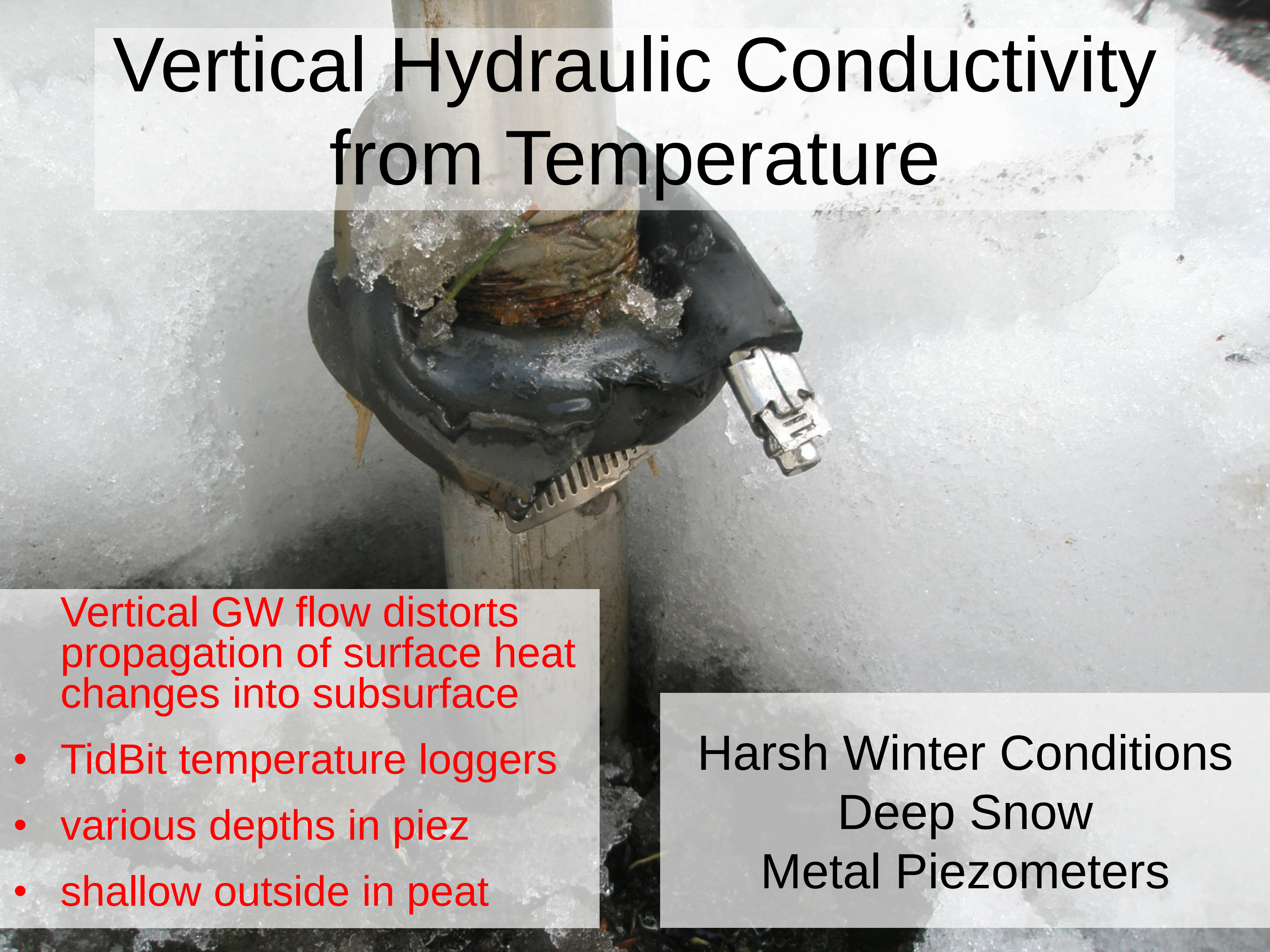




Parameter Estimation

- Vertical hydraulic gradients sensitive to K_{sat}(peat)
  - Can be determined using vertical T profiles and head
- Recession of Outlet flow sensitive to peat water retention
- Recession of stream flows sensitive to hillslope transmissivity and storage (K_{sat} and thickness)

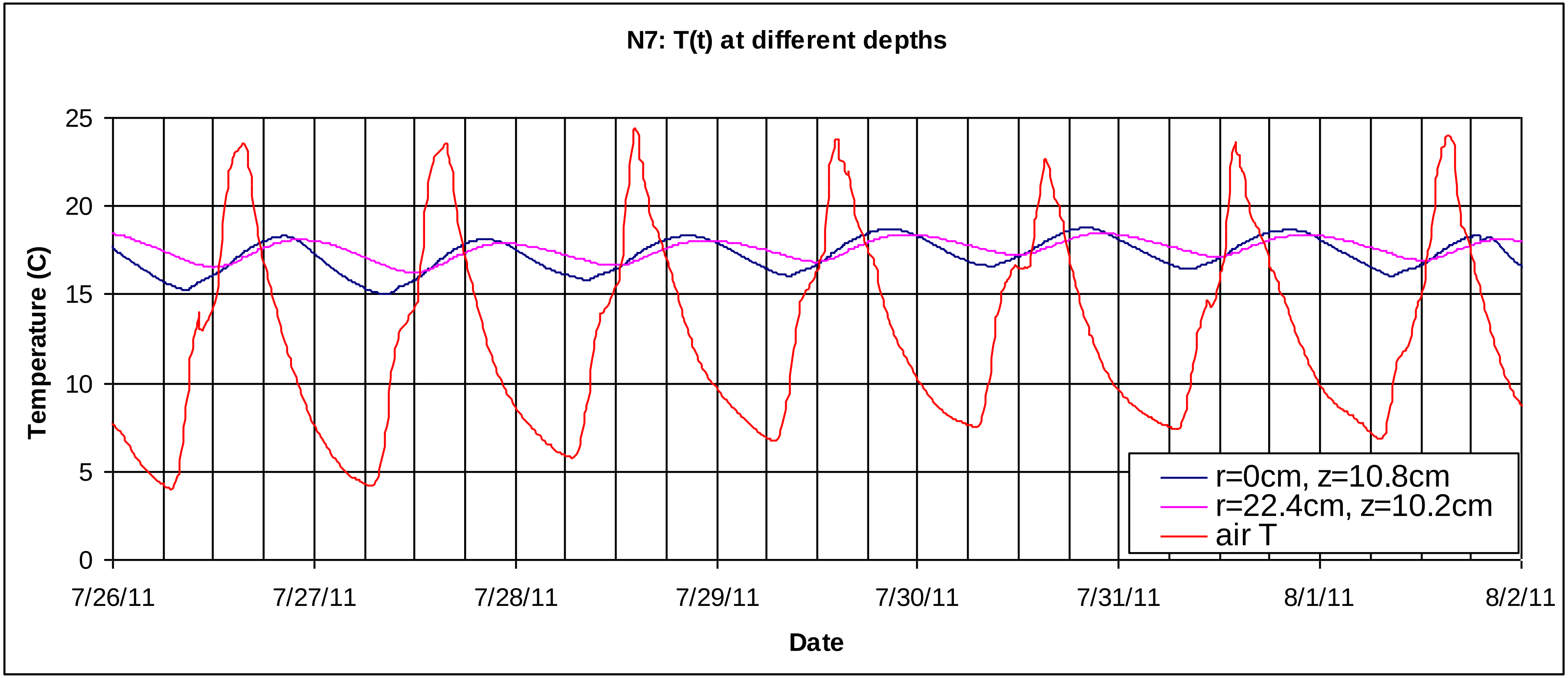
Vertical Hydraulic Conductivity from Temperature



- Vertical GW flow distorts propagation of surface heat changes into subsurface
- TidBit temperature loggers
- various depths in piez
- shallow outside in peat

Harsh Winter Conditions
Deep Snow
Metal Piezometers

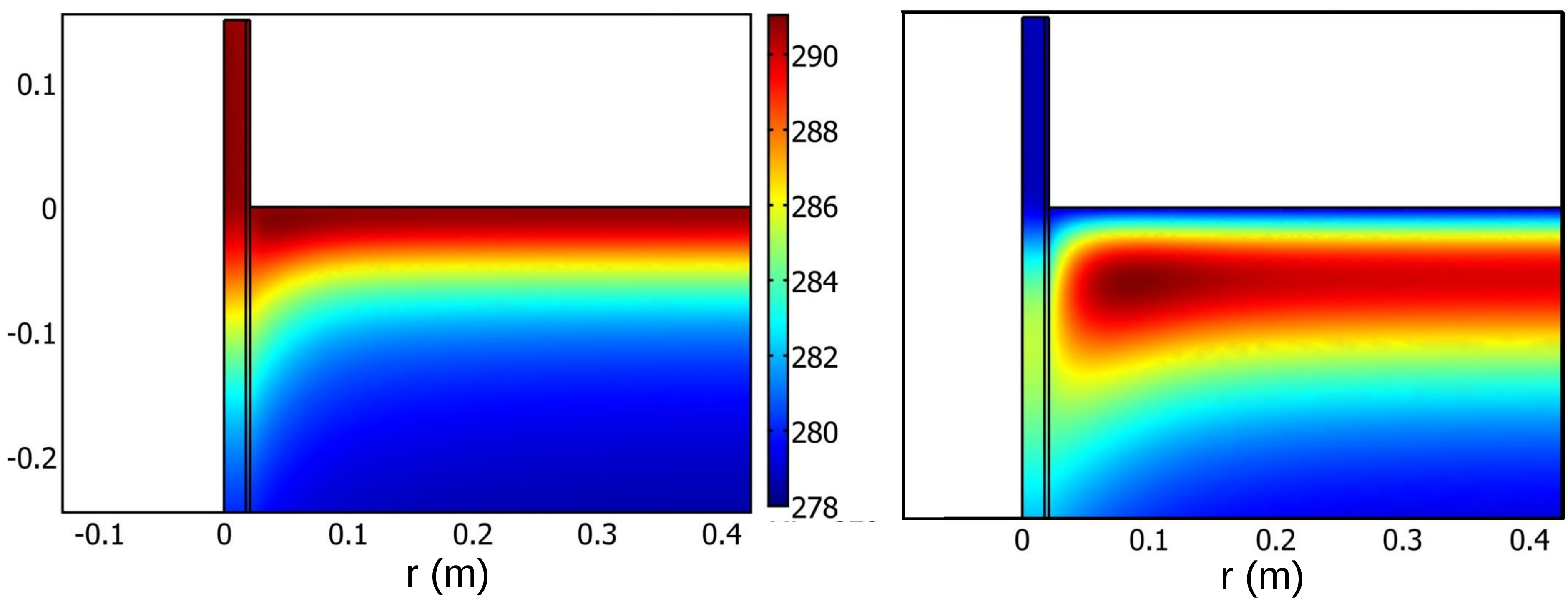
Temperature Observations



- Maximum T is delayed in both piez and peat relative to air T (~7-10 hours)
- Minimum T in piez is delayed relative to minimum air T (~1 hour)
- Minimum T in peat is delayed relative to air T and piez T (~5 hours)
- **Obvious difference between T signal in piezometer and in peat**

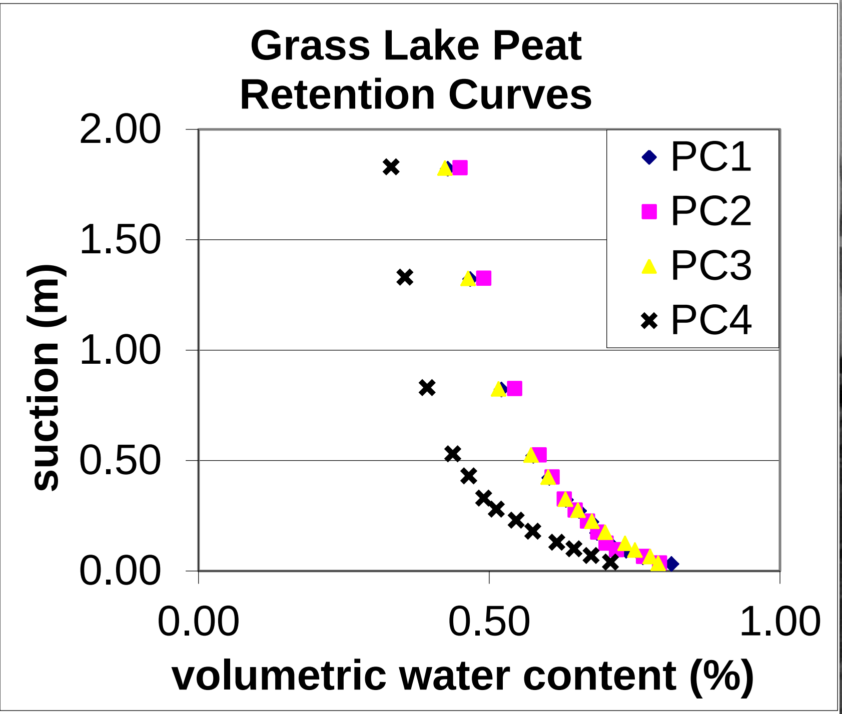
Effects of Metal on Temperature

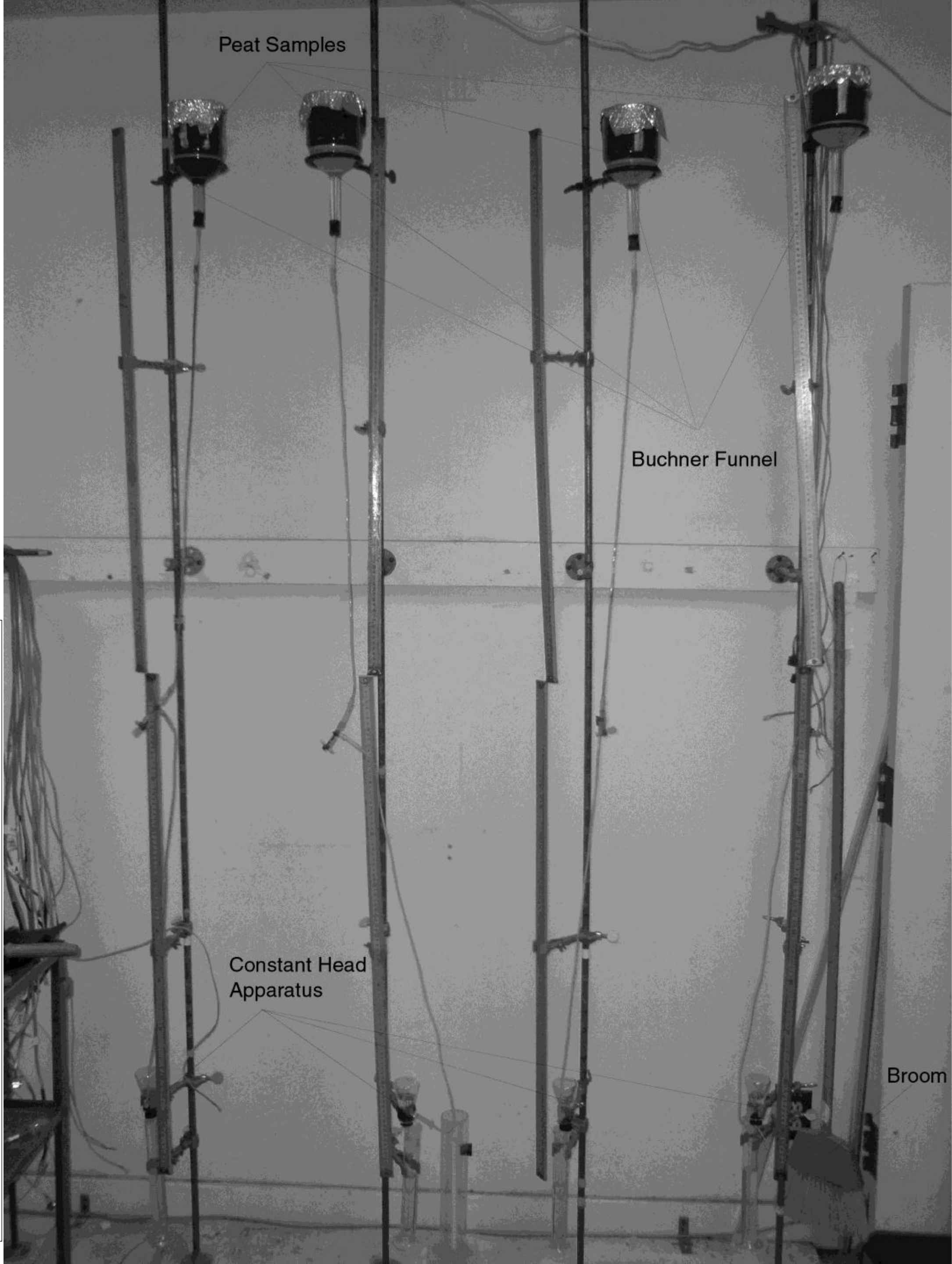
- Thermal Conductivity of metal 16 W m^{-1} K^{-1}
- Thermal conductivity of peat < 0.5 W m^{-1} K^{-1}
- At ~10 cm T_{inside} ~ 4°C higher than $T_{outside}$
- Max T_{inside} earlier than Max $T_{outside}$
- Significantly affects parameter estimates



Peat Water Retention

- Hanging water column
- Spec suction head to 1.5m
- Saturated water content ~80%
- Water content at 0.5m ~60%
- PC4 was the most decomposed sample





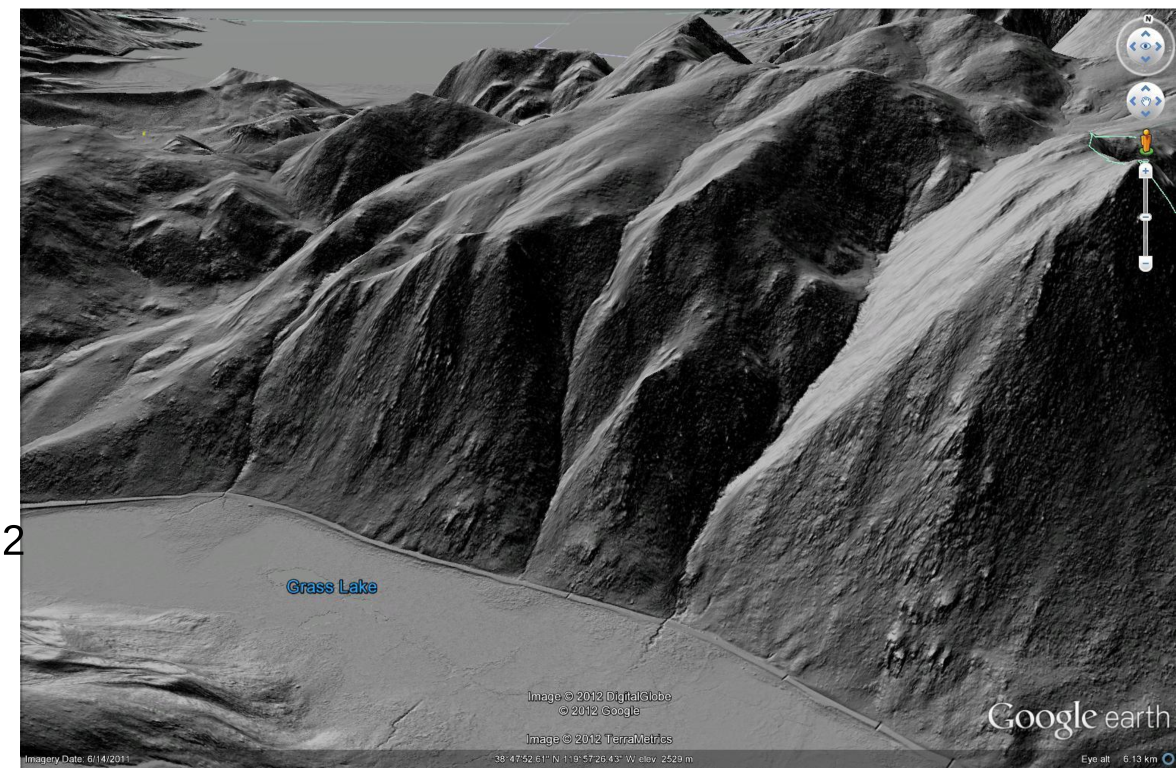
Shallow Subsurface Thickness

- Down cutting of streams in upper WS in response to glaciers
  - 80+m thick weathered bedrock (grus)
- Projection of glaciated bedrock surface
  - 5 to 40m thick glacial till
- Electrical Resistivity Imaging (Doug Clark, unpub.)
  - 80m thick valley fill (peat surface to bedrock)
- Probes and ERI
  - 0 to 10m thick peat
- Lidar Data was INDESPENSIBLE

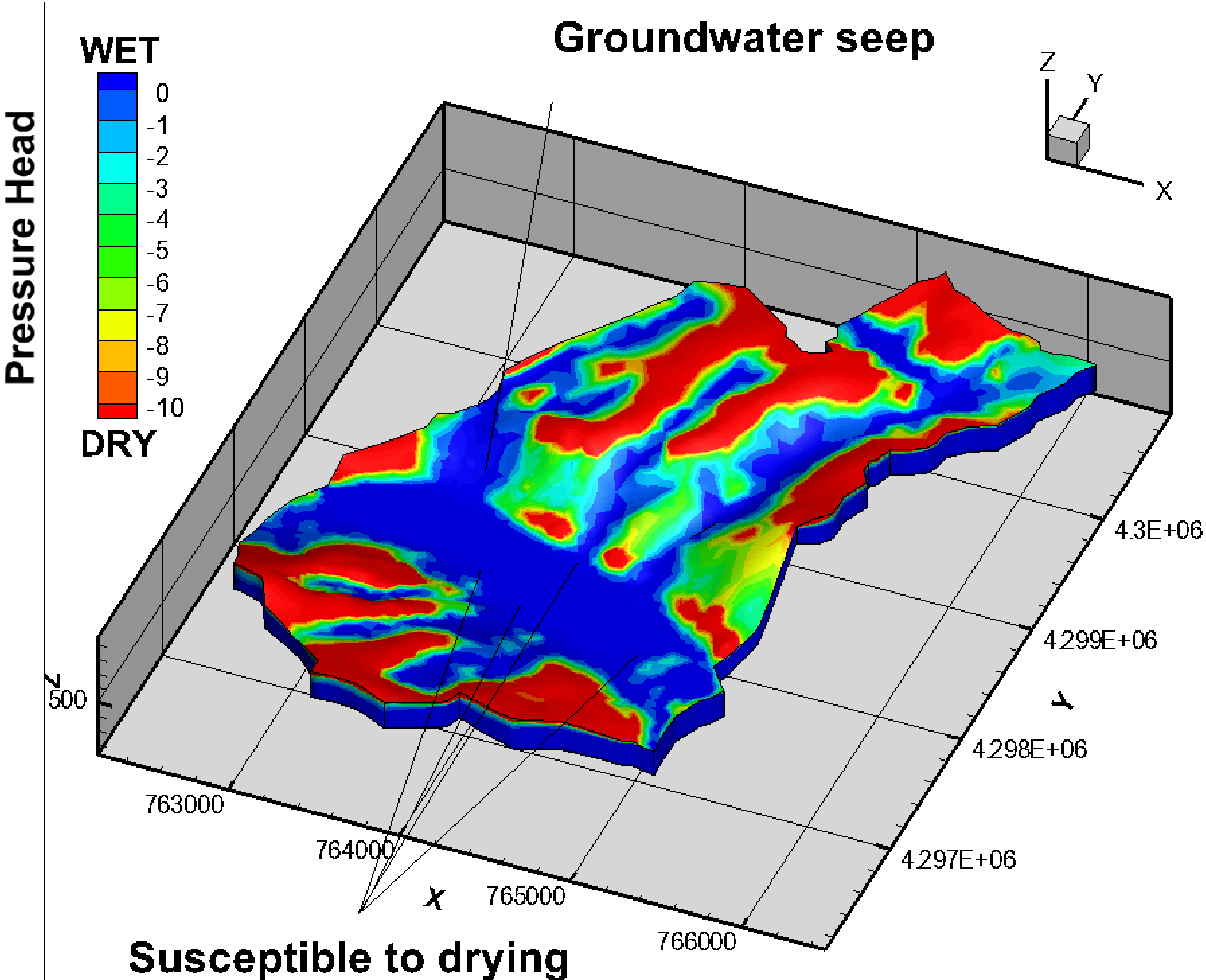
  \- Provided by

Tahoe Regional Planning Agency

http://dx.doi.org/10.5069/G9PN93H2



Watershed Model



Hydrogeosphere

Fully coupled SW-GW flow

1m of surface recharge

Drain for 6 month

Acknowledgements

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