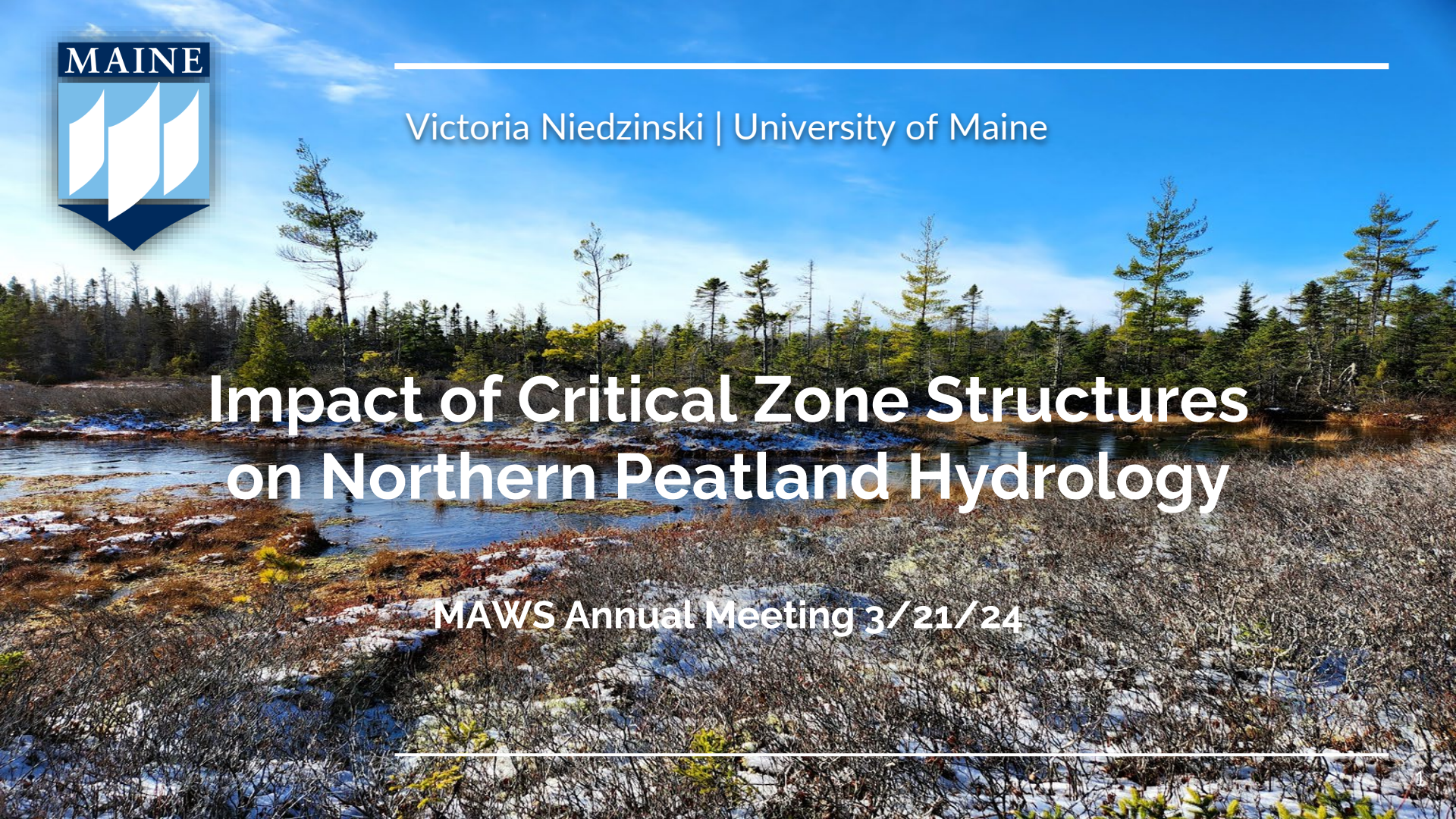

Victoria Niedzinski | University of Maine

Impact of Critical Zone Structures on Northern Peatland Hydrology

MAWS Annual Meeting 3/21/24

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Advisor:

Dr. Andy Reeve

Field assistance:

Angelina Bucco; Orion-Bay Tucker; Shawn Snyder

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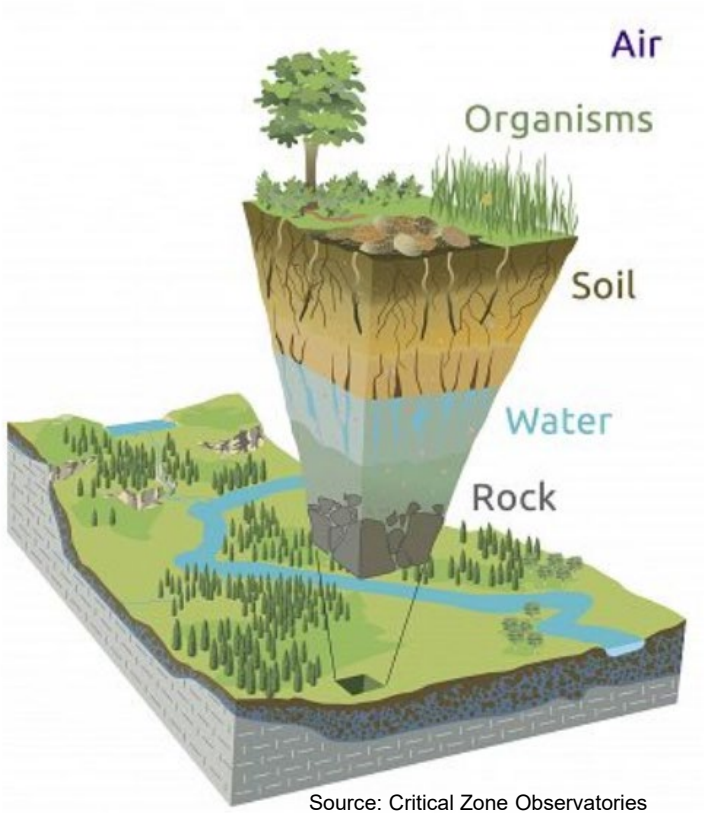
Josh Woods, Danny Woods, Travis Howard

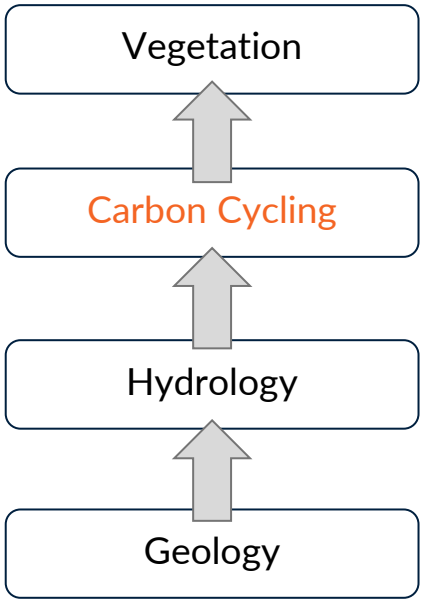
Research Question:

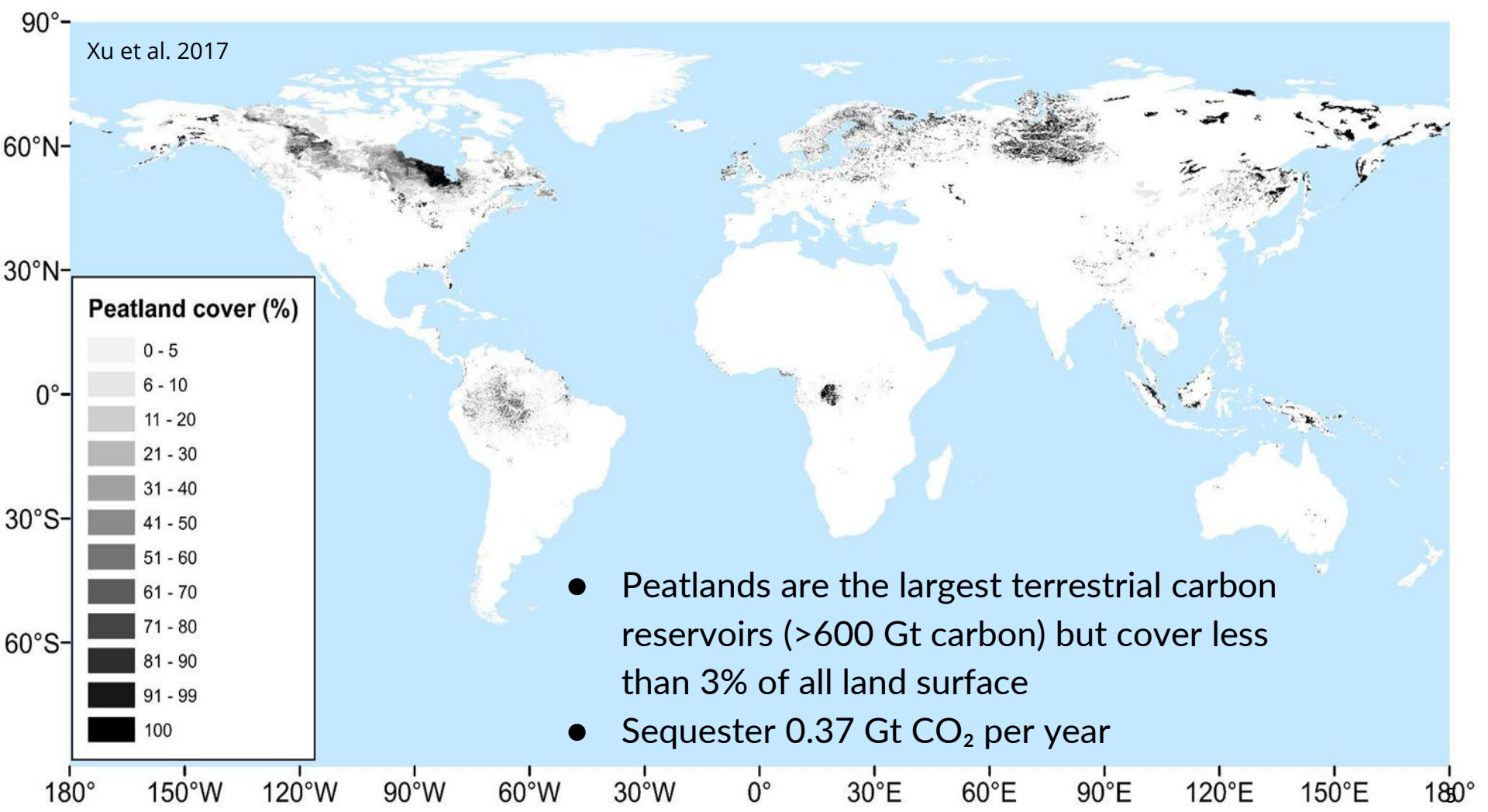
What is the role of buried permeable deposits within Maine's Peatlands on groundwater interactions and carbon cycling?



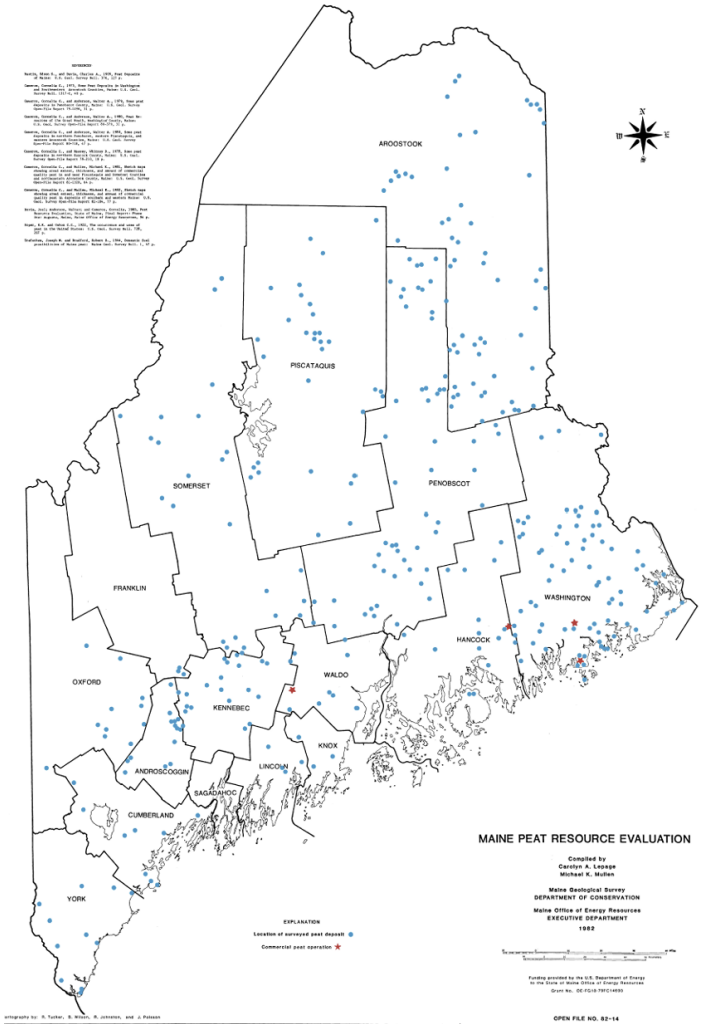
Source: Critical Zone Observatories

"How does the critical zone influence climate?" (NAS, 2020)



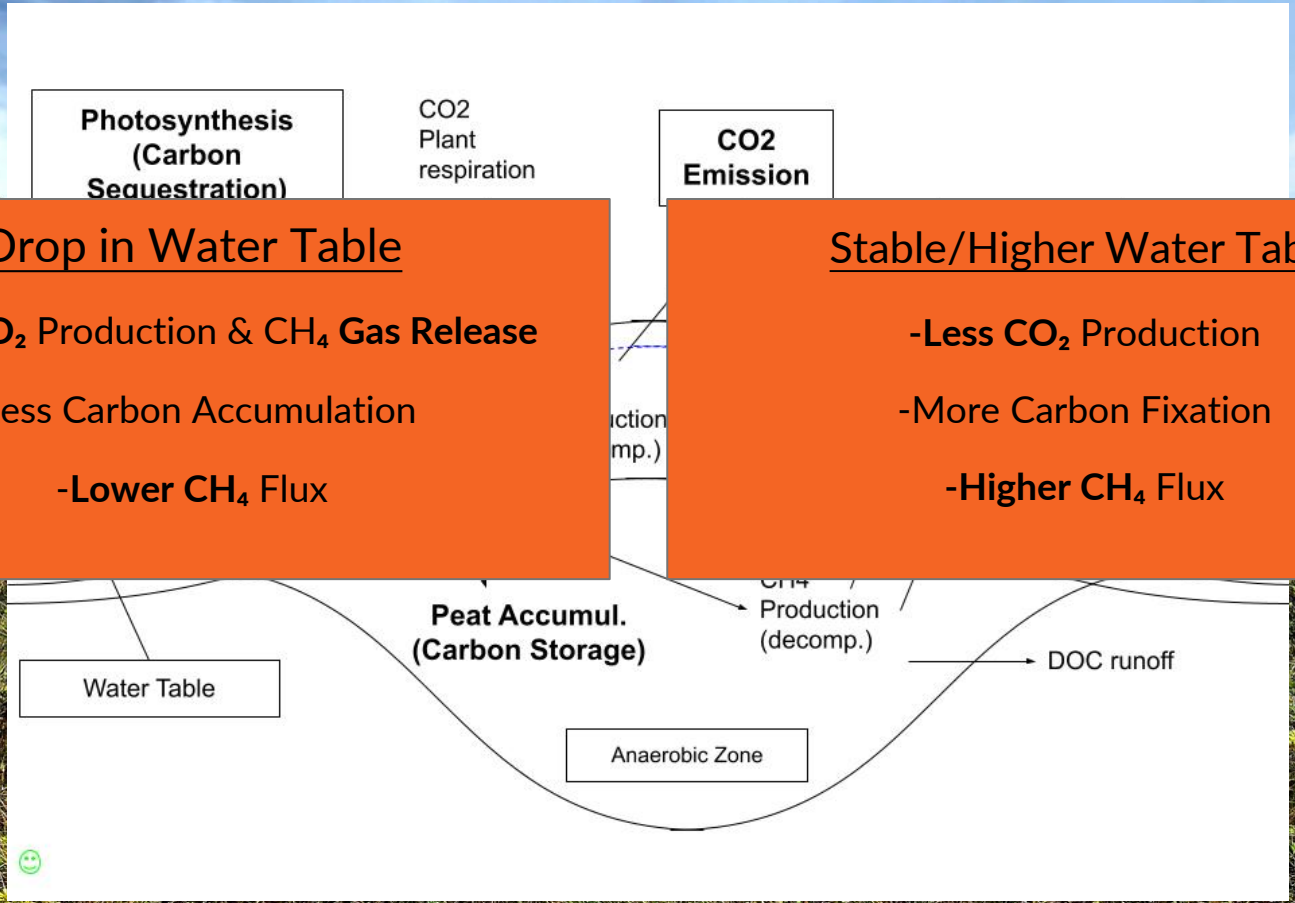


- Peatlands are the largest terrestrial carbon reservoirs (>600 Gt carbon) but cover less than 3% of all land surface
- Sequester 0.37 Gt CO_2 per year



- Maine contains 6,000-8,000 peat deposits within an estimated 250,000 acres of wetlands (Bai et al. 2016)

- According to the 2016 State of Maine Carbon Budget, wetlands act as a net carbon sink containing ~257 Mg C/acre
  - In comparison:
  - Agriculture soil ~77 MgC/acre
  - Forests ~122 MgC/acre
  - Salt Marshes ~140 MgC/acre



Drop in Water Table

-**More CO_2** Production & CH_4 **Gas Release**

-Less Carbon Accumulation

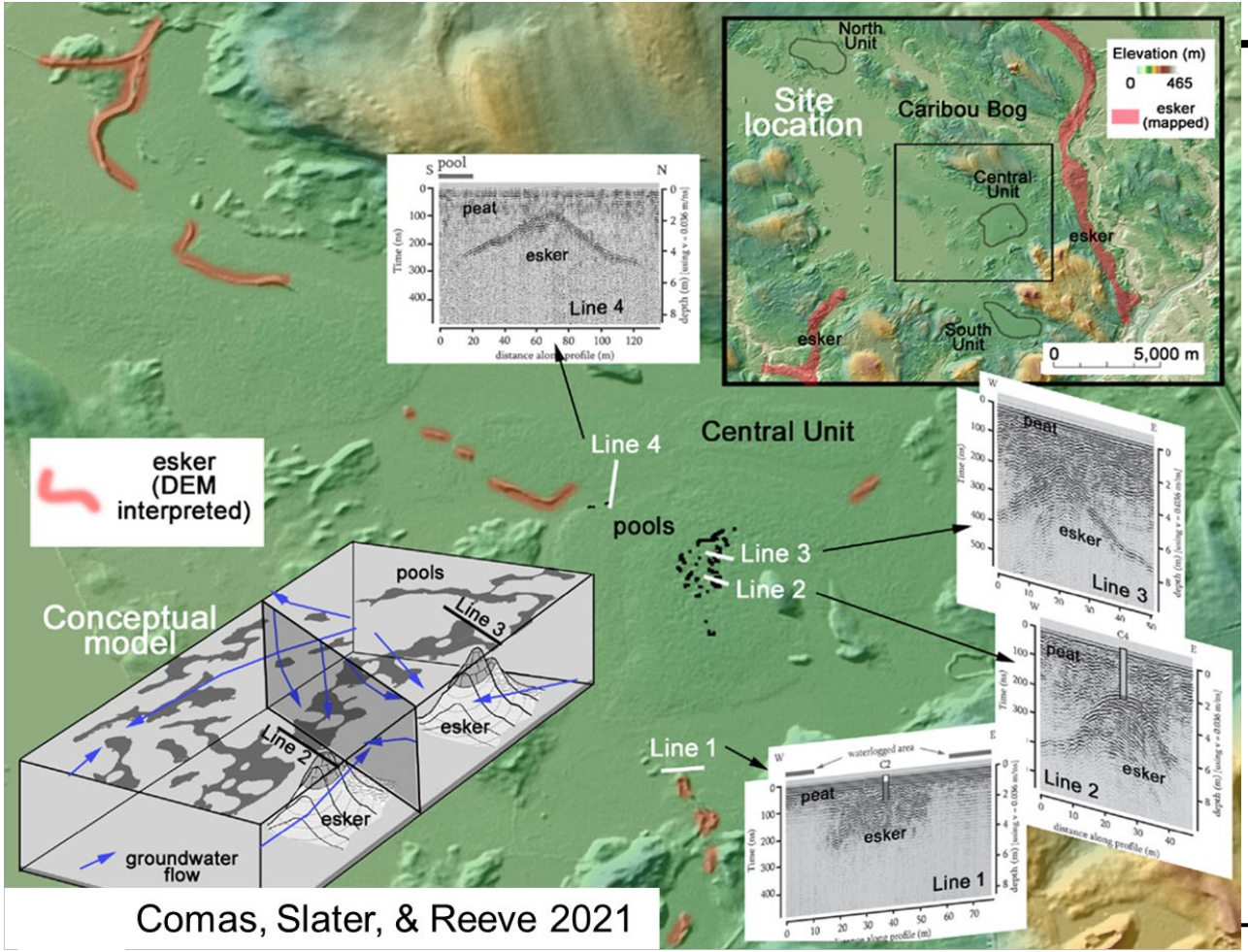
-**Lower CH_4** Flux

Stable/Higher Water Table

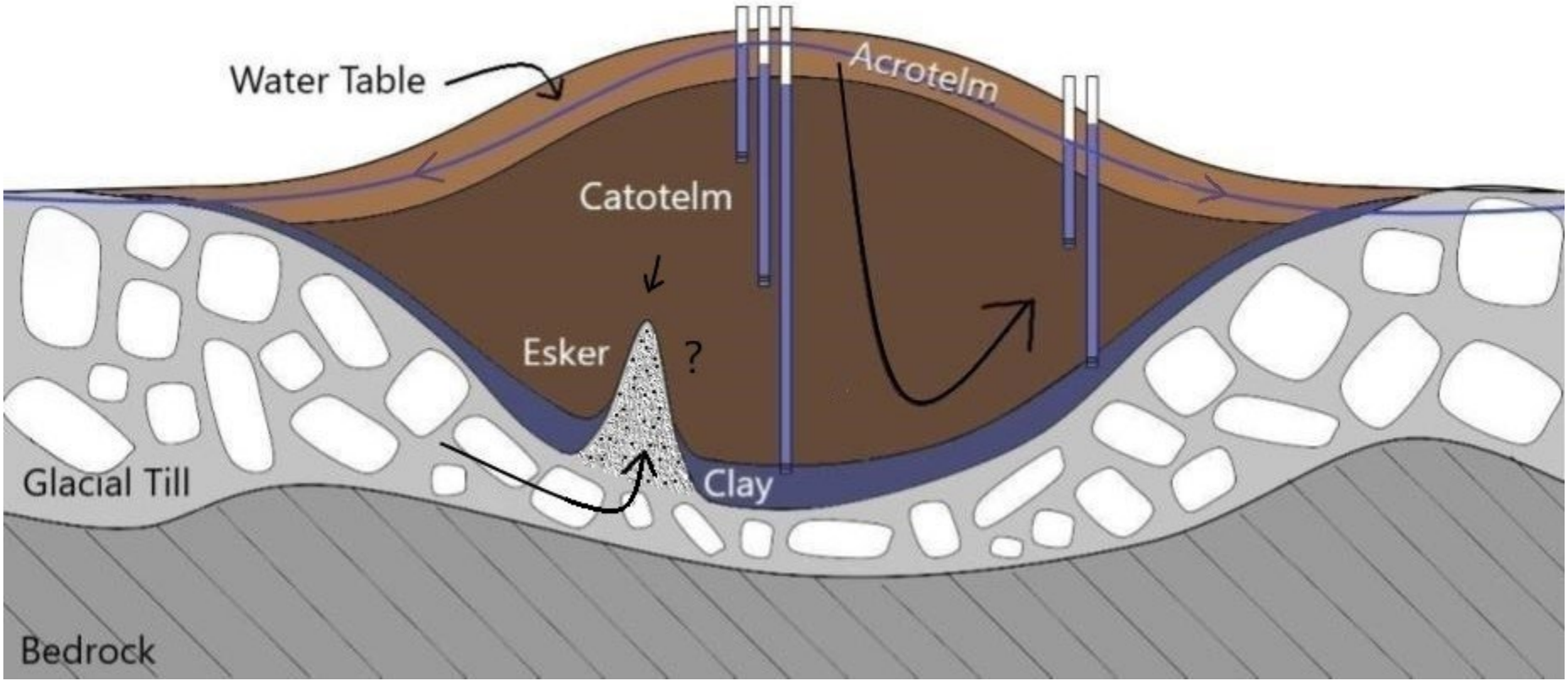
-**Less CO_2** Production

-More Carbon Fixation

-**Higher CH_4** Flux

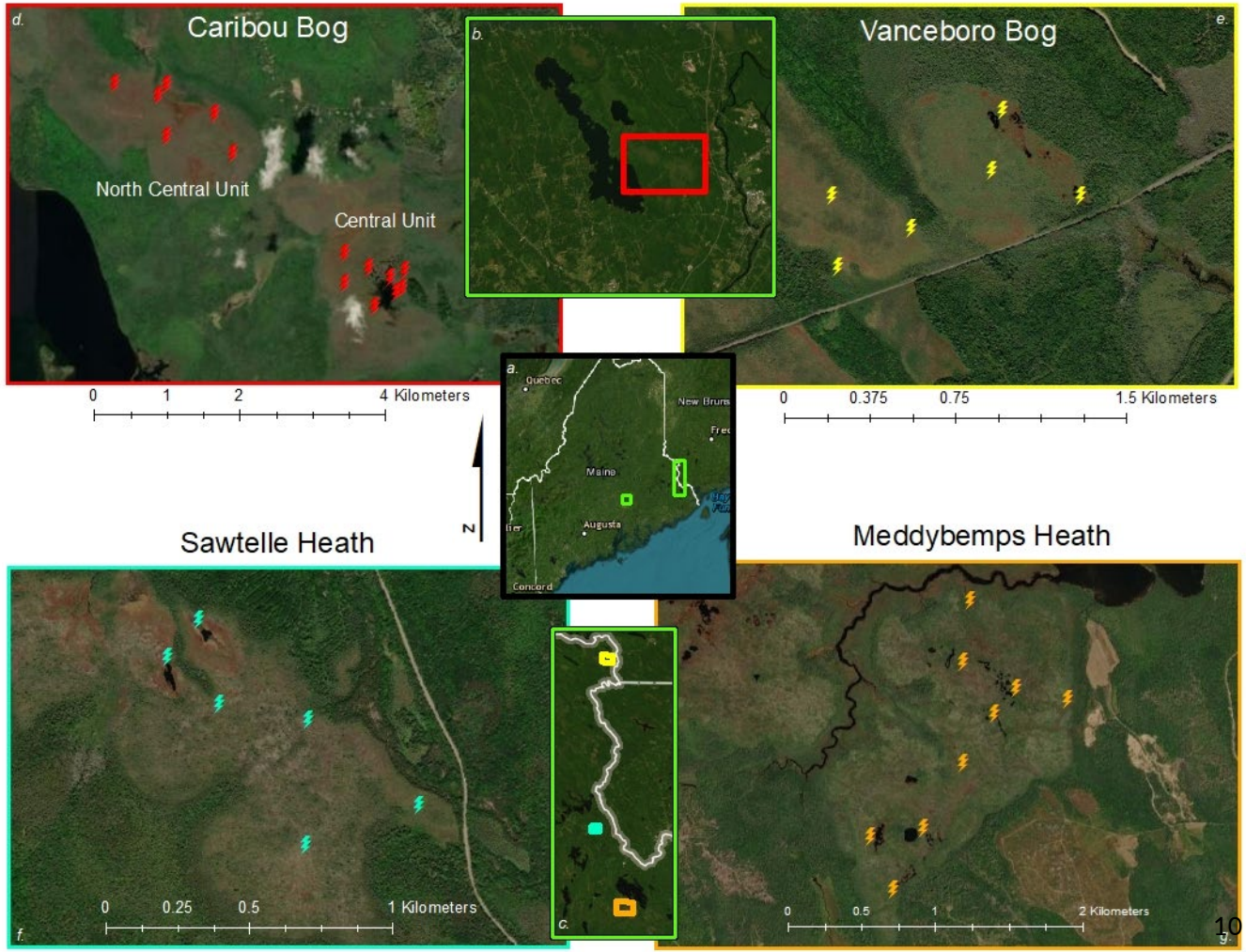


Buried eskers have been found to act as primary controls in Caribou Bog hydrology which influence pool formation, geochemical hotspots, and vegetation gradients (Chen et al. 2020)


Water Table
Acrotelm
Catotelm
Esker
?
Glacial Till
Clay
Bedrock

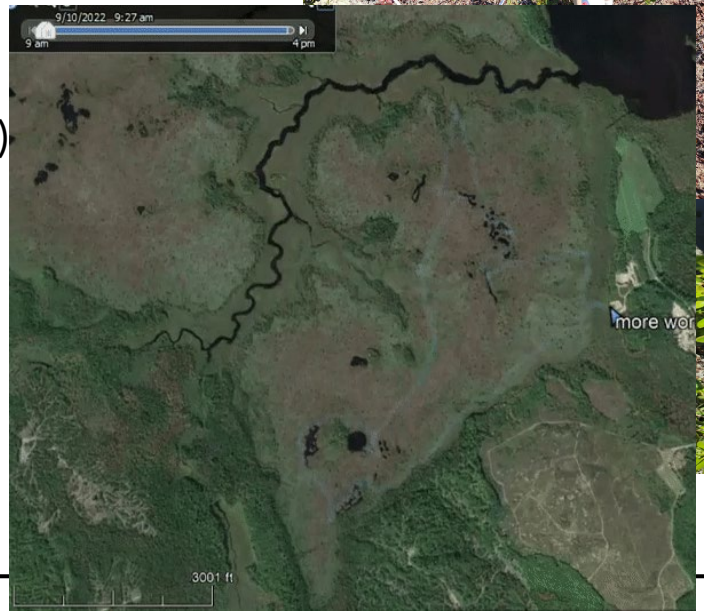
Study Area

Indicates a well location



Field Methods

- Installed 28 new well clusters
- Manual water levels
- Deployed Leveloggers
- GPS locations and elevation
- Specific conductance (µS/cm)
- Slug Testing (measure K)
- Peat Cores
- GPR imagery



Geospatial Datasets

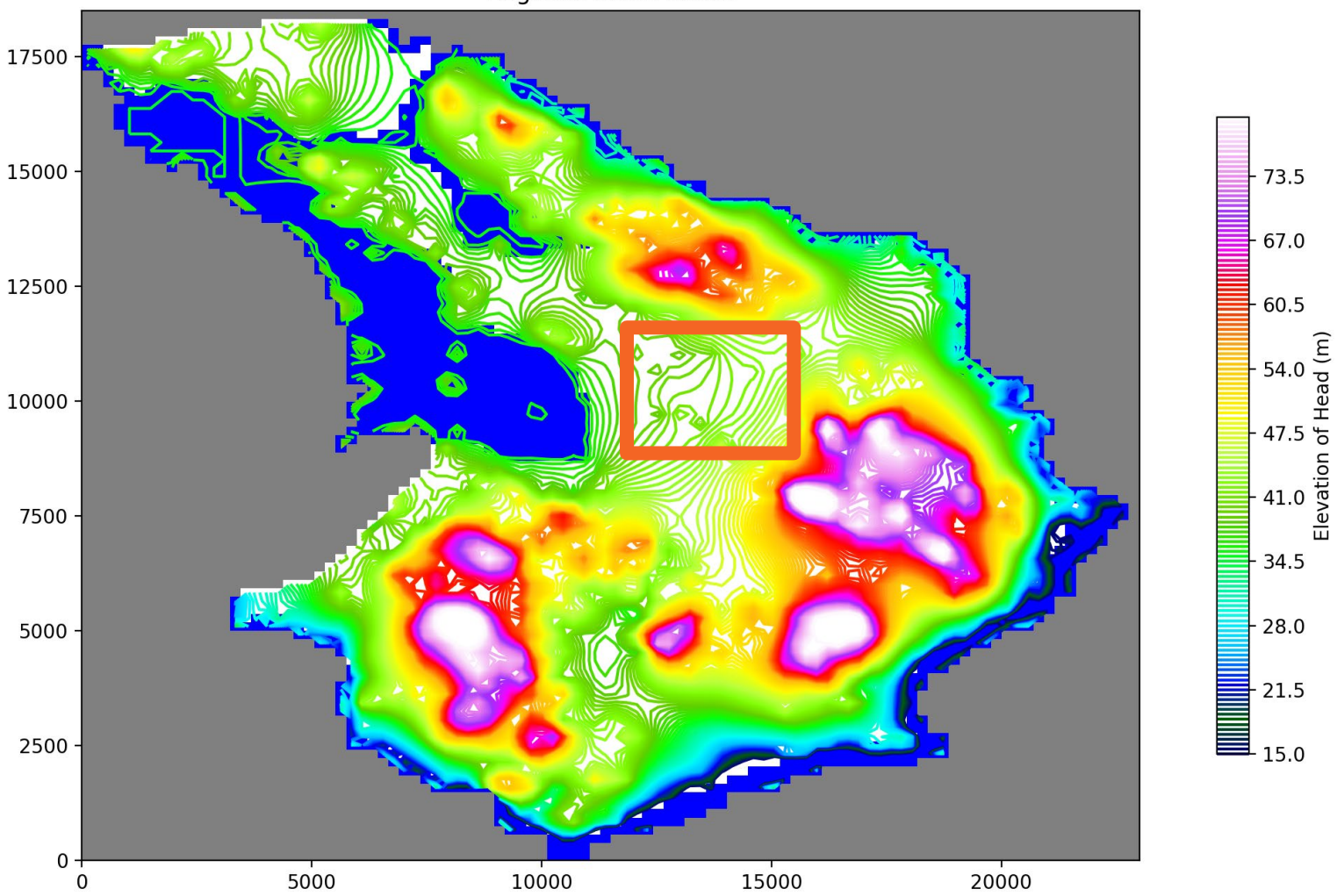
Downloaded Geospatial Datasets:

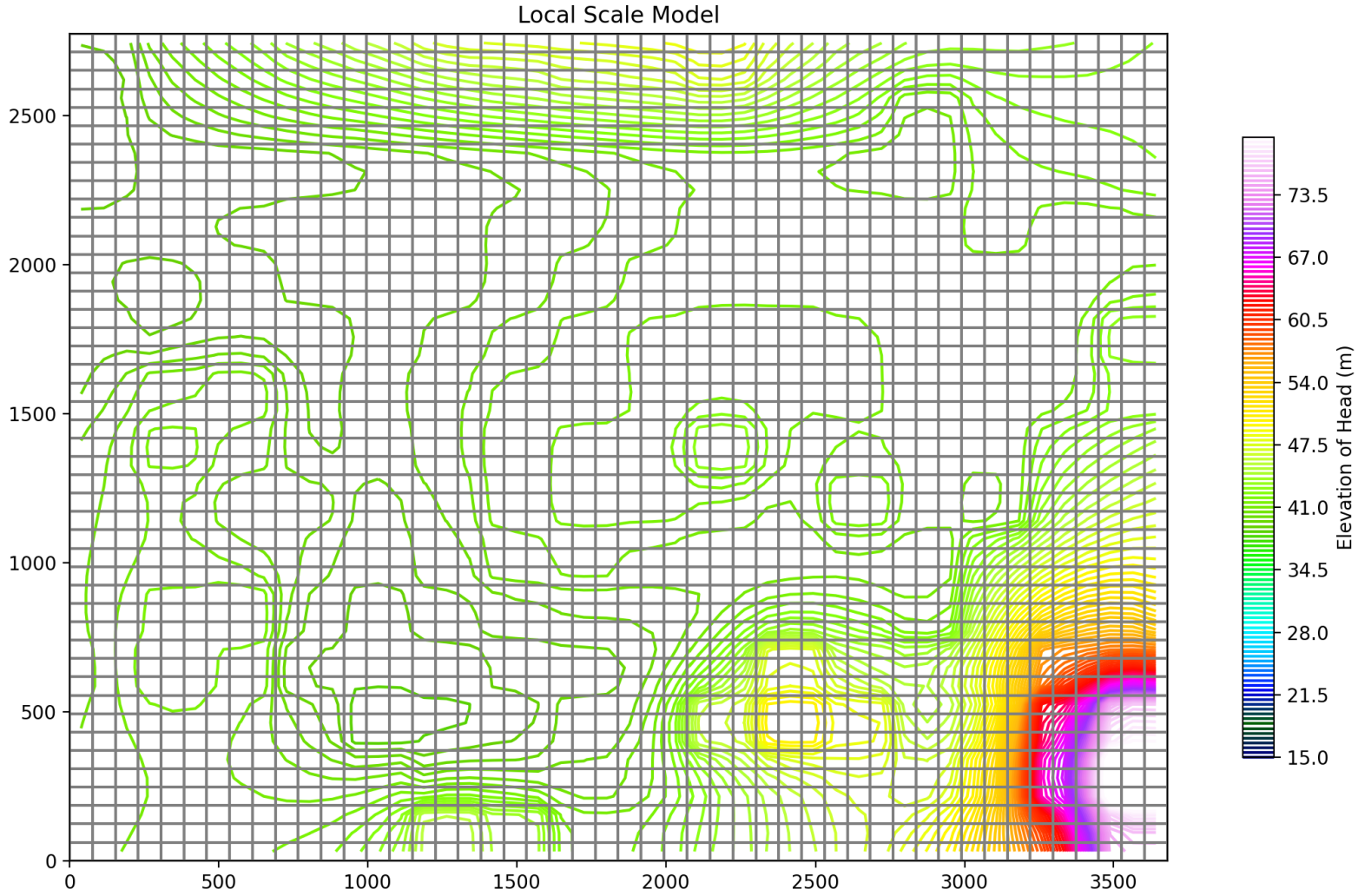
- DEM
- Surface Water
- Surficial and Bedrock Geology
- Soil-Water Balance
- Evapotranspiration
- Precipitation

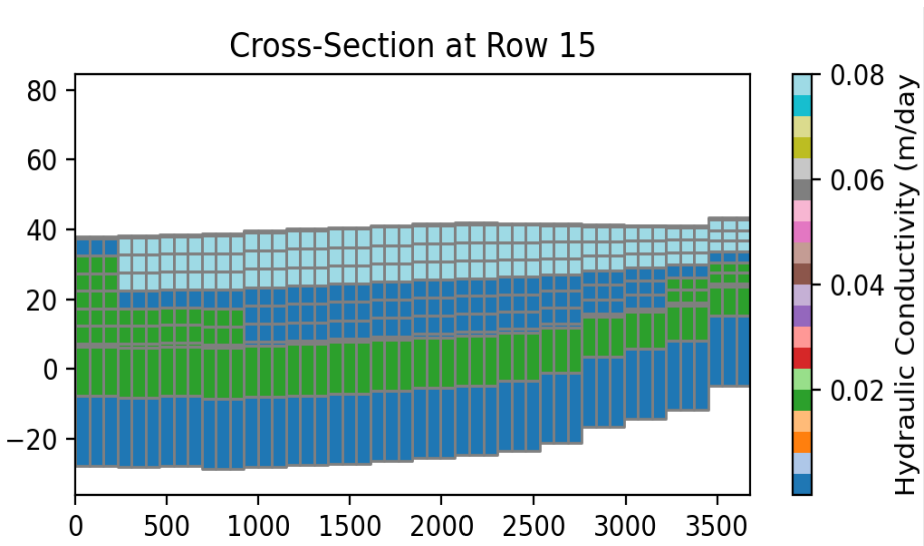
Created Geospatial Datasets:

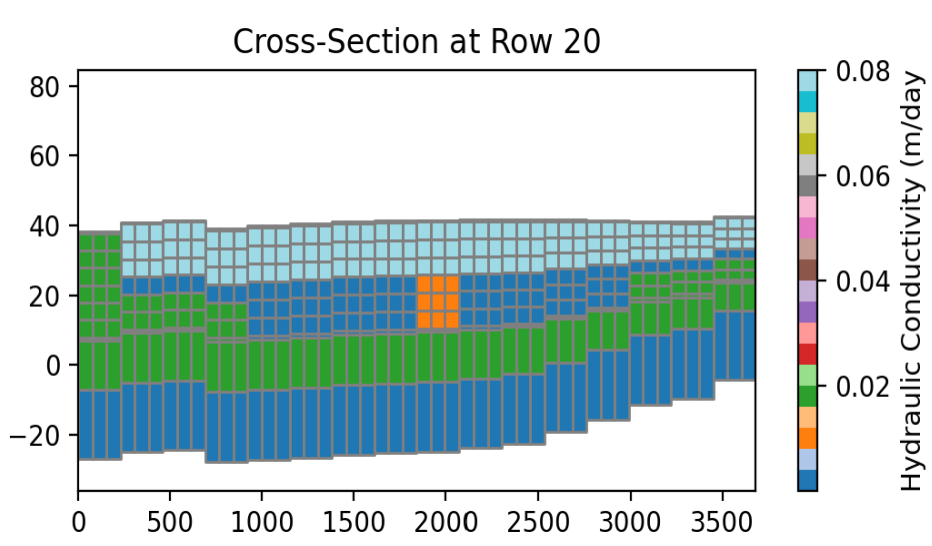
- GPR-derived esker locations
- Peat basin depth
- Hydraulic Head
- Hydraulic Conductivity
- Specific Conductance

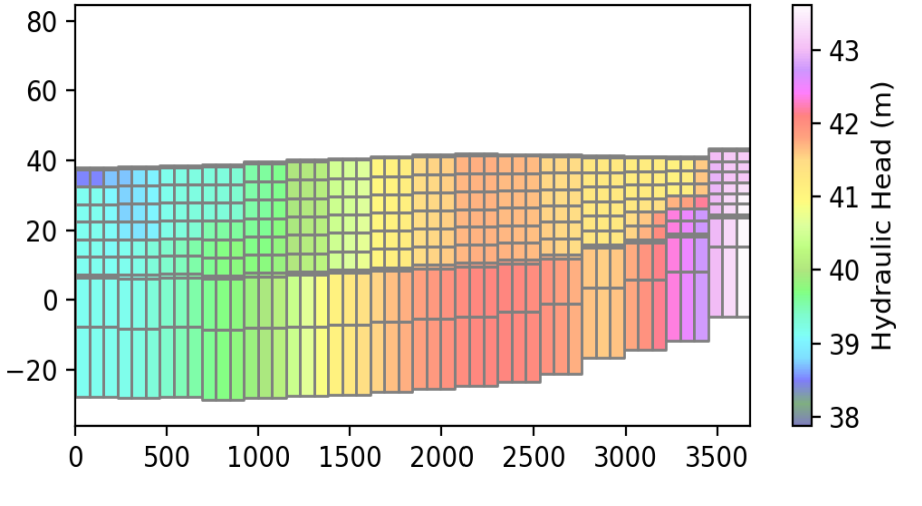
Used these dataset to create groundwater models using USGS Modflow 6 with the FloPy Interface

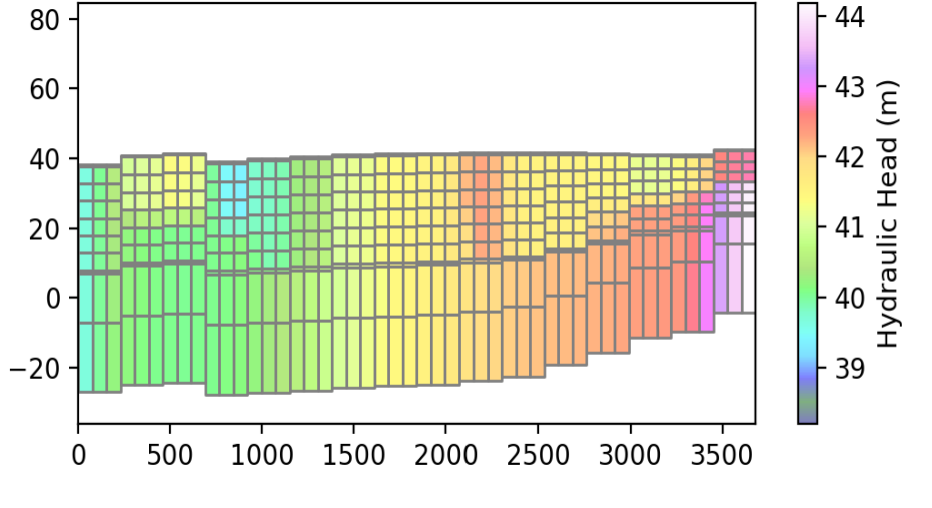

Regional Scale Model
17500
15000
12500
10000
7500
5000
2500
0
0
5000
10000
15000
20000
73.5
67.0
60.5
54.0
47.5
41.0
34.5
28.0
21.5
15.0
Elevation of Head (m)


Local Scale Model
2500
2000
1500
1000
500
0
0
500
1000
1500
2000
2500
3000
3500
73.5
67.0
60.5
54.0
47.5
41.0
34.5
28.0
21.5
15.0
Elevation of Head (m)


Cross-Section at Row 15
Hydraulic Conductivity (m/day)
0.08
0.06
0.04
0.02
80
60
40
20
0
−20
0
500
1000
1500
2000
2500
3000
3500


Cross-Section at Row 20
Hydraulic Conductivity (m/day)
0.08
0.06
0.04
0.02
80
60
40
20
0
−20
0
500
1000
1500
2000
2500
3000
3500


Hydraulic Head (m)
43
42
41
40
39
38
80
60
40
20
0
−20
0
500
1000
1500
2000
2500
3000
3500

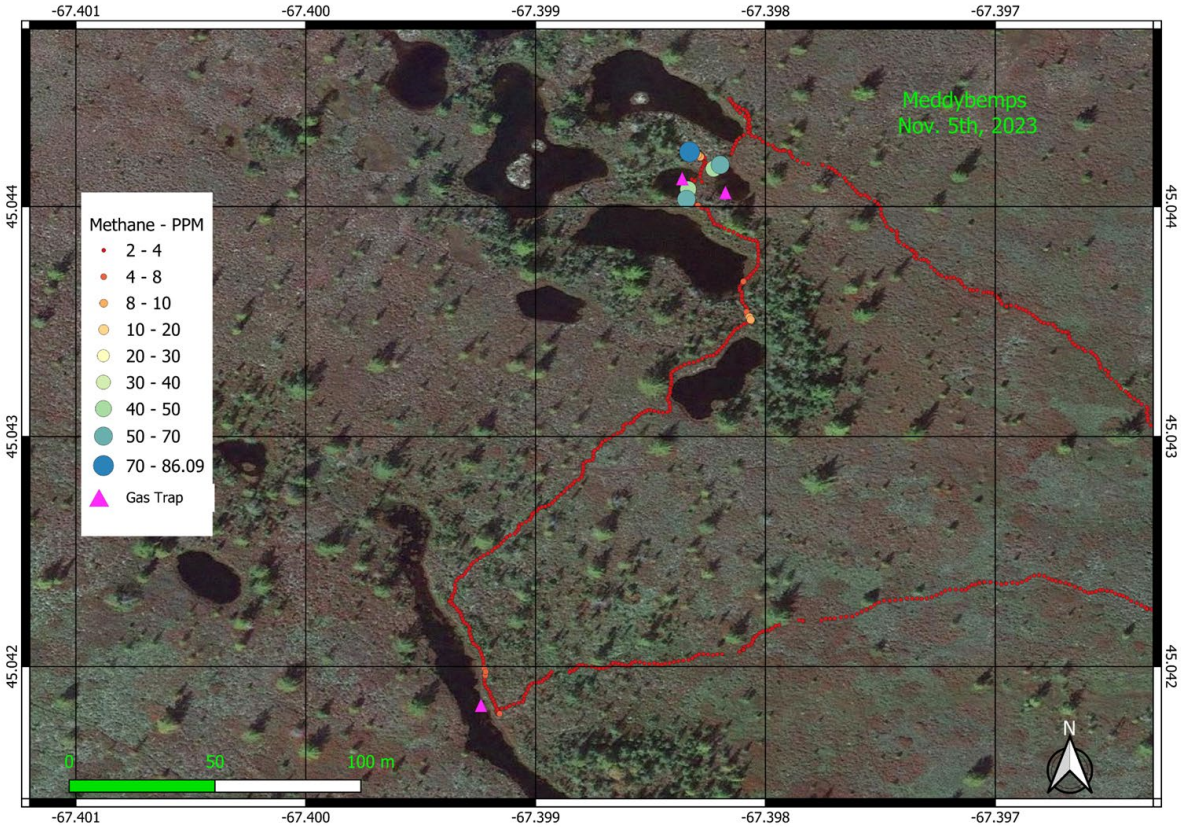

Hydraulic Head (m)
44
43
42
41
40
39
80
60
40
20
0
−20
0
500
1000
1500
2000
2500
3000
3500

Implication of Results

- Preliminary models shows that the underlying geology does exert a hydraulic influence within a peatland
- Suggests that ombrotrophic bogs in glaciated areas may not be completely separate from the regional aquifer
- Locating the eskers could provide ways to find geochemical hotspots (methane emissions)

Future work:

- Create and compare these results to a groundwater model of our other field sites
- Take measurements of methane and carbon dioxide and correlate to hydrology/esker locations



Questions?

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