

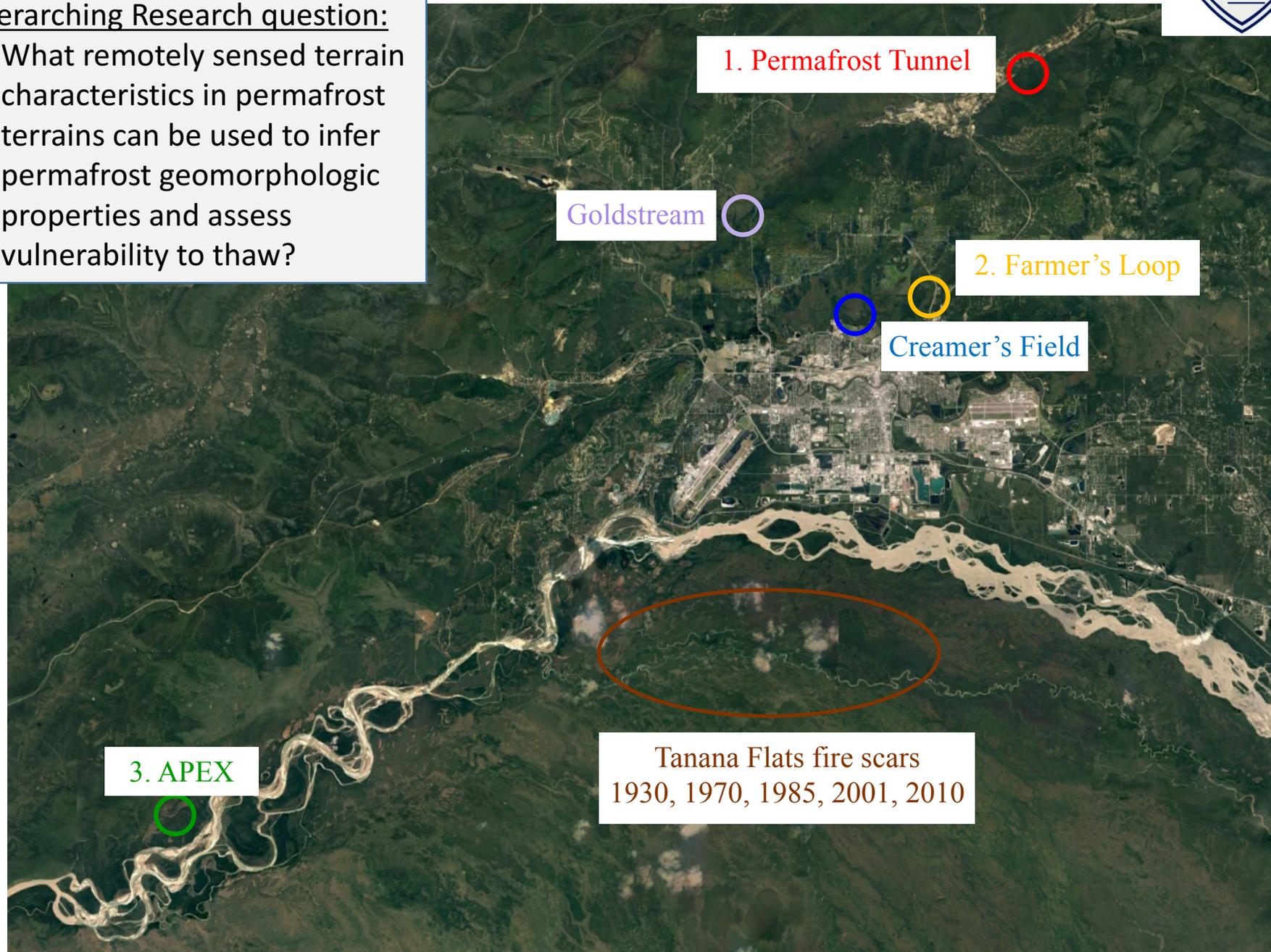
# Variations in Permafrost Wetland Terrain Feature Conditions

Tom Douglas, CRREL Alaska



## Overarching Research question:

- What remotely sensed terrain characteristics in permafrost terrains can be used to infer permafrost geomorphologic properties and assess vulnerability to thaw?

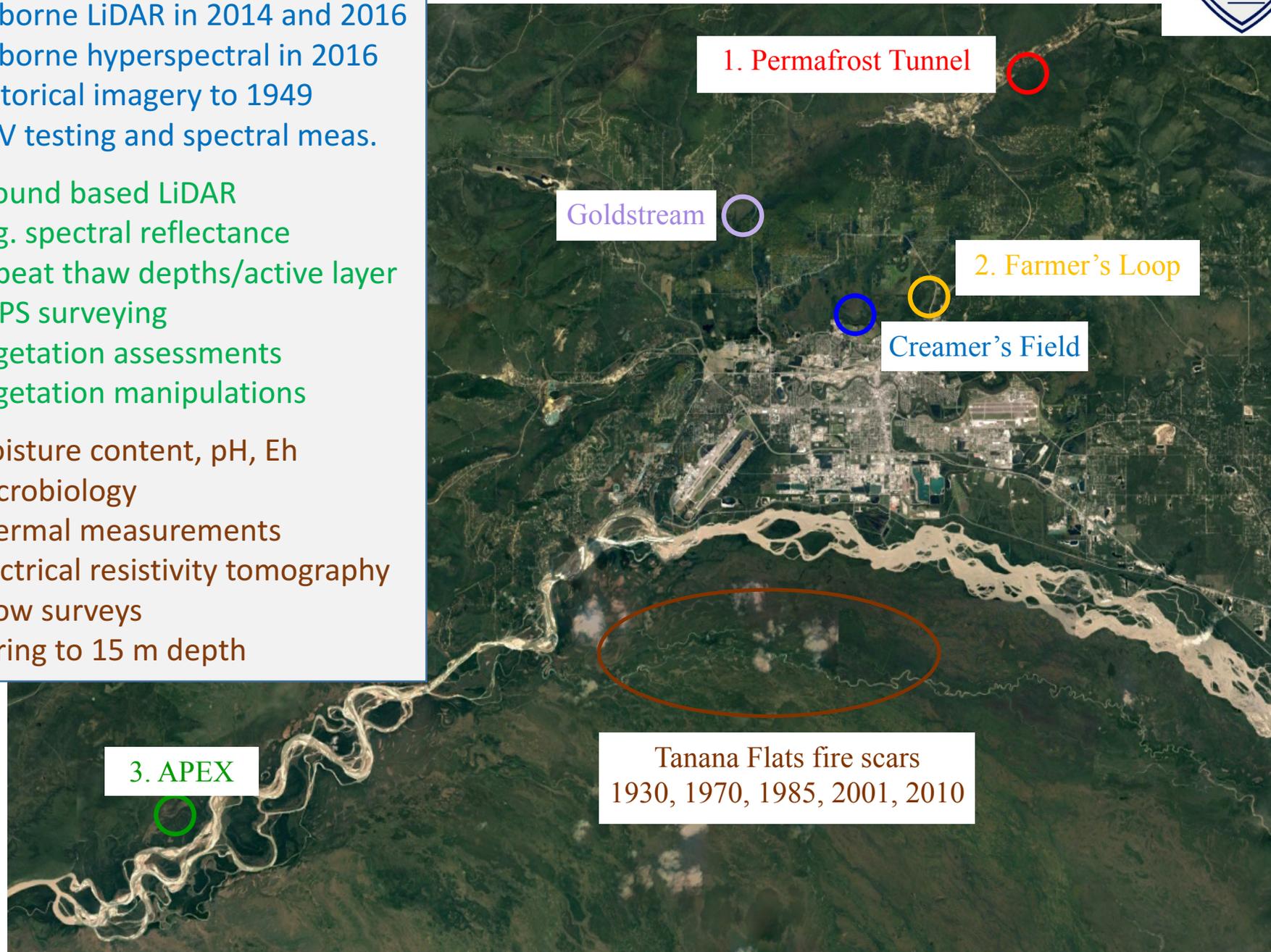




Airborne LiDAR in 2014 and 2016  
Airborne hyperspectral in 2016  
Historical imagery to 1949  
UAV testing and spectral meas.

Ground based LiDAR  
Veg. spectral reflectance  
Repeat thaw depths/active layer  
dGPS surveying  
Vegetation assessments  
Vegetation manipulations

Moisture content, pH, Eh  
Microbiology  
Thermal measurements  
Electrical resistivity tomography  
Snow surveys  
Coring to 15 m depth

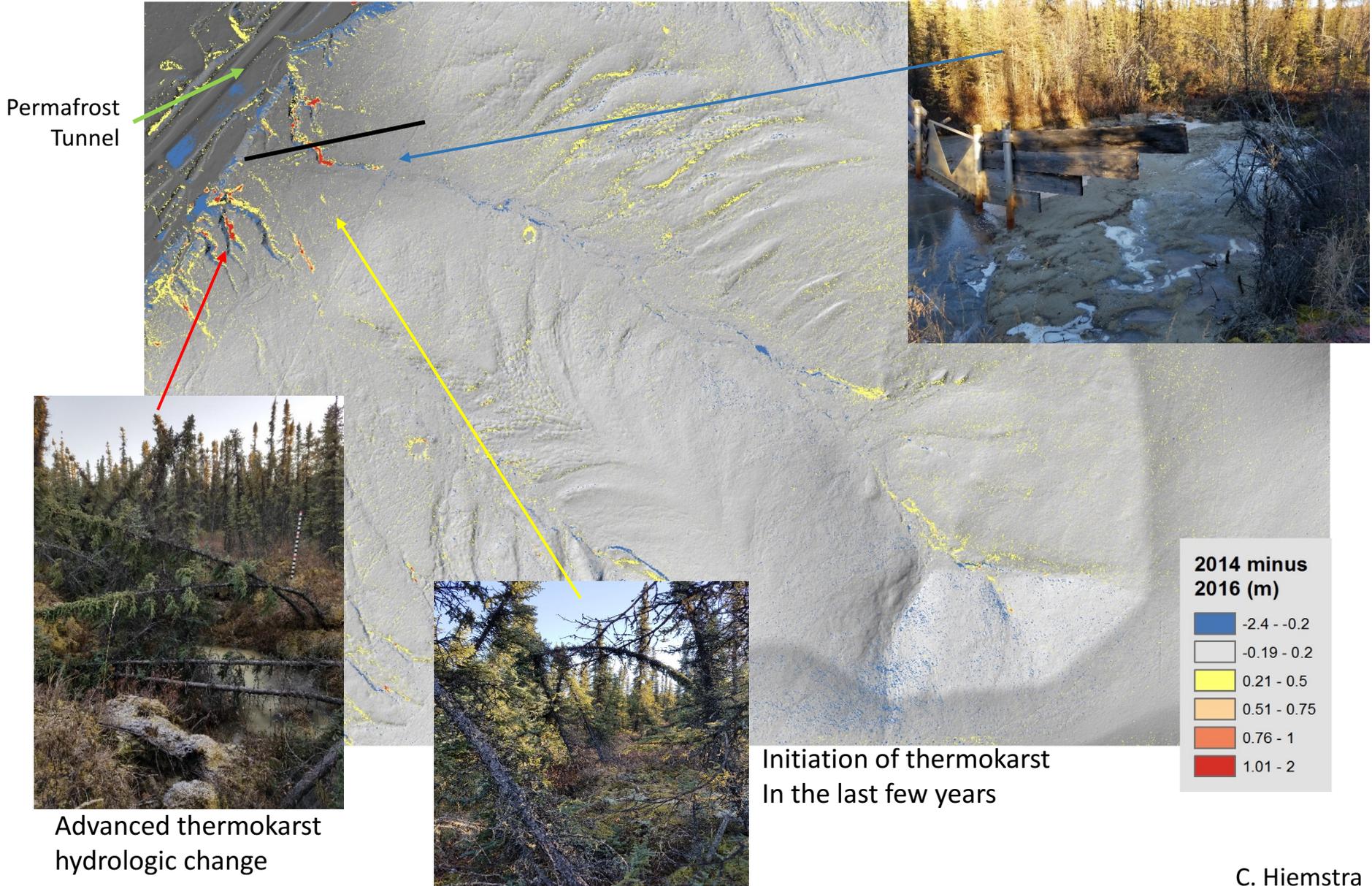


# Permafrost Tunnel- thermokarst driven hydrologic change

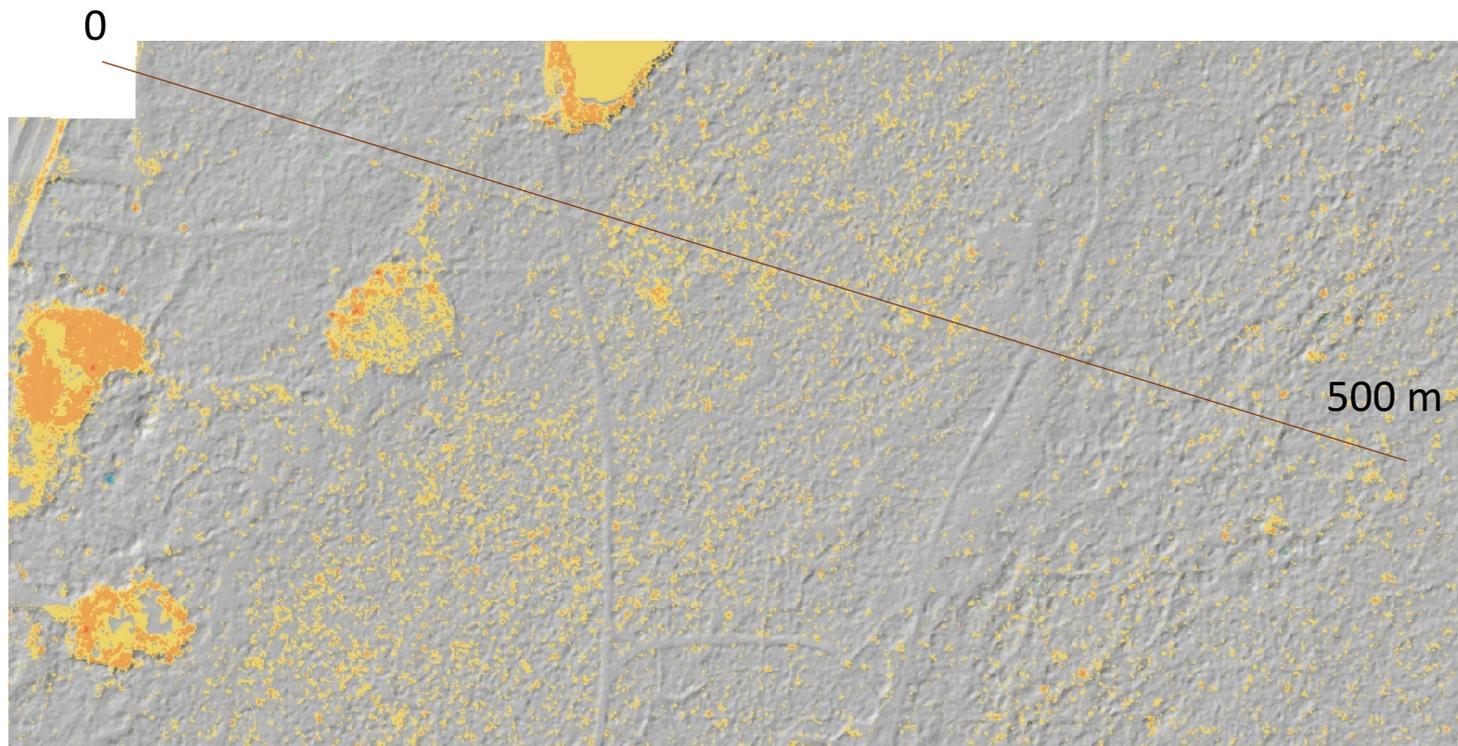
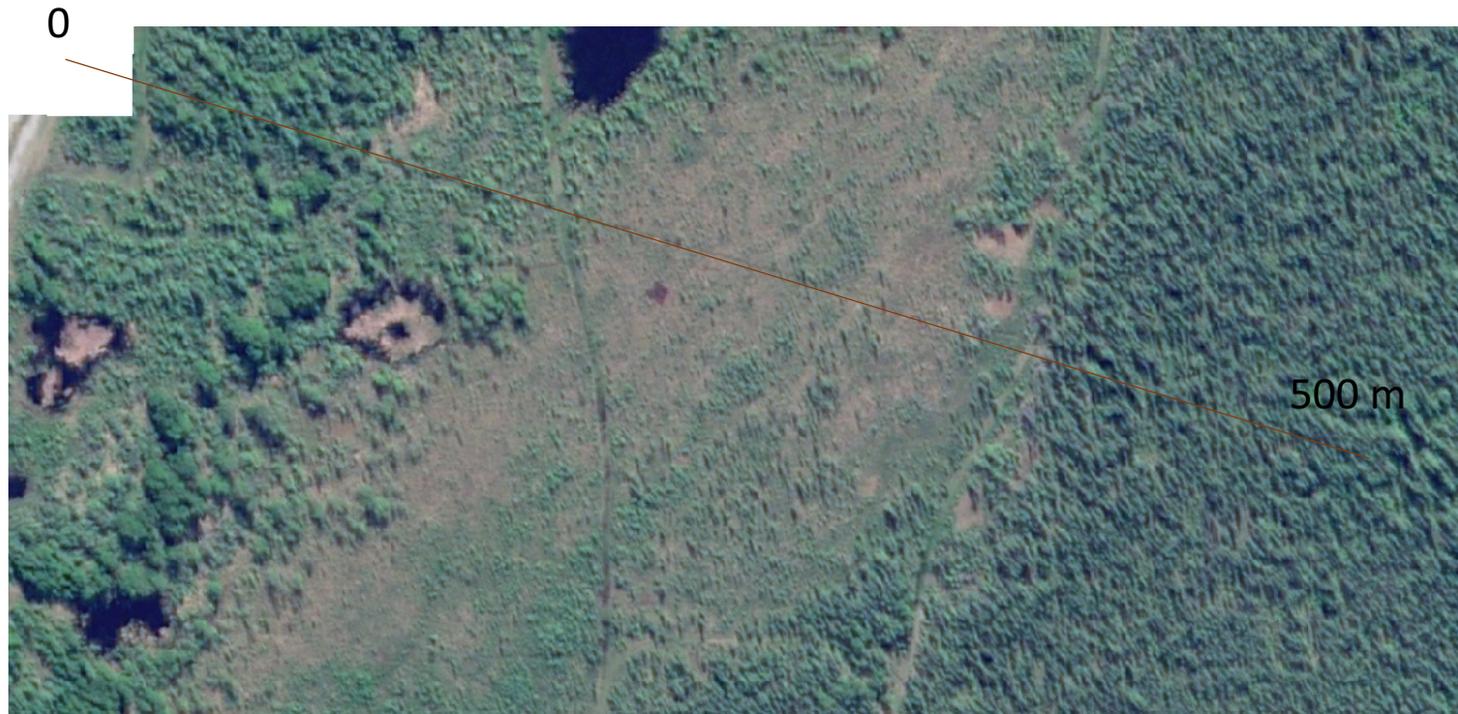
Gently sloping upland terrain. 10m high ice wedges covered by ~3m of silt

June-September Precipitation:  
2014: 223% above mean  
2015: 156% above mean  
2016: 183% above mean

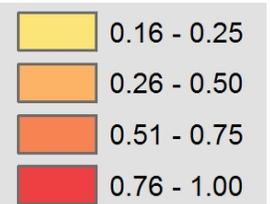
Downslope sedimentation/redistribution



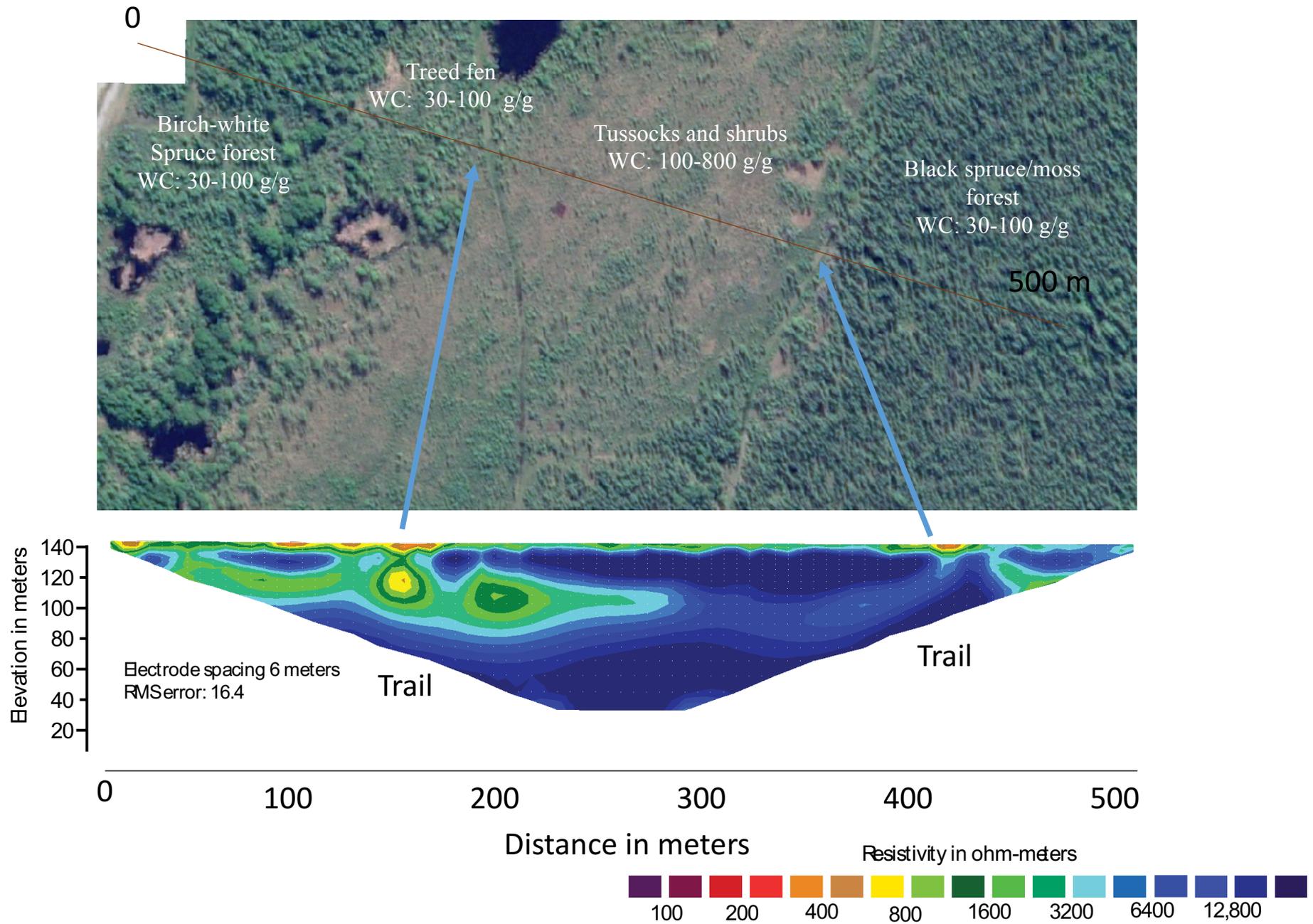
# Farmer's Loop- Worldview 2 image and repeat LiDAR



2014-2016  
LiDAR  
(meters)



# Farmer's Loop- Worldview 2 image and galvanic electrical resistivity tomography



Repeat thaw depth measurements along four 500 m long dGPS surveyed transects- one summer

Farmer's  
Loop

|  |                                |   |   |
|--|--------------------------------|---|---|
| Birch-white<br>Spruce forest<br>WC: 30-100 g/g | Treed fen<br>WC:<br>30-100 g/g | Tussocks and shrubs with increasing<br>shrub density<br>WC: 100-800 g/g | Black spruce/moss<br>forest<br>WC: 30-100 g/g |
|--|--------------------------------|---|---|



Trail

Trail

Farmer's  
Loop

|  |                                |   |   |
|--|--------------------------------|---|---|
| Birch-white<br>Spruce forest<br>WC: 30-100 g/g | Treed fen<br>WC:<br>30-100 g/g | Tussocks and shrubs with increasing<br>shrub density<br>WC: 100-800 g/g | Black spruce/moss<br>forest<br>WC: 30-100 g/g |
|--|--------------------------------|---|---|

Trail

Trail

Farmer's  
Loop

|  |                                |   |   |
|--|--------------------------------|---|---|
| Birch-white<br>Spruce forest<br>WC: 30-100 g/g | Treed fen<br>WC:<br>30-100 g/g | Tussocks and shrubs with increasing<br>shrub density<br>WC: 100-800 g/g | Black spruce/moss<br>forest<br>WC: 30-100 g/g |
|--|--------------------------------|---|---|

Trail

Trail

Farmer's Loop

|   |                             |  |  |
|---|-----------------------------|--|--|
| Birch-white Spruce forest<br>WC: 30-100 g/g | Treed fen<br>WC: 30-100 g/g | Tussocks and shrubs with increasing shrub density<br>WC: 100-800 g/g | Black spruce/moss forest<br>WC: 30-100 g/g |
|---|-----------------------------|--|--|

Tussock site:  
60 cm  $< 0^{\circ}\text{C}$  in mid November

Trail



Ice cemented silt

Transition zone

Trail

Repeat thaw depth measurements along four 500 m long dGPS surveyed transects- 4 years

Farmer's  
Loop

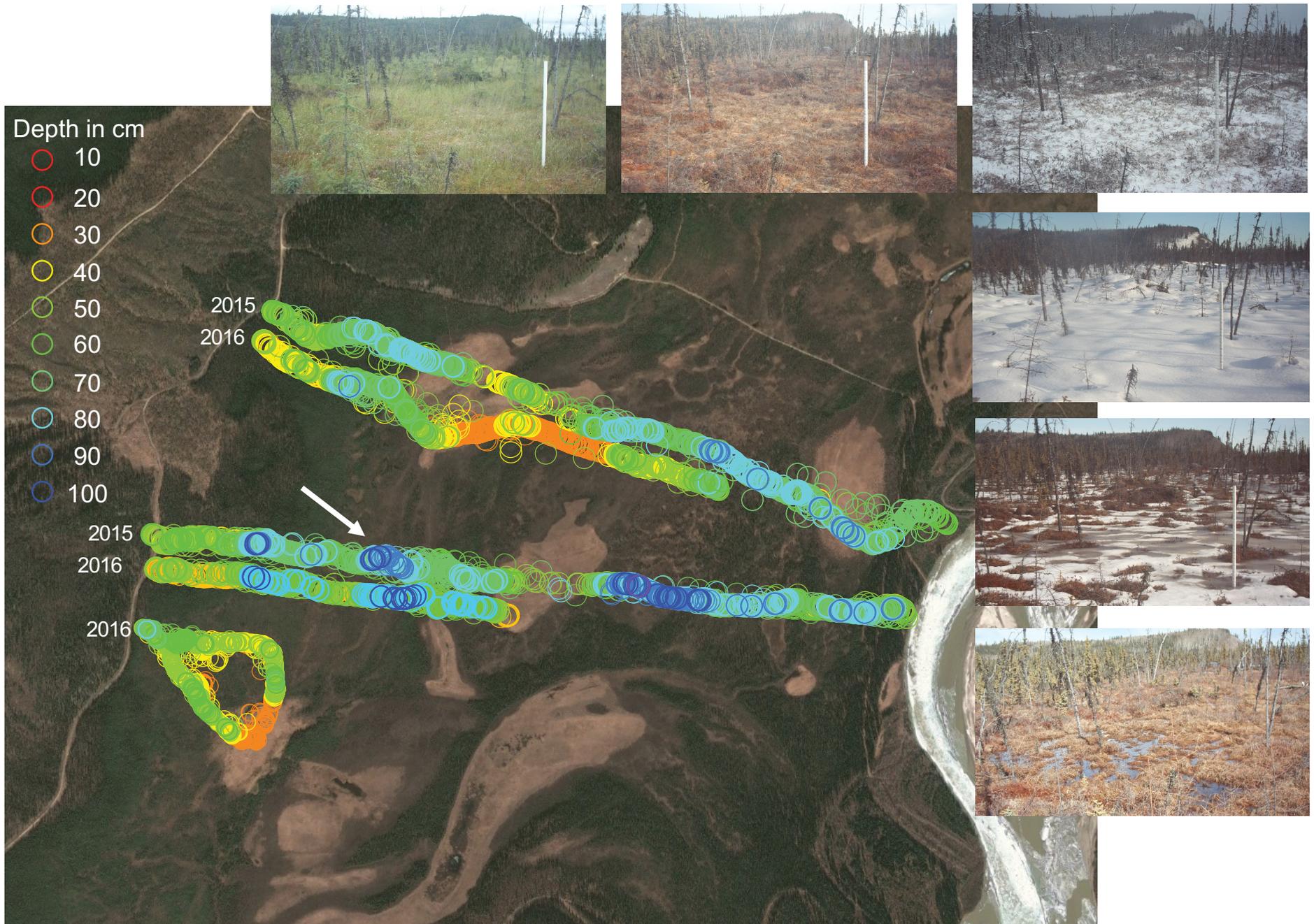
|  |                                |   |   |
|--|--------------------------------|---|---|
| Birch-white<br>Spruce forest<br>WC: 30-100 g/g | Treed fen<br>WC:<br>30-100 g/g | Tussocks and shrubs with increasing<br>shrub density<br>WC: 100-800 g/g | Black spruce/moss<br>forest<br>WC: 30-100 g/g |
|--|--------------------------------|---|---|

Trail

Trail

Similar repeat patterns across all four transects

APEX site- snow depths in 2015 and 2016- repeated patterns of ecotype/terrain-snow relationships  
-Hoping to have IceBridge fly all sites in March, 2017 coincident with a large snow campaign



Thomas.a.douglas@usace.army.mil