Understanding and scaling change in lowland permafrost:

Cross-scale feedbacks to hydrology and carbon

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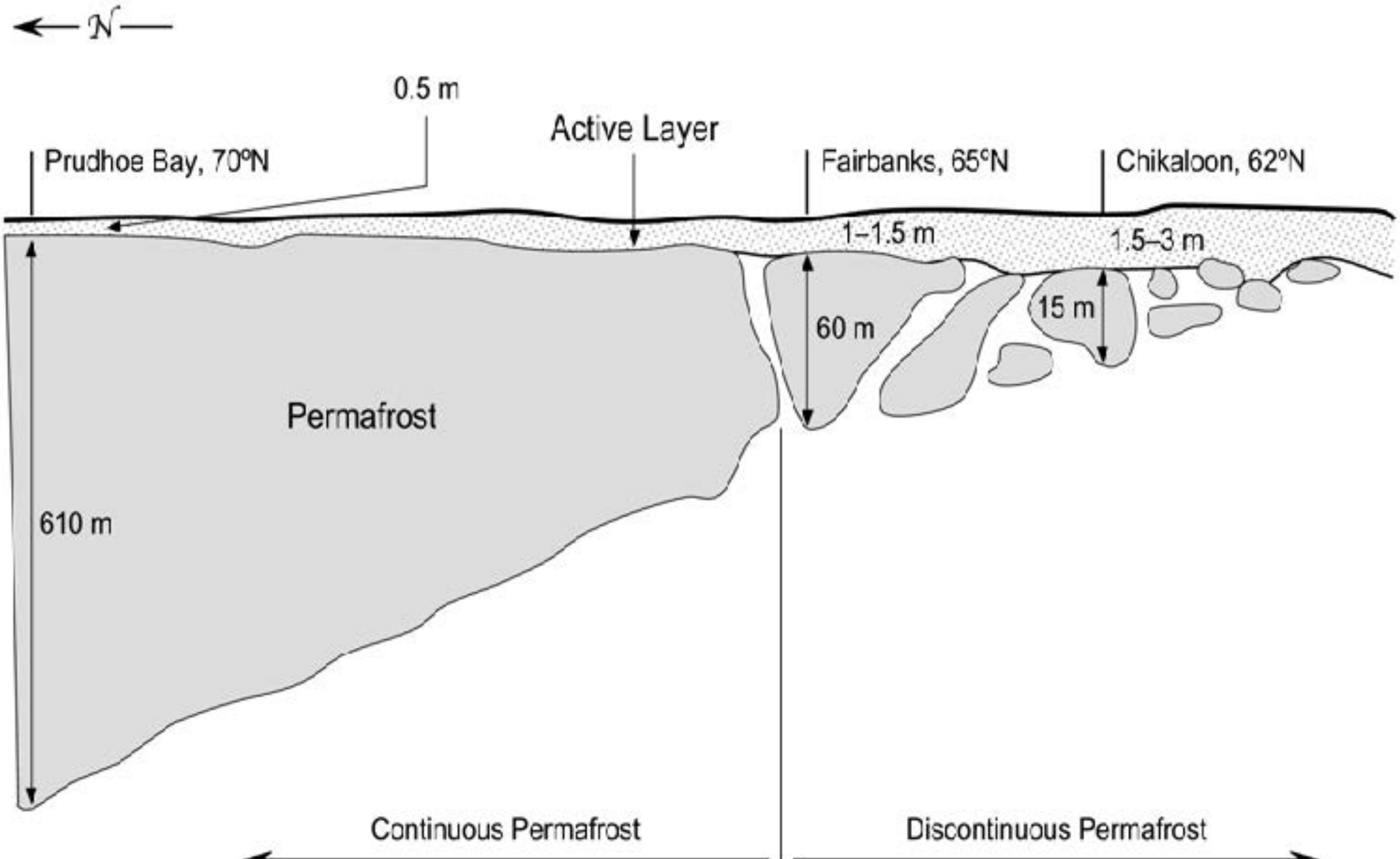
Permafrost is both climate- and ecosystem- driven



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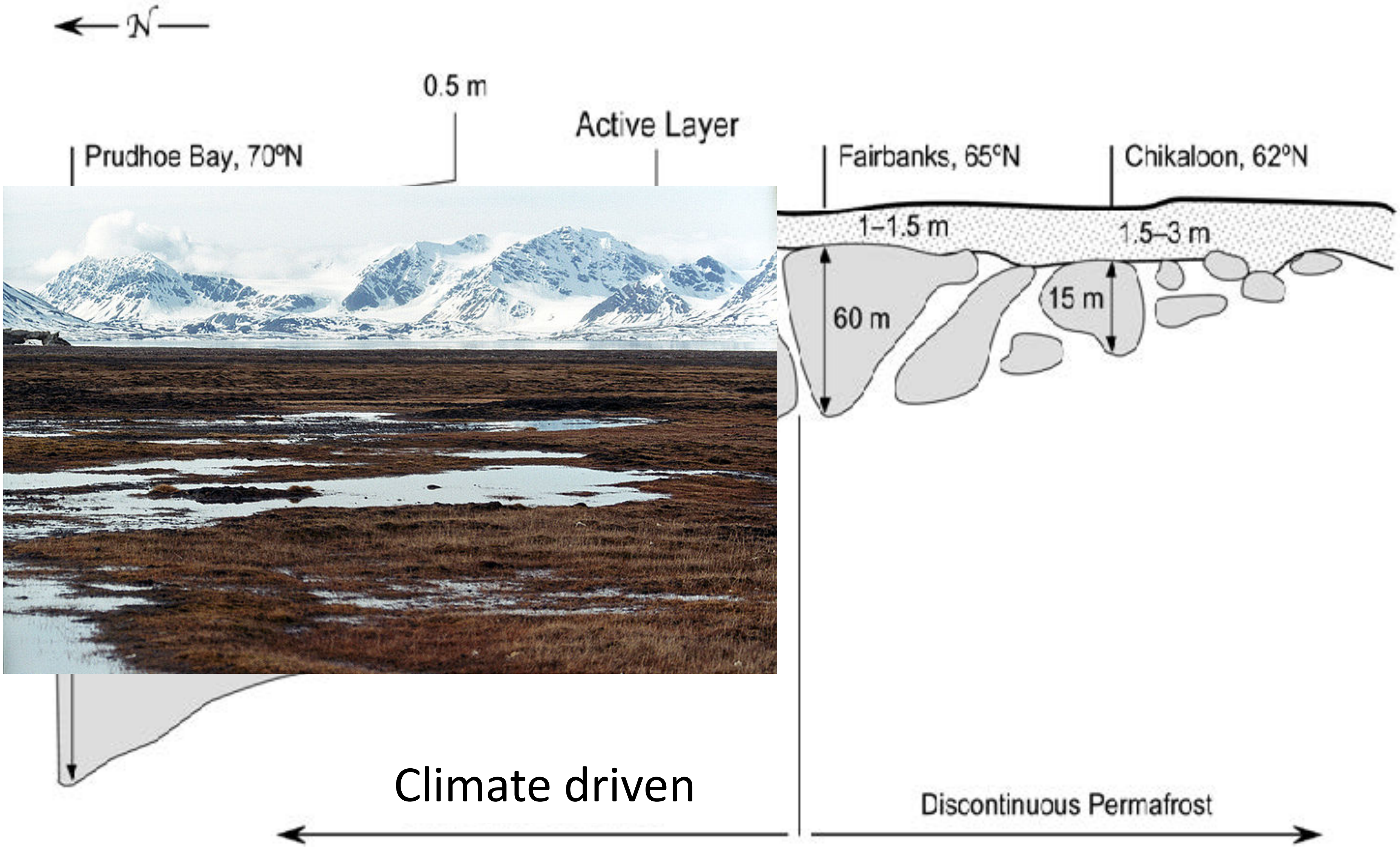

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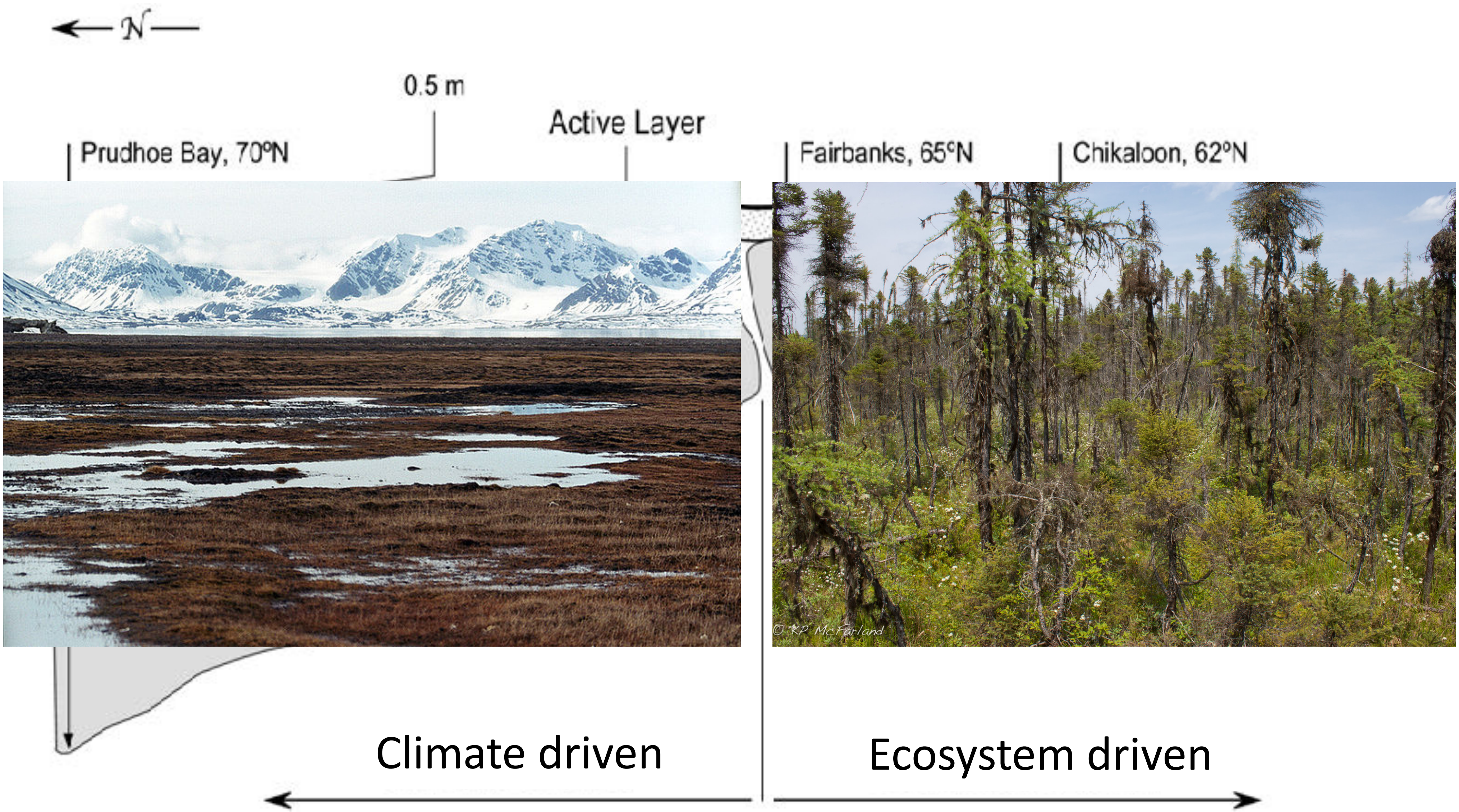
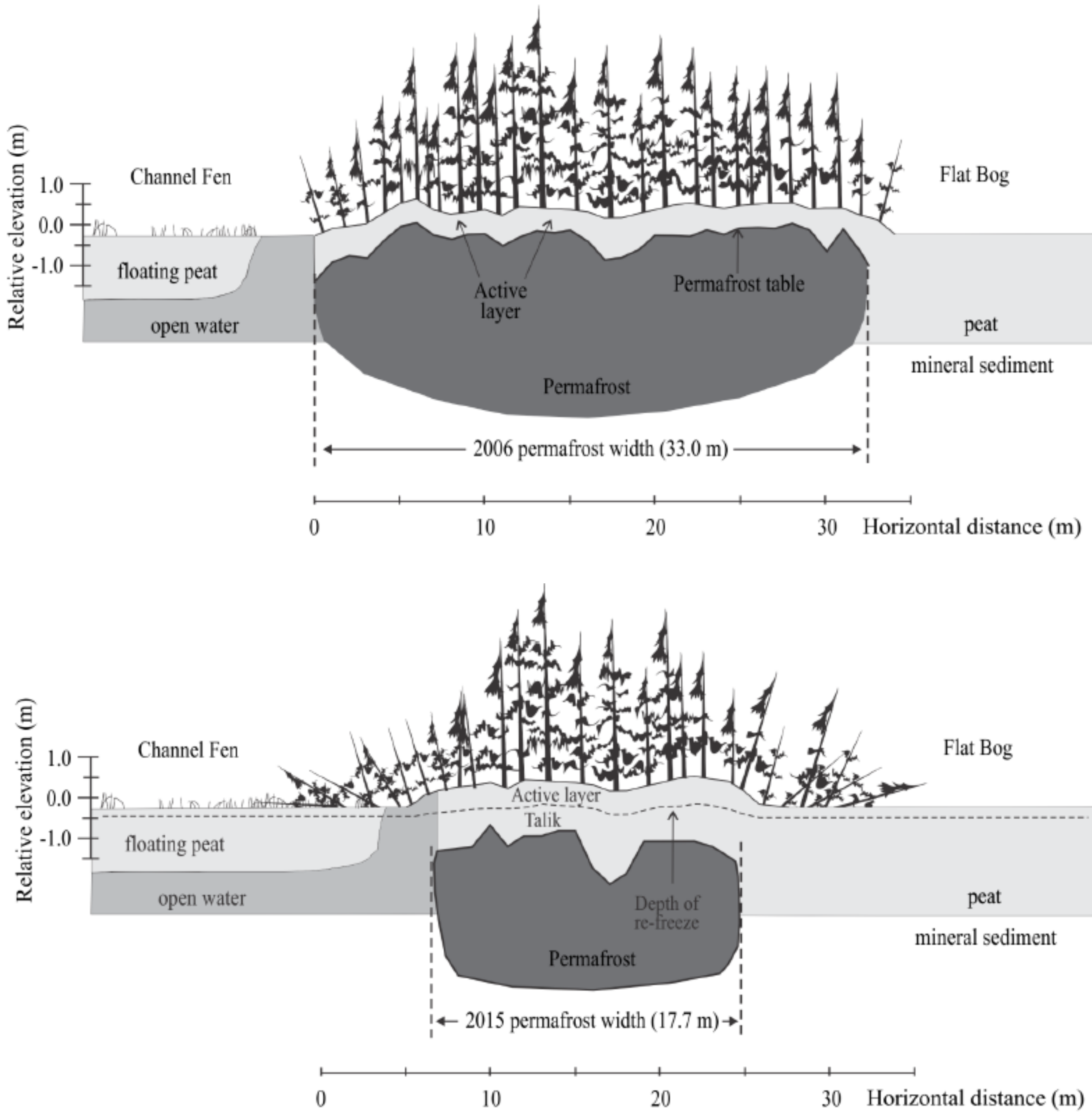
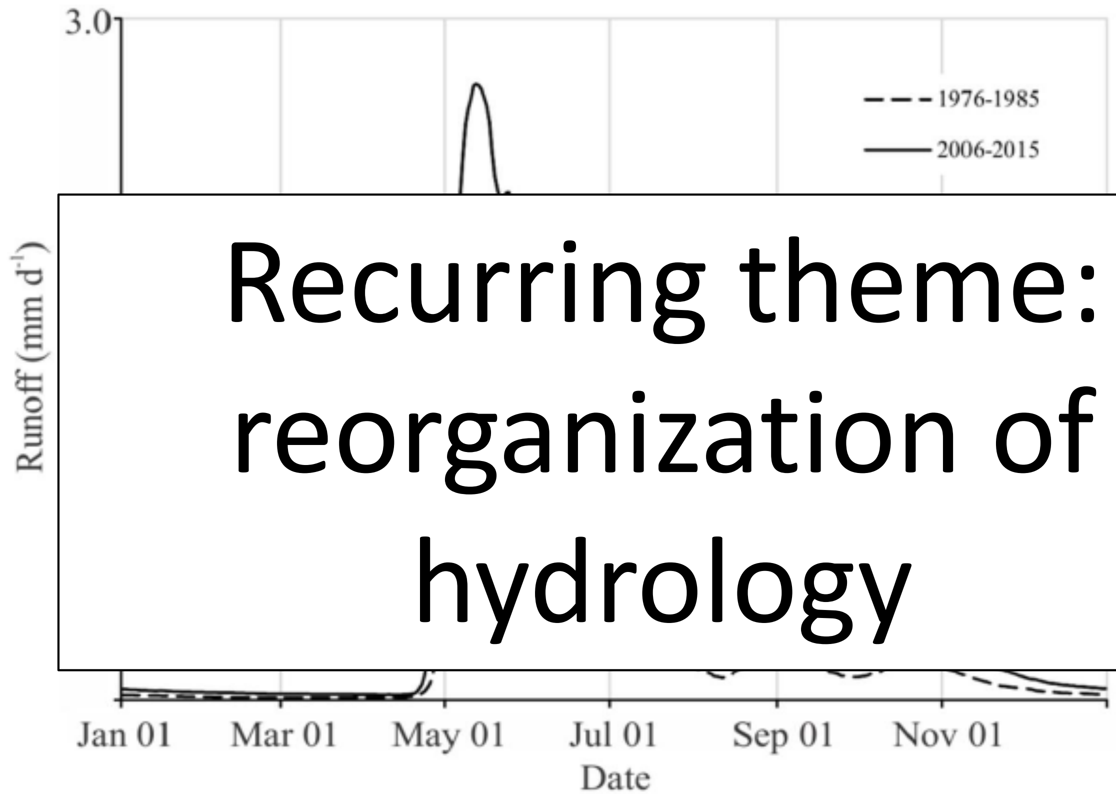


Abrupt thaw typically involves local subsidence and wetting



See work by Bill Quinton, Kevin Devito, Mike Waddington

Increasing runoff & basin drainage

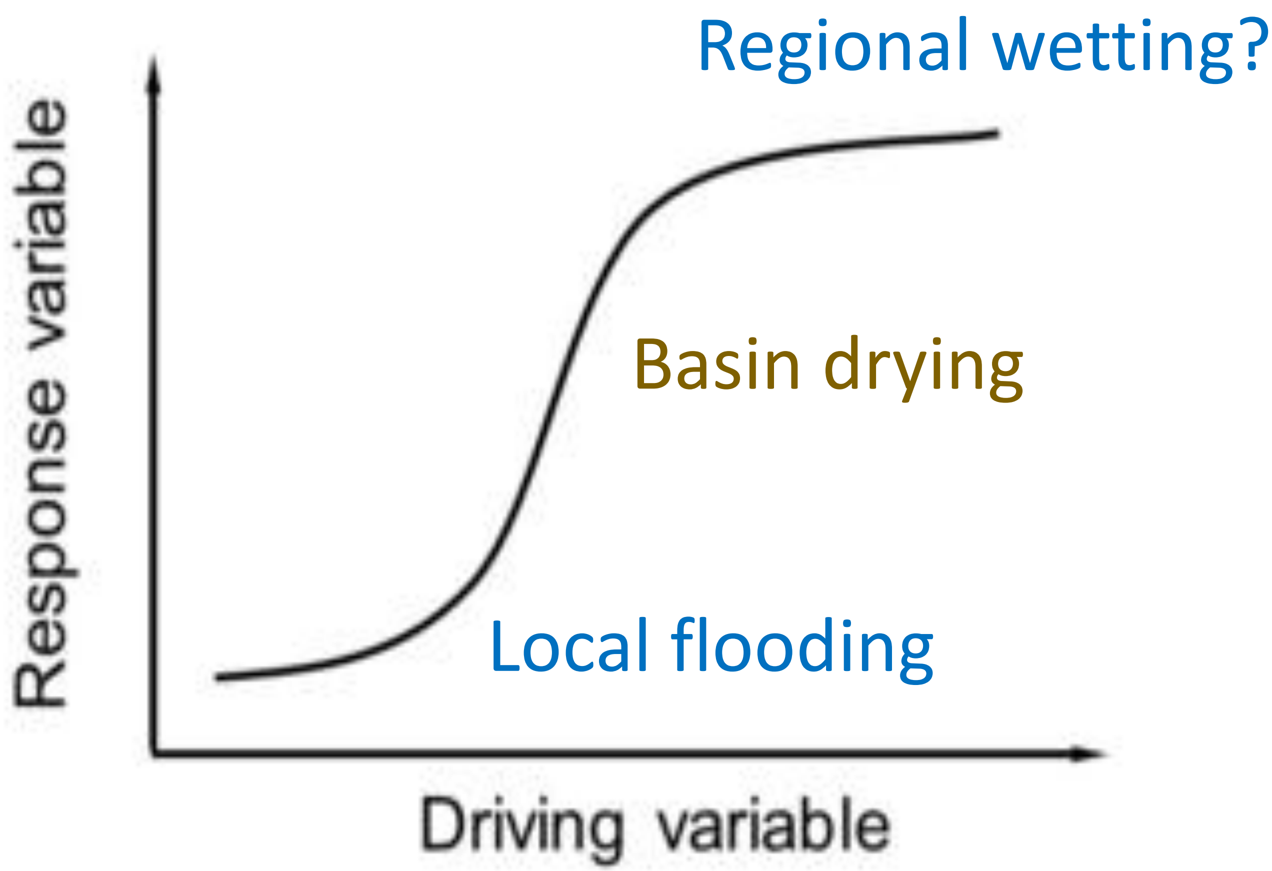


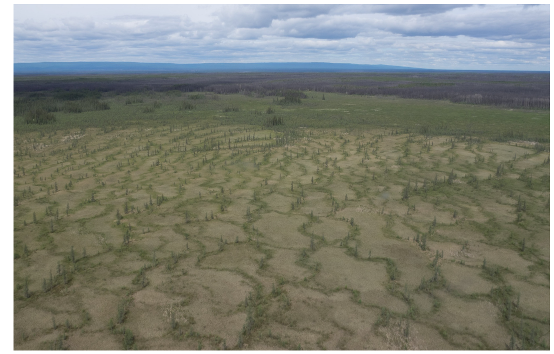
Recurring theme: reorganization of hydrology

	Avg. Runoff (mm)	Avg. Precip (mm)	Runoff Ratio
1976-85	87.2	364.5	**0.24**
2006-15	193.4	402.3	**0.48**

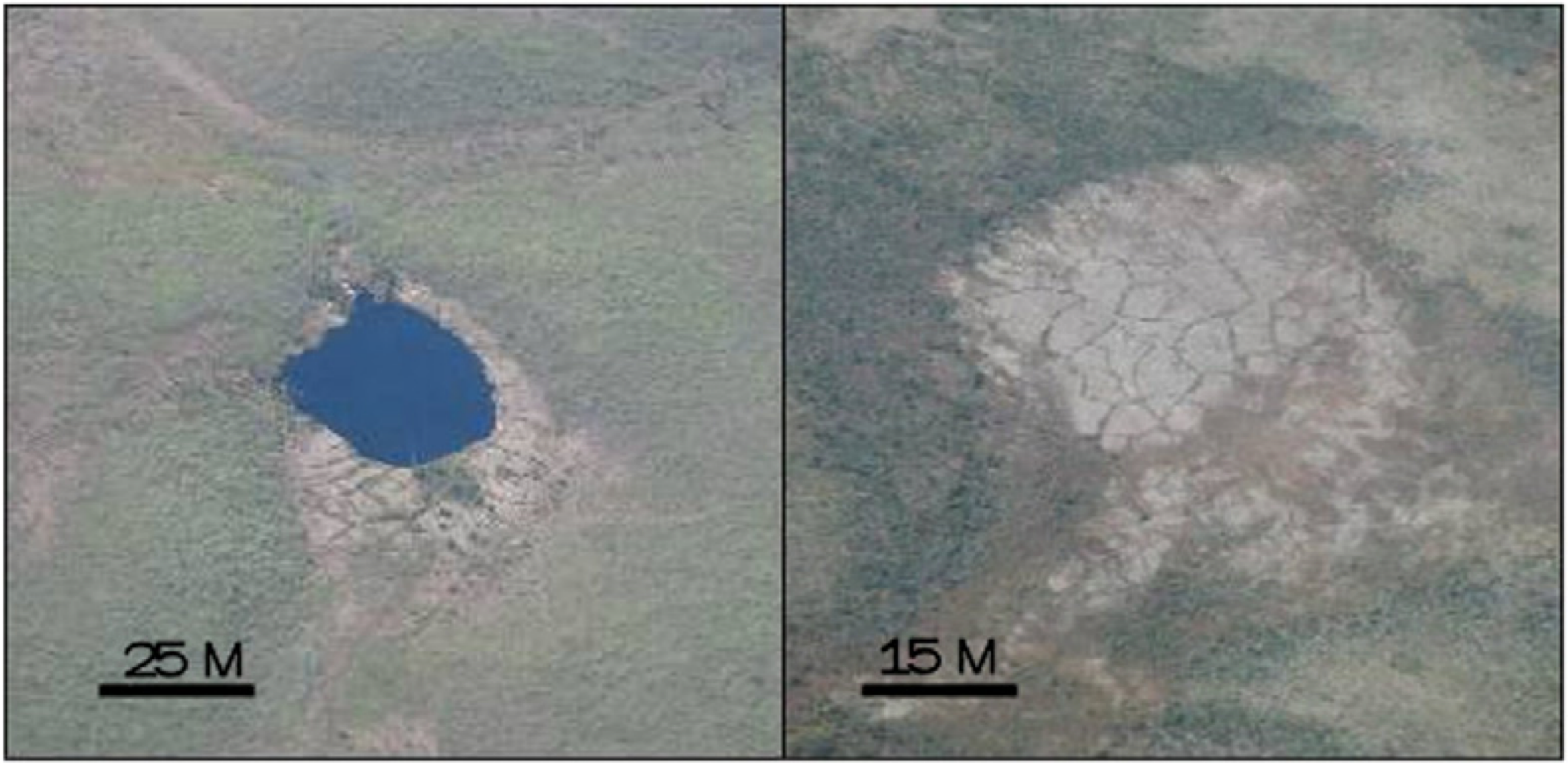
Quinton et al. papers

Cross-scale threshold change





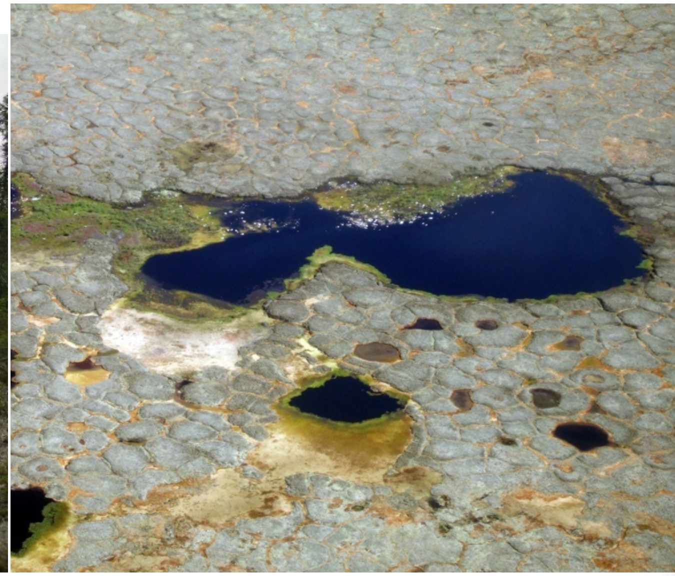
Wetting AND drying through time



Life Cycle of Thaw Lakes: Subsidence and Wetting -> Drainage -> Permafrost Recovery

Thermokarst state & transition model

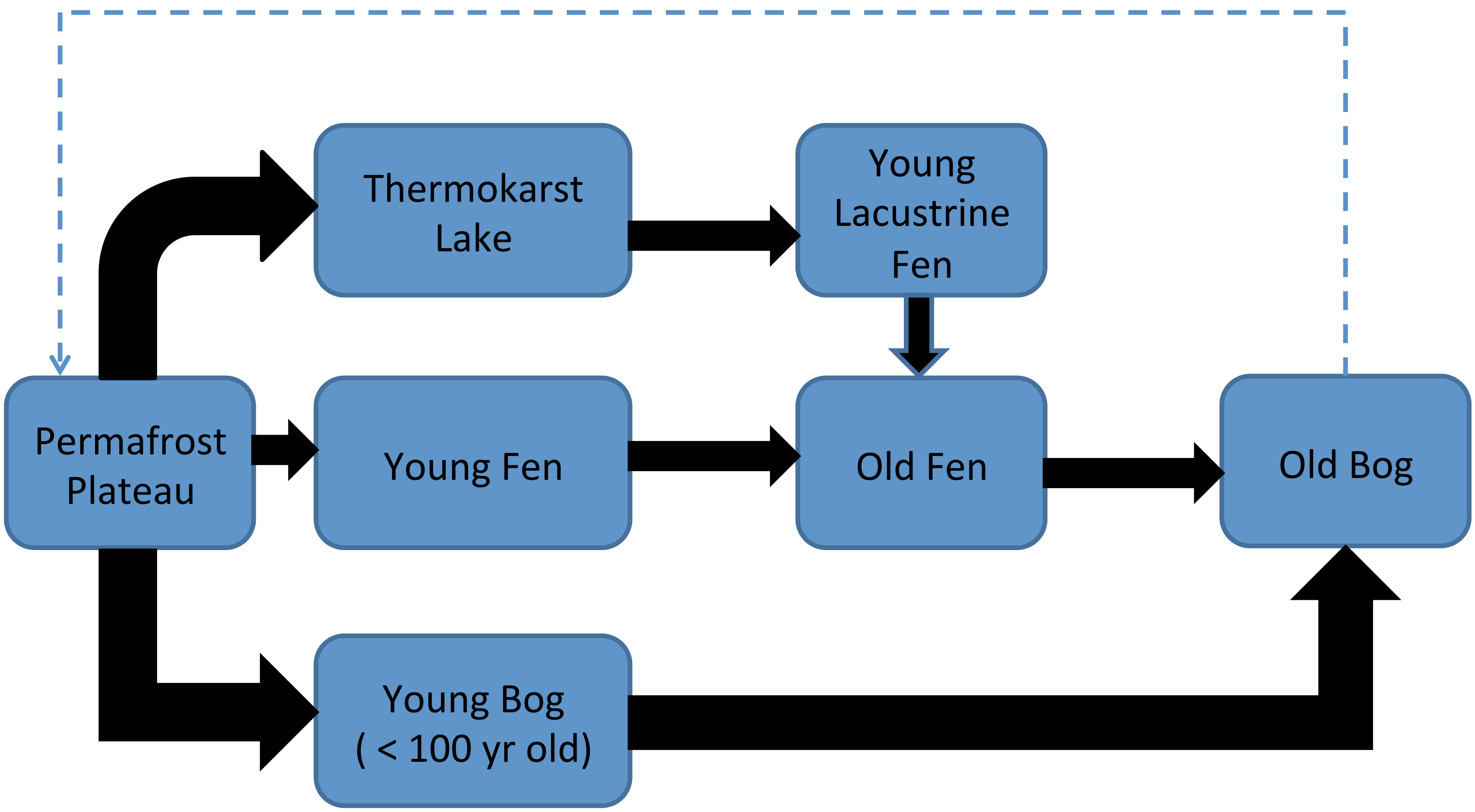

Lowland organic


Lowland mineral

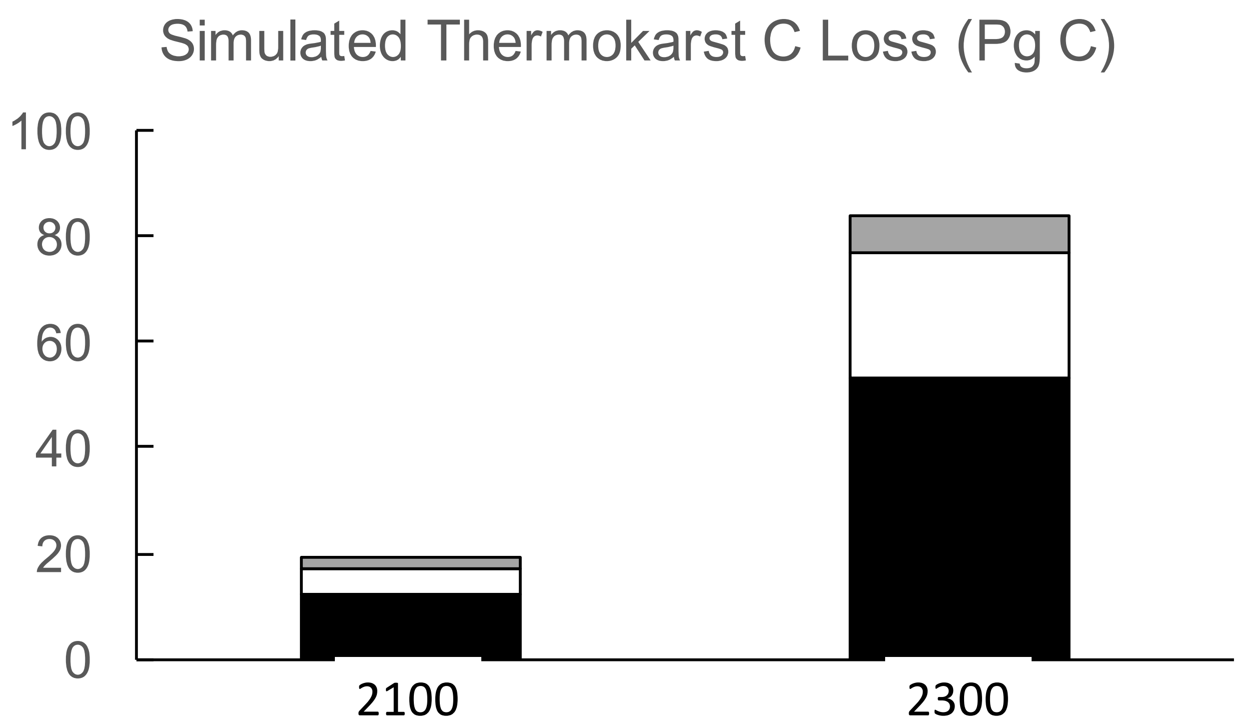

Upland mineral

For each generalized thaw trajectory, we synthesized data on:

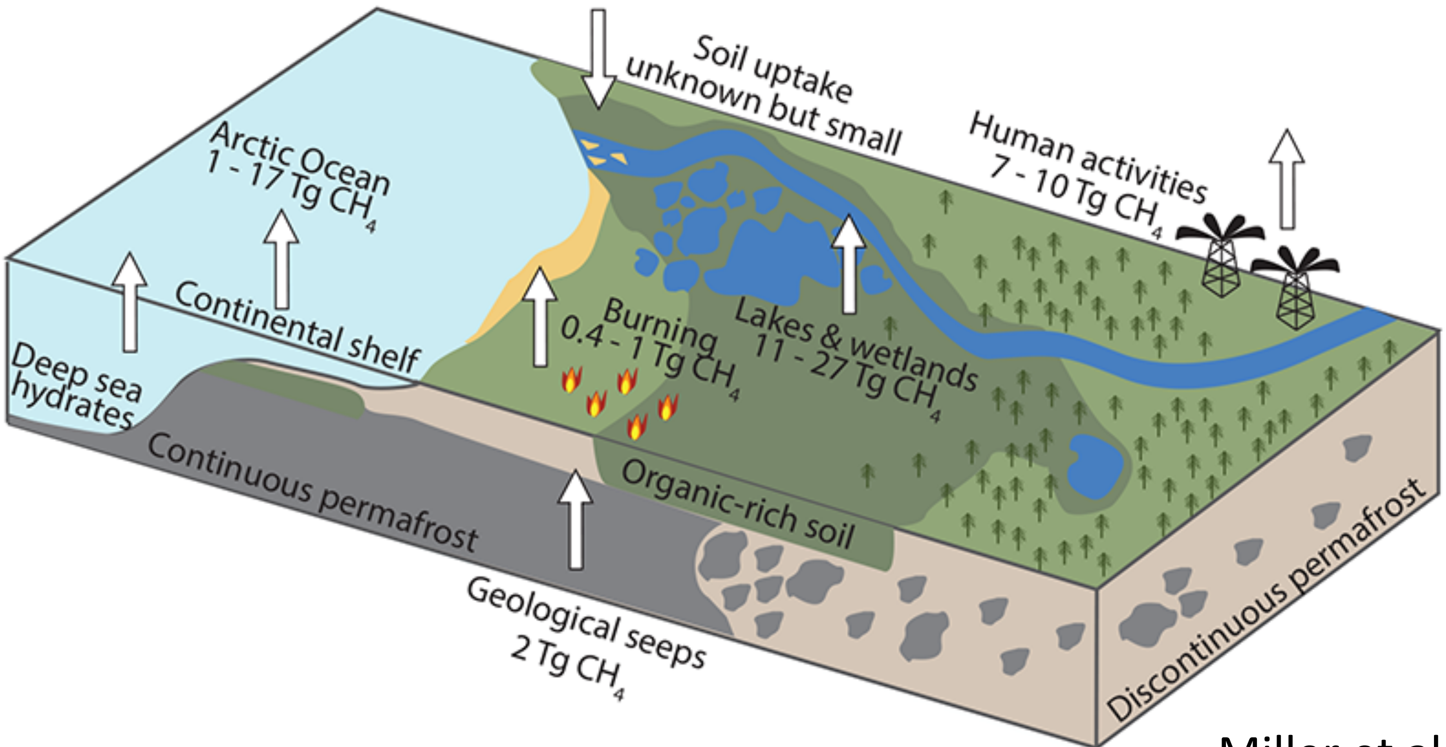
- *spatial extent of early and late thaw states*
- *transition rates between states*
- *carbon fluxes for each state*


Thermokarst Lake
Young Lacustrine Fen
Permafrost Plateau
Young Fen
Old Fen
Old Bog
Young Bog (< 100 yr old)

Thermokarst C losses dominated by upland environments



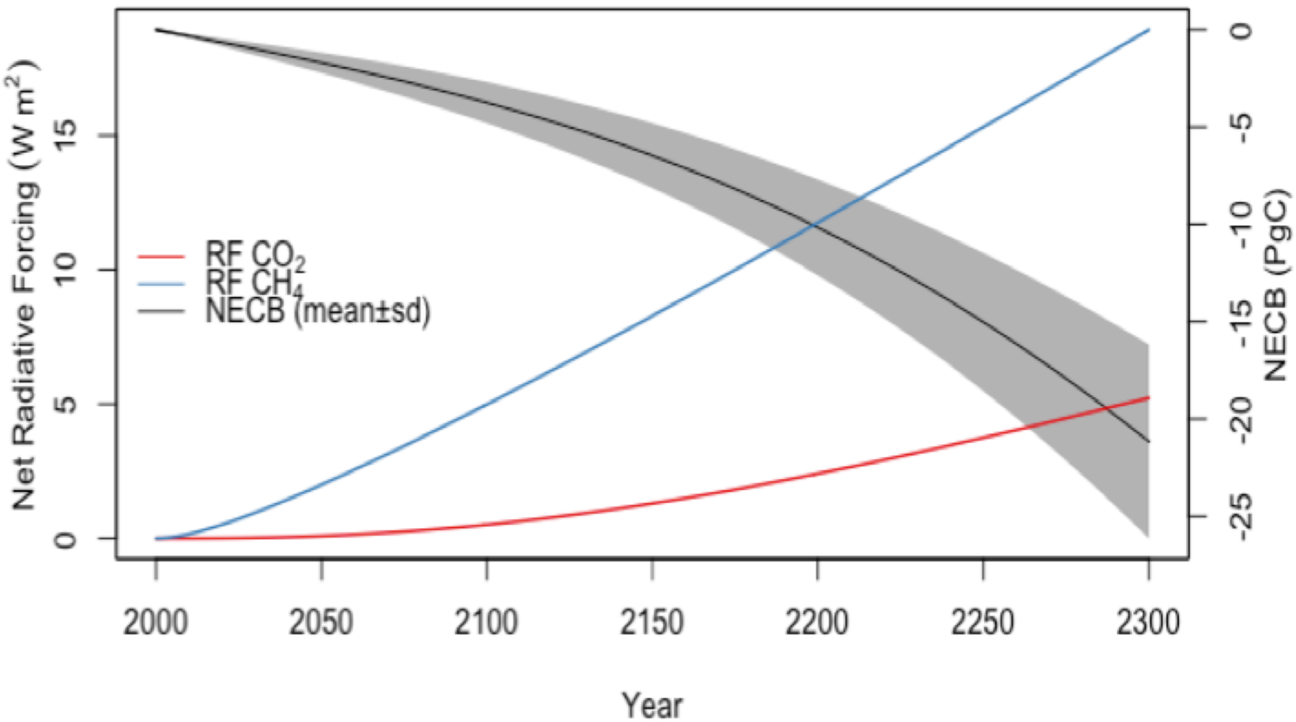
How important is CH_4 to permafrost C losses?



Miller et al. 2018. EOS

- *CH_4-C contributed little to total C release in a synthesis of year long incubations of permafrost soils (Schadel et al. 2016)*
- *However, CH_4 became significant in a 7+ year incubation (Knoblauch et al. 2018)*

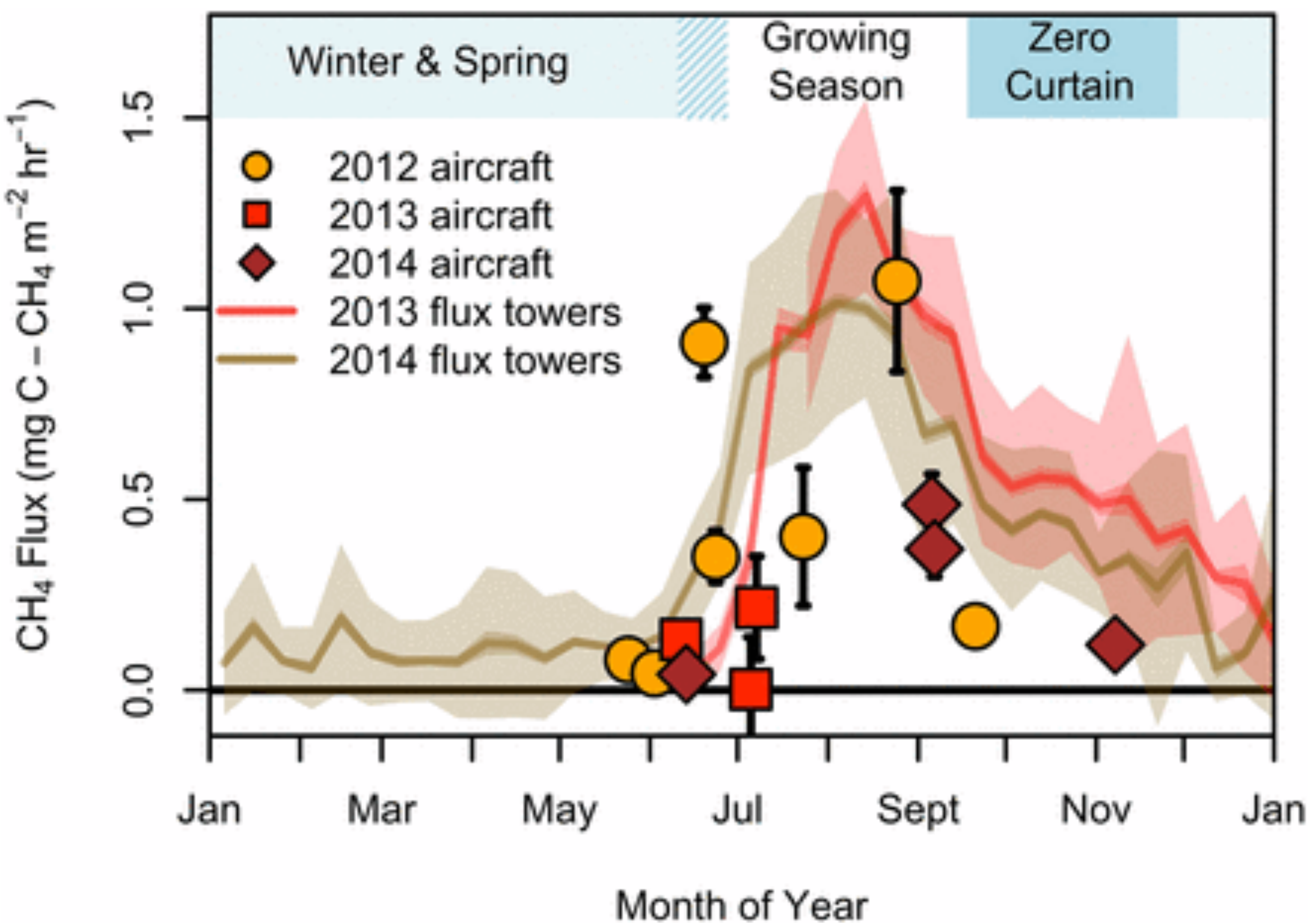
Oxic environments lost the most C with thaw, but radiative forcing of CH_4 was high across all landscape settings



Known Unknown #1
Fate of erosional material

Known Unknown #2

Emissions during zero curtain



Zona et al. 2016

Known Unknown #3

Methane seeps can transform the landscape

- Geologic sources of CH_4 (cf. Walter Anthony et al. 2012)
- Enhanced CO_2 uptake in Arctic ocean seep exceeded GWP of emitted CH_4 (Pohlman et al. 2017)

Recurring theme: Heterogeneity

Occurs in Time and Space

Permafrost thaw

Hot spot *process:*

20% of land at risk
<5% is an active feature

Abrupt thaw

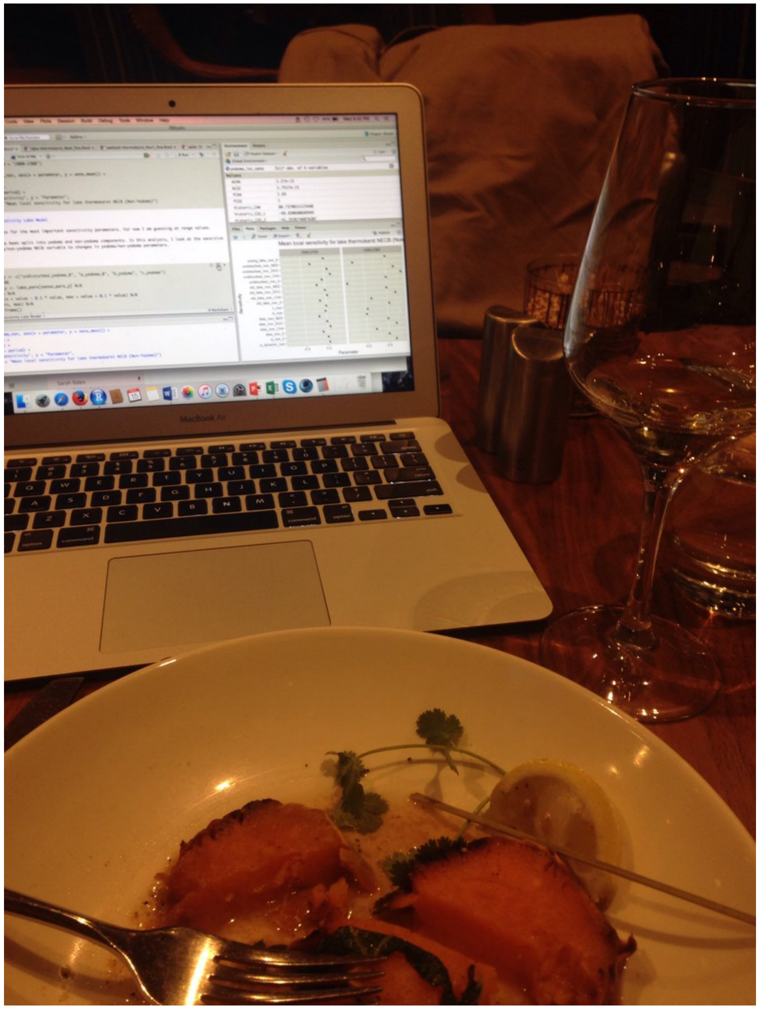
Hot moment *process:*

<5% of bubble trap measurements responsible for >95% of old C release

Methane ebullition

Public Engagement

Public Engagement



We all have stories to share. They are more powerful together so we have a unique opportunity for science engagement.

At lunch today, please join me to explore this and other outreach opportunities!

Thank you

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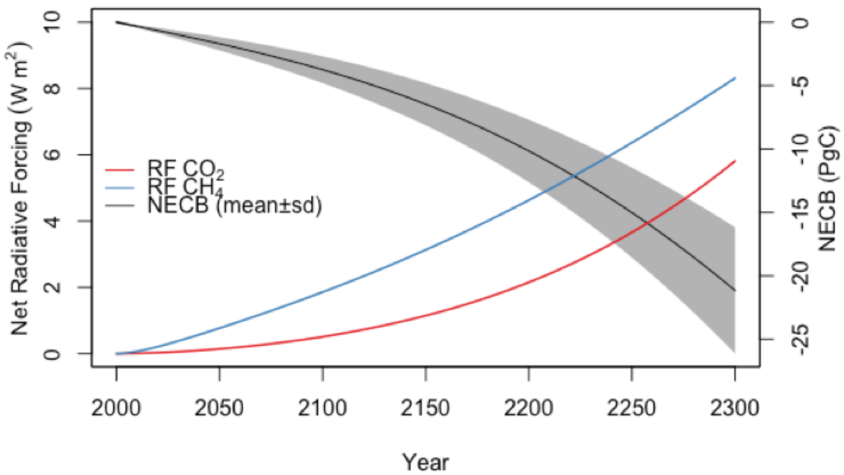
@queenofpeat

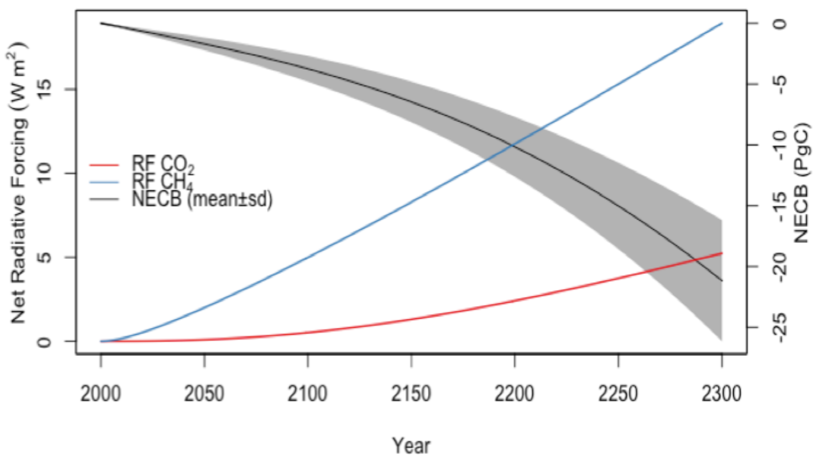
Principles for effective communication and public engagement on climate change

A Handbook for IPCC authors

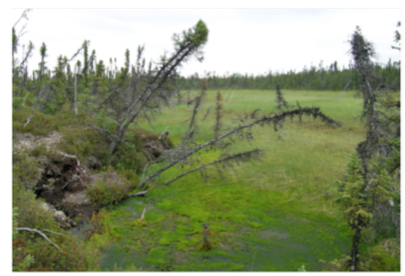
1. Be a confident communicator
2. Talk about the real world, not abstract ideas
3. Connect with what matters to your audience
4. Tell a human story
5. Lead with what you know
6. Use the most effective visual communication

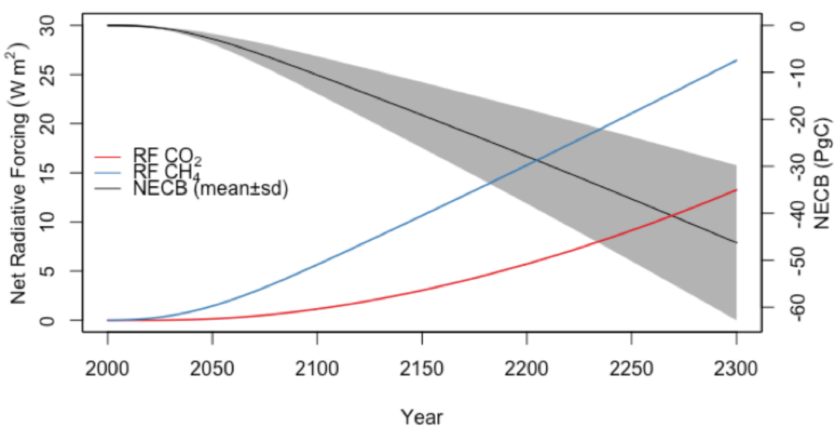


Mineral lowland terrain:
thaw lakes



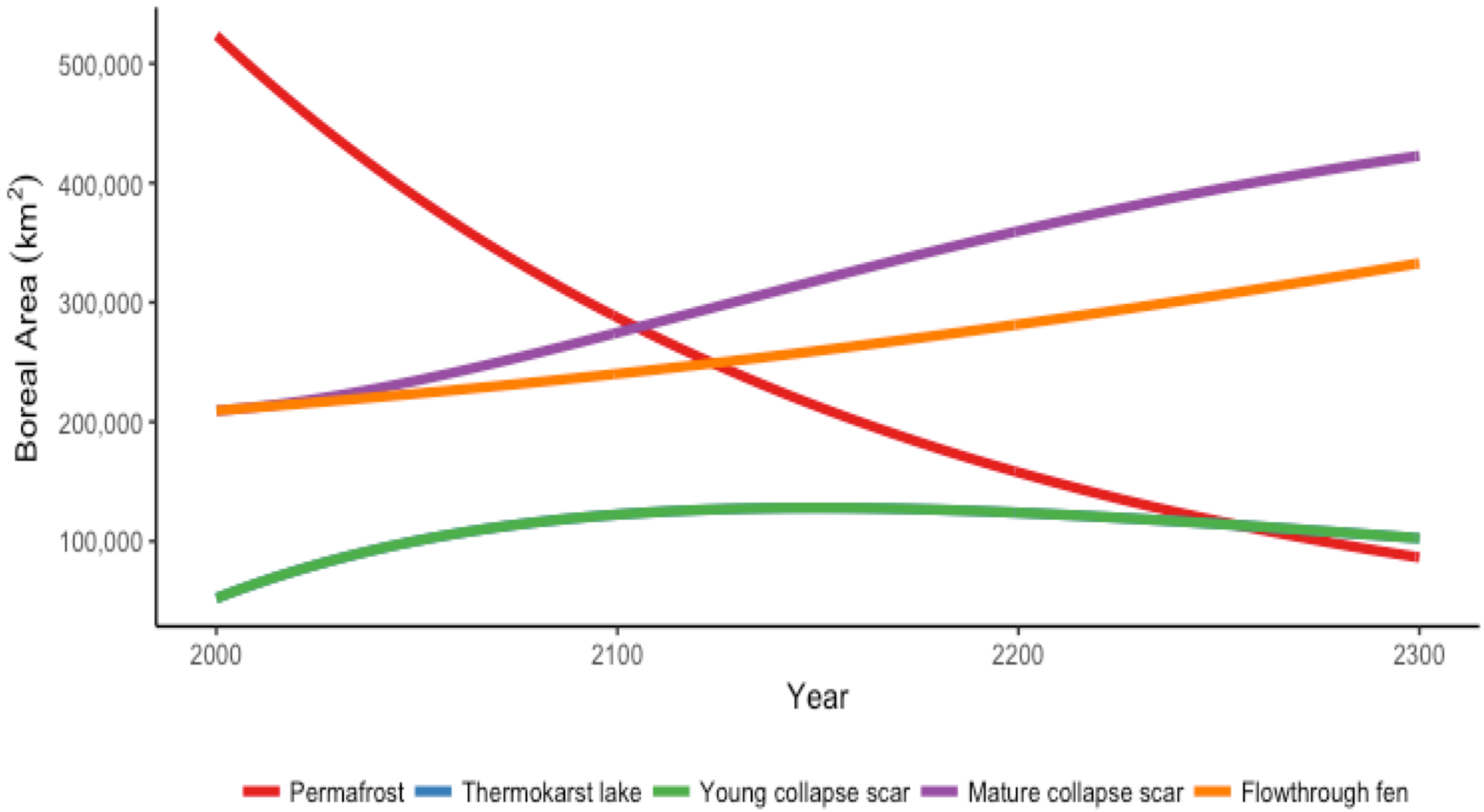
Organic lowland terrain:
thaw wetlands



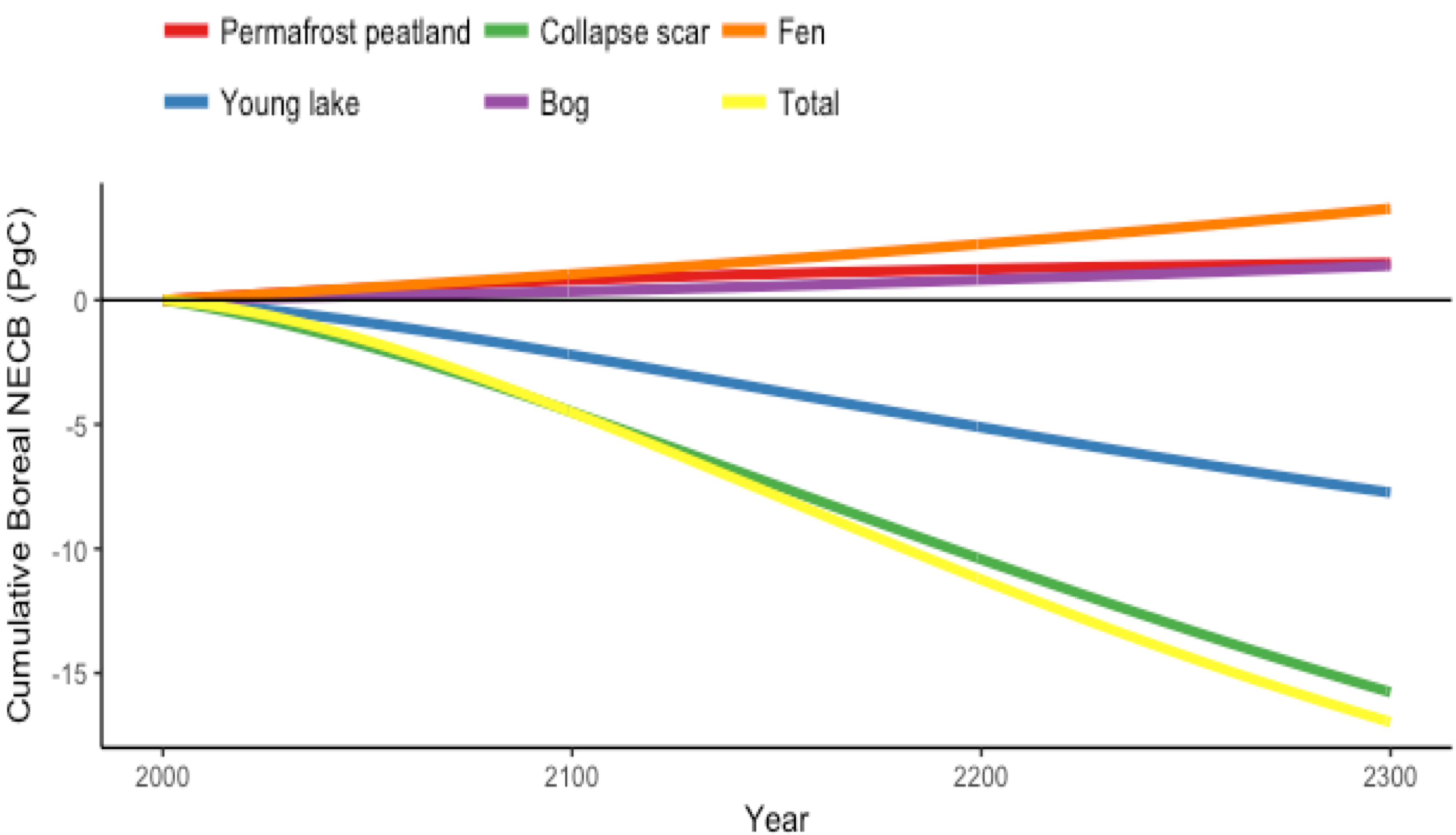


Hillslope terrain:
thaw slumps/slides

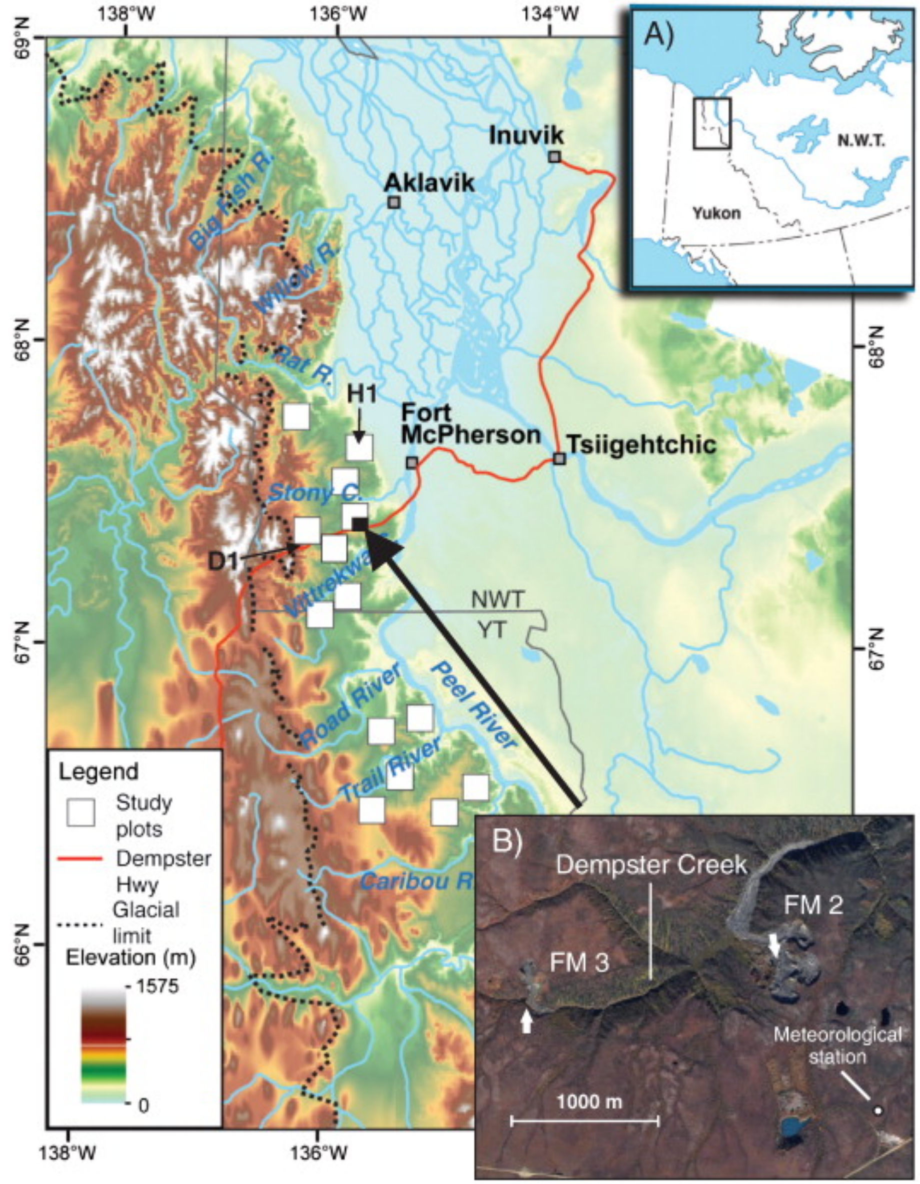
Simulated change in areas in lowland organic terrain



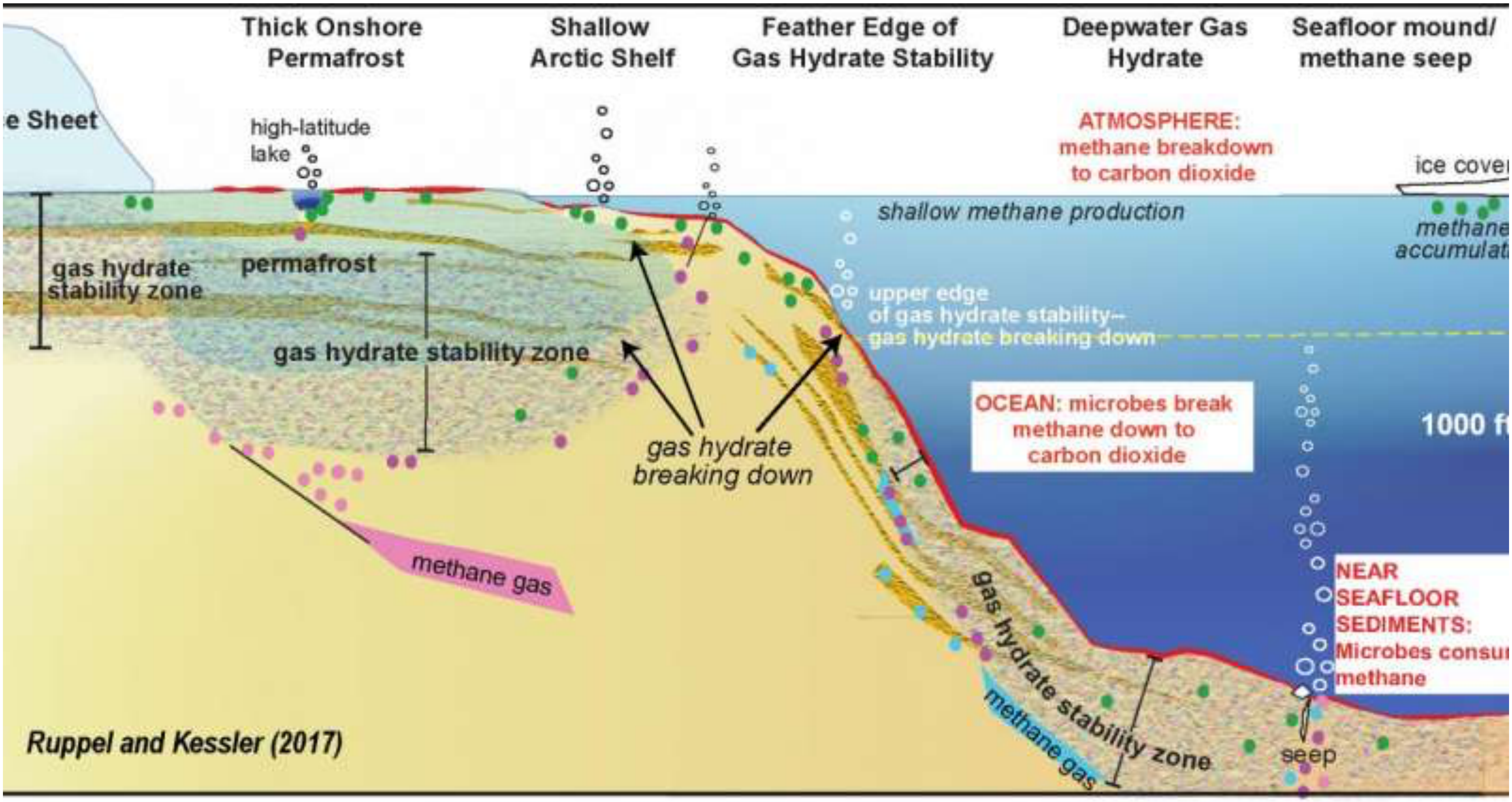
Simulated change in net ecosystem carbon balance



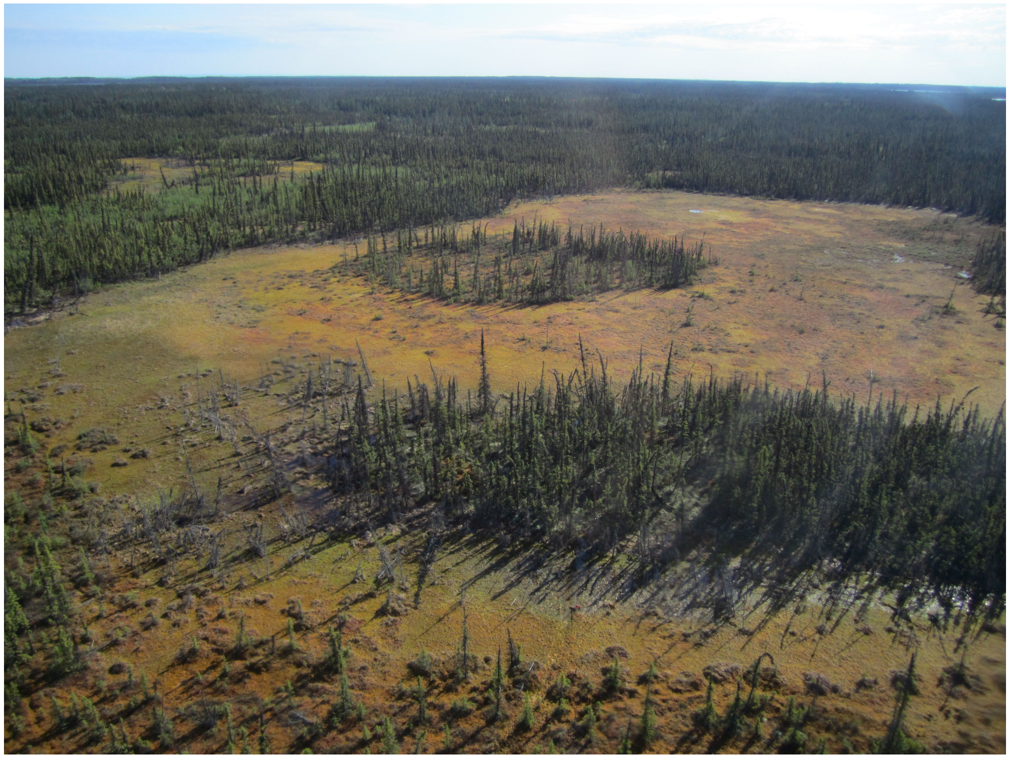
Case study: Peel Plateau megaslumps

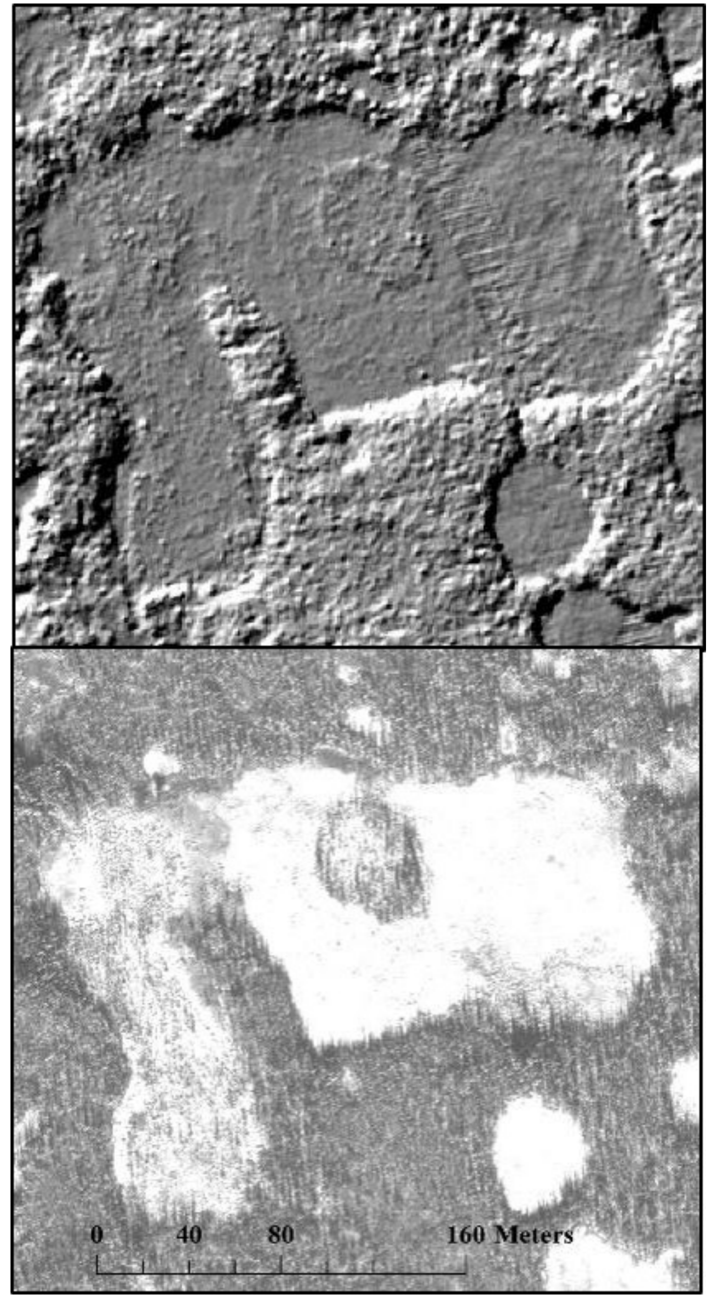


Gas hydrate breakdown unlikely to cause massive greenhouse gas release



What about permafrost peatlands?





permafrost = topography!

Sniderhan and Baltzer 2016