

Permafrost carbon release and degradation at the land-ocean interface

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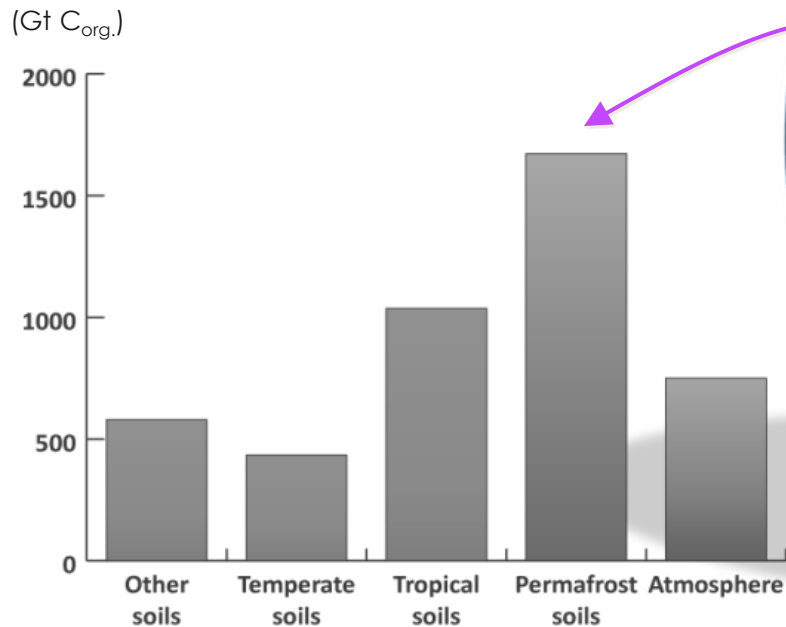


Background

24% of northern landmass

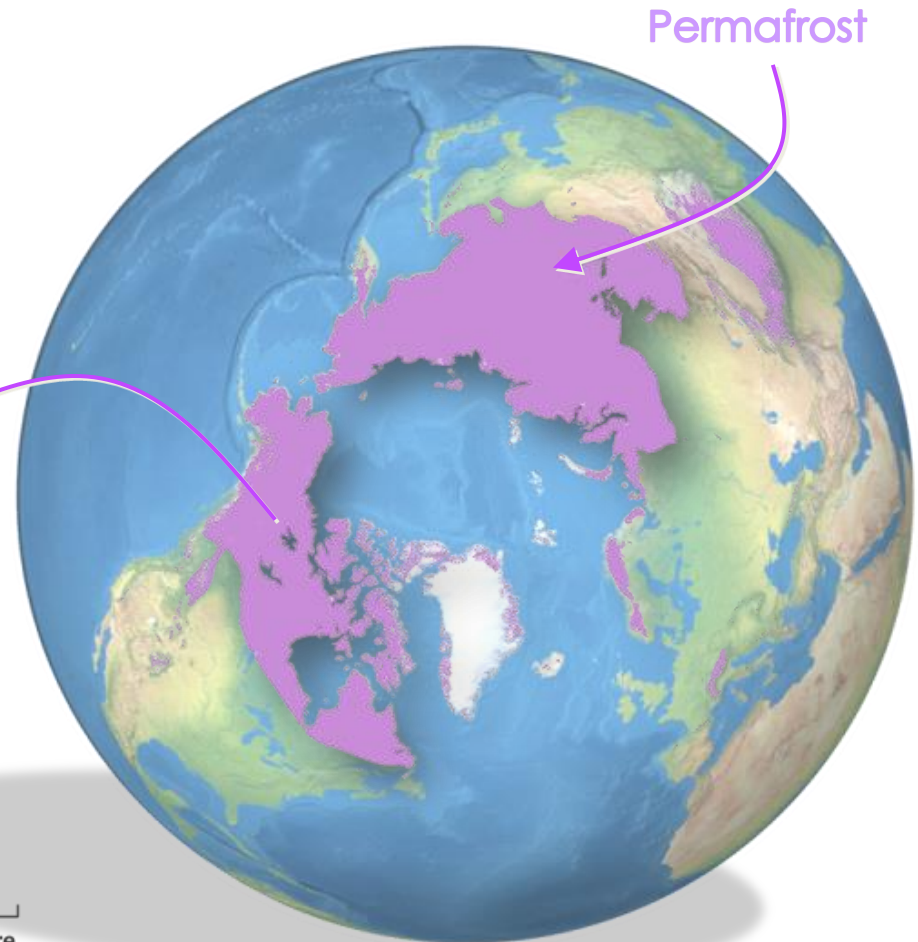
34% of global coasts

400,000 km of coastline



Global carbon storage in soils

TARNOCAI et al. 2009



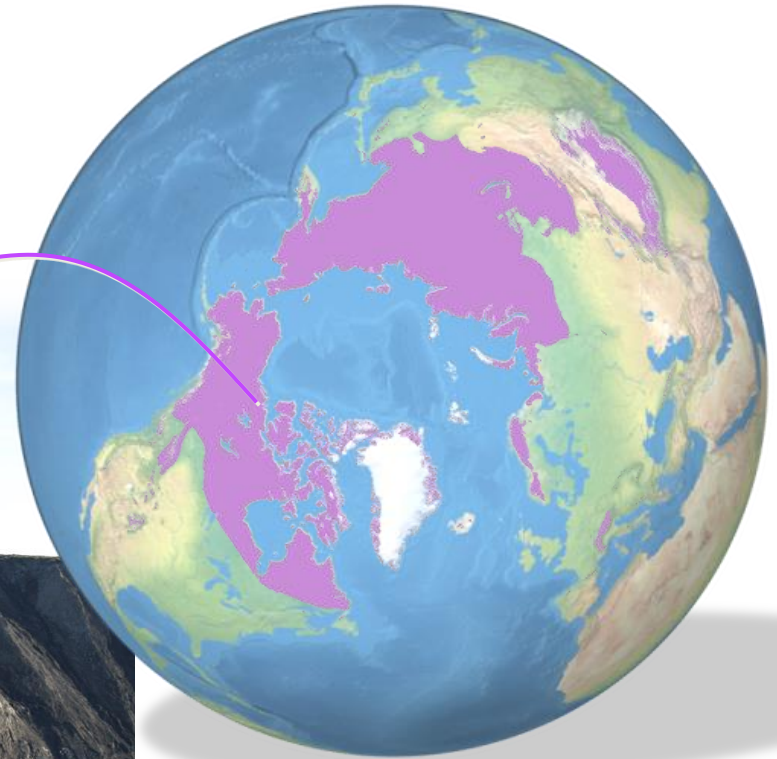
Background

2/3 of the coast are unlithified

Erosion rates up to 10 m yr^{-1}



Herschel Island, Yukon Coast, Canada



Permafrost coasts

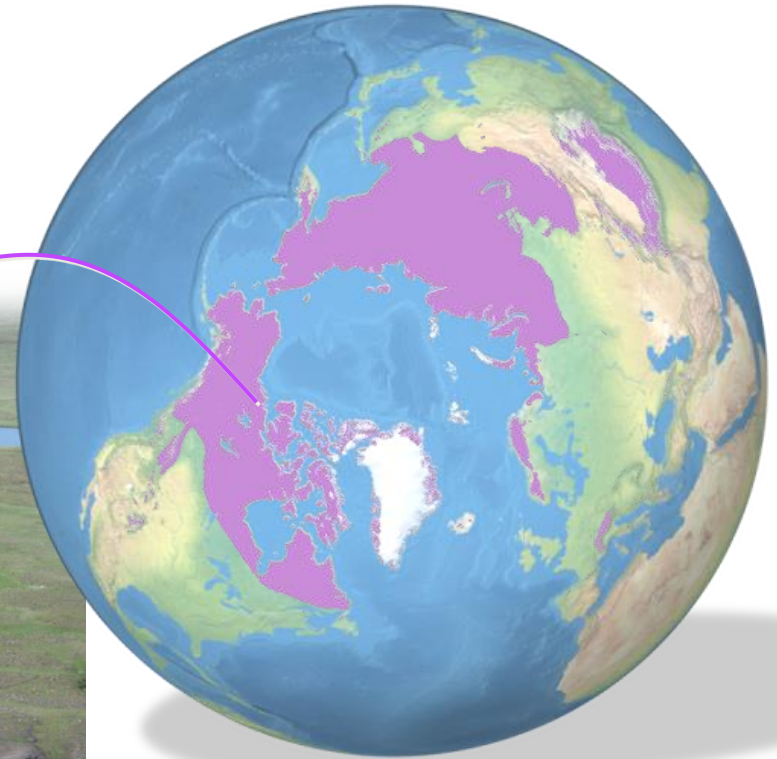
Background

2/3 of the coast are unlithified

Erosion rates up to 10 m yr^{-1}



Komakuk Beach, Yukon Coast, Canada



Permafrost coasts

Background

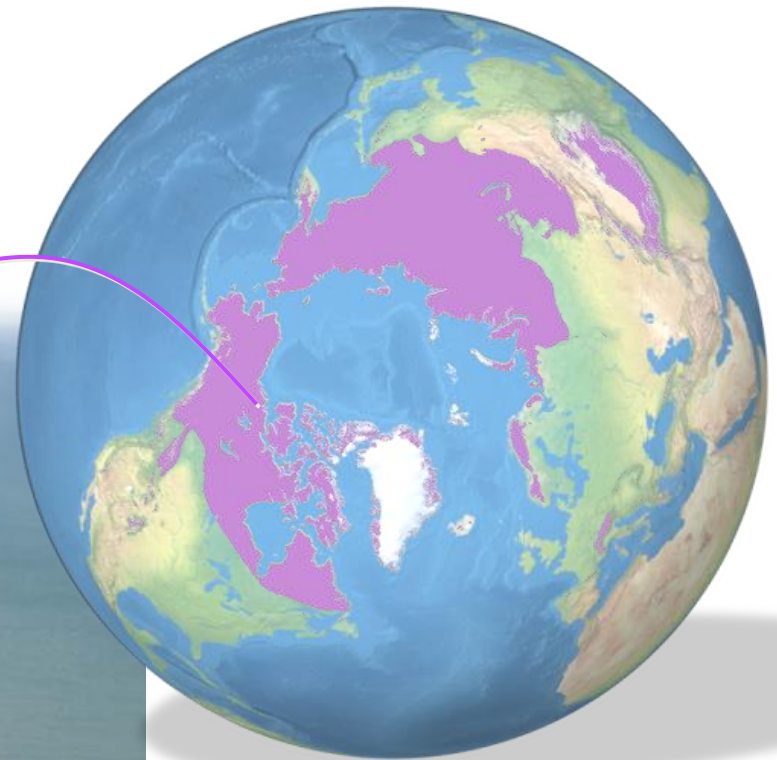
2/3 of the coast are unlithified

Erosion rates up to 10 m yr^{-1}



Herschel Island, Yukon, Canada

Photo: J. WOLTER



Permafrost coasts

Topic I



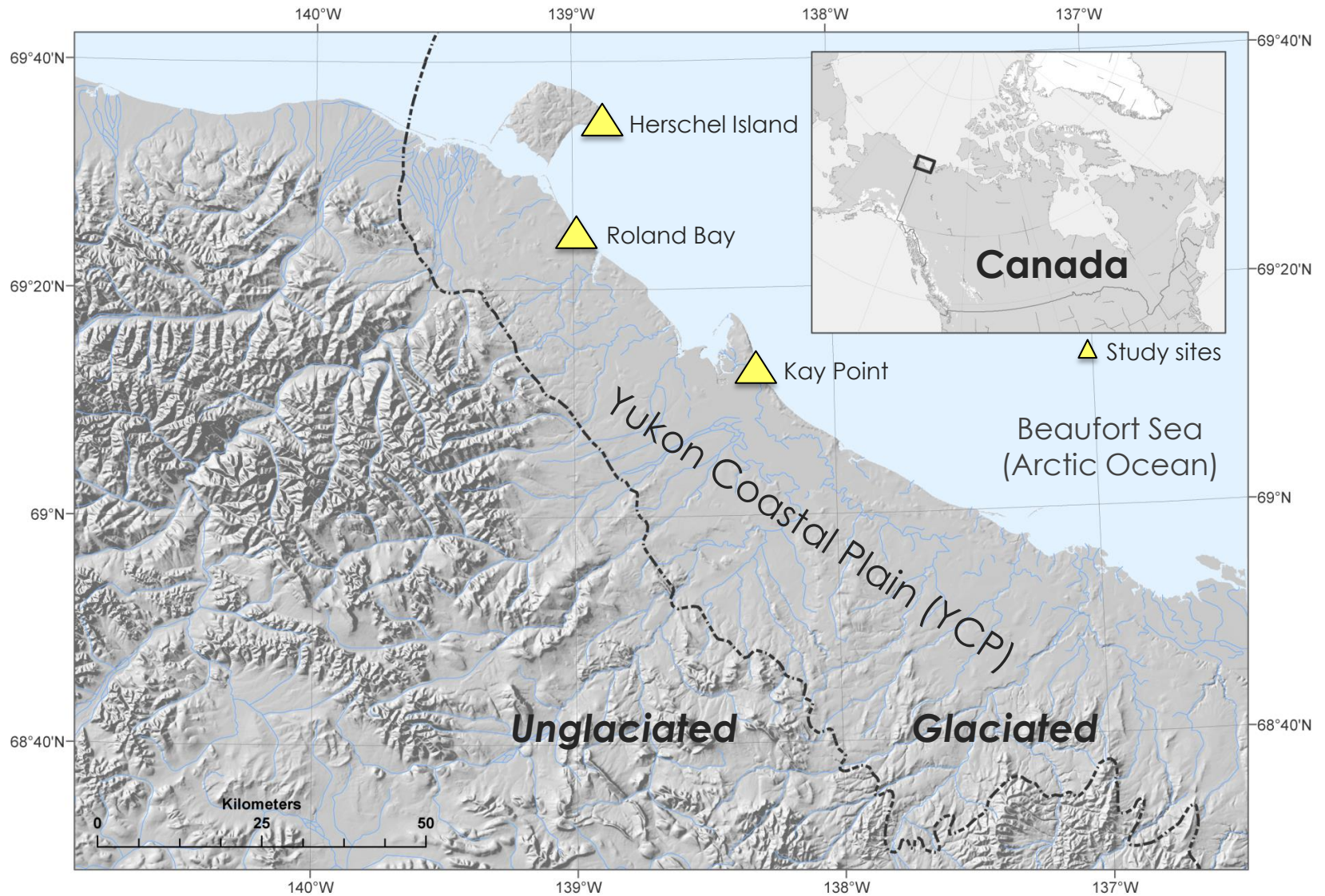
Permafrost coasts release...

Dissolved organic carbon (DOC)
OC \leq 0.45 μm

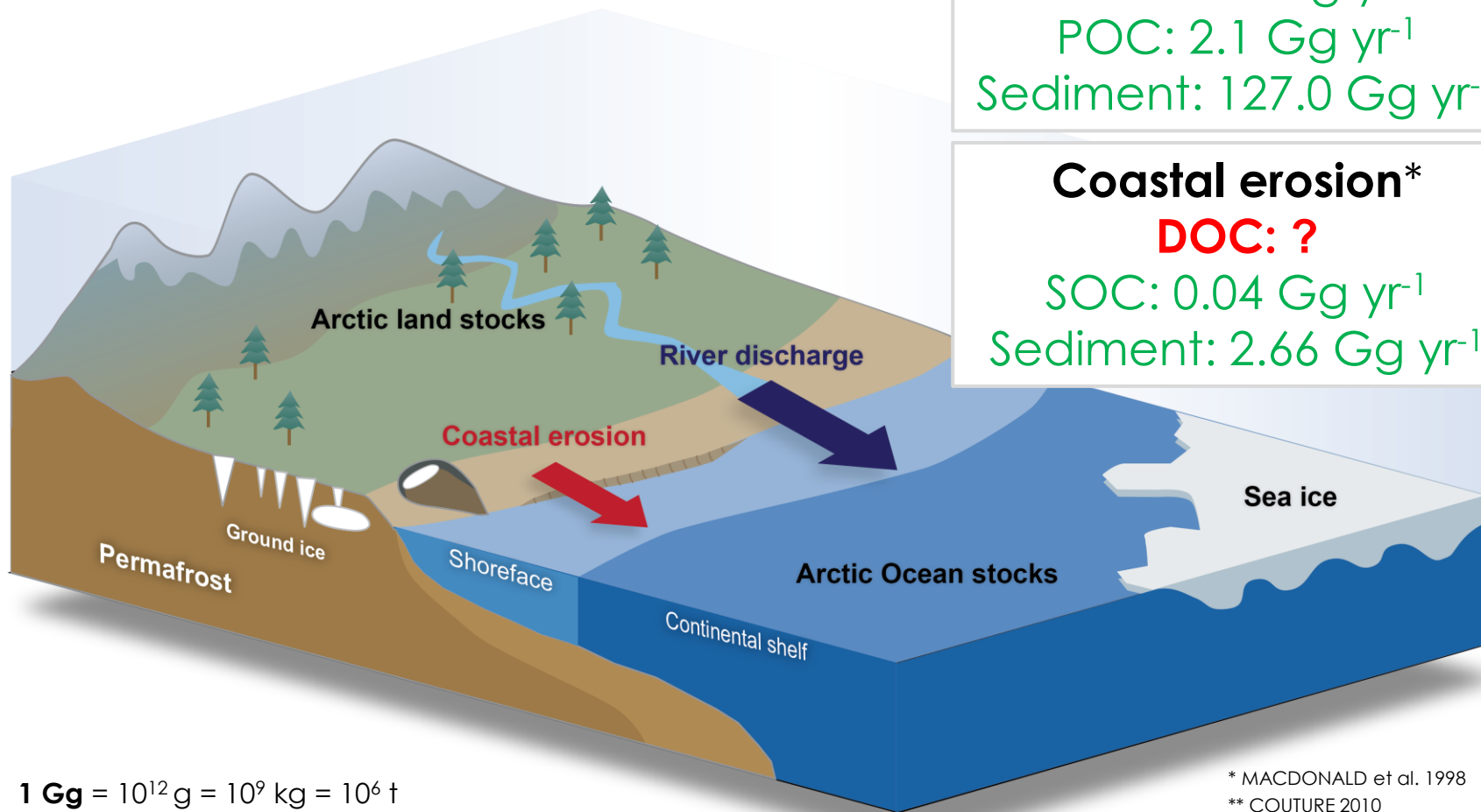
Particulate organic carbon (POC)

Sediments

Topic I: Release of DOC from ground ice



Topic I: Release of DOC from ground ice

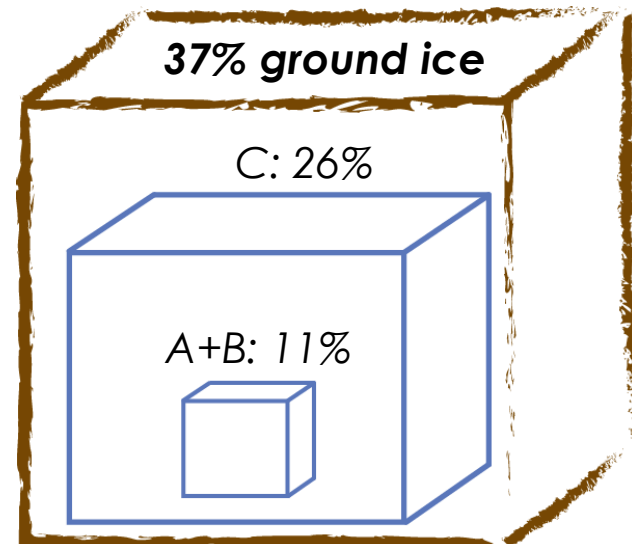


1 Gg = 10¹² g = 10⁹ kg = 10⁶ t

* MACDONALD et al. 1998
** COUTURE 2010

Topic I: Release of DOC from ground ice

- Ground ice content and types along the Yukon Coastal Plain

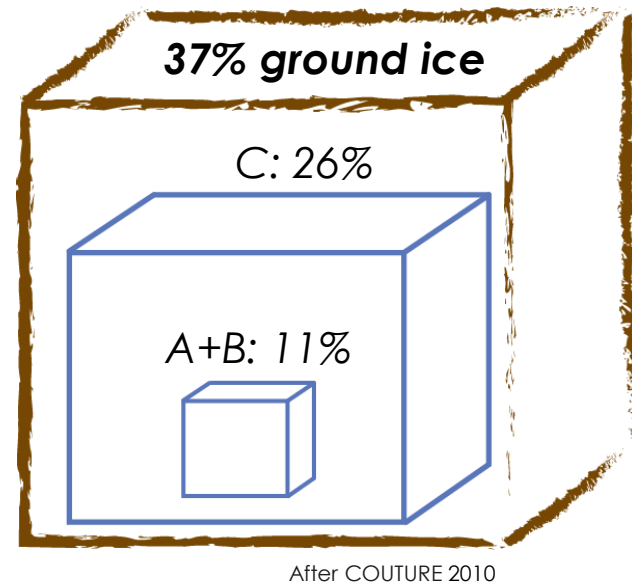
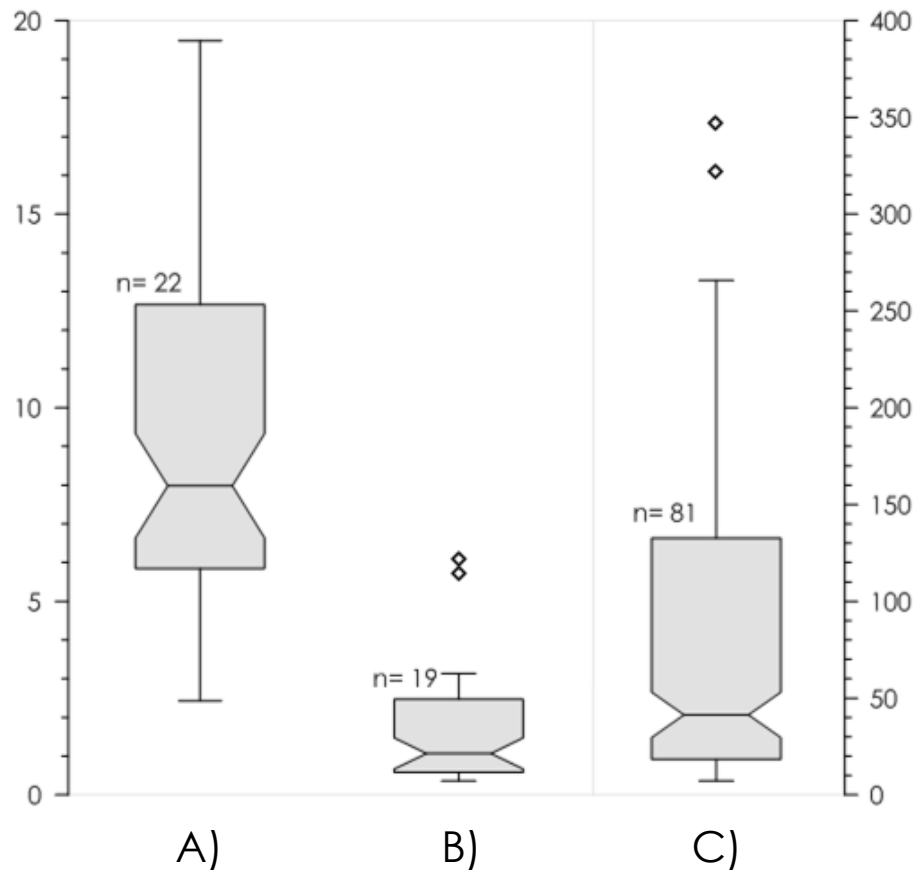


After COUTURE 2010

- A) Ice wedges
- B) Massive ice beds
- C) Pore/Non-massive intrasedimental ice

Topic I: Release of DOC from ground ice

- Ground ice content and types along the Yukon Coastal Plain



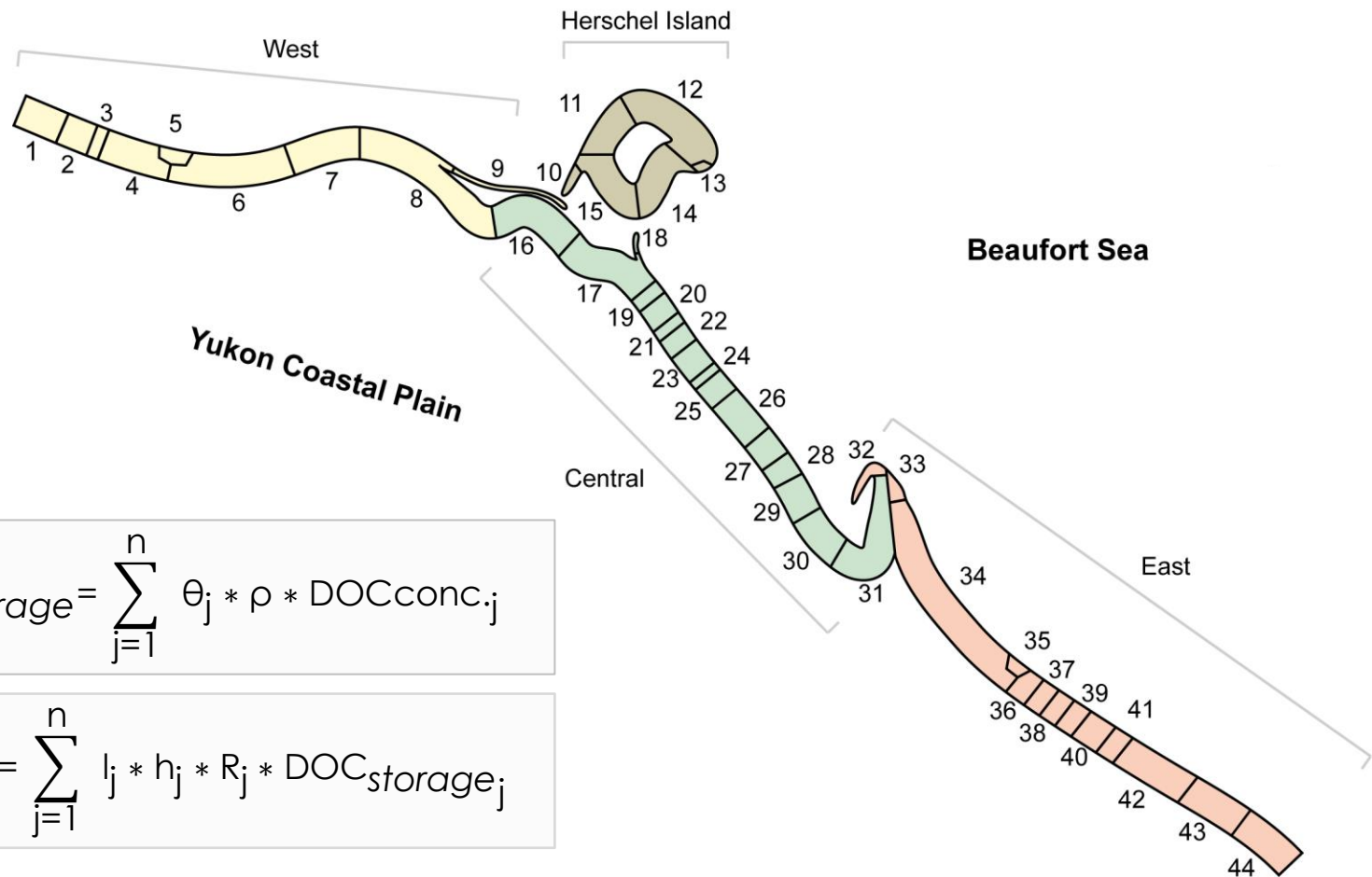
A) Ice wedges

B) Massive ice beds

C) Pore/Non-massive intrasedimental ice

Topic I: Release of DOC from ground ice

- Calculation of DOC flux

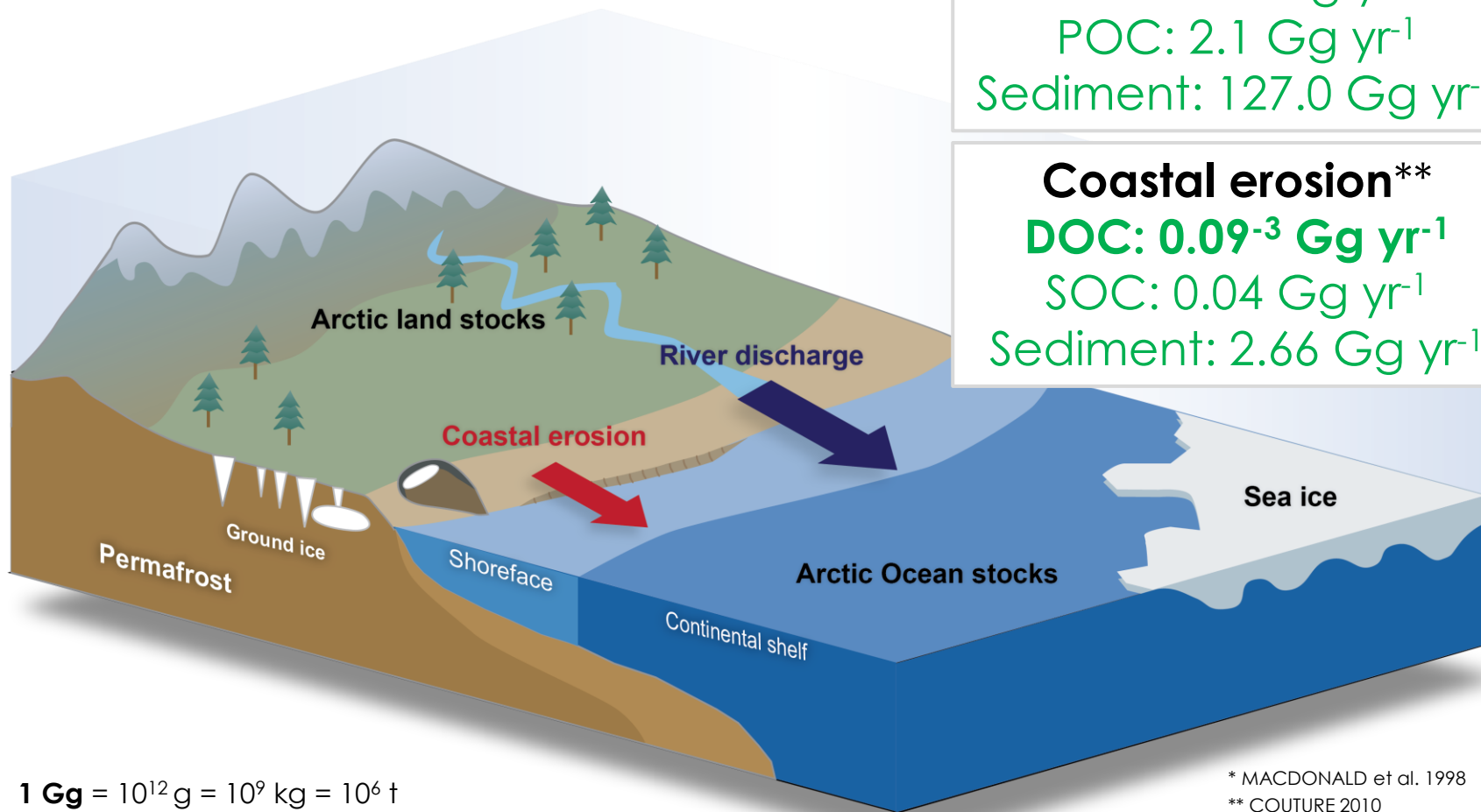


$$DOC_{storage} = \sum_{j=1}^n \theta_j * \rho * DOC_{conc.j}$$

$$DOC_{flux} = \sum_{j=1}^n l_j * h_j * R_j * DOC_{storage.j}$$

Modified, after COUTURE 2010

Topic I: Release of DOC from ground ice



Topic I: Conclusion



- Low dissolved organic carbon fluxes from eroding permafrost coasts
- Western part and Herschel Island are hotspots
- Mostly fluxes from ice thrust moraine ridges and lacustrine deposits
- Mostly as POC → DOC/POC ratio of ~1:1000
- OC input from the Mackenzie dominates the Beaufort Sea
- But: High bioavailability of DOC assumed
- Recent studies show high bioavailability
 - e.g. VONK et al. 2013 → DOC loss $> 34.0 \pm 0.8\%$ within two weeks
 - e.g. HOOD et al. 2009 → 45% of $\text{DOC}_{\text{terr.}}$ bioavailable

Topic II



Permafrost coasts release...

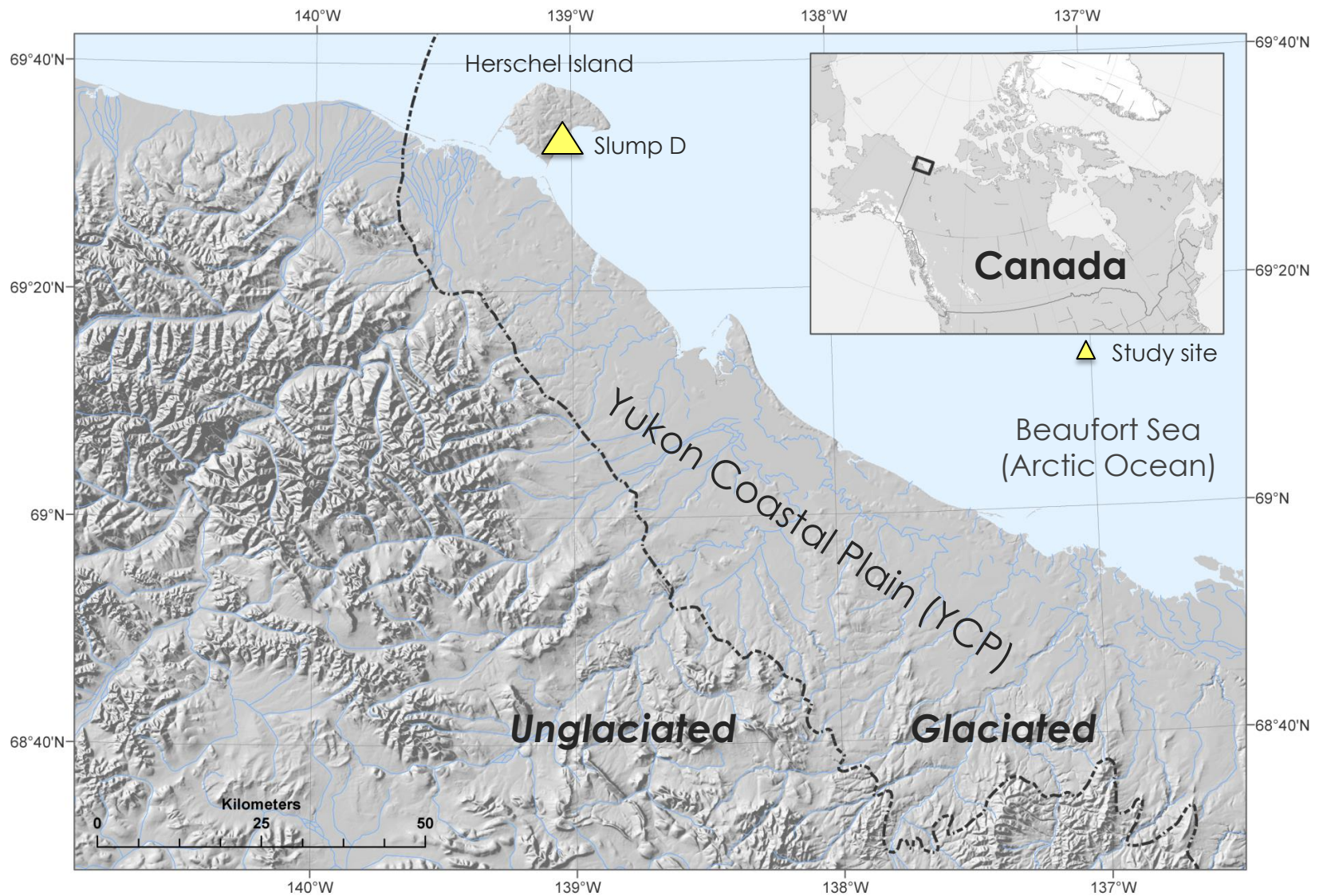
Dissolved organic carbon (DOC)
 $OC \leq 0.45 \mu m$

Particulate organic carbon (POC)

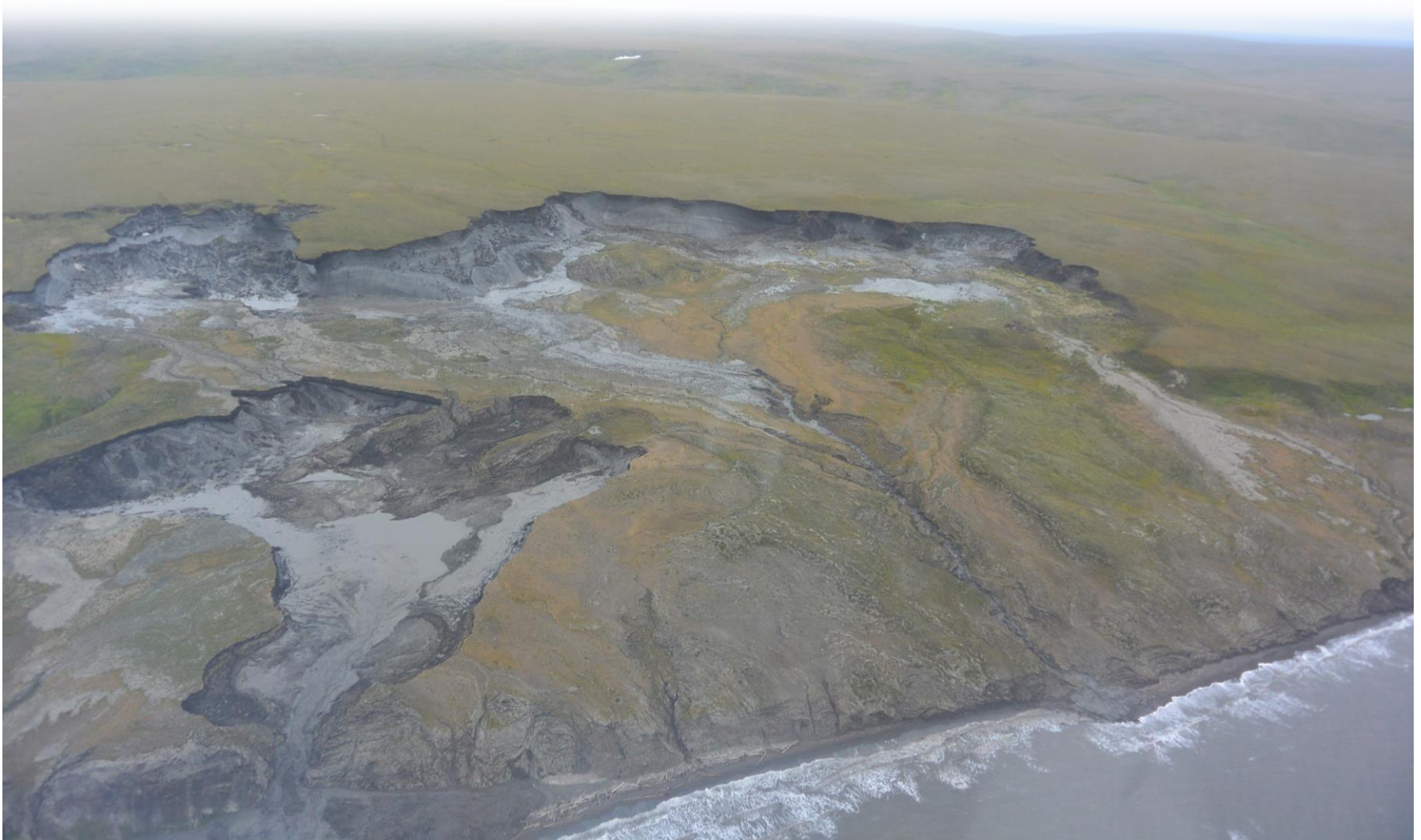
Nutrients (NH_4 , NO_2 , NO_3)

Sediments

Topic II: Degradation of organic matter

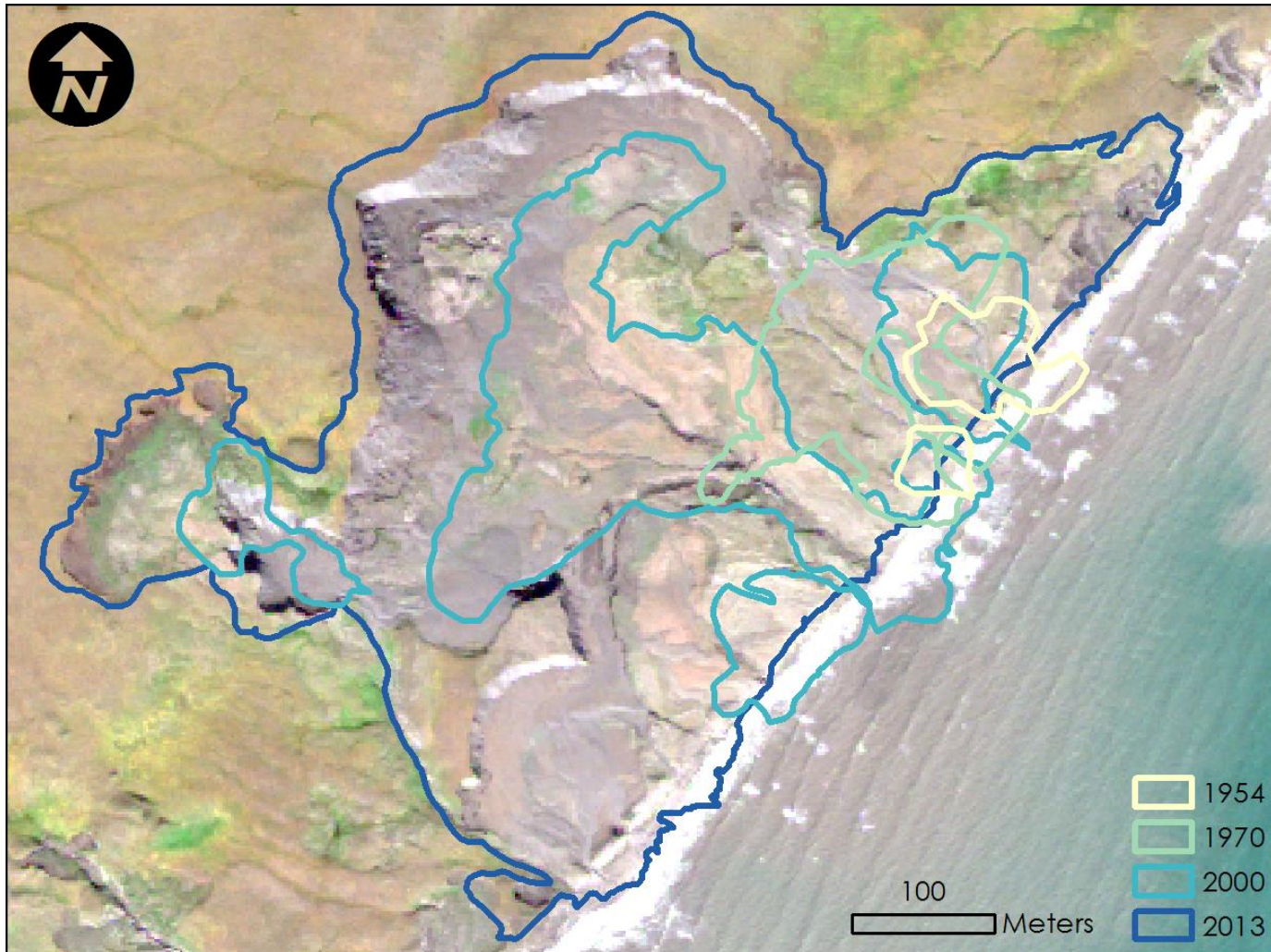


Topic II: Degradation of organic matter



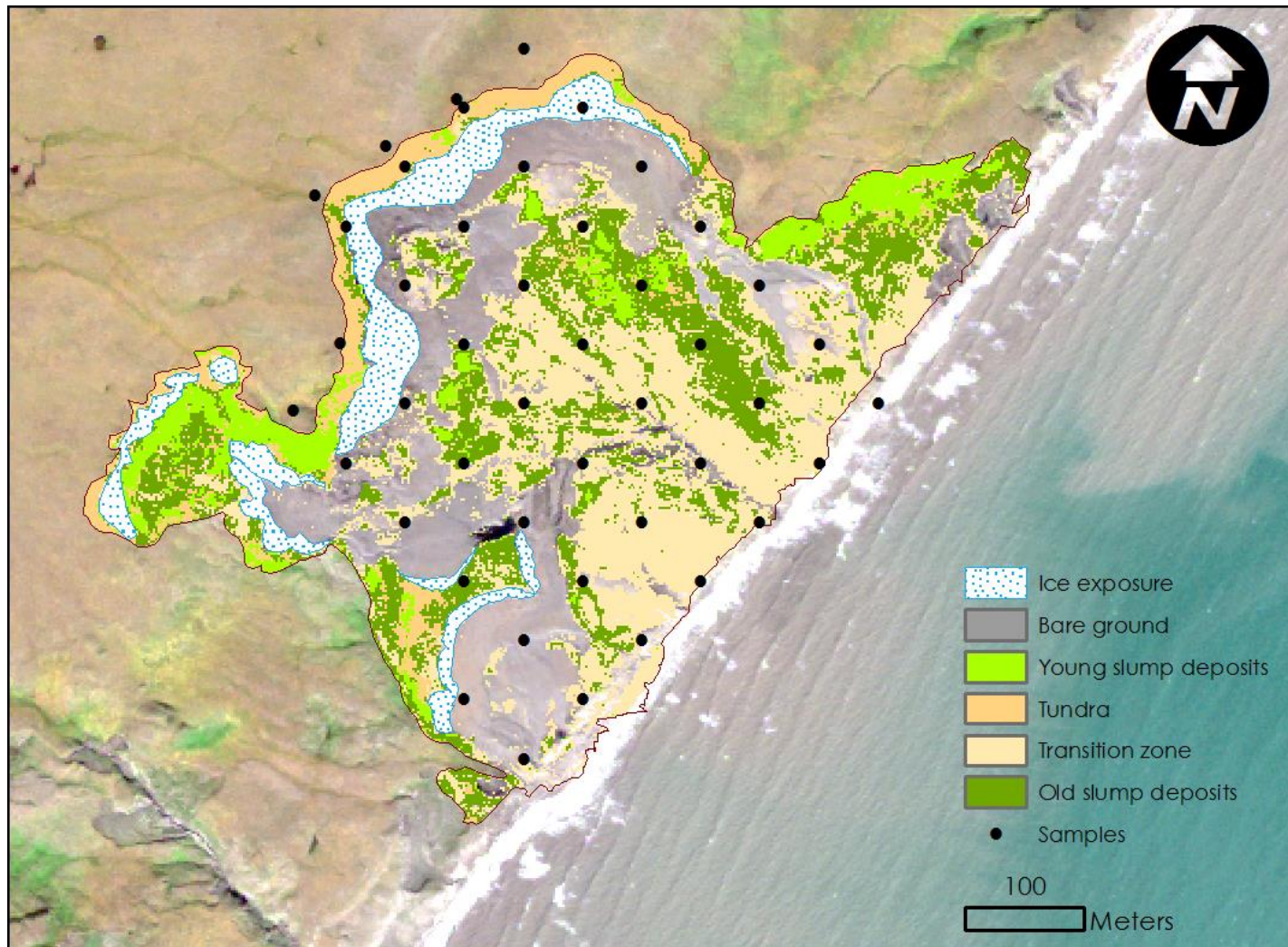
Retrogressive thaw slump: „Slump D“

Topic II: Degradation of organic matter



Evolution of „Slump D“

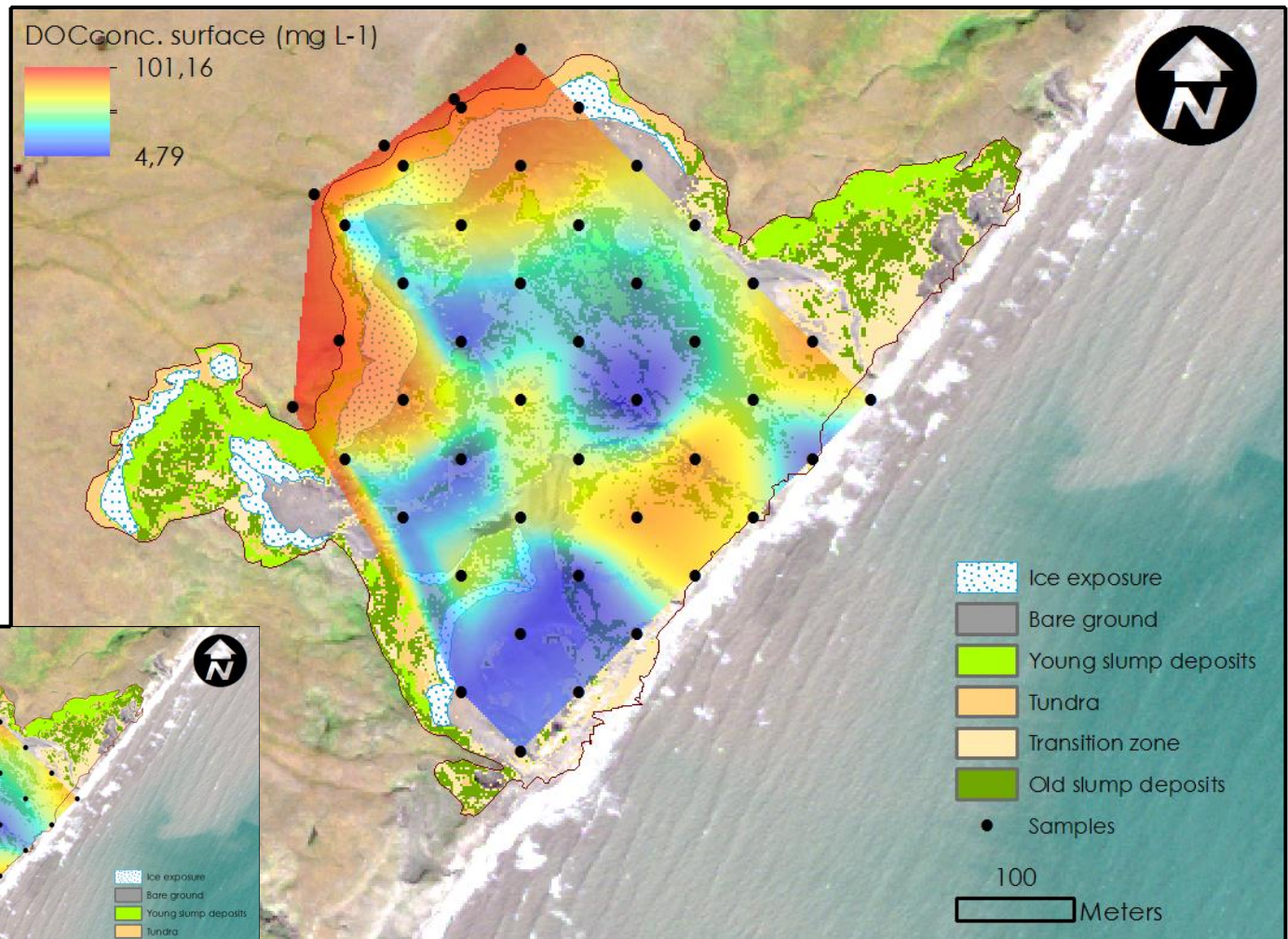
Topic II: Degradation of organic matter



Vegetation classification of „Slump D“ based on NDVI

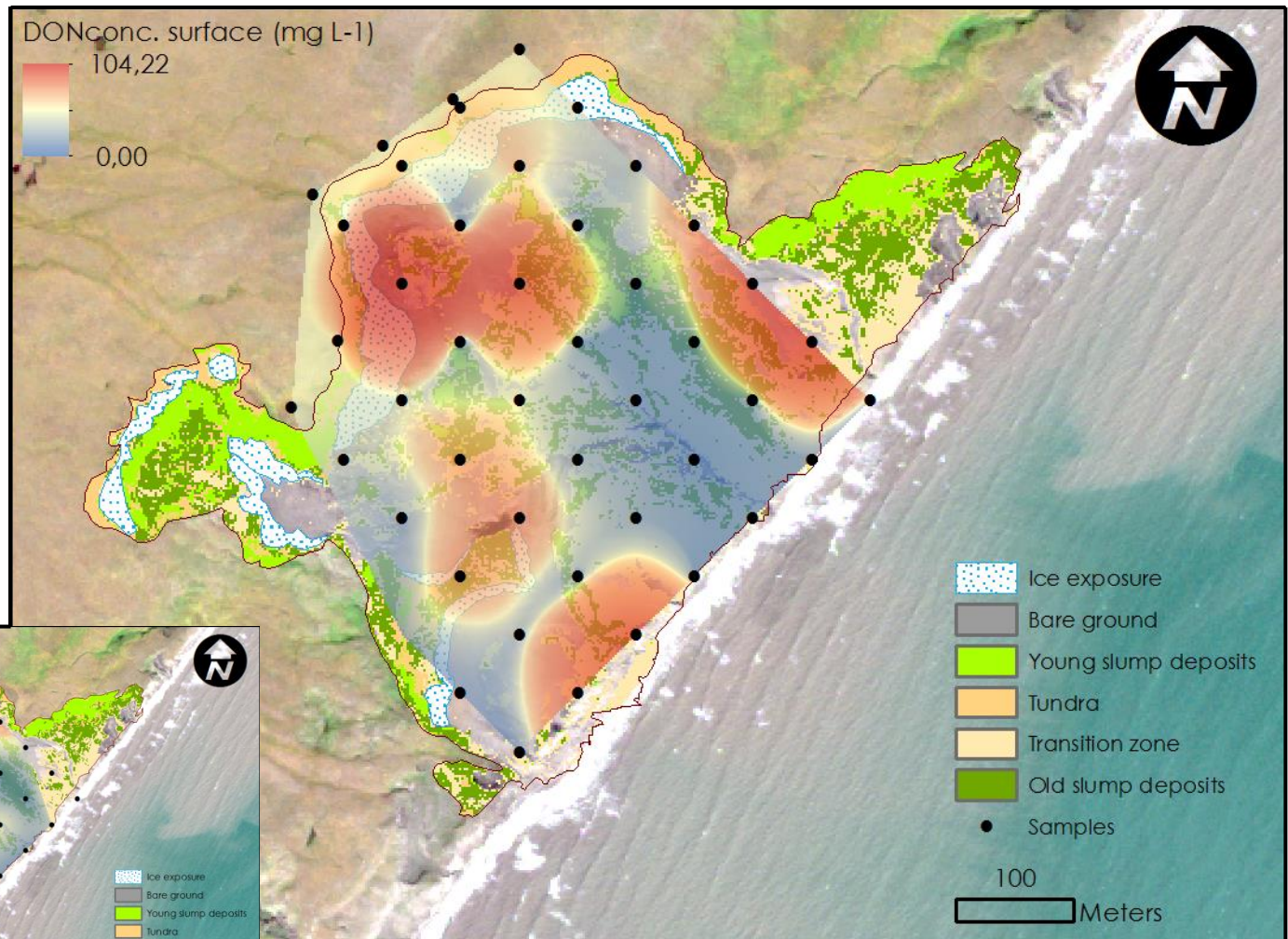
Topic II: Degradation of organic matter

DOC



Topic II: Degradation of organic matter

DON

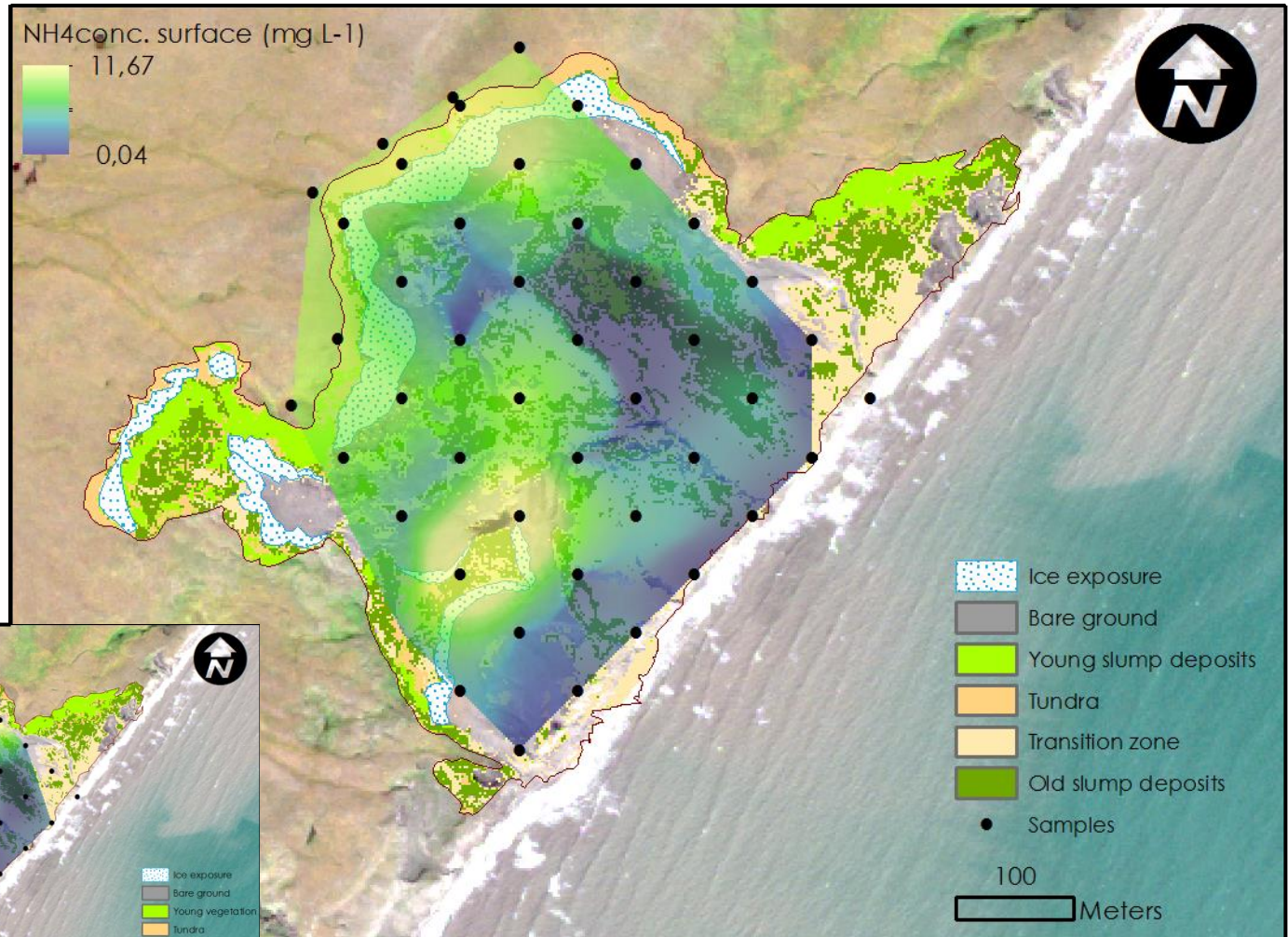


Surface/10cm depth

30cm depth

Topic II: Degradation of organic matter

NH₄



Topic II: Conclusion



- DOC conc. gradient from permafrost headwall to slump deposits
 - Degradation of DOC right after thawing
- High ammonium conc. directly after thawing
 - Indicator for quick depletion of organic material
- Strong degradation of organic material at the land-ocean interface

Outlook and open questions



What are the degradation mechanisms?

What are the **degradation** patterns of **POC**?

What happens with permafrost carbon after **transport** into the ocean?

What are possible **impacts** on nearshore marine **ecosystem**?

How is OC incorporated into local **food webs**?

PYRN

- PYRN celebrates its 10th anniversary
- Just released its long-term strategy until 2018
- Is seeking to increase the network
- More involvement of east asian partners planned
- @ICOP 2016 big young researcher workshop planned
- ICOP 2016 chance to be part of the new Executive Committee
- You can apply for travel funding!



Thank you very much for the attention!

Herschel Island, Yukon, Canada

