

Drained lake basins in lowland permafrost regions



APRI Annual Meeting 2022

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MAX PLANCK
GESELLSCHAFT



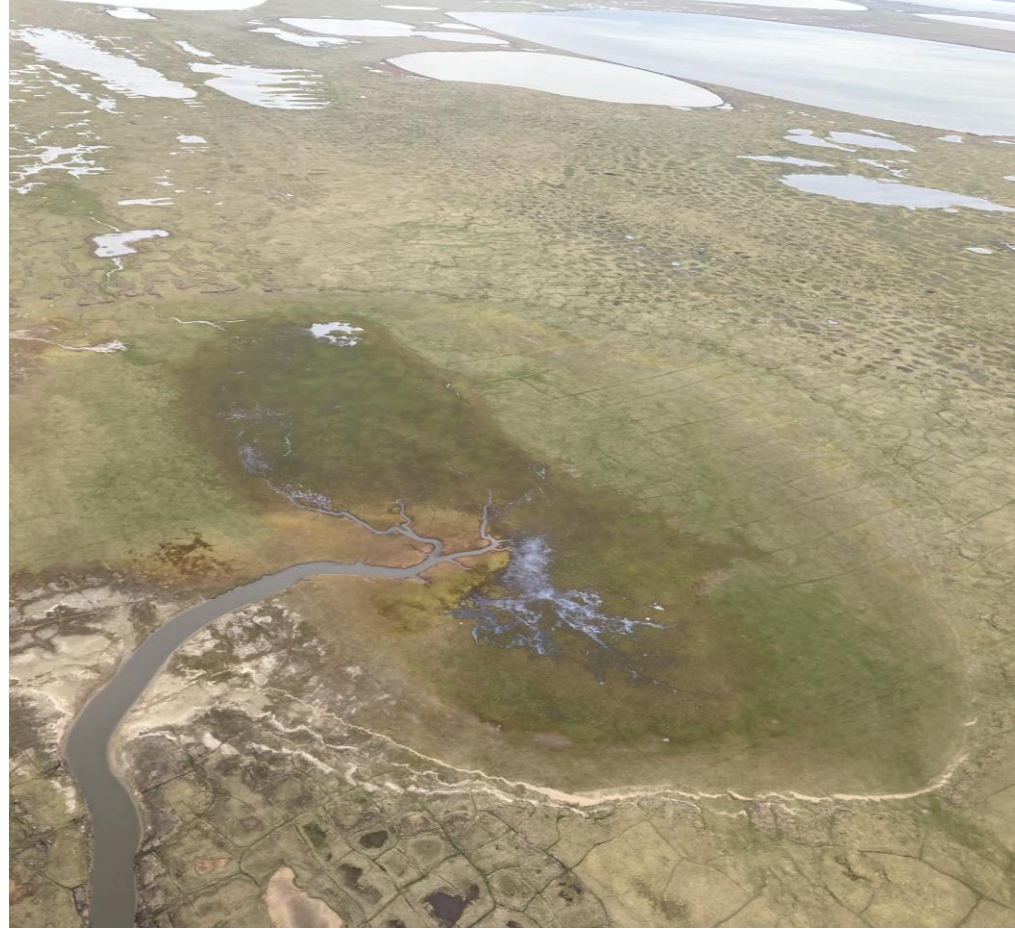
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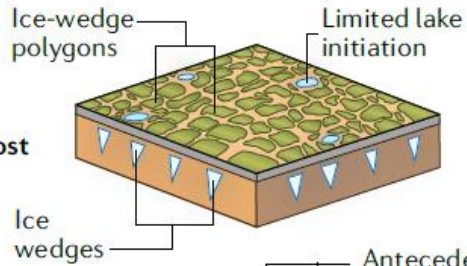
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Drained lake basins (DLBs) in lowland permafrost regions

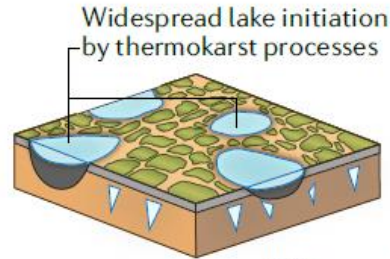
- Lakes and drained lake basins (**DLB**) are ubiquitous landforms in permafrost lowland regions.
- DLBs cover **50% to 75%** of permafrost lowlands in parts of Alaska, Siberia, and Canada
- DLB mapping/delineation using remote sensing
- Local - regional studies → large scale studies



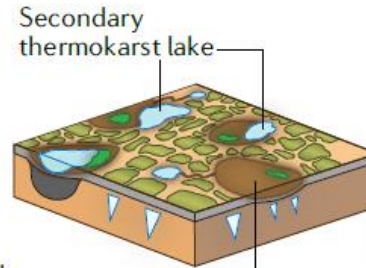
a End of Last Glacial Maximum



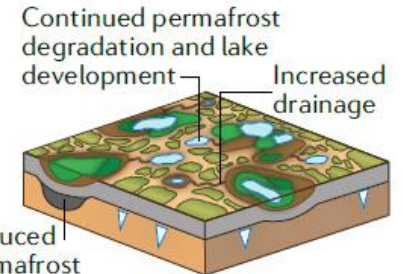
b Deglacial and Early Holocene



c Mid and Late Holocene



d Warmer future



Ice-rich permafrost

Ice-poor permafrost

Antecedent depressions

Widespread lake initiation

Lake drainage

Permafrost degradation

Permafrost aggradation

Reduced permafrost aggradation

Secondary thermokarst lake development

■ Active layer ▽ Ice wedge ■ Permafrost ■ Talik

Jones et al., 2022

Mapping DLBs on a circumpolar scale – International Permafrost Association Action Group

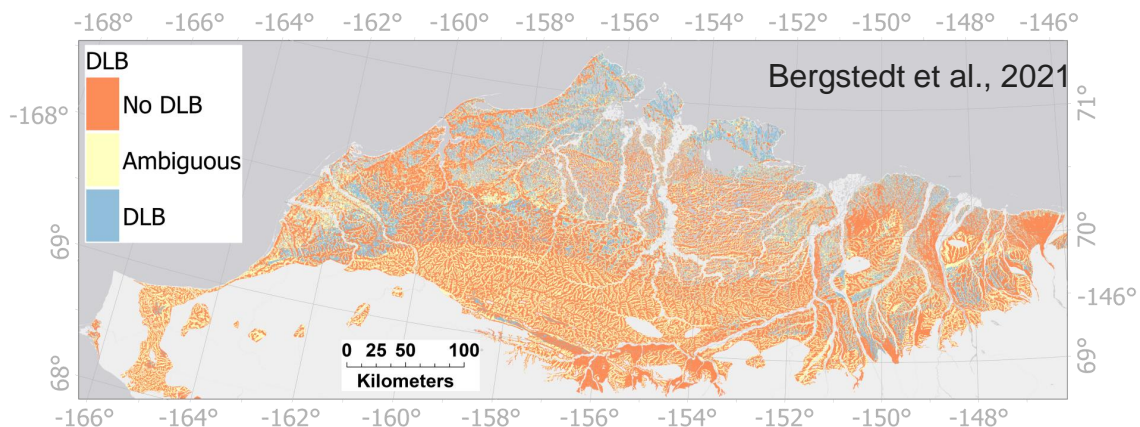
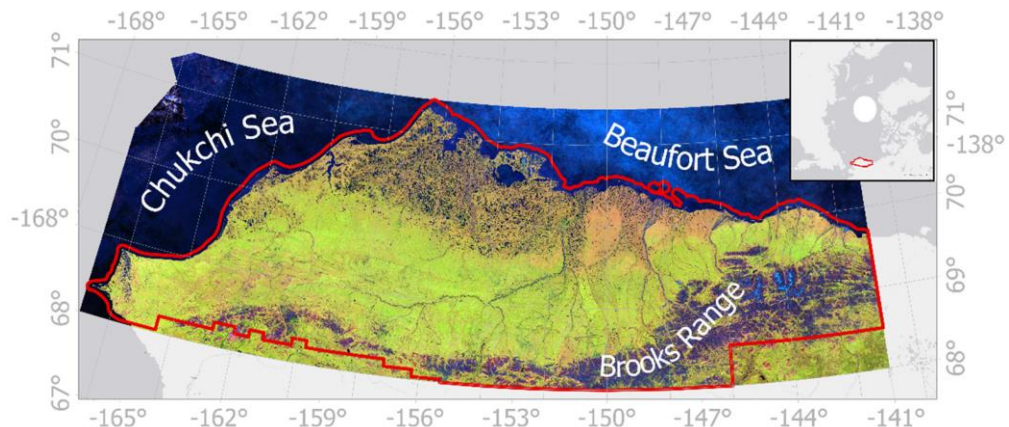
- Coordinated pan-Arctic scale effort
 - Deriving a pixel-by-pixel statistical assessment of likelihood of DLB
 - Quantify coverage of DLBs
 - Create a DLB drainage age database
 - Review Paper: Jones et al. 2022
- Constraining study area by Olefeldt et al. 2016 - Lake Thermokarst landscape coverage

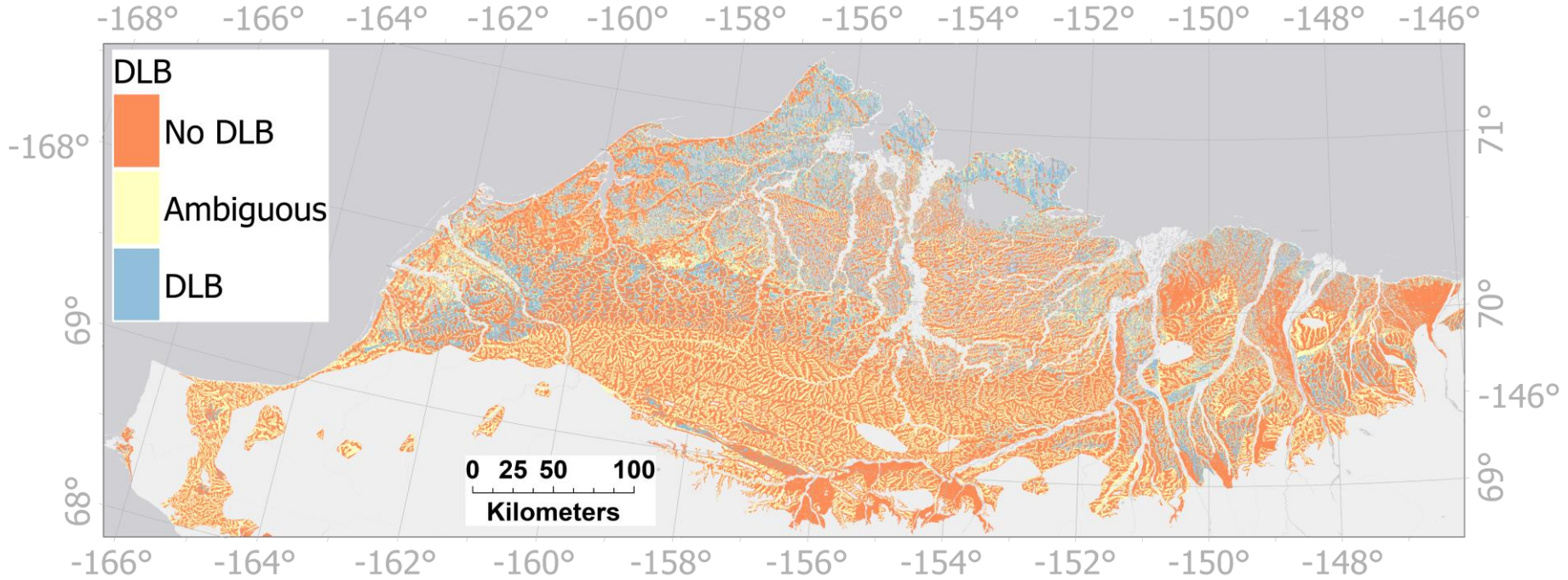


DLB map prototype – North Slope Alaska



- Statistical approach → Local Moran's I: measure of spatial association
- ArcticDEM → exclude ridges, narrow valley
- Calibrated using manually classified random points
- Validated using random points + previously published data



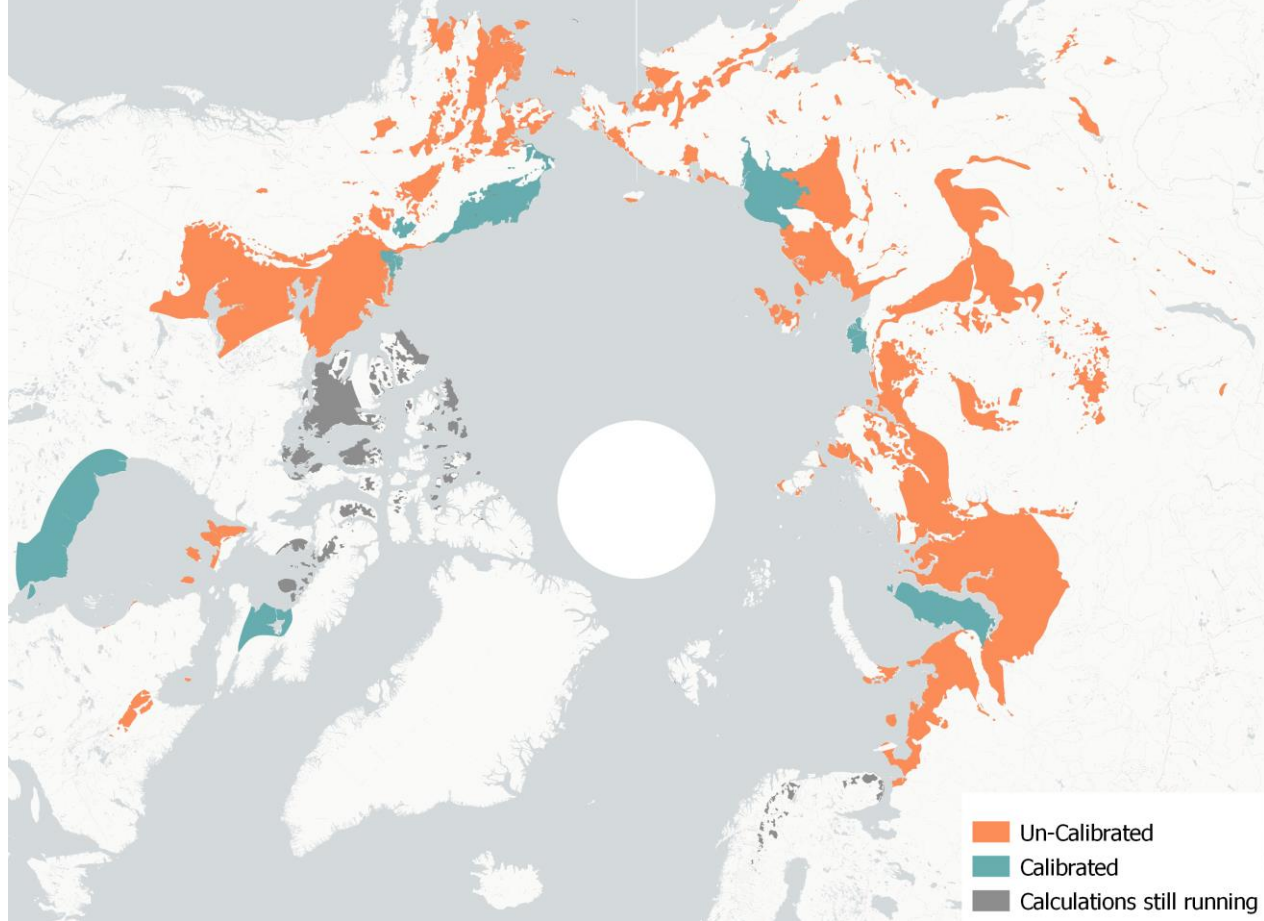


Bergstedt et al., 2021

Circumpolar DLB mapping effort - Status

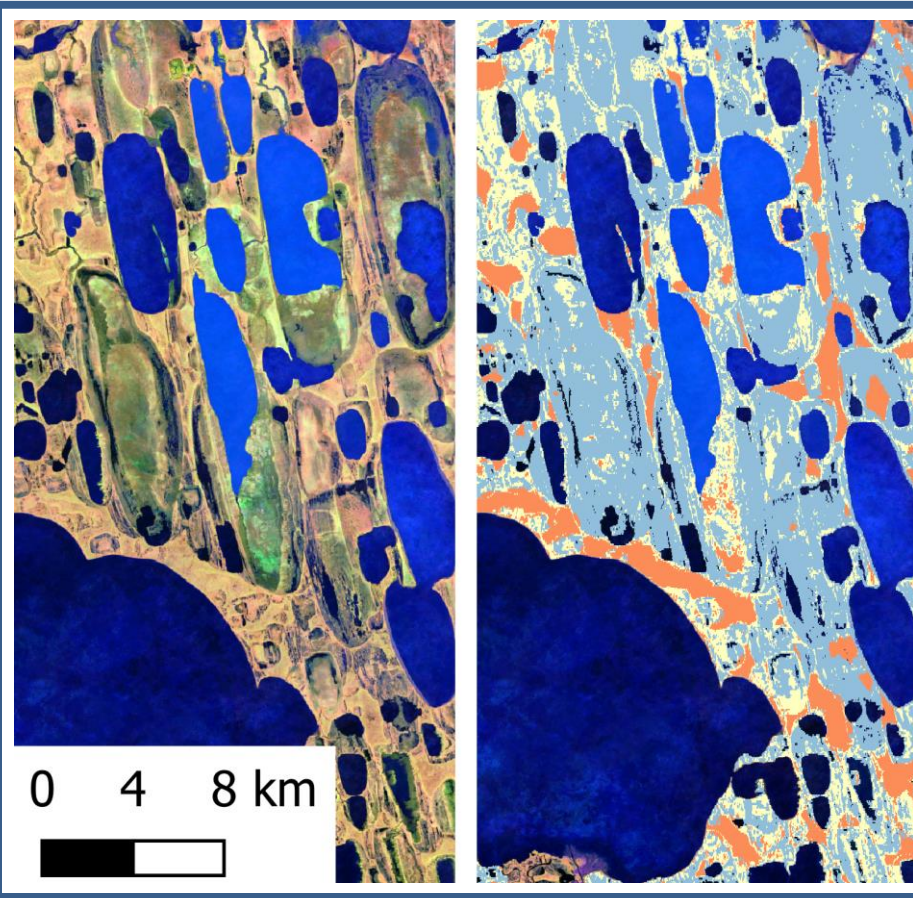
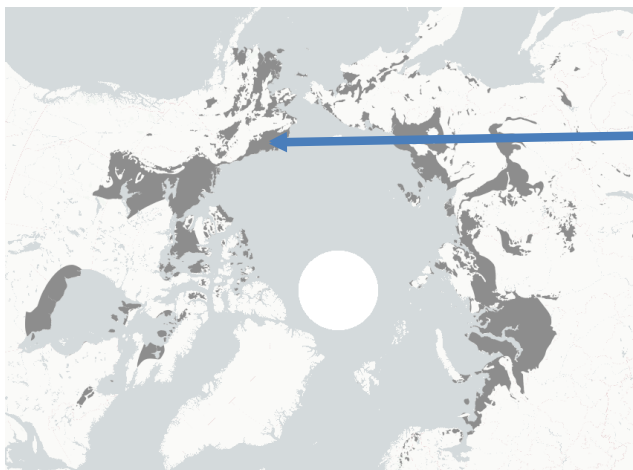
- Input data:
 - Landsat-8 imagery 2014-2019
 - Copernicus DEM
- Calibration ~2000 points manually classified
- Constraining study area by Olefeldt et al. 2016 - Lake Thermokarst landscape coverage

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DLBs north east of Teshekpuk Lake



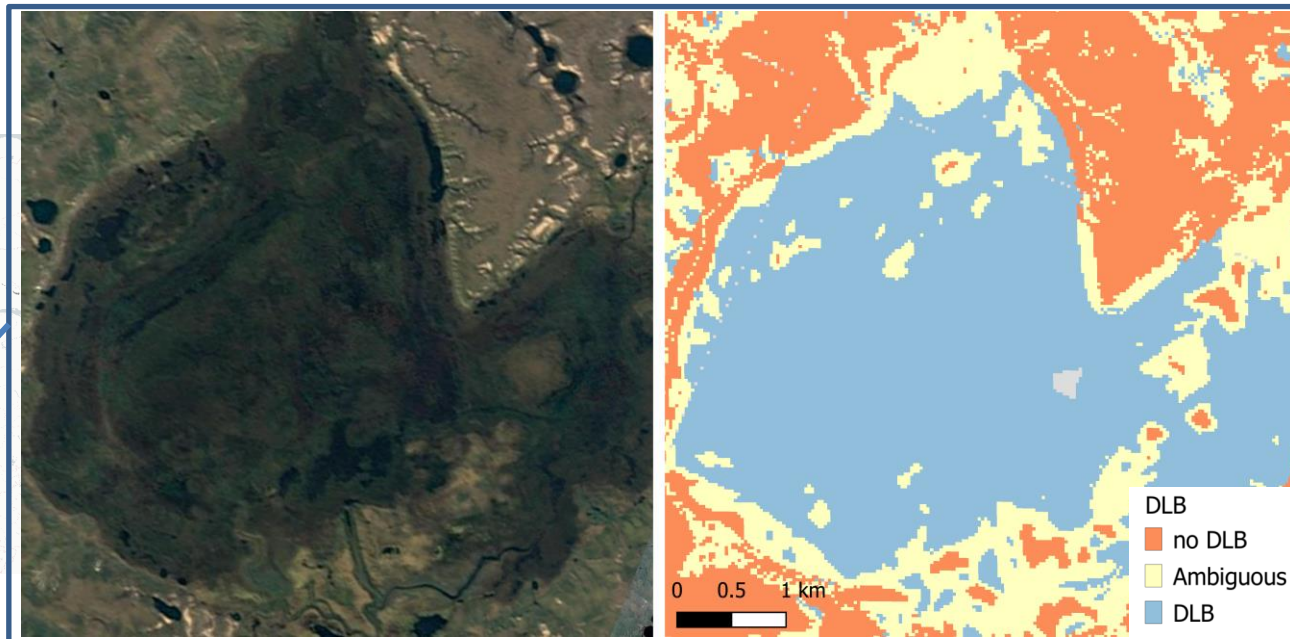
DLB

no DLB

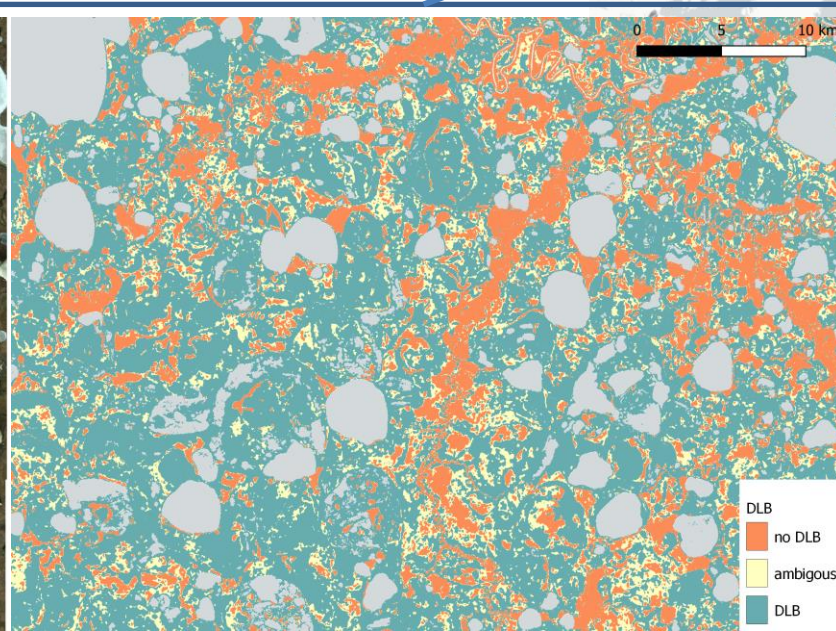
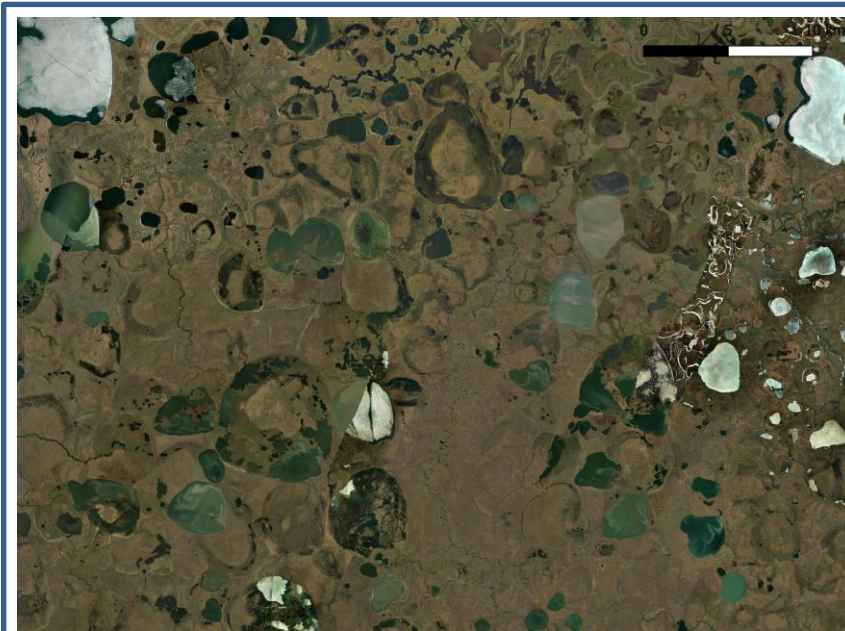
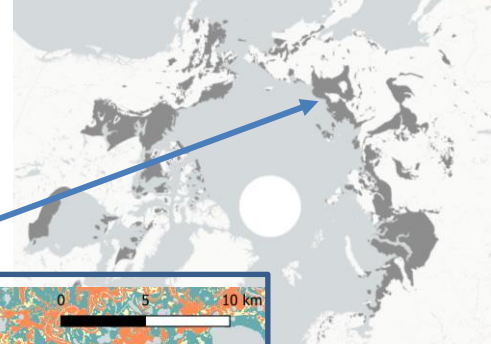
Ambiguous

DLB

DLBs on Yamal Peninsula, Siberia



DLBs Chersky Region



Database on DLB ages

Lead by Action Group members
Louise Farquharson, Juliane Wolter
+ Guido Grosse

- C14 Dates of lake drainage
- Radiocarbon dates from the base of terrestrial peat
- Collection from samples taken by AG members + dates from literature



Outlook

- Dedicated sessions at AGU 2022 and EUCOP 2023
- Publication of remote sensing based DLB inventory and DLB ages database
- Potential for “space for time” and upscaling efforts
 - Upscaling of field data
 - Potential classification of DLBs according to age



Thank you for your attention!

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Bergstedt, H.; Jones, B.M.; Hinkel, K.; Farquharson, L.; Gaglioti, B.V.; Parsekian, A.D.; Kanevskiy, M.; Ohara, N.; Breen, A.L.; Rangel, R.C.; Grosse, G.; Nitze, I. Remote Sensing-Based Statistical Approach for Defining Drained Lake Basins in a Continuous Permafrost Region, North Slope of Alaska. *Remote Sens.* 2021, 13, 2539. <https://doi.org/10.3390/rs13132539>

Frohn, R.C.; Hinkel, K.M.; Eisner, W.R. Satellite Remote Sensing Classification of Thaw Lakes and Drained Thaw Lake Basins on the North Slope of Alaska. *Remote Sens. Environ.* 2005, 97, 116–126.

Jones, B.M., Grosse, G., Farquharson, L.M. *et al.* Lake and drained lake basin systems in lowland permafrost regions. *Nat Rev Earth Environ* 3, 85–98 (2022). <https://doi.org/10.1038/s43017-021-00238-9>

