



EO4PAC & AMPAC

Polar Science Cluster Collocation Meeting 2021

EO4PAC

Earth Observation for Permafrost dominated Arctic Coasts

1st of July 2021 – 31st of June 2023



UNIVERSIDADE
DE LISBOA

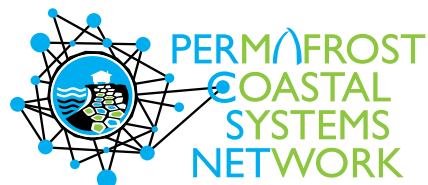


Instituto de Geografia
e Ordenamento do Território
UNIVERSIDADE DE LISBOA

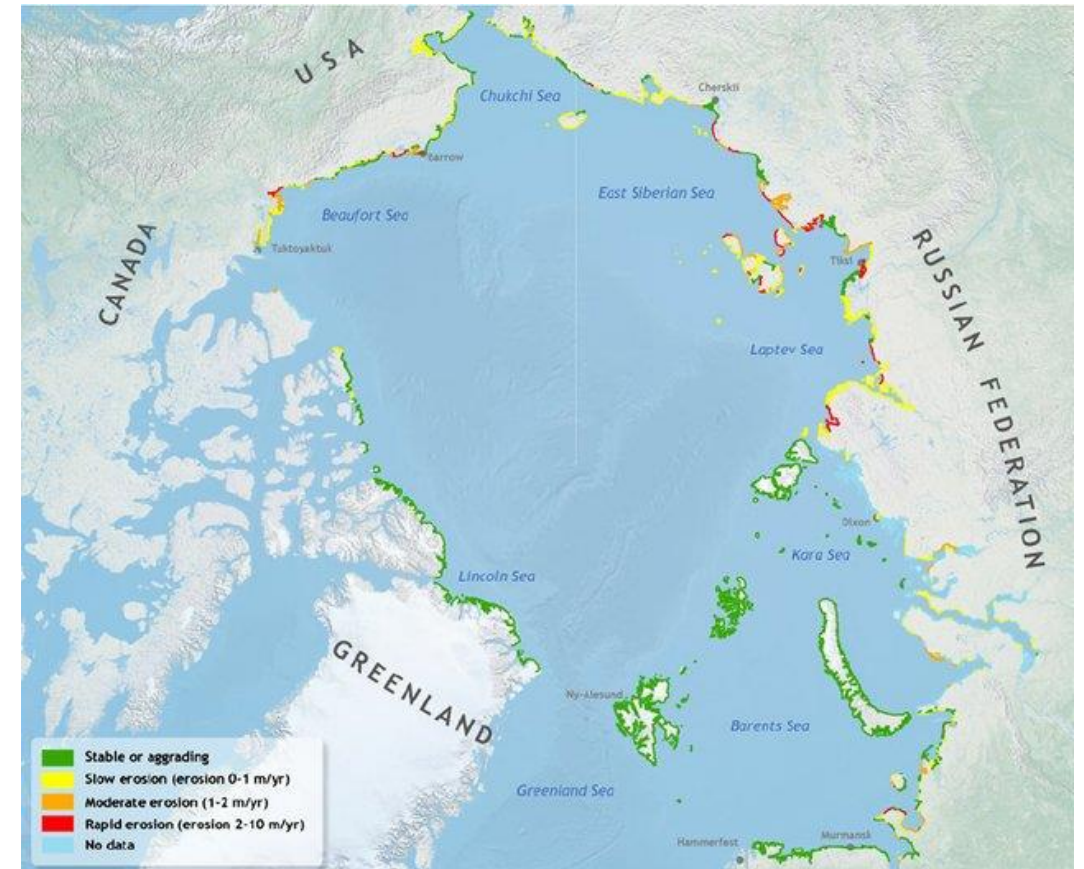


Project goal

- A roadmap for the next generation of the Arctic Coastal Dynamics database will be developed.
- Recent achievements of
 - HORIZON2020 Nunataryuk
 - ESA CCI+ Permafrost as well as
 - community efforts by international initiatives such as IASC T-MOSAIC and NSF PerCS-net form the basis.

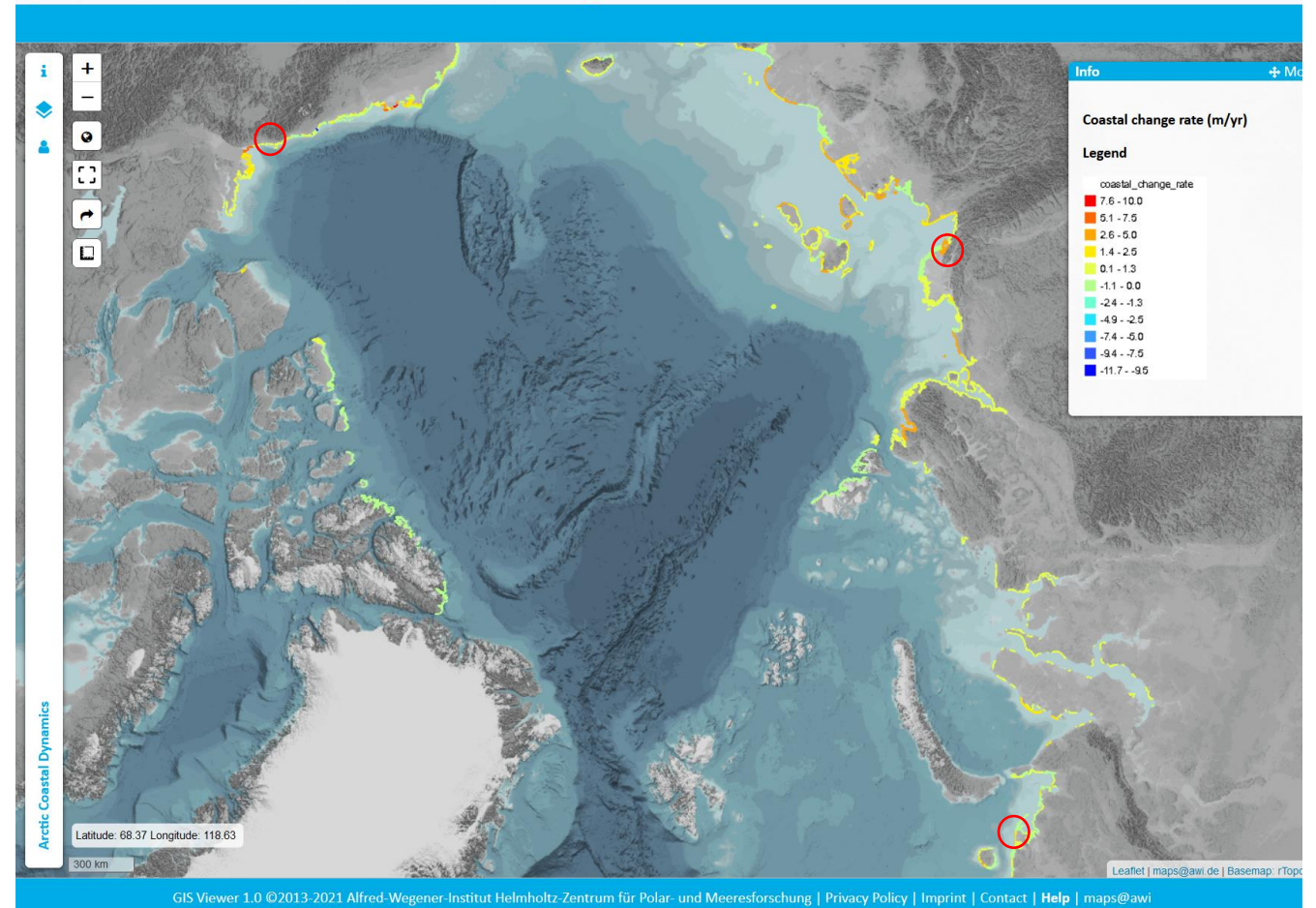
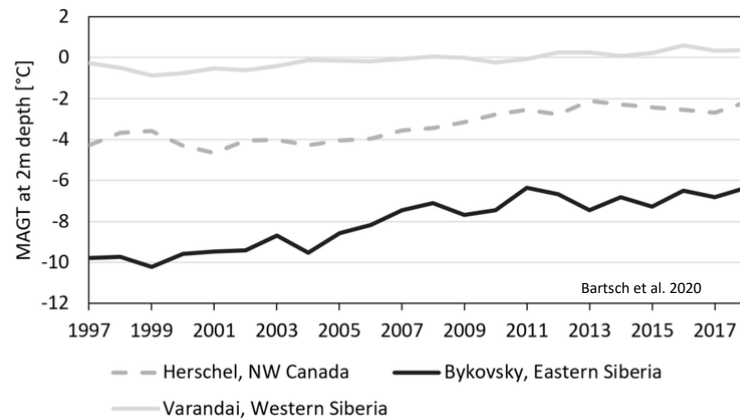


Lantuit et al. 2012



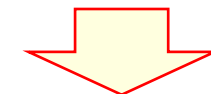
- ❖ Coastal erosion in regions with increasing ground temperatures

- MAGT – Mean Annual Ground Temperature



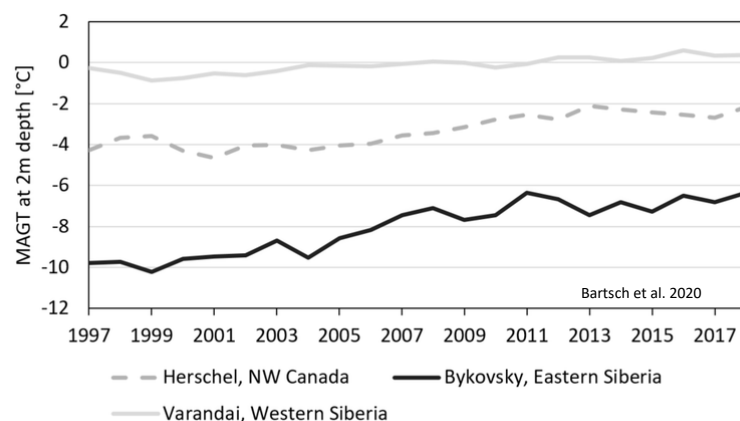


Landsat trend product
developed for automatized
lake change, thermokarst etc



- ❖ Coastal erosion in regions with increasing ground temperatures

- MAGT – Mean Annual Ground Temperature



	Rate from GlobPermafrost trend product 1999-2014	Rate from L- band SAR 2007- 2018	Previously published rates
Varandai (c)	n.a.	-5.41 ± 2.64	-1.8 (1951-2013) ¹
Herschel (B)	-4.19 ± 2.8	-7.02 ± 2.65	-6.8 (2012-2013) ²
Kay Point (B)	-3.94 ± 1.4	-5.90 ± 0.41	-1.7 (1990-2011) ³
Bykovsky (D)	-5.83 ± 2.8	-4.81 ± 1.37	$-1 - -2$ (1951-2006) ⁴

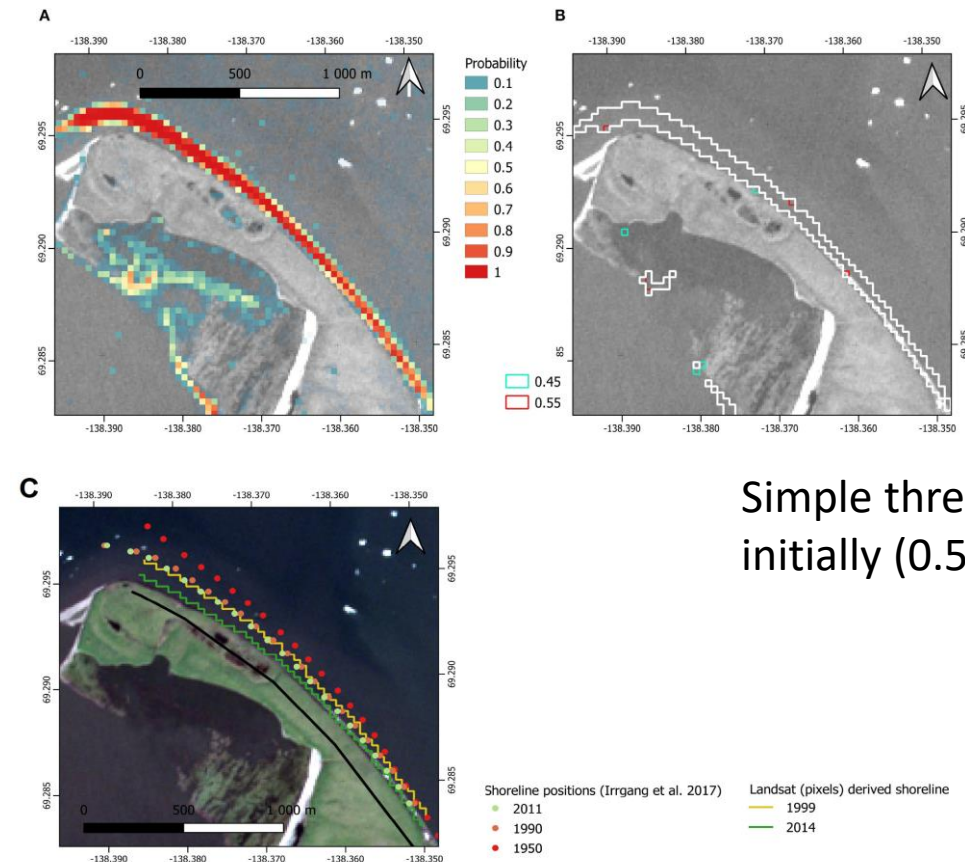
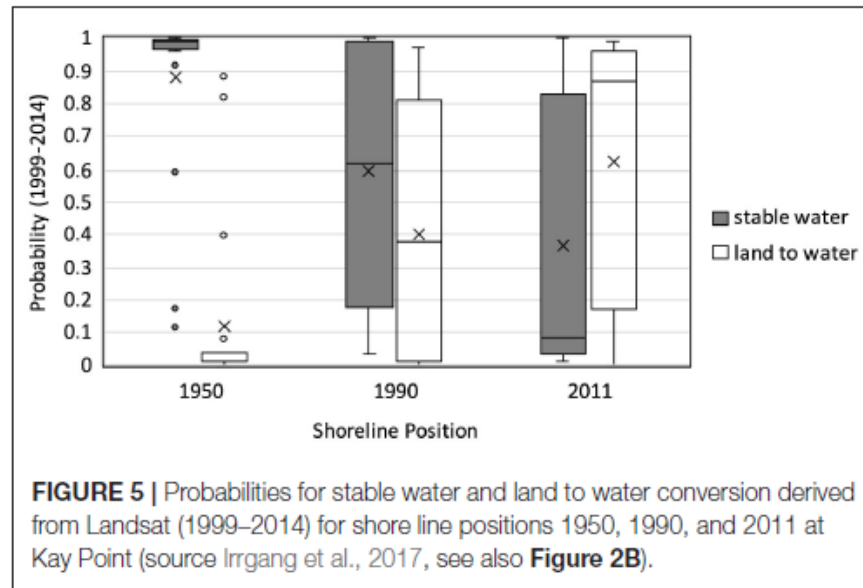


Bartsch et al. (2020), Frontiers in Cryos.



Landsat trend product developed for automatized lake change, thermokarst etc

- Probability of land to water and water to land change
- Method to extract coast position needs to be revised (e.g. thaw lake change approach uses Random Forest)

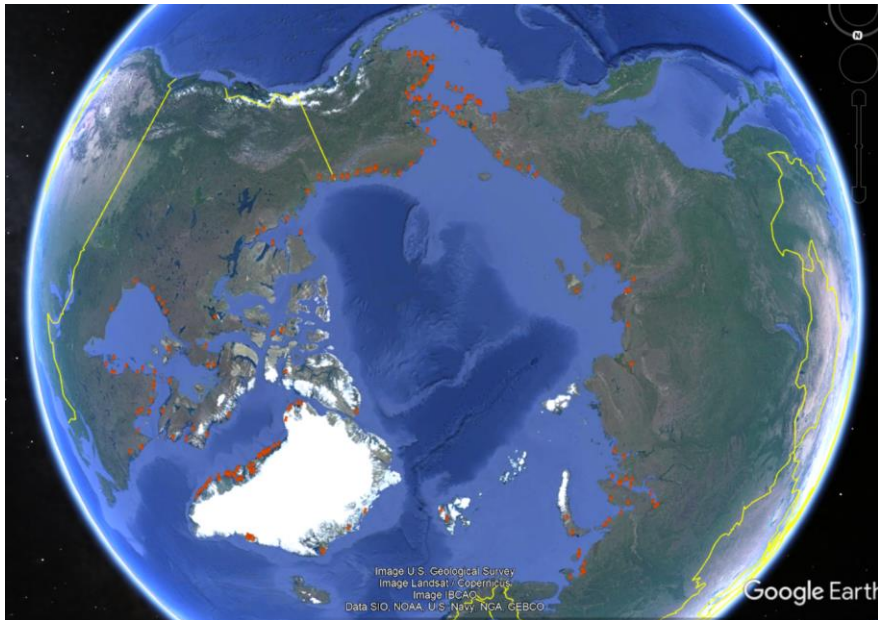


Simple threshold
initially (0.5)

Bartsch et al. 2020

Many Arctic settlements are located at the coast

- Nuanataryuk: Sentinel-1/2 derived Arctic Coastal Human Impact dataset (SACHI)
- Three classes: roads, buildings, other



SACHI subset for coastal settlements in permafrost regions



<https://permafrostcoasts.org/digital-media/> L. Farquharson, UAF

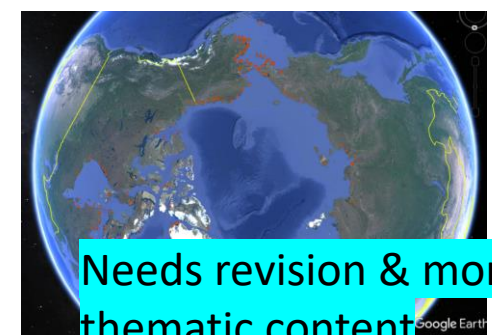
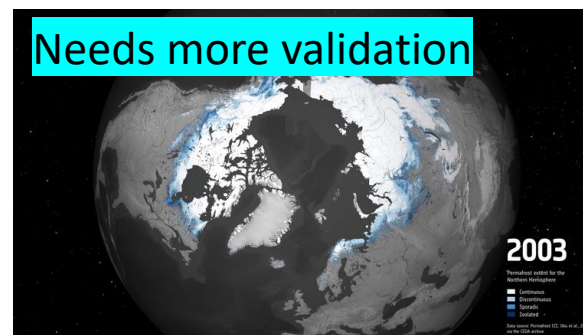
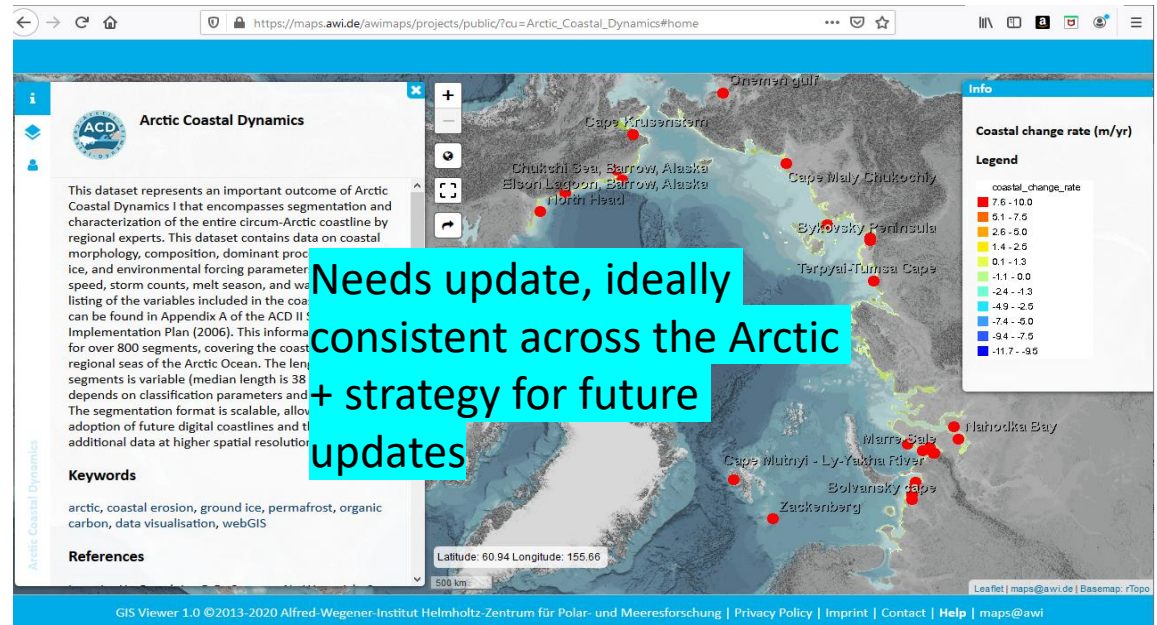
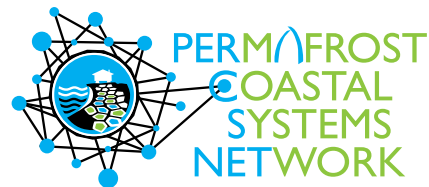
Nunataryuk/SACHI heritage

- 2424 Sentinel-2 images (acquisition fractions at granule extent) from years 2016 to 2020, + Sentinel-1 for each granule
- Building on Nunataryuk processing chain for super-resolution, atmospheric correction, temporal averaging
- DL (keras) re-processing
- Potentially fusion with XGBoost layers and post-processing



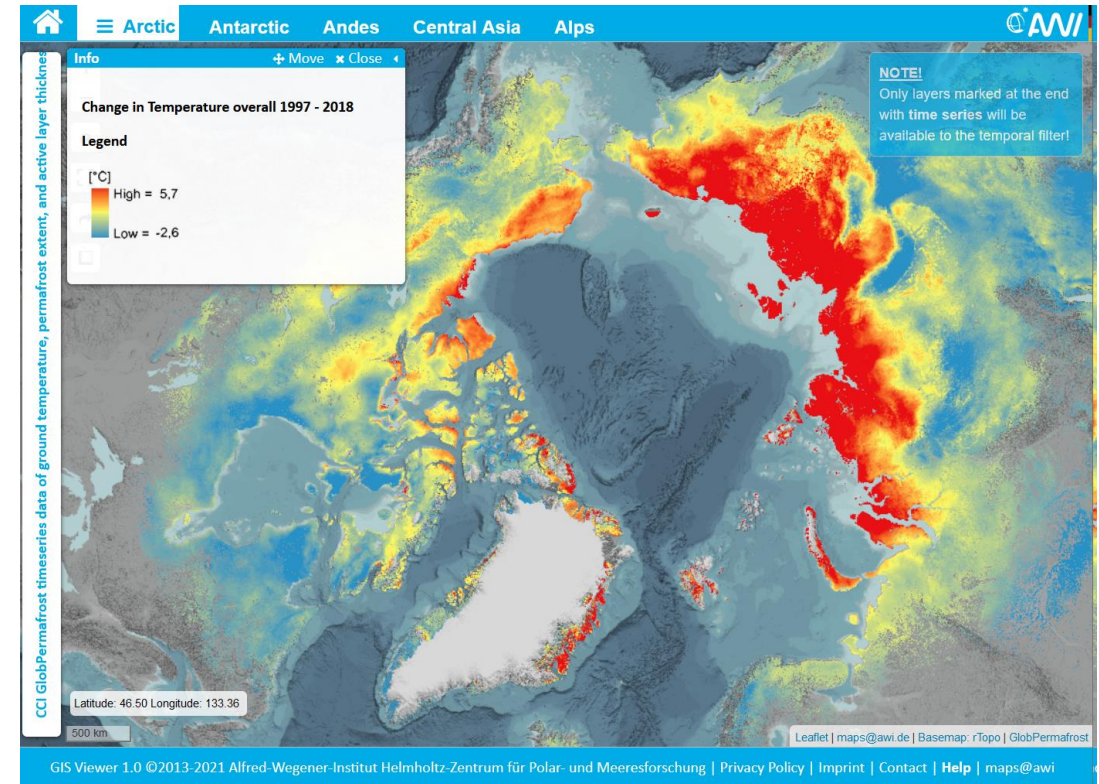
Project overall strategy

- A coastal erosion monitoring **scheme** already identified for **circumpolar** applicability will be implemented as baseline and **enriched by**
 - combination with a revised coastal settlement and infrastructure database and
 - permafrost ground temperature time series.
- A science community workshop will be organized for review of the baseline dataset and roadmap implementation in form of a white paper.



AMPAC – Arctic Methane and Permafrost Challenge

- Coastal erosion in regions with increasing ground temperatures, but not only
- EO4PAC – supports assessments of carbon transfer to ocean
- AMPAC – methane focus
 - Sources, processes and fluxes
- Both, EO4PAC and AMPAC, target the entire Arctic



AMPAC

- Permafrost lowlands with extensive wetlands affected

Example: wetland vulnerability (Karesdotter et al. 2021)

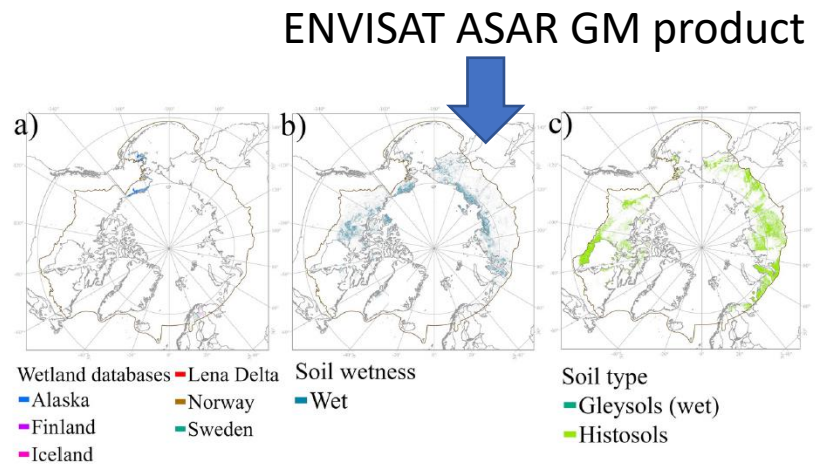
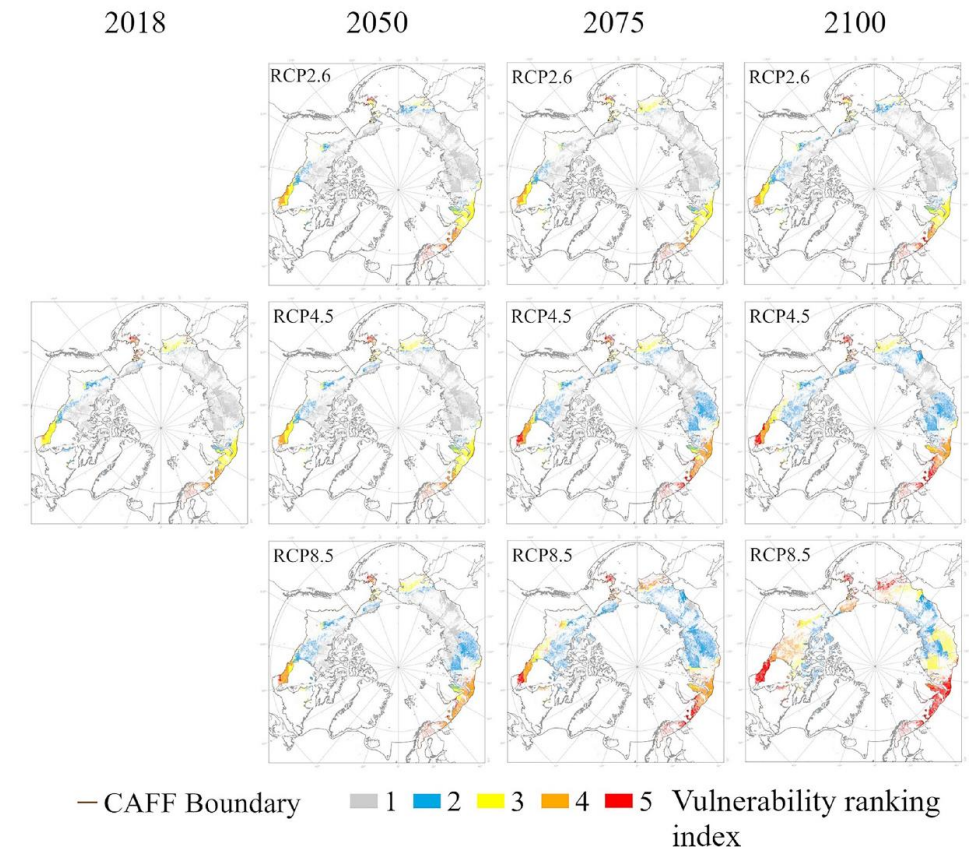


Figure 1. Datasets are used for the creation of the wetland map. (a) Wetland databases. (b) Soil wetness data (Widhalm et al., 2015a, 2015b). (c) Coverage of soil types that are wetlands (Kempen & Hengl, 2017). Projection: Azimuthal Equidistant.

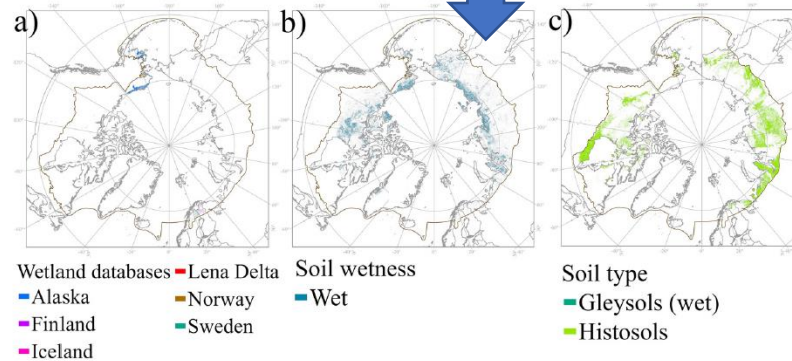


AMPAC

- Permafrost lowlands with extensive wetlands affected

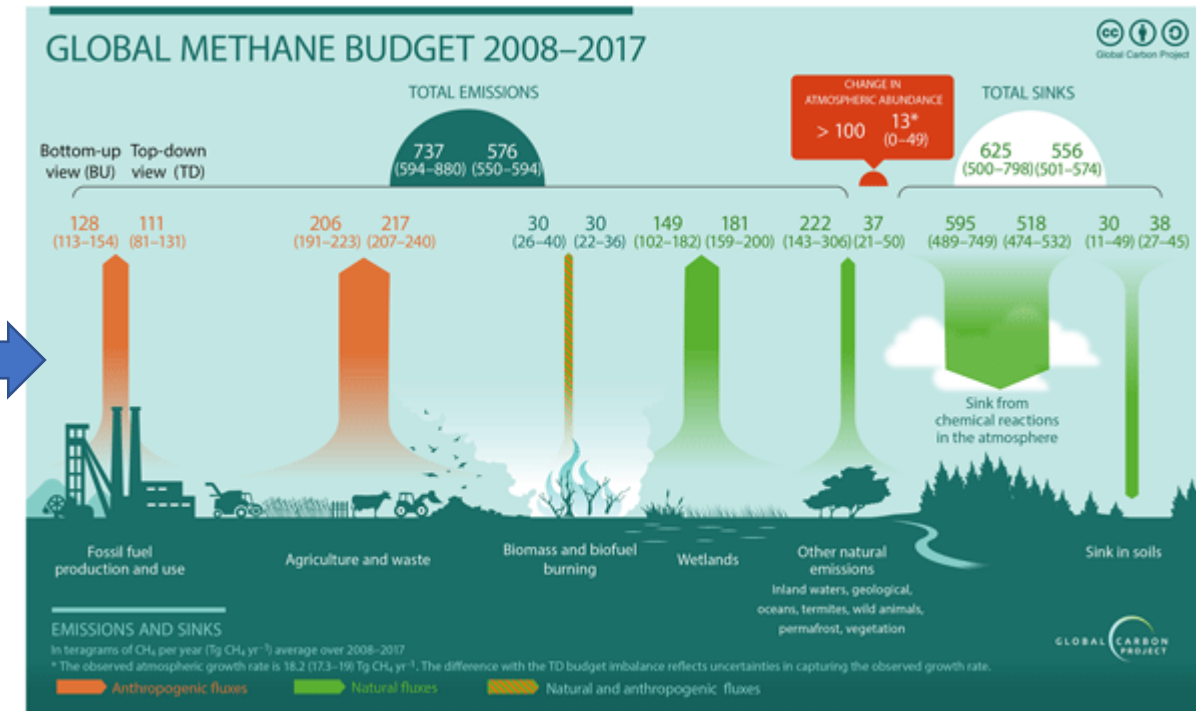
Saunois, M. et al. (2020): The Global Methane Budget 2000–2017, Earth Syst. Sci. Data, 12, 1561–1623, <https://doi.org/10.5194/essd-12-1561-2020>, 2020

ENVISAT ASAR GM product



(Karesdotter et al. 2021)

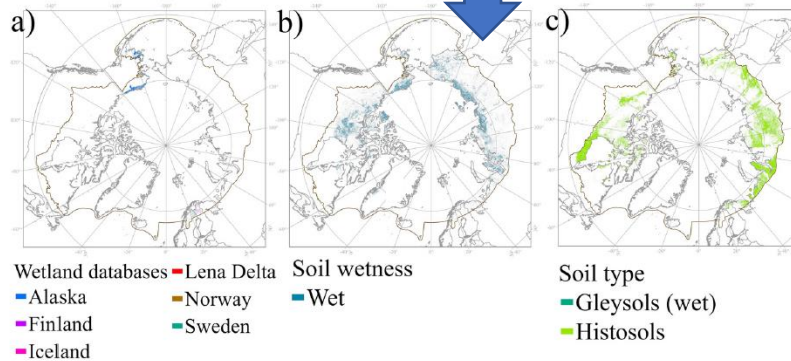
Figure 1. Datasets are used for the creation of the wetland map. (a) Wetland databases. (b) Soil wetness data (Widhalm et al., 2015a, 2015b). (c) Coverage of soil types that are wetlands (Kempen & Hengl, 2017). Projection: Azimuthal Equidistant.



AMPAC

- Permafrost lowlands with extensive wetlands affected

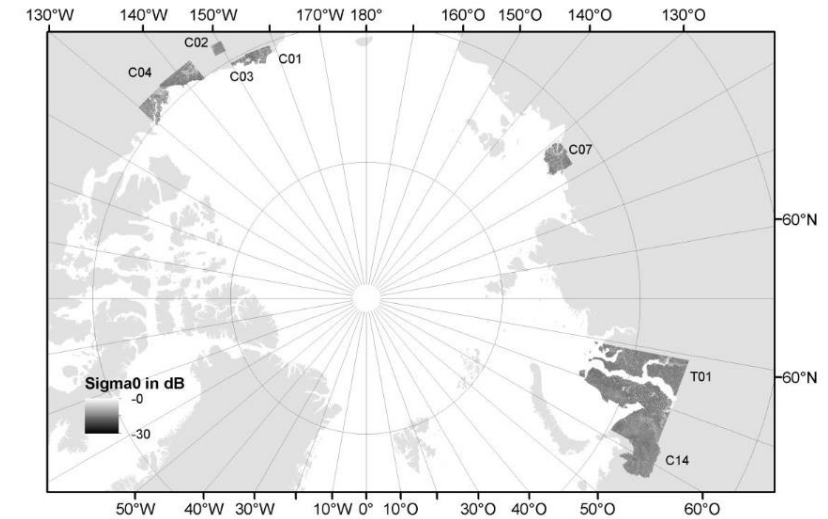
ENVISAT ASAR GM product



(Karesdotter et al. 2021)

Figure 1. Datasets are used for the creation of the wetland map. (a) Wetland databases. (b) Soil wetness data (Widhalm et al., 2015a, 2015b). (c) Coverage of soil types that are wetlands (Kempen & Hengl, 2017). Projection: Azimuthal Equidistant.

Sentinel-1 transfer and prototype in DUE GlobPermafrost

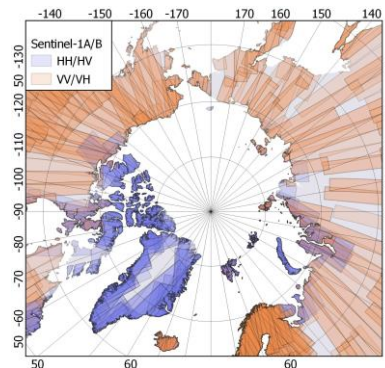


- But this only captures part of issues relevant to methane emissions, e.g. role of lakes needs to be considered, inundation dynamics etc

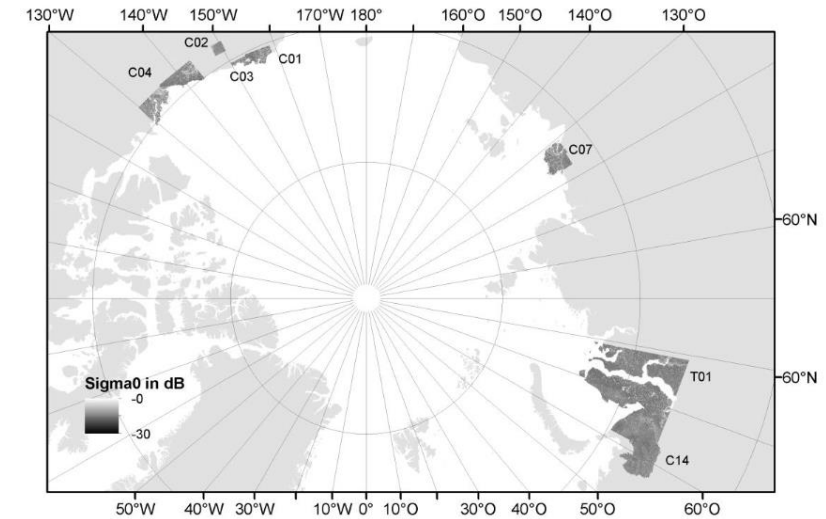
AMPAC

- Permafrost lowlands with extensive wetlands affected
- Requires C-HH; similar challenge as in EO4PAC (specifically with respect to future erosion monitoring – potential of SAR)

Bartsch et al. 2021 IGARSS



Sentinel-1 transfer and prototype in DUE GlobPermafrost



- But this only captures part of issues relevant to methane emissions, e.g. role of lakes needs to be considered, inundation dynamics etc

AMPAC

- There are various types of EO products with regional coverage and selected aspects. Some already used for circumpolar synthesis, but just a start
- Limitations of currently available datasets addressed in a number of studies, need to address them in a community effort (including benchmarking)
- Related activities, selection
 - RECCAP2-Permafrost focuses on natural fluxes within the permafrost region and is co-led by Gustaf Hugelius and Ted Schuur
 - International Permafrost Association (IPA) Permafrost and Carbon budgets Interest Group (IPaC) - Synthesis report: IPaC survey 'IPaC prioritized permafrost and carbon research topics' available
 - ERC Synergy project Q-Arctic: Quantifying disturbance impacts on feedbacks between Arctic permafrost and global climate

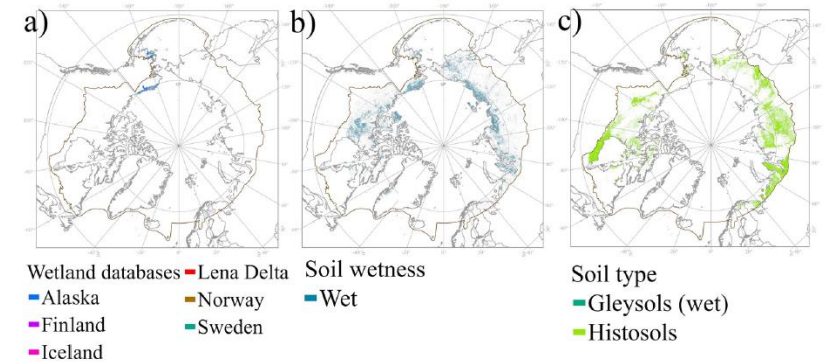


Figure 1. Datasets are used for the creation of the wetland map. (a) Wetland databases. (b) Soil wetness data (Widhalm et al., 2015a, 2015b). (c) Coverage of soil types that are wetlands (Kempen & Hengl, 2017). Projection: Azimuthal Equidistant.

(Karesdotter et al. 2021)