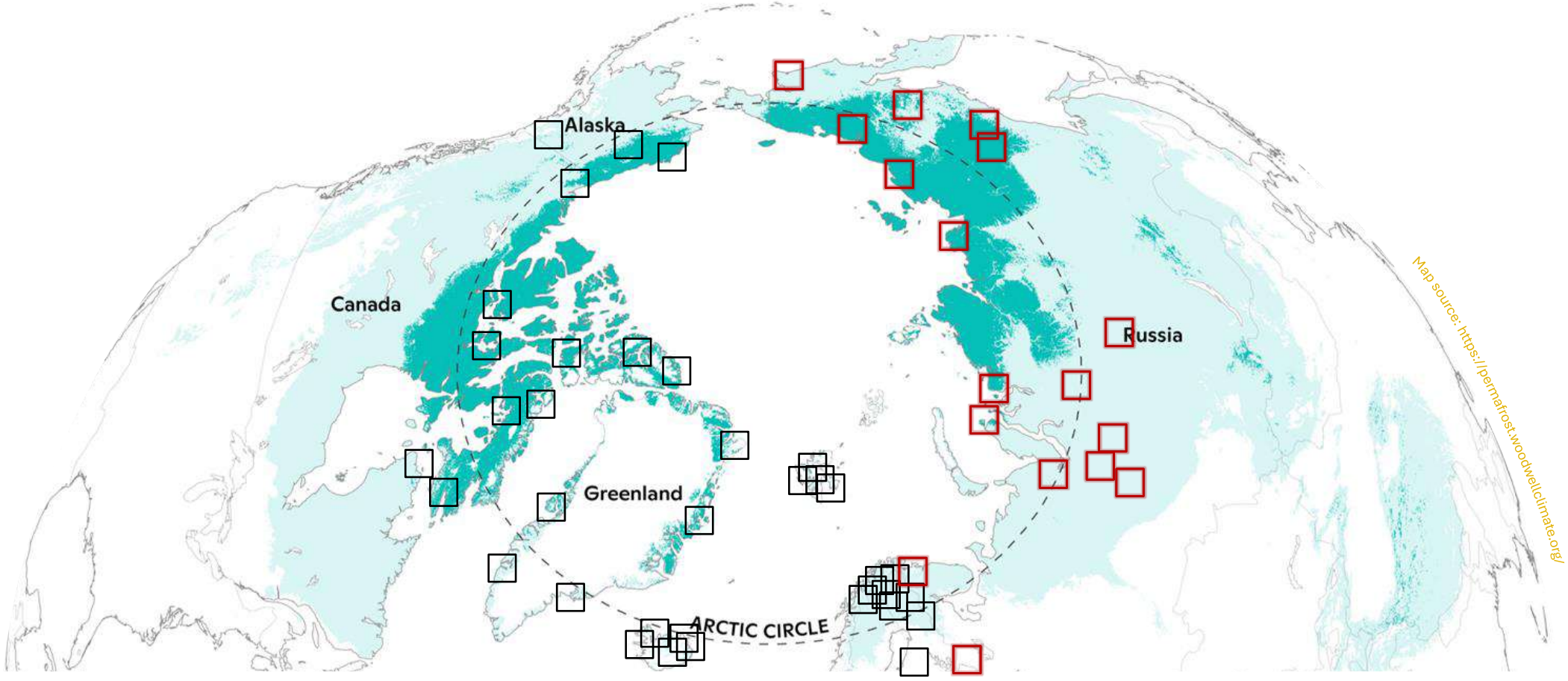


Observing capacities of INTERACT and the increasing bias view

*Efrén López-Blanco, **Elmer Topp-Jørgensen**, Torben R. Christensen, Morten Rasch, Henrik Skov, Marie F. Arndal, M. Syndonia Bret-Harte, Terry V. Callaghan, and Niels M. Schmidt*

EPSW 2024, Copenhagen, Denmark

Based on paper in Nature Climate Change 2024

INTERACT
interactassociation.org

The INTERACT network of

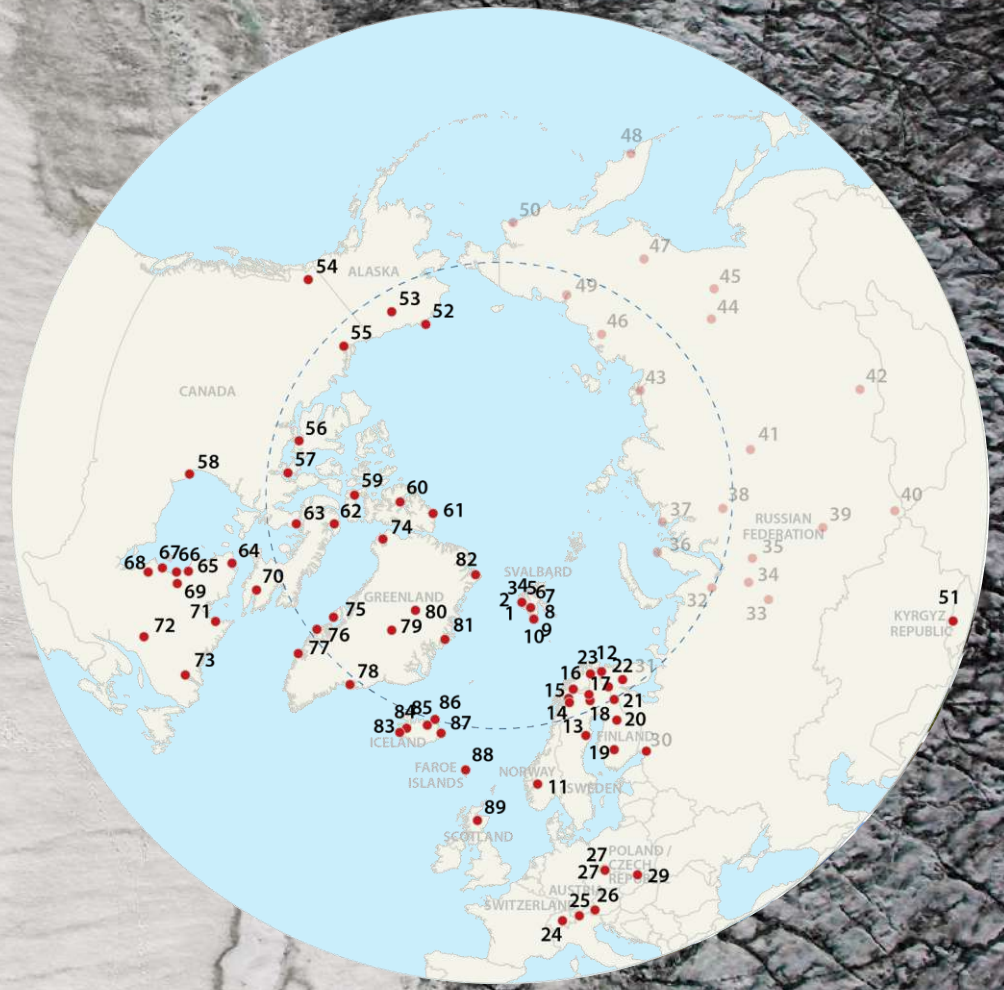
arctic research stations

75 research station + 21 russian stations currently on pause
EU funded 2011 – 2024

Improve services for the scientific community
Push for standardisation of operations and science

Non-profit association since 2022 - open for collaboration

Representative sampling:
How well do we understand change throughout the Arctic and what impact is the war in Ukraine having on this?



OBJECTIVE & research questions

Assess the potential biases in the view on current and projected terrestrial Arctic change. To do so, we ask the following RQs:

1. How well Arctic research stations represent abiotic and biotic ecosystem conditions at the pan-Arctic scale?

2. Does the exclusion of Russia from INTERACT accentuate any potential bias on Arctic change at the pan-Arctic level?

RATIONALE

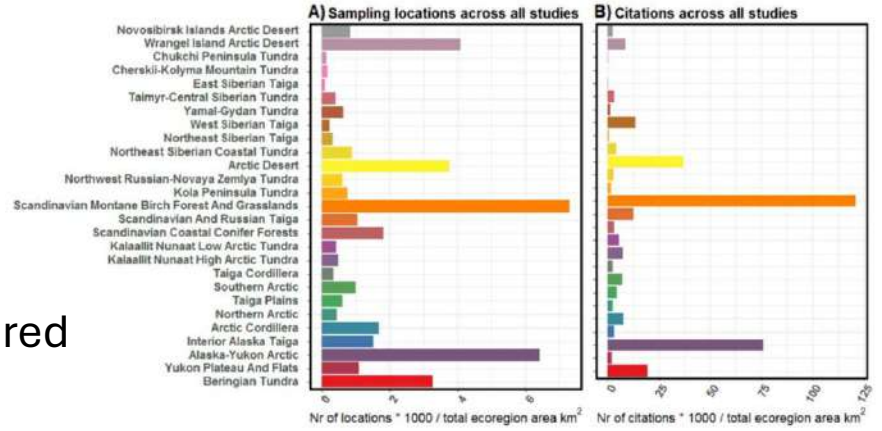
1. Much of the understanding of Arctic change is based on *in-situ* data measured on the ground at research stations.

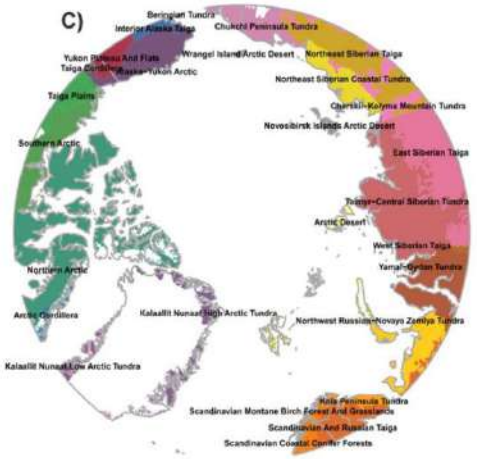
2. Limited funding and logistical challenges result in few scattered research stations, impacting optimal sampling.

3. Ground-based data collection and the resultant scientific publications are spatially clumped, and may thus not be representative of the Arctic region.

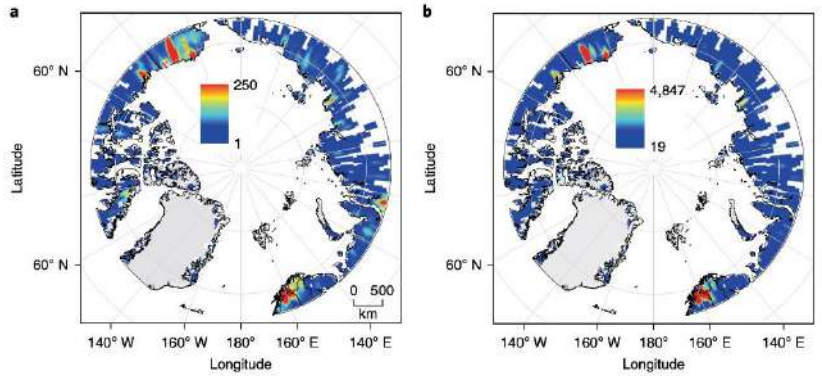
4. The overall ability to monitor the status and trajectory of the Arctic biome may be severely limited since the Russian parts of the Arctic are excluded from international fora due to the invasion of Ukraine.

Virkkala et al 2018 Environ. Res. Lett.



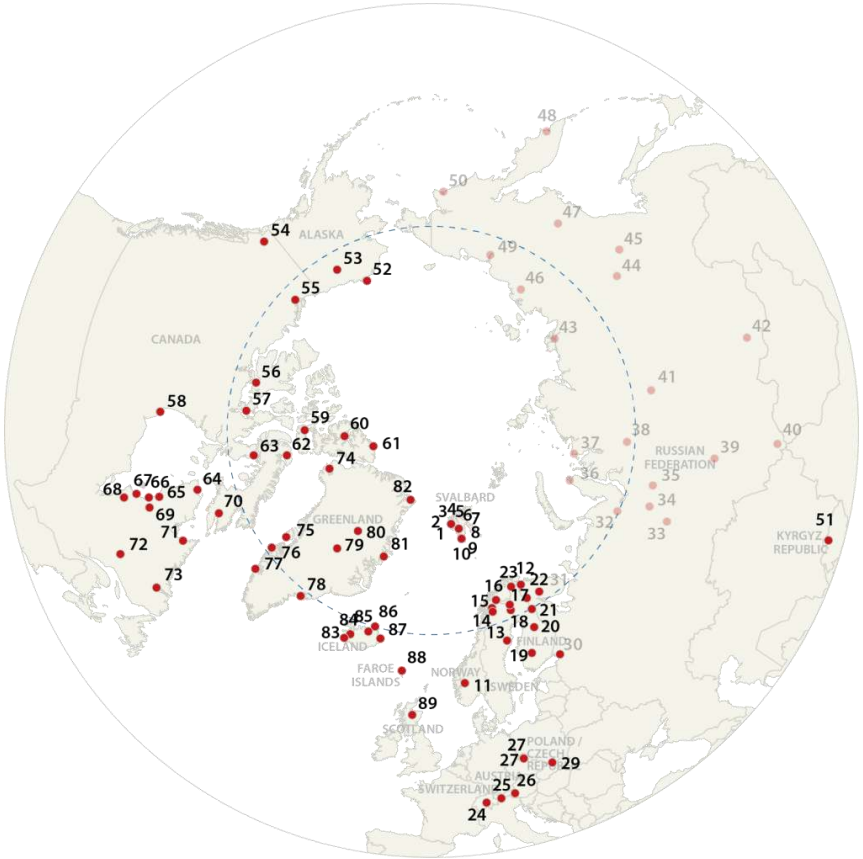


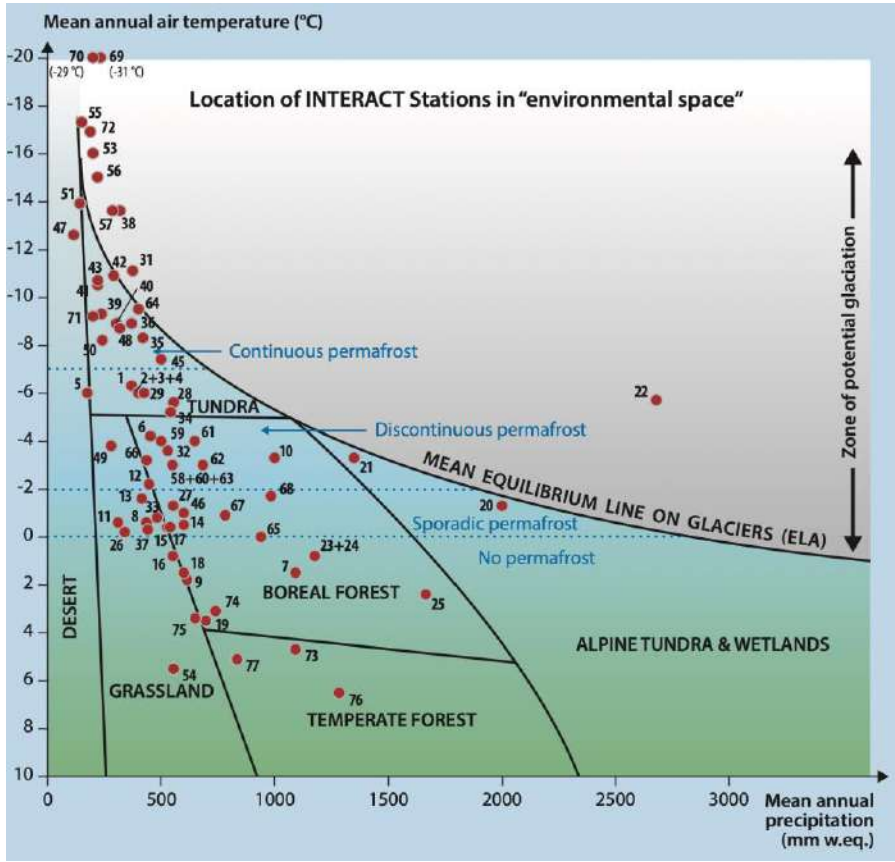
Metcalfe et al 2018 Nat. Ecol. Evol.



WHY INTERACT?

With 95 research stations in total, of which 21 are located in Russia, INTERACT (https://eu-interact.org/) is the most extensive network of research stations in the Northern hemisphere.

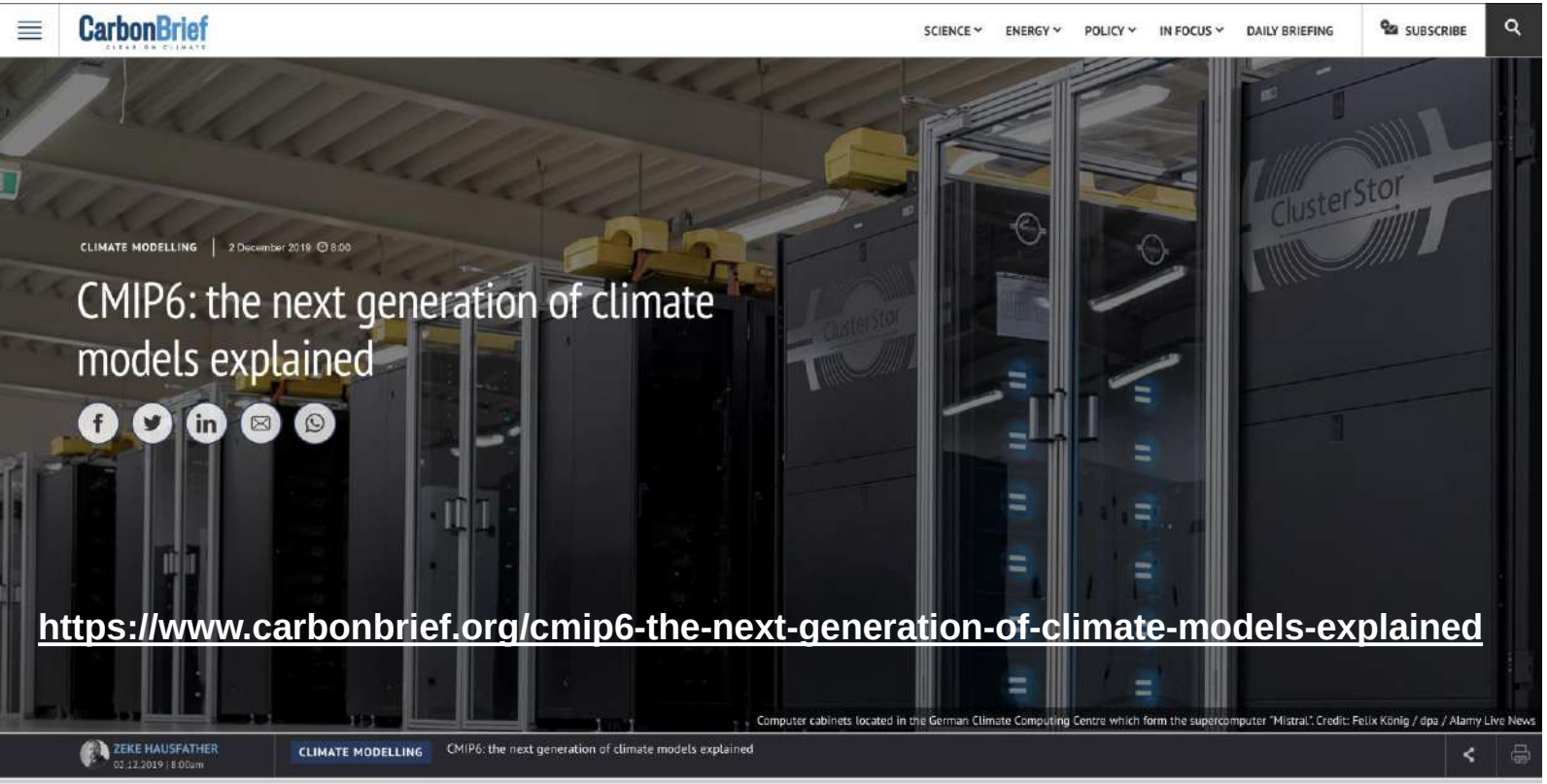




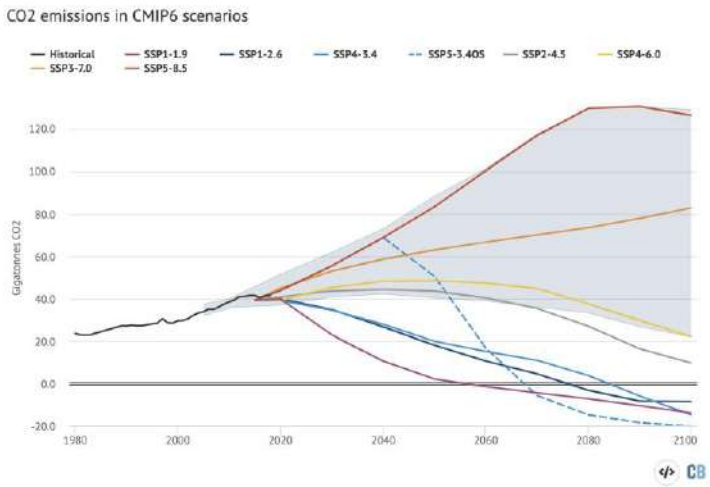
INTERACT
interactassociation.org

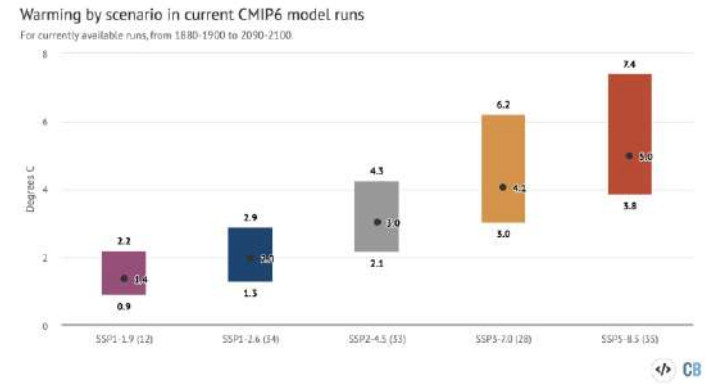
WHY ESM CMIP6?

Ecosystem models are the best tool we have 1) for inferring large-scale patterns in contemporary ecosystem conditions in a consistent manner and 2) for projecting into the future.



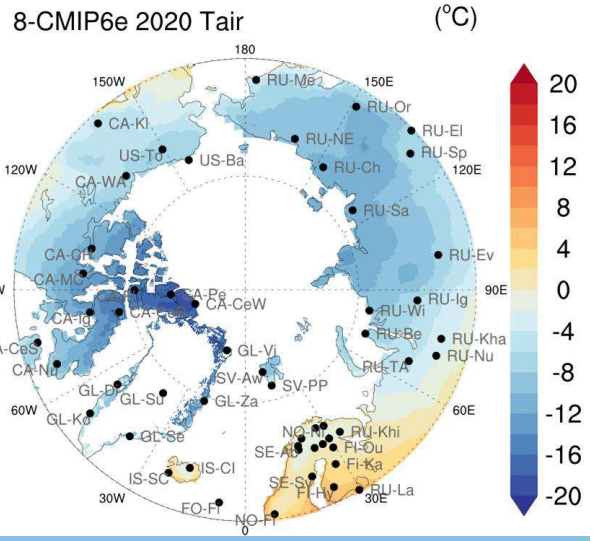
Climate models are one of the primary means for scientists to understand how the climate has changed in the past and may change in the future. These models simulate the physics, chemistry and biology of the atmosphere, land and oceans in great detail, and require some of the largest supercomputers in the world to

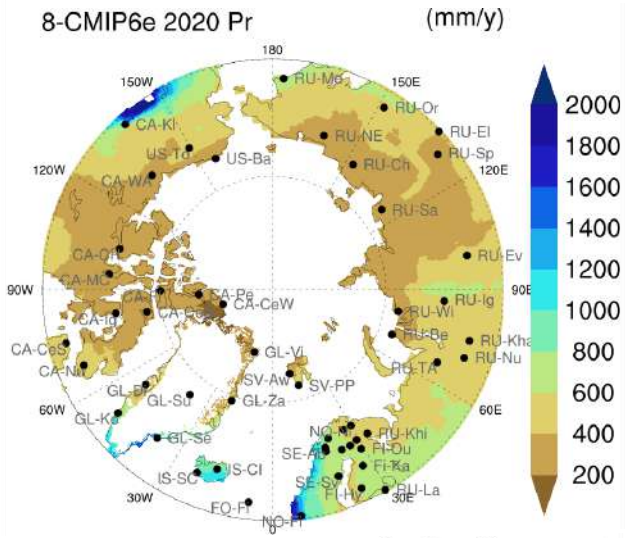


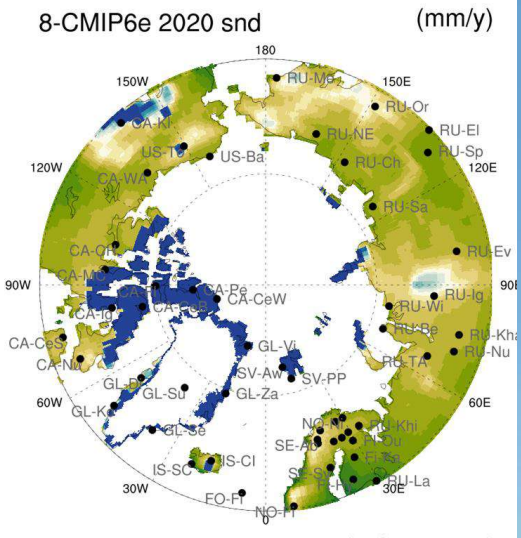


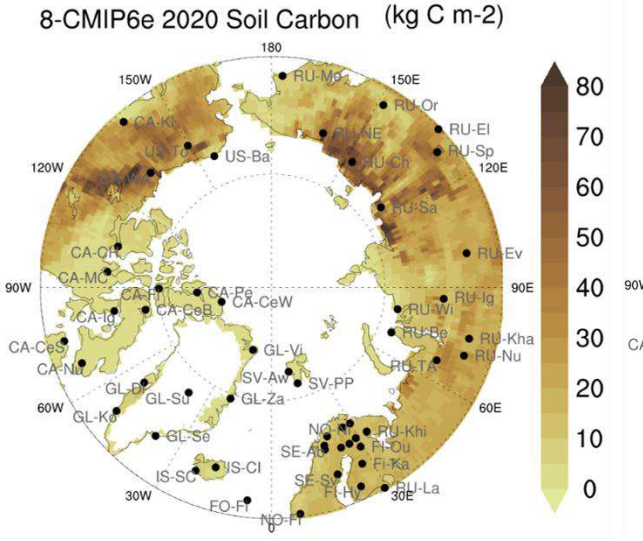
*>59°N ** Greenland Ice Sheet neglected ***8 CMIP6 future scenario SSP5.85
****Variable's choice inspired by AMAP Arctic Climate Change Update 2021

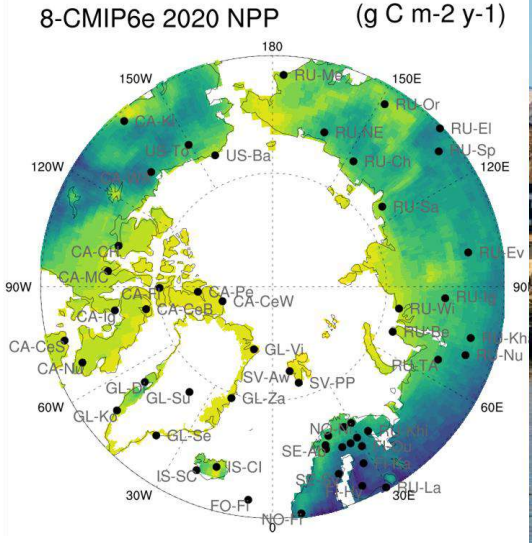
Essential Variables



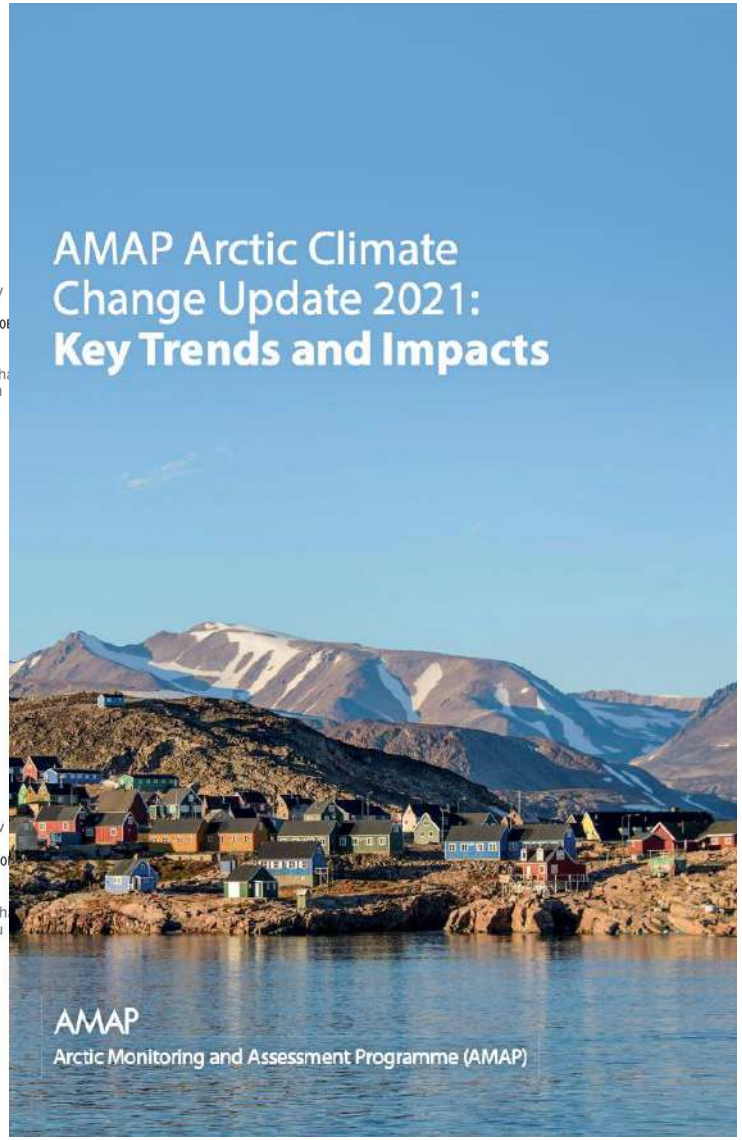








Temperature
Precipitation
Snowdepth
Soil Moisture
Biomass
Soil Carbon
Net Primary Production
Heterotrophic Respiration



CMIP6

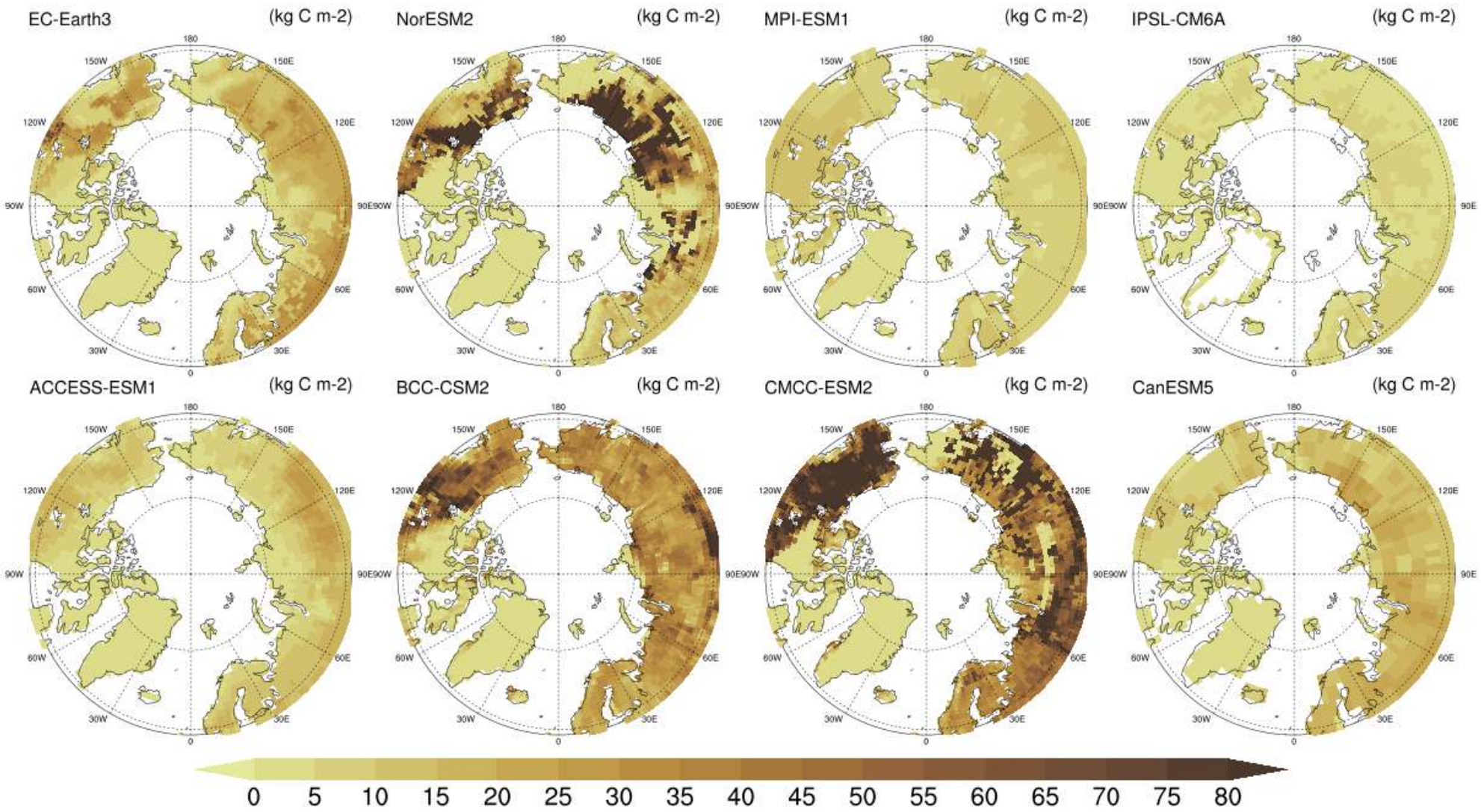
Model ID	Atmosphere model	Aerosol model	Land surface and and vegetation model	Spatial resolution
EC-Earth3-CC	IFS cy36r4 (TL255; 512 x 256; 91 levels)	-	HTESSEL (land surface scheme built in IFS) and LPJ-GUESS v4	0.703125°
NorESM2-MM	CAM-OSLO (1 degree; 288x192; 32 levels)	OsloAero	CLM5	1.25° x 0.94°
ACCESS-ESM1-5	HadGAM2 (r1.1; N96; 192x145; 38 250km levels)	CLASSIC (v1.0)	CABLE2.4	1.875°x 0.125°
BCC-CSM2-MR	BCC_AGCM3_MR (T106; 320x160; 46 levels)	-	BCC_AVIM2	1.125°
CanESM5	CanAM5 (T63L49; 128x64; 49 levels)	interactive	CLASS3.6/CTEM1.2	2.8125°
CMCC-ESM2	CAM5.3 (1degree; 288x192; 30 levels)	-	CLM4.5 (BGC mode)	1.25° x 0.94°
IPSL-CM6A-LR	LMDZ (N96; 144x143; 79 levels)	-	ORCHIDEE (v2.0, Water/Carbon/Energy mode)	2.5° x 1.27°
MPI-ESM1-2-LR	ECHAM v6.3 (T63; 192x96, 47 levels)	none, prescribed MACv2-SP	JSBACH3.20	1.875°

Air temperature

Precipitation

Biomass

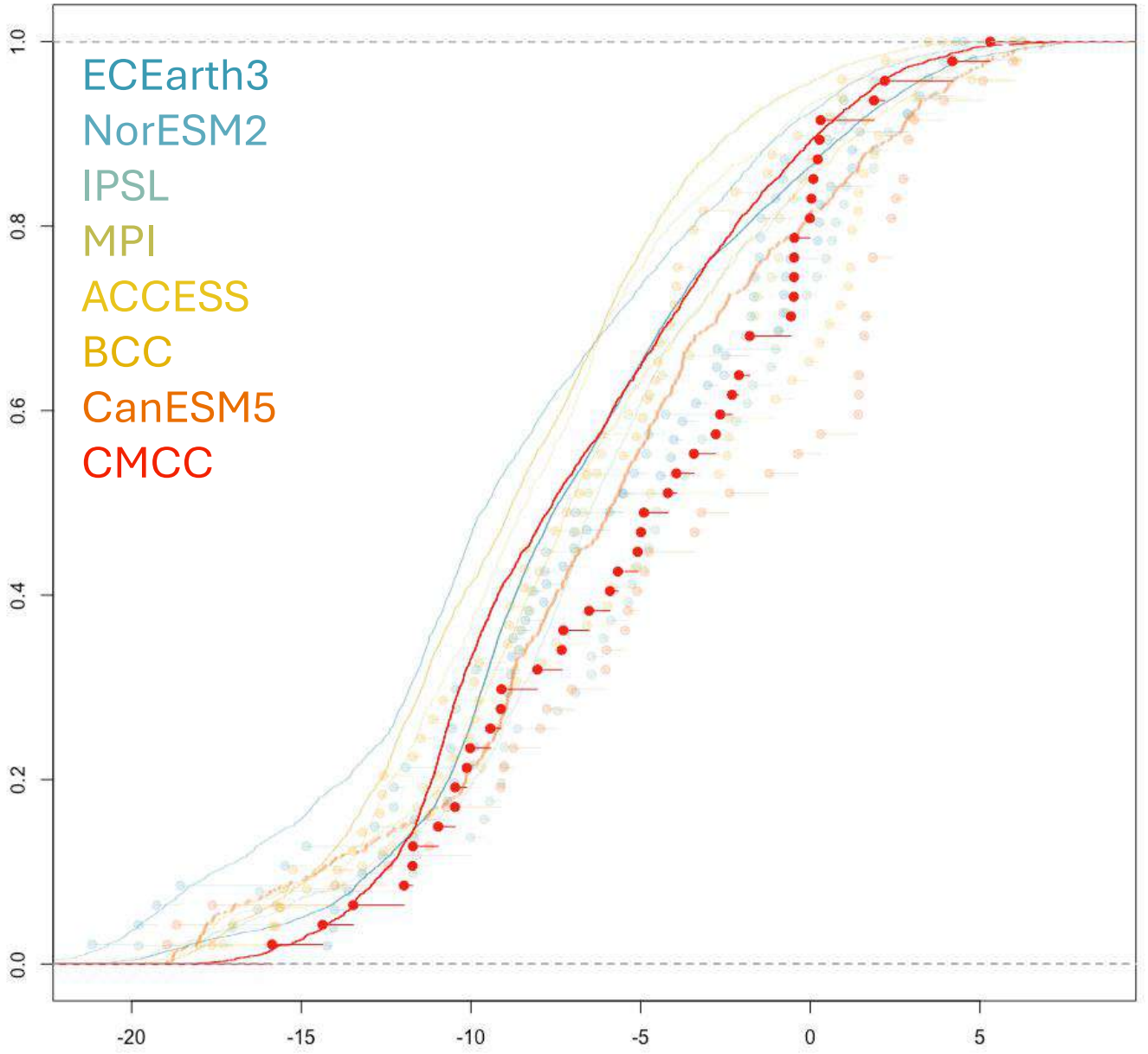
Soil carbon



METHOD

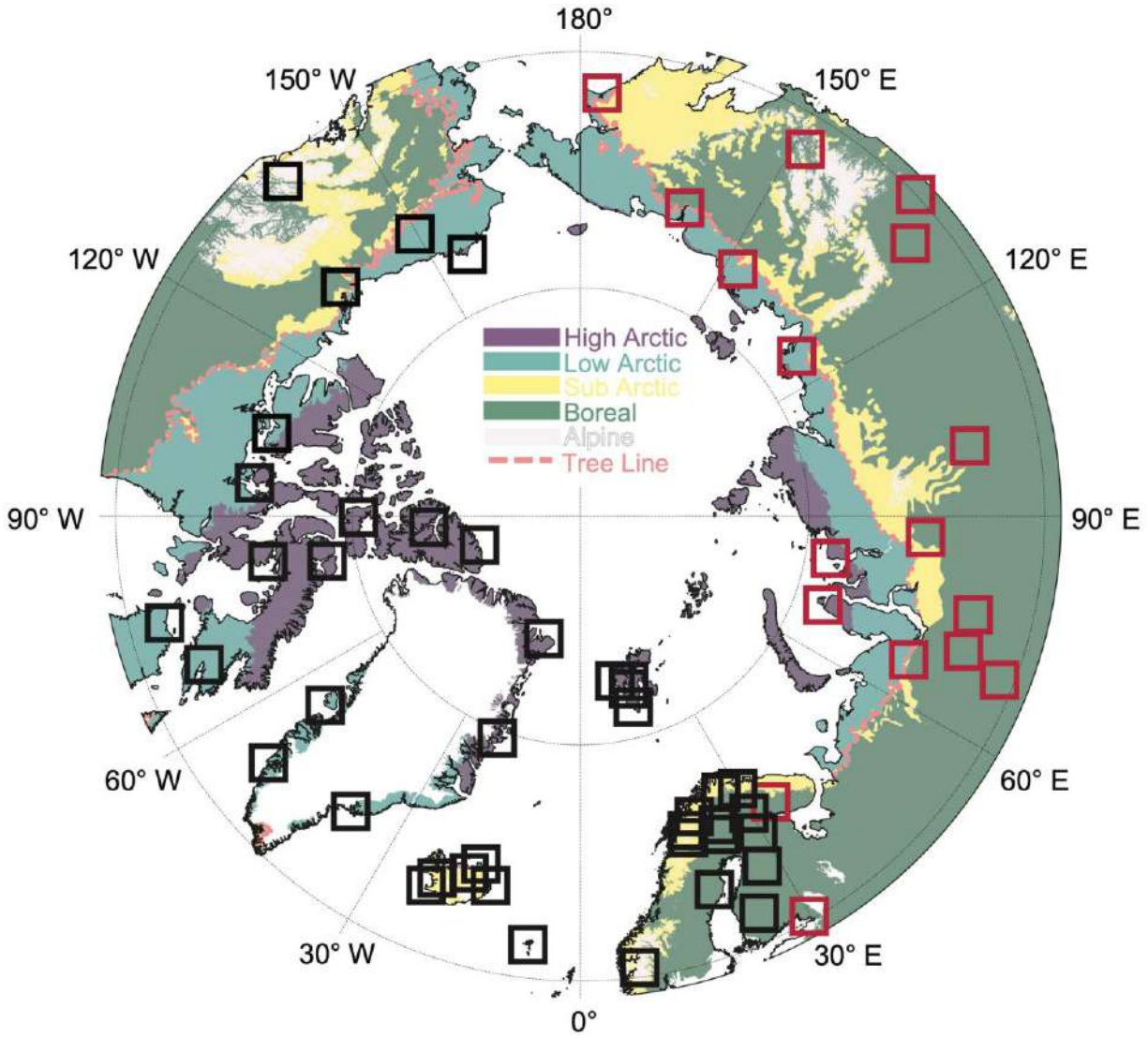
We calculated the maximum differences between the cumulative distribution functions (the D-values from Kolmogorov–Smirnov tests) of the pan-Arctic domain and INTERACT stations across the eight CMIP6 ESMs for each of the eight ecosystem variables.

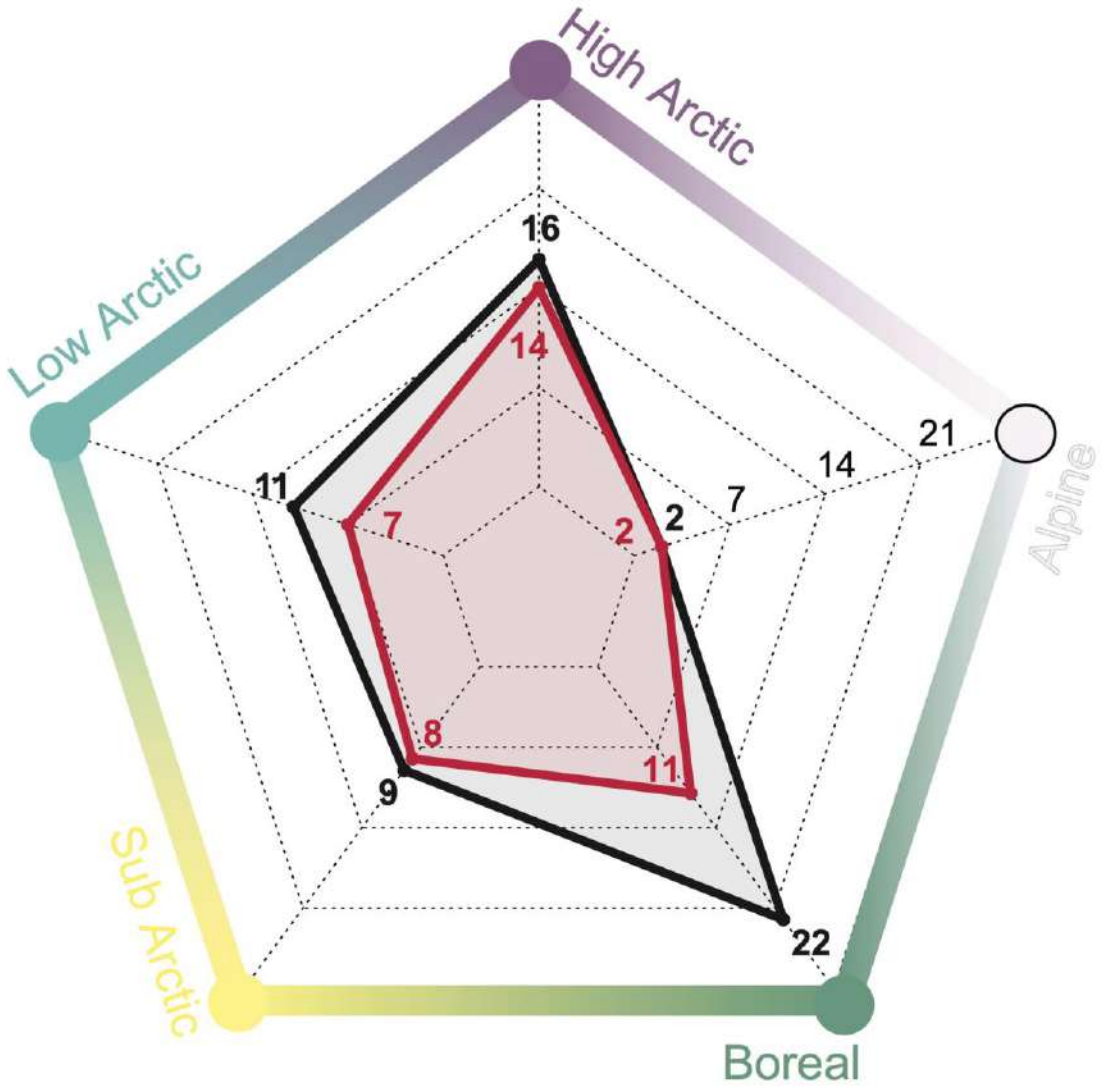
Significant D-values ($p<0.05$) are regarded as lack of representativeness between the INTERACT network and the pan-Arctic region.



Results (1/2)

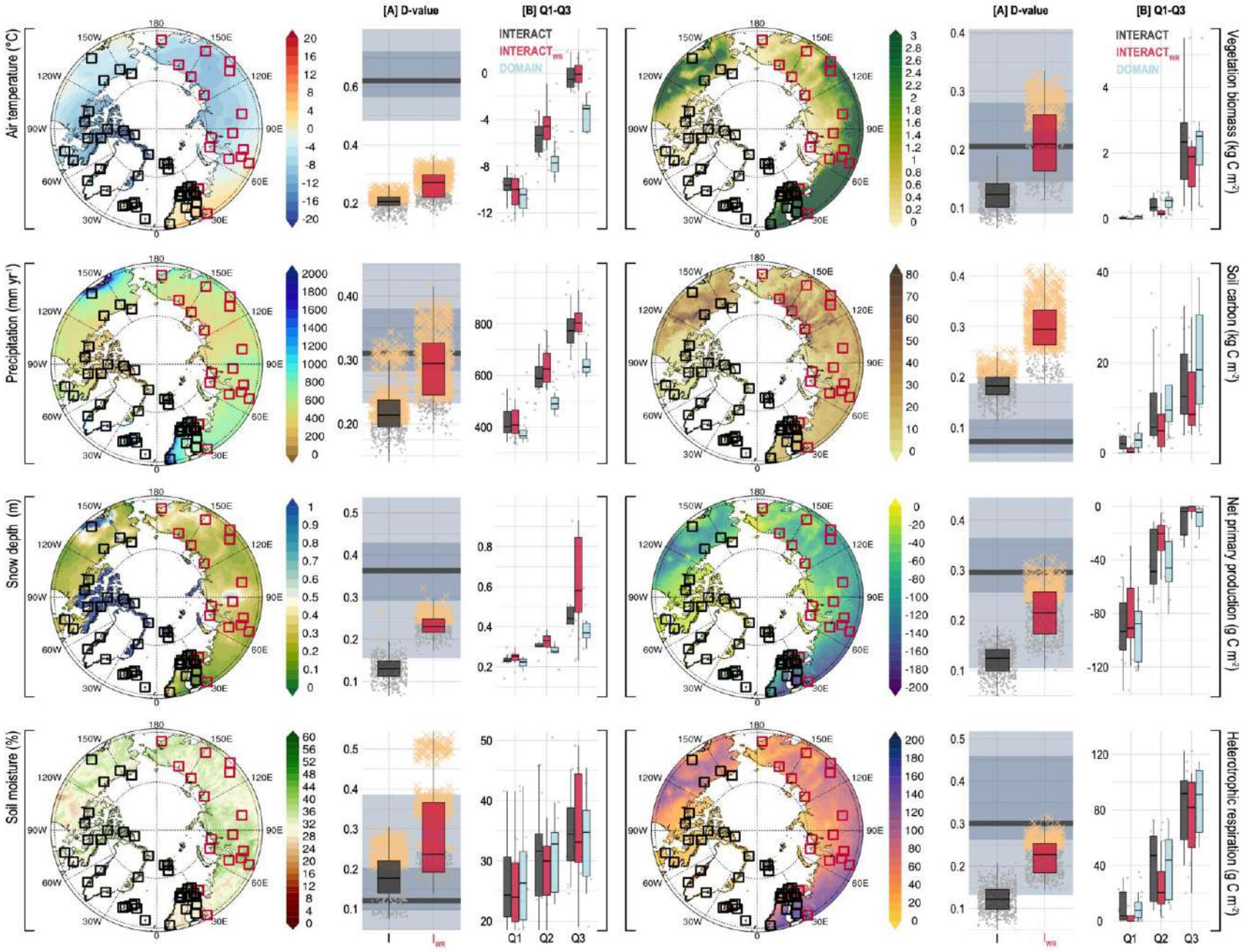
High Arctic = bioclimatic sub-zones A, B, and C, from the Circumpolar Arctic Vegetation Map (CAVM)
Low Arctic = CAVM sub-zone D
Sub Arctic = CAVM sub-zone E and the tundra forest sub-zone in the Ecoregion 2017 classification
Boreal = Ecoregion 2017 boreal forest sub-zone
Alpine = altitudes above 1000m below the tree line using the ArcticDEM product





López-Blanco et al. *Nat. Clim. Change (2024)*

Results (2/2)



López-Blanco et al. *Nat. Clim. Change (2024)*

Take home messages

Representativeness of all INTERACT stations

1. The INTERACT network is **consistently biased for some ecosystem variables** and is thus not fully representative of the ecosystem conditions across the pan-Arctic domain.

2. The INTERACT stations are generally located in the slightly **warmer** and **wetter** parts of the Arctic in areas with generally **deeper snowpacks**. INTERACT stations are also located in areas with **lower vegetation biomass** and **soil carbon** than the Arctic region.

Representativeness without Russian stations

1. Excluding Russian stations **lowers representativeness** across almost all ecosystem variables, with biases in some cases being of the same magnitude as the expected shifts caused by climate change by the end of the century.

2. The ability to both track and further project the development of the Arctic biome following climate-induced ecosystem change has **deteriorated**.

Future perspective

1. **Our analytical framework can be scaled-up with**

    A. **Any model variables available** (atmospheric, terrestrial, marine, …)
    B. **More ESM CMIP6 models** to increase the robustness of the analysis and learn about uncertainties

2. **Our approach can be used to synthesize the state of knowledge, quantifying potential biases and identify gaps to guide empirical studies. We can inform:**

    A. **Station managers** about which variables would be ecologically/scientifically relevant to monitor;
    B. **Researchers** about geographical gaps in circumarctic monitoring efforts;
    C. **Policymakers** about geographical gaps in infrastructure and monitoring efforts that needs to be addressed to improve robustness of assessments, important for well-informed decision-making to curb some of the negative consequences and risks exposed by climate change.

Important for representative ground-based observations and robust arctic assessments

INTERACT
interactassociation.org

Let’s INTERACT

Website:

Publications:

Station information:

Arctic permit systems:

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