From practitioners’ knowledge to climate modelling: obstacles, knowledge gaps and ways forward showcased through reindeer herding

Heidrun Matthes, Jarle W Bjerke, Jussi T Eronen, Bruce C Forbes, J Otto Habeck, Tim Horstkotte, Kirill Istomin, Teresa Komu, Jouku Kumpula, Roza Laptander, Antti-Juhani Pekkarinen, Sirpa Rasmus, Hans Tømmervik

goal: provide relevant and relatable climate change information to practitioners of environment dependent livelihoods

- mapping of the operational framework of the livelihood
- identification of critical climate conditions that impact the livelihood’s success

- if you are a practitioner, you do not need these steps
- as a climate scientist, I need them for context

- translating these conditions into climate indices
- identifying data sources: gaps in understanding, data availability and data quality
- calculating indices from appropriate data sources
- presenting results in a useable and relatable way

- taking the next steps for reindeer herding as an example
- showing the obstacles and solutions we found

mapping of the operational framework of the livelihood

identification of critical climate conditions that impact the livelihood's success

economics and operations of the livelihood

- Calving in enclosures
- Pasture rotation
- Traditional knowledge
- ...

competition (what other livelihoods are competing for the same resources)

- mining
- forestry
- wind power
- ...

(environmental) conditions the livelihood depends on

- Predator population
- Snow conditions
- ...

social and legal framework

- Indigenous rights
- Land-use planning
- Subsidies and compensations
- ...

CHARTER

identification of critical climate conditions that impact the livelihood's success

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early spring
- snow melt
- rain on snow
- ice crusts

spring (calving)
- snow free patches
- snow storms
- ice crusts
- river and lake ice

early summer (calf marking, migration)
- high water levels in rivers
- strong currents

summer
- insect harassment (insect numbers)
- insect harassment (insect attacks)
- hot summers
- wet/dry summers
- permafrost degradation
- shifts in occurrence of predators/plants
- snow bed degradation

early autumn
- mushroom growth
- warm conditions during rutting
- wet conditions during rutting

late autumn (rutting , round ups)
- wet/dry soil at the moment of first snow
- frozen/unfrozen soil at the moment of first snow

early winter (migration)
- rain on snow
- hoarfrost; frozen water on plants/lichen
- ice crust on bare ground (ground ice or frost)

winter
- rain on snow
- mild temperatures (from -5°C to +3°C)

mapping of the operational framework of the livelihood

identification of critical climate conditions that impact the livelihood’s success

translating these conditions into climate indices

identifying data sources: gaps in understanding, data availability and data quality

calculating indices from appropriate data sources

presenting results in a useable and relatable way

In an ideal framework, here is the entry point for the practitioner’s request. Example: Will hot summers intensify over the coming decades?

Clarifications: What does hot mean? What is your definition of summer? What is intensification (more hot days, days with higher temperatures …)?

Clarification: What spatial scale is needed? What type of future (best, worst, most likely …)? Is the data reliable (suitable)? What is the uncertainty?

Clarification: What type of output makes sense to the practitioner?

translating these conditions into climate indices

- translate the generalized critical conditions into climate indices we can compute from climate model output
- identify necessary variables

critical condition	meteorological variables	climate index	description
timing of snow melt	snow water equivalent or snow height (snw)	t_{melt}	date of the first day with snw = 0
rain on snow	liquid precipitation (rain), snow height or snow water equivalent (snw), daily minimum temperature (tasmin)	ROS	number of days with snw>3cm and rain>1mm and for the following day tasmin<0°C
ice crusts	daily minimum and maximum temperature (tasmin, tasmax)	ice_{snw}	number of days with snw>3cm and tasmin<0 °C and tasmax>0 °C
snow free patches	snow cover fraction (snfc)	t_{snfc}	date of the first day with snow cover fraction < 50%
snow storms	daily maximum wind speed (wndmax), solid precipitation (snow)	wnd_{snw}	days with wndmax>40km/h (11m/s) and snow fall > 10mm
river ice	river ice (ice_r)	t_{ice_r}	date of first/last day with ice_r>threshold (load bearing)
lake ice	lake ice (ice_l)	t_{ice_l}	date of first/last day with ice_l>threshold (load bearing)

identifying data sources

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- high water levels in rivers
- strong currents

~~daily snow height, snow cover fraction~~	daily precipitation ~~(liquid, solid)~~	~~daily dew point temperature~~
daily air temperature (mean, ~~minimum, maximum~~)	~~daily soil temperature and moisture~~	daily wind speed (mean, ~~maximum~~)
~~river~~ and ~~lake ice~~	~~river discharge~~	~~clouds~~

summer
- ~~insect harassment (insect numbers)~~
- insect harassment (insect attacks)
- hot summers
- wet/dry summers
- permafrost degradation
- ~~shifts in occurrence of predators/plants~~
- snow bed degradation

early autumn
- ~~mushroom growth~~
- warm conditions during rutting
- wet conditions during rutting

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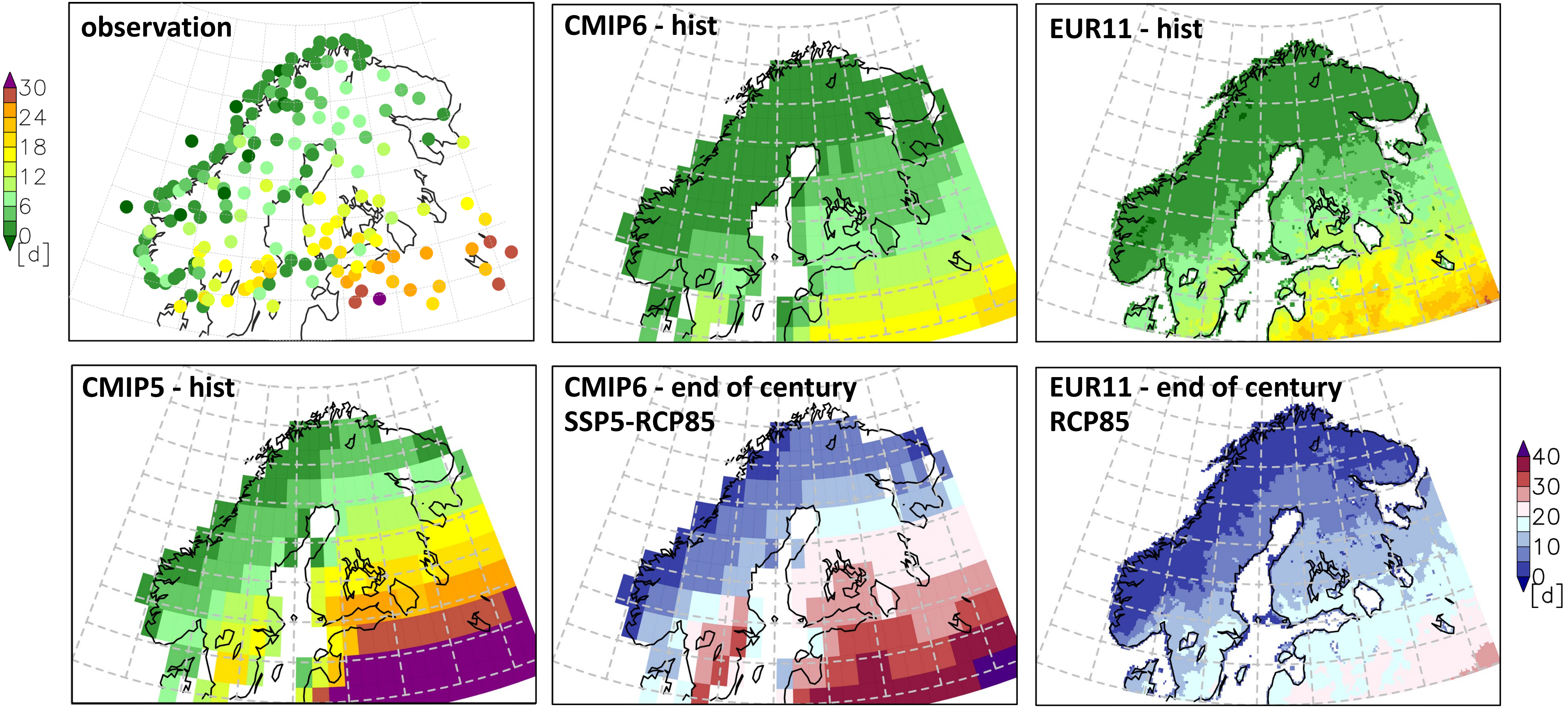
calculating indices from appropriate data sources

hot summers: days with maximum temperature above 25°C



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presenting results in a useable and relatable way

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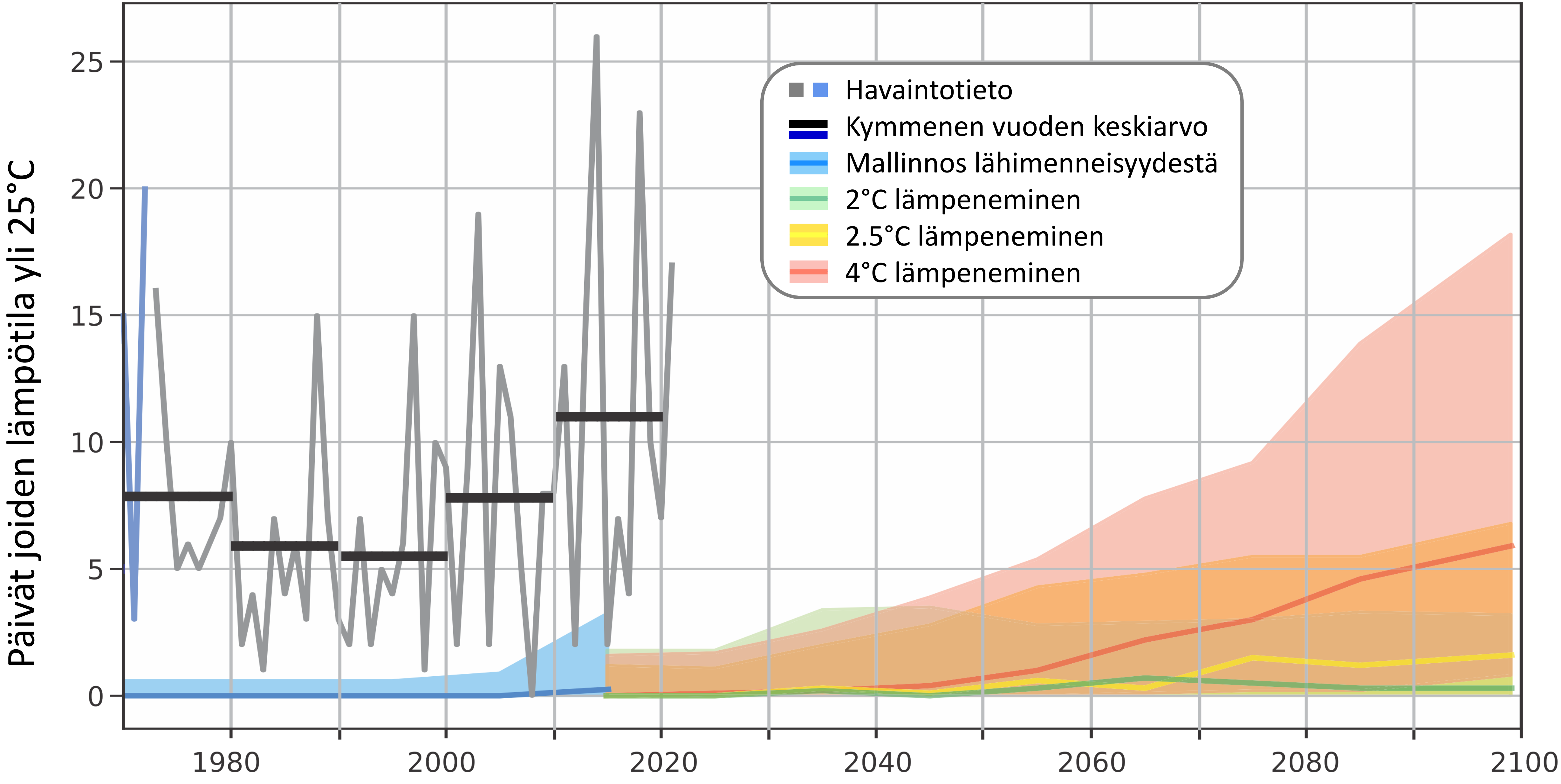

H. Matthes – EFI2024

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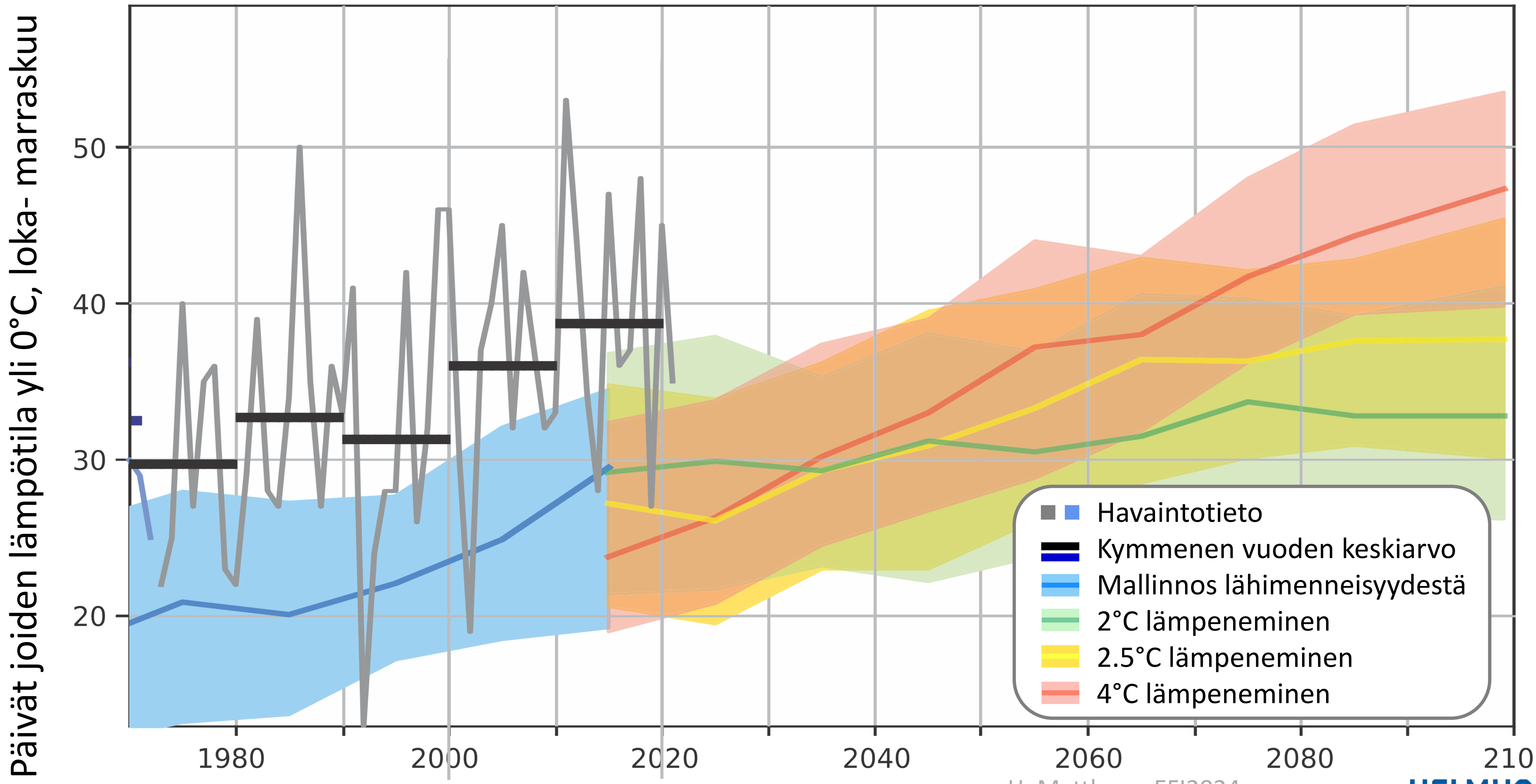

obstacles, gaps and ways forward

Where is what knowledge needed?

- translating critical climate conditions into climate indices requires background knowledge and context
- understanding suitability for purpose of model output also requires background knowledge and context

What should modelers consider?

- specific target groups of climate model projections have specific needs in variables
- providing information on different possible futures with adequate uncertainty estimates requires these variables from big intercomparison projects

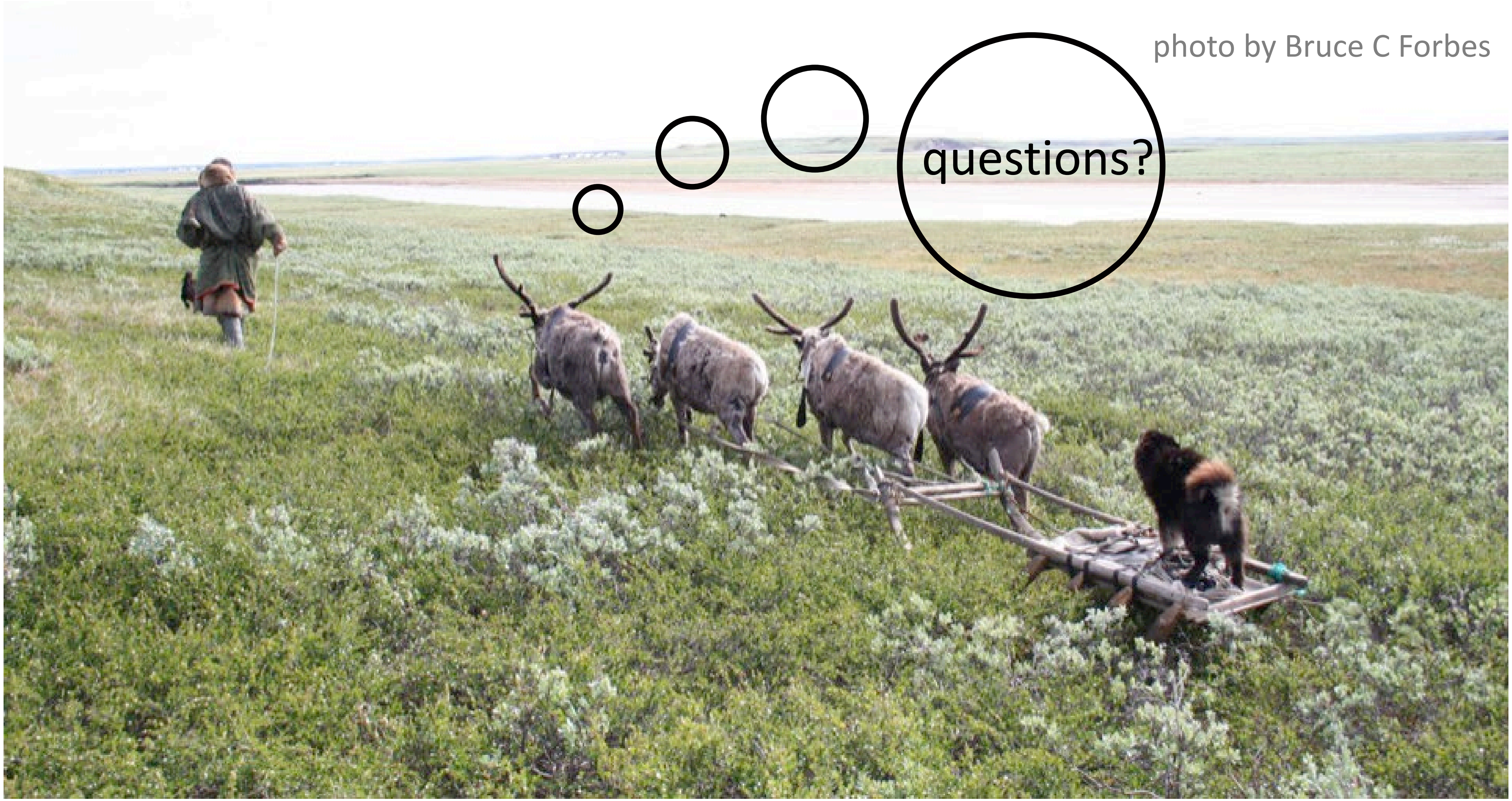

photo by Bruce C Forbes