German Centre for Integrative Biodiversity Research
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Using vegetation databases to assess thermal variability within 1-km^2 spatial units across Northern Europe

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Why caring about fine-grained thermal variability?

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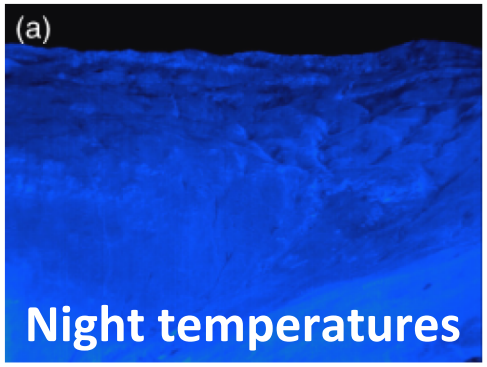
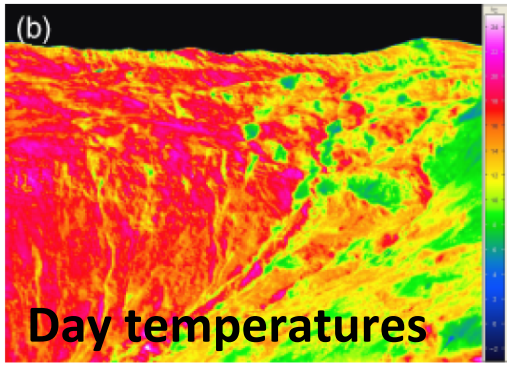
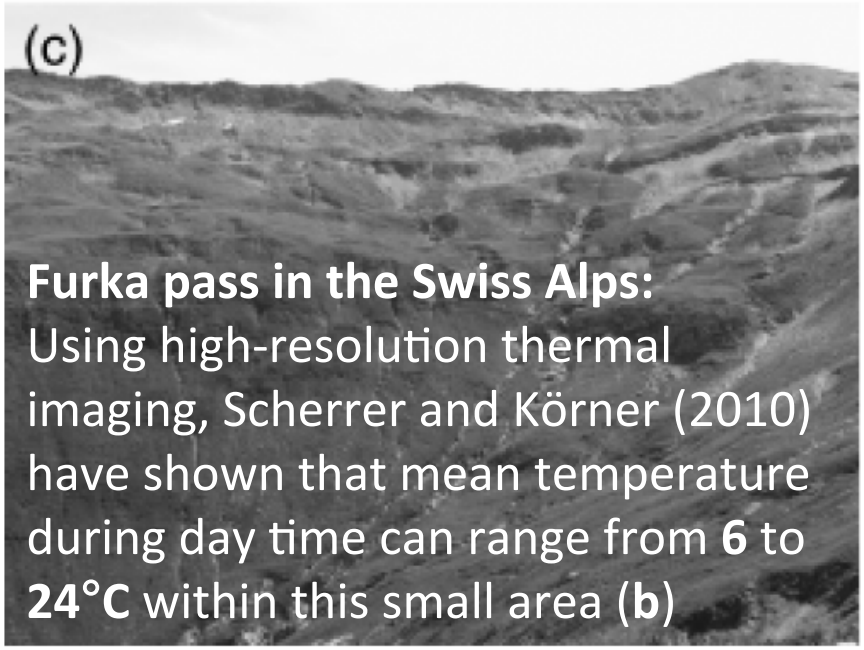
Infra-red thermometry of alpine landscapes challenges climatic warming projections

DANIEL SCHERRER and CHRISTIAN KÖRNER





Ccl: Short-distance escapes are available for plants to persist locally amidst unfavorable regional climatic conditions suggesting plant biodiversity to be less endangered than is expected by climate warming projections



Furka pass in the Swiss Alps: Using high-resolution thermal imaging, Scherrer and Körner (2010) have shown that mean temperature during day time can range from **6** to **24°C** within this small area (**b**)

How big is this thermal variability at broad scales?

- **Issue:**

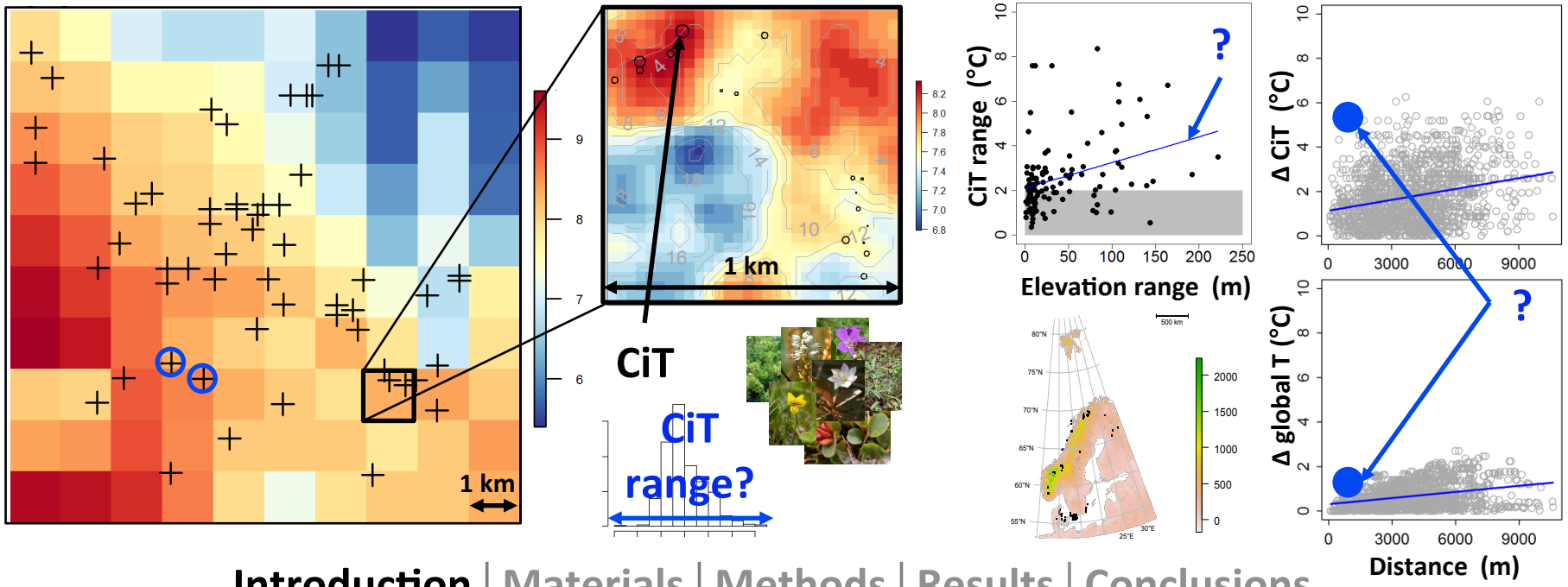
- This information is not yet available because the cost of using data loggers or high-resolution thermal imaging across large spatial extents is a limiting factor

- **Solution:**

- Vegetation geodatabases are already available across large spatial extents and can be used in combination with semi-quantitative plant species indicator values to infer biologically relevant temperature conditions from plant assemblages within <1000-m^2 units (**community-inferred temperatures: CiT**)

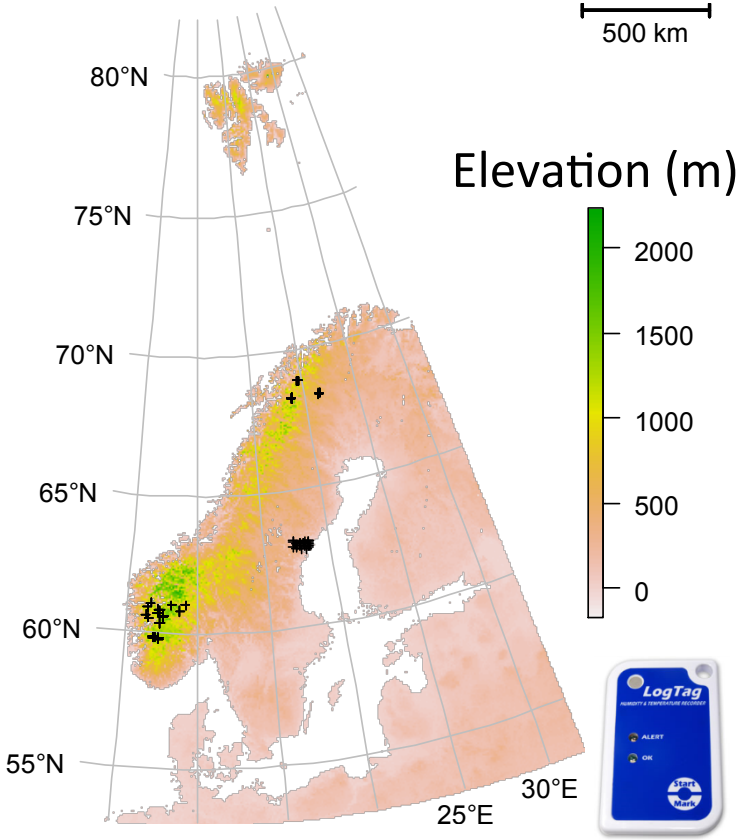
Main questions and objectives

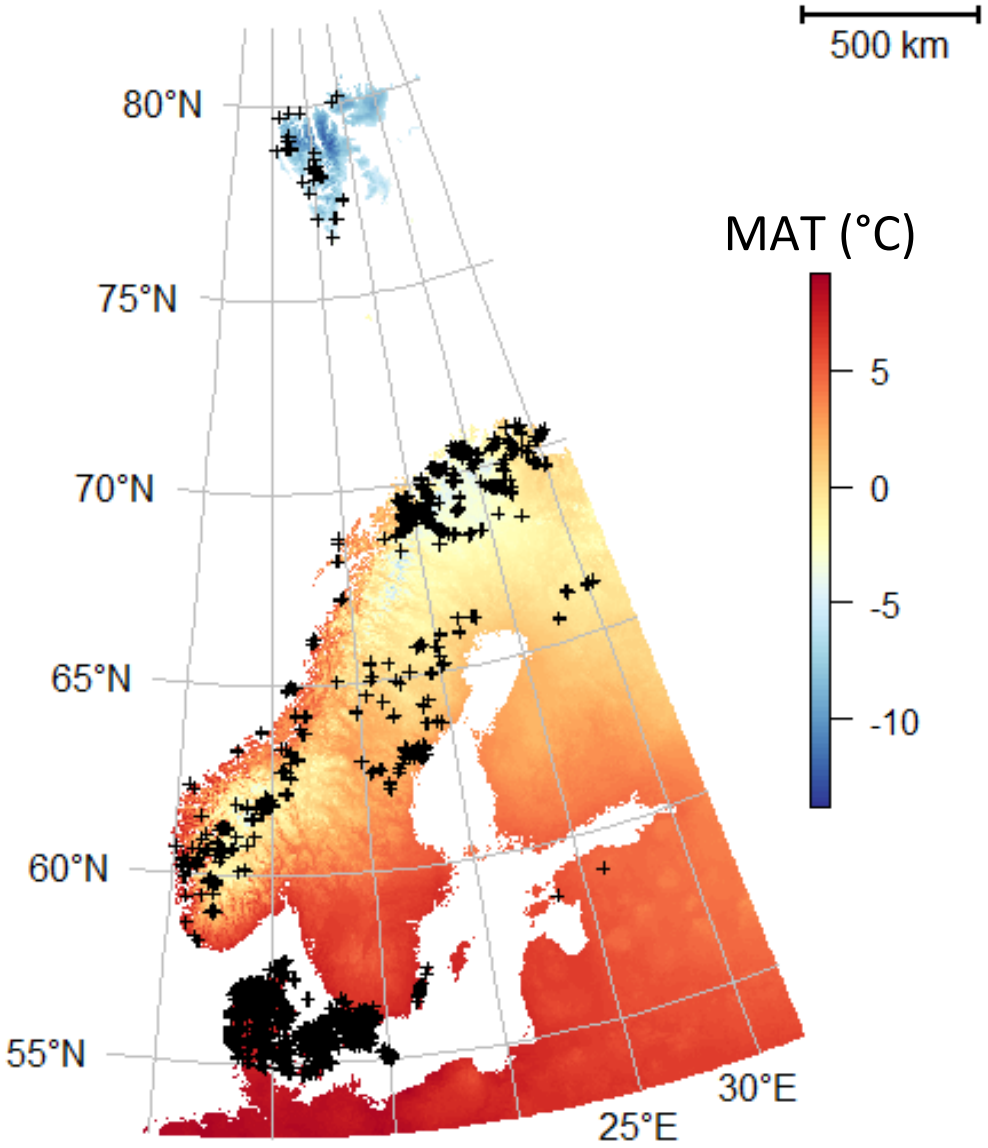
- Assessing thermal variability (CiT range) within 1-km^2 units (cf. WorldClim climatic unit, http://www.worldclim.org/)
- Analyzing the relationship between CiT range and variables reflecting terrain complexity (elevation range, roughness, etc.) at 1-km resolution
- Testing whether or not spatial turnover in CiT is greater than spatial turnover in globally interpolated temperatures (cf. WorldClim temperature grids)



Plot-scale data

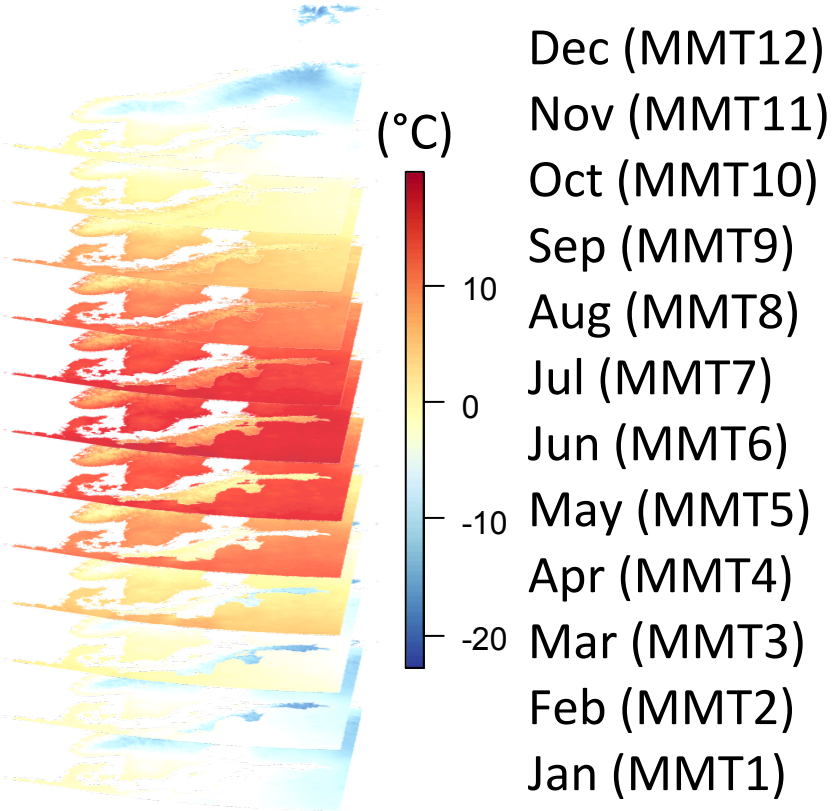
- **42117 vegetation plots across Northern Europe**
- **138 of these plots are equipped with miniature soil data-loggers**



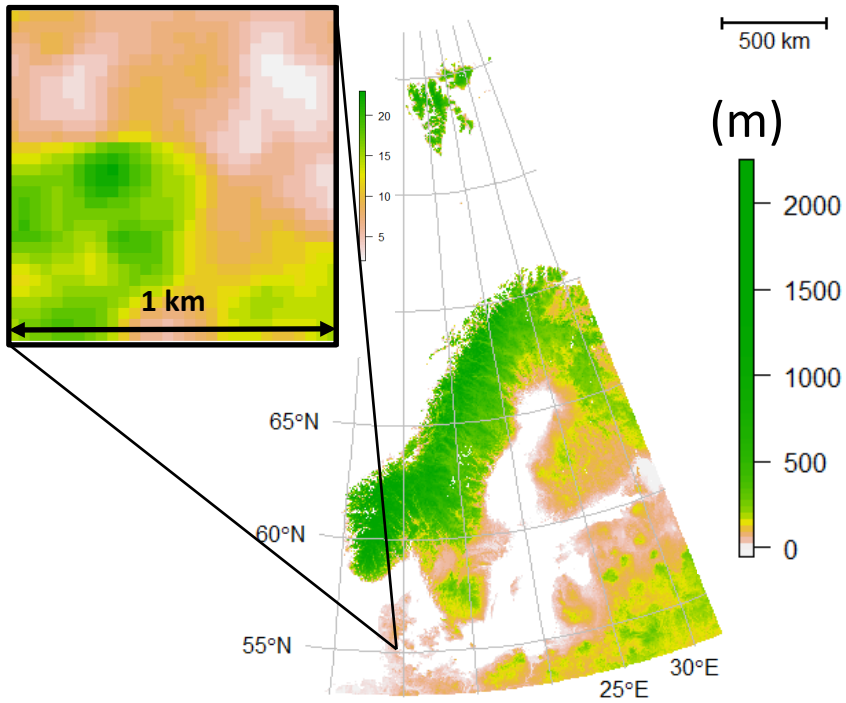


Gridded data

- **12 mean monthly temperature grids across Northern Europe at 1-km resolution (WorldClim)**



- **1 digital elevation model grid across Northern Europe at 33-m resolution (ASTERGDEM)**

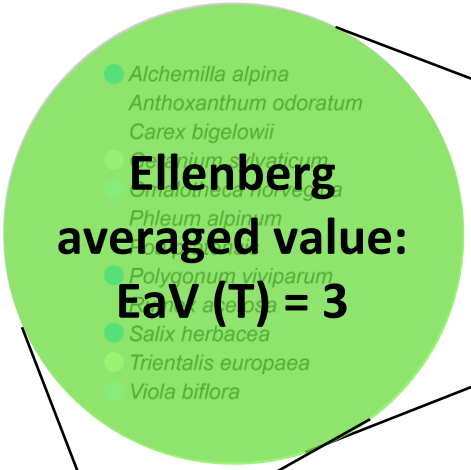


For each 1-km^2 unit, we computed: eleR, slopR, northR, eastR, expoR and roughM

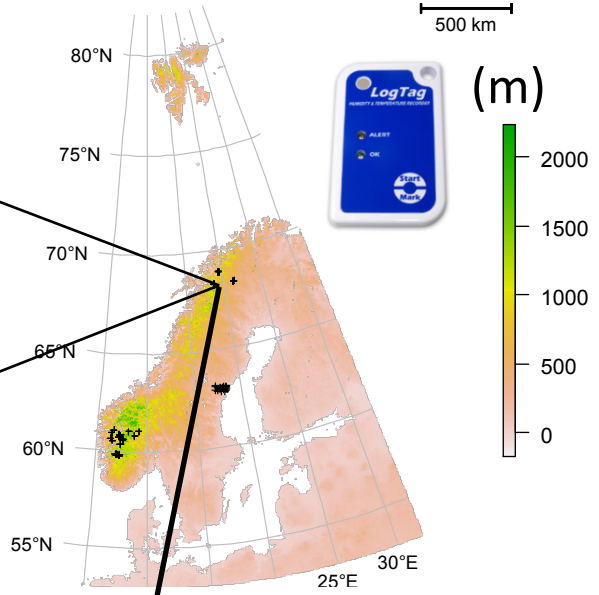
Bottom-up modeling approach to compute CiT

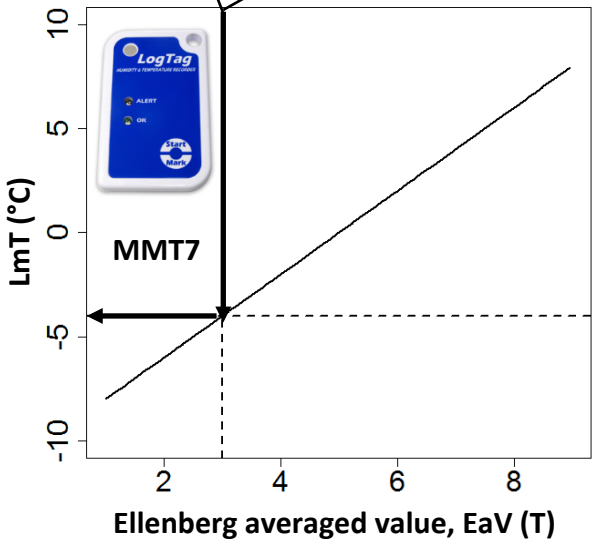
MMT7 from data-logger: LmT = -1°C

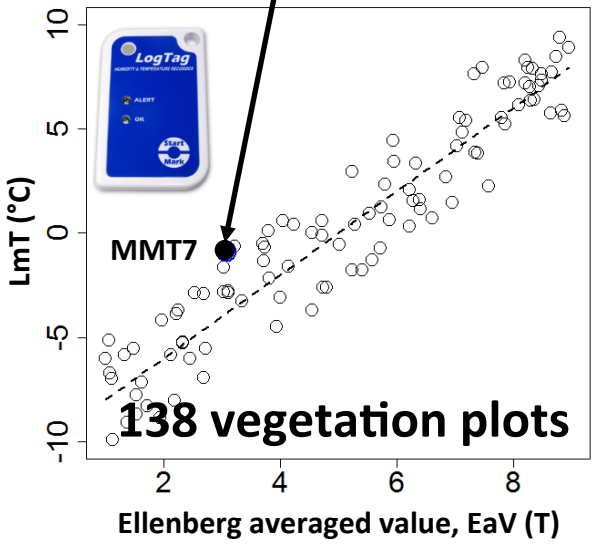
CiT = -4°C



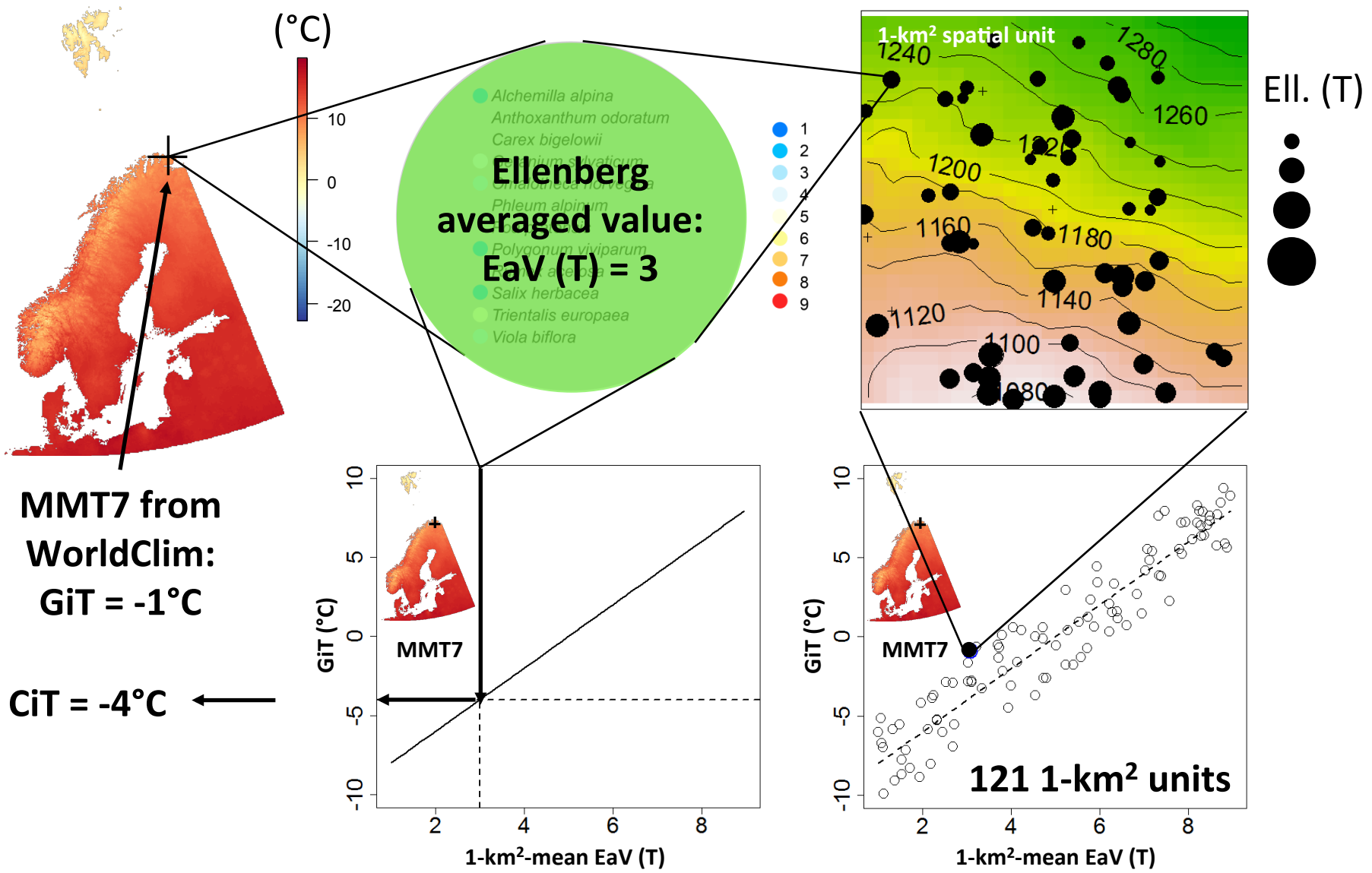
Ellenberg averaged value: EaV (T) = 3



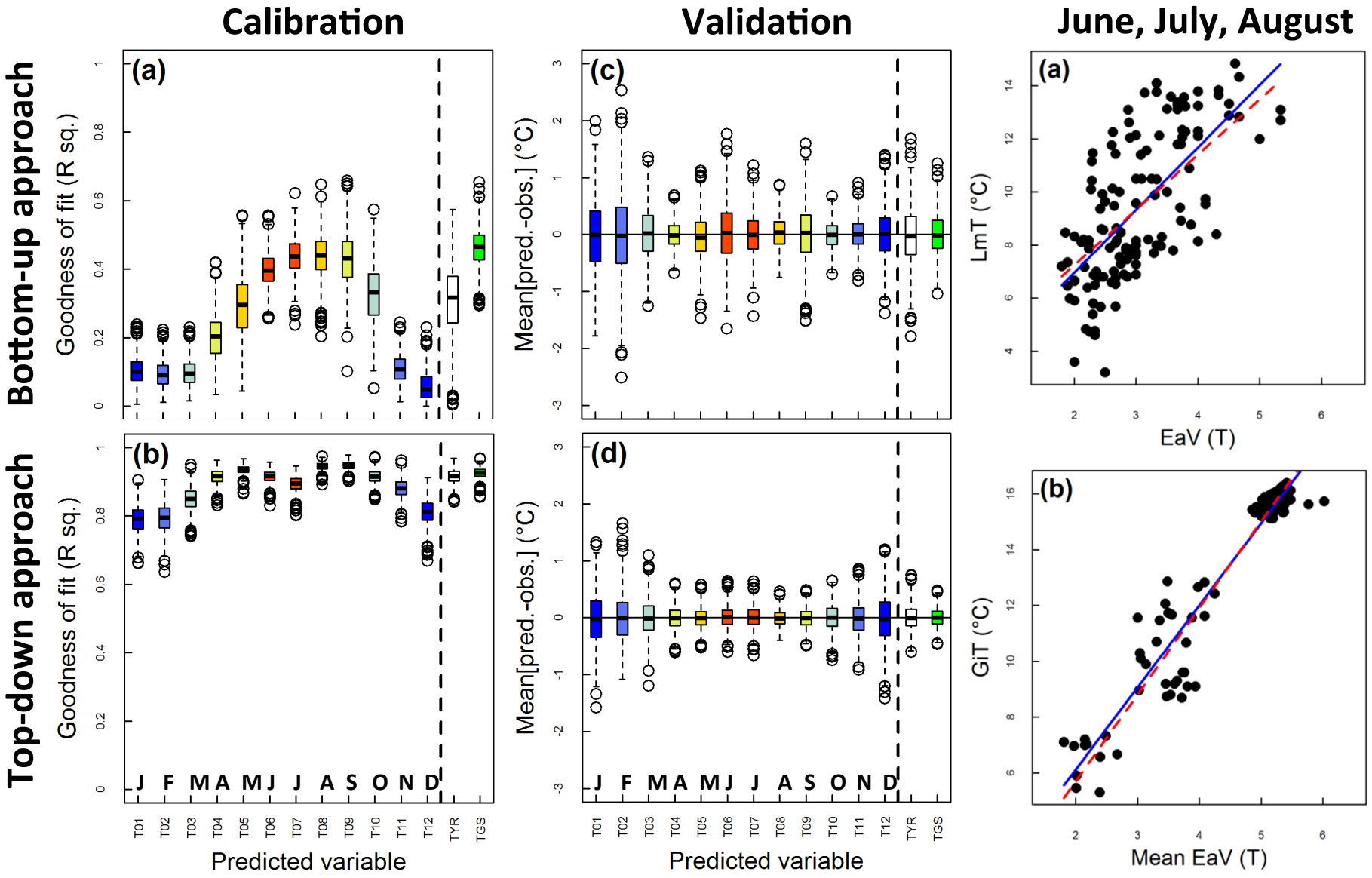




Top-down modeling approach to compute CiT

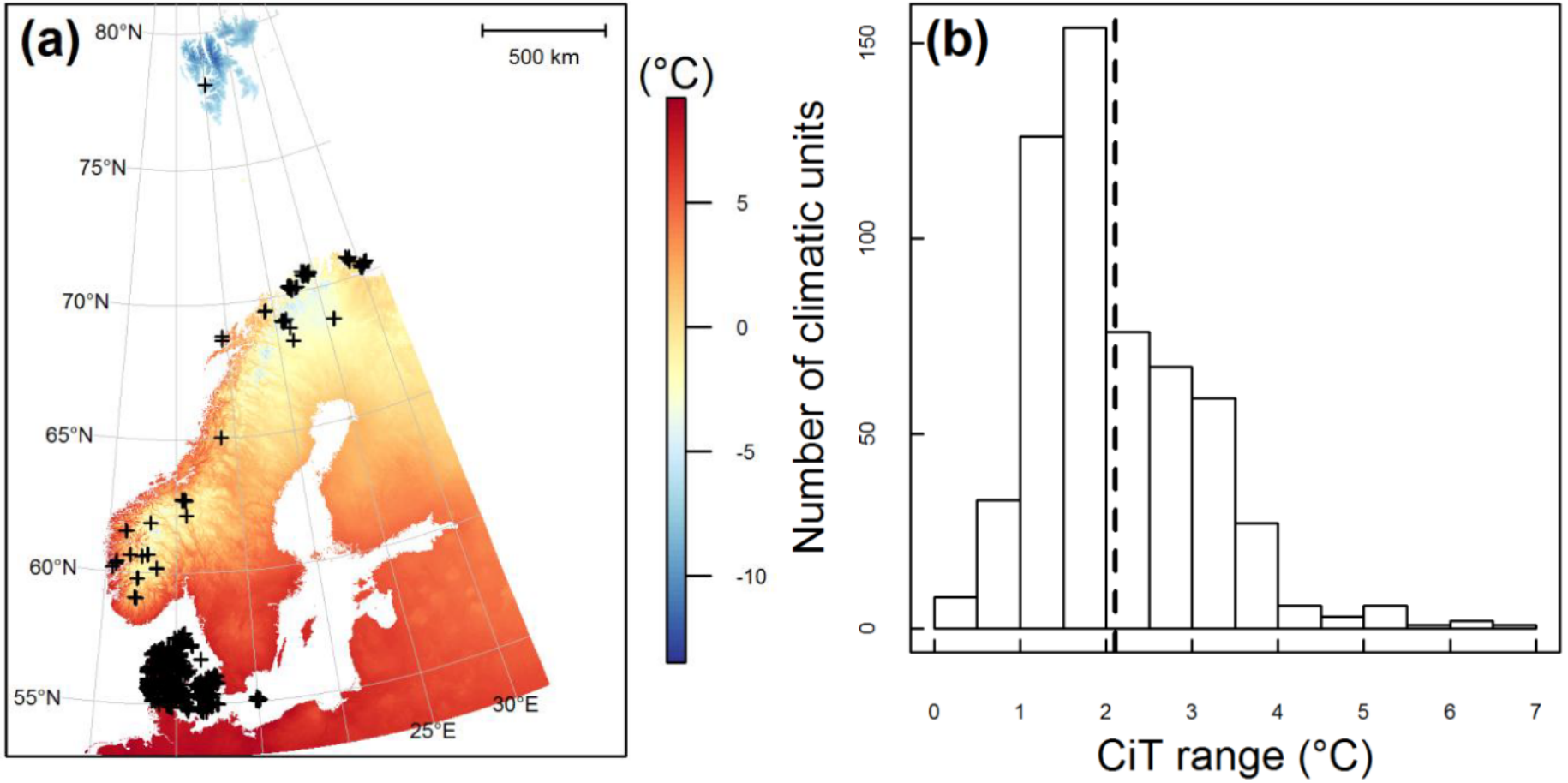


CiT reflects mean growing-season temperature



1-km² thermal variability ranges from 0 to 7°C

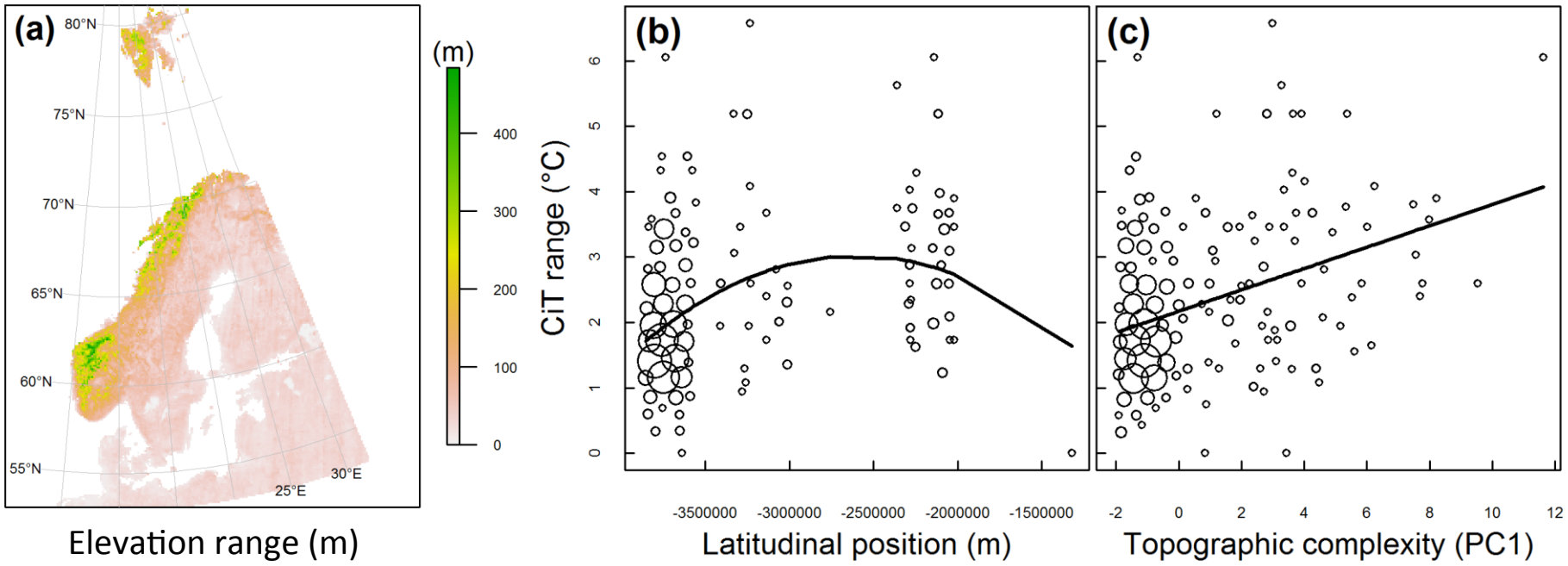
- 569 1-km² WorlClim units used to assess thermal variability across Northern Europe
- Thermal variability averages 2.1°C (SD = 0.97°C) across Northern Europe



Rough terrains offer high thermal variability

- **Thermal variability peaks at 60–65°N, where rough terrains are predominant due to the gross topography from southern to mid-Norway**

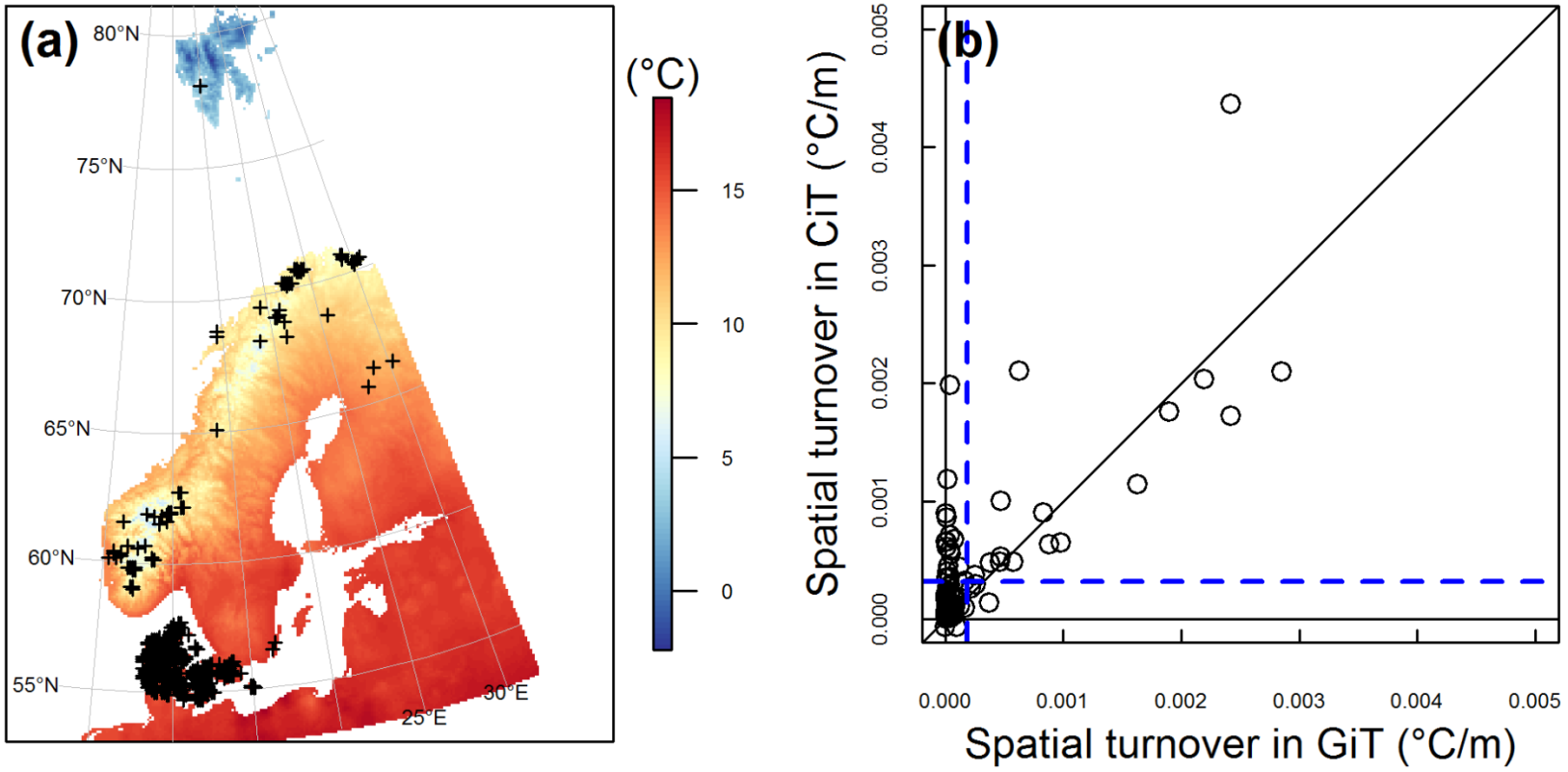
- **Thermal variability increases with terrain roughness averaging 1.97°C (SD = 0.84°C) and 2.68°C (SD = 1.26°C) within the flattest (PC1 < 0) and roughest (PC1 > 0) 1-km^2 WorldClim units respectively**



Thermal variability increases spatial turnover

- 349 100-km^2 WorldClim units used to assess spatial turnover in community-inferred temperature (CiT) and globally interpolated temperature (GiT)

- Spatial turnover in CiT within 100-km^2 units was, on average, 1.8 times greater (0.32°C/km) than spatial turnover in GiT (0.18 °C/km)

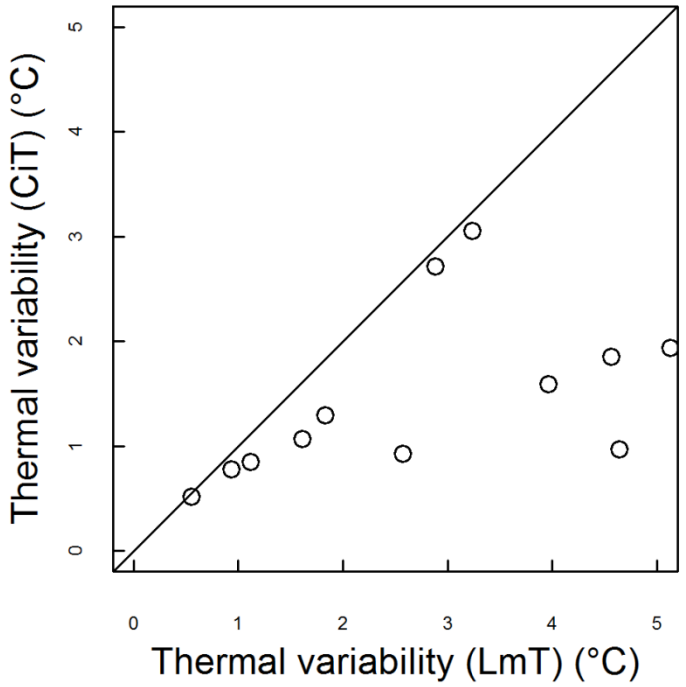


Take-home messages

- **Fine-grained (1 km^2) thermal variability increases local spatial buffering of future climate warming, even in the flattest terrains, and may provide short-distance escapes for species to persist locally amidst unfavorable regional climatic conditions**

- **Coarse-scale species distribution models ignoring this thermal variability tend to overestimate future species' range shifts and future biodiversity loss**

- **Our community-based approach may better reflects temperature conditions biologically relevant to plant community dynamics than measurements from short-term, localized miniature soil data-loggers even though it underestimated the actual fine-grained thermal variability**



For more information

Global Change Biology

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Local temperatures inferred from plant communities suggest strong spatial buffering of climate warming across Northern Europe

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