University of Zurich[UZH]

URPP Global Change and Biodiversity

Tundra Energy Fluxes under Changing Summer Precipitation

The Tundra Rain Experiment (TRain)

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Background

- The Arctic will undergo increases in future temperature and precipitation.
- It is unclear how these changes will affect the Arctic land surface energy budget (SEB; Figure 1).
- The SEB is an important driver of Earth system processes, such as the hydrologic and carbon cycles.
- We investigate the Arctic SEB and relative importance of biotic and abiotic drivers for its state and future development.

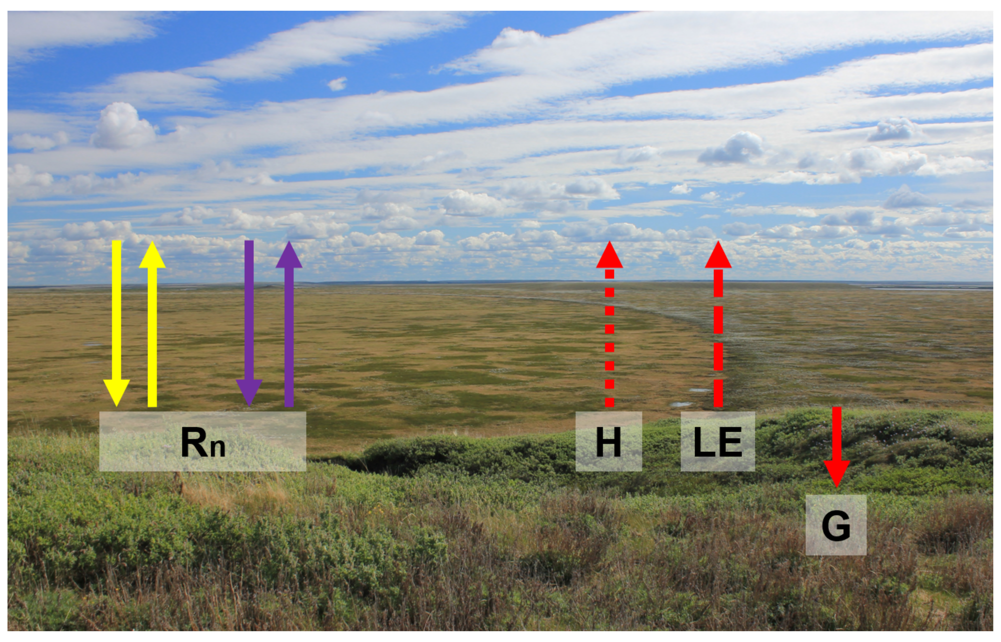

Figure 1: SEB describes the distribution of solar energy in the Earth system.

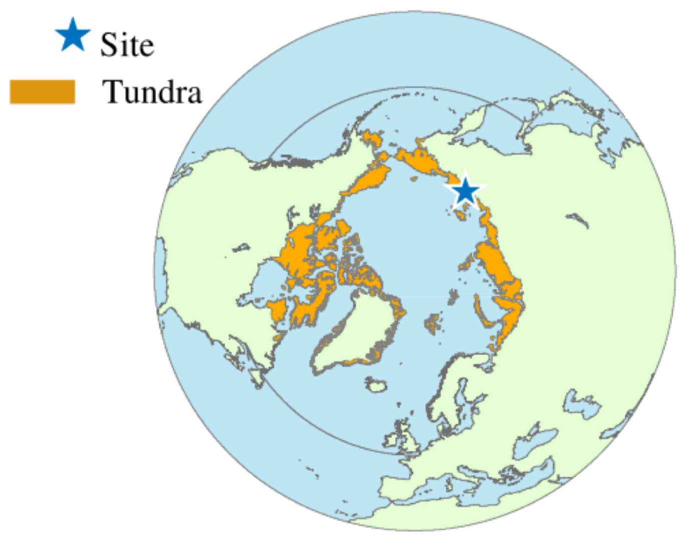

Figure 2: Location of Kytalyk nature reserve (from Juszak et al., 2017[1]).

Methods

EXPERIMENT

- Test effects of extreme precipitation regimes on energy fluxes, plant functional traits, and plant community diversity in the Arctic Tundra.
- Experimentally simulate precipitation scenarios on vegetation plots established at the Kytalyk nature reserve in northeast Siberia (70.83° N, 147.49° E; Figure 2).
- Three precipitation scenarios were experimentally simulated in this study using a relative treatment approach: extreme precipitation, control, and extreme drought.

MECHANISTIC MODELING

- Test effects of extreme precipitation regimes on plant traits, leaf optical properties, and species composition.
- Test effects of plant traits diversity on shortwave radiation, using the DART radiative transfer model[2,3].

Experimental Setup

- Experimental design is an adaptation of precipitation shelter design originally proposed in Gherardi and Sala (2013)[4].
- Both extreme drought and extreme precipitation are experimentally simulated using a relative treatment approach.

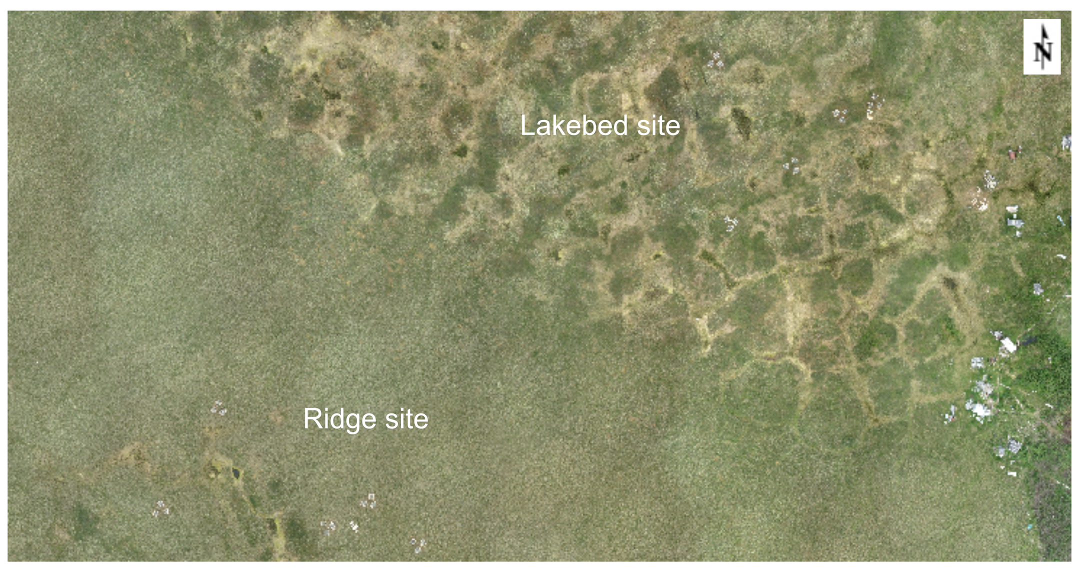

Figure 3: Drone image of the two experimental site locations: the Pleistocene ridge and the drained permafrost thaw lakebed.

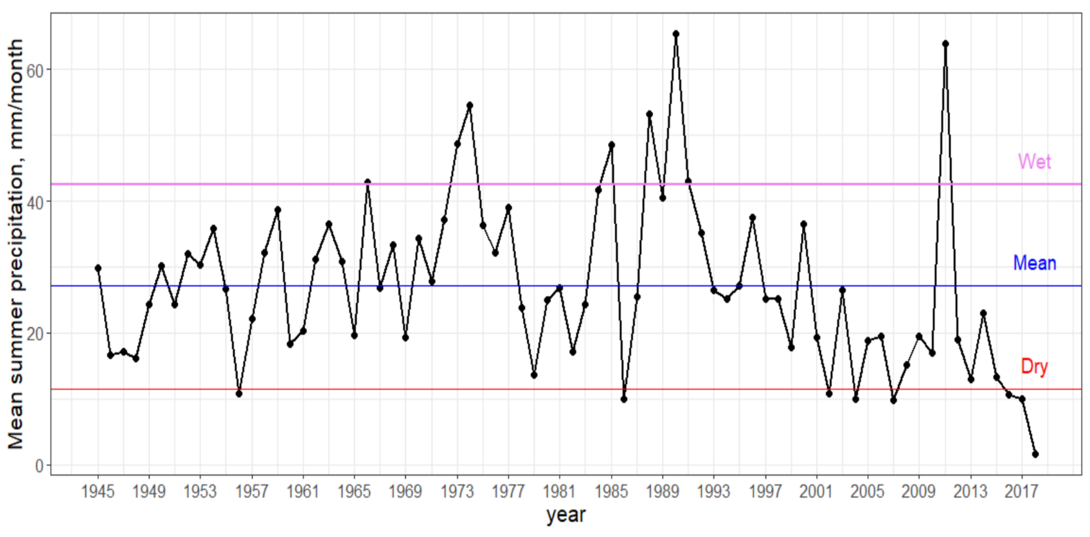

Figure 4: Mean 1944 to 2018 annual precipitation from the Chokurdakh meteorological station. 10th and 90th percentiles are indicated as the 'Dry' and 'Wet' lines, respectively.

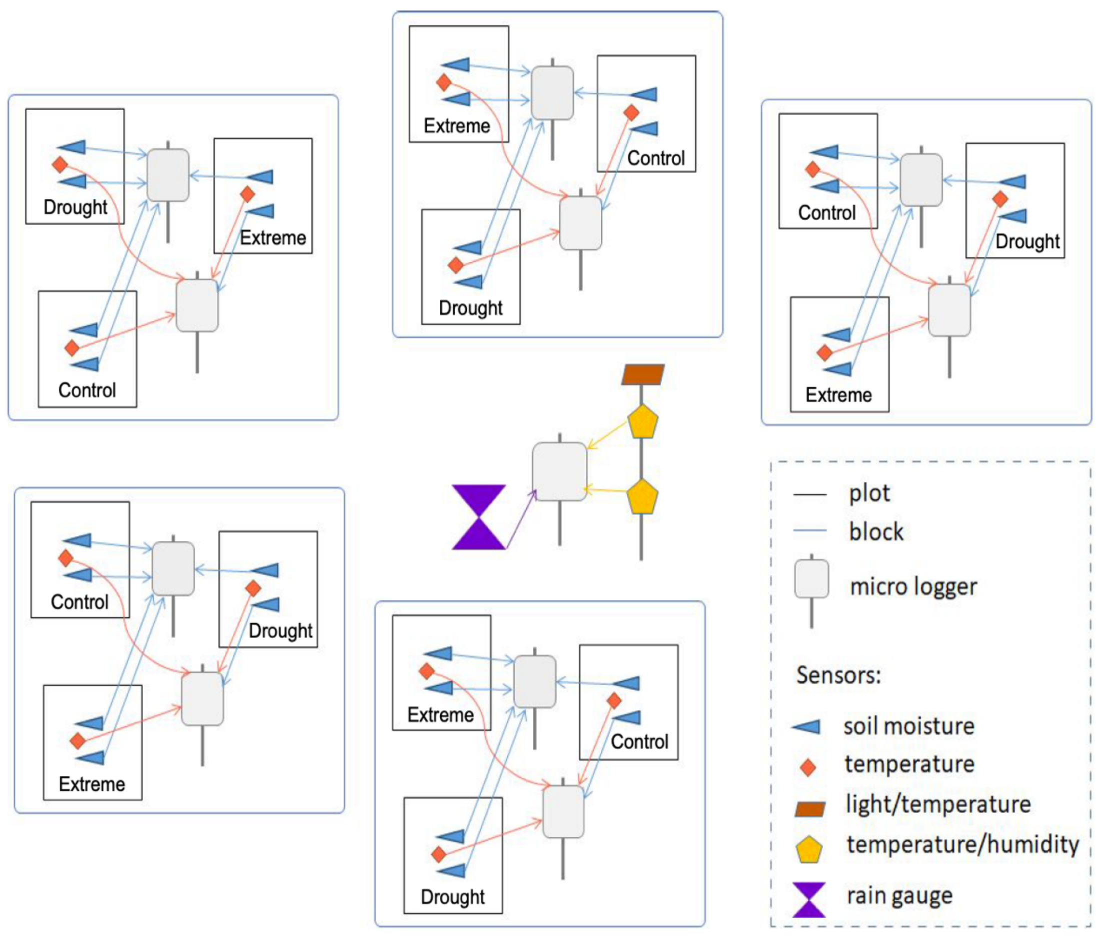

Figure 5: Example of a five-block layout for each of the two study sites at the Kytalyk nature reserve.

Figure 6: Image of the drought (A), extreme precipitation (B), and control (C) shelters built in the summer of 2019 at the Kytalyk nature reserve.

Expected Results

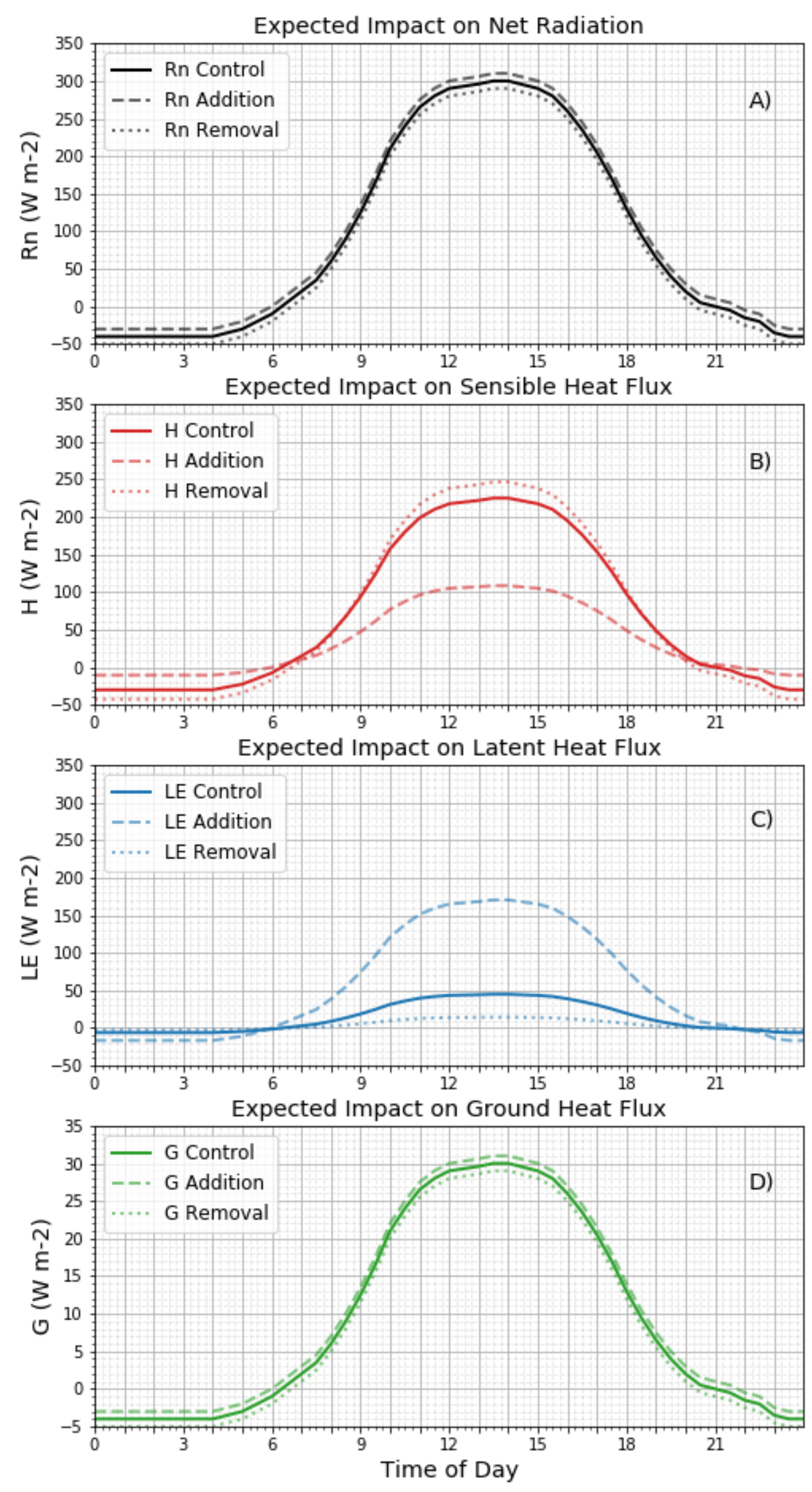

Figure 7: Expected impact of precipitation addition and removal on Rn (A), H (B), LE (C), and G (D). Note the change in y-axis scale for G. Data based on findings from Juszak et al.[5] and Lynch et al.[6].

Conclusion

We contribute to the understanding of an important, understudied component of the Earth system in a region that is rapidly changing and strongly impacting Earth system processes from local to global scales.

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