Microclimatic variability within topographically complex landscape and its influence on plant species composition

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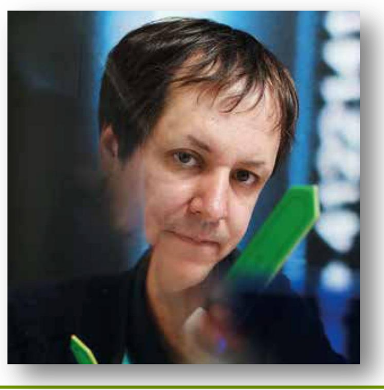
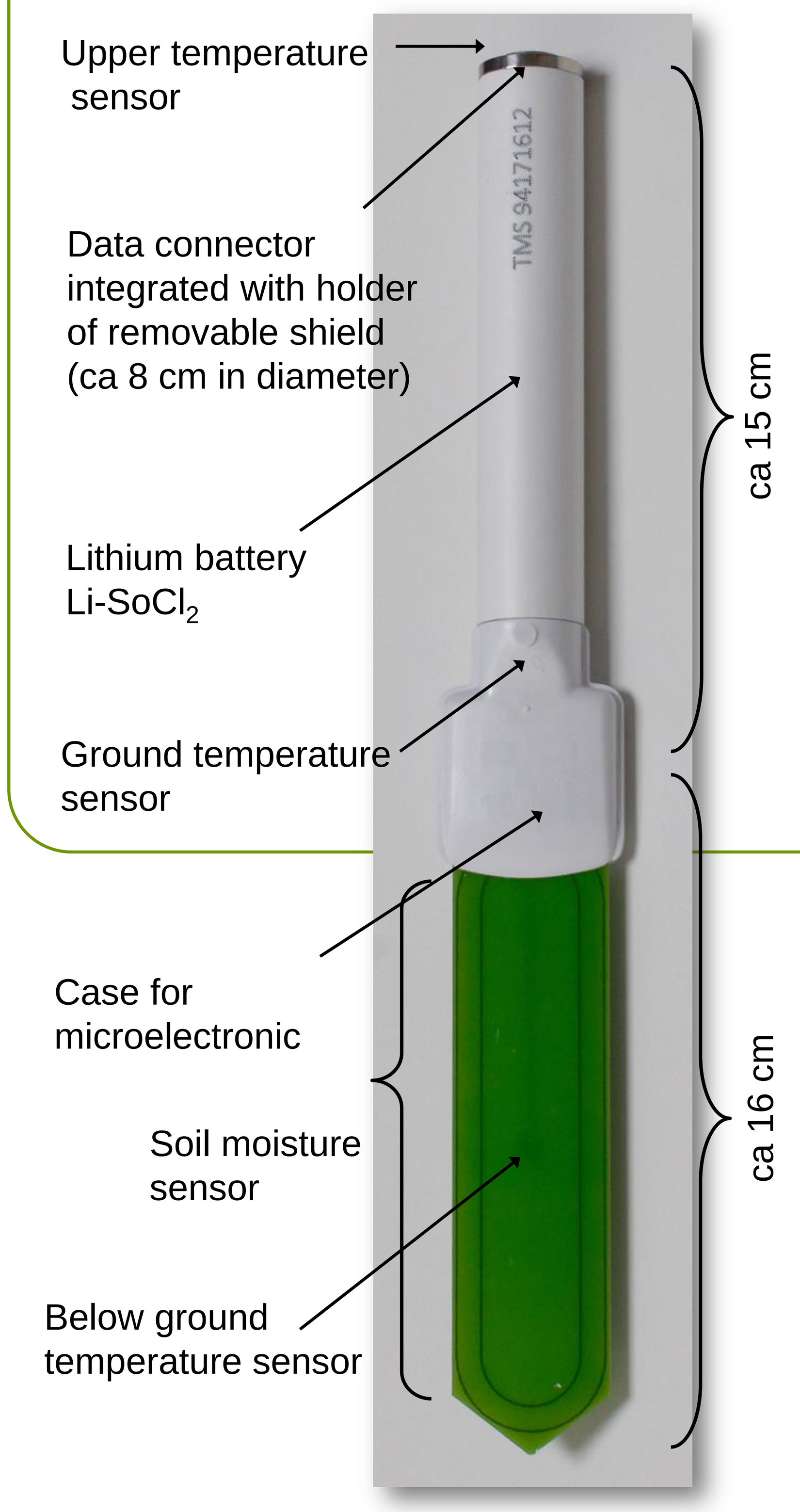


Tool used



Newly developed standalone unit (version TMS1-5 for continuous monitoring of microclimatic conditions. The unit equipped with datalogger features:

- Three MAXIM/DALLAS Semiconductor DS7505U+ temperature sensors with 0.0625°C resolution and ± 0.5 °C accuracy, for use at ca. - 10 , 0 and +15 cm relative to the soil surface.
- Proprietary soil moisture measurement technology based on time domain transmission (TDT) in which high frequency oscillation minimizes effects of soil salinity on moisture measurement.

Manufactured by TOMST (www.tomst.com), Wild et al. (2019)

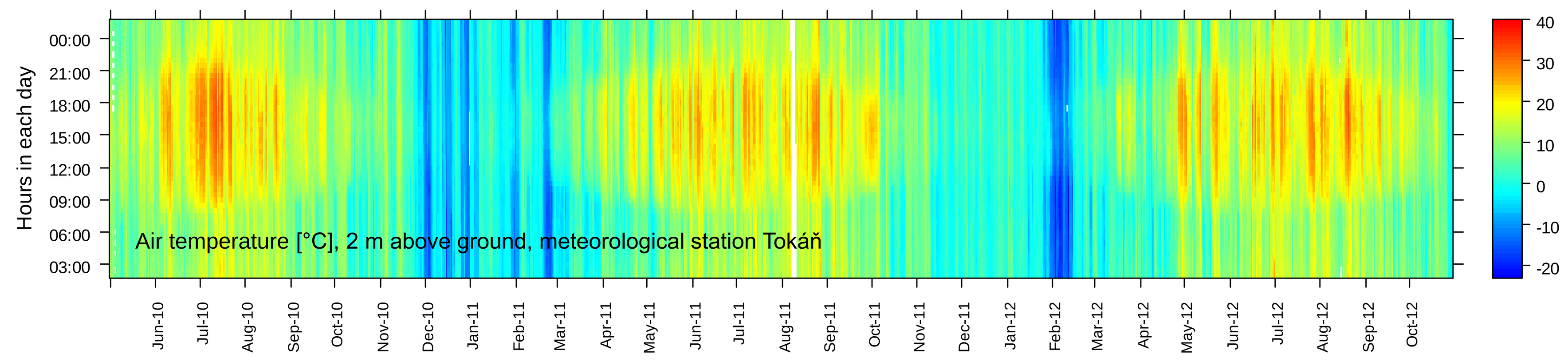
Detailed monitoring of air temperature near the ground confirmed that extreme climatic conditions, both warm and cold, occur on rock ridges, while valley floors are characterized by more stabile climate throughout the year

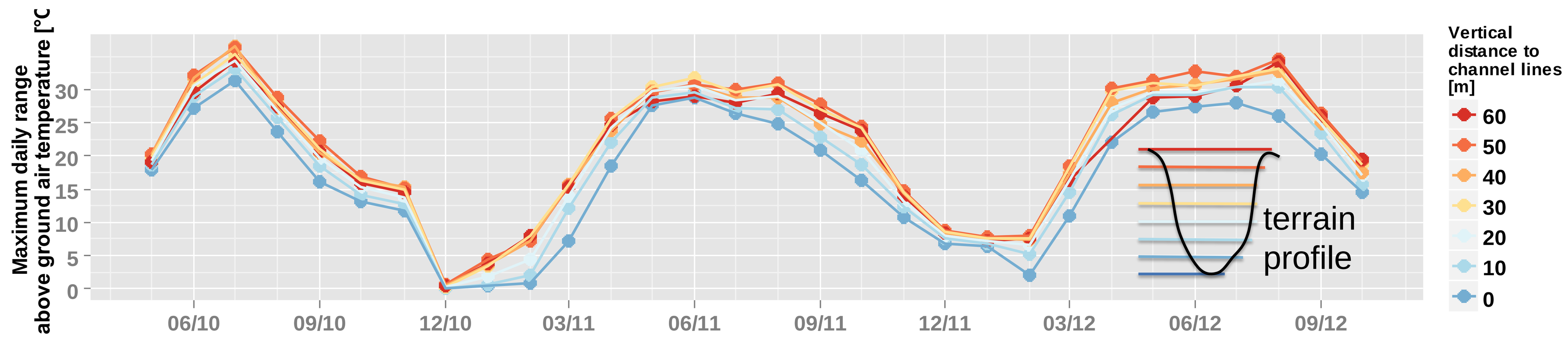
Average daily temperature measured at each locality 15 cm above ground and mesoclimate data represented by standard meteorological station (2 m above ground in meteorological screen) show differences up to 15 °C.

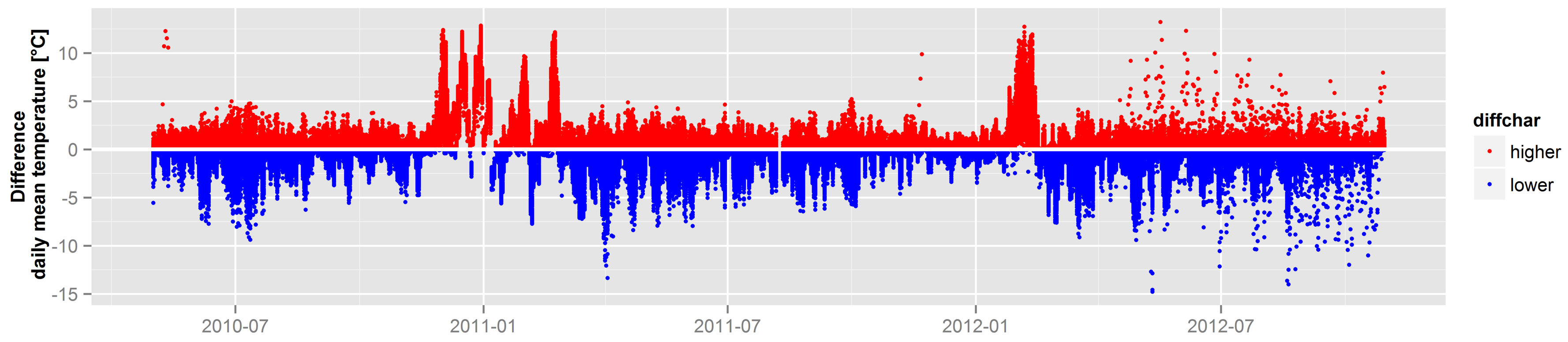
Aims

- To describe spatial pattern and seasonal variation of microclimate within topographically complex landscape.
- To link vegetation, topography and microclimate in order to explain small scale vegetation pattern.

Microclimate



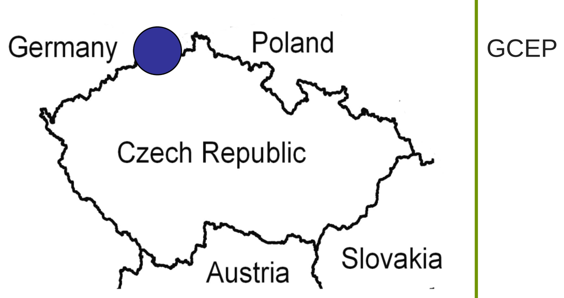


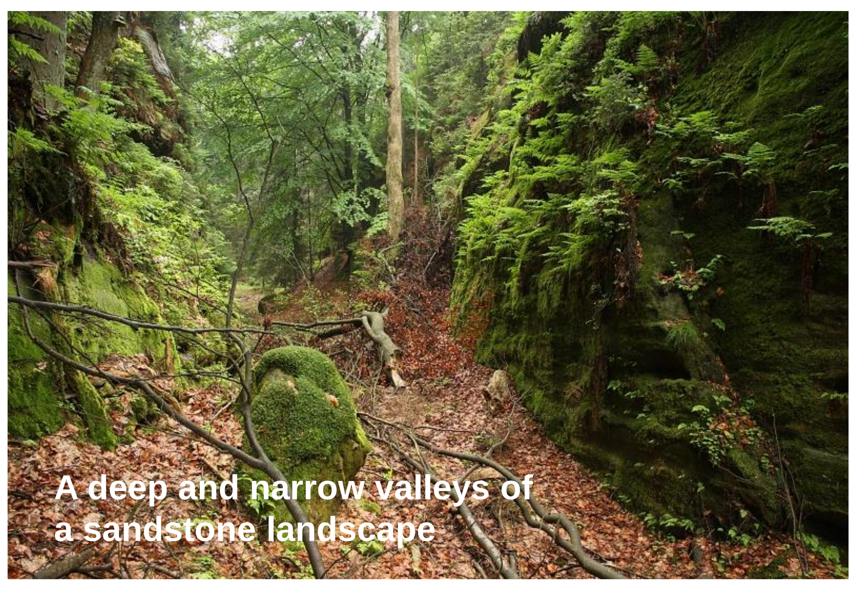


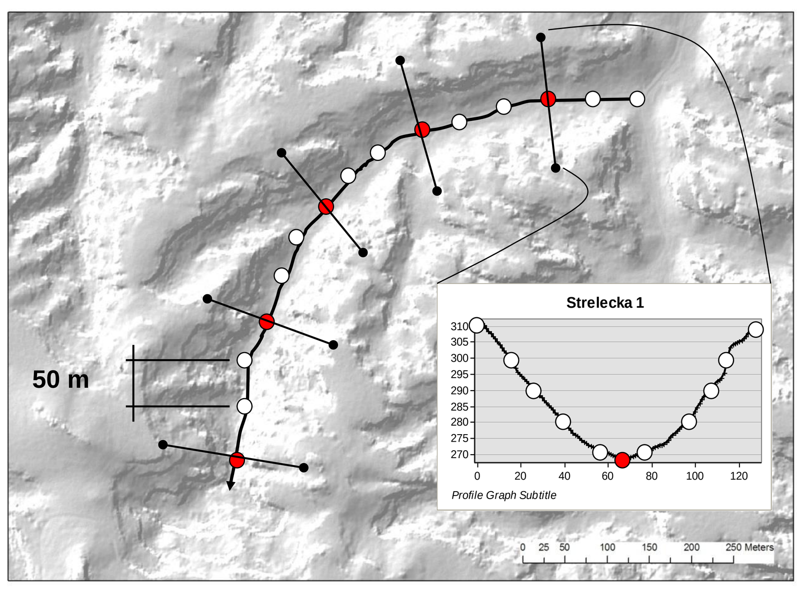
Methods

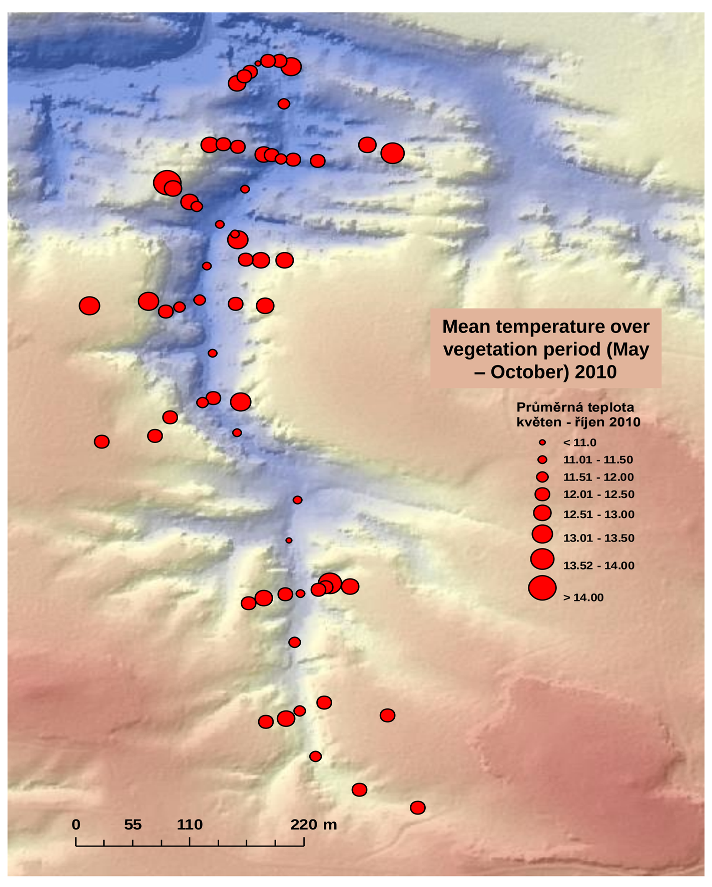
Microclimate

- Monitoring of temperature and soil moisture in deep valleys of a sandstone landscape (Bohemian Switzerland, Czech Republic).
- > 300 units installed in 2010 along an elevation gradient in 6 valleys in order to perform detailed (30 min. interval) measurement of seasonal dynamic of microclimatic conditions.









Example of spatial distribution of TMS1 units in one of the study valleys. Displayed mean temperatures over the 2010 vegetation period show distinct pattern of colder valley floors and warmer ridges in the sandstone terrain

Vegetation

- Plant species composition including dominant mosses recorded in 1 m² area surrounding each TMS unit.

Topography

- Terrain attributes were derived from 1 m LiDAR digital elevation model resampled to 5 m resolution using SAGA software (www.saga.org).

Data analysis

- Large dataset (> 50 mil. data points) of climatic data were processed and visualised using owner software TMSView and R language 2.15.2.
- The variability in species composition and different env. factors was visualised using function metaMDS() and envfit() from vegan R-package.
- The variation was partialed out using varpart() from the same package.

Highlights

- Topography of sandstone landscape largely modified the microclimatic condition up to magnitude of 15 °C (daily average) in comparison to data from standard meteorological station
- Valley floors meet the condition for macrorefugia formulated by Ashcroft et al. (2012, GCB). They have stable and distinctly different (extreme) microclimate from the surrounding area.
- The microclimate account for 14 % of small scale species composition and most of these variability is shared with topography as explanatory factor.

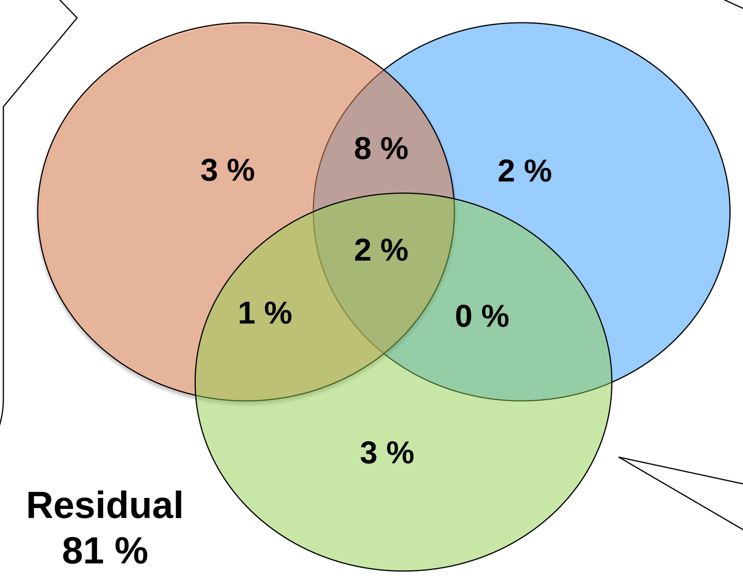
Microclimate, terrain and vegetation

Microclimate:

- Air temperature 10 cm above ground
- Growing degree days (base 10 °C)
- Minimum soil temperature
- Minimum above ground temperature
- Average minimum temperature
- Average maximum temperature
- Maximum daily range

Topography:

- Relative slope position
- SAGA wetness index
- Slope
- Potential solar radiation
- Vertical distance to channel line



Tree layer cover:

- Total tree cover
- Fagus sylvatica
- Picea abies
- Pinus sylvestris

Partition the variation of herb layer species composition with respect to microclimate, topography an tree layer cover

Wild et al. 2019 | TMS Producer

References

Wild, J., Kopecky, M., Macek, M., Sanda, M., Jankovec, J., Haase, T. (2019) **Climate at ecologically relevant scales: A new temperature and soil moisture logger for long-term microclimate measurement. AGRICULTURAL AND FOREST METEOROLOGY** 268: 40-47.

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Acknowledgement

This research is supported by Technology Agency of the Czech Republic project No. TA01021283 and by Norway Grants. We also thank all the people who have helped us with field data collection, and the staff of Bohemian Switzerland National Park, in particular Ivana Marková, for their support.
LiDAR DEM was kindly provided by TU Dresden, Department of Geoscience.