Field monitoring of microclimate: new combined thermal and soil moisture standalone unit

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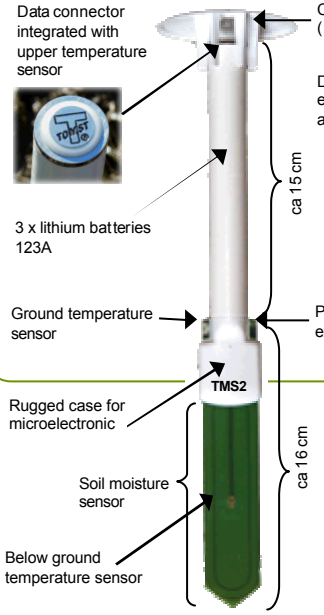
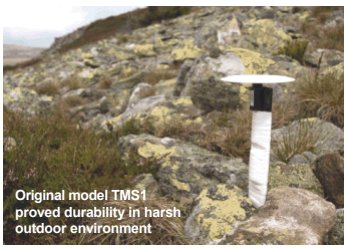
Technical description

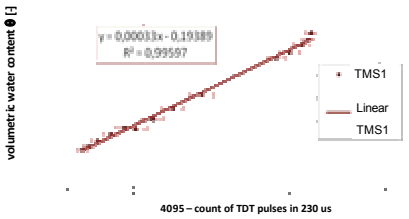


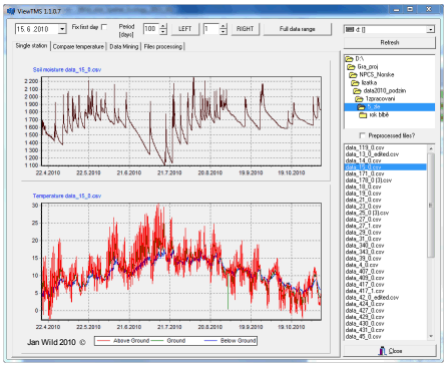


We have developed and field-tested a standalone unit (current version TMS2) for continuous monitoring of microclimatic conditions. The unit, manufactured by TOMST Ltd, features:

- 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.
- Data storage and battery life lasting the lifetime of the unit (ca. 5 year). More than 500 000 records protected against data loss and theft.

The original version (TMS1) of the unit was tested and calibrated in soil laboratories of the Czech Technical University in Prague, showing good linearity and only minor influences of temperature and soil salinity on recorded soil moisture values.





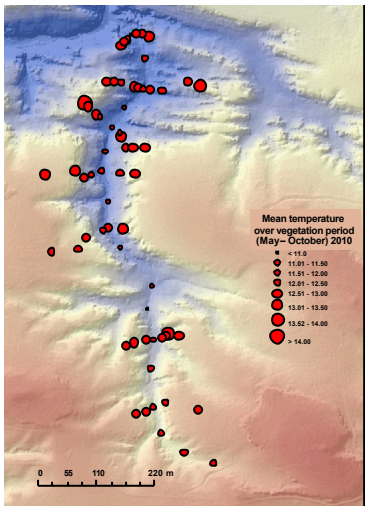
Software for visualization and basic data processing is available for free. Basic functionality includes:

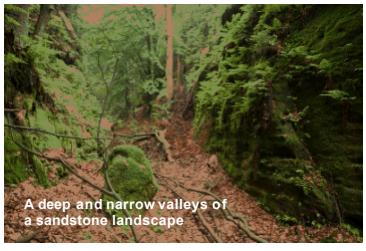
- Display of single unit data and comparison of data from two units.
- Detection of data anomalies such as unexpected leaps in values or missing measurements.
- Calculation of mean, minimum, and maximum temperature and moisture, as well as growing degree days.
- Batch processing of selected folders.

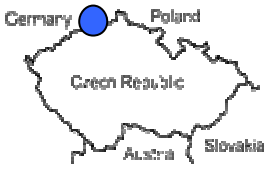
Case study

Monitoring of microclimate in sandstone landscape

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

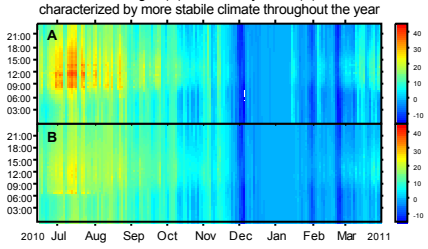






We used the first version (TMS1) of this unit for monitoring temperature and soil moisture in deep valleys of a sandstone landscape (Bohemian Switzerland, Czech Republic). About 400 units were installed in 2009 along an elevation gradient in 6 valleys in order to perform detailed (30 min. interval) measurement of seasonal dynamic of microclimatic conditions.

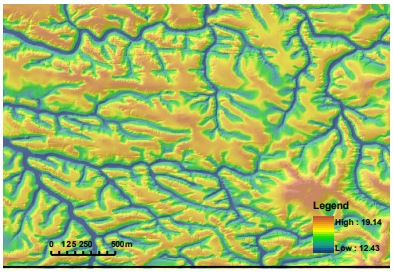
Detailed monitoring of air temperature near the ground confirmed that extreme climatic conditions, both warm and cold, occur on rock ridges (A), while valley floors (B) are characterized by more stabile climate throughout the year



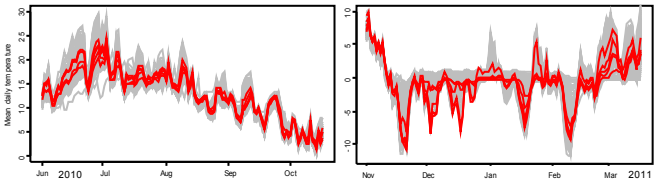
We found a close relationship between the measured variables and terrain topography derived from a high resolution, LiDAR based digital elevation model. This allowed us to produce highly detailed maps of soil moisture and temperature across the large area of Bohemian Switzerland (app. 80 km^2).

We further used the sensors for precise measurement of habitat conditions of several rare and nationally endangered species of vascular plants, bryophytes, and fungi. These field measurements provide important information about habitat requirements of the target species and strengthen our ability to predict species distribution in the face of ongoing climate change.

Example of extrapolated mean air temperature (10 cm above ground) during vegetation period



Course of mean daily air temperature s at the localities of rare boreo-montane polypore fungi *Phellinus nigrolimitatus* (red line) compared with ca. 250 localities along the whole topographic gradient (grey line). Localities of the target species were characterized by moderate climate during the vegetation period, but showed the lowest measured temperature during the winter period.



Variation in fine-scale microclimate influences species distributions and other important ecological processes, making fine-resolution monitoring of microclimate a necessary component of ecological research. Our standalone unit has been demonstrated to effectively gather fine-resolution data over a large and topographically varied region, showing it to be a very valuable tool for a wide range of research applications.

Acknowledgement
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