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Station for spatially distributed measurements of soil moisture and ambient temperature

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Third generation of combined thermal and soil moisture standalone field station coded TMS3 with wireless communication is presented. The device combines three thermometers (MAXIM/DALLAS Semiconductor DS7505U with -55 to +125°C range and 0.0625°C resolution, 0.5°C precision in 0 to +70°C range and 2°C precision out of this range). Soil moisture measurement is performed based on time domain transmission (TDT) principle for the full range of soil moisture with 0.025% resolution within the full possible soil moisture span for the most typical conditions of dry to saturated soils with safe margins to enable measurements in freezing, hot or saline soils.

Principal compact version is designed for temperature measurements approximately at heights -10, 0 and +15 cm relative to soil surface when installed vertically and soil moisture measurements between 0 and 12 cm below surface. Set of buriable/subsurface stations each with 2.2 meter extension cord with soil and surface temperature measurement provides possibility to scan vertical soil profile for soil moisture and temperature at desired depths. USB equipped station is designed for streamed direct data acquisition in laboratory use in 1s interval. Station is also equipped with the shock sensor indicating the manipulation. Presented version incorporates life time permanent data storage (0.5 million logs). Current sensor design aims towards improved durability in harsh outdoor environment with reliable functioning in wet conditions withstanding mechanical or electric shock destruction. Insertion into the soil is possible by pressing with the use of a simple plastic cover.

Data are retrieved by contact portable pocket collector (second generation) or by RFID wireless communication for hundreds meter distance (third generation) in either star pattern of GSM hub to stations or lined up GSM to station to another station both in comprised data packets. This option will allow online data harvesting and real time process control (e.g. optimized irrigation) by the end of 2013. User selected regimes of scanning in the field standalone model is 1,5 or 15 minutes for soil moisture and 1, 5, 10 or 15 minutes for the temperature (in their practical combinations) with a battery and datastorage lifetime ranging 1 – 10 years. Basic station diagnostics is recorded daily, comprehensive check is performed monthly.

The TMS2 undergoes calibration on sets of soils. Disturbed and packed cylindrical soil samples (approx. 20 liter) were subject to forced bottom air ventilation to distribute the moisture evenly along vertical axis during drying the sample with increased intensity. Database of soil-specific calibration curves is being built for various soil samples. TMS2 station has been calibrated for soil materials: sandy loam, quartz sand and peat. Calibration on selected undisturbed 7 liter samples, previously CT scanned for correct sensor placement, is in the progress. Temperature and salinity influence on the soil moisture results in drift of 0.05%/°C and 7%/(in full range of 0 to 10 miliSiemens/cm) and additional 2%/(in the range of 10 to 20 miliSiemens/cm) as found in 100% moisture solution.

Extended testing of TMS1 generation, predecessor of current design, is successfully performed in variety of field locations (central Europe, central Africa, Himalaya region). Results of long-term measurement at hundreds of localities are successfully used for i) evaluation of species-specific environmental requirements (for different species of plants, bryophytes and fungi) and ii) extrapolation of microclimatic conditions over large areas of rugged sandstone relief with assistance of accurate, LiDAR based, digital terrain model. TMS1 units are e.g. also applied for continuous measurement of temperature and moisture of coarse woody debris, which serves as an important substrate for establishment and growth of seedlings and is thus crucial for natural regeneration of many forest ecosystems.

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