A modular subsurface borehole-tower for deep vadose zone monitoring

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Some of the most urgent contemporary societal challenges ranging from climate change to ecosystem services and food security are strongly linked to processes taking place in the vadose zone. The growing interest in this critical zone prompted a massive deployment of eco-hydrological networks (TERENO, CZO, and more) focusing on long term and highly resolved monitoring of key variables such as soil moisture, pressure, temperature, gas fluxes and more. A challenge in all these endeavors remains the reliable and consistent acquisition of variables to depths of eco-hydrological interest (a few meters in some cases), especially soil moisture. In the absence of off-the-shelf sensor systems capable of vertically resolved acquisition of these variables, we developed a prototype of a modular borehole-based tower for simultaneous monitoring of water content, temperature, oxygen and CO_2 gas concentrations, and potentially other variables (relative humidity, capillary pressure). The modular tower is made up of 1.5 m sections of 75 mm PVC tubing with TDR waveguides mounted on outer walls. Each paired waveguides (0.15 m in length) were installed on two opposing sides of inflatable sections along the modular unit to ensure contact with the borehole walls. Oxygen and CO_2 are measured using solid-state and optical gas sensors that could be periodically calibrated for potential drift. A prototype that could be extended to 6 m depth and preliminary calibration results will be presented (as a potential design for future CZO's). We welcome suggestions for expansion and improvements.