Electrical Resistivity Used to Estimate Unfrozen Water Content

Permafrost and seasonally frozen ground cover vast regions of our planet and influence infrastructure integrity, slope stability, greenhouse gas release, and hydrologic function. Monitoring changes in ground temperature and/or the amount of unfrozen water present and help manage potential risk to our planet. Electrical resistivity tomography (ERT) is a geophysical method used to image subsurface resistivity over a range of spatial and temporal scales. Resistivity is closely related to subzero temperature and unfrozen water content, but the exact nature of this relationship is not well understood.

A new article in Vadose Zone Journal describes a laboratory experiment that quantified the relationship between electrical resistivity and temperature for a porous medium with different initial water saturations. Using a modified version of Archie’s equation, the authors of the article estimated unfrozen water content, which was shown to be independent of initial saturation. Lower resistivities at higher initial saturations were due to increased salinity of unfrozen fluid that resulted from ion exclusion during freezing.

These experimental results improve our understanding of the parameters that govern the resistivity of frozen ground. Establishing a relationship among electrical resistivity, temperature, and unfrozen water content is an important first step toward improving geophysical monitoring for a variety of applications in cold regions.

Adapted from Herring, T., E. Cey, and A. Pidlisecky. 2019. Electrical resistivity of a partially saturated porous medium at subzero temperatures. Vadose Zone J. 18:190019. View the full open access article online at http://doi.org/10.2136/vzj2019.02.0019

Soil Moisture Dataset for Remote Sensing and Land Surface Model Validation

Soil moisture not only sustains crops and rangelands but also influences the earth’s weather patterns through evaporation. The distribution of soil water is challenging to measure at scales relevant to weather-forecasting systems. In 2015, NASA launched the Soil Moisture Active Passive (SMAP) satellite to map surface soil moisture globally using a combination of active and passive microwave sensors with coarse resolution (10–40 km) and limited depth (5 cm). These data are needed at sufficient accuracy (<4%) for models that forecast weather, root-zone soil moisture, and flood potential.

A new article in Vadose Zone Journal describes the creation of the Texas Soil Observation Network (TxSON) to validate soil moisture retrievals from satellites and land surface models. TxSON is one of 18 core monitoring networks operating globally and consists of a dense network of in situ sensors installed at depths of 5, 10, 20, and 50 cm, measuring soil water content, temperature, and rainfall at 40 locations nested within 36-, 9-, and 3-km grid cells corresponding to SMAP products. Data from TxSON are fed directly, in real-time, into operational forecast systems.

The authors of the article say that they are making these data available, as well as processing scripts and metadata, to foster open data and reproducible research.

Adapted from Caldwell, T., T. Bongiovanni, M. Cosh, T. Jackson, A. Colliander, C. Abolt et al. 2019. The Texas Soil Observation Network: A comprehensive soil moisture dataset for remote sensing and land surface model validation. Vadose Zone J. 18. View the full open access article online at http://dx.doi.org/doi:10.2136/vzj2019.04.0034

TxSON is making the connection between soil moisture and the inevitable swing from drought to flood in the central Texas Hill Country. Photo by Richard Casteel.