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Trenton E. Franz
University of Nebraska-Lincoln, trenton.franz@unl.edu

Darin Desilets
Hydroinnova LLC, Albuquerque

Ammar Wahbi
International Atomic Energy Agency

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Cosmic-ray neutron probes on the high plains of Nebraska: applications to large scale agriculture

Trenton Franz (1), Darin Desilets (2), and Ammar Wahbi (3)

(1) University of Nebraska-Lincoln, Lincoln, United States , (2) Hydroinnova LLC, Albuquerque, NM, United States, (3) Soil and Water Management & Crop Nutrition Subprogramme, Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, International Atomic Energy Agency, Austria

Cosmic-rays have some surprising applications in precision agriculture. The cosmic-ray neutron probe (CRNP), when implemented as a roving instrument, can be used to create spatial maps of soil moisture, and from these maps soil hydraulic properties can be inferred. In this work, we combine data from a mobile CRNP with laboratory samples to make spatial predictions of soil hydraulic properties for select field sites around the state of Nebraska. These maps, which focus on wilting point and field capacity, can, in turn, be used to determine the optimal timing and application rates for irrigation farmers, many of whom have the capability to finely tune the spatial distribution of water applied on a field, but currently lack the requisite data to support such management practices. We find that $\sim$4 CRNP soil moisture maps are adequate to describe the dominant underlying spatial structure of the field (>75% of variability) using Empirical Orthogonal Functions. The CRNP soil moisture maps combined with an elevation layer provided strong statistical predictors of laboratory measured soil hydraulic properties. The economic viability of the method depends on numerous local cost factors but rising demand for water resources may dictate the need for innovative approaches such as this one to reduce future water use.