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Spatio-temporal analysis of Soil Moisture Using a Roving Cosmic-ray Neutron Probe

Introduction

- The upscaling of soil moisture information from in-situ stations and the downscaling of satellite-derived soil moisture information remains an open challenge in hydrology and agriculture.
- COSMOS rover has a great potential to measure and reveal spatio-temporal patterns in soil moisture at the landscape scale.

Objective

Our objective was to identify and quantify the main factors governing soil moisture spatial patterns at the landscape scale using a roving COSMOS probe.

Materials and Methods

- From July 2017 to May 2018 we conducted a total of 29 rover transects (160 km each) across a spatial domain of 77 km^2 near Gypsum, KS.
- The instrument was calibrated for the 0-15 cm depth using three calibration sites
- Volumetric water content (VWC) was estimated using empirical equation (Desilets et al., 2010) and corrected by water lattice, soil organic carbon and bulk density.

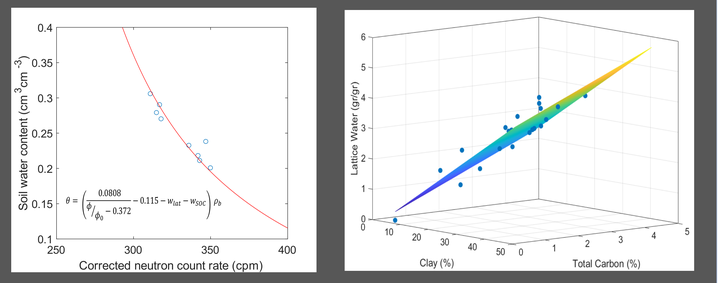

Figure 1: A) COMSOS calibration curve, B) Relationship between soil water lattice, clay content, and total carbon.

- A total of 29 rover measurements were taken at the Kansas Mesonet station located near Gypsum, KS.

Figure 2: Rover measurements next to Gypsum station

Results

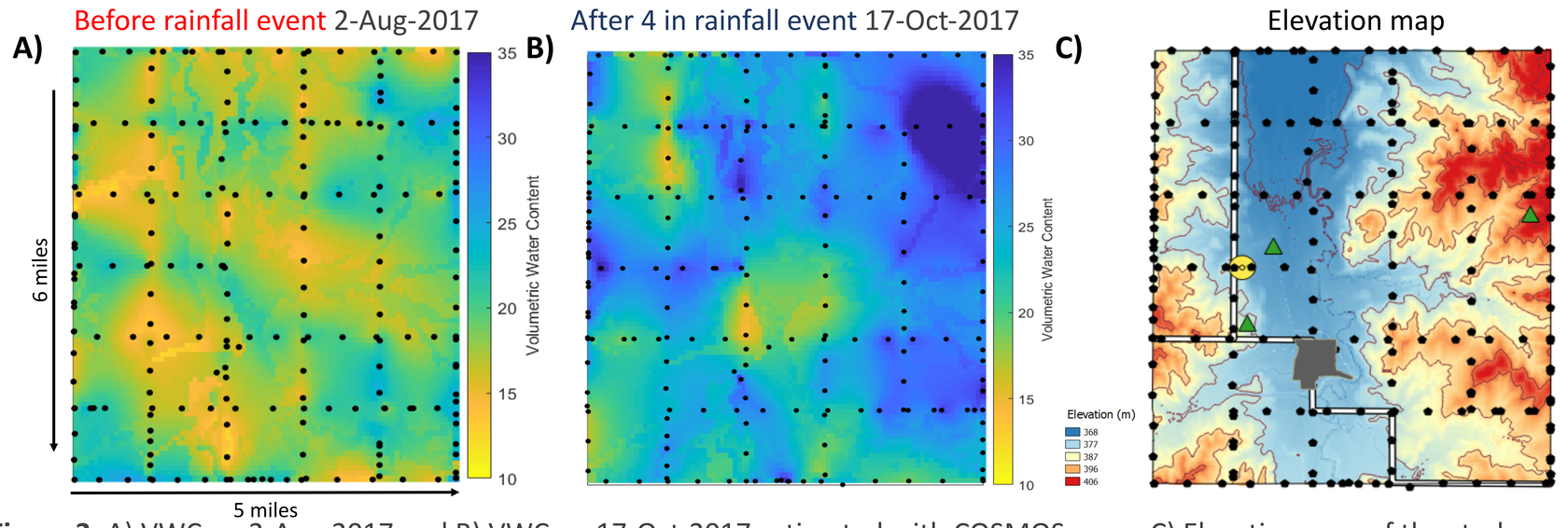

Figure 3: A) VWC on 2-Aug-2017 and B) VWC on 17-Oct-2017 estimated with COSMOS rover. C) Elevation map of the study domain. Black markers denote rover transect, yellow dot indicates the Kansas Mesonet station, green triangles indicates rover calibration sites. White lines indicate pavement roads and gray area represents the urban area of Gypsum, KS.

- COSMOS rover was able to capture distinctive spatial soil moisture patterns across the study area. Features such as urban zones, pavement roads, topography, and land cover seem to dominate the spatial pattern of the landscape.

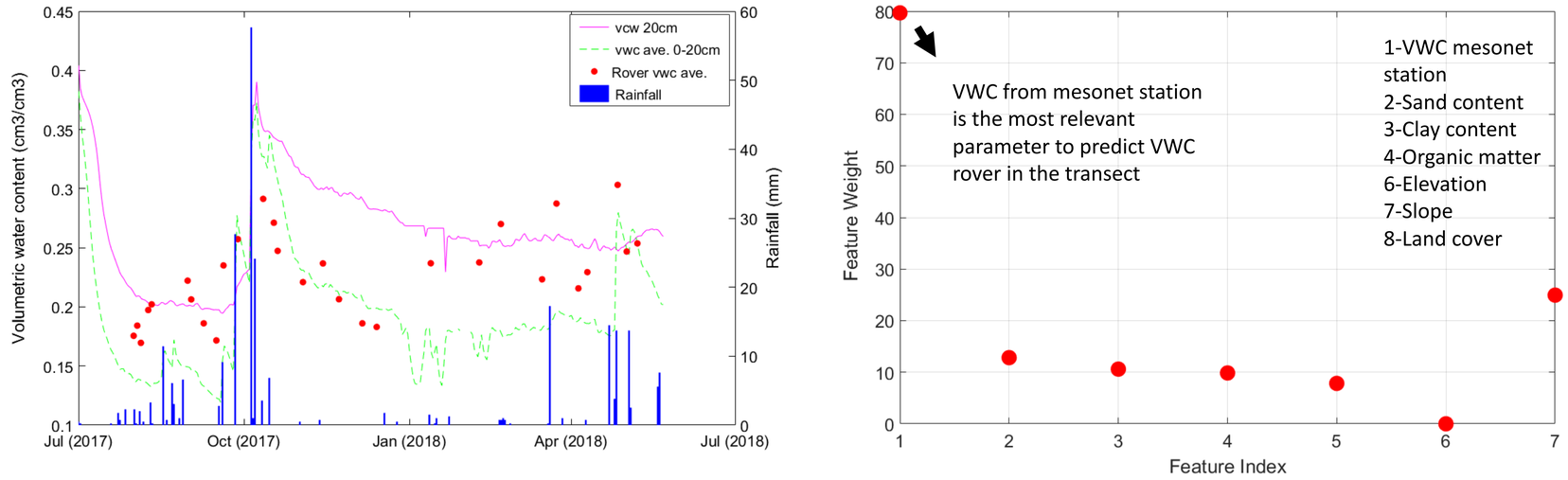

Figure 4: A) Comparison of soil water content from Gypsum station at different depths and the domain average VWC for each rover transect. B) Results of the neighborhood component analysis (NCA) .

- Soil moisture dynamics at the Gypsum station and rover measurements showed a strong temporal relationship. NCA analysis identified VWC from the in-situ station as the most relevant feature to predict rover neutron counts, suggesting that in-situ stations could be used to represent the temporal soil moisture dynamics of the transect.

Conclusions

- The COSMOS rover effectively captured the soil moisture spatial variability at the landscape scale.
- Soil moisture information from in-situ station have the potential to represent coarse temporal dynamics of larger spatial.

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