Field scale root zone soil moisture estimation by coupling cosmic-ray neutron sensor with soil moisture sensors

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INTRODUCTION

Climate change is having a major impact on water availability for food security including crop productivity. Securing food production under changing climate conditions requires good soil and water management. The estimation of field-scale root-zone soil moisture (RZSM) is essential for improving agricultural water management. The Cosmic Ray Neutron Sensor (CRNS) has recently been used for field-scale soil moisture (SM) monitoring in large areas and is a credible and robust technique but with vertical footprint limitation. Extending its vertical footprint to represent the root zone of major crops will be useful for irrigation management. The objective of this study is to extend the depth of the field-scale CRNS measurements to 60 cm by applying the exponential filter model of Wagner et al. (1999) and Franz et al. (2020). This was then compared with measured Drill & Drop (D&D) capacitance probe soil moisture content (SWC). This poster presents the preliminary results of this study.

MATERIAL & METHODS

Winter wheat cropped fields in Rutzendorf, Marchfeld region (Austria) were instrumented with a CRNS and Drill & Drop probes (Fig. 1). A set of six Drill & Drop probes was installed radially at 10, 60 and 120 m of the CRNS in two opposite directions, with an additional D&D probe installed close to the CRNS. To calibrate soil water content (θ) to the neutron counting rate using Desilets et al., (2010), 120 soil samples (3 radial distances 10 m, 60 m, and 120 m from the CRNS, 6 directions and 6 depths per location (0-5, 5-10, 10-15, 15-20, 20-25 and 25-30 cm). In addition, at zero and 150 m from the CRNS, 6 samples per location were also sampled for gravimetric water content and 14 samples for chemical analysis (soil organic carbon and lattice water) (Fig.2). In order to produce a smoothed SWC time series a Savitzky-Golay (SG) filter was applied to the corrected neutron data (Fig. 3).

Fig.1 Cosmic Ray Neutron Sensor (left); Drill & Drop capacitance probe (right) installed in Rutzendorf Austria

Fig.2 . Sampling pattern for calibration of the Cosmic Ray Neutron Sensor

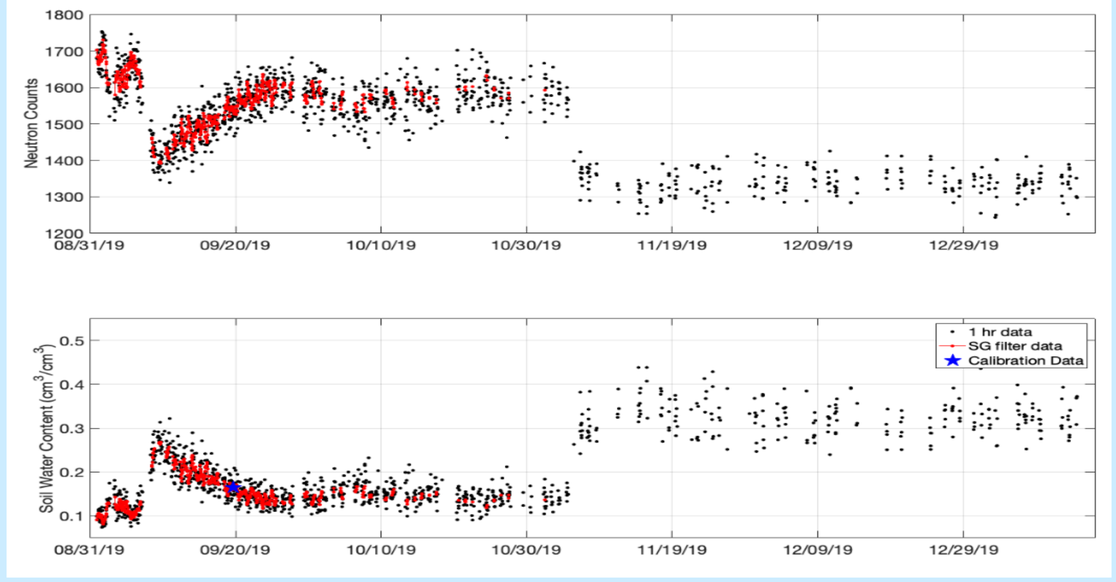

Fig.3: Time series of soil water content (SWC) of Cosmic Ray Neutron Sensor in Rutzendorf, Austria; 1 hour corrected neutron counts (black dots), the SG filter (red dots and line) and calibration data (blue star)

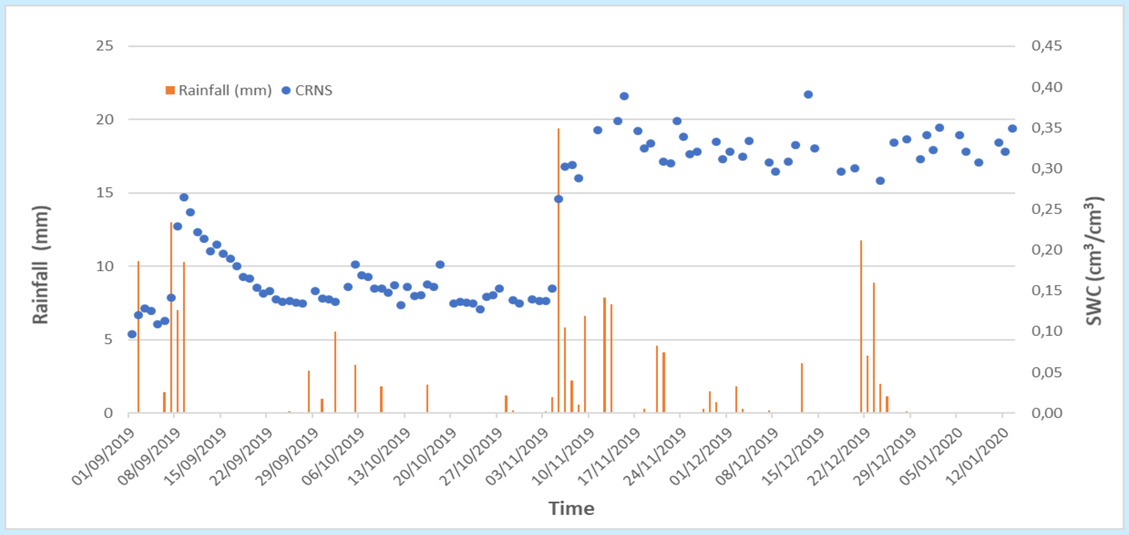

Fig.4: Time series of soil water content (SWC) of Cosmic Ray Neutron Sensor and rainfall in Rutzendorf, Austria

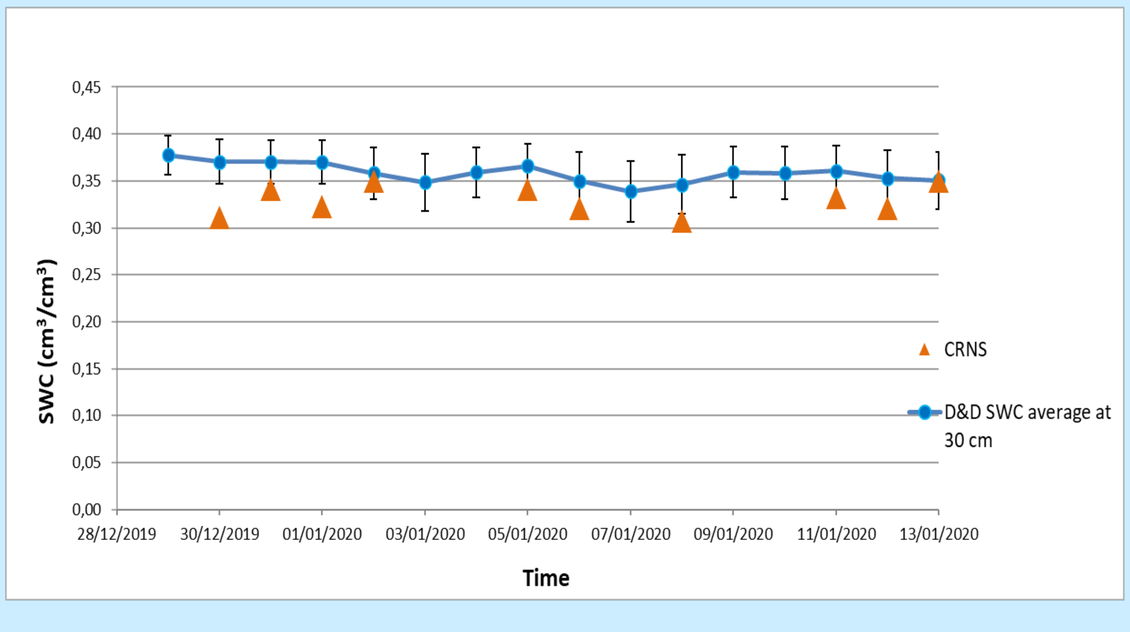

Fig.5: Time series of soil water content (SWC) of Cosmic Ray Neutron Sensor and Drill & Drop capacitance probe installed in Rutzendorf Austria

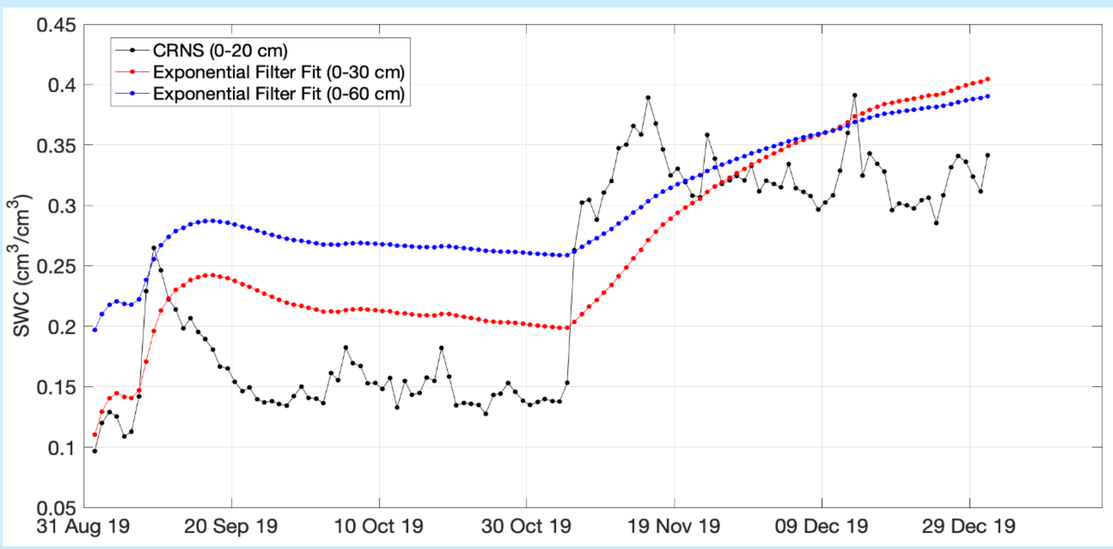

Fig.6:Time series of soil water content (SWC) of Cosmic Ray Neutron Sensor and estimated SWC with exponential filter in Rutzendorf Austria

RESULTS

The preliminary results showed that the CRNS measured soil water contents (SWC) reflecting rainfall pattern (Fig. 4).
The comparison between CRNS and D&D data shown that D&D probes at 30 cm gave fairly close values with the CRNS (Fig. 5), although it has a limited range, more SWC profile data needs to be monitored.
The results of applying the exponential filter model to model RZSM (up to 30 and 60 cm, respectively) from the field-scale surface soil moisture measurements of the CRNS is shown in Fig. 6. This model provides a soil water content (SWC) of deeper depths (up to 60 cm), but it has to be calibrated and compared with measured D&D profile SWC.

CONCLUSION

The CRNS describes very well the soil water content and sensitively reflect the effect of precipitation on SM. However, more field measurements have to be carried out to compare the CRNS landscape SWC values with in-situ SWC probes.

In order to calibrate the exponential filter model to a root zone product, more profile SWC data have to be estimated from a weighted average of the D&D probes

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