Comment on Dong and Ochsner (2018): "Soil Texture often Exerts stronger Influence Than Precipitation on Mesoscale Soil Moisture Patterns"

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Abstract

In their study, Dong and Ochsner (2018) used an extensive dataset of 18 cosmic-ray neutron rover surveys to assess the influence of precipitation and soil texture on mesoscale soil moisture patterns. Based on their analysis, they concluded that soil texture, represented by sand content, often exerts a stronger influence on mesoscale soil moisture variability than precipitation, represented by the antecedent precipitation index. However, we consider that Dong and Ochsner (2018) made a mistake in their calculation of volumetric soil moisture, such that their analysis on the influence of soil texture on soil moisture is not valid. This result does however not bring into question the paper's conclusion on the influence of soil texture on mesoscale soil moisture patterns.

Key points

- Dong and Ochsner (2018) assessed the influence of precipitation and soil texture on mesoscale soil moisture patterns
- Dong and Ochsner (2018) made a mistake in their calculation of volumetric soil moisture
- The original finding is considerably weakened

The cosmic-ray neutron (CRN) rover is a mobile application of the CRN sensing method to measure field-scale soil moisture noninvasively by surveying large regions (Schrön et al., 2018). Dong and Ochsner (2018) used an extensive dataset of 18 CRN rover surveys to assess the influence of precipitation and soil texture on mesoscale soil moisture patterns. To this end, they used sand content to represent soil texture and an antecedent precipitation index (API) to represent the influence of precipitation. Based on autocorrelation and Pearson correlation analysis, Dong and Ochsner (2018) concluded that soil texture often exerts a stronger influence on mesoscale soil moisture variability than precipitation.

We attempted to reproduce the results of Dong and Ochsner (2018) and found an error in the calculation of volumetric soil moisture from neutron count rates in their analysis (data was retrieved from https://osf.io/59j6c/). Dong and Ochsner (2018) wrongly derived volumetric soil moisture content from gravimetric soil moisture content (θ_g [g/g]) by dividing with the soil bulk density (ϱ_{bd} [g/cm^3]). Obviously, the correct approach to obtain the volumetric soil moisture

$$\theta_v = \theta_g \varrho_{bd} \quad (1)$$

content would be the multiplication of θ_g with ϱ_{bd}:

Fig. 1 exemplary shows the wrong volumetric soil moisture content as published by Dong and Ochsner (2018) in comparison to our own calculation of volumetric soil moisture with Eq. 1 for one measurement day. We found a considerably higher soil moisture content for all survey days after correction, which is not surprising because bulk density was always higher than 1.36 g/cm^3.

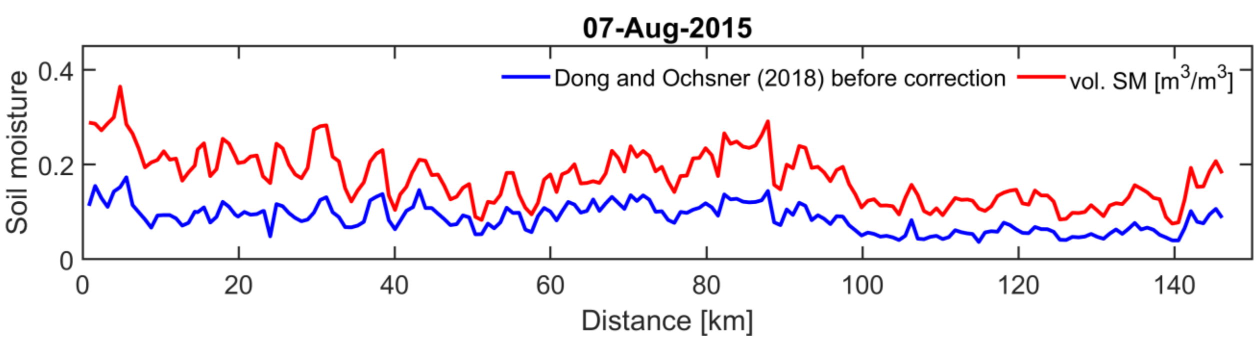

Fig. 1: Soil moisture along one of the measurement transects from Dong and Ochsner (2018). Originally published soil moisture (blue) and correctly derived volumetric soil moisture using Eq. 1 (red).

After correction of the originally published soil moisture content values of Dong and Ochsner (2018), some differences with the soil moisture content values we obtained from the neutron count rates were still present (Fig. 2). These differences are most pronounced between ~35 and ~75 km, where a distinct drop in soil bulk density that was used by Dong and Ochsner (2018, lower panel of Fig. 3) is visible. The soil data we extracted from the same database as used by Dong and Ochsner (2018) (SSURGO, https://websoilsurvey.sc.egov.usda.gov/, retrieved on 13 April 2020) did not feature this decrease in soil bulk density (not shown), which explains most of the remaining differences in water content estimates shown in Figure 2.

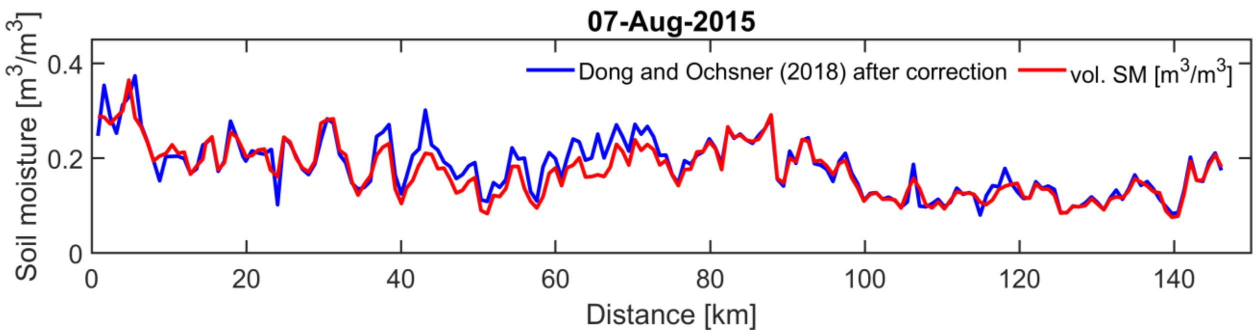

Fig. 2: Soil moisture along one of the measurement transects from Dong and Ochsner (2018). Corrected volumetric soil moisture obtained from the published soil moisture, and the volumetric soil moisture obtained in this study.

In a next step, we evaluated how the corrected soil moisture estimates affected the results and conclusions from Dong and Ochsner (2018). For this, the Pearson correlation coefficients presented in Fig. 9 of Dong and Ochsner (2018) were extracted using plot digitizer software (http://apps.automeris.io/wpd/). We found that the correlation between sand content and volumetric soil moisture was systematically lower compared to the original findings when using the corrected soil water content estimates (Fig. 3). Also, the correlation with API was not systematically lower anymore. Consequently, the conclusion that soil texture exerted a stronger influence on soil moisture than precipitation is considerably weakened based on our analysis.

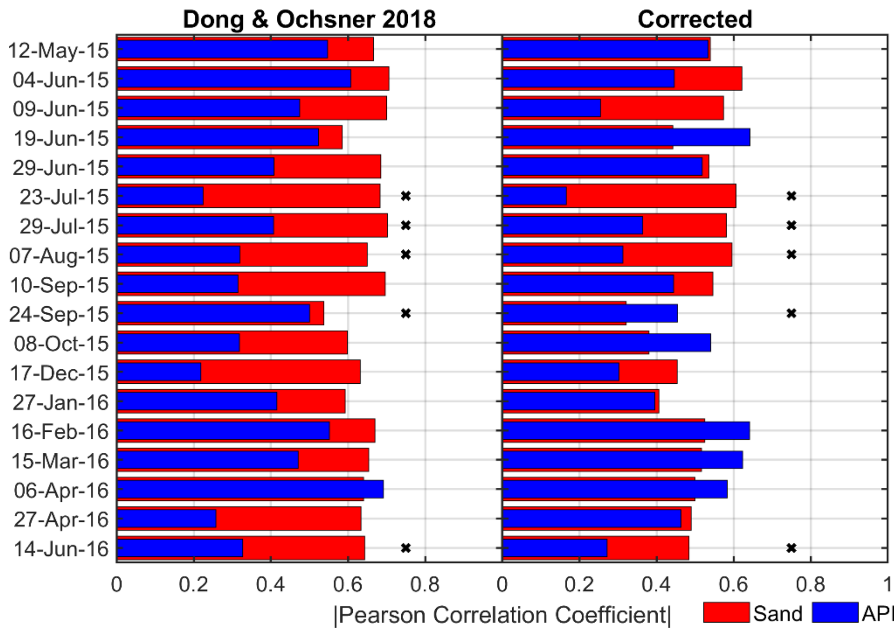

Fig. 3: Pearson correlation coefficients between soil moisture and API and soil moisture and sand content with the published, falsely derived volumetric soil moisture (subplot titled "Dong & Ochsner 2018") and with the corrected volumetric soil moistures (subplot titled "Corrected"). The correlation coefficients with sand content were all negative. The correlation coefficients with API were mostly positive, but some were negative and those are marked with crosses.

We found that the correlation coefficients are also influenced by the extraction of soil properties from the SSURGO database and the rover location assignment. Both steps involve some degree of subjectivity, as there are many complex processing steps involved. With the help of the authors, we have been able to reproduce the processing steps of Dong and Ochsner (2018) as good as possible. The remaining minor differences are most likely due to a recent update of the database after the original publication.

Dong and Ochsner (2018) used volumetric soil moisture for their analysis, which is perhaps more uncertain than gravimetric water content due to the need for uncertain bulk density values for conversion. Therefore, we also repeated the analysis for gravimetric soil moisture and found higher correlation with sand content while correlations with API were very similar. We hope that this exchange will generate further interest in the use of the CRN rover method to improve our understanding of the controls on mesoscale soil moisture patterns.

Acknowledgements

This research was funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) – project 357874777 of the research unit FOR 2694 "Cosmic Sense". We also acknowledge the NMDB database funded by EU-FP7. We thank Jingnuo Dong and Tyson Ochsner for making their dataset publicly available and for updating it for this work.

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Figure 1.

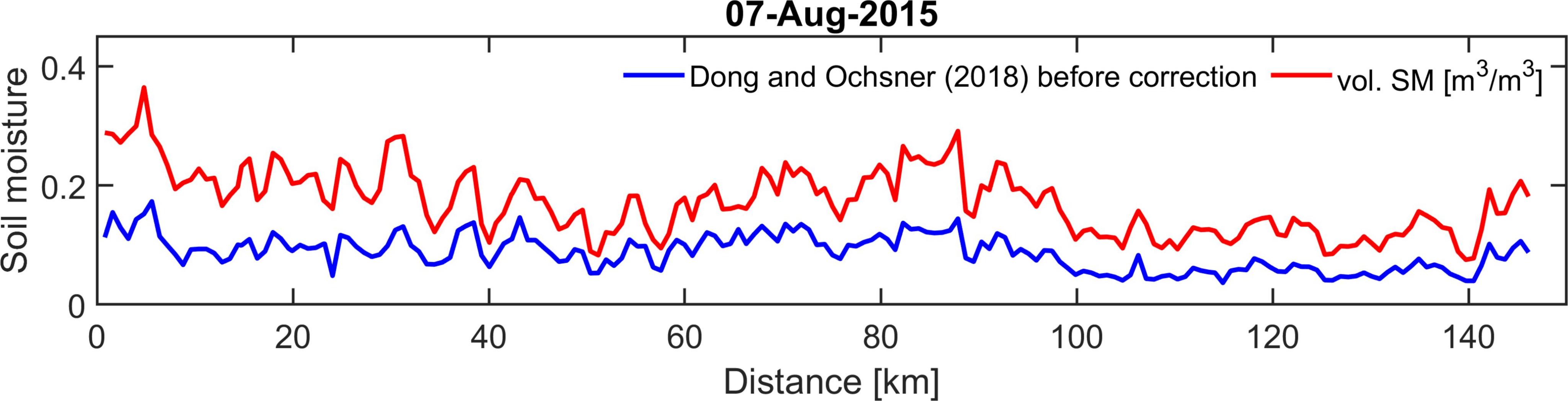
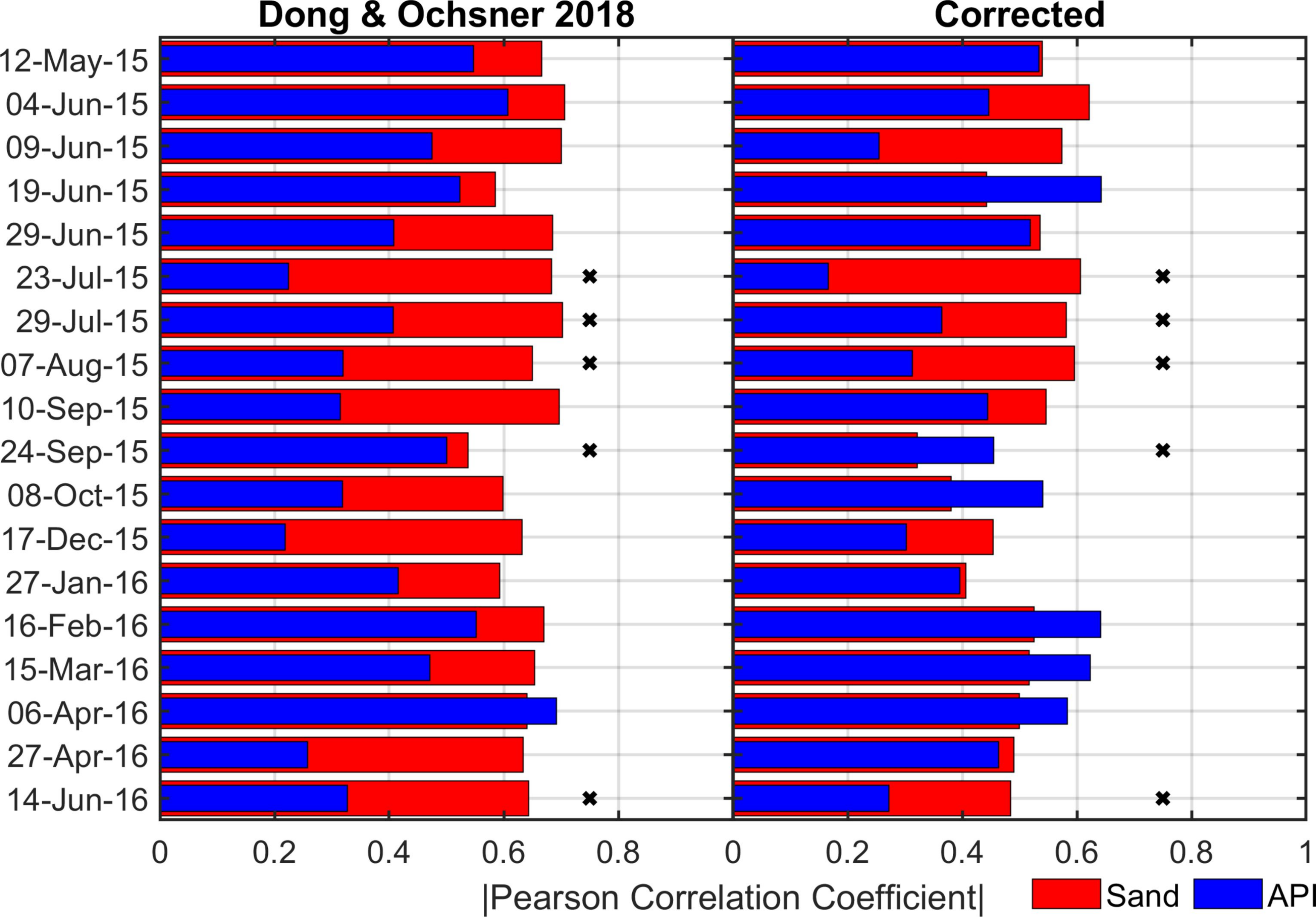

07-Aug-2015
Dong and Ochsner (2018) before correction
vol. SM [m3/m3]
Soil moisture
0
0.2
0.4
0
20
40
60
80
100
120
140
Distance [km]

Figure 2.


07-Aug-2015
Soil moisture [m3/m3]
0.4
0.2
0
0
20
40
60
80
100
120
140
Distance [km]
Dong and Ochsner (2018) after correction
vol. SM [m3/m3]

Figure 3.



Dong & Ochsner 2018
Corrected
12-May-15
04-Jun-15
09-Jun-15
19-Jun-15
29-Jun-15
23-Jul-15
29-Jul-15
07-Aug-15
10-Sep-15
24-Sep-15
08-Oct-15
17-Dec-15
27-Jan-16
16-Feb-16
15-Mar-16
06-Apr-16
27-Apr-16
14-Jun-16
0
0.2
0.4
0.6
0.8
1
|Pearson Correlation Coefficient|
Sand
API