Authors’ response to Referee 2

This paper presents a dataset of ongoing in situ soil moisture measurements in a region in the eastern part of the Netherlands. The dataset covers the time period since 2009, 20 locations, and measurements at five different depths (in general). The paper presents also results from field campaigns that resulted in calibration functions for the soil moisture sensors.

Authors’ response:
We would like to thank the referee for general positive feedback. In the text below, we provide our point-by-point response to the comments.

Most of the referee’s suggestions have been implemented. Our response to the referee comments is structured as follows:

- The native referee comment is labelled and written in black.
- The authors response is written in blue
- Text from the manuscript is written with the Times New Roman font whereby the native text is in black and the changes are in red

R2GC1:
The paper is in general sound and I have only minor comments. However, a major concern is whether publication is warranted in a high impact journal like ESSD, for only 20 point soil moisture time series for a period of 13 years. Question is whether the dataset is unique enough for this journal. I have suggested "minor revision", but alternatively a recommendation could also be "rejection". I leave this decision to the editor.

Authors’ response:
Our paper presents a unique dataset of in-situ soil moisture measurements in the Eastern part of the Netherlands. The uniqueness of this data set stems from its design as a network of fixed stations covering an area of 45 km by 40 km and measuring the soil moisture profile at nominal depths 5 cm, 10 cm, 20 cm, 40 cm and 80 cm for more than 10 years. Most of the current scientific articles reporting datasets based on in-situ measurements have generally a smaller temporal and spatial coverage in comparison to the presented work as will be further motivated in the following paragraph. Our paper also reports on complementary spatially distributed field measurements collected during campaigns organized in four different years, namely 2009, 2015, 2016 and 2017. Moreover, we have made an effort to describe in this paper an extensive collection of open third-party datasets (i.e. land cover/use, soil information, elevation, groundwater and meteorological observations) that can support the use of the Twente soil moisture and temperature datasets by other scientists and professional.

We have further investigated the suitability of our manuscript for the ESSD by searching in the title for the keyword ‘soil moisture’ and found 31 articles. From this collection of articles, we could identify at least eleven contributions of which the dataset relied on in-situ measurements. Those are listed below. The datasets reported in all articles cover a time span not significantly more 10 years and a similar spatial extent as the Twente region, with exception of Bogena et al. (2022) who report on an European network of cosmic ray probes. Three out of the eleven identified articles have a topic comparable to our manuscript, which are Benninga et al. (2018), Tetlock et al. (2019) and Zhang et al.
We have looked up the number of citations in Web of Science for those three articles and found that they are cited 18, 23 and 15 times, respectively. All three have been cited more than the journals impact factor. This leads us to the conclusion that the impact of the topic of our manuscript is at the appropriate level for the ESSD journal.

**Articles on in situ soil moisture measurement dataset:**


R2SC1:
L28. Instead of Mecklenburg et al., 2016 an earlier citation should be included.

Authors’ response:
The citation Mecklenburg et al. (2016) has been replace to a citation to Kerr et al. (2010)


R2SC2:
L114. What does “forest” mean here? Fruit trees? Please specify.

Authors’ response:
The forest in the study area are a mixture of coniferous and deciduous trees. Forest should in the context of the study area not fall under agriculture. Also based on the suggestion by Referee 1, forest and heath are removed from the sentence. The first sentence of the paragraph has been modified to include this information.

From the 2015 land use map from Statistics Netherlands can be deduced that 70.2 % of the land is used for agricultural activities, 13 % is mixed coniferous and deciduous forests, 11.3 % is built-up and the remaining 5.5 % is classified as water, recreational, dry and wet nature.

R2SC3:
L116. Probably harvested in September and October.

Authors’ response:
Only in the recent dry years farmers started with the harvest maize in September. In the past it was not unusual that the harvest would be postponed to November because the maize cobs needed more time to mature. The text is modified as follows:

Maize is planted in the months April/May and harvested in the period from September to November depending on the vehicle bearing capacity of the land and growing conditions.

R2SC4:
L185. What has happened in case of sensor failure? What if sensors had to be replaced? Was the same sensor type used? Was there a check for inhomogeneity in the measurement time series?

Authors’ response:
In the case of sensor failure the sensor was replaced by a similar METER group sensor, type EC-TM or STM. Prior to installation, every sensor was tested for its functionality using measurements of air and water.
The sensor-to-sensor variability was accounted for by the manufacturer’s sensor calibration against known dielectric standards as we wrote on l192-194. The installed sensor type is included in the data quality flags as explained on l333-337. This issue with the internal calibration of a specific batch of the STM sensors has been dealt with as reported in l354-359.

The following sentence has been added to the first paragraph of section 3.2.

The functionality of the probes were tested using measurements of water and air prior to deployment and the installed probe types are documented as a quality flag within the datasets, see section 6.

R2SC5:
L296-L303. Can you explain why these RMSE´s are so large? What is the RMSE for the average soil moisture content of a complete field or area?

Authors’ response:
The RMSE values are not specifically large for field campaigns during which soil moisture is measured in multiple fields and over the full dynamic range. The uncertainty levels are generally lower under controlled laboratory conditions or for a single prepared field because under those conditions soil sampling is more reliable due to the absence of natural variabilities in, for instance, soil clods and plant roots. This explanation is provided in the context of the conducted field campaigns around l300-303.

For comparison, Cosh et al. (2005) report on RMSEs varying from 0.027 up to 0.041 m³ m⁻³ and from 0.040 m³ m⁻³ up to 0.054 m³ m⁻³ for field specific and soil specific calibrations, respectively, see copied table below. We obtain for the 2009 campaign the highest RMSE value of 0.048 m³ m⁻³. This field campaign had the lowest number of sampling days in combination with the largest number of fields sampled, which may have led to a larger uncertainty. This explanation is given in l271-274 of the manuscript. We obtain for the 2015 field campaign a measurements uncertainty of 0.041 m³ m⁻³ with the ThetaProbe and for the 2016/17 campaign an overall RMSE of 0.032 m³ m⁻³ is achieved with the HydraProbe. So all-in-all the RMSEs are in line with the reported state-of-art.

<table>
<thead>
<tr>
<th>Data set</th>
<th>Generalized calibration</th>
<th>Soil specific calibration</th>
<th>Field specific calibration</th>
</tr>
</thead>
<tbody>
<tr>
<td>WC region</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.698</td>
<td>0.698</td>
<td>0.787</td>
</tr>
<tr>
<td>Bias (m³/m⁻³)</td>
<td>0.022</td>
<td>0.001</td>
<td>0.000</td>
</tr>
<tr>
<td>rmse (m³/m⁻³)</td>
<td>0.061</td>
<td>0.049</td>
<td>0.041</td>
</tr>
<tr>
<td>IA region</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.744</td>
<td>0.742</td>
<td>0.803</td>
</tr>
<tr>
<td>Bias (m³/m⁻³)</td>
<td>0.009</td>
<td>-0.014</td>
<td>0.000</td>
</tr>
<tr>
<td>rmse (m³/m⁻³)</td>
<td>0.053</td>
<td>0.054</td>
<td>0.040</td>
</tr>
<tr>
<td>Little Washita (LW)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.367</td>
<td>0.370</td>
<td>0.612</td>
</tr>
<tr>
<td>Bias (m³/m⁻³)</td>
<td>-0.010</td>
<td>-0.006</td>
<td>0.001</td>
</tr>
<tr>
<td>rmse (m³/m⁻³)</td>
<td>0.027</td>
<td>0.051</td>
<td>0.039</td>
</tr>
<tr>
<td>OS region</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.713</td>
<td>0.722</td>
<td>0.844</td>
</tr>
<tr>
<td>Bias (m³/m⁻³)</td>
<td>0.013</td>
<td>0.014</td>
<td>0.000</td>
</tr>
<tr>
<td>rmse (m³/m⁻³)</td>
<td>0.039</td>
<td>0.040</td>
<td>0.027</td>
</tr>
<tr>
<td>GN region</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.571</td>
<td>0.571</td>
<td>0.760</td>
</tr>
<tr>
<td>Bias (m³/m⁻³)</td>
<td>0.003</td>
<td>-0.007</td>
<td>-0.001</td>
</tr>
<tr>
<td>rmse (m³/m⁻³)</td>
<td>0.048</td>
<td>0.040</td>
<td>0.028</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.716</td>
<td>0.716</td>
<td>0.821</td>
</tr>
<tr>
<td>Bias (m³/m⁻³)</td>
<td>0.001</td>
<td>-0.006</td>
<td>0.000</td>
</tr>
<tr>
<td>rmse (m³/m⁻³)</td>
<td>0.053</td>
<td>0.050</td>
<td>0.037</td>
</tr>
</tbody>
</table>

Table copied from Cosh et al. (2005)

**R2SC6:**
L335. iv) instead of v)

*Authors’ response:*
*done*

**R2SC7:**
L343: Change to: “a readme document”

*Authors’ response:*
*We have changed this to ‘the readme document accompanying the dataset’.*

**R2SC8:**
L366. Do you compare here individual measurement points with measurements?

*Authors’ response:*
*These error metrics are based on the comparisons of the stations with the field average soil moisture obtained from the campaigns. This issue will be clarified in the new section on spatial representativeness that was suggested by referee 1.*

**R2SC9:**
L375. “lower groundwater levels” instead of “low groundwater levels”?

*Authors’ response:*
*Done.*

**R2SC10:**
L391. How do you explain this? Could it be related to preferential flow in the unsaturated zone?

*Authors’ response:*
*It is possible that preferential flow is an explanation. Another more likely explanation is that the shallow groundwater table causes a naturally fast response of the surrounding hydrology, especially in winters. This leads to the fact that groundwater table fluctuations match relatively well with temporal variations in soil moisture measured at 5 cm and 10 cm measured. The moisture content measured at 40 and 80 cm is under those conditions less responsive to rain events because the surrounding soil is already saturated. The following three sentences are added.*

*This can likely to be attributed to the shallow groundwater table in the study area that causes a naturally fast hydrological response. The groundwater table fluctuations match especially in winters well with the variations in soil moisture measured at 5 cm and 10 cm. The moisture contents measured at 40 and 80 cm is under those conditions less responsive to rain events because the surrounding soil is already saturated.*

**R2SC11:**
L394. Or opposite? In situ groundwater levels (whose availability is more abundant than soil moisture measurements) provide information on soil moisture content.

*Authors’ response:*
Indeed, in the western world in-situ groundwater measurements often (readily) available and soil moisture measurements not. In the majority world, however, in-situ groundwater monitoring networks are seldomly in place, while societies have a great demand for them. The text is modified as follows,

Hence, there lies also an opportunity to further investigate the connection between the water content in the unsaturated zone and the groundwater table. This knowledge may be used to provide soil moisture estimates in regions where groundwater monitoring wells are abundant or groundwater information based on surface soil moisture observed from space in countries where groundwater monitoring networks are absent.

R2SC12:
L423. Typo: “third-party”.

Authors’ response:
done

R2SC13:
Figure 8. Please explain the numbers in the figure (why twice “1”, “2”, “3” etc.)

Authors’ response:
These numbers stand for the measurement locations within a unique field. We have decided to remove this figure based on the suggestion by referee 1 and because we find it in retrospect of little added value to the text.