Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2020-274-RC1, 2020

Hydrology and Earth System Sciences
Discussions

Interactive comment on "Deep desiccation of soils observed by long-term high-resolution measurements on a large inclined lysimeter" *by* Markus Merk et al.

Katrin Schneider (Referee)

katrin.schneider2@kit.edu

Received and published: 3 August 2020

General comments The paper presents soil moisture data observations covering 20 years (and for some of the data even longer) measured at different soil depths and at a high temporal resolution. Soil moisture was measured at several locations in a large lysimeter on a landfill. The long and more or less continuous soil moisture observations with a high temporal resolution cover different climatic conditions and make the study valuable. This allows analyzing soil moisture development in the soil horizon under different climatic conditions over several years, including very dry conditions. The structure of the manuscript is clear and concise. Despite this wealth of data, I have

Printer-friendly version

Discussion paper

severe concerns that the way the data are presented and discussed misses important aspects. The discussion and interpretaion remains rather vague and should go into more detail. The manuscript requires a major revision. My suggestions are listed below:

Specific comments

1. The manuscript does not provide basic information on factors that have substantial influence on soil water movement and evapotranspiration. Please provide these information in the study site description, and also use these additional data in the interpretation and discussion of your results (e.g. by applying an analysis of variance) a) The data stem from two large lysimeters installed at a landfill. This makes a very specific case study, since the soil layers have been build up artificially. This specific case is not discussed in the paper, but it seems as if the landfill cover can be compared to surrounding non-artificial soil or landscapes. Unfortunately, there is no presentation of the soil profile(s) of the two lysimeters and no description of soil properties, like texture, bulk density, pore volume, pF values and so on. I assume that the cover of the landfill has to meet specific requirements, and I would expect that information on soil properties therefore are available. I recommend including a table with information on soil properties (in different depths or discretized by the layer type, e.g. recultivation layer, drainage layer etc.) in the site description, and along with that, a figure of the soil profile with indications of compaction horizons or other information which are specific to that soil.

b) Along with missing information on soil properties, there is no description of the vegetation cover of the landfill (if there is a cover, or is it bare soil / something else?). If the two lysimeters have the same (vegetation) cover type, the effects on evaporation, transpiration and drainage are likely comparable. The second lysimeter was implemented later than the first one. Are there changes in the (vegetation) cover between the two? Please add this information in the study site description, and also consider it in the further discussion and interpretation of results.

Printer-friendly version

Discussion paper

c) A photo might be helpful to give the reader an idea of the site

2. Information on mean annual and monthly precipitation and temperature at the study site or in its vicinity (e.g. from DWD station data) is missing. Since the authors discuss the effects of the very warm and dry summer 2003 on subsequent soil moisture, it would help the reader to see some information on average conditions and on the deviation from long-term averages during the observation period. Please add a table and/or figure with mean annual and mean monthly precipitation and temperature at least, and indicate the deviation from these average conditions during your observation period. You may also consider to highlight years with very strong deviations (e.g. very warm/cold, wet/dry).

3. The methods section (3.3. Theory and calculations) is very brief. Especially the Bayesian change point detection should be explained in more detail. Please also add a reference to the software you used for calculating the linear regression models.

4. Comparison of soil moisture measurements with modelled uFC: a) When using the (modelled) usable field capacity (uFC) provided by DWD I wonder why you did not try to make these data more comparable to the volumetric soil moisture measurements from the two lysimeters. This could either be done by converting the modelled uFC into volumetric soil moisture making use of the soil properties (in particular pF values, pore volume) these calculations are based on - as far as these information are provided along with the modelled uFC data. Or do it the other way round and calculate uFC at the soil moisture sampling points based on the volumetric soil moisture content and the soil properties (e.g. layer specific pF values) of the soil layers of the two lysimeters. This touches the above-mentioned missing information on soil properties. b) A discussion on how well modelled uFC can be compared with soil moisture measurements at the the lysimeters is missing. Presumably, the modelled uFC is based on non-artifical soils, but soil moisture observations at the two lysimeters represent conditions in an 'artificial' soil layer. Please include a more detailed discussion here, or skip the modelled uFC data, if the soil properties on which the calculations are based are not comparable the

conditions at the lysimeters.

5. Presentation of results: Figure 2 (discussed chapter 4) is hard to read and the information might therefore not reach the reader. Since there is many data 'squeezed' into this figure I find it hard to read or to really compare the different NP measurements. It is particularly difficult for the NP data of Field 1. Can think of another way of presenting the data, or (this goes more to the Editor) place this figure in landscape format? It might also be worth to plot it in a different way, e.g. calculate the difference from average for each depth increment over the entire observation period for each pixel/time step. I suggest to remove the map with modelled uFC at the bottom of Fig. 2 completely, or to move it to the appendix.

L. 149: explain climatic conditions 2003 (dry and hot summer in the study region) – this can be accompanied or underlined by further general information on climate characteristics at the study site over the study period (see also #2 of my general comments above)

L. 161 – 165: give a more detailed description on soil properties, and discuss the effects of soil compaction. Could a compaction horizon result in a capillary barrier in the soil layer? How would that effect soil water movement?

L. 193 – 199: please provide a more in-depth discussion in this paragraph on potential effects of soil compaction and why moisture patterns at some depths are more persistent than in other depth. E.g. continuously 'wet' conditions at approx. 100 cm in field 2 or at roughly 150 – 200 cm at field 1; why are there drier conditions in a small area above 150 cm at field 1).

L. 203 – 206: In this paragraph you argue that the shorter observation period in field 2 is reason why the observed decrease in soil moisture is not significant. I wonder if this is the only way of interpreting this result. A) When looking at Fig. 5 there seems to be a change in the direction of soil moisture change at approx. 70 cm at field 2. This might also correspond to the rooting depth (in case vegetation is present), resulting in

Printer-friendly version

Discussion paper

a quick recycling of precipitation via root water uptake / evapotranspiration which does not allow percolation to deeper soil layers. B) A compaction layer might further impede percolation. C) The different soil depths of field 1 and 2 and the different duration since the lysimeters have been installed, resulting effects on soil properties and (vegetation) cover should be discussed, too.

L. 209 – 212: please provide a more detailed discussion on the reasons for the observed reductions in soil moisture (e.g. in the context of precipitation / temperature regimes). Why is the reduction in the lowest part of the soil profile most pronounced from January – May in field 2, and why is it not obvious in field 1?

Figure 7, time series decomposition: this analysis is valuable to detect trend changes. As with Figure 2 I am concerned that, with the amount of data, the figure is still readable. As suggested before, it might be worthwhile to test different colour schemes, or highlight particularly relevant results.

L. 262: it is the first time in the manuscript that re-wetting from groundwater is mentioned. Are the lysimeters connected to the groundwater in this specific setting on a landfill? If so, please also describe this in the study site description

L. 270: which soil properties do you think of? Please include that in more detail in this paragraph

Technical comments:

Chapter 1

L. 27-28: which were the effects of El Nino? Please explain the results of the cited studies (Solander, Kolusu) in more detail (1-2 sentences) or skip it

L. 30-36: you could state which measurement type is used

L. 44-46: rearrange order of sentences (e.g. start with second sentence in this paragraph

L. 55 ‘with regard’ instead of ‘in regard’ Please check and correct where necessary throughout the manuscript: - ‘depth’ and ‘depths’ - ‘In depht’ vs. ‘in-depth’ - ‘at depth of’ vs. ‘at a depth of’

Chapter 2

Include information on soil properties (at least those that are most relevant for soil moisture movement/storage), (vegetation) cover of the landfill, and climate characteristics

Explain why the two lysimeters have different soil depths

L. 78: add year ‘. . .being taken in December 2000’ / ‘.. in December of that year’

Chapter 3

Are there more neutron probe measurement points in the lysimeters (since NP numbers start with 3, and if so, why was that data not used

L. 90: when was Field 2 constructed?

L. 122 – 127: could you please explain more clearly what you did here?

L. 134 – 137: please describe in more detail the Bayesian change point detection and time series decomposition: how is it done and which information does it provide?

Chapter 4

L. 141: please indicate the mentioned clay layer in Fig. 2

L. 155 – 157: it is hard to see the discussed results in the Figure in its current form (see #5 in general comments)

L. 157: change ‘. . .the missing occurrence. . .’ into a less complicated sentence

L. 160: delete ‘or so’

L. 168: delete duplicate ‘the bottom of’

Printer-friendly version

Discussion paper

L. 170: depending on the DWD station, there is an annual cycle of uFC at 60 cm depth, so I would not call it ‘minimal’

L. 171: ‘at a depth’

L. 172-173: Why is there a clear change in modelled uFC already after 2001, but for the soil moisture measurements this is only visible after 2003?

L. 177: add ‘and a mean time series from all sampling points at field 2 are shown’

L. 178 and 183: change ‘in the individual time series’ to ‘in the time series of NP at 170 cm’

L. 190: change ‘could be observed’ to ‘soil moisture decreases by 0.34 % . . .’

Figure 3: even with a good colour printer it is difficult to discern the colours representing the different years in the polar coordinate system. I suggest to try out other colour or gray scale palettes, or you just highlight very dry or very wet years.

L. 202: change end of sentence to ‘are indicated by a marker’

L. 208: I would not use ‘bias’ in this case, since the differences are not artefacts

L. 215 – 218: please discuss in more detail why less water is percolating during winter in recent years

L. 226: typo in the DWD station code?

L. 228: ‘increase’ instead of ‘increases’

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2020-274, 2020.