Review Paulus et al.

Major comments

This is a very interesting and well written paper that focusses on the capacity of EC systems to detect water vapour adsorption (using lysimeter data as verification data), for 2 contrasting sites/climates. The authors present solid data sets, further strengthened by careful filtering, and statistical analyses (including machine learning methods).

While I think it is a good thing that more than 1 site is presented, in my opinion the use of a temperate site (with very little adsorption) is a bit of a distraction to the main story line. However, note that I am not suggesting removing these data and related discussion, unless the other reviewers are of a similar opinion.

There are two shortcomings (although not 'deal-breakers' for me recommending this paper to be accepted pending minor revisions):

- there is little discussion of the (spatiotemporal variation in) EC footprint, which must have played an important role for the German site in particular

- the soil physical properties that affect the adsorption isotherm (clay type and clay content) are not mentioned (nor are data provided to describe the water retention curve). I think some of these properties (clay amount) could help explain the variation among the lysimeters.

Minor comments

- Line 1: In my opinion SVA also occurs during the daytime (mid to late afternoon), especially when there is a moist sea-breeze coming in.
- Line 24/25: You say "Although the two instruments substantially differ with regard to the evaporative fraction with 64 % and 25 % for the lysimeter and EC methods, they are in either case substantial". Is this for the full 24 hours? Or for nighttime only? And how is EF defined here?
- Line 28: "The adsorption of atmospheric water vapor by dry soils (SVA)". What does the S in SVA stand for? Soil? So Soil Vapor Adsorption. Make this clearer.
- Line 42: Replace 'soil parameters' by 'soil variables'
- Line 44-46: "The model-based numerical evaluation further confirmed the ability of this type of lysimeters to quantify SVA correctly (Saaltink et al., 2020). Based on the long time series, SVA has been observed to reach significant magnitudes". You are overusing the word 'the'. Say instead: " Model-based numerical evaluations further confirmed the ability of this type of lysimeters to quantify SVA correctly (Saaltink et al., 2020). Based on analysis of long time-series, SVA has been observed to reach considerable magnitudes".
- Line 55: Brackets missing around Kool et al. (2021)
- Line 58: What is meant by "SVA observations"? Do you mean independently verified 'by eye'? Surely EC measurements are also observations?
- Line 64: You mean "for all **vapour** fluxes at the land's surface"?

- Line 72: You could mention the word 'footprint' here and refer to the relevant EC literature?
- Line 92: say" "vertical distance between the EC sensors and the adsorbing soil surface"
- Line 99-100: I would remove "However, readers who are already well-versed in this subject matter may choose to skip these sections if deemed unnecessary". Most people already read scientific papers in a selective way.
- Line 101: I would say: "is expressed as the deviation of the total potential energy of the soil water relative to the reference state"
- Line 103: say: " .. is generally expressed in units of pressure...". I say this because of course it can be expressed in different units. On a mass basis we work with energy (Joules) per kg. Often J m^{-3} are used (potential on volume basis). This has the advantage that J m^{-3} = N m^{-2} = Pa.
- Line 103-104 are somewhat clumsy. Why are you comparing and contrasting SWC and psi_w in this way?
- Line 106: if you talk about the dominant force being the matric potential, then you may as well introduce the gravitational potential higher up, for completion and to avoid confusing the not so well versed readers..
- Line 112-113: you say "For better understanding, we added the conversion of Ψw into the SWC of a loamy sand (van Genuchten, 1980)". This is an akward way of saying that you used the water retention curve of a typical loamy sand to derive the SWC from Ψw values. Please keep the language as soil physical as possible.
- Line 118: say: " are adsorbed onto the soil particles".
- Line 129-140: It would be interesting to know what clay-type is found at this site (if will affect the shape of the adsorption isotherm) and how close to the sea this site is, e.g. are there sea-breeze effects that bring in moist air from the sea that gets adsorpted by the dry soil. I looked on the map and it is far away from the sea. Unlike the paper by Verhoef et al. that studied a site near Seville where moist air coming in in the late afternoon played a role.
- 142-152: again, do you now the clay type here?
- Section 3.2. Nowhere in this section do you mention the dominant wind direction and typical footprint size. I think this is an important omission. From googlemaps I can see that the area around the mediterreanean site is pretty homogeneous, but this is not the case for Selhausen? I am therefore not sure how comparable the lysimeter (bare soil) and EC data (vegetated field, representative of cropped fields overall which would decrease adsorption compare to open bare soil??) are for Selhausen? You say yourself later on "SVA was reported to be reduced below or in the vicinity of tall, active vegetation by 76 % (Kosmas).
- Also, in Section 3.2 and 3.3. Can you please give the resolution of the temperature and SWC sensors?
- Line 245: Put Sonntag in brackets
- Line 248: "downwelling (↓) and upwelling (↑)". Are the symbols SW and LW missing here? This looks strange.
- Starting at line 284: Would it not be better to use upward and downward arrows instead of IN and OUT?

- Line 305: This is the first time that you mention the words ‘soil hydraulic conditions’. Should this not be introduced much higher up?
- Line 306: This predictor list is very comprehensive, but what is missing are proper representatives of soil hydraulic properties (e.g. the slope of the water retention curve or air-entry value, or even better, properties that denote the specific surface area of the adsorbing soil particles, the clay in particular. This seems an omission to me.
- Line 327: why would adsorption be highest when “soil water supply is high”? Surely the soil needs to be fairly dry for adsorption to occur? Did you mean FOUT,EC?
- In Figures 3 and 4, make it clear that “solid vertical lines that mark the end of the night, sunrise, sunset, and beginning of the night, respectively” are in fact curved, not straight. Also, what is the straight vertical grey bar in Figure 4a??
- Line 360-361: Sure it depends on “soil-intrinsic physical properties”, but you never actually say what these are. Also, it also depends on the soil variables (soil temperature and soil moisture content)s, so please add this?
- Line 369: replace “more dry” with “drier”
- In Figure 6: Has the number of hours colouring code been explained properly and is it actually used much in the description around this graph? I found it a bit confusing. Around line 445 you discuss it a bit but it is not clear to me how these number of hours were counted or selected?
- Line 435-436: I don’t know what you mean by “This is not surprising given that under stable nighttime conditions F is suspected to leave the control volume other than in the vertical direction (advection, drainage flows) and thus undetected by the EC sensor”. Is there a word missing (“not” in front of “suspected”)?
- Following on from this: You have not defined control volume, footprint, fetch etc. higher up. In fact a footprint analysis for the data would be very welcome.
- Around Figure 8. The discussion here focusses on the temporally variable soil variables Ts and SWC. But it is not more likely that modest variations in clay content (and SOM?) among these lysimeters affect the adsorptive capacity of the soil in these lysimeters? Verhoef et al. (and Kosmas?) showed that adsorption is quite sensitive to clay content?
- Around Figure 8. There is no real explanation/discussion of the SHAP plots c and d. I am not sure how to interpret these and what it all means.
- Lines 576 and 577: incorporating vapour fluxes is not just important for hydrological models but also for land surface models. It would be good to make that point here and add the following reference? Garcia Gonzalez, R. , Verhoef, A. , Vidale, P. , Braud, I. (2012) Incorporation of water vapour transfer in the JULES Land Surface Model: implications for key soil variables and land surface fluxes. Water Resources Research , 48 (5). ISSN: 0043-1397 | doi: https://dx.doi.org/10.1029/2011WR011811