

***Interactive comment on “An Ensemble Square Root Filter for the joint assimilation of surface soil moisture and leaf area index within LDAS-Monde: application over the Euro-Mediterranean region” by Bertrand Bonan et al.***

**Anonymous Referee #2**

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**General Comments:**

This paper presents the LDAS-Monde EnSRF adapted to multivariate soil moisture and LAI assimilation. Results are presented and compared to the SEKF and to the model in the Euro-Mediterranean region for 2008-2017. The paper provides substantial contribution to scientific progress in the field of land surface data assimilation which is relevant for HESS. The analysis is very thorough, the paper is very well written and presented. I suggest it is published after the following comments are taken into account.

## Specific comments:

line 52, sentence starting by "Both brightness temperature..." is too vague: not all brightness temperature are influenced by vegetation dynamics. The authors should indicate specify that it is for low microwave frequencies

line 91-92: I find it too detailed to give the latitude and longitude min and max of the studied area in the introduction. These details are given in Section 3 and this is enough.

line 97: You should perhaps add the reference to the peer reviewed ERA5 paper submitted to by Hersbach et al. in 2019. Same comment line 218.

line 170-175: it would be very useful to give more details on the patch formulation in equations 3-4 as it was not provided in any of the previous papers describing the SURFEX SEKF. It could be added as an annex.

line 317: It is not very clear on this figure that the EnSRF estimates get closer to observation than the SEKF ones. Please revise the sentence.

line 320-323: The authors should refer to Table 1 at this stage of the results presentations. Table 1 is only used in support of the results presentation in section 4.5 (line 430). It would be very useful to refer to it everywhere its statistics are discussed. Same comment applies for example line 360, lines 368-369, .

Figure 3, caption is not clear. Replace "and difference between nRMSD for SEKF (b) and EnSRF (c) vs nRMSD Model." by "and nRMSD difference between assimilation experiments (SEKF in a, and EnSRF in b) and Model.

lines 332-345: This analysis and corresponding figures are interesting to understand the performance of the assimilation systems for the different vegetation types. It does not help to understand the EnSRF degradation in NW Spain and in the Alps shown in Figure 3. The authors should investigate further and present in the paper results in these areas.

line 321-323: The authors should comment on the fact that the model bias is the lowest also because the winter and summer negative bias is partly compensated by positive bias in autumn, whereas DA experiments correct for the autumn positive bias only.

line 371: It would be useful to comment on the negative correlations shown between model output and observed SSM in arid areas. The explication (short term variability) is given later and discussed in Section 5.1 (lines 479-480). It should be briefly mentioned already when the correlation map are shown. line 388: the authors should explain or clarify in the text why SM2 and SM6 are uncorrelated in summer over Spain and Northern Africa?

line 396: explain here the meaning of larger LAI leading to drier soil. It is pretty obvious that it is related to more evaporation, meaning that LAI influences soil moisture in this case, but it would be interesting to discuss here as the previous sentence is the other way around, with positive correlation and soil moisture influencing LAI. As commented above, it is not optimal to have the results presented here, but only partly explained, with the full explanation later in section 5.1. When reading Section 5.1, we have to go back in the paper to match the figure description and the figure interpretation given several pages later in Section 5.1. Please revise the text by merging section 5.1 with the presentation of the results in Section 4.

line 400-411: This paragraph starts with Figure 10, but then the second and third sentences "We observe that the SEKF has the same averaged SM4 as the model. Nevertheless we discern seasonal tendencies." are clearly not related to Figure 10. Then it discussed Figure 11, but line 404-405 ("EnSRF estimates..") content does not match Figure 11, but it is more adapted to Figure 10. So, this paragraph needs to be slightly reorganized.

line 413-415: "...in Figure 10. We identify these patterns for every month without any seasonality (not shown). For SEKF drier estimates are obtained through cycling as analysis increments are close to zero. For EnSRF, cycling is also responsible to this

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drying but analysis increments are not negligible (-0.01 m<sup>3</sup> .m<sup>-3</sup> for biggest values) and compensate the wet bias from model error in SM6 (not shown). " This suggest that SM6 negative increments have a larger amplitude in EnSRF than in EKF, however this is not obvious from Figure 10.

Section 5: The discussion provided in Sections 5.2 and 5.3 is excellent, it discusses the limits of the proposed EnSRF approach and perspectives to improve the system. Section 5.1 is less relevant to the discussion as it mainly supports of the results description and it provides information that was actually missing when reading Section 4 (see comments above). So, Section 4.1 (or most of it) should be merged with corresponding paragraphs Section 4.

line 576-577: the last sentence of the conclusion, starting with "Once fully tested, it should, hopefully, provide daily..." sounds technical and hazardous. Replace by something like "It will open the possibility to have access to daily..."

### Technical corrections:

- line 49: "Recently," (add a comma)
- line 71: replace "has" by "have". Also line 74 twice.
- line 109: move the reference to Albergel at al. and the end of the sentence. Same comment for the references given line 118 and line 119.
- line 121: "The lower boundary of the 14 soil layers (0.01...) .. was chosen to" is not clear. A more accurate language would perhaps be "The vertical soil discretization into 14 layers (0.01...) .. was chosen to"
- line 177: remove "of"
- line 222: remove "ISBA"
- line 404: add "particularly" as follow: "..in July, particularly in Northern Europe..."

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-line 413: "For the SEKF, ..."

-line 462: "introduce a larger negative bias"

-line 539-540: the sentence starting by "However, if we take ..." sounds familiar, reformulate it.

-line 541: what caveats?

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