Review of the manuscript:

Study of the Jacobian of an Extended Kalman Filter for soil analysis in SURFEXv5
submitted to Geoscientific Model Development by Duerinckx et al.

General Comments:

This paper presents a study on the application of an Extended Kalman Filter (EKF) for soil moisture and soil temperature analysis. Surface assimilation techniques are very important to improve the numerical weather prediction of near surface variables. The study is original and the results shown in the paper will be useful to the scientific community working in the field of data assimilation. The paper address a relevant scientific modelling question within the scope of GMD. The manuscript is well written and organized.
So, in my opinion the manuscript should be published, after a minor revision.

Specific comments and suggestions:

Page 7153, line 16: please correct: "observations measurements",

Page 7157: It is not clear the difference between ALARO and ALADIN. Please be more explicit

Page 7159,
line 7 $(y_0^t - H(x_b^0)) \rightarrow [y_0^t - H(x_b^0)]$
it is not clear the meaning of the subscript 0 in the y vector

Page 7160, line 24: Why this values: "1 K for 2 m temperature and 10 % for 2 m relative humidity" and for : "2 K for the background errors of T_s and T_2 and $0.1 \times (w_{fc} - w_{wilt})$ for W_g and W_2"

Page 7162,
lines 12/13: "runs from 12:00 to 18:00 UTC", every days?

Page 7163, paragraph lines 5-20:
Question: The noisy signal in the Jacobian values appear only in the therms related to the soil water content or also in the terms related to the soil temperature?
The figure 4 only show the noisy signal for the derivatives with respect to wg and w2, but for the terms with respect to Ts and T2 the period shown is outside the window were the noisy signal appear.
In my opinion the authors should clarify this question in the text.

Page 7163, line 20: The expression "(not shown)" should come after "the coupled case"

Page 7165, line 16: The aim of the filter is to cured only the impact of the oscillations that occurred at Ri critical values or also the oscillations that are due to non-linearities for SWI-values close to 0?

Page 7166, line 6: Which case?
The period, as well the time-steps of the runs should be given.

Page 7167, line 12/13: 6 July or 2 July? In the figure caption it is indicated the 2 July.

Page 7168, line 10: parturbation → perturbation

Page 7168, lines 18 and 19: should be Figure 9

Page 7168, line 23/24: the following conclusion:
"(...) a Jacobian calculated with a positive perturbation has the same size but an opposite sign as the Jacobian value calculated with a negative perturbation." seems to me a little bit strange and in contradiction against the values of H^+ - H^- shown in figure 8. **Please confirm the result and if it so, try to explain it**.

Page 7169, line 11: Should be Figure 10

Page 7172, line 26. Do you have testes some values for the B components?

Page 7173,
line 4/5: "The larger increment for FIL on 14 July corresponds to a heavy precipitation event in the region". The authors should try to justify why sometimes occur such strongly differences between REF and FIL.

line 18/19: "We tested this EKF with the assimilation of T 2 m and RH 2 m observations to correct errors in soil moisture and soil temperature". This comment should also have been spelled out previously, may be in the §3.

References:

Page 7175: the two first references are equal.

Figures

Figure 1. As I understand in the offline set-up the runs of the ALORO Model were coupled to the surfex. If so, the figure may be changed.

Figure 2. Figure 2 might be more informative (countries, lat / long)

Figure 6 : about the colour-scale: for the analysis in the text, the 0.0 should be in the centre of a class. The label does not indicate it, but maybe it's just a label error. If so, please correct it, if not it will be better to redo the figure.

Figure 8
The conclusion: "The offline approach has a smaller optimal perturbation size (black lines) and smaller jacobian values (red lines)" should not be indicated in the figure caption. on the other hand, the caption may indicates the differences between the top and the bottom figures

Figure 10 ↔ Figure 9 (Figure 9 is first refereed in page 7169, Figure 10 in page 7168)

Figure 10 The last sentence: "The linearity assumption is better approximated for the offline approach" should no appear in a figure caption.

Figure 11 The final sentence: ", i.e these are the optimal perturbation sizes." is not clear and not needed