

Interactive comment on “Monitoring of water and carbon fluxes using a land data assimilation system: a case study for southwestern France” by C. Albergel et al.

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The authors thank the anonymous reviewer #2 for his/her review of the manuscript and for the fruitful comments. For an easier comprehension, general comments of the referee are also reported (2.XX).

2.1 [P1708, L14+: Information about the three model configurations are mentioned at this point, at P1709, L6+ and P1710, L13+. Maybe this can be combined to one passage about configurations, also explaining the motivation why the authors are testing a case without precipitation data, but no cases with leaving out other data sources.]

Response 2.1 - Indeed, the description of the model configurations in Sect. 2.1 is
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redundant with the Introduction Section and this has to be corrected. The motivation for focusing on precipitation is that this meteorological variable is generally more difficult to monitor in data-poor areas.

2.2 [P1709, L20: What is the domain for the model? Is it only one grid point located at the SMOSREX measurement site or is the model run for a larger domain?]

Response 2.2 - In this study, the model only considers one grid point located at the SMOSREX experimental site. This is a first stage before developing the LDAS at larger scales within the SURFEX modelling platform.

2.3 [P1710, L13+: The control simulations are run without data assimilation?]

Response 2.3 - Open-loop simulations correspond to LDAS simulations with no SSM and LAI values used in the assimilation.

2.4 [P1711, L9: Is the ECOCLIMAP value of 1.82 used during the model run or is it overruled already at the beginning? What is the impact of arbitrarily changing the soil depth?]

Response 2.4 - Yes, the ECOCLIMAP d2 value of 1.82m is overruled already at the beginning. However running the LDAS under those conditions was tested, also (not shown). It was found that the LDAS is able to compensate for the error on soil depth: provided that a high model error (0.06^2 (m^3m^{-3})) is prescribed, the obtained scores on surface fluxes are similar to those of the RC LDAS with $d2=0.95m$.

2.5 [P1712, Eq(1): What is the index 0 at $h(x_0)$? What is t ?]

Response 2.5 - The t and 0 superscripts stand for time (t) and for the initial time ($t=0$). This will be added in the text.

2.6 [P1712, L15: Which temperature is used as threshold?]

Response 2.6 - This is a threshold on the simulated surface temperature.

2.7 [P1713, L15+: What is the impact if changing the value for T and can this value be used for other regions of the world too?]

Response 2.7 - Albergel et al. (2008) showed that, to some extent, the exponential filter method is not much sensitive to the T value. While an inter-annual variability of the yearly optimum T estimates was found for the SMOSREX in situ observations of soil moisture during the 2001-2007 period, the use of a unique value corresponding to the optimum value for the whole period did not significantly impact the Nash score. It must be noted that $T=11d$ was found to optimize the retrieval of the SMOSREX integrated soil moisture observations down to 0.95m, based on surface (0-6cm) soil moisture observations. Because a thinner upper layer (0.5-2 cm) of the soil is observed at C-band, T values higher than 11d are expected in the context of, e.g., ASCAT data, consistent with Wagner et al. (1999).

2.8 [P1714, L22+: Did the authors also use SSM data from satellites for assimilation/verification and if so, how well is the agreement to ground measurements?]

Response 2.8 - Albergel et al. 2009 and Rüdiger et al., 2009 used the SMOSREX in situ data to verify surface soil moisture (SSM) products derived from ASCAT, AMSR-E and ERS-Scat. Good correlations were found for most of them. An attempt (not shown) was made to assimilate these SSM products over SMOSREX. In spite of the scale issue (in general, the satellite products are available at scales of about 25km), the assimilation of VUA-NASA AMSR-E data (described in Rüdiger et al. 2009) had a positive impact on the best case LDAS in the zero-precipitation configuration, with r^2 and RMSE scores on w_2 of 0.65 and 0.04 m^3m^{-3} , respectively.

2.9 [P1717, L1+: With a low background error, there will be no seasonal cycle in w_2 ?]

Response 2.9 - Indeed, the use of a low background error (low with respect to the observational error), produces an analysis very close to the open loop and there is no seasonal cycle in w_2 .

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2.10 [P1717, L6+: Is the optimization of Bw_2 valid only for the SMOSREX site or also for other regions?]

Response 2.10 - It is unlikely that the optimization of Bw_2 performed for the SMOSREX site be valid for other sites or regions. Mahfouf et al. 2009 and Draper et al. 2009 assume that $Bw_2 \cdot 0.5$ is proportional to the soil moisture range (i.e. the difference between w_{fc} and w_{wilt}).

2.11 [P1717, L11+: I think this should be a separate chapter, maybe called verification as there is mentioned nothing more about error setting. Is the LAI used both for assimilation and verification during the tests?]

Response 2.11 - Yes, this part could be separated from the previous part dealing with observational and model errors. LAI is used both for assimilation and verification during the tests.

2.12 [P1721, L3+: Does this mean that precipitation values were set equal to zero or that no precipitation information was provided at all?]

Response 2.12 - It means that precipitation values were set equal to zero.

2.13 [P1723, L10+: For a low correlation of TB-derived SSM and in-situ SSM, the authors found a degradation of the results for w_2 . I am missing some conclusions about the impact of this result for further investigations (e.g. when taking into account satellite measurements which probably won't be correlated to the in situ measurements that well too).]

Response 2.13 - The quality of the analysis really depends on the quality of the model and of the assimilated data. The added value of the assimilation is governed by the quality of the observations with respect to the model. Information about the quality of the satellite retrievals, which may change from one period to another, is critical.

2.14 [P1726: There should be an outlook providing some examples what this model can be used for due to the knowledge gained by the investigations presented.]

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Response 2.14 - Draper et al. 2009 have shown the potential of the assimilation of satellite-derived SSM values in NWP applications, at a continental scale. In this study, the same LDAS is extended to the assimilation of LAI observations, the simulation of the surface carbon fluxes, and verified with in situ flux and soil profile observations at the local scale, without coupling with the atmosphere. This shows that the assimilation systems used in meteorology are flexible enough to assimilate new satellite observations, and can be adapted for environment monitoring applications, not coupled with atmospheric models.

2.15 [Table4: What does “standard and increased input error parameters” mean?]

Response 2.15 - Yes, it is a typo, “and with standard and increased input error parameters” should be deleted.

2.16 [Fig1: Did the authors investigate these time series in detail, e.g. are there annual trends or climatological significant events (e.g. drought in summer 2003) which might explain the differences in the statistical measures from year to year?]

Response 2.16 - There is no clear explanation for the year to year score of the Tb-derived SSM. However, it can be noted that the highest r^2 scores are found for 2003, 2005 and 2006, which were marked by significant summer droughts in southwestern France, as opposed to 2004 and 2007. This could be caused by the litter effect on the L-band Tb measured at SMOSREX, described in Saleh et al. 2007. Indeed, the dead vegetation material tends to intercept and accumulate rainwater, thus attenuating the soil emission. It is likely that this effect is more pronounced during wet years (more intercepted water and more vegetation material due to enhanced net primary production, as shown by Albergel et al. 2010).

2.17 [Fig2: For this experiment, only screen level parameters are assimilated, but no SSM or LAI?]

Response 2.17 - In this study, only SSM and LAI values are assimilated. The model

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is not coupled with the atmosphere and air temperature and air humidity data are not assimilated. In Fig. 2, the LDAS is used in a configuration where no SSM or LAI values are used in the assimilation. Moreover, an error was made in Fig. 2 (wrong soil texture). In the corrected Fig. 2, the RC simulation of w_2 is slightly shifted to higher values.

2.18 [Fig3: Why do the authors use a third order polynomial to fit the data and not a polynomial of higher order which might better fit the data set? For which time period this matching has been done?]

Response 2.18 - In the case of the SMOSREX site, the difference between modeled and observed SSM is relatively small, compared with large scale applications using satellite data (Draper et al. 2009). Using a higher order polynomial does not seem justified in this context: Fig. 3 shows that a third-order polynomial performs well, with the rescaled observation CDF very close to the model CDF. The whole 2001-2007 period was considered to perform the matching.

2.19 [Fig5: What happened in June to explain this large value for the Jacobians? Are there observations for w_2 and LAI available for this time? If so, please include them in the]

Response 2.19 - The Jacobians are governed by the physics of the model which may trigger non-linearities close to threshold values. In June 2003, a severe drought induces w_2 values lower than wilting point. Some variability is also observed in September and October when w_2 is close to wilting point.

2.20 [Fig. 6: What do the authors mean by “model error multiplied by 4”? Is it the background error Bw_2 , which was increased from 0.02 to 0.06? If in the open loop run no SSM is assimilated, there is no precipitation forcing and the value for w_2 is zero (from middle of 2003), how can the model create SSM-values higher than zero?]

Response to 2.20 - It is a typo. The model error (in units of m^3m^{-3}) is multiplied by 3. Non-zero SSM values in the open-loop zero-precipitation simulation are caused by dew

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deposition generated by the model. The rather strong impact of dew on the simulated SSM is caused by the very thin top soil layer represented by the model (in this study, a simple force-restore version of the model hydrology is used).

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