



## ***Interactive comment on “Verification of the new ECMWF ERA-Interim reanalysis over France” by C. Szczępta et al.***

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Response to Reviewer #1

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The authors thank the anonymous Reviewer #1 for his/her in-depth review of the manuscript and for the fruitful comments. For an easier comprehension of the authors' response, the comments of the referee are reported (1.XX).

1.1 [Apart from a necessary revision of the document structure and language, an attribution of discrepancies between the various data sets and the effects on the various terms in an offline land surface simulation should be included.]

## RESPONSE 1.1

The authors thank Reviewer #1 for the suggestions he/she made in order to improve the document structure and language and agree that more details should be given about attribution of discrepancies between the various data sets and the effects on the various terms in land surface simulations. Such details are contained in the different answers to the comments of Reviewer #1, given below. They will be included in the final version of this paper. As suggested by Reviewer #1, “ERA-I rescaled” is now referred to as “ERA-I-R”.

1.2 [Some in-depth analysis of the correlation between the bias and a number of suspected environmental conditions should be included, such as bias versus signal, bias versus altitude, distance to coast, surface characteristics, cloud cover...]

## RESPONSE 1.2

In order to investigate the influence of environmental conditions on the obtained biases and correlations, all the variables were analysed further, over a 18-year period (1991-2008), using all the ERA-I and ERA-I-R data available to the authors. Correlations and biases obtained from the comparison between ERA-I (or ERA-I-R for precipitation) and the reference SAFRAN (or Brion for the ISR) data set, were analysed with respect to various factors, such as altitude, the difference between the altitude used in the SAFRAN analysis and the altitude used in ERA-I, cloud cover, and the mean monthly or annual values of the considered variable. Regarding the distance to coast, France presents several coast lines (Mediterranean, Atlantic...) with contrasting climatic behaviours, and it was difficult to draw firm conclusions on the impact of this factor. The bias or correlation maps of the atmospheric variables (air temperature, precipitation, air humidity, ISR...) did not show common features close to coastlines. On the other hand, the grid-point altitude derived from SAFRAN may be higher (up to 1143 m) or lower (down to -390 m) than the ERA-I altitude. It was found that this factor has significant consequences on air temperature and air humidity. A summary of the main

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findings of the analysis is given below:

- Precipitation: No correlation was found between the precipitation scores (bias, RMSE or  $R^2$ ) and the grid points' altitude. Annual and monthly biases of ERA-I and ERA-I-R precipitation were compared with the associated mean annual and monthly SAFRAN precipitation estimates (18 annual values, and 12x18 monthly values). For monthly precipitation values, significant (F-test p-value close to zero) correlations were found with  $R^2 = 0.70$  for ERA-I and  $R^2 = 0.28$  for ERA-I-R. For annual precipitation values, a significant correlation was found with ERA-I ( $R^2 = 0.54$ , p-value < 0.001), but not for ERA-I-R ( $R^2 = 0.11$ , p-value > 0.05). In brief, the underestimation of precipitation by ERA-I is more marked for larger precipitation amounts. The remaining bias of the ERA-I-R monthly precipitation depends on the precipitation amount, also, but to a lesser extent.

- ISR: As for precipitation, the scores are not correlated with altitude or with any surface characteristic, but the monthly ERA-I bias correlates well ( $R^2 = 0.79$ ) with the mean monthly ISR. In order to investigate the impact of a possible misrepresentation of cloud cover by ERA-Interim, the ISR biases were compared with the precipitation biases. Although no correlation could be found between the two biases, it is likely that ERA-I tends to underestimate the cloud cover, consistent with the overestimation of the ISR and the underestimation of the precipitation. More studies are needed to investigate the cloud cover impact.

- Air temperature and air humidity: In contrast to precipitation and ISR, the altitude has a marked impact on the biases on air temperature and air humidity. The biases were analysed as a function of the altitude difference between SAFRAN and ERA-I for each ERA-I grid cell, at different times (00:00, 06:00, 12:00 and 18:00 UTC). Significant correlations are obtained, especially at 12:00 and 18:00 UTC ( $R^2 = 0.74$  and  $R^2 = 0.92$  for air temperature, and  $R^2 = 0.54$  and  $R^2 = 0.53$  for air humidity, respectively). On average, for grid-points presenting about the same ERA-I and SAFRAN altitude, no bias is observed for air temperature, while ERA-I overestimates air humidity (by 5.10-4 kg

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kg-1). When the SAFRAN altitude is greater than the ERA-I altitude (mainly in mountainous areas), ERA-I tends to overestimates both air temperature and air humidity values.

- Wind Speed: For wind speed, no relation could be found between the ERA-I scores and the suspected environmental conditions as presented before.

1.3 [As it is presented here, a list of differences between products and simulation results is presented without any judgment of where these differences come from, and/or how large the differences can be expected to be based on aspects like station representativity, natural variability, methodological differences etc. Without this expectation the reported differences have only little sense, and can not be appreciated fully.]

### RESPONSE 1.3

We understand this comment as a question about the sensitivity study performed over the SMOSREX grassland site in Sect. 4. In order to interpret the different ISBA-A-gs simulations generated by different atmospheric forcings, a cross-analysis of Tables 6 and 7 has to be performed. This analysis is presented below for soil moisture, LAI, and surface fluxes.

- w2: The impact on root-zone soil moisture of using the ERA-I-R precipitation is shown in Table 7 by the scores of the SAFRAN + ERA-I-R simulation. Indeed, in this case, precipitation is the only forcing variable differing from the reference SAFRAN forcing. The impact is small. As shown by Table 6, ERA-I-R precipitation is slightly overestimated and this bias produces a slight overestimation of w2 (Table 7). The same comparison between SAFRAN and SAFRAN + ERA-I ISR shows the impact of the ERA-I ISR (overestimated by 22.3 Wm-2 on average), with an underestimation of w2 of 0.008 m3m-3, consistent with the enhanced evapotranspiration (3.4 Wm-2 on average). When all the ERA-I-R variables are used,  $R^2$  is quite good (0.93) and the bias is very small (0.001 m3m-3). It seems that the overestimation by ERA-I of the ISR, tends to offset the impact of the overestimation by ERA-I-R, of the precipitation. On

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the other hand, using ERA-I, which markedly underestimates precipitation, significantly degrades the scores. In particular, w2 is underestimated. It can be concluded that the underestimation of precipitation by ERA-I has a marked impact on w2 and that the use of ERA-I-R precipitation permits to reduce this bias.

- LAI: Table 7 shows that the use of different precipitation estimates seems to have more impact on LAI (e.g. in terms of  $R^2$  or Nash score) than on w2. The slight overestimation of the precipitation by ERA-I-R produces a marked LAI overestimation (of 0.43  $m^2 m^{-2}$  on average). The use of the ERA-I ISR has less impact than the use of the ERA-I-R precipitation. As for w2, much better scores are obtained by the whole ERA-I-R than with SAFRAN + ERA-I-R precipitation (e.g. Nash of 0.84 and 0.62, respectively, and a bias reduced by more than 50%). The explanation is less evident than for w2 since both the overestimation by ERA-I of the ISR, and the overestimation of the precipitation by ERA-I-R, tend to enhance plant growth. It is likely that the use of the ERA-I air temperature, air humidity, and wind speed also impact the LAI simulations. As for w2, the score difference between ERA-I and ERA-I-R in Table 7 shows the positive impact of rescaling the ERA-I precipitation.

- Wg: Except for the simulation using SAFRAN + ERA-I ISR, surface soil moisture is quite affected by the use of different atmospheric forcings. Precipitation has a particularly large impact on this variable, and contrary to w2 and LAI, the whole ERA-I-R simulation markedly degrades the SAFRAN + ERA-I-R precipitation results.

- The surface fluxes (H, LE and F[CO<sub>2</sub>]) seem to be more sensitive to changes in the atmospheric forcing than w2 and LAI, and in general, lower  $R^2$  values are obtained. The score difference between ERA-I and ERA-I-R is particularly marked for F[CO<sub>2</sub>].

1.4 [In addition, the ISR comparison methodology is not unbiased. In the reference “Brion” data set a portion of SAFRAN data is blended, after which this blended data set is compared to SAFRAN again. The rationale of this blend is not clear to me. It is better to use a raw Brion dataset and attach uncertainty estimates to stations that are

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suspicious, or remove them from the comparison data set.]

#### RESPONSE 1.4

Indeed, in the reference Brion data set, a portion of SAFRAN data is used (partially for grid points with an altitude varying between 500 and 1500 m a.s.l., and totally for grid points with an altitude greater than 1500 m a.s.l.). This is due to the fact that the Brion ISR is based on in situ observations, which are scarce in mountainous areas. In order to investigate the use of pure Brion data, the same study as the one described in the discussion paper (Table 4) was performed for the grid points where the Brion data are considered alone (i.e. for altitudes below 500 m a.s.l.). This represents 76 % of the France domain (235 grid points among the 308 grid points covering the whole of France). For 2001 and 2003, similar ERA-I scores and biases ( $R^2$  ranging from 0.97 to 0.98, and mean bias from 8.2 to 9.2 Wm-2, respectively) are obtained vs. either the raw Brion data set or the blended data set.

1.5 [Also it is not clear why only two years of data were used. All data sets that are being compared at the level of France contain at least 7 years of data, as far as I can see. It is claimed that the two years are very different, but no attempt is undertaken to use this difference in order to explain the biases.]

#### RESPONSE 1.5

Two contrasting years, 2001 and 2003, were chosen to verify the ERA-I quality in detail. The same work was made over the 1991-2008 period for which the ERA-I estimates were available. The different scores will be presented in the final version of this paper, along with the scores for 2001 and 2003. In general, the results obtained over the 1991-2008 period are consistent with those for 2001 and 2003, at both the daily and monthly time scales. Also, the use of a long time series permits to map the standard deviations of the scores over the France domain. For the precipitation data, it is found that the inter-annual  $R^2$  variability is small (the mean standard deviation of  $R^2$  over France is 0.13) and fairly homogeneous over France. On the other hand, the inter-

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annual variability of the bias is more diverse and is larger in southern France (Corsica, Pyrenees, the Alps and close to the Mediterranean Sea). A possible explanation, for Mediterranean regions, is that intense precipitation events may occur more frequently than in other areas. Figure 5 shows that, like ERA-I, ERA-I-R markedly underestimates the most intense precipitation events. Since ERA-I-R tends to overestimate precipitation close to the Mediterranean Sea, more frequent intense precipitation events tend to reduce the mean annual bias. Therefore, the latter may vary from one year to another depending on the occurrence of intense precipitation events. As the monthly bias on ERA-I-R precipitation tends to increase with the monthly precipitation value (see Response 1.2, also), relative biases (ERA-I-R minus SAFRAN precipitation, scaled by the SAFRAN precipitation) were investigated. The relative bias is relatively homogeneous over France and, more often than not, ERA-I-R underestimates precipitation by about 10 %. However, for the Mediterranean regions close to the coast, ERA-I-R may locally overestimate precipitation, up to 79 % on a monthly basis. In a few mountainous areas close to Spain and Switzerland, ERA-I-R underestimates precipitation, down to -49 % on a monthly basis. The most extreme values (either negative or positive) of the relative biases are found in the areas presenting the largest variability of the bias from one year to another (see before).

1.6 [Also the evaluation of different time slices for the SMOSREX data (1990 – 2005 for the forcing data and trend analysis, 2001 – 2007 for LAI/soil moisture, 2005 – 2007 for turbulent fluxes) is quite unclear and not well justified in the Methods section.]

#### RESPONSE 1.6

We agree with Reviewer #1. The reason why we worked with different time intervals is related to the availability of the different data sets:

[1991-2008]: SAFRAN, ERA-I and ERA-I-R data availability

[1994-2007]: Brion data availability

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[2001-2007]: The field campaign of SMOSREX has been in operation since January 2001

[2005-2007]: Fluxes (CO<sub>2</sub> fluxes and sensible and latent heat fluxes) have been measured at SMOSREX since 2005.

These explanations will be clearly stated in the Methods section of the final version of the manuscript.

1.7 [Some specific remarks (I haven't tracked all typos and language corrections – there are many)]

RESPONSE 1.7

A copy editing work was performed by Copernicus before publication in HESSD, and the additional editorial comments of Reviewer #1 will permit to further improve the paper.

1.8 (7153-26) [what is denoted with the “...”?]

RESPONSE 1.8

“...” will be removed.

1.9 (7154-17) [delete “The precipitation...are described”]

1.10 (7154-21) [delete “a long”]

1.11 (7155-2) [(and other places): Precipitation is not a “parameter” but a “variable”]

RESPONSE 1.9, 1.10, 1.11

We agree with Reviewer #1. It will be corrected in the next version of the manuscript.

1.12 (7155-7) [PERSIANN is introduced here but very rapidly discarded because of a large bias (7163-5). Either don't include it at all in your analysis, or try to understand the background of this bias.]

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## RESPONSE 1.12

We agree with Reviewer #1. Persiann analysis is not fundamental to our study and this discussion will be removed.

1.13 (7155-1) [the section “precipitation data” contains a lot of text about the various data sets (SAFRAN, ERA) not only addressing precipitation. Reorganize as “2.1 Structure of datasets”, “2.1.1 SAFRAN”, “2.1.2 ERA-Int”, “2.1.3 Other data products”, “2.2 Precipitation”, “2.3 ISR”, “2.4 T, q and u”]

## RESPONSE 1.13

We agree with Reviewer #1. The new version of the manuscript will be organised accordingly.

1.14 (7156-7) [as far as I know ERA-Int also contains a 2m temperature and humidity, diagnosed from the 10m level. Why don’t you use this, or why don’t you mention it at all? By the way, Pitman and Perkins have already evaluated temperature quality in reanalysis data, and should be cited (A. J. Pitman, S. E. Perkins: Global and Regional Comparison of Daily 2 m and 1000-hPa Maximum and Minimum Temperatures in Three Global Reanalyses; Journal of Climate 22, 4667-4681)]

## RESPONSE 1.14

Indeed, ERA-I contains 2-m temperature and humidity variables diagnosed from the 10m level. These variables were described by Simmons et al. 2010. However, Pitman et al. (2009) showed that diagnosed 2-m temperature may vary a lot from one atmospheric analysis to another, and they suggested to use of the variables corresponding to the lowest atmospheric model level. In this study, the instantaneous meteorological forcing (such as air temperature, humidity and wind fields) are all extracted from a 10-m level, corresponding to the lowest atmospheric model level in ERA-Interim. That ensures the internal consistency of the fields and permits some flexibility on the choice of vertical interpolation within the surface boundary layer, which can be done following

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the modelling platform (e.g. using SURFEX stability function) which normally varies in models. The consequences of the use of the 2-m temperatures and humidity in the comparison with the SAFRAN reference are discussed in Response 1.36.

Pitman, A. J., and Perkins, S. E.: Global and Regional Comparison of Daily 2-m and 1000-hPa Maximum and Minimum Temperatures in Three Global Reanalyses, *J. Climate*, 22, 4667-4681, doi: 10.1175/2009JCLI2799.1, 2009.

Simmons, A. J., Willett, K. M., Jones, P. D., Thorne, P. W., and Dee, D. P.: Low-frequency variations in surface atmospheric humidity, temperature and precipitation: Inferences from reanalyses and monthly gridded observational data sets, *J. Geophys. Res.*, 115, D01110, doi: 10.1029/2009JD012442, 2010.

1.15 (7156-13) [“This method extracts the information...”: a vague phrase. Do you mean that you aggregated all data to the 2.5 degree resolution?]

#### RESPONSE 1.15

It is meant that the ERA-I precipitation rescaling factor is computed by interpolating conservatively the GPCP  $2.5^\circ \times 2.5^\circ$  grid to its equivalent T95 grid, interpolating conservatively the ERA-I T255 Gaussian grid to the same T95 Gaussian grid, computing the rescaling factor at this low resolution grid and then, finally, by interpolating conservatively the rescaling factor from the T95 to the T255 resolution (Balsamo et al. 2010). For this reason, this method preserves the small scale features of ERA-I while the rescaled monthly totals are consistent with the GPCP observations.

1.16 (7156-25 and 1757-9) [the political justification of GPCC etc can be deleted in this paper]

1.17 (7157-15) [“substantially the same” -> “essentially similar”]

#### RESPONSE 1.16, 1.17

We agree with Reviewer #1. It will be corrected in the next version of the manuscript.

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1.18 (Section 2.3) [why don't you look at nighttime T and q? The diurnal cycle (and biases therein) are very interesting (see also Pitman and Perkins)]

#### RESPONSE 1.18

In the present version of the manuscript, the verification of air temperature and air humidity is performed at 06:00 UTC and at 12:00 UTC. Extending the verification to other times (18:00 and 00:00 UTC) permits to better sample the diurnal cycle. Some results are presented in the following answers.

1.19 (7159-11) [delete "Although wind speed...From SAFRAN to ERA-I."]

#### RESPONSE 1.19

We agree with Reviewer #1. It will be corrected in the next version of the manuscript.

1.20 (2.4.1) [too little information is given on the available data and time ranges. Flux measurements are not mentioned here, but used later]

#### RESPONSE 1.20

More information will be given regarding the SMOSREX presentation (part 2.4.1) in the next version of the manuscript. A number of biophysical variables and surface fluxes are observed at the SMOSREX site. For example, soil moisture is observed at ten depths (0-6, 10, 20, 30, 40, 60, 70, 80, 90 cm) with an half hourly time step. It can be noted that from those measurements it is possible to estimate the root zone soil moisture content  $w_2$  ( $m^3 m^{-3}$ ), integrated over the root-zone profile (0-95 cm). Surface shortwave reflectances are observed by two CIMEL radiometers and permit, thanks to a method developed by Roujean and Lacaze (2002), to produce LAI values. Destructive observations of LAI were performed from 2001 to 2006 as well. Regarding the different fluxes observed at the SMOSREX site, CO<sub>2</sub>, sensible heat (H) and latent heat (LE) flux measurements are done through the eddy covariance micrometeorological method (Moncrieff et al., 1997) since 2005.

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Moncrieff, J., Valentini, R., Greco, S., Seufert, G., and Ciccioli, P.: Trace gas exchange over terrestrial ecosystems: method and perspectives in micrometeorology, *J. Exp. Bot.*, 48 (310), 1133–1142, 1997.

Roujean, J.-L., and Lacaze, R.: Global mapping of vegetation parameter from POLDER multiangular measurements for studies of surface-atmosphere interactions: A pragmatic method and its validation, *J. Geophys. Res.*, 107 (D12), doi: 10.1029/2001JD000751, 2002.

1.21 (2.4.2) [a discussion of the comparison metric must be included. How are you going to evaluate? When do you conclude the difference in forcing is significant? How do you attribute causes of differences? There are many ways to “compare” data sets. Be specific about your way and the purpose of it.]

## RESPONSE 1.21

Over the SMOSREX grassland, a number of studies have shown that the ISBA-A-gs model is able to simulate, reasonably well, the water, energy, and CO<sub>2</sub> fluxes, the LAI and the root-zone soil moisture (e.g. Albergel et al., 2010a,b), using either the locally observed atmospheric forcing or the atmospheric forcing from the nearest SAFRAN grid point. In this study, ISBA-A-gs simulations were produced using the SAFRAN atmospheric forcing as a reference, and, also, using ERA-I and ERA-I-R. The biophysical variables (w<sub>2</sub>, LAI and w<sub>g</sub>) were considered for the 2001-2007 period and fluxes (CO<sub>2</sub>, H and LE) for the 2005-2007 period. This choice was driven by the availability of observations for the different variables at the SMOSREX site. The ISBA-A-gs simulations using ERA-I or ERA-I-R, were compared with the simulation produced from the SAFRAN forcing. In order to evaluate the impact of using ERA-I or ERA-I-R, and to quantify the departure from the reference SAFRAN-driven simulation, a number of scores were computed, compared and analysed: square correlation coefficient, mean bias, RMSE and (for soil moisture and LAI) the Nash-Sutcliffe coefficient (NASH). In order to assess the relative impact on the ISBA-A-gs simulations of precipitation and

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ISR, which are the most biased ERA-I variables for this site, ISBA-A-gs was run in three configurations: (1) SAFRAN, (2) SAFRAN, except for SAFRAN precipitation replaced by the ERA-I-R precipitation, and (3) SAFRAN, except for SAFRAN ISR replaced by the ERA-I ISR.

1.22 (7161-15) [delete “In order to assess. . .too”]

1.23 (7151-20) [define a new acronym for “ERA Interim rescaled”, too much to repeat it all the time.]

1.24 (7161-20) [start new para at “Fig 3”]

1.25 (7162-5) [“more important” -> “larger”]

1.26 (7162-13) [rephrase as “Fig 5. . .correlation of monthly values of . . .of 2001.”]

RESPONSE 1.22, 1.23, 1.24, 1.25, 1.26

We agree with Reviewer #1. It will be corrected in the next version of the manuscript.

1.27 (7162-25) [from a single years evaluation you do not expect a clear seasonal pattern. That's why a multiyear evaluation is to be preferred strongly!]

RESPONSE 1.27

Yes. In the discussion paper, the temporal variation of the scores did not seem to depend on the precipitation amount for the years 2001 and 2003, which were studied independently. On the other hand, a 18-year evaluation of ERA-I and ERA-I-R shows that the biases on precipitation depend significantly on the precipitation amount (see Response 1.2). It is shown that at summertime, when the monthly precipitation presents low values, the biases are smaller.

1.28 (7163-10) [“less important” -> “still smaller”]

RESPONSE 1.28

We agree with Reviewer #1. It will be corrected in the next version of the manuscript.

1.29 (7163-19) [the “unbiased” Brion reference data is not unbiased as it contains SAFRAN information]

RESPONSE 1.29

We agree. The Brion dataset over the whole of France contains SAFRAN information and cannot be considered as unbiased. See Response 1.4.

1.30 (7163-22) [“are very similar”: I don’t see this. ERA-I clearly has higher values during Feb-Oct than the others]

RESPONSE 1.30

Yes, at the scale of the France domain, the three ISR estimates present similar day-to-day variations. However, ERA-I clearly has higher values from February to September.

1.31 (7164-7) [move this part to the “Methods” section]

1.32 (7164-19) [“greater” -> “higher”]

1.33 (7163-20) [“weak” -> “small”]

RESPONSE 1.31, 1.32, 1.33

We agree with Reviewer #1. It will be corrected in the next version of the manuscript.

1.34 (7165-2) [“No correlations found”: what is the explaining variable here? Is it just noise? Please explore more in depth where the differences come from.]

RESPONSE 1.34

This result is the counterpart for ISR of the results for precipitation (7162-22, Table 2). Similar to Response 1.27 for precipitation, monthly ISR scores for a single year (2001 or 2003), do not display a clear seasonal pattern. Performing a multiyear evaluation (over the whole period 1991-2008) permits to show that the overestimation of the monthly ISR by ERA-I is more marked for higher monthly ISR values. Conversely, the underestimation of the monthly ISR by SAFRAN is more marked for higher monthly

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ISR values.

1.35 (7165-6) [Suddenly vertical profiles are introduced here, while lines 5-10 should be discussed in section 2. I don't know what is meant here.]

#### RESPONSE 1.35

We agree with the Reviewer #1. This paragraph will be removed from the next version of the manuscript.

1.36 (7165-18) [the difference in bias between 6 and 12 UTC implies that ERA-I suppresses the diurnal cycle. It is important to check the behaviour at 18 and 00 UTC as well, and try to explain why this diurnal cycle is so off. Further in this section it is explained that the smoother topography can be held responsible for the bias. How does this work? Why would a smoother topography induce a diurnally varying bias?]

#### RESPONSE 1.36

In order to investigate the difference in air temperature bias, throughout the diurnal cycle, the analysis can be extended to 00:00 and 18:00 UTC. ERA-I tends to overestimate air temperature at 00:00, 06:00 and 18:00 UTC while it tends to underestimate this quantity at 12:00 UTC. That implies that ERA-I tends to reduce the diurnal cycle of air temperature. This tendency may be due to the ERA-I air temperature considered in this study at 10-m and not at 2-m like in SAFRAN. At nighttime, the surface radiative cooling may induce slightly lower air temperature close to the soil than at 10m above the soil. That may explain the biases obtained at 00:00, 06:00 and 18:00 UTC. On the contrary, air temperature may increase more quickly during the day (e.g. at 12:00 UTC) at 2-m than at 10-m. The smoother ERA-I topography on mountainous areas, triggers higher air temperatures (see Response 1.2), throughout the diurnal cycle and has an clear impact on the spatial distribution of the bias at 12:00 UTC (see Response 1.37).

1.37 (7166-2) [here an overestimation of ERA at 12 UTC in mountainous area is reported, while earlier an overestimation at 6 UTC is stated. This seems inconsistent.]

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## RESPONSE 1.37

As explained in Response 1.36, using 10-m instead of 2-m air temperature, may tend to produce slightly lower air temperature around midday, and higher air temperatures at night, at dawn and at dusk. The latter occurs over the whole France and particularly in mountainous areas. On the other hand, the underestimation at 12:00 UTC is not systematic: while ERA-I clearly underestimates air temperature in coastal regions (where ERA-I overestimates the altitude in comparison to SAFRAN), ERA-I overestimates air temperatures in mountainous areas (where ERA-I underestimates the altitude.)

1.38 (7166-4 to 8) [the argumentation is very unclear here, please rephrase]

## RESPONSE 1.38

On average, for the 1991-2008 period, ERA-I has virtually no air humidity bias at 06:00 UTC, but the spatial distribution of the bias is not homogeneous. The overestimation is marked for 29% of France (especially in Corsica, in southeastern France and in mountainous areas), with a mean bias of  $5.7 \times 10^{-4}$  kg kg $^{-1}$ . Over other regions, ERA-I slightly underestimates (mean bias of  $-2.3 \times 10^{-4}$  kg kg $^{-1}$ ) air humidity.

1.39 (7166-10) [why does a difference in altitude affect the humidity bias? Is there such a strong humidity gradient in this lowest atmospheric layer? What is the reason for this gradient? Please provide some more physical reasoning behind the observed biases.]

## RESPONSE 1.39

Air humidity is not independent from air temperature. When air temperature increases, air humidity tends to be greater. In this study, air humidity differences between SAFRAN and ERA-I correlate with the air temperature differences ( $R^2 = 0.65$ ). In mountainous areas, where the ERA-I altitude is smaller than the SAFRAN altitude, the ERA-I air humidity tends to be higher, which is consistent with the impact of altitude on air humidity. In other regions, the ERA-I air humidity is really close to SAFRAN. Regarding the diurnal cycle, the conclusions obtained for air temperature are valid for

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air humidity, and a slightly less marked ERA-I diurnal cycle is observed.

1.40 (7166-23) [strange that in 1990-2007 no temperature trend is observed, while all climate change assessments show a clear positive temperature trend over all European land areas in this period. What significance level was taken?]

#### RESPONSE 1.40

Yes, a more thorough evaluation of the trends was performed over the SMOSREX site. Trends from the SAFRAN data set were studied over France by Vidal et al. (2010) for precipitation and for air temperature (Tmin and Tmax), within the period 1958-2008. They show that, more often than not, precipitation trends are not significant, but that significant trends (either positive or negative) may be detected, locally. However, while trends derived from reference in situ observations are between 0.02 and 0.04 degreeC/year for Tmin, and around 0.035 degreeC/year for Tmax, the values derived from SAFRAN are more scattered (-0.04 to 0.06 degreeC/year for Tmin and 0.01 to 0.08 degreeC/year for Tmax). Over the shorter period (1991-2008) considered in this study, the following results are found with SAFRAN and ERA-I/ERA-I-R for the SMOSREX site: no significant trend is found for precipitation, a significant increase is found for both Tmin and Tmax for SAFRAN (0.073 degreeC/year and 0.036 degreeC/year, respectively), and for ERA-I (0.033 degreeC/year and 0.036 degreeC/year, respectively).

Vidal, J.-P., Martin, E., Franchistéguy, L., Baillon, M., and Soubeyroux, J.-M.: A 50-year high resolution atmospheric reanalysis over France with the Safran system, *Int. J. Climatol.*, 30, 1627-1644, doi: 10.1002/joc.2003, 2009.

1.41 (7167-6) [the section should not be called “Discussion” but “Results of offline model simulations”]

#### RESPONSE 1.41

We agree with Reviewer #1. It will be replaced in the next version of the manuscript.

1.42 (7167-10) [I assume you mean that the ERA-bias is “larger” rather than “more

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important". Yet, earlier you concluded that ERA has a higher correlation with Brion than SAFRAN, so this argument is not straightforward to me.]

#### RESPONSE 1.42

Yes, this sentence should be reworded as "This might be critical. Although both ERA-I and SAFRAN correlate very well with Brion (Sect. 3.2), the difference between ERA-I and the reference Brion estimates is larger than the difference between SAFRAN and the reference Brion estimates, especially at summertime."

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1.43 (7168-17) [it is strange that soil moisture is so sensitive to the precip forcing, but latent heat flux isn't. From the table also H seems to be affected a lot (strong difference in mean bias). What is the physical rationale behind these findings?]

#### RESPONSE 1.43

We agree with Reviewer #1 that this paragraph is not clear and we found a typo in Table 7: the bias obtained for the sensible heat flux H, with ERA-I-R is  $-4.3 \text{ m}^{-2}$  and not  $-44.3 \text{ m}^{-2}$ . This paragraph may be reworded as: "The  $R^2$  value between ERA-I- and SAFRAN-derived simulations of root zone soil moisture, surface soil moisture, LAI and CO<sub>2</sub> flux are improved by the use of the ERA-I-R precipitation. The use of ERA-I-R, permits to reduce the bias for most variables, particularly for root-zone and surface soil moisture, and for the sensible heat flux H. On the other hand, the use of ERA-I-R precipitation tends to increase the bias for the latent heat flux LE. This sensitivity study shows that the bias affecting the ERA-I precipitation may have a large impact on the simulation of the different biophysical variables and fluxes, including on their mean value."

1.44 (7168-22) [move this section to "Methods"]

#### RESPONSE 1.44

We agree with Reviewer #1. This section will be moved to the "Data and methods" section.

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1.45 (7170-25) [you conclude that precipitation is a major factor on the biophysical variables. Yet, a comparison between figs 9 and 10 shows that for two simulations with the same precipitation the LAI is very different for different ISR/T/q/wind forcings (SAFRAN with ERA-rescaled versus ERA-rescaled). This means that the other forcings are the most important ones.]

#### RESPONSE 1.45

We have to disagree. The red lines of Fig. 10 (SAFRAN + ERA-I-R) should be compared with the green lines of Fig. 9 (ERA-I-R). They are quite similar for both LAI and w2.

1.46 (7170-21) [why don't you mention that there is a mean bias at 6 and 12 UTC?]

#### RESPONSE 1.46

Yes. We agree that this part of the conclusion should be improved.

1.47 (7175) [in Table 2 (and in many other tables) too much detail is given, while an aggregated value (annual mean for instance) is lacking.]

#### RESPONSE 1.47

In Table 2, an aggregated value is not given because these aggregated values appear in Table 1.

1.48 [Table 3: remove "PERSIAN" from the entire analysis]

#### RESPONSE 1.48

We agree with Reviewer #1. Persiann analysis is not fundamental to our study and this discussion will be removed.

1.49 [Table 7: there is only one significant digit used in the CO2-flux column. Is that the maximum allowable accuracy?]

#### RESPONSE 1.49

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Yes. Two digits may be used.

1.50 [Figs 4 and further: the numbers in the legend are too small to be readable. Why is an absolute rather than a relative bias used for precipitation?]

RESPONSE 1.50

We agree that displaying relative biases for precipitation would bring useful information. This will be done in the final version of the manuscript.

1.51 [Fig 6: Rg is unexplained]

RESPONSE 1.51

“Rg” should be replaced by “ISR”.

1.52 [Fig 8: swap the upper right and lower left panels to match the layout in fig 4. Is the low bias in the central part of France in the lower left panel due to the data blend between Brion and SAFRAN? Please explore further in the main text]

RESPONSE 1.52

We agree with Reviewer #1. It will be replaced and detailed in the next version of the manuscript.

1.53 [Fig 9–10: the year numbers are missing on the horizontal axis]

RESPONSE 1.53

We agree with Reviewer #1. We will add the year numbers to the figure.

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 7, 7151, 2010.

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