Hydrol. Earth Syst. Sci. Discuss.,
doi:10.5194/hess-2016-661-AC1, 2017

Hydrology and Earth System Sciences
Discussions
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Interactive comment

Interactive comment on "Effects of multi-temporal high-resolution remote sensing products on simulated hydrometeorological variables in a cultivated area (southwestern France)" *by* Jordi Etchanchu et al.

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Received and published: 3 April 2017

Anonymous Referee #1: "General comment: the objective is significant. The problem of land cover spatial variability and remote sensing estimation at appropriate spatial scale is a key topic. However, several problems and comments are described below and need to be addressed. In particular, I have several doubts on the spatial scales of model, remote sensing observations and eddy covariance fluxes. I think that the paper can be accepted but the following clarifications need to be addressed for properly evaluating the paper. "

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Discussion paper

Authors: Thank you for your comments, which are pointing out that we should better highlight the issue of the spatial variability of the land cover in current land surface model. Indeed, this issue is the main motivation behind the field scale approach described in the paper. You will find all the explanation about this approach in the following answer to your specific comments. We have done several efforts to make it clearer to the reader. Also, to simplify the comprehension, we have decided to switch the evapotranspiration unit from a monthly averaged J.m-2.d-1 to a cumulated evapotranspiration over the month in mm.month-1. The text, figures and tables have been modified accordingly.

Anonymous Referee #1: “Specific comments: 1) Introduction: not really clear. You need to write more clearly the objectives and what is the new contribution of the paper.”

Authors: Efforts have been done to shorten the abstract and clarify the introduction. The objectives are now clearly defined in the new version: "Our study proposes to evaluate the impact of introducing high-resolution information on vegetation type and the LAI from Sentinel-2-like observations rather than the low resolution ECOCLIMAP-II product in ISBA-SURFEX simulations. The main point is to see if the model is able to capture a more accurate phenological cycle, especially the agricultural practices mentioned above, and to simulate its effects on hydrometeorological fluxes ... This way, we will point out the contribution on surface fluxes dynamics of using high spatial and temporal resolution vegetation forcing instead of low resolution climatology" The field scale approach, which constitutes the main novelty of the study, also appears more clearly: "The LSM was applied at the “field” scale to place it under homogeneous vegetation type conditions for each computation unit (only one PFT by unit). This field-scale modeling approach allows one to take into account the spatial variability of LAI values between fields while limiting the computation time in comparison to a pixel-based approach." This approach is described more clearly in the dedicated part (Numerical Experiments, Sect 3.1).

Anonymous Referee #1: “2) The following are comments and doubts on spatial scales of remote sensing observations, model and eddy covariance fluxes. What is the height of the eddy covariance tower? What is the foot print length? Are you comparing observed fluxes with modeled fluxes at 1 km resolution? If yes, why? I noted that the foot print of the eddy covariance tower may be not homogenous: are you addressing the spatial variability of the land cover in the foot print?”

Authors: The eddy covariance tower is 3.65m high on Lamasquère and 2.85m high on Auradé. A sentence has been added in the manuscript about it: "Each flux site is equipped with 1) eddy covariance systems to measure half-hourly sensible heat flux and evapotranspiration, installed at 2.8 and 3.65 meters above the soil at Auradé and Lamasquère, respectively" The tower location and data filtering insures that the footprint is totally included in the field when data are available, in accordance with the Carbo-Europe and GAG-Europe experimental protocols. Thus the vegetation in the footprint is homogeneous. A paragraph has been added to the section 2.2.3 to explain the filtering criteria: "These scalars are measured at 20 Hz and are integrated over 30 minutes to generate surface fluxes according to CarboEurope-IP flux computation and filtering procedures (Aubinet & al., 1999, Béziat & al, 2009). Thus, flux data (NEE, LE and H) were filtered to remove outliers and out of range data. We applied the recommended filtering criteria concerning 1) periods of low turbulence and tests on stationarity (Papale et al., 2006; Reichstein et al., 2005) because the Eddy Covariance assumptions are not fulfilled in those cases; 2) periods of rain because they disturb the signal of both the open path analyser, and the sonic anemometer, and 3) eventually, the spatial representativeness (footprint) of the fluxes. For this third filter, a fetch including 90 % of the flux was computed with the Kljun & al. (2004) model for each half-hourly EC flux value (F-90).Then, this fetch was compared with the distance between the mast and the edge of the plot in the main wind direction (D). If F-90>D, fluxes were discarded because we assumed that it was not sufficiently representative of the plot." These measured fluxes were compared to the modeled fluxes at the field scale. This field scale approach for the simulations is described in the answers below. It is also more accurately described in the new version of the paper.

Anonymous Referee #1: “3) Why are you not running ISBA at finer spatial scales? If you have remote sensing observations at 8 m resolution you can use ISBA at finer spatial scales than 1 km. The use of ISBA at finer spatial scale may help a lot to understand the effect of land cover heterogeneity on land surface fluxes. In this way, you can use properly the remote sensing observations at 8 m spatial resolution“

Authors: As presented in the abstract, the introduction and the section 3.1, we used a field scale approach for both our experiments. This approach constitutes the novelty of the study. It consists in doing simulations on an irregular grid where each calculation cell is a parcel, geolocalized by its centroid, defined by a polygon and associated to homogeneous vegetation (PFT). These plots are the ones determined from the Formosat-2 land cover maps (with GDAL_polygonize). The field scale seemed to us like a pertinent working scale for two reasons: - It is a coherent functional landscape unit with homogeneous vegetation dynamic and thus hydro-meteorological behavior. - It allows exploiting the high spatial resolution of Formosat-2 while limiting the calculation time compared to a pixel based approach at the resolution of Formosat. Running at 8m resolution is beyond the scope of the study and computationally intractable for such a large area. Efforts have been done throughout the entire manuscript to make this point clearer to the reader.

Anonymous Referee #1: “4) Figure 4: What is the spatial scale?”

Authors: This figure represents the study area which is a square with a 24km side. The scale has been added to the figure (cf. figure at the end)

Anonymous Referee #1: “5) Fig. 5. What is the aggregation scale for comparing LAI values? ECOCLIMAP-II database (1 km resolution) and Formosat-2 database (8 m resolution) are providing different LAI values at the same scale.”

Authors: As described in the answer to your point 3), both our experiments were done at the field scale. The Formosat-2 LAI was calculated by averaging the pixel values in each plot. An erosion was applied to the plots, with a 16m value (twice the size of the Formosat-2 resolution) to avoid border effects and geo-location uncertainties of the remote sensing product. The method of LAI retrieval is now more accurately described in the section 2.2.1. Each ECOCLIMAP-II grid cell is described by a composition of vegetation types (patches, Sect. 2.1). Each patch has its own LAI cycle derived from MODIS products (Faroux et al. 2013). In the reference simulation, the patches and corresponding LAI values for each field are taken from the nearest ECOCLIMAP-II regular grid cell (with a 1km resolution). Hence the comparison between the two experiments is done on each field by focusing on the same patch (i.e. the one given by the Formosat-2 land cover map). A sentence has been added in the section 3.2 to explain this: "Each plot has a unique patch in the FORMOSAT experiment, forced by the land cover map. Thus only the corresponding patch was taken into account when comparing with the ECOCLIMAP experiment. In the spatial comparison, if the corresponding patch was not present in the combination of patches of the plot, then this plot is excluded of the results. By this way we are sure that we can compare the fluxes on specific vegetation types. "

Anonymous Referee #1: “6) Figure 5 and 6. You need to show the comparison results for all the simulated period (2006-2010) not just one year. Are the hydrometeorological conditions the same for all the years. Typically Mediterranean regions are characterized by strong interannual variability, hence it is very interesting to evaluate it. in this way you can see the impact of the interannual variability of rainfall seasonality on LAI and fluxes.”

Authors: The figures 5 and 6 are only meant to support a discussion on the ongoing processes affected. Of course the comparison has been done over the whole period and leads to the same conclusions. A year-to-year variability is visible due to the changes in agricultural practices, which are closely related to the climatic conditions of the year. The tables 2 and 3 summarize these results by showing the correlation coefficient and the root mean square error between each experiment and in-situ measurements for both sites. It points out a systematic enhancement of the scores with amplitude depending of the year. Indeed, if the ECOCLIMAP-II LAI dynamic is closer to the measured and remotely sensed ones, the improvement is weaker and inversely. A sentence about this issue has been added in a new discussion section (Sect. 5 in the new manuscript): "The dependence on the year for the results on evapotranspiration (Fig. 7) may be justified by the climatic conditions of each year. Indeed, climatic conditions influence the farmers' decision concerning the seeding and/or harvest dates. If these dates are closer than the ones simulated by ECOCLIMAP LAI, the effect on evapotranspiration is weaker."

Anonymous Referee #1: "7) I'm not sure about figure 7. If you are modeling at 1 km spatial resolution, how can you simulate fluxes of specific cultivations (e.g., wheat, maize-sorghum, etc.)? in a 1 km grid cell you have more than 1 specific cultivation."

Authors: As said in the previous answers, we have done the simulations at the field scale. In the reference simulation, each field is represented by a combination of the 12 patches available in SURFEX. ISBA simulates the fluxes on each patch separately so you can choose each of these patches when you interpret the results. To compare on a specific cultivation, you just have to choose the corresponding patch in the results of the simulation. As describe in our answer to your point 5), a sentence has been added to clarify this point.

Anonymous Referee #1: "8) I'm trying to understand how SURFEX using ECOCLIMAP and SURFEX using FORMOSAT (and GDAL polygonise) are modeling each land cover component. Please, add information and explanations. "

Authors: The answers to your previous comments may have given you the answer to this one. In the reference simulation, the forcing of ECOCLIMAP-II is taken from the nearest regular grid cell for each vegetation type (patch). All these patches are simulated separately by SURFEX so you can focus on a specific patch for the results. For plots belonging to the same ECOCLIMAP-II grid cell, only parameters given by another set of forcing data than ECOLIMAP-II may change. It may be the case of the soil parameters or the meteorological forcing if they are not superposed to ECOCLIMAP-II. Also, the initialization of the soil temperature and water content may not be the same for all these plots. Indeed, our simulation grid changes every year as the land cover map changes too. Thus the plots are not exactly the same from year to year due to the polygonal segmentation with GDAL. To initialize the soil temperature and water content for each plot and each year, we use an interpolation using the inverse distance method on the 9 nearest neighboring plots in the previous year grid. To initialize the first year of simulation, we have done a simulation on the same grid but using the meteorological forcing of the year before. Your comments let us think that our manuscript was probably not clear enough regarding the use of the crop field as a computation unit. We hope that our explanations and the modifications made to manuscript have clarified this point in particular, despite the relative complexity of the unusual way we use SURFEX-ISBA. We think that your comments helped improve the clarity of the paper. We thank you again sincerely for your evaluation of our work.

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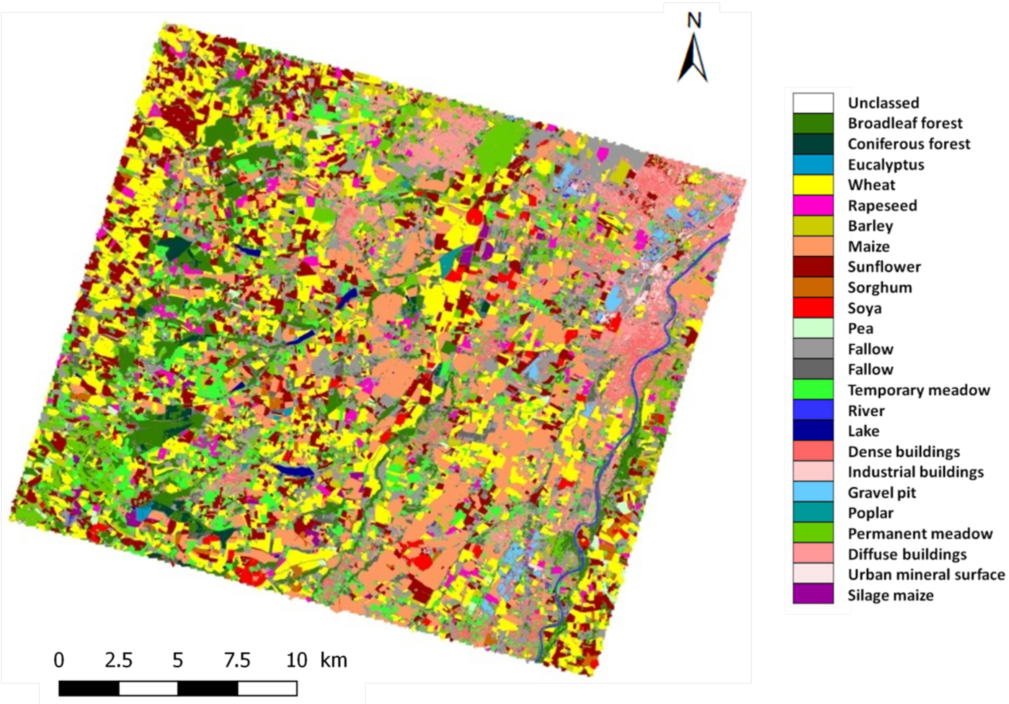
N
0 2.5 5 7.5 10 km
Unclassed
Broadleaf forest
Coniferous forest
Eucalyptus
Wheat
Rapeseed
Barley
Maize
Sunflower
Sorghum
Soya
Pea
Fallow
Fallow
Temporary meadow
River
Lake
Dense buildings
Industrial buildings
Gravel pit
Poplar
Permanent meadow
Diffuse buildings
Urban mineral surface
Silage maize

Fig. 1.