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Interactive comment on "On the use of high resolution satellite imagery to estimate irrigation volumes and its impact in land surface modeling" *by* Jordi Etchanchu et al.

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Dear Referee,

We would like to thank you for your review. It mainly points out that we have not been clear enough on the scope of the study (water management at the landscape scale) and opened too much the discussion on the global scale. Please find hereafter answers to your comments:

"1.) One essential improvement mentioned several times by the authors very prominently is the consideration of the Leaf Area Index (LAI) detected by processing high

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resolution satellite imagery from several sensors. However, the authors miss completely to describe why this is needed and why using LAI is better than using other vegetation indices that are easier to calculate."

We used LAI for 2 reasons. Firstly, SURFEX-ISBA uses LAI as input, like most LSMs, which assumed this variable to be representative of the transpirating area of the plants. Determining LAI instead of simpler vegetation indices is thus necessary. Secondly, we have reference values about measured LAI at the phenological stages mentioned in the study. As the LAI was necessary for computational reasons, it was natural for us to also take it to determine irrigation rules. But we agree that simpler vegetation indices could be good drivers of surfaces processes, such as ETR or Photosynthesis.

"The authors used imagery with a high spatial resolution (10 - 20 m) and a high revisiting time 3-5 days (page 8, line 5). With the help of the neural network tool BV-NET they derive LAI from reflectance values. After that, they averaged the derived LAI spatially for the plots compared in the study and also averaged the values in time to derive monthly values used in the LSM. I don't understand why such an effort is made when later the data will be averaged."

The LAI is averaged spatially at the field scale, which is here considered homogeneous, to save computation time and keep the interest of the high resolution by remaining on cells of simulations composed of a single species (opposed to mixed grid cell), as presented in our previous study (Etchanchu et al., 2017) In addition, the plot is the irrigation management unit. The temporal averaging is done essentially for technical reasons. SURFEX simulations are heavier to perform with daily forcing of the surface parameters. Simulations with decadal forcing could be envisaged. But the study mentioned previously also showed that monthly forcing of LAI is sufficient to increase significantly the simulated fluxes accuracy compared to using climatologies.

"Furthermore, deriving LAI from reflectance requires to know about the characteristics of the crop grown in the field (canopy architecture, leaf angle, crop height). This

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information is not available for large scale studies and using standard crop parameters introduces a considerable uncertainty into the LAI calculations. I'm therefore not convinced that using the LAI results in any improvement compared to the use of other vegetation indices that can be much easier computed with lower uncertainty such as NDVI or EVI."

As written above, the LAI is necessary for SURFEX. LAI calculated with BVNET is one of the best products already available on our study area and that is why we use it. By the way, new Copernicus products offer dynamic LAI at global scale at a resolution of 300m (https://land.copernicus.eu/global/products/lai).

"2.) I doubt that the methods used by the authors are appropriate for large scale application of the model. Many characteristics described by the authors, for example in section 3.1 (LAI when irrigation of maize starts, end of the irrigation period 45 days before harvest, irrigation rate, minimal return time), are only representative for maize grown in Southern France and I don't see any way to gather this information for other regions and other crops. Therefore I doubt that the approach is generic enough for global scale applications, an objective postulated by the authors."

We have not been clear enough on the scope of our study and are sorry for this. Global scale application is not an objective of this study. We aim at proposing ways to better simulate irrigation at landscape scale, essentially for water management applications. At this scale, agronomical models are too complex as they need many more inputs than Land Surface Models. The irrigation scheme development presented in the study only consists in giving a liberty degree on fixed irrigation parameters already present in the model. Determining values other than climatological values can be achieved by exploiting both technical documentation on crop management, given by government or private services in charge of agricultural management in the simulated area, and remote sensing data. The remote sensing data allows applying theoretical irrigation practices, which often depends on crop phenological stages, with the actual phenology of the crops.

"3.) Timing of irrigation and irrigation volume is derived in the present study mainly by considering LAI dynamics and the simulated actual soil moisture content. The authors show that using variable thresholds for the soil moisture to trigger irrigation events results in more realistic irrigation amounts for the region studied. However, again I'm not convinced that this finding can be generalized. In many other regions the timing of irrigation is fix and just determined by the water rights of the farmer. Furthermore, when irrigation water is free of cost and provided by big irrigation canals, farmers do not have any motivation to save water and consequently, they will use all the water that is supplied. This is completely different from situations where farmers pump their own water. Here farmers are more flexible but have to pay for energy and therefore tend to use less water."

Many agricultural areas in the world face or will face water management issues, especially in a changing climate context. This study shows that for such landscape scale applications, instead of taking climatological values for the irrigation parameters, expertise from agricultural management agencies can be used and spatialized by the mean of remote sensing data, leading in a more realistic estimation of the irrigation.

"So my general impression is that the authors managed very well to adjust the model to better reflect the specific situation in the region which they studied and to improve thereby the accuracy of the model results. However, this is on the expense of more complexity and an increasing number of assumptions and parameters. I don't see how the authors can manage to derive and implement this background knowledge at global scale. Consequently, because of these limitations, I see the risk that the authors turned their global scale LSM into a more detailed model that can only be applied successfully at regional level when all the background information is available."

As mentioned above, the number of parameters of the irrigation scheme is not increased as all the parameters already exist in most LSMs: irrigation period, dose, minimal return time, application time, triggering threshold. They are determined on the form of fixed climatological values or from other model variables. We just give them a

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liberty degree. This way, users can keep using default values but can also use more precise information if available. The particular values presented in this study are indeed adapted to maize crops. But the general methodology can be applied on every agricultural area where technical documentation about crop irrigation management exists. Such information is increasingly available on many regions. On regions with lack of such documentation, calibration should be performed instead of making assumptions on the triggering threshold. The data to calibrate on would be irrigation dates and dose. Such data can be obtained by questioning farmers, monitoring several representative plots in agricultural areas or from agencies in charge of agricultural management in the area. Calibration on surface soil moisture from high spatiotemporal resolution micro-wave remote sensing products, such as the surface soil moisture derived from Sentinel-1 data, could also be envisaged. Global scale simulation is not the scope of the present study but we aim at presenting a methodology to increase irrigation simulation accuracy at landscape scale with the help of high resolution remote sensing.

We hope the answers given meet your expectations. If any other question arises, we will be glad to answer it.

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