Dear Editor,

Please find below a point to point answer to the referees questions with the detail of modifications brought to the manuscript.

I thank you for the time you spent to handle this manuscript.

Sylvain ferrant

Subject: Answer to the referee #1

General comments:
The goal of this paper is to evaluate whether or not there is a significant gain of using LAI derived from RS on the simulation of water and nutrient fluxes at the watershed scale using an agro-hydrological model. This is a relevant scientific question and it is well aligned with the scope of HESS. Many studies already show that the assimilation of RS data in crop models improved a lot the model performance, especially when input parameters are not readily available. However, most of these previous studies have been done at the field scale, and the impact of RS data assimilation at the watershed scale has not been fully investigated.

In this paper the authors try to fill this gap by using a coupled model (STICS crop model and TNT hydrological model) on a small experimental watershed well instrumented. The results of the studies are well presented although the figures appear quite small and difficult to read in some cases (especially figures 1, 5, 6, 7 and 8). The results clearly show that the use of the LAI derived from RS data to re-initialize the seeding date improved the model performance for simulating crop yields and Nitrogen fluxes at the watershed scale. However, I have a comment concerning the initialisation and optimization of seeding date. The authors chose to compare two situations: simulations with a priori seeding date versus simulation with optimized seeding date. The author should clarify what is or what are the a priori seeding date(s). Is there a different date for each field or is it the same date for all fields with the same crop?

We answered to this question by adding a paragraph in material and methods to define what was called "a-priori" seeding dates:
Page 6 line 25:
"A priori" seeding dates were selected on the basis of farmer's annual enquiries. Only crop field owning to a member of this association and located within the municipality area are concerned. Yields are also collected but often correspond to an average yield of several and unidentified crop fields. This data base is not exhaustive: for example, in 2006, only a third of the seeding dates are recorded for the whole municipality area, none of the corresponding crop fields are included in the experimental catchment. In 2007, seeding dates of 18 crop fields among the hundred composing the catchment area are recorded. Expert opinion rules were used to fill the gaps of this data base. For one year, each missing seeding date is estimated by using the average seeding date recorded for the crop fields owned by a farmer. If no seeding date is recorded for a crop field belonging to the farmer, the average of recorded seeding dates, computed for the crop type (Wheat or Sunflower) and the year, is used. In this area, recorded winter wheat seeding dates could vary from the beginning of September to the end of November and sometimes even December. Sunflower seeding dates vary from the middle of March to the end of April. This data reconstruction on expert opinion rules aimed at finding appropriate seeding dates in relation to farmer behavior and climatic years.

In the material method it is mentioned that some dates are collected using field surveys. If these dates are used in the a priori simulations it should be clearly mentioned in the material and methods section because it has a significant impact on the results/discussion section. Indeed, I think that the authors should indicate if the improvement of LAI and biomass predictions was higher for fields with deduced seeding than for fields with actual seeding date? For fields with actual seeding date, are the optimized dates similar to the actual dates? If not, that could mean that the crop growth parameters are not well calibrated.

We have added a paragraph in the results section which presents the comparison between "true" and optimized seeding date, when it is possible:
Page 12, line 13:

"In 2007, 8 and 10 seeding dates for respectively winter wheat and sunflower crop field were recorded within the experimental catchment. The average difference between estimated and actual seeding date in 2007 is 20 and 8 days for respectively wheat and sunflower crop. It goes from 1 day to 1 month and 1 to 17 days for respectively wheat and sunflower. Three factors are behind these heterogeneous differences: inappropriate cultivar growth parameters; non accurate detection of emergence period by biased LAI interpolation from remote sensing; uncertainties behind farmer statements which are completed at the end of each year."

and another paragraph in the discussion result regarding the uncertainty behind the crop growth parameters:

page 14 line 36

"More generally, crop variety is not recorded in agricultural data base. In this specific study site, several varieties were recorded which were not pre-calibrated in the STICS model. The estimation of a "true seeding date" at catchment scale is accordingly not possible at present."

I think that these modifications can be easily made, so I recommend a minor revision.
Finally, I would like to mention that if the authors continue their work on this subject, it could be interesting to add a third scenario using average seeding date for the region (without using the dates collected in the field surveys). Indeed, in many occasions, agro-hydrological models are applied over large areas using rough estimates of seeding date based on regional recommendation. I suspect that in that case the improvement of simulation results would be much larger than those found in this study. A sensitivity analysis of the model concerning the seeding date would also be an inter sting complement to this work.

We agree with the referee and have added a small paragraph to explain that in the discussion section.

Page 14, line 20:

"The improvement achieved from the "*a priori*" situation constructed from the local database would have been made more evident by constructing a seeding-date scenario based on regional recommendations. This could be done in future applications at larger scale, e.g., by considering ground coverage of complete Formosat-2 scenes."

Specific and technical comments:
P7691 l14: ... a temporal...
P7694 l24: Please explain what AET means. Is it actual evapotranspiration? Page 7 line 17, AET is defined as actual evapotranspiration

P7695 l12: authors
P7695 l17: do you mean crop growth input parameters or crop management input parameters? Or both?
Page 4 line 12:
"crop management input parameters (seeding date and density) and soil input parameters (field capacity) in the functional crop model STICS"

P7695 l23: Dedieu et al., 2006 is missing from the references Dedieu 2007 has been added.

P7696 l5-6: "...physical knowledge-based base agro-hydrological models..." not clear.
Please rewrite. We choose the term functional.

P7696 l6: Please explain what HTSR means. Page 4 line 34 High Temporal and Spatial Resolution

P7696 l20: ...the way to shift...
P7701 l 19: a bibliographic reference is missing. There was no reference at all

P7702: Could you please indicate in section 2.4 witch method is used to calculate the potential evapotranspiration (Penman, Penman-Monteith, Priestley-Taylor,...) Penman-Monteith equations (page 9 line 6)

P7702 l19: crop emergence
P7703 l15: check the brackets. They do not seem well positioned.
P7704 l8: Nash and Sutcliffe reference is missing.
P7704 l11: ... in Ferrant et al. (2011, 2013), Page 10, line 3
. . .
P7707 l5: the re-initialization instead of the reinitializing
P7708 l6: seeding date re-initialization
P7708 l17: re-initialization instead reinitializing
P7710 l1: is it really NNE-SSW? On fig 8 it seems to be WNW-ESE. Page 13 line 36

P7710 l14: I recommend removing "about" in subtitles 4.1 to 4.5. done

P7710 l18-20: "In the study ... crop productivity" This sentence is not very clear. Could you please rewrite it.
Page 14 line 9
"In the context of the present study, Leaf Area Index and biomass are highly variable in space and time and within crop field. The high spatial resolution (around 10 to 20 meters) is sufficient to capture the spatial variability of crop productivity."

P7712 l15: STICS instead of TICS.
P7712 l21-22: It is true that the results showed that the re-initialization of the seeding date does not affect significantly the simulated water fluxes. However you also showed that AET was not very well simulated. So, I think that you could add a sentence saying that an improvement of AET simulation is needed in order to better evaluate whether or not the seeding date re-initialization has an impact on water fluxes.
Page 15, line 28
Nevertheless, an improvement of the AET simulation is still needed to confirm this result.

P7713 l9: hydrologic and atmospheric systems.
P7713 l10: a space is missing between "input" and "(crop field level)"
P7713 l16: other input parameters
P7714 l18: "physical knowledge based crop model (STICS)". Could you please use the same description throughout the text. I recommend to use "process-based model" for STICS.
Page 16, line 32
"The use of a process-based crop model (STICS) coupled with a"

Fig. 6: in the material and method section it is mentioned that some seeding dates were initialized using field surveys and missing dates were deduced. Is it possible to identify in Figure 6 what are the actual dates and the deduced dates?
As the seeding date from the field survey and the optimized seeding date do not have much reason to be equal as cultivar parameters have been fixed in this virtual experiment, we do not want to make the reader thinking that our method is able or not able to deduce the true seeding date.

Fig.7: I am not sure that it is relevant to show the interpolated LAI in 2008 since there was not enough data to make a good interpolation.
As this manuscript describes the technical approach, we think it is relevant to show its limit; this figure shows that a good sampling frequency of the landscape is needed to apply the method.

Referee 2:

This is an interesting article. I have only a few minor suggestions of modification detailed below.

1. There are some remaining typo and grammar mistakes that should be corrected. A few sentences need rephrasing. Correction by native English could be useful.

We have sent the manuscript to a professional English translation service: http://www.guybray.com/

2. P. 7696, L. 6: Define "HTSR"

HSTR means "High Spatial and Temporal Resolution", which stand for the decametric spatial resolution of satellite images that will be acquired for short time of revisit.

3. P. 7698, L. 7: Which PE formulation is used?

The PET is computed from Penman-Monteith equations.

4. I felt a bit lost in the period used for analysis: several similar periods are used throughout the text (2006-2010 p.7698L12 and elsewhere; 2005-2010 p.7698L22; 2006-2012 p.7698L25). Does this need harmonization or are these differences justified? (in which case this should be further explained)

The reviewer point out a problem that we will clarify in the abstract:
Page 1 line 26
And in the material and method: page 10 line 4 to 6
"we evaluated the simulations for the period 2005-2010 in terms of hydrological and nitrogen fluxes, as well as the evapotranspiration and LAI/biomass data that were measured in the experimental crop field (Figure 1). We used then the F2 LAI data from 2006 to 2010 to perform the optimization process of the LAI."

5. P. 7701, L. 19: What is "ref?" It has been removed

6. P. 7702, L. 19: Is "emergency" the right term? No it is emergence date

7. P. 7704, L. 9-10: NSE and RMSE are both based on the same model error (MSE).
How were they combined here?
We have been more specific page 9 line 40 :
"The Nash-Sutcliffe efficiency coefficient (Nash and Sutcliffe, 1970) was used as an optimization criterion to minimize mismatching for the daily discharge and nitrogen fluxes; RMSE was also used as a second performance indicator."

8. P. 7705, L. 7-14: Model performance appears quite poor. Are there explanations for that?
We added a paragraph page 10 line 35
"The comparison between the two similar agro-hydrological models SWAT and TNT2 suggests that one major reason behind these poor hydrological simulation performances is the dominant contribution of surface runoff to the discharge, which strongly impacts the NSE (Ferrant et al., 2011). These infra-daily fast transfers are strongly influenced by surface soil roughness, itself severely impacted by the argillaceous material composing the soil (40%). Surface cracking during dry periods and preferential flow paths resulting from soil erosion are not taken into account in the daily estimation of runoff from the TNT2 modeling approach."

9. P. 7712, L. 15: "STICS"
10. Figures: Beware of font size. Some texts are difficult to read in figures (figures 5a, 6, 7, 8, 10).
I have good quality pictures, I hope the online publishing process will improve the final quality of the figures.

11. Fig. 2: The equation symbols should be explained in details somewhere in the article, either in the text or in the figure caption

Page 20, line 12 in the figure caption:
"**The equation describing the growth of the LAI depends on the cumulative daily temperature ΣT. Kn and Kx are respectively the minimum and maximum of the interpolated LAI. Ti and Tf are respectively the cumulative temperature when the LAI reaches Kx/2 during the growth and the senescence phases. Parameters a and b correspond to the local slope of the temperatures Tf and Ti.**"