Answers to Anonymous Referee #1

Reviewer's comments are in **bold**.
Author's answers are in regular.
Author's additions/modifications in the text are in *italic*.

Major comments

1. The sensitivity tests of the model to the change of vegetation parameters are done by tuning LAI, crop/grass height and roots density respectively. And, the author claims the pronounced effect of increasing roots density on soil moisture content calculation. As a sink term in soil water balance equation, the root water uptake is assumed to have such big effects (e.g. less water storage). However, one concern raised on such kind of tuning, while considering the plant biology. The root distribution, root density of certain specific plant should have a certain statistical characters with respect to different soil textures. In the manuscript, there is no such kind of description related to what is the relation between the root density and crop/grass height, which will determine the LAI. This may mislead readers to adjust the parameters as they want to get 'good' results, which may create an alien plant that does not exist on Earth.

In our model configuration, there is no direct relationship between the root density, the height and the LAI for a PFT considered. We made this choice because we want to introduce and test the parameters which are simple and generic for a given PFT. That is why we have not used the module LPJ that simulates the dynamic vegetation (as said in page 5060 lines 12 to 14) in order to represent the link between the aerial part of the plant and the root in the soil. We preferred to limit the influence of each of those parameters linked together on the results when we compare them to the observations.

2. The stations the authors used are from GSMD and include 18 stations which were grass-covered as stated on page 5050 line 20-25. However, on page 5051 line 10-15, the author used Figure 4 to show most of stations are covered by 'C3 crops' instead of 'C3 grass', and pointed out for those stations located in grass land only have less than 10% grass cover. The prevailing type of vegetation is then defined as 'C3 crops'. However, for SECH2 (e.g. use a very high maximal value of LAI for grassland) and SECH3 (e.g. use a reduced height of vegetation which is more realistic to represent a grass cover), it seems to me that the author pay attentions only to grass cover instead of 'C3 crops'. Could the author explain in details about this choice? or Could the author add more discussion about SECH2 & 3 in regards to 'C3 crops'? It would be better to list what are the values pattern of LAI, PFT types, crop/grass height and roots density for different simulations (SECH1, 2, 3 ...etc.).

We were not clear enough to define the PFT choice we made to start our study for comparison with observations. In order to better explain the methodology, we modify the text from line 8 to 22 of page 5051 (or line 153-176 pages 8 and 9 of the new version):
Initially, the distribution of vegetation in SECHIBA is prescribed by the vegetation map. This distribution is compared with the vegetation cover on which the measurements were performed. Each measurement station is associated with the corresponding grid cell of the model, according to the coordinate of the station (see Table 3 in Appendix) as in Fig.5. The vegetation cover of the map differs from the one on which the measurements were performed (i.e. grass cover). Fig. 5a shows that few grid cells of the model are covered by grassland (grid cells containing stations 9, 11 and 82) and less than 10% of their area is covered by this PFT. The prevailing type of vegetation over Illinois in the vegetation map is the PFT "C3 crops" type. Eight grid cells containing stations are covered by the PFT "C3 crops" at least by 90% (no. 1, 5, 6, 8, 9, 13, 15 and 16) according to Fig. 5b. Consequently, a direct comparison cannot be established between results of integrated

simulated soil moisture over the grid cell and the measurements, until the proportion of one PFT is not above 90%. So the first objective is to gradually transform "C3 crops" PFT (that is prescribed in the model) in "C3 grassland" PFT on these grid cells to be closer to the experimental conditions (Sect. 3.2.1.). This allows a better agreement with the local characteristics of the vegetation cover on which the measurements were performed, and an evaluation of the weight of each parameters that have been modified in the model on simulated soil moisture.

For the control simulation (SECH1, see Table 2), we start the study from the distribution of vegetation imposed by the vegetation map over the eight grid cells containing high proportion of "C3 crops". First, gradual changes of crops parameters (LAImax (SECH2), root extraction parameter cv and crop height (SECH3) are performed. Then, we prescribed "C3 grassland" PFT over all the grid cells (SECH4) and a test of the new ET computation (see Sect. 2.2.3, SECH5) is performed to be closely related to the experimental conditions over a grass cover. At each step, […]

3. For the uncertainty in rainfall forcing data, the author actually just use the in-situ precipitation data instead of that from NLDAS forcing dataset. It is not appropriate to say the uncertainty in rainfall forcing data was analyzed in this way. The uncertainty should account for the reliability of the data (e.g. temporally or spatially), but not just a replace of one dataset by another. This part should be discussed further by using statistics analysis of rainfall data, if the author want to use the same subtitle.

We change the subtitle of section 3.2.2. in "*SWI variation according to precipitation data set*"
We modify the text everywhere we said « uncertainty in rainfall data » and in the beginning of the section we change the text a little bit (line 7 to 9 page 5057 or line 339-343 page 13-14 in the new version):
Precipitation dataset is crucial in soil moisture studies. As mentioned in section 2.1, we have found differences between NLDAS and in-situ observations. Thus, another evaluation of precipitation is tested in this study. NLDAS precipitation data is substituted by the in-situ precipitation, for each station in the corresponding grid cell of the forcing grid. This allows an evaluation of a soil moisture sensitivity to precipitation variation. The impact on soil moisture [...]

4. For section 3.2.3, the method to get measured field capacity. To my understanding, the author use a kind of 'relative' field capacity (here, the 'relative' is used compared to the original 'absolute' field capacity), or an 'effective'/'behavioral' field capacity (e.g. in regards to improve the model performance indirectly by adjusting the observations). Such kind of adjustment may be acceptable for regional application, where researchers can find plenty of in-situ data. However, it is not applicable for global application, which is the purpose of SECHIBA that has bee claimed by the authors as a global Land Surface Model (Page 5060, Line 18). Could the author discuss further this part with respect to the feasibility of field capacity correction in global scale? Is there another way to improve or correct the observation of soil moisture with respect to match the simulation generally?

We agree that the LSM SECHIBA has been developed to be part of a GCM which simulates the climate at global scale. However, the performance of SECHIBA cannot be established at a global scale. To define and analyze the reliability of this model, we are conducted to compare its results to observations at finer scale (regional? local?). During this type of exercise, some discrepancies between observations and models always occur. The difficulty is to understand why those variations exist and to point out how the assessment of field capacity obtained by the two evaluations (model and observations) impact this difference. That is why we have tested another method. The fact that the "observed" soil wetness index is in better agreement points out the relevance of determining field capacity from soil water profiles. To generalize this method, as you mentioned, it is important to have enough data at global scale and to evaluate the method for other regions. This implies a major study out of our possibilities. We think that it will be also an improvement to define an

evaluation of field capacity related to soil texture in the model.

Minor comments

1. Page5041 Line 9-12: It is not a smooth statements here. It is disrupting the context actually

You are right. The following sentence in italic is removed from the text (line 9-12 page 5041 or line 30 page 2 in the new version) :
[…] surface runoff. *Findell and Eltahir (1997) found a correlation between an initial state of soil moisture at saturation and rainfall during summer studying observed data from Illinois. D'Odorico and Porporato (2004) showed a dependence between summer precipitation and antecedent soil moisture conditions.* In climate [...]

2. Page5041 Line 21 as well as other places in the manuscript: 'eighth degree' —> '1/8th'

Corrected in the text

3. Page5042 Line 2: 'but also' —> 'and'

Corrected in the text

4. Page5042 Line6 as well as other places in the manuscript: 'the atmospheric forcing data set NLDAS', NLDAS is the North-American Land data Assimilation System. It is not a forcing dataset. However, you can say 'NLDAS forcing dataset' instead.

Corrected in the text

5. Page5043 Line15: what is the resolution for IGBP vegetation map (1/5th degree or 1/8th degree?)

We add some precisions in the text (line 14-16 page 5043 or page 3 section 2.2.1. in the new version):
[…] *(plus bare soil), prescribed by the 1 km global land cover map (International Geosphere Biosphere Programme (IGBP), Belward et al., 1999) reduced by a dominant-type method to 5 km spatial resolution with the Olson classification (Olson et al., 1983). Maximal fraction* […]

6.Page5046 Line 11: here the FAO soil texture map's resolution is 1/5th degree. How the author deal with different resolution of the vegetation map, soil texture map and the NLDAS forcing dataset in SECHIBA? Please discuss

In fact, this hydrological version do not depend on texture characteristic of the soil. Sorry for this mistake. We correct it in the text. Spatial resolution of the model is given by the forcing (i.e. NLDAS resolution (1/8th degree)) and the vegetation map is interpolated at this resolution.

7.In the model formulations, there is no description on how to determine the relative dryness of the upper soil layer and lower soil layer. What is the definition for them? What is the physics behind them? How to deal with them in SECHIBA?

The upper and lower soil layers have a depth which is defined in the scheme. It is then possible to compute the maximum of soil moisture when they are saturated. The relative dryness is compute as the ratio between the actual soil water content in the layer and the maximum of soil water content. The upper reservoir dries quickly according soil surface evaporation and maximum of root density.

The deeper reservoir is mostly under deep roots water adsorption.

8.Page 5050-5051: Please list each simulation running with its numerical settings on used parameterization schemes, used field capacity, PFT types, LAI, crop/grass height and roots density and so on. In table 2, please add PFT types, LAI, crop/grass height and roots density and so on for each station.

Table 2 is added listing each simulation with its numerical settings.
We don't have these detailed informations for the measurements for each stations so we can not do the same in Table 3.

9.For SECH4, please indicates clearly which type of vegetation is set everywhere the same

For SECH4, we set « C3 grassland » everywhere and not « C3 crops » (see corrected text in response of major comment n°2). We correct in the text, sorry about that.

10. Page 5055 Line 7: ... is not enough pronounced.... —> ... is not pronounced enough...

Corrected in the text

11.Page 5057 Line 13: NLDAS precipitation is lower... ——> 'lower' should be 'higher'

Corrected in the text

12.Page 5058 Line 6: .... we consider that the 0-10cm layer is not representative of the field capacity ....,. Is it true, even after heavy raining? please discuss

It is true that after heavy raining, the 0-10cm layer can be at field capacity. But at monthly time scale, this layer subjected to intense evaporation has a water content very variable. Therefore, field capacity is hardly reached (evaporation + drainage) and this layer can not be representative of the field capacity for the 2-meter soil.
We add in the text line 6 page 5058 (or 364-365 page 14 of the new version):
(we consider that the 0-10cm layer is not representative of the field capacity at monthly time scale).

13. Figure 2, please add P E on the top as equation 5 indicates

Added in the figure and in the legend description.

14. Figure 3, is it completely the same as De Rosnay and Polcher 1998's paper? if so, please ask for permission from them or the journal published it

I have already asked for permission to Jan Polcher who is co-author in both papers.

15. Legend description or legend name should be provided in the figure for figure 4.

Corrected : the titles « C3 grassland » and « C3 crops » are added in the figure.