The reviewers' comments and suggestions are very insightful and help to improve this paper. We really appreciate the reviewers' efforts and time. In the following we respond to the reviewers' comment (which are shown in blue fonts) and indicate the corresponding text revisions in the quotation marks. All the line numbers mentioned in our reply refer to those in the revisions.

Anonymous Referee #1

Received and published: 17 December 2015

The authors developed a stemflow model based on the SSiB model and run it at two sites with contrasting climates to study the impact of stemflow on soil water dynamics and consequent effect on surface energy fluxes. Though stemflow is insignificant in terms of volume, it is hydrologically and ecologically important for the forest and agriculture ecosystems due to its fast penetration through soil, localized and concentrated enhancement of soil water, the efficient transportation of nutrients along with the water, etc. Yet it is missing or taken account of as a component of throughfall in many modeling practices. This paper is valuable to demonstrate the importance of stemflow in a modeling aspect and I think the topic matches well with HESS. The work is of value is also because it is one of few modeling studies and for the first time to my knowledge develops a detailed parameterization. Also the paper is nicely written with clear logics and structure.

My comments and questions would be:

1. More modeling researches could be cited in the introduction paragraph, like Liang et al. (2009) proposed a 3D model in Journal of Hydrology. Also, a more recent review than the 2003 one is now available to cite, which is Levia and Germer (2015) in Reviews of Geophysics.

Reply: Thank you very much for these useful references. We have cited them in the revised manuscript on lines 36 and 31.

2. The authors proposed a new parameterization scheme describing the stemflow generation and its interaction with soil water, which is a very complex process and thus limitations and assumptions of the simple model should be stated or discussed. For example, the rainfall threshold for stemflow initialization is not taken into account and the variation of SLR is not considered.

Reply: Indeed there are many limitations and assumptions to the stem-root flow process in the simple model. We tried to cover them as much as possible in section 5, but may have missed some. So we appreciate the reviewer for pointing them out. In this example, due to lack of comprehensive measurements of stemflow, we have related the amount of stemflow to leaf drainage. Therefore, there is an implicit threshold for stemflow initiation that corresponding to the threshold of leaf drainage. We have stated this more clearly in the revision (lines 76-77). Meanwhile, we did conduct sensitivity tests to assess the impacts due to the SLR uncertainty. We hope this study may inspire others to carry out more comprehensive measurements on stemflow, with which we can further improve our parameterization.

3. Equations (3) and (4) indicate that the amount of root, in terms of root surface and root length, determines vertical and lateral flows. I am wondering if the vertical profile of root distribution taken into account or if a constant value is used. Since the two sites have different vegetation types, the difference in root

profiles may also be an explanation to the contrast of stemflow magnitude in addition to the precipitation intensity mentioned in the manuscript

Reply: The reviewer is right to point out the root distribution issue. In the SSiB model, there is a parameter to account for the root density. However, due to a lack of observational data, we used a uniform vertical distribution. Nevertheless, different root depths were used based on the measurements (100 cm for LHC and 140 cm for HAPEX). We mentioned this in the revision (lines 88-90). In recent years, U.S. Department of Energy has supported a number of projects to measure the root vertical distribution. With more data becoming available, we should be able to more realistically assess its effects. In the discussion section (lines 324-328), we pointed out this shortcoming and suggested further investigations.

4. The sentence "In Eq.(3), ... And horizontal root flow" (lines 5~7 on page 11788) is not precise since the equation does not show that hi is determined by the horizontal root flow. This sentence and the following one implies that equation (6) is derived from equation (3), which is not the case. It is from the conservation of mass instead.

Reply: Thanks for pointing this out. We have changed this sentence as the following (lines 93-94 in the revision): "The changes in root surface water thickness h_i obey the mass conservation principle and thus are controlled by the vertical and horizontal fluxes of root flow."

5. In Lines 14~16 on page 11790, the authors mentioned that the soil moisture of the second soil layer responds faster to precipitation and fluctuates more pronouncedly than that of the first layer. But it seems to me that Figure 2 does not show the difference in the response speed between different soil layers. (If you look at one precipitation event at the end of August, SM2 even did not respond to it.) Regarding the magnitude of fluctuation, it seems that SM2 fluctuates more pronouncedly during the dry season or the seasons with lower precipitation, while in the rainy season (June to September) SM1 shows stronger fluctuations. I think one of the explanations is that SM2 and SM3 are almost saturated in the rainy season.

Reply: Thanks for the reviewer's very careful observation. We have revised the sentences (lines 153-155) as follows: "However, the LHC measurements (Fig. 2) showed that the soil moisture fluctuation was stronger in the middle layer than in the upper layer during the dry season when the soil moisture was not saturated. Fluctuations were not obvious in rainy seasons when SM2 and SM3 are almost saturated."

6. In Figure 4, the overestimation of soil moisture in SM1 and the underestimation in SM3 in spring, can be explained by the missing of other mechanisms like hydraulic redistribution which provides a bypass of soil water through the inside of the root rather than the exterior surface of the root as in the case of stemflow transport.

Reply: Thanks for providing this explanation. We revised the sentences accordingly as (lines 210-212): "The overestimation of soil moisture in SM1 and the underestimation in SM3 in spring may be coupled, due to mechanisms that are missing in our model. This issue will be elaborated further in the discussion section." In the discussion section (lines 321-324) we stated that: "On the other hand, the overestimation of soil moisture in SM1 and the underestimation in SM3 in spring (Fig 4) may be explained by mechanisms like hydraulic redistribution (cf. Brooks et al., 2002), which provides a bypass of soil water through the inside of the root rather than the exterior surface of the root as in the case of stem-root flow transport."

7. The shading area in Figure 5b seems strange to me. I expect that the 50% curve should be enclosed by the shading area since the shading area shows a range from 0 to 100%. Is the shading area plotted by filling the areas between 0% and 100% curves? Or is it produced by a spectra of SLR values? It seems that latter is the case since it is mentioned in Lines 18~19 on page 11788 that the authors "conducted a series of sensitivity test with systematically varying ratio."

Reply: The shading areas are enclosed by the two extremes (i.e., 0% and 100%). Results with other SLR values (not shown) generally lie within these limits but may occasionally fall out of bound, indicating some nonlinearities. We have made it clearer in the revision (lines 190-192).

Some minor revisions: In Table 1, the units of soil tension and hydraulic conductivity are not given. Also, the annual rainfall at LHC in the table is slightly different from what is given in the text. Units in Table 2 and 3 are also missing. Though they are m2/m2 and m3/m3, would be better to show them.

Reply: Thanks for pointing them out. These units have been provided in Tables 1-3. We also revised the annual rainfall in Table 1 from 2316 mm to 2317 mm to be consistent with the text.