

Interactive comment on “Combined measurement and modeling of the hydrological impact of hydraulic redistribution using CLM4.5 at eight AmeriFlux sites” by C. Fu et al.

Anonymous Referee #1

Received and published: 23 January 2016

This paper by Fu et al investigated an interesting question about the important effects of hydraulic redistribution on soil moisture, evapotranspiration, Bowen ratio across eight Ameriflux sites characterized by contrasting climate regimes and multiple vegetation types. To address this question, the authors incorporated Ryel et al.'s (2002) empirical equation describing HR into the NCAR Community Land Model Version 4.5 (CLM4.5). They mainly found that HR is a significant hydraulic flow in wet sites with seasonal dry climate and inclusion of HR into CLM4.5 improved the model-measurement match in soil moisture, evapotranspiration, Bowen ratio particularly during dry seasons. The merit of this study is the integration of empirical data into CLM 4.5 across eight Ameriflux sites characterized by contrasting climate regimes and multiple vegetation types,

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although there are still uncertainty in some parameters. Overall, this paper is a pleasure to read and the results and conclusion are convincing.

Here I have some suggestions to the authors that may help improve the paper: 1) NCAR Community Land Model Version 4.5 (CLM4.5) is a big component in this study. The authors may need to give more information about CLM4.5 by summarizing the main characteristic of CLM4.5. 2) HR could be expressed in different spatial scale (i.e., patch scale and/or landscape scale). The authors may need to clarify this point. Also recent studies show that HR in cases with groundwater are significantly in contrast to the cases without ground water. However, at this time the information about the root depth/distribution, the potential access to ground water is lacked. 3) Indeed, there are some studies which have simulated the magnitude of HR flux itself and also the effects of HR on ET and vegetation. Thus, the authors may change the focus of novelty in this study. Would the novelty of this study focus on the comparison in the eight Ameriflux sites characterized by contrasting climate regimes and multiple vegetation types? Especially the six new sites along the Southern California Climate Gradient where HR has been less investigated? The integration of empirical data into CLM 4.5? 4) HR could also affect vegetation photosynthesis, growth, and dynamics. The results of vegetation dynamics as affected by HR may need to be included. There are also potentially two way interactions between vegetation and HR. 5) The modeling simulations tend to overestimate HR as compared to field studies. There are some studies which argue the dynamics root uptake (compensation) and plant water storage by stems could undermine the magnitude of HR. These points may need to be recognized in some details in the discussion.

Other minors points: Abstract (page 1): there are some sentences which are very similar with those in the main text. The authors may want to rephrase these sentences. line 25: it may be better to specify what the model-measurement match are. Introduction line 1 (page 2): delete soil moisture content since you have already talked about soil water potential gradient. May add isotope since isotope is another major method.

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line 4: may delete “following a precipitation event”. Hydraulic descent generally occur after rainfall events, but not necessarily since in theory hydraulic descent occur as long as soil water potential in the shallow soil is higher than that in deep soil. Line 12: delete “found” and also two “,” Line 13: may need to give more information about dynamics root uptake since some readers (especially the beginners studying HR) may not know this well. Line 15: again, the authors may need to change the novelty of this study. Line 17: the authors may need to add more information about “compensating for other hydrological deficiencies in the default model”. I guess that not too many readers as beginners studying HR know about this. Line 25: add “that” between “show” and “trees and shrubs. . .” Page 3 Line 1: change “use modeling approach, the Ryel et al. (2002) approach,” to “use modeling approach by Ryel et al. (2002)” Line 2: delete “from which HR can be directly inferred”? since it is obvious that the magnitude of HR flux is determined by soil water potential gradient (soil moisture) based on Ryel et al. (2002) approach Page 4 Line 9: what is the time scale of vegetation dynamics in CLM4.5. Or do you keep vegetation dynamics static in the model? Line 27: change “for” to “because of” Page 6 The results about figure 1: some points may need to be clarified. First: is the soil moisture reported as the daily or 30 min value? Second: when I analyzed the soil moisture value in the shallow and deep soil with and without HR for US-SRM, there is clearly hydraulic descent. But when looking at the soil moisture value in the shallow and deep soil with and without HR for US-Wrc, the red line (without HR) is consistently lower than the blue line (with HR) for some period (may be dry seasons when HR is significant), which means that hydraulic lift (HL) occurs across all the soil profile (0-230 cm). This is in contrast to what is shown in figure 3. Page 7 Line 4: change Table 6 to Table 5? Since the authors showed Table 6 before Table 5 in the result section Line 18: sap flow measurements are usually done for individual trees (patch scale). The authors may need to check whether Scott et al (2008) report the values of HR for individual trees (patch scale) or landscape scale. Line 25: the authors may want to present the results to appendix. Page 10 Line 16: while doing sensitivity analysis, the range of CRT (0.1-1.5) seems to be large with an

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order of magnitude. Did the author try other values with narrower range (say 0.4-0.8)? The study “Modeled hydraulic redistribution in tree-grass, CAM-grass, and tree-CAM associations: the implications of Crassulacean Acid Metabolism (CAM).” shows that HL is not sensitive to CRT with narrower range. Line 23: change “Measurement and modeling both” to “Modeling simulations”? since HR is not directly measured in this study. Page 11 Line 8-10: change “The US-Wrc panel in Fig. 4 also shows. (It is worth noting that the CLM4.5+HR model does not include the temperature fluctuation-driven vapor transport within soil shown by Warren et al. (2011))” to “The US-Wrc panel in Fig. 4 also shows., although the CLM4.5+HR model does not include the temperature fluctuation-driven vapor transport within soil shown by Warren et al. (2011)”? Line 12: change 2 m to 2000 mm Line 13-15: change the sentence “Hydraulic descent is limited, averaging 5.0 mm H₂O yr⁻¹ during 1999-2012, perhaps because soil moisture is higher with depth, limiting the driving gradient for hydraulic descent. ” to “Hydraulic descent is limited with the average values being 5.0 mm H₂O yr⁻¹ during 1999-2012”? If soil moisture is higher with depth, HL would occur. Line 25: may need add reference about bedrock if it is available. Page 13 Line 2-4: the authors may need to give more information about “deep water uptake” (Markewitz et al., 2010), “HR representation models” (Amenu and Kumar, 2008; Quijano and Kumar, 2015) or rephrase “deep water uptake” and “HR representation models”. At this time, there are not clear.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., doi:10.5194/hess-2016-24, 2016.

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