We thank the reviewer for his/her diligent effort to help improve the manuscript. In the following please find our point-by-point response to these comments, marked with a “R:”

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.

R: The following texts have been added in the revised manuscript to describe the characteristic of CLM:

“Surface heterogeneity in CLM is represented using a nested hierarchy of grid cells, land units, snow/soil columns, and plant functional types (PFTs). Different PFTs differ in physiological, structural and biogeochemical parameters. Within each vegetated land unit, multiple columns can exist, and multiple PFTs can share a column; vegetation state variables, surface mass and energy fluxes are solved at the PFT level, and soil parameters and processes are solved at the column level. Surface fluxes at the grid cell level (e.g., ET) are the area-weighted average across different components (PFTs, columns, and land units).”

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.

R: For the scale, we have explained the routine practice in applying land surface models to a site and try to avoid calling it a specific scale, namely, “At each study site, the simulations were implemented for the footprint of eddy flux tower” (lines 5-6, page 4).

The following sentences have been added to illustrate the root depth/distribution information and the potential access to groundwater:

“There are ten active soil layers in CLM, and a maximum depth of 3.8 m is used in this study (Table 3). The PFT-level root fraction *ri* in each soil layer is,

 (1)

where *zi* is the depth at the bottom of soil layer *i*, and *z*0 is zero. The PFT-dependent root distribution parameters *ra* and *rb* are adopted from Zeng (2001). From Equation (1), *ri* decreases exponentially with depth. In the present study, roots did not have access to groundwater through the simulation periods at all sites except US-Wrc where groundwater could rose into the tenth soil layer during the wet season. However, the groundwater level was below the tenth soil layers during dry season when HR occurred at the US-Wrc site as shown in Results section 3.1.2” (lines 8-16, page 4).

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?

R: To clarify this, we revised the corresponding sentences in abstract and introduction sections:

Changed from: ‘few (if any) has tackle the magnitude of the HR flux itself or the soil moisture dynamics from which HR magnitude can be directly inferred’, to: ‘few (if any) has done cross-site comparisons for contrasting climate regimes and multiple vegetation types via the integration of measurement and modeling’.

In introduction section:

Changed from: “However, most of these studies focused on how including HR might improve the model performance in simulating ET and in some cases soil moisture, and few (if any) has tackled the magnitude of the HR flux itself or the soil moisture dynamics from which HR magnitude can be directly inferred. It is not clear from these previous studies whether the HR-derived model performance might be caused by HR compensating for other hydrological deficiencies in the default model” to “Currently, few (if any) has investigated the effects of HR on land surface water and energy cycles in a comprehensive manner by using both the monitoring and modeling methods for contrasting climate regimes and multiple vegetation types”;

Changed from: ‘The objective of this study is to examine the performance of a commonly used modeling approach, the Ryel et al. (2002) approach, in capturing the magnitude of HR flux and/or soil moisture dynamics from which HR can be directly inferred’, to: ‘The objectives of this study are to investigate the impact of HR on land surface water and energy budgets based on both observational data and numerical modeling, and to explore how the impact may depend on climate regimes and vegetation conditions. Observed soil moisture at the six Southern California Climate Gradient sites was corrected for temperature first, and then HR signal was checked using the wavelet method. The modeling investigation is done through incorporating the HR scheme of Ryel et al. (2002) into the NCAR Community Land Model Version 4.5 (CLM4.5). To apply the hybrid model to the eight AmeriFlux sites, we first examined the performance of the hybrid model in capturing the magnitude of HR flux and/or soil moisture diel fluctuation from which a reasonable HR flux magnitude can be directly inferred; we then analyzed the role of HR in the water and energy cycles. The sensitivity of the modelled HR to parameters and the uncertainty in the modeling were also investigated in the present study. (lines 1-9, page 3)

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.

R: Vegetation dynamics is simulated in our following-up study that investigates the influences of HR on plant growth and more importantly on carbon/nitrogen cycles. Interestingly, for the HR impact on surface water and energy budgets, the results based on dynamic vegetation (which are being included as supplemental materials for our follow-up paper on carbon and nitrogen dynamics) are qualitatively similar. In the present manuscript however, we stick to the prescribed LAI so that the model and observational data pertain to the same vegetation conditions. However, in response to this comment, we have added the rationale of using prescribed LAI:

‘More subtle and interesting sources of uncertainty also likely influenced the model-measurement match. For example, strong inter-annual variation of precipitation, fire, and recovery from fire caused rather abrupt changes of PFT coverage and LAI at the US-SCs site. The US-SCg site is undergoing restoration to a native grassland community, and a large community of ephemeral annuals comes up following winter or summer rains at the US-SCc site. These variations were difficult to capture by satellite remote sensing data but undoubtedly affected soil moisture and ET in interesting ways. Without detailed ground-observational data to quantify them, simulations in this study used a climatological LAI seasonal cycle’. (lines 7-13, page 13)

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.

R: we had calibrated and analyzed the magnitude of the HR flux in the present study, as shown in the method (lines 14-20, page 5) and results section (section ‘3.1.1 HR flux simulations’).

The influences of the dynamic root uptake and plant water storage by stems on HR simulation have been mentioned, and two more references have been added in the discussion section in the revised manuscript, as

“In addition, the effects of several important factors warrant further investigation, including for example the root architecture (Yu and D’Odorico, 2014), dynamic root water uptake (Zheng and Wang, 2007), deep tap roots (Markewitz et al., 2010), above ground storage capacity (Hultine et al., 2003), temperature fluctuation-driven vapor transport within soil (Warren et al., 2015), and macro-pore flow (Fu et al., 2012,14). It is also important to compare different representations of HR models (Amenu and Kumar, 2008; Quijano and Kumar, 2015) to examine uncertainties related to model structure. (lines 23-28, page 13)

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.

R: we have done some slight revisions to the abstract.

line 25: it may be better to specify what the model-measurement match are.

R: It is now specified that the match is for “evapotranspiration, Bowen ratio, and soil moisture dynamics”.

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.

R: Some former studies did monitor soil water potential or soil moisture only, so we decided to keep both variables. Isotope method and corresponding reference have been added.

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.

R: We have specified it to be “usually following a precipitation event” (line 5, page2).

Line 12: delete “found” and also two “,”

R: “found” and corresponding colon have been deleted in the revised manuscript.

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.

R: The following annotations have been added to illustrate the dynamic root uptake, “(preferential uptake of moisture from areas of the root zone where moisture is more available, Lai and Katul, 2000)”. (lines 15-16, page2)

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.

R: we have deleted this sentence during rephrasing the novelty of the study.

Line 25: add “that” between “show” and “trees and shrubs: : :”

R: Added.

Page 3 Line 1: change “use modeling approach, the Ryel et al. (2002) approach,” to “use modeling approach by Ryel et al. (2002)”

R: we have deleted this sentence during rephrasing the novelty of the study.

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

R: What was ‘inferred” here is the validity of the magnitude of HR, so we are apt to keep it unchanged.

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?

R: In the revised manuscript, we have added: ‘The plant growth and carbon / nitrogen cycles were not simulated in this study. Instead, LAIs for each PFT were prescribed based on observational data’. (lines 1-2, page4)

Line 27: change “for” to “because of”

R: Changed to “due to”.

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.

R: ‘at daily time scale’ has been added to illustrate the time scale in Fig. 1. (line 22, page 6)

Actually, the red line (without HR) is NOT consistently lower than the blue line (with HR). The red line (without HR) was lower than the blue line (with HR) above 29 cm and was higher than the blue line below “49 cm” during dry periods at US-Wrc site, illustrating hydraulic lift from below 49 cm to above 29 cm, and it was consistent with what was shown in Fig. 3.

Page 7 Line 4: change Table 6 to Table 5? Since the authors showed Table 6 before Table 5 in the result section

R: The sequence of the Tables has been corrected.

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.

R: Scott et al (2008) reported the values of HR for landscape scale/ecosystem scale, and we have added “at ecosystem scale” in the revised manuscript. (line 8, page 8)

Line 25: the authors may want to present the results to appendix.

R: we have presented the results as Fig. S9 in appendix.

Page 10 Line 16: while doing sensitivity analysis, the range of CRT (0.1-1.5) seems to be large with an 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.

R: As shown in Fig. S10, the modeled HL was sensitive to CRT even with a narrow range, such as 0.5-0.75.

Line 23: change “Measurement and modeling both” to “Modeling simulations”? since HR is not directly measured in this study.

R: we have changed “Measurement and modeling both” to “The cross-ecosystem comparisons” in the revised manuscript.

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)”?

R: The contents in parenthesis are for information only, and are not closely related to the preceding sentence. So no change has been made.

Line 12: change 2 m to 2000 mm

R: Changed as suggested.

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.

R: Changed as suggested.

Line 25: may need add reference about bedrock if it is available.

R: ‘as shown in Kitajima et al. (2013)’ has been added in the revised manuscript.

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.

R: About deep water uptake, we have changed it to ‘deep tap roots (Markewitz et al., 2010); we have also changed “HR representation models” to “It is also important to compare different representations of HR models …” in the revised manuscript. (lines 25-27, page 13)