Response to Referee #1

By Sun S. et al.

The paper entitled "Predicting future US water yield and ecosystem productivity by linking an ecohydrological model to WRF dynamically downscaled climate projections" by S. Sun et al. evaluated future climate change impacts on the evapotranspiration (ET), water yield (Q), and gross primary productivity (GPP) in the Conterminous US. The manuscript is fairly well written. The preliminary manuscript tells the full story of how the future climate scenario (i.e. A2) would likely affect ET, Q, and GPP in the Conterminous US. In my view, however, the analyses are not adequate. Here, I have provided a number of comments for the authors to consider.

1. Like other modelling studies regarding climate change effects on water and carbon balance, the authors compared the hydrologic and carbon variables (e.g. P, ET, Q, and GPP) between the two periods. The differences in the variables between the two periods were caused by the climate change in your study. The results are not exciting, except for the combination of climatic and hydrological models. Further analysis, I think, can improve the readership and impact of this manuscript. I suggest the following two points for the authors' c. **a**. The preliminary comparisons were made based on HUC level. Those analyses were critical, for example, for each WRR. The results can also be further summarized based on the land cover and climatic zones and other variables. By doing this, could gain more information on how ET, Q, and GPP performed at each land cover, climate zones or other criterion in US. **b**. The authors compared the impacts of climate changes on each variable at different HUC level. As we can see from the results, different watersheds respond differently. Besides the spatial variability of the climate between HUC scales, the simulation results, in my opinions, offer a chance to evaluate how watershed characteristic (e.g. slope, land cover, etc.) affect the results. For example, the authors could investigate how ET, GPP, and Q changes respond to land cover, slope, etc. For simplicity, those relationships can be built as multiple regressions at annual step. Perhaps the relationships may not be strong, but any statistical relationship serves as supportive information for water resource management. For example, how does the ET and GPP change in forest and grass lands under different climate conditions?

Response:

a. We appreciate the referee's constructive suggestions. We agree with the referee on that land cover, in addition to climate zones, does affect how climate change impacts on ET, Q and GPP. We have made efforts to examine this aspect of the assessment. Considering the limited space of this manuscript and the major objective for providing a tool to assess the future climate change impacts on the key hydrological and ecosystem variables, we did not show the results in the current manuscript, but can be potentially added in the final version.

Results are highlighted below:

To illustrate the different responses of ET/GPP/Q by land cover to future climate change and the differences in area percentages of each land cover within each WRR, Table 1 provides a summary of the land cover type showed the highest changes of ET/GPP/Q for each WRR. This summary information is helpful for understanding which land cover dominates WRR responses.

Fig.1, Fig.2 and Fig.3 show the multi-year ET, Q and GPP during 1979-2007 and 2031-2060, and their differences, respectively. For the whole CONUS, ET (Fig.1(t)) and GPP (Fig.3(t)) of each land cover all increase with various increments (ranges of 0.3-10 mm yr^{-1} for ET and 0.6-34.8 gC m^{-2} yr^{-1} for GPP) due to the future climate change. Evidently, the increment of ET (37 mm yr^{-1} showed in Table 2 of the manuscript) averaged over the whole CONUS is mainly because of the increased ET in the land cover of crop, deciduous forest and shrubland. However, the larger contributions to the increased GPP over the CONUS are from crop and deciduous forest, with the rates of 34.8 gC m^{-2} yr^{-1} and 23.7 gC m^{-2} yr^{-1}, respectively. For Q averaged over the whole CONUS (Fig.2 (t)) , four land cover types show different increases, especially for the deciduous forest (3.1 mm yr^{-1}) and the crop (4.1 mm yr^{-1}). By contrast, Q in the other five types differently reduces, in particular for evergreen forest with the maximum values of -2.4 mm yr^{-1}. Just due to the different Q responses of each land cover to the future climate change, the CONUS mean Q over shows a slight increase (9 mm yr^{-1}). Similar to ET and GPP changes in the CONUS, each land cover within each WRR basically shows consistent increases (Fig.1a-s and Fig.3a-s), but with the various rates. In contrast, Q differently changes (i.e., increases or decreases) among all the land cover types for each WRR (Fig.2a-s).

Table 1 The land cover type with the highest changes of ET/GPP/Q in each WRR or the CONUS

WRR or The CONUS	ET	GPP	Q
1	Deciduous forest	Deciduous forest	Mixed forest
2	Deciduous forest	Deciduous forest	Deciduous forest
3	Evergreen forest	Crop	Evergreen forest
4	Crop	Crop	Crop
5	Deciduous forest	Deciduous forest	Deciduous forest
6	Deciduous forest	Deciduous forest	/
7	Crop	Crop	Crop
8	Crop	Crop	Crop
9	Crop	Crop	Wetlands
10	Crop	Crop	Crop
11	Crop	Crop	Deciduous forest
12	Shrubland	Crop	Crop
13	Shrubland	Shrubland	Shrubland
14	Shrubland	Evergreen forest	Evergreen forest
15	Shrubland	Shrubland	Shrubland
16	Shrubland	Shrubland	Shrubland
17	Shrubland	Evergreen forest	Evergreen forest
18	Shrubland	Evergreen forest	Evergreen forest
The CONUS	Crop	Crop	Deciduous forest

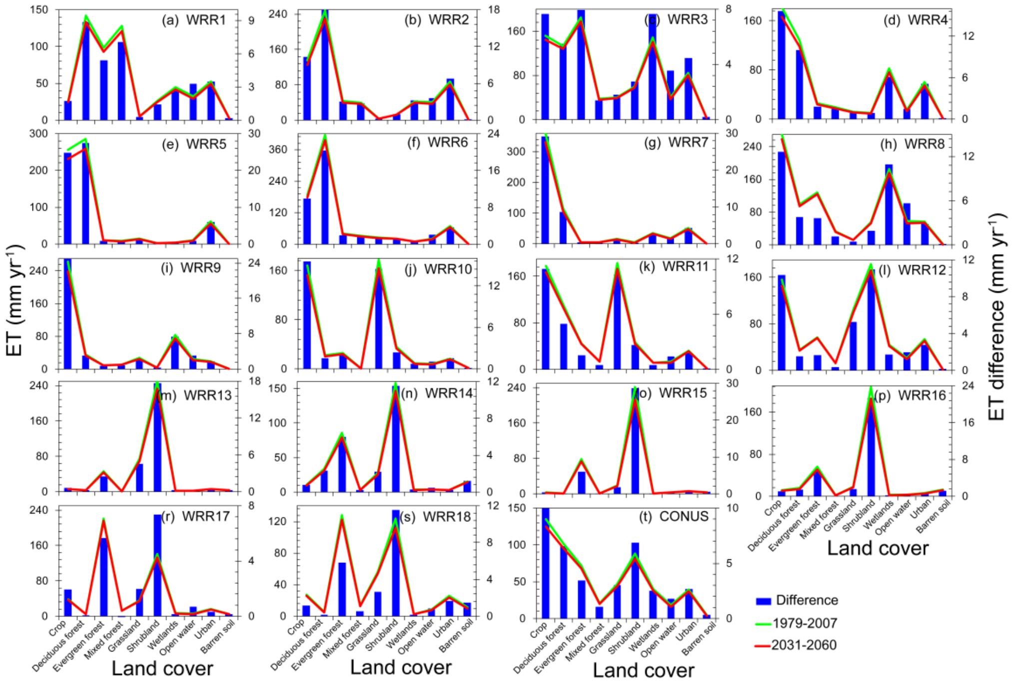

Fig.1 Multi-year mean ET for each land cover during 1979-2007 and 2031-2060, and their differences (future - baseline). ET values are weighted using the land cover area within each WRR or the CONUS.

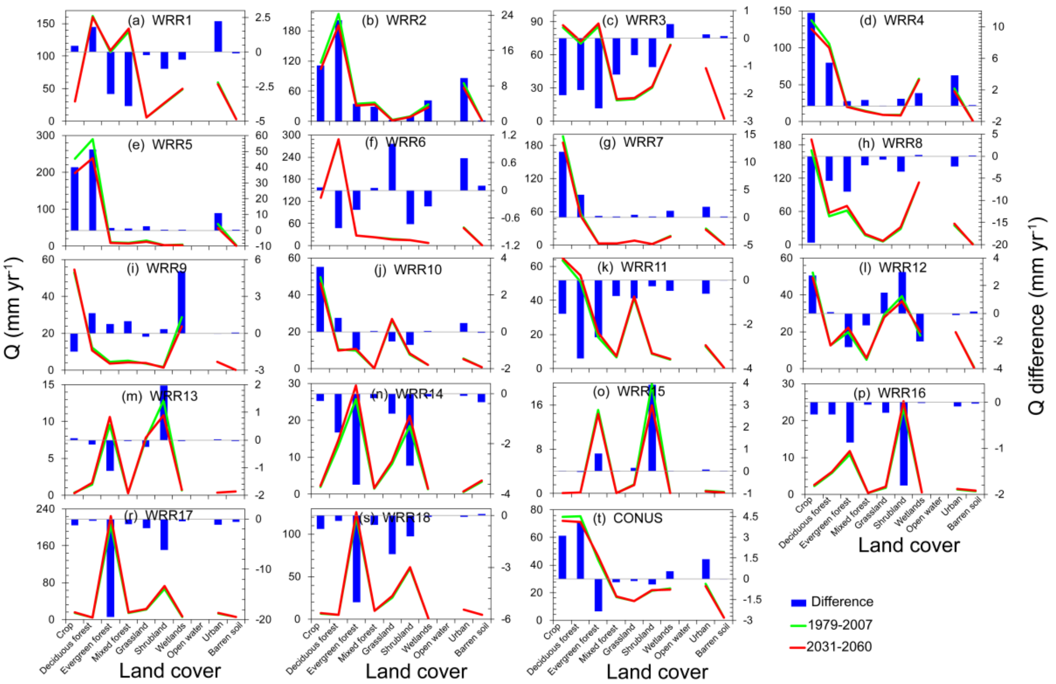

Fig.2 Multi-year mean Q for each land cover during 1979-2007 and 2031-2060, and their differences (Future-Baseline). Q values are weighted using the land cover area within each WRR or the CONUS.

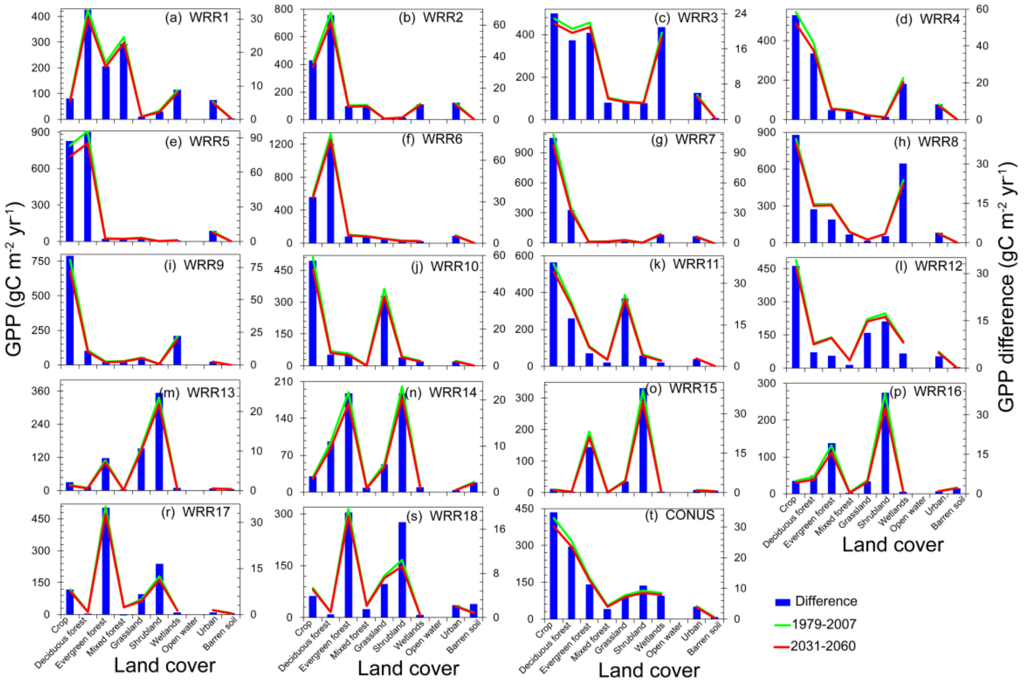

Fig.3 Multi-year mean GPP for each land cover during 1979-2007 and 2031-2060, and their differences (future - baseline). GPP values are weighted using the land cover area within each WRR or the CONUS.

b. According to the referee's comments, we have explored the relationship between ET/Q/GPP difference and the topographic parameters (e.g., elevation as determined by DEM) (Fig. 4). Obviously, ET, Q and GPP difference all negatively correlated with DEM over the CONUS. The negative correlations suggest that overall these variables will decrease with the increases in elevation or wester US (higher elevation) has lower ET. Q, and GPP. This is understandable since both P and PET are influenced by elevation. In addition, vegetation covers are influenced by elevation as well. Although the correlation coefficients are significantly, the main reason is the huge number of the samples (i.e., 82773). The influences of climate may mask the true effects of DEM when elevation ranges from 0 to 1200 m. To sum up, we think that the statistical relationships can serves as some useful information for water resource and vegetation management, but their uses are limited. Therefore, we do not plan to include the analysis in the revision.

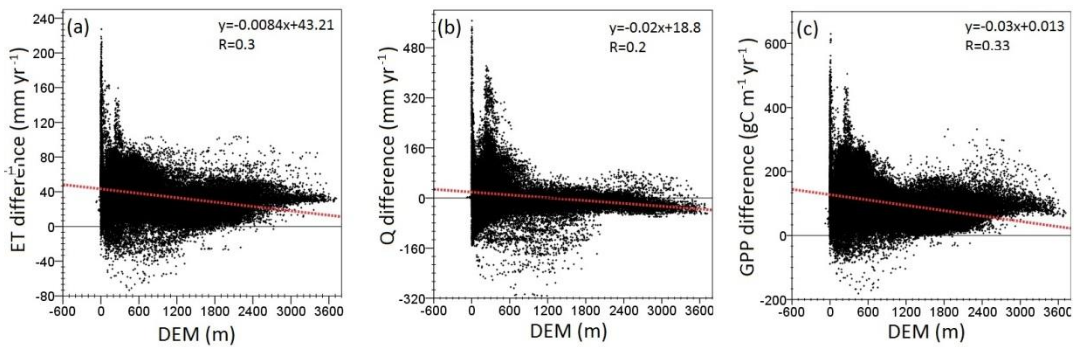

Fig.4 Scatter-plots of DEM vs. ET (a), Q (b) and GPP (C) difference

2. The author mentioned watershed scale in the manuscript (e.g. last paragraph of introduction) for several times. Can you specify the watershed scale? Do you mean the spatial scale at the 12 digit HUC scale?

Response: We have specified the watershed scale in the revised manuscript. For the detailed information, please see the revision. Seen from Figure 5, the size of the 12-digit HUC watershed ranges from 0.16 km^2 to 9238.44 km^2, with the median and the mean value of 88.18 km^2 and 94.97 km^2, respectively. For more than 80000 12-digit HUC watersheds, the area is between 50 km^2 and 170 km^2.

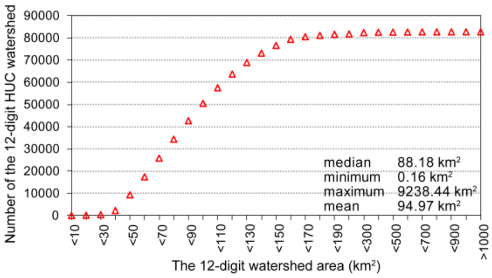

Figure 4. Statistics of the 12-digit watershed area

Yes, the WaSSI model performs hydrological and carbon fluxes simulations at the 12-digit HUC scale. Please see the sentence of "It operates on a monthly time step at the 8-digit HUC or 12-digit HUC watershed scale for the CONUS."

3. The reference style needs to be reformatted.

Response: We have reformatted the reference according to the *HESS* publication style. Please see the revised manuscript.