Reply to comment by M. Budde

We thank Mr. M. Budde for the helpful comments and have implemented the suggestions as described in details below.

Major comments

2.1. Significance testing
In the method section the authors mention that a Monte Carlo technique has been used to test the statistical significance. From this sentence alone it is not clear what the authors tested with this Monte Carlo technique. I suggest to be more specific and explain what has been tested.

Response: In the manuscript, we tested whether the runoff anomalies during the two types of El Niño years are different from its climatology mean using the Monte Carlo technique. We have rewritten the sentence (Line 149) to make it clearer according to the comment.

Before the start of the experiment, the authors decided to separate the runoff data for the two El Niño types. What I am wondering at, can those patterns be seen when all those cases are put together. So is it possible to take the opposite approach, and try to separate or identify those two types based on runoff data only?

Response: As the most important climate mode in the Earth system, El Nino event significantly impacts weather, climate and hydrology (including runoff) both regionally and globally. The climate variables such as precipitation, temperature and runoff will vary/change associate with the mode changes of El Nino/Southern Oscillation (ENSO), not the other way around. Our goal is to characterize the different impacts of the two types of El Niño on runoff over the US, not to identify the two types of El Niño based on runoff in the US. To identify different types of El Niño, we use the sea surface temperature data in the equatorial Pacific (Trenberth, 1997; Yu and Kim, 2013), which is widely applied in the climate field.

2.2. Hypothesis and discussing missing
There is no hypothesis given in their manuscript. With a well described hypothesis, it is easier to write a discussion about the results (Hess, 2004). Although they now and then argue a bit about the results, for example in on page 8984, it is a really good point to mention that the gauge stations are not well distributed over the whole CONUS. However I suggest to also add a paragraph "discussion".

Response: Previous researches suggest that climate variables such as precipitation and temperature respond differently to the two types of El Niño (Mo, 2010; Yu et al., 2012). Thus, response of runoff would likely to be different over the CONUS, this is our hypothesis and is listed in *introduction* section. We also added a *discussions* section in our revised manuscript as suggested (section 4).

2.3. Research period

This reflects the reason that four CP and only two EP El Niño's have been found in the research period. Because of the limited amount of EP cases, it is better to extend this period before 1990. This will increase the amount of possible cases for especially EP but also for CP El Niño's. As soon as there are more events would have been studied the amount of results that satisfy the 95% significance criterion can increase.

Response: We agree with the reviewer that a longer period with more El Nino events is always better in the study. However, the reliable observed runoff data only last from 1990-2009. To overcome the limitation, we added model outputs (which includes more El Nino events) and analyses to further validate results from observation in Section 3.3.

2.4. Goal of the research
The goal of this research was to understand the different impacts of the El Niño types. After reading this manuscript, I wonder if this was the right goal. It is mainly shown what the different impacts are, but little is shown that increases the understanding of the impacts. Several maps with spatial distributions have been showed but there is no explanation given why runoff anomaly in a certain area higher is than in another area.

Response: The goal of the research is two folded. First, we showed the impacts of two types El Nino on runoff over CONUS (section 3.1~3.3); Second, we try to understand what factors are most likely to contribute to the different response of runoff to the CP- and EP-El Nino (Section 3.4.1)**.** Our results indicate that in the current climate, different runoff patterns during the two types of El Niño are mainly determined by precipitation. Explanation of the precipitation pattern has been analyzed by (Yu and Zou, 2013) and (Mo, 2010), which are not repeated in the current research. However, we included some description in *discussion* section.

Minor comments:

3.1 In the introduction I already mentioned that the authors decided to choose the Atmospheric Research Community Climate System Model version 4 (NCAR-CCSM4) because it has the highest correlation. This model takes ocean, atmosphere, land and ice components and their interactions into account (Capotondi, 2013; Gent et al., 2011). I think it is good that they decided to really look at which model is the most suitable for this research. This is of course better than choose a model which the authors are familiar with or which is easy to use. So they decided well to choose the NCAR-CCSM4 model.

Response: Thanks for the compliment.

3.2 In the methods section the authors are saying that there are four CP El Niño events and two EP El Niño events according to Table 1 of Yu et al. (2012). However when I take a look at that table I see only 4 cases during the study period (2002-03, 2004-05, 2006-07, 2009-10). So I suggest to add a table as overview of the cases that have been used in this manuscript, because they are not mentioned in the table of Yu et al. (2012).

Response: Our study period is 1990-2009, not 1999-2009. Thanks for pointing out the typo in the current version of the discussion paper. During the 20-yr period (1990-2009), there are 4 CP-El

Niño (1991-1992, 1994-1995, 2002-2003, 2004-2005) and 2 EP-El Niño events (1997-1998, 2006-2007), in agreement with Yu et al. (2012). We also listed the detailed El Niño years in revised manuscript (section 2.2).

3.3 A short summarization of models which have been used in this research is given, I think it is well described why they have chosen those models. However I would like to see also a short explanation of the models. What kind of models are it and what kind of variables are needed for the model.

Response: All of the selected CMIP5 models are coupled atmospheric-ocean climate models, participating in the IPCC AR5. For the detailed description of those models, please refer to Taylor et al. (2012). According to the comment, we added a sentence in the revised manuscript (Please see section 2.1). Model variables used in the study have been mentioned in *methods* section (section 2.2).

Specific Comments

4.1 Page 8979 Line 21, this the first time that ENSO is mentioned. I would also mention that this stands for "El Niño Southern Oscillation".

Response: We have corrected this in the revised manuscript.

4.2 Page 8980 line 1 to 3, in this sentence it is given that El Niño is the dominant mode of climate variability. I would suggest to add a reference to it. For example, Van Oldenborgh, Philip, and Collins (2005).

Response: References (Van Oldenborgh et al., 2005) has been added as suggested.

4.3 Page 8981 line 24, mention that ERA-Interim a global atmospheric reanalysis is.

Response: We have added a sentence (Line 129) as suggested**.** ERA-Interim reanalysis is also one of the widely used data sets in climate community. For the description of the data, please refer to Dee et al. (2011).

4.4 Page 8982 line 20, replace '(SSTAs)' by '(SSTA)' as further in the manuscript always SSTA has been used.

Response: we have corrected this as suggested.

4.5 Page 8983 line 8, the absolute value which belongs to the -11% is missing, I think it is good to mention this value too.

Response: The value i.e., -180 mm yr^{-1}, does not miss. 180 mm yr^{-1} is around 31% of the climatology mean in NE region and 11% in PNW region, respectively. We have rewritten the sentence to make it clear in revised version.

4.6 Page 8985 line 5, it is not really clear what the percentages in this line means.

Response: The percentages indicate the ratios of those anomalies relative to their climatology mean. We have rewritten the sentence to make it clearer in the revised manuscript.

4.7 Table 1, add in the caption where CP and EP stand for.
Response: We have added the caption as suggested in the revised manuscript. Thank you.

References

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