**Response to review comments**

We thank the Associate Editor Eylon Shamir and the two anonymous reviewers for their thoughtful review and suggestions for further refining our manuscript. We have revised the manuscript accordingly and provide our point-by-point response to the review comments.

**Response to comments from Associate Editor Eylon Shamir**:

*The manuscript describes a detailed statistical analysis of climatology of extreme daily rainfall in PF. In my opinion the connection of the this analysis to synoptic analysis is missing. This analysis could have been compared to synoptic indices to better understand the drivers of the extreme events. I think that the least that can be offered is a comprehensive review and discussion of the atmospheric conditions that are conducive for extreme rainfall events during the different seasons. The only phenomena that was mentioned is t the tropical storm.*

We concur with the comment and have revised the manuscript to provide a more comprehensive review of the rain bearing systems in the different seasons that also increase the likelihood of bearing extreme rain events. We have used the following additional references for the discussion.

Ali, A., W. Abtew, S. Van Horn, N. Khanal, 2000: Temporal and spatial characterization of rainfall over Central and South Florida Journal of the American Water Resources Association, 36 (4), pp. 833-848

Baigorria GA, Jones JW, O’brien JJO (2007) Understanding spatial rainfall variability in southeast USA at different timescales. Int J Climatol 27:749–760

Barry D. Keim (1996): Spatial, synoptic, and seasonal patterns of heavy rainfall in the Southeastern United States, Physical Geography, 17:4, 313-328, DOI: [10.1080/02723646.1996.10642588](https://doi.org/10.1080/02723646.1996.10642588)

*I also recommend adding a discussion on the CPC dataset. This dataset should be described, evaluated, and discussed.  I am specifically interested in its inherited uncertainties for the PF region.  For example, how well this dataset captures the climataology of the region? is the gauge network sufficiently dense to cover the entire PF? The relatively coarse scale of the analysis (0.5 degrees).*

We provide a more thorough discussion of the CPC dataset in the revised manuscript:

We use the daily rainfall data from the Climate Prediction Center (CPC) (Xie et al. 2007 and Chen et al. 2008). This rainfall data is available on a 0.5°0.5° grid at daily interval from 01 January 1979 to 22 March 2018 over all continental regions. This dataset uses gauge reports from over 30,000 stations including those from Cooperative Observer network Program (COOP), and other national and international collections. A quality control is applied on these data collections before they are merged through an optimal interpolation technique following Gandin (1965) to construct the global gridded rainfall analysis on grid. In comparison to previous CPC products, the CPC unified daily gauge analysis presents spatial patterns and temporal changes of precipitation in better agreements with station data (Xie et al., 2010). Chen et al. (2008) showed that continental US, including Florida, has the highest density of rain gauges in the world. The mean station-to-station distance is around 30 km and the bias is less than |0.5%|. In a comprehensive review of gridded rainfall analysis, Sun et al. (2018) finds that the largest uncertainties of gridded analysis are found in complex mountain areas and in regions of sparse data coverage (e.g. northern Africa, polar latitudes, oceanic regions). In contrast, the flat terrain and relatively high density of rain gauges ensure a higher fidelity of the rainfall analysis over Florida.

Chen, M., W. Shi, P. Xie, V. B. S. Silva, V. E. Kousky, R. Wayne Higgins, and J. E. Janowiak, 2008: Assessing objective techniques for gauge-based analyses of global daily precipitation. *J. Geophys. Res*., 113, D04110, <https://doi.org/10.1029/2007JD009132>.

Gandin, L. S. (1965), *Objective Analysis of meteorological fields*, *.* Israel Program for Scientific Translations, 242 pp.

Sun, Q., Miao, C., Duan, Q., Ashouri, H., Sorooshian, S., & Hsu, K.-L. (2018). A review of global precipitation data sets: Data sources, estimation, and intercomparisons. Reviews of Geophysics, 56, 79–107. https://doi.org/10.1002/ 2017RG000574

*The authors should also consider the comments from reviewer 2 in there revised version of the manuscript.*   
 Yes, we have paid attention to comments from Reviewer 2.

**Response to comments from Reviewer 2**:

*1.      Sample size impact on results  
It appears that the authors' use of 39 years is enough even for seasonally segregated data for overall analysis. Overlaying ENSO could add additional challenge specially after removing extreme rainfalls. Perhaps commenting on those and providing analysis/plot of significance test using boot strapping on those would be helpful. There is also kinds of boot strapping one can do, that it self has some major assumptions. I would advise providing some more details on that.*

In Figs. 5-8 we have applied boot strapping to determine statistical significance. This was and is stated in Section 2b.

*2.       Spatial correlation  
There is no spatial correlation analysis in this work. Implication/insights derived from spatially independent analysis is extended into climate models ability in reproducing seasonal distribution at certain time of year that is spatially correlated. Understanding the influence of extremes rainfall on spatial structure of the rainfall is very important. Implication on skill of climate models that is the core of the result should be support by this analysis. You could look at things like variograms, for example. Ultimately, both spatial and temporal statistics are what matters for water resources management*

Variograms are more commonly used in Radar Meteorology, where one of the goals is to determine the spatial scale of the rain bearing system observed by the radar. Such variograms would not be practical for application in our study because of the discrete observations made from multiple platforms and rain gauges and discrete in time. Alternatively, variogram has also been used on monthly mean data to check on the adequacy of the density of rain gauge network (e.g., Ali et al. 2000).

We believe that our definition of extreme events will not conform to a spatial scale by definition. It is purely based on percentiles or fitting of a gamma function exclusively at a grid point without necessarily conforming to a spatial scale. This can result in unique extreme rain events disassociated with the spatial scale of the rain bearing system. To illustrate our point, we provide you with the following example: Let us take an instance of a cold frontal passage over PF. By our definition this frontal passage could produce an extreme rain event at a given grid point X based on the local frequency distribution of daily rainfall. At a neighboring grid point of X, say Y, the same frontal passage may not necessarily produce an extreme rain event based on its local frequency distribution of daily rainfall even if the rain rate at Y exceeds that over X from this particular frontal passage. So, in our quest to relate the extreme rain event to a spatial scale, if we fail to associate the extreme rain event at X with that at Y we will consequently fail to relate the extreme rain event of X with the cold front. But we know that the leading edges of these frontal passages are the most likely causes of extreme rainfall in the winter over Florida (Kiem 1996; Ali 2000; Baigorria et al. 2007). Therefore, based on the suggestion of the Associate Editor, we have introduced a more in depth review of the rain bearing systems in the different seasons that also increase the likelihood of bearing extreme rain events with the references indicated in the response to this specific comment from the Associate Editor.

*3.      Clearly demonstration of application of such work as it is more applied research than basic research  
At times the discussion seems targeted to long-term rainfall projection and at times it looks like for seasonal short-term projection. I think differentiating those and providing implication to both would improve the paper.  
For example, this key conclusion, line 406  
 "In the summer and fall seasons, PF has some of the largest fraction of landfalling tropical cyclones in the continental US. Yet we observe that the skewness and kurtosis of the daily rainfall distribution in the JJA and SON seasons are relatively less modulated by the removal of these extreme rain events than in the drier DJF and MAM seasons. Therefore, the lack of resolving the tropical cyclones in coarse global climate models may not be detrimental to its seasonal prediction skill over Florida."*  
*The above quoted sentence is from long-term rainfall simulation perspective (implication to water resources planning), but not from season near real time rainfall projection which this extreme events has significant impacts on. The ability to forecast next summer's rainfall is very important whereas if I am looking to a simulation of next 20 years it may not be and that is what the authors are arguing in this case for the summer season. We know the long-term ENSO statistics are not captured very well still but seasonal operational models can capture that pretty good once large scale climatic conditions are in place. That is what the authors are referring to when they talk about winter season. This two are difference from water resources management perspective and need to be clearly identified so readers shouldn't assume all the conclusion are applicable to all season and different time scale of management.*

We claim that coarse climate models are able to simulate the year-to-year variations of winter seasonal rainfall and even extreme winter daily rainfall events because they are associated with large-scale synoptic systems. In winter these extreme daily rain events contribute significantly to the seasonal total and overall seasonal statistics over PF. In the summer, fortunately the extreme daily rain events don’t contribute significantly to the seasonal total and the overall seasonal statistics. Even though the climate models may not resolve these extreme rain events, they still perform poorly in simulating the summer seasonal rainfall. This is because they have significant bias in simulating/predicting diurnal variations. We did not mention implication for long-term climate projections deliberately because the simulation of ENSO statistics (like their amplitude, spatial structure, duration etc.) for example, can have a bearing on winter rainfall over PF. These features of ENSO are highly uncertain in future climate projections. We have now clarified this issue in the revised text.  
  
*4.      Implications and/or the role of regional (finer scale) climate models  
Given the the authors' expertise in regional climate modeling, I would have liked if they could bring in the value of regional climate model and/or discussions of whether some of these implications do hold for those as well. There is an ongoing discussion in applied research community that whether the skill of large-scale climate model is all we can get or investment in finer scale models. Which one give us the best bang for our limited buck. These are worth considering at big picture policy level.*

Following this suggestion from the reviewer, we have added a paragraph in the concluding section on the applicability of our results to regional climate models.

*Miscellaneous  
Not sure I understood this sentence  
 "Since the landfalling tropical cyclones in PF contribute to some of these extreme rain events over PF,  the lack of sensitivity of the seasonal distribution of rainfall to extreme rain events suggest that the lack of resolving the tropical cyclones in the current global climate models (Kirtman et al. 2014; Rebecca et al. 2017) may not be as influential factor for their poor display of seasonal rainfall prediction skills in the summer and fall seasons over PF (Stefanova et al. 2011; Bastola et al. 2013; Tian et al. 2014)."*

We have rephrased the above as follows:

“The distribution of summer rainfall is not sensitive to extreme rain events, which are primarily produced by tropical cyclones. Thus, the results from our study suggest that the absence of resolving the tropical cyclones in our current climate models (e.g., Kirtman et al. 2014, Rebecca et al. 2017) may not be as detrimental for the seasonal simulation of summer rainfall over PF. However, these global climate models continued to display poor prediction skills in summer and fall seasonal rainfall over PF, suggesting that there are other responsible factors, like the poor simulation of the diurnal variations.”