1 **"The Probability Distribution of Daily Precipitation at the Point and**

2 **Catchment Scales in the United States" by Lei Ye et al.**

3 **Response to Simon M. Papalexiou (Referee #1)**

4

5 We greatly appreciate you for your constructive comments and suggestions. Our

6 responses to the comments are listed below.

7

8 **Comment 1: It only makes sense to advance a single continuous pdf for the wet**

9 **day case, regardless of where the data arises from, if one adds zeros, the**

10 **Lmoments will always land exactly on the Pearson Type III curve**

11 *Response:*

12 Thank you for pointing this out. In the revised manuscript, we will eliminate all the

13 results relating to the 'all day' or X>=0 conditions, focusing only on the probability

14 distribution of wet-day precipitation.

15

16 **Comment 2: Lines 363-365: "demonstrating that the parameter Gamma**

17 **distribution cannot describe the tail behavior of full-record series of**

18 **precipitation as has often been assumed in the past." These lines are just the**

19 **opportunity for commenting on tail issues. Summary shape statistics are of**

20 **course affected by the tail behaviour but they are not sufficient to reveal in a**

21 **robust way the behaviour of the tail if the whole sample is used (I mean all**

22 **nonzero values) and not values that belong to the tail. For example in the**

23 **paper the authors cite (Papalexiou and Koutsoyiannis, 2016) after the fitting**

24 **using L-moments various measures were proposed in order to compare the**

25 **fitting in the most extreme value, the largest extremes the whole sample etc.**

26 **The author can see that the performance of distributions changed, still the**

27 **GG performed better but the BrXII increased its performance too. I just want**

28 **to say that indeed this approach can favour specific distributions and exclude**

29 **others like the G2 the authors mention, yet this is based judging the whole**

distributional shape properties and it is not really robust to judge on the tail when using the whole nonzero sample. Also other global studies indicated the sub exponential nature of tails focusing on using only "tail" data (Papalexiou et al., 2013; Serinaldi and Kilsby, 2014); the latter was also applied in a seasonal basis, which by the way might be also a nice idea, i.e., the authors to explore seasonal variation.

Response:

Thank you for the comments. The sentence will be removed in the revised manuscript since our analysis of the full-record series of precipitation will be eliminated. The reviewer has suggested a good idea to explore the seasonal variation of the distribution of daily rainfall, which will be a portion of our future work. We will consider ideas introduced by Papalexiou and Koutsoyiannis (2016) and others concerning the impact of seasons on rainfall distributions. We are aware that the choice of a suitable distribution for modeling rainfall would be quite different if we were to focus our attention on the extreme tail behavior, as is the case for example, when one fits a distribution to the series of annual maxima or peaks above some threshold. However given our interest in all wet-day daily precipitation, most situations of practical relevance and concern are not with extreme rainfall, thus our attention will focus on the complete series of wet-day amounts, without special attention given to the largest values.

Comment 3: The P3 distribution is just the two-parameter Gamma distribution (G2) with an additional location parameter which does not affect the shape characteristics and thus τ_3 and τ_4. So the curve of P3 shown in $\tau_4-\tau_3$ ratio plots is the same as the G2. And obviously they have the same tail. The same holds for GPA and GP2 and for any other distribution that has one shape parameter and additional location parameters are added. Maybe to ease the reader, as different formulations can be found in the literature, it would be no harm to add a table of the distributions functions used.

59   *Response:*

60 Thank you. We will add a table to show the distribution functions. We appreciate the

61 comments of the reviewer reminding us of the fact that addition of a location parameter

62 does not impact the shape of the distribution.

63

64 **Comment 4: The Weibull distribution could also be added in the analysis as a**

65   **representative of distributions with stretched exponential tails.**

66 *Response:*

67 Thanks. We will add the analysis of Weibull distribution in the revision. Again, we

68 emphasize that our interest is in the entire distribution, without focusing attention on

69 the extreme tail behavior. We leave it to others to evaluate the distribution of annual

70 maximum precipitation to focus attention on extreme tail behavior of daily rainfall

71 amounts.

72

73 **Comment 5: When we use distributions with a location parameter to describe a**

74   **positive variable like the nonzero precipitation this parameter might end far**

75   **from zero or even negative indicating a lower bound. So, this distribution**

76   **cannot be used in stochastic modelling of precipitation as it will result in**

77   **inconsistent values. It would be interesting the authors to actually show some**

78   **box plots of the estimated parameters.**

79 *Response:*

80 We indeed found that some parameters are far from zero too. Box plots will be added

81 to illustrate the behavior of the distribution parameters of interest.

82

83 **Comment 6: The principle of parsimony should always be applied. If the authors,**

84   **generate samples from a 4-parameter distribution like the kappa and try to**

85   **estimate a posteriori the parameters, even for the sample sizes used here, they**

86   **will find a huge variability that makes, in my opinion, the operational use of**

87   **4-parameter distributions quite risky. Of course a 4-parameter distribution**

88   **like the kappa has a great flexibility, yet this does imply that a better fitting**

89   **to an observed sample is a better choice to extrapolate values for large return**

90   **periods.**

91   *Response:*

92   We fully agree that in most applications in hydrology, the principle of parsimony is

93   absolutely paramount, due to the short samples available for fitting distribuitons.

94   However, in this application, with samples sizes in the tens of thousands, concerns over

95   parsimony are not nearly as critical, even when estimating the Kappa distribution. This

96   fact has been shown nicely in the recent paper by Blum et al (2017) where they

97   demonstrated, for similarly length samples of daily streamflow the sampling properties

98   of estimated Lmoments from synthetic samples in their Figure 2.

99

100   **Comment 7: The authors, since this is the first large scale study on catchment**

101   **precipitation, could provide some analysis on the relation of catchment size**

102   **and distributional shape. As the spatial averaging process will tend to make**

103   **the distributions more bell-shaped and with thinner tails. This is the**

104   **explanation of the performance decrease of the heavy-tailed distribution**

105   **shown in Fig. 7 compared to Fig. 6 (commenting on the Wet-day; full-day**

106   **results should be modified).**

107   *Response:*

108   Thank you for your suggestion. In the revised manuscript, we will explore the relation

109   of catchment size and distribution shape. Of interest is the impact of catchment size on

110   both the LSkewness and LKurtosis of the fitted distributions of wet-day precipitation

111   amounts.

112

113   **Comment 8: Some regions of the USA, mainly in Midwest, show quite intense**

114   **changes (or maybe natural variability) on extremes. The authors could also**

115   **comment on that or do a quick extra analysis on the daily precipitation.**

116   *Response:*

117   Thank you. We will explore/comment on the changes of extremes in Midwest if

118   possible, but again, we remind the reviewer, that our attention is not on the behavior of

119   extreme precipitation, but rather, is on the distribution of the complete series of wet day

120   daily amounts under all conditions, not just extreme conditions.

121

122   **Comment 9: I believe the literature should be updated with many other works, e.g.,**

123   **there are several papers that are using other distributions for daily**

124   **precipitation, e.g., one that came to mind is the by Wilson and Toumi (2005).**

125   *Response:*

126   Thank you. We will update the literature review with a focus on the distribution of wet-

127   day precipitation amounts.