Response to Reviewer 1

Reviewer 1: This manuscript revisits the question of how rainfall intensity changes with temperature, considering this across different time scales, quantiles, and climate regions. The manuscript introduces the idea of quantifying intermittency of rain during a given time interval, and then applies a model that separates intermittency from thermodynamic controls on rainfall rates. This consideration of intermittency offers a novel way to interpret these intensity vs. temperature relationships and helps show that once intermittency is accounted for Clausius-Clapeyron scaling is preserved in many cases. This manuscript is a useful addition to the ongoing investigation of simple temperature controls on rainfall intensity.

Major comment: My one major comment relates to the explanatory power of quantifying intermittency. Page 8 Line 15 suggests that intermittency is a "much simpler" explanation of changes in scaling versus trying to explain shifts in dominant rainfall type. However, intermittency is not in itself a fundamental explanation. Temperature scaling of intensity has a basic physical principle at its root (the Clausius Claperyon relationship). Measuring intermittency is a convenient way to quantify shifts in some underlying relationship, but the relationship between temperature and intermittency is largely empirical and not something known a prior from basic principles. There is no fundamental physical principle that describes intermittency. I'm not questioning the value in quantifying intermittency and using it to isolate the thermodynamic scaling. But, I think the language in the manuscript should possibly be changed in places to better acknowledge that intermittency is not really the fundamental explanation, but just a convenient way to generally quantify the different dynamic controls limit atmospheric moisture availability. For instance, Page 12 Line 5 says "Intermittency is a key feature controlling the variability of precipitation". I would suggest it might be more appropriate to say something "Quantifying intermittency aids in identifying controls on variability of precipitation". There are several other places in the manuscript were this slight shift in presentation of intermittency might be warranted.

Response: Thank you for the suggestion. I agree, these are two very different types of relationships and it's important to be very clear about that. Temperature and maximum rainfall intensity are linked by a direct physical relationship (described by Clausius-Clapeyron). The link between temperature and intermittency is less tangible. It only has an indirect physical interpretation in terms of the maximum rate at which precipitable water can be replenished through evaporation and advection from surrounding regions (which depends on actual physical factors like temperature, radiation and wind speed). I will go over the paper again to make sure this is clearly stated and change the language wherever necessary.

Minor Comment 1:
In the abstract, the term intermittency should be defined more explicitly. At least for readers with less of a meteorology background, intermittency may be more familiar at longer time scales (dry periods and wet periods over weeks or months). So, the idea of considering intermittency over shorter time scales (hourly to daily) should be made clear at the beginning.

Response: Yes, that would be a valuable addition. I will add a paragraph about small-scale intermittency and some references to relevant publications in the text. Possible references (with short summary or discussion) include:

- "Characterizing Multiscale Variability of Zero Intermittency in Spatial Rainfall", by Kumar, P. and Foufoula-Georgiou, E. (1994)

- “The Droplike Nature of Rain and Its Invariant Statistical Properties”, by Ignaccolo, M. and De Michele, C. and Bianco, S. (2009).
- “New perspectives on rainfall from a discrete view” by De Michele, C. and Ignaccolo, M. (2013)
- “On the nature of rainfall intermittency as revealed by different metrics and sampling approaches”, by Mascaro, G. and Deidda, R. and Hellies, M. (2013).
- “Intra-event intermittency of rainfall: an analysis of the metrics of rain and no-rain periods” by Dunkerley, D. (2015)

Minor comment 2: Page 3 Line 17 & Line 22; Line 17 indicates data is from the USCRN but line 22 indicates stations include Canada and Siberia. There is an inconsistency here given that that the USCRN only includes stations in the US and Figure 1 only shows U.S. sites.

Response:
Yes, I see why this might be confusing. The USCRN network actually contains a few stations outside the U.S. But these did not satisfy the data requirements and were not considered in this analysis. I will revise the text accordingly to avoid any possible misunderstanding.

Minor comment 3: Page 3 Line 29 states that aggregation was performed with overlapping time windows (shifted by 5 minutes). If overlapping windows were used, this would suggest that each aggregate data point was not actually statistically independent , especially at longer time scales. For instance, if one had a 24 hour time window shifted by only 5 minutes, over 99% of the data from one window to the next would be the same. If this is what was actually done, there probably needs to be some accounting for the lack of independence of each data point. If this isn’t what was done, then the text should be clarified.

Response:
Yes, this is correct. The different values are not independent and there is no correction for this in the analyses. However, I don’t think this is a major problem considering the lengths of the time series and the type of analyses I perform (please correct me if I’m wrong). The main reason I consider overlapping windows is to better account for the fact that the starting time of the measurement periods is arbitrary. Otherwise, results would depend on the choice of the starting time. In addition, the same independence problem arises when samples are taken over non-overlapping time windows, although in this case it mostly affects the smaller scales instead of the large ones. To avoid any confusion, I will add some details in the methods section to better explain the motivation behind this choice of overlapping windows.

Minor comment 4: Page 3 Line 32: “one or several missing values”? Shouldn’t this just say “one or more missing values”?

Response:
Yes, the necessary correction will be made.

Minor comment 5: Page 5 Line 3: maybe define lacunarity as used here?

Response:
“lacunarity” should be understood in the sense of “how much of the time period is void of rain”. The larger the lacunarity, the more the rainfall is concentrated in time. This is similar to the notion of fractals which only “fill” a certain fraction of the space over which they are defined.

Minor comment 6: Figure 12 What is dashed line in bottom panel?

Response:
The dashed line represents the fitted linear regression (using least squares) of the change in I95-I99.7 as a function of air temperature. I forgot to mention this in the text and will add it during the revision.

Minor comment 7: Page 8 Lines 21 and 29 refer to changes in rainfall intensity per degree temperature while discussing Figures 4 and 5. If this can't be taken from the figure (I don't believe it can be), it could be helpful to be more clear that it comes directly from Eqn. 14 (especially at Line 29).

Response: Sure, no problem. I'll add a sentence in the text to mention this.

Minor comment 8: Page 8 Lines 9 to 14 This section mentions some different possible explanations of changes in scaling with temperature. As another explanation to possibly offer, I believe in some cases at high temperatures, there is moisture limitation at the land surface. The atmosphere might have capacity to hold moisture, but the land surface in the region has no moisture to give. Temperature merely becomes a proxy for the dryness of a given season.

Response: Yes, I think this is a valid point. Actually, there have been several other studies mentioning this effect before. I will add it to the text and point to the literature for more details.