

## Anonymous Referee #1

We thank the reviewer for all his/her comments which will help to improve the manuscript substantially. We want to thank you for the references provided in the review. Please, find below the response to your comments, questions, and suggestions.

- In the abstract, you mention atmospheric rivers but then there is no further mention of them in the text. Is it really needed to mention them there? - In the abstract we had mentioned the atmospheric rivers (ARs) because together with low-level jets (LLJ), they are the main structures that are associated with a transport of high atmospheric moisture and can trigger episodes of heavy rains or even floods. We agree with the reviewer that this may be misplaced and we will remove the reference in the latest version of the manuscript.

- There have been studies looking at atmospheric rivers and precipitation focusing on specific events across the central United States. The papers by Moore et al. (2012) and Nayak et al. (2016) are likely worth mentioning. – Both references proposed by the reviewer will be added to the introduction.

- More broadly, there have been a growing body of work related to moisture transport over the central United States (e.g., Nakamura et al. 2013; Lavers and Villarini 2015; Steinschneider and Lall 2015, 2016; Nayak and Villarini 2017). – Most of the references proposed by the reviewer will be included in the latest version of the manuscript.

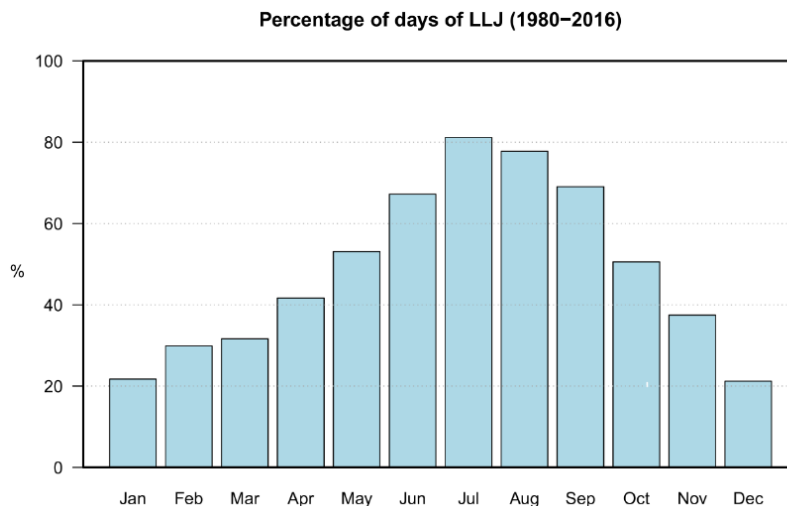
- Pg. 2, line 17: “Higgins et al. (1996)” – The typo has been corrected.

- Page 2, line 34: “which modulate a” – The typo has been corrected.

- Page 3, lines 17-18: “total amount of total precipitable water” seems a bit redundant. What about “amount of total precipitable water”? The same applies to other places in the text. – The text has been updated following the suggestion of the reviewer.

- Page 3, line 20: “as follows: in” – The typo has been corrected.

- Section 2.1: why is the focus only on July and not on June and August as well? Please clarify. - The Great Plains low-level jet (GPLLJ) is a phenomenon mostly related to the warm season. We have focused the study in the month of July because it is the month of the year when we find the highest frequency. Figure attached below shows the monthly distribution of GPLLJ detections.



- Page 3, line 24: “Rife et al. (2010)” – The typo has been corrected in the new version of the manuscript.

- Page 3, line 29: is there an impact on setting a threshold in terms of these differences? As of now, the only requirement is that the wind speed is higher at midnight compared to midday. What happens if you set a threshold, say 10% higher at midnight compared to midday? Would it be possible to have information related to the distribution of the differences between them?

The index is based on the temporal variation of the vertical wind structure. To obtain a day of GPLLJ it is necessary that two conditions are simultaneously met:

1. The wind speed is higher at midnight than at local noon.
2. The wind speed on the surface is higher than at high levels.

We do not believe it is adequate to apply a threshold in the detection of LLJ. The fact of establishing a threshold in one of the conditions would add subjectivity to the methodology used in the study. Nonetheless, if we set the arbitrary threshold of 10% in one of the conditions, the climatology however hardly changes. We have performed the calculation and applying the 10% threshold at midnight we identified 924 days of GPLLJ. However, without applying the threshold we get 931 days of GPLLJ (7 cases of difference). Have or not a day of GPLLJ is mainly due to the fulfilment of both initial conditions. Setting random thresholds only in one condition adds subjectivity to the methodology used in the study.

- Page 3, line 30: “than above it (4km)”? I still don’t think it is the right wording but it sounds a bit better than what is there. – Following the reviewer’s suggestion, the sentence now reads as follow: *The local midnight wind speed is higher at the surface (~ 500m) than above it (~ 4km).*

- Page 3, line 32: “Because of the jet”.

- Page 4, line 9: “variation of 5 the wind” is not clear.

- Page 4, line 17: “possible to calculate”.

- Page 4, line 30: “followed for 10”.

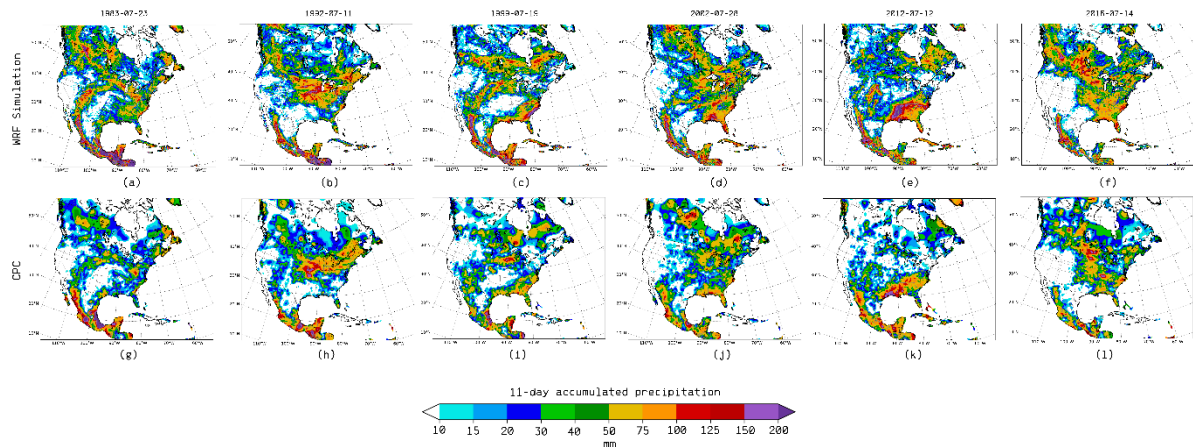
- Page 5, line 12: “above the 75th percentile”.

- Page 5, line 16: “is used to quantify the”.

The typos detected by the reviewer have been corrected in the latest version of the manuscript.

- Is it possible to show some results related to the validation of the WRF model with respect to observations?

We understand the reviewer is asking for some validation or comparison with observed precipitation, which is the most “tricky” variable to solve by all models, including WRF. Figure attached below compares 11-days accumulated precipitation for WRF simulations versus CPC gauge-analysis observations (<https://www.esrl.noaa.gov/psd/data/gridded/data.unified.daily.conus.html>) throughout the same periods. As the reviewer can note, WRF tends to slightly overestimate the precipitation, but it is in all respects represented quite well, both in amount and field distribution. This figure will be added to the supplementary material.



- Page 6, line 1: the symbol  $\phi$  for the instant flux of moisture was already used in equation 3. – “ $\phi$ ” has been replaced by “ $\sigma$ ” in the latest version of the manuscript.

- Page 6, line 16: the use of the correlation coefficient is not appropriate. Please use the Lilliefors test to test whether the data can be described by a Gaussian distribution.

Another option is the Jarque-Bera test.

We agree with the referee on the fact that the correlation coefficient is not an appropriate indicator of the normality of the distribution. Thus, we have applied the Jarque-Bera test which provided a p-value equal to 0.0055. We understand that this p-value is low enough for considering the LLJ distribution as Gaussian.

Accordingly, “A clear peak around  $11 \text{ m s}^{-1}$  is observed together with a Gaussian behaviour ( $R^2 = 0.95$ , red line)” has been replaced by:

“A clear peak around  $11 \text{ m s}^{-1}$  is observed together with a Gaussian behaviour (Jarque-Bera test p-value=0.0055, which provides a confidence level close to 99.5 %, red line)”

- Page 6, line 19: “spans 11 days”.

- I would remove the equation from the caption of Figure 1.

- Pg. 7, line 5: shouldn't this be Figure 2 instead of Figure 1?

The manuscript has been updated following the Reviewer's suggestions.

- Page 7, line 27: why not computing the climatology using all the days, rather than based on just a handful? - The calculation of the climatology using every day of GPLLJ would increase the computational cost in an excessive way. The methodology used in this work, especially the Eulerian model WRF, has a high computational cost. Besides, this multiply the number of simulations making this work unaffordable. In addition, the aim to this study is to quantify the average transport of moisture in a general perspective of the GPLLJ's behaviour. Fig. 4 shows an approximation to this result. This figure is calculated based on the statistical weight of each simulation of the 5 GPLLJ events analysed. Thus, this figure can be understood as a climatological approach to the moisture transport associated with the GPLLJ.

References:

1. Lavers, D.A., and G. Villarini, The contribution of atmospheric rivers to precipitation in Europe and the United States, *Journal of Hydrology*, 522, 382-390, 2015.
2. Moore, B.J., P.J. Neiman, F.M. Ralph, and F.E. Barthold, Physical processes associated with heavy flooding rainfall in Nashville, Tennessee, and vicinity during 1–2 May 2010:

- The role of an atmospheric river and mesoscale convective systems, *Monthly Weather Review*, 140, 358–378, 2012.
3. Nakamura, J., U. Lall, Y. Kushnir, A.W. Robertson, and R. Seager, Dynamical structure of extreme floods in the U.S. Midwest and the United Kingdom, *Journal of Hydrometeorology*, 14, 485–504, 2013.
  4. Nayak, M.A., G. Villarini, and A.A. Bradley, Atmospheric rivers and rainfall during NASA's Iowa Flood Studies (IFloodS) campaign, *Journal of Hydrometeorology*, 17(1), 257-271, 2016.
  5. Nayak, M.A, and G. Villarini, A long-term perspective of the hydroclimatological impacts of atmospheric rivers over the central United States, *Water Resources Research*, 53, 1144-1166, 2017.
  6. Steinschneider, S., and U. Lall, Daily precipitation and tropical moisture exports across the Eastern United States: An application of archetypal analysis to identify spatiotemporal structure, *Journal of Climate*, 28(21), 8585–8602, 2015.
  7. Steinschneider, S., and U. Lall, Spatiotemporal structure of precipitation related to tropical moisture exports over the eastern United States and its relation to climate teleconnections, *Journal of Hydrometeorology*, 17(3), 897–913, 2016.