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Interactive comment on "Tropical Moisture Exports, Extreme Precipitation and Floods in Northeast US" *by* M. Lu and U. Lall

Anonymous Referee #2

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Review of paper

"Tropical Moisture Exports, Extreme Precipitation and Floods in Northeast US"

by M. Lu and U. Lall

submitted to HESSD

This study investigates the role of tropical moisture exports (TMEs) for extreme precipitation and floods in the northeastern U.S. The authors use an previously published TME climatology by Knippertz and Wernli, and quantify the statistical linkage between TMEs entering the northeastern U.S. and precipitation and floods in the same region. The objective of this study is fine, but the quality of the text and figures is insufficient. Important aspects of the study are not well described, the text is confusing in several

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places (and contains too many details), and again the figures provide too much information and lack clarity and compelling evidence. Since I think that a complete rewriting of the paper is required, including a redesign of the figures, I recommend very major revisions.

Major comments:

A) The writing should be strongly improved, for instance in the abstract:

- I am not sure how an air mass can be "born", and why "primarily"? The TME approach only considers air masses of tropical origin.

- "contribute to the global climatology precipitation and its extremes" –> "... of precipitation"

- I am not sure what is meant by "birth process and steering of TME"

- what is meant by "TME birth and entrance"? I assume that the authors mean "tropical origin of TMEs and where they reach the NE U.S."

- what is meant by an "extreme TME"?

B) Important meteorological aspects are not well described, in several places because sentence are too long and contain too much information, e.g.:

- p. 1 line 24 (the first sentence of the introduction): this sentence mixes too many things and become incorrect. The surface baroclinicity mainly drives the extratropical westerlies (jet stream), which then leads to Rossby waves, which can break, and these Rossby wave breaking events are likely involved in events of strong meridional moisture transport. Such meridional moisture transport occurs in extratropical cyclones, but then it typically has no tropical origin; in contrast TMEs (meridional transport with tropical origin) often occurs without extratropical cyclones.

- p. 3 line 9: "Lu et al. (2013) associated TME from the Gulf of Mexico and Tropical North Atlantic Ocean (TNAO) ..." –> no need to introduce an abbreviation if it is not used

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later! "... east to the Bahamas islands" –> too much detail "... as the major moisture sources for the 1995 January flood in western France" –> end sentence here "... and demonstrated the predictability of the extreme precipitation given only the midlatitude sea level pressure (SLP) fields" –> totally different aspect, why mention predictability here? "...suggesting that steering mechanisms were important" –> isn't this trivial, of course the steering of moist air masses is important(?).

- p. 3 line 20: confusing mixture of "TME tracks" and "trajectories", why tracks? Please make clear that the TME approach is based on air parcel trajectories.

- p. 3 line 21: "Each trajectory has its moisture source calculated for every 100 km $\times$ 100 km box between the equator and 20°N" –> what does this mean? The TME approach by Knippertz and Wernli does not calculate moisture sources! "... such that 90% of all water vapor is integrated" –> I don't understand this.

- p. 3 line 26: "To ensure that the characteristics of the tropical air parcels are maintained on their way across the subtropics" –> what is meant by this? Which characteristics should be "maintained"?

- p. 4 line 20: "The number of TME that enters the N.E. USA on any given day depends on the associated birth process" –> what is meant by this? Do you simply refer to the region of TME origin? Or do you speak about the processes that make the tropical air mass leave the tropics?

C) I don't see TMEs studies primarily as studies of moisture sources, TME studies mainly address the question "where when and how does tropical moisture reach the extratropics?" For specific moisture source studies, backward trajectories are more feasible and sophisticated techniques have been developed to obtain detailed moisture source fields for extreme precipitation and flood events, see, e.g., the following studies:

Sodemann, H., C. Schwierz, and H. Wernli, 2008. Inter-annual variability of Greenland winter precipitation sources: 1. Lagrangian moisture diagnostic and North Atlantic

Oscillation influence. J. Geophys. Res., 113, D03107, doi:10.1029/2007JD008503.

Winschall, A., S. Pfahl, H. Sodemann, and H. Wernli, 2014. Comparison of Eulerian and Lagrangian moisture source diagnostics – the flood event in eastern Europe in May 2010. Atmos. Chem. Phys., 14, 6605-6619.

Piaget, N., P. Froidevaux, P. Giannakaki, F. Gierth, O. Martius, M. Riemer, G. Wolf, and C. M. Grams, 2015. Dynamics of a local Alpine flooding event in October 2011: moisture source and large-scale circulation. Quart. J. Roy. Meteorol. Soc., 141, 1922-1937.

D) p. 4/5: very nice that the authors have specific research questions; they sound good, but they are unclear to the reader. What is an "entrance mechanism"? What are "identifiable atmospheric circulation patterns"? Why identifiable?

E) To me, the tables are much too detailed. Consider only showing seasonal mean values (not monthly) and maybe reduce the number of tables.

F) Figures:

- to me, Fig. 1 is not insightful, "month" and "ENSO" should not be similar categories

- Fig. 2: far too many panels, please reduce the information such that it becomes attractive for the reader

- Fig. 3: is this for all TMEs, or only for TMEs entering the northeastern U.S.?

- Fig. 3-5: my impression is that some information in these figures is redundant. Would Fig. 5 not summarize the key information and Figs. 3 and 4 could be omitted?

- Figs. 7 and 8: I think here the reader is completely lost, this information is not yet well "digested" by the authors. These monthly fields look so strikingly different such that I don't know what I can learn from these fields. Why showing the entire Northern Hemisphere? The key processes of TMEs entering the northeastern U.S. should be much more local. Also I have no idea what the unit is in these panels (500 Pa? = 5

hPa?). Why are the signals not much stonger near the U.S.?

- Fig. 10: caption is unclear.

Minor comments:

1) Title, should read "... in the northeastern U.S."

2) p. 2 line 17: instead of Wernli (1997), it was Knippertz and Martin (2007, Weather and Forecasting), who introduced the term "moisture conveyor belt". This sentence is not fully clear to me, I think the main difference between ARs and TMEs is the Eulerian vs. Lagrangian defintion - this should be better emphasized.

3) p. 3 line 6: "note" –> "noted"

4) p. 3 line 7: "tropical born moist air masses" –> again, "born" does not make sense; air masses cannot be born or die, what changes is their moisture content, and therefore we can speak about moisture sources and sinks

5) p. 5 line 14: unit should be "kg" not "Kg"

6) p. 5 line 14: "The position of the air parcel was updated every 6 hours, thus each track has 29 (4 updates up to 7 days including birth place, $4 \times 7+1$) positions (latitudes & longitudes) recorded on its trajectory." This is terribly complicated and not understandable, why not just "For all TME trajectories, position information (lon, lat) is available every 6 hours". On line 21 you say the same thing again.

7) p. 5 line 22: "death location" is very awkward, this is just the end of the TME trajectory calculation!

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