Comment on egusphere-2022-612
Patrick Keys (Referee)

Referee comment on "Local moisture recycling across the globe" by Jolanda Theeuwen et al., EGUsphere, https://doi.org/10.5194/egusphere-2022-612-RC2, 2022

SUMMARY
The authors of "Local moisture recycling across the globe" explore the concept of local moisture recycling (LMR), and its distribution and characteristics globally. The authors aim to understand the drivers of LMR and explore the heterogeneity of the phenomena across latitudes, biomes, and elevations. In general, I find the work interesting and the analyses mostly sound. I think that once the authors can make some changes — which I think would fall into the minor category, but I suppose could be major — this ought to be published.

Here are several general comments followed by more line specific comments afterward.

GENERAL COMMENTS
1. "Drivers": I had some trouble with the word “drivers” being used to describe the role of e.g., CAPE, in LMR. While it's possible that some of the correlated variables could be causally related to LMR, there was no causal analysis completed (or a mechanistic explanation) as far as I could tell. Given that, it seems perfectly reasonable to say correlated phenomena (or similar) with regard to the variables that seemed to have convincing correlations with LMR, e.g., wetness or elevation.

2. LMR Definition: This is purely a suggestion, but I would strongly encourage the authors to frame the LMR idea conceptually first (which I think would force the authors to argue more clearly for the novelty of the idea), and then provide the specific way that they define it in the article (e.g., "LMR is __________, which we define here as ______"). The reason being that LMR could be a conceptually useful idea on its own, but others may make entirely different quantifications, or indeed develop a more robust geophysical definition later on. By distinguishing your conceptual contribution from the physical definition, you may give the concept more scholarly and applied longevity. Again, just a suggestion.
3. Expand the Introduction: Given the intended scope of this work, the introduction should be expanded to include discussion of past moisture recycling analyses that relate to the LMR idea. There are quite a lot of moisture recycling studies that examine: local recycling (though perhaps not at the global scale), the scale dependence of moisture recycling, and the role of different types of vegetation in the scale dependence of moisture recycling (e.g., van der Ent et al., 2014).

4. Discussion of robustness of a 10-yr climatology: The current draft of the paper does not suitably discuss the appropriateness of the time scale associated with the Utrack dataset in the context of climate variation. Given that the authors are making claims about 'average rates', correlating with phenomena to determine their relationship (potentially causative) of LMR, etc., it is necessary to provide both a justification and a discussion (including of limitations) vis a vis a 10-year climatology. Given that there are inter-annual (e.g., ENSO, Indian Ocean Dipole) and decadal-scale (e.g., Pacific Decadal Oscillation) modes of climate variability that could be systematically affecting some of these results, it is necessary to explain the role of a 10-yr only analysis. Saying that the data are only available for 10 years is not really sufficient. Acknowledging this temporal limitation is critical also for making sure readers can appropriately interpret the results, which could change with a longer time series. Again — I recognize the authors have mentioned the topic of the length of record albeit briefly, but a more in-depth discussion is needed.

5. A 50-km definition: The authors select 50 km as the spatial scale of their LMR definition. A bit more discussion is needed to explain the logic and rationale of why such a blanket definition across the terrestrial surface is appropriate, and not an orographically-, latitudinally-, or biome-dependent definition. I’m not suggesting to change away from 50 km, but enough other research has found that moisture recycling ratios and spatial scales are associated with vegetation type, position on continent relative to prevailing winds, proximity to mountains, etc. that the authors need to support their 50km definition more strongly.

SPECIFIC COMMENTS
L10 Consider saying “defined here as…”

L11 You could consider using the phrasing “a 10-year climatology…”

L21 See General Comment about Expanding the Introduction.

L23 The sentence beginning with “However, it is unknown…” seems like it might not truly reflect the state of knowledge about moisture recycling globally, and overclaim the knowledge gap. You could consider situating this more concretely in what is understood (e.g., from the perspective of vegetation type having different length scaling associated with moisture recycling, etc.)
L38 The authors propose to explore “spatial-temporal variation across the globe” but a 10 year climatology is not enough to support the “temporal variation” component.

L67 What is the origin of these correlated variables? I could not see whether they came from ERA5 or somewhere else. Likewise, given the range in geophysical process scale of these variables, it would be good to comment here (or in the discussion of limitations) on the spatial scale of some of these, and whether some are more or less appropriate at the scales of analysis used in the study.

L67 See General Comment about the word “Drivers.”

L78 It is worth noting (either here, or in the Discussion) that the specific continental configuration (and mountain ranges) relative to prevailing winds and the associated biome composition matters quite a lot for determining the distribution of moisture recycling ratios. I know that the authors know this already (just looking at the author names and their past publications) so it is a noticeable gap in the logic.

Fig3 This is an interesting figure, but I think that the bottom left panel provides the most insight. I would recommend pulling this figure out on its own, so that it can be seen in a larger capacity, given the density of dots and information presented.

L135 Again, drivers is probably not quite right here, since there is no sufficiently causal mechanistic explanation of the link between e.g., CAPE and LMR.

L141 This seems like a perfect opportunity to situate the findings in the sweep of convective storm literature. I suspect that a convective storm meteorologist might not find the statement very surprising “our results suggest a positive relation between convection and LMR.” That doesn’t mean it shouldn’t be said — just that some references aligning this statement with the corresponding literature seem prudent.

L149 If I’m looking at the right Miyamoto 2013 reference, the argument appears to be that the number of convective features increases dramatically with resolution. That being said, the statement that “convection is a local scale process (i.e., spatial scale of 100 km)” might want to be adjusted.

L145 The entire paragraph needs better referencing, since the authors are making numerous claims regarding convective storms, and how the LMR analysis relates to that field. Greater referencing would also give me (the reader) more confidence that these claims are supported by the broader field.
The global biome discussion is very interesting, but in its current presentation it both (a) reads as results, and (b) needs a supporting figure in the main text.

These findings are very interesting, and are well discussed. I would use the density of supporting references and citations here as an example of what is necessary in the “convection” section above.

The authors rely heavily (though not entirely) on Salmon et al 2011. Given the range of claims being discussed here, it seems prudent to include a few more references (than relying on Salmon et al. three times in the same paragraph.

I encourage the authors to cite the work by Kirsten Findell in this paragraph (see Refs below), who provides a global analysis which blends empirical analysis and theory to explore how continental moisture recycling may change over the coming century.

The sentence should be restructured for clarity.

It might be interesting to be able to state the standard deviation associated with the 1.6% number that is quoted throughout the paper.

REFERENCES
