EGUsphere, referee comment RC1
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Comment on egusphere-2022-530

Anonymous Referee #1

Referee comment on "The role of atmospheric rivers in the distribution of heavy precipitation events over North America" by Sara M. Vallejo-Bernal et al., EGUsphere, https://doi.org/10.5194/egusphere-2022-530-RC1, 2022

General comments:

This manuscript identifies a synchronization between landfalling atmospheric rivers (ARs) on the west coast of North America and heavy precipitation in central Canada. The authors use a novel technique of Event Synchronization to assess the timing of heavy precipitation across North America to a time series of landfalling ARs. Due to the relative timing of these events the authors conclude that there is a linkage between these events, suggesting a moisture pathway following AR landfall. The authors utilize network analysis to examine the statistical relationship in the timing of heavy rainfall and landfalling ARs, identifying the sequency of events: central Canadian precipitation is preceded by west coast precipitation when associated with high ranked ARs. Composite analysis is undertaken to present the synoptic scale conditions during and following landfall of high ranking ARs.

Specific comments:

Overall, this manuscript is presented very well, in a clear, precise manner. The writing style is generally excellent with minor grammatical errors identified below. Figures are presented well and the appendices complement the work well with important caveats addressed such as reproducibility with a second AR detection method. The methodology of event synchronization is certainly novel and its application in the analysis of precipitation time series is highlighted here. The applicability of the final conclusions, however, appear to overstate the scientific discoveries made throughout the manuscript. While the main conclusion of precipitation synchronization and AR landfall is very interesting, it raises many questions and does not represent a significant contribution by itself. The composite analysis contains confusions/errors (noted below) which does not allow for a suitable discussion of the related atmospheric dynamics. A major revision of the composite analysis is required for this paper to provide a substantial scientific contribution; to accurately describe the synoptic conditions during high ranking ARs that facilitate inland penetration of moisture following landfall.

It would also be beneficial for the authors to examine and discuss some of the literature on inland penetrating ARs and AR lifecycles in North America (such as Rutz et al., 2015; https://doi.org/10.1175/MWR-D-14-00288.1). This study has the potential of being beneficial to the AR community if it is presented within the context of modern AR studies. Some of the questions that arise are:

- Do the ARs remain as identifiable objects following landfall and during the central Canadian precipitation or have they undergone termination? Post-termination precipitation is an interesting concept that the presented findings may suggest.
- What are the synoptic conditions that allow for a high ranked AR to cause precipitation in central Canada? Are there some ARs that do not cause this precipitation, what atmospheric conditions allow for this to occur?

Specific comments:

Title: The word 'triggered' may not be suitable here as the local triggers of precipitation are not identified in the study. The focus is also on distant rainfall events, well beyond the landfall location (specifically in Canada). I would recommend rewording this, one possible option may be: 'Spatio-temporal synchronization of heavy precipitation in central Canada and landfalling North Pacific atmospheric rivers'

Line 6: Landfall is usually written without a hyphen.

Line 7: The term 'rank' is now being favored over the 'category' wording, with AR ranks referred to as 'AR1, AR2' rather than 'Cat 1, Cat 2'. This is to avoid confusion with hurricane terminology.

Line 10: 'AR strike' is ambiguous, does this mean landfall?

Line 15: This final conclusion is very broad and does not reflect the findings of the paper. An alternative is to say that this work will lead to a better understanding of inland precipitation events and how changing climate dynamics may impact precipitation occurrence and consequent impacts in a changing climate.

Line 19: 'where they landfall and cause copious rainfall' is too casual, could be improved to 'and can cause substantial precipitation following landfall'

Line 19 and 21: Do not need the parentheses inside the parentheses (this occurs multiple times throughout the manuscript).

Line 22: The grammar of this sentence needs to be fixed, too many conjunctions and becomes hard to follow.

Line 23: Need more introduction/literature discussion around increasing water vapor and ARs in a future climate. More nuanced than this sentence suggests.

Line 30: 'Will form at the front of a mid-latitude cyclone…', the term 'front' has strong connotations in atmospheric science and makes this sentence confusing. ARs tends to form as part of the cold front of a mid-latitude cyclone, specifically the pre-cold frontal lower-level jet.

Lines 32-39: This literature is not directly related to the study presented. This introduction should focus more on the inland penetration of moisture (ARs) and AR lifecycle pathways in North America (i.e. Guan and Waliser 2019; https://doi.org/10.1029/2019JD031205).

Line 67: Reanalysis precipitation can be problematic and contain biases, it would be beneficial to acknowledge this and if possible, provide a reference to the accuracy of this data product for the region of interest.

Methods: Very well written methods section, clear and concise. Could possibly use more description of the network analysis to make this more accessible, specifically for those unfamiliar with this approach.

Lines 154-156: These sentences need rewording

Figure 2: The spacing between precipitation on the coast and central Canada is intriguing. Is there a suitable reason for this? Possibly the role of topography?

Line 188: It appears the text has the sign wrong than what the graph shows, with negative divergence values at the coast and positive divergence values out in the Pacific.

Line 197: Double parentheses used again, these can be removed.

Line 220: The word ‘cascade’ makes it sound like many events, from what I interpret these results identify a sequence of 2 rainfall events, Coastal and then central Canada with 12 days following.

Line 226-227: The grammar of this sentence needs improving, hard to follow.

Section 3.5: This section is an assessment of the synoptic conditions and not the climate.

Line 230-231: ‘The moisture is distributed further to the mainland’, this is difficult to see on the figure, particularly over Canada. It appears that the moisture flux remains relatively in the same broad location, but becomes weaker.

Lines 232-234: This interpretation is problematic. The authors appear to be referring to maximums in geopotential height anomaly as ‘the cyclonic storm’, at 500 hPa this maximum rather signifies a ridge with a trough in the northwest of the scene (not a high-pressure area). This mid-level pressure dipole presented here implies a southwesterly geostrophic wind, bring warm moist air into the northern regions of North America. Since the vast majority of moisture transport is also in the lower atmosphere, the surface low (cyclone) is the key feature of interest, which will be located more towards the 500 hPa minimum in the northwest, with an assumed cold front running from the lower left of the scene towards the Canadian coastline which facilities the moisture transport. These results appear to show the importance of ridging over the Western USA for strong ARs to make landfall in Canada. I would recommend a full rewrite of this section to ensure the interpretation of this figure is correct.

Line 237: The word ‘continent’ after Pacific is not required.

Figure 6: This figure presenting the composite during all high ranked ARs. It will be very interesting if the authors could make similar figures for the conditions of when the landfalling AR does and does not cause synchronized precipitation in Canada. Are there specific atmospheric conditions that don’t allow for the deep inland penetration of moisture and subsequent precipitation? This would be a great appendix figure.

Line 260: This sentence is not easy to read, possible grammatical error, ‘…with ARs synchronize initially…’, this is the confusing part. May need to reword this.

Line 270: ‘…Maintaining a moisture flux…’ of what magnitude? Over 250 kg m^{-1} s^{-1}?

Line 280: Similar to comments about the abstract, this sentence needs to be reworded to better reflect the benefit of the science presented in this paper.