Review for The Cryosphere: Quantifying the Impacts of Atmospheric Rivers on the Surface Energy Budget of the Arctic Based on Reanalysis
Review #2

1. The addition of the new panel C in Figures 2-3 and 5-7 is appreciated and helps illustrate how important ARs are to each term of the surface energy budget. However, the original metric still does not seem mathematically sound enough for the conclusions that are being drawn from it.

   In the SEB contribution metric, the relative importance is inflated in some regions since the net SEB is near zero. Therefore, even a very small anomaly (e.g., < 8 W m^{-2}) is deemed to have a massive contribution even if it isn't enough to make any kind of material difference to the SEB/temperature/etc. This is especially true over land regions where seasonal net SEB can be very small (e.g., SEB = 0.4 W m^{-2} for Greenland in MAM). This is an especially problematic issue because some of the terms contributing to the SEB are of higher magnitude than the net SEB, with correlated but offsetting terms (e.g., LWD v. LWU or LWnet v. SWnet) can make the SEB near zero seasonally. Because of this, you can have anomalies that seem large when compared to net SEB, but actually are only a small contributor to seasonal totals (which is illustrated well in Figure 2 panels c vs d).

   If you consider the spatial pattern of net seasonal SEB, it is evident that the spatial variation in the relative contribution results (e.g., Figure 2d) are determined primarily by variation in the denominator (net SEB) rather than the numerator (e.g., LWD, LWnet, etc.). For example, in Figure 2d, there are much higher relative values over land than over the ocean, especially in Fall and Winter, least so in Summer. This tracks exactly with the net SEB being practically 0 W/m2 over land in Fall and Winter and appreciably positive (downward) in Summer. Every variable (including some that counteract each other) gives higher relative results over the continents. This issue is well demonstrated by Spring in Figures 2 (LWD) and 3 (LWnet). Comparing central Siberia to the Laptev Sea, LWD anomalies are clearly stronger over land than over the Laptev Sea (Figure 2b). In relative terms, the continental anomalies are also higher than the Laptev Sea (Figure 2d). Both central Siberia and the Laptev Sea have smaller absolute anomalies in LWnet than LWD – and the anomalies about the same continent versus land (Figure 3b). However, the relative impact again shows the continental anomalies being higher. It doesn't matter if the land has higher magnitude absolute anomalies than the ocean or not – both Figure 2 and Figure 3 yield higher relative anomalies for the land. In other words, the relative figures are telling us a lot more about the denominator than the numerator, meaning Figure 2d and Figure 3d are primarily telling us about SWnet rather than LWD or LWnet.

Caution should be used when drawing conclusions from a metric that can be easily skewed. The relative metric used is not mathematically incorrect, but the issue lies in how strongly the conclusions are drawn from said metric. For example, lines 914-916: "*ARs generate relatively smaller absolute anomalies in net SEB over continental areas (Fig. 7b), mainly attributable to the LWN. However, their impact on the mean SEB is substantial, especially in cold seasons (24-90%), far exceeding the corresponding frequency, which is primarily due to the smaller mean SEB (Fig. 7a).*" Here, it is stated that the "large contribution" is really just because of the small net SEB. However, the relative contribution metric is still used consistently to mathematically compare to the frequency and draw the main conclusions (e.g., in the abstract), even though it is clear that it is easily skewed.

The goal of understanding AR's contribution to seasonal net SEB can even be well approximated by directly comparing the mean absolute anomalies during ARs to the mean seasonal conditions for each term and the net SEB. Many of the conclusions can still be made supported by the values shown in panels (b) and (c), rather than strongly relying on panel (d) for the main conclusions. Therefore, although calculating a relative anomaly is mathematically fine (and they can stay in the results), relying on such anomalies in this case is logically flawed, and the authors should change the focus of the conclusions and abstract to reflect this.

2. I agree with other reviewers that the net SEB (Figure 7) should be shown much earlier (even before Figure 2 since the results in Figure 2 are relative to the net SEB). It would be helpful to illustrate the regions of low net SEB earlier so it's easy to see why those >> 100% contributions exist.

Technical comments:

- Fig 2: the colourbars for panels (c) and (d) are very close to being the same but are slightly different – suggest using the same colourbar if they're almost identical to make it easier to interpret
- Line 338: "the modest large contributions" – unclear how the contribution is both modest and large (perhaps "the modest increase in contributions" is what is meant here)
- Line 474-475: "except in winter when reduced climatological LWN cooling leads to *a slight increase contribution*" → "a slight increase in contribution"
- Supplemental figures: for the statistical significance figures, "The grey dots are plotted over regions of anomalies outside of the 95% confidence intervals based on two-tailed t-test" is unclear – Are the dots shown where the anomalies are not statistically significant at the 95% level?