Review of "Influence of atmospheric rivers and associated weather systems on precipitation in the Arctic" by Lauer et al.

General Comments:

The paper quantified the contributions of ARs, cyclones, and fronts to the total precipitation over the Arctic Atlantic sector during the two airborne campaigns, ACLOUD and AFLUX, using ERA5 data. It is found that during ACLOUD, AR- and front-related systems were most related to the precipitation rate. In contrast, during AFLUX, cyclone-related components played a dominant role in the precipitation rate. The authors further analyzed the precipitation types (convective or large-scale) and phases (snow or rain) associated with different systems. In addition, they quantified the uncertainty by comparing the results according to different AR and cyclone detection algorithms and the application of precipitation thresholds.

The paper was very interesting and mostly clear to read. The analysis was largely based on exploratory analysis. Linking ARs to Arctic precipitation and comparing their contributions with other weather systems using a new classification method seem appealing. It will be an important contribution to the AR literature. However, I have two main concerns which could be addressed and make the study clearer and more robust.

First, the authors consistently emphasized the assumption that seasonal differences account for the different results in the two campaigns. However, this work was mainly based on two short periods of airborne campaigns. It is too soon to attribute the different results during the two campaigns to seasonal differences. As the authors stated at the end of the paper, “for drawing robust conclusions about these seasonal differences, a long-term assessment exploiting the full ERA5 record is planned in the future”. Without the long-term climatology study, I would not suggest consistently implying different results during the two campaigns owing to the seasonal differences. Specifically, in lines 269-270, the hypothesis was made without any explanation. Lines 276-277, 302-304, 366-367, and 455-456 consistently emphasized the “seasonal differences.”

Second, the authors compared the results based on the different AR and cyclone detection algorithms in section 3.6. However, the authors did not explain why they should be so (such as Lines 445-454). Perhaps the authors can explain more about the observed different results based on the different algorithms, such as the different AR detection criteria between AR_Gu and AR_Go, the different physical aspects that each algorithm emphasized, and so on….

Specific Comments:

- Lines 49-51: I do not think that ARs “only cover about 10% of the Earth’s surface circumference but are responsible for more than 90% of the poleward moisture transport in and across mid-latitudes” were found by Nash et al, (2018). In Nash et al, (2018), they cited that “Annually, ARs contribute over 90% of the poleward moisture

transport in the middle to high latitudes, despite only covering ~10% of the Earth's circumference over the midlatitudes (Guan & Waliser, 2015; Zhu & Newell, 1998)."

Zhu, Y., and R. E. Newell (1998), A proposed algorithm for moisture fluxes from atmospheric rivers, Mon. Weather Rev., 126, 725–735, doi:10.1175/1520-0493(1998)126<0725:APAFMF>2.0.CO;2.

Guan, B. and Waliser, D. E.: Detection of atmospheric rivers: Evaluation and application of an algorithm for global studies, JOURNAL OF GEOPHYSICAL RESEARCH-ATMOSPHERES, 120, 12 514–12 535, https://doi.org/10.1002/2015JD024257, 2015.

- Lines 121 and 123, 148,150: atmospheric data in ERA5 on the standard pressure levels from 1000 hPa to 1 hPa (i.e., a total of 37 vertical pressures) are interpolated from the 137 hybrid sigma/model levels in the Integrated Forecasting System (IFS). However, surface pressures over the Arctic study domain may be lower than 1000 hPa at high altitudes (e.g, Greenland). Therefore, considering Arctic topography, it is best that the integration is from the surface to 300 hPa. However, I think the current calculations of the integration from 1000 hPa would not change conclusions.

- Line 125: by "the 85th percentile of IVT", do you mean seasonally-based 85th percentile of IVT as stated in Guan and Waliser (2015)?

- Lines 197-198: "5-25 °E", for me, it seems around 15-25 °E?

- Lines 297-298: I do not quite understand the point in the "Therefore, it could be possible that parts of light precipitation related to residual (or also to the other weather systems) might be in the vicinity of the detected AR shape." Maybe you can explain more about that.

- In lines 302-304, can you expand on what "AR-related intensity" are being referred to here?

- Lines 338-339: based on Table 3, should the sentence be "clear dominance of cyclones for AFLUX (co-located: 14%, only: 48%) compared to ACLOUD (co-located: 12%, only: 7%)"?

- Line 347: I am unsure about the sentence, "For rain, the fraction of total precipitation is highest for ACLOUD with 33% and lower for AFLUX with 10%". I suggest rewriting.

- Line 379: I do not quite understand “Thus, GuS mainly attributes precipitation frequently to fronts only (O-FRONTS).” How do you conclude this based on Table 1?

- Line 384: “Thus, GoS produces the strong precipitation contribution by cyclones discussed before” do you refer to GuS, not “GoS” as in the text?

- Lines 385-386: Would you please expand on the expression “Consequently, the contribution of ARs would increase by 8%, and the contribution of O-CYC would decrease by 6%” to be more clear?

- Line 390: Do you mean Figure 8?

- Line 50: do you mean by many regions’?