Review result of “Moisture origin, transport pathways, and driving processes of intense wintertime moisture transport into the Arctic” by Papritz et al.

Overall recommendation: Major revision

This study is an interesting topic. This manuscript examines the moisture sources of Arctic warming in different regions, whose findings help us improve an understanding of the occurrence of Arctic warming. However, there are some clarity and confusing issues in this manuscript so that I recommend a major revision. Especially, some results of this manuscript have been reported in other previous studies. However, the authors didn't make any comparison.

Major comments:

(1) Abstract is too long, which should be shortened to emphasize new findings different from previous results.

(2) In the introduction of this manuscript, some descriptions are misleading, which should be rewritten and re-organized. For example, please see the descriptions (yellow shading) below:

> events are often of planetary scale (Graversen and Burtu, 2016; Heiskanen et al., 2020), owing to blocking anticyclones that provide favourable conditions for inducing persistent and intense poleward moisture transport (Papritz and Dunn-Sigouin, 2020). However, Papritz and Dunn-Sigouin (2020) further showed that other events of intense zonal mean moisture transport are associated with poleward deflections of the storm track, in particular in the Nordic Seas, or they result from a combination of blocking and storm track deflections. Since cyclones form in a baroclinic environment, poleward flowing, humid air, for

Before Papritz and Dunn-Sigouin (2020), Luo et al. (2017, ERL and 2019, CD) have examined the different roles of high-latitude European blocking (or Scandinavian blocking) and Ural blocking with positive North Atlantic Oscillation (NAO^+) in influencing the poleward deflection of the storm track and producing persistent and intense poleward moisture transport toward the Barents-Kara Seas. The same issue also exists in other region of this manuscript. Maddonna et al. (2020) examined the control of atmospheric large-scale flows in cyclone variability over Barents-Kara Seas. Also see the review of Henderson et al. (2021). I think that the authors should cite the works of Luo et al. (2017, 2019), Maddonna et al. (2020) and Henderson et al. (2021) in the yellow shading region.

(3) Some descriptions of the integrals in $\bar{M}$ and Q are confusing. The authors should clearly describe what is $\iint$. For example: $\int_{70\mathrm{N}}^{90\mathrm{N}}\int_{p_s}^{p_0} v dx \frac{dp}{g}$?, $p_s = 1000hPa$ and $p_0 = 900hPa$?

(4) In section 3, the authors defined the layer near 700 hPa as the mid-troposphere is inappropriate. In general, the layer between 600 and 400 hPa is defined as the mid-

troposphere, whereas the layer between 1000 and 700 hPa is defined as the lower troposphere. I suggest that the authors should calculate the moisture transports and their trajectories following the new definitions of the mid-troposphere and lower troposphere.

(5) The results in section 4 are interesting. Some results of this section have been found in previous studies and some results are new. However, the authors didn't make any comparison with previous results. For example, in section 4.1 (Characteristics of moisture transport at 70N), some results are consistent with those of Zhong et al. (2018). The authors should at least compare their results to emphasize which results are new. In section 4.2 (Geographical distribution of moisture sources), some results are consistent with the previous findings. The authors should point out their difference with the previous results to emphasize which ones are consistent with previous results and which ones are new. For example, "a tongue of enhanced moisture uptake extends into the western North Atlantic along the warm side of the Gulf Stream front" has been found in Luo et al. (2017, ERL).

(6) The definitions of $\Delta\theta+\Delta T-$, $\Delta\theta+\Delta T+$, $\Delta\theta-\Delta T-$, $\Delta\theta-\Delta T+$ are confusing. I think that the authors should revise the definitions. $\Delta\theta+\Delta T-$ should be changed to $\Delta\theta+/\Delta T-$ in order to avoid a misunderstanding.

(7)

Climatologically, the moisture injected into the polar cap during zonal mean moisture transport events originates almost exclusively in the North Atlantic owing to the much higher number of events in this basin. The largest contributions of moisture associated with North Atlantic events stem from a band between 50° N and 70° N (accounting for $>50\%$ of the explained moisture), including the seas between Iceland, the British Isles, and Norway. Evaporation along the Gulf Stream front and its extension - the regions with the climatologically highest evaporation rates in the North Atlantic - provide moisture transported into the polar cap at mid-tropospheric levels, while they are of low importance for moisture transported in the lower tropo-

study. Furthermore, it is important to note that we do find moisture originating in the western North Atlantic, especially along the extension of the Gulf Stream front, to contribute to mid-tropospheric poleward moisture transport at 70° N ($\Delta\theta+\Delta T-$).

The results in the yellow shading region were not new results, which have been also noted by Luo et al. (2017). In these regions, the authors should mention the results of Luo et al. (2017).

(7) In section 5.4, the authors should emphasize new finding points different from previous results.

Suggested references are given below:

Luo, B., et al. 2019: The winter midlatitude-Arctic interaction: effects of North Atlantic SST and high-latitude blocking on Arctic sea ice and Eurasian cooling. **Climate Dynamics, 52**, 2981–3004

Maddonna, E., et al. 2020: Control of Barents Sea Wintertime Cyclone Variability by Large-Scale Atmospheric Flow. **Geophys. Res. Lett.**, **https://doi.org/10.1029/2020 GL090322**

Henderson, G., et al. 2021: Local and Remote Atmospheric Circulation Drivers of Arctic Change: A Review. Frontier in Earth Science, doi: 10.3389/feart.2021.709896