Summary

Using a Lagrangian back-trajectory method, this study highlights the role of diabatic heating associated with extratropical cyclones in affecting the high-latitude blocking and warming the Arctic. They found that 60% of extreme warm events of winter Arctic are preceded by Ural blocking. In these cases, 60% of the air parcels making up the Ural PV anomalies are associated with diabatic heating and 70% of the heated trajectories undergo maximum heating from the midlatitude North Atlantic.

Recommendation

Several prior studies on the importance of Ural blocking in driving the Arctic temperature have been predominantly statistical in nature. I believe that this study brings an important contribution by evaluating the role of diabatic heating in affecting the blocking through Lagrangian back-trajectory calculations. I thus recommend the authors to perform a major revision by considering the comments listed below.

Major comments:

(1) As suggested by the thermal budget analyses in Kim et al. 2021, the arctic temperature changes are primarily driven by the temperature advection associated with the SLP anomalies over the Ural region and partly cancelled by the diabatic heating. Wang et al., 2021 have suggested that diabatic heating acts as a damping mechanism for the Ural blocking both upstream and downstream. It seems important to make a comparison of the role of diabatic heating in this work to those results.

(2) The authors highlight the role of diabatic heating associated with the North Atlantic cyclones in affecting the Ural and Scandinavia blockings, however, the mechanisms of which are not comprehensively discussed in the current manuscript. They focus on the sources of low-PV air associated with the blockings and show that ascending warm air associated with Atlantic cyclones may influence the high-latitude blocking. I believe adding more discussions on the dynamics of heating from North Atlantic affecting the Ural blocking are necessary for publication in “weather and climate dynamics”.

(3) The title does not fully reflect the essence of the article. In the current manuscript, the authors highlight that diabatic heating associated with the Atlantic cyclones can affect the Eurasian atmospheric blocking. They didn’t show the impact of Eurasian blocking on the Atlantic cyclones. There are no discussions on the interaction between Atlantic cyclones and Eurasian atmospheric blocking. In this regard, the authors are encouraged to correct the title, e.g., to adjust it, excluding the mention of the interaction.

(4) In section 3, the authors show the trajectory classification results of three warm events in January 2006. However, the details of the methodology are introduced in section 5. I thus recommend the authors to move the trajectory classification methodology to section 2. It is more fluent for the manuscript flow and easier for the reader to understand the results in

section 3.

Minor comments:

Figure 1: the dashed cyan lines are hard to recognize as the background shading is already blue.

Figure 3 has too much information in panels (a)-(l). The green and purple lines as well as the magenta and blue boxes are hard to recognize in those plots. I thus recommend the authors to replot these panels.

Line 340/420, since many other processes (e.g., horizontal advection of temperature in Kim et al., 2021, barotropic and baroclinic processes associated with local wave activities in Wang et al., 2021) are not discussed in this section, the conclusion of "diabatic heating plays a major role in the blocking events" should be cautious.

References:

Kim, HJ., Son, SW., Moon, W. *et al.* Subseasonal relationship between Arctic and Eurasian surface air temperature. *Sci Rep* **11,** 4081 (2021). https://doi.org/10.1038/s41598-021-83486-5

Wang, M., Zhang, Y., & Lu, J. (2021). The evolution dynamical processes of Ural blocking through the lens of local finite-amplitude wave activity budget analysis. *Geophysical Research Letters*, 48, e2020GL091727. https://doi.org/10.1029/2020GL091727