

Weather Clim. Dynam. Discuss., referee comment RC1
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Comment on wcd-2022-18

Pengfei Zhang (Referee)

Referee comment on "Stratospheric downward wave reflection events modulate North American weather regimes and cold spells" by Gabriele Messori et al., Weather Clim. Dynam. Discuss., <https://doi.org/10.5194/wcd-2022-18-RC1>, 2022

Comments on wcd-2022-18:

This manuscript analyzes the stratospheric wave reflection events and the following tropospheric/surface weather evolutions in North America using reanalysis data. The authors start with a regional stratospheric wave reflection detection metric and 44 events have been detected since 1980. By comparing with the North American weather regimes, the wave reflection events show a transition from a regime characterized as a trough anomaly in North Pacific and a ridge anomaly in North America to a regime with a reversed pattern. The surface air temperature changes from warm anomaly to cold anomaly in about two weeks, presenting a large-scale decrease evolution.

I think the two mechanisms (wave-mean flow interaction and wave reflection) are in fact different aspects of the same planetary wave-zonal flow interaction rather than totally different dynamical mechanisms. Both are useful for our understanding of the influence of the stratosphere on the troposphere. While the wave-mean flow interaction has been well studied, relatively less attention has been paid to wave reflection. The current study is a systematic analysis of the tropospheric weather evolution following the detected wave reflections. The manuscript is straightforward and well-organized. I believe this manuscript could be a helpful reference for the research community of stratosphere-troposphere coupling. Thus, I think it could be acceptable after minor revision.

Specific comments:

1. What's the spatial pattern of the stratospheric polar vortex associated with the detected

wave reflection events? Stretching, shifting, or zonally symmetric weakening? The authors may add an Appendix figure at least.

2. Line 115-117: I'm wondering why the authors employed a lower threshold (1.5->1). To allow more samples? I'd guess the conclusions still hold with different thresholds, such as 1.5 or 2, but the authors may double-check and make a clear statement.

3. Table A1: event#42 the event detected in the 2017-2018 winter is different from their previous study (MK20). The authors may explain why.

Is it possible for a reflection event to occur in November?

It would be helpful for readers if the authors can add a column to show whether the event is associated with a major SSW.

4. Line 133 "except for a couple of days": I don't expect much difference, but just wondering whether the authors removed these cases in the following analysis, given they are not strictly downward? If a higher threshold (e.g., $RI > 1.5$) is used, is it possible $(v't)_{\text{Canada}}$ is completely lower than 0?

Technical:

1. Line 45: Zhang et al. 2020 discussed the North American cold spells following stratospheric anomalies mainly through the lens of wave reflection by giving the pre-existing Arctic surface conditions, which is more relevant to the discussion in Line 47, 50, and 320.

2. Line 123: It would be better to state the term $(v't)_{\text{sib}} > 0$?

3. Line 124: similar comment here, $(v't)_{\text{can}} < 0$?

4. Line 221 "Fig. A1": This is the first time Fig. A1 is called while Fig. A2-A4 are called earlier. The authors may adjust the order of the Appendix figures.

5. Line 139 "vertical wind shear": Do the authors mean "vertical shear of zonal wind"?

6. Line 189 "the southernmost portion of the USA": Although this is not a piece of key information, one cannot see that in the figures. The authors may slightly enlarge the domain.

7. Line 227-228 "using k-mean clustering of the leading 12 PCs of the daily Z500 anomalies": I'm not sure my understanding is correct. Did the authors reconstruct new Z500 daily anomalies using the leading 12 EOFs and their time series, and then assign this new reconstructed daily field to 4 groups using clustering?

8. Line 236-237 "before ... than climatology": Are the authors talking about the evolution from day0 to day 5 and then to day 8 in Fig.8c?

9. Figure A4: the authors may show the number of cases used to calculate each line in the figure legend.