Weather Clim. Dynam. Discuss.,
https://doi.org/10.5194/wcd-2020-9-RC2, 2020

Interactive comment on "The Life Cycle of Upper-Level Troughs and Ridges: A Novel Detection Method, Climatologies and Lagrangian Characteristics" *by* Sebastian Schemm and Michael Sprenger

Irina Rudeva (Referee)

irina.rudeva@bom.gov.au

Received and published: 28 April 2020

The paper presents a novel algorithm to detect troughs and ridges in the troposphere. The method is applied to 500 hPa ERA-interim data to show climatologies of these events and establish a link between their orientation to the ENSO. The approach offered in the paper is interesting and opens possibilities for future research on the role of trough/ridges in jet position, cyclogenesis, precipitation, etc. Overall, the method is new and results are valuable. I believe this paper may be accepted for publication after some revision.

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Discussion paper

Major:

My major comment has already been picked up by another reviewer: I would also like to see justification of the geopotential level used to identify troughs/ridges and, possibly, how results differ between levels. I can see a point in using an Hgt level as opposed to, e.g., PV, as Hgt levels are readily available in most model outputs, making this approach useful for analysis of, e.g., CMIP6 models. However, troughs/ridges are often seen as upper-level phenomena, while 500 hPa lies in the middle of the troposphere.

Other comments:

Abstract: It is said that tracking allows analysis of evolution of troughs/ridges. However, in my view, this paper does not present such analysis. Either remove this statement from the abstract (it can be kept in the description of the method) or add analysis of their life cycle.

p1, l.21-25: Add a figure showing a trough and a ridge.

p2, l.18: define E vector here

p.4, l.9-16: This part needs to be illustrated - draw a figure showing vectors discussed here

P.5, l28: give a brief description of Q vector here first, not only a reference

p.6,l22: can the absence of troughs be a result of northern boundary at 70N? Could it be that troughs extent further north and the part to the south of 70N is below the threshold on the length?

p.5, l. 32: The map at 06 UTC also suggests a significant trough in the Mediterranean, but it remains undetected. Is it due to the thresholds? In this case, some sensitivity test should be shown to justify the selection of thresholds.

p.6, l. 17: Is it frequency of trough area of trough axes?

p. 7, l.1: To confirm that Greenland troughs are more transient can you built pdfs of trough lifetime characteristics (propagation speed and lifetime) in regions of interest (over Greenland, Pacific that is discussed later and a reference region)

p7, l28-30: Given the difference in frequency of troughs and ridges, did you think of applying different thresholds for their identification. Troughs and ridges can be seen as advection of cold and warm air and, due to the variable air density, typical curvature of hgt may vary.

p.8: Can you think of reasons why there is no cyclone maximum near the Iberian Peninsula associated with a peak in trough frequency and Rossby wave breaking? I suggest that these conditions in the upper (middle) troposphere produce cut off lows not visible on the surface.

p.8, l34: Despite equatorward shift of troughs off the West coast of the US in summer, the ridges shift poleward during summer (something that one would have expected). Can you discuss what may cause summer poleward shift of troughs in this region?

p.10, l33: The text refers to Fig 6, which shows mean orientation of ridges and troughs. This plot is supposed to illustrate the 'dominance' of those systems in the Pacific, however, I think the frequency should be shown instead.

p.11: Did you test longer backward trajectories? Do troughs/ridges have life cycles? It will be nice to see some analysis on this. Are back trajectories in fig. 7 b,c sensitive to the stage of their development?

p.12: A histogram of north/south displacements might be interesting.It is worse noticing that fig. 8a,b and e,f are in good agreement with each other, i.e. decent corresponds to a reduction in potential temperature. However, then the statement that the downward motions occur along isentropic surfaces sloping equatorward is questionable (though I like to think that the flow is along isentropes).

p.12, l2: what is the difference between a trough with closed geopotential isolines and

a cyclone at that level?

p14, l.10: Is the code available online?

Minor:

Abstract: “methods that detect the initiation phase of upper-level Rossby wave development” - did you mean Rothlisberger et al. 2016 paper or another? I could not find a paper on this in the references.

p1, l.22: for a good reason

p1, l.24: replace enchanted with increased

p2, l.3: re-phrase to read better

P6,l19: change to ‘Altai’ (multiple times in the paper). Not sure whether this is still east Asia. Perhaps, Far East is better.

P.6,l20: remove ‘slightly’

Fig. 3, 4: On my screen continents are barely visible. As for elevated areas, I suggest either marking them with a different colour or hatching.

p.11, last line: I am not sure why you say ‘pushing air’, I guess it is being pushed. Perhaps ‘moving air’ is better.

p.12, l6: remove ‘most’

p.12, l3: change ‘ore’ to ‘or’

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