

Atmos. Chem. Phys. Discuss., referee comment RC1  
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## **Comment on acp-2021-444**

Anonymous Referee #2

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Referee comment on "Dynamical evolution of a minor sudden stratospheric warming in the Southern Hemisphere in 2019" by Guangyu Liu et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-444-RC1>, 2021

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The paper provides what the title is implying (in the best sense of the words) – a description of the SSW in the SH during 2019. This might not sound much, but the authors try to provide a comprehensive comparison to the 2002 SSW (a more “severe” event) and they attempt to provide an explanation for how such events can develop in the SH – here, in particular a wave guide explanation is explored for the 2019 event and could presumably play a slightly more prominent role in the discussion to provide the paper with a more unique selling point. I do not have any mayor concern regarding the paper – however, it does need some revision (clarifications and twists) before final publication in ACP.

Point-by-point – based on the abstract:

The paper uses JRA-55 from 2002 to 2019. Thus, the extremes “flank” the base-line analysis period. There should be an explanation why this is sensible – why not use earlier data as well?

Phrases like “strong warming” should be avoided – “rapid temperature increase” (or similar) would be more appropriate.

The way 2002 is compared with 2019 seems sometimes rather arbitrary. Maybe just state initially that 2002 has been explored extensively (in other papers) and summarise two key messages. Followed by a more complete/complex description of the 2019 event, in particular the unique role of PW1 and the waveguide point.

Point-by-point – based on the main text:

p1, l25: associated

p1, l28: is this always causal? If the displacement starts first, the strengthening of the Z1/PW1 would happen without a source in the troposphere ...

p1, l31: weak wave activity is ambiguous – the definition should be clearer ...

p2, l8: preconditioning should be briefly explained (beyond the citation) ...

p3, l1: plausible factors – what does this mean? A proposed mechanism for the initiation of the SSW in 2019? Please explain!

p3, l6: uses

p3, l7: Please provide a rationale for the time period chosen (see above)!

p3, l14: employ; What kind of wave forcing? Presumably some kind of “effective wave forcing” as the quantities are calculated from the gridded data and not the tendencies in the model - already daily averages are used?

p3, l21: steady zonal flow? Is this the zonal mean of quantity X (zonal wind, geopotential, etc.) based on the daily averaged data?

p3, l26: presumably “ $\bar{u}$ ” is the zonal mean zonal wind (and not the horizontal basic flow)?

p3, l29: explain briefly the Fourier transform and how you will derive the fluxes associated with the waves (basically slightly more detail would be nice) ...

p4, l1: Overview of SSW 2019 – I would suggest an overview of the 20002 event first (as the baseline case), followed by a description of the 2019 event – also it would be nice to provide a direct comparison of the temporal evolution (timing) of the warmings – the

figures exist, but the logic is not quite obvious to me ... (thus the suggestion to start with 2002, the literature and your descriptive plots of 2002 and to contrast those facts with 2019 and afterwards detailing 2019 ...)

p4, l8: what is "pronounced high temperature"?

p4, l26: warm air becomes warmer sounds too colloquial – presumably this could be phrased differently

p4, l28: presumably you could explain why this is obvious – in the current structure wave amplitudes are introduced in figure 4 (much later) ...

p5, l2: "daily changes" sound like a derivative ... the figure shows a time series of daily data

p5, l14: I don't understand the second part of the sentence – the chosen location is representative of the PNJ (close to the climatological maximum of the PNJ)?

p5, l28: "daily changes" sound like a derivative ... the figure shows a time series of daily data

p5, l33: Clear phrasing: PW1 and 2 refer to the actual wave and Z1 and Z2 are the corresponding amplitudes (the wave phase is not discussed – only indirectly with the fluxes) ...

p6, l20: "high latitudes of the stratosphere" is not very precise, please provide a latitude and altitude range ...

p6, l32: what is actually propagating? Presumably one would distinguish features that apparently "move" and waves that propagate – just a note of caution ...

p7, l1: be more precise – what do you call wave activity in this context? (This is a request to be more precise when referring to the quantities in the figures ...)

p7, l4: as the point before – and: is there a corresponding plot in a “proper” publication?

p7, l25: More framing would be nice – this is actually the best part of the paper. Do provide the reader with a better feeling for your hypothesis!

p7, l28: Figure 8 actually shows a time series – from this time series the reader can take (with your help) information regarding the interannual variability and the unique characteristics of 2002 and 2019 ...

p8, l2: If you would provide more information about the concept of preconditioning earlier (as suggested above), you could come back to it here and provide the case specific detail in more depth.

p8, l7: I was wondering if the eastward travelling wave point would merit some more detail ... (depends a bit on how the preconditioning will be explained in more detail)

p8, l15: what is meant with “abrupt occurrence”? An increase in amplitude (in conjunction with the preconditioning)?

p8, l17: I do not disagree, but the mechanism as such should be explained in more detail ...

p8, l28: This seems a central point. Alas, the current phrasing is not very clear and some more explanation and a better description would be nice. This seems to be the “nugget” of the paper and it would be nice to give it the prominence it deserves. Also, how does this compare to 2002? Or is a direct comparison (due to the different timing of the events) not possible? A comment along those lines would be useful.

p8, l32: The “Summary and Conclusion” needs adjusting to the changes triggered by the above ...

Figure 1: Do provide coherent labelling ( $\Delta T \leftrightarrow T$  gradient) – the gradient is actually not a gradient – it is a temperature difference between two latitudes – please remind the reader how JRA provides the zonal mean at the pole ... (if possible, please add units to the colour bars)

Figure 2: You average three days (averaged from 6 hourly data) and you do this subsequently for all three-day periods within your analysis period – “every three days” is also “over three days” – just make sure the description is as precise as possible ... (if possible, please add unit to the colour bar)

Figure 3: Please include a colour key in the figure (just describing it in the text is prone to error). Aside: This figure is obviously useful to mention the timing of the warmings, when discussing it.

Figure 4: y-labels for the bottom plots are missing, colour keys should be provided in the plot, presumably clarity of the description could be improved by avoiding the “verbal colour key”.

Figure 5: Please see comment for figure 3; labels at y-axis, if possible ...

Figure 6: Labels at y-axis, if possible; unit at colour bar, if possible ... (Why WN here? Everywhere else PW ...)

Figure 7: Labels at y-axis, if possible

Figure 8: Time series of ... (see comment above); in September – exact definition, please; colour key in the plot would be nice ...

Figure 9: Labels at y-axis, if possible