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Comment on acp-2021-444

Anonymous Referee #3

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-RC2, 2021

Review on:
"Dynamical evolution of a minor sudden stratospheric warming in the Southern Hemisphere in 2019", ACPD, 2021, by Liu et al.

In their paper, Liu et al. present an analysis of the 2019 minor SSW in comparison with the 2002 major SSW. The paper is well written and nicely describes the dynamical situation of the 2019 SSW. Unfourtunately, the study is not very thorough and does not provide many new insights. The main result that the wave guide may be the decisive feature for the generation of the SSW is interesting, but neither pointed out well enough in the paper, nor it is analysed in any detail (see below in the major points). Furthermore, I think some restructuring of the paper is required and possibly also some compressing, as a few points are repetitive. In general, I agree with reviewer #1 who writes that the paper can be published, but extensive revision should be made before that. I want to add a few points to those of reviewer #1, though, please see below.

On a different page I want to make the authors, but also the ACP editorial aware of the fact that for these type of purely dynamical studies there is since a good while the new copernicus journal Weather and Climate Dynamics (WCD). I don't think that journal stands in competition

to
ACP, rather it is complementary and in my opinion better suited for papers like this one, which
actually does not include any chemical analysis and the physics is largely limited to dynamics.
My point is, if my thinking on this is correct, the editors should probably deflect these type of
papers from ACP to WCD.

Best wishes

Major issues:

- All in all, I think not all figures add significant value to the story. E.g. Fig. 5 does not really provide more information than what had already been shown in Fig. 4 and moreover, some of the panels are more or less repeated in Fig. 9. So I'd say that one is obsolete. I have a similar feeling about Fig. 7, which does not really add anything to what
  had already been told in Fig. 4 and Fig. 6. I think the authors should go through the paper
  again and reconsider what is really necessary to tell the story and what is maybe only a side note.
- Section 4 "Discussion" needs to be seriously restructured. Only the middle part of it actually is a discussion (P8L1-13). The beginning and the end are further results parts and
  should treated as such. Instead, some of the real discussion seems to be in Sect. 5, e.g.
  P9L26-31.
- The paper "only" compares the two SSW events. In the SH, several other minor SSWs have taken place, mainly in the early 2000s and in the 80s. Why do you not compare the
  2019 event to those as well?
  Moreover, you give a quick reference to the S-RIP data. Can you elaborate on how clear
  and robust your findings are with regard to your JRA-55 data set. Are the results similar in other reanalysis data sets? In particular, as the wave guide is your main result, that
  should probably be consolidated with at least one other reanalysis data set or a model that
  reproduces the minor 2019 SSW.
- The study ends just where things start to become intersting, this is very disappointing. It
  is interesting how the different waves act together in 2002 and they don't in 2019. It is obvious that wave generation and wave propagation must be analysed in the next step. Special situations for wave generation have not been mentioned at all. The wave guide change is a nice result, but now it would be interesting how and why the refractive index
  (RI) forms this way. To my knowledge, the RI mainly depends on winds and temperatures.

So can the preconditioning with the strong winds be responsible for the way the wave guide forms? Is wave forcing prior to the SSW event responsible for the formation of that? If the authors refuse to make more analyses on this, I would at least expect some discussion and speculation in this direction, such that this study can be taken up as a starting point for a deeper analysis. And that brings me to my last major point:

- The paper does not provide any implications or outlook, or ideas for further studies how to get deeper into understanding this and especially, how to use your results to improve
  predictability on S2S time scales. Can for example the wave guide be predicted, are there
  any implications? A discussion on that should round up the paper in my eyes

Minor and technical issues:

- • P1L16: With "the values are larger", do you mean the wave driving was stronger? If so,
  write it.
- P1L24 remove "hereafter referred to as"
- P1L25 associated
- P1L26 during an SSW
- P1L17-19: This sentence is not really comprehensible this way when you are not already
  clear about the situation. Hence, please rephrase it.
- "the ocean-land and orography distribution", plus, remove "and small wave perturbations"
- It looks to me like the recent literature on the topic has not fully been addressed. I think
  for example the studies by Lee et al. (2020) and by Shen et al. (2020) have dealt with the topic too and their results could add value to this one (10.1029/2020JA029094 and 10.1029/2020GL089343)
- P5L3: change "normal" to "average"
- In P8L17-19 you state that you provide a plausible mechanism (the wave guide), but you
  provide the mechanism only afterwards. Turn that around!
- On P8L17-18 the sentence "wave guide propagation from the troposphere to the strato-sphere is controlled by the index of refraction" is written as if this would be a new result.
  But to that end this is just common theory. Please rephrase this.
- P5L28 Figure 4 shows time series of daily data of the geopotential....
  The fact that you see daily changes of PW1 and PW2 amplitudes can be put below in L31
  or so.
- Add labels to the colour bars at figures 1, 2, 5, 6, 7, 9
- Add legends to fig. 3, 4, 8
- P3L6: In this study, we use...
- Fig.1: add "â□¦ " to the 60S in the titles
- P18L3: What amplitude?

- Fig.6: Bad choice of colour bar values. Rather choose smaller max and min values, such that something can actually be seen here.