Ann. Geophys. Discuss.,
https://doi.org/10.5194/angeo-2020-55-AC1, 2020

Annales Geophysicae Discussions
Open Access
EGU

Interactive comment on "Seasonal evolution of winds, atmospheric tides and Reynolds stress components in the Southern hemisphere mesosphere/lower thermosphere in 2019" *by* Gunter Stober et al.

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Received and published: 5 October 2020

General comment:

Anonymous Referee #1

Seasonal evolution of winds, atmospheric tides and Reynolds stress components in the Southern hemisphere MLT in 2019 by Gunter Stober et al. Summary evaluation: This paper presents an analysis of data collected from measurements of six meteoric radars in the mid- to high-latitude southern hemisphere. The measurements are re-

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Discussion paper

lated to the height range of 75-105 km. The analysis aims to separate the mean winds, tides, and residual fluctuations, the latter representing gravity waves (GW) and considers Reynolds stress components. One-year-long time series of each parameter from each of the radar are constructed revealing characteristic seasonal patterns at each location. The momentum fluxes and wind variances are calculated using a recently developed algorithm (described elsewhere) which allows more accurate decomposition of the measured signal into a background flow and the GW fluctuations. Considerable longitudinal and latitudinal asymmetry (or variability) is found in the wintertime zonal and meridional wind patterns. Because a minor stratospheric warming occurred in the southern hemisphere in 2019, the observed asymmetry is believed to be related to the asymmetric structure of the polar vortex at mesospheric heights forming spatially variable filter for vertical GW propagation. The study introduces new multi-radar observations, utilizes sophisticated data retrieval methods, and contributes to a better understanding of the mesosphere-low thermo-sphere circulation and vertical coupling in the atmosphere. The paper seems significant and appropriate for publication but substantial revision is needed. The paper is interesting to read but this referee met some inconsistencies while reading. The following questions and comments should be addressed and clarified in the revised version.

General Reply:

We thank the reviewer for his suggestions which greatly improved the quality of the manuscript. Following these suggestions, we have updated all the figures and the corresponding paragraphs to keep the logical order. Further, we expanded the introduction and shortened the conclusion. The changes are indicated with latexdiff.

Comment:

3) Conclusion. This section (57 lines in total) is too broad to be a proper conclusion. A great part of the material included is more appropriate for the discussion section. There are even several references. The section should be shorter and more focused.

In its present form, it is difficult to take the main new results of the study. Here (or in the introduction), the main goal of the paper should be explicitly formulated. Lines 509-510. In the present paper a new retrieval algorithm is not presented but rather utilized, isn't it?

Reply:

We rewrote the introduction as well- as the conclusion to provide a more focused manuscript. The detailed changes are indicated by colors using latexdiff in the revised manuscript.

Comment:

4) Fig. 5. It is curious why the spring semidiurnal tidal amplitude at KEP is much larger than at all other stations. Is there any explanation? Other parameters do not show any considerable difference for KEP.

Reply:

A detailed investigation of why the semidiurnal tide during spring is amplified at KEP, but not as strong at the other stations is beyond the scope of this manuscript and a thorough investigation will require stratospheric data as well. Currently, merged data sets of model outputs and observations are prepared, but not yet available. However, it is the meridional component that is much stronger at KEP and seems to be related to the mean meridional wind, which shows only at KEP a strong southward wind during this time. The other stations at TDF, KSS and ROT show a reversal of the meridional component towards northward winds during this period. However, at this time we cannot confirm that this is the explanation for the tidal amplitude differences or whether there are additional effects from the stratosphere also playing a critical role. Further, global data sets are required to investigate migrating and non-migrating tidal components and how their forcing is affected by mean winds in the stratosphere, which might also help to understand the longitudinal differences. We added a reference to Murphy

et al., 2006, who investigated the non-migrating tides at the SH.

Comment:

5) Lines 453-458. The methodological shortcoming of this statement is that, based on one particular year during which an SSW occurred and without comparison with non-SSW years, we are not confident that the observed variability in the MLT winds is related to a wobbling and asymmetric polar vortex. The statement should be taken with caution. Maybe, the typical inter-station variability is of the same order.

Reply:

The statement refers to the climatological mean at TDF, which was compiled from the years 2008 to 2018. However, since the manuscript focuses on 2019, we added a statement underlining that the wobbling nature was found for 2019 and we refer to the climatology at TDF between 2008-2018. This is now explicitly mentioned in the revised manuscript. We also looked at the polar vortex asymmetry in the MLS climatology and found again a consistent pattern. This suggests that 2019 concerning the seasonal behavior was not an exceptional. Only due to the occurrence of the minor SSW it become rather unique.

Minor Comments:

Comment:

1)Title. Since the broad geophysical community of AnnGeo readers may not be very familiar with the acronym MLT, it seems better to use the full name: mesosphere-low thermosphere.

Reply:

This comment was withdrawn.

Comment:

2) For convenience, please indicate the radar codes in Fig. 1 (e.g., in the right panel) and include the full name of the sites to Table 1.

Reply:

Done.

Comment:

3) Line 186. Correct reference?

Reply:

A first version of the ASF(1D) is already described in Stober et al., 2017, although we did not introduce the acronym ASF in this paper and only present a brief description of the algorithm. The paper already mentions adaptive spectral filter. This is described at the end of section 2.1.

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