

Authors response to the reviewer#1 on “Are mean vertical velocities from PMSE a good representation of mean vertical winds?” by Nikoloz Gudadze et al.

We thank the referee for her/his helpful feedbacks and careful reading of our manuscript. We appreciate all the efforts improving the manuscript and acknowledge the given comments and suggestions. We provide detailed replies to all the raised comments listed below. All changes in the manuscript will be highlighted as bold text.

The remarked language changes are also included.

General Comments

Comment:

“For example, measurements are reported for two summer seasons using the so-called MAARSY radar located in Andoya, Norway. Nowhere, however, is the MAARSY radar described, including the operating frequency.”

Reply:

A paragraph with a general description of the radar (MAARSY) is added in the second section (Measurements and wind analysis)

Comment:

The title of the paper could also be better expressed. Given that the aim of the paper is to show how the true vertical wind can be measured in the presence of the downward motions of the ice particles that dominate the radar backscatter, maybe the title might be better framed as “Can VHF radars at polar latitudes measure mean vertical winds in the presence of PMSE?” In that sense, the first two sentences in the Conclusions best encapsulate the motivations for the paper and it would help the reader if they were repeated up front in the Introduction.

Reply:

We agree to reviewer suggestion and changed the title.

Comment:

The paper starts (p2) with an incorrect discussion of how the zonal wind structure in the MLT reverses sign. It does not occur through the gravity wave momentum deposition causing a direct “drag” on the zonal winds, with the meridional flow arriving as incidental by-product. It is just the opposite. 1. The eastward (westward) momentum deposition in the summer (winter) MLT drives a meridional summer-to-winter pole circulation. 2. This leads to rising (sinking) motions over the summer (winter) pole with consequential adiabatic cooling (heating). 3. Hence, the zonal-mean latitudinal temperature gradient in the MLT is reversed relative to that in the stratosphere and the zonal-mean zonal winds in the mesosphere

change sign through the thermal wind relation. This section should either be modified appropriately or deleted entirely to avoid confusion.

Reply:

Regarding the comment on zonal mean zonal wind behaviour according to thermal wind relation, we totally agree to the critics. However, cold summer mesopause and therefore zonal wind vertical behaviour is a byproduct of the chain process induced gravity wave momentum deposition (or zonal wave drag). It's accepted, that the sentence "Such forcing decelerates the westward zonal wind on the corresponding heights and causes widely observed wind reversal at the lowest thermospheric altitudes" (p.2 l.14) can be understood as a direct effect. We have modified it. The paragraph itself is necessary to explain the existence of the upward motion during summer seasons in the upper mesospheric altitudes.

Comment:

Confusion can also occur through mixing the use of vertical motions and vertical winds. For example, in the caption to Figure 1, the blue and red curves are labelled as "weighted mean vertical wind velocities" when they are actually vertical motions strongly weighted by the sedimentation speeds of the ice particles, i.e. not the vertical velocity of the neutral atmosphere. It is recommended that the terminology throughout the paper be corrected to ensure there is no misunderstanding of what is a vertical motion and what is a wind.

Reply:

We now use the term vertical velocities throughout the manuscript or describe why it can be interpreted as vertical wind.

Specific Comments

Comment:

P1, L12 "Disappearance" not "disappearing"?

Reply: *"disappearance"*

Comment:

P3, L15 Stoke's drift.

Reply: *Accepted*

Comment:

L4, L21 Brackets required around Hoppe and Fritts, 1995b

Reply: *Accepted*

Comment:

P5, L27 I do not understand “vertical shear amplitude of 5 m/s”. Should this not be 5 s-1?

Reply: *“Shear amplitude” here indicates a velocity difference between the given bins of the grid. We keep the terminology used in the referenced paper by Stober et al (2018a) and add the remarks in the text of the manuscript.*

Comment:

P8, L22 I do not understand the sentence starting “They found ...” Is “continued’ meant, rather than “preserved”?

Reply: *“continued”. „persisted“ is used in the referenced paper.*

Comment:

P9, L5 “threshold” rather than “point”?

Reply: *“value”. E.g. red circle above $\Delta w=0.4$ represents the average value of the velocity for all data points which uncertainty is lower than 0.4 (given value).*

Comment:

P9, 14 “is” before “available”.

Reply: *Accepted.*

Comment:

P9, L25 “reduced” rather than “slow down”.

Reply: *Accepted.*

Comment:

P9, L26 “sediment due to gravity”

Reply: *Accepted.*

Comment:

P9, L32 “Presenting”, not “pretending”.

Reply: *Accepted.*

Comment:

P10, L5 Remove brackets around Berger and Lübken, 2015.

Reply: *Accepted.*

Comment:

P10, L34 “downward motions” not “the downwelling”?

Reply: *Accepted.*

Comment:

Figs. 2, 3 “Positive wind values correspond to”

Reply: *Definitely.*

Comment:

Fig. 4 Do the 2D histograms represent “vertical wind measurements” or ‘vertical speed measurements?’

Reply: *“Vertical velocity measurements”. Please see the last reply in the general comments above.*

Comment:

What do the dashed blue lines in Fig 4 represent?

Reply: *Blue lines on Fig.4 are direct averages. It is now defined in the description of the figure.*