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Atmospheric Measurement Techniques Discussions

Interactive comment on "WIRA-C: A compact 142-GHz-radiometer for continuous middle-atmospheric wind measurements" *by* Jonas Hagen et al.

Anonymous Referee #3

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In recent years, global circulation models (GCMs) have been progressively extended higher to cover the whole stratosphere and in some cases the mesosphere. Weather and climate forecasting communities are moving toward a more comprehensive representation of the atmosphere to better capture stratospheric-tropospheric interactions and improve long-term forecasts. An important part of improving our understanding of the general circulation of the middle atmosphere (MA, from ∼12 to 90 km) is building a detailed knowledge of the MA dynamics through multiple complementary observational platforms. The combination of innovative relevant observations and numerical modeling contribute to a better prediction of dynamical properties of the MA. Assessment of the performance of several MA climate models becomes well documented through

the inter-comparison project for stratospheric processes and their role in climate initiative. During the last decade, there have been significant technical advances in the development of independent ground-based middle atmospheric wind and temperature measurements for numerical weather prediction models.

Given the importance of model validation in the middle and upper atmosphere regions, the paper by Hagen et al. provides new insight on the use of independent wind observations for GCM with the novel WIRA-C instrument. This study presents a new development of the ground-based microwave wind radiometer capable of wind speed measurements between 35 and 75 km altitude where routine observations are rare. Continuous measurements are compared with the ECMWF operational analyses at Maido observatory. Comparisons with wind lidar measurements are performed for independent validation.

Considering the novelty of this study, the detailed and high-quality of the analyses presented, I recommend that this paper should be published in Atmospheric-Measurement-Techniques, subject to consideration by the authors of the following minor revisions.

Abstract:

It could be mentioned that the WIRA-C does not need operator for routine operation. The WIRA-C is presented as an instrument which has never been used in ground-based radiometry before. WIRA-C should be presented as a new generation of WIRA.

Page 3, line 30: As opposed to WIRA which observed at an elevation angle of 22°, WIRA-C can select the angle. It could be here explained why this is important. Page 8, line 3 observations are still done at the four 22° elevation.

Page 9: Is there a reference for Equation 2?

Page 10, line 12: An integration time of 12h is chosen. How the wind measurements would be affected (larger error bar, reduced range of altitude?)

Page 11, line 1: Replace “Wind” by “wind”.

Page 14, line 26: How the errors would vary with the integration time? See comment above.

Page 14, line 35: This is not clear why the resolution for meridional wind measurement is larger than for zonal wind?

Page 18, line 7: The Integrated Forecast System cycle of the ECMWF product used in this should be mentioned.

Page 19, line 15: Discrepancies between model and observations are not so clear on the figure. I suggest to to add one additional subplot to Figures 11 and 13 showing the difference between WIRA-C and ECMWF convolved.

Page 19, line 21: The lower variability in the model is not visible on the figure (see comment above).

Page 20, line 3: As discussed, lidar data show very large vertical gradients in the wind speed, not only above 40 km but also below 35 km (e.g. Figure 16, 2016-08-22). They do not last more than one day. More descriptions of their characteristics (amplitude, vertical wavelength…) as well as explanations of their origin (internal gravity waves?) are welcome. The vertical gradients in lidar data are not visible in WIRA-C measurements. It can be recalled that WIRA-C, as well as ECMWF (partly) smooth these perturbations because of their vertical resolution.

Page 21, Figure 12: Mention in the legend that zonal winds are displayed. I suggest to enlarge Figures 12 and 14. The smoothed convolved ECMWF curve is not visible (change color?).

Page 22, Figure 13: Suggest to adjust the color scale to improve contrast.

Page 23, Figure 14: Why not showing all ranges of altitude as displayed by Figure 12, even measurements are not always available (Figure 13). In the legend, the ranges of

altitude should correspond to what is shown.

Page 26, Conclusion: It can be reminded that WIRA-C is an optimized version of WIRA (first sentence). Comparisons between the convolved ECMWF profiles and WIRA-C show an overall good agreement. However, some differences in wind strength at specific time periods are pointed out in the paper (e.g. Figure 11). In the perspective, WIRA-C should be presented more as an independent ground-based sounding technique to provide additional observational constraints in range of altitude where routine measurements are lacking rather than for sake of validation. A limitation of WIRA-C is the altitude resolution. As for the time resolution, are there other technical improvements to be explored in order to improve the vertical resolution? The complementarity of wind lidar (man-power needed for operation) and WIRA-C capable of continuously measurements of the middle atmosphere mean state can be addressed.

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