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Atmospheric Chemistry and Physics
Discussions

Interactive comment on "Observations of OH-airglow from ground, aircraft, and satellite: investigation of wave-like structures before a minor stratospheric warming" *by* Sabine Wüst et al.

Anonymous Referee #2

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General Comments The authors present a selection of results from a campaign of observations on OH-airglow emissions recorded from the ground, and from an aircraft flown inside the Arctic Circle during January and February 2016. The ground-based observations were made using infrared spectrometers deployed at ALOMAR and Kiruna, while the aircraft measurements were made with a "Fast" airglow imager taken over flight paths that included both observing stations.

These observations were supplemented with the inclusion of temperature and OH* VER profiles from the TIMED-SABER satellite instrument near the time and location of

the observations, in addition to horizontal and meridional wind data from the ECMWF.

The SABER data have been used to calculate the mean height and thickness of the OH* layer during the period of the observing campaign. There is good correspondence between the variation of the OH* layer brightness measured by the ground based spectrometers and that obtained from the SABER VER measurements. The Brunt-Väisälä (BV) frequency during the observing campaign was calculated for the OH* layer by weighting it by the VER measurements. It showed a steady decrease throughout the observing period – which was interpreted to imply a reduction in the static stability of the atmosphere during that tim interval.

Combining the OH*-layer averaged temperature data from the infrared spectrometers with the SABER temperature profiles, enabled the authors to calculate the gravity wave potential energy density (GWPED) contained in the spectrometer temperatures. Results were separated into those with periods > 60 and <= 60 minutes. GWPED for waves with T < 60 min were in the range 7 - 15 J/kg, whereas those waves with T > 60 mins were in the range 10 - 150 J/kg. A relatively clear maximum in the GWPED for the former group occurred around January 27th, which is close to the time of a minor stratospheric warming event. The authors interpret this coincidence as possible evidence that these longer period waves originate at tropospheric altitudes. The cubic spine fitted to the two wave groups is of doubtful value.

Images from the FAIM camera were used to calculate wavelengths and propagation directions of the waves and ripples detected in the images. These were separated into those with lambda > 15 km and those <= 15 km. In the case of flight 1 (Kiruna – Alomar and back making a triangle) waves with lambda > 15 were either NW or SE, whereas those with lambda <= 15 km tended to be SW or NE. The highest occurrence rate of waves occurred in both legs when the plane was passing over the highest mountain peaks.

The manuscript is well organised and the data is clearly presented. The methods used to identify the gravity waves in the image sequences are correct and the description of the methods used are clear. The text includes an appropriate set of references. The work is suitable for publication in ACP, provided that the minor points highlighted in the specific comments and in the technical corrections below are addressed.

Specific Comments On page13, the authors attempt to use the airglow brightness images to deduce something about whether static and dynamic instability is the dominant mechanism generating the ripples in flight 1 or flight 5. This is an interesting idea, but it is based entirely on assumptions which may or may not be true. In the absence of horizontal wind and temperatures data (see page 12, lines 31-33), we cannot say. This passage also assumes a relation between airglow brightness and temperature, which does not always hold strictly as pointed out in lines 17-19 on page 13.

A really useful reference on this point is the recent paper by Li et al. (2017), in which the authors study statistically the relation between ripples and the background atmosphere. Some of the statements made in the current manuscript are not supported in the work by Li et al. (2017), e.g., line 30 on page 11 states (referring to ripples) “They move with the background wind . . .”. Li et al. (2017) report that less than half of the ripples examined moved with the background wind, and were in fact real wave structures that are difficult to distinguish from real instability features.

The authors should read Li et al. (2017) and revise the current manuscript in the light of the results presented there.

Technical corrections Page 1, line 27; “evolvement” –> “evolution”. Page 1, line 29; “Special emphasize is put . . .” –> “Special emphasis is placed . . .”. Page 2, line 29; insert “(BV)” after “Brunt-Väisälä”. Page 3, line 18; insert “(GWPED)” after “density”. Page 3, line 24; omit “of” in “on board of the DLR”. Page 4, line 22; omit “certainly”. Page 6, line 10; replace “looked up” by “found”. Page 6, line 18; insert “ for the calculation of N” after “necessary”. Page 6, line 24; “catches” –> “includes”. Page 7, line 8; replace “The used 2D FFT algorithm needs equidistant data.” by “The 2D FFT algo-

rithm employed requires equidistant data.”. Page 9, line 21; insert “;” after “also. Page 9, line 28; “cut” –> “reduced”. Page 11, line 15; year of reference (2009) is inconsistent with line 7 on page 17. Page 12, line 17-18; suggest “Therefore, we conclude that gravity waves with periods longer than 60 min are more likely to could to a larger part be generated in the troposphere than gravity waves with periods shorter than 60 min.” Page 14, line 7; “In the same time” –> “At the same time”. Page 14, line 10; “could not be observed.” –> “were not observed.” Page 17, lines 5-7; year of reference (1995) is inconsistent with line 15 on page 11. Page 20, line 10; “preceding” –> “subsequent”. Page 21, line 6; “stand for” –> represent. Page 24, Figure 6(a) and 6(b); dashed grey line is very faint. Use a darker colour. Page 26, Figure 8(a); the grey line that shows the orography is so faint that it is almost impossible to see it. Page 29, Figure 11(a); the grey line that shows the orography is so faint that it is almost impossible to see it.

References Li, J., T. Li, X. Dou, X. Fang, B. Cao, C.-Y. She, T. Nakamura, A. Manson, C. Meek, and D. Thorsen (2017), Characterstics of ripple structures revealed in OH airglow images. J. Geophys. Res. Space Physics, 122, 3748-3759, doi:10.1002/2016JA023538

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