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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Universal power law of the gravity wave manifestation in the AIM CIPS polar mesospheric cloud images" *by* Pingping Rong et al.

Anonymous Referee #2

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In their paper the authors investigate the modulation of polar mesospheric clouds (PMCs) by gravity waves of horizontal wavelengths in the range 20 to 60km. A novel gravity wave tracking algorithm is applied to PMC observations by the AIM Cloud Imaging and Particle Size (CIPS) instrument. The wave detections are resampled depending on the background cloud brightness and the wave power obtained from the detection algorithm. By doing so, the wave detections follow a normal distribution, and it is possible to derive general properties of the whole distribution of wave detections. It is found that the wave power decays toward small scales with an exponent between -2.5 (for low spectral power events) and -3.2 (for strong events). Further, weak events are more blurry and seem to be affected by turbulence.

Overall, this study is an important step forward in the characterization of the interaction of gravity waves with PMCs. Particularly, the resampling of wave detections allows to deduce general properties of the wave distribution. The paper is well written, and the topic is of broad interest for the readership of ACP. The paper is therefore recommended for publication in ACP. There are only a few minor comments that should be addressed before publication.

MINOR COMMENTS:

(1) The introduction is too much focused on the very short horizontal wavelength gravity waves and their effect on PMCs. Only in Sect.5 and in the conclusions it is mentioned that also gravity waves with quite long horizontal wavelengths (of several hundred km and more) modulate PMCs, and that their wave power can be even stronger than that of the short scales addressed in the current paper. This information, however, should already be given in the introduction.

Therefore after p2, line 11 you should add the following information: It is also known that long horizontal scale gravity waves with wavelength of hundreds of km and longer exist in the mesosphere / lower thermosphere region (for example, Ern et al., 2011; Wachter et al. 2015). Corresponding variations are found in PMC brightness (for example, Carbary et al., 2000), and it was argued by Chandran et al. (2012) that observed PMC patterns may be caused by a superposition of large scale (>300km) and small scale (<300km) gravity waves with the large scale long period gravity waves producing the most significant increases in albedo.

References:

Carbary, J. F., Morrison, D., and Romick, G. J.: Transpolar structure of polar mesospheric clouds, J. Geophys. Res., 115, 24763-24769, 2000.

Chandran, A., D. W. Rusch, G. E. Thomas, S. E. Palo, G. Baumgarten, E. J. Jensen, and A. W. Merkel (2012), Atmospheric gravity wave effects on polar mesospheric clouds: A comparison of numerical simulations from CARMA 2D with AIM observations, J. Geophys. Res., 117, D20104, doi:10.1029/2012JD017794.

Ern, M., P. Preusse, J. C. Gille, C. L. Hepplewhite, M. G. Mlynczak, J. M. Russell III, and M. Riese (2011), Implications for atmospheric dynamics derived from global observations of gravity wave momentum flux in stratosphere and mesosphere, J. Geophys. Res., 116, D19107, doi:10.1029/2011JD015821.

Wachter, P., Schmidt, C., Wuest, S., and Bittner, M.: Spatial gravity wave characteristics obtained from multiple OH(3–1) airglow temperature time series, J. Atmos. Solar-Terr. Phys., 135, 192-201, 2015.

(2) p2 l28+29 and p3 l10 Here you are talking of "larger scale features". Please be more specific. Could this be larger scale gravity waves, or are there other effects?

(3) p3 l13+14: Here you mention that in the current paper no horizontal filtering is applied like in Chandran et al. (2010) where polynomial smoothing is used as a background, and only remaining fluctuations are analyzed. Still, your analysis technique focuses on a (narrow) range of horizontal wavelengths. This means that indirectly high pass filtering is applied by limiting the wavelet to the desired range of 20-60km (see p4 l10). The main difference to Chandran et al. (2010) is that you are using a sharp cutoff, and the spectral characteristics of the remaining wave spectrum will not be altered by the filter characteristics. I think this is an important point that should be mentioned more clearly.

(4) p5 l13 Please be more specific. What is the angular step/resolution used? Later in the conclusions, I learned that the step-width is 3deg. However, this information should be given also on p5 l13.

(5) Fig.4a; Sect.4.3, p7 bottom Since the resampling of wave events is an important step in your analysis, this should be briefly illustrated by an example. Suggestion:

If in Fig.3 an event would occur in the histogram (black curve) with 50% of the values

at weaker CWT power, this event would obtain a value of freq25=0.5, and we find this event in Fig.4a at the coordinates (0.5, albedo power of the event).

(6) p10, l16 and p23, caption of Fig.6: The normalization procedure was still not fully clear to me. Could you elaborate a bit more on this? Is one of the three brightness levels taken as a reference, and the others are normalized to match the reference? Is this normalization derived for a given wavelength position? How are the error bars in Fig.6 obtained?

TECHNICAL COMMENTS:

(1) p1 l10 Gravity wave display morphology and clarity level -> Gravity wave display, morphology, and clarity level

(2) p21, Fig.4 panels (a) and (b) overlap, please allow for more space between them

(3) p21, caption of Fig.4, about Fig.4b Please mention that the red dashed curve represents a Gaussian fit (normal distribution) to the data (black dots), while the thin black curve is a polygon that connects the data points. The magenta crosses represent normalized integrals over the number of detections below the respective analytic curves in Fig.4a.

Still, the following was still unclear to me: What is the magenta line in Fig.4b? Is this a fit through the magenta crosses?

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