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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 #1

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General comments:

This manuscript deals with the investigation of gravity wave signatures in polar mesospheric cloud (PMC) images observed with the CIPS instrument on the AIM spacecraft. More specifically, the authors attempt to determine a universal scaling law describing the scale dependence of the wave spectral power for the spatial scale range from about 20 to 60 km. The analysis approach is novel, as far as I can tell, and based on a directional 1-D wavelet analysis. The paper is overall well written, presents interesting results and should eventually be published in my opinion. I do ask the authors, however, to consider the following general and specific comments. My main concern is that

the analysis is based on several arbitrary assumptions and it is not clear to me how robust the obtained results (e.g., the derived spectral exponents) really are, and how they can/should be compared to similar studies based on different assumptions.

Here are some more general comments:

- The focus on wave signatures with wavelengths between about 20 and 60 km seems an unnecessary restriction in several parts of the manuscript, because many of the observed wave signatures have longer wavelengths (e.g. page 6, line 8 and the following lines).

- Wavelet power spectra are determined and analyzed in this study. In many studies on related subjects Fourier power spectra are analyzed. I'm wondering, whether the spectral exponents for wavelet and Fourier spectral are (necessarily) identical? The exponent will certainly depend on whether the wavelet power spectra are plotted as a function of wavelet scale or Fourier equivalent scale (see specific comment below). And perhaps the exponent depends somewhat on the mother wavelet used?

- "Wave tracking" and identification of gravity waves: The term "wave tracking" is used several times in the paper, but it seems no "tracking" of gravity waves is actually done. Spectral power in a certain scale range is used as a proxy for gravity wave activity, right? I'm wondering, whether enhanced spectral power is always an indicator for gravity waves? One can easily produce synthetic time series with similar scaling laws that have little to do with gravity waves. Perhaps some comments can be added along these lines of thought.

Specific comments:

Page 1, line 24: I suggest replacing "have played" by "play" in this sentence.

Page 2, line 21: "which is" -> "which are" ?

Page 3, section 2: Please mention what version of the CIPS data was used here. There may be different versions for the Level 0/1 and Level 2 data. All versions should

be mentioned.

Page 4, line 9: “The relevant scales for this study ARE”

Page 4, line 14: “These calculations will be carried out along all 360deg radial direction when being applied to CIPS PMCs”

Please mention explicitly for how many radial directions the analysis was carried out. Somewhere later you mention that this was done in 1 deg steps (page 10, line 2). I wonder how this is done specifically, and I think this should be described in more detail. You probably had to do a resampling (or projection) of the data onto each individual direction, which will also affect the spatial scales covered. I assume all of these effects were taken into account properly?

Page 4, line 19: “In a 6th-order Morlet wavelet (k=6) the scale s is almost precisely the period of the sinusoidal signal”

This is correct, but please mention whether you used the wavelet scale or the Fourier equivalent scale for the following analysis and discussions. This choice may/will affect the spectral exponents derived later.

Page 5, line 5: “Over the seven relevant ..”

I suggest keeping the sign of the slope, i.e., writing “ -0.54”.

Page 5, line 6: “later” -> “latter” ?

Same sentence: Looking at panel a) of Fig. 1, one observes that the dominant (apparent) period changes from about 5 grid units between 20 and 40 to about 10 grid units at 50 to 60, i.e. one would not expect to observe a clear spectral peak in the averaged power spectrum. In the original power spectrum (not averaged over the grid points), one would be able to identify this shift in the dominant period, i.e., you may also show the full power spectrum (but this is not really necessary in my opinion).

Page 5, line 13: “.. along all radial directions”

As above, it would be good to mention for how many directions this was done.

Page 5, line 15: “In addition, performing the CWT along all radial directions will efficiently capture the waves of all orientations without having to perform systematic CWT calculations along-orbit and cross-orbit.“

I don’t really understand the logic behind this statement (and I’m probably missing something here). Doing the analysis along all radial directions requires many more calculations than doing it only along-orbit and across-orbit, right?

Page 5, lines 17/18: It is not fully clear to me why it is necessary to use a 2-D FFT routine to carry out a 1-D wavelet transform?

Page 6, line 19: I suggest deleting “that” in “some physical process THAT yet to be unraveled”

Page 7, line 4: “.. carried out throughout the two northern summers in 2007 and 2010”

Was there a specific reason to limit the analysis to these two summers? If yes, it would be good to mention it.

Page 7, line 6: “We split the cloud population into two subsets ..”

I’m sorry, I read this and the following sentences several times, but I don’t fully understand the exact difference between the two groups. Can you please make this distinction more transparent. Also, it is not entirely clear to me, what freq_25 means. It seems, these sentences mix different definitions in a non-trivial way which makes it difficult to understand them.

Page 8, line 7: “We next adopt an analytic form to parameterize the relationship between the albedo power and freq_25 in order to resample the wave detections into a consistent normal distribution.”

This is certainly something one can do, but this step (and the sectioning performed) seems quite arbitrary to me. Why is a normal distribution really needed? My concern

is that the analysis is based on several arbitrary choices, which raises the question how robust the obtained results (e.g., spectral slopes) are and how they can be compared to other studies that are based on different assumptions.

Page 9, lines 3 – 7: As far as I can tell it is not mentioned how the line sectioning is done. Is it based on an analytic expression?

Page 10, line 28 and line 29: “noises” -> “noise” ?

Page 11, line 17: “mildly turbulent-like”

Can you express this in a more objective way. Looking at the Figures I’m not sure, what exactly is meant here. I also wonder, whether a conclusion like that can be drawn based on 3 cases only?

Page 12, line 7: “three-colored” -> “three colored”

Page 12, line 12: “it plays a minor importance.” -> “it is of minor importance.” or “it plays a minor role.” ?

Page 12, line 29: “wave lengths” -> “wavelengths”

Page 13, line 21: Suggest writing “fractal perimeter dimension” rather than just “fractal dimension”, because there are different fractal dimensions.

Page 15, line 13: “wave length” -> “wavelength”

Page 15, line 29: spaces before “Randall” and “von Savigny” missing

Page 16, line 6: delete extra space after last author

Page 16, line 8: add space before paper title.

Figure 1, caption, line 2: add space in “and11.3”

Figure 2, caption, line 5: “x5 km” -> “x 5 km” ?

Figure 3, ordinate label: “num of detections / bin”

It’s not clear (at least to me) what “bin” refers to here.

Figure 4, caption, line 3: “The dashed thick black lines roughly follow”

There only seems to be a single thick black line, not multiple lines.

Figure 6: It would be good to determine and present uncertainty estimates for the spectral slopes.

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