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Atmospheric Chemistry and Physics Discussions



# *Interactive comment on* "Quantification of waves in lidar observations of noctilucent clouds at scales from seconds to minutes" *by* N. Kaifler et al.

**Anonymous Referee #3**

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This manuscript presents new results on the temporal variability of NLC altitude and NLC volume backscatter coefficients with unprecedented temporal resolution based on LIDAR measurements with the well established RMR-LIDAR system at Alomar. The measurements clearly show evidence for variability down to temporal scales of 1 minute and below. Whether the wave signatures at periods below the Brunt-Väisälä-period are indicative of acoustic waves remains unclear. The manuscript is interesting, generally well written, and contains several novel aspects that are relevant for the NLC/mesosphere community. In my opinion the paper should eventually be published, but the following general and specific comments should be addressed.

Wavelet analysis is used to determine power spectra, whose spectral exponents are then compared to literature values for different atmospheric processes. I see two potential issues that may be associated with the performed wavelet analysis:

1. Before the wavelet transform a spline-interpolation with 1-hour temporal sampling is done and this interpolated time series is subtracted from the actual time series, if I understood correctly. This amounts to removing low frequency components from the time series and the resulting power spectrum and the spectral slope will be affected by that. I'm not sure how the obtained spectral slopes are in any way comparable to literature values.

2. The spectral slope of a wavelet power spectrum may differ from the slope of the standard Fourier power spectrum.

These two issues should be addressed. I was also wondering, why you didn't simply use the Fourier power spectrum in the first place, because you don't exploit or use the big advantage of wavelet analysis over Fourier analysis, i.e. that one gets both time and frequency information or localized frequency information.

Specific comments:

Page 7398, line 20: 'In summer, breaking GW at mesospheric or thermospheric altitudes drive the meridional circulation ..'

GWs can also penetrate into the mesosphere in the winter hemisphere, and also contribute there to the meridional circulation.

Page 7399, line 7: This is only a minor comment, but temperature can be high or low, but not cold, strictly speaking.

Page 7400, line 24: '.. acquired in 2011'

It's not clear what 'acquired in 2011' refers to. Was the single-pulse detection system acquired in 2011, or the results shown?



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Page 7401, line 10: '.. the measurement volume is 1.3 km'

Phrase is imprecise. '1.3 km' is not a volume.

Page 7401, line 19: 'per time t and altitude z' -> 'per time and altitude bin' ?

Page 7402, line 19: 'the quantization'

I guess you mean 'quantification'?

Page 7404, line 1: 'The datasets (30 s resolution) from both telescopes were analyzed separately and the results averaged.'

Were the data sets always fairly similar, so that averaging them makes sense?

Page 7404, line 23: 'For coherent waves'

Can you explain briefly, what exactly you mean by 'coherent' here?

Page 7405, lines 21 and 22: What are the numbers given in parentheses? As far as I can tell this is not mentioned in the paper.

Page 7406: 'For wavelet analysis, we subtract a cubic spline interpolation with supporting points at 1 h intervals, i.e. the series have at least three supporting points.'

I'm not sure I fully understand this statement. My interpretation is, that you spline-interpolate a curve to the time series values that are 1 hour apart in time. Then you subtract this interpolated curve from the time series, right? If this is the case, this procedure removes some of the low-frequency variability present in the time series and will make the resulting time series more stationary. In order words, the spectral exponents obtained will be changed, i.e. the absolute values of the spectral exponents will be reduced. Perhaps I'm missing a point here, but it seems you are manipulating the time series in such a way that the power spectra are affected in a non-trivial way which makes the interpretation of the resulting spectral exponents very difficult. Please also determine the spectral exponents without removing the spline-interpolated time



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series, and check how different the exponents are.

Page 7406, line 12: 'The average spectral slopes $\alpha$, which are indicated as black line below the spectra, are determined from linear fits to each spectrum.'

Another concern I have is that the spectral slopes determined using wavelet analysis may not be necessarily identical to the spectral slopes in the Fourier power spectrum. The spectral exponents usually discussed in the turbulence literature are exponents of the Fourier power spectrum. I'd imagine that the wavelet exponents for a Morlet wavelet might be similar to the Fourier spectrum exponents, because the basis of a Morlet wavelet is a complex exponential function; but differences may exist. This may also complicate the comparison of the derived spectral exponents to literature values. Again, perhaps I'm missing something and it is for some reason trivial that the wavelet power spectrum slope is identical to the Fourier spectrum slope? Wouldn't it be better to use the Fourier power spectrum for this application, because you don't use the time-frequency-spectra, anyway?

Page 7406, line 19: 'we identified locally and globally significant periods'

Please mention what the difference between locally and globally significant periods is.

Page 7406, line 21: 'To test the influence of noise we transform a time series of random numbers, too (the result is shown in shaded grey).'

I'm having difficulties to reconcile this statement with the following sentence in the caption of Fig. 8: 'The periods from a time series of random numbers that appear significant are shown in shaded grey.'

Why 'appear' significant? How do you judge, whether the periods are significant or not? Please clarify.

Page 7410, line 21 and 23: Sorry, but why are there 2 values for the maximum growth rate (one positive, one negative)



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Page 7411, line 2: this is just a minor comment, but for NLC radii of several tens of nm the scattering coefficient does not scale with r^6, but with the 4th-5th power of r. This doesn't change your conclusions, though.

Page 7412, section 4.4: As mentioned before, it should be clarified whether the spectral exponents derived from the LIDAR measurements are actually comparable to the literature values cited in this section. The issues to be considered are: a) how does the subtraction of the spline-interpolated time series affect the spectral exponents, b) are the wavelet power spectral really comparable to Fourier power spectra.

Page 7427, Fig. 7: What is the grey-shaded area in this Fig.?

Typos etc.:

Page 7400, line 11: 'by Taylor et al. (2009); Baumgarten et al.' -> 'by Taylor et al. (2009) and Baumgarten et al.'

Page 7404, line 16: 'This criteria' -> 'This criterion' (criterion is singular, criteria plural)

Page 7406, line 2: 'occurency' -> 'occurrence' ?

Page 7407, line 26: 'wavelet transformation' -> 'wavelet transform'

Page 7411, line 16: 'the waves observed by lidar are possible to BE observeD by ground-based cameras, too, ..' or 'the waves observed by lidar CAN BE observeD by ground-based cameras, too, ..'

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Interactive comment on Atmos. Chem. Phys. Discuss., 13, 7397, 2013.