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Interactive Comment

Interactive comment on "Gravity wave influence on NLC: experimental results from ALOMAR, 69° N" *by* H. Wilms et al.

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Reply to Anonymous Referee 1

We greatly appreciated your thorough review of the manuscript.

Regarding your concern on not being able to distinguish between gravity waves and tides, we performed the analysis again with a wind data set where the tides have been removed. The criterion to distinguish gravity waves from tides is that we assume tides to be phase stable for several days, as opposed to gravity waves. This method has been successfully applied in previous studies (eg., Singer et al., GRL 2005 and Hoffmann et al., AnnGeo 2008). By using this dataset we are for example able to exclude the terdiurnal tide to be responsible for the reduction of η around periods of 8h, see

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new Fig. 9. A discussion of effects due to planetary waves (and also tides) is included in the revised version of the manuscript (line 343):

Specific comments:

1) & 2) The seasonal cycle and planetary waves are now included in the introduction.

3) Thank you for pointing out the work of Ern et al., a reference has been added.

4) With 'gravity wave range' we mean periods up the 13h, which corresponds to the Coriolis parameter at ALOMAR. For this reason, the upper limit for the period range in Figs. 5 and 9 was set to 12h (meaning the wave band comprising periods from 11h to 13h).

5) This is completely right. For this reason we included the analysis with the wind data set without tides, which is then used to derive the reference variances. We discuss the effect of a possible bias in the revised manuscript (l. 157).

6) To prevent misunderstanding, this sentences about 'less' NLC during high gravity wave kinetic energy has been rephrased (l. 170).

7) A comment on the possible bias introduced by tides is now included in the revised manuscript (l. 190).

8) We express the 'summer season mean' by the global wavelet spectrum, which we calculate for the time frame from 1 June to 15 August. Almost all NLC detections at ALOMAR fall within this time frame (only two faint NLC occurred later than 15 August).

9) see above

10) see above

11) We have analyzed several parameters that could hint at different background conditions in 2008, but none of them revealed any peculiarities. Among those parameters were background temperatures from satellite data, mean PMSE occurrence rates, wind

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spectra, total wind variances and tidal amplitudes. As we were not able to explain the different behavior in 2008, we looked at the data itself and found that the clear trend was mainly due to two distinct NLC events, which we then discussed in further detail. A paragraph summarizing our findings on this subject is now included in the manuscript (l. 260).

12) The sentence has been rephrased to '... cannot be explained by an increased occurrence of gravity waves in this energy range' to prevent misunderstanding.

13) The term 'long term limit' has been clarified by '$\beta_{max} > 4 \times 10^{-10}$ m^{-1} sr^{-1}', as suggested.

14) When using the wind data without tides, the decrease around 8h is still present (see new Fig. 9), although the terdiurnal tides has been removed as well. We therefore conclude that the decrease is not caused by tidal influence.

15) This point is indeed important to mention and is now included in the revised version of the manuscript (l. 326).

16) For this event the data without tides does not show the preceding enhancement of the 8h wave. It therefore seems likely that it is caused by the terdiurnal tide (l. 380).

17) These results by Chandran et al. are now included in the revised version of the manuscript (l. 406).

The technical comments have been changed as suggested, thank you very much.

Reply to Anonymous Referee 2

Thank you for your encouraging comments on the manuscript. The following specific comments have been addressed in the revised version of the manuscript:

p. 20055, l. 2-4: To point out that the bands can be arbitrarily chosen, the following

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sentence is now included: 'The bands can be chosen around any desired central scale S. We use partly overlapping bands with 1h spacing between the central periods as indicated in Fig. 1.'

p. 20055, l. 22-24: This is now made clear in the revised version of the manuscript (l. 147).

p. 20057, l. 1-7: The power spectral density increases for smaller frequencies ($f^{-5/3}$ dependency). The kinetic energy density, or variance, in a certain frequency range is the integral over the spectrum (see Eq. 1). Hence, higher energy densities are obtained for larger periods and so the probability of observing NLC during higher kinetic energy densities also increases.

p. 20059, l. 22-26: Following your suggestion we examined all NLC with maximum brightness of $\beta_{max} > 30 \times 10^{-10}$ m^{-1} sr^{-1}. Only two further NLC events out of over 40 which were analysed showed enhanced wave activity around the 8h band. It seems that wave activity in this period band is not generally found prior to very strong NLC.

p. 20060, l. 25-28: We did perform the analysis on different brightness classes of NLC. The result for strong NLC are now included in Fig. 9. However, no different trend is found, but the dip at periods around 7h increased.

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1) The two panels have different x-axes, because the spacing of the scales s, for each of which the wavelet transformation is calculated, is exponential (fractional powers of 2, see Eq. 9 of Torrence and Compo, 1998). The reference variances however have equal spacing and the same band width of 2h each. To avoid confusion, it is explicitly stated in the revised version of the manuscript that the top panel has a logarithmic axis as opposed to the lower panel. The effect of tides is discussed in the revised manuscript

(l. 156, l. 190, l. 293 and l. 346) with an extended Fig. 9.

2) Only a small fraction of NLC are brighter than for example 15×10^{-10} m^{-1} sr^{-1} (see Fig. 2 of Fiedler et al. 2009). The period dependency of eta for single year data as shown in Fig 5 is therefore highly variable and strongly depends on single NLC detections. Thus, they are not included in the analysis. However, for the combined data set of the years 1999-2011 the underlying data set is large enough and the results for only strong NLC (brighter than 13×10^{-10} m^{-1} sr^{-1}) are included in Fig. 9.

3) We followed the suggestion and looked for differences throughout the NLC season. However, no new results have been found by dividing the NLC season.

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 20049, 2013.