

***Interactive comment on* “Stratospheric observations of noctilucent clouds: a new approach in studying large-scale mesospheric dynamics” by Peter Dalin et al.**

Peter Dalin et al.

pdalin@irf.se

Received and published: 14 October 2019

We thank anonymous Referee 2 for her/his useful comments and suggestions, which led to improvements of our manuscript. In the revised version of the manuscript we have carefully addressed Referee 2 comments and suggestions which are highlighted in green. Our detailed replies are provided below.

Please note that the title of the manuscript has been slightly changed to "Stratospheric observations of noctilucent clouds: a new approach in studying middle- and large-scale mesospheric dynamics".

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General comments: The paper presents a new data set, namely Stratospheric balloon measurements of Noctilucent clouds. Stratospheric balloon measurements are a rather new way of observing these clouds. The author claims that this new method has several advantages as listed in the manuscript, and as such I would expect it to yield new information about the clouds. However, in my view the manuscript mostly describes the observations, and is lacking such information. I believe more insights can be drawn from the data set by performing detailed studies such as time evolution of the cloud movements/growth.

Reply:

We partly agree with this comment that "more insights can be drawn from the data set by performing detailed studies such as time evolution of the cloud movements/growth."

At the same time, the present paper is a review paper on the first experiment dedicated to observations and studies of NLCs at middle- and large-scales (100-1500 km). A review paper on the PMC-Turbo experiment by Fritts et al. (2018) has been recently presented in the literature, describing various observed phenomena in PMCs without a deep analysis. The authors have stated that "An overview of the PMC Turbo experiment motivations, scientific goals, and initial results is presented here... These examples suggest clear benefits of CIPS and PMC Turbo image comparisons, and subsequent PMC Turbo papers addressing specific dynamics sequences will explore several of these cases in greater detail."

We also present a review paper on our experiment describing initial results. Detailed studies will be done in the future. We have added this information in the abstract of the revised manuscript (lines 33-35) as follows:

"Here we present a review paper on our experiment describing initial results. Detailed studies on time evolution of the cloud movements will be done in the future."

Comment: I also have an issue with the nomenclature of the paper. I do not believe

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these voids are the same as the much larger ice voids seen by CIPS Bailey et al. (2009) and Thurairajah et al. (2013b) or by Megner et al. (2018), since the sightings there were of a single void in an otherwise fairly homogeneous PSC cover. The formations here seem less round, and more like openings in an inhomogeneous cloud cover. Moreover, as the authors point out these features move with the wind, was not the case in Megner et al (2018). I therefore think it would cause confusion to name these by the same term 'ice voids', and suggest that the authors come up with another term.

Reply:

We believe it is unreasonable to introduce a new definition for a similar morphological phenomenon observed in NLCs/PMCs structures.

Thus, Figure 3c of Thurairajah et al. (2013a) as well as Figure 1, Figures 2a-3, 2a-4, Figure 3a, Figure 4a, Figure 5b, Figures 6a,c, Figure 7a of Thurairajah et al. (2013b) clearly demonstrate the presence of partial ice voids at the edges of the PMC area. Figure 9 of Rusch et al. (2009) also illustrates partial ice voids at the PMC edge. Figure 2 of Megner et al. (2018) shows the particular ice void having an incomplete oval shape, i.e., this was a partial ice void observed in NLCs.

We keep the definition "partial ice voids" unchanged in the revised manuscript.

Specific comments: 153-154 and Figure 3: It is unclear if the marked area is the actual PSC coverage or the observation area, or both, i.e. that the whole observation area was filled with clouds.

Reply:

The marked area is the actual NLC coverage. The observation area is larger. We have added this information on line 159 in the revised manuscript and in the caption of Figure 3:

"One can see that the NLC field (their actual coverage) extended mostly from the west to east along an area filled with low temperatures of 136-146 K. . ."

Comment: 189-193: Please explain how a large-scale gravity wave could produce the shapes/patterns of the cloud openings.

Reply:

This has already been explained a bit earlier (lines 185-186 in the previous manuscript and on lines 193-195 in the revised manuscript):

"Rusch et al. (2009) have hypothesized that ice voids could be caused by heating due to the passage of warm crests of a gravity wave."

Comment: 229-232: I do not believe one can determine that this is a vertical modulation from only one picture. If you have several pictures from different angles then this could be determined, but from one picture it is not possible to separate horizontal and vertical modulation.

Reply:

We are not 100% sure we understand this comment. Wave horizontal and vertical modulations are at the right angle to each other, and thus they do not produce a mutual interference. But we did analyze nine images at various viewing angles in order to deduce the maximum vertical displacement (amplitude) of this particular wave. The nine images showing progressive changes in the wave displacement can be found at the following webpage:

ftp://ftp.irf.se/outgoing/pdalin/NLC/SONC_experiment_2018_07_05/WAVE_AMPLITUDE/

We have added this information in the revised manuscript (lines 256-260):

"We have analysed nine images at various viewing angles in order to deduce the maximum vertical displacement (amplitude) of this particular wave. The nine images showing progressive changes in the wave vertical displacement can be found at the following webpage: ftp://ftp.irf.se/outgoing/pdalin/NLC/SONC_experiment_2018_07_05/WAVE_AMPLITUDE/"

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Comment: Figure 4 and 5: It is very difficult to judge the shape and clarity of the cloud openings when there are pre-drawn red lines to guide the eye. Please remove those. They could be replaced by arrows if you find it necessary.

Reply:

We have replaced the red lines with arrows indicating the centers of the partial ice voids. Please see new versions of Figure 4 and 5 attached.

Comment: Technical Corrections 177: remove 'there should be fulfill'

Reply: This has been removed.

Interactive comment on Ann. Geophys. Discuss., <https://doi.org/10.5194/angeo-2019-114>, 2019.

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Fig. 1.

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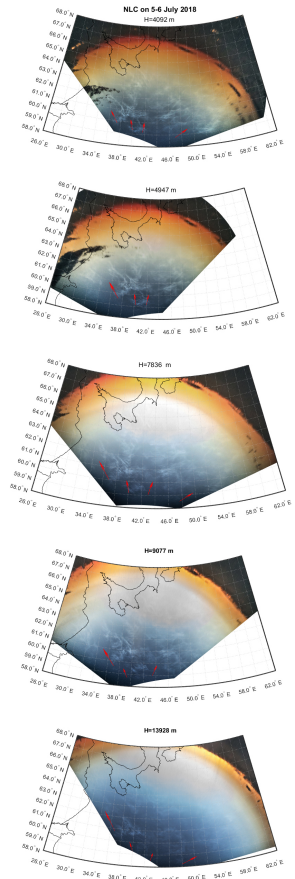


Fig. 2.

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