A review on the paper "Lidar measurements of noctilucent clouds at Rio Grande, Tierra del Fuego, Argentina" by Natalie Kaifler, Bernd Kaifler, Markus Rapp, Guiping Liu, Diego Janches, Gerd Baumgarten and Jose-Luis Hormaechea.

General comments:

In the present paper, the authors investigate noctilucent clouds (NLC) in the southern hemisphere at mid-latitude sites in southern Argentina. The authors have been using lidar soundings since 2017 and optical camera observations since 2019, enabling comparisons between the vertical lidar soundings and NLC spatial imaging in a common volume of the mesopause. The authors have found in total 19 NLC events, at an average height of 83.3 km, an average NLC occurrence rate of 6% and a NLC maximum in the morning hours. The ambient temperature above the lidar site was, on average, too high to support local NLC ice particle formation. The authors explain this by the northward transport of NLC. Another explanation is a possible influence of increasing space traffic producing enhanced amount of water vapor in the upper mesosphere.

I have found the present paper to be very interesting to the atmospheric community. I recommend the present paper for publication after minor revisions which are outlined below.

Specific comments:

Page 1, L.3: "At northern hemisphere mid-latitudes, the occurrence of NLC seems to increase with time."

This sentence should be removed from the abstract since it is debatable in the literature and it is beyond the scope of the present manuscript.

Page 1, L.16-17: "Noctilucent clouds (NLC) were discovered at northern-hemispheric mid-latitudes by visual observation of the horizon in twilight conditions (Backhouse, 1885; Jesse, 1885; Leslie, 1885)."

Please add here the paper by Tseraskii (1887) who observed, photographed and estimated the NLC altitude for the first time already in June 1885.

Page 2, L.25-28: " In recent decades, the number of observations in the northern hemisphere appeared to increase, and efforts were made to uncover the origins of mid-latitude NLC and study their possible relation to climate change (von Cossart et al., 1996; Nielsen et al.,2011; Hultgren et al., 2011; Gerding et al., 2013a; Russell III et al., 2014; Hervig et al., 2016)."

This is not the whole story of the topic regarding "the number of in the northern hemisphere appeared to increase…". The authors traditionally highlight one side of this topic only, and traditionally forgetting another side of this problem. There is a series of scientific publications clearly demonstrating a slight positive **statistically insignificant trend** or **about zero trend** in the NLC occurrence number and NLC brightness at middle latitudes (Dalin et al., 2020, Dubietis et al., 2010; Kirkwood et al., 2008; Kirkwood and Stebel, 2003; Pertsev et al., 2014; Zalcik et al., 2014, 2016). If the authors really want to highlight this topic then the authors should illuminate another side of this problem on about zero trend in the NLC occurrence at mid-latitudes as well (see Dalin et al., 2020 and references therein). Otherwise, this topic should be removed since it is beyond the scope of the present manuscript.

Page 2, L.40-42: "Prior to the deployment, no sightings of NLC north of 54°S have ever been reported from this or any other longitude in the southern hemisphere."

This sentence sounds strange. It is well-known that a big network of NLC observing stations was established in the southern hemisphere (between 45°S and 90°S) in the 1960s.

In particular, there were registered and photographed several NLC displays from Punta Arenas 53.1°S, 71.0°W (Chile). Besides, one can read the following statement from Fogle and Haurwitz (1966): "The brightest and most widespread displays observed on the expedition occurred during the period January 1-4 with the best display taking place on the night of January 3 (this display was also observed by personnel at the weather stations at **Port Stanley (51.7°S, 57.9°W) in the Falkland Islands**…". Thus, this is certainly "north of 54°S". Please see publications by Fogle (1964, 1965), Fogle and Haurwitz (1966) on NLC observations in the SH.

Page 6, L.128-129: "… the NLC layer is perturbed at periods below the Brunt-Vaisala period."

Some comment is needed here to explain how it is possible to observe periods in an NLC layer below the Brunt-Vaisala period.

Page 7, L.146-147: "In fact, NLC can be detected in camera images at locations close to the lidar beam and yet remain unvisible to the lidar."

Some comment is needed here to explain why NLC might be unvisible to the lidar, having NLC in images close to the position of the lidar beam.

Page 8-9, L.168-169: "Evidence for the very same small-scale dynamics are also found throughout the lidar soundings in the form of very short-period (around 1 min) modulations of the NLC layer with vertical displacements of few hundred meters."

In my opinion, this is a very interesting result which is better to demonstrate it in a figure. Please add a figure showing small-scale short-period (1 min) dynamics of the lidar sounding for this case.

Page 12, L.211: "The peak in brightness between 5–7:30 UT…"

Please add LT here as well.

Page 12, L.226: " Spectral power for periods between 6 h and 16 d are presented in Fig. 6"

In Fig. 6, one can see the period scale until 10 days. Where can I find periods of more than 10 days?

Page 13, L.232-233: "(Merkel et al., 2003) and (Merkel et al., 2008) detected a pattern in noctilucent cloud brightness related to the 5-day planetary wave from satellite measurements."

Here it is worth mentioning two papers by Dalin et al. (2008; 2011) which clearly demonstrated the influence of 2- and 5-day planetary waves on NLC activity.

Page 17, L.281-282: "An additional source of water vapour in the upper mesosphere and lower thermosphere that might trigger bright NLC especially at mid-latitudes is rocket engine exhaust (Stevens et al., 2012; Siskind et al., 2013; Stevens et al., 2022)."

Here it is worth mentioning the paper by Dalin et al. (2013) which clearly demonstrated the direct formation of NLC in the rocket exhaust trail.

Additional references:

Dalin, P., Perminov, V., Pertsev, N., and Romejko, V.: Updated long-term trends in mesopause temperature, airglow emissions, and noctilucent clouds. Journal of Geophysical Research-Atmospheres, 125, e2019JD030814, https://doi.org/10.1029/2019JD030814, 2020.

Dalin, P., Perminov, V., Pertsev, N., Dubietis, A., Zadorozhny, A., Smirnov, A., Mezentsev, A., Frandsen, S., Grönne, J., Hansen, O., Andersen, H., McEachran, I., McEwan, T., Rowlands, J., Meyerdierks, H., Zalcik, M., Connors, M., Schofield, I., Veselovsky, I.: Optical studies of rocket exhaust trails and artificial noctilucent clouds produced by Soyuz rocket launches, JGR-Atmospheres, 118, 14, 7850-7863, doi:10.1002/jgrd.50549, 2013.

Dalin, P., N. Pertsev, A. Dubietis, M. Zalcik, A. Zadorozhny, M. Connors, I. Schofield, T. McEwan, I. McEachran, S. Frandsen, O. Hansen, H. Andersen, V. Sukhodoev, V. Perminov, R. Balčiunas, V. Romejko: A comparison between ground-based observations of noctilucent clouds and Aura satellite data. J. Atmos. Solar-Terr. Phys., 73, 14-15, 2097-2109, doi:10.1016/j.jastp.2011.01.020, 2011.

Dalin, P., N. Pertsev, A. Zadorozhny, M. Connors, I. Schofield, I. Shelton, M. Zalcik, T. McEwan, I. McEachran, S. Frandsen, O. Hansen, H. Andersen, V. Sukhodoev, V. Perminov, V. Romejko: Ground-based observations of noctilucent clouds with a northern hemisphere network of automatic digital cameras. J. Atmos. Solar-Terr. Phys., 70, 11-12, 1460-1472, doi:10.1016/j.jastp.2008.04.018, 2008.

Dubietis, A., Dalin, P., Balciunas, R., & Cernis, K.: Observations of noctilucent clouds from Lithuania. Journal of Atmospheric and Solar - Terrestrial Physics, 72(14-15), 1090–1099, https://doi.org/10.1016/j.jastp.2010.07.004, 2010.

Fogle, B.: Noctilucent clouds in the southern hemisphere. Nature, 14, 204, 1964.

Fogle, B.: Noctilucent clouds over Punta Arenas, Chile. Nature, 66, 207, 1965.

Fogle, B., and Haurwitz, B.: Noctilucent clouds. Space Science Reviews, 6, 3, 279-340, 1966.

Kirkwood, S., Dalin, P., and Réchou, A.: Noctilucent clouds observed from the UK and Denmark—Trends and variations over 43 years. Annales Geophysicae, 26, 1243–1254, 2008.

Kirkwood, S., and Stebel, K.: Influence of planetary waves on noctilucent cloud occurrence over NW Europe. Journal of Geophysical Research, 108(D8), 8440. https://doi.org/10.1029/2002JD002356, 2003.

Pertsev, N., Dalin, P., Perminov, V., Romejko, V., Dubietis, A., Balčiunas, R., et al.: Noctilucent clouds observed from the ground: sensitivity to mesospheric parameters and long-term time series. Earth, Planets and Space, 66(1), 1–9, https://doi.org/10.1186/1880-5981-66-98, 2014.

Tseraskii, V. K.: Astronomichesky fotometr i ego prilozhenia (Astronomical photometer and its applications). Doctoral Dissertation, Mathematical Proceedings, XIII, Section 21, 626–631, 1887 (in Russian).

Zalcik, M. S., Lohvinenko, T. W., Dalin, P., and Denig, W. F.: North American noctilucent cloud observations in 1964–77 and 1988–2014: Analysis and comparisons. Journal of the Royal Astronomical Society of Canada, 110(1), 8–15, 2016.

Zalcik, M. S., Noble, M. P., Dalin, P., Robinson, M., Boyer, D., Dzik, Z., et al.: In search of trends in noctilucent cloud incidence from the La Ronge flight service station (55°N 105°W). Journal of the Royal Astronomical Society of Canada, 108(4), 148–155, 2014.