The database of observations of noctilucent clouds conducted

The aim of our research is to better understand dynamical processes in the middle atmosphere and layered icy phenomena occurred between 80 and 100 km as a transition region between the middle atmosphere and near space environment (so called the mesopause). A particular interest focuses on the layered phenomena called Noctilucent Clouds (NLC). NLC are the highest clouds in the Earth's atmosphere formed mostly between 80 and 90 km in summer time of both hemispheres, when the atmospheric temperature is extremely cold, as low as 120-145 K (−150 ÷ −130°C). NLC are composed of small water-ice crystals (~30–100 nm in radius) which effectively scatter sunlight, and hence these clouds are easily discernible against the twilight sky. Atmospheric dynamics plays a crucial role in variability of NLC on short- and long-term scales. Thus, turbulence, gravity and planetary waves, solar thermal and lunar gravitational tides produce significant variabilities of all basic atmospheric parameters, hence changing temporal and spatial evolution of NLC.

The presented data on NLC were obtained thanks to long-term observations performed by the large Moscow group of the experienced NLC observers who were regularly trained by the special NLC observation programme. The observations of NLC have been conducting in the Moscow region (~56^o N, 37^o E) since 1962 to present in summer time from about 20 May to 15 August. Before 2003, the data had been collected based on visual observations carried out by the observation programme elaborated by Grishin (1957), under general supervising by G.T. Zalyubovina (in 1962-1964) and by V.A. Romejko (from 1968 to 2011). Since 2003, visual observations have been systematically supported by time-lapse digital photographic recording organized by a group of scientists from the Institute of Atmospheric Physics, Swedish Institute of Space Physics (IRF-Kiruna) and other institutes. The digital measurements provide continuous observations during a whole night and whole summer season with higher temporal resolution and precision compared to the visual observations. That is why the number of detected NLC displays has increased since the start of the "digital" era. At the same time, we apply the same procedure for assessment of NLC parameters both for the "visual" (1962-2002) and "digital" (2003-present) observational era. In particular, the NLC brightness is visually estimated by the same procedure as described below. In transitional period 2003-2011 both visual observations and photographic recording were carried out.

The Moscow NLC database includes estimations of NLC parameters as well as weather conditions for each observable night. In case of visual observations, the twilight sky had been examined every 15 min during twilight and night. In case of photographic observations, the northern part of the sky have been examined every several minutes (the past ten years the time interval between taken images is 1 min) during a night. The photographic observations are being carried out from 20 May to 15 August. The nights without NLC appearing are kept in the database because they provide information about the weather allowance to register them.

The following parameters are estimated when conducting an observation:

- Date and time of the observation of a twilight sky (Moscow time);
- Time of appearance and disappearance of NLC;
- NLC brightness is visually estimated on a 5-point scale (Grishin, 1957), with an increment of 0.5, as the difference between the apparent NLC brightness and the background twilight sky. The lowest value at the threshold visibility is 0.5 points and the maximum brightness is equal to 5 points (Dalin et al., 2008; Pertsev et al., 2014; Romejko et al., 2003);
- The integral brightness of NLC is estimated as the sum of all brightness estimations for a given night, made with a time interval of 15 min;
- Morphological classification of NLC (I, IIa,b, IIIa,b,c, IVa,b,c) according to Grishin (1957);
- Tropospheric weather conditions are estimated on a 3-point scale (with an increment of 0.5). The lowest value (1) corresponds to the clear twilight arch of the sky (neither tropospheric clouds nor fog, and the atmosphere is transparent enough). The maximum value (3)

corresponds to the total coverage of the twilight arch of the sky covered either by tropospheric clouds or fog or strong aerosol loading (NLC cannot be detected).

References

Dalin, P., Pertsev, N., Zadorozhny, A., Connors, M., Schofield, I., Shelton, I., Zalcik, M., McEwan, T., McEachran, I., Frandsen, S., Hansen, O., Andersen, H., Sukhodoev, V., Perminov, V., Romejko, V., 2008. Ground-based observations of noctilucent clouds with a northern hemisphere network of automated digital cameras. J. Atmos. Sol.-Terr. Phys., 70, 1460–1472.

Grishin, N. I., 1957. Instructions for Noctilucent Cloud Observations (in Russian), 26 pp., Izdatelstvo Akad. Nauk SSSR, Moscow.

Pertsev, N., Dalin, P., Perminov, V., Romejko, V., Dubietis, A., Balčiunas, R., Černis, K., Zalcik, M., 2014. Noctilucent clouds observed from the ground: sensitivity to mesospheric parameters and long-term time series. Earth, Planets and Space, 66, 98, doi:10.1186/1880-5981-66-98.

Romejko, V.A., Dalin, P.A., Pertsev, N.N., 2003. Forty years of noctilucent cloud observations near Moscow: database and simple statistics. J. Geophys. Res., 108, D8, 8443, doi:10.1029/2002JD002364.

The following references should be cited whenever using the data of the Moscow NLC database:

Dalin, P., Pertsev, N., Zadorozhny, A., Connors, M., Schofield, I., Shelton, I., Zalcik, M., McEwan, T., McEachran, I., Frandsen, S., Hansen, O., Andersen, H., Sukhodoev, V., Perminov, V., Romejko, V., 2008. Ground-based observations of noctilucent clouds with a northern hemisphere network of automated digital cameras. J. Atmos. Sol.-Terr. Phys., 70, 1460–1472.

Pertsev, N., Dalin, P., Perminov, V., Romejko, V., Dubietis, A., Balčiunas, R., Černis, K., Zalcik, M., 2014. Noctilucent clouds observed from the ground: sensitivity to mesospheric parameters and long-term time series. Earth, Planets and Space, 66, 98, doi:10.1186/1880-5981-66-98.

Romejko, V.A., Dalin, P.A., Pertsev, N.N., 2003. Forty years of noctilucent cloud observations near Moscow: database and simple statistics. J. Geophys. Res., 108, D8, 8443, doi:10.1029/2002JD002364.

The data files are in ASCII text format.

The data can be freely downloaded at the following web resource of the A.M. Obukhov Institute of Atmospheric Physics: http://ifaran.ru/lab/lfva/NLC_data_engl.html

Filename	Description	File table format
NLC_Moscow_from_1962.txt	Observations of noctilucent clouds conducted in the Moscow region.	(1) Year (2) Month (3) First date for a given night (4) Second date for a given night (5) NLC Integral brightness (marks) (6) NLC maximum brightness (marks) (7) Weather code* (8) Start time** of NLC appearance (9) End time** of NLC appearance (10) Duration of NLC appearance (hours)
IMG_2016_06_22_UT21h19m.jpg IMG_2016_06_22_UT21h18m.jpg IMG_2016_06_23_UT21h17m.jpg IMG_2016_06_24_UT21h16m.jpg IMG_2016_06_24_UT21h15m.jpg	Some photoimages (from Obninsk, 2016) that were used in studies of NLC brightness variations	

*Weather code specification:

1.0 –“clear” (**0-5%** tropospheric cloud coverage of the twilight arch of the sky) and high atmospheric transparency;

1.5 – “almost clear” (**5-30%** tropospheric cloud coverage of the twilight arch) and high atmospheric transparency;

2.0 – “semiclear” (**30-75%** tropospheric cloud coverage of the twilight arch), the atmospheric transparency allows to register NLC;

2.5 – “poor visibility” (**75-95%** trop. cloud coverage) or almost opaque haze;

3.0 – “bad weather”- twilight arch is covered by tropospheric clouds (**95-100%** tropospheric cloud coverage) or opaque haze;

Since weather conditions frequently change in the course of night, the weather code may represent combined basic values like 1.2, 1.3, 1.52, 1.53, 3.21, 2.32 etc, reflecting changes in the tropospheric cloud coverage for a given night.

** In summer seasons, Moscow Time corresponded either to UTC+3 hours (for 1962-1980, 1991, and from 2015 to present) or UTC+4 hours (for 1981-1990, 1992-2014).

Last updated database: September 2018, Peter Dalin (pdalin@irf.se) and Nikolay Pertsev (n.pertsev@bk.ru)