INTERNATIONAL WORKSHOP ON NOCTILUCENT CLOUDS

Tallinn, Estonia, USSR, July 27–31, 1988

O.A. Avaste and G.E. Thomas

Tartu State University 202400 Tartu Estonia USSR
Received September 9, 1988

The International Workshop on Noctilucent Clouds was held in Tallinn, USSR from 27–31 July, 1988. The NLC Workshop was sponsored by the NLC Working Group of the Commission on the Meteorology of the Upper Atmosphere and the hosts were the Tartu State University and the Institute of Astrophysics and Atmospheric Physics of the Estonian Academy of Sciences. Thirty scientists from eight countries participated in the Workshop. The main topics of the Workshop were new data on the climatology and physics of NLC, especially problems connected with rocket soundings of the mesopause. Twenty papers were presented and a concluding discussion was held.

Co-chairman of the International Working Group on Noctilucent Clouds, G.E. Thomas (USA), gave a review of the previous NLC Workshop in Boulder, Colorado, March 16–18, 1988. He analyzed the main trends and open questions in ion chemistry versus NLC physics, dynamics of the mesopause, microstructure of NLC, and elecrodynamics of the mesopause, as well as climatology and morphology of NLC.

Two papers were devoted to the electrodynamics of the mesopause. A.M. Zadorozhny presented results of measurements of the vertical component of the electric field and a nitric oxide vertical distribution in the middle atmosphere from rocket measurements at the Heiss Island (81°N, 58°E) and Volgograd (48°N, 46°E). These measurements showed that during a quiet magnetic period, the electric field strength is significantly lower in the high-latitude mesospause than at middle latitudes. In a strong disturbance, the E-layer profile becomes similar to the mid-latitude one. At Volgograd, the dependence of the electric field on geomagnetic disturbances appears to be weaker. R.A. Goldberg (USA) gave a review on the problems of electrodynamics of the high-latitude mesosphere. He pointed out that the discovery of apparently large (V/m) electric fields within the mesosphere suggests that this region is more active electrically than previously suspected. New measurements show the influence of NLC on electric fields mapping downward from the ionosphere. Future projects are planned to study the mesospheric cloud influence on the local electrical environment. Electrical parameters can be used to track neutral air turbulence and wave structure at high latitudes, thereby providing a powerful tool for the study of mesospheric neutral dynamics and its relationship to the problems of electrodynamics.

Problems of the effects of gravity waves on the temperature field near the mesopause were discussed in the paper by A. Ebel (FRG). He demonstrated results deduced from a 3-D model of the global circulation: the depth of the temperature minimum, as simulated by the model, clearly depends on the intensity of gravity wave activity. He analyzed the interrelation between gravity wave breaking and NLC formation. E. Kopp (Switzerland) investigated the ion composition in the presence of NLC. The ions of the cold arctic mesopause regions could be candidates for nucleation cores of the ice particles that form noctilucent and polar mesospheric clouds (especially when the mesopause temperature is lower than 150 K). The composition of these ions can also give important information on the thermal structure and the composition of neutral minor species, such as H_2O, H_2O_2, NO and O. He analysed three rocket measurements above Kiruna (July 30 and August 13, 1978; August 3, 1982) in the presence of NLC. At the transition height, where the dominant proton hydrates change into molecular ions, the observed cut-off of proton hydrates is much sharper than the model would predict, a situation which indicates a sudden change of eddy transport.

M.I. Taylor (UK) [coauthors R.P. Lowe (Canada) and P.I. Baker, I. Ulwick (USA)] presented a paper on the association of NLC with the OH nightglow emission. Michelson interferometer measurements, carried out on several consecutive nights from Poker Flat Research Range, Alaska (65.1°N, 147.5°W) during August 1986, as well as NLC observation from Gulkana Airport (62.2°N, 145.5°W), demonstrated that a study of the OH intensity and temperature should provide information on the atmospheric conditions in the vicinity of the mesopause during NLC displays. P. Rothwell and P.N. Smith (UK) presented information on a CCD imaging system capable of studying the wave structure in NLC and OH airglow, possibly at the same time. This system has undergone a satisfactory initial test.

NLC climatology from Earth-surface observations was reviewed by N.P. Fast and W.H. Fast (USSR). O.B. Vasilyev (USSR) presented a review on several hypotheses of NLC genesis, composition, and structure of their particles.

G.E. Thomas, E.J. Jensen, O.B. Toon (USA) analyzed the seeming discrepancy in the comparison of photometric data for NLC and polar mesospheric clouds (PMC). In the latitude range (50°–65°), NLC brightness can be ten or more times higher than the atmospheric Rayleigh background. However PMC brightness, measured by satellite limb sensors, indicates very weak clouds (relative to background). These scholars also presented a time-dependent model, which considers small tidal variations of temperature and dynamics at mesopause height. This model showed that cloud brightness peaks at about 23 hours. This peak occurs primarily as the result of a burst of nucleation of new particles at the time of temperature minimum (at 19 hours), but also from an increased condensation growth of the pre-existing particles. A simple 1-D model of NLC formation was given by J.L. Langebraun(USSR). The demonstrated that the life-time of cubic and hexagonal ice particles in NLC cloud layer is higher than that of other forms, which fall out before they have grown to visible sizes.

A. Roddy (Ireland) pointed out the importance of laboratory studies of ice nucleation at low temperatures, relevant to noctilucent clouds. G. Witt (Sweden) presented the results of optical and rocket studies of summertime mesopause. N. Wilhelm (Sweden) characterized a small-size scattered light photometer for NLC experiments.

The nature of NLC was also analysed in the paper by M. Gadsden (Scotland) and W. Schroder (FRG). They presented a review on the climatological study of NLC in north west Europe. They pointed out the importance of comparing meteor train-drift data with the night-to-night occurrence of noctilucent clouds, the study of the morphology of wave-like patterns seen in noctilucent clouds, including the presence of gravity-wave breaking, and systematic measurements of the heights of noctilucent clouds by triangulation (parallactic photography from widely-separated sites).

The paper by A.I. Lazarev, O.A. Avaste and T.A. Damynova (USSR) was devoted to an analysis of the interrelations of NLC occurrence and volcanic eruptions. They proposed a hypothesis that the low-latitude NLC layers seen by Soviet cosmonauts are caused by the particles and gases transported to the mesopause when large volcanic eruptions occur.

U. von Zahn and W. Meyer (FRG) presented new data on the mesopause temperature, derived from the rocket campaign in Andoya Rocket Range (June 10 – July 19, 1987) during the MAC/SINE period. A total of 26 passive falling spheres were tracked precisely by radar systems, and temperature profiles were calculated. In either case the mesopause was at an altitude 88 ± 1 km, and its temperature was 128 ± 5 K. They pointed out that water vapor condensation may occur at mesopause altitudes not only in the regions in which temperatures are locally depressed by the passage of atmospheric waves, but also under undisturbed (= mean) conditions.

In his second paper, U. von Zahn discussed the temperature profiles of the mesopause derived from measurements of the Doppler-width of the laser-excited NaD_2 resonance lines. This technique enables us to determine from ground-based lidar measurements neutral gas temperatures between 80 to 110 km. Temperature profiles were collected at night over 10 min integration periods in 1 km altitude bins with an accuracy of ± 5 K. It was shown that from two winter soundings (1985/86, 1986/87) from December through February, the mesopause temperature was close to 193 K at an altitude of 100 km. C.R. Philbrick (USA) presented climatological mean values of rocket soundings. The mean conditions of the high latitude summer mesopause exhibit a temperature minimum near 125 K near 90 km.

The summer season is strikingly different from the winter, not only in the mean profile, but in the character, frequency and content of the wave structure. The summer profiles show very little wave activity below 70 km; however, waves of large amplitude can grow between 80 and 100 km. The sources of waves from below are limited in the summer and thus, nearly monochromatic waves are frequently observed. The waves observed are important in the formation of noctilucent clouds and other small condensation nuclei, because of the even lower temperatures reached at the minima of the wave; as low as 110 K is probably not uncommon.

The participants of the workshop had a sightseeing tour of Tallinn. They visited the Tartu State University and the Institute of Astrophysics and Atmospheric Physics in Töravere. The next meeting on the NLC problems, climatology, physics of nucleation, and monitoring from space, will be held within the framework of the IAMAP General Assembly in Reading, United Kingdom, where a half-day(morning) session on NLC will be held on August 2, 1989. The current issues to be addressed are: 1) characteristic sizes and shapes of NLC and PMC particles; 2) modes of nucleation and growth; 3) influence of waves, particularly breaking waves; 4) large-scale behaviour; 5) possible alteration of their chemical, ionic and electrical environment.

For further information, please, contact Dr. M.J. Taylor, Department of Physics, the University of Southampton, S09 5NH, United Kingdom.