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Noctilucent clouds and the background atmosphere above ALOMAR

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Noctilucent clouds (NLC) are the visible manifestation of ice particles persistently present in the polar summer mesopause region. Their formation is a rather complicated physical process depending on atmospheric background parameters, such as temperature and water vapor, which are hardly to measure directly at the altitudes of interest. This makes NLC an attractive tracer for dynamic processes in the atmosphere. Cloud parameters show variabilities at different time scales, ranging from minutes to decades, including tidal and solar cycle variations. Between 1997 and 2010 NLC have been observed by the ALOMAR Rayleigh/Mie/Raman (RMR) lidar in Northern Norway at 69° N, 16° E. During a total of 4340 measurement hours NLC were detected for more than 1850 hours on 440 different days, which is the largest NLC data base acquired by lidar. Collocated MF-radar measurements and calculations with the Leibniz-Institute Middle Atmosphere (LIMA-) model are used to characterize the background atmosphere. Temperature as well as horizontal winds at 83 km altitude show distinct differences during NLC compared to the absence of NLC. On seasonal mean it is colder and the winds have been stronger westward when NLC are detected. The wind separation is a robust feature as it shows up in measurement as well as model and it is consistent with the current understanding that lower temperatures support the existence of ice particles. For the whole 14-years data set there is no statistically significant relation between NLC occurrence and solar activity. The reason is that between 2005 and 2008 cloud occurrence and Lyman-α radiation were almost in-phase, contrary to the other years. On the other hand NLC occurrence and temperature at 83 km show a significant anti-correlation, which suggests that the thermal state plays a major role for the existence of ice particles and dominates the pure Lyman-α influence on water vapor during certain years. NLC above ALOMAR are strongly influenced by atmospheric tides. Depending on the parameter, diurnal and semidiurnal amplitudes and phases have different and partly strong year-to-year variations. Most striking features are shown by the NLC brightness: The semidiurnal amplitude has very low values during solar maximum and is over a period of 10 years significantly anti-correlated to Lyman-α radiation. The diurnal phase increases monotonic over the whole time series by more than 90°. In general, amplitudes as well as phases of NLC parameters are not constant over the years. They rather vary in a different manner, amplitudes can change by a factor of more than 3 and phases show changes up to 7 hours. Such year-to-year variability can impact time series generated from observations at fixed local times.