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Noctilucent clouds and their link to atmospheric dynamics

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Noctilucent clouds (NLC) are made of ice particles in the upper atmosphere at an altitude of about 83 km. They occur from middle to high latitudes in summer and consist of tiny particles of a few tens of nanometers only. NLC were first observed in 1885 and have been the only source of information from the upper atmosphere for a long time. Since then the clouds have been linked to processes in the lower atmosphere, for example as indicators for changes of water vapor, methane, and ozone in layers below the clouds. NLC are also affected from above through solar cycle effects and due to thermal tides.

Ice particles in NLC form in an altitude range where small-scale dynamics plays a major role even for the hemispheric thermal and dynamical structure. To understand the development of NLC, even on decadal scales, these small-scale processes need to be included in models. In observations these small-scale processes become evident for example in the variance of particle sizes in a given atmospheric volume or simply as wavy structures, when looking at the clouds by naked eye.

NLC still give new and important information from an altitude range where the multi-scale interaction of waves from tides with small-scale gravity waves is of importance for the global circulation. Using new high resolution observations it has become evident that the clouds are useful targets for studying multi-scale wave interactions and the transition to turbulence.

We will present our recent development in analyzing the horizontal structure of ground based NLC observations by camera in combination with lidar measurements and complemented by meteor radar data. This combination allows quantifying the vertical and horizontal structure of clouds and the underlying atmospheric dynamics on temporal scales down to seconds.