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On the Anthropogenic Origin of Noctilucent Clouds

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The MIMAS (Mesospheric Ice Microphysics and Transport) ice model is used to study the trend behavior of polar mesospheric clouds (PMCs) responding to long-term changes in mesospheric temperatures and water vapor at northern middle and high latitudes from 1871 until now. The calculated trends in PMC formation are partly forced by a long-term change in the thermal and compositorial state of the atmospheric background. We estimate the climate change in the PMC environment using trend studies with our Leibniz-Institute Middle Atmosphere (LIMA) model. We take into account long-term changes in solar activity and trace gas distributions. Furthermore, LIMA adapts NOAA CIRES 20thC V2 reanalysis data (20th century) that describes the temporal evolution of troposphere/lower stratosphere since 1871.

In the past we have concentrated on trends in ice layers mainly for periods after the late 1970s since satellite observations of background Parameters relevant for our topic are available since then. More recently we have extended our trend analysis of background temperatures and noctilucent Clouds (NLC) to a longer period, namely from 1871 to present. We concentrate on the most important drivers for NLC trends, namely carbon dioxide (CO_2) and water vapor (H_2O). Since the main increase of these species occurs in the last 40-50 years, NLC parameters such as occurrence frequency, mean integrated backscatter (IBS), mean altitude, and mean ice water content (IWC) increase accordingly. First, we will present and discuss long term trends in temperatures and water vapor. To separate their impact on the long term evolution of NLC, we have performed runs with temperature trends (caused mainly by increase of CO_2) and water vapor trends (caused mainly by increase of CH_4) separately. Trends of NLC parameters are rather small in the first couple of decades (namely from 1870 until approximately 1960) and accelerate significantly thereafter. We find that the reason for the observed enhancement of NLC brightness in the last decades is primarily the increase of water vapor, whereas the decrease of temperatures plays a secondary role. In our presentation we will discuss the implications of our results for the role of NLC as indicators for climate change.