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Trends in noctilucent clouds

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Noctilucent clouds are often cited as potential indicators of climate change in the middle atmosphere. They owe their existence to the very cold summer mesopause region (~130K) at mid and high latitudes. We analyze trends derived from the Leibniz-Institute Middle Atmosphere Model (LIMA) and the MIMAS ice particle model (Mesospheric Ice Microphysics And tranSport model)
for the years 1871-2008 and for middle, high and arctic latitudes, respectively.
Model runs with and without an increase of carbon dioxide and water vapor (from methane oxidation)
concentration are performed. Trends are most prominent after ~1960 when the increase of both carbon dioxide and water vapor accelerates. Negative trends of (geometric) NLC altitudes are primarily
due to cooling below NLC altitudes caused by carbon dioxide increase. Increases of ice particle radii and NLC brightness with time are mainly caused by an enhancement of water vapor.
Several ice layer and background parameter trends are similar at high and arctic latitudes but are substantially different at middle latitudes. This concerns, for example, occurrence rates, ice water content (IWC), and number of ice particles in a column. Considering the time period after 1960, geometric altitudes of NLC decrease by approximately 260m per decade, and brightness increases by
roughly 50% (1960-2008), independent of latitude. NLC altitudes decrease by approximately 15-20m
per increase of carbon dioxide by 1ppmv. The number of ice particles in a column and also at the altitude of maximum backscatter is nearly constant with time. At all latitudes, yearly mean NLC appear at altitudes where temperatures are close to 145+/-1K. Ice particles are present nearly all the time at high and arctic latitudes, but are much less common at middle latitudes. Ice water content and maximum backscatter are highly correlated, where the slope depends on latitude. This
allows to combine data sets from satellites and lidars. Furthermore, IWC and the concentration of water vapor at the altitude of maximum backscatter are also strongly correlated. Results from LIMA/MIMAS agree nicely with observations.