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Noctilucent cloud variations on centennial timescales

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Noctilucent clouds (NLC) represent some of the earliest observations in the transition region between the Earth's atmosphere and space (roughly at 80-120km). These clouds are located around 83 km altitude, consist of water ice particles and owe their existence to the very cold summer mesopause region (∼130K) at mid and high latitudes. There is a long standing dispute whether NLC are indicators of climate change in the middle atmosphere. We use model simulations of the background atmosphere and of ice particle formation for a time period of 138 years to show that an increase of NLC appearance is expected for recent decades due to increased anthropogenic release of methane being oxidized to water vapor in the middle atmosphere. Since the beginning of industrialization the water vapor concentration at NLC heights has presumably increased by about 40 percent (1 ppmv). The water vapor increase leads to a large enhancement of NLC brightness. Increased cooling by enhanced carbon dioxide alone (assuming no water vapor increase) counter-intuitively would lead to a decrease(!) of NLC brightness. NLC existed presumably since centuries, but the chance to observe them by naked eye was very small before the 20th century, whereas it is likely to see an NLC in the modern era. The eruption of volcano Krakatoa in 1883 has seemingly triggered the first observation of an NLC in 1885. In this paper we summarize our results for mid latitudes and expand the analysis to polar latitudes.