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Temperature and ice layer trends in the summer middle atmosphere

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We present results from our LIMA model (Leibniz Institute Middle Atmosphere Model) which nicely reproduces mean conditions of the summer mesopause region and also mean characteristics of ice layers known as noctilucent clouds. LIMA nudges to ECMWF data in the troposphere and lower stratosphere which influences the background conditions in the mesosphere. We study temperature trends in the mesosphere at middle and polar latitudes and compared with temperature trends from satellites, lidar, and phase height observations. For the first time large observed temperature trends in the summer mesosphere can be reproduced and explained by a model. As will be shown, stratospheric ozone has a major impact on temperature trends in the summer mesosphere. The temperature trend is not uniform in time: it is moderate from 1961 (the beginning of our record) until the beginning of the 1980s. Thereafter, temperatures decrease much stronger until the mid 1990s. Thereafter, temperatures are nearly constant or even increase with time. As will be shown, trends in ozone and carbon dioxide explain most of this behavior. Ice layers in the summer mesosphere are very sensitive to background conditions and are therefore considered to be appropriate tracers for long term variations in the middle atmosphere. We use LIMA background conditions to determine ice layer characteristics in the mesopause region. We compare our results with measurements, for example with albedos from the SBUV satellites, and show that we can nicely reproduce observed trends. It turns out that temperature trends are positive (negative) in the upper (lower) part of the ice layer regime. This complicates an interpretation of NLC long term variations in terms of temperature trends.