Clouds in the Vicinity of the Stratopause Observed with Lidars at Mid-latitudes (40.5-41°N) in China

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Abstract

A cloud event in the altitude range of 53-65 km was observed with lidars over Yanqing (40.5°N, 116°E) and Pingquan (41°N, 118.7°E) on 30 October 2018. Clouds with a multilayer structure first occurred within the line view of lidar at dawn (03:40-06:00LT). They were faint and tenuous, and the maximum volume backscatter coefficient (VBSC) was $1.4\times10^{-10}m^{-1}sr^{-1}$. At twilight, clouds with multilayer structures were reobserved via lidars, but they became much thicker, with a maximum VBSC of $11.2\times10^{-10}m^{-1}sr^{-1}$. The structure of the cloud layers varied with time, and they faded completely at approximately ~00:30 LT (+1 day). Measurements from SABER/TIMED were utilized for analysis, and it was found that before the onset of cloud event, a temperature anomaly occurred in the mesosphere over Beijing, and water vapor was also very abundant. The frost point temperature profile of water vapor was estimated, and lidar measurements showed that the atmospheric temperature was close to the frost point of water vapor in the vicinity of the stratopause when the mesosphere was undergoing a low-temperature phase. It was a rare mesospheric cloud event observed with lidars at rather low latitudes, and the clouds probably resulted from the nucleation of saturated water vapor due to the occurrence of a temperature anomaly in the mesosphere.

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Key words: mesospheric cloud, lidar observation, temperature anomaly

Key Points:

- Clouds with multilayer structure were firstly observed in the altitude range of 53-65 km with lidars at mid-latitudes (40.5-41°N) in China.
- These clouds were probably from the nucleation of water vapor due to a temperature anomaly in the mesosphere.

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A cloud event in the altitude range of 53-65 km was observed with lidars over Yanqing (40.5°N, 116°E) and Pingquan (41°N, 118.7°E) on 30 October 2018. Clouds with a multilayer structure first occurred within the line view of lidar at dawn (03:40-06:00 LT). They were faint and tenuous, and the maximum volume backscatter coefficient (VBSC) was $1.4\times10^{-10}\mathrm{m}^{-1}\mathrm{sr}^{-1}$. At twilight, clouds with multilayer structures were reobserved via lidars, but they became much thicker, with a maximum VBSC of $11.2\times10^{-10}\mathrm{m}^{-1}\mathrm{sr}^{-1}$. The structure of the cloud layers varied with time, and they faded completely at approximately ~00:30 LT (+1 day). Measurements from SABER/TIMED were utilized for analysis, and it was found that before the onset of cloud event, a temperature anomaly occurred in the mesosphere over Beijing, and water vapor was also very abundant. The frost point temperature profile of water vapor was estimated, and lidar measurements showed that the atmospheric temperature was close to the frost point of water vapor in the vicinity of the stratopause when the mesosphere was undergoing a low-temperature phase. It was a rare mesospheric cloud event observed with lidars at rather low latitudes, and the clouds probably resulted from the nucleation of saturated water vapor due to the occurrence of a temperature anomaly in the mesosphere.