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Long-term Variations in Ozone Levels over Beijing: Observations and Model Simulations

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Tropospheric ozone is a major pollutant and a short-lived greenhouse gas and has therefore attracted much concern in recent years. The ozone concentration in the troposphere and lower stratosphere over Beijing has been observed since 2002 by ozonesondes developed by the Institute of Atmospheric Physics. We used these balloon-based observations to analyze the long-term variability of ozone over Beijing during the whole period from 2002 to 2018. The ozonesondes measured increasing concentrations of ozone from 2002 to 2012 in both the troposphere and lower stratosphere. There was a sudden decrease in observed ozone between 2011 and 2012. After this decrease, the increasing trend in ozone concentrations slowed down, especially in the mid-troposphere, where the positive trend became neutral. We used the Chemical Lagrangian Model of the Stratosphere (CLaMS) to determine the influence of the transport of ozone from the stratosphere to the troposphere on the observed ozone profiles. Because there is no tropospheric chemistry in CLaMS, the sudden decrease simulated by CLaMS indicates that a smaller downward transport of ozone from the stratosphere after 2012 may explain a significant part of the observed decrease in ozone in the mid-troposphere and lower stratosphere. However, the influence of stratospheric ozone in the lower troposphere is negligible in CLaMS and the hiatus in the positive trend after 2012 can be attributed to a reduction in ozone precursors as a result of stronger pollution control measures in Beijing.