

## **Stratospheric intrusion associated with the cut-off low event over north China: A case study**

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A cut-off low (COL) is a closed upper-tropospheric low-pressure system, which is completely detached (cut off) from its polar source and extends to the south of the midlatitude westerly mean flow as a result of the deepening of a high-level trough. An intense COL event typically causes pronounced stratospheric intrusion into upper troposphere, which could lead to an unusual increase in the tropospheric ozone concentrations below. North China is among the three preferred areas of COL occurrences in the NH. Due to its long-time persistence, the COL often brings about cold spell and heavy rainfalls to northeast China. As a result, an intense COL event might even lead to severe flooding especially in late spring and early summer (from May to June). In the present study, the European Centre for Medium-Range Weather Forecasts (ECMWF) Interim reanalysis products (ERA-Interim) are used to investigate the dynamical and thermal structures of a COL event over north China in early July 2007. With the tropopause dipping down into the mid-troposphere, a warm-core cyclone occurs in the lower stratosphere and is located above the cold vortex, which exists throughout the middle and upper troposphere. This feature is also confirmed by the temperature and ozone retrievals from the Microwave Limb Sounder (MLS) and High Resolution Dynamics Limb Sounder (HIRDLS) instruments. Ozone profiles from MLS, HIRDLS, and Ozone Monitoring Instrument (OMI) are also applied to quantify the downward intrusion of ozone-rich stratospheric air and its contribution to the increase in local total column ozone. Moreover, the dynamical linkage between the intrusion of high potential vorticity (PV) air and the strengthening of the low-level cyclone is proposed according to the well-established Hoskins's "PV-thinking" theory.