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Impacts of Stratospheric Intrusion on Surface Ozone over Eastern China

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Ozone pollution is currently a serious environmental issue in China. Most of studies have attributed the surface ozone pollution over China to the strong photochemical production from anthropogenic sources. As another important source of tropospheric ozone, the stratospheric intrusion (SI), however, has been less concerned. This study investigates the SI events over the Yangtze River Delta in eastern China using the newest ERA5 (the fifth generation of ECMWF atmospheric reanalysis) meteorological and ozone data, the In-service Aircraft for a Global Observing System (IAGOS) ozone profiles and the station-based ground-level ozone measurements. Results indicate that SI plays important roles in spring and summer ozone pollution episodes over the Yangtze River Delta, eastern China. Based on CAM-Chem (the Community Atmosphere Model with Chemistry) and LPDM (Lagrangian Particle Dispersion Modeling) model simulations, we found that deep SIs contribute ~15 ppbv in spring and ~10 ppbv in summer to surface ozone variations in eastern China. A deep SI event occurred in 2018 spring associated with a strong horizontal-trough, which brought ozone-rich air from the stratosphere to the troposphere and resulted in severe surface ozone pollution over the Yangtze River Delta. From 7-year statistics, we found that strong SI events during summer are associated with a cyclonic valley between the South Asian High and the Subtropical High, accompanied by downward fast transport of ozone from the stratosphere to the troposphere. Our results provide important information for surface ozone prediction and control in eastern China.