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The stratospheric ozone rich cold intrusion during El-Nino over the Indian region: implication during the Indian summer monsoon

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Ozone in the upper troposphere is a dominant radiative constituent. In this study, we investigate ozone variability due to stratospheric intrusions in the upper troposphere over India, and its associated radiative impacts during monsoon breaks co-occurring with El Niño. For this purpose, we use the ECHAM5-HAMMOZ, Global-Chemistry-climate model simulations, and ERA-Interim reanalysis data. Our analysis shows that during El Niño deep stratospheric intrusions, occurring at the North India - Tibetan Plateau (NI-TP) region and the western edge of the monsoon anticyclone, lead to an enormous increase in ozone amounts (~160 ppb) in the upper troposphere over India. These intrusions elevate the surface ozone levels by ~20 ppb and ozone radiative forcing by ~0.33 W m⁻² at the top of the atmosphere (TOA).

Interestingly, the stratospheric intrusions are associated with a wave train composed of cyclonic and anticyclonic circulation in the upper troposphere, emanating from El-Niño region in the east Pacific, traversing towards NI-TP locale. The wave train transports extra-tropical cold air mass, producing an anomalous cooling of ~2 - 3 K in the upper troposphere over NI-TP. The cold wave train induces Rossby wave breaking (RWB), which facilitates stratospheric intrusions, thereby enhancing subsidence over NI-TP region. Additionally, this severe cold subsidence over North India during break days may further intensify the deficit rainfall condition during break days.