Atmospheric
Chemistry
and Physics

Supplement of

A mechanism of stratospheric O$_3$ intrusion into the atmospheric environment: a case study of the North China Plain

Yuehan Luo et al.

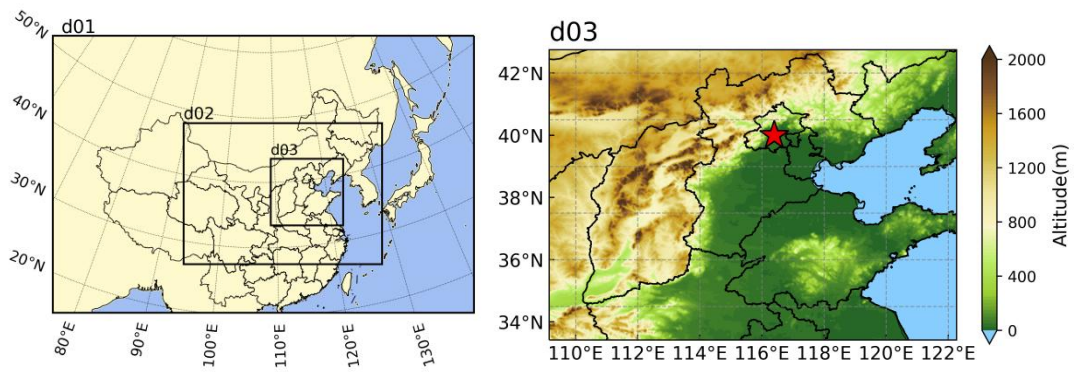*Correspondence to:* Tianliang Zhao (tlzhao@nuist.edu.cn)

Figure S1: The spatial distributions of three nesting domains d01, d02 and d03 with terrain altitude (m in a.s.l.). The red star represents the capital of China, Beijing.
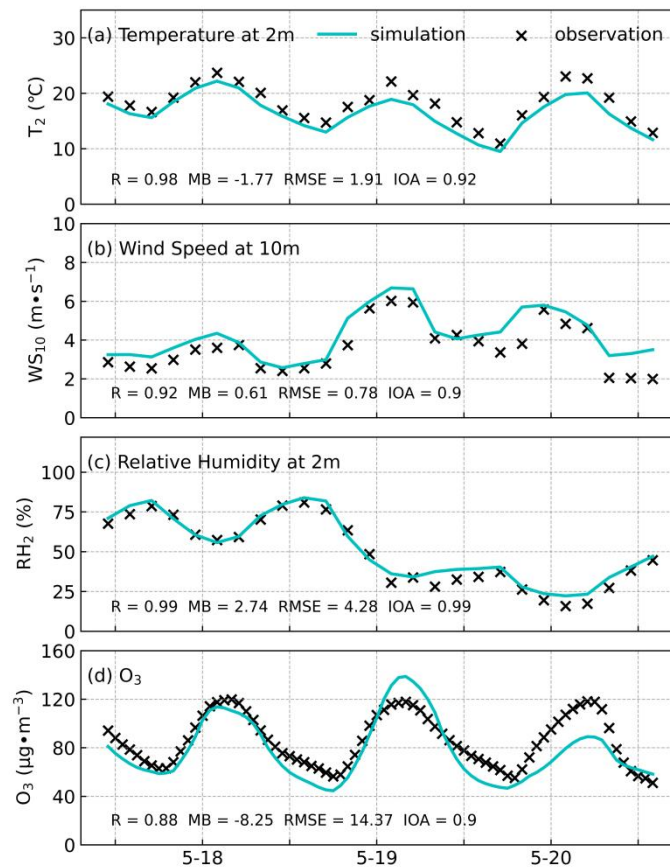

Figure S2: Hourly changes of simulated and observed meteorological elements and near-surface O_3 concentrations during May 18–20, 2019 averaged over North China.
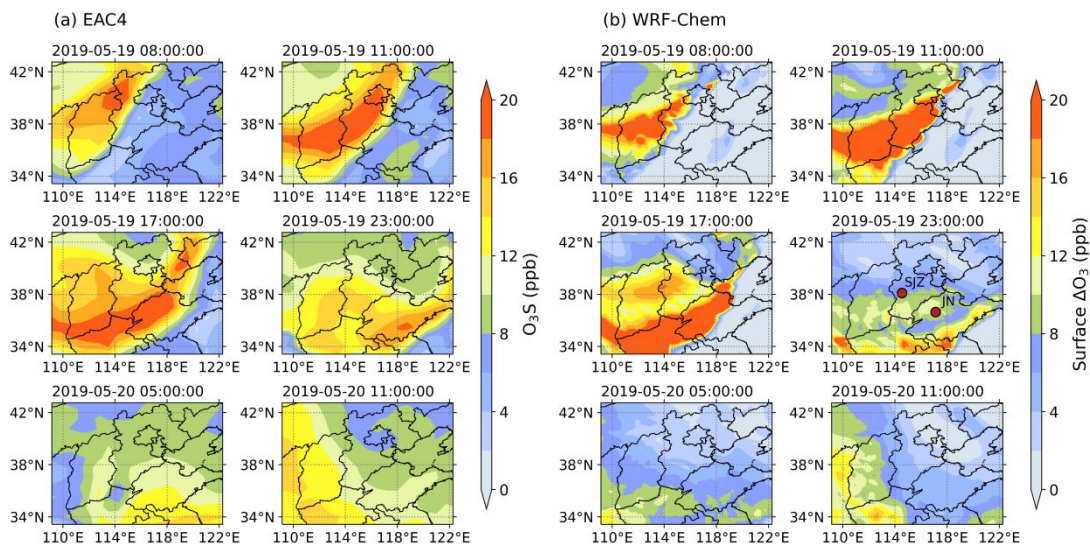
Figure S3: Spatial distribution of (a) the surface O_3S derived from EAC4 data and (b) the differences of surface O_3 between $CASE_{STRO3}$ and $CASE_{noSTRO3}$ simulations of WRF-Chem over the NCP. The red dots in (b) indicate the geographical location of the representative sites SJZ and JN in the NCP.
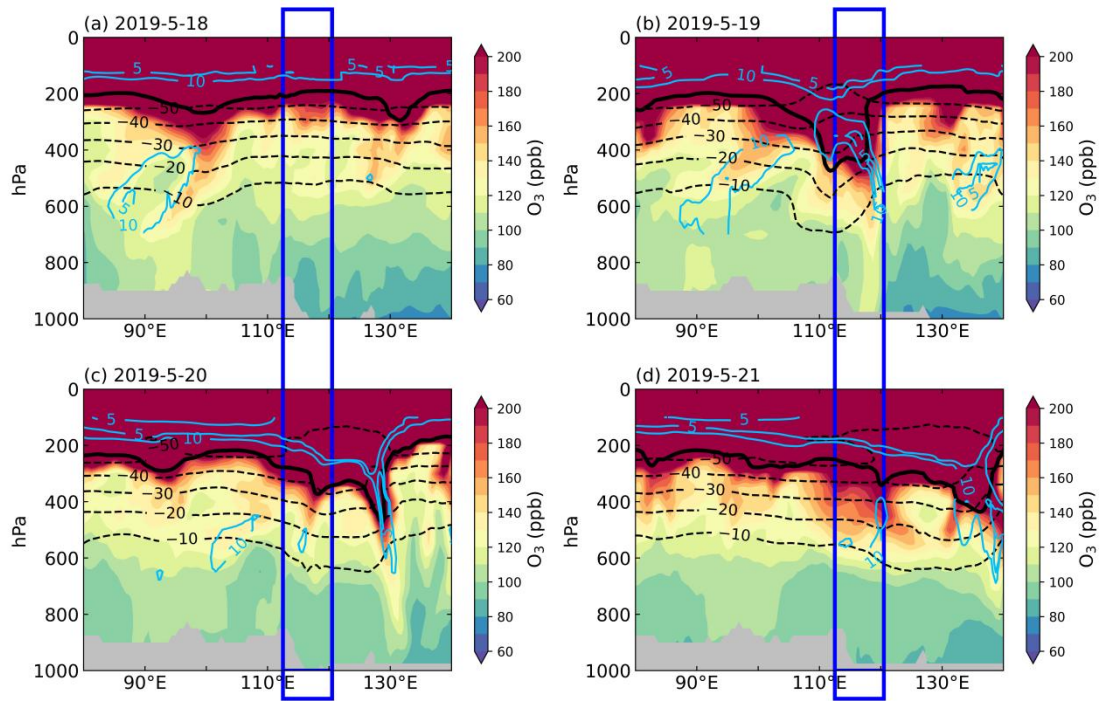
Figure S4: Latitudinal vertical sections of O₃ concentrations (color contours) averaged over 32 °N–40 °N from the MERRA2 data during May 18–21, 2019. Black solid lines indicate the dynamical tropopause labeled by PV=2. The dashed black lines represent air temperature (℃), the solid blue lines represent relative humidity (%), and the blue rectangles mark the NCP region.
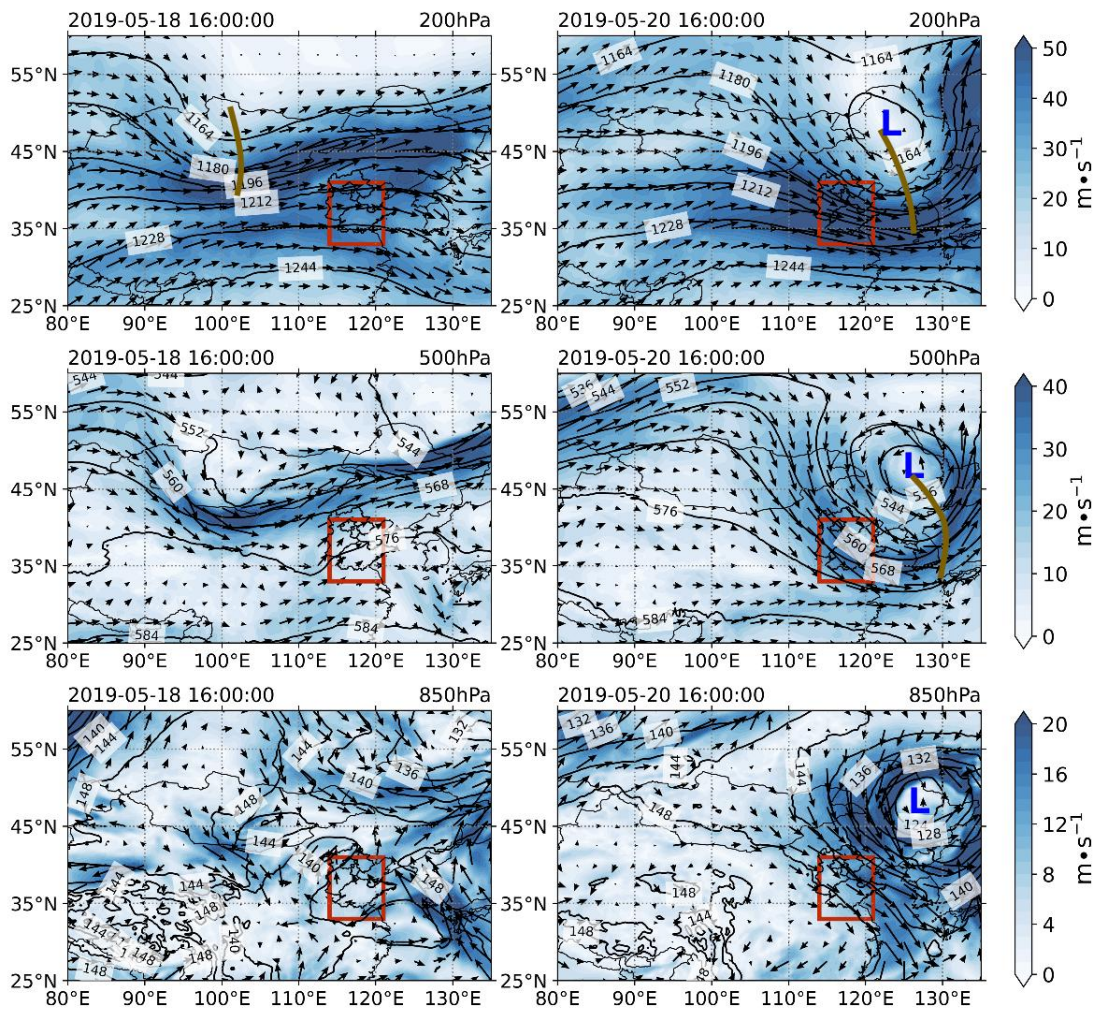
Figure S5: Atmospheric circulation patterns of horizontal wind vectors at 200 hPa, 500 hPa, and 850 hPa at 16:00 LST on May 18 and 20, 2019. The shaded colors and black arrows denote the horizontal wind speed (m·s⁻¹), and the black contour lines denote the geopotential height (gpdm). The red solid boxes indicate the scope of the NCP region.
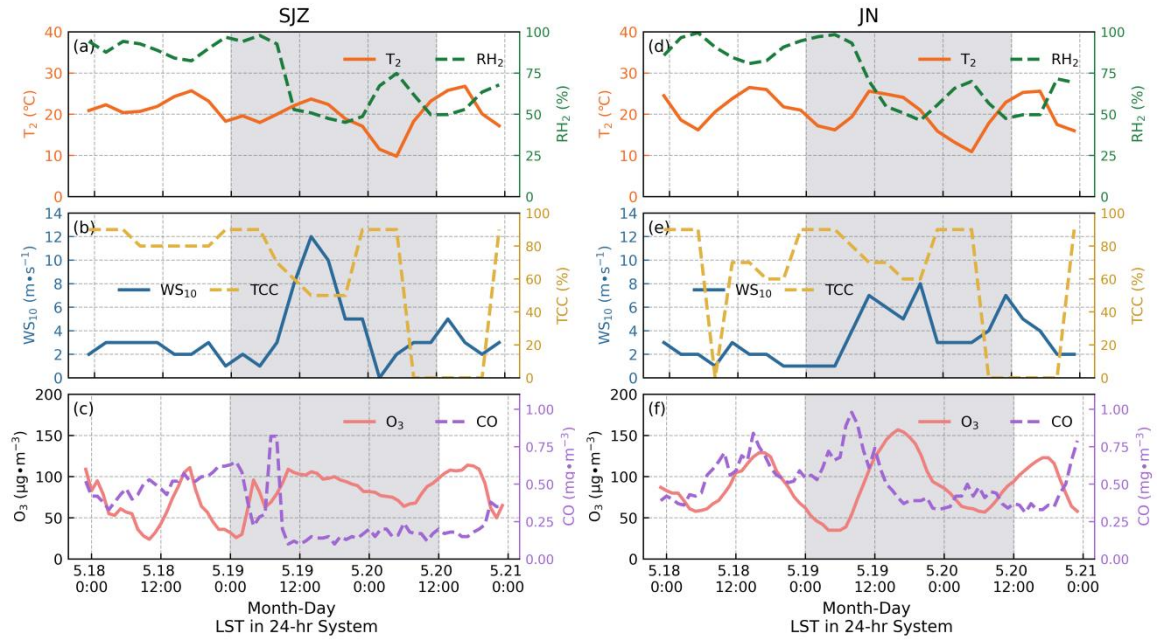
Figure S6: Hourly variations of (a, d) T_2, RH_2, (b, e) WS_{10}, and total cloud cover (TCC), (c, f) near-surface O_3 and CO concentrations in representative cities SJZ and JN from the observations in the NCP region. The shaded areas mark the periods of the SI to the near-surface layer.

Table S1: Physical and chemical parameterization schemes used in the WRF-Chem simulations.

Process	Parameters	WRF-Chem options
	Microphysics	Lin scheme
	Longwave radiation	RRTM scheme
	Shortwave radiation	Goddard scheme
Physical process	Boundary layer	YSU scheme
	Land surface	unified Noah land-surface model
	Surface layer	MM5 similarity scheme
	Cumulus	Grell 3D ensemble scheme
Chemical process	Gas-phase chemistry	CBMZ
	Aerosol module	MOSAIC_8bins