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The role of reactive nitrogen chemistry in the photochemical and haze pollution in China: WRF-Chem simulations of HONO and N2O5 processes and their impact on ozone and aerosol nitrate

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Nitrous acid (HONO) is a major source of the hydroxyl radical in the polluted troposphere. The heterogeneous uptake of dinitrogen pentoxide (N_2O_5) produces the particulate nitrate and the nitryl chloride ($ClNO_2$) hence the chlorine radical. The hydroxyl and chlorine radicals initiate the degradation of volatile organic compounds which leads to the production of ozone with the presence of nitrogen oxides (NO_x). Photochemical (ozone) and haze (particulate) pollution has raised huge concerns in China in recent years. However, the collective role of HONO, N_2O_5 and $ClNO_2$ chemistry in the formation of air pollution in China is yet to be quantified. Weather Research and Forecasting model coupled with Chemistry (WRF-Chem) has been incorporated with comprehensive reactive nitrogen oxides mechanism (ReNOM), including the latest HONO sources, the heterogeneous uptake of N_2O_5 and the subsequent $ClNO_2$ production and chlorine chemistry. The revised WRF-Chem was adopted to simulate the spatial-temporal distribution of HONO, N_2O_5 and $ClNO_2$, and to investigate the contribution of nitrogen chemistry to the production of ozone and secondary aerosol in China in summer when photochemical pollution is severe, and in winter season during which haze pollution is alarming in northern China. The simulations showed that the reactive nitrogen chemistry considerably increased the concentration of OH and Cl radical and hence the degradation of VOCs and the production of ozone; the chemistry altered the lifetime of NO_x and enhanced the transformation of NO_x into nitrate aerosol. Sensitivity simulations were conducted by reducing the NO_x and/or VOCs emission, and the difference between the simulated ozone with original emission and that with reduced emission will be used to identify the ozone formation regime in different areas of China. The spatial pattern of the ozone formation regime in China suggested by original and revised WRF-Chem will be compared and analyzed to explore the potential role of reactive nitrogen chemistry in the formation of ozone control strategy.