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Impacts of Additional HONO Sources on Concentrations and Deposition of NO_y in the Beijing-Tianjin-Hebei Region of China

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Reactive nitrogen-containing compounds (NO_y) are involved in many important chemical processes in the atmosphere, including aerosol formation as well as ozone (O_3) production and destruction. As NO_y deposition was increasing rapidly in China during 1980s $\sim$ 2000s, great effort is urgently needed to reduce N deposition. HONO, an important component of NO_y, is a significant precursor of the hydroxyl radical (OH) that drives the formation of O_3 and fine particles (PM2.5). Nevertheless, the detailed formation mechanisms of HONO and strength of its sources remain unclear. Unknown HONO sources and their potential impacts on air quality have gained extensive interests but to our current knowledge, the impact of HONO sources on regional-scale deposition of NO_y has not been quantified up to date. The goal of this work is to evaluate the effects of the additional HONO sources on concentrations and deposition of individual NO_y species as well as the NO_y budget in the northern Chinese regions being affected by heavy pollution.
Simulations of HONO contributions over Beijing-Tianjin-Hebei region (BTH) during summer and winter periods of 2007 using the fully coupled Weather Research and Forecasting /Chemistry (WRF/Chem) model are performed by including three additional HONO sources: 1) the reaction of photo-excited nitrogen dioxide (NO_2*) with water vapor, 2) NO_2 heterogeneous reaction at the aerosol surfaces, and 3) HONO emissions. The model results show that the three additional HONO sources produce a 20%$\sim$40% (> 100%) increase in monthly-mean OH concentrations in many urban areas in August (February), leading to a 10%$\sim$40% (10%$\sim$100%) variation in monthly-mean concentrations of NO_x, nitrate and PAN, a 5%$\sim$10% (10%$\sim$40%) increase in the total dry deposition of NO_y, and an enhancement of 1.4 Gg N (1.5 Gg N) in the total of dry and wet deposition of NO_y over this region in August (February). These results suggest that the additional HONO sources aggravate regional-scale acid deposition, emphasizing the paramount importance of the additional HONO sources in the NO_y budget.