HONO Chemistry and Its Impact on the Atmospheric Oxidizing Capacity Over the Indo-Gangetic Plain

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Abstract

Chemical processes involving nitrous acid (HONO) play a pivotal role as it is a notable source of hydroxyl (OH) radicals, influencing the oxidation capacity of the atmosphere. We conduct a comprehensive investigation into the temporal dynamics of HONO, other gases (nitrogen oxides (NO_x), ozone (O_3), ammonia (NH_3), sulphur dioxide (SO_2), and nitric acid (HNO_3)), particulate matter ($PM_{2.5}$), and meteorological parameters using measurements that took place during the Winter Fog Experiment (WiFEx) campaign in Delhi, India, during the winter of 2017–2018. Remarkable day-to-day variations in HONO concentrations are observed, with the peak value reaching 54.5 μg m^{-3} during a fog event. This coincides with elevated levels of sulfate and nitrate in aerosols, underscoring the significant role of heterogeneous fog chemistry in HONO production. We investigated HONO sources and sinks during fog periods by using a photochemical box model. The model shows that the gas-phased chemistry of HONO predicts concentrations lower by an order of magnitude compared to observations (peaking at 0.60 μg m^{-3} compared to the average observed value of 7.00 μg m^{-3}). The calculated production rates of HONO from observations for daytime and nighttime peaks are 3.10 μg m^{-3} h^{-1} (1.1×10^7 molecules cm^3 s^{-1}) and 2.00 μg m^{-3} h^{-1} (7.1×10^6 molecules cm^3 s^{-1}), respectively. This shows the existence of an undefined heterogeneous reaction pathway for HONO production. At the peak of HONO concentration, we estimated an OH formation rate of 9.4×10^7 molecules cm^3 s^{-1} due to the photolysis of HONO, which is much higher than the production of HONO from the reaction of O^1D with H_2O. This underscores the predominant role of HONO photolysis as the primary source of OH radicals compared to other pathways and highlights the significant role of HONO chemistry in influencing atmospheric oxidation capacity.

Early Career Scientist

YES, I am an early career scientist.

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