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Tropospheric Transformations of Nitrogen Oxides During Winter: Insights from the Recent UWFPS and WINTER Aircraft Campaigns

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Atmospheric reactions of inorganic nitrogen oxides critically influence the composition of the troposphere, the lowest layer of the atmosphere that supports all terrestrial life on Earth. From controlling the global budget and distribution of tropospheric oxidants, to degrading local air quality through the production of ozone (O_3) and secondary particulate matter (PM), understanding the underlying chemistry of reactive nitrogen oxides is vital to both improving our predictive capabilities of global tropospheric chemistry and to developing effective mitigation strategies in regions with persistently poor air quality. Despite decades of research into their chemical mechanisms, significant uncertainties remain in the seasonally dependent lifetime and distribution of nitrogen oxides. Key remaining questions include: 1) factors influencing nocturnal inter-conversion processes, which involve multiphase reactions, and 2) the quantitative contribution of these heterogeneous reactions to wintertime air pollution.

In this presentation, I will address these questions using observational and modeling-based analyses of data collected during two U.S. field campaigns during the winters of 2015 and 2017. First, I will discuss observations from the 2015 Wintertime INvestigation of Transport, Emissions, and Reactivity campaign that were used to inform a custom, iterative, inorganic nocturnal nitrogen chemistry box model. Iteratively fit to observations, this model was used to derive the first wintertime aircraft determinations of aerosol uptake coefficients of dinitrogen pentoxide (N_2O_5) and production yields of nitryl chloride ($ClNO_2$). Field-determinations of these parameters are further compared to laboratory-based parameterizations to evaluate the current representation of these processes in global models. Lastly, I will present results from the first aircraft observations in Salt Lake Valley, Utah, collected during the 2017 Utah Winter Fine Particulate Study. Observations and iterative box model simulations have been combined to assess the contribution of heterogeneous reactive nitrogen chemistry to wintertime PM formation in this region, which frequently violates PM air quality standards during wintertime pollution events.

Monday, May 21, 2018, 3:30 p.m
Refreshments 3:15 p.m
NCAR Foothills Laboratory
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Live webcast: http://ucarconnect.ucar.edu/live

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