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Impacts of cosmic dust throughout the Earth's Atmosphere (and Mars)

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In this seminar I will describe the results of a large study designed to determine the size of the cosmic dust input rate into the terrestrial atmosphere using a self-consistent treatment of cosmic dust from the outer solar system to the Earth's surface. An astronomical model which tracks the evolution of dust from various sources into the inner solar system was combined with a chemical ablation model to determine the rate of injection of metallic vapors into the atmosphere. Constraining these coupled models with lidar measurements of the vertical fluxes of Na and Fe in the MLT, and the rate of accretion of cosmic spherules at the South Pole, indicates that about 40 tonnes of dust enters the atmosphere each day, of which ~18% ablates. The subsequent atmospheric chemistry of the ablated metallic vapors is then examined using the Whole Atmosphere Community Climate Model (WACCM), coupled with the aerosol microphysics model CARMA to treat the interplay of meteoric smoke particles with the stratospheric sulfate layer. While the optical extinction of meteoric smoke in the lower mesosphere, and of refractory material in polar stratospheric clouds is satisfactorily modelled, the injection rate of Na and Fe atoms is too large (by a factor between 5 and 10) for WACCM to replicate the observed metal atom layer densities in the MLT. It appears that vertical transport by eddy diffusion has to be significantly supplemented by chemical transport produced by unresolved (sub-grid) gravity waves. The seminar will end by comparing the situation in the Martian atmosphere, where metallic layers have recently observed by NASA's Mars Atmosphere and Volatile EvolutioN (MAVEN) mission above 70 km. Exploring the radically different diurnal, seasonal and latitudinal variations of the metal layers compared to the terrestrial atmosphere, and the role of metal carbonate-rich ice particles in nucleating CO2-ice clouds, will then be explored using the Laboratoire de Meteorologie Dynamique (LMD) Mars general circulation model which extends from the surface to the Martian exosphere.

Monday, August 6, 2018, 3:30 p.m.

Refreshments 3:15 p.m.
NCAR Foothills Laboratory
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