RSPP seminars

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"Cosmic Dust in Planetary Atmospheres (including Earth)"

"Cosmic dust particles are produced in the solar system from the sublimation of comets as they orbit close to the sun, and also from asteroidal collisions between Mars and Jupiter. Recent advances in interplanetary dust modelling provide much improved estimates of the fluxes of cosmic dust particles into planetary (and lunar) atmospheres throughout the solar system. Combining the dust particle size and velocity distributions with new chemical ablation models enables the injection rates of individual elements to be predicted as a function of location and time. This information is essential for understanding a variety of atmospheric impacts, including: the formation of layers of metal atoms and ions; meteoric smoke particles and ice cloud nucleation; perturbations to atmospheric gas-phase chemistry; and the effects of the surface deposition of micrometeorites and cosmic spherules.

In this seminar I will describe the results of a large study designed to determine the input rate of cosmic dust to 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 vapours into the atmosphere. Constraining these coupled models with observations of IR emission from the Zodiacal Cloud, lidar measurements of the vertical fluxes of Na and Fe in the terrestrial mesosphere, and the rate of accretion of cosmic spherules at the South Pole, indicates that about 40 tonnes of dust enters the Earth's atmosphere each day. Having fitted the astronomical model to the terrestrial input, the same model can be used to predict the dust inputs into the atmospheres of Venus and Mars. A separate outer solar system model has also been used to determine the dust input into Titan's atmosphere. The Chemical Ablation Model (CABMOD), which is central to quantifying planetary impacts, has recently been tested using a novel experimental system developed at Leeds: a Meteor Ablation Simulator, which measures the evaporation of metals from meteoritic particles that are flash heated to over 2800 K with a time-resolved temperature profile simulating atmospheric entry.

Examples of the impacts of meteoric ablation will then be described. For Earth: mesospheric metal layers; polar vortex chemistry, including the freezing of NAT particles; deposition of bio-available Fe to the Southern Ocean. For Venus: oxidation of CO and removal of O_2 on meteoric smoke particles in the hot troposphere; and depletion of HCl in the mesosphere. For Mars: production of an Mg^+ layer which has recently been observed by optical spectroscopy on the MAVEN spacecraft, and layers of several metallic ions measured during "deep dip" campaigns with an onboard mass spectrometer; these layers were first observed after the flyby of Comet Siding Spring in October 2014. And for Titan: the production of benzene in the troposphere by the cyclo-trimerization of acetylene on dust particles".

Wednesday, June 14th at 2 pm in Physics LTD