2018 Workshop: Meteoroids and Space Debris

Long title
Meteoroids and Space Debris
Conveners
Julio Urbina
Sigrid Close
Description

A meteoroid is defined as a small, solid extraterrestrial object. Upon entry into a planet’s atmosphere, it heats and ablates off particles that then collide with the background neutrals, forming a dense plasma that extends around the meteoroid as well as behind it. These plasmas, referred to as meteors, have been studied for well over a century, yet many outstanding questions remain. In addition, space debris, also known as orbital debris, space junk, and space waste, is the collection of objects in orbit around Earth that were created by humans but no longer serve any useful purpose. These artificial meteors/Debris and meteoroids of astronomic origin are a long-standing threat to satellites, and both contribute to the flux of macroscopic particles into Earth's atmosphere. To address the outstanding questions currently under investigation in the field of meteor, meteoroid and debris science and engineering, we invite presentations on the physics of meteoroid and debris particles and their impacts effects on the atmosphere, ionosphere, and satellites. We also encourage presentations that address the engineering techniques for observing and characterizing the meteoroid and debris population, including any observational (i.e. lidar, radar, satellite and optical) or modeling method.

Agenda

16:00 - "Introduction". Julio Urbina – Penn State/ Sigrid Close – Stanford University

16:08 - "Meteor Research at Penn State". Julio Urbina/John Mathews – Penn State

16:25 - "Testing the Nature of Meteor Radio Afterglows". Savin Varhese – University of New Mexico

16:40 - "SKiYMET Meteor Radar at Poker Flat Research Range". Jared Klemm – University of Alaska Fairbanks

16:55 - "How do meteors form and how are they structured when radars first detect them?". Meers Oppenheim/Yakov Dimant/Glenn Sugar – Boston University

17:15 - "Photoionization of metallic species at sprites altitudes by far-UV emissions of LBH band system of molecular nitrogen". Victor Pasko – Penn State

17:35- "Meteoroid Orbital Surveys in the Southern Hemisphere: Update on current and future capabilities". Diego Janches – NASA

17:55 - "Discussion".

18:00 - Adjourn.

Justification

Every day billions of meteoroids impact and disintegrate in the Earth's atmosphere. This results in the deposition of mass, momentum and energy in the transition region of the ionosphere between the D and E region where the neutral atmosphere begins to play an important role in the evolution of the plasma environment due to ion-neutral collisions. This ablated material (whose mass loading of the upper atmosphere is still uncertain to within 2 orders of magnitude) results in the neutral metal layers traditionally observed between 85-105 km using lidar and plays an important role in the atomic chemistry of mesospheric metals. In addition, ablated constituents from the micrometeoroid particles sediment and condense to form meteoric smoke particles. This dusty plasma in the D region is a source of the condensation nuclei (CN) for ice layer-related phenomena such as: Polar Mesospheric Clouds and Polar Mesospheric Summer Echoes (PMSEs). The CN as well as the related phenomena are influenced by the forcing of the neutral winds and tides as well as chemistry. Through the action of advection, down-welling and meridional circulation these CN are transported into the lower atmosphere and contribute to phenomena such as Polar Stratospheric Clouds and stratospheric aerosols. Furthermore, these small particles act as a transport mechanism of mesospheric metals to the Earth's surface and ocean. It is also worth noting that larger meteoric particles that survive the ablation process in the upper atmosphere provide a space weather hazard in the form of impacts as well as iron rich materials that are deposited in the ocean.

This workshop addresses the CEDAR Strategic Thrust #2: Explore Exchange Processes at Boundaries and Transitions in Geospace, in particular, viewing Earth-

Atmosphere-Geospace coupling and interactions as a complete and interactive system, meteors contribute across a wide range of spatial and temporal scales as both a driver and catalyst of significance to microphysics and phenomena.

Meteors are routinely observed using a wide array of observational techniques in both the neutral and plasma environment and can be used as a tracer to study background parameters such as neutral winds, temperatures and tides. Many open questions exist in the meteor field. These range from gaps in fundamental understanding such as 1) what is the scatter process that results in radar observed meteor head echoes?, 2) what is the mass loading of the upper atmosphere by meteor ablation and why do estimates very so drastically?, 3) what is the relationship between meteor properties defined by the meteor input function and atmospheric phenomena tied to meteors? As with any study that uses the tools of system dynamics and system science one must first define the system (i.e. defining the boundaries, inputs and outputs in a thermodynamic system) and then make the simplifying assumptions that yield the relevant physics to the problem at hand. For meteor related studies, this system definition has often been implicit and related to boundaries defined by meteor ablation heights. But, as our measurement capability and knowledge increases regarding the SMC, we continue to push these traditional boundaries to uncover new insight into the processes, drivers, and feedbacks related to meteors within the Earth-Atmosphere-Geospace system allowing us to learn more about the coupling and interactions that can be uncovered using meteor science.

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