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Preface

Surfaces, atmospheres and magnetospheres of the outer planets and their satellites and ring systems: Part IX

This issue presents research work presented during the past year in sessions organized at several international meetings and congresses (like those of the European Geosciences Union (EGU), the Asia Oceania Geosciences Society (AOGS), the European Planetary Science Congress (EPSC) and others) focused on recent observations and models of the atmospheres, magnetospheres and surfaces of the giant planets and their satellites, as well as on their ring systems. Particular interest was devoted to results from space missions and ground-based observations of the Jupiter and the Saturnian systems, with modeling support which can also be applied to prepare future missions foreseen in the outer solar system, like the Jupiter Icy Moons Explorer (JUICE).

In their paper on radiative forcing of the stratosphere of Jupiter, Xi Zhang et al. use the global maps of temperature, ethane and acetylene from Voyager to Cassini, to calculate the heating and cooling rates for Jupiter's stratosphere, and find that temperatures in the lower stratosphere are not entirely controlled by radiation.

The study of Sittler and co-authors explores the local interaction of surfaces and atmospheres of Galilean moons with the surrounding plasma and magnetic field of Jupiter's magnetosphere. Reference is made to past Galileo observations, and new instrumentation concepts are explored for possible future missions to the Jovian system, Europa in particular. The authors argue that any future mission aiming to characterize the ocean through magnetic field measurements must also provide supporting measurements of the plasma ion and electron currents, as well as ion and neutral composition which form the background environment above the moon surface. The challenge in this lies in identifying endogenic materials amidst a background of magnetospheric species hitting the surface. A combination of surface, ionospheric and pickup ion composition measurements would also help assess Europa's chemical astrobiological potential. The authors highlight the need for 3D hybrid models simulating moon-magnetosphere interactions to accompany such observations. Such simulations, constrained by observations, would allow us to construct models of the global electric and magnetic field and plasma environment around Europa.

Jupiter's moon Europa possesses an exosphere maintained by the release of material from the surface through solar driven sublimation and high energy particle impact sputtering. Near the surface the exosphere is dominated by O_2 which originates from the surface ice, while at higher altitudes sputtered H_2O and H_2 are dominant. The study by Plainaki and co-authors investigates the exosphere of Europa, illustrating with the help of Monte Carlo simulations that the spatial distribution of Europa's exospheric gases changes with relative orientations of solar illumination and the incident plasma direction. The model is used to interpret UV emissions by Europa's exosphere observed by the HST. The simulations illustrate that the efficiency of the release of O_2 from the surface depends upon solar illumination and plasma impact direction.

In the paper of Milillo and coauthors, Energetic Neutral Particles (ENP) are used to relate exosphere particles to surface features on Europa and Ganymede, allowing to monitor the effect of plasma precipitation and resulting surface sputtering. The authors argue that with knowledge of the precipitating ions, an estimation of the efficiency of the surface sputtering processes can be made. The paper proposes new instrumentation for carrying out such measurements, the Ganymede and Europa Neutral Imaging Experiment (GENIE), a high-angular-resolution detector using the Time of Flight (ToF) technique, that can detect Energetic Neutral Particles (ENPs) in the energy range of 10 eV–several keV in the Jupiter environment. Key objective of GENIE is to map the locations of origin of the ENPs and thereby to investigate the interaction between the moon surfaces and their environments. The paper outlines science objectives, describes the instrumentation and provides simulated error estimates.

The companion papers about the Evolution of the Io footprint brightness aim to advance our understanding of the processes involved in Io's interaction with Jupiter's magnetosphere.

The first part, Evolution of the Io footprint brightness I: far-UV observations by Bonfond et al., presents the first brightness measurements of individual auroral spots of Io footprint in Jupiter's magnetosphere. It introduces a novel measurement method based on 3D simulations of the auroral features to derive the precipitated energy fluxes for individual spots. This unique dataset leads to the detection of strong brightness variations across Io's hemispheres, which points to the role of magnetospheric asymmetries as one source of brightness control.

The second part, entitled Evolution of the Io Footprint Brightness II: modeling by Hess et al., introduces a theoretical framework for understanding the aurora activity resulting from the interaction of Io with Jupiter's magnetosphere. The paper highlights the complexity of these interactions through a thorough description of the processes they involve. This approach leads to new insights on the brightness characteristics of the aurorae and their modulations, which the authors associate to the main and reflected Alfvén wing spots and the transhemispheric electron spot.

The paper by Kammer et al. investigates the upper atmosphere of Saturn's largest moon, Titan. It presents an analysis of EUV stellar occultation lightcurves from the Cassini Ultraviolet Imaging

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Spectrograph (UVIS), inferring vertical profiles of N_2 and CH_4 between 1000 and 1400 km. From the N_2 profiles, kinetic temperatures are derived, suggesting a high degree of variability in Titan's upper atmosphere, possibly related to energy deposition. The UVIS observations are compared with in situ measurements by the Cassini Ion Neutral Mass Spectrometer (INMS), which probes the same atmosphere region. A key aim of this work is to identify spatial and temporal (seasonal) variability in Titan's atmospheric structure as a precursor for improving theoretical models of atmospheric loss and understanding the physical processes that control these loss rates.

In their paper on the 2-micron spectral characteristics of the Titanian haze, Sim and co-authors reproduced the 2006 Cassini/VIMS solar occultation spectra using a radiative transfer program and propose non-unique combinations of alkane ices (such as CH_4, C_2H_6, C_5H_{12}, C_6H_{14}), with possible additions of nitrile ices (such as CH_3CN), to reproduce the 2-micron region of the spectra.

Thus, the latter seven papers of this issue cover different state-of-the-art research aspects on some of the largest and most intriguing satellites in our outer solar system: Ganymede, Titan, Europa, and Io, which are currently investigated or will be in the future by major space missions.

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