Available online at www.sciencedirect.com
ScienceDirect
Planetary and Space Science 56 (2008) 1571–1572
Planetary and Space Science
www.elsevier.com/locate/pss

Preface

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

This special issue of PSS is composed of selected articles based on research, presented during several different planetary meetings in 2007, including the European Geosciences Union (EGU) meeting (in particular sessions PS3.0 and PS3.1) in Vienna, Austria, from 16 to 20 April, the IUGG/IAMAS General Assembly (in particular sessions JMS12 and JMS13) in Perugia, Italy, from 2 to 13 July, the Asia Oceania Geosciences Society (AOGS) Meeting (in particular sessions PS09 and PS11) in Bangkok, Thailand, from 30 July to 4 August, and the European Planetary Science Congress (EPSC) Meeting (in particular sessions AO4 and PM1) in Potsdam, Germany, from 20 to 24 August.

The Editors wish to recognize here the excellent work of the conveners of these sessions, who strive to make the presentations of the studies in this particular field of the outer planetary systems as widely attended and broadcasted as possible. We wish to thank in particular the following colleagues: Cécile Ferrari, Jun Kimura, Jianping Li, Olivier Mousis, Ingo Müller-Wodarg, Jürgen Schmidt, Linda Spilker and Darrell Strobel.

The sessions organized during the past year focused on recent observations and models on the atmospheres and surfaces of the giant planets and their satellites. Particular attention was given to results from the *Cassini-Huygens* mission to the Saturnian System. After the successful descent and landing on Titan of the *Huygens* probe in 2005, the *Cassini* spacecraft has been returning a wealth of new data almost continuously, revealing an astonishingly complex and dynamic system. Complementary observations of the giant planets and their satellites were obtained from the ground. Besides the observations, several papers in this issue discuss results from laboratory experiments and models.

On the modeling of the observations front, the origin of the water in the stratosphere of Jupiter is revisited by Cavalié et al. in a paper in which they analyze the water vapor line at 557 GHz observed in 2002 with the Odin submillimeter satellite in 2002, as well as other SWAS observations. Their work applies a photochemical model to these observations in an effort to better understand the source of water vapor in the stratospheric region of the giant planet. They conclude that it is most likely of cometary origin (from the impact of Shoemaker-Levy 9) and predict a temporal variation according to which the line should become fainter and broader in the future.

Horner et al. review observations of the D/H ratio between deuterium and hydrogen in the Solar System and compare the impact of fractionation processes in the course of giant-planet formation. They conclude that the D/H ratio in water ice should emplace important constraints on the ambient temperature conditions prevailing in a giant-planet subnebula and the composition of planetesimals at around the time of regular satellite formation.

Brilliantov et al. quantitatively demonstrate that neither explosive boiling of subsurface liquid water, due to sudden pressure release caused by crack formation, nor explosive decomposition of clathrate hydrate can readily explain the characteristics of Enceladus's dust plume activity recently detected by *Cassini*.

The trapping of noble gases in clathrates on Titan is investigated by Thomas et al. In combination with experimental data on the characteristics of the crystalline network and on the intermolecular potentials, a hybrid statistical model for the efficiency of the trapping process is applied to various mixtures of Ar, Kr, Xe, CH_4, C_2H_6 and N_2, representative of Titan's early atmosphere. The different species' of noble gases are included simultaneously in the model, showing that the deficiency in Xe and Kr, as observed during the *Huygens* descent, can be well-explained by the trapping process. The deficiency of Ar, however, cannot be explained by trapping in clathrates and may be attributed to a partial vaporization of planetesimals in the Saturnian nebula.

Liu et al. report on GCM modeling work applied to Titan. A transposable planetary general circulation model (PGCM) is developed to simulate Titan's general circulation and study in particular some interesting phenomena such as equatorial superrotation, vertical meridional circulations and vertical structure in the satellite's atmosphere. The rotation rates' simulations suggest that these parameters significantly affect the dynamical structure of Titan's circulation.

Dobrijevic et al. have done valuable work in attempting to quantify the uncertainties in photochemical models.

0032-0633/$ - see front matter © 2008 Elsevier Ltd. All rights reserved.
doi:10.1016/j.pss.2008.08.015

In particular, they try to explain a phenomenon occurring in their Monte Carlo approach to Titan photochemical modeling and evaluation of modeling parameters that determine the reliability of such models. This phenomenon manifests itself as a bimodality evident in the C_2H_4 and C_2H_2 profiles. The authors explain this behavior by analyzing the chemical reactions that influence the C_2H_4 profile in the upper atmosphere, focusing on two reactions involving the CH radical-insertion into methane: $CH+CH_4 \rightarrow C_2H_4+H$, and hydrogen exchange with the hydrogen atom: $CH+H \rightarrow C+H_2$. The authors' contention is that competition for the CH radical between H and CH_4 can dictate the ultimate upper atmosphere profile for C_2H_4 and, by extension, C_2H_2, since C_2H_2 is primarily formed through C_2H_4 photolysis. The authors state that the uncertainties for the reactions are high enough such that $k(CH+H)/k(CH+CH_4)$ could be $>$ $[CH_4]/[H]$, which would trigger a stable node for C_2H_4 at about 2–3 orders of magnitude smaller than nominal. One of the main motivations of this study is trying to understand the INMS Titan observations of C_2H_4 and C_2H_2 in light of what models have predicted. In doing this exercise, the authors highlight the need for more precise laboratory data that serve as inputs in to the models, such as rate constants at low temperatures.

In support of interpreting the observations, several experimental and theoretical works are presented here. Carrasco et al. have critically reviewed various aspects of ion-molecule reactions for Titan ionospheric chemistry modeling. The work provides much insight into the complex chemistry operating in Titan's ionosphere and how models of this ionospheric chemistry are sensitive to basic model inputs such as (a) temperature/collision energy effects on reaction rates and especially product distributions, (b) the differential reactivity of ionic isomers, (c) the reactivity of excited states of ions and (d) pathways to the building of complex ions. They conclude that limiting factors to model predictivity come from model incompleteness for heavy ions production pathways, the differential reactivity of isomers, and to a lesser degree the temperature effects on the branching ratios of ion-molecule reactions. A call is made for more extensive experimental studies to fill the gap in our knowledge of ion-molecule reactivity.

Leonori et al. have applied the crossed molecular beam technique with mass spectrometric detection to investigate the reaction between C_2 and C_2H_2, an important one in extraterrestrial environments including Titan, Saturn and Uranus. C_4H+H is confirmed as the primary product but improvements are reported on the mechanisms of formation, on the characterization of the internal population of C_2 and on the interpretation of the scattering results.

In summary, this issue reports on current progress in the studies of the outer planetary systems from observational, experimental and modeling approaches, in the framework of a very active and exciting era in acquiring new data both from space and from the ground.

Editors
Athena Coustenis
Sushil Atreya
Piergiorgio Casavecchia
Julie Castillo
Odile Dutuit
Hauke Hussmann
Frank Sohl
LESIA (Bat 18), Observatoire de Paris-Meudon, 5 Place Jules Janssen, 92195 Meudon Cedex, France
E-mail address: athena.coustenis@obspm.fr (A. Coustenis)