with respect to Mercury's year, to the strong temperature gradient at the surface from day to night sides, and as a consequence the importance of surface/exosphere interaction, and to its intrinsic small magnetosphere which allows direct solar wind/surface interaction and a particular magnetospheric ion circulation. All these particularities give to Mercury's exosphere its peculiarity. But the most important and up to now most debated point when describing Mercury's exosphere is to properly include all the loss and supply processes of Mercury's exosphere. In the case of the sodium exosphere, several laboratory studies helped modelers to constrain such processes, whereas the present lack of laboratory studies and observations for the other elements supposed to be present in Mercury's exosphere make their study one of the main objective and most promising result of the future planed missions.

SA22A-02 1045h

Europa's Neutral Clouds: Probing the Atmosphere, Surface, and Subsurface

Matthew H Burger[1] ((434)924-4344; burger@virginia.edu)

Robert E Johnson[2] (rej@virginia.edu)

[1]University of Virginia, Astronomy Department, Charlottesville, VA 22903-0818, United States

[2]University of Virginia, Materials Science & Engineering Department, Charlottesville, VA 22903, United States

The existence of a sub-surface ocean at Europa and the possibility of its sustaining life is one of the most exciting scientific questions of our time. Unfortunately, the remoteness of the satellite makes it difficult to study this ocean directly. Studies of the atmosphere and atmospheric escape can provide clues needed for understanding Europa's icy shell and subsurface ocean. The composition and energy distribution of material escaping from Europa are indicative of the interaction between its surface and the local plasma. Observations of this material made from Earth can provide insight into Europa's surface composition and interior and will help determine the capabilities needed for future Europa missions. The discovery of Europa's molecular oxygen atmosphere (Hall et al. 1995) was quickly followed by ground based observations of a sodium exosphere extending more than ten satellite radii above Europa's surface (Brown and Hill 1996). Modeling of this exosphere by Leblanc et al. (2002) indicates that roughly 40% of the material sputtered from Europa's surface escapes forming an extended neutral cloud in orbit around Jupiter. Recent Cassini and Galileo spacecraft observations are suggestive of water products lost from Europa (Mauk et al. 2003, Lagg et al. 2003) and constitute the first observations of Europa's extended cloud. We consider models of the large scale morphology of this cloud which suggest significant morphological differences from the extensively studied Io neutral cloud. We also discuss strategies for confirming these predictions by observing the sodium and oxygen components of the neutral cloud as they extend along Europa's orbit. References: Brown, M. E. and R. E. Hill, Nature, 380, 229-231, 1996. Hall, D. T., D. F. Strobel, P. D. Feldman, M. A. McGrath, and H. A. Weaver, Nature 373, 677, 1995. Lagg, A., N. Krupp, J. Woch, and D. J. Williams, GRL, 30, 10-1, 2003. Leblanc, F., R. E. Johnson, and M. E. Brown, Icarus 159, 132-144, 2002. Mauk, B. H., D. G. Mitchell, S. M. Krimigis, E. C. Roelof, and C. P. Paranicas, Nature, 421, 920-922, 2003.

SA22A-03 1100h

Europa's Neutral Gas Torus

Barry H Mauk[1] (240-228-6023; Barry.Mauk@jhuapl.edu); Donald G Mitchell[1] (240-228-5000; Donald.G.Mitchell@jhuapl.edu); Richard W McEntire[1] (240-228-5000; Dick.McEntire@jhuapl.edu); Chris P Paranicas[1] (240-228-5000; Chris.Paranicas@jhuapl.edu); Edmond C Roelof[1] (240-228-5000; Edmond.Roelof@jhuapl.edu); Donald J Williams[1] (240-228-5000; Don.Williams@jhuapl.edu); Stamatios M Krimigis[1] (240-228-5000; Tom.Krimigis@jhuapl.edu); Andreas Lagg[2] (lagg@linmpi.mpg.de)

[1]The Johns Hopkins University Applied Physics Laboratory, 11100 Johns Hopkins Road, Laurel, MD 20723, United States

[2]Max Planck Institute for Aeronomy, Max-Planck-Strabe, 2, 37191, Katlenburg-Lindau 37191, Germany

In-situ energetic ion measurements from the Galileo spacecraft and remote energetic neutral atom (ENA) images from the Cassini spacecraft have been previously interpreted as revealing an unexpectedly massive torus of gas co-orbiting with Jupiter's moon Europa (Lagg et al., 2003; Mauk et al., 2003). Here we report on the results of detailed modeling of the ENA emission process from the Europa regions. Updates to the distribution and composition of the trapped energetic ion populations are included in the models, as are considerations of the partitioning of the gas products into multiple atomic and molecular species. Comparisons between the models and the Cassini observations reveal a torus with a total gas content equal to (0.5 +/- 0.2) E34 atoms plus molecules. This value is higher than, but within a factor of 3 of, an estimate inferred from a prediction of gas densities derived from Voyager plasma measurements and modeling of the interaction between the plasmas and the gases assumed to be emanating from Europa (Schreier et al., 1993). Lagg, A., N. Krupp, J. Woch, and D. J. Williams, Geophys. Res. Lett., 30, DOI 10.1029/2003GL017214, 2003. Mauk, B. H., D. G. Mitchell, S. M. Krimigs, E. C. Roelof, and C. P. Paranicas, Nature, 241, 920, 2003. Schreier, S., A. Eviatar, V. M. Vasyliunas, and J. D. Richardson, J. Geophys. Res., 98, 21231, 1993.

SA22A-04 1115h

Particle Modeling of the Io Inner Torus Boundary

M M Cowee[1] (mcowee@igpp.ucla.edu)

Y L Wang[1] (ylwang@igpp.ucla.edu)

C T Russell[1] (ctrussel@igpp.ucla.edu)

D A Gurnett[2] (dag@space.physics.uiowa.edu)

[1]Institute of Geophysics and Planetary Physics University of California, Los Angeles, 595 Charles Young Drive East, Los Angeles, CA 90095, United States

[2]Department of Physics and Astronomy, University of Iowa, Iowa City, IA 52242, United States

The Galileo spacecraft passed through the Io torus and its inner boundary on December 7, 1995 and November 5, 2002, during the J0 and A34 passes. Measured plasma densities on both passes indicated a steep gradient at the Io torus inner boundary located between 4.5 and 5 jovian radii (Io is at 5.9 Rj), as well as a much less steep gradient in the outer torus, with a boundary at distances greater than 8 Rj. A simple particle model for Iogenic ion pickup and torus formation developed by Wang et al. (2001) produced an ion distribution which spans distances as far as 0.5 Rj (20 Io radii) away from Io, as was observed by Galileo. Unlike observations, however, the modeled torus inner boundary is not steep and is much closer to Jupiter. It is possible that an outward transport of ions in the inner torus via flux tubes or some other mechanism will steepen the inner torus boundary. We alter the pickup conditions of the Wang et al. model and couple it to a simple radial convection model in an attempt to reproduce the observed inner boundary density gradient and location. In the Wang et al. model, which assumed a background plasma flow velocity at Io equal to the corotation velocity (74 km/s), the ion pickup velocity is 57 km/s. Decreasing the speed of the plasma flow, such that the ion pickup velocity is 20 km/s, is sufficient to move the inner boundary from 3.4 Rj to 4.7Rj.

SA22A-05 1130h INVITED

Surface-bounded Exospheres of the Icy Satellites

Valery I. Shematovich[1] (shematov@inasan.rssi.ru)

Robert E. Johnson[2] (rej@virginia.edu)

John F. Cooper[3] (jfcooper@pop600.gsfc.nasa.gov)

Mau C. Wong[4] (mauwong@jpl.nasa.gov)

[1]Institute of Astronomy RAS, 48 Pyatnitskaya str., Moscow 119017, Russian Federation

[2]Engineering Physics Program and Astronomy Department, University of Virginia , B 103 Thornton Hall, Charlottesville, VA 22903, United States

[3]Raytheon Technical Services Company LLC, SSDOO Project, Space Physics Data Facility, Code 632, NASA Goddard Space Flight Center, Greenbelt, MD 20771, United States

[4]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109, United States

Sputtering and radiolysis of the icy satellite surfaces are important sources of neutrals in the Jovian and Saturnian systems [1,2]. We have presented collisional Monte Carlo models of surface-bounded exospheres of the icy satellites in which the sublimation and sputtering sources of H2O molecules and their molecular fragments are accounted for as well as the physical and chemical exchange at the atmosphere-icy surface interface. Products of radiolytic interactions by more penetrating electrons and ions in the volume ice are incorporated into the sublimation source of escaping volatiles. The very tenuous hydrogen and oxygen exospheres originate from a balance between sources from irradiation of the icy satellite surface by solar UV photons and magnetospheric plasma and losses from pick-up ionization and ejection following dissociation or collisions with the low energy plasma ions. The surface-bounded exospheres of the icy satellites are characterized by the hot coronas formed due to atmospheric sputtering, by suprathermal radicals entering the regolith that can drive radiolytic chemistry, and by a supply of pick-up ions and neutrals into the surrounding planetary magnetosphere. This general picture of the surface-bounded exosphere formation is illustrated with calculations of the near-surface oxygen atmosphere of Europa and the supply rate of neutrals to the Europa's near-orbit torus[3]. The surface-bounded exosphere and neutral gas torus provide an extended region for the Jupiter Icy Moons Orbiter detection of neutrals and ions originating from Europa. [1] Johnson, R. E. 2002. Surface boundary layer atmospheres. In Atmospheres in the Solar System: Comparative Aeronomy (M. Mendillo, A. Nagy, J. H. Waite, Eds.) pp. 203-219. Geophys. Monograph, AGU. [2] Cooper, J.F., R.E. Johnson, B.H. Mauk, H.B. Garrett, and N. Gehrels 2001. Icarus 149(1), 133-159. [3] Shematovich, V.I., R.E. Johnson, J.F. Cooper, and M.C. Wong 2004, (submitted to Icarus).

SA23A CC: 220 C-E Tuesday 1330h

Aeronomy Posters

Presiding: **S Basu,** Air Force Research Laboratory**; J A Dodd,** Air Force Research Laboratory

SA23A-01 1330h POSTER

Hot O(^{1}D) Atoms in the Stratosphere and Mesosphere

Vasili Kharchenko[1] (617 4967536; vkharchenko@cfa.harvard.edu)

Alex Dalgarno[1] (617 4954403; adalgarno@cfa.harvard.edu)

[1]Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, Cambridge, MA 02138, United States

The thermalization of metastable oxygen atoms in the stratosphere and mesosphere has been investigated. Non-Maxwellian O(^{1}D) distributions have been calculated at altitudes of 25 and 50 km taking into account the energy-transfer and quenching collisions of fast O(^{1}D) atoms with the ambient gas. The evolution of the energy distributions of nascent metastable oxygen atoms, produced by ozone photolysis, has been determined by solving the time-dependent Boltzmann equation. The time-dependent and steady state O(^{1}D) distributions have been computed and used for calculations of parameters characterizing O(^{1}D) thermalization and quenching in the stratosphere and mesosphere. The steady state O(^{1}D) distributions contain 3 - 5% of non-thermal atoms. These fractions of hot atoms are larger by two to three orders of magnitude than the non-thermal fractions of hot ground state oxygen atoms. The effective temperature of the non-Maxwellian distributions have been found to be 14% and 33% higher than thermal temperatures of the ambient gas at 25 and 50 km. The non-equilibrium rate coefficients and yields of NO molecules in the atmospheric reaction O(^{1}D)+ N_2 corresponding to the non-Maxwellian distributions of O(^{1}D) atoms have been calculated.

SA23A-02 1330h POSTER

Observations of Equatorial Thermospheric Dynamics at Arequipa, Peru, during Magnetic Storms

Michael Faivre[1] (864-656-1427; faivre@clemson.edu)

J W Meriwether[1] (864 656-0915; john.meriwether@ces.clemson.edu)

M A Biondi[2] (412-624-9387; biondi+@pitts.edu)

[1]Clemson University, Department of Physics and Astronomy, 312 Kinard Laboratory, Clemson, SC 29634-0978, United States

[2]University of Pittsburgh, Department of Physics and Astronomy, Pittsburgh, PA 48831, United States

Measurements of thermospheric winds and temperatures were obtained at Arequipa, Peru, during five major magnetic storm periods between 1996 and 2002. The instrument used was a pressure scanning Fabry-Perot interferometer observing at the wavelength of 630

nm. The weather for these storm periods were generally clear so that measurements were obtained over successive nights, and the behavior of the thermosphere could be followed from the time of initiation to the termination of the magnetic activity. The results showed no particular parttern of behavior of the thermosphere in comparing the results for these storms. Among the highlights of the observed features were a reduction of the zonal thermospheric wind during the evening hours after twilight and a significant heating of the thermosphere during the course of the storm activity. The meridional winds were not larger than 100 ms−1 during any one storm period.

SA23A-03 1330h POSTER

Tidal Wave Observation Using A Multi-emission Fabry Perot Interferometer at Resolute Canada (75 N)

Q. Wu[1] (qwu@ucar.edu)

R. D. Gablehouse[1] (rdg@ucar.edu)

S. C. Solomon[1] (stans@ucar.edu)

T. L. Killeen[1] (killeen@ucar.edu)

[1]High Altitude Observatory National Center for Atmospheric Research, P.O.Box 3000, Boulder, Co 80307-3000, United States

A new multi-emission Fabry Perot Interferometer was installed at the Early Polar Cap Observatory in Resolute, Canada in the summer of 2003. The instrument will provide neutral wind measurements from the upper and lower thermosphere and the mesosphere using the O 6300, 5577 and OH 8920 Å emissions. The instrument is fully automated and will able to provide routine daily coverage during the northern winter season. During the 2003/04 northern winter season, we have observed strong 8-hour and 12-hour waves in the neutral winds from the OH and O 5577 emissions. The 8-hour wave was greatly damped between 87 and 97 km, while the damping in the 12-hour wave was much smaller. We will present some new results and discuss their implications.

SA23A-04 1330h POSTER

A Self-Consistent Derivation of Ion Drag and Joule Heating for Atmospheric Dynamics in the Thermosphere

Xun Zhu[1] (443-778-8764; Xun.Zhu@jhuapl.edu)

Elsayed R. Talaat[1] (443-778-3971; Elsayed.Talaat@jhuapl.edu)

Joseph B. Baker[1]

Jeng-Hwa Yee[1]

[1]Johns Hopkins Univ. Applied Phys. Lab., JHU/APL 11100 Johns Hopkins Road, Laurel, MD 20723, United States

The thermosphere is subject to additional electric and magnetic forces, not important in the middle and lower atmosphere, due to its partially ionized atmosphere. The effects of charged particles on the neutral atmospheric dynamics are often parameterized by ion drag in the momentum equations and Joule heating in the neutral energy equation. The formal relationship among the electromagnetic energy, atmospheric kinetic energy, and Joule heating is illustrated through the conversion terms among those three types of energy. It is shown that there will always be an accompanying conversion of kinetic energy into Joule heating when electromagnetic energy is generated through the dynamo mechanism of the atmospheric neutral wind. Likewise, electromagnetic energy cannot be fully converted into kinetic energy without producing Joule heating in the thermosphere. In this paper, the effect of neutral wind on Joule heating is analyzed in parallel with analysis of the energy conversion terms. Such a discussion has heretofore been lacking in the literature. Presented in this paper is the self-consistent parameterized form of ion drag in the momentum equations and Joule heating in the thermal energy equation for the neutral atmosphere that are functions of magnetic field, the Pedersen and Hall conductivities, and the difference between ion velocity and neutral wind.

SA23A-05 1330h POSTER

The Interaction of Auroral Electron Precipitation with the Thermosphere During the JOULE Experiment

Penny L. Slocum[1] (penny.slocum@aero.org); J. H. Clemmons[1]; J. H. Hecht[1]; R. F. Pfaff[2]; C. T. Steigies[3]; M. F. Larsen[4]; D. J. Strickland[5]

[1]The Aerospace Corporation, Space Sciences Department, M2/260 PO Box 92957 Los Angeles, CA 90009-2957, Los Angeles, CA 90009-2957, United States

[2]Goddard Space Flight Center, Greenbelt, MD, Greenbelt, MD, United States

[3]Christian-Albrechts-Universität zu Kiel, D-24098 Kiel, GERMANY, Kiel, Germany

[4]Clemson University, Clemson, SC, Clemson, SC, United States

[5]Computational Physics Incorporated, Fairfax, VA, Fairfax, VA, United States

The Joule experiment included a full complement of rocket and ground–based experiments to study phenomena associated with Joule heating in the auroral region. The present work concentrates on determining the amount of thermospheric heating present during the experiment. Heating from electron precipitation is estimated directly from the observed electron fluxes and from optical measurements of auroral emissions. The Joule heating rate is estimated using conductivities based on charge-carrier mobilities in the thermospheric gas in conjunction with the measured electric fields and winds.

SA23A-06 1330h POSTER

Thin Ionization Layers and the Enhanced Aurora

Jay R Johnson[1] (609-243-2603; jrj@pppl.gov)

Hideo Okuda[1] (609-243-2642; okuda@pppl.gov)

[1]Princeton University, Plasma Physics Laboratory, PO Box 451, Princeton, NJ 08543, United States

Nearly half of the time, auroral displays exhibit thin, bright layers known as "enhanced aurora." There is a substantial body of evidence that connects these displays with thin, dense, heavy ion layers in the E-region. Based on the spectral characteristics of the enhanced layers, it is believed that the enhanced emissions result when wave-particle interactions heat ambient electrons to energies at or above the 17 eV ionization energy of N_2. We investigate instabilities that occur in dense, heavy ion layers in the presence of strong cross-field currents that accompany electron precipitation. The heavy ion layer increases the growth rate of the instability and heats ambient electrons into a suprathermal tail. Such electrons could produce the enhanced emissions observed in the aurora. We present analytical full-wave solutions and full-particle electrostatic simulations of the nonlinear development of the instability.

SA23A-07 1330h POSTER

Impact of Solar Flare Radiation on the Ionosphere

H Warren[1] (hwarren@ssd5.nrl.navy.mil)

J D Huba[2] (huba@ppd.nrl.navy.mil)

G Joyce[2] (joyce@ppd.nrl.navy.mil)

[1]Space Physics Division, Naval Research Laboratory, Washington, DC 20375, United States

[2]Plasma Physics Division, Naval Research Laboratory, Washington, DC 20375‘, United States

We study the impact of enhanced solar flare radiation on the low- to mid-latitude ionosphere. The methodology is to develop an EUV irradiance spectrum based upon observations that can be used in the NRL ionosphere model SAMI3. Since solar irradiance observations typically do not have the cadence necessary to follow the evolution of a flare, we have developed techniques for computing flare spectra from the available solar data. The initial simulation study will use a generic flare radiation spectrum to test the technique and develop a baseline understanding of the impact of flare radiation on the ionosphere. Subsequent studies will ingest flare spectra based on actual events and model results will be compared to observations if available. A previous study of the Bastille Day storm found that flare radiation can increase the F-region ionosphere density by up to 50% [Meier et al., Geophys. Res. Lett. 29, 10.1029/2001GL013956, 2002]. Research

supported by ONR.

SA23A-08 1330h POSTER

The National Virtual Aeronomic Observatory (NVAO)

Brian D Sharpee[1] (650-859-2975; brian.sharpee@sri.com)

David L Huestis[1] (david.huestis@sri.com)

Tom G Slanger[1] (tom.slanger@sri.com)

Philip C Cosby[1] (philip.cosby@sri.com)

[1]Molecular Physics Laboratory SRI International, 333 Ravenswood Ave., Menlo Park, CA 94025, United States

Astronomical spectrographs routinely record the optical nightglow spectrum as part of nearly every observation. These spectra are often of high resolution and can offer larger simultaneous wavelength coverage than is traditionally available in experiments carried out by aeronomers. A small sample of such data, provided to SRI researchers by astronomers utilizing the W.M. Keck Observatory telescopes' instrumentation, has revealed information regarding previously unobserved features of the nightglow, as well as other atmospheric "surprises." A larger sample of such data drawn from similar instrumentation worldwide would offer the further benefits of large temporal and spatial baselines, yielding a unique resource for atmospheric researchers. The National Virtual Aeronomical Observatory (NVAO) is being developed to act as both a repository for such data, and as a conduit between the data in its proprietary astronomical form and the potential non-astronomer user desiring the data in a easily accessible and interpretable format. The eventual goal of the NVAO is to allow the student or researcher to carry out "observations" of specific aspects or features of the nightglow as measured at numerous times and locations, and to provide on-line tools for the data's interpretation. Presented here is the current status of and future plans for the NVAO as well as specific science results drawn from data to be archived in the NVAO.

SA23A-09 1330h POSTER

Preliminary Results From the SERSIO Experiment

P. Kintner[1] (pmk1@cornell.edu); E. Klatt[1]; K. Lynch[2]; M. Lessard[2]; K. Frederick-Frost[2]; J. Moen[3]; K. Oksavik[3]; D. Lorentzen[4]; F. Sigernes[4]; J. Homes[4]; Y. Ogawa[5]; M. Lester[6]; W. Denig[7]; D. Evans[8]

[1]Electrical and Computer Engineering, Cornell University

[2]Department of Physics and Astronomy, Dartmouth College

[3]Department of Physics, University of Oslo

[4]Arctic Geophysics, UNIS

[5]Solar-Terrestrial Environment Laboratory, Nagoya University

[6]Department of Physics and Astronomy, University of Leicester

[7]Airforce Research Laboratory,, Hanscomb AFB

[8]Space Environmental Center, NOAA

The SERSIO (Svalbard EISCAT Rocket Study of Ion Outflows) was conducted during the month of January 2004 and culminated with the launch of the SERSIO sounding rocket from Svalbard on January 22, 2004 at 08:57 UT. The launch conditions consisted of auroral emissions dominated by a strong 630.0 nm [OI] aurora located just equatorward of the LYR and NYA zenith, ion upflows exceeding 500 m/s and naturally enhanced ion-acoustic lines in the radar echoes. The event began at approximately 0850 UT and lasted for about one hour. The event followed by eight hours the arrival of a CME at 0105 UT and the event began with a period of strongly northward IMF (25 nT). The payload reached an altitude of 780 km encountering regions of ELF and VLF waves along with electron fluxes mostly below 1 keV. The particle measurements were supported by nearby passes of two DMSP spacecraft (F-14 and F-14), two NOAA spacecraft (NOAA-15 and NOAA-16) and the CUTLASS radar. We present the preliminary results from the imagers, EISCAT radars, CUTLASS radars, satellites, and rocket experiment.

SA23A-10 1330h POSTER

Statistical Validation of an Electron Density Retrieval Algorithm Using the 911ÅEmission

Ellen J Bennert[1] (1-202-767-6022; ebennert@ssd5.nrl.navy.mil); Clayton Coker[1] (ccoker@ssd5.nrl.navy.mil); Kenneth F Dymond[2] (kdymond@ssd5.nrl.navy.mil); Stefan E Thonnard[2] (sthonnard@ssd5.nrl.navy.mil); Sarah E McDonald[2] (smcdonald@ssd5.nrl.navy.mil); Andrew C Nicholas[2] (andrew.nicholas@nrl.navy.mil); Scott A Budzien[2] (budzien@nrl.navy.mil); Robert P McCoy[3] (mccoyr@onr.navy.mil)

[1]Praxis, Inc., Code 7607 Naval Research Laboratory 4555 Overlook Ave. S.W., Washington, DC 20375, United States

[2]E.O. Hulburt Center For Space Research, Code 7607 Naval Research Laboratory 4555 Overlook Ave. S.W., Washington, DC 20375, United States

[3]Office of Naval Research, Code 321SR 800 N. Quincy St, Arlington, VA 22217, United States

The Air Force Space Test Program launched the Advanced Research and Global Observations Satellite (ARGOS) on February 23, 1999. ARGOS was in a near-polar sun-synchronous orbit with an ascending node local time of 1430. The instruments on board used remote sensing techniques to measure the composition, density and temperature of the thermosphere and the ionosphere. On board ARGOS was the Low Resolution Airglow and Auroral Spectrograph (LORAAS) instrument, which measured upper atmospheric airglow in the far- and extreme-ultraviolet passband. Every ninety seconds a limb scan, or atmospheric radiance profile, was collected. This study will focus on a statistical validation of a one-dimensional electron density retrieval algorithm for the oxygen emission at 911Å. To do this, we will perform electron density profile retrievals using a one-dimensional algorithm. Our particular interest is in data from limb scans near the terminator. We will then compare these findings with data from ground-based ionosondes. Although ARGOS is no longer operational, this study will be valuable for the Special Sensor Ultraviolet Limb Imager (SSULI) on a recently launched satellite of the Defense Meteorological Satellite Program (DMSP). This first satellite to carry a SSULI instrument was launched October 18, 2003 into an orbit close to the terminator. The SSULI instruments are similar to LORAAS, and therefore we plan to use this analysis to demonstrate the value of using the 911Åemission for the retrieval of electron density profiles near the terminator.

SA23A-11 1330h POSTER

Generation of Metastable Helium and the 10830Å Emission in the Upper Thermosphere

Lara S Waldrop[1] (217-244-5129; lara@sky.csl.uiuc.edu)

Robert Kerr[2] (rkerr@nsf.gov)

Sixto Gonzalez[3] (sgonzalez@naic.edu)

John Noto[4] (noto@sci-sol.com)

[1]University of Illinois at Urbana-Champaign, Coordinated Science Laboratory 1308 West Main Street, Urbana, IL 61801, United States

[2]National Science Foundation, 4201 Wilson Blvd., Arlington, VA 22230, United States

[3]Arecibo Observatory, HC3 Box 53995, Arecibo 00612, Puerto Rico

[4]Scientific Solutions, Inc., 55 Middlesex Street, Unit 210, North Chelmsford, MA 01863, United States

Models of metastable helium, He(2^3S), production in the upper thermosphere and lower exosphere over Arecibo show that creation by recombination of He^+ can be non-negligible relative to the photoelectron impact on He(1^1S) source. Due to large ground-state He abundance in the winter, and to photoelectrons from an illuminated conjugate thermosphere, the strongest 10830Å intensities (arising from He(2^3S) solar resonance) occur during the winter. The contribution to the 10830Å airglow brightness from He^+ recombination reaches more than 10% in the morning twilight when He^+ peak concentrations are more than ∼30% of the topside composition, and He^+ recombination becomes increasingly dominant for solar zenith angles greater than 100°. Measurements of the topside ionosphere at Arecibo have shown that He^+ layer concentrations in the winter and near the equinoxes are often as high as 50% and significant He^+ concentrations can persist throughout the night. A hot metastable component from recombination renders ambiguous interpretation of the 10830Å spectral profile in terms of exospheric temperature. The presence of such a population may explain reported observations of 10830Å line widths that increase with shadow height, implying twilight temperatures much hotter than those expected of a thermalized neutral population. Modeling of 10830Å line profiles comprised of both thermal and nonthermal He(2^3S) components is investigated to assess the role of He^+ recombination in the generation of metastable He and the implications for the derivation of neutral temperature in the upper thermosphere.

SA23A-12 1330h POSTER

Tracking of Polar Cap Ionospheric Patches

Gary S. Bust[1] (512-835-3623; gbust@arlut.utexas.edu)

Geoff Crowley[2] (210-522-3475; gcrowley@swri.edu)

Bodo W. Reinisch[3] (978-934-4903; bodo_reinisch@uml.edu)

Mark R Hairston[4] (972-883-2826; hairston@utdallas.edu)

[1]Applied Research Laboratories The University of Texas at Austin, P.O. Box 8029, Austin, TX 78713-8029, United States

[2]Southwest Research Institute, 6220 Culebra Road P.O. Box 28510, San Antonio, Tx6 78228-0510, United States

[3]University of Massachusetts/Lowell, Center for Atmospheric Research 600 Suffolk Street, Lowell, MA 01854, United States

[4]William B. Hanson Center for Space Sciences, University of Texas at Dallas P.O. Box 830688 FO22, Richardson, TX 75083

Ionospheric patches are significant perturbations on F-region electron densities in the polar cap ionosphere. There are many questions related to their formation, transport, and eventual transformation into blobs on the nightside. In an earlier study, we showed that patches observed by ionosondes can be tracked across the polar cap using 2-D convection patterns and a trajectory analysis package. The present study allows for a full three-dimensional convection analysis of the patch fate. Measurements provided by three high-latitude tomography arrays located in Greenland, Alaska and Scandinavia are supplemented by ISR, Ionosonde and DMSP measurements. The data are assimilated into a 3-D global ionosphere model. The background model for the assimilation is the NCAR TIMEGCM, with comprehensive high latitude inputs. We will investigate several patch events and determine whether and under what conditions patches can be routinely tracked, given the instruments and moeling capabilities currently available.

SA23B CC: 519 A Tuesday 1330h

Mars Space Weather and Upper Atmosphere Science I *(joint with A, P, SH, SM)*

Presiding: **K Retherford,** Southwest Research Institute**; W Ward,** University of New Brunswick

SA23B-01 1330h INVITED

First Results of the Analyzer of Space Plasmas and Energetic Neutral Atoms (Aspera-3) Onboard Mars Express

Stas Barabash[1] (+46-980-79122; stas@irf.se)

ASPERA Team (stas@irf.se)

[1]Swedish Institute of Space Physics, Box 812, Kiruna 98128, Sweden

The scientific objective of the ASPERA-3 experiment is to study the solar wind - atmosphere interaction and characterize the plasma and neutral gas environment in the near-Mars space through energetic neutral atom (ENA) imaging and in-situ ion and electron measurements. The ASPERA-3 instrument comprises four sensors, two ENA sensors and an electron and ion spectrometer. The Neutral Particle Imager (NPI) provides measurements of the integral ENA flux in the energy range 0.1 - 60 keV with no mass and energy resolution but a comparatively high angular resolution of $4.6^\circ \times 11.5^\circ$. The Neutral Particle Detector (NPD) provides measurements of the ENA flux in the energy range 0.1 - 10 keV, resolving velocity and mass (H and O) with a coarse angular resolution of $5^\circ \times 30^\circ$. The ENA detection technique is based on the atom - surface interaction. The Electron Spectrometer (ELS) is a standard top-hat electrostatic analyzer in a very compact design covering the energy range 0.01 - 20 keV with an energy resolution of 8%. Ion mass resolving sensor IMA (Ion Mass Analyzer) provides ion measurements in the energy range 0.01 - 32 keV/q for the main ion components with mass/charge 1, 2, 4, 8, 16, and the molecular ion group (20 - 40) amu/q. The instantaneous field of view is $4.6^\circ \times 360^\circ$. Electrostatic sweeping performs the elevation ($\pm 45^\circ$) coverage. We present and discuss the first ASPERA-3 measurements during the cruise phase and at Mars. The focus will be given to (1) ENA observations in the interplanetary medium, (2) identification of the main plasma domains in the combined ion / electron data, (3) plasma observations inside the obstacle.

SA23B-02 1350h

First Observations from the ASPERA-3 ELS in the Mars Ionosphere

Rudy A Frahm[1] (1-210-522-3855; rfrahm@swri.edu); J. David Winningham[1] (1-210-522-3075; dwinningham@swri.edu); James R Sharber[1] (1-210-522-3853; jsharber@swri.edu); Stanislav Barabash[2] (+46-980-79122; stas@irf.se); Lundin Rickard[2] (+46-980-79063; rickard.lundin@irf.se); Dave R Linder[3] (+44-1483-204169; drl@mssl.ucl.ac.uk); Andrew J Coates[3] (+44-1483-204145; ajc@mssl.ucl.ac.uk)

[1]Southwest Research Institute, Department of Space Sciences and Engineering, 6220 Culebra Road, PO Drawer 28510, San Antonio, TX 78228, United States

[2]Swedish Institute of Space Physics, Kiruna Division, Box 812 S-981 28, Kiruna, Kiruna, Sweden

[3]Mullard Space Science Laboratory, University College London, Holmbury St Mary, Dorking, Surrey, RH5 6NT, United Kingdom

The Analyzer of Space Plasmas and Energetic Atoms (ASPERA-3) experiment is currently collecting data at Mars. ASPERA-3 determines the electron, ion, and neutral particle components of the plasma using four instruments: Electron Spectrometer (ELS), Ion Mass Analyzer (IMA), Neutral Particle Imager (NPI), and Neutral Particle Detector (NPD). The ELS instrument measures 128 logarithmically spaced samples of the electron spectrum between 1 eV and 20 keV every four seconds. Its 8% energy resolution allows a more detailed investigation of the plasma in the Martian environment than previous electron measurements. This paper presents the first results of ELS measurements in the ionosphere of Mars, including the first high-resolution measurement of the Martian photoelectrons. Spectral peaks are clearly seen where they have been predicted by models.

URL: http://www.aspera-3.org

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Solar Flux and Solar Wind Dependence of Dayside Photoelectron Fluxes in the Mars Strong Crustal Field Region

Michael W. Liemohn[1] (liemohn@umich.edu)

Jacki Frank[1] (jackims@umich.edu)

David L. Mitchell[2] (mitchell@ssl.berkeley.edu)

[1]University of Michigan, AOSS Department, 2455 Hayward St., Ann Arbor, MI 48109, United States

[2]University of California, Space Sciences Laboratory, Berkeley, CA 94720, United States

Observed characteristics of photoelectrons in the dayside ionosphere of Mars are examined. During the mapping and extended phases of its mission, the Mars Global Surveyor satellite routinely passes over the region of intense crustal magnetic fields in the southern hemisphere of Mars. When this occurs on the dayside (2 p.m. local time), the magnetometer and electron reflectometer instrument usually measures the planetary magnetic field and electrons produced by photoionization of the upper atmosphere. The electron fluxes respond to the solar flux illumination along the magnetic field line and the solar wind conditions surrounding the planet. Results from a systematic study of the electron flux intensity and pitch angle distribution are presented. The physical processes governing how the photoelectrons vary with solar flux and solar wind conditions are discussed.

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Effects of the late October 2003 Solar Storms at Mars: Mars Global Surveyor Observations

Dana Hurley Crider[1] (336 449-7269; dcrider@lepvax.gsfc.nasa.gov)

Jared R. Espley[2] (espley@rice.edu)

David A. Brain[3] (brain@ssl.berkeley.edu)

Mario H. Acuna[4] (mario.h.acuna@nasa.gov)

John E. P. Connerney[4] (john.e.connerney@nasa.gov)

[1]Catholic University of America, 106 Driftwood Dr, Gibsonville, NC 27249-3310, United States

[2]Rice University, Dept. of Physics and Astronomy, Houston, TX 77005, United States

[3]Space Science Laboratory, University of California, Berkeley, CA 94720, United States