modeled the ionosphere for solar fluxes from Hinteregger, and the S2K fluxes from K. Tobiska. We find that there is a large difference in the model ionospheres that result from the S2K v1.24 fluxes, which are based on the SNOE soft xray data, and the v2.22 fluxes, which are based on the TIMED SEE data. These differences are not limited to the soft xrays, but extend into the EUV as well. Previous models based on the SERF2 solar fluxes (Tobiska, 1991) had shown the double peaked structure (Fox et al., 1995). We show that the appearance of the double peak depends on both the EUV and soft xray fluxes.

SA24A-05 1640h

Testing Simple Parameterizations for the Basic Characteristics of the Martian Ionosphere

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Approximately 2000 profiles of ionospheric electron density between 100 and 200 km altitude have been generated by the Radio Science Experiment on Mars Global Surveyor and publicly released on the PDS. Basic parameters that can be extracted from each electron density profile include the altitude, peak density, and thickness of two distinct ionospheric layers, the topside scale height, and the overall total electron content and equivalent slab thickness. With the 2000 profiles spanning the years 1998-2001, the analysis will include effects of variability in the longitudes, latitudes, local times, and seasons sampled. Simple scaling laws for the behaviour of these ionospheric parameters will be tested. We will investigate the hypothesis that layer width, slab thickness, and topside scale height can be related to neutral atmospheric temperatures and that, when combined with peak altitudes, these results can be related to neutral atmospheric pressures. We will discuss the implications of our results for interactions between the neutral and ionized portions of the martian upper atmosphere.

SA24A-06 1655h

Ionospheric Layers of Mars and Earth

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The terrestrial ionosphere has four "classic layers" termed D, E, F1 and F2. At Mars, there are two distinct ionospheric layers that we call M1 and M2. In this paper we compare the electron densities of M1 and M2 measured by the Mars Global Surveyor (MGS) radio science experiment during 9-27 March 1999 with the electron densities of the terrestrial E and F1 layers derived from ionsonde data at six stations distributed around the globe. These ionospheric layers at the two planets are dominated by photochemistry, occur at similar atmospheric pressure levels, and their day-to-day variations are all linked to changes in solar activity. These variations provide the opportunity of making the first simultaneous study of four photochemical layers in the solar system. We introduce an "ionospheric layer index" to characterize ionospheric layers in general, and show that it varies between the M1, M2, E and F1 layers because different atmospheric chemistry and solar radiations are involved.

SA31A CC: 220 C-E Wednesday 0830h

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

Presiding: **S Ledvina,** University of California, Berkeley**; J R Espley,** Rice University

SA31A-01 0830h POSTER

Modeling Space Weather Effects on the Middle and Upper Atmosphere of Mars

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We have created a new Mars GCM that extends from about 14 km above the planetary surface to altitudes of about 300km, thus coupling the lower and upper atmospheres. The model includes Mars-appropriate dynamics, chemistry, and energetics. Some preliminary results for a dust-free atmosphere are presented, showing temperature and composition profiles, electron density distributions, and global wind patterns. The simulations are validated against Mars Global Surveyor measurements of neutral density and temperature, and electron density. We examine modeled and measured space weather effects in the variability of the Mars atmosphere.

SA31A-02 0830h POSTER

Impact of Vertical Dust Distributions on the Structure and Dynamics of the Mars Upper Atmosphere : A Sensitivity Study using Mars TGCM Simulations

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This research encompasses a study of the sensitivity of the Mars Thermospheric General Circulation Model (MTGCM) to vertical dust distributions in the lower atmosphere. Previous studies by Bougher et al (2003) have illustrated that including realistic lower atmospheric dust loading provides a more accurate portrayal of upper atmospheric dynamics. In particular, the observed polar warming during the latter part of Mars Odyssey's (ODY) Aerobraking Phase was largely reproduced by incorporating appropriate vertical dust profiles from the NASA Ames Mars General Circulation Model (MGCM) Murphy et al (2003). In the current simulations, we investigate the effects of modifying the Barney Conrath dust vertical mixing profiles on the resulting dynamics of Mars thermosphere. In addition, we use latitudinal and longitudinal variations in dust opacities from the Mars Global Surveyor (MGS) Thermal Emission Spectrometer (TES) Year One (1999-2000) and TES Year Two (2001-2002) data sets. Two primary benchmark cases are presented: Ls = 90, and Ls = 270, which correspond to MGS Phase 2 Aerobraking and the near end of Mars ODY Aerobraking. This sensitivity study represents a first step towards characterizing how dust storms may globally impact Mars' upper atmospheric regions.

SA31A-03 0830h POSTER

Low altitude low frequency magnetic oscillations at Mars

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Recently, general characterizations have been made of the magnetic oscillations observed in the Martian magnetosheath and below the magnetic pileup boundary. We expand upon that work to examine in detail the magnetic oscillations at the lowest observed altitudes. We find that low frequency magnetic oscillations at or below the proton gyrofrequency are consistently observed at altitudes as low as 200 km. We discuss the physical origin of these waves and what this implies about the plasma from which the waves originate. We also note the relevance of these waves in the exploration of the deep subsurface using inductive sounding techniques such as those found in magnetotelluric and magnetic gradiometry methods.

SA31A-04 0830h POSTER

3D multi-fluid simulations of the effect of dynamic solar wind conditions on the Martian magnetosphere

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Under quiet solar wind conditions, the strong surface magnetic field on Mars can modify the plasma inside the bow shock, and lead to the formation of mini-magnetospheres. The crustal magnetic field has no effect on the bow shock though. 3D multi-fluid simulations are used to study the effects of pressure pulses associated with storm conditions, on the structure of the inner Martian magnetosphere. The increased dynamic pressure of the solar wind pushes the bow shock closer to the surface, into a region where stronger magnetic fields can have substantial influence on the plasma. This can also lead to enhanced ionospheric outflow. Ionospheric outflow rates down the tail are calculated for a range of solar wind conditions and crustal magnetic field orientations.

SA31A-05 0830h POSTER

Predicting solar wind conditions at Mars

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High energy particles generated during solar/interplanetary disturbances will pose a serious hazard to crew members traveling beyond low-Earth orbit. In order to provide warnings of dangerous radiation conditions, mission operators will need accurate forecasts of solar energetic particle (SEP) fluxes and fluences in interplanetary space. However, physics-based models for accelerating and propagating SEPs require specifications and predictions of the solar wind conditions and IMF configuration near the evolving interplanetary shock region, and along the IMF lines connecting the shock to the observation point. We are presently using the Hakamada-Akasofu-Fry kinematic solar wind model to predict, in real time, solar wind conditions in the inner heliosphere, including at the location of Mars. We are also conducting retrospective Mars space weather studies by simulating solar wind conditions during significant solar event periods and comparing modeling results with disturbance signatures observed at Mars. These signatures include enhancements in the energetic particle environment at Mars, and instrument anomalies on spacecraft orbiting Mars. We will present recent study results.

SA31A-06 0830h POSTER

The "Mars-Sun Connection" and the Impact of Solar Variability on Mars Weather and Climate

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We develop the scientific case to measure simultaneously the UV and near-UV solar irradiance incident on the Mars atmosphere and at the Martian surface, to explore the effects and influence of Solar variability and "Space Weather" on Mars weather and climate, its implications for life, and the implications for astronaut safety on future manned Mars missions. The UV flux at the Martian surface is expected to be highly variable, due to diurnal, daily, and seasonal variations in opacity of atmospheric dust and clouds, as well as diurnal and seasonal variations in ozone, water vapor and other absorbing species. This flux has been modeled (Kuhn and Atreya, 1979), but never measured directly from the Martian surface. By directly observing the UV and near UV solar irradiance both at the top of the atmosphere and at the Martian surface we will be able to directly constrain important model parameters necessary to understand the variations of atmospheric dynamics which drive both Mars weather and climate. Directly measuring the solar UV radiation incident upon the Mars atmosphere and at the Martian surface also has important implications for astronaut safety on future manned Mars missions. The flux at the surface of Mars at 250 nm is also believed to be approximately 3000 times greater than that on Earth. This presents potential hazards to future human explorers as well as challenges for future agriculture such as may be carried out in surface greenhouses to provide food for human colonists. A better understanding of the surface flux will aid in designing appropriate protection against these hazards.

SA31A-07 0830h POSTER

Concepts for a Mars Upper Atmosphere Orbiter Mission to Study Atmospheric Escape

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According to the recent decadal survey "New Frontiers in the Solar System: An Integrated Exploration Strategy" report by the National Academy of Sciences, a Mars Upper Atmosphere Orbiter (MUAO) mission is required to "provide quantitative information on the various atmospheric escape fluxes, thus quantifying current escape rates and providing a basis for backwards extrapolation in our attempt to understand the evolution of Mars' atmosphere." Mars' atmosphere may once have been thick, warm, and wet, but how did it evolve into the thin, dry atmosphere of today? Specifically, how much water was lost by escape to space versus sequestration in the surface? We are investigating several candidate MUAO missions and instrument suites that address these questions of Martian climate change. We report a preliminary list of science goals and needed measurements for a MUAO mission. Initial results from a design study of neutral mass spectrometer, plasma analyzer, and far-ultraviolet spectrometer instruments conducted by SwRI will be discussed, along with future prospects for a NASA Mars Scout size MUAO mission.

URL: http://swim.swri.edu/

SA31B CC: 519 A Wednesday 0830h

The Extended Ionosphere: A Unifying Approach to Magnetosphere-Ionosphere Coupling I *(joint with SM)*

Presiding: **J Semeter,** SRI International**; J Horwitz,** University of Alabama in Huntsville

SA31B-01 0830h INVITED

Energetic (keV) Ionosphere-Origin Ions Found Between $R = 2$ and 23 R_E

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With the flight of ion composition instruments on the Polar satellite, beginning some eight years ago, adding to several earlier missions of varied orbits, we now have essentially contiguous altitude records of the outflow of energized ionospheric ions from $R = 2R_E$ (geocentric) to $R = 23R_E$, at least in the energy range from a few tens of eV/e to a few tens of keV/e. Magnetotail ion composition measurements in that energy range were first made more than 20 years ago during the ISEE mission (within 23 R_E) and are again being made with the Cluster satellites (within 20 R_E). According to the several years of ISEE measurements, the nearly omnipresent, singly charged oxygen ions, in particular, have a broad energy distribution within the tail plasma sheet, typically averaging about 3-5 keV. This may be contrasted with mean O^+ energies of only 0.2-0.4 keV observed in the ion outflow at $R \sim 2R_E$ by the Polar TIMAS instrument. The same instrument finds the O^+ mean energy to have increased to 1 keV or more by the time the ions have reached $R \sim 4 - 9R_E$, while the total rate of O^+ outflow (ions per second) above the nominal 15 eV minimum energy (plus spacecraft potential) has increased about fivefold. An important part of this progressive energization is transverse acceleration across the geomagnetic field lines. As will be shown, this process is sometimes resolved within the O^+ gyro period by the TIMAS instrument at these high altitudes. Early TIMAS results suggest that this kind of acceleration is intermittent and explosive and arguably caused by magnetic field-aligned space charge structures associated with earthward bursts of hot and filamentary magnetospheric plasma. The TIMAS data also imply that ionospheric ions are directly injected into the ring current region, but the very energetic O^+ ($\sim$100 keV) that is known to be a large component of the storm-time ring current has most likely arrived from the plasma sheet, undergoing adiabatic betatron and Fermi acceleration.

SA31B-02 0850h INVITED

Imaging Magnetospheric Perturbations of the Ionosphere/Plasmasphere System from the Ground and Space

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The thermal plasmas of the inner magnetosphere and ionosphere move across the magnetic field under the influence of electric fields. Irrespective of their source, these electric fields extend along magnetic field lines coupling the motion of thermal plasmas in the various altitude regimes. Modern remote-sensing techniques based both on the ground and in space are providing a new view of the large and meso-scale characteristics and dynamics of the plasmas of the extended ionosphere and their importance in understanding processes and effects observed throughout the coupled spheres of Earth's upper atmosphere. During strong geomagnetic storms, disturbance electric fields uplift and redistribute the thermal plasma of the low-latitude ionosphere and inner magnetosphere, producing a pronounced poleward shift of the equatorial anomalies (EA) and enhancements of plasma concentration (total electric content, TEC) in the post-noon plasmasphere. Strong SAPS (subauroral polarization stream) electric fields erode the plasmasphere boundary layer in the region of the dusk-sector bulge, producing plasmaspheric drainage plumes which carry the high-altitude material towards the dayside magnetopause. The near-Earth footprint of these flux tubes constitutes the mid-latitude streams of storm-enhanced density (SED) which produce considerable space weather effects across the North American continent. We use ground-based GPS propagation data to produce two-dimensional maps and movies of the evolution of these TEC features as they progress from equatorial regions to the polar caps. DMSP satellite overflights provide in-situ density and plasma flow/electric field observations, while the array of incoherent scatter radars probe the altitude distribution and characteristics of these dynamic thermal plasma features. IMAGE EUV and FUV observations reveal the space-based view of spatial extent and temporal evolution of these phenomena.

SA31B-03 0910h

Sub-Auroral Morning Proton Spots (SAMPS) as a Result of Plasmapause-Ring-Current Interaction

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The proton aurora imager SI-12 on the IMAGE spacecraft occasionally observed Sub-Auroral Morning Proton Spots (SAMPS) that rotate with 80-90 % of the Earth's corotation speed. Coincident particle measurements by DMSP confirm the source as pure high energy precipitating protons with energy likely above the detector limit of 30 keV. The spots appear after magnetic storms in the recovery phase and last for 1-4 hours in the magnetic local time region of 0600-1200 hours. IMAGE-EUV observations of the plasmasphere indicate a relationship with density gradients in the expanding plasmapause after magnetic storms. This is supported by nearby geosynchronous observations of increased cold plasma density. We interpret these spots as the result of the interaction of ring current protons with electromagnetic ion-cyclotron (EMIC) waves caused by the expansion and sub-rotation of the dense, cold plasmasphere ions. It is therefore a consequence of plasmasphere refilling after geomagnetic storms.

SA31B-04 0925h INVITED

Low Energy Neutral Outflow

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Analysis of ENA data from the LENA instrument on the IMAGE spacecraft shows that the terrestrial atmosphere is a copious emitter of low energy neutral atoms (10 - 300 eV) under all conditions. These emissions appear most intense when the spacecraft is close to the earth but as activity increases they can be seen at greater distances. The emissions correlate well with magnetic activity and increase at the same rate as the O^+ escape rate increases. Under extreme conditions such as the Bastille Day storm (July 14-16, 2000), the pattern of high latitude emissions matches