The whistler waves become unstable when the number density of the relativistic electron beam is high enough to overcome the damping by the population of colder electrons. The threshold conditions are studied for different ranges of the relevant atmospheric parameters. Once the whistler waves maintain large amplitudes due to the instability, the conditions for self-focusing and channel formation, and consequently the beam propagation are studied.

SA34A CC: 517 A Wednesday 1530h

Parker Lecture *(joint with SH, SM)*

Presiding: **D N Baker,** Laboratory for Atmospheric and Space Physics

SA34A-01 1540h INVITED

The Sun and Heliosphere as Revealed by Suprathermal Electrons

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Solar wind electron distributions near 1 AU are generally well described as a superposition of two distinct components: a cool core or thermal component and a relatively hot suprathermal component. The breakpoint between these two populations commonly occurs at about 60 eV at 1 AU. The suprathermal component carries the solar wind electron heat flux, is almost always nearly collisionless, behaves largely as a test particle population streaming freely through the solar wind along the heliospheric magnetic field, and is commonly highly anisotropic in the solar wind rest frame. In this lecture I demonstrate some of the remarkable spatial and temporal intensity and pitch angle variability of the suprathermal electron component at energies below about 1.4 keV, relate that variability to different solar and heliospheric processes, and illustrate aspects of the large-scale magnetic topology of the heliosphere revealed by suprathermal electron observations.

SA41A CC: 220 C-E Thursday 0830h

General Circulation Models, Global Dynamics, Energetics, and Composition in Solar System Atmospheres I Posters *(joint with P, SM)*

Presiding: **I Mueller-Wodarg,** Imperial College London; **G Crowley,** Southwest Research Institute

SA41A-01 0830h POSTER

Simulations of High-Latitude Vortices in the Atmosphere of Jupiter

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Jupiter's atmosphere as a function of latitude consists of persistent, alternating anticyclonic and cyclonic domains. Interestingly, all the anticyclonic domains contain conspicuous, long-lived anticyclones that drift zonally at speeds that are intermediate between the domain's alternating currents. The largest and oldest is the Great Red Spot (GRS) at 22°S, which has a minor axis greater than 12,000 km and an age measured in centuries, and the next largest and oldest are the White Oval Spots (WOS) at 33°S, which numbered three for over six decades but have recently merged into a single vortex that covers about 50% the area of the GRS. The amplitude and structure of the wind fields associated with the GRS and WOS have been well sampled with Earth-based and spacecraft observations. We are interested in both how the vortices are constructed and to what extent their dynamics tells us about the environment they reside in, especially the vertical structure of the atmosphere. Theories of the nonlinear stability of vortices indicate that different balances may hold for large versus small anticyclones, but unfortunately, this is difficult to test directly because we do not yet have good observations of the structure inside Jupiter's many smaller vortices. However, we can begin to reduce the possibilities of their interior structure and their environment with forward modeling. Here, we use the EPIC atmospheric model to study Jupiter's anticyclonic domain centered at 60°N, which contains two relatively large anticyclones with minor axes of ∼5,000 km that have persisted for over ten years. The bulk dynamics of these two vortices is well constrained by observations, for example they are known to often merge with smaller vortices that have minor axes ∼3,000 km. We find that for plausible temperature and wind profiles, their interactions mainly depend on the amplitude of their interior wind field, such that we can use the observations to constrain their structure. We present these results and discuss the relationship we have found between the strength of the vortices and their size and latitudinal position. This research is funded by NASA's Planetary Atmospheres and EPSCoR Programs.

URL: http://www.louisville.edu/research/cpl

SA41A-02 0830h POSTER

The thermospheres of Earth, Titan and Saturn compared

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While measurements for the past 4 decades have given us an in-depth understanding of our terrestrial thermosphere and its coupling to the lower atmosphere, the ionosphere and magnetospthere, little is yet known about the upper atmospheres on other planets of our solar system. In the coming months, the arrival of the Cassini/Huygens spacecraft at Saturn and Titan will give us a wealth of new observational constraints on their upper atmospheres which, in spite of their equal distances from the Sun, host very different environments. Using recently developed General Circulation Models for Saturn and Titan, we may however already in anticipation of these observations obtain an understanding of principal processes controlling the dynamics, energetics and global composition in their thermospheres. This talk will highlight some key results from such simulations and elaborate an understanding of similarities and differences between Earth, Saturn and Titan.

SA41A-03 0830h POSTER

Implementation of Clouds and Precipitation for Gas-Giant GCM simulations in the EPIC Model

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To date, most gas-giant atmospheric models have either been general circulation models (GCM) without active hydrological cycles, which capture many aspects of the observed vorticity dynamics but lack the important energy transfers and feedbacks of moist convection, or 1D or 2D simulations that include latent-heat release but are missing the full range of global dynamics. We present a progress report on the implementation and evaluation of a fully active hydrological cycle in the EPIC general circulation model with application to gas giants. For each species activated by the user (water, ammonia, etc.) we invoke five continuity equations covering the following phases: vapor, cloud liquid, cloud ice, rain and snow. For the interactions between phases we have adapted recent Earth-cloud schemes and developed simplified parameterizations for jovian conditions where necessary, which we describe. We are currently testing the behavior of the model in 1D and 2D cases, which facilitates comparison to previous work. For 3D simulations, our goals are to simulate the highly energetic convective water clouds observed northwest of Jupiter's Great Red Spot, and the characteristic filamentary morphology of ammonia clouds in Jupiter's cyclonic regions. This research is funded by NASA's Planetary Atmospheres and EPSCoR Programs.

SA41A-04 0830h POSTER

Application of the Isentropic/Terrain-Following Hybrid EPIC GCM to Venus with Topography

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A major problem in planetary atmospheric dynamics that remains elusive to our understanding is equatorial superrotation. Our neighboring planet Venus exhibits this trait: the solid planet has a very slow retrograde rotation of 243 days while the cloud top travels at speeds of 100 ms^{-1} at the equator, a feature known as the "four-day" wind. In order to maintain equatorial superrotation on Venus, three-dimensional (non-axisymmetric) eddies must transport angular momentum to low latitudes (Hide 1969). Several models support the Gierasch mechanism in which Hadley cells pump angular momentum upward at the equator and wave instabilities transport it towards the equator. However, there is also support for solar thermal tides and for topographically excited gravity waves as alternative eddy sources. One of the challenges is to distinguish the contribution of these effects on a given altitude region. Yamamoto and Takahashi (2003) are the first to report a fully developed superrotation for Venus. They use a low-resolution model that employs simplified physics and a configuration for Newtonian cooling, which, as they point out, uses a vertical heating profile that has an altitude of maximum heating rate that is 10 km lower than that of the cloud-top heating maximum. As our first terrestrial-planet application of the EPIC model with its new hybrid isentropic/terrain-following vertical coordinate, we are experimenting with the Yamamoto and Takahashi configuration and are performing additional sensitivity tests regarding the horizontal resolution and the Newtonian cooling profile. By using a hybrid as opposed to a traditional sigma terrain-following vertical coordinate, the EPIC GCM is able to conveniently calculate the Eliassen-Palm flux divergence in isentropic coordinates to diagnose wave transience and nonconservative effects and avoids having the signature of the topography carried all the way to the top of the model. None of the published Venus GCM work to date includes topography, although several authors have noted its likely importance. In fact, Venus has tall mountains: Ishtar Terra covers an area similar to that of Australia and contains the highest mountain, Maxwell Montes (10 km), and Aphrodite Terra covers an area similar to that of South America. We are testing the effects of orographic waves by scaling the topography (obtained from high-resolution Magellan data) from zero to full height in a series of simulations.

URL: http://www.louisville.edu/research/cpl/

SA41A-05 0830h POSTER

Meteorological Results From the Surface to the Thermosphere Using the Global Mars Multiscale Model

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We present the latest results from the G3M (Global Mars multiscale Model). The model is based on a semi-Lagrangian semi-implicit dynamical framework employed in the Canadian Meteorological Service of Canada's weather forecast model, GEM (Global Environmental Multiscale) model. The physics incorporated into the model includes a PBL, radiative heating by solar and IR of CO_2 and (currently a climatological distribution) aerosols, surface thermal conduction. The radiative scheme accounts for the absorption and scattering by dust in the solar and Infra-Red wavelengths, the CO_2 15 μm absorption band in the Infra-Red region and non-LTE effects of CO_2 cooling in the thermosphere, and the absorption of solar EUV and UV in the thermosphere and thermal conduction. The MOLA and TES measurements from MGS are used for the surface topography and the surface albedo and thermal conductivity respectively. The upper boundary has been extended to about 200km in order to have a more comprehensive dynamical interaction between the lower and

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upper atmosphere, and to ensure a consistent representation of the dynamical transport and tides. With the perspective of the numerous future Mars landers and to answer the questions related to local martian meteorology, the model is used at a relatively high resolution (down to 1 km) with in a 40 km high resolution domain with the zoomed configuration. The Canadian G3M though in an early stage of development shows good potential for reproducing the climate features and simulating the local flow over the complex terrain.

SA41A-06 0830h POSTER

The Global Ionosphere Thermosphere Model and it's Application to Planetary Atmospheres

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We present results from a new global ionosphere thermosphere model (GITM). The model is a self-consistent first-principles models of the coupled ionosphere thermosphere system of the Earth from 95 km to 500+ km. GITM solves for the non-hydrostatic thermospheric state in altitude coordinates, having a stretched grid in both the altitude and latitude directions. The combination of grid structure and a non-hydrostatic solution allows an investigation of small-scale, highly variable phenomena and their influence on the global structure of the system. In addition, the solver allows for supersonic flows, so planetary systems with high flow speeds can be easily investigated. The high-latitude electrodynamics are specified by input from external models, while the low-latitude electrodynamics are controlled by the self-consistent coupling between the ion and neutral flows. We present thermospheric and ionospheric results from a number of test problems, and discuss the application of this model to other planetary atmospheres such as Mars, Saturn, and Jupiter.

SA41A-07 0830h POSTER

The Global Ionosphere Thermosphere Model Results of the April 2002 Storm

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We present results from a new global ionosphere thermosphere model (GITM). The model is a self-consistent first-principles models of the coupled ionosphere thermosphere system from 95 km to 500+ km. GITM solves for the non-hydrostatic thermospheric state in altitude coordinates, having a stretched grid in both the altitude and latitude directions. The high-latitude electrodynamics are specified by input from AMIE, while the low-latitude electrodynamics are controlled by the self-consistent coupling between the ion and neutral flows. We present thermospheric and ionospheric results from the April 2002 storm period, comparing those results to observations from global imagers and measurements of NO. We further show the effects of small-scale structures in the aurora and ion flows on the global solution.

SA41A-08 0830h POSTER

Response of High Latitude Thermosphere Density and Composition to Magnetic Activity and IMF-By Effects

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Changes in the density and composition of the neutral atmosphere create variable satellite drag, adversely affecting missions involving space assets, such as collision avoidance. Existing empirical density models do not adequately account for dynamic changes in neutral density, leading to errors in predicted satellite positions. The major discrepancies between empirical models and data are at high latitudes, where extreme density variability is caused by the varying auroral inputs. There is still much to be learned about the behavior of the high latitude composition and density, and we report a modeling study that explores and discusses some of their basic characteristics. The model used for this study is the Thermosphere Ionosphere Mesosphere Electrodynamics General Circulation Model, which is a 3-D fully coupled global model of the ionosphere-thermosphere system driven by high latitude inputs. We present the results of numerical experiments to characterize the high latitude thermospheric density and composition response to different levels of magnetic activity. Finally, we include their IMF By dependence. We predict what are the likely UV signatures of these composition variations, and how they might be observed with UV imagers that are being flown today.

SA41A-09 0830h POSTER

Terrestrial thermospheric storm effects during the first weeks of the Dynamics Explorer 1 mission

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Global far-ultraviolet (FUV) images of Earth provide an unparalleled view of the development of thermospheric storms during periods of enhanced magnetic activity. More than 20 years ago, the Spin Scan Imager onboard the Dynamics Explorer 1 satellite obtained the first global images of the development of thermospheric perturbations caused by enhanced auroral activity. This capability comes from the FUV component of the imager, that by measuring the bright OI 130.4-nm triplet originating in the thermosphere can monitor variations in the relative thermospheric column abundances of O and N_2. Short-term variations in the ratio of these parameters usually indicate the recent occurrence of high-latitude Joule heating. The first several weeks of operation of the instrument (beginning in September, 1981) were marked by a particularly interesting series of magnetic substorm and storm events which all had an effect, to varying degrees, on the OI FUV dayglow brightness. In this study the O/N_2 variations are simulated for the entire period using the NCAR TIMEGCM in order to identify the causative factors in the development of O/N_2 depletions. This period was also marked by good measurements of the solar wind speed, density, and embedded magnetic field from the ISEE-3 satellite. These are important inputs for the TIMEGCM. Particular attention is paid to the sense of IMF By, which has a strong effect on the magnitude and local time of the peak in the high latitude neutral circulation speed.

SA41A-10 0830h POSTER

The Annual Cycle of Non-migrating Tides in the Extended Canadian Middle Atmosphere Model

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Temperature signatures associated with migrating and non-migrating tides have been diagnosed from one year of a four year run of the extended Canadian Middle Atmosphere Model. Significant temperature amplitudes are observed for eastward and westward non-migrating diurnal and semidiurnal wave 1 and wave 2 modes which in the meospause region are of a similar magnitude to the better known migrating tides. The amplitudes of the the non-migrating tides vary significantly in time. For most modes there are episodic enhancements in the amplitudes and changes in their latitudinal structure. Annual and semi-annual variations in the amplitudes are also observed. The variability of these modes is likely the result of variability in the tropospheric forcing and non-linear interactions between tides and planetary waves.

SA41B CC: 519 A Thursday 0830h

New Frontiers in Equatorial Ionospheric Observations and Models I

Presiding: **O de La Beaujardiere,** Air Force Research Laboratory**; V Eccles,** Space Environment Corporation

SA41B-01 0830h INVITED

Simultaneous observations of equatorial plasma bubbles from ground-based imagers and ROCSAT-1

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Using a set of ionospheric imagers located on the Haleakala Volcano on Maui, Hawaii a large database of observations of equatorial plasma bubbles in the Pacific sector has been compiled since data collection began in January 2002. These images provide information on the spatial structure of the depleted regions in electron density associated with equatorial spread-F. Often times, the bubbles drift into the fields-of-view of the imagers fully developed, implying a growth region to the west of the observing location. At other times, the development of individual bubbles can be tracked over almost an hour's time allowing for estimation of the bubble's upward velocity at the equator. Combining an entire night's worth of observations, a composite image can be formed allowing for the estimation of the growth region for the fully formed bubbles observed later in the night. Using simultaneous observations made by the ROCSAT-1 satellite (in a 600 km circular orbit with a 35° inclination) we can confirm these growth region estimates. In addition, the ROCSAT-1 provides in-situ measurements of the ion drift that can be compared to the bubble velocity derived from the images when developing bubbles are seen. This study highlights the insight gained by combining in-situ satellite measurements with ground-based observations. More studies of this type will become possible as additional satellites, such as C/NOFS, are launched in the future.

SA41B-02 0845h INVITED

Far Ultraviolet Imaging of the low-Latitude Nightside Ionosphere with the GUVI Instrument on TIMED

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