SPA-Aeronomy

SA12A MCC: Level 2 Monday 1330h

Airglow and Laboratory Studies Posters

Presiding: **R W Eastes,** Florida Space Institute

SA12A-1072 1330h POSTER

Observation of the O-atom Rydberg Series Produced by Radiative Recombination in the Equatorial Ionospheric Nightglow

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Radiative recombination [$O^+ + e \rightarrow O^*$] generates two manifolds of lines in the ionosphere - a quintet series and a triplet series of Rydberg transitions. The final radiative steps correspond to the VUV lines, 135.6 and 130.4 nm, respectively. The precursors of these two lines are the 844.6 and 777.4 nm transitions, but there are many other lines throughout the near UV into the infrared. Most have not previously been reported in the nightglow, and there are few observations of the quintet sequence from the laboratory. Sky spectra from the 10-meter Keck telescopes on Mauna Kea are proving to be an important aeronomic tool for many emission studies, and here we are able to determine accurate wavelengths for numerous O-atom Rydberg lines, some not previously detected. In addition, standard star intensity calibration of spectra taken with the ESI echelle spectrograph on the Keck II telescope enable us to determine absolute intensities of the Rydberg sequences during solar maximum, in 2000. The quintet manifold produces the greatest number of lines; in the nd-3p sequence the data extend to n = 11. Comparison is made with the cross section calculations of Escalante and Victor [1992], which include cascading contributions. Excellent agreement is found for the quintet sequences, in terms of the fall-off of cross sections with increasing values of n. For the triplets, the experimental data approach the optically thick calculations of Escalante and Victor, as expected. V. Escalante and G. A. Victor, Planet. Space Sci. 40, 1705 (1992)

SA12A-1073 1330h POSTER

Vibrational Distributions in the $A^3\Sigma_u^+$ and $A'^3\Delta_u$ States of O_2 in the MLT Nightglow: Results from Astronomical Sky Spectra

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Astronomical sky spectra from the Keck I telescope on Mauna Kea have been used to obtain vibrational distributions in the $O_2 A^3\Sigma_u^+$ and $O_2 A'^3\Delta_u$ states from rotationally-resolved Herzberg I *A-X* and Chamberlain *A'-a* band emissions in the terrestrial nightglow. The $A^3\Sigma_u^+$ distribution is similar to that presented in earlier publications, with the exception that there is significant population in the previously undiscerned v = 0 level. For the $A'^3\Delta_u$ state, the vibrational distribution is essentially the same as that of the $A^3\Sigma_u^+$ state when comparison is made in terms of the level energies. The intensity ratio at the peak of the distribution favors the *A-X* emission by a factor of four, as previously shown, and is probably a measure of radiative efficiency. The peaks in both population distributions are about 0.25 eV below the $O(^3P) + O(^3P)$ dissociation limit, and reflect both the pathways by which the nascent O_2^* molecule is generated and stabilized, and the collisional loss rates.

SA12A-1074 1330h POSTER

Laboratory Study of $O_2(b^1\Sigma_g^+, v = 1)$ Collisional Removal at Thermospheric Temperatures

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In the Earth's thermosphere, energy transfer from $O(^1D)$ to O_2 generates oxygen molecules in the v = 0 and 1 levels of the $O_2(b^1\Sigma_g^+)$ state. The emissions in the $O_2(b^1\Sigma_g^+ - X^3\Sigma_g^-)$ system (Atmospheric Band) present a major component of the Earth's airglow. Interpretation of the measured intensities of O_2 Atmospheric Band emissions can yield altitude profiles of oxygen atom density and local temperature in the lower thermosphere. To achieve this goal accurate laboratory measurements of the collisional removal rate coefficients of $O_2(b, v = 1)$ and their temperature dependence are essential. Atmospheric observations suggest that the relevant colliders for the removal of $O_2(b, v = 1)$ in the lower thermosphere are O_2 and $O(^3P)$. We report measurements of the rate coefficients for the collisional removal of $O_2(b, v = 1)$ by O_2, N_2, and CO_2, at temperatures in the range 300–1000 K. A state-specific two-laser technique is used, in which the visible output of the first laser directly excites O_2 to $O_2(b, v = 1)$, and the ultraviolet output of the second laser probes the $O_2(b, v = 1)$ population by resonantly enhanced multiphoton ionization via the v = 4 level of the $d^1\Pi_g$ Rydberg state. The temporal evolution of the $O_2(b, v = 1)$ population is monitored by varying the time delay between the two laser pulses. The rate coefficient of the collisional removal of $O_2(b, v = 1)$ by O_2 increases monotonically with temperature from about 1.5×10^{-11} cm^{3}s^{-1} to about 6×10^{-11} cm^{3}s^{-1} in the range 300–1000 K. Experiments with colliders N_2 and CO_2 determine the upper limits for the removal rate coefficients of $O_2(b, v = 1)$ by N_2 and CO_2 to be 2 orders of magnitude smaller. This work extends previous studies of $O_2(b, v = 1)$ at room and low temperatures.[1,2] We are currently planning experiments to investigate the collisional removal of $O_2(b, v = 1)$ by O atoms.
This study was supported by the NSF's Grant ATM-0209229. The participation of K. Phillips in this project was funded by NSF's Research Experiences for Undergraduates (REU) Program (Grant PHY-0097861). We wish to thank Drs. Richard A. Copeland and Tom G. Slanger for many insightful comments and discussions.
1. H. I. Bloemink, R. A. Copeland, and T. G. Slanger, J. Chem. Phys. **109**, 4237 (1998).
2. E. S. Hwang, A. Bergman, R. A. Copeland, and T. G. Slanger, J. Chem. Phys. **110**, 18 (1999).

SA12A-1075 1330h POSTER

Laboratory Measurements of the $O_2(a^1\Delta_g, v = 0)$ and $O_2(b^1\Sigma_g^+, v = 0)$ Yields Following Collisional Removal of $O_2(A^3\Sigma_u^+, v = 6–10)$

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Three-body oxygen atom recombination presents a major source of the nightglows of Earth and Venus. In this process the O_2 molecule is formed in the seven electronic states that lie below the $O(^3P) + O(^3P)$ dissociation limit. Information on the yields of the lowest O_2 electronically excited states, $a^1\Delta_g$ and $b^1\Sigma_g^+$, from O-atom recombination can be used to extract O-atom densities in the emitting atmospheric region from the atmospheric emission intensities in the $O_2(a^1\Delta_g–X^3\Sigma_g^-)$ and $O_2(b^1\Sigma_g^+–X^3\Sigma_g^-)$ bands. Previous SRI experiments showed rapid collisional transfer between the excited states in the energy region close to the dissociation limit [1]. Based on this, we argue that direct optical excitation to these states ($c^1\Sigma_u^-$, $A'^3\Delta_u$, $A^3\Sigma_u^+$) and the resulting energy flow is a reasonable proxy for the three-body O-atom recombination. This work presents studies of vibration level- and collider-dependent yields into the v = 0 levels of the $a^1\Delta_g$ and $b^1\Sigma_g^+$ states, following collisional deactivation of the v = 6-10 levels of the $A^3\Sigma_u^+$ state. Experiments are done at 240 K, a temperature slightly higher than temperatures relevant for the Earth's mesopause (altitude 80-100 km). Colliders pertinent to the atmospheres of Earth and Venus, O_2, N_2, and CO_2, are used. We employ a state-selective two-laser method, in which pulsed output of the first laser excites O_2 to $O_2(A, v = 6–10)$. A time-delayed second laser pulse detects $O_2(a, v = 0)$ and $O_2(b, v = 0)$ by resonance-enhanced multiphoton ionization via the $d^1\Pi_g$ Rydberg state. Temporal evolution of the $O_2(a, v = 0)$ and $O_2(b, v = 0)$ populations is determined by varying the time delay between the two laser pulses. We find that the $O_2(a, v = 0)$ yields from $O_2(A, v = 7–9)$ are nearly equal, while the yields from $O_2(A, v = 6$ and $10)$ are lower by 30-40%. The $O_2(b, v = 0)$ yields are nearly equal for $O_2(A, v = 8–10)$, and lower by 40-50% for $O_2(A, v = 6$ and $7)$. Temporal evolution of the $O_2(a, v = 0)$ signal following excitation to $O_2(A, v = 8)$ shows that production of $O_2(a, v = 0)$ occurs through a rapid several-step collision-driven process. Experiments with air show $O_2(a, v = 0)$ yield about 60% lower than the yield from pure O_2. Production of $O_2(a, v = 0)$ in air is about 3.5 times slower than in pure O_2. The $O_2(b, v = 0)$ yield from air is about the same as the yield from pure O_2. The results indicate that N_2 collider is not more efficient than O_2 in promptly producing $O_2(a, v = 0)$ and $O_2(b, v = 0)$. Preliminary experiments with CO_2 show that CO_2 collider is likely less efficient than O_2 in producing $O_2(a, v = 0)$. We will outline our current efforts to use comparison with products from a O_3/O_2 mixture to determine the *absolute* $O_2(a, v = 0)$ and $O_2(b, v = 0)$ yields as well as relative yields of these two states. Preliminary results show that about 2.5 times as much $O_2(a, v = 0)$ as $O_2(b, v = 0)$ is promptly formed upon $O_2(A)$ excitation. This work is funded by the NASA Ionosphere, Thermosphere, and Mesosphere Supporting Research & Technology Program and the NASA Planetary Atmospheres Program. [1] T.G. Slanger and R. A. Copeland, "Energetic Oxygen in the Upper Atmosphere and the Laboratory", Chem. Rev., in press.

SA12A-1076 1330h POSTER

Temperature Dependent Collisional Energy Transfer of N_2 ($a^1\Pi_g$ and $a'^1\Sigma_u$, $v = 0$ and 1)

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Lyman-Birge-Hopfield (LBH) emission of molecular nitrogen ($a^1\Pi_g - X^1\Sigma_g^+$) has been a rich source of information on the atmospheres of nitrogen-abundant planets and moons. Accurate modeling of the altitude-dependent LBH emission in airglow and aurora of the Earth would be an important step for remote sensing of the atmospheres of other planets and satellites in our solar system, such as Titan and Triton [1]. Recent models [2] incorporate collisionally induced electronic transitions (CIET) among the three nested singlet electronic states $a^1\Pi_g$, $a'^1\Sigma_u$, and $w^1\Delta_u$. However, several rate constants have to be estimated due to the lack of laboratory experimental data on the energy transfer processes and their temperature dependence. We have

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carried out two-color, pump-probe, resonance-enhanced multiphoton ionization (REMPI) experiments to determine collisional removal rate constants of $N_2(a^1\Pi_g$, v=0, 1) and $N_2(a'^1\Sigma_u$, v=0, 1) with N_2, O_2, and O colliders at 150, 240, and 300 K. In our experiments, ground state N_2 molecules are excited to the v=1 level of the $a^1\Pi_g$ state via a two-photon transition by the first laser pulse. A second laser probes either $N_2(a^1\Pi_g$, v=1) or the products of collisionally induced energy transfer, $N_2(a^1\Pi_g$, v=0) or $N_2(a'^1\Sigma_u$, v=0 and 1). The temporal evolution of the vibrational population is obtained by varying the time delay between the two pulses. Experimental results show that in the case of removal by N_2 the rate constants for $N_2(a^1\Pi_g$, v=0) and $N_2(a^1\Pi_g$, v=1) are similar and in good agreement with the literature values at 300 K. The rate constants for both states are comparable at 240 and 300 K and increase by 50 to 100% at 150 K, i.e. slightly faster rate coefficients should be used in atmospheric models. In the case of O_2 and O colliders the rate constants for $N_2(a^1\Pi_g$, v=1) removal are faster than that for N_2 by about 15 times and more than 50 times, respectively. For the first time, the temporal evolution of $N_2(a'^1\Sigma_u$, v=0) and $N_2(a'^1\Sigma_u$, v=1) is observed directly. The results for collisional removal of $N_2(a'^1\Sigma_u$, v=0) are in agreement with previous indirect measurements in the literature. For $N_2(a'^1\Sigma_u$, v=1) at 300 K, the direct temporal evolution measurements show a total removal rate constant similar in magnitude to those for $N_2(a^1\Pi_g$, v=0 and 1). We acknowledge the support of the National Science Foundation Aeronomy Program via grant ATM 9910914. [1] D.F. Strobel, R.R. Meier, M.E. Summers, and D.J. Strickland, *Geophys. Res. Lett.* **18** (1991) 689. [2] R.W. Eastes, *J. Geophys. Res.* **105** (2000) 18557.

SA12A-1077 1330h POSTER

High-Temperature Ultrahigh-Resolution Absorption Cross Section Measurements of O2 in the 91.1-91.8 nm Region

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The NII 108.5 nm, NII 91.7 nm, and the OII 83.4 nm are the prominent emission in the EUV airglow. The atmospheric extinction due to absorption by molecular N2 and O2 strongly affects the observed airglow emission fluxes. Since the temperature of the upper atmosphere of the Earth can be as high as 900 K it is important to know all relevant molecular cross sections at such temperatures. Therefore, the high-temperature ultrahigh-resolution photoabsorption cross section measurements of N2 and O2 in the extreme ultraviolet (EUV) region are important to their atmospheric modeling implications. A temperature change on a gaseous sample clearly will affect the Doppler broadened linewidth and the rotational and vibrational population distributions of the ground electronic state from which absorption takes places. The consequences of such a change are the enhancement or elimination of hot bands, the broadening or sharpening of rovibronic line shapes, the decreasing or increasing in cross section values of an absorption feature. In this poster we report ultrahigh resolution absorption cross section measurements of O2 with a resolution of 0.0008 nm in the 91.1-91.8 nm region at temperatures of 535 K and 295 K. The 6.65-m vertical off-plane Eagle spectrometer available at the Photon Factory, KEK, Tsukuba, Japan, was employed in the present study. The detailed temperature-dependent results of this work will be presented. This work is supported by NSF grant ATM-0096761.

SA12A-1078 1330h POSTER

Absolute Intensities of OH Meinel Band Emissions in Nightglow

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The visible nightglow emission spectrum in the wavelength range of 500 - 1060 nm observed with the ESI spectrograph on the Keck II telescope on Mauna Kea has been calibrated in absolute intensity units (Rayleighs/Å) using observations made of two photometric standard stars on the same nights. Nightglow intensities derived from the two independent standards agree to within 5%. In addition, the standard star observations delineate atmospheric water vapor absorptions that affect the intensity measurement of some nightglow emission lines. A total of 70 intensity-calibrated spectra, each covering the full spectral range at a resolution of 7000, are presently available for the periods of March 1, 2000 through March 5, 2000 and October 22, 2000 through October 25, 2000 with a total observing time of 53.3 hours. Seventeen Meinel emission bands appear in each spectrum with sufficient intensity for quantitative measurement, covering upper state vibrational levels v = 3 - 9. A total of 10 - 29 resolved lines at low rotational quantum numbers in the P_1, P_2, Q_1, Q_2, R_1, and R_2 branches are measured in each of the bands. The availability of extended lower state sequences (with constant upper state populations) and multiple branches allows the Meinel band transition moments to be critically evaluated from these data. This work is supported by NSF grant ATM-0139344.

SA12A-1079 1330h POSTER

Auroral emissions induced by ion precipitation during the 2000 Bastille Day storm

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The great geomagnetic storm of 15-16 July, 2000, presented a rare opportunity to study the Sun-Earth system under extreme conditions. Some of the most vivid manifestations of a geomagnetic storm are the polar aurorae that are particularly prominent at ultraviolet wavelengths. We present measurements of middle ultraviolet aurorae taken by the Ionospheric Spectroscopy and Atmospheric Chemistry (ISAAC) experiment on 16 July during the recovery phase of this Bastille Day storm. ISAAC was launched on the Advanced Research and Global Observation Satellite (ARGOS) in a 850 km circular, 0230/1430 LT Sun-synchronous orbit and obtained spectra of Earth's limb that include emissions from O^+, N^+, N_2 and NO. Measurements taken over the nighttime southern pole early in the recovery phase of the storm show strong auroral emissions in the O II 247.0 nm line that are consistent with proton precipitation and charge exchange with thermospheric atomic oxygen. These precipitating protons are also most likely the same ion population mirroring at low altitudes that are responsible for energetic neutral atoms (ENAs) observed from high altitude orbit. We corroborate these ISAAC measurements with simultaneous far ultraviolet spectra of Earth's limb obtained by the Low Resolution Airglow and Aurora Spectrograph (LORAAS) that was also flown on ARGOS.

SA12A-1080 1330h POSTER

O^+ ^4P-$^4D^0$ Lines in Aurora over Svalbard

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Spectrographic Imaging Facility (SIF) at the auroral station near Longyearbyen, in Svalbard, Norway, measures auroral spectra in three wavelength intervals (H_β, N_2^+ 1N(0,2) and N_2^+ 1N(1,3)), and images the aurora in the field aligned direction. Oxygen ion ^4P-$^4D^0$ multiplet (4639-4696 Å) is blended with the N_2^+ 1N(1,3) band. SIF observations of the intensity of this multiplet, and its relation to the other emissions are presented. The spectral data are used together with the images, and the incoherent scatter radar, to study the multiplet in context of different types of aurora. Typically, the intensity of the multiplet is about 0.1 of the N_2^+ 1N(0,2) band. This ratio is enhanced when the ionisation in the upper E-layer (140-190 km) is significant with respect to the E-layer peak below 130 km. Rayed arcs were observed on one such occasion, whereas on other occasions the intensity was below the threshold of the imager. The occurrence of the multiplet lines in proton aurora is discussed as well.

SA12A-1081 1330h POSTER

OI 630 Airglow Observations in the Polar Ionosphere

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Instruments operating in the polar caps through the past solar cycle have provided much new information on the structure and dynamics of the polar ionosphere. Digital ionosondes at several stations have yielded electron density profiles and f_oF_2 variations. Photometers monitoring [O] night airglow emissions over Eureka, Nanavut (80^0 N), have given a complementary view of the ionosphere. The 630 nm emission intensity is seen to be directly related to the f_oF_2 obtained from a CADI ionosonde operated at Eureka. We will report on the variations of these parameters through the past solar cycle, drawing on observations through each winter since 1991 from this site near the North Magnetic Pole. [O] emission intensities even under quiet conditions are seen to vary over a factor of ten or more through the solar cycle. During much of the time the airglow is enhanced by either polar auroras or F-layer patches (depending on the sign of the IMF B_z).

SA12A-1082 1330h POSTER

The O(^{1}D) emission rates observed by WINDII and simulated by the GLOW model

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WINDII data provide the first comprehensive observations of the O(^{1}D) emission rate (the red line) at altitudes of 100-280 km in both latitude and local time domains. Data from three December solstice seasons (1991/92, 1992/93, and 1994/95) show that the O(^{1}D) airglow emission rate strongly depends on the solar radiation as a function of the solar zenith angle, which is related to the local time and latitudinal variations, and a function of the F10.7cm solar flux, which is related to the solar cycle. Dynamic effect, including tides and planetary waves, on the airglow emission rate is also observed. WINDII O(^{1}D) data are compared to simulations by the airglow model, GLOW, showing satisfactory agreement. The simulations can be improved by using measured plasma data instead of the IRI model data.

SA12A-1083 1330h POSTER

Lyman-Birge-Hopfield Band Observations from ARGOS: Vibrational Populations and Their Altitude Dependence

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The N_2 Lyman-Birge-Hopfield (LBH) bands (a-X transition) extend throughout the Earth's far-ultraviolet spectrum in the dayglow and aurora. LBH band emissions are important for remote sensing of the Earth's thermosphere, used in both limb-scanning techniques that retrieve N_2 and O_2 densities and in nadir-viewing techniques for retrieving the O/N_2 column density ratios. There is significant uncertainty in modeling the LBH emissions, yet reliable interpretation of remote sensing data depends on the ability to accurately model the emissions. Over the years a wide variety of a-state vibrational population distributions have been inferred from different remote sensing experiments. We present the vibrational population distributions from ultraviolet spectra collected by the High resolution Ionospheric and Thermospheric Spectrograph (HITS) aboard the Advanced Research and Global Observation Satellite (ARGOS). These high spectral resolution (.2 nm) limb-scan data exhibit brighter emissions from the lower vibrational levels than would be expected from traditional models. The altitude- and latitude-resolved vibrational populations provide clues to the N_2 singlet excitation and cascade mechanisms that are key to correct interpretation of LBH observations.

SA12A-1084 1330h POSTER

Photodissociation and Photodissociative Ionization Excitation Emissions from Molecular Nitrogen in the Thermosphere: Results from Analysis of FUSE Dayglow Measurements

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Photodissociation and photodissociative ionization (PDI) excitations of molecular nitrogen result in a number of relatively bright far ultraviolet emission features in the dayglow in addition to the more commonly analysed emissions generated by photoelectron impact (e.g., the N_2 LBH band system). Provided spectral resolutions are high enough, several N_2 PDI features (e.g., N^+ 1085 Å) are of considerable interest as remote sensing alternatives to N_2 LBH. Recent work with Astro-1/Hopkins Ultraviolet Telescope (HUT) data [Bishop and Feldman, *JGR*, *108*(A6), 1243, doi:10.1029/2001JA000330, 2003] made this point but also showed that the emission ratios of the N_2 PDI N^*,N^+ lines in the dayglow are not consistent with the ratios of Samson et al [*J Chem Phys*, *95*, 717-719, 1991] obtained with a synchrotron light source. The Far Ultraviolet Spectroscopic Explorer (FUSE) dayglow measurements reported in Feldman et al [*JGR*, *106*, 8119-8129, 2001] are of sufficient spectral resolution to provide reference intensities and emission ratios. First-principles model analysis results for the FUSE LWRS ("low resolution", 0.38 Å) dayglow data from September 1999 for N_2 PDI N^*,N^+ and other N_2 features are presented and compared with the Astro-1/HUT analysis results.

SA12A-1085 1330h POSTER

Preliminary Validation of Atmospheric Neutral Density Derived From Ultraviolet Airglow Observations

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In the past, orbit determination and prediction for resident space objects relied on climatological models to estimate atmospheric drag. Characteristic of climatology, atmospheric density models have errors that range from 10% to 15%. For Low Earth Orbiting (LEO) satellites, the error due to an imprecise density specification is the most significant contribution to the error ellipse associated with the position of the object. Several techniques to obtain corrections for the atmospheric density models and improve orbit determination are in various stages of research and development. This paper presents ultraviolet airglow derived atmospheric density corrections for the NRLMSISE-00 model during January and February 2001. Observations of the naturally occurring airglow on the Earth's limb were obtained from the Low-Resolution Airglow and Auroral Spectrograph (LORAAS) on the Advanced Research and Global Observation Satellite (ARGOS). Inversion algorithms developed at the Naval Research Laboratory were used to retrieve neutral density profiles from the observations. The result of the inversion process produces four correction coefficients for the NRLMSISE-00 atmospheric model; one for the F10.7 cm solar flux model input parameter, and three scalars for the O, O2 and N2 model output. The proper application of these correction coefficients with NRLMSISE-00 allows for the calculation of a global total density specification. Ultraviolet airglow derived density for January and February of 2001 were first compared to climatology using the Jacchia J70 and NRLMSISE-00 models. Additionally the ultraviolet derived density was compared to global density specification from the High Accuracy Satellite Drag Model (HASDM) developed for the Air Force Battlelab. HASDM determines global atmospheric density by simultaneously evaluating the drag on a reference set of resident space objects. From the Space Surveillance Network (SSN) observations of the HASDM reference objects, in-track total density was computed using Special-K software for direct comparison to ultraviolet derived atmospheric density. The results of the preliminary validation of the ultraviolet airglow derived density specification are provided in this paper through comparisons to the techniques mentioned above.

SA12A-1086 1330h POSTER

Precision Measurement of the O II 732,733 nm Wavelengths from High Resolution Sky Spectra

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We present new measurements from high resolution sky spectra taken with the Keck I HIRES spectrograph of the wavelength splittings and intensity ratios between the components of the O^+ $2p^3$ $^2P_{1/2,3/2}$ - $^2D_{5/2}$ 732 nm and $^2P_{1/2,3/2}$ - $^2D_{3/2}$ 733 nm ionospheric emission line doublets. Specifically, the wavelength splittings of the 732 and 733 nm doublets are redetermined to be 0.1077 $\pm$ 0.0003 and 0.1080 $\pm$ 0.0003 nm, respectively. This determination represents a slight improvement in precision over previous astrophysical values. However, a number of atmospheric scientists have incorrectly used a much older value of about 0.08 nm in previous Fabry-Perot observational campaigns.

SA12B MCC: Level 2 Monday 1330h

New Measurement and Analysis Techniques Posters

Presiding: **Q Wu,** National Center for Atmospheric Research

SA12B-1087 1330h POSTER

Thermospheric Composition from Scale Height Analysis

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Efforts to validate spectroscopic methods of monitoring the thermosphere and ionosphere have led to renewed interest in thermospheric composition and models. In the past, different methods of measuring composition have produced conflicting results. In the present work, we use scale heights to constrain the composition measurements through the mean molecular mass and temperature. Scale height analysis has the advantage that it compresses the measurements, thus facilitating comparison and evaluation. To determine a physically reasonable composition profile, we start with a consideration of eddy diffusion near the intersection of the thermosphere with the mesosphere, and use scale height analysis at the higher altitudes. Neutral density measurements using improved drag coefficients constrain the sum of the constituents. The resulting composition at altitudes between 90 and 350 km at a time of average solar and geomagnetic activity will be compared with several data sets, and with some old and new thermospheric models.

SA12B-1088 1330h POSTER

An Evaluation of the Charge Exchange Equilibrium Technique to Derive [H]/[O]

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Quantification of neutral species densities in the upper thermosphere and lower exosphere using ground-based remote sensing remains a difficult problem. One method to derive [H]/[O] utilizes the O on H^+ charge exchange equilibrium equation (CEE) with incoherent scatter radar (ISR) observations of [H^+] and [O^+]. The CEE technique has been historically hamstrung by the requirement of very high precision measurements of minor constituents in the region where the equilibrium condition holds, and is not violated by H escape, near and just above the F-region peak. By taking advantage of the precise values of [H^+], [O^+], and T_i now available by consequence of the multiple ion spectral fitting at Arecibo, an investigation into the usefulness of the CEE condition for neutral density determination is now possible. More than 50 days of Arecibo topside ISR measurements are used to derive [H]/[O] at and above the F-region peak, and a statistical comparison with MSIS derived estimates is performed to evaluate the CEE technique. Local time, seasonal, and solar cycle trends are examined. Finally, the differences between the two estimates of [H]/[O] are also characterized.

SA12B-1089 1330h POSTER

Estimating the Neutral Atmospheric Forcing Using Data Assimilation

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Based on data assimilation techniques developed in meteorology and oceanography, a data assimilation system has been developed to provide a time-dependent estimate of the thermospheric density, temperature, and composition. Through its application, distinct characteristics of the neutral atmosphere have become apparent. It has been long realized that, unlike the troposphere, the neutral atmosphere is more strongly driven by external forcing, which includes Joule, particle, and solar heating. It has also been understood that knowing the forcing alone, over a period of days, can allow for a fairly accurate modeling of the neutral atmospheric conditions: density, temperature, and composition. Unfortunately, the magnitude and the distribution of the forcing are difficult to observe since scalar values are typically used to describe complicated processes. The research presented here attempts to better estimate the forcing and its effect on the neutral atmosphere from observing the neutral atmospheric conditions and the changes in these conditions spatially and temporally. Since the magnitude and distribution of the forcing cannot be observed directly, a statistical approach is used to provide the best' description for this process through data assimilation.