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In the last years several groups showed the importance of halogen chemistry (esp. Br and I) in the marine boundary layer (MBL). These halogens can impact the background chemistry in the MBL, esp. Ozone and DMS. Reactive halogens originate either from sea salt aerosol (Cl, Br) or are directly emitted as organic substances from the oceans (I) which rapidly photolyze. Based on our box and one-dimensional models we developed a parameterization for the involved gas phase - aerosol interactions and included it into the global three-dimensional chemical transport model MATCH-MPIC. With this model it is possible for the first time to evaluate the importance of reactive halogen chemistry in the troposphere on a global scale.

Apart from the implications of halogen chemistry on ozone, we will show the impact of BrO on the oxidation of DMS which has important implications for the yield of SO_2. We will also show in which regions the biggest effects of halogen chemistry is likely to be expected.

Recent observations with the satellite instrument GOME revealed the presence of large amounts (0.5 - 2 pmol/mol) of BrO in the troposphere. We will use the model to help indicate at which altitudes in the troposphere this BrO is located and what the sources for it are.

A51E-11 1140h

Uptake of organic acids by water droplets

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Size-resolved measurements of organic acid concentrations (HCOOH, CH3COOH) in cloud and fog droplets are analyzed. Considering their effective Henry's Law Constants it is evident that their equilibrium concentrations are dependent on the pH. At high pH values (pH > pKa) the concentration ratio in large/small droplets is dependent only on the pH values in the droplets. It is shown that at high pH values (pH = 7) these ratios for acetic acid and formic acid can be predicted fairly well in fog droplets, implying the existence of thermodynamic equilibrium. Deviations from this equilibrium can be caused by mass transfer kinetics and/ or by chemical reactions within the droplets. Based on a resistance model describing the uptake process it is quantified which step delays the achievement of thermodynamic equilibrium: For large droplets r > 5 mm) gas phase diffusion towards the droplet surface is time-limiting, whereas for smaller droplets interfacial mass transport, characterized by the mass accommodation coefficient a, is the time-controlling step. In general, the characteristic times for the transport, i.e. gas phase diffusion and mass accommodation, are much longer than the chemical decay of acids in the aqueous phase. The fast oxidation of the acids by radicals within the aqueous phase causes smaller concentrations than those predicted by thermodynamic equilibrium. At high pH values the formation processes of organic acids within the aqueous phase do not influence the equilibrium due to the low solubility of the precursors (aldehydes) compared to the high effective Henry's Law constants of the acids.

A52A MCC: Hall D Friday 1330h

Remote Sensing Posters *(joint with OS)*

Presiding: **R M Hoff,** University of Maryland, Baltimore County**; W W McMillan,** University of Maryland, Baltimore County

A52A-0083 1330h POSTER

ABOVE, The AIRS BBAERI Ocean Validation Experiment: Overview and Initial Results

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To provide correlative measurements characterizing the atmosphere and sea surface over the ocean for validation of NASA's Atmospheric InfraRed Sounder (AIRS) onboard the Aqua satellite, a complementary set of instruments was deployed to the United States Coast Guard (USCG) Chesapeake Light lighthouse platform. Located 25 km due east of Virginia Beach, VA, Chesapeake Light offers a relatively convenient site for measurements over the ocean while being far enough offshore for water only AIRS fields of view. Instruments deployed for AIRS forward model and radiance validation during August, September, and October, 2002, include the UMBC Baltimore Bomem Atmospheric Emitted Radiance Interferometer (BBAERI), the UMBC Elastic Lidar Facility (ELF), and Vaisala RS-90 rawinsondes. BBAERI provides profiling of the boundary layer and SST determination at 10 minute intervals 24-hours a day, as well as CO and O_3 tropospheric abundances. ELF provides profiles of aerosols and clouds up to 15 km at one minute resolution for 1-2 hours before and after each Aqua overpasse. Approximately 100 Rawinsondes were flown during the ABOVE deployment providing full atmospheric profiles of temperature and moisture up to at least 100 mb for virtually every Aqua overpass. Preliminary comparisons of ABOVE data products to AIRS observations and retrievals will be presented.

URL: http://physics.umbc.edu/~mcmillan/

A52A-0084 1330h POSTER

NASA GES DISC DAAC Data Holdings for AIRS/Aqua

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The Atmospheric Infrared Sounder (AIRS) is a high-resolution infrared sounder on the Earth Observing System polar-orbiting platform, EOS Aqua, which was successfully launched on May 4, 2002. AIRS is closely coupled with two microwave instruments, the Advanced Microwave Sounding Unit (AMSU-A) and the Humidity Sounder for Brazil (HSB). The data products from AIRS/AMSU-A/HSB are archived and distributed at the Distributed Active Archive Center (DAAC) located at the NASA Goddard Earth Sciences Data and Information Services Center (GES DISC).

AIRS has 2,378 channels measuring in the infrared range 3.74-15.4 μm and four channels measuring in the visible/near-infrared range 0.4-1.1 μm. AMSU-A is a temperature sounder that primarily provides atmospheric information in the presence of clouds, which is used to correct the AIRS infrared measurements for the effects of the clouds. Likewise, HSB provides information on snow/ice cover, precipitation, and the coarse distribution of moisture in the troposphere. Combined with simultaneous measurements from AIRS, the calibrated brightness temperature from AMSU-A and HSB is used to initialize the atmospheric moisture profile required for the retrieval of the final AIRS geophysical products.

The data product suite includes level 1B combined, geolocated and calibrated radiances and will include level 2 final retrievals of surface skin temperature, surface albedo, integrated precipitable water, radiative fluxes, various cloud properties and trace gases (ozone, methane, carbon dioxide, and carbon monoxide). Furthermore, AIRS/AMSU-A/HSB will obtain atmospheric temperature profiles with an accuracy of 1K for every 1 km layer in the troposphere (1K for every 4 km layer in stratosphere) and humidity profiles with an accuracy 20% in 2 km layers from the surface up through the troposphere. Global coverage is obtained twice daily (day and night) on a 1:30 p.m. sun-synchronous orbit from a 705-km altitude. For processing convenience, the data along the orbit is divided into 6-minute scenes. Each orbit has approximately 16 scenes.

The Atmospheric Dynamics Data Support Team (ADDST) at the GES DISC DAAC will be providing various user services including assistance with product ordering and distribution, channel/variable subsetting, data visualization, access to various technical documents, data mining, and educational resources. The data will be available via GES DISC DAAC Search and Order (http://daac.gsfc.nasa.gov/data/), the EOS Data Gateway (EDG) (http://eos.nasa.gov/imswelcome/), and an FTP site containing subsetted and reformatted data products. For more information, please visit AIRS Data Support web site at http://daac.gsfc.nasa.gov/atmodyn/airs/.

URL: http://daac.gsfc.nasa.gov/atmodyn/airs/

A52A-0085 1330h POSTER

High-Spectral Resolution Atmospheric Spectroscopy using EOS-AQUA AIRS

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The Atmospheric Infrared Sounder (AIRS), the first high-spectral resolution sounder satisfying operational requirements for numerical weather prediction, was launched in May of 2002. AIRS has 2378 spectral channels between 650 and 2700 cm^{-1} with a resolving power of $\sim$ 1300 and low noise. Comparisons between observed clear air AIRS spectra and spectra computed using the European Center for Medium Range Forecasting (ECMWF) analysis/forecast fields show remarkably good agreement for AIRS channels dominated by carbon dioxide emission. Similar comparisons for channels dominated by water vapor indicate systematic errors in the ECMWF water fields. Comparisons of AIRS observations to radiances computed from co-located lidar and radiosonde observations will be presented to clarify the source of the differences between ECMWF and AIRS observations. This work will demonstrate the importance of CO_2 line-mixing in computing AIRS radiances. In addition, the application of a new water continuum derived from laboratory measurements to AIRS radiative transfer calculations will be presented. A fast radiative transfer code to compute AIRS radiances is available from the authors.

AIRS daytime observations in the strong ν_3 band of CO_2 exhibit non-local thermodynamic emission, which we will compare to model calculations. These results are unique in that the observations are for nadir viewing, allowing global maps of non-LTE emission once per day.

AIRS also has several channels in the 1-0 band of carbon monoxide that allow measurements of the CO column content. Early results of AIRS global CO measurements will be presented.

A52A-0086 1330h POSTER

An Experiment for Improving SAGE III Mesospheric Ozone Retrieval

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This report presents an experiment that is intended to improve the mesospheric ozone retrieval for the third Stratospheric Aerosol and Gas Experiment (SAGE III). Using the charge coupled device (CCD), the SAGE III instrument is equipped with six subchannels in the

Hartley region between 287.54-nm and 293.16-nm wavelengths for measuring the mesospheric ozone. Through an onboard reprogramable computer software, the averaged signal from the six subchannel as a function of tangent height collected during spacecraft sunrises and sunsets is transmitted to ground receivers. The inferred atmospheric transmission at 290nm provides the essential information for determining the mesospheric ozone vertical distribution. Because the molecular/Rayleigh scattering contributes to the attenuation at 290nm in addition to ozone absorption, it is necessary to remove the molecular contribution for retrieval of mesospheric ozone concentration. The current operational retrieval removes the molecular contribution by using the SAGE III measurement at the 385-nm wavelength, which is basically a Rayleigh channel for altitudes above 45 km. However, because of the dynamic range of the 385-nm channel, its signal becomes noisy above 70 to 75 km. In the case of 290-nm channel, sufficient signal can be obtained even at 85- to 90-km level. In the present study, we demonstrate that the SAGE III mesospheric ozone retrieval can be improved by using the differential absoption technique (DAT). A simulation study is carried out by applying the DAT method to two of the six model simulated transmissions for the subchannels. Because the wavelength dependence of the Rayleigh contribution between 287.54 nm and 293.16 nm is minute and negligible, the mesospheric ozone concentration can be obtained up to 85- to 90-km altitude by using the DAT method. A comparison between the DAT results and the current operational retrieval is also included in the study.

A52A-0087 1330h POSTER

SAGE III Limb Scattering Measurements and Initial Inversion Results

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The Stratospheric Aerosol and Gas Experiment (SAGE III) instrument has started to make radiation measurements of the Earth limb. The initial data shows evidence of significant stray light, which is probably due to the scan mirror angular response function. A methodology to characterize this function and deconvolve its effect from the data will be discussed and presented in the first part of the paper. The inversion algorithm to retrieve Ozone profiles will then be described. It is based on the differential method developed for SOLSE/LORE and relies on a fast forward radiation model coupled with a SAGE 3 instrument model. Initial results will be presented for series of solar zenith angles and tangent point latitudes.

A52A-0088 1330h POSTER

Preliminary Assessment of SAGE II Version 6.2 Water Vapor Data Set

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Previously archived SAGE II data sets (version 6.1) which cover 17 years (1984-2002) of continuous records show a negative bias for the water vapor mixing ratios in the middle and lower stratosphere. Extensive studies have been conducted to investigate the cause of such biases and to further improve the corresponding data products. Indications of changes in the spectral location and the spectral width of the 0.94 micron wavelength channel have led to the upcoming revised version (version 6.2) of SAGE II water vapor data set.

The purpose of this paper is to present a preliminary assessment of the improved version 6.2 SAGE II water vapor measurements. Comparisons with balloonborne in situ observations as well as with the corresponding measurements from other satellite experiments (HALOE, POAM-3) will be shown to demonstrate the improvement achieved in SAGE II retrieved water vapor profiles.

A52A-0089 1330h POSTER

A Comparison of the Solar Cycle Signature in Vertical Ozone and Temperature Profiles Seen by SAGE II With Coupled Chemistry-Climate Model Results

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Solar variability is known to affect the Earth's climate. However, the exact mechanisms whereby small changes in extra-terrestrial solar irradiance over the 11 year solar cycle affect the climate are poorly understood. One of the primary objectives of the SOLar Impacts on Climate and the Environment (SOLICE) project is to assess the impact of solar variability on stratospheric ozone, radiative forcing and surface UV using coupled chemistry-climate models. Comparisons of model results and observations are expected to advance understanding of the mechanisms of solar-climate links.

Global vertical ozone profiles (version 6.1) from the Stratospheric Aerosol and Gas Experiment II (SAGE II), together with co-located NCEP/NCAR temperature profiles, have been examined for the solar cycle signature from October 1984 to June 2001 as a function of altitude/pressure and latitude. In addition to solar cycle forcing, ozone concentrations and temperatures may also be influenced by the Quasi-Biennial Oscillation (QBO), volcanic eruptions, the El Niño-Southern Oscillation (ENSO), tropopause height variations, and the solar zenith angle (time of day) at the measurement location [*Bodeker et al.,* JGR, vol. 103, 28661-28681, 1998]. These confounding effects must be eliminated before the solar cycle signal can be quantitatively identified. Two different approaches have been used:
1) Outside of volcanically perturbed periods, the QBO is expected to be the largest source of variability. Ozone and temperature profiles are sorted according to the phase of the QBO before profile differences between solar maximum and minimum are calculated.
2) A regression model, incorporating all forcings as basis functions, is applied to the ozone and temperature profiles and the amplitude of the solar cycle basis function is extracted.
These results are compared with output from the UMETRAC (Unified Model with Eulerian TRansport And Chemistry) coupled chemistry-climate model.

A52A-0090 1330h POSTER

Validation of OSIRIS Ozone Inversions

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The OSIRIS instrument onboard the Odin satellite, that was launched on February 20, 2001, is a combined optical spectrograph and infrared imager that obtains profil sets of atmospheric spectra from 280 to 800 nm when Odin scans the terrestrial limb. It has been possible to make a preliminary analysis of the ozone profiles using the Chappuis absorption feature. Three algorithms have been developed for ozone profile inversions from these limb spectra sets. We have dubbed these the Gattinger, Von Savigny-Flittner and DOAS methods. These are being evaluated against POAM and other satellite data. Based on performance, one of these will be selected for the operational algorithm. The infrared imager data have been used by Degenstein with the tomographic inversion procedure to derive ozone concentrations above 60 km. This paper will present some of these initial observations and indicate the best algorithm potential of OSIRIS to make spectacular advances in the study of terrestrial ozone.

A52A-0091 1330h POSTER

Detection and Tracking of High Altitude Cirrus Clouds With the InfraRed Imaging System of OSIRIS on Odin

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The OSIRIS (Optical Spectrograph and InfraRed Imaging System) instrument on the Odin satellite provides a unique data set for the study of near infrared enhanced scattering regions that have been observed near the tropical tropopause. The three infrared channels of the InfraRed Imaging System (IRIS), centered at 1.26, 1.27, and 1.53 microns, provide measurements of brightness, along uniformly spaced lines of sight, of the vertical limb profile of the atmosphere that allow for automated detection and determination of the horizontal and vertical structure of these regions of enhanced scattering. It is believed that these regions are high altitude tropical cirrus clouds that have potentially large climatic warming and cooling effects depending on their extent, duration, thickness, and location. Recent observations with MODIS on TERRA suggest that the extent of these clouds is greater than previously expected, both temporally and spatially. This paper discusses the use of the InfraRed Imaging System data to detect high altitude tropical cirrus clouds and examine their geographic characteristics.

A52A-0092 1330h POSTER

Validation of OSIRIS on Odin: Ozone Profiles and Total Column Since November 2001

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OSIRIS Optical Spectrograph and Infrared Imaging System is a Canadian instrument on a Swedish-led Odin satellite, which is in a sun-synchronous near-terminator orbit. In aeronomy mode the Optical Spectrograph (OS) scans the Earth limb from 6 km to 60 km or from 6 km to 100 km and measures near-90o-scattered limb radiation over the wavelength range of 280 nm 810 nm. A computer code developed at York University (Canada) is used to produce vertical profiles of the stratospheric ozone (10 km 50 km) from OS scan measurements on a regular basis as a level 2 data product. This paper is focused on the OSIRIS validation and presents a comparison of OS ozone profiles with ozone profiles obtained with the second instrument on Odin satellite mm/submm radiometer (SMR) as well as with several profiles measured by ozone-sondes. We also compare OS ozone profiles with those from POAM III and SAGE II, and compare the total ozone column maps generated by OS and TOMS. Ozone profiles from the Optical Spectrograph are in a good agreement (within 90% between 15 km and 35 km) with POAM III and SAGE II profiles when they belong to the same ozone field, i.e. measured over a homogeneous area without a large gradient in a total ozone column. Profiles measured near areas with a significant horizontal

structure in the ozone field usually show a difference in the altitudes near the ozone peak. The reasons for these apparent differences are discussed.

A52A-0093 1330h POSTER

Satellite-Derived Extinction at A Desert Site

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We have been conducting research aimed at enabling determination of desert optical environments from meteorological and satellite observations. To this end we have been making Rotating Shadowband Radiometer measurements, collecting aerosol size distributions, visibility and meteorological data continuously for the past 2 years in the Indian Wells Valley of the Mojave Desert of California. These data present an opportunity to validate satellite retrieval of atmospheric optical depth. Specifically, MISR-derived optical depths are compared to those derived from Shadowband measurements. A crude measure of extinction can be made by dividing the optical depth by the height of the mixing layer. The validity of this procedure is determined by comparison with extinction directly measured by nephelometers and calculated from measured aerosol size distributions.

A52A-0094 1330h POSTER

Two-day Wave Observations of UARS-MLS Mesospheric Water Vapor and Temperature

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The two-day wave disturbance is observed in the mesospheric temperature and water vapor based on new version data from the Upper Atmosphere Research Satellite Microwave Limb Sounder. Using two data segments during the Austral summers (January-February of 1992 and 1993) and the asynoptic mapping method, the strong wave signal is identified as zonal wavenumber 3 and westward period of about 2.1 days. The wave amplitudes are located near the core of the summer easterly jet with strongest wave amplitudes (as large as 11 Kelvins and 0.35 part per million by volume) near the mesopause. The temperature and water vapor wave strengths are highly correlated in time but their peaks are almost longitudinally out-of-phase. Poleward heat flux associated with upward wave energy propagation in the southern hemisphere points to baroclinic instability as the cause for the wave appearance. Growing wave signature in water vapor is observed in regions of strong meridional gradient of water vapor. Near the mesopause, wave breaking is suggested as moist polar air is displaced into the much drier subtropics and wave amplitude decays.

A52A-0095 1330h POSTER

ENVISAT/SCIAMACHY First Results on Instrument Performance, Retrieval and Validation of CO, CH_4 and Other Greenhouse Gases

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The Scanning Imaging Absorption SpectroMeter for Atmospheric CartograpHY (SCIAMACHY), launched on board the ENVISAT satellite on 1 March 2002, currently captures the absorption signatures in earth-scattered solar light due to some sixteen chemical species, as well as clouds and aerosols in a variety of nadir, limb, solar occultation, and lunar occultation modes, in eight ultraviolet, visible and near infrared channels (covering 240 nm to 2380 nm). Channels 6, 7 and 8, which work in the near infrared, were developed, calibrated and characterized in-flight at SRON. Of considerable interest is channel 8 in nadir mode, which may be used for the detection of tropospheric H_2O, N_2O, and in particular, CO and CH_4. These are important atmospheric constituents for understanding climate change and the knowledge of their global distribution will be considerably enhanced using satellite measurements. The final results of a channel 8 in-flight performance assessment will be presented along with retrieval and validation results and a retrieval method sensitivity and robustness analysis. Our retrieval results are derived independently of the operational ENVISAT/SCIAMACHY Level 2 data product and thus provide an additional point of comparison for validation, verification and, ultimately, incorporation into global circulation models.

URL: http://www.sron.nl/divisions/eos/sciamain.html

A52A-0096 1330h POSTER

Upper Limits of Stratospheric IO And OIO Inferred From Center to Limb Darkening Corrected Balloon-Borne Solar Occultation Visible Spectra; Implications For Total Gaseous Iodine And Stratospheric Ozone

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We report on upper limits of lower stratospheric IO (mean 0.151 ppt; 0.087 ppt; 0.072 ppt and lowest value 0.1 ppt; 0.069 ppt; 0.06 ppt at 20, 15, 12.5 km, respectively) and OIO (mean 0.157 ppt; 0.075 ppt; 0.057 ppt and lowest value 0.1 ppt; 0.059 ppt; 0.043 ppt at 20, 15, 12.5 km, respectively) inferred from balloon-borne solar occultation UV/visible spectroscopy (<20 km). The spectra were recorded during a series of LPMA/DOAS (Laboratoire de Physique Moléculaire et Applications/Differential Optical Absorption Spectroscopy) balloon flights that were conducted at different geophysical conditions i.e., inside the arctic winter vortex, at mid-, and high latitudes in spring, summer, and fall. Photochemical modeling that accounts for the iodine partitioning during the observations allows us to infer upper limits of total inorganic gas-phase iodine (I_y). Combining our measurements with photochemical modeling reveals a lower stratospheric I_y (< 20 km) of $\leq 0.1 \pm 0.02$ ppt and $\leq 0.065 \pm 0.01$ ppt taking into account, and neglecting OIO photolysis, respectively. For the middle stratosphere, the inferred total I_y is larger due to the smaller detection sensitivity there. The inferred small upper limit for stratospheric I_y provokes the following questions; does much less iodine enter the stratosphere than the amount expected from the tropopause entry level (primarily the tropical upper troposphere), or does it reside in other minor gaseous species, or eventually in a non-gaseous, i.e., particulate form, in the stratosphere ? The implication of our iodine measurement on stratospheric ozone is also briefly discussed.

A52A-0097 1330h POSTER

Retrieval From High-Resolution Outgoing Thermal IR Measurements in the Presence of Cirrus: a Sensitivity Study

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We explore how high spectral resolution measurements could aid the retrieval of atmospheric temperature and gas concentration profiles from outgoing IR spectra when optically thin cirrus is present. Simulated outgoing spectra, containing thin cirrus, are fitted with spectra not containing cirrus and the residuals are examined. For those lines with weighting functions peaking around the same altitude as the thin cirrus, narrow features are observed in the residuals. These narrow features are very sensitive to the resolution of the instrumental line shape (ILS). For thin cirrus these residual features are narrow ($0.1\ cm^{-1}$) so high spectral resolution is required for unambiguous observation. The magnitudes of these narrow features are larger than the noise of modern instruments. The sensitivities of these features to cloud height and cloud optical depth are also discussed. Our sensitivity studies also show that when the errors in the estimation of temperature profiles are not very large, the dominant contribution to the residuals is due to the misinterpretation of cirrus. An analysis from the point of view of the information content is also discussed. An understanding of the magnitude of the effect and the dependence on spectral resolution as well as spectral region is important for retrieval of spacecraft data and designing future infrared instruments for weather forecasting and greenhouse gas monitoring.

A52A-0098 1330h POSTER

Sun Photometer Laser and Lamp Based Radiometric Calibrations; Comparison with the Langley Technique and Implications on Remote Sensing

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Satellite-based remote sensing of the earth is a valuable data source for biological and oceanic studies. However when using remote sensing, it is necessary to correct the measured signal for atmospheric effects. As aerosols play a major role in atmospheric scattering, correcting algorithms based on Aerosol Optical Thickness (AOT) data have been developed to describe the scattering of radiation by aerosols. AOT data are collected by filter radiometers measuring the solar irradiance. The AOT is then retrieved applying the Beer-Bouger-Lambert Law to those measurements. Two radiometers, called Satellite Validation for Marine Biology and Aerosol Determination (SimbadA), were calibrated in this study. These instruments measure the upwelling radiance from the ocean as well as the solar irradiance, providing information on both marine reflectance and AOT.

The goals of this study were to calibrate the radiometers using independent methods, evaluate the uncertainties for each method, and assess the influence of the results in terms of the science requirements. The radiometers were calibrated in irradiance and radiance mode using a monochromatic, laser-illuminated integrating sphere, in radiance mode using two different lamp-illuminated integrating spheres, and in irradiance mode using the Langley technique.

First, a limited characterization of the instrument was conducted. The instruments temporal stability and its spectral out-of-band response were evaluated.

The instrument was then calibrated in radiance mode using a laser-illuminated integrating sphere that overfilled its field of view (FOV). The absolute radiance responsivity from this calibration was compared to results from measurements of two calibrated lamp illuminated spheres. The first comparison, with the NIST portable radiometric source (NPR), was a validation as good agreement between the two methods has been reported in previous studies. The second comparison was with the Hardy sphere from the Goddard Space Flight Center (GSFC) of the National Aeronautics and Space Administration (NASA). In this comparison the NASA radiance scale was compared to NISTs. A disagreement was observed and will be discussed.

Finally, an absolute irradiance responsivity calibration was performed with the laser based facility using

a small integrating sphere that underfilled the instruments FOV. This was done in order to do a comparison with the Langley technique, which is based on irradiance measurements. Using the absolute spectral responsivity obtained with the laser based calibration and a solar irradiance spectrum, the expected Top of the Atmosphere signal (V0) was determined and compared with the V0 obtained from the Langley calibration. Results will be presented and implications for derived AOT discussed.

A52A-0099 1330h POSTER

Monitoring Surface Long-wave Radiation Budget from Satellite: Validation

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The present study follows up on the analysis techniques developed earlier (Inamdar & Ramanathan, 1997) for the retrieval of surface long-wave radiation budget from satellites. In particular, the technique employs the top-of-atmosphere measurements made by the Clouds and Earths Radiant Energy System (CERES) sensor aboard the Tropical Rainfall Measuring Mission (TRMM) satellite in combination with other meteorological variables to analyze the energetics of the tropospheric column and surface. The analysis is separated into ocean and land regions. The two key parameters that are derived include, 1) the atmospheric greenhouse effect, which is the reduction in the clear-sky outgoing long-wave radiation representing the radiative heating of the surface-atmospheric column, and 2) the back-radiation from the atmosphere to the surface representing the radiative heating of the surface by the atmosphere. The latter parameter has been archived in the EOS data base and accessible from the NASA Langley Research Center CERES Data Archives.

In the present study, we compare the clear-sky long-wave surface radiation retrieved from the CERES broadband and window instrument (8 12 micron) with in-situ measurements at several sites over the globe for the period Jan Aug, 1998. The agreement is within the stipulated objectives of the broad EOS program. Further analysis of the seasonal and latitudinal variability unravels the water vapor radiative interactions in the tropics and supports our earlier conclusions, namely: Water vapor continuum plays a key role in both seasonal and latitudinal variation; it is a dominant source of net long-wave radiative cooling in the tropics and that the atmospheric column radiative cooling in the window (8 12 micron) exceeds the total broadband cooling. These observations have implications for the radiative-dynamical feedbacks that govern the tropical seasonal climate.

A52A-0100 1330h POSTER

Presence of a Madden-Julian Oscillation Signal in the TOMS Ozone Data

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We have discovered evidence of the Madden-Julian Oscillation (MJO) in the records of total column ozone abundances collected by the Total Ozone Mapping Spectrometer (TOMS). Analysis of a tropical band of the daily TOMS record displays spatial and temporal fingerprints of the MJO. TOMS is a highly precise record providing nearly continuous daily data from Nov.,1978 to Apr.,1993 and (separately) from Aug.,1975 to present on a $1^{\circ} \times 1.25^{\circ}$ latitude-longitude grid. This discovery opens up the possibility of a new and independent source of data for MJO studies, especially for the impact of the MJO on the troposphere-stratosphere interactions.

A52A-0101 1330h POSTER

A Satellite Derived Climatology of Radiation Fog in Central California Using GOES Infrared Imagery and the Nighttime Fog Product

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Radiation fog occurs frequently in the Central Valley of California during a season that begins in late October with the first cyclonic or frontal rainfall, and continues through mid-March. The GOES satellite system provides 4km and 1km spatial resolution, sub-hourly temporal resolution, and multi-spectral resolution of the study area. Radiation fog formation occurs most prominently after sunset so multi-spectral fog imagery (Nighttime Fog Product) is used in this study to detect the horizontal and vertical extent of fog, as well as the rate of fog growth during the nighttime hours.

The findings of this study reveal that radiation fog development is spatially variable with more horizontally extensive fogs developing in the southern sections of the Valley (south of 37°N latitude), and less extensive fogs to the north (Sacramento Valley). Radiation fog is also observed to vary in vertical extent. The patterns revealed in this study suggest that thicker fogs occur more readily when the event itself is more horizontally extensive. The more vertically developed areas of the fog cover are usually discontinuous and may form as early as 20:00LST. In general radiation fog forms in one of three distinct patterns across the Central Valley: 1) continuous horizontal extension from sunset (approximately 18:00LST) to sunrise (06:00LST), 2) horizontal extension interrupted for a number of hours around midnight, and 3) horizontal extension that peaks between 22:00LST and 23:00LST.

Both the spatial and temporal aspects of radiation fog development are strongly related to surface meteorological conditions. The study suggests that wind speeds under the threshold velocity of approximately 1.6m/s and southerly in origin are most conducive to rapid radiation fog extension both horizontally and vertically.

A52A-0102 1330h POSTER

An evaluation of trends in middle atmospheric water vapor from 1991-2002 as measured by HALOE, WVMS, and POAM

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We compare middle atmospheric water vapor measurements from the HALogen Occultation Experiment (HALOE), Water Vapor Mm-wave Spectrometer (WVMS), and Polar Ozone and Aerosol Measurements (POAM) instruments. Coincident WVMS and HALOE data are compared at the Network for the Detection of Stratospheric Change (NDSC) sites at Mauna Loa, Hawaii (19.5N, 204.4E) from 1996-2002 and at Lauder, New Zealand (45.0S, 169.7E) from 1994-2002. These datasets are first evaluated to provide estimates of relative instrumental trends, and are then analyzed individually for local geophysical trends. HALOE data is also compared with the high latitude POAM dataset at equivalent latitudes from 45N-55N. Finally, we look at the HALOE water vapor and H2O+2CH4 data globally, and compare the trend from 1991-1995 with the trend over the entire 1991-2002 dataset, and with trends from other instruments over previous decades. We also look at the variations in water vapor since 1996 in order to determine whether there is any significant long-term increase over the last 6 years.

URL: http://wvms.nrl.navy.mil

A52A-0103 1330h POSTER

Validation of Rain-Rate Retrieved from Advanced Microwave Sounding Unit (AMSU) over the Tropical Cyclone

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Rain-rate retrieval using the NOAA/AMSU (Advanced Microwave Sounding Unit) (Zaho et al., 2001) has been implemented at METRI/KMA since 2001. Here, we present the validation results of the AMSU derived rain-rate, especially for the rainfall associated with the tropical cyclone for 2001 and 2002. For the validation, we use rain-rate derived from the ground based radar and/or rainfall observation from the rain gauge in Korea. We estimate the bias score, threat score, bias, RMSE and correlation coefficient for total of 25 tropical cyclone cases. Bias score shows around 1.3 and it increases with the increasing threshold value of rain-rate, while the threat score extends from 0.4 to 0.6 with the increasing threshold value of precipitation. The averaged rain-rate for all 25 cases is 3.23mm/hr and 1.01mm/hr for the retrieved from AMSU and the ground observation, respectively. On the other hand, AMSU rain-rate shows a much better agreement with the ground based observation over inner part of tropical cyclone than over the outer part (Correlation coefficient for convective region is about 0.7, while it is only about 0.3 over the stratiform region). The larger discrepancy of the correlation coefficient with the different part of the tropical cyclone is partly due to the time difference in between ice water path and surface rainfall. Another possible cause is the different vertical rain structure within the tropical cyclone which will be further investigated. The detailed procedure we modified for the improvement of current algorithm will be discussed in the presentation.

Reference Zaho, L., F. Weng, and R. Ferraro, 2001: A physically-based algorithm to derive surface rainfall rate using advanced microwave sounding unit-B (AMSU-B) measurements. 11th Conf. on satellite meteorology and oceanography, American Meteorological Society 371-374.

A52A-0104 1330h POSTER

Observations of Typhoon Melissa during the Lidar In-Space Technology Experiment (LITE)

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The ability to predict the intensity and movement of tropical cyclones depends on understanding their structure. Information on tropical cyclone structure is provided by ground based Doppler radar; aircraft in situ, Doppler radar, and dropsonde measurements; and satellite soundings and images. Unfortunately, these instruments do not allow the vertical cloud structure of tropical cyclones to be studied. The Lidar In-space Technology Experiment (LITE), flown on the Space Shuttle in September 1994, however, did provide high vertical resolution measurements of clouds. The LITE lidar obtained profiles of backscatter counts over the western Pacific through cross-sections of Typhoon Melissa on September 15, 1994 near its peak strength, and on September 17, 1994, during its weakening phase.

During the strengthening phase the lidar data allowed precise measurements of the width and slope of Typhoon Melissa's eyewall. Measurements of cloud top heights of the cirrus outflow were also made and showed higher tops at the front of the storm. The boundary layer clouds at the base of the eye were observed with the highest cloud tops found toward the front of the typhoon. A clear ring of air adjacent to the eyewall suggesting strong subsidence surrounded the boundary layer clouds. An area of enhanced backscatter occurred near the top of the eye and there appeared to be significant blow-off of cirrus outflow from the eyewall cascading into the eye. This blow-off should evaporate and cool inside the eye and the subsidence it induces may extend all the way to the ocean surface along the eyewall causing the clear ring in the boundary layer clouds.

During the weakening phase, the lidar data show that the central convection no longer spans the entire troposphere. The cirrus shield above this convection was optically thicker than the cirrus downstream of it. The cirrus shield was between 4 and 5 km in geometric thickness for nearly the entire 4000 km that it spans with cloud tops nearly as high as those during the strengthening phase. The trailing cirrus connected the convection at the ITCZ to the typhoon center. Upstream of the central convection a thick cirrus shield from a spiral rainband was located approximately 3 km lower than the cirrus over the center of the typhoon and its trailing cirrus.

A52A-0105 1330h POSTER

Infrasound Sensors on a Budget - A simplified design

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Previous work has shown that some inexpensive electret microphones have a response that may be extended below 1/2 Hz by using suitable backing volume extenders. Current models are based on a simple enclosure and backing volume that can produce a microphone with a known response. By using a large number of consumer grade electret elements, it is possible to produce an infrasound sensor suitable for acoustic infrasound with low self noise. For research use, such systems must be calibrated. Two methods of calibration have been demonstrated, one using a bursting membrane in a calibration chamber and one using a small impulse pump on the backing volume (displacement method).

Such a sensor can easily be produced with simple tools and materials and may be of interest to both researchers and educators.

A52A-0106 1330h POSTER

A Comparison of Sulfur Dioxide Column Content Between Aircraft and Satellite Over the U.S. Mid-Atlantic

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Sulfur Dioxide (SO2) is a major contributor to air pollution in the mid-Atlantic region of the United States. Sources of SO2 include coal fired power plants as well as diesel engines. Fine particulate sulfate (with diameter less than 2.5 mm) formed from SO2 can cause health problems as well as decreased visibility. Reliable measurements of SO2 within the lower troposphere are needed to determine sources, test emission inventories and to evaluate federal air quality standards. Monthly averages of SO2 lower-tropospheric column content for various points in the mid-Atlantic region of the United States have been calculated from episodic aircraft measurements during the summer months of 2000 and 2001 (http://www.meto.umd.edu/ umdair/rammpp01.html). A Thermo Environmental Instruments 4 3C SO2 analyzer was used to obtain data during aircraft spiral profiles, usually made from the near-surface to an altitude in the range of 2.3 to 3.1 km. From June to August 2000, 44 columns of SO2 were calculated from aircraft profiles over 11 different locations between North Carolina and Pennsylvania. Individual column concentrations of SO2 ranged from 0.10 to 2.31 Dobson Units (DU). Monthly averaged column concentrations were made for each location and the average concentrations for 2000 ranged from 0.02 to 1.18 DU. In 2001, 149 columns of SO2 were obtained from 36 different locations for the months of May through August. The individual column concentrations ranged from 0.01 to 3.40 DU and the monthly averaged columns ranged from 0.05 to 3.40 DU. UV-visible spectra collected by the Global Ozone Monitoring Experiment (GOME) have been analyzed for SO2 by the research group at the University of Bremen in Germany (http://www.iup.physik.uni-bremen.de/gome/). The period of data collection by the University of Maryland team coincide with data collection by the University of Bremen. The monthly averages of SO2 determined from aircraft measurements are compared with measurements from the satellite in order to characterize the transport and dynamics of SO2 over the mid-Atlantic region.

A52A-0107 1330h POSTER

Spectrally Resolved Ocean Optics in the Vicinity of COVE Site

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Radiative transfer at the air-sea interface plays a significant role in the global climate system. Investigations of radiation to date have tended to focus on one of the two media (atmosphere or ocean) explicitly, regarding the other as a simple boundary condition or correction factor in remote sensing. Our analysis with the CERES Ocean Validation Experiment (COVE) treats both media explicitly using thorough measurements and coupled radiative transfer theory. Long-term observations at the rigid COVE sea platform are sponsored by the Clouds and the Earth's Radiant Energy System (CERES) program of NASA's Earth Observing System (EOS).

We show data from the Chesapeake Lighthouse and Aircraft Measurements for Satellites (CLAMS), which was a field campaign (June - August, 2001) at COVE, and from the summer of 2002. Analytical Spectral Devices spectroradiometers on board the NASA Langley OV-10 aircraft measured both downwelling and upwelling irradiances (350 - 2250 nm with an effective resolution of 8-12 nm interpolated to 1 nm); spectral albedo is readily obtained. In addition to calibration using data provided by the manufacturer, a second inter-instrument calibration was conducted using the same sources: outdoor solar radiation and an indoor 1000-W QTH lamp with 8" integrating sphere applied to both the uplooking and downlooking instruments.

The albedo of the ocean surface is a function of numerous variables; some are hard to measure. A Coupled Ocean-Atmosphere Radiation Transfer (COART) model based on Discrete Ordinate Radiation Transfer (DISORT) has been developed by Z. Jin. COART has been used to compute the spectral albedo of the ocean surface under various conditions. The measured data show reasonable agreement with the COART model results.

A52B MCC: Hall D Friday 1330h

Air Toxics: Regional Assessments Through Atmospheric Monitoring or Modeling Posters

Presiding: **B Hutzell,** U.S. Environmental Protection Agency**; R Bullock,** U.S. Environmental Protection Agency

A52B-0108 1330h POSTER

Modeling Mercury Atmospheric Deposition in the United States

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A multiscale modeling system that consists of a global chemical transport model (CTM) and a nested continental CTM was applied to simulate the atmospheric fate and transport of mercury over North America. Model performance was evaluated with data from the Mercury Deposition Network (MDN). Performance statistics were satisfactory with r2=0.81, error=18% and bias=4%. A set of model simulations was done for individual source areas to develop a response-surface model that can be used to conduct a large number of emission scenarios with minimal computational cost. The results of the response-surface model are shown to agree well with those of the original CTM. The response-surface model is used to investigate the effect of various emission scenarios on mercury deposition at selected receptors. The global background is calculated to contribute on average about 70% to mercury deposition in the contiguous United States.

A52B-0109 1330h POSTER

Seasonal and Diurnal Cycles of Elemental Mercury in the Marine Boundary Layer: Evidence for Rapid In-Situ Photo-Oxidation

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Gas-phase elemental mercury (Hgo) measurements were made at Cheeka Peak, Washington in the marine boundary layer for the period March December, 2001. Highest concentrations of Hgo were observed during the spring and lowest in late fall, with a seasonal amplitude of 21% of the mean value (1.56 ng/m3). Variability of Hgo over the entire data set gives a Junge lifetime of about 7 months, on the low end of the most recent published estimates. Hgo depletion was observed in all seasons during local pollution episodes that periodically influence Cheeka Peak. This depletion was strongest in the summer and when locally influenced air had enhanced CO concentrations. One particularly strong regional smog event in August produced an Hgo depletion of 37% below the monthly mean. Estimated removal rates based on average urban Hgo concentrations upwind of Cheeka Peak and average transport times, are on the order of days to weeks. Diurnal variability in air masses that had no contact with local sources was also large (as high as 29% peak-to peak amplitude). O3 exhibited a strong negative correlation with Hgo (as high as $R = -0.92$) during certain periods in the summer, in both polluted and clean air masses. These observations suggest a gap in the understanding of Hgo oxidation processes that occur in marine boundary layer of the mid-latitudes, since the fastest known Hgo reactions rates give a lifetime on the order of several months, which is not fast enough to account for our data.

A52B-0110 1330h POSTER

Atmospheric Lead and Bromine Levels in Central Europe

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Abatement measures (fuel composition) in recent years have depleted Pb and Br values in the environment in central Europe.

We studied atmospheric lead, Pb, and bromine, Br, over a two-year period at an urban site (Leipzig, weekly PM_{10} samples), and at several rural and urban sites in short-term campaigns (mostly daily TSP samples) in central Europe, 1998-2000. The samples were collected on quartz fibre filters and analyzed using x-ray fluorescence analysis (total element contents).

In the long-term study at the urban site, the levels were found to be 19.2 ng m^{-3} (0.66 mg g^{-1} PM_{10}) and 3.2 ng m^{-3} (0.11 mg/g PM_{10}) for Pb and Br, respectively, as the annual mean. Winter concentrations exceeded summer concentrations by a factor of 3, similar to other anthropogenically highly enriched elements (crustal enrichment factors for Pb and Br were 550 and 490, respectively). At rural sites (total sampling time 7 weeks) the levels were 13.4 ng m^{-3} (0.62 mg g^{-1} TSP) and 5.1 ng m^{-3} (0.24 mg g^{-1} TSP) for Pb and Br, respectively. The two elements are correlated, however, less pronounced than previously. By average, it was Pb/Br = 6.2. This value is higher than observed in previous years in Germany which raises the question whether sources other than vehicular traffic are significant today. Time dependent correlation coefficients between particulate phase mass fractions and source loadings which were based on air mass back trajectory analyses suggest the existence of two Pb species, which are undergoing a selection process during aging and, hence, differ by their atmospheric residence time.