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Poster Abstracts

New wavelength-dependent Smithsonian Astrophysical Observatory Air Mass Factor tables for UV/Vis retrievals

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A new set of AMF look up tables has been built at the Smithsonian Astrophysical Observatory (SAO) using calculations performed with the radiative transfer model VLIDORT for the 260 nm to 500 nm spectral range with a spectral resolution of 0.01 nm. The calculations have being performed for the 26 TOMS total ozone profiles, 12 solar zenith angles, 8 viewing zenith angles, 7 relative azimuth angles (RAA), 11 surface albedos and 6 cloud-top pressures. The normalized ozone Jacobians and the intensities have been fitted to the TOMRAD equation (Bhartia, 2001),

$$I = I_0(\theta_0,\theta) + I_1(\theta_0,\theta)\cos(\phi) + I_2(\theta_0,\theta)\cos(2\phi) + \frac{RI_r(\theta_0,\theta)}{(1-RS_b)},$$

to reduce the size of the look up tables and to avoid the need for albedo and RAA interpolation. The tables are stored in HDF-5 files to improve their access speed and to reduce their size.

Evaluation of recent updates to the spectroscopy of CO_2 and CH_4 in the thermal infrared using observations from TES and IASI

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Here we present the results of a rigorous validation of recent updates to the spectroscopic parameters for CO_2 and CH_4 in AER's line-by-line radiative transfer model LBLRTM against measurements from the Tropospheric Emission Spectrometer (TES) made during the HIAPER Pole-to-Pole Observations (HIPPO) of Carbon Cycle and Greenhouse Gases Study as well as from a global dataset of 130 clear-sky, nighttime, ocean, near-nadir measurements from the Infrared Atmospheric Sounding Instrument (IASI). LBLRTM is widely regarded as a reference standard within the atmospheric community, with users across a range of disciplines in government agencies, industry, and academia. LBLRTM has been used as the basis of the forward models for the NASA Aura Tropospheric Emission Spectrometer (TES) and the Infrared Atmospheric Sounding Interferometer (IASI). Spectral line parameters used in LBLRTM are now based on the HITRAN 2008 compilation, with selected notable exceptions, made only after extensive validation. Exceptions to HITRAN in the thermal infrared include updated CO_2 line positions and intensities, updated line mixing coefficients for CO_2 and CH_4, and improvements to the H2O line positions and intensities. We find that the LBLRTM v12.1 CO_2 spectroscopy is remarkably consistent between the CO_2 v2 and v3 bands, a significant improvement over the spectroscopy in LBLRTM v9.4. However, adding the CO_2 positions and strengths from the Carbon Dioxide Spectral Database (CDSD) in LBLRTM v12.1 to the TES line parameters degrades the performance of the TES CO_2 retrieval, which does not use the CO_2 v3 band. We also find that the LBLRTM v12.1 CH_4 spectroscopy is not a clear improvement over that in the TES v1.4 line parameters: strong residual features remain between 1295−1301 cm-1, suggesting further spectroscopic work on CH_4 is needed. Nevertheless the new parameters appear to reduce the positive bias in retrieved CH_4 profiles. The AER radiative transfer models and the associated databases (e.g., line parameters, continua, and molecular cross-sections) are publicly available from AER (http://www.rtweb.aer.com).

Top-down isoprene emissions over tropical South America inferred from SCIAMACHY and OMI formaldehyde columns

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We use formaldehyde (HCHO) vertical column measurements from the SCanning Imaging Absorption spectroMeter for Atmospheric CHartographY (SCIAMACHY) and Ozone Monitoring Instrument (OMI), in combination with a nested-grid version of the GEOS-Chem chemistry transport model, to infer an ensemble of top-down isoprene emissions estimates from tropical South America during 2006, using different model configurations and assumptions in the HCHO air-mass factor (AMF) calculation. Scenes affected by biomass burning are removed on a daily basis using fire count observations from multiple satellite instruments, and we use the local model sensitivity to identify locations where the impact of spatial smearing is small, though this comprises spatial coverage over the region. Within our modelling framework, we find use of the HCHO column data more tightly constrains the ensemble isoprene emission range from 27-61 Tg C to 31-41 Tg C for SCIAMACHY, and 45-98 Tg C to 28-49 Tg C for OMI. Median uncertainties of the top-down emissions are about 70-105% for SCIAMACHY, and 50-90% for OMI. We find the inferred emissions are most sensitive to uncertainties in cloud fraction and cloud top pressure, the choice of initial bottom-up isoprene emission inventory, and the retrieval of the HCHO vertical column itself. Construction of continuous top-down isoprene emission maps for the Amazon region, generally improves GEOS-Chem's simulation of HCHO columns over the tropical South America, with respect to both the SCIAMACHY and OMI data. However, if the local time top-down emissions are scaled to monthly mean values, we find the annual emission totals inferred from SCIAMACHY are nearly twice those determined from OMI. This difference cannot be explained by the different sampling characteristics of the sensors, or uncertainties associated in the AMF calculation.

A-Train Observations of Young Volcanic Eruption Clouds

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NASA's A-Train satellite constellation (including the Aqua, CloudSat, CALIPSO, and Aura satellites) has been flying in formation since 2006, providing unprecedented synergistic observations of numerous volcanic eruption clouds in various stages of development. Measurements made by A-Train sensors include total column SO_2 by the Ozone Monitoring Instrument (OMI) on Aura, upper tropospheric and stratospheric (UTLS) SO_2 column by the Atmospheric Infrared Sounder (AIRS) on Aqua and Microwave Limb Sounder (MLS) on Aura, ash mass loading from AIRS and the Moderate resolution Imaging Spectroradiometer (MODIS) on Aqua, UTLS HCl columns and ice water content (IWC) from MLS, aerosol vertical profiles from the Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP) instrument aboard CALIPSO, and hydrometeor profiles from the Cloud Profiling Radar (CPR) on CloudSat. The active vertical profiling capability of CALIPSO, CloudSat and MLS sychronized with synoptic passive sensing of trace gases and aerosols by OMI, AIRS and MODIS provides a unique perspective on the structure and composition of volcanic clouds. A-Train observations during the first hours of atmospheric residence are particularly valuable, as the fallout, segregation and stratification of material in this period determines the concentration and altitude of constituents that remain to be advected downwind. This represents the eruption 'source term' essential for dispersion modeling, and hence for aviation hazard mitigation. In this presentation we show examples of A-Train data collected during recent eruptions including Chaitén (May 2008), Kasatochi (August 2008), Redoubt (March 2009), and Eyjafjallajökull (April 2010). We interpret the observations using the canonical three-stage view of volcanic cloud development [e.g., Rose et al., 2000] from initial rapid ash fallout to far-field dispersion of fine ash, gas and aerosol, and results from numerical modeling of volcanic plumes [e.g., Textor et al., 2003] and discuss the degree to which the observations validate existing theory and models. We also describe plans for advanced SO_2 and ash retrieval algorithms that will exploit the synergy between UV and IR sensors in the A-Train for improved quantification of ash and SO_2 loading by volcanic eruptions.

Volcanic aerosols in the stratosphere: Decadal contributions from a global model and Aura data

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We use the global model GOCART to simulate the volcanic SO_2 and aerosols from 1997 to 2009 to investigate the volcanic contributions to the stratospheric aerosols during this period. We compare the model results with SO_2 data from OMI and MLS and aerosol vertical profiles with CALIPSO in several case studies. Our goal is to assess the volcanic contributions to the variations of stratospheric aerosols.

Middle- and Upper-tropospheric NO_2 abundance from the Ozone Monitoring Instrument (OMI) obtained by the cloud slicing technique

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Total column measurements of NO_2 from space-based sensors are of interest to the atmospheric chemistry and air quality communities; the relatively short lifetime of near-surface NO_2 produces satellite-observed hot-spots near pollution sources including power plants and urban areas. To use these data for air quality applications, proper accounting for contributions from stratospheric, upper-, and middle-tropospheric NO_2 is necessary. Here, we use cloud information including the cloud optical centroid pressure (OCP) from the Ozone Monitoring Instrument (OMI) as well as collocated cloudy vertical NO_2 columns (defined as the NO_2 column from top of the atmosphere to OCP), also from OMI. The cloudy NO_2 vertical columns used in our study are retrieved independently of any a priori NO_2 profile information. In the cloud-slicing approach, the slope of the cloudy NO_2 column versus the cloud optical centroid pressure is proportional to the NO_2 mixing ratio for a given altitude range. We retrieve coarse monthly-mean NO_2 profiles at selected urban and remote locations. We compare the obtained NO_2 profiles with in-situ aircraft profiles measured during the NASA Intercontinental Chemical Transport Experiment Phase B (INTEX-B) campaign. We also provide a map of NO_2 mean mixing ratio in clouds. While enhanced NO_2 in middle- and upper- troposphere commonly appears near polluted urban locations where NO_2 produced in the boundary layer may be transported vertically, possible signatures of lightning NO_2 are also shown over the US interior and Gulf of Mexico. Regional Chemical Transport Model (REAM) outputs are used to estimate the contributions of different sources to the middle- and upper-tropospheric NO_2 abundances.

NOx Emissions and Distributions: Results from DISCOVER-AQ

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Oxides of nitrogen, NOx, play a key role pollution ozone formation, but their emissions and chemistry remain uncertain. We will present column NO_2 content as measured remotely by OMI and in situ from aircraft during Discover-AQ (July, 2011) and compare results to CMAQ simulations. Model results using CMAQ with the chemical processor CB05 tend to keep NOx close to urban centers. The ratio of NO_2 measured upwind and downwind of the Baltimore/Washington metropolitan area suggests stronger rural sources, faster transport, or a longer effective lifetime for NOx. We also examine ratios among trace gases NOy, CO, and CO_2 measured during profiles to compare to emissions inventories. Results suggest that inventories overestimate emissions.

Satellite validation of important ozone-depleting and climate-forcing trace gases from airborne and ground based platforms

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Validation of important trace gases measured by instruments from the Aura satellite can benefit from similar co-located measurements on airborne and ground-based platforms. Through collaborations with the National Aeronautics and Space Administration (NASA) and the National Science Foundation, the National Oceanographic and Atmospheric Administration's Earth System Research Laboratory Global Monitoring Division (NOAA/ESRL/GMD) has measured a number of trace gases aboard manned and unmanned aircraft up to 21 km, and balloon platforms up to 32 km since 1991 at locations spanning the globe. We measure over 40 trace gases in the atmosphere including nitrous oxide (N_2O), chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs), methyl halides (CH_3Cl, CH3Br), numerous other halocarbons, sulfur gases (COS, SF6), and selected hydrocarbons. This presentation will highlight our recent observations of halocarbons and other trace gases during the NSF and NOAA sponsored HIAPER Pole-to-Pole Observations (HIPPO) campaigns over NDACC (Network for the Detection of Atmospheric Composition Change), AGAGE (Advanced Global Atmospheric Gases Experiment), and NOAA stations from 2009 to 2012, and other observations from the recent NASA and NOAA sponsored Unmanned Aircraft Systems (UAS) GloPac and ATTREX campaigns. The HIPPO campaign represents one of the most extensive sets of sounding of trace gases in the whole troposphere with measurements extending into the polar stratosphere. We will include comparisons with NDACC and satellite observations (ACE-FTS, Aura MLS and TES instruments).

A Climatology of Stratopause Temperature and Height in the Polar Vortex and Anticyclones

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Abstract: A global climatology of stratopause temperature and height is shown using 7 years of Microwave Limb Sounder satellite data, from 2004 to 2011. Stratopause temperature and height is interpreted in the context of the polar vortices and anticyclones defined by the Goddard Earth Observing System meteorological analyses. Multi-year, monthly mean geographic patterns in stratopause temperature and height are shown to depend on the location of the polar vortices and anticyclones. The anomalous winters of 2005/2006 and 2008/2009 are considered separately in this analysis. In the anomalous years, we show that the elevated stratopause in February is confined to the vortex core. This is the first study to show that the stratopause is, on average, 20 K colder and 5-10 km lower in the Aleutian anticyclone than in ambient air during the Arctic winter. During September in the Antarctic the stratopause is, on average, 10 K colder inside anticyclones south of Australia. The regional temperature and height anomalies, which are due to vertical ageostrophic motion associated with baroclinic instability, are shown to be climatological features. The mean structure of the temperature and height anomalies is consistent with moderate baroclinic growth below the stratopause and decay above. This work furthers current understanding of the geography of the stratopause by emphasizing the role of synoptic baroclinic instability, whereby anticyclones establish zonally asymmetric climatological patterns in stratopause temperature and height. This work highlights the need to consider zonal asymmetries when calculating upper stratospheric temperature trends.

Correlation analysis of column-density data with surface mixing ratios for O3 and NO_2 during DISCOVER-AQ

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The first deployment of the Earth Venture -1 DISCOVER-AQ (Deriving Information on Surface conditions from Column and Vertically Resolved Observations Relevant to Air Quality) project was conducted during July 2011 in the Baltimore-Washington region. In-situ sampling of trace gases was performed by the P-3B aircraft over fourteen flight days, allowing profiles of O_3 and NO_2 to be obtained over surface air quality monitoring sites. Surface-level volume mixing ratio data were made available for these monitoring sites by the Maryland Department of the Environment (MDE) and Environmental Protection Agency (EPA). These sites were also equipped with the ground-based Pandora

UV/Vis spectrometers, observing O_3 and NO_2 column amounts. Satellite observations for tropospheric O_3 and NO_2 (NASA Version 2.1) from Aura/OMI were available for the deployment period. A correlation analysis was performed between the tropospheric column amounts of O_3 and NO_2 (from integration of in-situ P-3B data, from Pandora spectrometers, and from Aura/OMI) and the surface mixing ratio data for each site. The P-3B columns demonstrate larger correlation with surface mixing ratios for O_3 than NO_2, yielding a high degree of correlation between the O_3 columns and surface values. The Pandora and OMI columns demonstrate larger correlation with the surface mixing ratios for NO_2, but yielding only a low to moderate degree of correlation. A linear regression analysis was also performed for O_3 and NO_2 to predict the surface ratio from the P-3B, Pandora, or Aura/OMI column amount, and prediction errors were assessed. These results suggest that ozone observations from future satellite instruments with sufficient sensitivity to the lower troposphere can be meaningful for surface air quality analysis.

Space-based constraints on lightning NOx production in the GEOS-Chem model over Southwest U.S. during North American summer monsoon

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Nitrogen oxides (NOx≡ NO + NO_2) produced by lightning make a major contribution to the production of tropospheric ozone. We conduct GEOS-Chem simulations at at 2°×2.5° (globally) and 0.55°×0.66° (one-way nested over North America) horizontal resolutions for 2006 and 2007, and compare simulation results with surface ozone observations from the Clean Air Status and Trend Network (CASTNet). In both years, largest discrepancies are seen during the late July and early August, when model results are baised high by up to 30 ppbv at elevated mountainous sites in the southern Rockies. Our sensitivity simulation shows that these biases are primarily caused by excessive lighting NOx emissions in the model, corresponding with deep convective activities associated with the North American summer monsoon that casts influences throughout much of the Southwest U.S. We compare tropospheric NO_2 columns produced from the model with that from OMI product. Large discrepancies are found during late July and early August in the Southwest U.S., and model results are biased up to three times of that from OMI observations. We examined the performance of three lightning NOx parameterization methods used in the model, which are based on cloud top height (CTH), convective mass flux (MFLUX) and convective precipitation (PRECON), respectively. We then use lightning flash rates observed by LIS/OTD satellite to constrain the parameterization of the lightning source of NOx in the model during the North American summer monsoon season. Results show that the excessive lightning emissions have great impact on the model's ability to predict tropospheric ozone budget. Using OMI tropospheric NO_2 product, we also show that the long-range transport from the tremendous amount of lightning that occurs over the Gulf of California is an important factor contributing to the excessive lightning NOx emissions during North American monsoon in GEOS-Chem.

Boundary Layer Measurements from Aura TES v005 water vapor retrievals

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A recent development for the EOS Aura Tropospheric Emission Spectrometer (TES) is a wide band retrieval (1170 to 1330 cm-1) to jointly estimate the mixing ratios of several species, including HDO, H_2O, CH_4, and N_2O. This new retrieval dramatically improves the vertical resolution in the lower troposphere for water vapor. In this study, TES v005 water vapor retrievals are used to identify the thickness of the boundary layer. Actual and expected retrieval errors will be compared using radiosonde validation data.

Comparison of Pandora Ground-Based Measurements of Total column NO_2 with OMI satellite Measurements

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NO_2 retreivals from the Pandora spectrometer system data are compared with OMI NO_2 measurements at the OMI overpass time. The comparison shows a systematic underestimate by OMI at a number of sites in the US, Korea, and Finland monitored by Pandora on days when there is significant amounts of NO_2 above values commonly associated with the stratosphere (< 0.2 DU). In highly polluted sites such as Busan or Seoul Korea, NO_2 values are observed to frequently exceed 1 DU. The OMI overpass observations are less than half the Pandora observed values. Comparisons with OMI at less polluted sites (e.g., GSFC in Maryland) show smaller, but significant underestimates.

Large Wildfires in the Pacific Northwest

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The AIRPACT-3 air quality modeling system, which uses the BlueSky model to derive fire emissions, is used to determine potential impacts of aerosols and trace gases in the Pacific Northwest from large wildfires. Model results are compared to the DOMINO (v2) and NASA (v2.1; research product) tropospheric NO_2 data products, the tropospheric ozone research product derived from Aura/OMI (Liu et al., 2010), and measurements made by nearby surface monitors. Carbon monoxide retrievals from AIRS and MODIS AOD are also used to assess model performance.

EOS Aura and ozonesonde profiles during 2005-2011

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Recovery of stratospheric ozone is one of the three themes of the Aura mission. Here we have used ozonesonde data from Sodankylä to study the long-term stability of the Aura measurements and secondly to provide trend calculations of the ozone profiles. Location of Sodankylä allows frequent sampling of air inside the Arctic stratospheric vortex. In average in January, February and March more than half of the sondes have sampled air inside the vortex. Sodankylä has participated in several satellite validation campaigns including SAUNA-1 and SAUNA-2 campaigns within the Aura mission and it also one of the initial stations in the GCOS Reference Upper Air Network. Regular sounding program involves a weekly ozonesonde during all seasons. We have flown ECC (electrochemical concentration cell) type of ozonesondes throughout the data record. Since the start of the Aura mission measurement procedures and sounding equipment do not have significant changes. ENSCI type of ECC sondes have been flown since early 2006 using 0.5% KI sensing solution. Brewer and ozonesonde total ozone measurements at Sodankylä are in a good agreement, average Brewer/sonde ratio has been 1.0. In average the MLS/sonde relative difference at the altitude from 20 to 30 km has been less than 2%, while above 30 km there has been an altitude dependent positive bias. MLS version 2.2. and 3.3 data were used to calculate year-to comparisons at all pressure levels, significant trends in MLS/sonde ratio were not detected. Also OMI/sonde profile comparisons did not show drifts relative to the sondes over time period 2005-2011.

Aura MLS Near-Real-Time Processing Stream for use in Data Assimilation

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The Microwave Limb Sounder (MLS) on the Aura satellite launched in July 2004 has produced daily global atmospheric data for over eight years. Since March 2008 MLS has provided temperature, geopotential height and ozone data products in near-real-time (NRT) with 90% of the data being available within three hours of the satellite observation time. We report on the recent testing of an improved near-real-time retrieval algorithm to produce temperature, geopotential height, ozone and water vapor on 12 levels per decade, and carbon monoxide, nitric acid, nitrous oxide and sulfur

dioxide on 6 levels per decade in pressure. The new NRT data products will be available by subscription to a production stream at the Goddard Earth Sciences (GES) Data and Information Services Center (DISC).

Polar Vortex and Temperature Diagnostics for Intercomparisons and MLS Data Inspection: Update on Antarctic 2012 Meteorology in Relation to Incoming MLS Data

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Stratospheric temperature diagnostics are important indicators for evaluating the severity of polar winters and the susceptibility to conditions that lead to ozone loss at the poles. The availability of many meteorological datasets with temperature products that span multiple years allows for direct comparisons between measurements (the Aura Microwave Limb Sounder, MLS), operational data assimilation systems (GEOS-5, NCEP, UKMO), and reanalysis data sets (ERA-Interim, MERRA, NCEP/NCAR Reanalysis). We focus on two diagnostics: first, the area where temperatures are less than the threshold temperatures for the formation of Polar Stratospheric Clouds (PSCs), and, second, the minimum daily temperatures over the course of the polar winters. Both diagnostics have a long history of use for monitoring the wintertime polar stratosphere, and we will present a comparison of results based on updated data products and analysis techniques. These and several other diagnostics of temperatures and the polar vortex are used in evaluating the consistency of incoming MLS data with meteorological conditions; an update on those conditions and related MLS data in the 2012 Antarctic winter will be presented.

Asian monsoon hydrology from TES and SCIAMACHY water vapor isotope measurements and the LMDZ model: implications for speleothem climate record interpretation

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Stable water isotopes mark different processes of the hydrological cycle, place constraints on water flux estimates between moisture reservoirs, and have been used as paleoproxies for climate research. Here we use stable isotopes of precipitation and vapor to characterize the moisture processes that control Asian monsoon precipitation and relate these processes to paleoclimate records from speleothem data. We focus on the observed increase of the isotopic composition in precipitation (d18Op) from the coastal southeastern (SE) China to northwestern (NW) China during the wet season, which contradicts the expectation from the Rayleigh distillation theory. The Laboratoire de Météorologie Dynamique-Zoom version 4 (LMDZ4) Atmospheric General Circulation Model (AGCM) nudged with reanalysis wind captures this increasing d18Op trend, and it also captures the observed dD vapor variations in satellite measurements from the Tropospheric Emission Spectrometer (TES) and the SCanning Imaging Absorption spectroMeter for Atmospheric CHartographY (SCIAMACHY). We find that d18Op is low over SE China as a result of local and upstream condensation and that d18Op is high over NW China because of evaporative enrichment of 18O when raindrops fall through the dry air. The correlation between local precipitation amount and d18O is consistently negative over relatively drier regions in Asia (mean annual precipitation < ~750 mm/year), but no consistent correlation appears over the southern part of China (south of ~30ºN). d18Op at cave sites over southern China is related more to upstream precipitation (Indian monsoon area) rather than local precipitation, but is well-correlated with the d18Op over large areas of southern and central China, consistent with coherent speleothem d18Op variations over different parts of China. Previous studies have found a high correlation between speleothem d18Op and millennial timescale climate forcings, and based on the agreement between the LMDZ simulations and observations, we suggest that the high correlation between insolation and speleothem d18Op in southern China captures the variations of hydrologic processes over Indian monsoon region on millennial and orbital timescales. The d18Op in the northern drier part (north of ~30ºN) of China on the other hand, possibly captures local hydrologic processes.

Lagrangian 'Matches' and related diagnostics for Aura MLS

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Accurate quantification of chemical destruction of stratospheric ozone each Arctic winter/spring requires a full understanding of the impact of dynamics on the temporal evolution of high latitude ozone profiles. Transport phenomena, including descent and the exchange of air between the polar vortex and lower latitudes, lead to changes in ozone abundance that must be disentangled from those due to chemical destruction. Accurate quantification of chemical loss is essential for identifying and characterizing the different stages of ozone layer recovery. We present a new application of the 'match' technique – originally developed for ozonesonde observations – to daily global ozone profile measurements from NASA's Aura Microwave Limb Sounder (MLS) instrument, launched in 2004. Lagrangian trajectories are used to identify cases where the same airmass is observed by MLS on multiple successive days. The decline in ozone abundance between selected successive 'matched' observations gives a measure of chemical destruction. The dense MLS daily coverage enables significantly more matches to be catalogued than is possible for sonde-based studies. In addition to describing our match approach, we will review other planned applications for the new MLS 'Lagrangian Trajectory Diagnostics' upon which our match calculations are based. MLS-match-derived estimates of chemical ozone loss for multiple Arctic winter/spring seasons will be presented, and findings compared to those from previous analyses. The MLS-match approach will also be used to quantify Antarctic polar ozone loss for selected 'ozone hole' seasons.

CO profile retrieved from combined TES and MLS measurements on Aura satellite

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Carbon monoxide (CO) is an important tracer in studies of pollution sources, air quality, and atmospheric transport and chemistry. CO is one of the major precursors for tropospheric ozone production. Its distribution in the upper-troposphere / lower-stratosphere (UTLS) provides very useful information in studies of UTLS exchange mechanisms. Satellite remote sensing observations of CO by an individual instrument are limited in sensitivity either in the troposphere or above tropopause. Here we present a new Aura CO data product, which is derived from combining Tropospheric Emission Spectrometer instrument (TES) and Microwave Limb Sounder (MLS) measurements. The new CO profiles cover the entire atmosphere with much improved vertical sensitivity over the two stand-alone products in the UTLS region. For example, compared to the TES CO profile with a degree of freedom for signal (DOFS) of less than 2, the Aura CO profile has up to 4 DOFS below 50 hPa. We present the retrieval algorithm, results, and preliminary data validation comparing the new Aura product to the balloon CO measurements.

Satellite Observations of Tropospheric Ammonia and Carbon Monoxide: Global Distributions and Correlations and Comparisons to Model Simulations

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The Tropospheric Emission Spectrometer (TES) instrument on NASA Aura satellite launched in 2004 provides global observations of tropospheric species that are highly relevant to studies of air quality, atmospheric chemistry and transport. We present TES observed seasonal and global distributions of ammonia (NH3) and carbon monoxide (CO). These two species are primary pollutants emitted to the Earth's atmosphere from both common and distinct sources associated with human activities. They are precursors of tropospheric aerosol formation and ozone production. We also examine the distributions and correlations of NH3 and CO from GEOS-Chem model simulations. The comparisons between satellite observations and model results are used to help demonstrate how well the global and seasonal pollutant sources are prescribed in the model. Performing the retrieval-model comparisons and distinguishing the information gained in satellite species retrievals from the a priori knowledge are challenging tasks. We will describe the characteristics of TES NH3 and CO retrievals and the method that we applied for TES and model data analyses in order to illustrate these challenges.

A Comparison of OMI with Version 8.6 SBUV/2

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Data from a series of eight SBUV and SBUV/2 instruments have now been reprocessed under NASA's MEaSUREs program to create a coherent ozone time series. In this processing, designated version 8.6, radiance adjustments were made for each instrument to maintain a consistent calibration. The integrated profile ozone from this processing should be the most accurate that we can produce since it depends on the highly ozone sensitive short wavelength channels. We have compared total column ozone data from OMI with the v8.6 ozone time series for SBUV/2 instruments on NOAA 16, 17, and 18. Because the new ozone cross sections produce an absolute offset, we have done a preliminary processing of the OMI data record using the v8.6 algorithm. Under current production processing OMI ozone is slightly lower than N17 ozone, but when the new Brion Daumont Malicet ozone cross sections are used, OMTO3 ozone is about 2% higher. An initial comparison with ozone from the NPP OMPS nadir mapper will also be shown.

Stratospheric and Mesospheric HO_2 observations from the EOS Microwave Limb Sounder

Luis Millan (JPL/CalTech; luis.f.millan@jpl.nasa.gov), S. Wang, and N. Livesey

This poster presents an offline retrieval algorithm of stratospheric and mesospheric hydroperoxyl radical (HO_2) from the Aura Microwave Limb Sounder. This new dataset provides two daily zonal means, one during daytime and one during nighttime, with a varying vertical resolution from about 4 km at 10 hPa to around 14 km at 0.0031 hPa. A description of the methodology and an error analysis are presented. A comparison against the Whole Atmosphere Community Climate Model (WACCM) demonstrates the robustness of the retrieval and indicates that the retrieval is sensitive enough to detect thin mesospheric HO_2 layer during both day and night.

New Aura MLS BrO observations and implications for Bry

Luis Millan (JPL/CalTech; luis.f.millan@jpl.nasa.gov), N. Livesey, W. Read, L. Froidevaux, D. Kinnison, R. Harwood, I. A. MacKenzie, and M. P. Chipperfield

This poster introduces a new inversion algorithm for retrievals of stratospheric BrO from the Aura Microwave Limb Sounder. This version is based on the algorithm described by Livesey et al. (2006) but uses a more realistic atmospheric state to constrain the retrieval. A description of the methodology and an error analysis are presented. Single daily profile precision uncertainty, when taking the ascending-descending (day-night) difference, was found to be up to 40 pptv while systematic error biases were estimated to be less than about 3 pptv. Monthly mean comparisons show broad agreement with other measurements as well as with state-of-the-art numerical models. We infer a 2005 yearly total inorganic Bry using the measured MLS BrO to be 20. 3± 4. 5 pptv, which implies a contribution from very short-lived substances to the stratospheric bromine budget of 5± 4. 5 pptv.

Improvements to Ozone Monitoring Instrument glyoxal retrievals

Christopher C. Miller (Harvard U.; cmiller@fas.harvard.edu), D.J. Jacob, G. Gonzalez Abad, K. Chance, and X. Liu

Non-methane volatile organic compounds (NMVOCs) are key species for determining the budgets of ozone, aerosols and the hydroxyl radical. Thus their emission to the atmosphere has important consequences for climate and air quality. Large uncertainties in global bottom up NMVOC emission estimates serve to complicate the assessment of their environmental impacts. Glyoxal and formaldehyde are tracers of NMVOC oxidation that can be measured from space. Both field and satellite observations have revealed characteristic glyoxal:formaldehyde ratios associated with different NMVOC emission sources, suggesting that joint inversions may provide additional useful information for constraining a range of NMVOC compounds. Here we present results from an improved glyoxal simulation within the GEOS-Chem chemical transport model that incorporates recent developments in NMVOC chemistry. We compare the model to recent ground based observations taken during the CABINEX 2009 field campaign to evaluate the model's updated gas phase chemical mechanism. Progress in improvements to the fitting of OMI spectra to produce glyoxal data products is also

presented. This includes, at least, statistically based removal of data spikes in the irradiances and radiances; improved modeling of the instrument transfer (slit) function; review of the reference spectrum database; common mode analysis; and reanalysis of wavelength fitting window selection. Future work will include implementation of the wavelength-dependent scattering weights/air mass factors discussed separately at this meeting, and studies to quantitatively understand differences among measurements of glyoxal and formaldehyde from OMI, SCIAMACHY, and the GOME instruments.

Overview of HIRDLS V7 Products

Bruno Nardi (NCAR/UCAR; nardi@ucar.edu), M. B. Rivas, L Smith, J. Gille & HIRDLS Team

HIRDLS updated V7 data products are summarized here. Significant modifications have been made in the radiance correction and retrieval algorithms for V7. Some of the previously released products, which include temperature, ozone, nitric acid, CFC11, CFC12, N_2O_5, NO_2 and several aerosol products, have improved significantly, both in terms of observed bias and random errors. Other products, such as N_2O and water vapor are released for the first time in V7. Comparisons for the newly released species will be presented as a preliminary validation, including estimates for the accuracy and precision. An update will be given on the improved species, making use of comparisons with other satellite data sets, balloon-sondes and lidar measurements.

Tropospheric Ozone Variations Governed by Changes in the Stratospheric Circulation

Jessica L. Neu (JPL/CalTech; Jessica.L.Neu@jpl.nasa.gov), T. Flury, G. Manney, N. Livesey, and J. Worden

Quantifying the stratospheric contribution to tropospheric O_3 has long been one of the "holy grail" problems in atmospheric sciences and a critical goal for numerous observing systems, including the Aura satellite. We provide the first large-scale direct observational estimate of the variability in tropospheric O_3 attributable to stratospheric O_3. Using six years of measurements from the Tropospheric Emission Spectrometer and Microwave Limb Sounder onboard Aura, we show that interannual variability in the stratospheric circulation on the order of +/- 20%, driven largely by ENSO and its interaction with the QBO, results in changes of +/- 20% in zonal mean Northern midlatitude stratospheric O_3 at 150 hPa. This variability in stratospheric O_3 explains 18% of the variance in Northern midlatitude tropospheric O_3 at 500 hPa. A 20% increase in stratospheric O_3 leads to a 3% increase in tropospheric O_3 approximately one month later. The interannual variability driven by the stratospheric circulation is thus ~1/4 the magnitude of the seasonal cycle, which is the dominant mode of variability in the Northern midlatitude mid-troposphere. Numerous modeling studies have predicted increases in the speed of the stratospheric circulation in the future due to increases in greenhouse gas concentrations, and these results have the potential to constrain estimates of the impact of this increase on tropospheric O_3 concentrations.

The NASA Langley Atmospheric Science Data Center: Online tool to effectively disseminate Level 2 Tropospheric Emission Spectrometer (TES) datasets

Lindsay Parker (NASA/LARC; lindsay.parker-1@nasa.gov), W. Baskin, P. Piatko, J. Kusterer, P. Rinsland, and J. Perez

Over the past decade the Atmospheric Science Data Center (ASDC) at NASA Langley Research Center has archived and distributed a variety of satellite mission and aircraft campaign datasets. These datasets pose unique challenges to science data users due to the sheer volume and variety of the data and the lack of intuitive features in the order tools available to the investigator. To meet the needs of emerging users, the ASDC addressed issues in data discovery and delivery through the development and deployment of several key capabilities:

- High resolution spatial-temporal metadata databases for key mission satellite datasets
- Data-driven interactive web applications leveraging AJAX-based elements
- Shared scientific workflow framework deployed on a configurable grid engine cluster
- Mission-specific subset modules capable of parameter-spatial-temporal subsetting and multiple format data output (HDF and NetCDF)

Sophisticated search and subset applications have been deployed at the ASDC for selected mission satellite datasets with a focus on implementing these key capabilities in a common framework and leveraging standards in data, access methods, and distribution. This enables rapid development and deployment of search and subset tools that provide enhanced access features for Earth Science data users.

Retrievals of Peroxy Acetyl Nitrate (PAN) from the Tropsopheric Emission Spectrometer

Vivienne Payne (JPL/CalTech; Vivienne.H.Payne@jpl.nasa.gov), M. Alvarado, K. Cady-Pereira, J. Worden, and S. Kulawik

Peroxy Acetyl Nitrate (PAN) is a thermally unstable reservoir for NOx that can be transported over large distances before converting back into NOx, thereby altering ozone formation far downwind from the original source. Satellite retrievals of PAN could potentially provide substantial information on the fate of NOx emissions from a range of sources including biomass burning and motor vehicles and the impact of these NOx emissions on global tropospheric ozone. PAN has previously been retrieved in the upper troposphere and lower stratosphere on a global scale from the MIPAS limb-sounder on Envisat. PAN signatures have also been observed in nadir observations of smoke plumes from fires by both the Aura TES and MetOp-A IASI instruments, but to our knowledge, PAN has not yet been retrieved in the nadir view on a global scale. Here we describe an approach for initial prototype TES PAN retrievals, including the retrieval approach, the choice of constraints and spectral microwindows and present some preliminary results of PAN retrievals over Asia.

NASA's Applied Remote Sensing Training Program (ARSET)

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The NASA Applied Remote Sensing Training Program (ARSET) provides technical capacity building activities to help integrate NASA Earth Sciences and data into environmental management activities. The program works directly with agencies in the public an private sector to 1) identify environmental management activities that could benefit from NASA Earth Science and 2) develop hands-on courses that teach the NASA products and offline and online tools best suited to the identified application area and their utilization for decision-support. Since 2009, ARSET has reached over 500 end-users and conducted 25+ in person and online NASA courses nationally and internationally. The air quality component of the program has developed training modules and case studies on the utilization of NASA trace gas and aerosol products for monitoring air pollution at ground level. ARSET also works closely with NASA funded PIs, algorithm developers, and NASA's Air Quality Applied Sciences Team (AQAST). Building on a successful 3-years effort in air quality workshops, in 2011 the program expanded its focus to water resources and disaster management. To learn more, visit the program websites at http://airquality.gsfc.nasa.gov and http://water.gsfc.nasa.gov.

Diurnal HIRDLS species: NO_2, N_2O_5 and $ClONO_2$

Maria Belmonte Rivas (UCAR; rivasm@ucar.edu), John Gille and the HIRDLS Team

The newest release of HIRDLS products (Version 7) incorporates the distribution of daily zonal Fourier coefficients of diurnally varying NO_2, N_2O_5 and ClONO2 observations over the latitude range from 64S to 80N. This work presents the preliminary quality scores that result from comparisons with correlative MIPAS and ACE measurements (including precision, accuracy and data limitations), and assesses their ability to inform our understanding of NOy / ClOy production and loss processes as currently encoded in the SD-WACCM chemical transport model.

Quantification of Atmospheric BrO

Ross Salawitch (U. Maryland; rjs@atmos.umd.adu), T. Canty, G. Mount, E Spinei, J. Herman, A. Cede, N. Abuhassan, S. Choi, R. McPeters, P. K. Bhartia, J. Joiner, J. Parrella, K. Chance, R. Suleiman, W. Simpson, B. Johnson, T. Kurosu, S. Tilmes, D. Kinnison, R. Garcia, J. Lee-Taylor, S. Madronich

Current studies point to a sizeable contribution of stratospheric inorganic bromine (Bry) loading from Very Short Lived (VSL) bromocarbons. This source of Bry is especially important for the lowermost stratosphere (LMS), leading to enhanced ozone depletion during times of high aerosol loading after major volcanic eruptions. Elevated Bry in the LMS leads to "hotspots" in total column BrO at high latitude during spring due to compression of air masses near the tropopause to high pressure. Space-borne observations of total column BrO must be carefully evaluated for influence of these stratospheric "hotspots" in order to properly quantify surface release of inorganic bromine. The next major hurdle in the field of atmospheric bromine is quantification of tropospheric BrO in extra-polar regions. If BrO is present at the ~1 to 2 ppt level through the global troposphere, this halogen would have important implications for tropospheric photochemistry (O3, NOx, oxidation of numerous organics). Precise measurement of tropospheric BrO has been elusive. We examine measurements of BrO from satellites (OMI and SCIAMACHY) and ground based instruments deployed during a recent validation campaign (spring 2011, Fairbanks, Alaska) to place limits on the abundance of BrO in the stratosphere and global troposphere. Implications of VSL bromine for geo-engineering of climate will also be described.

Geopotential Heights from HIRDLS Level-2 Temperatures and Tangent Height at Nominal Altitude

Leslie Smith (NCAR/UCAR; lsmith@ucar.edu), J.C. Gille and the HIRDLS Team

We utilize the High Resolution Dynamics Limb Sounder (HIRDLS) Version 7 Level-2 Temperatures and Tangent Height at Nominal Altitude to compute geopotential heights with significant vertical resolution. We compare the HIRDLS Level-2 geopotential heights with NCEP/NCAR, ECMWF, GMAO, and MLS colocated geopotential heights and discuss validation. We also outline some scientific applications for HIRDLS Version 7 geopotential heights.

The Origin of Stratospheric Air

Mark R. Schoeberl (Science and Technology Corporation; mark.schoeberl@mac.com), A. E. Dessler and T. Wang

The domain-filling, forward trajectory calculation model developed by Schoeberl and Dessler [2011] is used to investigate the origin of air that enters the stratosphere, and the origin of the driest and wettest air parcels. We compare results from NASA's MERRA, NCEP's CFSR, and ECMWF's ERAi reanalyses. The stratospheric air parcel origin is related to, but distinct from, the location of final dehydration zones. Final dehydration zones control stratospheric water vapor, but stratospheric air origin tells about the origin of non-water soluble constituents such as HCN or CO. The models broadly agree that stratospheric air parcel origins follow the ITCZ in winter with maxima over the tropical west Pacific and South America. The origins are more broadly dispersed in summer. Somewhat surprisingly, the seasonal cycle for the origins is small with most of the air parcel that enter the stratosphere from 360K originating in non-winter (DJF) months. The origin of the wettest and driest parcels shows that the driest parcels (1-3 ppmv) originate in the tropical West Pacific while the wettest (6-10 ppmv) parcels originate in the East Pacific/ Central America.

Satellite measurements of mid-latitude UTLS trace gases in the context of multiple tropopauses and upper-tropospheric jets

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The extra-tropical tropopause region is dynamically complex, with frequent occurrences of multiple tropopauses and of a "tropopause inversion layer" of enhanced static stability just above the tropopause. This tropopause structure is zonally-asymmetric and time-varying and, along with the UT jets and the stratospheric polar night jet, it defines the barriers and pathways that control UTLS transport. Mid-latitude secondary tropopauses are typically extensions of the tropical tropopause across the subtropical jet. They can cover a large region, at times extending poleward beyond 60 degrees latitude, and may reach the polar subvortex, particularly during SSW events. In the upper part of these inter-tropopause layers, above the layer of enhanced static stability, air is found to have characteristics suggesting low-latitude, often tropospheric, origin. Averages of trace gases that do not account for tropopause structure (such as zonal or equivalent latitude means) can obscure features of trace gas distributions, thus obscuring both the role of different transport processes in determining these distributions, and the impact of UTLS composition on climate. In this work we examine MLS, HIRDLS and ACE-FTS UTLS trace gas profiles, including H_2O, O_3, CO and HNO_3, in the context of extra-tropical tropopause and UT jet structure seen in GEOS-5 fields to gain understanding of UTLS trace gas distributions and transport barriers. Trajectory analysis provides insight into the origins and destinations of parcels in the inter-tropopause layer.

Joint climatology of ozone profiles and tropopause height

Viktoria F. Sofieva (FMI; viktoria.sofieva@fmi.fi), J. Tamminen, E. Kyrölä, G. Bodeker, and B. Hassler

We present new joint climatology of ozone profiles and tropopause height, which is aimed at reducing very large uncertainties of ozone values in upper troposphere and lower stratosphere (UTLS) reported in all existing sea-level-referenced climatologies. Because stratospheric ozone abundances are dramatically different from those in the troposphere, variations in the tropopause height induce large variability in altitude-referenced climatological ozone values in the UTLS. However, ozone profiles at a given location and over a typical climatological time interval of 1 month, cannot be considered as simply as a rigid vertical shift with respect to the tropopause height. These aspects of the problem suggest that there is value to be gained in creating ozone profile statistics that are sensitive to the location of the tropopause. To create the joint climatology of ozone profiles and tropopause height, ozone soundings collected in the BDBP (Binary Data Base of Profiles, Hassler et al., 2008) and SAGE-II measurements were used. For each 10° latitude zone and for each month, the ozone profiles were grouped according to tropopause height in 1-km intervals, and the mean ozone profile and variability were computed. The analysis is first performed separately for ozone sonde and SAGE-II profiles, and then the derived climatologies are merged to cover the altitude range from the surface to ~60 km. The combined climatology presents ozone mixing ratio profiles on a 1 km vertical resolution pressure altitude grid, according to the tropopause (or double tropopauses) height. The frequency of tropopause(s) height occurrence is also provided. This gives additional climatological information and allows the ozone-tropopause climatology to be transformed to a standard climatology of zonally mean ozone profiles. The derived tropopause statistics compare well with the previous studies. The created joint ozone-tropopause climatology demonstrates a significantly improved representation of the separation between the troposphere and stratosphere. It is characterized by reduced variability of monthly-mean data in the UTLS. This approach also allows some consideration of longitudinal variations since the tropopause height often contains longitudinal structure, which also affects ozone. The new climatology can be advantageous for use in satellite retrieval algorithms and in climate model simulations.

Stratospheric BrO abundance measured by a balloon-borne submillimeterwave radiometer

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Measurements of mixing ratio profiles of stratospheric bromine monoxide (BrO) were made using observations of BrO rotational line emission at 650.179~GHz by a balloon-borne SIS (superconductor-insulator-superconductor) submillimeterwave heterodyne receiver. The receiver incorporated a recently-developed digital polyphase spectrometer that provided uniform 700 kHz spectral resolution with 3 GHz measurement bandwidth. The balloon was launched from Ft.~Sumner, New Mexico (34 N) on 22 Sept 2011. Peak mid-day BrO abundance varied from 16+-2 ppt at 34 km to 6+-4 ppt at 16 km. Corresponding estimates of total inorganic bromine (Br_y), derived from BrO vmr (volume mixing ratio) using a photochemical box model, were 21+-3 ppt and 11+-5 ppt, respectively. Inferred Br_y abundance exceeds that attributable solely to decomposition of long-lived methyl bromide and other halons, and is consistent with a contribution from bromine-containing very short lived substances, of 4 ppt to 8 ppt. These results for BrO and Br_y were compared with, and found to be in good agreement with, those of other recent balloon-borne and satellite instruments.

Improved OMI BrO and OClO

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We present improved operational algorithms and data products for OMI bromine monoxide (BrO) and chlorine dioxide (OClO). The algorithms are, as before, based on the direct fitting of radiances. BrO is fitted from 319.0-347.5 nm, within the UV-2 channel of OMI, while OClO is fitted from 358.5.5-392.0 nm, in the visible channel. The model that is fitted to each measurement consists of the solar reference, attenuated by contributions from the target gas and interfering gases, rotational Raman scattering, additive and multiplicative closure polynomials and a common mode spectrum. The common mode spectra (one per cross-track position, computed on-line) are the average of several hundred fitting residuals and include any instrument effects that are unrelated to molecular scattering and absorption cross sections. The BrO retrieval uses albedo and wavelength-dependent air mass factors (AMFs), which have been pre-computed using climatological BrO profiles. The wavelength-dependent AMF is applied pre-fit to the BrO cross-sections, and the spectral fit retrieves vertical column densities directly. For OClO only slant columns are provided. Flagging for the OMI row anomaly is now included in the BrO and OClO products.

SHADOZ Comparisons to OMI-Derived Products (2005-2009): Progress & Instrument Issues

Anne M. Thompson, (Penn State Univ; amt16@psu.edu), J. C. Witte, S. K. Miller, D. W. Kollonige, S. Tilmes, S. J. Oltmans, B. J. Johnson, F. J. Schmidlin and the SHADOZ Team

In the period 2005-2009, during which 4 new stations joined the SHADOZ snetwork (Hanoi, Vietnam; Hilo, Hawaii; Alajuela/Heredia, Costa Rica; Cotonou, Benin), data from a total of 15 stations became available at: http://croc.gsfc.nasa.gov/shadoz; see also the hdf record at http://aura.gsfc.nasa.gov. Comparisons of OMI column ozone and the column integrated ozone from the sondes are presented for 13 stations for the years 2005-2009 (details in Thompson et al., 2012). The mean offset corresponds to 4% low for the sonde column, with a range from zero offset (Nairobi, Irene, Paramaribo) to 6-8% low (Hanoi, KL, Watukosek). This is an improvement in sonde-satellite agreement compared to SHADOZ offsets with the 1998-2004 EP/TOMS ozone record [Thompson et al. 2007]. Two factors contribute to the improvement: (1) a modified above-burst ozone column add-on based on the McPeters and Labow [2012] climatology; (2) changes in the properties of the sonde instrument (sensing solution, manufacturer) at some stations during the Aura era. We also present comparisons of sonde ozone integrated to 200 hPa with one version of a trajectory-enhanced tropospheric ozone residual product. SHADOZ stations are required to use ECC (electrochemical concentration cell) ozonesondes. However, over 14 years of operations, ECC instruments from 3 manufacturers have been deployed with a variety of sensing solution types, pump correction factors, and radiosondes. SHADOZ stations are presently re-processing their data records to compensate for these variations, according to recommendations of the O3S-DQA (Ozonesonde-Data Quality Assurance) activity of WMO-IGACO/Intl Ozone Commission/SPARC to create a unified dataset for the user community interested in global ozone and climate trends.

Updates on the OMI Cloud Pressure Product Derived from Rotational Raman Scattering

Alexander Vasilkov (SSAI and NASA/GSFC; Alexander.Vasilkov@ssaihq.com), J. Joiner, B. Fisher, and S. Marchenko

Cloud pressures are needed for accurate retrieval of ozone and other trace gases from satellite observations. OMI cloud pressures are derived from the high frequency structure of the top-of-atmosphere (TOA) reflectance in the UV caused by rotational Raman scattering (RRS). RRS generates filling-in of Fraunhofer lines in the TOA spectrum. Cloud screens RRS in the atmosphere below the cloud thus reduces the level of the filling-in, with the magnitude of the filling-in related to cloud pressure. This effective cloud pressure or optical centroid pressure (OCP) approximates an average pressure reached by backscattered solar photons. OCP characterizes how deep the solar photons penetrate the cloud and it is distinct from the physical cloud top derived from thermal infrared measurements. The OCP product, known as OMCLDRR, is currently available from Collection 3, version 1.9.0. A main change made in this latest version as compared with previous ones is the use of time-dependent soft calibration of TOA radiances. The soft calibration is based on assumption that OCP over Antarctic Plateau should be equal to the surface pressure. Then spectral residuals (observed minus calculated radiances) are computed for each swath position and the calculated residuals are used to correct TOA radiances. The soft calibration procedure is repeated for every year to account for possible changes in the OMI calibration. This time-dependent soft calibration is able to significantly reduce striping and trends in the OCP that are likely caused by instrument changes. Possible effects of the remaining OCP trends on the column ozone retrievals from OMI are considered. We compare multi-year OCP record with Aqua/MODIS cloud-top pressures collocated to nominal OMI pixels for various latitude and TOA reflectance bins.

Is mid-latitude convection activating chlorine in the lower stratosphere?

Tao Wang (Texas A&M Univ.; tao.wang@tamu.edu), A.E. Dessler, and M.R. Schoeberl

Anderson et al. [2012] recently argued that stratosphere-penetrating mid-latitude summertime convection over North America should be activating lower-stratospheric chlorine. The resulting active chlorine will then cause significant ozone depletion. We show measurements of ClO made by the Aura Microwave Limb Sounder that show no enhanced ClO over North America. This casts doubt on the importance of this mechanism.

Assimilation of the Microwave Limb Sounder Radiances

Krzysztof Wargan (SSAI at NASA/GSFC; krzysztof.wargan-1@nasa.gov), W. Read, N. Livesey, P. Wagner, H. Nguyen, and S. Pawson

It has been shown that the assimilation of limb-sounder data can significantly improve the representation of ozone in NASA's GEOS Data Assimilation Systems (GEOS-DAS), particularly in the stratosphere. The studies conducted so far utilized retrieved data from the MIPAS, POAM, ILAS and EOS Microwave Limb Sounder (EOS MLS) instruments. Direct assimilation of the radiance data can be seen as the natural next step to those studies. The motivation behind working with radiances is twofold. First, retrieval algorithms use a priori data which are either climatological or are obtained from previous analyses. This introduces additional uncertainty and, in some cases, may lead to "self-contamination" when the a priori is taken from the same assimilation system in which subsequently ingests the retrieved observations. Second, radiances can be available in near real time thus providing an opportunity for operational assimilation, which could help improve the use of infrared radiance instruments from operational satellite instruments. In this presentation we summarize our ongoing work on an implementation of the assimilation of EOS MLS radiances into the GEOS-5 DAS. This work focuses on assimilation of band 7 brightness temperatures which are sensitive to ozone. Our implementation uses the MLS Callable Forward Model developed by the MLS team at NASA JPL as the observation operator. We will describe our approach and recent results which are not yet final. In particular, we will demonstrate that this approach has a potential to improve the vertical structure of ozone in the lower tropical stratosphere as compared with the retrieved MLS product. We will discuss the computational efficiency of this implementation.

ACE-FTS Versions 3.0 Validation Update

Claire Waymark (U. Toronto; cwaymark@atmosp.physics.utoronto.ca), K. A. Walker, C. D. Boone, E. Dupuy, P. F. Bernath, J. Anderson, L. Froidevaux, C. Randall and J. M Zawodny

The ACE-FTS is one of two instruments launched on 12th August 2003 on-board the Canadian SCISAT-1 satellite. It is a high-resolution (0.02 cm-1) Fourier transform spectrometer which takes measurements over the 750-4400 cm-1 (2.2 to 13.3 μm) spectral region using solar occultation. ACE-FTS has been operating for over 8 years now, providing profiles of atmospheric temperature, pressure and more than 30 trace gas species over the ~85^{o}N to ~85^{o}S latitude range. The current ACE-FTS version has now been validated against data from the Aura-MLS, HALOE, SAGE II, SAGE III, POAM III and OSIRIS instruments, as well as previous ACE-FTS data versions. The data version comparisons having been produced for the ACE-FTS baseline species (O_3, H_2O, CH_4, NO_2, HNO_3, ClO NO_2, HCl, HF, N_2O, N_2O_5, CO, NO, CCl_2F_2 and CCl_3F), and the satellite instrument inter-comparisons having been produced for a number of species including O_3, NO_2, HCl, HF, H_2O, NO, CH_4, CO, HNO_3 and N_2O. Ongoing validation is essential in identifying any temporal changes due to issues such as aging of the instrument, therefore these comparisons are continually updated as new data becomes available. The Aura-MLS version 3.3 inter-comparisons have been expanded to include all species measured by both instruments (O_3, CO, H_2O, HCl, HNO_3 and N_2O).

Relationships between OLR, HIRDLS Gravity Wave Measurements, and Airborne Desert Dust Measurements

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A key source of momentum in the atmosphere is convection. This largely takes places in the upper troposphere, with the momentum transferred away from the generation source to drive other processes. A standard proxy for the convective generation rate in this region is the outgoing longwave radiation (OLR) from cloud tops; the higher cloudtops associated with large convective systems have a lower temperature, allowing an estimate of the rate of convection taking places at each location. Here, we compare NOAA estimates of OLR to HIRDLS-derived gravity wave momentum flux measurements in the UTLS and to desert dust measurements from the FENNEC aircraft measurement campaign in the lower troposphere, to elucidate the relationship between convective generation in the UTLS and the transfer of this momentum to other processes.

WRF-Chem simulations of aerosol impacts on summer monsoon precipitation over China

Longtao Wu (Univ. California; longtao.wu@jpl.nasa.gov), H. Su, and J. H. Jiang

East Asia is one of the most heavily polluted regions in the world. Many previous studies have shown that East Asian monsoon precipitation is affected by aerosols, but contradictory results exist. In this study, the WRF-Chem model is used to examine the aerosol impacts on precipitation over China during the East Asian summer monsoon (EASM). The 4-month model simulations reasonably reproduce the precipitation amount and the latitudinal shift of major rain bands associated with EASM. The model approximately simulates the aerosol distributions but significantly underestimates aerosols over East China during the second half of the simulations, probably too much wet scavenging in the model. In the first phase of EASM when the rain band is over South China, aerosols cool surface by scattering solar radiation. The cooling effect decreases the land-sea temperature difference, and thus weakens the strength of the monsoon circulation, causing a pattern of precipitation change resembling “southern flood and northern drought”. The precipitation changes are mainly resulted from the aerosol radiative effect while the aerosol microphysical effect acts in the opposite way with a smaller magnitude. In the second phase of EASM, the rain band shifts to the Yangtze River Basin and Northeast China. Aerosols absorb solar radiation and warm the atmosphere. In the meantime, aerosols serve as cloud condensation nuclei and delay rain formation by producing smaller cloud particles. Both the aerosol radiative and microphysical effects contribute to the northward shift of clouds and precipitation by inducing a pattern of precipitation change as “southern drought and northern flood”. Moisture budget analysis shows the change of precipitation in both phases of EASM is mainly contributed by the changes in vertical velocity associated with convection, while the horizontal advection of moisture plays a non-negligible role.

Improving Retrieval of Anthropogenic Sulfur Dioxide (SO_2) from OMI Observations

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Anthropogenic activities, such as fuel combustion, oil refining, and metal smelting, emit sulfur dioxide (SO_2) into the atmospheric planetary boundary layer (PBL), leading to air quality degradation near the source regions and in some cases long-range transport of pollution. Space-borne UV instruments, such as Aura/OMI, ENVISAT/SCIAMACHY, MetOp/GOME-2, and recently NPP/OMPS, provide a unique perspective on the spatial and temporal distribution of SO_2 over the globe. However accurate quantification of SO_2 in the PBL from these satellite measurements is challenging, because the SO_2 column densities from anthropogenic emissions are in general quite low (< 1 DU, 2.69×1016 molecules/cm^2), therefore their signals contained in the top-of-atmosphere radiance measurements are weak, often smaller than the noise level of instrument measurements. Currently the operational PBL pollution SO_2 data are produced with the band residual difference (BRD) algorithm using residuals from a TOMS-like total ozone algorithm at only four discrete wavelengths. This algorithm does not take full advantage of the hyper-spectral instruments, which contained many more SO_2 sensitive channels. In the presentation, we describe the recent progress in developing an advanced algorithm to improve detection and quantification of PBL SO_2, and compare the new retrievals with the operational OMI SO_2 products to show significant reduction in noise and bias. The new retrievals demonstrate enhanced sensitivity to SO_2 in the lower atmosphere, illustrating the potential of monitoring strong pollution events on a daily basis.

The Role DISCOVER-AQ can play in OMI validation of NO_2 and other species

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The objectives of NASA's air quality research campaign entitled "Deriving Information on Surface Conditions from COlumn and VERtically Resolved Observations Relevant to Air Quality" (DISCOVER-AQ) campaign mesh well with validation needs of OMI data products including NO_2 and aerosols. As the campaign name suggests, critical issues will be investigated regarding the application and interpretation of OMI's satellite-based column data. OMI NO_2 and aerosol data have little or no vertical sensitivity. In an attempt to fill the gap in critical vertical information about the distribution of NO_2, unique NO_2 -measuring sondes have been developed at KNMI. These sondes use chemiluminescence to measure variations in concentration of NO_2 in the boundary layer and free troposphere with high vertical resolution that OMI cannot detect. The sondes have been deployed in three major air quality measurement field campaigns including DISCOVER-AQ in the Baltimore/Washington area in July 2011. The flexible sonde platform has been used with a tethersonde balloon, via traditional balloon-borne launches, and onboard an aircraft. This type of multi-platform deployment will also be used in upcoming DISCOVER-AQ campaigns in the San Joaquin Valley (January 2013) and in Houston (September 2013). Detailed aerosol measurements about composition and optical properties made during the 2013 DISCOVER-AQ campaigns will also be used to verify OMI OMAERO AOT retrieval aerosol model choices. Data from ACAM spectrometer aircraft instruments will be used to compare aerosol index. Preliminary results including NO2-sonde profiles and OMI-to-DISCOVER-AQ data comparisons from the July 2011 DISCOVER-AQ measurement campaign will be shown as well as future OMI validation plans for upcoming field experiments of 2013.