

transpiration and photosynthesis/respiration) and ambient parameters (radiation, ambient NO<sub>x</sub> mixing ratios) allows to put the exchange rate into context. The question whether a compensation point may be identified will especially be addressed.

#### A21A-06 0915h

##### Fluxes of Primary and Secondary Biogenic Volatile Organic Compounds (BVOC) During the BEWA Field Experiments

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Biogenic volatile organic compounds (BVOCs) play a crucial role in the formation of photo-oxidants and particles through the diverse BVOC degradation pathways. Yet, current estimations about temporal and spatial BVOC emissions, including the specific BVOC mix are rather vague. This paper reports results from the determination of BVOC net emission rates that were obtained within the frame of the BEWA field experiments at the Waldstein site in the Fichtelgebirge in 2001 and 2002, an extended forest site that is largely dominated by Norway spruce (*Picea abies* [L.] Karst.). Stand fluxes of volatile organic compounds were determined with Proton Transfer Reaction Mass Spectrometry (PTR-MS) coupled to a Relaxed-Eddy-Accumulation (REA) system. The PTR-MS is capable to measure simultaneously a variety of organic trace gases, including oxygenated compounds. Air samples were taken at the top of a meteorological tower at the height of 32 m a.g.l. close to the Gill Sonic anemometer that controlled the REA-sampling. A critical value when using the REA approach is the Businger-Onclay parameter  $b$ . For this canopy type a  $b$  value of 0.39 (threshold velocity  $w_0 = 0.6$ ) was determined. The PTR-MS data show clear diurnal variations of ambient air mixing ratios of isoprene and monoterpenes, but also of oxygenated VOC such as methanol, carbonyls, methylvinylketone (MVK) and methacrolein (MAC). Canopy fluxes of isoprene reached up to  $7 \text{ nmol m}^{-2} \text{ s}^{-1}$  during daytime. The fluxes of the sum of monoterpenes were in the same range. MVK and MAC are products from isoprene oxidation. The BEWA data confirm this relationship and reveal a better correlation of MVK+MAC with isoprene ( $r^2=0.78$ ) than with the sum of monoterpenes ( $r^2=0.30$ ). In our study MVK+MAC fluxes were about 30% lower than isoprene fluxes. Both observations indicate active photochemical degradation of isoprene in this area. Acetaldehyde and acetone are typical intermediate compounds in the photochemical degradation of both anthropogenic and biogenic VOCs. However, they may also be emitted directly. Growing evidence shows that beside anthropogenic significant biogenic sources exist for both compounds. The results of the BEWA campaign reveal only a poor correlation between acetaldehyde and acetone ( $r^2=0.02$ ) indicating different origins of both species. The observations show that acetone deposition prevails suggesting that biogenic sources of acetone play a minor role, at least at this site. Acetaldehyde fluxes usually better agree with isoprene fluxes ( $r^2=0.55$ ). However, they correlate best with MVK+MAC fluxes ( $r^2=0.81$ ). This is an indication that acetaldehyde is primarily produced in photochemical degradation processes of VOC. Methanol canopy fluxes reached  $22 \text{ nmol m}^{-2} \text{ s}^{-1}$  and daytime methanol mixing ratios were up to 15 ppbv and were comparable with previously reported values. The methanol mixing ratios are consistent with its relatively long atmospheric life time of approximately 16 days making advection an important issue. However, twig enclosure measurements during the summer 2002 intensive field experiment at the Waldstein site did not reveal significant direct methanol emissions.

#### A21A-07 0930h

##### Turbulent Exchange of Particulate Matter During BEWA2000

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During BEWA2000, two field campaigns were conducted in the "Fichtelgebirge" mountains, NE-Bavaria, Germany, to study biogenic emissions of volatile organic compounds from a "Norway Spruce" forest. BVOC oxidation products may contribute to particulate mass through condensation on existing particles or new particle formation. Measurements of particulate mass, particle size distributions and vertical particle fluxes were jointly analyzed and interpreted. The particle number flux system included a sonic anemometer and two condensation particle counters. Particle size distributions were measured with a differential mobility particle sizer at the same height as the flux system at 22 m agl. Also, particle number concentrations were measured within the forest stand. Particle mass was obtained from impactor and high-volume sampler measurements. Particle numbers differed considerably within and above the forest. The in-canopy concentration ranged from 60 % to 100 % of the concentration above the canopy. A diurnal pattern with effective particle production in the canopy through turbulent mixing and/or particle formation in the morning and effective particle removal in the canopy through deposition and/or coagulation processes in the afternoon was found. An important conclusion from these findings is that not only particle concentrations but also particle size distributions may differ within and above the forest. Turbulent particle number fluxes exhibited a diurnal pattern with small fluxes in the night and large fluxes during daytime. In general, particle deposition dominated over emission. A characteristic "banana-shaped" development of the particle size distribution indicating formation of particulate matter and subsequent growth was found on several days. Strong deposition fluxes occurred during these events. Particle mass fluxes may be determined from a combination of size distribution measurements and size-resolved deposition models. The mass determined from size distributions agrees well with directly measured particle mass. However, the uncertainty of calculated mass fluxes remains large. Funding by the German federal research ministry through grants PT BEO 51-0339476C and PT UKF 07ATF25 is gratefully acknowledged.

#### A21A-08 0945h

##### BEWA2000 Studies on the Regulation of Isoprenoid Biosynthesis as Prerequisite for the Development of Process-Based Emission Models

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Trees produce a wide spectrum of volatile organic compounds (VOCs) including isoprene and monoterpenes, as well as oxygenated compounds like aldehydes, alcohols and carboxylic acids. Aim of the BEWA2000 project within the German joint research project AFO200 (Atmosphären Forschungsprogramm 2000) is to elucidate the metabolic pathways leading to the formation of these compounds, in particular volatile isoprenoids. The presentation summarises information on photosynthetic and non-photosynthetic precursors of isoprenoid biosynthesis, as well as on metabolites and enzymes of the plastidic isoprenoid pathway in isoprene- or monoterpene-emitting poplar (*Populus spec.*) and Holm oak (*Quercus ilex*). In particular, it discusses physiological, biochemical and molecular biological aspects, which are prerequisites for the development of process-based emission models describing the biochemical and physiological reactions leading to the emission of volatile isoprenoids.  
URL: <http://www.imk-ifu.fzk.de/bewa2000/>

#### A21B MCC: 3018 Tuesday 0800h

##### Asian Outflow to the North Pacific and U.S. Western Coast (joint with B)

**Presiding:** B J Huebert, University of Hawaii; D Parrish, NOAA Aeronomy Laboratory

#### A21B-01 0800h

##### Meteorological mechanisms favoring Trans-Pacific Transport of Eurasian Pollutants on intraseasonal to interannual timescales

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We use a 10-year global 3-D model simulation to conduct a systematic analysis of the meteorological mechanisms leading to long-range transport of Eurasian pollutants to the Northeast Pacific atmosphere. We find that export of Asian and European pollutants in the lower troposphere over East Asia is strongly correlated with anomalously low sea level pressures over East Asia, especially during spring. This correlation reflects the dominant role of mid-latitude cyclones as an export mechanism for Asian pollutants. Import of Asian and European pollution to the Northeast Pacific below 3 km altitude is positively correlated with the intensity of the Pacific High with maximum correlation found in spring/winter. This highlights that advection around the Pacific High is an efficient pathway to transport pollutants across the Pacific over the NE Pacific. Based on the centers of action found in the correlation analysis, we form teleconnection indices using sea level pressure (without the annual cycle) within two regions in the western and eastern Pacific. We compare these indices to intraseasonal and interannual variability in long-range transport and investigate their predictive ability in forecasting lower tropospheric trans-Pacific transport events. A similar analysis will be applied to long-range transport in the middle and upper troposphere.

#### A21B-02 0815h

##### Meteorological impact on eastern Asia tropospheric ozone during 1995-1996

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The impact of meteorology on eastern Asia tropospheric ozone distribution and transportation during 1995-1996 is researched by a regional scale chemistry model, which initial and boundary condition of species (O<sub>3</sub>, CO, and some long life VOCs) are obtained from a global chemistry model output. The comparison of model results with observations shows that the model reproduces the main diurnal and seasonal observed features. The differences of ozone distribution and transportation between years are mainly controlled by meteorology and meteorological factors combined with atmospheric chemistry processes, e.g., atmospheric cycle, cloud, precipitation and temperature. And the most obvious difference is found in April during 1995-1996.

A21B-03 0830h

### Biomass Burning versus Fossil Fuel Combustion Signatures of Air Masses Transported from Asia to the U.S. West Coast during ITCT2k2

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The goal of the Intercontinental Transport and Chemical Transformation experiment in 2002 (ITCT2k2) was to study the transport of air pollution from Asia across the Pacific Ocean, and the implications for the background atmospheric composition at the surface in North America. During research flights of the NOAA WP-3 research aircraft on May 5 and 17, strong enhancements of carbon monoxide (CO) and other species were observed in air masses that had been transported from Asia in the free troposphere to North America. The hydrocarbon composition of the air masses indicated that the highest CO levels were related to fossil fuel use. During the flights on May 5, 17 and other days, the levels of several biomass-burning indicators increased with altitude. This was true for acetonitrile (CH<sub>3</sub>CN), methyl chloride (CH<sub>3</sub>Cl), the ratio of acetylene (C<sub>2</sub>H<sub>2</sub>) versus propane (C<sub>3</sub>H<sub>8</sub>), and the percentage of particles measured by the PALMS (particle analysis by laser mass spectrometry) instrument that were attributed to biomass burning based on their carbon and potassium content. An ensemble of back-trajectories, calculated from the U.S. west coast at various latitudes and pressures during the entire ITCT2k2 period, showed that air masses from South-East Asia and China were generally transported at higher altitudes than air from Japan and Korea. Emission inventories estimate the contribution of biomass burning to the total emissions to be low for Japan and Korea, higher for China, and the highest for South-East Asia. Combined with the origin of the air masses versus altitude determined by the back-trajectories, this explains the measured altitude profiles of the biomass burning indicators.

A21B-04 0845h

### Properties of Aerosol Particles Transported From Asia to North America

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Fast response measurements of particle size distributions, bulk submicron particle composition, and single particle composition were made aboard the NOAA WP-3D research aircraft over the eastern Pacific Ocean and the western coast of North America. Simultaneous measurements of gas-phase tracers and photochemically reactive compounds, and meteorological analyses, show evidence of long-range transport of layers of aerosol particles from anthropogenic and biomass/biofuel sources in east and southeast Asia. The aerosol layers were vertically discrete and were often correlated with CO, NO<sub>x</sub>, O<sub>3</sub>, organic compounds, and meteorological features. Four distinct types of particles layers were encountered: 1) associated with biomass/biofuel combustion; 2) associated with urban and/or industrial sources but no SO<sub>2</sub>; 3) associated with urban and/or industrial sources including SO<sub>2</sub>; and 4) containing crustal material not associated with identifiable anthropogenic or biomass burning influence.

URL: <http://www.al.noaa.gov/ITCT/2k2/>

A21B-05 0900h

### Gas-Phase Chemical Characteristics of Transported Asian Emissions Observed During ITCT2k2 Over the Eastern North Pacific Ocean

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The gas-phase chemical characteristics of emission plumes transported from Asia across the Pacific Ocean observed during the Intercontinental Transport and Chemical Transformation experiment in 2002 (ITCT2k2) are described. The NOAA WP-3 conducted 13 research flights over the eastern Pacific Ocean and the western continental US at altitudes up to 8 km. Plume data were separated from the background air using 1 s measurements of carbon monoxide (CO), NO<sub>y</sub> and other gas-phase species along with back trajectory analysis. Based on these criteria, Asian transport plumes with CO mixing ratios greater than 150 ppbv were observed on six flights. Correlations between 1 s observations of CO and ozone (O<sub>3</sub>) and NO<sub>y</sub> are used to characterize the plumes. The O<sub>3</sub>/CO ratio varied among the different plumes. The NO<sub>y</sub>/CO ratios were similar in each plume and significantly lower than those derived from estimated Asian emission ratios. Observations of nitric oxide (NO), nitrogen dioxide (NO<sub>2</sub>), nitric acid (HNO<sub>3</sub>), peroxyacetyl nitrate (PAN), peroxypropionyl nitrate (PPN) and alkyl nitrates are used with the NO<sub>y</sub> measurement to further distinguish the transport plumes by their NO<sub>y</sub> partitioning. The reactive nitrogen observations along with the back trajectory analysis suggest that the NO<sub>y</sub> partitioning was largely controlled by the meteorological conditions during transport. NO<sub>y</sub> was primarily in the form of PAN in plumes that were transported in cold high latitude and high altitude regions, whereas in plumes transported in warmer lower latitude and altitude regions NO<sub>y</sub> was mainly HNO<sub>3</sub>. Additional gas phase species enhanced in these plumes include sulfuric acid, methanol, acetone, propane, and ethane. Identifying the gas phase chemical characteristics of these plumes is crucial in understanding the influence of the transport of Asian emissions on air quality in the Western U.S. and on global climate change through perturbations to the tropospheric ozone budget.

A21B-06 0915h

### Evaluation of pollutant outflow and CO sources during TRACE-P using model-calculated, aircraft-based, and MOPITT-derived CO concentrations

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Outflow of CO from Asia during March 2001 was evaluated using data from the TRACE-P mission and the MOPITT instrument in conjunction with model-calculated CO from the University of Maryland CTM.

Comparison of model-calculated CO with aircraft measurements was encouraging. Temporal and spatial variations in CO were well captured (mean correlation coefficient of 0.78); however, model-calculated mixing ratios were lower than observed especially below 850 hPa where negative biases of 60 ppbv were seen. "Non-standard" aerosol effects explain a portion of the negative biases. Below 300 hPa, biases between model-calculated and observed CO distributions were reduced by 6-9 ppbv when OH concentrations were adjusted to take into account the effect of aerosols on photolysis- and reaction-rates. Inverse modeling of CO was used to estimate the corrections to Asian CO emissions suggested by the combination of model simulations and aircraft measurements in the TRACE-P region. Resulting Asian correction factors were 1.70 ± 0.36 for fossil fuel/biofuel (ff/bf) emissions and 1.00 ± 0.30 for bb emissions. Resulting ff/bf emissions were 29.6 ± 6.2 Tg for March 2001 (323 ± 67 Tg for an entire year). Resulting bb emissions for March 2001 were 18.1 ± 5.4 Tg. Comparison of model-calculated CO with MOPITT measurements supported the results from our inverse modeling study. Without exception, mean March 2001 model-calculated CO profiles in the TRACE-P region from a simulation with adjusted CO sources were within a standard deviation of mean March 2001 MOPITT-sampled profiles. Finally, sampling biases need to be considered when interpreting low-latitude MOPITT profiles

A21B-07 0930h

### Asian Outflow to the Pacific Observed During PEACE-B Aircraft Campaign in April-May 2002

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Aircraft measurements of CO, NO, NO<sub>2</sub>, NO<sub>y</sub>, O<sub>3</sub>, and various other species were made during Pacific Exploration of Asian Continental Emission phase B (PEACE-B) conducted over the western Pacific in April-May 2002. Enhancements of CO up to 350 ppbv were observed at altitudes between 6 and 10 km over the southern part of Japan Sea on May 14. Back trajectories of sampled air masses suggest that some part of these air masses were uplifted over central China at latitudes around 30N one day prior to the encounter. High-altitude clouds were detected from the Geostationary Meteorological Satellite (GMS-5) in this region suggesting that convective transport of polluted air masses was responsible for these high CO values. Meteorological data analyses indicate that during PEACE-B warm moist air was frequently advected into a frontal zone at low altitudes from lower latitudes forming a frontal zone. In association with this unstable condition, cumulus convection that reached at altitudes higher than 500 hPa frequently appeared over this region. The subtropical jet was also located around 30N in this region and air masses uplifted by convection were efficiently transported to the Pacific by the jet. These mechanisms are considered to play important roles for venting polluted air masses in the boundary layer to the free troposphere over East Asia and rapid horizontal transport of uplifted air masses to the Pacific during PEACE-B. Chemical characteristics of air masses influenced by these processes are also presented and discussed.

URL: <http://atmchem.eorc.nasda.go.jp/GLACE/PEACE/htdocs/index.html>

**A21B-08 0945h****Constraints on the Sources of Tropospheric Ozone From  $^{210}\text{Pb}$ - $^7\text{Be}$ - $\text{O}_3$  Correlations**Hongyu Liu<sup>1,2</sup> (1-757-766-1703; hyl@nlanet.org)Daniel J. Jacob<sup>1</sup> (1-617-495-1794; dj@io.harvard.edu)Jack E. Dibb<sup>3</sup> (jack.dibb@unh.edu)Arlene M. Fiore<sup>1</sup> (afiore@post.harvard.edu)Robert M. Yantosca<sup>1</sup> (bmy@io.harvard.edu)<sup>1</sup>Harvard University, Department of Earth and Planetary Sciences and Division of Engineering and Applied Sciences, 29 Oxford Street, Cambridge, MA 02138, United States<sup>2</sup>National Institute of Aerospace, 144 Research Drive, Hampton, VA 23666, United States<sup>3</sup>University of New Hampshire, Institute for the Study of Earth, Oceans and Space, 39 College Road, Durham, NH 03824, United States

The  $^{210}\text{Pb}$ - $^7\text{Be}$ - $\text{O}_3$  relationships observed in three aircraft missions over the western Pacific (PEM-West A and B, TRACE-P) are simulated with a global 3-D chemical tracer model (GEOS-CHEM) driven by assimilated meteorological observations. Results are interpreted in terms of the constraints that they offer on sources of tropospheric ozone ( $\text{O}_3$ ). Aircraft observations of Asian outflow along the Asian coast show strong  $^{210}\text{Pb}$ - $\text{O}_3$  correlations in Sep-Oct (PEMWest A) but such correlations are only seen at low latitudes in Feb-Mar (PEM-West B and TRACE-P). Observations further downwind over the Pacific show stronger  $^{210}\text{Pb}$ - $\text{O}_3$  correlations in Feb-Mar than Sep-Oct. The model reproduces these results and attributes the seasonal contrast to strong  $\text{O}_3$  production and vertical mixing in Sep-Oct, seasonal shift of convection from China in Sep-Oct to Southeast Asia in Feb-Mar, and slow but sustained net  $\text{O}_3$  production in Asian outflow over the western Pacific in Feb-Mar. Seasonal biomass burning over Southeast Asia in Feb-Mar is also responsible for the positive  $^{210}\text{Pb}$ - $\text{O}_3$  correlations observed in the middle and upper troposphere at low latitudes near Asia and over the remote Pacific. The model reproduces the observed absence of  $^7\text{Be}$ - $\text{O}_3$  correlations over the western Pacific during Sep-Oct, implying strong convective and weak stratospheric influence on  $\text{O}_3$ . The model shows stronger  $^7\text{Be}$ - $\text{O}_3$  correlations than the observations during PEM-West B and TRACE-P, suggesting it does not underestimate the stratospheric source of  $\text{O}_3$ . We conclude that less than 20-30% of model  $\text{O}_3$  in the mid-latitude middle troposphere originates from the stratosphere in spring.

URL: [http://research.nlanet.org/~hyl/publications/liu2003\\_pbbeo3.pdf](http://research.nlanet.org/~hyl/publications/liu2003_pbbeo3.pdf)**A21C MCC: Level 2 Tuesday 0830h****The Aura Mission to Study Chemistry and Climate III Posters (joint with SA)****Presiding: A Douglass, NASA**

Goddard Space Flight Center; E

**Hilsenrath, NASA Goddard Space Flight Center****A21C-0969 0830h POSTER****Characterization of Aura-TES (Tropospheric Emission Spectrometer) Nadir and Limb Retrievals**Helen M Worden<sup>1</sup> (818-354-0532;Helen.Worden@jpl.nasa.gov); Reinhard Beer<sup>1</sup>

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The TES Level 2 algorithm retrieves vertical profiles of atmospheric temperature and trace gases from radiometrically calibrated measured spectra. The retrieval is based on minimizing the difference between a measured spectrum and a model spectrum, which is calculated for an estimated atmospheric state. This minimization is subject to smoothness constraints imposed on the atmospheric profiles being retrieved and is applied iteratively using a non-linear least squares solver. Algorithm descriptions and simulation results are presented. Simulations of the data acquired by TES along different orbit tracks were generated in order to test the TES nadir and limb retrieval algorithms for different spatial and temporal (seasonal and day/night) regimes. Noise added to simulated radiances is representative of the noise measured during TES instrument calibration. Retrieval results, including error analysis and expected vertical resolution, are shown for both the nadir and limb viewing modes of TES.

**A21C-0970 0830h POSTER****Spectral-Windows and Retrieval Characterization for Tropospheric Emission Spectrometer Nadir Retrievals**John R Worden<sup>1</sup> (818 393 7122;john.worden@jpl.nasa.gov); Susan S Kulawik<sup>1</sup> (818

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Spectral windows are reported for TES nadir retrievals of surface temperature, atmospheric temperature,  $\text{H}_2\text{O}$ ,  $\text{O}_3$ ,  $\text{CO}$ , and  $\text{CH}_4$ . Spectral windows are selected if they increase the information content, which is a function of an a priori covariance matrix and a posteriori covariance matrix. The posteriori covariance depends on an estimated smoothing error, measurement error, and systematic errors from interfering species and line parameter uncertainties. In order to ensure that spectral windows are robust over a variety of climatological conditions, the information content is computed for four regions representative of northern mid-latitude, southern mid-latitude, tropical, and polar climates. Characterization of TES retrievals are a consequence of the spectral window selection; therefore, we also report the expected errors and vertical resolution for TES nadir retrievals for these four climatologically representative profiles.

**A21C-0971 0830h POSTER****Calibration and Characterization of the Tropospheric Emission Spectrometer**David Rider<sup>1</sup> (818-354-3776;

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Prior to shipment of the Tropospheric Emission Spectrometer (TES) to the AURA spacecraft in late April, 2003, the instrument was put through an extensive series of thermal vacuum tests, over an 8-month period, to characterize and calibrate the instrument performance. During these tests, measurements were made

to characterize the field-of-view, radiometric and spectral performance of the instrument. The measurements were highly successful in for quantifying key instrument parameters and also permitted the characterization of many unexpected, but important instrument features. This presentation will describe the measurements and results of the TES pre-flight calibration.

**A21C-0972 0830h POSTER****Tropospheric Emissions Spectrometer (TES) One Day Test Objectives And Status**Michael C Lampel<sup>1</sup> (626.744.5411;mlampel@sdsio.jpl.nasa.gov); Helen Worden<sup>2</sup>(hmw@tes-mail.jpl.nasa.gov); Reinhard Beer<sup>2</sup>(Reinhard.Beer@jpl.nasa.gov); Kevin Bowman<sup>2</sup>

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The TES instrument will be launched as part of the EOS Aura spacecraft. The goal of the instrument is to observe important chemical species in the atmosphere,  $\text{O}_3$ ,  $\text{CH}_4$ ,  $\text{CO}$ , and others. The TES One Day Test processes 16 orbits (1 day which is defined as a global survey) worth of instrument observations: 1168 nadir target scenes (averages of 2 nadir observations pointing at the same geolocation) and 3504 limb target scenes. There are four science objectives for the ODT. First, to determine whether the "production mode" implementation of the species retrieval algorithm provides the required accuracy, robustness, and performance needed to be able to successfully process global survey data. Robustness refers to the ability to apply constraints, allow selection of retrieval algorithms and/or cost functions, and include enough detail in the forward model to account for the true variation of the atmosphere so that the majority of target scenes can complete successfully. Second, to determine what information out of the target scene retrievals will be most useful in enabling monitoring of science data quality, instrument performance, and compilation of relevant statistics. Third, to evaluate error analysis techniques for both single target retrievals and aggregations of retrievals, with emphasis on an entire global survey. Fourth, to determine whether ordering target scenes would allow additional improvements in performance. Status of the ongoing One Day Test will be presented including results of retrievals and corresponding error analysis. The degree to which the above objectives have been satisfied will be discussed.

**A21C-0973 0830h POSTER****Calibration of the EOS Microwave Limb Sounder on the Aura Spacecraft**Robert F Jarnot<sup>1</sup> (818 354 5204;

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The Microwave Limb Sounder experiment on the Aura Spacecraft (EOS MLS) is a direct descendant of the MLS experiment on the Upper Atmosphere Research Satellite (UARS MLS), with greater spectral coverage and increased measurement precision and bandwidth. Comprehensive pre-launch Radiometric, Spectral and Field-of-View calibrations were performed on the instrument prior to delivery. Experience gained with UARS MLS was used to improve calibration accuracy in all categories. Calibration results from EOS MLS will be presented, with descriptions of the enhancements applied to the techniques used on the earlier instrument.

URL: [http://mils.jpl.nasa.gov/joe/eos\\_mls.html](http://mils.jpl.nasa.gov/joe/eos_mls.html)