

The chemistry transport models (CTMs) aim to reproduce the observed distributions of the long-lived and short-lived species in the troposphere and stratosphere, including their annual and interannual variations and long-term trends. Various archived dynamics have been used by modellers to drive CTMs, including 3-D transport fields from general circulation models (GCMs) and data assimilation systems (DASs). We briefly review our zonal mean diagnostics package for evaluation of the transport properties of GCMs and DASs, highlighting some results that can be seen from the annual evolution of the monthly mean transport parameters. The package includes the trajectory code for particles dispersion and estimation of the zonal mean transport circulation and large-scale eddy mixing using the Eulerian tracer model. Comparative examples will be presented for the 2000 NCEP and ECMWF DASs, and MACCM2-95 GCM. The tracer model itself can be used to diagnose some subgrid vertical transport parameters from the global meteorological fields (e.g., convection and diffusion of tropospheric pollutants). We compare the first tropospheric CO retrievals from the MOPITT instrument on the Terra satellite with the CO-tracer simulations driven by the NCEP large-scale dynamics and convective transports that are estimated by different convective schemes from the NCEP archived history tapes.

#### A52A-0149 1330h POSTER

##### Systematic Errors in NOGAPS: Improvements to the Cloud and Turbulence Parameterizations

Joao Teixeira<sup>1</sup> (831 6564730; teixeira@nrlmry.navy.mil)

Timothy Hogan<sup>1</sup> (831 6564705; hogan@nrlmry.navy.mil)

<sup>1</sup>Naval Research Laboratory, Grace Hopper Ave, Monterey, CA 93943, United States

Turbulence, convection and clouds have a strong impact on the Earth's climate system. However, these processes are often active at scales smaller than the horizontal grid size of climate or numerical weather prediction models. Parameterization schemes are necessary in order to describe the impact of these sub-grid scale mechanisms on the large scale flow of the atmosphere. Improvements to the parameterization schemes can have significant effects on the reduction of systematic errors in climate models. A review of improvements to the cloud and turbulence schemes in NOGAPS and its impact on systematic errors will be presented.

#### A52A-0150 1330h POSTER

##### Application of Methods of Systematic Initial Model Tendency Error Detection to the Deduction of Underlying Sources of Systematic Errors

Ingo Kirchner<sup>1</sup> (+49-40-41173-387; kirchner@dkrz.de)

Bennert Machenhauer<sup>2</sup> (+45-39157-400; bm@dmi.dk)

Shuting Yang<sup>2</sup> (+45-39157-463; sy@dmi.dk)

<sup>1</sup>Max Planck Institute for Meteorology, Bundesstrasse 55, Hamburg 20146, Germany

<sup>2</sup>Danish Meteorological Institute, Lyngbyvej 100, Copenhagen OE 2100, Denmark

The causes of systematic errors in the time mean fields of a GCM are difficult to detect from an analysis of the errors themselves. Direct estimates of systematic initial tendency errors (SITEs) determined by assimilation of reanalysis data will on the other hand point more directly to the model components causing the errors. The ECMWF Reanalysis (ERA-15) data for the period 1982 until 1994 were assimilated in different ECHAM versions using different techniques, the SNMI with window, nudging and for a part of the period using the Total Insertion (TI) with window methods, introduced and validated in an accompanying presentation. The techniques uncover SITEs of the model in question, visible as rather similar structures. In the TI experiments, the SITEs are generally less weakened than in the SNMI experiment by balancing during the assimilation, in particular at upper levels, but contains more unbalanced spurious SITEs, caused by truncation and interpolation errors.

Using these methods assimilation runs were made and SITEs were determined. These were analysed with the purpose to deduce the causes of the systematic mean errors found in AMIP runs with the model. To try to distribute the total SITEs on different model processes we use methods based on comparisons of the three dimensional structure of the SITEs and the three dimensional structure of the time mean tendency fields of each of the model processes in question. This reveals deficiencies in the representation of key physical processes in the climate model, which together form a basis for improvement of the model.

#### A52A-0151 1330h POSTER

##### Spectral EOF Analysis: Another Way to Compare the General Circulation Model With Observation

Xianglei Huang<sup>1</sup> (1-626-392-3995; hx1@gps.caltech.edu)

John Farrara<sup>2</sup> (vwk206@atmos.ucla.edu)

Yuk L. Yung<sup>1</sup> (yly@gps.caltech.edu)

Richard M. Goody<sup>3</sup> (rgoody@capecod.net)

<sup>1</sup>Division of Geological and Planetary Sciences, California Institute of Technology, 1200 E. California Blvd., Pasadena, CA 91125, United States

<sup>2</sup>Department of Atmospheric Sciences, University of California, Los Angeles, 7127 Math Sciences Bldg., Los Angeles, CA 90095, United States

<sup>3</sup>Department of Chemistry and Chemical Biology, Harvard University, 101 Cummelon Drive, Falmouth, MA 02540-1609, United States

Spectrally resolved outgoing radiance could be a potentially powerful tool for testing climate models, especially testing the variability of models. To show how it can be used to evaluate the simulation of clouds in models, which is the major uncertainty in current climate models, we apply spectral empirical orthogonal function (EOF) analysis to observed outgoing radiance spectra and synthetic spectra derived from a general circulation model (GCM). The observation data were collected by IRIS (InfraRed Interferometer Spectrometer) aboard on Nimbus4. The modeled vertical profiles of temperature, water vapor and cloud optical depth were imported to MODTRAN (MODerate resolution TRANsmittance code) to compute the synthetic spectra. We focus our study on tropical oceans because they have smaller diurnal and seasonal cycle than other regions. The issues of different spatial and temporal sampling patterns of observation and GCM are carefully studied. It turns out that proper averaging over correct timescale before applying spectral EOF analysis is necessary because sampling patterns of GCM and observation are difference. For both observation and GCM output, cloud is the dominant contributor to the first principal component that accounts for more than 90% of the total variance. However, the amplitude of the first principal component derived from the IRIS is 2-3 times greater than that of the GCM simulation. This suggests that cloud variability in GCM is much less than the real atmosphere.

#### A52B MC: Hall D Friday 1330h

##### Chemistry and Transport Near the Tropopause: Results From the 1999 and 2000 ACCENT WB-57F Field Campaigns II

*Presiding:* R. Friedl, Jet Propulsion

Laboratory; K. Rosenlof, NOAA; M. Ross, The Aerospace Corporation

#### A52B-0152 1330h POSTER

##### Overview of ACCENT Near Tropopause Measurements

Randall R. Friedl<sup>1</sup> (818-354-3800; rfriedl@jpl.nasa.gov)

Martin N. Ross<sup>2</sup> (310-336-0360; martin.n.ross@aero.org)

<sup>1</sup>Jet Propulsion Laboratory, California Institute of Technology, MS 183-901, 4800 Oak Grove Dr., Pasadena, CA 91109, United States

<sup>2</sup>The Aerospace Corporation, MS 615, P.O. Box 92957, Los Angeles, CA 90009, United States

The Atmospheric Chemistry of Combustion Emissions Near the Tropopause (ACCENT and ACCENT 2) missions were multi-agency sponsored efforts to investigate the chemistry of rocket and aircraft emissions in the upper troposphere (UT) and lower stratosphere (LS). The missions utilized the NASA WB-57F aircraft and were based at Ellington Field in Houston, Texas during April and September, 1999 and August 2000. During ACCENT extensive sampling was conducted in the vicinity of the Dallas-Fort Worth airport where meteorological forecasts predicted accumulation of aircraft exhaust. The gaseous tracer data obtained during the Dallas flight indicate that the sampled air was substantially impacted by recent and aged aircraft exhaust. The ACCENT mission also collected near tropopause gaseous and aerosol data in the tropics and near and above hurricane Floyd. In this overview

presentation we will describe the mission objectives regarding the impacts of aviation on the global atmosphere and the meteorological planning tools applied to flight planning. A number of key chemical and aerosol observations will be highlighted.

#### A52B-0153 1330h POSTER

##### Transport in the Region of the Subtropical Jet Deduced From WB-57 Measurements and Mesoscale Modeling

Eric Ray<sup>1,2</sup> (303-497-7628; eray@al.noaa.gov)

Karen H. Rosenlof<sup>1</sup> (krosenlof@al.noaa.gov)

<sup>1</sup>NOAA/Aeronomy Lab, MS R/AL6 325 Broadway, Boulder, CO 80305, United States

<sup>2</sup>CIRES/Univ. of Colorado, Campus Box 216, Boulder, CO 80309

Recent WB-57 missions have provided a wealth of long-lived tracer and aerosol measurements in the upper troposphere and lower stratosphere. In this study we use in situ water vapor, ozone and meteorological measurements as well as vertical sounding data to investigate transport in the region of the subtropical jet. In addition, mesoscale model simulations from the NCAR MM5 are utilized to attempt to reproduce the observations and help determine possible mechanisms of transport. We focus on the flight of May 7, 1998 since it has several interesting features in the measurements taken as the flight crossed a jet exit region at roughly the 370 K level. On the tropical side of the jet, low water vapor and relatively high ozone mixing ratios were measured suggesting the air in this region had stratospheric characteristics. Yet according to MM5 output this region is well within the troposphere. Within the jet the water vapor mixing ratios are highly variable, with some mixing ratios higher than those measured on either side of the jet at the same isentropic level. This suggests that perhaps there was more vertical mixing within the jet than on either side of the jet. A third interesting feature in the measurements is seen several hundred km north of the jet just as the plane began to rise in altitude. Between 370-390K the water vapor increased sharply and the ozone decreased sharply at the same time the MTP instrument indicated the tropopause level had risen from 345 K to 370 K in less than 50 km. This feature is highly suggestive of a small filament of upper tropospheric air which has been transported to the north side of the jet. Each of these features is compared to MM5 output and trajectory analyses.

#### A52B-0154 1330h POSTER

##### Mass Spectra of Individual Aerosol Particles Acquired During Intercepts of a Space Shuttle Exhaust Plume

Daniel J. Cziczco<sup>1,2</sup> (303-497-3755; djcziczco@al.noaa.gov)

Daniel M. Murphy<sup>1</sup> (303-497-5640; murphyd@al.noaa.gov)

David S. Thomson<sup>1,2</sup> (303-497-3470; dthomson@al.noaa.gov)

<sup>1</sup>NOAA Aeronomy Lab, 325 Broadway R/AL6, Boulder, CO 80305, United States

<sup>2</sup>CIRES, The University of Colorado, Boulder, CO 80309, United States

The WB-57 aircraft accomplished fourteen distinct stratospheric intercepts of the exhaust plume from a space shuttle during ACCENT 2000. Liftoff of the shuttle Atlantis for STS-106 occurred at 8:46 am local (12:46 UTC) with intercepts occurring from 5 to 90 minutes afterward. The Particle Analysis by Laser Mass Spectrometry (PALMS) instrument, mounted in the nose of the aircraft, was used to acquire individual mass spectra of over 2500 particles during these intercepts. The majority of positive mass spectra indicate the presence of the metals Al, Fe, Zn, Ga, and V, all components found in the solid rocket fuel. Organic material, presumably from binding and curing agents, was also present. Negative mass spectra showed Cl from the oxidizer, ammonium perchlorate, as well as water. Rare exotic particles, for example those containing Ti and Ag and possibly formed during engine or seal ablation, were also detected. Particles originating from shuttle exhaust but also containing significant sulfuric acid were common toward the outer edge of the plume, especially during late encounters, suggesting that deposition or aerosol collision had occurred.

URL: <http://www.al.noaa.gov/PALMS/>

A52B-0155 1330h POSTER

**FTS Measurements of Enhanced Methane in Jet Contrails**

Eldon Puckrin<sup>1</sup> (705-748-1011 ext. 1698; epuckrin@trentu.ca)

Wayne F.J. Evans<sup>1</sup> (705-748-1011 ext. 1622; wevans@trentu.ca)

<sup>1</sup>Trent University, Environmental Resource Studies P.O. Box 4800, Water St. N., Peterborough, ON K9J 7B8, Canada

A Fourier Transform Spectrometer was used to take spectra of jet contrails under clear sky conditions from the ground. A BOMEM model DA-8 FTS with .02 cm<sup>-1</sup> resolution was used in conjunction with a pointing mirror. A clear sky spectrum was taken on the blue sky just beside the contrail. The spectra were divided to obtain a difference spectrum of the contrail alone. A 15% enhancement of methane was observed in addition to the thermal emission spectrum of ice. This measurement was repeated on several occasions with similar results. The spectrum were also used to estimate the long wave surface radiative forcing from the contrails.

A52B-0156 1330h POSTER

**Intercomparison of water vapor measurements taken during the ACCENT mission**

Kenneth K. Kelly<sup>1</sup> (303 497-3355; kellyk@al.noaa.gov)

Karen H. Rosenlof<sup>1</sup>

Holger Voemel<sup>2</sup>

Robert L. Herman<sup>3</sup>

<sup>1</sup>NOAA Aeronomy Laboratory, 325 Broadway, R/AL6, Boulder, CO 80305, United States

<sup>2</sup>CIRES/University of Colorado and NOAA Climate Monitoring and Diagnostics Laboratory, 325 Broadway, Boulder, CO 80305, United States

<sup>3</sup>NASA Jet Propulsion Laboratory, 4800 Oak Grove Ave, Pasadena, CA 91109, United States

During the ACCENT mission, four water instruments made measurements. The JPL tunable diode laser, NOAA frostpoint, and NOAA Lyman-alpha instruments flew on the NASA WB-57F high altitude aircraft. Additionally, there were a few coincident flights of the NOAA-CMDL balloon frostpoint instrument. Differences between measurement were noted during the flights. These differences will be discussed and related to past intercomparisons. Possible reasons for the differences will be presented.

A52B-0157 1330h POSTER

**Identification of the Source of Methyl Nitrate Observed in the Upper Troposphere During the April 1999 ACCENT Mission: A Successful Test of the Convective Influence Technique**

Henry B Selkirk<sup>1</sup> (650-604-6489; hselkirk@mail.arc.nasa.gov)

Elliot Atlas<sup>2</sup> (atlas@acd.ucar.edu)

Leonhard Pfister<sup>3</sup> (pfister@mindigo.arc.nasa.gov)

Randall Friedl<sup>4</sup> (Randall.R.Friedl@jpl.nasa.gov)

<sup>1</sup>Space Physics Research Institute, M/S 245-5 NASA-Ames Research Center, Moffett Field, CA 94035-1000, United States

<sup>2</sup>National Center for Atmospheric Research, P.O. Box 3000, Boulder, CO 80303, United States

<sup>3</sup>NASA-Ames Research Center, M/S 245-5, Moffett Field, CA 94035, United States

<sup>4</sup>Jet Propulsion Laboratory, 4800 Oak Grove Dr., Pasadena, CA 91109, United States

On the final two flights of the April 1999 phase of the joint NASA/USAF airborne research mission ACCENT (Atmospheric Chemistry of Combustion Emissions Near the Tropopause) based in Houston, Texas, the NASA WB-57 took tracer samples in an upper tropospheric air stream over the Gulf of Mexico. The science goal for these two flights was to intercept air that had emerged from a major flare-up of convection in the eastern Pacific ITCZ two to three days earlier, as had been indicated in convective influence forecasts generated by the ACCENT science team. We show that observed enhancements of the tracer methyl nitrate bear out the forecast predictions of convective influence.

On each flight, the NCAR Whole Air Sampler detected levels of methyl nitrate below 12 km that were at least twice the 1 to 2-pptv observed above that altitude. The second of the two flights, on April 23, was distinguished by a strong contrast between the samples on the lower leg below 12 km and the background levels above. On this day the WB-57 flew a simple flight profile: a level southbound leg at 35,000 feet (10.7 km) to 24.5°N and a return leg at 47,000 feet (14.3 km) with the potential temperature throughout the lower leg remaining within a degree of 338K while on the return leg varying between 360 and 370K. Virtually the entire lower leg, a span of over 4 degrees of latitude, had methyl nitrate levels between 4 and 5.5 pptv, while none of the samples at the higher elevation exceeded 1.5 pptv. This pattern of methyl nitrate enhancements is consistent with that of convective influence fields at flight time, both from the initial forecasts during the mission and the final analyses we present here. That is, the histories of air parcels initialized along the flight path and run at 338 K (the potential temperature of the lower leg) had encounters with convection over the eastern tropical Pacific as recently as 2 days ahead of the flight. In contrast, trajectories run at the 358 and 363K levels show no encounters with convection anywhere in the previous 5 days.

More significantly, recent measurements of methyl nitrate during the PEM-Tropics A and B missions provide strong evidence that production of this trace constituent is confined to the tropical sea surface. The observations of elevated levels of methyl nitrate in the upper troposphere of the subtropics would thus require a process in which tropical surface air was transported upward and mixed into free tropospheric air: in short, deep convection with detrainment and mixing into the upper tropospheric environmental air. This is entirely consistent with the picture presented by the results from the convective influence analysis. That is, moderately deep convection over the eastern tropical Pacific, sufficient to transport methyl nitrate-enriched air from the boundary layer to 10-12 km and no higher, is followed by the mixing of convective and environmental air and undisturbed transport over the course of a day or two downstream and northeastward out of the eastern Pacific, across Mexico and into the Gulf.

A52B-0158 1330h POSTER

**Critical Analysis of the Atmospheric Importance of Short-lived Bromo- and Iodoalkane Emissions Using the LLNL IMPACT Model**

Peter S Connell<sup>1</sup> (925-422-1811; connell2@llnl.gov)

Daniel J Bergmann<sup>1</sup> (bergmann1@llnl.gov)

Douglas A Rotman<sup>1</sup> (rotman1@llnl.gov)

<sup>1</sup>Lawrence Livermore National Laboratory, P.O. Box 808 L-103, Livermore, CA 94550, United States

Bromine and iodine-containing haloalkanes (e.g. bromomethanes and iodomethanes) other than the well-known Halons (e.g. CF3Br and CF2ClBr) may contribute important levels of ozone-destructive halogen radical species to the lower stratosphere, despite their typically short atmospheric lifetimes. For these gases, rapid photodissociation and/or hydrogen abstraction by tropospheric hydroxyl radical limit lifetimes to days or weeks and produce spatially variable tropospheric distributions, such that transport of surface emitted species to the upper troposphere arises episodically rather than as a result of a well-mixed tropospheric distribution. We have modeled the release and photochemistry of these species and the effects of their radical products in a 3-D model (the LLNL IMPACT model) that is constructed to represent both tropospheric and stratospheric photochemistry as well as the dynamical and physical processes, such as advection, convection, and precipitation scavenging, that determine the availability of halogens at the tropopause from these source species. We will present distributions, comparing results to tracers of tropospheric motions relevant to the species lifetimes, and photochemical effects compared to ozone destruction from the longer-lived bromine and chlorine-containing source gases.

This work was performed under the auspices of the U.S. Department of Energy by the University of California, Lawrence Livermore National Laboratory under contract No. W-7405-Eng-48.

A52B-0159 1330h POSTER

**Single-Particle Laboratory Studies of Heterogeneous H2O and HCl Processing on Clean and H2SO4-Coated Aluminum Oxide Particles**

Amy J R Hunter<sup>1</sup> ((978) 689-0003; hunter@psicorp.com)

David M Sonnenfroh<sup>1</sup> ((978) 689-0003; sonnenfroh@psicorp.com)

Wilson T Rawlins<sup>1</sup> ((978) 689-0003; rawlins@psicorp.com)

<sup>1</sup>Physical Sciences Inc., 20 New England Business Center, Andover, MA 01810, United States

Aluminum oxide particles exhausted from solid rocket motors may affect tropospheric and stratospheric radiative balance through nucleation and growth of water ice clouds, both locally in launch corridors and globally. These particles also are active toward chemisorption of HCl and dissociative chemisorption of CFCs. Plume particle surfaces are likely to contain H2SO4, possibly altering their activities toward uptake and chemical processing of HCl and HNO3. We have investigated activities of different types of aluminum oxide particles for uptake of gas-phase H2O and HCl, using a single-particle electrodynamic levitation apparatus. The particle types investigated were clean and H2SO4-treated alpha-Al2O3 and gamma-Al2O3. We also investigated metastable Al2O3 particles formed by rapid cooling from molten particles in a shock tube, analogous to particle processing in a rocket exhaust nozzle. Particles were treated with H2SO4 by vapor deposition in an oven. The kinetic measurements consisted of independent, simultaneous observations of mass uptake and particle size increase upon exposure of single levitated particles to fixed concentrations of H2O or HCl in slowly flowing gas mixtures at 1 atm. Alpha and gamma Al2O3 were essentially inert toward H2O and HCl uptake, however they readily adsorbed monolayer-equivalent levels of H2SO4 vapor. H2SO4-coated and metastable particles were active toward H2O and HCl uptake. The measured uptake efficiencies imply fast reaction rates within rocket exhaust plumes, potentially leading to CCN behavior as well as heterogeneous chlorine activation by these particles.

This research was supported by the Air Force Office of Scientific Research.

A52B-0160 1330h POSTER

**Fast-Response (4 Hz) In Situ Ozone Measurements by a UV Absorption Photometer on the WB-57F During ACCENT**

Wilson T Rawlins ((978) 689-0003; rawlins@psicorp.com)

Physical Sciences Inc., 20 New England Business Center, Andover, MA 01810, United States

The ACCENT (Atmospheric Chemistry of Combustion Emissions Near the Tropopause) campaign was a multi-agency investigation of the chemistry and dynamics of rocket and aircraft emissions in the upper troposphere (UT) and lower stratosphere (LS). The mission utilized the NASA WB-57F aircraft as the platform for a multi-investigator suite of measurement instrumentation for a wide variety of gas-phase and particulate species in the UT/LS. As part of this mission, the PSI UV Ozone Photometer obtained in situ ozone data at measurement frequencies of 1 and 4 Hz. Operation at 4 Hz on board the WB-57F produced ozone measurements with spatial resolutions near 50 m. These data can be used to investigate fine-scale ozone variability and mixing scales in the normal upper atmosphere and across sharp boundaries as observed in ozone-depleted rocket exhaust plumes. Fast-response ozone data were obtained in flights over Hurricane Floyd and into the ITCZ, as well as in encounters with exhaust plumes from an Athena solid-fueled rocket and from the Space Shuttle, both near 18 km altitude. In the rocket plume measurements, the data show well-defined regions containing near-zero ozone concentrations, which persist and expand for 0.5 to 1.5 hr after passage of the rocket. In addition, the data exhibit considerable spatial structure within the ozone-depleted regions that indicates a high degree of dynamic complexity in the intercepted plume segments. We will present an overview of the fast-response ozone data base, and will discuss chemical kinetic and dynamic implications of the rocket plume measurements.

This research was supported by NASA and by the Air Force Office of Scientific Research.

A52B-0161 1330h POSTER

**Observation of Volatile and Non-volatile Particulates in High Altitude Rocket Plumes**

Philip Whitefield<sup>1</sup> (573-341-4340; pwhite@umr.edu)

Donald Hagen<sup>1</sup> (573-341-4351; hagen@umr.edu)

Andrew P. Rutter<sup>1</sup>

Ray Hopkins<sup>1</sup>

Marty Ross<sup>2</sup>

<sup>1</sup>Cloud and Aerosol Sciences Laboratory, G-7 Norwood Hall University of Missouri-Rolla, Rolla, MO 65409-0430, United States

<sup>2</sup>Aerospace Corp., P.O. Box 92957, Los Angeles, CA 90009, United States

Measurements of Non-volatile and volatile ( $\sim 198^\circ\text{C}$ ) particulates were made at high altitude in the exhaust plumes of the following rockets: Atlas IIAS (AC-154 4/12/99 CCAS); Delta II (268-Landsat 7, 4/15/99 VAFB); Athena II (IKONOS, 9/24/99 VAFB); STS-106 (9/8/00, CCAS).

Size distributions and particulate concentration profiles of total and non-volatile particulates extending over the size range of 8-4000nm have been measured and will be presented. Data in the size range 340-4000nm was collected throughout the flight using laser particle counting techniques. Data in the size range 8-250nm were acquired only during plume incursions using a Grab Tank Sampling system [1].

Three modes were observed in the particulate size distributions for all launches studied. The relative mass fractions present in each mode will be discussed. A volatile component was observed for the first time in both the Athena II and STS-106 measurement flights and their mass ratios with respect to total estimated mass will be presented.

REFERENCES 1) Ross, M.N., P.D. Whitefield, D.E. Hagen and R. Hopkins, "In-Situ Measurement of the Aerosol Size Distribution in Stratospheric Solid Rocket Motor Exhaust Plumes", Geophys. Res. Lett. 26, 819-822. (1999).

#### A52B-0162 1330h POSTER

##### Water Vapor Enhancements in an Athena II Rocket Plume

Robert L Herman<sup>1</sup> (818-393-4720; robert.herman@jpl.nasa.gov)

Randall R Friedl<sup>1</sup> (818-354-3800; randall.r.friedl@jpl.nasa.gov)

Bruce W Gandrud<sup>2</sup> (303-497-1038; gandrud@ucar.edu)

<sup>1</sup>Jet Propulsion Laboratory, California Institute of Technology, Mail Code 183-401 4800 Oak Grove Drive, Pasadena, CA 91109, United States

<sup>2</sup>National Center for Atmospheric Research, P.O. Box 3000, Boulder, CO 80307, United States

One of the major goals of the Atmospheric Chemistry of Combustion Emissions Near the Tropopause (ACCENT) mission was to quantify rocket plume emissions and chemistry. On September 24, 1999, the NASA WB-57F aircraft intercepted an Athena II rocket plume multiple times in the lower stratosphere. Within the rocket plume, water vapor was enhanced two to four times above the background mixing ratio of 4.6 ppmv due to oxidation of the hydroxyl-terminated polybutadiene rocket propellant. Particle concentrations were also enhanced in the rocket plume. In this talk, we will address the following questions: What is the emission index (EI) of water from an Athena II rocket? Can plume dilution be estimated? Does a significant fraction of water condense onto particles in the rocket plume?

#### A52B-0163 1330h POSTER

##### Mass-Independent Fractionation of Oxygen-containing Radicals in the Atmosphere

James R Lyons (310-794-5047; jrl@ess.ucla.edu)

UCLA, Department of Earth and Space Sciences, Los Angeles, CA 90095-1567, United States

Mass-independent fractionation (MIF) of ozone has been observed in both the troposphere and stratosphere (e.g., Thiemens, 1999). Because ozone is a photochemically active species, its MIF signature can be imparted to other atmospheric molecules. Using a photochemical equilibrium model for short-lived radical species, I have computed the expected MIF for typical mid-latitude conditions. The model accounts for about 70% of recent measurements of  $\Delta^{17}\text{O}$  for  $\text{H}_2\text{O}_2$  in rainwater (Savarino et al., 1999), and predicts large MIF for  $\text{NO}_x$  and ClO species ( $\sim 40\text{--}70\text{‰}$ ), and their products ( $\text{ClONO}_2$  and  $\text{HNO}_3$ ). Furthermore, in the stratosphere oxygen exchange reactions between OH and  $\text{NO}_x$  yield OH with  $\Delta^{17}\text{O}$  from 2 to 45 ‰. Stratospheric water produced during H abstraction by OH would be similarly mass-independently fractionated. In the troposphere rapid exchange between OH and  $\text{H}_2\text{O}$  erases any MIF signature in OH. These model results depend on several O exchange reactions with unknown activation energies or rate coefficients known only as upper limits.

The model predicts that stratospheric  $\text{H}_2\text{O}$  should have a MIF signature, thus providing an additional method for distinguishing tropospheric water transported upward (or horizontally from the tropics) from water produced chemically in the stratosphere. An upper limit to  $\Delta^{17}\text{O}$  of stratospheric  $\text{H}_2\text{O}$  can be obtained from consideration of the quasi-conserved quantity  $2[\text{CH}_4] + [\text{H}_2\text{O}]$  for air parcels entering the stratosphere. Dessler et al. (1994) determined that  $2[\text{CH}_4] + [\text{H}_2\text{O}]$  constitutes 45 ‰ of the quasi-conserved sum, suggesting that  $\Delta^{17}\text{O}$  of  $\text{H}_2\text{O}$  has an upper limit value of  $\sim 20\text{‰}$ . However, this value neglects return of unoxidized

$\text{CH}_4$  to the troposphere. One-dimensional calculations that properly account for mixing are in progress.

#### A52C MC: 123 Friday 1330h Sampling Issues in Observing the Atmosphere II

Presiding: I Astin, University of Reading; L Di Girolamo, University of Illinois at Urbana-Champaign

#### A52C-01 1330h

##### Cloud Cover From Linear Transect Measurements: Sampling Issues

Larry Di Girolamo<sup>1</sup> (217-333-3080; larry@atmos.uiuc.edu)

Ivan Astin<sup>2</sup> (011-44-1189-318741; iva@mail.nerc-essc.ac.uk)

<sup>1</sup>University of Illinois at Urbana-Champaign, Department of Atmospheric Sciences 105 S. Gregory Street, Urbana, IL 61801 3070, United States

<sup>2</sup>University of Reading, NERC Environmental System Science Center, Reading, United Kingdom

Space-based cloud radars and lidars provide linear transect measurements along their orbital path. Their measurements are divided into smaller finite linear transects for analysis. A finite linear transect measurement may be assumed to be a representative sample of a geographically larger field. This assumption invites new statistical tools to be developed to tackle the sampling issues that arise. We will present two such statistical tools for examining cloud cover. The first provides the general probability distribution for the fraction of clouds along a finite transect. This distribution allows confidence intervals to be placed on the observed cloud fraction prior to measurement based on knowledge of the distributions for the cloud and clear-sky lengths. In this form, hypothesis testing of models for these length distributions can be made, given the observed cloud fraction. The second tool is derived by applying Bayes' theorem to the above distribution so that confidence intervals can be placed on the true cloud fraction. This second tool is applied to cumulus cloud fields, revealing that confidence for the true cloud fraction over typical climate model grid scales as measured by a radar or lidar in space is rather low. Finally, this approach gives a way of estimating the probability mass function for the number of clouds layers within a column perpendicular to the transect and hence the probability of a cloud layer obscuring one below.

#### A52C-02 1347h

##### Sampling Error Characteristics Of Cloud Observations From LiDAR

Martine van de Poll (44 118 935 26 99; hmvp@mail.nerc-essc.ac.uk)

NERC-ESSC, Harry Pitt Building, 3 Earley Gate, University of Reading, Reading, Ber RG6 6AL, United Kingdom

Height profiles of cloud fraction is an important parameter that is not well represented in GCMs and in smaller scale models. Improvements should come from new and existing remote sensing technologies that will increasingly provide the science community with direct observations of such profiles. However, an inherent error or uncertainty is associated with any cloud fraction estimate from remote sensing data due to instrument and atmospheric noise, sensor resolution and the sampling scheme. While all sources of uncertainties need to be investigated further, this project focuses on the characteristics of the errors originating from the sampling scheme.

Space-borne LiDAR data from the 1994 NASA LITE campaign is used to study and quantify the characteristics of such sampling errors in cloud fraction estimates from along transect measurements. This is done within a general model for sampling along a transect, which has been developed based on an approach from queuing theory, without making prior assumptions on the type of cloud distribution (Astin and Di Girolamo, 1999).

Results will be presented giving estimates of the cloud fraction and its distributions over a range of altitudes as evaluated from cloudy and clear interval lengths as observed along the transects of the LITE observations. The estimates themselves are refined to account for missing data due to attenuation of the LiDAR signal by dense cloud.

Further, the distribution of cloud cover fraction over the earth is also presented, which allows for climatological interpretation of the results. In this, estimates of the mean cloud cover fraction and distributions and confidence intervals are provided for pressure

levels from the boundary layer to the tropopause. Estimates are also inferred from transects over the whole globe, but separated into climatological regions based on mean precipitation-evapotranspiration, as well as separated by surface type such as clouds over land versus those above sea.

The above results allow examination of the error characteristics of the cover fraction estimates in relation with the underlying process and the LiDAR sampling scheme.

#### A52C-03 1404h

##### Spatial Variability of Derived Properties for Marine Stratus Clouds

Mark Matheson<sup>1</sup> (541-737-5692; mmatheso@oce.orst.edu)

James A Coakley<sup>1</sup> (541-737-5686; coakley@oce.orst.edu)

<sup>1</sup>Oregon State University, College of Oceanic and Atmospheric Sciences, Ocean Admin 104, Corvallis, OR 97331-5503

Cloud visible optical depth, droplet effective radius, and emission temperature retrieved from satellite imagers are validated by comparing them to the properties retrieved from ground-based remote sensing instruments or in-situ aircraft observations. This involves comparing an instantaneous two-dimensional satellite data set to a temporally averaged data set collected at one location (the ground station record) or to a linear transect (the aircraft record). To characterize some of the errors that may occur in such a comparison, cloud properties of a square region are derived from NOAA-14 1-km resolution AVHRR data. These properties are compared to a central transect of the same satellite data, which is used to simulate the cloud advecting over a ground station or an aircraft transect.

Autocorrelation lengths of all three derived cloud properties for marine stratus are less than 10 km and the autocorrelation functions fall below zero at approximately 20 km. Autocorrelations remain below zero for lags greater than 20 km probably because of mesoscale structure in the stratus fields. Such short autocorrelation lengths would appear to impose severe limits on the distances over which two cloud samples may be compared. Nevertheless, when the cloud properties averaged for the square regions are compared with the cloud properties averaged for the central transect, the area averaged and transect averaged properties are well correlated (greater than 0.975). For scales of order 30 km, the mean difference between the area averages and the transect averages is much smaller than the standard deviations of the data in an individual area, which is in turn much smaller than the range of the averages of all the areas used for analysis. This result is independent of sensor resolution for resolutions smaller than 8 km. These results indicate that cloud properties averaged for square regions can be meaningfully compared to cloud properties averaged for their central transect, supporting the use of ground instruments and aircraft transects to validate satellite retrievals.

In order to test for biases in derived cloud properties due to differences in satellite sensor and surface instrument resolution, the average cloud properties of small regions are calculated by two different methods. In the first method, radiances from each individual pixel are used to derive cloud properties, and the cloud properties are averaged over the entire area. In the second method, the radiances for the entire area are averaged and these averaged radiances are used to derive cloud properties. Of the derived cloud properties, only visible optical depth retrievals show bias, which increases with decreasing resolution. Visible optical depths calculated using the first method (derived then averaged) are lower than visible optical depths calculated using the second method (averaged then derived).

#### A52C-04 1421h

##### Analysis of Temporal Sampling Errors in CERES Data Products

Jesse D Kenyon<sup>1</sup> (757 827-4641; j.d.kenyon@larc.nasa.gov)

David R Doelling<sup>1</sup> (757 827-4634; d.r.doelling@larc.nasa.gov)

David F Young<sup>2</sup> (757 864-5740; d.f.young@larc.nasa.gov)

Takmeng Wong<sup>2</sup> (757 864-5607; TAKMENG.WONG@LaRC.NASA.GOV)

<sup>1</sup>Analytical Services and Materials, Inc, 1 Enterprise Parkway Suite 300, Hampton, VA 23666, United States

<sup>2</sup>NASA Langley Research Center, Mail Stop 420, Hampton, VA 23681-2199, United States

The Clouds and the Earths Radiant Energy System (CERES) Experiment is the latest and most accurate satellite-based instrument designed to measure the Earths global energy budget. With improvements in instrument calibration accuracy and stability, coupled with the development of new angular directional