

A41D-07 1040h

Comparison of MLS, HALOE, POAM-II, SAGE-II, and ILAS Measurements in October-November 1996 Using Traditional Correlative Analysis and Trajectory Hunting Technique

Michael Y Danilin¹ (781-761-2246; danilin@aer.com); Malcolm K.W. Ko¹ (781-761-2249; ko@aer.com); Lucien Froidevaux² (818-354-8301; lucien@mls.jpl.nasa.gov); Michelle L Santee² (828-354-2494; mls@praxis.jpl.nasa.gov); Richard M Bevilacqua³ (202-767-0768; bevilacq@poamb.nrl.navy.mil); Lawrence V Lyjak⁴ (303-497-1412; lv1@acd.ucar.edu); Joseph M Zawodny⁵ (757-864-2681; J.M.Zawodny@larc.nasa.gov); James M Russell⁶ (757-728-6893; jmr@hamptonu.edu); Yasuhiro Sasano⁷ (81-298-50-2444; sasano@nies.go.jp); Hitoshi Irie⁸ (81-3-5452-5145; irie@atmos.rcast.u-tokyo.ac.jp); Yutaka Kondo⁸ (81-3-5452-5145; kondo@atmos.rcast.u-tokyo.ac.jp); Courtney J Scott¹ (781-761-2243; scott@aer.com)

- ¹AER, Inc., 131 Hartwell Ave., Lexington, MA 02421, United States
- ²NASA JPL, 4800 Oak Grove Drive, Pasadena, CA 91109, United States
- ³Naval Reserach Laboratory, 4555 Overlook Ave., SW, Washington, DC 20375, United States
- ⁴NCAR, ACD, P.O. Box 3000, Boulder, CO 80303, United States
- ⁵NASA Langley Reserach Center, Mail Stop 475, Hampton, VA 23681, United States
- ⁶Hampton University, P.O. Box 6075, Hampton, VA 23668, United States
- ⁷University of Tokyo, 4-6-1 Komaba Meguro-ku, Tokyo 153-8904, Japan
- ⁸NIES, Atmospheric Env. Div., Tsukuba, Iba 305-0053, Japan

We compared version 5 Microwave Limb Sounder (MLS), version 19 Halogen Occultation Experiment (HALOE), version 6 Polar Ozone and Aerosol Measurement-II (POAM-II), version 6.0 Stratospheric Aerosol and Gas Experiment-II (SAGE-II), and version 5.20 Improved Limb Atmospheric Spectrometer (ILAS) measurements in the southern hemisphere in October-November 1996. The following species were compared: O₃ (measured by all instruments), H₂O (measured by ILAS, HALOE, and SAGE-II), NO₂ (measured by ILAS, POAM-II, and SAGE-II), HNO₃ (measured by MLS and ILAS), and CH₄ (measured by HALOE and ILAS). This comparison was performed using traditional correlative analysis and trajectory hunting technique (THT). Launching backward and forward 5-day trajectories from the location of measurements, the THT identifies air parcels sampled at least twice within a prescribed match criterion. Detailed sensitivity studies for the THT are performed. We conclude that the THT is a powerful tool for validation studies, making conclusions of the comparison statistically more robust.

A41D-08 1055h INVITED

Advances in Stratospheric Dynamics Attributable to UARS

Timothy J. Dunkerton (425 644-9660 x326; tim@nwra.com)

Northwest Research Associates, P.O. Box 3027, Bellevue, WA 98009-3027, United States

Observations obtained from instruments aboard the Upper Atmosphere Research Satellite (UARS) have led to significant advances in our understanding of dynamics and transport in the upper troposphere, stratosphere, and mesosphere, particularly in tropical and subtropical latitudes where ground-based observations are scarce and winds are difficult to derive from radiance. Global analyses from the UK Met Office, implemented in support of the UARS mission, played an important role in the interpretation of dynamical and constituent data from UARS. Several processes thought to be important prior to the UARS decade were confirmed with new and more extensive observations, including tropical upwelling, diabatic descent in the polar vortex, subtropical barrier, modulation of mean meridional circulation and eddy mixing by the QBO and SAO, interaction of the QBO with stratosphere and mesosphere SAO, and interaction between the QBO and annual cycle in the transport of trace species. More significant are the contributions of UARS data to our understanding of large-scale dynamics and transport in the tropical and subtropical upper troposphere and lowermost

stratosphere: the morphology of intraseasonal oscillations, Kelvin waves, monsoon circulations, and their role in stratosphere-troposphere exchange and dehydration of air entering the stratosphere.

The value of UARS observations for process studies is clear. In the longer term, UARS observations and data obtained from similar instruments aboard future satellite platforms will be found valuable for the assessment of climate sensitivity due to dynamics and transport: e.g., the regulation of water vapor by deep convection, and modulation of middle atmosphere composition and temperature by wave transport and induced mean meridional circulations.

A41D-09 1115h

On the distributions and EOFs of HALOE/UARS Ozone and Methane

Prabir K. Patra¹ (+81-45-778-5727; prabir@jamstec.go.jp)

M. S. Santhanam² (+91-11-686-1555; msanathan@in.ibm.com)

¹Frontier Research System for Global Change, 3173-25 Showa Machi, Kanazawa, Yokohama 236-0001, Japan

²IBM India Research Laboratory, Block-1, IIT-Delhi, Hauz Khas, New Delhi 110 016, India

Three dimensional (3D) analysis of O₃ and CH₄ have been made to study the longterm trends and influence of various dynamical phenomena on their distributions. We have used measurements from the Halogen Occultation Experiment (HALOE) on board the UARS in the period of December 1991 to November 2000. The analysis produces data base for a chemical constituent at 10⁰ × 5⁰ horizontal resolution at 19 pressure levels between 100 mb and 0.07 mb in season scale time interval. The 3D analysis constitute most realistic representation of the chemical species in the earth's atmosphere.

Empirical orthogonal functions (EOFs) are produced on 2D pressure levels as well as considering 3D volume space. The 3D EOF#1 for CH₄ captures the longterm trends above 100 mb. The subsequent EOFs capture the signal of the quasi-biennial, annual, and semiannual oscillations. This suggests that the 3D EOFs contain more information than those could be obtained from the 2D EOFs, and also the 3D EOFs construct a more compact basis set to represent the complete data set. This is one of advantages of the 3D analysis of the satellite observations on the irregular space and time coordinates. On the contrary the O₃ EOF#3 capture the QBO related variability prominently. The difference in EOFs of O₃ and CH₄ are primarily linked to their source region and associated transport mechanism.

Recently it has been shown that empirical correlation matrices in atmospheric and oceanic sciences can be modelled as random matrices. We apply the random matrix techniques and obtain a criteria to determine the significance of the computed EOFs. We also compare our results with the Monte-Carlo based techniques like rule-N. Our results indicate that RMT based criteria selects fewer EOFs, than the rule-N, and they correspond closely to physical significance as well. Thus, for the purposes of identifying the physically relevant features in EOFs, RMT based criteria provides realistic bounds.

A41D-10 1130h

Water Vapor, Ozone, and Cirrus in the Tropical Lower Stratosphere Observed by UARS

Hannah L Clark¹ (44 131 650 5092; H.Clark@ed.ac.uk)

Robert S Harwood¹ (44 131 650 5095; R.S.Harwood@ed.ac.uk)

Hugh C Pumphrey¹ (44 131 650 6026; H.C.Pumphrey@ed.ac.uk)

¹University of Edinburgh, Institute for Meteorology, University of Edinburgh, King's Buildings, Mayfield Road, Edinburgh EH9 3JZ, United Kingdom

The Microwave Limb Sounder (MLS) on the Upper Atmosphere Research Satellite (UARS) is sensitive to water vapor and ozone in the lower stratosphere and made coincident, daily measurements of the two species in the tropical region between September 1991 and April 1993. The Cryogenic Limb Array Etalon Spectrometer (CLAES), another of the instruments on UARS has a spatial and temporal coverage similar to that of MLS and can be used to indicate the presence of cirrus. We describe the characteristics of the air in which these cirrus are found. The frequency of appearance of cirrus clouds increases as relative humidity increases or as temperature decreases. Ozone mixing ratios have a tendency to be lower in regions where there are cirrus which may indicate that the air in which the cirrus are found has entered the stratosphere relatively recently. In some seasons, the location of cirrus is associated with the occurrence of deep convection. At

other times it is found remote from centres of deep convection suggesting that the cirrus are formed by slow ascent. The importance of cirrus in dehydrating the lower stratosphere and the consequences of cirrus formation within the context of stratosphere-troposphere exchange are discussed.

A41D-11 1145h

HALOE and SAGE Observations of Tropospheric Cirrus and Background Aerosol Near the Tropopause

Steven T Massie (303-497-1404; massie@ucar.edu)

NCAR, PO Box 3000, Boulder, CO 80307, United States

The HALOE and SAGE experiments have observed cirrus and background aerosol near the tropopause for a decade following the Pinatubo eruption in 1991. Time series of extinction from both experiments show that cirrus extinction increased in the 1990s as background aerosol extinction decreased. This result is contrary to microphysical model results.

Multiple wavelength extinction data are used to distinguish cirrus particles from background aerosol (e.g. volcanic particles) near the tropopause. These spectral techniques are discussed, in addition to the effects of particle shape upon extinction spectra, in relation to the cirrus and background extinction time series.

A42A MC: Hall D Thursday 1330h

New Insights Into Stratospheric Chemistry, Dynamics, and Transport IV

Presiding: W Norton, Clarendon Laboratory

A42A-0079 1330h POSTER

Where is an Entrance of the air to the Tropical Stratosphere?

Hiroaki HATSUSHIKA¹ (+81-11-706-2298; hatsushika@ees.hokudai.ac.jp)

Koji YAMAZAKI^{1,2} (+81-11-706-2361; yamazaki@ees.hokudai.ac.jp)

¹Graduate School of Environmental Earth Science, Hokkaido University, Kita-10, Nishi-5, Sapporo 060-0810, Japan

²Frontier Research System for Global Change/IARC, 3173-25, Showa-machi, Kanazawa-ku, Yokohama 236-0001, Japan

A trajectory analysis is done for investigating the path of the air with low water vapor mixing ratio into the tropical stratosphere in boreal winter. The parcels are advected for 1 month by the three-dimensional wind field in the SST forced AGCM simulation (Hatsushika and Yamazaki, 2001, GRL and also Yamazaki and Hatsushika, 2001 AGU Fall meeting). Initially many parcels were placed in the upper tropical troposphere. The entrance point to the stratosphere is defined as a location of the smallest saturation mixing ratio along the trajectory of the parcel which reached above 90 hPa after 1 month.

The entrance points are widely spread over the equatorial convective regions. The entrance of the stratosphere from the troposphere is neither completely uniform nor confined to the region of the 'stratospheric fountain', i.e. over Indonesia and western Pacific.

The trajectory calculation indicates many parcels enter into the stratosphere over Indonesia, although the time-mean vertical motion there is downward. This discrepancy is resolved by taking into account the transient eddies and long horizontal excursion within the tropopause region.

A42A-0080 1330h POSTER

Analysis and Modelling of Water Vapour and other Trace Gases in the Tropopause Region using CRISTA Data

Hendrik Feldmann¹ (0049 221 4002258; hf@eurad.uni-koeln.de)

Bernd Schaele² (0049 202 439 2606; schaele@wpos2.physik.uni-wuppertal.de)

Adolf Ebel¹ (0049 221 4002258; eb@eurad.uni-koeln.de)

Dirk Offermann² (0049 202 439 2604; offerm@wpos2.physik.uni-wuppertal.de)

¹Rhenish Institute for Environmental Research, EURAD Group, Aachener Str. 201-209, Cologne D-50931, Germany

²University Wuppertal, Physics Department, Gauss Str. 20, Wuppertal D-42097, Germany

For two periods in November 1994 and August 1997 the earth observation telescope CRISTA (CRYogenic Infrared Spectrometers and Telescopes for the Atmosphere) was brought to the earth orbit by a space shuttle.

During the second mission CRISTA was able to measure several trace constituents in the tropopause region. Among them are ozone and water vapour as particularly interesting species. A project about transport, chemistry and trace gas distribution in the tropopause region (TRACHT) has been created to carry out a comprehensive analysis of the observations. A global and a mesoscale model are employed (NUCAR-ROSE, global, and EURAD regional, vertical extension up to 10hPa). The studies aim at a better understanding of dynamical and chemical processes controlling the trace gas distributions on the one hand and improvement of the models on the other hand.

First results obtained for two different dynamical situations will be reported. First case: During most the CRISTA2 Episode an omega like pressure structure was located over the eastern Atlantic Ocean and parts of Europe. This blocking situation is seen by CRISTA as a humid region at the 200hPa level. Yet, to the west over the Atlantic and the east over the Black Sea very dry air reaches far to the south. The transport pattern for this mesoscale feature are analysed with both models. Aircraft data coinciding with the CRISTA data are also used. Second case: A region with high humidity over the Indonesian Archipelago offers the chance to study the process of deep convection in the tropics and its impacts on the uppermost troposphere. An intriguing question to be answered is the performance of the models in the tropical belt and the agreement of our results with global weather analysis (ECMWF, NRRP, UKMO).

The cases will be used to analyse the interaction of the lowermost stratosphere and the uppermost troposphere with respect to air mass and trace gas exchange.

A42A-0081 1330h POSTER

Study of Atmospheric Dynamics With the new Rotational Raman Lidar of RASC at Shigaraki, Japan

Andreas Behrendt¹ (behrendt@kurasc.kyoto-u.ac.jp)

Takuji Nakamura¹ (nakamura@kurasc.kyoto-u.ac.jp)

Michitaka Onishi¹ (m-onishi@kurasc.kyoto-u.ac.jp)

Toshitaka Tsuda¹ (tsuda@kurasc.kyoto-u.ac.jp)

¹Radio Science Center for Space and Atmosphere, Kyoto University Gokanoshio Ujiishi, Kyoto 611-0011, Japan

The new Raman lidar of the Radio Science Center for Space and Atmosphere (RASC) at Kyoto University is a five channel system optimized for the study of atmospheric dynamics in the upper troposphere and the stratosphere. The lidar transmitter is frequency-doubled Nd:YAG laser with 30 W output power at 532 nm. For the detection of the backscattered signal a Cassegrain telescope with a diameter of 0.82 m is used. Detection channels are for the elastic backscatter signal from lower and higher altitudes, two rotational Raman signals with opposite temperature dependency, and a water vapor Raman signal.

In the upper troposphere and stratosphere, the system measures the atmospheric temperature profile with rotational Raman technique. Rotational Raman lidar gives the temperature without external assumptions and is the only lidar technique which is unperturbed by the presence of cloud or aerosol particles. With the RASC lidar, rotational Raman signals with, to our best knowledge, at present highest intensity can be taken. This allows nighttime temperature measurements with a resolution of, e.g., 300 m with a few minutes in 10 km height, and made even the first daytime rotational Raman measurements possible. In heights above 30 km, another technique, Rayleigh integration lidar, is deployed. This method leads to higher resolution data than rotational Raman lidar but is perturbed in heights where background aerosols are present. As the upper limit for deriving rotational Raman data is near the stratopause, there is an altitude range where we can compare temperature data of both techniques.

In addition to temperature, our system measures the water vapor mixing ratio (H_2O Raman lidar technique) and, independently, the particle extinction coefficient α_{par} and the particle backscatter coefficient β_{par} (rotational Raman technique). Raman lidar uses the vibrational-rotational Raman backscatter signal as a reference signal to derive α_{par} and β_{par} . In contrast to this, our system makes use of the approximately 10-times stronger pure-rotational Raman signals for deriving both atmospheric temperature and a temperature independent Raman reference signal.

The system was set up at (34.8 °N, 136.1 °E) near Shigaraki, Japan, where also the MU (middle and upper atmosphere) radar, one of the world largest atmospheric radars, is located and allows simultaneous atmo-

lidar measurements. We will discuss the benefits of the new RASC Raman lidar for the study of atmospheric waves and dynamics and present first measurements.

A42A-0082 1330h POSTER

Spatiotemporal Patterns of the Interannual Variability of Total Column Ozone in the Tropics

Charles D. Camp¹ ((626) 395-6447; cdc@gps.caltech.edu)

Mark S. Roulston²

Yuk L. Yung³

¹Applied and Computational Mathematics, Caltech, MC 150-21, Pasadena, CA 91125, United States

²Pembroke College, Oxford, United Kingdom

³Division of Geological and Planetary Sciences, Caltech, Pasadena, CA, United States

Using the recently constructed Merged Ozone Data (MOD) set, we carried out an empirical orthogonal function (EOF) study of the temporal and two dimensional spatial patterns of the interannual variability of total column ozone in the tropics. Gridded MOD, combining the monthly mean column abundances collected by the Total Ozone Mapping Spectrometer (TOMS) and the Solar Backscatter Ultraviolet (SBUV and SBUV/2) instruments, provides a nearly continuous record from late 1978 to 2000 on a $5^\circ \times 10^\circ$ latitude-longitude grid. The precision of these measurements and their calibration allow very small signals, $\sim 1\%$ of total column ozone, to be clearly seen. The leading two EOF's of our study, which respectively account for 48% and 22% of the variance of the deseasonalized data, display structures attributable to the quasi-biennial oscillation (QBO), with influence from a decadal oscillation. The third EOF, accounting for 11% of the variance, represents an interaction between the QBO and the annual cycle. The fourth EOF, accounting for 4% of the variance, is related to the El Niño - Southern Oscillation. This EOF decomposition is robust; nearly identical patterns occur in the decomposition of just the deseasonalized TOMS dataset, a shorter record with a more finely resolved spatial grid. Similar decompositions occur for fields from the reanalysis product from the National Center for Environmental Prediction and National Center for Atmospheric Research. Using these analyses, we provide a plausible explanation of the deduced patterns in terms of the dynamical forcing of the stratosphere by the troposphere.

A42A-0083 1330h POSTER

Characteristics of Stratospheric Water Vapor Revealed by SAGE II (version 6) and HALOE (version 19) Observations Covering 1994-1999

ERWOON CHIOU (757-864-6810; e.chiou@larc.nasa.gov)

SAIC Corporation, Mail Stop 475 NASA Langley, Hampton, VA 23681, United States

SAGE II (Stratospheric Aerosol and Gas Experiment II) and UARS/HALOE (Halogen Occultation Experiment) have provided multi-year data sets of stratospheric water vapor profiles with similar spatial sampling frequency and similar vertical resolution.

The purpose of this paper is to examine the characteristics of water vapor in the stratosphere revealed by SAGE II (version 6) and HALOE (version 19) using observations covering the overlapping period 1994-1999. An interim empirical correction for the systematic bias has been applied to the SAGE II data set before comparison. The proposed correction scheme is based on the relative differences between SAGE II version 6 and version 5.9 data sets for the period 1986-1990. Correction factors are assumed to vary with altitudes, latitudes and seasons but without temporal variations.

Results will be presented to illustrate the consistent water vapor climatology in terms of seasonal zonal mean profiles, seasonal variations of the hygropause and the latitudinal variations at various pressure levels. Anticipated changes for the upcoming version 6.1 SAGE II water vapor data set will also be discussed.

A42A-0084 1330h POSTER

Two-Dimensional Modeling of the Fractionation of Nitrous Oxide Isotopomers in the Stratosphere

Christopher G. Morgan¹ (510-625-9476; cgm@gps.caltech.edu)

Yuk L. Yung¹ (626-395-6940; yly@gps.caltech.edu)

Mark A. Allen^{1,2} (626-395-6970; maa@gps.caltech.edu)

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

²Jet Propulsion Laboratory, 4800 Oak Grove Dr., Pasadena, CA 91109, United States

Both mass dependent and mass independent isotopic fractionations in atmospheric N_2O have recently been reported. We investigate the mass dependent isotopic fractionation mechanism, based on photolytic destruction, to explain the $15N/14N$ and $18O/16O$ fractionation of stratospheric N_2O and reconcile laboratory experiments with atmospheric observations. Two-dimensional (2-D) modeling results indicate that there is no compelling reason to invoke a significant chemical source of N_2O in the middle atmosphere. We compare model results with observations of isotopomer enrichment using three different methods of calculating photolytic cross-sections for each of the major isotopomers of N_2O . We find that the although the Yung and Miller approach, which postulates that changes in the zero point energies between the isotopomers causes shifts in their respective absorption profiles, can model the pattern of enrichment factors for each isotopomer relative to each other, this approach underestimates the magnitude of the enrichment factors. The ab initio approach by Johnson et al. provides better fit to the magnitudes of the enrichment factors, with the notable exception of the enrichment factor for the $15N14N16O$ isotopomer. A simpler, semi-empirical approach by Blake et al. is able to model the magnitude of all the enrichment factors, including the one for the $15N14N16O$ isotopomer.

A42A-0085 1330h POSTER

Ozone Profiles Retrieved From Odin/OSIRIS Observations of Limb-Radiance Spectra

Christian von Savigny¹ (416-736-2100-40218;

csavigny@stpl.cress.yorku.ca); Ian C. McDade¹

(mcdade@yorku.ca); Erik Griffioen¹

(erik@nimbus.yorku.ca); Craig S. Haley¹

(cshaley@yorku.ca); Christopher A. McLinden²

(chris.mclinden@ec.gc.ca); Christopher E. Sioris¹

(csioris@yorku.ca); Edward J. Llewellyn³

(edward.llewellyn@usask.ca); The Odin Team⁴

¹CRESS, York University, 4700 Keele Steet, Toronto, ON M3J 3L3, Canada

²ARQX, Meteorological Services of Canada, 4905 Dufferin Steet, Toronto, ON M3H 5T4, Canada

³Institute of Space and Atmospheric Studies, University of Saskatchewan, Saskatoon, SK S7N 5E2, Canada

⁴Odin Web Page, <http://www.snsb.se/Odin/Odin.html>

Vertical profiles of O_3 density derived from Odin/OSIRIS measurements of limb-scattered radiance spectrum profiles are presented. The optical part of OSIRIS consists of a grating spectrograph covering the spectral range from 280 to 800 nm with about 1 nm resolution. Ozone profiles are inferred using a method (Flittner et al., *GRL* 27, 2601, 2000) based on the analysis of normalized and paired limb-radiance profiles at a set of wavelengths covering the O_3 Huggins- and Chappuis-bands together with the pseudo-spherical multiple scattering radiative transfer model LIMBTRAN. Absorption in the Chappuis-bands is used to sense O_3 in the lower stratosphere, whereas absorption in the Huggins-system is used to infer O_3 between about 30 and 50 km. Together, the methods allow to recover O_3 densities throughout the stratosphere with a vertical resolution of about 2 km. A thorough sensitivity study investigating the dependence of O_3 retrievals on ground albedo, stratospheric aerosols, background atmosphere, and internal scattering is presented as well. Comparisons with O_3 profiles measured with balloon sondes show agreement within 10 %. Odin is a Swedish-led satellite project funded jointly by Sweden (SNSB), Canada (CSA), Finland (Tekes) and France (CNES).

URL: <http://www.osiris.yorku.ca>

A42A-0086 1330h POSTER

Sensitivity studies for space-based global measurements of atmospheric carbon dioxide

Jianping Mao¹ (301-867-2178; mao@qhearts.gsfc.nasa.gov)

S. Randolph Kawa² (301-614-6004; kawa@maia.gsfc.nasa.gov)

¹Science Systems and Applications, Inc, 10210 Greenbelt Road Suite 400, Lanham, MD 20706, United States

²NASA Goddard Space Flight Center, Code 916, Greenbelt, MD 20771, United States

Carbon dioxide (CO_2) is well known as the primary forcing agent of global warming. Although the climate

forcing due to CO₂ is well known, the sources and sinks of CO₂ are not well understood. Currently the lack of global atmospheric CO₂ observations limits our ability to diagnose the global carbon budget (e.g., finding the so-called "missing sink") and thus limits our ability to understand past climate change and predict future climate response.

Space-based techniques are being developed to make high-resolution and high-precision global column CO₂ measurements. One of the proposed techniques utilizes the passive remote sensing of Earth's reflected solar radiation at the weaker vibration-rotation band of CO₂ in the near infrared (~1.57 μm). We use a line-by-line radiative transfer model to explore the potential of this method. Results of sensitivity studies for CO₂ concentration variation and geophysical conditions (i.e., atmospheric temperature, surface reflectivity, solar zenith angle, aerosol, and cirrus cloud) will be presented. We will also present sensitivity results for an O₂ A-band (~0.76 μm) sensor that will be needed along with CO₂ to make surface pressure and cloud height measurements.

A42A-0087 1330h POSTER

Correlation of Ozone Anomalies With Global Gravity and Geomagnetic Fields

Raissa S Steblova¹ (1-845-365-8882; steblova@ldeo.columbia.edu)

IZMIRAN, Troitsk, Moscow Region 142092, Russian Federation

We performed a comparative analysis of the pattern of the ozoneosphere and of the Earth's gravity field on a global scale. The main parameters are assumed to be the total ozone (TO) and the ellipticity and anomalies of the geoid respectively. The ozone was mapped using the satellite data collected in 1978-1993. The 0 contour of the TO anomalies divides the Earth's surface into two wide regions, one positive, the other negative, comparable in size. This general pattern is disturbed with an isolated low over the western North America. The pattern of anomalous TO anti-correlates with elevations of the geoid. The TO high is centered over the zero magnetic meridian, and the TO low occupies first and third sectors assuming that the globe is divided into four sectors by the zero magnetic meridian and the meridian perpendicular to it.

These results agree with our earlier study based on the ground ozone observations in that there is a strong correlation between the ozoneosphere, on one hand, and the gravity and magnetic fields, on the other hand. The notable exception is polar regions where the modern ozone satellite data are very different as compared with older ground data.

References. Steblova, R.S., The ozoneosphere and the gravity field of the Earth, *Eos*, Trans. AGU, 76, S101, 1995.

A42A-0088 1330h POSTER

Ozone Loss in the Arctic Stratosphere During the Late-Winter/Spring of 1997: Application of A Technique of Chemical Species Mapping on Trajectories (CSMT) to Improved Limb Atmospheric Spectrometer (ILAS) Data

Akiko Kagawa¹ (+81-742-20-3738; kagawa@ics.nara-wu.ac.jp)

Sachiko Hayashida¹ (+81-742-20-3440; sachiko@ics.nara-wu.ac.jp)

¹Faculty of Science, Nara Women's University, Kita-uoya Nishi-machi, Nara 630-8506, Japan

We developed a technique that we named "Chemical Species Mapping on Trajectories (CSMT)" and applied it to ILAS (Improved Limb Atmospheric Spectrometer) data, to investigate chemical ozone destruction mechanisms in the late winter and early spring of 1997. CSMT is based on "Trajectory Mapping", proposed by Morris *et al.* [1995; 2000], to create synoptic maps using trajectories and satellite data. CSMT constructs a synoptic map of any chemical species by a combination of trajectory analysis and a photochemical box model. In our box model, we included a sufficient number of gas-phase and heterogeneous reactions, and PSC growth assuming both supercooled ternary solution (STS) and nitric acid trihydrate (NAT). All trajectories used were calculated by the EORC-TAM (Earth Observation Research Center Trajectory Analysis Model) with ECMWF (European Center for Medium-Range Weather Forecasts) meteorological data. The ozone and nitric acid maps derived by CSMT on 475 K were consistent with Microwave Limb Sounder (MLS) observations, suggesting the validity and reliability of CSMT. The maximum rate of ozone loss was calculated as about 32 ppbv/day in late February, and the total ozone loss integrated from January 13 to March 31 on

475 K was estimated as 0.8 ppmv when STS formation was assumed. The results are fairly consistent with other studies from that winter.

References

Morris *et al.*, *J. Geophys. Res.*, 100 (8), 16491-16505, 1995.

Morris *et al.*, *J. Geophys. Res.*, 105 (14), 17875-17894, 2000.

Acknowledgments

The chemical solver in our model was generated from the pre-processor provided by ACD (Atmospheric Chemistry Division)/NCAR (National Center of Atmospheric Research) by courtesy of J-F. Lamarque and Stacy Walters. ILAS data were provided by ILAS/DHF at NIES. We thank Sachiko Kawase for her help with this study

A42A-0089 1330h POSTER

Downward Motions in the Antarctic Polar Vortex as Seen in the ILAS N₂O Data

Hiroo Hayashi¹ (hayashi.hiroo@nies.go.jp)

Hideaki Nakajima¹ (hide@nies.go.jp)

Hiroshi Kanzawa¹ (kanzawa@nies.go.jp)

Takafumi Sugita¹ (tsugita@nies.go.jp)

Yasuhiro Sasano¹ (sasano@nies.go.jp)

¹National Institute for Environmental Studies, 16-2 Onogawa, Tsukuba 305-8506, Japan

N₂O mixing ratio data derived from the Improved Limb Atmospheric Spectrometer (ILAS) on board the Advanced Earth Observing Satellite (ADEOS) are used to investigate downward motions in the Antarctic polar vortex in the 1997 early winter. ILAS was an instrument employing solar occultation technique, and observed the polar stratosphere of the both hemispheres continuously during its observation period (November 1996 - June 1997). Using ILAS profiles for 10 successive days, we estimated the averaged distribution of N₂O mixing ratio in a equivalent latitude - height section. The same analysis was repeated for the data during the entire period, which produced a series of N₂O distribution maps every 10 days. From them downward motions in the Antarctic polar vortex were inferred. The results revealed that the descent speed is faster near the vortex center than in the vortex edge in fall and early winter. The latitudinal difference of downward motions seems to appear around late summer.

A42A-0090 1330h POSTER

Simulations of Polar Stratospheric Clouds and Denitrification Using Laboratory Freezing Rates

Katja Drdla¹ (1-650-604-5663; katja@aerosol.arc.nasa.gov)

Azadeh Tabazadeh¹ (1-650-604-1096; atabazadeh@mail.arc.nasa.gov)

¹NASA Ames Research Center, Mailstop 245-4, Moffett Field, CA 94035, United States

During the 1999-2000 Arctic winter, the SAGE III Ozone Loss and Validation Experiment (SOLVE) provided evidence of widespread solid-phase polar stratospheric clouds (PSCs) accompanied by severe denitrification. Previous simulations have shown that a freezing process occurring at temperatures above the ice frost point is necessary to explain these observations. In this work, the nitric acid freezing rates derived from laboratory measurements are used in the Integrated MicroPhysics and Aerosol Chemistry on Trajectories (IMPACT) model to calculate both PSC microphysical properties and their net effect on the denitrification process.

A range of cases have been explored, including whether the solid-phase PSC particles are composed of nitric acid dihydrate or trihydrate, whether the homogeneous freezing process occurs in the bulk or on the surface of stratospheric particles, and uncertainties in the derived freezing rates. Finally, the possibility that meteoritic debris enhances the freezing rate has also been examined. The results of these winter-long simulations have been compared with key PSC and denitrification measurements made during the SOLVE campaign. The cases that best reproduce the measurements will be highlighted, with a discussion of the implications for our understanding of solid PSC formation mechanisms.

A42A-0091 1330h POSTER

Inferring the Observed PSC Composition Using the Improved Limb Atmospheric Spectrometer (ILAS) Data Along With Trajectory Analysis

Naoko Saito¹ (+81-742-20-3738; naoko@leo.ics.nara-wu.ac.jp)

Sachiko Hayashida¹ (+81-742-20-3440; sachiko@ics.nara-wu.ac.jp)

Yasuhiro Sasano² (+81-298-50-2444; sasano@nies.go.jp)

¹Nara Women's University, Faculty of Science, Nara Women's University Kita-uoya Nishi-machi, Nara 630-8506, Japan

²National Institute for Environmental Studies, National Institute for Environmental Studies 16-2, Onogawa, Tsukuba 305-0053, Japan

The Improved Limb Atmospheric Spectrometer (ILAS) captured many polar stratospheric cloud (PSC) events in the Northern Hemisphere during the winter and early spring of 1997. We identified about 250 events in 65 profiles as PSCs in the Arctic. Preliminary analysis made it clear that the ILAS also observed many PSC events during the early winter of 1997 in the Southern Hemisphere. The ILAS aerosol extinction coefficient and nitric acid data were compared with the theoretically predicted values for supercooled ternary solution (STS), nitric acid dihydrate (NAD), and nitric acid trihydrate (NAT) particles at thermodynamic equilibrium to infer the chemical composition of the observed PSC particles. In mid-January of 1997, both the extinction coefficient and nitric acid values of some of the observed PSC events showed better agreement with the theoretical values for STS than with those of NAT or NAD. Although a few PSCs were observed in March, most of the PSCs observed late in the PSC season had features of nitric-acid-containing hydrates. An intensive analysis of the temperature histories suggested that most of the STS particles observed in January had experienced the thermal conditions necessary for the formation of liquid particles. The nitric-acid-containing solid PSC events observed in early March experienced temperatures below T_{NAT} for more than several days, and sometimes fell below T_{ice} during the 20-day period. They had not passed over typical mountainous area before their measurements, so the formation mechanisms of these solid particles should be explained from their synoptic scale temperature histories, without considering lee waves. They maintained relatively high nitric acid hydrate saturation ratios along their trajectory, which suggests their homogeneous nucleation.

A42A-0092 1330h POSTER

Validation of POAM III ozone: Comparisons with ozonesondes and satellite data

David W. Rusch¹ (3034928627;

David.Rusch@lasp.colorado.edu); Cora E. Randall¹ (3034928208; Cors.Randall@lasp.colorado.edu);

Richard M. Bevilacqua² (2027670768;

bevilacqua@nrl.navy.mil); Karl W. Hoppel² (2027671320; hoppel@opt.nrl.navy.mil); Jerry D.

Lumpe³ (7032041301; lumpe@cpi.com); Eric

Shettle² (2027671320; shettle@opt.nrl.navy.mil)

¹Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder, CO 80309-0392, United States

²Naval Research Laboratory, Code 7220, Washington, DC 20375, United States

³Computational Physics Inc., 8001 Braddock Road, Suite 210, Springfield, VA 22151, United States

Ozone results from the Polar Ozone and Aerosol Measurement III (POAM III) are compared to those from ozonesondes, the Halogen Occultation Experiment (HALOE) and the Stratosphere Aerosol and Gas Experiment II (SAGE II).

POAM and ozonesonde data agree within 5% in the 12 to 30 km region in both the Southern and Northern Hemispheres. The agreement is also excellent in the ozone hole where the ozone profiles are highly structured. At altitudes below 10 km POAM and sonde ozone show larger disagreement.

The comparisons between POAM III and the satellite instruments show that above 13 km ozone densities agree within about 5%, independent of time of year or hemisphere. Below 13 km, although the differences in ozone density are small, the percentage differences are larger, with POAM III ozone densities larger than SAGE II by 10 to 20% for most time periods, but reaching 40% in certain time periods. POAM III ozone densities are also larger than HALOE results at low altitudes. The agreement is improved if the coincidences occurring in the southern ozone hole are removed. The

absolute differences between POAM and the other instruments are less than 0.01 ppmv at all altitudes. The small residual differences between POAM III and SAGE II above 13 km are due to differences in the measured optical depths.

At altitudes below about 13 km where the ozone differences are larger, the derivation of ozone is complicated by several factors. Among these are the separation of ozone absorption from Rayleigh and aerosol scattering, the determination of the wavelength dependence of aerosol scattering, and the difficulty in properly registering the measured optical depths in altitude.

We conclude that the agreement between POAM and the three instruments is excellent above 13 km, that this agreement is not fortuitous, and the POAM III ozone data are fully adequate for scientific investigation. Below 13 km further research is needed to understand the differences.

A42A-0093 1330h POSTER

Validation of POAM III Aerosols: Comparison to SAGE II and HALOE

Richard M Bevilacqua¹ (202-767-0768; bevilacqua@nrl.navy.mil)

Cora E Randall² (cora.randall@lasp.colorado.edu)

Jerry D Lumpe³ (lumpe@cpi.com)

Karl W Hoppel¹ (karl.hoppel@nrl.navy.mil)

¹Naval Research Laboratory, Code 7220, Washington, DC 20375, United States

²Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder, CO 80309, United States

³Computational Physics Inc., 2750 Prosperity Ave., Fairfax, VA 22301, United States

We describe statistical comparisons between Polar Ozone and Aerosol Measurement (POAM) III and Stratosphere Aerosol and Gas Experiment (SAGE) II measurements of aerosol extinction in 1998 and 1999. SAGE II and POAM III are in qualitative agreement, and show that since the launch of POAM III in March of 1998, stratospheric aerosol extinctions at visible and near-IR wavelengths have remained at background levels. We present quantitative differences between the SAGE II and POAM III extinctions at 1020 nm and 450 nm for temporally and spatially coincident measurements. At 1020 nm the instruments agree to within about 30% from 10 to 22 km, where most of the aerosol extinction lies. Differences at 450 nm are similar to 1020 nm in the southern hemisphere, but much larger in the northern hemisphere. We have also compared the POAM and SAGE slant optical depths (the fundamental measurement quantity for both instruments) at both 1020 nm and 450 nm. The differences at 1020 nm are very similar to the extinction differences, suggesting that the retrieved extinction differences are primarily the result of fundamental measurement differences. However, at 450 nm there are statistically significant differences between the extinction and optical depth comparisons (extinction differences are much larger), suggesting that at least part of the extinction differences are the result of retrieval differences (aerosol separation, Rayleigh scattering specification, modeling of refraction, etc.) rather than fundamental measurement differences. Finally, we have compared derived surface areas and volume densities from POAM III, SAGE II, and the Halogen Occultation Experiment (HALOE). We find good qualitative agreement between all three instruments. Statistical differences can be explained by the aerosol extinction differences in the SAGE II comparisons, and by the lack of sensitivity on the part of POAM III and SAGE II to very small aerosols in the HALOE comparisons.

A42A-0094 1330h POSTER

Validation of POAM III Water Vapor using HALOE and MOZAIC

Karl W Hoppel¹ (202-767-1320;

karl.hoppel@nrl.navy.mil); Richard M Bevilacqua¹ (202-767-0768; bevilacqua@nrl.navy.mil); Cora E Randall² (randall@lasp.colorado.edu); Gerald Nedoluha¹ (nedoluha@nrl.navy.mil); Jerry D Lumpe³ (lumpe@cpi.com); Herman Smit⁴

¹Naval Research Laboratory, 4555 Overlook Ave S.W., Washington, DC 20375-5320, United States

²Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder, CO 80309-0392, United States

³Computational Physics Inc., 8001 Braddock Road, Suite 210, Springfield, VA 22151, United States

⁴Forschungszentrum Jlich, Jlich, Germany

The Polar Ozone and Aerosol Measurement (POAM III) has been successfully measuring stratospheric water vapor since March 1998. High resolution vertical

profile measurements are made on a daily basis in the Arctic and Antarctic regions. In this paper, the water vapor retrievals are validated by comparison with measurements from the Halogen Occultation Experiment (HALOE), and with Measurements of Ozone and Water Vapor by Airbus In-Service Aircraft (MOZAIC).

In the northern hemisphere, there are five periods of coincident measurements with HALOE, spanning 1998 to 2000. Quantitative comparisons show agreement to within 5% from 45 km down to 25 km. Below 25 km, POAM measurements are about 10% larger than HALOE. In the southern hemisphere, POAM water vapor is about 10% larger than HALOE from 15 km to 45 km.

The airborne, in situ MOZAIC instruments provide a large number of measurements which can be used to validate POAM measurements in the highly spatially variable regions of the upper troposphere and lowermost stratosphere, where water vapor mixing ratios are much larger than those found throughout most of the stratosphere. The comparisons shows that there is no statistically significant difference in the response of the two instruments to changes in water vapor, and that, in the high water vapor mixing ratio regime where the MOZAIC measurements are most accurate, the POAM water vapor mixing ratios are systematically larger than MOZAIC by about 10%.

A42A-0095 1330h POSTER

POAM Ozone Measurements and Validation in the Upper Troposphere and Lowermost Stratosphere

Ana I Prados¹ (202-767-1021;

prados@wvmspc4.nrl.navy.mil); Gerald Nedoluha¹ (nedoluha@nrl.navy.mil); Richard Bevilacqua¹ (bevilacqua@nrl.navy.mil); Karl Hoppel¹ (karl.hoppel@nrl.navy.mil); Doug Allen¹ (drallen@ventus.nrl.navy.mil); Alain Marengo² (mara@aero.obs-mip.fr); Valerie Thouret² (thov@aero.obs-mip.fr)

¹Naval Research Laboratory, 4555 Overlook Avenue SW, Washington, DC 20375, United States

²Laboratoire d'Aerologie, 14 Avenue Edouard Belin, Toulouse, France

We provide a validation of Polar Ozone and Measurement (POAM) III ozone observations in the uppermost troposphere and lowermost stratosphere by comparison to ozone data from the Measurement of Ozone and Water Vapor by Airbus In-Service Aircraft (MOZAIC) program. The results suggest that POAM Ver.3 ozone mixing ratios in the 9-12 km region are systematically high by about 14%, consistent with POAM/ECC sonde comparisons. However, the relative variations in the POAM and MOZAIC data sets are in excellent agreement, indicating that POAM ozone measurements provide a data set suitable for studying ozone and air transport properties in the UT/LS region. Based on POAM UT/LS measurements, we are able to differentiate between tropospheric and stratospheric air parcels, and we observe a distinct seasonal cycle in ozone mixing ratios in the lowermost stratosphere during all POAM years. In the northern hemisphere high latitudes, POAM ozone mixing ratios and correlations with POAM water vapor and PV derived equivalent latitude strongly suggest that beginning in early summer air is transported from the upper troposphere at lower latitudes into the lowermost stratosphere, and that this air moves gradually poleward. In the tropopause region, POAM captures seasonal and inter-annual ozone variations, including the transition from mixing ratios typical of the upper-most troposphere, to air of stratospheric influence.

A42A-0096 1330h POSTER

Inference of Global Mean Temperature Trend and Climate Change From MSU and AMSU

Cuddapah Prabhakara¹ ((301)614-6193; cuddapah@climate.gsfc.nasa.gov)

Robert A. Iacovazzi² ((301)614-6210; robert@cloud.gsfc.nasa.gov)

Jung-Moon Yoo³ ((301)614-6816; yoo@climate.gsfc.nasa.gov)

¹NASA Goddard Space Flight Center, Code 913, Greenbelt, MD 20771, United States

²Science Systems and Applications Inc., Princess Garden Parkway, Lanham, MD, United States

³EWHA Womens University, 11-1 Daehyun-Dong, Seoul, Korea, Republic of

Microwave Sounding Unit (MSU) and Advanced MSU (AMSU) radiometers flown on the NOAA operational satellite series are potentially valuable as global temperature monitoring devices. Spencer and Christy

(1990) pioneered the analysis of mid-tropospheric temperature, given by MSU Channel 2 (Ch 2) at 53.74 GHz, to derive the global temperature trend. Also, in addition to monitoring global temperature, these microwave radiometers have the potential to reveal inter-annual climate signals in tropics (Yulaeva and Wallace, 1994).

We have analyzed the data of MSU Ch 2 and AMSU Ch 5 (53.6 GHz) from the NOAA operational satellites for the period 1980 to 2000, utilizing the NOAA calibration procedure. The data are corrected for the satellite orbital drift based on the temporal changes of the on-board warm blackbody temperature. From our analysis, we find that the global temperature increased at a rate of 0.13 (+ -) 0.05 Kdecade⁻¹ during 1980 to 2000. From an Empirical Orthogonal Function (EOF) analysis of the MSU global data, we find that the mid-tropospheric temperature in middle and high latitudes responds to the ENSO forcing during the Northern Hemisphere Winter in a distinct manner. This mid-latitude response is opposite in phase to that in the tropics. This result is in accord with simulations performed with an ECMWF global spectral model by May and Bengtsson, (1998). This study shows a potential use of the satellite observations for climatic change.

A42A-0097 1330h POSTER

Retrieval of Stratospheric O₃ and NO₂ Density Profiles From a DOAS Analysis of UV-Visible Limb Scatter Measured by OSIRIS

Craig S Haley¹ (1-416-736-2100-33517;

cs Haley@yorku.ca); Christopher E Sioris¹; Christian von Savigny¹; Ian C McDade¹; Erik Griffioen¹; Christopher A McLinden²; Edward J Llewellyn³; The Odin Team⁴

¹Centre for Research in Earth and Space Science, York University, 4700 Keele Street, Toronto, ON M3J 1P3, Canada

²Meteorological Service of Canada, Environment Canada, 4905 Dufferin Street, Toronto, ON M3H 5T4, Canada

³Department of Physics and Engineering Physics, University of Saskatchewan, Saskatoon, SK S7N 5E2, Canada

⁴Odin webpage, <http://www.snsb.se/Odin/Odin.html>

Space-based atmospheric remote sounding measurements of minor species in the stratosphere using UV-visible radiances have traditionally been of two types: occultation measurements (POAM, SAGE) and nadir measurements (TOMS, GOME). These types of measurements are limited by either restricted spatial coverage (occultation) or poor vertical resolution (nadir). A new type of measurement, with the potential of providing both good spatial coverage and good vertical resolution, is limb scattered sunlight. This type of measurement has been used to recover O₃ in the mesosphere and NO₂ in the stratosphere from SME measurements and recently has been used to retrieve stratospheric ozone density profiles from SOLSE/LORE measurements. A number of new instruments are employing this method, including OSIRIS, onboard the recently launched Odin satellite, and SCIAMACHY, which will be launched on ENVISAT in late 2001. Though the measurements themselves are relatively straightforward to make, the process of retrieving minor species densities and other information from the radiances is complicated due to the viewing geometry.

A method that has proved successful for analysing UV-visible measurements made with ground-based instruments and with satellite nadir-viewing instruments has been that of Differential Optical Absorption Spectroscopy (DOAS). With the DOAS method absorption features are used to recover slant column densities which are then converted to vertical column densities through calculated air mass factors. Here we present the application of the DOAS method to limb scattered sunlight. In this application, apparent column densities are calculated through an analysis of measured limb radiances in a similar fashion as the calculation of the slant column densities in other applications. The complication here is that there is no straightforward relationship between these apparent column densities and the vertical column density. We describe how these apparent column densities, measured over a range of tangent heights, may be inverted using the Optimal Estimation (OE) approach to determine local density profiles, and apply the technique to the retrieval of stratospheric O₃ and NO₂ from OSIRIS measurements.

Odin is a Swedish-led satellite project funded jointly by Sweden (SNSB), Canada (CSA), Finland (Tekes), and France (CNES).

A42A-0098 1330h POSTER

Validation of POAM III NO₂ Measurements

Cora Randall¹ (303-492-8208;

randall@lasp.colorado.edu); Jerry Lumpe² (lumpe@cpi.com); Richard Bevilacqua³ (bevilacqua@nrl.navy.mil); Karl Hoppel³ (hoppel@nrl.navy.mil); David Rusch¹ (rusch@lasp.colorado.edu); Eric Shettle³ (shettle@nrl.navy.mil); Larry Gordley⁴ (l.l.gordley@gats-inc.com); Klaus Pfeilsticker⁵ (klaus.pfeilsticker@iup.uni-heidelberg.de); Karin Kreher⁶ (k.kreher@niwa.cri.nz)

¹Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder, CO 80309, United States

²Computational Physics, Inc., 8001 Braddock Road Suite 210, Springfield, VA 22151, United States

³Naval Research Laboratory, 4555 Overlook Ave., SW, Washington, DC 20375, United States

⁴GATS, 11864 Canon Blvd., Newport News, VA 23606, United States

⁵Institut fur Umweltphysik, INF 229, Heidelberg, Germany

⁶NIWA, Private Bag 50061, Central Otago, New Zealand

The Polar Ozone and Aerosol Measurement (POAM) III instrument is a nine-channel (354 to 1018 nm) solar occultation instrument designed to measure stratospheric profiles of ozone, nitrogen dioxide and water vapor densities, aerosol extinction at five wavelengths, and temperature. It was launched onboard the Satellite Pour l'Observation de la Terre (SPOT) 4 in March of 1998 into a sun synchronous orbit, and is currently operational. In this paper we describe POAM III NO₂ measurements and their associated errors, and show comparisons to correlative data. POAM III NO₂ is derived through differential measurements at 439.6 nm (NO₂-on channel) and 442.2 nm (NO₂-off channel), between the altitudes of 20 and 40 km. The random error of the NO₂ retrievals is less than 5% between about 21 and 38 km, and increases to about 6% at 40 km and 8% at 20 km. The vertical resolution of the retrieved NO₂ is about 1.5 km or better between altitudes of 25 and 35 km, increasing to nearly 3 km at altitudes of 20 and 40 km. We show comparisons between POAM NO₂ and NO₂ derived from the satellite-based Halogen Occultation Experiment (HALOE), as well as other airborne and ground-based instruments. These comparisons demonstrate that POAM measurements of NO₂ are reasonable in terms of their magnitude, profile structure, and temporal variations. A statistical analysis of the POAM-HALOE differences shows that, on average, these differences are less than 0.2 ppbv below 34 km, increasing to about 0.7 ppbv by 40 km (POAM higher than HALOE). This corresponds to a relative difference at 40 km of about 15%, which is within the range quoted for previous comparisons between HALOE and other correlative data. We conclude that the POAM III NO₂ data are valid for scientific use.

A42A-0099 1330h POSTER

Stratospheric O₃ and ClO Observations From the Submillimeter Radiometer Onboard the Odin Satellite

Joachim Urban¹ (urban@observ.u-bordeaux.fr);

Nicolas Lautie¹; Eric le Flochmoen¹; Philippe Ricaud¹; Jerome de la Noe¹; Philippe Baron²; Frank Merino²; George Witt²; Donal Murtagh³; Patrick Eriksson³; Carlos Jimenez³; The Odin Team⁴

¹Bordeaux Observatory, Floirac, France

²MISU, Stockholm University, Stockholm, Sweden

³Chalmers University of Technology, Gothenburg, Sweden

⁴Odin web page, <http://www.snsb.se/Odin/Odin.html>

The Odin satellite carrying a sub-mm radiometer (SMR) and the Optical Spectrograph and Infra Red Imaging System (OSIRIS) was launched in February 2001. The two instruments will provide vertical profiles on a global basis of various atmospheric constituents such as O₃, ClO, HNO₃, N₂O, H₂O and its isotopes H₂¹⁸O, HDO and H₂¹⁷O. The aim of this poster is to present the capabilities of the SMR radiometer for the study of O₃ and ClO in the stratosphere. Some first results will be presented for the period July to October.

Odin is a Swedish-led satellite project funded jointly by Sweden (SNSB), Canada (CSA), Finland (Tekes) and France (CNES).

A42A-0100 1330h POSTER

Canonical Trace Gas Relationships and Altitude Spectrum of Air in the Arctic Vortex

Pavel A Romashkin^{1,2} (303-497-7408;

pavel.romashkin@noaa.gov); Dale F Hurst^{1,2}; Eric A Ray^{2,5}; Fred L Moore^{1,2}; James W Elkins¹; Arlyn Andrews³; Steve Wofsy³; Bruce Daube³; Christoph Gerbig³; Paul T Bui⁴

¹NOAA-CMDL, R-CMDL1, 325 Broadway, Boulder, CO 80305, United States

²CIRES, University of Colorado, Boulder, CO 80309, United States

³Harvard University, Harvard University, Cambridge, MA 02138

⁴NASA-ARC, NASA-ARC, Moffett Field, CA 94035

⁵NOAA-AL, R-AL1, 325 Broadway, Boulder, CO 80305, United States

In situ measurements of a suite of trace gases with stratospheric lifetimes from 5 to 120 years at 19-22 km in the Arctic vortex in 2000 suggest that canonical tracer relationships in the vortex are significantly different from those in middle latitudes. We demonstrate that these relationships, which are established as early as October-November and are diagnostic of the transport of the air and fate of ozone-depleting compounds, can form without significant entrainment of midlatitude air into the vortex. Because the timescales of mixing in the vortex are short compared to lifetimes of even the shortest lived trace gases, the photolysis is not important in forming canonical vortex relationships. What is important is the altitude that air parcels descend from to form a given parcel in the vortex by mixing with other parcels from other altitudes. To obtain a distribution of the original altitudes in air parcels in the vortex we analyze a simple integral model of the evolution of the midlatitude canonical tracer relationship to the vortex ones. This model shows that in the mature arctic vortex the air at the 20 km altitude consists of about 70% of the air originated at higher altitudes and 10% from the lower altitudes. This air mixes quasi-horizontally inside the vortex to form a canonical vortex relationship. These results also conform to existing transport models that indicate that the entire mesosphere may be flushed and descended into a winter polar vortex.

A42A-0101 1330h POSTER

Peroxy Radicals and Ozone Photochemistry during the Northern Hemisphere Winter-to-Spring Transition

Christopher A. Cantrell¹ (303-497-1479; cantrell@ucar.edu)

TOPSE Science Team

¹National Center for Atmospheric Research, 1850 Table Mesa Drive, Boulder, CO 80303

Peroxy radicals and many other species were measured during the winter-to-spring seasonal transition of 2000. Species were measured aboard the NCAR/NSF C130 as flights were performed from February through May from 40 to 85 degrees north latitude. Numerical models were used to evaluate the role of various processes in the production and loss of peroxy radicals and the effect on the ozone tendency. The measurements and the results of this analysis will be presented.

A42A-0102 1330h POSTER

Measurements of the D/H and ¹³C/¹²C Isotope Ratios in Stratospheric CH₄ from the POLARIS, STRAT, and SOLVE Campaigns

Andrew L Rice¹ (949-824-3271; arice@uci.edu)

Stanley C Tyler² (949-824-2685; styler@uci.edu)

Michael C McCarthy³ (510-642-4499; mike_mac@uclink4.berkeley.edu)

Kristie A Boering^{3,4} (510-642-3472; boering@cchem.berkeley.edu)

Elliot Atlas⁵ (303-497-1425; atlas@acd.ucar.edu)

¹University of California, Irvine, Dept. of Chemistry, Irvine, CA 92697-2025, United States

²University of California, Irvine, Dept. of Earth System Science, Irvine, CA 92697-3100, United States

³University of California, Berkeley, Dept. of Chemistry, Berkeley, CA 94720-1460, United States

⁴University of California, Berkeley, Dept. of Earth and Planetary Science, Berkeley, CA 94720-1460, United States

⁵National Center for Atmospheric Research, Atmospheric Chemistry Division, Boulder, CO 80307, United States

We report δD and δ¹³C measurements of stratospheric CH₄ from 78 air samples collected aboard the NASA ER-2 aircraft during the SOLVE (2000), POLARIS (1997), and STRAT (1996) campaigns. These measurements are the first to be reported using continuous flow gas chromatography isotope mass spectrometry, which provides for high precision of measurement on 63 ml of air. The δD-CH₄ data comprise the only high precision data set of this kind to date. Precision of measurement is ±1.5‰ for δD (vs. V-SMOW) and ±0.07‰ for δ¹³C (vs. V-PDB) on samples with as little as 700 ppb CH₄. The samples cover latitudes ranging from 1°S to 89°N and altitudes ranging from 11 to 21 km. Values of δD range from -89.8‰ for CH₄ near the tropical tropopause to +26.4‰ for CH₄ in the polar vortex. Similarly, values of δ¹³C range from -47.3‰ to -34.0‰. The isotopic enrichment in CH₄ with decreasing mixing ratio is a result of kinetic isotope effects in CH₄ loss processes, i.e. chemical reaction with OH, Cl, and O(¹D), as the air mass ages. Our measurement data have been compared to calculated values using the LLNL 2-D chemical-radiative-transport model of the atmosphere. We discuss the observed trends in δD and δ¹³C of CH₄ and their implications for stratospheric chemistry.

A42A-0103 1330h POSTER

Modeling δ¹³C and δD of Stratospheric Methane: Implications for Kinetic Isotope Effects and the Isotopic Composition of Tropospheric Methane

Michael C McCarthy¹ (510-642-4499;

mike_mac@uclink4.berkeley.edu); Kristie A Boering^{1,2} (510-642-3472;

boering@cchem.berkeley.edu); Andrew L Rice³ (949-824-5755; arice@uci.edu); Stanley C Tyler⁴ (949-824-2685; styler@uci.edu); Peter Connell⁵ (925-422-1811; connell2@llnl.gov); Elliot Atlas⁶ (303-494-1425; atlas@acd.ucar.edu)

¹Department of Chemistry, University of California, Berkeley, CA 94720-1460

²Department of Earth and Planetary Science, University of California, Berkeley, CA 94720-4767

³Department of Chemistry, University of California, Irvine, CA 92697-2025

⁴Department of Earth System Science, University of California, Irvine, CA 92697-3100

⁵Atmospheric Science Division, Lawrence Livermore National Laboratory, Livermore, CA 94550

⁶Atmospheric Chemistry Division, National Center for Atmospheric Research, Boulder, CO 80307

New measurements of δD and δ¹³C in stratospheric CH₄ from 78 whole air samples collected aboard the NASA ER-2 aircraft during the STRAT, POLARIS, and SOLVE field campaigns are compared with model results from the Lawrence Livermore National Laboratory 2-D model. Although uncertainties in stratospheric transport are not small, the effect of these uncertainties on the isotopic compositions is likely small compared to the current range of experimental values for the kinetic isotope effects (KIEs) for the ¹³C and D isotopomers of CH₄ and their associated experimental uncertainties. Thus, by comparing the new δ¹³C and δD observations from the stratosphere with various model scenarios that vary the KIEs for OH, Cl, and O(¹D), the uncertainty in the laboratory KIEs may be reduced. Furthermore, latitudinal and seasonal trends in the observations are compared with modeled variability. In addition, model results predict the influence of the KIEs of stratospheric sinks on the δ¹³C and δD of CH₄ in the free troposphere, which is of importance in inverse models that use isotopic compositions to derive the magnitude and distribution of methane sources to the atmosphere.

A42A-0104 1330h POSTER

POAM III retrieval algorithm and error analysis

Jerry D Lumpe¹ (703-764-7501; lumpe@cpi.com)

Richard M Bevilacqua² (202-767-0768; bevilacqua@nrl.navy.mil)

Karl Hoppel² (202-767-1320; karl.hoppel@nrl.navy.mil)

Cora E. Randall³ (303-492-8208;
randall@lasp.colorado.edu)

¹Computational Physics Inc, 8001 Braddock Road
Suite 210, Springfield, VA 22151, United States

²Naval Research Laboratory, 4555 Overlook Ave SW,
Washington, DC 20375, United States

³Laboratory for Atmospheric And Space Physics, Uni-
versity of Colorado, Boulder, CO 80309, United
States

The Polar Ozone and Aerosol Measurement (POAM) III instrument measures atmospheric optical depth in nine spectral bands (from 354 to 1018 nm) using the solar occultation technique. From these fundamental measurements it is possible to retrieve altitude profiles of O₃, NO₂, H₂O, and O₂ (or total) density, as well as aerosol extinction, in the stratosphere and upper troposphere. POAM III was launched on the SPOT 4 satellite in March of 1998 and is still in routine operation, making measurements at high latitudes in both hemispheres. In this paper we summarize the algorithms used to produce the POAM III version 3 dataset. The first step of the retrieval process involves the derivation of absolute pointing information and normalization of the measured radiances to produce atmospheric transmission profiles. Conversion of the resulting transmission data to geophysical profiles is achieved via a two-step process, beginning with a spectral inversion to partition the various gas and aerosol components of the measured slant optical depth, followed by a spatial inversion to produce altitude profiles of gas density and aerosol extinction from the path integrated quantities. Both steps of the retrieval process utilize the technique of optimal estimation for the numerical inversion. A formal error analysis of the version 3 retrievals is also presented, including estimates of the total random error budget for the retrieved profiles. Results of this analysis compare well with independent estimates of retrieval precision obtained by calculating the retrieval variances in geophysically quiescent time periods.

URL: <http://www.cpi.com>

A42A-0105 1330h POSTER

The Odin Atmospheric Mission

Donal Murtagh¹ (donal@rss.chalmers.se); Edward J Llewellyn²; Erkki Kyri³; Gerard Megie⁴; Urban Frisk⁵; The Odin Team⁶

¹Chalmers University of Technology, Dept of Radio and Space Science, Goteborg SE-412 90, Sweden

²ISAS, University of Saskatchewan 116 Science Place, Saskatoon, SK S7N 5E2, Canada

³Finnish Meteorological Institute, Geophysical Research Division Box 503, Helsinki SF-00101

⁴Service d'Aronomie du C.N.R.S., Inst Simon Laplace, Paris 75732, France

⁵Swedish Space Corporation, Box 4207, Solna SE-17104, Sweden

⁶The Odin web page,
<http://www.snsb.se/Odin/Odin.html>

The Odin satellite was launched on 20 Feb 2001 and has begun its joint Astrophysics and Aeronomy mission. Odin is a joint project between Sweden, Finland, France and Canada with various parts of the satellite and its instruments being built in the various countries. The aeronomy mission is aimed at understanding the physical and chemical processes that control the distribution and temporal behaviour of various trace gases in the stratosphere and mesosphere, in particular ozone and water vapour as well as gases controlling the destruction of ozone. To this end Odin carries two instruments: a sub-mm radiometer SMR and an Optical Spectrograph and Infra Red Imaging system both particularly suited to the measurement of different gases. The sub-mm region is perhaps the best region to measure ClO that is closely related to catalytic ozone destruction during the polar winters while the optical spectrograph will allow us to retrieve NO₂ as well as BrO with good precision. Both of these gases are also intimately related to the control of ozone concentrations in the stratosphere. Further because of the close cooperation with the astronomical community the SMR measure the strongest sub-mm line of water vapour making Odin especially suited for measurements in the upper mesosphere where it will be able to make single profile measurements to altitudes above 80 km.

Odin is a Swedish-led satellite project funded jointly by Sweden (SNSB), Canada (CSA), Finland (Tekes) and France (CNES).

A42B MC: 123 Thursday 1330h

SAFARI 2000: The Southern African Regional Science Initiative II

Presiding: H Annegarn, University of the Witwatersrand; M King, NASA Goddard Space Flight Center

A42B-01 1330h

Overview and Stratification of the Meteorological Conditions During the SAFARI 2000 Dry Season Campaign

Robert J. Swap¹ (+1 804 924 7714;

swapper@virginia.edu); Stuart J. Piketh² (+27 11 717 6533; stuart@crg.bpb.wits.ac.za); Deborah C. Stein¹ (+1 804 924 7714; dcs5v@virginia.edu); Tali Freiman² (+27 11 717 6534; tali@crg.bpb.wits.ac.za); Roelof P. Burger³ (+27 58 303 5571; roelof@metsys.weathersa.co.za); Steven Greco¹ (804 924 7714; srg@cyclone.swa.com)

¹University of Virginia, Dept. of Environmental Sciences 291 McCormick Rd. P.O. Box 400123, Charlottesville, VA 22903, United States

²University of the Witwatersrand, Climatology Research Group Private Bag 3, Johannesburg WITS 2050, South Africa

³South African Weather Bureau, METSYS Private Bag X15, Bethlehem 9700, South Africa

As part of the Southern African Regional Science Initiative, SAFARI 2000, an overview of the meteorology of southern Africa during the dry season intensive field campaign is presented. Atmospheric conditions during the SAFARI 2000 dry season campaign of August-September 2000 are examined, classified, and stratified according to general synoptic types and horizontal and vertical transport characteristics. In addition to the chronological examination of the evolution of the synoptic conditions responsible for the observe, severe southern African aerosol events, similar days are grouped together and mean characteristics of the vertical structure, horizontal and vertical transports, synoptic circulations and the frequency of occurrence are presented. Of particular interest is the evolution of the chemically and optically impacted southern African atmosphere during the last week of August and the first 10 days of September, 2000. Ground-based, in-situ and remotely sensed data sets are utilized to characterize this period. The synoptic conditions during the intensive field campaign are placed into a larger regional and global climatological context so as to allow for the extrapolation of the findings of SAFARI 2000 intensive campaigns to time periods outside of the intensive episodes of direct observation. The results of direct comparisons of the synoptic conditions experienced during SAFARI 2000 to those conditions experienced during the Southern African Fire-Atmosphere Research Initiative, SAFARI-92, will also be presented.

A42B-02 1345h INVITED

Cloud and Radiation Studies during SAFARI 2000

Steven Platnick¹ (301-614-6243;

platnick@climate.gsfc.nasa.gov); Michael D. King² (301-614-5636; king@climate.gsfc.nasa.gov); Peter V. Hobbs³ (206-543-6027; phobbs@atmos.washington.edu); Simon Osborne⁴ (44 252-395774; simon.osborne@metoffice.com); Stuart Piketh⁵ (27 11-716-3142; stuart@crg.bpb.wits.ac.za); Roelof Ruijns⁶ (roelof@ucar.edu)

¹University of Maryland Baltimore County, 5401 Wilkens Ave., Baltimore, MD 21228, United States

²NASA Goddard Space Flight Center, Code 900, Greenbelt, MD 20771, United States

³University of Washington, Dept. of Atmospheric Sciences, Box 351640, Seattle, WA 98195, United States

⁴Meteorological Research Flight, Cody Technology Park, Ively Road, Farnborough Gu14 6TD, United Kingdom

⁵University of Witwatersrand, Private Bag X3, Johannesburg 2050, South Africa

⁶National Center for Atmospheric Research, P.O. Box 3000, Boulder, CO 80307, United States

Though the emphasis of the Southern Africa Regional Science Initiative 2000 (SAFARI-2000) dry season campaign was largely on emission sources and

transport, the assemblage of aircraft (including the high altitude NASA ER-2 remote sensing platform and the University of Washington CV-580, UK MRF C-130, and South African Weather Bureau JRA in situ aircrafts) provided a unique opportunity for cloud studies. Therefore, as part of the SAFARI initiative, investigations were undertaken to assess regional aerosol-cloud interactions and cloud remote sensing algorithms. In particular, the latter part of the experiment concentrated on marine boundary layer stratocumulus clouds off the southwest coast of Africa. Associated with cold water upwelling along the Benguela current, the Namibian stratocumulus regime has received limited attention but appears to be unique for several reasons. During the dry season, outflow of continental fires and industrial pollution over this area can be extreme. From below, upwelling provides a rich nutrient source for phytoplankton (a source of atmospheric sulfur through DMS production as well as from decay processes). The impact of these natural and anthropogenic sources on the microphysical and optical properties of the stratocumulus is unknown. Continental and Indian Ocean cloud systems of opportunity were also studied during the campaign.

Aircraft flights were coordinated with NASA Terra Satellite overpasses for synergy with the Moderate Resolution Imaging Spectroradiometer (MODIS) and other Terra instruments. An operational MODIS algorithm for the retrieval of cloud optical and physical properties (including optical thickness, effective particle radius, and water path) has been developed. Pixel-level MODIS retrievals (1 km spatial resolution at nadir) and gridded statistics of clouds in the SAFARI region will be presented. In addition, the MODIS Airborne Simulator flown on the ER-2 provided high spatial resolution retrievals (50 m at nadir). These retrievals will be discussed and compared with in situ observations.

A42B-03 1400h INVITED

Physical and Chemical Characterization of Southern African Aerosols and Trace Gases

Peter V. Hobbs¹ ((206) 543-6027;
phobbs@atmos.washington.edu)

University of Washington, Department of Atmospheric Sciences, Box 351640, Seattle, WA 98195-1640, United States

In support of the Southern African Fire-Atmosphere Research Initiative (SAFARI-2000), the University of Washington carried out thirty-one research flights over five countries in Southern Africa. These flights provided in situ measurements of the physical and chemical properties of the aerosol and clouds in the region, as well as remote sensing measurements of optical depths, up and down irradiances, and surface reflectivities. Vertical profiles of various gases and aerosols in the region will be shown. During the period of the measurements (August-September 2000), biomass burning was an important source of atmospheric aerosols and gases. Emission ratios, emission factors, and the characteristics of trace species produced by biomass burning will be shown. This paper will also serve as an introduction to several other papers in this session.

URL: <http://cargun2.atmos.washington.edu/sys/research/safari/>

A42B-04 1415h

"River of Smoke" - Characteristics of the Southern African Springtime Regional Biomass Burning Haze

Harold Annegarn¹ (27-11-717-6551;

annegarn@src.wits.ac.za); Robert J Swap^{1,2} (1-804-9247714; rjs8g@virginia.edu); Stuart J Piketh¹ (27-11-717-6533; piketh@src.wits.ac.za); Peter Hobbs³ (1-206-543-6027; phobbs@atmos.washington.edu); Antonio Queface¹ (27-11-717-6548; queface@hotmail.com); Tali Freiman¹ (27-11-717-6533; tali@crg.bpb.wits.ac.za); Steve Platnick⁴ (1-301-614-6243; platnick@climate.gsfc.nasa.gov)

¹AERG and CRG, University of the Witwatersrand, Bernard Price Building P Bag X3, WITS, Johannesburg 2050, South Africa

²Department of Environmental Sciences, University of Virginia, Clarke Hall, Charlottesville, VA, United States

³Department of Atmospheric Sciences, University of Washington, Box 351640, Seattle, WA 98195-1640, United States

⁴NASA Goddard Space Flight Centre, Code 913, Greenbelt, MD 20771, United States

The atmosphere over southern Africa during the austral spring (August to October) is characterised by episodes of intense haze, lasting several days at a time. Results from the SAFARI 92 field campaign developed