NASA Langley Research Center to study and characterize stratospheric aerosols. The results presented here, which include a long-term lidar record spanning 30 years, were obtained with a ground-based 48-inch lidar. We will present selected backscatter ratio profiles measured during periods of enhanced aerosol loading produced by the Pinatubo eruption and profiles measured during periods well after the Pinatubo aerosol was removed. In addition, lidar integrated backscatter measurements will be compared with optical depth measurements obtained by SAGE and SAGE II satellite-based instruments, which employ the solar occultation technique.

URL: http://www-sage2.larc.nasa.gov/

A41D-0721 0830h POSTER

Retrieval Analysis of Aerosol Properties Deduced From Extinctions at SAGE II, SAGE III, and HALOE Wavelengths

Glenn K Yue[1] (757-864-2678; Genn.K.Yue@nasa.gov)

Cheng-Hsuan Lu[2] (301-763-8000; clu@ncep.noaa.gov)

[1]NASA LaRC, 100 NASA Road, Hampton, VA 23681, United States

[2]RS Information Systems, 1651 Old Meadow Road, McLean, VA 22102, United States

SAGE II measures aerosol extinctions at four visible and near IR wavelengths. SAGE III measures aerosol extinctions at five additional wavelengths; the longest one is 1.55 micron. On the other hand, all HALOE aerosol channels are at IR wavelengths ranging from 2.45 to 5.26 micron. There are comparison opportunities when HALOE and SAGE II or SAGE III conduct measurements at close locations and times. The advantages of the following three methods of approach are discussed: (1) Converting HALOE aerosol extinctioni to extinctions at SAGE III wavelengths; (2) Converting either SAGE II or SAGE III aerosol extinctions to extinctions at HALOE wavelengths; (3) Deducing aerosol properties from SAGE II, SAGE III, and HALOE extinction measurements. It is found that in general, the conversion to extinction at 1.55 micron from HALOE measurements is more accurate than other approaches. It is also found that the retrieval uncertainty is highly dependent on the measurement uncertainty associated with each data set. The preliminary results of comparing HALOE with SAGE II or SAGE III are presented and the relatively larger discrepancies shown at higher altitudes are discussed.

A41D-0722 0830h POSTER

The Climatology of the High-Latitude Stratospheric Aerosol Measured by POAM From 1993 to 2003

Helen M Steele[1] ((818) 677-3512; cox@atmos.ucla.edu)

Jerry D Lumpe[2] ((703) 764-7501; lumpe@cpi.com)

Richard Bevilacqua[3] ((202) 767-0768; bevilacqua@nrl.navy.mil)

Cora E Randall[4] ((303) 492-8208; randall@lasp.colorado.edu)

[1]Dept. of Geography California State University, Northridge, 18111 Nordhoff St, Northridge, CA 91330, United States

[2]Computational Physics, Inc., 8001 Braddock Road, Ste 210, Springfield, VA 22151, United States

[3]Naval Research Laboratory, Code 7220, Washington, DC 20375, United States

[4]Laboratory for Atmospheric and Space Physics, UCB 392 University of Colorado, Boulder, CO 80309, United States

We present a climatology of the high-latitude stratospheric aerosol derived from the multi-wavelength extinction data of the POAM II and III instruments from 1993 to 2003. Stratospheric aerosols north of 54 N and south of 63 S were continually monitored by POAM II between September 1993 and November 1996. These data clearly show the decay of the volcanic aerosol from the Pinatubo eruption which was still evident when the spacecraft ceased operation at the end of 1996. POAM III was launched into a similar orbit in March 1998 and has monitored the seasonal variation in the aerosol layer since its recovery to background levels. Extinction data from these two instruments at six wavelengths from the ultraviolet to near-infrared are combined through principal component analysis to yield total aerosol surface area, volume and effective radius. The temporal and spatial evolution of these physical parameters, employed in chemistry and climate models, are presented and analyzed.

A41D-0723 0830h POSTER

Characterization of Aerosol and PSC Sensitivity of ACE Solar Occultation Measurements

Annmarie Eldering[1,2] (818-354-4941; Annmarie.Eldering@jpl.nasa.gov)

Helen Steele[2,3] (818-677-3532; cox@atmos.ucla.edu)

[1]JPL/Caltech, 4800 Oak Grove Drive MS 183-601, Pasadena, CA 91109, United States

[2]UCLA Atmospheric Sciences, 7127 Math Sciences, Los Angeles, CA 90065, United States

[3]Cal State Northridge, Department of Geography 18111 Nordhoff Stree, Northridge, CA 91330, United States

The ACE Fourier Transform Interferometer was launched on SCISAT on August 12, 2003 to make solar occultation measurements. This high spectral resolution (0.02 cm^{-1}) instrument has broad spectral coverage (750-4100 cm^{-1}). In the work presented here, we will discuss the potential of ACE measurements for characterizing stratospheric sulfate aerosol (SSA) and polar stratospheric clouds. Previously reported studies showed that the high spectral resolution solar occultation measurements of ATMOS, which have limited spectral coverage, can be used to characterize SSA composition under high and moderate loadings. It has also been shown that MkIV airplane-based measurements, with a spectral range similar to ACE, have use in characterizing aerosol size. The work presented here is a sensitivity study of ACE measurements to characterize aerosol size and composition under current aerosol loading conditions and higher aerosol loadings.

A41D-0724 0830h POSTER

A 25-year History of Aerosol Extinction Measurements by the Stratospheric Aerosol Gas Experiment Series

Larry W Thomason[1] (757 864 6842; l.w.thomason@nasa.gov)

Ghassan Taha[2] (g.taha@larc.nasa.gov)

Susan Kizer[3] (757 864-2666; s.h.kizer@larc.nasa.gov)

[1]NASA Langley Research Center, Mail Stop 475, Hampton, VA 23681, United States

[2]University of Arizona, NASA Langley Research Center Mail Stop 475, Hampton, VA 23681, United States

[3]SAIC, NASA Langley Research Center Mail Stop 475, Hampton, VA 23681, United States

The Stratospheric Aerosol and Gas Experiment (SAGE) series of instruments has now produced over 25 years of aerosol extinction measurements. These instruments consist of SAM II (1978-1993), SAGE (1979-1981), SAGE II (1984-present), and SAGE III (2002-present). This period encompasses several significant volcanic perturbations of the stratosphere including those by El Chichon in 1982 and Pinatubo in 1991. Since these events are relatively rare, the record between 1978 and the present is dominated by the lengthy relaxation back to non-volcanic levels. Within this period, at least two periods have been suggested to have reached a non-volcanic level throughout the stratosphere: 1979 and after 1999. In this presentation, we will compare mean and seasonal behavior of SAGE measurements those periods and discuss the problems associated with the use of SAGE data infer changes in stratospheric levels between them. Chief among these difficulties are the long-term stability of the instruments, the cross calibration of the instruments, and dynamic range of the instruments. All of these factors are crucial in establishing confidence limits on any derived difference in stratospheric aerosol levels between these periods.

A41D-0725 0830h POSTER

Comparing the Climatic Impact from Low Latitude versus High Latitude Volcanic Eruptions

Luke Oman[1] (732-932-3891; oman@cep.rutgers.edu)

Alan Robock[1] (732-932-9478; robock@envsci.rutgers.edu)

Georgiy Stenchikov[1] (732-932-3637; gera@envsci.rutgers.edu)

[1]Department of Environmental Sciences, Rutgers University, 14 College Farm Road, New Brunswick, NJ 08901, United States

Explosive volcanic eruptions cause large amounts of SO_2 to be injected into the stratosphere. The SO_2 is converted to sulfate aerosols over time, which cause a significant radiative perturbation to the climate system. The resulting climate response should depend strongly on the latitude of the eruption. We examine these differences using observations and a new version (model E) of the Goddard Institute for Space Studies (GISS) general circulation model (GCM), comparing the temperature and circulation responses of the low latitude Mount Pinatubo (15°N) eruption on June 15, 1991, with those from the high latitude Katmai (58°N) eruption, which occurred on June 6, 1912. For the Pinatubo eruption, we constructed an aerosol data set utilizing SAGE II observations as well as other remote sensing instruments. Our new simulations with the GISS GCM, as well as previous simulations with the GFDL SKYHI and Max Planck ECHAM 4 GCMs, have shown that volcanic aerosol heating of the lower stratosphere from thermal IR and solar near-IR radiation causes changes in the circulation of the stratosphere by increasing the meridional temperature gradient, resulting in a stronger polar vortex. They also showed that reduced solar radiation in the troposphere caused cooler temperatures in the subtropics, which decreased the meridional temperature gradient. This caused a reduction in the amplitude of planetary waves and allowed further strengthening of the polar vortex. The resulting forced positive phase of the Arctic Oscillation caused changes in tropospheric circulation. For Katmai, aerosol data were derived primarily from pyrheliometric observations, and show that while the optical depth was similar in magnitude to the Mount Pinatubo eruption, it was confined to the Northern Hemisphere generally north of 30°N. Modeling of this eruption showed mainly mid- and high latitude cooling over continental areas for approximately 1 year following the eruption. This caused an increase in the meridional temperature gradient. Simulations also indicate a warmer and weaker stratospheric polar vortex in the first winter following the eruption.

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A41E MCC: Level 2 Thursday 0830h

Remote Sensing of Atmospheric Constituents II Posters

Presiding: **V S Connors,** NASA Langley Research Center

A41E-0726 0830h POSTER

Using Structure Tensors for Atmospheric Parameter Estimation

Mark O. Wenig[1] (301 614 5979; wenig@code916.gsfc.nasa.gov)

Jim F. Gleason[1] (301 614 6036; gleason@code916.gsfc.nasa.gov)

[1]NASA, Goddard Space Flight Center, Greenbelt, MD 20771, United States

The structure tensor is a common tool for estimating motion in image sequences. The structure tensor can be extended to estimate other dynamical parameters such as diffusion constants or exponential decay rates. A general mathematical framework was developed for the direct estimation of the physical parameters that govern the underlying processes from image sequences. This estimation technique can be adapted to the specific physical problem under investigation, so it can be used in a variety of applications in trace gas, aerosol, and cloud remote sensing. The fundamental algorithm will be extended to the analysis of multi-channel (e.g. multi trace gas) image sequences and to provide solutions to the extended aperture problem. Based on this analysis, a method to compute atmospheric data parameter fields will be presented.

A41E-0727 0830h POSTER

New Laboratory Measurements of the Spectral Line Parameters of CO Applicable to Atmospheric Remote Sensing.

Keeyoon Sung[1] (1-631-632-9388; jqsrt@notes.cc.sunysb.edu)

Prasad Varanasi[1] (1-631-632-8313; pvaranasi@notes.cc.sunysb.edu)

[1]INSTITUTE FOR TERRESTRIAL AND PLANETARY ATMOSPHERES, STATE UNIVERSITY OF NEW YORK AT STONY BROOK, STONY BROOK, NY 11794-5000, United States

New high-resolution (0.005 cm^{-1}), low-temperature (87-300 K), measurements of the spectral line parameters in the 1-0, 2-0, and 3-0 bands of CO are reported. The line parameters are the absolute intensities, collision-broadened half-widths, collision-induced line shifts,and the variation of these

parameters with temperature. By using N_2, O_2, and air, as the broadening gases we have obtained data that are directly applicable to infrared remote sensing of the atmosphere.It is interesting to observe that, while the collision-broadened half-widths of lines with the same rotational quantum numbers in the three bands are practically the same, the collision-induced line shifts show a marked increase that is progressive with the upper vibrational quantum number of the band. This observation may prove crucial in the interpretation of atmospheric observations.

A41E-0728 0830h POSTER

The MicroMAPS Project: A NASA - Virginia Space Grant Consortium Initiative

Vickie S Connors[1] (757-864-5849; v.s.connors@larc.nasa.gov); Henry G. Reichle[2] (hreichle@crosslink.net); William Morrow[3] (bmorrow100@lycos.com); John Companion[4] (jcompani@odu.edu); Mary Sandy[4] (msandy@odu.edu); Chris D Hall[5] (cdhall@vt.edu); Houston Wood[6] (hwood@virginia.edu); Robert J Ribando[6] (rjr@virginia.edu)

[1]NASA Langley Research Center, Atmospheric Sciences Competency, MS 401B, Hampton, VA 23681, United States

[2]Retired, NASA Langley Research Center, Hwy 665, Moon, VA 23109, United States

[3]Resonance Ltd, 143 Ferndale Drive North, Barrie, Ont L4M 4S4, Canada

[4]Virginia Space Grant Consortium, 600 Butler Farm Road, Hampton, VA 23666, United States

[5]Virginia Polytechnic Institute and State University, Aerospace and Ocean Engineering Dept, 205 Randolf Hall, Blacksburg, VA 24061, United States

[6]University of Virginia, Aerospace and Mechanical Engineering Dept, Charlottesville, VA 22904, United States

The MicroMAPS instrument is a nadir-viewing, gas filter correlation radiometer that operates in the 4.67-micrometer band of carbon monoxide. MicroMAPS was designed at North Carolina State University and built at Resonance Ltd in Canada for flight on the NASA-Clark spacecraft, under the Small Spacecraft Technology Initiative. Because of spacecraft-related delays, the Clark mission was cancelled in February 1998. The instrument was removed from the spacecraft in August 2000 and placed in storage at NASA Langley Research Center until the initiation of the current MicroMAPS project in 2002. The primary goal of the MicroMAPS mission is to examine the chemical and transport processes in the lower atmosphere. The scientific objectives are to 1) demonstrate the reliability and accuracy of the two-layer profiles and total column amounts of CO in the troposphere; 2) provide additional CO measurements and profiles to investigators who develop combined chemistry-transport models, data assimilation models, and other regional- to global-scale atmospheric models; and 3) complement the measurement matrix of space-based CO sensors such as MOPITT on the Terra and TES on the AURA spacecrafts. Test flights of the MicroMAPS CO remote sensor on the Proteus 281 aircraft (owned by Scaled Composites, Inc.) will enable the development and testing of data retrieval algorithms for this instrument, and the verification of these remote CO measurements through comparisons with CO profiles that are measured directly. The aerospace engineering student team from Virginia Polytechnic Institute completed the instrument system and the enclosure design in May 2002. The new composite enclosure replaces the nose of the starboard tail boom during MicroMAPS flights. The instrument system consists of MicroMAPS, an optical window, a data acquisition computer, environmental sensors, and a power inverter. The integrated instrument system, after testing at NASA Langley is completed, will be shipped to Scaled Composites, Inc. in Mojave, CA, to be integrated, calibrated, and flown on a series of test flights. These initial data sets will be used to test the prototype retrieval algorithms under development by the engineering student team at the University of Virginia. The MicroMAPS instrument system will fly on-board Proteus, as a non-interfering payload in collaboration with other integrated payloads.

A41E-0729 0830h POSTER

MicroMAPS Missions for CO Detection

Patrick E. Hopkins[1] (434 242-2875; peh4v@virginia.edu)

Steven A. Tangen[1] (434 244-0954; sat6e@virginia.edu)

Robert J. Ribando[1] (434 924-6289; rjr@virginia.edu)

Houston G. Wood[1] (434 924-6297; hgw9p@virginia.edu)

Vickie S. Connors[2] (757 864-5849; v.s.connors@larc.nasa.gov)

[1]Mechanical & Aerospace Engineering University of Virginia, 122 Engineer's Way P.O. Box 400746, Charlottesville, VA 22904-4746, United States

[2]NASA Langley Research Center, MS 401B, Hampton, VA 23681

The ultimate goal of MicroMaps is to detect CO and N2O from an orbital platform. The instrument is equipped with CO and N2O gas cells configured to observe the earth's IR radiance in a band centered at 4.67 microns. Utilizing these gas cells in a selective chopper, the instrument produces its signal by forming the difference between the incoming energy as seen though one of the gas cells and a second cell that is either evacuated or contains a non-absorbing gas. From the chopper the beams are directed to a detector where they are electronically differenced. The resulting signals will be used with pre- and post-flight calibration for data reduction. A test flight for MicroMAPS is planned on the Proteus aircraft. To prepare for this flight a full-scale theoretical model of the data Proteus is expected to obtain is produced. This model includes total upwelling radiance of the earth in the wavenumber range of 2080 cm-1 to 2280cm-1 transmission of the earth's radiance through the optical window, the band pass filter, and the optical chopper which includes transmission through and emission of the gas in the gas cells. The model produces 5K increments in the range of 280.15K to 310.15K for the blackbody source. Each source temperature includes a model of instrument temperatures with the same range. This upwelling radiance vs. wavenumber data is then integrated over wavenumber for all the temperatures to give us a theoretical model of total radiance vs. temperature of the target for multiple instrument temperatures. The atmospheric radiance was obtained using Line By Line Radiative Transfer Model (LBLRTM) with the HITRAN 1992 database. Gas cell transmissions were obtained via HITRAN-PC, which uses the same database. For comparison, the atmospheric radiance was also generated using HITRAN 1996 with LBLRTM and using HITRAN 2000 with an independent program written in MATLAB with the GENSPECT toolbox. This theoretical model will be used in conjunction with preflight calibration data to give a theoretical prediction of CO concentration. Once the Proteus flies, the post-flight calibration data will be used to reduce the in-flight difference signals. This result will be compared with the predictions of CO concentrations based on theoretical models.

A41E-0730 0830h POSTER

Vertical Resolution and Information Content of MOPITT CO Profiles

Merritt N. Deeter[1] (mnd@eos.ucar.edu)

Louisa K. Emmons[1] (emmons@ucar.edu)

John C. Gille[1] (gille@ucar.edu)

David P. Edwards[1] (edwards@ucar.edu)

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

The MOPITT (Measurements of Pollution in the Troposphere) remote sensing instrument was designed to monitor global distributions of carbon monoxide and methane from a space-based platform using gas correlation radiometry. MOPITT became operational in March, 2000 after being launched in late December, 1999. Current MOPITT retrievals of CO are based on a subset of the instrument's eight 4.6 μm-band channels. The sensitivity of the retrieved CO profile to the 'true' profile is expressed mathematically by the retrieval averaging kernels. Analysis of the averaging kernels reveals valuable information about (1) vertical resolution and (2) inclusion of a priori information. Calculated averaging kernels for operational retrieved CO profiles indicate the capability of resolving tropospheric CO into approximately two layers. Calculation of the averaging kernels' eigenvectors and eigenvalues provides additional insights into issues of vertical resolution and information content. Instruments such as MOPITT that exploit thermal infrared radiation for trace gas profile retrievals are sensitive to temperature contrasts within the atmosphere and at the surface/atmosphere interface. Over land, retrieval vertical resolution (and information content) varies considerably between daytime and nighttime observations due to the diurnal variability of surface/atmosphere temperature contrasts. Over deserts, for example, resolution is usually much greater for daytime observations than for nighttime observations. Over the oceans, retrieval vertical resolution also follows patterns associated with skin temperature (with the highest resolution observed typically in tropical regions). Comparisons of the vertical gradient of MOPITT retrieved CO profiles with in-situ CO profiles measured using aircraft-based instruments are consistent with the vertical resolution indicated by the calculated averaging kernels. Similar findings apply to comparisons of MOPITT retrievals with output from the chemical transport model 'MOZART.' Thus, we find that from (1) averaging kernel calculations using operational retrievals, (2) comparisons with validation results based on in-situ measurements, and (3) comparisons with a chemical transport model that MOPITT retrievals contain quite useful information regarding the vertical distribution of carbon monoxide (in addition to its total column value).

A41E-0731 0830h POSTER

Verification Of Rainfall Estimates Over Africa Using RFE, NASA MPA-RT, And CMORPH

Kevin B Laws[1] (301-763-8000x7584; kevin.laws@noaa.gov)

John E Janowiak[2]

George J Huffman[3]

[1]RS Information Systems Inc. - Climate Prediction Center, NCEP/NWS/NOAA, 5200 Auth Road, Camp Springs, MD 20746, United States

[2]Climate Prediction Center, NCEP/NWS/NOAA, 5200 Auth Road, Camp Springs, MD 20746, United States

[3]Science Systems and Applications, Inc. and Laboratory for Atmospheres, NASA/GFSC, Goddard Space Flight Center Code 912, Greenbelt, MD 20771, United States

Daily rainfall estimates over Africa are derived using the CPC Rainfall Estimation version 2.0 (RFE) algorithm. The RFE technique is used operationally by FEWS-Net and the Africa Desk at the NOAA/Climate Prediction Center to provide weekly weather hazard assessments to the U.S. State Department's Agency for International Development. The RFE algorithm provides daily 0.10° x 0.10° estimates by combining passive microwave and infrared-derived satellite rainfall estimates with daily gridded surface rainfall measurements. This paper and associated presentation will describe the point-to-grid box verification technique and present a preliminary validation of the RFE algorithm by comparing the estimates to rain gauge data from the Global Telecommunication System and other independent surface weather stations in Africa. Two other near-real-time precipitation estimates that have comparable timeliness and time/space grid intervals, the NASA Goddard TRMM Multi-satellite Precipitation Analysis - Real Time (MPA-RT) and the CPC MORPHing technique (CMORPH), will also be compared to similar stations to help gauge the performance of the RFE approach.

A41E-0732 0830h POSTER

The Evaluation of an improved AMSU rain rate algorithm

Shuang Qiu[1] (Shuang.Qiu@noaa.gov)

Paul Pellegrino[1] (Paul.Pellegrino@noaa.gov)

Ralph Ferraro[2] (Ralph.R.Ferraro@noaa.gov)

Limin Zhao[3] (Limin.Zhao@noaa.gov)

[1]QSS Group, Inc., 4500 Forbes Blvd. Suite 200, Lanham, MD 20706, United States

[2]NOAA/NESDIS/Office of Research and Applications, 5200 Auth Road, Camp Springs, MD 20746, United States

[3]NOAA/NESDIS Office of Satellite Data Processing and Distribution, 4251 Suitland Road, Suitland, MD 20395, United States

Improvements have been made to the rain rate retrieval from the Advanced Microwave Sounding Units (AMSU). The new features of the improved rain rate algorithm include the two-stream corrections on the satellite brightness temperatures, cloud and rain type classification and removal of the two ad hoc thresholds in the ice water path (IWP) and effective diameter (De) retrieval where the scattering signals are very small. A monthly mean comparison has been made between the improved algorithm and the current NOAA operational algorithm. In addition, comparison with monthly mean rainfall derived from SSMI, TRMM, and GPCP are also conducted in the evaluation. These comparisons indicate that the new algorithm greatly reduces the previous positive bias over ocean, while increases rainfall intensity and picks up more light rain over land. Also, Pacific Atolls rain gauges are used to demonstrate the greatly improved rain rate retrieval over the tropical Pacific ocean. Results of a winter time case study over California from February 2003 further confirm the enhanced ability of the new algorithm in identifying both light and heavy rain over land.

A41E-0733 0830h POSTER

AIRS/AMSU/HSB Data at Goddard Earth Science DISC DAAC

Sunmi Cho (cho@daac.gsfc.nasa.gov)

Jianchun Qin (jcq@daac.gsfc.nasa.gov)

Jason Li (jyli@daac.gsfc.nasa.gov)

Li Lu (lu@daac.gsfc.nasa.gov)

The Atmospheric Infrared Sounder (AIRS) data product suite is now available at the NASA/GSFC Distributed Active Archive Center (GDAAC) located at the NASA Goddard Earth Sciences Data and Information Services Center (GES DISC) in Greenbelt, Maryland, USA. AIRS data products are a combination of AIRS, Advanced Microwave Sounding Unit (AMSU-A) and Humidity Sounder for Brazil (HSB) measurements. Global coverage by the instruments is obtained twice daily (day and night) and the data along the orbit is processed into 6-minute granules. AIRS alone has 2,378 channels measuring in the infrared range 3.74-15.4 mm and four channels measuring in the visible/near-infrared range 0.4-1.1mm. A day's worth of AIRS data is divided into 240 scenes each of 6 minute duration. The data is produced in HDF-EOS format and generally become available 30-36 hours after satellite measurement from the GDAAC. Level1B data (calibrated, geo-located radiances) contains radiances from 2378 AIRS infrared channels in the 3.74 to 15.4 μm and 4 visible/near infrared channels in the 0.4 to 1.0 μm, and brightness temperature from 15 AMSU-A channels in the 50 - 90 GHz and 23 - 32 GHz and 4 HSB in the 150 - 190 GHz. The brightness temperature from two microwave instruments is used to initialize the surface temperature and atmospheric temperature profile required for the retrieval of the final AIRS geophysical products. Level2 data (geophysical parameters) is grouped into three products - Cloud-Cleared Infrared Radiance, Standard Retrieval, and Support Retrieval. The retrieval products contain atmospheric parameters such as temperatures, humidity, cloud, water vapor, and ozone in 28 pressure levels and 100 pressure levels respectively. Support Retrieval product is intended for the knowledgeable, experienced user of AIRS/AMSU-A/HSB products. It contains high resolution profiles intended to be used for computation of radiances, as-yet unimplemented research products and various parameters and intermediate results used to evaluate and track the progress of the retrieval algorithm. AIRS/AMSU-A/HSB data products can be ordered on line at no cost via the GDAAC Search and Order interface or the EOS Data Gateway (EDG). Most recent data may also be obtained from the Data Pool, an online cache that provides FTP access for quick download. Daily summary browse images and preview images of individual data granules are also accessible from the search interfaces to help users evaluate the data prior to ordering or downloading. The Atmospheric Dynamics Data Support Team (ADDST) at GDAAC is providing science and data support to assist users in understanding, accessing, and applying the AIRS data products. An extensive informational AIRS data support web site has been prepared by ADDST for data users at http://daac.gsfc.nasa.gov/atmodyn/airs/

A41E-0734 0830h POSTER

Comparison of MISR and AERONET Aerosol Optical Depths Over Desert Sites

John Martonchik[1] (818.354.2207; john.v.martonchik@jpl.nasa.gov)

David Diner[1] (818.354.6319; david.j.diner@jpl.nasa.gov)

Ralph Kahn[1] (818.354.9024; ralph.kahn@jpl.nasa.gov)

Barbara Gaitley[1] (818.354.0552; barbara.gaitley@jpl.nasa.gov)

[1]Jet Propulsion Laboratory, 4800 Oak Grove Drive, Pasadena, CA 91109, United States

Aerosol optical depth is now routinely retrieved over vast areas of the Earth's surface by many different satellite instruments. The ocean provides the easiest surface type over which to perform these retrievals because it is sufficiently black at near-IR wavelengths to allow its reflectance to be conveniently ignored. Thus, the detection and measurement of large dust plumes can be made over the ocean, showing that some of these plumes can extend over trans-oceanic distances. The sources of this dust are mainly the deserts of Africa and Asia and it is in these areas that aerosol retrievals are conventionally not attempted, due to the uncertain but high reflectivity of the surface. The MISR (Multi-angle Imaging SpectroRadiometer) instrument on the Terra space platform uses both the angular variation of scene spatial contrast and near invariance of the angular signature of surface spectral reflectance to retrieve aerosol properties over land. As such, retrievals over a wide variety of land surface types can be realistically attempted, including highly reflecting deserts. Here, we compare MISR and AERONET optical depth retrieval results for five desert sites, spanning Saharan Africa and Saudi Arabia and covering the year 2002. We show that MISR can successfully retrieve dust amounts over desert areas and, thus, can provide needed information on dust activity close to the source regions.

A41E-0735 0830h POSTER

Polarization Study of the O2 A-Band and Its Application to the Retrieval of O2 Column Abundance

Yibo Jiang[1] (ybj@mls.jpl.nasa.gov)

Xun Jiang[2] (xun@gps.caltech.edu)

Run-Lie Shia[2] (rls@gps.caltech.edu)

Stanley P. Sander[1] (Stanley.P.Sander@jpl.nasa.gov)

Yuk L. Yung[2] (yly@gps.caltech.edu)

[1]Jet Propulsion Laboratory, 4800 Oak Grove Drive, Pasadena, CA 91109, United States

[2]Caltech 150-21, 1200 E. California Blvd, Pasadena, CA 91125, United States

Light reflected or transmitted by a planetary atmosphere contains information about molecules and particles in the atmosphere. Therefore, accurate modeling of the radiation field may be used to retrieve information on atmospheric composition. In this work, a multilayer model for a vertically inhomogeneous atmosphere is implemented by using the doubling-adding method for a plane-parallel atmosphere. By studying the absorption, scattering and the degree of polarization of the reflected solar light from the sea surface (by glint) in the O2 A-band, around 760 nm, we show the sensitivity of the retrieval to aerosols. From high-resolution reflectance measurements, it is possible to retrieve O2 column abundances with precision of 0.1% for clear sky (OB́rien et al., 1997). However, there may be errors associated with the presence of small amounts of aerosols and cirrus clouds. The linear polarization is very sensitive to the aerosol and cirrus distributions. Therefore, its measurement can also be used to assess their presence and quantify the associated errors in the retrieval of O2 column abundances.

A41E-0736 0830h POSTER

Identifying Meteorological Regimes Using Satellite Data

Neil D Gordon[1] (858-822-4611; ndgordon@ucsd.edu)

Joel R Norris[1] (jnorris@ucsd.edu)

Christopher P Weaver[2] (weaver@cep.rutgers.edu)

Stephen A Klein[3] (Stephen.Klein@noaa.gov)

[1]Scripps Institution of Oceanography, University of California, San Diego, 9500 Gilman Drive Mail Code 0224, La Jolla, CA 92093, United States

[2]Center for Environmental Prediction, Rutgers University, 14 College Farm Road, New Brunswick, NJ 08901-8551, United States

[3]Geophysical Fluid Dynamics Laboratory / NOAA, Princeton University Forrestral Campus / US Route 1 P.O. Box 308, Princeton, NJ 08542, United States

We use a k-means clustering algorithm to group meteorological regimes with similar cloud properties retrieved from the Geostationary Operational Environmental Satellite (GOES8). We attempt to link each cluster, dictated by cloud properties, to a dynamic regime associated with cool season extratropical cyclones. Meteorological data is then averaged over the times associated with each cloud cluster to ensure that the cloud regimes are physically consistent. The analysis is restricted to a single Global Climate Model-sized box over the Southern Great Plains (SGP) site of the Atmospheric Radiation Measurement (ARM) program during the months of Jan-Mar, Nov-Dec of 2000. The ARM Continuous Forcing (ACF) Data Set is used to describe the meteorology of the single column over the ARM SGP site for each cluster and the Rapid Update Cycle (RUC) 40-km, isobaric Numerical Weather Prediction Analysis provides a representative picture of the mesoscale meteorology. We compare simulated cloudiness from a Single-Column Model (SCM) forced by ACF data to determine the sources for GCM parameterization deficiencies in predicting specific cloud types.

A41E-0737 0830h POSTER

Spatial Structure in Clear-Air Water Vapor

William A.M. Blumberg[1] (781-377-2951; william.blumberg@hanscom.af.mil)

Joe Shanks[2] (858-625-2211; jgs@photon.com)

Andrew J. LePage[3] (781-273-2820; lepage@visidyne.com)

A. T. Stair[3] (781-273-2820; ats@visidyne.com)

[1]Air Force Research Laboratory, Space Vehicles Directorate, 29 Randolph Road, Hanscom AFB, MA 01731, United States

[2]Photon Research Associates, 5720 Oberlin Drive, San Diego, CA 92121, United States

[3]Visidyne Inc., 10 Corporate Place, South Bedford St., Burlington, MA 01803, United States

Small-scale spatial variations in clear air water vapor are an important feature of the local structure of the lower atmosphere. The Multispectral Atmospheric Mapping Sensor (MAMS) flown on the NASA ER-2 aircraft collected data on small-scale spatial structure in clear air water vapor in the 6.2 - 6.9 micron water vapor band. The Aquameter Water Band Radiometer flown on the AFRL FISTA (Flying Infrared Signatures Technology Aircraft) collected spatial structure data on in three water band channels (5.4 - 7.2, 5.6 - 6.1, and 5.7 - 6.7 microns). Wave structures with spatial scales varying from tenths to tens of kilometers were observed. In addition, spatial structure in column densities of clear air water vapor have been determined from the atmospheric correction of high spatial resolution data collected by aircraft-borne hyperspectral sensors. This paper will review these measurements, discuss models for sources of the observed structure, and assess planned air and space-based data collections on small-scale spatial structure in clear air water vapor.

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Development of *in situ* Formaldehyde Sensors

Frank N Keutsch[1] ((617) 495-5922; frank@huarp.harvard.edu)

Thomas F Hanisco[1]

James G Anderson[1]

[1]Department of Chemistry Harvard University, 12 Oxford Street, Cambridge, MA 02138, United States

In situ measurements of formaldehyde (CH_2O) are important for a better understanding of photochemistry and CH_2O can be used as a tracer, especially for large-scale convective events. In the latter case the measurement of CH_2O being entrained and detrained from the convective event at all altitudes with instruments optimized for these conditions is of particular interest. This requires *in situ* observations of CH_2O with high sensitivity (<10 pptv/sec.) and high vertical and temporal resolution, resulting from the large variation of CH_2O concentrations from the troposphere to the lower stratosphere and the short photochemical lifetime of CH_2O. In addition, such observations are of interest for validation of OMI, which is being deployed on the AURA satellite. We discuss the development of state-of-the-art CH_2O sensors based on both mid-infrared integrated cavity output spectroscopy (ICOS) and UV laser-induced-fluorescence (LIF) and cavity-ringdown spectroscopy (CRDS) employing novel laser technology. The sensitivities of these are expected to be 50 pptv/10sec., 25 pptv/10sec.,and 1 pptv/10sec. for ICOS, CRDS, and LIF, respectively. The compact and light-weight ICOS and CRDS instruments will be ideally suited for observations in the troposphere whereas the high sensitivity LIF instrument will be used in the upper troposphere and stratosphere, which will also allow a direct comparison of the two instruments. We have developed a calibration method that replaces permeation tubes, which require careful calibration themselves. Instead our CH_2O calibration utilizes a microinjector that introduces a highly repeatable and well-known amount of CH_2O into the detection axis. This method can also be employed during field deployments. The strategy of simultaneous ICOS and LIF detection tied into laboratory and field calibrations will bring the accuracy and quality of laboratory kinetics studies to *in situ* observations and will allow a detailed and fundamentally important analysis of systematic errors. Progress on the laboratory systems will be discussed.