A12B-0096 1330h POSTER

The Accuracy of the Satellite Aerosol Optical Depth Retrieval

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If we want to determine the top of the atmosphere aerosol radiative forcing with the accuracy of 0.5 W/m2 we need to know the aerosol optical depth (AOD) over the land with the accuracy of 0.015. None of the current operational satellite based instruments for AOD retrieval has been able to achieve this accuracy. The RMSE (Root Mean Square Error) of the AVHRR (Advanced Very High Resolution Radiometer) is typically between 0.06 and 0.15, while the RMSE of the MODIS (MOderate resolution Imaging Spectroradiometer) over the land has been estimated to be 0.05+0.2AOD, which varies between 0.07 and 0.21 for AOD between 0.1 and 0.8. Theoretical analysis suggests that the uncertainties in aerosol phase function (due to uncertainties in aerosol shape, size distribution and optical properties) are the major obstacles for accurate aerosol optical depth retrieval. These uncertainties lead to a much larger error in aerosol optical depth retrieval at large scattering angles (usually at close to nadir view), than at the off nadir views at medium scattering angles. The Department of Energy research satellite instrument, the Multispectral Thermal Imager (MTI), is capable to retrieve the aerosol optical depth with the accuracy of 0.03 using the off nadir view at medium scattering angles. Based on our theoretical analysis and on the MTI experience we suggest that to achieve the required accuracy in the AOD retrieval the future satellite instruments using single or dual-view should use off nadir views and combination of visible and near infrared spectral bands.

A12B-0097 1330h POSTER

Application of Principal Component Analysis to the Analysis of Atmospheric Aerosol Size Distributions

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Atmospheric size distributions provide important fundamental information for studying atmospheric particle physics. To capture enough information using a distribution with reasonable resolution results in massive data sets. For example, 5-minute scans with 30 size bins produces 8640 data points per day. The complexity of such data set usually creates difficulties in data handling and interpretation. Principal Component Analysis (PCA) provides a way to reduce the dimensionality of data sets and produces a simpler yet quantitatively equivalent data set. The simplified data set usually provides an easier mean for data interpretation. In applying PCA to size distribution data, there are several important aspects that one needs to pay attention to. These include proper weighting for the data, correct selection of the number of components to extract and a rotation scheme to transform the result to simple structure for interpretation. In this poster, these important issues in applying PCA to size distribution data will be discussed. A new weighting scheme for size distribution data has been developed. This new weighting scheme allows one to fit the size distribution data more accurately without requiring too many components. Application of Varimax rotation to the eigenvectors enables one to turn the eigenvectors to a simple and physically meaningful size distribution function. As a result, a complete distribution can be broken down into a series of simple and independent distributions for easy interpretation. Furthermore, procedure on how to extract the correct number of components will be addressed. Finally, some field study measurements from Pacific 2001 and other studies held in Southern Ontario will be used as an illustration of how to make use of the rotated scores to explain some atmospheric process such as local nucleation and transport.

A12B-0098 1330h POSTER

Towards a conceptually rigorous definition of an aerosol size distribution

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We apply and extend recent results of Larsen et al. (2003), concerning spatial and temporal correlations among aerosol particles, to correlations among different size bins. The basic question addressed is: what should be a reasonable set of requirements on coherence vs. collection times, in order to define a physically meaningful notion of a size distribution and its time evolution? To that end, we present and examine new high temporal resolution aerosol data in the form of 5 contemporaneous time series, corresponding to five different aerosol size bins. We calculate cross-correlation functions among the different sizes and discuss the implications of variable coherence times on the notion of the aerosol size distribution. References: M.L. Larsen, W. Cantrell, J. Kannosto, A.B. Kostinski, "Response from Authors to Comment on "Detection of Spatial Correlations among Aerosol Particles", to appear In Aerosol Science and Technology M.L. Larsen, W. Cantrell, J. Kannosto, A.B. Kostinski, "Detection of Spatial Correlations Among Aerosol Particles", Aerosol Science and Technology, 2003, vol. 37, no. 6, pp. 476-485.

A12B-0099 1330h POSTER

Assimilation of Satellite-derived Aerosol Optical Thickness in a Mesoscale Model: A Case Study.

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Aerosol retrievals from satellite measurements play an important role in monitoring aerosol spatio-temporal distributions. Few studies have attempted to assimilate the satellite aerosol products into the models to improve aerosol forecast. Furthermore, most current aerosol models are off-line, in which the aerosol radiative effects are not directly considered during the simulations. This study uses the Colorado State University Regional Atmospheric Modeling Systems (CSU RAMS) and the GOES8 aerosol retrievals during Puerto Rico Dust Experiment to investigate how the aerosol modeling can be improved by assimilating the satellite retrievals. A four-stream radiative transfer model was integrated into the RAMS to consider the aerosol radiative effect in the model simulation in a "real" scenario (rather than offline). Aerosol transport model is built upon a tracer advection module in RAMS with addition of emission and deposition components. Satellite retrievals from GOES8 are assimilated into the RAMS using nudging schemes. Modeled aerosol optical thickness (AOT) and mass concentration are then compared with the measured quantities. Results show that the assimilation of GOES8 AOTs with high-temporal resolutions provides a promising method to improve aerosol modeling. The challenges in assimilation of satellite column AOTs into the 3D models are discussed.

A12C MCC: 3018 Monday 1340h

The Aura Mission to Study Chemistry and Climate I *(joint with SA)*

Presiding: **A Douglass,** NASA Goddard Space Flight Center**; E Hilsenrath,** NASA Goddard Space Flight Center

A12C-01 1350h INVITED

The High Resolution Dynamics Limb Sounder (HIRDLS) Experiment on Aura

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Previous space-based observations have contributed much to our knowledge of the stratosphere in recent decades. These observations have been characterized by large horizontal or vertical scales, leaving a range of unobserved phenomena at smaller scales. This is especially true near the tropopause, where rapid vertical changes in temperature and composition have been unobserved on a global basis. This presentation will briefly review some of the current science questions, including troposphere-stratosphere exchange, both in the tropics and mid-latitudes, as well as filamentation at internal barriers in the atmosphere, and the requirements they place on the desired measurements. Accurate and precise observations of temperature, and a number of trace species having a range of atmospheric lifetimes as well as different source and sink regions are needed, with horizontal resolutions of a few degrees or less, and vertical resolutions of $\sim$ 1 km. The species chosen are O3, H2O, CH4, N2O, NO2, N2O5, HNO3, CFC11, CFC12, ClONO2, and aerosol properties. New requirements on the instrument include the ability to make measurements at multiple azimuths, using narrow fields of view, oversampling, multiple spectral intervals for some species, as well as high radiometric accuracy and precision, and careful calibration. The instrument description shows how these requirements are met. The HIRDLS instrument is a 21 channel limb-scanning infrared radiometer, based on a folded off-axis telescope and HgCdTe detectors cooled to 62 K. The 2-axis scan mirror is capable of making vertical scans across the limb over a wide range of azimuths from the orbital plane, resulting in complete global coverage of all species. The scan parameters are programmable from the ground, so observations may be tailored to specific geophysical situations. Finally, examples of retrievals of simulated radiances illustrate the expected precision and resolution of the data.

URL: http://www.eos.ucar.edu/hirdls/

A12C-02 1410h

EOS MLS, the Earth Observing System Microwave Limb Sounder

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EOS MLS is an instrument that remotely senses Earth's upper troposphere, stratosphere and mesosphere by measuring millimeter and submillimeter wavelength thermal emission from the atmospheric limb. It will be operated on the EOS Aura satellite starting in 2004, and is a follow-on to the MLS on the Upper Atmosphere Research Satellite. New technology enables many more measurements by EOS MLS than were possible with UARS MLS, and measurements to lower altitudes. The EOS MLS measurement suite includes H_2O, OH, HO_2, O_3, ClO, HCl, HOCl, BrO, N_2O, HNO_3, CO, HCN, CH_3CN, volcanic SO_2, temperature, cloud ice and geopotential height. All measurements are made day and night, simultaneously and continuously over 82S -82N latitudes on each orbit. Scientific objectives are to improve knowledge in areas of (1) stratospheric chemistry and chemistry-climate interactions, (2) upper tropospheric processes that affect climate variability, and (3) pollution in the upper troposphere. This talk will give an overview of the EOS MLS experiment.

A12C-03 1430h

Science Goals of EOS-Aura's Ozone Monitoring Instrument (OMI)

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The Ozone Monitoring Instrument (OMI) will fly on NASA's EOS-AURA satellite, scheduled for launch in early 2004. OMI is a UV/VIS, nadir viewing spectrometer that will provide near global coverage of solar backscatter radiances in one day using a wide field telescope. OMI has several technological advances, but has heritage from the TOMS, SBUV, GOME, GOMOS and SCIAMACHY. Using the wavelength range 270 to 500 nm with a 0.5 nm resolution, OMI will measure several key parameters for stratospheric and tropospheric chemistry and for climate research, including O_3, NO_2, SO_2, OClO, HCHO, BrO, UVB, aerosols, and cloud heights and fraction. Combining OMI data with the other Aura instruments will allow derivation of tropospheric gases important for air quality studies. OMI's high spatial resolution (13 x 24 km^2) will allow observation between clouds, thus giving better penetration into the troposphere than any other UV/VIS backscatter instrument flown to date. Science questions addressed by OMI include: • *Is the ozone layer recovering?* • *What are the sources and distribution of aerosols and trace gases that affect global air quality?*

• *What are the roles of tropospheric ozone and aerosols in climate change?*
• *What are the causes of surface UV-B change?* Proven TOMS and DOAS retrieval algorithms for trace gases will be employed as well as new ones, which will take advantage of experience gained by both European and US scientists. OMI ozone data will be of the same quality as TOMS to insure continuity of ozone trends detected to date. Tropospheric ozone will be retrieved using two algorithms developed for TOMS but tailored for OMI and using ozone profiles from all Aura instruments. Measurement of aerosols characteristics will be enhanced using data from the A-Train. Some of these algorithms are presented in the Aura poster session, while all OMI algorithms are available at http://eospso.gsfc.nasa.gov/. Performance of the OMI instrument and its algorithms relative to Aura's science goals will be discussed. Information on possible co-operation in the OMI validation program will be given.

A12C-04 1450h INVITED

The EOS AURA Tropospheric Emission Spectrometer (TES)

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The Tropospheric Emission Spectrometer (TES) is a high-resolution infrared Fourier Transform spectrometer that operates in both limb and nadir viewing modes for the investigation of the physics and chemistry of the Earth's lower atmosphere. TES is currently being integrated onto the AURA spacecraft in readiness for launch into Sun-synchronous polar orbit early in 2004. The talk will focus on pre-delivery system tests and calibrations as they impact the expected on-orbit performance.

A12C-05 1510h

Validation of Aura Data: Needs and Implementation

Lucien Froidevaux[1] (818-354-8301; Lucien.Froidevaux@jpl.nasa.gov); Anne R Douglass[2] (Anne.R.Douglass@nasa.gov); Mark R Schoeberl[2] (Mark.R.Schoeberl@nasa.gov); Ernest Hilsenrath[2] (Ernest.Hilsenrath@nasa.gov); Douglas E Kinnison[3] (dkin@ucar.edu); Mark Kroon[4] (Mark.Kroon@knmi.nl); Stanley P Sander[1] (Stanley.P.Sander@jpl.nasa.gov)

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Validation of Aura data: needs and implementation L. Froidevaux, A. R. Douglass, M. R. Schoeberl, E. Hilsenrath, D. Kinnison, M. Kroon, and S. P. Sander We describe the needs for validation of the Aura scientific data products expected in 2004 and for several years thereafter, as well as the implementation plan to fullfill these needs. Many profiles of stratospheric and tropospheric composition are expected from the combination of four instruments aboard Aura, along with column abundances, aerosol and cloud information. The Aura validation working group and the Aura Project have been developing programs and collaborations that are expected to lead to a significant number of validation activities after the Aura launch (in early 2004). Spatial and temporal variability in the lower stratosphere and troposphere present challenges to validation of Aura measurements even where cloud contamination effects can be minimized. Data from ground-based networks, balloons, and other satellites will contribute in a major way to Aura data validation. In addition, plans are in place to obtain correlative data for special conditions, such as profiles of O3 and NO2 in polluted areas. Several aircraft campaigns planned for the 2004-2007 time period will provide additional tropospheric and lower stratospheric validation opportunities for Aura; some atmospheric science goals will be addressed by the eventual combination of these data sets. A team of "Aura liaisons" will assist in the dissemination of information about various correlative measurements to be expected in the above timeframe, along with any needed protocols and agreements on data exchange and file formats. A data center is being established at the Goddard Space Flight Center to collect and distribute the various data files to be used in the validation of the Aura data.

A12C-06 1525h

Contribution of AURA-OMI and A-train observations to the understanding of tropospheric aerosol absorption effects on climate

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It is well known that aerosols contribute to the mitigation of the warming effect of the greenhouse gases by scattering back to space a fraction of the incoming solar radiation. Particle absorption, however, alters the radiative properties of the atmosphere by reducing the aerosol cooling effect and warming the atmosphere. Since black carbon containing aerosols are of anthropogenic origin, the quantification of the atmospheric aerosol load over the industrialized areas as well as over the areas affected by biomass burning is necessary to reduce the currently large uncertainties on the climate role of aerosol absorption. The near UV approach of aerosol absorption sensing from space developed and tested using measurements by the Total Ozone Mapping Spectrometer (TOMS), will be applied to observations by the Ozone Monitoring Instrument (OMI), on the AURA platform. OMI will measure the aerosol absorption optical depth by taking advantage of the strong signal resulting from the interaction of aerosol absorption and the large molecular scattering in the near UV spectral region. OMI measurements of aerosol absorption optical depth over ocean and land surfaces, in conjunction with additional aerosol related information derived from other sensors in the A-train (e.g., aerosol vertical distribution from CALIPSO observations and aerosol size and optical depth in the visible and near IR from Aqua-MODIS), will provide valuable information on the spatial and temporal variability of absorbing aerosols. The AURA-OMI observational record of aerosol absorption optical depth over the estimated 6-year lifetime of the mission will constitute the first global long-term data set on aerosol absorption optical depth.

A12D MCC: 3016 Monday 1340h

Tropical Cirrus Anvils: Properties and Processes III *(joint with SA, AE)*

Presiding: **E Jensen,** NASA Ames Research Center**; D E Anderson,** NASA Headquarters

A12D-01 1340h

Evaluation of the Adapative Infrared Iris Hypothesis Using TRMM Satellite Measurements

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Significant controversy surrounds the adaptive infrared iris hypothesis put forth by Lindzen et al. (2001), whereby tropical anvil cirrus detrainment is dependent on the underlying temperature and this dependence acts as an iris to inhibit changes in the surface temperature. This hypothesis implies increased precipitation efficiency in regions of higher sea surface temperatures (SSTs) which reduces cirrus detrainment. Tropical Rainfall Measuring Mission (TRMM) satellite measurements are used to investigate the adaptive infrared iris hypothesis. Pixel-level Visible and Infrared Scanner (VIRS) 10.8 μm brightness temperature data and Precipitation Radar (PR) rainrate data from TRMM are collocated and matched to determine individual convective cloud boundaries. Each cloudy pixel is then matched to the underlying SST. This study examines clouds with a single convective core to determine if a relationship exists between the size of convective clouds and the underlying SSTs. In doing so, we address some of the criticisms of the Lindzen et al. study by eliminating the cloud-weighted SST and limiting ourselves to only clouds identified as convective by the PR. The proposed mechanism for the iris hypothesis is also examined using cloud size and rainfall information. Normalizing cloud size by the amount of rainfall from the cloud provides information on whether or not the cloud size decreases at higher SSTs with increasing rainfall. Preliminary results support the adaptive infrared iris hypothesis and mechanism. It should be noted, however, that the strength of support for the iris is dependent on the brightness temperature threshold chosen for the cloud boundaries. Regressions of cloud size with SST show negative slopes and correlations signifying that cloud size decreases with increasing SST as proposed by Lindzen et al. Normalized cloud size by rainfall regressed against SST also shows a negative slope and correlation, indicating that the amount of rainfall from a cloud does increase as the cloud size decreases at higher SSTs.

A12D-02 1355h

An examination of the spatial relationship between the water minimum and convection in the TTL

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Recently, it has been argued that the region where water vapor is a minimum in the tropical tropopause layer is located downstream of convection. If true, this would suggest that in situ dehydration was playing a role in regulating water vapor near the tropical tropopause. In this presentation, I will use UARS MLS water vapor measurements, as well as various proxies for convection, to argue that the water vapor minimum is closely collocated with convection. I will also provide potential explanations as to why previous analyses have reached a different conclusion.

A12D-03 1410h

Combined Lidar-Radar Measurements of Tropical Cirrus Anvils During the CRYSTAL-FACE Field Campaign

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During the CRYSTAL-FACE field experiment the Cloud Physics Lidar (CPL) and the new Cloud Radar System (CRS) were flown together on the NASA ER-2 aircraft, providing the first high-altitude collocated measurements from lidar and cloud profiling radar. The lidar and radar provide complementary measurements with varying degrees of vertical measurement overlap within cloud layers and permit near-complete vertical coverage through the atmosphere. In this presentation a description of the combined airborne lidar-radar measurements will be given, followed by a comparison of instrument sensitivity. Focus will be on cirrus anvils observed during several days of the CRYSTAL-FACE experiment. Data from July 23, 28, and 29 will be used to show evolution of the temporal and structural features of the cirrus anvils using the full profiling capability permitted with the combined lidar-radar measurements. On these particular days, flight tracks designed specifically to capture evolving cirrus anvils allow an unprecedented view of the cirrus anvil life cycle.

URL: http://cpl.gsfc.nasa.gov

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