A32C-04 1440h

New Measurements of Aerosol Vertical Structure from Space Using the NASA Geoscience Laser Altimeter System (GLAS): Applications for Aerosol Transport Models

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In the past, satellite measurements of aerosols have only been possible using passive sensors. Analysis of passive satellite data has lead to an improved understanding of aerosol properties, spatial distribution, and their effect on the earth's climate. However, direct measurement of aerosol vertical distribution has not been possible using only the passive data. Knowledge of aerosol vertical distribution is important to correctly assess the impact of aerosol absorption, for certain atmospheric correction procedures, and to help constrain height profiles in aerosol transport models. On January 12, 2003 NASA launched the first satellite-based lidar, the Geoscience Laser Altimeter System (GLAS), onboard the ICESat spacecraft. GLAS is both an altimeter and an atmospheric lidar, and obtains direct measurements of aerosol and cloud heights. Here we show an overview of GLAS, provide an update of its current status, and discuss how GLAS data will be useful for modeling efforts. In particular, a strategy of using GLAS to characterize the height profile of dust plumes over source regions will be presented, along with initial results. Such information can be used to validate and improve output from aerosol transport models. Aerosol height profile comparisons between GLAS and transport models will be shown for regions downwind of aerosol sources. We will also discuss the feasibility of assimilating GLAS profiles into the models in order to improve their output.

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

A32C-05 1455h

IN SITU AEROSOL SIZE DISTRIBUTIONS AND RADIATIVE CLOSURE STUDY DURING AEROSOL INTENSIVE OPERATION PERIOD (ARM-IOP)

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During the Aerosol Intensive Operation Period of the Department of Energy's Atmospheric Radiation Measurement (ARM) program, the microphysical, chemical, and radiative properties of atmospheric aerosol were characterized in detail at ARM Southern Great Plains (SGP) site in north central Oklahoma in May, 2003. A differential mobility analyzer and an optical particle counter measured aerosol size distribution from 25 nanometers to several microns. Aerosol chemical composition and hygroscopicity were characterized using a Particle Into Liquid Sampler and a high flow tandem differential mobility analyzer system, respectively. Combined with the chemical composition and hygroscopicity measurements, aerosol size distributions measured were used to predict a wide range of aerosol optical properties and compared to the simultaneous direct measurements. This closure study allows one to assess the validity of the physicochemical description of the aerosol when closure is achieved, and also provides insight into potential sources of error when some or all of the comparisons result in disagreement.

A32C-06 1510h

Suborbital measurements of spectral aerosol optical depth and its variability at sub-satellite-grid scales in support of CLAMS, 2001

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As part of the Chesapeake Lighthouse and Aircraft Measurements for Satellites (CLAMS) experiment, July 10 - August 2, 2001, the 14-channel NASA Ames Airborne Tracking Sunphotometer (AATS-14) was operated aboard the University of Washington CV-580 during 10 research flights (45 flight hours). Among others, CLAMS research goals included validation of satellite-based retrievals of aerosol properties. AATS-14 measures the direct solar beam transmission at 14 discrete wavelengths (354-1558 nm), yielding aerosol optical depth spectra and columnar water vapor for such validation purposes. Comparisons of AOD between the AERONET Cimel instrument at COVE and airborne measurements by AATS-14 in its vicinity showed good agreement with largest r-square correlation coefficients at wavelengths of 380 and 500nm (>0.99). Coordinated low-level flight tracks of the CV-580 during Terra overpass times permitted validation of over-ocean MODIS level 2 (MOD04_L2) multi-wavelength AOD data (10x10km, nadir) in 16 cases on 3 separate days. While the correlation between AATS-14 and MODIS-derived AOD was poor with an r-square of 0.55, almost 75% of all MODIS AOD measurements were still in the desired uncertainty range ($\pm 0.03 \pm 0.05$*AOD). This may be due to the small AODs (generally less than 0.1 at 500nm) encountered in these comparison cases. An analogous coordination exercise resulted in 7 exact over-ocean match-ups between AATS-14 and MISR measurements. The comparison between AATS-14 and the MISR standard algorithm regional mean AODs showed a much stronger correlation with an r-square of 0.94. However, MISR AODs were systematically higher than the corresponding AATS values, with an rms difference of 0.06. AATS data collected during nine extended low-level CV-580 flight tracks were used to assess spatial variability in AOD at horizontal scales up to 100 km. At UV and mid-visible wavelengths, the largest absolute gradients in AOD were 0.1-0.2 per 50 km horizontal distance. In the near IR, analogous gradients rarely measured 0.05. On any given day, the relative gradients in AOD were remarkably similar for all wavelengths, with maximum values of 70% per 50 km and more typical values of 25%. We will discuss the implications of these unique measurements of AOD spatial variability for common validation practices of satellite data products and for comparisons to large-scale aerosol models.

A32C-07 1525h

Modeling Radiative Forcing by Aerosols: How Good is Good Enough?

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Radiative forcing of climate change by anthropogenic aerosols is now recognized as the largest uncertainty in climate forcing F over the industrial period. This uncertainty limits inference of Earth's climate sensitivity λ either empirically or by comparison of observed temperature change over the industrial period ΔT with modeled temperature change obtained by imposing a time-dependent forcing in a climate model. Either way, for a desired uncertainty in λ of, say, 30% (e.g., temperature increase resulting from doubling atmospheric CO_2 $\Delta T_{2x} = 3 \pm 1$ K), the required uncertainty in F is about 20%. The resultant required uncertainty in aerosol forcing depends on the magnitude of this for cing. If total aerosol forcing is small, the requisite uncertainty can be quite large, e.g., a factor of 2 for aerosol forcing -0.4 W m^{-2}. However as aerosol forcing magnitude increases the requirement is much more stringent, e.g., for aerosol for c ing -1.2 W m^{-2}, 10%, comparable to present uncertainty in greenhouse gas forcing. This talk examines quantifiable uncertainties in aerosol forcing and apportions them between contributions from atmospheric chemistry, atmospheric radiation, and c l ou d microphysics. Unless and until present uncertainties are greatly reduced it will not be possible to place confident limits on Earth's climate sensitivity, limiting society's ability to confidently plan to adapt to or mitigate future climate chang e arising from increasing atmospheric concentrations of greenhouse gases. n

URL: http://www.ecd.bnl.gov/steve/schwartz.html

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A32D MCC: 3018 Wednesday 1600h

Integrating Aerosol Measurements and Models VII *(joint with OS, GC)*

Presiding: **J Penner,** University of Michigan**; S Kinne,** Max-Planck-Institut für Meteorologie

A32D-01 1600h

THE AEROCOM PROJECT: DIAGNOSTIC OF AEROSOL MODULES IN GLOBAL MODELS

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Aerosol introduces one of the larger uncertainties in climate modeling. This led to new efforts in the global modeling community to represent aerosol properties and processes in more detail (including interactions with chemistry and clouds). With a distinction among different aerosol types, new untested assumptions were made and need to be evaluated, preferably to measurements. The AeroCom project http://nansen.ipsl.jussieu.fr/AEROCOM seeks to document differences of aerosol component modules (of global models) and to assemble useful data-sets for model evaluations. AeroCom's overall goals are the identification of weak components in aerosol modeling and an assessment of current uncertainties with respect to simulated aerosol optical properties and the associated radiative forcing. AeroCom participation is still open to any aerosol-component global modeling group and any measurement-groups, which measure properties relevant to simulated aerosol properties and aerosol parameterizations. First results on unified data-sets and on model performance will be presented.

URL: http://nansen.ipsl.jussieu.fr/AEROCOM

A32D-02 1615h

AEROCOM - First Results from the Global Aerosol Model Intercomparison Project

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Aerosols play an important, but not well-quantified role in Earth's global climate. Aerosols exert a direct radiative effect, and they also influence the radiative properties of clouds. Observations from satellites and from the ground are currently not sufficient to adequately characterize the nature and distribution of aerosols in the atmosphere. However, numerical simulations of aerosols in global models that are carefully evaluated with observations facilitate the investigation of aerosol effects on the climate system. A number of complex multi-component aerosol modules embedded in various global models has been developed in recent years. Initial comparisons among these models and comparisons of the model results to remote sensing data (e.g., Penner et al. and Kinne et al.) indicated a need for more detailed assessments, which are now performed within AEROCOM. Anonymized results from the first experiment with about 10 models will be presented. The different models have either been forced with meteorological data for the year 1996, 1997, 2000, 2001, or have been run in a climatological mode. We focus on five aerosol components: dust, sea salt, sulfate, black carbon and organic particulate matter. The model results are compared with each other and with new remote sensing measurements of aerosols from ground and space. We will analyze simulations of total aerosol load and of single components in the atmosphere. We try to explain differences in the results from different models by examining the individual parameterizations of the physical processes and of the sources. Among others we will present the aerosol distribution in atmosphere, and particle compositions and sizes. The removal processes (wet and dry deposition, gravitational settling) will be investigated and budgets will be shown. We aim at an evaluation of the quality of aerosol simulation in current global models. The simulated optical properties of the aerosol will be studied and compared with satellite data to get a more realistic assessment of the aerosol's impact on climate.

URL: http://nansen.ipsl.jussieu.fr/AEROCOM

A32D-03 1630h

AEROCOM : Global Aerosol Models Tested Against Surface Observations

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Through the AEROCOM project, work is realized to perform a rigorous evaluation of existing global aerosol models. Part of this evaluation consists of assembling observational data-sets, in order to compare measurements and model outputs for characteristic aerosol properties. This work presents the result of such a comparison regarding the aerosol composition at selected surface sites. From several regional and global datasets (EMEP, GAW, IMPROVE, etc), aerosol sites were chosen. This selection of ground sites is done to evaluate the aerosol composition in each region of the globe and for at least one complete year, in order to have information on the seasonal variations. The years 1996-1997-2000-2001 were chosen as reference years for the comparison exercise. These years were simulated by the different models involved in AEROCOM. The parameters concerned in this work are sulfate, black carbon, total particulate matter, dust and sea-salt concentrations. This global comparison allows one to see whether a bias between model and observations is due to large specific local gradients in the aerosol concentration fields or due to a more systematic error in the model. Results from a similar comparison performed with aerosol optical properties, in particular optical depth using the AERONET data-set, are analyzed using modeled aerosol composition.

URL: http://nansen.ipsl.jussieu.fr/AEROCOM

A32D-04 1645h

Blending AERONET, MODIS and GCM Aerosol Size Information

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Retreivals from AERONET surface observations of solar radiance provide column-averaged detailed aerosol size distributions and optical properties for a select number of locations around the globe. Measurements from MODIS provide a high spatial resolution global coverage of more simplified column-averaged aerosol size information, namely the small mode optical depth fraction and the Angstrom exponent. GCMs perform chemical and dynamical transport of various aerosol types to predict three dimensional aerosol mass mixing ratios but with highly simplified size assumptions. By exploiting the correlations between the aerosol quantities derived from AERONET, MODIS and GCM, we suggest that an improved global distribution of aerosol sizes can be deduced.

A32D-05 1700h

Comparison of GCM Calculated Aerosol Fields and Their Equivalents From In-Situ and Remote Sensing Measurements

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Aerosols are thought to play an important role in the global climate system. However, their effects on the radiation budget and even their global distribution and composition are not understood satisfactorily. A new aerosol model in the ECHAM5 GCM allows the calculation of the aerosol radiative effects from the explicitly simulated size distribution, composition, and mixing state. It represents the species sulfate, black carbon, organic carbon, sea salt and dust via a superposition of seven log-normal modes. The model treats gas-phase and cloud liquid-phase sulfur chemistry, the nucleation of new sulfate particles, condensation of sulfate on pre-existing particles, coagulation, the transfer of particles from the insoluble to the soluble modes, and the thermodynamic equilibrium with the water vapour phase. Emissions of mineral dust, sea salt and DMS are calculated online. The sink processes sedimentation, dry deposition and wet deposition are treated in dependence of size and composition. For each aerosol mode the optical properties are calculated based on the simulated size and composition to serve as input to the ECHAM5 radiation scheme for simulations of the aerosol radiative effect. To demonstrate the new model's capability, aerosol fields from multi-annual simulations will be presented and compared to available measurements. Modelled aerosol mass, composition, and size-distribution will be evaluated utilizing in-situ surface and aircraft measurements. Simulated aerosol optical depth, absorption, and size-information will be confronted with their remote-sensing derived counterparts from AVHRR, MODIS, TOMS and AERONET.

A32D-06 1715h

Global Modeling of Tropospheric Aerosols by LLNL IMPACT and Comparisons with Field and Satellite Measurements

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A new version of LLNL IMPACT (Integrated Massively Parallel Atmospheric Chemical Transport) model driven by NCAR CCM3 has been used to study the global aerosol cycle in the troposphere. We will present global distributions of five major aerosol components (sulfate, organic carbon, black carbon, dust, and sea salt) and their seasonal variations. Emissions of sulfate, organic carbon, and black carbon are based on available emission inventories while emissions of dust and sea salt particles are calculated in the model to be consistent to the instantaneous local meteorology. This new version with a compact sulfur chemical mechanism (21 prognostic species) is aiming at developing the aerosol climatology and exploring the impact of aerosols on climate variability and climate change. By applying the monthly averages of O3, OH, HO2, and H2O2 from previous IMPACT simulations with full chemistry (100 prognostic species), sulfate is formed through both gas and aqueous oxidation from SO2 and DMS emissions. Other aerosol types are assumed to be injected into the global model in the particulate form. We will compare the aerosol optical thickness with satellite measurements and examine the consistency of the individual aerosol concentrations to field measurements at different geographical locations to evaluate the accuracy of the model. * Work performed under the auspices of the U.S. Department of Energy by the University of California, Lawrence Livermore National Laboratory under contract No. W-7405-Eng-48.

A32D-07 1730h

Analysis Of Climate Response To Aerosol Direct And Indirect Effects By Aerosol Transport-Radiation Model

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The aerosol transport-radiation model, SPRINTARS, simulates global distributions of main tropospheric aerosols, i.e., black carbon, organic carbon, sulfate, soil dust, and sea salt. It is coupled to an atmospheric general circulation model (AGCM), including the radiation process for the aerosol direct and first indirect effects and the large-scale condensation process for the second indirect effect. The cloud droplet number concentration is diagnosed by the aerosol number concentration, size distribution, chemical properties, and updraft velocity based on the Köhler theory. To couple the aerosol direct effect with AGCM also results in treating the aerosol semi-direct effect. In this study, SPRINTARS coupled to mixed layer ocean simulates the equilibrium climate response to the direct and indirect effects by anthropogenic aerosols. Changes in temperature and hydrological cycle are especially analyzed.

A32D-08 1745h

Global Estimates of the Influence of Sulphate and Carbonaceous Aerosols on Radiation and Clouds in an AGCM

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A version of NCAR CCM3.2 extended with the Rasch and Kristjansson (1998) cloud scheme and a lifecycle scheme for sulphate and carbonaceous aerosols (Iversen and Seland, 2002), is run as an AGCM (CCM-Oslo). The present aerosol treatment starts out from prescribed properties of sea-salt and continental particles (background), whilst sulphate, black carbon and primary organic carbon are calculated in prognostic mode from emissions used in IPCC-TAR. Produced particles are allocated according to production mechanisms. These include oxidation followed by nucleation or condensation, coagulation in clear and cloudy air, and oxidation in cloud droplets. The degree of internal vs. external mixing and the turnover from hydrophobic to -philic BC are thus determined by processes. A special treatment of vertical transport and scavenging during deep moist convection has been designed. Interpolation between tabulated discrete values of optical and water-activity parameters enables estimates of interactions between the aerosol particles, clouds and radiation (Kirkevag and Iversen, 2002; Kristjansson, 2002). The Tables have recently been updated for a more realistic background aerosol according to observations, and with OC. Results provided for the ongoing AEROCOM intercomparison project (Schultz and Kinne) will be discussed.

URL: http://nansen.ipsl.jussieu.fr/AEROCOM/aerocomhome.html