A12E MCC: 3018 Monday 1600h

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

Presiding: **M R Schoeberl,** NASA Goddard Space Flight Center**; A Douglass,** NASA Goddard Space Flight Center

A12E-01 1600h

Potential of Observations From the Tropospheric Emission Spectrometer to Constrain Regional Sources of Carbon Monoxide

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We have conducted an observing system simulation experiment for the Tropospheric Emission Spectrometer (TES) satellite instrument to determine the potential of nadir retrievals of carbon monoxide (CO) from this instrument to constrain estimates of regional sources of CO. We use the GEOS-CHEM global chemical transport model to produce a pseudo-atmosphere in which the relationship between sources and concentrations of CO is known. Linear profile retrievals of CO are calculated by sampling this pseudo atmosphere along the orbit of TES. These retrievals are used as pseudo-observations with a maximum a posteriori inverse algorithm to estimate regional CO sources. This algorithm accounts for the vertical resolution of the retrieval, instrument errors, and representation and transport errors in the GEOS-CHEM simulation of CO. We show that, with proper characterization of observation errors observations from TES have the potential to significantly reduce uncertainty in estimates of regional sources of CO. We also examine the sensitivity of the a posteriori source estimates to possible sources of error such as regional biases in the CO chemistry or errors in the sub-regional source distribution.

A12E-02 1615h

Key Issues and Strategies for Measurements in the Tropical, Subtropical and Midlatitude UT/LS

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The tropical upper troposphere and lower stratosphere (UT/LS) contain critical questions for atmospheric chemistry and climate. This region also represents the gateway for constituents entering the middle atmosphere, and contains the Tropical Tropopause Layer (TTL). The concept of a tropopause layer, as opposed to level, recognizes that the composition and motion of air in this region are influenced by a combination of tropospheric and stratospheric processes. The TTL extends vertically from the level of maximum convective outflow (200-250 hPa) to the cold point tropopause or, alternatively, to the highest altitude of convective clouds, which sometimes overshoot the tropopause. The TTL extends meridionally to the subtropical jets and tropopause break. During boreal summer, the jet stream and tropopause break are displaced well to the north, near 45° N, and the thermodynamic characteristics of tropical air extend into midlatitudes. During boreal winter, equatorial tropopause temperatures attain their lowest values. These seasonal variations are climatological features of the TTL that recur from year to year. Interannual variations are of secondary importance compared to climatology. More important are the enormous spatial variations, due to monsoon circulations, that accompany the seasonal evolution of the UT/LS. In order to understand the role of the UT/LS and TTL in Earth's climate system it is essential to understand the climatological behavior of this region and spatial variations of the climatology. Observational sampling of the UT/LS is currently a priority in the US, Europe and Japan. Measurement strategies require guidance on the nature of the UT/LS and the identification of key unanswered questions. Certain questions are particularly amenable to ground-based observations. Such observations serve a two-fold purpose: (i) direct measurement of the UT/LS, and (ii) validation of satellite data in this critical, but difficult to observe, altitude range. Our talk presents a brief overview of UT/LS climatology, some comments on aspects of the climatology that require further study, and a focus on the extremes of the climatology for the purpose of satellite validation. The implications of UT/LS behavior for validation of EOS satellite datasets are discussed, along with possible strategies to augment the planned or proposed field missions with one or more balloon campaigns in order to extend the spatial coverage of satellite validation.

A12E-03 1630h

Stratospheric Ozone Trends and the Ozone Monitoring Instrument (OMI)

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The Ozone Monitoring Instrument (OMI) is the Dutch-Finnish contribution to NASA's EOS-Aura satellite scheduled for launch in January 2004. OMI is an imaging spectrometer that will measure the backscattered Solar radiance in the wavelength range of 270 to 500 nm. The instrument provides near global coverage in one day with a spatial resolution of 13x24 km^2. OMI is a new instrument, with a heritage from TOMS, SBUV, GOME, GOMOS and SCIAMACHY. OMI's unique capabilities for measuring important trace gases and aerosols with a small footprint and daily global coverage, in conjunction with the other Aura instruments, will make a major contribution to our understanding of stratospheric and tropospheric chemistry and climate change. OMI will provide data continuity with the 23-year ozone record of TOMS. There are three ozone products planned for OMI: total column ozone, ozone profile and tropospheric column ozone. We are developing two different algorithms for total column ozone: one similar to the algorithm currently being used to process the TOMS data, and the other an improved version of the differential optical absorption spectroscopy (DOAS) method, which has been applied to GOME and SCIAMACHY data. The main reasons for starting with two algorithms for total ozone have to do with heritage and past experience; our long-term goal is to combine the two to develop a more accurate and reliable total ozone product for OMI. In this presentation we will focus on the expected contribution of OMI data to the monitoring of the stratospheric ozone layer. Key algorithm issues will be discussed as well as results of applying the OMI algorithms to the GOME data.

A12E-04 1645h

Stratospheric HOx Sensitivity and Accuracy From Aura MLS Instrument

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The Aura Microwave Limb Sounder (MLS) instrument has channels devoted to measuring OH and HO_2 in the stratosphere. Sensitivity estimates show that daily zonal means of OH concentration will be obtained with better than 10 % precision from 10 hPa to 0.02 hPa with a vertical resolution of 6 per decade up to 0.1 hPa. The sensitivity for HO_2 is smaller by at least an order of magnitude because of spectroscopic line strength. Nonetheless, monthly zonal means can be measured with 30 % precision from 7 hPa to 0.07 hPa for HO_2 and 50 hPa to 0.003 hPa for OH. This precision can be improved to 10 % by regularization or modest reduction of vertical resolution. The vertical limits are imposed by water vapor absorption at the low altitude limit and by falloff of HOx concentrations at the high altitude limit. These precision estimates are based on measured noise performance and includes calibration factors for sideband ratio and field-of-view shape. The precision estimates also include the effect of uncertainty in temperature. Additional factors that influence the accuracy include knowledge of line widths, systematic errors in the field-of-view and spectral averaging, and errors in the estimation of water and ozone. All of these factors should be small compared to the precision errors.

URL: http://mls.jpl.nasa.gov

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A12E-05 1700h

Aura as Part of Integrated Global Atmospheric Chemistry Observations (IGACO)

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The Aura satellite will become one of the cornerstones for the establishment of an integrated observational system for atmospheric composition measurements. Although atmospheric chemistry measurements lag the observational system for physical variables by several decades, all the components for such a system are either in place or, with careful planning, readily available at a reasonable cost within the next few years. What is missing is a strategic plan. Thus, recognizing the need for improvement and continuity of observation programs and for the integration of observation techniques and data, the "Integrated Global Atmospheric Chemistry Observations" (IGACO) theme has been adopted as one of several themes that fall under the umbrella of the Integrated Global Observing Strategy (IGOS). Tentatively to be completed within the year, the IGACO theme report will provide an analysis of the current and projected global atmospheric chemistry observing system, define the chemical variables that are prime candidates for an integrated global approach, and suggest a methodology as to how the IGACO system can be implemented. The IGACO report will also define gaps in the near-term measurement capabilities and make recommendations as to how such shortcomings might be remedied. The IGACO theme evolves from the establishment of IGOS, which was formed in1998 through a formal exchange of letters amongst 13 founding partners including CEOS (Committee on Earth Observation Systems, which includes most of the world's space agencies), WMO/GAW (World Meteorological Organization's Global Atmospheric Watch Program), IGBP (International Global Biosphere Program), UNEP (United Nations Environmental Program), and others. Initially four themes were approved for development of an observational plan or Theme Report: The Ocean, The Global Water Cycle, The Global Carbon Cycle and Atmospheric Chemistry. A panel of international scientists co-convened by WMO and the European Space Agency is in the process of developing the atmospheric chemistry theme report. This presentation will focus on the status of this theme report, which is currently under review by the international atmospheric chemistry community. Included in the report is a summary of the contributions of existing and committed space missions and ground networks in support of these needs. The report will also encourage the development of refined chemical transport models and data assimilation systems needed to interpret atmospheric chemistry observations and to predict the future state of the atmosphere. Lastly, the report will urge the adoption of a globally integrated prioritized and cost effective approach that will encourage environmental and health protection agencies to participate in global atmospheric monitoring strategies.

A12E-06 1715h

EOS Microwave Limb Sounder Retrievals: New Approaches, Theory and Results From Simulations.

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An overview is given of the retrieval and forward model algorithms that form the 'Level 2 processing' for the Microwave Limb Sounder (MLS) instrument on the EOS Aura spacecraft. These are the algorithms used to convert the calibrated observations of thermal microwave emission from the Earth's limb into estimates of atmospheric temperature and composition for use by the scientific community. The algorithms take into full consideration atmospheric inhomogeneities along the line of sight, in what is essentially a 'tomographic' view of the limb sounding optimal estimation retrieval problem. Results are shown from pre-launch simulations of the EOS MLS measurement system. These give the expected precision of atmospheric data products from the MLS instrument, and have been key to the MLS science team's preparation for the EOS Aura launch. Great benefit has been obtained from designing the software to be flexible enough for both routine data processing and the generation of simulated data and various other pre- and post- launch support and testing.

A12E-07 1730h

PV Mapping and the Precision of Lower Stratospheric Ozone Column Measurements From Satellites

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AURA is expected to produce more precise measurements of ozone throughout the lower stratosphere than has been possible from previous satellite instruments. Excellent precision in lower stratospheric ozone measurements is needed in order to assess ozone changes in this region and, in particular, for inferring tropospheric ozone columns by the residual method. In this paper PV mapping (using the NCEP re-analysis data set) is combined with SAGE II and HALOE ozone measurements and the precision of these measurements and of PV mapping at mid-latitudes is assessed. It is shown for example that PV mapping in the lowest part of the stratosphere can account for a significant fraction of the differences between ozonesonde measurements at Hohenpeissenberg and Payerne which are approximately 400km apart. There is no difference between using SAGE or HALOE or a combination of all the ozonesonde measurements at mid-latitudes for defining the PV-ozone relationships. The calculations thus suggest that the limitation on the precision of PV-mapped ozone is determined by the precision of PV estimates from the assimilation models. The precision of PV-mapped, mid-latitude, lower-stratospheric ozone columns from SAGE and HALOE measurements is estimated.

A12E-08 1745h

The High Resolution Dynamics Limb Sounder (HIRDLS) Validation Plan

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HIRDLS is an infrared limb-scanning radiometer designed to sound the upper troposphere, stratosphere, and mesosphere to determine temperature; the concentrations of O3, H2O, CH4, N2O, NO2, HNO3, N2O5, ClONO2, CFC11, CFC12, and aerosols; and the locations of polar stratospheric clouds and cloud tops. HIRDLS will obtain distributions of constituents with horizontal and vertical resolution superior to that previously obtained. The vertical resolution is approximately 1.2 km. The horizontal resolution is tunable depending on science and validation needs. Typical scan modes will have 5 x 5 degrees global coverage in a 12 hour period. Special scan modes are available for regional coverage with a horizontal resolution of approximately 1 x 1 degrees. The overall validation goals are to provide an assessment of the uncertainties of each HIRDLS data product. For this presentation, HIRDLS validation priorities and challenges will be discussed in conjunction with available correlative data. The importance of temperature, O3, and H2O sondes and lidar data will be discussed, with gaps in current measurement frequency and distributions highlighted. Special attention will be focused on the planned NASA aircraft campaigns (e.g., INTEX E, W; TC4, and POLAR). The need for aircraft data for validation of gravity wave structure will be shown. The inclusion of heavy lift balloons (e.g., for Mk IV) will be emphasized, especially for validation of correlative data where stratospheric distributions are limited (e.g., ClONO2, N2O5, and HNO3). The value of cross comparisons between HIRDLS and the other Aura instruments, along with available occultation and other limb viewing instruments will be outlined. The role of 3-D chemical transport models driven with analyzed meteorological fields for zero order validation, along with the use of chemical data assimilation techniques will also be discussed.

A12F MCC: 3016 Monday 1600h

Chemistry and Physics of Clouds

(joint with SA, AE, GC)

Presiding: **G L Kok,** Droplet Measurement Technologies**; L M Avallone,** Laboratory for Atmospheric and Space Physics, University of Colorado

A12F-01 1600h

Ground Based Remote Sensing of the First Aerosol Indirect Effect: An Update

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The first aerosol indirect effect can be defined as an increase in the shortwave albedo of clouds due to higher concentrations of atmospheric aerosol, whereby the aerosol acts as cloud condensation nuclei to produce increased cloud droplet concentrations and smaller, more reflective droplets. The current work is one step toward achieving a more complete understanding of the indirect effect, which will consequently allow for a better determination of how changes in cloud induced by aerosol may affect the radiation budget and thus the climate. We utilize a series of continuous ground-based measurements from the Southern Great Plains (SGP) Atmospheric Radiation Measurement (ARM) program to investigate the indirect effect. Days that exhibit ice-free, single layered, nonprecipitating clouds are analyzed, with the indirect effect quantified as the relative change in cloud droplet effective radius for a relative change in aerosol extinction (under conditions of equivalent cloud liquid water path). Several cases from the first six years of our analysis (1998-2003) are described here, and probable reasons for the differences in the cloud response to aerosol among the cases are discussed.

A12F-02 1615h

Effects of Arctic Haze on Low-level Cloud Microphysics

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Aerosol measurements from the NOAA Climate Monitoring and Diagnostics Laboratory (CMDL), and cloud retrieval data from the Atmospheric Radiation Program (ARM), located near Barrow, Alaska, are used to study the interactions between Arctic Haze and low-level arctic cloud microphysics. The measurements of aerosol scattering (σ_{sp}), droplet concentration (N), and droplet effective radius (r_e) show that haze events are associated with higher concentrations of droplets and smaller droplet effective radii. Nucleation events, with high Aitken nucleus concentrations but low (σ_{sp}), show no relationship with N or r_e. Therefore, long-range transported aerosols, rather than those produced by in-situ production, dominate the impact on cloud microphysical and radiative properties in Arctic winter through spring.

A12F-03 1630h

Airborne Digital In-Line Holographic System for 3-D Imaging of Cloud Particles

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We have developed an airborne holographic instrument for obtaining cloud particle sizes and shapes and their three-dimensional spatial distribution. The primary scientific motivation for the instrument is to provide *in-situ* measurements of cloud particle spatial correlations, conditioned on particle size. Accurate quantification of spatial correlations at cm-scales and below has been elusive, in part because only one-dimensional spacing data have been available. The optical technique used in the instrument is based on 'in-line holography,' where the same collimated light source serves as both the reference beam and the object beam. The system is completely digital, including the capture of holograms using a CCD array, transmission of the data via optical fiber, and subsequent reconstruction of the real image. During the recent IDEAS-3 field project hosted by the NCAR Research Aviation Facility the instrument was tested in flight for the first time, where holograms containing populations of cloud droplets, drizzle drops, and ice crystals were obtained.