COMMUNITY WORKSHOP ON AIR QUALITY REMOTE SENSING FROM SPACE: DEFINING AN OPTIMUM OBSERVING STRATEGY

February 21 - 23, 2006

Center Green CG1 Auditorium, National Center for Atmospheric Research, Boulder, Colorado, USA

Session 2: Current Observational Capabilities, Limitations and Lessons Learned.
Co-chairs: P. K. Bhartia and Dave Diner

ORAL PRESENTATIONS

Bhartia, NASA Goddard Space Flight Center, USA

Studies of tropospheric ozone and aerosols by backscatter ultraviolet remote sensing

P. K. Bhartia, Sushil Chandra, Omar Torres, Jerry Ziemke, Joanna Joiner and Alexander Vasilkov
NASA GSFC

During the last decade, the backscatter ultraviolet (BUV) technique has emerged, somewhat unexpectedly, as a powerful method for remote sensing of tropospheric ozone and aerosols from space. In this talk we will discuss our experience in applying this technique to more than quarter century of TOMS data. We will also discuss recent enhancements in ozone information content achieved by combining MLS and OMI data from the Aura satellite, and the work currently in progress in understanding what information UV data can add to the aerosol information derived by the more traditional VIS/NIR methods. Based on this experience, we will discuss how high temporal resolution BUV measurements could be synergistically combined with data from operational sensors on the polar orbiting METOP and NPOESS satellites for air quality research and application.

Chance, Harvard Smithsonian Center for Astrophysics, USA

Satellite Measurements of Global Tropospheric Pollution: Toward Development of Geostationary Capability

Kelly Chance
Harvard Smithosian Center for Astrophysics

Satellite measurements in the UV and visible have now demonstrated that useful tropospheric pollution measurements can be made for NO2, HCHO, and O3, and that routine anthropogenic SO2 pollution measurements may be become possible. Specifically, tropospheric NO2 measurements are used to track pollution and to refine NOx emission inventories; HCHO measurements monitor natural and anthropogenic VOC emissions and improve emission inventories; O3 measurements track the production, transport, and evolution of the tropospheric abundance. SO2 from volcanic sources can readily be measured, but the capability to measure anthropogenic sources routinely is not yet in place.

Many scientists and institutions have shown interest in the possibility of monitoring pollution globally and continuously from geostationary orbit. In this talk I will use my experience in the GOME, SCIAMACHY, and OMI programs to discuss how an effective geostationary instrument and program could be implemented, taking into account both positive and negative lessons learned from the current missions. Recommendations for technology development to improve measurements will be made: These chiefly involve choice of detector type, involve tradeoffs between available 1-D and 2-D devices, and optimization of spectrometer design. I will discuss program development and management, including allocation of resources; instrument design; the physics underlying algorithms and the development and implementation of data analysis algorithms; instrument calibration and characterization; data product production, distribution and validation; and the hurdles to regulatory and public policy usage.

Drummond, U. Toronto, Canada

Carbon Monoxide Measurements from Space: Past, Present and Future

James R. Drummond

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Measurements of tropospheric carbon monoxide from space have now been made for over 20 years starting with the Measurements of Air Pollution from Satellites (MAPS) instrument, continuing with the Measurements Of Pollution In The Troposphere (MOPITT) instrument and now with other satellite instruments. In the future we shall have new instruments, including some operational ones which will carry the measurements forward.

The demands on instrumentation are many: coverage, resolution, accuracy and so on and the operational constraints are also important, particularly as regards validation of the space measurements. However there are also some serious limitations on the possibilities of measurements from space and these need to be fully understood in order to provide and effective compromise between the desires of modellers, the abilities of the instrument scientists and the constraints of launches, spacecraft and budgets.

This presentation will attempt to outline some of these issues and provide some framework for discussing what instrumentation could be deployed in the foreseeable future (next 10-20 years). The major items to be addressed are: Vertical, Spatial and Temporal resolution, Coverage, Revisit Time, Accuracy/Precision and desired contemporaneous measurements. All of these exist in a “trade space” in which emphasising one parameter will probably compromise another. Using what we have learned from the current instrumentation, we can look into the future for the next generation of instruments and intelligently guide all the various parts of the enterprise: instrumentation, modelling and validation.

Aben, Netherlands Inst. for Space Res., Netherlands

Quantitative analysis of SCIAMACHY CO measurements: retrieval, calibration

and error analysis

I. Aben (1), A. Gloudemans (1), H.Schrijver (1), J. de Laat (1), M.van den Broek (1), M. Krol (1,2,3), R.Jongma (1)

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The satellite instrument SCIAMACHY has been measuring CO for several years now. These near-infrared CO total column measurements are the first with a good sensitivity to the surface. But, its retrieval has been complicated: the atmospheric signal is low compared to the instrumental background, CO has only weak near-infrared absorption lines, often interfering with strong H2O and CH4 lines, and most importantly, the near-infrared detectors are covered by a time-varying ice layer and suffer from radiation damage. The calibration issues are successfully addressed by a detailed correction scheme included in the retrieval algorithm. Individual CO column measurements by SCIAMACHY have a rather low precision of 10-100 % or more. However, by averaging the data spatially and temporally a measurement precision of 1 % for monthly means can be achieved under ideal circumstances (cloud-free pixels, high surface albedo) and 10% for lower surface albedos. Quantitative comparisons of measured seasonal variations with a chemistry-transport model simulation show good agreement for very different types of seasonal cycles. Observed differences can be attributed to an inaccurate representation of model emissions, confirmed by recent updates of biomass-burning emission data bases. Thus, SCIAMACHY CO measurements are of sufficient quality to provide useful new information, although the dependence of measurement precision on the signal level (i.e. surface albedo and solar zenith angle) and cloud cover should be considered carefully. Future air-quality missions performing near-infrared CO measurements will therefore benefit greatly from smaller foot prints increasing the number of cloud-free measurements, and from smaller instrumental background signals.

Bowman, Jet Propulsion Lab., USA

Observing signatures of air pollution from space: prospects and challenges for nadir thermal infrared spectrometers

Kevin W. Bowman, Annmarie Eldering, John Worden, Bill Irion, Michael Gunson, Reinhard Beer

JPL

Tropospheric ozone and its precursors are a key measure of air quality and the characterization of the processes governing their magnitude and distribution is one of the central scientific challenges. Knowledge of both the vertical and horizontal distribution of ozone in the troposphere is critical to distinguishing between anthropogenic and natural sources of air quality on both regional and global scales.

Thermal infrared remote sounders offer unique capabilities for the quantification of the spatio-temporal distribution and evolution of ozone and its precursors. We briefly review past, present, and future thermal infrared spectrometers with a particular focus on TES

and AIRS. We use these two instruments to discuss the trade-off in ozone coverage in terms of greater vertical resolution from TES versus greater horizontal sampling from AIRS and the impact of that trade-off on understanding air quality. Finally, we point towards future requirements and capabilities based on lessons learned from these instruments.

Barnet, NOAA/NESDIS, USA

Trace Gas Products from High Resolution Infrared Instruments

Chris Barnet, Mitch Goldberg, Mous Chahine, Eric Maddy, Xingpin Liu, Xiaozhen Xiong, Lihang Zhou
NOAA/NESDIS/STAR

The Atmospheric Infrared Sounder (AIRS), launched in May of 2002, has the capability to measure trace gases, including ozone, carbon monoxide, methane, carbon dioxide, nitric acid, nitrous oxide, and sulfur dioxide. These products can also be derived from future sounders such as the Infrared Atmospheric Sounding Interferometer (IASI), the Cross-track Infrared Sounder (CrIS), and Hyperspectral Environmental Suite (HES), to be launched in 2006, 2008, and 2012, respectively. Together these instruments can provide measurements of the mid-tropospheric concentration of these gases for at least two decades.

This talk will focus on the current status of these products at NOAA/NESDIS, derived from the AIRS instrument, and plans for the future instruments. Monthly maps of carbon trace gas concentrations from multi-year AIRS reprocessing experiments have been produced along with the associated vertical retrieval weighting functions. Results from these experiments will be discussed with an emphasis on theutility and limitations of these datasets in modeling. Comparisons of the AIRS ozone products with in-situ measurements taken during the Stratospheric- Tropospheric Analysis of Regional Transport (START) experiment will also be shown as an example of remotely sensed trace gas measurements.

Palmer, U. Leeds, UK

Using satellite observations of atmospheric composition to study links between European air quality and global climate: current and future research

Paul Palmer, Ken Carslaw (*University of Leeds, UK*), Maria Athanassiadou, Bill Collins (*UK Meteorological Office, UK*), Thomas Kurosu and Kelly Chance (*Harvard-Smithsonian Center for Astrophysics, USA*)

The spatial resolution of new space-borne chemical composition data is for the first time good enough to study air quality over the UK and mainland Europe. Using these data to study air quality over the UK, in particular, presents many challenges, including semi-permanent cloud coverage, and the large seasonal cycle in the length of daylight. These challenges are accompanied by an opportunity to study links between regional air quality and climate, e.g., marine aerosol-cloud interactions. Here, we present a preliminary comparison of the distribution of gas and particle pollutants from the UK National Atmospheric Emissions Inventory and satellite column observations of NO2 and HCHO from OMI, and aerosol properties from MODIS. We discuss how we will use the satellite data to improve modelling of European air quality. We also discuss the associated development of a nested regional-scale version of the UKMO Unified Model, which will be coupled with gas and aerosol chemistry mechanisms, developed as part of the UK Chemistry Aerosol community model, and subsequently used to interpret the satellite observations. The distinct advantage of using this model is that we can relate what we learn about regional air quality to global climate via the global chemistry-climate version of the Unified Model.

Volkamer, U. California - San Diego, USA

What can we learn by remote sensing glyoxal (CHOCHO) from space?

Rainer Volkamer (1), Mario Molina, Thomas Wagner, Roman Sinreich, Steffen Beirle, Andreas Richter, Folkart Wittrock, Thomas Kurosu and Kimberly Prather
University of California, San Diego

As part of the Integrated Program on Urban, Regional and Global Air Pollution, the first direct detection of Glyoxal (CHOCHO) in the atmosphere was accomplished by means of Differential Optical Absorption Spectroscopy (DOAS). CHOCHO measurements from space seem possible and enable to better identify photochemical hot-spots in the atmosphere http://www.sciencemag.org/content/vol308/issue5727/twil.dtl). Following this suggestion, CHOCHO has been tentatively detected by various research teams in spectra collected by the OMI and SCIAMACHY instruments on-board the EOS-Aura and ENVISAT satellites.

The CHOCHO dataset collected in Mexico City provides useful insights with regard to what we can learn from this novel indicator molecule. In Mexico City CHOCHO, in contrast to formaldehyde (HCHO), is almost exclusively produced from the oxidation of volatile organic compounds (VOCs); airborne sources largely dominate over direct emission sources. Time-resolved glyoxal measurements constrain the rate of VOC oxidation, and allow to test our understanding of air pollution from (1) gas-phase VOC oxidation processes, (2) secondary organic aerosol (SOA) formation, and (3) the emission inventory of e.g. HCHO in urban air.

As part of this talk selected opportunities arising from the feasibility of measuring CHOCHO from space are discussed, as well as challenges that present themselves for future satellite missions, if these were to systematically exploit CHOCHO, in combination with other indicators (e.g. CO measurements), to better inform the design of strategies meant to control air pollution and the related climate forcings.

Munro, EUMETSAT, Germany

Atmospheric Composition Measurements from the EUMETSAT Polar System (EPS) and plans for Post-EPS

Rosemary Munro, Peter Schlüssel, Dieter Klaes, Pepe Phillips, Christophe Accadia
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The EUMETSAT Polar System (EPS) comprises a series of three operational meteorological satellites (MetOp A-, B- and C) with an expected mission lifetime of fifteen years. The first MetOp satellite will be launched on the 30th June 2006 with a payload, which includes the Second Global Ozone Monitoring Experiment (GOME-2), and the Infrared Atmospheric Sounding Interferometer (IASI) both of which will monitor atmospheric composition. The GOME-2 will perform operational global monitoring of ozone column densities and profiles, and column densities of other atmospheric trace gases such as NO2, BrO, OClO, HCHO, SO2 and H2O. The IASI, in addition to measuring high quality profiles of temperature and humidity will also measure layer ozone amounts and total columns of N2O, CO, CH4 and CO2. A description of the characteristics of these products will be given.

Preparation for a follow-on mission in the timeframe after 2020, post-EPS has started with mission analysis activities. A number of potential missions are envisaged including an atmospheric chemistry mission targeting three main application areas, ozone and surface UV, air quality and climate chemistry interaction. A summary of the outcome of the user requirements definition process will be provided.

Kahn, Jet Propulsion Lab., USA

Measuring Aerosol Pollution from Space: Capabilities, Limitations, and Next Steps

R Kahn

Jet Propulsion Laboratory, Pasadena, CA

Compared to in situ measurements, space-borne detectors are relatively blunt instruments for studying atmospheric aerosols, especially with regard to localized urban pollution, where very high spatial resolution and detailed chemical information are highly valued. Until recently, only column-averaged aerosol optical depth over dark water, derived from assumed aerosol micro-physical properties, could be retrieved routinely from space. But the regional scales encompassed by key aerosol sources and populated areas affected create opportunities for satellites to contribute. And recent advances in spacecraft measuring capabilities, such as those represented by NASA's Earth Observing System MISR and MODIS instruments, are beginning to reliably retrieve particle column amounts over land as well as water water, and to constrain column-average particle size, shape, and single-scattering albedo along with spectral optical depth. Polarization, UV, and lidar techniques promise to provide added sensitivity to particle composition and vertical distribution. Taken together, these new data are improving our ability to identify and track aerosol air mass types on regional and larger scales, giving added value and context to more detailed particle micro-physical properties that can be measured in situ at selected points.

This talk will review the strengths and limitations of current space-based aerosol products, with emphasis on MISR and MODIS capabilities for urban settings, and will suggest how they may fit with in situ and surface measurements. The role of the upcoming INTEX-B/MIRAGE and GoMACCS/TexAQS field campaigns in validating satellite retrievals of urban aerosol pollution, and in furthering our experience at integrating surface, aircraft, and satellite aerosol information among themselves and with models will be briefly discussed. The importance of satellite direct downlink and rapid

retrieval processing capabilities for air quality analysis and prediction, coupled with the need for high spatial resolution (1-3 km) satellite aerosol retrievals, will also be mentioned.

Winker, NASA Langley Res. Center, USA

Contributions to Air Quality Monitoring from the CALIPSO lidar

Dave Winker
NASA LARC

Maps of aerosol optical depth derived from passive satellite instruments are beginning to be used in air quality assessments. These measurements have no information on the vertical distribution of aerosol, however, introducing uncertainties into air quality forecasts. Lidar measurements are required to map the vertical distribution of aerosol. The CALIPSO satellite was designed to improve our understanding of the role of aerosols and clouds in the climate system and will fly as part of the A-train starting early next year. CALIPSO carries a two-wavelength polarization lidar which will produce aerosol measurements relevant to air quality. These measurements will complement the passive measurements already available from instruments such as MODIS-Aqua. In addition to providing aerosol profiles coincident with MODIS observations, CALIPSO will also observe aerosols in situations where MODIS cannot: above overcast cloud layers, below thin clouds, and at night. CALIPSO two-wavelength polarization data also provide information on aerosol type which can be used to help identify the sources of the observed aerosols. This talk will discuss the capabilities of CALIPSO and potential benefits to the air quality community.

Paciorek, Harvard School of Public Health, USA

Using satellite observations to estimate long-term human exposure to particulate matter: Characteristics of remote sensing data useful for environmental epidemiology

Chris, Yang Liu, Douglas Dockery, Helen Suh, Francine Laden, and Joel Schwartz
Harvard School of Public Health

Recent work validating satellite-based aerosol optical thickness (AOT) measurements using ground-based AOT and PM2.5 measurements open the way to using remote sensing data to estimate exposure to particulate matter. These estimated exposures over space and time can be linked to health outcome data at the personal level to estimate the health effects of particulate matter. The satellite data increase our spatial coverage and intensity of measurements, compared to ground monitoring. In turn, ground monitoring calibrates the satellite measurements and provides finer spatial resolution where monitors are available. By integrating satellite data and ground monitoring, we hope to take advantage of both sources of information to refine our estimation of exposure for health studies. A particular application is the long-term effects of PM2.5 on cardiovascular disease and mortality amongst participants in a large 30-year cohort study of U.S. nurses. We discuss a framework for using satellite data with monitoring data for health effects analysis and the particular characteristics of remote sensing data desirable for this type of work.

POSTER PRESENTATIONS

Boersma, Harvard University, USA

Near-real time retrieval of tropospheric NO2 from OMI

Folkert Boersma (1,2) , Henk Eskes (2), Pepijn Veefkind (2), and Ellen Brinksma (2)
(1) Now at Harvard University, (2) KNMI, De Bilt, the Netherlands

KNMI has been providing near-real time information on tropospheric NO2 concentrations over Western Europe since 7 October 2005. Within approximately 3 hours of an actual overpass of the EOS-AURA satellite over Western Europe at about 13:45 hrs local time, an image of retrieved tropospheric NO2 concentrations over Europe is published online at www.knmi.nl/omi and www.temis.nl. The near-real time data is planned to be delivered to dedicated users like ECMWF and NOAA. These data may also cover other areas in the world.

In the paper, we will discuss various aspects of the near-real time retrieval of tropospheric NO2. First of all, we will outline the retrieval method that is based on the classical DOAS approach with two major innovations. The first innovation is the use of a data-assimilation technique to better constrain the stratospheric background. The second innovation involves the use of forecasted ECMWF meteo fields to predict the a priori profile shape (and the stratospheric background) with a chemistry-transport model. These predicted retrieval inputs are stored and immediately available once the actually retrieved NO2 slant columns have been processed at NASA computing systems and sent to KNMI. Furthermore we will discuss the averaging kernels that are intrinsic to the data product that allow users to use their own a priori profiles. Finally, we investigate the error budget of the near-real time retrievals, and show some preliminary validation results.

Bowman, Jet Propulsion Lab., USA

Analysis of the zonal variation of ozone and its precursors in the Southern hemisphere for November 2004: an integrated approach

Kevin W. Bowman (JPL), Dylan Jones, Jennifer Logan, Helen Worden, Annemieke Gloudemans, Ilse Aben, Pieternel Levelt, Pepijn Veefkind, Line Jourdain, John Worden, Greg Osterman, Susan Kulawik

We investigated the processes governing the distribution of ozone and its precursors in the Southern hemisphere for November 2004 based on an integrated analysis of satellite data, sonde measurements, global modeling, and emission inverse analysis. We examine the vertical distribution of ozone from TES and SHADOZ and how this distribution correlates with key ozone precursors CO and NO2 from TES, MOPITT, SCIAMACHY, and OMI. In addition, signatures of biomass burning, bio-fuel, and lightning are investigated with MODIS, LIS, and OMI and are used to determine possible sources of ozone precursors.

These datasets are then compared to the GEOS-Chem model run for the same time period. This comparison points towards deficiencies in the model specification of emissions. Updated emissions are estimated based on a linear Bayesian inverse analysis of the CO distribution of TES observations. These a posteriori emissions are used to recalculate GEOS-Chem ozone and CO fields. Comparisons of these a posteriori fields with TES ozone are used to determine the role of emissions in the distribution of ozone.

Brunner, U. Wisconsin - Madison, USA

Estimation of Biomass Burning PM2.5 Emissions Using GOES WFABBA Fire Characterization Data

Jason Brunner (1), Christopher C. Schmidt (1), Xiaoyang Zhang (2), Shobha Kondragunta (2)

(1) Cooperative Institute for Meteorological Satellite Studies, Madison, WI, (2) National Environmental Satellite, Data, and Information Service, Camp Springs, MD

The Wildfire Automated Biomass Burning Algorithm (WF_ABBA) provides half-hourly fire detection and characterization from the current Geostationary Operational Environmental Satellite (GOES) system. Fire data has many uses, and one use of particular developing interest is estimation of biomass burning emissions. In 2005 the National Environmental Satellite, Data, and Information Service (NESDIS) funded the Cooperative Institute for Meteorological Satellite Studies (CIMSS) to provide WF_ABBA data to and collaborate on a project estimating PM2.5 emissions using the WF_ABBA fire location and characterization data as the fire source function. GOES pixels have a resolution of 4 km at the sub-satellite point, and as a result contain a variety of fuels and landcover types that can be resolved to an extent by higher spatial resolution databases. When multiple fuel types are present, it is unknown which fuel type is burning within a given pixel for a given fire, so a method for determining what fuel types lay within a GOES pixel, as well as a region defining the navigational error, was developed. This method was applied in case studies to a fuel load database supplied by NESDIS to produce emissions values under different circumstances, such as assuming that the fire is burning the dominant fuel type and that the fire is evenly distributed amongst the available fuel types. Results of this analysis are compared to available field data for those specific case studies to determine what value this approach may have.

Drori, Hebrew University of Jerusalem, Israel

Partitioning CO sources using satellite measurements

Ron Drori, Uri Dayan, Ilan Levy

The Hebrew University of Jerusalem

Recent publications show that CO has a significant interannual variation. It is assumed that biomass burning is the main reason for this variability. A first step towards the understanding of biomass burning relative role as a CO source is to partition between CO that had been emitted from biomass burning and all other sources. Edwards had shown that for biomass burning there is a high correlation between CO total column and Fine Mode aerosol Optical Depth (FMOD). An objective algorithm is presented to partition CO sources based on the assumption that only biomass burning emits simultaneously CO

and small aerosols, CO that originate from biomass burning will gain high correlation where all other sources will gain low correlation. MOPITT (CO) and MODIS (FMOD) data where used to test this algorithm. The algorithm computes for each pixel the correlation between CO and FMOD from a surrounding box. The Results show a nice resemblance between areas that gained high correlation to MODIS fire counts and model results. The synergy of MOPITT and MODIS is shown to be very fruitful and such a synergy has to be in mind in future missions.

Gupta, U. Alabama - Huntsville, USA

Satellite Remote Sensing of Air Quality over Global Urban Areas

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Study of urban air quality and anthropogenic aerosols have gained significant attention of scientists, government and environmental agencies over the last few years due to its adverse effects on human health, global biota, climate and economy. Anthropogenic particulate matter (PM or aerosols), one of the major pollutants affecting the air quality in urban areas of the world, vary in chemical composition in different parts of the world. New generation remote sensing satellites have demonstrated capabilities for monitoring global aerosols with very high spatial and temporal resolutions. This study will explore the relationship between surface measured PM2.5 mass and satellite derived aerosol optical thickness over several urban locations in different parts of the world. Results show that there is an excellent correlation between the daily mean satellite and ground-based values with a linear correlation coefficient of 0.96. However the hourly correlation coefficients range between 0.11-0.85. The effects of meteorological parameters such as mixing height, relative humidity, and cloud cover on PM2.5 –AOT relationship are also estimated using case studies in United States. One year worth of chemical composition of PM2.5 data from IMPROVE network along with MODIS aerosol data will be used to infer more about chemical and optical properties of aerosols.

Hegarty, U. New Hampshire, USA

Utilizing Aura Measurements to Investigate Outflow and Intercontinental Transport from North America

Jennifer Hegarty, Huiting Mao, and Robert Talbot
University of New Hampshire, Durham, NH 03824

This study examines the role of synoptic-scale atmospheric circulations in the export and intercontinental transport (ICT) of air pollutants from North America to Europe. Using vertical profile measurements from the Tropospheric Emission Spectrometer (TES) onboard the Aura satellite, sub-orbital observations from the AIRMAP air monitoring network in the northeastern U.S., meteorological analyses from the National Centers for Environmental Prediction (NCEP), and results from a global chemical transport model, the study will address three fundamental questions: 1.) what are the primary transport mechanisms in each season that determine the export of air pollutants from North America?, 2.) what are the spatial and temporal variations in tropospheric ozone (O_3) and

its precursors over the North Atlantic that correspond to the various transport scenarios identified in (1)?, and 3.) how does seasonal and interannual variability in transport impact background surface O3 levels over the North Atlantic and Western Europe? The details of our investigative approach and some initial results are presented on this poster.

Kalashnikova, Jet Propulsion Lab., USA

The effects of smoke and dust aerosols on UV-B radiation in Australia from ground-based and satellite measurements.

Olga Kalashnikova, Frank Mills, Annmarie Eldering, Don Anderson and Ross Mitchell
Jet Propulsion Laboratory, California Institute of Technology

An understanding of the effect of aerosols on the biologically- and photochemically-active UV radiation reaching the Earth's surface is important for many ongoing climate, biophysical, and air pollution studies. In particular, estimates of the UV characteristics of the most common Australian aerosols will be valuable inputs to UV Index forecasts, air quality studies, and assessments of the impact of regional environmental changes. Based on MODIS and MISR measurements, we have analyzed the climatological distributions of Australian dust and smoke particles and have identified sites where collocated ground-based UV-B and ozone measurements were available during episodes of relatively high aerosol activity. Since at least June 2003, overhead ozone and surface UV spectra (285-450 nm) have been measured routinely at Darwin and Alice Springs in Australia by the Australian Bureau of Meteorology (BoM). Using collocated AERONET sunphotometer measurements at Darwin and collocated BoM sunphotometer measurements at Darwin and Alice Springs, we identified several episodes of relatively high aerosol activity that could be used to study the effects of dust and smoke on the UV-B solar irradiance at the Earth's surface. We will present an analysis of the differences in the measured UV-B irradiances at various aerosol optical depths of both aerosol types. The changes in the UV irradiance introduced by variations in the aerosol optical depth and type will be compared to the changes expected from total column ozone variations.

Kondragunta, NOAA/NESDIS, USA

Satellite-derived PM2.5 Emissions in Near Real Time from Natural and Wildfires for Air Quality Forecasting Applications

Shobha Kondragunta (1) and Xiaoyang Zhang (1,2)
(1) NOAA/NESDIS Center for Satellite Applications and Research, Camp Springs, MD, (2) ERT, Inc., Jessup, MD

NOAA/NESDIS developed a new algorithm to derive biomass burning emissions of PM2.5 from remotely sensed fire products in near real time for regional and global air quality applications. The algorithm for deriving emissions from forest fires depends on several key inputs such as fuel load, fraction of fuel consumed, emissions factors etc. in addition to fire location, size, and severity. The algorithm development involved developing (a) a new live fuel load database using maximum monthly MODIS Leaf Area Index (LAI) and allometric models that relate leaf foliage mass with other biomass types such as branches, shrubs etc., (b) a fuel moisture category using AVHRR Normalized Vegetation Index (NDVI) product, and (c) emission factors database.

The algorithm was applied to hourly observations of fire events in 2002 over the Contiguous United States (CONUS) to test and evaluate the algorithm. PM2.5 emissions for 2002 were derived using our fuel load database, fuel moisture category, emissions factors, satellite (GOES) observed fire location and size. The 2002 PM2.5 emissions derived using this new algorithm were compared to those available from other sources including those from EPA's National Emissions Inventory. These comparisons and assessments of uncertainties in satellite-derived emissions will be presented.

Kondragunta, NOAA/NESDIS, USA

Air Quality Forecast Verification using Satellite Data

S. Kondragunta (1), P. Lee (2), J. McQueen (3), C. Kittaka (4,7), A. Prados (5), P. Ciren (6), I. Laszlo (1), B. Pierce (7) R. Hoff (5), J. Szykman (8)

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NOAA's operational geostationary satellite retrievals of aerosol optical depths (AODs) were used to verify National Weather Service (NWS) experimental (research mode) particulate matter (PM2.5) forecast guidance issued during the summer 2004 International Consortium for Atmospheric Research on Transport and Transformation/New England Air Quality Study (ICARTT/NEAQS) field campaign. The forecast period was encompassed by long range transport of smoke from fires burning in Canada and Alaska and a regional-scale sulfate event over the Gulf of Mexico and the eastern United States (U.S). Over the 30-day time period for which daytime hourly forecasts were compared to observations, the categorical (event defined as AOD > 0.65) forecast accuracy was between 60% and 99% with a mean of ~80%. Hourly normalized mean bias (forecasts – observations) ranged between -50% and +50% with forecasts being biased high when observed AODs were small and biased low when observed AODs were high. Normalized Mean Errors are between 50% and 100% with the errors on the lower end during July 18-22, 2004 time period when a regional scale sulfate event occurred. Spatially, the errors are small over the regions where sulfate plumes were present. Correlation coefficient (r) also showed similar features (spatially and temporally) with a peak value of ~0.6 during July 18-22, 2004 time period. The dominance of long-range transport of smoke into the US during the summer of 2004, which the model lacked due to its static boundary conditions, skewed the model forecast performance. Enhanced accuracy and reduced normalized mean errors during the time period when a sulfate event prevailed shows that the forecast system is very capable of issuing PM2.5 forecasts for urban/industrial pollution events.

Li, Rutgers University, USA

Ground-based PM2.5 Measurements of the NY City Urban Plume

Min Li(1) (presenter), Monica Mazurek(1), Steve McDow(2)
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The Speciation of Organics for Apportionment of PM2.5 network operating from May 2002 to May 2003 provides an important data set as input for comparison to remote, satellite observations of the New York City area urban plume. PM2.5 mass, elemental carbon, organic carbon, and organic molecular constituents were measured at 3 urban sites (Elizabeth, NJ, Queens, NYC, Westport, CT) and 1 rural upwind site (Chester, NJ). These bulk and molecular-level ground-based physical and chemical PM parameters had seasonal patterns and spatial differences among the four sites. PM2.5 mass varied from 10 to 25 ug/m3 with the highest levels in summer and winter, and 20 to 80% of it was organics. The vehicle emission markers, hopanes were higher in winter and spring at all sites with ng/m3 abundance. Dicarboxylic acids, the potential secondary organic aerosol markers, were more abundant in summer in ng/m3 range and had similar concentrations at the urban sites and the rural site. n-Alkanoic acids, markers for multiple primary sources, had fairly consistent concentrations throughout the year, but the urban sites tended to have higher abundance than the rural site. Connecting such surface-based PM2.5 measurements and source apportionment information to characteristics of urban plumes from remote, satellite platforms should provide new modeling and assessment tools for urban air quality managers.

Disclaimer: Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.

Liu, Harvard Smithsonian Center for Astrophysics, USA

First Directly Retrieved Global Distribution of Tropospheric Column Ozone

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Ozone profiles and tropospheric ozone are derived from back scattered radiance spectra in the ultraviolet measured by the GOME using the optimal estimation technique. The retrieved TCO clearly show signals due to convection, biomass burning, stratospheric influence, pollution, and transport. The retrievals are capable of capturing the spatiotemporal evolution of TCO in response to regional or short time-scale events such as the 1997-1998 El Niño event and a 10-20 DU change within a few days. The mean biases relative to ozonesonde observations are usually within 3 DU (15%) and the standard deviations are within 3-8 DU (13-27%). The global distribution of TCO displays nearly zonal bands of enhanced TCO of 36-48 DU at 20ºS-30ºS during the austral spring and at 25ºN-45ºN during the boreal spring and summer. The overall structure is very similar to the GEOS-CHEM model simulation with small biases of <±5

DU and consistent seasonal cycles in most regions, especially in the southern hemisphere. This method can be readily applied to observations from current or next generation of nadir-viewing UV/visible instruments such as SCIAMACHY, OMI, GOME-2, and OMI to derive ozone profiles, total ozone and tropospehric ozone.

Liu, Harvard School of Public Health, USA

Relationship between ground-level PM2.5 concentrations and MISR and MODIS aerosol optical thickness measurements in St. Louis area

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Aerosol optical thickness (AOT) data retrieved by the multiangle imagingspectroradiometer (MISR) and the moderate resolution imaging spectroradiometer (MODIS) was compared to PM2.5 concentrations in St. Louis, MO and surrounding areas. Regression models were developed to investigate the relationship between PM2.5 concentrations and MISR or MODIS AOT. Both models also included as covariates meteorological variables obtained from NOAA's Rapid Update Cycle model. Both MISR and MODIS AOT were highly significant predictors of PM2.5 concentrations, with the MISR model explaining a greater percentage (61%) of the variability in PM2.5 concentrations than the MODIS model (51%). Our results show that with meteorological parameters as covariates, both MISR and MODIS AOT can be used to quantitatively estimate PM2.5 pollution levels. Since the two models had highly comparable regression coefficients and the predicting power of MISR AOT is restricted by its smaller data sample size, combining MISR and MODIS AOT data might benefit from the higher accuracy of MISR and better spatial coverage of MODIS. Finally, the newly developed particle size / shape indicators in MISR and MODIS aerosol product did not significantly improve the association of AOT and PM2.5 concentrations.

Massie, Nat. Center for Atmospheric Res., USA

TOMS observations of increases in Asian aerosol in winter from 1979 to 2000

Steven T. Massie (1), Omar Torres, Steven J. Smith

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Emission inventories indicate that the largest increases in SO2 emissions have occurred in Asia during the last 20 years. By inference, these increases should produce positive aerosol optical depth trends. Increases in TOMS aerosol optical depths between 1979 and 2000 are present over the China coastal plain (17% per decade) and the Ganges river basin in India (11% per decade) in winter. Since desert dust storms and Boreal fires are important sources of aerosol opacity in Spring and Summer, it is important to separately account for the three sources of aerosol (desert dust, Boreal smoke, and anthropogenic aerosol). This is partly accomplished by analyzing aerosol optical depths as a function of season. We also discuss the utility of analyses of multi-wavelength optical depth data to achieve this aerosol identification goal.

Merrill, U. Rhode Island, USA

Analysis of Ozonesonde Profiles Including Meteorological Factors

John Merrill (University of Rhode Island), Samuel J. Oltmans and Bryan Johnson (NOAA/CMDL) and Anne Thompson (Pennsylvania State University)

Advection of balloon-borne ozonesondes by the ambient wind can be analyzed using gridded meteorological data, and the technique challenged with GPS tracking data. The impact of the instrument response time of the ozonesonde can be assessed, and preliminary results on this will be outlined. The relationship between meteorological factors and the profile characteristics for recent intensive ozonesonde campaigns will be summarized in the context of satellite instrument validation.

Muller, University College London, UK

Intercomparison of MISR and MODIS Aerosol measurements including PM2.5 in London and Los Angeles

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An investigation was performed at the urban scale to evaluate the potential of MODIS and MISR for aerosol retrievals over large urban areas, including Los Angeles, Mexico city, the North Ganges Plain, London and Western Europe where growing population, geographical and topographical location and climate characteristics increase the chances for the development of hazardous pollution episodes.

Inter-comparisons between Particulate Matter smaller than 10μm and 2.5 µm (PM10 and PM2.5) measured at ground level for Los Angeles and London urban areas and MODIS and MISR aerosol products was performed for different dates between October 2000 and April 2001. MODIS and MISR aerosol products showed similar morphology and inter-comparisons with ground-based sun photometer measurements from the AERONET network showed close agreement within the pre-specified range even over urban areas.

The higher sensitivity of MISR to particle sizes between 0.1 and 2 µm, showed better correlations with smaller particles from ground-based measurements (PM2.5). Sensitivity studies showed that MODIS is poorer at detecting coarser particles (larger than 1µm). The results from this study indicate that overall the correlation between ground measurements (particularly PM10) and MODIS and MISR retrievals is low.

However, the results do show the temporal development of cloud-free pollution episodes and the need for the retrieval of AOT at resolutions down to 1km in order to better match the resolutions of street-level PM2.5 measurements. An unique experiment is described which is shortly to commence to combine the use of MODIS, MISR and METEOSAT Second Generation AOT estimates with ground-level sun photometers and street-level PM2.5 measurements to try to disambiguate the role of trans-migration vs local sources in PM pollution across the UK and better identify “hot-spot” regions than the existing street-level network co-ordinated for the UK government by UKAEA.

Newchurch, U. Alabama - Huntsville, USA

Air Quality Research at UAH

Mike Newchurch/UAH, Sundar Christopher/UAH, Kevin Knupp/UAH, Kirk Fuller/UAH, Dick McNider/NSSTC, Kelly Chance/SAO, Xiong Liu/SAO, Randall Martin/Dalhousie

Research activities underway at UAH address several aspects of Air Quality remote sensing. We have assessed the accuracy of most tropospheric ozone satellite residual techniques with respect to ozonesonde measurements and in a modeling context primarily in the tropics. Some methods work better than others in some domains, but none is satisfactory for air quality forecasting. More recent work with direct retrievals from TOMS, GOME, SCIMACHY, and OMI provides more promise not only for tropospheric ozone, but also for NO2 and HCHO. Aerosol retrievals from GOES, AVHRR, and MODIS, studied in the context of a mesoscale model, provide useful information that could be used for air quality forecasting. In addition to our satellite retrievals and modeling of aerosols and gases, we make weekly ozonesonde measurements and are developing lidars to measure aerosols (elastic backscatter), tropospheric ozone (DIAL), and boundary layer winds (Doppler wind lidar). Additional boundary layer profiling instruments include a sodar, 915MHz profiler, and ceilometer (UAH MIPS). These lidar and profiling instruments are located in Huntsville, AL and reside inside the measurement domain of a dual-polarization radar (ARMOR) and a NEXRAD radar (Hytop). We are also developing instrumentation for real time trace gas and aerosol speciation with FTIR and with polarization FTIR. Our participation in many recent campaigns (SOS, Nashville 99, TEXAQS 2000, INTEX-NA, et al.) with both ozonesonde measurements and CMAQ modeling have resulted in significant expertise in the modeling and interpretation of campaign measurements. This expertise contributes to a technology transfer program (SPORT) that has been providing research products using real-time data assimilation of GOES data into MM5 to the NOAA/NWS Huntsville forecasting office for operational evaluation. This process could also be implemented for evaluation of air quality forecasting products.

Osterman, Jet Propulsion Lab., USA

Quantifying variability in tropospheric ozone over the Southeastern United States in 2004-2005 using TES nadir measurements

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JPL

TES is a Fourier Transform Spectrometer making measurements of trace gases in the Earth's troposphere from the NASA Aura spacecraft. Among the measurements made by TES over the past year was a series of high spatial resolution nadir measurements over the Southeastern portion of the United States in October-November 2004 and again in July-August 2005. We will use TES data from these special observations to examine enhanced levels of tropospheric ozone seen over the southeastern US during the summer months and compare those observations to the October-November 2004 data. The vertical profiles and latitudinal gradients of ozone derived from TES observations will be used to characterize the spatial structure of the Southeastern ozone maximum. TES measurements of carbon monoxide and TES standard "global survey" measurements will provide further insight into understanding the chemical composition of the troposphere above this region of the US.

Pougatchev, Space Dynamics Lab., USA

Tropospheric Ozone Structures Captured by Downward Looking Thermal Emission Spectrometer NAST-I Instrument INTEX-A and Crystal Face Campaigns Case Study

Nikita S. Pougatchev (Space Dynamics Laboratory), Daniel K. Zhou (NASA Langley Research Center), Gail E. Bingham (Space Dynamics Laboratory), Stephen A. Mango (NPOESS project Office), William L. Smith (Hampton University)

Ozone spatial distribution has been retrieved from high resolution upwelling thermal emission spectra recorded by the airborne NAST-I spectrometer during INTEX-A (July, 2004) and Crystal Face (July 2002). Retrievals were validated against in situ measurements and compared to modeling results. We used eigenvector and statistical analysis to determine how well retrievals can reproduce vertical structure of in situ profiles and to estimate vertical resolution of the retrievals. We used atmospheric structure function approach to determine how much of horizontal variability can be captured by retrievals. We analyzed relations between CO, ozone and H2O distribution and compared them to in situ data.

We demonstrated that ozone retrievals are in a good agreement with the data available for comparison and validation. Vertical resolution of the ozone profile was estimated to be between 4 km and 5 km. We also demonstrated that ozone measurements analogous to NAST-I are capable to capture reliably small and mesoscale horizontal atmospheric motion in layers ~2km thick or larger. Simultaneous measurements of ozone, CO, water vapor, and temperature provide some information on the mechanisms driving ozone distribution.

Rinsland, NASA Langley Res. Center, USA

ACE measurements of pollutants in the Arctic

Curtis Rinsland
NASA Langley Research Center

We report simultaneous observation of trace gases related to boreal fire emissions at 50°N-68°N latitude (29 June to 23 July 2004) from ACE (Atmospheric Chemistry Experiment) solar occultation infrared Fourier transform spectra in the upper troposphere and lower stratosphere. Mixing ratios for the relatively long-lived biomass burning products CO, C2H6, HCN, CH3Cl, and CH4 show plumes with mixing ratios up to 189 ppbv (10-9 per unit volume) for CO, 830 pptv (10-12 per unit volume) for HCN, 1.40 ppbv for C2H6, 3.00 ppbv for CH3Cl, and 2.09 ppmv for CH4 in the upper troposphere. Correlated temporal and spatial variations reflect their common emission source and transport. ACE elevated tropospheric mixing ratios occur in boreal regions of western Canada and Alaska near those of elevated CO measured from space by the MOPITT (Measurements of Pollution in the Troposphere) instrument. Back trajectory calculations and maps of fire distributions for the measurement time period indicate the elevated levels measured by both instruments originated primarily from convective transport of the emissions to higher altitudes.

Schäfer, Forschungszentrum Karlsruhe, Germany

PM10, PM2.5 and PM1 spatial distribution in the region of Munich determined by satellite images on the basis of the ICAROS NET platform

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The problem of many cities in Europe with the new limit values of PM10 of the Directive 1999/30/EC and the discussion about the implementation of PM2.5 monitoring measurements is leading to determine also the spatial distribution of PM concentrations. This task is the general objective of ICAROS NET project which is finalized now. A networked interactive computational environment was developed and demonstrated that allows the integration and fusion of environmental information from remote sensing observations, ground air quality measurements, and pollution transport models in order to minimize uncertainty in decision-making regarding operational air pollution control and abatement. The methodological approach and some results of the ICAROS NET campaigns will be described in the oral presentation of Dimosthenis Sarigiannis.
In the case of Munich it was possible to integrate beside the PM10 concentration determination the evaluation of PM2.5 and PM1 concentrations. The validation results of a summer and a winter campaign in 2003 including determination of the mixing layer height (ceilometer monitoring) will be presented. The growing of the particles with the rising of the relative humidity is considered in the first layer data fusion module. Introducing population data of Bavaria in exposure-response derived from large epidemiological studies both in EU and USA health impact indices such as population vulnerability, mortality and morbidity are calculated.

Schmidt, U. Wisconsin - Madison, USA

Ozone Estimates With Current and Future GOES

Christopher C. Schmidt, Jinlong Li
University of Wisconsin- Madison

The Geostationary Operational Environmental Satellites (GOES) have had since the launch of GOES-8 in 1995 the ability to do estimates of ozone based on infrared data, primarily from the 9.6 μm band of the GOES Sounder. These estimates capture near tropopause and stratospheric ozone and possess too high a degree of error to allow for reliable estimates of ozone in the troposphere. The ozone estimates have allowed for tracking of features such as tropopause folds and ozone enhancements due to smoke. The ozone estimates are produced by a regression method which extracts the available information from the GOES Sounder data. That same method can be applied to the Hyperspectral Environmental Suite proposed for GOES-R, and based on current specifications HES can achieve a degree of accuracy that would allow estimation of the ozone in the tropospheric column within a usable degree of error. Examples from the current GOES Sounder will be presented, as will simulation studies for ozone from the proposed HES.

Schofield, NOAA Chemical Sciences Div., USA

Remote sensing of the optical properties of clouds

Robyn Schofield
NOAA Chemical Sciences Division, Boulder

Remote sensing of the optical properties of clouds is essential in obtaining a global estimate of the radiative forcing due to aerosol induced changes in clouds. A new technique for the retrieval of cloud effective radius using combined Near-Infrared, intensity and microwave measurements is described. Microwave measurements of brightness temperature are made routinely as part of the Aerosol and Radiation Measurement (ARM) program. Near-infrared measurements are conducted using spectroscopic measurements made in the wavelength region between 900 and 1700 nm. The effective radius of clouds is retrieved using an optimal estimation retrieval scheme that takes into account the measurements, their uncertainties, prior knowledge of the effective radius and its uncertainty. The technique is applied to ground-based observations of clouds made during September at Barrow, Alaska, 2004.

Spada, Inst. Marine and Atmospheric Res., Netherlands

Is there a resolution limit to trace gas retrieval from space?

F. Spada (1), M. C. Krol (2,3), J. Landgraf (3)
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New sensors to measure the UV-vis radiance from space have been developed. These sensors have better horizontal spatial resolution, in order to maximize cloud free pixels and thus allow more useful retrievals of vertical amounts of trace gases. However, the column amount of trace gases are not determined directly, but using retrieval algorithms that translate measured radiances into vertical trace gas columns.

Since radiation does not necessarily travel from the sun to the earth and back to the satellite instrument, the information carried by the radiation reaching the satellite is normally diffuse in nature, especially in the presence of clouds and aerosols in the UV-vis spectral range. Due to these effects, reducing the pixel sizes beyond a certain limit would not increase the actual resolution.

Although this smoothing of trace gas absorption is well known from theory, it is largely ignored in discussions that aim at nadir-looking instruments with high horizontal resolution. In this presentation a first attempt is presented to evaluate the impact of radiative smoothing on satellite remote sensing. Here the adjoint Monto Carlo 3D radiative transfer model McSCIA, that uses the Equivalence Theorem to seperate atmospheri absorption and scattering, is employed. Results indicate that for cases with very small ground pixels (e.g. 4x4 km, 440 nm for tropospheric NO2), the information about trace gases is coming more from outside the sub-satellite volume than from inside. A first estimate of effects due to uniform cloud cover and uniform aerosol distributions are also presented.

Stephens, NOAA/NESDIS, USA

Current Capabilities and Future Needs for the Hazard Mapping System in Support of Air Quality Analysis and Forecasts

George Stephens and Mark Ruminski
NOAA/NESDIS

The Hazard Mapping System (HMS) of NESDIS is an operational system that blends automated satellite fire detects with a manual quality control procedure. Smoke plume extent is also analyzed in a completely manual process utilizing animated visible imagery from geostationary sensors. Analysts also record coordinates of those fires which are producing smoke emissions (most fires analyzed produce no discernable smoke plume). This information is used to initiate the Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model which provides a 48 hour forecast of smoke generated from the designated fires, soon to be used operationally as a smoke forecast tool by the National Weather Service.

Future refinements to the smoke analysis will include improvements using satellite based sensors such as the Ozone Monitoring Instrument (OMI), the Atmospheric Infrared Sounder (AIRS), and derived products. The most promising progress in the past few years have been the speciation of aerosol types and the capability to provide aerosol optical thicknesses over snow/ice cover and more land masses. However, there are still deficiencies that future systems may be able to address. Aerosol detection in cloudy areas is critical, especially for tracking long range/duration smoke episodes. The improvements cited have been implemented on polar orbiting satellites, but are limited only one look per day per satellite in low and mid latitudes. This does not allow for detection of smoke in fast changing conditions due to wildfires and short lived agricultural fires. The spatial resolution is also somewhat coarse (13x24 km in the case of OMI) to detect local effects due to fires. To be used ideally a vertical distribution of smoke concentration is needed in order to improve the accuracy of transport and dispersion models.

Thongboonchoo, King Mongkut's Inst. Technology, Thailand

Application of using remote sensing for biomass burning estimation: Case study in Thailand and Mekhong River Basin Sub Region (Laos, Cambodia, and Vietnam)

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The biomass burning activities in Southeast Asian especially in Mekhong River Basin Sub Region (MRBSR) countries (Thailand, Laos, Cambodia, and Vietnam) usually occurs during dry season (Jan-May). These burning activities are driven by demanding of cheap energy sources, landing for agricultural purpose, and clearing crop residue before the next crop cycle. The estimation of air pollutants emitted from these activities is crucial for study role of biomass burning and could lead to strategies for prevention. The Satellite information from the Asia Pacific Network for Disaster Mitigation using Earth Asia Pacific Network for Disaster Mitigation (ANDES) are used for this study from availabilities of both the temporal and spatial location of fires activities. Those hotspot are classified from land use type, the number of fires in each land use type and burned area are calculated, the biomass loading and burning efficiency from field study as long as the emission factor from peer literatures are used for air pollutants estimation in this study. The preliminary results for year 2002 reveal the forest fires and crop residue burning area are major sources of air pollutants from these activities in the regions and exception bushes fire in Vietnam. The chemical transport model such as STEM2K1 of the University of Iowa, USA will be later used to evaluate the emission inventories and role of biomass burning activities along with surface observation and possible satellite information such as CO from MOPITT project at NCAR, ozone and aerosols from NASA's TOMS project.

Zhou, NASA Langley Res. Center, USA

Tropospheric CO and O3 observed with airborne Fourier Transform Spectrometer

Daniel K. Zhou, Allen M. Larar, Bradley R. Pierce, Xu Liu, William L. Smith, Stephen A. Mango, and Nikita S. Pougatchev
NASA LaRC

High resolution infrared spectral radiances from aircraft and space-based observations contain information about tropospheric ozone (O3) and carbon monoxide (CO) as well as other trace species. A methodology of retrieving tropospheric and O3 and CO from such remotely sensed spectral data has been developed. Tropospheric O3 and CO abundances, together with the thermodynamic properties (i.e., temperature and moisture profiles and cloud microphysics properties), are determined using a hybrid retrieval approach that combines the algorithms of physically-based statistical eigenvector regression, simultaneous-iterative matrix inversion, and single gas profile error minimization matrix inversion. The regularization algorithm (or minimum information solution) is used in the physical iteration inversions. The NPOESS Airborne Sounder Testbed-Interferometer (NAST I) aboard high altitude aircraft has been collecting data throughout many field campaigns. Detailed retrieval analyses based on the NAST-I instrument system along with retrieval results from several recent field campaigns are presented herein to demonstrate NAST-I measurement and retrieval capability. NAST-I hyperspectral radiances and retrievals can be used for satellite sensor calibration and validation.