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

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

Session 3: Modeling and Data Assimilation
Chair: Daniel Jacob

ORAL PRESENTATIONS

Brasseur, Nat. Center for Atmospheric Res., USA

Chemical Weather Prediction and the Potential Impact of Satellite Data

Guy P. Brasseur
National Center for Atmospheric Research, Boulder, CO

The chemical composition of the troposphere is strongly affected by meteorological variability. Observations from space provide accurate measurements of the atmospheric abundance of chemical compounds, and show the signature of mass transport at different spatial and temporal scales. Chemical weather is defined as local, regional, and global distributions of important trace gases and aerosols, and their variability on time scales of minutes to days, particularly in light of their various impacts, such as human health and ecosystem vulnerability.

The paper presents an overview on issues related to chemical weather, including observational and modelling aspects, data assimilation and operational systems. The EU-sponsored GEMS Project, which is an attempt to provide global operational analyses and predictions of chemical weather, will be presented.

Pawson, NASA Goddard Space Flight Center, USA

Assimilation of Chemical Data from NASA's EOS Instruments: Experiences from the GMAO

Steven Pawson, Ivanka Stajner, Andrew Tangborn and Krzysztof Wargan
Global Modeling and Assimilation Office, NASA Goddard Space Flight Center

An objective of NASA's GMAO is to combine models and observed data in manners that improve our understanding of the atmosphere. Data assimilation is an important tool for this work, with an emphasis on how the observations can realistically constrain the assimilation in the presence of uncertainties in the model transport and chemistry. For constituents, two present foci are on ozone and carbon species, which provide a broad range of examples about the challenges involved in extracting physical information about the state of the atmosphere by using data assimilation. This presentation will focus on a number of questions, including:

a. Constraining tropospheric ozone using stratospheric profiles (from, say, Aura MLS) and total column information (from, say, Aura OMI) – where are the sensitivities?
b. Tropospheric ozone from operational satellites – how much information can be extracted from operational data time series, such as SBUV?
c. How do "deep-layer constraints" on gases such as CO, as obtained from near-nadir sounders such as MOPITT and AIRS, help constrain the system and can these lead to improvements in air-quality monitoring and forecasting?

The intention of the presentation is to identify aspects of the chemical data assimilation that are sensitive to present-day uncertainties in model formulation (such as sub-grid transport), yet where the constraints from present observations may be too weak to adequately correct for the model error. Examples of how potential new data types may help constrain these problems will be given: issues of horizontal, vertical and temporal sampling will be considered.

Jacob, Harvard University, USA

Global air quality models: value of satellite data

Daniel Jacob
Harvard University

Regional air quality models require accurate estimates of intercontinental transport and background levels of pollutants, and their relationships to pollutant sources. This information must be obtained from global tropospheric chemistry models evaluated and constrained with observations. I will discuss how satellite observations of ozone, aerosols, and related species can be used to test and improve global tropospheric chemistry models, and to derive model error statistics relevant for air quality applications.

Martin, Dalhousie University, Canada

Estimation of Emission Sources Using Satellite Data

R. V. Martin
Dalhousie University

Chemical transport models have been applied with considerable success to satellite measurements of tropospheric composition to provide top-down constraints on emissions of reactive trace gases of relevance to air quality. This talk will begin with a review of current approaches and of their capabilities. Particular attention will be devoted to estimating emissions of nitrogen oxides and volatile organic compounds from observations of nitrogen dioxide and formaldehyde. Those approaches will be compared with algorithms for inference from satellite data of emissions of carbon monoxide and sulfur dioxide. The talk will then identify issues for development of future space-based remote sensing capabilities. It will include discussion of the limitations of current approaches and areas for algorithm development such as simultaneous inversion of multiple species. It will identify constraints of the current observing capability, and provide recommendations about the value of increasing vertical, horizontal, and spatial resolution to improve emissions estimates.

Heald, U. California - Berkeley, USA

Transpacific transport of CO and aerosols as observed from space

Colette L. Heald (1), Daniel J. Jacob, Rokjin J. Park, Becky Alexander, T. Duncan Fairlie, Arlene M. Fiore, Robert M. Yantosca, the TRACE-P, MOPITT and MODIS Science Teams

(1) Center for Atmospheric Sciences, University of California, Berkeley

In combination with in situ observations, satellite observations provide powerful constraints on the evolution, frequency and impact of pollution transport events. We employ observations from the MOPITT and MODIS satellite instruments aboard EOS-Terra to examine the transpacific transport of carbon monoxide (CO) and aerosols. MOPITT observed four major events of transpacific transport of Asian pollution to the west of North America in spring 2001. One of them was observed by the TRACE-P aircraft during transit flights across the Pacific. Using the GEOS-CHEM model as an intermediary we have examined the development of this plume across the Pacific in the MOPITT and aircraft observations. For the same year, we use MODIS observations of aerosol optical depths (AODs) over the North Pacific, together with surface aerosol measurements at the IMPROVE network of remote U.S. sites, to improve understanding of the transpacific transport of Asian aerosol pollution and assess the ability of the GEOS-Chem CTM to quantify Asian aerosol enhancements in U.S. surface air. Sulfate observations in the NW United States in spring 2001 show higher concentrations on the days of model-predicted maximum Asian influence (1.04 µg m-3) than seasonal mean values (0.69 µg m-3). Distinct Asian sulfate episodes correlated with dust events are observed in the NW United States and simulated with the model. The mean Asian pollution enhancement in that region in spring is 0.16 µg m-3, which is higher than the estimated natural concentration of 0.09 µg m-3 presently used as objective for regulation of visibility in U.S. wilderness areas.

Byun, U. Houston, USA

Utilization of Satellite Measurements at Various Stages of Atmospheric Modeling to Improve Air Quality Simulations

Daewon W. Byun, Chang-Keun Song, Hyun Cheol Kim, Soontae Kim, and Bonnie Cheng

Institute for Multidimensional Air Quality Studies, University of Houston, Houston, Texas, USA

Air quality models have been used as a part of the basic decision-making supporting tools for the federal, state, and local governments in improving air quality through controlling the emissions of the air pollution precursor species. These air quality models are mainly composed of three components: (1) physical and chemical processors which described natural processes involved with air quality in terms of equations and the accompanying formulas and parameters, (2) numerical methods to solve the equations using the input information, and (3) input data, which include initial and boundary conditions, emissions inventory, meteorological information, etc. There have been steady progresses in improving the science components related to the first two. But further improvements on

these areas are hindered due to the large uncertainties inherent in the input information. Although the federal and local agencies and research communities have made steady progress improving the accuracy of emissions and meteorological inputs, the uncertainties in the top and lateral boundary conditions present significant difficulties in assessing the effects of regional or long range transport events, which is essential to determine the effectiveness of local control strategies such as the State Implementation Plan. It has been suggested that satellite observations and their derived information can be utilized to augment such inputs for the air quality modeling. We will present examples of utilizing such data for air quality modeling and forecasting studies in East Texas. They include improvement of the land-surface process modeling in a meteorological model with the satellite derived high resolution land use and land cover data, more accurate estimation of isoprene emissions to represent the biogenic contribution on air quality, assimilation of satellite measurements of stratospheric and tropospheric residual ozone through the downscaling from the global models, application of satellite measured high resolution sea surface temperature data, and utilization of the satellite derived fire emissions to improve the regional air quality forecasting.

Chin, NASA Goddard Space Flight Center, USA

Using global aerosol models and satellite data for air quality studies: Challenges and data needs

Mian Chin
NASA Goddard Space Flight Center

Aerosol particles, also known as PM2.5 (particle diameter less than 2.5 μm) and PM10 (particle diameter less than 10 μm), is one of the key atmospheric components that determines air quality. Yet, air quality forecasts for PM are still in their infancy and remain a challenging task. It is difficult to simply relate PM levels to local meteorological conditions, and large uncertainties exist in regional air quality model emission inventories and initial and boundary conditions. Especially challenging are periods when a significant amount of aerosol comes from outside the regional modeling domain through long-range transport. In the past few years, NASA has launched several satellites with global aerosol measurement capabilities, providing large-scale "chemical weather" pictures. NASA has also supported development of global models which simulate atmospheric transport and transformation processes of important atmospheric gas and aerosol species. I will present the current modeling and satellite capabilities for PM2.5 studies, the possibilities and challenges in using satellite data for PM2.5 forecasts, and the needs of future remote sensing data for improving air quality monitoring and modeling.

Wang, Harvard University, USA

Mesoscale Modeling of Dust and Smoke Transport: How Geostationary Satellite Can Help?

Jun Wang1, Sundar A Christopher2, U.S. Nair2, Jeffrey Reid3, Elaine Prins4, Jenny Hand5, Jim Szykman
1. Department of Engineering and Applied Science, Harvard University, Cambridge, MA
2. Department of Atmospheric Science, University of Alabama in Huntsville, Huntsville,

AL, 3. Navy Research Laboratory, Monterey, CA, 4. UW-Madison Cooperative Institute for Meteorological Satellite Studies, Madison, WI, 5. Co-operative Institute for Research in the Atmosphere (CIRA), Colorado State University, 6. US EPA/ORD/NERL/Environmental Sciences Division, RTP, NC

A polar orbiting satellite generally provides a global view of the earth and atmosphere every 1-2 days. In contrast, the observation coverage of a geostationary satellite is usually limited within a particular region (1/3 of the globe), but has a high temporal resolution up to 5-15 minutes. Therefore the geophysical parameters retrieved from a geostationary satellite, if accurate enough, could play an important role for the improvement of air quality monitoring and modeling in hourly to daily time scales. In this talk, I will show two case studies on assimilating geostationary satellite derived aerosol optical thickness and fire emission products for the meso-scale modeling of Saharan dust transport over the Puerto Rico region in summer 2000, and Central American smoke transport to the Southeastern U.S. in spring 2003. Comprehensive comparison with ground-based observations showed that the assimilation enables the model to capture successfully the diurnal variation of smoke and dust transport. Further analysis also implied that the radiative effects of smoke aerosols have an important feedback on the evolution of boundary layer and atmospheric lapse rate, a mechanism that is not well represented in the off-line air quality models. Various outstanding issues (such as speciation of aerosol chemical composition and aerosol profiles from satellite measurements) are discussed. Finally, an outlook is presented on the prospective applications of next generation geostationary satellite (such as GOES-R) and its combination with the EOS polar orbiting satellites.

Krol, Wageningen University, Netherlands

Model analysis of high aerosol loads over northern India as observed by MISR

Maarten Krol, Alexander de Meij, Frank Dentener, Larry di Girolamo
Air Quality Group, Wageningen University, NL

We use the Tracer Model, version 5 (TM5) model to simulate the aerosol distribution over India during the dry winter monsoon season. Observations of the Multi-angle Imaging SpectroRadiometer (MISR) reveal that high aerosol loads are present in the northern Indian state Bihar. These high loads are associated with high aerosol precursor emissions, and the specific topography and meteorology of the region. TM5 simulates the distribution of the main aerosol classes, including inorganic nitrate-sulphate-ammonia aerosols. The advantage of the TM5 model is the ability to zoom in over a specific region. Here, we compare individual MISR aerosol optical depth (AOD) observations, binned on a 1x1 degree mesh, to simulations of the TM5 model. Although the description of aerosol in a global chemistry transport model is associated with many uncertainties, the analysis shows that many events of high AOD as observed MISR are reproduced by the model.

Schafer, Forschungszentrum Karlsruhe, Germany

Satellite-aided computational assessment of air quality and associated health effects

D. Sarigiannis (1), A. Gotti (1), N.I. Sifakis (2), K. Schäfer (3), M. Tombrou (4), N.

Soulakellis (5)
1. European Commission – Joint Research Centre, via E. Fermi 1, 21020 Ispra (VA) Italy, 2. National Observatory of Athens, Penteli, Athens, Greece, 3. Forschungszentrum Karlsruhe, Garmisch-Partenkirchen, Germany, 4. National Kapodistrian University of Athens, Zografou Campus, Athens, Greece, 5. University of the Aegean, Mytilene, Greece

The current state of the art in air quality assessment and management comprises analytical measurements and atmospheric transport modeling. Recent work has demonstrated the feasibility of using an innovative approach based on the use of satellite-derived data of atmospheric pollution indicators in conjunction with atmospheric dispersion models and ground data to derive quantitative maps of particulate loading within the planetary boundary layer. ß
Information filtering techniques are used to reduce the error of the information fusion algorithm and, consequently, produce the best possible estimate of tropospheric aerosol. The effectiveness of the filtering techniques depends on factors such as relative error variance across the computational domain, and precision of model input, i.e. on the accuracy of the ground emissions inventory and the reliability of measured ambient aerosol concentrations. The ICAROS NET fusion method was applied in the greater area of Athens, Greece, Munich, Germany and Milan, Lombardy over several days of observation in order to its demonstrate its validity.
The results showed that the conceptual model for tropospheric aerosol formation and fate in the atmosphere that has been developed based on experimental analyses across different European sites provides highly accurate estimates of particulate pollution at very high spatial resolution in various environmental settings and the reliability of the computational methodology across different seasonal features, climatic conditions and emission intensity is robust. The overall error is reduced to levels lower than the best atmospheric models and pollutant concentration maps produced by spatial interpolation of measurements from the ground.

POSTER PRESENTATIONS

Fu, Harvard University, USA

Space-Based Formaldehyde Measurements as Constraints on Volatile Organic Compound Emissions in Asia

Tzung-May Fu*, Daniel J. Jacob
Harvard University, Division of Engineering and Applied Sciences
Paul I. Palmer
University of Leeds, School of Earth and Environment
Kelly Chance
Harvard-Smithsonian Center for Astrophysics, Atomic and Molecular Physics Division

Formaldehyde (HCHO) columns measured from space by solar backscatter allow quantitative mapping of reactive volatile organic compound (VOC) emissions. We analyze measurements from the GOME satellite instrument between 1996 and 2001 over Asia and compare the resulting monthly constraints on VOC emissions with the latest biogenic, anthropogenic, and biomass burning emission inventories. Multivariate regression, exploiting the spatial and seasonal variations of the HCHO column data, is used to quantify regional contributions from these different emission types. We show that the current inventory for Chinese anthropogenic emissions is 25% too low in winter due to an underestimation of vehicular activities. The current biogenic inventory is a factor of 2 to 4 too low for China and a factor of 2 too high for Indonesia. Satellite observations also show that Asian biomass burning emissions are 6 times larger than the current estimation. Large HCHO signals are consistently observed in early summer over the North China Plain, implying a large, previously unrecognized source from winter wheat harvesting and crop residual burning. We estimate about 30 to 70% of crop residual is burned in field in China.

Hitchman, U. Wisconsin - Madison, USA

Using GMAO Ozone to Explore the Maintenance of the Ozone Croissant

Matthew H. Hitchman (1), Marek J. Rogal, Amihan S. Huesmann, Ivanka Stajner, and Hiroo Hayashi

(1) University of Wisconsin - Madison

Monthly mean column ozone during southern winter and spring usually exhibits a croissant shape near 50S, stretching from the Indian to the Pacific Ocean, reaching maximum intensity in October. A new, global assimilated 3D ozone data set from NASA's Global Modeling and Analysis Office (GMAO) is used to explore daily, monthly, and interannual variability associated with the ozone croissant. The ozone patterns are crucial in illustrating poleward/downward transport by synoptic Rossby waves. Maintenance of the ozone croissant involves two primary aspects: 1) Outflow pulses from the top of the southeast Asian monsoon, around the Australian High (AH), and into the Southern Indian Ocean excite Rossby wave packets which travel eastward, break, and transport ozone into the croissant region. 2) Upward amplification of the AH often coincides with a stalling planetary wave two ridge in the winter stratosphere. The associated wave two ozone pattern provides a local, rich source of ozone in the lower stratosphere for transport by synoptic waves into the croissant.

Hitchman, U. Wisconsin - Madison, USA

Contribution of Stratospheric Ozone to the "China Clipper" During INTEX

Matthew H. Hitchman (1), Marcus L. Buker, R. Bradley Pierce, Nicholas A. Zachar, and Amanda Kis

(1) University of Wisconsin - Madison

Globally assimilated stratospheric ozone is used to initialize high resolution regional models over the Pacific to quantify the contribution of ozone flux across the tropopause to tropospheric ozone travelling from Asia to the west coast of the United States. The two-scale method of Buker et al. (2005) allows quantification of irreversible and reversible stratosphere/troposphere exchange. The contribution of stratospheric ozone is treated with a separate conserved ozone field. The focus is on two distinct transport paradigms: classical tropopause folding associated with synoptic cyclones and tropopause folding associated with convective complexes, as shown by Hitchman et al. (2004). Consideration will be given to satellite observational resolution relative to modelling capabilities.

Holloway, U. Wisconsin - Madison, USA

The Impact of Synoptic Processes on Global Air Pollution Transport

Tracey Holloway (1), Larry W. Horowitz (2), Heather L. Woods (1)
1 Center for Sustainability and the Global Environment (SAGE), University of Wisconsin—Madison, Madison, WI 53726 (Holloway presenting: taholloway@wisc.edu, 608 262-5356), 2 NOAA Geophysical Fluid Dynamics Laboratory, Princeton, NJ 08540

When and where do regional processes affect hemispheric air pollution transport? Characterizing locations where local and synoptic scale chemistry and transport contribute to the global budget of trace atmospheric species is a first step towards understanding what smaller-scale mechanisms are most important, and how they affect larger scales. To identify "hot spots" of synoptic influence on global atmospheric constituents, we use a global chemical transport model (Model of Ozone and Related Tracers, MOZART v. 2), and separate horizontal chemical flux into monthly mean and episodic components. The episodic component serves as a proxy for synoptic activity, as it reflects the correlation of wind velocity and concentrations of trace species on time scales less than a month (we examine correlations at every 15-minute model timestep, as well as hourly and daily correlations). Our initial study examines carbon monoxide, and is being extended to ozone and aerosols. This project complements the goals of the NASA Aura satellite mission, and other effort to monitor atmospheric constituents from space, in linking regional air quality with global chemistry and transport.

Lary, NASA Goddard Space Flight Center, USA

An Objectively Optimized Sensor Web

David Lary, Mark Schoeberl, Stephen Talabac, Mike Seablom
NASA, Goddard Space Flight Center, Greenbelt, MD

We outline a prototype simulator for a generic objectively optimized earth observation system with plug-ins for integrated scientific analysis, assimilation, and observation scheduling. The simulator will be able to perform a number of "what if" scenarios that can be used in the objective design of autonomous Sensor Webs. The system envisioned will dynamically adapt the what, where, when and mode (e.g. global survey or zoom-in) of the observations made in an online fashion to maximize information content, minimize uncertainty in characterizing the system's state vector for a given observation capability. Put simply, we will use measures of what we do not know to direct our future observations, and use measures of how important it is to know it to determine the scheduling priority of observations. What we do not know will be quantified by state vector uncertainty supplied by the assimilation system. How important it is to know it will be quantified by information content also supplied by the assimilation system. The geographic extent of the uncertainty maxima is one metric that can be used to determine whether zoom in or survey mode is required. In the generic case, the system could be used to specify high-level goals such as the remote identification of sites of likely wild fires, pollution events or other hazards. We use a specific prototype system applied to atmospheric chemistry. A chemical assimilation system will be part of the Sensor Web

prototype. The assimilation system will provide routine estimates of state vector uncertainty and information content. The maxima in the uncertainty fields will be used as area targets for the target-tracking algorithm. The information content will be used as the priority of observing that target.

Millet, Harvard University, USA

Formaldehyde (HCHO) columns measured from space

D.B. Millet, D.J. Jacob, S. Turquety, R.C. Hudman, S. Wu, A. Fried, J. Walega, B.G. Heikes, D.R. Blake, H.B. Singh, B.E. Anderson, A.D. Clarke
Harvard University, Earth and Planetary Sciences

Formaldehyde (HCHO) columns measured from space provide constraints on emissions of volatile organic compounds (VOCs). Quantitative interpretation requires characterization of errors in HCHO column retrievals and relating these columns to VOC emissions. Retrieval error is mainly in the air mass factor (AMF) which relates fitted backscattered radiances to vertical columns, and requires external information on HCHO, aerosols, and clouds. Here we use aircraft data collected over North America and the Atlantic to determine the local relationships between HCHO columns and VOC emissions, calculate AMFs for HCHO retrievals, assess the errors in deriving AMFs with a chemical transport model (GEOS-Chem), and draw conclusions regarding space-based mapping of VOC emissions. We show that isoprene drives observed HCHO column variability over North America; HCHO column data from space can thus be used effectively as a proxy for isoprene emission. From observed HCHO and isoprene profiles we find an HCHO molar yield from isoprene oxidation of 1.6 ± 0.5, consistent with current chemical mechanisms. Clouds are the primary error source in the AMF calculation; errors in the HCHO vertical profile and aerosols have comparatively little effect. The mean bias and 1σ uncertainty in the GEOS-Chem AMF calculation increase from <1% and 15% for clear skies to 17% and 24% for half-cloudy scenes. With fitting errors, this gives an overall 1σ error in HCHO satellite measurements of 25–31%. Retrieval errors, combined with uncertainties in the HCHO yield from isoprene oxidation, result in a 40% (1σ) error in inferring isoprene emissions from HCHO satellite measurements.

Stenchikov, Rutgers University, USA

Space- and Ground-based Observations and Modeling of the Aerosol Plume from the World Trade Center Collapse and Fire on September 11, 2001

Georgiy Stenchikov (1), David Diner (2), Ralph Kahn (2), Alexander Smirnov (3), Brent Holben (3)
1. Department of Environmental Sciences, Rutgers University, New Brunswick, NJ 08901, 2. Jet Propulsion Laboratory, Pasadena, CA 91109, 3. Goddard Space Flight Center, Greenbelt, MD 20771

Here we study the catastrophic aerosol release in a highly populated urban area produced by the collapse of the World Trade Center (WTC) in New York City (NYC) on September 11, 2001. Intensive combustion of the WTC complex remains covered a 16-acre area known as Ground Zero; until September 14, the site continued producing a

steady, elevated source of hazardous gases and aerosols. A detailed spatial and temporal description of the pollution fields' evolution is needed to fully understand their environmental and health impact, but many existing in situ aerosol monitoring stations in the vicinity were completely plugged with dust immediately after the collapse. However, the aerosol plume was remotely sensed from the ground and from space. Here we combine numerical modeling of micrometeorological fields and pollution transport using the Regional Atmospheric Modeling System (RAMS) and Hybrid particle and Concentration Transport (HYPACT) model with AERONET and MISR retrievals, to realistically reconstruct plume evolution.

RAMS meteorology calculations were conducted on multiple nested grids, with the finest grid being 250m x 250m, centered on Lower Manhattan, allowing us to resolve scales of the order of a city block. Pollutant transport was studied using the HYPACT model that accepts RAMS meteorological output. RAMS/HYPACT results were tested against surface observations, Landsat images, and Multi-angle Imaging Spectrometer (MISR) retrievals. AERONET continuously collected plume data in NYC from the roof of the Goddard Institute for Space Studies (GISS) in Upper Manhattan. MISR viewed the WTC on September 12 at 1603 UTC with 275m pixel resolution when the plume blew southwest, reporting a plume altitude around 1500 m, and a regionally averaged visible optical depth of 0.1.

The aerosol retrievals from ground- and space-based instruments provide important constrains for our plume simulations. We were able to reconstruct the evolution of the aerosol plume for the entire period following the WTC collapse and fire at Ground Zero. We relatively accurately calculated the plume height, directionality, and timing. Comparisons between calculated and observed column aerosol loadings allowed us to roughly estimate the magnitude of the aerosol source on September 12 and 13, 2001. The simulated pollutant distributions were provided to an exposure assessment group which will further analyze the environmental and health impacts.

Turquety, Service d'Aeronomie, France, France

Importance of peat burning and injection heights in boreal fire emissions: evaluation with MOPITT satellite observations for the summer 2004

S. Turquety (1,2), D. J. Jacob (1), J. A. Logan (1), R. C. Hudman (1), R. M. Yevich (1), F. Y. Leung (1), C. L. Heald (1), R. M. Yantosca (1), L. K. Emmons (3), D. P. Edwards (3), G. W. Sachse (3), J. Holloway (4) and the INTEX Science Team.,

(1) Division of Engineering and Applied Science, Harvard University, Cambridge, MA, (2) Now at Service d'Aéronomie, IPSL, Paris, France (turquety@aero.jussieu.fr), (3) Atmospheric Chemistry Division, NCAR, Boulder, CO, (4) NASA Langley Research Center, Hampton, VA, (5) Aeronomy Laboratory, NOAA, Boulder, CO

Boreal wildfires constitute a major perturbation for tropospheric chemistry in the high and mid latitudes of the Northern Hemisphere, with important consequences for air quality and climate. Understanding the influence from these fires in terms of emissions and transport is all the more necessary as their occurrence is expected to increase as a result of climate change.

The summer of 2004 was one of the strongest fire seasons on record for Alaska and western Canada. We present a daily fire emission inventory for that season, including consideration of peat burning and high-altitude (buoyant) injection, and evaluate it in a global chemical transport model (GEOS-Chem CTM) simulation of CO through comparison with ICARTT aircraft, and MOPITT satellite observations. The inventory is constructed by combining daily area burned reports and MODIS fire hotspots with average estimates of fuel consumption and emission factors based on ecosystem type. We estimate the total emissions of CO to 25 Tg CO, including 7 Tg CO from peat burning. Our simulation shows that including emissions from peat burning improves the agreement between simulated and observed CO.

Model comparisons to observations are very sensitive to the altitude of injection of the fire emissions in the CTM, highlighting the importance of considering pyro-convective events when simulating fire influences. We explore the top-down constraints on both the fire emissions and their injection height provided by the available atmospheric observations of CO.

Vijayaraghavan, Atmospheric & Environmental Res., USA

Evaluation of a Regional Air Pollution Model with Satellite Measurements

Krish Vijayaraghavan (1), Yang Zhang (2), Hilary E. Snell (3), and Jian-Ping Huang (2)
(1) Atmospheric & Environmental Research, Inc., San Ramon, CA, (2) North Carolina State University, Raleigh, NC, (3) Atmospheric & Environmental Research, Inc., Lexington, MA

The U.S. EPA Models-3 Community Multiscale Air Quality (CMAQ) Modeling System is applied to simulate tropospheric ozone (O3), carbon monoxide (CO), nitric oxide (NO), nitrogen dioxide (NO2), volatile organic compounds (VOCs) and other gases, as well as particulate matter for year 2001 over a modeling domain with a horizontal grid resolution of 36 km and encompassing the continental United States and parts of Canada and Mexico. Model predictions from CMAQ are then evaluated against measurements from satellites. The simulated monthly mean total tropospheric O3 column abundance is compared with tropospheric O3 residuals derived from concurrent measurements from the Total Ozone Mapping Spectrometer (TOMS) and the Solar Backscatter Ultraviolet (SBUV) instruments. Simulated monthly mean tropospheric NO2 and formaldehyde (HCHO) columns are compared with data from the Global Ozone Monitoring Experiment (GOME) instrument on the ERS-2 satellite. The total aerosol optical depth (AOD) calculated using CMAQ predictions with an empirical approach offline is evaluated against monthly mean data from the Moderate Resolution Imaging Spectroradiometer (MODIS) on board the Terra satellite. Differences in the spatial and temporal distributions as well as seasonalities of the column abundance of the modeled and satellite-derived products are analyzed.

Yudin, Nat. Center for Atmospheric Res., USA

On the data analysis of MOPITT radiances in the chemistry transport models: benefits and concerns

Valery A.Yudin, D.P. Edwards, G. Francis, L.K. Emmons, J-F. Lamarque, S-P, Ho, J.C. Gille, M.N. Deeter, D. Mao, and D. Ziskin
National Center for Atmospheric Research, Boulder CO

The multi-year retrievals of carbon monoxide (CO) from the MOPITT radiance data demonsrate success of the satellite missions to derive the year-to-year variations of CO related to highly variable biomass burning events. The data assimilation and inverse modeling studies with the MOPITT retrievals also highlight importance of the continuous data coverage for the regional and global air quality evaluations. Recently several other satellite instruments began to report CO distributions. The first comparisons between these data sets (retrievals) set up a number of questions for the remote sensing of tropospheric constituents. To address these questions in this paper we will discuss benefits of the direct analysis of the MOPITT radiances in the modern chemistry transport models. This framework allows to show the consistency of the information coming from the satellite instruments, as well it helps to evaluate the systematic data-data and data-model differences (biases). The possible schemes for corrections of radiance and model biases will be overviewed.

Zhang, Harvard University, USA

Ozone-CO correlations from TES test model estimates of intercontinental transport of ozone pollution

Lin Zhang, Daniel J. Jacob, Jennifer A. Logan and Solene Turquety
Department of Earth and Planetary Sciences and Division of Engineering & Applied Sciences, Harvard University, Cambridge, MA
Kevin Bowman, Qinbin Li and Helen Worden
Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA

The Tropospheric Emission Spectrometer (TES) aboard the EOS Aura satellite provides global collocated measurements of ozone and CO in the troposphere. The resulting information on ozone-CO correlations offers constraints on the sources and transport of tropospheric ozone. We use TES ozone and CO observations in different seasons to quantify these correlations, and to interpret them with the GEOS-Chem chemical transport model driven by assimilated meteorological observations. TES observations for July 2005 show significant ozone-CO correlations downwind of continents with large industrial and biomass burning sources. The associated $\Delta O3/\Delta CO$ enhancement ratios are larger than 0.6 mol mol-1 in the middle troposphere. The GEOS-Chem model reproduces the ozone-CO correlations and enhancement ratios observed by TES, providing an important test of the model simulation of intercontinental transport of ozone pollution. Analysis of the model correlation fields shows that the potential of TES to observe ozone-CO correlations is presently limited by retrieval error. Recent reduction of the CO measurement noise should greatly increase the value of the TES ozone-CO correlation data for quantifying the continental outflow and intercontinental transport of ozone pollution.