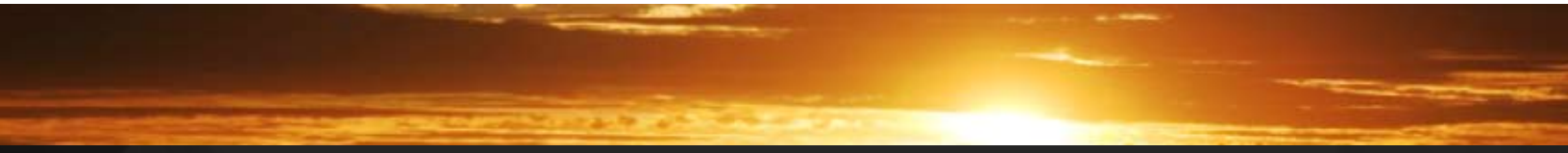

FINAL PROGRAM

AEROSOL AND ATMOSPHERIC OPTICS

VISIBILITY & AIR POLLUTION

SEPTEMBER 24-28, 2012 · WHITEFISH, MT

Air & Waste Management Association

FINAL PROGRAM

ABOUT THE CONFERENCE

This international conference will provide a technical forum on advances in the scientific understanding of the effects of aerosols on urban, regional, continental and global scale haze and radiation balance. The conference will specifically address: emission sources, atmospheric conditions and aerosol characteristics associated with haze and aerosol urban visibility; regional haze; climate forcing; innovative aerosol, haze and radiation balance monitoring assessments and modeling methods; and urban and regional haze and aerosol climate forcing policy, regulatory, and economic issues related to implementation of U.S. EPA standards and rules, including the adopted emissions controls in state and EPA permits, rules, and implementation plans for the Regional Haze Rule and the expected impact of the anticipated PM Visibility and SO2/NOx Secondary Standards.

GENERAL INFORMATION

CONTINUING EDUCATION CREDIT OPPORTUNITIES

Conference and course attendees may be eligible for continuing education credits. For more information, please contact Gloria Henning at glhenning@awma.org or 412-904-6021.

LOCATION & LODGING

Grouse Mountain Lodge
2 Fairway Drive
Whitefish, MT 59937
Phone: +1-406-892-6729
http://www.grousemountainlodge.com

TRANSPORTATION

Complimentary shuttle service from the Glacier Park International Airport (FCA) is available through the Grouse Mountain Lodge with advance notice. Amtrak services the Whitefish Train Depot (WHF) and shuttle service is complementary through the Lodge with advance notice.

Visit http://www.grousemountainlodge.com/getting-here for more information.

CONFERENCE PROCEEDINGS

Conference Proceedings are available to conference attendees on the conference website. Attendees will receive an email with login information. Presentations will be collected during the conference and added to the site after the event. Attendees will be notified by e-mail when the full proceedings are available.

CONFERENCE COMMITTEE

Conference Chair:
Delbert Eatough, Brigham Young University

Conference Committee:
Joe Adlhoch, Air Resource Specialists, Inc.
Eric Edgerton, Atmosphere Research & Analysis, Inc.
Phil Hopke, Clarkson University
C.V Mathai, Arizona Public Service Company
Chuck McDade, University of California, Davis
Tom Moore, Western Governor's Association
Bret Schichtel, National Park Service
Ivar Tombach, Consultant
Jay Turner, Washington University
Tony Ward, University of Montana

ABOUT THE AIR & WASTE MANAGEMENT ASSOCIATION

A&WMA is a not-for-profit, nonpartisan professional organization that enhances knowledge and expertise by providing a neutral forum for technology exchange, professional development, networking opportunities, public education, and outreach to more than 8,000 environmental professionals in 65 countries. A&WMA also promotes global environmental responsibility and increases the effectiveness of organizations to make critical decisions that benefit society. For more information, please visit www.awma.org.

A&WMA Federal Tax ID # 25-6048614.

FINAL PROGRAM

SPECIAL EVENTS

VISIBILITY SPECIALTY CONFERENCE PHOTO CONTEST

Outside the Glacier Room

Conference participants were invited to participate in the Visibility Photo Contest. Photos capturing urban, rural, and wilderness examples of spectacular visibility, impaired visibility, unusual optical effects, visibility instrumentation, or people engaged in visibility research or protection were welcomed. Photos will be on display outside of the exhibit hall (Glacier Room) throughout the conference. A&WMA would like to thank both Kristi Gebhart and Anna Lee Farber as organizers and judges for the photo contest and thank Air Resource Specialists, Inc. for providing the prizes.

GLACIER NATIONAL PARK EXCURSION

Wednesday, September 26, leave Grouse Mountain Lodge at 12:20p.m.

All participants are invited to spend the afternoon exploring in Glacier National Park. Pick up a box lunch before boarding the bus and don't forget sunscreen, rain jacket, water, bear spray, camera, and binoculars! Choose from one of the following activities:

Bus 1: IMPROVE Site and Johns Lake Trail group (Group A)

Drive to IMPROVE Site (about 60 minutes) for a visit with a park ranger. Following the talk, drive to Johns Lake Trail Head. The walk to Johns Lake is 1.5 – 2 miles round trip through old growth forest with rolling terrain, and a moderate climb to the lake. After the walk, continue on to Lake McDonald Lodge.

Bus 2: Historic Walk and Apgar Village group (Group B) or Trail of Cedars and Avalanche Lake groups (Group C).

Drive to the Start of the Interpretive Walk at the Administration Building in the Park Headquarter Area where Group B will leave the bus, spend about an hour on the interpretive walk, and then walk about 2 miles along the bike path to Apgar Village where there is an NPS visitors center and numerous gift shops. After exploring, continue on to Lake McDonald Lodge.

Group C will continue to the Trail of Cedars parking lot where participants may either:

1. Walk an easy interpretive boardwalk and paved handicap accessible path for about 1 hour at the Trail of Cedars. This group will then continue to the NPS Visitors Center in Apgar Village to spend a little over an hour before they join Group B and continue to McDonald Lodge.
2. Start on the Trail of Cedars boardwalk to the halfway point at Avalanche Gorge then hike the trail to Avalanche Lake which winds through old growth forest with spectacular views of waterfalls and Avalanche Lake (4-5 miles round trip, 700 ft elevation change) then continue on to Lake McDonald Lodge.

Bus 3: Upper McDonald Creek Trail group (Group D) and Trail of Cedars and Avalanche Lake groups (Group C).

Drive to the Start of the Upper McDonald Creek Trail (about 60 minutes) where Group D will enjoy the relatively flat trail that is about 5 miles one way. This walk gives an opportunity to view birds and other wildlife, hear the creek, and view cascades. This group will then continue on to Lake McDonald Lodge.

Group C will continue to the Trail of Cedars parking lot where participants may start on the Trail of Cedars boardwalk to the halfway point at Avalanche Gorge and take the hike to Avalanche Lake which winds through old growth forest with spectacular views of waterfalls and Avalanche lake (4-5 miles round trip, 700 ft elevation change) then continue on to Lake McDonald Lodge.

At the Lake McDonald Lodge there will be an NPS staff member to give a brief interpretive program for our group and answer any questions. There is a gift shop and restaurants. Buses will return to at 6:00, 6:15 and 6:30. For more details, please visit http://visibility.awma.org under the events tab.

NIGHT SKY PROGRAM

Wednesday, September 26, Whitefish Lake State Park between 7:30p.m. and 10:30p.m.

Join us for an evening looking into the heavens with telescopes. The event will be lead by Joe Adlhoch and Mark Tigges, ARS, Fort Collins, CO, Chad Moore, CIRA, Fort Collins, CO, and Mark Wagner, Glacier National Park. Several scopes will be provided by this group as well as the Whitefish Astronomy Club. There will be a full moon during the conference so we will focus on looking at the moon, at Saturn, and at a few star clusters that will be visible. The viewing site is about 2 miles from the Lodge. Small groups of about 20 will be taken to the State Park from Grouse Mountain Lodge about every 20 minutes to allow all the chance to participate without the group being too large.

FINAL PROGRAM

PROFESSIONAL DEVELOPMENT COURSES

Course registration includes refreshment breaks and a copy of the course manual. For more information about the courses and instructors contact Robin Lebovitz at rlebovitz@awma.org or 412-904-6020.

INTRODUCTION TO VISIBILITY AND AEROSOL OPTICS

Monday, September 24, 2012
8:00a.m. – 12:00p.m.
Room: Upper Glacier Nordic

Instructors: *Dr. William Malm and Dr. Bret Schichtel, National Park Service Air Resource Division*

This course is intended to give attendees an understanding of fundamental principles of visibility, including the relationship of emissions to aerosol formation, atmospheric optical properties, and human perception issues as they relate to viewing scenic landscape features. Visibility concepts will be demonstrated with actual photographs showing the effect of haze on landscape features, the role that sun angle plays in the competition between path and scene radiance, the difference between uniform and layered haze, and different emission types. Photographs will also demonstrate how absorbing and scattering aerosols compete to change the appearance of layered and uniform hazes.

THE RELATIONSHIP OF VISIBILITY TO PARTICLE COMPOSITION AND SOURCES

Monday, September 24, 2012
1:00p.m. – 5:00p.m.
Room: Upper Glacier Nordic

Instructor: *Philip Hopke, Center for Air Resources Engineering and Science, Clarkson University, Potsdam, NY*

This course will present the underlying basis for differences in the interaction of light with particles of differing composition and the relationships that have been developed for prediction of visible range based on particle composition. Visibility can also be related to sources The conceptual framework of receptor models, a mass balance approach, will be described. The resulting mathematical approaches can be then implemented depending on what a priori information is available. Applications of several types of models to various particle composition problems will be described with an emphasis on the practical use of Positive Matrix Factorization for both elemental and organic species data.

PM2.5 SAMPLING AND ANALYSIS FOR EXTINCTION CALCULATION

Monday, September 24, 2012
8:00a.m. – 12:00p.m.
Room: Upper Glacier Alpine

Instructors: *Judith C. Chow, Sc.D. and John G. Watson, Ph.D., Desert Research Institute, Nevada System of Higher Education*

This course will examine causes of haze; describe visibility metrics and measurement methods; introduce aerosol properties, review recent developments in aerosol sampling systems for integrated and continuous PM mass, size, and chemical components; review filter-based PM2.5 mass and chemical analyses; and identify the observables needed for mass reconstruction, chemical extinction calculation, and receptor modeling. It will also enumerate examples from past studies to identify and demonstrate the use of a variety of software to conduct descriptive data analysis and to assist data visualization and interpretation.

CONTEMPORARY AEROSOL OPTICS

Monday, September 24, 2012
1:00p.m. – 5:00p.m.
Room: Upper Glacier Alpine

Instructors: *Dr. Hans Moosmüller and Dr. Rajan K. Chakrabarty, Desert Research Institute*

This course will outline the importance of aerosol optics for visibility impairment and radiative forcing of climate change, identifying the relevant optical parameters that are needed for understanding and modeling. This will be followed by a general discussion of aerosol physics and optics before focusing on contemporary techniques for the calculation and measurement of aerosol optical properties. Numerical techniques discussed will include both exact calculations and useful approximations while the discussion of measurement techniques will include in situ, filter-based, and remote sensing techniques and instruments for the quantification of scattering, absorption, and extinction coefficients, phase functions and asymmetry parameters.

TECHNICAL PROGRAM - Monday, September 24, 2012

7:30a.m. - 5:00p.m.
Conference Registration
Foyer outside of Continental Divide

TECHNICAL PROGRAM - Tuesday, September 25, 2012

7:00a.m. - 5:00p.m.
Conference Registration
Foyer outside of Continental Divide

7:00a.m. - 8:00a.m.
Continental Breakfast
Pavillion

8:00a.m. - 9:40a.m.
Opening and Plenary
Continental Divide

Opening Welcome:
Sara Head, AECOM and President Elect of the Air & Waste Management Association

Plenary Speaker:
William Malm, National Park Service Air Resource Division

Presentation Topic:
Visibility Perception: Past, Present, and Future

Plenary Speaker:
Eric Wilcox, Division of Atmospheric Sciences, Desert Research Institute

Presentation Topic:
Physical connections between atmospheric visibility and regional climate change

9:40a.m. – 10:00a.m.
Coffee Service
Glacier Room

TRACK A

SESSION 1A. AEROSOL AND VISIBILITY FIELD STUDIES AND MONITORING NETWORKS

EAST - Continental Room
Session Chairs:
Chuck McDade, *University of California, Davis*
Joe Adlhoch, *Air Resource Specialists, Inc.*

10:00a.m. - 10:20a.m.
Control #40
Temporal Trends in Urban and Rural Particulate Sulfate Ion Concentrations Across the United States
Jenny L. Hand, Cooperative Institute for Research in the Atmosphere (CIRA), Colorado State University, Fort Collins, CO

10:20a.m. - 10:40a.m.
Control #24
Reanalysis of a 15-Year Archive of IMPROVE Samples
Nicole Pauly Hyslop, Crocker Nuclear Laboratory, University of California, Davis, Davis, CA

Only presenting author is listed in the Technical Program. Full author block is included in the proceedings.

TRACK B

SESSION 2. NEW AND CURRENT FIELD MONITORING TECHNIQUES FOR MEASURING BLACK CARBON AND AEROSOL ORGANIC MATERIAL

WEST - Continental Room
Session Chairs:
Ann Dillner, *University of California, Davis*
Tony Ward, *University of Montana*

10:00a.m. - 10:20a.m.
Control #17
Diurnal Black Carbon And Visibility Trends In Los Angeles And Mexico City : A Tale Of Two Cities
Darrel Baumgardner, Centro de Ciencias de la Atmósfera, Universidad Nacional Autonoma de México, Ciudad Universitaria, Mexico

10:20a.m. - 10:40a.m.
Control #119
Infrared Spectroscopic Organic Functional Group Analysis of IMPROVE Samples
Travis C. Ruthenburg, Crocker Nuclear Laboratory, University of California, Davis, Davis, CA

FINAL PROGRAM

TECHNICAL PROGRAM - Tuesday, September 25, 2012

TRACK A

SESSION 1A. AEROSOL AND VISIBILITY FIELD STUDIES AND MONITORING NETWORKS (CONT'D)

10:40a.m. - 11:00a.m.
Control #118
Aerosol Decadal Trends: In-situ Measurements of Number Concentration and Optical Properties
John A. Ogren, National Oceanic and Atmospheric Administration, Earth System Research Laboratory, Boulder, CO

11:00a.m. - 11:20a.m.
Control #13
Sources of and trends in visibility reducing particles in the Lake Tahoe basin, 1990-2009
Mark Green, Desert Research Institute, Reno, NV

11:20a.m. - 11:40a.m.
Control #76
Aerosol Measurements from the Southeastern Aerosol Research and Characterization (SEARCH) Study: PM Composition and Trends, 1999 - 2010
Charles L. Blanchard, Envair, Albany, CA

11:40a.m. - 12:00a.m.
Control #125
AMS Measurements in National Parks of Aerosol Mass, Size and Composition, Comparison with Filter Samples and Correlation with Particle Hygroscopicity
M. Lizabeth Alexander, EMSL, Pacific Northwest National Laboratory, Richland, WA

TRACK B

SESSION 2. NEW AND CURRENT FIELD MONITORING TECHNIQUES FOR MEASURING BLACK CARBON AND AEROSOL ORGANIC MATERIAL (CONT'D)

10:40a.m. - 11:00a.m.
Control #33
A Field Instrument for Semi-Continuous Monitoring of Organic Marker Compounds
Jaron C. Hansen, Department of Chemistry and Biochemistry, Brigham Young University, Provo, UT

11:00a.m. - 11:20a.m.
Control #80
Light Absorption Properties of Brown Carbon in Fresh and Photo-Chemically Aged Biomass Burning Emissions
Allen L. Robinson, Center for Atmospheric Particle Studies, Carnegie Mellon University, Pittsburgh, PA

11:20a.m. - 11:40a.m.
Control #104
Speciation of Atmospheric "Brown" Carbon
Jeffrey L. Collett, Colorado State University, Department of Atmospheric Science, Fort Collins, CO

11:40a.m. - 12:00a.m.
Control #121
Determination of Long Term Atmospheric Elemental Carbon Concentrations Using Lake Sediments
Liaquat Husain, Department of Environmental Health Sciences, School of Public Health, SUNY Albany, Albany, NY

12:00p.m. - 1:30p.m.
Lunch
Pavillion
Speaker: Mark Wagner, *Glacier National Park Night Sky Program*

SESSION 1B. AEROSOL AND VISIBILITY FIELD STUDIES AND MONITORING NETWORKS

EAST - Continental Room
Session Chairs:
Judith Chow, *Desert Research Institute*
Rob Farber, *Southern California Edison*

1:30p.m. - 1:50p.m
Control #36
Characterizing the relationship between atmospheric visibility and pollutant sources in different weather conditions in Central Taiwan
Shih-Yu Chang, School of Public Health, Chung Shan Medical University, Taiwan

SESSION 3A. BLACK CARBON EMISSIONS IN DEVELOPED AND DEVELOPING COUNTRIES

WEST - Continental Room
Session Chairs:
Philip Hopke, *Clarkson University*
Shamsh Pervez, *Pt. Ravishankar Shukla University*

1:30p.m. - 1:50p.m
Control #8
Biomass Burning Contribution to Ambient Air Particulate Levels at Navgongo, in the Sahel Savannah Zone of Ghana
Francis G. Ofosu, National Nuclear Research Institute, Ghana Atomic Energy Commission, Accra, Ghana.

TECHNICAL PROGRAM - Tuesday, September 25, 2012

TRACK A

SESSION 1B. AEROSOL AND VISIBILITY FIELD STUDIES AND MONITORING NETWORKS (CONT'D)

EAST - Continental Room

1:50p.m. - 2:10p.m
Control #37
Emission Inventory and Speciation of PM in the Yangtze River Delta Region, China
Xiao Fu, School of Environment, Tsinghua University, Beijing, China

2:10p.m. - 2:30p.m
Control #54
Urban Visibility Measurements in Fort Collins, Colorado
Cassie Archuleta, Air Resource Specialists, Inc. (ARS), Fort Collins, CO

2:30p.m. - 2:50p.m
Control #58
Photoacoustic Measurements for the IMPROVE Program
Hans Moosmüller, Desert Research Institute, Nevada System of Higher Education, Reno, NV

2:50p.m. - 3:10p.m
Control #82
Airborne Measurements of Black Carbon at Remote Locations Using Miniature High-performance Aethalometers
Griša Močnik, Aerosol d.o.o., Slovenia

3:10p.m. - 3:30p.m
Control #21
Visibility and Real- time Black Carbon Measurement in a Coastal Area of Southern China
S. C. Lee, Department of Civil and Structural Engineering, Research Center for Environmental Technology and Management, The Hong Kong Polytechnic University, Hong Kong, China

TRACK B

SESSION 3A. BLACK CARBON EMISSIONS IN DEVELOPED AND DEVELOPING COUNTRIES (CONT'D)

WEST - Continental Room

1:50p.m. - 2:10p.m
Control #15
Personal Exposure to Black Carbon in Dhaka, Bangladesh
Philip K. Hopke, Institute for a Sustainable Environment, Clarkson University, Potsdam, NY

2:10p.m. - 2:30p.m
Control #69
Atmospheric Black Carbon in PM2.5 from Several Cities in Indonesia
Muhayatun Santoso, Center of Nuclear Technology for Materials and Radiometry, National Nuclear Energy Agency (BATAN), Indonesia

2:30p.m. - 2:50p.m
Control #78
U.S. Inventory of Mobile Source Black Carbon Emissions
Louis Browning, ICF International, Aptos, CA

2:50p.m. - 3:10p.m
Control #2
Organic and black carbon in PM2.5 at an urban traffic environment of Dhaka, Bangladesh
Bilkis A. Begum, Chemistry Division, Atomic Energy Centre, Dhaka, Bangladesh

3:10p.m. - 3:30p.m
Control #6
Characterization and Source Apportionment of Airborne Particulate Loadings at Various Receptor Site-Classes of Lagos Mega-City, Nigeria
Kayode O. Owoade, Department of Physics, Obafemi Awolowo University, Ile-Ife, Nigeria

3:30p.m. - 4:00p.m.
Break
Glacier Room

FINAL PROGRAM

TECHNICAL PROGRAM - Tuesday, September 25, 2012

TRACK A

SESSION 4. PANEL DISCUSSION: PROMISE AND PROBLEMS OF ADVANCED PARTICULATE MONITORING AND ANALYSIS METHODS FOR ROUTINE NETWORKS

EAST - Continental Room

Session Chair:

Bret Schichtel, *National Park Service*

John C. Vimont, *National Park Service*

4:00p.m. - 5:20p.m.

Panelists:

Eric S. Edgerton, *Atmospheric Research & Analysis*

Jeffrey L. Collett, Jr., *Colorado State University*

Judith C. Chow, *Desert Research Institute*

Hans H. Moosmüller, *Desert Research Institute*

TRACK B

SESSION 3B. BLACK CARBON EMISSIONS IN DEVELOPED AND DEVELOPING COUNTRIES

WEST - Continental Room

Session Chairs:

Philip Hopke, *Clarkson University*

Francis Ofosu, *Ghana Atomic Energy Commission*

4:00p.m. - 4:20p.m.

Control #115

The Brahmaputra River Valley: a Regional Hotspot of Black Carbon Emissions

Rajan K. Chakrabarty, Laboratory for Aerosol Science, Spectroscopy and Optics, Division of Atmospheric Sciences, Desert Research Institute, Reno, NV

4:20p.m. - 4:40p.m.

Control #26

Black Carbon Emission and Ambient Air Levels in Developing Asian Countries

Nguyen Thi Kim Oanh, Environmental Engineering and Management, Asian Institute of Technology, Thailand

4:40p.m. - 5:00p.m.

Control #114

Significant Contribution of Emissions from Asian Religious and Cultural Activities to Atmospheric Brown Clouds

Shamsh Pervez, School of Studies in Chemistry, Pt. Ravishankar Shukla University, Raipur, India

SESSION 5. BIO MASS BURNING, CARBONACEOUS AEROSOLS AND SHORT LIVED CLIMATE FORCERS EFFECTS ON HAZE AND CLIMATE

WEST - Continental Room

Session Chair:

Kip Carrico, *AECOM*

5:00p.m. - 5:20p.m.

Control #117

Anticipating the Impacts of Wildfire Emissions Under Climate Change -- A Strategy for Developing Inventories Suitable for Projecting Future Climate Forcing

Brooke L. Hemming, US Environmental Protection Agency National Center for Environmental Assessment, Global Change Research Program, RTP, NC

TECHNICAL PROGRAM - Tuesday, September 25, 2012

TRACK A

SESSION 1C. AEROSOL AND VISIBILITY FIELD STUDIES AND MONITORING NETWORKS

EAST - Continental Room

Session Chair:

Chuck McDade, *University of California*

5:20p.m. - 5:40p.m.

Control #11

Aerosol Chemistry and Hygroscopic Growth in U.S. National Parks

Douglas Lowenthal, Desert Research Institute, Reno, NV

5:40p.m. - 6:00p.m.

Control #87

Ambient Aerosol Hydration State at Three U.S. National Parks

Nathan F. Taylor, Department of Atmospheric Sciences, Texas A&M University, College Station, TX

TRACK B

SESSION 5. BIO MASS BURNING, CARBONACEOUS AEROSOLS AND SHORT LIVED CLIMATE FORCERS EFFECTS ON HAZE AND CLIMATE (CONT'D)

5:20p.m. - 5:40p.m.

Control #74

Comparative Fire Emissions Analysis: the DEASCO3 Project and the EPA 2008 NEI

Tom Moore, Western Governors' Association – Western Regional Air Partnership, Fort Collins, CO

5:40p.m. - 6:00p.m.

Control #77

Contributions of Biomass Burning and Other Sources to Fine Particulate Carbon at Rural Locations Throughout the United States

Bret A. Schichtel, National Park Service, Cooperative Institute for Research in the Atmosphere, Colorado State University, Fort Collins, CO

6:00p.m. - 7:30p.m.

Exhibitor Reception

Glacier Room

TECHNICAL PROGRAM - Wednesday, September 26, 2012

7:00a.m. - 5:00p.m.

Conference Registration

Foyer outside of Continental Divide

7:00a.m. - 8:00a.m.

Continental Breakfast

Pavillion

SESSION 6A. INFORMATION AND TECHNOLOGY NEEDS FOR FUTURE REVISIONS OF THE SECONDARY PM NAAQS

EAST - Continental Room

Session Chairs:

Naresh Kumar, *EPRI*

Marc Pitchford, *Desert Research Institute*

8:00a.m. - 8:20a.m.

Control #20

Evolution of Thought on Monitoring Methods to Support a Secondary PM National Ambient Air Quality Standard to Protect Visibility

Marc Pitchford, Desert Research Institute, Reno, NV

SESSION 7. SATELLITE AND OTHER REMOTE SENSING APPLICATIONS TO HAZE/AEROSOL MONITORING

WEST - Continental Room

Session Chairs:

Mark Green, *Desert Research Institute*

Hans Moosmuller, *Desert Research Institute*

8:00a.m. - 8:20a.m.

Control #16

An Iterative Fitting Algorithm for Matching Aerosol Size Distributions to Spectral Extinction Data

Ratish Menon, Centre for Environmental Science and Engineering, Indian Institute of Technology, Bombay, Mumbai

FINAL PROGRAM

TECHNICAL PROGRAM - Wednesday, September 26, 2012

TRACK A

SESSION 6A. INFORMATION AND TECHNOLOGY NEEDS FOR FUTURE REVISIONS OF THE SECONDARY PM NAAQS (CONT'D)

EAST - Continental Room

8:20a.m. - 8:40a.m.
Control #34
Measurement of Scattering in an Urban Area Using a Nephelometer and PM2.5 FDMS TEOM Monitor: Accounting for the Effect of Water
Delbert J. Eatough, Department of Chemistry and Biochemistry, Brigham Young University, Provo, UT

8:40a.m. - 9:00a.m.
Control #46
Scientific Issues Regarding Using a PM2.5 NAAQS to Protect Urban Visibility
Ivar Tombach, Consultant, Camarillo, CA

9:00a.m. - 9:20a.m.
Control #31
Analysis of Visibility at Canadian Speciation Monitoring Sites
Keith Jones, Air Quality Science Unit, Meteorological Services of Canada, Environment Canada, Vancouver, BC, Canada

9:20a.m. - 9:40a.m.
Control #42
Visibility Perception in the Lower Fraser Valley of British Columbia, Canada: Results from a Public Survey
John P. Gallagher, Stantec Consulting, Burnaby, BC, Canada

TRACK B

SESSION 7. SATELLITE AND OTHER REMOTE SENSING APPLICATIONS TO HAZE/AEROSOL MONITORING (CONT'D)

WEST - Continental Room

8:20a.m. - 8:40a.m.
Control #44
Developing a High Spatial Resolution Aerosol Optical Depth Product Using MODIS Data for Evaluating Aerosol During Large Wildfire Events
Jennifer L. DeWinter, Sonoma Technology, Inc., Petaluma, CA

8:40a.m. - 9:00a.m.
Control #55
Understanding the Spatial Resolution of Satellite Observations of Aerosols: the Example of MODIS
Edward J. Hyer, Naval Research Laboratory, Monterey, CA

9:00a.m. - 9:20a.m.
Control #81
Airborne High Spectral Resolution Lidar Measurements Relevant to Air Quality
Michael D. Obland, NASA Langley Research Center, Hampton, VA

9:20a.m. - 9:40a.m.
Control #93
Remote Sensing of Surface Visibility from Space: An East Coast Case Study
Amy L. Kessner, Department of Earth and Atmospheric Sciences, University of Nebraska - Lincoln, Lincoln, NE

9:40a.m. - 10:00a.m.
Break
Glacier Room

SESSION 6B. INFORMATION AND TECHNOLOGY NEEDS FOR FUTURE REVISIONS OF THE SECONDARY PM NAAQS

EAST - Continental Room
Session Chairs:
Naresh Kumar, *EPRI*
Marc Pitchford, *Desert Research Institute*

10:00a.m. - 10:20p.m.
Control #88
A Test of the Scientific Validity of the Visual Air Quality "Preference Study" Method
Anne E. Smith, NERA Economic Consulting, Washington, DC

SESSION 8. AEROSOL - OPTICAL RELATIONSHIPS

WEST - Continental Room
Session Chairs:
Ivar Tombach, *Consultant*
Hans Moosmuller, *Desert Research Institute*

10:00a.m. - 10:20p.m.
Control #7
Long-term Trends and Characteristics of Visibility in Two Megacities of Southwest China: Chengdu and Chongqing
Yuan Chen, College of Environmental Science and Enginering, Peking University, Beijing, China

TECHNICAL PROGRAM - Wednesday, September 26, 2012

TRACK A

SESSION 9. PANEL DISCUSSION: SCIENTIFIC ISSUES AND INFORMATION FOR A VISIBILITY-RELATED PM2.5 NAAQS

EAST - Continental Room

Session Chairs:
Marc Pitchford, *Desert Research Institute*
Richard Poirot, *Vermont Department of Environmental Conservation*

10:20a.m. - 12:00p.m.
Panelists:
John Watson, *Desert Research Institute*
Bill Malm, *Cooperative Institute for Research in the Atmosphere*
John Molenar, *Air Resources Specialist Inc.*
Phil Hopke, *Clarkson University*

TRACK B

SESSION 8. AEROSOL - OPTICAL RELATIONSHIPS (CONT'D)

WEST - Continental Room

10:20a.m. - 10:40p.m.
Control #9
Characterizations of Secondary Aerosol and its Extinction Effects on Visibility over Pearl River Delta Region, China
Xuejiao Deng, Institute of Tropical and Marine Meteorology, China Meteorological Administration, Guangzhou, China

10:40a.m. - 11:00p.m.
Control #45
Analysis of Measurements of Atmospheric Aerosol Composition and Optical Properties in the Southeastern US
Ivar Tombach, Consultant, Camarillo, CA

11:00a.m. - 11:20p.m.
Control #48
Characterizations Analysis of Sulfur Dioxide and Sulfate during Low Visibility Periods Over Pearl River Delta Region, China
Fei Li, Institute of Tropical and Marine Meteorology/ Key Open Laboratory for Tropical Monsoon, China Meteorological Administration, Guangzhou, China

11:20a.m. - 11:40p.m.
Control #60
Single Scattering Albedo of Fine Mineral Dust Aerosols Controlled by Iron Concentration
Hans Moosmüller, Desert Research Institute, Nevada System of Higher Education, Reno, NV

11:40a.m. - 12:00p.m.
Control #127
Molecular Structure and Light Absorption by Carbonaceous PM
Brooke L. Hemming, US EPA National Center for Environmental Assessment, Global Change Research Program, RTP, NC

12:15p.m - 6:30p.m.
Box Lunch and Excursion to Glacier National Park
Details on page 3

7:30p.m. - 10:30p.m.
Night Sky Visibility Program
Details on page 3
May be shifted to Tuesday or Thursday evening if cloud cover requires

FINAL PROGRAM

TECHNICAL PROGRAM - Thursday, September 27, 2012

7:00a.m. - 5:00p.m.
Conference Registration
Foyer outside of Continental Divide

7:00a.m. - 8:00a.m.
Continental Breakfast
Pavillion

TRACK A

SESSION 10A. AEROSOL AND VISIBILITY MODELING AT GLOBAL, REGIONAL AND LOCAL SCALES

EAST - Continental Room
Session Chairs:
Brian Meland, *University of Colorado - Boulder*
Joe Scire, *Exponent*

8:00a.m. - 8:20a.m.
Control #94
Global Analyses and Forecasts of Aerosol Impacts on Visibility
Douglas L. Westphal, Naval Research Laboratory, Monterey, CA

8:20a.m. - 8:40a.m.
Control #4
Using the GEOS-Chem Adjoint Model to Determine the Sensitivity of Top of Atmosphere Polarizations to Aerosol Emissions
Brian S. Meland, University of Colorado-Boulder, Mechanical Engineering Dept., Boulder, CO

8:40a.m. - 9:00a.m.
Control #111
California's Impact on Grand Canyon Visibility Since 1980
Rob Farber, Southern California Edison, Rosemead, CA

9:00a.m. - 9:20a.m.
Control #63
Impacts of Future Changes in Climate, Emissions and Land Cover and Land Use on PM2.5 and O3 over the U.S.
Maria Val Martin, Atmospheric Science Department, Colorado State University, Fort Collins, CO

9:20a.m. - 9:40a.m.
Control #84
Accuracy of Visibility Protocol Modeling in BART Evaluations
Gale F Hoffnagle, TRC Environmental Corporation, Windsor, CT

TRACK B

SESSION 11. AEROSOL, OPTICAL AND RADIOMETRIC MONITORING METHODS

WEST - Continental Room
Session Chair:
Chuck McDade, *University of California, Davis*

8:00a.m. - 8:20a.m.
Control #14
A Long Record of Light Absorption by Sampled Fine Particulate Matter
Warren H. White, Crocker Nuclear Laboratory, University of California, Davis, Davis, CA

8:20a.m. - 8:40a.m.
Control #23
Measurement Uncertainty in IMPROVE Aluminum and Silicon Concentrations when Sulfur Concentrations are High
Ann M. Dillner, IMPROVE Program, Crocker Nuclear Laboratory, University of California Davis, Davis, CA

8:40a.m. - 9:00a.m.
Control #97
LPV-4 LED Transmissometer
John V. Molenar, Air Resource Specialists, Inc., Fort Collins, CO

SESSION 12. HUMAN PERCEPTION OF VISIBILITY

WEST - Continental Room
Session Chair:
William C. Malm, *Colorado State University*

9:00a.m. - 9:20a.m.
Control #56
A Review of Old Visibility Metrics and a Proposal of a New Metric
William C. Malm, Cooperative Institute for Research in the Atmosphere, Colorado State University, Fort Collins, CO

9:20a.m. - 9:40a.m.
Control #95
Effect of Clouds on the Perception of Regional and Urban Haze
John V. Molenar, Air Resource Specialists, Inc., Fort Collins, CO

TECHNICAL PROGRAM - Thursday, September 27, 2012

TRACK A

SESSION 10A. AEROSOL AND VISIBILITY MODELING AT GLOBAL, REGIONAL AND LOCAL SCALES (CONT'D)

EAST - Continental Room

9:40a.m. - 10:00a.m.
Control #73
A Recommended Method to Disclose Visibility Impacts For NEPA Analyses
Courtney A. Taylor, AECOM, Fort Collins, CO

TRACK B

SESSION 12. HUMAN PERCEPTION OF VISIBILITY (CONT'D)

WEST - Continental Room

9:40a.m. -10:00a.m.
Control #106
Towards a Visibility Management Program in British Columbia: The Development of a Visual Air Quality Index for the Lower Fraser Valley
Steven K Sakiyama, Air Protection Section, British Columbia Ministry of Environment, Victoria, BC, Canada

10:00a.m. - 10:20a.m.
Break
Glacier Room

SESSION 13. PANEL DISCUSSION: IMPLEMENTING VISIBILITY REGULATIONS: POLICY & TECHNICAL ISSUES

EAST - Continental Room
Session Chairs:
C.V. Mathai, *Arizona Public Service Company*

10:20a.m. -12:00a.m.
Panelists:
Tom Moore, *Western Governors' Association*
Frank Prager, *Xcel Energy*
Pat Brewer, *National Park Service*
Anne Hedges, *Montana Environmental Information Center, Montana*
Additional panelist to be determined

SESSION 14. CRITICAL LOADS AND ATMOSPHERIC DEPOSITION TECHNIQUES IN DEVELOPING AND IMPLEMENTING DEPOSITION BASED AIR QUALITY STANDARDS

WEST - Continental Room
Session Chairs:
Rich Scheffe, *EPA*
Richard Poirot, *Vermont Department of Environmental Conservation*

10:20a.m. -10:40a.m.
Control #22
Technical And Policy Challenges in Developing A Secondary Air Quality Standard for Aquatic Acidification
Richard Scheffe, U.S. Environmental Protection Agency, Office of Air and Radiation

10:40a.m. -11:00a.m.
Control #47
Nitrogen Research Contributions to Critical Loads Science and Policy
Tamara F. Blett, National Park Service, Air Resources Division, Lakewood, CO

11:00a.m. -11:20a.m.
Control #89
Improvements in Critical Load Estimation: Effect of Natural Organic Acids and Base Cation Supply Rate
Eladio M. Knipping, Electric Power Research Institute (EPRI), Washington, DC

FINAL PROGRAM

TECHNICAL PROGRAM - Thursday, September 27, 2012

TRACK A

TRACK B

SESSION 14. CRITICAL LOADS AND ATMOSPHERIC DEPOSITION TECHNIQUES IN DEVELOPING AND IMPLEMENTING DEPOSITION BASED AIR QUALITY STANDARDS (CONT'D)
WEST - Continental Room

11:20a.m. -11:40a.m.
Control #98
Stable Nitrogen Isotopic Signatures as Potential Source Tracers for Nitrate Deposition: The Signature of Coal-Fired Power Plant NOx
Naresh Kumar, Electric Power Research Institute, Palo Alto, CA

11:40a.m. -12:00p.m.
Control #110
Development of the Next Generation of Flux Measurement Tools
Michael P. Hannigan, Mechanical Engineering Department, University of Colorado, Boulder, CO

12:00p.m - 1:30p.m.
Lunch
Pavillion
Speaker:
Mark Biel, *Natural Resources Program at Glacier National Park*

SESSION 15. HAZE RULE 2013 CHECK-IN AND 2018 PLANNING MILESTONES TO ACHIEVE THE U.S. NATIONAL VISIBILITY GOAL
EAST - Continental Room
Session Chairs:
C.V. Mathai, *Arizona Public Service Company*
Tom Moore, *Western Governors' Association*

1:30p.m. - 1:50p.m.
Control #86
Critical Review Update: Visibility Science and Regulation
John G. Watson, Desert Research Institute, Reno, NV

1:50p.m. - 2:10p.m.
Control #53
The Regional Haze Rule Reasonable Progress Report Project for 116 Western Class I Areas
Cassie Archuleta, Air Resource Specialists, Inc. (ARS), Fort Collins, CO

SESSION 10B. AEROSOL AND VISIBILITY MODELING AT GLOBAL, REGIONAL AND LOCAL SCALES
WEST - Continental Room
Session Chairs:
Brian Meland, *University of Colorado - Boulder*
Joe Scire, *Exponent*

1:30p.m. - 1:50p.m.
Control #112
Estimating Surface Visibility at Hong Kong from Ground-based LIDAR, Sun Photometer and Operational MODIS Products
Muhammad I. Shahzad, The Hong Kong Polytechnic University, Department of Land Surveying and Geo-Informatics, Hung Hom, Kowloon, Hong Kong, China

1:50p.m. - 2:10p.m.
Control #105
Evaluation of CALPUFF with the CAPTEX Tracer Dataset
Jelena Popovic, Exponent, Inc., Natick, MA

TECHNICAL PROGRAM - Thursday, September 27, 2012

TRACK A

SESSION 15. HAZE RULE 2013 CHECK-IN AND 2018 PLANNING MILESTONES TO ACHIEVE THE U.S. NATIONAL VISIBILITY GOAL (CONT'D)

EAST - Continental Room

2:10p.m. - 2:30p.m.
Control #91
Comparative Analysis of 2005-09 "1st Progress Period" and 2000-04 "Baseline" Regional Haze Rule Metrics
S. A. Copeland, CIRA/USDA Forest Service, Lander, WY

2:30p.m. - 2:50p.m.
Control #79
Regional Haze Progress Assessment 2000-2010
Patricia Brewer, National Park Service, Denver, CO

2:50p.m. - 3:10p.m.
Control #28
Use of SEARCH Oak Grove Data for Estimating Ambient NH3 Concentrations over the GoM
John J. Jansen, Southern Company Services, Inc., Birmingham, AL

SESSION 16. ASSESSMENT OF HAZE FROM NATURAL SOURCES

EAST - Continental Room
Session Chair:
Tom Moore, *Western Governors' Association*

3:10p.m. - 3:30p.m.
Control #66
Long Term Dust Aerosol Production from Natural Sources in Iceland
Pavla Dagsson-Waldhauserova, The University of Iceland, Reykjavik, Iceland

TRACK B

SESSION 17. AEROSOL EFFECTS ON HAZE, DIRECT AND INDIRECT FORCING

WEST - Continental Room
Session Chairs:
Philip Hopke, *Clarkson University*
Bilkis Begum, *Atomic Energy Center*

2:10p.m. - 2:30p.m.
Control #64
Hygroscopicity of Fossil Fuel Combustion Aerosols: Characterization and Effects on Clouds in Global Modeling
Olga Popovicheva, Moscow State University, Moscow, Russia

2:30p.m. - 2:50p.m.
Control #107
Direct Radiative Forcing Due to Regional Formation of Sulfate from Reactions of SO2 with Criegee Biradicals
Qi Ying, Zachry Department of Civil Engineering, Texas A&M University, College Station, TX

2:50p.m. - 3:10p.m.
Control #102
Physical Responses of Clouds to the Direct and Indirect Climate Forcing of Soot and Smoke Aerosols
Eric M. Wilcox, Division of Atmospheric Sciences, Desert Research Institute, Reno NV

3:10p.m. - 3:30p.m.
Control #129
The Physical Properties of Black Carbon and Other Light-Absorbing Material Emitted from Prescribed Fires in the US
Gavin R. McMeeking, Dept. of Atmospheric Science, Colorado State University, Fort Collins, CO

3:30p.m. - 3:50p.m.
Break
Upper Glacier Room

FINAL PROGRAM

TECHNICAL PROGRAM - Thursday, September 27, 2012

3:30p.m. - 5:30p.m.
Poster Session
Upper Glacier Room

SESSION 1A. AEROSOL AND VISIBILITY FIELD STUDIES AND MONITORING NETWORKS

Control #25
Identifying Sources of Uncertainty Using Covariance Analysis
Nicole Pauly Hyslop, Crocker Nuclear Laboratory, University of California, Davis, Davis, CA

Control #29
Tempo-spatial Variation of Anthropogenic VOCs Emissions in China, 1978-2008
Yu Bo, College of Environmental Sciences and Engineering, Peking University, Beijing, China

Control #41
Estimates of Urban Excess in PM2.5 Speciated Aerosol Concentrations Using the CSN and IMPROVE Networks
Jenny L. Hand, Cooperative Institute for Research in the Atmosphere (CIRA), Colorado State University, Fort Collins, CO

Control #43
A New Approach for XRF Analysis in IMPROVE
Charles McDade, Crocker Nuclear Laboratory, University of California, Davis, Davis, CA

Control #52
Natural Events Affecting Phoenix Arizona's Air Quality
Scott Cismoski, Air Resource Specialists, Inc., Fort Collins, CO

Control #113
Characteristics of Typical Haze Pollution Events in Yangtze River Delta: Results from a Regional Joint Campaign
Zhen Cheng, School of Environment, Tsinghua University, Beijing, China

Control #130
Impacts of Aerosol Compositions on Visibility Impairment in Xi'an, China
Jun-ji Cao1, Key Laboratory of Aerosol, SKLLQG, Institute of Earth Environment, Chinese Academy of Sciences, Xi'an, China

Control #131
Preliminary Analysis of Winter Visibility Variation in Xi'an, China
Yichen Wang, Key Laboratory of Aerosol, SKLLQG, Institute of Earth Environment, Chinese Academy of Sciences, Xi'an, China

SESSION 2. NEW AND CURRENT FIELD MONITORING TECHNIQUES FOR MEASURING BLACK CARBON AND AEROSOL ORGANIC MATERIAL

Control #30
Uncertainty in the Carbon Fraction Distribution on Filters Used for Artifact Correction in the IMPROVE Network Filters
Ann M. Dillner, Crocker Nuclear Laboratory, University of California Davis, Davis CA

Control #38
Discrimination Between Biomass and Fossil Fuel Combustion Using the "Aethalometer Ångström Model": Influence on Air Quality in Different Environments
Griša Močnik, Aerosol d.o.o., Ljubljana, Slovenia

Control #59
Review of Aerosol Light Absorption Measurement
Hans Moosmüller, Desert Research Institute, Nevada System of Higher Education, Reno, NV

Control #61
Development of a Supercontinuum Photoacoustic Aerosol Absorption and Albedo Spectrometer for the Characterization of Aerosol Optics
Hans Moosmüller, Desert Research Institute, Nevada System of Higher Education, Reno, NV

Control #83
Improved Instrument for Measurement of Aerosol Black Carbon with Real-Time Compensation for Filter Loading Effects
Anthony D. A. Hansen, Magee Scientific, Berkeley, CA

SESSION 3A. BLACK CARBON EMISSIONS IN DEVELOPED AND DEVELOPING COUNTRIES

Control #5
Concentrations of Particulate Matter from an Iron-Smelting Plant Located Along a Busy Highway in Southwestern Nigeria
Kayode, O. OWOADE, Department of Physics, Obafemi Awolowo University, Ile-Ife, Nigeria

Control #108
Black Carbon Emission from Barbeque Activities during College Football Games
Qi Ying, Zachry Department of Civil Engineering, Texas A&M University, College Station, TX

TECHNICAL PROGRAM - Thursday, September 27, 2012

3:30p.m. - 5:30p.m.
Poster Session
Upper Glacier Room

SESSION 5. BIO MASS BURNING, CARBONACEOUS AEROSOLS AND SHORT LIVED CLIMATE FORCERS EFFECTS ON HAZE AND CLIMATE

Control #12
Data Processing Technique for Multiangle Lidar Sounding of Poorly Stratified Polluted Atmospheres. Theory and Experiment
Cyle E. Wold, USDA Forest Service, Missoula Fire Sciences Lab., Missoula, MT

Control #65
Aerosols during Moscow extreme smoke event of August 2010: physico-chemistry and long range transport in Europe
Olga Popovicheva, Moscow State University, Moscow, Russia

Control #120
Carbonaceous Aerosol Determination in an Urban and a Rural Site in the Philippines
Angel T. Bautista VII, Philippine Nuclear Research Institute, Commonwealth Ave., Diliman, Quezon City, Philippines, Institute of Environmental Science and Meteorology, University of the Philippines, Diliman, Quezon City, Philippines

Control #132
High Park Fire 2012 Smoke Impacts on Air Quality in Fort Collins, Colorado
Christian M. Carrico, AECOM, Inc., Fort Collins, CO

Control #135
PM2.5 Emissions from wood burning in Butte, Montana
Kumar Ganesan, Department of Environmental Engineering, Montana Tech of the University of Montana, Butte, Montana

SESSION 8. AEROSOL - OPTICAL RELATIONSHIPS

Control #10
Studies of infrared and visible optical properties of mineral dust
Jennifer M. Alexander, Department of Physics and Astronomy, University of Iowa, Iowa City, IA

Control #39
Visualization of Visibility Conditions Associated with Temporal Trends in Light Extinction Coefficients for Remote and Rural Aerosols Simulated using WinHaze
Jenny L. Hand, Cooperative Institute for Research in the Atmosphere (CIRA), Colorado State University, Fort Collins, CO

SESSION 8. AEROSOL - OPTICAL RELATIONSHIPS (CONT'D)

Control #103
Organic Material to Organic Carbon Mass Ratio Inferred from Speciated PM2.5 Measurements in the Southeastern United States
Stephanie L. Shaw, Electric Power Research Institute, 3420 Hillview Ave., Palo Alto, CA

SESSION 12. HUMAN PERCEPTION OF VISIBILITY

Control #126
Linking Visual Range, PM2.5 Concentrations and the Air Quality Index - What do we tell the Public in Smoke-Filled Wildfire Situations?
Susan M. O'neill, USDA Forest Service, Seattle, WA

SESSION 15. HAZE RULE 2013 CHECK-IN AND 2018 PLANNING MILESTONES TO ACHIEVE THE U.S. NATIONAL VISIBILITY GOAL

Control #99
Using MOVES in Support of Hawaii's Regional Haze Rule FIP Development
W. Seth Hartley, ICF International, 620 Folsom St., San Francisco, CA

Control #133
Best Available Retrofit Technology (BART) Analyses for Three Arizona Power Plants
Uma Shankar, University of North Carolina at Chapel Hill-Institute for the Environment, Chapel Hill, NC

Control #134
Predicted BART Visibility Benefits – Real or Illusion?
Sara J. Head, AECOM, Camarillo, CA

SESSION 16. ASSESSMENT OF HAZE FROM NATURAL SOURCES

Control #109
Volcanic Contributions to Haze at Hawaii Volcanoes and Haleakala National Parks
Patricia F. Brewer, National Park Service, Air Resources Division, Denver, CO

FINAL PROGRAM

TECHNICAL PROGRAM - Thursday, September 27, 2012

3:30p.m. - 5:30p.m.
Poster Session
Upper Glacier Room

SESSION 17. AEROSOL EFFECTS ON HAZE, DIRECT AND INDIRECT FORCING

Control #3
Vibrational Spectroscopy and Quantum Mechanics Calculations of Nitric Acid Chemisorbed on γ-Al2O3 and TiO2
Juan G. Navea, Chemistry Department, Lawrence University, Appleton, WI

SESSION 20. SOURCE ATTRIBUTION OF AEROSOL AND HAZE

Control #18
Source Signatures of Atmospheric Carbonaceous Matter in Urban-Industrial Environment of Central India
ShamshPervez, School of Studies in Chemistry, Pt. RavishankarShukla University, Raipur, India

TECHNICAL PROGRAM - Friday, September 28, 2012

7:00a.m. - 12:00p.m.
Conference Registration
Foyer outside of Continental Divide

7:00a.m. - 8:00a.m.
Continental Breakfast
Pavillion

TRACK A

SESSION 18. POTENTIAL IMPACTS OF EMISSIONS FROM OIL AND GAS FIELDS ON VISIBILITY AND HAZE

EAST - Continental Room
Session Chairs:
Delbert Eatough, *Brigham Young University*
Courtney Taylor, *AECOM*

8:00a.m. - 8:20a.m.
Control #96
Winter Photochemical Ozone Events in the Upper Green River Basin
John V. Molenar, Air Resource Specialists, Inc., Fort Collins, CO

8:20a.m. - 8:40a.m.
Control #85
Implications of Oil and Gas Emissions Inventory Methodology Differences
Courtney A. Taylor, AECOM, Fort Collins, CO

TRACK B

SESSION 19A. ATMOSPHERIC NITROGEN - A BRIDGE BETWEEN VISIBILITY, ECOLOGICAL AND AGRICULTURAL ISSUES

WEST - Continental Room
Session Chairs:
Jeffery Collett, *Colorado State University*
Bret Schichtel, *National Park Service*

8:00a.m. - 8:20a.m.
Control #71
Measurements of Reactive Nitrogen in Grand Teton National Park
Anthony J. Prenni, Atmospheric Science Department, Colorado State University, Fort Collins, CO

8:20a.m. - 8:40a.m.
Control #72
Nitrogen Deposition in the Grand Tetons a Temporal and Spatial Perspective
Derek E. Day, Cooperative Institute for Research in the Atmosphere (CIRA), Fort Collins,CO

TECHNICAL PROGRAM - Friday, September 28, 2012

TRACK A

SESSION 18. POTENTIAL IMPACTS OF EMISSIONS FROM OIL AND GAS FIELDS ON VISIBILITY AND HAZE (CONT'D)

EAST - Continental Room

8:40a.m. - 9:00a.m.
Control #124
A Comprehensive Emissions Inventory of Upstream Oil and Gas Activities in the Rocky Mountain States
Amnon Bar-Ilan, ENVIRON International Corporation, Novato, CA

9:00a.m. - 9:20a.m.
Control #123
Measurements of Wintertime Organic Aerosol Formation in Utah's Uintah Basin Oil and Gas Fields
Shane M. Murphy, Department of Atmospheric Science, University of Wyoming, Laramie, WY

9:20a.m. - 9:40a.m.
Control #128
2012 Uinta Basin Winter Ozone Study
Seth N. Lyman, Utah State University Office of Commercialization and Regional Development, Vernal, UT

9:40a.m. - 10:00a.m.
Control #90
Upper Green River Basin Winter Ozone Study
Till Stoeckenius, ENVIRON International Corporation, Novato, CA

TRACK B

SESSION 19A. ATMOSPHERIC NITROGEN - A BRIDGE BETWEEN VISIBILITY, ECOLOGICAL AND AGRICULTURAL ISSUES (CONT'D)

WEST - Continental Room

8:40a.m. - 9:00a.m.
Control #51
Organic Nitrogen Concentrations and Species in Aerosol and Precipitation Samples from the Rocky Mountains
Katherine B. Benedict, Department of Atmospheric Science, Colorado State University, Fort Collins, CO

9:00a.m. - 9:20a.m.
Control #57
Source Apportionment of Ammonia at Rocky Mountain National Park using Modeled Conservative Tracer Releases
William C. Malm, Cooperative Institute for Research in the Atmosphere, Colorado State University, Fort Collins, CO

9:20a.m. - 9:40a.m.
Control #100
Spatial and Temporal Sensitivities in Results of Back-Trajectory Based Receptor Models as Applied to the Rocky Mountain Atmospheric Nitrogen and Sulfur Study Part II (RoMANS II)
Kristi A. Gebhart, Air Resources Division, National Park Service

9:40a.m. - 10:00a.m.
Control #62
Modeling the Fate of Atmospheric Reduced Nitrogen in the Western United States During the Rocky Mountain Atmospheric Nitrogen and Sulfur Study Part II (RoMANS II)
Marco A. Rodriguez, AECOM, Fort Collins, CO

10:00a.m. - 10:20a.m.
Break
Glacier Room

FINAL PROGRAM

TECHNICAL PROGRAM - Friday, September 28, 2012

TRACK A

SESSION 20. SOURCE ATTRIBUTION OF AEROSOL AND HAZE

EAST - Continental Room
Session Chairs:
John Watson, *Desert Research Institute*

10:20a.m. - 10:40a.m.
Control #1
Effect of Change in Cookstove Types on Visibility - Case Study of the Berkeley-Darfur Stove and Three-Stone Fire
Yungang Wang, Lawrence Berkeley National Laboratory, Berkeley, CA

10:40a.m. - 11:00a.m.
Control #27
Regional Ozone, Particulate Matter and Visibility Source Apportionment Modeling of the Western United States
Ralph Morris, ENVIRON International Corporation, Novato, CA

11:00a.m. - 11:20a.m.
Control #92
Source Apportionment of Primary and Secondary Fine Particles; a Hybrid Model
Timothy M. Sturtz, Civil & Environmental Engineering, University of Washington, Seattle, WA

11:20a.m. - 11:40a.m.
Control #101
Source Apportionment Studies Focused on Wood Smoke in the Northern Rockies and Fairbanks, Alaska
Tony J. Ward, The University of Montana, Center for Environmental Health Sciences, Missoula, MT

11:40a.m. - 12:00a.m.
Control #116
Success in Reducing PM2.5 in the Neighborhood North of the Houston Ship Channel – Voluntary Efforts Based on Field Study Results and Source Attribution
James H. Price, Texas Commission on Environmental Quality, Austin TX

12:00a.m. - 12:20a.m.
Control #122
Evaluation of PM2.5 and PM10 Mass Closure Formulae
Judith C. Chow, Desert Research Institute, Reno, NV

TRACK B

SESSION 19B. ATMOSPHERIC NITROGEN - A BRIDGE BETWEEN VISIBILITY, ECOLOGICAL AND AGRICULTURAL ISSUES

WEST - Continental Room
Session Chairs:
Jeffery Collett, *Colorado State University*
Bret Schichtel, *National Park Service*

10:20a.m. - 10:40a.m.
Control #19
A Pilot Monitoring Study of Atmospheric NHx at Selected IMPROVE sites
Jeffrey L. Collett, Jr.1, Atmospheric Science Department, Colorado State University, Fort Collins, CO

10:40a.m. - 11:00a.m.
Control #67
Nitrate in the Southeastern U.S: Have Concentrations Increased Over Time?
Eric S. Edgerton, Atmospheric Research & Analysis, Inc., Cary, NC

11:00a.m. - 11:20a.m.
Control #32
The Effect of a Large Scale Poultry Cull on Ambient Ammonia, PM2.5 and Visibility in the Lower Fraser Valley, B.C., Canada
Keith Jones, Environment Canada, Vancouver, BC, Canada

EXHIBITION

LOCATION
Glacier Room

EXHIBITION HOURS
Tuesday, September 25 ..... 8:00 am – 7:00 pm
Wednesday, September 26 ..... 8:00 am – 12:00 pm
Thursday, September 27 ..... 8:00 am – 5:30 pm
Friday, September 28 ..... 8:00 am – 12:00 pm

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Abstracts from the 2012 Whitefish Conference

Both the Abstracts for a Given Session and the Associated Poster Sessions are Given Under the Session Number

Track A

Session 1A: Aerosol and Visibility Field Studies and Monitoring Networks

Control Number 40

Temporal trends in urban and rural particulate sulfate ion concentrations across the United States.

Jenny L. Hand Cooperative Institute for Research in the Atmosphere (CIRA), Colorado State University, Fort Collins, CO, **Bret A. Schichtel** National Park Service, Air Resource Division, CIRA, Colorado State University, Fort Collins, CO, **William C. Malm** Cooperative Institute for Research in the Atmosphere (CIRA), Colorado State University, Fort Collins, CO, **Marc Pitchford** Division of Atmospheric Sciences, Desert Research Institute, Reno, NV

We examined particulate sulfate ion concentrations across the United States from 1989–2010 using remote data from the Interagency Monitoring of Protected Visual Environments (IMPROVE) network, and from 2000–2010 using data from the Environmental Protection Agency's (EPA) urban Chemical Speciation Network (CSN). Measured sulfur dioxide (SO_2) emissions from power plants from 1995–2010 from the EPA's Acid Rain Program were also examined. The IMPROVE long-term (1989–2010) annual mean particulate sulfate ion concentrations have decreased significantly across the United States (-1.8% yr^{-1}). Statistically significant short-term (2000–2010) urban and rural trends were quite similar across the United States (-3.9% yr^{-1} and -4.2% yr^{-1}, respectively). In addition, short-term total annual SO_2 emissions from power plants across the United States have decreased at a similar rate (-4.9% yr^{-1}); comparisons between the two trends revealed a linear relationship. Annual mean short-term sulfate ion concentrations decreased more rapidly in the East relative to the West due to differences in seasonal behavior at certain regions in the West. Specifically, positive wintertime trends in the central and northern Great Plains and positive springtime trends in the western United States were observed. These positive trends could not be explained by changes in local and regional power plant SO_2 emissions, suggesting that other influences lead to increases in sulfate ion concentrations. This work implies that on annual mean basis across the United States, air quality mitigation strategies have been successful in reducing the particulate loading of sulfate in the atmosphere; however, for certain seasons and regions, especially in the West, current mitigation strategies appear insufficient.

Control Number 24

Reanalysis of a 15-year archive of IMPROVE samples

Nicole P. Hyslop[1], Warren H. White[1], and Krystyna Trzepla[1]

[1]Crocker Nuclear Laboratory, University of California, One Shields Ave, Davis, CA 95616
Principal contact: Nicole P. Hyslop, Academic Coordinator, Crocker Nuclear Laboratory, University of California, One Shields Ave, Davis, CA 95616, (530)754-8979, nmhyslop@ucdavis.edu

The IMPROVE (Interagency Monitoring of PROtected Visual Environments) network monitors aerosol concentrations at about 170 rural or remote sites throughout the United States. Twenty-four-hour filter samples of fine particulate matter ($PM_{2.5}$) are collected every third day and analyzed for elements, ions,

carbon, and total mass. About 30 of these sites have operated continuously since 1988, and the sustained data record (http://views.cira.colostate.edu/web/) offers a unique window on regional aerosol trends through a period of changing anthropogenic and natural emissions.

For the elemental measurements, the same sampling conditions have been maintained throughout the program. All elemental analyses have been performed by Crocker Nuclear Laboratory at the University of California in Davis, and all original sample filters collected since 1995 are archived on campus. The suite of reported elements has remained constant, but the analytical methods employed for their determination have evolved. For example, the elements Na – Mn were determined by PIXE through November 2001, by XRF analysis in a He-flushed atmosphere from December 2001 through December 2004, and by XRF analysis in vacuum since January 2005. In addition to these fundamental changes, incompletely-documented operational factors such as detector performance and calibration details have introduced variations in the measurements.

Because the past analytical methods were all non-destructive, the archived filters can be re-analyzed with the current analytical systems and protocols. The 15-year sample archives from Great Smoky Mountains National Park, Mount Ranier National Park, and Point Reyes National Seashore were recently selected to generate such analytically homogeneous data series. For each site, the complete historical series of consistently collected samples was processed in a single analytical batch. The agreement between the new analyses and original determinations varies with element and analytical era, as illustrated in Figure 1.

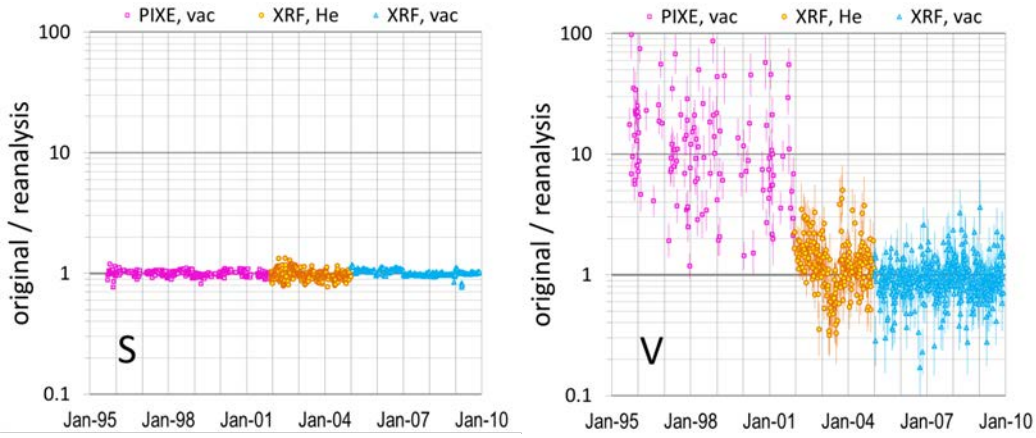

Figure 1. Long-term repeatability of analyses for sulfur and vanadium. Each point represents one 24h $PM_{2.5}$ filter sample from Great Smoky Mountains National Park, and shows the ratio of mass loadings (g/g) determined by the original analysis, performed shortly after sampling, and recent reanalysis with current system and protocol. Sample dates are indicated at the bottom, and major method distinctions are indicated at the top.

Control Number 118

Long term trend analysis of aerosol optical properties at GAW and IMPROVE stations

M. Collaud Coen[1], E. Andrews[2], A. Asmi[3], M. Fiebig[4], A. M. Fjaera[4], P. Laj[5], C. Lund-Myhre[4], J. A. Ogren[2], J.-P. Putaud[6], P. Sheridan[2], A. Virkkula[3], A. Wiedensohler[7], and E. Weingartner[8]

[1]MeteoSwiss, 1530 Payerne, Switzerland
[2]NOAA, Earth Systems Research Laboratory, Boulder, Colorado, 80305, USA
[3]Department of Physics, University of Helsinki, P.O. Box 64, Helsinki, Finland

[4]Norwegian Institute for Air Research Instituttveien 18, 2027 Kjeller, Norway
[5]Lab. de Glaciologie et Géophys. de l'Environ., University of Grenoble, 38 402 St Martin d'Hères Cedex, France
[6]European Commission, Joint Research Centre, 21027, Ispra, Italy
[7]Leibniz Institute for Tropospheric Research, 04318 Leipzig, Germany
[8]Laboratory of Atmospheric Chemistry, Paul Scherrer Institut, 5232 Villigen, Switzerland
Detecting trends of aerosol variables of interest to climate studies from in-situ, ground-based monitoring stations is not trivial. Few in-situ measurement records of the core aerosol/climate variables (absorption and scattering coefficients) exceed 10 years; this paper considers 10-year trends in light scattering and absorption from 20 and 8 stations, respectively. High natural variability on time scales ranging from years to hours as well as uncertainties caused by changes and biases in measurement methodology are a major limitation for deriving statistically relevant trends. An initiative being performed in the framework of the WMO-GAW programs, using new, quality-controlled information provided by NOAA, IMPROVE and EUSAAR/ACTRIS networks, is re-analyzing time series of aerosol variables in order to provide climate-relevant indications on long-term trends of some aerosol variables. Close collaboration with station operators allows identification of ruptures in the records, such as gaps, instrumental changes, or sampling protocol changes, which must be considered in the analysis.
Analyses of 10-year records for scattering coefficient show a general decrease that is most significant at the IMPROVE stations in the continental US. The decrease can be as high as 50%/decade, but for most stations is in the range of 10 to 20%/decade. These trends can be correlated with the decrease of sulfate concentrations in the eastern United States in the last two decades. In contrast, negative trends are not observed for Europe, which may be due to the EU sites being located at marine or high altitude locations. Preliminary results for absorption coefficients show that trends are generally negative, particularly at continental US and polar sites. Regardless of the overall tendency of the 10-year trends, analysis of trends for specific seasons reveals additional complexity of aerosol variability

Control Number13.

Sources of and trends in visibility reducing particles in the Lake Tahoe Basin, 1990-2009

Mark Green, L.W.- Antony Chen, Desert Research Institute, David W. DuBois, New Mexico State University, **John V. Molenar, Air Resource Specialists**

ABSTRACT

Speciated $PM_{2.5}$ data has been collected for about 20 years (1990- present) at a rural location in the Lake Tahoe Basin (Bliss State Park) and about 15 years (1989-2004) at an urban site in South Lake Tahoe. The Bliss State Park site is representative of the Desolation Wilderness, a Class I air quality area with visibility protection under the Clean Air Act. Carbonaceous aerosol dominated reconstructed fine mass at both sites with 58% at Bliss State Park (BLIS) and 68% at South Lake Tahoe (SOLA). Fine mass at SOLA is 2.5 times that at BLIS, mainly due to enhanced organic and elemental carbon (OC and EC). SOLA experiences a winter peak in $PM_{2.5}$ mainly due to OC and EC from residential wood combustion, while BLIS experiences a summer peak in $PM_{2.5}$ mainly due to OC and EC from wildfires. Carbonaceous aerosol dominates visibility impairment causing about ½ the reconstructed aerosol light extinction at BLIS and 70% at SOLA. Trend analysis (1990-2009) showed statistically significant decreases in aerosol extinction at BLIS on 20% best and 60% middle visibility days and statistically insignificant upward trends on 20% worst days. SOLA (1990-2003) showed statistically significant decreases in aerosol extinction for all day categories, driven by decreasing OC and EC. From the regional haze rule baseline period of 2000-2004 until 2005-2009, BLIS saw 20% best days improving and 20% worst days getting worse due to increased wildfire effects. Receptor modeling was performed using positive matrix factorization (PMF) and chemical mass balance (CMB). It confirmed that 1) biomass burning dominanted $PM_{2.5}$ sources at both sites with increasing importance over time; 2) low combustion

efficiency burning accounts for most of the biomass burning contribution; 3) road dust and traffic contributions were much higher at SOLA than at BLIS; 4) industrial combustion and salting were minor sources.

Control Number 76

Aerosol Measurements from the Southeastern Aerosol Research and Characterization (SEARCH) Study: PM Composition and Trends, 1999 - 2010

Charles L. Blanchard[1] and Eric S. Edgerton[2]

[1] Envair, 526 Cornell Avenue, Albany, CA 94706
[2] Atmospheric Research and Analysis, 410 Midenhall Way, Cary, NC 27513

Abstract

Since mid-1998, the Southeastern Aerosol Research and Characterization (SEARCH) study has operated eight extensively instrumented monitoring sites, comprising four urban/non-urban pairs, located inland and along the coast of the Gulf of Mexico in the southeastern U.S. Mean 1999 – 2010 $PM_{2.5}$ mass concentrations were 10.7 – 12.3 $\mu g\ m^{-3}$ at coastal sites and 11.5 – 16.5 $\mu g\ m^{-3}$ at inland sites, comprising 4.6 – 6.8 $\mu g\ m^{-3}$ inorganic species (40 – 50% of $PM_{2.5}$ mass), 4.0 – 7.9 $\mu g\ m^{-3}$ carbonaceous material (36 – 48% of $PM_{2.5}$ mass), and 0.3 – 1.0 $\mu g\ m^{-3}$ major metal oxides (MMO) (2.6 – 6.2% of $PM_{2.5}$ mass). Downward trends in ambient carbon monoxide (CO), sulfur dioxide (SO_2) and oxidized nitrogen species (NO_y) averaged 1.2 $\pm$ 0.4 to 9.7 $\pm$ 1.8 percent per year from 1999 to 2010. Downward trends in mean annual sulfate (SO_4) concentrations ranged from 3.7 $\pm$ 1.1 to 6.2 $\pm$ 1.1 percent per year. Mean annual organic matter (OM) and elemental carbon (EC) concentrations declined by 3.3 $\pm$ 0.8 to 6.5 $\pm$ 0.3 and 3.2 $\pm$ 1.4 to 7.8 $\pm$ 0.7 percent per year. Mean annual $PM_{2.5}$ mass concentrations declined by 1.7 $\mu g\ m^{-3}$ to 5.2 $\mu g\ m^{-3}$ at rural sites and by 3.0 $\mu g\ m^{-3}$ to 7.4 $\mu g\ m^{-3}$ at urban sites. From 2005 to 2009, network mean annual SO_4 concentrations declined from 4.2 $\pm$ 0.2 to 2.4 $\pm$ 0.09 $\mu g\ m^{-3}$ and remained at 2.4 $\pm$ 0.06 $\mu g\ m^{-3}$ in 2010. In contrast, network mean annual OM concentrations declined from 4.7 $\pm$ 0.4 to 3.0 $\pm$ 0.2 $\mu g\ m^{-3}$ from 2005 to 2009, then increased to 3.5 $\pm$ 0.3 $\mu g\ m^{-3}$ in 2010. Downward trends in concentrations of $PM_{2.5}$ mass, SO_4, OM, and EC were accompanied by declining mean annual particle light scattering from 2005 to 2010. Trends are interpreted in reference to weather and emission changes.

Control Number 125

AMS Measurements in National Parks of Aerosol Mass, Size and Composition, Comparison with Filter Samples and Correlation with Particle Hygroscopicity and Optical Extinction Properties

M. Lizabeth Alexander[1], Don R Collins[3], Naresh Kumar[4], Nathan Taylor[3], John Allen[5] Matthew Newburn[1], Douglas H Lowenthal[2], Barbara Zielinska[2]

1. EMSL, Pacific Northwest National Laboratory, Richland, WA, USA.
2. Division of Atmospheric Sciences, Desert Research Institute, Reno, NV, USA.
3. Atmospheric Institute, Texas A&M University, College Station, TX, USA.
4. Air Quality Business Area, Electric Power Research Institute, Palo Alto, CA, USA
5. Arizona State University, Tempe, AZ, USA

We report a comparison of results from aerosol studies at Great Smoky Mountain National Park (2006), Mt. Rainier National Park (2009) and Acadia National Park (2011), all associated with class I visibility areas associated with IMPROVE (Interagency Monitoring of Protected Visual Environments) sites. The atmospheric aerosol composition in these sites is influenced by a number of anthropogenic as well as

biogenic sources, providing a rich environment for fundamental aerosol studies. The primary purpose of these studies was to add state-of-the-art aerosol instrumentation to the standard light extinction and aerosol measurements at the site, used to determine parameters for the "IMPROVE light extinction reconstruction equation", adopted by the EPA to estimate light extinction from atmospheric aerosol concentrations and Rayleigh scattering. The combination of these diverse measurements also provides significant insight into fundamental aerosol properties such as aging and radiative forcing. New instrumentation included a quadrupole aerosol mass spectrometer (Aerodyne Q-AMS-Smoky Mountain Study), a high resolution aerosol time-of-flight mass spectrometer (Aerodyne HR-ToF-AMS – Mt. Rainier and Acadia studies) for real time measurements that directly address the relationship between sulfate, nitrate, and OC size and concentration, which is related to cloud and dry gas-to-particle conversion as air masses age during transport, the relationship between WSOC hygroscopic growth and oxygenated organic (OOA) composition, the OCM/OC ratio, and the chemical composition that determines the ambient hygroscopic state. The OCM/OC ratio and organic water uptake was addressed with high-volume and medium volume PM2.5 aerosol samples. Aerosols were collected daily on Teflon coated glass fiber filters (TGFF) in four high-volume PM2.5 samplers operated by DRI. These measurements provide the fraction of total OC that is water-soluble. Ambient hydration state was determined in the field with an ambient state TDMA (AS-TDMA). Aerosols are classified at ambient RH with an ambient diameter of Da. Correlation of the hydration state with the size and composition determined by the AMS will be presented and correlated with standard optical extinction data from instrumentation located at these IMPROVE sites.

Session 1A: Aerosol and Visibility Field Studies and Monitoring Networks

Control Number 36

Characterizing the relationship between atmospheric visibility and pollutant sources in different weather conditions in Central Taiwan

Shih-Yu Chang, School of Public Health, Chung Shan Medical University, Taiwan

Control Number 37

Characteristics of typical haze pollution events in Yangtze River Delta: results from a regional joint campaign

Zhen Cheng[1], Jingkun Jiang[1], Shuxiao Wang[1], and Jiming Hao[1],

[1] School of Environment, State Key Joint Laboratory of Environment Simulation and Pollution Control, Tsinghua University, Beijing 100084, China

Abstract

Visibility of Yangtze River Delta, China is decreasing in recent years by meteorological sites long-term observation, and it has become a critical concerned issue, for either scientific workers, environmental policy makes or the public. To investigate the haze pollution in Yangtze River Delta, a regional joint campaign was conducted at five megacities (Shanghai, Nanjing, Suzhou, Hangzhou, and Ningbo) from 5/1/2011 to 1/31/2012. Particulate matter concentration (PM_{10} and $PM_{2.5}$), aerosol optical properties, visibility, and gaseous pollutants concentration (SO_2, NO_2, O3, VOCs, etc.) were measured using online instruments. Daily sampled filters were analyzed for $PM_{2.5}$ compositions including inorganic ions, OC/EC and trace elements. Haze pollution events happen frequently in Yangtze River Delta. There are often more than 100 days having haze pollution each year in these megacities. The average $PM_{2.5}$ concentration in six megacities is 67ug/m^3 during the sampling period. The average chemical

concentration of organic matter, elemental carbon, nitrate, sulfate, ammonium, fine soil is 18.4ug/m^3, 5.3ug/m^3, 10.3ug/m^3, 12.5ug/m^3, 10.7ug/m^3, and 3.1ug/m^3, respectively. The other of 7.4ug/m^3 is unidentified. During haze event, atmospheric visibility can be as low as 500m. Several typical haze pollution events are identified: northern dust storm transport with high coarse particle concentration (e.g., PM_{10}: 0.5~0.8mg/m^3, $PM_{2.5}$: 0.1~0.15mg/m^3) and high crustal element concentration such as Fe/Al/Ca; biomass burning induced haze with high $PM_{2.5}/PM_{10}$ ratio (e.g., 70-90%) and high concentration of potassium and levoglucosan; secondary aerosol formation with high $PM_{2.5}/PM_{10}$ ratio and high concentration of sulfate, nitrate, ammonium, and organic carbon. Meteorological conditions also contribute to the haze pollution events.

Session Associated Poster Presentation

Control Number 29

Tempo-spatial variation of anthropogenic VOCs emissions in China, 1978-2008

Yu Bo, Shaodong Xie
College of Environmental Science and Engineering, Peking University, Beijing 100871; China
E-mail: boyu@pku.edu.cn

Abstract: Volatile organic compounds (VOCs) play an important role in complex regional air pollution and threaten human health directly in China. Multiyear emission inventories of anthropogenic VOCs in China for 1978-2008 were established based on time-varying statistical data, literature surveyed and model calculated emission factors, which were further gridded at a high spatial resolution of 40 km×40 km using the GIS methodology. Results show that VOCs emissions in China was 25.96 Tg in 2008, including mobile source 7.90 Tg, industrial processes 6.58 Tg, solvent utilization 3.95Tg, biomass burning 3.82 Tg, and fossil fuel combustion 3.71 Tg. Motorcycles, industrial and commercial coal consumption, passenger cars, straw burning as fuel, heavy duty vans, biomass open burning, coke production, firewood burning, production of chemical materials and products, and architectural paint were primary emission sources, which generated more than 0.8 million tons, accounting for 61.70% in total emissions. China's VOCs emissions experienced a continuous growth during the period of 1978-2008, with the emission increasing by 3.68 times from 7.05 million tons in 1978 to 25.96 million tons in 2008. During the time, emissions experienced steady, fluctuating, and rapidly rising phases, which coincided well with China's economic growth, with a correlation coefficient of 98.27%. Besides, source contributions of VOCs emissions showed remarkable annual variation, the major emission sources changed from fossil fuel and biomass burning to mobile source, industrial processes, and solvent utilization. Mobile source had become the most important source since 2000. Spatial distribution of VOCs emissions illustrates that high emissions were mainly concentrated in developed regions of northern, eastern and southern coastal areas, which produced more emissions than the relatively underdeveloped western and inland regions. Particularly, developed area covering 12.20% of China's territory, generated 44.18%-51.62% of the total emissions. Highest emissions were concentrated in the Yangtze River Delta region, Beijing-Tianjin-Hebei region, and Pearl River Delta area, covering 2.34%, 1.06%, and 0.79% of China's territory, generating 13.20%, 8.95%, and 6.13% of the total emissions, respectively. Emission intensities were the highest in Yangtze River Delta and Pearl River Delta region, at 32.8 and 31.1 thousand tons per square kilometers, which were 12.18 and 11.54 times of the mean value. Annual variation of VOCs spatial distribution showed that the tendency of emission intensity and emission per capital were both increasing, and high emission intensity area expended year by year.
Keywords: VOCs, emission factors, emissions inventory, historical trend, spatial distribution

Control Number 41

Estimates of urban excess in $PM_{2.5}$ speciated aerosol concentrations using the CSN and IMPROVE networks.

Jenny L. Hand*
Cooperative Institute for Research in the Atmosphere (CIRA), Colorado State University, Fort Collins, CO, **Bret A. Schichtel** National Park Service, Air Resource Division, CIRA, Colorado State University, Fort Collins, CO, **William C. Malm** Cooperative Institute for Research in the Atmosphere (CIRA), Colorado State University, Fort Collins, CO, **Marc Pitchford**
Division of Atmospheric Sciences, Desert Research Institute, Reno, NV, **Neil H. Frank**
Air Quality Assessment Division, U.S. Environmental Protection Agency, Research Triangle Park, NC

ABSTRACT

The rural IMPROVE network (Interagency Monitoring of Protected Visual Environments) and EPA's urban Chemical Speciation Network (CSN) are two long-term monitoring networks that are responsible for measuring speciated $PM_{2.5}$ aerosol composition around the United States. The IMPROVE network was initiated in 1988 with the primary objectives of tracking spatial and temporal trends in visibility and identifying the aerosol species responsible for visibility degradation in protected federal areas. The CSN urban network began in early 2000 with the purpose of identifying sources, developing implementation plans, and supporting ongoing health effects research. Although the networks operate independently and for different purposes, both networks monitor the same major aerosol species and previous work has demonstrated that collocated data from both networks agreed closely depending on species. Therefore, differences in aerosols at urban versus remote regions were investigated by combining data from over 300 sites from both networks. We investigated annual and monthly urban excess from data averaged from 2007–2010. The largest urban excess was estimated for nitrate ion, particulate organic matter, and light absorbing carbon concentrations, while the urban excess in sulfate ion concentrations was the lowest. We did not compute urban excess for $PM_{2.5}$ soil concentrations as comparisons of collocated data showed significant biases between the networks. This work has implications for understanding the impacts of urban sources and transport into remote regions and their influence on regional background concentrations

Control Number 43.

A New Approach for XRF Analysis in IMPROVE

Charles McDade[1], Nicole Hyslop[1], Krystyna Trzepla-Nabaglo[1], and Warren White[1] [1]Crocker Nuclear Laboratory, University of California, One Shields Avenue, Davis, CA 95616

Abstract

Crocker Nuclear Laboratory (CNL) at UC Davis has employed new instrumentation for x-ray fluorescence (XRF) elemental analysis of samples collected in the IMPROVE network. The new XRF instrument at UC Davis is the PANalytical Epsilon 5. This new XRF system provides a number of benefits, including enhanced stability of the chemical results, better equipment reliability, a modern and secure data handling system, and strengthened traceability of the data to support regulatory applications.

The old XRF systems at UC Davis had been in use since the early years of IMPROVE and they had become outdated and increasingly unreliable. They were controlled by VAX computers that were over twenty years old and still ran legacy software code written for an even earlier generation of hardware. It

became evident that new equipment would be needed to maintain the sample throughput and data quality needed for IMPROVE.

The design of the Epsilon 5 provides improvements over CNL's legacy XRF systems. Unlike the CNL systems, the Epsilon 5 uses a polarized beam. Polarization reduces unwanted spectral background, thereby producing cleaner spectra. Cleaner spectra enhance the ability to investigate physical phenomena with minimal interference from instrumental artifacts.

The Epsilon 5 uses secondary x-ray excitation, in which primary x-rays from a single x-ray tube excite a series of elemental targets, each of which then emits characteristic x-rays that are used to excite the aerosol samples. Each element in a sample is most efficiently excited by x-rays within a narrow energy range. The Epsilon 5 differs from CNL's custom-built XRF systems which used primary emissions from only two anodes, copper and molybdenum, to excite the samples. Primary emission has the advantage of strong x-ray flux, but it has the disadvantage of providing only two excitation energies so that many elements are being excited far from their optimal regions.

To enhance the usefulness of the Epsilon 5, the design engineer and machinists at CNL have worked with PANalytical to design a modified sample holder, custom-designed for IMPROVE's 25 mm filters, that increases the instrument's capacity from 48 to 126 filters without reloading. A specially designed vacuum head picks up each filter from its holder and places the filter in the x-ray chamber for analysis. This CNL-designed modification to the Epsilon 5 gives the instrument the filter capacity needed to accommodate a large network such as IMPROVE without the labor intensive sample changing required by standard commercial instruments.

Session 1B: Aerosol and Visibility Field Studies and Monitoring Networks

Control Number 36

Characterizing the relationship between atmospheric visibility and pollutant sources in different weather conditions in Central Taiwan.

Chung-Yih Kuo[1,2], Yu-Chieh Chen[1], Shih-Yu Chang[1,2*], Chun-Hung Chou[1], Chun-Chieh Huang[1], Chung-Hao Cheng[1], Cheng-Jung Huang[3]

[1]School of Public Health, Chung Shan Medical University, Taichung 402, Taiwan

[2]Department of Family and Community Medicine, Chung Shan Medical University Hospital, Taichung 402, Taiwan

[3]Fortelice International Co., Ltd., Taipei, Taiwan.

Abstract

In recent years, the rapid urbanization of Taichung urban area results in air quality deterioration and atmospheric visibility degradation. The major factors influencing atmospheric visibility are gaseous and particulate pollutants, as well as meteorological conditions. However, the traditional filter-based method, the sample for a long period of sampling time, is unable to provide rapidly spatial and temporal changes

in both aerosol composition and concentration. Such limits are critical in understanding the reactions between atmospheric visibility and soluble aerosol species in the atmosphere.

In order to establish the relationship between atmospheric visibility and major air pollutants and weather conditions, In-situ Gas and Aerosol Composition monitor (IGAC) and Long Path Visibility transmissometer (LPV-3) were used to measure hourly soluble ions and visibility in Taichung urban area. Three weather types of typhonic peripheral circumfluence, stationary, and transmission were classified according to the hourly meteorological parameters (wind speed, wind direction, atmospheric temperature, and relative humidity) and the typhoon paths. This study discussed the relations of atmospheric visibility to soluble aerosol species and meteorological parameters among different weather types in the sampling periods of summer, autumn, and winter.

Results showed that atmospheric visibility is the best in the transmission weather type even in different seasons due to good atmospheric diffusion conditions. According to factor analysis, secondary aerosols are the major factor influencing atmospheric visibility. The analysis of correlation between atmospheric visibility and coarse and fine aerosol concentration found that $PM_{2.5}$ is the major aerosol particle influencing atmospheric visibility, and the $PM_{2.5}$ is in nonlinearly exponential relation to atmospheric visibility. When the $PM_{2.5}$ concentration is higher than 35 μgm^{-3}, the atmospheric visibility degradation is aggravated. The results of this study proved that the secondary nitrate and chloride emitted from vehicle and stack burning respectively are the major aerosol species influencing atmospheric visibility. Therefore, atmospheric visibility can be improved by reducing vehicle exhaust and stack burning in Taichung urban area.

Keywords: atmospheric aerosol, aerosol optical properties, in-situ IC, soluble ion, $PM_{2.5}$, IGAC

Control Number 37

Emission Inventory and Speciation of PM in the Yangtze River Delta region, China

Xiao Fu[1], Shuxiao Wang[1], Bin Zhao[1] and Jiming Hao[1],

[1] School of Environment, State Key Joint Laboratory of Environment Simulation and Pollution Control, Tsinghua University, Beijing 100084, China

Principal Contact: Xiao Fu, PhD Student, School of Environment, State Key Joint Laboratory of Environment Simulation and Pollution Control, Tsinghua University, Beijing 100084, China.

Abstract

The Yangtze River Delta (YRD), with well-developed industry and high population density, is one of the most developed but polluted regions in China. This paper developed an emission inventory for particulate matter, which are important pollutants to visibility decreasing, in this region for 2010 year. A bottom-up and technology-based methodology was used in large emission sources, such as power plants, cement factories and iron factories. The emissions of PM_{10}, $PM_{2.5}$, BC and OC in the 25 cities of this region for the year 2010 were 1038kt, 669kt, 120kt and 173kt, respectively. Shanghai, Suzhou and Xuzhou were cities with largest emissions of PM. For PM_{10}, industrial process and open burning of biomass contributed 26.9% and 18.1%. Emissions of industrial process and domestic sources account for 28.9% and 19.7% of

$PM_{2.5}$. The largest emission sources of BC are industrial process, on-road transportation and domestic sources, accounting for 59.1% in total. Domestic sources and open burning of biomass contribute largest to OC. Besides BC and OC, $PM_{2.5}$ emission were also broken down into some trace matters based on Chinese local research and Speciation database of US, such as SO_4^{2-}, NO_3^-, NH_4^+, Mg, Al, crustal elements and so on. This work will be helpful to simulate effects of aerosol on visibility and climate forcing in the next step.

Control Number 54

Urban Visibility Measurements in Fort Collins, Colorado

Cassie Archuleta1, Patrick Reddy2, Gordon Pierce2, Gregory Harshfield2; Lucinda Smith3, Brian Woodruff3

1 Air Resource Specialists, Inc. (ARS), 1901 Sharp Point Drive, Suite E, Fort Collins, CO 80525

2Colorado Department of Public Health and Environment, 4300 Cherry Creek South Drive, Denver, CO 80246

3City of Fort Collins Natural Resources Department, 215 North Mason Street, Fort Collins, CO 80524

Abstract

Visual qualities of the atmosphere, including the color, texture and clarity of a scene, are some of the more obvious indicators of general air quality to the general public. The city of Fort Collins has monitored visibility impairment since 1993, and the issue continues to be of high importance. Specifically, residents consistently express concerns about the “brown cloud” in Fort Collins.

The Colorado Department of Health and Environment (CDPHE) reports a daily Visibility Standard Index (VSI) for both Denver and Fort Collins. The VSI is measured using a transmissometer and calculated based on a Denver visibility standard that was developed using both quantitative measures of visibility and public perception. The transmissometer used to measure visibility impairment consist of a transmitter that emits light, and a receiver that detects light, separated over a long path length. The fraction of light lost due to atmospheric light scattering and absorption corresponds to the measured visibility impairment. Visibility measurements are also supported at each location by nephelometers, which measure the light scattering component of visibility impairment at a fixed point.

This summary will include measurements and trends from the City of Fort Collins transmissometer against the Denver urban visibility standard and VSI. The summary will also include comparisons of nephelometer and transmissometer data, address some of the pitfalls associated with long term trend analysis using transmissometer data, and discuss recent upgrades to new Light Emitting Diode (LED) transmissometer technology.

Control Number 58

Photoacoustic Measurements for the IMPROVE Program

Hans Moosmüller[1] and W. Patrick Arnott[2,1]

[1] Desert Research Institute, Nevada System of Higher Education, 2215 Raggio Parkway, Reno, NV 89512

[2] Physics Department, University of Nevada, Reno, Nevada System of Higher Education, 1664 N. Virginia Street, Reno, NV 89557

Abstract

As visibility impairment is an optical phenomenon, direct optical measurements of the extinction and its absorption and scattering components are of great interest for the IMPROVE visibility research and monitoring program. In addition, such measurements are relevant to emerging rules in urban-focused visibility, particulate matter radiative forcing, and climate change. The recent commercial availability of the single-wavelength photoacoustic extinctiometer (PAX) operating at different wavelengths (i.e., blue, green, and near infrared) will make it feasible to integrate these instruments into the IMPROVE network. Expected benefits include (1) the first-principle measurement of particulate matter (PM) light absorption, scattering, and extinction coefficients and single scattering albedo, (2) the routine characterization of PM absorption and scattering spectra and Ångström coefficients as well as their use for source attribution of PM absorption to black carbon, brown carbon, and mineral dust, and (3) the improved calibration of filter-based measurements of light absorption through calibration and quality assurance with PAXs. This presentation will focus on our plans for and possible progress in demonstrating the utility of photoacoustic measurements in the IMPROVE program.

Control Number 82

Airborne measurements of Black Carbon at remote locations using miniature high-performance Aethalometers

Griša Močnik [1] , Anthony D.A. Hansen [1,2] , and Matevz Lenarčič [3]

[1] Aerosol d.o.o., Kamniška 41, SI-1000 Ljubljana, Slovenia 2 Magee Scientific, 1916a M.L. King Jr. Way, Berkeley, CA 94704, USA [3] Aerovizija d.o.o., Savinjska 4, SI-3331 Nazarje, Slovenia

Abstract

While measurements of atmospheric aerosols are routinely performed at ground-level around the world, there is far less knowledge of their vertical distribution: yet this data is a crucial requirement for our understanding of the dispersion of pollutants of anthropogenic origin, with their associated effects on radiative forcing, cloud condensation, and other adverse phenomena. Black Carbon (BC) is a unique tracer for combustion emissions, and can be detected rapidly and with great sensitivity by filter-based optical methods. It has no non-combustion sources and is not transformed by atmospheric processes. Its presence at altitude is unequivocal. Recent technical advances have led to the development of miniaturized instruments which can be operated on light aircraft or carried aboard commercial passenger flights. From January to April 2012, a 'Pipistrel Virus' single-seat ultra-light aircraft flew around the world on a photographic and environmental-awareness mission. The flight track crossed all seven continents and all major oceans, with altitudes up to 8.9 km ASL. The aircraft carried a custom-developed high-sensitivity dual-wavelength miniature Aethalometer, operating at 370 and 880 nm with special provision to compensate for the effects of changing pressure, temperature and humidity. The instrument recorded BC concentrations with high temporal resolution and sensitivity better than 5 ng/m³. We shall present examples of data from flight tracks over remote oceans, uninhabited land masses, and densely populated areas, analyzing the spectral dependence of absorption to infer the contributions to BC from

fossil fuel and biomass combustion, or detect the presence of Saharan mineral dust. We have also operated miniature instruments in the passenger cabins of long-distance commercial aircraft. Since there are no combustion sources within the cabin, any BC in the ventilation air must necessarily have originated from the outside air near the tropopause at the operating altitude of 10 ~ 12 km. We shall compare some of these data with the data from the ultra-light aircraft at remote locations, albeit at lower altitudes.

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http://www.cgsplus.si/portals/0/WGF/wglfPage.htm

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Control Number 21

Real-time Black Carbon Measurement in a coast area of south China

S. C. LEE[1] and Y. CHENG[1,2]

[1] Department of Civil and Structural Engineering, Research Center for Environmental Technology and Management, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong, China

[2] Department of Environmental Science and Technology, School of Human Settlements and Civil Engineering, Xi'an Jiaotong University, No.28 Xianning West Road, Xi'an, Shaanxi, 710049, China

Abstract

Black carbon (BC) is an anthropogenic aerosol that significantly warms the atmosphere and reduces visibility through absorption of solar radiation. BC was measured continuously using a model AE-31 Aethalometer from April 2011 to January 2012 at Hok Tsui (22.13°N, 114.15°E), where is a continental outflow, downwind monitoring site, located in a coastal area near Hong Kong. The average BC concentration during the sampling period is 2.1±1.6 μg m^{-3}, comparable to the average BC value of 2.4±1.8 μg m^{-3} measured at Hok Tsui from June 2004 to May 2005 (Cheng et al. 2006). The maximum monthly average of BC was in December (3.5±1.7 μg m^{-3}) and the minimum was in June (0.9±0.8 μg m^{-3}). Northerly/northeasterly winds usually prevailed in fall, winter, and spring, corresponding with relatively high BC concentrations during these seasons. In contrast, southerly and northwesterly winds prevailed during the summer and BC concentrations were low. The BC pollutant events were associated with the increased number of hours of reduced visibility that recorded by the Hong Kong Observation.

Key word: Black carbon, BC, visibility, Hong Kong

Session 1C: Aerosol and Visibility Field Studies and Monitoring Networks

Control Number 40

Aerosol Chemistry and Hygroscopic Growth in U.S. National Parks

Douglas Lowenthal[1], Barbara Zielinska[1*], Don Collins[2], Nathan Taylor[2], Lizabeth Alexander[3], and Naresh Kumar[4] [1] Desert Research Institute, 2215 Raggio Pkwy., Reno, NV 89512

[2] Texas A&M University, College Station, TX 77843, [3] Pacific Northwest National Laboratory, 902 Battelle Blvd., Richland, WA 99352 [4] EPRI, 3412 Hillview Ave., Palo Alto, CA 94303

Abstract

A long-term research program was conducted to address issues related to estimating light extinction in the IMPROVE network. The "IMPROVE equation" estimates $PM_{2.5}$ light scattering (Bsp) as the sum of Bsp by ammonium sulfate, ammonium nitrate, organic matter (OM), and soil. Dry scattering efficiencies are assumed to increase with increasing concentration. Hygroscopic growth, which enhances Bsp, is assumed to be associated with sulfates and nitrates, but not organics. The organic mass to organic carbon ratio (OM/OC) is assumed to be 1.8. Field studies were conducted at Great Smoky Mountains NP (GRSM), TN, during summer, 2006, and winter, 2007, Mount Rainier NP (MORA), WA, during summer, 2009, and Acadia NP (ACAD), ME, during summer, 2011 to examine these assumptions. $PM_{2.5}$ filter samples were collected daily for one month during each study. Aerosol hygroscopic growth and hygroscopic state (e.g., hysteresis loop versus smooth growth) were measured in-situ. Size-resolved chemical composition was measured with an Aerodyne Aerosol Mass Spectrometer (AMS). Filter samples were analyzed for ions, organic carbon (OC), elemental carbon (EC) and water-soluble organic carbon (WSOC). Water extracts were treated with solid phase absorbents to remove inorganic ions and low molecular weight organics. The OM/OC ratio was measured directly on the isolated WSOC and residues from dichloromethane extracts. Hygroscopic growth of aerosols generated from the WSOC was measured in the laboratory by hygroscopic tandem differential mobility analysis (H-TDMA). WSOC comprised 22, 23, 77, and 93% of OC at GRSM (summer), GRSM (winter), MORA, and ACAD, respectively. Average OM/OC ratios at GRSM (summer), GRSM (winter), MORA, and ACAD were 2.0, 2.7, 2.1, and 2.2, respectively. OM/OC ratios derived from elemental composition measured with the AMS at MORA ranged from 1.8 to 2. WSOC hygroscopic growth factors at 90% RH were higher in summer (1.19) than winter (1.06) at GRSM and averaged 1.13 at MORA. There was no evidence of hysteresis at GRSM during summer; particles were always in the most hydrated state. During winter, hysteresis was observed 49% of the time and particles were in a less hydrated (deliquescent) state 17% of the time. The temporal and spatial variation of these properties and their relationship with aerosol composition and ambient conditions will be discussed.

Control Number 87

Title: Ambient Aerosol Hydration State at Three U.S. National Parks

Authors: Nathan Taylor[1], Don Collins[1], Douglas Lowenthal[2], Barbara Zielinska[2], Lizabeth Alexander[3], Naresh Kumar[4]

[1] Texas A&M University, College Station, TX 77843, [2] Desert Research Institute, 2215 Raggio Pkwy., Reno, NV 89512, [3] Pacific Northwest National Laboratory, 902 Battelle Blvd., Richland, WA 99352 [4] EPRI, 3412 Hillview Ave., Palo Alto, CA 94303

Relative humidity driven hydration phase transitions in ambient aerosol often exhibit hysteresis, resulting in multiple possible hydration states for some range of RH. These hydration states often exhibit vastly different physicochemical properties. In the common case of ammonium sulfate, a meta-stable, aqueous hydration phase features up to three times the volume and light scattering efficiency per solute mass of the alternative, thermodynamically-favored, crystalline state. Further, the aqueous phase is a preferred site for several important heterogeneous reactions such as dinitrogen pentoxide hydrolysis. Though the significance of aerosol hydration state for climate, visibility and heterogeneous chemistry is well established, few measurements have been made of the hydration state of ambient aerosol.

We will present results from four field deployments of a unique tandem differential mobility analyzer (TDMA) configuration with two primary capabilities: identifying alternative stable or meta-stable ambient aerosol hydration states associated with hysteresis in aerosol hydration behavior and determining the actual Ambient hydration State (AS-TDMA). The AS-TDMA was installed at a site in eastern Tennessee on the border of Great Smoky Mountains (GRSM) National Park for projects during the summer of 2006 and winter of 2007-2008. During the summers of 2009 and 2011, similar campaigns were conducted at Mount Rainier and Acadia National Parks.

At GRSM during the summer, 12% of the aerosols sampled in continuous AS-TDMA measurements were found to posses two possible hydration states under ambient conditions. In every case, the more hydrated of the possible states was occupied. The remaining 88% did not posses multiple possible states. In continuous measurements during the winter, 49% of the aerosols sampled possessed two possible ambient hydration states; the remainder possessed only one. Of those aerosols with multiple possible ambient hydration states, 65% occupied the more hydrated state; 35% occupied the less hydrated state. At Mount Rainier National Park hysteresis was rarely detected (<5%) by AS-TDMA measurements. In every case, the most hydrated state was occupied. Preliminary analysis of the Acadia AS-TDMA measurements indicate only one brief period during which hysteresis (most hydrated state) was detected.

Our findings are supported by concurrent measurements of ambient condidtions, aerosol hydration behavior by TDMA, and aerosol composition by filter-based methods and aerosol mass spectrometer. These will be presented to illustrate factors controlling ambient hydration state.

Session 6A. Information and Technology Needs for future Revisions of the Secondary PM NAAQS

Control Number 20

Evolution of Thought on Monitoring Methods to Support a Secondary PM National Ambient Air Quality Standard to Protect Visibility

Marc Pitchford[1]

[1]Executive Director, Division of Atmospheric Sciences, Desert Research Institute, Reno, NV 89512-1095, 775-674-7127, marcp@dri.edu.

Topic: Implementation of the Potential U.S.EPA Secondary PM NAAQS to Protect Non-Class I Area Visibility.

Abstract

EPA proposed that a new Secondary Particulate Matter National Ambient Air Quality Standard (PM NAAQS) could be based on PM light extinction levels in place of the traditional PM mass concentration, to address the issue that no single PM concentration level would provide comparable levels of visibility protection under both dry and humid conditions, due to the water growth of hygroscopic PM components. Early in their PM NAAQS review process, EPA suggested direct optical measurements of light extinction or its components (light scattering and absorption) with hourly time resolution as a plausible monitoring approach. Later they acknowledged the lack of a federal reference method (FRM) for light extinction monitoring and insufficient time and resources to develop an FRM prevented the use of direct optical measurements of a light extinction. They then suggested an

alternative approach much like the one used by the Regional Haze rule that estimates light extinction from 24-hour PM speciation data. In the first version of this PM speciation-based light extinction approach, hourly PM mass concentrations data from continuous PM monitoring and hourly relative humidity data are used along with longer averaging time PM composition information to estimate hourly light extinction for all hours of every day. Finally concerns raised about the accuracy of hourly PM data from the continuous PM monitors resulted in a proposal to use 24-hour speciation data collected at a one day in three or one day in six frequency to generate 24-hour light extinction estimates for the speciation sampling days. This paper describes and discusses the rationale and consequences of EPA's evolution of thought concerning how light extinction would be monitored in support of a possible Secondary PM NAAQS to protect visibility.

Control Number 31

Analysis of Visibility at Canadian Speciation Monitoring Sites

Keith Jones and Joanna Zhao

Air Quality Science Unit, Meteorological Service of Canada, Pacific and Yukon Region, Environment Canada, 201-401 Burrard Street, Vancouver, BC, Canada, V6C 3S5

Abstract

While there is no dedicated national visibility monitoring network in Canada analogous to the US IMPROVE network, data from speciation monitoring sites located in various regions of the country can be used to characterize visibility. The objective of this paper is to characterize spatial and temporal trends in visibility at multiple sites across Canada, including those in both urban and rural settings. Speciation data collected at more than 15 sites across Canada over varying periods between 2003 and 2011 were used to calculate reconstructed light extinction based on methods used in the U.S. IMPROVE network. The sites were grouped into 3 main regions: Western Canada, Ontario-Quebec, and the Maritimes. In general, the greatest light extinction episodes occur primarily in the Ontario-Quebec region, while the coastal sites experience the lowest. Overall, ammonium sulphate, ammonium nitrate, organic carbon (OC), and elemental carbon (EC) make up greater than 80% of light extinction, while the remaining ~20% comprise of coarse mass, nitrogen dioxide (NO2), fine soil and sea salt contributions. Ammonium sulphate contributions tends to be highest during the summer and show an increasing pattern from west to east. Ammonium sulphate was the highest contributor to reduced visibility at sites in the Ontario-Quebec and Maritimes region on both the 20% haziest and 20% clearest days. Ammonium nitrate contributions were highest during the winter especially in the Ontario-Quebec region, where it was the second largest contributor to light extinction on the 20% haziest days. Contributions from ammonium nitrate were particularly lower in the Maritimes region. OC contributions tend to be highest in the summer, while EC contributions tend to peak during the summer and fall months. Generally, OC and EC components were the largest contributors to reduced visibility at British Columbia sites on the 20% haziest days. Results will be further interpreted in the context of recent source apportionment studies using positive matrix factorization (PMF).

Control Number 34

Measurement of Scattering in an Urban Area Using a Nephalometer and $PM_{2.5}$ FDMS TEOM Monitor: Accounting for the Effect of Water

Delbert J. Eatough[1], Paul Cropper[1] and Jaron C. Hansen[1]

[1]Department of Chemistry, Brigham Young University, Provo, UT 84604. 801-375-5535, delbaert@eatough.net.

Topic: Implementation of the Potential U.S.EPA Secondary PM NAAQS to Protect Non-Class I Area Visibility.

Abstract

EPA is in the process of evaluating plans for a potential new secondary PM standard based on visibility in Urban areas. It would be desirable if the new standard was based on a direct measurement of extinction and if it was based on semi-continuous measurements to better correlate with human perception. This could be accomplished by either an estimation of extinction from semi-continuous PM data or by direct measurement of scattering and absorption. We have compared the estimation of particulate scattering from 1-h measurements of PM fine and coarse mass along with estimation of absorption from aethalometer measurements, with scattering measured directly using a nephalometer. The study took place in Lindon, UT during February and March 2012. The nephalometer measurements were corrected for coarse particle scattering and compared to measurements using an FDMS $PM_{2.5}$ TEOM. The two measurements agreed with a mass scattering coefficient of 3.5 ± 0.3 m^2/g at relative humidity below 80%, but the nephalometer gave higher scattering results at higher humidity because water absorbed by the particles at high humidity is not measured by the FDMS TEOM. The difference between the two results was consistent with the estimated composition of the aerosol, except for conditions when fog was present. The FDMS data could be corrected for this difference using appropriate IMPROVE protocols if the particles composition is known. However, a better approach may be to use a particle measurement system which allows for semi-continuous measurements but also measures particle bound water. For example, a GRIMM Model 1.107 aerosol spectrometer, or comparable instrument has been shown to meet this objective.

Control Number 42

Visibility Perception in the Lower Fraser Valley of British Columbia, Canada: Results from a Public Survey

John P. Gallagher[1,2] and Ian G. McKendry[1]

[1] Department of Geography, University of British Columbia, 1984 West Mall, Vancouver, BC V6T 1Z2, Canada, [2] Current Affiliation: Stantec Consulting, 4370 Dominion Street, Burnaby, BC V5G 4L7, Canada .

Abstract

A study was conducted during the spring of 2011 in the Metro Vancouver region of British Columbia (BC) to assess public perceptions of visual air quality (VAQ) under different air pollution conditions. VAQ was defined as the visibility effect caused solely by air quality conditions, excluding those associated with weather conditions such as fog and rain. Unlike more objective air quality variables, VAQ is fundamentally linked to the individual and their perception of the scene. For this reason, the study consisted primarily of a survey that was administered live to a total of 301 adults drawn from 17 different groups. In Part 1 of the survey, participants were asked to view and rate on a scale of 1 to 7 the VAQ as depicted in 30 digital photos of a scene from Chilliwack, BC. For Part 2 of the survey, the same photos were shown in a different order and participants were asked to rate the visibility condition of each one as either acceptable or unacceptable based on their own visibility standard. Results from Part 1 of the

survey showed that averaged subjective ratings of VAQ had an approximately linear relationship to deciview, which is an index of haziness derived from measures of light extinction. Results were similar for the different survey groups and different demographic categories. Age was the only demographic factor that showed statistically significant differences between categories, with young respondents displaying a tendency to rate the images more favorably (i.e. they perceived the visibility to be better for the same scene) than two of the older age groups. Acceptability ratings from Part 2 of the survey were similar to those of two previous Lower Fraser Valley VAQ studies from the 1990s, indicating that public perception of VAQ in the region has not changed substantially in the intervening years. However, when asked directly for their opinion on the region's VAQ trend over the most recent five years, long-term residents were ten times more likely to respond that it had deteriorated than to indicate that it had improved. Results from this study are being used in the development of a regional visual air quality index.

Control Number 46

Scientific Issues Regarding Using a PM2.5 NAAQS to Protect Urban Visibility

Ivar Tombach, Consultant, 753 Grada Ave., Camarillo, CA 93010

Abstract The US Environmental Protection Agency (EPA) has been considering proposing a secondary (i.e., welfare-based) National Ambient Air Quality Standard (NAAQS) for fine particulate matter (PM2.5) for the purpose of protecting visibility nationwide, particularly in urban areas, to supplement the more stringent Regional Haze Rule that already applies at Class I areas such as national parks and wilderness areas. In the last few years, the EPA has issued several documents that present its evolving thinking about the scientific basis for such a secondary NAAQS, alternative forms for it, and issues connected with its implementation. As the next step, EPA is expected to propose a PM NAAQS, including a secondary NAAQS for PM2.5, around August 2012. This paper addresses scientific issues of importance for developing and implementing the NAAQS, and provides relevant insights gleaned from analysis of urban aerosol and optical measurements made by the SEARCH (Southeastern Aerosol+Research+and+Characterization)+ network. Issues addressed in the paper include the following: (1) What is the desired level of visibility to be maintained? Can that level apply uniformly nationwide? (2) Is there a quantitative relationship between visibility (the attribute to be protected) and the PM2.5 concentration (presumably the attribute to be measured for conformity with a PM2.5 NAAQS)? (3) How is the visibility that people typically observe for short intervals in the daytime linked to current measurements of PM2.5 mass concentration averaged over 1 and 24 hrs, and of PM2.5 chemical composition averaged over 24 hrs? (4) In light of the capabilities and performance of currently available technology for routine measurement of PM2.5 and visibility, what would be an operationally-feasible mechanism for determining compliance with a secondary PM2.5 NAAQS? How these issues are resolved will influence the development of approaches for controlling emissions to achieve air quality consistent with the secondary NAAQS.

Session 6B. Information and Technology Needs for future Revisions of the Secondary PM NAAQS

Control Number 88

A Test of the Scientific Validity of the Visual Air Quality "Preference Study" Method

Anne E. Smith, NERA Economic Consulting, 1255 23rd Street, NW, Washington, DC 20008.

Abstract

The U.S. Environmental Protection Agency (EPA) is considering setting a secondary National Ambient Air Quality Standard (NAAQS) for particulate matter (PM) to maintain urban visual air quality (VAQ) above the level that adversely affects public welfare. EPA is relying on a type of survey it calls a "VAQ preference study" to determine this level. Individuals are shown photographs of the same vista under a range of different visibility conditions, and asked to state whether the VAQ in each photograph is "acceptable" or "unacceptable." EPA considers the effect on public welfare to be adverse at the VAQ level that at least 50% of respondents deem unacceptable (the "VAQ cutpoint"). Given its central role in setting a NAAQS, the scientific validity of this method is an important question. This paper describes a controlled experiment of the robustness of results from the VAQ preference study method, and is the only known exploration of the scientific validity of the VAQ preference study method. This study replicated the survey instrument from an existing VAQ preference study. Then, two variants of the same survey (in which the only change was to show respondents a different range of VAQ levels) were tested on separate samples of individuals. The three variants of the survey produced substantially, statistically significantly, different estimates of the VAQ cutpoint. In contrast, all three variants produced comparable results for a task at the start of each survey in which respondents were asked to rate the VAQ in each photograph on a scale of 1 to 7 (without any opinion on the acceptability of each level). This indicates that respondents in each survey variant were equally able to relate the range of VAQ shown to them in the survey to the range of visibility conditions they experience in daily life. Thus, the significantly different estimates of VAQ cutpoints across survey variants cannot be attributed to inability on the part of respondents to discern whether they were being shown the entire range of actual visibility conditions. This supports a conclusion that VAQ preference surveys do not actually estimate individuals' enduring preferences regarding VAQ, because an absolute preference structure would not be malleable to the particular levels of VAQ over which their preferences are elicited.

Session 10A. Aerosol and Visibility Modeling at Global, Regional and Local Scales

Control Number 94

Global Analyses and Forecasts of Aerosol Impacts on Visibility

Douglas L. Westphal[1], Rudolf B. Husar[2], Shawn E. McClure[3], James R. Campbell[1], Edward J. Hyer[1], Jeffrey S. Reid[1], Walter R. Sessions[4], and Jianglong Zhang[5]

[1]Naval Research Laboratory, 7 Grace Hopper Ave., Monterey, CA 93943, [2]Washington University, 1 Brookings Drive, St. Louis, MO 63130, [3]CIRA, Colorado State University, 1375 Campus Delivery, Fort Collins, CO 80523, [4]CSC, 7 Grace Hopper Ave., Monterey, CA 93943, [5]University of North Dakota, 4149 University Avenue, Grand Forks, ND 58202

Abstract

The Naval Research Laboratory has developed the Navy Aerosol Analysis and Prediction System (NAAPS) which, since 1999, has produced global analyses and 6-day forecasts of sulfate, smoke, dust and sea salt aerosols, AOD and visibility. The initial conditions for each forecast cycle are produced by the NRL Atmospheric Variational Data Assimilation System - Aerosol Optical Depth (NAVDAS-AOD), the only operational aerosol data assimilation system. Together, NAAPS and NAVDAS-AOD provide an efficient method for assimilating satellite data (MODIS, MISR, and CALIPSO) with model data to produce a consistent 3-D analysis with significant value to scientists and Air Quality (AQ) decision-makers. The model suite is run four times a day at the Fleet Numerical Meteorology and Oceanography

Center. The global coverage directly provides quantitative information on the long-range transport of aerosol particles and the impact on visibility in North America. NASA has funded a new capability for providing NAAPS analyses to the community via the Federated Data System (DataFed) and the Visibility Information Exchange Web System (VIEWS). Digital data and graphical analyses are provided in near-real-time as well as for retrospective studies up to ten years in the past. In this paper, the models will be described, the decision support systems will be demonstrated, and example applications will be presented**.**

Control Number 4

Using the GEOS-Chem Adjoint Model to Determine the Sensitivity of Top of Atmosphere Polarizations to Aerosol Emissions

Brian S. Meland[1], Xiaoguang Xu[2], Daven K. Henze[1], Jun Wang[2]
[1] University of Colorado - Boulder, Mechanical Engineering Dept., Boulder, CO 80309
[2] University of Nebraska - Lincoln, Dept. of Earth and Atmospheric Sciences,Lincoln, NE 68588

Abstract

Atmospheric aerosols play a number of important roles in the Earth's atmosphere, affecting radiative transfer, heterogeneous trace gas chemistry, and serving as sites for cloud nucleation. Unfortunately, the temporal and spatial distribution as well as the chemical composition and microphysical properties of atmospheric aerosols are still very uncertain owing to inherent limitations of remote sensing measurements. These uncertainties can lead to errors in radiative transfer calculations as well as in chemical transport models which both rely on accurate estimates of aerosol concentrations or emissions as inputs.
Recent studies have found that polarimetric measurements are able to provide a more detailed assessment of aerosol physical and chemical properties. The polarimetric measurements determine three or four of the components of the Stokes vector of scattered light from aerosols, rather than just the intensity. Since atmospheric aerosols can have lifetimes on the orders of days or weeks, they can be transported over intercontinental distances and impact light scattering far from their source regions.
This work uses the adjoint of the GEOS-Chem chemical transport model with the VLIDORT vectorized radiative transfer model to determine how top of the atmosphere (TOA) polarization of scattered light is effected by aerosol emissions, chemical composition, and assumed microphysical properties. Aerosol concentrations for 13 species calculated using the GEOS-Chem forward model are used as inputs for the VLIDORT radiative transfer model to calculate the full Stokes vector and its Jacobian matrix for scattered light at the TOA over North America. The Jacobian matrix then serves as the adjoint forcing terms in the GEOS-Chem Adjoint model which steps backwards in time to determine the contributions of previous (non-local) emissions on polarization. These results help to show the utility of development and application of polarimetric measurements from remote sensing platforms.

Control Number 111

California's Impact on Grand Canyon Visibility During the Past 20 Years

Rob Farber, Kristi Gebhart, Jason Monroe, Bong Kim

During the spring through early fall, California emissions and aerosols frequently impact the Grand Canyon. During this period, the prevailing flow is from the cooler Pacific Ocean to the hotter southwestern deserts including the Grand Canyon on the Colorado Plateau. This work examines the

frequency of Grand Canyon impacts from two major urban areas in California, the San Joaquin Valley and the Los Angeles Basin. Back trajectory analysis is used. Then, using these frequency impact results, emission reductions from these two urban airsheds are examined during the past 20+ years. These emissions are regressed against speciated aerosol data from the Grand Canyon to estimate the amount of aerosols reaching the Grand Canyon from these two source areas over the past 20 years. This analysis will provide an estimate of the frequency of aerosol (visibility) impact and a further estimate of the portion of aerosols (haze) emanating from California urban centers.

Control Number 63

Impacts of future changes in climate, emissions and land cover and land use on PM2.5 and O3 over the US

Maria Val Martin[1] , Colette L. Heald[2] , Jean-Francois Lamarque[3] , Simone Tilmes[3] and Louisa Emmons[3]
Atmospheric Science Department, Colorado State University, Fort Collins, CO 80523 [2] Department of Civil and Environmental Engineering, Massachusetts Institute of Technology, Cambridge, MA 02139, [3] National Center for Atmospheric Research, Boulder, CO 80301

We present a modeling analysis to show the potential future consequences of climate, emissions, and land cover/use changes on the air quality over the US. We use the global chemistry-climate Community Earth System Model (CESM), constrained by present-day and 2050 meteorology, emissions (i.e., anthropogenic, biomass burning and biogenic) and land cover/use scenarios obtained from the IPCC AR5. We test the RCP4.5 and RCP8.5 scenarios and focus on changes in PM2.5 and O3. Our analysis shows that climate, emissions and vegetation changes between 2000 and 2050 could lead to decreases in PM2.5 up to 12 µg/m3 over the US, in particular eastern US. Summertime surface O3 levels are also predicted to decrease up to 20 ppbv over large areas in the US. We will discuss further these results in terms of the different RCP scenarios, and quantify the changes resulting from climate, emissions and land cover/use alone. In addition, we will specifically explore the effects of future changes in the visibility at the US National Parks.

Control Number 84

Comparisons of EPA Protocol CALPUFF modeling to IMPROVE Data

Gale F. Hoffnagle, CCM, QEP
Affiliation: TRC Environmental Consultants, 21 Griffin Road North, Windsor, CT 06095

Abstract

The US EPA Regional Haze Rules require that modeling of the potential impact of sources subject to the rule be performed. US EPA specifies a particular version of CALPUFF be run with a defined protocol designed to be conservative. This paper compares total particulate, sulfate and nitrate particulate results from the protocol CALPUFF for specific power plants to those parameters from the IMPROVE network in Colorado, North Dakota and Montana. The data and model results are matched for the specific days of measurement. The protocol CALPUFF shows over-prediction which decreases with distance between the source and receptor. Because better modeling methodologies are available, CALPUFF has also been run with those advances and shown to perform much better compared to the data. There are three data comparison sets and discussions of other comparisons in the literature. Much better model results can be obtained than by using the required EPA BART protocol.

Control Number 73

A Recommended Method to Disclose Visibility Impacts For NEPA Analyses

Courtney A. Taylor[1] and Jim Zapert[2]

[1] AECOM, 1601 Prospect Parkway, Fort Collins, CO 80525, [2] Carter Lake Consulting, PO Box 994, Laramie, WY 82073 .

Abstract

Under the Clean Air Act (as amended in 1977), Federal Land Managers are responsible for the protection air quality related values (AQRVs) in designated Class I and Class II areas. To evaluate air pollution effects on AQRVs, the Federal Land Managers established the Federal Land Managers' AQRV Work Group (FLAG), which provides guidance for permitting authorities to assess the impacts of new and modified sources. As part of the National Environmental Policy Act (NEPA), Federal Land Managers are also required to assess air quality and AQRV impacts for activities proposed for federal lands. Currently, the FLAG 2010 permitting guidance is used to assess AQRV impacts during NEPA analyses; however, this guidance was not developed for NEPA analyses and, currently, no formal NEPA guidance has been issued for assessing visibility impacts.

Several different methods to calculate the change in visibility will be presented using modeling results that are representative of a NEPA analysis. This topic is provided to inform the Federal Land Managers and suggest a methodology to assess visibility impacts as part of NEPA analyses.

Session Associated Poster Presentation

Control Number 75

Modeling Fugitive Dust in the Powder River Basin: A Case Study Coupling Emission Rates with Meteorological Parameters

Marco A. Rodriguez[1], Chao-Jung Chien[1], Zion S. Wang[1], Caitlin Shaw[1], and Courtney A. Taylor[1]

[1] AECOM, 1601 Prospect Parkway, Fort Collins, CO 80525

Abstract

The Powder River Basin in northeast Wyoming is the largest coal mining region in the United States. Particulate matter with an aerodynamic diameter of 10 micrometers or less (PM_{10}) is the primary pollutant of concern in this region due to surface mining activities and associated fugitive dust emissions. Historically, modeling fugitive dust has been problematic due to uncertainties in emissions, insufficient information to characterize the timing and release of emissions, and the paucity of monitors in areas dominated by dust. In this work, a chemical transport model (CTM) will be used to assess impacts to air quality and air quality related values in the Powder River Basin. New tools developed by the United States Environmental Protection Agency (USEPA) will be used to couple the timing and release of the fugitive dust emissions with meteorological parameters, including snow cover and soil moisture. Model results will be evaluated by comparison to all available particulate monitoring data, including over 40 PM_{10} monitors located in the Powder River Basin alone.

Session 15. Haze Rule 2013 Check-In and 2018 Planning Milestone to Achieve the U.S. National Visibility Goal

Control Number 86

Critical Review Update: Visibility Science and Regulation

John G. Watson[1] and Judith C. Chow[1]

[1]Desert Research Institute, 2215 Raggio Pkwy, Reno, NV 89511, USA

Abstract

Much has changed since the 2002 critical review[1] and discussion[2] on U.S. visibility monitoring and the regional haze rule. New instrumentation has been perfected for monitoring light extinction components, and understanding of the multiwavelength nature of scene perception has improved. National emission inventories have been updated, especially for natural and prescribed fires, with satellite detection being used for verification. The IMPROVE network data have been put to many more uses than their original focus on tracking visibility trends. The effects of changes in instrumentation and measurement protocols on these trends have been evaluated and found to be small compared to the long-term decreases in light extinction components. A new chemical extinction formula better accounts for sulfate and nitrate size distributions, as well as the effects of relative humidity on light scattering. $PM_{2.5}$ and visibility state implementation plans were submitted in 2008 and new emission reduction measures have been introduced in the five regional planning areas. Other countries, such as China, have used the IMPROVE network as an example for tracking their own changes in visibility. Visibility is being perceived as part of multipollutant[3] air quality strategies that have effects on human health, climate, and ecosystem damage. Extensive references to useful reports and publications have been compiled to document these changes since 2002.

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Control Number 53

The Regional Haze Rule Reasonable Progress Report Project for 116 Western Class I Areas

Joe Adlhoch[1], Cassie Archuleta[1], Emily Vanden Hoek[1], and Tom Moore[2]

[1] Air Resource Specialists, Inc. (ARS), 1901 Sharp Point Drive, Suite E, Fort Collins, CO 80525

[2] Western Regional Air Partnership, CIRA, CSU, 1375 Campus Delivery, Fort Collins, CO 80523

Abstract

The EPA's Regional Haze Rule (RHR) protects visibility in 156 Class I federal areas, including national parks and wilderness areas. The RHR mandates that man-made emissions affecting these Class I federal areas be steadily reduced to constitute "reasonable progress" towards natural condition goals, or conditions without any man-made influences, by the year 2064.

The rate of visibility improvement between RHR baseline conditions (2000-2004) and natural visibility conditions (2064) is defined as the glide path for the uniform rate of progress toward visibility goals. States are required to develop full reasonable progress implementation plans every 10 years (2008, 2018, et cetera) and then to assess progress towards natural conditions in 5-year incremental periods between full plans (2013, 2023, et cetera). The first reasonable progress report will address changes between baseline conditions and the 2005-2009 first progress period. The Western Regional Air Partnership (WRAP), in coordination with 15 western states, is preparing regional technical work products for states to develop the first of these reasonable progress reports for the 116 Class I federal areas located in the WRAP region. This summary will present data related to regional haze progress in the WRAP region, including changes in monitoring and emissions data between the RHR baseline and progress periods.

Control Number 91

Comparative Analysis of 2005-09 "1st Progress Period" vs. 2000-04 "Baseline" IMPROVE RHR Data

Scott A. Copeland[1], Tom Moore[2]

[1]CIRA, Washakie Ranger Station, 333 East Main Street, Lander, WY, 825202, Western Governors' Association, CSU/CIRA, 1375 Campus Delivery, Fort Collins, CO, 80523-1375

Abstract

At the heart of the Regional Haze Rule is the concept of tracking progress towards natural conditions by examining 5 year blocks of IMPROVE data. Five year averages were chosen over individual years to attempt to smooth out the effects that variations in meteorology or wild fires can have on the data. When considering five year means, especially of the best 20% and worst 20% haze days, even one anomalous year can still influence implied trends.

Broad trends in visibility across the United States were documented in the IMPROVE Report V. In many cases these trends were consistent with documented changes in aerosol precursor emissions. Some individual IMPROVE sites and groups of IMPROVE sites behaved counter to the broad patterns or counter to the trends expected due to emissions changes. One example is the four Northern Class I regional haze tracking progress sites in Northern Minnesota and Northern Michigan, which had increasing 5 year annual mean sulfate concentrations when most other IMPROVE sites east of the 100th meridian measured significant decreases. Decreases in sulfate concentrations are expected due to decreases in SO2 emissions across the eastern United States and in proximal southern Canadian provinces. The influence of outlier years is described, and comparisons of Baseline to 1st Progress Period air mass histories, data completeness, analytical interferences, and other air quality data sets are used understand the details behind reported trends.

Control Number 79

Emissions and Visibility Response in 2005-2009 to Regulatory Policy

Patricia Brewer[1], Tom Moore[2], Jenny Hand[3], Scott Copeland[3]

[1]National Park Service, 12795 W. Alameda Parkway, P. O. Box 25287, Denver, CO 80225, [2]Western Governors' Association, CIRA, Colorado State University, 1375 Campus Delivery, Fort Collins, CO, 80523-1375, [3]CIRA, Colorado State University, 1375 Campus Delivery, Fort Collins, CO, 80523-1375

Abstract

The Regional Haze Rule required states to develop implementation plans that demonstrate reasonable progress by 2018 toward achieving natural visibility conditions at Class I national parks and wilderness areas by 2064. The Rule further requires states to submit a progress report five years after submitting the first implementation plan (due December 2007). The first report is to evaluate progress toward the visibility improvement goals for 2018. This paper provides a regional evaluation of progress in reducing emissions and improving visibility over the period 2005 to 2010 compared to the baseline period 2000 to 2004. IMPROVE monitoring data and state emissions data will be used to demonstrate the regional trends in visibility and responses to regulatory policy.

The Environmental Protection Agency just began approving state plans in 2012. As a result, the emissions reductions between 2005 and 2009 are not due to emissions controls implemented specifically for regional haze, but rather to existing state and federal requirements. Sulfur dioxide and nitrogen oxides emissions from combustion sources are significant contributors to aerosol mass that impairs visibility and also are precursors to ozone and fine particles. Federal requirements that have led to emissions reductions in 2005 to 2009 include the National Ambient Air Quality Standards for ozone and fine particles, the Clean Air Interstate Rule and its intended successor the Cross State Air Pollution Rule that reduce emissions from electric utilities, consent decrees with several utilities, and the suite of federal standards for cleaner engines and cleaner fuels for on-road and non-road mobile sources. As well, several states rules are already resulting in emissions reductions from electric utilities (e.g. DE?, GA, IL, MD, NC, add others). The economic recession reduced electric generation and emissions. The dramatic increase in oil and gas production has led to a drop in natural gas prices and decreased use of coal. The greatest visibility improvements appear to have occurred at the Class I areas most impacted by anthropogenic sources.

Control Number28

Estimation of Ambient NH3Concentrations over the Gulf of Mexico

John J. Jansen, Principal Scientist, Southern Company, Birmingham,

Abstract

Gaseous ammonia (NH3) is the predominant alkaline compound in the atmosphere and, as such, plays important roles in particle nucleation, aerosol neutralization and PM2.5accumulation. NH3is also of interest in regulatory circles as an input variable for Best Available Retrofit Technology (BART) modeling of aerosol concentrations in Class I areas. Most Class I areas are located on land, but some (including the Breton Island NWR) are located in marine environments. Hence, there is a regulatory

requirement to specify NH3concentrations over the open waters of the Gulf of Mexico for model calculations. Unfortunately, there are no systematic measurements of NH3over the Gulf of Mexico, and it is necessary to estimate NH3concentrations based on other considerations. This presentation uses a weight of evidence approach to estimate NH3concentrations over the Gulf of Mexico and to recommend use of data from the Oak Grove, MS SEARCH site for BART calculations. Based on this analysis, four convergent lines of evidence show that NH3concentrations at Oak Grove, MS represent a realistic upper limit estimate for those over the Gulf of Mexico. These lines of evidence are as follows: 1) NH3emission rates imply lower NH3concentrations over the Gulf of Mexico than adjoining near-coastal areas; 2) NH3concentrations at the SEARCH site in Gulfport, MS average 260 ppt when air mass transport is on-shore from the Gulf of Mexico; 3) data from the near-coastal NADP AMON site at Cape Romain, SC exhibit long-term (2008-2010) average NH3concentrations of 280 ppt; and 4) equilibrium calculations based on Gulf of Mexico surface water chemistry suggest summertime maximum NH3concentrations of roughly 200-300 ppt and much lower concentrations (≤150 ppt) during winter and spring.It should be noted that Oak Grove data exhibit peak NH3 concentrations in the spring, whereas seawater temperatures and chemistry would suggest peak concentrations over the Gulf ofMexico during the summer. Considering that fine particulate nitrate formation (i.e., NH4NO3) is promoted at lower temperatures, this implies that model calculations using Oak GroveNH3 data will tend to overestimate fine particulate nitrate concentrations over the Gulf of Mexico.

Session Associated Poster Presentations

Control Number 99

Using MOVES in Support of the Regional Haze Rule FIP Development

W. Seth Hartley[1], Andrew Shaprio[2], Mark Lee[2], Uma Shankar[3], and Sarav Arunachalam[3]

[1] ICF International, 620 Folsom St., San Francisco, CA 94107, [2] ICF International, 2222 NC 54 E, Suite 480, Durham, NC 27713, [3] UNC Institute for the Environment, 137 E. Franklin St, Chapel Hill NC 27599

Abstract

The U.S. Environmental Protection Agency recently proposed an updated Clean Air Act Regional Haze Federal Implementation Plan for Hawaii designed to manage visibility at and maintain the scenic beauty of Hawaii's two Class I areas – the Haleakala and Hawaii Volcanoes National Parks. Regional visibility impairment is caused by the aggregate emissions of air pollutants from a variety of natural and anthropogenic sources. In preparing the technical analysis to support the FIP, modeling of particulate and gaseous pollutant emissions attributable to on-road mobile sources was conducted with EPA's MOVES emissions model. Since the use of MOVES to support emissions inventory development for regional haze programs is fairly new, obstacles involving relevant data identification and collection had to be identified and overcome. This paper presents results and lessons learned in applying MOVES when developing FIP-based emissions analyses, including proper data collection and analysis methodologies and spatial allocations of emissions. A presentation and discussion of the resulting emissions in both recent and future years follows. These emission trends indicate that both statewide VMT, emissions, and on-road influence on visibility at Haleakala are dominated by Honolulu county, as expected given its urbanization. However, the relative isolation of Hawaii Volcanoes Park ensures that only emissions within Hawaii County bear significant impacts there. Although VMT is expected to increase, predicted statewide emissions of visibility-relevant species show a dramatic reduction in future years. A comparison

to prior analyses conducted with different models and data sources indicates that use of MOVES leads to significantly larger emission inventory values for particulates and moderately larger values for nitrogen oxides for recent years. In future years, significantly lower inventory values are predicted with MOVES for volatile organic compounds than with other methods. Predicted speciation profiles of the particulate emissions from the model along with contributions by source types are also discussed. Finally, an overview of use of these results in development of Hawaii's Regional Haze Program and Long Term Strategy is presented. Additional materials are available at www.regulations.gov under Docket Number EPA-R09-OAR-2012-0345 and at http://www.epa.gov/region9/air/actions/hawaii.html.

Session 16. Assessment of Haze from Natural Sources

Control Number 66

Long Term Dust Aerosol Production from Natural Sources in North-east Iceland

Pavla Dagsson-Waldhauserova[1,2], Olafur Arnalds[1], and Haraldur Olafsson[2,3]

[1] The Agricultural University of Iceland, Hvanneyri, Borgarnes, IS 311, Iceland, [2] The University of Iceland, Sæmundargata 2, Reykjavik, IS 101, Iceland, [3] The Icelandic Meteorological Office, Bustadavegur 9, Reykjavik, IS 150, Iceland

Abstract

Iceland is a volcanic island in the North Atlantic Ocean with maritime climate, mild and moist winters but cool summers. In spite of moist climate, large areas are with limited vegetation cover where >40% of Iceland is classified with considerable to very severe erosion and 21% of Iceland are volcanic sandy deserts. Natural emissions from these sources influenced by strong winds affect not only regional air quality in Iceland ("Reykjavik haze") but dust particles are transported over Atlantic ocean > 1000 km at times. The aim of this paper is to place Icelandic dust production area into international perspective, present long term frequency of dust storm events in NE Iceland, and estimate dust aerosol concentrations during reported dust events.

Meteorological observations with dust presence codes and related visibility were used to identify the frequency and the long-term changes in dust production in NE Iceland. There were annually 16.4 days on average with reported dust observations on weather stations within the NE erosion area, indicating extreme dust plume activity and erosion within the NE deserts, even though the area is covered with snow during the major part of winter. During the last decade the highest occurrence of dust events in six decades was reported. We have measured saltation and aeolian transport during dust/volcanic ash storms in Iceland which give some of the most intense wind erosion events ever measured.

Dust affects the ecosystems over much of Iceland, providing new, un-weathered materials on the surface. Icelandic dust aerosol causes regional-global scale haze. It is likely to affect the ecosystems of the oceans around Iceland, and it brings dust that lowers the albedo of the Icelandic glaciers, increasing melt-off due to global warming.

Session Associated Poster Presentation

Control Number 109

Volcanic Contributions to Haze at Hawaii Volcanoes and Haleakala National Parks

Patricia Brewer[1], John D. Ray[1], Kristi Gebhart[2]

[1]National Park Service, 12795 W. Alameda Parkway, Denver, CO 80225-0287, [2]National Park Service, CIRA, Colorado State University, 1375 Campus Delivery, Fort Collins, CO, 80523-1375

Abstract

The Regional Haze Rule requires states to improve visibility on the 20% worst visibility days and prevent any degradation of visibility on the 20% best days. The Kilauea volcano on the island of Hawaii in Hawaii Volcanoes National Park presents a unique challenge to characterize natural background visibility conditions in the presence of a significant and variable natural emissions source. This poster will present IMPROVE monitoring data, volcanic emissions data, and forward trajectory analyses to examine the potential contributions of volcanic emissions to sulfate aerosol mass at the two Parks. The poster will also discuss the implications of the natural source for evaluating natural background conditions in these two parks. The Kilauea volcano has been erupting since 1983. From 1983 to 2008, emissions from the Pu'u O'o vent were typically 2000 metric tonnes per day with occasional higher episodes. Beginning in 2008, the Halema'uma'u vent at the Kilauea Crater began emitting at 2000 metric tonnes per day, while eruptions from the Pu'u O'o were diminished. Episodes of emissions greater than 6000 metric tonnes per day have briefly occurred since 2011. Forward trajectory analyses demonstrate the predominant trade winds carry the volcanic emissions westward over the island and the Pacific Ocean. The aged volcanic emissions can be transported back east onto the island of Maui and observed at the two IMPROVE monitors in Haleakala National Park. Wind trajectories indicate that this pattern is more frequent during the winter months and least frequent during the summer months.

Session 18. Potential Impacts on Emissions from Oil and Gas Fields on Visibility and Haze

Control Number 96

Winter Photochemical Ozone Events in the Upper Green River Basin

John V. Molenar, Air Resource Specialists, Inc., 1901 Sharp Point Drive, Suite E, Fort Collins, CO 80525

Ozone is an air pollutant that can cause severe respiratory health effects, especially in children and the elderly. Traditionally, photochemical ozone production has been considered a summertime, urban phenomenon where hourly average ozone concentrations may exceed 150 ppb compared to background values of ~50 ppb. Wintertime U.S. ozone concentrations are generally 35-50 ppb. However, in February, 2005 routine air quality monitoring in rural Upper Green River Basin, Wyoming, in the vicinity of the Jonah-Pinedale Anticline natural gas field, measured hourly ozone concentration greater than 120 ppb at air temperatures as low as -17^{o}C. After verifying the validity of the ozone data, investigations lead to the realization that these winter ozone production events were occurring in the Oil and Gas development area during very specific conditions: under stagnant, cold, high pressure meteorological systems typified by low surface wind speeds; snow cover; and limited cloudiness, surface based temperature inversions trap high concentrations of ozone precursors emitted by Oil and Gas activities at night followed by rapid daytime photolytic ozone production with hourly average ozone concentrations rising from 10-30 ppb (night) to >140 ppb (shortly after solar noon). This paper will present an overview of the time period 2005-09 covering the initial discovery and studies of these events. Similar wintertime

ozone production is probably occurring around the world under comparable industrial and meteorological conditions.

Control Number 85

Implications of Oil and Gas Emissions Inventory Methodology Differences

Courtney A. Taylor[1], Linsey DeBell[1], Chris Driscoll[1], and Caitlin Shaw[1]

[1] AECOM, 1601 Prospect Parkway, Fort Collins, CO 80525

Abstract

Typically the impacts of oil and gas development projects are assessed as part of Environmental Impact Statements (EIS), which are required under the National Environmental Policy Act (NEPA) if activities are proposed to occur on federally-managed lands. As part of a NEPA analysis, the project's air emissions are estimated and a modeling analysis may be required to estimate air quality impacts. If required, an oil and gas EIS regional modeling analysis couples a project-specific oil and gas emissions inventory (EI) with a basin-wide EI.

Importantly, the project-specific EIs are developed using very different methods than the basin-wide EIs. The project-specific EIs are usually developed using a bottom-up approach with estimates of activity data for all aspects of the project, including construction, operations, and mobile sources. In contrast, basin-wide EIs are usually developed based on surveys of operations, with varying response rates. Comprehensive basin-wide EIs for oil and gas exploration and production activities are difficult to develop due to the large number of emissions sources below permit requirements, gaps or uncertainties in the emission factors, and the potential variability in operations throughout a basin.

Once the EIs are prepared for modeling, the model is run twice, once with the project-specific emissions and again without the project-specific emissions. The difference between the model-predicted impacts for these two runs is calculated and the change in impacts is attributed to the project. Since the modeled impacts are often derived using relative response factors, coupling inconsistent EIs could lead to under- or over-prediction of estimated project impacts.

For this analysis, oil and gas EI methods will be compared and evaluated. Several different project-specific, bottom-up EIs will be compared with the basin-wide EI by normalizing emissions to a per well basis. This comparison will be performed for two different basins: the Uinta Basin in Utah, and the Greater Green River Basin in Southwest Wyoming. Ideally, top-down and bottom-up EIs would provide similarly accurate and complete emission information, providing confidence in the modeling inputs. If differences between the EIs exist, these differences will be examined to determine if the differences are due to data gaps, emission factors, operational assumptions, application of control technologies, or other factors. At the conclusion of the talk, implications of EI methodology differences and uncertainties will be assessed in the context of model-predicted impacts to visibility and ozone.

Control Number 124

Trends in Oil and Gas Emissions in the Intermountain West

Amnon Bar-Ilan[1], Ralph Morris[1] and Tom Moore[2]

[1] ENVIRON International Corporation, 773 San Marin Drive Suite 2115, Novato, CA 94998, [2] Western Governors' Association, CSU/CIRA,1375 Campus Delivery, Fort Collins, CO, 80523-1375 .

Abstract

The Western Regional Air Partnership (WRAP) and the Western Energy Alliance (WEA) have been jointly co-sponsoring the development of highly-detailed, basin-level emission inventories associated with upstream oil and gas exploration and production throughout the Intermountain West. These inventories, known as the "Phase III" study have now developed inventories for the baseline 2006, midterm projected 2012 and 2015, and some 2009 calendar years. These inventories taken as a whole can be used to demonstrate emissions trends in the upstream oil and gas sector. These trends reflect the complex mix of factors influencing future year oil and gas emissions including continued development of existing resources, discovery of new resources, decline in older formations and oil and gas plays, and the impacts of regulatory requirements on oil and gas sources. This analysis presents a comparison of 2006, 2008, 2009, 2012 and 2015 inventories generated as part of the Phase III project for criteria pollutants including NOx, VOC and SOx. Emissions from specific high-tier source categories and their trends over time are examined, including compressor engines, drilling, well venting and tank and dehydrator venting. The analysis also examines control information gathered as part of the historic year inventories, and projected impacts of controls on future year projected inventories. Changes in spatial distribution of production and production types can be tracked to a limited extent through the Phase III inventories and these trends are presented. The study shows that on a per-unit-production basis, future trends in oil and gas emissions are highly variable by region, by production type, and by the control level required in the Rocky Mountain States. The study includes recommendations for tracking trends in oil and gas activity, and areas of uncertainty that can affect future inventory projections**.**

Control Number 123

Title: Measurements of Wintertime Organic Aerosol Formation in Utah's Uintah Basin, a Region with a High Level of Oil and Gas Extraction Activities

Presenting Author: Shane Murphy, Department of Atmospheric Science, University of Wyoming, 1000 East University Avenue, Laramie, WY

Coauthors, Joost DeGouw, Chemical Sciences Division, NOAA, 325 Broadway, Boulder, CO, Carsten Warneke, Chemical Sciences Division, NOAA, 325 Broadway, Boulder, CO, Jessica Gilman, Chemical Sciences Division, NOAA, 325 Broadway, Boulder, CO

Abstract:

The Uinta Basin is an area of heavy oil and gas extraction conducted primarily through hydraulic fracturing. In the winter of 2010-2011 the basin experienced numerous high-ozone events with concentrations often exceeding 100 ppb. PM 2.5 monitoring by the city of Vernal in the Uintah Basin have shown wintertime exceedances of the EPA 8-hour national standard, though the source and composition of particulates remains unclear. Filter measurements made by the Energy Dynamics Laboratory at Utah State during the winter of 2011 indicate that the average composition of PM 2.5 can be over 80% organic mass.

In the winter of 2012 we deployed an Aerodyne Aerosol Mass Spectrometer (AMS) to the Uintah Basin as part of the Energy and Environment - Uintah Basin Winter Ozone Study (E&E UBWOS). Proton transfer reaction mass spectrometer (PTRMS) and gas chromatography-mass spectrometry (GC-MS) systems were deployed alongside the AMS during the study, allowing for correlation of the reaction of gas-phase volatile organic compounds (VOC's) to aerosol formation. Despite the absence of snow cover during the study, secondary organic aerosol formation was

observed. The aerosol yields observed will be compared to those predicted by models and the potential for aerosol formation under high ozone conditions will be discussed. The fraction of aerosol formed locally versus imported into the region will also be discussed.

Control Number 128

Title: 2012 Uintah Basin Ozone Study

Author: Seth Lyman, Energy Dynamics Laboratory, Utah State University

Revised abstract: High wintertime ozone concentrations have been observed in the Uintah Basin in eastern Utah, with one hour maxima as high as 149 ppb in the winter of 2010-2011. While a number of sources of NOx and VOCs exist in the Basin from the oil and gas industry and other activity, high winter ozone has only been observed during periods of extensive snow cover, strong, sustained inversions, and clear skies. During the winter of 2011-2012, a diverse research team carried out an extensive suite of measurements throughout the region in an effort to better understand the sources, chemistry, and meteorology that lead to high wintertime ozone. The team characterized the speciation and spatial distribution of many ozone precursor sources and worked to better understand the complex wintertime meteorology in the Basin. Snow cover and inversion conditions were minimal during the winter of 2011-2012, and even though ozone precursors (especially VOCs) were abundant, ozone concentrations above the EPA NAAQS were not observed during this campaign. Several indicators of active photochemistry were observed, however, including a high mass percent of organic carbon on particulate matter samples. While PM2.5 concentrations above the EPA standard have not been observed in the Basin in recent years, precursor emissions--coupled with photochemistry--are likely to contribute to regional haze.

Control Number 90

Upper Green River Basin Winter Ozone Study

Till Stoeckenius , ENVIRON International Corp. 773 San Marin Dr., Suite 2115 Novato, CA 94998

Unusual high ozone concentrations occasionally exceeding 75 ppb (8-hour average) have been observed at monitoring sites in the oil and gas production regions of the upper Green River Basin of western Wyoming since monitoring began in 2005. These elevated ozone concentrations occurred exclusively during the late winter months (February – April). Given the unusual nature of these events and the potential human health and regulatory implications, the Wyoming Department of Environmental Quality (WDEQ) sponsored an extensive field measurement program known as the Upper Green river Winter Ozone Study (UGWOS). UGWOS was conducted in various configurations over four consecutive late winter (February – March) seasons beginning in 2007. UGWOS included both enhanced routine surface monitoring networks during each two month season and intensive monitoring of surface and aloft conditions during periods when high ozone concentrations were forecast to occur. Measurements included routine surface aerometric parameters, aircraft sampling, surface and aloft canister sampling of organic gasses, rawinsondes/ozonesondes, tethersondes, and wind profiler measurements.

High ozone levels were not observed during the first year (2007) of the study due to a lack of snow cover. More extensive snow cover in 2008 resulted in several high ozone events which were well documented by the enhanced routine and intensive monitoring activities. Additional ozone episode data were collected in 2009, 2010 and 2011.

UGWOS data are housed in annual Access database files available for download from the WDEQ website. Annual UGWOS reports describe the data that were collected during the year and presents a limited set of key analyses and conclusions. UGWOS results show that elevated ozone episodes in southwestern Wyoming are characterized by an extremely shallow surface boundary layer and light boundary layer winds. In addition, snow covered ground is shown to play a critical role due to a very high UV albedo and via enhancement of low-level stability. High early morning NOx and VOC concentrations were observed on episode days. These conditions lead to strong vertical and horizontal ozone gradients: meandering plumes of high ozone concentrations impacting specific sites within the study area were observed. Ozone formation was rapid during the mid-morning hours with no evidence of overnight carryover of aged pollutants contributing significantly to the following day's ozone levels. Data analyses and photochemical box modeling suggest that at least some of the ozone peaks occur in a VOC limited regime as concentrations of fuel combustion equipment and overall low VOC reactivity produce low reactivity weighted VOC/NOx ratios. Investigations into the primary chemical pathways leading to ozone formation under these unusual wintertime conditions are continuing. Preliminary investigations by University of Houston suggest a potentially important role of mid-day HONO formation.

Session 20. Source Attribution of Aerosol and Haze

Control Number 1

Effect of Change in Cookstove Types on Visibility – A case study using the Berkeley-Darfur Stove and Three Stone Fire

Yungang Wang*, Ashok Gadgil, Thomas Kirchstetter

Lawrence Berkeley National Laboratory, One Cyclotron Road, Berkeley, CA 94720

Presenting author: Yungang Wang

One-third of the world's population uses cook stoves to prepare their food. Inefficient biomass cookstoves can contribute to visibility degradation, deforestation, soil erosion, global warming, poor indoor and outdoor air quality, respiratory disease and unnecessarily high fuel costs. There have been a number of studies to evaluate impacts of biomass cookstove emissions on health and climate. However, the effect of biomass cookstove use on visibility has been rarely reported in the current literature. This study quantifies light scattering and absorption properties of particulate matter (PM) emitted from Berkeley-Darfur Stove (BDS) and traditional Three Stone Fire (TSF) at the Lawrence Berkeley National Laboratory (LBNL) cookstove testing facility. The BDS was designed as a fuel efficient alternative to the TSF to aid refugees in Darfur, Sudan, who walk long distances from their camps and risk bodily harm in search of fuel wood for cooking. The absorption and scattering coefficients of PM from BDS and TSF are measured using a photoacoustic absorption instrument equipped with a reciprocal nephelometer and a particle-soot absorption photometer. The BDS and TSF are compared using a modified Water Boiling Test (WBT) intended to simulate a major component of daily cooking of a common food in Darfur refugee camps. Results of statistical analyses on light scattering and absorption coefficients and the comparison of the effect of BDS and TSF on visibility will be presented. A discussion on the relationship between optical properties of biomass cookstove PM and ambient meteorological conditions will be included in the paper as well. This study will provide environmental and socioeconomic implications for developing countries where biomass cookstoves are widely being used.

Control Number 27

. Regional Ozone, Particulate Matter and Visibility Source Apportionment Modeling of the Western United States

Ralph Morris[1] and Tom Moore[2]

[1] ENVIRON International Corporation, 773 San Marin Drive Suite 2115, Novato, CA 94998
[2] Western Governors' Association, CSU/CIRA,1375 Campus Delivery, Fort Collins, CO, 80523-1375

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Abstract

The Western Regional Air Partnership (WRAP) is conducting the West-wide Jump-start Air Quality Modeling Study (WestJumpAQMS) to develop the next generation of photochemical modeling databases for the western U.S. for use in ozone, particulate matter (PM), deposition and visibility planning. The WestJumpAQMS is extending the concept of the WRAP Regional Modeling Center (RMC) by applying photochemical grid models (PGMs) using a 36/12/4 km nested grid domains with the 36 km domain covering the continental U.S. (CONUS), the 12 km domain covering the western U.S. and 4 km domains focused on the Rocky Mountain states. The Comprehensive Air-quality Model with extensions (CAMx) was applied for the 2008 calendar year and the results compared against observations in a model performance evaluation. The model was evaluated for ozone and other gaseous species, PM and speciated PM species and sulfur and nitrogen deposition. CAMx was then used to perform ozone and PM source apportionment modeling that obtained the contributions of natural emissions (i.e., biogenics plus fires), international transport (i.e., boundary conditions for the 36 km CONUS domain from a global chemistry model) and state-specific anthropogenic emissions. The PM source apportionment results were extracted for Class I areas and processed to obtain visibility impairment using the latest IMPROVE reconstructed mass extinction equation. State-specific visibility source apportionment results are reported for each Class I area. The contribution of background visibility was calculated several different ways by first including natural emissions and international transport and then adding in Canada, Mexico, and offshore shipping contributions. The background visibility estimates were compared with the natural condition goals at the Class I areas. The contributions to visibility are reported for the annual average as well as the best and worst visibility days.

Control Number 92

Source Apportionment of Primary and Secondary Fine Particles; a Hybrid Model

Timothy M. Sturtz[1], Timothy V. Larson[1], Bret Schichtel[2]

[1] Civil & Environmental Engineering, University of Washington, 201 More Hall, Box 352700, Seattle, WA 98195, [2] National Park Service, Cooperative Institute for Research in the Atmosphere, Colorado State University, 1375 Campus Delivery, Fort Collins, Colorado 80523

Abstract:

Source apportionment of primary and secondary fine particulate matter ($PM_{2.5}$) is often pursued using either chemical transport modeling (CTM) or receptor modeling. When both approaches are used on the same data, the models are typically compared post-hoc. Both modeling approaches have advantages and disadvantages. A hybrid modeling approach incorporating both CTM results as well as measured species concentrations for each sample within the Multilinear
Engine model framework provides a platform to leverage the advantages of both modeling techniques-

one set of equations describes the traditional receptor based mass balance and the other set describes the presumed linear relationship between the CTM predicted source contributions and those inherent in the mass balance model. Testing of this hybrid method was conducted using both synthetic and real-world fine particle carbon data. The synthetic data were developed using the CAPITA Monte Carlo (CMC) model and Comprehensive Air quality Model with Extensions (CAMx) to simulate primary and secondary concentrations from fire, mobile, point and area sources. Predicted source contributions from these models were taken as the "truth". Random error was then added to these predictions and used as the CTM priors. Synthetic monitored data was developed by multiplying the "true" contributions for each source by a randomly selected set of source profiles created with error from the original "true" profiles. Real-world data were obtained from the Interagency Monitoring of Protected Visual Environments (IMPROVE) network and associated CTM predictions were developed from CMC simulations of total aerosol carbon. The hybrid model was compared to the "truth" for the synthetic data and compared to the observed total carbon for the real-world data. The root mean squared error (RMSE) was used to quantify the model fit. The average RMSE over all sources in the synthetic data set were 0.23, 0.20, and 0.57 micrograms carbon per cubic meter for CMC, the hybrid model, and species-based mass balance (PMF) respectively. The RMSE of total carbon for the real world data were 4.61, 1.95, 2.12 micrograms carbon per cubic meter for CMC, the hybrid model, and PMF respectively. For the synthetic data, the hybrid model predictions compared with the "truth" by source category were improved over the CTM priors and PMF alone. For the real world data, the hybrid model showed significant improvement in predicting total carbon relative to purely species-based PMF, some of the resulting source profiles were significantly different than those from PMF alone.

Control Number 101

Source Apportionment Studies Focused on Wood Smoke in the Northern Rockies and Fairbanks, Alaska

Author: Tony J. Ward

Affiliation: The University of Montana, Center for Environmental Health Sciences

Abstract

Several valley communities in western Montana have wintertime $PM_{2.5}$ concentrations that approach (and sometimes exceed) the 24-hour $PM_{2.5}$ National Ambient Air Quality Standard (NAAQS) of 35 $\mu g/m^3$. In addition, Fairbanks, Alaska has some of the highest measured ambient $PM_{2.5}$ concentrations in the United States. $PM_{2.5}$ source apportionment programs were carried out within five western Montana valley communities as well as Fairbanks. Filter samples were analyzed for mass and chemical composition, with these data utilized in a Chemical Mass Balance (CMB) computer model to apportion the sources of $PM_{2.5}$ throughout the winter months.

Results showed that wood smoke (likely residential woodstoves) was the major source of $PM_{2.5}$ in each of the communities, contributing from 50% to ~80% of the measured wintertime $PM_{2.5}$. The other sources of $PM_{2.5}$ identified by the CMB model were secondary sulfate (8-20%), ammonium nitrate (3-11%), diesel exhaust (not detected-10%), and automobiles (not detected-7%). Approximately 1% of the $PM_{2.5}$ was unexplained by the CMB model. Results of ^{14}C analyses showed that between 44% and 76% of the measured $PM_{2.5}$ came from a new carbon (wood smoke) source. Levoglucosan, a known chemical marker of wood smoke, was also measured in elevated concentrations in some of the studied airsheds. In summary, the CMB model results, coupled with the ^{14}C and levoglucosan results, support that wood smoke is a major contributor to the overall $PM_{2.5}$ mass in Fairbanks, as well as the rural, northern Rocky Mountain airsheds throughout the winter months.

Control Number 116

Success in Reducing $PM_{2.5}$ in the Neighborhood North of the Houston Ship Channel – Voluntary Efforts Based on Field Study Results and Source Attribution

James H. Price[1], Bryan Lambeth[1], David W. Sullivan[2], Keith Sheedy[1], and Richard J. Tropp[3]

[1] Texas Commission on Environmental Quality, PO Box 13087, Austin TX 78711-3087. [2] The University of Texas at Austin, Center for Energy and Environmental Resources, 10100 Burnet Rd. Austin, TX, 78758-4445, [3] Desert Research Institute, 2215 Raggio Parkway, Reno NV 89512

Abstract

When 2005 $PM_{2.5}$ data became available in April, 2006, and the three-year average $PM_{2.5}$ concentration representing the neighborhood north of the Houston Ship Channel reached 15.0 micrograms per cubic meter ($\mu g/m^3$), the Texas Commission on Environmental Quality (TCEQ) initiated daily collection of quartz as well as Teflon $PM_{2.5}$ filter samples for chemical speciation analysis. Data analysis methods included positive matrix factorization (PMF), wind direction analysis for total mass, for species, and for PMF factors. The analyses assessed $PM_{2.5}$ and PM_{10} mass as a function of wind direction, the relationship between $PM_{2.5}$ mass and wind speed as a function of wind direction, the relation of wind direction and the contribution to the total mass concentration exceeding 15 $\mu g/m^3$, and the relation of average $PM_{2.5}$ mass to hour of the day and day of the week. The analyses identified two PMF mineral factors as the principal difference between this site (Clinton Drive) and other sites in the area. One was composed of typical soil elements. The other consisted largely of calcium sulfate, which was a byproduct of an industrial process. Voluntary efforts by local businesses, the Port of Houston Authority, and city and county governments took hold and reduced $PM_{2.5}$ concentrations significantly by the end of 2007. The paper describes these voluntary efforts. The 2005 – 2007 $PM_{2.5}$ annual averages were 15.9, 16.0, and 15.6 $\mu g/m^3$, respectively. The 2008 – 2011 averages were 14.0, 12.6, 12.3, and 12.2 $\mu g/m^3$. In 2006 the $PM_{2.5}$ average at Clinton Drive was 2.6 micrograms higher than a similar site 3 miles away; by 2009 the difference was reduced to 0.5 $\mu g/m^3$.

Control Number 122

Evaluation of $PM_{2.5}$ and PM_{10} Mass Closure Formulae

Judith C. Chow[1], John G. Watson[1], and Douglas H. Lowenthal[1], L.-W. Antony Chen[1], and Xiaoliang Wang[1]

[1] Desert Research Institute, 2215 Raggio Pkwy, Reno, NV 89511, USA

Abstract

Some of the oxygen (O), hydrogen (H), and nitrogen (N) components of $PM_{2.5}$ and PM_{10} samples are not quantified by the normally applied elemental, ionic, and carbon fraction analysis methods. These are compensated for by multipliers that assume certain chemical forms. Thirteen different weighting formulae have been applied, with the IMPROVE formula being the one most commonly used. These formulae are applied to different data sets, including those from IMPROVE acquired over 20 years in central California to determine the extent to which mass closure can be improved. The 1.8 OC multiplier is optimum for most samples at IMPROVE sites, except when there is evidence of fire and a larger multiplier is more appropriate. The 1.4 OC multiplier is more appropriate for urban areas, except when there is evidence of residential wood combustion or secondary organic aerosol. The method by which the organic vapor adsorption

artifact adds uncertainty to the weighting is described. Soil is a small fraction of $PM_{2.5}$ and mass closure is not sensitive to the weighting scheme, but different soil compositions in central California call for different weighting factors. The IMPROVE sea salt assumption is sufficient at all but coastal sites where sea salt sometime reacts with nitric acid. Characteristic ratios of measured chemical components provide indications of the source material and more appropriate weighting factors that improve mass closure.

Session Associated Poster Presentations

Control Number 18

Source signatures of atmospheric carbonaceous matter in urban-industrial environment of central India

Yasmeen F. Quraishi Pervez[1*], Neha Dubey[2], Gurugubelli Balakrishna[2] and Shamsh Pervez[**2]

[1] Department of Enggineering chemistry
Chhatrapati Shivaji Institute of Technology (CSIT), Kolihapuri, Durg, 491001

[2] School of Studies in Chemistry
Pt. Ravishankar Shukla University, Raipur, India. 492010

*Presenting author: dr.ypervez@gmail.com, , Mobile: +918966000017
** Author for correspondence: shamshpervez@gmail.com, mobile: +919425242455

Abstract

Multi-complexity in combustion processes involved and material consumed by different industrial and domestic anthropogenic activities in various urban-industrial areas of India have shown higher degree of variability in carbon fraction of classified atmospheric levels (ambient PM, personal respirable particulates and dust fallouts). An assessment of relative source contribution to carbonaceous matter found in selected atmospheric levels: ambient, indoor and surfaces, has been carried out. EV-CMB has been executed using developed source profiles representing the study area and PMF 3.0 has also been executed for results comparison in selected particle matrix. Results have shown that higher degree of variation occurred in relative source strengths of speciated carbonaceous matter; organic (OC) and elemental carbon (EC) across the urban micro-environments; residential, commercial and sensitive zones. Paved road dust has shown potential contribution to atmospheric OC in all sites (20-35%) compared to natural soils and industrial emissions. Two different industrial areas having different composition of industrial processes; one is composed of chemical, fertilizers, vegetable oils, plastic and some iron metallurgical processes, another is composed of mainly ferrous metallurgical processes have shown different pattern of relative contribution to carbonaceous matter with varied ratios across the selected receptor zones. In case personal respirable particulates (RPM), workplace indoors have shown major contribution to total carbon fractions (TC), whereas household fuel burning and outdoor industrial sources have shown comparable contribution to indoor RPM-TC with local soils and paved roads. Road-traffic emissions and industrial emissions have shown major contribution to ambient OC and EC, respectively in different strength across the selected urban receptor zones.

Key words: Carbonaceous matter, atmospheric levels, coarser and fine particulates, source apportionm

Track B

Session 2: New and Current Field Monitoring Techniques for Measuring Black Carbon and Aerosol Organic Material

Control Number 17

Diurnal Black Carbon and Visibility Trends In Los Angeles And Mexico City: A Tale Of Two Cities

D. Baumgardner[1], A. Retama[2], B. Gandrud[3]

[1] UNAM, Centro de Ciencias de la Atmosfera, Mexico City, Mexico [2] Sistema de Monitoreo Atmosférico, Mexico City, Mexico [3] Droplet Measurement Technologies

The metropolitan area of Los Angeles, with an estimated population of almost 18 million people, and Mexico City, with an estimated population of more than 20 million inhabitants, share a common problem of serious air pollution - in particular, high concentrations of black carbon (BC). Geographically they are quite different – Los Angeles is a coastal, sea level city spreading over 12000 km2 on the California Pacific Coast at a latitude of 340 while Mexico City is surrounded by mountains at an altitude of 2300 m, latitude of 19.50 and covers approximately 2500 km2 . In the Spring of 2012, two photoacoustic extinctiometers (PAX), newly developed instruments to measure the optical properties of aerosols with derived BC, were deployed in Los Angeles and Mexico City where several weeks of measurements were conducted to study the daily trends in BC concentrations, absorption and light scattering coefficients and single scattering. Some of the principal results were: • The Mexico City average, daily peak values were double those of Los Angeles but hourly maximum values were similar, reaching almost 10 µg m-3 • There are clear differences in weekday and weekend trends and maximum concentrations: Los Angeles had higher concentrations and broader peaks on weekends than weekdays while Mexico City had much higher concentrations on weekdays than weekends. • Differences between Los Angeles and Mexico City are related to contrasts in meteorology and traffic patterns, particularly boundary layer growth, wind patterns and the fraction of diesel burning vehicles. This presentation will describe the measurement technique and explain the reasons behind the similarities and differences in the daily trends in BC measurements in these two megacities.

Control Number 119

Infrared spectroscopic organic functional group analysis of IMPROVE samples

Travis C. Ruthenburg[1] and Ann M. Dillner[1]

[1] Crocker Nuclear Laboratory, University of California, Davis, One Shields Avenue, Davis, CA 95616

Abstract

The organic fraction of atmospheric particulate matter is known to affect visibility, climate and human health. The Interagency Monitoring of Protected Visual Environments (IMPROVE) program operates a

national air quality monitoring network of over 170 sites in the United States. Co-located samplers collect fine particulate matter less than 2.5 micrometers in diameter (PM2.5) on polytetraflouroethylene (PTFE), nylon and quartz filters and coarse particulate matter on PTFE filter. PM2.5 filters are analyzed by x-ray fluorescence, ion chromatography and thermo-optical carbon analysis, respectively. Currently organic carbon mass (OC) in fine particulate matter is determined by a thermo-optical method. Organic mass is calculated as the product of OC and 1.8. In order to better estimate the mass and understand the composition of the organic fraction of aerosols, PTFE filters from seven IMPROVE sites are analyzed using a Fourier transform infrared (FT-IR) spectrometer. Multivariate calibrations based on laboratory-generated standards are used to quantify individual organic functional groups present in ambient samples. FT-IR derived organic mass and OC are compared to thermo-optical OC.

Control Number 33

Field Instrument for Semi-Continuous Monitoring of Organic Marker Compounds

Jaron C. Hansen[1], Paul Cropper[1], Edgar D. Lee[2], Bob Cary[3] and Delbert J. Eatough[1]

[1]Department of Chemistry, Brigham Young University, Provo, UT 84604. 801-4222-6040, jhansent@chem.byu.edu , [2]Torion Technologies Inc., American Fork, UT 84003., [3]Sunset Laboratory, Tigard, OR 97223

The identification of sources and atmospheric formation processes which lead to particulate organic material is an important tool in understanding the causes of visibility degradation. Particulate organic compounds which are unique to a source or class of sources have been identified which aids in the apportionment of particulate organic material. Usually, the determination of these compounds is limited to a 24- hour or longer sampling period followed by laboratory determination of the compounds of interest. We have previously reported on the development of a semi-continuous monitor that collects particles, volatilizes the collected marker compounds from the particles, followed by direct in-field determination using GC/MS of the marker compounds of interest[1]. The previously reported instrument had a detection limit of about 50 ng which limited its ability to measure compounds of interest in an hour sample. We have modified the instrument to improve its sensitivity. This has included replacing the 100 µm (i.d.) GC column with a 250 µm (i.d.) column, increasing by a factor of four the capability of the MS vacuum pump and redesigning the resistively heated GC system to give more uniform heating of the column. The MS has been replaced with a new toroidal ion trap (Torion Technologies Inc.) that provides for determination of a wider range of masses with lower detection limits. The option of trapping and preconcentrating of analytes at the head of the GC column by either an air or Peltier cooler trap before transferring them to the GC has also been developed. These improvements have resulted in a 50 fold increase in sensitivity of the instrument and make possible the hourly average determination of compounds such as levoglucosan, dehydroabietic acid, steric acid, cholesterol, benzo[ghi]fluoranthene, and a7a(H), 21β(H)-hopane, the compounds used in the evaluation of the instrument. Design of the instrument, determination of detection limits and illustration of the determination of these compounds in mixtures and in ambient aerosols will be presented. The instrument will be field tested in Los Angeles this August and preliminary results from that campaign will be presented.

[1] Lin L., Lee M.L., Eatough D.J. (2010) "A Review of Recent Advances in Detection of Organic Markers in Fine Particulate Matter and Their Use for Source Apportionment", *J. Air & Waste Manage. Assoc.*, 60, 3-25.

Control Number 80

Light absorption properties of brown carbon in fresh and photo-chemically aged biomass burning emissions

Allen L. Robinson[1,2], Rawad Saleh[1], Christopher J. Hennigan[1], Gavin R. McMeeking[2], Wayne K. Chuang[1], Hugh Coe[3], Neil M. Donahue[1*]

[1]Center for Atmospheric Particle Studies, Carnegie Mellon University, USA, [2] Department of Atmospheric Science, Colorado State University, USA, [3] Centre for Atmospheric Science, University of Manchester, UK

Climate forcing calculations treat black carbon (BC) and dust as the only particulate light absorbers. Recent studies have shown that some organic aerosols, referred to as brown carbon (BrC), also absorb light. BrC has been identified in biomass burning emissions; however, its light absorption properties are poorly quantified. We have estimated imaginary refractive indices (absorptivity) of organic aerosol in fresh and photo-chemically aged biomass burning emissions. The experiments were conducted at Carnegie Mellon University (CMU) and at the US Fire Science Laboratory in Missoula, MT as part of the Third Fire Lab at Missoula Experiment campaign (FLAME 3) in 2009. The CMU experiments featured emissions from residential wood burning (oak) in a woodstove, and the FLAME experiments examined small-scale open burns of fuels consumed by wildland and prescribed fires in the US (gallberry, and pocosin pine). In both experiments, primary emissions were diluted and injected into a smog chamber, and then exposed to black lights to initiate photo-oxidation, which generated secondary organic aerosol. The evolution of smoke in the chamber was characterized using a suite of real-time instruments including a scanning mobility particle sizer, aerosol mass spectrometer, single particle soot photometer, and an Aethalometer. We used a core (BC) – shell (organic) Mie theory model to determine the absorptivity of the shell that best fits absorption measured using an Aethalometer. The organic aerosol in both fresh and aged emissions was brown, with absorptivity comparable to BC at short visible wavelengths. To illustrate the potential implication of BrC from biomass burning on climate forcing, we calculated a simple forcing efficiency.

Control Number 104

Speciation of Atmospheric "Brown" Carbon

Jeffrey L. Collett, Jr.[1], Yury Desyaterik[1], and Yele Sun[1,2]

[1] Colorado State University, Department of Atmospheric Science, Fort Collins, Colorado 80523
[2] currently at State Key Laboratory of Atmospheric Boundary Layer Physics and Atmospheric Chemistry, Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing, China

Abstract

While black carbon (BC) is the most absorbing aerosol compound in the atmosphere, light absorption by organic matter in the visible and near ultraviolet (UV) wavelength range is of growing interest. Biomass burning emissions and secondary organic products of aqueous phase atmospheric chemistry, in particular, have received attention as potentially important sources of this "brown" carbon. Here we present analysis of light-absorbing species in aerosol particles and cloud samples. Aerosol samples included both fresh and aged smoke samples from biomass burning. Cloud water was collected in eastern China. High organic carbon concentrations (up to 200 ppmC) were measured in periods where these clouds were impacted by agricultural burning emissions. Cloud samples and aqueous aerosol extracts were analyzed with a liquid chromatograph coupled with a UV/Vis diode array absorbance detector followed by a time-

of-flight mass spectrometer (ToF-MS) with an electrospray ionization source. The combination of on-line absorbance and MS detection permits us to identify compounds associated with strong absorbance in the near UV and visible. Most absorbance peaks in sample chromatograms exhibited a corresponding ion current peak, in positive and/or negative mode, in the ToF-MS. The high resolution, accurate mass spectra from the ToF-MS allow determination of the elemental composition of the detected compounds. When available, UV/Vis spectra for these compounds were compared with reference NIST spectra. Key light-absorbing compounds identified in both the aged smoke aerosol extracts and cloud water samples included nitro-aromatic compounds ($C_6H_5NO_3$, $C_6H_5NO_4$, $C_7H_7NO_4$, $C_8H_9NO_4$, $C_9H_9NO_4$, $C_7H_7NO_3$, and $C_8H_7NO_3$), and aromatic carbonyl compounds ($C_7H_6O_3$ and $C_9H_8O_3$). These compounds contributed at least 50% of the total absorbance measured in cloud samples over a wavelength range of 300 to 450 nm and were also important contributors to aged, biomass burning smoke samples. Nitroaromatic compounds were important, but not dominant light absorbing species in fresh smoke samples. Reduced nitrogen species contribute at most 8% of the total absorbance in strongly light absorbing cloud samples

Control Number 121

. Determination of Long Term Atmospheric Elemental Carbon Concentrations Using Lake Sediments

Liaquat Husain[1,2], Tanveer Ahmed[2,] Akhtar Shareef[2], and Abdul Bari[2]
[1]Department of Environmental Health Sciences, School of Public Health, SUNY Albany, Albany, NY 12201-0509, [2]Wadsworth Center, NYS Department of Health, Albany, NY 12201-0509

Black carbon (BC) or elemental carbon (EC) produced during incomplete combustion of fossils fuels, biomass fuels and forest fires strongly absorbs solar radiation and contributes to global warming. Historical atmospheric EC concentration, $[EC]_{atm}$, data is limited both spatially and temporally. These long term trend data are needed to evaluate climate models that estimate global warming. We have developed a new technique that allows to retrieve past $[EC]_{atm}$ over centuries. The long term $[EC]_{atm}$ data then can be used to : (1) compare model estimated $[EC]_{atm}$ emissions based on energy consumption; (2) to study long term trends in $[EC]_{atm,}$ and (3) shed light on reasons for variation in the concentrations. The method is based on the calibration of atmospheric deposition of EC in the lake sediments for a period of decades, and using the deposition rate and EC concentrations in the sediments determined over long periods, over several centuries, to determine the $[EC]_{atm}$. Here we report the measurements of $[EC]_{atm}$ from lake sediments of West Pine Pond (WP) reported earlier for the period ~1700 to 2005. In addition, we also report EC measurement for the period ~1000-2005 from one more lake, Deer Pond (DP), located close to WP. We also determined the EC flux for both the lakes. The comparison of historical pattern of EC flux in WP and DP between ~1700 and 2005 agreed well, within experimental uncertainties. The mean pre-industrial EC flux in WP for the period from~1700 to-1850 was found to be 0.05±0.02 $gm^{-2}yr^{-1}$ and showed excellent agreement with the value of 0.07-±-0.02 $gm^{-2}yr^{-1}$ found in DP for the period from ~1000 to1850. Also the pre-industrial EC flux from WP and DP was in excellent agreement with that obtained by *Elmquist et al.* [2007], who reported that the pre-industrial flux of EC in rural lake in Stockholm was steady with ±50% of 0.07 g/m^2yr from ~11th century up to start of 18th century. This is an important conclusion, where two sites almost ~6400 km apart gave the same pre-industrial EC flux. The mean $[EC]_{atm}$ estimated from WP for the period ~1700-1850 was found to be 62±22 ng/m^3. This is in excellent agreement with the value of 68±19 ng/m^3 found from DP for ~1000-1850 period. From the results of $[EC]_{atm}$ estimated from WP and DP, it is concluded that the preindustrial $[EC]_{atm}$ was stable around 65 +- 29 ng/m^3. The results of comparison with global models will be presented.

Session Associated Poster Presentation

Control Number 30

The impact of inorganic particles on the pyrolysis of organic carbon in thermal optical reflectance analysis in the IMPROVE network

Ann M. Dillner[1], Hege Indresand[1]

[1]IMPROVE Program, Crocker Nuclear Laboratory, University of California Davis, Davis, CA, 95616, USA

Abstract

The IMPROVE (Interagency Monitoring of PROtected Visual Environments) network measures organic (OC) and elemental carbon in PM2.5 samples at over 150 non-urban sites in the United States. The thermal optical reflectance (TOR) method is used to measure carbon as it evolves during heating. Total organic carbon is the sum of the thermal fractions OC1, OC2, OC3, OC4 and an estimate of the carbon pyrolyzed on the filter due to heating (OP fraction). Gas and particle phase OC are collected on quartz filters and measured by TOR. To correct for gas phase adsorption, the IMPROVE network collects back-up filters at 13 network sites and subtracts the monthly median carbon fractions from the back-up filters from the filters collected at all sites. Interestingly, there is typically no OP on the back-up filters. Two possible explanations include that the gas phase material does not pyrolyze or that the pyrolysis of atmospheric carbonaceous material requires inorganic particles to catalyze the pyrolysis reactions.

To determine if inorganic particles impact the amount of OP, multiple sets of four parallel ambient samples were collected on quartz filters. Each sample consisted of a front filter, a back-up filter and for the some samples also included field blanks. In the laboratory, ammonium sulfate (AS) or sodium chloride (NaCl) particles were loaded onto the ambient samples. For fourteen sampling events, one of the four parallel samples (including the front and back-up sampled filter and the blank filters) had the 95th %ile of AS in the IMPROVE network added to the filters and another had the 50th percentile of AS added to the filters. For controls, the third of the parallel samples had only air pulled through the filter and the fourth was not altered after the ambient sampling. The experiment was repeated using NaCl for four sampling events.

The back-up filters with no added particles had little or no OP as is typical for network back-up filters but those with added inorganic particles had substantial amounts of OP. The total organic carbon did not change due to the addition of inorganic particles. This suggests that the distribution of carbon fractions of gas phase artifact on the front filter is different than the distribution of the fractions on the back-up filter adding uncertainty to the OC artifact correction by fraction. The OP on the blank filters was zero for both treated and untreated filters and unchanged on the front filters.

Control Number 38

Discrimination between biomass and fossil fuel combustion using the “Aethalomer Angstrom model”: influence on air quality in different environments

Griša Močnik1, Luka Drinovec1, Irena Ježek1, Janja Turšič2, Gregor Muri2, Tanja Bolte2, Jean-Eudes Petit3, Jean Sciare3, Peter Zotter4, Andre S.H. Prévôt4, and Anthony D.A. Hansen1,5

1 Aerosol d.o.o., Kamniška 41, SI-1000 Ljubljana, Slovenia, 2 Environmental Agency of Republic of Slovenia, Vojkova 1b, SI-1000 Ljubljana, Slovenia3 LSCE, CNRS-CEA-UVSQ, Orme des Merisiers,

Gif-sur-Yvette, France 4 Paul Scherrer Institut, CH-5232 Villigen PSI, Switzerland 5 Magee Scientific, 1916A M.L. King Jr. Way, Berkeley, CA 94704, USA

Abstract

In recent years the contribution to aerosolized particulate matter from biomass combustion is increasing because of promotion of biomass as a renewable fuel, its price advantage relative to fossil fuels, and availability. However, carbonaceous aerosols have a negative impact on human health, visibility, climate change and ecosystems. Consequently, accurate determination of the contributions from different source categories is important.

The analysis of optical absorption data at multiple wavelengths using the "Aethalometer Ångström model" allows us to apportion Black Carbon (BC) and other carbonaceous aerosol components to sources from fossil fuel and biomass combustion. We determined the impacts on local air quality from these two source categories in different urban locations in Europe: Paris (France), Reiden (Switzerland), Zagorje and Nova Gorica (Slovenia), and Klagenfurt (Austria). These include locations where biomass combustion was traditionally used for domestic heating, as well as cities where biomass was not thought to play a major part in particulate air pollution. At all locations, aerosol light absorption was measured by a multi-wavelength Aethalometer (model AE31, AE33, or both), with time resolution measured in minutes. At several locations, concentrations of major anions and cations, OC and EC, levoglucosan, PAH's and trace elements were determined from collected filters or by on-line measurements.

We present the results of the source apportionment for these different locations in relation to other analyzed parameters, focusing especially on tracers of biomass combustion. Biomass emissions are a significant contributor to air pollution at all locations. The correlation between BC fraction attributed to biomass combustion and levoglucosan is excellent, with slopes which vary according to the predominant fuel. The data show diurnal cycles of biomass emissions clearly different from the diurnal cycles of fossil fuel combustion. We also perform mass closure, and show that the main contribution to PAH concentrations in winter comes from biomass combustion. The results demonstrate the greatly improved analytical performance of the new Aethalometer model AE33 for measurement of BC. Coupling the new instrument with the "Ångstrom analysis model" enables automatic real-time source apportionment of BC and other components of carbonaceous aerosols with a time resolution of 15 minutes or less.

Control Number 59

Review of Aerosol Light Absorption Measurement

Hans Moosmüller[1], Rajan K. Chakrabarty[1], and W. Patrick Arnott[2,1]

[1] Desert Research Institute, Nevada System of Higher Education, 2215 Raggio Parkway, Reno, NV 89512 [2] Physics Department, University of Nevada, Reno, Nevada System of Higher Education, 1664 N. Virginia Street, Reno, NV 89557

Abstract

The quantitative measurement of aerosol light absorption is still a challenge. Simple, commonly used filter measurements are prone to measurement artifacts due to particle concentration and modification of particle and filter morphology upon particle deposition, optical interaction of deposited particles and filter medium, and poor angular integration of light scattered by deposited particles. In situ methods measure particle absorption with the particles in their natural suspended state and therefore are not prone to effects related to particle deposition and concentration on filters. Photoacoustic and refractive index-based measurements rely on the heating of particles during light absorption, which, for power-modulated light sources, causes an acoustic signal and modulation of the refractive index in the air surrounding the

particles that can be quantified with a microphone and an interferometer, respectively. These methods may suffer from some interference due to light-induced particle evaporation. Laser induced incandescence also monitors particle heating upon absorption, but heats absorbing particles to much higher temperatures to quantify black carbon mass from the thermal radiation emitted by the heated particles. Extinction-minus-scattering techniques have limited sensitivity for measuring aerosol light absorption unless the very long absorption paths of cavity ring-down techniques are used. Systematic errors can be dominated by truncation errors in the scattering measurement for large particles or by subtraction errors for high single scattering albedo particles. Remote sensing techniques are essential for global monitoring of aerosol light absorption. While local column-integrated measurements of aerosol light absorption with sun and sky radiometers are routinely done, global satellite measurements are so far largely limited to determining a semi-quantitative UV absorption index.

Control Number 61

Development of a Supercontinuum Photoacoustic Aerosol Absorption and Albedo Spectrometer for the Characterization of Aerosol Optics

Ian Arnold[1,2], Hans Moosmüller[1], Noopur Sharma[3], Claudio Mazzoleni[3], and W. Patrick Arnott[2]

[1] Desert Research Institute, Nevada System of Higher Education, 2215 Raggio Parkway, Reno, NV 89512, [2] Physics Department, University of Nevada, Reno, Nevada System of Higher Education, 1664 N. Virginia Street, Reno, NV 89557, [3]Department of Physics, *Michigan Technological University,* 1400 Townsend Drive, Houghton, MI 49931

Abstract

The ongoing development of a novel **P**hotoacoustic **A**erosol **L**ight **A**bsorption and **A**lbedo **S**pectrometer (PALAAS) for real time, in situ, first principle measurement of aerosol light absorption, scattering, and single scattering albedo spectra is discussed. This instrument utilizes a novel broadband supercontinuum laser covering the solar spectral range from 400 to 2000 nm for simultaneous measurement of aerosol light absorption and scattering coefficients and aerosol single scattering albedo in 32 customizable spectral bands, thereby increasing the number of bands by about one order of magnitude over state-of-the-art three-wavelength photoacoustic instruments. Simultaneous absorption and scattering measurements in these 32 bands will be enabled by using prisms to (1) spatially separate the super continuum spectrum, (2) modulate each spectral band at an individual acoustic frequency with a custom optical chopper, (3) recombine the spectrum into a laser beam, and (4) send the laser beam through a photoacoustic resonator. Measurements of the scattering coefficient with a scattering sensor in the photoacoustic instrument and the absorption coefficient with the photoacoustic instrument can be achieved for all 32 wavelength bands simultaneously by decoding modulation frequencies with fast Fourier transform (FFT) analysis. This instrument will be used for characterizing carbonaceous aerosol optics, visibility impairment, and radiative forcing by providing real time, in situ, first principle measurements of aerosol light absorption, scattering, and albedo spectra covering most of the terrestrial solar spectrum.

Control Number 83

Improved Instrument for measurement of Aerosol Black Carbon with real-time compensation for Filter Loading Effects

Anthony D. A. Hansen 1 , Luka Drinovec 2 and Griša Močnik 2, 1 Magee Scientific, 1916a M.L. King Jr. Way, Berkeley, CA 94704, USA 2 Aerosol d.o.o., Kamniška 41, SI-1000 Ljubljana, Slovenia

Abstract

Several instruments offer semi-real-time analysis of aerosol Black Carbon concentrations in an air stream, measuring the optical absorption of a deposit accumulating on a filter. All of these instruments exhibit non-linearity as a function of aerosol loading. The analysis of 'conventional' Aethalometer® data reveal that the magnitude and sign of this effect shows strong variations indicative of changes in aerosol composition, appearing as a function of sampling location, season, aging and air-mass atmospheric chemistry history, and other possible factors. The new Model AE33 Aethalometer compensates for these effects by collecting two aerosol samples simultaneously in parallel, but at different rates of accumulation. Mathematical combination of the data streams in real time provides an extrapolation back to "zero loading" to provide a measure of BC concentration independent of loading effects. The algorithm also yields a real-time value of the compensation parameter 'k' which may provide additional information about the aerosol. This data is gathered at up to 7 optical wavelengths from 950 nm to 370 nm, and with time resolutions as rapid as 1 second even in 7-λ mode. This new Aethalometer also performs automatic 'dynamic zero' testing using internally filtered air; and permits the verification of its optical response using a Validation Kit of 'Neutral Density' optical elements whose absorbance is (in principle) traceable to standards. This poster will present an overview of the measurement principle; the combination of the parallel data streams; and examples of data when sampling both ambient and source-impacted atmospheres to illustrate the loading compensation, 'k' factor interpretation, and real-time source apportionment based on the wavelength dependence of optical absorption.

Session 3A: Black Carbon Emissions in Developed and Developing Countries

Control Number 8

Biomass burning contribution to ambient air particulate levels at Navrongo, in the Sahel Savannah Zone of Ghana

F.G. Ofosu [1], P.K. Hopke* [2], I.J.K. Aboh [1] S. A. Bamford [1]

[1] *National Nuclear Research Institute, Ghana Atomic Energy Commission, Box LG 80, Legon, Accra, Ghana.*
fgofosu@gmail.com, joyaboh@yohoo.com, bamford_s@yahoo.com
[2] *Center for Air Resources Engineering and Science, Clarkson University, Box 5708, Potsdam, NY 13699-5708, USA hopkepk@clarkson.edu*

Abstract

The levels of airborne particulate matter and their major sources at Navrongo a town in the Sahel Savannah Zone of Ghana was determined in this work. This area is prone to frequent particulate pollution episodes due to Harmattan dust and biomass burning mostly from perennial bushfires. The contribution of combustion emissions, particularly from biomass and fossil fuel to ambient air particulate loadings was assessed. This work was carried out from February 2009 to February 2010 in Navrongo. Gent air samplers with 47 mm nuclepore and quartz fiber filters were used to sample PM_{10} ambient air particulates into two size fractions, coarse ($PM_{10-2.5}$) and fine ($PM_{2.5}$). Elemental carbon (EC) and organic carbon (OC) concentrations were determined using Thermal Optical Reflectance (IMPROVE/TOR) method to analyze the quartz filters. Elemental composition was determined using energy-dispersive X-ray fluorescence analysis of the nuclepore filters. The average mass concentration values for PM_{10}, coarse, and fine particulates obtained at Navrongo were found to be 112 mg/m^3, 79 mg/m^3, and 33 mg/m^3, respectively. High levels of carbon species were observed in the months of

November to March being the period of Harmattan and severe bush fires. Total carbon was found to contribute approximately 40% of the ambient air $PM_{2.5}$ particulate mass. Positive matrix factorization (PMF) results suggested six sources independently contributing to $PM_{2.5}$ mass; two stroke engines, gasoline emissions, soil dust, diesel emissions, biomass burning, and resuspended soil dust. Biomass combustion (18 %) was identified as the second highest contributor to $PM_{2.5}$ particulate matter at Navrongo after soil dust.

Control Number 15

Personal Exposure to Black Carbon in Dhaka, Bangladesh

Philip K. Hopke
Institute for a Sustainable Environment
Clarkson University
Box 5708
Potsdam, NY 13699

Jeffrey Blair and Steven Blair
AethLabs, Inc.
2180 Folsom St, 3rd Floor
San Francisco, CA 94110

A personal exposure 2-wavelength aethalometer prototype was used to measure black carbon in Dhaka, Bangladesh during a two week period in December 2011. Dhaka is one of the most heavily polluted megacities in the world with dense traffic, significant coal-fired brick kilns, and extensive use of biomass burning for heating and cooking by the shanty dwellers in Dhaka. Although the official population of Dhaka is about 10 million, it is estimated that there are another 10 million uncounted inhabitants mostly living in shanties. Very few of the measurements were actual ambient concentrations, and largely reflected concentrations within offices or vehicles on the streets. Concentrations in a vehicle were as high as 175 $\mu g/m^3$. With typical indoor values in range of 10 to 20 $\mu g/m^3$. Delta-C values suggested that for the areas of Dhaka where the measurements were made, there was little contribution of biomass burning to the BC concentrations and traffic was the dominant source. Further work on the sources of carbonaceous aerosol will be presented in a companion paper by Begum et al.

Control Number 69

Atmospheric Black Carbon in $PM_{2.5}$ from Several Cities in Indonesia

Muhayatun Santoso[1], Diah Dwiana Lestiani[1], Philip K. Hopke[2]

[1]Center of Nuclear Technology for Materials and Radiometry, National Nuclear Energy Agency (BATAN), Jln. Tamansari 71, Bandung 40132, Indonesia, [2]Center for Air Resources Engineering and Science, Department of Chemical and Biomolecular Engineering, Clarkson University, Potsdam, NY 13699-5708, United States

Abstract

Samples of airborne particulate matter were collected at several cities in Indonesia: Bandung, Jakarta, and Yogyakarta from March 2010 - December 2011. The samples were collected once a week using a Gent stacked filter unit sampler in two size fractions of 2.5 µm (fine, $PM_{2.5}$) and 2.5 to 10 µm (coarse, $PM_{2.5-10}$). Black carbon was measured using an EEL Smoke Stain Reflectometer. The average of $PM_{2.5}$ during the sampling period for Bandung, Jakarta and Yogyakarta were 16.68; 16.76 and 8.58 ug m^{-3}, respectively. The average of BC in 2010 for Bandung, Jakarta and Yogyakarta were 2.85; 3.38 and 1.68 ug m^{-3}, respectively, while for the average of BC in 2011 were 3.05; 3.17 and 2.20 ug m^{-3}, respectively. When the 24 hours BC concentration is compared to the $PM_{2.5}$ concentrations, it showed that BC comprises about 10-58% of the fine particulate matter collected at Bandung, Jakarta and Yogyakarta. The average ratio of BC to $PM_{2.5}$ concentrations at Bandung, Jakarta and Yogyakarta were 20%; 22% and 25%. Bandung and Jakarta cities compared with Yogyakarta showed higher value of $PM_{2.5}$ and BC concentrations, which indicated that pollution occurred in Bandung and Jakarta are more polluted than Yogyakarta. The contribution of BC source in three cities was also discussed, ascertain the local and regional sources of BC.

Keywords: airborne particulate matter, $PM_{2.5}$, black carbon, Jakarta, Bandung, Yogyakarta

Control Number 78

U.S. Inventory of Mobile Source Black Carbon Emissions

Louis Browning, ICF International, 831-662-3683, Louis.Browning@icfi.com

Black carbon (BC) emissions are currently not accounted for in the current US GHG inventory submitted to the Intergovernmental Panel on Climate Change (IPCC). Recent studies have shown that BC is responsible for as much as 40% of current net warming (10-20% of gross warming). Because of its large effect on radiative forcing and relatively short residence time in the atmosphere, BC presents some unique opportunities for postponing the effects of climate change.
A large portion of BC emissions come from mobile sources both on and off road. This paper discusses the various sources of mobile source BC emissions and provides both emission factors by source and total inventory calculations.

BC is calculated for on-road vehicles using EPA's MOVES model and mapped to the various vehicle categories used in the IPCC submission. $PM_{2.5}$ emission factors include exhaust, crankcase and extended idle emissions but do not include tire and brake wear. Light-duty gasoline vehicles tend to have BC to $PM_{2.5}$ ratios around 21 percent, light-duty diesel vehicles tend to have BC to $PM_{2.5}$ ratios around 57 percent, and heavy-duty diesel vehicles have BC to $PM_{2.5}$ ratios around 77 percent. Heavy duty diesel vehicles and heavy duty diesel buses contribute only about 24 percent of CO_2 emissions, but they contribute over 90 percent of the BC emissions. On the other hand, light duty gasoline vehicles and trucks contribute 73 percent of the CO2 emissions but less than 7 percent of the BC emissions.
For offroad engines, suggested factors are derived from the NONROAD model using black carbon to $PM_{2.5}$ ratios found in the literature. Rail, aircraft and marine vessel emission factors are also taken from the literature. BC emissions in CO_{2eq} amount to 19.1 percent of CO_2 emissions from on-road vehicles using a 20 year horizon and over 6.8 percent of CO_2 emissions using a 100 year horizon. Around 86 percent of BC emissions come from diesel non-highway equipment and another 10 percent comes from commercial marine vessels operating on distillate fuel. Tier 4 technology for heavy-duty diesel engines reduces the global warming potential of BC emissions by a factor of 10.

Control Number 2

Organic and black carbon in PM2.5 at an urban site at Dhaka, Bangladesh

Bilkis A. Begum*1, Anwar Hossain2, Nurun Nahar2, Andreas Markwitz3 and Philip K. Hopke4

1Chemistry Division, Atomic Energy Centre, P.O. Box 164, Dhaka-1000, 2Chemistry Department, JahangirNagar University, 3Institute of Geological and Nuclear Sciences Limited, National Isotope Centre, Lower Hutt, New Zealand, 4Center for air Resource Engineering and Science, Clarkson University, NY, USA

ABSTRACT

The results from 1-year of measurements of PM2.5 mass, organic carbon (OC), and black carbon (BC) concentrations are presented for an urban traffic-influenced site, the Farm Gate in Dhaka, Bangladesh. The measurements were based on sampling using two simultaneously operating AirMetrics samplers. The concentrations of OC and BC concentrations in PM2.5 varied from 5 to 96 mg/m3 and 4 to 48 mg/m3, respectively. The concentrations of PM2.5 varied from 11 to 328 mg/m3. The particulate organic matter (POM) accounted for an average of 46 ± 11 % of the PM2.5 whereas BC was 33 ± 12%. The effects of meteorological conditions on the variability of OC and BC concentration were examined and the contribution of secondary organic aerosol to the total OC was estimated. The concentrations of OC and BC relative to the total PM2.5 are high and correlated well with wind speed and temperature. The OC/BC ratio correlated with wind speed, temperature, and sulfur concentration. Based on these relationships, we concluded that the dominant sources of BC at this site included both local and regional. The local sources are traffic, coal combustion (brick kilns) and biomass burning (rice parboiling mill, open waste burning and cooking).

Keywords: PM2.5, Organic carbon (OC), Black carbon (BC), and Particulate organic matter (POM)

Control Number 6

Characterization and Source Apportionment of Airborne Particulate Loadings at Various Receptor Site-Classes of Lagos Mega-City, Nigeria.

Fawole, O. G, Owoade, O.K., Ogundele, L. T., and Olise, F.S.

Environmental Research Laboratory, Department of Physics, Obafemi Awolowo University, Ile-Ife. Nigeria.

Abstract

Elemental characterization and apportionment of ambient airborne particulate matter (AAPM) was carried out to ascertain and update information on air quality around the major receptor site-classes of Lagos Mega-City.

Samples of two fractions (fine and coarse) of AAPM were collected on Nucleopore polycarbonate filters (0.4 and 8.0 μm) using a low volume Gent air sampler equipped with Norwegian Institute for Air Research (NILU) stacked filter unit (SFU). The elemental characterization of the samples was done using Instrumental Neutron Activation Analysis (INAA). Qualitative and quantitative source apportionment was done using Positive Matrix Factorization (PMF) with the INAA obtained elemental concentrations and uncertainties as input data.

The mean mass concentrations of AAPM (PM_{10}) were 93.3±27.2, 79.2±15.5, 48.5±21.7 and 52.7±22.1μg/m^3 for Residential (R), Heavy Traffic (T), Marine (M) and Industrial (I) sites respectively. The average value of $PM_{2.5}/PM_{10}$ ratio was 0.41±0.15 for the sampling sites in the Mega City, implying that a large chunk of the PM loadings is from the coarse fraction. The mass concentration of the particulate matter was such that, Residential>Traffic>Industrial>Marine. PM mass loading was more on weekdays

than on weekends (by a factor of about 1.5) except at the marine site-class. Thirteen (13) elements viz: Al, As, Br, Ce, Cu, K, La, Mg, Mo, Na, Sb, Sm, and Zn were detected by INAA. The correlation coefficients for As and Sb, and Br and Zn were r(As, Sb)=0.81 and r(Br, Zn)=0.71, suggest same source for these pairs of elements. Mg, Br, K and Na had the highest concentrations while the rare earth elements (REEs) (La, Ce and Sm) were detected in ultra-trace concentrations. The sources of particulate matter (PM) and their quantitative contributions were: Biomass burning (18.3 %), Crustal/re-suspended soil dust (42.3 %), industrial emission/coal combustion (2.4 %), sea salt (14.0 %) and traffic emission (23.0 %). The study found that the limits set for PM_{10} was exceeded on about 70 % of all the samples and 80 % of the samples in the residential area. The study concluded that PM loading was higher on weekdays than on weekends with the coarse fraction ($PM_{2.5-10}$) being the more dominant.

Session Associated Poster Presentations

Control Number 5

Concentrations of Particulate Matter from an Iron-Smelting Plant Located along a busy Highway in Southwestern Nigeria

Owoade, O.K., Jegede, O. O., Ayoola, M.A., Ogundele, L. T., Bashiru, M. I., Fawole, O. G, and Olise, F.S.
Environmental Research Laboratory and Meteorology Sections, Department of Physics, Obafemi Awolowo University, Ile-Ife. Nigeria.

Abstract
Measurements of the concentrations of the particulate matter (PM) have been carried out within and outside the premises of an iron-smelting plant (open-furnace type) located along a busy highway at the outskirts of the city of Ile-Ife, Nigeria (7.5^{o}N, 4.5^{o}E), simultaneously with meteorological observations between April 2011 and February 2012. The sole aim of the study was to establish the link between the PM concentration level and the local weather in the vicinity of the plant.

Samples of fine ($PM_{2.5}$) and coarse ($PM_{2.5-10}$) airborne particulate matter were collected on Nucleopore® polycarbonate filters using the low-volume GENT air sampler. This sampler was equipped with a NILU stacked filter unit and the air was sampled at the rate of 15 – 16 l/min. The particulate mass loading is quantified by the mass concentration and about 110 samples were collected for each of the particulate fractions over two major seasons (dry and wet) in Nigeria.

For the observation period, the mean concentrations of the $PM_{2.5}$ and $PM_{2.5-10}$ were 298.56 μg/m^3 and 418.50 μg/m^3 respectively, for the daytime, and 135.20 μg/m^{3}and 93.97 μg/m^3 at the nighttime. The elevated values of the coarse PM concentrations in the daytime suggest the air was highly turbid due to the low speeds of the surface wind (U < 1.5 m/s) and unstable conditions, leading to deep convective mixing and low ventilation in the vicinity of the plant. Active settling by the PM in the evening periods due to stable lapse rate is believed to be responsible for the larger concentrations of fine particulate matter. The concentrations of $PM_{2.5}$ and $PM_{2.5-10}$ during the rainy (April – October) and dry (November – March) seasons, which were 145.03 μg/m^3 and 201.84 μg/m^3, and 407.50 μg/m^3 and 153.04 μg/m^3, respectively, showed that coagulation and coalescence in the humid conditions were effective in raising concentrations of the coarse PM.

Control Number 108

Black Carbon Emission from Barbeque Activities during College Football Games

Sri Harsha Kota[1], Hongliang Zhang[1], Qi Ying[1], Yungang Wang[2], Philip K. Hopke[3]

[1] Zachry Department of Civil Engineering, Texas A&M University, College Station, TX 77843
[2] Lawrence Berkeley National Laboratory, Berkeley, CA 94720
[3] Dept. of Chemical and Biomolecular Engineering, Clarkson University, Potsdam, NY 13676

Abstract

College football games are highly popular in the U.S. and often associated with pre- and post-game barbeque activities. The objective of this study is to evaluate the impact of the barbeque activities on local air quality and to determine black carbon (BC) emission rate from a typical barbeque stove. Two two-wavelength Aethelometers (370 nm and 880 nm) were deployed side-by-side to continuously measure BC concentrations on the top of a 28 m tall building near the Kyle Field in College Station, Texas during the football season from September to November 2011. Multiple filter samples of TSP are also taken using a high volume sampler before, during and after several football games. On a typical game day there were approximately 2000 barbeque stoves in use. BC concentrations were two to five times higher during the game days than corresponding non-game days with a peak concentration of 3 $\mu g\ m^{-3}$ observed during the traditional Texas A&M vs. University of Texas on the Thanksgiving weekend. On average, BC accounts for 8% of the total PM mass on non-game days and up to 16% on game days. Using meteorology data collected from a nearby weather station 1.8 miles south-west from the sampling station and the AERMOD model, BC emission factors for a typical stove can be back calculated. Monte-Carlo simulations will be conducted to determine the uncertainties in the estimated emission rate due to uncertainties of various AERMOD model inputs. The calculated BC emission rate will be compared with reported literature values for outdoor barbeque. This method has the advantage of being able to estimate average BC emission rate under real outdoor atmospheric conditions and a variety of stove and fuel types and cooking styles. It will allow a realistic estimation of BC emissions from barbeque activities in other places, such as national parks, and could improve the estimation of visibility impairment due to these activities.

Session 3B: Black Carbon Emissions in Developed and Developing Countries

Control Number 115

The Brahmaputra River Valley: a Regional Hotspot of Black Carbon Emissions

Rajan K. Chakrabarty,* Mark A. Garro, Eric M. Wilcox, and Hans Moosmüller
Laboratory for Aerosol Science, Spectroscopy and Optics, Division of Atmospheric Sciences, Desert Research Institute, Reno, Nevada 89512, USA

*** Principal Contact**: Rajan K. Chakrabarty, Assistant Research Professor, Desert Research Institute, 2215 Raggio Parkway, Reno, NV – 89512

Abstract

The Brahmaputra River Valley (BRV) of South Asia – originating in the Tibetan Plateau and extending into eastern India – has been experiencing extreme regional climate change in recent years. In this talk, we will discuss the results from a week-long study conducted to measure black carbon (BC) aerosol concentrations at Guwahati, the largest metropolitan city in the BRV region during January and February of 2011. The median BC concentrations were found to be higher than those measured during winter months in mega cities of India and China, and significantly higher than in urban locations of Europe and USA. The

mean cloud-free surface aerosol radiative forcing due to BC aerosols in this region is estimated at -63.4 Wm^{-2} and top of the atmosphere cloud-free forcing is +11.1 Wm^{-2}. The net atmospheric absorption due to BC over Guwahati translates to a heating rate of ~2 K/day for the lower atmosphere under cloud-free conditions. The potential regional climatic impacts associated with large surface cooling and high lower atmospheric heating will be discussed.

Control Number 26

BLACK CARBON EMISSION AND AMBIENT AIR LEVELS IN DEVELOPING ASIAN COUNTRIES

Nguyen Thi Kim Oanh

Environmental Engineering and Management, Asian Institute of Technology, Thailand

Abstract

Black carbon (BC) is the toxic and light absorbing component of atmospheric aerosols that could contribute significantly to atmospheric radiation balance. BC is the product of incomplete combustion and is originated from various combustion processes. Rapid increase in the source intensity such as urban traffic, industries, and open agriculture burning in Asian developing countries build up high levels of BC in the air. This paper presents the ambient PM and BC data from 6 Asian countries (Thailand, China, India, Indonesia, Philippines, and Vietnam) measured during the period from 2000 to 2008 within the framework of the air pollution project coordinated by AIT. The BC content in $PM_{2.5}$ shows less seasonal variations than the $PM_{2.5}$ itself. On the other side the difference in BC levels between the urban and remote sites in each country is significantly larger than that in $PM_{2.5}$ levels. The BC levels reached above 50 and 30 $\mu g/m^3$ in Beijing and Manila, respectively, on some days during the dry season. For other urban areas BC was generally below 10 $\mu g/m^3$. The presence of BC at the remote sites, though at lower levels, indicates possible contribution from regional transport. Traffic, residential combustion, solid waste open burning and biomass open burning were identified, by emission inventory, as the major BC emission sources in Southeast Asia countries.

Keywords: black carbon, urban air levels, remote area levels, emission sources, Asia

Control Number 114

Significant Contribution of Emissions from Asian Religious and Cultural Activities to Atmospheric Brown Clouds

Shamsh Pervez[1*], Rajan K. Chakrabarty[2], Shippi Dewangan[1], and Yasmeen Pervez[3]

[1]School of Studies in Chemistry
Pt. Ravishankar Shukla University, Raipur, CG, 492010, India, [2]Division of Atmospheric Sciences
Desert Research Institute, Reno, NV, USA, 89512, [3]Department of Engineering Chemistry
CSIT, Kolihapuri, Durg, CG, 491001, India

Abstract

Atmospheric brown clouds (ABC), observed as widespread layers of brownish haze over Asia, are regional scale plumes of air pollutants, consisting of mainly aerosol particles such as black carbon. ABCs are believed to have played a major role in regional climate and hydrological cycle changes and in masking as much as 50% of the surface warming due to the global increase in greenhouse gases. This presentation will provide, for the first time, an estimate of the contribution of carbonaceous aerosols emitted from various combustion activities (both outside and indoors) involved during daily and seasonal rituals and cultural activities in India and Southeast Asia to ABCs. Our findings show that religious and

ritual activities emit a significant total carbon fraction of 174.67±21.84 Gg/year. Multi-wavelength optical characterization of particulate emissions reveals that particles contain both black and brown carbon. In summary, this talk will highlight – 1) the complicated types of carbonaceous aerosols emitted from cultural practices and their contribution to ABCs, 2) the urgent necessity to incorporate the emission factors into global carbon inventory, and 3) the incorporation of the optical properties of particulate matter into radiative forcing models for accurate characterization of global warming.

Session 5. Biomass Burning, Carbonaceous Aerosols and Short Lived Climate Forcers Effects on Haze and Climate

Control Number 117

Anticipating Biomass Burning Under Climate Change -- A Strategy for Developing Inventories Suitable for Projecting Future Impacts

Brooke L. Hemming, Ph.D., US EPA National Center for Environmental Assessment, 109 TW Alexander Drive RTP, NC 27711

Abstract

Black carbon-containing particles produced by combustion of fossil fuels are understood to absorb solar radiation with the greatest efficiency. However, a largely unexplored source of light absorbing carbon -- uncontrolled biomass combustion including wildfires, prescribed burning and agricultural burning -- may be an increasingly important contributor to atmospheric light absorption as traditional soot sources are controlled and alternative, less polluting, fuels are adopted. An array of climate-related changes in wildland and managed ecosystems due to shifting global isotherms (warming), changing precipitation patterns (drought alternating with periods of heavy precipitation) and increasing vulnerability to disease and insect damage, are expected to result in significant increases in the incidence of wildfire. Ambient observations of wildfire plumes have shown that, while these emissions contain less black soot than fossil fuel combustion plumes, the other forms of light absorbing carbon (brown carbon, BrC) present in the plume also contribute to light absorption. Accounting for these materials in present and future climate studies requires more detailed accounting for organic materials than is currently available in biomass burning inventories. The organic compounds present in biomass combustion plumes are known to vary as function of fuel type, fuel load and other burning conditions. Changing climate will alter these variables: geographic distribution of plant species will differ from the present; fuel loadings will be affected by drought-heavy precipitation cycles, and; burning conditions will change with the new meteorological patterns anticipated under warming climate conditions. The biofuels engineering literature, among other fields, offers useful insight into the relationship between biomass type, and burning conditions and the chemical composition of the resultant emissions. A strategy for developing biomass emissions inventories with sufficient detail to account for climate-relevant change will be suggested in this presentation.

Control Number 74

Comparative Fire Emissions Analysis for the DEASCO3 project and the EPA 2008 NEI

Tom Moore[1], Matthew Mavko[2], David Randall[3], Mark Fitch[4]

[1]Western Governors' Association, CSU/CIRA, 1375 Campus Delivery, Fort Collins, CO 80523-1375
[2]Air Sciences Inc., 111 SW 5th Avenue, Suite 2080, Portland, OR 97204
[3]Air Sciences Inc., 1301 Washington Avenue, Suite 200, Golden, CO 80401

[4]National Park Service, Fire Management Program Center, 3833 South Development Avenue, Boise, ID 83705

Abstract

As part of a project examining fires' contribution to ozone for the purposes of SIP support, we are building a detailed retrospective national "planning-grade" fire emissions inventory for the year 2008. Methods used will build off of previous inventory work done for the WRAP, including the 2002 emissions inventory, and the on-going Fire Emissions Tracking System (FETS). The basis of the 2008 emissions inventory is the existing FETS database, which includes planned and accomplished burned reports for several western states within the WRAP region. To gather additional activity data, the FETS database will be expanded to accept data from additional sources, including the national Monitoring Trends in Burn Severity (MTBS) data set, NOAA's Hazard Mapping System (HMS) data, and ground-based reports from areas outside the WRAP region. We will employ a reconciliation process to match ground-based activity tracking with HMS and MTBS data. We will classify detects without a match using related, observed data. Emissions will be calculated for all burns using CONSUME and the latest 30m FCCS layer, and MTBS burn severity. Other supporting information will be used to aid emissions calculations, including daily precipitation maps produced by NWS and fuel moisture from WIMS. We will employ quality assurance across the data stream and external review of the estimated emissions as well. Calculated fire emissions from our project will be compared to those from the EPA 2008 NEI for selected regions and time periods. We will present the differences in space, time, and emissions magnitudes to assist NEI and our project users in understanding the emissions results and evaluating the methodologies behind the reported emissions. Reported fire totals at the State and Federal level for 2008 will be used to the extent possible to evaluate the performance of each methodology.

Control Number 77

Contributions of biomass burning and other sources to fine particulate carbon at rural locations throughout the United States

Bret A. Schichtel[1], Marco A. Rodriguez[2], Michael G. Barna[1], Kristi A. Gebhart[1], Leigh A. Patterson[4], Jeffrey L. Collett[4] and William C. Malm[2]

[1]National Park Service, Cooperative Institute for Research in the Atmosphere, Colorado State University, Fort Collins, Colorado 80523-1375; [2]Cooperative Institute for Research in the Atmosphere, Colorado State University, Fort Collins, Colorado 80523-1375, [3]Atmospheric Modeling Division, National Exposure Research Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, [4]Department of Atmospheric Science, Colorado State University, Fort Collins, Colorado, 80523-1371

Carbonaceous compounds are a significant component of fine particulate matter (PM2.5) and contribute to haze in class I areas. The Regional Haze Rule sets the goal of returning visibility on the worst haze days to natural conditions by 2064. To achieve this goal, it is necessary to understand the contributions of natural and anthropogenic sources to the particulate carbon in class I areas. To address this need, a receptor-oriented, Lagrangian particle dispersion model with highly simplified physical/chemical processes was developed to simulate PM2.5 total carbon (TC) concentrations and the contributions from wildfire, vegetation, mobile, area, and other sources in rural areas. The model was used to simulate the TC at rural IMPROVE monitoring sites from 2006-2008. Modeling evaluation revealed potential spatial and temporal biases in the model results. To reduce these biases and refine the source attribution results an inverse modeling approach was used that regressed the source attribution results against the measured TC data using a Bayesian regression method. In this presentation, the seasonal and spatial patterns of the refined source contributions from 2006 through 2008 are presented. During the summer months, the TC

was predominantly due to biomass burning and secondary organic carbon from vegetation. Smaller contributions from area and mobile sources also occurred. During the winter months, vegetation and biomass burning had smaller contributions, while the relative contributions from mobile sources increased, and area sources were the largest contributor, accounting for about half of the TC. Different fire seasons were also evident, with large contributions during the summer months due to wildfires and smaller contributions during the spring and fall when prescribed and agricultural fires regularly occur.

Session Associated Poster Presentations

Control Number 120

Carbonaceous Aerosol Determination in an Urban and a Rural Site in the Philippines

Angel T. Bautista VII[1], Preciosa Corazon B. Pabroa[1], Joseph Michael D. Racho[1], Flora L. Santos[2] and Leni L. Quirit[3]

[1]Philippine Nuclear Research Institute, Commonwealth Ave., Quezon City 1101, Philippines,
[2]Notre Dame de Vie Institute, 383 Sentinela Road Brgy. Encanto, Angat 3012, Bulacan, Philippines,
[3]Institute of Chemistry, University of the Philippines, Diliman, Quezon City 1101, Philippines

Abstract

Carbonaceous aerosol, broadly classified into organic carbon (OC) and elemental carbon (EC), are atmospheric particulates known to have significant effects to health, climate, and visibility. Concentrations of OC and EC in the $PM_{2.5}$ range were measured for an urban (Valenzuela City, Metro Manila) and a rural (Angat, Bulacan) site in the Philippines from September 2011 to February 2012. The method employed was thermal-optical reflectance (TOR) following the IMPROVE_A protocol. As expected, OC (8.77 ug/m^3) and EC (6.89 ug/m^3) levels were higher in the urban site compared to the rural site (OC: 4.60 ug/m^3, EC: 2.58 ug/m^3). OC accounted for 24.1% and 14.2% while EC for 19.2% and 8.2% of the whole $PM_{2.5}$ mass for the urban and rural sites, respectively. Compared to cities of neighboring countries in Asia, OC levels of the urban site are generally lower while EC levels are higher than most, with OC/EC ratios of about 1.33. This suggests the dominance of combustion sources with minimal secondary organic aerosol formation and highlights the need for regulation of such emissions. Comparison with black carbon (BC) levels obtained through reflectometry (a method currently used for monitoring in the country) shows that EC levels obtained using TOR were poorly correlated with BC and are generally lower by about a factor of 2. This is probably due to the presence of other light-absorbing particulates other than EC. Further efforts are necessary to better understand the nature of carbonaceous aerosol and its possible sources by investigating specific carbon fractions and by exploring their possible application for source apportionment.

Control Number 12

Data Processing Technique for Multiangle Lidar Sounding of Poorly Stratified Polluted Atmospheres. Theory and Experiment

Cyle Wold[1], Vladimir Kovalev[1], Alexander Petkov[1], Wei Min Hao[1]

[1]USDA Forest Service, Missoula Fire Sciences Lab., 5775 Highway 10 West, Missoula, MT 59808

Abstract

Scanning elastic lidar is the most appropriate remote sensing tool for investigating the optical properties of smoke-polluted atmospheres. However, current researchers are not able to extract the full information that scanning lidar data contain. Moreover, most multiangle solutions for

extracting the optical characteristics of the sounded atmosphere work satisfactorily only in atmospheres well-stratified horizontally. When working in real atmospheres, even a slight deviation from the required atmospheric stratification may result in an unacceptable measurement error, especially, in clear or relatively clear atmospheres. This is why the inversion of multiangle lidar signals into vertical aerosol profiles is generally considered an ill-posed and ill-conditioned problem.

The data processing method developed at the Missoula Fire Sciences Laboratory is based on the transformation of the ill-conditioned Kano-Hamilton solution into a modified well-conditioned solution. This is achieved through a combination of lidar inversion techniques used in multiangle and one-direction measurements.

The improvement achieved with this combined method stems from the difference in the measurement accuracy when determining different profiles extracted from the linear fit of the logarithms of the signals measured in different slope directions. These signals allow extracting vertical profiles of the optical depth and the backscatter coefficient by determining the slope of the linear fit and its intersect with the vertical axis, respectively. In many cases, the backscatter coefficient is determined with better accuracy than the differential optical depth. Moreover, using the inversion methods recently developed by the authors, one can significantly improve this accuracy.

The extraction of the profiles of the extinction coefficient of interest from the profile of the relative backscattering is an additional issue, which has no common solution. The authors' approach to this problem is based on applying a set of solutions with different restricting assumptions and determining the altitude intervals where the discrepancies in the extracted profiles obtained with these selected solutions do not exceed acceptable boundaries.

In the report, the theory of a new lidar data processing technique will be presented along with the results of processed experimental data.

Control Number 65

Aerosols during Moscow extreme smoke event of August 2010: physico-chemistry and long range transport in Europe

Olga Popovicheva[1], Elena Kireeva[1], Natalia Persiantseva[1], Magdalena Kistler[2], Lila Diapouli[3], Kostas Eleftheriadis[3]

[1] Moscow State University, Leninskie Gory 1, Moscow, 119234, Russia, [2] Vienna University of Technology, Getreidemarkt 9//164, 1060, Vienna, Austria, [3] N.C.S.R. "Demokritos", Ag. Paraskevi, 15341, Attiki, Greece,

Abstract

Current ability to predict the climate changes and health impacts is strongly limited by large uncertainties associated with characterization of biomass burning (BB) aerosols emitted by intensive wildfires. This study report data about aerosol physico-chemistry of extreme smoke event in Moscow and of fires in central European part of Russia at distant monitoring in Europe in August 2010. Aiming to help fulfilling the gap that exists for characterization of wildfire smoke characteristics in the Moscow region, detail physico-chemical characterization of aerosols from experimental fires derived in flaming and smoldering processes is presented. Broad chemical features are inferred from elemental analysis, analysis of EC and OC, molecular biomarkers, ionic content, and organic/inorganic functionalities. Individual particle analysis performed by scanning electron microscopy provides the morphology and composition of smoke aerosols at the microscopic level. The extended approach for application of the hierarchic cluster

analysis is elaborated to describe the types of BB aerosols according to their morphology and chemical composition. Fresh-emitted open fire smoke, aerosols aged in urban atmosphere during extreme smoke event in Moscow, and smoke plume in Athens, identified by back trajectory analysis, are quantified by a number of characteristic groups representative for environmental and climate concern. Together with organic/inorganic structure, ion content, and biomarkers composition they show that smoke aerosols composes a broad class of morphologically and chemically heterogeneous species which always undergo some form of physical change or evolution during transport and aging. The data presented here improve the our knowledge base for the type of aerosols emitted from wildfires, especially due to frequent break outs in Russia and Europe, leading to extreme smoke episodes, affecting profound visibility, public health and mortality.

Control Number 132

High Park Fire 2012 Smoke Impacts on Air Quality in Fort Collins, Colorado

Christian M. Carrico, Vincent R. Scheetz, AECOM, Inc. Fort Collins, CO 80525.

Biomass smoke from wildland fire is an emerging concern for impacts on visibility, climate feedbacks, human health, and air quality regulatory compliance. Fundamental smoke physical and chemical properties play a large role in determining impacts. During June 2012, the High Park Fire burned in the Roosevelt National Forest near Fort Collins, Colorado. It was the most damaging wildfire in Colorado history, burning over 87,000 acres and 250 homes, though damages were soon eclipsed by the nearby Waldo Canyon Fire. Severe episodic smoke impacts on air quality resulted, affecting hundreds of thousands of residents on the Front Range of Colorado. During the High Park Fire, we measured $PM_{2.5}$ mass concentrations and sub-0.5 micrometer diameter particle size distribution. The $PM_{2.5}$ instrument was operated indoors in a lab facility near the fire boundary to determine worker exposure. The ambient particle size distribution measurement was located approximately 8 miles further east of the fire. One-hour $PM_{2.5}$ concentrations episodically exceeded 100 $\mu g/m^3$, and were particularly elevated during early morning periods of atmospheric stability. The dominant number size mode varied considerably during smoke episodes, but ultrafine particles predominated number distributions. Typically coincident episodes at the two sites demonstrated that the smoke impacted a wide region. The dataset is investigated to yield insights into fresh biomass smoke properties and air quality impacts.

Control Number 135

PM2.5 Emissions from wood burning in Butte, Montana

Kumar Ganesan, Department of Environmental Engineering, Montana Tech of the University of Montana, Butte, Montana

(Abstract not found in data base)

Session 7. Satellite and Other Remote Sensing Applications to Haze/Aerosol Monitoring

Control Number 16

An iterative fitting algorithm for matching aerosol size distributions to spectral extinction data

Ratish Menon[1], Rudolf B. Husar[2] and Virendra Sethi[1]

[1]Centre for Environmental Science and Engineering, IIT Bombay, Mumbai- 400076, India
[2] Department of Energy, Environmental and Chemical Engineering, Washington University in St.Louis, St.Louis, MO - 63130

Abstract

An iterative algorithm has been developed to retrieve aerosol size distribution from the spectral extinction measurements. The algorithm considers the aerosol size distribution to be made up of fixed number of narrow log-normal distributions (sigma =1.2) in the size range from 0.1μm to 5 μm, equally spaced on a log-scale with spacing equal to their geometric standard deviation. These narrow distributions have a common complex refractive index, m=1.5, n=0.01. The total extinction by the overall size distribution is the sum of the contributions from individual narrow log-normal distributions. The key component of this algorithm is an automated iteration scheme that selectively modifies the volume of individual log-normal distributions until there is an optimal fit between observed and computed spectral extinction. The fitting procedure uses heuristic constraints that are incorporated in the initial conditions. Smallest initial size is 0.4 μm, incremented downward until the fitting errors stabilize. Initially, a gap between fine and coarse particle modes (0.7-3.0 μm) is introduced and iteratively filled with mass. The coarse particle contribution is handled by the addition of spectrally neutral extinction. An uncertainty envelop is proposed for the retrieved size distributions based on the ambiguity in aerosol refractive index and due to non-uniqueness in size distribution especially on the lower and upper end of the narrow optical measurement window. The paper presents example results of this algorithm as applied to the AOT data from Aerosol Robotic Network (AERONET). The results of the retrieved volume size distributions confirm the nearly universally occurring mode in the 0.2-0.4 μm size range. However, in many instances another mode around 1.0 μm is also evident. This paper also demonstrates the usability of retrieved size distributions in multi-sensory aerosol characterization at various global locations.

Control Number 44

Developing a High-Spatial Resolution Aerosol Optical Depth Product Using MODIS Data for Evaluating Aerosol During Large Wildfire Events

Jennifer L. DeWinter[1], Sean M. Raffuse[1], Michael C. McCarthy[1], Kenneth J. Craig[1], Loayeh K. Jumbam[1], Scott Fruin[2], Fred W. Lurmann[1]

[1] Sonoma Technology, Inc., 1455 N. McDowell Blvd., Suite D, Petaluma, CA 94954
[2] Keck School of Medicine, University of Southern California, Los Angeles, CA 90089

Satellite-derived Aerosol Optical Depth (AOD), a measure of atmospheric aerosol loading determined by a satellite-based measurement, has been used to understand spatial variations in aerosol that are not well-represented by ground-based monitoring, often because of sparse monitoring networks. Remotely sensed AOD can be particularly useful during wildfire events when aerosol levels can vary widely over small spatial scales depending on the location of the smoke plume, vertical mixing, and prevailing winds. However, the standard AOD product at 10 x 10 km spatial resolution, available from the NASA Moderate Resolution Imaging Spectroradiometer (MODIS) instrument, can be too spatially coarse to adequately capture intra-urban variability or other fine-scale variations near smoke plumes during wildfires. In addition, the assumed aerosol optical

properties used for the standard NASA product are not representative of biomass burning aerosol, there are often missing AOD data due to failed retrievals over the bright land surfaces of the western United States, and the cloud masking algorithm can incorrectly label heavy smoke as clouds. To improve the usefulness of the AOD product during wildfires, we developed a localized AOD product covering Northern California at 500-meter spatial resolution using raw MODIS data for the summer of 2008, a period with multiple large and lengthy wildfires in the region. The algorithm uses local biomass burning aerosol optical properties, local surface reflectance data, and a "relaxed" cloud filter. The high-resolution AOD was regressed against hourly surface-based $PM_{2.5}$ concentrations observed at monitors throughout the domain; results show that the AOD explains more than 50% of the variance in hourly surface $PM_{2.5}$ concentrations observed during the wildfires. The AOD-$PM_{2.5}$ relationship was then used to estimate surface-layer particulate concentrations that can be used for exposure assessment. We will present our methodology for developing high-resolution estimates of AOD over California during the 2008 Northern California fires and will discuss extensions of the product to better characterize visibility and haze during smoke events.

Control Number 55

Understanding the Spatial Resolution of Satellite Observations of Aerosols: the Example of MODIS

Edward Hyer (1), Douglas Westphal(1), Jeffrey Reid (1), Jianglong Zhang (2), James Campbell (1) Cindy Curtis (1)

(1) Marine Meteorology Division, Naval Research Laboratory, Monterey, CA 93943
(2) Department of Atmospheric Sciences, University of North Dakota, Grand Forks, ND 58202

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Abstract:

Satellite data are potentially valuable to air quality studies in that they can provide spatial coverage of a domain that is far greater than what can be achieved with sparse ground networks, and they can be used for initialization of atmospheric models for short-term forecasting of air quality. The last few years have seen a proliferation of satellite aerosol products which deliver estimates of aerosol optical depth as their primary retrieved parameter. However, aerosol optical depth from the surface to the top of the atmosphere is an inexact match to visibility, and is only indirectly related to particulate concentrations at the surface which are most important for health impacts. Satellite information can be used for both of these applications with careful consideration of the relationship between the air quality metrics and what the satellite is capable of observing directly. This talk discusses a range of satellite aerosol products in the context of this relationship. Visual interpretation of satellite data as well as quantitative applications such as aerosol data assimilation will be discussed. The talk will highlight several hazards of face-value application of satellite aerosol products to air quality applications, paying special attention to vertical distribution of aerosol, spatial resolution effects, temporal sampling effects, and sources of error and uncertainty in the satellite data.

Control Number 81

Airborne High Spectral Resolution Lidar Measurements Relevant to Air Quality

Michael D. Obland[1], Richard A. Ferrare[1], Sharon P. Burton[1], Amy J. Scarino[2], Raymond R. Rogers[1], Chris A. Hostetler[1], Johnathan W. Hair[1], Anthony L. Cook[1], David B. Harper[1], James J. Szykman[1], James H. Crawford[1]

[1]NASA Langley Research Center, Hampton, Virginia, 23681-2199 , [2]Science Systems and Applications, Inc., Hampton, Virginia, 23681

Abstract

The NASA airborne High Spectral Resolution Lidar (HSRL) has been deployed in nineteen atmospheric measurement campaigns and collected over 1100 hours of data during nearly 350 flights since 2005. Profile measurements of aerosol extinction (at 532 nm), backscatter (at 532 and 1064 nm), and depolarization (at 532 and 1064 nm) along the aircraft flight track, many of which were taken in coordination with other participating research aircraft, satellites, and ground sites, constitute a diverse data set for use in characterizing the spatial and temporal distribution of aerosols, as well as properties and variability of the Planetary Boundary Layer (PBL). The high spectral resolution technique allows for independent determination of aerosol backscatter and extinction. These properties can then be combined with other HSRL measurements to determine aerosol type within 8 classifications and partition aerosol optical depth between these classifications. Knowledge of the aerosol type, amount, and altitude relative to the boundary layer provides data relevant to air quality at the surface and long-range transport of aerosols above the boundary layer.

This work examines the variability of the PBL during the NASA-funded DISCOVER-AQ mission (Deriving Information on Surface Conditions from Column and VERtically Resolved Observations Relevant to Air Quality). During this campaign, the HSRL instrument flew on board the NASA King Air aircraft and executed 26 flights (104 hours) along a consistent ground track in conjunction with in situ aerosol measurements from ground-based instruments, radiosondes, and instruments on board the NASA P-3 aircraft. Spatial and temporal statistics of PBL height are presented.

Control Number 93

Remote Sensing of Surface Visibility from Space: An East Coast Case Study

Amy L Gehring[1], Jun Wang[1], Robert C. Levy[2,3], Lorraine A. Remer[4], and Peter R. Colarco[3]

[1] Department of Earth and Atmospheric Sciences, University of Nebraska - Lincoln, Lincoln, NE, 68588, [2] Science Systems and Applications, Inc., Lanham, Maryland, 20760, [3] NASA Goddard Space Flight Center, Greenbelt, Maryland, 20771, [4] University of Maryland Baltimore County, Baltimore, Maryland, 21250

Abstract

Visibility is a good indicator of air quality, and thus accurate measurement of atmospheric visibility is important for health reasons as well as for the safety of both aviation and ground transportation. Currently, measurements of visibility are limited by a lack of spatial coverage in areas where visibility is important but not measured, such as around highways and national parks. In this study, an evaluation of remote sensing techniques to determine surface visibility is performed. Aerosol optical depth (AOD) measurements from the MODerate Resolution Imaging Spectroradiometer (MODIS) are compared with one-minute extinction coefficient (visibility = $3.0/b_{ext}$) data from the Automated Surface Observing System (ASOS). However, since the one-minute ASOS data currently lack quality control regulations, methods for quality control are developed. These methods include steps to limit unrealistic variability, poor calibration, and inconsistent formatting. Different protocols for spatial averaging of the MODIS data (1x1, 3x3, and 5x5 pixels) are tested against temporal averages of the ASOS data (±15, ±30, ±60, and ±90 minutes) to compare the two datasets for the East Coast region for the years 2000 to 2010. Data from the Goddard Earth Observing System Model Version 5 (GEOS-5) is

incorporated to account for the vertical distribution of aerosol in the atmosphere through three techniques: 1) dividing out the Planetary Boundary Layer from MODIS AOD, 2) using the model data as a scalar for MODIS AOD, and 3) a combination of the first two techniques. Preliminary results show moderate correlations between MODIS AOD and ASOS extinction coefficient with higher correlations during summer months and lower correlations during winter months. Furthermore, incorporation of vertical profile information from GEOS-5 generally improves the correlation for all three techniques.

Control Number 93

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Abstract

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Session Associated Poster Presentation

Control Number 68

PLNET Data Products and Applications for Aerosol Transport and Air Quality Studies

Timothy A. Berkoff[1,2], John T. Sullivan[1], Alexandra St. Pé[1], Daniel Orozco[1], Rubén Delgado[1], Raymond M. Hoff[1], Ellsworth J. Welton[2], Kevin S. Repasky[3], and Joseph A. Shaw[3]

[1]University of Maryland Baltimore County, Baltimore, Maryland 21250, [2]NASA Goddard Space Flight Center, Greenbelt, Maryland 20771, [3]Montana State University, Bozeman, Montana 59717

Abstract

The NASA Micro-Pulse Lidar Network (MPLNET, see: http://mplnet.gsfc.nasa.gov/) is a federated network of Micro-Pulse Lidar (MPL) systems designed to measure aerosol and cloud vertical structure continuously, day and night, over long time periods required to contribute to climate change studies and provide ground validation for satellite sensors in the Earth Observing System (EOS) and related aerosol modeling efforts. Most MPLNET sites are co-located with NASA Aerosol Robotic Network (AERONET) sunphotometers. These joint super sites provide both column and vertically resolved aerosol and cloud data, such as: optical depth, single scatter albedo, size distribution, aerosol and cloud heights, planetary boundary layer (PBL) structure and evolution, and profiles of extinction and backscatter. MPLNET results have contributed to studies of dust, biomass, marine, and continental aerosol properties, the effects of soot on cloud formation, aerosol transport processes, and polar clouds and snow. MPLNET data has been used to validate and help interpret results from NASA satellite sensors such as GLAS, MISR, and TOMS. MPLNET is a federated network, and is composed of our own sites, and others run by, or with help from, partner research groups from around the world. Principal investigators for individual sites may be from NASA, other US government agencies, universities, or foreign research groups.

In this presentation, we will describe MPLNET data products in general and show examples in the use of results for air quality and aerosol transport applications. Montana State University has recently joined MPLNET, enabling long-term records of aerosol profiling at the University's Bozeman Montana campus. The system remained operational all through 2011 and is now undergoing calibration at NASA Goddard in 2012 needed to generate future quality assured data products. Even though the 2011 data are in preliminary form, they are still useful for qualitative assessments and determination of layer heights. Numerous aerosol features were observed in 2011, including smoke from Pacific Northwest and Canadian wildfires, inter-continental transport from Asia, in addition to boundary layer dynamics. Examples will be presented using the Bozeman site data to illustrate various cases and how vertical profiling can be used to characterize and assess the impact of aerosols.

MPLNET is funded by the NASA Earth Observing System (EOS), and the NASA Radiation Sciences Program. In the past, additional funding for research cruises at sea was provided by the NASA SIMBIOS project.

Session 8. Aerosol – Optical Relationships

Control Number 7

Long-term Trends and Characteristics of Visibility in Two Megacities of Southwest China: Chengdu and Chongqing

Yuan Chen[1] and Shao-dong Xie[1]: [1]College of Environmental Science and Engineering, Peking University, No.5 Yiheyuan Rd, Haidian District, Beijing 100871, P.R. China

Abstract

Visibility is widely recognized as an excellent indicator of air quality, since it reflects the combined influences from atmospheric pollutants and synoptic processes. Visibility trends, along with their relationships with various meteorological factors and PM_{10} pollution, in the two megacities of Chengdu and Chongqing in southwest China were analyzed using the daily data from National Climatic Data Center and Air Pollution Index (API) from Ministry of Environmental Protection of China. Average annual visibility in the period of 1981-2010 in Chengdu and Chongqing were 7.8±3.6 and 5.6±3.7 km, respectively. Visibility trends in both cities have shown deteriorations when compared with those in 1980s and 1990s, although a minor visibility recovery with synchronous PM_{10} reductions were observed in recent

years. Moreover, only 8% of APIs belonged to the category of clean air and PM_{10} dominated 80% of the primary pollutants. The current PM_{10} levels in Chengdu and Chongqing were 111 and 107 $\mu g\ m^{-3}$ in 2011.

Correlation and Principal component analysis (PCA) were carried out to investigate the key factors affecting visibility. Visibility only shows a weak correlation with PM_{10}, due to the changes in size distribution of particles. In Chengdu, visibility displayed weak correlations with various factors, whereas visibility was most strongly related with relative humidity in Chongqing, as more hygroscopic components in particles. PCA results further confirmed that high relative humidity and low wind speed enhance the formation of low visibility event under high PM_{10} concentrations. Temperature and pressure also played important roles in affecting visibility as they were indicators of weather system. Mathematical models for visibility prediction indicated that visibility was most sensitive to reduction in PM_{10} concentration. More information about $PM_{2.5}$ and other gaseous pollutants would improve the accuracy of the models. This study would be helpful in understanding visibility degradation in southwest China, evaluating the impact of particulate pollution and proposing possible improvement measures.

Control Number 9

Characterization of secondary aerosol and its extinction effects on visibility over Pearl River Delta Region, China

Xuejiao Deng1 , Dui Wu1, Jianzhen Yu2 , Alexis K. H. Lau2,Xiuji Zhou3 , Zibing Yuan2, Wai Man NG2 ,Fei Li1,Haobo Tan1, Cheng Wu2, Claisen M. C. Yeung2, Tao Deng1, Huanhuan Chen1

1 Institute of Tropical and Marine Meteorology/ Key Open Laboratory for Tropical Monsoon,China Meteorological Administration, Guangzhou,China, 2 Hong Kong University of Science and Technology, Hong Kong, China., 3 Chinese Academy of Meteorology Science, Beijing ,China.

Abstract

The filter sample of aerosol, ion chromatogram and therm-optical transmission are used to obtain spectral analysis of aerosol constituents from July 2007 to March 2008. The minimum OC/EC ratio is used to calculate the primary and secondary organic carbon and the extinction effect of the quota of the secondary aerosol on visibility is estimated. As indicated in the analysis, the mass of secondary aerosol takes up 50% of the total mass of PM2.5; the OC/EC ratio is larger than 2 and there are significant characteristics of secondary aerosol generation; the quotas of secondary OC are comparable with those of sulphate and there is obvious enrichment of secondary aerosol under the condition of relative pollution. In a dry environment, the extinction weight is 59% for the secondary aerosol while being as high as 84% if the environment is highly humid (RH=90%). The hygroscopic growth of the aerosol can reduce visibility greatly, and thus increase the haze index, so that the secondary aerosol shares much larger quotas with relative pollution. For the Pearl River Delta (PRD), secondary aerosol and carbonaceous aerosol, especially secondary organic carbon (SOC), are a very acute problem; the study of the generating mechanism and sources for secondary aerosol and the keys to the effort of controlling visibility in this region.

Control Number 45

Analysis of Measurements of Atmospheric Aerosol Composition and Optical Properties in the Southeastern US

Ivar Tombach, Consultant, 753 Grada Ave., Camarillo, CA 93010

Abstract

Measurements made by the Southeastern Aerosol Research and Characterization 1(SEARCH) network over a 6 year period, 2005-2010,have been analyzed to determine the spatial and temporal behavior of the atmospheric aerosol and its optical effects. Measured light extinction at both rural and urban locations was compared to 1-hr and 24-hr average particulate matter composition and concentration. One objective was to identify quantitative relationships between these properties and to evaluate common semi-empirical formulas (such as several versions of the IMPROVE algorithms) for estimating chemical light extinction from aerosol measurements. The SEARCH network has measured aerosol mass concentration, chemical composition, light extinction, and meteorology at eight urban and rural locations in the southeastern United States since 1998. Mass concentrations and chemical compositions of fine and coarse fractions of particulate matter are determined from 24-hr filter samples collected on multiple media and as 1-hr averages from semi-continuous measurements. Hourly light scattering and absorption by desiccated aerosol (RH~10%) are measured by integrating nephelometers and aethalometers, respectively. Analysis of this robust data set shows that, for desiccated aerosol, some forms of chemical extinction estimates correlate relatively well with the optical measurements, although the factor relating the two variables depends on site location and season of the year. Their correlation is better for 24-hraverages than for hourly measurements, and the relationship during daylight hours typically differs from that during the night. Particle growth due to increasing RH increases the extinction efficiency (extinction per unit mass of particles) of any given aerosol, results in large diurnal variation of extinction in this more-humid part of the US, and considerably complicates the extinction vs. aerosol relationships.

Control Number 48

Characterizations analysis of Sulfur dioxide and sulfate during low visibility periods over Pearl River Delta Region, China

Fei Li1 2, Haobo Tan1, Xuejiao Deng1, Chunsheng Zhao2, Dui Wu1, Tao Deng1, Wanyun Xu2, Biting Liao3

1 Institute of Tropical and Marine Meteorology/ Key Open Laboratory for Tropical Monsoon,China Meteorological Administration, Guangzhou,China. 2Department of Atmospheric and Oceanic Sciences,School of Physics,Peking University, Beijing,China. 3Chinese Academy of Meteorological Sciences,Beijing,China.

Measurements of visibility and aerosol properties were made continuously at Panyu as part of the field campaign in Pearl River Delta (PRD) during 2010. Visibility, sulfur dioxide (SO2), meteorological data and concentration of soluble ionic composition of aerosols were simultaneously measured using a visibility sensor (Belfort-model6000), a SO2 analyzer (EC9850), an Automatic Weather Station (AWS) and a Monitoring instrument for AeRosols and Gases (MARGA) , respectively. All of these observations showed pronounced variability in time. With this dataset, we could analyze the temporal characteristics of SO2 and sulfate during the selected low visibility (<5km) periods. Results demonstrated that the mean value of SO2 mixing ratio during low visibility periods is 32.2±24.6ppbv. The seasonal SO2 mixing ratio is lowest in summer and highest in autumn. On December, the highest monthly SO2 mixing ratio is up to 51.9±39.5ppbv, which is almost triple high of the SO2 annual mean. With the meteorological data results, it's considered that visibility deterioration is extraordinary relate to high relative humidity and local wind over PRD because of their effects in production and cumulation of sulfate. Furthermore, we found that besides the high concentration of SO2 and sulfate, there were often accompanied by some special weather conditions during low visibility days, like peripheral airflow of typhoon, high pressure and so on.

Control Number 60

Single Scattering Albedo of Fine Mineral Dust Aerosols Controlled by Iron Concentration

Hans Moosmüller[1], Johann P. Engelbrecht[1], Michał Skiba[1,2], Garrett Frey[3], Rajan K. Chakrabarty[1], and W. Patrick Arnott[4,1]

[1] Desert Research Institute, Nevada System of Higher Education, 2215 Raggio Parkway, Reno, NV 89512, [2]Institute of Geological Sciences, Jagiellonian University, Kraków, Poland, [3]Department of Geological Sciences and Engineering, University of Nevada, Reno, Nevada System of Higher Education, 1664 N. Virginia Street, Reno, NV 89557, [4]Physics Department, University of Nevada, Reno, Nevada System of Higher Education, 1664 N. Virginia Street, Reno, NV 89557

Abstract

We present results on the mineralogical and optical properties of suspended fine desert dust samples from Africa, and the Middle East. Optical properties of mineral dust are needed for the modeling of visibility impairment and radiative transfer as input for global and regional climate models. Specifically, single scattering albedo (SSA) is the key parameter determining, in connection with the albedo of the underlying scene, if aerosols contribute to direct radiative cooling or heating. Samples from multiple sources are suspended in the laboratory and their fine portion (i.e., $PM_{2.5}$) is selected by a cyclone with a cut-off of 2.5 μm. The resulting fine dust, relevant for long-range transport, is characterized by real-time instruments and filter sampling. Absorption and scattering coefficients and SSA are measured with dual-wavelength (i.e., 405 and 870 nm) photoacoustic spectroscopy and reciprocal nephelometry. In addition, particle size distribution is characterized with an optical aerosol spectrometer and filter samples are analyzed for elemental composition. The SSA is shown to have a strong linear correlation with the iron content of the sample. This correlation is useful to relate optical and chemical measurement and to contribute to source apportionment and radiative transfer calculations. Specifically, if these results hold in general, satellite measurements of SSA, as planned for NASA's ill-fated GLORY mission, could yield aerosol iron mass fraction, or in reverse analysis of filter samples with x-ray fluorescence could yield information on aerosol SSA. Results on Ångström coefficients of absorption, scattering, and extinction coefficient and SSA are also presented.

Control Number 127

Recent Insights Regarding Molecular Structure and Light Absorption by Carbonaceous PM

Brooke L. Hemming, Ph.D., US EPA National Center for Environmental Assessment, 109 TW Alexander Drive RTP, NC 27711

Abstract

Substantial effort has been applied to understanding the climate forcing effects of black carbon-containing particles. While more effort is necessary, especially concerning warming effects of BC at the regional scale, consideration should also be given to light absorbing particle phase organics. Numerous *in situ* and laboratory observations suggest that light absorbing organics may enhance local and regional warming in areas affected by large scale biomass burning. Observations have further shown a wavelength dependence of light absorption by filter-bound organic combustion emissions that differs by source, as well as by the burning conditions and combustion stage for an individual source. The degree of variability in the light absorbing capacity of primary organic PM suggests the need for a more nuanced understanding of the

production of primary light absorbing carbon -- in order to better predict current emissions impacts and those in the future, in a warmer climate.

This presentation will summarize the conclusions of a synthesis of the literature from several fields (chemical physics, organic chemistry, biofuels engineering, combustion sciences, atmospheric sciences and others). Several lines of evidence suggest that organic and black carbon can be treated as existing on a continuum defined by total solar energy absorbed as a function of mass. By characterizing combustion sources according to the distribution of carbonaceous materials emitted as a function of burning stage and combustion conditions, estimates of potential climate forcing by these sources may be possible. By accounting for the specific variables affecting the light absorbing capacity of the emissions of given sources, such as wildfire in a changing landscape, projection of climate forcing by these sources into the future may be possible.

Session Associated Poster Presentation

Control Number 10

Studies of infrared and visible optical properties of mineral dust

Jennifer M. Alexander[1], Olga Laskina[2], Brian Meland[3],
Vicki H. Grassian[2], Mark A. Young[2], and Paul D. Kleiber[1]

[1] Department of Physics and Astronomy, University of Iowa, Iowa City, IA 52242
[2] Department of Chemistry, University of Iowa, Iowa City, IA 52242
[3] Department of Mechanical Engineering, University of Colorado, Boulder, CO 80309

Abstract

Atmospheric dust plays a key role in the Earth's radiation balance, affecting climate forcing by direct and indirect means. Accurately treating the radiative transfer effects of dust requires knowledge of aerosol concentration, composition, size, and shape distributions. While much of this information can be obtained from satellite or ground-based remote sensing measurements, the retrieval algorithms depend on precise models of the aerosol optical properties. Unfortunately, accurate modeling of dust optical properties is complicated because atmospheric dust particles are typically irregular in shape and can be an inhomogeneous mixture of different minerals.

In this work, infrared extinction and visible scattering phase function and polarization profiles are measured for complex authentic dust mixtures including field samples of Saharan sand and Iowa loess. Particle size distributions are measured simultaneously along with the optical properties. These samples are modeled as external mixtures of mineral dust components. Experimental data are compared with T-Matrix theory simulations using *a priori* particle shape models for each mineral component. The success of this approach is highlighted for these complex dust mixtures.

Control Number 39

Visualization of visibility conditions associated with temporal trends in light extinction coefficients for remote and rural aerosols simulated using WinHaze.

Jenny L. Hand*
Cooperative Institute for Research in the Atmosphere (CIRA), Colorado State University, Fort Collins, CO

Bret A. Schichtel
National Park Service, Air Resource Division, CIRA, Colorado State University, Fort Collins, CO

William C. Malm
Cooperative Institute for Research in the Atmosphere (CIRA), Colorado State University, Fort Collins, CO

Marc Pitchford
Division of Atmospheric Sciences, Desert Research Institute, Reno, NV

ABSTRACT

Temporal trends in total aerosol extinction (b_{ext}) and deciview (dv) were computed from 1989–2010 using data from the IMPROVE (Interagency Monitoring of Protected Visual Environments) network. Visualization of b_{ext} and dv levels associated with temporal changes in aerosol loading was simulated at user-specified scenes with the computer software program WinHaze 2.9.9 (Air Resource Specialists). We chose approximately 50 scenes for national parks and wilderness areas for which we computed valid trends in b_{ext}. Beginning and end periods were based on the availability of data. The 50th percentile speciated aerosol concentrations and an 80% relative humidity were specified, along with default optical properties (i.e., the "original" IMPROVE algorithm) for all simulations. "Split-images" were generated to demonstrate the visual scene at the beginning and end of the trend period. Several examples will be chosen to demonstrate measureable impacts of changes in b_{ext} on the visual scene, thereby personalizing the effectiveness of air quality mitigation strategies such as the Environmental Protection Agency's Regional Haze Rule.

Control Number 103

Organic Material to Organic Carbon Mass Ratio Inferred from Speciated $PM_{2.5}$ Measurements in the Southeastern United States

Stephanie L. Shaw[1], D. Alan Hansen[2], Aparna Vemuri [2], Justin Walters [3], and Eric S. Edgerton [4]

[1] Electric Power Research Institute, 3420 Hillview Ave., Palo Alto, CA
[2] Previously of Electric Power Research Institute, 3420 Hillview Ave., Palo Alto, CA
[3] Southern Company Services, 600 N. 18th St, Birmingham, AL
[4]Atmospheric Research & Analysis, Inc., 410 Midenhall Way, Cary, NC

Carbonaceous material (CM), including organic and elemental forms, typically comprises approximately 40% to over 75% of annual average $PM_{2.5}$ mass in urban areas of the United States. One of the most prevalent ways to characterize CM is to measure organic carbon (OC) and elemental carbon (EC) by one of several thermal-optical approaches, whereby a small section of a sample filter is subjected to a set of increasing temperatures in an inert gas flow while the reflectance or transmittance of the filter is monitored and the volatilized OC is quantified as CO_2 or CH_4. One limitation of thermal-optical methods is that they do not determine the mass of OM – which contains heteroatoms such as hydrogen, oxygen, nitrogen and sulfur – only of OC. Thus, some scaling ratio of OM to OC must be assumed, derived or

inferred if the mass of OM, and, thus, its contribution to $PM_{2.5}$ mass, and indirectly, light extinction, is to be determined. Many different approaches have been taken to infer OM, and a range of estimated values exists for the OM/OC ratio.
This work investigates the spatial and temporal patterns of the OM/OC ratio in the Southeastern United States using a chemical mass balance approach. The data used was measured in the Southeastern Aerosol Research and Characterization study (SEARCH) network, which encompasses 4 urban-rural pairs of cities. SEARCH provides data on more than 30 components of fine $PM_{2.5}$, and about 20 in PM_{10}. Many of these are measured continuously or semi-continuously, as well as on 24 hr filters. The OM/OC ratios determined by PM component mass balance from approximately 10 years of SEARCH filter data currently available (1998-2007) will be presented for various conditions. Estimates of the impacts of including particle bound water, sea salt, and an extended list of trace and water soluble elements in the mass balance will be presented. Comparisons between the urban and rural sampling locations, and seasonal differences in these patterns, will also be presented.

Session 11. Aerosol, Optical and Radiometric Monitoring Methods

Control Number 14'

A long record of light absorption by sampled fine particulate matter

Warren H. White,[1] Brian P. Perley,[1] Krystyna Trzepla[1] and Nicole P. Hyslop[1]

[1] Crocker Nuclear Laboratory, University of California, One Shields Avenue, Davis, CA 95616

Abstract

The IMPROVE network has collected 24h $PM_{2.5}$ samples on PFTE filters since 1988, at a sustained frequency of twice a week or every third day. The network now includes about 170 sites, about 70 of these having operated continuously since 1995. Light absorption by samples collected since mid-1994 has been measured at 633 nm with the U.C. Davis Hybrid Integrating Plate/Sphere (HIPS). This system directs a diffused laser beam at the back side of the filter, recording backscatter from the filter with an integrating sphere on the near side, and transmission through the filter and sample deposit with an integrating plate on the far side. The backscatter is used to estimate the transmission of the unexposed filter, whose ratio to the observed transmission then yields a measure of absorption by the deposited sample. This paper presents recent work to calibrate this measurement and to verify its consistency over the years.

Control Number 23

Measurement Uncertainty in IMPROVE Aluminum and Silicon Concentrations when Sulfur Concentrations are High

Hege Indresand[1], Ann M. Dillner[1]

[1]IMPROVE Program, Crocker Nuclear Laboratory, University of California Davis, Davis, CA, 95616, USA

Abstract

Silicon (Si) and aluminum (Al), measured by X-ray fluorescence analysis (XRF) in the IMPROVE (Interagency Monitoring of PROtected Visual Environments) network, are important elements for evaluating soil content in particulate matter. The network has issued data advisories

on Al and Si measurements stating that when sulfur concentrations are high, silicon concentrations can be larger than expected and aluminum may not be detected when it is likely to be
present (vista.cira.colostate.edu/improve/data/QA_QC/Advisory.htm). Typically the silicon to iron (Fe) ratio in particulate matter is between 1 and 6, but in some IMPROVE samples the Si/Fe is more than doubled when the sulfur content compared to soil is at the high end of the observed range. A laboratory experiment was carried out to determine the conditions and extent of measurement uncertainty in Al and Si when sulfur to soil ratio (expressed as S/Fe) is high. Ambient samples encompassing the Al and Si concentration ranges in the IMPROVE network and with low sulfur were collected using IMPROVE samplers and analyzed by the same XRF system used to analyze IMPROVE samples. In the laboratory, a layer of pure ammonium sulfate particles (S) was deposited onto the samples to obtain S/Fe similar to network values. Although the real Al and Si
concentrations are unchanged when S is added, the reported concentrations in treated samples are significantly different. Si increases with increasing S/Fe, and is higher than the untreated samples by up to 300 %. Aluminum concentrations are over-reported or under-reported by up to ±50% when S/Fe < 70. When S/Fe ≥ 70 Al may be up to 250% higher than expected or erroneously reported as below the MDL. No sulfur interferences in Si and Al measurements are observed for samples with S/Fe < 8. Fe measurements are not impacted by the addition of sulfur.Based on these experimental results, recommendations are made for using IMPROVE Si and Al data from December 1, 2001 through December 31, 2010. About half the data have S/Fe < 8 and are not impacted by the sulfur interference. For samples with S/Fe > 70, which is ~5% of the data, there are large measurement errors in Al and Si mass and these data should be used with extreme caution. Samples with 8 ≤ S/Fe < 70 account for about 45% of the data and the Al and Si data from these samples should be used with caution.

Control Number 97

PV-4 LED Transmissometer

John V. Molenar[1]

[1]Air Resource Specialists, Inc., 1901 Sharp Point Drive, Suite E, Fort Collins, CO 80525

A transmissometer directly measures the irradiance of a light source after the light has traveled over a finite atmospheric path. The transmittance of the path is calculated by dividing the measured irradiance at the end of the path with the calibrated initial intensity of the light source. Using Bouger's law, the average extinction (b_{ext}) of the path is calculated from the transmittance and length of the path. It is attributed to the average concentration of all atmospheric gases and ambient aerosols along the path. Transmissometers are the only instrument able to make a completely ambient measurement of b_{ext} without perturbing or selectively sampling atmospheric aerosols or gases. In 1985 the National Park Service funded the development of a long-path transmissometer, Optec LPV-2. The LPV-2 proved to be an instrument that could accurately measure ambient b_{ext} and continues to successfully operate at many sites in the IMPROVE, NPS, USFS, state, urban, and special study visibility networks. By 2009 LED light sources had become brighter and less expensive. A LED light source uses less power than the tungsten filament lamp, has a useful life of over 10,000 hrs, can be electronically modulated, and is un-polarized. The LPV-4 LED transmitter has been developed to address

operational issues related to the tungsten lamp used in the LPV-2. This has reduced power requirements, removed the need to have multiple calibrated lamps for a year of operation, eliminated data loss due to chopper motor failures, and eliminated the lamp brightening issue.

Session 12. Human Perception of Visibility

Control Number 56

A Review of Old Visibility Metrics and a Proposal of a New Metric

William C. Malm[1], Marc L. Pitchford[2]

[1]Cooperative Institute for Research in the Atmosphere, Colorado State University, Fort Collins, Colorado, 80523-1375
[2]Division of Atmospheric Sciences, Desert Research Institute, 2215 Raggio Parkway, Reno, Nevada, 89512-1095

Principal Contact: William Malm, Senior Research Scientist, Cooperative Institute for Research in the

Visibility metrics fall into two broad categories: those that are scene dependent those that are not. Which of the many visibility metrics is used to communicate levels of haze is to some degree dependent on what kind of information is being conveyed. If the goal is to contrast and compare levels of visibility across broad geographic areas, then a visibility metric that is scene independent is most appropriate. On the other hand, particles emitted into the atmosphere can result in a radiance field that determines whether an observer can see the haze itself or that degrades the scenic quality of landscape features observed through the haze, whether it is uniform or layered. Given the spatial distribution of radiance values, there have been many and varied visibility metrics proposed to describe the perceptual characteristics of haze as well as the degradation of the visual quality of landscape features. Different metrics describe different visual air quality characteristics. Indices that are not scene dependent are referred to as universal metrics, as opposed to scene-dependent metrics. Existing metrics will be reviewed and a new universal visibility metric, unimpaired visual range, will be discussed.

Control Number 95

Effect of Clouds on the Perception of Regional and Urban Haze

John V. Molenar[1] and William C. Malm[2]

[1]Air Resource Specialists, Inc., 1901 Sharp Point Drive, Suite E, Fort Collins, CO 80525
[2] Cooperative Institute for Research in the Atmosphere, Colorado State University, Fort Collins, CO 80523

Over the past 30 years there has been much conjecture on how clouds affect the perception and valuation of haze, especially in vistas without distant terrain features. Initial National Park Service (NPS) perception studies done in 1979-1981 used actual 35mm slides to present varying haze levels with clear skies and clouds to observers. One of the results was that with identical haze levels, images with clouds were rated higher than the same scene with clear skies; but the same incremental change in visual air quality between images with and without clouds was perceived to be similar. After the initial NPS work, almost all studies conducted to date have only used clear sky images. The main reasons were: (1) to focus the observer's attention on the haze and not scenic beauty of the clouds, (2) in actual images of a vista it is impossible to capture identical cloud fields with varying haze levels, and (3) computer

generating images with a standard cloud field was computationally difficult, time consuming, and expensive. Current computer processing power has removed the last two issues. We will report on a pilot study that uses computer generated images of National Park and Urban vistas with and without a standard cumulus cloud field to address the issue of the effect of clouds on perception of regional and urban hazes. Additionally, for the first time we employ a survey mechanism that allows the participant to directly control the haze levels of the image they view to make judgments of.

Control Number 106

Towards a Visibility Management Program in British Columbia: The Development of a Visual Air Quality Index for the Lower Fraser Valley

Steven K. Sakiyama (presenter) and Markus O.B. Kellerhals

Air Protection Section, British Columbia Ministry of Environment, 2975 Jutland Rd,
Victoria, British Columbia, Canada V8W 3C8

Abstract

Visibility impairment due to air pollutants occurs during the summer in the Lower Fraser Valley (Vancouver and eastern valley region) where views to spectacular mountain vistas can be impaired by haze. One of the goals of the Metro Vancouver Integrated GHG and Air Quality Management Plan is to "Improve Visual Air Quality" – reflecting the value of visibility this region and the need to protect and improve it. Efforts toward establishing a visibility management program for British Columbia are ongoing through the multi-agency, BC Visibility Coordinating Committee (BC VCC). In particular, the BCVCC has established a pilot visibility program for the Lower Fraser Valley that includes monitoring, science and policy development. One of the key issues is the establishment of a visibility goal and an appropriate metric. Although the extinction coefficient or deciviews are useful metrics, two forms of a perception-based metric (or "Index") are under consideration. Both are calculated from measured deciviews and classify visibility conditions in 5 categories (ranging from "excellent" to "very poor") similar to approaches used in Denver, Phoenix and New Zealand. The Index provides a meaningful way to characterize visibility for the public and allows flexibility in terms of expressing a goal (such as reducing the frequency of very poor days by x %). The results of the public perception survey conducted by Gallagher and McKendry (2011) are the basis for both forms of the Index: one using the visual air quality ratings (the Visual Air Quality Rating) and the other the % of survey participants rating the scene as acceptable (the Acceptability Based Index). An RH criterion of > 75% was established in order to screen out periods of impaired visibility due to meteorological factors (low cloud, fog, rain). In addition, a website was created to test how well these forms of the Index match the actual visibility conditions. The website includes the current scene (via a live webcam) at two locations in the Lower Fraser Valley along with measures of RH, deciviews, light extinction, $PM_{2.5}$ and both forms of the Index.

Session Associated Poster Presentations

Control Number 35

Analysis of Visual Air Quality with the Ongoing Process of Urbanization in Shandong Province

Daqiu Li Shiyong Du, Lujian Hou Guolan Fan, Houquan Tang, Xixiang Yin（Jinan Academy of Environmental Sciences, Jinan 250014, PR, China）

Abstract: Based on the available spatio-temporal data on visibility and pollutants concentrations from monitoring stations across Shandong, the paper addressed the details of visual air quality issues with the ongoing process of urbanization. Visibility showed a significant decreasing trend during the past 60 years in Shandong, meanwhile, the change of visibility possessed seasonal and monthly characteristics: the best was in summer, especially in July, in winter was the worst, particularly in January, the average visual range is less than 5 kilometers. Air pollution was one of the key factor for visibility degradation and variation.

Control Number 126

Linking Visual Range, PM2.5 Concentrations and the Air Quality Index – What do we tell the Public in Smoke-Filled Wildfire Situations?

Susan O'Neill[1], Pete Lahm[2], Mark Fitch[3], Mike Broughton[4]

[1]Susan O'Neill, Air Quality Scientist
(prior to 7/1/2012) USDA Natural Resources Conservation Service, 1201 NE Lloyd Blvd., Suite 1000, Portland, OR, 97232
(as of 7/2/2012) USDA Forest Service PNW Research Station, 400 N 34th St, Suite 201, Seattle,
[2]USDA Forest Service, Fire and Aviation Management, 201 14th St. SW, Mailstop: 1107, Washington, DC 20024

[3]US Department of Interior, National Park Service, Division of Fire and Aviation Management, 3833 South Development Ave., Boise, ID 83705

[4]US Department of Interior, Fish and Wildlife Service, 7333 W. Jefferson Ave. Suite 375, Lakewood, CO 80235

In the arid northern Rockies in smoky wildfire conditions, a methodology was developed where PM2.5 concentrations are estimated from a visual range (VR) measurement. The estimated (nominally 1-hr) PM2.5 concentration is then extrapolated to a 24-hr value and linked to the air quality index (AQI). The AQI is used to inform the public about potential health impacts from poor air quality conditions, and in this case, wildfire smoke. Given that large wildfires and large-scale smoke impacts occur nationally, from the southeastern US to the west coast, this methodology has been adopted by many states and the EPA. However, there is concern that important caveats are lost along the way – that it is only applicable in arid conditions and that most of the air quality impacts are attributable to smoke (not confounded by other anthropogenic sources). Analysis will be presented illustrating the importance of these caveats based upon the Interagency Monitoring of PROtected Environments (IMPROVE) light extinction equation which was rearranged to solve for the organic carbon component as a function of VR and relative humidity to simulate smoky conditions while including average background values of the other species. Initial analysis shows that the initial study compares well with results from the IMPROVE equation calculations, however, as the contribution of background anthropogenic and hydrophilic species increases (e.g. ammonium-sulfates and ammonium-nitrates) and relative humidity exceeds approximately 70%, then the VR ranges depart from the PM2.5 ranges in the methodology. Furthermore, when the human eye is used to estimate a VR, uncertainty is introduced that exceeds the specificity of the ranges of the AQI in the methodology. Inconsistencies also exist in how the methodology is applied across state lines. This presentation will summarize how this methodology is applied by many state air quality agencies and the EPA to inform the public, highlight these concerns in more depth, and discuss the supporting analysis done with the IMPROVE light extinction equation. However, perhaps more importantly, the purpose of this presentation is to

generate dialog based on the concerns outlined above – what do we tell the public in smoke-filled wildfire situations when there is no monitoring data? What is the scientific basis of this VR/PM2.5/AQI linkage and what are the right limitations of use? Is it strong enough to be used nationally to inform the public about potentially unhealthy air quality or how can it be improved upon or replaced to meet public health warning objectives?

Session 14. Critical Loads and Atmospheric Deposition Techniques in Developing and Implementing Deposition Based Air Quality Standards

Control Number 22

Technical and policy challenges in developing a secondary air quality standard for aquatic acidification.

Richard Scheffe, Adam Reff, James Kelly

The U.S. EPA developed a new linked aquatic and atmospherics system model to calculate the aquatic acidification index (AAI) which potentially could be used as the basis for a combined oxides of nitrogen and sulfur secondary National Ambient Air Quality Standard (NAAQS) addressing aquatic acidification. In developing and implementing an AAI based standard, a myriad of challenges are associated with the uniqueness of combining multiple pollutants and multiple environmental media in an existing NAAQS process which typically addresses one pollutant in a single environmental medium. This presentation will briefly describe the initial application and results of the AAI model and illustrate challenges of infusing critical load estimates, ecoregion spatial areas and non-regulated reduced nitrogen compounds into the established air quality management framework.

Control Number 47

Why Excess Nitrogen Deposition Matters in Natural Environments: Developing Critical Loads to Describe Ecosystem Condition and Effects Thresholds.

Tamara F. Blett[1] and Bret Schichtel[2]

[1]National Park Service, Air Resources Division, P.O. Box 25287, Lakewood, CO 80225.
[2] National Park Service, Cooperative Institute for Research in the Atmosphere, Fort Collins, CO 80523.

Abstract

Recent research into the characteristics, abundance, transport, and deposition of nitrogen compounds are rapidly advancing the state of the science. Stable isotope ratios, prevalence of organic nitrogen, site–specific intensive studies, and atmospheric modeling advances using increasingly finer spatial scales have all provided valuable contributions in our understanding of atmospheric nitrogen. This abstract explores why these advances are important in improving our understanding of the effects of nitrogen in natural environments, and how nitrogen chemistry information can be combined with evaluation of nitrogen effects on ecosystems to enhance both air quality policy and scientific endeavors.

Atmospheric nitrogen compounds deposited in sensitive natural ecosystems can alter soils, surface waters, and biota in both subtle and dramatic ways. A “critical load” of air pollution defines a deposition level below which sensitive parts of an ecosystem are protected. Critical loads for nitrogen have recently been developed on national scales to describe empirical and modeled impacts to a diverse suite of sensitive

resources such as aquatic algae, lichen biodiversity, soil mycorrhizae, and alpine plants. Critical loads represent an approach connecting science and policy, as they are increasingly being used to link ecosystem change thresholds to air quality emissions reduction policies and land management strategies. Current scientific advances increasing our understanding of atmospheric nitrogen deposition are greatly enhancing our ability to develop ecosystem critical loads.

Control Number 89

Critical Knowledge Gaps Surrounding Critical Loads

Eladio Knipping, Electric Power Research Institute (Corresponding Author)
Steve Gherini, Karen Summers, Tetra Tech, Inc.

The approach for determining critical loads for aquatic acidification proposed by the U.S. Environmental Protection Agency (EPA) during the recently completed review of Secondary National Ambient Air Quality Standards for Oxides of Nitrogen and Sulfur is based on an alkalinity (ANC) balance. There are at least two key areas where additional information is needed to improve the accuracy of EPA's proposed methods: inclusion of the effect of natural organic acids and estimation of the base cation supply rate. Research is underway to address both these areas.

Naturally occurring organic acids add color to water and influence its acid-base chemistry. Changes in organic acid concentrations can easily overwhelm any improvements in ANC and pH associated with reductions of deposition acidity. No method for addressing DOC was included in the Final Policy Assessment Document developed during the review of the Secondary NAAQS for NOx and SOx. EPA's new Pilot Project to obtain information in support of future proposed secondary standards is focused primarily on ambient concentrations and deposition and is not expected to investigate the role of organic acids. New research is planned to extend the previously developed method for estimating the effect of organic acids on pH using a representation of DOC as a polyprotic organic acid analogue, pKa's, and solubility at different degrees of protonation. The method will be tested using water quality data for selected US watersheds.

EPA's method proposed in the Policy Assessment Document sets the allowable mineral acidity input to watersheds equal to the preindustrial (or pre-acidification) supply of base cations. EPA does not consider the base supply by ion exchange as a sustainable input of base cations. EPA's approach to estimating base cation supply was demonstrated to be unsatisfactory in part because of its reliance on a Henricksen like "F" factor (Henricksen, 1984). New research is underway to evaluate recently compiled data on base cations in soil and mineralogy (e.g., from the USGS Geochemical Landscapes Project, National Geochemical Survey Database and the US Forest Service Inventory). The data will be used to show availability of base cations and silica and to identify areas with low or high base cation supply rates.

Control Number 98

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Critical Knowledge Gaps Surrounding Critical Loads

Eladio Knipping, Electric Power Research Institute (Corresponding Author)
Steve Gherini, Karen Summers, Tetra Tech, Inc.

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Control Number 110

Development of the Next Generation of Flux Measurement Tools

Berkeley B. Almand[1], Michael P. Hannigan[1], Gregory Miller[1], Nicolas Masson[1], Allison Moore[1], Kevin Klinkel[1], Alex Demarias[1], Ricardo Piedrahita[1], John Ortega[2], Eladio M. Knipping[3]

[1]University of Colorado, 427 UCB, Boulder, CO, 80309
[2]National Center for Atmospheric Research, P.O. Box 3000, Boulder, CO, 80307
[3]Electric Power Research Institute, 2000 L Street NW Suite 805, Washington, DC 20036

Abstract

The United States Environmental Protection Agency (EPA) has proposed a pilot program that will add the ability to measure atmospheric fluxes of NO_2 and NO to its existing atmospheric deposition program. Since these fluxes have the potential to impact changes to the secondary National Ambient Air Quality Standards (NAAQS), there is concern about the lack of actual dry flux measurements in current flux assessment schemes. Our research effort will address this concern by creating and deploying a robust, inexpensive, and continuous multiple-species gas-flux monitoring system, which can provide data for a variety of relevant atmospheric pollutants. An inexpensive tool will allow for an exploration of the spatial variability of fluxes as multiple flux measurements would be possible for the same resources as was previously required for a single flux measurement site.

We have designed and built a prototype dynamic flux chamber, which currently measures CO_2 and CO flux. The next step will be to integrate SO_2, NO, NO_2 and NH_3. The complete first-generation chambers cost less than $2500, and the ultimate goal is to reduce the cost to $1000 per chamber. This low-cost design is possible because of the use of inexpensive sensors. The sensors range from $5 to $150 in cost, and are currently used for alarm indicators in chemical and manufacturing processes. Through previous research

efforts, we have demonstrated that these inexpensive sensors are often well suited for environmental assessment applications. The CO_2 sensor that is installed in the chamber is a non-dispersive infrared sensor, with noise of ~1 ppm. Electrochemical sensors will be installed to detect NH_3, NO_x and SO_2. Once these sensors are installed, we will conduct a feasibility study to characterize their performance as well as develop in-field automated calibration tools.

We will present the flux chamber development efforts and show pilot field study results for CO_2 and possible other pollutants species depending on progress to date. In addition, we will bring the flux chamber to demonstrate the operation of the system.

Session 10B. Aerosol and Visibility Modeling at Global, Regional and Local Scales

Control Number 112

Estimating Surface Visibility at Hong Kong from Ground-Based Lidar, Sun Photometer and Operational MODIS Products

Muhammad I. Shahzad[1, 2], Janet Nichol[1], Jun Wang[2], James R. Campbell[3] and Simone Lolli[4]

[1] The Hong Kong Polytechnic University, Department of Land Surveying and Geo-Informatics, Hung Hom, Kowloon, Hong Kong, [2] University of Nebraska, Department of Earth and Atmospheric Sciences, Lincoln, NE, 68503, USA, [3] Naval Research Laboratory, Monterey, CA, 93943, USA, [4] Joint Center for Earth Systems Technology, NASA, Goddard Space Flight Center, Greenbelt, MD-20771, USA

Abstract

Surface visibility has decreased in recent years near Hong Kong due to increased air pollution attributed to speedy social and economical development in the region. Aside from deteriorating health standards that corresponding with increasing air pollution, reduced visibility adversely impacts even the most routine civil and public operations, most notably including transportation and aviation. Regional estimates of visibility, solved operationally using available ground and satellite-based estimates of aerosol optical properties and vertical distribution, may prove more effective than standard reliance on a few existing surface visibility monitoring stations. It has been demonstrated that such satellite measurements correlate well with near-surface optical properties, despite these sensors providing no range-resolved information and the use of indirect parameterizations necessary to solve relevant parameters.

Therefore, by expanding such analysis to include vertically-resolved aerosol profile information from an autonomous ground-based lidar instrument, the purpose of this work is to develop an algorithm for automated assessment of surface visibility. Regional visibility maps are generated, centered on Hong Kong, using co-incident ground-based lidar, sun photometer and MODIS aerosol optical depth datasets Using an 355 nm extinction coefficient profile solved from the lidar, MODIS AOD are scaled down to the surface to generate a regional composite depiction of surface visibility. Our results demonstrate the potential for applying passive satellite depictions of broad-scale aerosol optical properties, surface lidar and zenith-viewing sun photometer data to resolving near-surface, and thus visibility-impacting, aerosol particles for improving quantitative assessments of visibility.

Control Number 105

Evaluation of CALPUFF with the CAPTEX Tracer Dataset

Jelena Popovic, Joseph S. Scire, David G. Strimaitis, Zhong-Xiang Wu Exponent, Inc., 9 Strathmore Road, Natick, MA 01760

ABSTRACT

An evaluation of the CALPUFF model has been conducted using the Cross-Appalachian Tracer Experiment (CAPTEX) dataset. CAPTEX, a major field study performed in 1983, was designed to measure the long-range transport and diffusion of pollutants in the atmosphere. CALPUFF is the US EPA approved Guideline model for long-range transport applications. Meteorological conditions during the tracer study are simulated with runs of the MM5 mesoscale meteorological model at horizontal grid resolutions of 12 km and 4 km, and these are also merged with observation data using the CALMET diagnostic model. Model performance is presented for each grid resolution using both quantitative (statistical) and qualitative (graphical) model performance measures. The results of these CALPUFF runs are compared to the analysis recently performed by ENVIRON and EPA (EE), who evaluated six long-range transport (LRT) models with several tracer datasets. Important deficiencies in the EE study are noted. Critical model variables, meteorological dataset limitations and limitations of the evaluation procedures used in the EE study are assessed, as well as the conclusions made based on the statistical measures used in their study. The CALPUFF modeling results are compared to the modeling results of the other LRT models from the EE study.

Session 17. Aerosol Effects on Haze, Direct and Indirect Forcing

Control Number 64

Hygroscopicity of fossil fuel combustion aerosols: characterization and effects on cirus clouds in global modeling

Olga Popovicheva1, Yuxing Yun2, Joyce Penner2

1Moscow State University, Leninskie Gory, Moscow, 119234, Russia
2AOSS, University of Michigan, Ann Arbor, MI 48105

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Abstract

Fossil fuel (ff) combustion emission is remaining to bring one of the great uncertainties into climate impacts because the poor characterization of aerosol ability to act as ice nuclei and induce the heterogeneous vs homogeneous freezing in cirrus clouds. Major transport (road, aviation, shipping) - emitted aerosols are characterized with emphasis on key properties responsible for interaction with water. Advanced studies prove the high heterogeneity of combustion aerosols in a wide range of physico-chemical properties, from hydrophobic through a range of hydrophilicity, to hygroscopic. This presentation reviews the mechanisms of water uptake that impact the ice nucleation ability of aerosols at the cirrus cloud level. The relationship between aerosol physico-chemistry and cloud microphysics is proposed on the basis on a concept of quantification of water uptake allowing the separation of combustion aerosols into hydrophobic, hydrophilic, and hygroscopic. To better quantify the role of ff combustion aerosols in climate change, a new scheme is developed in a coupled climate and aerosol transport model (CAM-IMPACT). This scheme explicitly calculates the aging of ff combustion-emitted aerosols due to condensation and coagulation of sulfates. The hygroscopicity of aerosols is determined by the layers of sulfate coating on their surface according to criteria developed in laboratory observations. This approach allows the identification of the range of combustion aerosol hygroscopicity responsible for

heterogeneous ice nucleation in cirrus clouds and the most significant combustion aerosol effect on climate forcing.

Control Number 107

Direct Radiative Forcing due to Regional Formation of Sulfate from Reactions of SO_2 with Criegee Biradicals

Jingyi Li[1], Qi Ying[1], Bingqi Yi[2], Ping Yang[2] and Humberto Bravo Alvarez[3]

[1] Zachry Department of Civil Engineering, Texas A&M University, College Station, TX 77843, [2] Department of Atmospheric Science, Texas A&M University, College Station, TX 77843, [3] Center for Environmental Contamination and Atmospheric Sciences, National Autonomous University of Mexico, Mexico D.F. CP 04510

Abstract

Criegee biradicals generated from ozonolysis of unsaturated hydrocarbons have been reported to react with SO_2 and NO_2 50 to 10,000 times faster than previously estimated in a recent study that directly determines the reaction kinetics of the biradicals. The faster reaction rate of SO_2 with criegee biradicals suggests that it could be a significant source of sulfate in the atmospheric boundary layer as important as the SO_2 + OH pathway. This leads to speculations that the criegee radicals may play a more significant role in regional and global budgets of sulfate and potentially contribute to direct radiative forcing. In this study, the Community Multiscale Air Quality (CMAQ) model with Master Chemical Mechanism version 3.2 (MCM v3.2) is applied to evaluate the effect of faster criegee biradical reaction rates with SO_2 and NO_2 on regional concentrations of sulfate in the Southeast US and in the Mexico City Metropolitan Zone. While southeast US represents an area with significant biogenic emissions with influence from anthropogenic emissions, Mexico City represents an area with significant anthropogenic alkene emissions and high SO_2 concentrations from fossil fuel combustion and natural sources. Optical properties based on the predicted aerosol concentrations are used in the radiative transfer model RRTMG to calculate the direct radiative forcing due to aerosols. By comparing the aerosol direct radiative forcing with and without the criegee radial pathways, the effect of the criegee biradical + SO_2 pathway on regional radiative balance can be determined.

Control Number 102

Physical responses of clouds to the direct and indirect climate forcing of soot and smoke aerosols

Eric M. Wilcox, Desert Research Institute, 2215 Raggio Parkway, Reno,

Abstract

The conventional view of the indirect effect of aerosols is that the albedo of polluted clouds is larger owing to an increase in the concentration of cloud drops and a decrease in the size of cloud drops compared to clouds forming in clean conditions. This process is expected to cool the climate. However, in spite of showing a significant inter-hemispheric difference in aerosol optical depth, global observations from satellites show little inter-hemispheric difference in cloud optical thickness and a weaker aerosol indirect effect than predicted by global models. Likewise, the conventional view of the semi-direct effect of soot and smoke aerosols that absorb sunlight is that these aerosols enhance the evaporation (i.e. burn-off) clouds. This process is expected to warm the climate. However, the dynamical response of clouds to aerosol heating of the atmosphere depends significantly on the relative altitude of the absorbing aerosol layer and the cloud layer. This talk will present results from analyses of in-situ and satellite remote sensing data that explore the dynamical responses of clouds to aerosol direct and indirect effects on climate. These include an exploration of processes that may mitigate the indirect effect of aerosols, as well as evidence of a semi-direct effect of absorbing aerosols that thickens clouds instead of burning them off.

Control Number 129

The physical properties ofblack carbon and other light-absorbing material emitted from prescribed fires in the US

Gavin R. McMeeking[1,2], Sonia M. Kreidenweis1, Robert J. Yokelson[3], Amy P. Sullivan[1], Taehyoung Lee[1], Jeffrey L. Collett, Jr[1], Edward Fortner[4], Timothy Onasch[4], Sheryl Akagi[3], Jonathan W. Taylor[5], and Hugh Coe[5]

1 Department of Atmospheric Science, Colorado State University, Fort Collins, CO, 80523 2 Droplet Measurement Technologies, Boulder, CO, 80301 3 Department of Chemistry and Biochemistry, University of Montana, Missoula, MT, 59812 4 Aerodyne Research, Inc, Billerica, MA,01821 5 Centre for Atmospheric Science, University of Manchester, Manchester, M13 9PL, UK

.Abstract

Black carbon(BC)aerosol emitted from fires absorbs light, leading to visibility degradation as well as regional and global climate impacts. Fires also emit a wide range of trace gases and particulates that can interact with emitted BC and alter its optical properties and atmospheric lifetime. Non-BC particulate species emitted by fires can also scatter and absorb light, leading to additional effects on visibility. Recent work has shown that certain organic species can absorb light strongly at shorter wavelengths, giving it a brown or yellow color. This material has been classified as brown carbon, though it is not yet well defined. Land managers must find a balance between the negative impacts of prescribed fireemissions on visibility and air quality and the need to prevent future catastrophic wildfire as well as manage ecosystems for habitat restoration or other purposes. This decision process requires accurate assessments of the visibility impacts of fire emissions, including BC and brown carbon, which in turn depend on their optical properties. We present recent laboratory and aircraft measurements of black carbon and aerosol optical properties emitted from biomass burning. All measurement campaigns included a single particle soot photometer (SP2) instrument capable of providing size-resolved measurements of BC mass and number distributions and mixing state, which are needed to separate the BC and brown carbon contributions to total light absorption. The laboratory experiments also included a three-wavelength photoacoustic spectrometer that provided accurate measurements of aerosol light absorption. The laboratory systems also characterized emissions after they had been treated with a thermal denuder to remove semi-volatile coatings, allowing an assessment of the role of non-BC coatings on bulk aerosol optical properties. Emissions were also aged in an environmental smog chamber to examine the role of secondary aerosol production on aerosol optical properties.

Session Associated Poster Presentation

Control Number 3

Vibrational spectroscopy and quantum mechanics calculations of nitric acid chemisorbed onγ-Al2O3 and TiO2

Rachel W. Welch, Ellen M. Coddens, and Juan G. Navea, Chemistry Department, Lawrence University, Appleton, WI,

One mechanism for the atmospheric removal of nitrogen oxides is wet deposition through the formation of nitric acid (HNO3). However, as the wet deposition takes place, HNO3is also chemisorbed onto aerosols, and recent studies have found that this adsorbed nitrate (NO3-)undergoes heterogeneous photochemical reduction to regenerate nitrogen oxides back into the atmosphere. In this work, we carried out kinetic studies of the photochemistry of chemisorbed NO3-with simulated solar radiation on components of tropospheric aerosols, specifically alumina(γ-Al2O3) and titanium dioxide (TiO2); the photochemistry on these surfaces differs in both rate and yield. While the reaction on γ-Al2O3has a higher yield than TiO2, it has a smaller pseudo-first order rate constant. One parameter that affects the reaction is the coordination symmetry of the chemisorbed molecule. Vibrational spectroscopy allowed us to explore the coordination of NO3-chemisorbed on γ-Al2O3and TiO2. To aid with the vibrational assignments, ground-states of NO3-adsorbed on a TiO2clustermodel ([Ti2O(OH)6(H2O)2(NO3)]-1) and γ-Al2O3clustermodel ([Al2(OH)5(m-OH)(NO3)]-1) were optimized with a B3LYP/6-31+G(d) basis set. A two-layer on N-layered integrated molecular orbital and molecular mechanics (ONIOM) method was used when optimizing and calculating the vibrational modes for the chemisorbed nitrates. Different coordination structures are proposed based on the correlation between spectral and theoretical frequencies. Monodentated, bidentated, and bridging structures were observed for γ-Al2O3, while TiO2 minimization yielded only monodentated and bidentated structures. This is the first time that these calculations have been carried out for nitrate chemisorbed on TiO2. This work represents a new approach to comparing chemisorbed NO3-structureson different surfaces, which helps to better understand the reactivity of chemisorbed nitrate on components of tropospheric aerosols.

Session 19A. Atmospheric Nitrogen – A Bridge between Visibility, Ecological and Agricultural Issues

Control Number 71

Measurements of Reactive Nitrogen in Grand Teton National Park

Anthony J. Prenni[1*], Katherine B. Benedict[1], Ezra J.T. Levin[1], Amy P. Sullivan[1], Yi Li[1], Xi Chen[1], Derek Day[2], Taehyoung Lee[1], Yury Desyaterik[1], Misha Schurman[1], Bret Schichtel[3], William C. Malm[3], Sonia M. Kreidenweis[1] and Jeffrey L. Collett Jr.[1]

[1]Atmospheric Science Department, Colorado State University, 1371 Campus Delivery, Fort Collins, CO 80523, USA, [2]Cooperative Institute for Research in the Atmosphere, Colorado State University, Fort Collins, CO 80523, USA, [3]National Park Service, Cooperative Institute for Research in the Atmosphere, Colorado State University, Fort Collins, CO 80523, USA

Abstract.

While nitrogen is an essential nutrient for plant growth, excess inputs of reactive nitrogen can adversely affect terrestrial and aquatic ecosystems, particularly in sensitive ecosystems found at high elevations. Grand Teton National Park (GTNP) is home to such sensitive natural areas and is in close proximity to potential reactive nitrogen sources, including agricultural emissions from the Snake River Valley and emissions of oxidized nitrogen from oil and gas activity in Wyoming. The Grand Tetons Reactive Nitrogen Deposition Study (GrandTReNDS) was conducted in spring-summer 2011, with the aim of better understanding potential sources of reactive nitrogen influencing the region, spatial variability of reactive nitrogen in the atmosphere, and current levels of nitrogen deposition. For this pilot study, gas, aerosol and precipitation chemistry measurements were conducted at a network of sites across GTNP and in the surrounding areas. A core measurement site, located west of GTNP at Grand Targhee Ski Resort, had the most comprehensive suite of instrumentation, including real-time measurements of ammonia and NO_y. This presentation will provide an overview of GrandTReNDS and will present some project highlights. Our measurements suggest that ammonia was the most abundant atmospheric reactive nitrogen species at the core site, and concentrations showed a clear daily pattern, with maximum concentrations around noon and minimum concentrations during nighttime hours. Dry deposition of ammonia and wet deposition of ammonium provided the dominant pathways for reactive nitrogen deposition during the study period. Low atmospheric concentrations of nitric acid resulted in a low dry deposition flux; small deposition velocities and low concentrations resulted in small dry deposition fluxes for nitrogen-containing fine particles. In addition to the nitrogen sources noted above, we found elevated concentrations of all measured nitrogen species when impacted by biomass burning, suggestive of a potentially large, intermittent natural source of atmospheric reactive nitrogen in this region.

Control Number 72

Nitrogen Deposition in the Grand Tetons a Spatial and Historical Perspective

Derek E. Day[1], Bret A. Schichtel[2], Katherine B. Benedict[3], Anthony J. Prenni[3], Ezra J.T. Levin[3], Amy P. Sullivan[3], Yi Li[3], Xi Chen[3], Taehyoung Lee[3], Yury Desyaterik[3], Misha Schurman[3], William C. Malm[1], Sonia M. Kreidenweis[3] and Jeffrey L. Collett Jr.[3]

[1] Cooperative Institute for Research in the Atmosphere, Colorado State University, [2] Air Resources Division, National Park Service, [3] Department of Atmospheric Science, Colorado State University

Abstract

Measured deposition, particularly reduced nitrogen compounds, has increased throughout the Rocky Mountains in the western United States. Although nitrogen is an essential plant nutrient, historically its availability has been limited in most ecosystems. There is growing evidence that the increased N deposition from anthropogenic activities to the high alpine lakes in Grand Teton National Park has past the critical threshold and changes to these ecosystems are occurring by favoring species which require more nitrogen. The deposition of nitrogen compounds in National Parks throughout the region is therefore a concern for natural resource managers. In the spring and summer of 2011, the Grand Tetons Reactive Nitrogen Deposition Study (GrandTReNDS) field study was conducted to better understand the composition and levels of the nitrogen deposition and the contributing sources. In support of this study a climatological analysis of the spatial, temporal and compositional patterns of nitrogen compounds from the CASTNET (dry deposition), NADP (wet deposition), IMPROVE (PM2.5) and USGS snow pack chemistry networks for sites around the Grand Teton National Park was conducted. These results will be presented and contrasted with deposition and particle concentration data collected during the GrandTReNDS field study.

Control Number 51

Organic nitrogen concentrations and species in aerosol and precipitation samples from the Rocky Mountains

Katherine B. Benedict[1], Yury Desyaterik[1], Bret A. Schichtel[2], and Jeffrey L. Collett, Jr[1].

[1]Department of Atmospheric Science, Colorado State University, Fort Collins, CO 80523-1376.
[2]National Park Service, Cooperative Institute for Research in the Atmosphere, Colorado State University, Fort Collins, Colorado 80523-1375

ABSTRACT

Nitrogen deposition is a growing issue in the mountain west as human activity continues to increase. Until recently inorganic nitrogen has been the focus of sampling in the region; however, research in Rocky Mountain National Park (RMNP) has shown that organic nitrogen (ON) is an important contributor to nitrogen deposition in the region. To better understand potential sources of ON, filter and precipitation samples were collected in RMNP and Grand Teton National Park (GTNP) and analyzed for organic nitrogen. Total water soluble ON (WSON) and the molecular formulas of nitrogen-containing organics were measured to understand the importance and potential sources of ON in these national parks. Total WSON was measured by a difference method using a Shimadzu TOC V_{CSH} total organic carbon analyzer with a total nitrogen module and ion chromatography for inorganic nitrogen compounds. In $PM_{2.5}$ aerosol samples concentrations ranged from 0.05 μg N/m^3 to 0.6 μg N/m^3. The highest ON concentrations were measured when the sampling sites were impacted by smoke. ON contributed 12-48% of total water soluble nitrogen measured in aerosol, with an average of 18% in RMNP and 29% in GTNP. In both GTNP and RMNP ammonium was the dominant nitrogen species. In precipitation samples, organic nitrogen contributed an average of 23% and 27% to measured total nitrogen, in RMNP and GTNP and wet deposition of ON contributed similar fractions in RMNP (18%) and GTNP (16%) to total reactive nitrogen deposition.

Organic nitrogen species were determined using liquid chromatography coupled with electrospray ionization and both negative and positive ion time-of-flight mass spectrometry (MS). A variety of compounds were identified including nitrophenols and organosulfur-nitrogen compounds in the negative mode and amides and amines in the positive mode. The organosulfur-nitrogen compounds are likely nitric acid and sulfuric acid esters of monoterpene oxidation products. Significantly more compounds were identified in the positive mode but further analysis to elucidate the structures is necessary to identify the type of compounds present. To better understand the sources of ON, the speciation data set has been examined for correlation among identified ON compounds and other measured parameters including concentrations of gaseous ammonia and nitric acid and inorganic aerosol species.

Control Number 57

Source Apportionment of Ammonia at Rocky Mountain National Park using Modeled Conservative Tracer Releases

William C. Malm[1], Bret A. Schichtel[2], Michael G. Barna[2], Kristi A. Gebhart[2], Marco A. Rodriguez[1], Jeffrey L. Collett, Jr.[3], Carrico, Christian M.,[4] Benedict, Katherine B.[3], Prenni, Anthony J.[3], Sonia M. Kreidenweis[3]

[1]Cooperative Institute for Research in the Atmosphere, Colorado State University, Fort Collins, Colorado, 80523-1375, [2]National Park Service, Cooperative Institute for Research in the Atmosphere, Colorado State University, Fort Collins, Colorado, 80523-1375, [3]Department of Atmospheric Science, Colorado

State University, Fort Collins, Colorado, 80523-1371, [4]AECOM, 1601 Prospect Parkway, Fort Collins, Colorado, 80525

ABSTRACT

Changes in ecosystem function at Rocky Mountain National Park are occurring because of emissions of nitrogen and sulfate species along the Front Range of the Colorado Rocky Mountains, as well as sources farther east and west. The nitrogen compounds include both oxidized and reduced nitrogen. A year-long monitoring program of various oxidized and reduced nitrogen species was initiated to better understand their origins as well as the complex chemistry occurring during transport from source to receptor. Specifically, the goals of the study are to characterize the atmospheric concentrations of nitrogen species in gaseous, particulate, and aqueous phases (precipitation and clouds) along the east and west sides of the Continental Divide; identify the relative contributions to atmospheric nitrogen species in Rocky Mountain National Park (RMNP) from within and outside of the state of Colorado; identify the relative contributions to atmospheric nitrogen species in RMNP from emission sources along the Colorado Front Range versus other areas within Colorado; and identify the relative contributions to atmospheric nitrogen species from mobile sources, agricultural activities, and large and small point sources within the state of Colorado. Monitoring data of ammonium/ammonia and nitrogen oxides/nitrates are combined with modeled releases of conservative tracers from source regions around the United States to apportion these species to their respective sources, using a variety of receptor modeling tools.

Control Number 100

Spatial and temporal sensitivities in results of back-trajectory based receptor models as applied to the Rocky Mountain Atmospheric Nitrogen and Sulfur Study Part II (RoMANS II).

Kristi A. Gebhart[1,] Bret A. Schichtel[1], William C. Malm[2], Marco A. Rodriguez[2], Michael G. Barna[1], Catherine Benedict[3], Jeffrey L. Collett, Jr.[3]

[1] Air Resources Division, National Park Service, [2] Cooperative Institute for Research in the Atmosphere, Colorado State University, [3] Department of Atmospheric Science, Colorado State University

During November 2008 through November 2009 measurements of reactive nitrogen and other chemical species were measured at Rocky Mountain National Park (RMNP), Colorado on the east side of the continental divide in an area with sharp terrain gradients arising from the sharp transition between the high plains and foothills to the east and the mountain peaks to the west. This spatial inhomogeneity presents a challenge for meteorological models. The predominant wind direction is westerly, however easterly winds occur during certain large scale flow patterns and due to differential heating of the slopes, especially during afternoons. Due to the geography, most urban, agricultural, and industrial activities in the state are east of RMNP. To accurately determine the influence of sources on this measurement site, it is important to be able to accurately model the easterly wind flow when it occurs.

Several different source apportionment techniques were applied. However, all of them relied on output from the Weather Research and Forecasting (wrf) model that was used to generate

gridded meteorological fields. Despite several iterations of wrf with various combinations of input data and physics options, assessment of the model output consistently showed that it did not adequately capture the easterly flow at the receptor site. Often the modeled easterly winds in the plains did not extend as far west as the receptor though local wind measurements showed there actually was easterly flow at that site. Due to the complex terrain, it was speculated that the modeled winds in a nearby grid cell or at a slightly different time might match the true winds at the receptor site better than those in the correct grid cell. Several experiments were carried out to test the hypothesis. This paper describes those related to the back trajectory analyses. The TrMB model is a regression technique that uses measured concentrations as the dependent variable and back trajectory residence time in several source regions as independent variables. Tests of sensitivity of TrMB to the timing and spatial accuracy of the winds were conducted in which trajectories from the preceding and following day and from grid cells 12 km east, north, west and south were compared to results from using trajectories started on the correct grid cell and day.

Control Number 62

Modeling the fate of atmospheric reduced nitrogen in the western United Statesduring the Rocky Mountain Atmospheric Nitrogen and Sulfur Study Part II (RoMANS II).

Marco A. Rodriguez1*, Michael G. Barna2, Kristi A. Gebhart2, Jennifer L. Hand1, Derek Day1, Bret A. Schichtel2, Catherine Benedict3, Jeffrey L. Collett,Jr.3, and William C. Malm1

1Cooperative Institute for Research in the Atmosphere, Colorado State University 2Air Resources Division, National Park Service 3Department of Atmospheric Science, Colorado State University

Excess wet and dry deposition of nitrogen-containing compounds is a concern at a number of national parks. The Rocky Mountain Atmospheric Nitrogen and Sulfur Study Part II (RoMANS II)campaign was conducted from November 2008 to November 2009 to characterize the composition of reactive nitrogen and sulfur deposited in Rocky Mountain National Park (RMNP) and to estimate the contributions from different source regions and source types. In this study, the Comprehensive Air Quality Model with extensions (CAMx) was used to simulate the fate of gaseous and particulate species subjected to multiple chemical and physical processes. This work presents a detailed operational model evaluation with special emphasis on the inorganic reduced nitrogen species measured during RoMANS II. The initial model simulations had poor model performance, requiring a subsequent refinement of the model emissions, meteorology, and ammonia deposition velocities. These adjustments have led to improved model performance. A source apportionment of ammonia concentrations at multiple receptors in Colorado, including RMNP, was estimated with the particulate source apportionment tool (PSAT) in CAMx. Preliminary PSAT results show that the source apportionment was quite sensitive to the receptor selection in the model. A series of receptors were placed across the Continental Divide; the western-most receptors showed that one of the largest contributors to ammonia concentrations was the boundary conditions, while receptors placed on the eastern side showed that sources of ammonia along the Colorado Front Range and to its east were the largest contributors. Receptors were also placed in all class I areas in Colorado. Generally, the attribution can be grouped in two main regions: northwestern Colorado (Mount Zirkel, Rawah, Flat Tops, Eagles Nest, Maroon Bells) and southwestern Colorado (West Elk, Black Canyon, La Garita, Mesa Verde, Weminuche, Great Sand Dunes). The northern class I areas seemed to be affected mainly by the local contributions, followed by northern California and the Snake River valley source regions, while

the southern class I areas were mostly affected by the local contributions, followed by the northern and southern California source regions.

Session 19B. Atmospheric Nitrogen – A Bridge between Visibility, Ecological and Agricultural Issues

Control Number 19

A Pilot Monitoring Study of Atmospheric NHx at Selected IMPROVE sites

Xi Chen[1], Derek Day[2], Bret Schichtel[2], William Malm[2], Jose Mojica[3], Chuck McDade[3], Eva Hardison[4], Sonia M. Kreidenweis[1], and Jeffrey L. Collett, Jr.[1,*]

[1] Atmospheric Science Department, Colorado State University, Fort Collins, CO 80523 USA, [2] NPS/CIRA, Colorado State University, Fort Collins, CO 80523 USA,[3] Crocker Nuclear Laboratory, University of California, Davis, CA 95616 USA, [4] Environmental Chemistry Department, RTI International, RTP, NC 27709 USA

Abstract

IMPROVE samplers were adapted to collect total NHx (gas phase ammonia and particle phase ammonium) to monitor particle impacts on visibility, and determines sources and contributions of ammonia to excess nitrogen deposition in Rocky Mountain ecosystems. Selected sampling site include 9 IMPROVE sites: Rocky Mountain, CO; Mesa Verde, CO; Yellowstone, WY; Glacier, MT; Bandelier, NM; Bondville, IL; Cedar Bluff, KS; Wind Cave, SD; Chiricahua, AZ. Phosphorous acid coated cellulose filters were evaluated to determine their ability to accurately monitor total NHx. Tests in Fort Collins, CO revealed excellent agreement between total NHx measurements made using the new IMPROVE module and a conventional URG annular denuder/filter-pack sample. The IMPROVE NHx sampling module can provide reliable measurements of total NHx at a much lower cost than conventional, multi-component samplers, facilitating its widespread deployment. Initial NHx filter cartridges were machined from Polyoxymethylene (POM), which proved susceptible to acid degradation and resulted in artifact methylamine formation during field deployment in 2010. Methylamine was formed from released formaldehyde and collected ammonia/ammonium on filters. After further testing, the filter holders were remanufactured from polypropylene. This eliminated the artifact amine formation and the pilot network was restarted in spring 2011 with the new design. NHx measurements conducted from April to December 2011 showed a pattern of increasing NHx concentrations in late spring/early summer (June) and a decrease in winter, starting in September for most of the sites. This pattern is consistent with expected seasonal patterns in agricultural emissions of ammonia. Both Bondville and Cedar Bluff, however, still exhibit quite abundant winter NHx, which may reflect continued agricultural emissions trapped within a shallower winter boundary layer. Dry deposition of NH_3/NH_4^+ was estimated by adopting SO_2/particulate dry deposition velocities calculated by the Multi-Layer Model used by CASTNET, which had sites co-located with most of the pilot IMPROVE NHx samplers.

Control Number 67

$PM_{2.5}$ Nitrate in the Southeastern U.S: Have concentrations increased over time?

Eric S. Edgerton, President, Atmospheric Research & Analysis, Cary, NC 27513

Abstract

The Southeastern Aerosol Research Characterization (SEARCH) study has measured $PM_{2.5}$ mass and composition at 6-8 sites in AL, FL, GA and MS since 1998. During this time, concentrations of numerous $PM_{2.5}$ components have exhibited significant decreases. In particular, sulfate concentrations have decreased by roughly 50 percent across the SEARCH domain. Given that sulfate is largely associated with ammonium ion (e.g., as mixtures of ammonium sulfate and ammonium bisulfate), sulfate reductions imply increased atmospheric ammonia and increased potential for formation of ammonium nitrate (nitrate replacement).

This presentation will examine trends in $PM_{2.5}$ sulfate, ammonium and nitrate and gas phase ammonia to answer the questions: Do we see evidence of nitrate replacement in the southeastern U.S. and, if not, why not? Data from discrete filter based measurements will be used to look at monthly and seasonal effects. Continuous measurements will be used to assess short-term effects at urban and rural sites in the SEARCH network.

Control Number 32

The effect of a large scale poultry cull on ambient ammonia, PM2.5 and visibility in the Lower Fraser Valley, B.C. Canada

Keith Jones, Roxanne Vingarzan and Joanna Zhao

Air Quality Science Unit, Meteorological Service of Canada, Pacific and Yukon Region, Environment Canada, 201-401 Burrard Street, Vancouver, BC, Canada, V6C 3S5

Abstract

Ammonia has been identified as an important species in fine PM formation and degraded visual range in the Lower Fraser Valley (LFV) of British Columbia. The agricultural sector is the largest source of airborne ammonia, contributing 66% of Canadian emissions in the region, with the poultry industry contributing the greatest proportion of emissions at 36%. An outbreak of avian influenza in poultry February 2004 in the Abbotsford area of the LFV led to the slaughter of 19 million birds by the end of May 2004. Restrictions were lifted in early July 2004, and most farms had completed poultry repopulation by late summer, however, to avoid an overflow of product entering onto the market, restocking occurred over six months and full poultry repopulation was completed by the end of January 2005. The poultry cull provided a unique opportunity to study the effects of the temporary curtailment of the most significant source of ammonia emissions in the region on ambient ammonia and $PM_{2.5}$ concentrations and visibility conditions in the LFV. Results of the study showed that despite average NH_3 concentrations at Abbotsford during the summers of 2005-09 being 3.8 times higher than that of the cull year there were no statistically significant decreases in $PM_{2.5}$ levels and only slight improvements in visibility (~10%) during the cull period. The contribution of sulphate, nitrate, elemental carbon and coarse mass to extinction were observed to be lower during the summer of the cull compared to average 2005-2009 summer levels, while the organic carbon contribution was observed to be higher. Results of the study agree with previous analyses suggesting that an overabundance of ammonia exists in the airshed. The implication for air quality management is that control of ammonia emissions alone is likely to be largely ineffective at producing reductions in fine PM and significantly improving visibility. Instead, a multi-pollutant reduction approach, which would

simultaneously target the major precursors of fine PM (NOx, SO2 and VOCs), in addition to ammonia, may be more effective at lowering fine PM and improving visibility.