Final Program

Air & Waste Management Association

Air & Waste Management Association's

Aerosol & Atmospheric Optics: Visual Air Quality and Radiation

April 28 – May 2, 2008
Red Cliffs Lodge • Moab, UT

ABOUT THE CONFERENCE

This international conference will provide a technical forum on advances in the scientific understanding of the effects of aerosols on 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 climate forcing; innovative aerosol, haze and radiation balance monitoring assessments and modeling methods; and haze and aerosol climate forcing policy, regulatory, and economic issues, including the development of state implementation plans for the Regional Haze Rule.

GENERAL INFORMATION

Registration

Registration will be located in the Castle Creek Winery.

Registration Hours:

Tuesday	7:00 a.m. – 5:00 p.m.
Wednesday	7:00 a.m. – 12:00 p.m.
Thursday	7:00 a.m. – 5:00 p.m.
Friday	7:00 a.m. – 12:00 p.m.

All platform sessions will be held in the Rio Grande. Poster sessions will be held in the Colorado.

Presenters' Breakfast

Presenters and Session Chairs are invited to meet for a complimentary continental breakfast on the day of their session involvement to review program details. Presenters should bring their presentations on a CD or memory stick to this meeting. The breakfast will be held at 7:00 a.m. daily in the Cowboy Grill, which is located in the Lodge.

Continuing Education Credits Opportunities

Conference attendees may be eligible for continuing education credit (e.g. PDHs, CLEs) based upon their participation in conference events. A&WMA has been granted exempt status approval to be a Florida Board of Professional Engineers Continuing Education Provider (exempt provider #EXP 00079), and is an Accredited Provider of CLE in Pennsylvania (Provider #947).

Additionally, A&WMA can issue certificates to those interested in documenting continuing education and professional development hours. Please visit the on-site registration area to take advantage of these opportunities.

Conference Proceedings

Conference proceedings will be posted on an A&WMA web site. Attendees will be notified by e-mail when the papers/presentations are available.

Hotel Information

Red Cliffs Lodge
Mile 14, Highway 128
Moab, UT 84532

Phone: 435-259-2002
Fax: 435-259-5050

Any messages and/or faxes should be delivered to the Air & Waste Management Association's registration desk.

Exhibition

Please visit the exhibit and learn more about related products and services. The exhibition will be held in Rio Grande.

Hours:

Tuesday	8:00 a.m. – 5:00 p.m.
Wednesday	8:00 a.m. – 12:00 p.m.

Exhibits

Air Resource Specialists, Inc.
American Ecotech LLC
In-Tox Products
Magee Scientific Company
Met One Instruments
URG Corp.

Activities

Arches National Park: Participants will travel by bus to Arches National Park. The bus will depart from Red Cliffs Lodge (entrance outside of Colorado Room) at 12:30 p.m. Dinner will follow all Arches National Park tours at 7:30 p.m. at Canyonlands by Night & Day. The bus will return to Red Cliffs Lodge and Aarchway Inn at 9:00 p.m.

Colorado River Boat Ride: Participants will travel by bus to Canyonlands by Night & Day. The bus will depart from Red Cliffs Lodge at 6:00 p.m. Dinner will follow the River Boat Ride at 7:45 p.m. The bus will return to Red Cliffs Lodge and Aarchway Inn at 9:00 p.m.

Conference Committee

General Conference Co-Chairs
Delbert Eatough, *Brigham Young University*
David Maxwell, *National Park Service*

Technical Program Co-Chairs
Mark Green, *Desert Research Institute*
Bret Schichtel, *National Park Service*

Conference Committee
Scott Archer, *U.S. Department of the Interior*
Judy Chow, *Desert Research Institute*
Richard Countess, *Countess Environmental*
Rob Farber, *Southern California Edison*
Kristi Gebhart, *National Park Service*
Philip Hopke, *Clarkson University*
Julie Winchester, *National Park Service*

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, 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.

CONFERENCE SPONSOR

Air Resource Specialists, Inc.

Air Resource Specialists, Inc. (ARS) provides professional consulting and support services in air quality-related environmental monitoring, analysis, modeling, compliance, and auditing. Formed in 1981, ARS has successfully conducted a wide range of applications and research contracts for federal, state, municipal, and tribal agencies, and industrial clients. ARS staff includes more than 45 scientists, field specialists, and support personnel with over 450 years of combined experience in environmental disciplines. Maintaining close, cooperative, and professional working relationships, ARS services clients throughout North America from its corporate offices in Fort Collins, Colorado.

FINAL PROGRAM

Tuesday, April 29, 2008

7:00 a.m. – 5:00 p.m. Conference Registration (Castle Creek Winery)

7:00 a.m. – 8:00 a.m. Presenters' Breakfast (Cowboy Grill)

7:00 a.m. – 8:00 a.m. Coffee Service (Castle Creek Winery)

8:00 a.m. – 5:00 p.m. Exhibits (Rio Grande)

Session 1: Aerosol Physical/Optical Properties

Chairs: William Malm, *National Park Service*
Patrick Arnott, *University of Nevada Reno*

8:00 a.m. **Using High Time Resolution Aerosol and Number Size Distribution Measurements to Estimate Atmospheric Extinction**
William Malm, *National Park Service*

8:15 a.m. **Relationships between Light Scattering and Aerosol Properties at Urban and Rural Locations in the Southeast**
Ivar Tombach, *Consultant*

8:30 a.m. **Ambient Aerosol Hydration States and Hydration Profiles from Great Smoky Mountains National Park**
Donald Collins, *Texas A&M University*

8:45 a.m. **Advanced IMPROVE Studies**
Barbara Zielinska, *Desert Research Institute*

9:00 a.m. **Applications of Nephelometers in Visibility and Fine Particulate Monitoring**
John Carney, *American Ecotech*

9:15 a.m. **Surface Stimulated Raman Scattering on High Q-factor Aerosol Droplet with "Whispering Gallery Modes"**
Mikhail Jouravlev, *Tel-Aviv University*

9:30 a.m. **Question & Answer**

9:45 a.m. – 10:05 a.m. Refreshment Break (Castle Creek Winery)

Session 2: Aerosol Climatology and Natural Sources

Chairs: Judith Chow, *Desert Research Institute*
Ivar Tombach, *Consultant*

10:05 a.m. **Determination of Aerosol Mass Scattering Efficiencies: Hygroscopic and Spatial Trends Within the IMPROVE Network**
Kevin Perry, *University of Utah*

10:20 a.m. **Aerosol Optical Property Monitoring: Symbiosis of Climate and Visibility Studies**
Elisabeth Andrews, *University of Colorado, Boulder*

10:35 a.m. **Spatial Variability in the Seasonal Distribution of $PM_{2.5}$ Speciated Aerosol Composition Data from the IMPROVE and STN Networks**
Jenny Hand, *Colorado State University*

10:50 a.m. **Decrease in Aerosol Sulfate, Elemental Carbon and Total Sulfur Concentrations Over Three Decades in the Northeastern U.S.**
Liaquat Husain, *NYS Department of Health*

11:05 a.m. **Regional Haze Rule Natural Level Estimates Using the Revised IMPROVE Aerosol Reconstructed Light Extinction Algorithm**
Scott Copeland, *USDA Forest Service*

11:20 a.m. **Sea Salt: Are We All Thinking of the Same Thing?**
Ivar Tombach, *Consultant*

11:35 a.m. **Modeling of Aerosol Extinction in the Sea and Coastal Atmosphere Surface Layer**
Gennady Kaloshin, *Institute of Atmospheric Optics SB RAS*

11:50 a.m. **Question & Answer**

12:05 p.m. – 1:30 p.m. Luncheon Speaker (Colorado)
Energy & Climate Policy in the West
Rick Sprott, *Utah Department of Environmental Quality*

Session 3: Biomass Burning and Results from the FLAME Study

Chairs: Sonia Kreidenweis, *Colorado State University*
Hans Moosmuller, *Desert Research Institute*

1:30 p.m. **Developing a Coherent Description of Biomass Burning Visibility Impacts by Bridging the Gaps Between Climate, Meteorology, and Air Quality Grade Research**
Jeffrey Reid, *Naval Research Laboratory*

2:00 p.m. **Effects of Gas-Particle Partitioning and Photochemical Aging on Organic Aerosol Emissions from Wood Combustion**
Allen Robinson, *Carnegie Mellon University*

2:15 p.m. **Characterization of Light Absorption from Organic and Elemental Carbon Emitted by Biomass Burning**
Gavin McMeeking, *Colorado State University*

2:30 p.m. **Hygroscopic Growth and Cloud Condensation Nuclei Activity of Primary Biomass Smoke Aerosol**
Sonia Kreidenweis, *Colorado State University*

2:45 p.m. **Question & Answer**

2:55 p.m. – 3:15 p.m. Refreshment Break (Castle Creek Winery)

3:15 p.m. **A Method for Smoke Marker Measurements for Determining the Contribution of Biomass Burning to Ambient $PM_{2.5}$ Organic Carbon**
Amy Sullivan, *Colorado State University*

3:30 p.m. **Study of Aerosol from Wood Burning Versus Other Sources (AEROWOOD) Using a Multiwavelength Aethalometer**
Ernest Weingartner, *Laboratory of Atmospheric Chemistry*

3:45 p.m. **Black Carbon and Backward Trajectories of Air Masses Over a Tropical Urban Center of Sao Paulo, Brazil**
Glauber Mariano, *National Institute for Space Research*

4:00 p.m. Assessment of Carbon Sampling Artifacts in the IMPROVE, STN/CSN, and SEARCH Networks
Judith Chow, *Desert Research Institute*

4:15 p.m. Question & Answer

4:25 p.m. – 6:00 p.m. Poster Session (Colorado)

Visualization of Synthetic Visual Impairment Scenery Using a 3-D Immersive CAVE System
Dave DuBois, *Desert Research Institute*

Sky Color and Cloud's Appearance: Sensitive Indicators of Urban Visual Air Quality
Marc Pitchford, *NOAA*

Characterization of Aerosols in U.S. Southwest Cities Using Aerosol Models in Conjunction with Optical Monitoring Techniques
Rosa Fitzgerald, *University of Texas at El Paso*

Cavity Ring Down and Cavity Enhanced Detection Measurements of Extinction from Smoke Generated through Laboratory Combustion of Wildland Fuels
Hans Moosmuller, *Desert Research Institute*

Aerosol Light Scattering at High Relative Humidity
Ernest Weingartner, *Laboratory of Atmospheric Chemistry*

Light Scattering by Semi-Volatile Nitrate Particles in Mid-Continental North America
Warren White, *University of California, Davis*

In Situ Extinction Efficiency of Fugitive Dust from Cattle Feedyards
Brent Auvermann, *Texas A&M University*

The Code MaexPro for Visibility Modeling in the Marine and Coastal Environment
Gennady Kaloshin, *Institute of Atmospheric Optics SB RAS*

Optec NGN-2 LED Ambient Integrating Nephelometer
John Molenar, *Air Resource Specialists, Inc.*

Digital Camera Monitoring Technologies, Systems, and Products
Scott Cismoski, *Air Resource Specialists, Inc.*

Source Attribution for Carbon at Class I Areas in Southeastern U.S.
Patricia Brewer, *VISTAS*

Quantifying the Natural Conditions Goal of the Regional Haze Regulations
Ivar Tombach, *Consultant*

Primary and Secondary Aerosol Contributions to Aerosol Light Scattering in Mexico City during the MILAGRO Campaign
Guadalupe Paredes-Miranda, *University of Nevada Reno*

Repeatability of PM Emissions during Laboratory Combustion of Wildland Fuels
Hans Moosmuller, *Desert Research Institute*

Comparisons of Particle Morphology and Composition from Individual Particle Analysis of Biomass Burning Aerosols from Young and Aged Smoke
Jenny Hand, *Colorado State University*

Hygroscopicity Measurements and Comparisons with Theoretical Values for Fresh Biomass Smoke Obtained During Laboratory Burns
Derek Day, *Colorado State University*

VIEWS/TSS: An Integrated Systems Solution for Air Quality and Regional Haze Planning
Shawn McClure, *Colorado State University*

IMPROVE Data Substitution Methods for Regional Haze Planning
Cassie Archuleta, *Air Resource Specialists, Inc.*

Quantification of Light Pollution with a Wide Field CCD Camera
Dan Duriscoe, *National Park Service*

8:00 p.m. Scenery of the Night and the Effect of Light Pollution
Dan Duriscoe, *National Park Service*
(Rio Grande)

9:00 p.m. Optional: Star Gazing

Wednesday, April 30, 2008

7:00 a.m. – 12:00 p.m. Conference Registration (Castle Creek Winery)

7:00 a.m. – 8:00 a.m. Presenters' Breakfast (Cowboy Grill)

7:00 a.m. – 8:00 a.m. Coffee Service (Castle Creek Winery)

8:00 a.m. – 12:00 p.m. Exhibits (Rio Grande)

Session 4: Decision Support Systems

Chairs: Stefan Falke, *Northrop Grumman*
Shawn McClure, *Air Resource Specialists, Inc.*

8:00 a.m. Applications of the Three-Dimensional Air Quality System to Western U.S. Air Quality: Smog Blog, Smog Stories, and AirQuest
Jill Engel-Cox, *Battelle Memorial Institute*

8:15 a.m. Web Resources for Sharing and Analyzing Information about Smoke from the October 2007 Southern California Wildfires
Stefan Falke, *Northrop Grumman*

8:30 a.m. WRAP TSS - A Decision Support System for Regional Haze Planning in the Western United States
Tom Moore, *Western Regional Air Partnership*

8:45 a.m. The WRAP Technical Support System (TSS) as a Model for Technical Data Sharing
Patrick Barickman, *Utah Division of Air Quality*

9:00 a.m. Question & Answer

FINAL PROGRAM

Session 5: Policy, Regulatory and Economic Issues

Chair: Rich Poirot, *VT Department of Environmental Conservation*

9:15 a.m. Source Contributions to Visibility Impairment in the Southeastern and Western United States
Patricia Brewer, *VISTAS*

9:30 a.m. Deterministic Source Apportionment Modeling to Assess the Source Regions and Categories Contributions to Regional Haze in the Central United States
Ralph Morris, *ENVIRON International Corporation*

9:45 a.m. Dry Sorbent Injection for SO_3/SO_2 Reduction from Coal and Oil-Fired Boilers
Keith Day, *O'Brien & Gere*

10:00 a.m. Question & Answer

10:15 a.m. – 10:35 a.m. Refreshment Break (Castle Creek Winery)

Session 6: Policy, Regulatory and Economic Issues – Panel Session

Chairs: Tom Moore, *Western Regional Air Partnership*
Todd Hawes, *Environmental Protection Agency*

10:35 a.m. Section 309 Regional Haze SIP Developed in Utah
Colleen Delaney, *Utah Division of Air Quality*

10:50 a.m. Status of State Implementation Plans to Meet the Requirements of the Regional Haze Rule
Todd Hawes, *Environmental Protection Agency*

11:05 a.m. North Carolina's Experience with the Regional Haze State Implementation Plan
Sheila Holman, *NC DENR*

11:20 a.m. The Colorado Experience in Developing a Regional Haze State Implementation Plan
Ray Mohr, *Colorado Department of Public Health and Environment*

11:35 a.m. Discussion

12:05 p.m. – 9:00 p.m. Optional: Arches National Park & Dinner

Thursday, May 1, 2008

7:00 a.m. – 5:00 p.m. Conference Registration (Castle Creek Winery)

7:00 a.m. – 8:00 a.m. Presenters' Breakfast (Cowboy Grill)

7:00 a.m. – 8:00 a.m. Coffee Service (Castle Creek Winery)

Session 7: Satellite and Other Remote Sensing

Chairs: Mark Green, *Desert Research Institute*
Pubu Ciren, *Perot Systems Government Service, Inc.*

8:00 a.m. Retrieval of Aerosol Optical Depth from Geostationary Satellites and Applications for Air Quality Monitoring
Pubu Ciren, *Perot Systems Government Service Inc.*

8:15 a.m. Spatiotemporal Analysis of Aerosol Optical Depth Data over the Contiguous US from GOES Imager
Chuanyu Xu, *Perot Systems Government Service Inc.*

8:30 a.m. Comparison of Aerosol Optical Depth from GOES Aerosol and Smoke Product (GASP) to IMPROVE $PM_{2.5}$ Mass Stratified by Chemical Composition, RH, Particle Size Distribution, and Season
Mark Green, *Desert Research Institute*

8:45 a.m. Use of Satellite Remote Sensing to Obtain Surface Particulate Matter and Surface Extinction Coefficients in Hong Kong and the Pearl River Delta
Alexis Lau, *The Hong Kong University of Science and Technology*

9:00 a.m. Estimating $PM_{2.5}$ Component Concentrations Using MISR Retrieved Aerosol Microphysical Properties in the Continental United States
Yang Liu, *Harvard University*

9:15 a.m. Application of the Lidar Remote Sensing Technique to Quantitative Characterization of Emissions from Agricultural Facilities
Vladimir Zavyalov, *Space Dynamics Laboratory*

9:30 a.m. Intercomparison of Lidar and Satellite Observations of Smoke Plumes and Haze During the October 2007 Southern California Fires
David Stoker, *The Aerospace Corporation*

9:45 a.m. Question & Answer

10:00 a.m. – 10:20 a.m. Refreshment Break (Castle Creek Winery)

Session 8: Gaseous and Particulate Nitrogen – RoMANS Field Study Results

Chair: Jeffrey Collett, *Colorado State University*

10:20 a.m. Spatial and Temporal Variability in Trace Gas and Aerosol Nitrogen Species During the Rocky Mountain Airborne Nitrogen and Sulfur (RoMANS) Study
Jeffrey Collett, *Colorado State University*

10:35 a.m. Predicting Total Nitrogen Deposition at National Parks
Michael Barna, *National Park Service*

10:50 a.m. Regional Air Quality Model Simulation of the Rocky Mountain Atmospheric Nitrogen and Sulfur Study: Preliminary Results and Analysis
Marco Rodriguez, *Colorado State University*

11:05 a.m. Source Apportionment of Sulfur and Nitrogen Species at Rocky Mountain National Park using Modeled Conservative Tracer Releases and Tracers of Opportunity
William Malm, *National Park Service*

11:20 a.m. Preliminary Back Trajectory-Based Source Assessments for Airborne Particulate Matter and Deposited Ions at Rocky Mountain National Park, CO
Kristi Gebhart, *National Park Service*

11:35 a.m. Question & Answer

11:50 a.m. – 1:20 p.m. Luncheon Speaker (Colorado)
Dust: Why We Should Really Care
Jayne Belnap, *USGS*

Photo Slideshow

Session 9: Gaseous and Particulate Nitrogen

Chair: Eladio Knipping, *EPRI*

1:20 p.m. Characterization of the Winter Midwestern Particulate Nitrate Bulge
Marc Pitchford, *NOAA*

1:35 p.m. NH_3 Monitoring in the Upper Green River Basin, Wyoming
John Molenar, *Air Resource Specialists, Inc.*

1:50 p.m. Continuous Ammonia and Ammonium Measurements from the Southeastern U.S.
Rick Saylor, *Atmospheric Research and Analysis, Inc.*

2:05 p.m. Development and Testing of Analyzers for Routine, Continuous Measurement of HNO_3, NH_3 and Fine Particulate NO_3^- and NH_4^+
Eric Edgerton, *Atmospheric Research and Analysis, Inc.*

2:20 p.m. Studies of Amine Formation in Ambient Aerosols Using On-line Single Particle Mass Spectrometry
Kim Prather, *University of California*

2:35 p.m. Question & Answer

2:50 p.m. – 3:05 p.m. Refreshment Break
(Castle Creek Winery)

Session 10: Source Apportionment-Receptor Models

Chairs: Philip Hopke, *Clarkson University*
John Watson, *Desert Research Institute*

3:05 p.m. A Novel Approach for Apportioning Visibility Impairment to Sources of $PM_{2.5}$ in Fresno, CA in December 2003
Delbert Eatough, *Brigham Young University*

3:20 p.m. An Innovative Approach for Apportioning Visibility Degradation to Sources of $PM_{2.5}$ in Riverside/LA Basin Area in the Summer of 2003 and 2005
Robert Farber, *Southern California Edison*

3:35 p.m. Impacts of an Isolated Single Source in Rural Vermont
Philip Hopke, *Clarkson University*

3:50 p.m. A Spatial Analysis of PMF Factor Concentrations Associated with Back Trajectories at Douglas Pass, Colorado
Patrick Reddy, *Colorado Department of Public Health and Environment*

4:05 p.m. Estimating the Contribution of Smoke to Fine Particulate Matter Using a Hybrid-Receptor Model
Bret Schichtel, *National Park Service*

4:20 p.m. Question & Answer

4:35 p.m. – 6:00 p.m. Poster Session
(Colorado)

Midterm Aerosol Vertical Profiling Over an Urban Area (Sao Paulo, Brazil)
Eduardo Landulfo, *IPEN*

Aerosol and Plume Height Measurements from Satellites for Air Quality Studies
Nancy Ritchey, *SSAI*

An Aerosol Generation System for Producing $PM_{2.5}$ Filter Deposits of Known Composition
Hege Indresand, *University of California, Davis*

Sample Deposit Geometry and Effective Filter Face Velocities
Charles McDade, *University of California, Davis*

Toward Evaluation of the Uncertainty of Element Determination Using EDXRF Technique
Krystyna Trzepla-Nabaglo, *University of California, Davis*

Ammonia and Nitrate Measurements from Various Network Sampling Systems
Derek Day, *Colorado State University*

Carbonaceous Measurements from Laboratory Controlled Combustion Sources
John Watson, *Desert Research Institute*

Observed Precision in the IMPROVE Network
Nicole Hyslop, *University of California, Davis*

Regional Impacts of Oil and Gas Development in the Western United States
Marco Rodriguez, *Colorado State University*

Assessing Biomass Burning Impacts on Rural Air Quality and Visibility in the South-Eastern U.S. Applying $PMF_{2.0}$ to SEARCH Network Data
Karsten Baumann, *Atmospheric Research and Analysis, Inc.*

Comparison of Results for Apportioning Visibility Degradation to Sources of $PM_{2.5}$ Using a Conventional Source Apportionment-Visibility Budget Approach and Using a Novel Approach Where the Extinction Data are Included in a PMF Analysis
Delbert Eatough, *Brigham Young University*

Comparative Analysis of Numerical Models for Daytime Mixing Height Estimation in Tropical Conditions
Duong Minh, *Czech University of Life Science*

Wind Modeling of Chihuahuan Desert Dust Outbreaks
Nancy Rivera, *University of Texas at El Paso*

Inspiring Environmental Stewardship by Linking Science, Technology, and Art
Julie Winchester, *Colorado State University*

Spatial and Temporal Trends in Fine Particulate Carbon in the United States
Bret Schichtel, *National Park Service*

Measurement of Reactive Gas and Particulate Phase Nitrogen Species in the SEARCH Network
Eric Edgerton, *Atmospheric Research and Analysis, Inc.*

Simulating Nitrogen Tracers from Regional Sources for RoMANS
Michael Barna, *National Park Service*

Spatial Patterns in Wet Deposition During the 2006 Rocky Mountain Atmospheric Nitrogen and Sulfur Study (RoMANS)
Jenny Hand, *Colorado State University*

Lessons Learned for the U.S. Regional Haze Rule for Managing Visibility
Joseph Adlhoch, *Air Resource Specialists, Inc.*

6:00 p.m. – 9:00 p.m. Optional: Colorado River Boat Ride & Dinner

Friday, May 2, 2008

7:00 a.m. – 12:00 p.m. Conference Registration (Castle Creek Winery)

7:00 a.m. – 8:00 a.m. Presenters' Breakfast (Cowboy Grill)

7:00 a.m. – 8:00 a.m. Coffee Service (Castle Creek Winery)

Session 11: Source Apportionment – Source Oriented Models

Chairs: Michael Barna, *National Park Service*
Naresh Kumar, *EPRI*

8:00 a.m. Evaluation of Aerosol Model Performance in a Coupled Meteorology-Chemistry Model against Speciated Measurements for January and July 2002
Uma Shankar, *University of North Carolina*

8:15 a.m. CAM_x Visibility Modeling Conducted for the Columbia River Gorge National Scenic Area Air Quality Study
Chris Emery, *ENVIRON International Corporation*

8:30 a.m. Use of Photochemical Grid Models to Assess the Air Quality and AQRV Impacts of Proposed Oil and Gas Production Projects in the Western U.S.
Sue Kemball-Cook, *ENVIRON International Corporation*

8:45 a.m. Linking Air Quality and Watershed Management Models
Eladio Knipping, *EPRI*

9:00 a.m. Regional Haze and Smoke Predictions from the BlueSky Smoke Modeling Framework
Sean Raffuse, *Sonoma Technology*

9:15 a.m. Impacts of Emissions Speciation and the Revised IMPROVE Equation on Predicted Visibility Impacts
Michael Zimmer, *Trinity Consultants*

9:30 a.m. Effects of Ambient Ammonia Concentrations on CALPUFF Nitrate Predictions and Modeled Effectiveness of NO_x Controls
Courtney Gorin-Taylor, *ENSR*

9:45 a.m. Question & Answer

10:00 a.m. – 10:20 a.m. Refreshment Break (Castle Creek Winery)

Session 12: Field Studies and Monitoring Networks

Chairs: Warren White, *University of California, Davis*
Marc Pitchford, *NOAA*

10:20 a.m. New Methods for Quality Control, Data Validation, and Flagging of IMPROVE Data
Lowell Ashbaugh, *University of California, Davis*

10:35 a.m. Interagency Monitoring of Protected Visual Environments (IMPROVE) Detection Limits
Nicole Hyslop, *University of California, Davis*

10:50 a.m. Comparisons of Sulfur and Sulfate Measured in IMPROVE
Charles McDade, *University of California, Davis*

11:05 a.m. A Cabinet of Curiosities: IMPROVE's On-line Data Advisories
Warren White, *University of California, Davis*

11:20 a.m. Question & Answer

11:35 p.m. Meeting Adjourns

12:30 p.m. Shuttle Departs for Salt Lake City

NOTES

Printed on Recycled Paper

Abstract Book

Air & Waste Management Association's

Aerosol & Atmospheric Optics: Visual Air Quality and Radiation

April 28-May 2, 2008
Moab, UT

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Session Index

Session 1: Aerosol Physical/Optical Properties

Control #: 30

Advanced IMPROVE Studies

D. Lowenthal, B. Zielinska, B. Mason, S. Samy, V. Samburova, Desert Research Institute, Reno, NV; D. Collins, C. Spencer, N. Taylor, Texas A&M University, College Station, TX; J. Allen, C. Tyree, Arizona State University, Tempe, AZ; N. Kumar, EPRI, Palo Alto, CA.

A multi-year study is being conducted at U.S. National Parks to address outstanding scientific issues related to the U.S. EPA Regional Haze Rule (RHR). Progress in attaining background visibility under the RHR is monitored using aerosol light extinction estimated from IMPROVE filter sample concentrations. In the original "IMPROVE" equation, $PM_{2.5}$ light scattering (Bsp) was calculated from the products of ammonium sulfate, ammonium nitrate, organic carbon mass (OM), and fine soil concentrations and corresponding fixed dry scattering efficiencies and terms [f(RH)] which account for enhancement of Bsp by hygroscopic growth. A revised IMPROVE equation has been published and approved for implementation under the RHR. With this model, dry scattering efficiencies for sulfates, nitrates, and organics are assumed to vary as a function of concentration. The conversion factor between organic mass (OM) and organic carbon (OC) was increased from 1.4 to 1.8 because higher values are expected at remote locales. Two of the original assumptions are retained: 1) organics are not hygroscopic; and 2) hygroscopic growth by sulfates and nitrates is described by the upper branch of the hysteresis loop, implying a maximum amount of water growth and thus, Bsp. Concentration-varying scattering efficiencies imply a direct relationship between particle size and concentration. Experiments were designed to address these issues at several national parks, including Great Smoky Mountains, TN (GRSM), Grand Canyon, AZ (GRCA), Puget Sound, WA (PUSO), and Acadia, ME (ACAD). The issue of whether sulfates and nitrates exhibit hysteresis or deliquescent hygroscopic growth is addressed *in-situ* using an ambient state hygroscopic tandem differential mobility analyzer (AS-HTDMA). Organic hygroscopic growth is measured in the laboratory by extracting water-soluble organics (WSOC) from high-volume $PM_{2.5}$ aerosol samples, removing inorganic ions with XAD solid-phase absorbents, re-aerosolizing the WSOC, and measuring its growth curve as a function of RH with a HTDMA. The OM/OC ratio is determined by weighing the combined residues of isolated WSOC and dichloromethane extracts of $PM_{2.5}$ filters and measuring their respective OC content with thermal-optical reflectance. The relationship between dry particle size and chemical concentration is measured *in-situ* using the Aerodyne Quadrupole Aerosol Mass Spectrometer (Q-AMS). Results are presented for a field study conducted at GRSM during the summer of 2006.

Control #: 32

Using High Time Resolution Aerosol and Number Size Distribution Measurements to Estimate Atmospheric Extinction

W. Malm, National Park Service, Fort Collins, CO; G. McMeeking, S. Kreidenweis, E. Levin, C. Carrico, D. Day, J. Collett, Jr., Colorado State University, Fort Collins, CO.

Rocky Mountain National Park is experiencing reduced visibility and changes in ecosystem function due to increasing levels of oxidized and reduced nitrogen. The ROcky Mountain Atmospheric Nitrogen and Sulfur study (ROMANS) was initiated to better understand the origins of sulfur and nitrogen species as well as the complex chemistry occurring during transport from source to receptor. As part of the study, a monitoring program was initiated for two one-month time periods, one during the spring the other during late summer/fall. The monitoring program included intensive high time resolution concentration measurements of number size distribution, inorganic anions, and cations, and 24-hour time resolution of fine and coarse mass, sulfate, nitrate, carbon, and soil-related elements. These data are combined to estimate high time resolution concentrations of fine and coarse mass and fine mass species estimates of ammoniated sulfate, nitrate, and organic and elemental carbon. Hour-by-hour extinction budgets are calculated by using these species concentration estimates and measurements of size distribution and assuming both internal and external particle mixtures. Summer extinction was on the average about three times higher than springtime extinction, while during spring months all species contributed approximately equal amounts of extinction and during the summer months carbonaceous material extinction was 2 to 3 times higher than other species.

Control #: 38

Surface Stimulated Raman Scattering on High Q-factor Aerosol Droplet with ''Whispering Gallery Modes''

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The numerous optical nonlinear effects accompany the propagation of the high-power electromagnetic energy both inside and around the aerosol droplets. This work is aimed to develop the theory for the optical probe based on the aerosol droplets for the detection of the ultra-fine concentration of chemical impurities and nanoparticles on the surface of the high Q-factor aerosol droplet. The theory of coupled electromagnetic modes such as a "Wispering Gallery Mode" is used to describe the dynamics of the self-interaction of the single modes and the integral coefficients of the interaction surface modes were introduced [1]. We consider the system both the nanoparticles and three-level atom of chemical impurities placed in a microcavity[2,3]. The two atomic levels without direct coupling but it means than the effective coupling is the result of interaction between the laser pump and whispering gallery modes. The effective coupling is described by the Hamiltonian in the rotate wave approximation with the cavity enhanced coefficient in resonance provided by the spatial overlapping whispering gallery modes. To determine the decay rate we can write the well known Schrodinger's equation in the interaction case, and for two modes interaction assuming that the dielectric dielectric loss only on boundary of nanoparticles and employed the usual Wigner-Weisskopf's equation and relation of Manley-Rowe for the conservation energy we produced the threshold and gain for Raman enhancement scattering on the surface of aerosol droplets[4]. We expect the Q-factor of an aerosol droplet is high and equals 10^7. It is found that the threshold of stimulated Raman scattering on the surface of water aerosol droplet consists of $10\text{-}10^3$, W/cm^2. Self-interaction of the two single modes of the aerosol droplet leds to the lowering threshold on the surface of the droplet. The threshold measurement is effective tool for detection of chemical impurities and nanoparticles in aerosol clouds. This effect could be used for the creation of the novel optical devices for the finding of the environmental pollution and for the remote sensing analysis. **Acknowledgements**: Author would like to thank for Prof. A.Nitzan for the scientific and financial support.

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Control #: 45

Applications of Nephelometers in Visibility and Fine Particulate Monitoring

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The presentation will briefly discuss the basic theory behind the science of nephelometry, and then will review several case studies from around the globe where nephelometers are being used to improve our scientific knowledge concerning fine particulates. Topics addressed will include the principle of light scatter and how light scatter is proportional to the amount of fine particulate present in an air mass, in turn calculating visible range. We will provide details of the latest advanced light sources used for calculating visible range, and distinguishing between various particle types. Additionally we will explain how the use of a three wavelength nephelometer allows for characterization of fine particulate contributing to haze and impaired visibility. The presentation will then review several case studies from around the globe where nephelometers have been employed in fine particulate monitoring applications. Cases studies will include; nephelometers used in visibility networks in USA and in Australia; nephelometers used in extremely high particulate load environments in China; research applications of three wavelength nephelometers in determination of impact of auto emissions and other visibility impairments in Canada, including woodsmoke emissions; and visibility networks associated with power generation facilities. Finally, the presentation will briefly explore some of the latest research into nephelometers being used for purposes of enhancing PM2.5 monitoring programs.

Control #: 82

Ambient Aerosol Hydration States and Hydration Profiles from Great Smoky Mountains National Park

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Aerosols containing certain common species of inorganic salts exhibit hysteretic hygroscopic growth. Which hydration state particles occupy greatly determines their optical properties. Thus, to evaluate the "IMPROVE" equation, measurements were made both of the hysteretic hygroscopic growth curves and ambient hydration states. Two hygroscopic tandem differential mobility analyzer (HTDMA) systems were deployed at a rural site near the Great Smoky Mountains NP in Tennessee from July 16th through August 19th, 2006 and October 30th, 2007 through January 31st, 2008. One HTDMA was modified to measure the proportion of particles exhibiting hysteresis, their ambient hydration states, and the residual hydration of the stable branch (an ambient state (AS)-HTDMA). The second HTDMA system, along with standard hygroscopicity measurements, performed RH scans. Two types of scans were conducted: one mapping the growth of an initially dry size-segregated aerosol through deliquescence, the other the drying of an initially hydrated aerosol. During the summer measurements, ~40 % of the particles observed exhibited hysteresis. The hydration state of all particles subject to hysteretic branching was metastable. The RH scans reflected this degree of hysteretic behavior. These results were anticipated from seasonal ammonium: sulfate ratios, high relative humidities and active boundary layers. Further, they do not indicate substantial deviation from the "IMPROVE" equation due to hysteresis during the summer. At abstract submission, the majority of the winter measurements had not been completed. Meanwhile, early results show, and lower RH, increased atmospheric stability and higher ammonium: sulfate ratios portend, more variability in hydration state and more hysteretic behavior. These results will also be presented.

Control #: 91

Relationships Between Light Scattering and Aerosol Properties at Urban and Rural Locations in the Southeast

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The Southeastern Aerosol Research and Characterization (SEARCH), network has been making aerosol mass concentration, chemical composition, and light extinction measurements at eight urban and rural locations in the southeastern United States since 1998. Mass concentrations and chemical compositions of fine and coarse particulate matter fractions are determined from 24-hr filter samples on multiple media and from semi-continuous measurements. Integrating nephelometers, with Nafion dryers on the inlets and monitoring of the relative humidity at the instruments' optical chambers, measure the light scattered by the dried aerosol, and light absorption by the aerosol is measured by aethalometers. The optical light extinction measurements made during 2005-2007 were compared to semi-continuous and 24-hr particulate matter measurements at both rural and urban locations. Measured light extinction from the desiccated aerosol was compared with (1) chemical extinction estimated with the IMPROVE algorithms and other formulas, and (2) PM2.5 concentration measurements. Several episodes where the air quality was dominated by smoke from wildfires provided opportunity to explore the unique characteristics of smoky, carbon-rich air. While the data analyses are currently under way, initial results show that standard chemical extinction estimates correlate relatively well with the optical measurements, although the slopes of the regression lines differ from urban to rural areas. The correlation between light scattering measurements and modified TEOM mass concentration measurements is also quite good and, again, the slopes of the regression lines (which represent the mass scattering efficiency of the aerosol) differ from location to location, especially between urban and rural locations. This latter finding implies that to use an integrating nephelometer to indicate the diurnal variation in PM2.5 concentrations, such as those measured by the 24-hr Federal Reference Method sampler, requires periodic site-specific calibration. The causes of some nonlinear behavior observed in both types of comparisons are currently being investigated and results will be reported in the conference proceedings manuscript.

Session 2: Aerosol Climatology and Natural Sources

Control #: 48

Regional Haze Rule Natural Level Estimates Using the Revised IMPROVE Aerosol Reconstructed Light Extinction Algorithm

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A new technique is presented to estimate natural condition haze levels in deciview units at each Interagency Monitoring of PROtected Visual Environments (IMPROVE) monitoring site for use instead of the "default natural conditions" deciview estimates provided in the Environmental Protection Agency's Regional Haze Rule. The technique presented here, dubbed "natural conditions II", uses aerosol concentration distributions from monitoring data and provides estimates of the natural levels of each of the seven components of aerosol extinction used in the revised IMPROVE algorithm for estimating light extinction from aerosol speciation data. It addresses deficiencies associated with the default natural conditions methodology and by using the revised IMPROVE algorithm it provides a consistent approach for determining the nominal 60-year rate of progress metric as required by the Regional Haze Rule for states that have selected to use the revised algorithm for estimating current haze conditions. Spatial distributions of the natural conditions II deciview values and the change in natural haze estimates compared to the default natural conditions are presented. Also shown is a process whereby the natural conditions II results can be used to develop 60-year glide slopes for individual aerosol species. Natural "hazy day" deciview values generally changed by less than 1 deciview, with exceptions generally due to influences of sea salt and organic mass.

Control #: 60

Spatial Variability in the Seasonal Distribution of $PM_{2.5}$ Speciated Aerosol Composition Data from the IMPROVE and STN Networks

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Characterizing the spatial variability in the seasonal composition of key aerosol species is essential for estimating their contribution to visibility degradation and to $PM_{2.5}$ total mass concentration. Previous analyses using IMPROVE (Interagency Monitoring of Protected Visual Environments) data have shown that the seasonal distribution of aerosol composition varies significantly as a function of species and geographic region. Data from the IMPROVE network are particularly useful for this type of analysis as the network operates over 170 monitoring sites throughout the United States. In addition to the mostly remote/rural sites operated by IMPROVE, the Speciated Trends Network (STN), operated by the Environmental Protection Agency, collects $PM_{2.5}$ speciated aerosol data at over 200 urban/suburban monitoring sites. By combining data from the IMPROVE and STN networks, the seasonal distribution of key aerosol species can be explored as a function of geographical region, specifically the differences in seasonality between urban versus rural locations. We will examine the monthly mean mass concentrations of ammonium sulfate, ammonium nitrate, particulate organic matter, light absorbing carbon and mineral dust aerosols, and their contribution to $PM_{2.5}$ mass concentrations. Evaluating the differences in monthly mean distributions for these species as a function of geographic region is necessary for understanding the effects of emission sources and atmospheric processes governing their concentrations in the atmosphere.

Control #: 62

Decrease in Aerosol Sulfate, Elemental Carbon and total Sulfur Concentrations Over Three Decades in the Northeastern US

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Aerosol SO4, and elemental (EC) carbon play important role in reducing visibility and earth's radiation budget. Therefore, we have continuously determined their concentrations at Whiteface Mountain (altitude 1.5km), NY, from 1978 through the present. Filters have been collected daily (1978 to 1987), and every 48 h from 1988 to 2007. Concentrations of SO4 have been determined for the entire 30-y period using ion chromatography. The SO4 concentration decreased sharply from ~6 µg/m3 in 1978 to ~3 µg/m3 in 1981. It changed little from 1981 through 1991. The mean concentration for the 1992-94 period was ~20% lower compared to the 1981-91 period. A sharp decrease of 47% was observed during 1995-96 compared to the 1981-91 period. The decrease in SO4 concentration was proportional to the decrease in the cumulative SO2 emissions in eight states upwind of and contiguous to New York State (PA, OH, IN, IL, MI, KY, WV, WI, and ONT, Canada). From 1997 through 2006 the concentration slowly decreased by ~20%. This is consistent with the decrease in upwind emissions. SO2 concentrations were also determined. Concentration of total sulfur (TS = sum of Sulfur present as SO2 + SO4) also exhibited a linear relationship with the upwind emissions. It is thus concluded that further reduction in SO2 emissions will result in at least proportional decrease in aerosol SO4 which in turn will result in improved visibility. We also determined EC concentrations in monthly composite samples for the 1978 through 2006 period using the thermal-optical method. Samples were available for 292 months out of 348 months or 84% coverage. No seasonal variation in the concentration was observed. Mean EC concentration for the 1978- 1986 period was ~500ng/m3, it decreased sharply to ~300 ng/m3 in 1987, remained around 200 ng/m3 in 1988 to 1993. There was a significant increase in concentration in 1995-96, to about 300ng/m3. A sharp decrease in concentration has since occurred. From 1997 to 2006 the concentration has remained fairly constant to about 65 ng/m3. We expect to obtain the emission inventory data, at least, for selected periods and investigate the relationship between the observed EC concentrations and EC emissions. We have previously shown [Khan et al., JGR, vol 111, D04303,doi:10.1029/2005JD006505,2006] that the EC aerosol collected at Whiteface Mountain represent the regional aerosol and hence are of particular importance in both estimating radiative forcing as well as their effect on visibility in the region.

Control #: 65

Determination of Aerosol Mass Scattering Efficiencies: Hygroscopic and Spatial Trends Within the IMPROVE Network

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Atmospheric aerosols directly affect the Earth climate system by scattering some of the incoming, solar radiation back to space. The resultant radiative forcing, however, depends on the aerosol chemical composition and the particle size distribution, which are quite variable in both space and time. This study examined hygroscopic growth patterns and spatial trends in the scattering efficiency of aerosols utilizing data from the Interagency Monitoring of Protected Visual Environments (IMPROVE) network. A robust regression technique was applied to 16 IMPROVE sites that had coincident aerosol chemical composition and light scattering measurements. The goal of this regression analysis was to calculate the mass scattering efficiencies for sulfates, nitrates, sea salt, mineral dust, organic carbon, and coarse mass aerosols as a function of relative humidity. This analysis indicated that sulfate particle hygroscopic growth factors were much larger at sites in the western half of the United States. This difference was attributed to smaller size distributions at the western sites as indicated by smaller dry mass scattering efficiencies. Although the organic carbon dry mass scattering efficiencies were similar at most locations, hygroscopic growth was observed only at sites in the eastern United States where internal mixing with sulfate is likely. Nitrate dry mass scattering efficiencies and hygroscopic growth factors were only plausible at sites with large urban aerosol loadings. At these locations, the hygroscopicity of nitrate particles was similar to that of sulfate in the eastern United States. Unlike the other species, mineral dust displayed hydrophobic tendencies at all sites. The large spatial variations of the dry mass scattering efficiencies and hygroscopic growth factors indicate explicit spatial differences in the chemical and microphysical characteristics of aerosol populations that are disregarded by most global climate models.

Control #: 93

Sea Salt: Are We All Thinking of the Same Thing?

I. Tombach, Consultant, Camarillo, CA.

Sea salt is an important contributor to particulate matter, especially in coastal areas. The fine fraction of sea salt is of interest because of its contribution to the mass concentration of PM2.5 and because of its radiative transfer properties (it is hygroscopic and effectively scatters light). The radiative transfer contributes to light extinction in regional haze and plays a role in the radiative balance of the atmosphere. The role of fine sea salt has to be considered in programs to achieve or maintain National Ambient Air Quality Standards for PM2.5, in efforts via the Regional Haze Regulations to reduce visibility impairment in scenic areas, and in the forcing of climate change. However, the conventions that have evolved for quantifying PM2.5 mass concentrations and light extinction by particulate matter do not necessarily address the same sea salt as does the geophysicist, particularly in the presence of atmospheric reactions of sea salt with nitric and sulfuric acid. This paper reviews what constitutes sea salt in the geophysical sense, and how that compares with the "sea salt" that is most appropriate for each of the applications mentioned above. In some cases sea salt is considered to be only the NaCl-centered mixture that derives from seawater; in other cases derivative products such as NaNO3 and Na2SO4 may also be appropriately considered as sea salt; yet others might need to account for the chloride lost in reactions with acids. These distinctions are important, because various sampling and analytical techniques for determining sea salt concentrations in the aerosol quantify different portions of the sea salt spectrum; some techniques may be more appropriate for one application than another. This paper also reviews approaches for the measurement of fine sea salt and recent applications of those measured quantities in the quantification of PM2.5 mass concentrations, regional haze, and global radiative balance, and comments on the appropriateness of the quantifications that were used. The current approach of the IMPROVE program for measuring chloride ion concentrations and using those measurements to estimate light extinction is included in this review, which includes results of quantitative comparisons of different measurements. Finally recommendations are made for appropriate and practical methods that can be used operationally for monitoring fine sea salt concentrations in the forms most appropriate for each of the three types of applic ations.

Control #: 97

Aerosol Optical Property Monitoring: Symbiosis of Climate and Visibility Studies

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NOAA has been measuring aerosol optical properties at baseline observatories for more than three decades, and at regional stations for 15 years. These measurements provide the components necessary to calculate aerosol light extinction and visibility. The primary aim, however, of the NOAA monitoring network and field campaigns is to assess the aerosol radiative forcing of climate. In keeping with that goal we measure the entire suite of aerosol optical properties needed to calculate aerosol radiative forcing (e.g., the amount of aerosol, the absorbing nature of the aerosol and information about the angular scattering properties of the aerosol). Here we describe some of our findings based on measurements made both at long term monitoring sites and from shorter field campaigns. We present values for aerosol light extinction and radiative forcing efficiency as a function of location and aerosol type to highlight the wide range of aerosol properties observed and to point out some factors controlling the influence of aerosol particles on Earth's radiative balance. We show the importance of observing the temporal and spatial variability when considering the effect of aerosol particles on climate. Finally, we discuss the additional effort that might be required for established visibility monitoring networks to 'double-dip' in order to acquire the measurements needed to meet their goals (e.g., visibility monitoring) and to obtain the data necessary for climate forcing calculations.

Control #: 111

Modeling of Aerosol Extinction in the Sea and Coastal Atmosphere Surface Layer

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The aerosol microphysical model of the sea and coastal atmosphere surface layer developed within the framework of joint researches of the atmosphere surface layer and interaction of ocean - land - atmosphere is considered. The given model is based on long-term files of the experimental data received in a different season for Baltic, Mediterranean and Northern Seas at researches microphysical and a chemical composition of marine and coastal aerosol. The model is executed for particles sizes of 0.05 - 100 μm on radius and advanced by present time for a heights range 0 - 25 m. Ranges of wind speed change make 3 - 18 m/s, sizes of fetches up to 120 km, relative humidity (RH) 40 - 98 %. Distribution of particles on sizes *N (r)/dr* is submitted to coastal aerosol model as the sum of four modified lognormal functions, according to the representations which have settled for today: where r_{o1} = 0.03, r_{o2} = 0.24, r_{o3} = 2, r_{04} = 10 μm - modal radiuses, - the growth factor connected with RH, A_i denote the concentration (in cm^{-3} μm^{-1}), and C_i - the width i^{th} mode. As against available models NAM and ANAM A_i and C_i of parameterization versus size fetch and wind speeds. These empirical ratios are received from the regression analysis of dependence of concentration of an aerosol from speed of a wind and size of area of dispersal of waves. The fourth mode represents the biggest particles which produced from waves whitecaps. The distribution function shape is resulted depending on change meteorological parameters and heights above sea level. The received results are discussed in comparison with available microphysical models NAN and ANAM.

Session 3: Biomass Burning and Results from the FLAME Study

Control #: 14

A Method for Smoke Marker Measurements for Determining the Contribution of Biomass Burning to Ambient PM2.5 Organic Carbon

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Smoke from wildfires and prescribed fires can have a significant impact on fine particle (PM2.5) concentrations, leading to formation of regional haze (visibility impairment) and affecting the earth's radiation balance (global climate change). However, current monitoring technology is not capable of apportioning contributions from anthropogenic emissions such as those from mobile sources or from prescribed fires or wildfire emissions. In order to routinely determine contributions of prescribed fires and wildfires to fine particle organic carbon concentrations, there is a need for a robust and inexpensive technique for measuring concentrations of smoke tracer compounds. Therefore, a new technique to measure levoglucosan and other carbohydrates was developed using high-performance anion-exchange chromatography with pulsed amperometric detection. This approach utilizes a simple aqueous filter extraction procedure and is relatively inexpensive, offering numerous advantages over traditional methods. A study at the Fire Science Research Lab in Missoula, MT was conducted in 2006 and 2007 to collect information on emissions of levoglucosan and water-soluble potassium, two possible biomass combustion tracers. Results of our analysis of levoglucosan, water-soluble potassium, organic and elemental carbon in fine particles produced from open burning of fuels characteristic of wildfires will be presented. The results have shown that levoglucosan is fairly correlated with organic carbon. Although the levoglucosan is a fairly low fraction of the organic carbon, the ratio of levoglucosan to organic carbon appears to have a pattern based on fuel type. Additionally, this carbohydrate measurement method appears to provide a combusted fuel type fingerprint as we have observed that there are unique peak patterns in sample chromatograms across different types of fuels.

Control #: 17

Developing a Coherent Description of Biomass Burning Visibility Impacts by Bridging the Gaps Between Climate, Meteorology, and Air Quality Grade Research

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The ubiquitous nature of biomass burning results in far reaching impacts in climate, meteorology, and air quality. Despite biomass burning's position as a common forcing agent, different fields have historically coped with smoke research in very different manners. Poor communication between the fields has, at times, led to misunderstandings and ultimately, duplication of effort. Fortunately, information and insight are beginning to migrate between fields. Advances in remote sensing and modeling technology now allow for true interdisciplinary work to broadly cross-cut through the communities interested in biomass-burning. This talk is intended to give a broad overview of the state-of-the-science in biomass burning aerosol research in the fields of climate science, numerical weather prediction of aerosol particles, and visual air quality with emphasis on how the climate science can be applied to the later. Differences in key diagnostic variables are compared and contrasted between the fields. For example, direct climate forcing has historically focused on a column integrated world. Conversely, air quality research inevitably is more concerned with surface concentrations and visibility. This difference in "point-of-view" at times has led to significantly different physical interpretations of smoke particle properties and impacts and in validation techniques and interpretation. Further, uncertainties in fundamental microphysical properties of smoke particles have strikingly different error propagations for the climate, weather and air quality communities. Lastly, in this talk we discuss the different aspects of satellite and ground based remote sensing utilization and what satellites can and cannot do. In particular the outlook for future satellite missions and products will be reviewed. This talk concludes with recommendations for future interdisciplinary research and an efficient division of effort.

Control #: 22

Characterization of Light Absorption from Organic and Elemental Carbon Emitted by Biomass Burning

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Over 40 different fuels were burned at the Fire Science Laboratory in Missoula, Montana during the Fire Lab at Missoula Experiments (FLAME) 1 and 2 in 2006 and 2007. This study examines the visible and near-UV light absorption of organic and elemental carbon emitted by these fires using a spectrometer, thermal-optical analysis (TOA) techniques, and a variety of chemical extraction and analysis methods. A large range in elemental-to-total carbon ratios was observed, reflecting the variety of fuels and combustion conditions during the burns. Organic carbon in some samples, particularly those dominated by smoldering-phase combustion, absorbed visible and near-UV light. The wavelength dependence of absorption was quantified by the exponent of a power trendline fit through the data: the so-called Angstrom absorption exponent (a). Angstrom absorption exponents ranged from ~0.7 for flaming phase- and EC-dominated fuels to ~3.5 for smoldering phase- and OC-dominated fuels. We relate a to combustion conditions, fuel types and EC/TC ratios to develop an approach for modeling this wavelength dependence of absorption in atmospheric climate and visibility models. We also investigate the impacts that light absorbing organic carbon may have on the TOA techniques used to identify OC and EC in atmospheric monitoring networks and subsequent consequences for light absorption predictions based on these measurements.

Control #: 31

Hygroscopic Growth and Cloud Condensation Nuclei Activity of Primary Biomass Smoke Aerosol

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The Fire Lab at Missoula Experiment (FLAME) is an ongoing collaboration investigating biomass smoke properties important to air quality and aerosol-cloud-climate interactions. In laboratory experiments, we measured aerosol hygroscopic growth and cloud condensation nuclei (CCN) activity for particles from fresh smoke generated in the combustion of fuels common to U.S. wildland fires. Particle diameter growth factors (GF) were measured with a hygroscopic tandem differential mobility analyzer (HTDMA) for $5 < RH < 95\%$. A CCN counter measured the relationship between particle dry diameter and critical supersaturation at $s \sim 0.3$, 0.5, 0.7, and 0.9%. The hygroscopicity parameter, kappa, compares HTDMA and CCN measurements on a common scale, with kappa ~1 representative of common hygroscopic salts and kappa~0.01 representative of weakly hygroscopic organic species. For the variety of smokes sampled during FLAME, we observed a wide range of hygroscopic behavior, $0.02 < kappa < 0.6$. The ratio of inorganic ions to carbonaceous material strongly influenced observed values of hygrosopicity. The hygroscopicities inferred from HTDMA and CCN data agreed well for samples in which the mass fraction of inorganic ions was large. For smoke samples with compositions dominated by organic carbon, the hygroscopicities inferred from HTDMA data were considerably less than those inferred from the observed CCN activity. In those samples, it appears that particles must be exposed to very high humidities (>95%) before some hygroscopic components are fully dissolved and contribute to water uptake and observed CCN activity.

Control #: 49

Effects of Gas-Particle Partitioning and Photochemical Aging on Organic Aerosol Emissions from Wood Combustion

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Experiments were performed to investigate the effects of photo-oxidation on organic aerosol (OA) in dilute wood smoke. The wood smoke was produced by burning a mixture of hardwoods in a small wood stove then injected into a 10 m^3 Teflon smog chamber filled with clean air; initial wood smoke OA concentrations were between 30 - 200 µg m^{-3}. The diluted wood smoke was exposed to UV light to initiate photo-oxidation; changes in particle and gas-phase composition were monitored continuously with an Aerosol Mass Spectrometer (AMS), a Proton Transfer Reaction Mass Spectrometer (PTR-MS) and a Scanning Mobility Particle Sizer (SMPS). The data were analyzed to determine the production of SOA, investigate the potential decay of levoglucosan, and characterize the change of the OA mass spectra. Photochemical oxidation of wood smoke produces substantial secondary organic aerosol (SOA), increasing the OA concentration in one experiment by a factor of 2.5 after several hours. In all experiments, AMS spectra of the OA under UV radiation indicate formation of progressively more oxidized material. To investigate the evolution of OA composition, AMS spectra were decomposed into two components: a spectrum corresponding to the fresh primary emissions and a residual spectrum which evolves over time. In experiments with significant SOA production, the residual spectra are very similar to those similarly derived from photo-oxidation of diesel exhaust, oxidized organic aerosol (OOA) spectra derived from factor analysis of ambient data sets, and aged OA measured in remote rural areas. This suggests that the contribution of potentially unaccounted-for SOA precursors emitted from biomass burning (among other sources) may make a considerable contribution to the ambient OA loading.

Control #: 54

Black Carbon and Backward Trajectories of Air Masses Over a Tropical Urban Center of Sao Paulo, Brazil

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Black Carbon (BC) particles are one of the most important fractions of atmospheric particulate material, produced mainly by burning of biomass and fossil fuel from industrial and vehicular sources. Sao Jose dos Campos, a city of the state of São Paulo, Brazil, is an urban center with a high potential for air pollution by having extensive industrial park, a large number of vehicles in circulation and topographical conditions unfavorable to the atmospheric dispersion. Concentrations of BC, were continuously monitored using an Aethalometer (Magee Sci., Inc., USA, Model AE-42), from 13 July 2007 to 30 September 2007. Observations were recorded at the time base of 30 min interval. The average value of BC was 785.9 ng.m-3, and the highest concentrations observed was 10157.9 ng.m-3. The behavior observed for the weekdays is synchronized with the movement of vehicular traffic, with maximum early in the morning and at the end of the afternoon. In the weekends, when the density of vehicular traffic is less, the daily average concentrations observed showed a different behavior, indicating the presence of another major source during the early morning. In order to investigate the origin of the parcel of air that were on the region of Sao Jose dos Campos in the days of measurement was used to model HYSPLIT_4, giving the preferred trajectories and grouping them in order to ascertain the possible sources emission BC to the region. The results show that the largest concentrations of BC are from the regions of the President Dutra highway, the oil refinery's Petrobras and the airport of the city.

Control #: 56

Study of Aerosol from Wood Burning Versus Other Sources (AEROWOOD) Using a Multiwavelength Aethalometer

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Wood burning as a source of heating during the cold winter period can contribute to elevated particle mass concentration. This condition may be further enhanced in the presence of strong and persistent temperature inversion. Considering the adverse health effects related to exposure of particulate matter from combustion processes, it is of great interest to adequately quantify how much each sources, e.g. wood combustion, traffic, secondary aerosols, contribute to the total particle mass concentration. Studies using multiwavelength Aethalometer have shown that the aerosol light absorptions in the near UV and visible wavelengths are much more enhanced in the presence of wood smoke than those observed at traffic site or from laboratory diesel soot measurements (Kirchstter et al. 2004; Sandradewi et al., 2007a; Schnaiter et al., 2003). A linear regression model is introduced which allows for a quantification of particle mass from wood burning and traffic (PMwb, PMtraffic) using aerosol light absorption parameters from the Aethalometer. The results obtained with this „Aethalometer model" are compared with the 14C source apportionment method applied on the high volume (HIVOL) filter samples taken during the field campaigns in Switzerland. The model is developed using data from winter campaigns in Roveredo, an Alpine valley village located ~300 m above sea level with ~2200 inhabitants where ~77% of the households use wood burning for heating (Szidat et al., 2007; Sandradewi et al., 2007b). The Aethalometer model is then further applied on winter campaign data in Zurich (urban background) and in Reiden (highway site). Additionally, the Aethalometer model results are compared to published wood smoke tracer such as levoglucosan and mannosan (pyrolysis product of biopolymer cellulose), and mass fragment 60 (m/z 60) and potassium measured by a quadrople aerosol mass spectrometer (Alfarra et al., 2007).

Control #: 118

Assessment of Carbon Sampling Artifacts in the Improve, STN/CSN, and Search Networks

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The adsorption of organic vapors onto quartz-fiber filters during $PM_{2.5}$ and PM_{10} sampling for thermal/optical carbon analyses causes organic carbon (OC) concentrations to be overestimated. The composition of the adsorbed material, its exchange between the adsorbed and gaseous phases, the degree to which filters become saturated, and how the amount of OC adsorbed differs among filter media and sampling environments has been widely examined but is poorly understood. To assess the extent of this artifact and to evaluate methods used to correct it, field blank and backup filter data from the IMPROVE, STN and SEARCH networks were compiled and analyzed and experiments were performed on stored filter remnants. Hypotheses tested and findings are:

• ***OC artifact on blank/backup filters depends on sampling protocol and differs among ambient networks.*** IMPROVE field blanks TC (or OC) are generally in the range of 2.0 - 2.5 $\mu g/cm^2$ while the STN/CSN and SEARCH field blanks are below or close to 1 $\mu g/cm^2$. Since both IMPROVE and SEARCH use Pallflex® Tissuquartz filters, filter material does not appear to be the cause of difference. The lower SEARCH and STN/CSN field blank levels are probably caused by short passive exposure periods (on the order of minutes) which do not allow sufficient time for organic vapors to diffuse to and through the filters. IMPROVE field blanks reside for seven days in the sampler with the sampled filters. Among the five STN/CSN samplers, URG MASS reports the lowest field blank levels. The IMPROVE backup filter OC (from six sites only) is ~30% higher than its network average field blank OC, while the SEARCH backup filter OC is 57% higher than it network average field blank OC. The backup filters contain both positive and negative artifacts, and the negative artifact could be enhanced by the preceding organic denuder equipped in the Particle Composition Monitor (PCM3) used by the SEARCH network.

• ***Adsorbed organic carbon on the field blank is less than that on the backup filter, which is less than that on the bottom half of the front filter.*** There is a decreasing gradient of OC with depth in the front and backup filters. It cannot be assumed that the front and backup filters are saturated with adsorbed organic vapors. In this study, diesel soot sample filters were sliced and it was found that the bottom half of quartz-fiber front filters contains four times higher OC than quartz-fiber backup filters. Liquid particles can also penetrate into the front and backup filters, and this will give a different result than if the same substance were collected on the surface as a dry particle. This was demonstrated by adding levoglucosan to diesel soot samples as a dry particle suspension and as a liquid solution.

• **Aging** ***of aerosol reduces SVOC content and the organic sampling artifact.*** Comparisons between urban and non-urban sites in the SEARCH network are consistent with this hypothesis, but they are not sufficient to prove it. Average OC on quartz-fiber backup filters was ~22% higher at the urban sites, with 1.46 ± 1.47 $\mu g/cm^2$ at urban sites and 1.20 ± 0.9 $\mu g/cm^2$ at the non-urban sites in the SEARCH network. The urban increments between the urban and non-urban sites were ~77% for OC1 and 20% for OC2. The majority of this low temperature OC is gaseous VOCs. During the IMPROVE/STN comparison study, field blank carbon levels were not necessarily lower at rural sites than at urban sites, though this could be due to the extent of VOC saturation. The contrast between urban and rural sites can only provide indirect indication of aging effect since the degree of aging is not known.

• ***The organic sampling artifact influences the OC/EC split for both IMPROVE and STN/CSN analysis.*** This was demonstrated for a relatively simple case that mixed diesel exhaust (for which the IMPROVE_A_TOR and STN_TOT protocols usually agree) with liquid and solid levoglucosan. When a diesel soot sample is mixed with levoglucosan, the reflectance and transmittance relationship (as determined by thermal/optical methods) only changes when the liquid levoglucosan is spiked into the filter rather than when solid levoglucosan is collected onto the filter surface. When sampling artifact does char and the char occurs within the filter, it is expected to influence the OC/EC split for either TOR or TOT analysis. This is due to the different distribution and absorption effic iency between char (pyrolyzed OC) and EC. The magnitude of this influence should depend on the amount of char with respect to the amount of EC. However, in the current experiment, the char generated by levoglucosan is too low in any case compared to EC. IMPROVE_A and STN/CSN carbon analysis shows consistent EC concentrations between pure diesel soot and diesel soot/solid resuspended levoglucosan within 1% and 10%, respectively.

Session 4: Decision Support Systems

Control #: 47

WRAP TSS - A Decision Support System for Regional Haze Planning in the Western United States

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The U.S. EPA Regional Haze Rule requires states to complete comprehensive technical analyses of air pollutants that impair visibility, to define long-term goals and control strategies to improve visibility in the nation's 156 visibility-protected Federal Class I areas, 75% of which are in the Western U.S. The underlying monitoring and emissions inventory data collection and regional modeling and data analysis efforts in the West have been coordinated by the Western Regional Air Partnership, and are being relied upon by the states in the West to prepare regional haze implementation plans. To assess and utilize these vast quantities of data for regional air quality planning, a Technical Support System has been developed to provide summary data for RHR-required elements, as well as transparent access and decision support for state regulators, the reviewers of the implementation plans, and all interested parties. This paper will review the TSS conceptual model and design, planning and development process, data management, and decision support tools and operations. Future maintenance and development plans will also be discussed, to address anticipated or possible extensions, including decision support for the health and welfare standards for particulate matter and ozone, mercury and acid deposition issues, and climate change, as well specific emissions management programs for greenhouse gases and wildland fire.

Control #: 64

The WRAP Technical Support System (TSS) as a Model for Technical Data Sharing

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Due to the revised National Ambient Air Quality Standards, future air quality modeling and analysis is certain to include PM2.5 and ozone modeling for state implementation plans in new nonattainment areas. Further, leasing of oil and gas development rights and emission inventories related to climate change will require large time commitments from many state air quality agencies. As a consequence, in addition to the WRAP work on regional haze, there are a significant number of air quality modeling projects underway or in the planning stages in the western region dealing with other air quality issues. Studies range from the Pacific Northwest Environmental Science and Technology Consortium modeling of PM2.5 from agricultural burning, to the Four Corners Air Quality Task Force modeling of the effects of oil and gas development. Over several years of development the Technical Support System (TSS) has become a functional set of tools for data sharing and analysis. While it will continue to serve the core group of air quality planners in the development of state-wide regional haze SIP's, it is possible build upon the investments made thus far and extend usefulness of the system to include other pressing air quality issues. Three potential extensions to the system are suggested in this paper. These are 1) A currently funded project through NASA to integrate satellite data into the TSS to both improve model results by incorporating satellite data in the model and enhance the ability to compare the effectiveness of control strategies implemented in the regional haze plans. 2) A flexible means to extract regional subsets of gridded model data; whether from the SMOKE emissions model or the CMAQ air quality model and 3) a new focus on greenhouse gas emissions to address specific needs of this rapidly evolving component of emissions inventories.

Control #: 88

Applications of the Three-Dimensional Air Quality System to Western U.S. Air Quality: Smog Blog, Smog Stories, and AirQuest

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Satellite remote sensing data are becoming a core data source for forecasting and studying air quality. When imagery is available in near real-time, satellite sensors can provide supplemental information to enhance air quality forecasts and to monitor large events, such as wildfires. Quantitative satellite sensor data, such as aerosol optical depth, can be related to ground-based monitors if the PBL is well mixed and can be used for retrospective analysis and model enhancement. Access to satellite remote sensing imagery for these applications has improved over the last 5 years, but continuing enhancement is needed to improve usefulness and accessibility. The western U.S. has been particularly understudied and underserved, since some of first satellite air quality products were more highly correlated with air pollution in the sulfate-dominated east, where the surface reflectance is darker than the west, where the aerosol is more homogeneous, and where it is confined primarily to the boundary layer. In the west, topography and surface reflectance are clearly impeding factors in retrieving AOD from space for most (but not all) sensors. The NASA-funded Three Dimensional Air Quality System (3D-AQS) project is designed to improve satellite data accessibility for the air quality community, specifically regulatory policy analysts at the U.S. Environmental Protection Agency, state and local government air quality forecasters, and air quality modelers. The project has three key initiatives: create and make accessible quantitative satellite sensor datasets relevant to ground-based monitors and air quality models; improve near real-time imagery from multiple sensors; and develop better methods to integrate and visualize vertical aerosol information from ground-based and space-based lidar systems. This paper will present several case studies of 3D-AQS data applied to western air quality: observed aerosol pollution reported in near real-time on the U.S. Air Quality weblog, media stories containing satellite imagery on the California wildfires; and quantitative datasets for western U.S. monitors available from the EPA AirQuest database.

Control #: 103

Web Resources for Sharing and Analyzing Information about Smoke from the October 2007 Southern California Wildfires

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Drought and Santa Ana winds created a "perfect fire" situation in Southern California in late October 2007. A wealth of information created by diverse organizations was disseminated through the Web in near real time to help emergency responders, researchers, managers, and the public better understand and react to the active fires and smoke. Data resources included surface PM2.5 concentrations, satellite and aerial imagery of fire locations, burned area, and smoke plumes, and modeled forecasts of smoke emissions and concentrations. The Internet was also used to deliver “packaged” information reports that summarized data or presented status, such as air quality health alerts. Dissemination mechanisms ranged from ftp sites for “raw” data file download and simple web pages, to standard-based interfaces for accessing the data and dynamic “Web 2.0” web applications, such as blogs, wikis and mapping applications, to visualize and browse information. In many cases, information from one organization was used by another organization, processed or combined in some way to derive new information, and then re-disseminated through the Web. We review how smoke and air quality data and tools were generated, disseminated and used during the Southern California fire and smoke event and assess the “degree” of their interoperability - the ability of one organization to use the data or tools from another organization in their own information processing, analysis or decision-making environment. We particularly focus on the ability to work with information within geospatial and temporal dimensions and examine the data formats, information flows, Web technologies, and targeted audiences for the information. The paper highlights successes in multi-organization information sharing as well as gaps in interoperability, such as difficulty in accessing data values used in a map or the need to expend substantial effort in converting among data formats. The experiences gained in using the Web during the Southern California fires can help define guidelines, standards, tools, and processes for improving monitoring and assessment information systems in preparation for future large air quality events.

Session 5: Policy, Regulatory and Economic Issues

Control #: 11

Source Contributions to Visibility Impairment in the Southeastern and Western United States

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The Regional Haze Rule requires states to complete comprehensive technical analyses of air pollutants that impair visibility and to define long-term strategies to improve visibility in the nation's 156 visibility-protected Federal Class I areas (118 in the West and 18 in the Southeast U.S.) This article summarizes regional differences in visibility, source contributions to regional haze, and projected visibility improvement by 2018 in response to emissions reductions expected under existing federal and state regulations for the southeastern and western regions of the United States. These analyses have been supported by the Visibility Improvement - State and Tribal Association of the Southeast and the Western Regional Air Partnership, respectively, and are being relied upon by the states in the Southeast and West to prepare regional haze implementation plans. Current visibility is more degraded in the Southeast than in the West and larger absolute visibility improvements are expected by 2018 in the Southeast. For the baseline period, 2000-2004, visibility on the 20% haziest days ranged from 22 to 31 deciviews (dv) for Class I areas in the Southeast and from 9 to 20 dv for Class I areas in the West, excluding Alaska and Hawaii. In the Southeast ammonium sulfate, primarily from sulfur dioxide (SO_2) emissions from electric utilities and industrial boilers, is the major contributor to haze on the 20% haziest days; organic carbon mass, primarily from biogenic emissions and biomass burning, also contributes to haze. Visibility on the 20% haziest days is projected to improve by 1.7 to 7.4 dv by 2018 primarily in response to SO_2 emission reductions from electric utilities in the Southeast under the Clean Air Interstate Rule, state regulations, and consent decrees. Western Class I areas are influenced to varying degrees by ammonium sulfate from point sources; ammonium nitrate from nitrogen oxide (NO_x) emissions from mobile and point sources; organic carbon mass, primarily from wildland fire, and windblown dust. The Clean Air Interstate Rule does not apply to the western states so Best Available Retrofit Technology (BART) is the primary regulatory requirement applicable to control point source SO_2 and NO_x emissions. Cleaner fuels and engines will reduce NO_x emissions from mobile sources. Smoke management programs will allow mitigation of prescribed fire impacts. Visibility improvements from expected emissions controls in the West by 2018 range from ~3 dv at the most impaired to a few tenths of a dv at the least impaired Class I areas.

Control #: 24

Deterministic Source Apportionment Modeling to Assess the Source Regions and Categories Contributions to Regional Haze in the Central United States

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Five Regional Planning Organizations (RPOs) are performing the technical analysis necessary to support the development of the Regional Haze State Implementation Plans (SIPs) due December 2007. The RPOs are using the CMAQ and CAMx deterministic photochemical grid models to model a 2002 base year and 2018 future-year to project the observed visibility from the 2000-2004 Baseline to 2018 to assess whether reasonable progress is being made toward natural visibility conditions at Class I areas in 2064. To assist in the assessment of which sources are contributing to the current and future visibility impairment at Class I areas in the central U.S., the Central Regional Air Planning Association (CENRAP) applied the PM Source Apportionment Technology (PSAT) in the CAMx model to determine the source regions and source categories that contribute to visibility impairment at Class I areas under current (2002) and future (2018) year conditions. The CAMx PSAT source apportionment results were used to: (1) identify the source regions (states) that contribute to visibility impairment at each Class I area to assist in the consultation process among states; (2) identify the source regions and categories that contribute visibility impairment at Class I areas as part of assessing the need for additional controls as part of the reasonable progress assessment; (3) identify the contributions of international transport and natural sources to visibility impairment; and (4) develop alternative 2018 Uniform Rate of Progress approaches. This paper discusses the CENRAP CAMx PSAT modeling results and how they were used to address each of the issues listed above. This includes the development of the PSAT Visualization Tool that was provided to the CENRAP States for use in development their regional haze SIPs.

Control #: 35

Dry Sorbent Injection for SO3/SO2 Reduction from Coal and Oil-Fired Boilers

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"Visual Air Quality" is effected by Blue or Brown SO3 plume generated from coal and oil fired boilers. This presentation will demonstrate the effectiveness of using "Duct Injection" (DI) technology to control SO3 and SO2. Duct Injecting is the process of injecting dry sorbents, Trona or Hydrated Lime into the gas existing the boiler. SO3 and SO2 are scrubbed from the gas stream reacting and attaching to the sorbent and then collected in the particulate control device downstream from the injection location. This technology is now proven to be effective at eliminating Blue / Brown haze generated from SO3. Using Case studies the presentation will cover the use of Duct Injection on a 650 MW coal fired boiler with SCR and wet FGD. DI design, sorbent injection ratio's, O&M and capital cost will be reviewed for controlling SO3. The use of DI for SO2 control is helping the older, smaller coal fired boilers reduce their SO2. The utilities are faced with several unknowns when determining the remaining life of their older / smaller units. Due to the cost of installing wet or dry scrubbers for SO2 control several utilities are implementing DI for SO2 control. The technology can be designed and implemented with one year and can effectively capture 50 to 70% of the units SO2. An added benefit when controlling SO2 with dry sorbent is that NOx and Mercury are also captured. Typical systems are capturing 15 to 20% NOx and from 40 to 90% Mercury. DI design, sorbent injection ratio's, O&M and capital cost will also be reviewed for controlling SO2.

Session 6: Policy, Regulatory and Economic Issues - Panel

Control #: 34

Status of State Implementation Plans to Meet the Requirements of the Regional Haze Rule

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The first Regional Haze State Implementation Plans (SIPs) to meet the requirements of the 1999 Regional Haze Rule were due on December 17th, 2007. States are required to establish incremental progress goals for each Class I area to improve visibility, and ultimately, reach natural background conditions (visibility conditions that existed before manmade impairment) by 2064. The first long-term period projections for measuring progress are analyzed for 2018 and every 10 years thereafter. States consider their contribution to visibility problems in Class I areas within and outside the state. Emission reduction measures should address all types of manmade emissions including stationary, area, and mobile sources, and prescribed fires. States can take into account emission reductions due to ongoing air pollution programs (such as programs to reduce particulate matter) and may initially be able to demonstrate reasonable progress based on those reductions alone. Control strategies developed as a result of this rule are expected to improve visibility over broad geographic areas, beyond the Class I areas, including metropolitan areas. This paper examines the status of the SIPs and proposed control strategies on a national level from a Federal perspective, including SIP reviews by EPA and the FLMs. A discussion is provided of the critical aerosol species affecting specific geographic areas of the country and the control measures established by the States in their SIPS to ensure reasonable progress towards meeting the 2018 goals. A summary of the Best Available Retrofit Technology (BART) determinations made by the States will be discussed as well as measures that States are asking nearby contributing States to consider for making visibility improvements in their Class I areas.

Control #: 53

North Carolina's Experience with the Regional Haze State Implementation Plan

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Under the Regional Haze Rule, States are required to submit state implementation plans (SIPs) to the USEPA that set out each state's plan for meeting the national goal of a return to natural visibility conditions by 2064**.** The SIPs for the first review period were due December 17, 2007. These plans cover long-term strategies for visibility improvement between baseline conditions in 2000-2004 and 2018. The plan includes the states' reasonable progress goals, expressed in deciviews, for visibility improvement at each affected Class I area for this first planning period. The Regional Haze SIPs must also include determinations of the baseline visibility conditions (expressed in deciviews) for the most impaired and least impaired days. In addition, states must include a monitoring strategy for measuring, characterizing, and reporting of regional haze visibility impairment. The long-term strategy includes enforceable emissions limitations, compliance schedules, and other measures as necessary to achieve the reasonable progress goals. States must also consider ongoing control programs, measures to mitigate construction activities, source retirement and replacement schedules, smoke management programs for agriculture and forestry, and enforceability of specific measures. States are required to evaluate progress toward reasonable progress goals every 5 years to assure that installed emissions controls are on track with emissions reduction forecasts in each SIP. A full Regional Haze SIP with the reasonable progress goals for the next planning period (2018-2028) is due in 2018. This paper examines the challenges North Carolina experienced with completing the first Regional Haze SIP, both technical and policy oriented issues. In particular, the Best Available Retrofit Technology (BART) exemptions and determinations and the establishment of the 2018 reasonable progress goals will be examined. Finally, a summary of the implementation work including the first progress report due in 2012 will be discussed.

Control #: 68

Section 309 Regional Haze SIP Developed in Utah

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Utah is one of five states that developed a regional haze State Implementation Plan (SIP) in 2003 under 40CFR 51.309 that was based on the 1996 recommendations of the Grand Canyon Visibility Transport Commission (GCVTC). A §309 SIP is deemed to have shown reasonable progress toward the long-term visibility goal for the 16 Class I Areas on the Colorado Plateau if the GCVTC strategies are implemented. A glide path analysis is not required. Utah is unique because all five Class I areas in the state are covered by the §309 Plan. The GCVTC recommended a comprehensive strategy that includes all pollutants and all sectors to address regional haze at the 16 Class I areas. SO_2 emissions from stationary sources are reduced through regional milestones, with a backstop trading program if the milestones are not met. Fire is addressed through enhanced smoke management programs, including an emission tracking system. Pollution prevention is implemented through energy conservation, energy efficiency, and the use of renewable resources. Mobile source emissions are reduced through national Tier 2 standards. Growth in Clean Air Corridors is tracked to ensure that visibility is not degraded. There were many technical challenges that needed to be overcome during the development of the 2003 SIPs. A complete regional western inventory had never been compiled, and improvements were needed for fire, oil and gas area sources, and dust. Regional modeling was developed and refined, laying the groundwork for the WRAP's current modeling. Utah is making a limited use of the current modeling because Utah's SIP was completed in 2003. The §309 SIPs have been in place since 2003 and have been very effective. The plans must be updated to address EPA's 2005 BART guidelines and 2006 provisions governing alternatives to BART. These updates will result in new SO_2 milestones for stationary sources, but the underlying strategies and program details that were adopted in the 2003 SIPs will be maintained. The new milestone will ensure a 49% reduction in SO_2 emissions between 1990 and 2018.

Control #: 124

The Colorado Experience in Developing a Regional Haze State Implementation Plan

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This paper focuses on the process that Colorado has gone through to propose a SIP revision to address the requirements of the Regional Haze Rule. The State of Colorado has drafted a Regional Haze State Implementation Plan (SIP) for the twelve Mandatory Class I areas I the state. This Plan, when approved by the Colorado legislature, will be one of the first in the west to be submitted. However, this SIP revision was incomplete in an important way. It does not include, as required under the Rule, specific Reasonable Progress Goals for each of the twelve Class I areas in the state. The reasons for this will be presented in the paper but relate to the hearing process and incorporating diverse and complex stakeholder comment and testimony within a short time frame. The approved Colorado SIP establishes limits for sources subject to Best Available Retrofit Technology (BART) and addresses the other requirements in the Rule. At the hearing approving part of the Plan, the Colorado Air Quality Control Commission directed, by Order the Air Pollution Control Division to convene a broad-based stakeholder process which would address issues raised at the hearing and lead to proposing a future reasonable progress rule to be included in the SIP. The SIP development process that Colorado has used, utilizes the latest Western Regional Air Partnership (WRAP) visibility analysis, tools, emission inventories, attribution and modeling to complete the technical analyses for the Regional Haze SIP. The Air Division has proposed though this process a presumptive approach to meet the Reasonable Progress requirement. A methodology and rationale have been developed and presented to stakeholders participating in this process that: 1.) describes the technical basis for identifying significant sources and source categories; 2.) identifies significant sources; 3) outlines a process for evaluating existing controls; and, provides "off-ramps" for legitimate reasons (existing controls, in-place voluntary emission reduction agreements, etc.). The paper will focus on the technical basis of this approach.

Session 7: Satellite and Other Remote Sensing

Control #: 36

Estimating PM2.5 Component Concentrations Using MISR Retrieved Aerosol Microphysical Properties in the Continental United States

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A fractional aerosol optical depth (AOD) method has been developed which uses MISR-retrieved aerosol microphysical properties to estimate ground level concentrations of $PM_{2.5}$ mass and its major components such as particle sulfate, nitrate, and organic carbon. Previous research on linking satellite aerosol retrievals with ground-level particle pollution has all used the standard satellite product, i.e., total AOD as one predictor. In contrast, this three-step approach is able to separate the AOD contributions of various aerosol types defined by MISR retrieval algorithms, and treat the AOD values related to different aerosol types as individual predictor variables. Therefore, this method solves the problem that the optical properties of different aerosol types may have different impacts on representing aerosol mass. Preliminary analysis shows that latest MISR aerosol microphysical properties (version 17 and higher) have good sensitivity and internal consistency in distinguishing different particle types and shapes as well as various aerosol mixtures. We use the fractional AOD values calculated by this method, along with aerosol transport model constraints to study seasonal and annual spatial characteristics of fine particles and its major components over the continental United States. Over four years of $PM_{2.5}$ speciation data (2000 - 2004) from EPA's STN and IMPROVE network monitors are collected, and matched with MISR pixels in space and time. Regression models are established with fractional AODs as major predictors for $PM_{2.5}$ mass concentration, sulfate, nitrate and organic carbon in the eastern and western US respectively. These models show substantially improved predictive powers when compared with similar models using total-column AOD as a single predictor. Finally, we predict the spatial distribution of all the significant $PM_{2.5}$ species wherever there is MISR data.

Control #: 37

Spatiotemporal Analysis of Aerosol Optical Depth Data over the Contiguous US from GOES Imager

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A long-term data set of Aerosol Optical Depth (AOD) derived from Geostationary Operational Environmental Satellite (GOES) Imager for the years 2001-2007, covering the Contiguous United States (CONUS), has been generated. GOES AOD data are available at 30-minute intervals and thus analysis of this data was carried out from sub-daily to seasonal and annual time scales. Climatological mean AOD maps show that AODs are higher in the eastern US despite various controls imposed by the Environmental Protection Agency (EPA) on power plants and other industrial sources. AODs are lower in the northwestern US unless a particular year is dominated by wildfires. Seasonally, in the Spring and Summer, AODs are higher with seasonal variation the strongest in the eastern US. In conjunction to GOES AODs, Aerosol Robotic NETwork (AERONET) AOD measurements were analyzed and are found to be in good agreement with GOES, especially in the eastern US where dynamic range of AODs is high. In contrast, GOES and AERONET AODs are not in agreement in the western US; in the western US, AODs are generally low and even any small errors in retrieval algorithm can lead to large uncertainties in derived AOD. Changes in GOES AODs on different spatial and temporal scales can be used as a proxy to study changes in visibility at National Parks and air quality over populated regions.

Control #: 67

Application of the Lidar Remote Sensing Technique to Quantitative Characterization of Emissions from Agricultural Facilities

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Many types of particulates and gases from agricultural operations can have major consequences on air quality. Agriculture, through wind erosion, tillage and harvest operations, burning, diesel-powered machinery and animal production operations, is a source of particulate matter and gases. Agricultural sources vary both temporally and spatially due to daily and seasonal activities and inhomogeneous wide area sources. Conventional point sampling methods originally designed for regional, well mixed aerosols are challenged by the disrupted wind flow fields caused by the structures and varied surface temperature. Lidar (LIght Detection And Ranging) technology provides a means to obtain quantitative information on particle size distributions as functions of space and time. This paper describes the combination of a three-wavelength lidar with a standard point sampler array to provide unambiguous measurement and characterization of the particulate emissions from agricultural production operations. The inversion algorithm allows us to extract particulate optical parameters from lidar measurements at three laser wavelengths (355, 532, and 1064 nm), convert these parameters to the particle size distribution, and estimate particulate mass concentration in the emitted plume. *In situ* point measurements of particulate physical and chemical properties are used to calibrate lidar data and to constrain lidar retrievals to minimize overall retrieval errors. The scanning lidar geometry allows us to measure temporal and 2D/3D spatial variations of mass concentration fields for different particulate fractions (PM_1, $PM_{2.5}$, PM_{10}, and TSP) applicable for USEPA regulations. Differenced downwind and upwind measurements provide an integrated aerosol concentration profile that is multiplied by the wind profile to provide the emission source flux term for the facility. This approach assumes only conservation of mass, eliminating reliance on boundary layer theory. We demonstrate the ability of our measurement system to provide size fractioned mass concentrations and emission rates from several agricultural operations. The comparison of mass concentration fields retrieved from the lidar data with emission/dispersion model simulations is also presented.

Control #: 72

Comparison of Aerosol Optical Depth from GOES Aerosol and Smoke Product (GASP) to IMPROVE PM2.5 Mass Stratified by Chemical Composition, RH, Particle Size Distribution, and Season

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The USEPA is interested in using satellite remote sensing data to estimate levels of PM2.5. Here we report on comparisons of aerosol optical depth (AOD) from GOES Aerosol and Smoke Product (GASP) to IMPROVE network PM2.5 mass and AErosol RObotic NETwork (AERONET) ground-based AOD. We focus attention on the Bondville, Illinois site because there is collocated IMPROVE sampling and an Aeronet site. GASP provides aerosol optical depth at 0.55 um using top of atmosphere visible channel radiance measured from GOES east and GOES west. Time resolution is typically every 30 minutes during daylight hours. The IMPROVE sampler provides a 24-hour integrated sample of PM10 mass, PM2.5 mass, and elemental composition on a one day in three schedule. AERONET provides aerosol optical depth at multiple wavelengths and aerosol size distribution as well as other derived parameters such as Angstrom exponent from ground based daytime measurements. For several reasons we may expect limited correlation between AOD and PM2.5- such as some periods having significant AOD from coarse mass, periods with high water growth of aerosols, seasonal changes in mixing depth, etc. We stratified cases by RH group, major chemical component, size distribution, and season. GOES AOD correlated best with PM2.5 mass during periods with mainly small particles, moderate RH, and sulfate dominated aerosol. It correlated poorly when RH is very high or low, aerosol is primarily organic, and when coarse to fine mass ratio is high. GASP AOD also correlated best with AERONET AOD when particles are mainly fine, suggesting the aerosol model assumptions (e.g. size distribution) may need to be varied geographically for GASP to achieve better AOD results.

Control #: 85

Intercomparison of Lidar and Satellite Observations of Smoke Plumes and Haze During the October 2007 Southern California Fires

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Several concurrent data sources were used to characterize the smoke and haze produced during the Oct. 24-26, 2007 Los Angeles and San Diego fires. Local atmospheric measurements, in addition to satellite data, were compared to soundings acquired by Aerospace Corporation's ultraviolet Rayleigh lidar operating at 355 nm. At the time the lidar was capable of resolving the low altitude vertical backscatter from the smoke plumes up to 5 km with temporal resolution of 1 minute. During peak plume intensity the vertical structure was observed to be highly stratified (containing between 3 and 5 vertically separated layers) and plume boundaries displayed periodic density oscillations. The most stratification was observed during low convection, low wind conditions. Air parcel back trajectory calculations were performed using the 3-D Weather Research and Forecasting (WRF) model wind fields at 5 km resolution in order to trace the plume origin. The day-to-day temporal evolution of concurrent aerosol optical density was retrieved from MODIS satellite data, and compared to the particulate backscatter intensity of the lidar data in order to determine optical density profiles. *In situ* measurements of particle mass (PM2.5) were also compared to particle size distributions obtained by inertial impaction sampling of the ground aerosol content. The size distribution of smoke samples was determined by scanning electron micrograph analysis and found to be composed primarily of particles below 0.5 microns in diameter. We found that by comparing several data sources we were able to enhance our understanding of the structure observed in the vertical lidar smoke profiles. This work was supported by The Aerospace Corporation IR&D program.

Control #: 102

Use of Satellite Remote Sensing to Obtain Surface Particulate Matter and Surface Extinction Coefficients in Hong Kong and the Pearl River Delta

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Although Hong Kong has one of the densest air quality monitoring network in the world it is unable to provide a comprehensive description of air quality over the entire region. For example, many distinct air sheds (e.g., Tseung Kwan O, Sai Kung, Sheung Shui, the southern side of Hong Kong and Lantau and others) are still not adequately covered by the current monitoring network. It is not possible to adequately describe air quality across all air sheds or to differentiate the air quality at a small scale within the same district. The cost for doing so with technologies currently used at the air quality monitoring stations is prohibitive. Based on satellite remote-sensing data, we have developed algorithms to calculate the 2-dimensional distributions of surface Particulate Matter (PM) and Surface Extinction Coefficient (SEC) with resolution down to 1 km. The validity of our algorithms has already been proven with air quality monitoring station data from the Environmental Protection Department. We have integrated these algorithms and developed a system capable of deriving wide-area high-resolution surface distributions using satellite data. The information content provided by this system is dramatically better than what is available with conventional monitoring technologies. We will describe the algorithms used and discuss their application to IMPROVE measurements in the United States.

Control #: 106

Retrieval of Aerosol Optical Depth from Geostationary Satellites and Applications for Air Quality Monitoring

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Satellite remote sensing has a potential role to play in monitoring air quality over large spatial scales. The unique nature of geostationary platform, i.e., high temporal resolution, further strengthens its application through the added capability to resolve any variability on a time scale that is crucial for air quality monitoring. NOAA NESDIS has developed an algorithm to retrieve aerosol optical depth (AOD) from measurements of a single visible channel onboard Geostationary Operational Environmental Satellite (GOES) Imager. As an operational product, GOES AOD has been provided over the day-lit portion of CONUS every 30 minutes. Successful applications have been demonstrated on various aspects, such as estimation of fire emission, smoke concentration and assimilation into air quality forecast model. In this paper, we present overview of the retrieval algorithm, sensitivities of the GOES AOD product to various assumptions, improvements and synergetic comparison of AOD from GOES-East and GOES-West in the overlap regions. Comprehensive validations of GOES AOD against both ground-based (such as AERONET), air-borne measurements and retrieval from other satellites (such as MODIS) are also conducted and will be presented in this paper. It is indicated that GOES AOD is able to capture the variability of aerosol within an accuracy of ±30%. Few examples showing the application of GOES AOD in air quality monitoring work will be presented.

Session 8: Gaseous and Particulate Nitrogen – RoMANS Field Study Results

Control #: 23

Spatial and Temporal Variability in Trace Gas and Aerosol Nitrogen Species During the Rocky Mountain Airborne Nitrogen and Sulfur (RoMANS) Study

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Recent ecological studies have shown a number of deleterious effects due to elevated and increasing deposition of nitrogen compounds in Rocky Mountain National Park (RMNP). Both nitrogen and sulfur species also contribute substantially to visibility degradation in the region. The Rocky Mountain Airborne Nitrogen and Sulfur (RoMANS) Study was conducted to improve our understanding of the sources and transport of airborne nitrogen and sulfur species within RMNP as well as their deposition pathways. Two field campaigns were conducted, in spring and summer 2006, to characterize pollutant transport and deposition during seasons with historically high nitrogen deposition inputs. Several measurements sites were operated within the park, at locations to the west and east of the park boundaries, and at locations near the northeastern, northwestern, and southeastern boundaries of the state of Colorado. Measurements at several sites included 24-hour integrated gas concentrations (ammonia, nitric acid, sulfur dioxide) PM2.5 composition, and wet deposition. A core measurement site in the park included more detailed and higher time resolution chemical, optical, and size distribution measurements. Measurements here included 15 min measurements of PM2.5 composition using a Particle Into Liquid Sampler (PILS) and continuous measurements of several trace gas species. Strong gradients were observed in both oxidized and reduced nitrogen species concentrations and gas-particle partitioning across the study domain. Changes in transport patterns significantly affected observed concentrations of nitrogen and sulfur species in the park. Concentrations of nitrogen species were generally highest when air was transported from the east, a region with substantial urban and agricultural nitrogen emissions. An overview of study measurements and insights into the dominant pathways for nitrogen deposition in the park will be provided.

Control #: 33

Source Apportionment of Sulfur and Nitrogen Species at Rocky Mountain National Park using Modeled Conservative Tracer Releases and Tracers of Opportunity

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Visibility degradation and changes in ecosystem function 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. The ROcky Mountain Atmospheric Nitrogen and Sulfur study (ROMANS) was initiated to better understand the origins of sulfur and nitrogen species 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 sulfur and 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 sulfur and nitrogen species in Rocky Mountain National Park (RMNP) from within and outside of the state of Colorado; identify the relative contributions to atmospheric sulfur and nitrogen species in RMNP from emission sources along the Colorado Front Range versus other areas within Colorado; and identify the relative contributions to atmospheric sulfur and nitrogen species from mobile sources, agricultural activities, and large and small point sources within the state of Colorado. As part of the study, a monitoring program was initiated for two one-month time periods, one during the spring, the other during late summer/fall. Monitoring data of ammonium/ammonia, nitrogen oxide/nitrates, and sulfur dioxide/sulfates is combined with tracers of opportunity and 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 #: 79

Preliminary Back Trajectory-Based Source Assessments for Airborne Particulate Matter and Deposited Ions at Rocky Mountain National Park, CO

K. Gebhart, W. Malm, B. Schichtel, M. Barna, National Park Service, Fort Collins, CO; M. Rodriguez, J. Hand, J. Collette, C. Carrico, T. Lee, A. Sullivan, Colorado State University, Fort Collins, CO.

Increasing deposition of nitrogen and sulfur compounds in Rocky Mountain National Park (RMNP), Colorado has the potential to cause irreversible ecosystem changes. Additionally, airborne particulate matter causes visibility degradation in this class I area. These issues led to the 2006 Rocky Mountain Nitrogen and Sulfur Study (ROMANS) designed to help determine the source contributions to these species. In addition to data collected during ROMANS, there are longer-term measurements of particulate matter and deposition from nationwide monitoring networks that can be used for assessment of spatial and temporal patterns. Back trajectories were calculated hourly at four start heights during 2006 for all ROMANS and other monitoring sites using output from the Pennsylvania State University/National Center for Atmospheric Research Fifth Generation Mesoscale Meteorological Model (MM5) as input to the trajectory model. MM5 was calculated on nested grids with 36, 12, and 4 Km spacing with the finest grid over Colorado. Meteorological data collected as part of ROMANS, including several near-surface stations, a radar profiler, and a SODAR were assimilated into the calculations. The back trajectories were analyzed by several qualitative statistical techniques to determine source areas that were likely to have influenced particulate concentrations and deposition in RMNP during the spring and summer ROMANS field campaigns. The same techniques were also applied, though with less temporal resolution, for the remainder of 2006. One technique shows areas most often predicted to be upwind during time periods when measured concentrations or deposition were high. Another estimates the likelihood that if an air mass passed over a source region, it arrived at RMNP during a time of high concentration or deposition. Finally, a multiple linear regression model using concentration or deposition as the dependent variable and time spent in selected source regions as independent variables was used to estimate average fractional contributions from source areas. Correct source attributions for deposited nitrogen and sulfur at RMNP depend on accurately modeled winds, moisture, clouds, and precipitation. Complicating meteorological issues include localized orographic precipitation and wind patterns, stagnation in valleys, and sparse observations in mountainous areas. Therefore, the utility of these trajectory techniques for complex terrain and for deposition will also be discussed.

Control #: 95

Regional Air Quality Model Simulation of the Rocky Mountain Atmospheric Nitrogen and Sulfur Study: Preliminary Results and Analysis

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Rocky Mountain National Park (RMNP) is downwind of many anthropogenic sources of air pollution. There is evidence that the accumulation of nitrogen compounds in RMNP has crossed a critical load, indicating that changes are occurring to the park ecosystems and may reach a point where the changes could be irreversible. The Rocky Mountain Nitrogen and Sulfur Study (RoMANS) took place to further our understanding of the emissions that affect the ecosystems and visibility in the Rocky Mountain region of Colorado and to explore strategies that could mitigate their pollution effects. The study was conducted in two one-month intensive sampling periods during 2006 and one of its goals is to identify the overall mix of sulfur and nitrogen in the air and precipitation on the park. The current work presents preliminary results of the modeling component of RoMANS. The Comprehensive Air Quality Model with extensions (CAMx) is used to simulate the fate of gaseous and particulate species subjected to emission, dispersion, chemical reaction, and removal processes in the troposphere by solving the pollutant continuity equation on a three-dimensional grid. CAMx is used to simulate the spring and summer 2006 RoMANS field campaigns. The model spans the continental US with a horizontal resolution of 36 km for the largest domain, but it includes two nested grids at 12km and 4km to resolve the effects of the Rocky Mountains complex terrain. Output from simulations performed with the Pennsylvania State University/National Center

for Atmospheric Research Fifth Generation Mesoscale Meteorological Model (MM5) is used to drive the air quality model. This study uses an updated version of the 2002 Western Regional Air Partnership annual emissions inventory. The new inventory reflects the emissions from mobile sources and ammonia that correspond to the RoMANS sampling periods. This work will present the results of a preliminary model performance evaluation focused on both concentration and deposition of nitrogen species by comparing model-simulated values with ambient air quality data from the field campaigns.

Control #: 107

Predicting Total Nitrogen Deposition at National Parks

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The CAMx regional air quality model was used to simulate annual total nitrogen deposition for 2002. Measurements indicate that many regions, such as the Intermountain West, are seeing increased nitrogen fluxes that have the potential to alter fragile alpine ecosystems. Nitrogen species evaluated for this study include nitrogen oxides, nitric acid, peroxyacetyl nitrate, organic nitrates, ammonia, and particulate nitrate and ammonium. Key questions to be addressed are: What is the contribution of organic nitrates, which are not routinely measured? Is dry deposition of ammonia an appreciable component of the overall nitrogen flux? What is the relative importance of dry deposition vs. wet deposition? For this simulation, the Carbon Bond - IV chemistry mechanism and the ISORROPIA inorganic aerosol thermodynamics module were employed. Both wet and dry deposition were simulated. A multi-layer resistance model was used to estimate deposition velocities for gases and aerosols. For wet deposition, uptake into the aqueous phase was treated as a function of rainfall rate, cloud water content, gas solubility and diffusivity, and aerosol size. Wind fields, emissions, and boundary conditions for this simulation were provided by the Regional Modeling Center of the Western Regional Air Partnership, and the model domain was defined with the 36 km national RPO grid.

Session 9: Gaseous and Particulate Nitrogen

Control #: 20

Characterization of the Winter Midwestern Particulate Nitrate Bulge

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A previously unknown multi-state region of elevated particulate nitrate concentration was detected as a result of the expansion of the IMPROVE network of remote-area PM speciation monitoring sites into the Midwestern U.S. that began in 2002. Mean winter ammonium nitrate concentrations exceed 4μg/m^3 in a region centered on Iowa, which makes it responsible for as much as half of the particle light extinction. Prior to this discovery, particulate nitrate in the U.S. was thought to be a dominate component of the $PM_{2.5}$ only in parts of California and some urban areas. Comparisons of the spatial patterns of particulate nitrate with spatial patterns ammonia and nitrogen oxide emissions, suggests that the nitrate bulge is the result of the high emissions of ammonia associated with animal agriculture in the Midwest. Nitrate episodes at a number of locations in the eastern U.S. are shown to be associated with transport pathways over the Midwest, suggesting long-range transport of either ammonia or ammonium nitrate. Thermodynamic equilibrium modeling conducted on data from the Midwest show the relative importance of atmospheric ammonia and nitric acid in the production of $PM_{2.5}$. This is a particular concern as the SO_2 emissions in the U.S. are reduced, which increases the amount of ammonia available for ammonium nitrate production.

Control #: 39

Continuous Ammonia and Ammonium Measurements from the Southeastern U.S.

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Gaseous ammonia is the dominant base in the troposphere. Its neutralization reactions with sulfuric and nitric acids form ammonium salts that comprise a significant portion of atmospheric particulate matter. The primary sources of ammonia to the atmosphere are thought to include waste products of domesticated livestock (including hogs, cattle, poultry, and sheep) and fertilizer application to croplands and pastures, with smaller contributions from industrial and vehicular sources. Biomass burning is also known to be a source of ammonia and ammonium, although the overall contribution of this source to ammonia emission budgets is poorly understood. Although much is known about atmospheric ammonia, including its primary sources and its importance in atmospheric chemistry, far less is known about the magnitude and variability of emissions from these sources and the spatial and temporal distribution of near-surface concentrations. The paper presents new high-time-resolution measurements of ammonia and particulate ammonium from the Southeastern Aerosol Research and Characterization (SEARCH) study monitoring network. SEARCH was designed and implemented in 1998-1999 in an effort to provide extensive long-term data on the sources and chemical characteristics of atmospheric particulate matter (PM). Routine measurements at SEARCH sites include trace gases (O3, SO2, CO, NO, NO2, HNO3 and NOy), surface meteorology, filter-based fine and coarse PM mass and composition, as well as semi-continuous PM2.5 mass and composition. Continuous measurements of gaseous ammonia at SEARCH sites, combined with co-measured trace gas, PM, and meteorological data help provide a better understanding of the sources and atmospheric behavior of this important atmospheric component. In particular, SEARCH measurements at the Yorkville, Georgia, site indicate the importance of local poultry operations as sources of ammonia, and in combination with NOy sources transported from urban areas these sources influence the formation of ammonium nitrate aerosol. Additionally, SEARCH ammonia measurements provide an estimate of the importance of wildfires and prescribed burning on the overall ammonia budget.

Control #: 70

NH3 Monitoring in the Upper Green River Basin, Wyoming

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A long term ammonia air monitoring study was initiated in December, 2006 at Boulder, Wyoming, by Shell Exploration & Production Company. The monitoring site is located in the Upper Green River Basin of western Wyoming southwest of the Bridger Wilderness, a Class I area with an IMPROVE monitoring site. This region is experiencing rapid development of natural gas resources with possible consequences of air quality and visibility impacts in the Bridger Wilderness. Very limited short-term ammonia measurements are available for this region. Thus, the primary objective of this study is to characterize the local nitrogen budget and specifically, ammonia concentrations and concentrations of related gases and particles in the basin for at least one year. Gaseous and particulate measurements were collected twice per week (integrated 3-day and 4-day samples) beginning December 15, 2006 and continuing through March, 2007. Samples were collected using coated annular denuders and stacked filters in a University Research Glassworks (URG) sampler. The Colorado State University Atmospheric Science Department provided laboratory-prepared sample media and laboratory analysis for gas and particle concentrations. Standard operating procedures, technical instructions, and a QAPP for instrument installation, operation and maintenance, field sampling, filter handling, and laboratory analyses were developed and submitted to Wyoming Department of Environmental Quality - Air Quality Division. The paper will present the monitoring protocols, analyses, and initial interpretation of the collected data.

Control #: 117

Development and Testing of Analyzers for Routine, Continuous Measurement of HNO_3, NH_3 and fine particulate NO_3^- and NH_4^+

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The need for continuous measurements of particulate matter (PM) and gas phase precursors has been recognized for many years. Recent promulgation of ambient air quality standards for PM has brought this need for high temporal resolution into sharper focus and intensified R&D of continuous analyzers (e.g., EPA SuperSite Program and Air Quality Health Centers). Despite many advances, continuous measurements of PM (other than mass) and PM precursors are generally limited to short-term, intensive campaigns operated by highly trained individuals or research groups. Penetration of continuous methods into routine, long-term monitoring networks is extremely limited. Measurement capabilities exist and are readily available. The challenge lies in engineering a robust system with streamlined maintenance and data reduction requirements, so that it can be operated within the resource constraints of a routine network. This paper will describe results of an EPRI-sponsored project to adapt measurement techniques currently used in the Southeastern Aerosol Research and Characterization network (SEARCH) for use in routine networks (e.g. SLAMS and CASTNet). SEARCH uses denuder difference techniques and trace level commercial NO/NOx analyzers to measure HNO_3, NH_3 and fine particulate NO_3^- and NH_4^+ at sub-ppb and sub-microgram/m3 levels, with hourly or better temporal resolution. Given that State and Local networks employ similar analyzers for compliance monitoring, the SEARCH approaches are eminently adaptable for widespread use. Equipment modifications will be described and results of several field campaigns designed to estimate accuracy, precision and bias will be presented.

Control #: 123

Studies of Amine Formation in Ambient Aerosols Using On-line Single Particle Mass Spectrometry

K. Prather, University of California

Low molecular weight amines are emitted by a variety of widespread anthropogenic and biogenic sources, constituting an important class of environmental pollutants. Amines can undergo a variety of reaction processes in the atmosphere including oxidation and photochemistry. Using single particle mass spectrometry, our group has detected amines in ambient aerosols in a number of locations throughout the world. These observations inspired lab studies by Angelino et al. aimed at investigating the formation of amine-nitrate and amine-sulfate salts in lab studies (Angelino, et al. 2001). We showed in these studies that amines undergo rapid nucleation with nitric and sulfuric acid to form amine salts. The behavior of amines in the atmosphere is similar to ammonium nitrate formation showing a strong temperature and relative humidity dependence. However, in contrast once amine salts form in the particle phase, this can be a non-reversible process, leading to the accumulation of these species in the particle phase. This presentation will discuss real-time measurements of ambient amines in Riverside, CA. In this study, a thermodenuder coupled to an aerosol time-of-flight mass spectrometer was used to study the size, chemistry, and volatility of amines during two different seasons in Riverside, CA. The presentation will describe the different behavior of amines observed during these two seasons. New measurements of the optical properties of highly aged aerosols in Riverside will also be presented. A discussion of prospects for measuring amines in ambient aerosols and quantifying their abundance will also be discussed.

Session 10: Source Apportionment – Receptor Models

Control #: 21

An Innovative Approach for Apportioning Visibility Degradation to Sources of $PM_{2.5}$ in Riverside/LA Basin Area in the Summer of 2003 and 2005

R. Farber, Southern California Edison, Rosemead, CA; D. Eatough, Brigham Young University, Provo, UT.

An intensive ambient field sampling program occurred in the Riverside area in July 2003 and again in July - August 2005. During the summer, this area is well known for reduced visibility due to copious amounts of both secondary and primary aerosols from the many sources associated with 16 million residents in the LA Basin. The often moist marine airmass emanating from the onshore Pacific Ocean seabreezes lead to accelerated conversion of gas to particles. Additionally, these pollutants are trapped below a strong and shallow 10C summer inversion as the Pacific High dominates this region during the summer. State-of-the art 1-hr average semi-continuous aerosol mass and composition measurements (including the semi-volatile nitrate and organic material components) were made during these two sampling periods. $PM_{2.5}$ mass, chemical species including sulfate, organic material, nitrates, black carbon, gas phase precursors, time-of-flight single particle measurements, and airport visibility was collected and analyzed. Hourly averaged visibility were obtained from airport observations. Visibility was converted to extinction using the appropriate Koschmeider formulation. The data sets, minus the extinction data have been previously analyzed for source contributors using PMF source apportionment techniques. These data, with the extinction hourly average data added are now being analyzed by the PMF technique to determine what factors ("sources") are contributing to both $PM_{2.5}$ mass and visibility impairment. Diurnal information will be critically important for this analysis. Additionally, "source extinction" coefficients inferred from the PMF results will also be calculated and compared to previous work.

Control #: 46

A Spatial Analysis of PMF Factor Concentrations Associated with Back Trajectories at Douglas Pass, Colorado

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A spatial analysis of Positive Matrix Factorization factor concentrations that have been associated with back trajectory points shows possible source region contributions for sulfate, nitrate, wood combustion, and geologic source factors at the Douglas Pass IMPROVE monitor in western Colorado. We used the National Oceanic and Atmospheric Administration (NOAA) Air Resources Laboratory (ARL) HYbrid Single-Particle Lagrangian Integrated Trajectory model or HYSPLIT to calculate back trajectories for IMROVE sample days in 2005 at the Douglas Pass monitoring site in western Colorado. A total of 576 back trajectory points were calculated for each sample day. These points represent 48 hours of back trajectory points for every two-hour period during a sample day. This spread of points provided a comprehensive picture of the possible air mass source areas for the sample during the previous two days. With about 120 sample days in 2005, this exercise yielded about 70,000 back trajectory points. Source factor concentrations were associated with trajectory points for the sample day, and a moving spatial average was applied to the resulting data for the whole year. Despite the use of meteorological fields with a 40-kilometer grid resolution and the complex terrain of the study area, this method located likely source areas with an apparently high degree of accuracy.

Control #: 50

A Novel Approach for Apportioning Visibility Impairment to Sources of $PM_{2.5}$ in Fresno, CA in December 2003

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An intensive ambient field sampling program occurred at the Fresno, CA EPA Supersite during December 2003. This area often experience prolonged episodes of fog and low clouds during the winter and such was the case in this December study. The boundary layer airmass was moist and stagnant with visibilities reduced to a few feet during the first half of the study period. During the second half of the study, inversions were present each day, but no fog occurred. State-of-the-art 1-hr average semi-continuous aerosol and composition measurements were made during this month. Measurements included determination of the semi-volatile species nitrate and semi-volatile organic material. $PM_{2.5}$ mass (measured using both an FDMS TOEM and a GRIMM monitor), and chemical species including sulfate, organic material (both nonvolatile and semi-volatile), nitrate, chloride, ammonium, black carbon, Aethalometer measured UV absorption, gas phase precursors, and airport visibility were collected and analyzed. In addition, both temperature and relative humidity data are available on an hourly basis. Visibility will be converted to extinction using the appropriate Koschmeider relationship. Using this continuous and rich data set, on an hourly averaged time scale, the PMF factor analysis method will be used to determine what "sources" are contributing to both $PM_{2.5}$ mass and visibility impairment. The PMF analyses will be performed both with and without the extinction data included. The diurnal information aids substantially in the source apportionment analysis. Consistency will be examined for the PMF analysis performed with and without the extinction data. The results will give the diurnal variation in the fractional contribution to extinction for each identified "source". Additionally, "source extinction" coefficients will also be calculated and compared to previous work.

Control #: 59

Estimating the Contribution of Smoke to Fine Particulate Matter using a Hybrid-Receptor Model

B. Schichtel, W. Malm, National Park Service, Fort Collins, CO; J. Collett, A. Sullivan, A. Holden, L. Patterson, Colorado State University, Fort Collins, CO.

Carbonaceous aerosols are a major component of fine particulate mass that can adversely affect health and contribute to haze in national parks and wilderness areas. Recent results from radiocarbon studies have shown that 80-100% of the fine particulate carbon measured in rural areas and ~50% in two urban areas are from biogenic sources. Smoke from fire-related activities is thought to be a large contributor to the biogenic carbon, particularly in the western and southeastern United States. However, federal land managers and policy makers currently lack the tools necessary to separate carbonaceous aerosols originating from fire from industrial- and mobile-source activities and vegetation on a routine basis. A hybrid source apportionment tool is being developed that integrates measured tracer species of smoke and other sources of carbonaceous material with atmospheric modeling and dispersion results. The tool is being developed in the receptor framework using positive matrix factorization (PMF), where modeling results are introduced as an additional constraint on the receptor model. A synthetic dataset was constructed simulating the primary and secondary aerosol contributions of fire, mobile, point, and area sources to total fine particulate carbon at three receptor sites. Concentrations of trace aerosol species, commonly measured above the detection limits in the IMPROVE network, were constructed by applying source profiles for each source category to the simulated source contributions. Multiple measured source profiles were used for each source category to simulate the variability in the source profiles. Measurement error was added to the trace species and 100% error was added to the modeling results. It was shown that the incorporation of both the synthetic tracer concentrations and modeling data resulted in lower source apportionment errors than using either the tracer species or modeling data alone.

Control #: 104

Impacts of an Isolated Single Source in Rural Vermont

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In order to reduce the use of residual oil and the resulting operating costs, an isolated large paper mill situated on the NY side of the southern end of Lake Champlain made a limited test of burning tire derived fuel (TDF) during November 2006. Because of concerns for the potential effects of the TDF combustion, an intensive downwind monitoring program was operated in rural, western Vermont to provide time-resolved data on gaseous and particulate constituents including SO_2, gaseous and particulate mercury species, particulate sulfate, organic and elemental carbon (OC/EC), black carbon and particle number distributions. Twenty-four hour integrated $PM_{2.5}$ samples were collected daily and analyzed for mass, elements, ions, and OC/EC were collected at two sites. Size-fractionated aerosol samples were collected with U. C. Davis 8-stage DRUM samplers, with subsequent synchotron XRF elemental analysis at three-hour time resolution. These data were examined to identify plume events both during the limited TDF combustion period and during the rest of the month. Although there was only a limited period when TDF was burned, the effect of the plant plume could be observed in the time resolved data. The data sets were used in source apportionment studies and the results of these analyses will be presented.

Session 11: Source Apportionment – Source Oriented Models

Control #: 15

CAMx Visibility Modeling Conducted for the Columbia River Gorge National Scenic Area Air Quality Study

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This paper describes the meteorological, emissions and air quality modeling conducted as part of the Columbia River Gorge National Scenic Area Air Quality Study (Gorge Study). The modeling analyses reported herein comprise just one component of the entire Gorge Study to assess projected trends in future visibility impairment, to provide a simulation assessment of source apportionment by type and region, and to test several "what-if" scenarios for future year conditions. To meet the goals of the Gorge Study, chemical transport modeling was performed using ENVIRON's Comprehensive Air Quality Model with extensions (CAMx), in combination with emission inputs from the U.S Environmental Protection Agency's (EPA) Models-3 Sparse Matrix Operating Kernel Emissions (SMOKE) system, and meteorological inputs from the Pennsylvania State University / National Center for Atmospheric Research (PSU/NCAR), Fifth Generation Mesoscale Model (MM5). The general approach for the Gorge Study modeling was to leverage the considerable regional visibility modeling work already conducted by the Western Regional Air Partnership (WRAP) Regional Planning Organization (RPO) that addresses the requirements of the federal Regional Haze Rule. Following the WRAP modeling methodology, the Gorge Study modeling component employed CAMx to simulate two season-representative high PM/extinction episodes with a wide array of sensitivity tests and Probing Tool applications for both a 2004 base year and the 2018 future year. Based on visibility measurements during the 2003-2005 enhanced monitoring periods, two multi-day seasonal episodes in 2004 were selected for the Gorge Study modeling: a summer period over August 10-22, and an autumn period over November 3-18. A 10-day "spinup" period was added before each episode to reduce the influence of initial conditions. Modeling was conducted on a series of telescoping nested grids, with the finest high-resolution grid focusing on the Gorge area. The CAMx PM Source Apportionment Technology (PSAT) probing tool was used to assess source category and region-specific attribution to sulfate, nitrate, carbonaceous, and primary particulates at several monitoring sites within the Gorge. PSAT was applied for both 2004 base and 2018 future years. Finally, a group of five "what-if" scenarios were simulated to provide estimated visibility improvements with the removal (or significant reduction) of emissions from specific sources.

Control #: 63

Linking Air Quality and Watershed Management Models

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Air quality models and watershed models are typically applied independently by different researchers to simulate different things: atmospheric pollution and land/water ecosystem impacts, respectively. The end points of the air models (ground-level concentrations and deposition) are generally the starting point of the watershed models (atmospheric input into ecosystems), but little effort has been made to link them in a rigorous manner. Rigorous chemical and physical linkages would allow researchers to follow the path of pollutants emitted into the air, their transport and transformation in the atmosphere, their deposition to the earth, and their impacts on watersheds and water bodies after interactions with other natural and human-caused substances. The linked models could be used to rigorously evaluate the water quality changes that would result from the reduction of air emissions from specific sources or categories of sources_a capability that does not currently exist. It would also allow for a systematic apportionment of pollutant loadings to watersheds and water bodies from the sources contributing to atmospheric deposition as well as ground-level point and non-point sources. The air quality model AMSTERDAM (Advanced Modeling System for Transport, Emissions, Reaction, and Deposition of Atmospheric Material) is used to simulate processes affecting atmospheric ozone, particulate matter, mercury, and acidic and nitrogenous compounds. AMSTERDAM (formerly known as CMAQ-MADRID-APT-Hg) is derived from the U.S. Environmental Protection Agency's (EPA's) Community Multiscale Air Quality model (CMAQ) and will be available to the public in early 2008. WARMF (Watershed Analysis Risk Management Framework) is an advanced modeling system that simulates multiple watershed processes in order to predict contaminant loadings to water bodies and pollutant concentrations in water, sediment, and fish tissue. WARMF is publicly available through EPA. Linking two advanced

models such as AMSTERDAM and WARMF will provide an efficient way to obtain additional information previously unavailable to decision makers. For example, researchers could use such a linkage to determine the impact of reductions in NOx/SO_2 emissions from power plants_or perhaps even just one power plant_on net nitrogen levels in a water body. A linkage between AMSTERDAM and WARMF will help synergize the capabilities of these two powerful modeling systems. This presentation will present results of a project underway to link AMSTERDAM and WARMF to achieve these advantages.

Control #: 69

Effects of Ambient Ammonia Concentrations on CALPUFF Nitrate Predictions and Modeled Effectiveness of NO_x Controls

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The CALPUFF model is an advanced Lagrangian puff dispersion model approved by the USEPA for long-range transport applications. These applications involve predictions of criteria pollutant concentrations as well as regional haze (including Best Available Retrofit Technology (BART) analyses) and acid deposition in Class I areas. As part of the USEPA approval process, the CALPUFF model was evaluated with several tracer studies including both long-range and short-range datasets. However, independent evaluations of the CALPUFF chemical transformation modules, MESOPUFF II and RIVAD, have shown significant prediction biases of the inorganic chemical constituents involved in secondary particulate matter formation. These biases exist in other advanced models, such as CMAQ, indicating that these discrepancies are not unique to CALPUFF chemistry. Importantly, a significant component of total model uncertainty is due to model inputs such as background concentrations and inflow boundary conditions. The sensitivity of CALPUFF predicted nitrate concentrations to ammonia inputs is investigated using a case study. A critical component of inorganic secondary particulate matter formation is the availability of ammonia. Previous model evaluation studies have assumed a uniform background ammonia concentration, with values ranging up to 10 ppb. Initialization of CALPUFF using a single background value for ammonia may not be appropriate to accurately reproduce the complex non-linear chemical interactions within the sulfate-nitrate-ammonia system. Alternatively, this study investigates the effects of seasonal variations in background ammonia on predicted nitrate formation. As a separate analysis, spatially variable ammonia concentrations are used to evaluate the sensitivity of model predictions to the location of emissions. To emphasize the importance of including appropriate ammonia values, these sensitivity analyses will be performed for a controlled and uncontrolled point source. The control device selected for this analysis is Selective Catalytic Reduction (SCR), which is used to control NO_x emissions through reaction with ammonia and a catalyst. The effectiveness of post-combustion NO_x controls such as SCR is complicated by un-reacted ammonia (ammonia slip) and its subsequent reactions with other flue gases, such as SO_2. In some cases, especially during the summer, it is possible that the ammonia slip from SCR operation will degrade visibility as a result of increased production of ammonium sulfate. The ammonia slip from SCR operation is an overlooked component of visibility benefits, particularly when it is not incorporated in BART modeling analyses.

Control #: 75

Evaluation of Aerosol Model Performance in a Coupled Meteorology-Chemistry Model against Speciated Measurements for January and July 2002

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Elemental or black carbon aerosols absorb solar radiation and have direct and indirect effect on radiative forcing. Unfortunately, global EC data are rather sparse. Therefore, for planetary radiative forcing calculations atmospheric EC burdens are obtained from model estimates based on energy consumptions. In this work we have attempted to evaluate a multiscale integrated model for aerosol physics, chemistry and radiative effects using measurements of EC and sulfate at two sites in New York State. The EC and sulfate concentrations were measured for January, February, July and August 2002 at Mayville, and Whiteface Mountain. Our Mayville site is located near Lake Chattaqua, ~100 km southwest of Buffalo and ~530 km upwind of Whiteface Mountain. Our observatory at Whiteface Mountain is located at an altitude of

1.5 km above mean sea level. Whereas at Mayville samples were collected daily, the duration of sampling at Whiteface Mountain varied from 6 to 48 h. The observations of elemental carbon and sulfate from Whiteface and Mayville for the summer of 2002 have been used along with other network measurements from the IMPROVE and CASTNet networks to evaluate METCHEM, a tightly coupled meteorology-chemistry model in nested simulations over the U.S. to examine the radiative impacts of absorbing and scattering aerosols. The model is being driven by a high-quality bottom-up inventory of emissions compiled by the Regional Planning Organizations for their 2002 visibility assessments, and the National Emissions Inventories compiled previously by the U.S. EPA in the years 2002 and 1999, to compare both the effects of evolving emissions, and the successive improvements in characterizing emissions from wildfires as well as other source categories in these inventories. Results of aerosol concentrations, aerosol optical depths and direct radiative forcing from January and July are inter-compared between simulations using the RPO and EPA inventories.

Control #: 87

Regional Haze and Smoke Predictions from the BlueSky Smoke Modeling Framework

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Smoke from biomass burning events, both large and small, contributes to haze on many scales. Predicting smoke impacts from wildland fires presents multiple challenges, such as obtaining the best available fire data, reconciling data from multiple information sources, characterizing fuels, and predicting plume heights. Currently, real-time smoke predictions are available across the lower 48 states via the BlueSky smoke modeling framework. BlueSky modularly links computer models of fuel consumption and emissions, fire, weather, and smoke dispersion into a system for predicting the cumulative impacts of smoke from prescribed fires, wildfires, and agricultural fires. Each night, BlueSky obtains regional meteorological predictions and reported burn information from state and federal agencies, merges these data with models of fuel consumption and emissions, and processes dispersion and trajectory models to produce regional estimates of smoke concentrations for the next two days. Recent advances throughout the smoke modeling pathway (from input fires to downwind pollutant concentrations) have improved our ability to model haze events from wild, agricultural, and prescribed fires. The BlueSky smoke modeling framework has recently been modernized and upgraded in several key ways: satellite data are now incorporated to provide information on the location and size of fires; the most recent fuel loading, fuel consumption, and emission models have been added; and the Community Multiscale Air Quality model (CMAQ) is being used to predict concentration fields of PM2.5 and ozone nationally from both fire and anthropogenic emissions. Predictions from the new BlueSky framework are now being validated. This paper explores some early results of the analysis in the context of visibility and regional haze with a particular focus on the addition of satellite-detected fires.

Control #: 94

Use of Photochemical Grid Models to Assess the Air Quality and AQRV Impacts of Proposed Oil and Gas Production Projects in the Western U.S.

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Oil and gas production in the western states has been increasing as demand for local sources of energy have risen. The development of an oil and gas production project usually involves the preparation of an Environmental Impact State (EIS) that discloses the potential environment effects of the project. Such environmental effects include the potential impacts of emissions from oil and gas production on air quality (AQ) and air quality related values (AQRVs), AQRVs include visibility and deposition. In the past, oil and gas EISs have used the AERMOD Gaussian plume model to estimate the near-source AQ and the CALPUFF Lagrangian puff model to estimate the far-field AQ and AQRV impacts. With ozone becoming an increasing concern, some oil and gas EISs have also required the application of a photochemical grid model (PGM) to address potential ozone impacts. However, the current generation of PGMs are "one-atmosphere" models (e.g., CMAQ and CAMx) that also estimate particulate matter (PM) and deposition, in addition to ozone. Thus they can provide the same far-field AQ and AQRV impacts as CALPUFF, only using current state-of-science chemistry algorithms rather

than the overly simplistic and out-of-date chemistry algorithms used in CALPUFF (developed in 1983). This paper presents the use of a PGM to estimate the potential AQ and AQRV impacts due to an oil and gas production project in Wyoming. The CMAQ and CAMx PGMs were first applied for a summer and winter month and evaluated to determine which model performed best. The best performing PGM was then selected to perform the AQ and AQRV impacts assessment of the oil and gas production project. The paper describes the model application and evaluation methodology and how the PGM modeling results were used to project future year 8-hour ozone, PSD pollutant concentrations, visibility and deposition impacts at Class I and sensitive Class II areas. The advantages and disadvantages of using a PGM instead of CALPUFF for performing AQ and AQRV assessments are provided.

Control #: 101

Impacts of Emissions Speciation and the Revised IMPROVE Equation on Predicted Visibility Impacts

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Use of speciation techniques recommended by the Visibility Improvement - State and Tribal Association of the Southeast (known as VISTAS) for sources such as coal-fired boilers can lead to overly conservative visibility impacts in near-by Class I areas. An example will be provided for a BART applicability study for a fictitious 830 MMBtu/hr coal-fired utility boiler in Kentucky. This unit is assumed to be subject to BART, CAIR, and Kentucky SIP provisions. The unit is a pulverized coal-fired, dry bottom, wall-fired boiler equipped with an electrostatic precipitator and low NO_X burners. Due to its age and grandfathered status, it is assumed that the boiler has no SO_2 control technology such as flue gas desulfurization (FGD). A unit such as this one generates a significant amount of visibility affecting pollutants (i.e., about 20,000 tpy of SO_2 2,300 tpy of NO_X, and 1,300 tpy of total PM_{10} emission), which could lead one to assume regional haze is impacted at a Class I area only 118 kilometers away. This presentation examines methodologies within the guidelines suggested by the VISTAS BART modeling protocol, in which less conservative assumptions were utilized allowing a more representative estimation of visibility impacts at the near-by Class I area. A few of the options that will be presented are: using a refined conversion rate of SO_2 emissions to sulfuric acid, altering the FLM default portion of inorganic condensable PM emitted, representing actual 24-hour emission rates instead of potential emissions, using the revised IMPROVE algorithm approach, and/or repartitioning nitric acid to nitrates in the presence of ambient ammonia. The results examine the implications to visibility degradation at the most impacted Class I area (Mammoth Cave, Kentucky) attributable to the fictitious coal-fired source using the CALPUFF model.

Session 12: Field Studies and Monitoring Networks

Control #: 26

Comparisons of Sulfur and Sulfate Measured in IMPROVE

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Most fine-particle sulfur is present as sulfate. Measured concentrations are therefore expected to exhibit the ratio [S]/[SO4=] ~ 32/(32 + 4x16) = 1/3. Reported concentrations often depart from this ratio by more than their reported uncertainties. In the IMPROVE network sulfur and sulfate are determined on two separate filters analyzed by two separate analytical methods: sulfur by X-ray fluorescence (XRF) on Teflon filters and sulfate by ion chromatography (IC) on nylon filters. The comparison of these redundant measurements can provide a useful quality assurance check. IMPROVE data have exhibited a tendency toward S/SO4= ratios elevated about 10 to 15 percent above the expected value of 1/3. Independent lines of evidence point to sulfur measurement bias as the source of most of the observed variation. First, the S/SO4= ratio has exhibited several abrupt shifts, each of which occurred along a calendar month boundary. The XRF analyses, unlike the IC analyses, are quality assured in calendar-month batches, and some of the observed jumps coincided with recalibrations of the XRF system used to determine sulfur. With the advent of a new, more stable vacuum XRF system beginning with samples collected in January 2005, the ratio has become more stable, but still hovers around 10 to 15 percent. Abrupt shifts are smaller but still tend to occur on monthly boundaries. Sulfur and sulfate have also been compared at six urban sites where IMPROVE samplers are collocated with those from EPA's Chemical Speciation Network (CSN). Collocated data offer four-way comparisons of sulfur and sulfate from IMPROVE and CSN. In all of these comparisons, the S/SO4= ratio is elevated substantially above 1/3 only when IMPROVE sulfur is part of the comparison.

Several lines of investigation are underway to better understand the S/SO4= relationship in IMPROVE:

• Some Teflon filters have been extracted and analyzed for sulfate by IC to assess differences in sampling between the Teflon and nylon filters.

• Some nylon filters have been subjected to a second extraction to verify that all sulfate is being extracted for analysis.

• Teflon and nylon filter sampling systems have been operated side-by-side, with and without the denuder typically used before the nylon filter, to identify any sampling differences that may be contributing to the elevated ratio.

• An aerosol generation system is being developed and tested to provide Teflon filters spiked with known amounts of ammonium sulfate, to be used for challenging the XRF system.

Control #: 41

Interagency Monitoring of Protected Visual Environments (IMPROVE) Detection Limits

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The IMPROVE network uses X-ray fluorescence (XRF) spectroscopy to measure twenty-four elements in particulate matter (PM) samples. Several of these elements are consistently measured near their detection limits. Measurements near the detection limit have higher relative uncertainties than measurements well above the detection limit. In order to properly use and interpret these data, the detection limits must be well-characterized. There are various definitions for detection limits: to avoid false positives (i.e., measured but not present in sample), to avoid false negatives (i.e., present in sample but not measured), and to obtain quantitative data (i.e., less than 10% uncertainty). Published techniques for characterizing these detection limits require the ability to prepare standards using the same sample preparation methods as normal samples at concentrations close to the detection limits. Accessible techniques for creating uniform ambient concentrations of these trace elements have yet to be developed. Also, detection limits are particularly difficult to determine for multi-species analyses because they are often dependent on the concentrations of other species. Therefore,

alternative means for determining the detection limits are being devised. This work calculates and compares detection limits using various data sets including filter blanks, sample re-analyses, and collocated data. The filter blanks provide limits for avoiding false positives. The re-analyses and collocated data provide limits for avoiding false negatives. IMPROVE currently reports what are referred to as minimum detectable limits (mdl's), which are measures of the background in the peak region of the spectra, for each filter analyzed. These mdl's are consistency lower than the detection limits developed in this work.

Control #: 86

New Methods for Quality Control, Data Validation, and Flagging of IMPROVE Data

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Long-term monitoring of particulate matter for visibility trends requires careful attention to measurement methods to ensure that observed trends represent real changes in the atmosphere rather than changes in the measurements themselves. The IMPROVE program has been operating since 1987 and has undergone a number of changes since its inception. For example, in 2000 the low-Z elements (below iron) were analyzed using Proton Induced X-ray Emission (PIXE) and high-Z elements (iron and above) were analyzed by X-ray Fluorescence using a Mo anode (Mo-XRF). Beginning December 1, 2001 the low-Z elements (up to and including iron) were analyzed using XRF with a Cu anode (Cu-XRF) to improve analytical sensitivity. Elements above iron continued to be analyzed using Mo-XRF. More recently, two Cu-XRF instruments have been employed to maintain data throughput. UC Davis has implemented a number of procedures to analyze IMPROVE measurements, validate them, ensure data quality, and flag suspect data. These methods include monthly checks on the analytical measurements, validation of calculated concentrations, and specific flagging of the data to alert users to potential problems. They have proven useful to examine measurement changes such as those described above, and have allowed us to discover potential data issues that may affect analysis. For example, we have observed small differences in the results of the two Cu-XRF systems. We also found that the introduction of new calibration foils for the Mo-XRF system resulted in changes to the calibration factors for the elements Ni, As, Se, Br, Rb, and Pb that could be observed in their effects on reported ambient concentrations. We will discuss the data quality and validation tools we use, the features in the data we have discovered due to their use, and highlight the methods we use to inform data users.

Control #: 89

A Cabinet of Curiosities: IMPROVE's On-line Data Advisories

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The Interagency Monitoring of Protected Visual Environments (IMPROVE) network tracks the concentration and chemical composition of haze aerosols at about 170 locations throughout the United States. Data are and documentation provided on-line at http://vista.cira.colostate.edu/improve/, where users can download, in addition to species concentrations, sample-specific uncertainties, detection limits, data flags, and other supporting information. These routine, fine-scale indicators do not always capture everything that is known about data quality. Data from different eras may differ, for example, in patterns that do not correspond to plausible atmospheric signals. If no rationale can be identified for correcting or invalidating one of the conflicting measurement sets, there is then a network-level uncertainty that is not reflected in the uncertainties reported with individual samples. Alternatively, improvements may be made in an analytical method to yield data whose greater accuracy can be distinguished in large-scale comparisons. If the data from earlier measurements are already in wide use, users may prefer to recognize and accept the resulting discontinuity. IMPROVE has begun to address such situations with a series of data advisories, available at http://vista.cira.colostate.edu/improve/Data/QA_QC/Advisory.htm. These advisories follow a standard format giving the species, sites, and sampling periods involved, the phenomenon at issue, and a recommended course of action for users of the data, accompanied by a succinct account of the technical basis and supporting evidence. This presentation reviews the growing collection.

Poster Session A

Control #: 10

In Situ Extinction Efficiency of Fugitive Dust from Cattle Feedyards

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Cattle feedyards emit fugitive particulate matter that reduces downwind visibility, which presents an opportunity to use visibility measurements as a surrogate for measurement of PM mass concentration. We compare time-resolved PM mass concentrations (µg m-3) and atmospheric extinction coefficients (km-1) measured simultaneously along the downwind boundary of a commercial cattle feedyard to compute "extinction efficiency," the change in atmospheric extinction that results from a unit change in PM mass concentration. Expected values for the actual, in-situ extinction efficiency of total suspended particulate (TSP) and its fraction less than 10 microns aerodynamic equivalent diameter (PM10) are 0.2-0.5 and 0.4-0.8 m2 g-1, respectively. These in situ extinction efficiencies are of the same order of magnitude as Malm's published value of 0.6 m2 g-1 for dry, coarse material. The statistical power of our regression procedures was reduced by the presence of significant autocorrelation, the systematic dependence of the regression error term, and we present a comparison of remedial techniques to refine the regression coefficients and eliminate, or at least reduce, the influence of autocorrelation in these time-series data. Recent work by Brooks et al. (2006) has shown that a fraction of feedyard dust is hygroscopic and subject to deliquescence, the influence of which on our measurements has not yet been explained. Determination of the atmospheric extinction efficiency of feedyard dust will facilitate the use of transmissometry as an intuitive, real-time surrogate for time-averaged PM10 and/or TSP concentration.

Control #: 12

Primary and Secondary Aerosol Contributions to Aerosol Light Scattering in Mexico City during the MILAGRO Campaign

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A marked feature of aerosol optics in Mexico City during the MILAGRO Campaign in March 2006 was the diurnal variation of the aerosol single scattering albedo. This parameter has a strong influence on determining the sign (heating or cooling) of aerosol radiative forcing at visible and UV wavelengths, and is determined by aerosol chemistry, mixing state, hygroscopicity, and size distribution. Aerosol light absorption at 532 nm is largely due to black carbon, also known as soot, that arises from incomplete combustion. Aerosol light scattering is primarily associated with aerosol of an organic carbon nature, though contributions from nitrates, sulfates, dust, and other less important types contribute as well. The sources of primary organic aerosol include cooking activities, motor vehicle traffic, regional biomass burning, and industrial activities. The diurnally averaged aerosol single scattering albedo at 532 nm in Mexico City during MILAGRO was a minimum of 0.62 at around 5 a.m. local time due to the strong influence of soot. The single scattering albedo increased dramatically after sunrise as scattering aerosol increased while soot concentrations decreased as vertical mixing in the atmospheric boundary layer became more pronounced. The single scattering albedo stabilized to a constant value of around 0.85 from 11 a.m. until about 2 p.m. as the boundary layer was well mixed. It is very likely that secondary aerosol formation from gaseous precursors contributed as much as 60% of the aerosol scattering when the aerosol single scattering albedo peaked at mid day. This paper combines aerosol light scattering and absorption measurements at 532 nm with real time aerosol mass spectrometer measurements of aerosol chemistry and organic aerosol classification to provide evidence and analysis of the relative contributions of primary and secondary aerosol to particulate light scattering.

Control #: 18

Sky Color and Cloud's Appearance: Sensitive Indicators of Urban Visual Air Quality

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Visibility protection has been characterized as a remote area air quality issue; especially for the western U.S., where the combination of relatively good air quality and large terrain features that are viewable from significant distances results in visual air quality that is highly sensitive to changes in PM concentrations. The Visibility Protection Provisions of the Clear Air Act and the subsequent promulgation and implementation of the Regional Haze Rule are evidence of the value associated with our ability to preserve and enhance views of spectacular scenes in national parks and wilderness areas. Good visual air quality has been recognized as important in a couple of western U.S. urban areas (i.e. Phoenix, AZ and Denver, CO) where local air quality regulations that are more stringent than the National Ambient Air Quality Standards have been enacted specifically to meet locally-determined acceptable haze levels. As in the case of western remote-area visibility, these western urban areas afford views of large terrain features from the urban area, as well as skylines from the urban perimeter that due to the regionally good air quality can be viewed from significant distances so are relatively sensitive to changes in PM concentrations. However for many U.S. urban areas, the lack of complex terrain, few tall buildings and foreground features that block views results in a dearth of sensitive scenic views. This paper explores the utility of changes to sky color and the appearance of clouds in the sky as alternate sensitive indicators of urban visual air quality. It describes an approach needed to develop quantitative relationships between changes in air quality and sky conditions and to display these changes so they can be used to assess the perceptibility and possible perceived benefits associated with improved urban visual air quality.

Control #: 40

Comparisons of Particle Morphology and Composition from Individual Particle Analysis of Biomass Burning Aerosols from Young and Aged Smoke

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Estimates of radiative properties of biomass smoke depend on a complicated array of aerosol properties such as composition, hygroscopicity, particle size, and shape. Individual particle analysis with electron microscopy is particularly useful in understanding smoke properties because particle composition, morphology, and the degree of mixing can vary significantly during biomass burning events, and these variations may not be evident from bulk samples. Single particle samples were collected and analyzed with computer-controlled scanning electron microscopy with energy dispersive analysis of X-rays. Results suggest that aged ambient smoke particles obtained during a regional haze event in California were typically dominated by tar balls, a type of refractory organic carbon particle that is very efficient at scattering light but only slightly hygroscopic at high relative humidity. Soot was rarely observed on samples during peak smoke impacts at the measurement site. In contrast, samples of young (hours-old) smoke obtained during laboratory studies of known biomass fuel burns during the 2004 and 2006 FLAME experiments (Fire Lab at Missoula Experiment) typically showed long chain type soot particles often mixed with inorganic species, and comparably few tar balls. The hygroscopicity of young smoke ranged widely depending on fuel type. The differences observed between young (laboratory) and aged (regional haze) smoke particles demonstrate how the complexity of biomass smoke contributes to uncertainties in its radiative properties.

Control #: 43

Digital Camera Monitoring Technologies, Systems, and Products

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Practical and affordable digital cameras have been used for monitoring air quality since their development in the late 1990s. High resolution digital cameras replaced existing 35mm film cameras in federal, state, and local visibility monitoring networks. These regulatory organizations currently operate air quality or visibility digital camera monitoring networks to capture a record of air quality conditions, record special events such as visible smoke from wild fires or unusual meteorological conditions, and provide public outreach via Web sites and other communication media. Current digital camera technologies produce a wide spectrum of image qualities, ranging from inexpensive low resolution time-lapse to super high quality still images. All digital cameras used in monitoring networks are just one component of systems that include housing and positioning, power, communications, and camera control. System configurations differ based on where the system will be installed and operating, expected environmental conditions in the monitoring area, accessibility to the system, and available power and communications infrastructure. Digital camera products include high quality still images for Web or print media and time-lapse video for investigation of air quality dynamics. Various examples of high resolution digital camera systems, deployment options, current installations, custom output products, and Web sites are presented.

Control #: 44

Source Attribution for Carbon at Class I Areas in Southeastern U.S.

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Organic Carbon Mass is the second largest contributor to fine particle mass and visibility impairment at Class I areas in the southeastern US (sulfate is the largest contributor). Source attribution of carbon is complicated because mass measured at the monitor is a combination of primary fine particle carbon and secondary organic aerosols (SOA) that are formed from gaseous organic precursors that can be either anthropogenic or biogenic in origin. In addition to the standard IMPROVE PM mass and speciation measurements, VISTAS used high volume samplers with PM2.5 inlet and quartz filters to collect carbon at four Class I areas in southeastern US (Mammoth Cave, Great Smoky Mountains, and Shenandoah National Parks and Cape Romain National Wildlife Refuge) and in Raleigh, NC. Carbon 14 isotope analyses of the samples indicate that the majority of carbon is of modern origin. CMB and PMF receptor modeling for these same samples is consistent with C14 results, indicating small contributions from gasoline or diesel. Biomass burning is a significant contributor on some days. Most carbon (85% on average) is unidentified by CMB; PMF assigns some of this unidentified mass to biogenic emissions. The CMAQ air quality modeling tracks carbon from primary emissions separately from SOA formation and tracks SOA formed from biogenic emissions separate from anthropogenic sources. In this paper, CMAQ modeling results will be compared to CMB results for the contributions of primary sources of PM2.5 organic carbon. CMAQ estimates of SOA from anthropogenic and biogenic sources will be compared to seasonal variations in the concentrations of residual unexplained OC and polar organic compounds that are markers of SOA from anthropogenic and biogenic precursors.

Control #: 57

Aerosol Light Scattering at High Relative Humidity

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Aerosol light scattering is strongly dependent on relative humidity (RH) as shown by model calculations in Nessler et al. (2005). Nevertheless it is recommended within the Global Atmosphere Watch aerosol monitoring network to measure aerosol light scattering coefficients at RH below 40%, in order to be able to compare results from different locations. As ambient RH values are typically higher, we built a humidification system for a nephelometer (TSI model 3563) that

allows for measurement of scattering coefficients at a defined and controlled RH in the range 20-90%. In the humidified nephelometer the aerosol first enters a humidifier (a heatable Gore-Tex tube), which is controlled by a first temperature and RH sensor. Then, the aerosol passes through a dryer and its efficiency is controlled by a second sensor. The dryer can be operated without drying the air. Then, the light scattering coefficient of the aerosol particles is measured by the nephelometer at a controlled temperature and RH. If the particles hygroscopic properties experience a hysteresis behavior, the upper and lower branch of this hysteresis curve can be measured by varying the humidifier RH and dryer settings. First measurements will be presented where the new instrument was tested with monodisperse sodium chloride (NaCl) and ammonium sulphate (AS) particles produced by nebulization of an aqueous solution. A CPC was running in parallel to the humidified nephelometer to monitor the number concentration of the monodisperse particles. For monodisperse D = 100 nm sized AS particles the scattering coefficient at 90% RH is seven times higher than for dry conditions. A very good agreement between measured humidograms and theoretical predictions based on Mie theory were found. The humidified nephelometer was also employed in the field and RH dependent scattering enhancement factor of ambient aerosols will be presented. Measurements were performed in the Black Forest, Germany (remote location in the planetary boundary layer) as well as at the Jungfraujoch, Switzerland (a high alpine site located in the free troposphere at 3580 m asl.)

Control #: 58

IMPROVE Data Substitution Methods for Regional Haze Planning

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The EPA's Regional Haze Rule (RHR) sets a 60-year timeline for states to improve visibility within federal Class I Areas from "baseline" (2000-2004) levels to "natural conditions" by 2064. To track progress under the RHR, states and tribes use speciated aerosol measurements collected by the IMPROVE program. RHR guidance outlines data completeness requirements designed to balance the need for data from individual days, seasons, and years to be reasonably representative of ambient aerosol concentrations at each monitoring site. For sites with incomplete data during the baseline years (fewer than 3 complete years), appropriate tracking metrics for regional haze planning cannot be calculated, so RHR guidance provides provisions to "patch" data when specific statistical conditions are met. Regional Planning Organizations (RPOs), working with states and technical support contractors, developed additional data substitution methods for sites that did not have the required baseline data after data were patched. These additional substitutions included a combination of methods including estimating missing species from other on-site measurements and appropriately scaling data collected at selected donor sites which had favorable long-term comparisons. Substituted data sets were submitted to the Visibility Information Interchange Web System (VIEWS) database for 19 IMPROVE monitoring sites important to regional haze planning. These data are referred to as "substituted" data to differentiate them from the RHR "patched" data. A summary of data substitution methods and results used by VISTAS, WRAP and CENRAP will be presented.

Control #: 71

Characterization of Aerosols in U.S Southwest Cities Using Aerosol Models in Conjunction with Optical Monitoring Techniques

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Aerosol properties depend largely upon the size of particles, which makes it the most important parameter for characterizing the aerosol. We focus this study on applying an aerosol inverse reconstruction model (R.Pearson, R.Fitzgerald and J.Polanco, 2007) and novel algorithms to retrieve aerosol size distribution using optical depth data. Our methodology uses Twomey's regularization technique that suppresses ill-posedness by imposing smoothing and non-negativity constraints on the desired size distributions. We have also applied T-matrix codes (Mischenko, et.al.) to study the scattering from irregularly shaped particles that exhibit rotational symmetry. The optical depth data was obtained

using ground Multi-filter Rotating Shadow band Radiometers (MFRSR), located at the cities of El Paso, TX and La Jornada, NM. We present results for mineral dust and soot for the cities of El Paso and La Jornada. In addition, irradiance results for the city of El Paso, obtained using the TUV Model (S. Madronich, et. al., 1999), which is based on a Radiative Transfer Model, are compared against corresponding MFRSR irradiance results. This work will lead to better in situ characterization of aerosols and their impact on urban and rural cities. Furthermore, it will give a more accurate assessment of regional aerosol transport and provide better boundary conditions for air quality models.

Control #: 77

Optec NGN-2 LED Ambient Integrating Nephelometer

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The Optec NGN-2 ambient integrating nephelometer is designed to operate in low power, low maintenance, ambient conditions, and to minimally heat the ambient aerosol. Since 1993, NGN-2s have been operated successfully in federal, state, local, and industry sponsored visibility monitoring programs. Ambient aerosol scattering data from these instruments were recently used to derive the new IMPROVE reconstructed extinction equation. Even though the NGN-2 was designed to minimally heat the ambient aerosol as it passed through the optical scattering chamber, the use of an incandescent light source results in a slight heating of approximately 1-2 ^{O}C. At high ambient relative humidities (>80%), an increase in temperature in the chamber as small as 1^{O} C will result in a 8-10% lowering of the relative humidity in the chamber. If highly hydroscopic aerosols are present (Ammonium Sulfate or Nitrate) and ambient relative humidity is high, the aerosol scattering measured by the nephelometer can be nearly 100% less than the actual ambient scattering. In addition the use of an incandescent light requires a mechanical chopping system to modulate the light source and the light source has a short life span resulting in frequent operator site visits to change out the lamp. A high output LED light source has recently been incorporated into the NGN-2. The light source has a life span of thousands of hours, emits essentially no heat, and is electronically modulated which allows the removal of the mechanical chopper. The paper presents theoretical modeling of Optec NGN-2 LED integrating nephelometer and results of comparison testing and operation of the instrument in field programs. Included in the analyses are comparisons to other currently available integrating nephelometers.

Control #: 78

Visualization of Synthetic Visual Impairment Scenery Using a 3-D Immersive CAVE System

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The work summarized here focuses on the development of a methodology and software system to demonstrate the 3-dimensional display of visibility based on numerical models. In particular, the goal of this visualization project demonstrated the capability of realistically representing visibility in a synthetic environment. This demonstration project tested the concept of using the DRI 3-D immersive system to visualize the interference of air pollutants on radiative transfer process and hence on visual range. The 3-D immersive system uses a CAVE™/FLEX™ four sided immersive display. As a FLEX system, this large display is able to convert between standard CAVE-mode, where the participants are nearly surrounded by projected computer imagery, and open-mode providing a 27 foot wide-screen projection system. In both modes, this system provides for large-scale stereoscopic image projection combined with a 3D immersive interface that allows the participants to interact with the virtual worlds in an intuitive style. The demo allowed the user to turn 360 degrees and see what an observer on the ground would see. We used predictions from MM5 to generate meteorological fields and the CAMx photochemical model to generate concentrations of ammonium nitrate and sulfate, along with aerosol precursor species, wind speed and direction, temperature, relative humidity and other variables in southern

California. Initial work has been made to calibrate simulations of atmospheric visibility with scene camera images from the US Forest Service air quality image archive. The synthetic scene was visualized in a modified version of Cave5D. Images from the Cucamonga Wilderness site (CUCA1) were chosen because the site is within the project's Southern California domain and archive images from that site were available for dates during the simulation period of October 31, 2002 through November 9, 2002.

Control #: 80

Hygroscopicity Measurements and Comparisons with Theoretical Values for Fresh Biomass Smoke Obtained During Laboratory Burns

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The physical, chemical, and optical properties of aerosols generated from burning a wide array of common North American plant materials have been studied at the Rocky Mountain Research Station Fire Sciences Laboratory in Missoula, MT. The hygroscopic properties of these aerosols were investigated using nephelometry and are reported here. Two nephelometers simultaneously measured the light scattering coefficient b_{sp}, one nephelometer measured dry, $b_{sp(dry)}$, where relative humidity, RH, was generally less than 20%, while the second nephelometer measured the humidified light scattering coefficient, $b_{sp(wet)}$, where humidity was in the range ($20 < RH < 95$). The ratio of the signals from these two nephelometers are plotted versus the measured relative humidity, RH, to obtain an *f(RH)* growth curve. A wide range of growth, *f(RH)* values between 1.1 and 2.5 at 85% RH, was observed. Typically aerosol particles from the evergreen type plants were non-hygroscopic, while aerosols generated from brushy type plants exhibited significant water uptake. The measured aerosol growth curves are compared with theoretical growth curves generated using measured inorganic aerosol composition, thermodynamic models for estimating inorganic aerosol water uptake, and aerosol size distributions. The difference between the theoretical growth curves and the measured growth curves are attributed to organic water uptake. In general the contribution of organics to water uptake, measured by nephelometry, is small.

Control #: 83

Light Scattering by Semi-Volatile Nitrate Particles in Mid-Continental North America

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The State of Illinois maintains a research site in rural Bondville for collaborative monitoring of the regional atmosphere. Three different networks independently collect filter samples at this site for analysis of nitrate, sulfate and other ions by chromatography. The Clean Air Status and Trends Network (CASTNet) collects week-integrated total-particle samples on Teflon. The Interagency Monitoring of Protected Visual Environments (IMPROVE) network collects 24-hour $PM_{2.5}$ samples on Nylon behind a carbonate denuder to remove ambient nitric acid. The Climate Monitoring and Diagnostics Laboratory (CMDL) collects 24-hour PM_1 samples on Teflon for comparison with continuous monitoring of PM_1 light scattering by an integrating nephelometer, situating both measurements behind a heated inlet programmed to maintain relative humidities below 40%. The sample heating employed by CMDL his little impact on nitrate particles during their brief passage through the nephelometer, but over 24 hours results in substantial losses from the sample collected on the filter. The CASTNet and IMPROVE measurements show that Bondville routinely experiences high wintertime concentrations of fine particulate nitrate that are not captured in the heated samples collected by CMDL filters. Multiple regressions show the higher nitrate concentrations observed in unheated filter samples to be needed to account for the observed scattering in heated CMDL samples. Incorporating these unheated nitrate data into the analysis of the heated nephelometer data reveals that nitrate is a significant contributor to the region's haze.

Control #: 98

Quantifying the Natural Conditions Goal of the Regional Haze Regulations

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The aspiration of the U.S. regional haze program is to reduce haze in most larger national parks and wilderness areas (Class I areas) by the year 2064 to the point that the visibility there no longer reflects the influence of man's activities, i.e., reaches "natural conditions". In order to develop air pollution emissions management strategies in furtherance of this long-term goal, an essential piece of information is the amount and composition of the visibility-impairing aerosol that would exist under natural conditions at each Class I area. As a starting point, the U.S. EPA has stated "default" annual-average natural conditions concentrations of six components of the aerosol, as averaged over the eastern and western halves of the country, for use in the initial phase of haze management. This paper reports on the results of a study that evaluated the EPA-prescribed protocols for setting the natural conditions goals for each Class I area. The implications of the uncertainties in the default estimates were assessed, potential refinements for various geographic areas and some specific Class I areas were considered, and the sensitivity of haze management strategies to assumptions about natural conditions were calculated. The study found that the prescribed approach for estimating natural conditions on the haziest 20% of the days at each Class I area produces estimates that may be useful operationally, but often are not scientifically credible. A major impediment is the attempt to sandwich natural conditions concentrations at all 156 Class I areas into just two categories -- East and West. Based on analysis of the geographic distributions of air pollutant concentrations and haze, meteorology, and topography, dividing the country into 15 zones shows promise of describing nationwide natural conditions more realistically. An initial evaluation of information relevant to natural conditions resulted in identification of some potential adjustments to the default concentrations on a zone-by-zone basis. The influence of these adjustments on the needed rates of reduction of pollutant concentrations was then evaluated, with the conclusion that in most zones changes of up to about 10% in the needed reduction rates could occur, with larger changes possible at specific Class I areas.

Control #: 99

Cavity Ring Down and Cavity Enhanced Detection Measurements of Extinction from Smoke Generated through Laboratory Combustion of Wildland Fuels

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Cavity Ring Down (CRD) and Cavity Enhanced Detection (CED) Measurements allow for the determination of optical extinction coefficients with compact instruments and excellent sensitivity and dynamic range. CRD/CED techniques were used during the FLAME (Fire Lab at Missoula Experiment) study to characterize the optical properties of fresh smokes generated through the laboratory combustion of wildland fuels. We present results of the performance of a new 0.5-m cavity length cavity ring-down instrument (CRD) for the measurement of aerosol extinction. This successor of a previous 1-m length extinction cell allows for easy field deployment due to a more compact and user-friendly design. The system shows excellent stability, measuring filtered air extinction with a negligible drift of 0.01 Mm-1 over a 5 hour time period. Shortening of the cell length to 0.5 m did not result in a loss of instrument sensitivity, which averaged 0.08 Mm-1 (standard deviation of 1 min data points) and was thus comparable to the sensitivity of the previous 1-m cell (0.09 Mm-1). Simultaneous measurements of particulate matter mass density and optical scattering and absorption coefficients allowed for the study of PM extinction mass efficiency, single scattering albedo, and optical closure. Results will be presented for smokes from a variety of wildland fuels and resulting smoke properties.

Control #: 100

Repeatability of PM Emissions during Laboratory Combustion of Wildland Fuels

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Laboratory combustion of wildland fuels allows for the determination of particulate matter (PM) related emission factors under controlled conditions with individual fuels and well-defined fuel and combustion properties. However, due to the non-deterministic nature of open combustion processes together with variations in fuel composition and arrangement, measurements are never exactly repeatable. During the FLAME (Fire Lab at Missoula Experiment) study, three individual, consecutive burns with near-identical fuel and combustion conditions were done for most fuels. While three replicates allow for the identification of individual outliers, no meaningful statistics can be obtained. To obtain such a statistics, seventeen replicate burns of Ponderosa Pine needle litter with a nominal fuel weight of 250 g were made during the 2006 FLAME study at the US Forest Service Fire Science Laboratory. Ponderosa Pine needle litter is a common forest fire fuel found in mid-latitudes. Due to its relatively fine structure at the nominal fuel weight, fuel beds can be built fairly reproducibly. PM emissions were characterized through filter sampling and continuous instruments. Filter analysis included gravimetric, organic and elemental carbon measurements. Continuous measurements included gravimetric measurements and light scattering, absorption, and extinction measurements. The statistics of combustion characteristics and PM emissions will be discussed.

Control #: 112

The Code MaexPro for Visibility Modeling in the Marine and Coastal Environment

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In the report the description of the last version of MaexPro code (**M**arine **a**erosol **ex**tinction **Pro**file) for calculation spectral and vertical profiles of aerosol extinction coefficient a(?), aerosol sizes distribution, area distribution, volumes distribution, modes aerosol extinction spectra is submitted. Code MaexPro is a computer program under constantly development to estimate of EO systems signal power at a location place in which a fetch is key entrance parameter. The program carries out calculation a(?), as functions of atmospheric effects using standard meteorological parameters, aerosol microphysical structure, a spectral band and a height of the sensor location place. Spectral behavior a(?) can be submitted as graphically, and as tables. Commands overplot for superposition or change of figures; profiles extrapolation; a lens; all kinds of possible copyings; the data presentation, convenient for an input in code MODTRAN, and etc. are stipulated. The code MaexPro is a completely mouse-driven PC Windows program with a user-friendly interface. Calculation time of spectral and vertical profiles of a(?) depends on the necessary wave length resolution, radius of aerosol particles and the location place height, and does not exceed tens seconds for each new meteorological condition. Other calculations characteristics, such as aerosol sizes distribution, area distribution, volumes distribution, modes aerosol extinction spectra, are performed in a few seconds.

Control #: 116

VIEWS/TSS: An Integrated Systems Solution for Air Quality and Regional Haze Planning

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The Visibility Information Exchange Web System (VIEWS) is an online decision support system developed to help federal land managers (FLMs) and states evaluate air quality and improve visibility in federally-protected ecosystems according to the stringent requirements of the EPA's Regional Haze Rule and the National Ambient Air Quality Standards. VIEWS was recently selected by the Western Regional Air Partnership (WRAP), a collaboration of western states, tribes, and local agencies administered by the Western Governor's Association and the National Tribal Environmental Council, to serve as the infrastructure for the WRAP's Technical Support System (TSS). The TSS is an

extended suite of analysis and planning tools designed to help planners develop long term emissions control strategies for achieving natural visibility conditions in Class I Areas by 2064. The architected combination of VIEWS and the TSS represents an integrated system that supports a unique synergy of national and regional air quality objectives by providing a consolidated, online system of data access and decision-making tools to planners, researchers, stakeholders, policy makers, and federal agencies across the nation. VIEWS/TSS employs an advanced data acquisition and import system to integrate data from several air quality data centers into a single, highly-optimized data warehouse. Ground-based measurements from dozens of monitoring networks, air quality modeling results, and detailed emissions inventories are imported and updated on a regular basis using a generalized, uniform data model and carefully standardized metadata. Names, codes, units, and quality flags from the source datasets are carefully mapped to a unified paradigm, and native formats and organizations are transformed into a common, normalized database schema. This design enables users to explore, merge, and analyze datasets of widely-varying origin in a consistent, unified manner with a common set of tools and web services. This degree of interoperability allows decision-makers to analyze diverse datasets side-by-side and focus on high-level planning strategies without having to contend with the details of data management and manipulation.

Control #: 127

Quantification of Light Pollution with a Wide Field CCD Camera

D. Duriscoe, C. Moore, National Park Service, Fort Collins, CO; C. Lughinbuhl, US Naval Observatory.

The National Park Service has developed a portable CCD camera system capable of precisely documenting nighttime sky brightness. This system has been deployed in over 55 parks to inventory night sky quality, identify light pollution sources, establish a baseline, and separate natural and artificial signals. The resultant images, depicted in 'fisheye' view with false color, have been effective at raising management concern and public understanding of the loss of night sky visibility.

Control #: 128

Scenery of the Night and the Effect of Light Pollution

D. Duriscoe, C. Moore, National Park Service, Fort Collins, CO

The importance to a technological society of places where people can retreat and contemplate pristine and beautiful landscapes cannot be overstated. For many, there is no scenery more inspiring than the appearance of the night sky. Increasingly, the public, environmental stewards, and land managers are seeing the view of the starry night sky as an endangered resource worthy of protection. Data collected by the National Park Service shows the far–reaching effect of light pollution caused by poor quality outdoor lighting and exacerbated by aerosol scattering. In this presentation we examine the 'other half' of the visibility equation— the scenery at night.

Poster Session B

Control #: 13

Comparative Analysis of Numerical Models for Daytime Mixing Height Estimation in Tropical Conditions

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Mixing height, z_i , is an important variable which determines the air volume available for the dispersion and concentrations of gases and aerosols, as well as being involved in many predictive and diagnostic methods. The research has been carried out to conduct a comparative analysis of mixed layer height simulations, in order to study the influence of shear term and moisture contents. Two mixed layer preprocessors are numerically analyzed to determine the daytime development of the convective boundary layer. Influence of moisture content is expressed with the replacements of and into the simulation steps and sensitivity analysis. Determinations are based on actual surface measurements from Hanoi, Vietnam ($21^0$01'N, $105^0$48'E), with humid tropical conditions in summer. Simulation results increase fine and show a good agreement with the theoretical evolution of tropical mixing height. Daily maximum value of z_i reaches approximately 1800m. Simulations with moisture content effect give significant values higher than those without it with the average difference is around 120m ÷ 150m, in correlation with the average increasing of tropical mixing height about 7% ÷ 9%. The Bowen ratio, *ß*, is also analyzed in order to indicate the surface energy budget and fluxes balance with the influence of surface evaporation. The obtained values range from $0.4 < ß < 0.6$ over the moist surface where large of energy goes into evaporation, which indicate that surface evaporation plays an important role in convective mixing processes. Analysis indicates that BLES model gives higher values than the bulk mixed layer model with the maximum difference, ?z , is about 140m. Different developments come from the initial growth rate during the first hour, when the morning radiation inversion occur and also result from the use of additional closure specified the entrainment flux, , which is obtained by the additional turbulence production. BLES simulates with actual values of make the relative amounts of surface mechanical production changes, which increase the mixed layer heights and therefore enhance development pattern. Meanwhile, by using the constant values *ß*? suggested by Pino (2003) in the bulk mixed layer model, initial shear production occurs at the surface and is also accounted at the entrainment zone with changes geotropic wind, [m/s]. Comparison shows that z with shear production cases increases similarly in both models in comparison to the pure buoyancy consideration.

Control #: 16

Aerosol and Plume Height Measurements from Satellites for Air Quality Studies

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Satellite measurements of aerosols and aerosol characteristics from the Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO), and the Multi-angle Imaging SpectroRadiometer (MISR) instruments are available on global and regional scales. These measurements are essential for air quality research and applications. Example applications of CALIPSO and MISR data products for air quality studies will be presented. CALIPSO provides new insights into aerosol abundance, size and layers, including volcanic emissions, dust storms, clouds, and pollution events with measurements from three instruments, Cloud-Aerosol LIdar with Orthogonal Polarization, Imaging Infrared Radiometer, and Wide Field Camera. MISR collects multi-angle as well as multi-spectral data never before obtained by satellite instruments. The additional information contained in these data make it possible to obtain aerosol amount, particle size and composition, as well as plume heights. The Atmospheric Science Data Center (ASDC) in Langley's Science Directorate leads NASA's program for the processing, archival and distribution of Earth science data in the areas of radiation budget, clouds, aerosols, and tropospheric chemistry. The Data Center was established in 1991 to support NASA's Earth Observing System and the U.S. Global Change Research Program. It is unique among NASA data centers in the size of its archive, cutting edge computing technology, and full range of data services. Additional information about all ASDC data products, images and tools is available from the ASDC web site, http://eosweb.larc.nasa.gov.

Control #: 19

Midterm Aerosol Vertical Profiling Over an Urban Area (Sao Paulo, Brazil)

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During the Dry Season (July-September) of 2007 aerosol profiling campaign was carried with an aerosol backscattering LIDAR system in São Paulo, Brazil. The main goal of this campaign was to observe the aerosol load in the lower troposphere (up to 10 km) and its daily behavior in order to check for air dispersion conditions, planetary boundary and mixed layer daily evolution, mid and long range transport. For the latter we used air mass trajectory analysis and satellite data. With the LIDAR analysis we can provide the aerosol optical properties in the visible range (532 nm) and quantities such as aerosol backscattering and extinction coefficients. Altogether we could measure during 60 days, since when there was the presence of precipitation no measurement was conducted. Collocated with the LIDAR was a AERONET Sunphotometer which help in characterizing the aerosol optical properties. Our data was correlated with the Environmental Air Quality index generated with the aid of EPA certified air quality station distributed over the city of São Paulo in order to improve the air quality nowcasting and forecasting. We shall present in our study some case studies in which we could observe long and mid range biomass burning aerosol transport into the metropolitan region of São Paulo.

Control #: 27

Sample Deposit Geometry and Effective Filter Face Velocities

C. McDade, A. Dillner, H. Indresand, University of California, Davis, Davis, CA.

Filter face velocities are normally calculated based on the diameter of the sample on the filter and the volumetric flowrate through the filter. Such face velocities are an accurate representation when the sample is distributed uniformly across the filter surface. For some types of filters, however, the deposit covers only a portion of the filter surface. In these cases the true face velocity will be greater than that determined from a full-filter calculation since the air flow is directed through a smaller area. Face velocities can influence the volatilization of collected particulate matter, so accurate knowledge of face velocities can be important. In the IMPROVE network Teflon filters are collected for the determination of PM_{10} gravimetric mass and of $PM_{2.5}$ gravimetric mass and elemental concentrations. During sampling each Teflon filter is backed by a metal screen with an array of small round holes, ranging in diameter from 0.009 inch to 0.013 inch, depending on the specific cassette model in use. Air flows through the filter only in the areas in front of the holes, resulting in a sample deposit in an array of tiny dots that mimic the array of holes in the screen. Thus, the filter deposit area is smaller than the total filter area. In this paper the filter deposit areas and their related estimated face velocities will be calculated for a variety of commonly used aerosol samplers, including the IMPROVE PM_{10} and $PM_{2.5}$ samplers and the various samplers used in EPA's Chemical Speciation Network.

Control #: 29

Spatial Patterns in Wet Deposition During the 2006 Rocky Mountain Atmospheric Nitrogen and Sulfur Study (RoMANS)

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Atmospheric nitrogen and sulfur species can cause a number of damaging effects to the environment, including visibility degradation and alteration of ecosystem function and surface water chemistry due to the deposition (wet and dry) of these species to the surface. These changes can be especially important to delicate high altitude ecosystems. In Rocky Mountain National Park (RMNP) the atmospheric concentrations and deposition of nitrogen species have increased in recent years. Previous studies suggest there is some spatial distribution to deposition of nitrogen, with higher values typically observed east of the Continental Divide. Elevated levels of pollutants from the Front Range metropolitan areas in conjunction with upslope wind conditions are most likely contributing to increased deposition in the park, however long range transport could also play a role. The Rocky Mountain Atmospheric Nitrogen and Sulfur (RoMANS) study was designed and conducted to explore these issues. The study occurred during two campaigns, timed to encompass high deposition periods in RMNP. The first campaign occurred in spring (March and April) 2006, followed by the summer campaign during July and August 2006. An extensive network of sites was operated, with several sites located within the park to evaluate the spatial variability of measured species due to the complex mountain terrain. In addition, several sites were operated around Colorado at locations that were potentially upwind of RMNP, in order to more fully investigate the sources of nitrogen to the park. As part of the suite of observations at these sites, wet deposition measurements were performed on a variety of temporal scales, including daily and hourly resolution at some sites during precipitation events. We present results of wet deposition measurements during the spring and summer field campaigns, focusing primarily on the spatial and temporal patterns observed during the study.

Control #: 42

Observed Precision in the IMPROVE Network

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The Interagency Monitoring of Protected Visual Environments (IMPROVE) program is a cooperative measurement effort in the United States designed to characterize current visibility and aerosol conditions in scenic areas (primarily National Parks and Forests) and to identify chemical species and emission sources responsible for existing man-made visibility impairment. In 2003 and 2004, the IMPROVE network began operating collocated samplers at several sites to evaluate the precision of its measurements. This is the first time that the 18-year old IMPROVE network routinely operated collocated samplers, and thus the first opportunity to evaluate the precision of the IMPROVE measurements. This paper presents the precisions calculated from the collocated data according to the Environmental Protection Agency's guidelines (CFR, 1997). The precisions range from 4% for sulfate to 131% for phosphorous. Several factors are influencing the precisions: the precision tends to improve with increasing detection rates, is typically better when the analysis is performed on the whole filter instead of just a fraction of the filter, and is better for species that are predominantly in the smaller size fractions. Every concentration reported by IMPROVE is accompanied by a predicted precision value. The predicted precision values range from 4.8% for sulfate to 52% for the third elemental carbon fraction. In only a few cases (sulfate, $PM_{2.5}$ mass, and the second organic carbon fraction) are the observed precisions less than or equivalent to the predicted precisions. This suggests that the predicted precisions do not accurately reflect the actual precisions in many cases, and that sources of error are either not identified or underestimated in the current predictions. CFR, Code of Federal Regulations Part IV Environmental Protection Agency 40 CFR Parts 53 and 58 (1997) Revised Requirements for Designation of Reference and Equivalent Methods for PM2.5 and Ambient Air Quality Surveillance for Particulate Matter; Final Rule http://www.epa.gov/ttn/oarpg/t1/fr_notices/pm-mon.pdf, Page 71-72.

Control #: 51

Wind Modeling of Chihuahuan Desert Dust Outbreaks

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Global atmospheric dust plays many roles in Earth's climate system. Major dust storms cause significant particulate loadings and visibility degradation, often far from their source areas. Wind patterns associated with dust outbreaks can be modeled via simulations related to the transport, dispersion, and deposition of mineral particles. Previously, sources of major dust outbreaks in the Chihuahuan Desert region (along the border between Texas, New Mexico, and Mexico) were identified through remote sensing. In this work, HYSPLIT back trajectory and MM5 (NCAR/Penn State Mesoscale Model) analyses were applied to these events to evaluate large-scale airflow patterns and the meteorological conditions giving rise to dust events, with a particular focus on the major dust events of April 15-16 and December 14-16, 2003. Results from NOAA HYSPLIT back trajectory analyses suggest wind speeds during these events =10 m/s at a height of 100 m, compared to 4 m/s during non-dust periods. The trajectories approached the surface and wind speeds increased at locations consistent with dust sources observed in satellite imagery. Weather maps showed low precipitation amounts and dry conditions during dust periods. Previous studies in this area have shown an anti-correlation between dust concentration and precipitation. Residence time and source contribution function analyses suggested that large-scale cyclonic wind patterns were associated with the extreme dust events observed. Contour plots of the dimensionless source contribution function ($S_{i,j}$) >1 (higher than random occurrence) showed that trajectories arrived at the receptor site consistent with large-scale cyclonic activity. MM5 data showed surface wind speeds increased dramatically to >12 m/s at source locations during the April event, blowing from the southwest, consistent with the advection of the dust plumes in satellite images. For the December event, wind speed in the source area increased to >12 m/s at the time the event was first detected on satellite, in a direction consistent with observed motion of dust plumes. This application of back-trajectory and meteorological models has improved our understanding of the meteorological processes associated with major dust events in southwestern North America.

Control #: 61

Spatial and Temporal Trends in Fine Particulate Carbon in the United States

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Carbonaceous compounds are a major component of fine aerosol mass and have a number of adverse effects, including health effects, contribution to regional haze, and both positive and negative forcing on the earth's radiation balance. This presentation will examine the spatial patterns of total fine particulate ($PM_{2.5}$) carbon and its seasonal and long-term trends throughout the United States. The analysis will exploit data from the IMPROVE (Interagency Monitoring of Protected Visual Environments) network and the Environmental Protection Agency's Speciated Trends Network (STN). The IMPROVE network has been used to collect $PM_{2.5}$ mass since 1988 and today has over 170 monitoring sites, of which 69 have seven or more years of data suitable for trend analysis. Along with other species, the $PM_{2.5}$ samples are analyzed for organic (OC) and elemental carbon (EC) using a thermal optical reflectance (TOR) technique. The STN network began operating in 2000 and currently has over 200 monitoring sites where $PM_{2.5}$ samples are collected. These samples are analyzed for OC and EC using thermal optical transmittance (TOT). It has been shown that TOR and TOT produce equivalent total carbon (OC + EC) concentrations; however, the OC and EC concentrations differ. IMPROVE sites are located primarily in rural and remote areas while STN sites are generally in urban and suburban locations. Merging the STN data with the IMPROVE data extends the spatial aerosol patterns from the surrounding remote areas into urban areas, providing insights into the total carbon concentrations contributed by regional and local sources. These spatial patterns will be examined for each season aggregated from the 2004-2006 data. Long-term trends from only the IMPROVE total carbon time series will be examined.

Control #: 73

An Aerosol Generation System for Producing $PM_{2.5}$ Filter Deposits of Known Composition

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A novel aerosol generation system combined with an IMPROVE $PM_{2.5}$ sampler has been developed. Aerosols are generated from solution with a constant-output-atomizer using compressed zero-grade air. Aerosols are dried with a diffusion-dryer before entering a 0.6 m3 dilution chamber in-line with an IMPROVE $PM_{2.5}$ sampler operating with a flow rate of 22.8 Lpm. Excess air is introduced after drying and removal of particles. Relative humidity in the chamber is kept below 25 %. The $PM_{2.5}$ sampler allows four consecutive filters to be collected with sampling times varying between 1 to 1440 minutes. The aerosol deposit is a function of solute, solution concentration, and sampling time. The major purpose of the system is the production of aerosol deposits of known composition on IMPROVE-type filters which can be used for testing of equipment and analysis methods. Currently the focus lies in the collection of ammonium sulfate particles on IMPROVE Teflon filters. Ammonium sulfate particles have been produced from various solution concentrations. Filter mass has been analyzed gravimetrically and correlated to sulfur and sulfate measurements by X-ray Fluorescence (XRF) and Ion Chromatography. The aerosol generation system provides a mechanism for independent evaluation of analytical accuracy. Single species aerosols, such as those made from pure ammonium sulfate, can provide a cross-check on the standard reference materials used to calibrate the XRF system. Multi-species aerosols, those including both sulfur and silicon for example, hold promise in helping to evaluate cross-species interferences in the XRF spectral peaks.

Control #: 76

Assessing Biomass Burning Impacts on Rural Air Quality and Visibility in the South-Eastern U.S. Applying PMF2.0 to SEARCH Network Data

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Guided by the Endangered Species Act, the Department of Interior through the Fish and Wildlife Service mandates that land owners in the SE use prescribed burning (PB) to recreate the natural fire regimes needed to maintain the health of its native forest ecosystems and thus protecting the habitat of threatened and endangered species (e.g. the red cockaded woodpecker, gopher tortoise, etc.) that are designated by state initiatives for wildlife management. Native songbirds and flora are also dependent on fire in many of these ecosystems. Although ~70 % of the forested land is privately owned in the South-East, most intense burnings with highest emissions occur on the military installations, where more than 5,000 acres can be burned on a single day. Across the South-Eastern landscape, more than 8 million acres are burned every year, whereby most of the burns occur between January and June. A large fraction of the PM emitted during PB consists of primary particulate organic compounds. However, due to its incomplete combustion, PB emissions contain substantial amounts of aromatic hydrocarbons, biogenic terpenes (especially isoprene), and other reactive VOCs that are involved in the atmospheric formation of secondary organic aerosol (SOA), and that contribute to increased visibility impairments in the rural South-East. Comprehensive $PM_{2.5}$ mass and species composition data have been collected since 1998 at three rural south-eastern sites as part of the South-Eastern Aerosol Research and Characterization (SEARCH) network; i.e. near Yorkville, GA (50 km W from Atlanta), Centreville, AL (90 km SW from Birmingham) and Oak Grove, MS (70 km N of Gulfport). For all three sites and years 2001 to 2006, the average OC fractions of $PM_{2.5}$ FRM mass for the first 6 months each year are similar to the last 6 months, whereas the OC/EC ratios are consistently lower in the first half and higher in the second half of each year on average. This paper will shed light on possible reasons for this observation and what role local vs. regional PB and wild fire emissions are playing in SOA formation and $PM_{2.5}$ mass contribution by carefully applying the PMF2.0 receptor model to robust SEARCH data sets, and by comprehensive evaluation of the PMF results in conjunction with high-resolution measurements during individual plume events.

Control #: 81

Toward Evaluation of the Uncertainty of Element Determination Using EDXRF Technique

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Crocker Nuclear Laboratory at University of California performs routine energy-dispersive x-ray fluorescence (EDXRF) analysis for the IMPROVE network. Elements from nickel to zirconium, and lead, are determined with a molybdenum anode tube as the excitation source, and the lighter elements are determined using a copper anode tube. Quality assurance for both determinations includes regular reanalyses of two fixed collections of representative ambient samples, each containing about thirty five filters. On the molybdenum system, both of these selections have undergone twenty three analyses since January 2006, performed at roughly monthly intervals. This paper presents an initial look at the unique set of data provided by these reanalyses. Standard spectrometric theory is used to estimate spectroscopic counting errors that are included in the total uncertainty reported with each elemental concentration. The series of reanalyses allows the additional uncertainty contributed by longer-term instrumental and/or analytical variations to be estimated. This paper presents comparisons of the long-term variability observed in molybdenum-system reanalyses with our reported estimates of total analytical uncertainty. Inter-element correlations in the observed variability, and the dependence of this variability on mean composition, are examined for mechanistic insights and possible improvements in both the operation and reporting of the X-ray fluorescence analysis.

Control #: 84

Measurement of Reactive Gas and Particulate Phase Nitrogen Species in the SEARCH Network

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Gaseous and particulate nitrogen species play important roles in atmospheric chemistry and physics. Nitric acid (HNO_3) is the major end product of NOx oxidation and a major source of nitrogen in wet and dry deposition. Ammonia (NH_3) is the predominant basic gas in the troposphere. As such, it plays an important role in the gas-particle partitioning, chemical composition and physical properties of atmospheric aerosols. Under thermodynamically favorable conditions, reaction between HNO_3 and NH_3 produces NH_4NO_3, which can be is a major component of $PM_{2.5}$, especially during cold periods. Reaction between NH_3 and sulfuric acid aerosol produces ammonium bisulfate and ammonium sulfate, in varying proportions, and modifies light scattering characteristics of the bulk aerosol. This presentation discusses real-time measurements methods and observations of HNO_3, NH_3, and fine particulate NO_3^- and NH_4^+ in the Southeastern Aerosol Research and Characterization (SEARCH) network. Fine particulate NO_3^- and NH_4^+ are measured continuously (5-minute time resolution) using a 3-channel chemiluminescent NOy analyzer. Sample air is drawn through a 2.5 micron Dp_{50} inlet, then through two annular denuders and a carbon honeycomb denuder to remove acidic and basic gases as well as the preponderance of gas phase NOy. Sample flow is then split into three channels. Particulate NH_4^+ is defined as the difference between channels 1 and 2, while particulate NO_3^- is defined as the difference between channels 2 and 3. Gaseous HNO_3 and NH_3 are measured continuously with 2-channel chemiluminescent NOy analyzers. In the HNO_3 system, one channel samples ambient air directly and the other samples through a KCl-impregnated annular denuder. HNO_3 is then defined as the difference between the two channels. In the NH_3 analyzer, both channels sample ambient air through a Na_2CO_3-impregnated annular denuder followed. One channel then goes directly to a combination Pt-Mo converter, while the other passes through a citric acid impregnated annular denuder and then into a Pt-Mo converter. NH_3 is defined as the difference between the two channels. Data characteristics will be presented and field observations will be used to: 1) calculate short-term (hourly or contributions to $PM_{2.5}$ mass; 2) determine degree of SO_4 neutralization by NH_3; 3) compare observed NH_4NO_3 concentrations with those expected based on thermodynamic considerations; and 4) investigate diurnal patterns and short-term events.

Control #: 96

Regional Impacts of Oil and Gas Development in the Western United States

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As population in the Western United States grows, electricity generation and fossil fuel production increase, leading to significantly higher NOx emissions from energy generation. The oil and gas development in recent years has the potential to affect both the visibility and air quality of various Class 1 areas in the region. The following work presents an analysis of these impacts using the Comprehensive Air quality Model with extensions (CAMx). CAMx is a state-of-the-science 'one-atmosphere' Eulerian photochemical dispersion model that has been widely used in the assessment of gaseous and particulate air pollution (ozone, PM2.5, PM10). Meteorology and emissions inventories developed by the Western Regional Air Partnership Regional Modeling Center are used to establish a base line simulation for the year 2002. The predicted range of values for particulate species in the National Parks and other Class I areas in the Western US is then evaluated with available observations. This evaluation demonstrates the model suitability for subsequent planning, sensitivity, and emissions control strategy modeling. Once the base line simulation has been established an analysis of the model results is performed to investigate the regional impacts of oil and gas development on the concentrations and deposition of particulates (sulfate, nitrate, ammonium) with the potential to affect visibility as well as gas species (ozone, NOx) that affect the air quality of Class 1 areas.

Control #: 105

Comparison of Results for Apportioning Visibility Degradation to Sources of $PM_{2.5}$ Using a Conventional Source Apportionment-Visibility Budget Approach and Using a Novel Approach Where the Extinction Data are Included in a PMF Analysis

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A common approach which has been used to apportion visibility degradation to sources in the past involves a straightforward linear regression fit of extinction data and source apportionment results, analogous to the approach used to assign extinction to the various species in particulate matter when the particulate composition is know. In two other abstracts submitted for this conference we have described a novel approach where the visibility degradation was assigned to sources by incorporating the extinction data directly into a PMF analysis. This approach was illustrated in these abstracts for data sets obtained in the Riverside CA area in July 2003 and again in July - August 2005 and for an intensive ambient field sampling program at the Fresno, CA EPA Supersite during December 2003. For each of these studies, hourly average data were obtained on the $PM_{2.5}$ mass and the various components of the fine particles (sulfate, nitrate, ammonium ion, nonvolatile organic material, semi-volatile organic material, BC, etc.), the major gas phase precursors (NO_x, CO, O_3, etc.), and airport measured visibility. In all cases PM and visibility apportionment results where obtained both including and excluding the visibility data in the apportionment analysis. In this poster presentation, the visibility extinction budget results and the inferred mass extinction coefficients obtained from using this novel approach will be compared to those obtained using the conventional linear regression fit of extinction data and sources apportionment results. Agreement between the two results will be highlighted and possible reasons for any observed differences in the two approaches discussed

Control #: 108

Simulating Nitrogen Tracers from Regional Sources for RoMANS

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A key aspect of the Rocky Mountain Atmospheric Nitrogen and Sulfur Study (RoMANS) is understanding which emission sources contribute nitrogen to Rocky Mountain National Park (RMNP). One approach for addressing this is a series of tracer simulations produced by the CAMx regional air quality model. The two primary nitrogen species within the emission inventory are nitrogen oxides (NOx) and ammonia (NH3). The source categories and source regions for

these two pollutants vary significantly. For example, near RMNP, there are significant NOx emissions from vehicles in the Denver metropolitan area, as well as NH3 emissions from animal feedlot operations in northeastern Colorado. During periods of 'upslope flow' along the Front Range, it is anticipated that these sources may have a significant impact on the park. More distant nitrogen sources, such as NOx emissions from large coal-fired power plants, or NH3 emissions from the Midwest, may also affect RMNP. The CAMx RoMANS simulations were performed on a nested 36/12/4 km model grid, with the 4 km grid covering most of Colorado. Two periods were evaluated, corresponding to the spring and summer 2006 RoMANS field campaigns. Tracer emissions were scaled to the base case NOx and NH3 emissions, and plume rise characteristics for point sources were maintained, resulting in similar transport of the tracers as compared to the 'real world' emissions. Approximately 90 source regions were considered. Three scenarios were evaluated to determine the impact of an individual source region on nitrogen at RMNP: a perfectly conserved tracer simulation, to establish the maximum impact of a source region of interest, and two simulations in which tracer was lost through wet and dry deposition.

Control #: 115

Ammonia and Nitrate Measurements from Various Network Sampling Systems

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Air pollution has been shown to have adverse affects on sensitive aquatic and high alpine ecosystems by the deposition of various aerosol species and is known to adversely impact visibility. Visibility impairing particulate matter is monitored within selected Parks and other Class 1 areas by the Interagency Monitoring of Protected Visual Environments (IMPROVE) network. Dry deposition is estimated, from a model, using gas and particle concentrations and meteorological parameters measured by the Clean Air Status and Trends Network, CASTNet. These monitoring networks have been successful in furthering our understanding of ambient aerosols and selected trace gases across the United States; however, they have proven to be insufficient both in the species that are measured and the time resolution of the measurements to fully characterize the ambient aerosol and adequately characterize deposition events on synoptic time scales sufficient for apportionment studies. Ammonia, NH_3, is ubiquitous and the most important basic gas in the atmosphere. Its reaction with acidic gases such as H_2SO_4 and HNO_3 are important sources of fine particles. The degree of neutralization of sulfate aerosol by ammonia gas determines the acidity of the sulfate aerosol, which is important to aerosol hygroscopicity, and thus particle growth and visibility, acid deposition, human health affects, and to the earth's radiation budget. The concentration of NH_3 in the atmosphere is also important for the gas/particle phase equilibria of some species such as ammonium nitrate, NH_4NO_3, which impacts visibility and can influence deposition. In some areas of the country, where livestock farming is intensive, ammonia can be the most prevalent form of nitrogen being deposited from the atmosphere. Despite the importance of the NH_3/NH_4^+ system to atmospheric chemistry there is no national network that has made routine measurements of ammonia gas and significant problems have been documented with the measurement of its particle phase counterpart ammonium ion. The objectives of this study include developing sampling protocols for accurate network applicable monitoring of NH_3, HNO_3, and SO_2 gases as well as accurate determination of particle phase NO_3^- and NH_4^+.

Control #: 119

Carbonaceous Measurements from Laboratory Controlled Combustion Sources

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A laboratory has been established to investigate and characterize carbonaceous particulate from multiple sources using a dilution and residence system. These sources include a diesel generator, an acetylene flame, an electric arc, and a wood stove. Particle mass, light transmission (b_{abs}), organic and elemental carbon (OC and EC) concentrations, and particle size were measured and the mass absorption efficiency and the Angstrom absorption coefficient were determined for each source. An inter-comparison between three different filter based OC/EC measurements and investigation of the sample matrix were made. All sources samples were able to be reproduced with 10 - 15%, except for wood smoke which was 40 -

50%. The presence of salt (i.e., NaCl) had no effect on the OC/EC split for the IMPROVE_A and STN thermal-optical methods, but lowered the amount of EC in the French two-step method. The presence of salt in these source samples altered the carbon fractions in EC, with higher carbon abundances appearing in lower temperature fractions. Particle size distribution using scanning mobility particle sizers also varied with different dilution rations and by different source types.

Control #: 125

Inspiring Environmental Stewardship by Linking Science, Technology, and Art

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The communication of sound research is increasingly important if an informed and knowledgeable public is to play a larger role in evaluating proposed environmental laws and determining new policies. Awareness of environmental systems and an understanding of emerging environmental issues will create the motivation to make long-lasting behavioral changes. Scientists and researchers can play an important role in helping to educate the public. The NPS/CIRA visibility research group had an active education and outreach programs that builds on the expertise of scientists involved in the study of regional haze and visibility, aerosol composition and atmospheric chemistry, and the origins of gases and particles affecting visibility and ecosystems. In an ongoing effort to develop education and public outreach materials that reflect current research, the NPS and other partners are using interactive media to engage a diverse public audience with presentations designed to make them aware of pollution effects on ecosystems in remote parks and wilderness areas. Concepts and ideas are presented in an engaging and entertaining format, making extensive use of rich media formats. This presentation will demonstrate some of these formats, including web, multimedia, and print based projects.

Control #: 126

Lessons Learned for the U.S. Regional Haze Rule for Managing Visibility

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In April 1999, the U.S. Environmental Protection Agency (EPA) promulgated the Regional Haze Rule (RHR) to address the impairment of visibility caused by many sources over wide geographic areas. Under the rule, states are required to set goals for improving visibility in 156 Class I areas. States are working to reach these goals by developing State Implementation Plans that contain enforceable measures and strategies for reducing visibility-impairing pollution. Through a collaborative effort of air management agencies in British Columbia, a visibility coordinating committee has been formed to solicit input on the importance of visibility to various sectors and to review visibility management options. As the committee moves forward in developing a draft management approach, there is a need to learn from the U.S. experience in managing visibility under the Regional Haze Rule. On behalf of Environment Canada, Air Resource Specialists conducted a survey of key stakeholders in the RHR process. To ensure a broad representation of the potentially diverse lessons learned, the survey included participants from the EPA, Regional Planning Organization leadership, U.S. federal land managers, state representatives, key consultants, industry and environmental stakeholders.

Survey questions focused on stakeholders' perceptions of:

- The usefulness and limitations of monitoring, emissions and modeling methodologies, resulting data sets, and tracking metrics.
- Policy considerations and agency roles within the RHR process.
- Expected effectiveness of haze reduction strategies and meeting RHR milestones.

Also investigated was the question of how jurisdictional differences between Canada and the U.S. might affect the development of a similar rule in Canada. The results of this survey and a discussion of how the lessons learned could influence Canada's efforts will be presented.