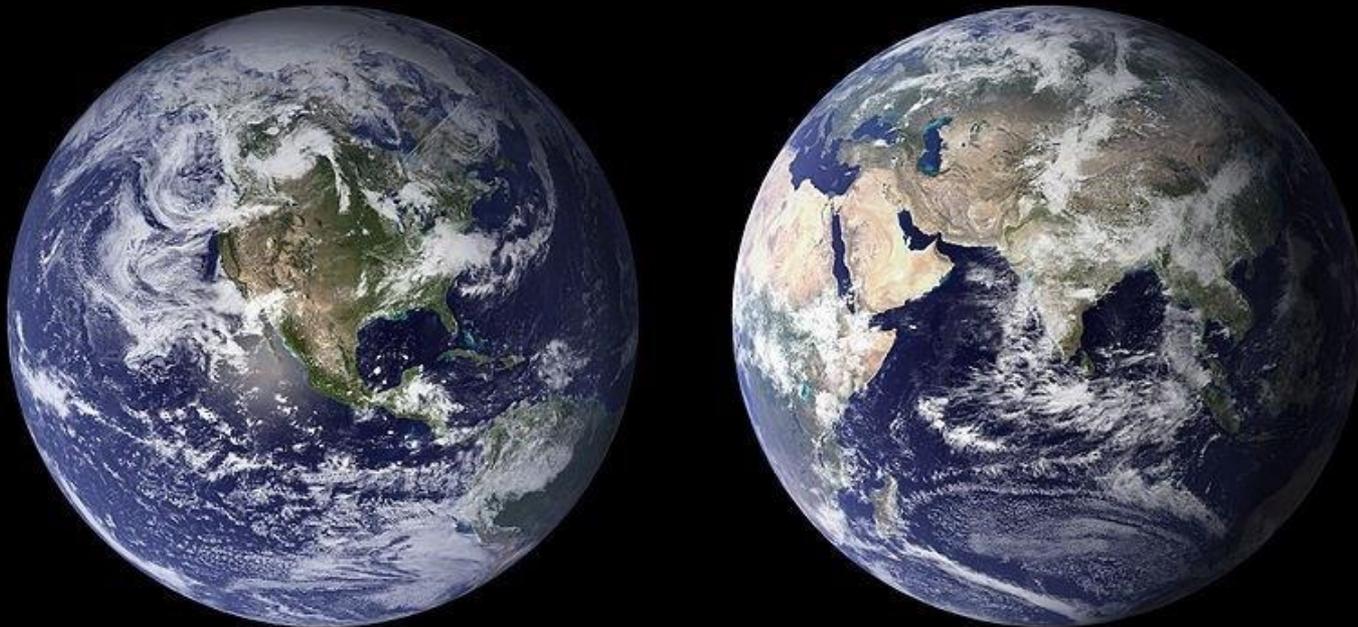
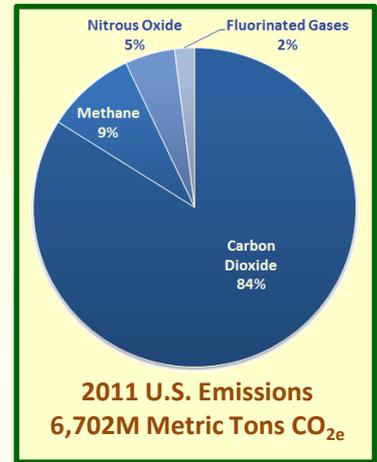


NIST Greenhouse Gas and Climate Science Measurements Program Review

**August 1 & 4, 2014 – NIST, Gaithersburg
August 11 – NIST, Boulder**



Greenhouse Gas and Climate Science Measurements Program

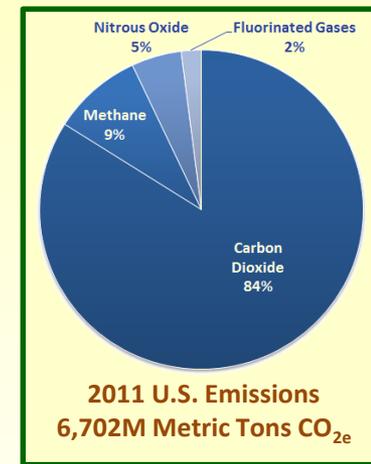


Objectives:

- **Develop advanced measurement tools and standards to improve accuracy capabilities of:**
 - **Greenhouse gas emissions inventory data**
 - Independently diagnose and verify greenhouse gas emissions data both nationally and internationally
 - Emphasize applications for cities and metropolitan areas
 - **Remote observations, both satellite and surface-based**
 - Extend measurement science and develop measurement tools that advance understanding and description of the Earth's climate and its drivers of change.

Greenhouse Gas and Climate Science Measurements Program

Greenhouse Gas Inventories



- The performance metrics for national and international greenhouse gas mitigation activities and future policies.
- Reliable quantification is fundamental to equity and fairness in implementing mitigation structures whether they be regulatory or market-based.
- Advances in a range of measurement capabilities are needed to assess progress toward and attainment of mitigation targets.

Greenhouse Gas Emissions and Climate Communities

A Range of Interests, Capabilities, & Practices



Greenhouse Gas Emissions and Climate Communities

A Range of Interests, Capabilities, & Practices

GHG Reporting:

- GHG Emissions & Offsets
- National Inventory Basis
- Bottom-Up - *Measurable*
- Accountancy Focus
- *Principles of Legal Metrology?*

Climate Science:

- Observing the Atmosphere
- Research Orientation
 - Bio-Geochemical Processes
 - Atmospheric & Oceanic Processes
- Top-Down - *Verifiable*
- Significant Complexity Levels
- Well-Established organizations with extensive documentation methods
- Use of Measurements & Standards is well established, but new/more accurate methods/standards are needed



Definitions

- UNFCCC – United Nations Framework Convention on Climate Change
- MRV
 - **Measurable** – Emissions are capable of being measured
 - **Reportable** – Measured, and therefore, reported
 - **Verifiable** – *Independent* validation of reported emissions data
- NAMAs – Nationally Appropriate Mitigation Activities
 - Challenged to meet MRV requirements for Consistency, Transparency, Comparability Completeness, and Accuracy.
- Bottom-up – Emissions determination using in-facility methodologies, e.g., Continuous Emissions Measurement (CEMs) systems for stack gas flows or fuel calculation methods for total plant emissions
- Top-Down – Emissions determined from observations of the atmosphere – GHG flux into and through it

**Bali Action Plan,
UNFCCC - COP 13 (2007)**

The General Technical Measurement Problem

GHG Inventory: time integrated GHG flux or mass flow rate
both emissions and uptake by the biosphere
= mass flow rate * GHG mass conc. * time period

$$\dot{M}_{GHG} = \dot{M}_{Total} \sum_j C_j$$

\dot{M}_{GHG} - GHG Mass Flux
 \dot{M}_{Total} - Total Mass Flux
 C_j - j^{th} GHG Concentration

- GHG Inventory data is mass flow or flux to or from the atmosphere
- Accuracy depends on gas concentration and total gas mass flux values
- SI Traceability has potential to ensure comparability levels of inventories, especially between sources and sinks, often widely separated in the world using different quantification methods.

A Metrologist's Assessment of the Current Greenhouse Gas Inventory Situation

- Realized GHG inventory accuracy levels are elusive. Large differences among methods, factors of ~2 reported
- Desired levels are challenging & target dependent – U.S. Target - 17% reduction by 2020
- Developed nation inventory accuracy statements are thought to be good (acceptable), if below 10% uncertainty (UNFCCC Annex 1 Countries),
But, independent, verification method is currently used or available
- Technically rigorous uncertainty estimating methods are needed

Greenhouse Gas and Climate Science Measurements Program Components

- **Stationary/Point Source Metrology**
 - Increase accuracy of Continuous Emission Monitoring technology
 - Test Beds to advance flow measurement research in smoke stacks
- **Geospatially Distributed GHG Source Metrology**
 - Measurement Tools and Test Beds Characterizing Emission in Urban Areas - Urban GHG Concentration Domes
 - Develop Capabilities to Independently Diagnose GHG Emission Inventory Accuracy
 - Geospatially Dense GHG Observing Networks
 - Indianapolis Flux Experiment (INFLUX)
 - INFLUX Extensions to Megacity Test Beds
 - Los Angeles Megacity Carbon Project
 - Northwest Corridor Project
 - Development of an International Greenhouse Gas Metrology Framework Supporting Inventory Diagnosis and MRV

- **GHG Measurements, Standards, Ref. Data, and Tools**
 - GHG Concentration Standards
 - Spectroscopic Reference Data
 - Surface Air Temperature Assessment
 - Flux Measurement Tools
- **Climate Science Measurements - Advanced Satellite Calibration Standards**
 - Optical and Microwave Measurements and Standards
- **Aerosol & Particulate Measurement Science (Black Carbon)**
 - Optical Properties
 - Development of Reference Materials and Advanced Measurements

Thanks for Attending and/or Participating

Thanks to:

- **Dr. Tamae Wong**
 - The brains and drive behind setting up this review, the documentation templates, and organizing this agenda
- **Carol Rushing**
 - Arrangements for rooms, etc.
- **Program participants**
 - Providing project information in the format requested, preparing your presentation
 - Doing great research and sharing some of the result with us today.

Review Objective:

- **Gather information from individual projects supported by the program**
- **Get up to date on your research**
- **Use it to:**
 - **Grist for James' mill to sell the program outside NIST**
 - **Make the program description and planning document current**
 - **Develop a summary presentation of the program for NIST staff and management**
 - I hope to give presentations in Gaithersburg and Boulder in the early Fall describing the current program state
 - **Improve web presence for the program and its components by working with the web masters in each OU and in PBA**
- **Presentations and project sheets will be available**

Greenhouse Gas and Climate Science Measurements Program Review August 1, Gaithersburg, MD

Dates: August 1 (Friday) and August 4 (Monday), 2014

Location: NIST Gaithersburg, Building 215, Room C103

Program Areas

1. Stationary/Point GHG Emission Source Metrology
2. Distributed GHG Source Metrology
3. GHG Standards and Metrology Tools
4. Climate Science Measurements - Advanced Satellite Calibration Standards
5. Black Carbon Aerosol Measurement Science

Day 1 August 1 (Friday) Gaithersburg 215/C103

Agenda

Start	Item	Speaker	Contributors
8:30 AM	Introduction and Program Overview	James Whetstone	
8:40 AM	Program Areas: Point & Distributed Source Metrology Sensor Science Division, PML Fire Research Division, EL Statistical Engineering Division, ITL	James Whetstone	
8:50 AM	Metrology for Coal-Burning Power Plant Emissions Monitoring	Mike Moldover	Aaron Johnson, Joey Boyd, Keith Gillis, Rodney Bryant, Jacob Ricker, and Iosif Shinder
9:20 AM	Standards Test Beds for Greenhouse Gas Emissions	Rodney Bryant	Aaron Johnson, Matthew Bundy, Iosif Shinder, R. Paul Borthwick, Jiann Yang, Elizabeth Moore, Joey Boyd, John Wright, Jacob Ricker, Michael Moldover, Kieth Gillis, Dan Sawyer
9:50 AM	Discussion		
10:10 AM	Urban Greenhouse Gas Measurements Testbeds: Indy, LA, and NE Corridor	James Whetstone	
10:40 AM	Statistical Methods for Plume Measurement and Model-based Estimation of GHG Sources	Daniel Samarov Adam Pintar Lo-Hua Yuan	Adrian Sandu, Blaza Toman, Israel Lopez-Coto, Kuldeep Prasad
11:10 AM	Greenhouse Gas Emissions and Transport	Kuldeep Prasad	Israel Lopez-Coto, Heming Hu
11:40 AM	Discussion		
12:00 PM	Lunch		
1:00 PM	Program Area: GHG Standards & Metrology Tools Chemical Sciences Division, MML Statistical Engineering Division, ITL	Roger van Zee	
1:10 PM	Reference Data for GHG Sensing	Joe Hodges	David Long, Zach Reed, Adam Fleisher
1:40 PM	Sensor Development: Metrology Tools for Climate Science	David Long	Zach Reed, Adam Fleisher, Joe Hodges
2:10 PM	Discussion		
2:30 PM	Standard Reference Materials and Gas Metrology	Jerry Rhoderick	Frank Guenther, Bob Miller, Mike E. Kelley, Gerald Mitchell
3:00 PM	Seawater pH - Moved to Monday, 10:40	Jason Waters	Ken Pratt, Regina Easley
3:30 PM	Discussion		
3:40 PM	End of the Day Summary	James Whetstone	

Ground rules for Presentations and the Day

- **Please observe the time slots**
 - James will keep time
 - Orange Card – 5 minutes
 - Red Card – Stop in no more than 1 minute
- **Discussion periods**
 - Please Keep your questions for presenters in mind to ask during these times if possible

Greenhouse Gas and Climate Science Measurements Program Review August 4, Gaithersburg, MD

Agenda

Dates: August 1 (Friday) and **August 4 (Monday)**, 2014

Location: NIST Gaithersburg, Building 215, Room C103

Program Areas

1. Stationary/Point GHG Emission Source Metrology
2. Distributed GHG Source Metrology
3. GHG Standards and Metrology Tools
4. Climate Science Measurements - Advanced Satellite Calibration Standards
5. Black Carbon Aerosol Measurement Science

Day 2 August 4 (Monday) Gaithersburg 215/C103

Start	Item	Speaker	Contributors
8:30 AM	Introduction and Overview	James Whetstone	
9:00 AM	Program Area: Black Carbon Aerosol Measurement Science Materials Measurement Science Division, MML Chemical Sciences Division, MML	Pam Chu	
9:10 AM	Carbonaceous Aerosols Measurements	Chris Zangmeister	Sean McGivern, James Radney, Joseph Conny, Keith Gillis, Joseph Hodges (Univ of MD) Michael Zachariah, Mingdong Li, Russell Dickerson, Xiaofei Ma
9:40 AM	Heterogeneous Atmospheric Dust: Individual Particle Microanalysis, Optical Property Modeling, and Lab-Generated Particle Analogs	Joe Conny	Sean Collins, Reid Gunn, Andrew Herzing, Xiaofei Ma Diana Ortiz-Montalvo, Robert D. Willis (U.S. EPA)
10:10 AM	Secondary Organic Aerosols	Sean McGivern	Christopher Zangmeister, James Radney, Alicia Pettibone, Joseph Klems, Donald Burgess, Thomas Allison
10:40 AM	Sea Water pH	Jason Waters	Ken Pratt, Regina Easley
11:00 AM	Discussion		
11:30 AM	Program Area: Intro Climate Science Measurements Sensor Science Division, MML Quantum Electronics and Photonics Div, MML Statistical Engineering Division, ITL	Gerald Fraser	
11:40 AM	Surface Temperature Measurement Validated Uncertainties, New Meas. Methods, and 3D Microclimate Measurement	Greg Strouse and Antonio Possolo	Wyatt Miller, Hung-kung Liu, Adam Pintar, Nien-fan Zhang
12:10 PM	Discussion		
12:20 PM	Lunch		
1:00 PM	Calibration of Earth-Viewing Satellite Sensors	Joseph Rice	Steve Brown, Leonard Hanssen, Carol Johnson, Steve Maxwell, Keith Lykke, Ping-Shine Shaw, John Woodward, Yuqin Zong
1:30 PM	Advanced Reflectance/BRDF Standards for Surface and Atmospheric Albedo Measurements	Heather Patrick	David Allen, Catherine Cooksey, Thom Germer, Joseph Rice, Benjamin Tsai
2:00 PM	Surface and Exo-Atmospheric Solar Measurements	Tom Lucatorto, Eric Shirley	Alex Farrell, Mitch Furst, Ed Hagley, Leonard Hanssen, Carol Johnson, Toni Litorja, Joseph Rice, Howard Yoon
2:30 PM	Discussion		
3:00 PM	Exo-atmospheric Standards for Satellite Sensor Calibration and Nighttime Aerosol Quantification	Claire Cramer	Steve Brown, Keith Lykke, John Woodward
3:30 PM	Ocean Color Measurement	Carol Johnson	Steve Brown
4:00 PM	Discussion		
4:30 PM	End of the Day Summary	James Whetstone	

A Measurement Systems Concept Supporting Mitigation

Enhancing Consistency, Transparency, Comparability, and Accuracy

