NASA Air Quality Applied Sciences Team Update

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Southeast Texas Photochemical Modeling Technical Committee
July 21, 2014
Air Quality Applied Sciences Team (AQAST)

**EARTH SCIENCE SERVING AIR QUALITY MANAGEMENT NEEDS**

**Earth science resources**
- satellites
- suborbital platforms
- models

**Air Quality Management Needs**
- Pollution monitoring
- Exposure assessment
- AQ forecasting
- Source attribution of events
- Quantifying emissions
- Natural&foreign influences
- AQ processes
- Climate-AQ interactions
AQAST members

- Daniel Jacob (leader), Loretta Mickley (Harvard)
- Greg Carmichael (U. Iowa)
- Dan Cohan (Rice U.)
- Russ Dickerson (U. Maryland)
- Bryan Duncan, Yasuko Yoshida, Melanie Follette-Cook (NASA/GSFC); Jennifer Olson (NASA/LaRC)
- David Edwards (NCAR)
- Arlene Fiore (NOAA/GFDL); Meiyun Lin (Princeton)
- Jack Fishman, Ben de Foy (Saint Louis U.)
- Daven Henze, Jana Milford (U. Colorado)
- Tracey Holloway, Steve Ackerman (U. Wisconsin); Bart Sponseller (Wisconsin DRC)
- Edward Hyer, Jeff Reid, Doug Westphal, Kim Richardson (NRL)
- Pius Lee, Tianfeng Chai (NOAA/NESDIS)
- Yang Liu, Matthew Strickland (Emory U.), Bin Yu (UC Berkeley)
- Richard McNider, Arastoo Biazar (U. Alabama – Huntsville)
- Brad Pierce (NOAA/NESDIS)
- Ted Russell, Yongtao Hu, Talat Odman (Georgia Tech); Lorraine Remer (NASA/GSFC)
- David Streets (Argonne)
- Jim Szykman (EPA/ORD/NERL)
- Anne Thompson, William Ryan, Suellen Haupt (Penn State U.)
AQAST organization

• AQAST supports two types of projects:
  ➢ Investigator Projects -- core funding to individual members
  ➢ Tiger Team Projects – collaborations between AQAST members with supplementary funding to address urgent air quality management needs

• All AQAST projects bridge Earth Science and air quality management:
  ➢ Use Earth Science resources with clear air quality management outcomes
  ➢ Team up with partners in air quality management

• AQAST has flexibility in how it allocates its resources
  ➢ Members can adjust their IPs to meet evolving air quality needs
  ➢ Proposed Tiger Teams compete annually for funding to address the most pressing needs
  ➢ The team is self-organizing and can respond quickly to demands

Quick, collaborative, flexible, responsive to the needs of the AQ community
What makes AQAST unique?

All AQAST projects connect Earth Science and air quality management:
- Involve active partnerships with air quality managers, have deliverable application outcomes
- Expand relationships through meetings, online tools, newsletters

AQAST has flexibility in how it allocates its resources:
- Members adjust work plans to meet evolving air quality needs
- Multi-member “Tiger Teams” are organized each year to address newly emerging, pressing problems requiring coordinated activity
- AQAST is self-organizing and can respond quickly to demands

Quick, collaborative, flexible, responsive to the needs of the AQ community

www.aqast.org
AQAST Biannual Meetings
**Scope of current AQAST projects**

### Partner agency

- **Local:** RAQC, BAAQD
- **State:** TCEQ, MDE, Wisconsin DNR, CARB, Iowa DNR, GAEPD, GFC
- **Regional:** LADCO, EPA Region 8
- **National:** EPA, NOAA, NPS

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**Theme**

**Satellites:** MODIS, MISR, MOPITT, AIRS, OMI, TES, GOES

**Suborbital:** ARCTAS, DISCOVER-AQ, ozonesondes, PANDORA

**Models:** MOZART, CAM AM-3, GEOS-Chem, RAQMS, STEM, GISS, IPCC, CMAQ, CAMx, WRF-Chem

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**Earth Science resource**
Communication Tools

• Website: http://aqast.org

NASA Air Quality Applied Sciences Team

Earth Science Serving Air Quality Management Needs

• Media Center: http://www.aqast-media.org

NASA Air Quality Applied Sciences Team

MEDIA CENTER

Resources for members of the press and public

• Newsletter: subscribe through website

Email: aqast_news-join@seas.harvard.edu
Applying Satellite Data to Air Quality Management

Research conducted by the NASA Air Quality Applied Sciences Team (AQAST) shows that Earth science data are a great potential resource for air quality managers.

- Monitoring $\text{PM}_{2.5}$ for health: past, present, and future directions (Liu et al.)
- Air quality forecasting (Hu et al.)
- Interactions between climate change and US air quality (Mickley et al.)
- Using satellite observations to measure power plant emissions and their trends (Streets et al.)
- Detecting and attributing episodic high background ozone events (Fiore et al.)
- Integrating satellite data into air quality management: experience from Colorado (Witman and Holloway)
AQAST Highlight:
Satellite formaldehyde data detect anthropogenic VOC sources

OMI formaldehyde, May-Aug 2005-2008

- Formaldehyde seen from space is sensitive to highly reactive VOCs (HRVOCs) including isoprene, alkenes
- “Oversampling” allows for the first time quantitative detection of US urban and industrial plumes
- Houston HRVOC emissions in NEI08 are 5x too low

Lei Zhu, Daniel Jacob, Loretta Mickley (Harvard)
Year 3 Tiger Teams
selected with extensive input and review from AQ management community

1. Web-enabled tools for air quality management decision support 
   (Szykman, Spak) with EPA, Iowa DNR, San Joaquin Valley APCD

2. Source contributions to O$_3$ and PM$_{2.5}$ pollution episodes across Eastern US 
   (Holloway, Fiore) with LADCO, Wisconsin DNR, MDE, TCEQ

3. Dynamic inputs of Natural Conditions for Air Quality Models (DYNAMO) 
   (Cohan) with EPA, TCEQ, CARB

4. Satellite NO$_2$ columns, NO$_x$ emissions, and air quality in North America 
   (Streets) with EPA, LADCO, MDE

5. Satellite signatures of emissions associated with US oil & gas extraction 
   (Thompson) with BLM, EPA Region 8, MARAMA, CenSARA, Oklahoma DEQ, 
   MDE, CDPHE

6. Air quality reanalysis (translating research to services) 
   (Carmichael) with EPA, CARB, Georgia DNR, MDE, Virginia DEQ
Designing effective SIPs requires knowledge of source contributions to $O_3$ and $PM_{2.5}$ pollution episodes.

Observed pollution levels are the summation of in-state, out-of-state, international and natural sources.

AQAST can help quantify these components; how can we be most effective?

- Build a framework for continued communication with the stakeholders
- Request priority high-$O_3$ and high-$PM_{2.5}$ episodes from AQM (2007-2013)
- Analyze some of these episodes & provide “recipes” for determining source contributions

**AQAST TT Members**

**monthly teleconferences**

**Air Agencies**
- MDE, MO DNR, NH DES, NYSDEC, TX/TCEQ, WI DNR/LADCO, OTC, NESCAUM, US EPA...
- ...your agency??
Relationships and Trends among Satellite NO₂ Columns, NOₓ Emissions, and Air Quality in North America

Tiger Team Update

David Streets, Greg Carmichael, Dan Cohan, Ben de Foy, Bryan Duncan, Arlene Fiore, and Tracey Holloway

Presented at AQAST 7 Meeting
Harvard University, MA
June 17-19, 2014
DYNAMO Objectives

- GOES satellite based photosynthetically active radiation (PAR) and photolysis rates
- Daily varying stratospheric ozone columns in GEOS-Chem and CMAQ
- Improved biogenic emissions
  - Satellite PAR & dynamic vegetation in MEGAN
  - New soil NO emissions scheme in CMAQ
- Sharing of products through EPA’s RSIG
DYNAMO Air Quality Management Partners

• US EPA: Jesse Bash, Pat Dolwick, and Chris Misenis
• Texas Commission on Environmental Quality: Mark Estes
• California Air Resources Board: Jeremy Avise
AQAST Research Priorities at Rice

• Inverse modeling of NO\textsubscript{x} using OMI NO\textsubscript{2}
• Satellite-based clouds and photolysis
• Enhanced biogenic emissions estimates
  • Satellite-based dynamic vegetation conditions
  • Improved soil NO\textsubscript{x} model
• How all of the above influence pollutants and their sensitivities to emissions controls
Satellite observations applied to ozone attainment planning in Texas

1. Photolysis Rates assimilated using GOES data (A. Pour-Biazar, U. Alabama-Huntsville)
2. NO\textsubscript{x} Emissions inverted from OMI and TexAQS-II data
3. Model how revised inputs affect ozone responsiveness
4. Provide results to TCEQ and stakeholders for upcoming SIP attainment planning

Daniel Cohan (Rice U.)
Δ Biogenics Model (MEGAN)

Leaf Area Index (LAI) — Biogenics Model (MEGAN) — OMI (& GOME-2)

MODIS — Leaf Area Index (LAI) — Biogenics Model (MEGAN) — HCHO

isoprene
Research Priorities for SET PMTC??

• AQAST is designed to be responsive to the needs of air quality management community: *What would you like to see emphasized?*
  
  – Applications of satellite and sub-orbital data?
  – Research and deliverables that would benefit SIPs or other decision-making?
  – Interactions among NASA, scientists, state & federal agencies, RPOs, and stakeholders
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