HAQAST Tiger Team: 
Supporting the use of satellite data in 
State Implementation Plans (SIPs) 

Arlene M. Fiore
(amfiore@ldeo.columbia.edu) 
LDEO/Columbia University 
HAQAST4 @ University of Wisconsin - Madison 
Madison WI, 7-16-18

haqast.org
How can satellite data be included in State Implementation Plans (SIPs)?

(1) Weight-of-evidence that a particular strategy is anticipated to succeed in attainment, or to show that transported pollution is confounding attainment efforts.

(2) Evaluation of air pollution modeling and/or constraints on these models such as through data assimilation.

(3) Evidence supporting “exceptional event(s)” demonstrations.
HAQAST “Satellite-data-in-SIPs” Tiger Team Objectives

(1) Identify at least three different examples where satellite data had been used in a SIP and showcase the application in a user-friendly, technical guidance document.

(2) Share widely so interested agencies can benefit from lessons learned by other agencies facing similar challenges.

(3) Provide a forum for regular communication, enabling HAQAST PIs to address (some) emerging questions as they arise.
Who is involved, and in what capacity?

- **HAQAST “SIP” TT members**
  - "Early Adopters": Agencies already using satellite data; approaches to be documented by HAQAST (3 case studies)

- **“Beta Testers”**: Agencies interested to try approaches outlined in draft technical guidance docs

- **Other local, state, regional air quality and health agencies** who access HAQAST guidance docs via webinars, meetings, websites
HAQAST “SIP” TT Participants

HAQASTers: Arlene Fiore (LDEO/Columbia), Bryan Duncan (NASA GSFC), Jessica Neu (NASA JPL), Daven Henze (University of Colorado – Boulder), Talat Odman and Ted Russell (Georgia Institute of Technology), Daniel Tong (George Mason University), Mark Zondlo (Princeton University), Jonathan Patz and Tracey Holloway (University of Wisconsin—Madison), Jeremy Hess (University of Washington).

Stakeholder partners (9+ groups): South Coast Air Quality Management District (California) [Sang-Mi Lee], Connecticut [Kurt Kebschull, Michael Geigert, Kiernan Wholean], Texas Commission on Environmental Quality (TCEQ) [Mark Estes]; Georgia Environmental Protection Division (GA EPD) [Jim Boylan, Tao Zeng]; Bay Area Air Quality Management District [Steve Soong; Saffet Tanrikulu]; Mid-Atlantic Regional Air Management Association (MARAMA) [Susan Wierman], Northeast States for Coordinated Air Use Management (NESCAUM) [Paul Miller]; U.S. EPA [Barron Henderson, Gail Tonneson, Pat Dolwick]; OTC [Shyamala Rajan]. Other agencies are joining calls: NJ, NY, MD, SUNY Albany

Plus outreach to health stakeholder communities
• Holloway team: comparing across PM$_{2.5}$ datasets used in health studies & reaching out to multiple health stakeholder groups
Tech. Guidance Doc: Using space-based HCHO/NO$_2$ as an indicator of O$_3$ sensitivity

- NASA HAQAS T Team
  - Developed the methodology (Jin et al., 2017)

- Air Quality Agency Early Adopters
  - Delivered a technical guidance on using satellite HCHO/NO$_2$ in SIPs

- Beta Testers
  - Agencies tried the approach outlined in the technical guidance and provided feedback

- Other local, state, regional air quality and health agencies
  - The technical guidance is publicly available on "NASA air quality from Space"

Slide c/o X. Jin (Columbia)
Three Technical Guidance Documents Completed

A Brief Tutorial on Using the Ozone Monitoring Instrument (OMI) Nitrogen Dioxide (NO₂) Data Product for SIPS Preparation

https://doi.org/10.7916/D80K3S3W

And archived at Columbia U Academic Commons Repository

https://doi.org/10.7916/D84B4HT6

Guide to Using Satellite Images in Support of Exceptional Event Demonstrations

https://doi.org/10.7916/D8M34C7V
Using satellite observed formaldehyde (HCHO) and nitrogen dioxide (NO2) as an indicator of ozone sensitivity in a SIP

Xiaomeng Jin; Arlene M. Fiore; Michael Geigert

Title: Using satellite observed formaldehyde (HCHO) and nitrogen dioxide (NO2) as an indicator of ozone sensitivity in a SIP

Author(s): Jin, Xiaomeng
Fiore, Arlene M.
Geigert, Michael

Date: 2018

Type: Reports

Department(s): Lamont-Doherty Earth Observatory

Persistent URL: https://doi.org/10.7916/D8M34C7V

Notes: Access processing tools that accompany this technical guidance document at https://blog.ideo.columbia.edu/atmoschem/datasets/. This document was produced by the NASA HAQAST Tiger Team "Supporting the Use of Satellite Data in State Implementation Plans (SIPs)" led by Professor Arlene Fiore. For additional resources see: https://airquality.gsfc.nasa.gov/aq-managers.

Publisher: NASA Health and Air Quality Applied Sciences Team

Abstract: Although State Implementation Plans (SIPs) typically rely on observations from ground-based networks and regulatory models, satellite data is increasingly available to state agencies and can also inform and supplement state implementation plans to improve air quality. An advantage of satellite data is that it provides information for a broader area than sampled by ground-based networks. This document provides examples and guidance for using satellite products of formaldehyde (HCHO) and nitrogen dioxide (NO2) to inform ground-level ozone sensitivity to emissions of nitrogen oxides (NOx) versus volatile organic compounds (VOC) in state implementation plans. Analysis of changes in ozone sensitivity over periods where emission controls have been implemented can provide insights into the efficacy of those past strategies and the likely efficacy of proposed future emission control programs.

Subject(s): Air quality
Air quality--Measurement
Air quality management
Air quality management--Evaluation

Item views: 61

Metadata: text | xml

Suggested Citation: Xiaomeng Jin, Arlene M. Fiore, Michael Geigert, 2018, Using satellite observed formaldehyde (HCHO) and nitrogen dioxide (NO2) as an indicator of ozone sensitivity in a SIP, Columbia University Academic Commons, https://doi.org/10.7916/D8M34C7V.
Links to these docs are now up on NASA’s air quality from space website “Managers” tab

Publicly available NASA satellite data can help with State Implementation Plans (SIPs)

Background: NASA’s Earth science program maintains a large fleet of earth-observing satellites, all of which offer free data products. A number of these can be used to illustrate NOx emissions trends and their relevance to ozone attainment, as well as for weight-of-evidence under the EPA’s Exceptional Events Rule. A collaborative team of NASA-funded scientists and public stakeholders has recently developed a suite of easy-to-follow technical guidance documents to support state and local air quality agencies that want to bring the power of NASA’s satellites to bear on the documentation of exceptional events. This work is a product of the NASA Health and Air Quality Applied Sciences Team (HAQAST) Year 1 (2017-2018) Tiger Team “Supporting the Use of Satellite Data in State Implementation Plans (SIPs)”

What, specifically, can NASA help me with? Our team has developed three guidance documents:

Thanks to Bryan Duncan and his team for hosting these!
PROJECT Update: Publicly available NASA satellite data can help with State Implementation Plans

Background: NASA’s Earth science program maintains a large fleet of earth-observing satellites, all of which offer free data products. A number of these can be used to illustrate NO₂ emissions trends and their relevance to ozone attainment, as well as for weight-of-evidence under the EPA Exceptional Events Rule. A collaborative team of NASA-funded scientists and public stakeholders developed a suite of easy-to-follow technical guidance documents to support state and local air quality agencies that wish to incorporate NASA satellite products into their policy planning documents. This work is a product of the NASA HAQAST 2017-2018 Tiger Team “Supporting the Use of Satellite Data in State Implementation Plans (SIPs).”

What, specifically, can NASA help me with? Our team has developed three guidance documents:

- Using satellite observed formaldehyde (HCHO) and nitrogen dioxide (NO₂) as an indicator of ozone sensitivity in a SIP
- A Brief Tutorial on Using the Ozone Monitoring Instrument (OMI) Nitrogen Dioxide (NO₂) Data Product for SIP Preparation
- A Guide to Using Satellite Images in Support of Exceptional Event Demonstrations

Have air quality managers used satellite data in submitted SIPs? Yes. Our technical guidance documents were developed in close concert with air quality experts at state air agencies, including the Texas Commission on Environmental Quality (TCEQ) and the Connecticut Department of Energy and Environmental Protection (DEEP). Satellite data can be used as one component in overall weight of evidence (alongside evidence from ground monitors, models, etc.). These technical guidance documents provide field-tested examples of successful uses.

Where can I go to find out more? Each of the technical guidance documents is available at https://airquality.gsfc.nasa.gov/aq-managers, which also provides links to data and visualization tools, demonstrations of real-world uses, and other useful information for the health and air quality management communities.
HAQAST members Russell/Odman/Qin developed a Technical Guidance Doc in review; SCAQMD expressed interest in beta-testing
Tech. Guidance Doc in prep: How can I incorporate satellite data into boundary conditions used by my regional model?

HAQAST member Jessica Neu (NASA JPL) is generating boundary conditions for use by SCAQMD in their SIP modeling. BAAQMD also interested.
### Responding to emerging needs: Satellite ammonia primer (Mark Zondlo, Princeton)

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Satellite</th>
<th>Day, equator crossing time (local)</th>
<th>Pixel size at nadir (km²)</th>
<th>NH₃ data availability</th>
<th>Product</th>
<th>Spectral Resolution (cm⁻¹)</th>
<th>Noise (K)</th>
<th>Swath width (km)</th>
<th># pixels across swath</th>
<th>Data accessible to public</th>
</tr>
</thead>
<tbody>
<tr>
<td>IASI</td>
<td>MetOp-A</td>
<td>9:30</td>
<td>12 x 12</td>
<td>2007-present</td>
<td>column</td>
<td>0.5</td>
<td>0.17</td>
<td>2200</td>
<td>60</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>MetOp-B</td>
<td>8:45</td>
<td>12 x 12</td>
<td>2013-present</td>
<td>column</td>
<td>0.5</td>
<td>0.17</td>
<td>2200</td>
<td>60</td>
<td>Y</td>
</tr>
<tr>
<td>CrIS</td>
<td>S-NPP</td>
<td>13:30</td>
<td>14 x 14</td>
<td>2014-present</td>
<td>profile</td>
<td>0.625</td>
<td>0.04</td>
<td>2200</td>
<td>90</td>
<td>late 2018</td>
</tr>
<tr>
<td>TES</td>
<td>Aura</td>
<td>13:30</td>
<td>5.3 x 8.5</td>
<td>2004-2015</td>
<td>profile</td>
<td>0.1</td>
<td>0.15</td>
<td>5.3</td>
<td>1</td>
<td>Y</td>
</tr>
<tr>
<td>AIRS</td>
<td>Aqua</td>
<td>13:30</td>
<td>13.5 x 13.5</td>
<td>2002-present</td>
<td>profile</td>
<td>0.5</td>
<td>0.2</td>
<td>1650</td>
<td>90</td>
<td>TBD</td>
</tr>
</tbody>
</table>

Credit: NASA

Credit: CNES
Responding to emerging needs: “How-to” for city-specific NO$_2$ trends from NASA Giovanni

HAQAST member Daniel Tong is developing a “How-to” create a long-term NO$_2$ time series over your city, directly from the NASA Giovanni website (https://giovanni.gsfc.nasa.gov)

This short tutorial steps through an example for NYC metro area
Deliverables for HAQAST “Satellite Data in SIPs” TT

1. Initial Phone meetings between HAQAST participants and ‘early-adopters’ → Completed (3). Some overlap arose for addressing emerging questions

2. Technical guidance documents
   → 3 completed & archived in Columbia U repository with dois
   → 1 draft circulating; 1 in prep
   → primer on NH3 satellite products
   → data analysis scripts accompany some docs
   → short “how-to” create your own satellite NO\textsubscript{2} time series using Giovanni

3. Monthly team-wide phone calls
   → some dedicated to discussion of a single case study or emerging need (e.g., September 2017 call on fire influence → added a technical guidance doc; May 2018 call discussed new pub on NO\textsubscript{2} trends; LISTOS field campaign → summary notes from phone meetings available on team website

   https://blog.ldeo.columbia.edu/atmoschem/haqast-tt-satellite-sips/

4. Web documentation housed @ airquality.gsfc.nasa.gov “Managers” Tab

5. Disseminate case studies: one page memos; permanent archival of tech. guid. docs); meetings including HAQAST3/4; regular phone meetings of regional groups
Fiore/Kinney Core Project: Using satellite products and models to inform air quality planning and health accountability

Objective 1: Assess value and uncertainties in satellite-based approaches for PM$_{2.5}$ exposure mapping over NYS (Xiaomeng Jin, LDEO/Columbia)

Objective 2: Conduct multi-pollutant health impact analysis for the past decade over NYS. (Mike He, Columbia School of Public Health)
Year 2 Progress Update, PI Fiore

Source attribution using satellite products and models to inform air quality planning and health accountability

- Assess uncertainties in deriving surface PM$_{2.5}$ from satellite AOD over NYS
  - Paper using a CMAQ simulation from NYS DEC collaborators, MODIS MAIAC product & DISCOVER-AQ data circulating with coauthors

- Connect trends in air pollution exposure to hospital records over NYS from last decade
  - Ongoing analysis of satellite and other PM$_{2.5}$ datasets (including from satellite) + OMI NO$_2$ surface product, and ozone (fused CMAQ and AQS from EPA)
  - Deriving new exposure functions & consider uncertainty as represented by the spread in trends across multiple PM$_{2.5}$ products + findings from paper in first bullet above

- Advance understanding of background ozone across the U.S.A.
  - Paper accepted on interannual variability in individual background sources from 2004 to 2012 (ACP)
  - Co-authored accepted review paper (Elementa)

- 8+ academic talks; 6+ stakeholder or public talks; hosted and obtained support for HAQAST3; team members visited CT DEEP in August 2017; 3+ teleconferences with NYS DEC and DOH stakeholder partners; Kinney authored “Interactions of Climate Change, Air Pollution & Health” (Current Environmental Health Reports).

Tiger Team (TT) Participation

- Leading TT on Satellite Data in SIPS.
  - Communication: monthly calls with 9+ stakeholders, meeting notes, team web page, visit to CT DEEP, editing + archival of 3 technical guidance docs linked to NASA AQ from space site
  - Student Xiaomeng Jin wrote a technical guidance document on using HCHO:NO$_2$ as an indicator for ozone sensitivity to NO$_x$ versus VOC.
  - Worked with Daegan Miller to develop 1-page memos

- Co-I Pat Kinney Leading Tiger Team on Hi-Resolution PM2.5 data for health applications
  - Communication: monthly team calls; team web page; regular stakeholder calls; final webinar being planned.
  - MAIAC-derived estimates of 1 km$^2$ PM$_{2.5}$ generated over NYC and southern California
  - Impacts assessed for cardiac and respiratory health outcomes

- TT Duncan/West: Demonstrating Efficacy of Environmental Regulations over the EUS
  - Trends in HCHO:NO$_2$ as indicator of changes in ozone sensitivity over the NE
  - Student Xiaomeng Jin provided animation of HCHO, NO$_2$, and HCHO:NO$_2$ for https://airquality.gsfc.nasa.gov/ozone.