



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

Arlene M. Fiore

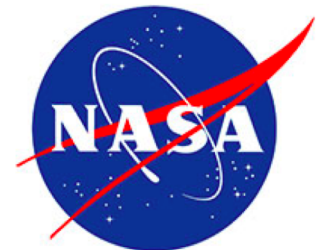
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LDEO/Columbia University

HAQAST4 @ University of Wisconsin - Madison
Madison WI, 7-16-18



haqast.org



2016-2019

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

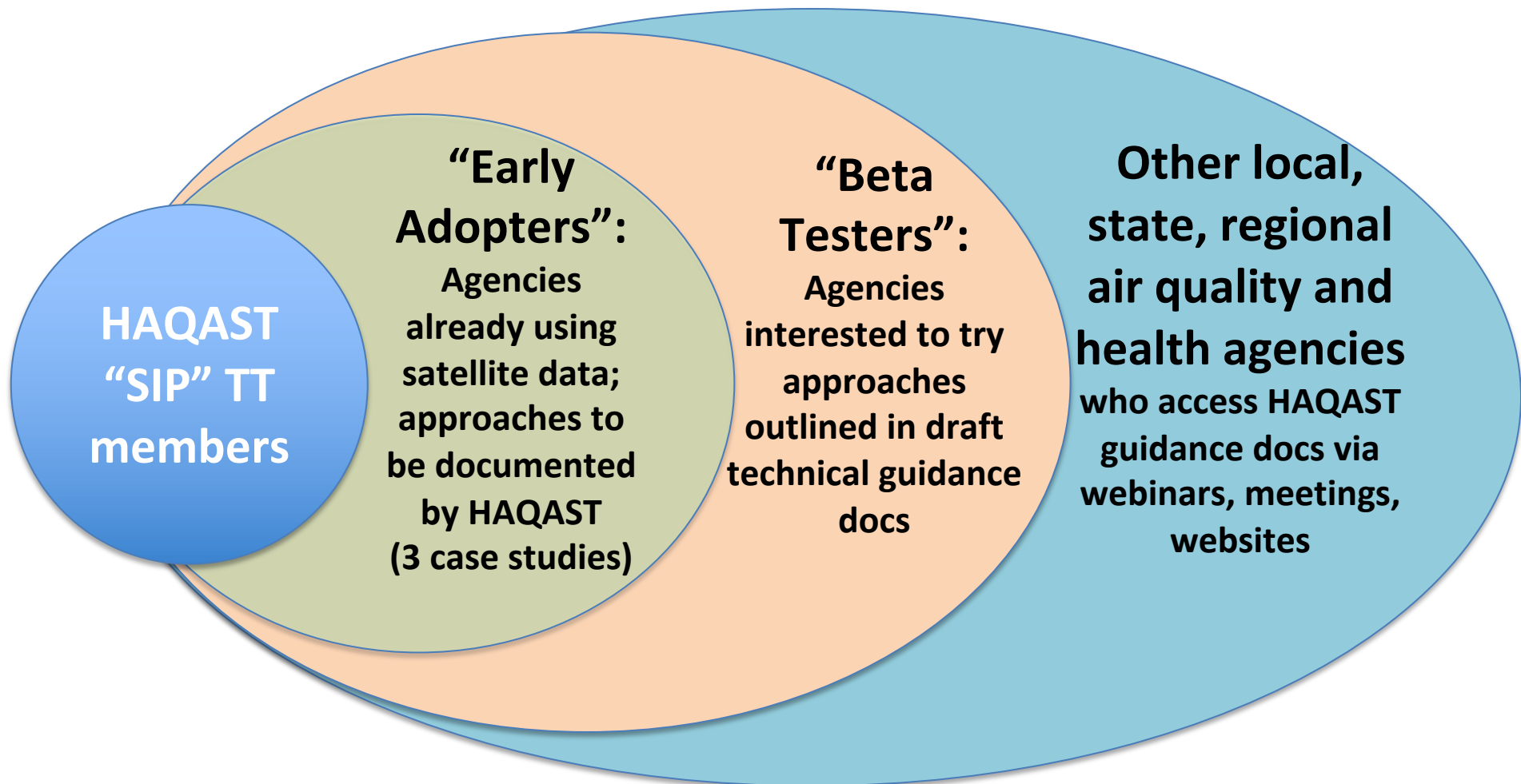
document.

(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 Participants

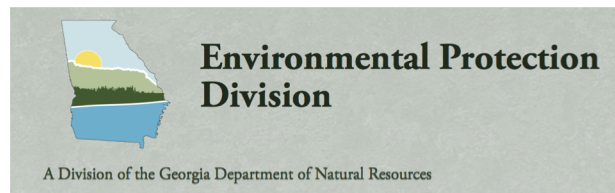
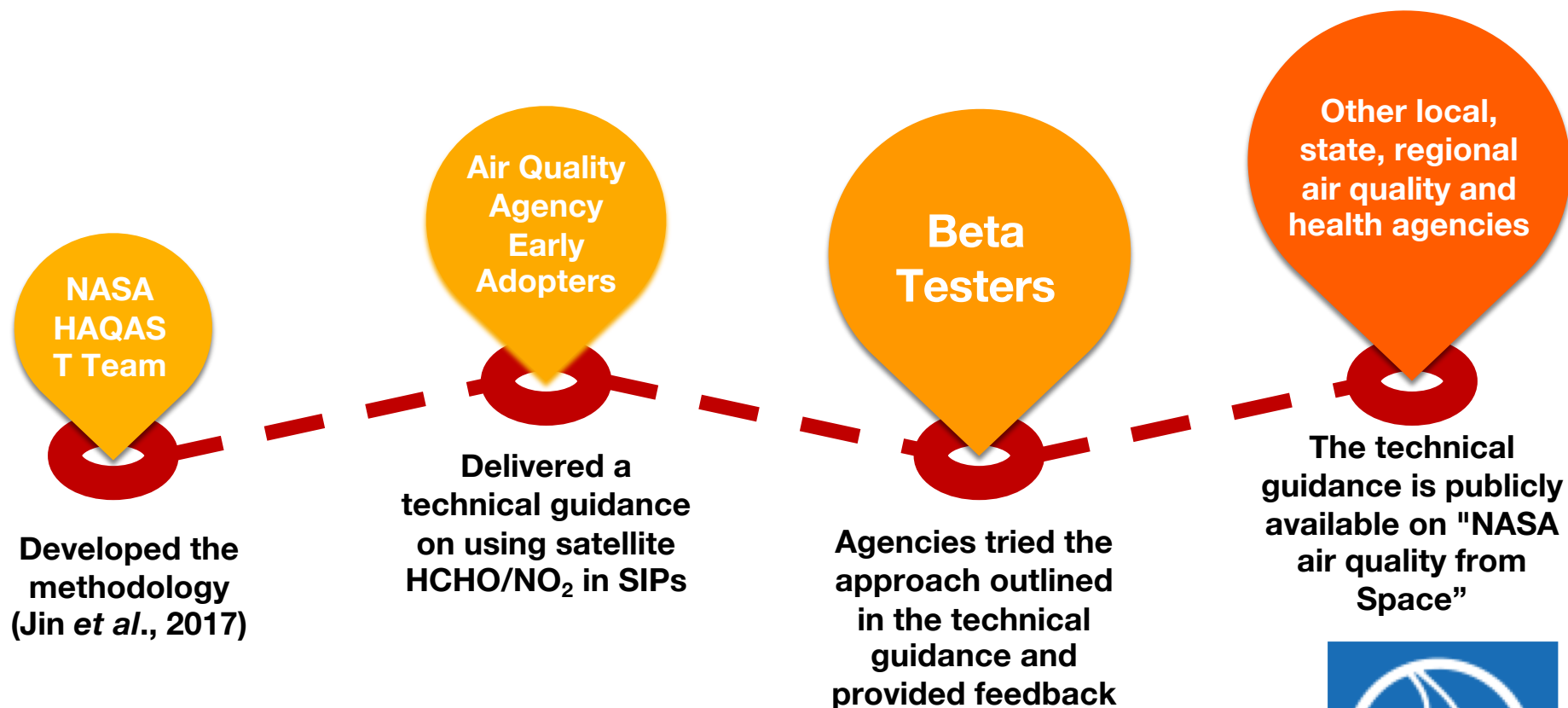
HAQASTers: Arlene Fiore (LDEO/Columbia), Bryan Duncan (NASA GSFC), Jessica Neu (NASA JPL), Daven Henze (University of Colorado – Boulder), Talat Odman and Ted Russell (Georgia Institute of Technology), Daniel Tong (George Mason University), Mark Zondlo (Princeton University), Jonathan Patz and Tracey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

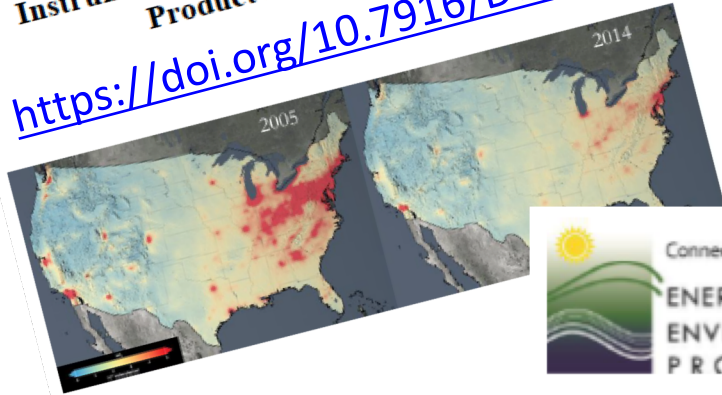
Tech. Guidance Doc: Using space-based HCHO/NO₂ as an indicator of O₃ sensitivity



Three Technical Guidance Documents Completed

A Brief Tutorial on Using the Ozone Monitoring Instrument (OMI) Nitrogen Dioxide (NO_2) Data Product for SIPs Preparation

<https://doi.org/10.7916/D80K3S3W>



Lead Author: Bryan N. Duncan (NASA)
Contributing Authors: Michael Geigert (CT DEEP)

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**



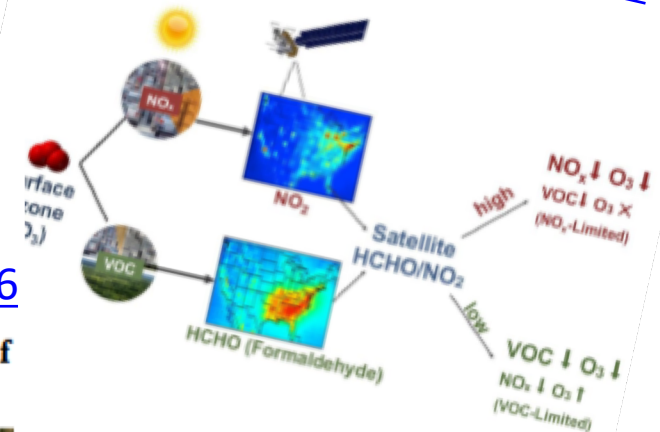
Michael Geigert

CTDEEP

March 2018

Using satellite observed formaldehyde (HCHO) and nitrogen dioxide (NO_2) as an indicator of ozone sensitivity in a SIP

<https://doi.org/10.7916/D8M34C7V>



: Xiaomeng Jin and Arlene Fiore (LDEO/Columbia)
Michael Geigert (CT DEEP)
Publication Date: June 12, 2018

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 (NO_x) 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>.

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ABOUT
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BROWSE DEPARTMENTS
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Links to these docs are now up on NASA's air quality from space website "Managers" tab



AQ Managers

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 NO_x 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!

One-page memos available for a quick overview



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 NO_x 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.

Based on a
suggestion from
Zac Adelman
(LADCO).

Thanks to
Daegan Miller for
drafting
this "team
overview" memo
+ one memo for
each technical
guidance doc



Technical Guidance Document

NASA Health and Air Quality Applied Sciences Team
2017–18 Tiger Team Project

Supporting the use of satellite data in State Implementation Plans

Comparison of CMAQ Simulation to Satellite Observations: NO₂ Column versus OMI NO₂

Prepared by:

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School of Civil & Environmental Engineering
Georgia Institute of Technology
311 Ferst Drive, Atlanta, GA 30332-0512

May 1, 2018

HAQAST members
Russell/Odman/Qin
developed a
Technical Guidance
Doc in review;
SCAQMD expressed
interest in beta-
testing

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Tech. Guidance Doc in prep: How can I incorporate satellite data into boundary conditions used by my regional model?



image credit: https://www.nasa.gov/mission_pages/aura/main/index.html

Artist's concept of the Aura spacecraft

Credits: NASA

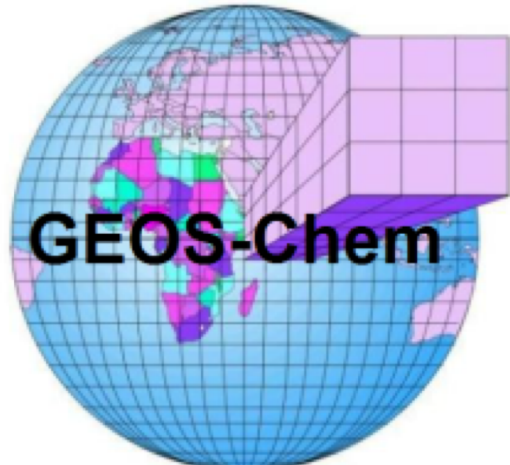


image credit: <http://acmg.seas.harvard.edu/geos/doc/man/>

HAQAST member Jessica Neu (NASA JPL) is generating boundary conditions for use by SCAQMD in their SIP modeling. BAAQMD also interested.

CMAQ predicted ozone for June 1, 2013

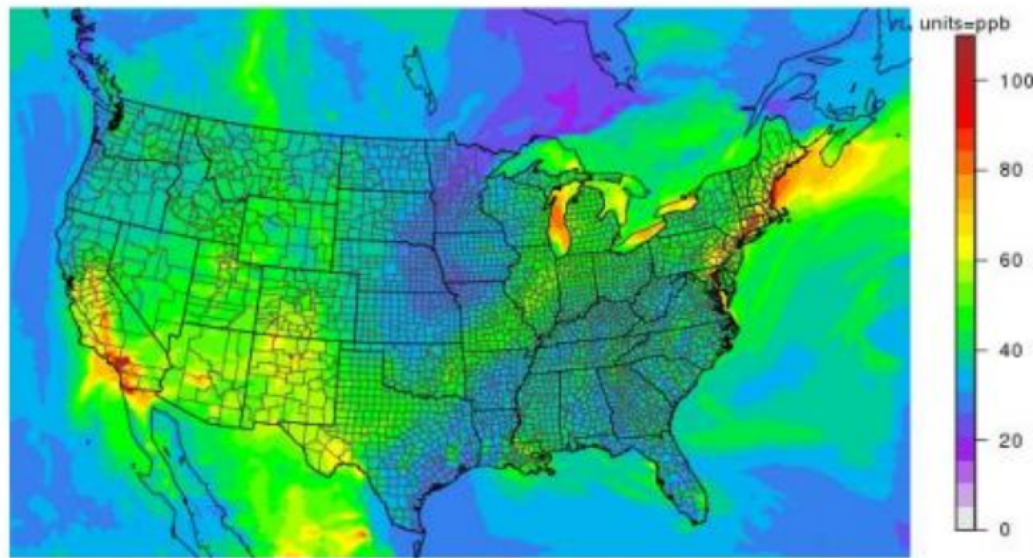
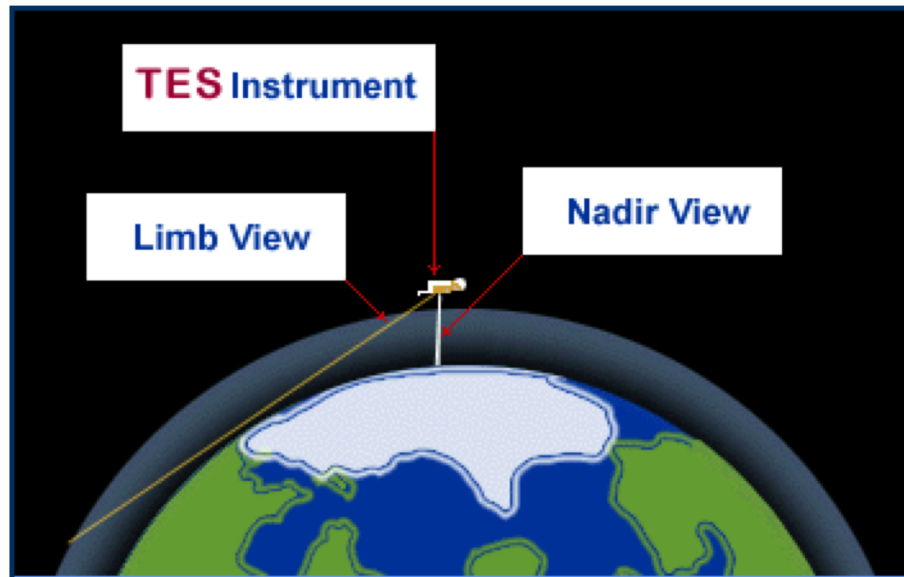


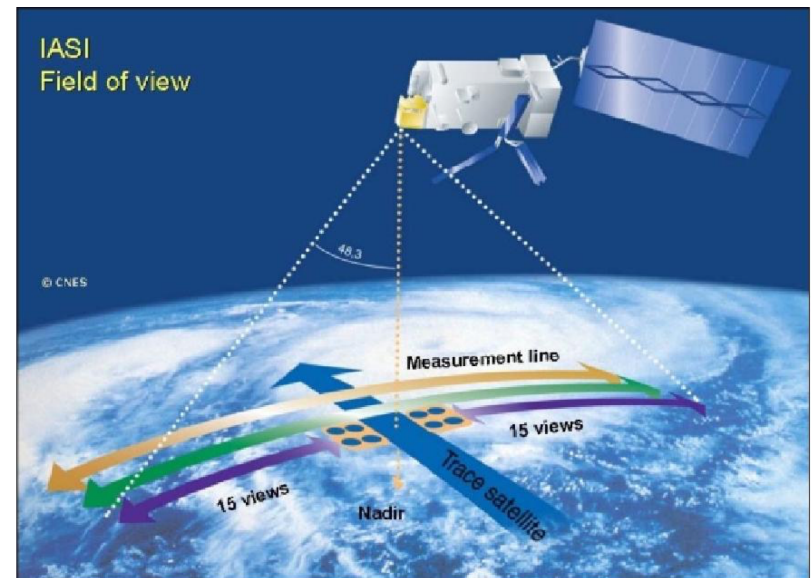
image credit: <https://www.epa.gov/cmaq/cmaq-models-0>

Responding to emerging needs: Satellite ammonia primer (Mark Zondlo, Princeton)

Instrument	Satellite	Day, equator crossing time (local)	Pixel size at nadir (km ²)	NH ₃ data availability	Product	Spectral Resolution (cm ⁻¹)	Noise (K)	Swath width (km)	# pixels across swath	Data accessible to public
IASI	MetOp-A	9:30	12 × 12	2007-present	column	0.5	0.17	2200	60	Y
	MetOp-B	8:45	12 × 12	2013-present	column	0.5	0.17	2200	60	Y
CrIS	S-NPP	13:30	14 × 14	2014-present	profile	0.625	0.04	2200	90	late 2018
TES	Aura	13:30	5.3 × 8.5	2004-2015	profile	0.1	0.15	5.3	1	Y
AIRS	Aqua	13:30	13.5 × 13.5	2002-present	profile	0.5	0.2	1650	90	TBD

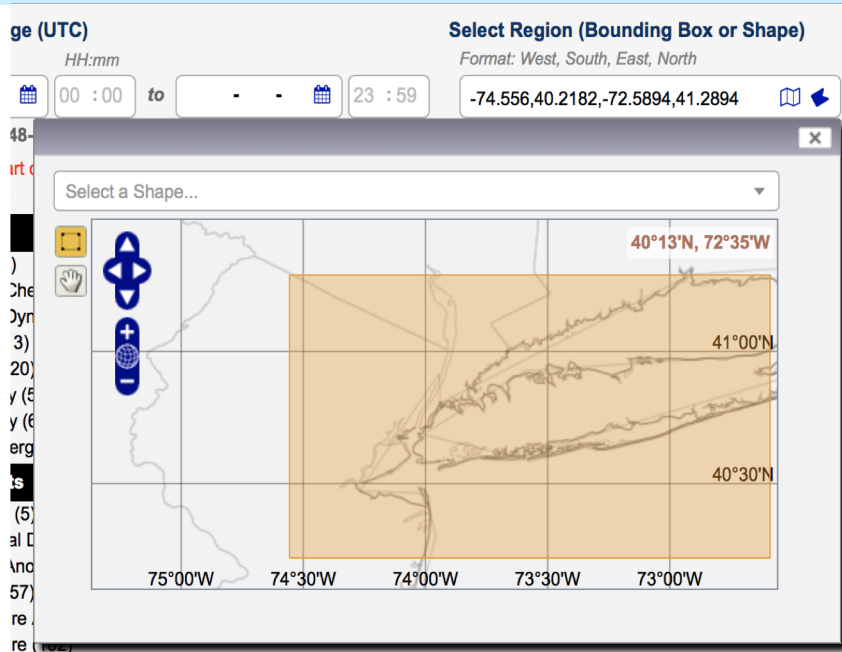


Credit: NASA



Credit: CNES

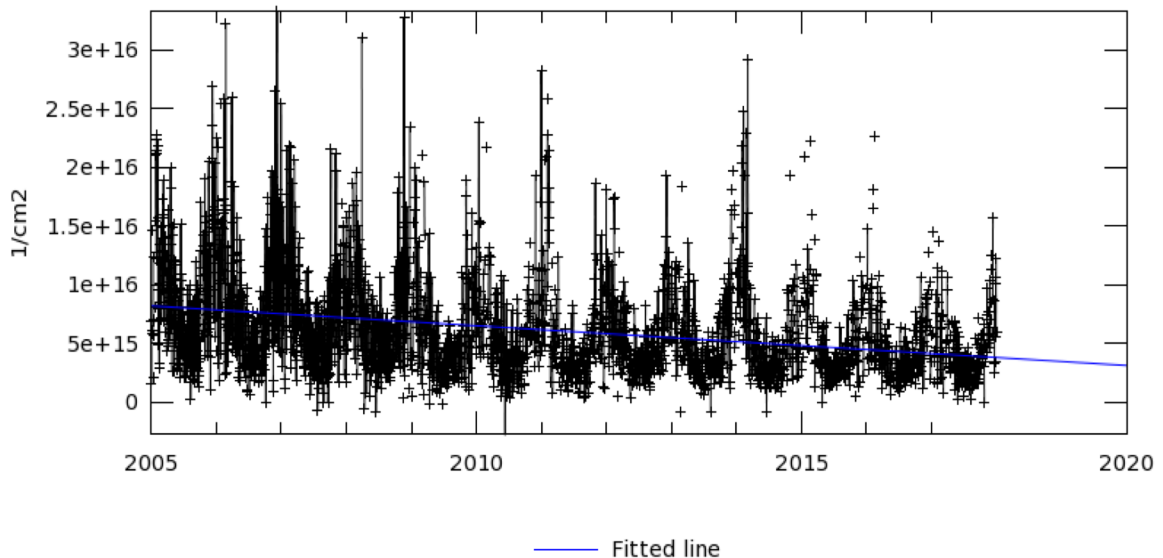
Responding to emerging needs: “How-to” for city-specific NO₂ trends from NASA Giovanni



HAQAST member Daniel Tong is developing a “How-to” create a long-term NO₂ time series over your city, directly from the NASA Giovanni website (<https://giovanni.gsfc.nasa.gov>)

Time Series, Area-Averaged of NO₂ Tropospheric Column (30% Cloud Screened) daily 0.25 deg. [OMI OMNO2d v003] 1/cm² over 2005-01-01 - 2017-12-31, Region 74.556W, 40.2182N, 72.5894W, 41.2894N

**This short tutorial
steps through an
example for NYC
metro area**



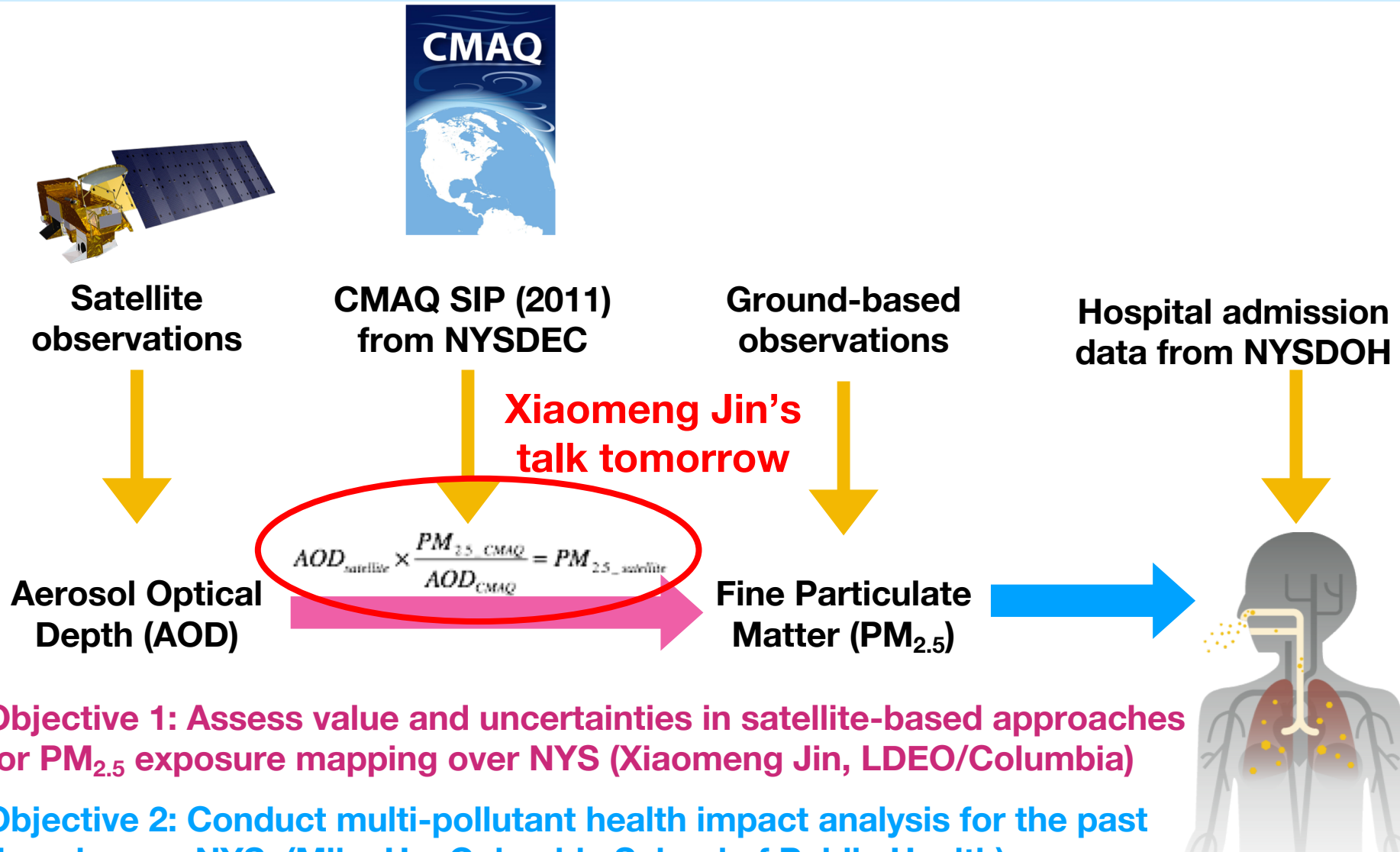
Deliverables for HAQAST “Satellite Data in SIPs” TT

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 NO₂ 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 NO₂ trends; LISTOS field campaign
→ **summary notes from phone meetings available on team website**

<https://blog.ideo.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 $PM_{2.5}$ 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>.