Using Satellites, Ground Observations & Models to Inform Air Quality and Health Analyses

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Feature

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"What We Breathe Impacts Our Health: Improving Understanding of the Link between Air Pollution and Health"

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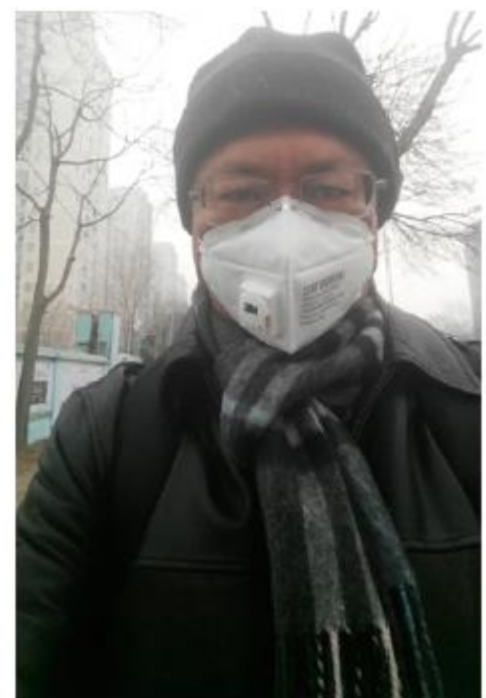
- Air pollution is underappreciated for global health.
- Air pollution and its health impacts are changing globally, and will change in ways interrelated with climate change.
- Air pollution science offers new possibilities: new measurement methods measuring more chemical components, cheap sensors that can be widely deployed, satellites, and models.
- There is a need for the communities of air pollution science and air pollution health effects science to work together better.



HAQAST

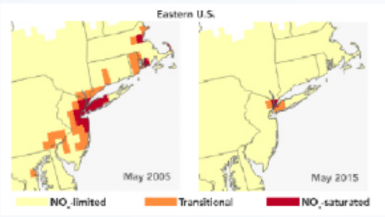
NASA Health & Air Quality Applied Sciences Team

State Implementation Plans

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

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)"

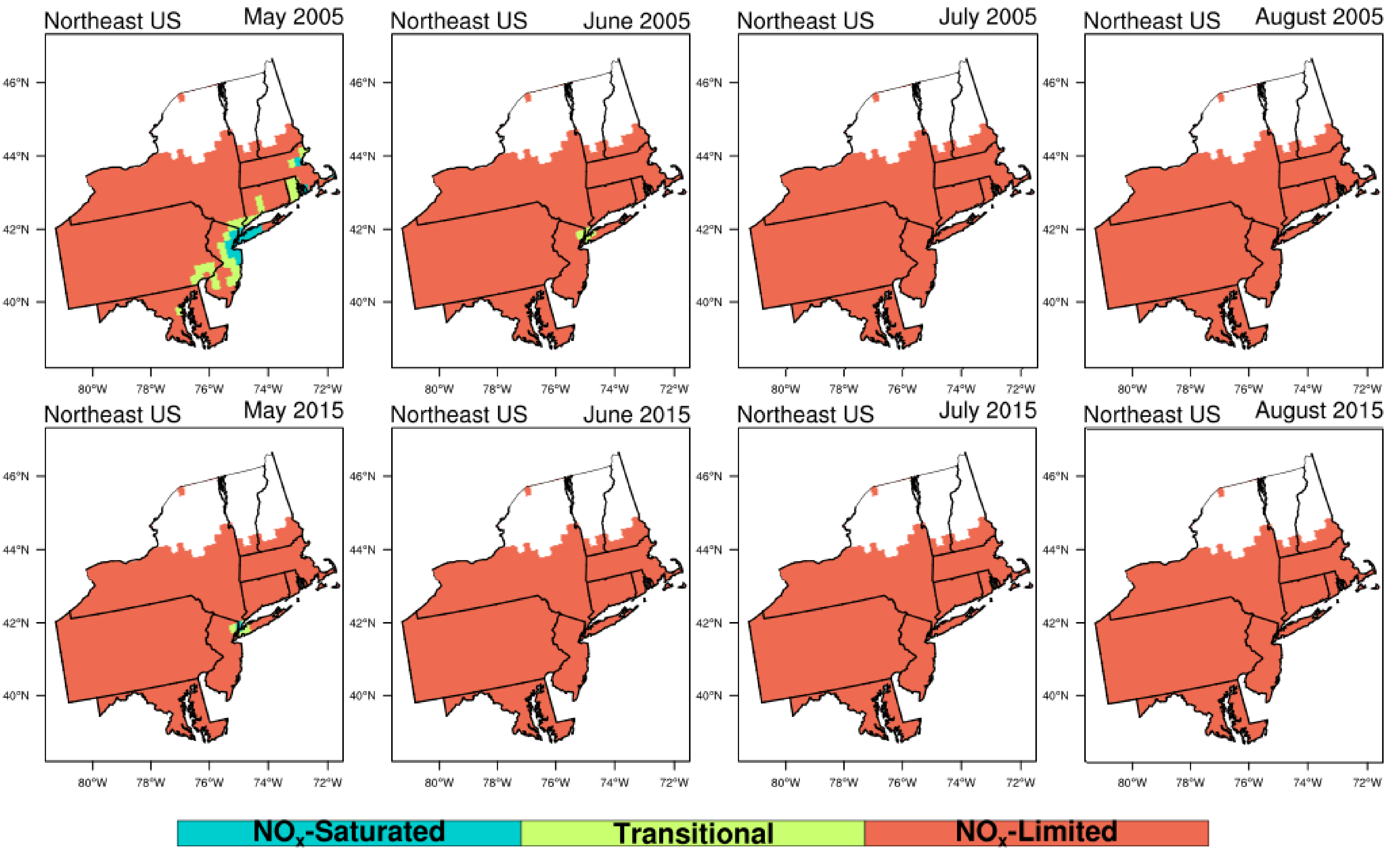
What, specifically, can NASA help me with? Our team has developed three guidance documents:



The change in the sensitivity of O_3 formation from 2005 to 2015 as inferred from Aura OMI HCHO and NO_2 data. This figure is based on the work of Jin et al. (2017). Figure credit: NASA.

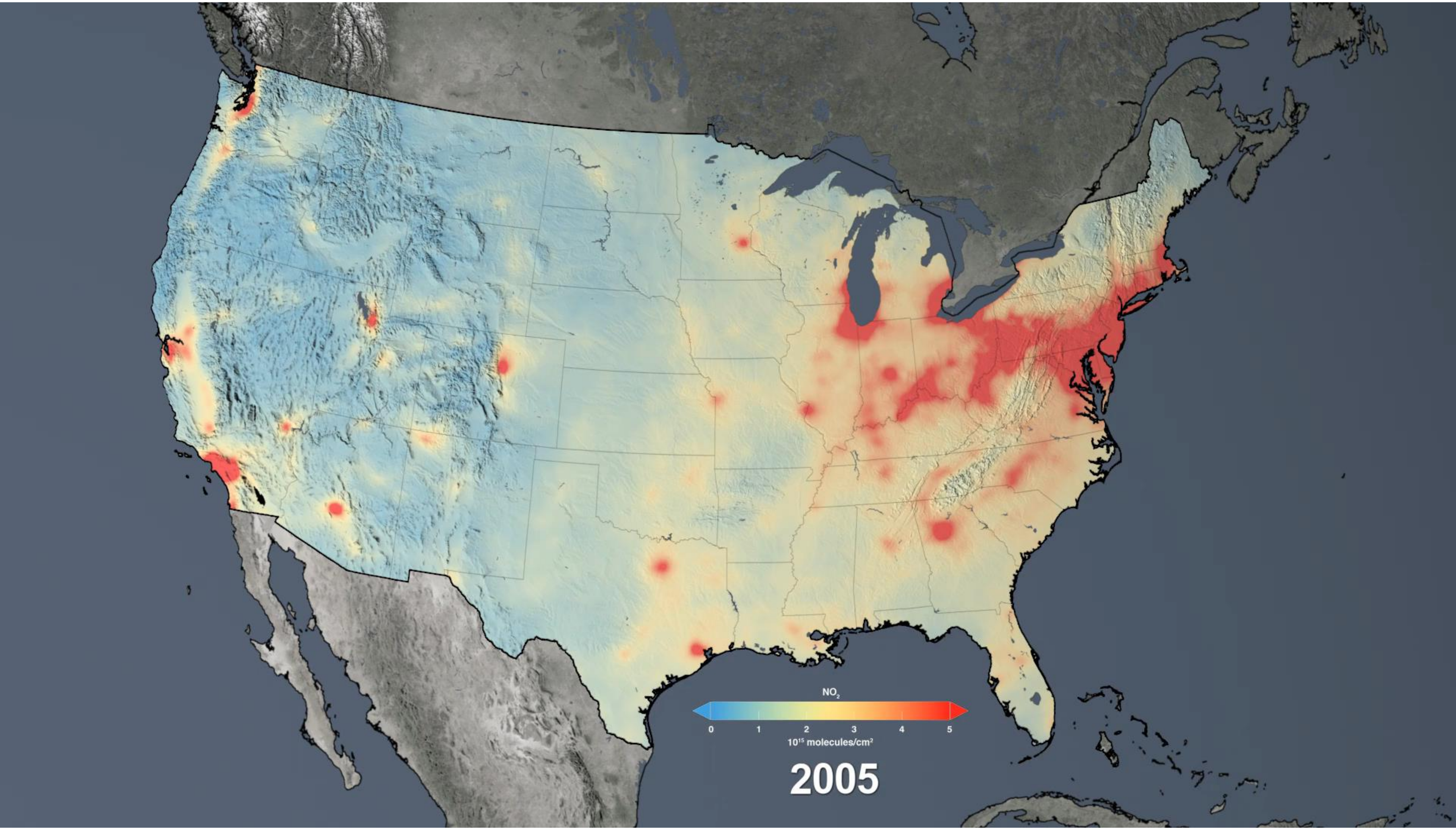
- **Using satellite observed formaldehyde (HCHO) and nitrogen dioxide (NO_2) as an indicator of ozone sensitivity in a SIP:** Although State Implementation Plans (SIPs) typically rely on observations from ground-based networks and regulatory models, satellite data is increasingly available to state agencies 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 (NO_2) 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.
- **A Brief Tutorial on Using the Ozone Monitoring Instrument (OMI) Nitrogen Dioxide (NO_2) Data Product for SIP Preparation**: Although State Implementation Plans (SIPs) typically rely on observations from ground-level monitoring networks and regulatory modeling, satellite data is increasingly available to state agencies. Below is an example of how one state agency used satellite data to supplement a state implementation plan 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 nitrogen dioxide (NO_2), a precursor to ground-level ozone and nitrate aerosol, in state implementation plans. It also provides some guidance on using SO_2, a precursor to sulfate aerosol.
- **Guide to Using Satellite Images in Support of Exceptional Event Demonstrations:** The Exceptional Events Rule, contained in Title 40 of the Code of Federal Regulations Part 50.14 (40CFR50.14), was revised by EPA in October of 2016. Although many elements go into the technical

$HCHO/NO_2$ from OMI



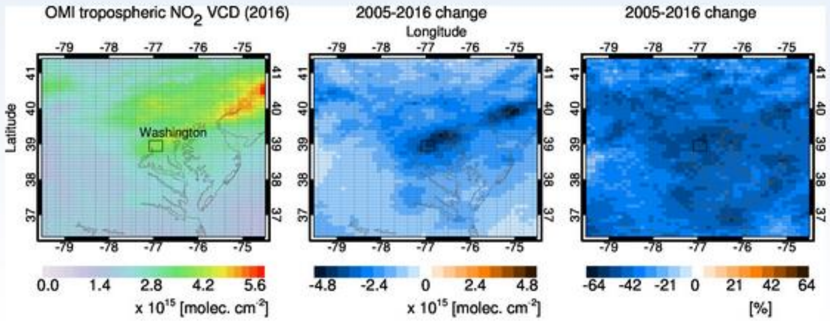
Jin, Fiore et al.

OMI NO_2 Trends



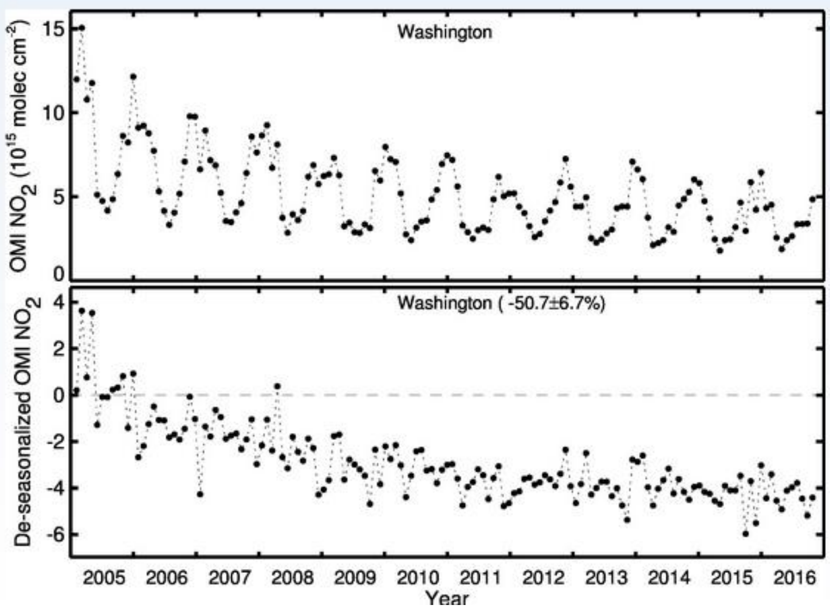
Washington D.C.

Change in NO_2: -50.72
2016 Avg. NO_2: 8.65 (1e15 molec cm²)



Washington D.C. Trend Map

OMI versus AQS data for Washington D.C.. The filled circles represent trends for EPA AQS surface monitors.



Washington D.C. Line Plot

Monthly OMI Nitrogen Dioxide data (top panel) and de-seasonalized data (bottom panel) for Washington D.C.

Exceptional Event Demonstration

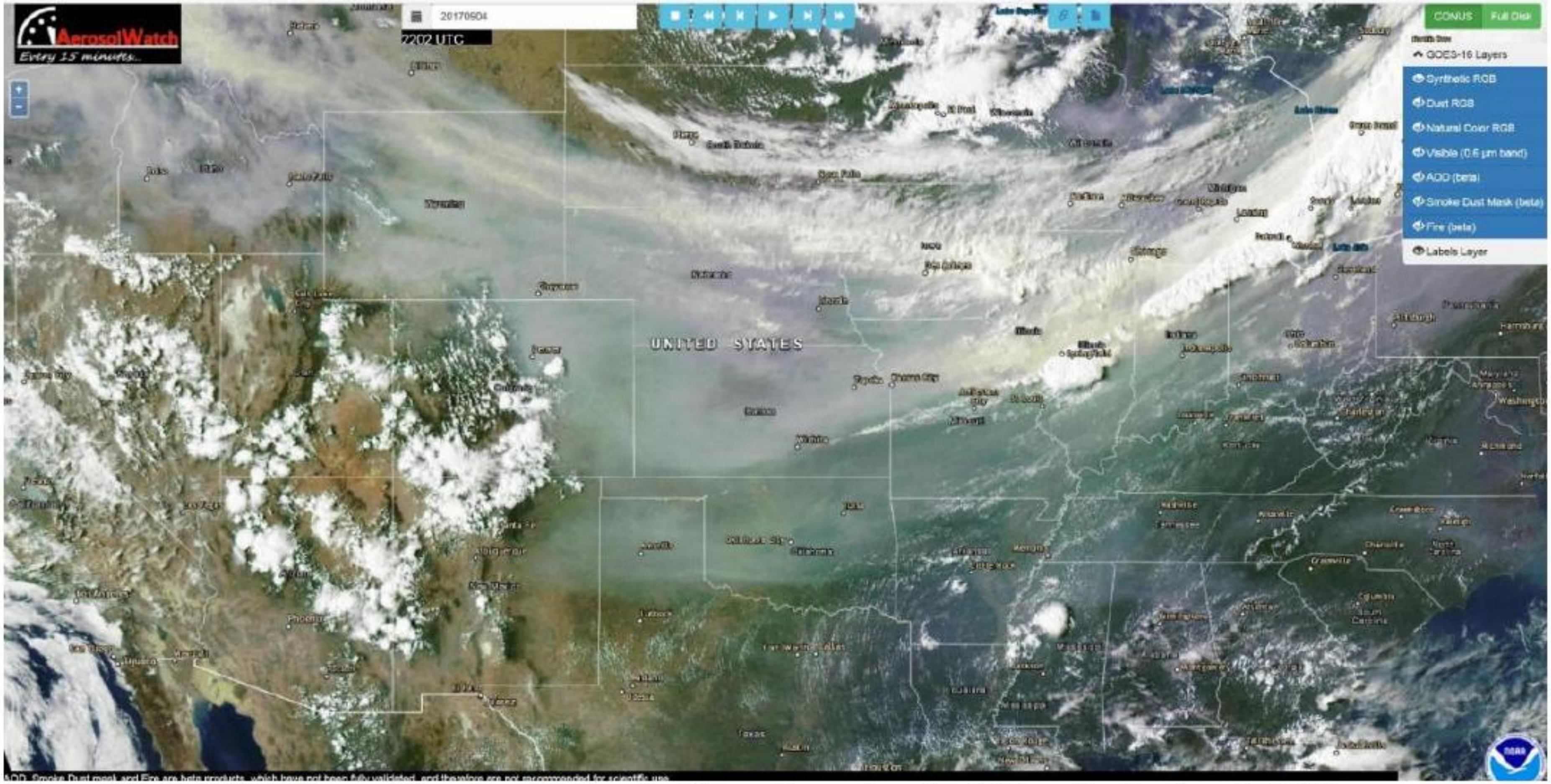
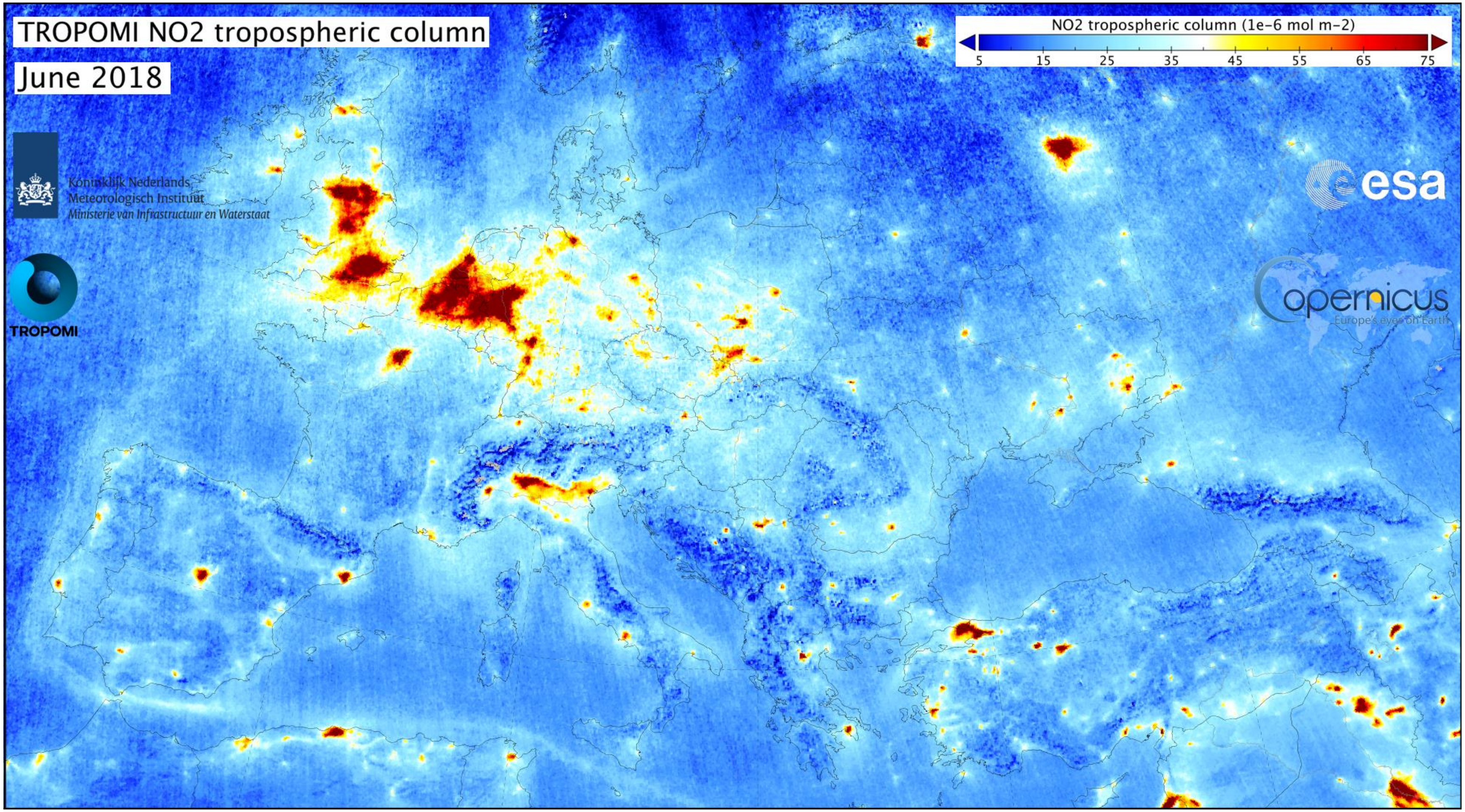


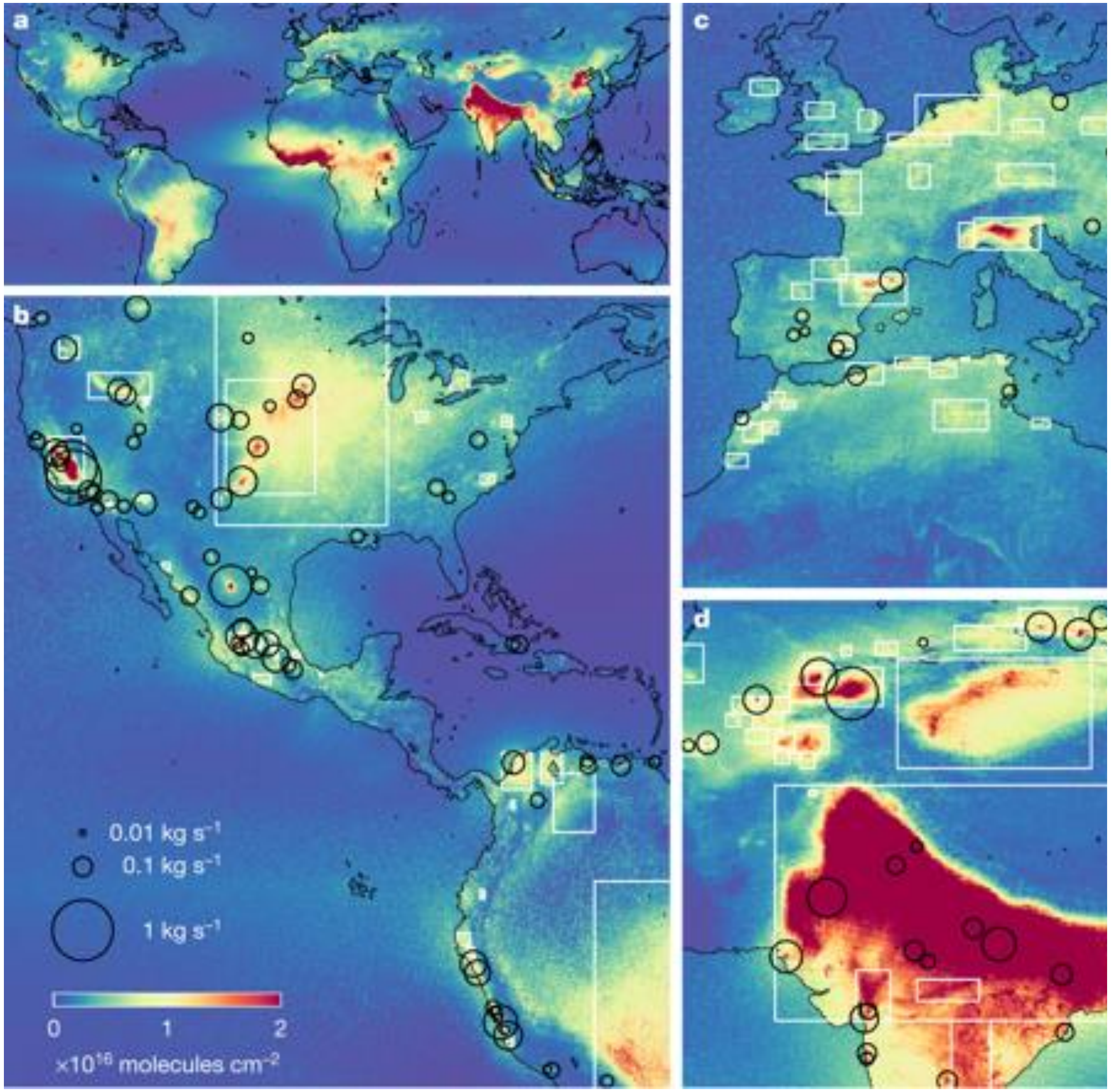
Figure 17. GOES-16 Image Showing the Smoke Plume Spanning the U.S on September 4, 2017

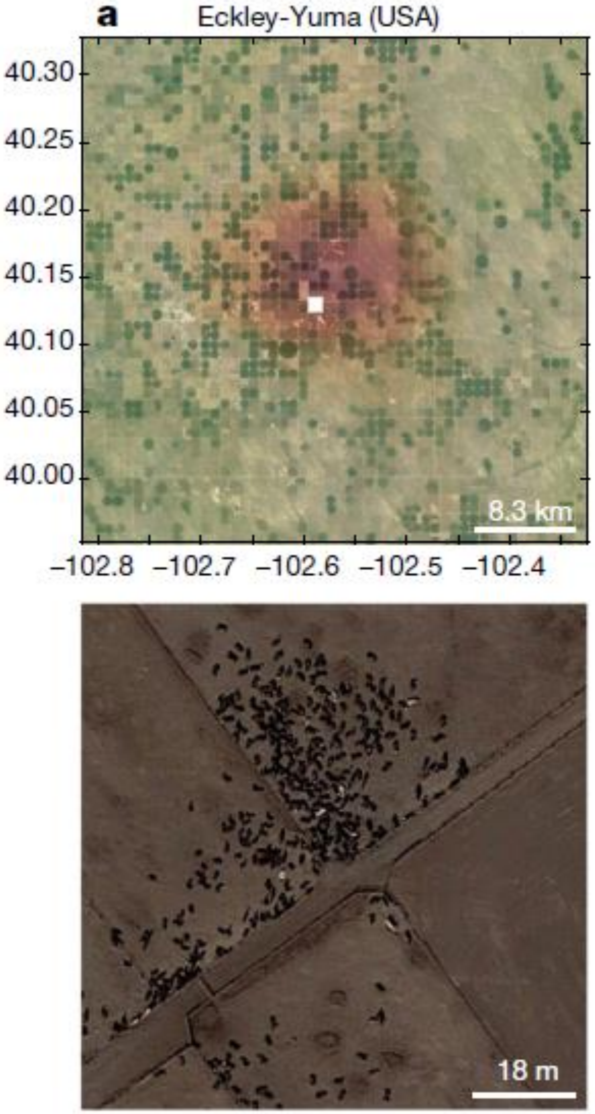
Geigert, 2018

TROPOMI High-Resolution NO_2



Identifying Ammonia Sources

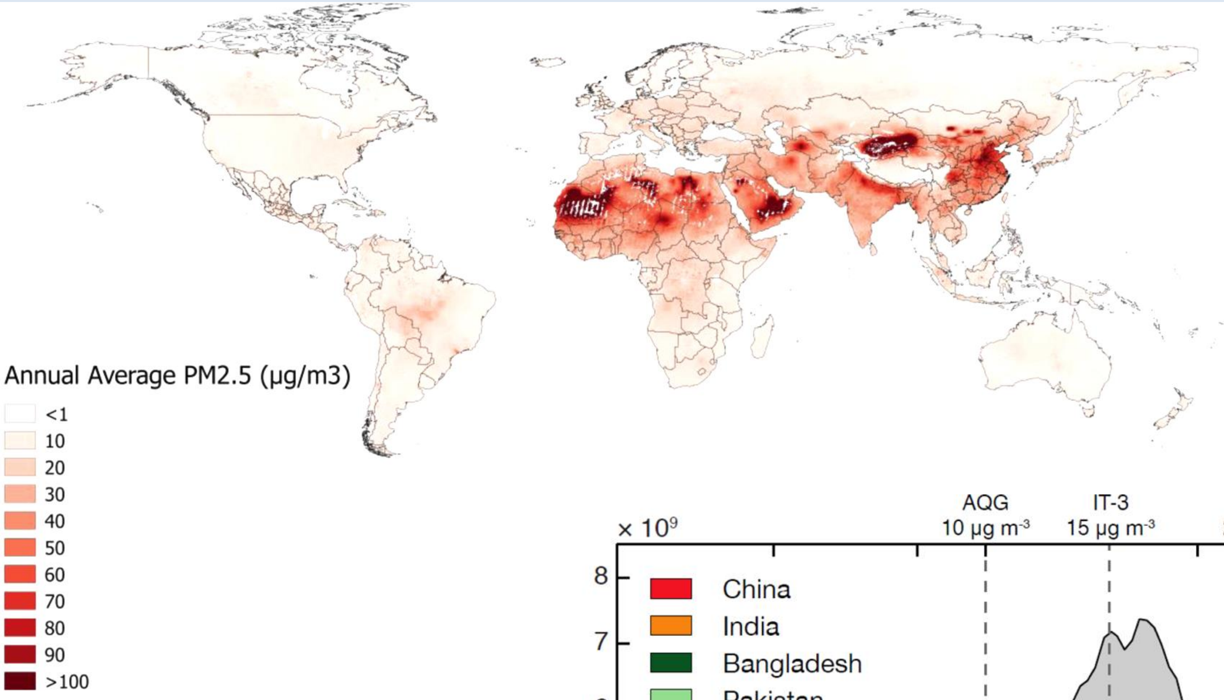


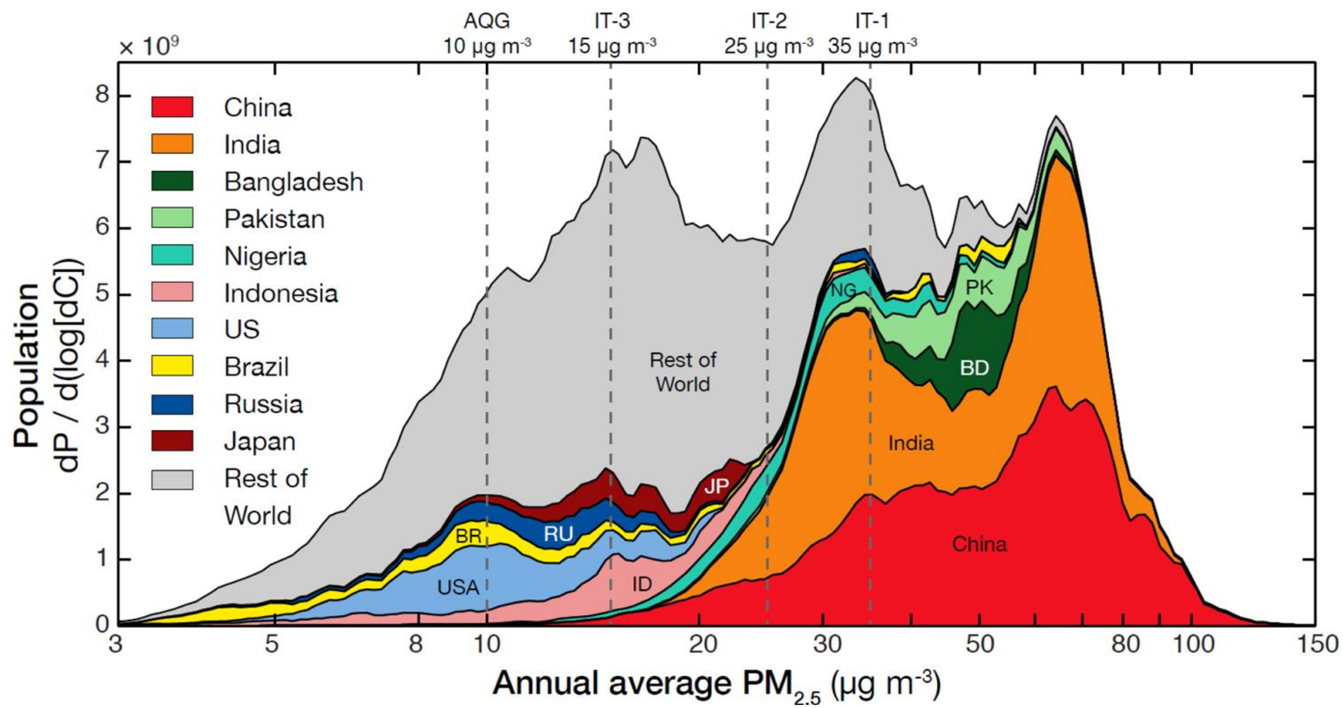


Cattle feedlot

Van Damme et al. (2018)

Mapping Global Surface $PM_{2.5}$ Concentrations

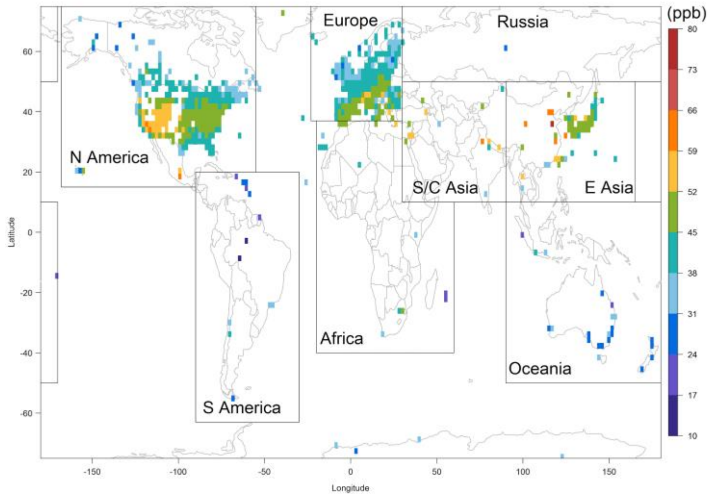




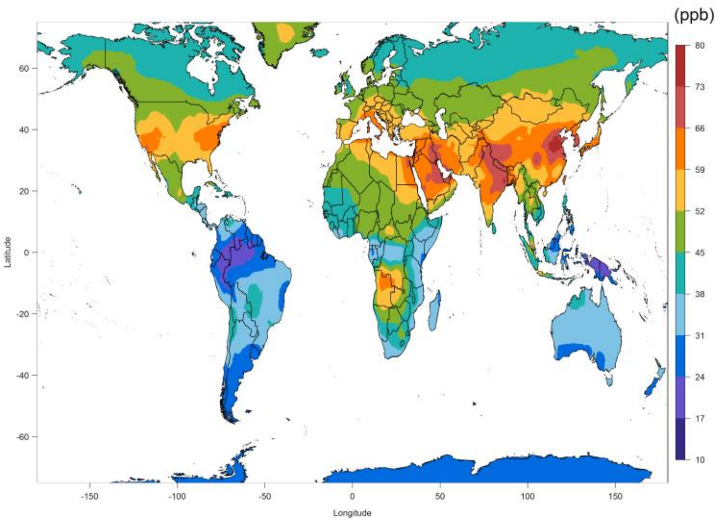
Brauer et al. (2016)

Mapping Global Surface Ozone Concentrations

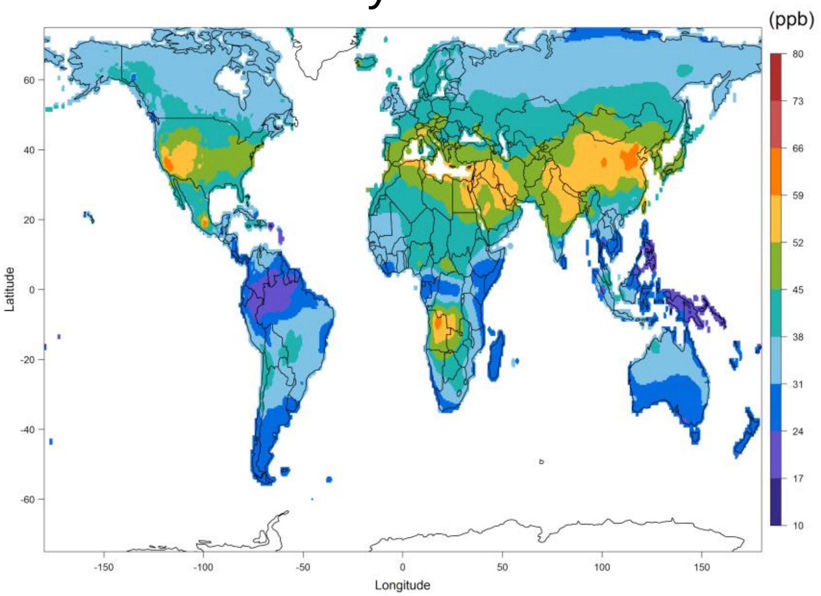
TOAR
tropospheric ozone assessment report



ccmi
chemistry-climate model initiative

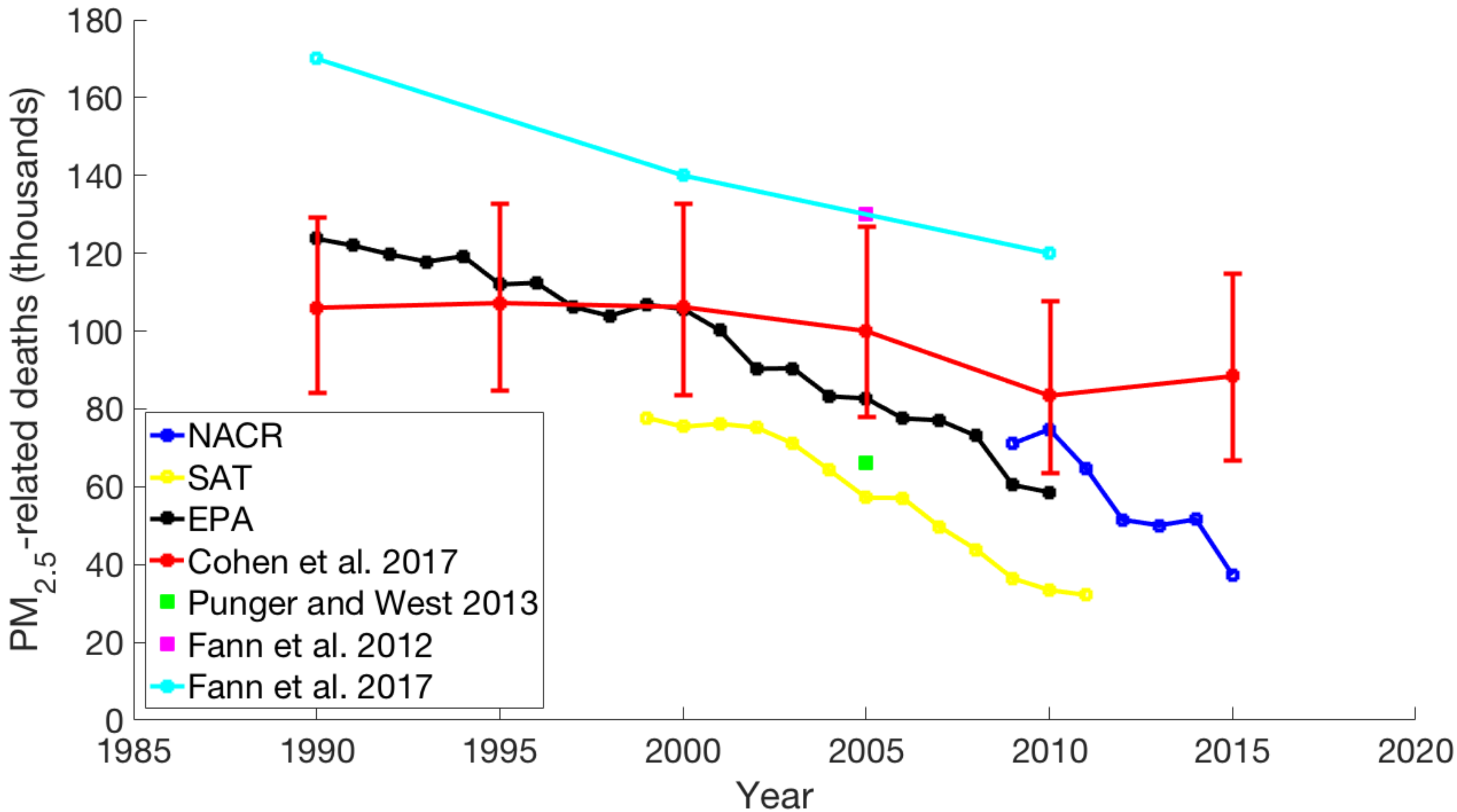


Fused ozone surface concentration used by GBD 2017



Chang et al. (GMD, 2019)

$PM_{2.5}$-Related Deaths in the US



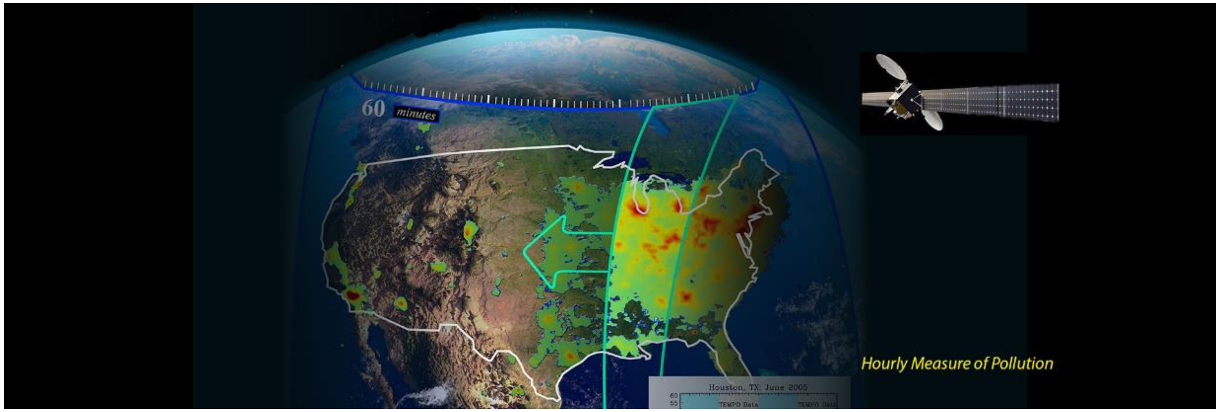
Zhang et al. (2018, ACP); Nawaz et al. (in prep.)

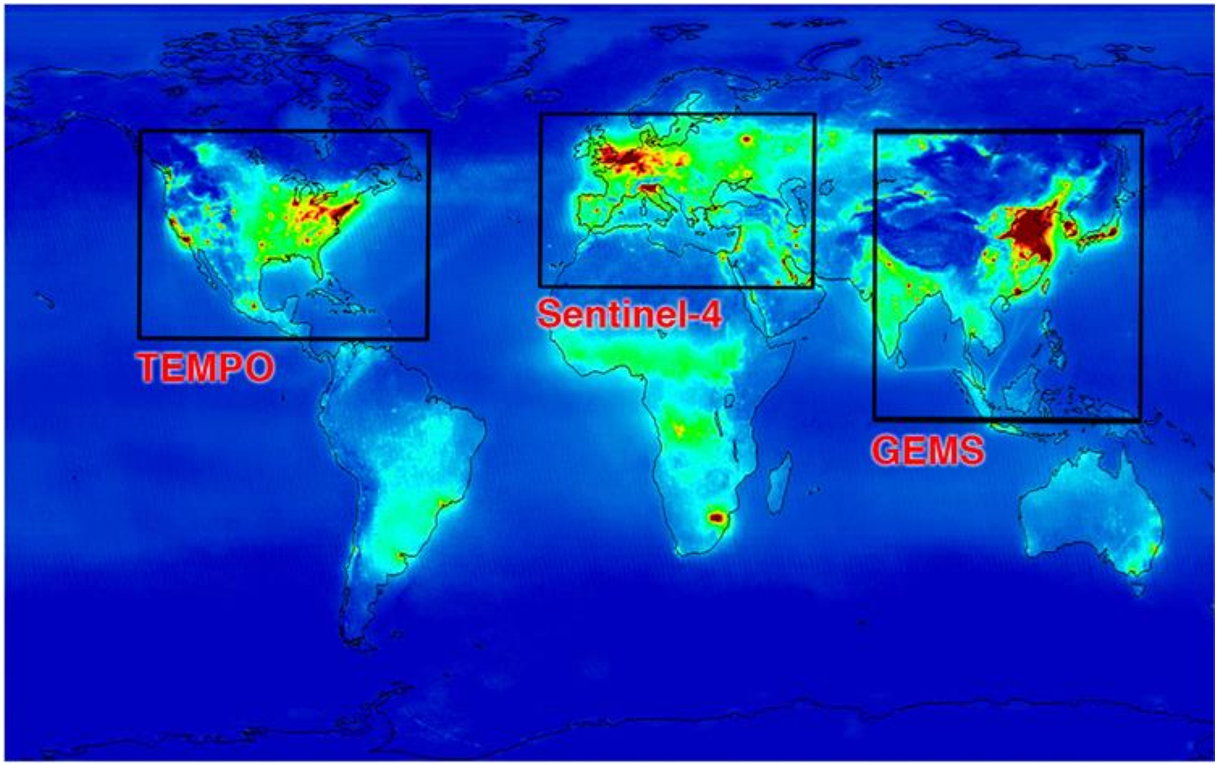
TEMPO Satellite-

Geostationary

Hourly, ~1km resolution

Launching 2019?





MAIA

- Launch 2022?
- Focus PM in Megacities
- Los Angeles, Atlanta and Boston are primary target areas