

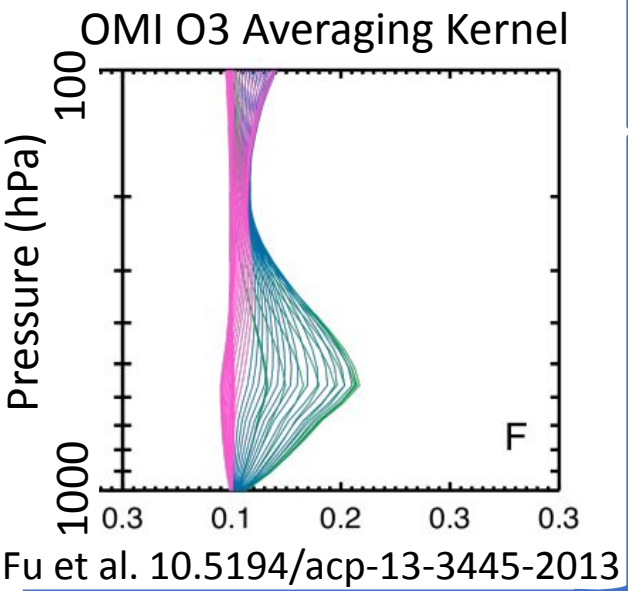
GeoXO AC Town Hall Panel: Current and Future Applications of Satellite Data

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US EPA Office of Air Quality Planning and Standards
2021-04-29

Thanks to the OAQPS Satellite Forum group and others for contributions to the content!

Disclaimer: Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.

How does EPA use satellite data regularly?



Often not directly interpretable as surface

- Most often total column measurement with low sensitivity to the surface for some species.
- Requires model “priors” and “kernels” or “assimilation” for interpretation to ground level.

Meteorological Model Inputs

- Land use/Land Cover, Digital Elevation Maps
- GHR Sea Surface Temperatures
- Data assimilation (e.g, GEOS, CAMS, GDAS, WRF)

Emissions Inputs

- e.g., MEGAN, FINN, GFED, BlueSky
- Fire detection, land area burned

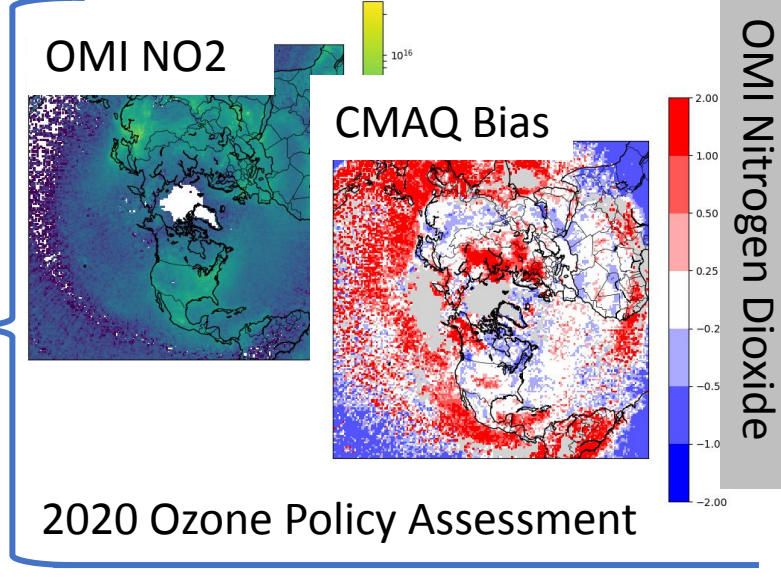
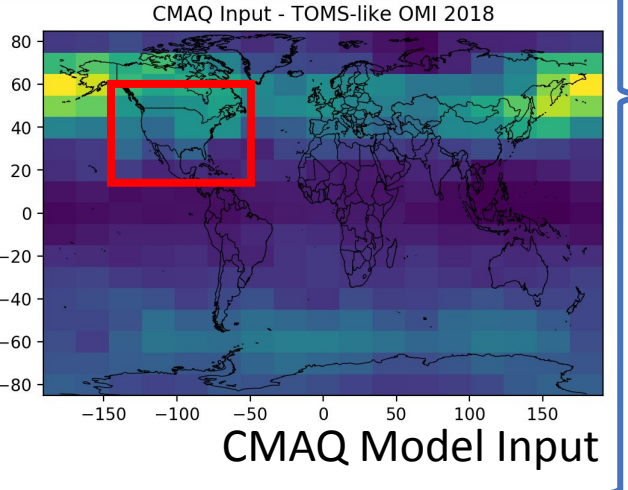
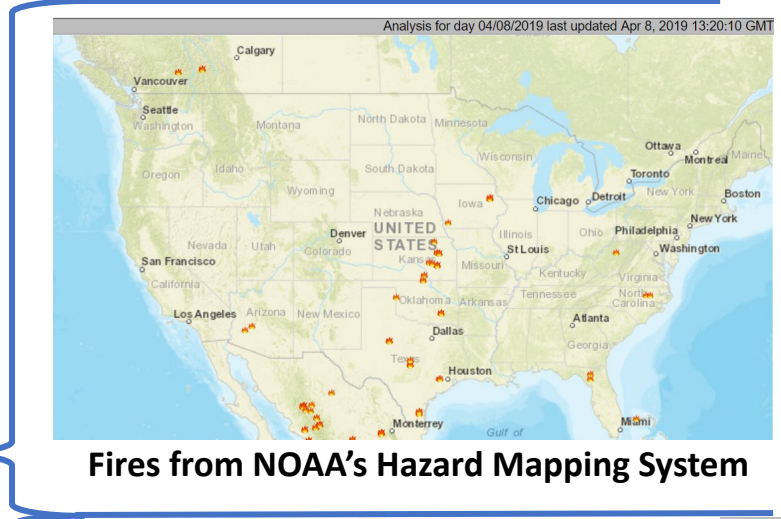
Air Quality Model Inputs

- Land use/Land Cover, Digital Elevation Maps
- **Daily coarse** TOMS/OMI Ozone to adjust j-values
- Other existing products, new products?

Air Quality Model or Emissions Evaluation*

- OMI Nitrogen Dioxide Tropospheric Columns
- OMI Ozone Tropospheric Columns
- OMI Formaldehyde Columns
- MODIS Aerosol Optical Depth
- CRIS Ammonia

Moving towards assimilation!*



*More detail on next slides

Evaluation for surface concentration estimates (increasing use)

Model evaluation*

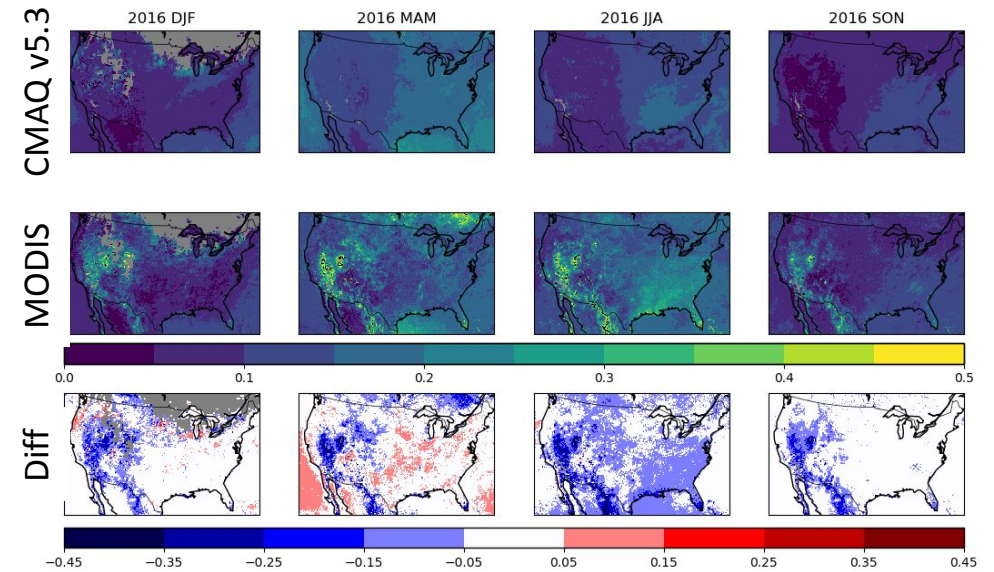
- Provide qualitative or quantitative constraints.
- Often indirect: total columns as surrogate for surface

Emissions Quality Assurance

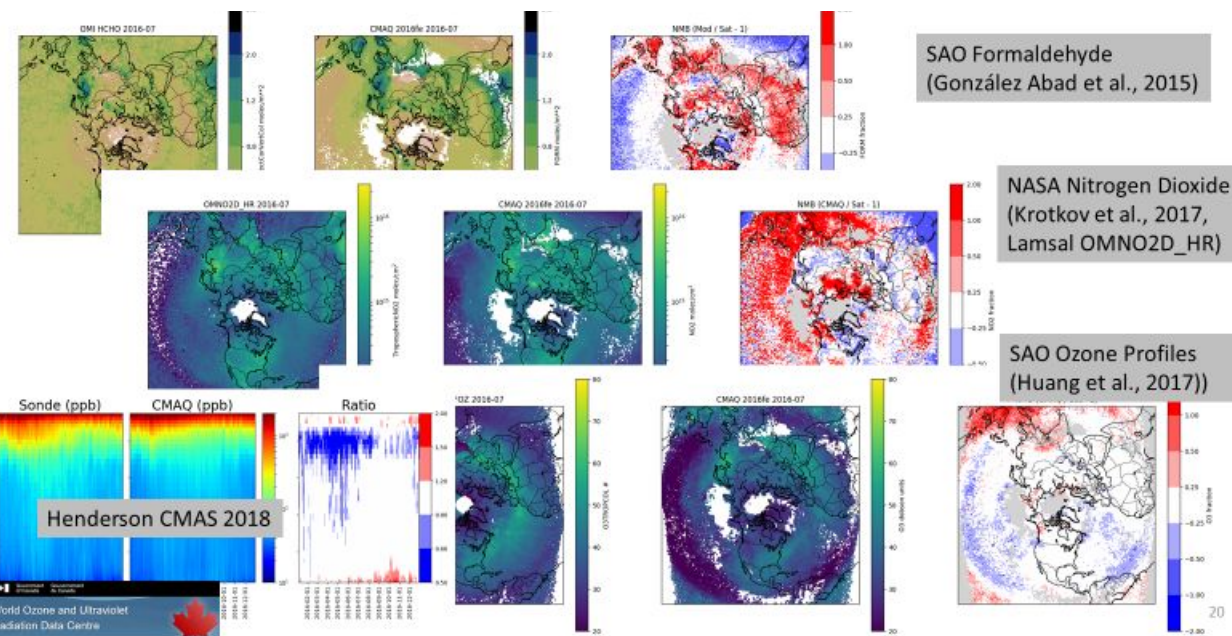
- NO2 and SO2 top-down constraint techniques are available
- Useful for evaluating current inventories even if not directly applied
- Many emissions have a diel profile

Model processes and performance varies by time of day and at fine spatial scales that benefit from geostationary.

*Aerosol Optical Depth



*Gases: NO2, O3, HCHO



JGR Atmospheres

Research Article | Full Access

Satellite Formaldehyde to Support Model Evaluation

Monica Harkey, Tracey Holloway, Eliot J. Kim, Kirk R. Baker, Barron Henderson

First published: 24 December 2020 | <https://doi.org/10.1029/2020JD032881>



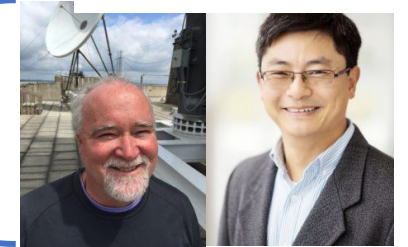
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Recent Webinar on Chemical Assimilation helping EPA toward routine application



- Motivated by Health and Air Quality Applied Science Team (HAQAST) project with Brad Pierce and Daniel Tong
 - Tiger Team project included technology transfer.
 - Research fellow James East implementing at EPA
- Assimilation experts from NASA and Academia advised on:
 - Numerical assimilation frameworks that can improve air quality predictions
 - Practical applications relevant to criteria pollutants and associated uncertainties
 - Ongoing research needs for satellite validation and retrieval improvements
- Huge success! Great panelists! Great attendance!



Chairs:

Barron H. Henderson
Bryan N. Duncan

Panelists:

Ron C. Cohen
R. Bradley Pierce
Kazuyuki Miyazaki
Zhen Qu

Attendees:

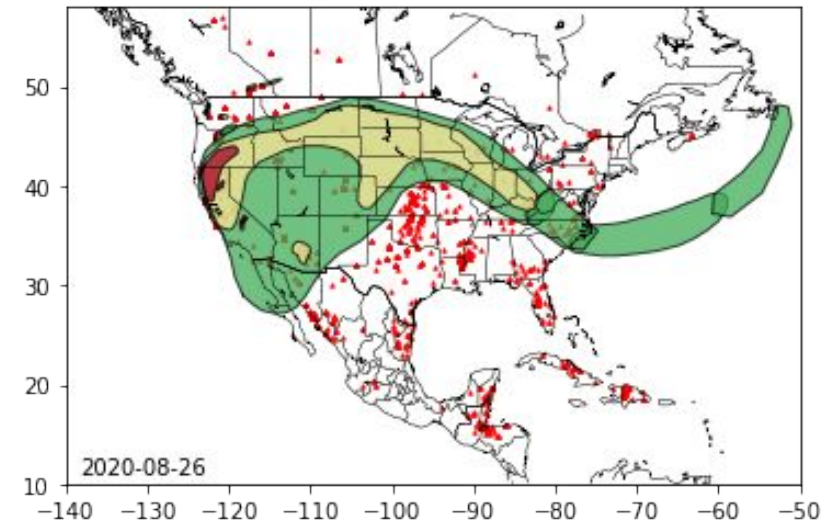
112 around the world

Use of satellites in Exceptional Event Demonstrations

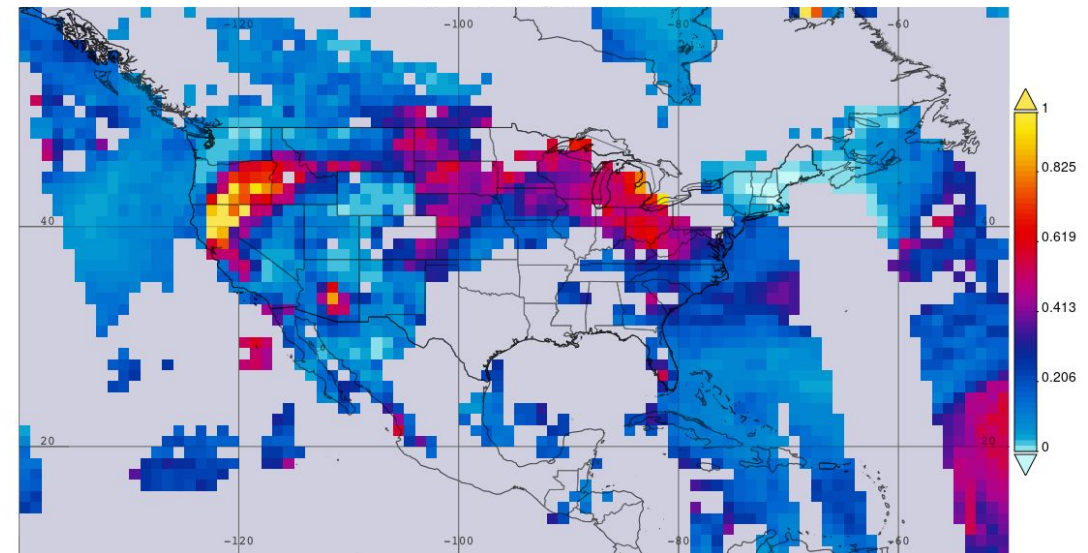
- Satellite data are used routinely as part of, and to evaluate, exceptional event demonstrations, e.g. to show influence of wildfires or stratospheric intrusions on local ambient air quality
- Characterization of individual events would benefit greatly from more spatially and temporally continuous tracking via satellite tools
- Increased availability of products providing vertical information linking satellite data to surface concentrations (e.g. ground based lidar, ceilometers) would also support our ability to attribute changes in surface concentrations to specific events

(Processed with NASA's Giovanni interface)

Data from NOAA HMS Smoke Product



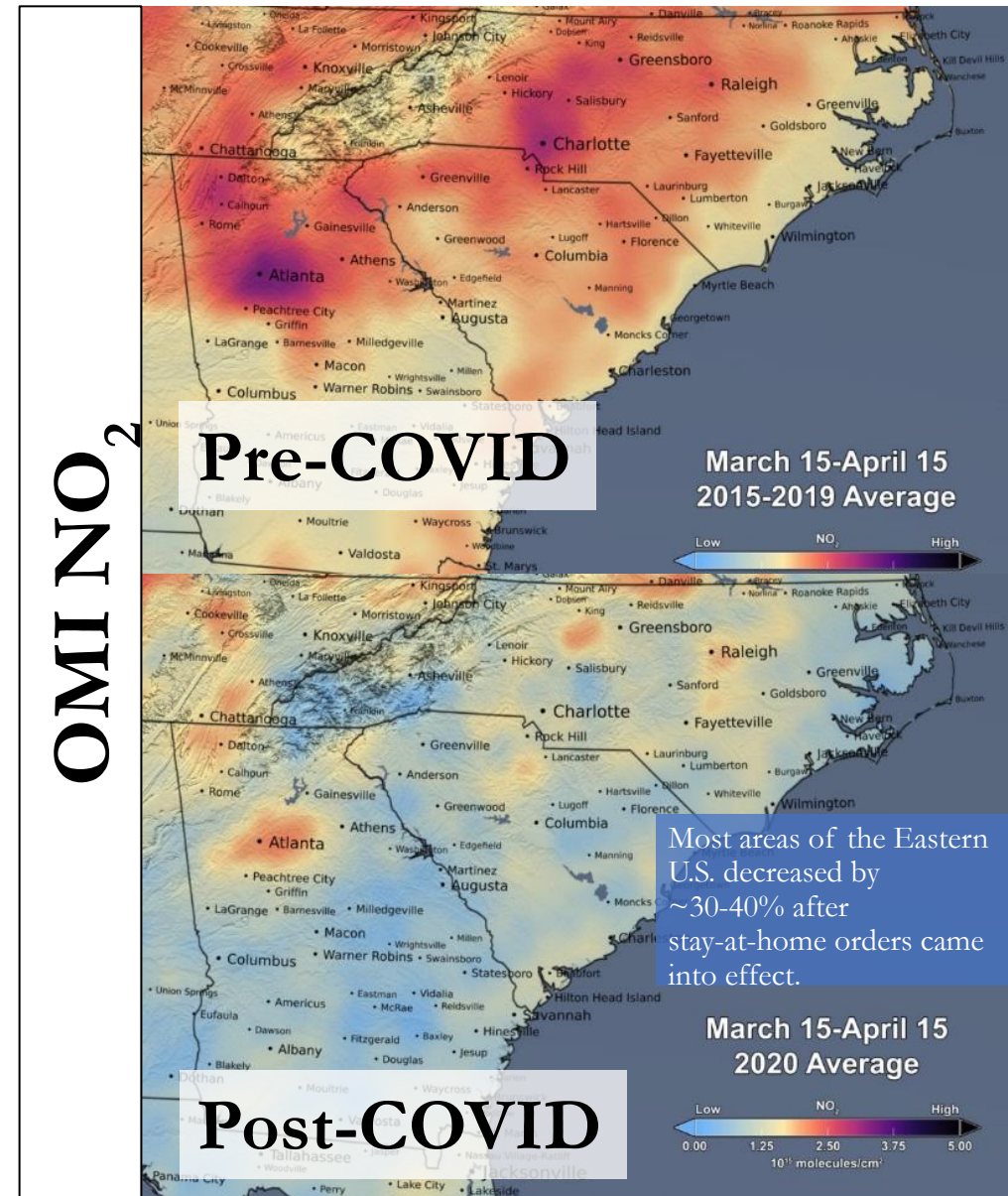
Aqua MODIS AOD Level 3 for 8/26/20



Policy-relevant modeling opportunities for satellite incorporation

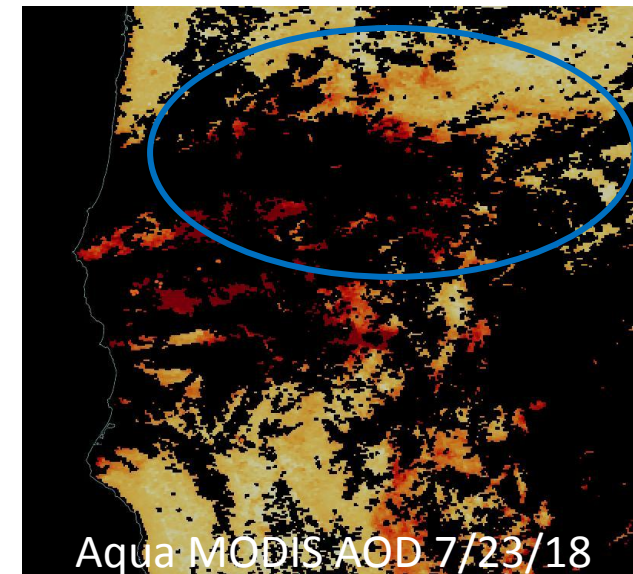
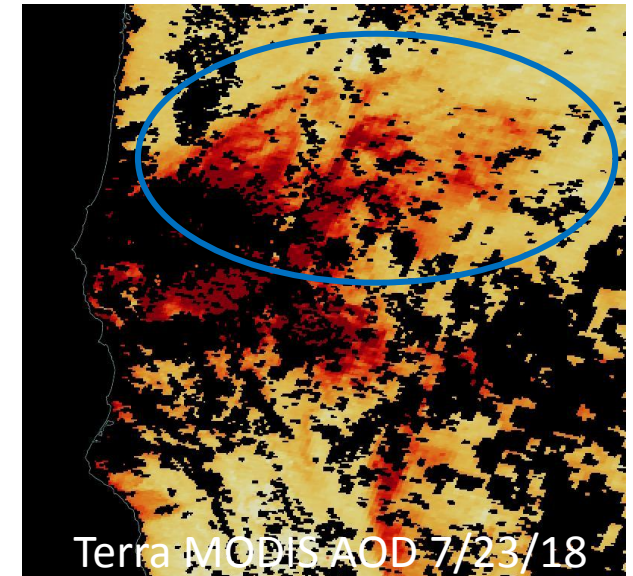
NASA OMI Team

- Regional modeling is dependent on global “boundary conditions”
 - Inter-continental anthropogenic transport and natural emissions largely contribute to what enters our model and is not the focus of controls.
 - International inventories are often updated less frequently or are a challenge to integrate into our platform
- Emission Inventory Development
 - Quality assurance by evaluation and comparison
 - Temporal and spatial variation
 - Existence or absence of “hotspots” or Regional outliers
 - Constraints on uncertain sources (NO_x/VOC, but aerosol precursors)
 - Wildland fires, Soil NO_x
 - International Emissions, Area sources
- Rapid changes like COVID
 - What level of constraints can the satellite apply?
 - Urban vs rural areas?



Possibilities with geostationary satellite information

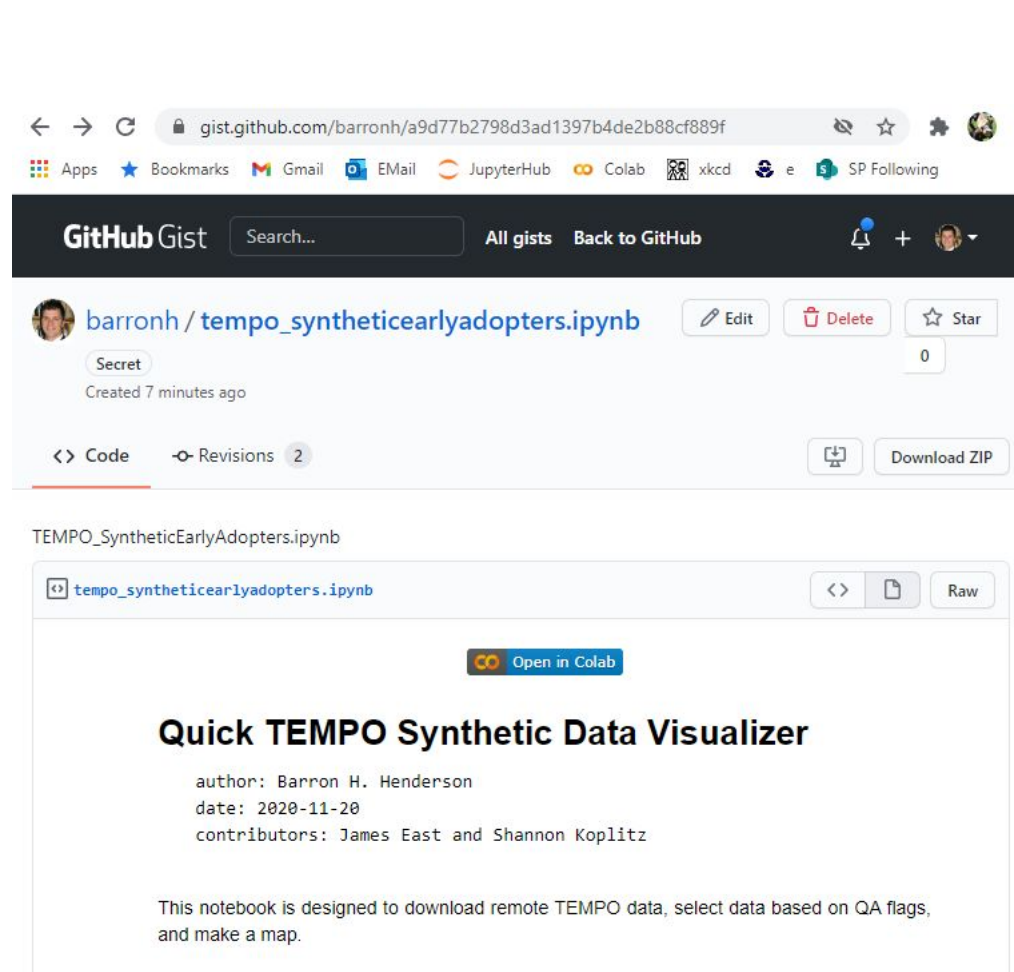
- More complete coverage of episodic events – e.g. wildfire plumes
- Better characterization of diurnal dynamics and interactions with emissions – e.g. land-sea breeze changes near coastal monitors
- More refined differentiation of proximal emission sources and chemical processes
- Increased confidence in relationships between satellite data and surface concentrations



Processing for GOES and Synthetic TEMPO Data

If you want to get started with geostationary satellite data but aren't sure how, try plotting GOES-16 AOD or TEMPO Synthetic NO2 data.

These are primers, and not targeted toward specific applications.

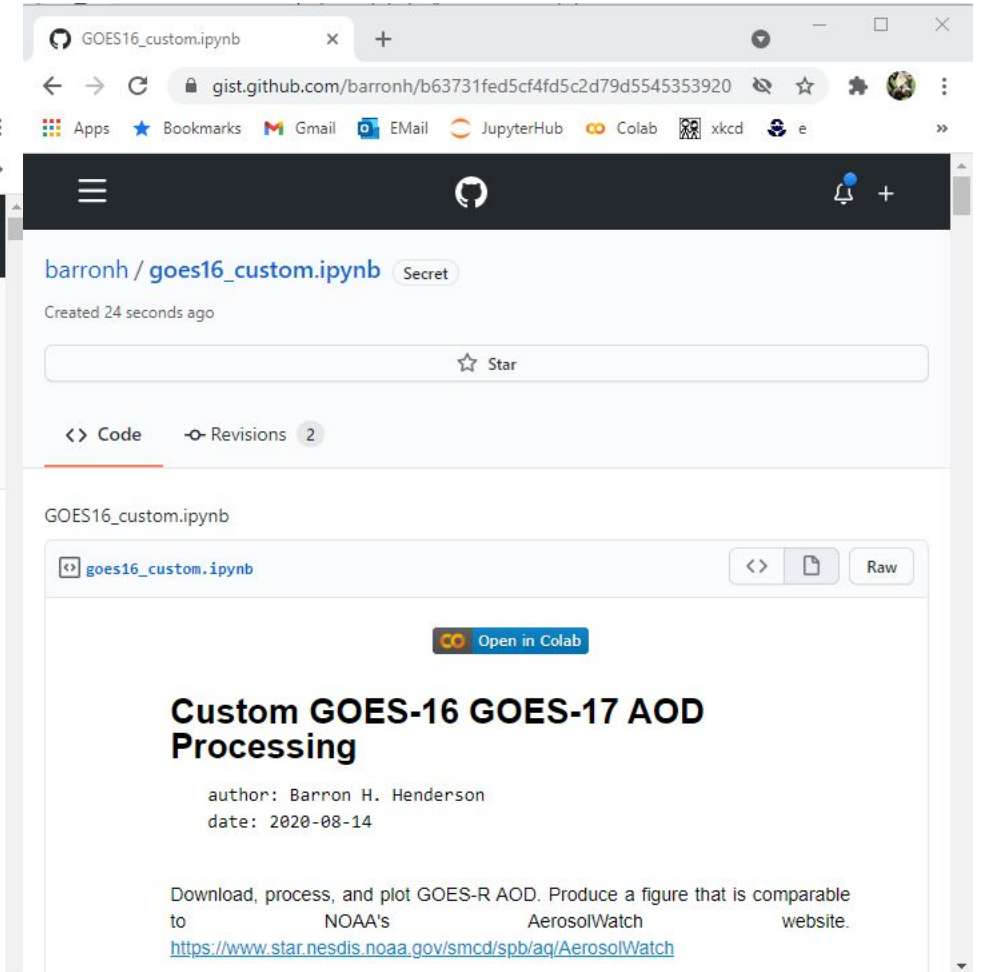


The screenshot shows a GitHub Gist page for a notebook titled "tempo_syntheticearlyadopters.ipynb" by user "barronh". The page is marked as "Secret" and was created 7 minutes ago. It features a "Code" tab and a "Download ZIP" button. Below the notebook title, there is a "Quick TEMPO Synthetic Data Visualizer" section with the following text:

author: Barron H. Henderson
date: 2020-11-20
contributors: James East and Shannon Kopplitz

This notebook is designed to download remote TEMPO data, select data based on QA flags, and make a map.

<https://gist.github.com/barronh/a9d77b2798d3ad1397b4de2b88cf889f>



The screenshot shows a GitHub Gist page for a notebook titled "goes16_custom.ipynb" by user "barronh". The page is marked as "Secret" and was created 24 seconds ago. It features a "Code" tab and a "Download ZIP" button. Below the notebook title, there is a "Custom GOES-16 GOES-17 AOD Processing" section with the following text:

author: Barron H. Henderson
date: 2020-08-14

Download, process, and plot GOES-R AOD. Produce a figure that is comparable to NOAA's AerosolWatch website.
<https://www.star.nesdis.noaa.gov/smcd/spb/aa/AerosolWatch>

<https://gist.github.com/barronh/b63731fed5cf4fd5c2d79d5545353920>

Outlook

- Near term
 - Continuing use of available polar satellites.
 - Increasing utilization of existing geostationary satellites.
 - Looking for collaborations to more fully leverage suite of products.
 - Increases capacity for upcoming instruments and data.
- Looking forward
 - Need characterized uncertainties based on validation.
 - Need surface-level diagnostics and characterization of representativity.