Satellite Data Comparison with Field Campaigns through Worldview, SOOT and ArcGIS

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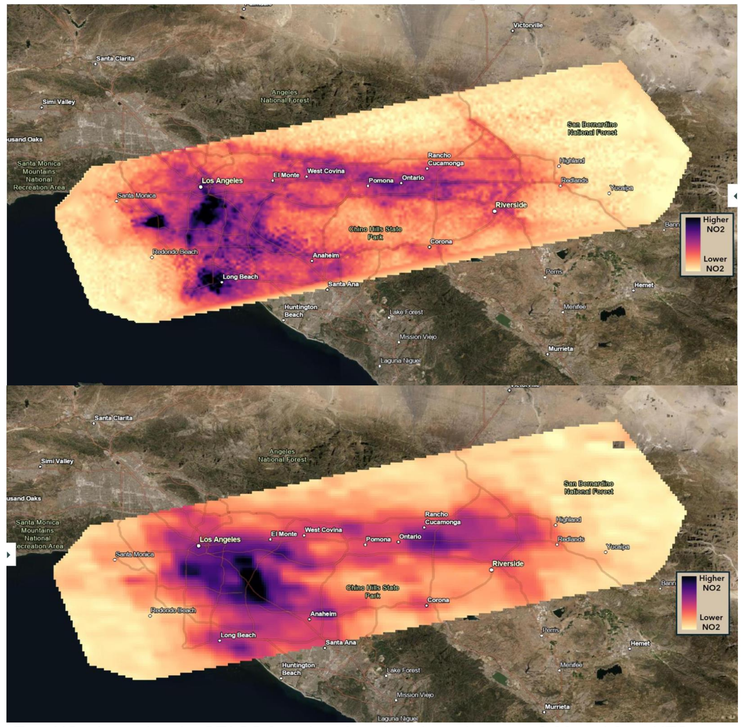
Synergistic TEMPO Air Quality Science (STAQS)

The Synergistic Tropospheric Emissions: Monitoring of Pollution (TEMPO) Air Quality Science (STAQS) field campaign integrated TEMPO satellite observations with traditional air quality monitoring to improve understanding of air quality science. STAQS was conducted furin summer 2023 over urban areas including Los Angeles, New York City, and Chicago. The Johnson Space Center (JSC) Gulfstream-V (G-V) aircraft and the NASA Langley Research Center (LaRC) Gulfstream-III (G-3) were outfitted with various remote sensing payloads including the GeoCAPE Airborne Simulator (GCAS), High Spectral Resolution Lidar-2 (HSRL-2), Hagh-Altitude Lidar Observatory (HALO), and Airborne Visible InfraRed Imaging Spectrometer – Next Generation (AVIRS-NG). The Tropospheric Ozone Lidar Network (TOLNet) ground-based lidars contributed tropospheric ozone profiles, while Pandora spectrometers provided ozone, NO_2, and HCHO measurements.



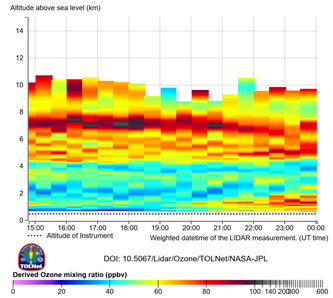
Top: NO_2 data taken by STAQS from Los Angeles plume between 3:30 and 6pm UTC August 22, 2023

Bottom: NO_2 data taken by TEMPO from the same plume at 5:30pm UTC

https://storymaps.arcgis.com/stories/1d61ee9b494b47a1b8e0091dfd3977ce

Satellite validation campaigns

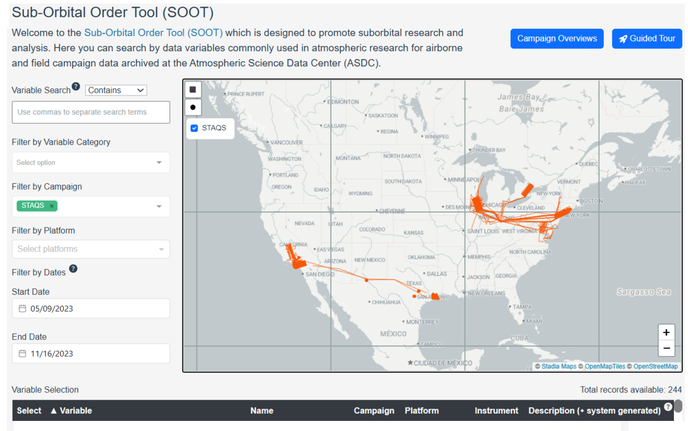
The ASDC houses data from various satellite validation campaigns. The purpose of these campaigns is to test accuracy and validity of satellite instruments using in situ and remote sensing instruments aboard aircrafts. Three examples of satellite validation campaigns at the ASDC are STAQS, the Airborne and Satellite Investigation of Asian Air Quality (ASIA-AQ), and the Plankton, Aerosol, Cloud, ocean Ecosystem - Postlaunch Airborne eXperiment (PACE-PAX). ASIA-AQ flew in 2024 to validate South Korea's Geostationary Environment Monitoring Spectrometer (GEMS) and PACE-PAX flew in 2024 to validate the Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) mission. Ground-based networks like the Tropospheric Ozone Lidar Network (TOLNet) also work in tandem with field campaigns to validate satellite data. The image on the right is an ozone profile taken by TOLNet at the NASA Jet Propulsion Laboratory (JPL) on August 22, 2023.



TOLNet ozone profile taken August 22, 2023, at NASA JPL.

Sub-Orbital Order Tool (SOOT)

The Sub-Orbital Order Tool (SOOT) is the suborbital data accession tool developed by the ASDC. SOOT has both a search mode and browse mode. The search mode allows for users to refine searches to variables, locations via bounding box, campaign, platforms, as well as time-boxing data between a start and end date. The browse mode allows the user to view data by campaign and deployment, platform, Principal Investigator, data ID's, and data start dates. SOOT also has a merge capability, allowing users to select multiple files with the same platform, campaign, date, and launch, and merge the files into one file by date.



ASDC Sub-Orbital Order Tool (SOOT) home page with STAQS flight tracks.
https://asdc.larc.nasa.gov/soot/search

NASA Worldview

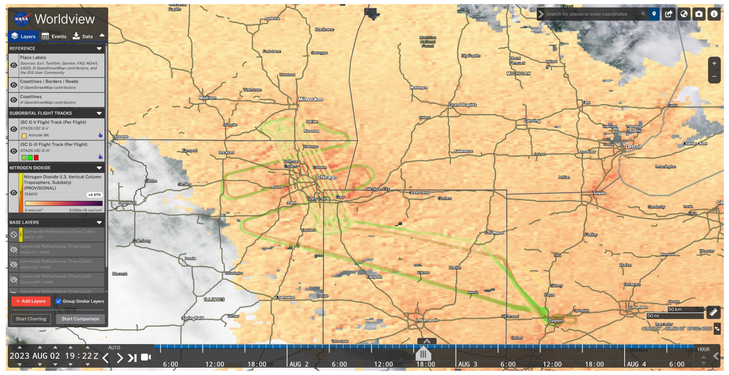
https://worldview.earthdata.nasa.gov

The below screenshot from NASA Worldview displays a multi-layer geospatial visualization centered over the Chicago metropolitan area and surrounding Midwest states, including Illinois, Indiana, Ohio, Michigan, and Wisconsin. The dominant data layer — shown in a gradient from pale yellow to deep red/orange — represents TEMPO Level 3 sub-daily NO_2 vertical column concentrations in the troposphere, ranging from 0 to 3.0×10^{16} molecules/cm². Elevated NO_2 concentrations (shown in red and orange tones) are clearly visible over and downwind of major urban and industrial centers, most notably the Chicago–Gary corridor, as well as portions of Detroit, Indianapolis, and the broader Ohio Valley industrial region — all well-known hotspots for vehicle emissions, industrial activity, and energy production.

Overlaid on the NO_2 layer are two suborbital aircraft flight tracks: the JSC G-V (shown in green/yellow dotted lines, color-coded by altitude) and the JSC G-III (shown in green, yellow, and red dotted lines). The G-V track depicts a characteristic survey pattern looping over the Chicago area and extending southeast toward Dayton, Ohio, while the G-III track follows a complementary path — consistent with coordinated airborne field campaign sampling strategies designed to validate satellite retrievals and characterize atmospheric composition at multiple altitudes.

The temporal context shown in the timeline at the bottom — August 2, 2023, at ~18:00–19:00 UTC — corresponds to TEMPO's afternoon overpass window, during which daytime photochemical NO_2 production from urban emissions is typically near its peak. Gray cloud coverage is visible over Lake Michigan and portions of Wisconsin and Michigan, partially limiting satellite retrievals in those regions.

This visualization exemplifies the power of integrating spaceborne remote sensing (TEMPO) with suborbital remote sensing observations (G-V and G-III aircraft) for air quality monitoring, satellite validation, and the study of pollution transport across the eastern United States.



NASA Worldview visualization of TEMPO Nitrogen Dioxide (NO_2) vertical column tropospheric concentrations (Provisional, v4 STD) over the Upper Midwest and Great Lakes region on August 2, 2023, at 19:22 UTC, overlaid with JSC G-V and JSC G-III suborbital flight tracks.

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https://forms.gle/mRYqLf8of7Mp9Un88

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