National Aeronautics and Space Administration

NASA

Mid-Atlantic Gas Emissions Quantification (MAGEQ)

DATA PRODUCT PREVIEW

December 2025

nasa.gov

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INTRODUCTION

This document previews forthcoming data products from the 2025 Mid-Atlantic Gas Emissions Quantification (MAGEQ) airborne campaign. Science teams are currently completing quality checks, analysis, and preparing datasets for release on open-access data platforms. Enclosed is a summary of planned data products, including file types, data formats, and timelines for availability.

Please complete our stakeholder survey to let us know about your communication preferences, potential uses for the data, and any barriers for adoption. This information helps to ensure that we are providing the most useful and accessible data to meet stakeholders' current and future needs.

ABOUT MAGEQ

The MAGEQ campaign is a multi-agency effort to coordinate airborne and ground measurements of mid-Atlantic regional emissions. By leveraging existing assets and fostering scientific alignment, MAGEQ is designed to maximize efficiency of interagency airborne observation campaigns, fill data gaps identified by public and private sector stakeholders, and deliver trusted remote sensing data through rigorous evaluation and communication.

From June through August 2025, aircraft operated by NASA and NOAA measured emissions over urban, wetland, agricultural, and petrochemical areas using advanced measurement technologies to collect gas samples and remote sensing observations of atmospheric composition. These airborne data are being examined alongside satellite and ground-based observations supported by government, academic, corporate, and nonprofit partners.

Read more on NASA.gov:
NASA Aircraft Coordinate Science Flights to Measure Air Quality

TYPES OF DATA

In Situ Sampling Collection

In situ is a Latin phrase meaning “in the place.”

How it works: Instruments are placed directly on the aircraft (inside or mounted externally) and actively draw in air or make contact with the environment as the plane flies through it.

What it measures: These instruments act like a flying laboratory, providing direct, highly accurate measurements of the concentration of specific gases and aerosols (tiny particles) at that exact location and altitude.

Why it matters: This provides the “ground truth” (or in this case, the “air truth”) data needed to validate and calibrate the other type of measurement (remote sensing) and to deeply understand the chemical processes occurring in the atmosphere.

Remote Sensing of Atmospheric Gases

Remote sensing means measuring something without actually touching it.

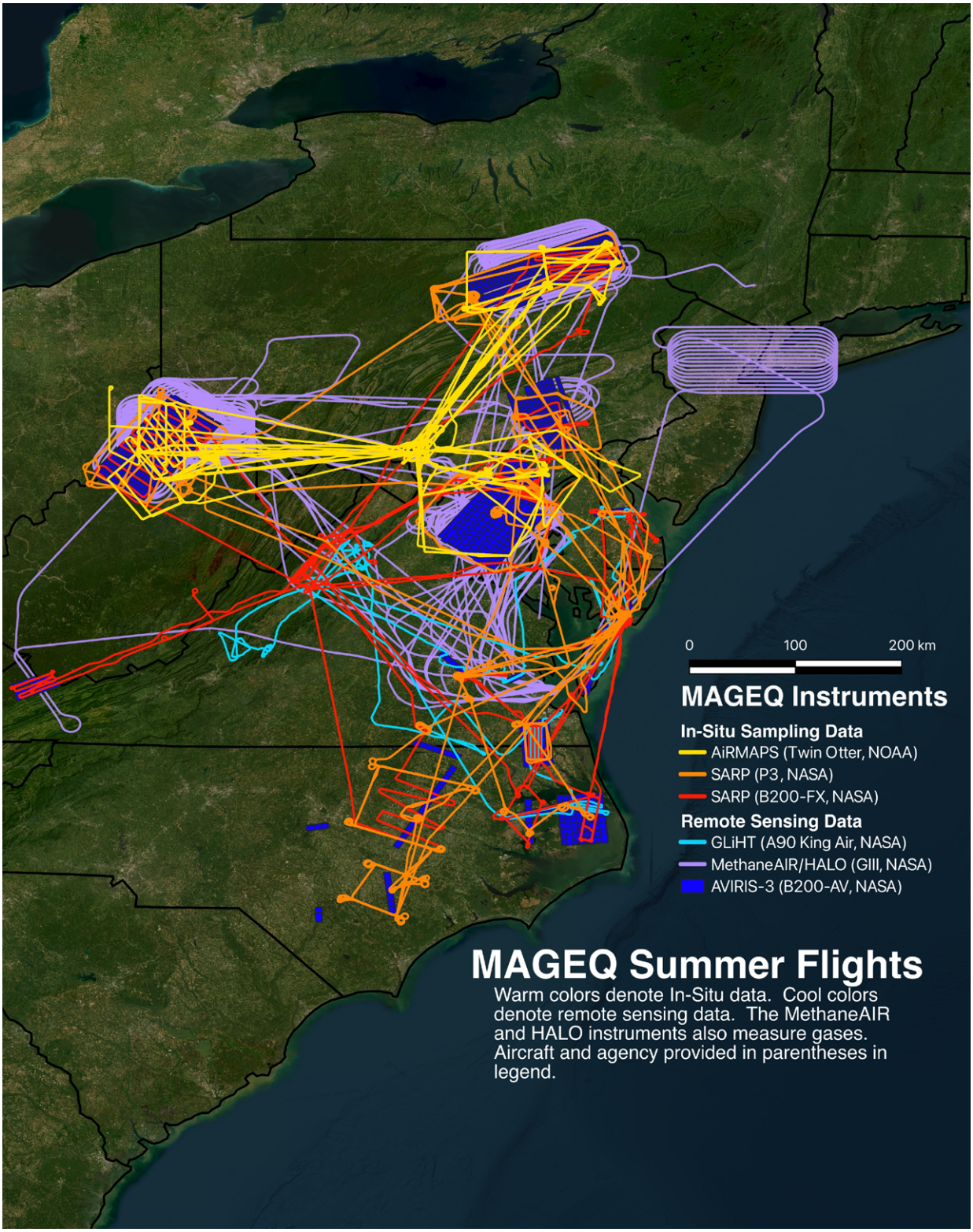
How it works: Instruments on the aircraft look down at the surface or up through the atmosphere using technologies like lasers, radar, and specialized cameras. They measure emissions by observing how the gases and surfaces interact with light (like how much light they absorb or reflect).

What it measures: This provides a broad, wide-area view of the atmosphere, collecting data on the distribution and total amount of gases (like methane or ozone) and surface properties over large regions.

Why it matters: While in situ data gives precise points, remote sensing maps the entire area, showing how emissions spread and move across urban, wetland, and agricultural areas. This data is also critical for validating and improving measurements taken by satellites orbiting far above.

FLIGHT MAP

MAGEQ flights were performed by six research aircraft and took place over the East Coast during Summer 2025. This map displays the flight tracks of the planes that collected data as part of this campaign. Locations were selected after discussions with relevant stakeholders on their data needs and interests. Please note that some of the flight tracks are transit periods and do not necessarily indicate data collection over all locations highlighted.

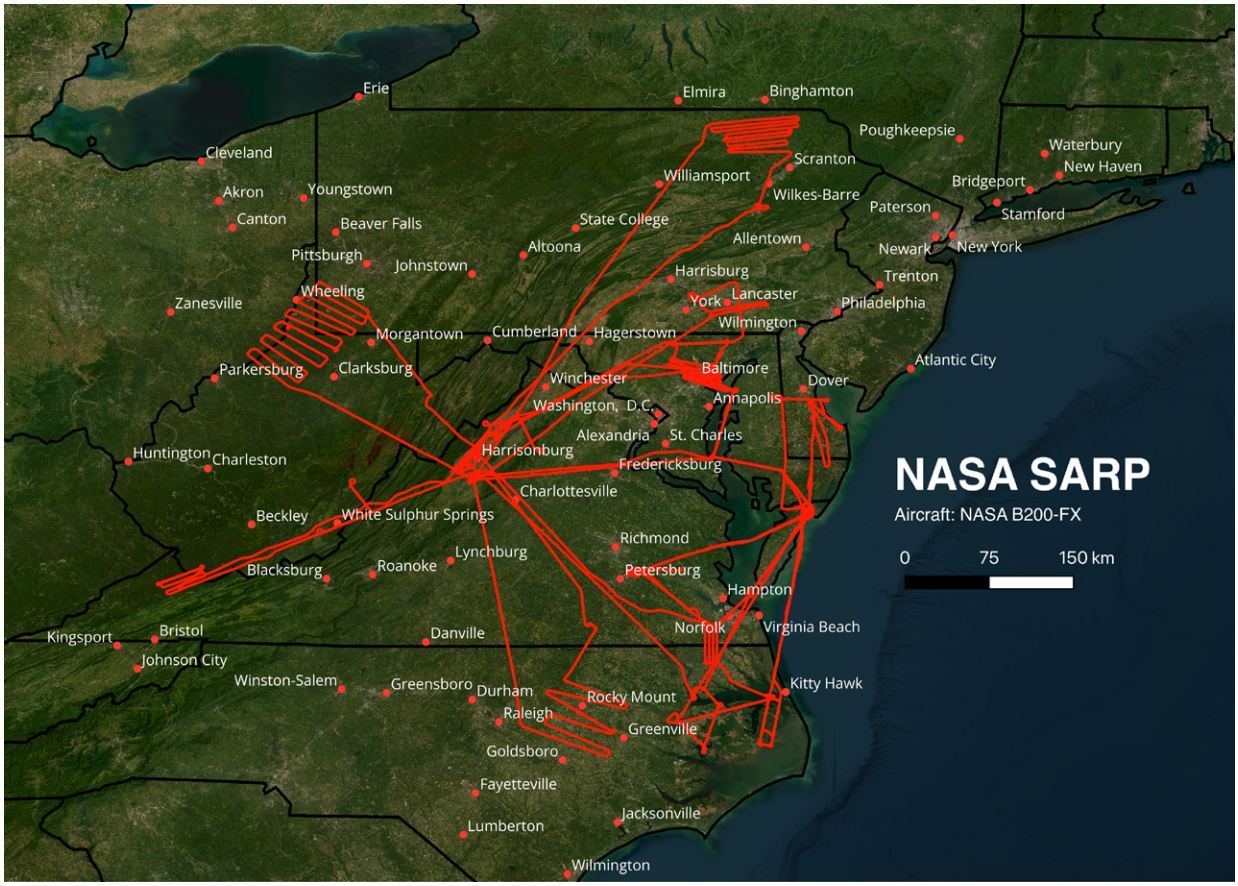


IN SITU SAMPLING COLLECTION

In Situ Gas Concentrations and Fluxes

Supporting Programs: NASA's Student Airborne Research Program and U.S. Greenhouse Gas Center

Aircraft: B200-FX (Dynamic Aviation)



The B200-FX aircraft flew over the east coast of the United States during 12 days of flights. The aircraft performed low-level sampling over wetlands, coal mines in Virginia, agricultural areas in Pennsylvania, and urban areas to measure emissions of carbon dioxide (CO_2), methane (CH_4), and nitrogen oxides (NOx). The flights were part of NASA's Student Airborne Research Program, an eight-week summer internship for rising-senior undergraduates, held annually on the east and west coasts of the United States.

DATA PRODUCT PREVIEW	
FLIGHTS TIMELINE	June 22–25, July 7–9, & July 11–15, 2025
DATA PRODUCTS	• In situ gasphase tracers: Ozone (O_3), 1 Hz, 10 Hz; Nitrogen Dioxide (NO_2), 1 Hz); Formaldehyde (HCHO), 1 Hz; 3D winds, 1 Hz, 20 Hz; CO_2, CH_4, and water vapor (H_2O), 0.5 Hz, 10 Hz • Fluxes of CO_2, CH_4, latent heat, and sensible heat
STORAGE	NASA LaRC Suborbital Science Data for Atmospheric Composition
FILE DATA & FORMAT	International Consortium for Atmospheric Research on Transport and Transformation (ICARTT) files, ASCII format
APPROX SPATIAL RESOLUTION	• Most data is 1 Hz • Upon request, some data is available at a faster rate of 10–100 Hz
APPROX TEMPORAL RESOLUTION	100 m for 1 Hz
AVAILABILITY TIMELINE	• Most preliminary data is available now, password-protected (password available on request) • Final B200-FX data is expected by December 31, 2025
PENDING ANALYSIS	Tropospheric Emissions: Monitoring of Pollution (TEMPO) validation for HCHO and NO_2

Principal Investigator

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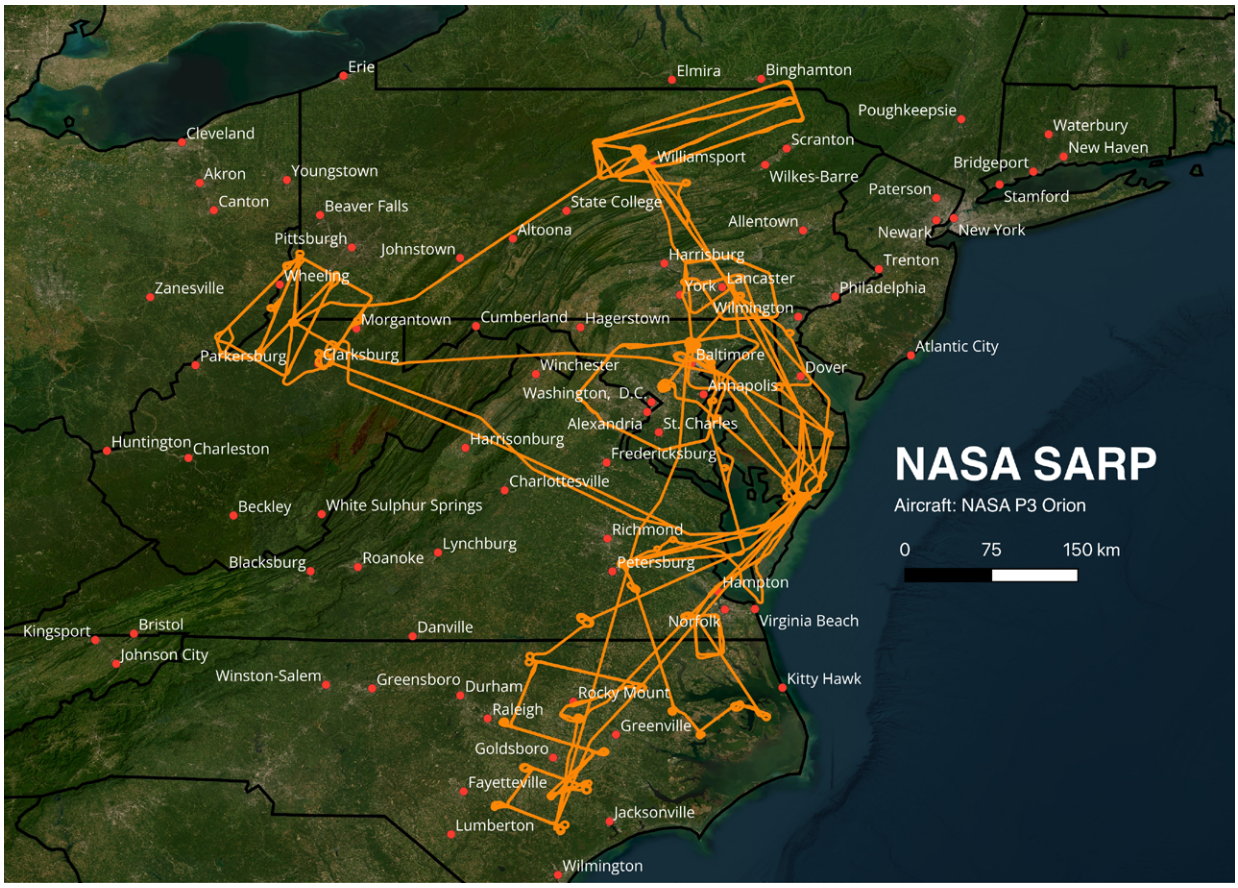
IN SITU SAMPLING COLLECTION

Whole Air Sampler Analysis

Supporting Program: NASA's Student Airborne Research Program

Aircraft: NASA P-3 Orion



The P-3, operated out of NASA's Wallops Flight Facility in Virginia, is a four-engine turboprop aircraft outfitted with a six-instrument science payload. The P-3 aircraft flew over the east coast United States during a total of 10 days of flights as part of NASA's Student Airborne Research Program. The P-3 acquired trace gas and aerosol observations in multiple emitting locations, including urban and industrial areas, chicken farms, container ships, pulp mills, and landfills.

DATA PRODUCT PREVIEW	
FLIGHTS TIMELINE	June 23-25, July 8-9, July 11, July 14-15, & July 17-18, 2025
DATA PRODUCTS	• In-situ Volatile Organic Compounds (VOCs) from cans (e.g., the Whole Air Sampler), many compounds • NOx, O_3, Carbon Monoxide (CO), CO_2, CH_4, Nitrous Oxide (N_2O) • Aerosol size distributions, number counts, absorption, composition by aerosol mass spectrometer (AMS)
STORAGE	NASA LaRC Suborbital Science Data for Atmospheric Composition
FILE DATA & FORMAT	ICARTT files, ASCII format
APPROX SPATIAL RESOLUTION	• 1 Hz • Upon request, some data is available at a faster rate of 10-100 Hz or a slower rate of 1 sample per 1-2 minutes • WAS filled 144 canisters per flight (nominal 7-hour [420 minute] flights), time to fill cans hence spatial resolution variable
APPROX TEMPORAL RESOLUTION	100m for 1 Hz
AVAILABILITY TIMELINE	• Most preliminary data is available now, password-protected (password available on request) • WAS laboratory analysis completion date and availability timeline is TBD • Further analysis is not planned/funded for P-3 data
PENDING ANALYSIS	WAS data in QA/QC procedures

Principal Investigator

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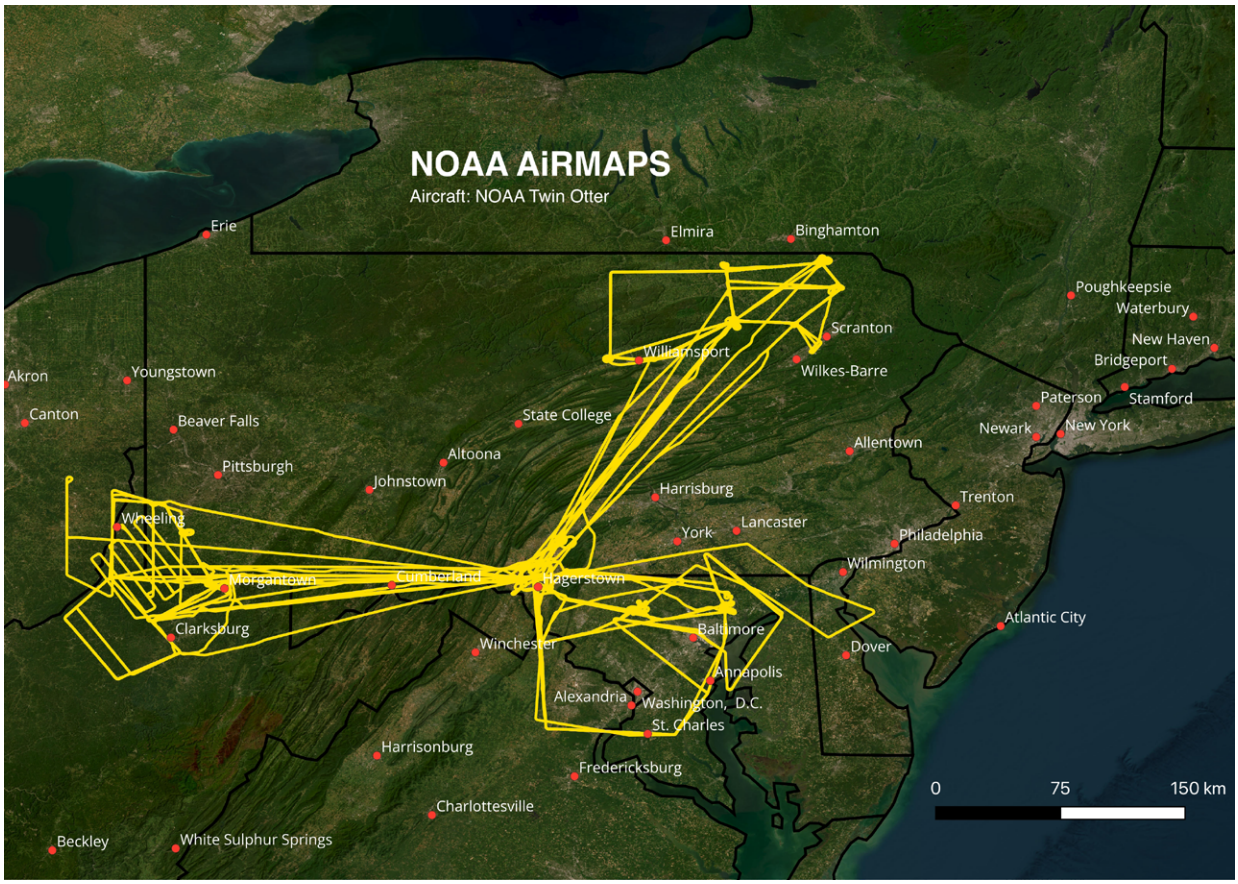
IN SITU SAMPLING COLLECTION

Gas Phase GHG, O_3, NOx and VOC

Supporting Program: NOAA AiRMAPS

Aircraft: NOAA Twin Otter



NOAA's Twin Otter aircraft flew over urban areas and coal shafts in Maryland, Pennsylvania, and the District of Columbia as part of their multi-year Airborne and Remote sensing Multi Air Pollutant Surveys (AiRMAPS) project. Over the course of 20 days of flights, this team collected in situ data on CO, CO_2, CH_4, H_2O, N_2O, and O_3, using onboard instruments including Picarro, Tunable Diode Laser Absorption Spectroscopy (TDLS), Cavity Ring-Down Spectroscopy (CES/CRDS), and Programmable Flask Package (PFP) sampler.

DATA PRODUCT PREVIEW	
FLIGHTS TIMELINE	July 7-8, July 11-12, July 14-18, July 20-25, July 28, July 3, & August 1-3, 2025
DATA PRODUCTS	• In situ gas-phase tracers: 1 Hz CO, CO_2, CH_4, H_2O, ethane, NOx, the sum of reactive nitrogen oxides (NOy), O_3; 5 Hz CH_4, CO_2, H_2O • VOCs and halocarbons from a programmable flask package (12 flasks per flight, roughly 15 secs per flask) • 1 Hz and 5 Hz winds, temperature, and relative humidity from in-situ Aircraft-Integrated Meteorological Measurement System (AIMMS) probe
STORAGE	BAQMS Data
FILE DATA & FORMAT	In-situ data: ICARTT files, ASCII format
APPROX SPATIAL RESOLUTION	• 1 Hz / 60 m along the flight track • Higher resolution may be available upon request for selected data
APPROX TEMPORAL RESOLUTION	1 Hz standard Higher resolution may be available upon request for selected data
AVAILABILITY TIMELINE	• Final quality-controlled data will be available for campaign participants no later than February 1, 2026 • Data will be available to the public no later than August 1, 2026
PENDING ANALYSIS	• Converting measurements of atmospheric composition and winds to fluxes of major trace gases (CH_4, CO_2, CO, NOx) around the urban areas and oil and gas basins flown • Analyzing air quality impacts such as O_3 production efficiencies • Comparing trace gas fluxes out of the surveyed areas to emission estimates from airborne and satellite remote sensing instruments

Principal Investigator

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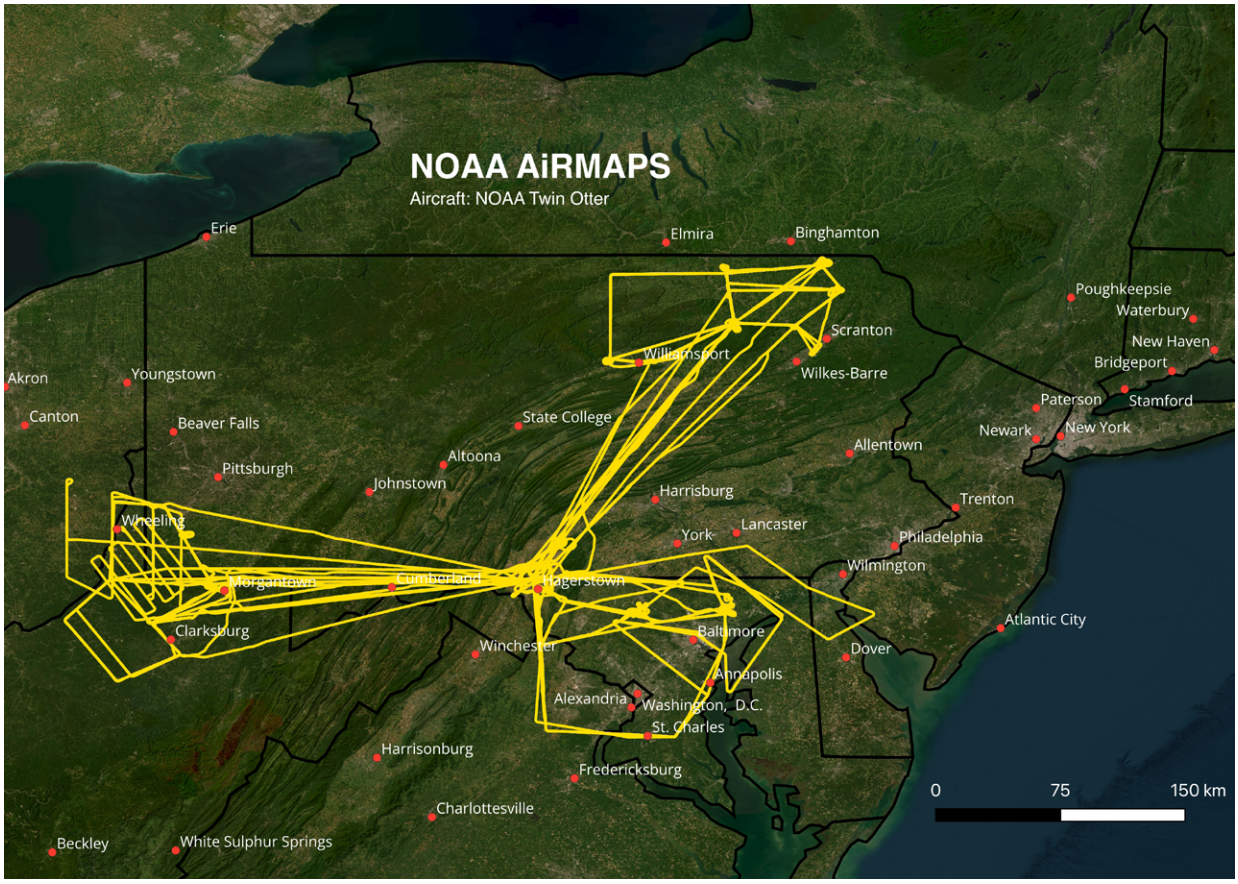
REMOTE SENSING OF ATMOSPHERIC GASES

Airborne Doppler Lidar

Supporting Program: NOAA AiRMAPS

Aircraft: NOAA Twin Otter



NOAA's Twin Otter aircraft flew over urban areas and coal shafts in Maryland, Pennsylvania, and the District of Columbia. Over the course of 20 days of flights, instruments including the Airborne Doppler Lidar, Picarro, TDLS, CES/CRDS, and PFP sampler gathered information about wind profiles and plumes of CO, CO_2, CH_4, H_2O, N_2O, and O_3.

DATA PRODUCT PREVIEW	
FLIGHTS TIMELINE	July 7–8, July 11–12, July 14–18, July 20–25, July 28, July 30, & August 1–3, 2025
DATA PRODUCTS	Planetary Boundary Layer (BPL) height and wind profiles from Doppler lidar
STORAGE	BAQMS Data
FILE DATA & FORMAT	Lidar data, netCDF format
APPROX SPATIAL RESOLUTION	• 1 Hz / 60 m along the flight track • Higher resolution may be available upon request for selected data
APPROX TEMPORAL RESOLUTION	• 1 Hz standard • Higher resolution may be available upon request for selected data
AVAILABILITY TIMELINE	• Final, quality-controlled data will be available for campaign participants no later than February 1, 2026 • Data will be available to the public no later than August 1, 2026
PENDING ANALYSIS	• Input datasets to the analysis from the in-situ data collected by the NOAA aircraft • Conduct methane modeling and leverage observations to evaluate NOAA Greenhouse Gas And Air Pollutants Emissions System (GRA^{2}PES) methane emissions

Principal Investigator

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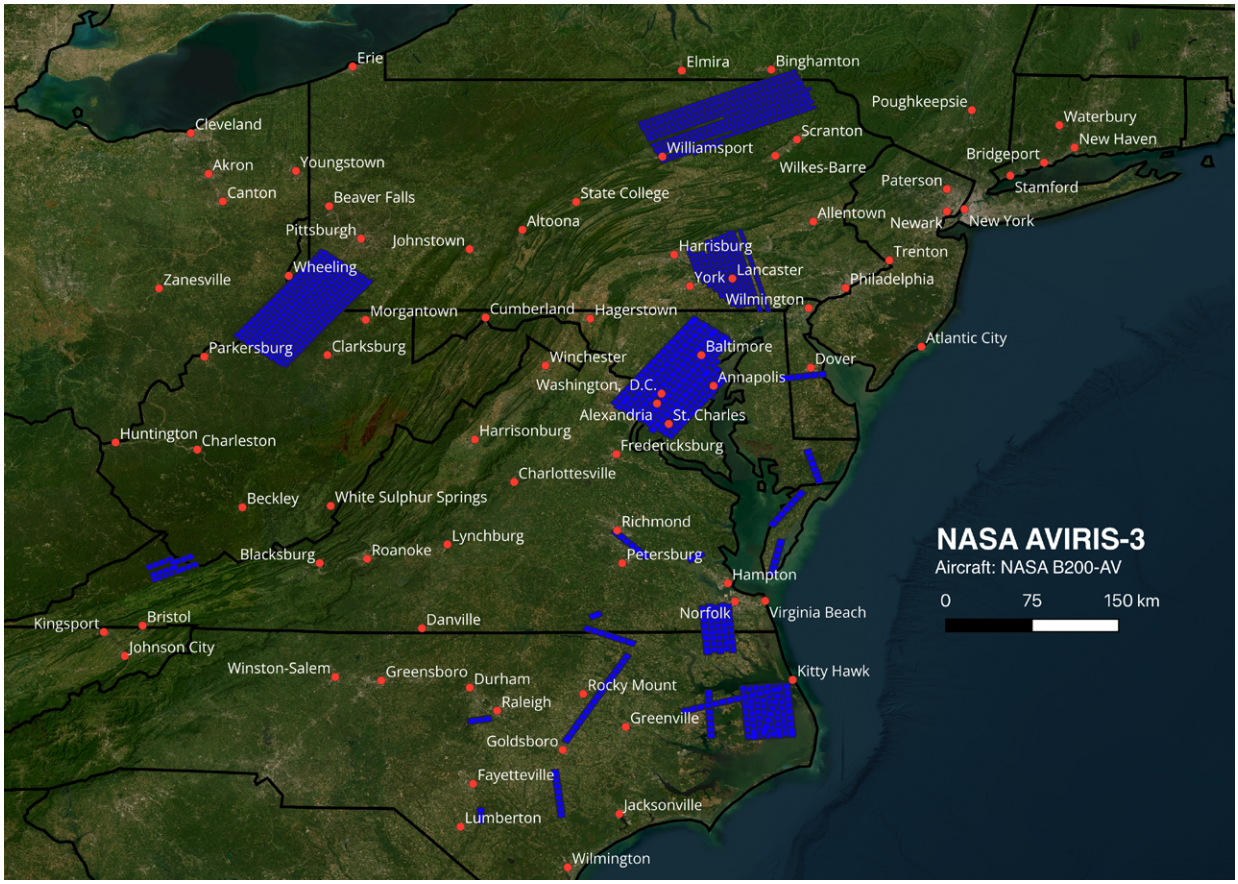
AVIRIS-3 VSWIR Imaging Spectroscopy

Supporting Program: MAGEQ

Aircraft: B200-AV (Dynamic Aviation)



The B200-AV aircraft flew with NASA's Airborne Visible Infrared Imaging Spectrometer 3 (AVIRIS-3), which is used to measure CH_4 and CO_2 enhancements, ecosystem composition and function, and water quality via visible to shortwave infrared (VSWIR) spectroscopy at 7.5 nanometer (nm) spectral resolution. Over the course of 17 flight days, the AVIRIS-3 campaign mapped the Baltimore–Washington metropolitan area, northeast and southwest Marcellus, wetland areas in North Carolina, agricultural areas in Pennsylvania, and some regions with coal mines in West Virginia.

DATA PRODUCT PREVIEW	
FLIGHTS TIMELINE	July 7-8, July 11-12, July 14-18, July 20-21, July 23-25, July 28, & August 2-3, 2025
DATA PRODUCTS	• At-sensor Radiance (400-2400 nm at 7.5 nm intervals) • CH_4 and CO_2 enhancements • Delineated CH_4 and CO_2 plumes • Visible to Shortwave Infrared Surface Reflectance (400-2400 nm at 7.5 nm intervals, atmospherically corrected)
STORAGE	ORNL DAAC
FILE DATA & FORMAT	• Radiance and Reflectance datasets delivered as netCDF files • CH_4 and CO_2 enhancement measurements in raster GeoTIFF format
APPROX SPATIAL RESOLUTION	• All product resolutions determined by flight altitude. • Most data collected at ~4m resolution, with some lines <4m
APPROX TEMPORAL RESOLUTION	NA, surface imager
AVAILABILITY TIMELINE	• At-sensor radiance available now • CH_4 and CO_2 enhancements available now • CH_4 and CO_2 delineations will be available in 2026 • Surface reflectance will be available in 2026
PENDING ANALYSIS	Delineation of plumes and emission quantification leveraging ancillary data including windspeed

Principal Investigators

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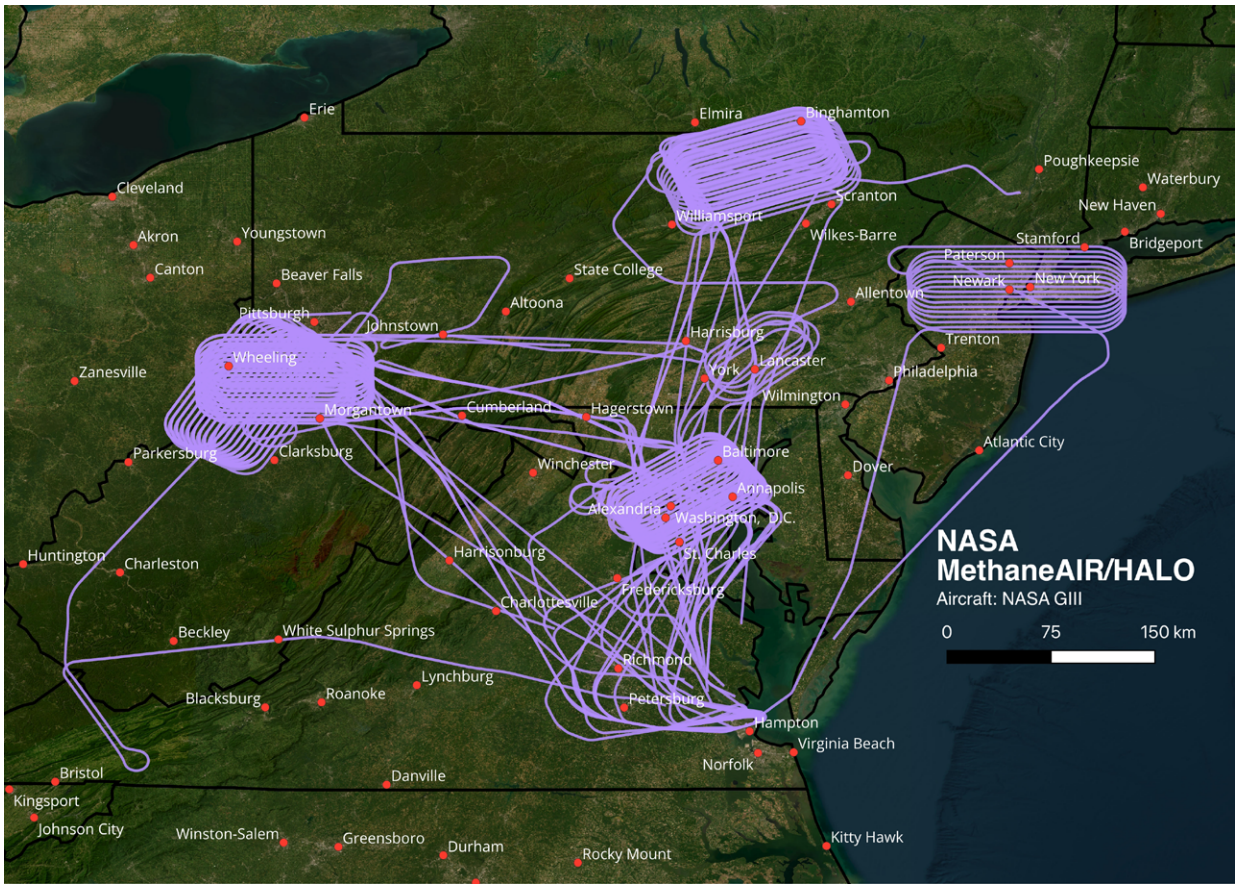
HALO and MethaneAIR

Supporting Program: MAGEQ

Aircraft: NASA GIII



The NASA Langley Gulfstream-III (GIII) aircraft flew with the High-Altitude Lidar Observatory (HALO) integrated path methane lidar and high spectral resolution lidar and MethaneAIR high resolution imaging spectrometer instruments, with repeated surveys of the same region over two-day periods, creating uniquely data-rich, comprehensive observational dataset of CH_4 concentrations, aerosols, and planetary boundary layer heights and their changes over time. Over the course of 32 days and 28 research flights, NASA's GIII aircraft performed different flights delivering an ambitious set of measurements that will help scientists understand how emissions change at different times of day in oil and gas and urban regions.

DATA PRODUCT PREVIEW	
FLIGHTS TIMELINE	July 9, July 11–12, July 15, July 17, July 21–25, July 28–29, August 2–4, & August 9–11, 2025
DATA PRODUCTS	• HALO: CH_4 columns, aerosol/cloud profiles, PBL heights • MethaneAIR: CH_4 columns
STORAGE	• Preliminary Data: NASA LaRC Suborbital Science Data for Atmospheric Composition • Final Data: ASDC
FILE DATA & FORMAT	• HALO: HDF 5 • MethaneAIR: netCDF
APPROX SPATIAL RESOLUTION	• HALO – XCH4: ~100m, 1km, no swath – Aerosol backscatter, depolarization, mixing layer height: 2km second x 15 m – Aerosol extinction and typing: 12km x 300 m • MethaneAIR – XCH4: gridded to 10m x 10m, 4.5 km swath
APPROX TEMPORAL RESOLUTION	• HALO – XCH4: 2 Hz, 5 second – Aerosol backscatter, depolarization, mixing layer height: 10 second – Aerosol extinction and typing: 60 second • MethaneAIR – 10 Hz, or 25m along track
AVAILABILITY TIMELINE	• HALO: Preliminary data available now; final data available in March 2026 • MethaneAIR: Preliminary L3 products available by January 31, 2026; final L3 products available in 2026
PENDING ANALYSIS	• Plumes of CH_4 will be identified and associated emissions quantified using documented methods from Chulakadabba et al. 2023 • Area total emissions and heat maps of emissions will be modeled using geospatial inverse modeling methods

Principal Investigators

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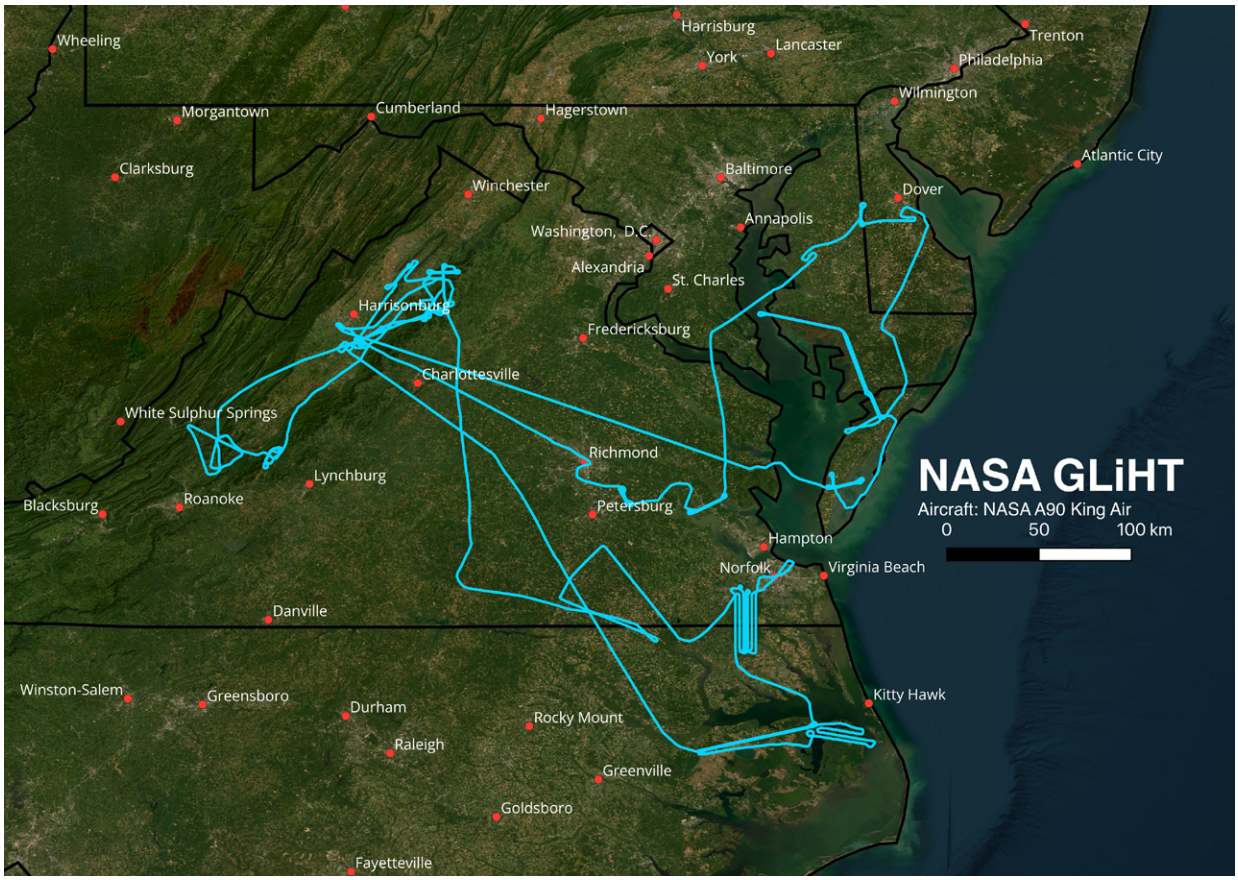
MethaneAIR Steven Wofsy, Harvard University, wofsy@g.harvard.edu

G-LiHT Airborne Imaging System

Supporting Program: MAGEQ

Aircraft: Beechcraft King Air A90



NASA's Beechcraft King Air A90 aircraft flew with Goddard's Lidar, Hyperspectral, and Thermal (G-LiHT) portable airborne imaging system. G-LiHT simultaneously maps the composition, structure, and function of terrestrial ecosystems using: Lidar for 3D structure of vegetation; high-resolution stereo imaging cameras for individual tree crown mapping; imaging spectroscopy for species composition and vegetation physiology; and thermal infrared measurements of heat and moisture stress in vegetation. Over the course of a week, G-LiHT covered a wide range of study sites, including coastal ecosystems impacted by saltwater intrusion in Maryland and North Carolina, areas of targeted restoration of forest and wetland ecosystems in Virginia and North Carolina, focal areas for nature-based solutions to support land management, and three National Wildlife Refuges.

DATA PRODUCT PREVIEW	
FLIGHTS TIMELINE	August 11, August 12, & August 14, 2025
DATA PRODUCTS	• Initial data products (using existing data processing workflows): trajectories, quicklooks, tile boundaries, classified LAZ pointclouds, canopy height model, digital terrain model, Lidar metrics, high-resolution Red, Green, Blue, and Near-Infrared (RBG-NIR) orthomosaics • Forthcoming products (prototype): thermal infrared (TIR) mosaics and land surface temperature (LST), VSWIR surface reflectance and standardized vegetation index (SVI)
STORAGE	Preliminary data: G-LiHT Final data: LP-DAAC or ORNL DAAC
FILE DATA & FORMAT	• LAS for raw lidar point clouds, raster for some products, tabular for GPS/IMU, vector for flight tracks/flight line info, shapefile for tile boundaries, KML for quick looks and quick mapping of existing flight data • netCDF, ascii/text, geotiffs, LAS/LAZ, KML, png, ascii, shapefile
APPROX SPATIAL RESOLUTION	• RGB-NIR camera imagery: centimeter • Lidar point clouds: centimeter • 1 to 20m gridded products
APPROX TEMPORAL RESOLUTION	Variable: single-pass, solar noon +/- 3 hours
AVAILABILITY TIMELINE	• Preliminary version: - Preliminary lidar data by December 15, 2025 - Thermal, imagery, VNIR hyperspectral: February 28, 2026 • Final version: - Final lidar and stereo data expected by January 31, 2026 - Other data expected by May 31, 2026
PENDING ANALYSIS	• Integration with eddy covariance data to better understand spatial and temporal variability in CO_2, CH_4 and H_2O of wetlands in the mid-Atlantic region • Integration with ground-based measurements of forest stands to better understand the impacts of salinity intrusion on coastal forests • Assessment of stand structure of mixed hardwood and pine upland forests on the Eastern Shore of Maryland

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