

➤ GeoXO is NOAA's geostationary constellation
➤ **ACX** is the atmospheric composition instrument on board GeoXO Central, to be launched in 2030s

Attribute	What	Why
Coverage	CONUS, southern Canada, northern Mexico, Caribbean	Hourly inputs to national air quality, hazard and fire forecasting capabilities and warnings.
Spatial Resolution	8x3 km ² @ nadir	Resolve sources, including cities, highway corridors, airports, oil/gas fields, large point sources like fires and power plants.
Temporal Resolution	60 min	Capture diurnal variations in pollution emissions, photochemistry, and exposure. Detect episodic events like wildfires and volcanoes. Select for cloud-free conditions. Increase geographic coverage compared with LEO or surface observations.
Spectral Coverage / Resolution	UV: 300-500 nm Vis: 540-740 nm Both @ 0.6 nm	UV: ozone, nitrogen dioxide, formaldehyde, sulfur dioxide, absorption aerosol optical depth. Vis: cloud/aerosol layer height, PBL ozone, vegetation.

Abstract

NOAA includes an atmospheric composition instrument (ACX) for the planned GeoXO mission to advance NOAA's capabilities of air quality monitoring over North America. Similar to its geostationary predecessors, GEMS and TEMPO, the ACX provides hyperspectral coverage from ultraviolet (UV) to visible, allowing high-cadence and high spatial resolution observations of air pollutants such as O₃, NO₂, HCHO, SO₂, and particulate matter (PM) during the day. In this poster, we present an advanced algorithm for NO₂ retrieval from the visible (405 - 465 nm) spectrum and its application to the GEMS radiance measurements. We describe the technique for instrument characterization and identification of instrument artifacts for improving retrieval precisions, soft calibration approach for removing systematic biases in NO₂ retrieval, algorithm physics implementations to achieve high accuracy retrieval, and method for effective stratosphere-troposphere separation. Comparisons of NO₂ with polar-orbiting instruments (such as SSP TROPOMI) as well as the GEMS standard NO₂ product to demonstrate high-quality retrievals are achieved with the GeoXO NO₂ algorithm.

NO₂ Algorithm for GeoXO ACX

Direct Vertical Column Fitting (DVCF) Algorithm for NO₂ Retrievals

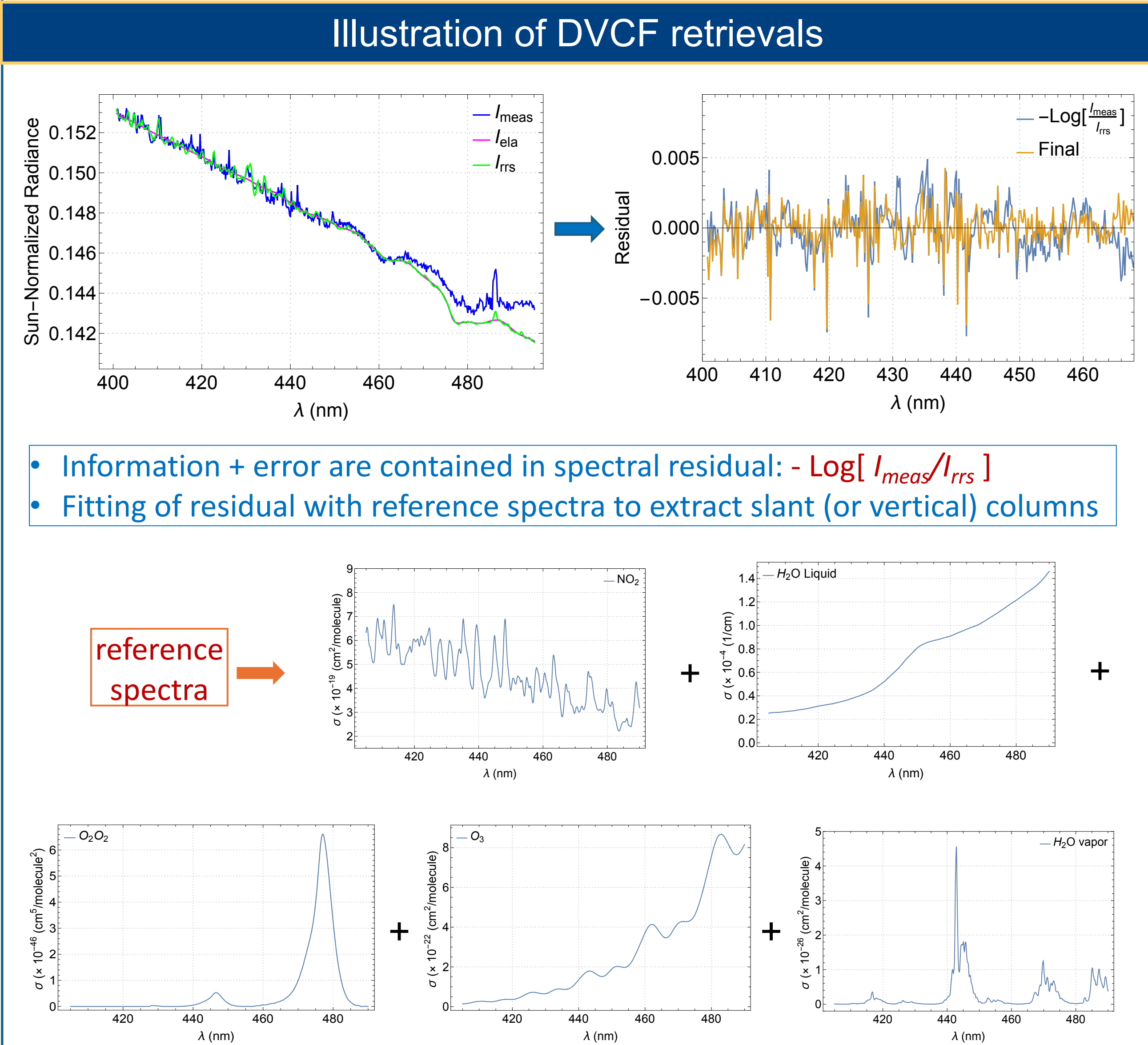
$$\ln I_m(\lambda) - \ln I_{TOA}(\lambda) = V \int_0^\infty \frac{\partial \ln I_{TOA}(\lambda)}{\partial \tau_z} S_z \sigma(\lambda, T_z) dz - \sum_i^m \xi_i \sigma_i(\lambda, T_i) + \sum_{k=0}^n \frac{\partial \ln I_{TOA}(\lambda)}{\partial R} \Delta R_k (\lambda - \lambda_0)^k + \varepsilon$$

- λ : wavelength
- I_m : measured radiance
- I_{TOA} : radiative transfer simulation
- σ : gas absorption cross sections
- R : reflectivity or cloud fraction
- NO₂ vertical column
- NO₂ Shape factor
- Gas absorber slant columns : ξ_i
- Aerosol Index
- Altitude-resolved AMF: $-\frac{\partial \ln I_{TOA}}{\partial \tau_z}$

Advanced Algorithm Features

- Allow accurate algorithm physics: explicit treatment of aerosol and surface BRDF to provide accurate representation of spectral and altitude variations of measurement sensitivities (DOAS's equivalent is the improved AMF).
- Allow more accurate stratosphere-troposphere separation by combining retrievals from UV and VIS spectra
- Allow soft calibration to correct biases in radiometric calibration and instrumental features that interfere with the interpretation of molecular absorptions.

References:
Yang et al., 2014, DOI: 10.1002/2014GL060136
Huang et al., 2022, DOI: 10.1016/j.atmosenv.2022.119367



Objectives

In preparation for GeoXO ACX, we apply the ACX NO₂ algorithm to proxy data (such as GEMS, TEMPO, and TROPOMI) to develop and perfect techniques for handling measurement characteristics:

- wavelength registrations
- instrument spectral responses
- anomalous pixels
- calibration biases
- common mode spectra

