

GeoTASO Project Summary and Relevance

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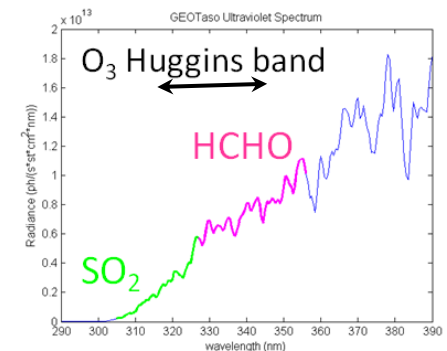
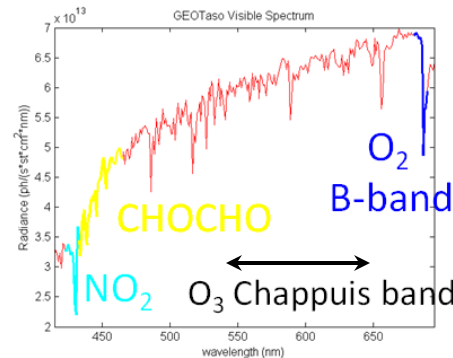
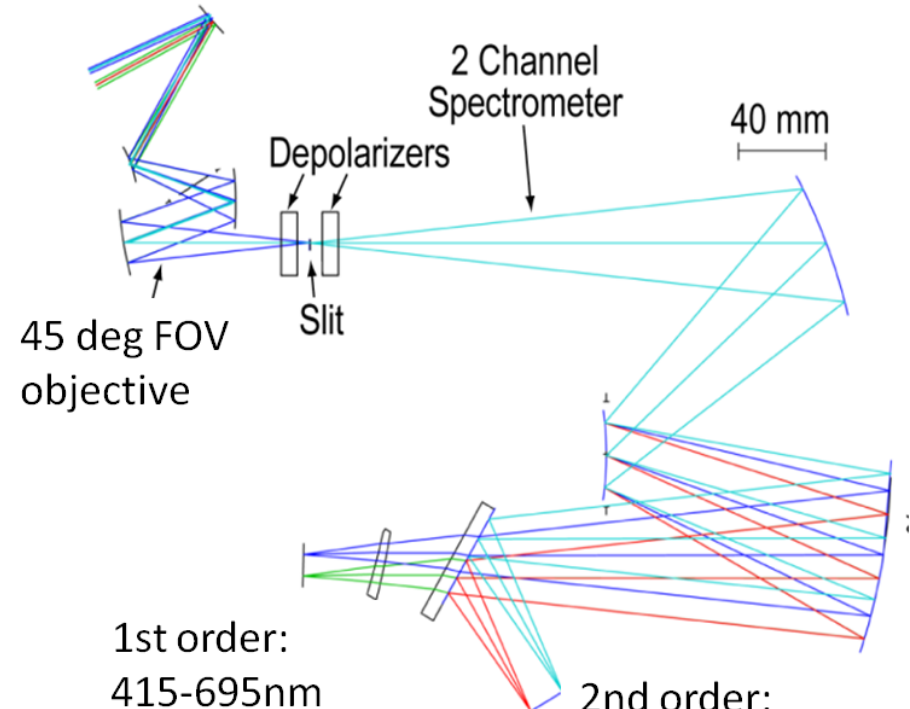
Agility to Innovate, Strength to Deliver



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Sensor Concept Overview

- Airborne nadir-viewing wide-swath imaging spectrometer
- Two channel spectrometer uses:
 - 1st order diffraction for Visible
 - 2nd order diffraction for UV
- Dichroic beamsplitter and spectral filtering key elements in multi-order design
- Polarization: Low polarization sensitivity telescope and electronic depolarizer for spectrometer
- Field-swappable spectrometer slits to change spectral passband and sampling





GeoTASO Status

- **NASA ESTO funded project close to completed:**

- Demonstrated multi-order spectrometer for air quality measurements
- Fielded reconfigurable airborne system and collect real scene data
- Used data to test air quality retrieval algorithms

- **Airborne system**

- Sensor, data collection/control system, zenith fiber port, and nadir port window form system
- Configured to fly on NASA's Falcon HU-25C airplane
- Mount/window can be adapted for other platforms

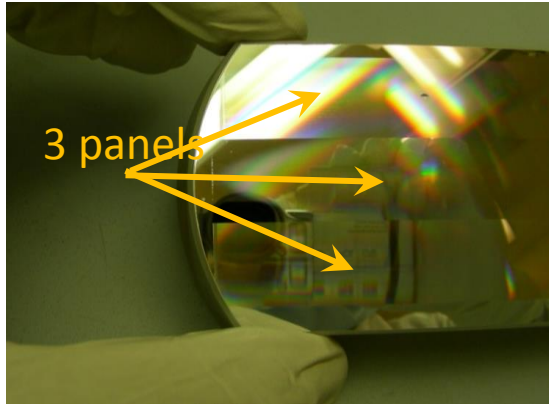
- **Flight data**

- Have data from flight tests in Virginia and flight campaign in Houston (w/DISCOVER-AQ)
- Data (including viewing/solar information) available in HDF5 format
- Have data for a variety of scenes, different altitudes, different slit sizes, different times of day

- **Calibration data**

- Measurements mainly from testing at Goddard
- Calibration includes radiometric, polarization
- Working with algorithm team to improve Level 1b data

Key Optical Components Developed



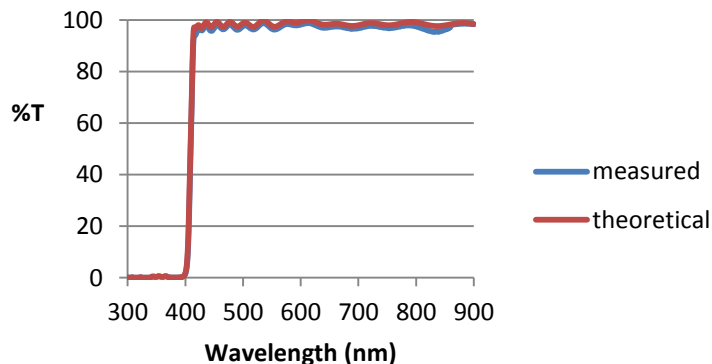
Offner spectrometer grating:

- Offner form of spectrometer ideal for spectral imaging, but needs convex, blazed grating
- Second attempt grating meets requirements:
 - High efficiency peaked at 310 nm
 - Low scatter/ghosting

Spectral filtering:

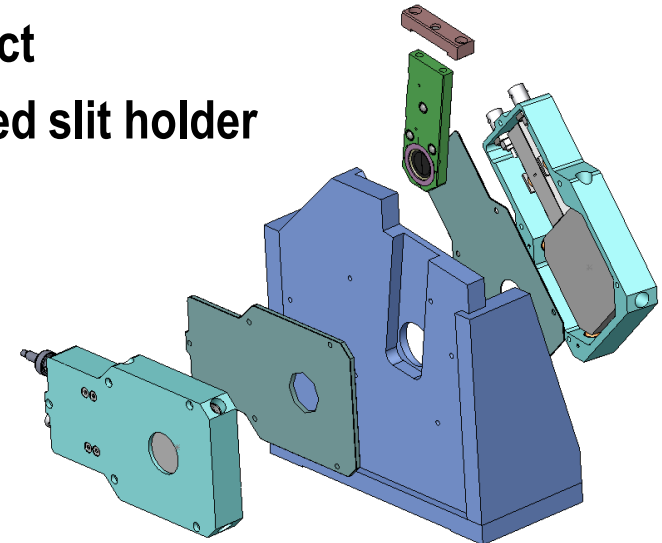
- Needs good rejection of unwanted wavelengths

Dichroic



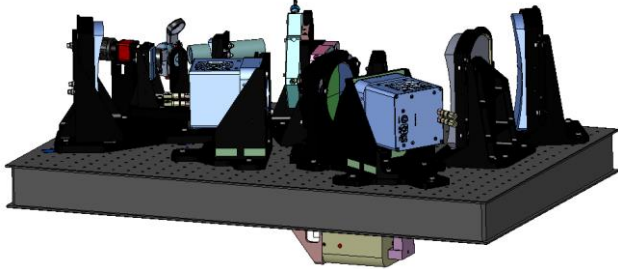
Depolarizer/Changeable slit assy:

- Electronic depolarizer from PolZero ACT project
- Precision-registered slit holder for field slit swaps

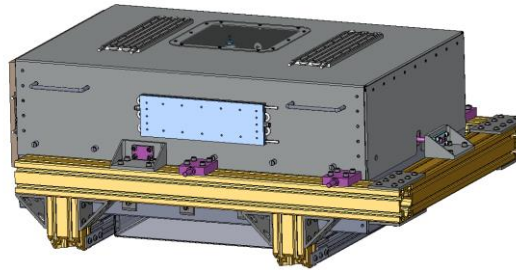


Sensor Design and Assembly

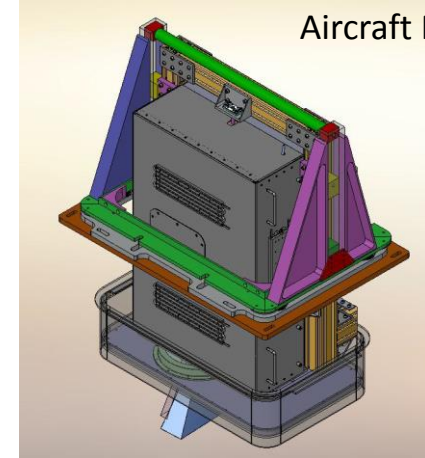
Optical Bench



Thermal Enclosure and Frame



Aircraft Mount



Langley's Falcon HU-25C



GeoTASO on the Falcon



Parameter	Value
Max altitude	12 km
Swath	9 km
Ground spot	40 x 80 m
Ground sampling	10 x 50 m
Single pixel SNR	20 – 50

Flight Campaign Overview



- **July test flights over VA and Chesapeake Bay**

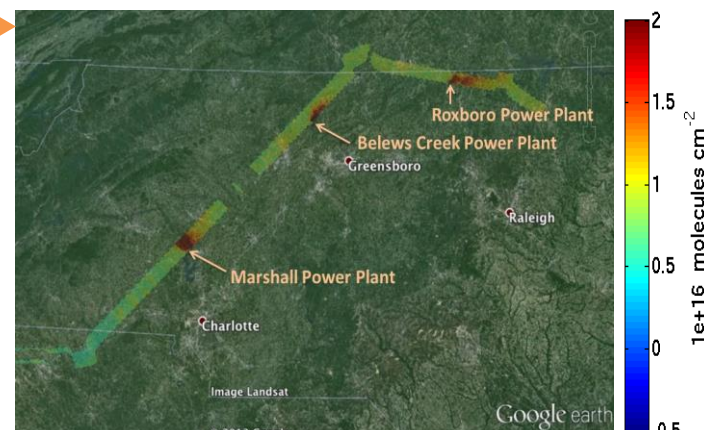
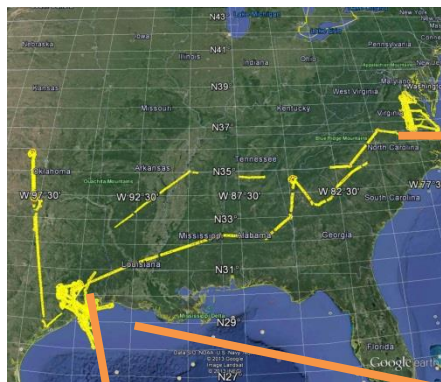
- Land/water and urban/rural sites
- Overflight of Langley ground site
- Duplicated ACAM test flight path

- **September Houston campaign:**

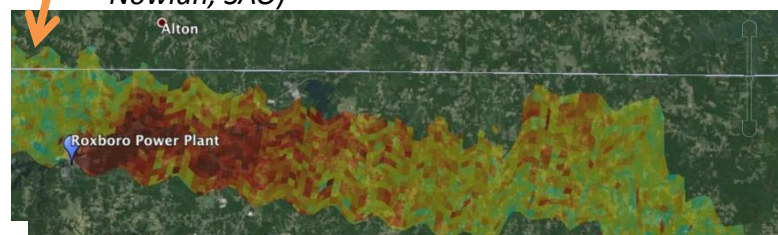
- Coflights with B200 (ACAM and HSRL) over urban sites
- Coflight with B200 over Gulf out to GeoCAPE boat
- Different slit widths on different days
- Tested depolarizer effect over land/water

- **32 total flight hours of data**

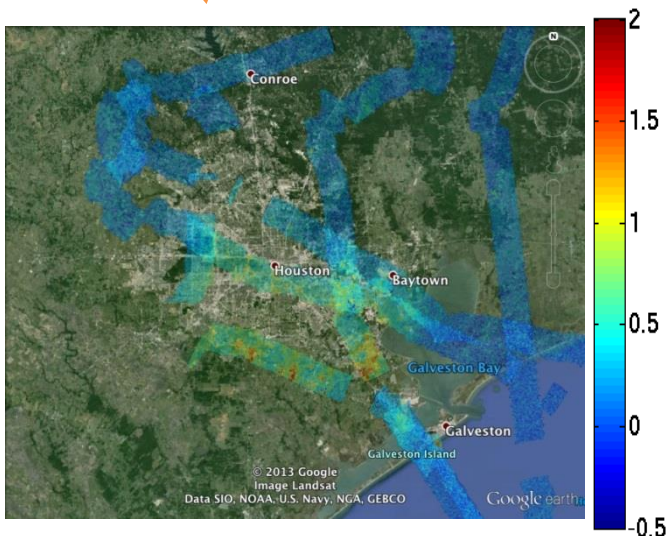
Flight Data and Retrieval Highlights



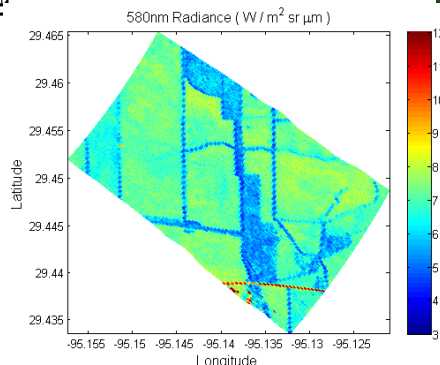
NO₂ slant columns measured over North Carolina's three largest coal power plants on 24 September 2013 at ~500 × 500 m resolution during flight home from Houston to NASA Langley. (courtesy Caroline Nowlan, SAO)



Closeup of the Roxboro Steam Plant NO₂ plume. GeoTASO measured enhanced NO₂ >40 km downwind of the plant. (courtesy Caroline Nowlan, SAO)



NO₂ slant columns measured over Houston on 24 September 2013 at ~500 × 500 m resolution. GeoTASO flew the same ground tracks as the DISCOVER-AQ team to enable direct comparisons. (courtesy Caroline Nowlan, SAO)



Surface reflectance studies tie radiance levels to features like trees (blue) and green grass (yellow-green) to develop a spectral reflectance model. (courtesy Jun Wang, U Nebraska)

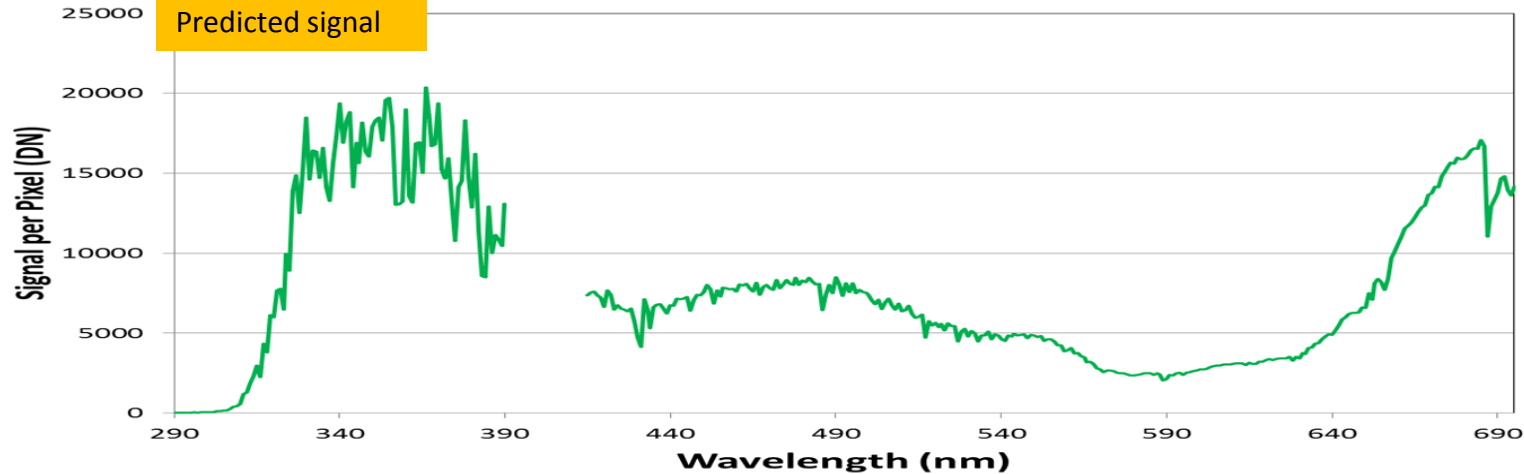


Initial Spectral Signal Measurements

Nadir view radiance (over forest)



Predicted signal



Measured spectral signal close to predictions



- **Aerosols and surface reflectance**
 - Specific bands of interest identified and flight data examined
 - Comparison of model-predicted radiance and measured radiance shows need for absolute radiance calibration of the visible channel
- **Trace gas pollutants:**
 - NO₂ retrievals using flight and zenith sky data from 420nm to 460nm show high sensitivity
 - HCHO retrievals using 330-360 nm show need for better fixed pattern calibration/characterization of UV channel
- **Instrument characterization**
 - Line shape
 - Wavelength calibration

Upcoming GeoTASO Activities

- **Calibration and data processing at Ball**
 - Characterize UV stray light
 - Use Ball calibration sphere for full field radiometric calibration
 - Reprocess flight data with new calibration values
 - Lineshape scans using tunable laser (funds permitting)
- **Flight planning and campaigns**
 - Flying July 23 – Aug ? on Falcon in Front Range area of Colorado with DISCOVER-AQ and FRAPPE campaigns (59 hrs flight time funded)
 1. Coincident D-AQ tracks overflying B-200 with ACAM for data validation
 2. Diurnal studies flying D-AQ flight tracks with two sorties per day for morning-midday-afternoon-evening comparisons
 3. GEO-CAPE atmosphere retrieval studies: low pass and high pass over same site to validate ground return subtraction from retrievals. Perform over different terrain types - plains, vegetated forest, urban, foothills.
 4. Raster scans over Denver for AQ map.

