The GeoTASO IIP Project to Support GeoCAPE Atmospheric Science

Jim Leitch

Ball Aerospace
jleitch@ball.com
303-939-5280

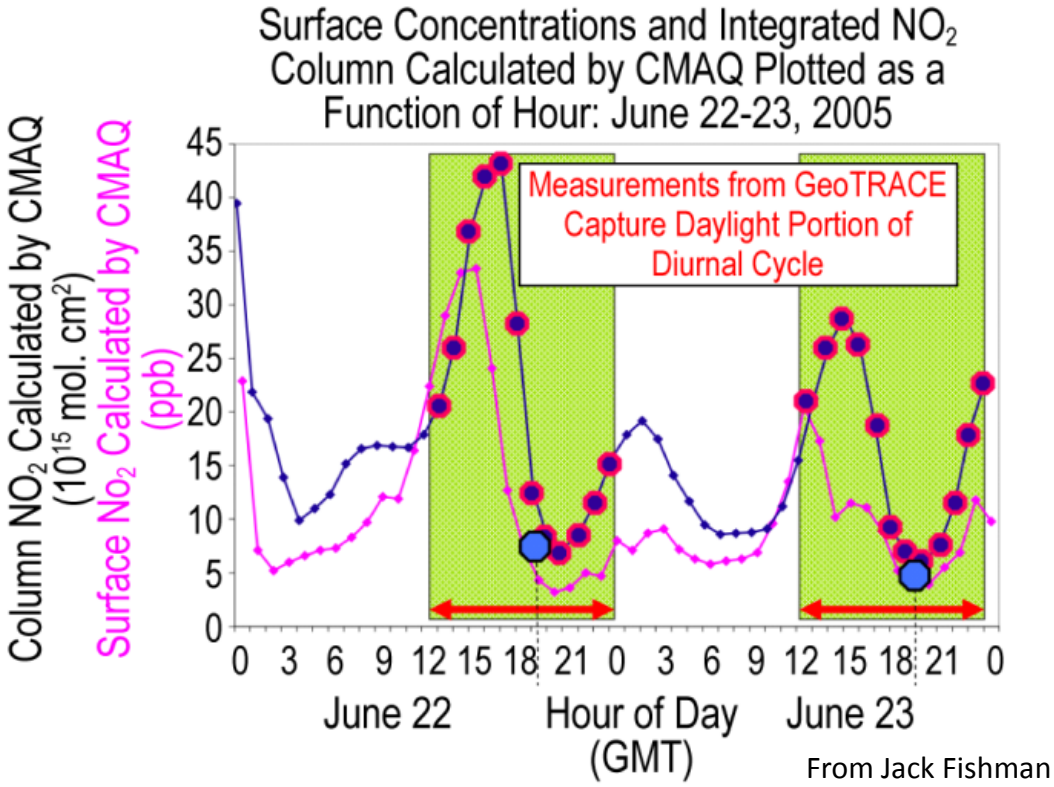
Ball Aerospace
& Technologies Corp.

Agility to Innovate, Strength to Deliver

GeoCAPE Atmospheric Science

- Measurements of aerosols and trace gases in the troposphere, especially close to the ground
- Geostationary observations for multiple measurements each day (as frequently as hourly)
- Possible Sensors: UV/Vis Spectrometer, IR GFCR, FTS

Gases
Ozone (O3)
Nitrogen Dioxide (NO2)
Sulfur Dioxide (SO2)
Formaldehyde (HCHO)
Glyoxal (CHOCHO)
Methane (CH4)
Carbon Monoxide (CO)

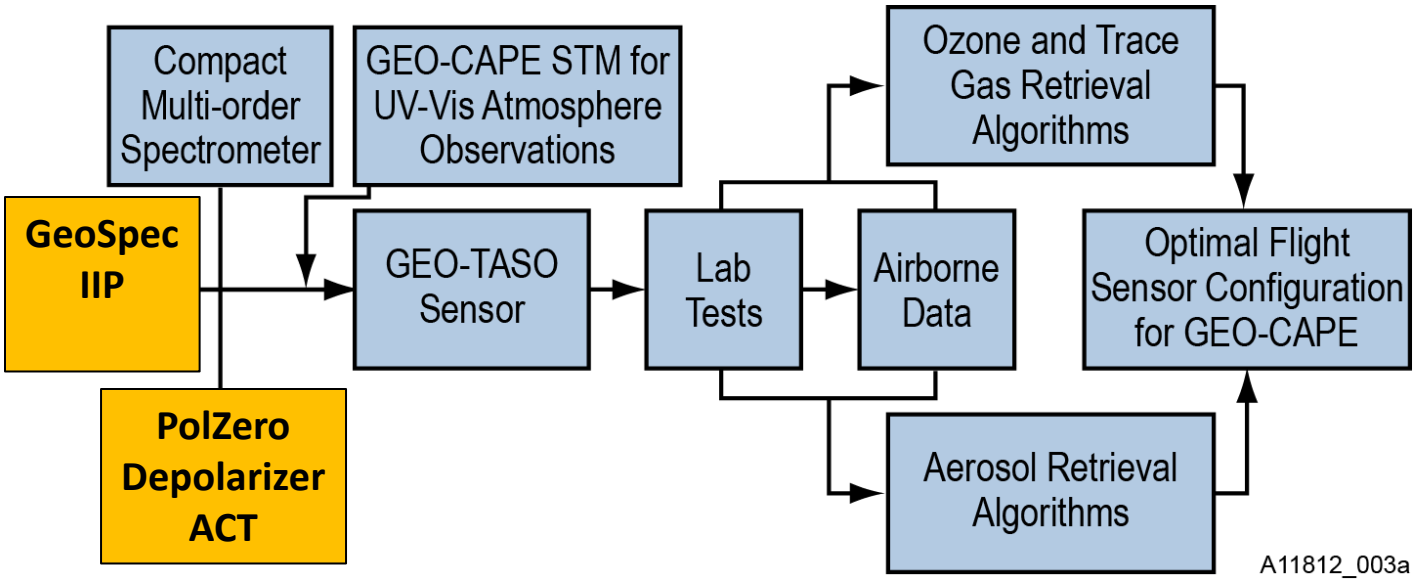


From Jack Fishman

GeoTASO Will Bridge the Science to Sensor/Algorithm Requirements Gap

Project goals:

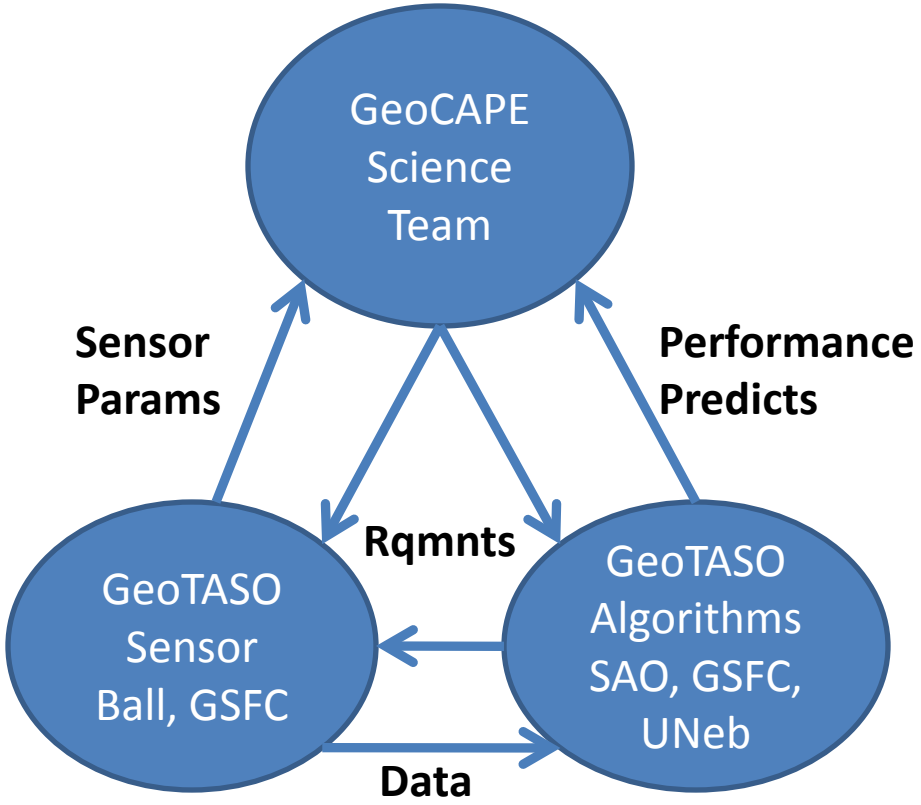
- Demonstrate a compact sensor configuration for a UV-Vis spectrometer
- Test spectral parameter dependence of retrievals
- Collect real scene data from an airborne platform to test retrievals and advance retrieval algorithm readiness



Project draws from previous ESTO-funded work on spectrometers (GeoSpec) and depolarizers (PolZero) and from retrieval studies

GeoTASO Team

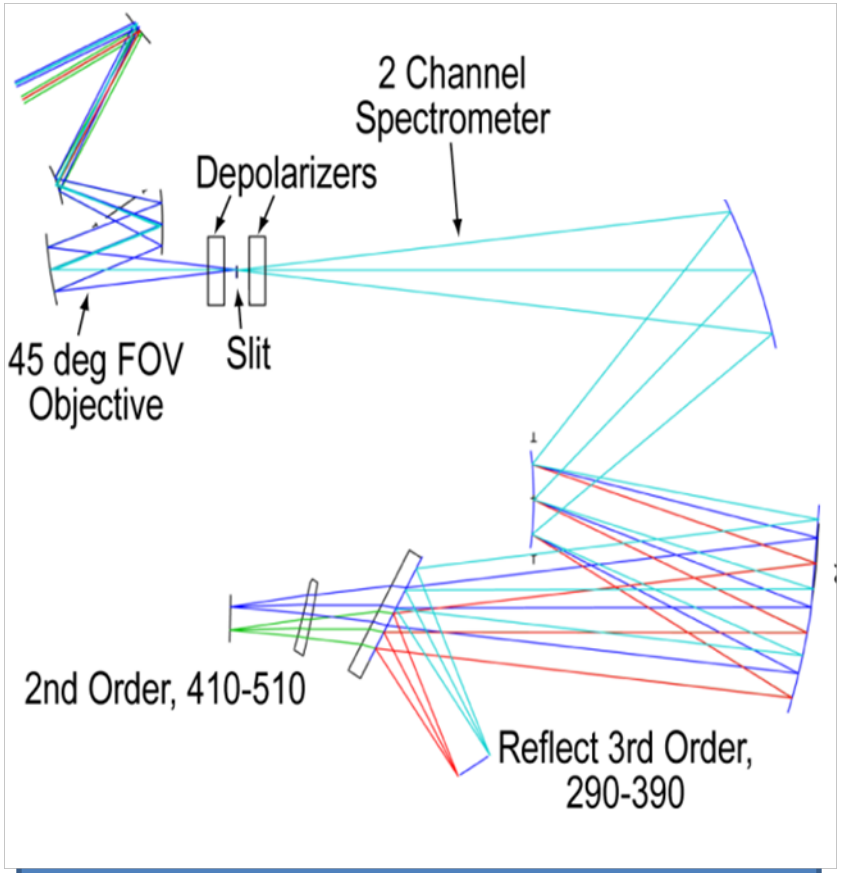
- Ball Aerospace
  - Jim Leitch, Principal Investigator
  - Tom Delker, Sensor Technical Lead
  - Bill Good, Airborne Measurements
- NASA/GSFC
  - Scott Janz, Instrument Requirements, Sensor Advisor
  - Ken Pickering, Science Requirements, Campaigns
  - Nick Krotkov, Science Requirements, Trace Gas Retrievals
- Harvard/SAO
  - Kelly Chance, Trace Gas Retrievals, Instrument Requirements
  - Xiong Liu, Ozone Retrievals, Instrument Requirements
- U Nebraska
  - Jun Wang, Aerosol Retrievals, Science Requirements



GeoTASO Sensor: Multi-order Offner Spectrometer

- Spectrometer
  - Multiple diffraction orders from grating
  - Orders are spatially overlapped
  - Dichroic split of two spectral ranges
- Dichroic beamsplitter and filters for detectors are critical components
- Two designs under consideration:
  - High spectral resolution (290-510nm)
  - Extended spectral coverage (290 – 785nm)

Feature	Use
Wide-angle telescope	Match OMI footprint
Time Domain Depolarizer	Reduces sensor polarization sensitivity with very little blur
Replaceable slit	Easily change spectral passband/sampling values



Overlapping diffraction orders keep spectrometer small

Trade Space and Spectral Parameters

Spectral Sampling	Spectral Passband UV / Vis	Comment
2	0.2 / 0.3	Minimally sampled
3	0.3 / 0.45	Captures passband asymmetry
4	0.4 / 0.6	Highest sampling

Selectable Spectral Sampling/Passband

- Replaceable slit allows change of spectral parameters
- Gives data for retrieval tests using several passband/sampling combinations

Multi-order spectrometer options

- Can extend spectral coverage if passbands relaxed
- Change in coverage moves split between channels
- Cases given here are at 3 samples per passband FWHM

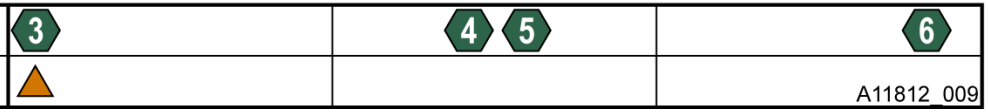
Parameter	Original Design	Extended Range Design
Spectral Range	290 – 510 nm	290 - 785 nm
Spectral passband	0.3 nm (UV) 0.45 nm (Vis)	0.57 nm (UV) 0.86 nm (Vis)
Spectral Split Posn	400 nm	490 nm

Trace Gas and Aerosol Retrieval Tests

- Verification of algorithm sensitivity studies
  - Retrieval dependence on spectral sampling, SNR, spectral passband
- Test of retrievals using real scene data
  - High spatial scale and spectral scale data to be used
- Comparison with space-based measurements using underflights of OMI
  - Sensor FOV matches OMI footprint
  - Tests of spatial scale effects from oversampled OMI footprint
- Tests of algorithm approaches and fitting details
  - Optimal estimation versus nonlinear least-squares fitting of AMF-normalized reference spectra
  - Aerosol and cloud interference
  - Albedo variation at visible wavelengths

Project Timeline and Planned Activities

SOW Task	Task Description	Year 1	Year 2	Year 3
1	Mission & Systems Engineering			
2	Instrument Development			
3	Assembly, Integration & Test			
4	Instrument Performance Testing			
5	Flight Testing			
6	Trace Gas Retrievals & Final Report			



- Year 1: Requirements, Design, Procurements/Fabrication
- Year 2: Assembly/Alignment, Lab Tests, Calibration, Algorithm Prep
- Year 3: Flight Campaigns, Retrievals

GeoTASO Project Summary

- Initial trades and requirements work based on STM, algorithm sensitivity studies
- Compact, 2-channel spectrometer offers lower mass approach for space sensor
- Sensor-algorithm system development and test through GeoTASO prepares full science measurement chain for the GeoCAPE mission
- Project start date: Now?