GeoTASO Retrieval Activities at JPL: First Results

Thomas P. Kurosu, Vijay Natraj, Jessica L. Neu

Jet Propulsion Laboratory/California Institute of Technology, Pasadena, CA

2015 GEO-CAPE Workshop
31 August 2015
EPA, NC

Summary

GeoTASO (Geostationary Trace Gas and Aerosol Sensor) is an airborne, 2-channel UV/Vis imaging spectrometer, built by Ball Aerospace and designed and operated to advance mission-readiness of the upcoming Earth Venture TEMPO mission. GeoTASO is covers the spectral range of 290–390 nm (UV) and 415–695 nm (VIS) with about 0.4 nm (UV) and 0.9 nm (VIS) spectral resolution. The nominal measurement mode is downward looking (nadir), interspersed with short periods of upward looking (zenith) observations. The swath covers ~8 km across-track with 50 m x 80 m ground patch resolution. Co-adding of individual measurement spectra both along- and across-track to achieve higher signal-to-noise is required before performing trace gas retrievals.

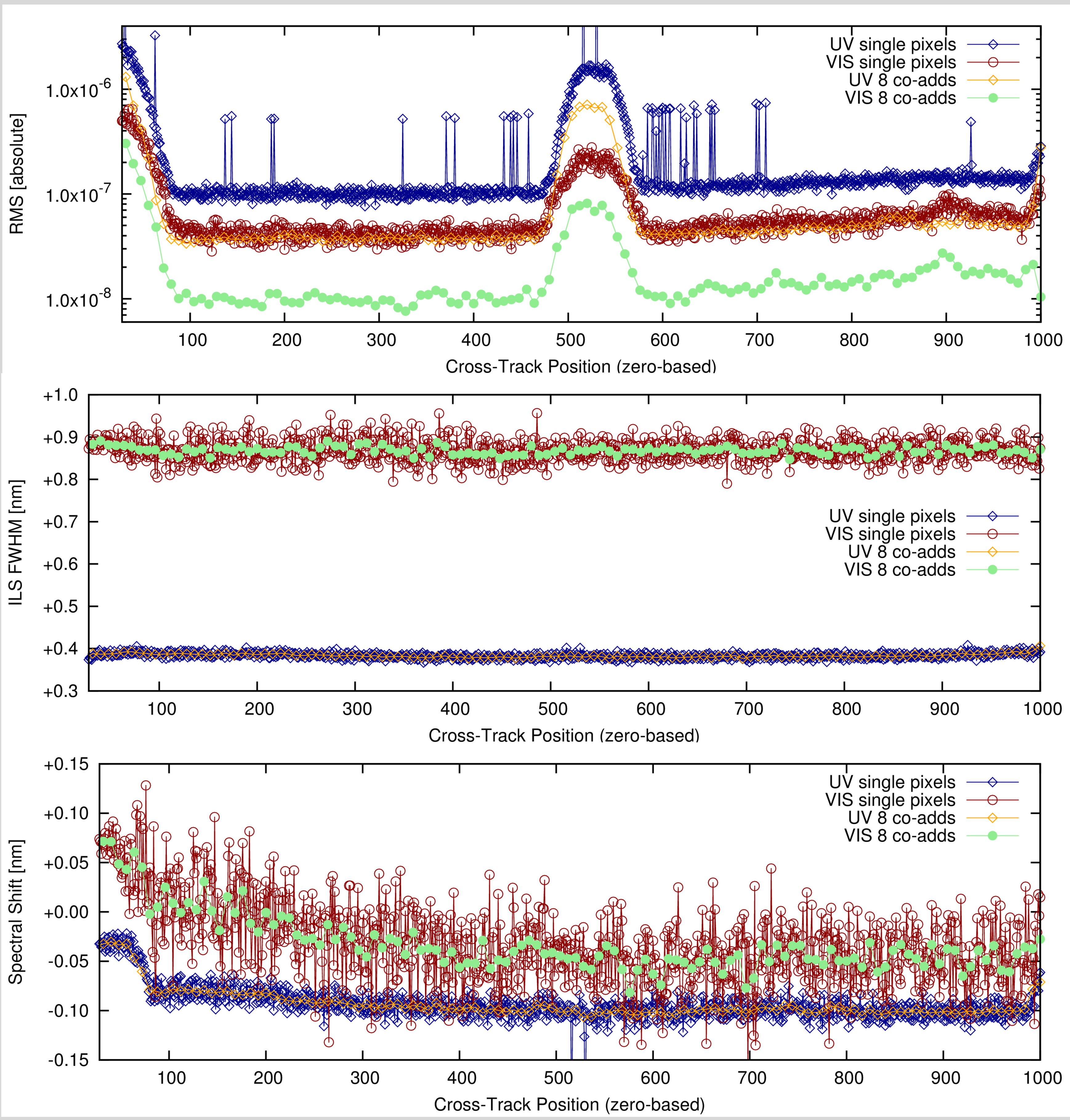
JPL activities to date have focused on the adaptation of a JPL-developed proto-type non-linear least squares spectral fitting algorithm newly developed for processing of Suomi NPP/OMPS satellite observations. The ultimate goal is the combination of the spectral fitting algorithm with fast radiative transfer methods also developed at JPL, as well as existing JPL tools for atmospheric profile retrievals. The preliminary results presented here are from the initial application of the spectral fitting code to a portion of the GeoTASO Denver deployment on 11 August 2014. This application proved more challenging than expected due to the difficulties in the adaptation of satellite-specific code for aircraft observations and the comparably low signal-to-noise GeoTASO spectra themselves. While O_3 slant columns can be retrieved with confidence, NO_2 signals are still mostly elusive. Calibration parameters like the instrument line shape and spectral shift can be retrieved from both nadir and zenith viewing observations.

The immediate next steps will focus on the optimization of co-adding and fitting window approaches for O_3 and NO_2, followed by the implementation of fast radiative transfer for the derivation of actual vertical columns. Finally, profile retrieval capabilities will be added to the JPL GeoTASO retrieval tool. The retrieval of smaller trace gases like CH2O will not be explored until the main targets of O_3 and NO_2 can be retrieved with confidence.

Zenith Mode Calibration Fits

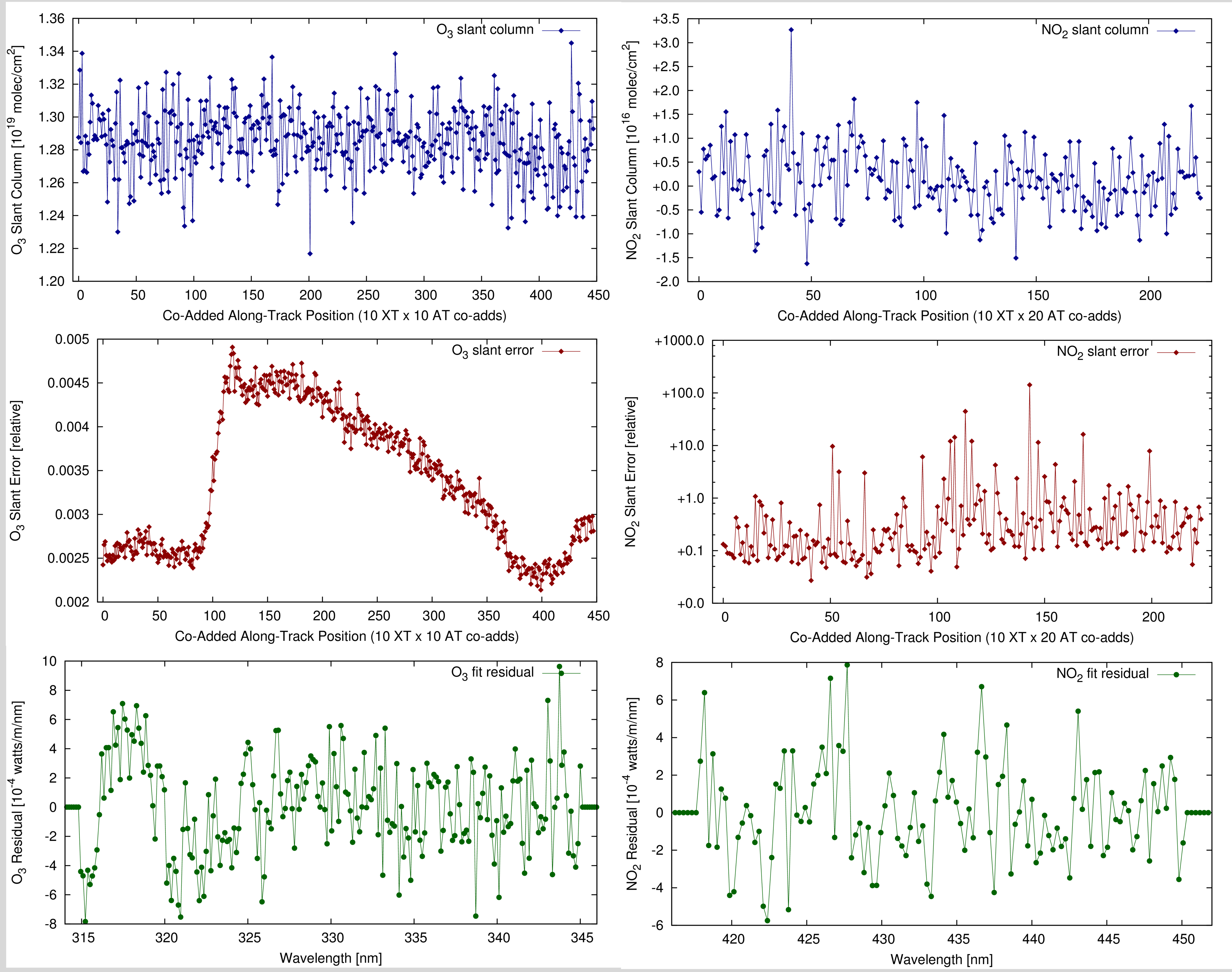
In the upward-looking zenith mode observations, only the central portion of the CCD gets illuminated by a small optical fiber, while the outer portions of the CCD essentially record stray light. Nevertheless, the recorded light across the CCD is sufficient (provided high enough co-adding) to perform calibration retrievals for instrument line shape (ILS) and spectral shift.

The images below show results for calibration fits to the spectra from one period zenith sky observations ("20140811_11-05-49"). For each of the 1033 cross-track positions, all 123 along-track spectra have been co-added. Retrievals have been performed for the UV (310 – 360 nm) and VIS (420 – 460 nm), on the both single and 8 co-added cross-track positions. The RMS (top plot) illustrates the different illumination conditions between the fiber-illuminated center (the "hump") and the straylight-illuminated outer part of the CCD. However, neither the retrieved ILS parameters (full width at half maximum, FWHM; middle) nor the spectral shift (bottom) depend on the CCD illumination conditions.



O_3 and NO_2 Slant Column Fits

A nadir segment in the middle of the 2014-08-11 Denver flight ("11-32-57", 4,473 along-track nadir observations) has been processed with the preliminary JPL retrieval tool for O_3 (spectral window 315–345 nm) and NO_2 (418–450 nm). Radiances have been fitted against the standard *Chance&Kurucz* 2010 Kit Peak solar spectrum. For each retrieval, 10 cross-track positions (#511–520) and either 10 (O_3) or 20 (NO_2) along-track spectra have been co-added. While the retrieval performance for O_3 is highly encouraging, NO_2 suffers from large retrieval uncertainties. More algorithm tuning is clearly required.



Level 1 HDF-EOS5 to netCDF4 Conversion

GeoTASO Level 1 (L1) data are currently released in HDF-EOS5 format, and the contiguous measurements are chunked into multiple files. For improved compatibility with commercial and open source software applications, a Python 3 script has been developed that reformats the L1 data files to netCDF4 output, into a single file for each contiguous nadir/zenith period (separate for UV and VIS), correctly ordered according to increasing wavelengths. This script is available upon request from thomas.kurosu@jpl.nasa.gov.