Version 7 of the OSIRIS Ozone Data Product

Algorithm Upgrades to the Radiative Transfer Model, Instrument Point Spread Function, and Satellite Pointing Solution

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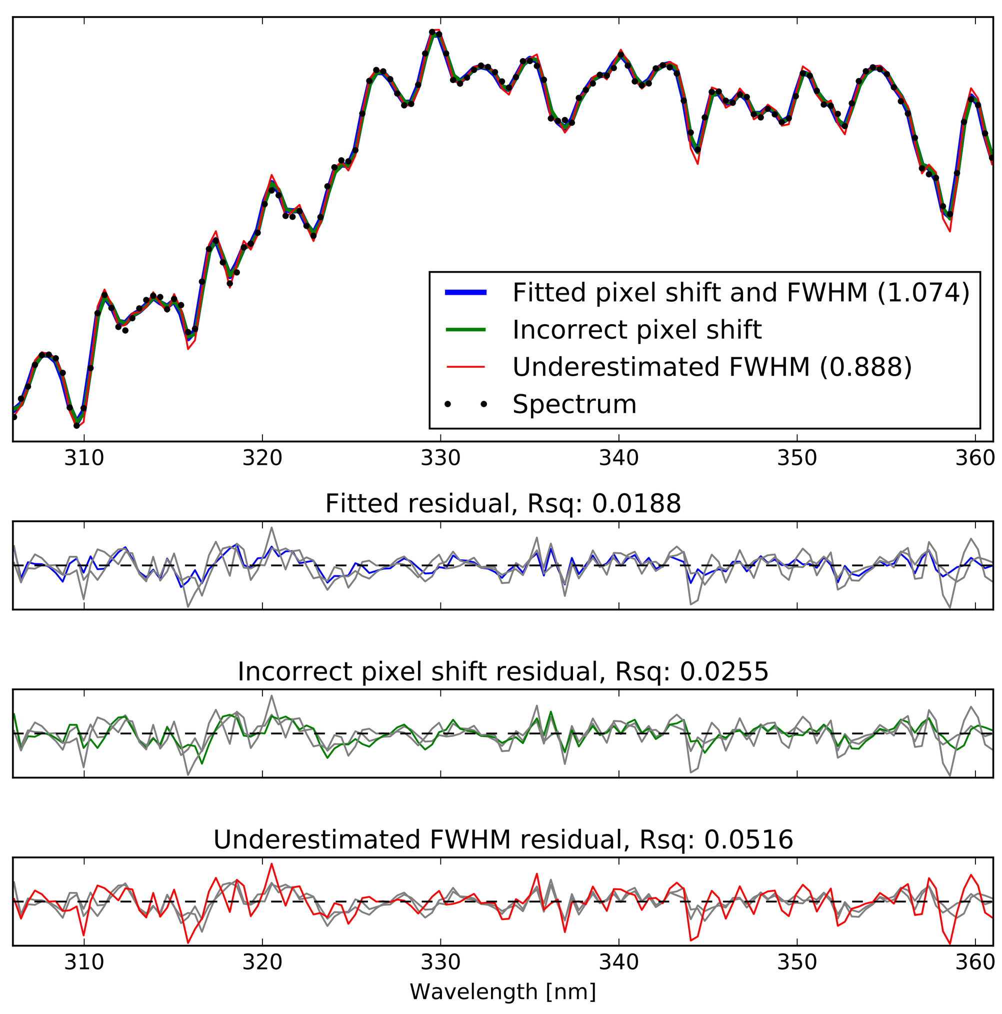
Introduction

The longevity of the Odin mission (15 years) coupled with the quality measurements of the OSIRIS instrument has made the ozone data product a useful and popular data set.
Three major upgrades to our current processing chain will be implemented in our next round of data processing (version 7):

- improved accuracy in modelling the instrument point spread function and wavelength shift of the OSIRIS optics
- accounting for the shift in altitude of the retrieved profile due to drift in the satellite attitude solution, and
- algorithm upgrades to the radiative transfer model (the forward model in the retrieval).

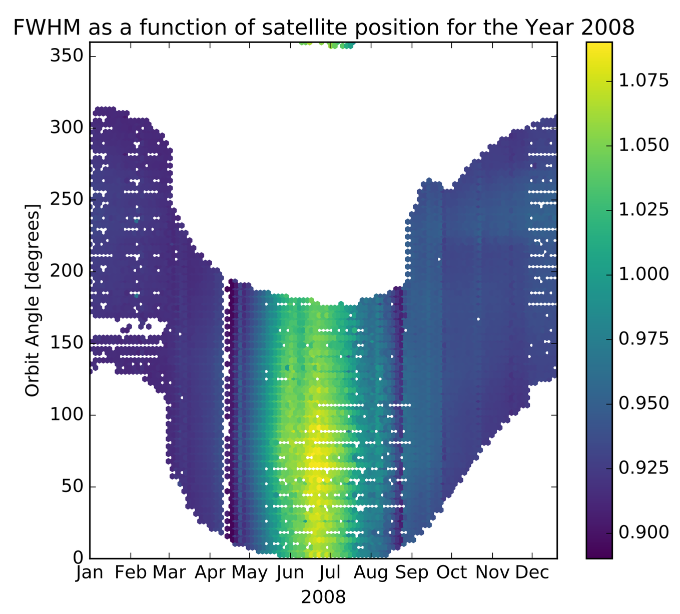
Instrument Point Spread and Pixel Shift

An improved time-dependent characterization of the instrument point spread function and wavelength (pixel) shift of the OSIRIS optics will be applied to the next round of processing which will diminish biases in the data due to seasonal environmental changes of the satellite bus.
The instrument point spread function of the 5.07 data products has been upgraded to use substantially more spectral points (thereby reducing the error in the parameter estimation), and improved estimates of the ozone cross section and solar spectrum (BDM and SAO2010, respectively). The new method uses a non-linear least-square optimization to find the best-fit instrument point spread parameter (which has a blurring affect on the observed spectrum) across 141 pixels (between 306 nm and 361 nm) and wavelength shift (which creates a small shift to the pre-flight pixel/wavelength calibration.)

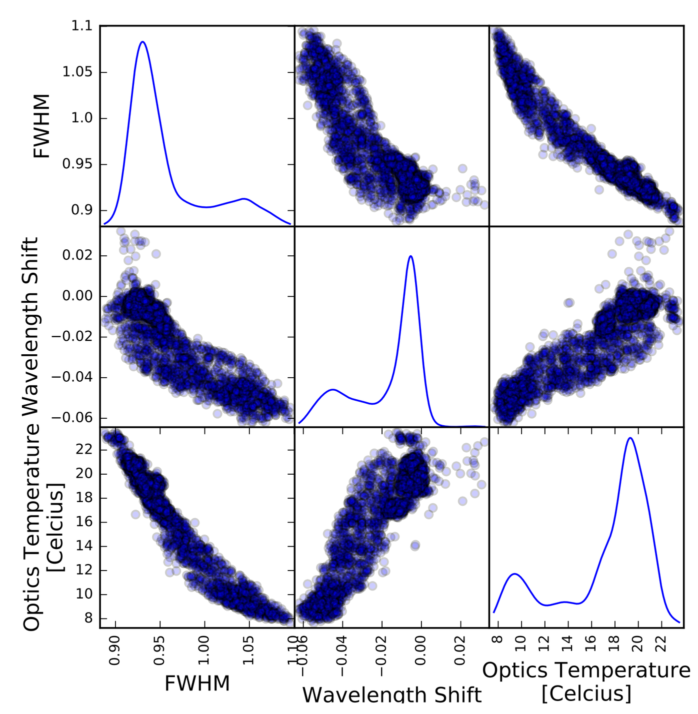


The UV portion of the OSIRIS spectrum at 50 km (black) is fitted with the convolved solar spectrum and attenuated by a convolved ozone cross section. The convolution parameter of both the cross section and solar spectrum is fit as well as the shift in wavelength (blue). Two improperly fitted computed spectra are shown for comparison; green showing an incorrect pixel shift, and red showing an incorrect convolution size.

When plotted, the fit parameters computed by the new algorithm properly match the known behaviour of the OSIRIS instrument during the eclipse portion of its orbit (during summer). While in eclipse, the optics temperature, causing an increase in spectral blur and a small shift (0.15 pixel) across the detector.



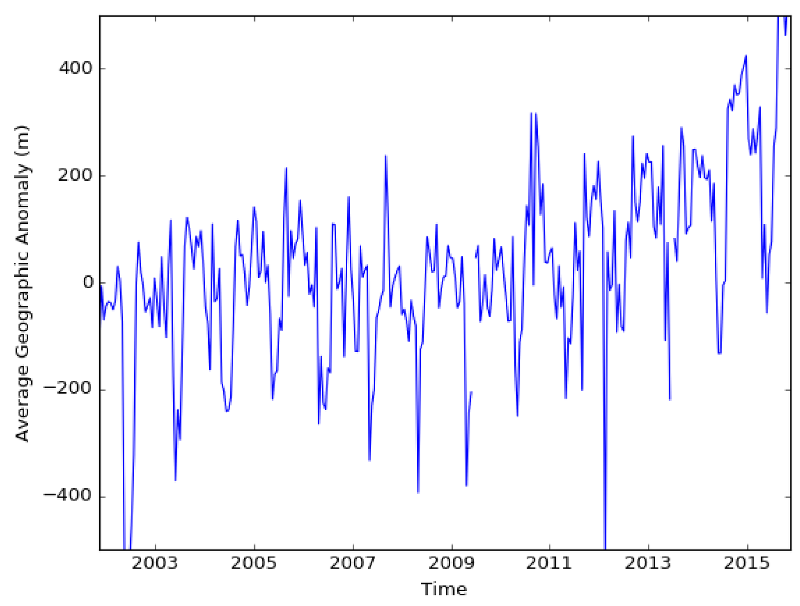
The fitted FWHM parameter as a function of time and satellite orbit angle. During the summer when the satellite goes into eclipse, the temperature of the optics decreases and the detected spectra blurs.



The two fitted parameters (FWHM and wavelength shift) correlated to each other and to the instrument temperature. When the instrument optics cool, the detector experiences both a small shift in wavelength and an increased blur.

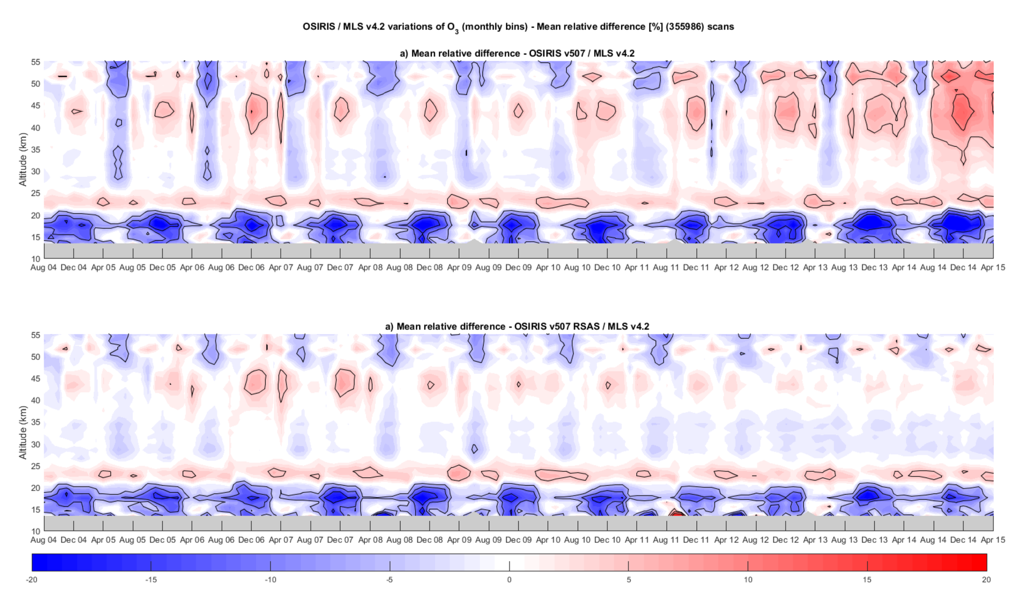
Pointing Correction

Every summer, the sun-synchronous orbit of Odin brings the satellite into an eclipse period. The reduction in solar energy incident on the Odin spacecraft has a net cooling effect on the OSIRIS instrument. It is believed that thermal expansion/contraction causes OSIRIS to twist slightly out of alignment with the Odin star trackers and therefore register a tangent altitude with an offset of $\sim$400 m.
To account for the registration offset, Rayleigh Scattering Attitude Sensor (RSAS) values are calculated for every scan in the OSIRIS mission. Individual RSAS values are smoothed over a day to reduce the measurement noise. The altitude correction is then applied to the data products.



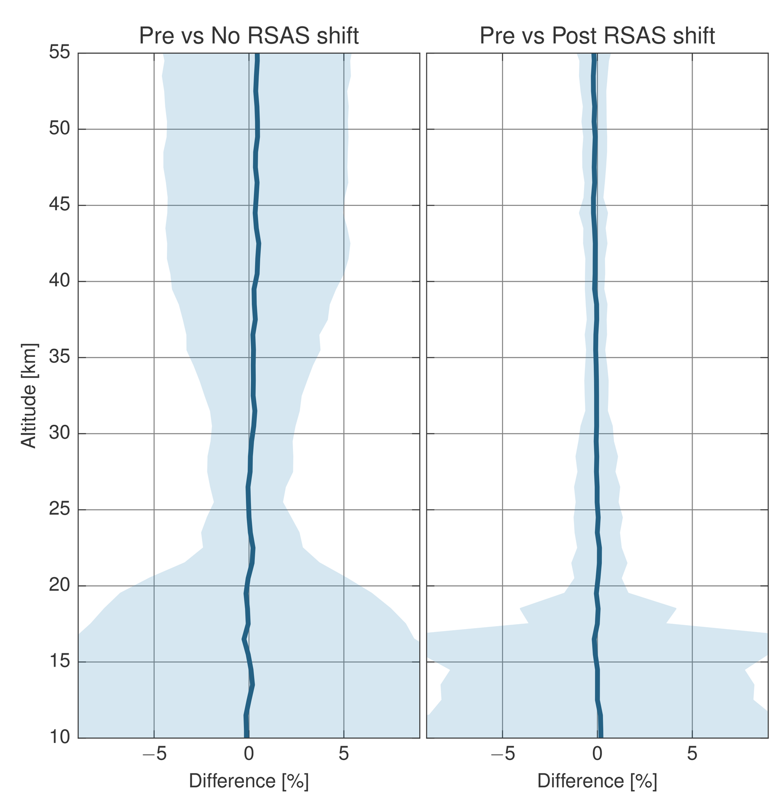
The altitude correction calculated from the OSIRIS RSAS data. The y-axis shows the adjustment that is made to the altitude of the data.

The result of applying the adjustment is twofold: it reduces the anomalous seasonal variation in the data products as well removing the overall drift in the dataset.



The mean differences between the post-retrieval altitude corrected OSIRIS ozone product and the MLS ozone product as a function of time and altitude. The seasonal biases are largely reduced. Additionally, the overall drift between the two datasets has disappeared altogether.

For the next round of processing the altitude corrections will be applied prior to the retrievals (to the lines of sight) instead of as a post-retrieval correction as is done with 5.07. Preliminary studies show that the difference in individual scans is in the range of 5–10% below 20 km and that the mean profiles do not change.



The difference in applying the RSAS correction to the lines of sight prior to the retrievals (version 7) compared with after the retrievals.

Radiative Transfer Upgrades

Significant upgrades to the radiative transfer model include improvements in calculating the diffuse field, which particularly affects modelling shorter wavelengths at high instrument solar zenith angles.
Other radiative transfer model improvements include:

- migrating to the ECMWF ERA-Interim air density and temperature products as inputs to the forward model.
- improved integration techniques (line of sight and diffuse field)