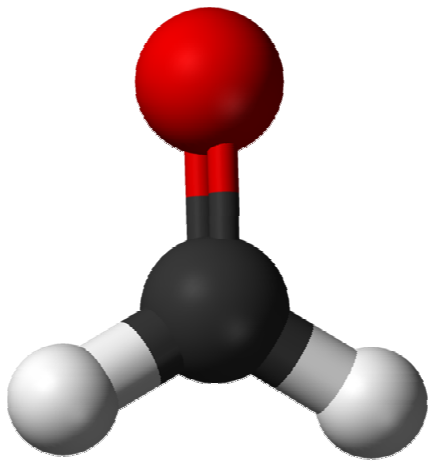
Update on OMI formaldehyde total column retrieval



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Owerview

- Formaldehyde in the atmosphere
- Ozone Monitoring Instrument
- The operational retrieval
- Known issues of the operational retrieval
- Intended upgrades to the operational retrieval
  - Spectroscopy
  - Monthly average irradiance
  - Row anomaly
  - Fitting outliers treatment
  - AMFs weighted reference cross sections

Formaldehyde in the atmosphere

- Product of volatile organic compounds oxidation it can be used as proxy for them
  - Biogenic activity
  - Pyrogenic activity
  - Anthropogenic emissions
- Background levels linked to methane oxidation
- Short atmospheric lifetime therefore suitable candidate for studies of VOCs surface emissions

Ozone Monitoring Instrument (OMI)

- Visible: 350 – 500 nm
- UV:
  - UV-1 270 – 314 nm
  - UV-2 306 – 380 nm
- Spectral resolution: 1.0 – 0.45 nm FWHM
- Spectral sampling: 2 – 3 for FWHM
- Detector CCD: 780 x 576 (spectral x spatial) pixels
- Duty cycle: 60 minutes on daylight side
- IFOV: 13 x 24 km

The operational retrieval

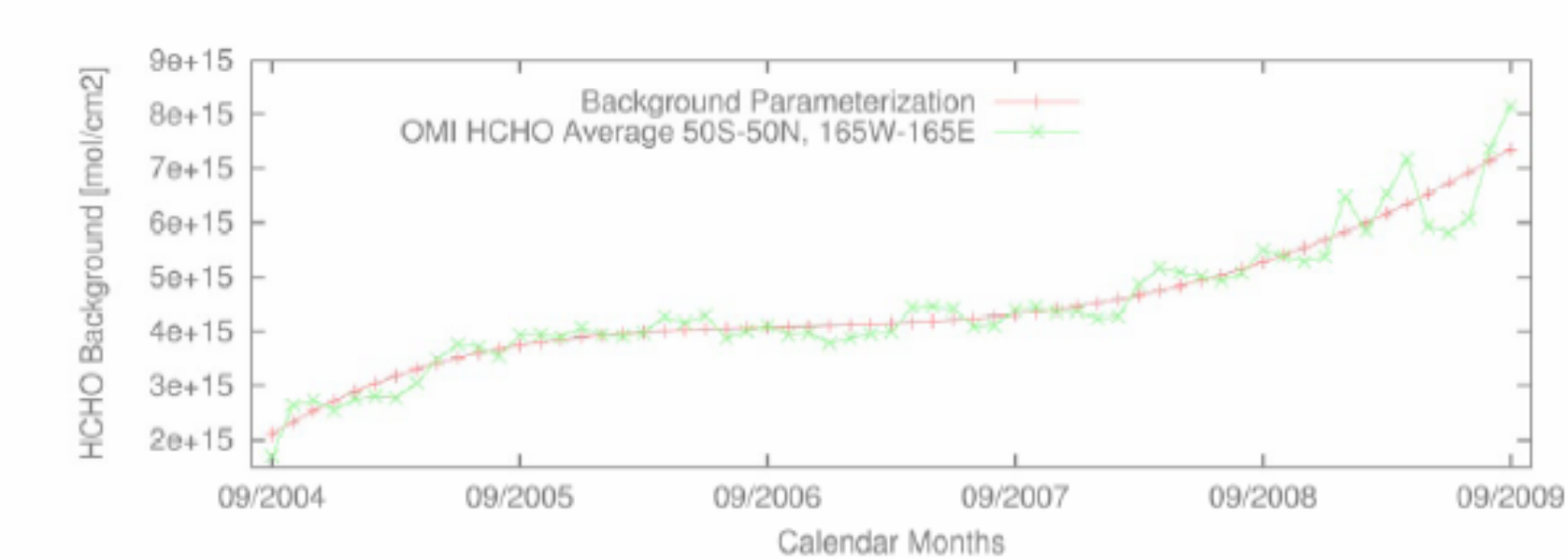
- Two step retrieval, boas fit of slant columns + AMFs to convert to vertical column density
- AMFs calculated using LIDORT and GEOS-Chem climatologies at 328 nm

Summary of Algorithm Fitting Specifics

Fitting window	327.5 – 356.5 nm
Baseline polynomial	3rd order
Scaling polynomial	3rd order
Instrument slit function	Hyper-parameterization of pre-flight measurements
Wavelength calibration	Spectral shift (no squeeze)
Solar reference spectrum	Kurucz, 1995
HCHO cross sections	Cantrell *et al.*, 1990; 300K
O_3 cross sections	Malicet *et al.*, 1995; 228K
NO_2 cross sections	Vandaele *et al.*, 1998; 220K
BrO cross section	Wilmouth *et al.*, 1999; 228K
Molecular Ring cross sections	Chance and Spurr, 1997
Sampling correction	Computed on-line
Residual common mode spectrum	Computed on-line

Known operational retrieval issues

- No row anomaly flagging
- Across-track striping in the data product
- Increasing values of the background concentrations along the mission
- Increasing values of the fitting RMS along the mission



(Kim et al., 2011 ACPD)

Intended upgrades to the operational retrieval

- Spectroscopy updates
- Monthly average irradiance calibration to replace the 3 year solar composite
- Row anomaly flagging
- New approach to deal with the outliers in the fitting residuals
- Implement AMF-weighted cross-sections for direct retrieval of total vertical density columns

Spectroscopy updates

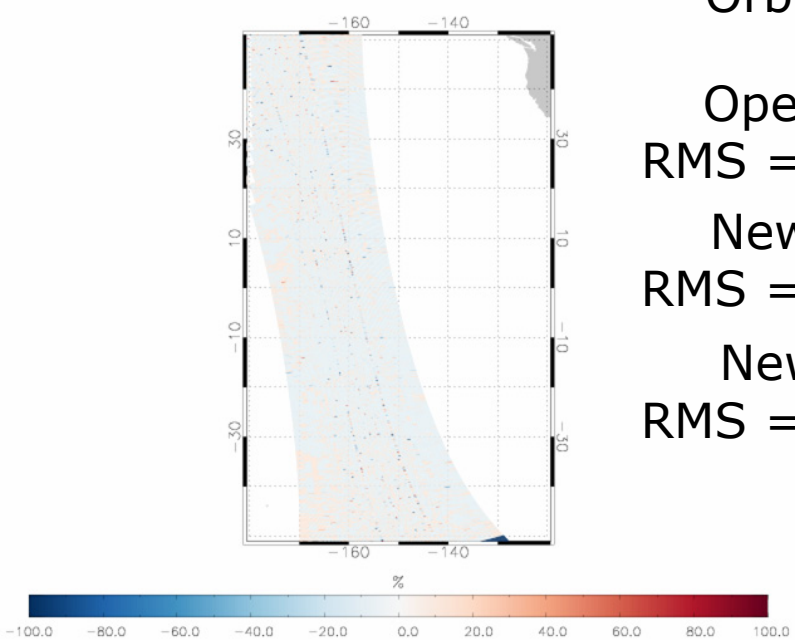
- HCHO spectroscopy by Chance and Orphal ,JQSRT 112, 2011
- Solar reference spectra to Chance and Kurucz, JQSRT 111, 2010

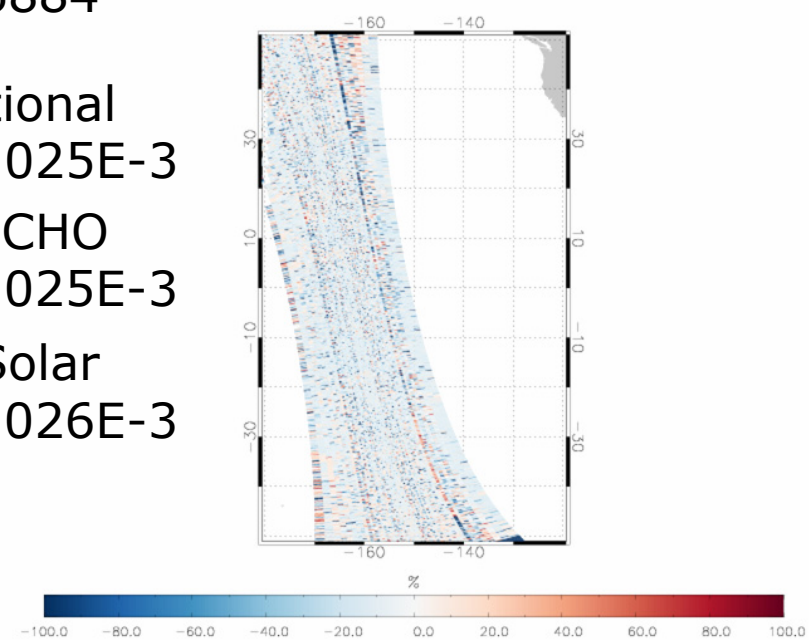
Orbit 6884

Operational
RMS = 1.025E-3

New HCHO
RMS = 1.025E-3

New Solar
RMS = 1.026E-3

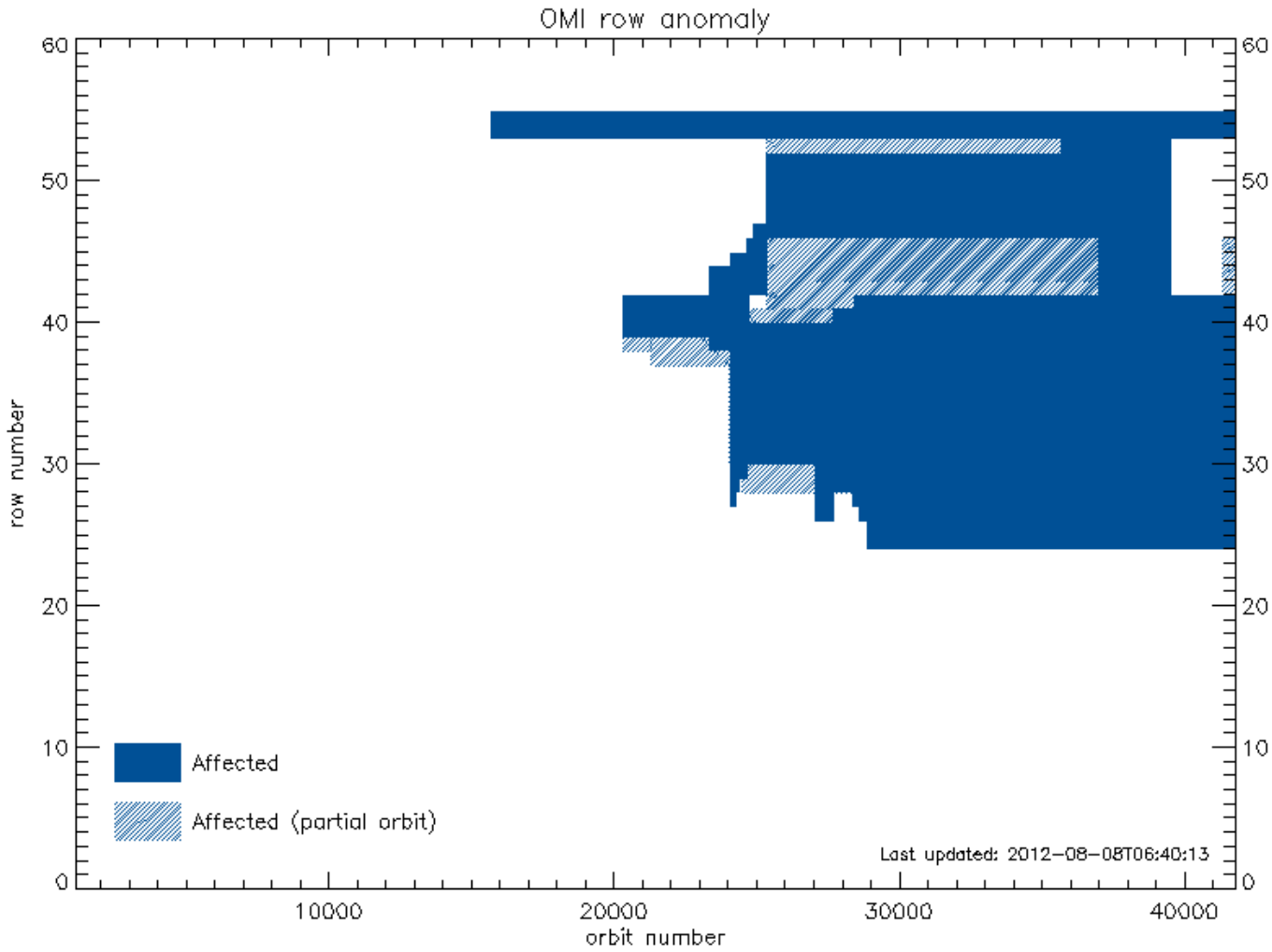




3 year solar composite replaced by solar monthly average irradiance

- We plan to implement a new solar monthly mean irradiance
- Built with the closest 31 days to the target day. Irradiance normalized to 1 AU
- Should improve the solar wavelength calibration (shift)
- Will try how works to fit the slit function to an asymmetric Gaussian using these monthly mean irradiance spectra

Row anomaly flagging



Outliers in the fitting residuals

- Actual implementation: Discard wavelengths with big fitting residuals > 3σ average
- 1 iteration for solar and radiance wavelength calibration, 2 iterations for radiance reference and radiance fit
- Try Hampel Identifier

AMFs weighted cross sections

- Newly developed wavelength dependent AMF tables for weak absorbers will allow for consideration of the wavelength dependence in the AMFs.
- Introduction of surface reflectance in the retrievals using Kleipool albedo database
- Weighting the HCHO reference cross sections prior to fitting will allow direct retrieval of total column density
- Post processing computation of effective AMFs running a second retrieval without weighted reference cross sections

Post implementation of new retreival features

- Check for alternative fitting windows. The newly developed direct retrieval of total columns should allow for bigger fitting windows
- Check for behavior of background levels
- Try different polynomial degrees

- Expected delivery time, 2 to 3 months