SCIAMACHY: Spectral Calibration in the SWIR Channels

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Introduction

SCIAMACHY (SCanning Imaging Absorption spectroMeter for Atmospheric CHartographY) was a scanning nadir and limb spectrometer covering the wavelength range from 212 nm to 2386 nm in 8 channels. It doubled its originally specified in-orbit lifetime of five years before the communication to the ENVISAT platform failed in April 2012. We are now in the postprocessing phase F.

Standard calibration approach (using SLS) cannot be done for short wave infrared (SWIR) channels, because

- The PtCrNe lamp has not enough lines in the SWIR range
- Increasing number of bad pixels interfere with line detection

Alternative Approach: Use DOAS like fit algorithm that simultaneously fits the measured radiance S using a reference S_{ref} and polynomials for radiance P_B and wavelength P_A (first suggested by *Noel et al 2012*):

$$\ln(S) = P_B(\lambda) + \ln(S_{ref}(P_A(\lambda)))$$

The method was extended by us and already tested for the Sentinel-4 UVN and the former Earth Explorer 8 candidate mission CarbonSat. For the method to work it is essential to have a good knowledge of the in-flight spectral response function and its change over time.

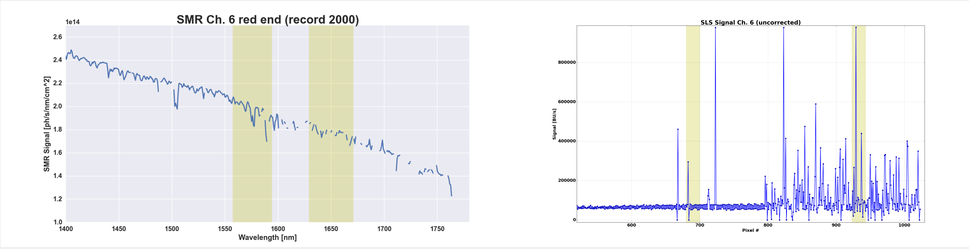

Figure 1: *Left: Sun Mean Reference (SMR) in channel 6 as measured in record 2000. Shaded areas mark the retrieval windows for CH_4. Right: Spectral Line Source (SLS) Measurements in channel 6. Shaded areas mark the region of known SLS lines.*

ISRF Fit

The ISRF was fitted using a highly resolved reference and the model function

$$M = ISRF * Irradiance + Noise$$

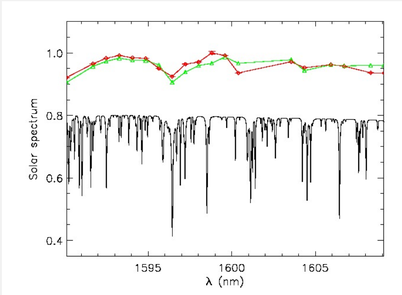

Figure 2: *Fit for retrieved Instrument Spectral Response (ISRF). Black: Reference., green: model, red: measurement.*

Parameter Tests

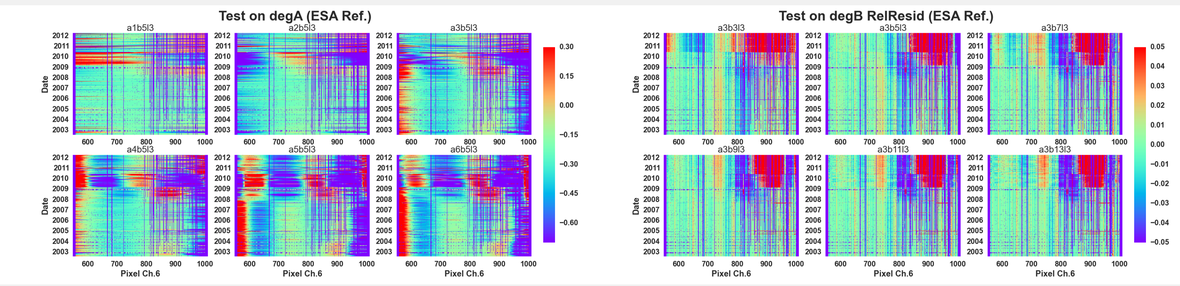

Figure 3: *Left: Test for polynomial degree of P_B. Colors show the difference to the on-ground calibration in nm. Right: Test for polynomial degree of P_A. Colors show the radiance residual of the fit. Each plot shows the result with changed degree of P_A (left) and P_B (right) as indicated in the plot title.*

Wavelength Shift & Fit Quality

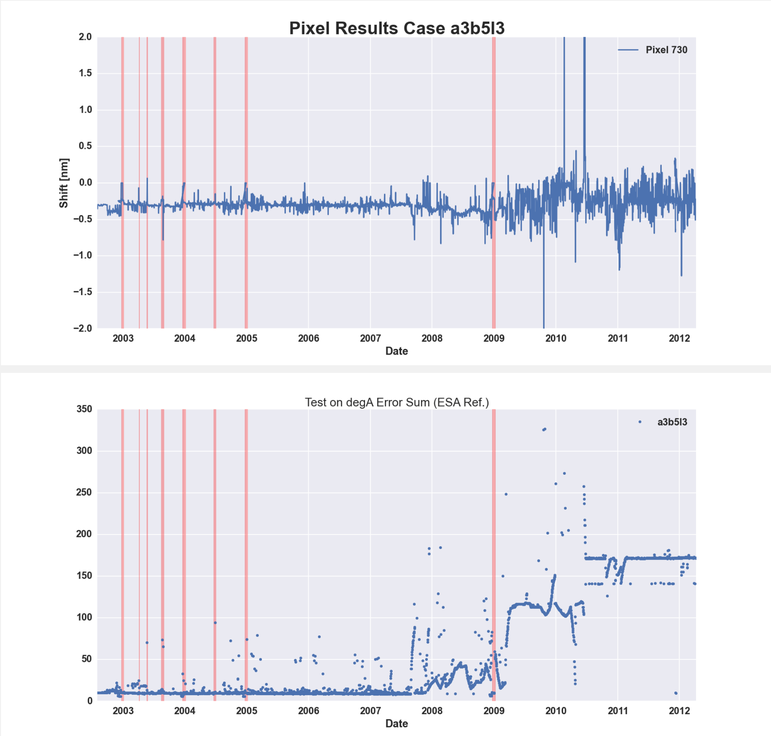

Figure 4: *Top: Difference to on-ground calibration for pixel 730 (1536 nm) vs. time. Bottom: Error sum for fit vs time. Shaded areas mark times of decontamination or instrument anomalies where the results are not reliable.*

First Results

- Degree of $P_A > 4$ leads to unrealistic results
- Change in spectral axis seems to be relative constant in time, at least until March 2009 → on-ground to in-flight effect?
- Bad pixels have a significant influence on the result
- In March 2009 and June 2010 the fit gets suddenly worse, possibly because
  - Important pixels get bad
  - Optical path degradation
  - Change of spectral features of the diffuser (unlikely for channel 6)
- Besides a few occasional deviations, overall the results do not show temporal variations of the ISRF during the mission

Examining the Bad Pixel Mask

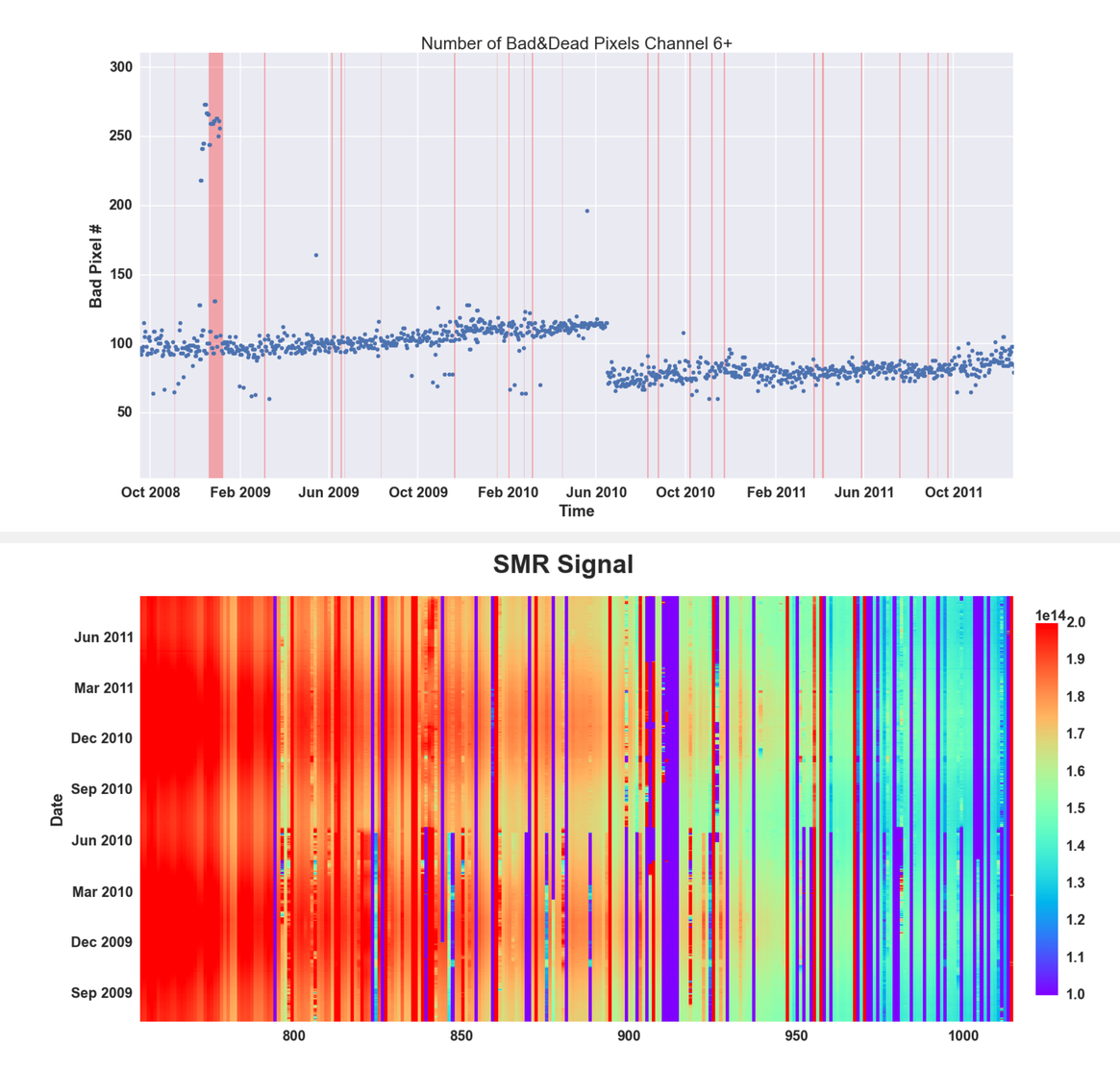

Figure 5: *In June 2010 the number of bad pixels surprisingly drops (top). Looking at the solar signal (bottom, color coded plotted against time (y) and pixel (x)), the improvement seems to be real and not an artefact of the bad pixel algorithm: Pixels that before June 2010 have very different signals from their neighbours show a reasonable signal afterwards (time axis is vertical in the bottom plot).*

Summary & Outlook

Summary:

- Wavelength axis seems to undergo mainly a one time change on-ground to in-flight
- Typical shifts are few tenth of the spectral sampling interval
- Bad Pixels contradictory information for June 2010 change:
  - Drop in number seem to be justified by first look on SMR signals, but...
  - ...fit worsens, which may indicate that more bad pixels were included (because they were no longer excluded by the mask)
- Other reason for drop in fit quality could be optical path degradation

Outlook:

- Repeat the analysis with data of the new Level 1 V9 processor (which will be finalised this summer)
- Take a closer look at the bad and dead pixel mask
- Check the influence of the new spectral calibration on the methane retrieval

References & Further Information

- S. Noël et al., Quantification and mitigation of the impact of scene inhomogeneity on Sentinel-4 UVN UV-VIS retrievals, Atmos. Meas. Tech., 5, 1319-1331, 2012
- Level 0-1c ATBD: http://atmos.caf.dlr.de/sciamachy/documents/level_0_1b/scia01b_atbd_master.pdf (will soon be updated for Version 9)
- Gottwald, Manfred, and Heinrich Bovensmann, eds. SCIAMACHY – Exploring the changing Earth's Atmosphere. Springer Science & Business Media, 2010.

Contact Information

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