Impact of calibration changes on SCIAMACHY CO retrievals

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L1-2 Feedback in Verification

Operational processors evolve constantly to be always state of the art. Usually the processing is split into a Level-1 chain that produces radiances from raw data and a Level 2 chain that generates the geophysical products. This complicates the development and the verification of the processors. At DLR we developed an optimised scheme to ensure the correct implementation of the algorithms and to separate the effect of Level 1 induced changes on Level 2 data from the effect of L2 algorithm changes. For this purpose the verification is done in two steps

1. *Check the correct implementation of each L2 algorithm using the current (operational) Level 1 processor*
2. *After step 1 was successful, use the now frozen L2 processor with the **new** Level 1 processor to identify changes*

This allows the **parallel** development of both processors and ensures a testing of the complete chain.

The Vanishing CO

The step 2 test for the CO total column showed that using the new Level 1 processor, the total columns of CO were a factor 3 smaller compared to the previous product (using L1 V7)

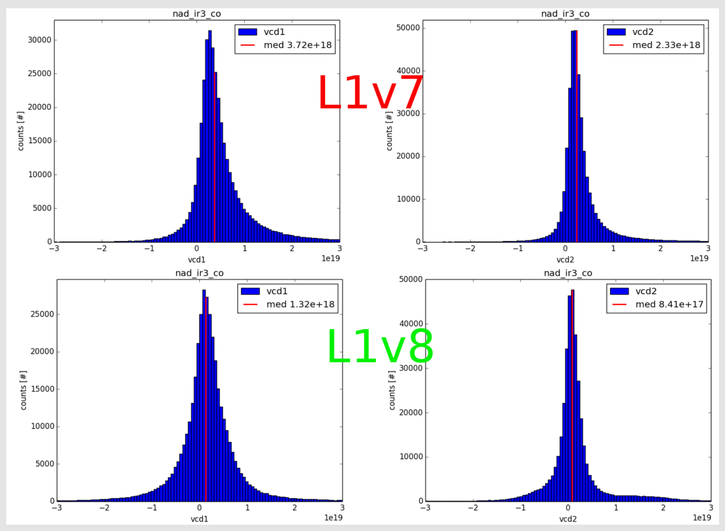

Fig. 1: Histogram of CO values from verification data set. Left: xCO, Right CO.

The Empirical Fix on L2 Basis

The unphysical CO values were corrected by adjusting the Level 2 fit settings. An evaluation based on 2004 data showed that the CO values are again in a reasonable range and show the expected structures

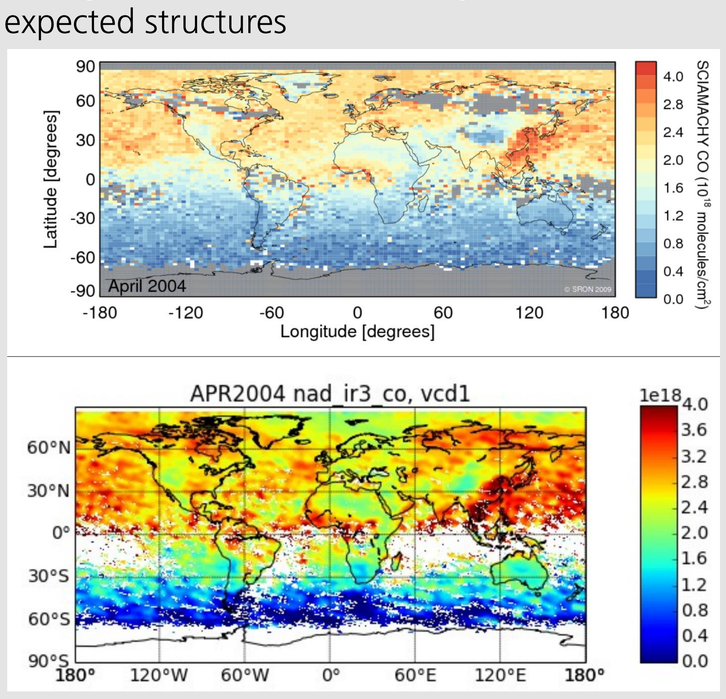

Fig. 2: Comparison of a monthly mean of April 2004 of the Processor CO (bottom) with the CO columns derived by SRON(top)..

Changes in Level 1 V7 to V8

While the adjusted CO algorithm shows again good results, it is still important to find out what L1 change did decrease the CO result by a factor of 3. From Version 7 to Version 8 the following algorithms changes were especially important for the SWIR range

1. *The dark correction was adjusted to exclude problematic measurements from the dark fit.*
2. *The radiometric calibration data were updated*
3. *A new degradation correction was introduced*

Method and Dataset

In this first investigation we used the so-called verification data set. This data set is used to check the correct implementation of the algorithms. For Version 7 it comprises 180 orbits from the years 2002 – 2008. The version 8 dataset was extended to cover also the following years. The datasets are *not* evenly distributed over the years.

The following calibration parameters were compared: Fixed Pattern Noise (Fig. 5 top), leakage current (middle) and reflectances (bottom). Additionally we also looked at changes in the dead and bad pixel mask. While this algorithm was not changed, the data that are used to determine the bad pixels changed.

We did a one-to-one orbit comparison for all datasets that were found valid in both versions (150 orbits).

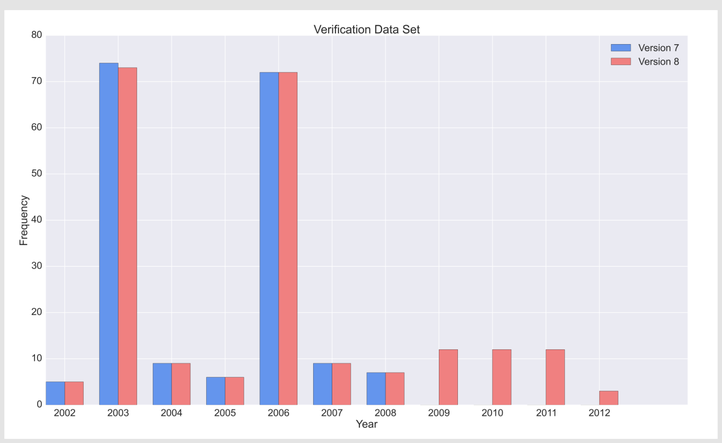

Fig. 3: Calibration steps for L0-1 Processing.

First Results

The dead and bad pixel mask showed some changes, although not enough to explain the observed factor 3 difference between the retrievals:

- 97.52% of the pixels in all observations were marked in the same way in both versions
- 2.05 % of the pixels were marked bad in V8 but not in V7 (see Fig. 4)

However, FPN and leakage current show a significant change for nearly all observations of the dataset near 2328 nm and near 2330 nm see figure 4).

An earlier study using synthetic spectra had found that perturbation of the radiance for the pixels around the CO absorptions near 2330 nm, 2334 nm and 2325nm can change the retrieval by a factor 10 or more. Especially the absorption at 2330 nm is important for the retrieval.

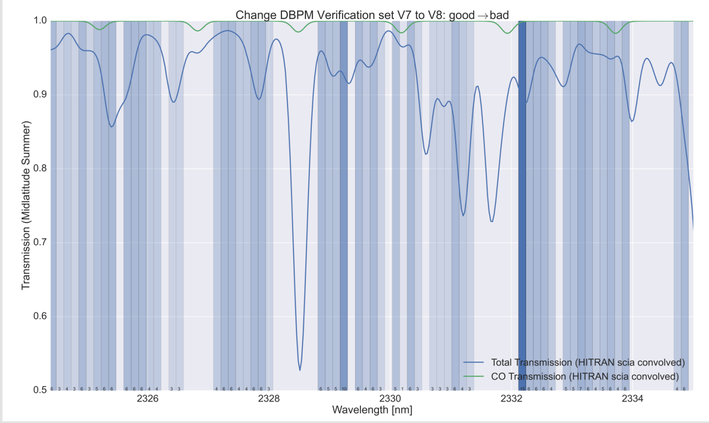

Fig. 4: Pixels that went from good to bad because of the algorithm changes from V7 to V8 plotted on top of the atmospheric transmission in the CO retrieval window. The darker the shades the more pixel changes were observed in the data set.

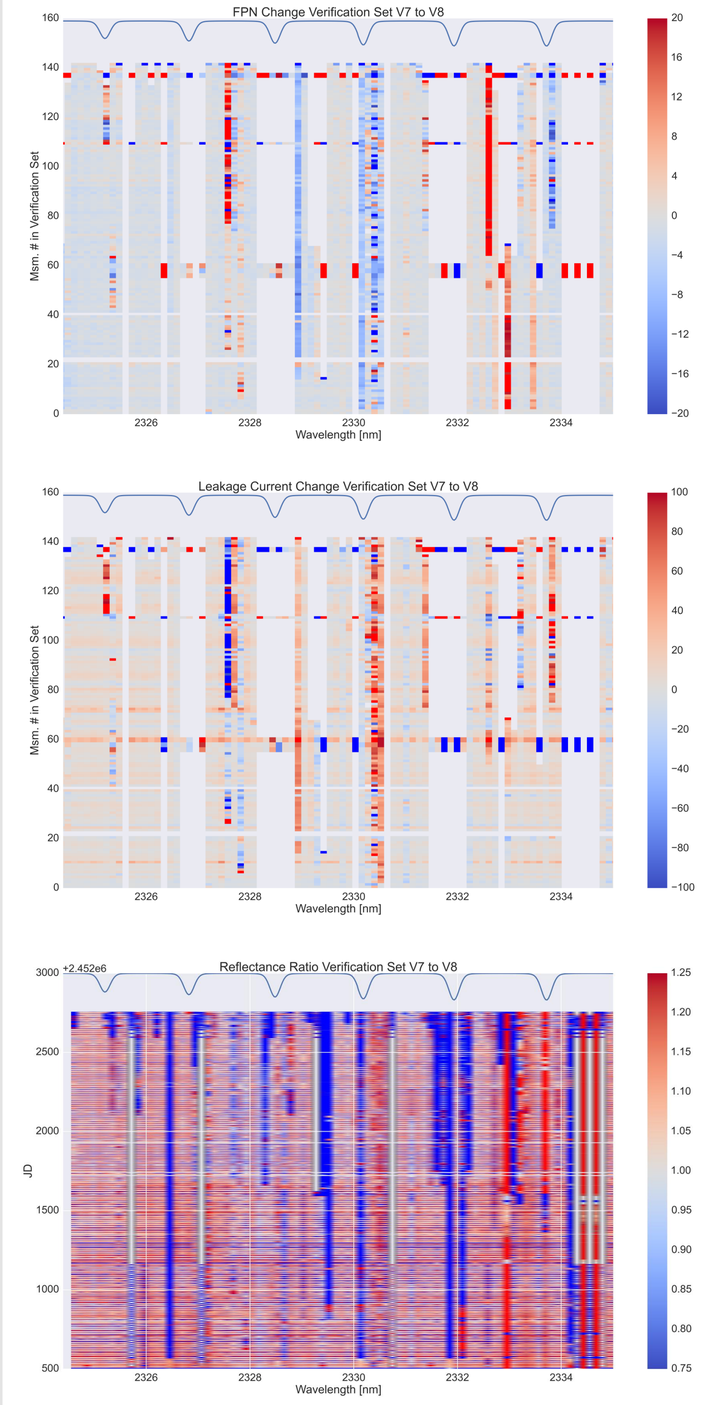

Fig. 5: Comparisons of calibration parameter changes. On top of the figures the scaled transmission of CO is shown. For the top figures we masked out bad pixels, for the reflectances we left them in to show the time evolution.

Future Plans

The next processor Version 9 will have additional changes important for the SWIR range:

- Updated wavelength calibration
- New bad and dead pixel identification
- Change of dark correction

We plan to:

- Check the impact of all planned changes for processor V9
- Enlarge the comparison dataset and make it representative for the mission
- Include Methane in the analysis
- Set-up a tool box to facilitate the analysis and to be able to directly analyse the impact of L1 changes on L2 in a few automated steps

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