SCIAMACHY: Level 0-1 Processor V9 and Phase F Re-processing

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Introduction

SCIAMACHY (SCanning Imaging Absorption spectroMeter for Atmospheric CHartographY) was a scanning nadir and limb spectrometer After the platform failure in April 2012, SCIAMACHY is now in phase F. It had unique capabilities:

- It could measure in Nadir, Limb and Occultation modes
- It observed Sun, Moon and Earth regularly for 10 years
- It covered the wavelength range from 212 nm to 2386 nm in 8 channels.
- It could detect a large variety of atmospheric gases (e.g. O_3, H_2CO, CHOCHO, SO_2, BrO, OClO, NO_2, H_2O, CO, CH_4, among others) and did provide information about aerosols and clouds
- It measured column densities and vertical profiles of trace gas species in the mesosphere, in the stratosphere and in the troposphere.

Processor Architecture
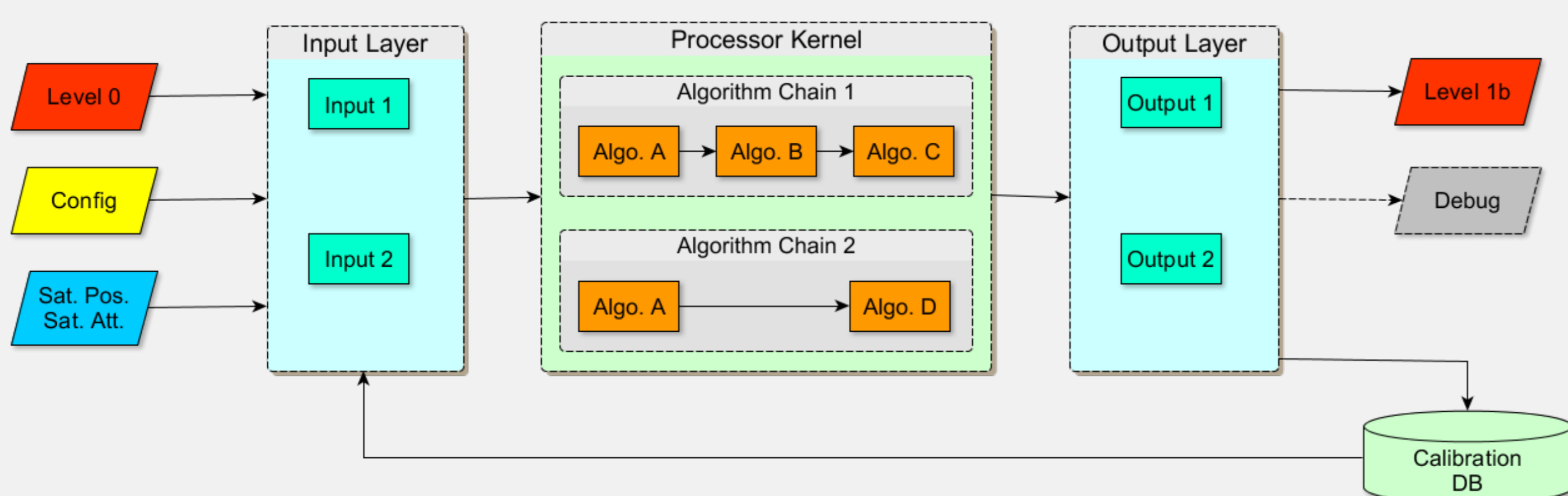
The DLR developed Generic Calibration & Processing System GCAPS is used as framework for the Level 0 decommutator and the Level 1 processor. The framework provides a generic kernel, I/O layers and database interfaces. Processors for specific purposes and/or instruments are realised by adding plug-ins to the framework using the framework API. The user can define different calibration chains and can enable or disable plug-ins via a simple XML configuration file without the need of recompilation. The framework is also used in the operational Level 1 processing for MERLIN.

Processor History

In the first phases of the mission, the operational processor was implemented by industry, based on specifications and an IDL prototype from DLR-IMF. Major changes:

Processor	Major Changes
V. 1-2 (1998)	First specification of processor (main elements)
V. 3 (2000)	Updated version using on-ground results, final pre-launch version
V. 4 (2003)	Alignment of industrial processor to DLR specification
V. 5 (2003)	Updates for polarisation algorithm Updates for initialisation parameters (PMD, state set-up times etc.) Improved etalon correction Geolocation angle update Memory effect correction (MEC) update for 0.03125s
V. 6 (2005)	Use in-flight memory effect correction for channels 1-5 Introduction of SciCal for calibration data Implement non-linearity correction for channels 6-8 Misalignment parameters updated Dark correction uses 5 darks with option to use darks from the same orbit Polarisation uses now theoretical U Stokes parameter for all wavelengths
V. 7 (2008)	Introduction of stray light matrix for channel 2 Software patch for on-board error in the writing of scanner encoder values

For version 8 onwards the re-implementation by industry was abandoned and the DLR processor (now C++ GCAPS framework) was used. Major changes:

Processor	Major Changes
V. 8 (2012)	Introduction of scan mirror model for the degradation correction of radiances Introduction of stray light matrix for channels 3-8 Improvement of MEC for Limb measurements Improvements for hot pixel correction for Limb Update of key data
V. 9 (2018)	Completely new polarisation algorithm New corrections for SWIR channels Key data updated Sun mean reference (SMR) calculation updated Update of scan mirror model Switch to netCDF format

New in V. 9: Operations Information

In order to preserve important instrument information after the end of the mission, the following information was **added** to the Level 1b products:

- Operational change request valid for the product
- Platform housekeeping data
- Instrument housekeeping data
- Orbit and state information

## Contact Information

Updated Degradation Correction

The degradation correction of SCIAMACHY was updated to better take into account the scan angle dependency and sun diffuser degradation. The top figure shows uncorrected values (E0), the bottom a corrected spectrum of channel 2 over time; here only the sun distance related variations are visible. Vertical bars mark decontaminations.
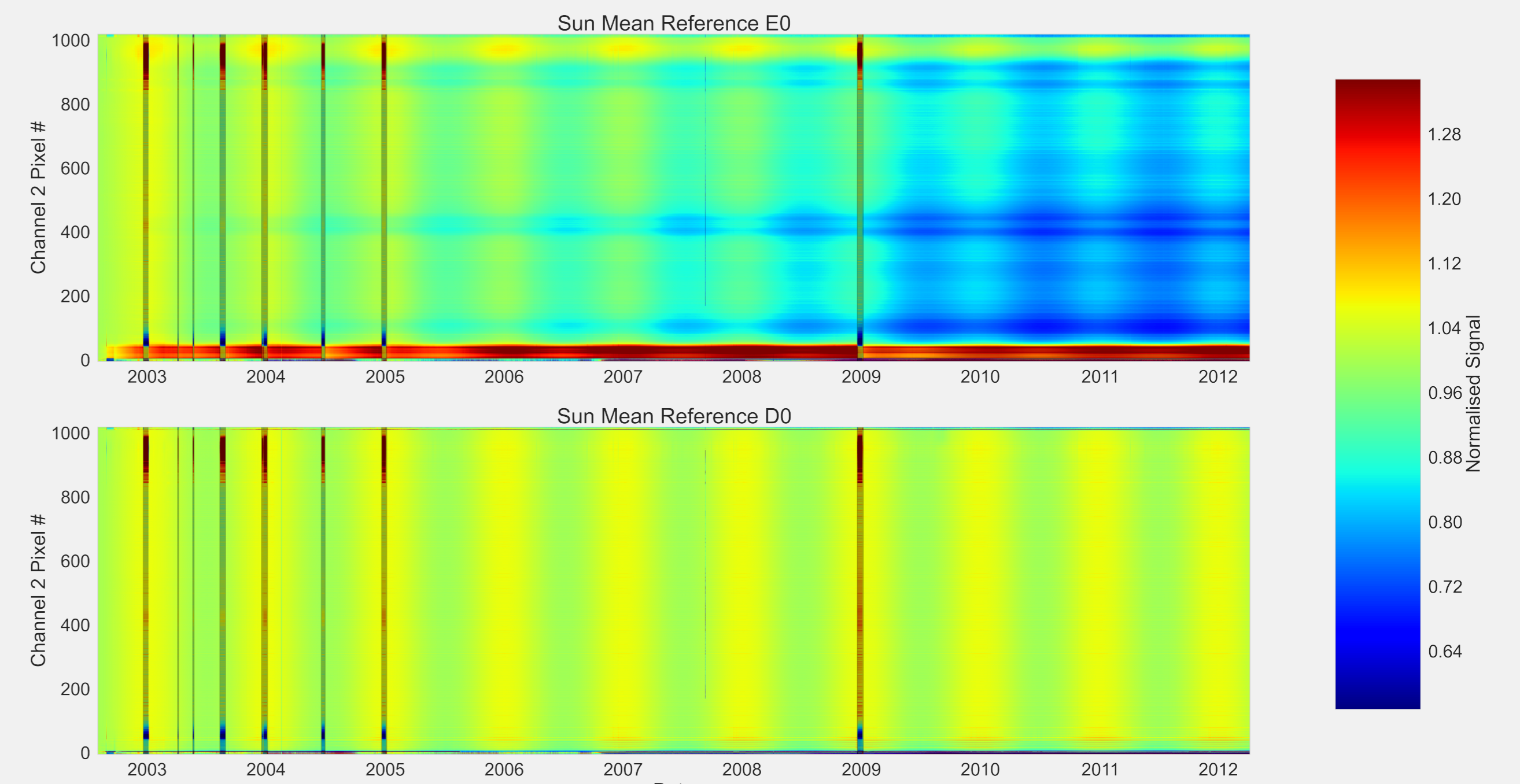
Better Polarisation Correction

- Polarisation determination in Limb UV was updated to better reflect the spectral structure
- Polarisation determination for the Nadir UV theoretical point was updated (CHEOPS algorithm from GOME-1)
- Polarisation determination for Limb/Nadir from PMDs was completely reformulated
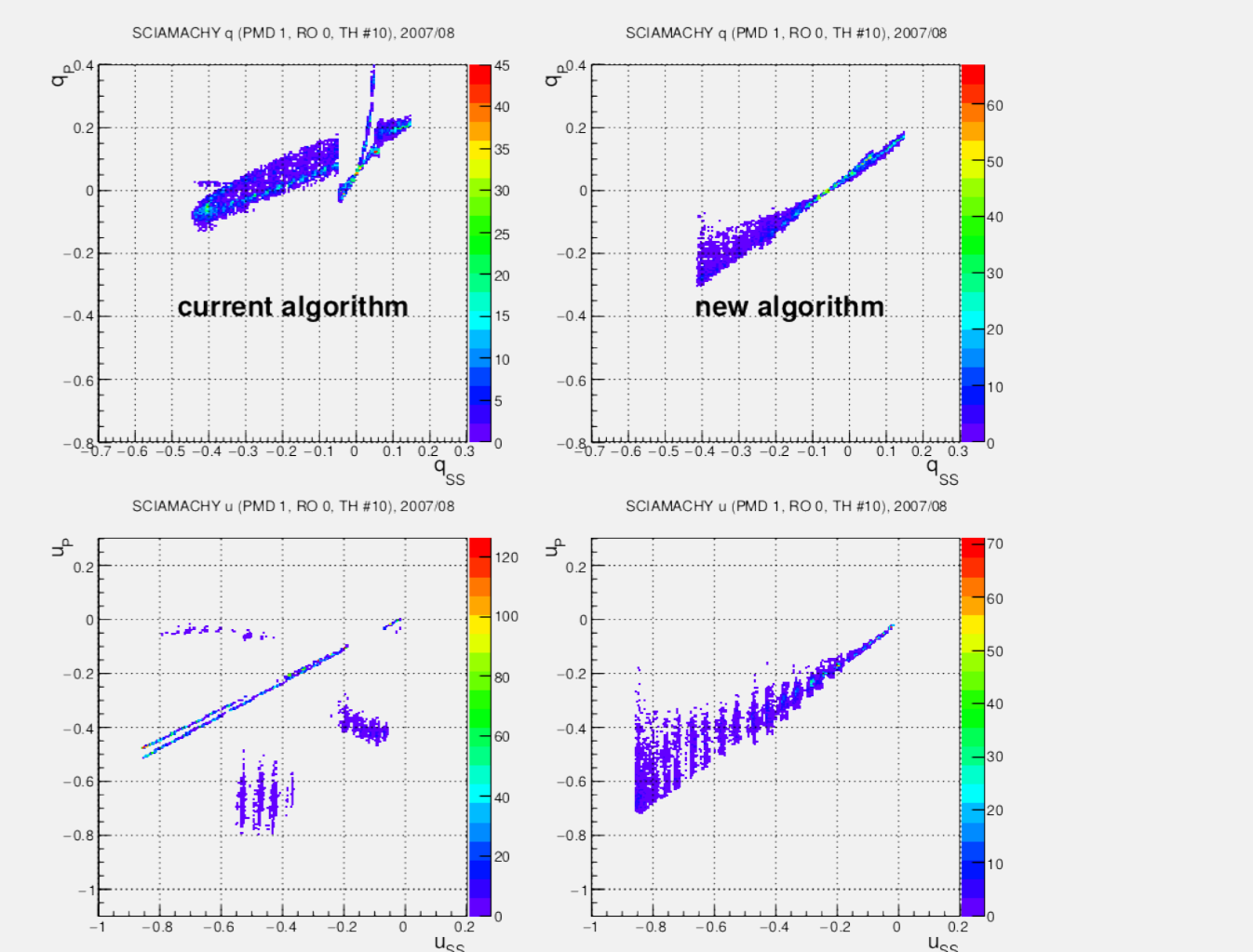
Updated Pointing

- Limb and occultation retrievals need very accurate pointing information for proper tangent heights.
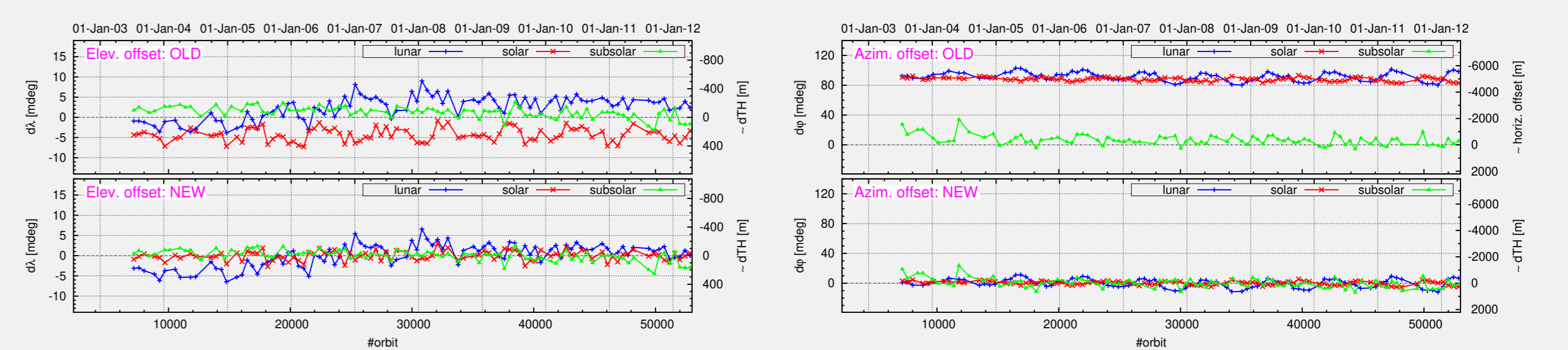- For the first time, lunar measurements have been utilized for this purpose.

Figure: *Elevation and azimuth angle offsets. OLD: Mispointing with the current processor. NEW: Remaining mispointing with the improved pointing parameters (IUP).*

SWIR Improvements

The SWIR channel calibrations saw several improvements:

- Updated **spectral calibration**
- Updated **bad & dead pixel mask** dynamic correction for channel 8
- Updated **dark correction** for channel 8 improving the orbital dependency correction

Products now in netCDF4

- future proof and accessible with standard tools
- useful information for users added to more easily filter results
- geolocation for individual measurements instead of only for the minimum observation time
- Right: Example for the new geolocation. Coloured rectangles represent individual Nadir observations. Black rectangles represent PMD observations and their centre (dots).
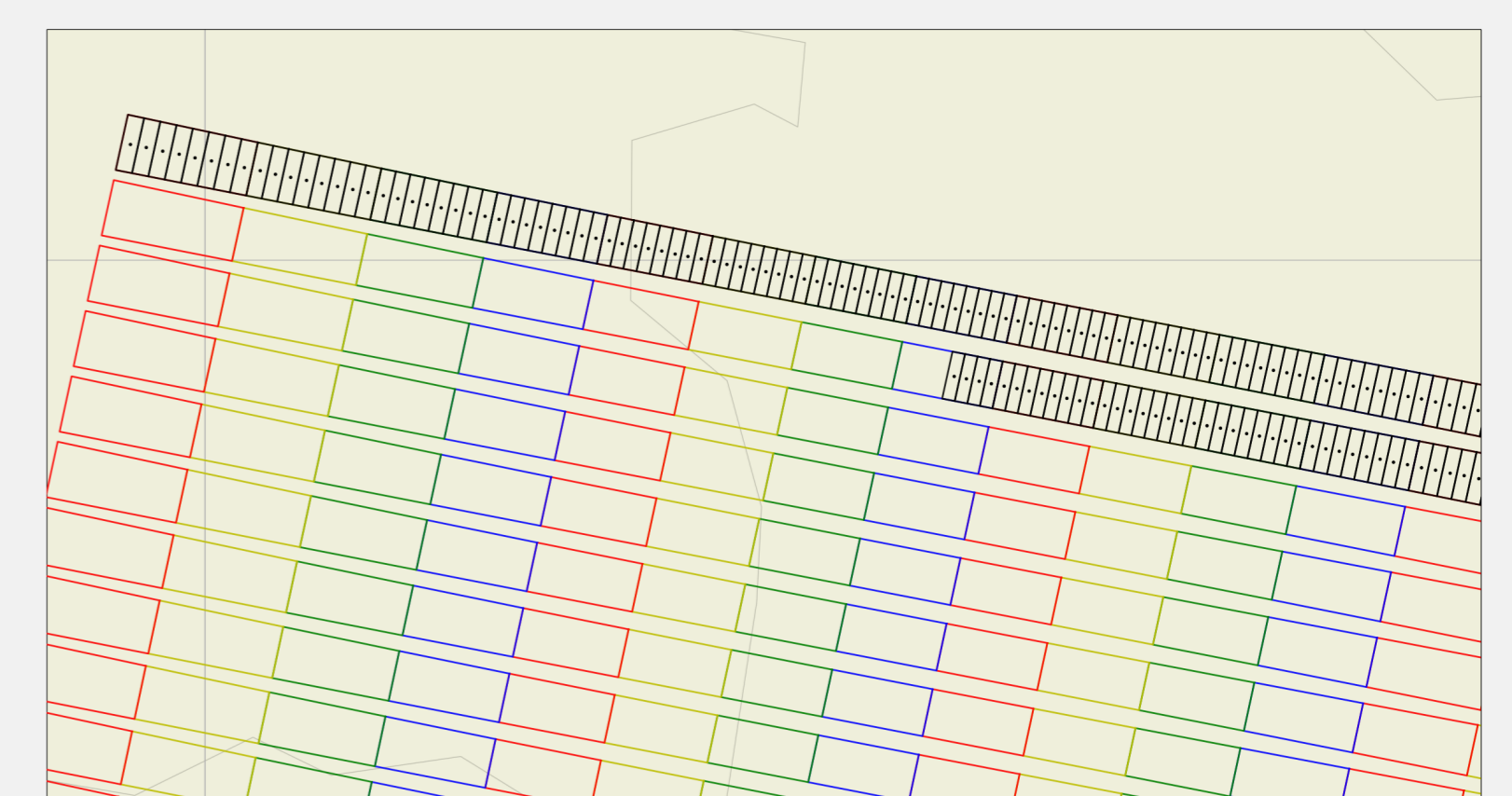
References & Further Information

SCIAMACHY L0-1c Processor ATBD Algorithm Theoretical Baseline Document for Processor V.9 ENV-ATB-DLR-SCIA-0041 Issue 7, 2018,
`https://atmos.eoc.dlr.de/sciamachy/docu_l1.html`