The Status of the FDR4ATMOS Project

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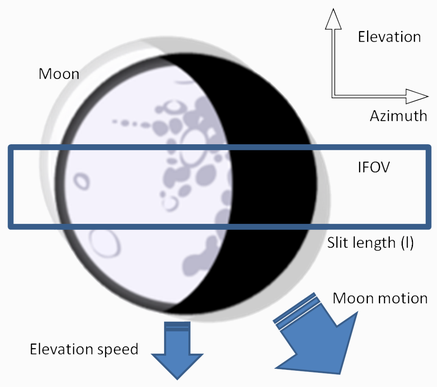
Project Task A: Improving SCIAMACHY Level 1 data

The project FDR4ATMOS (**Fundamental Data Records in the domain of satellite Atmospheric Composition**) has been initiated by the European Space Agency (ESA). Task A of the project covers the **improvement of the SCIAMACHY Level 1b degradation correction**, with the aim to remove ozone trends from the SCIAMACHY Level 2 data set that were introduced during the development of baseline version 9 (both data sets not released). We will also, for the first time, **add calibrated lunar data to Level 1**, covering the whole spectral range of SCIAMACHY and the full mission time.

Lunar Data

- SCIAMACHY made regular Moon measurements and covered a large range of observation parameters
- The spectral range and resolution of the observations constitute a unique data set
- The lunar disk fills part of the slit and was scanned several times. Each individual scan had a 2 second duration.
- In total there were 1123 measurements of the moon covering a wide range of lunar observation geometries

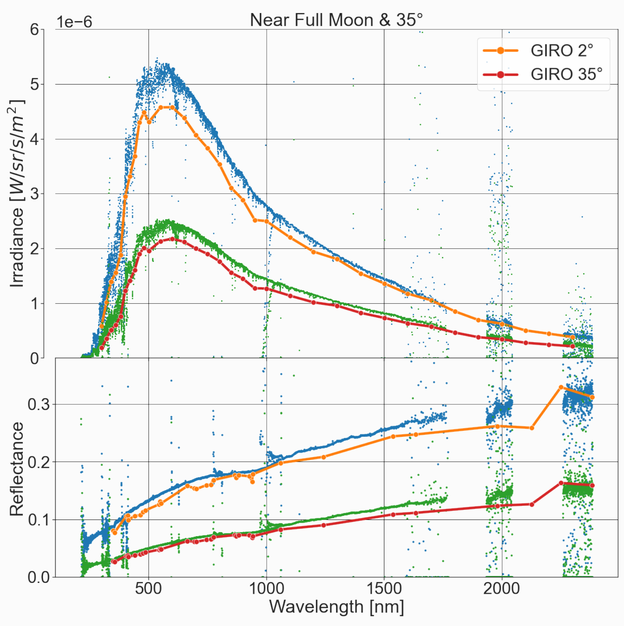


The new SCIAMACHY Level 1 product will contain

- Averaged data for the orbit, including reflectance and irradiance for the full disk
- Individually measured data
- Additional parameters to be used in further analysis like lunar phase angle, lunar latitude and longitude etc.

Lunar data validation

- We used the ROLO/GIRO (e.g. Wagner et al. 2015) as an independent validation source
- **Top:** Comparison full disk irradiance GIRO vs SCIAMACHY data (dots)
- **Bottom**: Comparison full disk reflectance GIRO vs SCIAMACHY data
- The data agree within the estimated error of the ROLO data (Stone, T. et al. 2004)
- There is no discernible trend in the SCIAMACHY data (not shown) over the mission lifetime; the degradation correction works



Fixing the O_3 trend

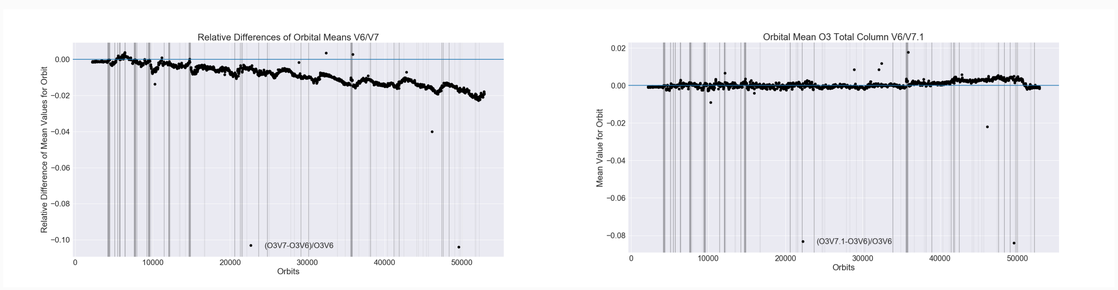


Figure: Comparison of orbit averages of O3 vs time. Left: Comparison of data using Level 1 V9 with a previous version that did not show a trend in the validation. Right: Using the Improved Level 1 V10 data. The trend has disappeared.

Status/Outlook

- The algorithm implementation has been finished and the quality checking has started
- The full mission Level 1 data processing will finish 2021
- The Level 2 (geophysical products) data will be processed in January/February 2022
- After validation the data will be prepared for a release to the users
- **All products will be in netCDF format** instead of the previously used byte stream format

Contact Information

If you like to have further information, you can reach me at guenter.lichtenberg@dlr.de

References & Further Information

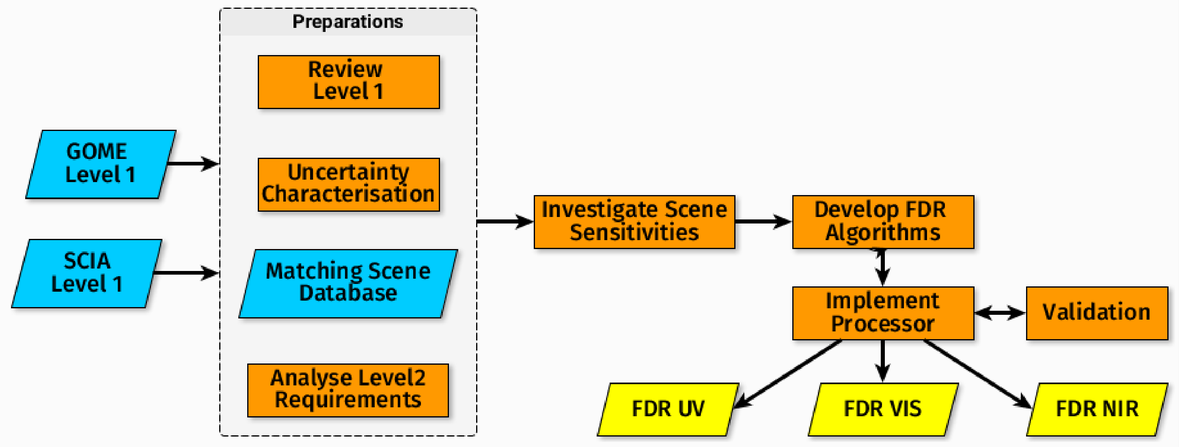
- Stone, Thomas & Kieffer, H.. (2004). Assessment of uncertainty in ROLO lunar irradiance for on-orbit calibration. Proceedings of SPIE - The International Society for Optical Engineering. 5542. 10.1117/12.560236.
- Wagner, S.C. et al. A summary of the joint GSICSâCEOS/IVOS lunar calibration workshop: Moving towards intercalibration using the Moon as a transfer target. In Proceedings of the Sensors, Systems, and Next-Generation Satellites XIX, Toulouse, France, 21â24 September 2015; Volume 9639, p. 96390Z.

Project Task B: FDR Long time series for spectrometers

A Fundamental Data Record (FDR) is a long-term record of selected Earth observation Level 1 parameters (radiance, irradiance, reflectance), possibly multi-instrument, which provides improvements of performance with respect to the individual mission data sets.

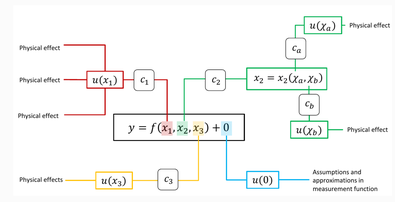
The aim of task B of the project is to be a pathfinder for future harmonisation of spectrally highly resolved data from other instruments, starting with 2 well known instruments and the spectral ranges for the retrieval of SO_2, O_3 (UV), NO_2 (VIS) and cloud properties (NIR). The FDR will contain **harmonised irradiances and radiances with associated uncertainties**.

Developing FDRs



Uncertainty determination

- The determination of the uncertainties will be done according to metrological principles
- The FDR uncertainties are a combination of those of the primary input data (the Level 1 data fo GOME and SCIAMACHY) and additional uncertainties that may be introduced by the harmonisation procedure



- Thus in the first step we are reviewing the errors and systematic effects associated with individual GOME-1 and SCIAMACHY Level 0-1 processing, based on the measurement functions for the calibration.
- This will lead to a tables containing the (estimated) errors, the error correlations and the estimated impact
- From the tables an uncertainty tree will be built
- The uncertainties and their derivation will be documented and the documentation will be available to the user.

Solar irradiances

Level 1 data are input for trace gas retrieval, which depends on spectral features
⇒ the harmonisation should not remove or change those
⇒ only broadband features are harmonised

Method for the irradiance harmonisation:

- the reference point for the irradiance harmonisation is the zero point for the SCIAMACHY degradation
- the transfer function for GOME-1 irradiance is calculated by
  1. Ratio of GOME-1 irradiance to SCIAMACHY reference
  2. Convolution of the ratio with a 2nm Gaussian
  3. Multiplication of the irradiance with the convolved ratio
- In this way, remaining instrument effects like the changing etalon are removed from GOME-1 irradiances
- Currently we optimise the procedure

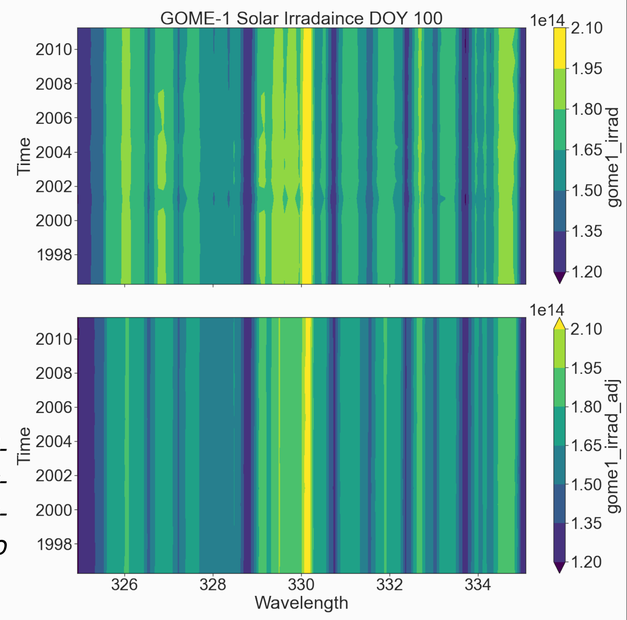


Figure: *Original (top) and harmonised irradiance vs time (y) and wavelength (x). The harmonised values are constant with time as expected, remaining artefacts are partially due to the contour plot discretisation.*

Outlook and next steps

- The harmonisation of the irradiances has to be optimised
- Work on the harmonisation of the radiances has started by building a matching scene database
- Studies on scene dependent effects has started (see figure for a first result)
- The goal of the project is to have an operational processor that can be easily adjusted for the harmonisation of other spectral ranges and instruments

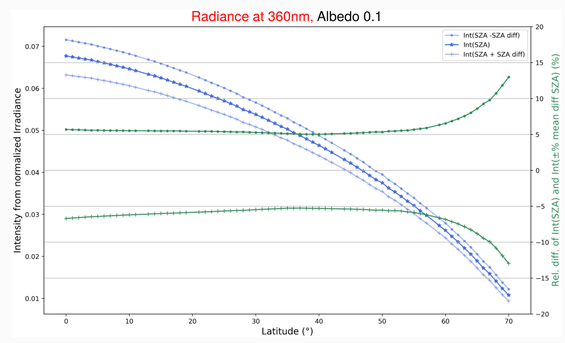


Figure: Modelled Effect of the different SZA angles GOME/SCIAMACHY for a given scene. Due to the different local times of the orbits, the modelled intensity shows differences of around 5%, higher for high latitudes (green lines).