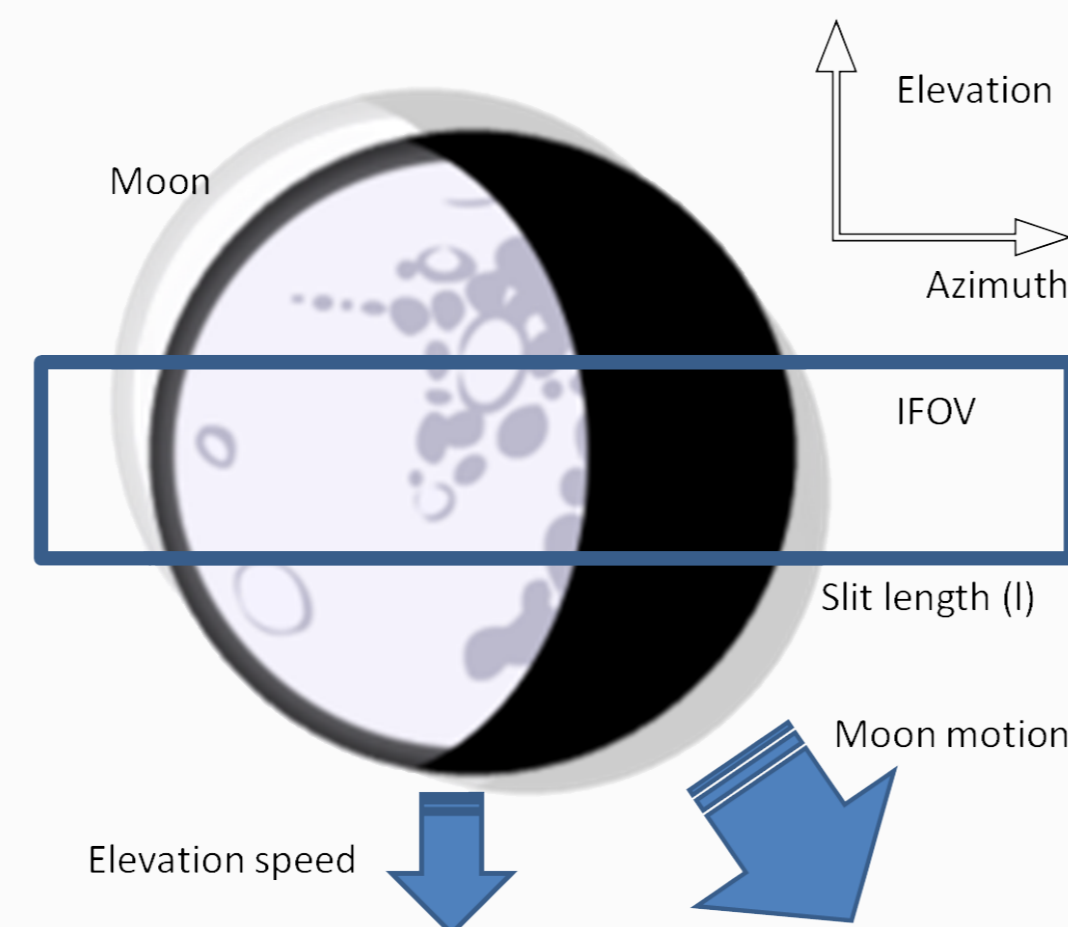


Project Task A: Improving SCIAMACHY Level 1 data

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

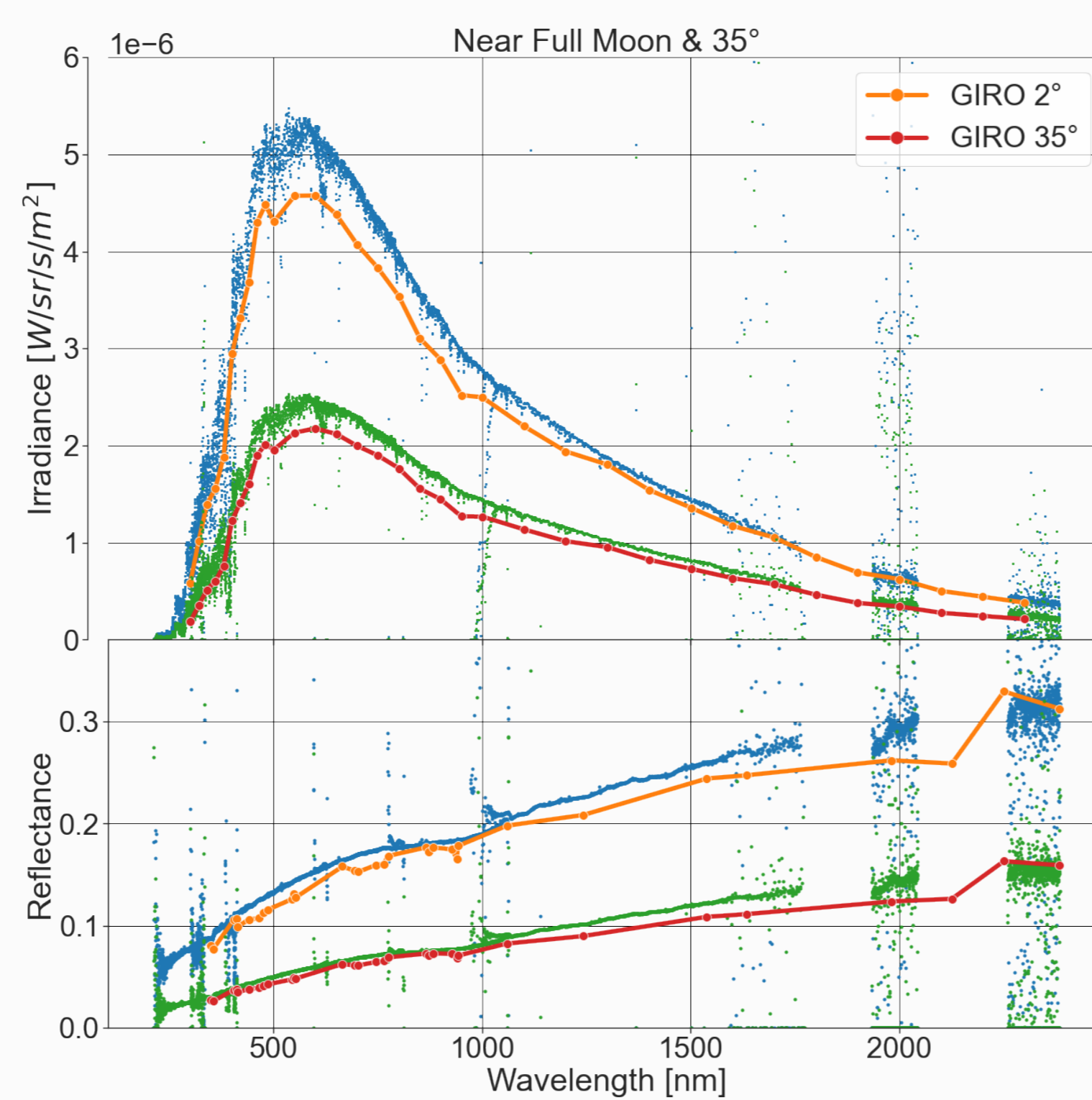


The new SCIAMACHY Level 1 product will contain

- ▶ 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 O₃ trend

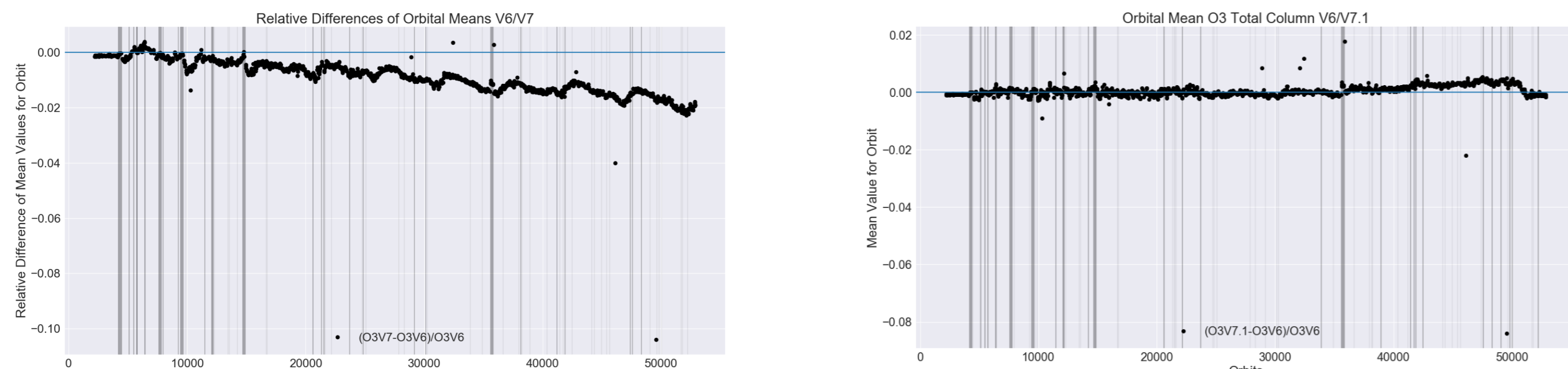


Figure: Comparison of orbit averages of O₃ vs time. Left: Comparison of data using Level 1 V9 with a previous version that did not show a trend in the validation. Right: Using the Improved Level 1 V10 data. The trend has disappeared.

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

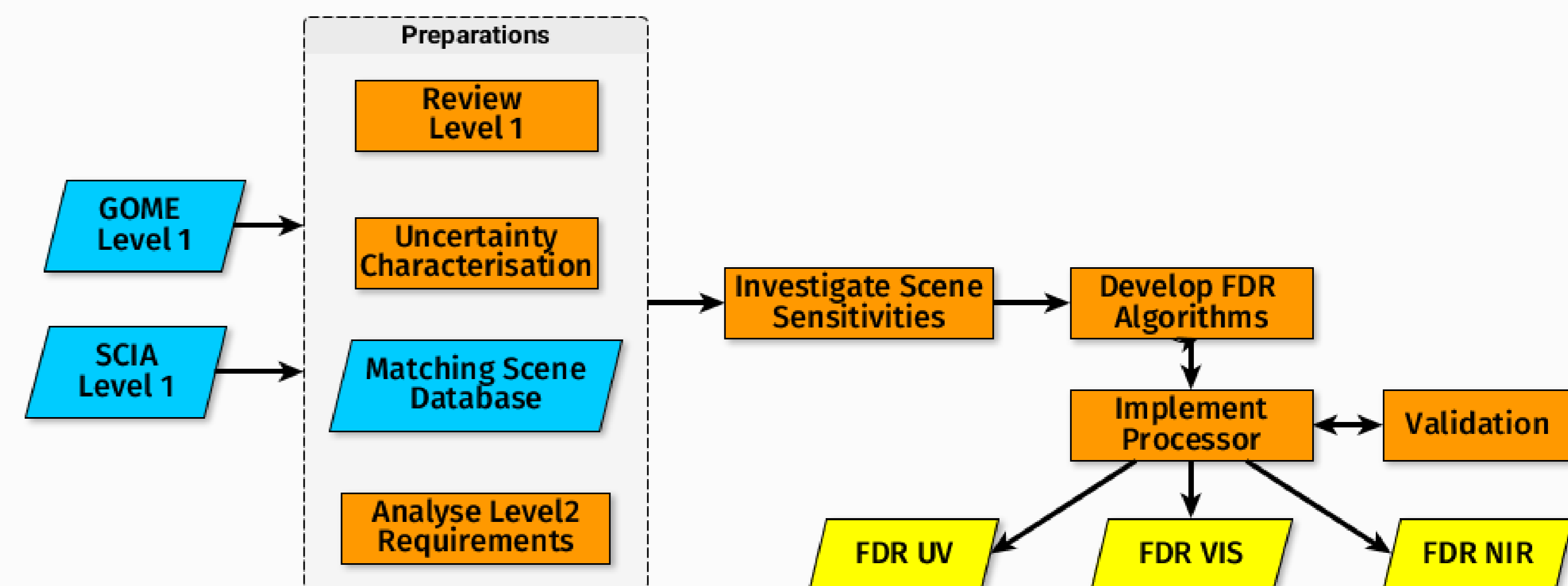
- ▶ Stone, Thomas & Kieffer, H.. (2004). Assessment of uncertainty in ROLO lunar irradiance for on-orbit calibration. Proceedings of SPIE - The International Society for Optical Engineering, 5542. 10.1117/12.560236.
- ▶ Wagner, S.C. et al. A summary of the joint GSICS&CEOS/IVOS lunar calibration workshop: Moving towards intercalibration using the Moon as a transfer target. In Proceedings of the Sensors, Systems, and Next-Generation Satellites XIX, Toulouse, France, 21&24 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.

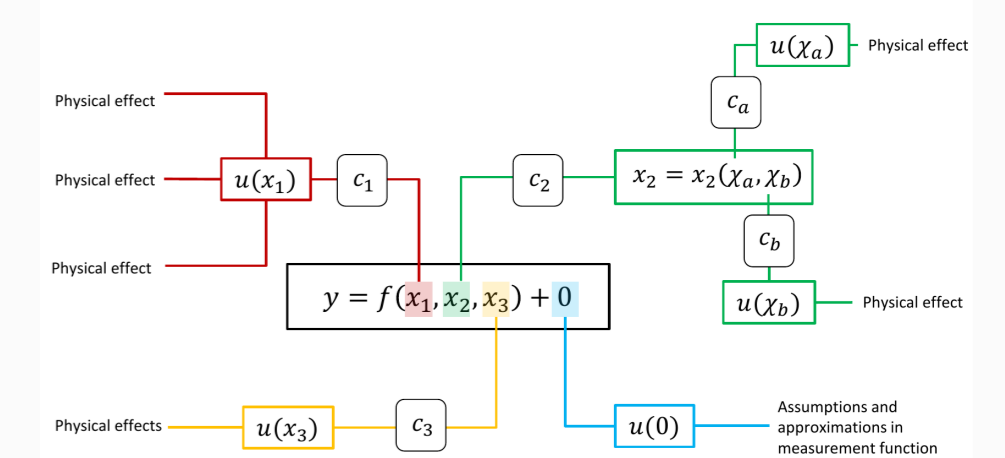
The aim of task B of the project is to be a pathfinder for future harmonisation of spectrally highly resolved data from other instruments, starting with 2 well known instruments and the spectral ranges for the retrieval of SO₂, O₃ (UV), NO₂ (VIS) and cloud properties (NIR). The FDR will contain **harmonised 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 for 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.



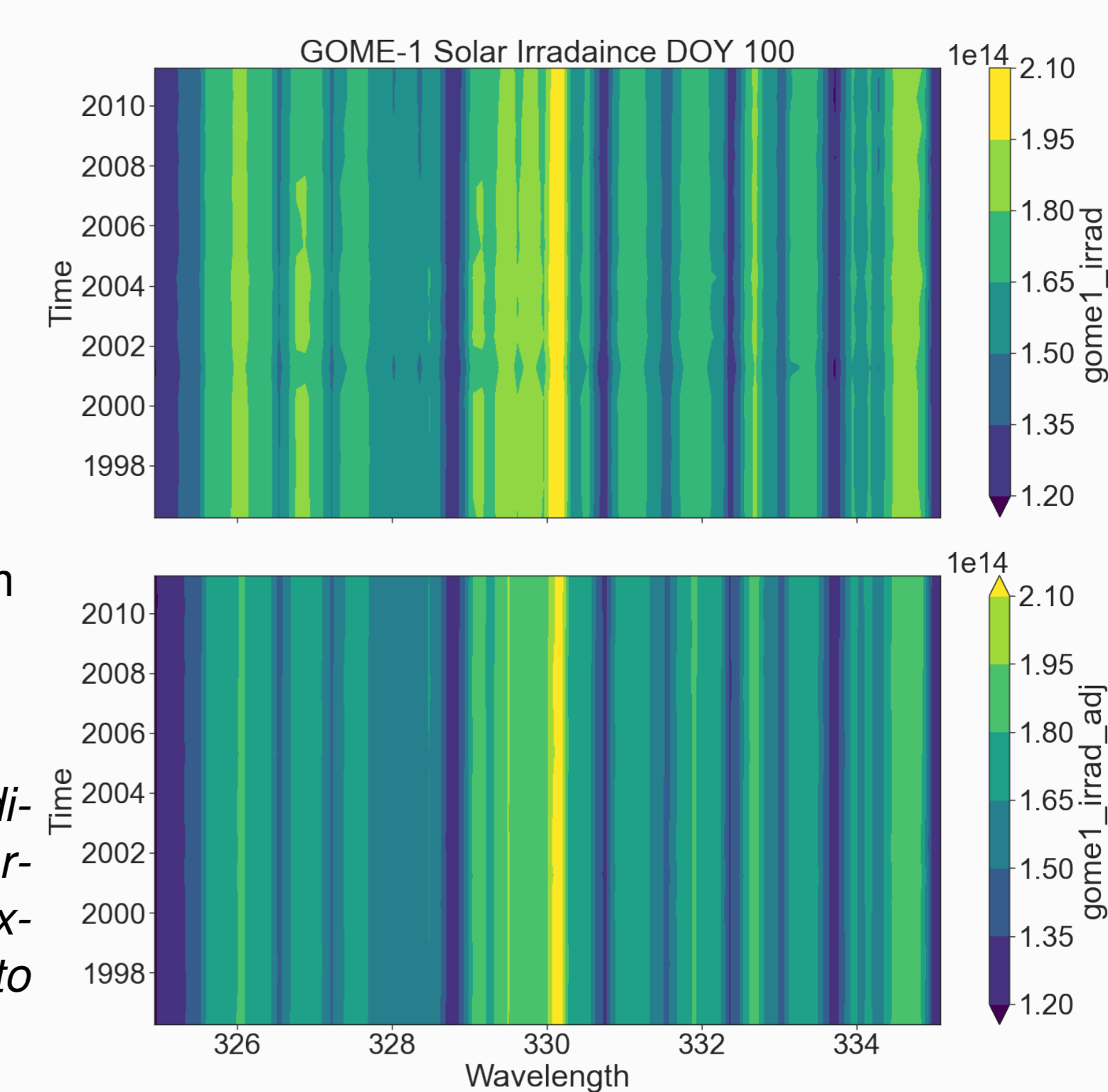
Solar irradiances

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

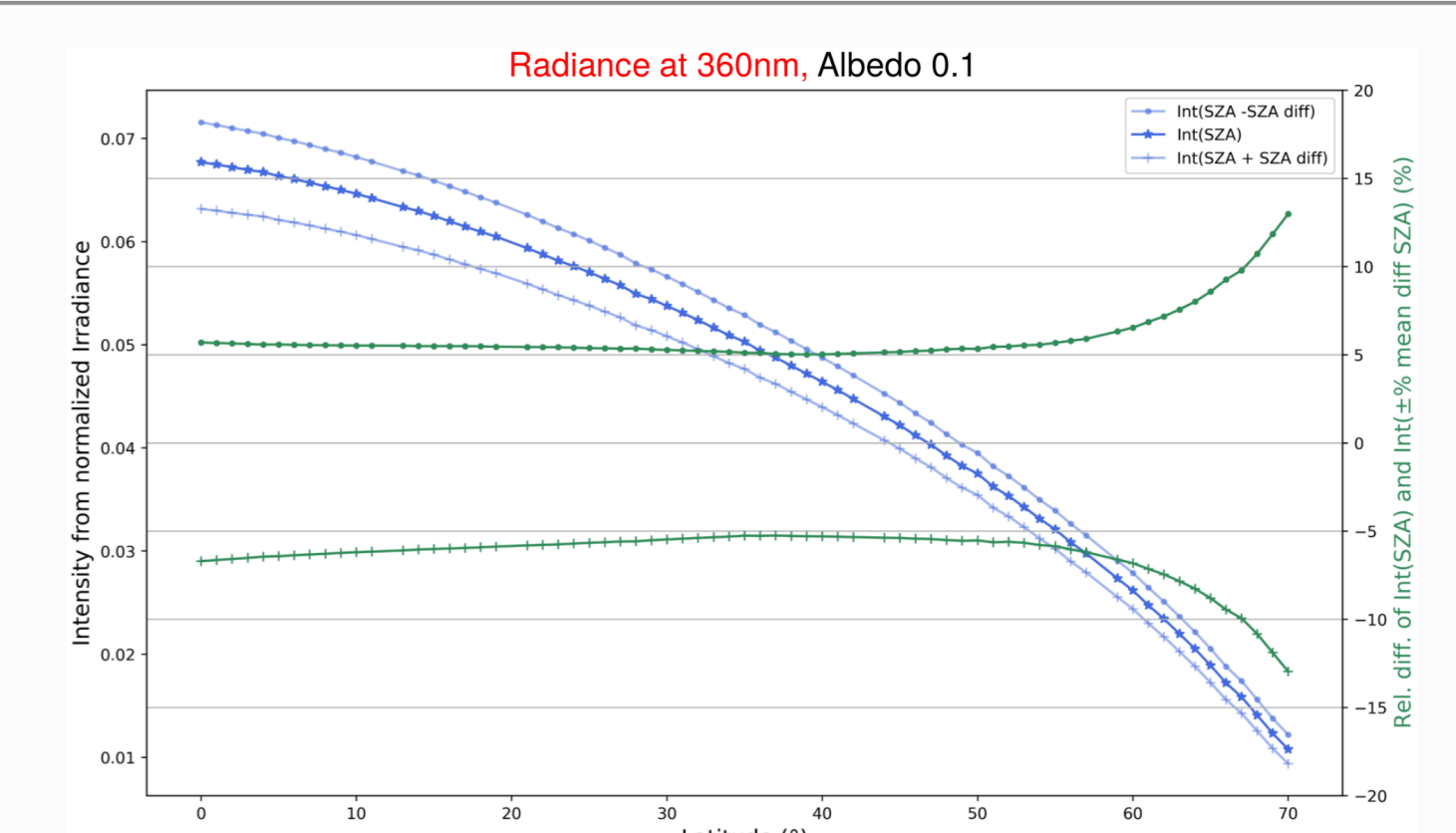


Figure: Modelled Effect of the different SZA angles GOME/SCIAMACHY for a given scene. Due to the different local times of the orbits, the modelled intensity shows differences of around 5%, higher for high latitudes (green lines).