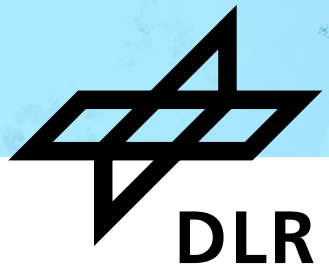
ATMOS 2024

FDR4ATMOS: A data set for harmonised solar irradiance and Earth reflectances and future plans



Introduction

- The Fundamental Data Record for ATMOSpheric Composition (FDR4ATMOS) project is part of the ESA Long Term Data Preservation (LTDP) programme
- The main objective of the FDR4ATMOS project is to develop a cross-instrument Level 1 product for GOME-1 and SCIAMACHY (phase 1) and to add GOME-2 data (phase 2)
- The FDR product contains *harmonised* irradiances and reflectances
- The focus is on the spectral windows in the UV, VIS and NIR used for O3, SO2, NO2 total column retrieval and the determination of cloud properties.
- The FDR4ATMOS products are based on Level 1, i.e. on irradiances and reflectances.

General Method

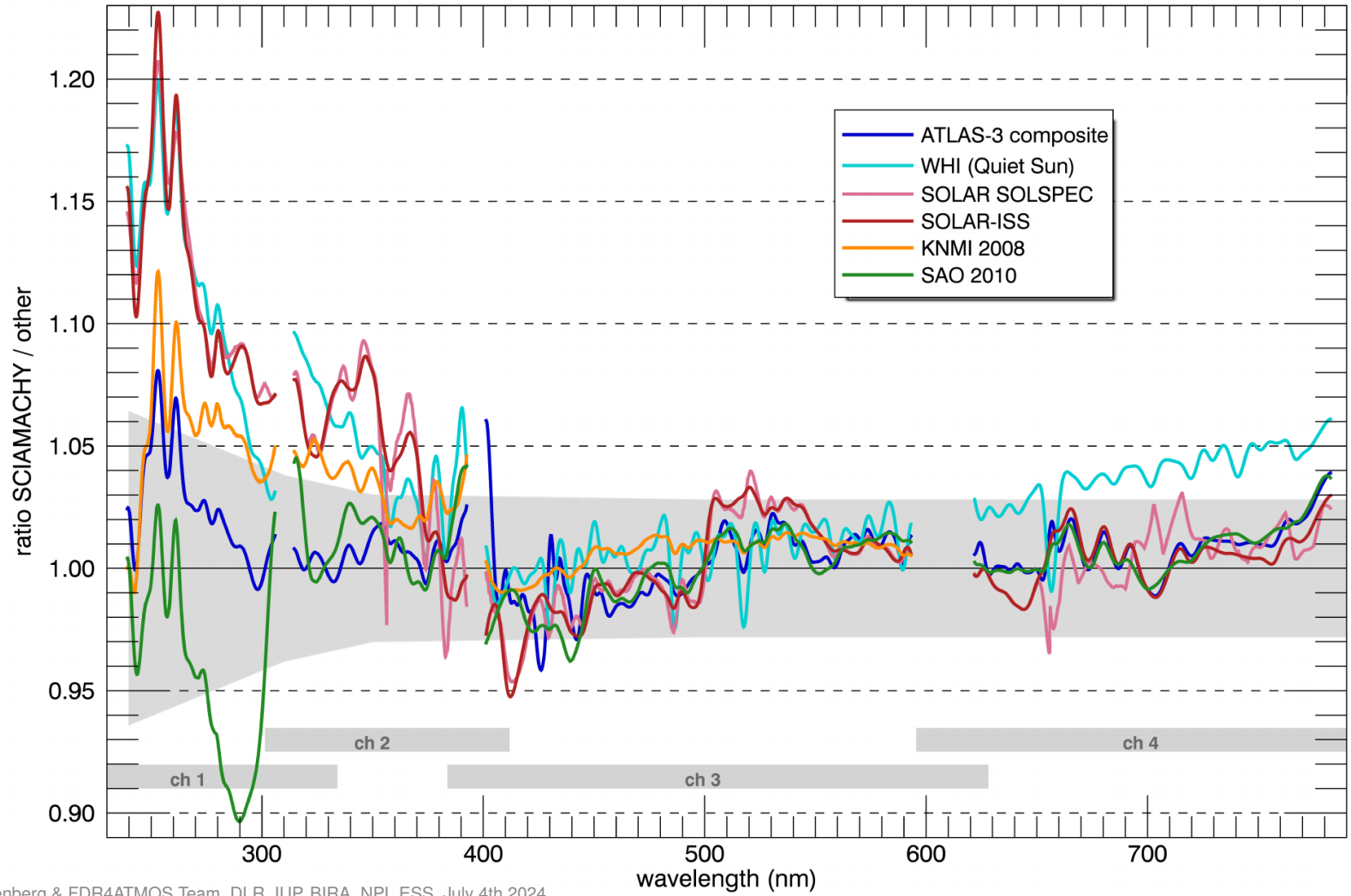
- Generic Formula:

$$S_{inst1} = S_{inst2} \times C_{\Delta inst} \times C_{1,scene}(geometry, S_{inst1.2}, \ldots) + C_{2,scene}$$

- Goal: Harmonise the broadband signal offset while keeping spectral structures
- Steps:
  - Align the spectral grids of both instruments
  - Ratio instrument spectra
  - Smooth ratio by polynomial (avoids Level 2 impact for DOAS like retrievals) $\Rightarrow$ Scaling factors
  - Investigate scene dependent effects
  - Apply to fully resolved spectra

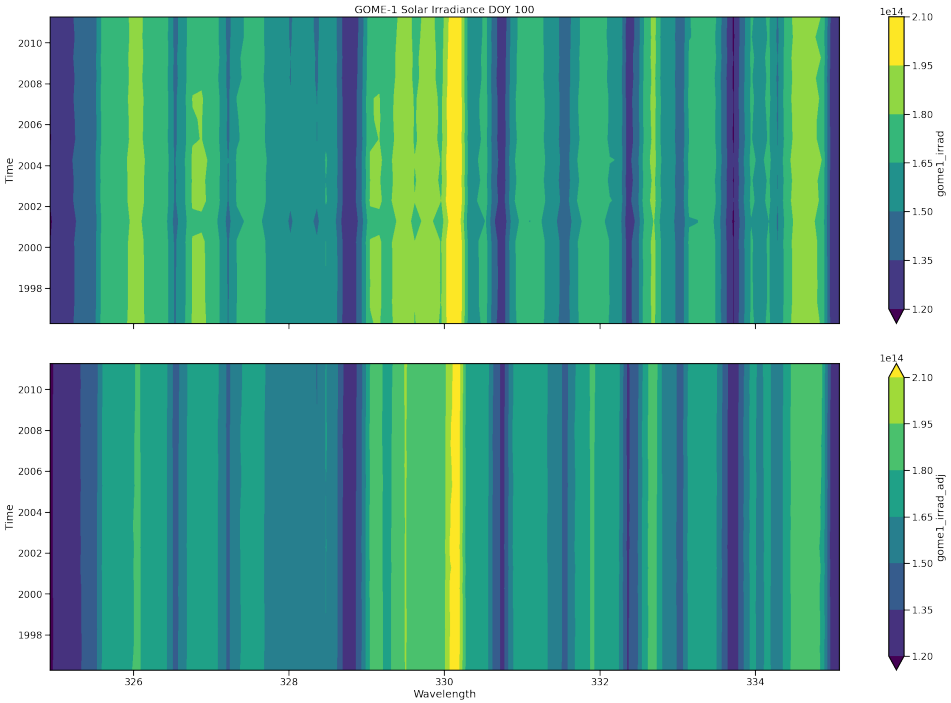
Harmonisation Solar Irradiance - Reference

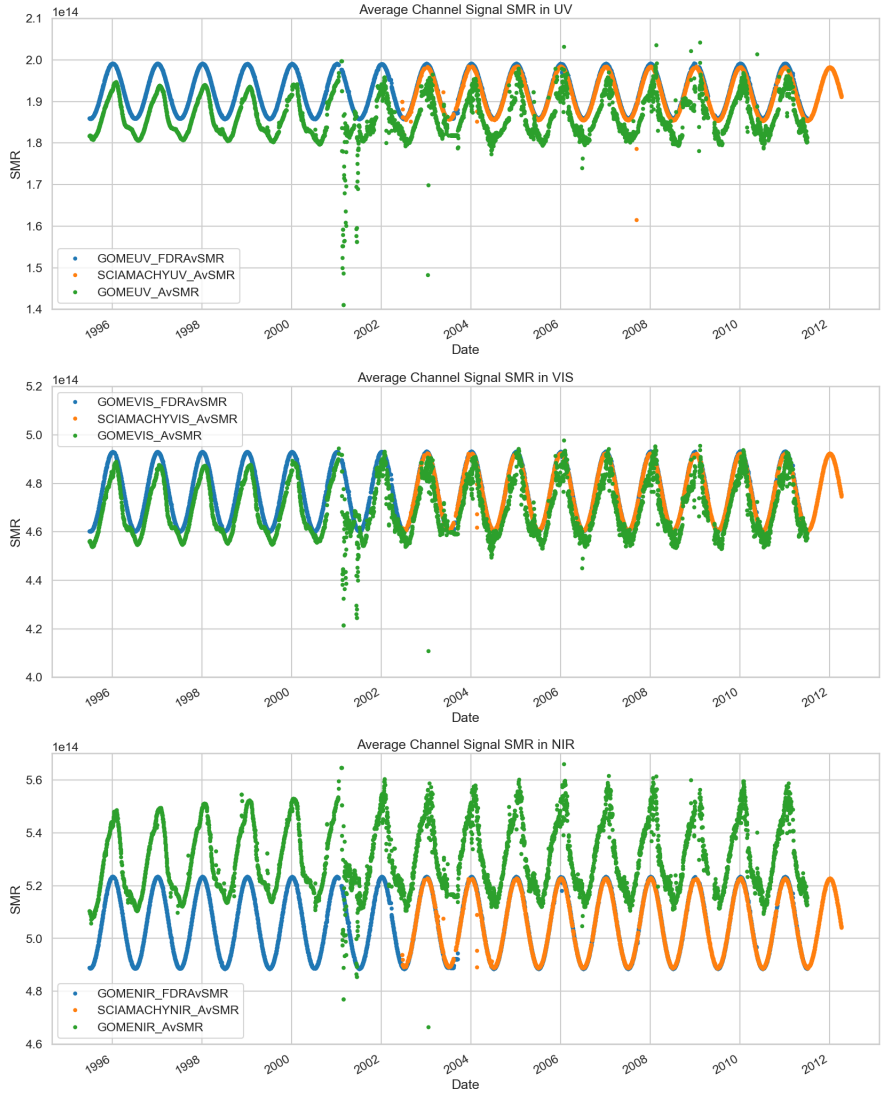
A Validated SCIAMACHY measurement was used (Hilbig et al. 2018):



Harmonisation Solar Irradiances

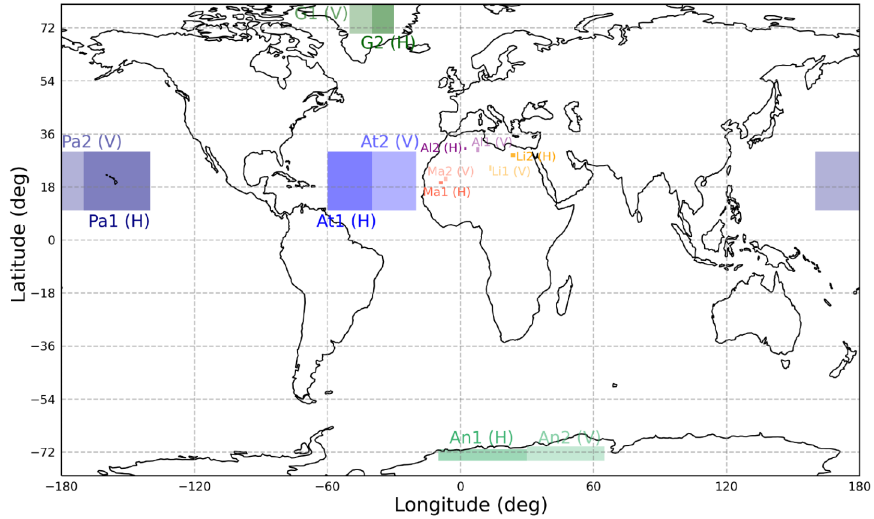
- Etalon GOME-1 removed
- BSDF related pattern removed
- Below: Original and corrected (UV)
- Right: Channel Averages

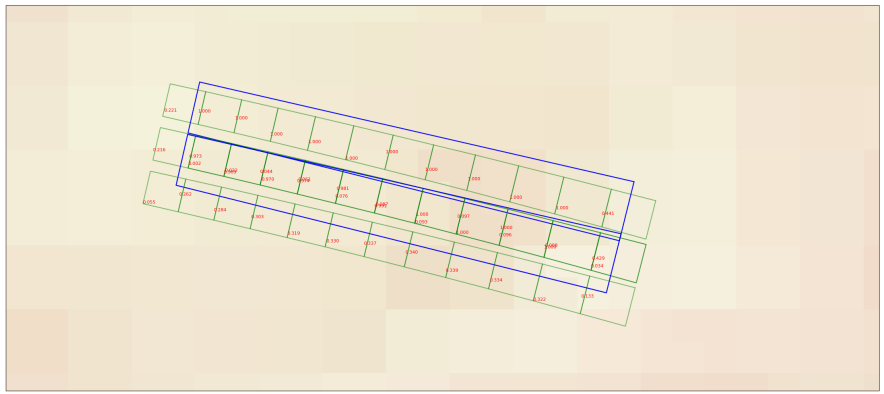




Harmonisation Reflectances - Method

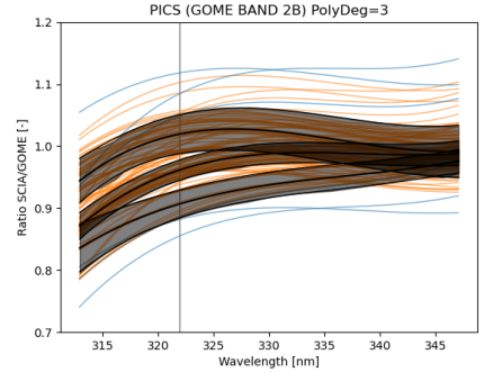
- Harmonisation was done on reflectances (cancels multiplicative instrument effects, e.g.GOME-1 etalon)
- Matching Scenes with homogeneous signal have been defined to
  - cover different signal levels to avoid instrumental biases due to e.g. non-linearity
  - cover different observation geometries
  - Ocean scenes could not be used (high variation)
- Spatially higher resolved SCIAMACHY data were mapped onto GOME-1 footprints
- Harmonisation factors were calculated for all scenes (reference year 2003)

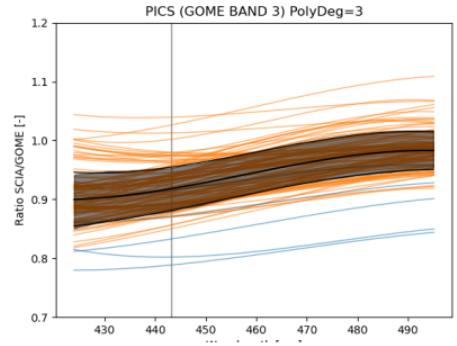


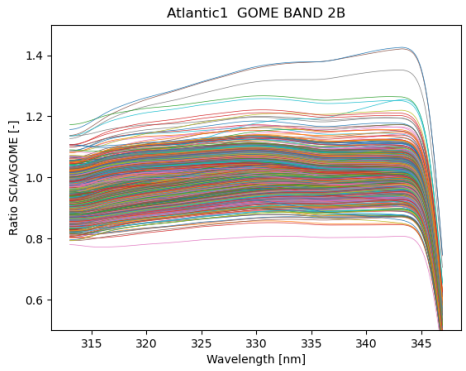


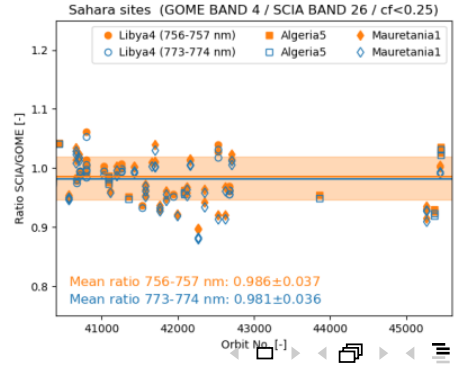
Harmonisation Reflectance - Transfer Factors

- Transfer curves for all PIC Sites
  - Blue thin line: Excluded curves
  - Black line: Average of all 2003 observations
  - Shaded Area: Standard deviation of Average
- Top: UV
  - 3 curves, one for each viewing angle (East - Nadir - West)
  - Polynomial 3rd degree
- Middle: VIS Polynomial 3rd Degree
- Bottom NIR:
  - Excluded O2A band Absorption
  - One factor for whole channel
- No scene dependencies found
- Ocean scenes are looked into



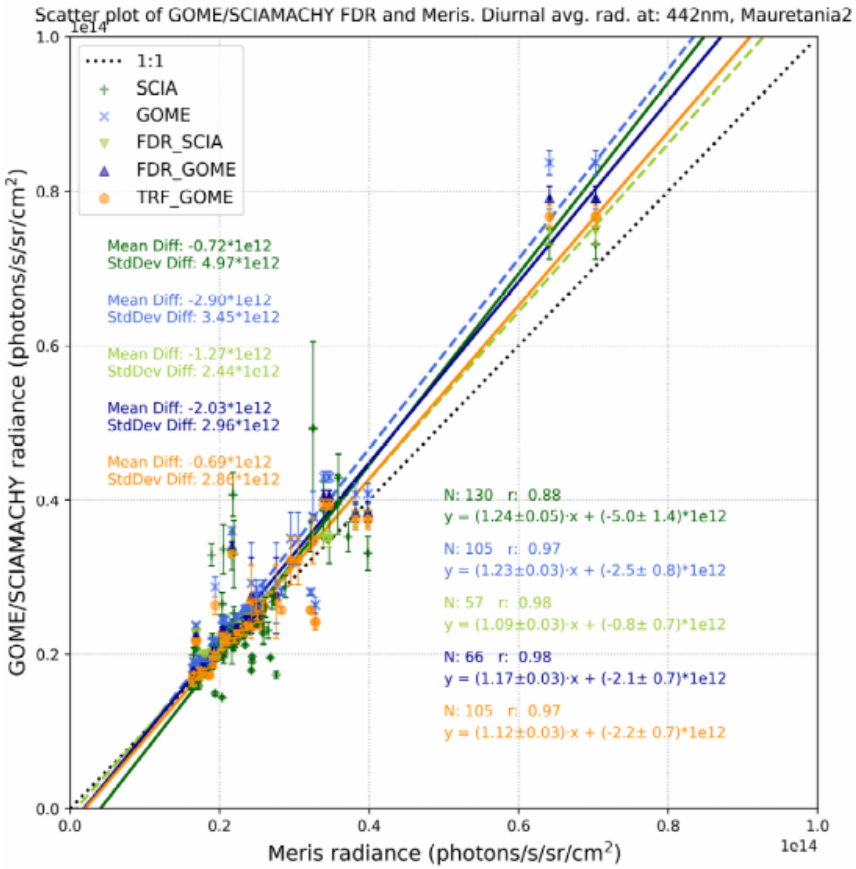


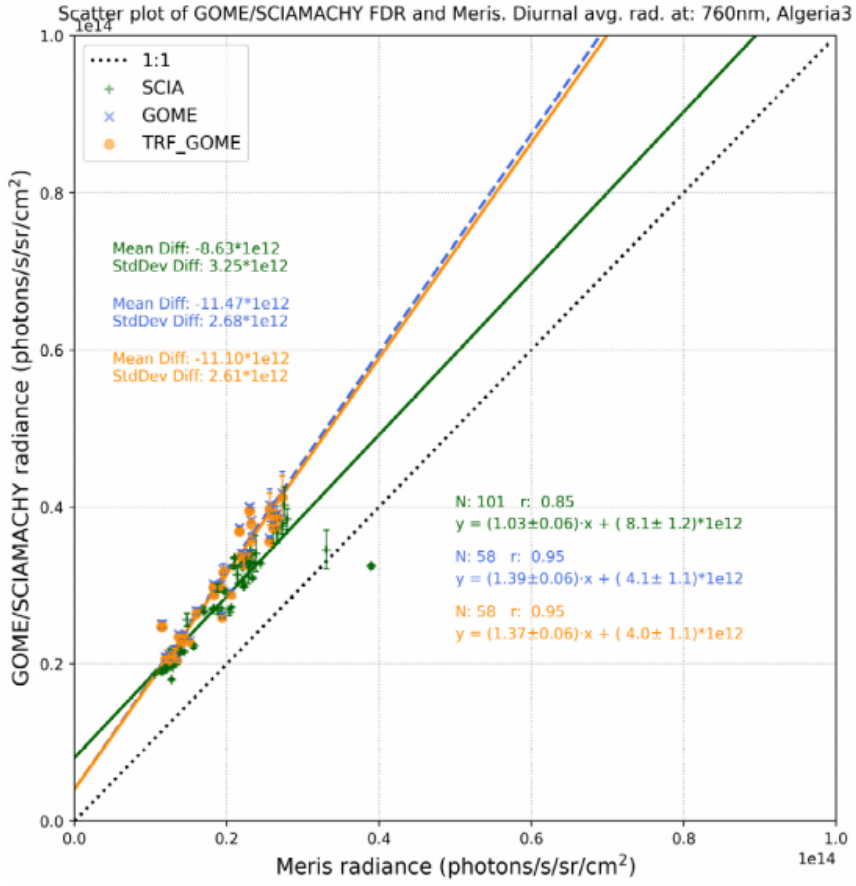




Harmonisation Reflectance - Validation

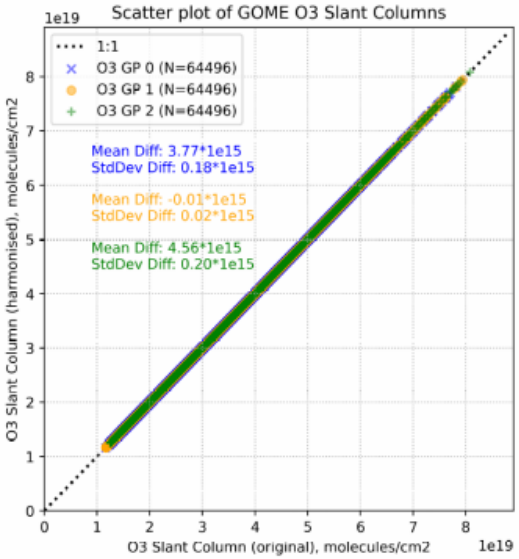
- Daily averages in VIS band agree well with MERIS
- Daily averages in NIR show offset (band mismatch) but show a good correlation

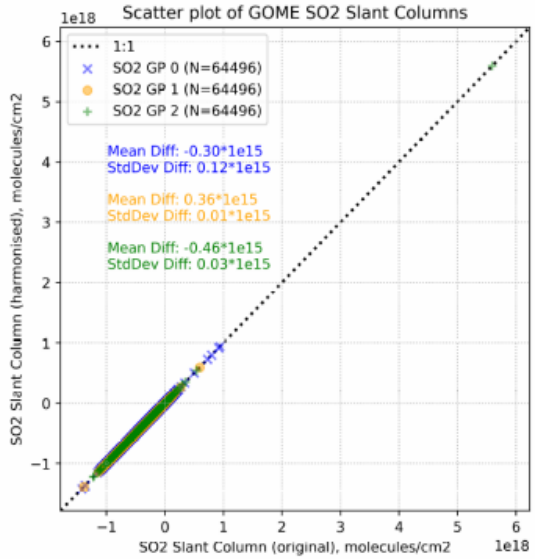


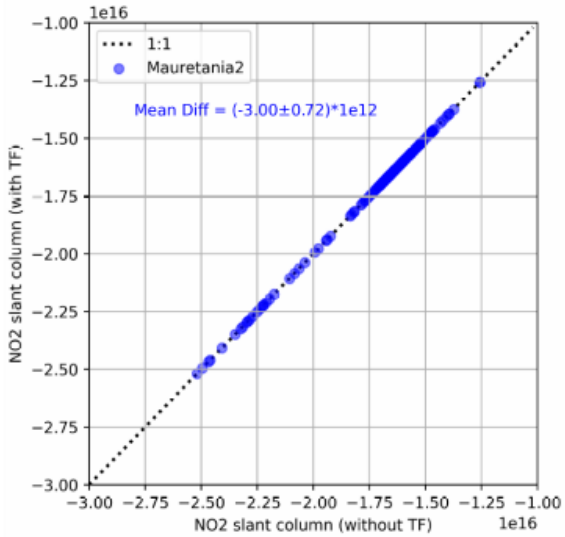


Harmonisation Reflectance - Level 2 Impact

- Limited Level 2 impact study was done
- No negative impact on Level 2 DOAS retrieval of O3, SO2, NO2
- This is expected because of the polynomial harmonisation function
- An extended check on Level 2 impact is planned for the next phase

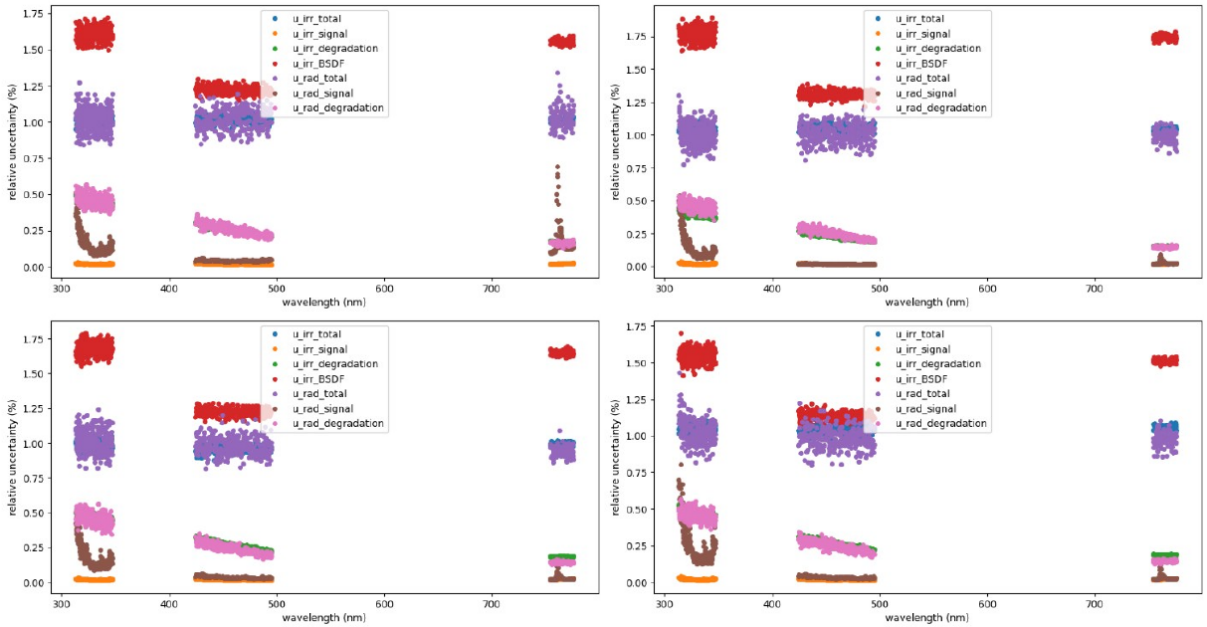






Uncertainties

- For the first time Level 1 uncertainties for both instruments were calculated using strict metrological principles
- From this information, for typical measurements
  - An error propagation model was set up and used to separate different types of uncertainties
  - Error correlations were calculated
- The analysis is currently limited by availability of calibration information and number of scenes analysed
- Further improvement and analysis is planned for the next phase



Summary

- FDR added value
  - GOME-1 SMR harmonised to independently validated SCIAMACHY SMR
  - SCIAMACHY data scaled to minimum integration time in band
  - Reflectances directly available in FDR
  - GOME-1 UV viewing angle dependency mitigated
  - Level 1 errors were thoroughly analysed an decomposed into systematic/random components
- Open:
  - Time dependency GOME-1 is the same as in original data (reflectance degradation)
  - Reason for unusable ocean scenes
- Open points will be addressed in Phase 2 together with the incorporation of GOME-2 data

Next Phase

- The following is planned for the next phase that started 12/23:
  - Study and develop GOME-1 degradation correction
  - Add more scenes for harmonisation factor derivation, bring down uncertainties
  - Reason for unusable ocean scenes
  - Incorporate GOME-2 A-C data into time series
  - Develop lunar model from SCIAMACHY and GOME-2 data
  - Deliver lunar irradiance/reflectance from GOME-2 (as done for SCIAMACHY , see poster 135)
  - Extend calculation of uncertainties
  - Extend Level 2 impact checks

FDR4ATMOS Team

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