Lessons learned from L1 UVN spectrometers for multi-sensor ECV generation

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EO Level 1 lessons learned, ESRIN, June 11, 2013

DLR

Overview

- Motivation

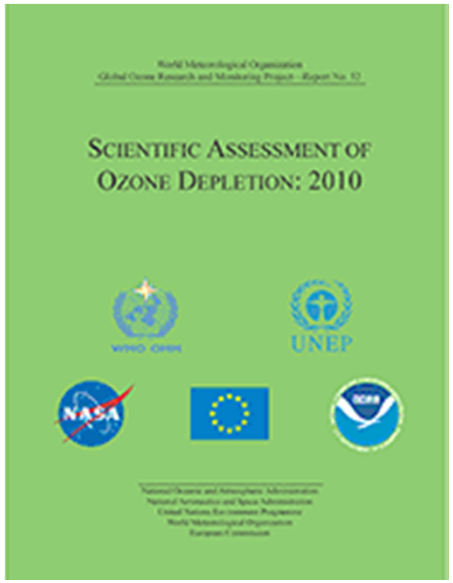
- Retrieval Algorithm: Requirements on L1 Products
  - DOAS
  - GODFIT

- L1 Soft Corrections
  - Relative degradation correction
  - Absolute radiometric and degradation correction

- Multi-Sensor Ozone ECV

- Summary

GOME-type Ozone ECV – WMO/UNEP Assessment



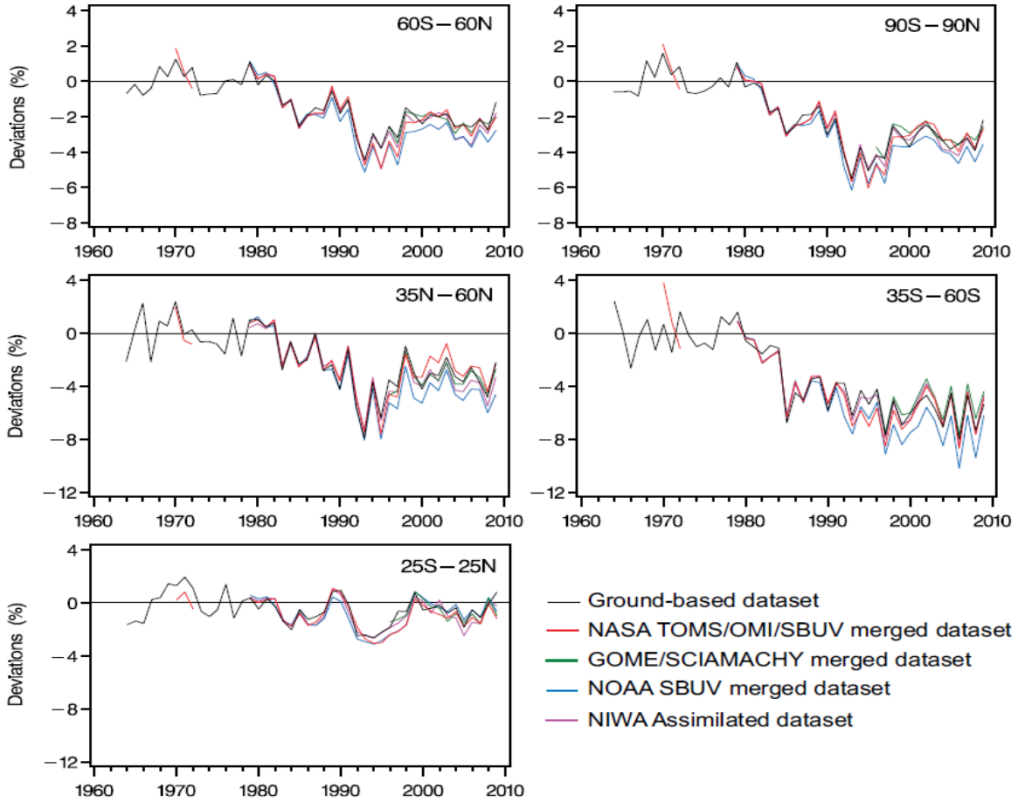


Fig. 2.2, WMO/UNEP Scientific Assessment of Ozone Depletion 2010

GOME-type Total Ozone – Essential Climate Variable

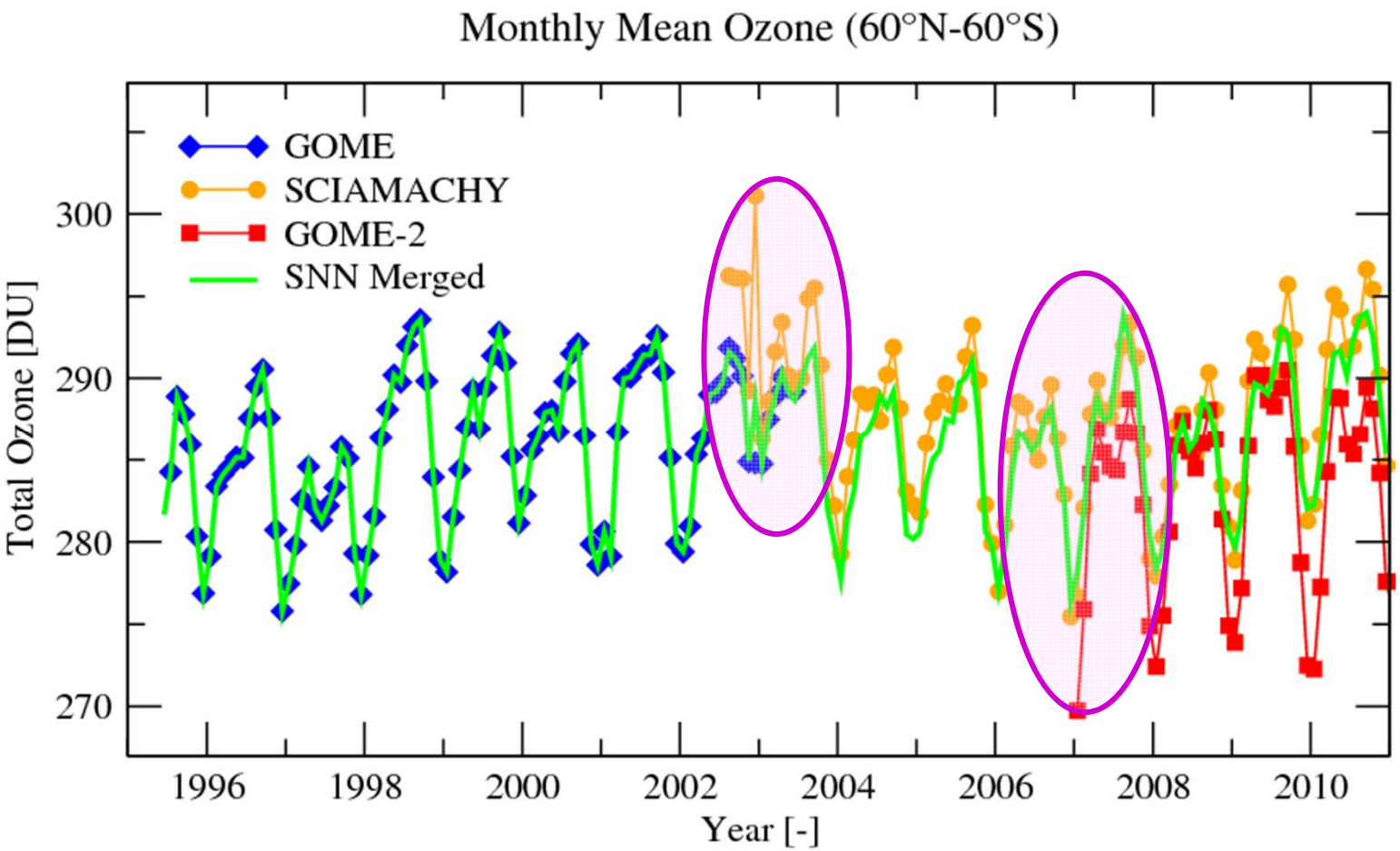
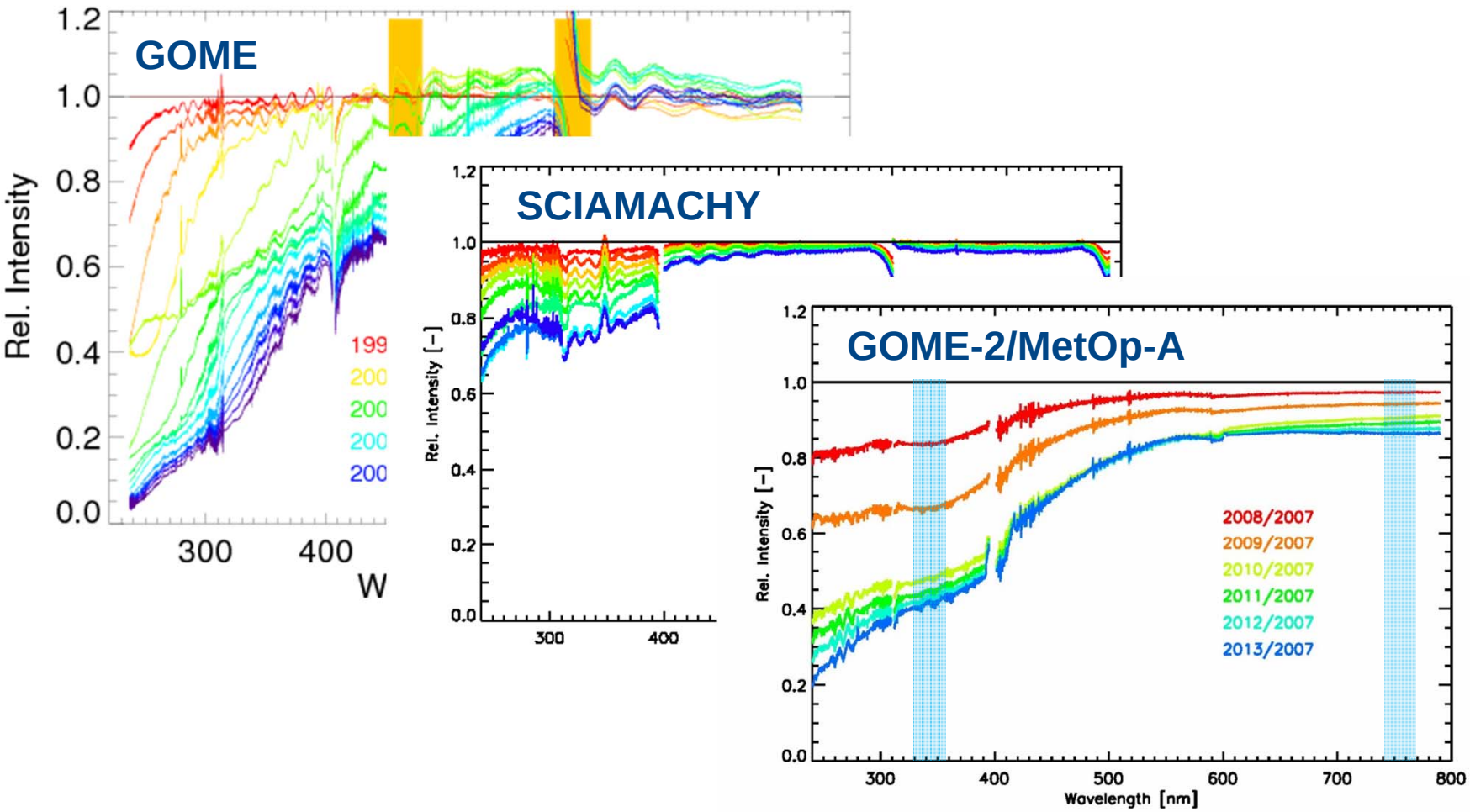


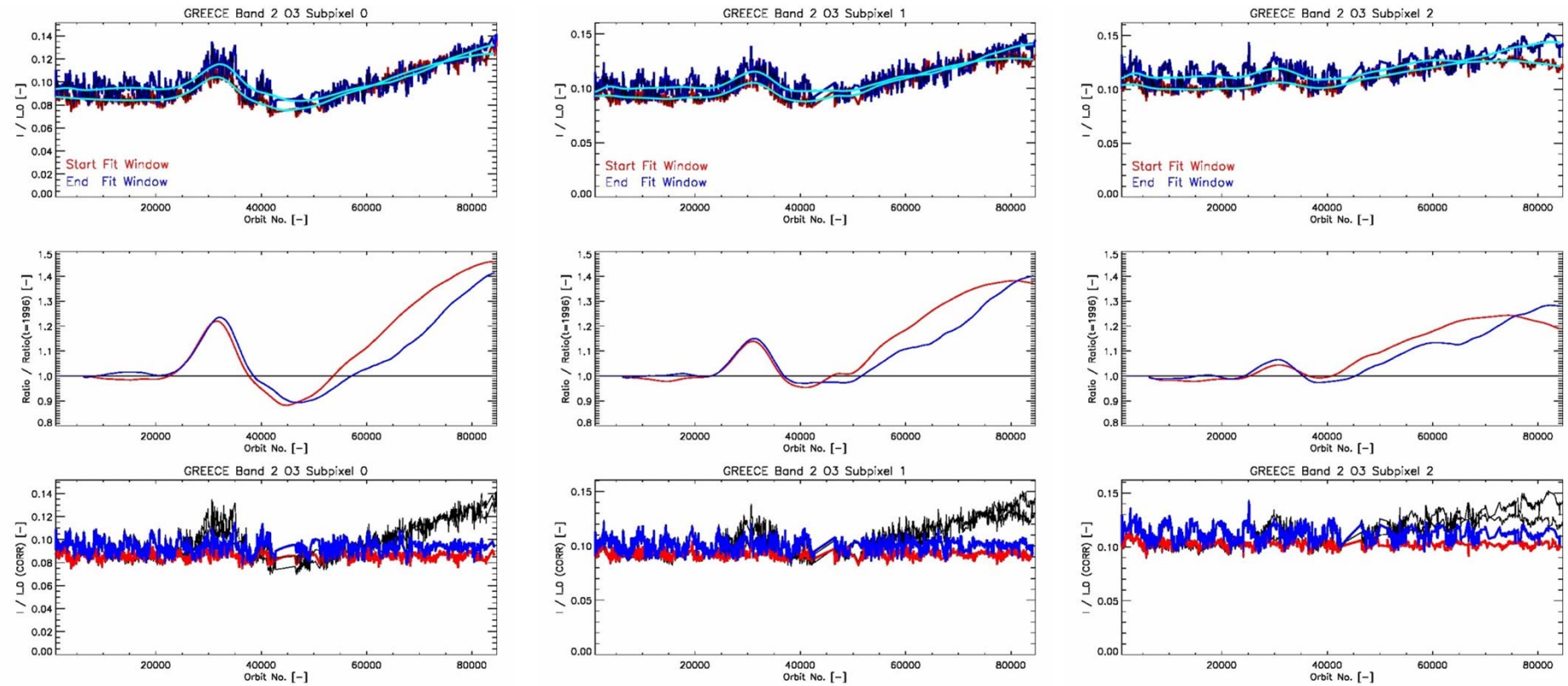
Fig. 5, Loyola and Coldewey-Egbers, JASP 2012

Instrument Degradation – Irradiance



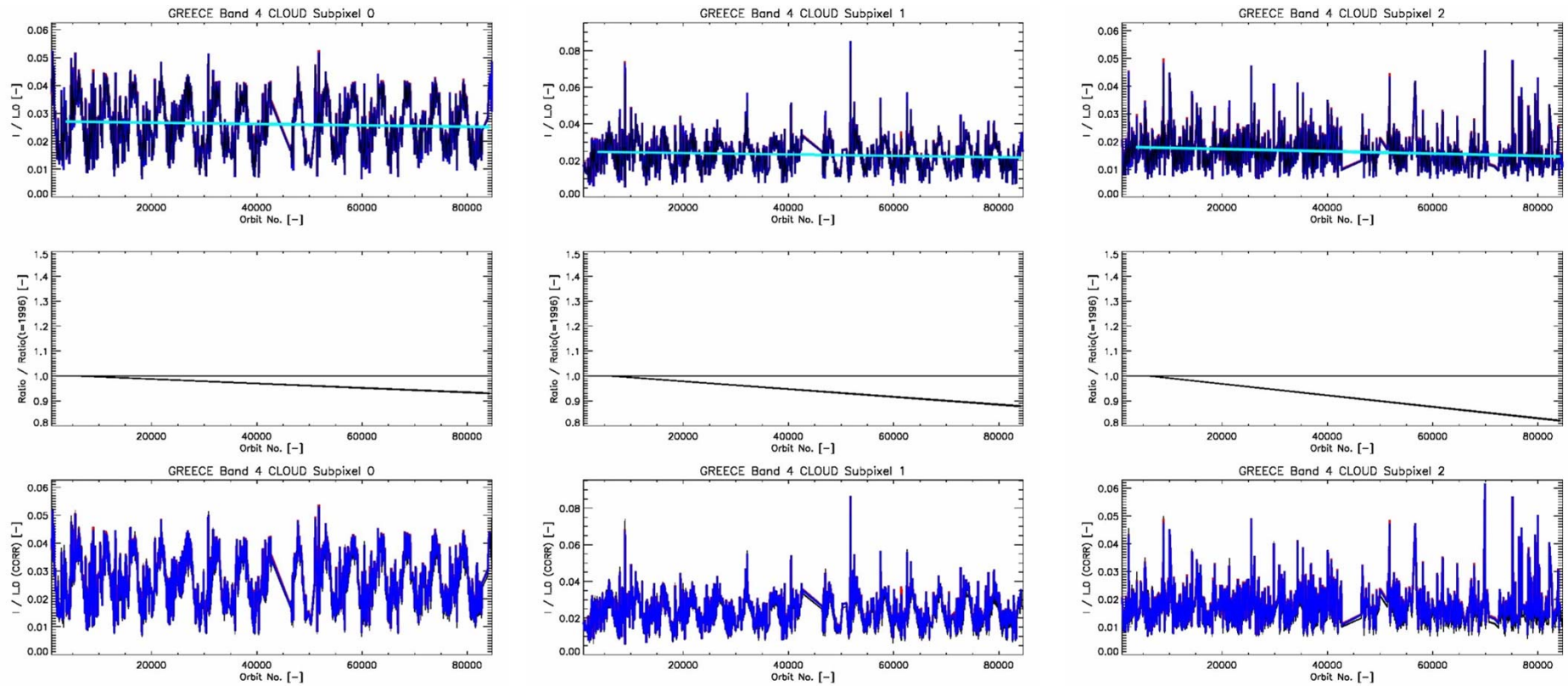
GOME Degradation – Reflectance 325-335nm

East | Nadir | West

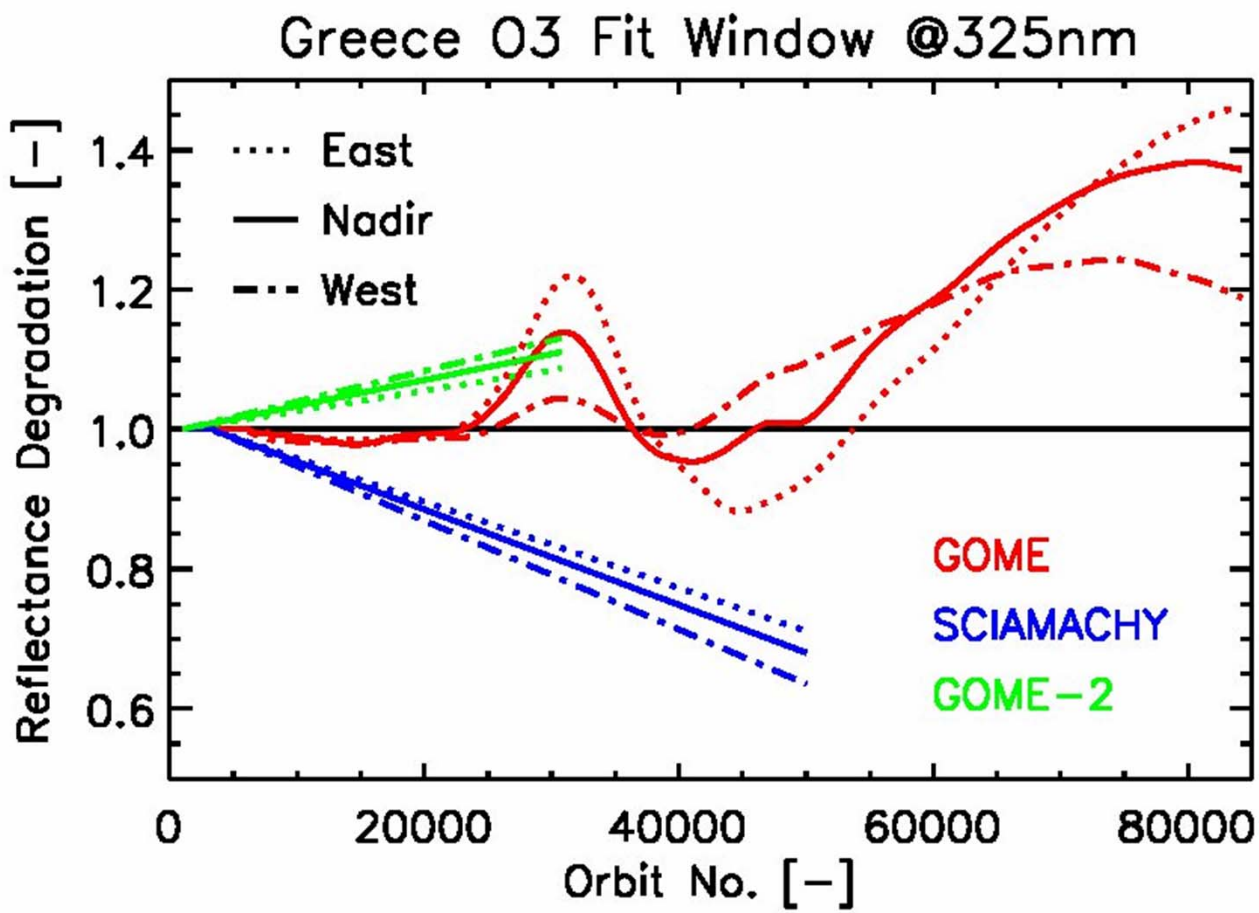


GOME Degradation – Reflectance 758-761nm

East | Nadir | West



Degradation Comparison – Reflectance 325nm

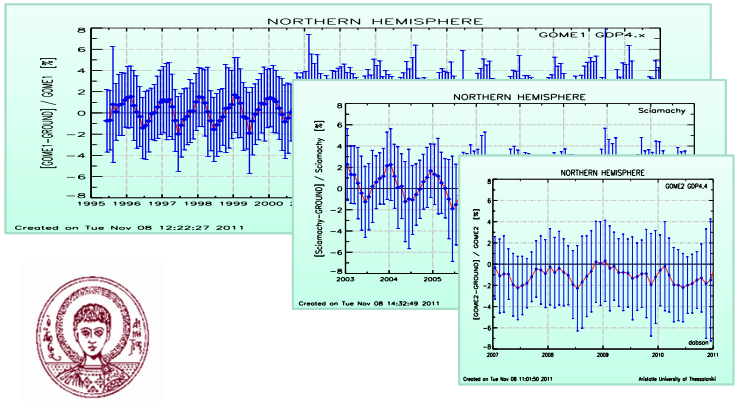


GOME-type Total Ozone – GDP 4.x Overview

- Two steps GDOAS approach
  - **DOAS fit** for ozone slant column and effective temperature
  - **Iterative AMF/VCD** computation using a single wavelength

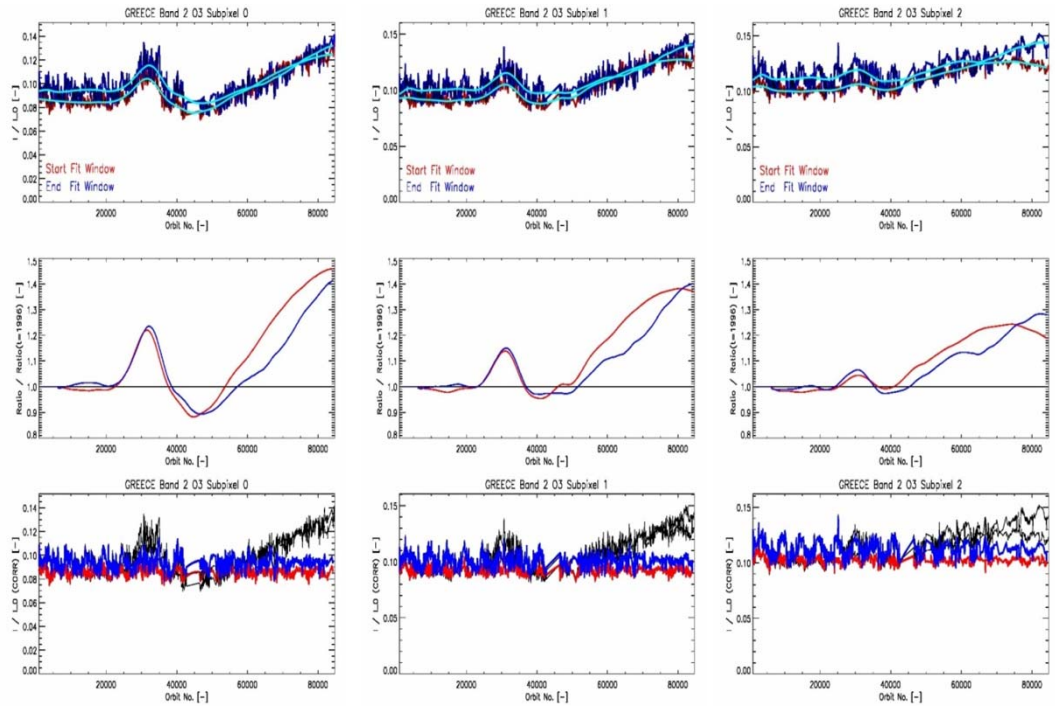
- Improved O3 Retrieval
  - **Molecular Ring** correction (Van Roozendael et al., JGR 2006)
  - **On-the-fly RTM** simulations **LIDORT** v3.3 (Spurr, 2003)
  - **Cloud** correction **OCRA&ROCINN** v2.0 (Loyola et al., TGRS 2007)
  - **Intra-cloud**, **sun-glint** and scan angle (Loyola et al., JGR 2011)

- Independent **Geophysical Validation**
  - D. Balis et al., JGR 2007
  - …
  - Antón and Loyola, JGR 2011
  - Koukouli et al., AMT 2012



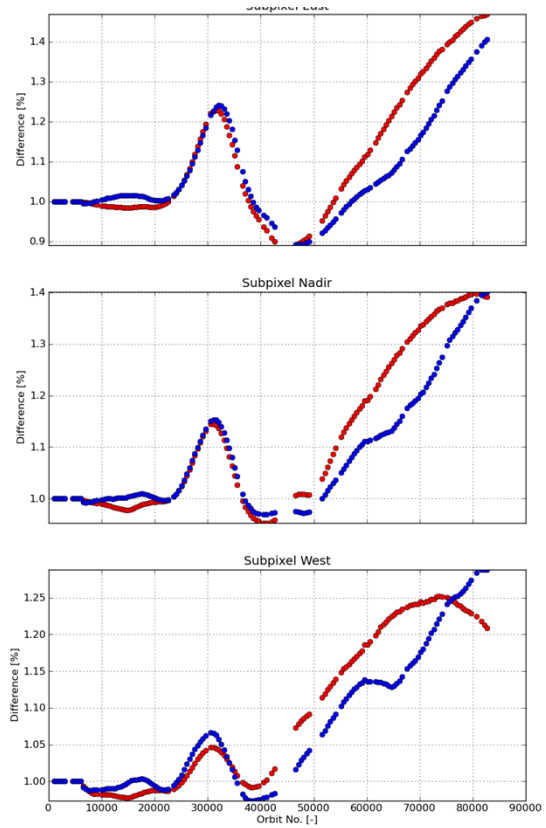
L1 effects on DOAS retrievals

East | Nadir | West



Polynomial of DOAS fit:

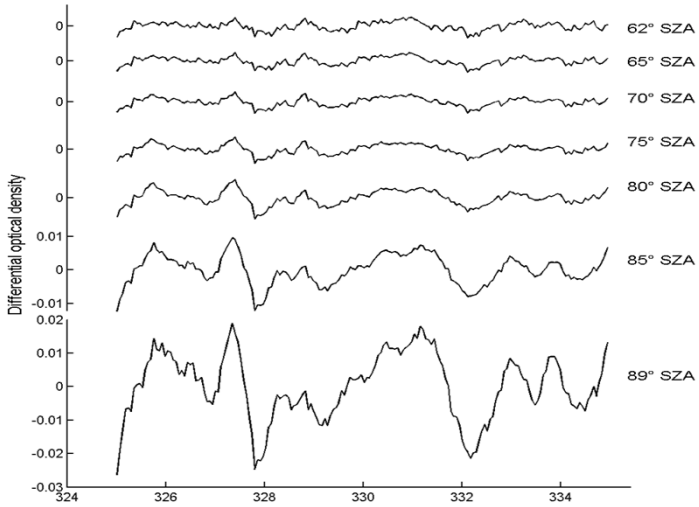
Corrected vs. Reference



GOME-type Total Ozone – GODFIT Overview

- One steps fitting approach
  - **Direct fitting** of L1 measurements to reflectances simulated with LIDORT for the retrieval of **total ozone and temperature**-shift
  - Improved **Ring** correction and atmospheric **polarization**
  - An **scene albedo is fitted** simultaneously to the ozone column.
  - **Soft-calibration of level-1 reflectances**

DOAS residuals



Direct-fitting residuals

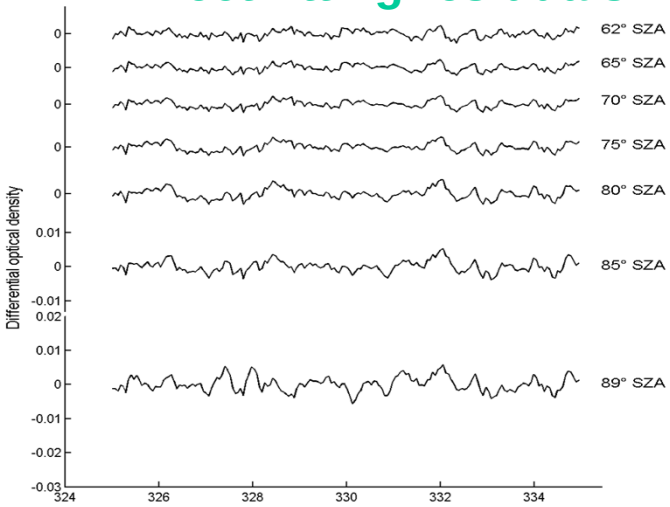
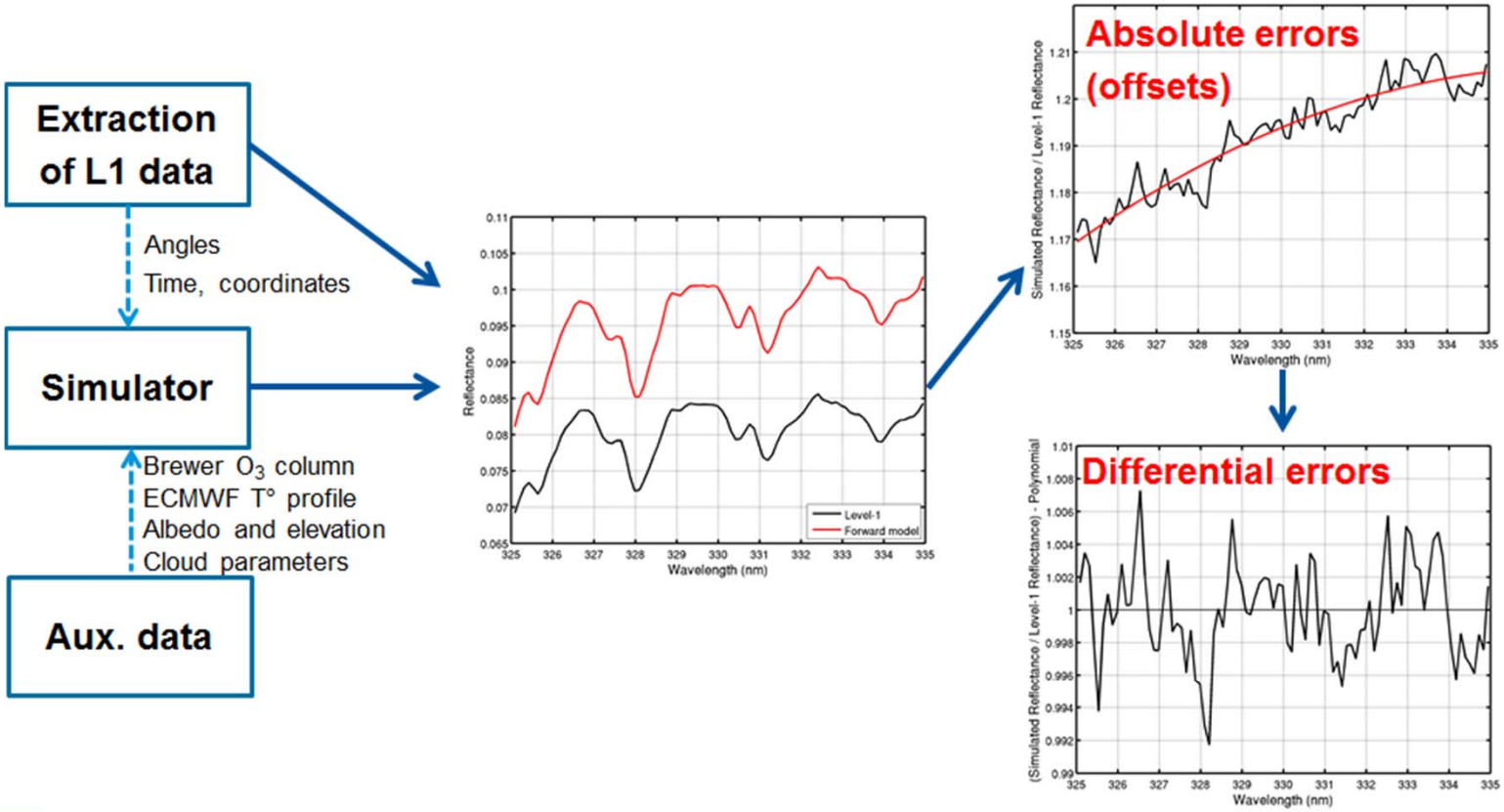


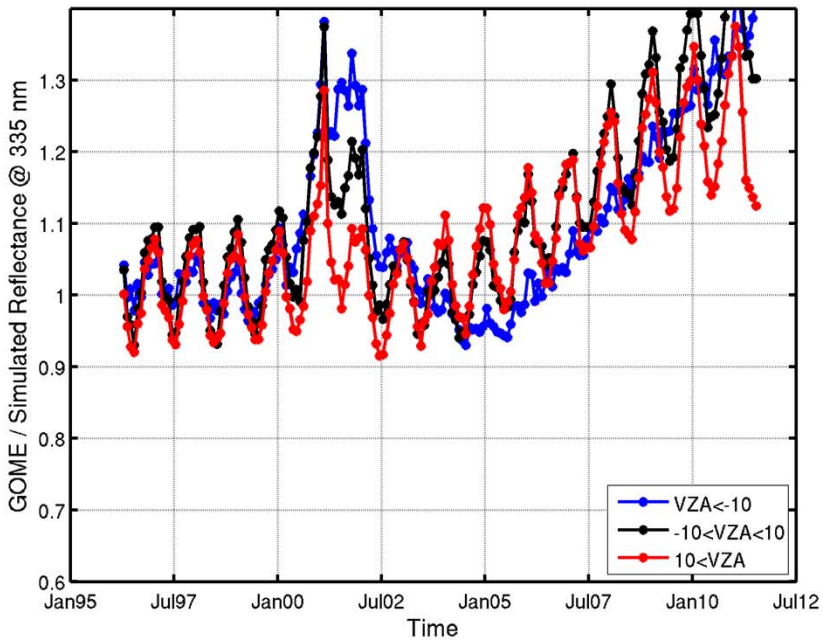
Fig. 6, Van Roozendael *et al.*, JGR 2012

Soft-calibration of L1 reflectances

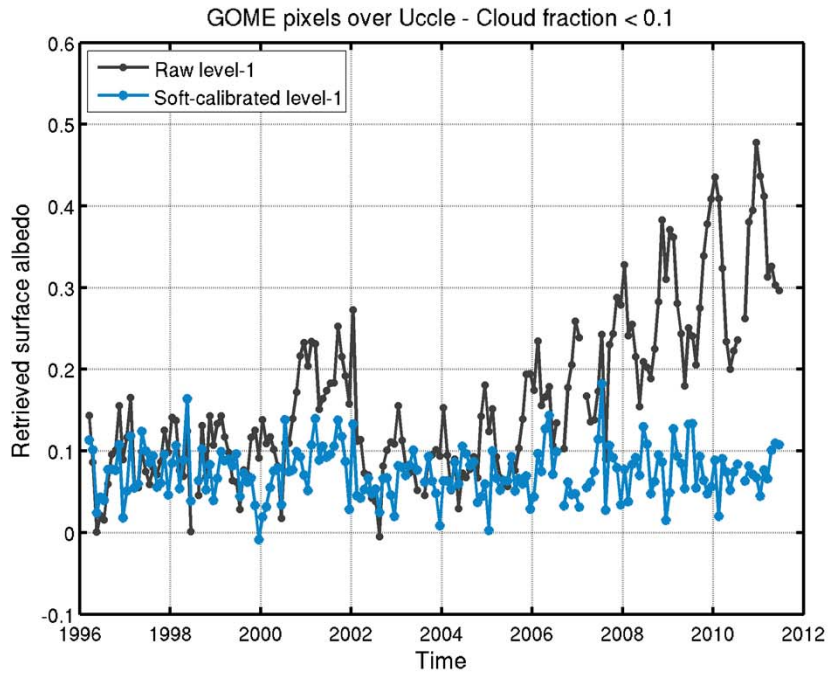


L1 effects on GODFIT retrievals

GOME degradation at 335nm

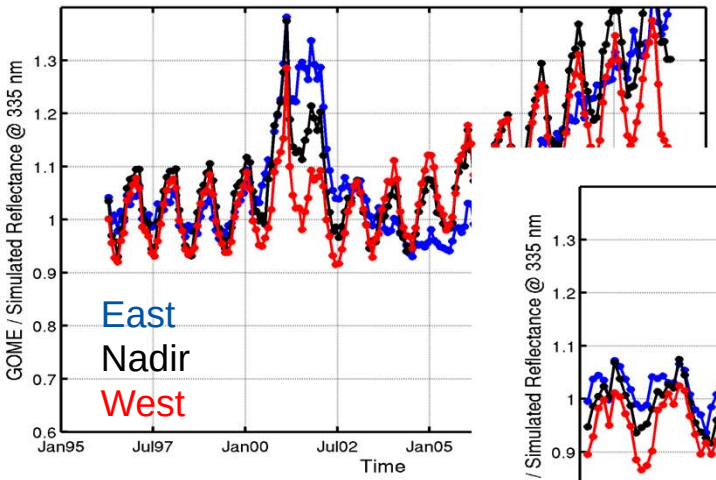


Retrieved scene albedo (clear sky)

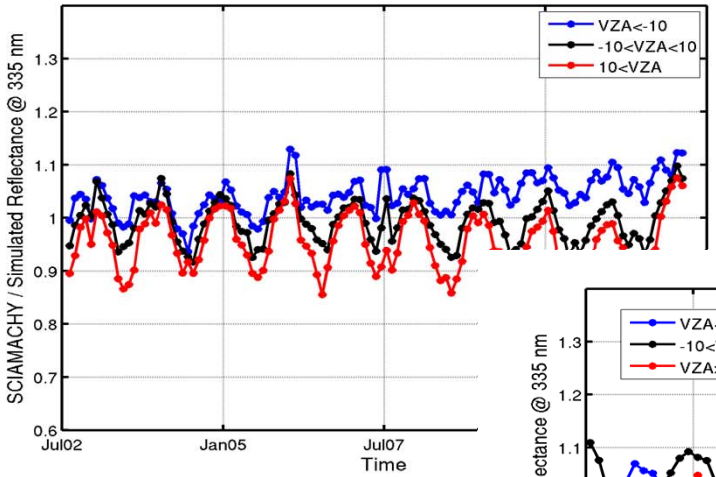


L1 Soft-calibration – Comparison @ 335nm

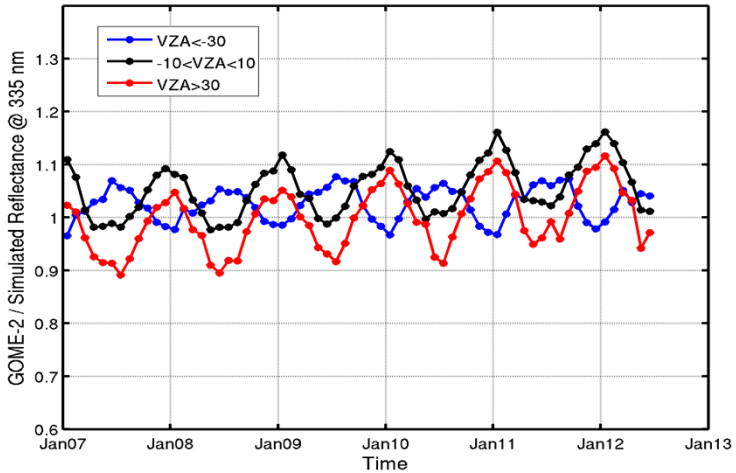
GOME



SCIAMACHY

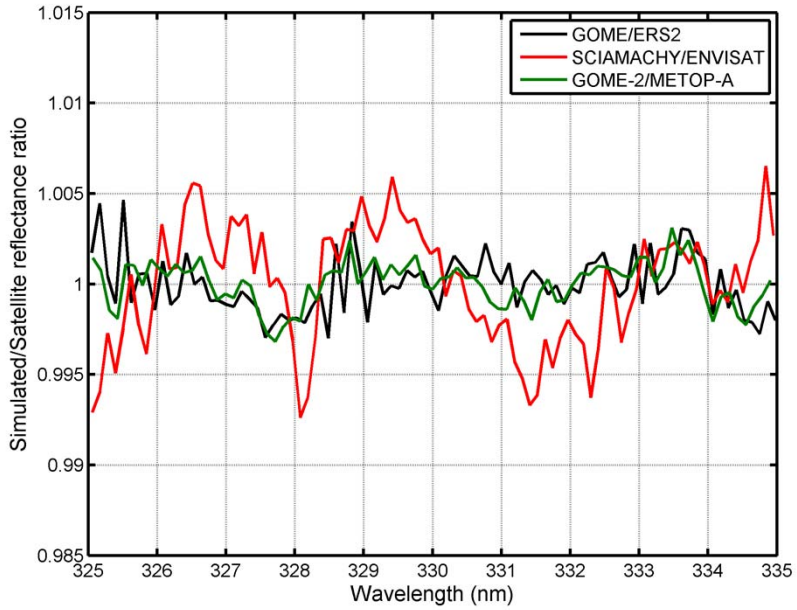


GOME-2

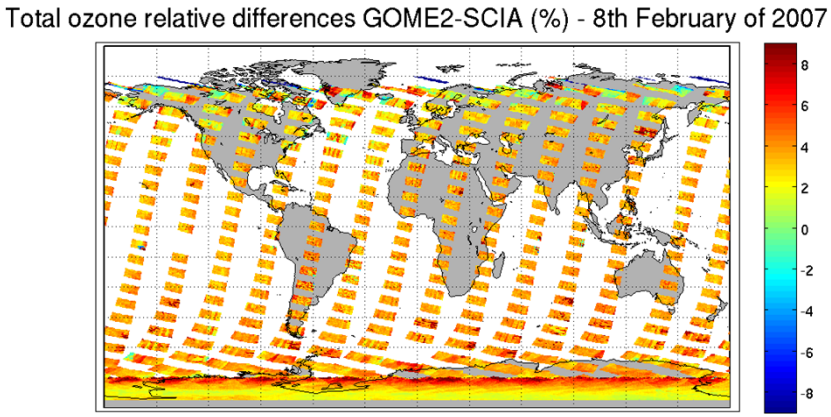


L1 Soft-calibration – Spectral Features

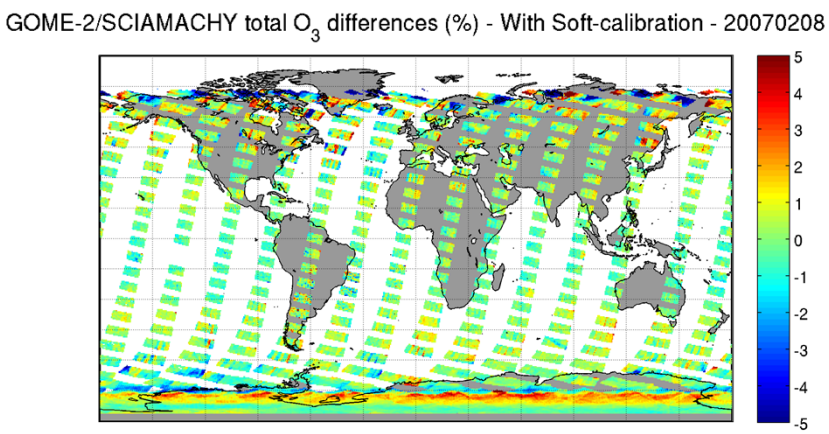
Simulated/Level-1 reflectance



GOME-2 vs SCIAMACHY (raw L1)



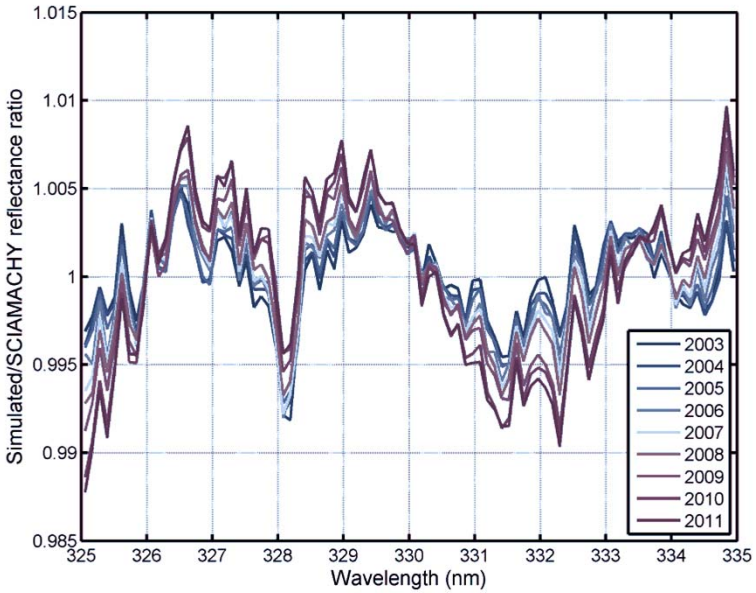
GOME-2 vs SCIAMACHY (Soft-calibrated L1)



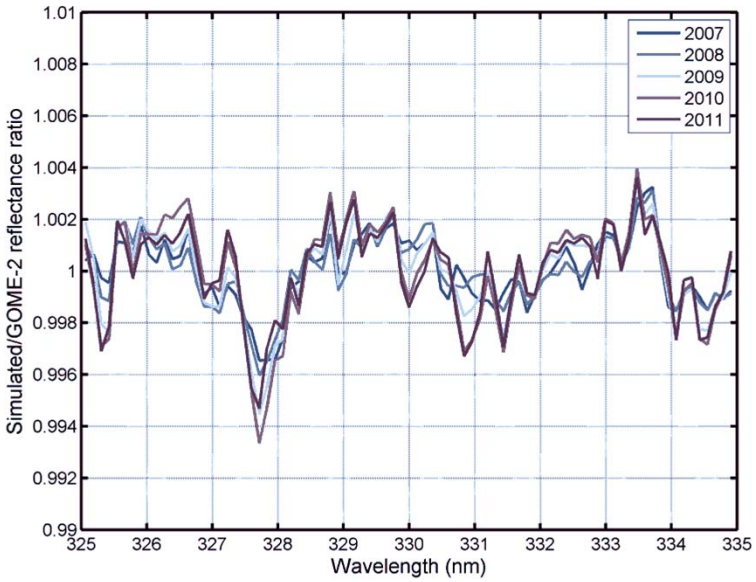
L1 Soft-calibration – Spectral Features (2)

Time dependence of **artificial structures**
in SCIAMACHY and GOME-2 spectra

SCIAMACHY

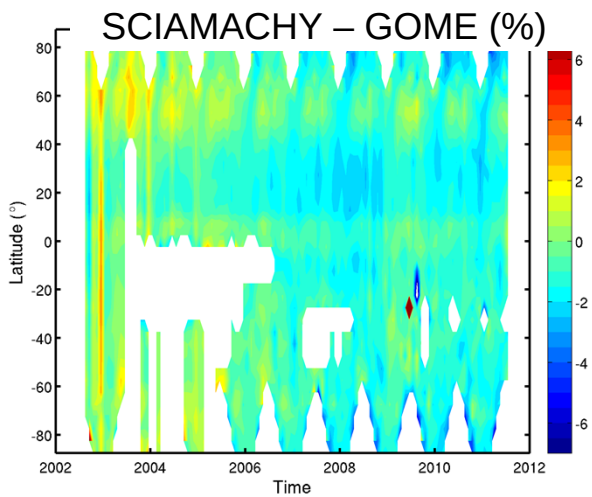


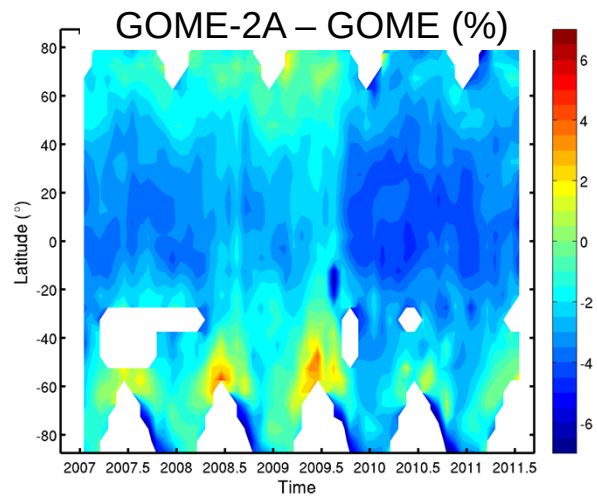
GOME-2



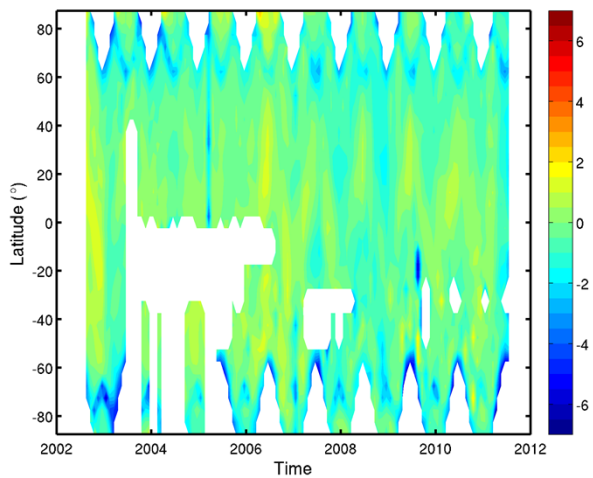
L1 Soft-calibration – Results Ozone

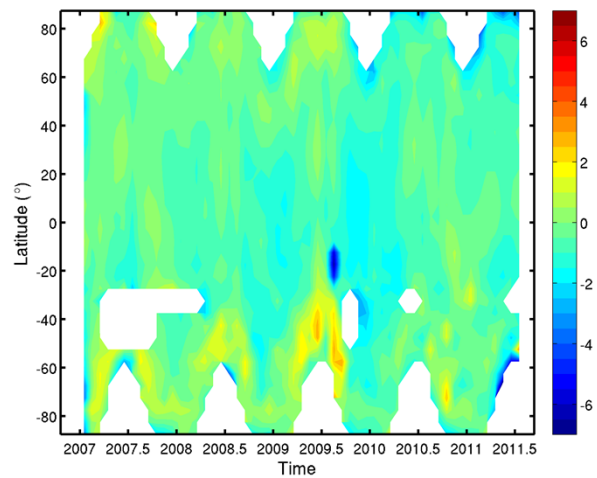
Current level-2 operational products (DOAS)





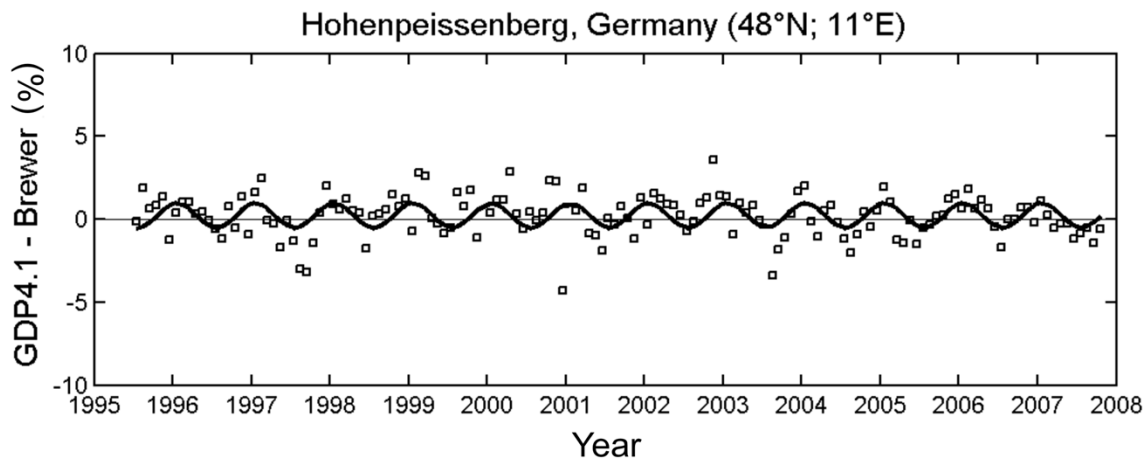
O_3-CCI level-2 products (GODFIT)





GOME-type Total Ozone – Time Series

- Inter-Satellite Calibration: Select one data set as reference (GOME) and correct others (SCIAMACHY and GOME-2) for spatial and temporal biases and drifts

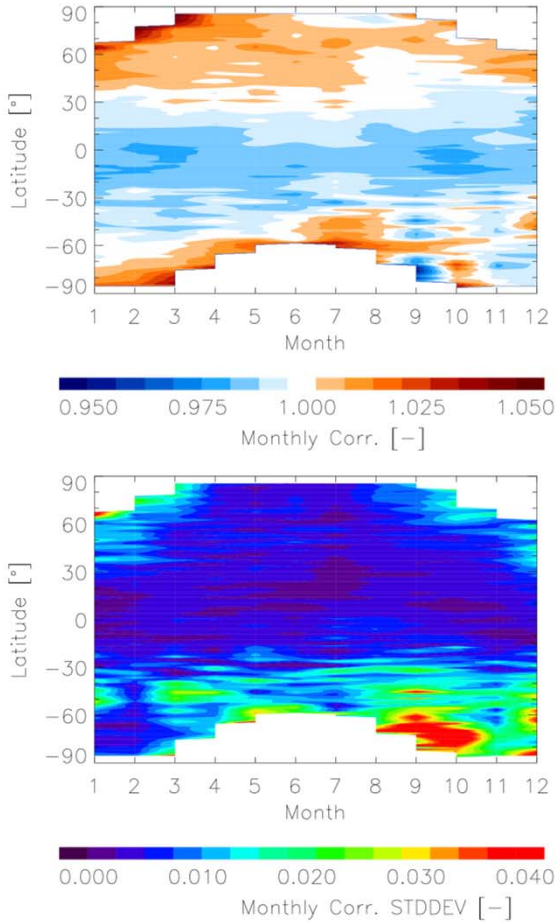


- Self-consistent and independent long-term dataset staring in 1995
- Ground-based data used for geophysical validation
- Merged product used for climate model evaluation

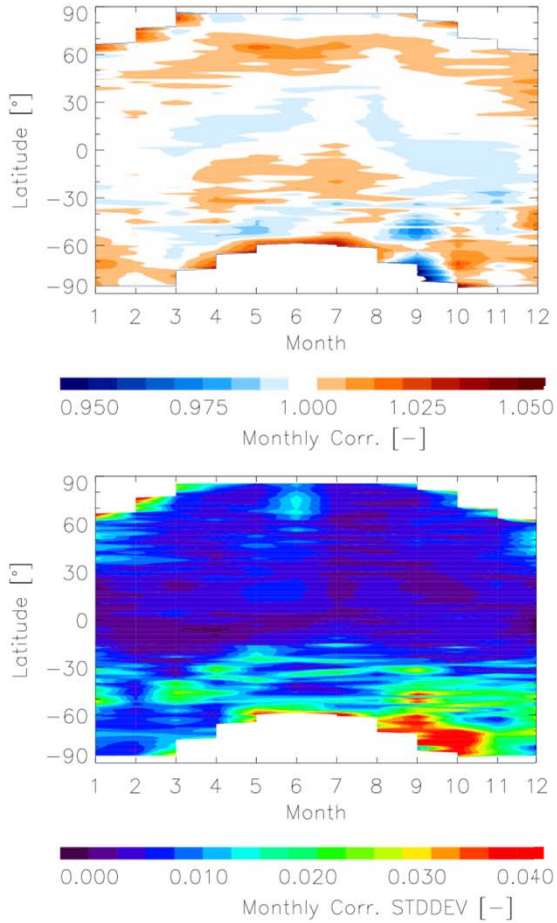
GTO-ECV – SCIAMACHY Correction

Corr. fac.

- Std.dev.



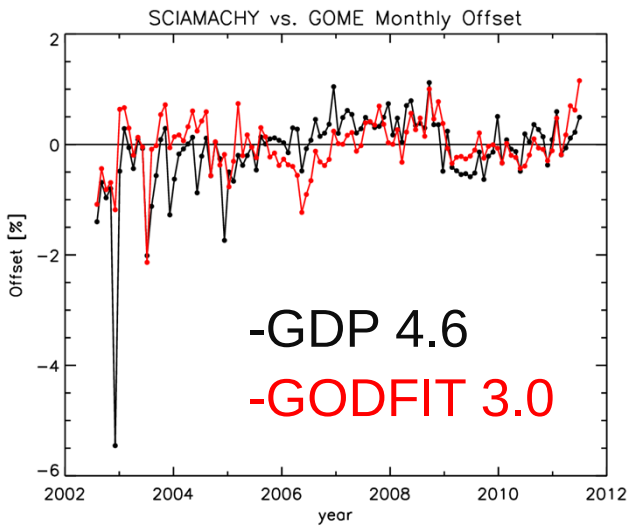
GDP 4.6



GODFIT 3.0

Polynomial as a function of latitude and month (Jan-Dec)

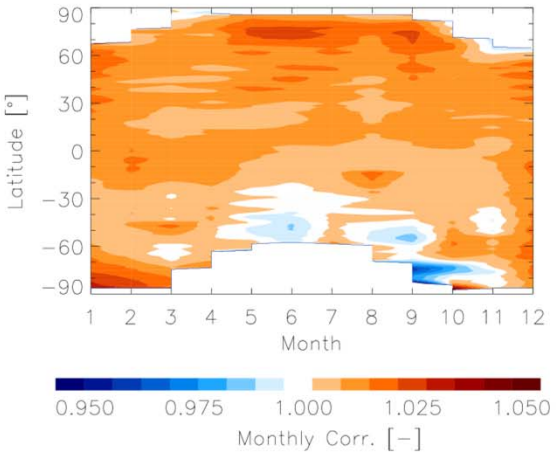
+ Offset for each individual month

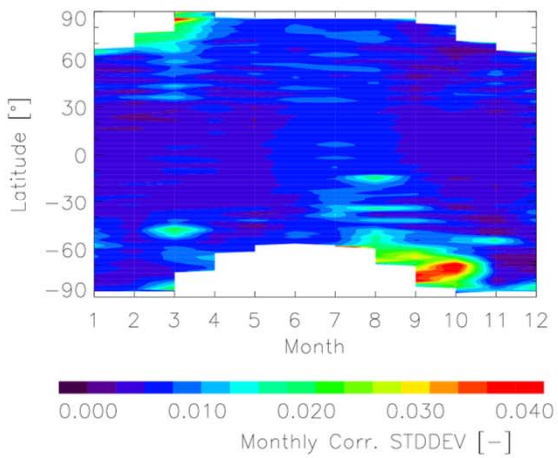


GTO-ECV – GOME-2/MetOp-A Correction

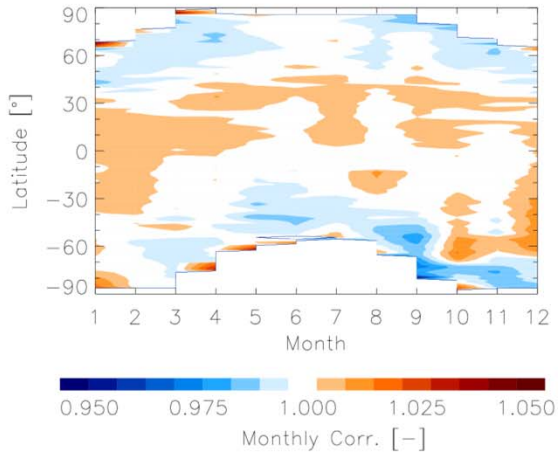
Corr. fac.

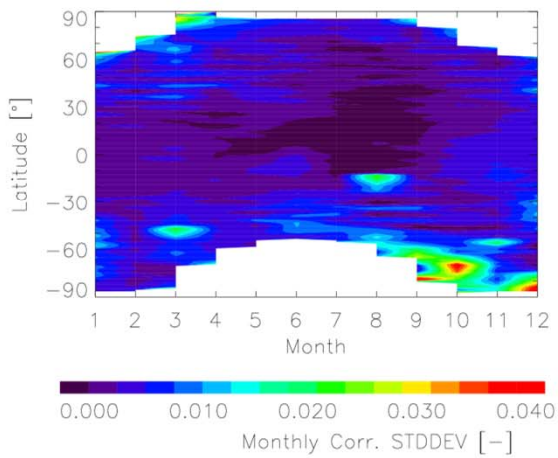
- Std.dev.





GDP 4.6

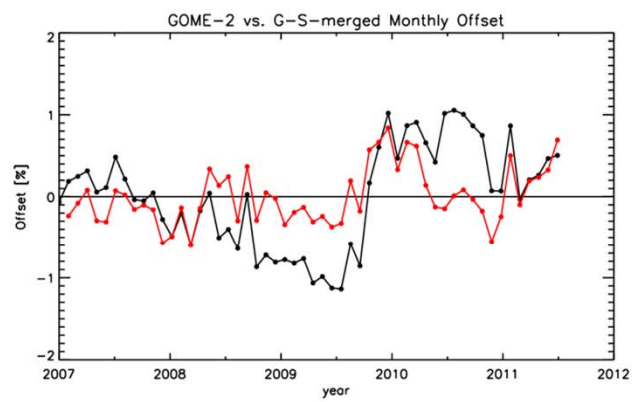




GODFIT 3.0

Polynomial as a function of latitude and month (Jan-Dec)

+ Offset for each individual month



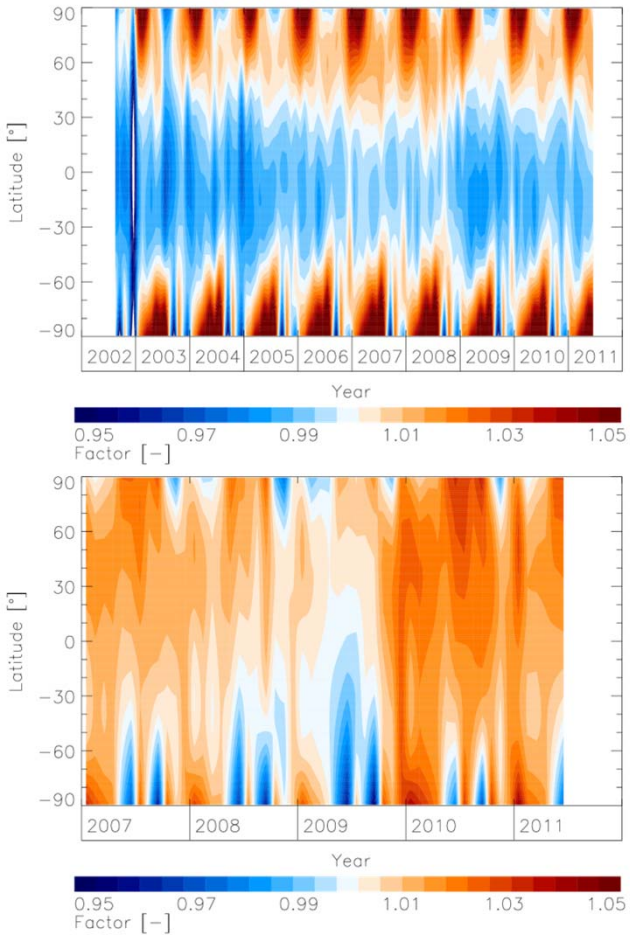
-GDP 4.6

-GODFIT 3.0

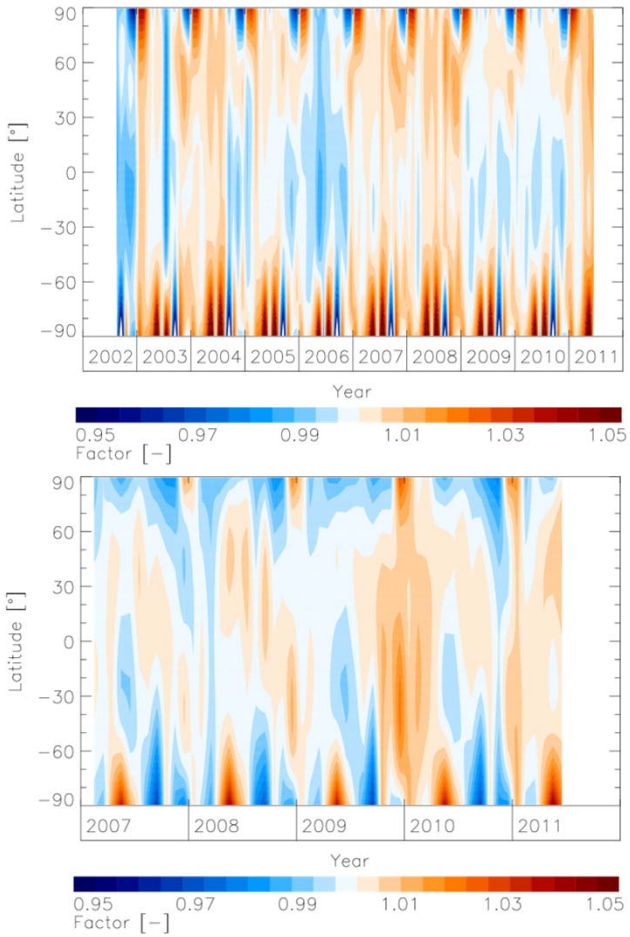
GTO-ECV – SCIAMACHY&GOME-2 Corrections

SCIAMACHY

GOME-2



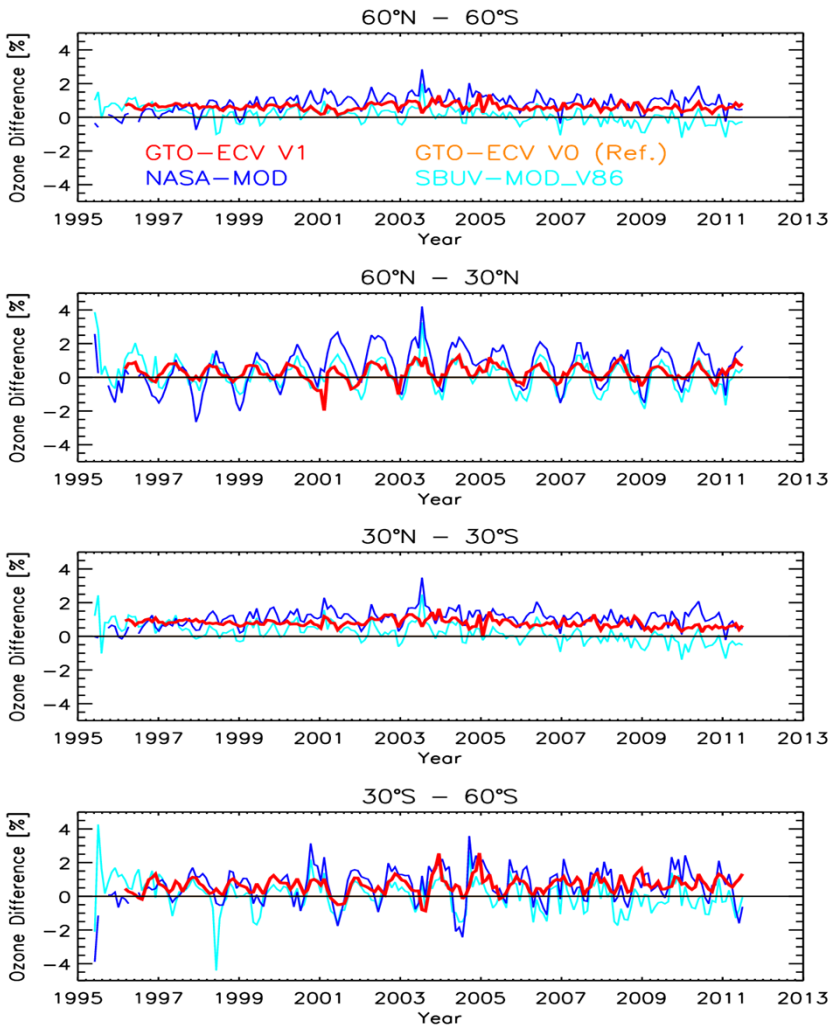
GDP 4.6



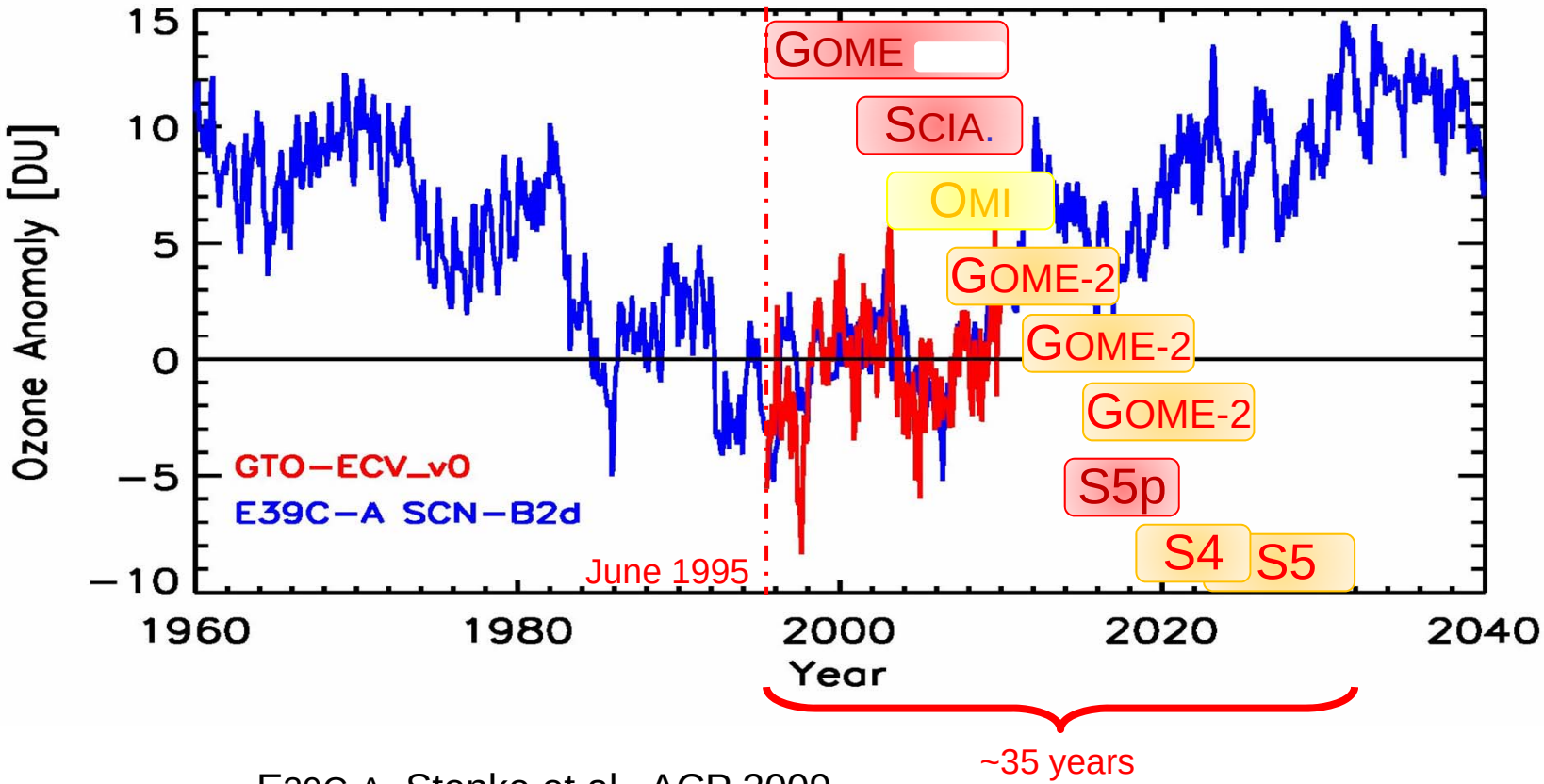
GODFIT 3.0

GTO-ECV – Comparison with NASA/NOAA

-GTO-ECV V2 (GODFIT 3.0)
-NASA-MOD (TOMS+SBUV(/2) V8)
-NASA-MOD (SBUV(/2) V8.6)



Long-Term AC Monitoring with European Sensors



— E39C-A, Stenke et al., ACP 2009

— GTO-ECV, Loyola et al., IJRS 2009

Total Ozone Comparison – Decadal Evolution

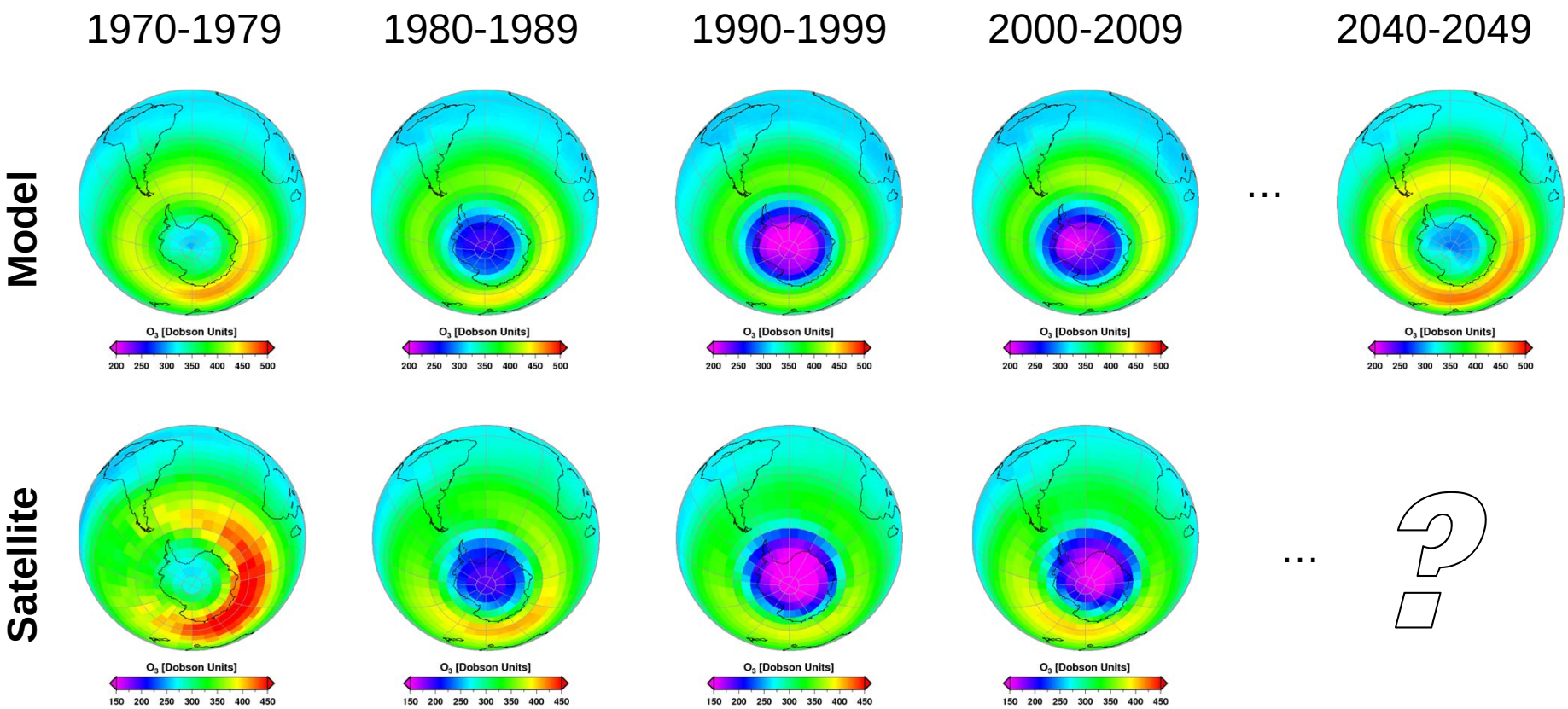


Fig. 12, Dameris and Loyola, Climate Change book, 2011

Conclusions

- Accurate L1 UVN products required for ECV generation:
  - Generate best possible L1 products for single sensors (on-ground calibration, in-flight calibration, L1 algorithms, degradation, etc.)
  - Inter-calibrate the L1 from several sensor and create FCDR from current missions: GOME, SCIAMACHY, OMI, GOME-2/MetOp-A and GOME-2/MetOp-B

- Close interaction of L1, L2 and ECV teams
  - Instrument and retrieval knowledge
  - L1 & L2 soft-corrections

- European atmospheric composition ECVs covering 35 years
  - Include ECV and L1 FCDR requirements for Sentinel 5P, 4 and 5