

SCIAMACHY Validation Summary

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*Contributions from Renske Timmermans, Klaus Bramstedt, Ankie Piters and the
SCIAMACHY validation community*

Level 1 validation

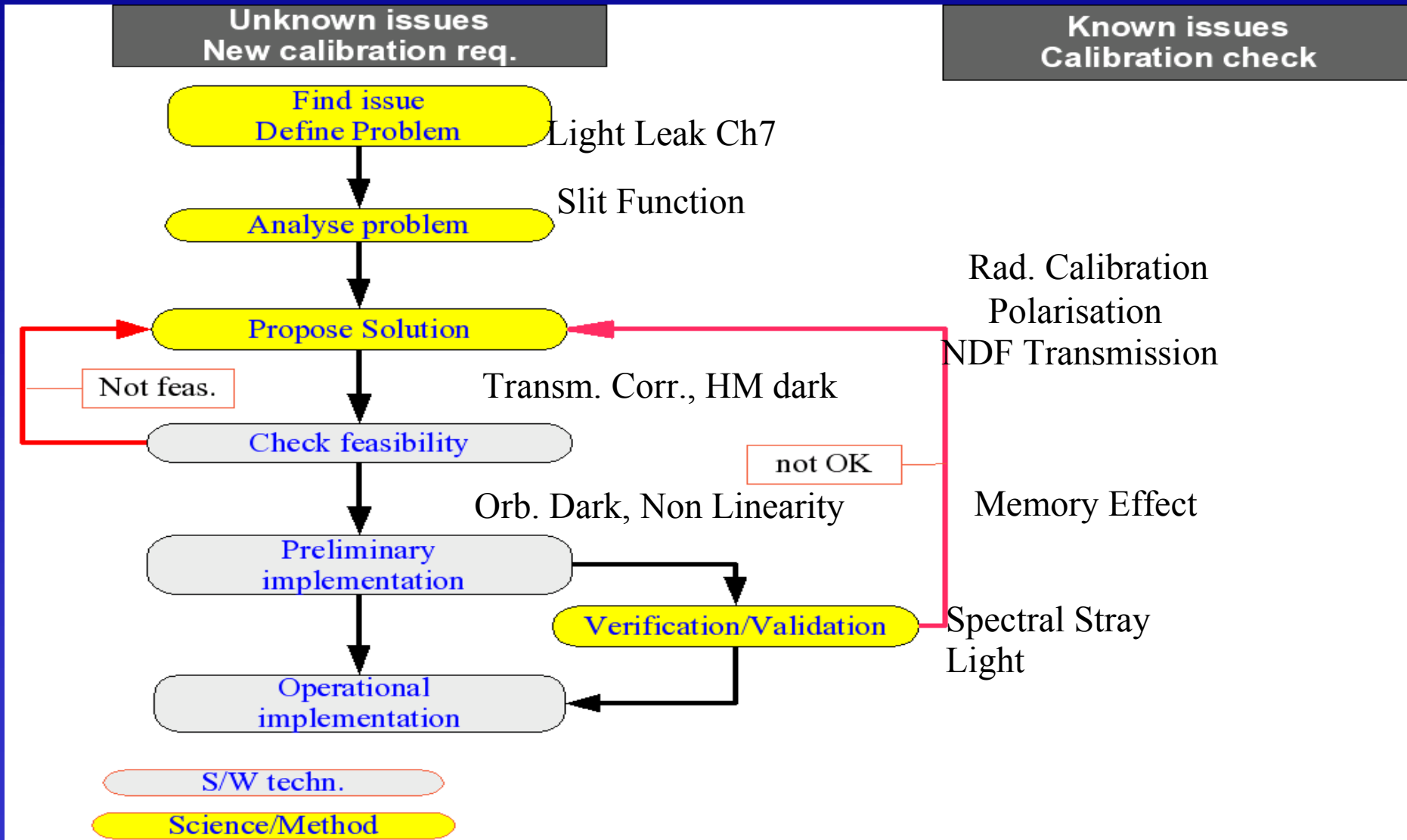
Operational products

Non-operational products

Recommendations

Conclusions

Level 1 status



Level 1 Critical issues

- Implementation time for L1 changes has to be improved. We need
 - Better communication between L1 and L2
 - A quick way to test new algorithms is needed (already possible in a limited- way with the SRON L1 patch routines, a way to remove the limitations is under discussion with ESA/DLR)
 - Speed up of the implementation time
- All open issues will be tracked by Calibration TT and **SCIAMACHY Quality Assurance Team** and communicated
- Information about data processor changes has to be given to users in a transparent way

SCIAMACHY Summary

Presentations at this meeting

Nadir (NRT)			Limb (OL)		
UV/Vis	NIR	UV/IR	UV/Vis	NIR	UV/IR
O3 (v)	H2O (v)	cloud fr	O3 (p)	H2O (p)	Aerosol
NO2 (v)	N2O (v)	cloud tp	NO2 (p)	N2O (p)	
BrO (s)	CO (v)	AAI	BrO (p)	CO (p)	
SO2 (s)	CO2 (v)			CO2 (p)	
OCIO (s)	CH4 (v)			CH4 (p)	
HCHO (s)				p,T (p)	
UV index					

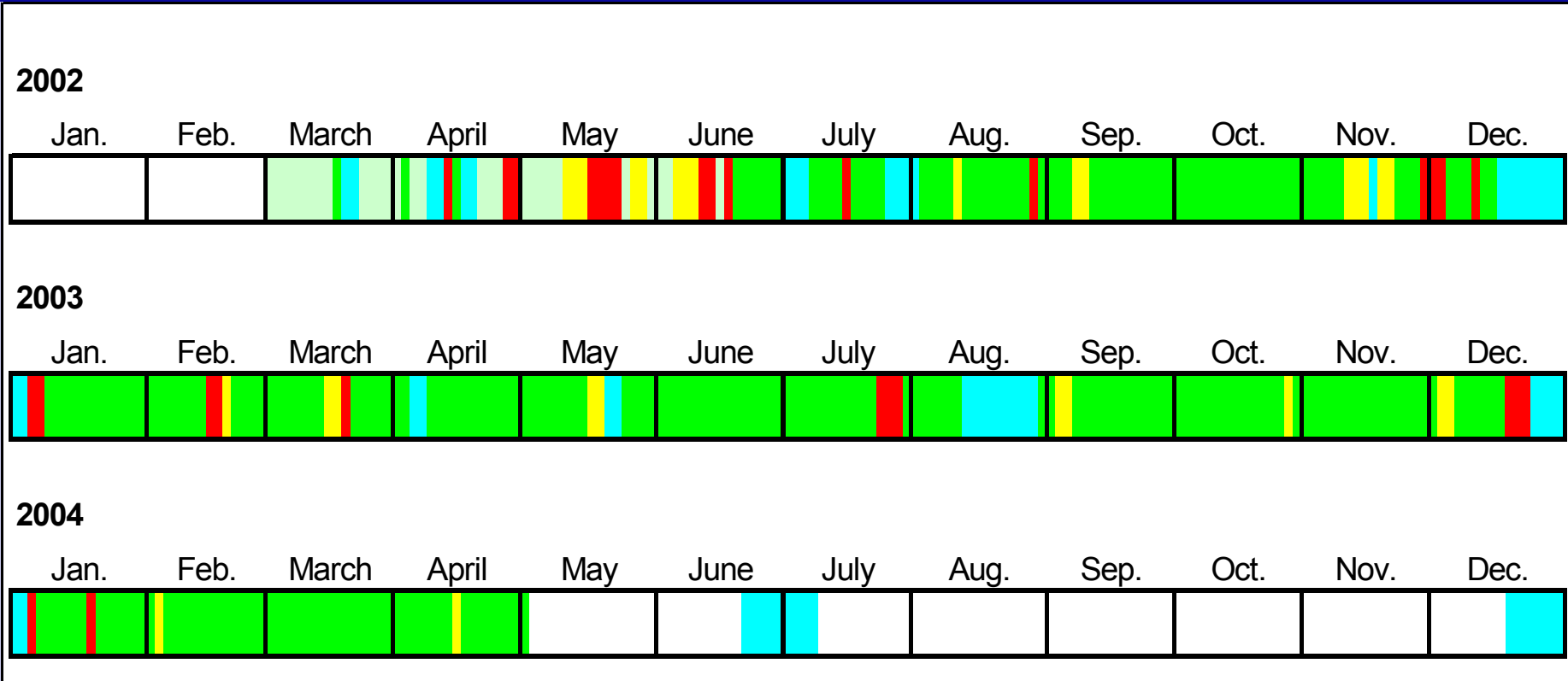
→ *non-operational products*

Nadir			Limb	Nadir+Limb
UV/Vis	NIR	UV/IR	UV/Vis	UV/Vis
O3 (v/p)	N2O (v)	cloud fr	O3 (p)	NO2 (t)
NO2 (s/v/t)	CO (v)	cloud tp	NO2 (p)	
BrO (v)	CO2 (v)	AAI	BrO (p)	
SO2 (s/v)	CH4 (v)	AOT	OCIO (p)	
OCIO (s/v)				Occult.
HCHO (v)				O3
H2O (v)				NO2
UV index /dose				NO3

→ *operational products*

	oral presentation
	poster presentation
	under development, no presentation

SCIAMACHY operations



Nominal Measurement

Decontamination (reduced measurement)

OCM or "ENVISAT off"

"SCIAMACHY off"

from DLR

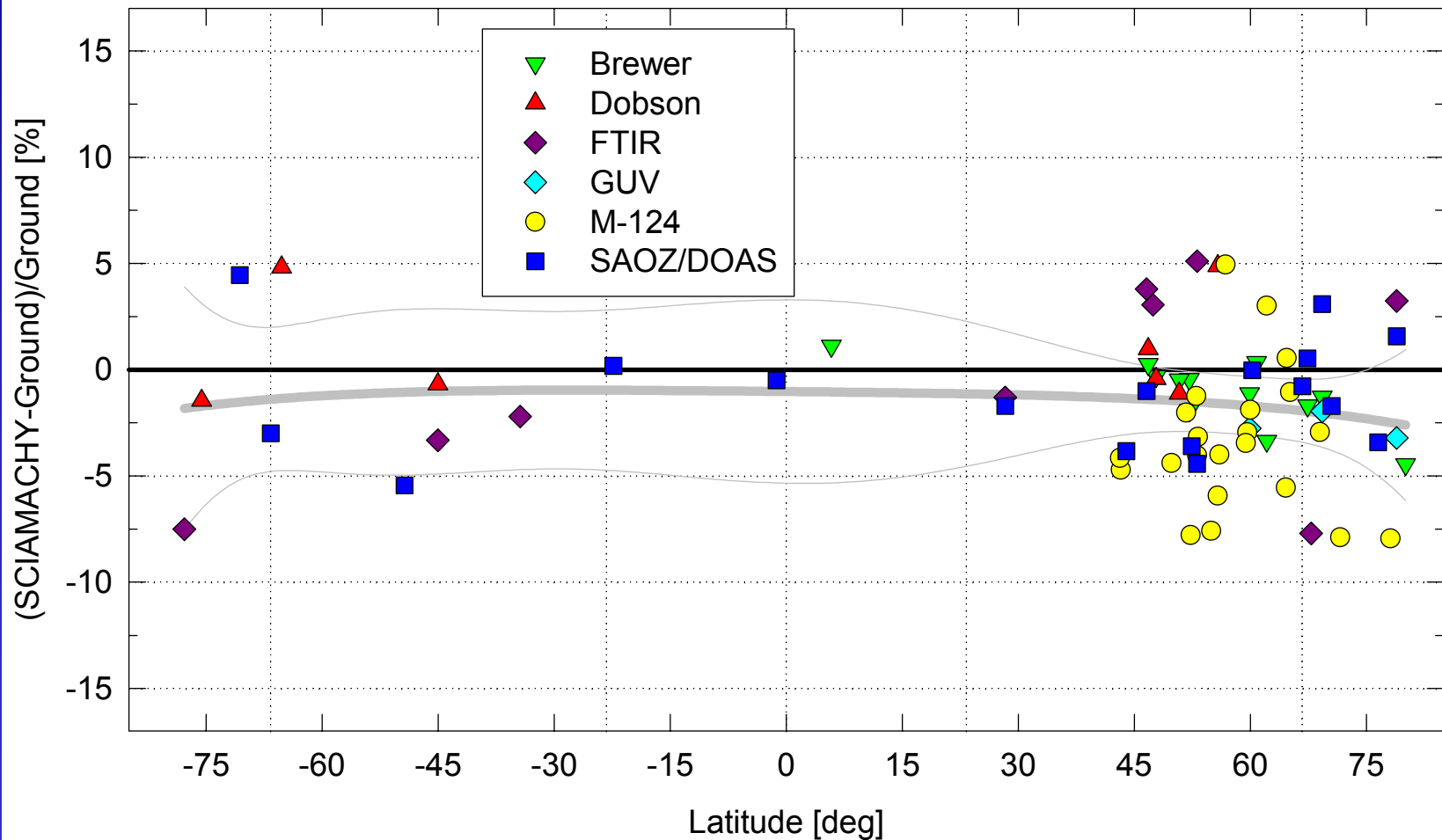
- Very stable instrument in the first two years of operation

O3 column

- NRT product (vs 5.01) better than Dec 2002 (vs 3.53):
 - comparable (but not equal) with GOME processor version 2.x (old version with known errors)
 - Agreement within 2-10%, on average underestimation few percent
 - sza dependence 8-10%, total ozone dependence, season/latitude dependence
 - cloud fraction dependence for some stations (not seen in GDP 2.x)
- Algorithm verification (comparison with non-operational products at KNMI and BIRA):
 - *AMF jumps could not be checked yet (data 2003 is needed)*
 - *Slant columns show systematic offsets of up to 10 % near the poles*
 - *Known AMF errors partly cancel with slant column errors*
 - *Algorithm and auxiliary files should be updated to be at least consistent with GOME.*
- Scientific products (KNMI and BIRA): worldwide average bias 1-1.5% , rms ~5 %
- KNMI: viewing angle dependence 2%, cloud fraction dep. 2-2.5%

O₃ column

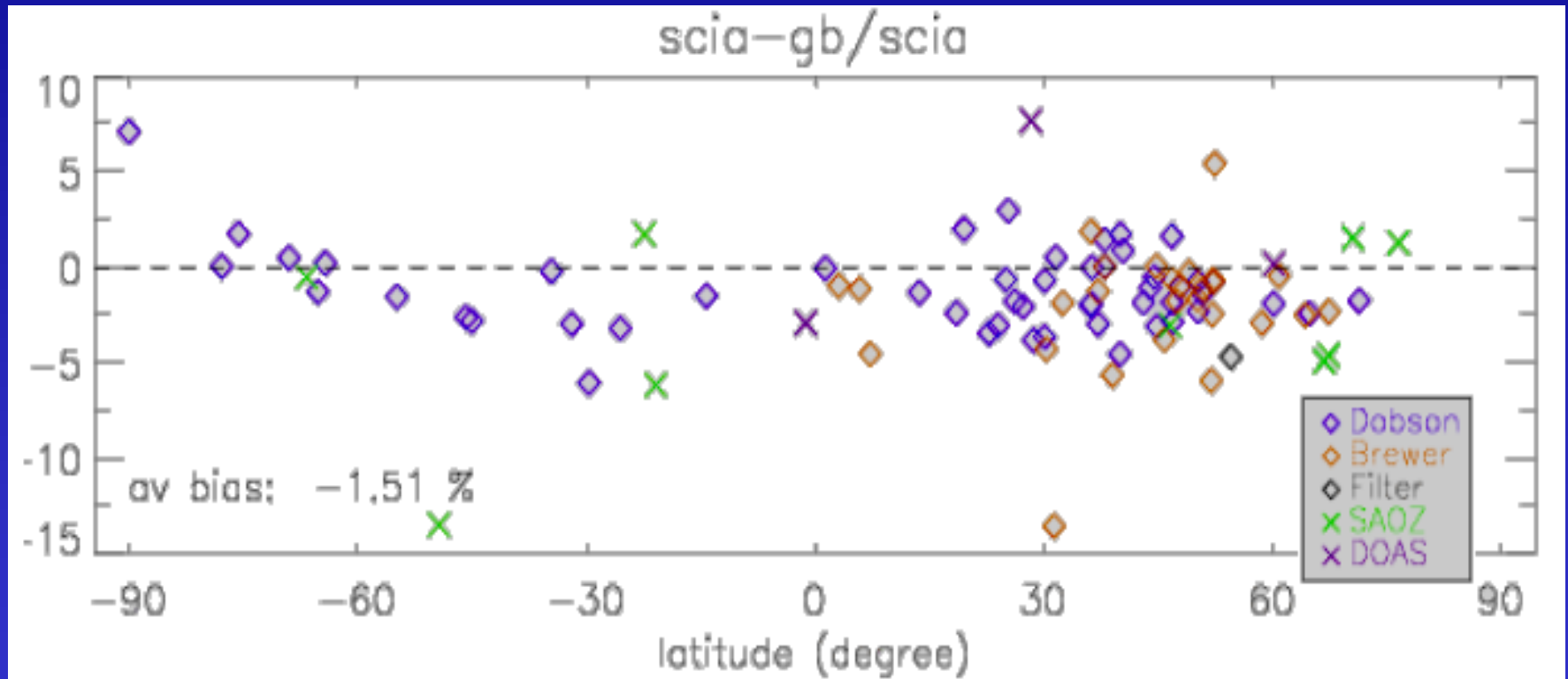
SCIAMACHY (SCI_NL 5.01) vs NRT Ground-based Total O₃



Provided by J.-C. Lambert (BIRA)

O3 column

TOSOMI



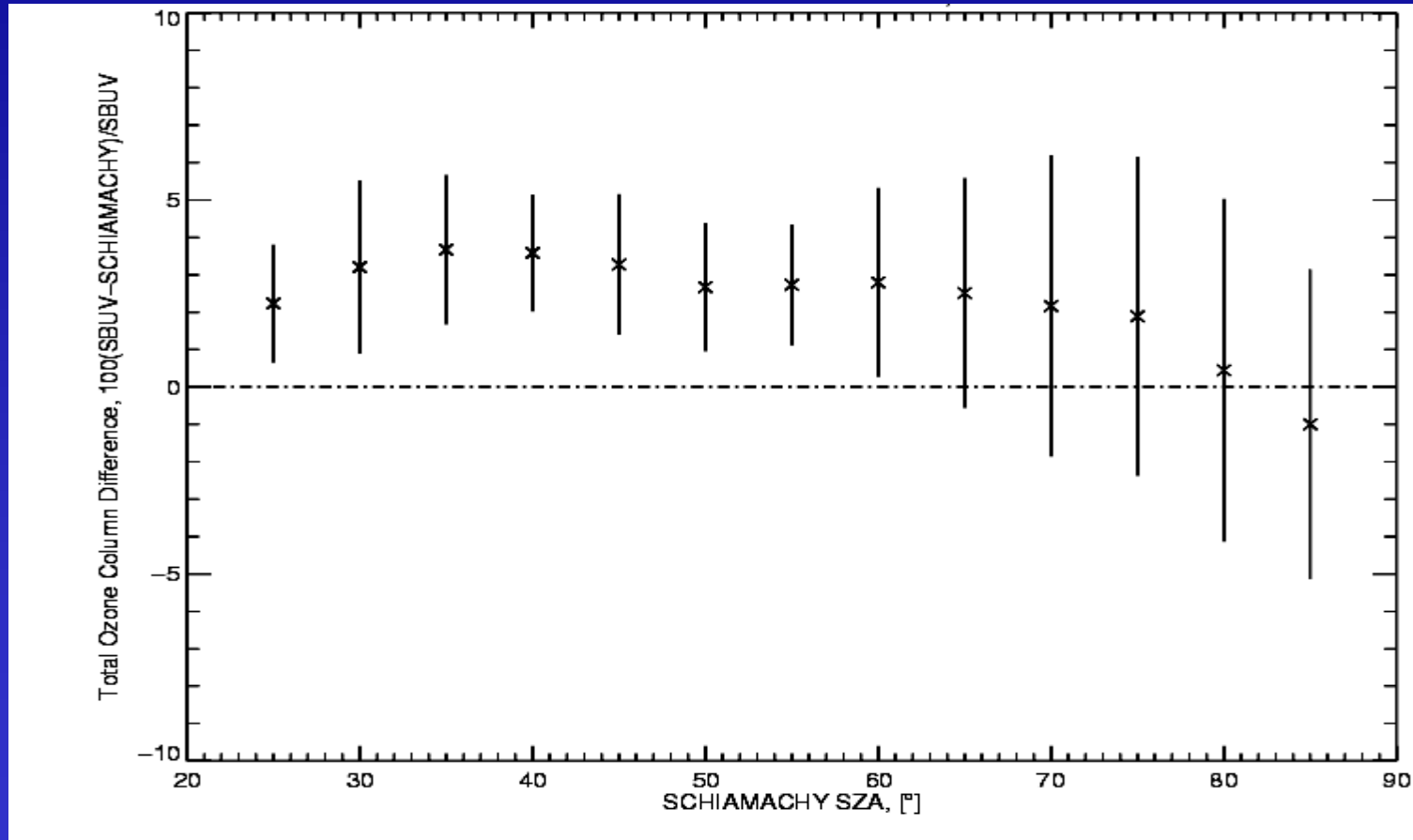
Provided by E. Brinksma (KNMI)

O3 column

SBUV/2-SCIAMACHY

SBUV/2

Provided by E. Hilsenrath (NASA)

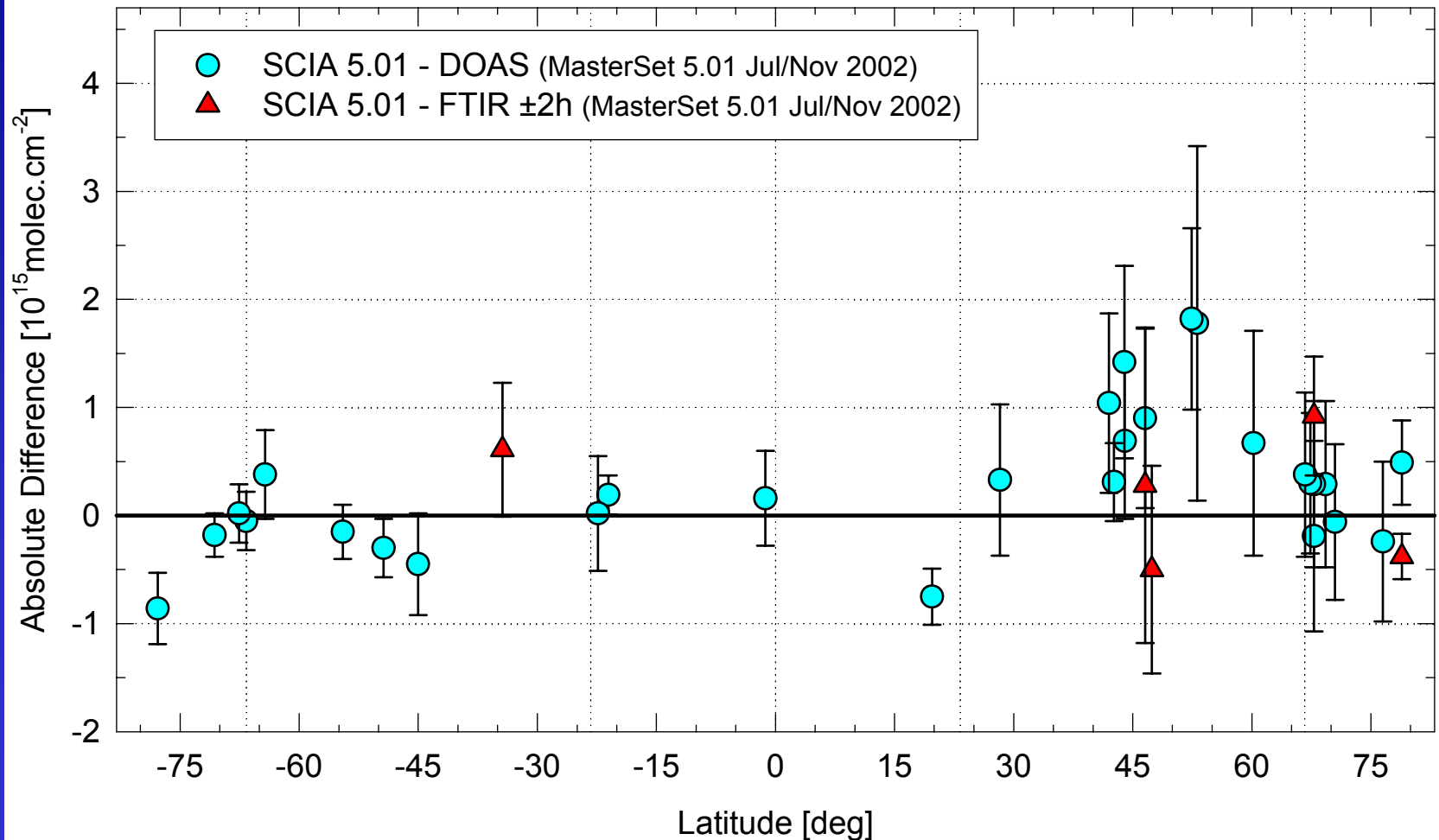


NO₂ column

- NRT product much better than in Dec 2002:
 - Good agreement (a few 10^{14} molec.cm⁻²) for ‘clean’ stations; larger differences for polluted regions reflecting the difference in sensitivity to the troposphere;
 - Comparison with GOME (GDP 3.0) gives reasonable results;
 - *Problem observed in clean polar stations in fall/winter;*
 - *Algorithm and auxiliary files should be updated to be at least consistent with GOME.*
- Scientific products (IFE, BIRA): good agreement, small differences between them.
- Scientific products (SAO, KNMI, IUP-Heid): in progress, SAO: ok, underestimation at low and mid-latitudes, KNMI ok, AMF accuracy unclear.

NO₂ column

SCIAMACHY NRT 5.01 vs Ground-based NO₂ Vertical Column



Provided by J.-C. Lambert (BIRA)

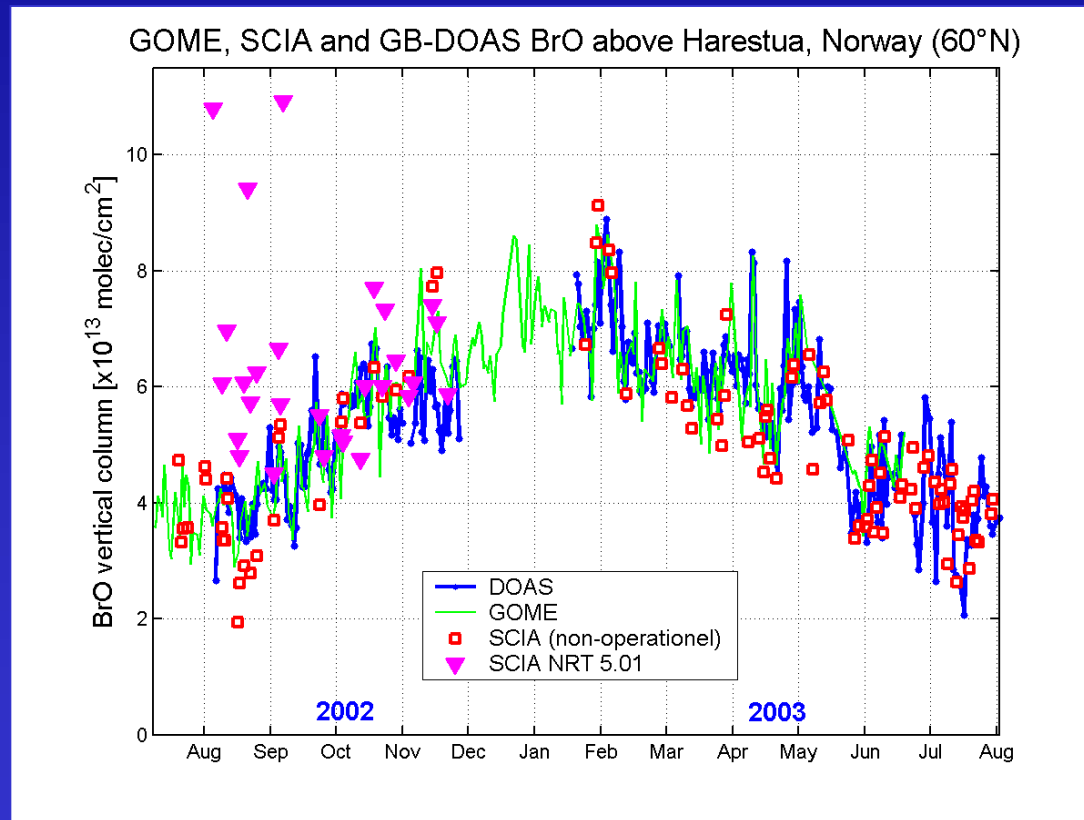
Other DOAS products

BrO – NRT	Large pos. bias (20-100%) for small SCDs, otherwise agreement within $\pm 20\%$
BrO (IFE, IUP-Heid, BIRA)	Results are promising, consistent with groundbased and GOME
BrO (SAO)	No validation yet

SO ₂ (IFE, BIRA)	Good agreement with GOME; measurements during strong pollution events needed for quantitative validation
OCIO (IFE, IUP-Heid)	Good agreement with GOME, offset and high scatter can be reduced by including polarisation spectra and additional correction spectra
HCHO (SAO, IFE, IUP-Heid, BIRA)	Currently retrieval is hampered by errors in level 1b product

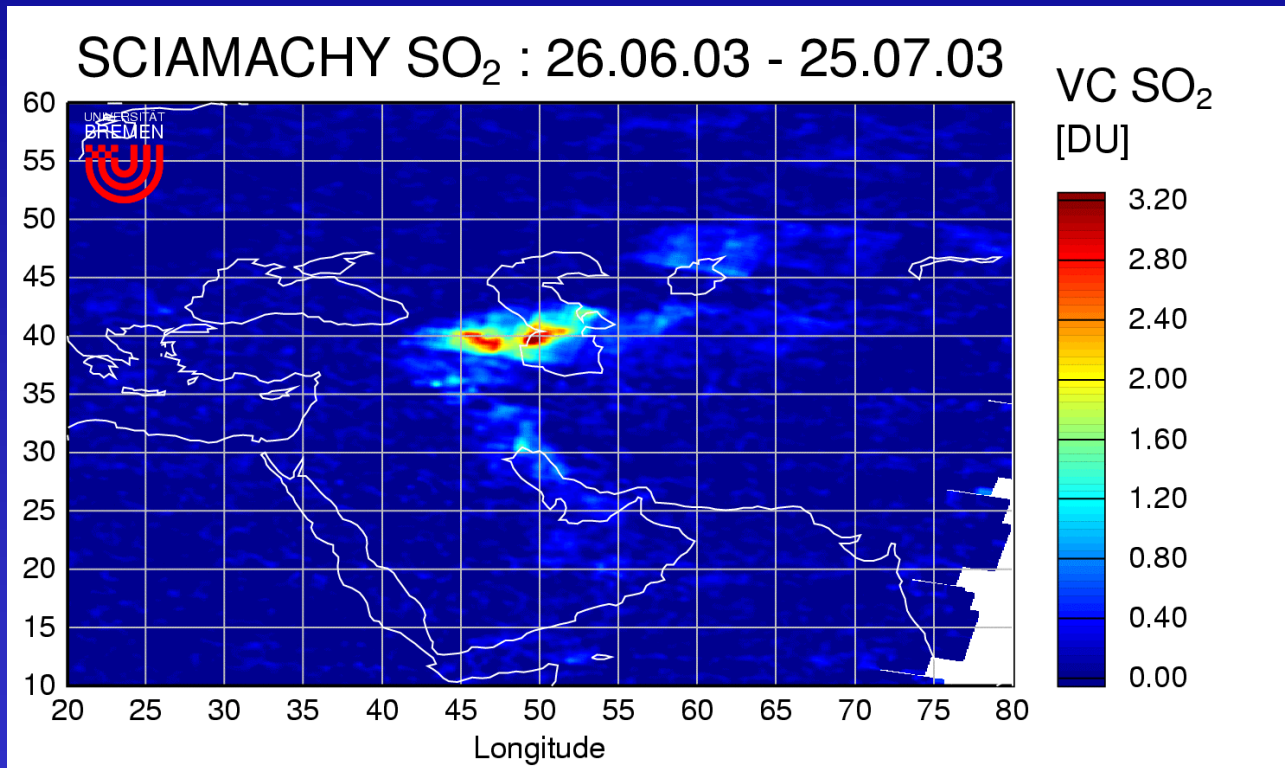
BrO columns

DOAS, GOME and SCIAMACHY
BrO VCDs above Harestua (60°N)



Provided by M. v Roozendaal (BIRA)

SO₂ columns



Fire in a sulphur
plant in
Qayyarah, Iraq

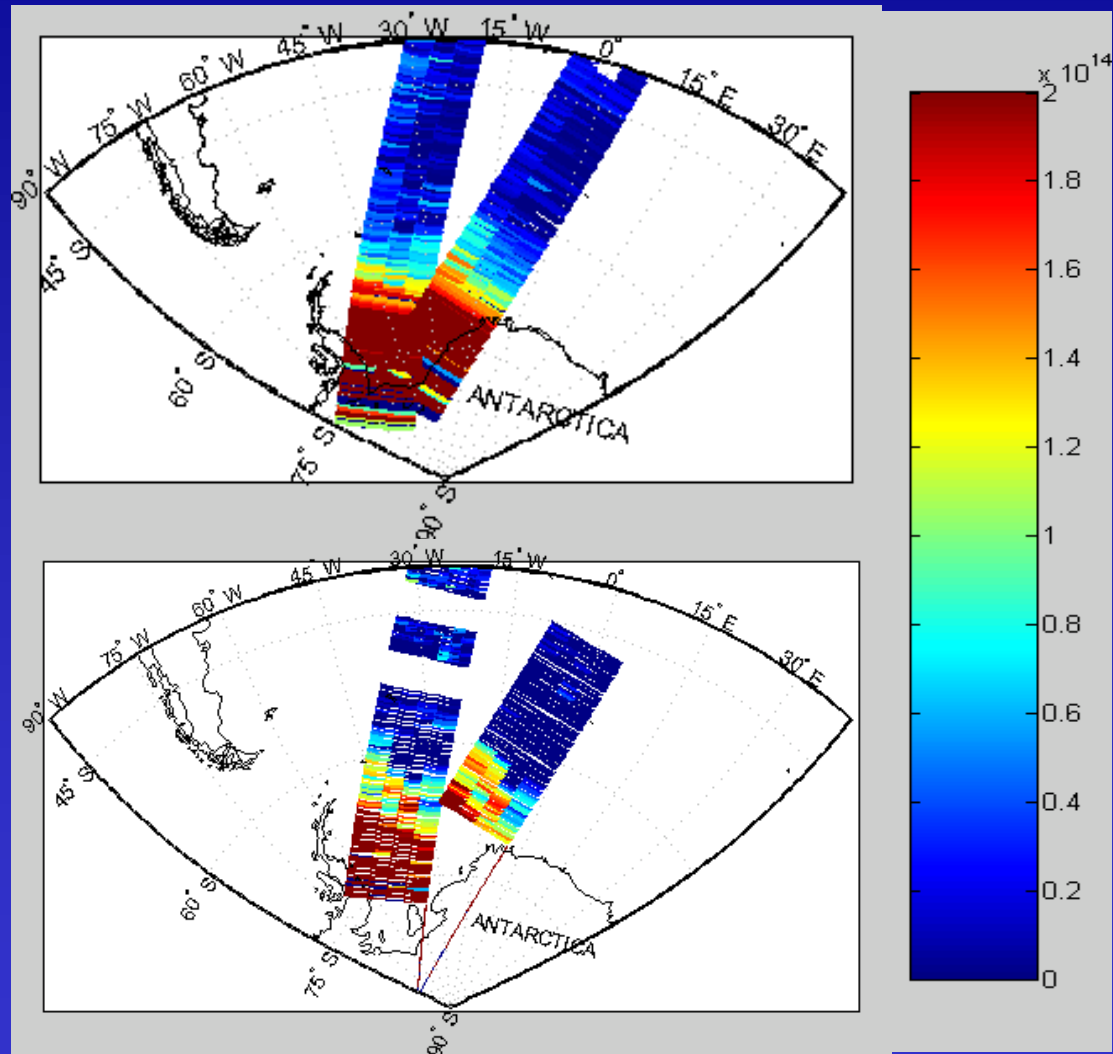
Provided by
Andreas Richter
(IFE-Bremen)

OCIO columns

OCIO

Comparison with GOME

(data:Uni-Heidelberg)



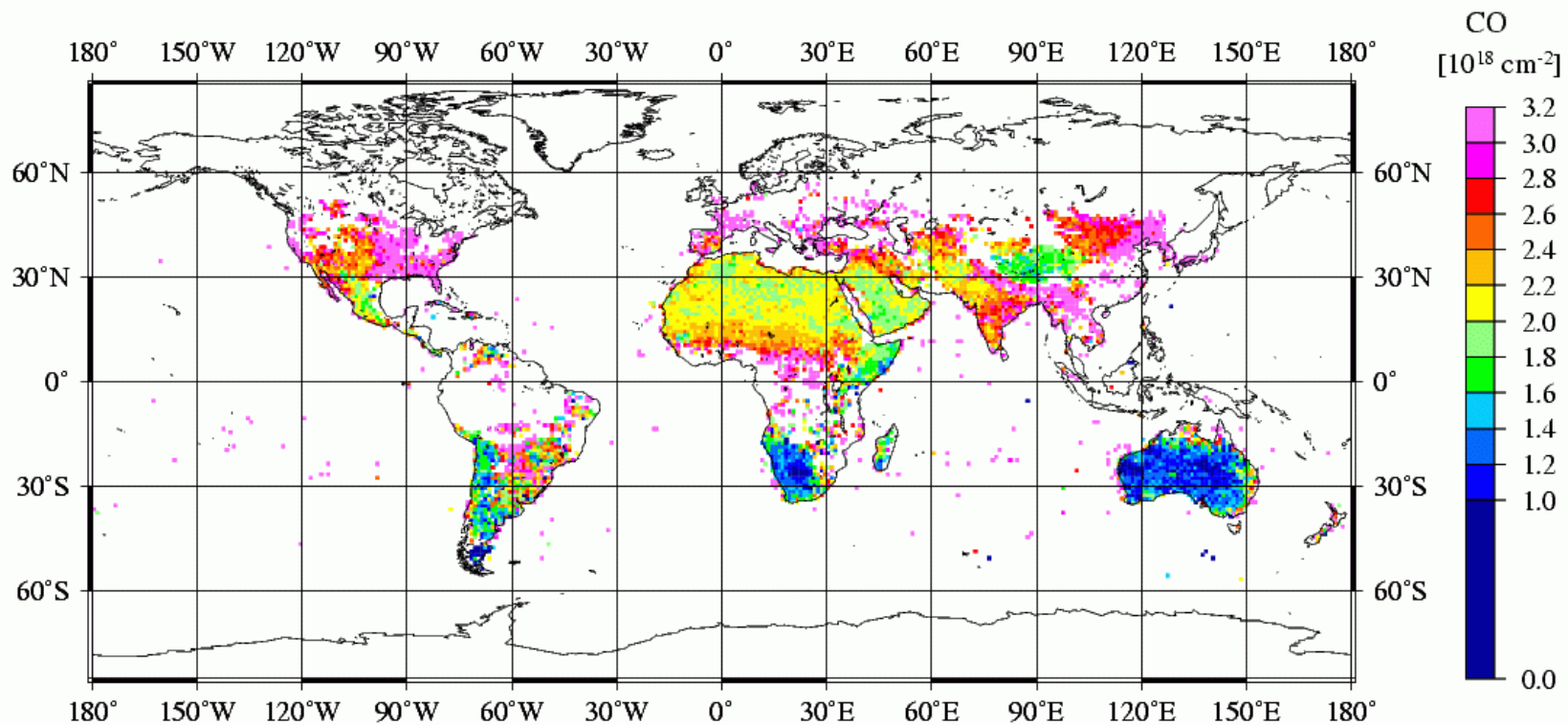
'NIR' columns

CH4 (IFE, SRON)	Looks good, offsets cloud-free pixels up to 5 % (TM3), mostly within 20% for limited individual gb comparisons
CH4 (IUP-Heid)	No validation yet (suffer from a lack of data)
CO (IFE, SRON)	Looks good, offsets cloud-free pixels up to 40 %
CO (IUP-Heid)	No validation yet
N2O (IFE)	Looks good, offsets cloud-free pixels mostly within 20%
N2O (IUP-Heid)	No validation yet
CO2 (IFE)	Poster results, looks reasonable
CO2 (IUP-Heid)	No validation yet
H2O (IFE) <i>from visible</i>	Small offset ($\sim -10\%$), scatter $\sim 30-40\%$
H2O (SRON, MPI) <i>from visible</i>	Offset -20 to -25% , method still being optimised for new wavelength region

CO columns

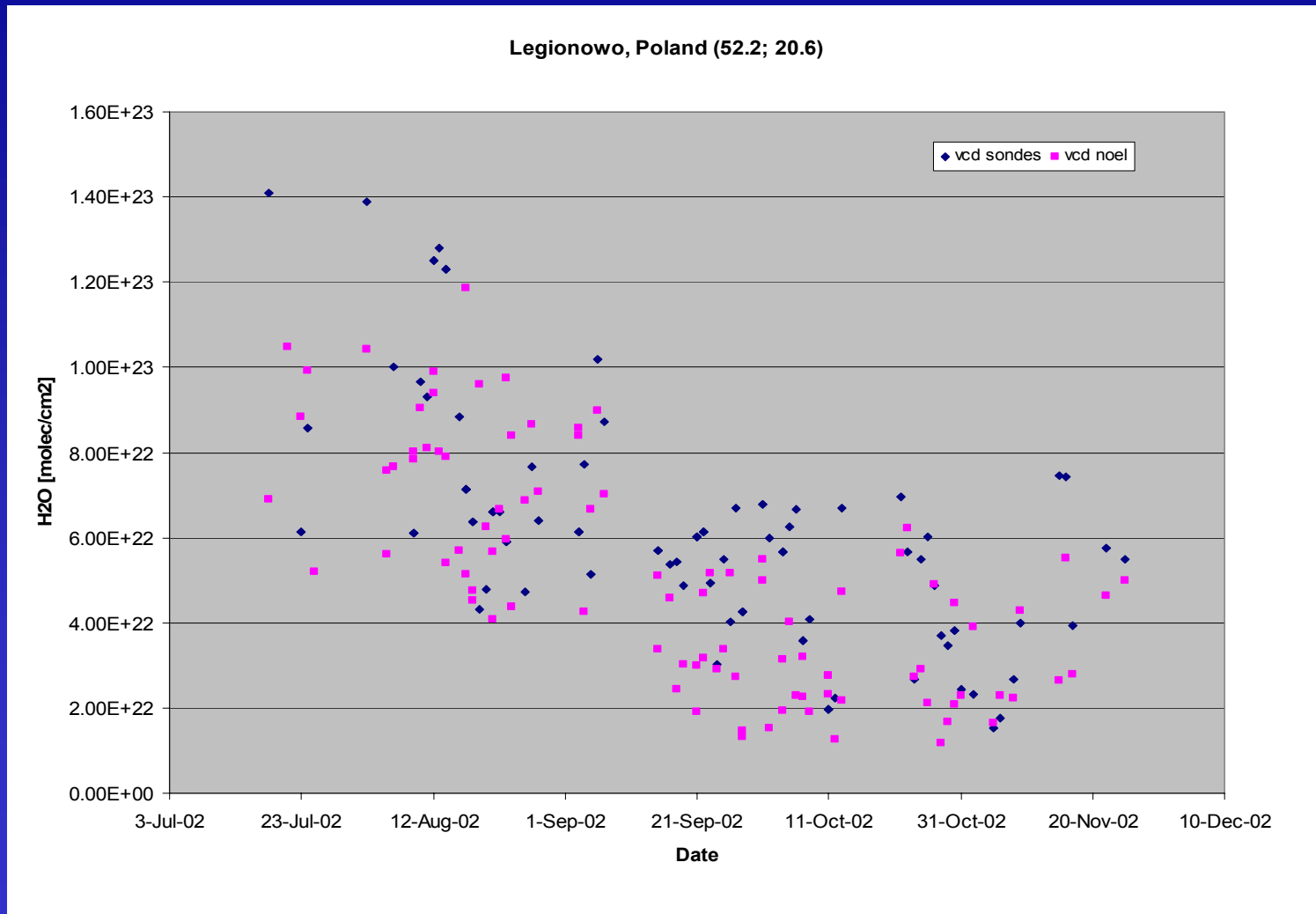
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March 2004



Provided by A. Gludemans (SRON)

H2O columns



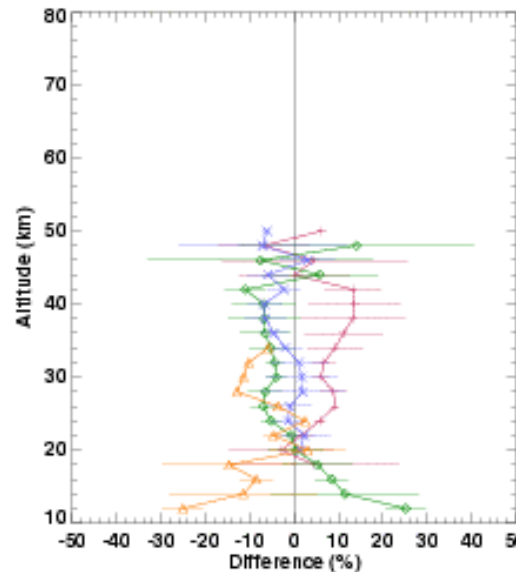
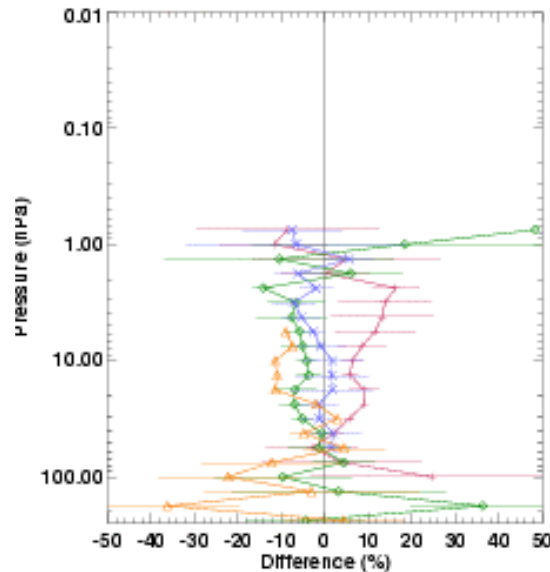
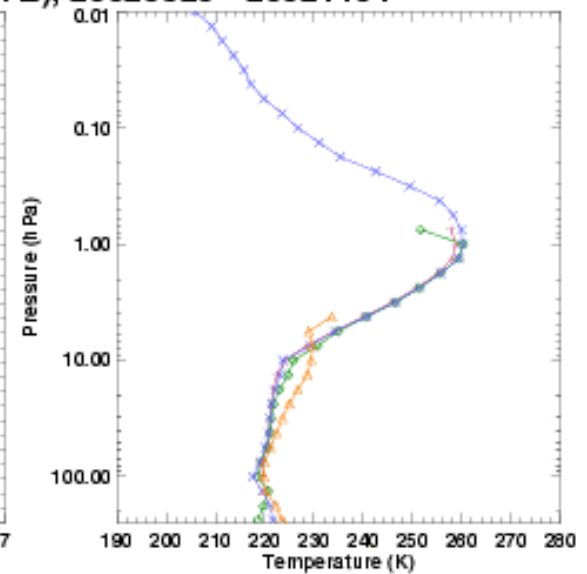
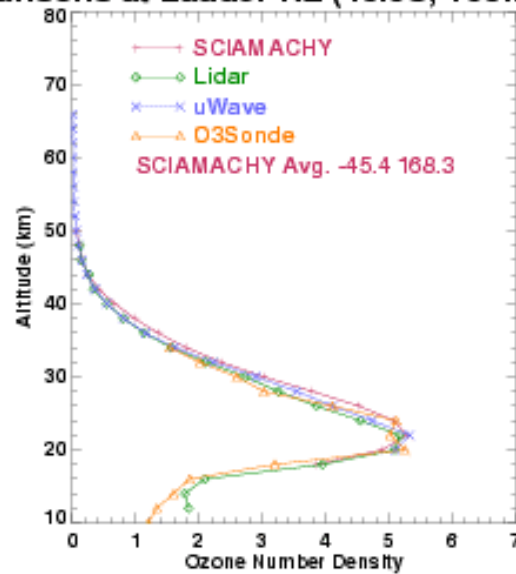
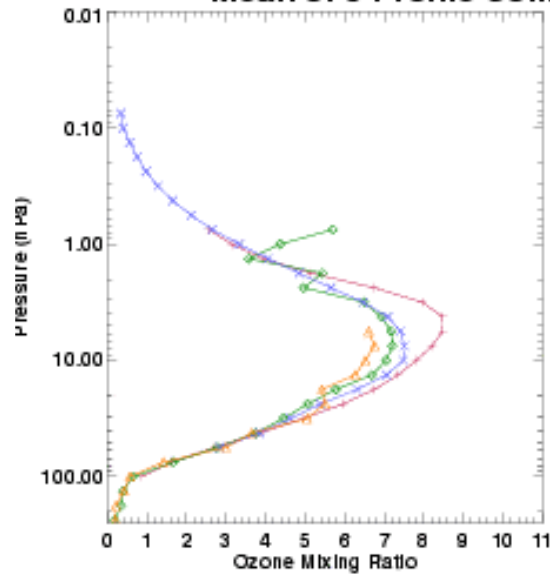
Provided by R. Timmermans (KNMI)

O₃, NO₂, BrO, OClO profiles

O ₃ profile OL	Bias from -8 to 12% (preliminary due to pointing issue) with groundbased data
O ₃ profile (IFE)	version 1.6 bias from -7 to 15% compared to HALOE, from -20 to +30 % compared to lidar/sonde
O ₃ mes. profile (IFE)	Preliminary results on poster, reasonable results
NO ₂ profile OL	SCIA ~50% higher than HALOE between 25-40 km, ~10% unphysical values
NO ₂ profile (IFE)	within 15% (22-33km) of HALOE, 10-35% lower than SAGE II (too high?), reasonable/good agr. with DOAS/SAOZ, phot. corr. needed
NO ₂ profile (SAO)	good agreement with SAOZ (<15%), with photochemical correction
BrO profile (SAO, IFE)	few comparisons already promising, problems < 20 km, phot. corr. needed
OClO profile (SAO)	No validation results yet

O3 profiles

Mean of 3 Profile Comparisons at Lauder NZ (45.0S, 169.7E), 20020820 - 20021104

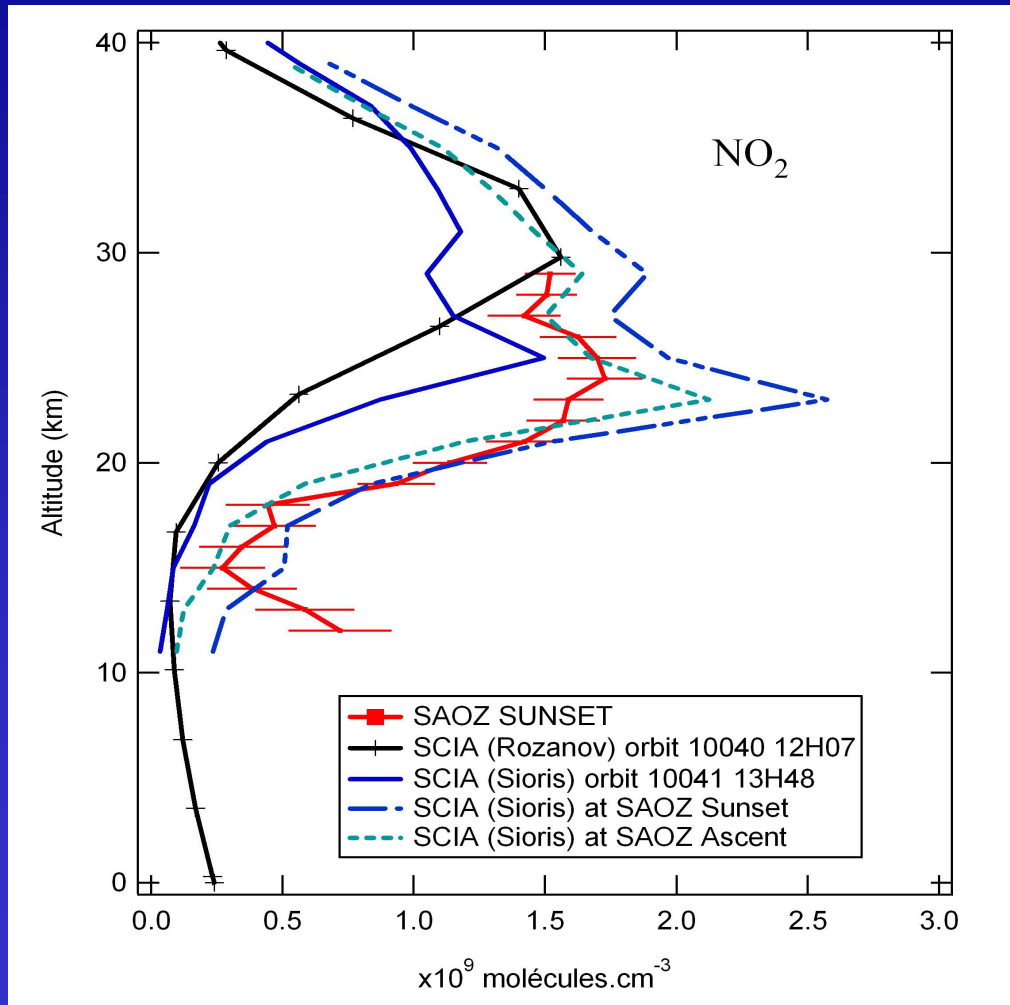


Difference Calculation:
 $[(\text{Instrument}-\text{Mean})/\text{Mean}] * 100$
Error Bars eq $2 * \text{Std.Dev.} / \text{sqrt}(n)$

Selection Criteria: +24 hrs
 Satellite lat range: +/- 2.5 lon range: +/- 12.0
 SCIAMACHY O3 err max (%): 25%

INSTRUMENTS:
 SCIAMACHY_v2.1
 Lidar
 uWave_Dy
 O3Sonde
**SCIAMACHY V2.1 OL -
 MID-LAYER CORRECTION MADE
 LDR COMPOSITE ATMOSPHERE**

NO₂ profiles

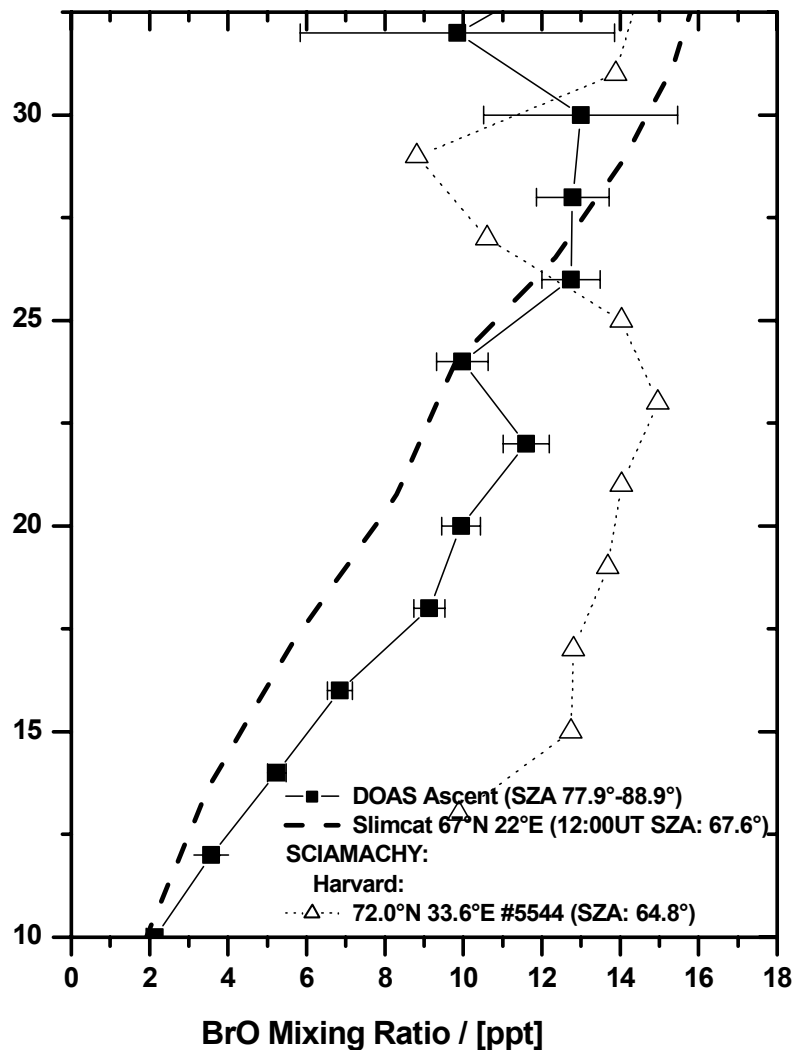
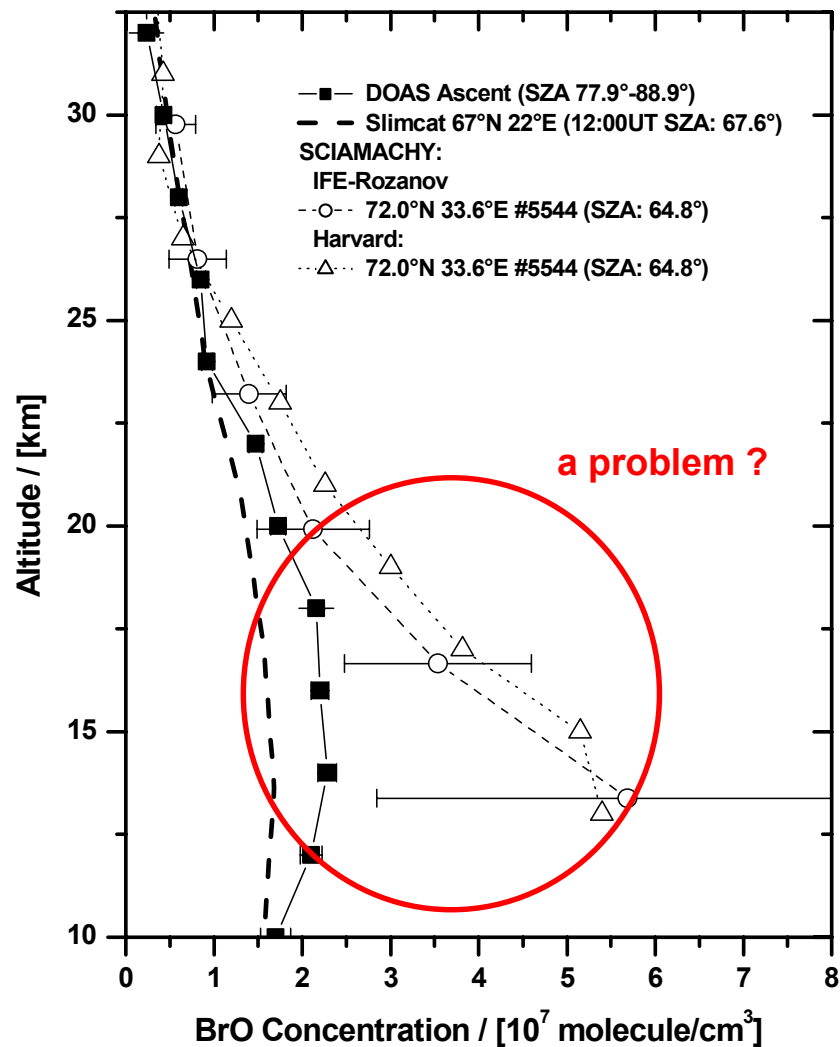


Provided by LPMA-CNRS

BrO profiles

Provided by K. Pfeilsticker (IUP-Heid)

Kiruna March 23, 2003

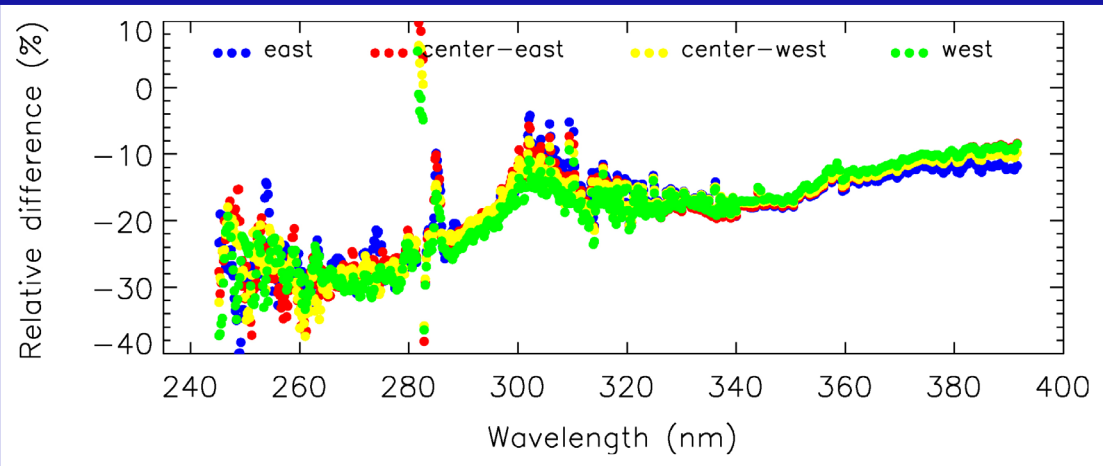


Reflectance

- Offsets in nadir reflectance are 15-25% (ch 1-5), unknown for ch 6, variable (ice) for ch7&8
- Correction factors for the radiometric calibration (irradiance, radiance and reflectance) derived from on-ground and in-flight data lead to significant improvements
- Limb reflectance not validated yet, probably has several problems
- NIR issues addressed (and improved) for scientific NIR retrievals (e.g. with patched level 1b from SRON), solutions not yet implemented for the operational products

Reflectance

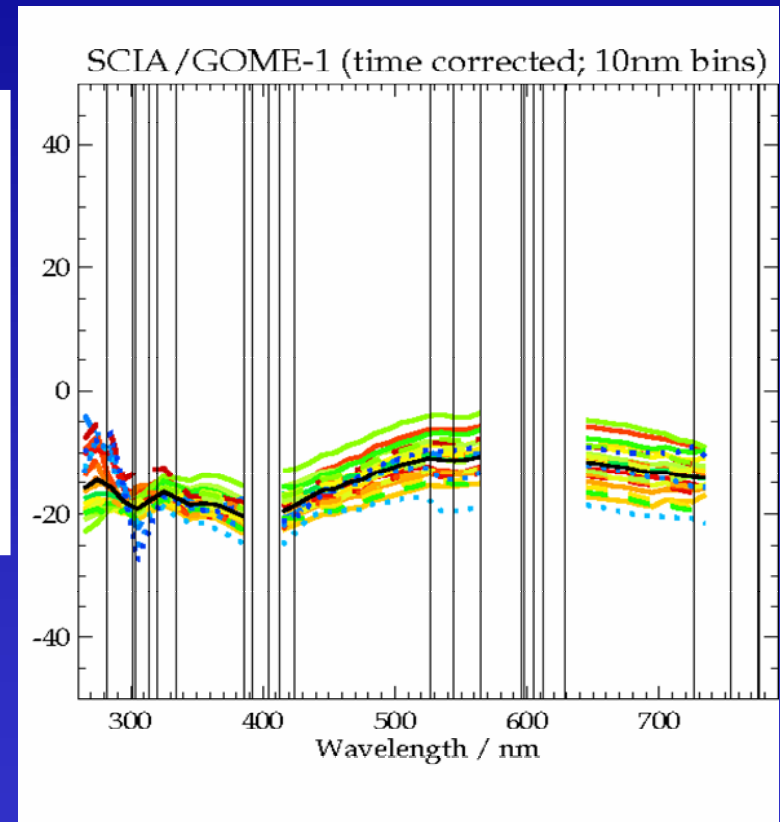
Reflectance comparison SCIA-DAK



No scan angle dependence

Provided by G. van Soest and G. Tilstra (KNMI)

(SCIA-GOME)/GOME



Provided by R. Siddans (RAL)

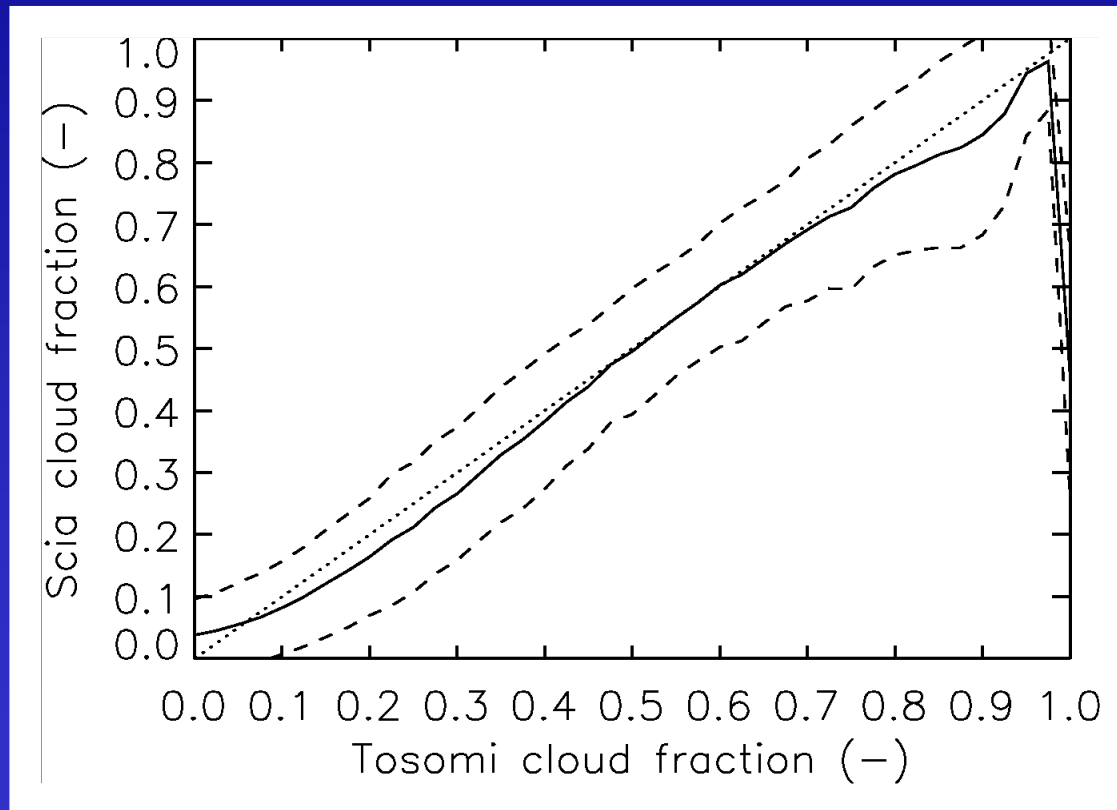
clouds, aerosol

Cloud fraction (NRT)	Very good correlation with FRESCO for val. ref. set, accuracy ~0.1
Cloud fraction (KNMI)	Not yet fully validated, but accuracy ~0.1
Cloud fraction (IUP-Heid)	Good comparison with GOME
Cloud top pressure (KNMI)	Difference with MODIS 100 hPa
Cloud top pressure (IFE)	Good agreement (only 1 comparison)

AAI (NRT)	very sensitive to level 1b, shows too high values
AAI (KNMI)	very sensitive to level 1b, shows good comparison to TOMS when corrected
AOT (IFE)	very sensitive to level 1b, shows reasonable comparison with MERIS when corrected

Cloud fraction

OCRA

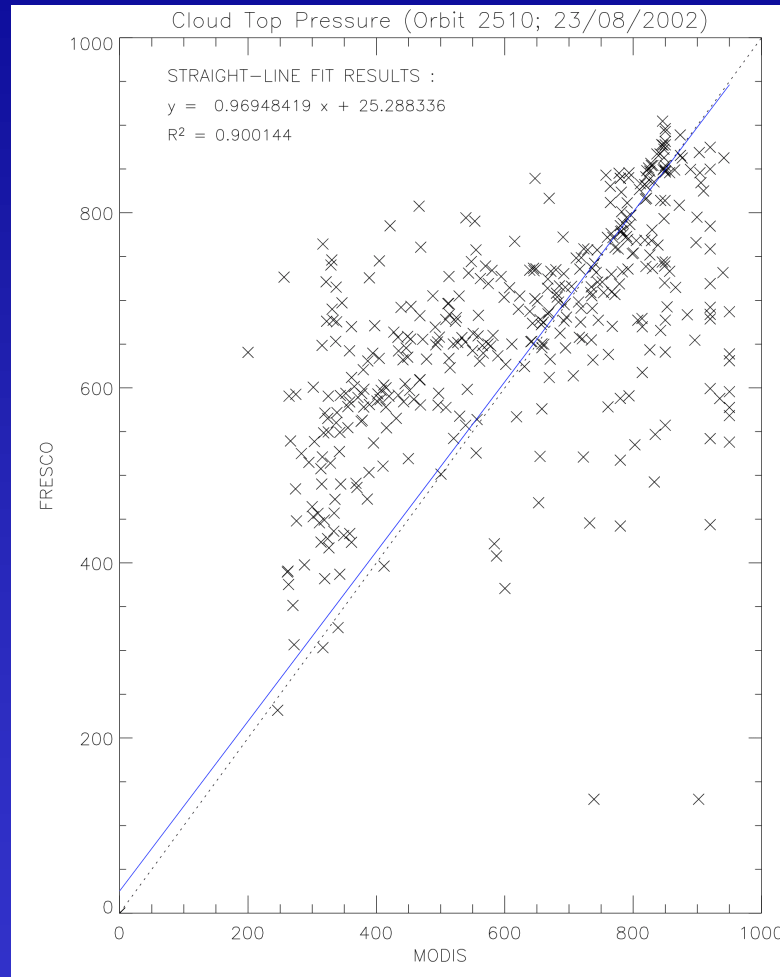


FRESCO

Provided by P. Stammes (KNMI)

Cloud top pressure

FRESCO

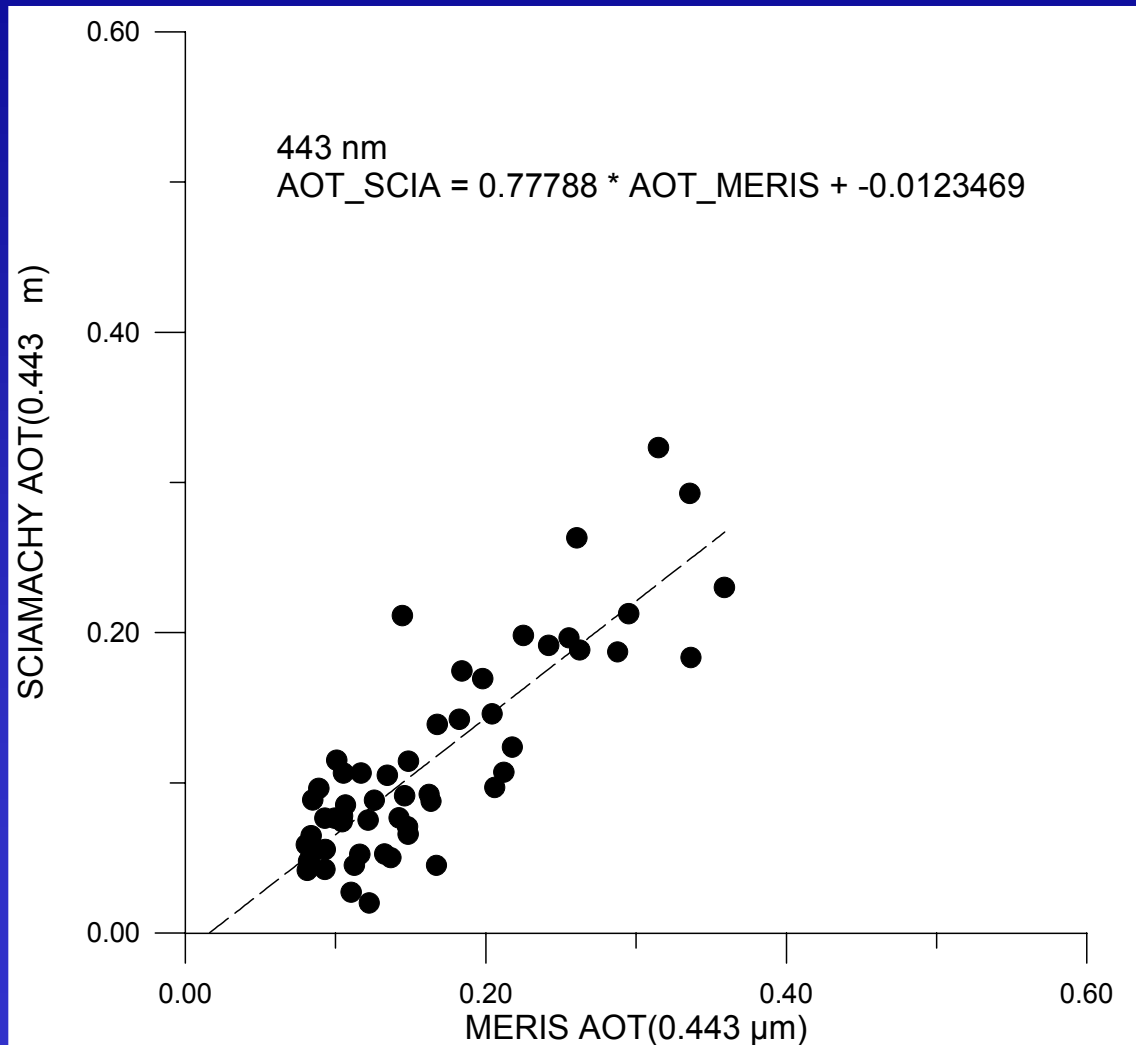


Reasonable agreement.
Difference is
about 100 hPa.

MODIS

Provided by P. Stammes (KNMI)

Aerosol



Provided by von Hoyningen (IFE)

Results on web site

- Data quality reports for all operational and non-operational products will be available on the SCIAMACHY validation web site:

<http://www.sciamachy-validation.org/>

- SCIAMACHY validation product coordinators will be responsible for the content of these reports
- Feedback from scientists on data quality is encouraged → interactive posting of results and discussion on web site
- Reports updated throughout SCIAMACHY lifetime, and beyond

Recommendations

- Operational data processor (lv 1-2) should include a.s.a.p. known improvements from the scientific retrievals. Product developers should formulate PCRs (Processor Change Requests) for this.
- Operational DOAS algorithms should be improved to be consistent with current and future GOME operational algorithms to create a consistent data set.
- Further improvements of level 0-1 processor (polarisation features in UV, absolute radiometric calibration and calibration of the NIR channels 7&8) are urgent needed and should be implemented a.s.a.p.

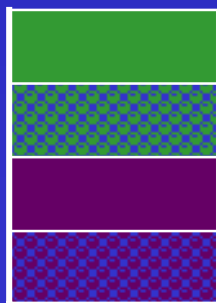
Recommendations (2)

- A well defined validation reference set should be processed *completely* after each processor upgrade, before reprocessing the complete mission.
- Product user manuals should be written, including detailed format and content description.
- Auxiliary files should be available and well documented.
- All changes in processor algorithm and initialisation files should be well documented and announced well in advance (if possible).

Validation status - overview

Nadir (NRT)			Limb (OL)		
UV/Vis	NIR	UV/IR	UV/Vis	NIR	UV/IR
O3 (v)	H2O (v)	cloud fr	O3 (p)	H2O (p)	Aerosol
NO2 (v)	N2O (v)	cloud tp	NO2 (p)	N2O (p)	
BrO (s)	CO (v)	AAI	BrO (p)	CO (p)	
SO2 (s)	CO2 (v)			CO2 (p)	
OCIO (s)	CH4 (v)			CH4 (p)	
HCHO (s)				p,T (p)	
UV index					

operational products



prel. validation: OK

prel. validation: problems

verification: OK

verification: problems

non-operational products

Nadir			Limb	Nadir+Limb
UV/Vis	NIR	UV/IR	UV/Vis	UV/Vis
O3 (v/p)	N2O (v)	cloud fr	O3 (p)	NO2 (t)
NO2 (s/v/t)	CO (v)	cloud tp	NO2 (p)	
BrO (v)	CO2 (v)	AAI	BrO (p)	
SO2 (s/v)	CH4 (v)	AOT	OCIO (p)	
OCIO (s/v)				Occult.
HCHO (v)				O3
H2O (v)				NO2
UV index /dose				NO3

Validation status – preliminary conclusions

- SCIAMACHY products have improved considerably since December 2002, both in number and in quality
- Many SCIAMACHY products now available for research, both operational and non-operational
- Systematic offset and RMS could already be attached to a number of columns and profiles, sometimes for several geophysical conditions.
- All validation results are still preliminary in the sense that:
 - larger data sets are necessary to find seasonal and other effects
 - not all available/planned validation sources were used
- Some products are not validated yet, because of:
 - lack of suitable collocations:
 - SO₂: special events
 - sensitivity to level 1b errors: (AAI, AOT)
 - lack of time