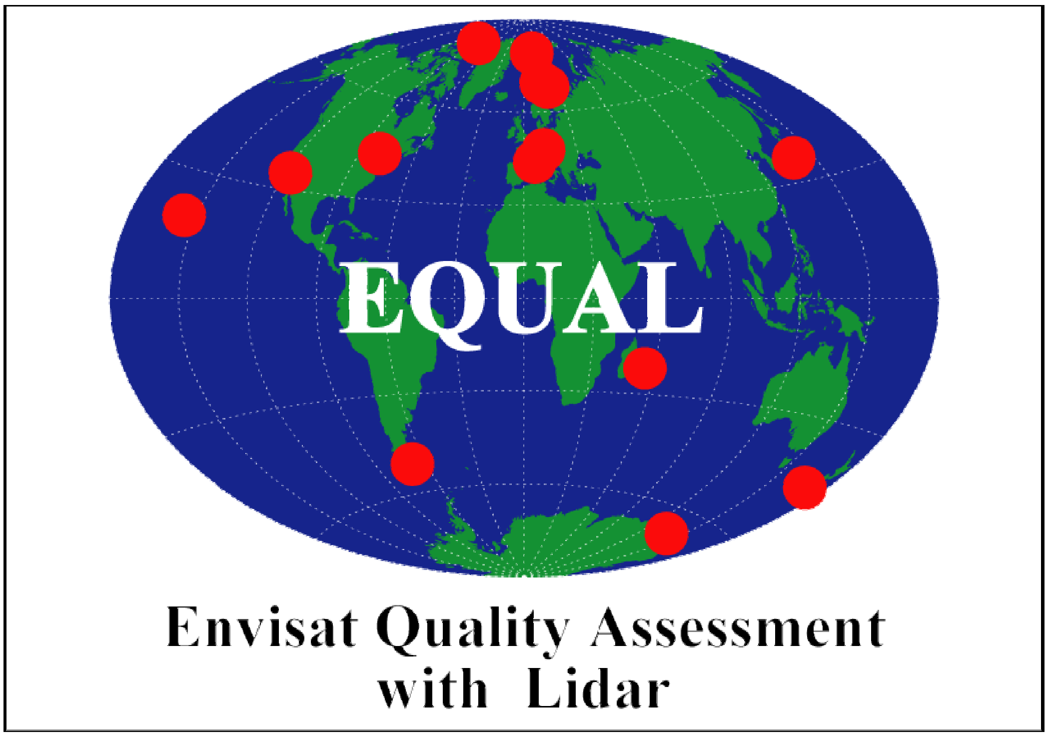
Final Report

2004-2007



Prepared by: Anne van Gijsel (RIVM)
Reviewed by: Thorsten Fehr (ESA)
Issued on: 14-03-2008
Contract no: 18193/04/NL/AR

Table of Contents

Summary

This is the final report of the EQUAL project. This project has supported and performed the quality assessment of ozone and temperature profiles retrieved from ENVISAT data using lidar data during the period 2004-2007. In this period, data from 13 lidar stations part of the EQUAL network were submitted to the correlative database maintained by the Norwegian Institute for Air Research (NILU). Until 12 March 2008, a total of 3382 temperature and 3406 ozone profiles has been submitted.

During the four project years, various versions of MIPAS, SCIAMACHY and GOMOS profiles have been validated. GOMOS ozone profiles (GOPR 6.0dh) have shown an excellent agreement with lidar data with a bias within 5% between altitudes of 18–45 km. The quality of the ozone profiles was found to be mainly influenced by the limb illumination condition. Further improvement of the high-resolution temperature product (HRTP) is recommended.

Ozone profile validation results have shown a good agreement of MIPAS FR (IPF 4.61/4.62) with lidar with a bias within ±5% at altitudes ranging from 15 to 40 km. The results of the comparison with MIPAS temperature profiles indicate an altitude-dependent bias which is generally smaller than 1–2 K, consistent with the specified MIPAS systematic error component.
In comparison with lidar ozone profiles, a small positive bias was found for the MIPAS RR data throughout the stratosphere ranging from 0 to 20%. Nevertheless, individual comparisons have shown a very good agreement in the high vertical structures in the profiles.

SCIAMACHY ozone profiles from the validation reference data set (IPF version 3.00) show a reasonable agreement with lidar, sonde and microwave data. The data retrieved using the IFE 1.63 algorithm show similar validation results and are consistent with IPF 3.00.
ESA has recently reprocessed the SCIAMACHY level 2 data with processor version 3.01, which now contains all four (when available) profiles derived from the limb scans rather than one profile calculated from the average of these scans. Validation results indicate that this version is still underestimating the ozone concentration around the ozone maximum. Furthermore, around 40 km there is still a visible artefact (related to the reference height). Deviations are mostly within 20% between 20 and 50 km.

The EQUAL project has in the four years of the project duration contributed to more than 10 scientific articles and over 30 conference contributions in the form of posters and presentations. Five technical notes have been submitted to the instrument quality working groups and various other publications have been prepared within the project.

1. Introduction

This is the final report of the ENVISAT Quality Assessment by Lidar (EQUAL) project led by the Dutch National Institute for Public Health and the Environment (RIVM). The objective of this project has been to provide the European Space Agency (ESA) with adequate support for the assessment and reporting on the product quality of temperature and ozone profiles retrieved from ENVISAT data in the period 2004-2007. In order to fulfil this objective, temperature and ozone profiles obtained with stratospheric lidars from a total of 13 stations (see **Figure 1**) have been collected and made accessible for comparison.

Chapter 2 provides an overview of the available measurements that were submitted to the correlative database maintained at NILU. This document continues with the availability of the ENVISAT data and the validation approach in chapter 3. The validation activities carried out are subsequently presented for GOMOS (chapter 4), MIPAS (chapter 5) and finally SCIAMACHY (chapter 6). The last chapters give an overview of EQUAL-related publications (7) and present the conclusions (8).

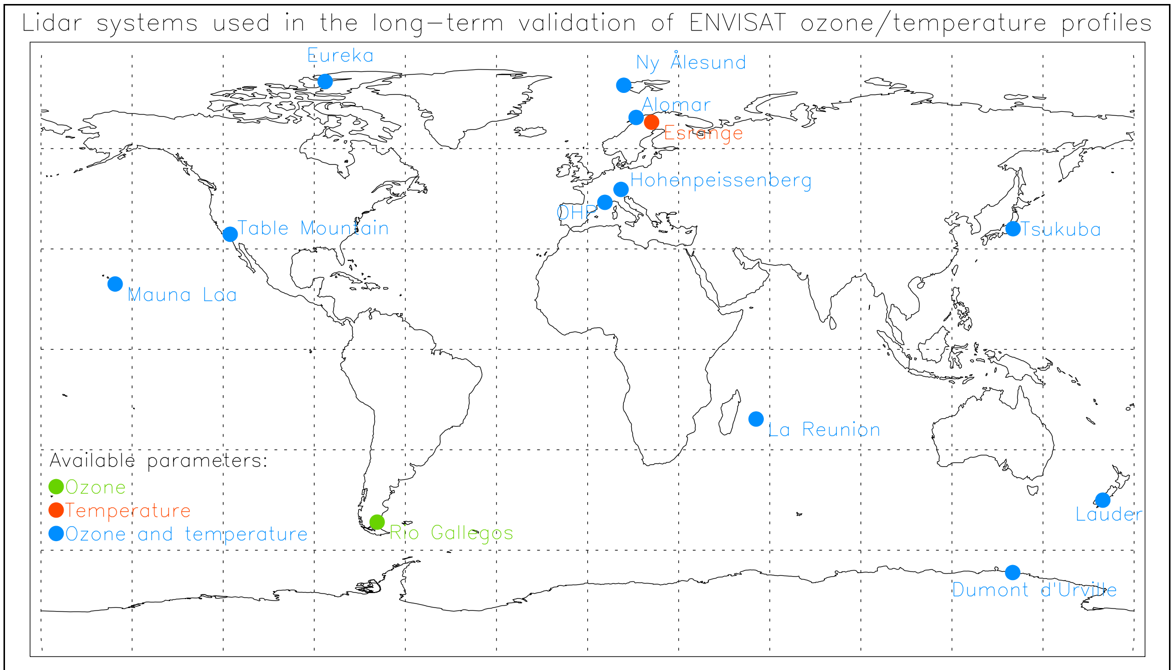


Figure 1: Station locations of all lidar instruments used in the EQUAL project.

2. LIDAR Data

The EQUAL network initially consisted of eleven lidar stations, but at the beginning of 2006 it has been extended with two more stations; one in Southern Argentina and one on the Antarctic (see **Figure 1** and **Table 2-1)**. The statistics of the lidar data that have been measured, processed, converted (to HDF) and submitted to the ENVISAT Cal/Val database (maintained by NILU) are shown in **Figure 2** for the ozone profiles and in **Figure 3** for the temperature profiles. Each figure presents per month the number of days with lidar measurements. Note that multiple profiles per day are counted as one in this representation. The first set of panels regard the ozone measurements, while the second part concerns the temperature measurements. In each panel title we have indicated with an acronym the station location (see **Table 2-1**) and the system name which corresponds to the filename in the NILU database (e.g., files with MSC003 in their name contain ozone profile information and MSC004 temperature profile information, and both for Eureka, Canada).

Table 2-1: Overview of LIDAR systems: acronyms, locations and parameters

Ground station	Acro	Lat.	Long.	Parameter	System name
Eureka	EUR	80.05	–86.42	Ozone, temperature	CARE.STB.EC001 (was MSC003), CARE.STB.EC002 (was MSC004)
Ny Ålesund	NYA	78.92	11.93	Ozone, temperature	AWI001, AWI002
Alomar	ALO	69.30	16.00	Ozone, temperature	NILU001, NILU002
Esrange	ESR	67.88	21.10	Temperature	UBONN003
Hohenpeissenberg	HOH	47.80	11.02	Ozone, temperature	DWD001, DWD002
Obs. Haute Provence	OHP	43.94	5.71	Ozone, temperature	CNRS.SA001, RMR_CNRS.SA001
Tsukuba	TSU	36.05	140.13	Ozone, temperature	NIES001, NIES002
Table Mountain	TMF	34.40	–117.70	Ozone, temperature	NASA.JPL003 (was CNRS.SA003), NASA.JPL004 (was CNRS.SA002)
Mauna Loa	MLO	19.54	–155.58	Ozone, temperature	NASA.JPL001 (was CNRS.SA004), NASA.JPL002 (was CNRS.SA005)
La Reunion	LAR	–20.80	55.50	Ozone, temperature	LPA001, LPA002
Lauder	LAU	–45.04	169.68	Ozone, temperature	RIVM002, RIVM003#
Rio Gallegos	RGA	–51.6	–69.3	Ozone	CEILAP001
Dumont d'Urville	DDU	–66.67	140.01	Ozone, temperature	CNRS.SA007*, RMR_CNRS.SA002#

* System (currently) unavailable due to technical problems

Data is currently being processed and not yet available

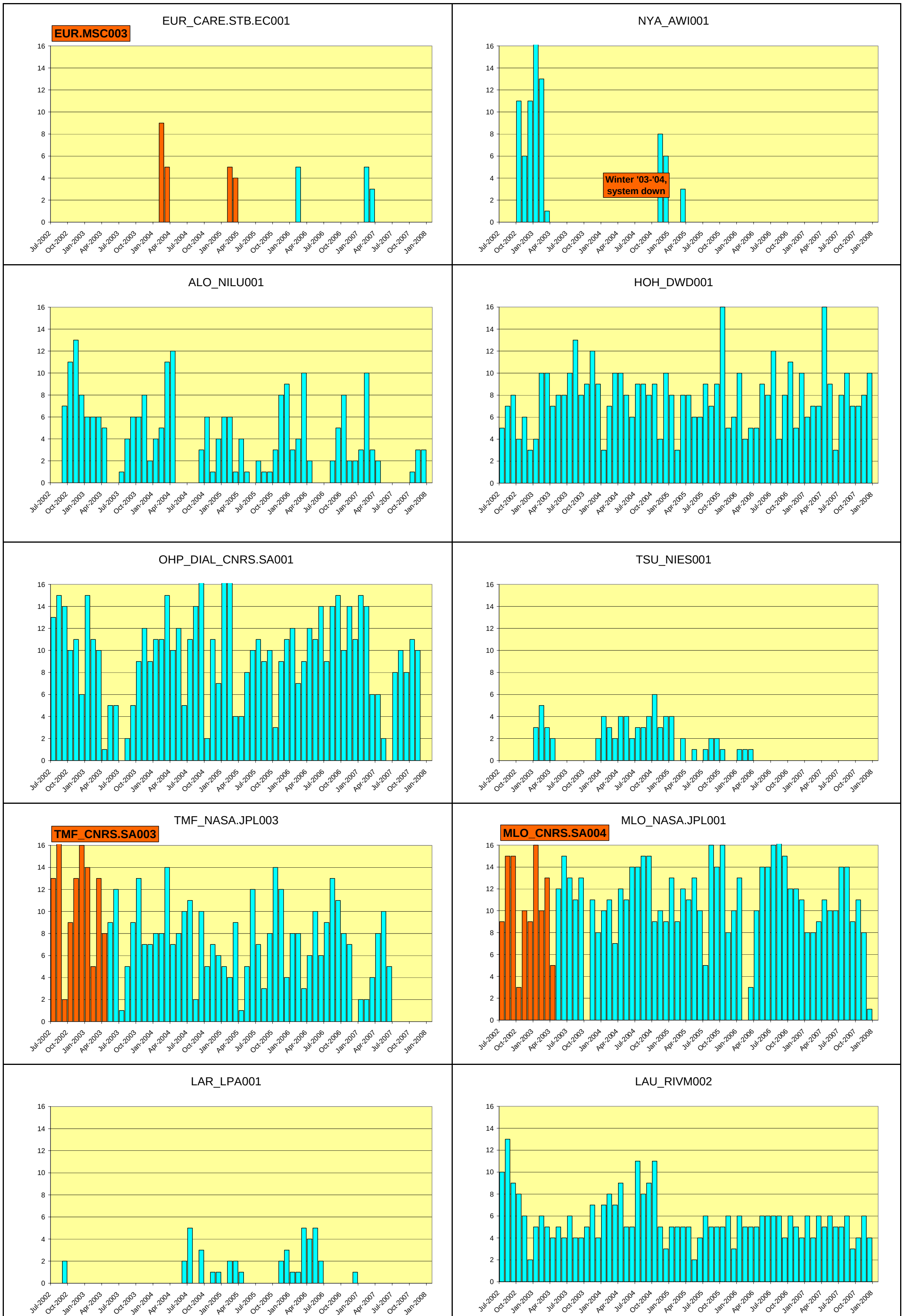


Figure 2: Statistics of available OZONE lidar data in the NILU database. Numbers indicate the number of days per month with lidar measurements. Note that the maximum range for the numbers is fixed to 16 and larger numbers are not displayed (see Tables 10-1 – 10-6).

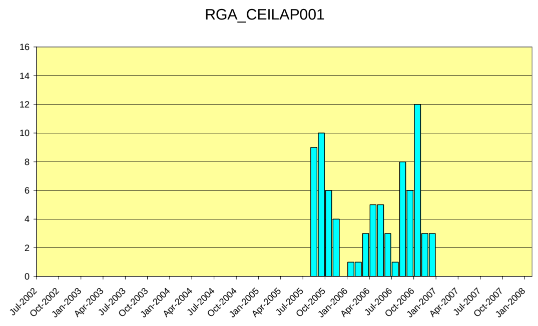
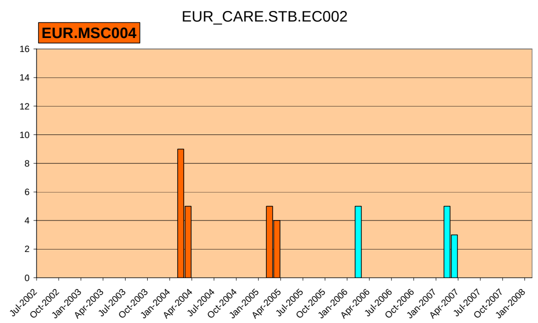
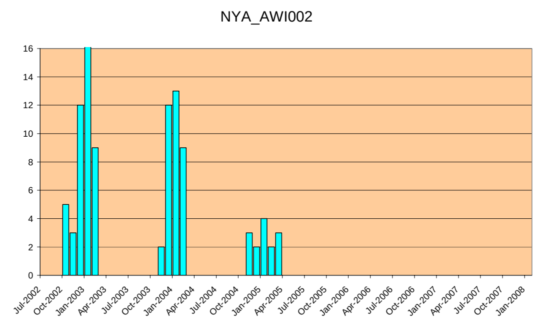
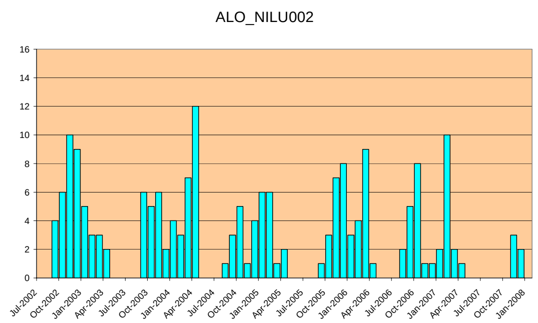
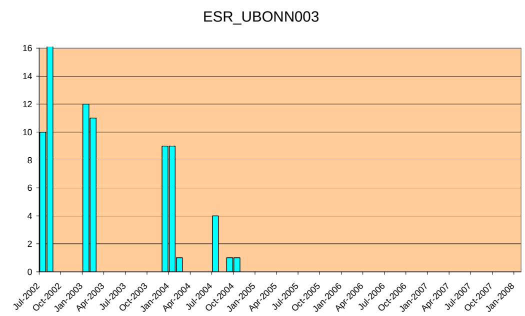


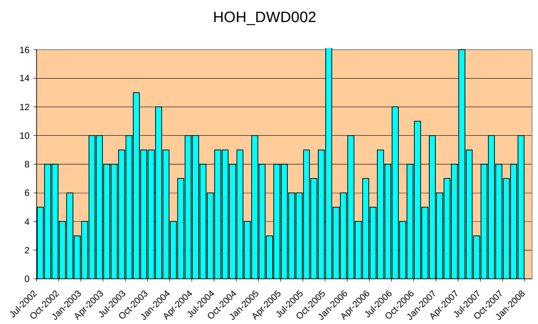
Figure 2. Continuation











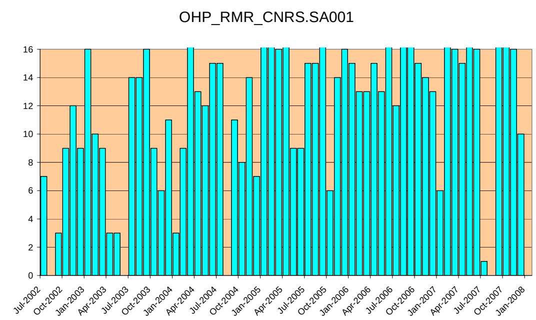


Figure 3: Statistics of available TEMPERATURE lidar data in the NILU database. Numbers indicate the number of days per month with lidar measurements. Note that the maximum range for the numbers is fixed to 16 and larger numbers are not displayed (see Tables 10-1 – 10-6 for these values).

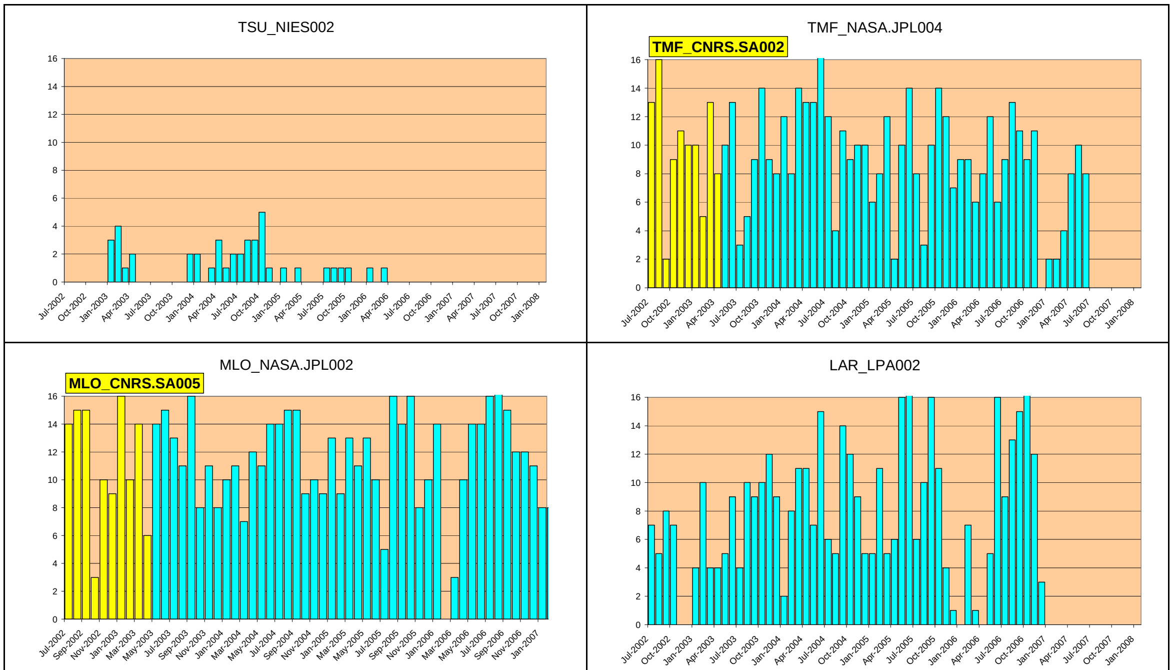


Figure 3. Continuation

3. ENVISAT data availability and validation approach

3.1. Data availability

In this section we give an overview of the available ENVISAT data (level 2) for the EQUAL project (see **Table 3-1**, **Table 3-2** and **Table 3-3**). Note that data might have been (temporarily) available but not acquired within the EQUAL project. These tables serve as a rough indication and they are not a precise representation of actual data availability.

Legend: **……** = potential data, **……** = available data

Table 3-1: Available ENVISAT Data from IPF Processor

Instrument	2002	2003	2004	2005	2006	2007
GOMOS	....	....	....	....	....	....
MIPAS	....	....	....	RR-mode...	....	....
SCIAMACHY	....	....	....	....	....	....

Table 3-2: Available ENVISAT Data from Prototype Processor

Instrument	2002	2003	2004	2005	2006	2007
GOMOS	....	....	....	....	....	....
MIPAS	....	....	....	RR-mode.....	....	....
SCIAMACHY	....	....	....	....	....	....

Table 3-3: Available ENVISAT Data from Scientific Institutes

Instrument	2002	2003	2004	2005	2006	2007
GOMOS*	....	....	....	....	....	....
MIPAS	....	....	....	RR-mode.. .	....	....
SCIAMACHY	....	....	....	....	....	....

* As enough GOMOS data are available through the nominal ESA processing chain, we only obtained access to a 'scientific' data set of the high-resolution temperature product (HRTP).

3.2. Validation approach

3.2.1. Introduction

The validation approach used in this project has been outlined in 'EQUAL Annual Report 2004' (Meijer and Swart, 2005), which as a final preparation result provides lists containing direct pointers to two collocated profiles (i.e., filenames and other directional information). The validation approach and target level-2 data quality have also been described in (Meijer et al., 2005c; Meijer et al., 2004a). In the next section we will shortly summarise the carried out steps.

3.2.2. Status per Instrument

For GOMOS data coincident with the measurements of the lidar stations in the EQUAL network, the overpass tables and collocation lists have been generated for the complete period between July 2002 and December 2007. The lists are based on available reprocessed and operational GOMOS data. In order to support the algorithm development of the high-resolution temperature product, we have generated special lists focusing on some near-perfect collocated observations (<300 km and <10 hours). We have generated HDF files of GOMOS data in collocation with ground-based stations. Each of these files contains one profile with all relevant additional information required for validation studies.

For MIPAS data coincident with the measurements of the lidar stations in the EQUAL network, the overpass tables and collocation lists have been generated for the period between July 2002 and April 2004. Since January 2005 MIPAS is measuring in a reduced resolution (RR) mode, providing a second dataset.
The collocation lists have been generated using available (and downloaded) MIPAS data that were successfully converted to HDF files. In these files we have added ECMWF collocated pressure, temperature and geometric altitude information with the support of KNMI using their TOSTI software (Tool for Orbital Spatial and Temporal Interpolation by Arjo Segers, http://www.knmi.nl/~segers/tosti/html/tosti.html).

For SCIAMACHY data coincident with the measurements of the lidar stations in the EQUAL network, the overpass tables and collocation lists have been generated for the complete period between July 2002 and February 2006. Available profiles data have also been converted to HDF files containing one profile with all relevant additional information required for validation studies. Special attention has been put to secure unique file naming for each of the potential 4 profiles per limb measurement state and for different data sources (operational (ESA) and scientific (e.g., IFE)). We are currently (December 2007) obtaining the newly processed SCIAMACHY level 2 IPF 3.01 profiles, which contain (to a maximum of) 4 profiles from the limb scans.

3.2.3. Software Development

The validation software has been extended and can generate overpass tables and collocation lists for any list of ground-based stations and is suitable for balloon ozone sonde, lidar and microwave radiometer data stored in the NILU database. Software has been used to supply other validation scientists with overpass tables and collocation lists (e.g., for sites like L'Aquila, Potenza, OHP) relating to ENVISAT validation studies. The software can also deal with both mission planning information and performed/available ENVISAT data. Processing time has been reduced by also verifying the availability with respect to the time of measurements for possible collocations (based on geographical location).
In 2006 we put effort in developing a more robust methodology for estimating the remaining altitude shift. Both MIPAS and SCIAMACHY suffer from inaccurate attitude information of the satellite platform resulting in an altitude shift of the limb profile data. A software tool based on correlation was developed for an objective estimation of this shift. Both this tool and other validation software can analyze any sub set of the data including per station/instrument analysis.

The following three chapters will provide an overview of the validation results obtained per instrument during the four years duration of the EQUAL project.

4. GOMOS

In the four years of the duration of the EQUAL project, we have been validation various versions of GOMOS processors, ranging from IPF 4.02 to 5.00 and GOPR 6.0a to GOPR 6.0dh. The quality of the ozone profiles was found to be mainly influenced by the limb illumination condition (Meijer et al., 2004a) and overall agreement has been found to be very good between ± 20 and 60 km. For GOPR 6.0cf the GOMOS ozone profiles have even shown an excellent agreement with lidar data with a bias within 5% between altitudes of 15–45 km.
Six different aerosol models have been tested in the GOMOS processor in 2007 (a seventh model was planned for, but was not available at the time of analysis). These models implemented a characterisation of the wavelength (λ) dependence of the aerosol scattering as a constant, a linear function, a quadratic function or a cubic function. The models were run for a reference dataset and all cases with a dark atmospheric limb condition (SZA>108º) were validated. It was observed that the ozone maximum was best captured by the two quadratic aerosol models (normal or inverse dependence on λ) and the largest deviations from the ground-based measurements were found for the processing with the aerosol concentration/wavelength dependence being considered constant. Finally, at low altitudes (< 20 km), the forward quadratic aerosol model seemed to give somewhat better results than the inverse quadratic model. Our current validation activities are focussing at the full time series of available GOMOS ozone profiles (2002-2007) in preparation of an article for the special issue in ACP.

In **Figure 4** (top) we show the comparison results of the latest GOMOS ozone profiles (6.0 dh) compared to lidar observations for the period July 2002 until August 2007 (consolidated or reprocessed with the same processor version). In the top panels we present the validation results for all GOMOS ozone profiles which fit to the following critera: 1) less than 800 km and less than 20 hours from the ground-based measurement; 2) limb flag equal to 0 (dark limb); 3) both the GOMOS as well as the lidar measurements should have an error < 30%; 4) the ozone number density given by GOMOS should be greater than 0 and smaller than 10^{19} molecules/m^3. The overall conclusion is that GOMOS ozone profile show an excellent agreement with lidar data. The bias is within 5% between 18–45 km altitude.
The bottom panel of **Figure 4** shows the analysis for each main latitude region. We can observe that for the mid-latitudes the agreement is excellent, but that for the tropical region below 22 km GOMOS is starting to overestimate the ozone concentration. Furthermore, for the Polar Regions, we see that GOMOS is underestimating the ozone concentration. During the GOMOS QWG meeting in February 2008 it was pointed out that aurora may play a role in these offsets. This is currently under investigation.

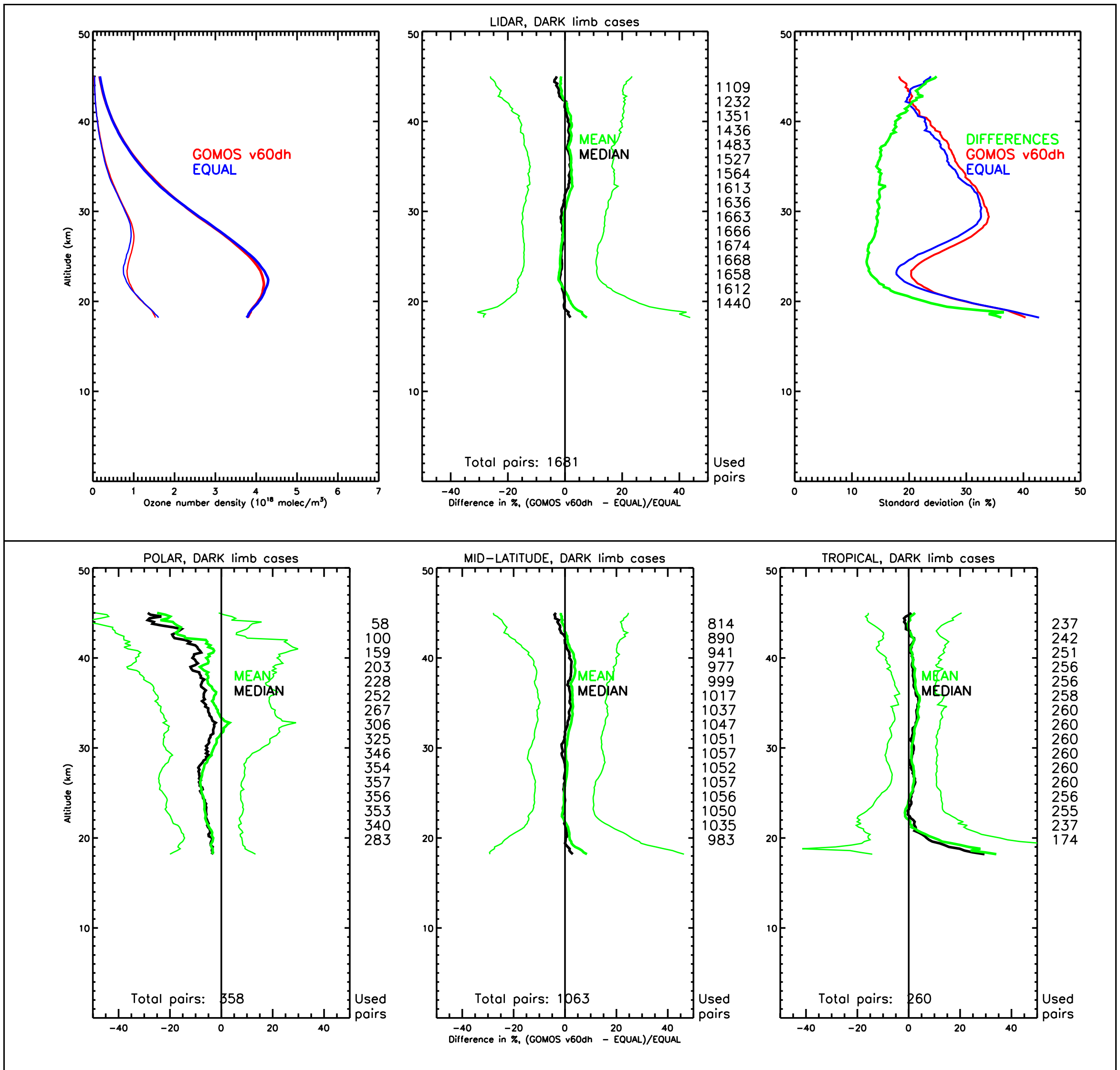


Figure 4: Intercomparison results of all accepted GOMOS and paired LIDAR correlative data. (left) Mean GOMOS (bold red line) and LIDAR (bold blue line) ozone profiles and their standard deviations (thin lines in corresponding colors). (middle) Mean (bold green line) and median (black line) differences between all the paired GOMOS and LIDAR data as a percentage of the latter. For the mean profile, we also plotted the (1σ) standard deviation of the differences (thin green line). Numbers at the right of the middle panel indicate, for some altitude levels, the number of pairs used at that level. (right) A comparison between the standard deviation of the differences (green line) and the standard deviation of all GOMOS (red line) and LIDAR (blue line) ozone profiles.

Upper panels show results for GOMOS using the selection criteria as currently provided in the disclaimer. Bottom panels show results for three latitude regions.

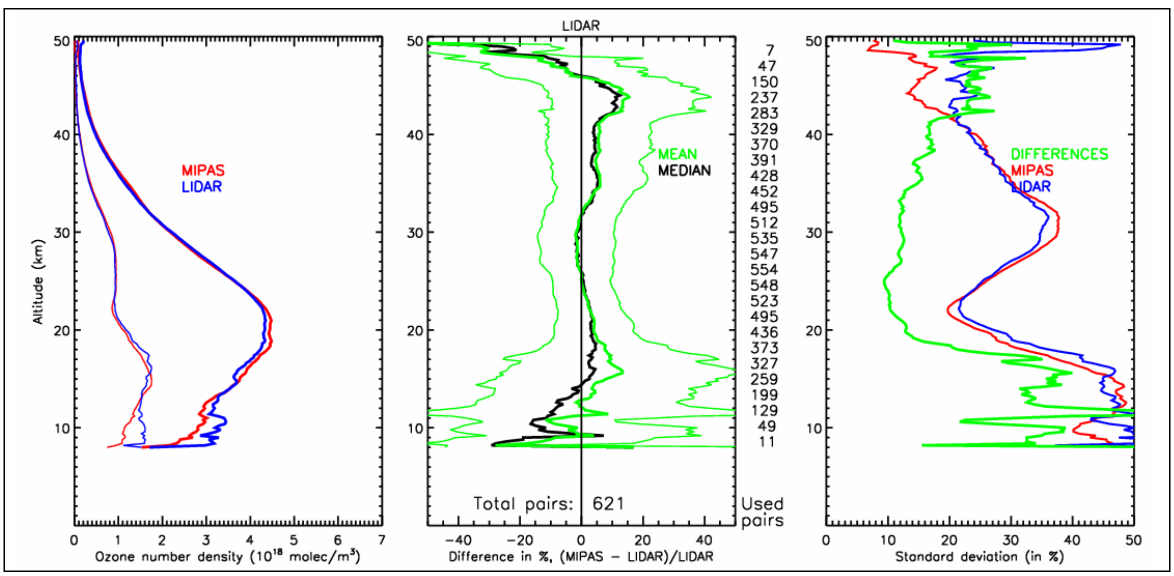
In addition to the ozone profiles, we also obtained preliminary data from a project led by FMI for improving the high-resolution temperature product (HRTP). The processing was done on a reduced set of the validation reference set. The reduction was a result of stricter collocation criteria, which are required for temperature profile validation. The data were often found to be missing or duplicated and the first results point out that further improvement of the algorithm is

5. MIPAS

The data from the operational ESA processor had been made available though the D-PAC ftp-site. These data were from MIPAS measurements using the full resolution mode and were processed either with

version IPF 4.61 or IPF 4.62. Data are available up to March 2004 when the instrument encountered an anomaly and seized measuring in full resolution mode.
The ozone profile validation results show a good agreement of MIPAS (IPF 4.61/4.62) with lidar. In the altitude range 15–40 km the bias is within ±5%, and above and below this range the bias increases to 15–20%. In the tropical and mid-latitudinal regions MIPAS is slightly too high in the ozone peak. The results of the comparison with MIPAS temperature profiles indicate an altitude-dependent bias which is generally smaller than 1–2 K, consistent with the specified MIPAS systematic error component.

MIPAS resumed its operations in January 2005. The measurement strategy had been altered to a reduced resolution mode (RR-mode) and as a consequence also the data processing required an upgrade to deal with this new data. This upgrade had been implemented at the end 2006 and was used on the MIPAS validation reference set.
First results were presented at the Envisat symposium held in Montreux, Switzerland. Compared to lidar measurements (<500 km and < 20 hours), a small positive bias was found for the MIPAS RR data throughout the stratosphere ranging from 0 to 20%. This bias is higher than the one that was established for the mission in full resolution measurement mode (Meijer et al., 2006c). However, individual comparisons showed a very good agreement in the high vertical structures in the profile.
In **Figure 5** we show MIPAS (v4.61 and v4.62) validation results when compared to lidar measurements. The top panels show the results of the ozone profile comparison and the bottom panels the results of the temperature profile comparison. Collocation criteria were 400 km and 10 hours for the allowed maximum spatial and temporal differences, respectively. The ozone profiles show a good agreement with lidar data, and the bias (slightly positive) is generally within 10% between 12–45 km altitude. The temperature profiles also show a good agreement with lidar data, and the bias is slightly positive (+1 K) at lower altitudes (15–42 km) and slightly negative (–2 K) at higher altitudes (42–68 km).



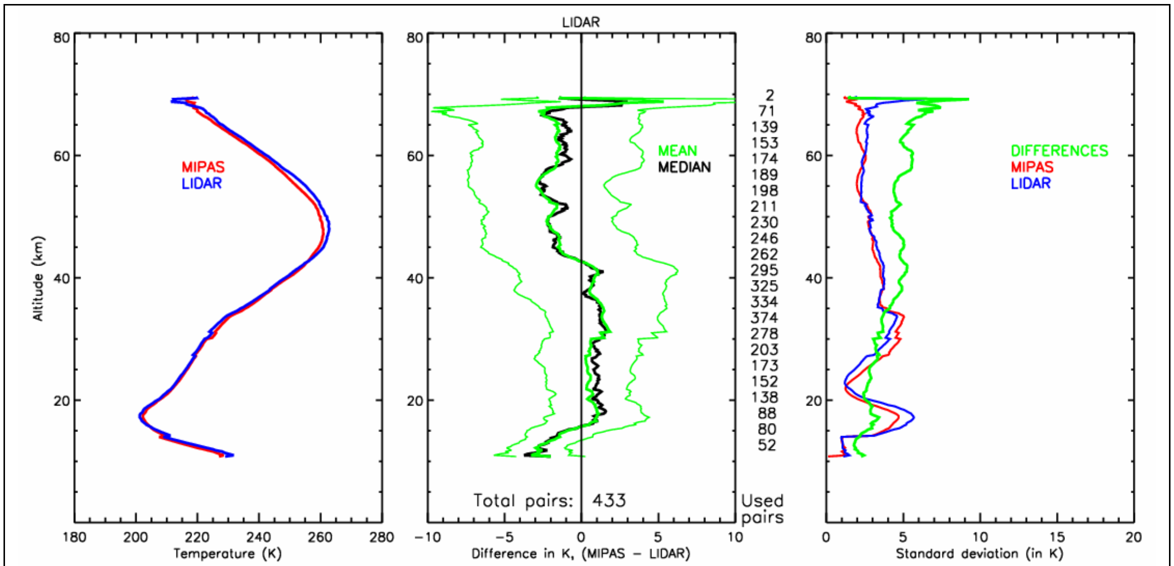


Figure 5: Same as Figure 4, but now showing results of (top) MIPAS ozone profiles and (bottom) MIPAS temperature profiles compared to lidar data. Note that the scale used for the temperature comparison is absolute rather then relative (middle and right bottom panels), and that the altitude range is more extended. The altitude information for the MIPAS profiles has been obtained by transferring MIPAS pressure data to geometric altitude using ECMWF data interpolated to the position of the MIPAS profile.

6. SCIAMACHY

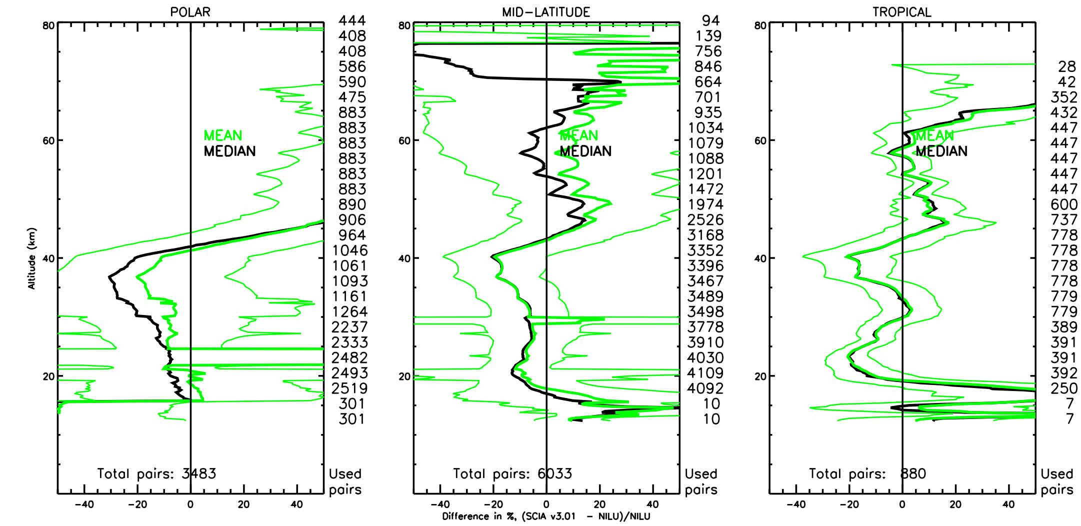
Temperature profiles in the SCIAMACHY files are climatological values and they are not retrieved. Originally it was foreseen to retrieve temperature information from the infrared channels, but these measurements suffer from ice on the detectors, which makes it impossible to retrieve temperature. The current status for alternative algorithms using measurements from the other channels is unclear for the operational processor.

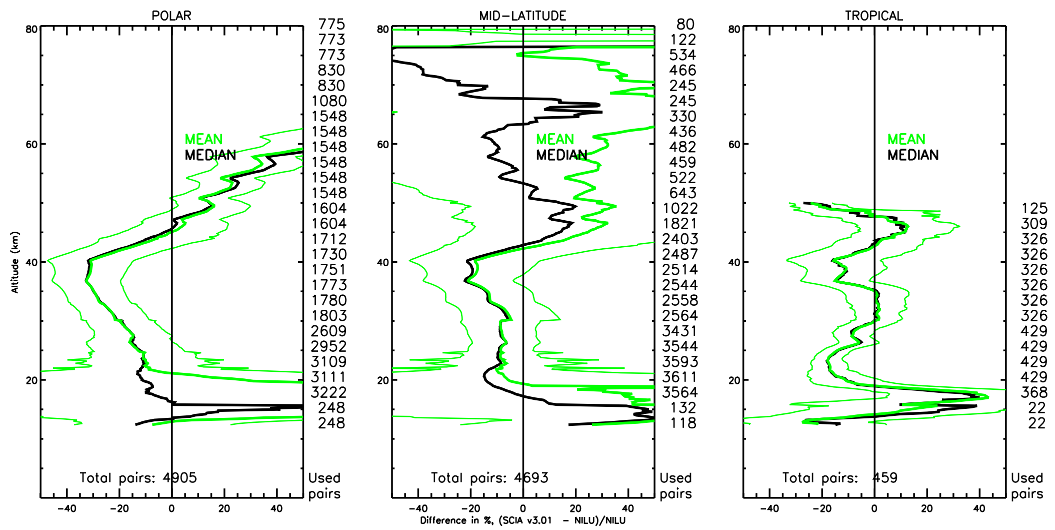
The data from the operational ESA processor covered observations since November 2004 in offline version OL-v2.5. The processor had been upgraded in July 2006, and since then data were available in version OL-3.0. This latter version had also been used to process the SCIAMACHY validation reference set. Additionally, we had contacted the IFE group in Bremen (Germany) for non-operational products (Christian von Savigny). These products concerned ozone profiles retrieved from limb data using the level-1 data of the validation reference set.

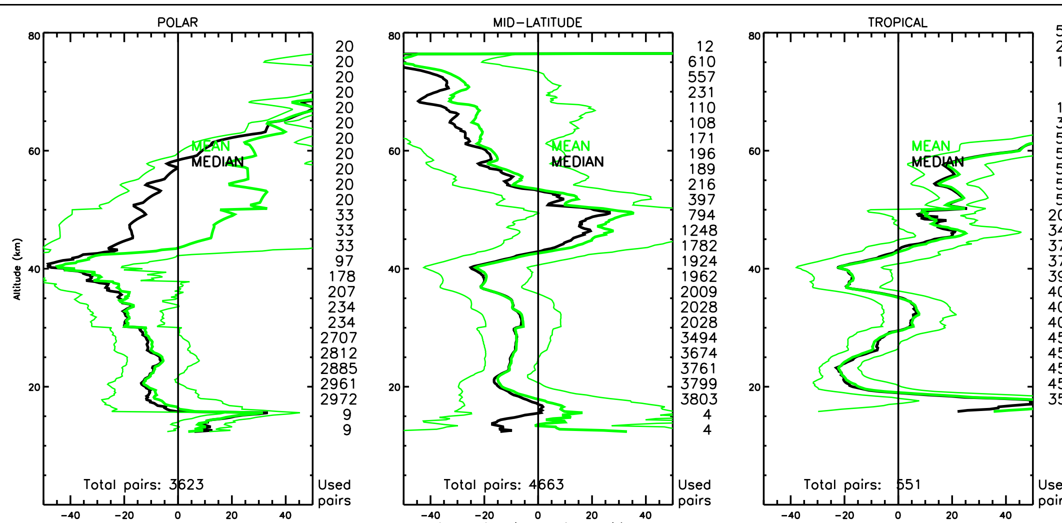
The OL-3.0 algorithm has been used for the validation reference set. The quality of the level-2 data has significantly improved compared to previous versions. Currently SCIAMACHY ozone profiles from the validation reference data set (IPF version 3.00) show a reasonable agreement with lidar, sonde and microwave data. There is a negative bias of 5–20% in the altitude range 18–38 km with the smaller values in the range 25–35 km. At 40-km altitude there is a 25% negative bias in the SCIAMACHY profiles. Comparisons in the altitude range 18–38 km show that the precision of SCIAMACHY is better than 10–15%. In the Polar Regions the SCIAMACHY ozone profiles show a larger negative bias above the ozone peak. In general for all regions, the high ozone concentrations in the ozone peak and the profile just below the peak are underestimated by about 10–20%. The validation results do not indicate a clear dependence of the derived bias on solar zenith angle and validation instrument. The data retrieved using the IFE 1.63 algorithm show similar validation results and are consistent with IPF 3.00.

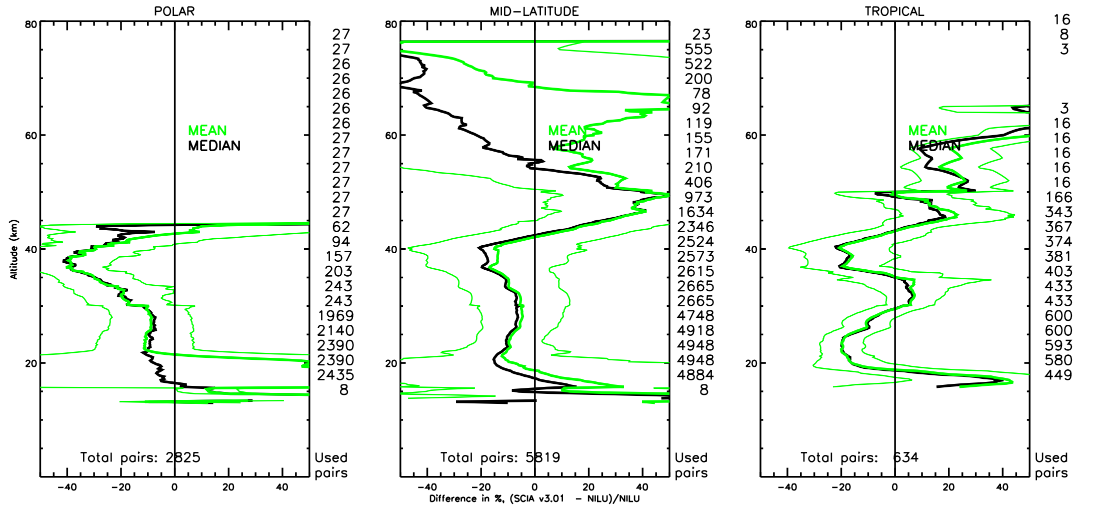
ESA has recently finished reprocessing SCIAMACHY level 2 data with processor version 3.01. This version now contains all four (when available) profiles derived from the limb scans rather than one profile calculated from the average of these scans.

In **Figure 6** we show validation results of SCIAMACHY ozone profiles (IPF 3.01) for the years 2002-2007 compared to ground- and balloon-based data. As the total dataset was very large, it was split into groups of months for processing reasons.

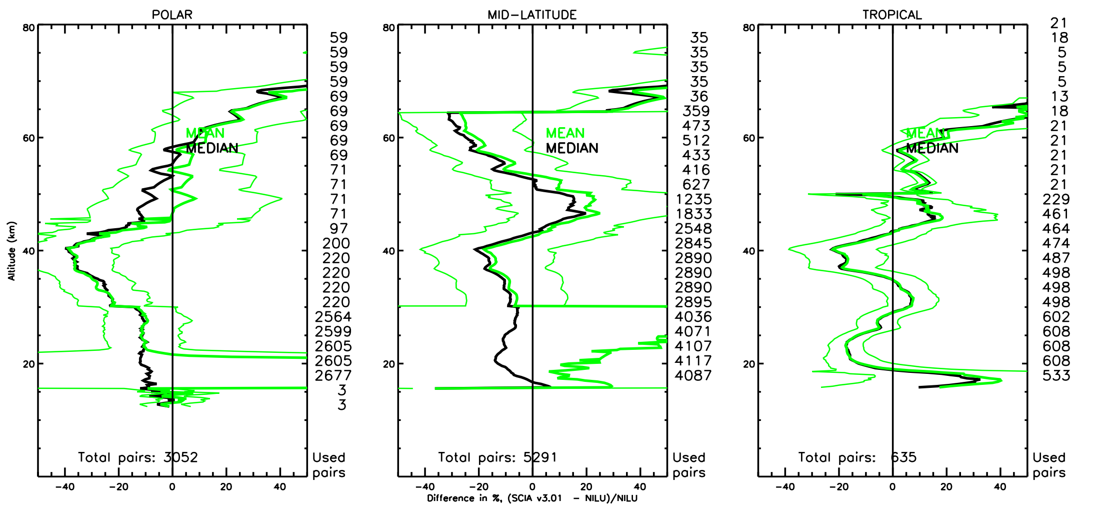

POLAR
MID-LATITUDE
TROPICAL
MEAN
MEDIAN
Altitude (km)
Total pairs: 3483
Total pairs: 6033
Total pairs: 880
Used pairs
444 408 408 586 590 475 883 883 883 883 883 883 890 906 964 1046 1061 1093 1161 1264 2237 2333 2482 2493 2519 301 301
94 139 756 846 664 701 935 1034 1079 1088 1201 1472 1974 2526 3168 3352 3396 3467 3489 3498 3778 3910 4030 4109 4092 10 10
28 42 352 432 447 447 447 447 447 600 737 778 778 778 778 779 779 389 391 391 392 250 7 7
Difference in %, (SCIA v3.01 – NILU)/NILU
a)


POLAR
MID-LATITUDE
TROPICAL
MEAN
MEDIAN
Altitude (km)
Total pairs: 4905
Total pairs: 4693
Total pairs: 459
Used pairs
775 773 773 830 830 1080 1548 1548 1548 1548 1548 1548 1604 1604 1712 1730 1751 1773 1780 1803 2609 2952 3109 3111 3222 248 248
80 122 534 466 245 245 330 436 482 459 522 643 1022 1821 2403 2487 2514 2544 2558 2564 3431 3544 3593 3611 3564 132 118
125 309 326 326 326 326 326 326 429 429 429 429 368 22 22
Difference in %, (SCIA v3.01 – NILU)/NILU
b)

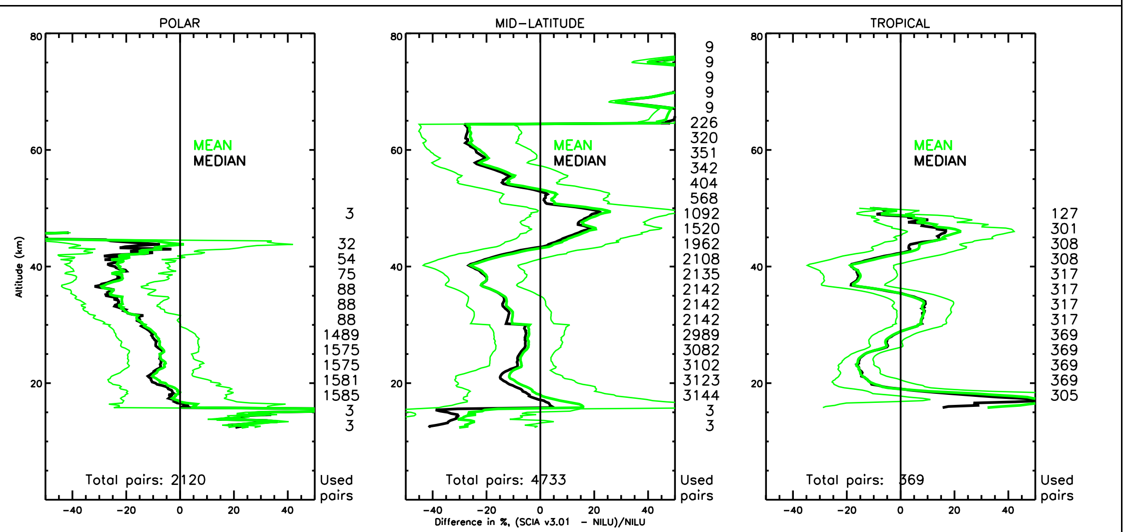

POLAR
MID-LATITUDE
TROPICAL
MEAN
MEDIAN
Altitude (km)
Total pairs: 3623
Total pairs: 4663
Total pairs: 551
Used pairs
20 20 20 20 20 20 20 20 20 20 20 33 33 33 97 178 207 234 234 2707 2812 2885 2961 2972 9 9
12 610 557 231 110 108 171 196 189 216 397 794 1248 1782 1924 1962 2009 2028 2028 3494 3674 3761 3799 3803 4 4
51 23 11 5 5 11 35 51 51 51 51 51 208 344 378 378 393 404 404 404 452 455 457 457 355
Difference in %, (SCIA v3.01 – NILU)/NILU
c)



d)



e)



f)

Figure 6: Same as Figure 4, but now showing results of SCIAMACHY ozone profiles retrieved with IPF 3.01 for the three main latitude regions over 6 periods (YYYYMM): a) 200208 – 200304; b) 200305 – 200312; c) 200401 – 200506; d) 200506 – 200604; e) 200605 – 200612; f) 2007.

Some funny points in the profiles are visible as deviations of the mean from the median (for instance around 30 km for **Figure 6a** mid latitudes). The overall shapes are fairly constant in time for the different latitude regions. The ozone maximum is underestimated with 10 to 20%. For the mid-latitudes, the differences with the ground-/balloon-based instruments then start to decrease with increasing altitude to about 30 km where the bias is about -5 to -7% and then increases to a secondary minimum at 40 km (which is used as a reference height in the retrieval) upon which it starts to change direction again. For the tropics, this pattern is very similar, except that the differences are more pronounced (e.g. the trend from the ozone maximum to about 30-33 km even passes through 0 and becomes a positive bias). For the Polar Regions, the 40 km inflection point is also strongly pronounced. This suggests a strong effect of the reference height on the retrieval.

7. Presentations and publications

Several general papers/presentations have been created reporting on the activities of the EQUAL project (e.g. Meijer, 2004a). During the EGU general assembly in Vienna, 24-29 April 2005 and at the Aura Science meeting in Den Haag, 8-10 November, we presented general posters (Meijer et al., 2005a) about the EQUAL project and some of the major validation results. A similar overview on ENVISAT validation by lidar was presented during a Latin American lidar conference in Columbia (Snoeij et al., 2005). The previous EQUAL project leader also presented the EQUAL project in the SPIE online newsroom after an invitation (Meijer, 2006b).

In 2006, a large number of proceeding contributions resulted from two conferences: the First conference on Atmospheric Science from 8–12 May (Meijer et al., 2006a; Ridolfi et al., 2006; Stebel et al., 2006b) and later from 4–7 December the Third Workshop on Atmospheric Chemistry and Validation of ENVISAT (ACVE-3) (Meijer et al., 2006b; Meijer et al., 2006c; Meijer et al., 2006d; Snoeij et al., 2006; Stebel et al., 2006a).

The lidar data for Lauder made available through this project has been used to validate all three atmospheric instruments onboard ENVISAT at this site (Wood et al., 2004).
A number of publications, resulting from lidar data partially measured and funded through the EQUAL project, is of a more scientific nature. During the EGU general assembly in Vienna, 2–7 April 2006, we contributed to two proceeding papers presented at an oral session (Kyrölä et al., 2006b; Steinbrecht et al., 2006a). The long-term ozone trend analyses by Steinbrecht et al. has also been published in the Journal of Geophysical Research (Steinbrecht et al., 2006b) and led to a press release by *Rijksimstituut voor Volksgezondheid en Milieu* (RIVM, 2006) which was picked up by several Dutch national and regional news papers and web sites. Lidar profiles were also used to validate a neural network retrieval scheme for GOME (Iapaolo et al., 2007).

In the following sub-sections of this chapter, we will describe per instrument the presented contributions resulting from the validation activities performed during the EQUAL project using lidar data from one or more of the EQUAL partners.

7.1. GOMOS Ozone and Temperature Profile Validation

A first EQUAL publication related to GOMOS was published in 2004 in Meteorologica (Meijer, 2004c). In this year, our work was presented at two conferences (Meijer et al., 2004b; Meijer et al., 2004c)and finally, a publication on GOMOS ozone profiles appeared in JGR (Meijer et al., 2004a). This paper became part of the PhD thesis of Yasjka Meijer (the EQUAL project leader until May 2007), who received the PhD title in 2005. In that year, a contribution was made to (Kyrölä et al., 2005) which was presented at the AGU fall meeting.
The availability of the complete mission data set of GOMOS led to an intensive validation activity analyzing these data. Initial results were presented during the Quality Working Group (QWG) meeting #10 from 8–9 February 2006. More in-depth analysis results were presented during the ATMOS and ACVE-3 conferences at ESRIN, Frascati (Meijer et al., 2006a; Meijer et al., 2006b; Snoeij et al., 2006). During both conferences we have contributed to the general discussion and provided recommendations for product improvements and usability.
The validation of the high-resolution temperature profile of GOMOS was performed in a joint contribution of the EQUAL and Norwegian Prodex project led by NILU. The results were presented during the ATMOS and ACVE-3 conferences (Stebel et al., 2006a; Stebel et al., 2006b). Although the

HRTP had significantly improved, the quality and reliability of this product was still insufficient for scientific use.
An overview of the status of the GOMOS sensor to which we contributed was presented at the EGU meeting (Kyrölä et al., 2006b). The collaboration with the same first author also resulted in a joint publication in JGR (Kyrölä et al., 2006a).
A technical note on the comparison of GOPR 6.0cf and 6.0ab was prepared in 2006 (Meijer, 2006a) and on the comparison of two aerosol models in 2007 (Meijer, 2007b). Preliminary results of the follow-up study, with the comparison of six aerosol models used in the GOMOS ozone retrieval scheme, were presented by Thorsten Fehr on behalf of the EQUAL project at the GOMOS quality working group meeting #15 held in September 2007 in Brussels. Validation results of GOMOS data were presented at the ENVISAT symposium in Montreux (Meijer et al., 2007).

7.2. MIPAS Ozone and Temperature Profile Validation

At ACVE-2 held in 2004, the first validation results of MIPAS ozone profiles (Blumenstock et al., 2004) and temperature profiles (Blum and Fricke, 2004; Fricke et al., 2004) were presented.
Preliminary results of the comparison of MIPAS ozone and temperature profiles were also presented during the ATMOS and ACVE-3 conferences (Meijer et al., 2006a; Meijer et al., 2006c; Ridolfi et al., 2007b; Ridolfi et al., 2006). The results of MIPAS ozone validation were also presented by *Cortesi et al.* during the ATMOS conference but did not result in a conference paper. Two separate joint papers have been prepared and submitted to ACPD (Cortesi et al., 2007a; Ridolfi et al., 2007c) which were recently accepted in ACP (Cortesi et al., 2007b; Ridolfi et al., 2007a).
A technical note was prepared for the MIPAS QWG on the comparison of MIPAS RR ozone profiles with lidar profiles (Meijer, 2007a) and these results were also presented at the ENVISAT symposium in Montreux (Meijer et al., 2007).

7.3. SCIAMACHY Ozone and Temperature Profile Validation

In the first year of the project, the validation of SCIAMACHY ozone profiles was presented at ACVE-2 (Brinksma et al., 2004) and two presentations were given at the SCIAMACHY validation workshop (Lolkema, 2004; Meijer, 2004b).
Various additional presentations were given in 2005 on the validation of SCIAMACHY ozone profiles (Lolkema, 2005a; Lolkema, 2005b; Lolkema et al., 2005; Meijer et al., 2005a; Meijer et al., 2005b; Snoeij et al., 2005) and an overview of the analysis results was provided to support the processor upgrade (Meijer et al., 2005c).
In January 2006 the ACPD paper of Brinksma et al. (2005) was published in ACP (Brinksma et al., 2006). In the comparison we showed summary analysis results for lidar compared with SCIAMACHY IPF 2.5 and IFE (Bremen) 1.62 data. A complete overview of these results and other findings were published in a RIVM report by (Lolkema et al., 2007). We also contributed to the final report of the NIVR project for SCIAMACHY validation led by KNMI (Piters et al., 2006).
The altitude shift found in SCIAMACHY products continued to be a focus of attention in 2006 (von Savigny and Lolkema, 2006). Despite the decrease in the magnitude of the altitude shift, a remaining altitude shift was of the order of 800 m was still found (Meijer et al., 2006d; van Gijsel and Meijer, 2006a). ESA responded promptly to this issue which has received much attention in the second half of 2006 (e.g. pointing meeting at IUP/IFE Bremen, van Gijsel and Meijer, 2006b). The investigations yielded some promising results toward resolving the problem to within the pre-launch attitude specifications.
The validation of the SCIAMACHY ozone profiles (3.00) was presented at ACVE-3 (Meijer et al., 2006d; Snoeij et al., 2006) and at the Envisat symposium in Montreux (Meijer et al., 2007).

8. Conclusions

The aim of this project has been to assess the quality of ENVISAT's ozone and temperature profiles with lidar data, and check for possible dependencies on certain parameters. One of the main objectives was to make lidar ozone and temperature profiles available for validation activities. Currently over 6700 profiles are stored in HDF-format in the correlative database at NILU. These profiles are quite evenly spread over the period July 2002 until the end of 2007, and cover several different global regions.
From data of the planned measurements for GOMOS, MIPAS and SCIAMACHY coincidences have been derived with the lidar stations and from the currently available lidar data we have derived listings of collocated measurements. Since the beginning of the EQUAL project, there is a significant improvement in the ENVISAT data availability, which resulted in several assessment studies and algorithm development support.

The current status of the validation activities is that an extensive analysis of ENVISAT data has been performed for GOMOS ozone, MIPAS (RR) ozone and MIPAS temperature profiles. The GOMOS HRTP and SCIAMACHY ozone profiles have been validated on a limited data set and their data still require further improvement before an extended processing and analysis are feasible. A complete overview of the validation status of each instrument is provided in Table 8-1 and Table 8-2.

Table 8-1: Validation status of ENVISAT Data from IPF Processor

Legend: …... = complete assessment, …... = initial assessment, …... = no assessment.

Instrument	Ozone version	Temperature version
GOMOS	GOPR 6.0cf, several intermediate, IPF 5.0	HRTP from GOPR 6.0cf
MIPAS	IPF 4.61/4.62	IPF 4.61/4.62
SCIAMACHY	IPF 2.5, IPF 2.8, IPF 3.0, IPF 3.01	not applicable

Table 8-2: Validation status of ENVISAT Data from 'Scientific' Processing

Legend: …... = complete assessment, …... = initial assessment, …... = no assessment.

Instrument	Ozone version	Temperature version
GOMOS	Only from prototype	HRTP from FMI
MIPAS	None	None
SCIAMACHY	IFE 1.62, IFE 1.63	Not applicable

9. References

Blum, U. and Fricke, K.H., 2004. Validation of MIPAS temperature data with the U. Bonn lidar at Esrange during July and August 2002, ACVE-2, Frascati, Italy 3-7 May 2004, pp. poster ESA SP-562.

Blumenstock, T. et al., 2004. Comparisons of MIPAS O_3 profiles with ground-based measurements. In: D. Danesy (Editor), Second workshop on Atmospheric Chemistry Validation of ENVISAT (ACVE-2). ESA SP-562. European Space Agency, ESRIN, Frascati, Italy, pp. 7.

Brinksma, E.J. et al., 2005. Geophysical Validation of SCIAMACHY Limb Ozone Profiles, Atmospheric Chemistry and Physics Discussions. Copernicus, pp. 4893–4928.

Brinksma, E.J. et al., 2006. Geophysical Validation of SCIAMACHY Limb Ozone Profiles, Atmospheric Chemistry and Physics. Copernicus, pp. 197–209.

Brinksma, E.J. et al., 2004. SCIAMACHY ozone profile validation. In: D. Danesy (Editor), Second workshop on Atmospheric Chemistry Validation of ENVISAT (ACVE-2). ESA SP-562. European Space Agency, ESRIN, Frascati, Italy, pp. 11.

Cortesi, U. et al., 2007a. Geophysical validation of MIPAS-ENVISAT operational ozone data, Atmospheric Chemistry and Physics Discussions. Copernicus, pp. 5805–5939.

Cortesi, U. et al., 2007b. Geophysical validation of MIPAS-ENVISAT operational ozone data. Atmospheric Chemistry and Physics, 7(18): 4807-4867.

Fricke, K.H. et al., 2004. MIPAS temperature validation by radiosonde and lidar, ACVE-2 Frascati, Italy 3-7 May 2004, pp. ESA SP-562.

Iapaolo, M. et al., 2007. GOME ozone profiles retrieved by neural network techniques: A global validation with lidar measurements. Journal of Quantitative Spectroscopy and Radiative Transfer, 107: 105–119.

Kyrölä, E. et al., 2006a. Nighttime ozone profiles in the stratosphere and mesosphere by the Global Ozone Monitoring by Occultation of Stars on Envisat. Journal of Geophysical Research, 111: D24306.

Kyrölä, E. et al., 2005. Polar Night Observations of O3, NO2, and NO3 by GOMOS on Envisat, AGU Fall Meeting, San Francisco (CA), USA.

Kyrölä, E. et al., 2006b. GOMOS/ENVISAT overview, European Geosciences Union 2006. Geophysical Research Abstracts, Vienna, Austria, pp. 6507.

Lolkema, D.E., 2004. Validation of SCIAMACHY ozone profiles: an extensive approach, presentation at the SCIAMACHY Validation Workshop, Bremen, 6–8 December 2004.

Lolkema, D.E., 2005a. Pre-validation of the new SCIAMACHY ozone profile data with correlative lidar data, SCIAMACHY verification meeting, Bremen, Germany.

Lolkema, D.E., 2005b. Validation of OL O3 profiles with groundbased observations, SADDU meeting, Oberpfaffenhofen, Germany.

Lolkema, D.E., Meijer, Y.J. and Swart, D.P.J., 2005. Validation of SCIAMACHY ozone profiles, Aura Science Team Meeting, The Hague, The Netherlands.
Lolkema, D.E., Meijer, Y.J. and Swart, D.P.J., 2007. Validation of SCIAMACHY limb ozone profiles with lidar. 722611 004, RIVM, Bilthoven, The Netherlands.
Meijer, Y.J., 2004a. Envisat data validation set to continue, The Living Planet. European Space Agency.
Meijer, Y.J., 2004b. Envisat Quality Assessment with Lidar; a project to support the long-term validation of SCIAMACHY's ozone and temperature profiles, presentation at the SCIAMACHY Validation Workshop, Bremen, 6–8 December 2004.
Meijer, Y.J., 2004c. Ozonprofielen gemeten met sterren. Meteorologica, 13(4): 28–29.
Meijer, Y.J., 2006a. Comparison of EQUAL results from GOPR_60cf and GOPR_60ab (technical note to GOMOS-qwg), RIVM, Bilthoven.
Meijer, Y.J., 2006b. Satellite ozone profiles checked using ground-based laser radars. SPIE Newsroom: pp. 3.
Meijer, Y.J., 2007a. Comparison of MIPAS-RR and EQUAL lidar ozone profiles (technical note to MIPAS-qwg), RIVM, Bilthoven.
Meijer, Y.J., 2007b. Comparison of two aerosol models used in GOMOS processing (technical note to GOMOS-qwg), RIVM, Bilthoven.
Meijer, Y.J. et al., 2007. Long-term validation of GOMOS, MIPAS and SCIAMACHY ozone and temperature profiles by the ENVISAT quality assessment with lidar (EQUAL) project, ENVISAT symposium. ESA SP-636. European Space Agency, Montreux, Switzerland, pp. 5.
Meijer, Y.J. et al., 2005a. Envisat quality assessment with lidar (Equal): a project to support the long-term validation of ozone and temperature profiles, EGU. Proceedings, Vienna, Austria.
Meijer, Y.J. et al., 2005b. Envisat quality assessment with lidar (Equal): a project to support the long-term validation of ozone and temperature profiles, Aura Science Meeting, The Hague, The Netherlands.
Meijer, Y.J. et al., 2006a. Long-term validation of GOMOS, MIPAS and SCIAMACHY ozone and temperature profiles by the ENVISAT quality assessment with lidar (EQUAL) project, First Atmospheric Science Conference. ESA SP-628. European Space Agency, ESRIN, Frascati, Italy, pp. 6.
Meijer, Y.J. et al., 2006b. Pole-to-pole validation of GOMOS ozone profiles by the Envisat Quality Assessment with Lidar (EQUAL) project, Third workshop on Atmospheric Chemistry Validation of ENVISAT (ACVE-3). ESA SP-642. European Space Agency, ESRIN, Frascati, Italy, pp. 11.
Meijer, Y.J. et al., 2006c. Pole-to-pole validation of MIPAS ozone profiles by the Envisat Quality Assessment with Lidar (EQUAL) project, Third workshop on Atmospheric Chemistry Validation of ENVISAT (ACVE-3). ESA SP-642. European Space Agency, ESRIN, Frascati, Italy, pp. 7.
Meijer, Y.J. et al., 2006d. Pole-to-pole validation of SCIAMACHY ozone profiles by the Envisat Quality Assessment with Lidar (EQUAL) project, Third workshop on Atmospheric Chemistry Validation of ENVISAT (ACVE-3). ESA SP-642. European Space Agency, ESRIN, Frascati, Italy, pp. 9.
Meijer, Y.J., Lolkema, D.E. and Swart, D.P.J., 2005c. Overview of EQUAL Analysis Results (in support of ESL processor upgrade verification), RIVM, Bilthoven.
Meijer, Y.J. and Swart, D.P.J., 2005. Envisat Quality Assessment with Lidar: Annual report 2004, RIVM, Bilthoven.
Meijer, Y.J. et al., 2004a. Pole-to-pole validation of Envisat GOMOS ozone profiles using data from ground-based and balloon sonde measurements. Journal of Geophysical Research, 109: D23305.
Meijer, Y.J. et al., 2004b. GOMOS ozone profile validation using data from ground-based and balloon-sonde measurements. In: D. Danesy (Editor), Second workshop on Atmospheric Chemistry Validation of ENVISAT (ACVE-2). ESA SP-562. European Space Agency, ESRIN, Frascati, Italy, pp. 9.
Meijer, Y.J. et al., 2004c. Pole-to-pole validation of GOMOS ozone profiles using data from ground-based and balloon-sonde measurements. In: C.S. Zerefos (Editor), Quadrennial Ozone Symposium (QOS). International Ozone Commission (IOC), Kos, Greece, pp. 101–102.
Piters, A.J.M. et al., 2006. SCIAMACHY validation 2003–2005 -- Dutch contribution -- Annual Report 2005, KNMI, De Bilt.
Ridolfi, M. et al., 2007a. Geophysical validation of temperature retrieved by the ESA processor from MIPAS/ENVISAT atmospheric limb-emission measurements. Atmospheric Chemistry and Physics, 7(16): 4459-4487.
Ridolfi, M. et al., 2007b. Geophysical validation of MIPAS/ENVISAT temperature, International Union of Geodesy and Geophysics (IUGG), Perugia, Italy.

Ridolfi, M. et al., 2006. Geophysical validation of temperature retrieved by the ESA level 2 processor from MIPAS/Envisat measurements, First Atmospheric Science Conference. ESA SP-628. European Space Agency, ESRIN, Frascati, Italy, pp. 6.

Ridolfi, M. et al., 2007c. Geophysical validation of temperature retrieved by the ESA processor from MIPAS/ENVISAT atmospheric limb-emission measurements, Atmospheric Chemistry and Physics Discussions. Copernicus, pp. 5439–5513.

RIVM, 2006. Ozonlaag herstelt, Press release, Bilthoven, pp. 1.

Snoeij, P., Attema, E., Meijer, Y.J. and Swart, D.P.J., 2005. ENVISAT Validation by LIDAR, Third Workshop Lidar Measurements in Latin America, Popayán, Colombia.

Snoeij, P. et al., 2006. Summary of the atmospheric chemistry instrument validation results as presented at the ACVE-3 workshop Third workshop on Atmospheric Chemistry Validation of ENVISAT (ACVE-3). ESA SP-642. European Space Agency, ESRIN, Frascati, Italy, pp. 10.

Stebel, K. et al., 2006a. Comparison of GOMOS high-resolution temperature profiles (HRTP) with data from selected EQUAL lidar and radiosonde sites, Third workshop on Atmospheric Chemistry Validation of ENVISAT (ACVE-3). ESA SP-642. European Space Agency, ESRIN, Frascati, Italy, pp. 9.

Stebel, K. et al., 2006b. Validation of the GOMOS high-resolution temperature product (HRTP) using lidar, First Atmospheric Science Conference. ESA SP-628. European Space Agency, ESRIN, Frascati, Italy, pp. 6.

Steinbrecht, W. et al., 2006a. Is upper stratospheric ozone beginning to turn around?, European Geosciences Union 2006. Geophysical Research Abstracts, Vienna, Austria, pp. 6366.

Steinbrecht, W. et al., 2006b. Long-term evolution of upper stratospheric ozone at selected stations of the Network for the Detection of Stratospheric Change (NDSC). Journal of Geophysical Research, 111(D10308).

van Gijsel, J.A.E. and Meijer, Y.J., 2006a. Remaining Altitude Shift in SCIAMACHY Data (technical note to SCIAVALIG and SCIA-qwg), RIVM, Bilthoven.

van Gijsel, J.A.E. and Meijer, Y.J., 2006b. Tangent height offsets estimated by correlation analysis of ground-based data with O3 limb profiles, SCIAMACHY pointing meeting, Bremen, Germany.

von Savigny, C. and Lolkema, D.E., 2006. Update on the limb pointing problem - indications for horizontally tilted scanning, SADDU meeting.

Wood, S.W. et al., 2004. Contributions to ENVISAT data validation from NIWA, New Zealand, ACVE-2, Frascati, Italy 3-7 May 2004, pp. ESA SP-562.

10. Appendix 1: Overview of submission statistics - tables

In this section we give an overview of the lidar data submitted to the ENVISAT Cal/Val database at NILU in table format. In **Table 10-1** we present the number of days (661) with measurements during the Commissioning Phase of ENVISAT, and most of these data have been submitted prior to the EQUAL project. In **Table 10-2** we present the statistics for the data measured in 2003. Although the EQUAL project formally started in January 2004, the project partners additionally contributed data of 2003 and hence filled the gap between the end of the Commissioning Phase and the start of the project, which is a bonus for the project and amounts in total an extra 1259 days with measurements. In **Table 10-3** we present the data measured in 2004, which come to a total of 1381 days. In **Table 10-4** we present the data measured in 2005, which come to a total of 1262 days with measurements. In **Table 10-5** we present the data measured in 2006, which now come to a total of 1286 days with measurements submitted to the database. In **Table 10-6**, the data for 2007 is presented with a total of 855 measurement days so far. Note that not all data has been submitted yet and that some differences for previous years can be found when comparing with the annual reports (2004-2006) due to new submissions and re-processing.

Table 10-1: Data submission statistics, Commissioning Phase (2002)

(in grey temperature lidar systems)

Station	System	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Total
ALO	NILU001	0	0	7	11	13	8	39
ALO	NILU002	0	0	4	6	10	9	29
ESR	UBONN003	10	19	0	0	0	0	29
HOH	DWD001	5	7	8	4	6	3	33
HOH	DWD002	5	8	8	4	6	3	34
LAR	LPA001	0	0	2	0	0	0	2
LAR	LPA002	7	5	8	7	0	0	27
LAU	RIVM002	10	13	9	8	6	2	48
LAU	RIVM003	0	0	0	0	0	0	0
MLO	CNRS.SA004	9	15	15	3	10	9	61
MLO	CNRS.SA005	14	15	15	3	10	9	66
NYA	AWI001	0	0	0	11	6	11	28
NYA	AWI002	0	0	0	5	3	12	20
OHP	l_CNRS.SA001	13	15	14	10	11	6	69
OHP	r_CNRS.SA001	7	0	3	9	12	9	40
TMF	CNRS.SA003	13	16	2	9	11	10	61
TMF	CNRS.SA002	13	17	2	9	13	16	70
TOR	MSC001	2	0	1	2	0	0	5
TOTAL all systems		108	130	98	101	117	107	661

Note that submission of data for Lauder (temperature) is still foreseen after completion of the temperature retrieval scripts. The system in Toronto broke down in 2002 and has not been submitting measurements beyond 2002.

Table 10-2: Data submission statistics, 2003 (in grey temperature lidar systems)														
Station	**System**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**	**Total**
ALO	NILU001	4	5	11	12	0	0	0	0	3	6	1	4	50
ALO	NILU002	4	3	7	12	0	0	0	1	3	5	1	4	32
ESR	UBONN003	9	1	0	0	0	0	4	0	1	1	0	0	32
HOH	DWD001	3	7	10	10	8	6	9	9	8	9	4	10	108
HOH	DWD002	4	7	10	10	8	6	9	9	8	9	4	10	111
LAR	LPA001	0	0	0	0	0	2	5	0	3	0	1	1	0
LAR	LPA002	2	8	11	11	7	15	6	5	14	12	9	5	90
LAU	RIVM002	7	8	7	9	5	5	11	8	9	11	3	2	59
LAU	RIVM003	0	0	0	0	0	0	0	0	0	0	0	0	0
MLO	CNRS.SA004	16	10	13	5	End	-	-	-	-	-	-	-	44
MLO	NASA.JPL001	-	-	-	Start	12	15	13	11	13	0	11	8	83
MLO	CNRS.SA005	16	10	14	5	End	-	-	-	-	-	-	-	45
MLO	NASA.JPL002	-	-	Start	1	14	15	13	11	16	8	11	8	97
NYA	AWI001	0	0	0	0	0	0	0	0	0	0	8	6	35
NYA	AWI002	13	9	0	0	0	0	0	0	0	0	3	2	41
OHP	l_CNRS.SA001	11	11	15	10	12	5	11	14	17	2	11	7	84
OHP	r_CNRS.SA001	3	9	17	13	12	15	15	0	11	8	14	7	111
TMF	CNRS.SA003	10	5	13	7	End	-	-	-	-	-	-	-	35
TMF	NASA.JPL003	-	-	-	Start	9	12	1	5	9	13	7	7	63
TMF	CNRS.SA002	14	5	13	8	End	-	-	-	-	-	-	-	40
TMF	NASA.JPL004	-	-	Start	1	10	13	3	5	9	14	9	8	72
TSU	NIES001	3	5	3	2	0	0	0	0	0	0	0	2	15
TSU	NIES002	3	4	1	2	0	0	0	0	0	0	0	2	12
TOTAL all systems		172	138	115	65	79	90	75	92	110	97	114	112	1259

Note that submission of data for Lauder (temperature) is still foreseen.

Table 10-3: Data submission statistics, 2004 (in grey temperature lidar systems)														
Station	**System**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**	**Total**
ALO	NILU001	4	5	11	12	0	0	0	0	3	6	1	4	46
ALO	NILU002	4	3	7	12	0	0	0	1	3	5	1	4	40
ESR	UBONN003	9	1	0	0	0	0	4	0	1	1	0	0	16
EUR	MSC003	0	9	5	0	0	0	0	0	0	0	0	0	14
EUR	MSC004	0	9	5	0	0	0	0	0	0	0	0	0	14
HOH	DWD001	3	7	10	10	8	6	9	9	8	9	4	10	93
HOH	DWD002	4	7	10	10	8	6	9	9	8	9	4	10	94
LAR	LPA001	0	0	0	0	0	2	5	0	3	0	1	1	12
LAR	LPA002	2	8	11	11	7	15	6	5	14	12	9	5	105
LAU	RIVM002	7	8	7	9	5	5	11	8	9	11	5	3	88
LAU	RIVM003	0	0	0	0	0	0	0	0	0	0	0	0	0
MLO	NASA.JPL001	10	11	7	12	11	14	14	15	15	9	10	9	137
MLO	NASA.JPL002	10	11	7	12	11	14	14	15	15	9	10	9	137
NYA	AWI001	0	0	0	0	0	0	0	0	0	0	8	6	14
NYA	AWI002	13	9	0	0	0	0	0	0	0	0	3	2	27
OHP	l_CNRS.SA001	11	11	15	10	12	5	11	14	17	2	11	7	126
OHP	r_CNRS.SA001	3	9	17	13	12	15	15	0	11	8	14	7	124
TMF	NASA.JPL003	8	8	14	7	8	10	11	2	10	5	7	6	96
TMF	NASA.JPL004	12	8	14	13	13	17	12	4	11	9	10	10	133
TSU	NIES001	4	3	2	4	4	2	3	3	4	6	3	4	42
TSU	NIES002	2	0	1	3	1	2	2	3	3	5	1	0	23
TOTAL all systems		106	127	143	138	100	113	126	88	135	106	102	97	1381

Note that submission of data for Lauder (temperature) is still foreseen.

Table 10-4: Data submission statistics, 2005 (in grey temperature lidar systems)														
Station	**System**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**	**Total**
ALO	NILU001	6	6	1	4	1	0	2	1	1	3	8	9	42
ALO	NILU002	6	6	1	2	0	0	0	0	1	3	7	8	34
DDU	CNRS.SA007	0	0	0	0	0	0	0	0	0	0	0	0	0
DDU	RMR_CNRS.SA002	0	0	0	0	0	0	0	0	0	0	0	0	0
ESR	UBONN003	0	0	0	0	0	0	0	0	0	0	0	0	0
EUR	MSC003	0	5	4	0	0	0	0	0	0	0	0	0	9
EUR	MSC004	0	5	4	0	0	0	0	0	0	0	0	0	9
HOH	DWD001	8	3	8	8	6	6	9	7	9	16	5	6	91
HOH	DWD002	8	3	8	8	6	6	9	7	9	17	5	6	92
LAR	LPA001	0	2	2	1	0	0	0	0	0	0	2	3	10
LAR	LPA002	5	11	5	6	16	17	6	10	16	11	4	1	108
LAU	RIVM002	5	5	5	5	2	4	6	5	5	5	6	3	56
LAU	RIVM003	0	0	0	0	0	0	0	0	0	0	0	0	0
MLO	NASA.JPL001	13	9	12	11	13	10	5	16	14	16	8	10	137
MLO	NASA.JPL002	13	9	13	11	13	10	5	16	14	16	8	10	138
NYA	AWI001	0	0	3	0	0	0	0	0	0	0	0	0	3
NYA	AWI002	4	2	3	0	0	0	0	0	0	0	0	0	9
OHP	l_CNRS.SA001	17	17	4	4	8	10	11	9	10	3	9	11	113
OHP	r_CNRS.SA001	18	18	16	17	9	9	15	15	20	6	14	16	173
RGA	CEILAP001	0	0	0	0	0	0	0	9	10	6	4	0	29
TMF	NASA.JPL003	5	4	9	1	5	12	7	3	8	14	12	4	84
TMF	NASA.JPL004	6	8	12	2	10	14	8	3	10	14	12	7	106
TSU	NIES001	4	0	2	0	1	0	1	2	2	1	0	0	13
TSU	NIES002	1	0	1	0	0	0	1	1	1	1	0	0	6
TOTAL all systems		119	113	113	80	90	98	85	104	130	132	104	94	1262

Note that submissions of data for Esrange (temperature) and Lauder (temperature) are still foreseen.

Table 10-5: Data submission statistics, 2006 (in grey temperature lidar systems)														
Station	**System**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**	**Total**
ALO	NILU001	3	4	10	2	0	0	0	2	5	8	2	2	38
ALO	NILU002	3	4	9	1	0	0	0	2	0	0	0	0	19
DDU	CNRS.SA007	0	0	0	0	0	0	0	0	0	0	0	0	0
DDU	RMR_CNRS.SA002	0	0	0	0	0	0	0	0	0	0	0	0	0
ESR	UBONN003	0	0	0	0	0	0	0	0	0	0	0	0	0
EUR	CARE.EC.STB001	0	5	0	0	0	0	0	0	0	0	0	0	5
EUR	CARE.EC.STB002	0	5	0	0	0	0	0	0	0	0	0	0	5
HOH	DWD001	10	4	5	5	9	8	12	4	8	11	5	10	91
HOH	DWD002	10	4	7	5	9	8	12	4	8	11	5	10	93
LAR	LPA001	1	1	5	4	5	2	0	0	0	0	0	1	19
LAR	LPA002	0	7	1	0	5	16	9	13	15	18	12	3	99
LAU	RIVM002	6	5	5	5	6	6	6	6	4	6	5	4	64
LAU	RIVM003	0	0	0	0	0	0	0	0	0	0	0	0	0
MLO	NASA.JPL001	13	0	3	10	14	14	16	18	15	12	12	11	138
MLO	NASA.JPL002	14	0	3	10	14	14	16	18	15	12	12	11	139
NYA	AWI001	0	0	0	0	0	0	0	0	0	0	0	0	0
NYA	AWI002	0	0	0	0	0	0	0	0	0	0	0	0	0
OHP	l_CNRS.SA001	12	7	9	12	11	14	9	14	15	10	14	11	138
OHP	r_CNRS.SA001	15	13	13	15	13	17	12	18	17	15	14	13	175
RGA	CEILAP001	1	1	3	5	5	3	1	8	6	12	3	3	51
TMF	NASA.JPL003	8	8	3	6	10	6	9	13	11	8	7	0	89
TMF	NASA.JPL004	9	9	6	8	12	6	9	13	11	9	11	0	103
TSU	NIES001	1	1	1	0	0	0	0	0	0	0	0	0	3
TSU	NIES002	1	0	1	0	0	0	0	0	0	0	0	0	2
TOTAL all systems		117	68	84	88	113	114	111	133	135	140	103	80	1286

Note that submissions of data for Dumont d'Urville (temperature), Ny Ålesund (temperature and ozone), Esrange (temperature), Lauder (temperature) and Tsukuba (ozone and temperature) are still foreseen.

Table 10-6: Data submission statistics, 2007 (in gray temperature lidar systems)

Station	System	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Total
ALO	NILU001	3	10	3	2	0	0	0	0	0	1	3	3	25
ALO	NILU002	2	10	2	1	0	0	0	0	0	0	3	2	20
DDU	CNRS.SA007	0	0	0	0	0	0	0	0	0	0	0	0	0
DDU	RMR_CNRS.SA002	0	0	0	0	0	0	0	0	0	0	0	0	0
ESR	UBONN003	0	0	0	0	0	0	0	0	0	0	0	0	0
EUR	CARE.EC.STB001	5	3	0	0	0	0	0	0	0	0	0	0	8
EUR	CARE.EC.STB002	5	3	0	0	0	0	0	0	0	0	0	0	8
HOH	DWD001	6	7	7	16	9	3	8	10	7	7	8	10	98
HOH	DWD002	6	7	8	16	9	3	8	10	8	7	8	10	100
LAR	LPA001	0	0	0	0	0	0	0	0	0	0	0	0	0
LAR	LPA002	0	0	0	0	0	0	0	0	0	0	0	0	0
LAU	RIVM002	6	4	6	5	6	5	5	6	3	4	6	4	60
LAU	RIVM003	0	0	0	0	0	0	0	0	0	0	0	0	0
MLO	NASA.JPL001	8	8	9	11	10	10	14	14	9	11	8	1	113
MLO	NASA.JPL002	8	8	9	12	10	11	14	14	9	11	8	2	116
NYA	AWI001	0	0	0	0	0	0	0	0	0	0	0	0	0
NYA	AWI002	0	0	0	0	0	0	0	0	0	0	0	0	0
OHP	l_CNRS.SA001	15	14	6	6	2	0	8	10	8	11	10	0	90
OHP	r_CNRS.SA001	6	17	16	15	17	16	1	0	18	20	11	10	152
RGA	CEILAP001	0	0	0	0	0	0	0	0	0	0	0	0	0
TMF	NASA.JPL003	2	2	4	8	10	5	0	0	0	0	0	0	31
TMF	NASA.JPL004	2	2	4	8	10	8	0	0	0	0	0	0	34
TSU	NIES001	0	0	0	0	0	0	0	0	0	0	0	0	0
TSU	NIES002	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL all systems		74	95	74	100	83	61	58	64	62	72	70	42	855

Note that submissions of data for Dumont d'Urville (temperature), Ny Ålesund (temperature and ozone), Esrange (temperature), Lauder (temperature), Tsukuba (ozone and temperature), Rio Gallegos (ozone), Table Mountain Facility (ozone and temperature) and Observatoire Haute Provence (ozone) are still foreseen.