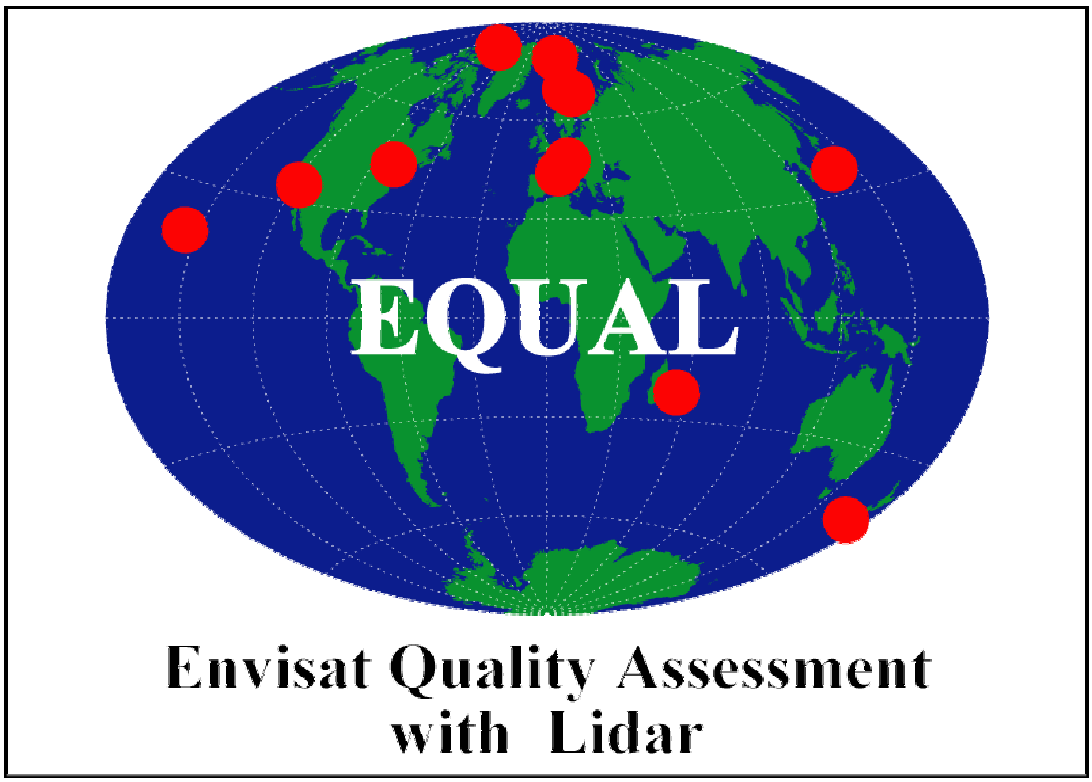
Progress Report

April – June 2005



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1 Introduction

This is the progress report of the EQUAL project led by RIVM. The two Work Packages (WPs) in this project basically involve lidar data submission to the NILU database and validation activities of ENVISAT data with these data. The satellite instruments involved are GOMOS, MIPAS and SCIAMACHY, and in particular we will be investigating their results regarding ozone and temperature profiles. This document describes the work performed for these two WPs and related activities in the indicated period (see cover page).

2 LIDAR Data

2.1 Overview of Data Submission - Figures

The statistics of the lidar data that have been measured, processed, converted (to HDF) and submitted to the NILU database are shown in **Figure 1** for the ozone profiles and in **Figure 2** 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 set concerns the temperature measurements. In each panel title we have indicated with an acronym the station location and the system name (see **Table 1**), which correspond 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 1. Overview of LIDAR systems: acronyms, locations and parameters

Groundstation	**Acro**	**Lat.**	**Long.**	**Parameter**	**System name**
Eureka	EUR	80.05	-86.42	Ozone, temperature	MSC003, 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	DIAL_CNRS.SA001, RMR_CNRS.SA001
Toronto	TOR	43.66	-79.40	Ozone	MSC001
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	-21.80	55.50	Ozone, temperature	LPA001, LPA002*
Lauder	LAU	-45.04	169.68	Ozone, (temperature)	RIVM002, RIVM003#

* NEW data set in the NILU database which has previously not been submitted.

Data of these systems are currently not available in the NILU database.

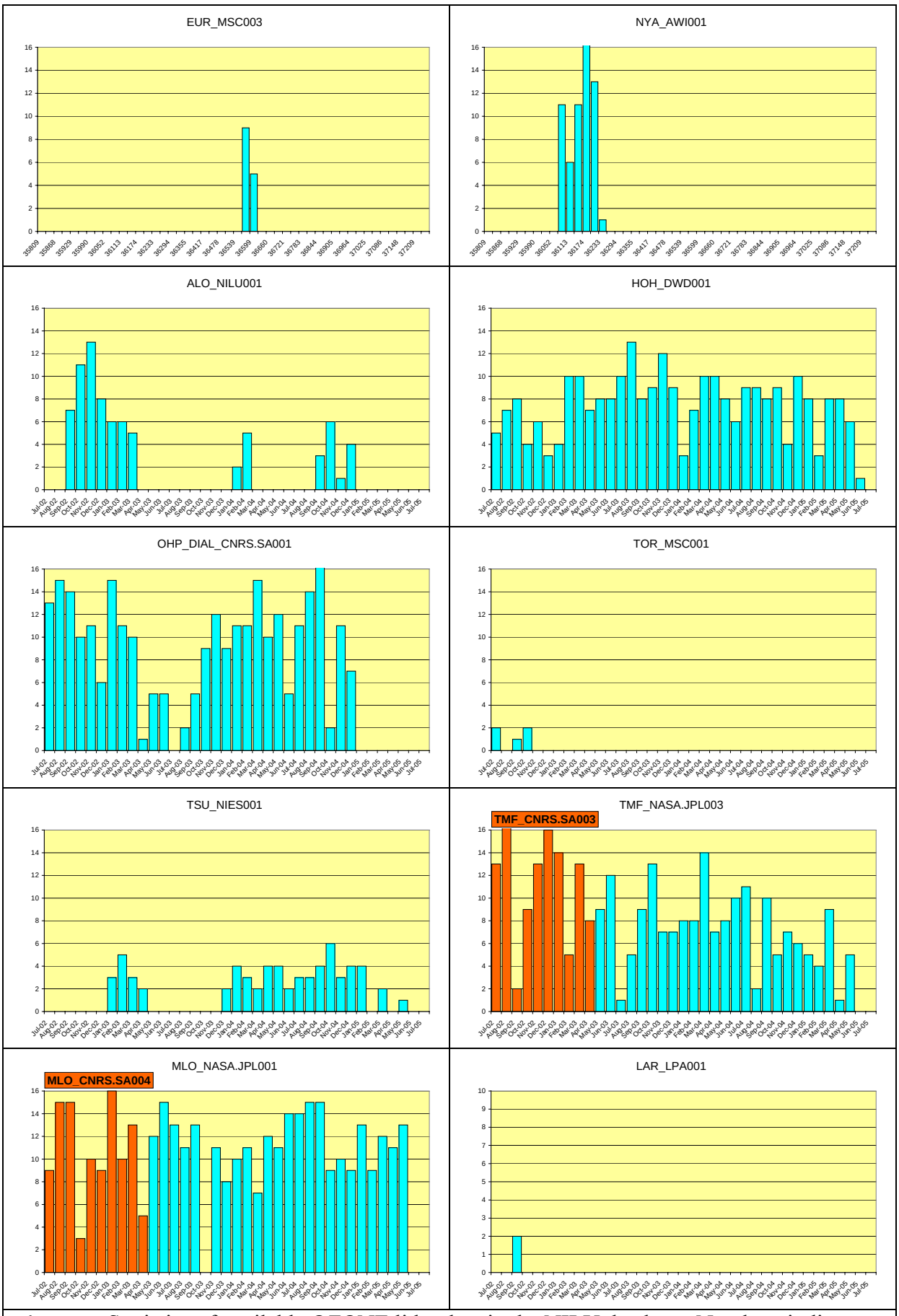

Figure 1. Statistics of available OZONE lidar data in the NILU database. Numbers indicate the number of days per month with lidar measurements.

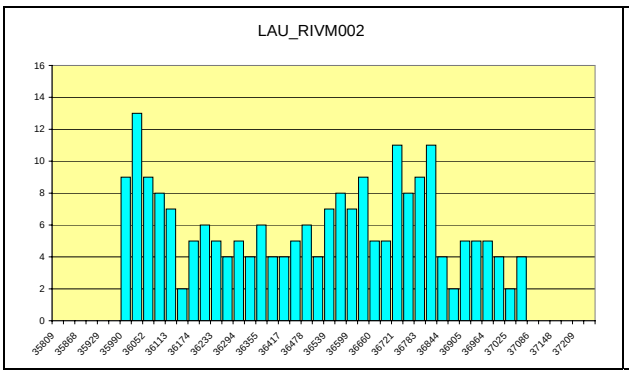

Figure 1. Cont.

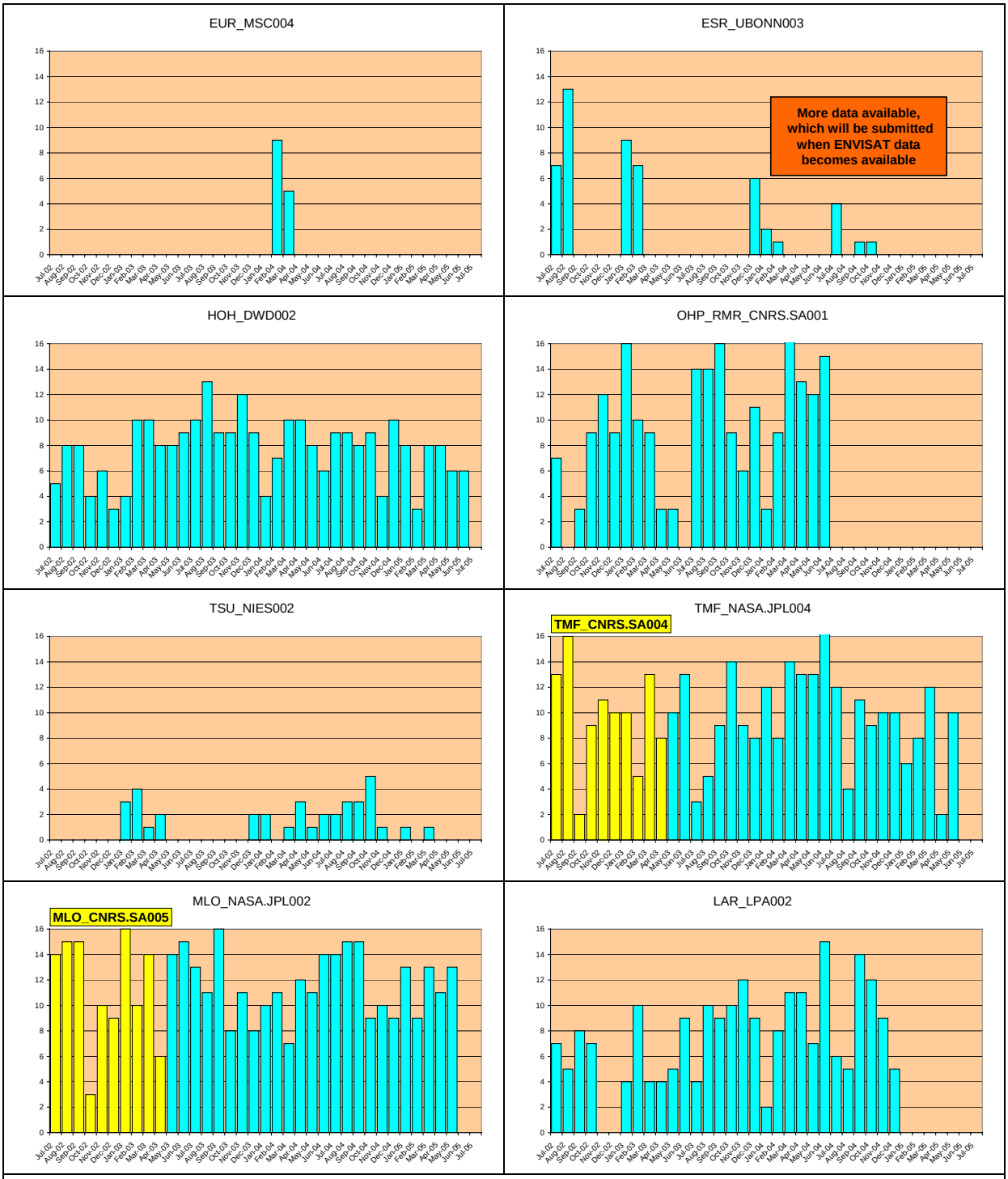

Figure 2. Statistics of available TEMPERATURE lidar data in the NILU database. Numbers indicate the number of days per month with lidar measurements.

2.2 Overview of Data Submission – Tables

In this section we give an overview of the lidar data submitted to NILU in Table form. In **Table 2** we present the number of days (**603**) with measurements during the Commissioning Phase of ENVISAT, and most of these data have been submitted prior to the EQUAL project. In **Table 3** 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 **1142** days with measurements. In **Table 4** we present the data measured in 2004, which now come to a total of **1200** days with measurements submitted to the NILU database. In **Table 5** we present the data measured in 2005, which now come to a total of **286** days with measurements submitted to the NILU database. The overall total of lidar data in the NILU database is **3231** days with measurements.

Table 2. Data submission statistics, Commissioning Phase (2002)
(in gray 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	0	0	0	0	0
ESR	UBONN003	7	13	0	0	0	0	20
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	9	13	9	8	7	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	11	6	11	28
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		104	124	94	90	105	86	603

Table 3. Data submission statistics, 2003 (in gray temperature lidar systems)														
Station	**System**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**	**Total**
ALO	NILU001	6	6	5	0	0	0	0	0	0	0	0	0	17
ALO	NILU002	0	0	0	0	0	0	0	0	0	0	0	0	0
ESR	UBONN003	9	7	0	0	0	0	0	0	0	0	0	6	22
HOH	DWD001	4	10	10	7	8	8	10	13	8	9	12	9	108
HOH	DWD002	4	10	10	8	8	9	10	13	9	9	12	9	111
LAR	LPA001	0	0	0	0	0	0	0	0	0	0	0	0	0
LAR	LPA002	4	10	4	4	5	9	4	10	9	10	12	9	90
LAU	RIVM002	5	6	5	4	5	4	6	4	4	5	6	4	58
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	21	13	1	0	0	0	0	0	0	0	0	0	35
NYA	AWI002	0	0	0	0	0	0	0	0	0	0	0	0	0
OHP	l_CNRS.SA001	15	11	10	1	5	5	0	2	5	9	12	9	84
OHP	r_CNRS.SA001	16	10	9	3	3	0	14	14	16	9	6	11	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		142	108	102	54	74	81	70	78	89	76	86	83	1142

Table 4. Data submission statistics, 2004 (in gray temperature lidar systems)														
Station	**System**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**	**Total**
ALO	NILU001	2	5	0	0	0	0	0	0	3	6	1	4	21
ALO	NILU002	0	0	0	0	0	0	0	0	0	0	0	0	0
ESR	UBONN003	2	1	0	0	0	0	4	0	1	1	0	0	9
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	0	0	0	0	0	0	0	0
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	4	2	86
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	0	0	0
NYA	AWI002	0	0	0	0	0	0	0	0	0	0	0	0	0
OHP	l_CNRS.SA001	11	11	15	10	12	5	11	14	18	2	11	7	127
OHP	r_CNRS.SA001	3	9	17	13	12	15	0	0	0	0	0	0	69
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		80	115	125	114	100	111	106	87	119	93	74	76	1200

Table 5. Data submission statistics, 2005 (in gray temperature lidar systems)														
Station	**System**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**	**Total**
ALO	NILU001	0	0	0	0	0	0							0
ALO	NILU002	0	0	0	0	0	0							0
DDU	x?x	0	0	0	0	0	0							0
ESR	UBONN003	0	0	0	0	0	0							0
EUR	MSC003	0	0	0	0	0	0							0
EUR	MSC004	0	0	0	0	0	0							0
HOH	DWD001	8	3	8	8	6	1							34
HOH	DWD002	8	3	8	8	6	6							39
LAR	LPA001	0	0	0	0	0	0							0
LAR	LPA002	0	0	0	0	0	0							0
LAU	RIVM002	5	5	5	4	2	4							25
LAU	RIVM003	0	0	0	0	0	0							0
MLO	NASA.JPL001	13	9	12	11	13	0							58
MLO	NASA.JPL002	13	9	13	11	13	0							59
NYA	AWI001	0	0	0	0	0	0							0
NYA	AWI002	0	0	0	0	0	0							0
OHP	l_CNRS.SA001	0	0	0	0	0	0							0
OHP	r_CNRS.SA001	0	0	0	0	0	0							0
TMF	NASA.JPL003	5	4	9	1	5	0							24
TMF	NASA.JPL004	6	8	12	2	10	0							38
TSU	NIES001	4	0	2	0	1	0							7
TSU	NIES002	1	0	1	0	0	0							2
TOTAL all systems		63	41	70	45	56	11	0	0	0	0	0	0	286

3 ENVISAT Data in HDF

In the EQUAL project RIVM generates a database of collocated ENVISAT and lidar measurements at the selected stations. An optional proposed item in the Technical Proposal for the EQUAL project was the generation of ENVISAT collocated data in HDF. This effort would significantly reduce the stored data volume, increase the portability and accessibility of these data, and in addition clarifies which data are collocated with certain locations.

The first step toward such a specific database has been made and at RIVM we have generated HDF files of SCIAMACHY ozone profiles collocated within 1000 km of 32 different ground-based measurement sites, which apart from lidar also includes sonde and microwave stations. Each SCIAMACHY HDF file contains one profile, and in addition all related information required for validation and traceability to the original data.

In the coming months the same effort will be undertaken for MIPAS and GOMOS profiles. The conversion of GOMOS profiles is not strictly necessary for data volume reduction, but it allows a better accessibility to these data for our EQUAL partners due to the format change.

4 Validation Activities

This section describes per instrument the validation activities performed during the reporting period using lidar data of one of the EQUAL partners. Apart from the instrument specific activities, which are described in the sub sections below, we have also presented a poster about the EQUAL project **[1]** at the EGU in Vienna, Austria (24-29 April 2005). This poster showed the project overview and most recent validation results of each satellite instrument (hard- and/or softcopies of the poster can be provided on request).

4.1 GOMOS Ozone and Temperature Profile Validation

In May and June we have significantly contributed to the final choices for the GOMOS processor upgrade. The version of this upgrade will also be used to perform the reprocessing of all GOMOS data by ACRI. In support of the evaluation of different processor settings, in total 15 test data sets have been generated by ACRI. The main differences incorporate a focus on the used aerosol model and the cross section database used for ozone and NO2 retrieval. The performed analysis by RIVM is exactly the same for all data sets and is analogue to the analysis published in JGR-D **[2]**. The overall recommendation for the retrieval was to use the current aerosol model ($1/\lambda$), not to fix air densities to ECMWF values, to use the new level-1 processing (60c), and to use the (new) Bremen ozone cross section database. An analysis report **[3]** has been generated which describes this work performed.

During a meeting at ACRI (France) on June 20, the GOMOS-qwg has performed its final verification of the recommended processor settings. The contribution of the analysis performed within the EQUAL project played a significant role in the final decision, especially in the choice to use a new ozone cross section database, which largely removes the remaining –2.5% bias compared to the correlative measurements.

In addition to the test data sets, there will be a new data set made available for pre-validation. Furthermore, the latest processor version generates HRTP (high-resolution temperature profiles) which will be subjected to comparison analyses with lidar (and possibly sonde) temperature profiles. After reprocessing, the EQUAL project will also get early access to these reprocessed GOMOS data generated by ACRI.

4.2 MIPAS Ozone and Temperature Profile Validation

At a splinter session during the EGU in Vienna, Austria the MIPAS-qwg organized a meeting for all involved scientists to concert a special journal issue which will incorporate the validation of all MIPAS products. The EQUAL project will contribute to both the ozone (lead author U. Cortesi) and the temperature (lead author M. Ridolfi) joint validation paper. Once it is clear which MIPAS data version will be used for the validation, the analysis of these data will take place with high priority and should lead to first results in early September.

4.3 SCIAMACHY Ozone and Temperature Profile Validation

In May and June we have been involved in the pre-validation of the new SCIAMACHY ozone profile data. In conjunction with IFE (Bremen), DLR is developing a new retrieval algorithm, and four schemes were considered for implementation. The early results of these data were compared with correlative lidar data. Unfortunately the data set was limited, and therefore there were only 32

collocated profiles with one of the EQUAL lidar measurements. Conclusions are that each of the four different algorithms give almost exactly the same comparison results, that the *a priori* profiles compare better than the retrieved profiles, and that there is still an altitude shift in the data. An attempt was made to correct for this altitude shift by using a shift estimated by applying the TRUE-algorithm of C. von Savigny (IFE, Bremen). Applying the TRUE-shift to the SCIAMACHY data indeed gives better comparison results but some problems remain and there is still a bias of –20 to 0% between 18- and 50-km altitude. The results were presented on 16 June 2005 during the Verification Meeting for SCIAMACHY L2 processor upgrade for limb products at IFE, Bremen (Germany).

5 References

[1] Envisat Quality Assessment with Lidar (EQUAL); a project to support the long-term validation of ozone and temperature profiles, Y.J. Meijer, and the EQUAL team, *Proceedings of EGU*, EGU05-A-08146, Vienna, Austria, 24-29 April 2005.

[3] Pole-to-pole validation of Envisat GOMOS ozone profiles using data from ground-based and balloon sonde measurements, Y.J. Meijer, et al., *J. Geophys. Res.*, *109*, D23305, doi:10.1029/2004JD004834 (http://www.agu.org/pubs/crossref/2004/2004JD004834.shtml), 2004.

[3] Overview of EQUAL Analysis Results (in support of ESL processor upgrade verification), Y.J. Meijer, D.E. Lolkema, D.P.J. Swart, *EQUAL Analysis Report*, RIVM, Bilthoven (NL), 14 June 2005.