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TASTE - TECHNICAL ASSISTANCE TO ENVISAT VALIDATION
BY SOUNDINGS, SPECTROMETERS AND RADIOMETERS

ANNUAL REPORT #2 - FEB 2005 – FEB 2006

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CONTENTS

A. INTRODUCTION

The TASTE project provides ESA with Technical ASsistance To Envisat atmospheric chemistry validation throughout the satellite lifetime. The project involves an international consortium gathering complementary expertise in remote sensing and satellite validation, namely, BIRA-IASB (Belgium), CNRS/SA (France), FMI-ARC (Finland), IFE/Bremen (Germany), IMK/FZK (Germany), INTA (Spain), KMI-IRM (Belgium), KNMI (Netherlands), NIWA (New Zealand), and SPbSU (Russia), and their collaborators. Main tasks relate to the coordination of the consortium (WP 1000), the collection and delivery of correlative data to the ENVISAT Cal/Val database operated at NILU on behalf of ESA (WP 2000/3000), geophysical validation studies based on comparisons between ENVISAT (GOMOS, MIPAS and SCIAMACHY) and ground-based data sets (WP 3000/4000), and the valorisation of the validation results (WP 6000) after concerted consolidation (WP 5000).

The present document reports on activities carried out in the second term of ESA TASTE project (Contract No. 3-10885/03/NL/MM), from February 2005 till the end of February 2006. Section B reviews the provision of correlative data records. Section C gives an overview of the validation work performed during the reporting period and to which members of the consortium have contributed. Section D reports on the valorisation of the correlative data and of the validation results. Sections E and F conclude with perspectives for next term and with a list of publications resulting from/associated with the project.

B. CORRELATIVE DATABASE

B.1. Data collection

The following correlative measurements have been collected for Envisat validation purposes:

- O_3 vertical column from Dobson and Brewer ultraviolet spectrophotometer and from M-124 ultraviolet filter radiometer;
- O_3 vertical distribution from balloon-borne electrochemical ozonesonde and from ground-based millimetre wave radiometer;
- O_3, NO_2 and BrO vertical column and OClO slant column from UV-visible Differential Optical Absorption spectrometer (UVVIS);
- O_3, NO_2, CO, CH_4, HNO_3, and N_2O data from (Fourier Transform) infrared (FT)IR spectrometer.

Correlative measurements have been collected at the geographical locations identified in Figure 1. They cover a variety of major geophysical features in the polar and middle latitudes of both hemispheres and in the tropics. In general, there is at least one representative of every instrument technique by latitude region. The list includes the five primary stations (Arctic, Alpine, Hawaii, New Zealand and Antarctic) of the WMO/GAW Network for the Detection of Atmospheric Composition Change (NDACC, formerly the NDSC) plus a list of complementary stations. The Russian/NIS ozone-monitoring network enhances considerably the geographical sampling over Eurasia.

Collected data sets have been converted into the agreed HDF 4.1.3 format and uploaded to the Envisat Cal/Val database. Upload Status Tables presented in Subsections B.3 to B.6 display, month by month, an estimate of the number of measurement days uploaded to Cal/Val. The upload of 2005 data is progressing. Nearly all instruments have worked nominally and for a majority of them correlative data acquired directly by members of the consortium have been uploaded within a few months after data acquisition. The larger delay or some minor data gaps experienced at some stations or with some instruments can be justified in most cases by field realities. Uploads of data acquired partly by third parties, sometimes on a best effort basis (e.g. ozone columns measured at a few stations of the M-124 network and the SAOZ network), are sometimes experiencing larger delays, but it must be pointed out that most of those delayed data sets have still already been available to Envisat validation through other means. In any cases uploads of delayed data sets are progressing. Data have also been uploaded from optional stations.

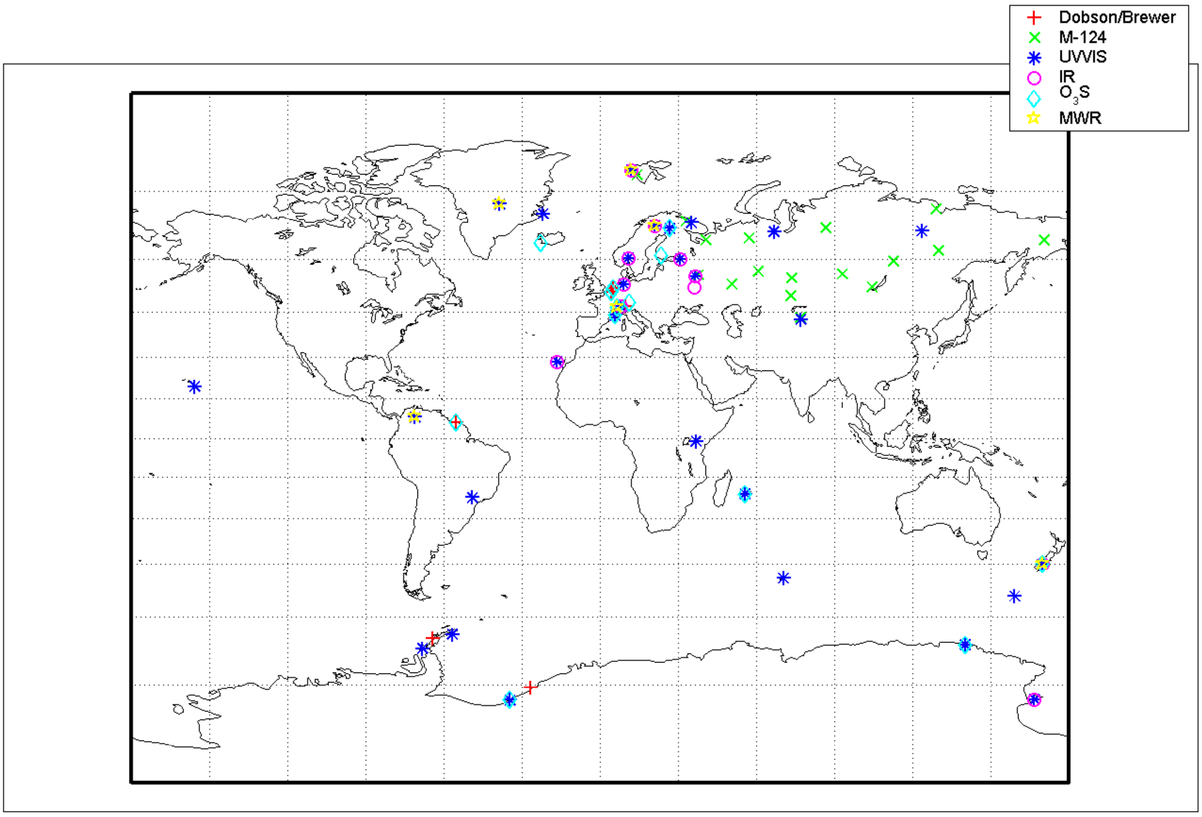

Figure 1. *Geographical distribution of the ground-based sensors contributing to TASTE: Dobson and Brewer UV spectrophotometers, M-124 UV filter radiometers, UV-visible DOAS spectrometers (UVVIS), IR and FTIR spectrometers (IR), balloon-borne ozonesondes (O_3S), and millimetre wave radiometers (MWR).*

Finally, although the TASTE project requires formally only data from January 2004 onwards, the consortium has contributed data of 2002 and 2003 as well to bridge the gap between the preliminary Commissioning Phase validation and the "routine" validation phase addressed by the project. Upload Status Tables presented in Subsections B.3/B.4 show that uploads of "historical" data sets acquired in 2002 and 2003 are complete for nearly all instruments.

To get a consistent overview despite the wide variety of ground-based techniques, numbers reported in the Upload Status Tables of Subsections B.3 to B.6 represent the amount of days for which there is at least one measurement suitable for Envisat validation. It should be noted that the actual amount of individual measurements acquired by an instrument and stored on Cal/Val vary with:

- The type of instrument: e.g. direct sun observations (Brewer, Dobson, FTIR and M-124) depend on weather conditions while scattered-light UVVIS observations are feasible virtually in all weather;
- The latitude: e.g., most of standard techniques do not provide measurements during polar night;
- The data type and file format adopted by the Data Submitter: some stations store data in monthly files, others in daily files, and others by individual measurement; some Brewer or microwave data files report one measurement every 30 min (reaching sometimes several thousands a month) while others provide only daily averages (thus a maximum of 31 values a month);
- The type of data processing: SAOZ/UVVIS data at remote stations processed in real-time by the built-in software and transmitted to CNRS via the ARGOS satellite system, include only one average value for each twilight, while reprocessing at the central laboratory of all the recorded spectra yields one value for every individual measurement.

It should also be noted that current Upload Status Tables report only part of the data actually available on Cal/Val. Tables are generated automatically using FTP-based tools developed at BIRA-IASB in the first year of the project. Due to changes in FTP transfer and databases permissions, which occurred at NILU in 2005, a few data directories are currently not accessible by those database monitoring tools. Data stored in these directories are not visible in the current Upload Tables, but they can be downloaded from the Cal/Val database and be used by the Envisat validation community. Permission problems are currently being solved.

B.2. Climatological verification

A large part of the contributing instruments are part of the NDSC. The NDSC Data Protocol is structured to ensure excellent data quality while providing ready data access. It recognises that, in order to produce a verifiable data product, sufficient time is needed to collect, reduce, calibrate, test, analyse, and inter-compare the streams of preliminary analyses at every NDSC site. Among others, seasonal analyses may be required for observations from both individual and multiple sites and it is expected that such a procedure shall yield the verifiable product referred to as "NDSC data" within a two-year period after acquisition. The faster data availability aimed at by the project implies that limited time only is available to recalibration, state-of-the-art processing or simply quality verification. Therefore we have developed and implemented verification procedures to check first-order quality/consistency of the fresh near-real-time (NRT) data collected in the frame of the project.

The quite large number of contributing instruments and stations implies the use of automated routines flagging non-standard events, which can be looked at more carefully once detected. At ground stations where long enough time-series are available in the NDSC and WOUDC databases, the verification procedure consists in comparing fresh data to climatological means and standard deviations that we calculate on low-pass filtered time-series acquired, if possible, since 1995. A log file is created, which identifies in a first time aberrant data, e.g. impossible Dobson data during polar night or sunrise NO_2 columns exceeding systematically sunset NO_2 columns. Then, column values deviating from the climatological mean by more than 2σ and 3σ are pointed out. Trains of consecutive values falling out of the $\pm 3\sigma$ interval are looked at carefully to determine whether such persistent deviations may be due to data quality issues, to natural atmospheric variability, or to unexpected atmospheric features like the 2002 Antarctic vortex split. Single values falling out of the $\pm 3\sigma$ interval without belonging to a justifiable 2σ train are flagged accordingly but not rejected systematically since they could be associated e.g. to real events of extreme variability or to tropospheric pollution episodes enhanced by multiple scattering within clouds. For newer stations with shorter time-series, consistency checks are based on data already stored at NILU Cal/Val, acquired by other instruments at nearly collocated stations, or even by the same instrument. The climatological verification method was illustrated in the *TASTE Progress Report January-October 2004* issued in November 2004.

B.3. Monthly Data Distribution for 2002

Brewer	Lat.	J	F	M	A	M	J	J	A	S	O	N	D	#
Sodankylä	67°N		0	0	0	1	0	0	24	30	24	3		82
Jokioinen	61°N	0	0	0	0	0	0	0	18	28	29	15	1	91
De Bilt	52°N	0	0	0	0	1	30	31	31	30	31	30	31	215
Uccle	51°N	0	0	0	0	0	1	29	31	27	31	28	31	178
Arosa	46°N	27	24	24	26	25	27	24	25	22	25	18	20	287
Paramaribo	6°N	2	2	0	0	0	28	31	31	30	22	25	31	202

Dobson	Lat.	J	F	M	A	M	J	J	A	S	O	N	D	#
Uccle	51°N	19	18	17	9	0	0	0	0	0	0	0	0	63
Arosa	46°N	29	21	26	23	22	26	27	26	19	28	14	21	282
Lauder	45°S	21	18	19	15	20	15	18	19	19	27	20	15	226
Vernadsky	65°S	31	28	31	30	*Polar night*			31	30	31	30	31	273
Halley	76°S	31	28	31	15				6	30	31	30	31	233

UV-Vis	Lat.	J	F	M	A	M	J	J	A	S	O	N	D	#
Ny-Ålesund	79°N	*Polar night*		0	0	0	0	30	31	29	24	*Polar night*		114
Scoresbysund	70°N	14	24	27	22	26	26	18	24	30	29	4		244
Kiruna	68°N	23	28	31	30	31	1	21	31	24	21	28	2	271
Sodankylä	67°N	30	28	30	30	31	30	31	31	30	31	30	31	363
Zhigansk	67°N	30	28	31	30	31	30	31	31	30	31	29	26	358
Harestua	60°N	0	0	0	0	0	26	22	23	30	25	29	29	184
St Petersburg	60°N	0	0	0	0	0	0	30	30	25	28	0	0	113
Zvenigorod (optional)	*55°N*	0	0	0	0	0	0	20	31	30	0	0	0	81
Bremen	53°N	0	0	0	0	0	0	28	31	30	31	30	0	150
Jungfraujoch	47°N	0	0	0	0	31	30	31	31	30	31	30	31	245
O.H.P.	44°N	31	24	29	30	31	30	31	31	21	23	28	31	340
Issyk-Kul (optional)	*43°N*	0	0	0	0	0	0	31	29	22	31	30	29	172
Izaña	28°N	0	0	0	0	0	0	31	28	28	31	20	12	150
Mauna Loa	19°N	31	28	30	30	31	30	31	23	30	31	30	31	356
Nairobi	1°S	0	0	0	0	0	0	0	0	30	31	30	31	122
Saint Denis	21°S	25	21	28	20	0	0	0	0	0	0	13	31	138
Bauru	22°S	29	21	27	27	31	30	22	26	27	31	24	31	326
Lauder	45°S	31	28	31	30	31	30	31	28	29	31	29	31	360
Kerguelen	49°S	20	28	31	30	31	30	31	31	30	31	29	31	353
Macquarie	55°S	31	28	31	30	1	30	31	31	29	31	30	31	334
Marambio	64°S	29	28	31	28	18	0	8	30	30	28	27	31	288
Dumont d'Urville	67°S	31	28	31	30	31	30	31	31	30	31	30	31	365
Rothera	68°S	29	26	29	27	27	20	29	28	29	28	29	29	330
Belgrano	78°S		9	23	19	*Polar night*			11	28	29	*Polar day*		119
Arrival Heights	78°S		12	31	22				11	30	25			131

(FT)IR	Lat.	J	F	M	A	M	J	J	A	S	O	N	D	#
Ny-Ålesund	79°N			0	5	7	10	5	6	8	0			41
Kiruna	68°N		0	0	0	0	0	15	13	4	9	5		46
St Petersburg	60°N	0	0	0	0	0	0	7	13	11	0	0	0	31
Obninsk (optional)	*55°N*	0	0	0	0	0	0	6	14	6	2	3	3	34
Zvenigorod (optional)	*55°N*	0	0	0	0	0	0	8	6	9	2	0	6	31
Bremen	53°N	0	0	0	0	0	0	0	1	8	2	3	4	18
Izaña	28°N	0	0	0	0	0	0	8	15	13	9	8	4	57
Lauder	45°S	13	17	21	12	13	11	16	10	15	12	13	11	164
Arrival Heights	78°S	8	5	3	0	*Polar night*				9	10	6	8	49

M124	Lat.	J	F	M	A	M	J	J	A	S	O	N	D	#
Barentsburg	78°N			0	0	0	0	30	0	0	0			30
Tiksi	72°N			0	0	0	0	30	0	0	0			30
Murmansk	69°N		0	0	0	0	0	29	29	0	0	0		58
Igarka	67°N		0	0	0	0	0	0	21	0	0	0		21
Markovo	65°N	0	0	0	0	0	0	31	27	29	15	0	0	102
Petchora	65°N	0	0	0	0	0	0	31	30	30	25	0	0	116
Arhangelsk	65°N	0	0	0	0	0	0	29	25	23	21	0	0	98
Yakutsk	62°N	0	0	0	0	0	0	30	17	30	14	0	0	91
St Petersburg	60°N	0	0	0	0	0	0	30	30	25	28	0	0	113
Vitim	59°N	0	0	0	0	0	0	30	30	26	17	0	0	103
Krasnoyarsk	56°N	0	0	0	0	0	0	29	29	28	23	0	0	109
Moscow	56°N	0	0	0	0	0	0	31	31	26	0	0	0	88
Omsk	55°N	0	0	0	0	0	0	31	31	29	29	0	0	120
Samara	53°N	0	0	0	0	0	0	31	30	29	26	0	0	116
Irkutsk	52°N	0	0	0	0	0	0	30	31	28	26	0	0	115
Karaganda	50°N	0	0	0	0	0	0	30	31	30	21	0	0	112

Ozonesonde	Lat.	J	F	M	A	M	J	J	A	S	O	N	D	#
Sodankylä	67°N	0	0	1	1	1	0	0	6	5	5	10	13	42
Keflavik	64°N	0	0	0	0	0	0	0	0	0	0	0	8	8
Jokioinen	61°N	0	0	0	0	0	0	0	0	3	5	0	3	11
De Bilt	52°N	0	0	0	0	3	4	4	6	7	6	4	3	37
Uccle	51°N	0	1	0	0	0	0	9	9	13	15	11	11	69
Hohenpeißenberg	48°N	13	11	13	11	9	8	10	8	8	8	12	11	122
Payerne	46°N	0	0	0	0	0	0	14	14	11	13	11	10	73
Paramaribo	6°N	0	0	0	0	0	4	5	4	4	5	3	3	28
Lauder	45°S	0	0	0	0	3	4	5	4	4	10	11	5	46
Marambio	64°S	0	0	0	0	0	0	1	6	6	8	8	7	36
Dumont d'Urville	67°S	0	0	0	0	0	0	4	4	6	6	3	2	25
Belgrano	78°S	0	0	1	1	1	3	3	3	4	5	2	2	25

MicroWave	Lat.	J	F	M	A	M	J	J	A	S	O	N	D	#
Ny-Ålesund	79°N	0	0	0	0	0	0	0	0	0	0	0	0	0
Kiruna	68°N	-	-	-	-	-	-	-	-	-	-	3	30	33
Payerne	46°N	0	0	0	0	0	0	26	27	29	30	23	30	165
Lauder	45°S	0	0	0	0	0	0	31	27	22	16	21	24	141

B.4. Monthly Data Distribution for 2003

Brewer	**Lat.**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**#**
Sodankylä	67°N		17	31	30	31	30	28	31	29	25	5		257
Jokioinen	61°N	6	25	28	29	29	25	31	28	30	30	16	3	280
De Bilt	52°N	31	28	31	30	31	30	31	31	30	31	29	31	364
Uccle	51°N	12	28	30	7	31	30	30	31	30	30	30	30	319
Arosa	46°N	21	23	27	25	28	28	27	28	27	22	24	23	303
Paramaribo	6°N	31	28	29	28	31	30	31	31	28	31	30	31	359

Dobson	**Lat.**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**#**
Arosa	46°N	22	22	28	26	31	30	27	29	23	22	21	22	303
Lauder	45°S	12	12	19	13	16	18	21	16	18	15	17	16	193
Vernadsky	65°S	31	28	31	30	*Polar night*			31	30	31	30	31	273
Halley	76°S	31	27	31	16				7	30	31	30	31	234

UV-Vis	**Lat.**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**#**
Ny-Ålesund	79°N	*Polar night*		0	27	31	29	31	30	30	23			201
Summit	72°N			0	0	0	0	0	31	22	31			84
Scoresbysund	70°N	8	26	29	27	27	27	30	27	30	31	21		283
Kiruna	68°N	23	28	31	30	31	1	21	31	30	31	30	3	290
Sodankylä	67°N	31	21	31	30	31	30	31	31	30	31	30	31	358
Zhigansk	67°N	11	25	30	30	31	30	29	30	30	7	26	-	279
Salekhard	67°N	0	0	0	0	0	0	0	0	0	31	30	31	92
Harestua	60°N	31	28	27	27	31	26	31	31	30	31	30	30	353
St Petersburg	60°N	0	0	0	0	0	0	0	0	0	0	0	0	0
Zvenigorod (optional)	*55°N*	0	0	0	19	23	21	27	30	29	30	20	15	214
Bremen	53°N	0	0	0	0	0	0	0	0	0	0	0	0	0
Jungfraujoch	47°N	18	24	31	30	31	28	30	31	30	31	30	31	345
O.H.P.	44°N	31	28	31	30	31	30	31	31	30	24	30	25	352
Izaña	28°N	28	24	7	24	25	14	31	30	21	17	28	17	266
Mauna Loa	19°N	31	24	26	0	0	30	30	31	30	31	30	28	291
Nairobi	1°S	31	28	31	30	31	30	31	31	30	31	30	31	365
Saint Denis	21°S	31	28	31	30	31	30	30	31	27	20	30	31	350
Bauru	22°S	30	23	30	29	31	30	29	28	30	30	26	25	341
Lauder	45°S	29	24	31	30	30	30	31	29	30	31	30	31	356
Kerguelen	49°S	31	28	31	30	31	30	31	31	30	31	30	31	365
Macquarie	55°S	31	27	31	30	31	30	31	31	30	24	28	31	355
Marambio	64°S	31	28	31	24	31	20	24	28	29	31	30	31	338
Dumont d'Urville	67°S	31	28	31	30	31	30	31	30	30	31	30	31	364
Rothera	68°S	30	24	29	27	30	28	29	28	29	30	29	29	342
Belgrano	78°S		16	29	10	*Polar night*			9	28	28	*Polar day*		120
Arrival Heights	78°S		12	31	22				10	30	25			130

(FT)IR	Lat.	J	F	M	A	M	J	J	A	S	O	N	D	#
Ny-Ålesund	79°N			3	6	1	1	1	3	0	0			15
Kiruna	68°N	5	9	18	9	2	5	14	8	13	8	0		91
St Petersburg	60°N	0	0	0	0	0	0	0	0	0	0	0	0	0
Bremen	53°N	1	9	5	3	1	2	2	2	4	2	1	1	33
Izaña	28°N	8	4	9	13	15	12	4	0	0	0	0	0	65
Lauder	45°S	15	18	19	17	13	11	14	14	14	15	16	16	182
Arrival Heights	78°S	10	6	8	2	*Polar night*				6	10	14	10	66

M124	Lat.	J	F	M	A	M	J	J	A	S	O	N	D	#
Barentsburg	78°N			0	0	0	0	0	0	0	0			0
Tiksi	72°N			0	0	0	0	0	0	0	0			0
Murmansk	69°N		0	0	0	0	0	0	0	0	0	0		0
Igarka	67°N		0	0	0	0	0	0	0	0	0	0		0
Markovo	65°N	0	0	0	0	0	0	0	0	0	0	0	0	0
Petchora	65°N	0	0	0	0	0	0	0	0	0	0	0	0	0
Arhangelsk	65°N	0	0	0	0	0	0	0	0	0	0	0	0	0
Yakutsk	62°N	0	0	0	0	0	0	0	0	0	0	0	0	0
St Petersburg	60°N	0	0	0	0	0	0	0	0	0	0	0	0	0
Vitim	59°N	0	0	0	0	0	0	0	0	0	0	0	0	0
Ekaterinburg	57°N	0	0	0	0	0	0	0	0	0	0	0	0	0
Krasnoyarsk	56°N	0	0	0	0	0	0	0	0	0	0	0	0	0
Moscow	56°N	0	0	0	0	0	0	0	0	0	0	0	0	0
Omsk	55°N	0	0	0	0	0	0	0	0	0	0	0	0	0
Samara	53°N	0	0	0	0	0	0	0	0	0	0	0	0	0
Irkutsk	52°N	0	0	0	0	0	0	0	0	0	0	0	0	0
Karaganda	50°N	0	0	0	0	0	0	0	0	0	0	0	0	0

Ozonesonde	Lat.	J	F	M	A	M	J	J	A	S	O	N	D	#
Sodankylä	67°N	17	6	12	5	4	4	6	4	2	5	4	4	73
Keflavik	64°N	6	6	5	0	0	0	0	0	0	0	0	1	18
Jokioinen	61°N	6	3	7	0	0	0	0	0	0	0	0	0	16
De Bilt	52°N	5	4	4	6	2	4	5	4	4	4	4	5	51
Uccle	51°N	13	14	13	12	11	12	4	11	13	14	10	11	138
Hohenpeißenberg	48°N	11	10	12	11	8	5	9	8	9	9	11	13	116
Payerne	46°N	14	8	12	10	12	12	12	12	12	11	13	13	141
Paramaribo	6°N	6	3	5	4	5	4	5	5	4	4	3	2	50
Lauder	45°S	4	3	9	5	4	4	5	4	4	6	10	6	64
Marambio	64°S	2	2	2	1	2	9	13	13	10	9	7	6	76
Dumont d'Urville	67°S	2	1	1	2	4	8	8	5	0	0	0	0	31
Belgrano	78°S	1	1	3	2	2	4	11	12	9	8	4	1	58

MicroWave	Lat.	J	F	M	A	M	J	J	A	S	O	N	D	#
Ny-Ålesund	79°N	0	9	31	29	0	0	30	20	23	31	30	30	233
Kiruna	68°N	22	25	23	28	24	21	19	21	25	26	27	28	289
Zugspitze	47°N	-	11	25	13	20	20	16	-	-	-	-	-	105
Payerne	46°N	29	28	27	30	30	30	31	21	27	28	27	31	339
Lauder	45°S	22	24	27	0	0	0	0	0	0	0	0	0	73

B.5. Monthly Data Distribution for 2004

Brewer	**Lat.**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**#**
Sodankylä	67°N		18	30	30	31	23	31	31	29	23	2		248
Jokioinen	61°N	3	26	30	30	30	27	30	29	29	31	16	0	281
De Bilt	52°N	30	29	31	30	31	30	31	30	30	31	30	30	363
Uccle	51°N	0	0	16	30	31	30	31	30	30	30	30	26	284
Arosa	46°N	22	26	26	23	26	24	26	25	23	28	23	24	296
Paramaribo	6°N	31	29	24	29	31	30	27	30	30	28	24	27	340

Dobson	**Lat.**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**#**
Arosa	46°N	21	24	20	25	24	22	28	25	24	29	22	23	287
Lauder	45°S	17	17	17	18	16	17	19	19	16	17	20	19	212
Vernadsky	65°S	31	29	31	30				31	30	31	30	31	274
Halley	76°S	31	26	29	15	*Polar night*			4	30	31	30	31	227
Arrival Heights	78°S	-	-	0	0				0	0	0	0	0	0

UV-Vis	**Lat.**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**#**
Ny-Ålesund	79°N			31	29	31	30	31	31	30	25			238
Summit	72°N			27	29	15	0	0	8	30	31			140
Scoresbysund	70°N		0	16	30	31	30	25	28	30	27	18		235
Kiruna	68°N	23	16	31	27	31	0	0	23	30	31	30	2	244
Sodankylä	67°N	22	29	25	30	31	29	31	31	30	31	30	30	349
Zhigansk	67°N	3	17	3	-	-	-	-	-	-	-	-	-	23
Salekhard	67°N	29	27	29	30	31	30	30	31	28	30	30	30	355
Harestua	60°N	29	29	31	28	31	30	27	28	30	29	29	29	350
St Petersburg	60°N	27	23	29	29	31	30	29	28	29	30	26	26	337
Zvenigorod (optional)	*55°N*	13	25	15	0	0	0	15	30	30	26	25	22	201
Bremen	53°N	0	0	0	0	0	0	0	0	0	0	0	0	0
Jungfraujoch	47°N	17	29	31	25	27	25	12	10	25	31	22	29	283
O.H.P.	44°N	20	29	31	30	31	28	30	31	30	31	17	0	308
Issyk-Kul (optional)	*43°N*	31	28	30	27	31	30	30	31	26	30	30	13	337
Izaña	28°N	6	27	30	26	31	27	30	28	30	30	29	29	323
Mauna Loa	19°N	30	27	31	30	0	0	0	0	0	0	0	0	118
Mérida	8°N	-	-	-	-	15	28	-	-	-	6	24	4	77
Nairobi	1°S	29	28	30	30	30	28	26	30	21	23	27	31	333
Saint Denis	21°S	22	18	24	26	31	30	30	19	30	10	22	21	283
Bauru	22°S	14	27	28	27	29	27	31	31	28	28	12	26	308
Lauder	45°S	30	29	31	28	29	30	31	31	30	28	30	30	357
Kerguelen	49°S	15	28	31	30	31	30	30	30	30	31	30	29	345
Macquarie	55°S	24	29	30	30	31	30	31	31	30	19	30	31	346
Marambio	64°S	28	28	27	29	31	26	31	30	30	30	29	30	349
Dumont d'Urville	67°S	18	29	31	30	31	30	31	31	30	31	30	30	352
Rothera	68°S	29	28	28	28	29	27	31	31	30	30	30	30	351
Belgrano	78°S		15	30	23	*Polar night*			12	30	30	*Polar day*		140
Arrival Heights	78°S		0	0	0				0	0	0			0

(FT)IR	Lat.	J	F	M	A	M	J	J	A	S	O	N	D	#
Ny-Ålesund	79°N			0	0	4	3	4	2	2	0			15
Kiruna	68°N	2	10	8	10	14	3	0	0	0	0	0		47
St Petersburg	60°N	2	2	10	24	9	12	5	11	4	6	2	1	88
Zvenigorod (optional)	*55°N*	1	6	11	12	10	8	4	15	4	4	5	0	80
Bremen	53°N	0	2	4	2	0	0	0	0	0	0	0	0	8
Izaña	28°N	0	0	0	0	0	0	0	0	0	0	0	0	0
Lauder	45°S	15	15	8	19	6	10	9	12	9	6	8	9	126
Arrival Heights	78°S	5	3	8	1	*Polar night*				7	14	12	10	60

M124	Lat.	J	F	M	A	M	J	J	A	S	O	N	D	#
Murmansk	69°N		19	26	21	0	27	29	30	26	0	4		182
Markovo	65°N	9	20	0	0	0	0	0	0	0	0	0	0	29
Petchora	65°N	7	17	25	28	29	29	31	28	29	0	0	0	223
Arhangelsk	65°N	6	16	25	27	27	29	31	30	27	0	0	0	218
Yakutsk	62°N	0	0	21	30	29	30	24	30	26	0	13	7	210
St Petersburg	60°N	27	23	29	29	31	30	29	28	29	30	26	26	337
Magadan	60°N	27	0	20	25	24	20	23	25	21	23	24	23	255
Vitim	59°N	0	0	21	26	29	12	30	30	26	0	22	14	210
Krasnoyarsk	56°N	22	19	22	25	28	29	31	30	27	25	21	16	295
Nikolaevsk	53°N	0	0	20	20	25	24	27	23	26	19	24	22	230
Petropavlovsk	53°N	0	0	0	0	0	26	22	26	26	0	26	29	155
Samara	53°N	16	20	24	24	30	28	30	31	29	23	19	8	282
Irkutsk	52°N	0	0	0	0	0	15	30	28	30	30	30	24	187
Karaganda	50°N	26	21	0	0	0	0	0	0	0	0	0	0	47
Voronezh	50°N	0	0	29	20	30	30	30	31	30	27	28	21	276
Yuzhno-Sahalinsk	47°N	0	0	26	27	28	0	30	30	30	30	26	19	246
Omsk	55°N	0	0	0	0	0	0	0	0	0	0	0	0	0
Samara	53°N	16	20	24	24	30	28	30	31	29	23	19	8	282
Irkutsk	52°N	0	0	0	0	0	15	30	28	30	30	30	24	187
Karaganda	50°N	26	21	0	0	0	0	0	0	0	0	0	0	47

Ozonesonde	Lat.	J	F	M	A	M	J	J	A	S	O	N	D	#
Sodankylä	67°N	3	2	5	4	4	5	3	4	5	4	4	6	49
Keflavik	64°N	1	3	3	0	0	0	0	0	0	0	0	1	8
Jokioinen	61°N	0	0	0	0	0	0	0	0	0	0	0	1	1
De Bilt	52°N	4	4	2	4	4	4	5	5	4	4	4	5	49
Uccle	51°N	11	12	14	12	11	12	11	10	13	12	10	11	139
Hohenpeißenberg	48°N	10	12	13	10	8	7	7	9	11	9	11	12	119
Payerne	46°N	13	9	13	13	13	13	12	13	13	11	13	11	147
Paramaribo	6°N	4	4	3	4	4	3	5	3	5	5	4	4	48
Lauder	45°S	4	5	5	4	4	5	3	3	4	3	1	2	43
Marambio	64°S	2	2	2	2	1	2	6	4	4	6	8	6	45
Dumont d'Urville	67°S	0	0	0	0	0	0	0	0	0	0	0	0	0
Belgrano	78°S	2	3	2	2	3	3	3	3	6	4	3	2	36

MicroWave	Lat.	J	F	M	A	M	J	J	A	S	O	N	D	#
Ny-Ålesund	79°N	0	0	0	0	0	0	0	0	0	0	0	0	0
Summit	72°N	0	0	0	0	0	0	0	0	0	0	0	0	0
Kiruna	68°N	0	0	0	0	10	27	23	24	23	27	27	13	174
Bremen	53°N	25	28	23	0	10	0	0	0	0	0	0	0	86
Payerne	46°N	27	24	30	30	30	27	27	29	30	23	24	28	329
Mérida	8°N	-	-	-	-	4	18	14	29	30	27	28	24	174
Lauder	45°S	0	0	0	0	0	0	0	0	0	0	0	0	0

B.6. Monthly Data Distribution for 2005

Brewer	**Lat.**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**#**
Sodankylä	67°N		19	30	30	31	30	31	29	26	25	1		252
Jokioinen	61°N	5	23	30	28	31	30	28	30	4	31	19	0	259
De Bilt	52°N	31	28	31	30	27	5	0	0	0	0	0	0	152
Uccle	51°N	29	27	0	0	0	2	0	0	30	31	26	31	176
Arosa	46°N	22	19	26	26	26	27	26	22	26	26	23	20	289
Paramaribo	6°N	29	25	31	27	31	30	3	0	0	0	0	0	176

Dobson	**Lat.**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**#**
Arosa	46°N	22	18	22	22	26	26	28	22	24	28	23	20	281
Lauder	45°S	18	0	0	0	0	0	0	0	0	0	0	0	18
Vernadsky	65°S	31	28	31	30				31	29	0	0	0	180
Halley	76°S	31	28	30	12		*Polar night*		4	30	6	0	0	141
Arrival Heights	78°S	0	0	0	0				0	0	0	0	0	0

UV-Vis	**Lat.**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**#**
Ny-Ålesund	79°N	*Polar night*		0	0	0	0	0	0	0	0	*Polar night*		0
Summit	72°N			0	0	0	0	0	0	0	0			0
Scoresbysund	70°N	13	27	30	0	28	30	31	31	27	2	21		240
Kiruna	68°N	23	28	31	30	31	0	22	31	0	0	0	0	196
Sodankylä	67°N	31	28	31	30	31	30	31	31	30	4	30	0	307
Zhigansk	67°N	-	-	-	-	-	-	-	-	-	-	0	0	0
Salekhard	67°N	31	28	30	30	31	30	31	31	30	5	28	28	333
Harestua	60°N	26	28	30	28	31	30	27	28	27	31	30	4	320
St Petersburg	60°N	29	27	31	27	29	29	31	31	30	30	26	27	347
Zvenigorod (optional)	*55°N*	2	7	31	28	31	20	0	0	0	0	0	0	119
Bremen	53°N	0	0	0	0	0	0	0	0	0	0	0	0	0
Jungfraujoch	47°N	31	28	31	26	12	16	24	12	20	31	26	25	282
O.H.P.	44°N	31	28	31	30	27	30	31	31	30	3	30	30	332
Issyk-Kul (optional)	*43°N*	26	28	30	29	30	30	31	31	29	30	30	29	353
Izaña	28°N	31	16	27	30	30	28	31	29	29	30	30	12	323
Mauna Loa	19°N	0	0	0	0	0	0	0	0	0	0	0	0	0
Mérida	8°N	24	28	31	21	23	19	20	0	0	0	0	0	166
Nairobi	1°S	31	28	29	30	31	30	30	31	28	30	0	0	298
Saint Denis	21°S	22	28	31	30	27	30	28	28	30	2	22	11	289
Bauru	22°S	25	28	30	30	28	30	31	26	29	4	30	22	313
Lauder	45°S	30	18	31	30	31	30	31	31	0	0	0	0	232
Kerguelen	49°S	30	26	31	30	30	23	31	30	29	4	29	27	320
Macquarie	55°S	31	28	31	16	31	28	31	31	0	0	0	0	227
Marambio	64°S	27	28	29	25	30	27	31	31	29	30	30	0	317
Dumont d'Urville	67°S	31	28	31	30	31	30	31	31	30	4	30	30	337
Rothera	68°S	28	28	31	30	31	26	25	26	30	5	0	0	260
Belgrano	78°S		16	28	17	*Polar night*			0	0	0	*Polar day*		61
Arrival Heights	78°S		0	0	0				0	0	0			0

(FT)IR	Lat.	J	F	M	A	M	J	J	A	S	O	N	D	#
Ny-Ålesund	79°N	*Polar night*		0	0	0	0	0	0	0	0	*Polar night*		0
Kiruna	68°N	0	0	0	0	0	0	0	0	0	0	0		0
St Petersburg	60°N	1	5	15	12	8	10	12	10	7	10	0	0	90
Zvenigorod (optional)	*55°N*	3	8	8	8	9	9	11	17	6	0	1	1	81
Bremen	53°N	0	0	0	0	0	0	0	0	0	0	0	0	0
Izaña	28°N	0	0	0	0	0	0	0	0	0	0	0	0	0
Lauder	45°S	16	8	10	14	8	11	6	10	9	9	10	5	116
Arrival Heights	78°S	8	8	2	0	*Polar night*				4	8	6	8	44

M124	Lat.	J	F	M	A	M	J	J	A	S	O	N	D	#
Murmansk	69°N		19	24	25	20	22	26	27	28	27	5		223
Petchora	65°N	11	27	28	27	21	30	31	30	30	30	20	0	285
Arhangelsk	65°N	7	25	26	26	23	29	31	31	29	28	17	0	272
Yakutsk	62°N	7	13	18	29	21	30	31	29	30	24	14	7	253
St Petersburg	60°N	29	27	31	27	29	29	31	31	30	30	26	27	347
Magadan	60°N	25	22	21	25	0	23	18	26	28	24	21	26	259
Vitim	59°N	19	24	16	29	22	28	29	30	28	16	18	13	272
Krasnoyarsk	56°N	18	23	27	25	23	29	31	31	28	28	18	25	306
Nikolaevsk	53°N	22	17	16	23	0	28	27	0	0	17	17	9	176
Petropavlovsk	53°N	19	19	11	17	16	27	27	25	24	26	24	25	260
Samara	53°N	18	18	22	27	22	29	30	31	30	30	24	15	296
Irkutsk	52°N	30	27	30	27	23	23	30	28	28	31	21	19	317
Karaganda	50°N	26	21	0	0	0	0	0	0	0	0	0	0	47
Voronezh	50°N	20	20	30	29	22	29	31	27	29	26	23	9	295
Yuzhno-Sahalinsk	47°N	18	21	13	23	16	22	30	28	28	27	26	18	270
Samara	53°N	18	18	22	27	22	29	30	31	30	30	24	15	296
Irkutsk	52°N	30	27	30	27	23	23	30	28	28	31	21	19	317
Karaganda	50°N	0	0	0	0	0	0	0	0	0	0	0	0	0

Ozonesonde	Lat.	J	F	M	A	M	J	J	A	S	O	N	D	#
Sodankylä	67°N	6	9	7	3	4	4	4	5	3	4	5	3	57
Keflavik	64°N	8	7	10	0	0	0	0	0	0	0	0	1	26
Jokioinen	61°N	5	7	7	0	0	0	0	0	0	0	0	0	19
De Bilt	52°N	4	6	6	4	5	8	3	4	4	1	1	0	46
Uccle	51°N	11	12	12	13	11	13	12	13	14	0	0	0	111
Hohenpeißenberg	48°N	12	13	12	13	9	9	10	10	9	9	13	12	131
Payerne	46°N	11	12	11	13	13	13	14	13	14	13	12	12	151
Paramaribo	6°N	0	2	7	2	3	4	3	4	2	1	0	0	28
Lauder	45°S	2	2	0	0	0	0	0	0	0	0	0	0	4
Marambio	64°S	2	2	1	2	2	7	8	6	5	10	9	7	61
Dumont d'Urville	67°S	0	0	0	0	0	0	0	0	0	0	0	0	0
Belgrano	78°S	2	3	2	2	1	3	3	4	4	5	3	2	34

MicroWave	Lat.	J	F	M	A	M	J	J	A	S	O	N	D	#
Ny-Ålesund	79°N	0	0	0	0	0	0	0	0	0	0	0	0	0
Summit	72°N	0	0	0	0	0	0	0	0	0	0	0	0	0
Kiruna	68°N	22	21	27	0	0	0	0	0	0	0	0	0	70
Payerne	46°N	29	28	27	12	0	0	0	0	0	0	28	30	154
Mérida	8°N	12	28	31	20	28	22	16	0	0	0	0	0	157
Lauder	45°S	0	0	0	0	0	0	0	0	0	0	0	0	0

C. VALIDATION ACTIVITIES

During the reporting period, Envisat level-2 products were generated in routine by Processing and Archiving Centres (PAC) operated at/on behalf of ESA, and also by scientific institutes with their homemade retrieval software tools. The TASTE Consortium has performed substantial validation work for all available data products under his duty, and provided detailed quality assessments as well as feedback to algorithm and processing teams in view of the improvement of the Envisat ground segment and level-1-to-2 data processors. Where relevant, validation studies based on correlative data collected within TASTE have been augmented with similar data collected from archives of the NDACC, WOUDC and SHADOZ programmes.

Validation has been carried out both independently by individual partners, using their own methods, and jointly by all partners, using a common approach. This dual approach has generated constructive discussions and yielded a consolidated appreciation of Envisat data quality. Details of the studies fall beyond the scope of this report but they can be found in the reports and publications listed in Sections D and F. This report concentrates on the main achievements obtained during the reporting period. A ZIPPED Annex attached to this report provides monthly means and standard deviations of the differences between Envisat and correlative data sets.

C.1. GOMOS

During the reporting term, several GOMOS ozone profile products have been available for validation. Comparisons have been performed using ozone profile data acquired by ozonesonde, lidar and millimetre wave radiometer and directly collected within TASTE or available through other Envisat validation projects (EQUAL and AO/Cat-1 projects) or other data archives (NDACC, SHADOZ, WOUDC). Several types of comparisons have been performed, yielding among others classical vertically resolved statistics, and time-series statistics for partial columns defined by altitude levels. Space and time collocation criteria where set to 500km from ground-based station to tangent point; ozonesonde and lidar within 12h; and microwave radiometer within 2h to 15min depending the integration time specific to the instrument.

C.1.a GOMOS Prototype Processor 6.0b

GOMOS ozone profile data sets covering 2003 have been generated by version 6.0b of the prototype data processor operated at ACRI on behalf of ESA. Comparisons show that GOMOS O_3 profiles GOPR 6.0b are affected strongly by the brightness of the limb through which the star occults. Bright limb situations give GOMOS profiles of poor quality. When selecting only dark limb occultations, GOMOS O_3 profiles agree well with the correlative data. At mid and low latitudes, differences in 2003 are within 5-10% in the altitude range of 20-50 km. Partial columns agree generally to within 5% on an average, as illustrated in Figure 2 for the NDACC/Alpine station. However, in some cases, we observed larger differences or systematic biases that cannot be account in the error budget. Below and above the 20-50 km range larger differences are reported. At high northern latitudes, the agreement is poorer, but atmospheric variability plays certainly a role. When investigating time structures, a 5-10% agreement was observed, in line with aforementioned height features results. Comparisons show no critical dependence on the occultation angle with Envisat orbit plane.

For the upper part of GOMOS profiles, comparisons with lidar and microwave radiometer measurements have been carried out with common procedures in the Artic, at Northern mid latitudes, in Hawaii and in New Zealand. Comparisons make appear a constant mean positive difference at European station in the 34-40 km and 40-50 km altitude ranges. At Ny-Ålesund negative differences are noted at 40-50 km. In all other analysed situations, GOMOS partials column data agree well with those reported by the ground-based instrumentation

The ZIPPED Annex contains monthly means and standard deviations of the absolute (*GOMOS_60b_abs.xls*) and relative (*GOMOS_60b_rel.xls*) differences between GOMOS and ground-based ozone profiles in 5 partial columns defined by altitude levels (18-23 km, 23-28 km, 28-34 km, 34-40 km, and 40-50 km).

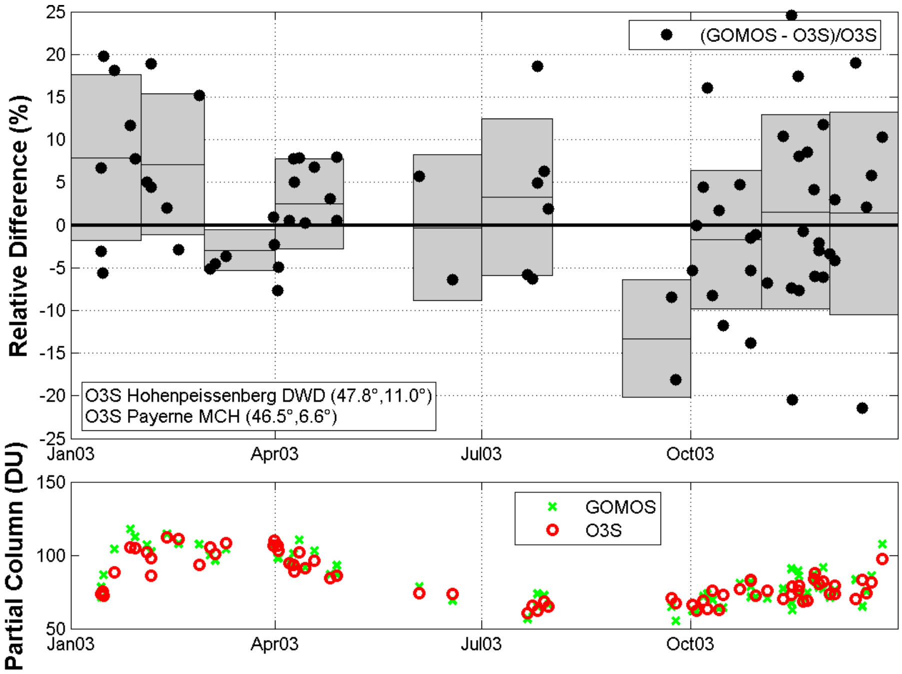

Figure 2. *Comparison of GOMOS 6.0b and ground-based (ozonesonde) ozone partial column from 18 to 23 km, observed in 2003 at the NDACC/Alpine sites of Hohenpeißenberg (Germany) and Payerne (Switzerland). Lower plot: time-series of ozone partial column; upper plot: percent relative difference in ozone partial column. Shaded rectangles indicate the monthly mean and 1σ standard deviation of the GOMOS/ozonesonde differences.*

C.1.b GOMOS IPF 4.02

During the reporting term, GOMOS ozone profile data have been processed by IPF 4.02. Data available for validation cover the period from May 2004 till January 2005, when GOMOS operation was interrupted due to a severe instrument anomaly. After several tests, GOMOS operation resumed at end of July 2005. A few ozone profiles from the period to July-September 2005 have been retrieved with IPF 4.02 and are also available to validation teams. Comparison results for IPF 4.02 are mostly similar to those obtained with version 6.0b, but they show larger discrepancies in some cases. As for 6.0b, negative mean differences are observed in the Artic, in the Northern Atlantic and over Northern Europe in the 18-23 km altitude range, although with a reduced amplitude. Comparisons reveal no constant mean difference between GOMOS and lidar or microwave radiometer in the upper part of the profile, but the result are more scattered. The ZIPPED Annex contains monthly means and standard deviations of the absolute (*GOMOS_402_abs.xls*) and relative (*GOMOS_402_rel.xls*) differences between GOMOS and ground-based ozone profiles in 5 partial columns (18-23 km, 23-28 km, 28-34 km, 34-40 km, and 40-50 km).

C.1.c GOMOS Prototype Processor 6.0f and IPF 5.0

At the end of the reporting term, the entire GOMOS data set was reprocessed at ACRI with a new version of the Prototype Processor. Delta validation of this new version was carried out mainly in the framework of EQUAL project, on the basis of comparisons with lidar data. Consequently, GOMOS IPF was upgraded to version 5.0. During next term, TASTE partners will consolidate validation of GOMOS ozone profile processed with IPF 5.0. This new version also includes new data products like NO_2 and OClO profile data. The relevance of TASTE UVVIS column data for the validation of those new GOMOS species will be investigated. Support will be given to the GOMOS QWG.

C.2. MIPAS

In 2005 MIPAS atmospheric profile data retrieved with Off-Line IPF versions 4.61 (covering 2003) and 4.62 (Jul.-Dec. 2002 and Jan./March 2004) have undergone an extensive validation coordinated by "molecule coordinators" from various institutes, with the objective to publish consolidated results in a special issue of *Atmospheric Chemistry and Physics*. TASTE activities have played a major role in this coordinated effort, providing ground-based geophysical validation of nearly all MIPAS operational products.

C.2.a MIPAS IPF 4.61/4.62 Temperature

MIPAS temperature profile data have been confronted to correlative measurements acquired by temperature sensors embarked with balloon-borne electrochemical ozonesonde, and also by temperature lidars associated with the NDACC and/or the EQUAL project. The time overlap between the 4.61 and 4.62 data sets is too scarce at the time of this report to intercompare the two versions of the processor. However, for temperature profiles, the comparison of the two versions using the ground-based network as a standard transfer shows a similar agreement.

The analysis includes assessments of the different contributions to the total comparison error. MIPAS and ground-based measurement errors are obtained from the literature. We have estimated comparison errors associated with vertical smoothing differences, horizontal inhomogeneities within the MIPAS line-of-sight, and geolocation differences. Comparison results reflect dynamics and photochemistry influences and can be classified as follows: in the lower stratosphere, results regroup around the major synoptic systems; in the higher stratosphere, dominating photochemistry yields a more zonal behaviour. In general, the comparison error is dominated by the incertitude associated with horizontal inhomogeneities and variability. This incertitude can account for the observed standard deviation of the comparisons in most of the cases, which varies with seasons. Horizontal variability is followed in magnitude by errors associated with geolocation differences. The latter also correlate with the standard deviation of comparisons, but their amplitude is dominated by MIPAS line-of-sight inhomogeneities. Errors associated with vertical smoothing differences are smaller. Their effect is an increase of the comparison noise and it could also account for a small, constant offset in the comparisons.

Generally, the difference between MIPAS and ozonesonde temperature data falls within the comparison error budget. This is illustrated in Figure 3 for several sites of the Arctic and Alpine NDACC stations. After convolution of the correlative profile by the MIPAS averaging kernels and after biasing the correlative profile with the MIPAS a priori profile, in order to account for the difference in vertical smoothing of the true vertical distribution (Rodgers comparison method), the mean difference is found to fit into the estimated total systematic error, and the standard deviation of the differences is found to match very well the estimated total random error of the comparison. Results vary a lot from a station to another but with mostly negative difference for Kenyan and Southern Atlantic stations. We also observe systematically positive or negative differences between MIPAS and ozonesonde temperature data at SHADOZ stations in the equatorial zone and in Polynesia. Comparisons in New Zealand also show a negative difference.

At altitudes higher than 25km, the number of ozonesonde data coincident with MIPAS observations decreases and can become statistically insufficient at some stations. For the upper part of the profile we have performed comparisons with 5 temperature lidars of the Northern Hemisphere (from Greenland to Hawaii). The results make appear a constant positive bias at mid latitude in the 15-7 hPa and 7-3 hPa partial columns. At 3-0.8 hPa, MIPAS temperature data are lower than the correlative observations at the Mauna Loa station. The comparison error budget cannot account for these observed differences. In all other analysed situations, MIPAS partials column data agree well with those reported by the ground-based instrumentation, and the observed differences fit well within the comparison error budget.

The ZIPPED Annex (*MIPAST_abs.xls*) contains monthly means and standard deviations of the absolute difference between MIPAS and ground-based temperature profiles in 6 partial columns defined by pressure levels (75-35 hPa, 35-15 hPa, 15-7 hPa, 7-3 hPa, and 3-0.8 hPa). More detailed results and individual comparison graphs for every station have been communicated to the respective "molecule coordinator".

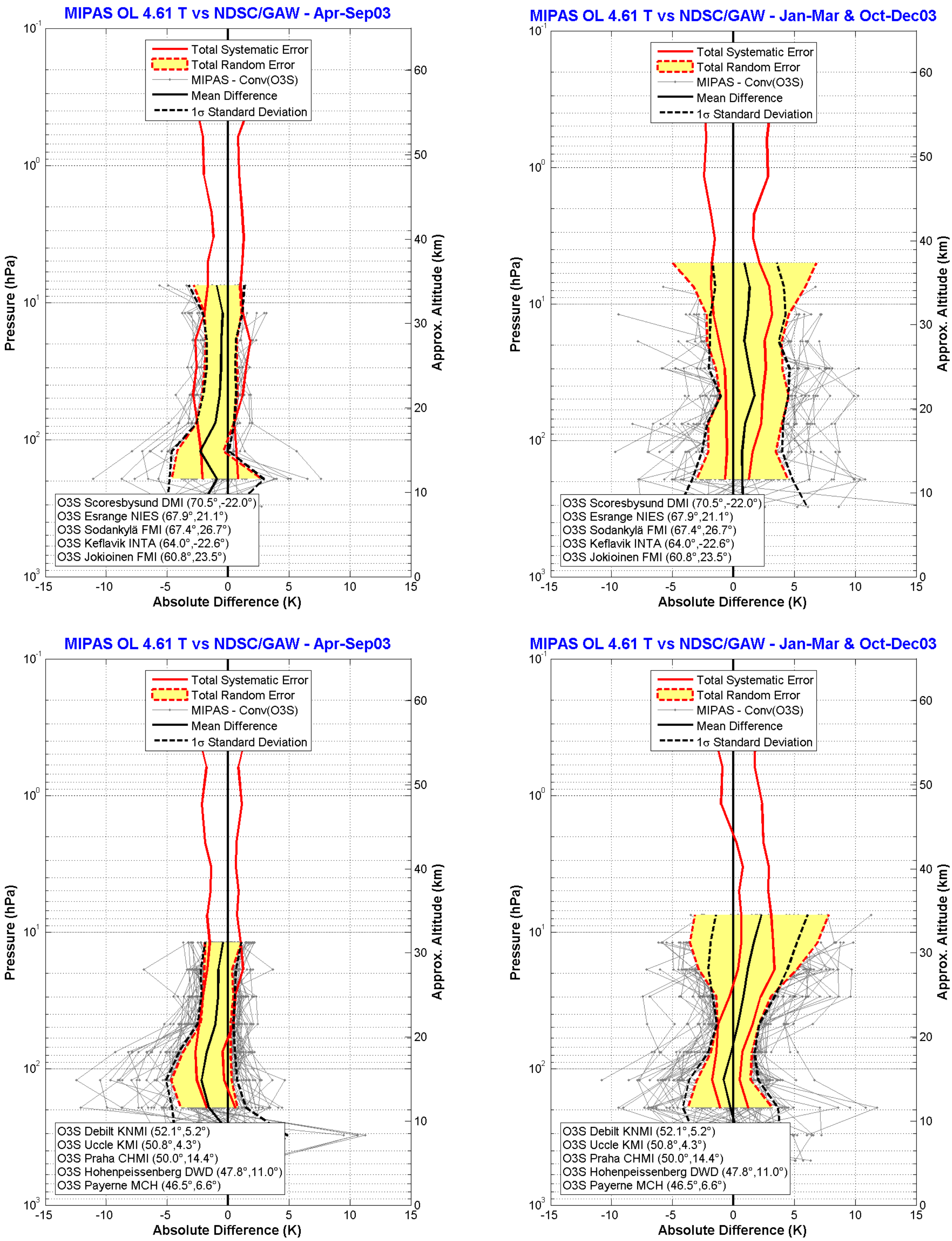

Figure 3. *Comparison of MIPAS 4.61 temperature profile data with correlative balloon-based observations in 2003 at several sites of the NDACC Arctic (upper plots) and Alpine (lower plots) stations. Left: April-September 2003 data; right: January-March and October-December 2003 data. Bold lines and shaded areas in foreground: comparison statistics; grey thin lines in background: individual comparisons.*

C.2.b MIPAS IPF 4.61/4.62 Ozone

MIPAS ozone profile data have been confronted to correlative measurements acquired by balloon-borne electrochemical ozonesonde and by ground-based millimetre wave radiometer associated with the NDACC and/or TASTE, by ozone lidars associated with the NDACC and/or the EQUAL project, and by ground-based FTIR spectrometers of the NDACC. The latter effort results from the collaboration established between IMK/FZK, BIRA-IASB, NIWA, University of Liège, and University of Wollongong. Contributing FTIR stations are Kiruna (Sweden, 68°N), Jungfraujoch (Switzerland, 46.5°N), Wollongong (Australia, 34°S), Lauder (New Zealand, 45°S) and Arrival Heights (Antarctica, 78°S). The vertical resolution of FTIR ozone profile is about 8 km in a height range from ground to about 35 km. The resolution of the original MIPAS profile has been degraded to that of the FTIR. The difference versus height is calculated and compared with the error bars. Furthermore, partial columns are compared. The lower limits of ozone partial columns is 12 km, in agreement with the most common lowest altitudes of MIPAS scans, and the upper limits of 40 km correspond to the limit of ground-based FTIR sensitivity. The used coincidence criteria is 500km in space and 6 hours in time; it has been reduce to a maximum of 300 km in space and 3 hours in time at Kiruna and Arrival Heights to deal with the highest variability in the polar region during the winter-spring period.

Ground-based comparisons reported at the Envisat symposium held in Salzburg (6-10 September 2004, see previous annual report) have been extended to the entire MIPAS IPF 4.61/4.62 data record. The global mean agreement remains within the 5%-10% level at altitudes down to 18km. MIPAS reports larger partial columns than the ground based-instruments: (a) in the 75-35 hPa layer at Northern and Southern middle latitudes, the Equator and the Tropics; (b) at 35-15 hPa at the Equator, in the Tropics, and in Antarctica during the ozone hole event; and (c) at 3-0.8 hPa at European stations. At 7-3 hPa, MIPAS partial columns underestimate correlative observations in Hawaii. In most cases, comparison results can be interpreted by considering the different error contributions, but they are exceptions, as e.g. illustrated in Figure 4: MIPAS reports systematically higher ozone values at the Antarctic station of Belgrano during the springtime ozone hole, and systematically lower ozone values at Arctic stations in the 7-30 hPa pressure range during summer. The ZIPPED Annex contains monthly means and standard deviations of the absolute (*MIPASO3_abs.xls*) and relative (*MIPASO3_rel.xls*) difference between MIPAS and ground-based ozone profiles in 6 partial columns defined by pressure levels (75-35 hPa, 35-15 hPa, 15-7 hPa, 7-3 hPa, and 3-0.8 hPa). More detailed results and individual comparison graphs for every station have been communicated to the respective “molecule coordinator”.

Comparisons between MIPAS ozone profiles and those measured by FTIRs confirm results obtained with ozonesonde, lidar and microwave radiometer data. The comparison of the ozone partial columns measured by MIPAS and FTIR show a mean difference of –1% to 1.5% or less and a scatter of 4% to 6% at the five analysed stations. Comparison of O_3 profiles with FTIR measurement show a good agreement within the error bars at Kiruna, Jungfraujoch and Lauder. We observed larger discrepancies at pressures higher than 30 hPa at Wollongong and at pressures higher than 70 hPa at Arrival Heights. There is no significant difference whether MIPAS profiles have been adapted to FTIR resolution or not.

C.2.c MIPAS IPF 4.61/4.62 Nitric Acid, Nitrous Oxide and Methane

For the validation of Envisat IR species, the original TASTE proposal included the provision of vertical columns only by a network of FTIR spectrometers. In the meantime, appropriate techniques have been developed in the NDACC framework to retrieve profiles from ground-based FTIR spectra, providing new validation opportunities for a list of Envisat data products. Thanks to the strong collaboration between IMK/FZK, BIRA-IASB, NIWA, University of Liège, and University of Wollongong, vertical profiles of HNO_3, N_2O and CH_4 have been retrieved at the NDACC stations of Kiruna (Sweden, 68°N), Jungfraujoch (Switzerland, 46.5°N), Wollongong (Australia, 34°S), Lauder (New Zealand, 45°S) and Arrival Heights (Antarctica, 78°S). The resolution of the original MIPAS profile has been degraded to that of the FTIR. The difference versus height is calculated and compared with the error bars. Furthermore, partial columns have been compared. The lower limits of 12 to 16 km of partial correspond to the most common lowest altitudes of MIPAS scans while the upper limits of around 30 km correspond to the ground-based FTIR sensitivity.

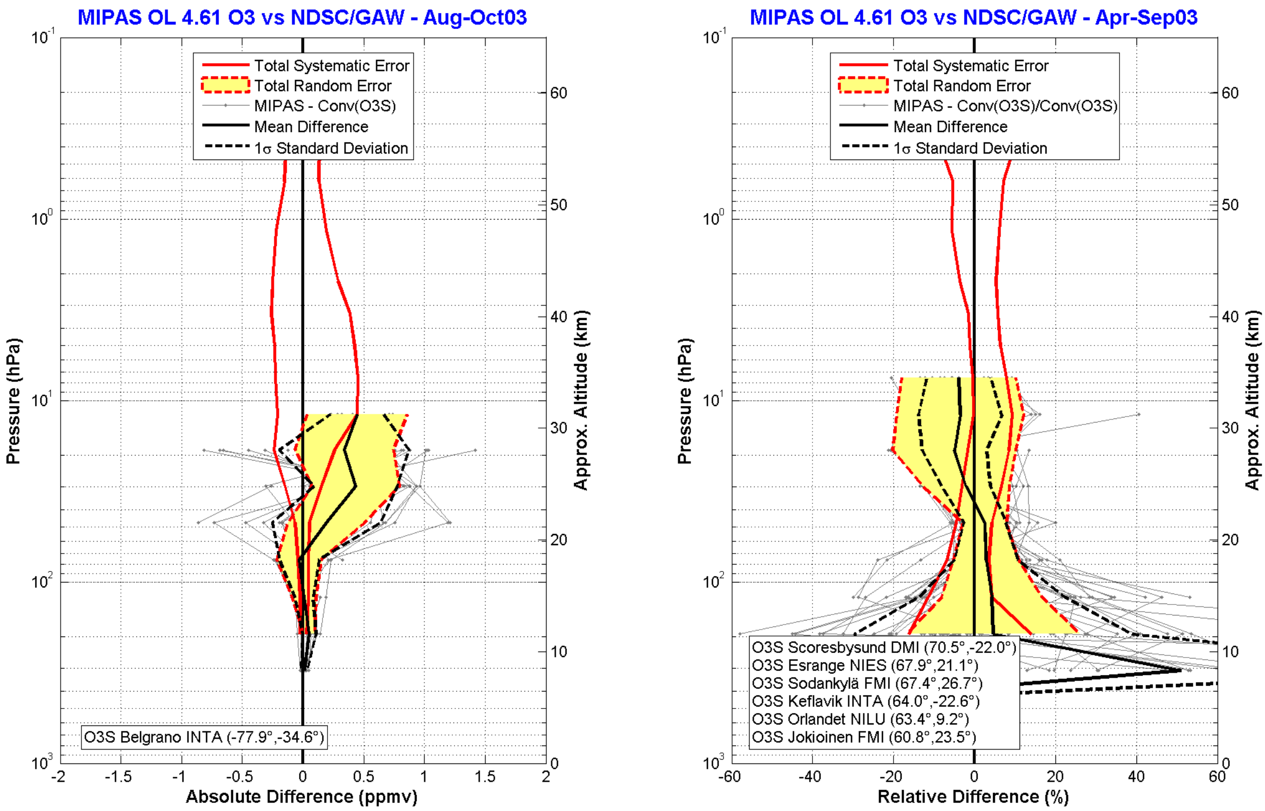

Figure 4. *Comparison of MIPAS 4.61 ozone profile data with correlative ozonesonde observations in 2003 at the Antarctic site of Belgrano during ozone hole conditions (left) and at several sites of the NDACC Arctic (right) station. Same legend as Figure 3.*

For comparisons with MIPAS, coincidence criteria used are a maximum of 500 km difference in space and 6 hours in time at middle and low latitudes. This criteria has been reduced to a maximum of 300 km in space and 3 hours in time at polar latitude stations to deal with the highest variability of the investigated molecules in the polar region during the winter-spring period. To avoid errors due to an incorrect height assignment MIPAS profiles were taken on a pressure scale.

For HNO_3, a comparison of spectroscopic data used showed a difference of 13.7% in line strength while other parameters, like pressure broadening, were identical. Therefore, a scaling factor of 0.863 has been applied to the original FTIR results. HNO_3 profiles agree within the error bars. The mean difference is less than 0.4 ppbv. The comparison of partial columns shows a good agreement at all middle a high latitude stations with mean difference of les than 3% (-1% at the Jungfraujoch, +2% at Arrival Heights and +1% at Lauder), with a scatter of less than 11% (11%, 10% and 7% respectively). Comparisons at Wollongong show a bias of +9% with a scatter of 4%. The reason of this disagreement has still to be investigated.

MIPAS profiles of N_2O and CH_4 show oscillations in some cases. On average N_2O profiles agree with FTIR data and are better than CH_4 profiles. Comparison of MIPAS CH_4 profiles with Kiruna FTIR data shows a small bias of about 0.2 ppmv, a high bias of MIPAS. The comparisons results of N_2O profiles with correlative data from the five FTIR stations show a good agreement at Kiruna, Jungfraujoch and Lauder with a mean difference of maximum –2% and a standard deviation within 7%. At Wollongong and Arrival Heights a bias appears with mean differences of –7% and +10% respectively. But for those 2 stations, the statistics are quite poor: 15 and 13 coincidences only, respectively. The profiles agree within the errors bars, excepted for Wollongong at pressures lower than 50 hPa, where the amount of N_2O is less important.

C.2.d MIPAS IPF 4.61/4.62 Nitrogen Dioxide

The validation of MIPAS NO_2 profiles with ground-based techniques is hampered by two critical issues: the marked diurnal cycle of the nitrogen oxides family, and the fact that MIPAS NO_2 data start only at about 26 km, missing 30-40% of the total stratospheric column of NO_2. Moreover, NO_2 profiling is not a standard technique of the NDACC and, currently, only a few UV-visible DOAS stations of the network have developed retrieval algorithms yielding about 4 pieces of independent information on the NO_2 vertical distribution. In the framework of the MIPAS coordinated validation, attempts were made at BIRA-IASB to compare such ground-based NO_2 profile retrievals with MIPAS partial columns. A main advantage of the method is that the ground-based retrieval algorithm includes a photochemical model, which reduces considerably diurnal cycle effects. Comparisons can also be performed with both daytime and nighttime MIPAS data. Preliminary results based on UV-visible data at Harestua (Norway, 60°N) are encouraging and the technique will be further developed in the next future.

Two other ground-based validation methods have been explored to test the geophysical relevance of MIPAS NO_2 data. Their principle relies on comparisons of MIPAS partial columns with ground-based measurements of the vertical column acquired either by UV-visible or by FTIR spectrometry. The stratospheric column not available from MIPAS (or *ghost column*, below 26 km) has been assessed by assimilating MIPAS profile data into the BIRA-IASB 4D-var assimilation system BASCOE. For comparisons with UV-visible observations, which are acquired at twilight, a coupled version of the PSBCOX/SLIMCAT model has been run jointly at BIRA-IASB and U. Leeds to provide adequate correction of diurnal cycle effects. For comparisons with FTIR observations, which are acquired throughout the day, there is no need to use photochemical modelling: the time and space differences between the FTIR and MIPAS measurements are simply limited to 1 h and 300 km. As an attempt, ground-based comparisons have been conducted from pole to pole at about 20 UV-visible stations and also at the FTIR stations of Kiruna (Sweden, 68°S) and the Jungfraujoch (47°N, Switzerland). They show that the seasonal variation is captured very well by MIPAS daytime data. The annual mean difference ranges from a few percent to 20%, depending on the station and the latitude. As illustrated in Figure 5, the pole-to-pole comparison reveals no significant meridian structure, provided that the effect of the known temperature dependence of the NO_2 UV-visible absorption cross-sections is taken into account (UV-visible stations retrieving NO_2 columns with room-temperature cross-sections, thus with a negative offset of 15-20%, are plotted in a different colour).

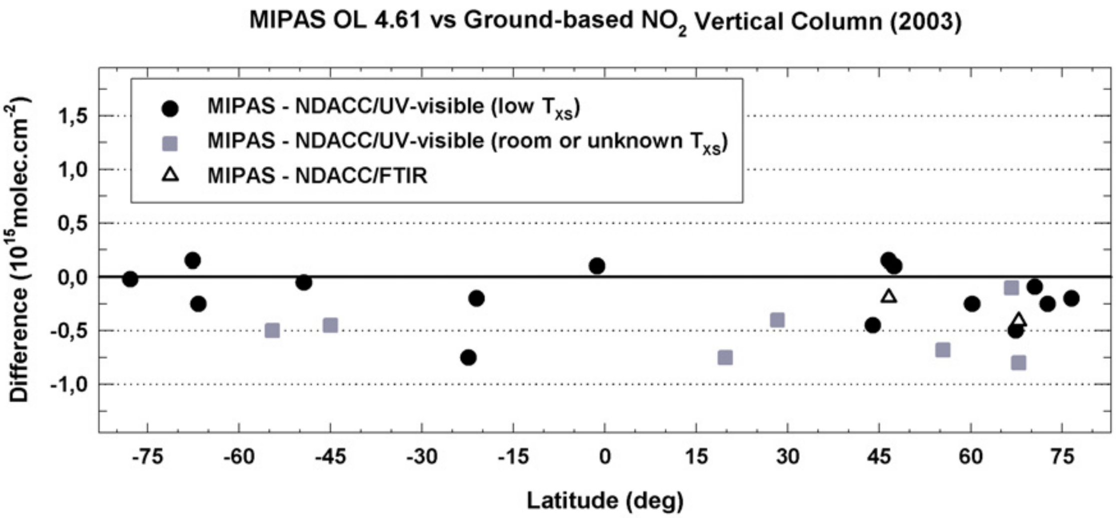

Figure 5. *Meridian structure of the mean absolute difference between NO_2 stratospheric columns derived from MIPAS 4.61 profile data and measured by ground-based networks of the NDACC (UV-visible and FTIR).*

C.3. SCIAMACHY

During the reporting period, operational processing of SCIAMACHY ozone, nitrogen dioxide and bromine monoxide columns has continued with IPF 5.04. Freshly acquired O_3 and NO_2 data, as well as historical data reprocessed with this version of the OL processor, have been systematically confronted to ground-based data collected within TASTE and also from the NDACC and WOUDC data archives. Ground-based comparisons confirm all conclusions reported in December 2004 at the SCIAMACHY validation workshop organised by the SCIAMACHY Validation and Interpretation Group (SCIAVALIG) in Bremen (Germany).

C.3.a SCIAMACHY IPF 5.01/5.04 Ozone and Nitrogen Dioxide Columns

From January through September, the O_3 and NO_2 column data products generated by SCIAMACHY IPF 5.04 offer the level of quality expected from a processor based on GOME GDP 2, that is, a reasonable mean agreement on an annual basis but with seasonally varying errors. However, validations of data from mid-October through December reveal, especially for total ozone, much larger errors exhibiting a marked meridian structure, as illustrated in Figure 6. Those errors correlate with cloud fraction, ghost vertical column and air mass factor values. The problem re-appears every year during the same season. Despite those unacceptable errors from a quantitative perspective, SCIAMACHY 5.04 total ozone capture qualitatively all geophysical signals reported by ground-based instruments and by other satellites, as illustrated in Figure 7 at OHP (France).

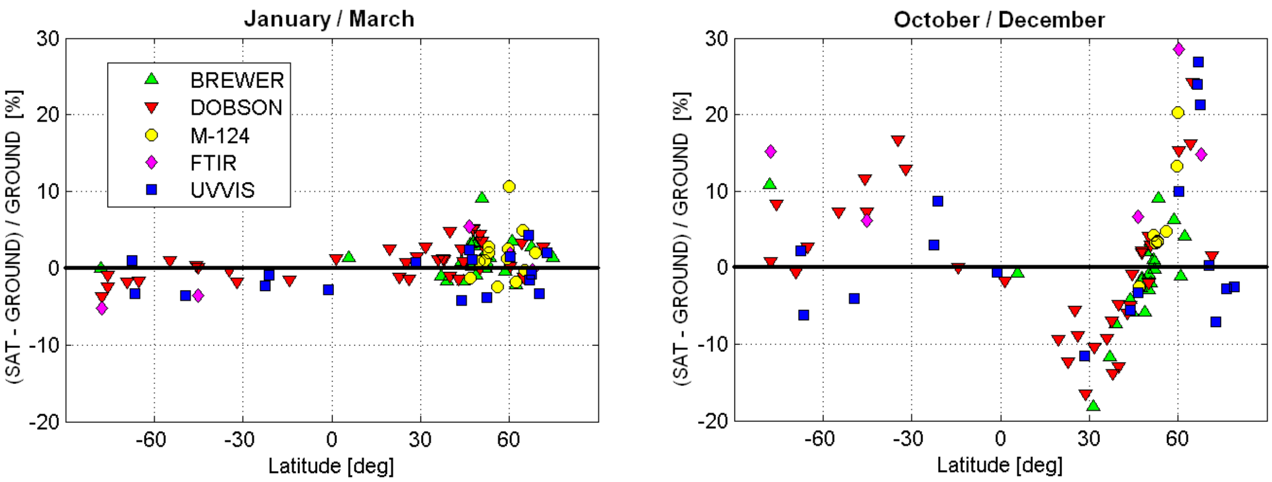

Figure 6. *Meridian structure of the seasonally mean relative difference between SCIAMACHY NL_5.04 and ground-based total ozone, for Jan/March (left) and Oct/Dec (right).*

C.3.b SCIAMACHY IPF 5.01/5.04 Bromine Monoxide Column

In 2004, a limited ground-based validation of SCIAMACHY IPF NL 5.01/5.04 BrO columns conducted at a few Northern Hemisphere stations concluded to a reasonable agreement with ground-based and GOME data for large slant columns but a large overestimation of small column values. In 2005, an extension of this preliminary validation, among others to Southern Hemisphere stations, revealed a list of additional problems. Several of them will be addressed in 2006 in the framework of the SCIAMACHY Quality Working Group.

C.3.c SCIAMACHY IPF 5.01/5.04 NIR Column Products

Near-infrared operational products are still under development and not ready yet for validation. Validation of near-infrared products generated by scientific institutes has continued during the reporting term and results will appear soon in publications.

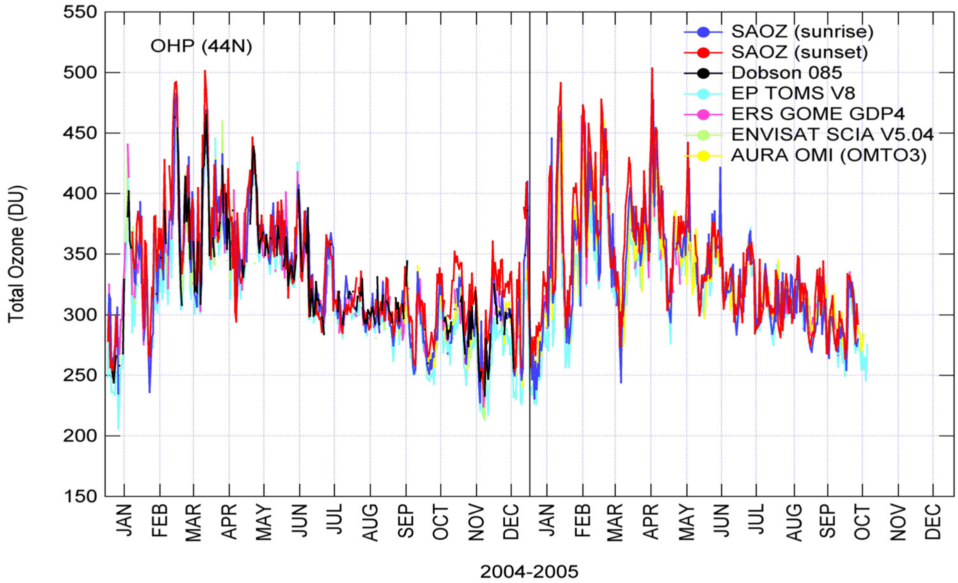

Figure 7. *Total ozone measured at OHP (France, 44°N) by SCIAMACHY NL_5.04, by ground-based instruments (SAOZ and Dobson) and by the GOME, TOMS and OMI satellite systems.*

D. VALORISATION

D.1. Presentations at meetings and symposia

Results obtained by members of the consortium independently or in a concerted way were reported and discussed at dedicated Envisat QWG and Science Advisory Group meetings and during several scientific workshops and major symposia:

- TEMIS Workshop, Frascati, Italy (January 24-25, 2005)
- 3rd UFTIR Progress Meeting, Brussels, Belgium (February 14, 2005)
- SCIAMACHY Scientific Working Subgroup for Algorithm Development and Data Usage (SADDU), Oberpfaffenhofen, Germany (February 17, 2005)
- Aura Validation Meeting (March 1, 2005) and EOS Aura Science Team meeting (March 2-3, 2005), Pasadena, USA
- NDSC UV-Visible Working Group meeting, Torrejón de Ardoz, Spain (June 6-8, 2005)
- NDSC IR Working Group meeting, Toronto, Canada (June 13-15, 2005)
- SCIAVALIG Meeting, De Bilt, The Netherlands (October 6, 2005)
- MIPAS validation papers coordination meeting, Karlsruhe, Germany (November 29-30, 2005)
- Aura Science Team Meeting on Atmospheric Constituents with Participation from ENVISAT, GOME, and ACE, The Hague, The Netherlands (November 8-10, 2005)
- NDSC/NDACC Steering Committee meeting, Tenerife, Spain (November 8-11, 2005)
- CEOS/Calibration and Validation Working Group meeting, Frascati, Italy (November 8-11, 2005)
- UFTIR Final Meeting, Brussels, Belgium (16-17 January 2006)

D.2. Publications and reports

The third TASTE progress meeting took place on October 6, 2005, at De Bilt (Netherlands).

At the time of the present Annual Report, the "Geophysical Validation of SCIAMACHY: 2002-2004" special issue of the Atmospheric Chemistry and Physics journal (ACP) is near completion and most of papers are available on-line (http://www.copernicus.org/EGU/acp/acp/special_issue15.html).

A web-based article on TASTE and the ground-based validation of Envisat was issued on June 30, 2005, at the following address: http://www.esa.int/esaLP/SEMAZS5DIAE_LPcampaigns_0.html.

Members of the TASTE consortium have contributed to a list of peer-reviewed papers, conference proceedings and reports, outlined in Section F.

E. PERSPECTIVES FOR NEXT TERM

E.1. Correlative Database

It is expected that activities related to the collection and submission of correlative data will continue on the same basis.

E.2. Validation Activities

A major activity in 2007 will be the delta-validation of improved processors and products for the three Envisat atmospheric chemistry instruments. For GOMOS, reprocessed data sets (GOPR_LV2 6.0f in-line with the upcoming operational processor version IPF 5.0) are currently available at D-PAC. They have already undergone a delta-validation and complete validation is now required, as well as routine validation. This new version also includes new data products like NO_2 and OClO profile data. The relevance of TASTE UVVIS column data for the validation of those new GOMOS species will be investigated. For MIPAS, results from the double slide, reduced resolution data are expected to be ready in 2006 so that proper (delta-)validation can be carried out by the time of ACVE-3. For SCIAMACHY, the implementation of a GDP4-like algorithm in the Off-Line SCIAMACHY processor established at DLR is currently near completion. Availability of reprocessed data sets, or at least validation data sets, is expected also in advance of ACVE-3. In the meantime, as a routine verification of the long-term behavior of SCIAMACHY, the team will go on with ground-based comparisons of current IPF version 5.04 until the foreseen upgrade.

It is timely to stress the link between the TASTE effort and three initiatives of importance. The first one relates to the Sodankylä Total Column Ozone Intercomparison campaign (SAUNA, 31/03-07/04 2006), co-sponsored by NASA, ESA and other institutions with the objective to improve total ozone retrieval algorithms and satellite validation at high latitudes and under high ozone column conditions. Several TASTE partners will participate, with a clear benefit for TASTE activities. The second interesting link is with the EC FP6 project called GEOMON. In this framework, several TASTE partners will work together and with other institutions to further improve satellite validation methods and establish standards. The third link is with the GSE: TASTE validation results are a necessary input to several GMES services foreseen in the PROMOTE-II proposal.

E.3. Valorisation

Next major events for Envisat validation, in which TASTE partners will play an active role, will be the MIPAS Validation special issue of ACP in the first half of 2006, and ACVE-3 at ESRIN on October 23-27, 2006. Discussion and dissemination of results will be ensured through the participation to other meetings of various communities involved directly in Envisat, in working groups of the NDACC, and in atmospheric research in general. Participation to the following scientific events is anticipated:

- March 20-22, 2006, Bremen (Germany): 3rd International DOAS Workshop
- April 2–7, 2006, Vienna (Austria): European Geophysical Union General Assembly
- May 8-12, 2006, Frascati (Italy): ESA Atmospheric Science Conference
- May 2006 (Japan): NDACC IR WG meeting
- May 29 - June 1, 2006, Toronto (Canada): Annual meeting of the Canadian Meteorological and Oceanographic Society (CMOS), "Weather, Oceans and Climate: Exploring the Connections"
- June 5-6, 2006, Heraklion (Greece): AT-2 Workshop
- July 16-23, 2006, Beijing (China): 36th Scientific Assembly of the Committee on Space Research (COSPAR)
- July 2006, Beijing (China): CEOS WG Cal/Val Atmospheric Chemistry Subgroup meeting
- September 26-28, 2006, Observatoire de Haute Provence (France): NDACC Steering Committee meeting

As mentioned, validation results produced through TASTE will also serve as input to several GSE PROMOTE services and as feedback to GEOMON research.

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