LIFETIME VALIDATION OF SCIAMACHY AND MIPAS ABOARD ENVISAT (ENVIVAL-LIFE)

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ABSTRACT

The ENVISAT mission with the three atmospheric chemistry instruments (SCIAMACHY, MIPAS, and GOMOS) is in very good health. An extension of the ENVISAT mission to the end of 2013 has now been approved by the ESA Programme Board. With a projected lifetime of more than 10 years for all ENVISAT atmospheric chemistry (AC) instruments, an unique decadal time series of atmospheric trace gas observations relevant for stratospheric ozone assessments, study on ozone-climate interaction, green-house gas emissions as well as global and regional air quality will be available.

An important prerequisite for using these data is the need to ensure and verify that the accuracy and precision of the instruments are maintained over such a long period. The accuracy and precision of the ENVISAT instruments can be assessed by comparisons with correlative measurements from the ground, balloon-borne, and other satellites during the lifetime of the satellite instruments. This is the main goal for the German national joint project ENVIVAL-LIFE (Lifetime Validation of SCIAMACHY and MIPAS aboard ENVISAT). Participants are University Heidelberg (IUP-UH), University Bremen (IUP-UB), University Frankfurt (IAU-UF), Karlsruhe Institute of Technology (IMK-KIT), and Forschungszentrum Jülich (ICG-FZJ).

Key words: ENVISAT; earth science; atmospheric chemistry; validation; remote sensing.

1. INTRODUCTION

The main activities in ENVIVAL-LIFE, a German funded project that runs from 2009 to 2012, are:

- validation of reprocessed and processed SCIAMACHY and MIPAS trace gas data from 2002 to 2012 using available correlative data from satellites, ground network, and balloon-borne measurements,
- re-analysis and analysis of balloon data from past and new campaigns to be carried out in coming years
- maintenance of the Heidelberg and Bremen ground-based DOAS networks,
- analysis of ground data from the BREDOM and Heidelberg ground DOAS network for validation of SCIAMACHY and MIPAS data,
- validation of scientific ENVISAT retrievals and comparisons to operational data products,
- verification of new scientific and operational data products from SCIAMACHY and MIPAS.

Partners in ENVIVAL-LIFE are University Heidelberg (IUP-UH), University Bremen (IUP-UB), University Frankfurt (IAU-UF), Karlsruhe Intitute of Technology (IMK-KIT), and Forschungszentrum Jülich (ICG-FZJ). The national commitment to ENVIVAL-LIFE is strongly motivated by the strong scientific contribution from Germany to the SCIAMACHY and MIPAS missions [1, 2].

2. VALIDATION WITH GROUND-BASED DATA

Using data from the DOAS networks and WMO-GAW stations, total columns from ESA and scientific retrievals are to be validated over the entire ENVISAT mission lifetime (O_3, NO_2, formaldehyde, glyoxal, IO, SO_2, HONO, and BrO). New operational ESA nadir data products from SCIAMACHY, following ozone and NO_2, are to be introduced in coming years: BrO, SO_2, and water vapor. Important element is the repeated validation following reprocessing of SCIAMACHY level-1 data and/or update of retrieval algorithms. ENVIVAL-LIFE also supports

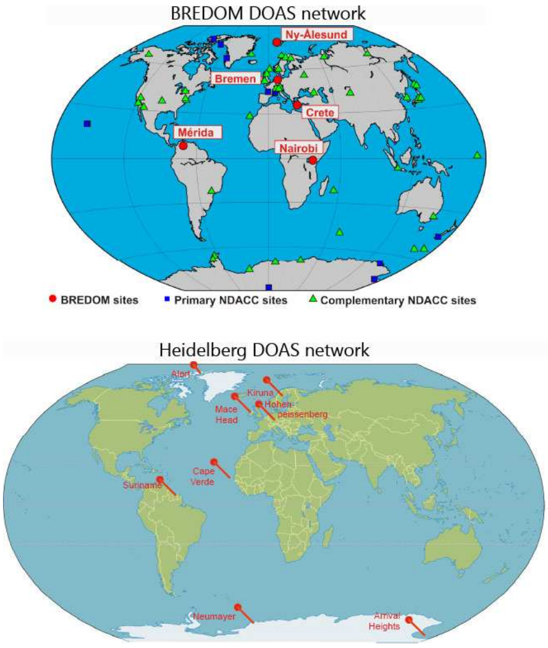

Figure 1. The groundbased DOAS networks of the Universities of Bremen (top) and Heidelberg (bottom) were mainly formed to support satellite validation, in particular for GOME, SCIAMACHY, and GOME-2 which use the DOAS approach in nadir viewing geometry and are, therefore, complementary to the ground observations. Longest time series are provided by zenith-sky measurements, but recently off-axis viewing geometries (MAX-DOAS) were implemented for tropospheric observations and profiling.

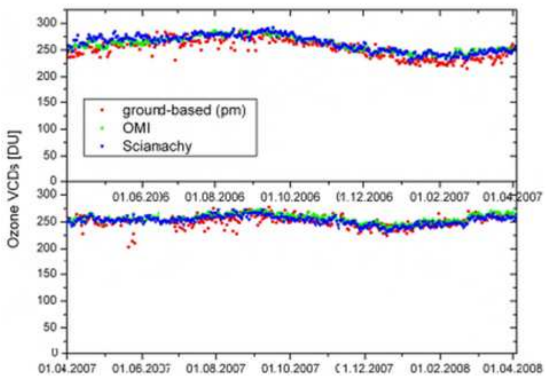

Figure 2. Comparison of DOAS ozone vertical columns from Paramaribo, Surinam, with SCIAMACHY and OMI overpass data.

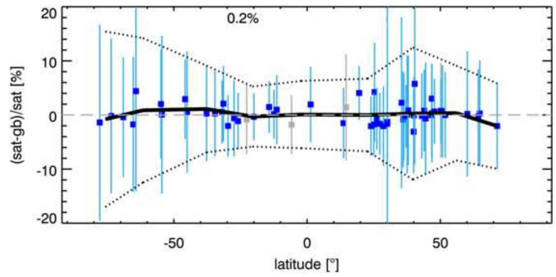

Figure 3. Mean bias between SCIAMACHY WFDOAS total ozone [3, 4] and WMO/GAW Dobson total ozone station data from 2002 to 2007. The average bias for all overpass data is 0.2%. Dotted lines indicate 2σ uncertainties in the satellite-station bias.

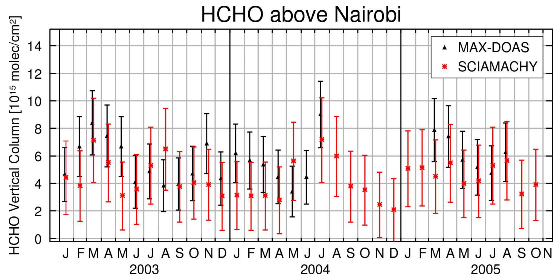

Figure 4. SCIAMACHY and BREDOM tropospheric formaldehyde observations above Nairobi, Kenya.

Table 1. Balloon flights with German payloads dedicated to and useful for ENVISAT validation.

Period	Launch site	Payload(s)	Geophysical Situation
Sept./Oct. 2002	Aire s/l Adour/F	MIPAS-B, TRIPLE,	mid-latitude, fall
Jan. -March 2003	Kiruna/S	MIPAS-B, LPMA/DOAS, TRIPLE	Arctic winter/spring
June/July 2003	Kiruna/S	MIPAS-B, TRIPLE	Arctic summer
Oct. 2003	Aire s/l Adour/F	LPMA/DOAS	Mid-latitudes fall
March 2004	Kiruna/S	LPMA/DOAS	Arctic winter/spring
June 2005	Teresina/ Brazil	MIPAS-B, BONBON, LPMA/DOAS	inner tropics
October 2006	Aire s/l Adour/F	CLAIRE	mid-latitude, fall
June 2008	Teresina/ Brazil	MIPAS-B, TWIN, LPMA/DOAS	inner tropics
March 2009	Kiruna/S	MIPAS-B, TWIN	Arctic winter/spring
August 2009	Kiruna/S	LPMA/DOAS	Arctic summer

Table 2. Instrumentation of the German payload as flown in ballon campaigns from Table 1.

payload	technique	instrument name	trace gases
MIPAS-B	FTIR	MIPAS-B (KIT)	e.g. NO_2, H_2O, O_3, CH_4, HNO_3
TRIPLE/TWIN	CCRF (chemical conversion resonance fluorescence)	HALOX-B (FZJ)	BrO, ClO, (ClO dimer), $ClONO_2$ (indirectly OClO)
	Whole air sampler (gas chromatograph)	BONBON, CLAIRE (UF)	N_2O, CFC-11,-12,-113, CH_4, SF_6, CO_2
LPMA/DOAS	Sun occultation DOAS (UV/vis)/limb DOAS	DOAS (UH)	e.g. BrO, NO_2, OClO, IO, OIO

the maintenance of the DOAS networks (see Fig. 1) and extending the measurement capabilities, for instance, to detect tropospheric species and to enable trace gas profiling. Figures 2-4 show few examples of SCIAMACHY validation using ground data from the German DOAS networks and WMO-GAW Dobson stations.

3. VALIDATION WITH BALLOON BORNE DATA

Ballon-borne data are particular valuable for validation of vertically resolved satellite trace gas profiles as, for instance, provided by MIPAS and SCIAMACHY. Table 1 lists the German payload contribution to and Table 2 the corresponding instrumentation in past balloon campaigns during the ENVISAT mission. Some launches were financed by ESA and DLR to directly support ENVISAT validation. ENVIVAL-LIFE has been providing partial financial support to the balloon campaign in March 2009 (see Table 1). Further ESA balloon campaigns with about one launch per year are in planning. As part of ENVIVAL-LIFE past balloon-born data will be improved and reprocessed and new upcoming campaigns prepared, carried out, and new data analysed. A particular emphasis is on validating the new *optimised resolution mode* MIPAS data (e.g. after 2005 MIPAS spectral resolution has been reduced and spatial resolution enhanced to overcome a mechanical problem) and new trace gas data products from ENVISAT. Figure 5 shows comparisons between balloon data and ENVISAT (SCIAMACHY and MIPAS) for selected flights and NO_2. MIPAS N_2O comparison to whole-air-sampler ballon data are shown in Fig. 6.

4. VALIDATION WITH OTHER SATELLITE DATA

Column data (O_3, NO_2) as well as profile data (O_3, NO_2, H_2O, BrO) from ENVISAT are to be validated with data from several available satellite missions (profilers: HALOE, SAGE II, SMR, OSIRIS, SABER, MLS, ACE-FTS, MAESTRO, column data: GOME1, OMI, GOME2, SBUV2). Figure 7 shows the mean differ-

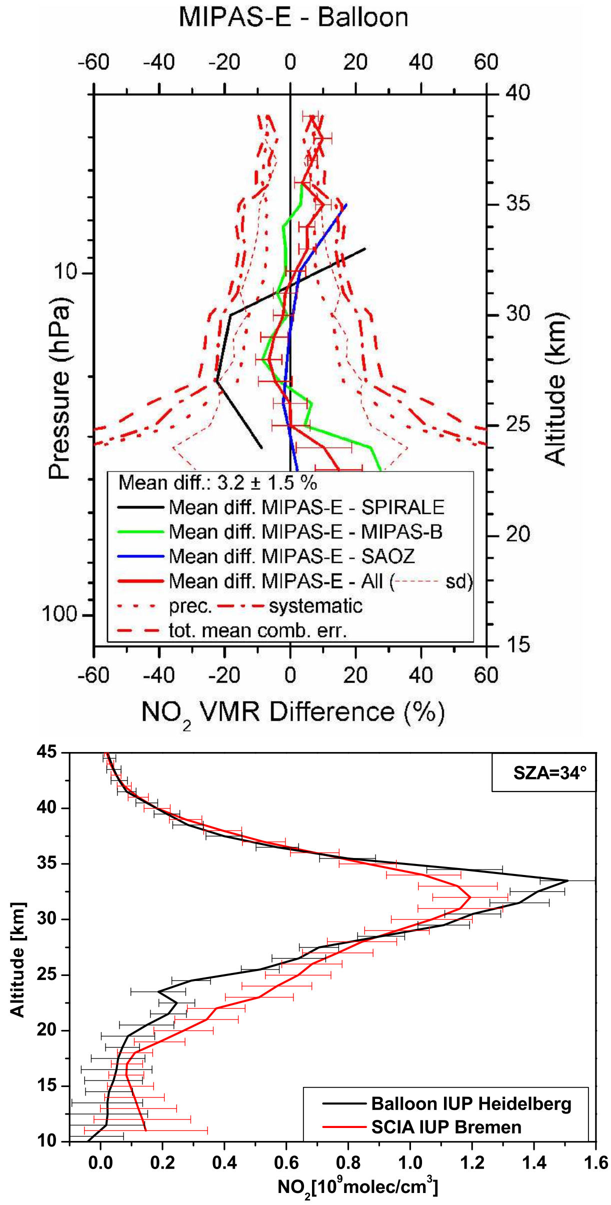

Figure 5. NO_2 profile comparisons between different balloon data and ENVISAT. Top: Comparison of MIPAS-B and other balloon data with MIPAS/ENVISAT (MIPAS-E) as summarised in Wetzel et al. [5]. Bottom: Comparison between DOAS balloon and SCIAMACHY above Teresina, Brazil, in June 2005 [6].

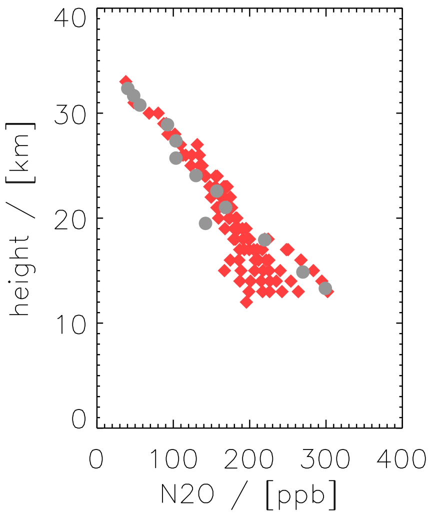

Figure 6. Collocated N_2O observations from MIPAS from back trajectory calculations (red) and whole air sampler data during the Kiruna June 2003 campaign.

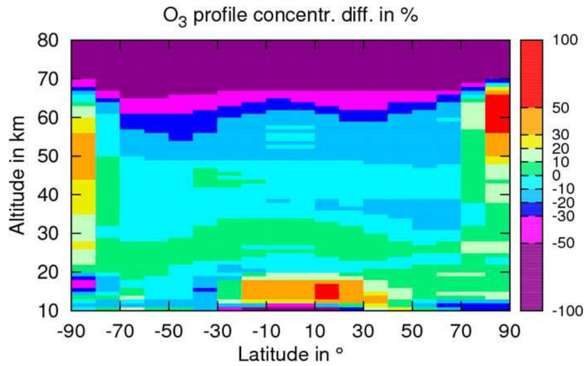

Figure 7. Mean bias between SCIAMACHY and MLS/AURA ozone over the period 2005-2008. Above 65 km the SCIAMACHY ozone retrieval is biased towards the a-priori profile explaining the large difference to MLS observations.

ence over the time period 2005-2008 between SCIAMACHY and MLS/Aura ozone, for example, indicating good agreeement. In addition to trace gas validation, SCIAMACHY radiances and irradiances are to be compared with MERIS and solar missions like SOLSPEC/ISS and SIM/SORCE.

5. CONCLUSION

ENVIVAL-LIFE, a joint national project, dedicated to mission lifetime validation of MIPAS and SCIAMACHY has started this year and will continue until near the official end of the ENVISAT mission currently scheduled for 2013. Main emphasis is to provide information on the long-term performance of both atmospheric chemistry missions. In ENVIVAL-LIFE a combination of different correlative data sets from ground networks, balloon campaigns, and other satellites will be used to assess the trace gas data accuracy and precision over a decade.

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REFERENCES

[1] Bovensmann, H., et al., 1999, J. Atm. Sci. 56, 127

[2] Fischer, H., et al., 2008, Atmos. Chem. Phys. 8, 2151

[3] Bracher, A., L.N. Lamsal, M. Weber, K. Bramstedt, M. Coldewey-Egbers, J. P. Burrows, 2005, Atmos. Chem. Phys. 5, 2357

[4] Weber, M., L. N. Lamsal, M. Coldewey-Egbers, K. Bramstedt, J. P. Burrows, 2005, Atmos. Chem. Phys. 5, 1341

[5] Wetzel et al., 2007, Atmos. Chem. Phys. 7, 3261

[6] Kritten, L., Time dependent profiling of UV/vis absorbing radicals by balloon-borne spectroscopic limb measurements and implications for stratospheric photochemistry, Ph.D. Thesis, Heidelberg University, Germany, 2009.