LONG-TERM VALIDATION OF GOMOS, MIPAS AND SCIAMACHY OZONE AND TEMPERATURE PROFILES BY THE ENVISAT QUALITY ASSESSMENT WITH LIDAR (EQUAL) PROJECT

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ABSTRACT

The latest analysis results of new processing algorithms and new data are presented in this paper and are part of the Envisat Quality Assessment with Lidar (EQUAL) project. New ozone profiles retrieved from measurement of MIPAS in RR-mode (IPF v5.00) were analyzed and they show good agreement with lidar data, especially some high vertical structures in the data are well represented. GOMOS ozone profiles (IPF v5.00), measured in the second half of 2006 and operationally processed by ESA, are in very good agreement with lidar data, which is in line with previous results [1]. Sciamachy ozone profiles (IPF v3.00), measured in the second half of 2006 and operationally processed by ESA, show a negative bias of 10-20% compared to lidar data, which is also in line with previous results [2]. We also show that limb measurements, processed with the current processor version of MIPAS and Sciamachy, still result in data with an altitude shift of about 1000 m with an opposite sign for each instrument owing their viewing direction.

1. INTRODUCTION

The Envisat Quality Assessment with Lidar (EQUAL) project supports the long-term validation of ENVISAT and is financed by ESA. The data under investigation are the ozone and temperature profiles of the Global Ozone Monitoring by Occultation of Stars (GOMOS), Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) and Scanning Imaging Absorption Spectrometer for Atmospheric Chartography (SCIAMACHY) instruments. Here we present the latest results of MIPAS data processed with a new algorithm suitable to deal with measurements from MIPAS observations in reduced resolution (RR) mode (section 2). MIPAS-RR data are from a limited dataset provided to selected scientific teams (within the quality working group) for validation. The final products might differ following additional corrections to enhance the data quality based on the results of the validation teams. Since July 2006 both GOMOS and Sciamachy data are operationally processed by ESA with two new IPF algorithms, IPF 5.00 and IPF 3.00, respectively. These

Table 1. Overview of EQUAL lidar stations

Groundstation	Latitutde	Longitude
Eureka	*80.05*	*–86.42*
Ny Ålesund	*78.92*	*11.93*
Alomar	*69.30*	*16.00*
Esrange	*67.88*	*21.10*
Hohenpeissenberg	*47.80*	*11.02*
Obs. Haute Provence (OHP)	*43.94*	*5.71*
Toronto	*43.66*	*–79.40*
Tsukuba	*36.05*	*140.13*
Table Mountain	*34.40*	*–117.70*
Mauna Loa	*19.54*	*–155.58*
La Reunion	*–21.80*	*55.50*
Lauder	*–45.04*	*169.68*
Rio Gallegos	*–51.60*	*–69.30*
Dumont d'Urville	*–66.67*	*140.01*

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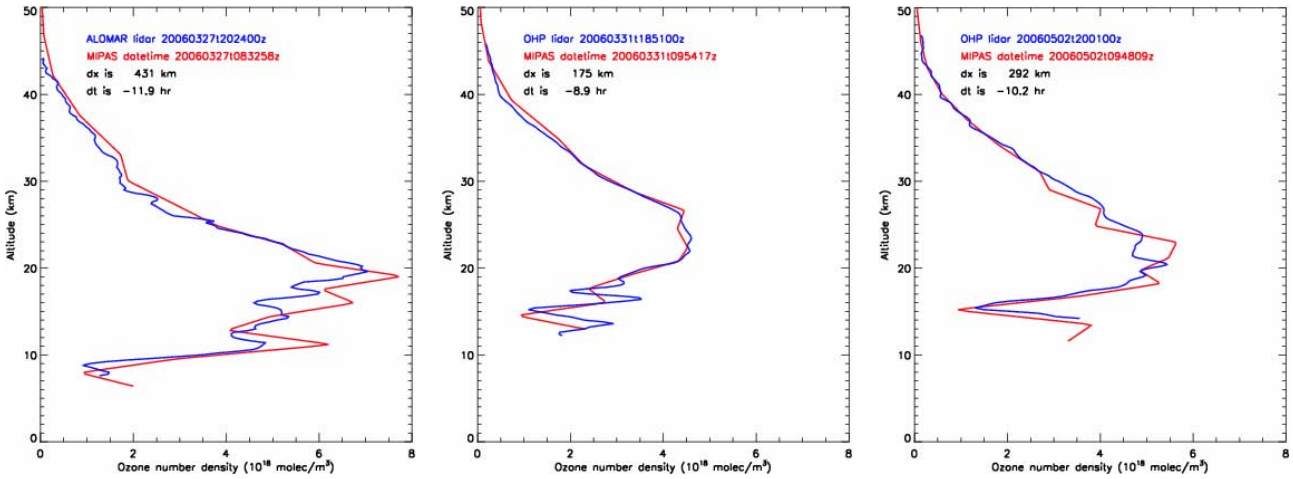

Figure 1. Comparison of MIPAS RR (red) and collocated LIDAR (blue) ozone profiles. The distance (dx) and the time difference (dt) between the two observations are indicated in the panels.

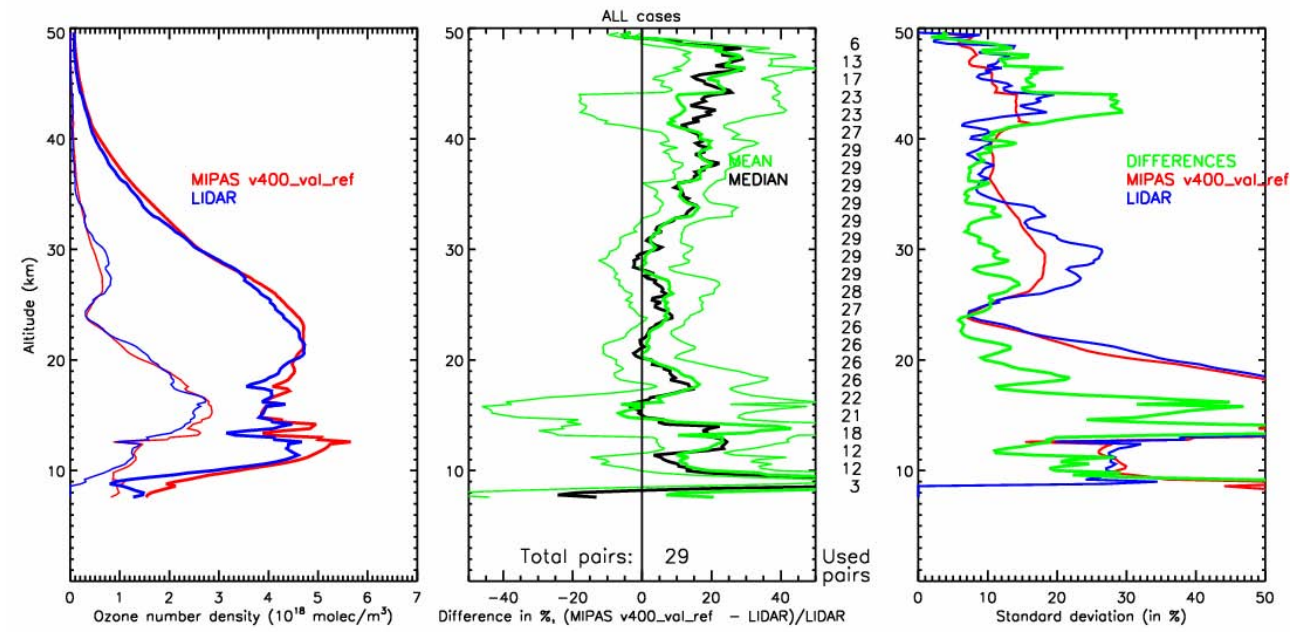

Figure 2. Averaged analysis results of MIPAS RR ozone profiles compared to LIDAR. (left) Mean MIPAS (bold red line) and LIDAR (bold blue line) ozone profiles and their standard deviations (thin lines in corresponding colors). (middle) Mean (bold green line) and median (black line) differences between all the paired MIPAS 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 MIPAS (red line) and LIDAR (blue line) ozone profiles.

new data are compared to lidar data (Tab. 1) measured in the second half of 2006 (section 3). An overview of estimated altitude shifts for limb observations is presented in section 4.

2. MIPAS-RR OZONE PROFILES

Since January 2005 MIPAS measures in a reduced resolution (RR) mode. This requires a new processing algorithm which has been tested on a validation reference set which includes coincidences with LIDAR measurements. Some example profile comparisons are shown in Fig. 1. For the vertical scale we used MIPAS pressure, which was converted to geometric altitude using ECMWF data.

In Fig. 2 we show the analysis results averaging all coincidences with lidar (<500 km, <20 hrs). A small

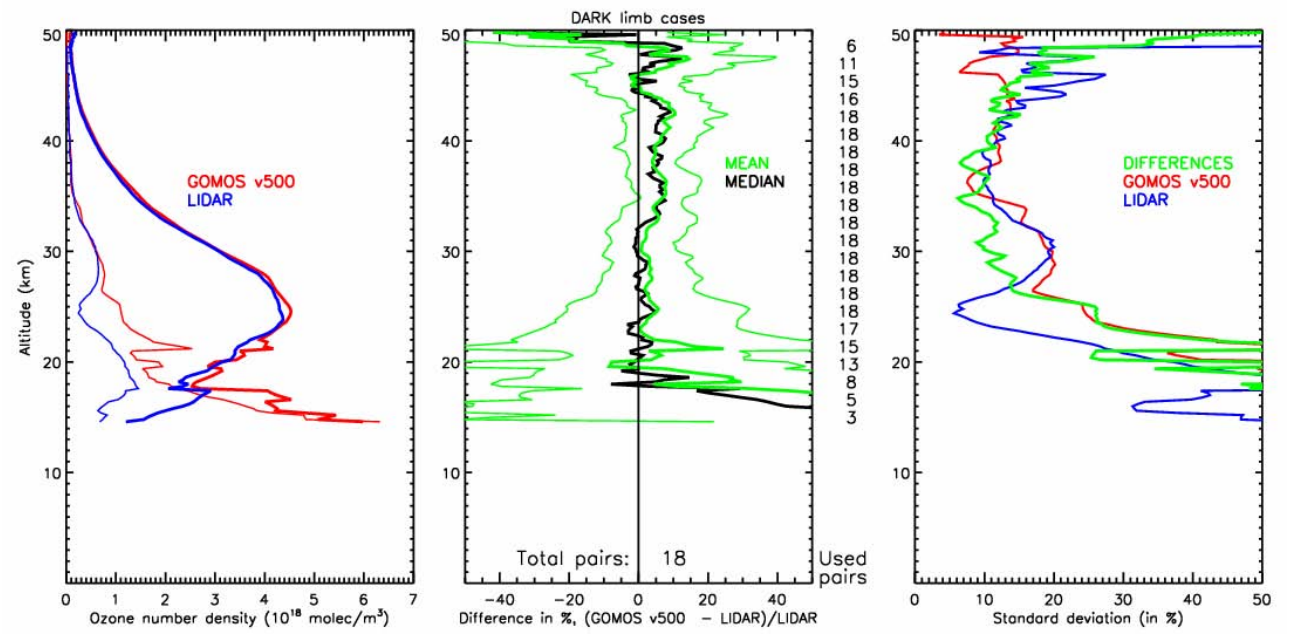

Figure 3. Same as Fig. 2, but now showing averaged analysis results of GOMOS (IPF v5.00) compared to LIDAR ozone profiles (data are from second half of 2006).

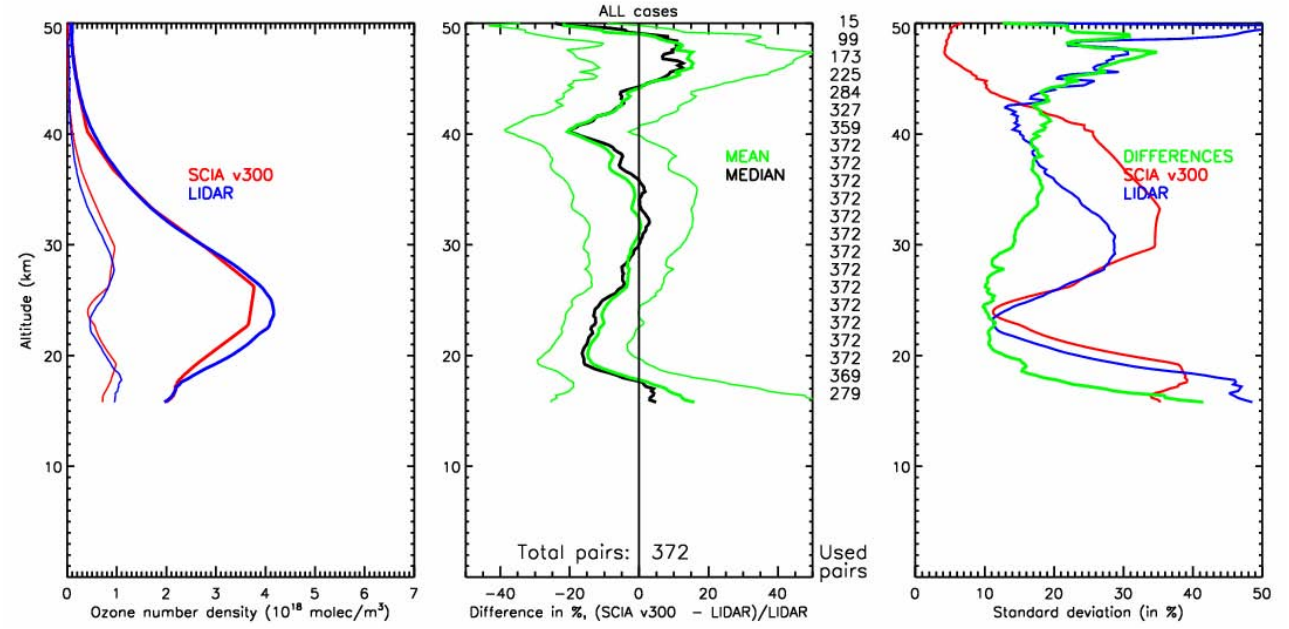

Figure 4. Same as Fig. 2, but now showing averaged analysis results of SCIAMACHY (IPF v3.00) compared to LIDAR ozone profiles (data are from second half of 2006).

positive bias throughout the stratosphere is observed ranging from 0 to 20%. This bias is higher than the one currently established for the mission in full resolution measurement mode [3]. Despite the deteriorated averaged bias, individual comparisons show astonishing agreement in the high vertical structures in the profile.

3. NEW PROCESSING OF GOMOS AND SCIAMACHY OZONE PROFILES, 2006

Since July 2006 both GOMOS and Sciamachy limb data are operationally processed by ESA with two new IPF algorithms, IPF 5.00 and IPF 3.00, respectively. For GOMOS this should yield the same results as the prototype processor (GOPR 6.0d), which was used for

the mission reprocessing covering July 2002 until July 2006. For Sciamachy it is a new algorithm developed for the processing of its limb profile measurements. The EQUAL project not only aims at monitoring new algorithms but also monitors the data quality of recently measured data. Therefore we have analyzed these new data by comparing them to LIDAR data which were measured in the second half of 2006. The new GOMOS analysis results (IPF 5.00) are shown in Fig. 3 and for Sciamachy (IPF 3.00) in Fig. 4.

The analysis results derived from these recent data sets and processing algorithms are in line with the results presented in [1, 2]. Therefore we conclude that the operational processor and the prototype of GOMOS retrieve the same results, as expected. We also conclude that the results of the validation reference set of Sciamachy were not unique and the same negative bias is observed in recent data. This also applies to the altitude shift in the profiles which remains present with the current algorithm.

4. ALTITUDE SHIFT IN LIMB OBSERVATION, MIPAS AND SCIAMACHY

Limb observations require a high accuracy of Envisat's attitude information. Currently this information has been too inaccurate for profile retrieval, and consequently MIPAS and Sciamachy ozone profiles represented on an altitude scale demonstrate shifted profiles. As these instruments observe the atmospheric limb in opposite directions, compared to each other, also their corresponding shift has a different sign. Sciamachy observes the atmospheric limb in the platform's flight direction while MIPAS looks backward.

As an illustration of how this shows up in retrieved profile data, we have found lidar data in coincidence with either two or even three satellite instruments. These triple and quadruple profile comparisons are shown in Fig. 5. The positive altitude shift of Sciamachy profiles is sometimes concealed as these data have a negative bias in the ozone concentrations (see section 3). In order to reveal such shifts we have established an objective method based on correlation [2, 4]. We found that Sciamachy profiles have a shift upward of about 1 km. MIPAS profiles, represented on an altitude grid, have a downward shift of about 1 km. More information on the MIPAS shift and other results of MIPAS in RR mode can be found in [5].

In the satellite data processing there has been an improvement in the derivation of the limb pointing retrieval. Nevertheless, there is clearly a remaining altitude offset which is consistent for both instruments and as expected with opposite signs. Initiatives by ESA and other parties trying to resolve this remaining issue already show promising results and should hopefully eliminate this remaining problem in the profile data of future processing.

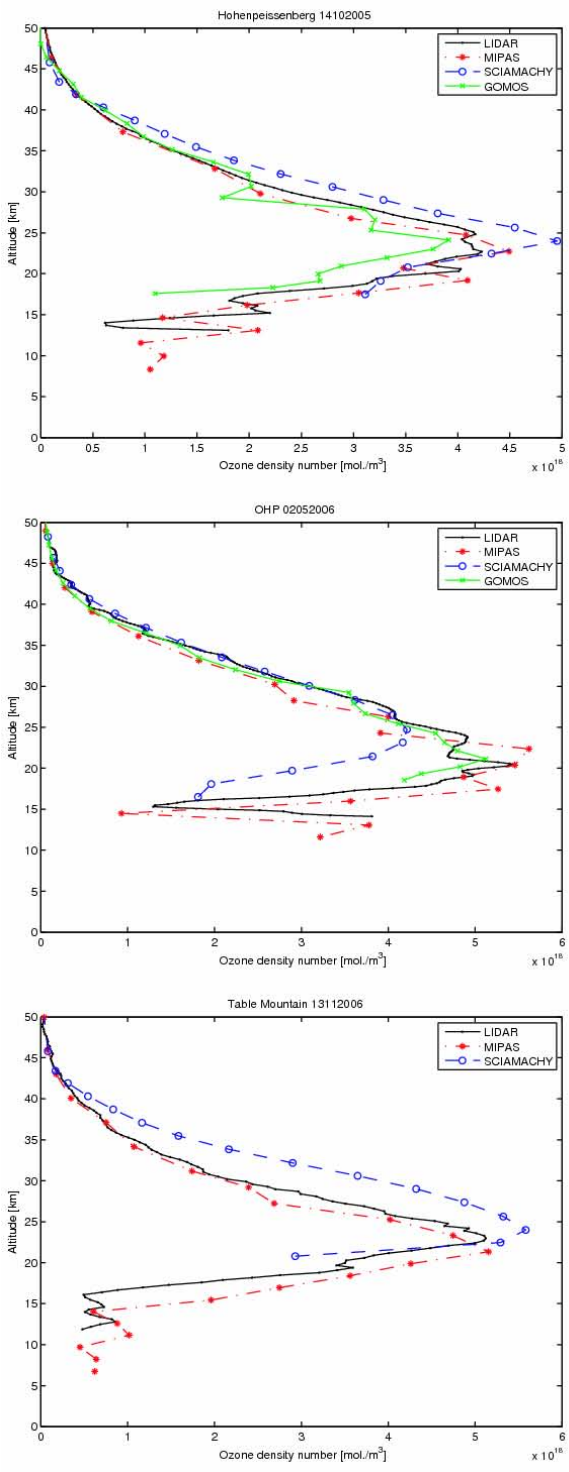

Figure 5. Triple and quadruple comparisons of GOMOS, MIPAS, Sciamachy and LIDAR observations at one location. MIPAS altitude data were used illustrating the presence of an altitude shift.

5. REFERENCES

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