Response to reviewers' comments

We thank both reviewers for their attention to our paper acp-2009-805: **"**Climatology and comparison of ozone from ENVISAT/GOMOS and SHADOZ/balloon-sonde observations in the southern tropics". We kindly acknowledge their comments and suggestions. We present here the detailed replies of each referee comment.

Review #1

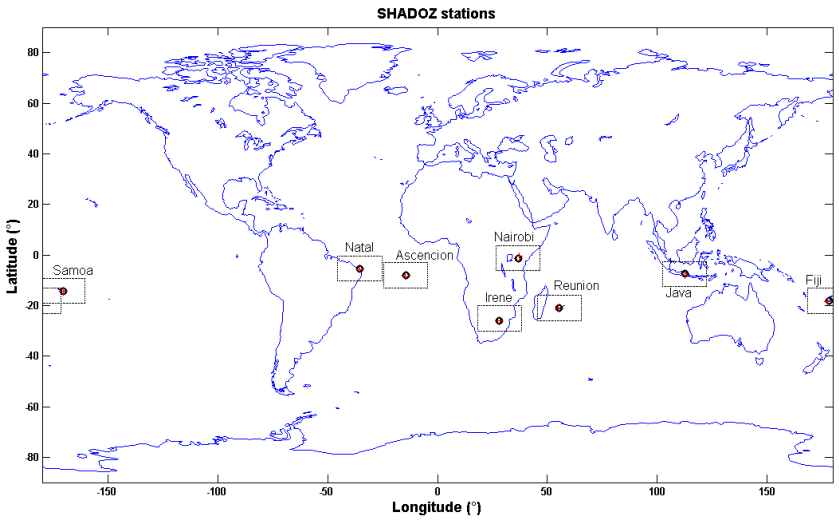
Reviewer #1

The course spatial sampling of GOMOS RATHER than any instrumental errors associated with the ozonesonde would explain the large differences between GOMOS and the sondes. It is remiss of the authors not consider GOMOS course sampling (5x10!!) as a source of error.

Authors

This is correct. The course spatial sampling of GOMOS could be considered as a source of error. In order to consider that course sampling effect, we compute the latitude/longitude averages for every site. The figure below represents the map of SHADOZ stations selected in the SH and the region of latitude and longitude discrepancies (±5°, ±10°). We note that the latitude/longitude averages (depicted in red-cross symbols) derived for all GOMOS profiles and for each station show good coincidence with actual sites' coordinates. Indeed, this suggests that the error due to GOMOS course sampling is minor.

This point is clarified in the revised manuscript.



Reviewer #1

You already quoted the Thompson et al. and Johnson et al. studies which show a ~5% precision error. Ergo, difference > 5% seen above 21 km are not due to the sondes. I do not accept the speculation that the sonde altitude registry is the only error to consider in the summary. The authors should expand their discussion to include GOMOS instrument errors which I feel has not been well explained, particularly since the authors take the view of ozonesonde measurements as 'truth'.

Authors

We agree with this comment. In fact, the sonde altitude registry is not the only error to consider. GOMOS instrumentals errors could introduce some biases and are to be taken into account. As reported by Tamminen et al. (2010), the main sources of GOMOS errors are due to random effects: measurement noise and scintillations (10% around 15 km and 0.5% to 4% in the stratosphere, values correspond to nighttime measurements). And the largest part of the systematic error is due to imperfect aerosol modeling which impacts mainly the O_3 retrievals (others sources of systematic errors are due to uncertainties in cross sections of the trace gases and in the atmospheric temperature). Scintillation caused by air density irregularities is a nuisance for retrievals of atmospheric composition. In GOMOS retrievals, the scintillation effect is corrected using scintillation measurements by the fast photometer (Sofieva et al., 2009). The remaining perturbations, due to the incomplete scintillation correction, are not negligible. It induces an error of 0.5–1.5% in ozone retrieval at altitudes 20–40 km; see recent studies of Sofieva et al. (2009) and Tamminen et al. (2010) for more details.

We clarified this in the discussion and the summary of the revised version.

Reviewer #1

Meteorology is also not taken account. Sampling of different air masses far from the location of the sonde launch locations is also another source of the differences. One cannot expect the sondes to ascend in a straight line to 30km. Unfortunately, without GPS sondes a true comparison cannot be made.

Authors

The displacement of the sondes from 0 to 30 km is most of the time smaller than 120 km (assuming a wind speed < 20ms^{-1} and an ascent time of 6000s, 5 ms^{-1} ascent speed) which is small compared to the area of GOMOS observations around the station (±5°, ±10°). This effect is then not a large source of error. The meteorology may represent a source of the differences between GOMOS and SHADOZ, but it does not have a significant effect.

It was clarified in the revised version.

Technical corrections: All technical errors (×2) have been taken into account in the revised manuscript.

Review #2

Reviewer #2

However, it fails to present a robust validation (by direct comparison of collocated measurements) of the GOMOS measurements for these stations. No comparison of direct collocated measurements is performed.

Authors

This point is discussed below in the 2nd specific comment.

Reviewer #2

In addition to that, I recommend to extent the climatology and validation to a global data set, using for the validation the global ground-based/balloonborne, data set used in Meijer et al. 2004, in order to reach a data set which is of use to a wider science community

Authors

Contrary to the northern hemisphere, ground based stations in the southern hemisphere are very sparse. Moreover, the tropical stratosphere is a region where ozone is created by sunlight and where significant changes are expected to occur. The tropical stratosphere is however a region where it is difficult to measure ozone by satellite experiments because of increased Rayleigh atmospheric attenuation, high altitude clouds, low temperature, high humidity and dense aerosols (Borchi et al., 2007). It is therefore essential to compare the few stations operating in the SHADOZ project with the performances of the stellar occultation instrument GOMOS.

We clarified this point in the introduction of the revised version.

However, the extension of the climatology and validation to a global data set is a good suggestion for future studies.

Reviewer #2

The paper also misses a discussion of the results, especially on the usage of the presented GOMOS ozone climatology.

Authors

This is correct. In the revised version, we expand our discussion on the results especially on the implication of the GOMOS instrumental errors (explained in response to the 2nd reviewer #1's comment) and we included the usage of the GOMOS ozone climatology. The usage of the presented climatology could lead to the GOMOS primary objective, i.e, study and assessment of trends in the stratosphere. Furthermore, as reported by Bertaux et al. (2000), it could be essential for improving atmospheric models for prediction of future changes.
This was added in the revised version.

Specific Comments:

Reviewer #2

1. Some typos:

Page 1460, line 9: "In Fact" should be "In fact".

Page 1463, line 14: "Additionnaly" should be "Additionally".

Figure caption 2, 2nd sentence: change to "The GOMOS dataset has a global coverage for the time period 2002 to 2008, while the SHADOZ dataset covers the years from 1998 to 2008 and ..."

Authors

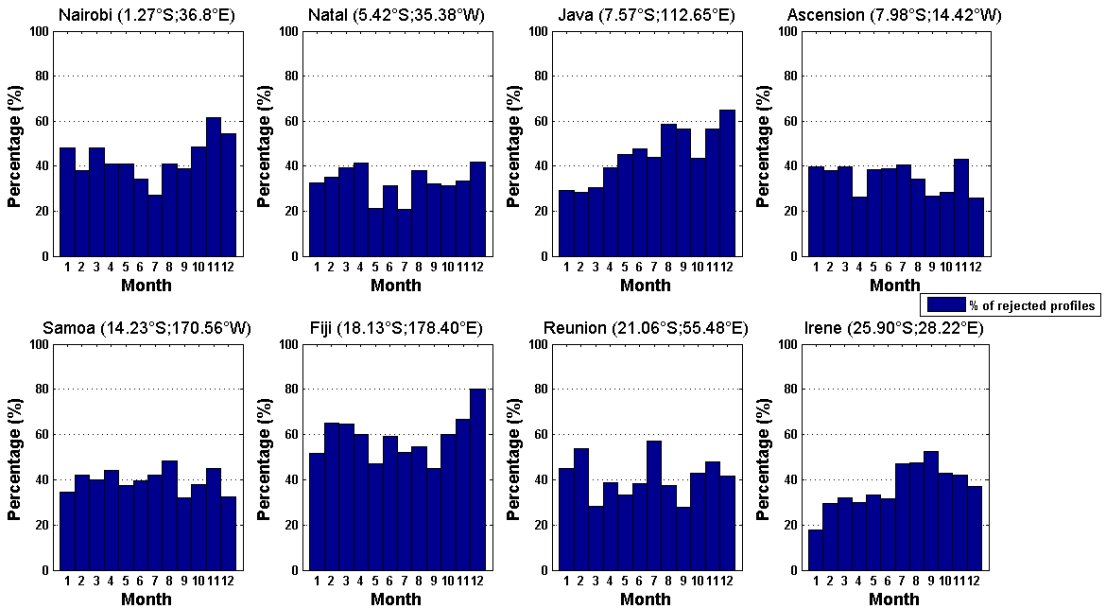
All these modifications have been taken into account in the revised version.

Reviewer #2

2. Page 1465, 2nd paragraph - to detail one of the above mentioned critique: For a robust validation each collocated ozone profile measurement pair of ozone sonde and GOMOS should be analysed for the absolute and relative difference, then over all comparisons at one collocations the mean and RMS should be calculated. By just using the mean values of monthly measurements a bias is introduced since both data sets cover different times and different amounts of data within the months are averaged (also different years are used for the same month).

Authors

In our point of view, the method of comparison applied in the study is also valid and correct. We also used the median as a robust estimator in order to reject outliers on GOMOS profiles. Furthermore, when we consider only the 2002-2008 period of time for the SHADOZ dataset, the number of profiles decreases. As shown in the figure below, in average the percentage of rejected profiles is ~40% for each station. This could lead to a degradation of the statistics. However, we note that comparisons between GOMOS and SHADOZ obtained for the 2002-2008 period are matching well with those derived for the 1998-2008 period.



Reviewer #2

3. Page 1466, last sentence first paragraph: The sentence is unclear. Do you mean that the results for GOMOS compared to SHADOZ at 20-30 km are representative for all monthly averages and stations?

Authors

We agree with the reviewer that this sentence in unclear. It is now changed in the revised manuscript to explain that despite the observed differences there is a satisfactory agreement between GOMOS and SHADOZ in the 20-30 km altitude range.

Reviewer #2

4. Page 1466, line 20: At 27-30 km GOMOS is not larger at all sites!!!

Authors

In the manuscript, we did not write "in the 27-30 km…" but "in the 21-30 km…". In this altitude range (21-30 km), GOMOS is generally larger than SHADOZ at all sites except at Irene and Nairobi.

Reviewer #2

5. Page 1466, 1st sentences and figure caption Fig. 6: "global" median is not the appropriate expression- this is rather the mean and median over all monthly comparisons!

Authors

This modification has been taken into account in the revised version.

Reviewer #2

6. Page 1466, 2nd paragraph: Please make clear what is the use of or outcome for analysing for median and mean of the differences.

Authors

The outcome from analyzing median and mean of the differences allows examining if the statistical distribution of the differences is well represented by a standard Gaussian distribution (mean and median should be quite similar) or if it is strongly influenced by outliers (mean and median are very different).

This is clarified in the revised version.

Reviewer #2

7. Fig 4: The colour range for the 0-15% should have higher contrast in order to pronounce the different levels within this range

Authors

Figure 4 has been changed in the revised manuscript. In the new figure, the color range for 0-15% has higher contrast in order to pronounce the different levels within this range.

Reviewer #2

8. Figure caption 5: Make clear that these differences are based on comparisons of monthly means.

Authors

It is clarified in the revised version.