Response to referee 1

We thank the referee for the comments and useful suggestions. Unfortunately we noticed that the review is based on the originally submitted manuscript and not the manuscript published in AMTD, which has already numerous grammatical corrections. We have only responded to the remarks that are also applicable to the published document.
Each remarks of the referee is given in italic with our response just below the remark.

GENERAL COMMENTS

This is an essential paper that describes an important total column ozone database. Personally, I would have thought that this paper would be more suitable for the Earth System Science Data (ESSD) journal but if the editor is comfortable with the paper being published in AMT then I would certainly have no objection. The paper will be suitable for publication in AMT once the concerns detailed below have been dealt with.

Since the paper contains detailed analyses and validation of the ozone data set, we thought it to be more suitable for AMT.

SPECIFIC COMMENTS

Page 1, line 11: For people who are not experts in the field I think that it would be better to say 'surface observations of the ozone column from Brewer and Dobson spectrophotometers'.

We have changed this.

Page 2, line 17: It is not clear to me what is meant by 'Long consistent'. Perhaps words like 'Multi-decadal structurally homogeneous' better capture what you have in mind?

We changed this according the suggestion of the referee.

Page 2, line 17: Rather than the vague term 'ozone protocol' why not specifically refer to the Montreal Protocol?

We changed this.

Page 2, line 21: How does the 'for quantifying ozone depletion' here differ from the 'trend analysis' 3 lines earlier? Aren't these simply stating the same thing?

We mention here "quantifying ozone depletion" in relation to ozone recovery as a result of the Montreal protocol. In that respect, warming of the atmosphere plays a role here.

Page 3, line 5: You should state what the end year was for version 1 of the database.

We have added the time period for the MSR1

Page 3, line 19: I am not sure that many readers of your paper will understand what you mean by 'the effective temperature of the total ozone'. I think that you need to explain this in more detail.

We start the short explanation of constructing the MSR by stating that details are explained in van der A et al. (2010). The effective temperature is discussed in this paper in more detail.

Page 3, line 27: This section heading is very obscure. Don't you simply mean 'Satellite-based total ozone measurements'?

We changed the title of the section according this suggestion.

Page 4, line 7: You will need to define the 'UV-VIS' acronym here.

We think this is a widely used acronym, which is usually not specified.

Page 5, line 9: Is there a specific reason why the total column ozone measurements from the filter instruments were not used?

This is explained in the discussion of the MSR1 in van der A et al. (2010). We have added a reference to the MSR1 in the text.

Page 7, line 13: You haven't said anything about any differences between version 2.1 and version 2.9 of the Cariolle scheme.

We had forgotten to add the reference to Cariolle and Teyssedre (2007), which was already in our reference list. Here differences in versions are explained.

Page 7, line 20: Could, or should, the rejected observations feed back to suggest additions to your 'blacklist'?

The rejected observations refer to outliers based on the difference between satellite observations and model forecast, while the blacklist is for ground observations.

Page 9, line 14: Do you mean 'restrained' or 'constrained' by the observations?

We changed restrained into constrained.

GRAMMAR AND TYPOGRAPHICAL ERRORS

Page 1, line 18: I would suggest replacing 'the debiased satellite' with 'the bias- corrected satellite'. And elsewhere in the paper I would suggest replacing 'debiased' with 'bias-corrected'.

We prefer to call it debiased as this often used in the literature.

Page 1, line 24: Replace 'extended with 13 years' with 'extended by 13 years'.

Agreed

Page 1, line 19-20: I think that the whole phrase 'driven by meteorological analyses of the European Centre for Medium-Range Weather Forecasts (ECMWF)' can be deleted since this is stated later in the abstract.

Agreed

Page 2, line 3: Replace 'the fifties' with 'the 1950s'.

Page 2, line 5: Replace 'early eighties' with 'early 1980s'.

Page 3, line 29: Replace 'the seventies' with 'the 1970s' and similarly elsewhere.

Page 4, line 23: Replace 'the seventies' with 'the 1970s'.

We have replaced all fifties, seventies, and eighties throughout the text.

Page 2, line 3: Replace 'are observed' with 'have been observed'.

Page 4, line 16: Replace 'Level 2 data is' with 'Level 2 data are'.

Agreed

Page 2, line 3: Replace 'Dobson instruments' with 'Dobson spectrophotometers'.

Agreed

Page 2, line 23: Replace ’its amendments’ with ’its amendments and adjustments’.

Agreed

Page 2, line 24: Replace ’latest WMO scientific assessment’ with ’latest WMO/UNEP scientific assessment’.

Page 2, line 29: Replace ’latest assessment’ with ’latest WMO/UNEP scientific assessment’.

Agreed

Page 3, line 1: Replace ’event splitting up the South Pole vortex’ with ’event that split the Antarctic vortex into two sub-vortices’.

Agreed

Page 3, line 6: Replace ’data has’ with ’data have’.

We have corrected all verb mismatches with the word ‘data’ throughout the text.

Page 3, line 18: Replace ’ground observations of ozone’ with ’ground-based observations of ozone’ since these are not observations of ozone at the ground. Similar changes need to be made elsewhere in the manuscript.

We have corrected this throughout the paper.

Page 4, lines 2-3: Replace ’until the year 2003’ with ’until 2003’.

Agreed

Page 4, line 21: Replace ’are yet too’ with ’are currently too’.

Agreed

Page 4, line 24: Replace ’till’ with ’until’ and likewise elsewhere throughout the manuscript.

We have corrected “till” two times.

Page 5, line 3: I think that it would be clearer if instead of ’made at surface sites’ you wrote ’made at ground stations’.

Agreed.

Response to referee 2

General Comments:

This is an important article in that it gives a comprehensive description about a use- ful total ozone assimilation product of use to the stratospheric community. I like the revision of the title as it clearly reflects what is new about this dataset as opposed to version 1. I would like to see more discussion and comparison to the previous version so that it is clear that more is happening here than a simple extension in the time period covered and higher resolution. I recommend publication, but significant work remains to correct grammar in the text and clarity of the figures.

Specific Comments:

1) P 3286 line 28 to P3287 line 1: I have several comments on the first sentence of this paragraph. First the phrase 'and the time period has been extended' should be deleted since previous paragraph has elaborated that point. Second, the intro sentence now says there are several improvements made to the methodology, but lists only the resolution change. The word 'several' means 3 or more. There are other methodology improvements listed further in the paper which could be mentioned here, for example 2nd order SZA correction, and the use of ERA-Interim instead of ERA-40. Last, as the paragraph stands the emphasis is on the resolution change. Unless new information is added to the product to support a change in resolution, adding more points could be nothing more than interpolation to intermediate points. This and an extension in the time period hardly motivate a new product name (MSR1 vs. MSR2) as there is no genuine difference in the two, simply time extension and interpolation. Even the use of updated satellite data does not justify this since you are then adjusting the satellite data to ground-based which potentially removes and advantage of the reprocessing. I do believe that MSR2 is an improved and distinct dataset and that the increased resolution is more than simple interpolation, but in this introductory section, you have not yet outlined the most significant improvements made in this work.

We have adapted this paragraph by listing the main improvements for the new version of the MSR2:

- Improved spatial resolution of the model runs, assimilation and output.
- The chemistry parameterization of the model has been updated
- The model is driven by three-hourly meteorology.
- New corrections for the satellite data has been derived

2) P 3290 line 16: Those regression coefficients that significantly reduce the RMS between satellite and ground are calculated and applied to the satellite data. What does this mean? How do you determine which to use, and then how are they calculated. Table 2 is the results of all being fit at once. Also the RMS in Tables 2 and 3 seem nearly the same, so it is unclear that your goal of reducing RMS is being achieved. Please elaborate.

The objective was to identify which corrections were needed to remove biases between the datasets. We tested all possible combinations of {time, viewing and solar zenith angles, T_{eff}} to select those parameters that remove a significant fraction of the dependence of the RMS difference between satellite and ground measurement. The results are shown in Table 2

(originally Table 3). We have removed the original Table 2, since it only represents an intermediate result and may cause confusion.

3) P 3295 lines 12-14 and figure 6: The brief statement about the comparison to MSR1 seems lacking and a shallow reasoning for the improvement over MSR1. Indeed one of the aspects that MSR2 handles differently is the SZA corrections of the satellite data. Is there anything of interest in the dependence of OmF and OmA on SZA as demonstrated by the two different versions MSR1 and MSR2?

Figure 6 can directly be compared to Figure 9 in van der A et al. (2010) about MSR1. In this comparison one can see that there is an improvement in bias also for the OmF and OmA as function of the SZA. Figure 8 gives a more direct comparison by showing the OmA results of both MSR1 and MSR2. In the text we added a remark about the improved SZA correction. In the discussion of Figure 8 we added: "The MSR1 shows more pronounced small scale structures with sizes of the order of 500 km."

4) P3295 line 27-3296 line3: It seems that a comparison of OmA between MSR1 and MSR2 would be more informative. Or is it that the OmA so small in both, it is not meaningful? It seems that Figure 8 is the only comparison between MSR1 and MSR2 in the paper that indeed shows where they differ. This deserves more discussion. Indeed there are lines for both in Figure 3, but these virtually overlap. I would like to see more discussion about what the improvements do. Is there a result for the increased resolution?

We think the OmF is more interesting since it also includes the forecast error on top of the analysis error and is an upper boundary of the uncertainty in the ozone fields. Since the processing is very time consuming, we only have results for all improvements together. It is therefore difficult to discuss the effect of increased resolution separately.

5) P3296 line 28: In fact the patterns seem to be mostly latitudinal bands, or perhaps tied to Northern vs Southern hemisphere.

There is no line 28 on this page, but we assume this remark is about Fig. 8. We agree with the referee that there seems to be a slight North-South difference of 1-2 DU, which was stronger for MSR1. We have added this to the paper.

6) P3297 line 10: This statement confuses me: "The data set is based on the observations of 15 different satellite instruments with nadir observation in the UV." This is the first mention of the 'nadir' requirement. Did you only use the nadir data, or was a nadir point critical in choosing the satellite. If you only used the nadir data, then how was Figure 6d created? I probably missed something that explains this.

In this case we meant nadir as opposite to satellites looking in limb direction. We understand this makes it only confusing and we have removed this "nadir" remark.

7) P 3297 lines 23-24: states that OmA is better in MSR2 than MSR1, but you showed OmF instead in Figure 8.

The OmA is shown in Figure 6 and 7. Based on these Figures the conclusion is valid. For Figure 8 we thought the OmF is more interesting to show.

Technical Corrections:

There are many remaining grammar errors. Some are listed below.

1) P 3286 line 8: the verb 'is' should be 'are'. ('applications are' for a proper subject/verb match).

We have changed this.

2) P3289 line 22: Why are the Dobson/Brewers listed in an appendix table? There is no text for an appendix, and the table is discussed in the main text. It is not clear to me why this listing is simply not Table 3. Likewise Table A2 has only 2 columns of information of the 5 presented that are additional to that in Table 1. Perhaps these could be combined.

The annex tables are part of the acknowledgement to all data providers for the ground-based and satellite data used in this paper. We have removed Table 2 to reduce the number of tables.

3) P 3290 lines 8-11. There is a troubling switching of verb tenses. in these lines: 'are avoided', has been created', 'was defined' and 'number is' shows a switch from present tense to various forms of past tense , back to present tense. These several lines could be written as: By fitting all data together, regional biases that be be caused by offsets of individual ground instruments are avoided. For each satellite product an "overpass" dataset is created for all ground station and a maximum allowed distance between the centre of the ground pixel and the ground station is defined (see column "Dist." In Table 1). This number is. . .". These fluctuations in tense occur throughout the paper, for example the very next paragraph has many.

Agreed, we have changed the text here to the present tense.

4) P 3291 line 7: first occurrence of TM5, please define the acronym.

5) P 3291 line 10 first occurrence of TMDAM in the main body of the paper. Please define the acronym.

TM5 and TMDAM are no acronym. They are just the names of the chemistry-transport model

and the data assimilation system.

6) P 3291 14, p3292 line 15 and P3292 line 24-25: you have "3 hourly"," 3-monthly" and "three monthly". Choose to hyphen or not, and to spell out the number or not, and be consistent. It seems to me that '3-month mean' and '3-month average' is preferred (month as opposed to monthly). The term 'monthly' only seems correct when it is a full single month in the mean. So P 3292 line 10 would be "The 6-hour instantaneous and monthly mean ozone fields. . ." for example.

Agreed, we have changed the text.

7) It is appropriate to define acronyms separately in both the abstract and the main body text, it is not typically necessary to define the acronym multiply within the body. If there is justification to do so, then please choose to hyphenate of not consistently: OmF is defined in the abstract (P 3284 line 28) as "observation-minus-forecast (OmF)" and for the first time in the main body section 3 (P 3292 lines 4-5) as a paraphrased text, again in the main body section 4.2 (P3293 line 5) as observation minus forecast (OmF) without hyphens, again in section 4.3 (p3294 line 11 with the hyphens, I the Figure 4 caption without the hyphens. Be consistent please.

We have changed this to "observation-minus-forecast" with hyphens throughout the text.

8) P 3293 line 3 "time independent" and "time-dependent" should either both be hyphened or not.

We have changed this.

9) P3296 line2: MSR1 graph is no longer an inset in this version.

We have changed this.

10) Figure 1: The years are unreadable. Perhaps best to only print every other year, and enlarge them.

We have enlarged the text in this Figure

11) Figure 2: The axis labels are too small. Replace Nr. With #.

Here, the text has also been enlarged and Nr is replaced with #.

12) Figure 3: Change: 'the orange line model values' to 'the orange line shows the model values' to avoid confusion of the use of the word model. All of the text in this figure is too small.

The caption has been adapted. If the text in this Figure will be enlarged further, the plot itself will become very small, therefore it might be better to publish bigger Figures above each other.

13) Figure 4: The grey titles on the right axis are too light and too small. In the caption unify the presentation of Observation minus Forecast. In the text you often use hyphens and always use lower case.

We have increased the font size of all the text and made the grey scale darker.

14) Figure 6: The fonts are upgraded here and more readable. Use these fonts on the other figures. In the caption change "the dashed lines represents" to "the dashed lines represent". A case of subject/verb mismatch.

The caption has been adapted

15) Figure 9: The lines need to be thicker. What does msr214 refer to?

We have removed the plot title to avoid confusion. We do not think the lines should be thicker for this Figure.

16) Figure 10: The Key is too light. The lines need to be thicker.

The Figure has been adapted.