We are grateful to the three reviewers for their helpful and thoughtful comments. The following provides point-to-point responses to the questions from Reviewer 1.

Reply to Reviewer #1

- Observational database: The presented ozone climatology is based on ozone soundings only. Due to the limited spatial coverage of the measurement stations this leads to data gaps in the climatology. Would it be possible to use other in-situ data like MOZAIC to fill these gaps?

Reply: Yes, this is an excellent suggestion. Extending this dataset with other datasets available, such as MOZAIC (for the troposphere) and SAGE + OSIRIS (for the stratosphere), is planned. Preliminary results for MOZAIC show excellent agreement with the tropospheric sonde climatology, where MOZAIC has coverage.

- In the introduction it is mentioned that there are similar ozone climatologies based on trajectory mapping methods. One plus of the present dataset is certainly the length of the data record. Nevertheless, some more motivation would be desirable. How do trajectory approach and results compare to other studies?

Reply： Two such studies are mentioned. Stohl et al. (2001) used only one year of MOZAIC data, so coverage was limited in both time and space (there was poor coverage in the southern hemisphere). In addition, MOZAIC data do not generally reach the stratosphere, although some flights reach the lowermost stratosphere at northern latitudes. As we note above, an independent climatology derived from MOZAIC data show excellent agreement with the tropospheric sonde climatology, where MOZAIC has coverage. The Schoeberl et al. (2007) study used trajectory-mapped MLS data to fill gaps in the stratospheric coverage in order to derive the tropospheric ozone column. We have not yet compared these products with ours but that is also planned.

Our climatology is therefore unique, as the others we cited do not use trajectory-mapping, and most are not three-dimensional.

- Sect. 2.1: The ozone stations use different types of ozonesondes, and at some stations there was a change in the sonde type during the long-term ozone record. In those cases, was there any homogenization of the data record? Does a change in the sonde type introduce any bias to the derived ozone climatology?

Reply: Yes, different types of ozonesondes have been used during different periods. No attempt has been made to homogenize the data record; data submitted to the WOUDC have been processed and screened for quality by the station operator and can be expected to represent the station's best effort at accuracy. Past practices are currently being re-evaluated and station data records homogenized under the Ozonesonde Data Quality Assessment activity of the SPARC /IGACO

/IOC /NDAAC[1] initiative on "Past Changes in the Vertical Distribution of Ozone". Future versions of the climatology presented here may then use the re-evaluated data. The current version uses the data as they currently are found in the WOUDC. The biases introduced by such changes are generally small, and will be an important consideration only when deriving long-term trends.

- P 16839, l 6: Why do you use 4-day trajectories? In Sect. 4.4 it is mentioned that the results improve with 6-day trajectories. How was the "optimal" length of the trajectories determined?

Reply: We conservatively took 4 days as the limit for this work. Stohl and Seibert (1998) found, using Absolute Horizontal Transport Deviation (AHTD) and Absolute Vertical Transport Deviation (AVTD) as measures, the minimum AHTD for three-dimensional trajectories to be ~200 km after 2 days, increasing to ~500 km after 4 days and to 1000 km after 6 days, while the minimum AVTD was ~200, 800, and 1000 m, respectively, after 2, 4, and 6 days, for trajectories starting from the stratosphere. Tropospheric trajectories show increases of AHTD and AVTD over time that are even larger (Stohl and Seibert, 1998). We found that 4-day trajectories usually provide near or over 70% coverage in recent decades in the stratosphere and troposphere (see Liu et al., 2013 and Section 4.4). In the troposphere, we found that standard errors in the ozone field become larger with 6-day trajectories, as we expect from the growth of trajectory errors.

- P 16839, l 14-16: What is the purpose of the two vertical coordinates? Which one is used in the paper?

Reply: The two vertical coordinates are convenient for different applications. One of the motivations for developing this dataset is to provide an a priori for the atmospheric modeling community. We consulted with modelers in the community and had requests for both coordinates. In future work, pressure coordinates may also be provided. The coordinate from sea level is used in the paper. This information is now added in the text.

- P 16849, l 1-2: Which tropopause height is used to separate tropospheric and stratospheric ozone data? The NCEP/NCAR tropopause? How good are tropospause folds.

Reply: In fact, all figures and tables in this paper are only based on the conventional ozone climatology (the first dataset mentioned in the paper) that does not separate tropospheric and stratospheric ozone data. For the second and third datasets mentioned in the paper, tropopause heights were determined from each ozonesonde profile according to the World Meteorological Organization

[1] SPARC – Stratosphere-Troposphere Processes And their Role in Climate
IOC = International Ozone Commission
IGACO = Integrated Global Atmospheric Chemistry Observations
NDACC = Network for the Detection of Atmospheric Composition Change

(1992) criterion, that is, the lowest height at which the temperature lapse rate falls to 2ºC/km or less, provided that the average lapse rate for 2 km above this height is also not more than 2º C/km. Profiles without a defined tropopause were excluded. Tropopause folds are not separately analyzed in this paper.

- Fig. 2: It is hard to identify the differences between the soundings and the trajectories. A plot showing differences between Sonde and Traj might be better, similar to Fig. 4.

Reply: A plot with the relative differences is added and discussed.

- Fig. 4: Wouldn't it be better to show the difference between SAGE and Traj? I guess you want to validate the trajectory-based climatology against SAGE and not the sonde data, right?

Reply: The purpose of Figure 4 is to compare the trajectory-derived ozone climatology (Traj) and the SAGE data with the sonde data, i.e. to use the sonde data as a standard. The comparison between Traj and SAGE for the same location and time period is made in detail in Figures 5-7. In Figure 4, the ozonesonde and SAGE profiles are coincident, while ozonesonde and Traj profiles are at the same location, month, and decade. Nevertheless, we hope the reader can draw the mean difference between Traj and SAGE profiles from Figure 4 without much difficulty.

- P 16842, l 26: The plots for JJA show the smallest scatter for all three cases. Any idea why this is the case?

Reply: The validation with ozonesonde and satellite data is generally better in JJA than in other seasons (see Figures 4, 5, and 7 and Table 3). This may be due to that wind speeds in JJA are not as strong as in other seasons, reducing trajectory lengths. The lower scatter in the SAGE measurements in JJA is most likely because geophysical variability is generally lower during this season in the Northern Hemisphere where more sonde measurements are available.

- P 16844, l 6: What do you mean by "individual station biases"? Please be a bit more precise.

Reply: More precise discussion is now provided in Section 3.2.

- Fig. 8 and 9: Why do you use different types of plots to compare the ozone climatology with SAGE and OSIRIS data, respectively?

Reply: The SAGE ozone data cover a longer periods than OSIRIS data, and have been more extensively validated and studied. The OSIRIS data were analyzed as a supplement to cover recent years. We summarized this comparison in fewer plots as we thought it is less important.

- Sect. 4.2, Table 4: Do the decadal ozone changes agree with ozone trends derived from other observational datasets? A bit more discussion of the results presented in

Sect. 4 would be desirable.

Reply: More discussion now is provided in Section 4.2, in comparison with earlier observations of ozonesonde and SAGE data.

- P 16846, l 21/22: From Fig. 13 I got the impression the latitudinal gradient shows a maximum in winter and a minimum in summer, not in spring and fall, at least on the Northern Hemisphere.

Reply: Thanks. The maximum and minimum are now discussed for the Northern and Southern Hemispheres separately. More quantitative information is provided.

- P 16848, l 7/8: Why do you use 4-day trajectories for the climatology when you get better results with 6-day trajectories?

Reply: Please also see our reply on P 16839. As found by Stohl and Seibert (1998), trajectory errors grow with time. Although 6-day trajectories seem to give larger coverage and to slightly decrease the standard errors in the stratosphere, in the troposphere, we found that standard errors in the ozone field become larger with 6-day trajectories. In addition, the ozone lifetime can be shorter than 6 days in the troposphere, especially near the boundary layer. Therefore, 4-day trajectories were used throughout this study.

- P 16850, l 24-26: This statement is true for HALOE, but not necessarily for SAGE-II.

Reply: The statement is rephrased.

- P 16851, l 1-2: It's hard to say which dataset gives the best results in the troposphere, but from Fig. 16 I would say that SAGE-II shows the best agreement with the ozone sondes, at least in the lower troposphere.

Reply: The statement is rephrased.

- In general, I would like to encourage a more careful and profound presentation and discussion of the new ozone climatology. Not everything improves with the new dataset.

Reply: Thanks. Some limitations of this ozone climatology are discussed in Summary and Conclusions.

- Conclusions: Are there any plans to extend the climatology to the most recent years (2009-2013)? Is the trajectory-based ozone dataset publicly available?

Reply: Yes, in fact this has already been done (very recently) and is available. Additional work with MOZAIC and SAGE data is underway. We are in the process of making the trajectory-based ozone dataset available at the WOUDC website. Currently, the reader is encouraged to contact the authors for access to the dataset.

- P 18640, l 25: Northern

Reply: Changed.

- P 16849, l 13: 30 N and 70 N

Reply: Thanks. This is changed to 30 °N to 70 °N.

-Fig. 1: People with red-green blindness might have problems to distinguish the red and green dots.

Reply: Thanks for the reviewer's care. The color is changed to blue.

-Fig. 10, lower right panel: (g) -> (h)

Reply: This is changed in Figure 13.