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 3.

Reply to Reviewer #3

The authors should clearly point out, what the advantage of this data set over existing data bases and climatologies is. Particularly their method, which includes stratospheric vertical motion on the basis of reanalysis data should be evaluated more in detail. What is the uncertainty which is introduced by the vertical motion in particular in stratosphere, where vertical ozone gradients are large and vertical motions from reanalysis data have a large error? Does the climatology cover the seasonality of polar ozone correct? Seasonally resolved plots of vertical cross sections would be interesting here. Also a quantification of the error introduced by the vertical wind would be useful (by e.g. showing the variance).

> *Reply: We agree with the review that there are significant uncertainties associated with vertical motion in trajectory mapping. To the extent that errors are random, though, they may be expected to be reduced by averaging, and as Figure 14 shows, most 5x5 degree bins contain many samples. We made comparisons of trajectory-derived vertical profiles with ozonesondes and satellite data explicitly in Figures 2, 4, 8, and 9. Seasonal variations of ozone at different altitudes are assessed in Figures 2, 4, 7, 8, and 9 for the globe and at selected stations including a site (Eureka) in the Arctic. Vertical distributions of ozone in a long term and for different seasons are displayed in Figures 2, 8, and 10. These comparisons suggest that the current trajectory calculation does capture vertical motion adequately, even over the UTLS region where ozone vertical gradient is very sharp. However, we do find what appears to be bias in the vertical motion over mountainous regions, as noted in the paper. As noted in the paper, we have more confidence in the ozone climatology in the northern hemisphere than in the southern hemisphere, where there are fewer ozonesondes and radiosondes. The advantages of this ozone datasets are now explicitly stated in Summary and Conclusions.*

p.16839: What is the resolution of the driving NCEP reanalysis data to construct the trajectories? Which time step was used for the trajectory calculation? Does HYSPLIT use the 3-D kinematic wind fields for vertical motions or are diabatic heating rates used? This is particularly important for the bias in Fig.7, which is large over elevated terrain. Is there any physical motivation to use a 4 day period for the calculation?

> *Reply: The resolution of the driving NCEP reanalysis data is 2.5° by 2.5° in latitude and longitude. Trajectories were calculated every hour and output every 6 hours. NCEP reanalysis provide the 3-D kinematic wind fields, including vertical motions. 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 (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). Please also see our reply to Reviewer 1 on similar questions.

p.16840, l-5: What kind of tropopause is used? Dynamical or WMO? If WMO, how are the tropopause breaks included?

Reply: Actually, all figures and tables in this paper are based on the conventional ozone climatology (the first dataset mention in the paper) that does not require the use of tropopause. For the second and third datasets mentioned in the paper, Tropopause heights were determined for each profile according to the World Meteorological Organization (1992) criterion. Tropopause breaks are a feature of the atmospheric circulation, and so are present in the NCEP analysis fields that drive the trajectory analysis.

p.16844, l.1-5: If the terrain induced vertical motion were responsible for the large bias over mountains, why is no effect evident over the two Americas? This could be eventually checked by comparing mean vertical velocities of the trajectories (or the variance of vertical velocity).

Reply: A negative bias against SAGE over mountains is visible along the west coast of the two Americas in JJA at 19.5 km (Figure 7). It is also (we think) visible in that region in DJF at 19.5 km, although not in the southern part of South America, due to missing data. The bias is more obvious over Tibet and Greenland, probably because these large regions have higher average altitude than the western Americas.

The authors should include a refernce to the work by Hassler et al., ACP, 2013 (which was not yet available in the final version, when this manuscript was published).

Reply: Indeed. We now cite and briefly discuss this interesting paper.

Another open question is the analysis of free tropospheric ozone, where satellites have restrictions due to clouds, the stratospheric column and vertical resolution. Why do the authors not stronger emphasize the tropospheric data? Does the method give valid data there?

Reply: Yes, the tropospheric ozone results are quite good. A paper using the same approach appears in this issue: "A global tropospheric ozone climatology from trajectory-mapped ozone soundings". Since that paper discusses the tropospheric results, we have focused here on the stratosphere.