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Supplement of

Evidence for a continuous decline in lower stratospheric ozone offsetting ozone layer recovery

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The following figures provide supporting evidence and information for the main journal article.

**Figure S1:** 1998-2016 ozone change. As for Fig. 1 of the main article; from left to right, SWOOSH, GOZCARDS, SBUV-NOAA, and SBUV-NASA composites.

**Figure S2:** Example results of the merging procedure detailed in Ball et al., 2017, applied to GOZCARDS (dark blue), SWOOSH (light-blue) ozone composites in the 0-10°N band at four pressure levels indicated in the top right of each panel. The resulting Merged-SWOOSH/GOZCARDS timeseries is shown as a dashed-black line with two standard deviation uncertainty in grey shading.
Figure S3: SAGE-II/OSIRIS/OMPS posterior distributions for the 1998-2016 ozone changes. See caption of Fig. 2 of the main article for details.
Figure S4: SAGE-II/CCI/OMPS posterior distributions for the 1998-2015 ozone changes. See caption of Fig. 2 of the main article for details.
Figure S5: The fraction of data available for the (top) stratospheric column ozone and total column ozone, (middle) upper stratosphere, and (bottom) lower stratosphere posterior estimates in Fig. 2 of the main article, and Figs. S3 and S4. Global (right) are much lower in SAGE-II/OSIRIS/OMPS and SAGE-II/CCI/OMPS because if data are missing in any latitude in a particular month, the global partial column or stratospheric column ozone is assigned no data.
Figure S6: Posterior distributions in the middle stratosphere for the 1998-2015/2016 ozone changes. Similar to panels in Fig. 2 of the main article, but for the middle stratosphere (32-10 hPa, ~24-32 km) for (top) Merged-SWOOSH/GOZCARDS, (middle) SAGE-II/CCI/OMPS, and (bottom) SAGE-II/OSIRIS/OMPS.
Figure S7: SAGE-II/OSIRIS/OMPS (red), SAGE-II/CCI/OMPS (black) at 30 and 17 km (upper and lower pair, respectively), and Merged-SWOOSH/GOZCARDS (blue) at pressure levels of approximately the same altitudes at 10 and 83 hPa, respectively. The upper panel of each pair shows the deseasonalised changes relative to 2005--2013, and the lower panel shows SAGE-II/OSIRIS/OMPS and Merged-SWOOSH/GOZCARDS relative to (i.e. minus) SAGE-II/CCI/OMPS. Approximate dates when OSIRIS and OMPS were introduced into the composites are shown with vertical red lines, before/after which a shift in the mean appears.
Figure S8: Ozone over Arosa, Switzerland, 1970-2016. (a) Absolute ozone from SBUV total column ozone overpass observations (red) compared to the ground-based Arosa total column ozone observations (black), with Arosa shifted to the SBUV mean for 1998-2013; (b) as for (a) with the seasonal cycle removed; (c) the monthly difference between timeseries in (b) and a 24-month Gaussian smoothing (thick line).
**Figure S9:** SOCOL-SD posterior distributions for the 1998-2015 ozone changes. See caption of Fig. 2 of the main article for details.
Figure S10: WACCM-SD posterior distributions for the 1998-2014 ozone changes. See caption of Fig. 2 of the main article for details.
Figure S11: As for Fig. 3 of the main article, but with deseasonalised and regression model timeseries from SOCOL-SD (purple) and WACCM-SD (blue). DLM results for SBUV total column ozone and Merged-SWOOSH/GOZCARDS are retained in this plot from Fig. 3 of the main article; see Fig. 3 of the main article for more details.
Figure S12: As for Fig. 3 of the main article and Fig. S11, but with deseasonalised model timeseries only from WACCM-SD using MERRA-1 (blue) and MERRA-2 (red).
Figure S13: Mean and two standard errors of tropical column ozone change between 2005 and 2016 from OMI/MLS. The upper panel shows the absolute levels in 10° latitude bins in 2005 (blue) and 2016 (red), while the lower panel gives the difference between 2005 and 2016 with combined errors, similar to the right panel of Fig. 4 of the main article.

Supplementary references: