Inconsistencies between chemistry climate model and observed lower stratospheric trends since 1998
(Ball et al.)

Supplementary materials

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

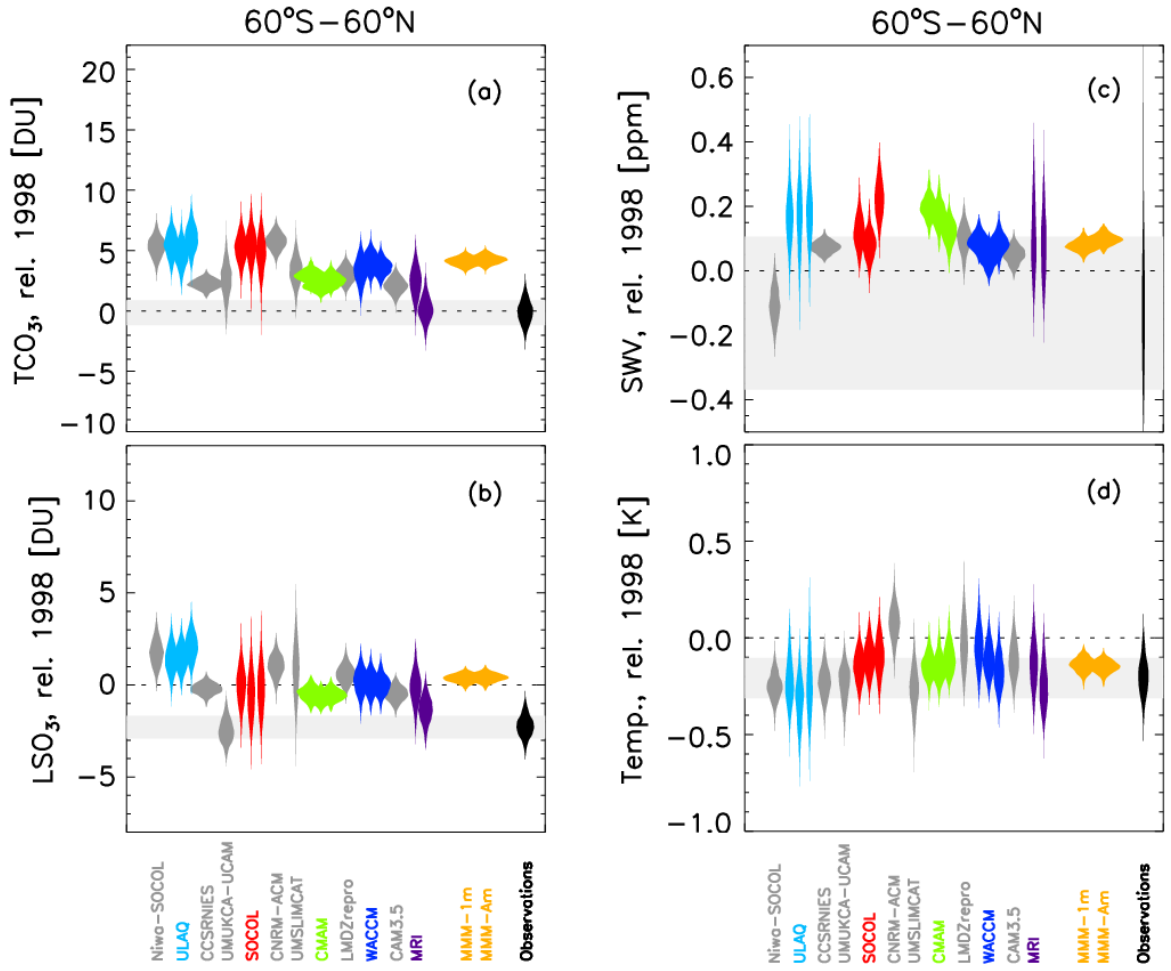

Figure S1: Stratospheric 1998-2016 60ºS-60ºN changes in models and observations. As for Fig.2: (**a**) Total column ozone, (**b**) lower stratospheric ozone, (**c**) stratospheric water vapour, (**d**) temperature. See Fig. 2 caption for details.

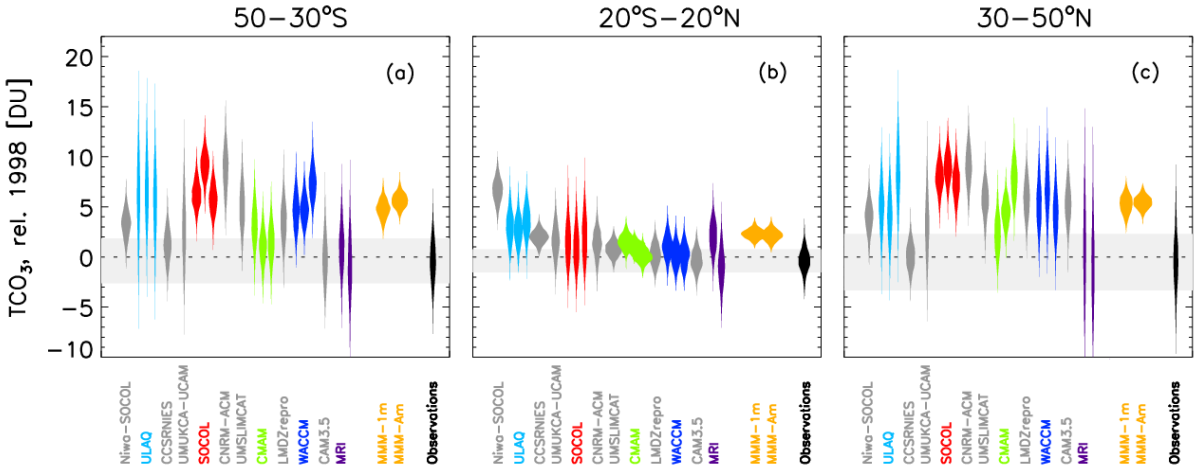

Figure S2: Total column ozone 1998-2016 changes in models and observations. See Fig. 2 caption for details.

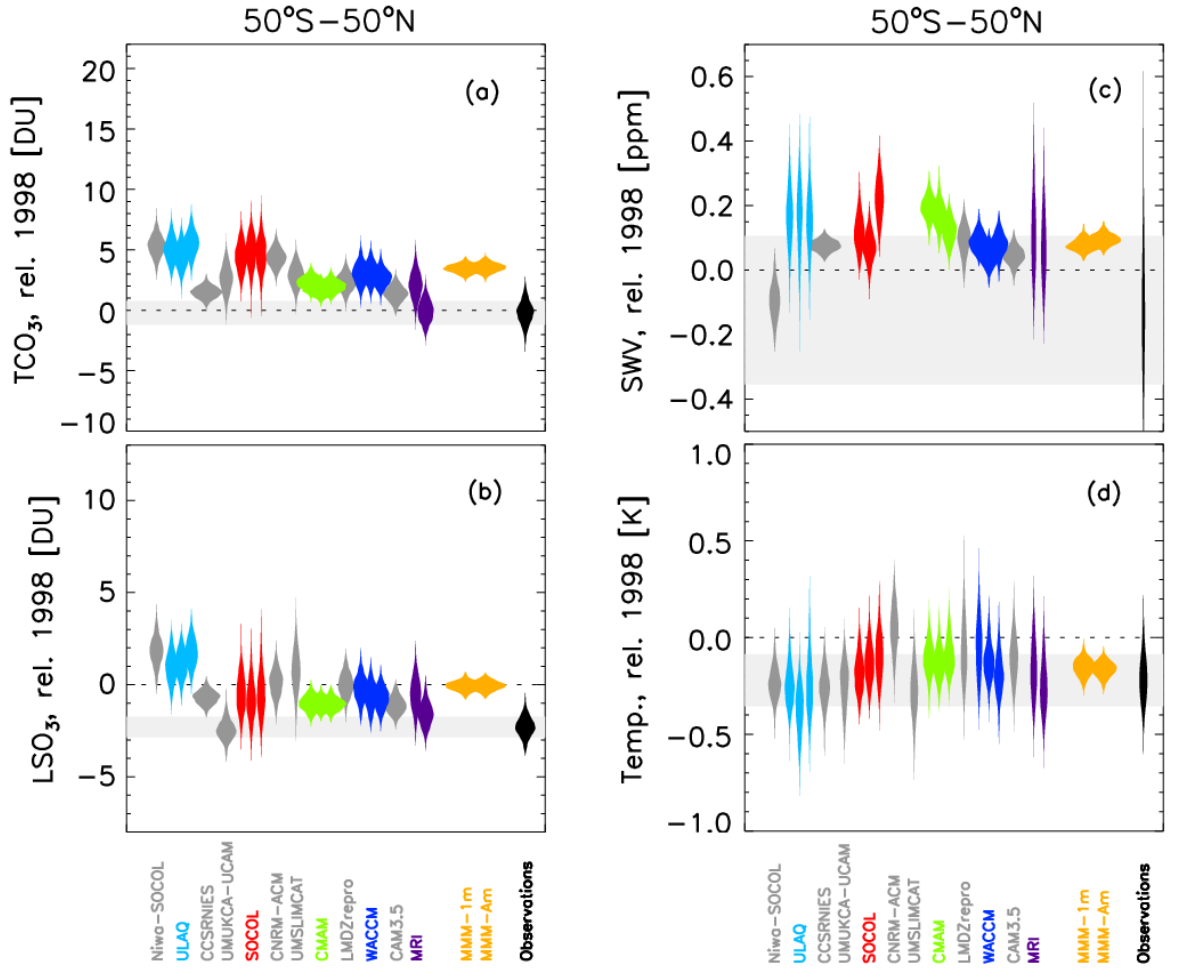

Figure S3: Stratospheric 1998-2016 50°S-50°N changes in models and observations. (**a**) Total column ozone, (**b**) lower stratospheric ozone, (**c**) stratospheric water vapour, (**d**) temperature. See caption of Fig. 2 for details.

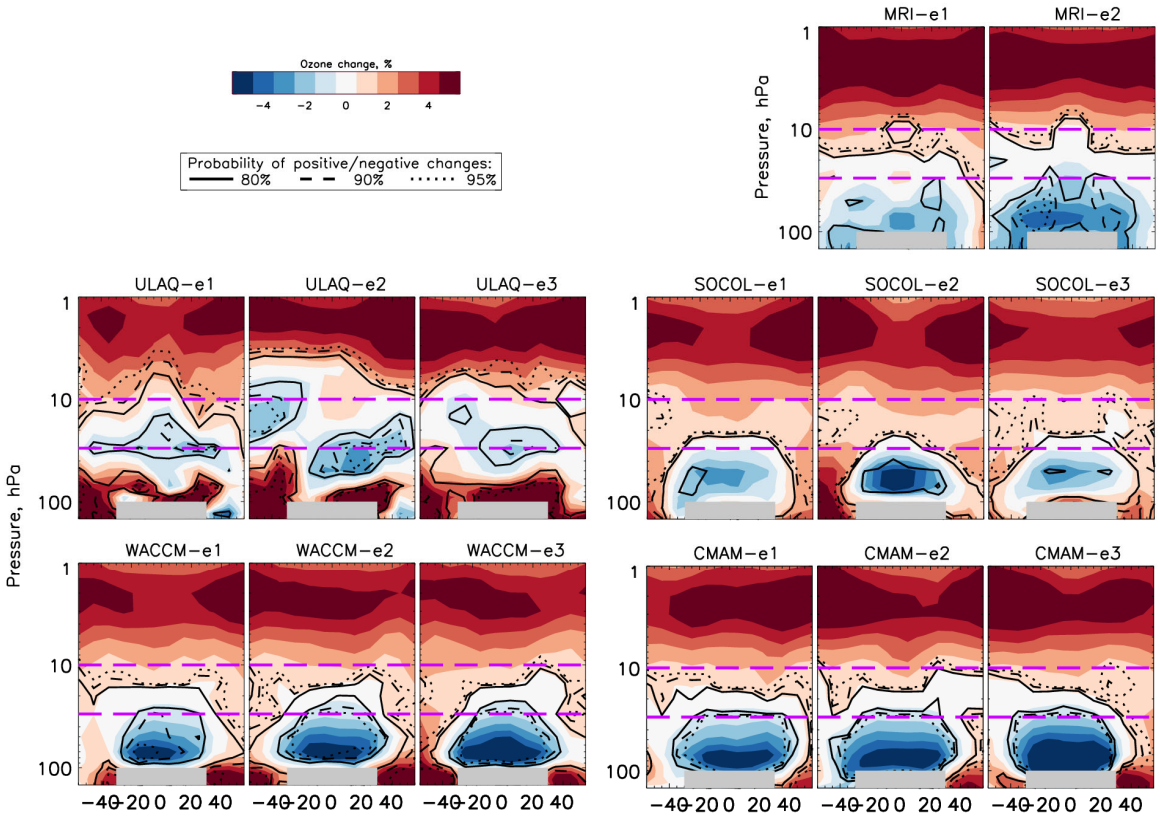

Figure S4: Latitude-pressure ozone changes over 1998-2016. Ensemble members for five ensemble mean models from Fig. 3. See Fig. 3 caption for details.

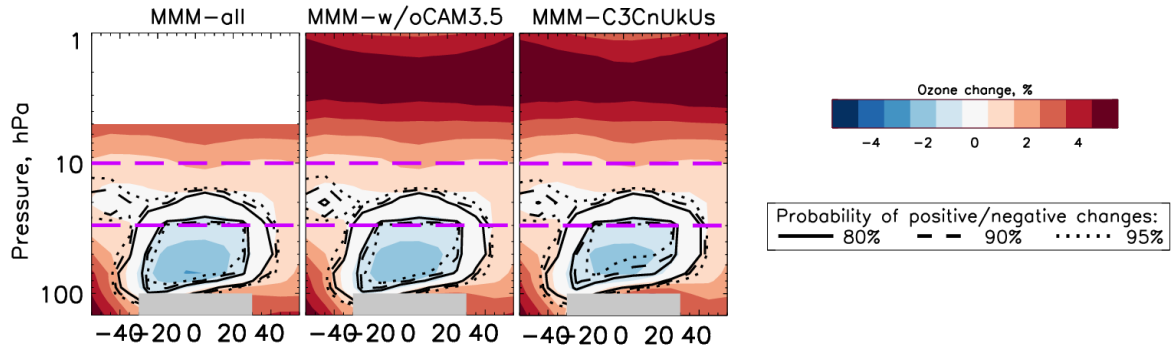

Figure S5: Latitude-pressure ozone multi-model mean changes over 1998-2016. (**left**) MMM including CAM3.5 that lacks data <5 hPa; (**middle**) MMM without CAM3.5 (as in Fig. 3b, for comparison); (**right**) MMM sensitivity test, i.e. MMM without CAM3.5, CNRM-ACM, UMUKCA-UCAM, UMSLIMCAT. See caption of Fig. 3 and Methods for details.

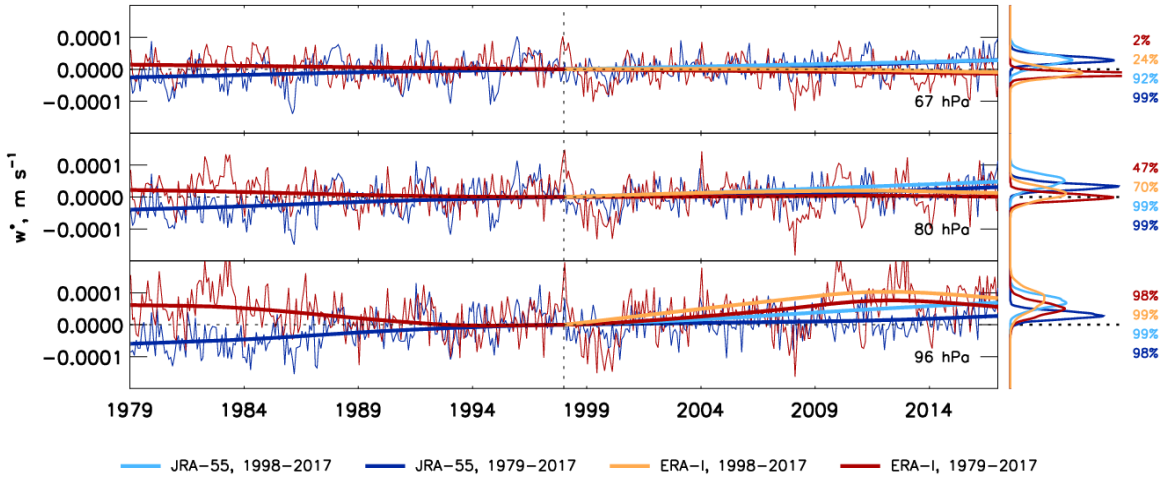

Figure S6: Tropical (20ºS-20ºN) residual upwelling for 1979-2017. Residual upwelling for ERA-Interim (orange/red) and JRA-55 (light/dark-blue) with non-linear trends for 1979-2017 and 1998-2017; the PDFs represent the change since 1998 in each case and are the same as in Fig. 4b.

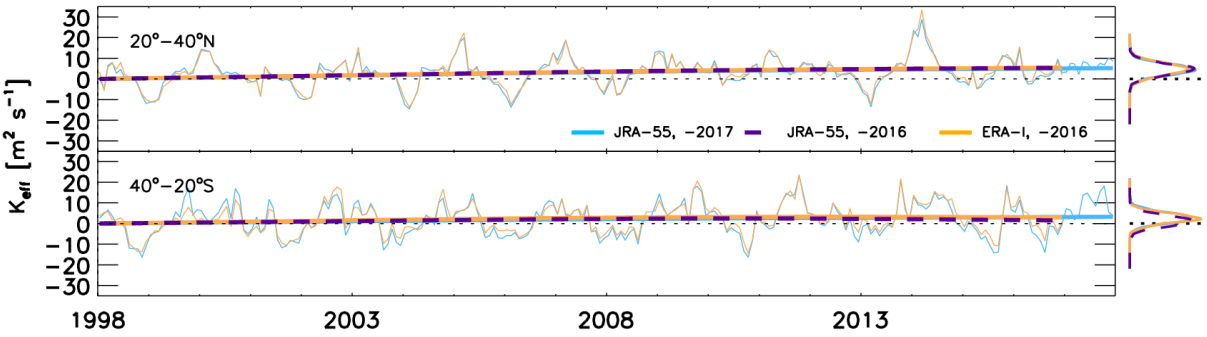

Figure S7: Effective mixing since 1998 from reanalyses. (**a**) 40ºS-20ºS and (**b**) 20º-40ºN. The PDFs of the changes over 1998-2016 and 1998-2017 are the same as those presented in Fig. 4.

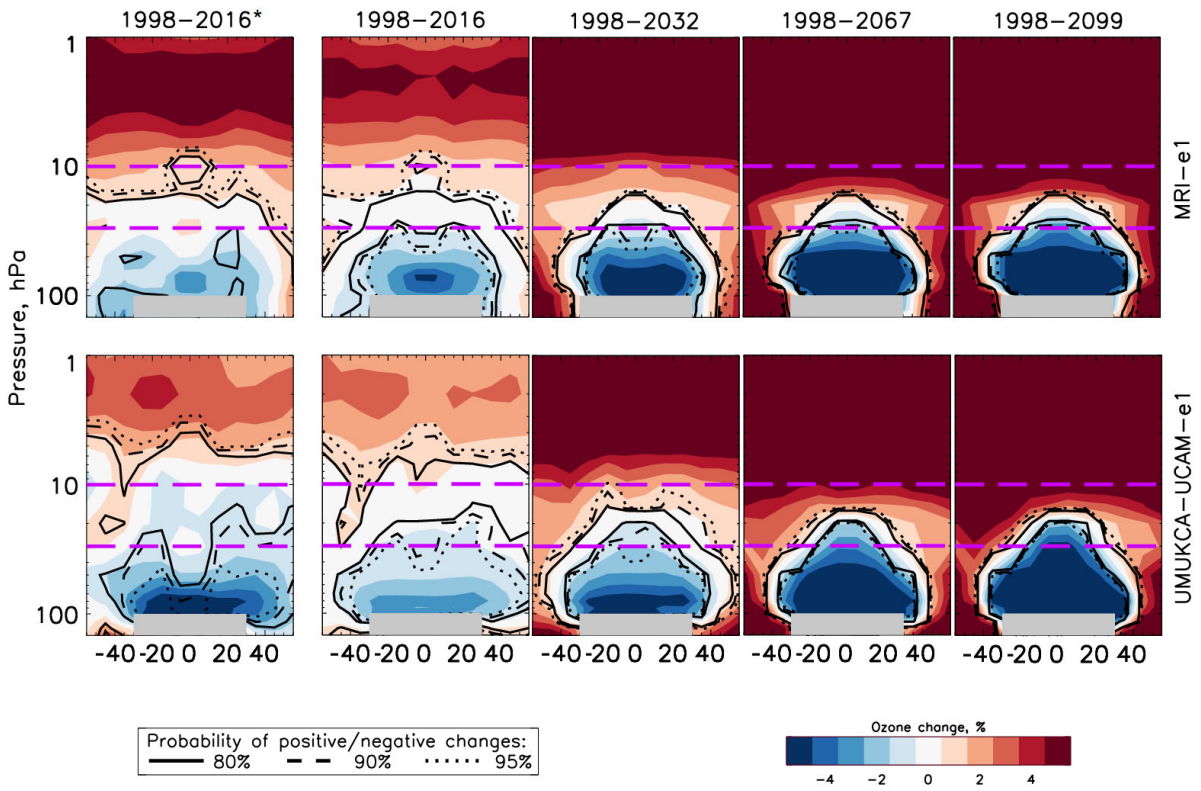

Figure S8: Latitude-pressure ozone changes in the 21st Century since 1998. (**Top row**) MRI, (**bottom**) UMUKCA-UCAM; (**left**) 1998-2016* is the ensemble member (e1) from Figs. S2 and 3, respectively; (**right**) 1998-2016, -2032, -2067, and -2099 using change estimated from non-linear trend calculated using whole period to 2099. See Fig. 3 caption for details.