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Historical tropospheric and stratospheric ozone radiative forcing using the CMIP6 database

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We calculate ozone radiative forcing and stratospheric temperature adjustments, estimated with the fixed dynamical heating method, for the period 1850-2014 using the newly available CMIP6 ozone dataset. The CMIP6 total ozone RF (1850s-2000s) is 0.28 $\mathrm{W\,m^{-2}}$ (which is 80% higher than that of our CMIP5 estimation with a consistent framework), and 0.30 $\mathrm{W\,m^{-2}}$ out to the present day (2014). Our results show that the total ozone RF grows faster from the 1940s until the 1970s, slows towards the 2000s (during the recent hiatus on global warming) and shows a renewed growth thereafter. The long-wave component is systematically larger than the short-wave but since the 1990s the short-wave radiative forcing exceeds the long-wave radiative forcing as a result of negative values of long-wave component in the stratospheric radiative forcing. Global stratospheric ozone RF is positive between 1930 and 1970 (in contrast with CMIP5 which has close to zero negative values) and then turns negative, but remains positive in the Northern Hemisphere throughout. The comparison of Northern and Southern hemispheric contributions to radiative forcing shows that even for tropospheric radiative forcing the Northern Hemisphere contribution is more than 2 times larger than Southern Hemisphere due to higher ozone precursor emissions plus the impact of Antarctic ozone depletion on Southern Hemisphere. Derived stratospheric temperature changes show a localized cooling in the sub-tropical lower stratosphere due to tropospheric ozone increases (more marked on the northern hemisphere), and cooling in the upper stratosphere due to ozone depletion by more than 1 K already prior to the satellite era (1980), and by more than 2 K out to the present day (2014).