Response in Red.

References to line/paragraph numbers are provided with respect to the previous preprint (available online) and not the revised version.

Text Changes in Blue.

The changed text includes references to figures and tables from the revised manuscript.

We now recognize that our method of calculating the tropospheric CH4 lifetime by dividing the tropospheric CH4 burden by the tropospheric CH4 oxidation rate, isn't consistent with previous studies that calculate this quantity. We now estimate this quantity correctly and consistently with previous studies: dividing the total atmospheric CH4 burden by the tropospheric CH4 oxidation rate (Prather 2007). With this method, we now calculate a tropospheric CH4 lifetime of ~8.42 years for the year 2010 as opposed to the previously calculated ~7.13 years (Table S4). The 2000-2018 mean tropospheric CH4 lifetime from our simulations is ~8.54 years which is well within the 7.1 - 10.6 years of ACCMIP range reported by Voulgarakis et al., 2013.

We now modify the paragraph at line 231:

"The tropospheric methane lifetime (~8.54 years), calculated as the total atmospheric methane burden divided by tropospheric methane oxidation rate, decreases with high certainty (-0.01 years/yr; Table S5) in our simulations (Fig. 4a: Magenta line). This result is contrary to the expectation that methane lifetime might increase due to increasing methane concentrations leading to a smaller availability of OH radicals to oxidize methane (Prather et al., 1996). CH4 oxidation with OH radical being the major loss pathway for CH4, we show the time-series of OH in Fig.4b. Here we simulate an increasing trend in air-mass-weighted tropospheric OH concentration (a prominent indicator for tropospheric oxidizing capacity; e.g., Voulgarakis et al., 2013, Chua et al., 2023) but with low certainty. Nevertheless, the CH4-reaction-weighted tropospheric OH concentration (Lawrence et al., 2001) shows an increasing trend with high sensitivity. This increasing trend in tropospheric OH concentration is consistent with the trend discussed in Chua et al., (2023) and explains the decreasing lifetime of CH4 as these quantities are inversely proportional. The increasing OH availability despite increasing CH4 concentration could be due to increasing NOx emissions over the simulated period that recycle HO2 to OH (e.g. Lelieveld et al., 2008; Chua et al., 2023). The mean magnitude of our air-mass-weighted tropospheric OH concentration (~12.63 * 105 molec/cm3) is slightly larger than previous studies (~10.75 * 105 molec/cm3 in Chua et al., 2023 or ~11.7 * 105 molec/cm3 in Voulgarakis et al., 2013) which is likely why we

simulate a mean tropospheric CH4 lifetime slightly smaller than the aforementioned studies (~9 years), but within the multi-model range (7.1-10.6 years) reported in Voulgarakis et al., (2013)."

The timeseries figure (Fig. 4) shown in response to referee #1's major comment #4 is now modified as shown below:

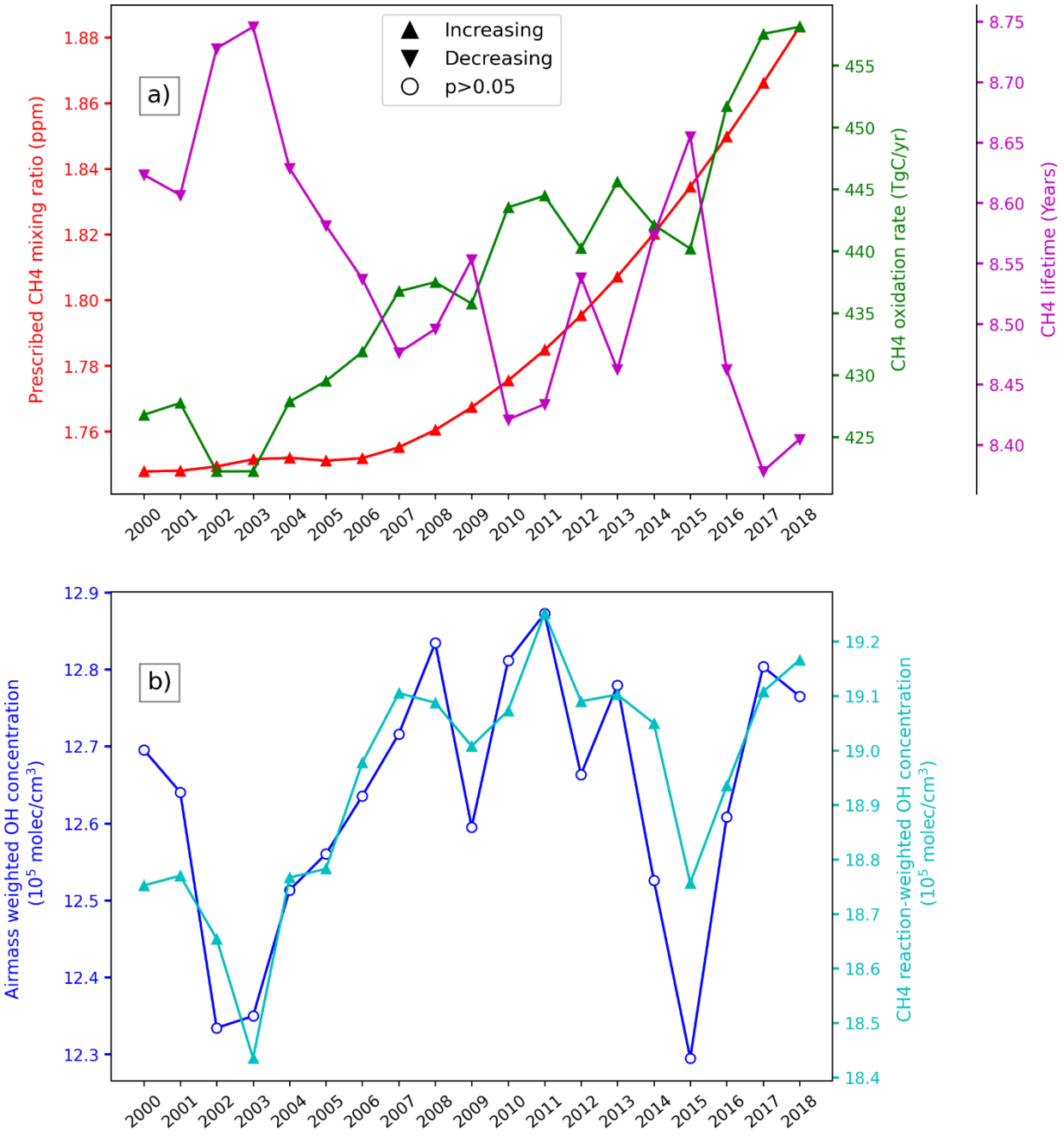

Fig. 4: a) Red line: Annually varying Methane mixing ratio (in ppm) prescribed in our model. Green line: Tropospheric Methane oxidation rate (in TgC/yr) simulated by our model. Magenta line: Tropospheric Lifetime of Methane (in years). b) Airmass weighted and CH4-reaction weighted tropospheric OH concentration (in 10^5 molec/cm^3). The symbols on the plotted timeseries indicate the sign of trend in the plotted quantity. The mean values, slope of trend, 95 % confidence interval and p-value for the 2000-2018 period are provided in Table S5.

Reference (in addition to the ones in preprint and previous author response file)

Prather, Michael J. "Lifetimes and time scales in atmospheric chemistry." *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences* 365.1856 (2007): 1705-1726.