**We thank the reviewer for the helpful comments provided. All of them have been addressed in the revised manuscript. Please see our itemized responses below.**

**Comment 1:** For certain experiments in this study, the authors use a compilation of methane emissions that is based on bottom-up estimates (inventories and process-models) and not constrained by atmospheric observations (lines 263-266). The resulting increase in emissions between 2000 and 2016 is 70 Tg/yr. This is a large difference, compared to emission scenarios constrained by methane mole fractions [CH4], which place the increase in the order of 20-40 Tg/yr (depending on start and end period). For examples, see Saunois et al. (2017, doi.org/10.5194/acp-17-11135-2017) with best estimates of around 24 Tg/yr between the two periods 2002-2006 and 2008-2012 or Nisbet et al. (2019, doi.org/10.1029/2018GB006009), who estimate a ~44 Tg/yr difference between 2000-2005 and 2015-2018. Bottom up emissions have been repeatedly shown to overestimate the increase in methane after 2007, as reviewed by Saunois et al. (2017). Consequently, the increase of [CH4] in the atmosphere is strongly overestimated in the present study as seen in Fig. 8, where the modelled difference in [CH4] between 2000 and 2010 is >70 ppb, while the observation is ~25 ppb. The modelling presented here is outside my area of expertise, yet it would be interesting how the overestimate in methane emissions will influence the simulated CH4-OH dynamics.

**Comment 3:** Would a lower rate of emissions increase produce a significantly different result? The unrealistic CH4 evolution makes it difficult to assess the importance of the findings for the recent methane budget. For example, the authors state that varying OH from 2000 to 2010 suppressed [CH4] by 5-15 ppb (line 538). Would that value hold for a slower [CH4] increase? Does the stated OH effect as equivalent to 7-20% of the emissions change (line 540) represent a fixed percentage of any emissions increase or would it scale with the emissions scenario (in which case the OH effect could be equivalent to 16-45% of the emissions change of Saunois et al., 2017)? In my opinion, the relevance of the presented findings for the wider community could be strongly enhanced by a more realistic emission scenario.

**Response for these two related comments: We performed two additional experiments with emissions fixed to 2000 to test the influence of emission scenarios on the results presented.**

**We have added in the text:**

**Section 2.2.2 (method)**

**"In addition, we conducted two simulations during 2000-2010 driven by emission inventories fixed to the year 2000 to test the influences of the emission bias on our results. The two simulations use OH fields simulated by CESM-WACCM, one with inter-annual variations of OH (Run_fix_emis) and the other one with OH field fixed to 2000 (Run_fix_emis_OH)."**

**Section 4.2.2 (results)**

**"To test whether the impacts of [OH] year-to-year variations on $CH_4$ mixing ratios depends on the chosen emission scenarios, we compare the above results with that calculated by an extreme scenario where model simulations are driven by fixed emissions (year 2000, Run_fix_emis and Run_fix_emis_OH, table 2). With emissions fixed to 2000, the $CH_4$ mixing ratio increased by 2ppbv from 2000 to 2010, and increasing OH (CESM-WACCM OH fields) can reduce $CH_4$ mixing ratio by 13.5ppb in 2010, comparable to 13.9 ppb calculated by Run_std and Run_fix_OH with CESM_WACCM OH fields. The results indicate only small effect of emission scenario choice on the absolute changes in $CH_4$ mixing ratios due to OH variations. However, our choices have a large effect on the relative changes to the total modeled $CH_4$ increase. Indeed, if we use the emission scenarios that match observations (~+25ppbv of $CH_4$ mixing ratio increase from 2000-2010 instead of ~70 ppb here, Ed Dlugokencky, NOAA/ESRL, 2019), the $CH_4$ mixing ratio changes due to OH can contribute to more than half (13.5-13.9ppbv versus 25ppbv) of the changes driven by emissions."**

**We also included two model experiments in Table 2.**

**Table 2.** List of LMDz experiments and model setups.

| | Simulation period | Inter annual variability in [OH] | Inter annual variability in CH4 emissions |
|---|---|---|---|
| Run_standard | 2000-2010 | 2000-2010 | 2000-2010 |
| Run_REF-C2 | 2011-2016 | 2010 apply inter-annual variability from REF-C2 | 2011-2016 |
| Run_OH_inc | 2011-2016 | 2010 apply annual growth rate of 1‰ | 2011-2016 |
| Run_OH_dec | 2011-2016 | 2010 apply annual decrease rate of 1% | 2011-2016 |
| Run_fix_OH | 2000-2016 | Constant OH (year 2000) | 2010-2016 |
| Run_fix_emis | 2000-2010 | 2000-2010(CESM-WACCM only) | Constant (2000) |
| Run_fix_emis_oh | 2000-2010 | Constant OH (year 2000 CESM-WACCM only) | Constant (2000) |

**Comment 2:** E.g., is the offline LMDz model subject to CH4-feedback on OH?

**Response: We clarify in the text:" Chemical sinks of $CH_4$ are calculated using prescribed three-dimensional OH and $O(^1D)$ fields, and variation in $CH_4$ cannot feedback on OH."**