

## ***Interactive comment on “On the role of trend and variability of hydroxyl radical (OH) in the global methane budget” by Yuanhong Zhao et al.***

**Anonymous Referee #2**

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This study investigates the impact of CCM calculated OH fields on the long-term trend and interannual variability in global methane emissions as inferred from atmospheric inversions. It is concluded that accounting for the CCM simulated trend in OH implies a significantly larger increase in methane emissions in the past decades than previous estimates that did not consider changes in OH. In addition, correlations between OH variations and El Nino are found that reduce the variability in inferred emission, notably in the Tropics. The manuscript, that is well written, provides a useful contribution to the scientific discussion on the drivers of the global increase of methane, contrasting the view on the role of OH that follows from the more common use of MCF. The study also mentions important limitations of using MCF, suggesting that the CCM-derived OH scenario is more consistent. However, in my opinion the evidence in support of this

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suggestion is very limited. Besides this point, there are a few other points that need further attention as explained below. Overall, only minor revisions will be needed to accept this paper for publication.

### **GENERAL COMMENTS**

The study provides an analysis of the main drivers of variability and trends in OH using output from the CCMs. It is mentioned that both chemical and climatological influences are considered. However, the budget that is provided in Table 2 only lists chemical drivers. A study by Dentener et al (ACP, 1993) (which would be worth referencing in this context) identified an important contribution of meteorology on OH variability. Apart from changes in water vapour, those influences, including temperate and changes in circulating, are not discussed here.

The discussion of the results rightly mentions the different outcomes obtained using MCF or CCM derived OH, and their significance for global methane. From the evidence that is presented it is not possible in my opinion to conclude which of the views is right. Nevertheless, the conclusion section mentions that ‘the evidence for increasing OH given by CCM models and other literature, the accuracy of MCF-based OH inversions after the mid-2000s remains an open problem’. So, in short, the accuracy of MCF is the “open problem” that could explain the disagreement in the opinion of the authors. However, the consistency between CCM’s itself cannot be considered as evidence, since these models are not independent and could therefore all be wrong for the same reason. To give an example that might introduce important uncertainty in CCM derived variations, the role of changes in aerosols on OH is not discussed at all. Either appropriate evidence should be presented of CCM’s being more accurate than MCF or a more objective position should be taken regarding this question.

### **SPECIFIC COMMENTS**

line 38, 40: the numbers that are mentioned in these sentences lack an uncertainty estimate.

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line 148: How is Inv\_OH\_var detrended?

line 249: What is meant by 'response of OH to CO.'?

line 253: Banda et al 2016 is a good reference to add here for the effect of Mt. Pinatubo.

line 280-283: Similar conclusions on emission anomalies during El Nino were drawn by Butler et al, JGR, 2005, which would be useful references and comparing here.

Figure 3: what do the lines represent in this figure represent?

Figure 5: Emission anomalies are shown compared to what? Initially I assumed that the mean was subtracted. However, the bars for the different time slices don't add up to zero.

#### TECHNICAL CORRECTIONS

line 119: 'For each OH field' io ' .. fields'

line 122: The parenthesis in this sentence should be fixed.

line 170: 'This continuous increase in' io 'This continuously increases in', and 'based on MCF inversions' io 'based in the MCF inversions'

line 205: 'NO+HO2' io 'NO+NO2'

line 249: 'anomaly in OH primary' io 'anomaly OH primary'

line 250: 'during the 1991-1992.' io 'during 1991-1992.'

line 322: 'the Tropics' io 'the tropics'

line 324: 'twice that of the inversion' io 'twice of the inversion'

line 334: 'and their impact' io 'and its impact'

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