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Interactive comment on "Historical greenhouse gas concentrations" *by* Malte Meinshausen et al.

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Reply to Comment by Olaf Morgenstern:

Thank you for the comment. We would however feel uncomfortable to follow the suggestion of using ppmv, ppbv and pptv units for the following reason (I thank in particular Ray Weiss from the author team for discussions and wording contributions here):

Volume ratios of real gases are dependent on temperature and pressure. Most gas volumes are given at STP (standard temperature and pressure), namely 0 degrees C and 1 atmosphere. The concept behind the "v", in ppmv for example, is that if you could separate the gas in question from the rest of the dry air you could measure each volume (nominally at STP), and then report the ratio of these volumes. But many of the gases we measure in atmospheric chemistry, such as CFC-11, for example, are actually liquids at STP so the concept is meaningless in these cases. Even for CO2,

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which is much more ideal than CFC-11, the difference between the ideal gas volume and the real gas volume is about 1 part in 150 at STP, yet we report results that strive to be accurate to about 1 part in 4000 (i.e. 0.1 ppm). The concept of the “v” in ppmv, ppbv, etc. may make sense in the ideal world of an introductory high school chemistry course, but breaks down completely under even a rudimentary level of scrutiny. Mole fractions are the only sensible way to report these results.

We hence suggest to add to the final manuscript a clarification like this:

"All mixing ratios given here are as dry air mole fractions, denoted as parts per million (ppm), parts per billion (ppb) and parts per trillion (ppt). Note that dry air mole fractions are independent of temperature and pressure, while volume mixing ratios for real non-ideal gases are not, and at standard conditions can differ significantly from their corresponding mole ratios."

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