

**Review to: Atmospheric measurements of ratios between CO<sub>2</sub> and co-emitted species from traffic: a tunnel study in the Paris megacity, by Ammoura et al., 2014**

The paper presents measurements of CO<sub>2</sub>, CO, NO<sub>x</sub> and VOCs from a tunnel study in the Paris region. The results are reported as ratios to CO<sub>2</sub>, which can in principle be converted to emission factors per unit of fuel or per km driven; such measurements are important for verifying and / or updating emission inventories, like the Airparif in the present paper. Ratios of CO to CO<sub>2</sub> are also useful for estimating the fossil fuel burning contribution to atmospheric CO<sub>2</sub> variations. This paper very useful, and well suited for publication in ACP.

I find the paper very well written, concise enough and easy to follow. I recommend it for publication after minor revision. Please find my comments below.

**General comments**

1. The reported values for the measured species are mole fractions (or volume mixing ratios, if we consider all these gases ideal) – and not concentrations. I suggest replacing “concentration” with “mole fraction” through the paper.
2. Introduction: I think some more information on VOCs would be useful: why are they important (only CO<sub>2</sub> tracers, or also pollution?), which are the most important species related to traffic, are they regulated by Euro standards, etc. Similarly, more background information on CO and NO<sub>x</sub> would be good.
3. In my understanding, the night-time measurement results were averaged (for each species) and this average was then considered “background” and subtracted from individual measurements to get the  $\Delta$ s. If this is correct, then the choice of background should not affect the slope of the fit (which is the ratio), but only the intercept. It is shown in the supplement that the two considered background options give the same results, but using directly the measured mole fractions without subtracting the background should give exactly the same results.
4. In such a tunnel, water, gases and aerosols have higher concentrations than on open roads. How important is the chemistry in these conditions? Is it possible that some of the species measured are partly lost through chemical reactions or deposition? Or that some species are not (only) directly emitted, but formed afterwards through chemistry? In this regard, how representative would be the tunnel measurements for open air emissions?
5. The result for fluent traffic conditions are now given as a secondary result, and only used for comparison with Popa et al., in Sect. 4.3. I see the point of the authors, that these results are less well determined, and they want to report the most precise results. I think however the fluent traffic results are important and should get more attention in the paper. The emission inventories need measurement results for all traffic conditions, and imprecise results are better than no results. Moreover, some of the spread of these results could be due to real variability in emissions, thus it also contains information.

For CO, it is known that low speed emissions can be higher than average, even with a hot engine (e.g. Kean et al., 2003; Zhang et al., 2011). Here the comparison is made between Airparif, which I think includes average traffic conditions, and measurement results biased towards congested, low speed traffic. If all traffic conditions were considered, it could be that the authors will observe an overestimation of CO:CO<sub>2</sub> ratios in Airparif, related to a decrease in CO emissions over time. The CO:CO<sub>2</sub> ratios for fluent traffic could maybe be better estimated using the available measurements outside tunnel.

### Specific comments

Abstract, line 12: I suggest to replace “and rush hour periods” with “and on rush hour periods”

Abstract, line 13: I think “To those ...” should be “From those ...”

Abstract, line 16: “ $\Delta$ species” – later in the paper is “ $\Delta$ Species”, with capital S – check consistency

page 20199, line 25: I think “characterized” should be “characterize”

page 20199, line 26: the word “well” should be moved at the end of the phrase, or after “represent”

page 20200, line 1: “Megaparis” is spelled sometimes “MegaParis” – please check consistency

page 20200, line 5: “and of its carbon isotopes” – I would remove “of”

page 20200, lines 8 – 9: “to originate for 30% from traffic and for 70% from gas heating” – I think the two “for” should be removed

page 20203, line 8: “analysed continuous CO<sub>2</sub>, CO and H<sub>2</sub>O measurements” – I suggest to replace with “performed continuous CO<sub>2</sub>, CO and H<sub>2</sub>O measurements” or “analysed/measured CO<sub>2</sub>, CO and H<sub>2</sub>O continuously”

page 20203, line 11: “Gas Chromatograph” does not need capitals

page 20203, line 11: please check the calibration scales: by my knowledge NOAA-X2007 scale is only for CO<sub>2</sub>, and the most recent calibration scale for CO is X2004.

page 20203, line 22: it would be good to mention here which NMHC species were measured

page 20204, lines 3 – 4: “The total uncertainty on the data was estimated better than 15%” – please consider reformulating, e.g. “The total uncertainty of the data was better than 15%”

page 20208, lines 20 – 25: Are the species emitted from fuel evaporation not correlated to the number of vehicles, the same as CO<sub>2</sub>? If yes, shouldn't there be a better correlation between these species and CO<sub>2</sub>? Also, did these species exhibit higher than background mole fractions in the tunnel? – if yes, and if there are not many such measurements published, it may be useful to report them, at least as a time series plot in the supplement.

page 20209, lines 13 – 15: Did Gros et al., 2014 use the same data? If yes, then it's not surprising that the results are similar.

page 20216, line 25: "Volatile" typo

page 20219, lines 29 – 31: Is Roustan et al. still in press?

page 20222, Table 1 caption: there is no  $\Delta\text{NO}_x$  in table, but  $\Delta\text{NO}$  and  $\Delta\text{NO}_2$

page 20223, Table 2: I would also include here on a separate line the results of this study for fluent traffic. See also the general comments.

## References

Kean, A. J., Harley, R. A., and Kendall, G. R.: Effects of vehicle speed and engine load on motor vehicle emissions, *Environmental Science & Technology*, 37, 3739-3746, 2003.

Zhang, K., Batterman, S., and Dion, F.: Vehicle emissions in congestion: Comparison of work zone, rush hour and free-flow conditions, *Atmospheric Environment*, 45, 1929-1939, 2011.

-