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Atmospheric Chemistry and Physics
Discussions

Interactive comment on "The Effect of Varying Engine Conditions on Unregulated VOC Diesel Exhaust Emissions" *by* Kelly L. Pereira et al.

Anonymous Referee #1

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Some comments on "The effect of varying engine conditions on unregulated VOC diesel exhaust emissions"

In Europe almost half of all new passenger cars are diesel vehicles. The large number of diesel vehicles means that their emissions are an important source of air pollution in urban environments. This study focuses on speciated VOCs, including 16 individual and 8 groups of compounds and effects of a home-retrofitted DOC on the mass emissions and chemical composition of these VOCs from an older diesel engine. VOCs contribute to less than half of the organics in diesel exhaust with these specific compounds contributing an even smaller fraction (e.g. classic paper Schauer et al. EST 1999 or more recent papers by Gentner PNAS 2013 or Zhao et al. EST 2015). The majority of organic emissions from diesel vehicles are IVOCs. This paper does not

provide this important context.

The major weakness of the paper is that there is no substantive connection between the emissions data and air quality. Instead the paper focus on engine operations and emissions (an interesting topic but it seems outside the scope of ACP). Such a connection seems important for publishing in an atmospheric science journal. Therefore this study seems poorly suited to Atmospheric Chemistry and Physics.

The paper makes numerous claims about the novelty and importance of the work. Many papers have examined VOC speciation of diesel exhaust and robust VOC speciation profile exist for diesel exhaust (the major problem with these profiles is the lack of IVOC data). The paper provides a very limited review of this literature and some readers may be confused on state of knowledge of diesel VOC emissions after reading the intro.

The paper states multiple times that few studies have reported speciated emissions as a function of engine conditions. It is true that less is known about speciation as function of engine load and DOC then cycle based emissions (but much more work has been published than cited by this paper; a super quick search revealed multiple papers including Combust Flame, 118, 179, 1999; Atmos Env 42, 769, 2008, etc.). This paper, similar to the previously published work, clearly shows variations with engine loads and control technologies. The general trends (e.g. higher emissions at lower loads and changes in composition with loads) are consistent with the published literature. Similarly the results for the effectiveness of the DOC are similar to other studies (though at the low end of effectiveness presumably due to the retrofit nature of this application). More data are always good but the results are not especially novel from an emissions perspective. What are the implications of this new data from an atmospheric perspective (the focus of ACP)?

Air quality impacts depend on the integrated emissions (from many engines operated over a wide range of load conditions). The purpose of test cycles is to measure representative emissions that are relevant to atmosphere (emissions models like MOVES are moving to a more dynamic representation). Is there some problem with existing diesel VOC emissions profiles used by models and inventories that this paper is addressing? That was not clear (nothing jumps out to me), but I don't see an atmospheric question this paper is addressing. It seems more like engine / control technologies related questions. Maybe the paper belong in a different journal?

The study has used an advanced instrument (2D-GC-MS). However, the much of the analysis focuses on emissions of a commonly characterized subset of VOCs (n-alkanes and aromatics) that contribute a minor fraction of emissions. In addition, they are not the dominant source of SOA (e.g. dominated by IVOCs) or toxicity (carbonyls) from diesels. Not leveraging more the advanced 2D GC data seemed like a potentially missed opportunity.

The engine is operated over extremely simple test cycles (e.g. constant speed and load or idle followed by constant load for a number of minutes). This is very unrepresentative of essentially all actual in-use scenarios and it is misleading to even refer to them as things like short journey. The real time data in engine literature shows that often emissions are dominated by hard transient events.

It is helpful to understand results from laboratory studies by relating them to real-word measurements. In this study, agreement was found between engine tests and highway tunnel measurements for alkanes (C9-C13). Authors argue that "The emission factors in this study were comparable to on-road diesel vehicular emissions measured in Gentner et al. (2013), suggesting the results shown in this study are consistent with on-road diesel exhaust emissions." However, emission factors of hydrocarbons from diesel vehicles depend on many factors, such as vehicle type, driving condition, fuel type and aftertreatment devices. For example, Dallmann et al. (2012, EST) show that emission factors of pollutants for diesel vehicles span a wide range at the Caldecott tunnel where measurements in Gentner et al. (2013) were made. In the absence of further constraints, the comparison between measurements in this study and those

in Gentner et al. (2013) might not lead to this claim of consistency in both measurements. If the author's claim is true, it means that other factors, including the fuel type, vehicle type and emission control device, are insignificant for diesel emissions. This is in contrast to results that both chassis dynamometer testing and field measurements that catalyzed diesel particulate filters remove hydrocarbons very efficiently (May et al., 2014, AE; Dallmann et al., 2012 EST). Finally, this comparison is made with a 2010 fleet of on-road diesel trucks/vehicles. Shall we expect much lower emission factors from diesel vehicles from a present on-road fleet of diesel vehicles?

Authors mention that a typical DOC is expected to remove 50 to 70% of the total hydrocarbon emissions. The DOC tested in this study likely has much lower removal efficiency for hydrocarbons, much lower than 46% for measured VOCs if considering the fall substantially lower or no removal efficiency for IVOCs by this DOC (e.g. their data suggest less efficient for removal of C12 branch aliphatics compared to other VOCs with lower carbon number. This indicates that the DOC has no effect on IVOCs, predominated by species with carbon number >12). It seems likely that the DOC tested in this study does not represent the performance of most DOCs and one must be careful trying to generalize. Manufacturers carefully consider thermal management and other operating conditions to ensure that a DOC operates effectively. It was not clear that installation of the DOC on this engine took those factors into account.

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