Response to referee #2 on

Characterizing the evolution of physical properties and mixing state of black carbon particles: from near a major highway to the broader urban plume in Los Angeles

by

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We thank the reviewer for the comments, although we disagree with the overall assessment of the near-road measurements in our study. We chose sampling days for the near-road measurements based on appropriate meteorology. An oversite correctly pointed out by the reviewer is that the submitted version of the paper neglected to include weather observations supporting our assertion that winds were from the southwest such that pollutants from the freeway were advected nearly perpendicularly and to the northeast. Recall that the freeway runs nearly north-south at 330°, so ideal wind conditions for our measurements would be out of the southwest at 240° (see page 5 starting at line 10 of the submitted paper).

In the Los Angeles basin there is no shortage of weather stations, both through governmental and airport stations, as well as commercial weather station networks like Weather Underground and Weather Bug. Table 1 (below) presents wind speed and direction for the Santa Monica airport, which is 3.9 km (2.4 mi) from the sampling site. Atmospheric flows during the day in this near-coast region are dominated by quite stable onshore sea breezes from the southwest as shown in the table. Meteorological conditions during the sampling periods were such that our mobile transects were along an ideal path for accurately characterizing the pollutants from the freeway as they were advected from the southwest. We will add Table 1 to the paper to support this assertion. There was of course some variability in the wind speed and direction within each measurement period and also from day to day, and this is the main source of variability that is accounted for in the error bars shown in Figure 1.

Our figure 1 from the submitted paper shows that black carbon mass concentrations overall decrease with distance from the freeway. Since black carbon mass can be considered a conservative tracer, this, in it of itself, corroborates our argument that distance from the freeway is a reasonable indicator of atmospheric dilution and aging. However, BC mass versus distance does not decrease monotonically. We discuss this in the submitted version of the paper (section 3.1.1), and how, even though winds originated from the southwest, turbulent eddies and flow irregularities from quickly moving vehicles could cause deviations in the monotonic decrease of BC concentrations with distance from the freeway (hence with increased atmospheric dilution). For this reason, we present plots in the submitted version of the paper (i.e., Figure 2) that show black carbon microphysical properties (e.g., fraction of particles that are thickly coated) versus black carbon mass concentrations. Again, we do this because black carbon mass is a conservative tracer and an excellent indicator of dilution. Thus, we provide evidence that we are investigating black carbon microphysical properties as they age near the freeway at fast temporal scales and asymptote to background levels.

Because one of our main study goals was to investigate how BC microphysical properties vary as distance from a major freeway increases, we do include the figure showing BC properties at different distances from the freeway (Figure 1), even though this may not be a perfect indicator of dilution or aging time. Investigating BC properties versus distance to the freeway has important implications on human exposure to BC aerosols, for example, how likely those BC particles are to deposit in the human respiratory system, and whether they are coated with potentially harmful species. It also has policy relevance since regulations can limit development types at various distances from freeways (e.g., school playgrounds adjacent to freeways). Regulations cannot be set based directly on dilution or aging of pollutants.

Another comment made by the referee is the desire to see measurements upwind of the freeway. We thought of this idea too, but there are additional roadways upwind of the freeway that would have confounded interpretation of the upwind measurements. Though the upwind roadways are small sources compared to the highly trafficked I-405 freeway, upwind measurements would have been in close proximity to the upwind vehicular sources, and thus would have confounded the measurements. The Los Angeles Cemetery is a very unique measurement site in that it is a large area adjacent to the freeway without any sources of pollutants. This is why it has been used for multiple measurement campaigns in past studies (e.g., Zhu et al. 2002, Zhang et al. 2004). Thus, it allows for measuring changes to aerosols emitted by vehicles on the freeway without closer confounding sources.

Our last comment is to respond to the referee's suggestion about using micrometeorological modeling of the near-freeway environment. In an ideal world this could help confirm dispersion of the freeway emissions, though in our opinion, this is quite unnecessary, given that we can report BC properties (e.g. fraction of BC that is thickly coated) versus BC mass concentrations. We have used micrometeorological models for other research topics (see e.g. Taleghani et al. 2016), and we are thus quite familiar with the limitations of these models. They would not be able to resolve the turbulent eddies induced by large volumes of quickly moving vehicles, which is likely the cause of distance from the freeway being an imperfect indicator of dilution and age (see discussion in the 3rd paragraph). Either way, this type of modeling seems unnecessary given that we can report BC properties versus black carbon mass concentrations.

In summary, we think that we have addressed the reservations of the reviewer and that our interpretations of the near-roadway measurements are sound.

Table 1. Observed wind speed and direction for Santa Monica airport, which is 3.9 km (2.4 mi) from the near-roadway measurement site. Times shown are within 15 minutes of the near-roadway sampling periods.

Santa Monica Municipal Airport – Wind Data (Weather Underground)				
Date	**Time**	**Cardinal Direction**	**Degree Direction**	**Speed (mph)**
August 4, 2016 **Sampling Period:** **12:26 to 13:45**	12:51	SW	214 – 236	11.5
	13:51	WSW	236 - 259	11.5
August 5, 2016 **Sampling Period:** **12:15 to 13:31**	12:51	SW	214 – 236	8.1
September 12, 2016 **Sampling Period:** **12:18 to 1:36**	12:51	SSW	191 - 214	9.2
	13:51	WSW	236 – 259	10.4
September 14, 2016 **Sampling Period:** **11:59 to 13:16**	11:51	WSW	236 - 259	8.1
	12:51	SW	214 - 236	9.2

References

Taleghani M, Sailor D, Ban-Weiss GA (2016) Micrometeorological simulations to predict the impacts of heat mitigation strategies on pedestrian thermal comfort in a Los Angeles neighborhood. Environmental Research Letters. 11, 1-12, doi:10.1088/1748-9326/11/2/024003

Zhang, K. M., Wexler, A. S., Zhu, Y. F., Hinds, W. C., and Sioutas, C. (2014) Evolution of particle number distribution near roadways. Part II: the ‘Road-to-Ambient’ process, Atmos. Env., 38, 6655-6665.

Zhu, Y., Hinds, W. C., Kim, S., and Sioutas, C.(2002) Concentration and size distribution of ultrafine particles near a major highway, J. Air and Waste Manage. Assoc., 52, 1032-1042.