Data Article

Real-world exhaust temperature and engine load distributions of on-road heavy-duty diesel vehicles in various vocations

Kanok Boriboonsomsin, Thomas Durbin, George Scora, Kent Johnson, Daniel Sanchez, Alexander Vu, Yu Jiang, Andrew Burnette, Seungju Yoon, John Collins, Zhen Dai, Carl Fulper, Sandeep Kishan, Michael Sabisch, Doug Jackson

a University of California at Riverside, United States
b infoWedge, United States
c California Air Resources Board, United States
d US Environmental Protection Agency, United States
e Eastern Research Group, Inc., United States

ABSTRACT

Real-world vehicle and engine activity data were collected from 90 heavy-duty vehicles in California, United States, most of which have engine model year 2010 or newer and are equipped with selective catalytic reduction (SCR). The 90 vehicles represent 19 different groups defined by a combination of vocational use and geographic region. The data were collected using advanced data loggers that recorded vehicle speed, position (latitude and longitude), and more than 170 engine and aftertreatment parameters (including engine load and exhaust temperature) at the frequency of one Hz. This article presents plots of real-world exhaust temperature and engine load distributions for the 19 vehicle groups. In
each plot, both frequency distribution and cumulative frequency distribution are shown. These distributions are generated using the aggregated data from all vehicle samples in each group.

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### Specifications Table

| Subject area          | Engineering          |
|-----------------------|----------------------|
| More specific subject area | Emissions control from diesel engines |
| Type of data          | Graph                |
| How data was acquired | The data were collected from 90 heavy-duty vehicles using J1939 Mini Logger™ produced by HEM Data. |
| Data format           | Analyzed             |
| Experimental factors  | The 90 vehicles represent 19 different groups defined by a combination of vocational use and geographic region. Almost all of the vehicles have engine model year 2010 or newer and are equipped with SCR. |
| Experimental features | The data collection effort spanned from November 2014 to September 2016, but was intermittent depending on when the vehicles and data loggers were available. For each vehicle, the data were collected for a minimum period of one month. The collected data include vehicle speed, position (latitude and longitude), and more than 170 engine and after-treatment parameters at the frequency of one Hz. |
| Data source location  | All the vehicles are domiciled and operated mostly in California, United States. |
| Data accessibility    | The data are provided in this article. |
| Related research article | Boriboonsomsin, K., Durbin, T., Scora, G., Johnson, K., Sandez, D., Vu, A., Jiang, Y., Burnette, A., Yoon, S., Collins, J., Dai, Z., Fulper, C., Kishan, S., Sabisch, M., and Jackson, D. (2018). “Real-world exhaust temperature profiles of on-road heavy-duty diesel vehicles equipped with selective catalytic reduction.” Science of the Total Environment, accepted on Mar 29, 2018. |

### Value of the data

- The data allows for a comparison of real-world exhaust temperature and engine load distributions by vocation.
- The data can be compared with other data from different locations and new data collected in future works.
- The exhaust temperature distributions can be used to analyze the potential NOx conversion efficiency of different types of SCR, as done in Ref. [1].
- The data can be used to support the design of exhaust aftertreatment systems for heavy-duty diesel vehicles in specific vocations.

1. **Data**

   The data includes plots of real-world exhaust temperature and engine load distributions for the 19 different groups of on-road heavy-duty vehicles in California as defined by a combination of
vocational use and geographic region (Figs. 1–19). In each plot, both frequency distribution and cumulative frequency distribution are shown. These distributions are generated using the aggregated data from all vehicle samples in each group. Note that the exhaust temperature here is referred to the exhaust gas temperature at the inlet of SCR.

2. Experimental design, materials, and methods

The research team targeted data from 100 vehicles that are domiciled in the state of California, and designed a vehicle sample matrix that balanced between the number of vocations and the number of vehicles in each vocation. The targeted vehicles are from commonly found vocations that, collectively, represent the majority of the NOx emission inventory of heavy-duty diesel vehicles in California [2]. Due to various reasons, such as not being able to recruit vehicles (or a specific number of vehicles) in some groups, lost data loggers, etc., the final dataset includes 90 vehicle samples in 19 groups defined by a combination of vocational use and geographic region as listed in Table 1.

All of the 90 vehicles are either commercial class 7 (GVWR 26,001–33,000 lbs) or class 8 (GVWR > 33,000 lbs). All the vehicles run on conventional diesel engines except the six urban buses (diesel hybrid electric) and the five express buses (compressed natural gas). Most of the vehicles have engine

![Fig. 1. (Top) real-world exhaust temperature distributions and (bottom) engine load distributions of Group 1a (Line haul – out of state).](image-url)
model year 2010 or newer and are equipped with SCR. There is a good balance between vehicle samples from both regions of California when considering the overall vehicle samples as a whole, although not every vehicle group includes vehicle samples from both regions of the state.

The data were collected using J1939 Mini Logger™, produced by HEM Data, that recorded vehicle speed, position (latitude and longitude), and more than 170 engine and aftertreatment parameters (including engine load and exhaust temperature) at the frequency of one Hz. The data collection effort spanned from November 2014 to September 2016, but was intermittent depending on when the participating fleets were successfully recruited and when the vehicles and data loggers were available. For each vehicle, the data were collected for a minimum period of one month with many vehicles having data collected for several months.

Fig. 2. (Top) real-world exhaust temperature distributions and (bottom) engine load distributions of Group 1b (Line haul – in state).
Fig. 3. (Top) real-world exhaust temperature distributions and (bottom) engine load distributions of Group 2a (Drayage – Northern California).
Fig. 4. (Top) real-world exhaust temperature distributions and (bottom) engine load distributions of Group 2b (Drayage – Southern California).
Fig. 5. (Top) real-world exhaust temperature distributions and (bottom) engine load distributions of Group 3 (Agricultural).
Fig. 6. (Top) real-world exhaust temperature distributions and (bottom) engine load distributions of Group 4a (Construction).
Fig. 7. (Top) real-world exhaust temperature distributions and (bottom) engine load distributions of Group 4b (Concrete mixers).
Fig. 8. (Top) real-world exhaust temperature distributions and (bottom) engine load distributions of Group 5a (Food distribution).
Fig. 9. (Top) real-world exhaust temperature distributions and (bottom) engine load distributions of Group 5b (Beverage distribution).
Fig. 10. (Top) real-world exhaust temperature distributions and (bottom) engine load distributions of Group 5c (Local moving).
Fig. 11. (Top) real-world exhaust temperature distributions and (bottom) engine load distributions of Group 6 (Airport shuttle).
Fig. 12. (Top) real-world exhaust temperature distributions and (bottom) engine load distributions of Group 7 (Refuse).
Fig. 13. (Top) real-world exhaust temperature distributions and (bottom) engine load distributions of Group 8a (Urban buses).
Fig. 14. (Top) real-world exhaust temperature distributions and (bottom) engine load distributions of Group 8b (Express buses).
Fig. 15. (Top) real-world exhaust temperature distributions and (bottom) engine load distributions of Group 9a (Freeway work).
Fig. 16. (Top) real-world exhaust temperature distributions and (bottom) engine load distributions of Group 9b (Sweeping).
Fig. 17. (Top) real-world exhaust temperature distributions and (bottom) engine load distributions of Group 9c (Municipal work).
Fig. 18. (Top) real-world exhaust temperature distributions and (bottom) engine load distributions of Group 9d (Towing).
Fig. 19. (Top) real-world exhaust temperature distributions and (bottom) engine load distributions of Group 10 (Utility repair).
Table 1
Information about vehicle samples in each group.

| Vehicle group                  | ID | Name                          | No. of Flt. | Fleet location | No. of veh. | Engine ID | Make         | Model | Model year | HP |
|--------------------------------|----|-------------------------------|-------------|----------------|-------------|-----------|--------------|-------|------------|----|
| 1a Line haul - out of state    | 1a | North                         | 3           |                | 18          | Cummins   | ISX15 450   | 2012  | 450        |    |
| 1b Line haul - in state        | 1b | South                         | 3           |                | 20          | Cummins   | ISX15 550   | 2014  | 550        |    |
| 2a Drayage - Northern California| 2a | North                         | 1           |                | 99          | Cummins   | ISX15 450   | 2012  | 450        |    |
| 2b Drayage - Southern California| 2b | South                         | 5           |                | 73          | MACK      | MP8-415C  | 2012  | 415        |    |
| 3 Agricultural                 | 3  | South                         | 8           |                | 85          | Paccar    | MX          | 2010/11| n/a        |    |
| 4a Construction                | 4a | Both                          | 6           |                | 1           | Cummins   | ISB6.7 240 | n/a   | 240        |    |
| 4b Concrete mixers             | 4b | Both                          | 5           |                | 83          | Cummins   | ISL9 350   | n/a   | 350        |    |
| 5a Food distribution           | 5a | South                         | 5           |                | 50          | Detroit Diesel | DD13  | 2013  | 500        |    |
| 5b Beverage distribution       | 5b | South                         | 6           |                | 9           | Paccar    | PX-9        | 2003  | n/a        |    |
| 5c Local moving                | 5c | South                         | 1           |                | 49          | Navistar  | A410        | 2013  | 410        |    |
| 6 Airport shuttle              | 6  | North                         | 5           |                | 57          | Cummins   | ISL         | 2012  | n/a        |    |
| 7 Refuse                       | 7  | North                         | 6           |                | 24          | Cummins   | ISL         | 2010  | 380        |    |
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Table 1 (continued)

| Vehicle group          | No. of Flt. | Fleet location¹ | No. of veh. | Engine | Make     | Model     | Model year | HP  |
|------------------------|-------------|-----------------|-------------|--------|----------|-----------|------------|-----|
| 8a Urban buses         | 1           | North           | 6           | 68     | n/a      | n/a       | n/a        | n/a |
|                        | 69          | n/a             | n/a         | 70     | n/a      | n/a       | n/a        | n/a |
|                        | 108         | n/a             | n/a         | 109    | n/a      | n/a       | n/a        | n/a |
|                        | 110         | n/a             | n/a         | 8b Express buses | 1 | South      | 5 | 93  | Cummins | ISL G280 | 2013 | 280 |
|                        | 94  | Cummins | ISL G280 | 2013 | 280 |
|                        | 95  | Cummins | ISL G280 | 2013 | 280 |
|                        | 96  | Cummins | ISL G280 | 2013 | 280 |
|                        | 97  | Cummins | ISL G280 | 2013 | 280 |
| 9a Freeway work        | 1           | Both            | 5           | 3      | Cummins | ISB6.7 260 | 2012 | 260 |
|                        | 4      | Cummins | ISB6.7 260 | 2012 | 260 |
|                        | 37     | Cummins | ISB6.7 260 | 2012 | 260 |
|                        | 38     | Cummins | ISB6.7 260 | 2012 | 260 |
|                        | 62     | Cummins | ISB6.7 260 | 2012 | 260 |
| 9b Sweeping            | 1           | Both            | 5           | 40     | Cummins | ISB6.7 280 | 2012 | 280 |
|                        | 41     | Cummins | ISB6.7 280 | 2012 | 280 |
|                        | 42     | Cummins | ISB6.7 280 | 2012 | 280 |
|                        | 43     | Cummins | ISB6.7 280 | 2012 | 280 |
|                        | 44     | Cummins | ISB6.7 280 | 2012 | 280 |
| 9c Municipal work      | 1           | South           | 3           | 5      | Detroit Diesel | DD13 12.8  | 2010 | 500 |
|                        | 6      | Cummins | ISB6.7 240 | 2010 | 240 |
|                        | 7      | Cummins | ISB6.7 240 | 2010 | 240 |
| 9d Towing              | 2           | Both            | 7           | 45     | Cummins | ISX15 550 | 2012 | 550 |
|                        | 46     | Cummins | ISX15 525 | 2014 | 525 |
|                        | 47     | Cummins | ISX15 550 | 2014 | 550 |
|                        | 48     | Paccar | PX-8        | n/a   | n/a  |
|                        | 105    | Cummins | ISB6.7 260 | 2014 | 260 |
|                        | 106    | Cummins | ISB6.7 280 | 2013 | 280 |
|                        | 107    | Cummins | ISB6.7 281 | 2014 | 280 |
| 10 Utility repair      | 1           | North           | 5           | 63     | Detroit Diesel | DD13  | 2012 | 500 |
|                        | 64     | Detroit Diesel | DD13  | 2012 | 500 |
|                        | 65     | Detroit Diesel | DD13  | 2012 | 500 |
|                        | 66     | Detroit Diesel | DD13  | 2012 | 500 |
|                        | 67     | Detroit Diesel | DD13  | 2012 | 500 |
| **Total**              | 24         |                 | 90          |        |          |           |            |     |

¹ North = Northern California; South = Southern California.

² No SCR temperature data.
Transparency document. Supporting information

Transparency data associated with this article can be found in the online version at https://doi.org/10.1016/j.dib.2018.04.044.

References

[1] K. Boriboonsomsin, T. Durbin, G. Scora, K. Johnson, D. Sandez, A. Vu, Y. Jiang, A. Burnette, S. Yoon, J. Collins, Z. Dai, C. Fulper, S. Kishan, M. Sabisch, D. Jackson, Real-world exhaust temperature profiles of on-road heavy-duty diesel vehicles equipped with selective catalytic reduction, Sci. Total Environ. 29 (2018).

[2] K. Boriboonsomsin, K. Johnson, G. Scora, D. Sandez, A. Vu, T. Durbin, Y. Jiang, A. Burnette, Collection of Activity Data from On-Road Heavy-Duty Diesel Vehicles. Final report prepared for the California Air Resources Board, May, 2017.