UCR College of Engineering- Center for Environmental Research & Technology

Vocation-Specific Activity Patterns and Temperature Effects of On-Road Heavy-Duty Diesel Vehicles in California

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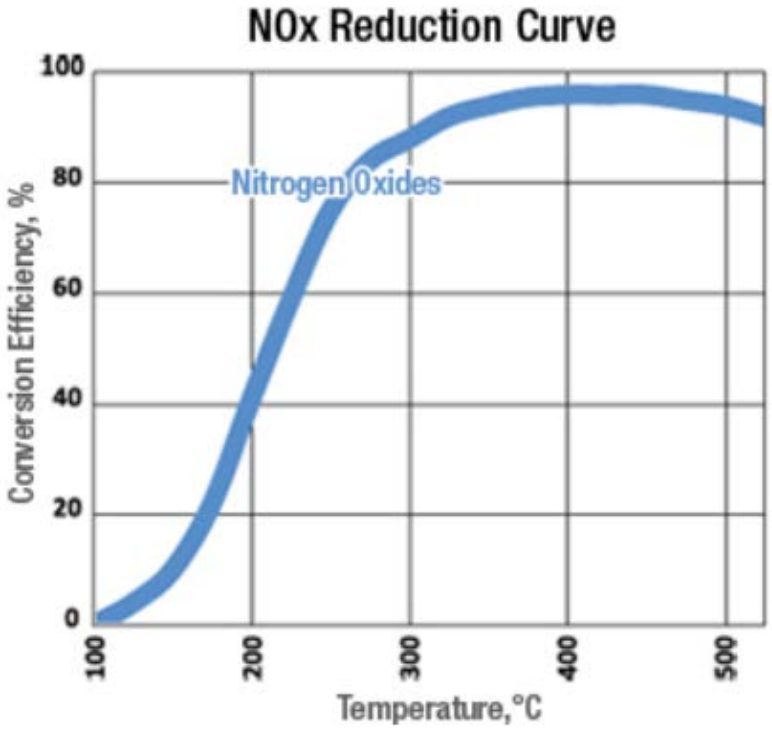
Background

- Selective Catalytic Reduction (SCR) is used in most diesel engines to meet 2010 NO_x emission standards.
- NO_x Conversion is highly dependent on SCR temperature.
- Typically, SCR needs to be at least 200°C before significant NO_x reduction is achieved.
- There are several situations where SCR may not be at the required temperature:
  - Cold start
  - Idling
  - Low load engine operation
- The fraction of these situations in heavy-duty diesel vehicle (HDDV) operation varies by vocational use.

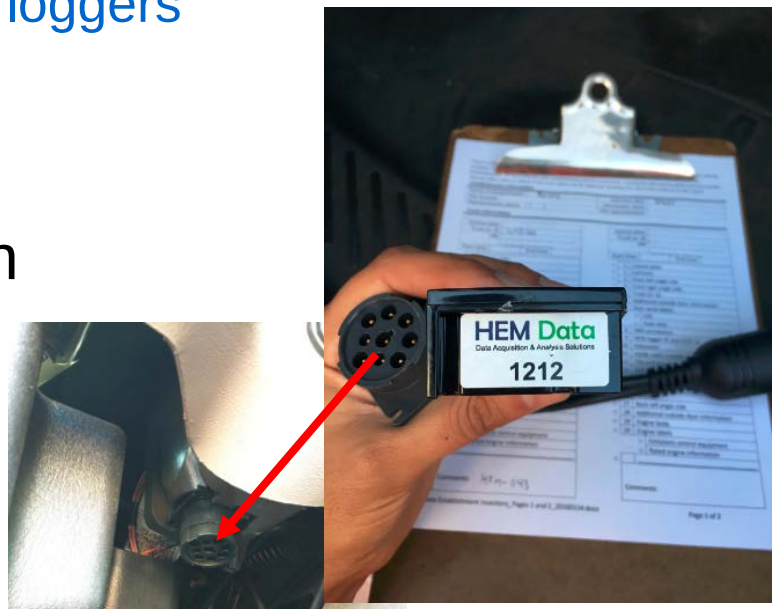


Project Objectives

- Characterize HDDV activity profiles (e.g., duty cycles, starts, and soak time).
  - For different types of vocational use (line haul, drayage, construction, delivery, etc.)
- Identify fraction of vehicle operation that SCR effectiveness may be compromised.
  - Low SCR inlet temperature
- Compare results with emission certification test cycle.
  - Analyze the representativeness of the certification cycle in reflecting real-world emissions of NO_x

Approach

- Collect real-world vehicle activity and engine operation data from 100 trucks for minimum of one month each.
  - Cellular-based GPS & ECU data loggers
  - 1 Hz data frequency
  - 170 SPNs in J1939 format
- Vehicle and engine information
  - Engine & VIN labels
  - License plate
  - Odometer
  - Body (front, sides, rear)
  - Exhaust temperature probes
  - Etc.

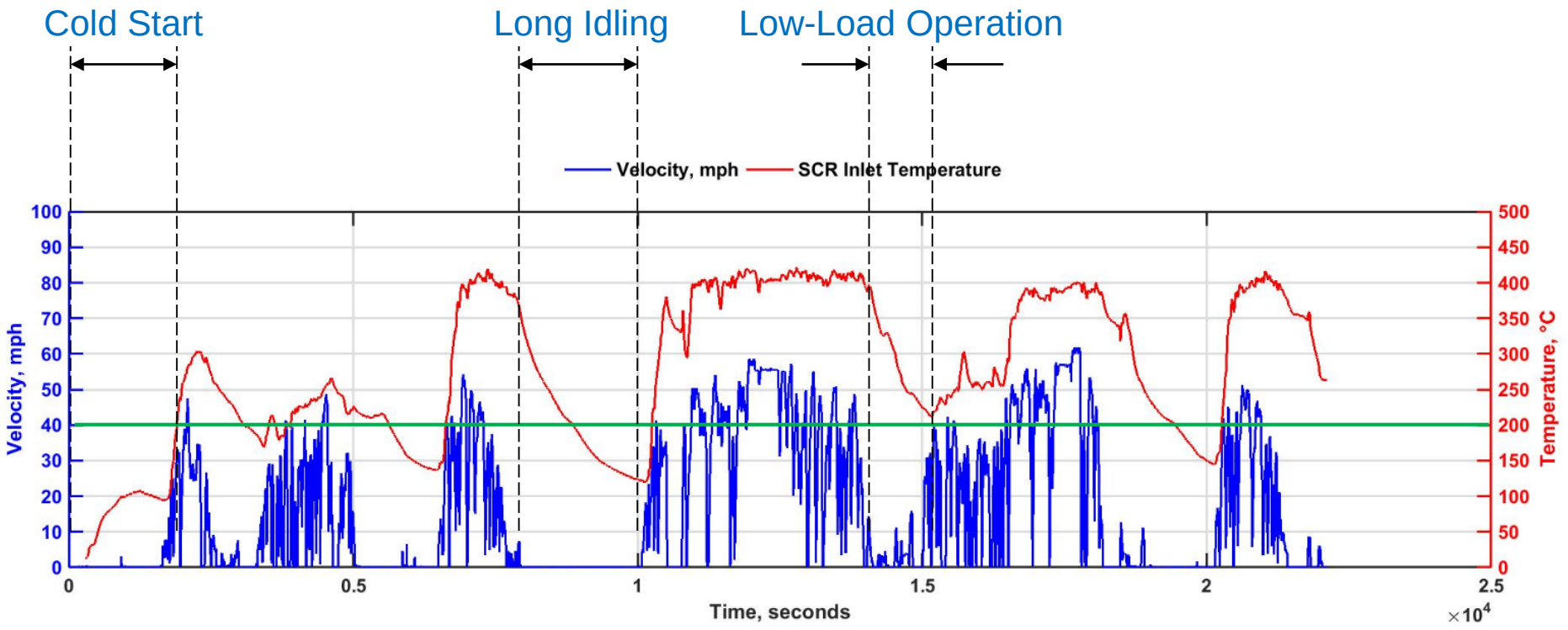


Targeted Truck Vocations

- Line haul
- Drayage
- Agricultural
- Construction
- Food/beverage distribution
- Shuttle
- Refuse
- Transit
- Public work
- Utility

Sample Data

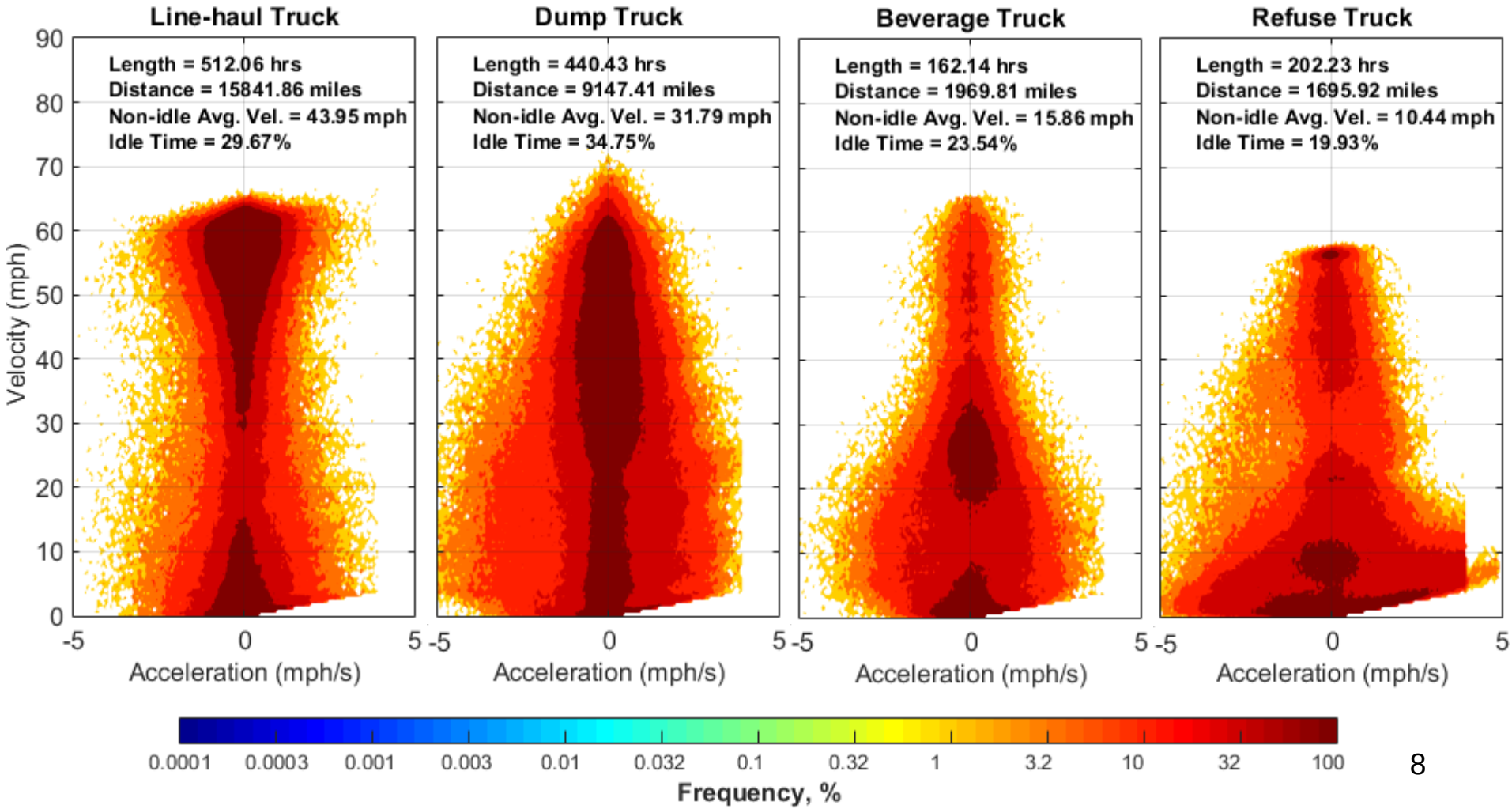
- One trip (engine on to off) of a dump truck



Vehicle Statistics for Four Selected Vehicles

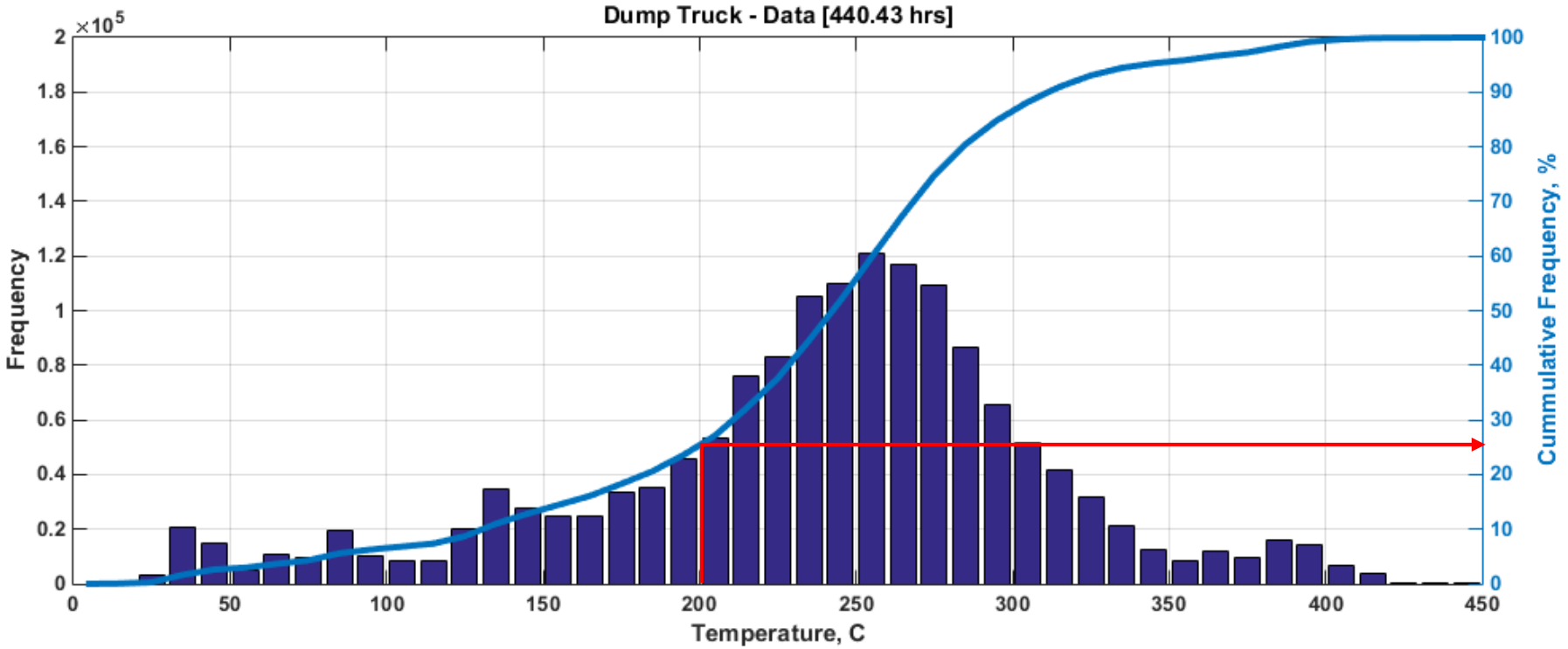
Vocation	Model Year	Data Collection Period (Begin-End)		Time (hrs)	Distance (mi)	Number of Trips	Average Trip Length (mi)	Non-idle Average Velocity (mph)	Idle Time (%)	Average Idle Duration (sec)	Trips per Hour	Trips per 100 mi
Line-haul	2012	7/3/2015	10/1/2015	512.1	15,841.86	417	38.0	44.0	29.7	62	0.81	2.63
Dump	2010	2/4/2015	5/27/2015	440.4	9,147.41	347	26.4	31.8	34.8	77	0.79	3.79
Beverage	2013	2/9/2015	5/4/2015	162.1	1,969.81	592	3.3	15.9	23.5	27	3.65	30.05
Refuse	2012	4/22/2015	9/18/2015	202.2	1,695.92	81	20.9	10.4	19.9	17	0.40	4.78

Joint Speed-acceleration Frequency Distribution by Vocation

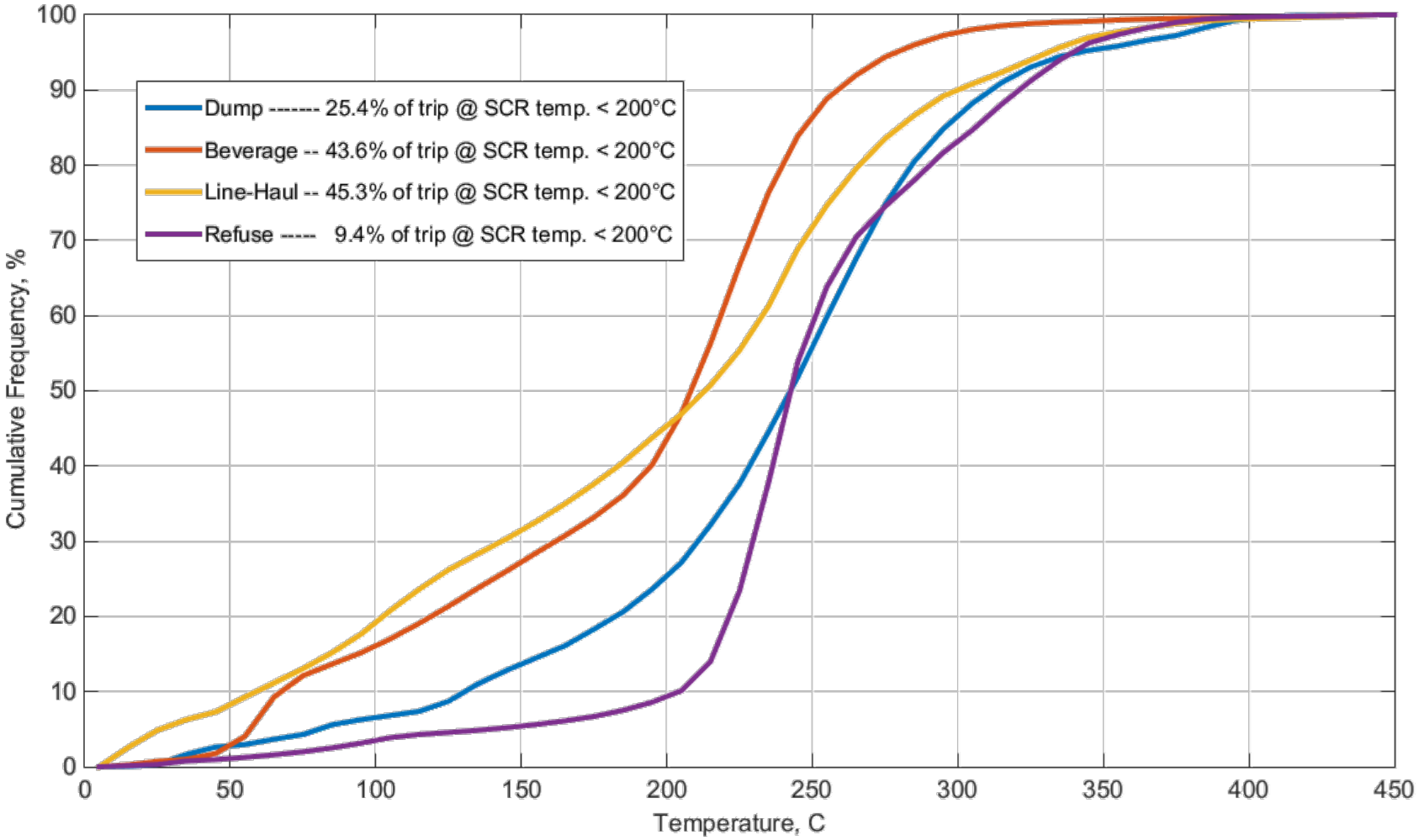


SCR Temperature Distribution

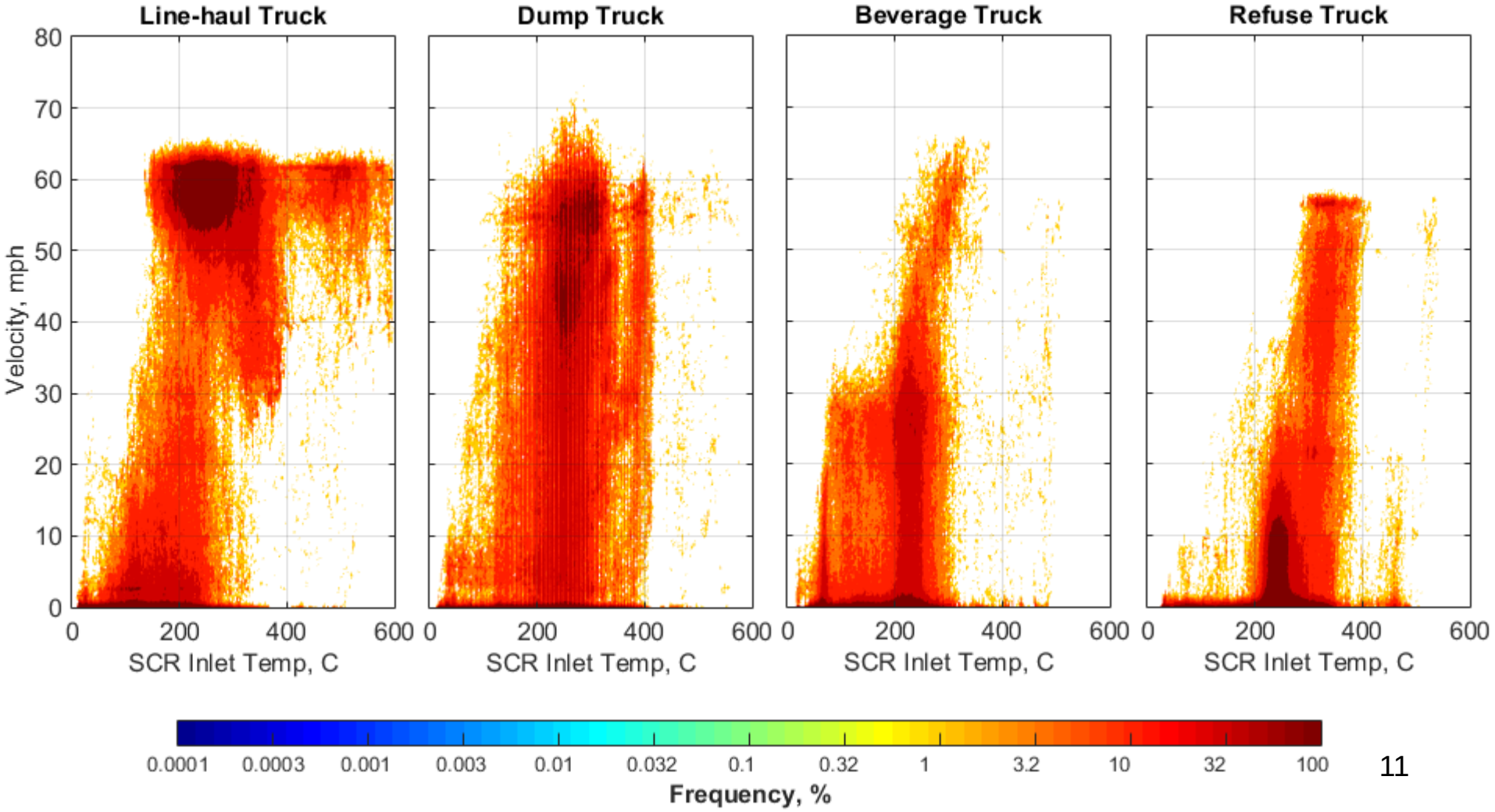
- 25.4% of the trip having SCR temp. lower than 200 °C



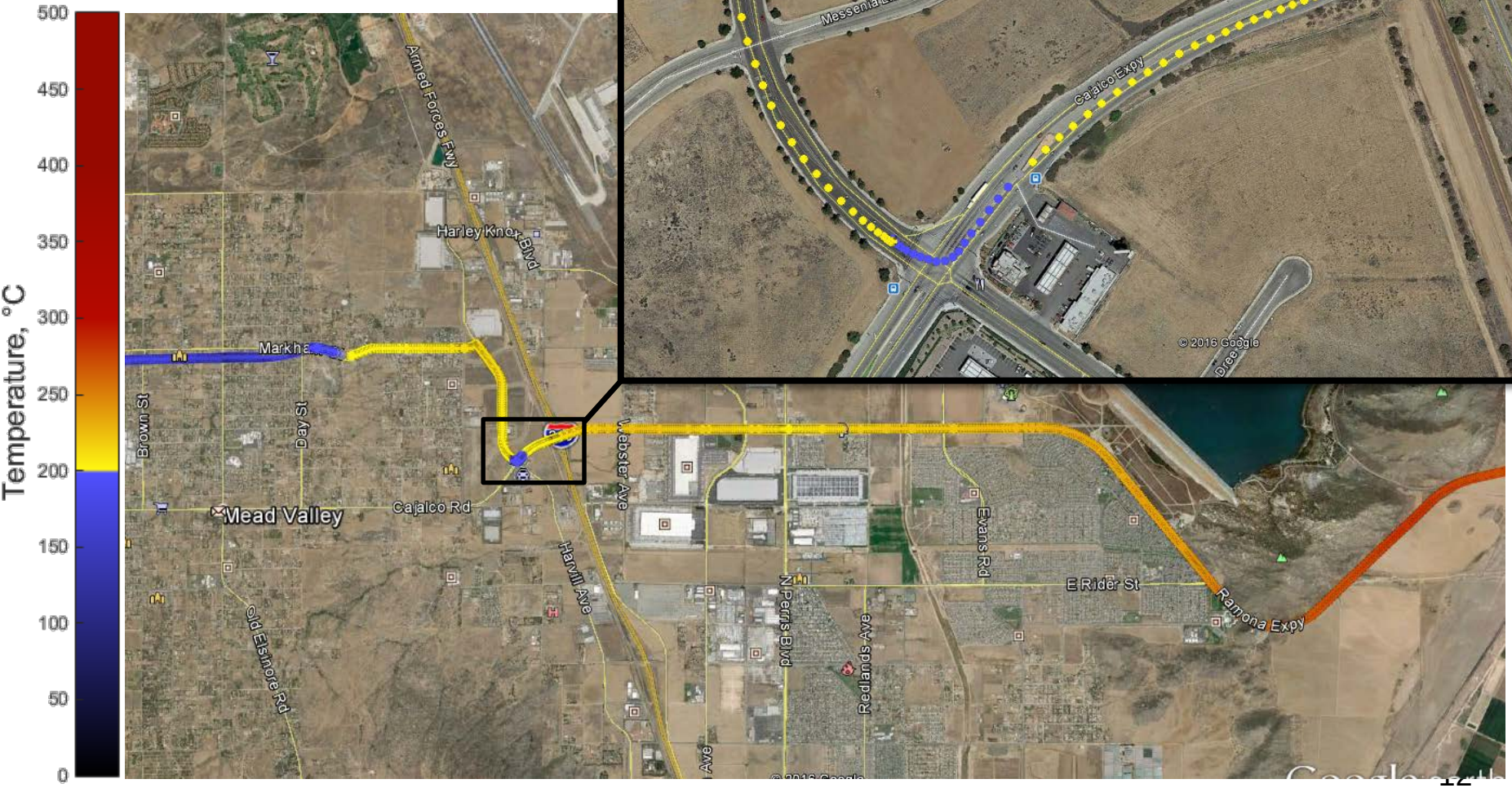
Cumulative Frequency for SCR Temperature by Vocation



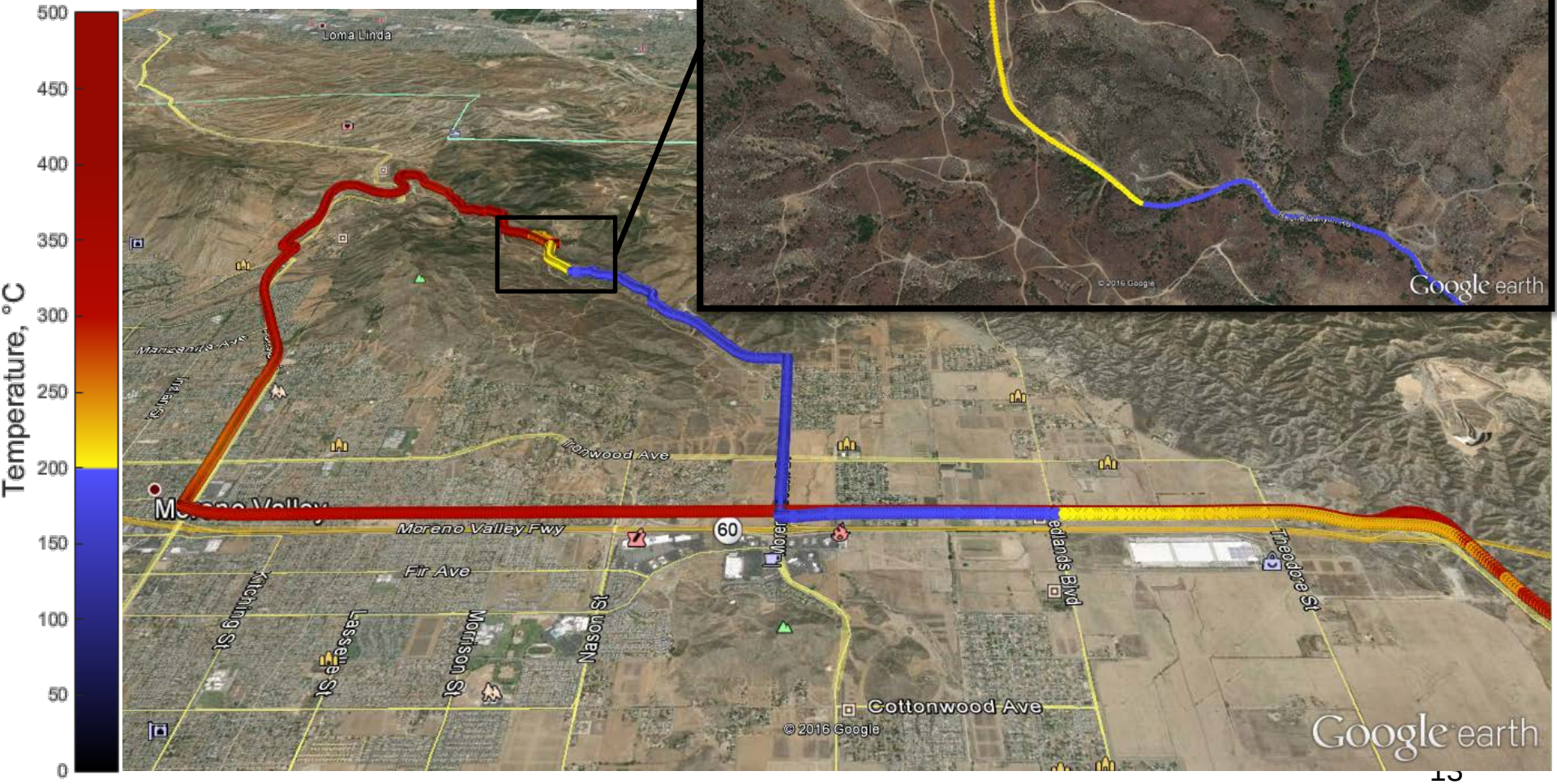
SCR Inlet Temperature vs. Velocity by Vocation



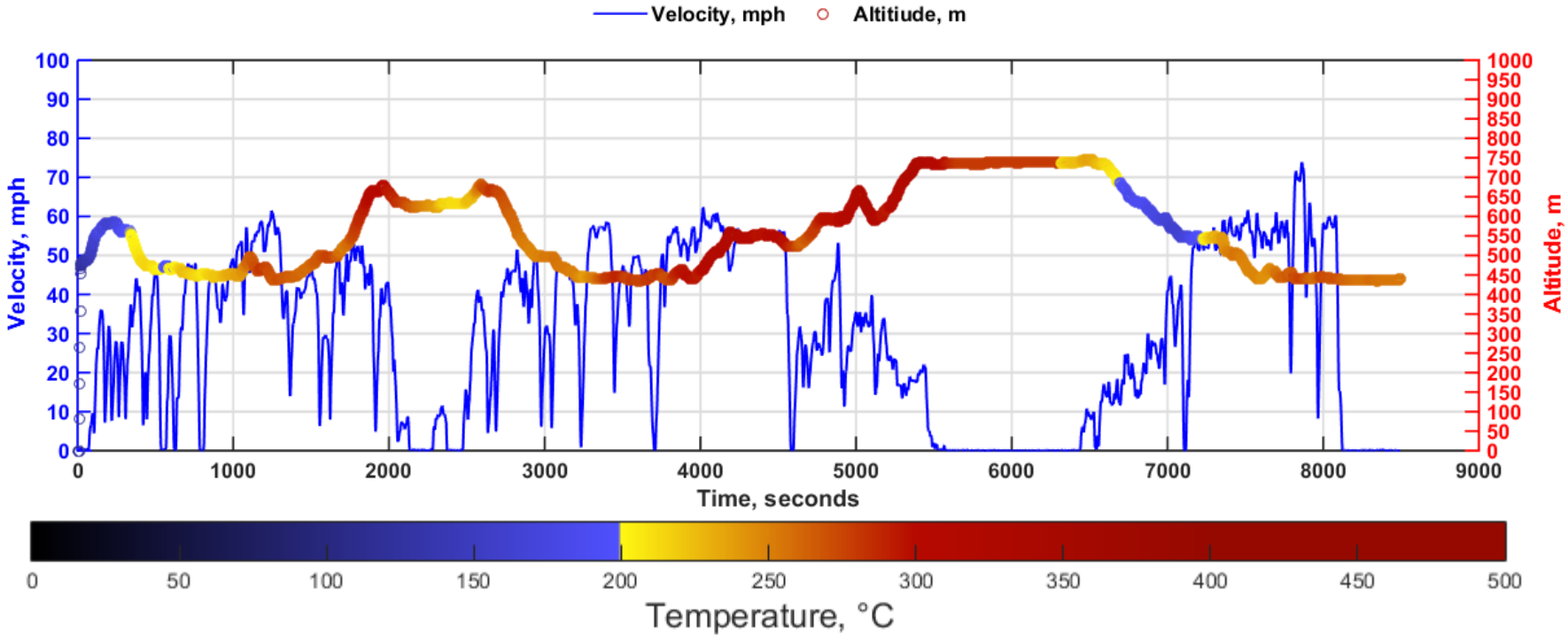
Cold Start and Idle Effect on Temperature



Low Load Effect on Temperature



Low Load SCR Cooling Effect Resulting from Negative Grade



Summary

- This project is collecting a rich set of vehicle activity and engine operation data from a variety of HDDV vocations.
- Data can be used to:
  - Characterize HDDV activity patterns.
  - Develop vocation-specific driving cycles.
  - Understand implications on SCR effectiveness, real-world NO_x emissions, and NO_X inventories.
  - Develop SCR temperature models.
  - Etc.
- Project is still ongoing.
  - Data collection period ending in spring 2016.
  - Project completion in summer 2016.

Additional Information

- Acknowledgements
  - California Air Resources Board
  - U.S. Environmental Protection Agency
  - Participating fleets
  - infoWedge
  - HEM Data
  - Contributing staff at CE-CERT, UC Riverside

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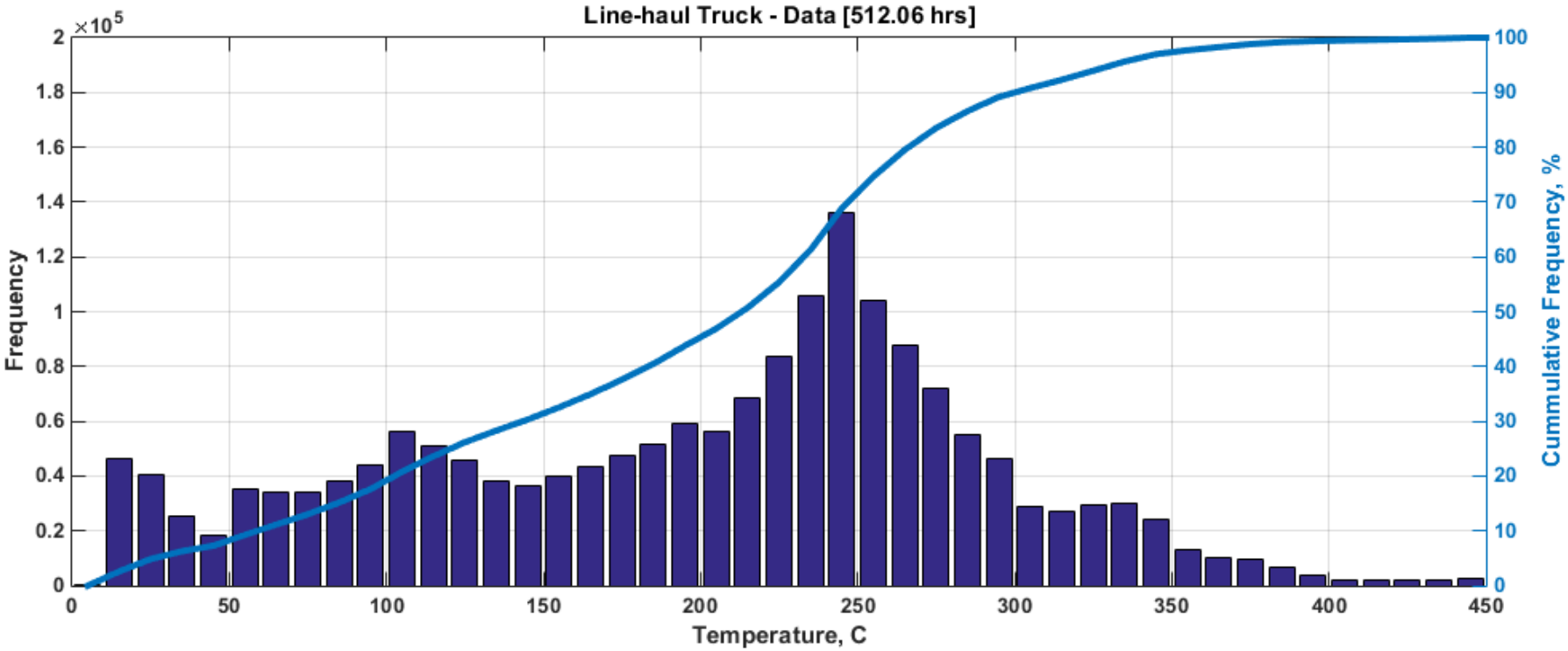
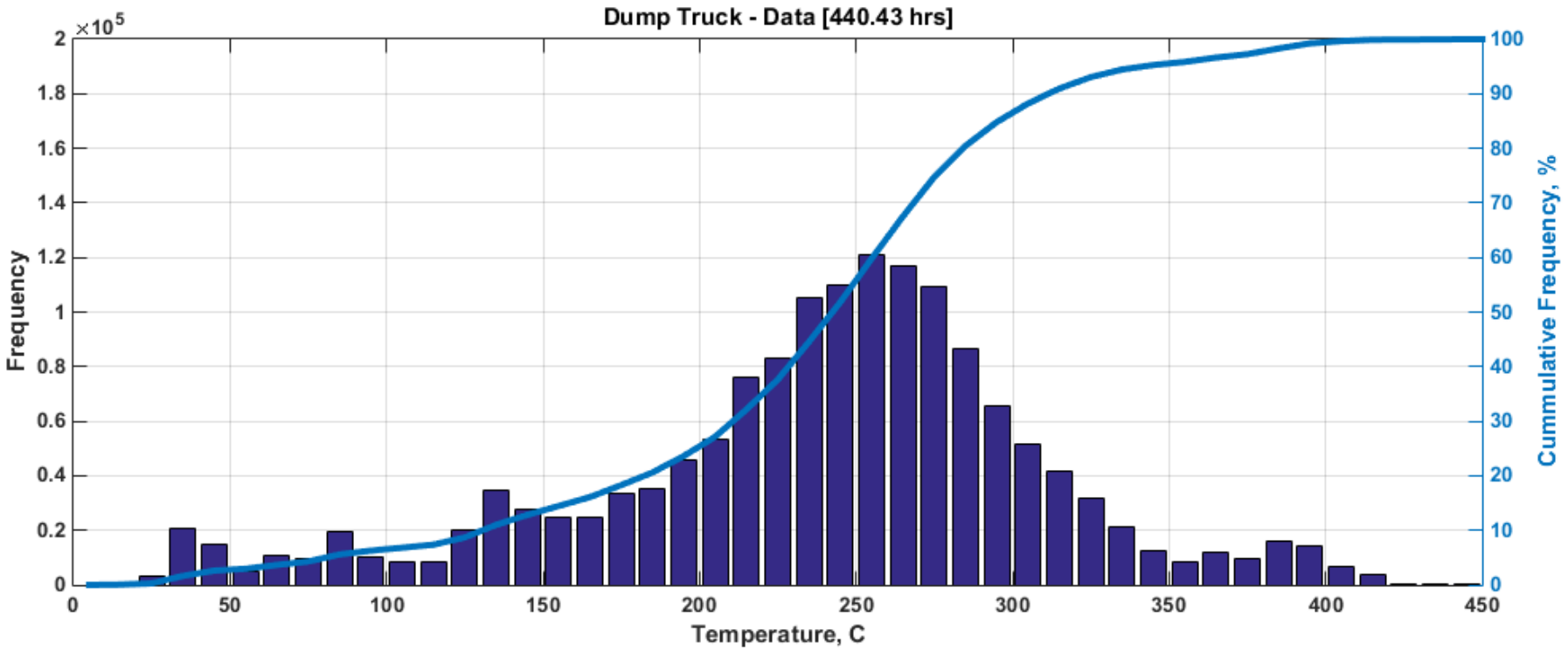
Extra


Line-haul Truck - Data [512.06 hrs]
×10^5
Frequency
Cummulative Frequency, %
Temperature, C
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
0
10
20
30
40
50
60
70
80
90
100
0
50
100
150
200
250
300
350
400
450

Extra


Dump Truck - Data [440.43 hrs]
×10^5
Frequency
Cummulative Frequency, %
Temperature, C
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
0
10
20
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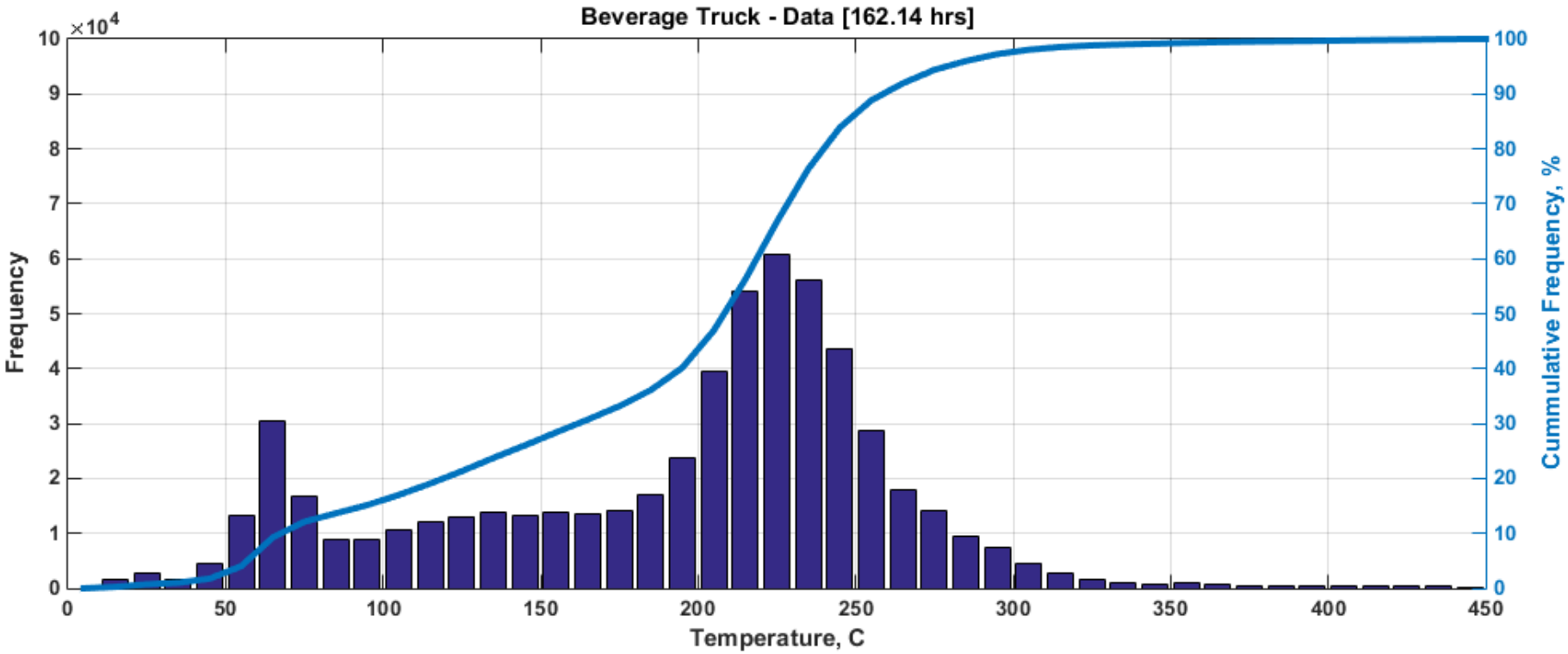
Beverage Truck - Data [162.14 hrs]
×10^4
Frequency
Cummulative Frequency, %
Temperature, C
0
1
2
3
4
5
6
7
8
9
10
0
10
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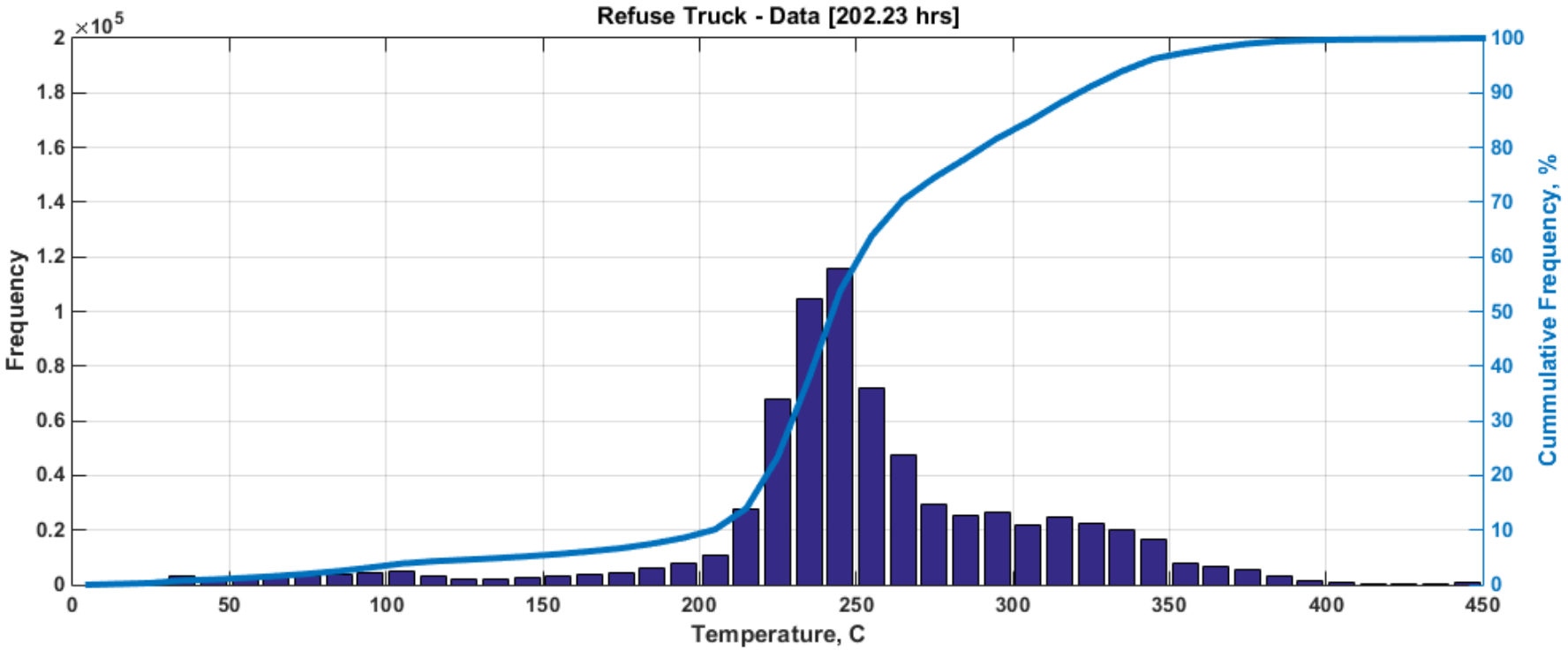
Extra


Refuse Truck - Data [202.23 hrs]
×10^5
Frequency
Cummulative Frequency, %
Temperature, C
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
0
10
20
30
40
50
60
70
80
90
100
0
50
100
150
200
250
300
350
400
450