Development of Chemically-Resolved Speciation Profiles for Attainment Planning

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Background

* Attainment plans provide the blueprint for areas in non-attainment of ambient air quality standards.
* Air quality modeling is an important tool to support the attainment plans.
* Chemically-resolved inventory is one of the key components for air quality modeling.
* Speciation profiles are used to create the chemically-resolved inventory.
* CARB speciation program: http://www.arb.ca.gov/ei/speciate/speciate.htm

CARB Speciation Profiles

* Consumer Products Profiles
  * Based on survey data
* Gasoline Vehicle Emission Profiles
  * 1991, eliminated lead
  * 1996, set specifications for sulfur, aromatics, benzene, etc.
  * 1999, eliminated MTBE
  * 2004, E6 gasoline fuel
  * 2010, E10 gasoline fuel
* Ocean-going vessel PM profiles
  * July 1, 2009, 0.26% MGO or 0.5% MDO
  * Jan. 1, 2012, 0.1% MGO or 0.1% MDO

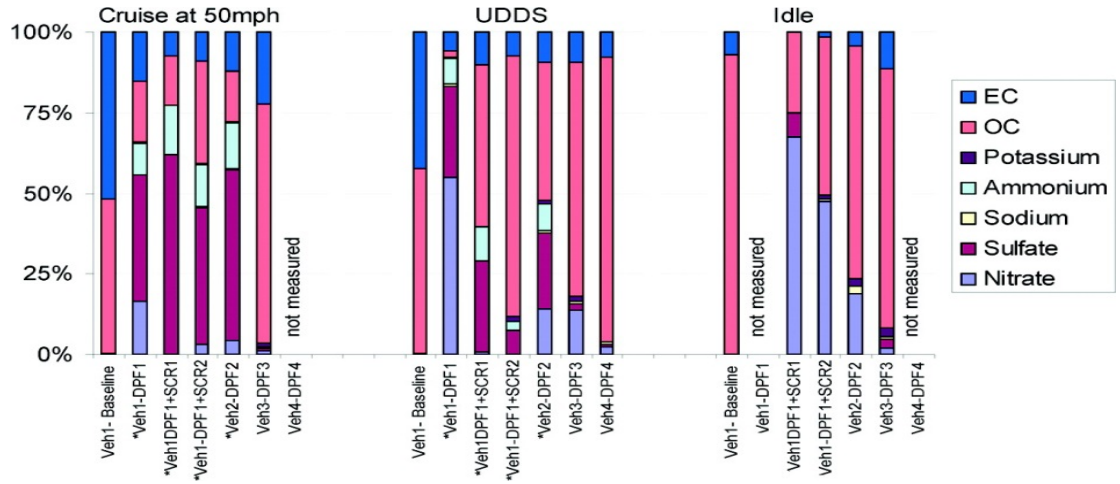
Truck and Bus Rule

Require heavy –duty diesel trucks that operate in California to be upgraded to reduce emissions:

* Beginning 1/1/2012, newer heavier trucks and buses must meet PM filter requirements.
* Starting 1/1/2015, lighter and older heavier trucks must be replaced.
* By 1/1/2023, nearly all trucks and buses will need to have 2010 model year engines or equivalent.

Effect of DPF on PM Emissions

* DPF reduces the PM emissions by several orders of magnitudes
* The fraction of EC in PM greatly decreases after applying DPF



Herner et al. EST, 2011, 45(6)

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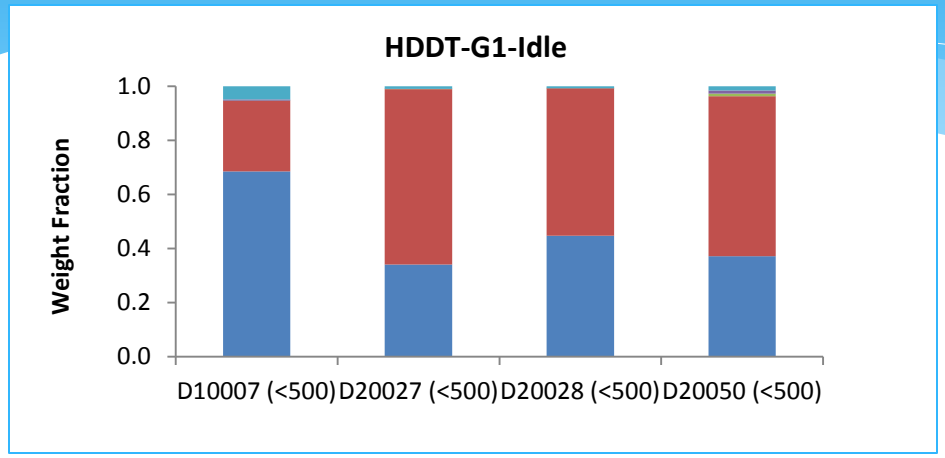
Selected Studies for Profile Making

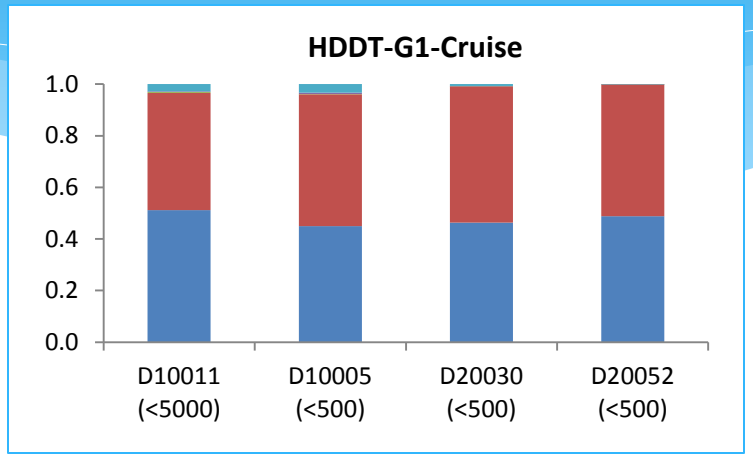
Field	Contents
Test Type	Chassis dynamometer, Engine dynamometer
Engine Model Year	from 1984 to 2007
Aftertreatment	Non-aftertreatment; Aftertreatment: *trap, DPF, oxidant catalyst, CRT, CCRT, V-SCRT, Z-SCRT, DPX, EPF, EGR/CGI+(DOC)CDPF*
Diesel Fuel	Diesel 2, Jet A, CLSF, ECD, ECD-1, F-T, low aromatic diesel, pre-93 diesel, reformulated diesel, LSD, ULSD
Test Cycle	Idle, creep, cruise, HW, CBD, CCS, HCS, CSHVR, FTP, MC, transient, UDDS, CARB 5-modes, 16-hour

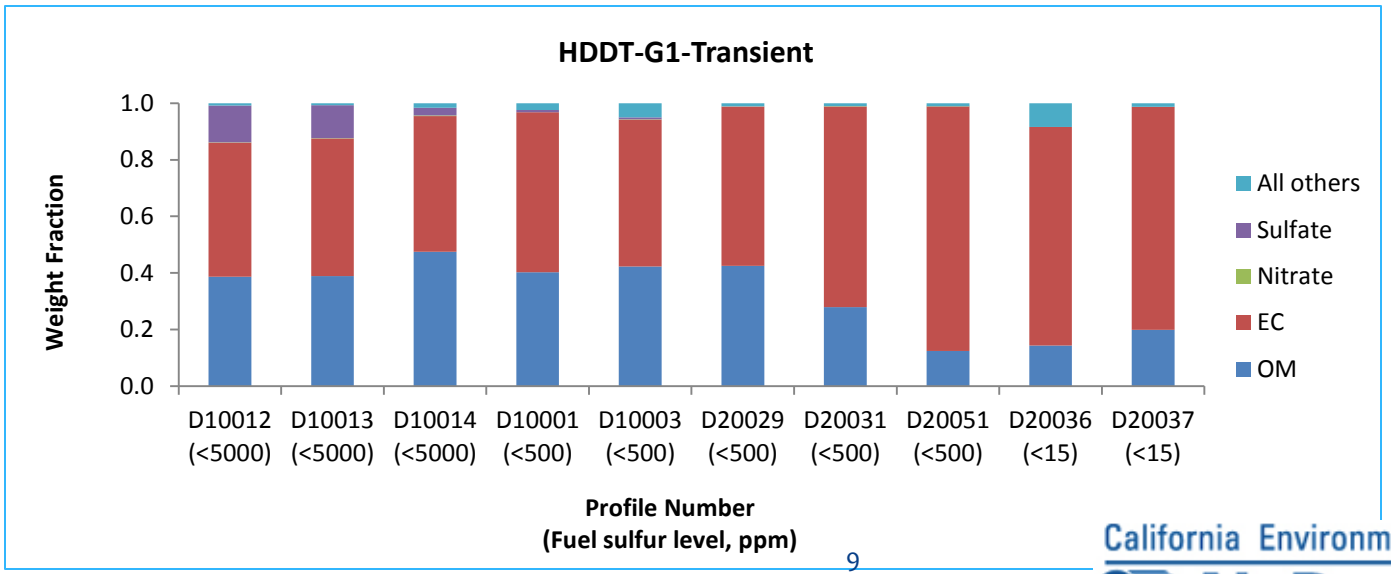
Model Year/After-treatment (MY/AT) Grouping

Engine Model Year (MY)	Exhaust After-treatment (AT)	
	without	with
Pre 1994	G1	G2
1994-2002	G3	G4
2003-2006	G5	G6
2007-2009	/	G7
2010 and newer	/	G8

MY/AT Profile for HDDT: G1







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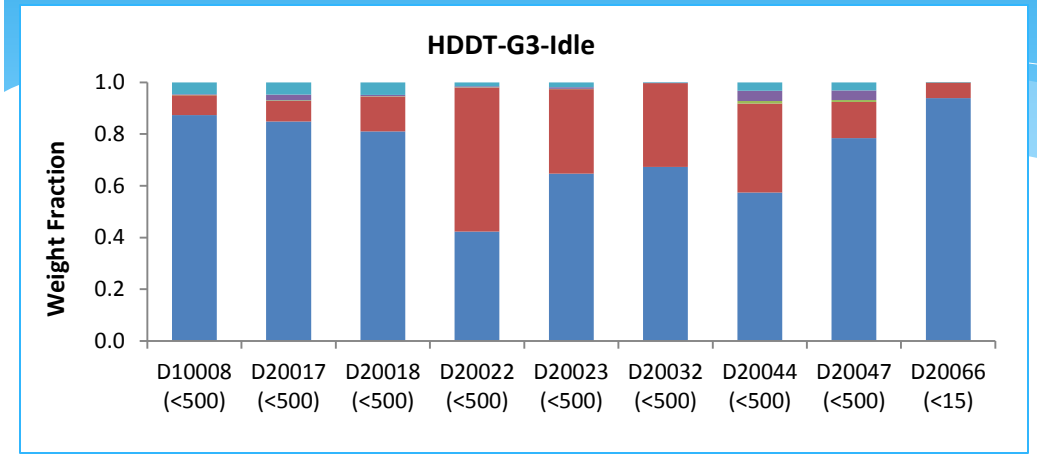
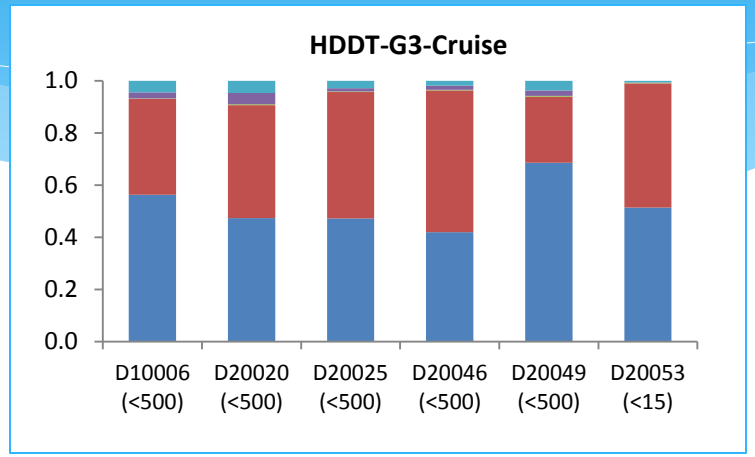
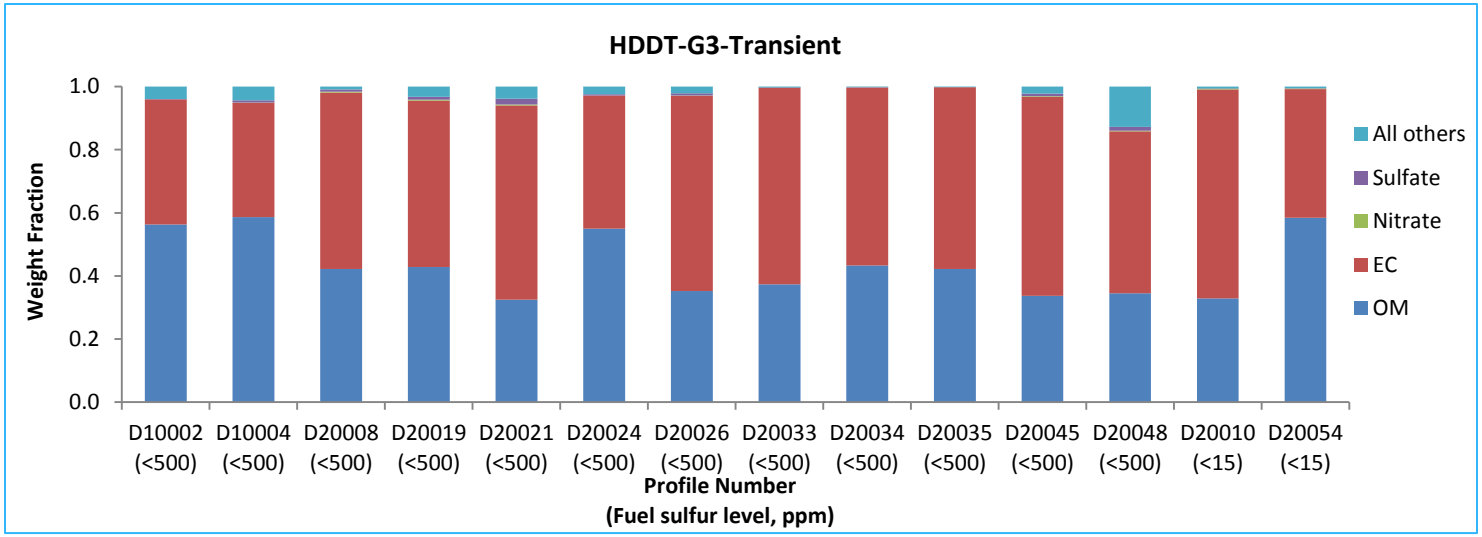
MY/AT Profile for HDDT: G3







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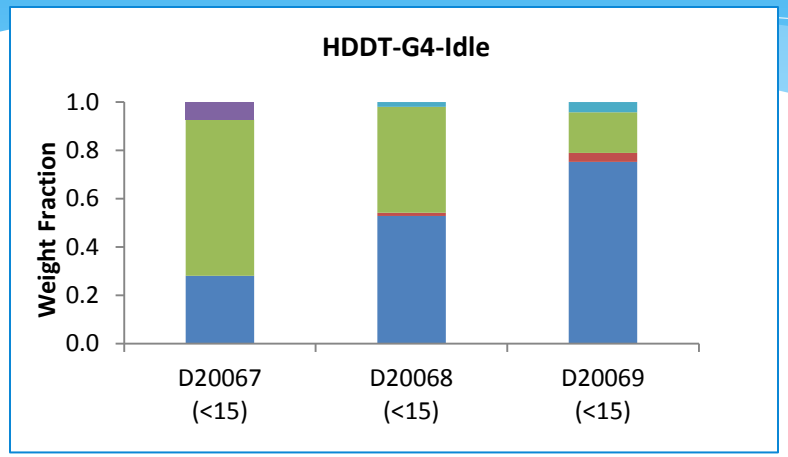
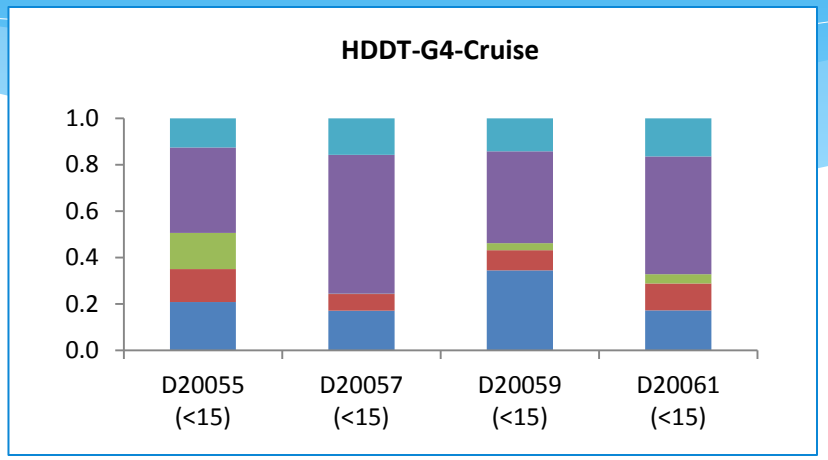
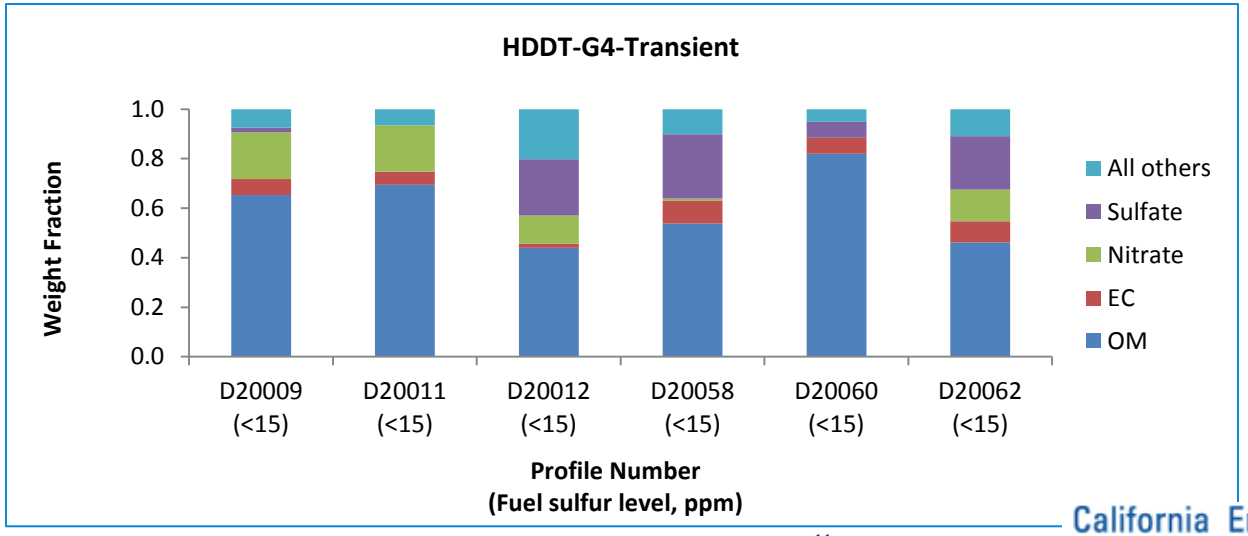
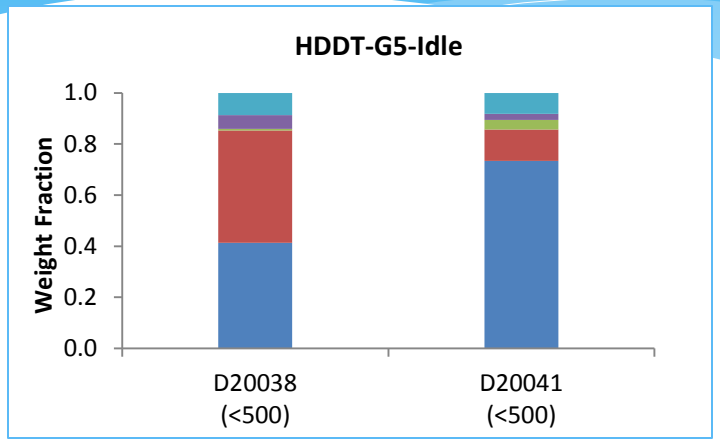
MY/AT Profile for HDDT: G4

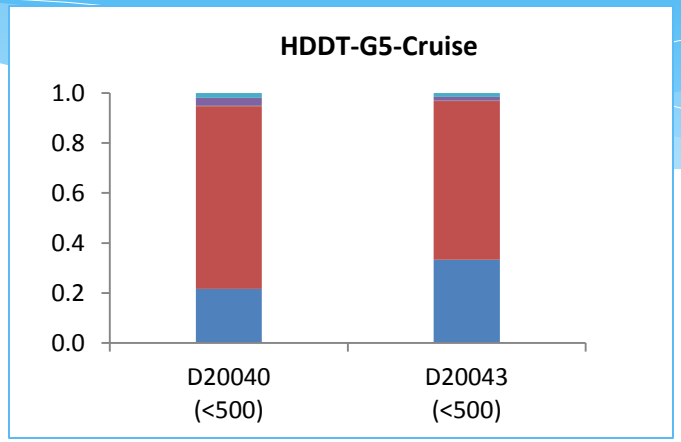


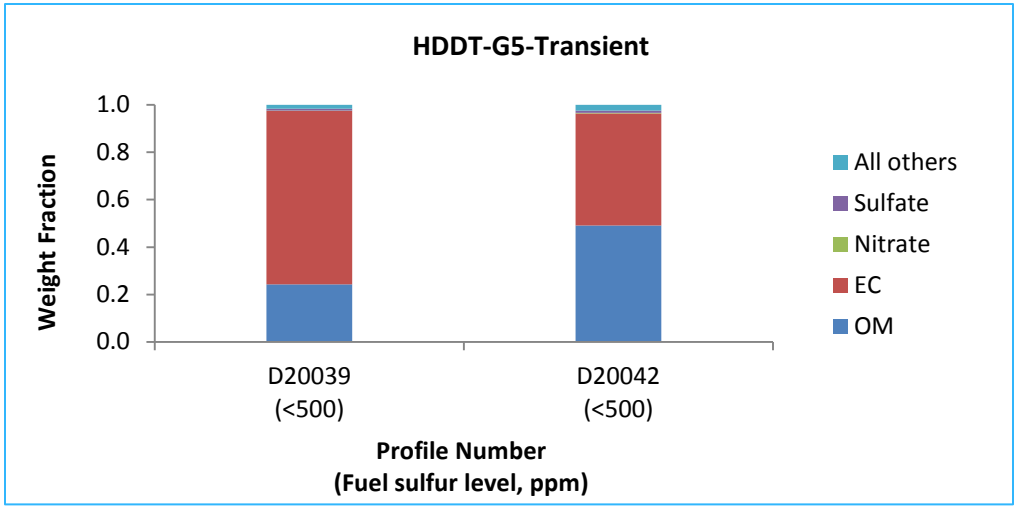




MY/AT Profile for HDDT: G5







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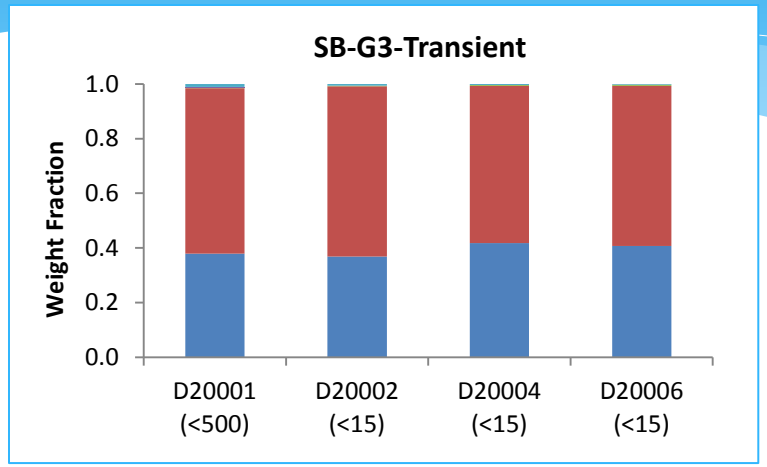
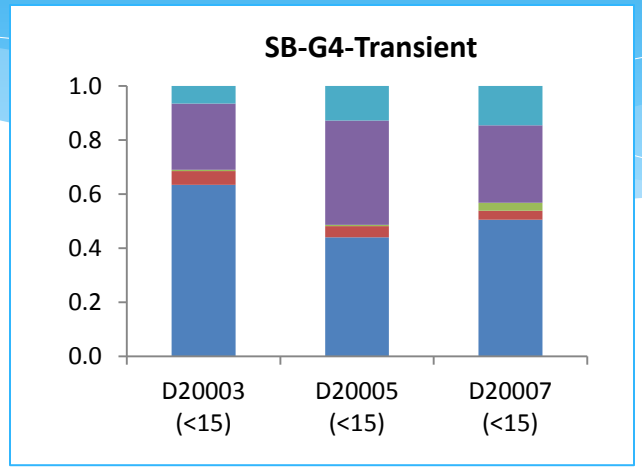
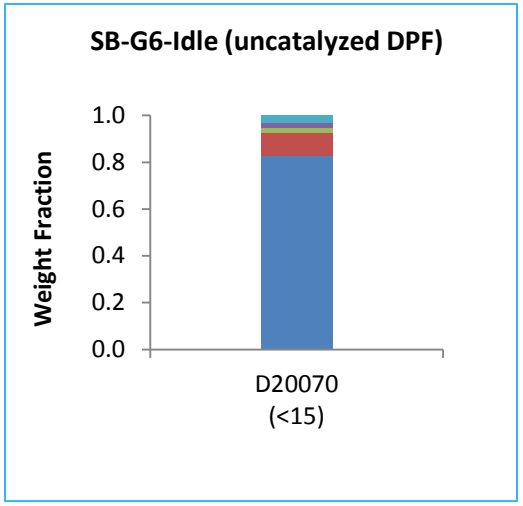
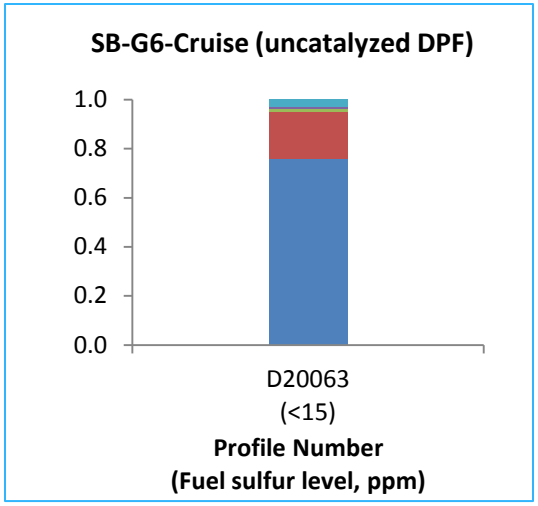
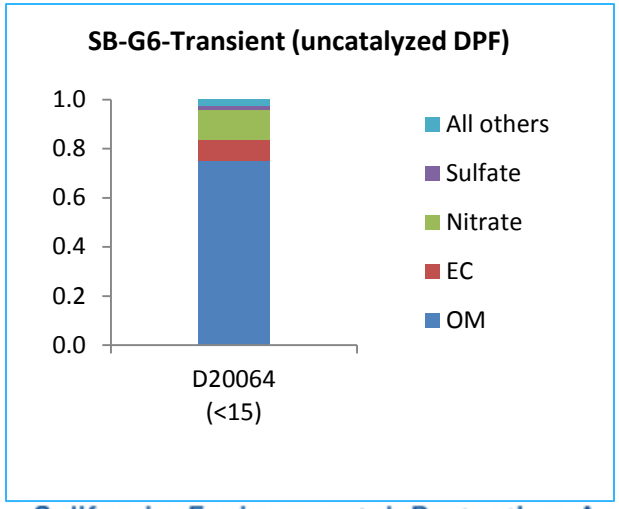
MY/AT Profile for School Bus



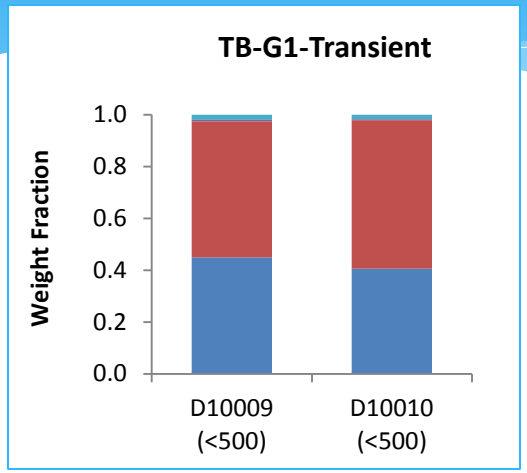


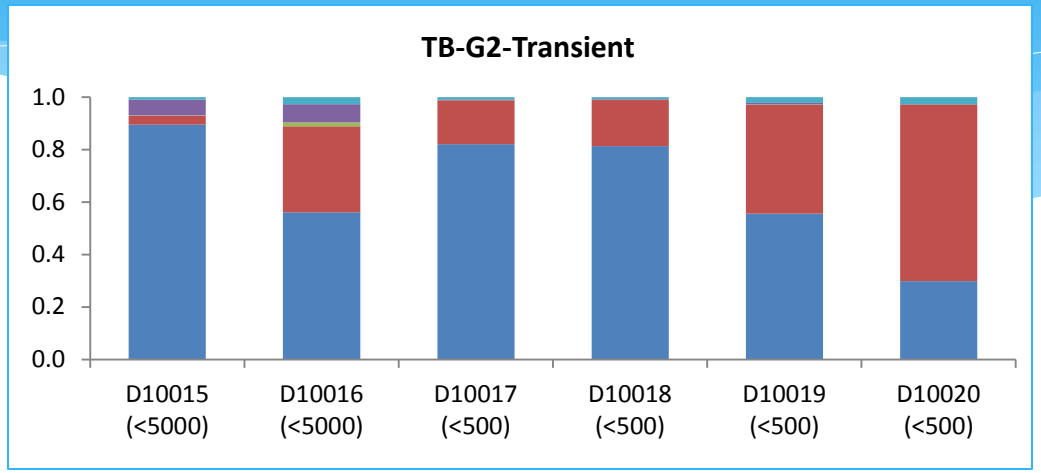


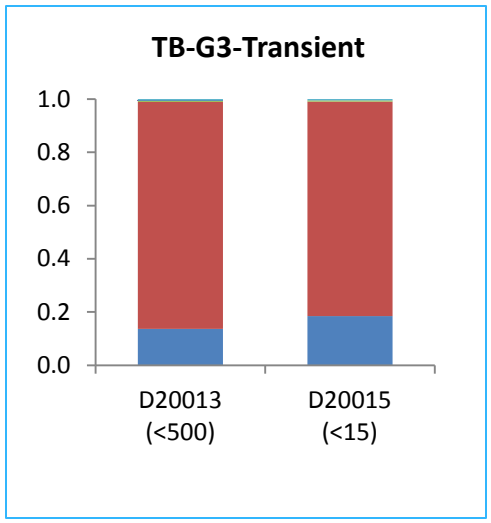


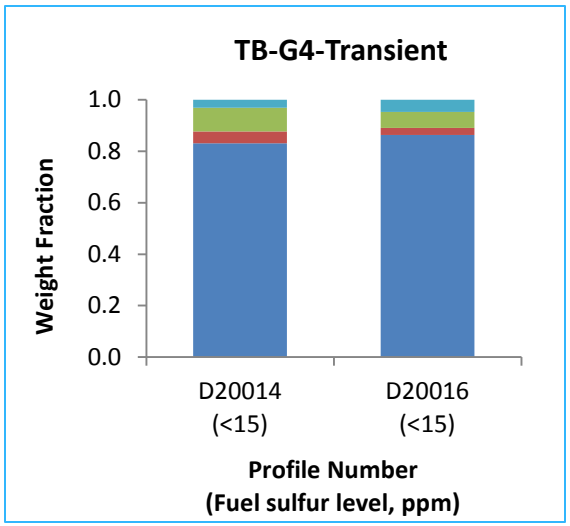


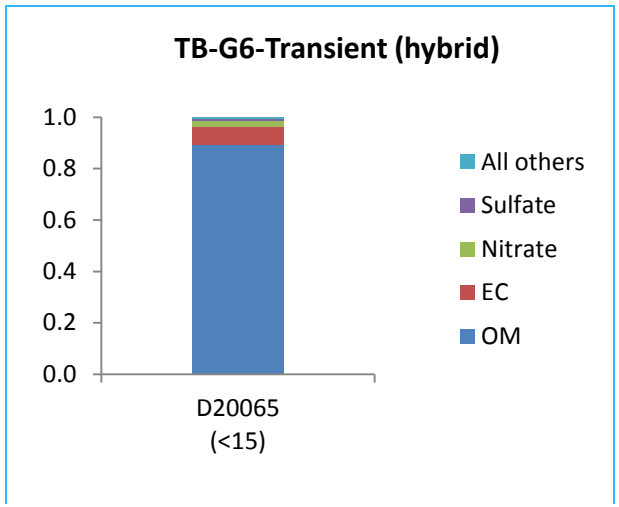
MY/AT Profile for Transit Bus



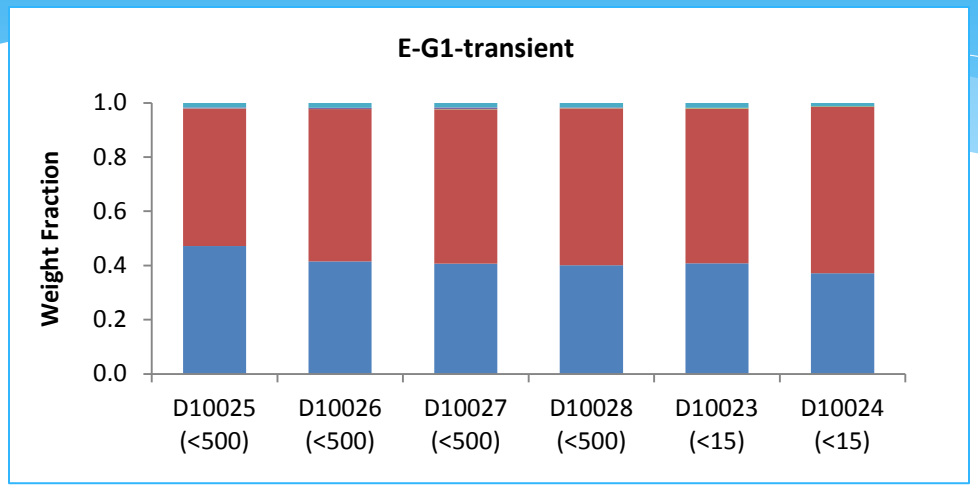


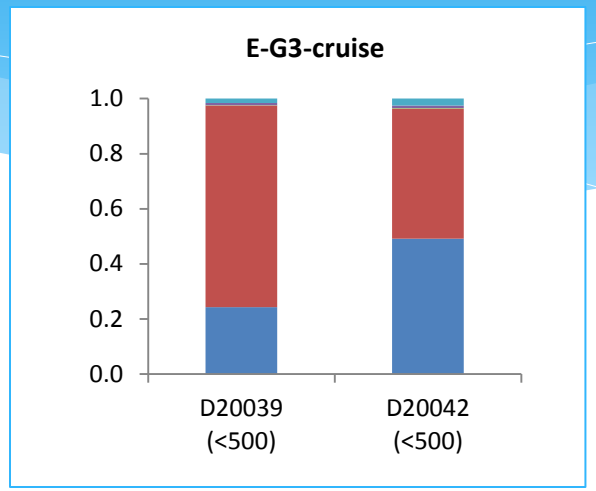


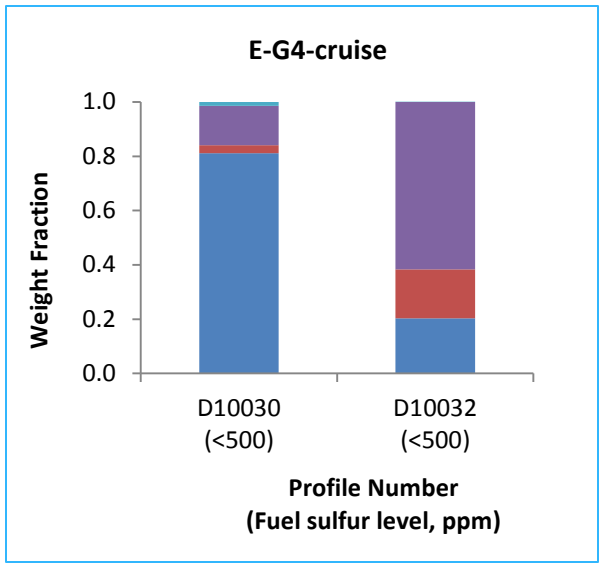


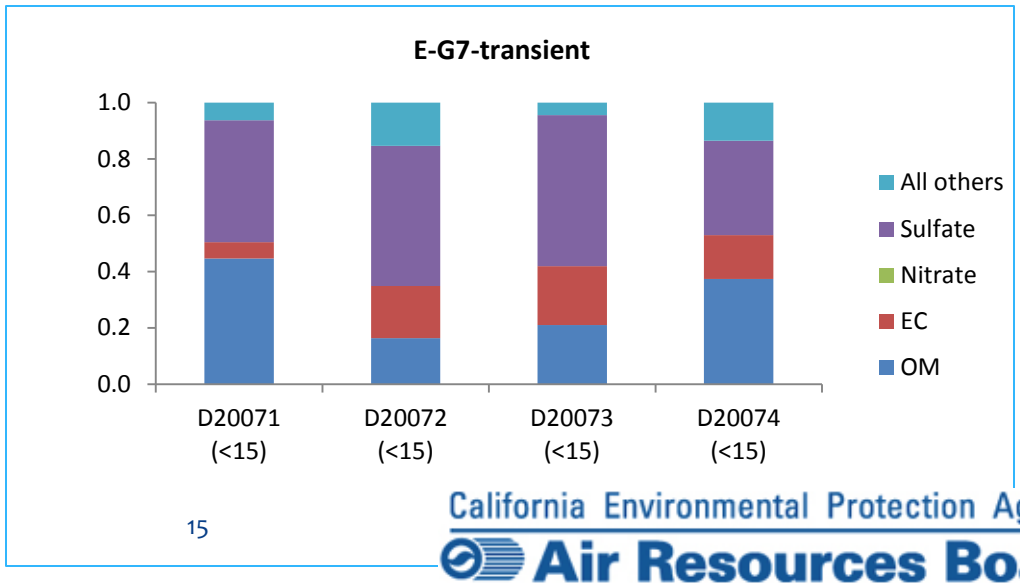


MY/AT Profile for Engine









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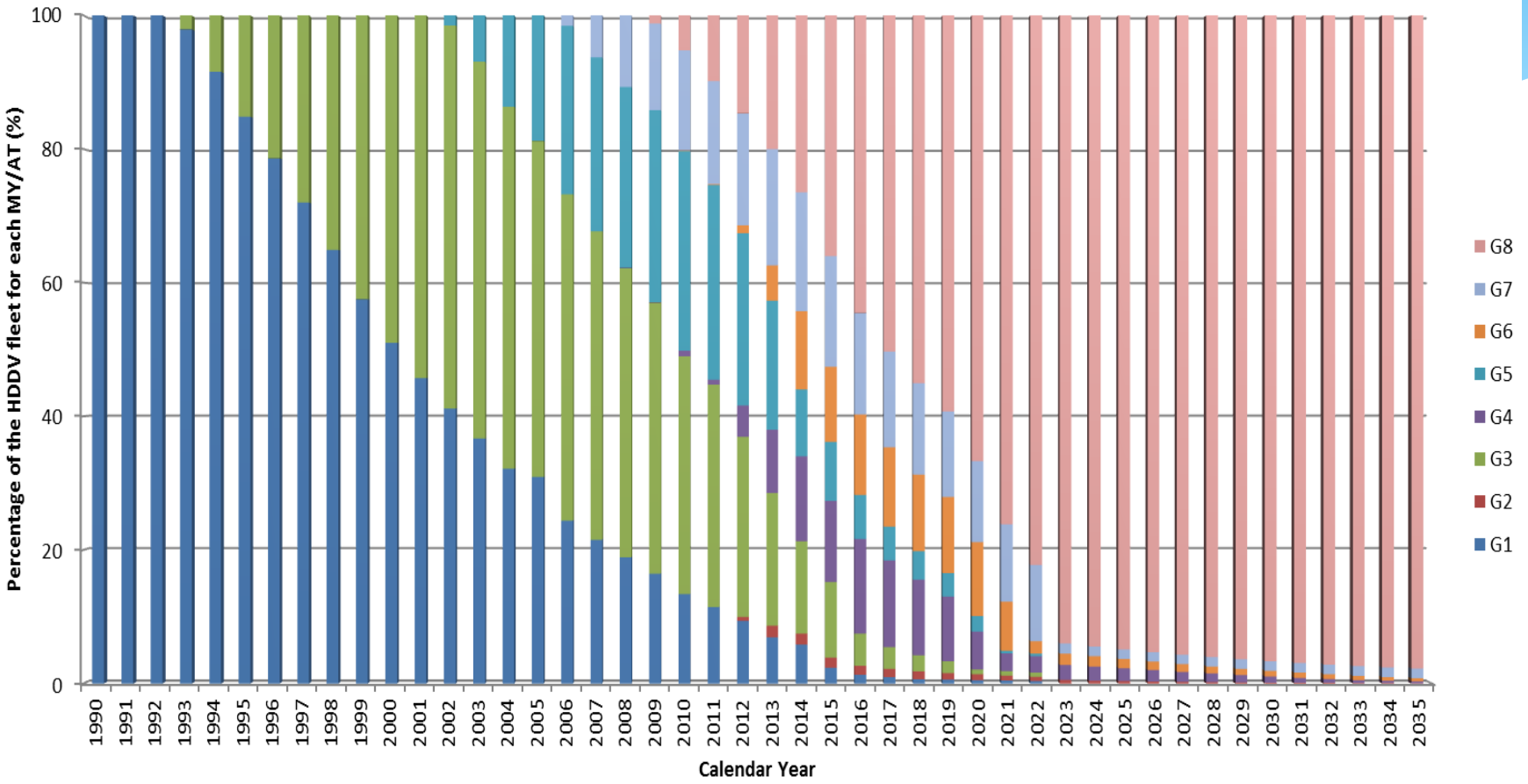
Summary of MY/AT Profiles

Assumptions

Type	Cycle	MY/AT							
		G1	G2	G3	G4	G5	G6	G7	G8
HDDT	Idle	4252	4258	4255	4258	4261	4258	4277	
	Cruise	4253	4259	4256	4259	4262	4259		
	Transient	4254	4260	4257	4260	4263	4260		
School Bus	Idle	4252	4258	4255	4258	4261	4258		
	Transient	4254	4260	4264	4260	4263	4260		
Transit Bus	Idle	4252	4258	4255	4258	4261	4258		
	Transient	4269	4260	4271	4260	4263	4260		
Engine	Cruise			4275	4276				
	Transient	4274						4277	

California HDDV Fleet Composition



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Profile for Each Calendar Year

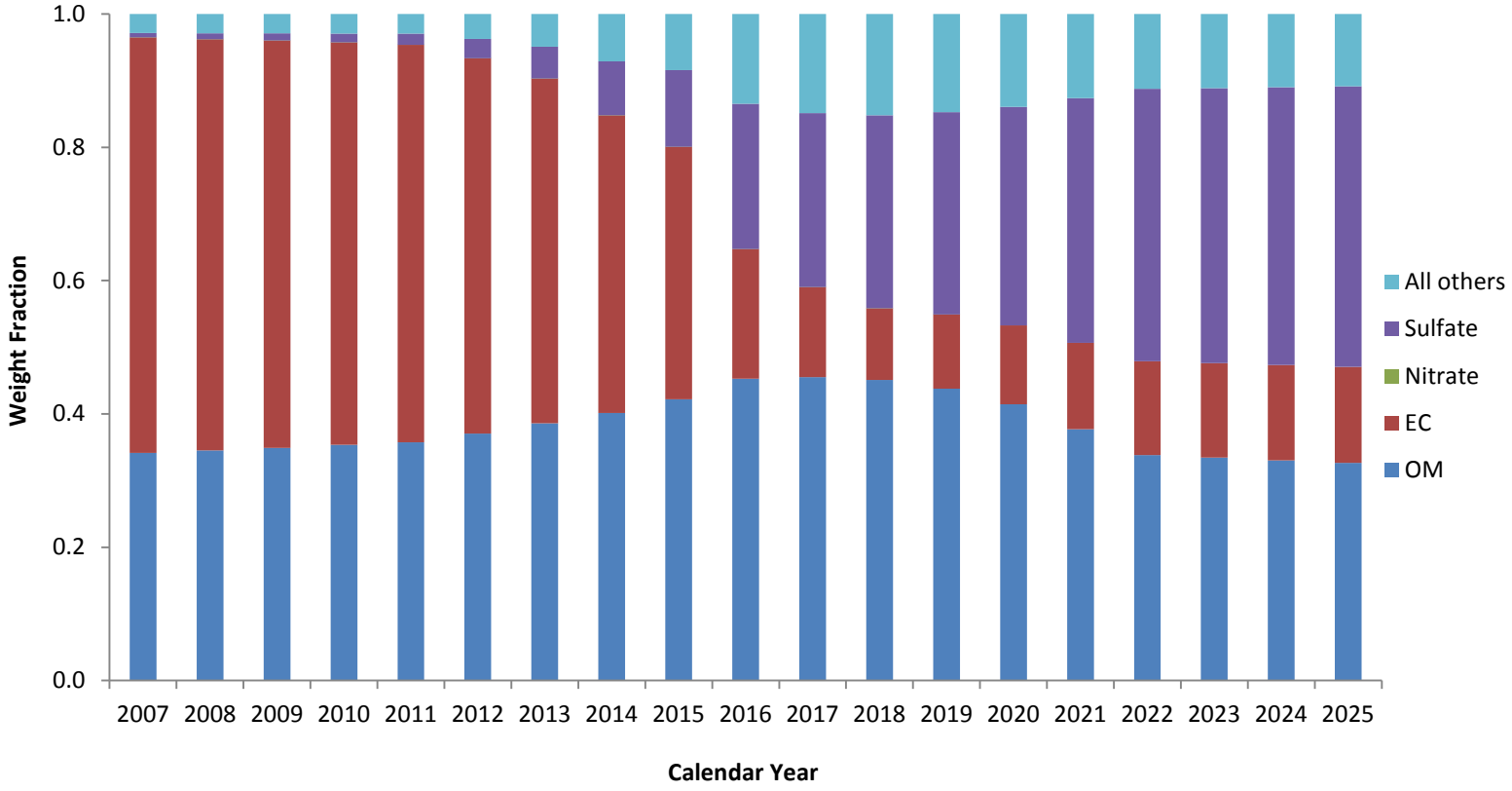
$$F_{Y_k}^{S_j} = \sum_{i=1-8} (F_{G_i}^{S_j} \times P_{G_i}^{Y_k})$$

- $F_{Y_k}^{S_j}$: weight fraction of Species *j* in the CY profile for Year *k* fleet;
- $F_{G_i}^{S_j}$: Weight fraction of Species *j* in the MY/AT profile for Group *i (i=G1, G2, G3, G4, G5, G6, G7 and G8);*
- $P_{G_i}^{Y_k}$: CY fleet composition fraction of Group *i* vehicles in the fleet of Year *k*, weighted by $PM_{2.5}$ mass.

Calendar Year Specific Profiles

Calendar Year	HDDT			SB		TB	
	Idle	Cruise	Transient	Idle	Transient	Idle	Transient
2007	6071	6072	6073	6074	6075	6076	6077
2008	6081	6082	6083	6084	6085	6086	6087
2009	6091	6092	6093	6094	6095	6096	6097
2010	6101	6102	6103	6104	6105	6106	6107
2011	6111	6112	6113	6114	6115	6116	6117
2012	6121	6122	6123	6124	6125	6126	6127
2013	6131	6132	6133	6134	6135	6136	6137
2014	6141	6142	6143	6144	6145	6146	6147

HDDT Transient Profiles



Profile Assignment

Vehicle	Cycle	EICSUB Name
HDDT	Cruise	Motor Coach, PTO, T6 Ag, T6 CAIRP heavy, T6 CAIRP small, T6 instate construction heavy, T6 instate construction small, T6 instate heavy, T6 instate small, T6 OOS heavy, T6 OOS small, T7 Ag, T7 CAIRP, T7 CAIRP construction, T7 NNOOS, T7 NOOS, T7 other port, T7 POAK, T7 POLA, T7 tractor, T7 tractor construction
	Transient	T6 public, T6 utility, T7 public, T7 single, T7 single construction, T7 SWCV, T7 utility
SB	Transient	SBUS
TB	Transient	All Other Buses

Summary

* The year-specific composite diesel PM profiles are able to reflect the CARB truck and bus regulation.
* The MY/AT profile pool needs to be updated with new testing data for newer vehicles.
* Speciation profile development is meeting the challenges posed by new technology or regulations.
* The inventory categories needs to be changed to face the emerging air quality issues.

THE END

Thank you!

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