

COLD TEMPERATURE EFFECTS ON SPECIATED MSAT EMISSIONS FROM LIGHT-DUTY VEHICLES OPERATING ON GASOLINE AND ETHANOL BLENDS

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Background

- The Energy Independence and Security Act of 2007 (EISA) mandated an increase in biofuels use in the transportation sector to 36 billion gallons by 2022.
- The US EPA MSAT rule set limits of nonmethane hydrocarbon emissions from light-duty gasoline vehicles operating at cold temperatures phased in starting 2010.
- Exhaust MSAT emissions data at cold temperatures remain sparse.
- The objective of this study was to investigate the impacts of ethanol blends on speciated exhaust emissions from light-duty gasoline vehicles at cold temperatures

Dynamometer Testing

Vehicle properties

Vehicles	1) Honda Civic	2) Chevrolet Impala	3) Chrysler Town & Country
Model Year	2008	2008	2008
FFV?	No	Yes	Yes
ODO	26,459 km	23,785 km	78,283 km
Weight	1,361 kg	1,814 kg	2,155 kg
Cylinders	4	6	6

Burke-Porter 4100, 48 in. roll electric chassis dynamometer

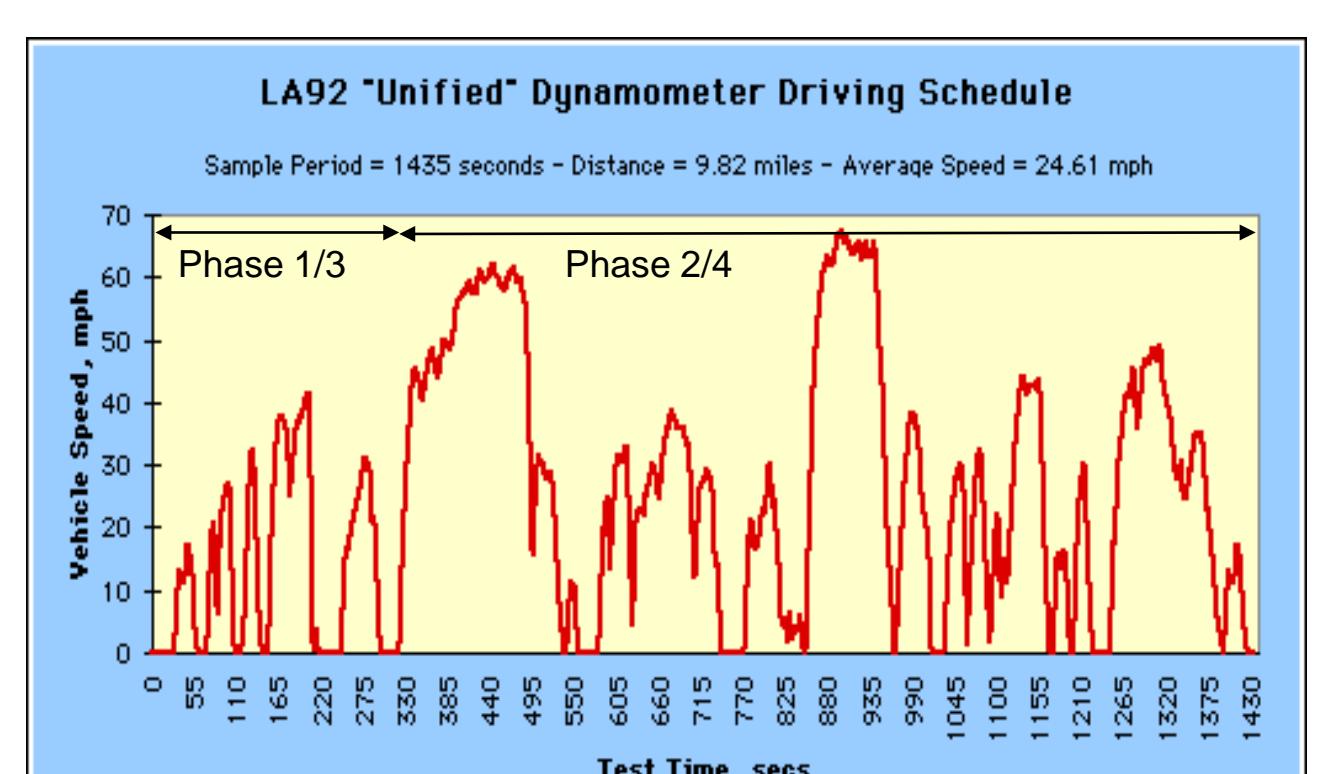


Fuel properties

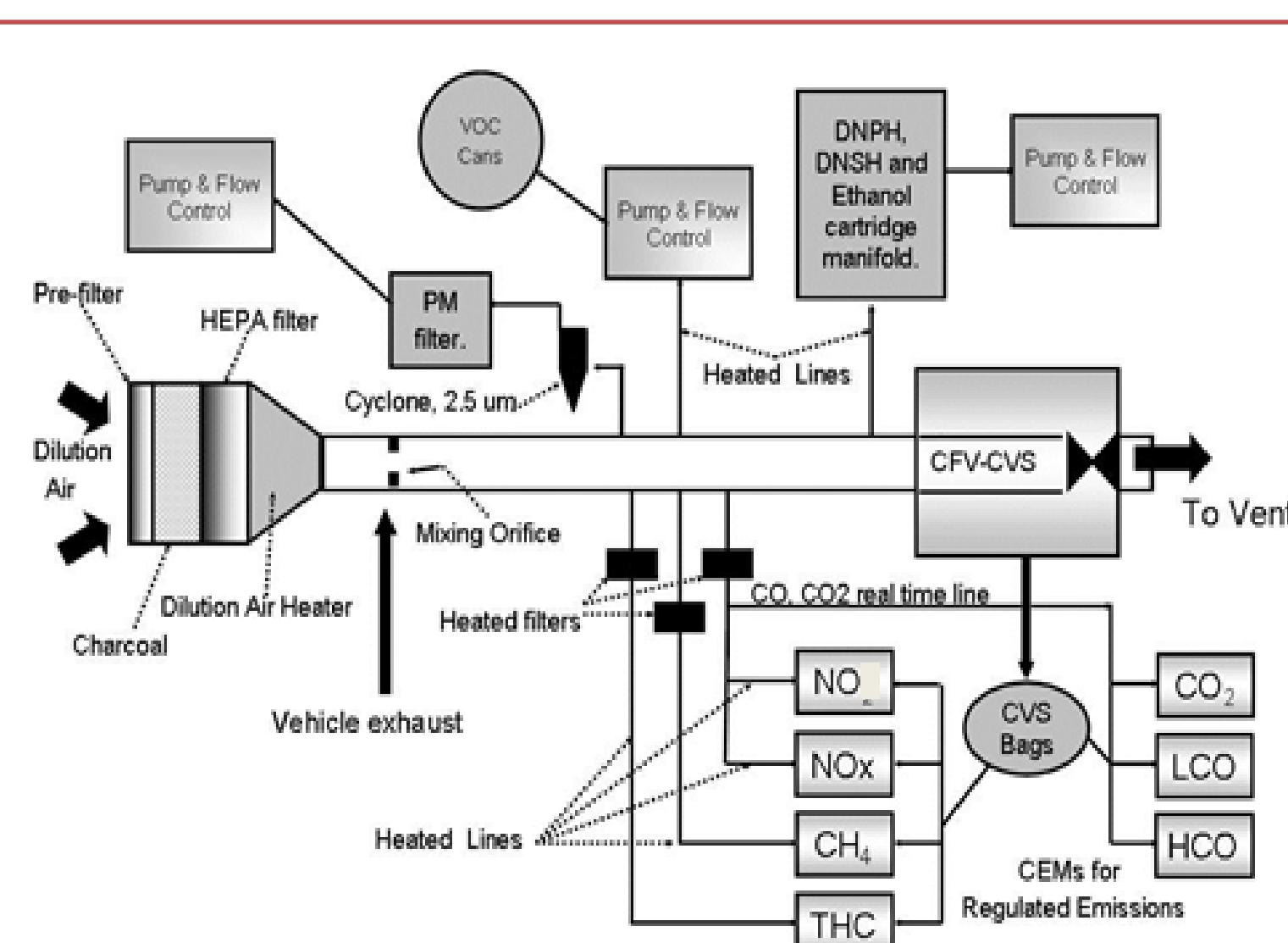
Fuels	Summer grade fuels			Winter grade fuels*		
	SE0	SE10	SE85	WE0	WE10	WE85
RVP, psi	9.1	9.0	8.6	12.3	12.7	12.4
Ethanol % v/v	0.0	8.6	84.0	0.0	8.7	77.7
Benzene % v/v	1.03	1.04	0.93	1.08	1.10	0.97
ASTM D6729						
Saturates % mol	69.1	55.7	5.6	70.6	57.6	8.4
Aromatics % mol	26.5	22.3	2.1	25.4	20.9	2.7
Olefins % mol	3.3	2.9	0.1	3.1	2.7	0.2
Oxygenates % mol	0.1	18.3	92.0	0.1	18.1	88.3

*Butane added to winter fuels

LA92 "Unified" 4-Phase Driving Cycle



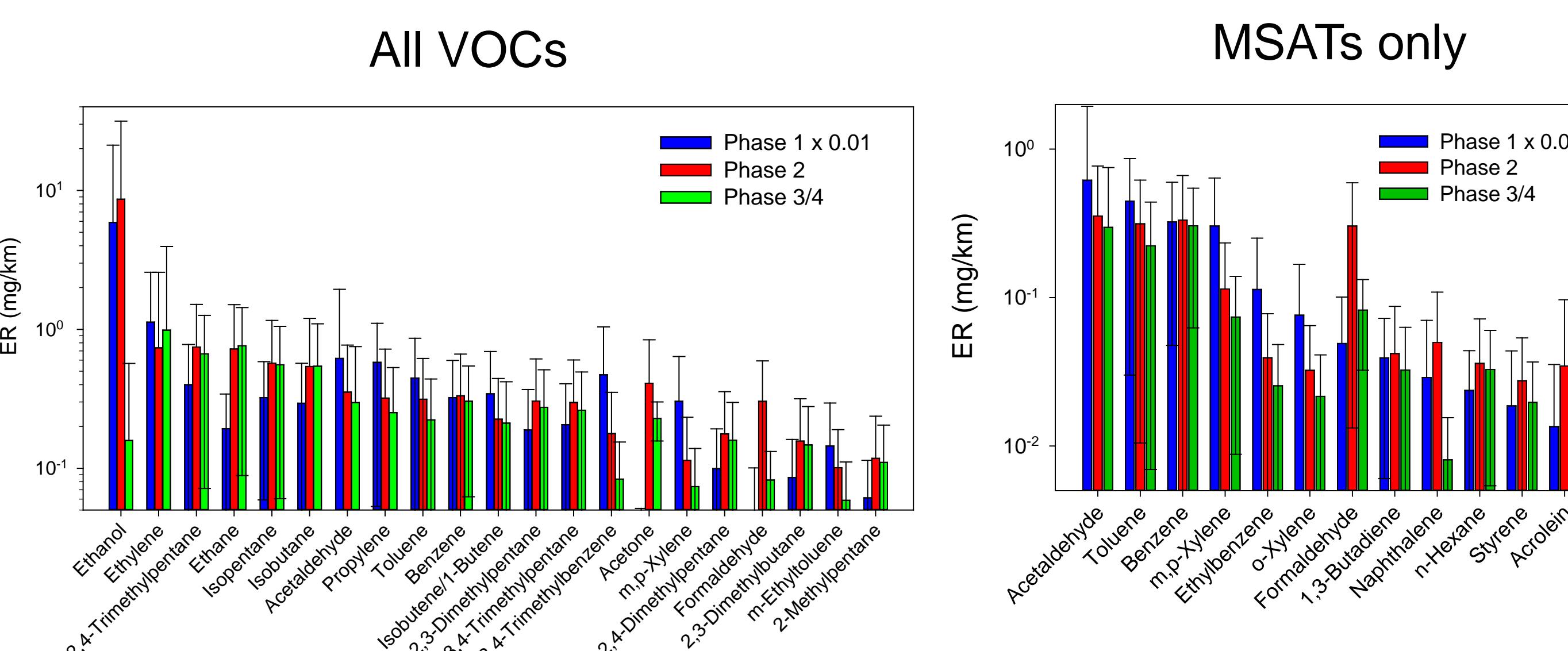
Dilution tunnel and sampling setup



Test matrix

Test	Vehicle	Fuel	Temp (C)	N
1	1	SE0	24	3
2	1	WE10	-7	6
3	1	WE0	-7	3
4	1	SE10	24	3
5	2	WE0	-7	3
6	2	SE85	24	3
7	2	WE10	-7	3
8	2	WE85	-7	3
9	2	SE10	24	3
10	2	SE0	24	4
11	3	SE10	24	5
12	3	SE85	24	3
13	3	WE10	-7	4
14	3	WE0	-7	3
15	3	SE0	24	3
16	3	WE85	-7	3

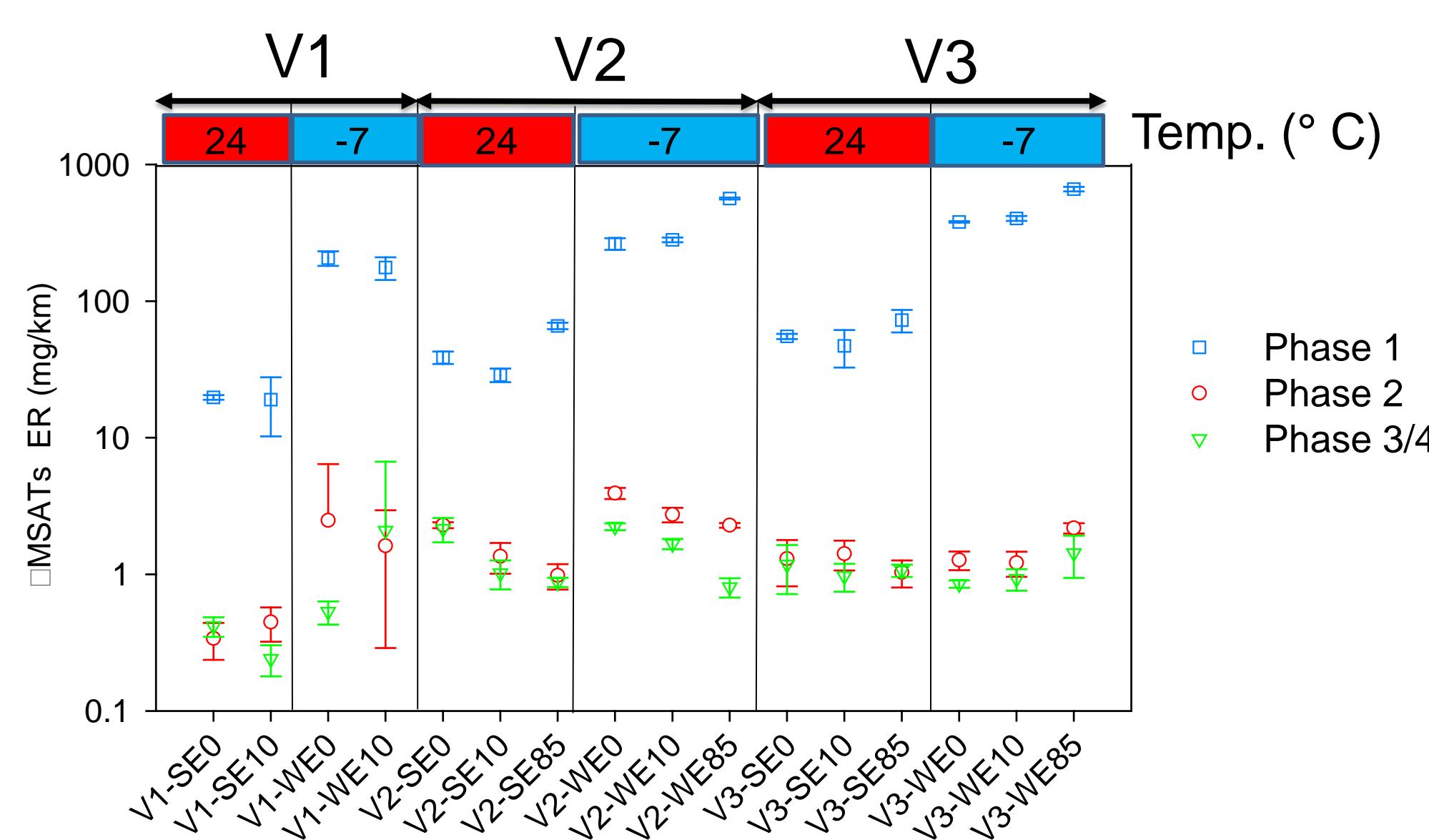
VOC Emission Profiles



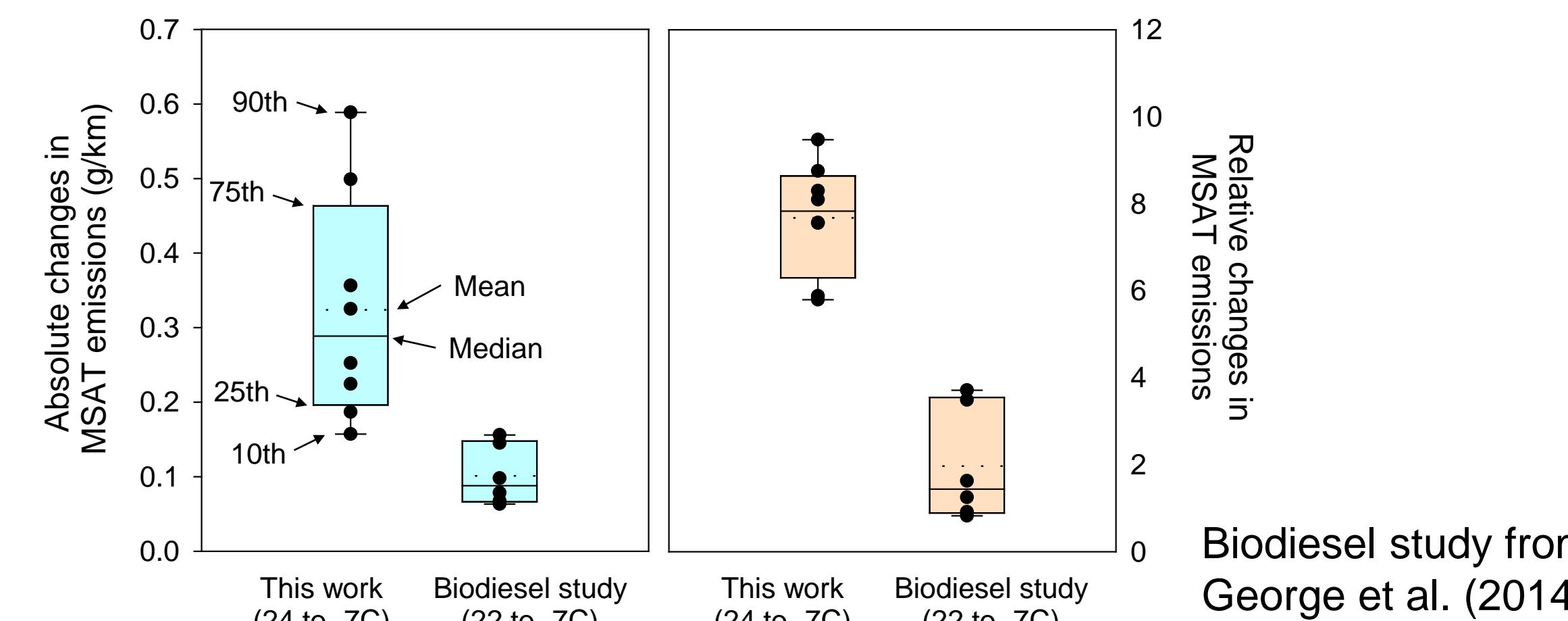
- Average VOC emissions during Phase 1 cold start were ~100 times higher than other phases, while Phase 2 and 3 / 4 had similar emission profiles
- Acetaldehyde, monoaromatics and formaldehyde were the most important contributors to speciated MSAT emissions for all phases

Temperature Effects

Σ MSATs by test condition

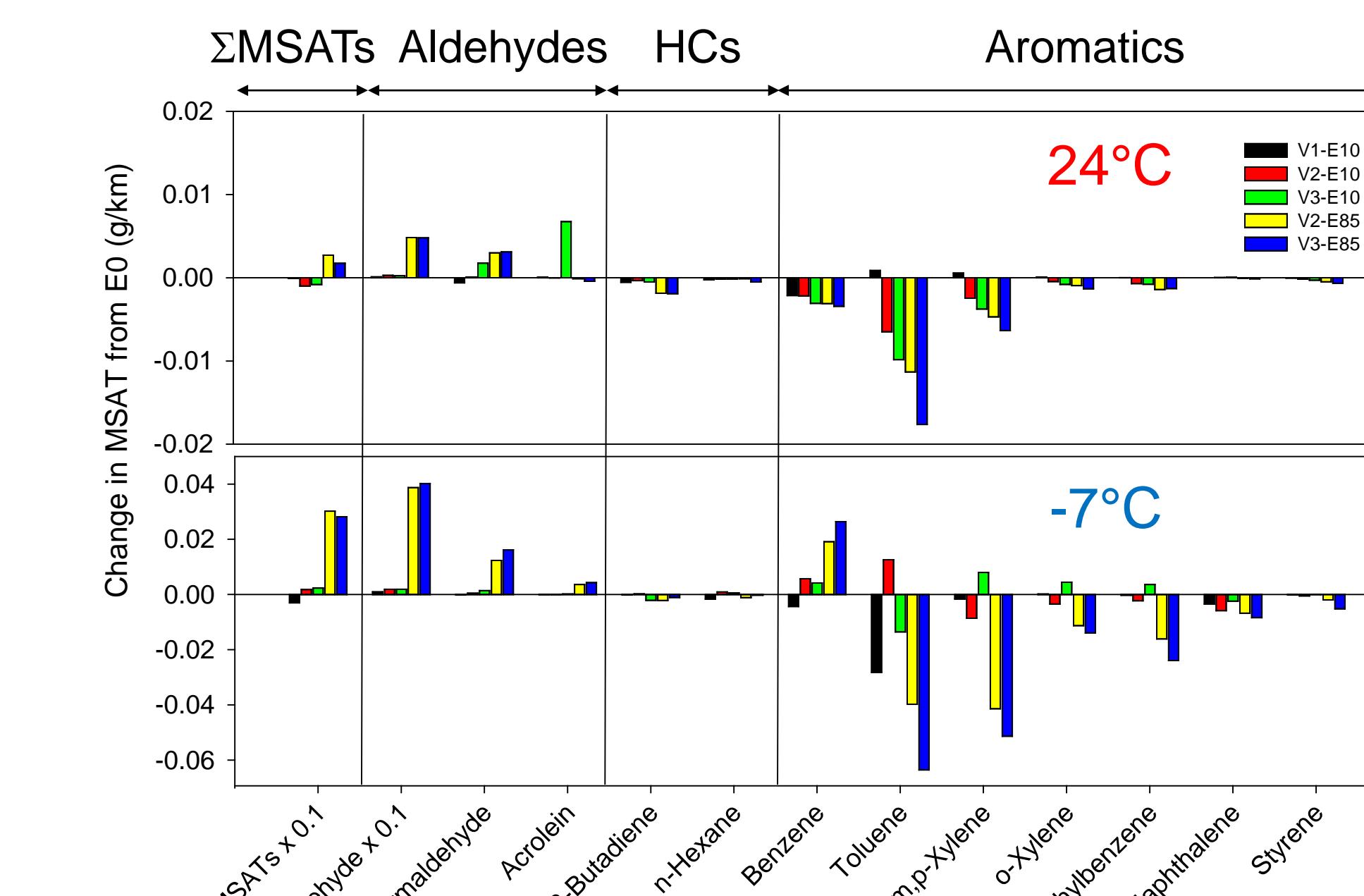


Σ MSATs enhancements from cold temperature during cold starts



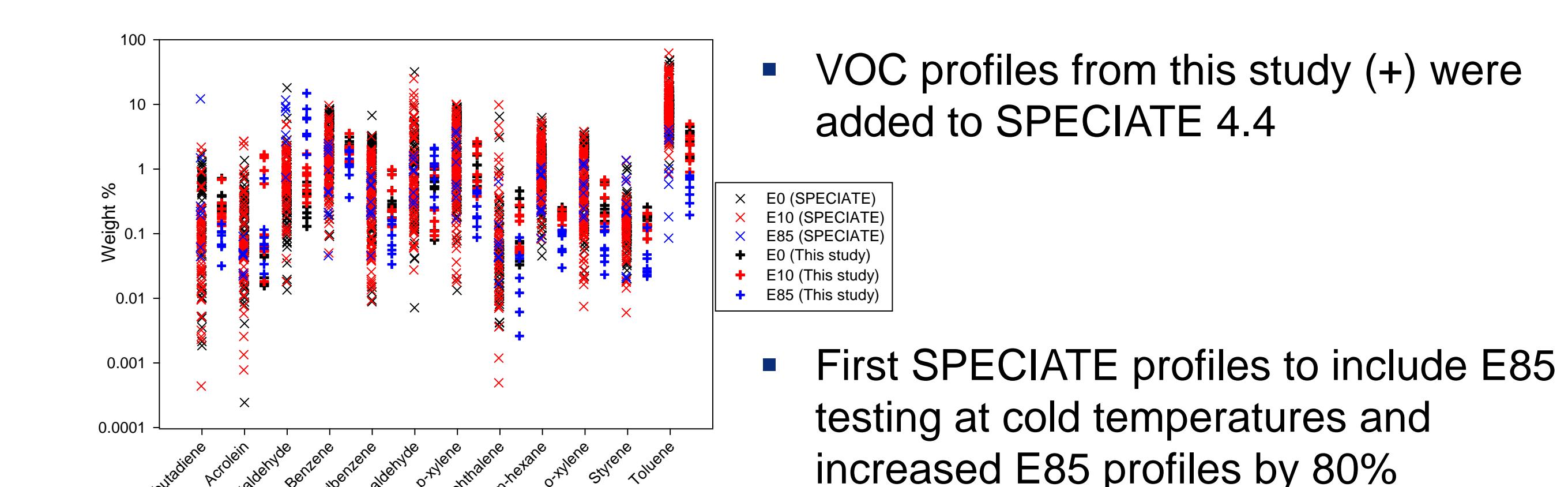
Fuel Effects

Absolute Changes in MSATs emissions during Phase 1



- Phase 1 Σ MSAT E0 to E85 changes were dominated by acetaldehyde
- Aldehydes increased from E0 to E10 and E85; aromatics varied by temperature and fuel
- MSAT/NMHC increased with ethanol % in fuel

SPECIATE Comparison



- VOC profiles from this study (+) were added to SPECIATE 4.4
- First SPECIATE profiles to include E85 testing at cold temperatures and increased E85 profiles by 80%

Conclusions

- Cold start (Phase 1) and cold temperature (-7°C) substantially enhanced MSAT emissions compared to other phases and warm temperature (24°C) conditions.
- Addition of ethanol to the fuel increased aldehyde emissions, but had variable effects on aromatics depending on fuel and ambient conditions.
- Emission profiles from this study represent a considerable increase in E85 profiles in SPECIATE, including the first E85 profiles at cold temperature.

Acknowledgements

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