Improving Chemical Transport Model Predictions of Organic Aerosol: Measurement and Simulation of Semivolatile Organic Emissions from Mobile and Non-Mobile Sources

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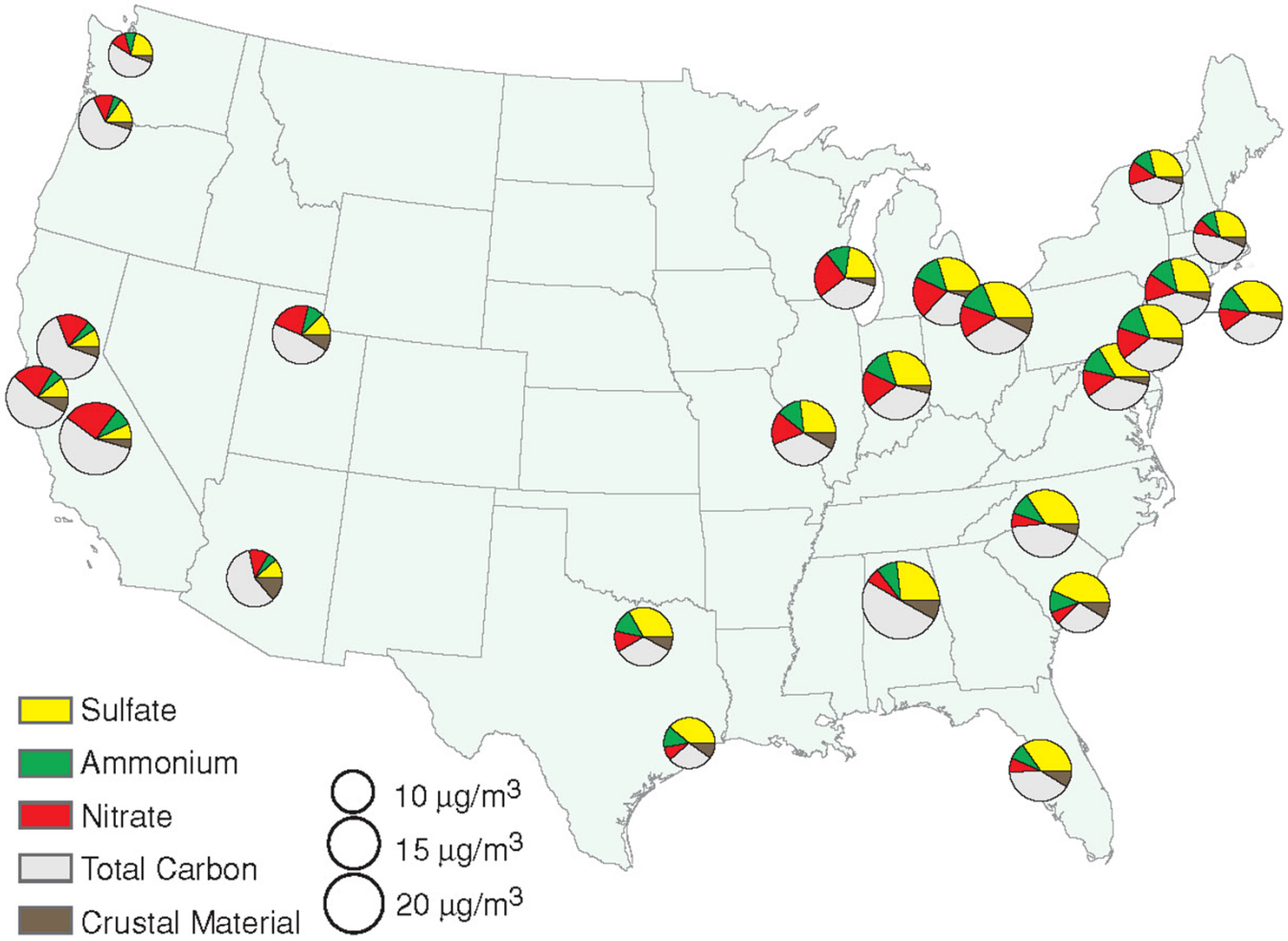
Organic aerosols are ubiquitous



(NARSTO PM Assessment 2004)

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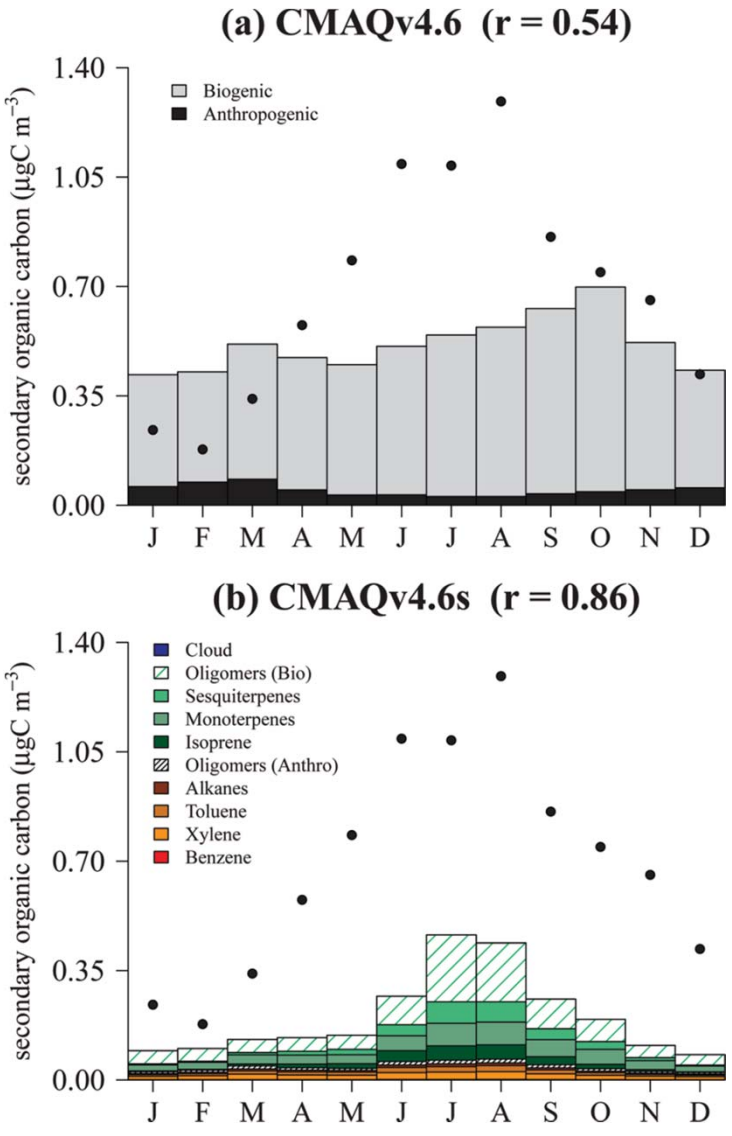
CTMs have trouble predicting organic aerosol concentrations



(Carlton et al. EST 2010)

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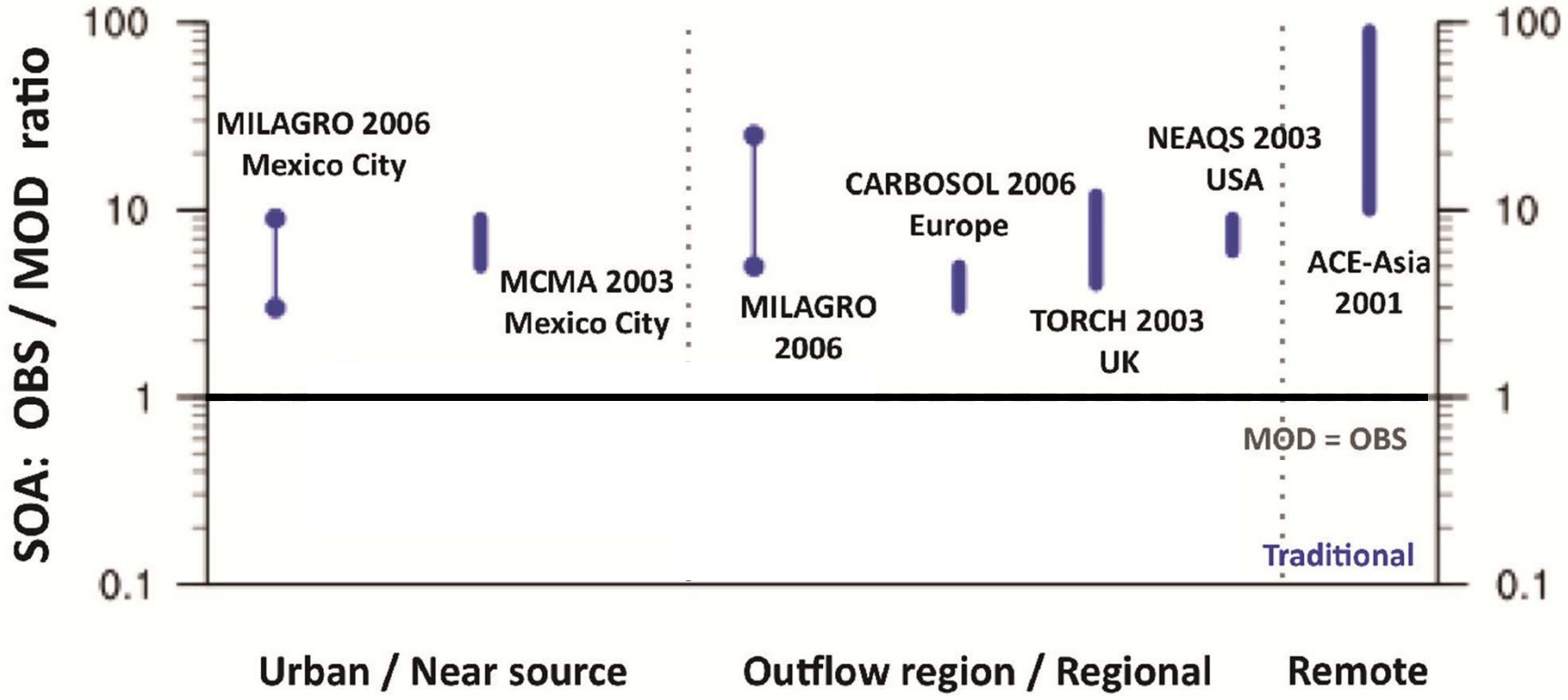
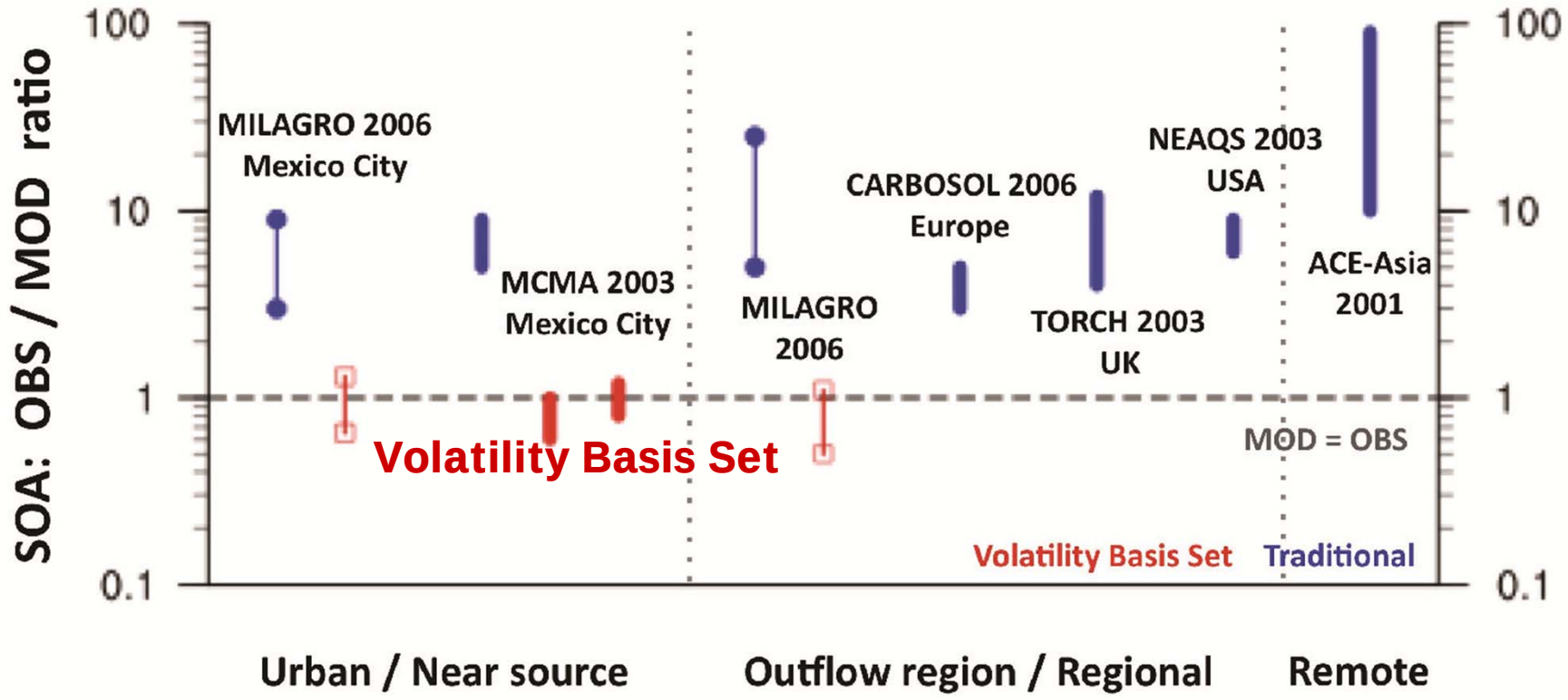
Consistent under-prediction of SOA



(Hodzic et al. ACPD 2010)

VBS approach improve model performance



(Hodzic et al. ACPD 2010)

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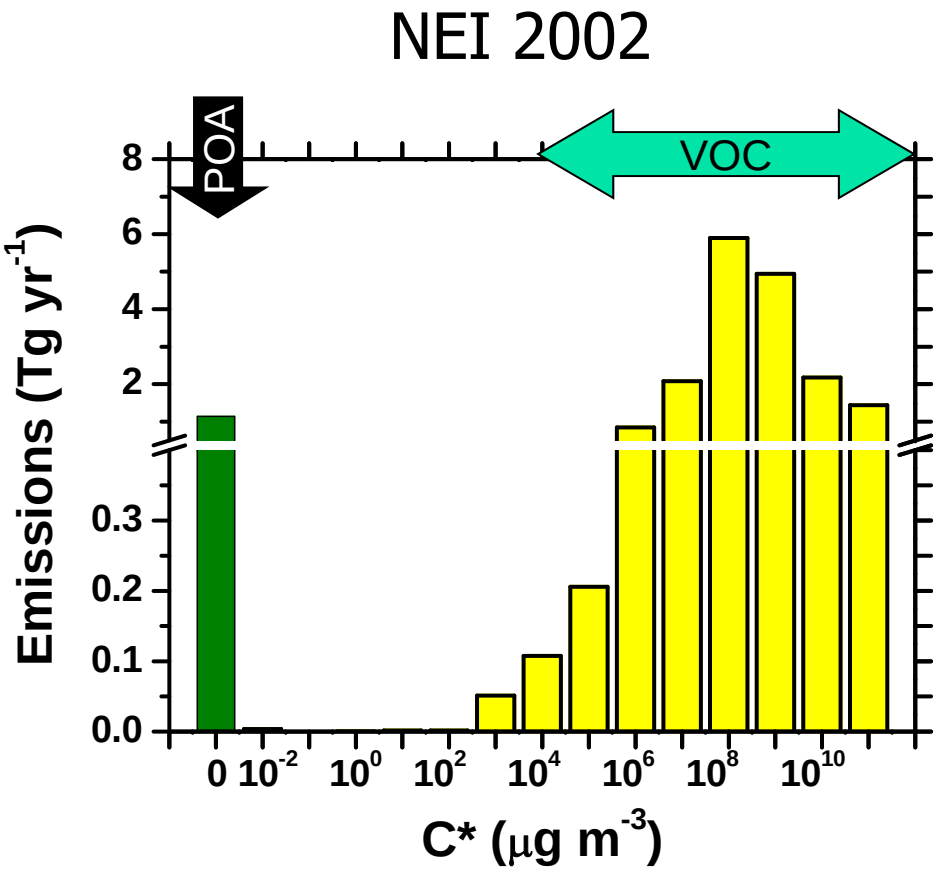
Traditional Emission Inventory



- Canister/bag for THC and VOC speciation
- Quartz filter for POA

(Shrivastava et al., JGR 2008)

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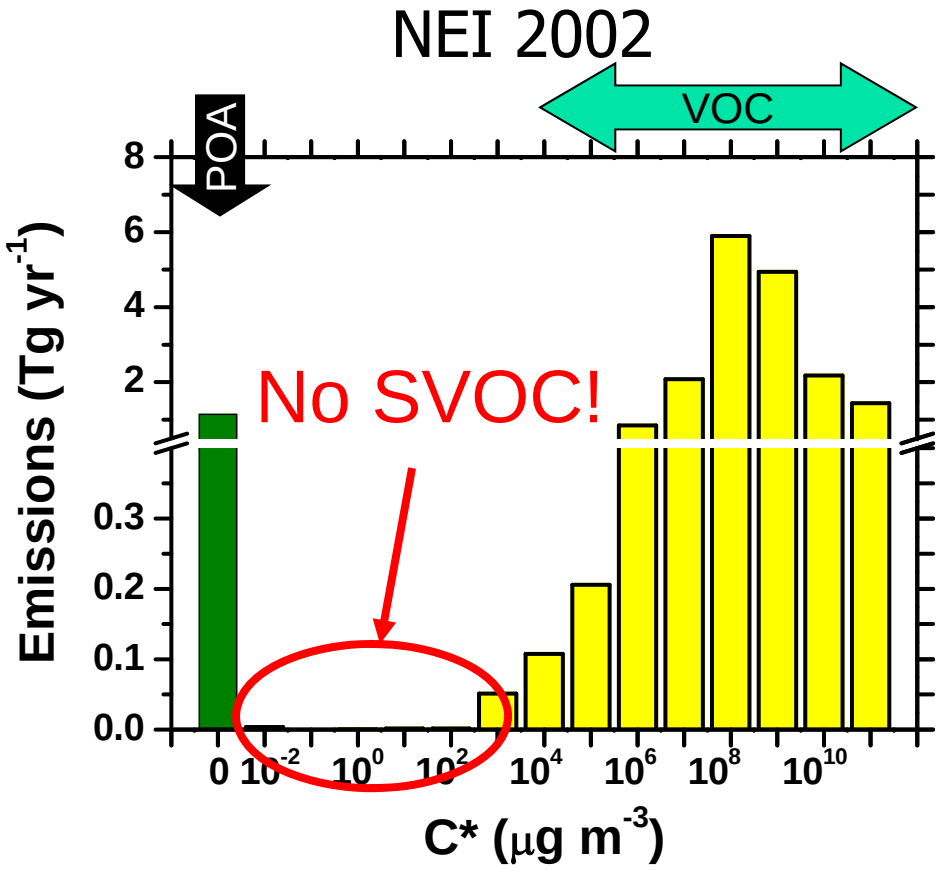
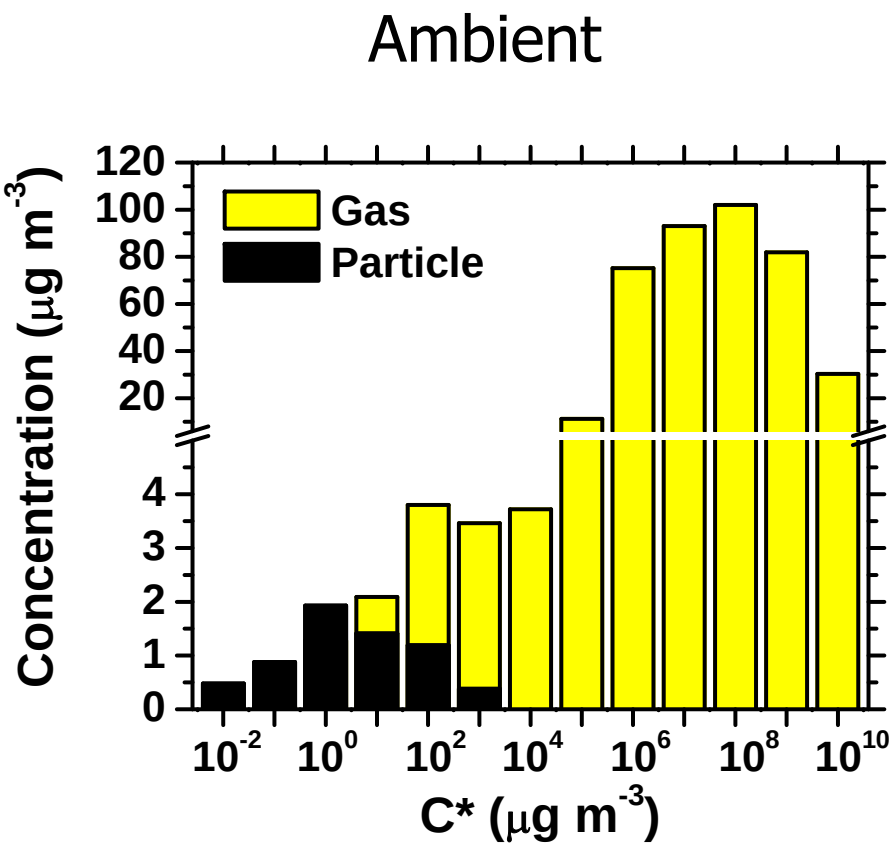
Traditional Emission ≠ Ambient

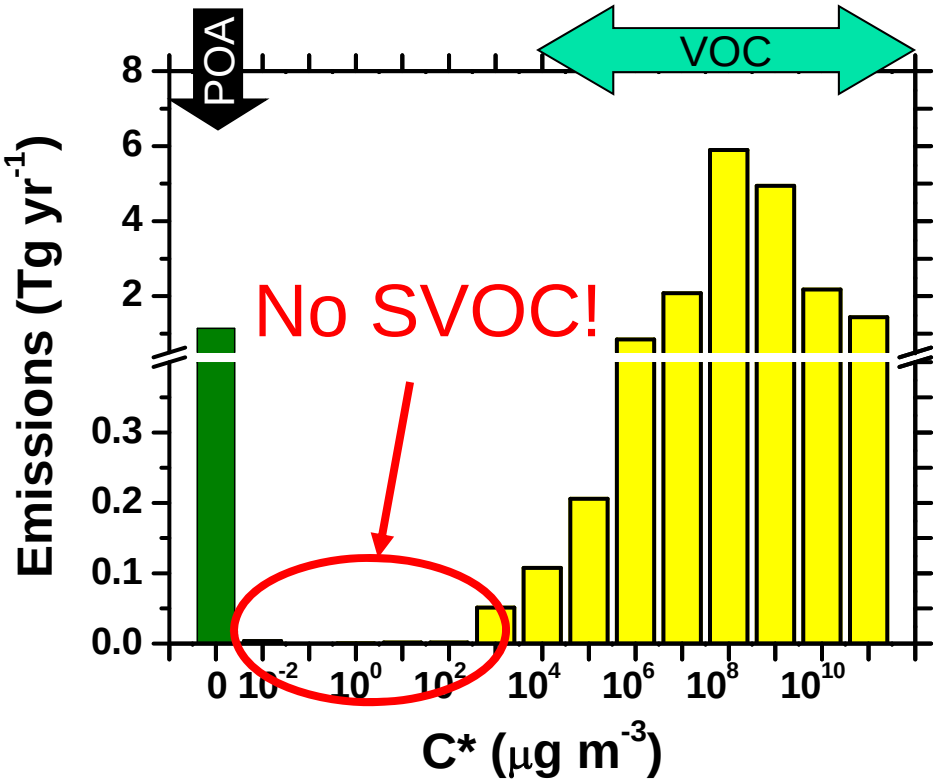




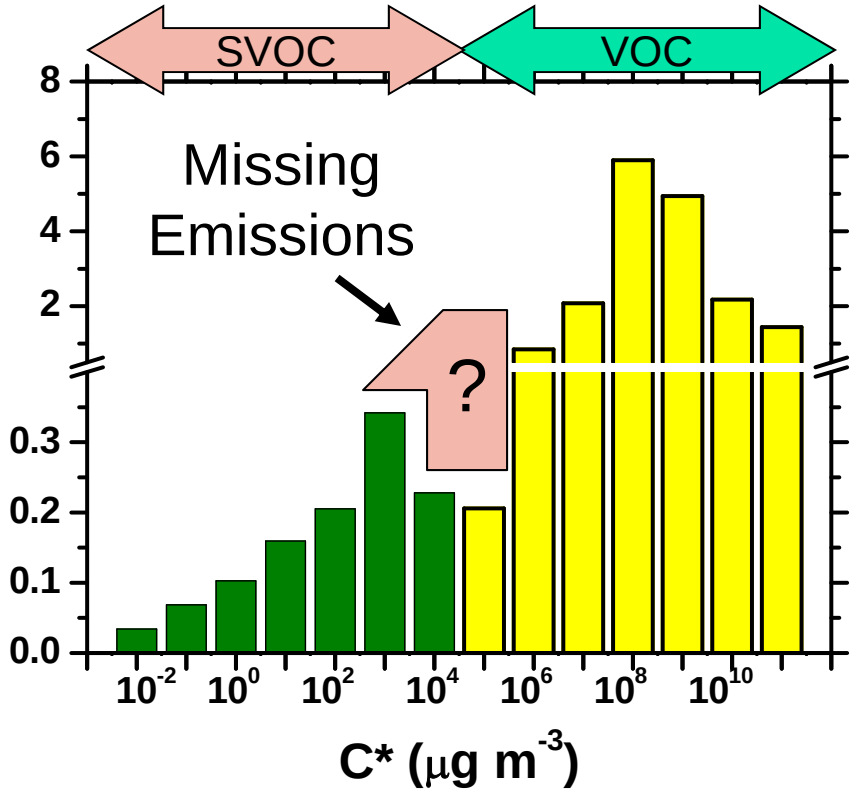
(Shrivastava et al., JGR 2008)

VBS Emission Inventory

NEI 2002



VBS Inventory



(Shrivastava et al., JGR 2008)

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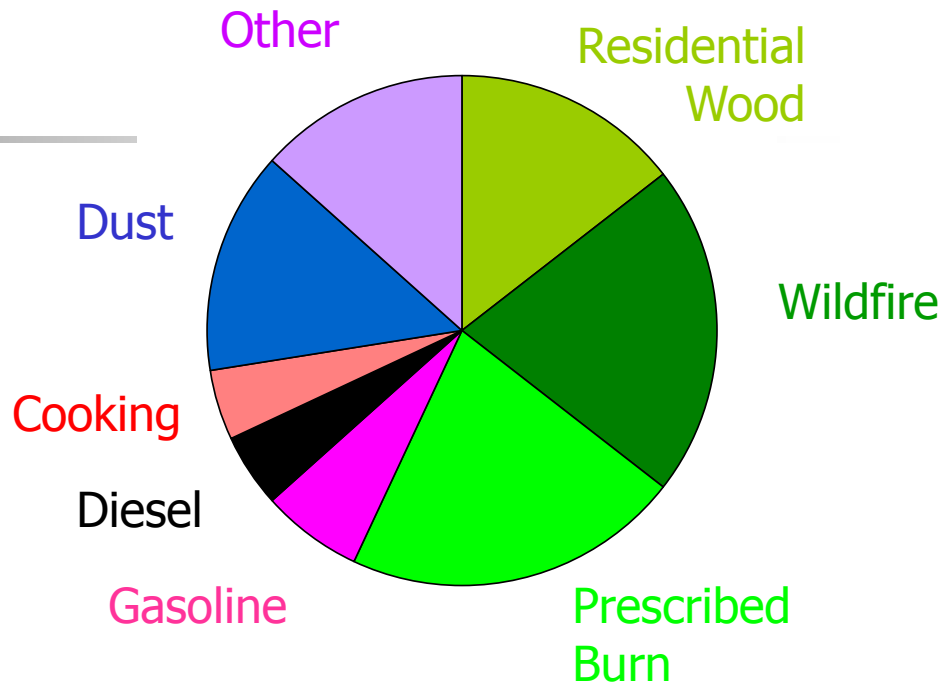
Data Gaps

NEI 2002 POA Emissions



Volatility Distributions

Source	10^{-2}	10^{-1}	10^{0}	10^{1}	10^{2}	10^{3}	10^{4}	10^{5}	10^{6}
Diesel	0.01	0.01	0.04	0.21	0.18	0.45	0.10	?	?
Res. Wood	0.05	0	0.05	0.25	0.15	0.45	0.05	?	?
Pres. Burn									
Wildfire									
Gasoline									
Cooking									
Dust									
Other									

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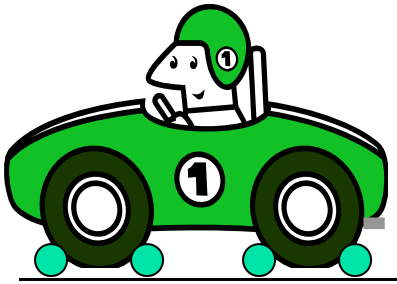
Overview of Project

- Task 1. Characterize low volatility organic emissions from in use mobile sources
- Task 2. Test methodologies for measuring volatility distributions of primary emissions
- Task 3. Measure ambient concentrations and of low-volatility organics
- Task 4. Analysis of emissions data and emission inventory development
- Task 5. Chemical transport modeling

Task 1. Mobile Source Testing

- Three campaigns
  - **1. Light Duty:** 47 in-use vehicles Haagen Smit (May 10)
  - **2. Heavy Duty Diesel:** CARB diesel lab (Mar. 11)
  - **3. More LDV and non-road:** Haagen Smit (Summer 11)
- In-use vehicles & standard test cycles



Chassis Dynamometer Tests Over Standard Duty Cycle

CVS

Direct Characterization (Task 1 and 2)

Portable "Smog" Chamber (CRC support)

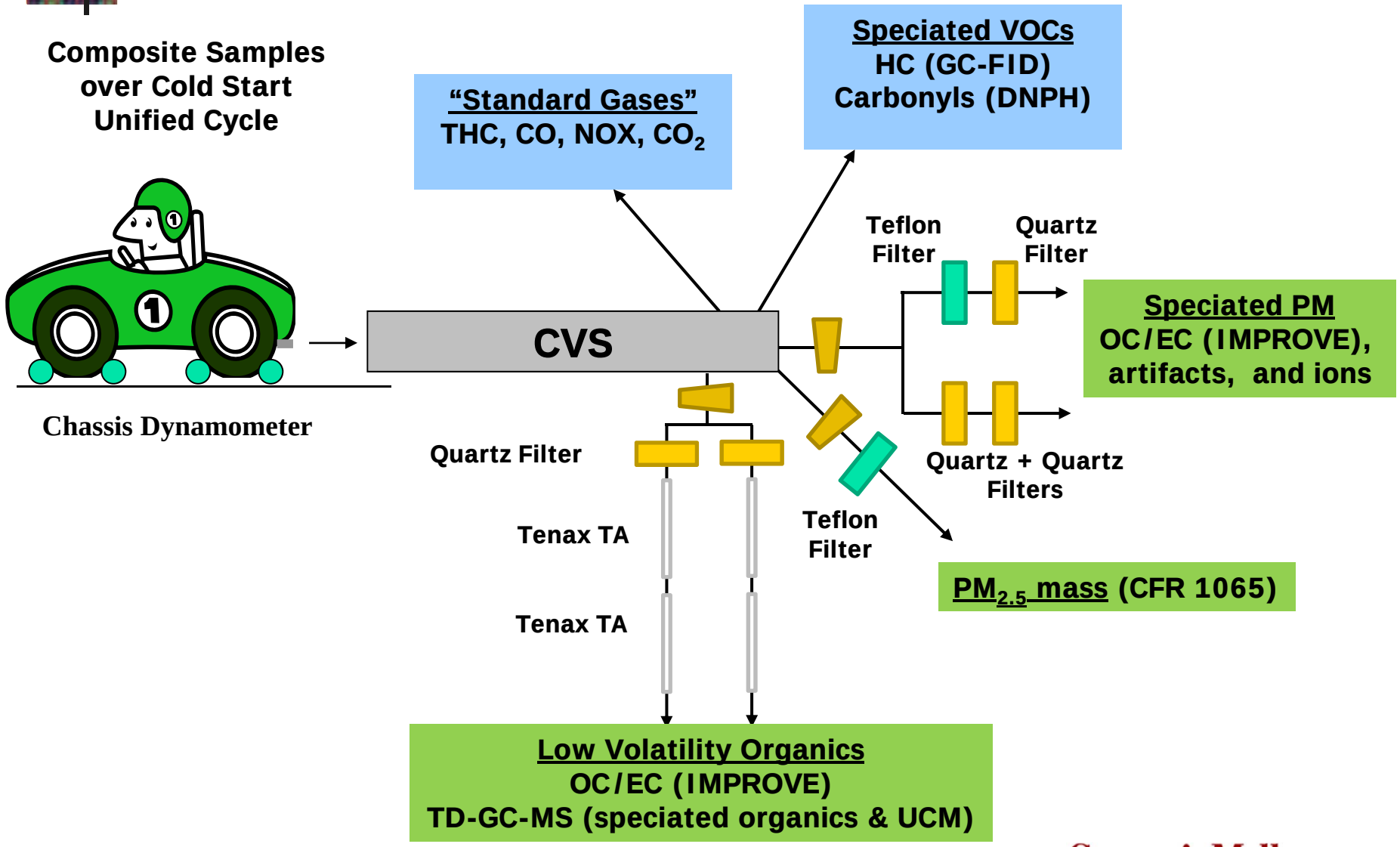
Experimental Set-Up at Haagen-Smit Lab

Vehicles tested using Unified Cycle

Primary emissions characterized with CVS

Secondary aerosol production investigated with portable smog

Primary Emissions Characterization



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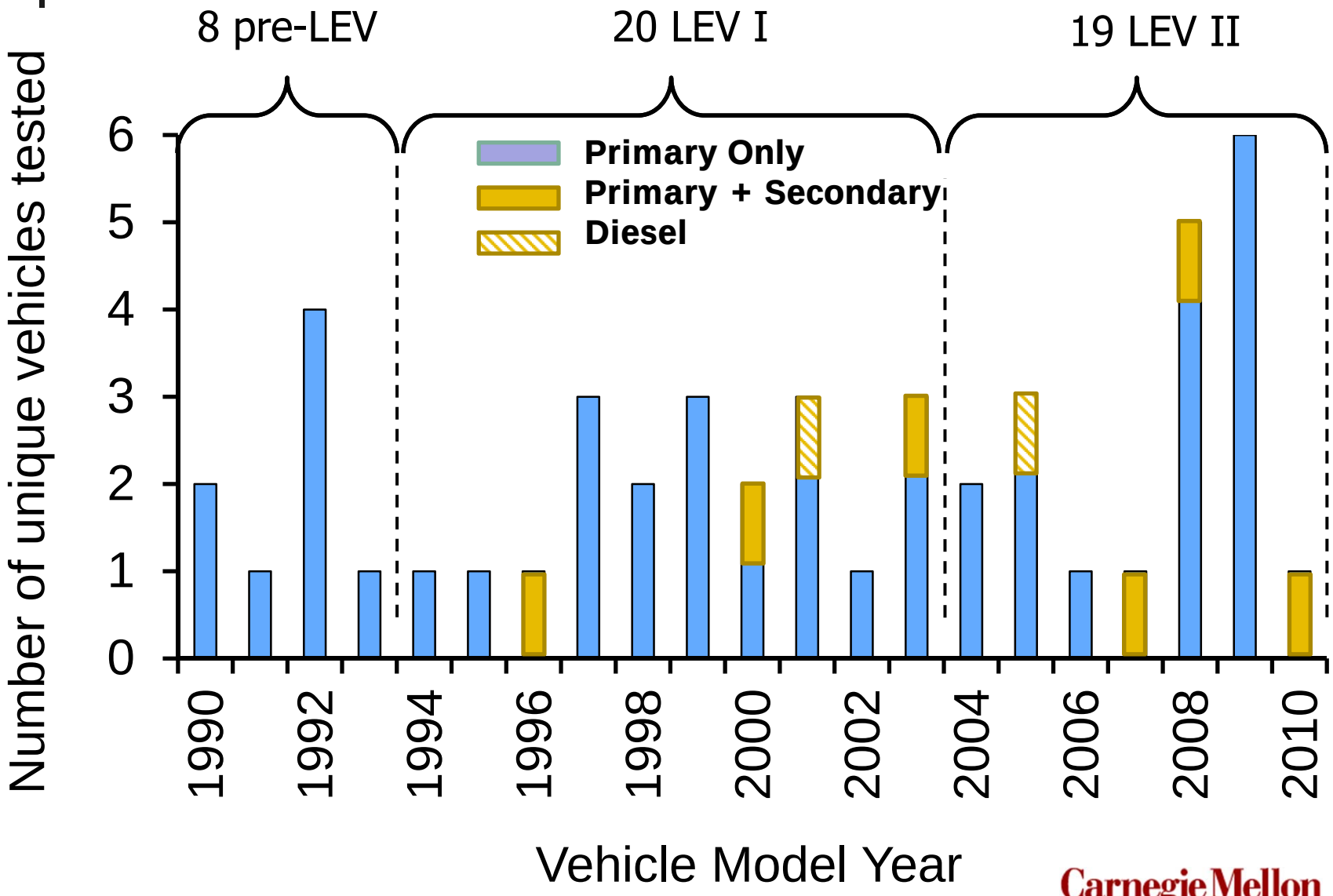
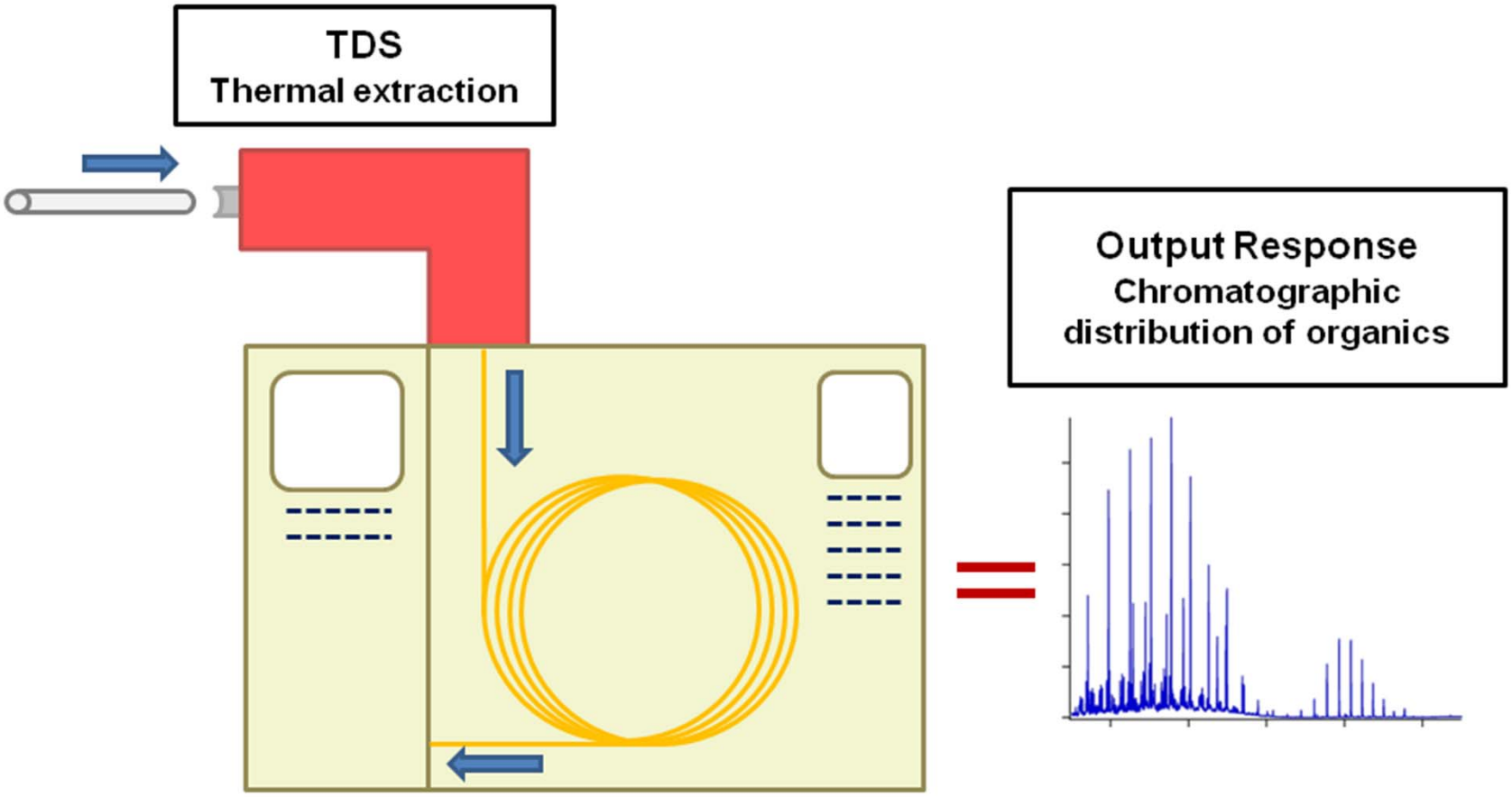
Summer 2010 LDV Test Fleet



Planned Test Fleets for Future Campaigns

- Winter 2011 HDV testing
  - 2010 tractor with DPF and SCR
  - 2007 tractor with DPF
  - 2006 tractor no after treatment
  - 2001 tractor no after treatment
  - CNG Transit bus?
- Summer 2011 Non-road / LDV campaign
  - ~ 10 LDV (variable test cycle and fuel)
  - Non-road sources (lawn mowers, boats, etc.)

GC/MS of Filters and Tenax Samples

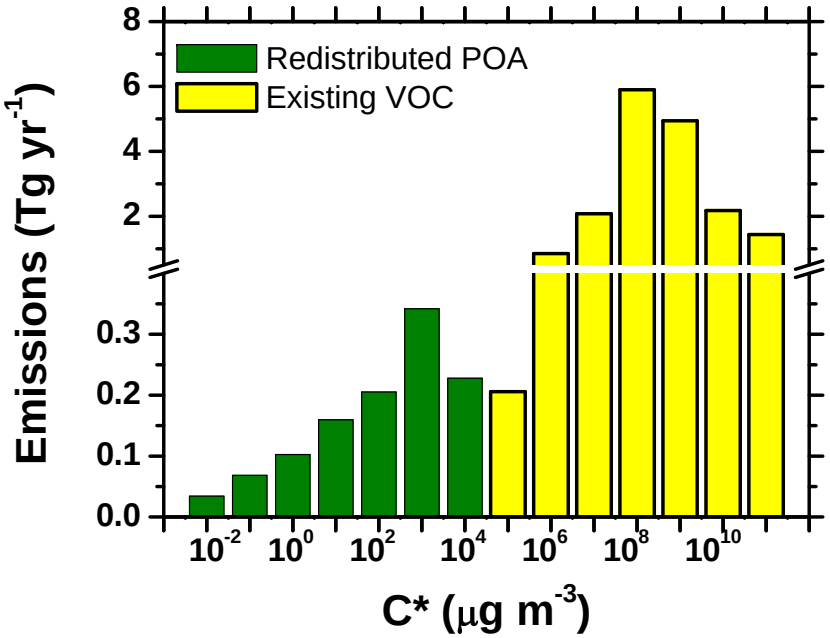


Task 3. Ambient measurements of low volatility organics

Squirrel Hill Tunnel on I-376 in Pittsburgh

- Tunnel study to characterize emissions from large in-use fleet
- Ambient measurements for model evaluation:
  - California – CALNEX
  - Pittsburgh – summer and winter

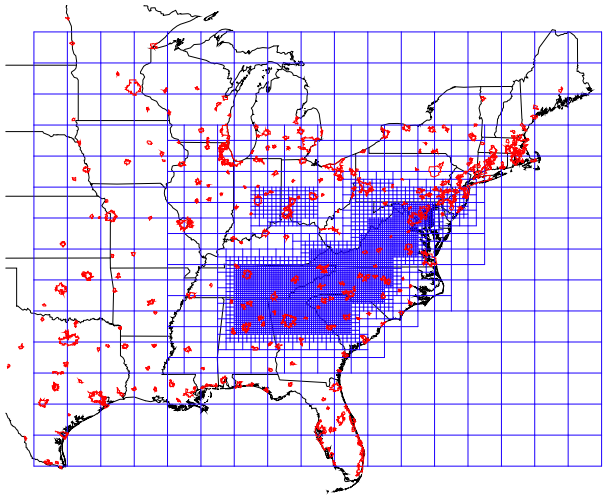
Task 4. Emission inventory development



Volatility based US emissions used derived by Shrivastava et al. (JGR, 2008)

- Derive volatility distributions from source test data
- Inventory development:
  - Replace existing POA emissions with new volatility based data
  - Update/refine emissions for traditional SOA precursors (VOCs … single ring aromatics, etc.)
- Investigate techniques to infer volatility information from existing emissions data

Task 5. Chemical Transport Modeling



- Research version of PMCAMx
- Simulations for CA and Eastern United States
  - California – CALNEX (?)
  - Eastern US -- 2001-2002 (?)
- Evaluate with ambient data
- Sensitivity studies
  - Uncertainty in emissions
  - Future emission scenarios

Acknowledgments

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  - EPA-STAR
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  - CRC – CMU chamber experiments
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Cold Start Unified Cycle