“High Emitters” and MOVES

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MOVES

What is MOVES2010?

- **Motor Vehicle Emission Simulator**
- **EPA's replacement for MOBILE**
- **Estimates total emissions & energy use from all on-road sources at national, local or project levels**
- **Official version released December 2009**
  - Replaces MOBILE6.2 as EPA's official car & truck emissions model for SIPs and conformity determinations
- **Based on "modal" emissions**
  - Allows finer scale (e.g., project level) modeling
  - No longer limited to data on specific test cycles - greatly broadens data sources to include lab, PEMS, I/M over any cycle

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Pollutants covered in MOVES

- **HC** (THC, NMHC, NMOG, TOG, VOC)
- **CO**
- **NO_x** (NO, NO_2)
- **NH_3**
- **SO_2**
- **$PM_{10,2.5}$** (OC, EC, sulfate, brake, tire)
- **GHG (**CO_2, CH_4, N_2O)
- **Toxics**
- **Energy** (total, petroleum, fossil)

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Emissions Processes in MOVES

- **Running**
- **Start**
- **Extended Idle (“hoteling”)**
- **Evaporative**
  - Permeation, Vapor Venting, Liquid Leaks
- **Refueling**
  - Vapor loss, Spillage
- **Crankcase**
- **Tire Wear**
- **Brake Wear**

History: "High Emitters" in MOBILE

- **Emission rates usually based on relatively small samples; concern they did not capture "tail" of emission distribution**
- **Created "high emitter" category to improve in-use prediction, provide basis for modeling I/M programs**
  - Assumed a "bi-modal" population of vehicles
- **"High emitters" defined as discrete category based on multiple of FTP standard (e.g. > 2x FTP standard)**
  - High emitter emission levels assumed constant
- **Separate fuel impacts, off-cycle emissions etc. required for "high emitter" vehicles**

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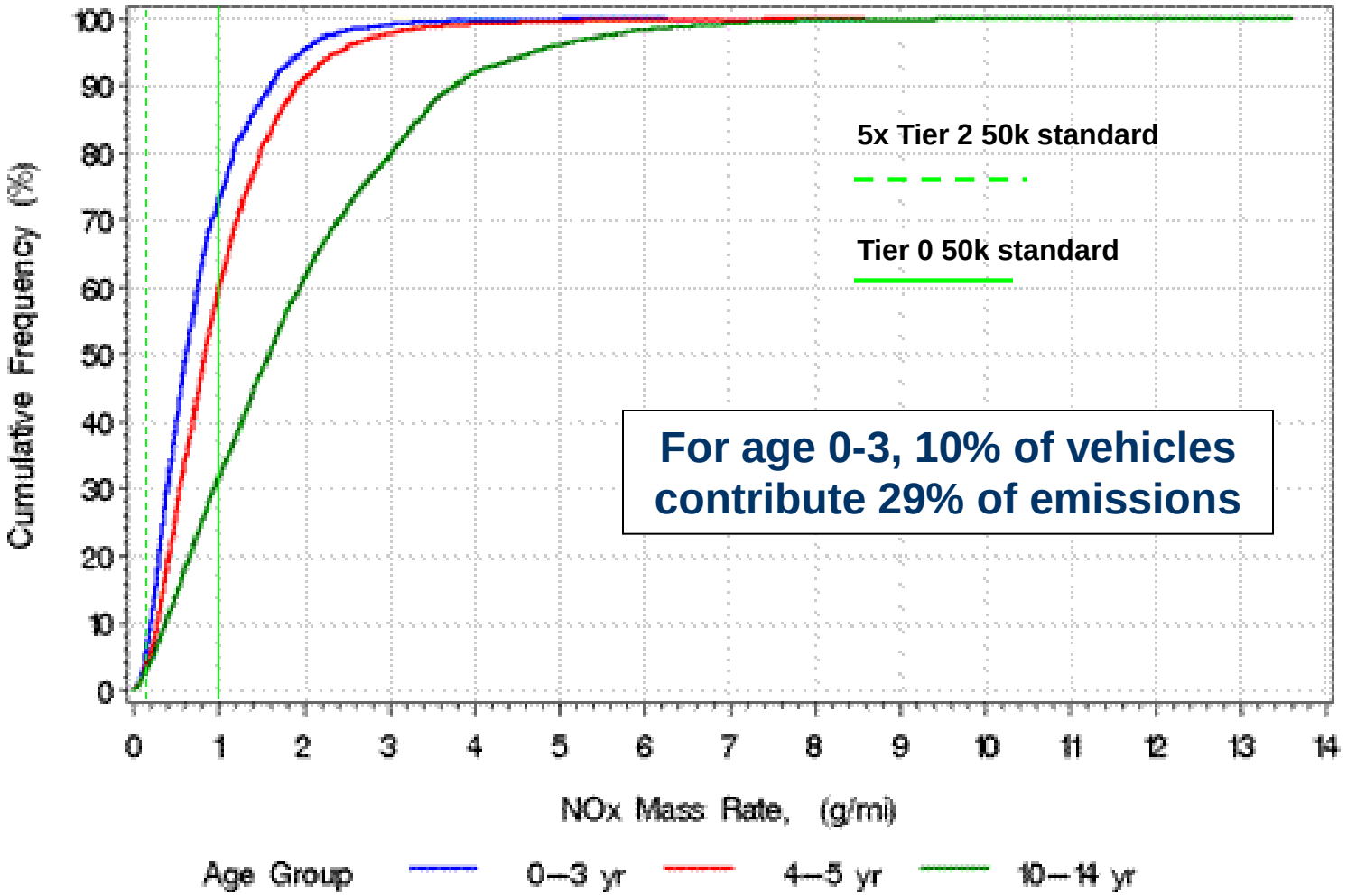
Defining "High Emitter" Problematic

- What is the right data source?
  - Largest datasets (I/M and RSD) miss start emissions, the largest contributor to overall HC, CO and PM emissions
- What pollutants?
- What emission processes?
- What operating range?
- What emission standards?
  - Tier 2 Bin 5 vehicle with NOx emissions 5x greater than the standard is cleaner than nearly all Tier 0s with normal deterioration….which is the "high emitter"?
- Depends on context: fleet turnover, I/M, compliance…

Example: Distribution of Tier 0 LDV NOx data Arizona I/M (IM147)



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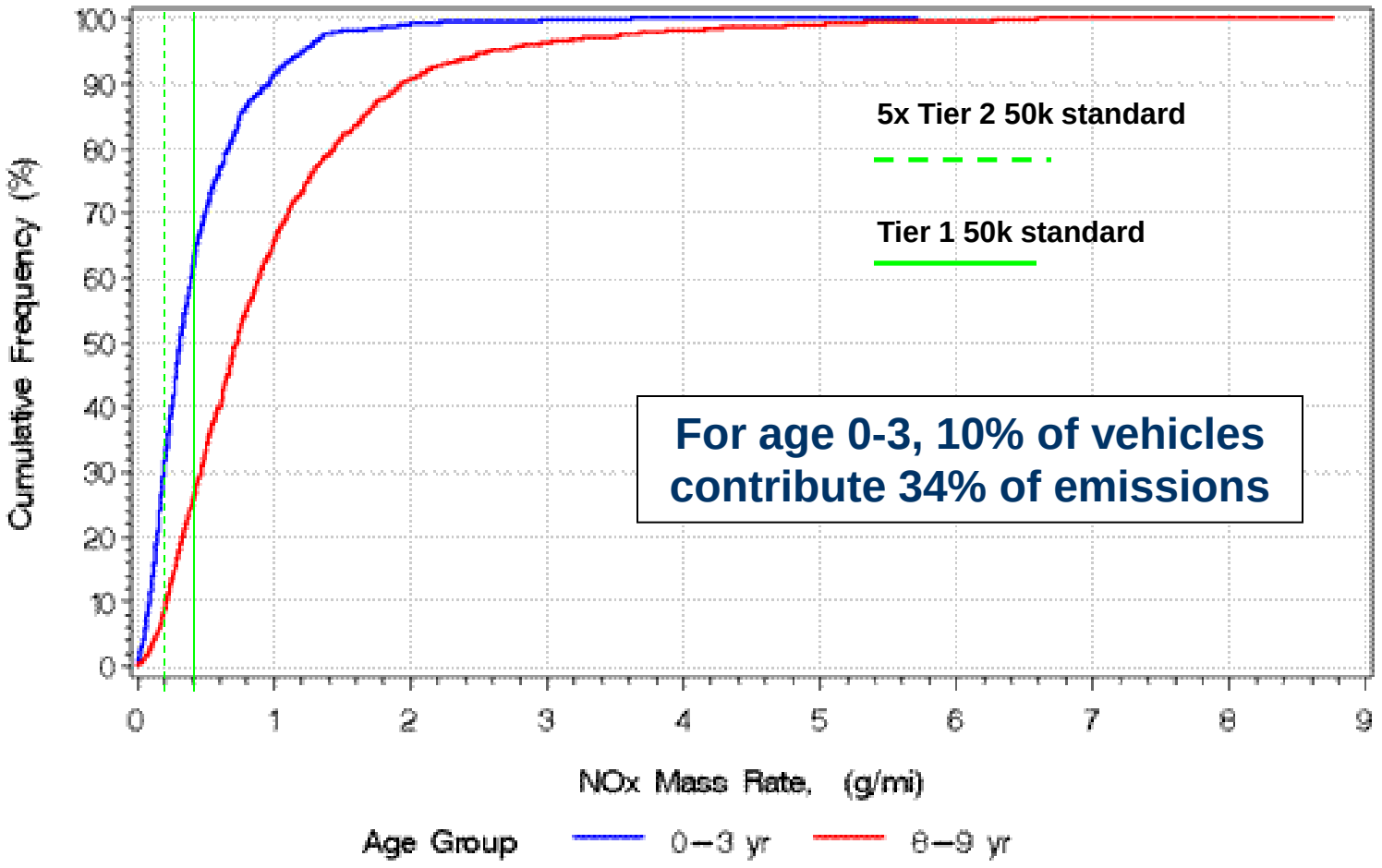

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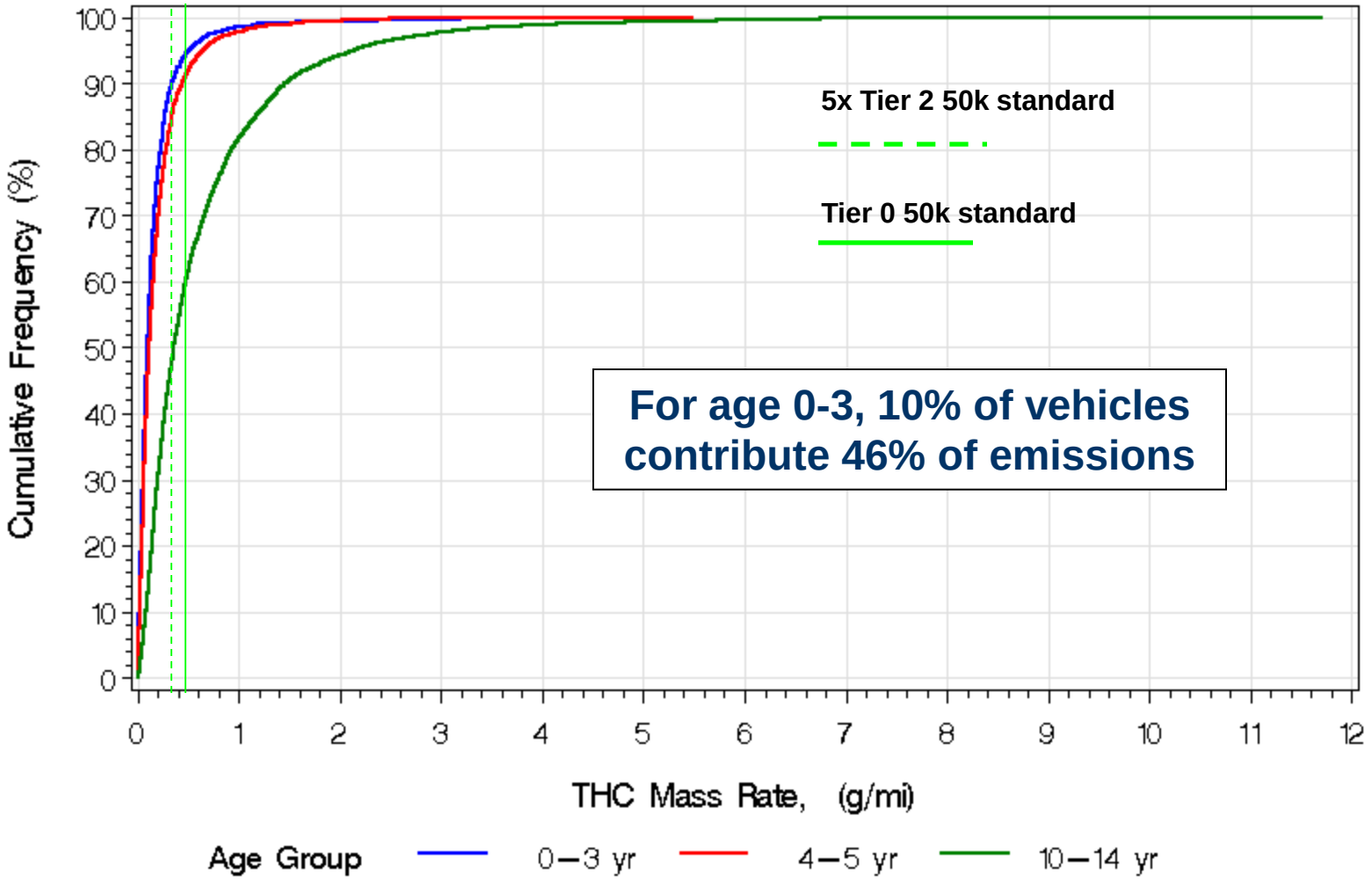

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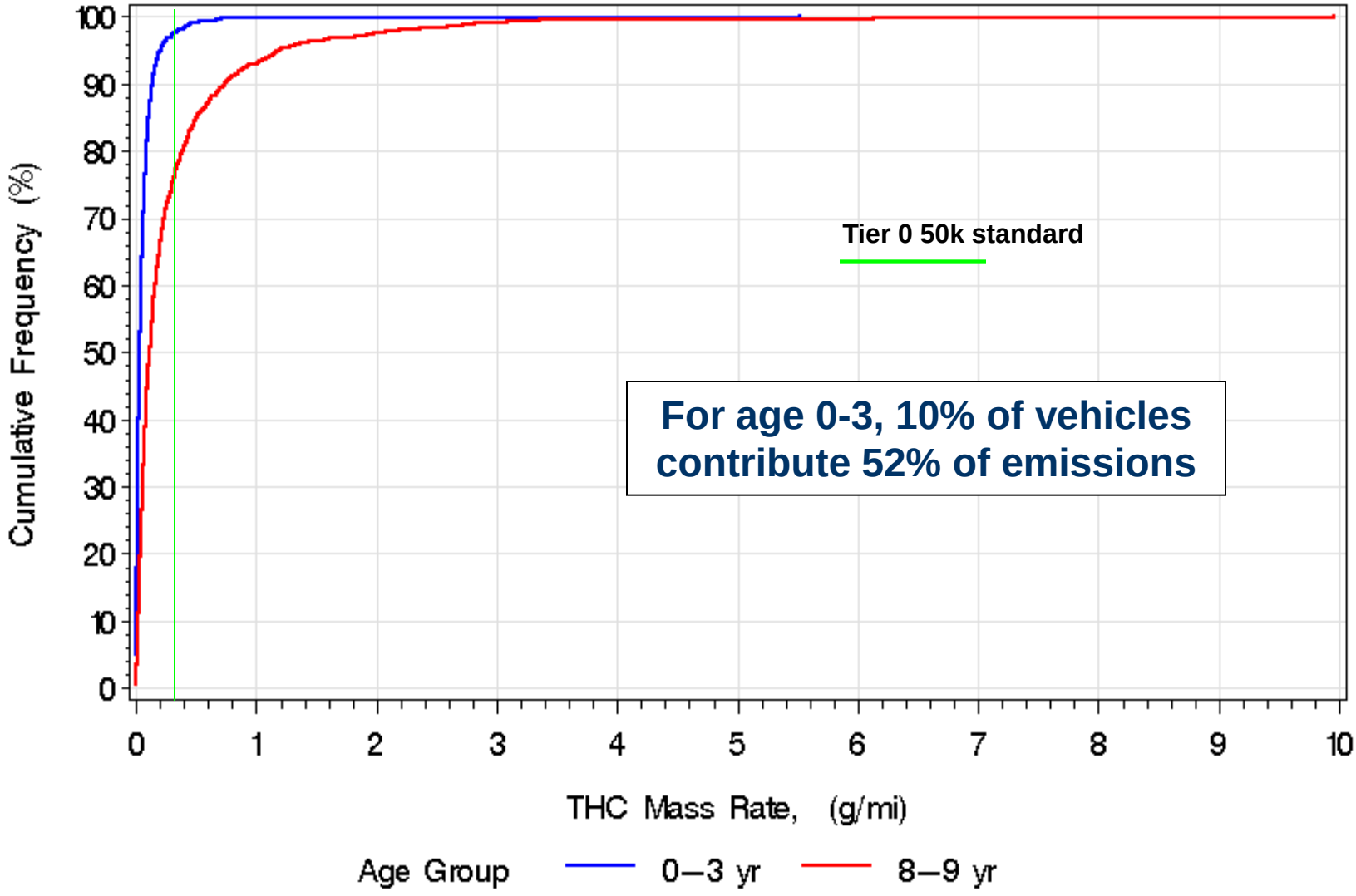

Updated Thinking in MOVES

- **Need to capture high emissions**
- **Vehicle emissions not bimodal; emissions are a continuous distribution with a long tail**
  - Exception: evaporative vapor venting
- **Representative data is paramount; larger datasets enabled by MOVES capture the "tail"**
- **Emission rates in MOVES reflect average of distribution, including "tail"**
  - More appropriate for modeling emission inventories
- **Methods emerging to increase representativeness of data to be used for modeling**

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The Challenge of Emission Factor Research

- **Need very large samples to reflect the tail**
  - If sampling fully at random
- **RSD and I/M provide these samples, but are a limited snapshot of the total emissions**
- **PEMS provides on-road emissions, but sample sizes are limited**
- **Emerging "hybrid" approach:**
  - Screen vehicles using RSD
  - Develop stratified samples based on RSD score
  - Test vehicles in each strata with PEMS for on-road emissions
  - Reweight PEMS results according to strata RSD weighting
- **Enables much smaller sample sizes**

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Beginning to implement "next generation" sampling approach

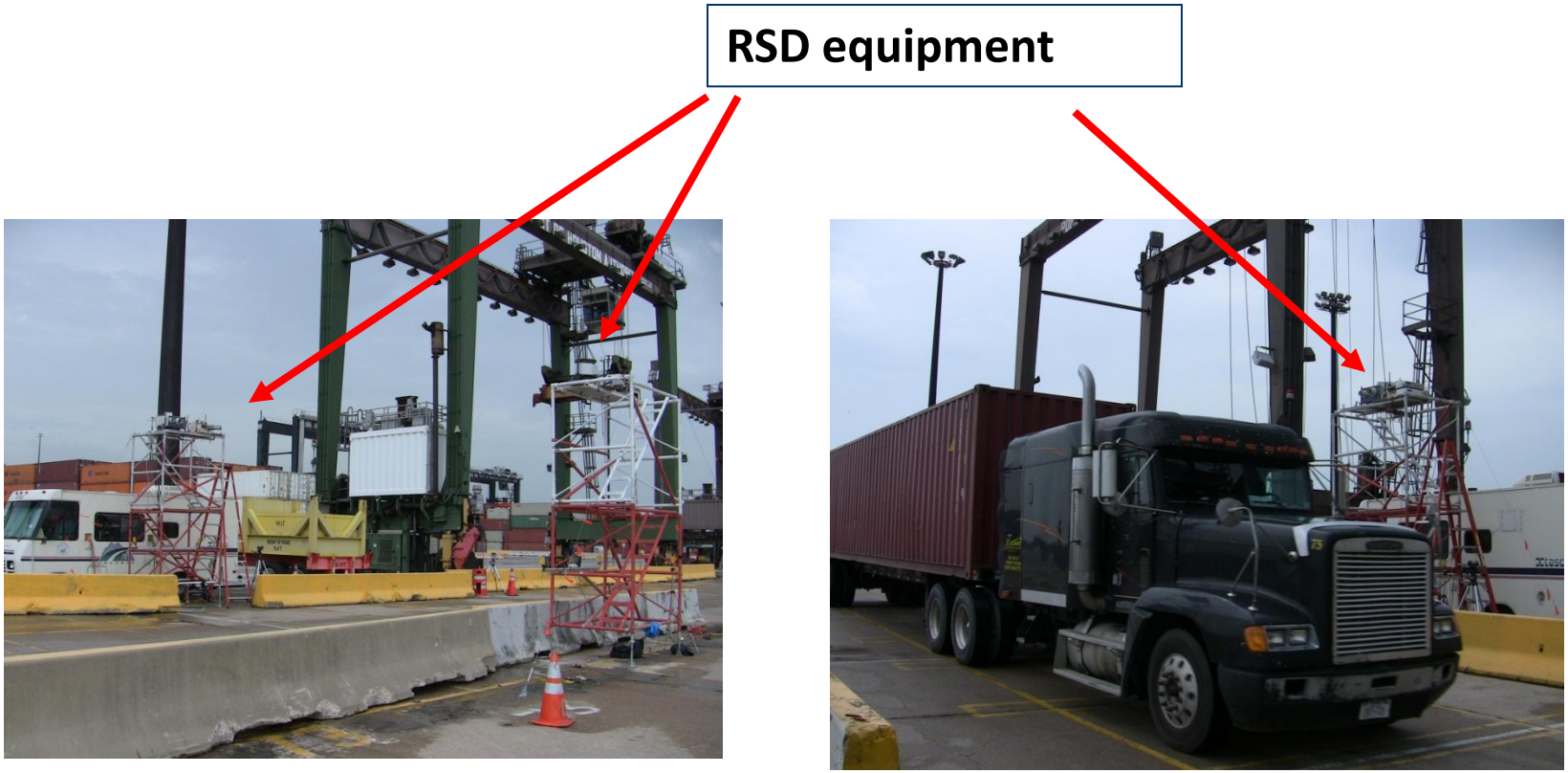
- **Evaporative Leak Detection Study (2008-10)**
  - Method developed to detect high evap vehicles using RSD
  - Confirmed using portable SHED
  - Developing way to apply to much larger RSD datasets
- **Houston Port Drayage Study (2009-10)**
  - First to implement hybrid of RSD and PEMS
- **Tier 2 PEMS Study (2010+)**
  - RSD conducted at 6 sites around Metro Detroit (~80,000 hits)
  - PEMS testing planned on ~100 Tier 2s selected based on RSD
  - Considering additional cities for 2011/2012

Evaporative "Leaker" Field Study

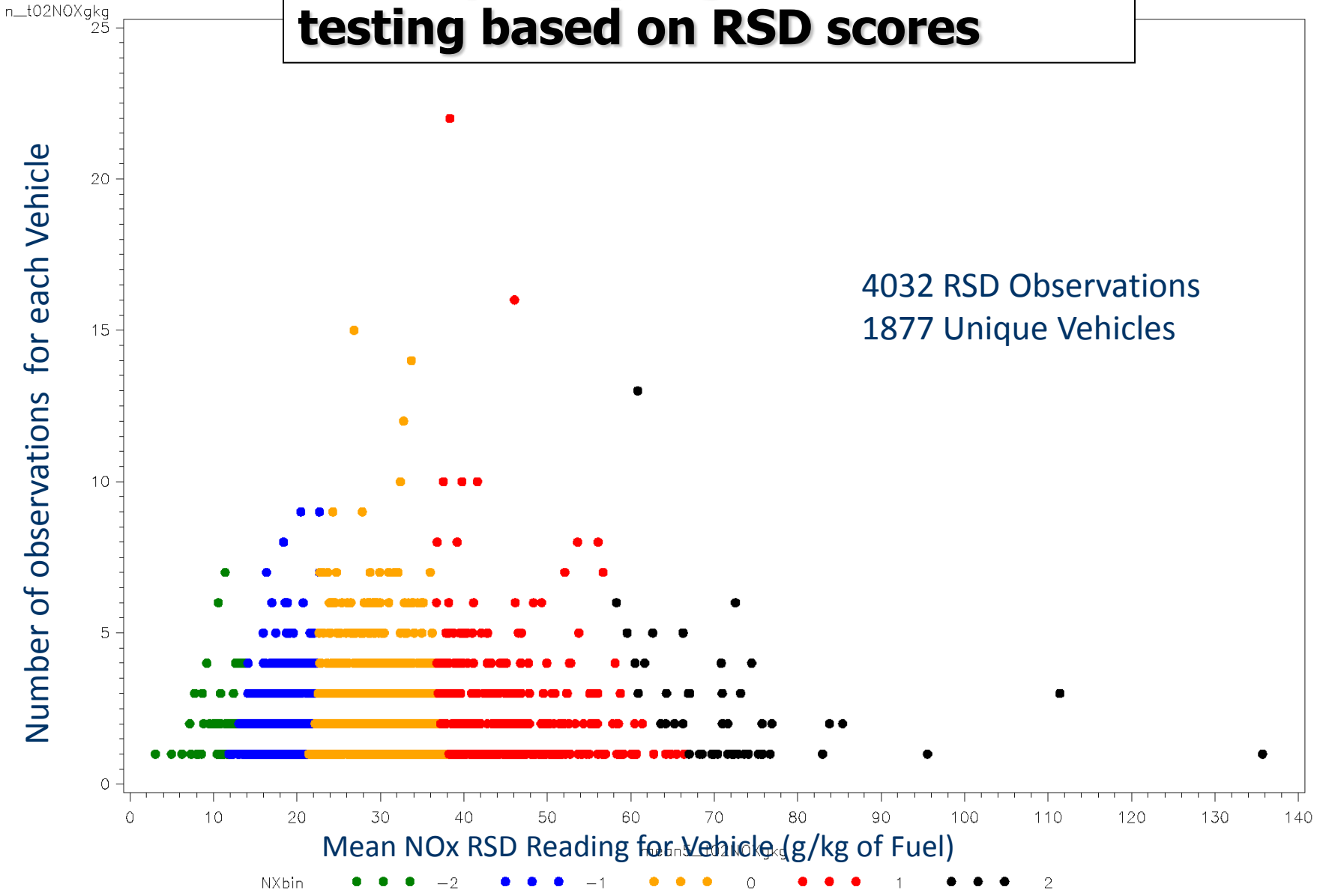
- Evaporative vapor emissions either contained, or leaking
- In collaboration with CRC and Colorado, developing groundbreaking approach to quantifying frequency of evap leakers
- Developed method to find evap leakers using roadside remote sensing
- Verified using portable SHED

Houston Port HD Drayage Study

- ~ 4,000 RSD hits on 1,900 trucks entering port
- PEMS testing on sample of these, stratified by emission level



Develop sampling strata for field testing based on RSD scores



/proj1/EPA_Drayage/rsd_variability2.sas 13OCT09 08:23

Developed Model Year and Nox Bins for Field Set and Desired Stratified Sample

Field Set

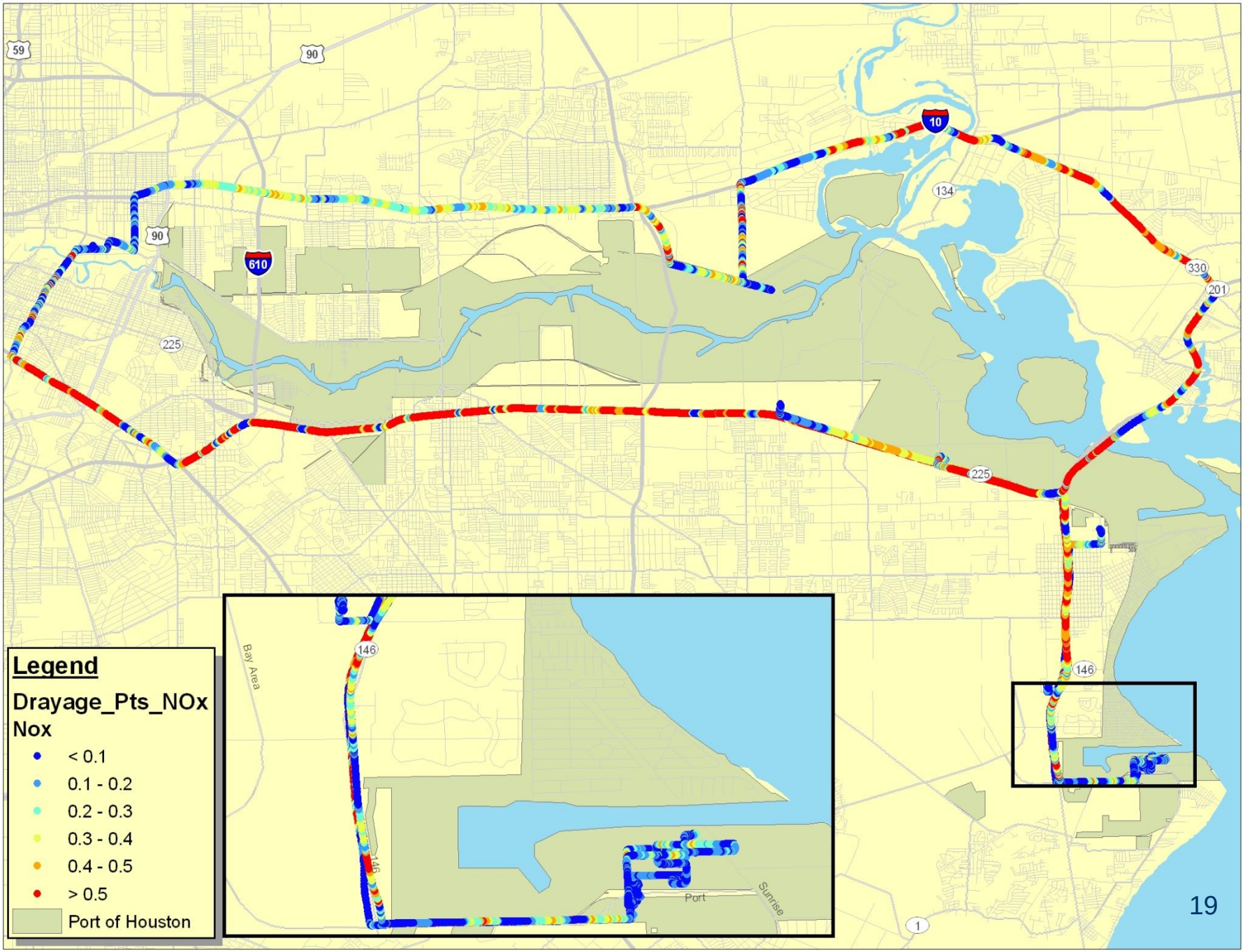
	NXbin					
	-2	***-1***	***0***	***1***	***2***	
1978-1993	8	23	69	20	2	**122**
1994-1997	1	34	259	175	25	**494**
1998-2003	11	234	636	168	16	**1065**
2004-2006	11	65	43	8	4	**131**
2007-2010	15	20	26	4	0	**65**
	46	**376**	**1033**	**375**	**47**	***1877***

Proportional

	NXbin					
	-2	***-1***	***0***	***1***	***2***	
1978-1993	0.1	0.4	1.2	0.3	0.0	**2.1**
1994-1997	0.0	0.6	4.4	3.0	0.4	**8.4**
1998-2003	0.2	4.0	10.8	2.9	0.3	**18.2**
2004-2006	0.2	1.1	0.7	0.1	0.1	**2.2**
2007-2010	0.3	0.3	0.4	0.1	0.0	**1.1**
	0.8	**6.4**	**17.6**	**6.4**	**0.8**	***32***

Stratified

	NXbin					
	-2	***-1***	***0***	***1***	***2***	
1978-1993	1	1	1	1	1	**5**
1994-1997	0	1	2	2	2	**7**
1998-2003	1	2	3	2	2	**10**
2004-2006	1	2	1	1	1	**6**
2007-2010	1	1	1	1	0	**4**
	4	**7**	**8**	**7**	**6**	***32***


Legend
Drayage_Pts_NOx
Nox
< 0.1
0.1 - 0.2
0.2 - 0.3
0.3 - 0.4
0.4 - 0.5
> 0.5
Port of Houston
59
90
610
225
10
134
330
201
146
Bay Area
Port
Sunrise
1

Summary

- **"High emitter" definition depends on context**
- **MOVES focus is on including high emissions by ensuring underlying data captures distribution tail**
- **MOVES analysis suggests similar emission trends between Tier 0, Tier 1 and Tier 2, relative to standards**
  - Will confirm Tier 2 with upcoming PEMS study
- **EPA research focused on capturing in-use emission distribution, by capitalizing on strong points of RSD and PEMS**
  - Cost effective, efficient, robust