Advancing Nonroad Model Development Through Data Partnerships

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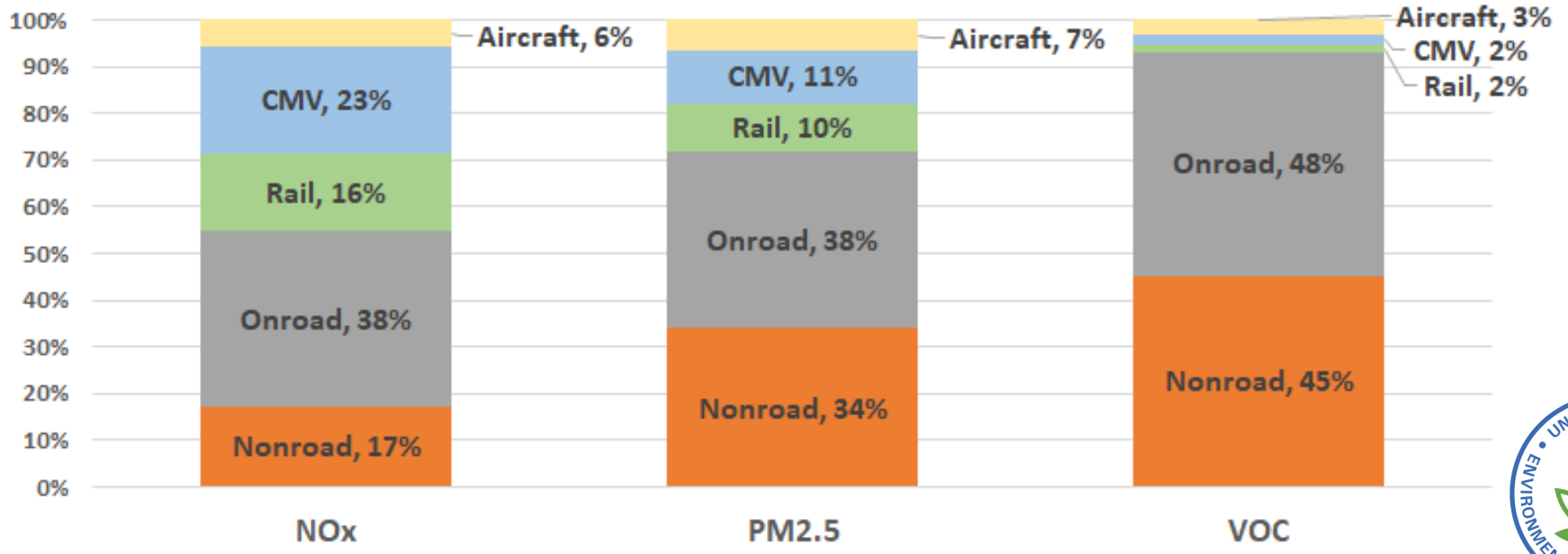
Nonroad Model Development

- EPA first released the stand-alone Nonroad model in 1998
  - Incremental updates in 2000, 2002, 2005, 2008, 2014, and 2018; incorporated into MOVES platform in 2014
- Most of the model's source data – e.g., equipment populations, spatial and temporal allocations, annual activity rates, emission rates – date to the model's first public release
- As nonroad emissions continue to comprise a significant share of the mobile sector emissions inventory, EPA is working on updating the Nonroad model to better reflect the nonroad equipment sector

Relative share of 2028 NOx, PM2.5, and VOC inventories: mobile sources



Source: Emissions Inventory Collaborative (2019). 2016beta Emissions Modeling Platform: http://views.cira.colostate.edu/wiki/wiki/10197.

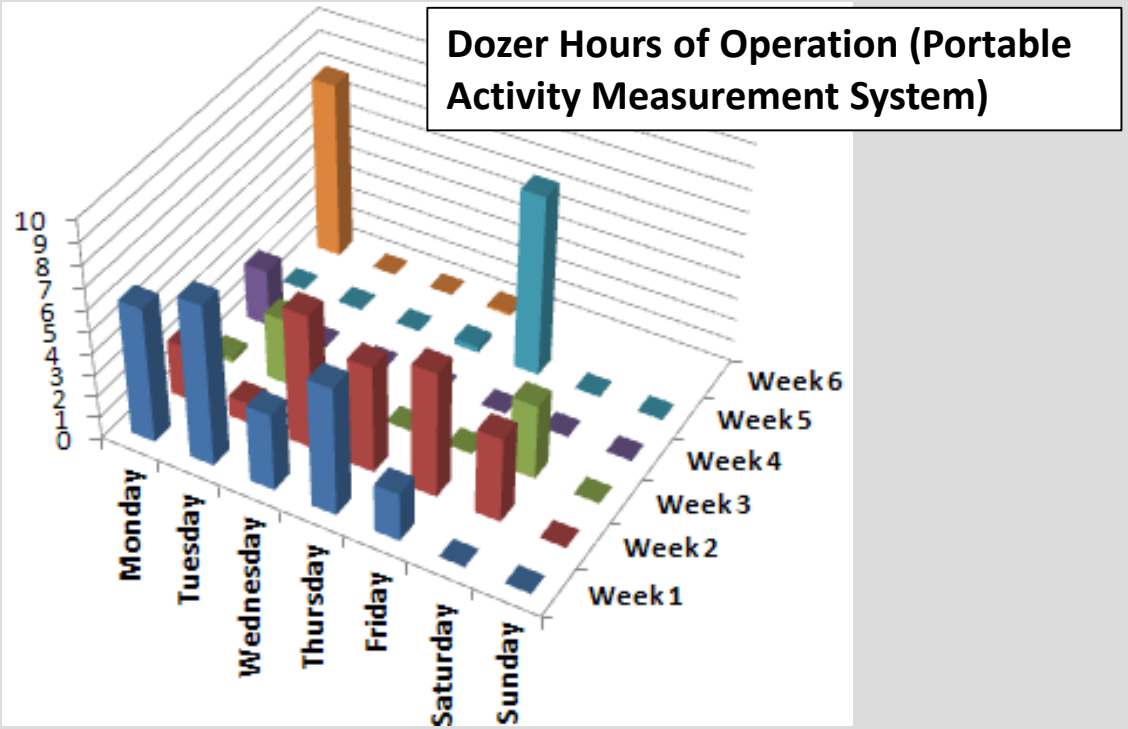
Nonroad Model Development

- Along with redesigning and recoding the Nonroad model, EPA is seeking to update the model by capitalizing on new sources of real-world nonroad activity and emissions data
- Newer measurement platforms generate a near-continuous stream of nonroad activity data such as fuel consumption, equipment turnover, and usage patterns (e.g., number of trips, hours of operation at idle vs. under load, weekday/weekend and seasonal variations)

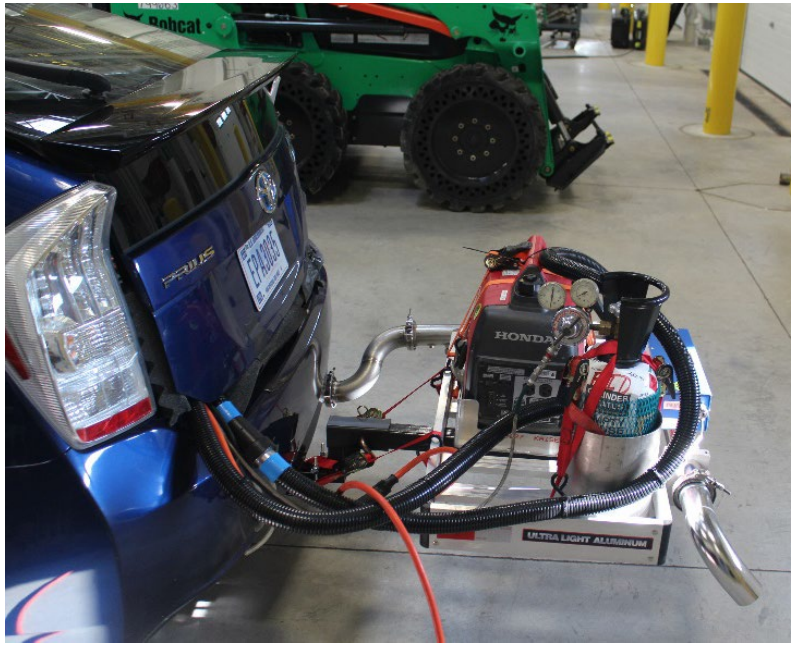
Example: Dozer Activity

Current assumptions in Nonroad:

- Rubber Tire Dozers operate 900 hours/year; Crawler Dozers operate 700 hours/year
- Activity rate is constant by equipment size and fuel type
- Activity rate is constant over time (populations vary, but not activity levels)
- Activity rate is constant by region (same in all states, counties)

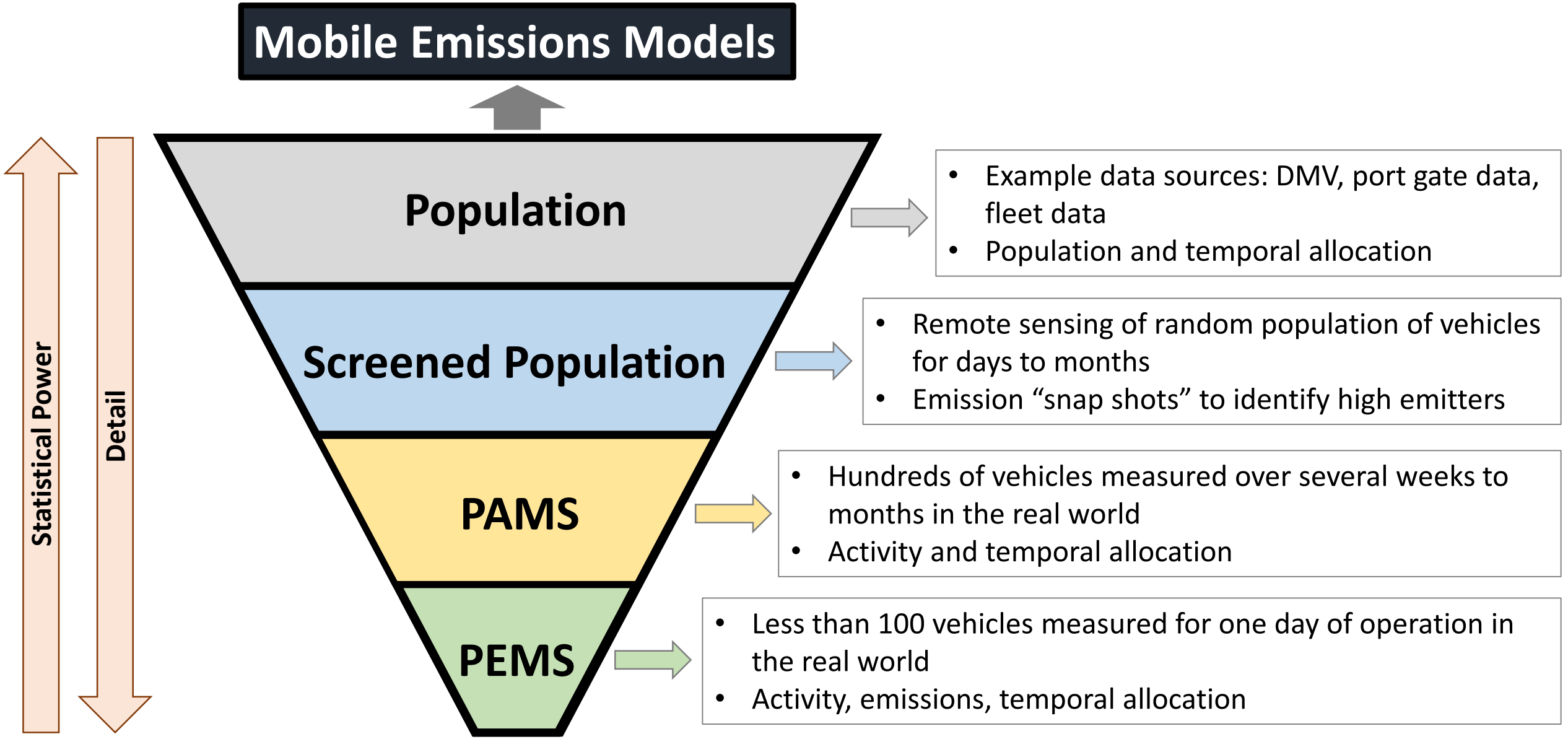


Real-World Mobile Source Activity and Emissions Data



- There have been major advances over the last decade in our ability to gather and manage mobile source activity and emissions data:
  - Portable Emission Measurement Systems (PEMS) gather detailed activity, engine, and emissions data during real-world operations
  - Lower-cost Portable Activity Measurement Systems (PAMS) collect detailed activity and engine data
  - Onroad and nonroad vehicle fleets increasingly using onboard telematics and fleet management software
- EPA relies on these real-world data to develop and refine mobile source emissions inventory models:
  - Baseline emission rates
  - Vehicle speed profiles, age distributions, drive and duty cycles
  - Spatial and temporal allocation of activity and emissions
  - Regional and seasonal variability in nonroad equipment usage

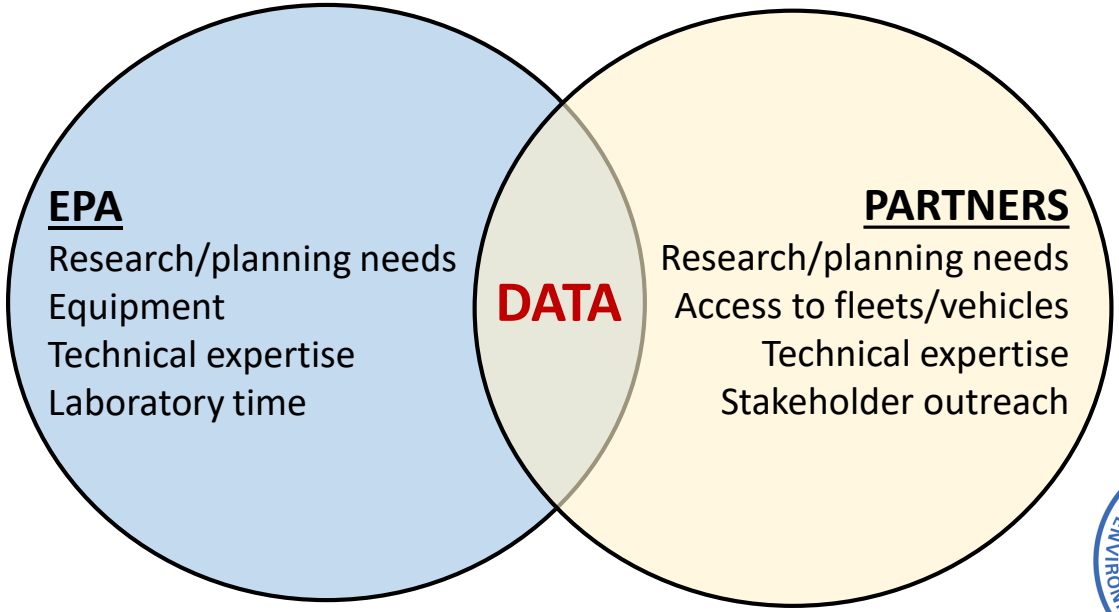
Integrated Real-World Test Design



Leveraging Resources

- Collecting real-world mobile source data requires substantial investment in equipment, data, computing, and staff
- Collaborating with state and local agencies, academic institutions, and private fleets allows EPA and its partners to leverage resources in order to meet respective research needs
- Partners work together to:
  - Develop data and testing procedures and protocols
  - Gather data
  - Develop new sampling methodologies
  - Test/develop measurement equipment
  - Enhance modeling efforts
- Results in a data "win-win"
- EPA's support mechanisms include **Cooperative Research and Development Agreements (CRADAs)**, Interagency Agreements (IAGs), and contractor support

Measurement Method	Equipment Costs (per unit)
PAMS	$600 – $1,000
Mini-PEMS	$20,000 – $30,000
PEMS	$200,000 – $300,000
Laboratory testing: chassis and/or dynamometer	$3,000,000 +



CRADA: Texas A&M Transportation Institute (TTI)

- TTI-EPA CRADA focuses on collecting and analyzing activity data from Construction equipment
- Working with state DOTs and private fleets to access fleet information and telematics data
  - Texas Department of Transportation
  - California Department of Transportation
  - Private construction firm operating primarily in Texas

Over 4,800 pieces of nonroad equipment

Wheeled Graders: 599

Sweepers: 488

Forklifts: 378

Rollers: 512

Wheeled Loaders: 466

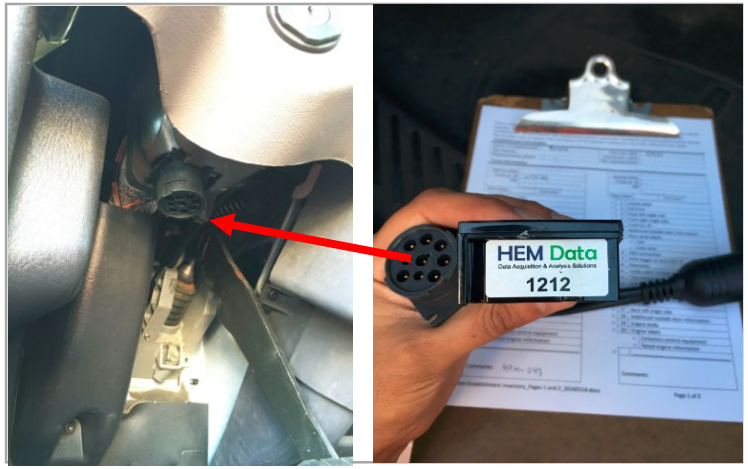
CRADA: Texas A&M Transportation Institute (TTI)

- Data fields include:
  - **Equipment specifications:** make, model, model year, VIN, purchase date, description, fuel type, hour meter reading at delivery
  - **Engine specifications:** make, model, model year, serial number, horsepower (gross, net), displacement, engine family, engine tier
  - **Usage information:** reporting period start and end date/time; number of trips, hours of use, distance traveled, and hours idled over reporting period; odometer reading at end of reporting period, lifetime run hours, fuel purchases (date, fuel type, volume purchased)

Data Provider	# of pieces	Data Coverage
Texas Department of Transportation	3159	Summary data for 2014-6/2018; quarterly data from 6/2018
California Department of Transportation	1551	Weekly data from 7/2017-10/2018; daily data from 10/2018
Private construction firm in Texas	146	Weekly data from 6/2016-10/2018; daily data from 10/2018

CRADA: University of California, Riverside

- CRADA between EPA and University of California, Riverside Center for Environmental Research and Technology (CE-CERT) provides for coordination of data being collected under California Air Resources Board programs
  - Data logging equipment
  - Data output and database design
  - Sampling methodologies
  - Data analysis and QA/QC
- Program underway to sample 100 pieces of Construction equipment in California (each for 3-4 weeks) → EPA providing PAMS and analysis support
- Second-by-second PAMS data: engine starts, soak times, engine RPM, torque, engine load, exhaust temperature, pedal/operator position, GPS
- Equipment survey form used to collect engine and vehicle information such as equipment type, vocational use, engine maker, engine size, engine model, engine model year, aftertreatment configuration, shift start/end times



Mini-logger that fits on the in-cab J1939 connector, to acquire vehicle diagnostic data

- EPA and CE-CERT also collaborating with the California Department of Transportation to conduct emissions and activity measurements from 10 pieces of Tier 4 construction equipment
  - EPA providing PEMS and PAMS instrumentation

Informing Model Design and Assumptions

- In-use and fleet management data collected in these and other planned programs will be used by EPA to update the Nonroad Model
  - Better account for variability in usage patterns of nonroad equipment, e.g.:
    - Temporal and spatial variability (diurnal, weekend/weekday, seasonal, regional)
    - Engine size (how does usage vary with engine size?)
    - Equipment/engine age (what is the decline in usage as equipment/engines age?)
    - Vocation, fuel type
  - Estimates of idle versus non-idle time → building block for possibly incorporating modal emissions into the model
  - Better characterization of the relationship between fuel consumption/emissions and engine load
  - Better understanding of maintenance practices → can inform scrappage and deterioration assumptions in the model
  - Emphasis on designing a model that is more user-friendly and amenable to user inputs

Partnering with EPA

- EPA continues to develop tools and methodologies to further support gathering mobile source activity and emissions data → data partnerships are a cornerstone of this effort

- EPA is actively seeking partnerships to help gather better data to address current and future research needs and improve our data analysis and modeling capabilities

  → Real-world activity data to improve our ability to model emissions from nonroad equipment is a priority

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