

EMISSIONS INVENTORY DEVELOPMENT IN CALIFORNIA

San Joaquin Valley Public Advisory Workgroup
September 30, 2015

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Presentation Outline

- Emission Inventory Overview
- Inventory Development
- Inventory Forecasting
- Spatial Allocation

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Emission Inventory

A comprehensive estimate of air
pollutant emissions, by source,
for a specific geographic area
during a given time period

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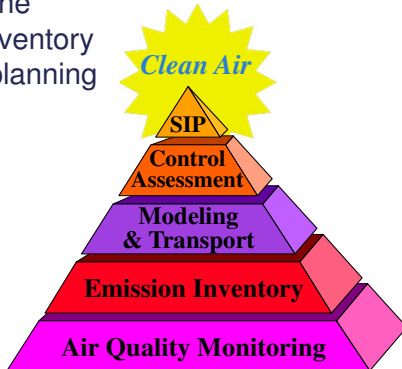
Uses for Emission Inventories

- Identify pollutants of concern and their sources
- Determine amount, distribution, trends
- Input to air quality modeling
- Identify and track control strategies
- Input to health risk assessment

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How does the emission inventory fit into the planning process?



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Types of Emissions Sources

- Stationary Sources
- Areawide Sources
- Mobile Sources (On-Road and Off-Road)
- Natural Sources

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Pollutants

- Criteria Pollutants (related to SIPs)
 - Reactive organic gases (ROG)
 - Oxides of nitrogen (NO_x)
 - Oxides of sulfur (SO_x)
 - Particulate matter (PM_{10} and $\text{PM}_{2.5}$)
 - Ammonia (NH_3)
- Toxic Air Pollutants
 - Hundreds of toxic compounds and metals

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Stationary Sources

- Refineries
- Manufacturing
- Food processing
- Electric utilities
- Gas stations
- Dry cleaners
- Stationary engines



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Areawide Sources

- Consumer products
- Solvents
- Paved & unpaved road dust
- Farming operations
- Open burning



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Mobile Sources

- Cars
- Trucks and Buses
- Aircraft
- Trains
- Ships
- Recreational vehicles
- Farm equipment



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Natural Sources

- Biogenics
- Geogenics
- Wildfires
- Windblown dust



Types of Inventories

- Planning (annual and seasonal)
- Forecasted (future year projections)
- Gridded/Modeling

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INVENTORY DEVELOPMENT
PROCESS

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Resources

- Continuous and iterative process
- Over 40 people at State level
- Additional staff in each of 35 air districts
- Millions in research dollars

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Agency Responsibilities

- ARB coordinates with 35 local air pollution control/air quality management districts
- Districts have responsibility for all point sources
- ARB and districts share responsibility for areawide sources
- ARB is responsible for all mobile and natural sources

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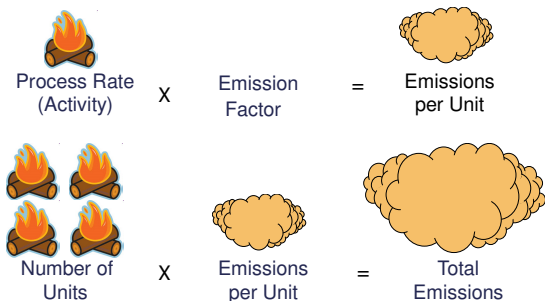
California Inventory at a Glance

- Over 800 emission categories
- Over 3,200 subcategories
- Over 23,000 unique stationary sources
- Historical facility data from 1979 to 2013
- Emission forecasts to 2035

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Estimating Emissions



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Point Sources

- Facility operators report activity, emissions data, temporal data, and other facility information to local air district
- Various estimation methodologies available
 - Continuous emission monitors
 - Source testing
 - Fuel consumption
 - Published emission factors
 - Material balance
 - Engineering judgment

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Areawide Sources

- ARB and/or local air districts develop estimation methodologies
- Data sources:
 - County-level activity data from surveys, industry reports, census reports, other government agencies
 - Emission factors from U.S. EPA (AP-42) or special studies

On-Road Mobile Sources

- ARB has developed motor vehicle emissions models since 1970s. EMFAC2014 is most recent on-road model
- Data sources:
 - DMV vehicle registration data
 - Emission factors by vehicle class, technology and model year
 - Travel activity (vehicle-miles, or VMT) from local transportation planning agencies

Off-Road Mobile Sources

- ARB has developed category-specific models (trains, ocean-going vessels, commercial harborcraft, recreational boats, off-road equipment)
- Each model reflects the unique characteristics (equipment types, activity, emission factors, economics) of the source category

EMISSION INVENTORY
FORECASTING

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What is a Forecasted Emissions Inventory?

- Projection of a base year inventory that reflects expected growth or decline in emissions
- Uses growth surrogates based on forecasted trends such as fuel consumption, economic conditions, or population growth
- Reflects effects of existing emission controls and other emission reduction programs

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Inventory Forecasts

- All emission forecasts are conducted by ARB
- Point and areawide sources are forecasted from base-year inventory using the California Emission Projections and Analysis Model (CEPAM)
- Mobile source emissions are forecasted by EMFAC and off-road models

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Basic Forecasting Equation

$$E_{FY} = E_{BY} \times GF \times CF$$

where:

E_{FY} = Future year emissions

E_{BY} = Base year emissions

GF = Growth Factor

CF = Control Factor

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Growth Factors

- Derived from forecasted trends for economic or demographic surrogates that best correlate to the activity for a given source category
- Growth surrogate examples:

Source Category	Growth Surrogate
Industrial Boilers	Fuel Consumption
Consumer Products	Human Population
Architectural Paint	Housing Units

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Sources of Growth Surrogate Data

- Industry forecasts
- Local governments (population forecasts, VMT projections, etc.)
- State and federal government agencies (census data, fuel consumption, employment data, etc.)
- Econometric models (economic output and employment forecasts)

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Control Factors

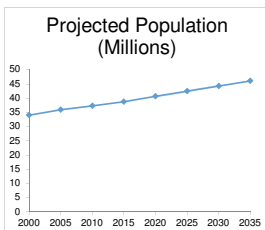
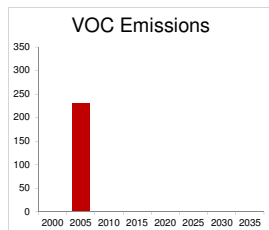
- Control factors account for emission reductions from adopted rules and regulations
- Derived from adopted ARB regulations, District rules, or other agencies' regulations which result in emission reductions from a source category
- They can also reflect a technology change on a particular emission process

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Emissions Forecasting Example

Consumer Products
230 tons/day VOC in 2005

Growth Surrogate:
State Human Population



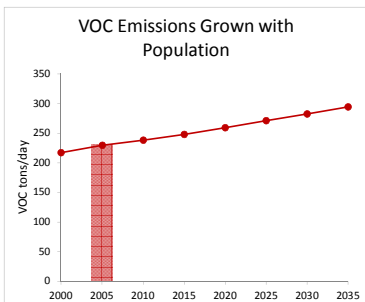
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Emissions Forecasting: Grown-Only Emissions

Growth Profile

Year	Growth Factor
2005	1.00
2010	1.04
2015	1.08
2020	1.13
2025	1.18
2030	1.23
2035	1.28



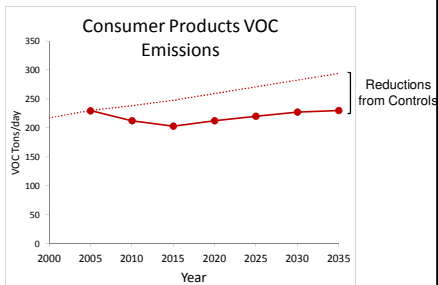
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Emissions Forecasting: Grown and Controlled Emissions

Control Profile

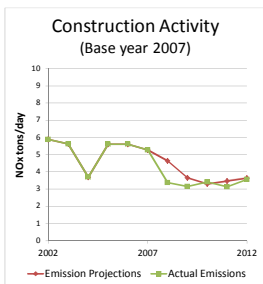
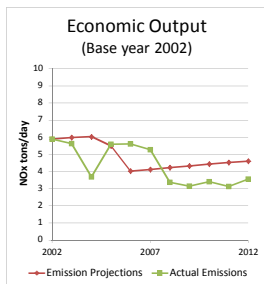
Year	Control Factor
2005	1.00
2010	0.89
2015	0.82
2020	0.82
2025	0.81
2030	0.80
2035	0.78



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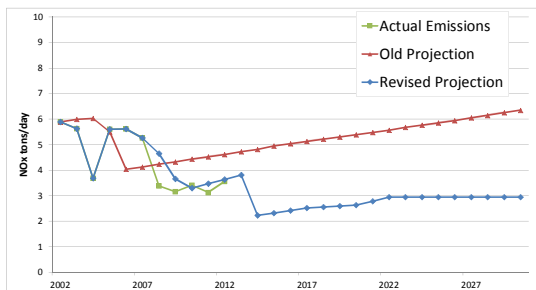
Impact of Growth Surrogate Selection: Glass Manufacturing NOx Projections



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Long-term Glass Manufacturing NOx Emissions Projections



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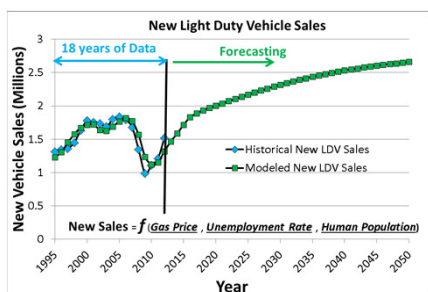
On-Road Mobile Source Forecasting

- EMFAC2014 uses actual vehicle fleet data to estimate emissions through 2012
- Incorporates new methodologies to forecast vehicle emissions through 2050
- Key forecasts are new vehicle sales and VMT projections

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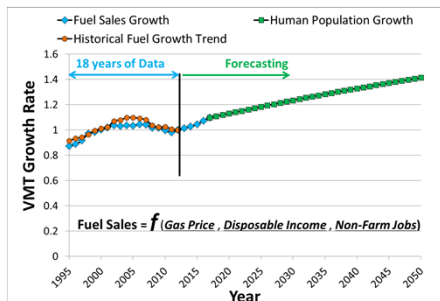
New Vehicle Sales Forecast



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VMT Projections



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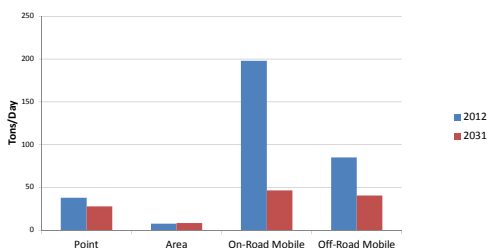
Sample Off-Road Model Updates

- Locomotives
 - Activity forecasts for individual train types
 - Accounts for rail line changes in grade
 - Growth rates are consistent with ARB's ocean-going vessel and truck growth projections
- Diesel Agricultural Equipment
 - Reflects equipment used on California farms
 - Activity data and growth rates developed by agricultural economists in cooperation with ag community

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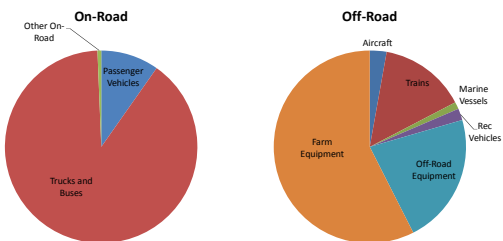
San Joaquin Valley NOx Emissions



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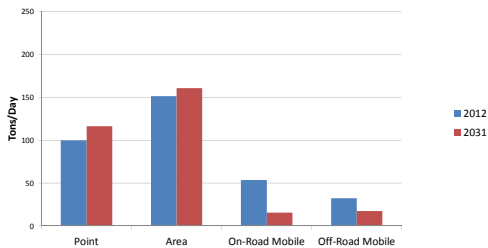
Dominant NOx Emission Sources (2012)



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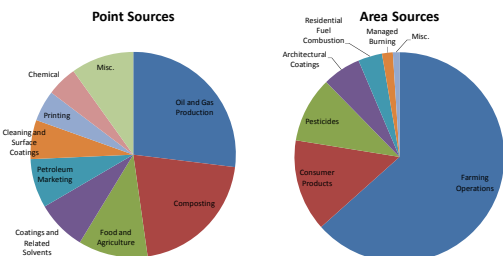
San Joaquin Valley VOC Emissions



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Dominant VOC Emission Sources



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SPATIAL ALLOCATION

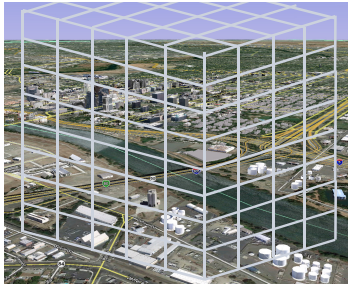
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Emissions 'Gridding'

Planning inventory

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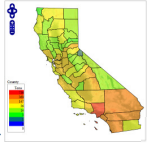
Modeling inventory



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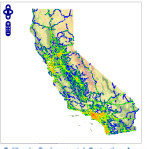
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Modeling Inventory Development



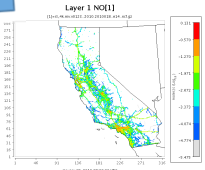
Planning Inventory

- Annual Estimates (tons/yr)
- County Totals
- Criteria Pollutants



Modeling Inventory

- Hourly
- Gridded
- Speciated



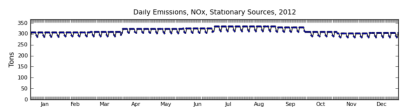
Layer 1 NOx

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Point Source Allocation

- Spatial - actual location of facility (latitude/longitude)
- Temporal - how emissions vary by:
 - Month
 - Day of week
 - Hours per day
 - Assigned for each individual process

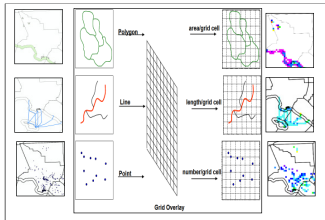



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Area Source Allocation

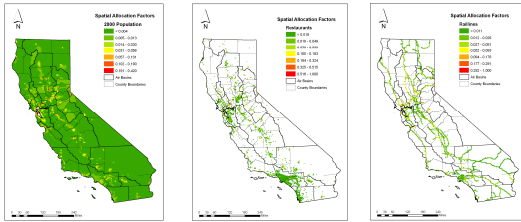
- Spatial - distributed by a surrogate that best represents location of emissions



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Area Source Spatial Allocation Examples



Polygon

Point

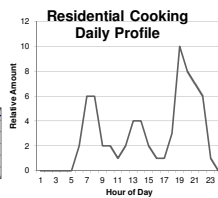
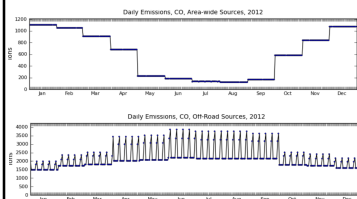
Line

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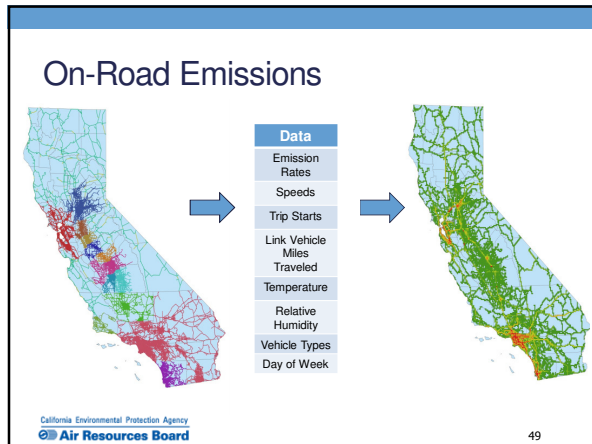
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Area Sources Temporal Allocation

- How emissions vary by:
 - Month
 - Day of week
 - Hours per day



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Summary

- Emission inventories provide technical foundation for clean air plans
- Inventory development takes time and significant resources
- Development process is a continuous and iterative
- Cooperative effort between government agencies and industry

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Thank You!

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