

# LOCOMOTIVE AND AIRCRAFT EMISSION INVENTORIES

## OVERVIEW

The WRAP Mobile Sources Forum (MSF) funded a project to develop a mobile source emission inventory with regionally consistent methods. This emission inventory was used in a complete comprehensive emission inventory for Regional Haze Modeling efforts in the Western Region of the U.S. Locomotive emissions were estimated using fuel consumption and freight density data, and EPA emission factors. Aircraft emissions for towered airports were estimated using the aircraft emissions model of the Federal Aviation Administration. The emission inventories take into account all federally promulgated controls. Locomotive emissions in the Western States decrease for most pollutants from 2002 to 2018 with fleet turnover to newer engines that meet more stringent federal standards. In April of 2007, EPA proposed further controls for locomotive engines that will reduce NO<sub>x</sub>, PM, and VOC emissions. Aircraft emissions increase from 2002 to 2018 as there are no controls that take effect in that period, but their contribution to the overall mobile source inventory is very small.

## SIP DEVELOPERS AND POLICY MAKERS

Locomotive emissions are an important off-road emissions category; aircraft less so

The WRAP inventory is a regionally consistent inventory (consistent approach, methods, and data)

Includes all "on the books" federal controls

New federal controls for locomotives have been proposed.

## STATE & LOCAL EMISSION INVENTORY DEVELOPERS

Locomotive activity data are not publicly available; aircraft data are

Best locomotive inventories are based on local activity data obtained directly from railroads

WRAP inventory includes some local locomotive emissions estimated by state/local agencies

## BACKGROUND

### LOCOMOTIVES

- Railroad types
  - Class I railroads most important (UP and BNSF in west)
  - Class II/III (<10%)
  - Passenger/Commuter (small)
  - Excursion (insignificant)
- Emission inventory scope:
  - Pollutants: NO<sub>x</sub>, SO<sub>2</sub>, VOC, CO, PM<sub>10</sub>, PM<sub>2.5</sub>, NH<sub>3</sub>.
  - Locomotive Classes I, II, and III
  - Geographic resolution: WRAP states and tribes, county level
  - Temporal resolution: 2002 base year, 2008/2013/2018 future years, annual

### AIRCRAFT

- Aircraft types
  - Air carriers – larger turbine-powered commercial aircraft with at least 60 seats or 18,000 lbs payload capacity
  - Air taxis – commercial turbine or piston-powered aircraft with less than 60 seats or 18,000 lbs payload capacity
  - General aviation – small piston-powered, non-commercial aircraft
  - Military aircraft
- Emission inventory scope – same locomotive except emissions are seasonal

## METHODS — LOCOMOTIVE EMISSIONS

- General approach: emissions = fuel consumption \* g/gal emission factors
- National activity allocated to counties using freight density data
- County level emissions estimated
- Locomotive data sources:

Data	Source
2002 Fuel consumption	Class I - Association of American Railroads Class II/III - American Short Line & Regional Railroad Association
Historic freight movements (allocation surrogate)	Bureau of Transportation Statistics
Emission factors (emissions/gal)	EPA
2002 Locomotive emissions provided by state/local agencies	Alaska; Arizona; California; Clark County, NV; Idaho; Wyoming;

- Locomotive emissions projections:
  - Fuel consumption projected from historical trends in national freight ton-miles/year and freight company efficiency
  - Emission factors reduced to adjust for fleet turnover using EPA analysis of existing Tier 1/2 standards, including ultra low sulfur fuel (15 ppm) in 2012

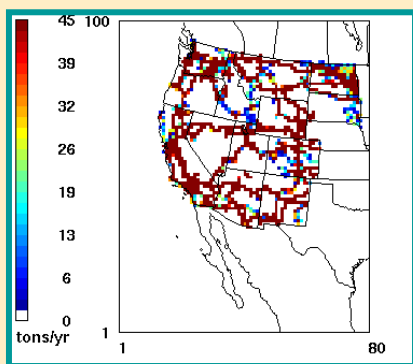
## METHODS — AIRCRAFT EMISSIONS

- Activity data is number of landing and take offs (LTOs)
- Emissions = LTOs \* emission factor/LTO
- WRAP 2002 emissions based on EPA 2002 National Emission Inventory (NEI2002) aircraft emissions estimates
  - Emissions estimated for 549 towered airports in WRAP states
  - Used FAA Emissions and Dispersion Modeling System (EDMS)
  - Used detailed FAA activity data by airframe for air carriers
  - Fleet average emission factors for air taxis and general aviation
- Inserted improved aircraft emissions estimates provided by other state/local agencies: Alaska (WRAP project), Arizona, California, Clark County (NV), Idaho, Wyoming
- Seasonal emissions estimated using FAA monthly LTO activity by state and aircraft type
- Aircraft emissions projections
  - FAA LTO projections by airport (aggregated to county) and aircraft category
  - No emissions standards/factors changes

# RESULTS

## LOCOMOTIVE EMISSIONS

2002 Locomotive NOx Emissions



Western States Total Locomotive Emissions (tons)

	VOC	NOx	CO	PM10	PM2.5	SO2
2002	43	963	116	26	25	69
2018	45	741	156	26	25	1
% Change	4%	-23%	34%	-1%	-1%	-99%

## AIRCRAFT EMISSIONS

Western States Total Aircraft Emissions (tons)

	VOC	NOx	CO	PM10	PM2.5	SO2
2002	53	83	472	16	14	6
2018	73	137	634	18	16	9
% Change	39%	66%	34%	13%	13%	44%

### EMISSIONS SUMMARY FILES AVAILABLE ON PROJECT WEB SITE:

- Excel files with emissions by county and state, 2002 and 2018
- Excel file with summary 2002 and 2018 locomotive emissions by state
- Excel files with plots and data tables of emissions by state for each year

SMOKE IDA files, 2002 and 2018 <http://www.wrapair.org/forums/ef/UMSI/index.html>

## OTHER RELEVANT POINTS

### Locomotive Emissions

EPA proposed new Tier 3 standards for locomotives in March 2007.

% Change	-38%	0%	-13%	-33%	0%	0%
Reduction (tons)	(17)	-	(20)	(8)	-	-

**California initiatives:** ARB/Class I railroads 2005 Memorandum of Understanding to use ultra low sulfur fuel prior to EPA required date, wider use of idle reduction devices, better operator training, and demonstration projects.

California ARB is currently performing health risk assessments for major rail yards in the state (<http://www.arb.ca.gov/railyard/hra/hra.htm>) using detailed activity data for each facility and time-in-mode emissions calculations.

### Aircraft Emissions

New FAA EDMS model was released after NEI2002 and WRAP aircraft emissions were estimated. Future inventories should use the latest model, which includes PM emission factors not in previous version

## FUTURE WORK

2018 Locomotive emission inventories in the future will need to incorporate EPA new rule effects when finalized

## RESEARCH INFORMATION NEEDS

- Accuracy of emissions estimates depends on accuracy of activity data. For smaller scale state/local inventories:
  - Locomotive activity can be obtained from the railroad companies.
  - Aircraft data are available from FAA for towered airports, and more detail can be provided by local airport authorities, including time-in-mode data.
- Military aircraft can be a significant source of emissions in some areas, but activity data are very difficult to obtain.

## CONTACT INFORMATION

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