Offroad Mobile Source Emissions and Retrofit Options in the WRAP Region

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WRAP Mobile Sources Forum Call

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Outline of Presentation

- Background
- Emissions
- Ambient air quality
- Current retrofit technologies
- Sample of retrofit programs
- Important elements of a retrofit program
- Funding sources and other incentives
- Options for the WRAP
- Sources for more information

Background

- Offroad emissions are expected to exceed onroad emissions by 2013 for NOx and already exceed onroad emissions for $PM_{2.5}$.
- Although new and stringent standards are being implemented for offroad sources, phase-in does not begin until 2011 and may not be complete until 2030+.
- Retrofit programs accelerate environmental and public health benefits and provide flexibility to implementation plans and industry compliance.
- Technological and administrative options for retrofits are available and rapidly growing.

Background

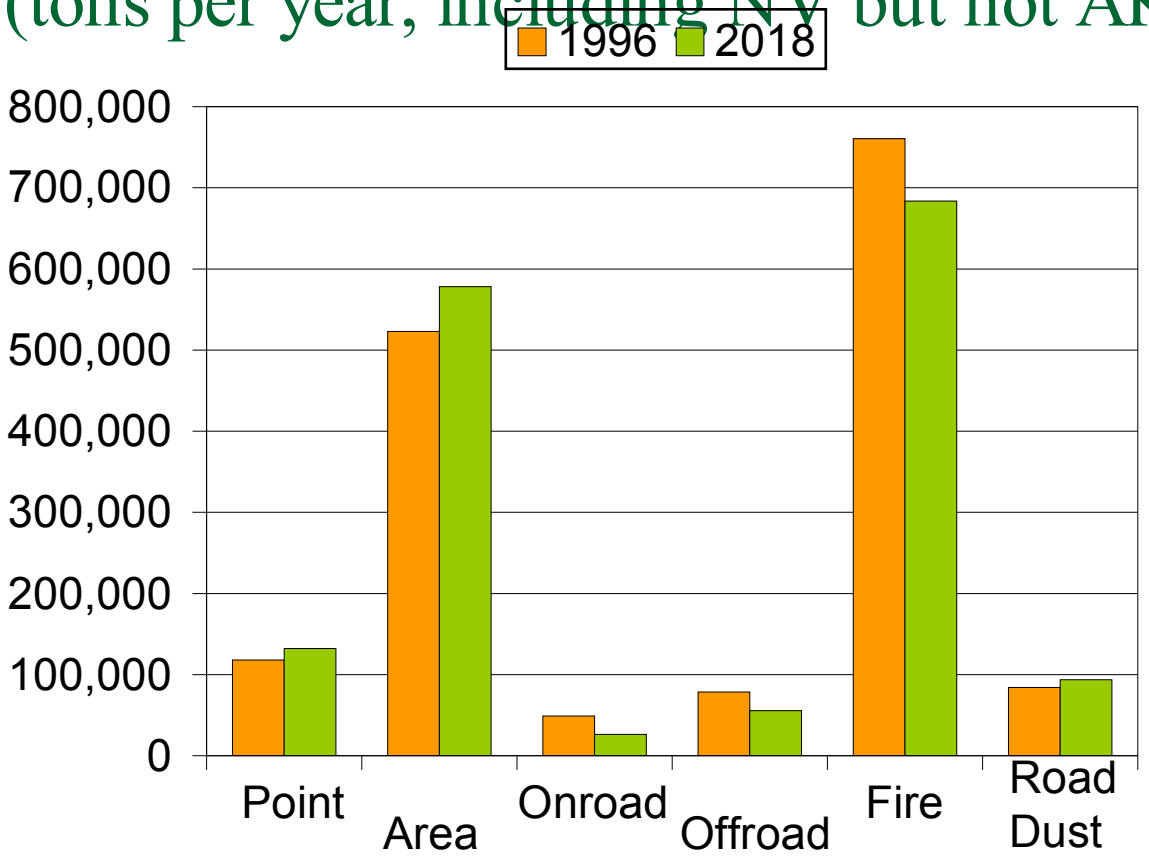
- Worldwide, exhaust controls have been added for 25 years to over 250,000 offroad engines of almost all types, agriculture being the primary exception.
- Offroad retrofits pose unique challenges due to wide range of sizes and operating conditions.
- The WRAP Board has identified offroad emission reductions as necessary for achieving “reasonable progress” and has called for EPA and WRAP members to collaborate on diesel retrofit programs.

Here, the Term "Retrofit" Includes ...

- Retrofit / Aftertreatment
  - Catalysts, filters, crankcase controls, EGR
- Refuel
  - ULSD, biodiesel, emulsion, electrification, CNG
- Rebuild
  - Tune-up, repair, certify existing engine
- Repower
  - Install new engine in existing equipment
- Replace
- Idle control

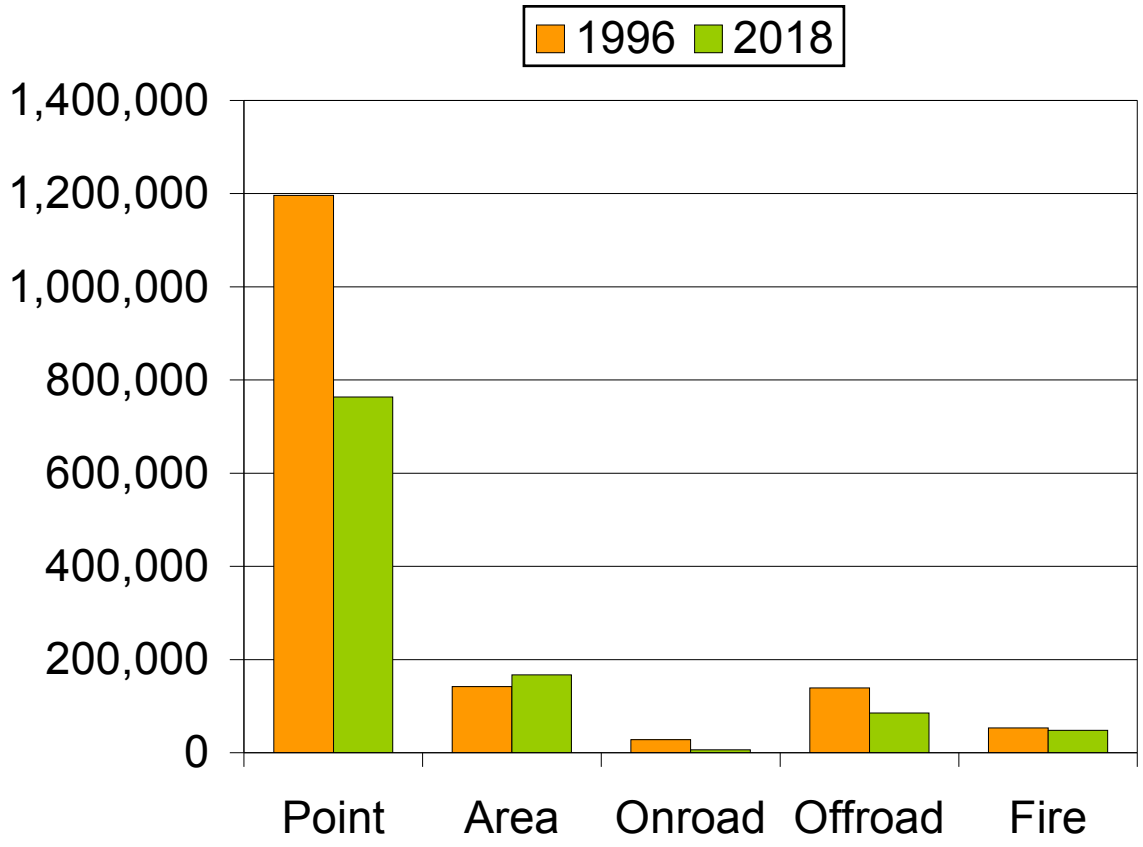
$PM_{2.5}$ Emissions in the WRAP Region

(tons per year, including NV but not AK)



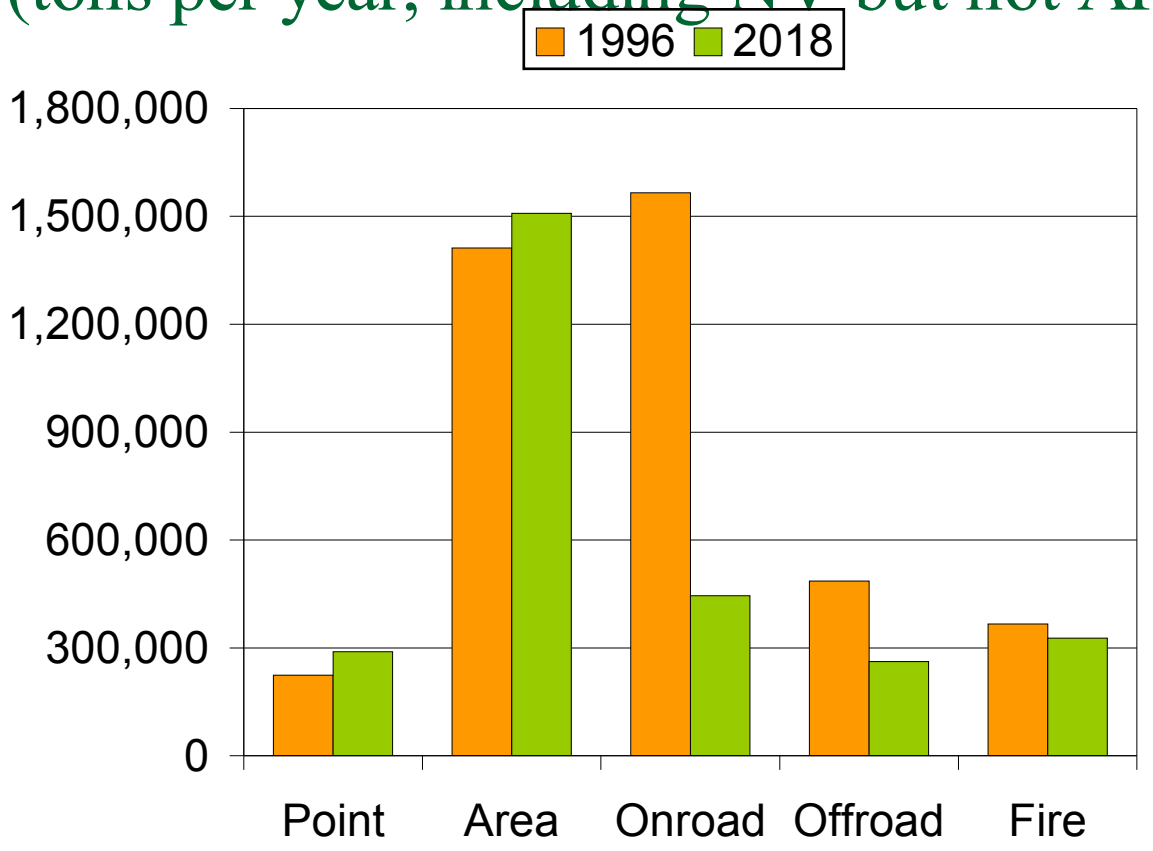
- Proposed tier IV offroad exhaust stds not included
- 83% of offroad from diesel
- Area sources comprised mostly of agriculture, construction, and residential wood combustion
- Different types of PM have different visibility impacts

SO_2 Emissions in the WRAP Region
(tons per year, including NV but not AK)



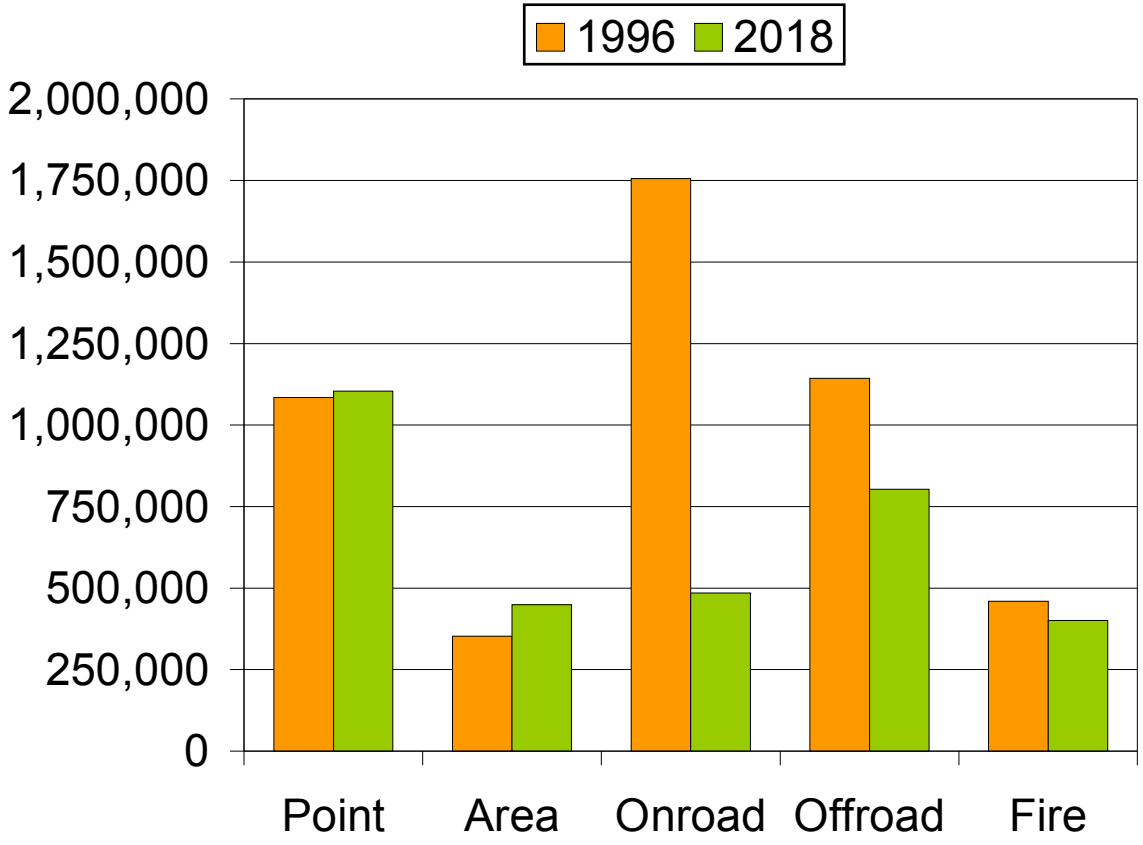
- Assumes 15 ppm fuel sulfur and 9-state Annex
- 99% of offroad from diesel

VOC Emissions in the WRAP Region
(tons per year, including NV but not AK)



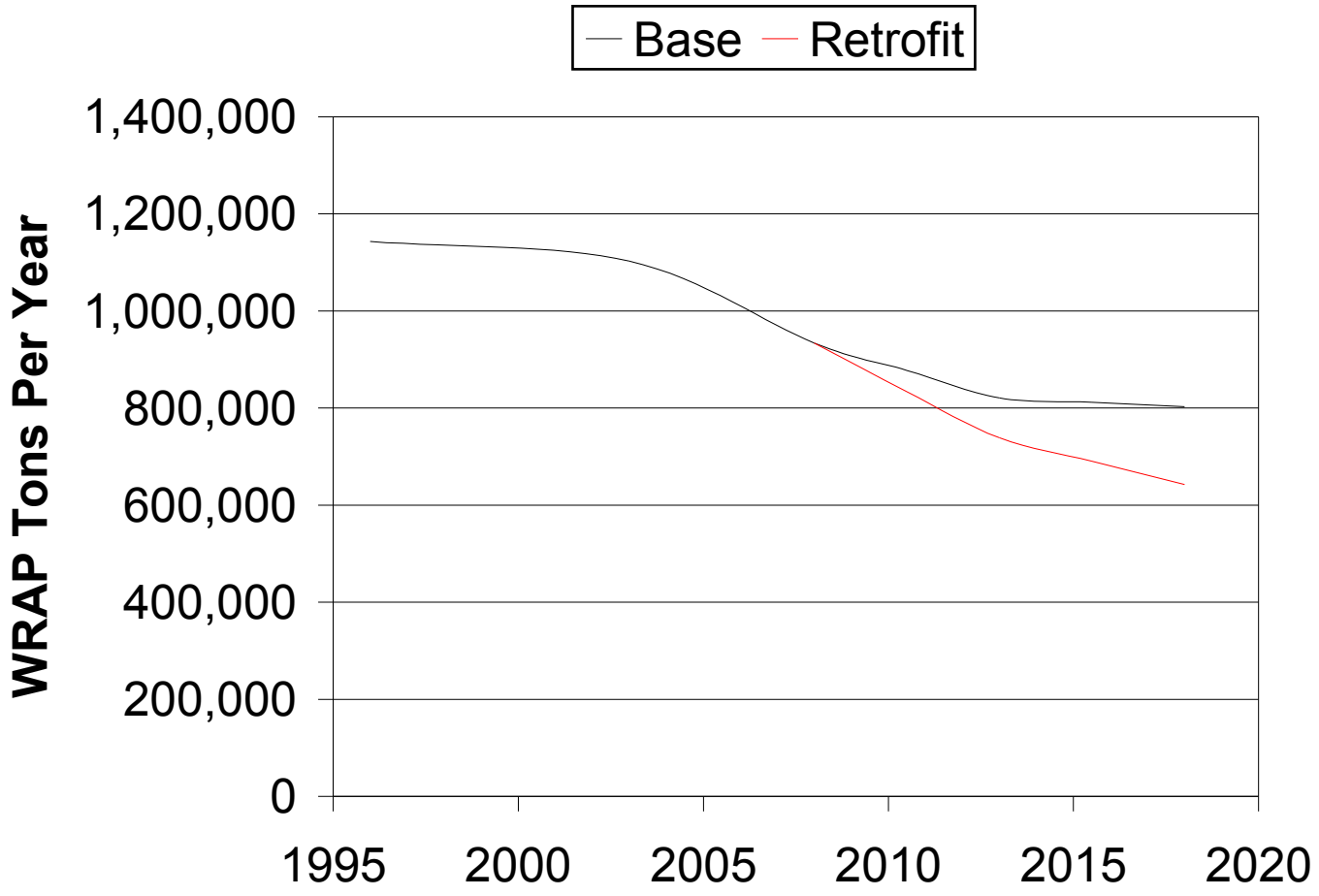
- 28% of offroad is from diesel
- Area sources comprised mostly of surface coating, other solvent use, residential wood combustion, and petro storage
- VOCs contribute to secondary PM

NOx Emissions in the WRAP Region
(tons per year, including NV but not AK)

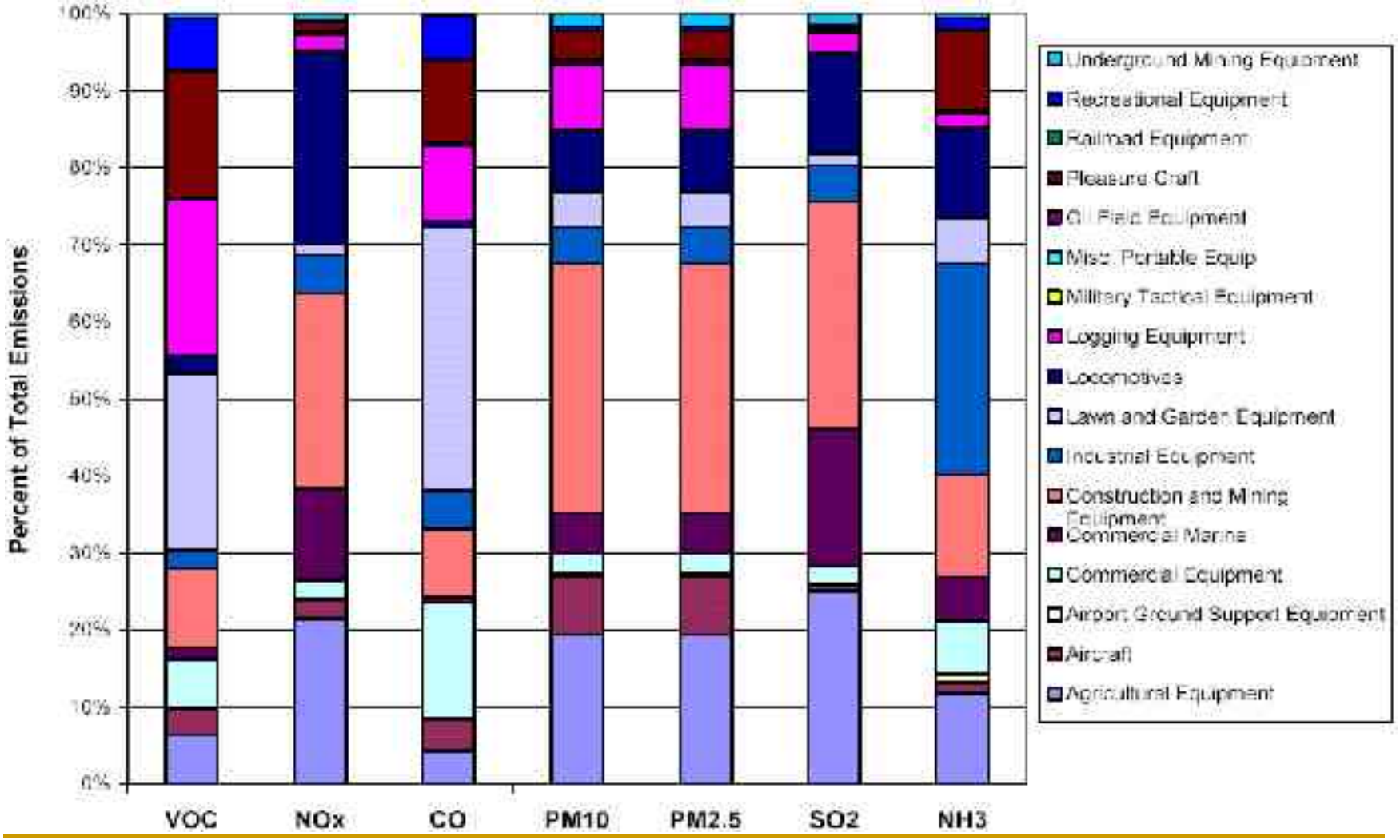


- 93% of offroad is from diesel

Hypothetical Acceleration of NOx Reductions Due to In-Use Programs



1996 Offroad Emissions by Sector
(June 2000 NONROAD Model)



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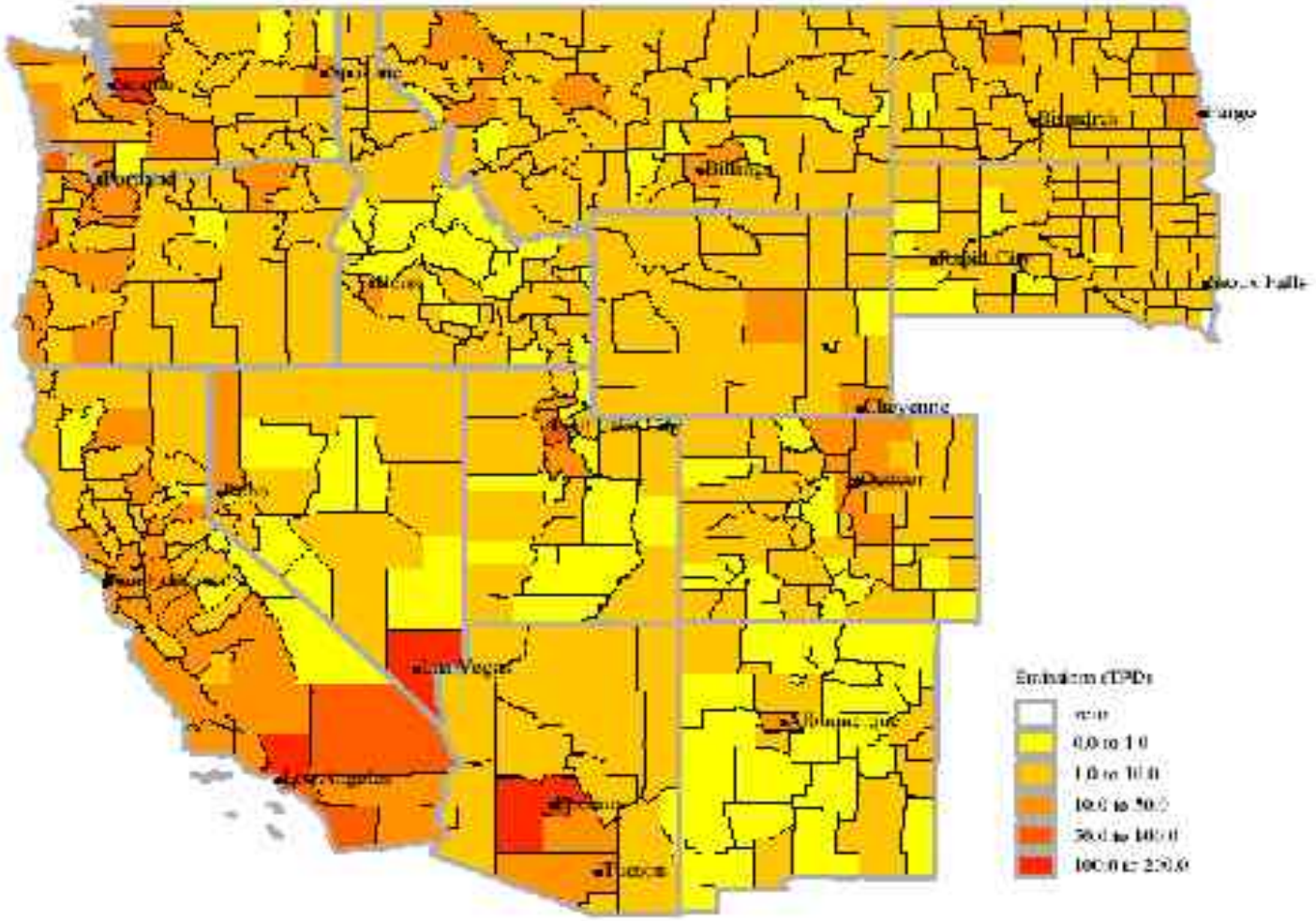
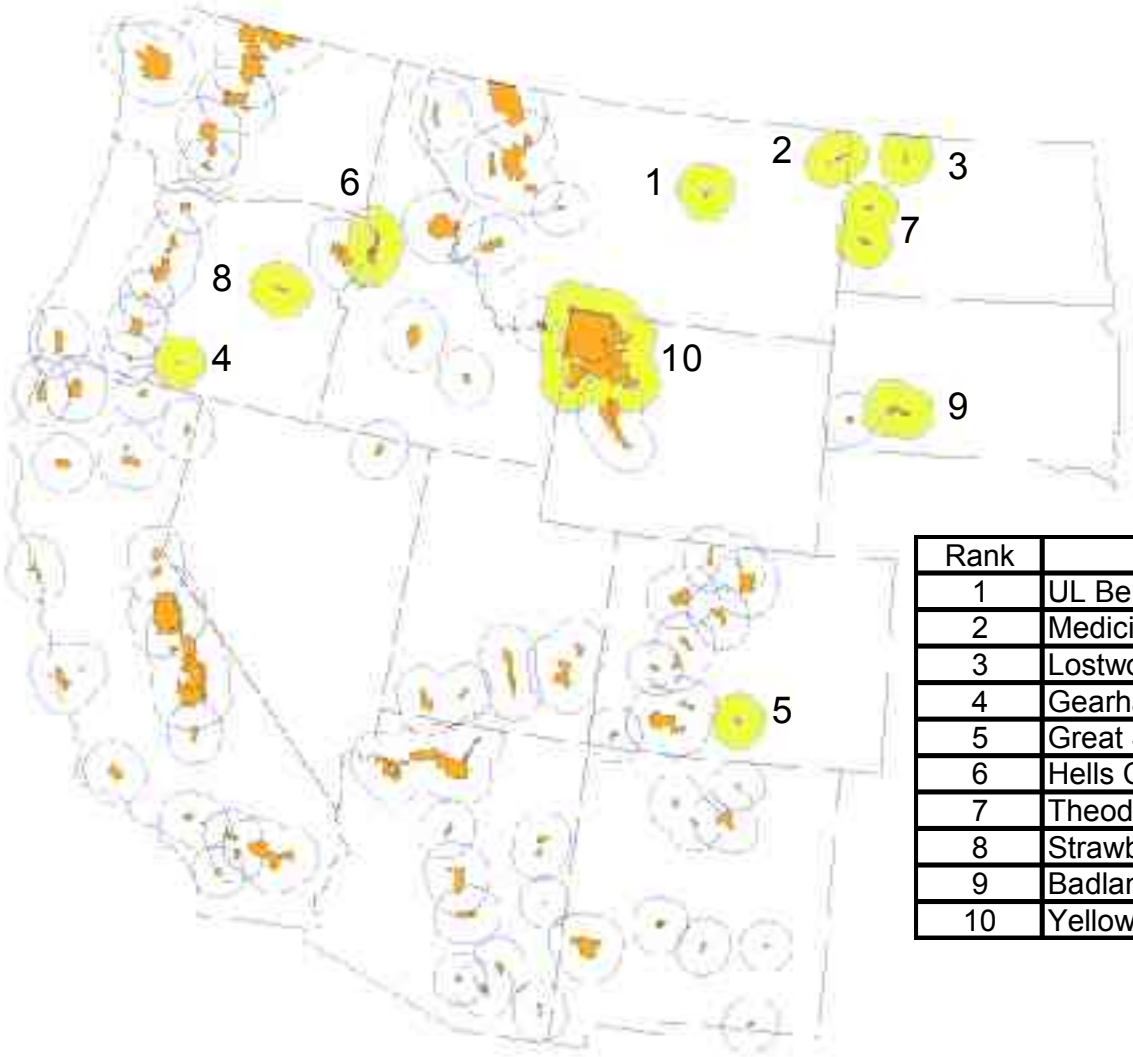
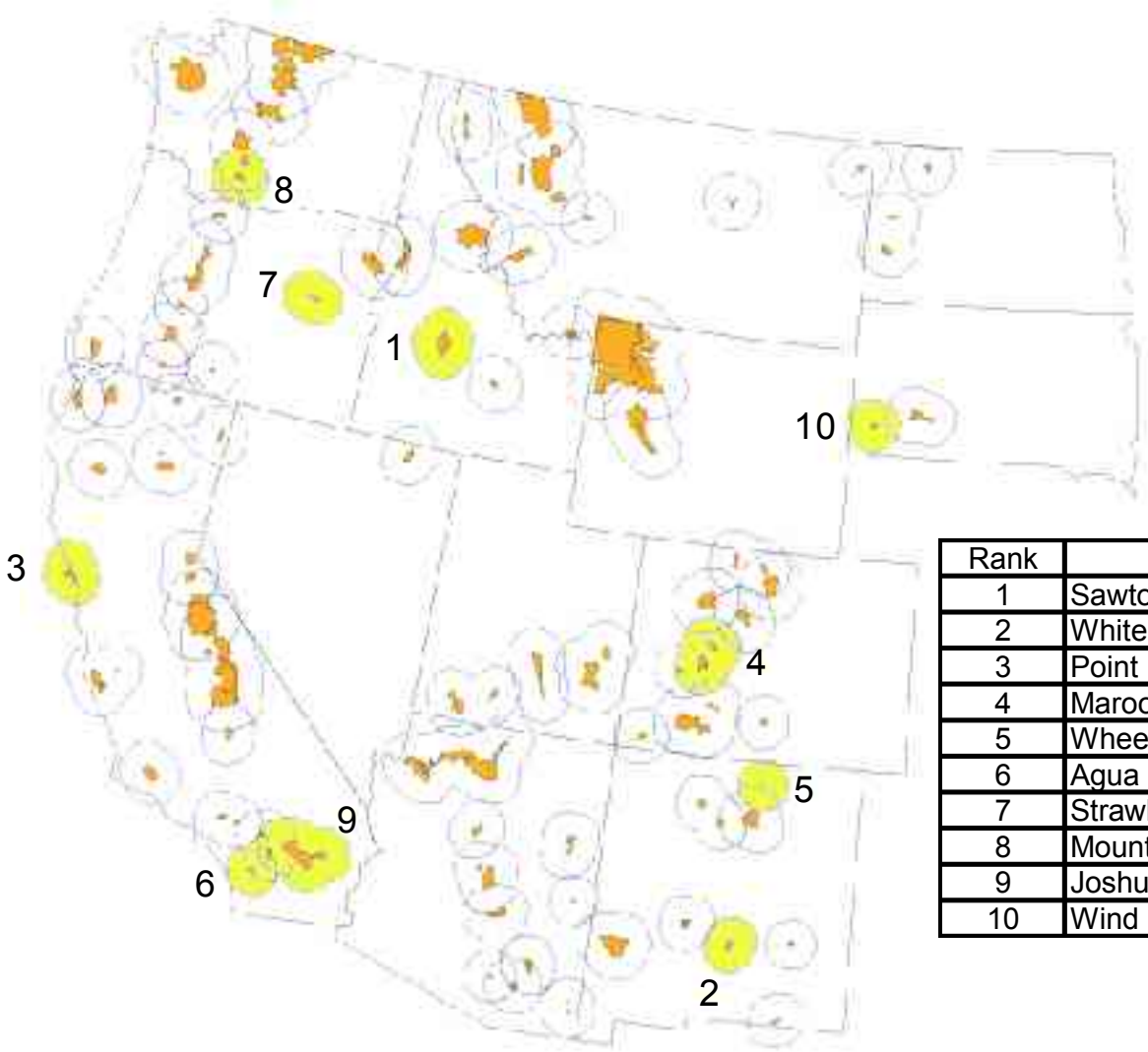


Class I Areas with the Greatest Contribution of Agricultural Equipment to Nearby NOx Emissions (1996)



Rank	Class I Area(s)	%	tons
1	UL Bend	87	443
2	Medicine Lake	62	1,529
3	Lostwood	52	1,747
4	Gearhart Mountain	37	183
5	Great Sand Dunes	37	536
6	Hells Canyon	33	415
7	Theodore Roosevelt	31	1,505
8	Strawberry Mountain	23	126
9	Badlands	21	353
10	Yellowstone/Teton/Grand Teton	21	1,127

Class I Areas with the Greatest Contribution of Construction & Mining Equipment to Nearby NOx Emissions (1996)



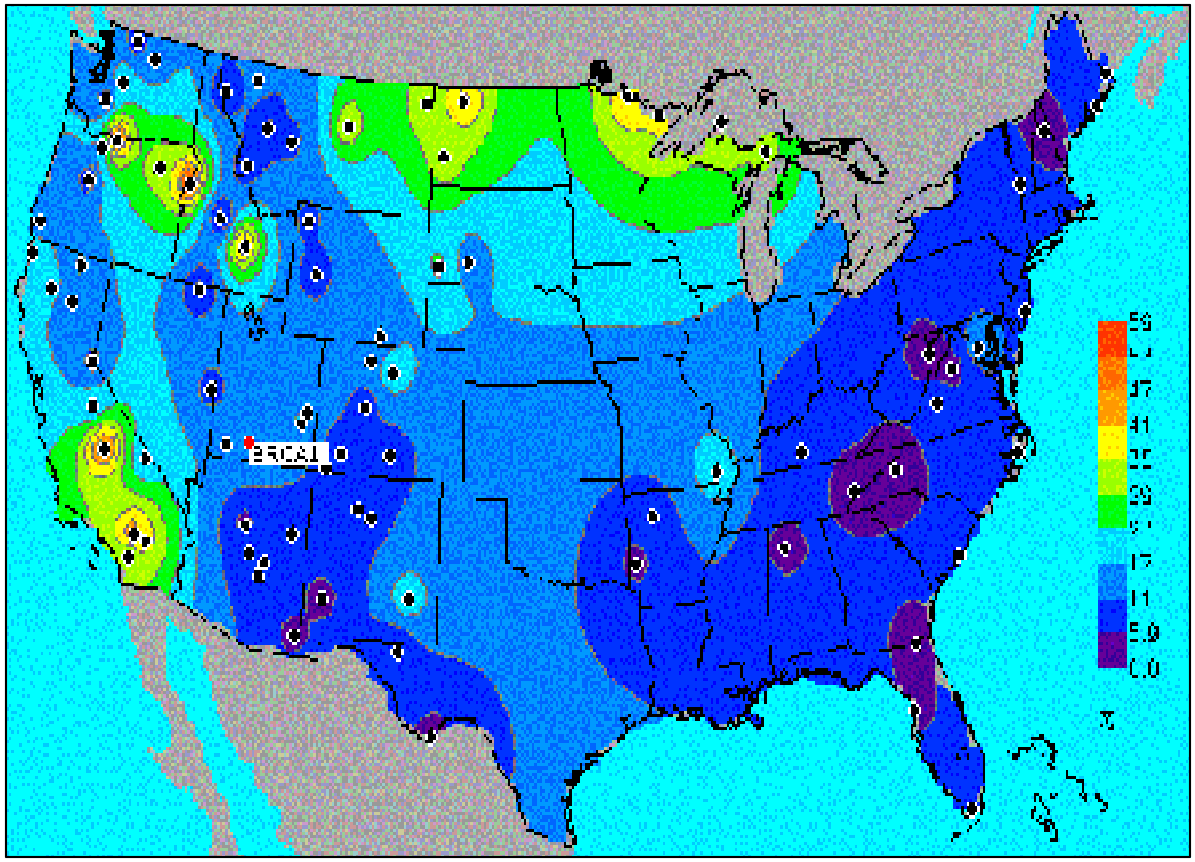
Rank	Class I Area(s)	%	tons
1	Sawtooth	18	80
2	White Mountain	17	191
3	Point Reyes	17	16,213
4	Maroon Bells-Snowmass/West Elk	16	653
5	Wheeler Peak	13	200
6	Agua Tibia	13	4,990
7	Strawberry Mountain	12	69
8	Mount Adams	11	181
9	Joshua Tree	11	1,864
10	Wind Cave	11	199

Class I Areas with the Greatest Contribution of Locomotive & Railroad Equipment to Nearby NOx Emissions (1996)

Rank	Class I Area(s)	%	tons
1	Diamond Peak	63	2,735
2	Gates of the Mountains	50	3,112
3	Lava Beds	45	1,522
4	Pasayten/ N. Cascades/G. Peak	43	3,213
5	Glacier	41	2,851
6	Cabinet Mountains	39	926
7	Mt. Jefferson/Washington/3 Sisters	38	3,921
8	Red Rock Lakes	33	374
9	Mission Mountains/Scapegoat	30	3,907
10	Mt. Hood	27	4,893

IMPROVE Monitoring Data

Percent of Light Extinction Due to
Ammonium Nitrate on the 20% Worst Days (2001)



- Percentages are higher when natural sources of haze are excluded
- On some of the worst days on the Colorado Plateau, nitrate is 40-60%
- WRAP “Attribution of Haze” project to provide more detail on source contributions

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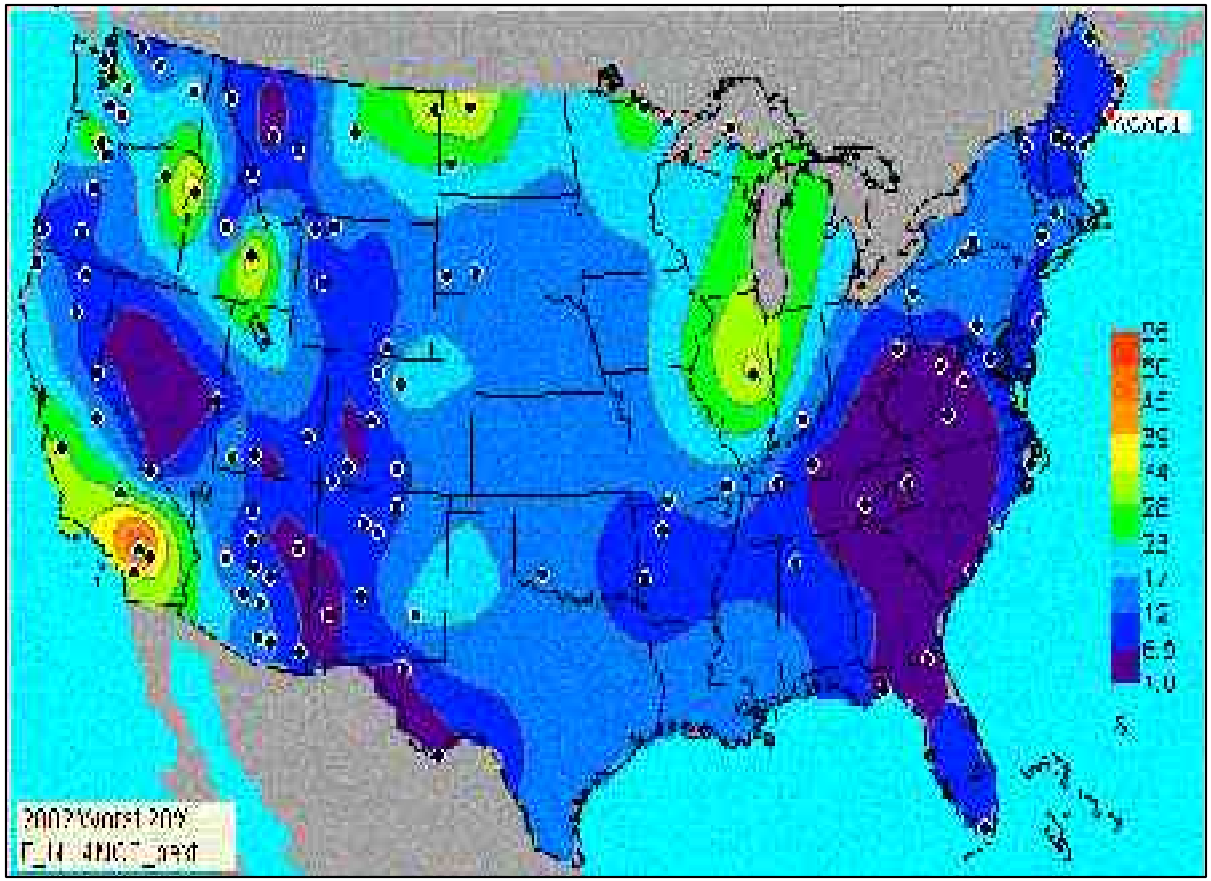
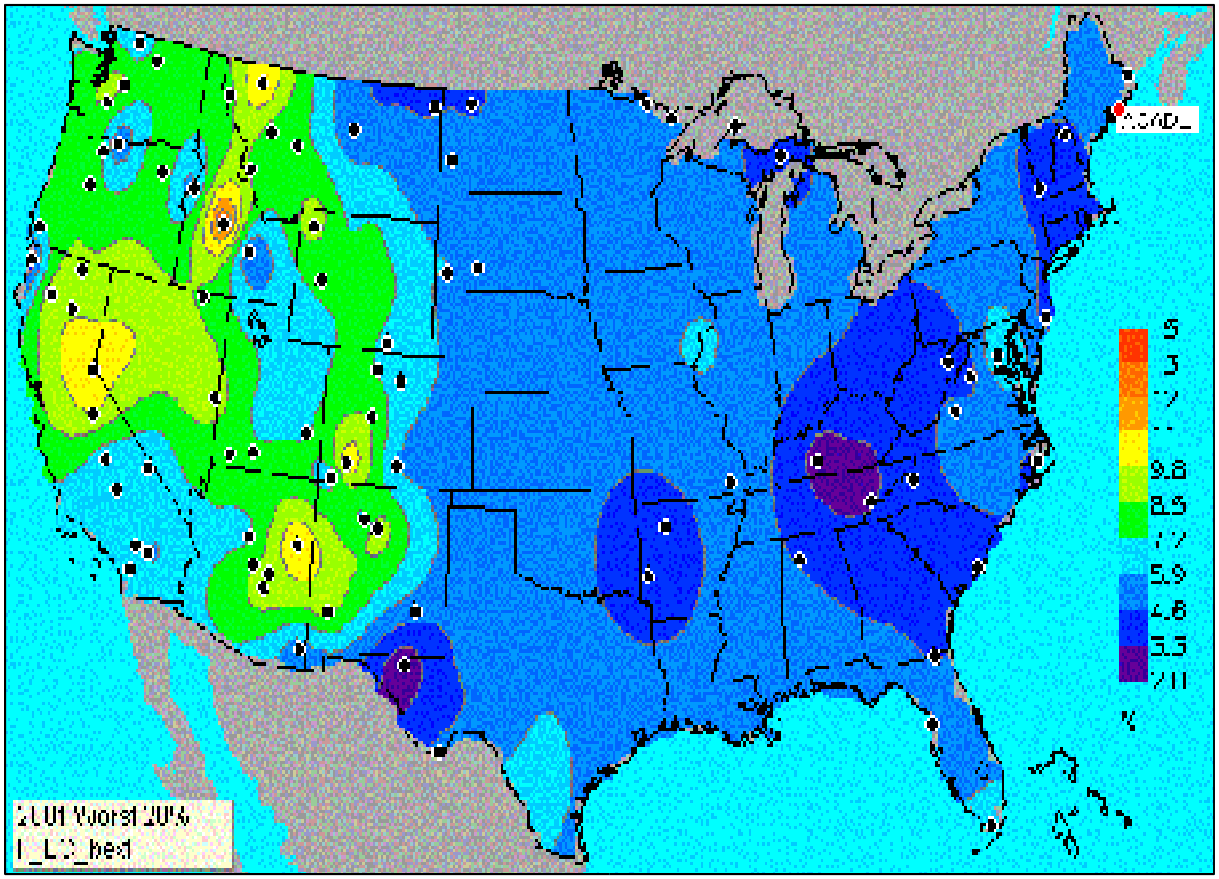


IMPROVE Monitoring Data

Percent of Light Extinction Due to
Elemental Carbon on the 20% Worst Days (2001)



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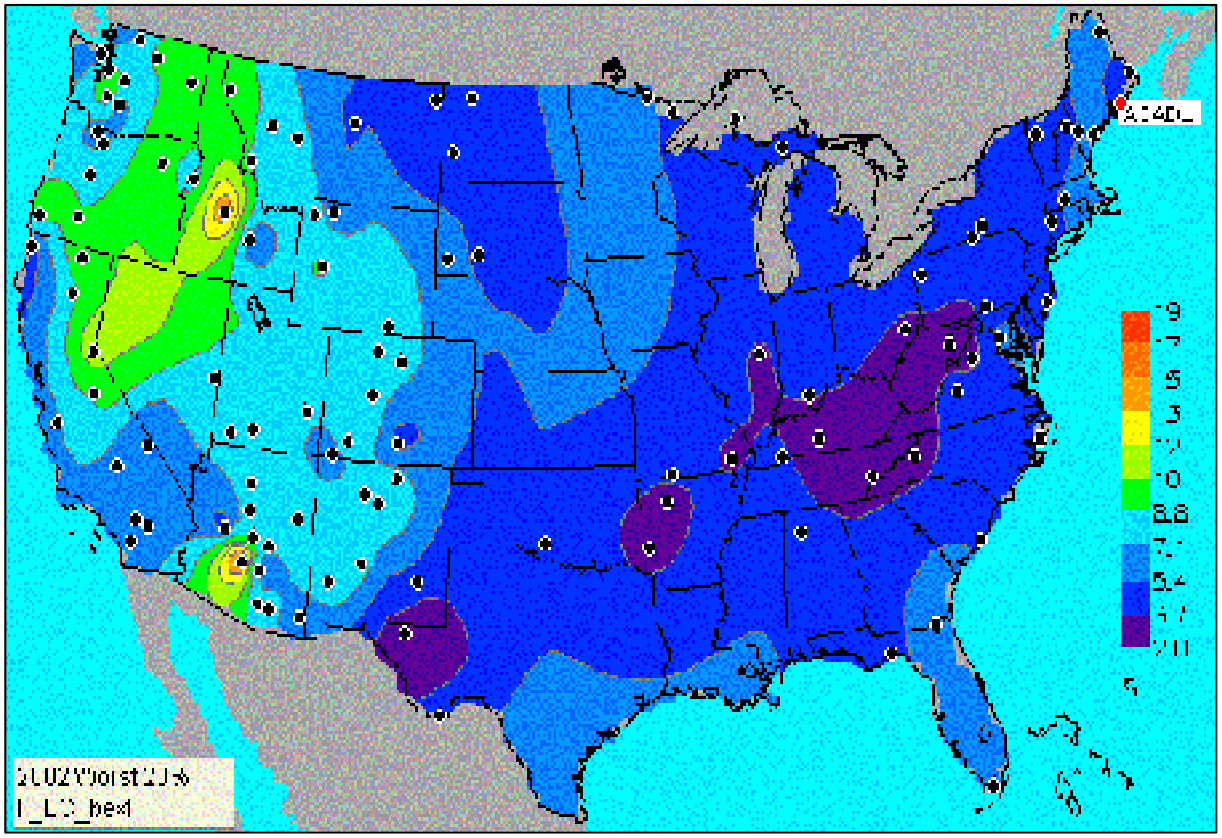

Aftertreatment Technologies

- To various extents, each technology below is affected by fuel sulfur, has a slight fuel penalty (0 - 3%), and controls multiple pollutant.
- Diesel oxidation catalysts (DOCs)
  - Most widely used technology to date
  - Applicable to virtually all engines and vehicles
  - No maintenance required
  - Can reduce PM emissions by 25-50% depending on fuel sulfur and the soluble organic fraction of PM
- Diesel particulate filters (DPFs)
  - Widely applied, but some applications (due to low exhaust temperature) require active regeneration, which is not yet practical for some existing vehicles

Aftertreatment Technologies

- Crankcase controls
- Selective catalytic reduction (SCR)
  - Due to reductant storage requirements, use has been limited to large engines (e.g., ships and locomotives), but capable of 60-90% reduction
- Lean NOx catalysts
  - More broadly applicable, but only modest NOx reductions
- NOx adsorber catalysts
  - Under development, but capable of 90% NOx reduction
  - Currently operate over narrow temperature ranges

Retrofit Effectiveness

Retrofit Option	Typical Control Efficiency (%)			Cost
	HC	NOx	PM	
Diesel Oxidation Catalysts	50 - 90	--	20 - 50	$1 - 2k
Diesel Particulate Filters	50 - 95	--	80 - 95	$5 - 8k
4-Way Catalysts	80	20	70	$8 - 10k
Lean-NOx Catalysts	--	20	--	$5 - 10k
Selective Catalytic Reduction	50 - 90	65 - 90	15 - 30	$10 - 20k
NOx Adsorbers	90	> 90	10 - 30	R&D
Exhaust Gas Recirculation	--	50	--	R&D
Ultra-Low Sulfur Fuel	--	--	10 - 15	1 - 20¢/gal
Emulsified Fuel	--	5 - 30	20 - 50	1 - 20¢/gal
Biodiesel Fuel (B20)	20 - 30	2 (inc.)	10 - 30	10 - 50¢/gal
Fuel-Born Catalysts	< 50	< 10	< 30	5¢/gal
Repair/Rebuild	75	?	40	$0.5 - 2.5k
Repower/Replace	?	60 - 98	80 - 98	$30 - 40k

Sources: Environmental Protection Agency, Diesel Technology Forum, Manufacturers of Emission Controls Association.

Sample of Offroad Retrofit Programs

- Federal
  - EPA Idle Reduction Program
  - EPA Ground Freight Partnership Program
- California
  - Portable engines > 50 hp by 2020 (proposed rule)
  - Various locomotive and commercial marine and port initiatives
  - Various projects funded by districts & state (Carl Moyer program)
- Washington
  - All construction projects funded by state (proposal being developed)
  - Working with cruise lines to put in shore-line power
  - Converted cranes to electrical power
- Oregon, Colorado, and probably others
  - Tax credit for retrofits (35% in OR)

Sample of Offroad Retrofit Programs

- Texas
  - Port of Houston applying DOC/SCR systems and fuel additives for 50-250 vehicles (cranes, gantries, etc.)
  - Various refueling, repowering, and retrofit projects funded by state
- Massachusetts
  - All construction projects funded by the state or MBTA
  - DOCs and 500 ppm S fuel for 15-22 locomotives ($1.25M)
  - ~200 construction vehicles involved with the Big Dig
- Connecticut
  - All construction vehicles > 60 hp involved in the New Haven corridor project
- Georgia
  - Construction incentives/requirements at Hartsfield Int'l expansion

Sample of Offroad Retrofit Programs

- New York City
  - All city-owned/leased vehicles > 50 hp must use ULSD and best available technology
- Chicago
  - Auxiliary power units to reduce locomotive idling
- Mt. Ranier
  - Biodiesel and exhaust controls for trucks and equipment

Important Elements of a Retrofit Program

- Emission reductions desired
- Vehicles to be addressed
  - Those under common control may have an advantage
- Available emission control technologies
  - Broadly applicable technologies may have an advantage over application-specific approaches
  - Should use certified equipment (not yet available for offroad?)
  - Must be compatible with or tailored to engine size and backpressure specs, engine duty-cycle, exhaust temps
  - Vehicle integration (muffler replacement, in-line install)
- Fuel quality requirements
  - Sulfur levels
  - Impacts of alternative fuels on equipment

Important Elements of a Retrofit Program

- Capital and operating costs
- Maintenance requirements
- Vehicle maintenance
  - Schedules may dictate best time for installation
  - Retrofits work better when engine rebuilt to manufacturer's specification before installation
- Education and training of vehicle operators, fleet managers, and the public
- Ensuring emission reductions are achieved

Funding Sources & Other Incentives

- Some jurisdictions require retrofits or equivalent reductions for some equipment (CA, MA, CT, NYC, and EPA's locomotive rebuild standard).
- Approaches listed below are voluntary, but incentives may be strong and/or driven by certain regulations.
- Mobile source emission reduction credits for use in ...
  - Tier IV federal offroad compliance (proposed)
  - Stationary source compliance (NSR offsets, cap-and-trade, etc

States which permit MSERCs

Funding Sources & Other Incentives

- Public funding
  - EPA grants (Voluntary Diesel Retrofit Program, Mobile Source Outreach Assistance Grants)
  - CMAQ funds (not applicable to fuels)
  - USDA/NRCS Environmental Quality Incentives Program
  - State and local grants and tax incentives
- Government actions
  - Retrofit publicly-owned vehicles
  - Modify contract awarding procedures
  - Use supplemental environmental projects (see StEPP Foundation)
  - Retrofit in lieu of paying fines for smoke violations
  - Exempt retrofitted vehicles from smoke inspections, use restrictions, and vehicle registration fees and taxes
  - Publicly recognize fleet operators who retrofit

Funding Sources & Other Incentives

- Implementation plan credits
  - Most or all of the above actions can produce credits towards use in meeting emission reduction targets in state and tribal air quality implementation plans.
  - EPA allows up to 3% of the total emission reductions in a SIP to be from voluntary mobile source programs.

Options for WRAP

- Guidance for members and stakeholders
  - Sector-specific technologic and administrative options tailored to western sources, impacts, and opportunities (e.g., fuel availability, fleet characteristics, current programs, etc.)
- Coordination, tracking, and market development
  - Track offroad projects, transferable onroad projects, emerging technologies, and policy developments
  - Evaluate costs, benefits, and other issues
  - Communicate results to stakeholders and public
  - Identify and facilitate markets for emission reduction credits

Options for WRAP

- Demonstration projects
  - Fill data gaps
  - Advance a current or promising technology or approach
  - Target sources closest to / having greatest impact on Class I areas
  - Partnerships and co-sponsorship would be critical

For More Information ...

- EPA's Office of Transportation and Air Quality
  - http://www.epa.gov/otaq/retrofit
- CARB's Mobile Source Program
  - http://www.arb.ca.gov/msprog/msprog.htm
- Diesel Technology Forum
  - http://www.dieselforum.org
- Manufacturers of Emission Controls Association
  - http://www.meca.org
- DieselNet
  - http://www.dieselnet.com