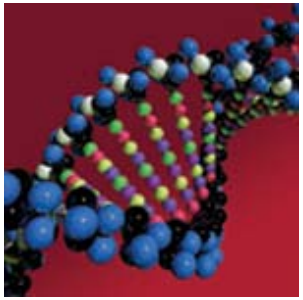
Overview of Miscellaneous EIs In-and-Around the WRAP Region


Gerard Mansell, ENVIRON

Regional Haze Emissions Inventories – Lessons Learned Workshop

Salt Lake City, UT

September 25-26, 2007

ENVIRON

PRESENTATION OVERVIEW

- Review & Evaluate EI's outside of WRAP
- Regional summaries by RPO/Region
  - Consider completeness, consistency, reasonableness
  - Consider relevance of non-WRAP regional EIs
- International EIs – Canada, Mexico, Eastern Pacific Shipping
- RPO Inventory Summaries
  - Summaries by source category/pollutant

Emissions Modeling

- SMOKE emissions model
  - Generate AQ model-ready EIs based on county-level inventory data
  - EI data submitted by states/tribes/local agencies
  - Biogenic emissions (BEIS)
- Regional emissions models
  - WRAP RMC WB Dust model
  - WRAP RMC GIS NH3 model
- Other emission inventories
  - Off-shore Commercial Marine Shipping
  - WRAP Oil & Gas

Inventory Scenarios

- 2002 Base Case - “2002 Base Case” or “Base02”
  - The Base02 inventory represents the actual conditions in calendar year 2002 with respect to ambient air quality and the associated sources of criteria and particulate matter air pollutants.
  - The Base02 inventories are used to validate the air quality model and associated databases and to demonstrate acceptable model performance with respect to replicating observed particulate matter air quality.
- 2000-04 Baseline Period Planning Case - “Plan02”
  - The Plan02 inventory represents baseline emission patterns based on average, or “typical”, conditions
  - The Plan02 inventory provides a basis for comparison with the future year 2018 projected emissions, as well as to gauge reasonable progress with respect to future year visibility.
- 2018 Future-year Base Case - “2018 Base Case” or “Base18”
  - These emissions are used to represent conditions in future year 2018 with respect to sources of criteria and particulate matter air pollutants, taking into consideration growth and controls.
  - Modeling results based on this emission inventory are used to define the future year ambient air quality and visibility metrics.
- 2018 Preliminary Reasonable Progress - “PRP18”
  - These emissions are used to evaluate the regional haze air quality for future year 2018 conditions with all known and expected controls as of March 2007.
  - Provide predicted 2018 future year air quality and visibility conditions in the Western Class I areas for December 2007 regional haze plans.
  - Modeling results based on this emission inventory are used to gauge reasonable progress with respect to future year visibility.

Emission Source Categories

- *Stationary Area Sources:* Sources that are treated as being spread over a spatial extent (usually a county or air district) and that are not movable
  - Examples of stationary area sources are residential heating and architectural coatings. Numerous sources, such as dry cleaning facilities, may be treated either as stationary area sources or as point sources.
- *Mobile Sources:* Vehicular sources that travel on roadways. Data in on-road inventories can be either emissions or activity data.
  - Activity data consist of vehicle miles traveled (VMT) and, optionally, vehicle speed.
  - Examples of on-road mobile sources include light-duty gasoline vehicles and heavy-duty diesel vehicles.
- *Stationary Point Sources:* These are sources that are identified by point locations, typically because they are regulated and their locations are available in regulatory reports.
  - Point sources can be further subdivided into electric generating unit (EGU) sources and non-EGU sources
  - Examples of non-EGU point sources include chemical manufacturers and furniture refinishers.
- *Fugitive Dust Sources: Agricultural, Construction, Road Dust; Windblown Dust*
- *Fire Sources: Wildfires, Prescribed fires, Wildland Fire Use*
  - *Treated as point sources within WRAP; may be area sources in other RPOs*
- *Biogenic Sources:* Biogenic emissions from vegetation; characterized by land use data

Regional Emission Inventory Summaries

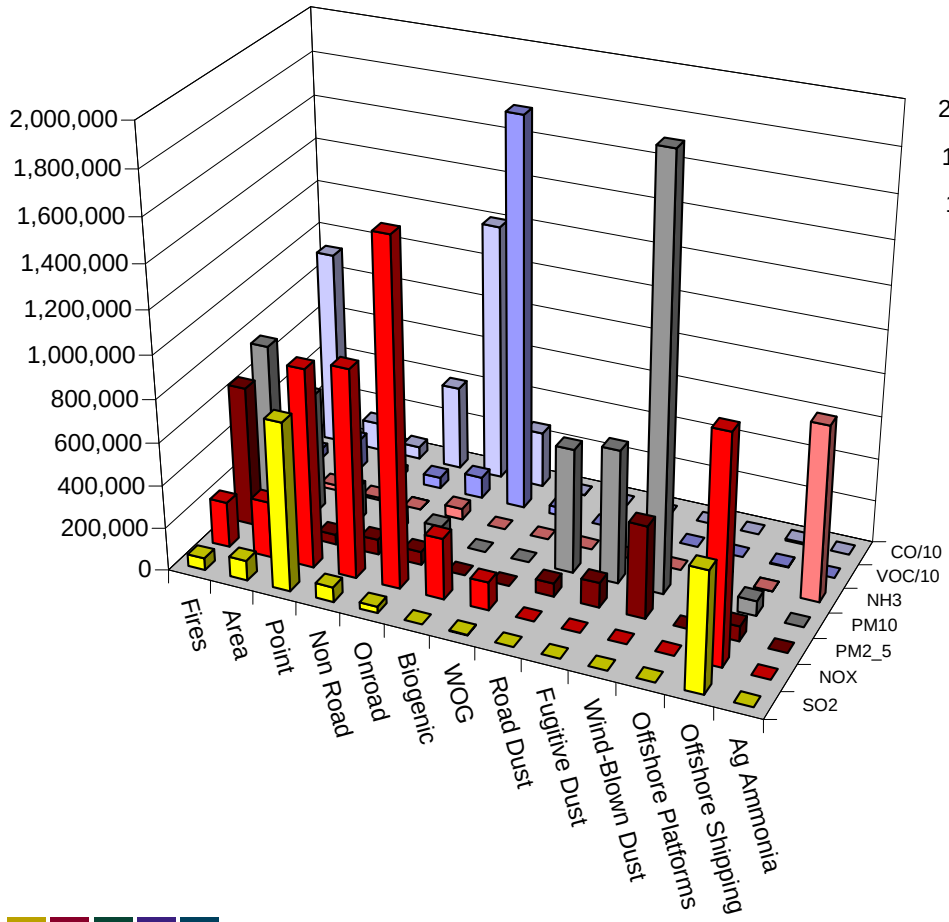
- Are the regional inventories Complete? Reasonable? Consistent?

- Summarize & Review for:
  - Completeness
  - Reasonableness
  - Representative
- Summarize by:
  - Source category
  - Region
  - Pollutant
- Comparisons across :
  - Regions
  - Source categories
  - Inventory scenarios

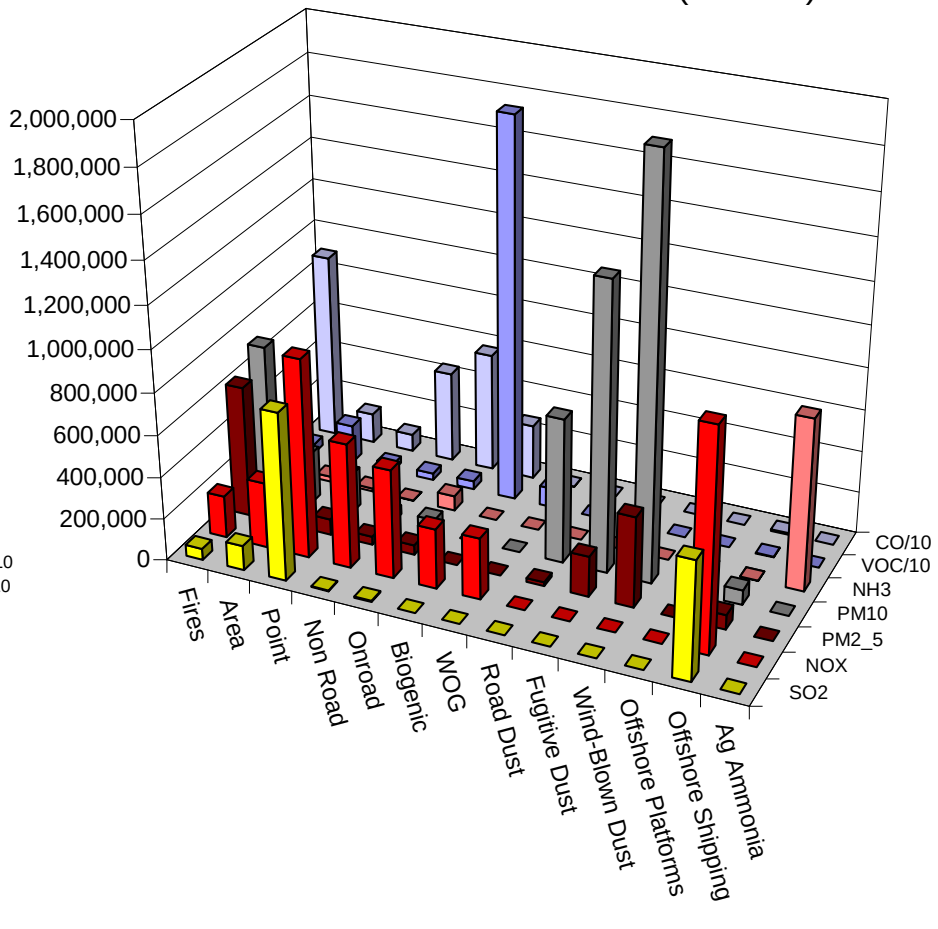
Regional Emission Inventory Summaries

WRAP States

WRAP Annual 2000-04 Baseline (Plan02)



WRAP Annual 2018 Base Case (Base18)



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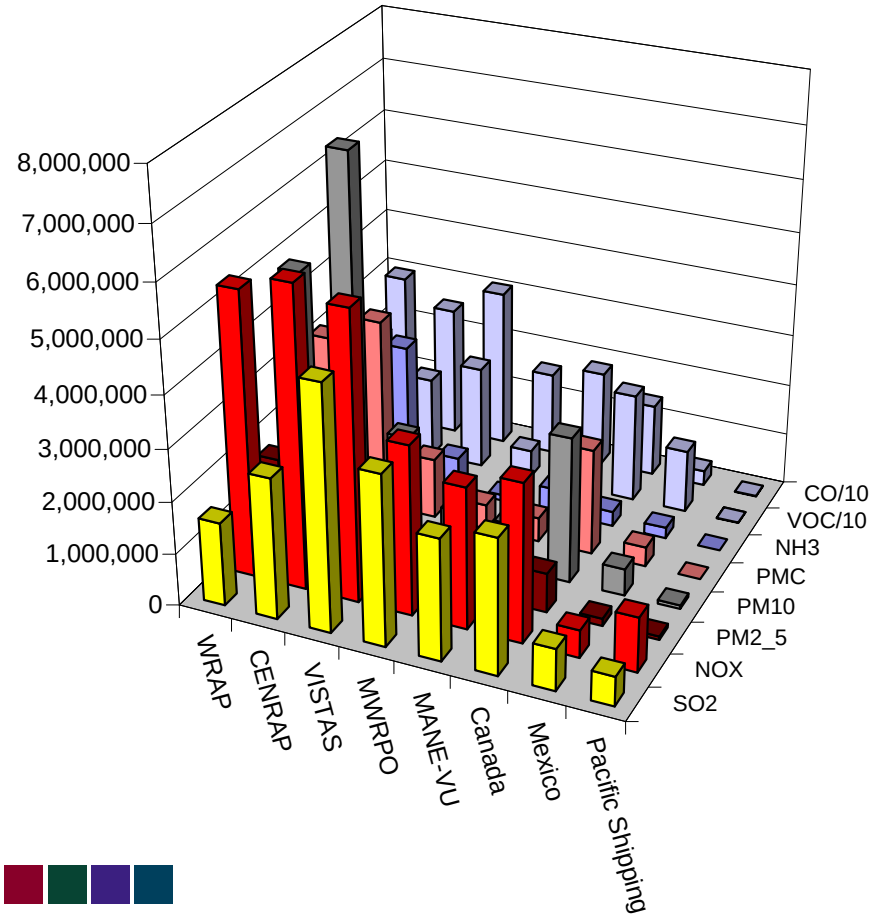
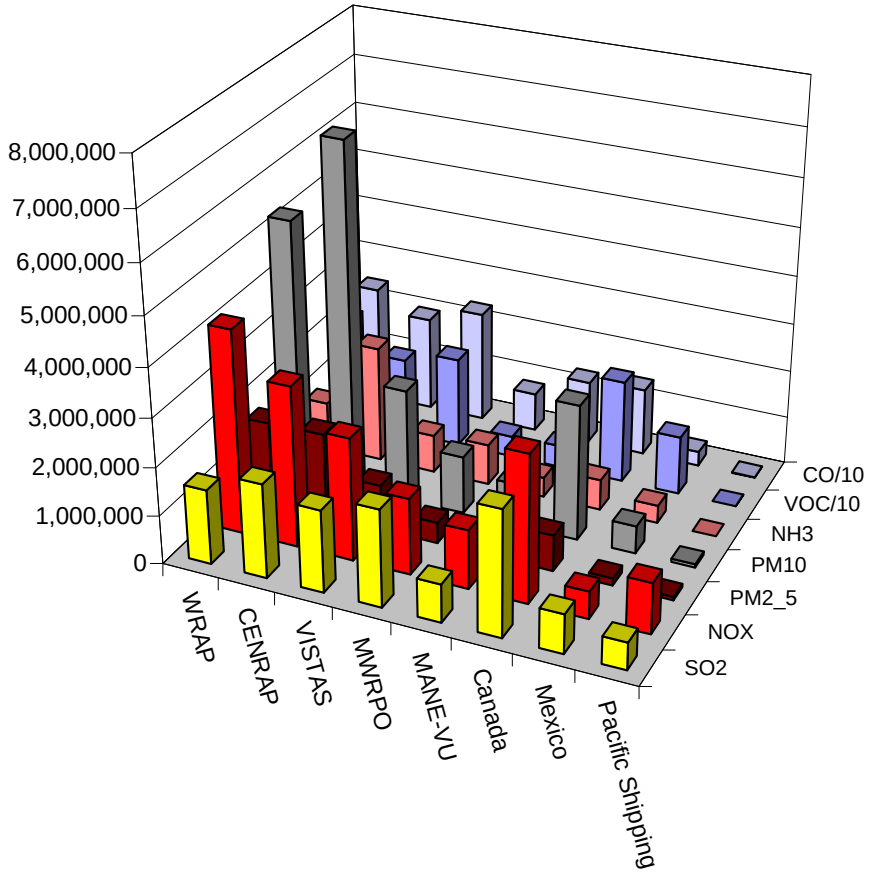
Regional Emission Inventory Summaries

Entire Modeling Domain

Annual 2000-04 Baseline (Plan02)



Annual 2018 Base Case (Base18)



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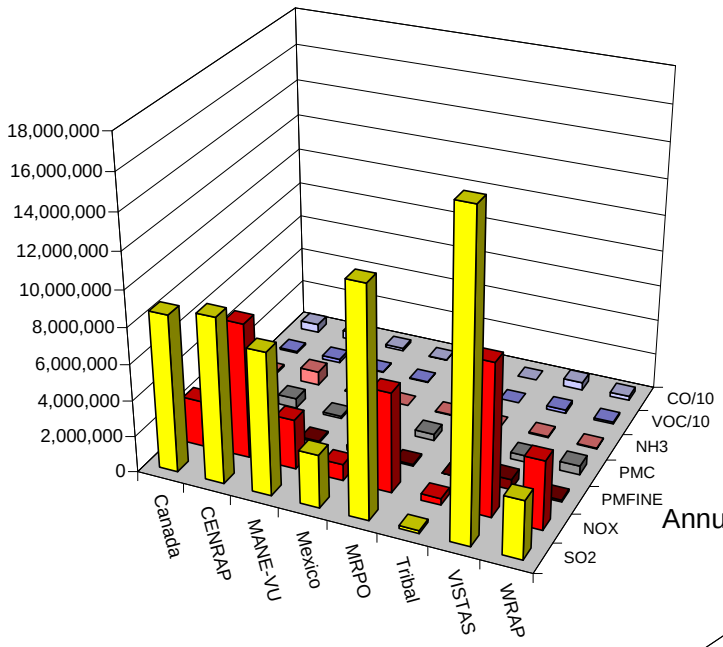
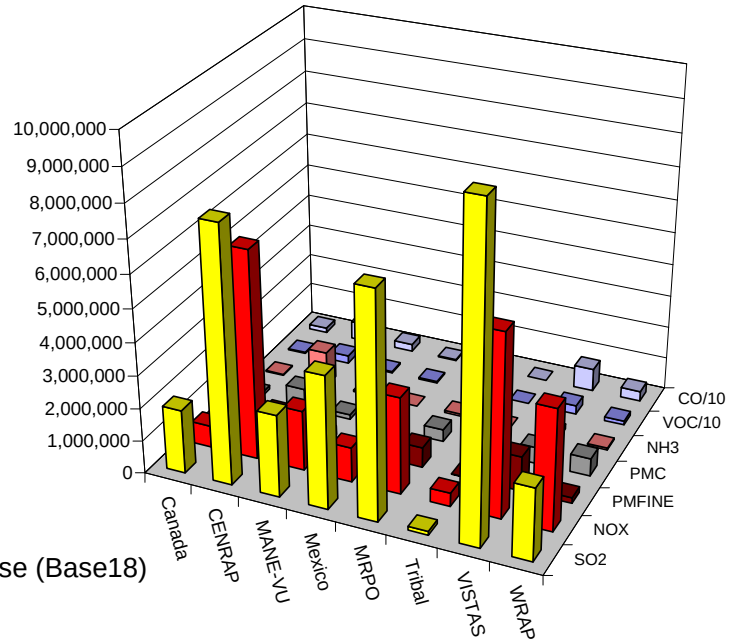
Stationary Point Sources

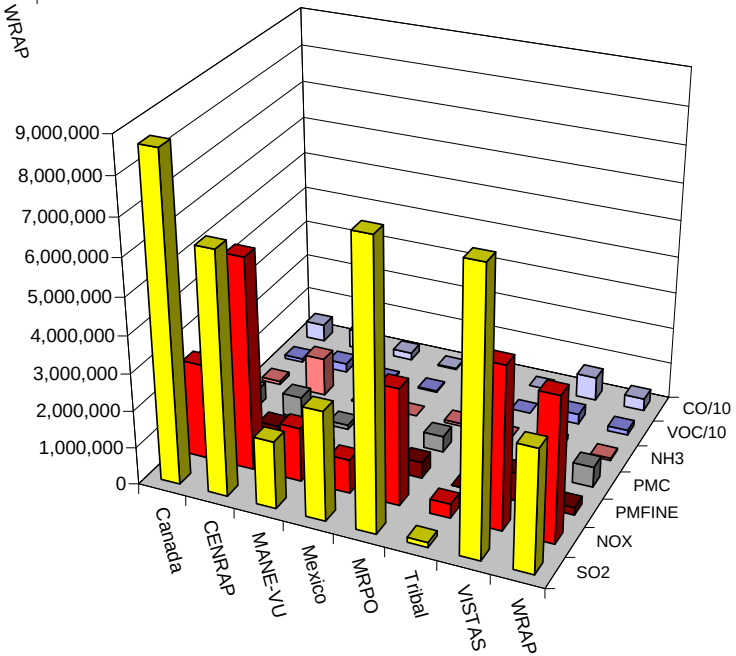
Annual 2000-04 Baseline (Plan02)



Annual 2018 Preliminary Reasonable Progress Case (PRP18)



Annual 2018 Base Case (Base18)



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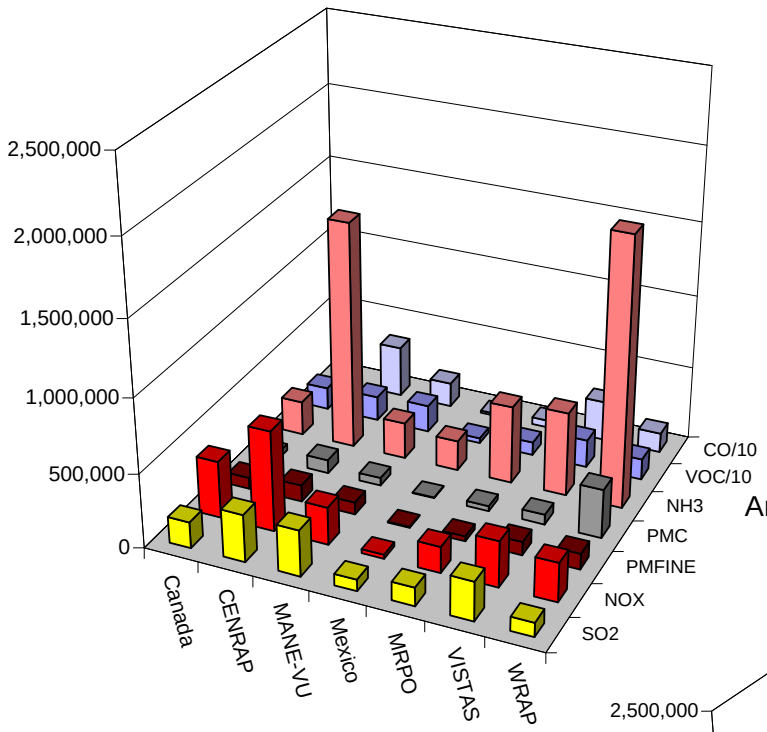
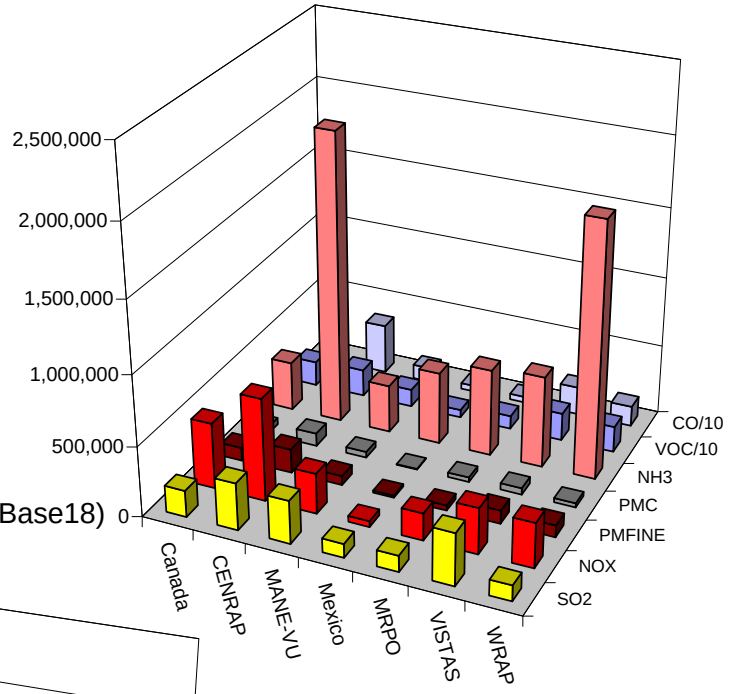
Stationary Area Sources

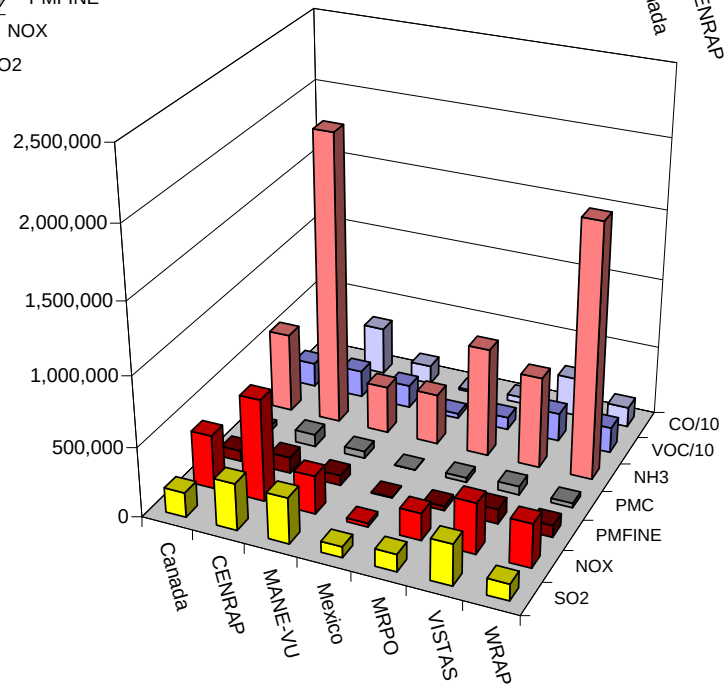
Annual 2000-04 Baseline (Plan02)



Annual 2018 Preliminary Reasonable Progress Case (PRP18)



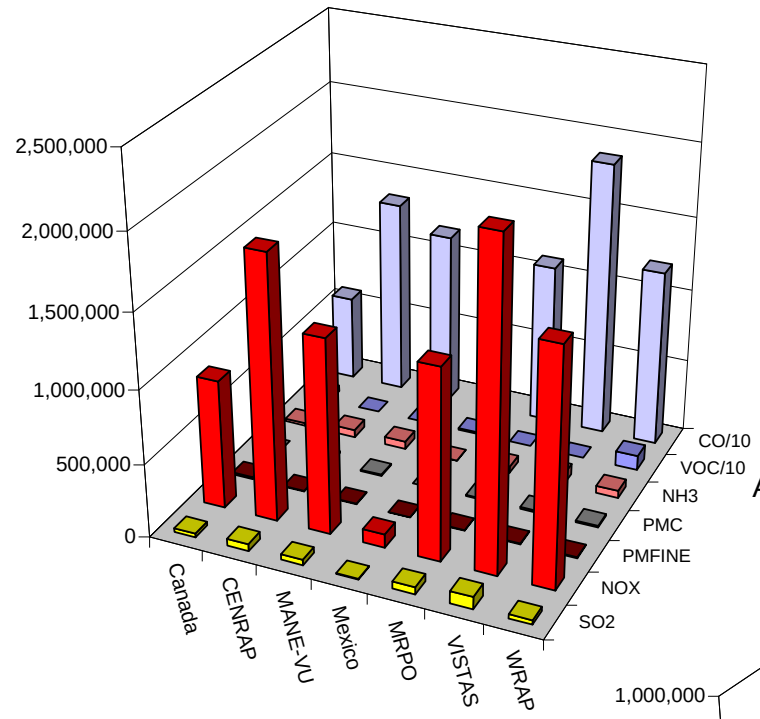
Annual 2018 Base Case (Base18)



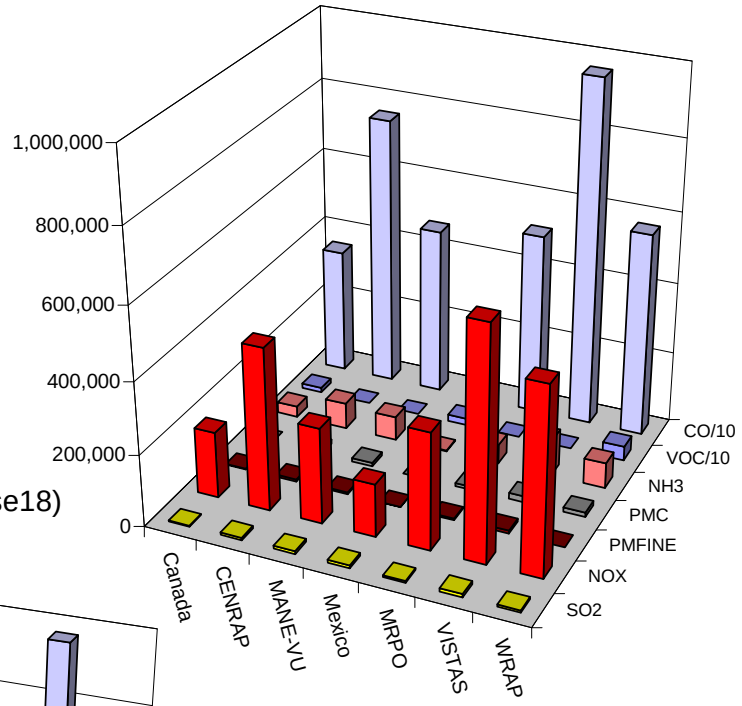
ENVIRON

On-Road Mobile Sources

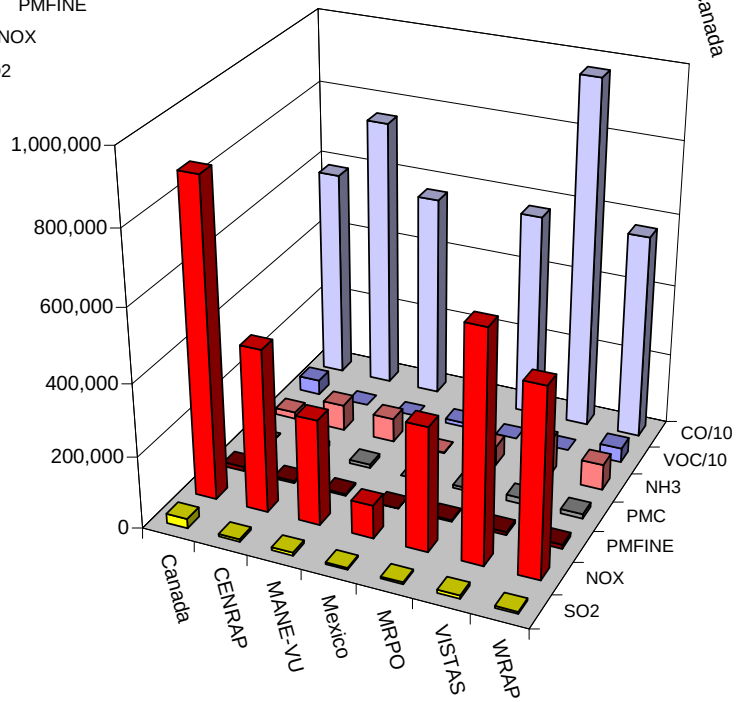
WRAP Annual 2000-04 Baseline (Plan02)



Annual 2018 Preliminary Reasonable Progress Case (PRP18)



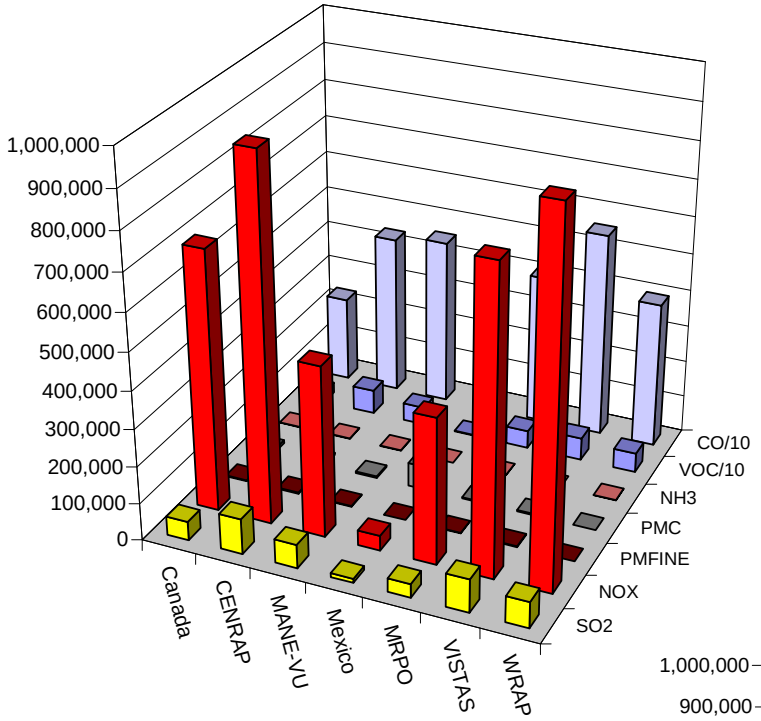
Annual 2018 Base Case (Base18)



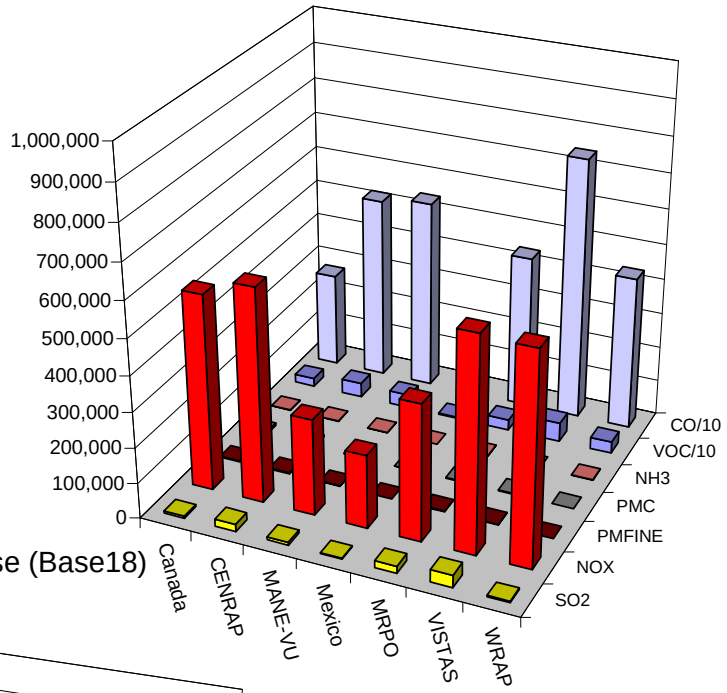
ENVIRON

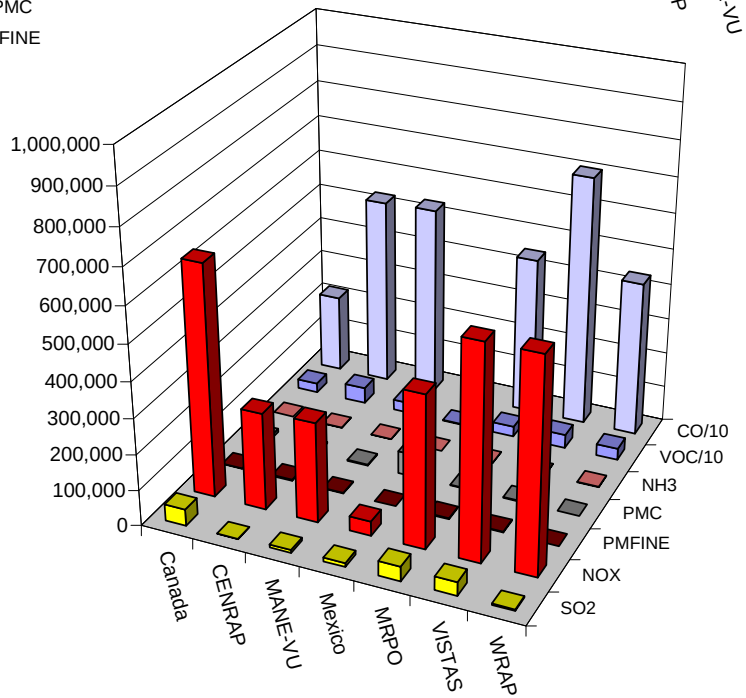
Off-Road Mobile Sources

Annual 2000-04 Baseline (Plan02)



Annual 2018 Base Case (Base18)

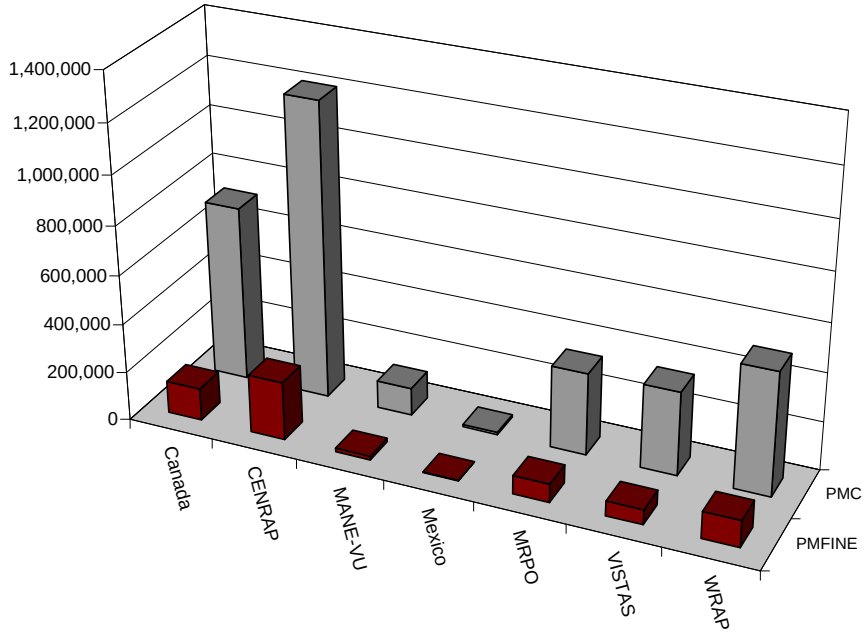




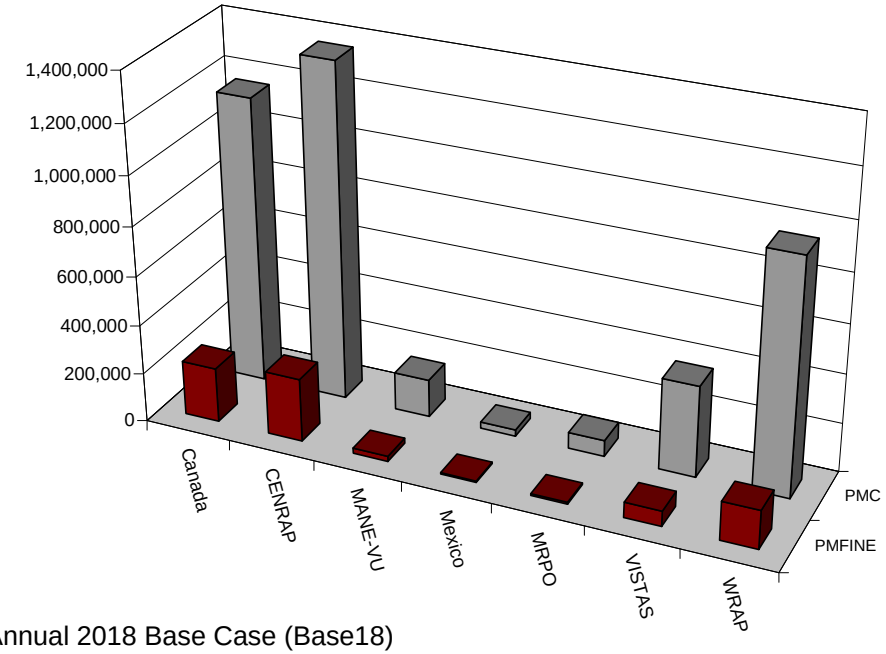
ENVIRON

Fugitive Dust

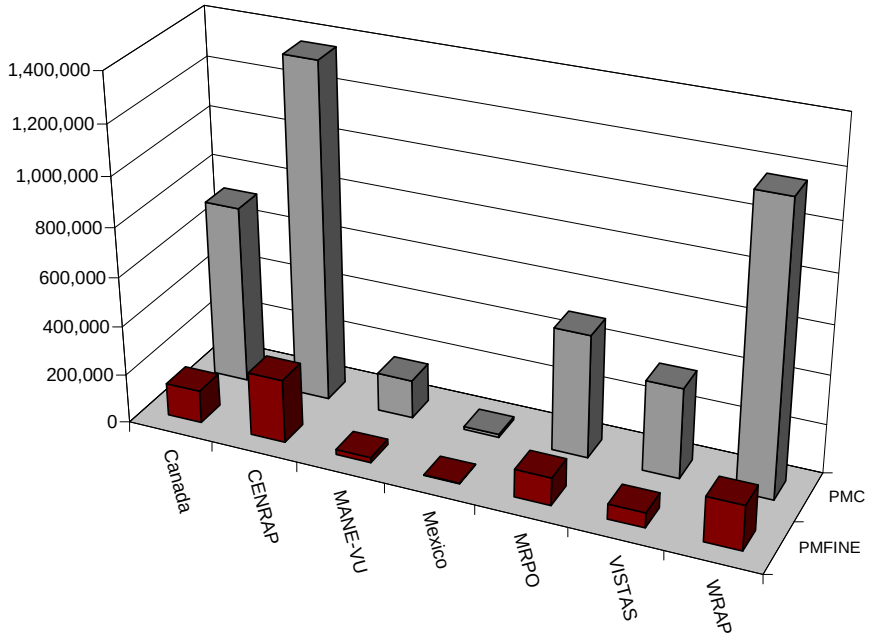
Annual 2000-04 Baseline (Plan02)



Annual 2018 Preliminary Reasonable Progress Case (PRP18)



Annual 2018 Base Case (Base18)



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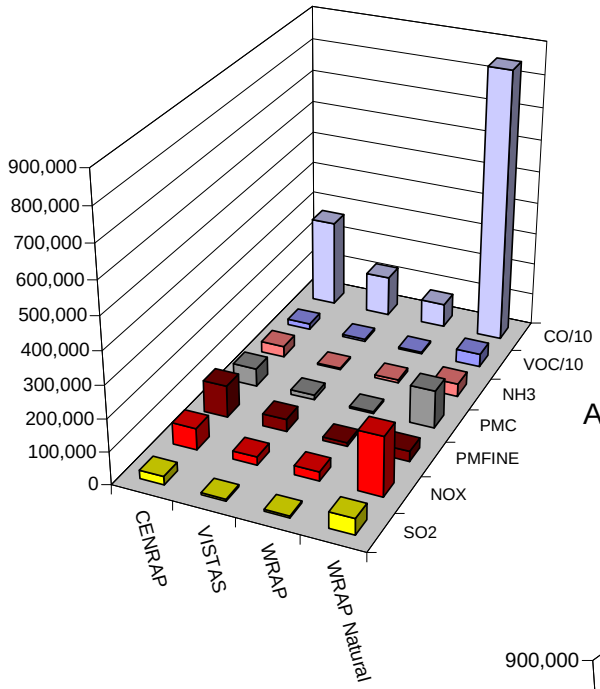
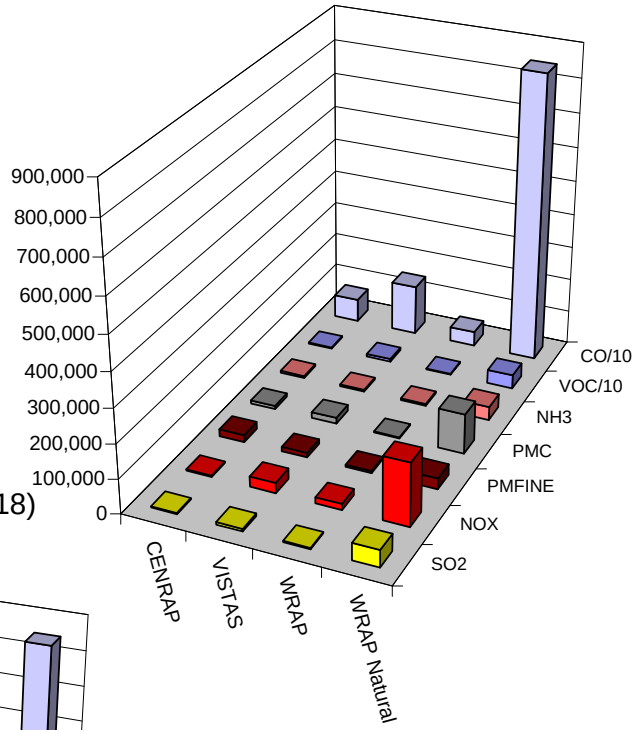
Fire Emission Sources

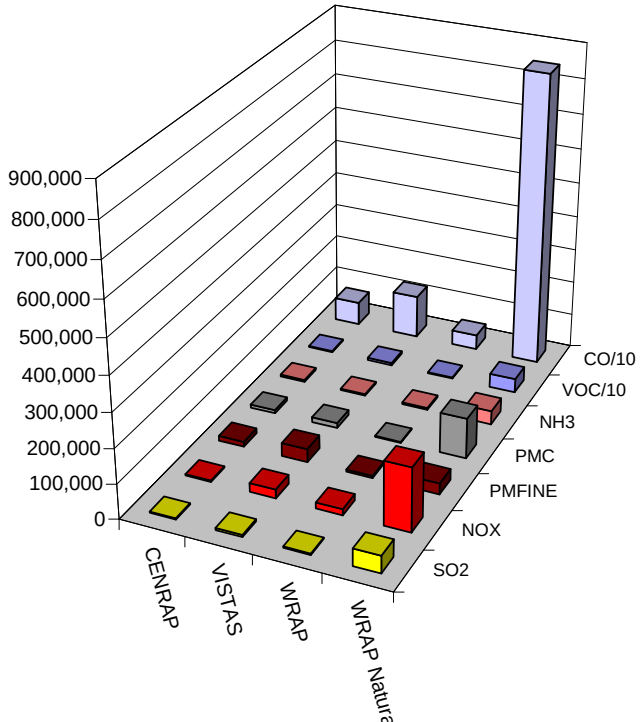
Annual 2000-04 Baseline (Plan02)



Annual 2018 Preliminary Reasonable Progress Case (PRP18)



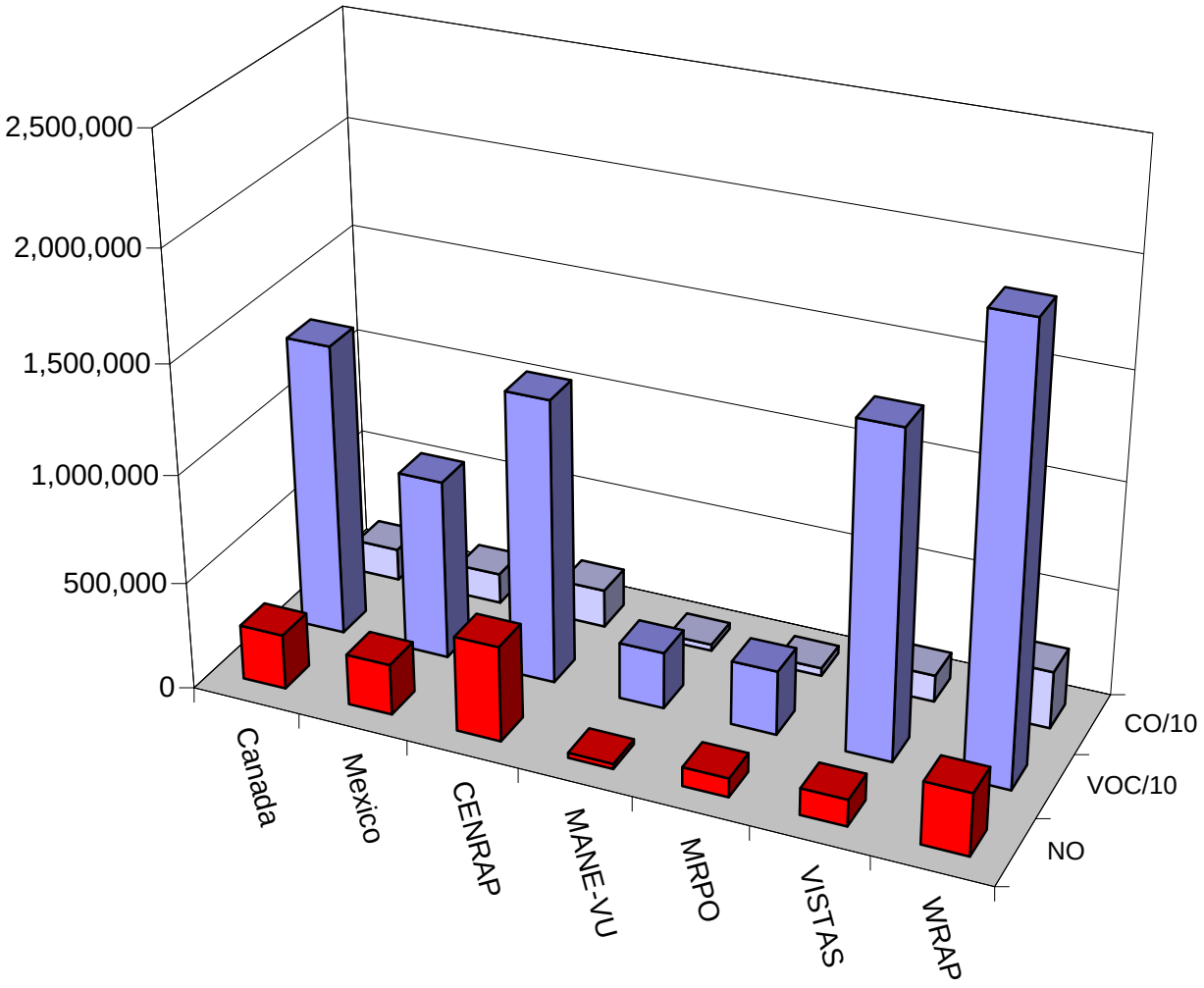
Annual 2018 Base Case (Base18)



ENVIRON

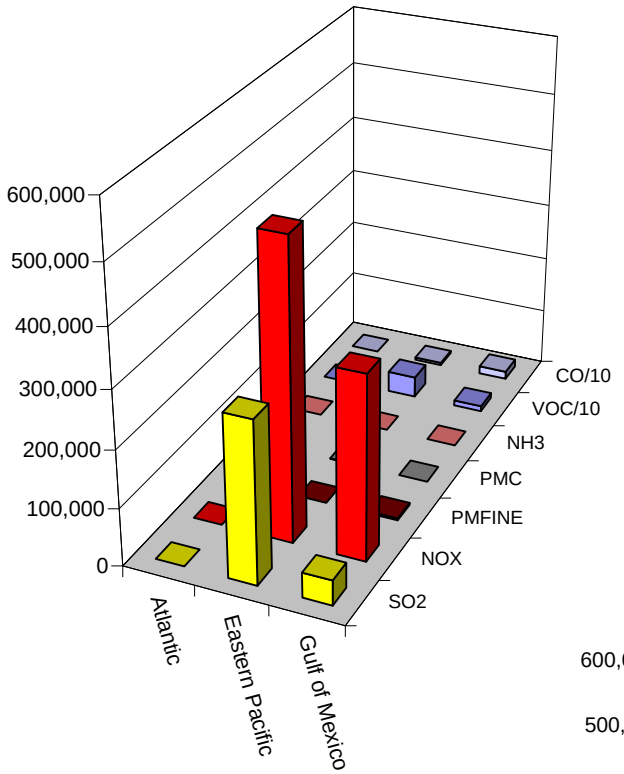
- Biogenic Sources

Annual 2000-04 Baseline (Plan02)

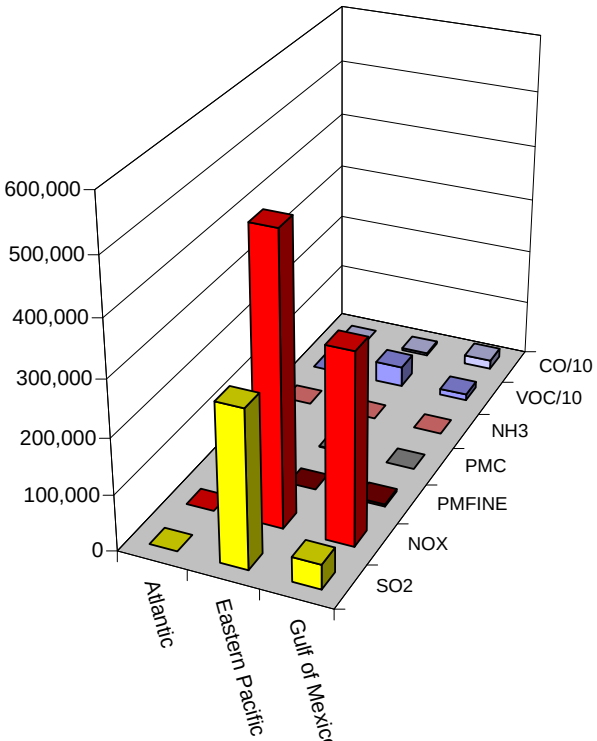


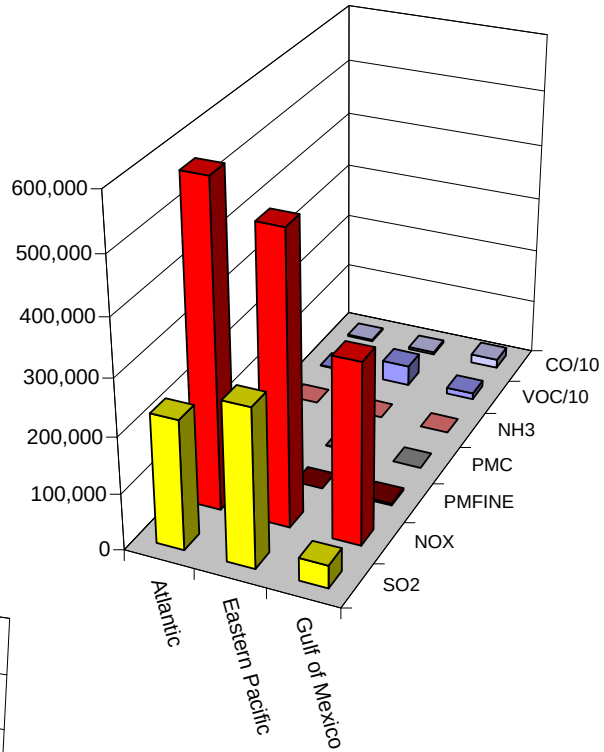
Off-shore Marine Shipping Sources

Annual 2000-04 Baseline (Plan02)



Annual 2018 Base Case (Base18)





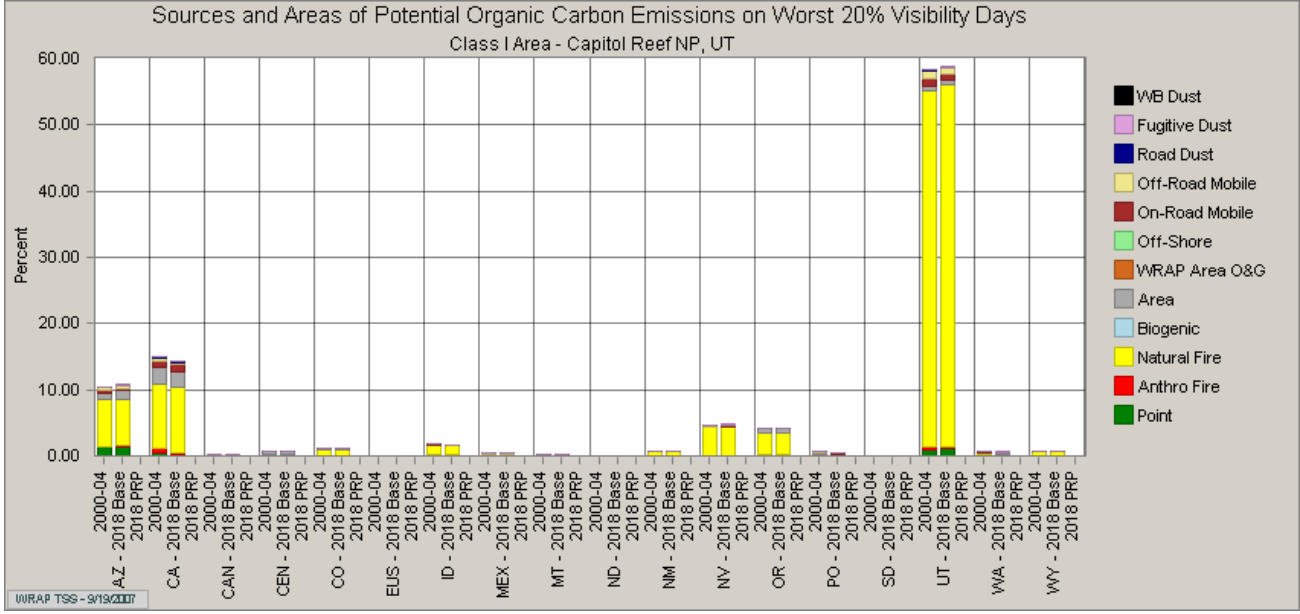
ENVIRON

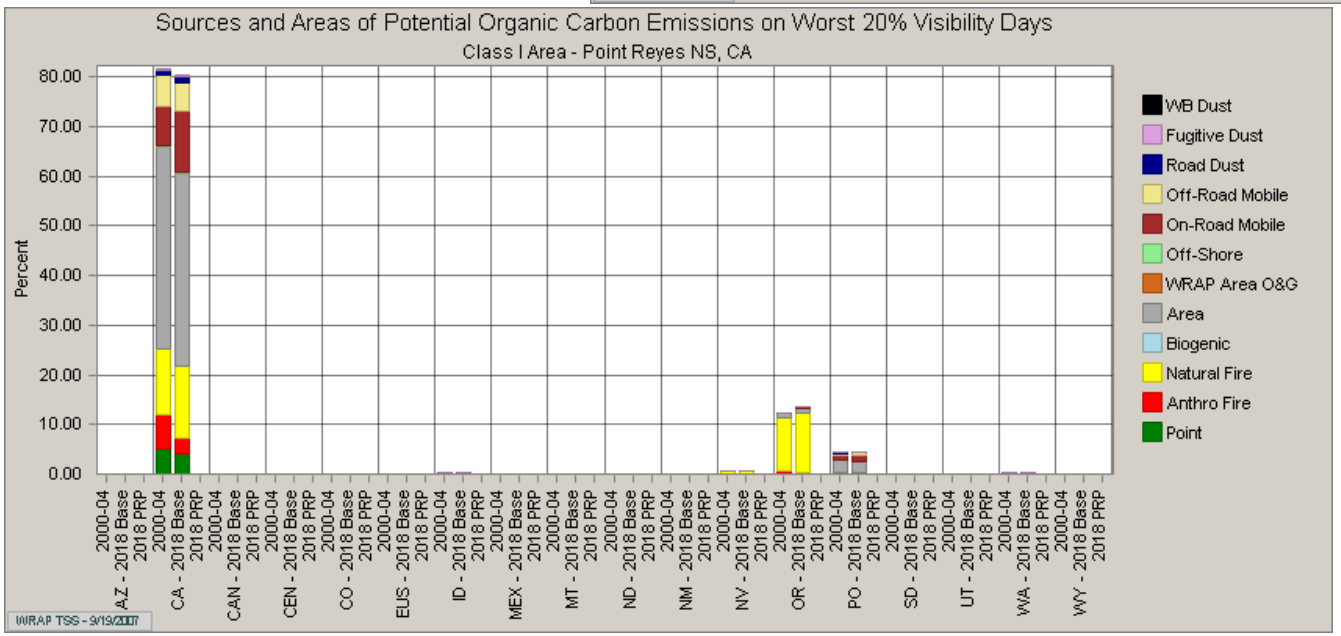
Are International/Other RPO EIs Relevant to WRAP ??

- WRAP is only part of the modeling domain
- Must consider WRAP's impact on Class I Areas outside WRAP States
- Emissions from outside WRAP can impact visibility at WRAP Class I Areas
- Depends on location/magnitude
- Need complete accurate databases, including emission inventories, to support defensible Regional Haze modeling efforts

- How can we determine relevance??

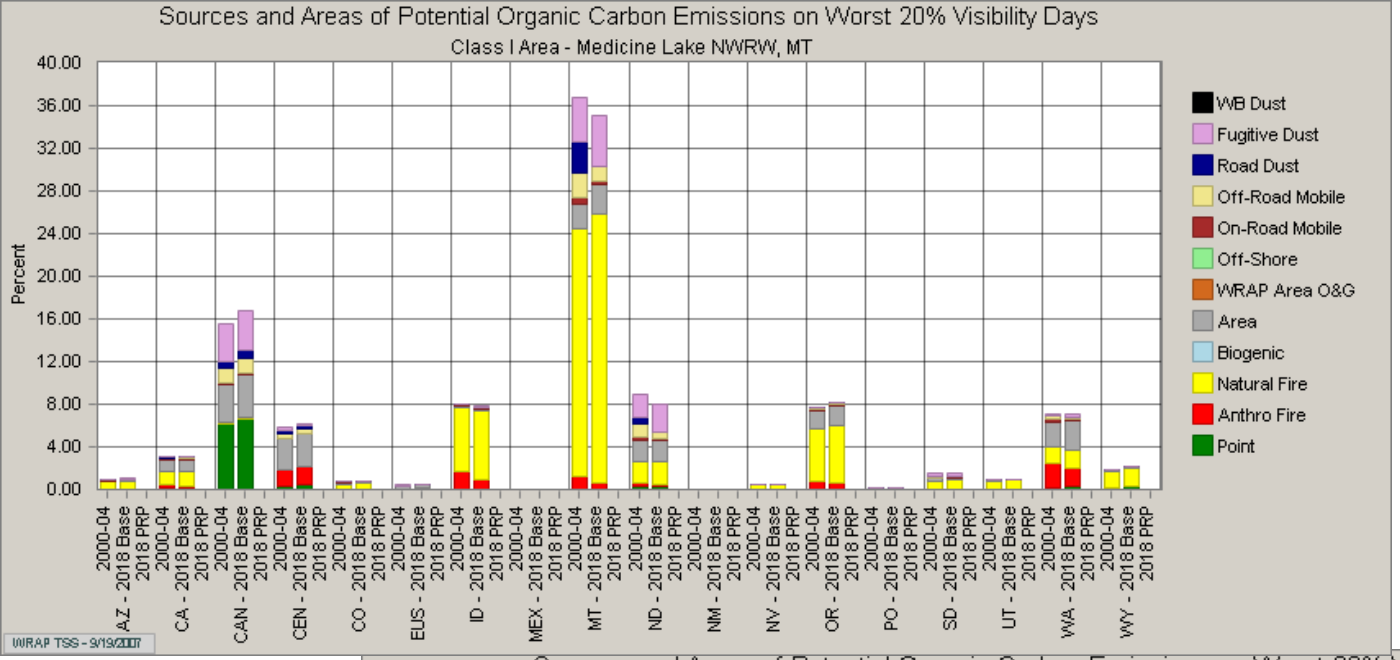
Consider PSAT and/or WEP Analyses to determine relevance & sources of visibility degradation**

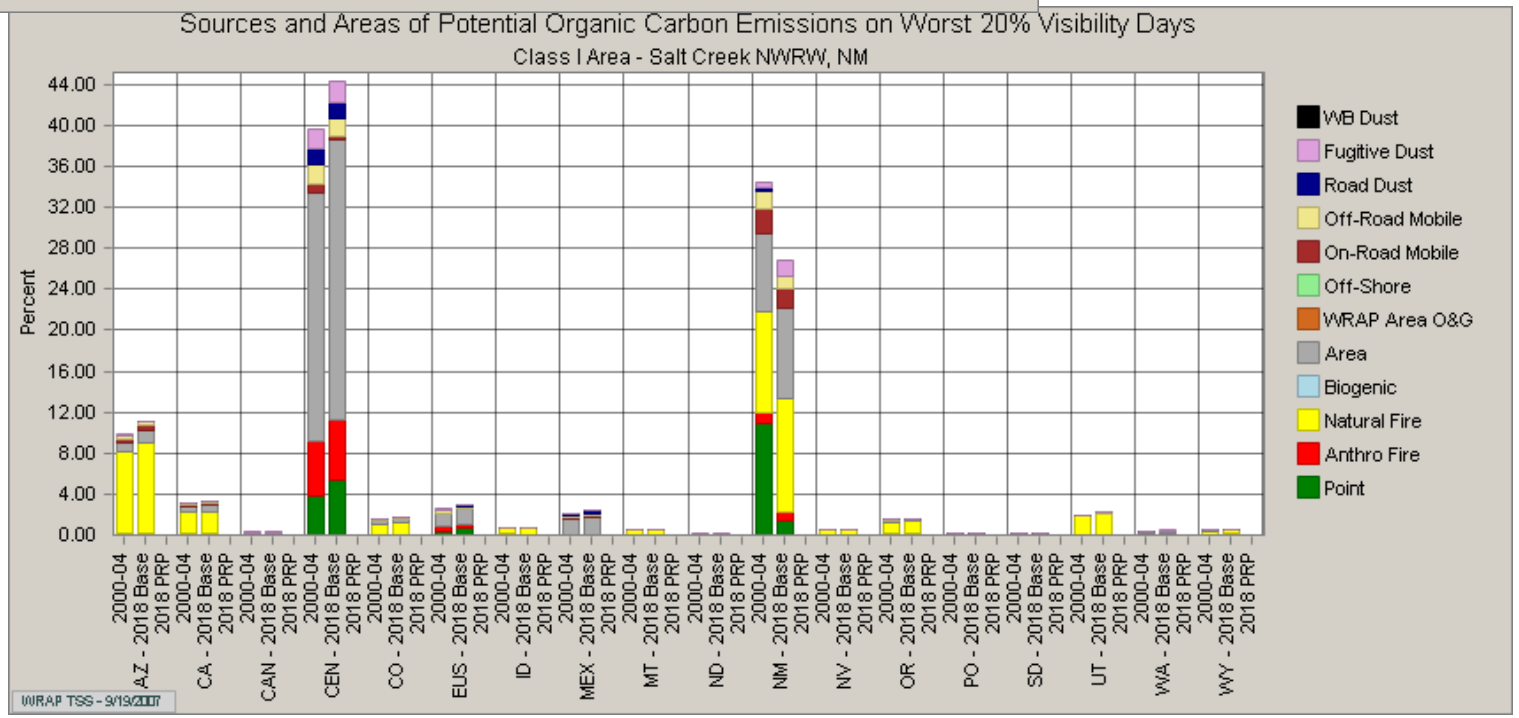




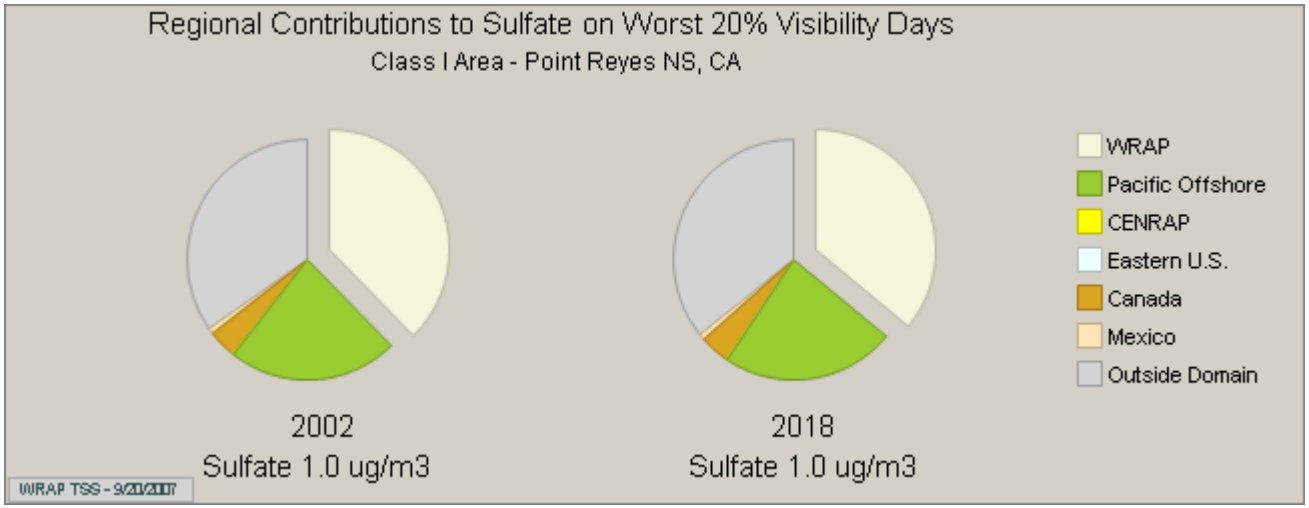
**Assumes the EI is "complete" and "reasonable"

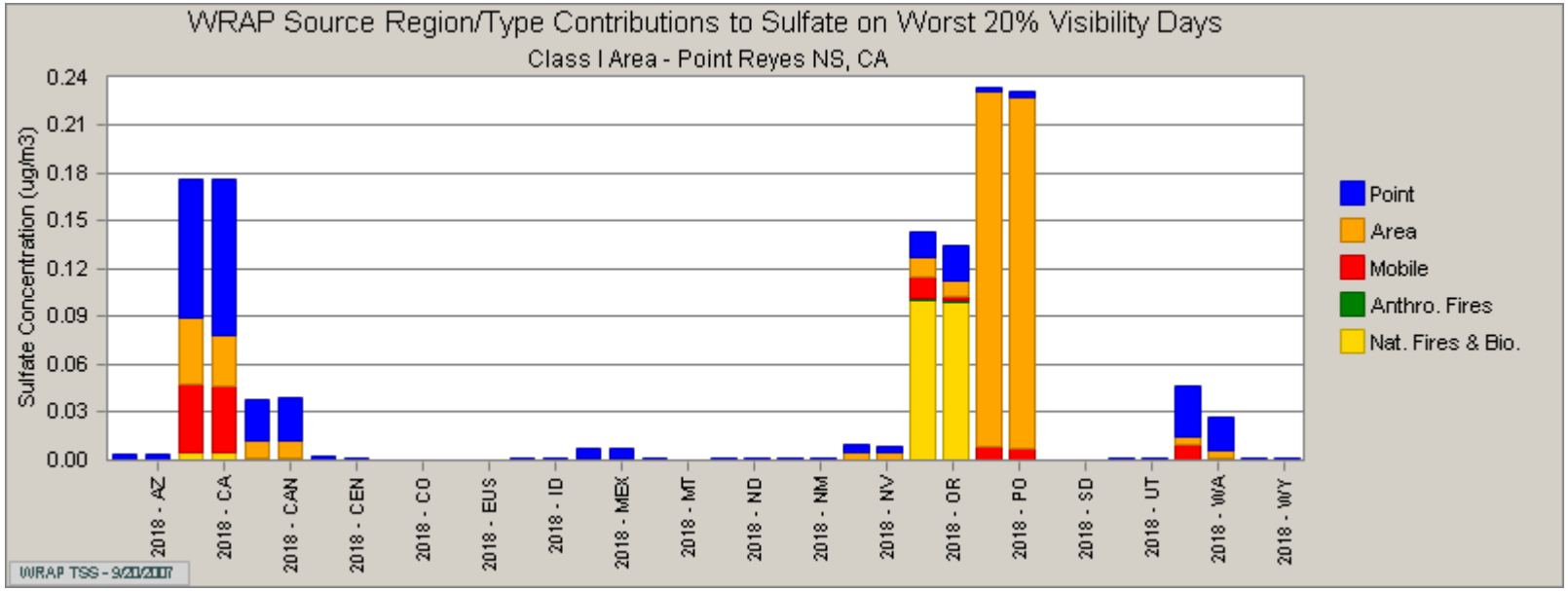
ENVIRON


Sources and Areas of Potential Organic Carbon Emissions on Worst 20% Visibility Days
Class I Area - Medicine Lake NWRW, MT
Percent
40.00
36.00
32.00
28.00
24.00
20.00
16.00
12.00
8.00
4.00
0.00
2000-04
2018 Base
2018 PRP
AZ - CA - CAN - CEN - CO - EUS - ID - MEX - MT - ND - NM - NV - OR - PO - SD - UT - WA - WY -
WB Dust
Fugitive Dust
Road Dust
Off-Road Mobile
On-Road Mobile
Off-Shore
WRAP Area O&G
Area
Biogenic
Natural Fire
Anthro Fire
Point
WRAP TSS - 9/19/2007


Sources and Areas of Potential Organic Carbon Emissions on Worst 20% Visibility Days
Class I Area - Salt Creek NWRW, NM
Percent
44.00
40.00
36.00
32.00
28.00
24.00
20.00
16.00
12.00
8.00
4.00
0.00
2000-04
2018 Base
2018 PRP
AZ - CA - CAN - CEN - CO - EUS - ID - MEX - MT - ND - NM - NV - OR - PO - SD - UT - WA - WY -
WB Dust
Fugitive Dust
Road Dust
Off-Road Mobile
On-Road Mobile
Off-Shore
WRAP Area O&G
Area
Biogenic
Natural Fire
Anthro Fire
Point
WRAP TSS - 9/19/2007

ENVIRON


Regional Contributions to Sulfate on Worst 20% Visibility Days
Class I Area - Point Reyes NS, CA
WRAP
Pacific Offshore
CENRAP
Eastern U.S.
Canada
Mexico
Outside Domain
2002
Sulfate 1.0 ug/m3
2018
Sulfate 1.0 ug/m3
WRAP TSS - 9/21/2007


WRAP Source Region/Type Contributions to Sulfate on Worst 20% Visibility Days
Class I Area - Point Reyes NS, CA
Sulfate Concentration (ug/m3)
0.24
0.21
0.18
0.15
0.12
0.09
0.06
0.03
0.00
2018 - AZ
2018 - CA
2018 - CAN
2018 - CEN
2018 - CO
2018 - EUS
2018 - ID
2018 - MEX
2018 - MT
2018 - ND
2018 - NM
2018 - NV
2018 - OR
2018 - PO
2018 - SD
2018 - UT
2018 - WA
2018 - WY
Point
Area
Mobile
Anthro. Fires
Nat. Fires & Bio.
WRAP TSS - 9/21/2007

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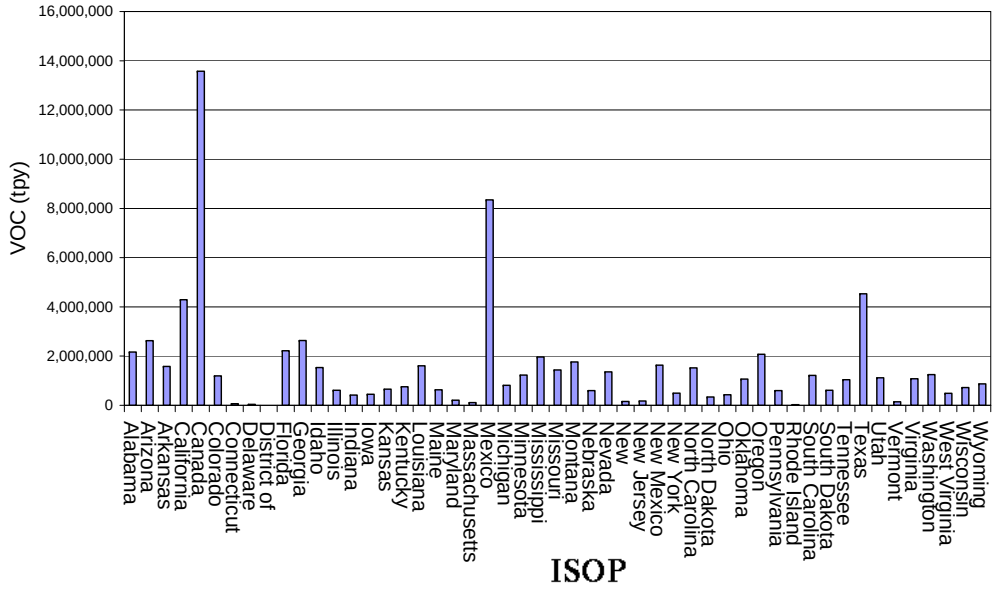
Regional Emissions Models

- SMOKE BEIS
  - BEIS3 implemented within SMOKE
  - Based on land use characterization (BELD3)
    - Tree species (FIA);
    - Agricultural crop distributions by county (USDA; NASS)
    - Other landcover types – grasslands, shrublands, urban land, barren land, etc. (USGS)
  - CMAQ model-ready gridded data generated by SMOKE
  - Pollutants include:
    - VOC
    - NO
    - CO

SMOKE BEIS

Annual 2002 Biogenic VOC Emissions (tpy)



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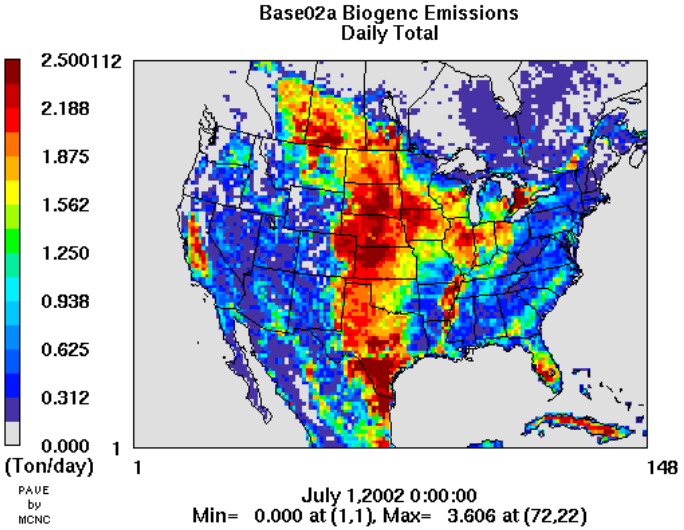
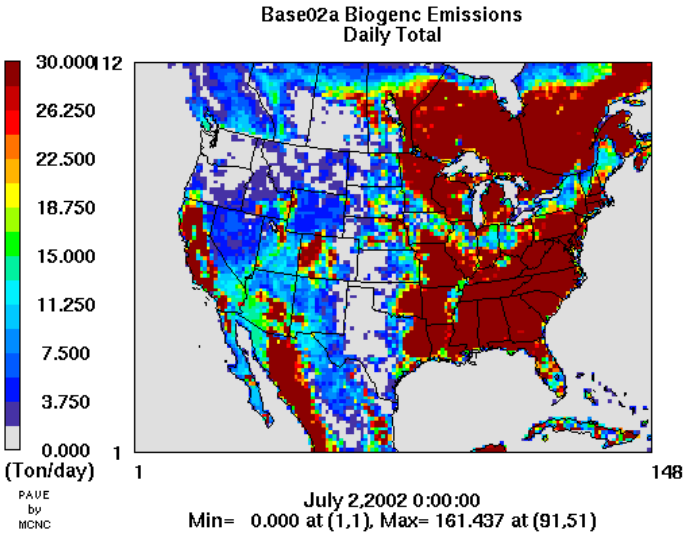
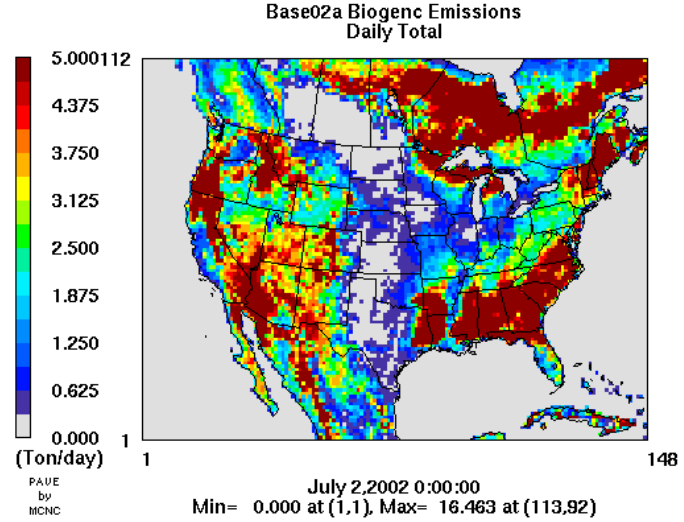


ISOP



TERPB



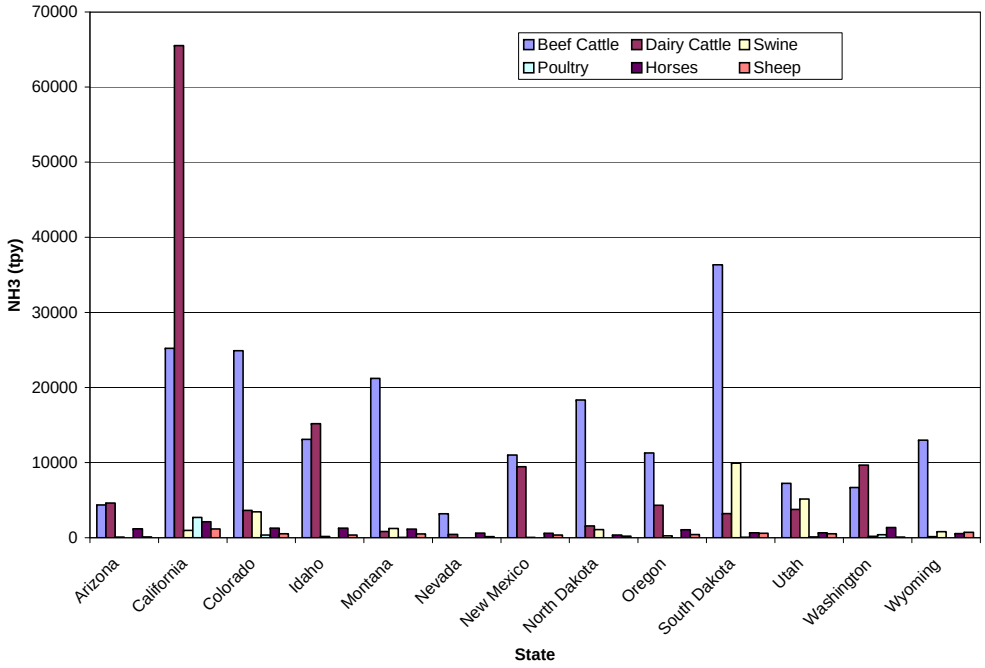
ENVIRON

Regional Emissions Models

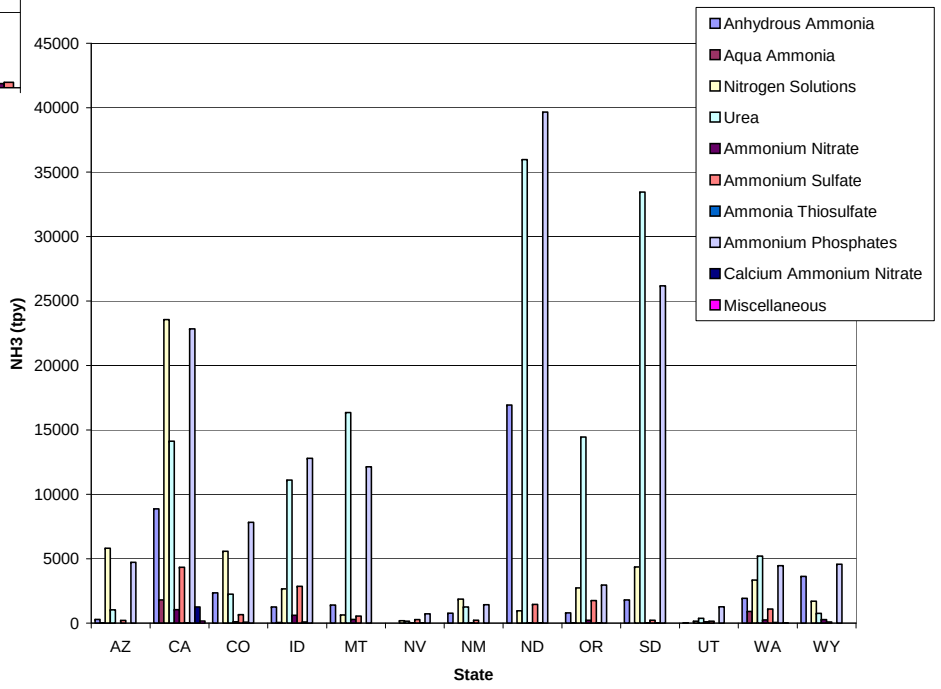
- WRAP RMC GIS NH3 Model
  - Developed as GIS-based modeling system
  - Incorporates environmental parameters – soil pH, met data (winds, temperatures)
  - Source categories include:
    - Livestock
    - Fertilizers
    - Native Soils
    - Domestic Sources
    - Wild Animals
  - Based on 2002 activity data (no future year projections)
    - Monthly activity data for fertilizers; annual for livestock, domestic, wild animals
    - Activity data for soil emissions based on LULC (2000 NALC)
  - No Mexico or Canada
  - Model estimates hourly emissions based on temporal variations of met data
  - Only WRAP states used for regional modeling
  - Other RPO's estimated separately – varies by RPO

WRAP RMC GIS NH3 Model

2002 Annual Livestock NH3 Emissions

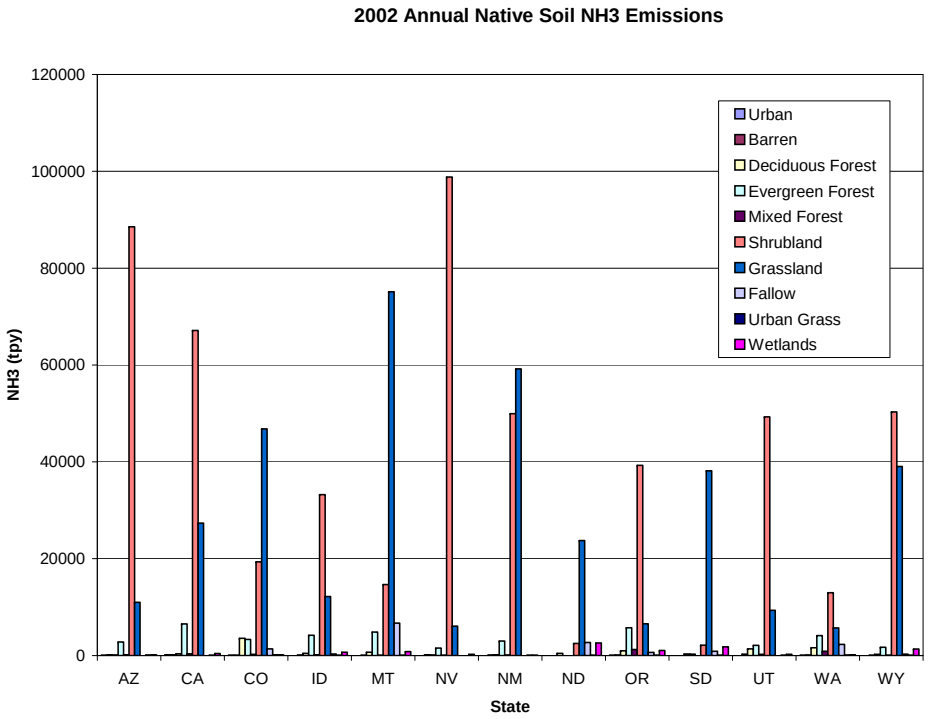


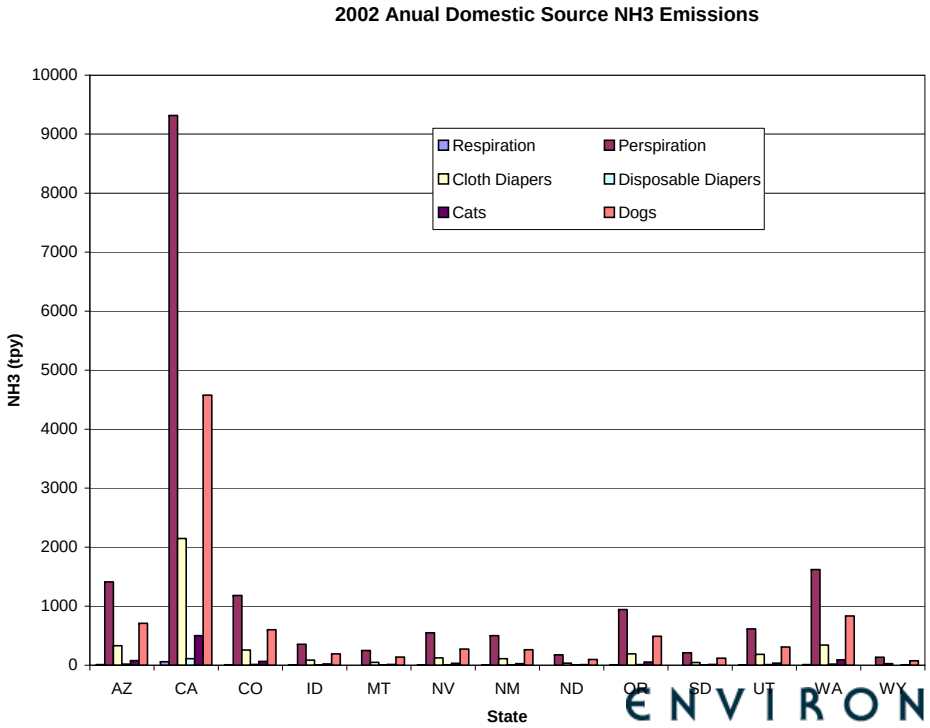
2002 Annual Fertilizer NH3 Emissions



ENVIRON

WRAP RMC GIS NH3 Model

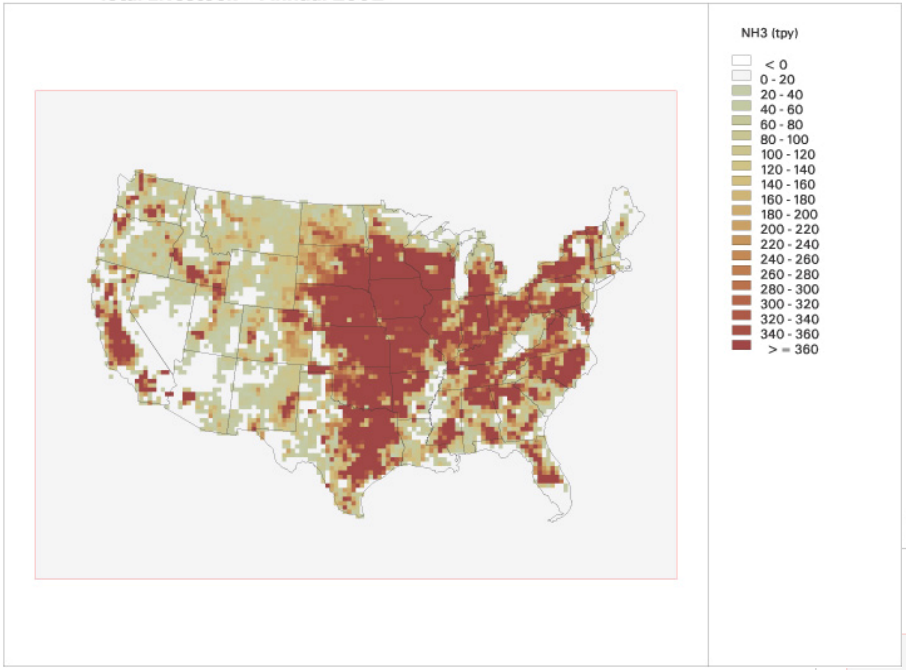




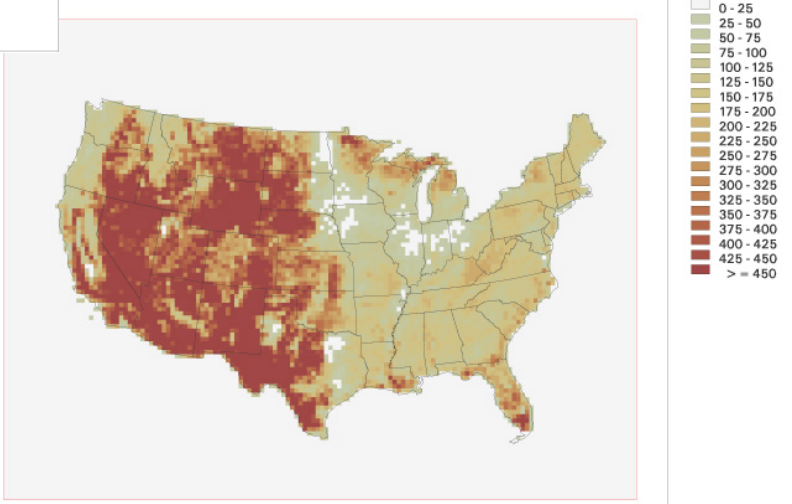
ENVIRON

WRAP RMC GIS NH3 Model

Gridded NH3 Emissions
Total Livestock - Annual 2002



Gridded NH3 Emissions
Total Native Soils - Annual 2002

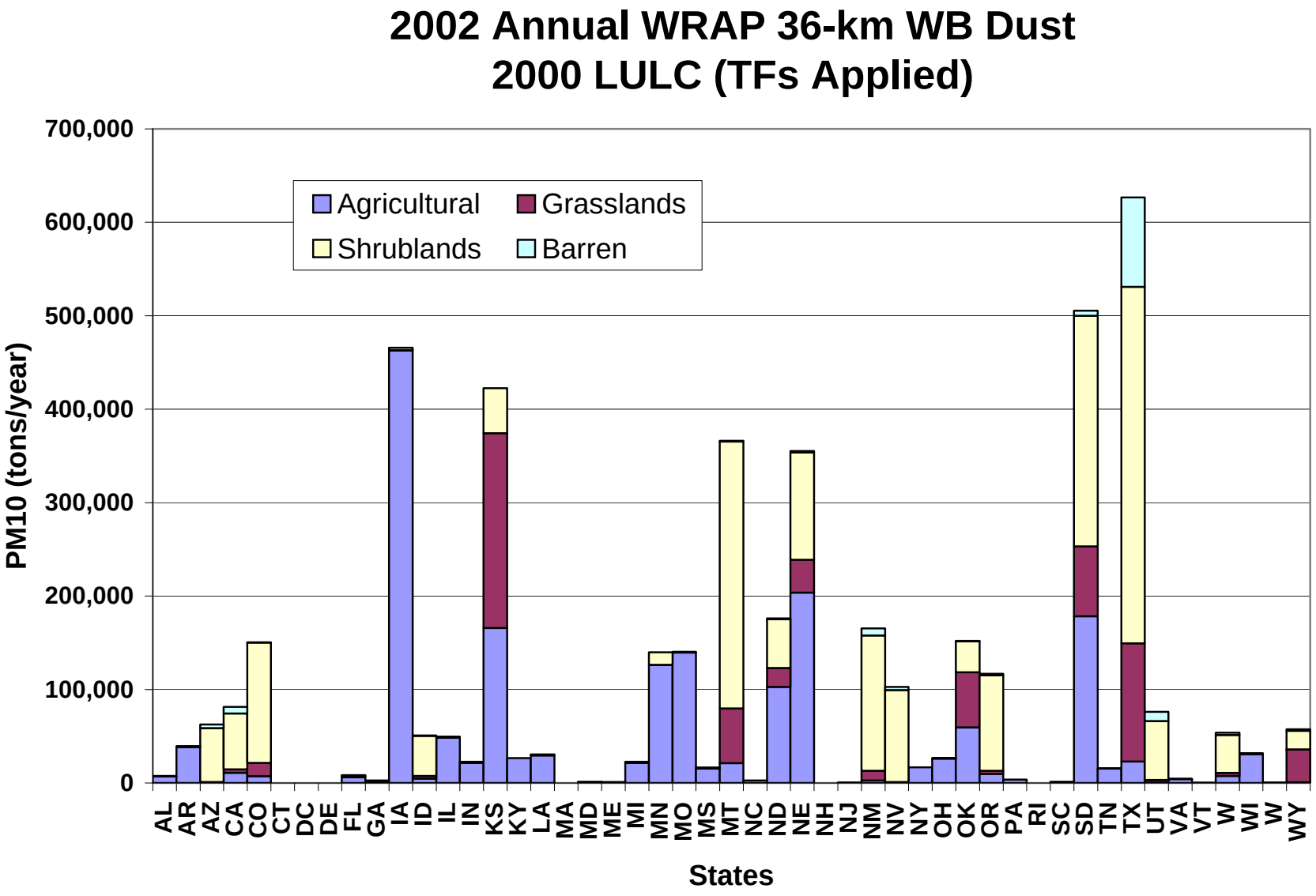


ENVIRON

Regional Emissions Models

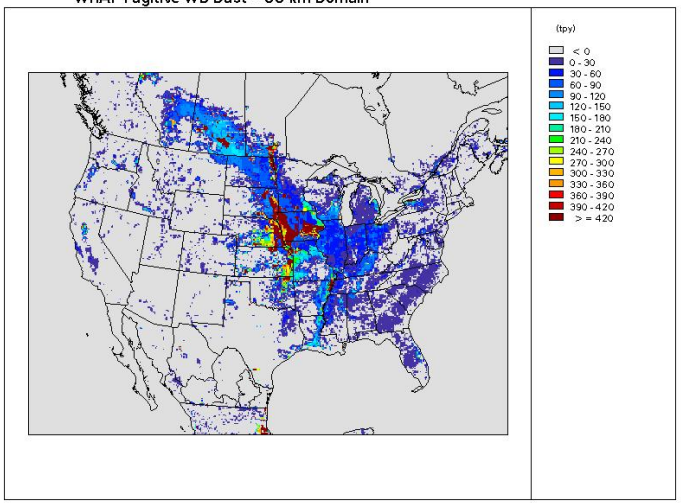
- WRAP RMC WB Dust Model
  - Developed in Phases, based on recent literature reviews, results of fields studies, erosion models
  - Estimated WB Fugitive Dust emissions from Barren, Shrub, Grass, and Ag lands (No forest or Urban lands)
  - Applied Domain-wide
  - Highly dependent on accurate, detailed LULC & Soil characteristics, and wind fields
  - Many assumption & limitations
  - More detailed agricultural data incorporated for Western US
    - These data lacking for Mexico & Canada; less detailed for Eastern US
  - Held constant for all emission scenarios

WRAP RMC WB Dust Model

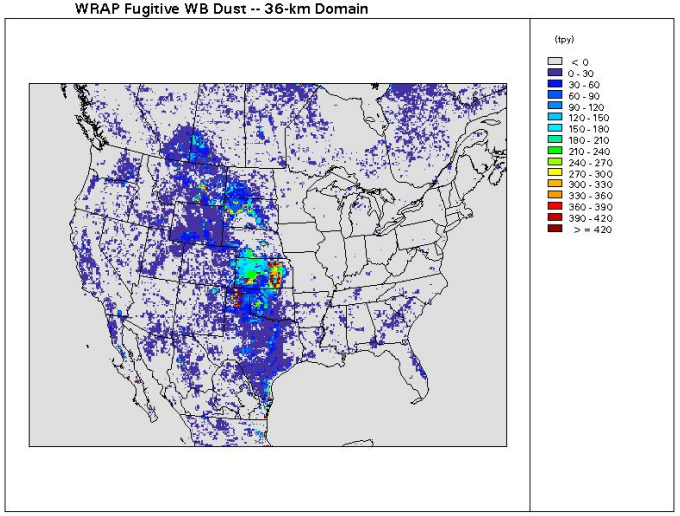


WRAP RMC WB Dust Model

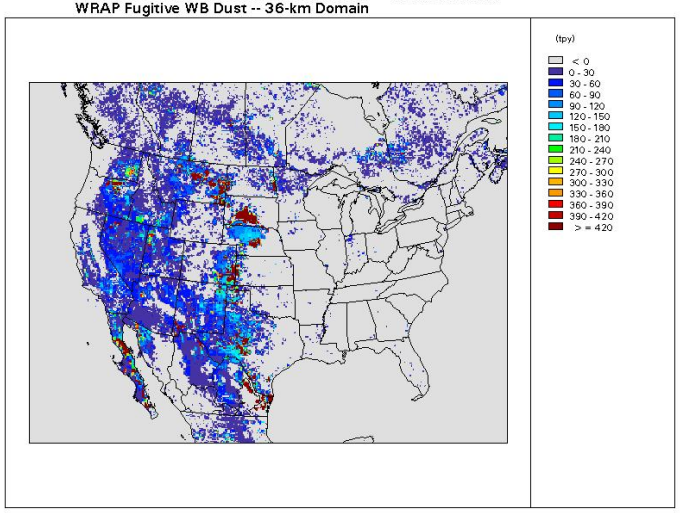
2002 Annual PM10 Emissions - Agricultural
WRAP Fugitive WB Dust -- 36-km Domain



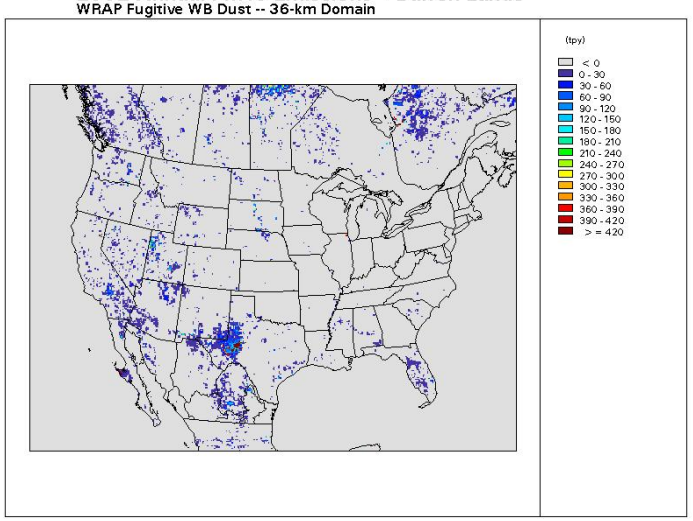
2002 Annual PM10 Emissions - Grasslands
WRAP Fugitive WB Dust -- 36-km Domain



2002 Annual PM10 Emissions - Shrublands
WRAP Fugitive WB Dust -- 36-km Domain



2002 Annual PM10 Emissions - Barren Lands
WRAP Fugitive WB Dust -- 36-km Domain



ENVIRON

Regional Boundary Conditions

- Regional Boundary Conditions (BCs) based on 2002 GEOS-CHEM simulations
- GEOS-CHEM
  - 3-D global circulation/chemistry model
  - Driven by assimilated met observations from the Goddard Earth Observing System (GEOS) of NASA
  - Has been used by numerous researchers for a range of atmospheric composition problems, including future climates and planetary atmospheres
  - Managed & supported by Atmospheric Chemistry Modeling Group at Harvard University
- Joint RPO study coordinated by VISTAS conducted 2002 GEOS-CHEM simulation
  - 6-hourly observed met data; 3-hourly surface obs
  - 1deg x 1deg, 55 layers through Aug . 2002; 1deg X 1.25deg, 48 layers after Aug 2002
  - GEOS-CHEM chemical species mapped to CB-IV species by Univ. Houston
  - Reformatted as day-specific. 3-hourly BCs for CMAQ simulations

Eastern Pacific Marine Shipping

- Emission inventory scope:
  - Pollutants: NOx, SO2, VOC, CO, PM10
  - OGV in OR, and WA; OGV and smaller vessels in CA.
  - Offshore transit emissions
  - Temporal resolution: 2002 base year, 2008/2013/2018 future years, annual. But for 2018 modeling to date, emissions were held at 2002 levels
- Vessel Types:

Source Definition	Purpose	Engine Application	EPA Engine Category Type
Deep draft	Ocean-going large vessels	Propulsion	3
		Auxiliary	2
Tow or Push Boats	Barge Freight	Propulsion	1 or 2
		Auxiliary	1
Tugs	Vessel assist and support functions	All engines	1 or 2
Ferries	Passenger and car ferries	All engines	1 or 2
Other Vessels	Support vessels or excursion boats	All engines	1 or 2
Dredges	Dredging projects	All engines	1 or 2
Commercial Fishing	Market fishing	All engines	1
Military	Coast Guard and Navy	All engines	Gas Turbine, 1, or 2

Eastern Pacific Marine Shipping

- Technical Approach
  - Large ocean-going vessel (OGV) near port and within shore
    - Ship calls and vessel power
    - Activity per call
  - OGV offshore
    - From work of James Corbett, Univ. of Delaware
    - Uses ship positioning data (a subset of all vessels from a global database)
    - Scaled to all vessels
    - Biased low near shore, so near port grid cells replaced with near port emissions estimates
  - California provided OGV and some smaller vessel emissions, including transit emissions within 100 miles of coast

Eastern Pacific Marine Shipping

Results

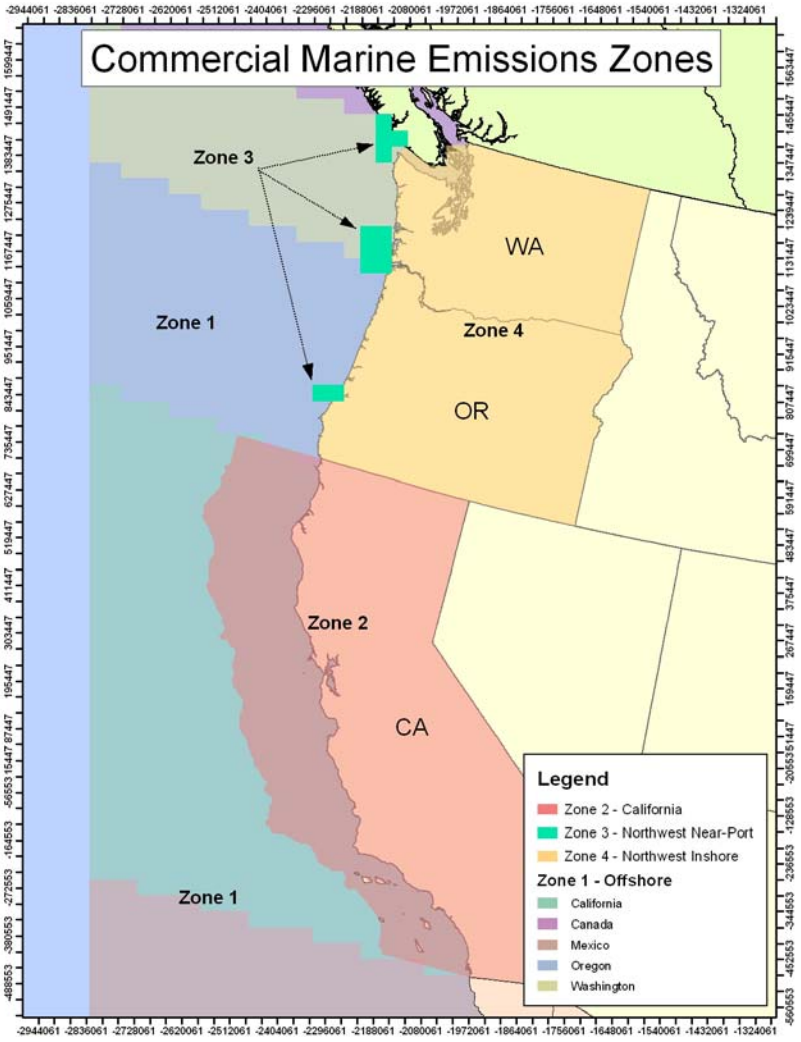
Summary of 2002 West Coast NOx Emissions (tons per year)

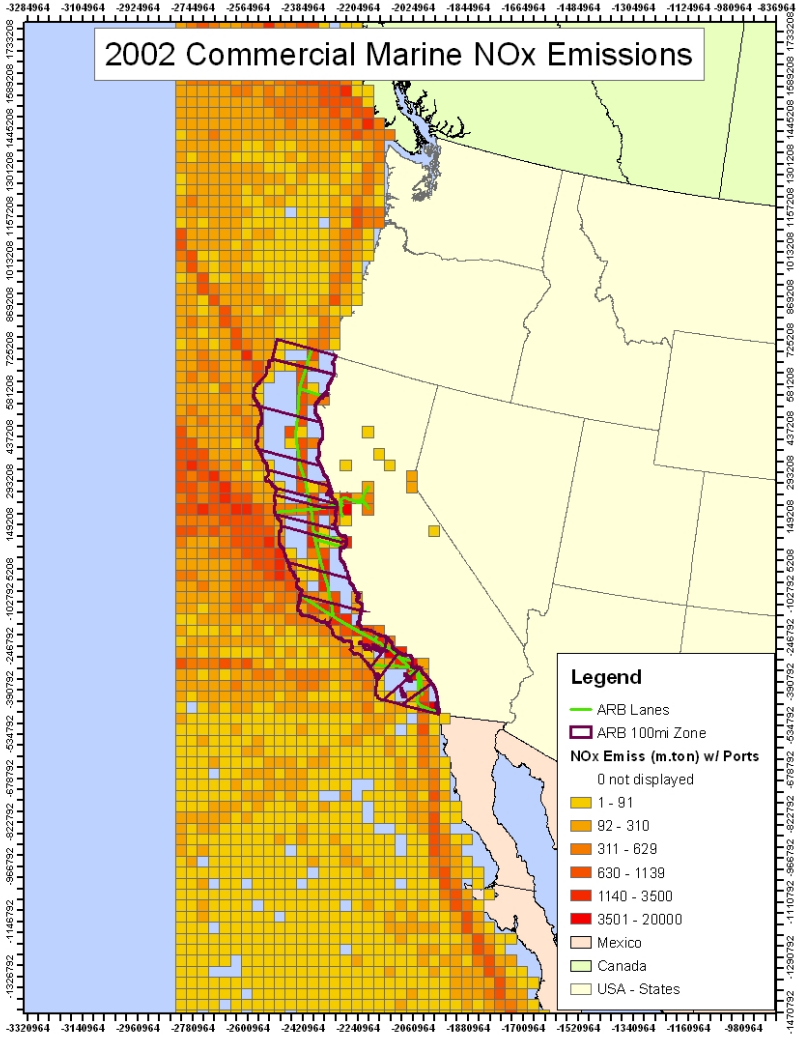
State	Commercial Marine				
	Total	Offshore - Zone 1	Coastal/In-Shore - Zones 2,3,4		
			Total	*Near-Port - Zone 3*	*Inshore - Zone 4*
California	243,480	131,930	111,550	NA	NA
Oregon	43,265	41,113	2,152	736	1,415
Washington	58,922	44,692	14,231	3,467	10,764
Total	345,667	217,734	127,933	4,204	12,179

Summary of 2002 West Coast SO2 Emissions (tons per year)

State	Commercial Marine				
	Total	Offshore - Zone 1	Coastal/In-Shore - Zones 2,3,4		
			Total	*Near-Port - Zone 3*	*Inshore - Zone 4*
California	120,240	74,181	46,059	NA	NA
Oregon	23,863	23,119	744	532	212
Washington	32,964	25,130	7,835	2,483	5,352
Total	177,068	122,430	54,637	3,015	5,564

Eastern Pacific Marine Shipping





Eastern Pacific Marine Shipping

Key Points

- Large ocean-going vessels (OGV) are a very large source of SOx and PM emissions (burn very high sulfur residual fuels)
- OGV are primarily foreign flagged and outside US EPA control
- Smaller harbor craft are US-flagged and EPA has proposed new controls
- Activity projections are controversial and highly variable
- For 2018 modeling to date, emissions have been held at 2002 levels
- OGV emissions can be estimated using port call data
- Smaller vessel activity data is more difficult to obtain
- Most West Coast ports are conducting emission inventory efforts

Mexico Emission Inventories

- Phase I: 1996 – 1999
- Phase II: 2000 – 2003 (6 Northern States)
- Phase III: 2004 – 2006 (32 States)

- Mexico 1999 NEI
  - Base year – 1999
  - Entire country – 32 states; 2,443 municipalities
  - Criteria pollutants
  - Sources:
    - Point
    - Area
    - On-road motor vehicles
    - Nonroad mobile

Mexico Emission Inventories

- US EPA-funded WGA project to develop first-ever national emissions inventory for Mexico EPA, and for use in U.S. air quality modeling
- Area, On-Road Mobile, Non-Road Sources – Very Straightforward
- Point Sources – Gap Filling Necessary:
  - Centroid of municipality/locality, if coordinates were missing
  - Non-disclosure of non-Federal sources if <4 per NAICS
  - SCC-level stack data

Source Type	NO_x	SO_2	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
Point	494,745	2,903,265	273,239	184,800	327,678	219,269	
Area	304,461	214,479	1,921,757	2,756,593	484,081	353,037	1,430,586
On-road	480,164	26,902	631,594	5,149,744	22,622	20,724	8,346
Nonroad	290,752	3,840	38,764	169,316	41,047	39,816	
Total	**1,570,121**	**3,148,486**	**2,865,354**	**8,260,453**	**875,428**	**632,846**	**1,438,933**

ENVIRON

Mexico Emission Inventories – Lessons Learned

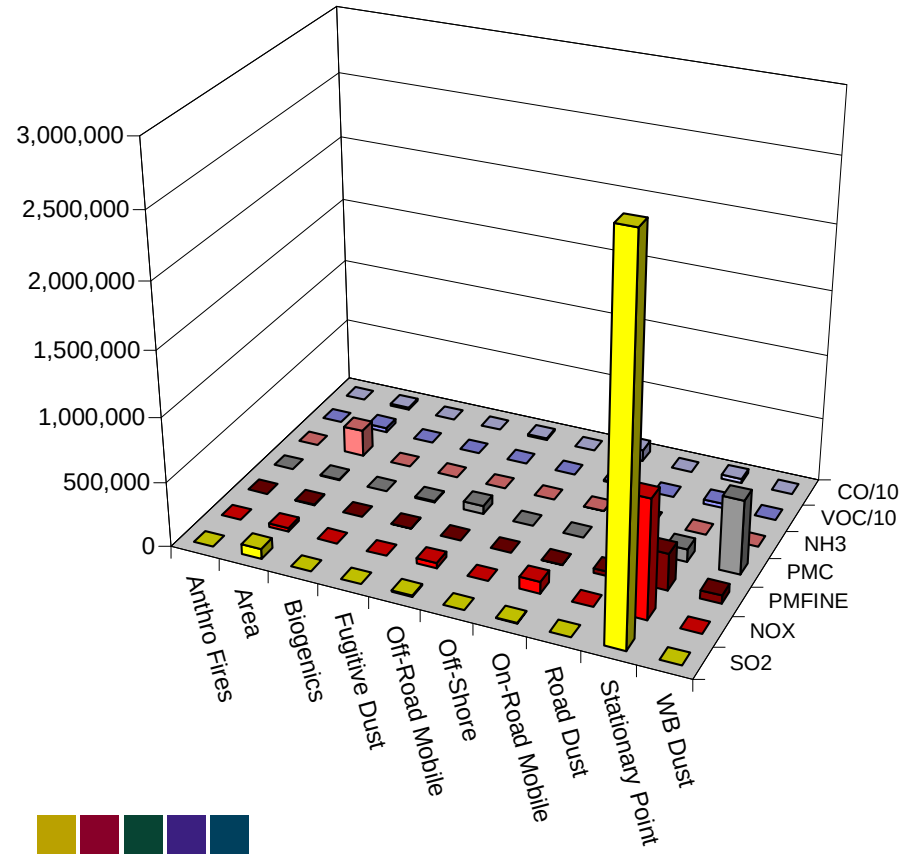
- Point Sources
  - Increase number of facilities reporting emissions
  - Require SCC/process-level of detail
  - Require NH_3 and VOC reporting
  - Establish format for submittals and train State Environmental Agencies
  - Develop Mexico-specific emission factors and temporal profiles:
    - Power Plants
    - Oil and Gas Production
    - Nonmetallic Minerals
- Mobile Sources
  - Improve upon Mexico NEI methodology (per capita emissions and daily VKT + MOBILE6-Mexico EFs => 7 areas, extrapolated based on population):
  - Local VKT data
  - Improved/expanded vehicle fleet information
  - More extensive vehicle emissions data for model improvement
- Collect population and use data for other non-road equipment:
  - Industrial/Commercial Equipment
  - Recreation Vehicles and Boats
  - Lawn and Garden Equipment
  - Oil Field and Airport Service Support Equipment
  - Logging Equipment

Mexico Emission Inventories – Lessons Learned

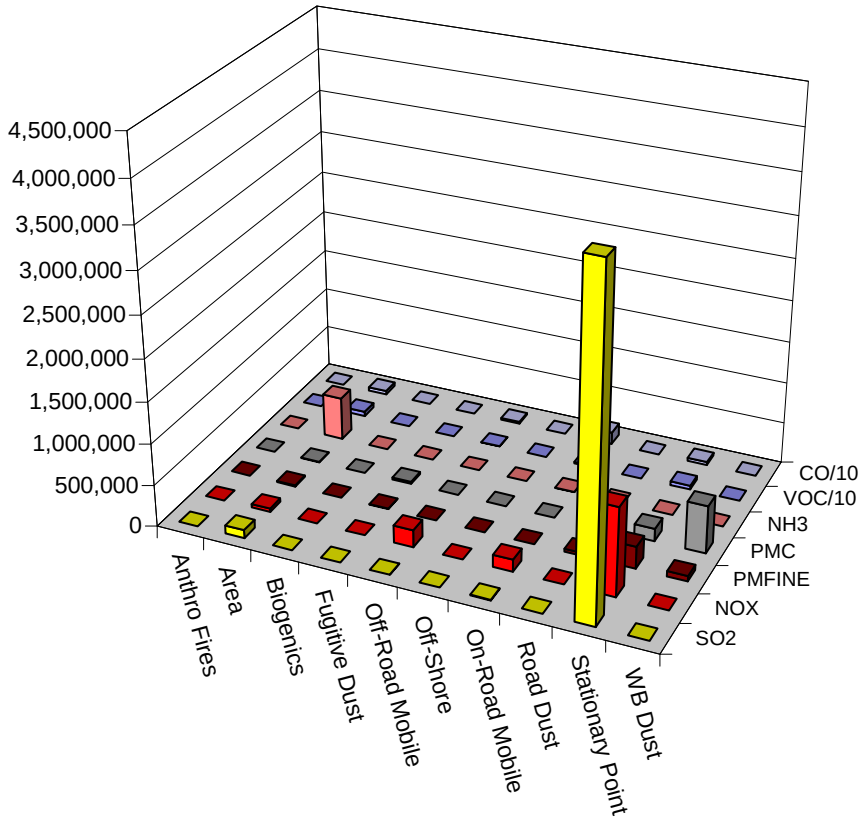
- Area Sources
  - Improve evaporative VOC estimates with better data from industry or other methods (surveys)
  - Collect more extensive data on agricultural sources via cooperation with Secretariat of Agriculture, Livestock, Rural Development, Fisheries, and Food (SAGARPA):
    - Fugitive Dust (tilling, feedlots)
    - Ammonia (livestock, fertilizer application)
    - Agricultural burning
  - Local data collection for estimating paved/unpaved road dust emission factors (AP-42 method) and vehicle activity
    - Yuma/San Luis Río Colorado (Sonora)
    - Mexicali
- For all WRAP analyses, only a 1999 emissions year has been used for Mexico inventory

Mexican Emission Inventory Summary

Mexico Annual 2000-04 Baseline (Plan02)



Mexico Annual 2018 Preliminary Reasonable Progress Case (PRP18)



Note:
Plan02 includes only six Northern States
PRP18 includes entire country

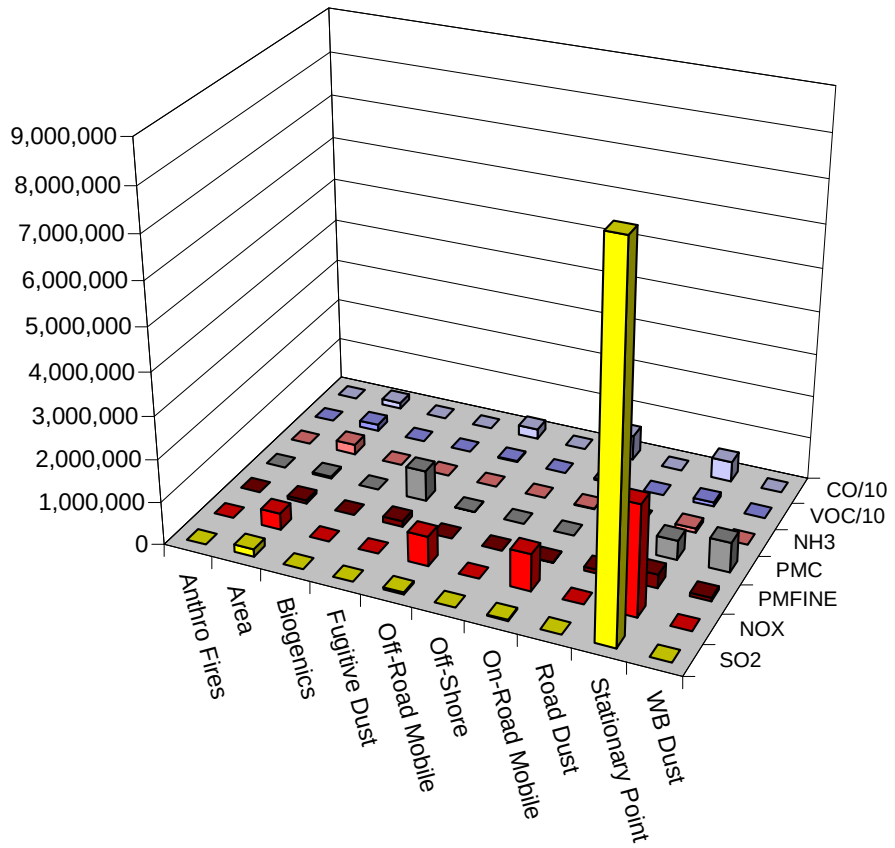
ENVIRON

Canadian Emission Inventories

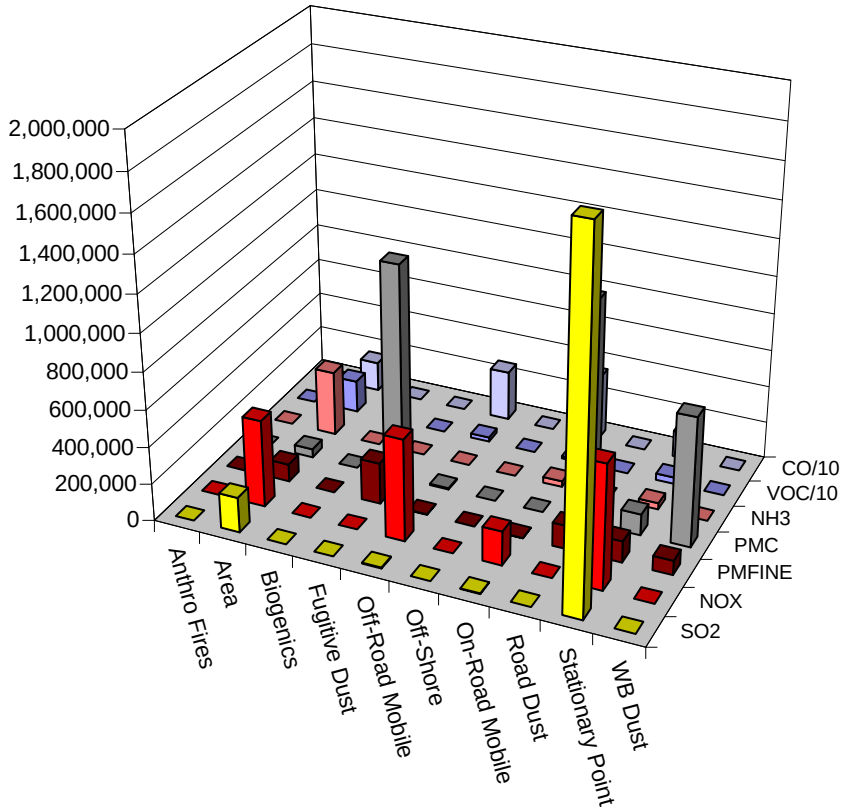
- 2002 Planning & 2018 Base Case
  - 2000 Version 2 EI from Environment Canada
    - Area, Stationary Point; Mobile
  - Fugitive WB Dust from RMC WB Dust model
  - Ontario point fires
- 2018 Preliminary Reasonable Progress
  - 2020 EI from Environment Canada
    - Area, Stationary Point; Mobile
  - Fugitive WB Dust from RMC WB Dust model
  - Ontario point fires
- Issues associated with point source stack parameters; gridding surrogates; activity/emissions data at Provincial-level

Canadian Emission Inventory Summary

Canada Annual 2000-04 Baseline (Plan02)



Canada Annual 2018 Preliminary Reasonable Progress Case (PRP18)



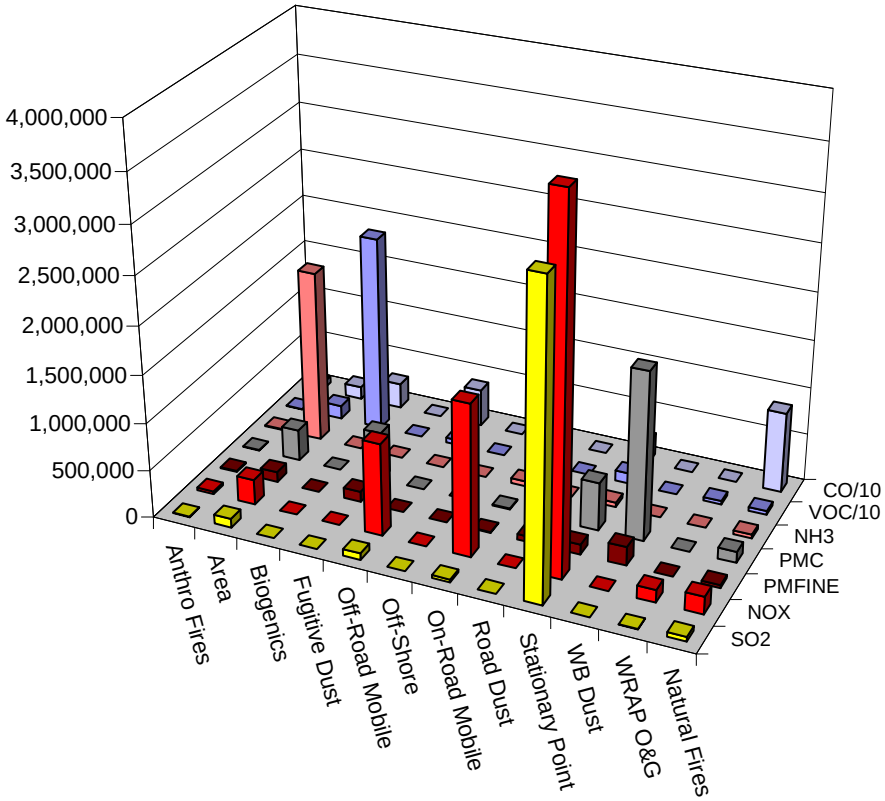
ENVIRON

RPO Emission Inventory Summaries

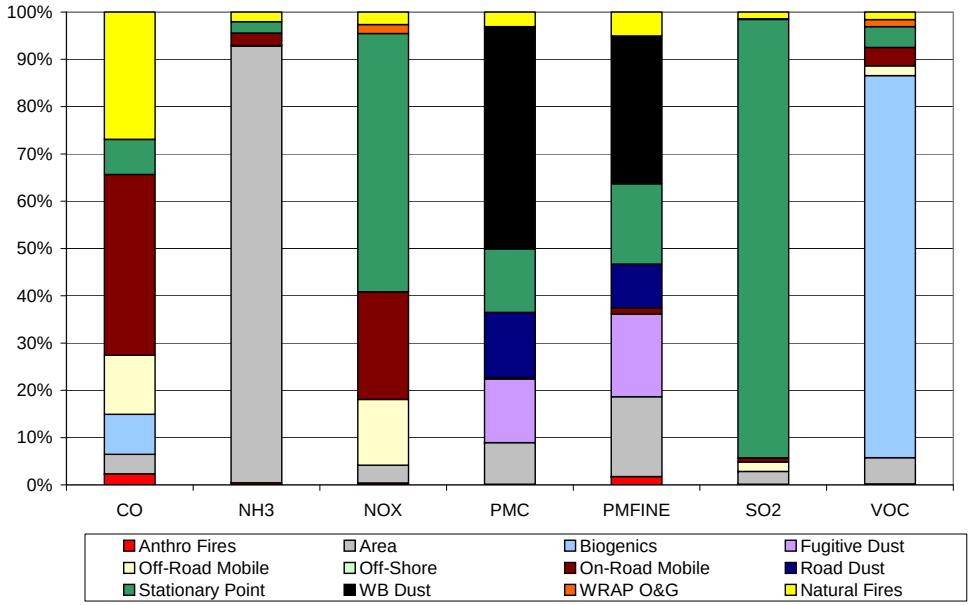
- Summarize & review by RPO
- Summarize by source category & pollutant
- Consider completeness; reasonableness.

WRAP EI Summary

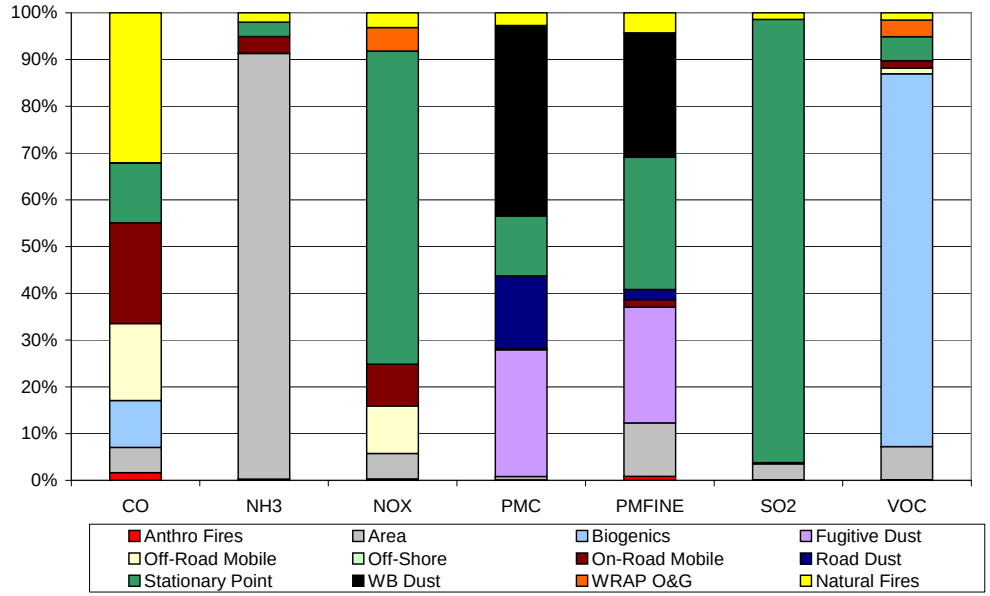
WRAP Annual 2000-04 Baseline (Plan02)



WRAP Annual 2000-04 Baseline (Plan02)



WRAP Annual 2018 Base Case (Base18)



ENVIRON

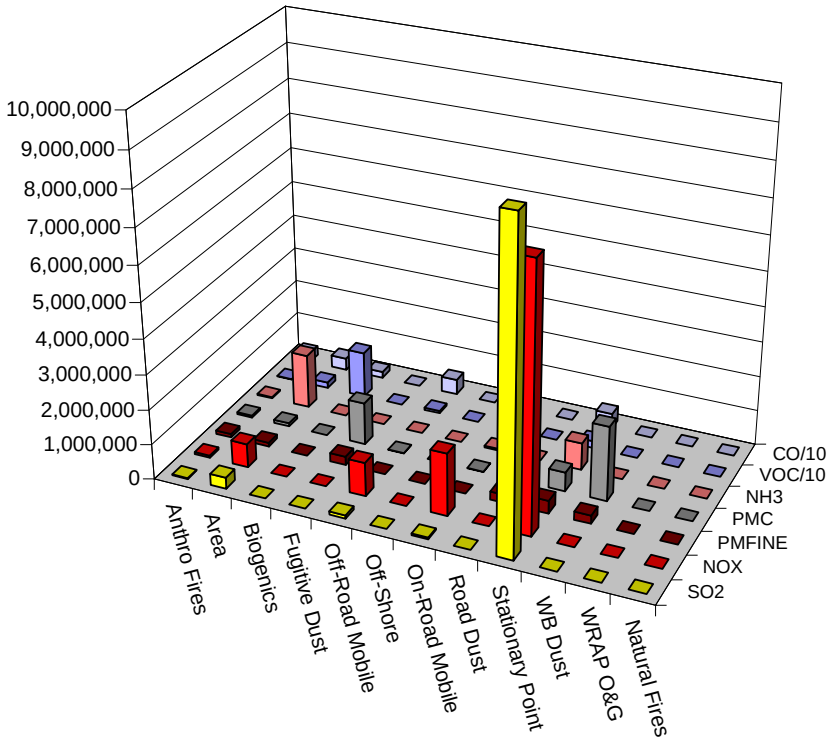
CENRAP Regional Emission Inventory

Typ02G; Base18G

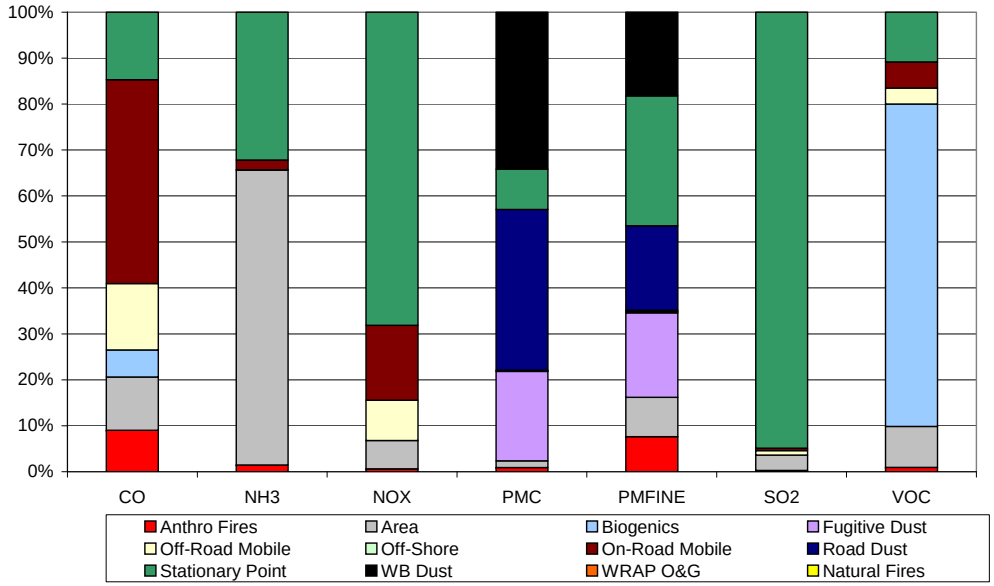
- Stationary Point
  - Actual 2002 data with CEM-based temporal profiles
  - 2018 based on CEM data; not IPM run
- Area Sources
  - 2002 county-level estimates
  - Separated fugitive & road dust sources
  - Removed stage II refueling
  - Reconciliation of NH3 sources
  - NH3 emissions primarily from CMU model
- On-road Mobile
  - Annual County-level VMT & MOBILE6 input files for all CENRAP States.
- Non-Road Mobile
  - Annual 2002 estimates for all CENRAP states
  - MN replaced with MRPO BaseK non-road estimates
  - IA replaced non-road Ag estimates with MRPO BaseK
  - TX replaced with TX estimates
- Fire Sources
  - Agricultural; prescribed; wildfires – point and area sources

CENRAP EI Summary

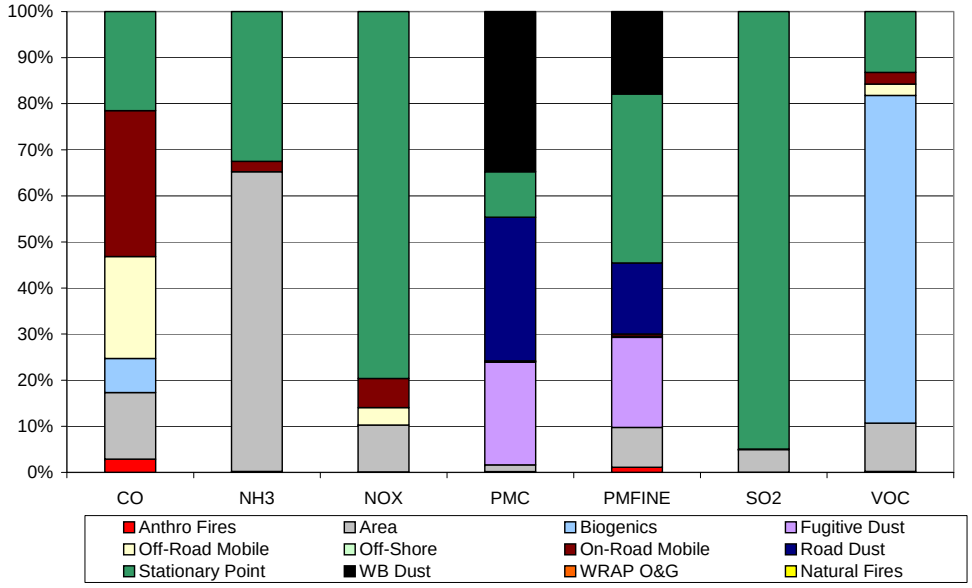
CENRAP Annual 2000-04 Baseline (Plan02)



CENRAP Annual 2000-04 Baseline (Plan02)



CENRAP Annual 2018 Base Case (Base18)



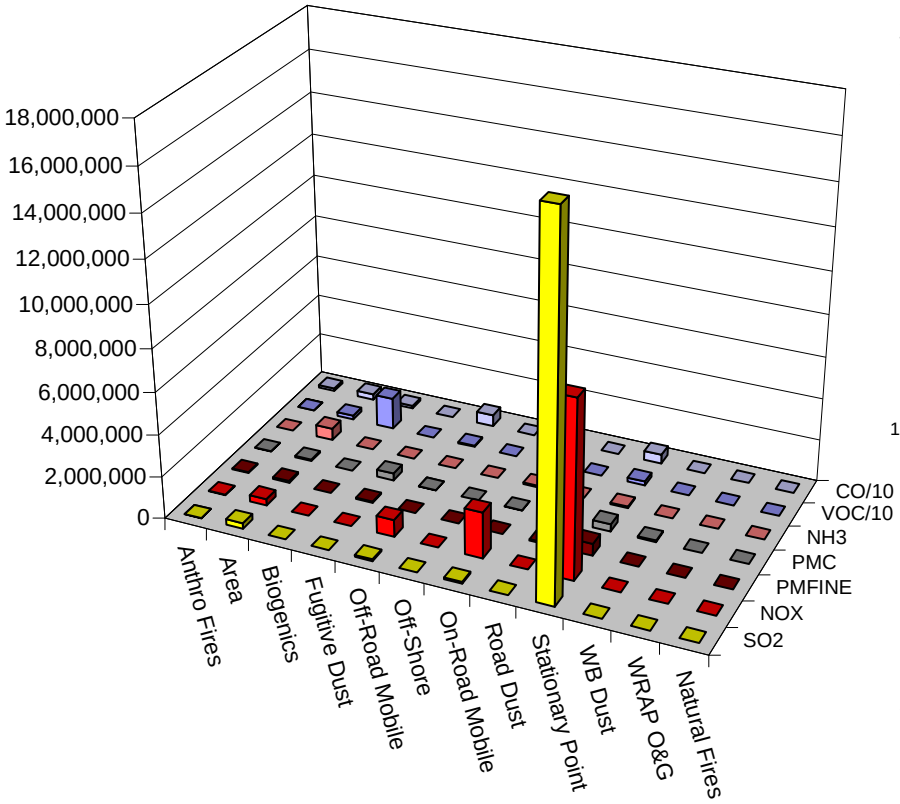
ENVIRON

VISTAS/MRPO/MANE-VU

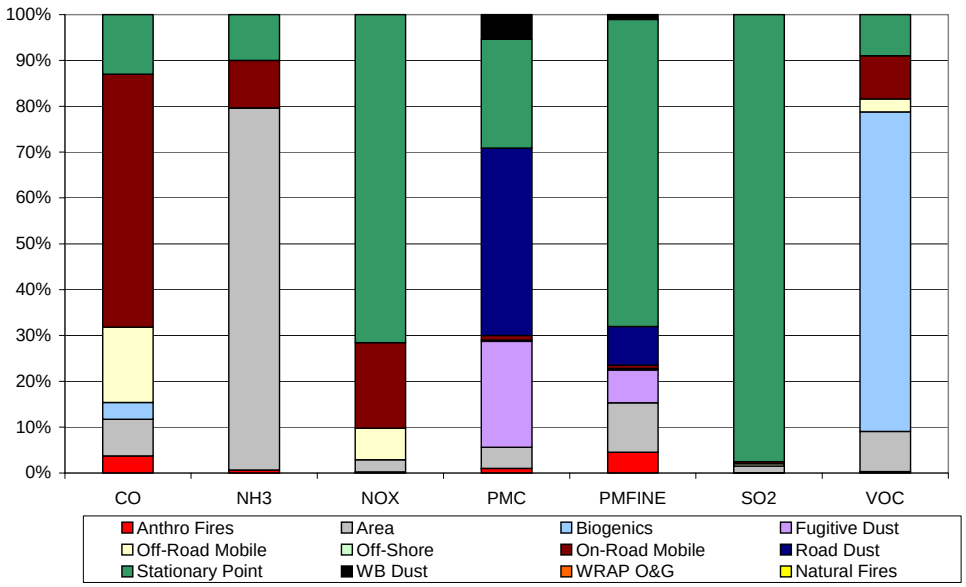
- VISTAS – 2002 Version F
- MRPO – 2002 Version K
- MANE-VU - 2002 version 2
- Point source temporal profiles updated with CEM-based profiles - removed IPM-based profiles
- Fugitive dust sources adjusted fpr PM10/PM2.5 ratios; updated transport fractions
- Updated 2018 growth factors for MRPO

VISTAS EI Summary

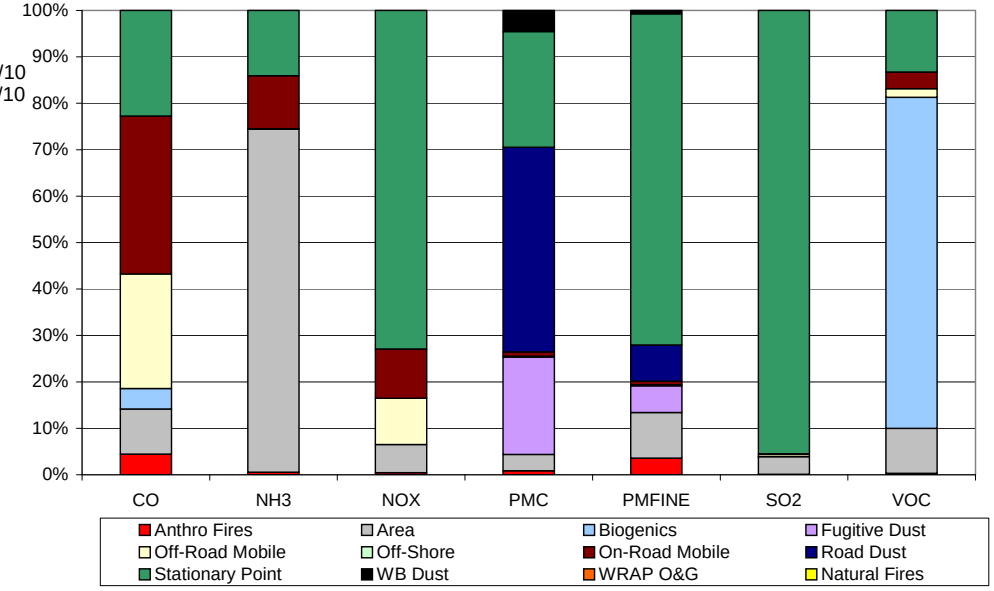
VISTAS Annual 2000-04 Baseline (Plan02)



VISTAS Annual 2000-04 Baseline (Plan02)

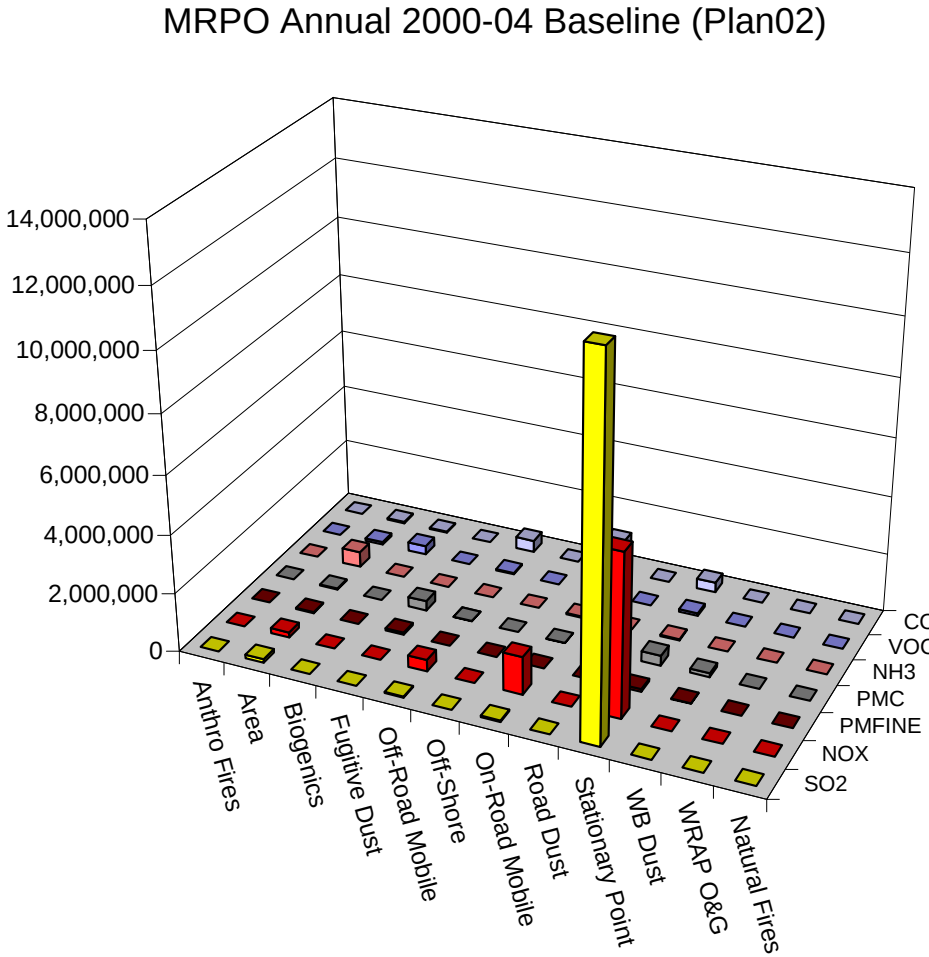


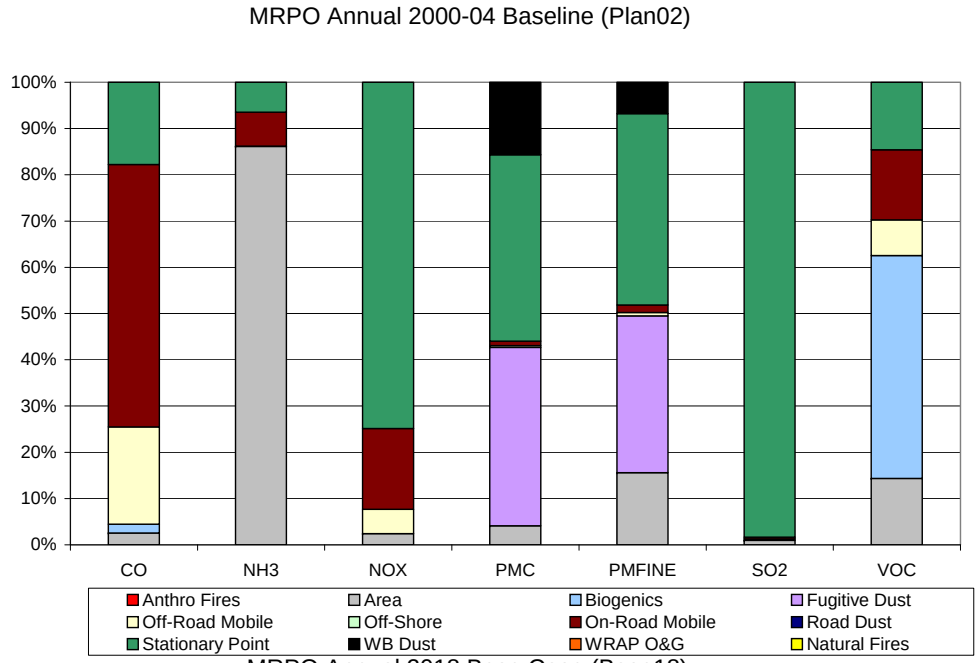
VISTAS Annual 2018 Base Case (Base18)

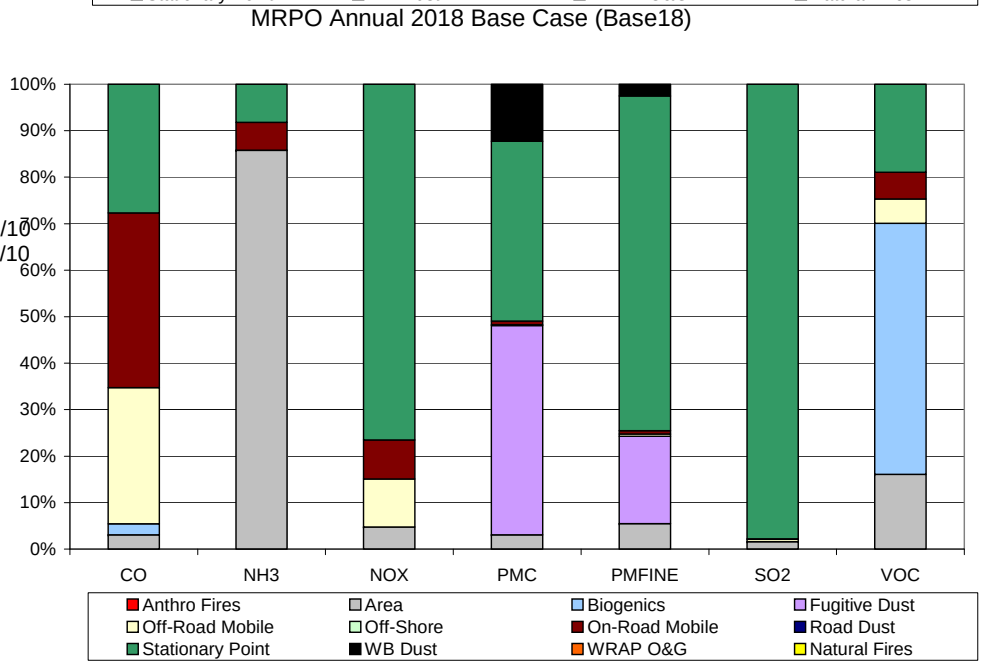


ENVIRON

MRPO EI Summary



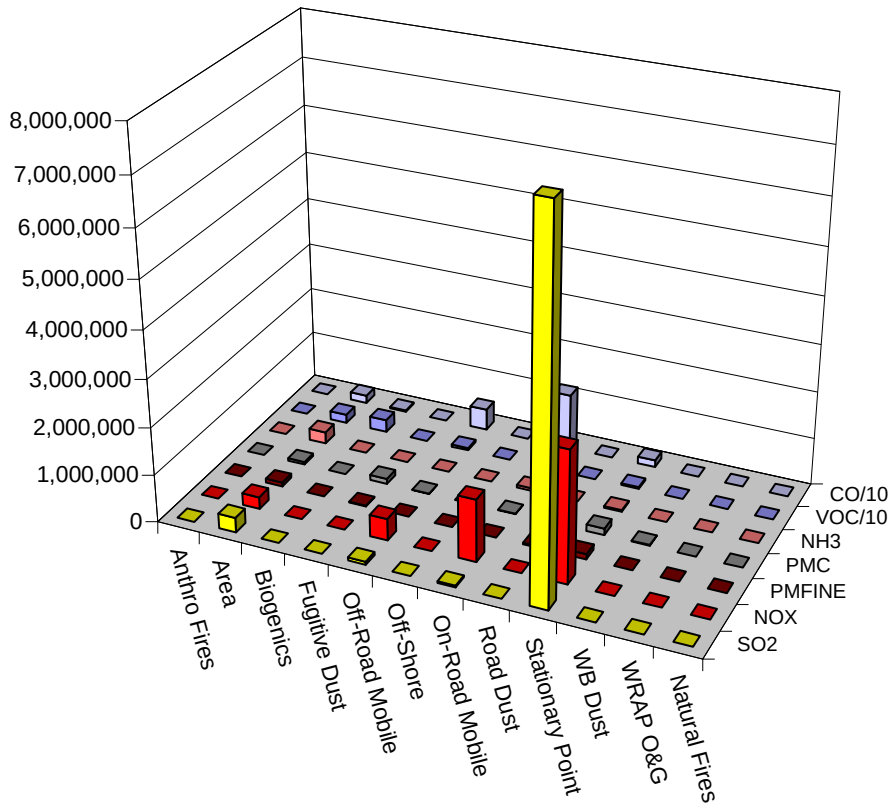




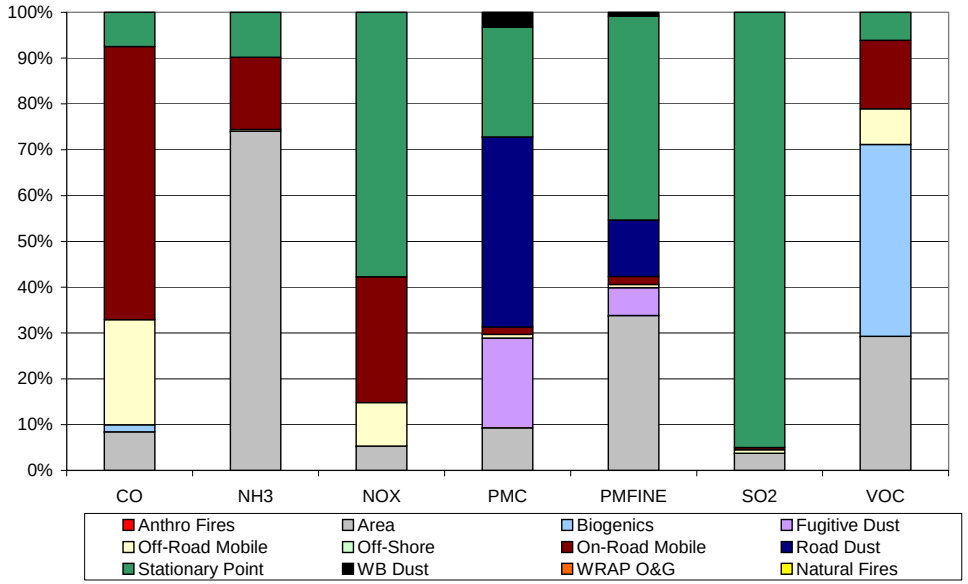
ENVIRON

MANE-VU EI Summary

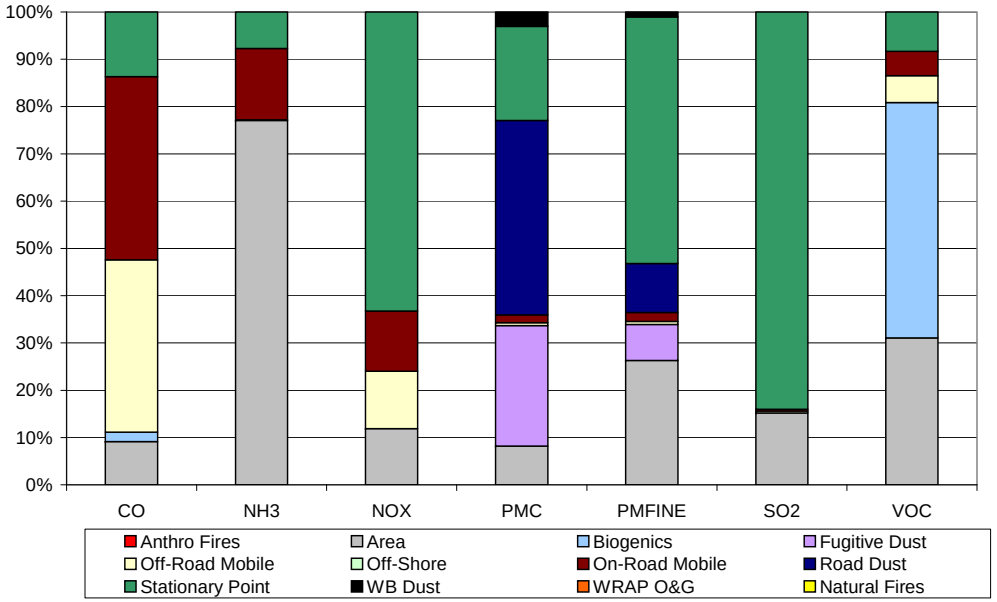
MANE-VU Annual 2000-04 Baseline (Plan02)



MANE-VU Annual 2000-04 Baseline (Plan02)



MANE-VU Annual 2018 Base Case (Base18)



ENVIRON