Regional Haze Technical Analysis using the Colorado Emissions Trace

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Abstract

In developing the Regional Haze technical support documents for Colorado's twelve Class I Areas (CIAs), the Air Pollution Control Division "Division" created a technical analysis tool known as the Emissions Trace or "ET." The ET graphically combines the vast array of regional haze information, data and analysis contained on the Western Regional Air Partnership (WRAP) Technical Support System (TSS) website into a "trace" that tracks particulate impacts at the CIA to the sources of emissions. The ET merges information from the PM Source Apportionment Technology (PSAT) modeling, Weighted Emissions Potential (WEP) modeling and maps, and emissions inventory with the statewide stationary source and area source pivot tables. The ET is specific to each CIA for six pollutants (e.g. sulfate, nitrate, organic carbon, elemental carbon, fine soil and coarse mass). It focuses on the worst days in 2018 to allow for easy identification of significant natural and anthropogenic sources and the percentage contribution of each category of emissions.

Introduction

Colorado has a long history of working on visibility issues including the study of the Denver Brown Cloud in the 1970s and 1980s, implementation of the Denver Urban Visibility Standard[1] in 1990; USFS certification of visibility impairment at the Mt. Zirkel Wilderness in 1993 and associated visibility study[2] and our active involvement in the Grand Canyon Visibility Transport Commission and Western Regional Air Partnership.

In December of 2007, the Colorado Air Quality Control Commission approved most of our Regional Haze State Implementation Plan (SIP) including all required plan elements except for the reasonable progress process of setting Class I area goals and associated consultation with federal land managers and nearby states. Upon approval by the Colorado Legislature, our plan should be formally submitted to EPA sometime in June 2008. At that time Colorado will join the few states with submitted RH SIPs and likely be the first western state to do so.

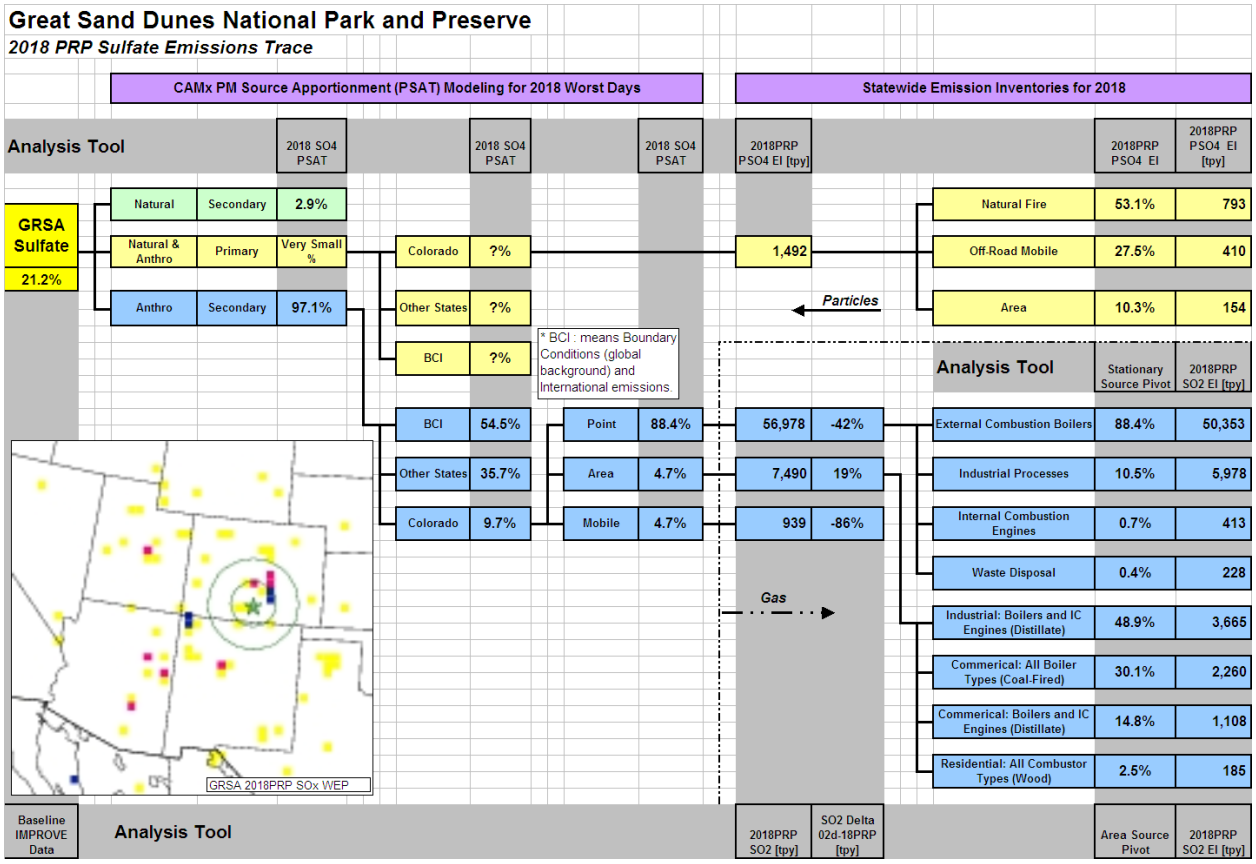
The Colorado emissions trace analysis for sulfate, nitrate, organic carbon (OC), elemental carbon (EC), fine soil and coarse mass (CM) can be found in Section 8 of the Regional Haze Technical Support Documents for Colorado's twelve CIAs. These documents are on the Division's website at the following link:

http://www.cdphe.state.co.us/ap/regionalhaze.html.

Sulfate Emissions Trace

Sulfate is perhaps most closely associated with point source emissions since coal-fired boilers represent the majority of sulfur emissions in the west. Figure 1 illustrates an example sulfate ET for Great Sand Dunes National Park & Preserve (GRSA) that is based on Preliminary Reasonable Progress (PRP) emission projections for 2018.

Figure 1: 2018 PRP sulfate emissions trace for GRSA



The information included in the ET is a consolidation of WRAP modeling and emission inventory data that can be obtained on the WRAP TSS website at the following link:

http://vista.cira.colostate.edu/tss/Results/HazePlanning.aspx

In the above figure, the purple highlighted areas denote the general source of the columns of information listed directly below. Areas highlighted in gray (analysis tool) identify the more specific source of the information displayed in each column. For example, the far left gray column (e.g. GRSA sulfate = 21.2%) is obtained from baseline period IMPROVE (Interagency Monitoring of Protected Visual Environments) monitoring data for the worst days in the metric of reconstructed extinction. Table 1 includes the data used to calculate percent sulfate extinction based on the 5-year average that excludes Rayleigh light scattering. Rayleigh, which refers to the scattering of light due to air molecules, is excluded from this calculation because the ET is focused on extinction associated with air pollution emissions.

Table 1: Baseline period reconstructed extinction using IMPROVE monitoring data for 20% worst days at GRSA

20% Worst Days										
Site	Method	Year	N	SO4 Extinction	NO3 Extinction	OMC Extinction	EC Extinction	Soil Extinction	CM Extinction	Total
GRSA1	NIA	2000	20	6.21	1.72	10.64	2.24	2.76	9.46	
GRSA1	NIA	2001	23	7.04	1.75	5.07	1.22	2.28	5.78	
GRSA1	NIA	2002	23	5.15	2.51	10.76	1.99	4.08	10.79	
GRSA1	NIA	2003	24	6.27	1.09	9.06	1.93	2.84	6.47	
GRSA1	NIA	2004	24	5.2	2.74	6.82	1.32	2.1	3.71	
			average:	5.97	1.96	8.47	1.74	2.81	7.24	28.2
				21.18%	6.96%	30.04%	6.17%	9.97%	25.68%	100.00%

The map in the lower left of Figure 1 is a zoom view of the SOx WEP map for the 20% worst days at GRSA. It identifies the 36-kilometer grid cells that contribute to 2018 PRP SO2 emissions. The location of the IMPROVE monitor is indicated by a green star surrounded by 100 km and 200 km radius concentric circles. The WEP map tool is an analysis technique that distinguishes the predominant emission source regions contributing haze-forming pollutants at each CIA based on 5-years of historical meteorology. The CIA specific WEP map for each haze pollutant is determined by multiplying the annual emission inventory for all source categories by the Air Mass Residence Time (2000-04) values that are normalized relative to each CIA. The resultant map provides the distance weighted emissions potential of each grid cell relative to the CIA receptor. The darker colored grid cells denote the highest contributors and the lighter colored grid cells are lesser contributors to impacts at GRSA. It is important to note that the WEP analysis does not address secondary particulate formation (e.g. no complex chemistry) or deposition at the CIA receptor.

The upper left side of Figure 1 contains the PSAT modeled output. Sulfate particles are tracked under three different categories: natural secondary aerosol (denoted in light green), natural & anthropogenic primary aerosol (denoted in light yellow) and anthropogenic secondary aerosol (denoted in blue). Secondary sulfate aerosol generally forms through a reaction between gaseous NH3 and SO2 resulting in an ammonium sulfate particle, often referred to as "sulfate." Primary sulfate aerosol is a directly emitted sulfate particle generally resulting from combustion of a fuel containing sulfur. The emissions associated with each of the three categories of aerosol can be "traced" by following the lines from left to right.

The percent contribution for two of the three categories is resolved from the 2018b PSAT modeled output. Although the PSAT modeling doesn't allow for determining the percent contribution of primary sulfate, it is assumed to be a small contributor relative to secondary sulfate. Comparing the 2018 PRP emission inventory for Colorado primary sulfate (~1,500 tpy) with 2018 PRP statewide SO2 emissions (~69,500 tpy) indicates that this assumption is reasonable.

Table 2 provides sulfate PSAT model output for five source categories and a separate category for outside the model domain (OD). OD represents the contribution at the edge of model domain, which is slightly different than the Boundary Conditions – International (BCI) that

includes OD along with impacts from Canada, Pacific Ocean (PO), and Mexico. The source types of interest are the columns in green and blue. Prior to the green column is "SReg" indicating the source region. As denoted in light green, the natural secondary sulfate contribution (~3%) is assumed from the biogenic concentrations for all source regions, except OD. The WRAP PSAT modeling did not apportion OD by source category, so it is assumed to be a separate category. Denoted in blue, the anthropogenic secondary sulfate contribution (~97%) is determined by adding all point, area and mobile sources for all source regions, except OD. Denoted in tan, the relative contributions for BCI, Colorado and Other States categories are determined by adding the concentrations for each respective category and dividing by the sum total concentration. Denoted in bright maroon, the Colorado share of contribution for mobile (4.7%), area (4.7%), and point (88.4%) is determined by dividing each respective category by the total state concentration.

Table 2: Sulfate PSAT modeling for 20% worst days at GRSA

20% Worst Days															
site	Year	modelrun	param	N	SReg	Nat. Fires & Bio.	Anthro. Fires	Mobile	Area	Point	OD	Sum	BCI	Colorado	Other States
GRSA1	2018	base18b36	PS4	23	AZ	0.002	0	0.001	0.001	0.023		0.027			0.027
GRSA1	2018	base18b36	PS4	23	CA	0.002	0	0.002	0.002	0.008		0.014			0.014
GRSA1	2018	base18b36	PS4	23	CAN	0	0	0	0.002	0.011		0.013	0.013		
GRSA1	2018	base18b36	PS4	23	CEN	0	0	0	0.004	0.029		0.033			0.033
GRSA1	2018	base18b36	PS4	23	CO	0.001	0	0.002	0.002	0.038		0.043		0.043	
GRSA1	2018	base18b36	PS4	23	EUS	0	0	0	0	0.001		0.001			0.001
GRSA1	2018	base18b36	PS4	23	ID	0.003	0	0	0	0.002		0.005			0.005
GRSA1	2018	base18b36	PS4	23	MEX	0	0	0.001	0.005	0.029		0.035	0.035		
GRSA1	2018	base18b36	PS4	23	MT	0	0	0	0	0.001		0.001			0.001
GRSA1	2018	base18b36	PS4	23	ND	0	0	0	0	0.006		0.006			0.006
GRSA1	2018	base18b36	PS4	23	NM	0.001	0	0	0.004	0.031		0.036			0.036
GRSA1	2018	base18b36	PS4	23	NV	0	0	0	0.002	0.004		0.006			0.006
GRSA1	2018	base18b36	PS4	23	OR	0.001	0	0	0	0.001		0.002			0.002
GRSA1	2018	base18b36	PS4	23	PO	0	0	0	0.016	0.008		0.024	0.024		
GRSA1	2018	base18b36	PS4	23	SD	0	0	0	0	0		0			0
GRSA1	2018	base18b36	PS4	23	UT	0.002	0	0	0.001	0.012		0.015			0.015
GRSA1	2018	base18b36	PS4	23	WA	0	0	0	0	0.001		0.001			0.001
GRSA1	2018	base18b36	PS4	23	WY	0.001	0	0	0.001	0.009		0.011			0.011
GRSA1	2018	base18b36	PS4	23	OD						0.169	0.169	0.169		
					Sum	0.013					Sum	0.442	0.241	0.043	0.158
						2.9%						97.1%	54.5%	9.7%	35.7%
					CO Share			4.7%	4.7%	88.4%					

Based on the SOx emissions inventory in Table 3, it is important to note that although the PSAT modeling above identifies both natural fire and biogenic as sources of natural secondary sulfate, only natural fire is implicated since biogenic emissions are zero.

Table 3: Colorado SO2 emission inventory for 2002 and 2018

Region	Scenario	Year	Point	Anthro Fire	Natural Fire	Biogenic	Area	WRAP Area O&G	Off-Shore	On-Road Mobile	Off-Road Mobile	Road Dust	Fugitive Dust	WB Dust	Total
Sulfur Dioxide															
CO	Plan02d	2002	97,978.5	91.8	2,541.9		6,299.2	118.2		4,146.8	2,468.8				
CO	Prp18a	2018	56,978.4	79.3	2,541.9		7,490.2	10.6		568.4	370.8				68,039.6

Referencing the right side of Figure 1, the statewide emission inventory information for various categories and subcategories of emission sources are listed including total statewide gaseous SO2 along with the change in emissions from 2002 to 2018. For example, point source SO2 emissions using 2018 PRP projections are 56,978 tons per year, which is a 42% reduction from the 2002 estimates. The state level apportionment, source categories and subcategories are sorted top-down by level of significance.

Further to the right on Figure 1, subcategories of point and area sources are listed based on information from the Stationary Source Pivot Table and Area Source Pivot Table respectively.

Both pivot tables are MS EXCEL workbooks that include WRAP state level emissions of various pollutants sorted by Source Classification Code (SCC) that can be found on the WRAP website under the Stationary Sources Joint Forum (SSJF) at the following link:

http://www.wrapair.org/forums/ssjf/pivot.html

Several levels of SCC detail can be determined depending on how the pivot table is sorted. Tables 4 and 5 provide different summary levels of aggregation for the 2018 PRP SO2 emissions for Colorado point and area sources.

Table 4: Colorado point source pivot table for 2018 PRP SO2 emission inventory

State	CO		
Sum of SumOfSO2_ANN			
SCC1_DESC	SCC3_DESC	Total	SCC1_Subtotal
External Combustion Boilers	Electric Generation	47,243	
	Industrial	2,872	
	Commercial/Institutional	236	
	Space Heaters	2	50,353
Industrial Processes	Mineral Products	2,737	
	Chemical Manufacturing	1,322	
	Petroleum Industry	1,274	
	Primary Metal Production	378	
	Food and Agriculture	100	
	Miscellaneous Manufacturing Industries	78	
	Oil and Gas Production	68	
	Pulp and Paper and Wood Products	11	
	Secondary Metal Production	10	5,978
Internal Combustion Engines	Electric Generation	250	
	Industrial	151	
	Commercial/Institutional	11	
	Engine Testing	1	413
Waste Disposal	Solid Waste Disposal - Government	166	
	Solid Waste Disposal - Commercial/Institutional	44	
	Solid Waste Disposal - Industrial	19	228
Petroleum and Solvent Evaporat	Organic Solvent Evaporation	5	
	Surface Coating Operations	1	6
Grand Total		56,979	56,979

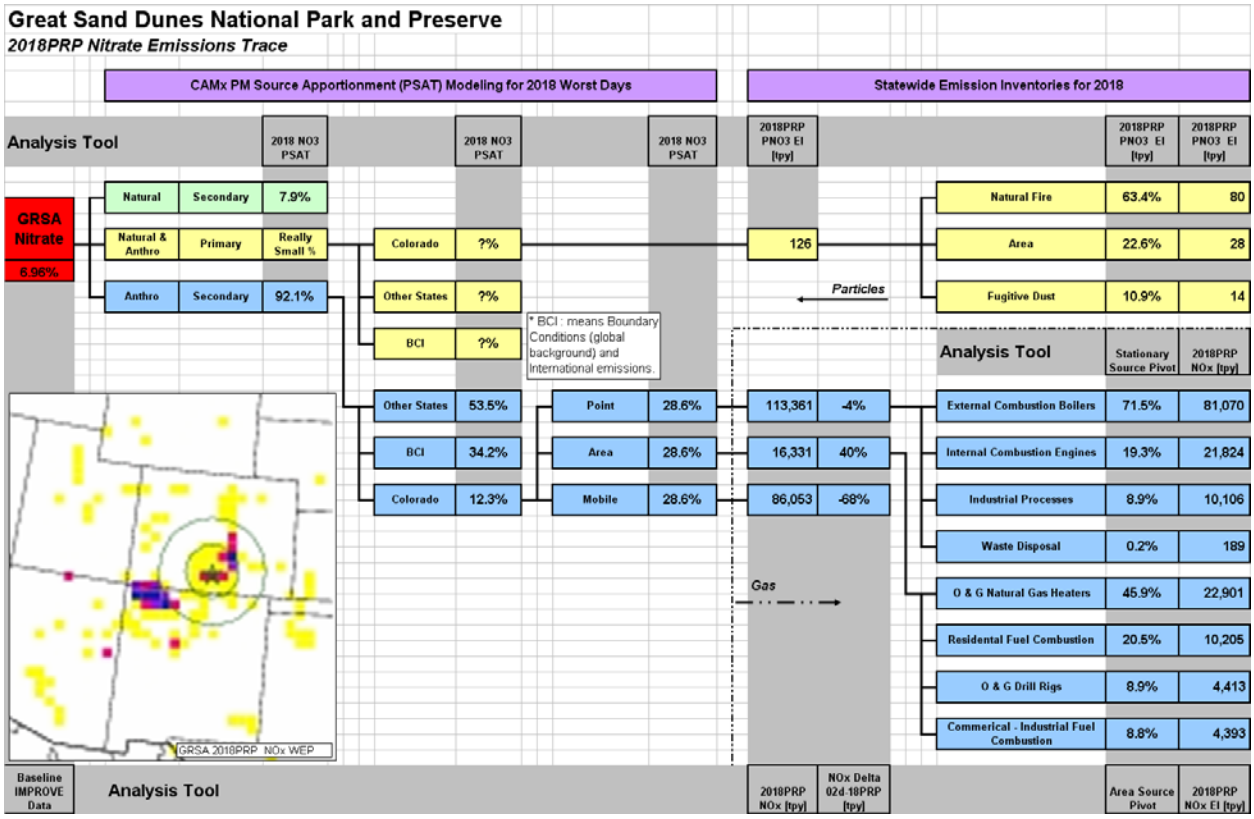
Table 5: Colorado area source pivot table for 2018 PRP SO2 emission inventory

State	CO				
Sum of Emissions				Pollutant	
SCC1_DESC	SCC3_DESC	SCC6_DESC	SCC8_DESC	SO2	Grand Total
Stationary Source Fuel Combustion	Industrial	Distillate Oil	Total: Boilers and IC Engines	3,665	3,665
		Kerosene	Total: All Boiler Types	6	6
	Commercial/Institutional	Bituminous/Subbituminous Coal	Total: All Boiler Types	2,260	2,260
		Distillate Oil	Total: Boilers and IC Engines	1,108	1,108
		Anthracite Coal	Total: All Boiler Types	71	71
		Kerosene	Total: All Combustor Types	9	9
		Natural Gas	Total: Boilers and IC Engines	7	7
		Liquified Petroleum Gas (LPG)	Total: All Combustor Types	1	1
	Residential	Wood	Fireplaces: Insert; non-EPA certified	46	46
			Fireplaces: General	42	42
			Woodstoves: General	41	41
			Fireplaces: Insert; EPA certified; non-catalytic	22	22
			Non-catalytic Woodstoves: EPA certified	19	19
			Fireplaces: Insert; EPA certified; catalytic	9	9
			Catalytic Woodstoves: General	8	8
		Bituminous/Subbituminous Coal	Total: All Combustor Types	85	85
		Natural Gas	Total: All Combustor Types	54	54
		Distillate Oil	Total: All Combustor Types	35	35
		Liquified Petroleum Gas (LPG)	Total: All Combustor Types	5	5
Industrial Processes	Oil and Gas Production	All Processes	Drill rigs	10	10
		Natural Gas Liquids	Tanks - Flashing & Standing/Working/Breathing, Uncontrolled	0	0
		Crude Petroleum	Pneumatic Devices	0	0
			Heaters	0	0
			Tanks - Flashing & Standing/Working/Breathing	0	0
		Natural Gas	CBM - Dewatering pump engines	0	0
			Heaters	0	0
			Pneumatic Devices	0	0
			Compressor Engines	0	0
			Dehydrators	0	0
			Completion - Flaring and venting	0	0
Grand Total				7,501	7,501

Nitrate Emissions Trace

Area and mobile sources can be significant contributors to nitrate impacts at a particular CIA depending on proximity of NOx emissions. Figure 2 illustrates an example nitrate ET for GRSA that is based on PRP emission projections for 2018. Since the WRAP performed state level PSAT modeling for both sulfate and nitrate, the explanation of the nitrate ET is comparable to sulfate, except that NOx emissions are the underlying contributor to nitrate.

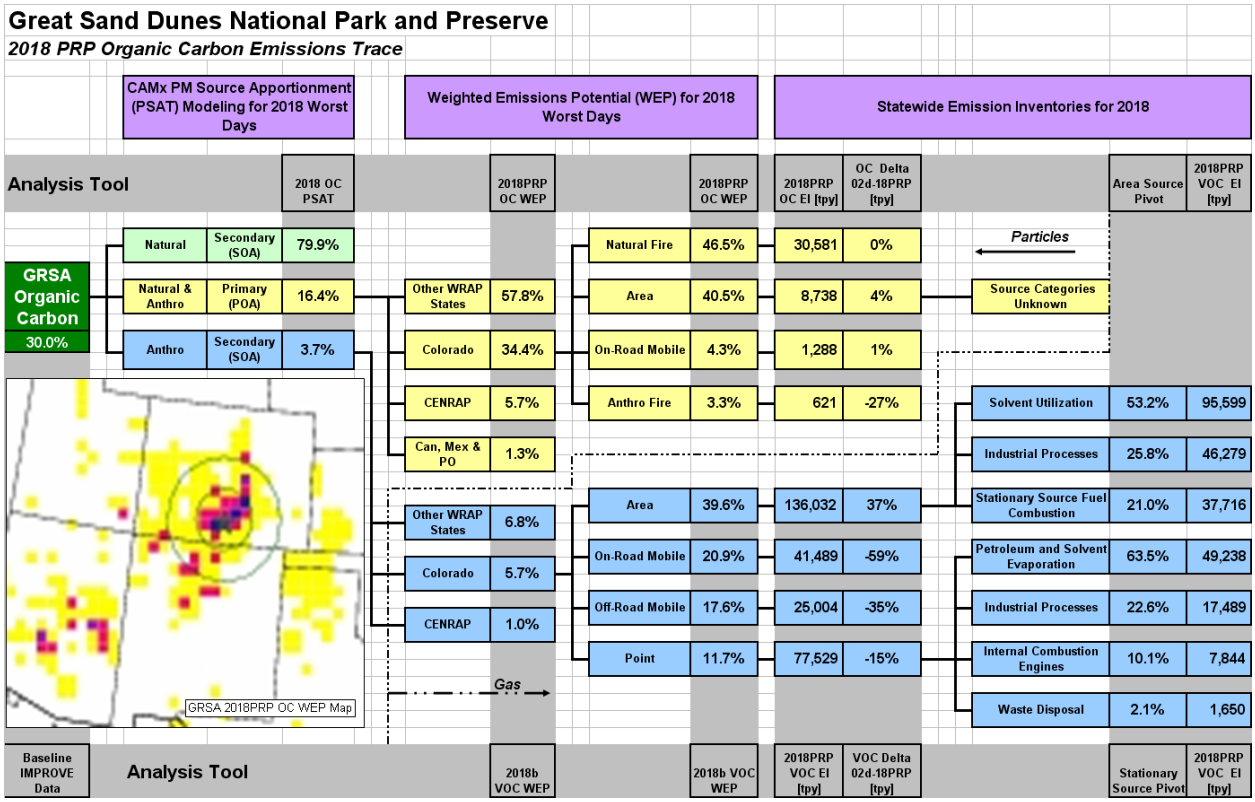
Figure 2: 2018 PRP nitrate emissions trace for GRSA



Organic Carbon Emissions Trace

Throughout most of the west, the majority of organic carbon originates from natural fire secondary organic aerosols (SOA) and primary organic aerosols (POA) with some contributions from area source primary organic aerosols. Organic carbon is probably the most complex visibility impairing pollutant because of the number of organic species and possible interactions with other pollutants including ozone. Figure 3 illustrates an example OC ET for GRSA that is based on PRP emission projections for 2018.

Figure 3: 2018 PRP OC emissions trace for GRSA



The WRAP did limited OC PSAT modeling to determine the attribution of natural and anthropogenic sources for both primary and secondary aerosols that is presented in Table 6.

Table 6: GRSA OC PSAT for 2018b emission inventory

OC-PSAT for worst days							
Scenario	Site	year	N	Anthro. & Bio. Primary	Biogenic Secondary	Anthro. Secondary	Total
2018b Base Case	GRSA1	2018	23	0.22	1.07	0.05	1.34
				16.4%	79.9%	3.7%	

The WRAP considered full PSAT modeling for OC but it was judged as too expensive and time consuming to be practical, so the WEP tool was created as a cost effective gap-filling analysis technique that provides a reasonable approximation of apportionment. An updated OC PSAT using the 2018PRP emission inventory is not in the WRAP's work plan, so the 2018b OC PSAT is the most current information available.

The state level OC apportionment is determined by using the OC WEP for POA and VOC WEP for SOA. Table 7 provides the OC WEP data used to determine the state level and source category POA apportionment in Figure 3 above. The state groupings and source categories highlighted in yellow below identify the top 4 contributors to primary aerosol.

Table 7: GRSA OC WEP for 2018PRP emission inventory

GRSA OC WEP																
Site	Param	SReg	Year	Point	Anthro Fire	Natural Fir	Biogenic	Area	WRAP Area	Off-Shore	On-Road M	Off-Road M	Road Dust	Fugitive Du	WB Dust	Total
GRSA1	Organic Carbon	AZ	2018 PRP	0.095	0.172	12.262	0	1.933	0	0	0.511	0.484	0.085	0.096	0	15.638
GRSA1	Organic Carbon	CA	2018 PRP	0.145	0.129	4.666	0	1.158	0	0.003	0.306	0.221	0.088	0.022	0	6.738
GRSA1	Organic Carbon	CAN	2018 PRP	0.023	0	0.004	0	0.079	0	0	0.001	0.014	0.01	0.035	0	0.166
GRSA1	Organic Carbon	CEN	2018 PRP	1.298	0.108	0.002	0	3.156	0	0	0.067	0.346	0.321	0.439	0	5.737
GRSA1	Organic Carbon	CO	2018 PRP	0.023	1.136	15.984	0	13.911	0	0	1.485	1.056	0.217	0.569	0	34.381
GRSA1	Organic Carbon	EUS	2018 PRP	0.02	0.028	0.001	0	0.036	0	0.002	0.002	0.013	0.002	0.001	0	0.105
GRSA1	Organic Carbon	ID	2018 PRP	0.006	0.08	0.639	0	0.024	0	0	0.01	0.012	0.006	0.008	0	0.785
GRSA1	Organic Carbon	MEX	2018 PRP	0.037	0.001	0.015	0	0.52	0	0	0.053	0.083	0.067	0.004	0	0.78
GRSA1	Organic Carbon	MT	2018 PRP	0.001	0.016	0.32	0	0.026	0	0	0.004	0.003	0.012	0.006	0	0.388
GRSA1	Organic Carbon	ND	2018 PRP	0.001	0.002	0.012	0	0.006	0	0	0.001	0.002	0.001	0.009	0	0.034
GRSA1	Organic Carbon	NM	2018 PRP	0.147	0.367	15.58	0	2.485	0	0	0.468	0.252	0.103	0.233	0	19.635
GRSA1	Organic Carbon	NV	2018 PRP	0.01	0.001	0.834	0	0.031	0	0	0.021	0.022	0.006	0.019	0	0.944
GRSA1	Organic Carbon	OR	2018 PRP	0.004	0.086	1.184	0	0.256	0	0	0.01	0.009	0.002	0.004	0	1.555
GRSA1	Organic Carbon	PO	2018 PRP	0.068	0	0.007	0	0.119	0	0.028	0.042	0.047	0.009	0.001	0	0.321
GRSA1	Organic Carbon	SD	2018 PRP	0	0.001	0.08	0	0.027	0	0	0.004	0.006	0.005	0.017	0	0.14
GRSA1	Organic Carbon	UT	2018 PRP	0.109	0.053	9.937	0	0.135	0	0	0.124	0.098	0.013	0.028	0	10.497
GRSA1	Organic Carbon	WA	2018 PRP	0.009	0.071	0.076	0	0.204	0	0	0.014	0.012	0.002	0.01	0	0.398
GRSA1	Organic Carbon	WY	2018 PRP	0.029	0.027	0.884	0	0.067	0	0	0.01	0.016	0.001	0.005	0	1.039
				Totals												
			Other WRAP States	57.8												
			CO	34.4												
			CEN	5.7												
			CAN, MEX & PO	1.3												
			CO [%]	0.07%	3.30%	46.49%	0.00%	40.46%	0.00%	0.00%	4.32%	3.07%	0.63%	1.65%	0.00%	

A similar VOC WEP table using the 2018b emission inventory was previously available on the WRAP TSS, but recent website updates apparently have removed access to this information. Generally, anthropogenic VOC is typically a small contributor to OC visibility impairment, so lack of VOC WEP information probably isn't significant. Table 8 provides the VOC WEP data used to determine the state level and source category SOA apportionment in Figure 3 above. The VOC WEP estimates natural SOA (denoted in green) at about 87%, which is pretty close to ≈80% estimate produced from the OC PSAT modeling listed in Figure 3.

Table 8: GRSA OC WEP for 2018PRP emission inventory

Great Sand Dunes National Monument, CO																					
Weighted Emissions Potential for 2018 Worst Days - WRAP Base18b Emission Inventory																					
Species	Source Category	AZ	CA	CO	CO%	ID	MT	NV	NM	ND	OR	SD	UT	WA	WY	PO	CENRAP	East US	Mex	Can	Sub
VOC	Point	0.0537	0.0343	0.5545	11.7%	0.001	0.0012	0.0033	0.4528	0.0002	0.0065	0.0003	0.0426	0.0036	0.0147	0.0195	0.143	0.0042	0.013	0.0014	170.2262
VOC	Area	0.7218	0.2233	1.8773	39.6%	0.0682	0.0076	0.0481	0.7057	0.0029	0.0708	0.0077	0.1348	0.0364	0.0136	0.036	0.5932	0.0169	0.1767	0.0408	603.1569
VOC	WRAP Area O&G	0.0003	0.009	0.4691	9.9%	0	0.0004	0	2.8306	0.0004	0	0	0.12	0	0.0915	0.0009	0.005	0	0	0	444.8753
VOC	Off-Shore	0	0.0122	0	0.0%	0	0	0	0	0	0	0	0	0	0	0.127	0.0001	0.0057	0	0	18.2968
VOC	On-Road Mobile	0.2411	0.0945	0.9918	20.9%	0.0038	0.0027	0.0233	0.1736	0.0002	0.0075	0.001	0.0546	0.0073	0.0026	0.0136	0.13	0.006	0.0782	0.0069	231.9268
VOC	Off-Road Mobile	0.1819	0.0778	0.8326	17.6%	0.0048	0.0013	0.0201	0.1125	0.0005	0.0054	0.0018	0.049	0.0057	0.0044	0.013	0.0794	0.005	0.013	0.0025	177.9494
VOC	Road Dust	0	0	0	0.0%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VOC	Fugitive Dust	0	0	0	0.0%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VOC	WB Dust	0	0	0	0.0%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VOC	Anthro Fire	0.003	0.0025	0.0157	0.3%	0.0011	0.0002	0	0.0037	0	0.0013	0	0.001	0.0028	0.0003	0	0.0475	0.0004	0.0001	0	10.0498
VOC	Natural Fire	0.0451	0.0008	0.0042		0.0006	0.0004	0.0001	0.0139	0	0.0008	0.0004	0.0091	0.0001	0.0004	0	0	0	0	0.0001	9.5976
VOC	Biogenic	7.5251	2.3738	52.5425		0.2464	0.1773	0.8519	11.108	0.0145	0.2586	0.1329	3.9441	0.1105	0.2867	0.1345	3.2865	0.1109	3.5838	0.1025	10946.72
Natural SOA	86.87%	7.5702	2.3746	52.5467	0	0.247	0.1777	0.852	11.1219	0.0145	0.2594	0.1333	3.9532	0.1106	0.2871	0.1345	3.2865	0.1109	3.5838	0.1026	12612.799
Colorado	5.74%			4.741	100%																
Can, Mex & PO	0.54%															0.21			0.281	0.0516	
Other WRAP States	6.81%	1.2018	0.4536			0.0789	0.0134	0.0948	4.2789	0.0042	0.0915	0.0108	0.402	0.0558	0.1271						
CENRAP	1.00%																0.9982				

Table 9 provides the OC emission inventory data that is associated with primary aerosols, and the VOC emission inventory data that is associated with secondary aerosols. Similar to Tables 4 and 5, point and area source VOC emissions can be determined from MS EXCEL pivot tables. Primary OC is not inventoried by Colorado, so OC SCC specific data isn't available in the pivot tables.

Table 9: Colorado OC and VOC 2018PRP emission inventories

Region	Scenario	Year	Point	Anthro Fir	Natural Fire	Biogenic	Area	WRAP Area	Off-Shore	On-Road Mo	Off-Road M	Road Dust	Fugitive D	WB Dust
Organic Carbon														
CO	Prp18a	2018	3.0	620.8	30,580.7		8,737.9	-		1,288.1	865.1	135.1	676.9	

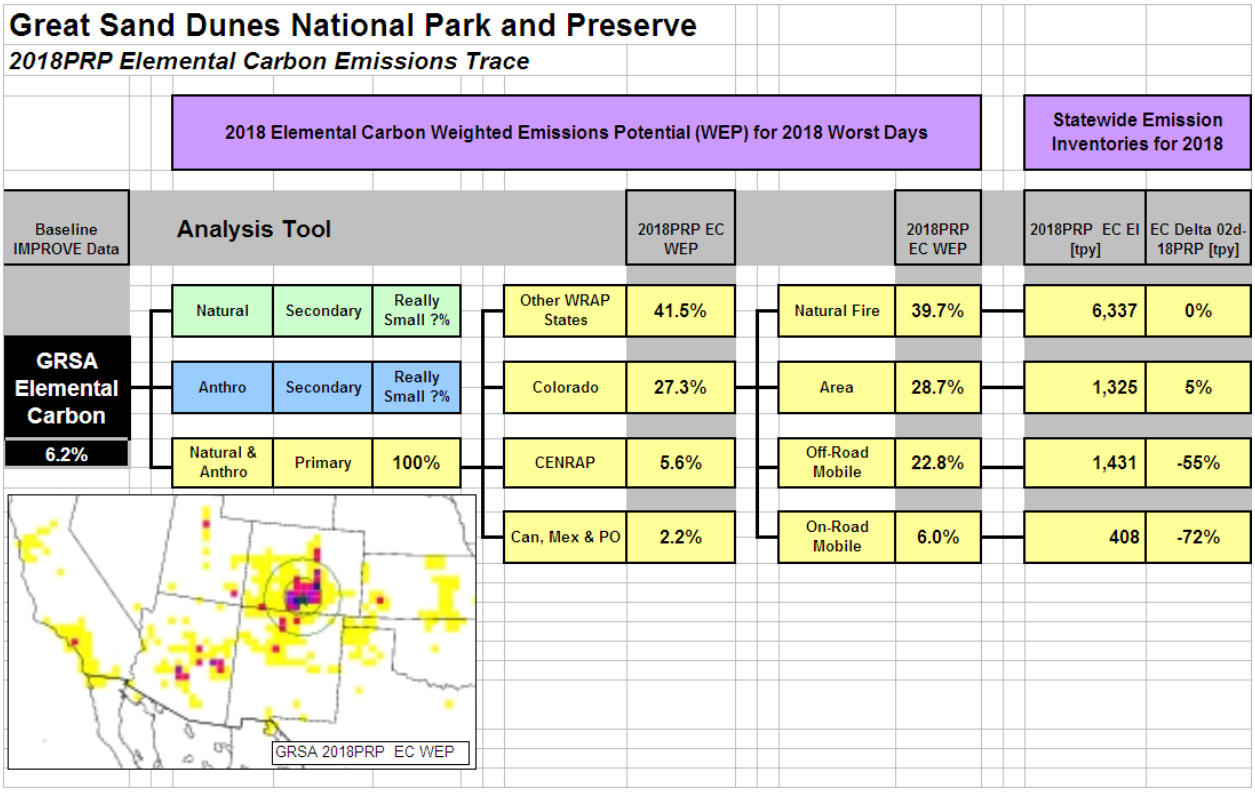
Region	Scenario	Year	Point	Anthro Fir	Natural Fire	Biogenic	Area	WRAP Area	Off-Shore	On-Road Mo	Off-Road M	Road Dust	Fugitive D	WB Dust
Volatile Organic Carbon														
CO	Prp18a	2018	77,529.0	665.5	20,404.1	804,776.8	136,032.1	43,639.3		41,488.8	25,003.6			

Elemental Carbon Emissions Trace

Elemental carbon is produced during the combustion of carbonaceous fuels and is very effective at absorbing light. Figure 4 illustrates an example EC ET for GRSA that is based on PRP emission projections for 2018.

Unlike sulfate, nitrate and OC, PSAT modeling was not done for EC, so the EC WEP tool is used to determine state apportionment and source categories similar to the OC WEP data listed in Table 7. Colorado doesn't inventory EC emissions, so SCC specific data isn't available in the pivot tables.

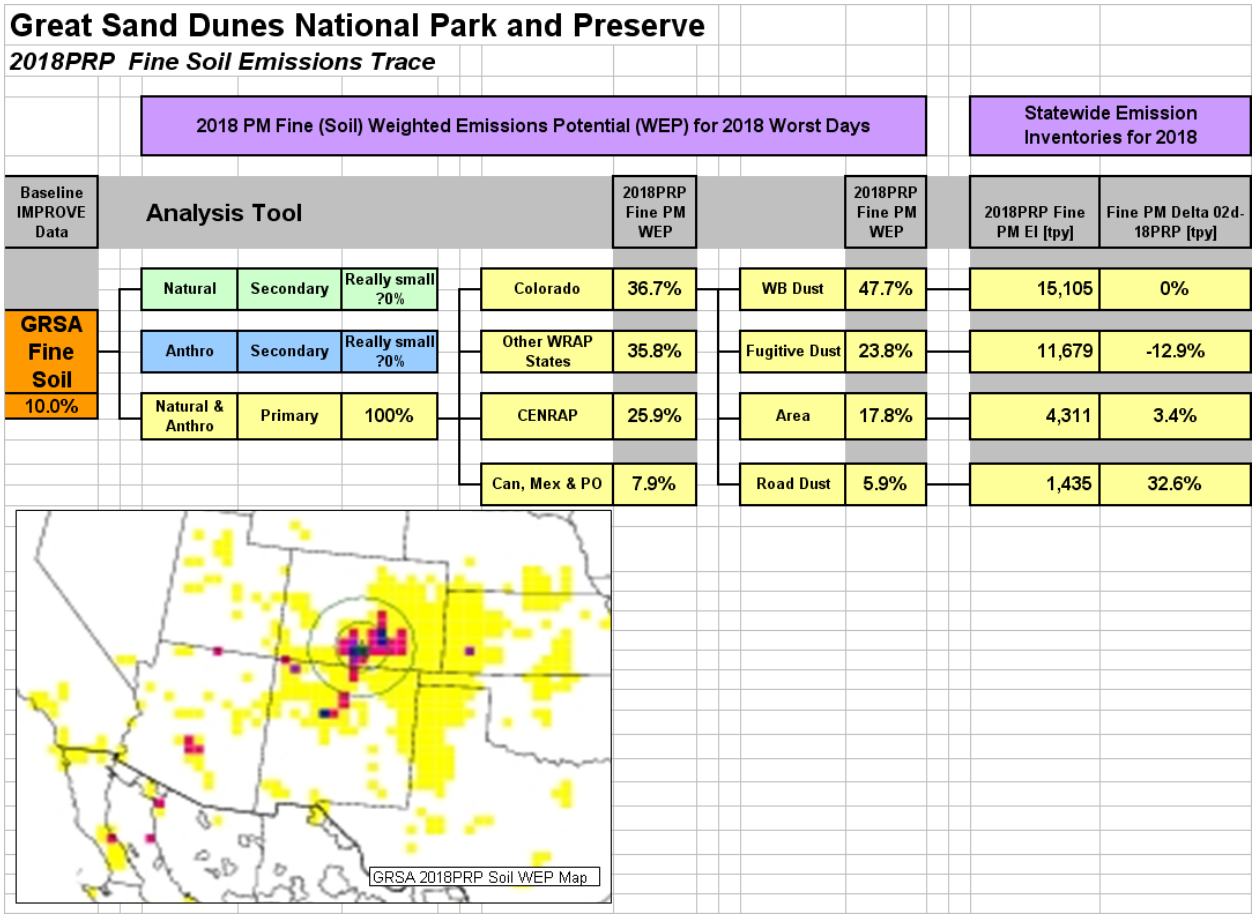
Figure 4: 2018 PRP EC emissions trace for GRSA



Fine Soil Emissions Trace

Fine soil measured at the IMPROVE monitor is determined from captured fine particles of aluminum, silica, calcium, iron and titanium that are assumed to come from wind blown dust, fugitive dust and road dust. The WEP analysis uses emission inventory information for fine particulate matter (PM <2.5 μm in diameter), which probably doesn't directly correspond to fine soil thereby creating some uncertainty in sources and effective control measures. Figure 5 illustrates an example Fine Soil ET for GRSA that is based on PRP emission projections for 2018.

Figure 5: 2018 PRP Fine Soil emissions trace for GRSA

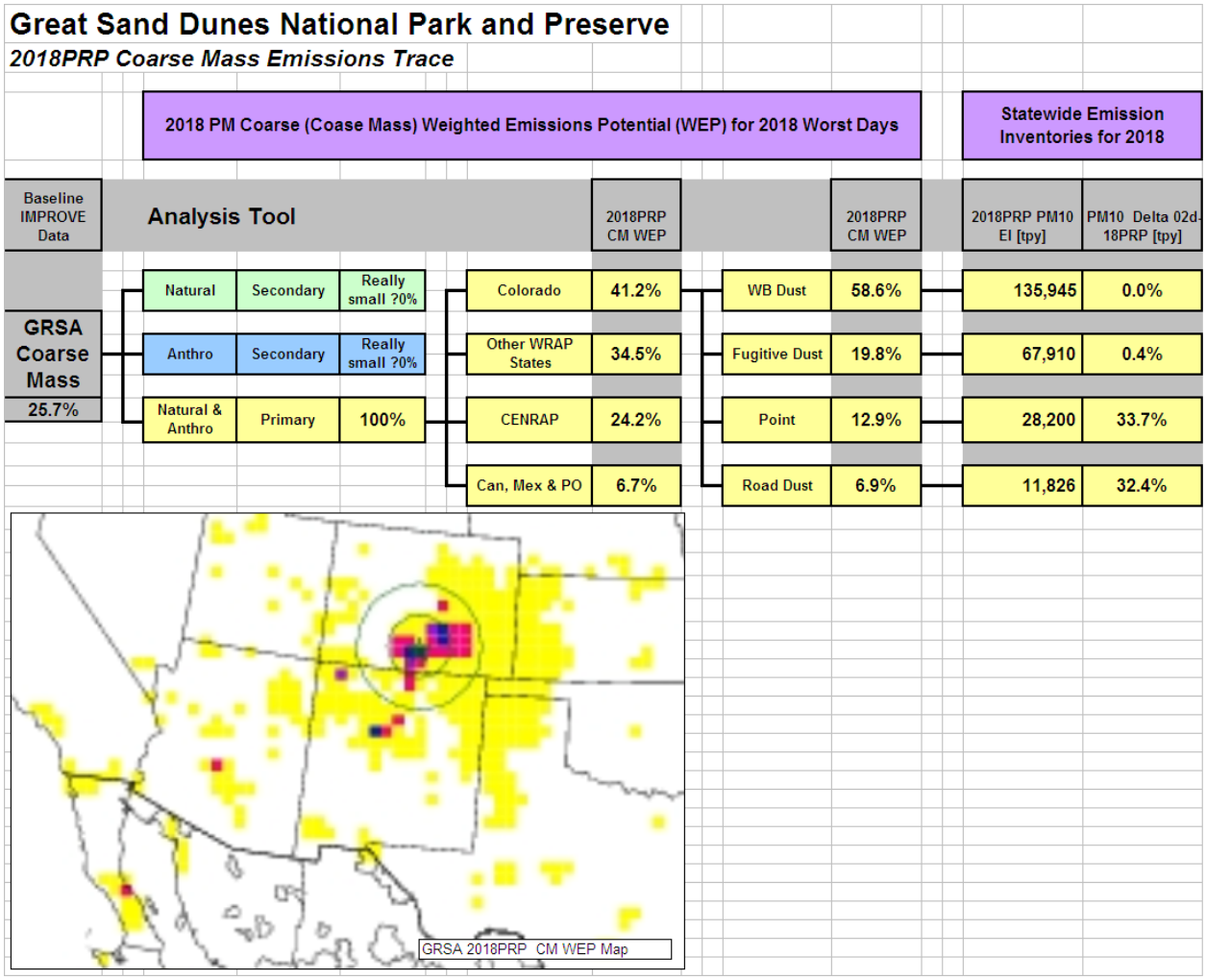


The fine PM WEP tool is used to determine state apportionment and source categories similar to the OC WEP data listed in Table 7. Colorado will begin to inventory fine PM emissions next year; although it appears that the correlation between inventoried fine PM and monitored fine soil is poor. Therefore it is unlikely that potential controllable fine soil source categories can be identified through a fine PM emission inventory process.

Coarse Mass Emissions Trace

Coarse mass is defined as the difference between PM10 and PM2.5 measured at the IMPROVE monitor. The WEP analysis uses the coarse portion of PM to apportion state level impacts and contributing source categories. Figure 6 illustrates an example CM ET for GRSA that is based on PRP emission projections for 2018.

Figure 6: 2018 PRP Coarse Mass emissions trace for GRSA



Looking at the above Colorado source categories, it appears that windblown and fugitive dust comprises the majority of CM emissions.

Conclusions

The Colorado Emissions Trace provides a compact consolidation of a vast array of complex technical information into a simplified graphical display for the six visibility impairing pollutants. The ET provides clarity on which pollutants and source categories are significant along with apportionment of state level impacts. Moreover, the ET is designed to provide a quick high-level summary for each Class I area of what is known and the limitations for each pollutant along with the modeling and tools used to support the technical analysis. In the Regional Haze process, where consultation with federal land managers and coordination with nearby states is required, the ET can be helpful since so much technical information can summarized into a few pages. The ET can be easily updated with new modeling or data because the ET is generated in a spreadsheet that can be interlinked with other information.

References

[1] Colorado Department of Public Health and Environment - Air Quality Control Commission, "Ambient Air Quality Standards [5 CCR 1001-14]"; p21.

[2] Watson, J.; Blumenthal, D., et al., "Final Report – MZVS, Mount Zirkel Visibility Study"; http://vista.cira.colostate.edu/improve/Studies/ZIRKEL/FinalReport/zirkelfinalreport.htm

Key Words

Emissions Trace
Regional Haze
Sulfate
Nitrate
Organic Carbon
Elemental Carbon
Fine Soil
Coarse Mass
Emission Inventory