

Western Regional Modeling and Analysis Platform

2014 Modeling Update for March 12, 2020

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WRAP RTOWG Webinar

March 12, 2020

RAMBOLL

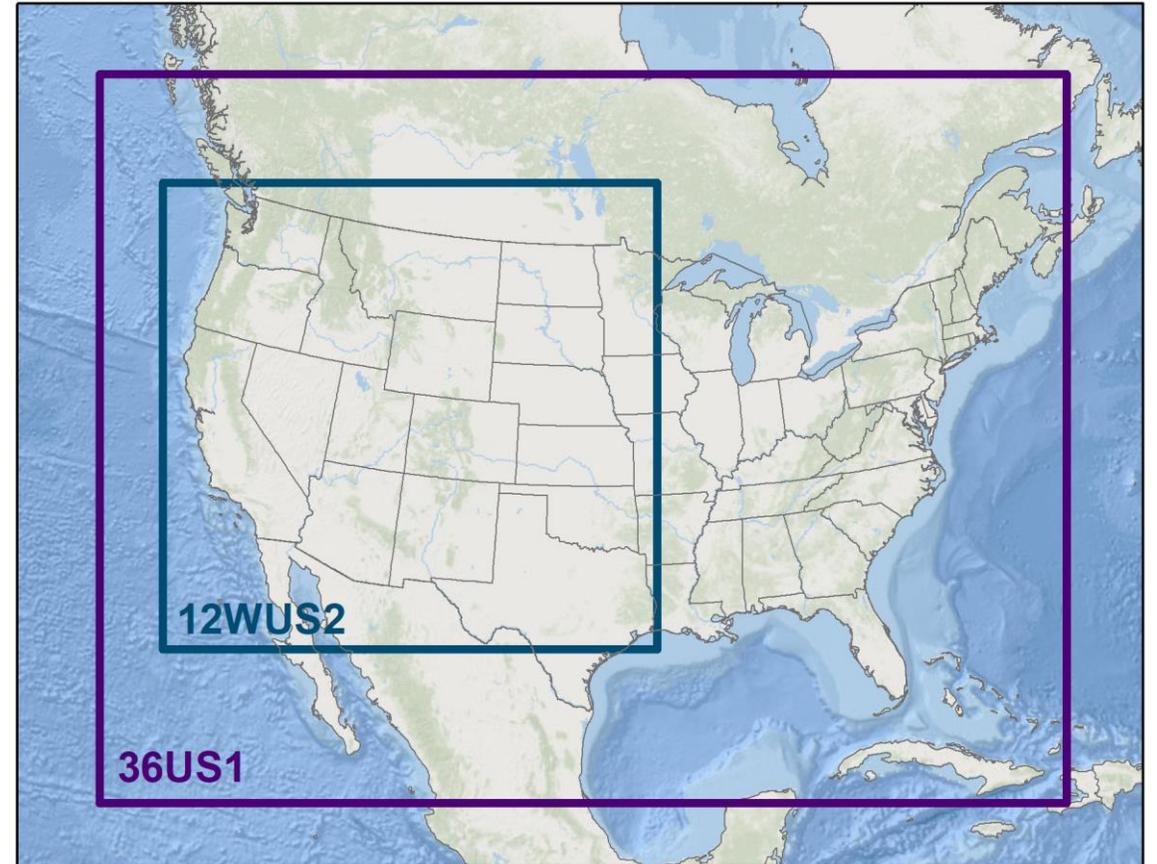


The Show So Far – WRAP 2014 Modeling

- RTOWG webinar Jan 22, 2020 on CAMx 2014v2 MPE
- Last RTOWG webinar on Feb 26, 2020 covered the following:
 - Compare CAMx 2014v2 and Representative Baseline Modeling Results
 - Weighted Emissions Potential/Area of Influence (WEP/AOI)
 - Completed through Residence Time analysis (AOI) -- Need 2028 EI for WEP
 - 2028 Emissions and Modeling Update -- Preliminary 2028 Emissions
 - Five Run Specification Sheets (posted for Comments)
- Today's (Mar 12, 2020) Content
 - Initial WEP analysis for CIAs
 - Overlay gridded emissions (e.g., SO₂) on EWRT (e.g., B_{AmmSO4})
 - White Paper on 2028 Visibility Projection approaches
 - Comments on 5 Run Specification Sheets
 - Next Steps

WRAP/WAQS 2014 Modeling Platform

- WAQS 2014 36/12-km WRF Meteorology
- BCs based on WRAP 2014 GEOS-Chem
- 2014v2 NEI w/ State Updates Emissions
 - Model Performance Evaluation
- RepBase (2014-2018) Emissions
 - NAT and ZROW Zero-Out
 - Source Apportionment
- 2028OTBa & 2028OTBb Emissions
 - (a) RepBase and (b) 2014 Actual Fires
 - 2028 Visibility Projections
 - Source Apportionment
- Dynamic Evaluation
 - 2002 Emissions



2028 Source Sectors

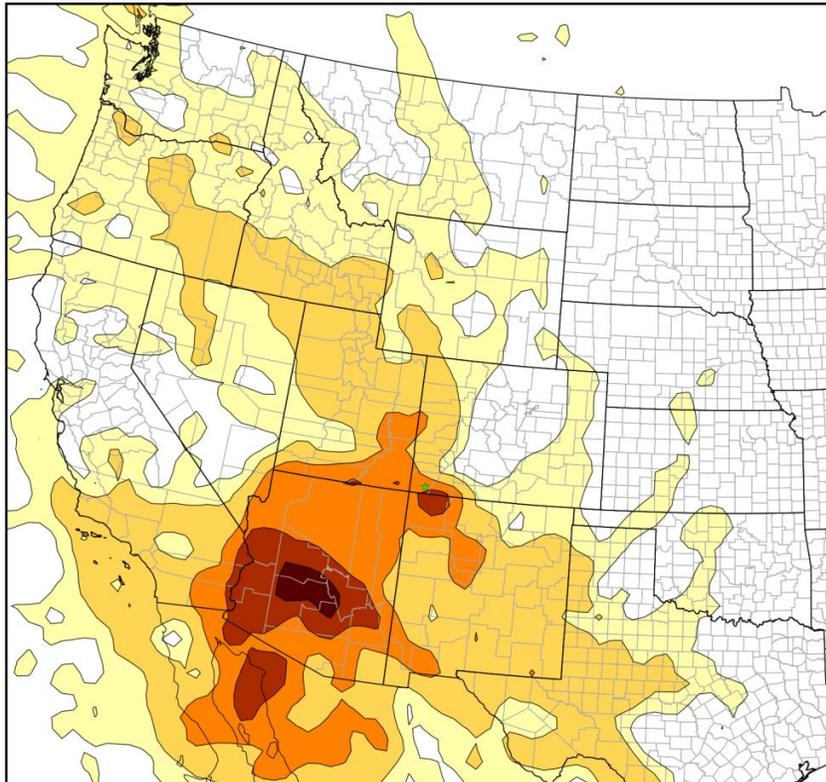
- Last step of WEP is to overlay gridded emissions on EWRT
- Current using “Combined Sector” from SMOKE emissions processing
 - California ARB provided emissions that were processed separately with most low-level sectors not disaggregated
 - Results in incomplete gridded emissions source sectors for some categories
 - Emissions for California and non-California states in different gridded files
- California currently disaggregating their low-level emissions so that proper source sector analysis can be performed

WRAP2014v2	WRAP RepBase	2028OTB	Combined Sector
afdust_wrapv2_adj	afdust_adj	afdust_adj	afdust_adj
ag_wrapv2	ag	ag	ag
cmv_c1c2_wrapv2	cmv_c1c2 (point only)	cmv_c1c2 (point only)	CMV_c1c2c3
cmv_c3 (point only)	cmv_c3 (point only)	cmv_c3 (point only)	
nonpt_wrapv2	nonpt	nonpt	nonpt
nonroad_wrapv2	nonroad	nonroad	nonroad
np_oilgas_wrapv2_only	np_oilgas	np_oilgas_wrap_only	np_oilgas
np_oilgas_wrapv2	np_oilgas_Nowrap	np_oilgas	
onroad	onroad	onroad	Non-US
onroad_can	onroad_can	onroad_can	
onroad_mex	onroad_mex	onroad_mex	
othafdust_adj	othafdust_adj	othafdust_adj	
othar	othar	othar	
othpt (point only)	othpt (point only)	othpt (point only)	
	othptdust_adj	othptdust_adj	
ptegu_wrapv2	ptegu_nonwrap (point only)	ptegu_nonwrap (point only)	ptegu
	ptegu_wrap (point only)	ptegu_wrap	
	airport	airport	ptnonipm
ptnonipm_wrapv2	ptnonipm_nonwrap (area+point)	ptnonipm_nonwrap (area+point)	
		ptnonipm_wrap (area+point)	ptnonipm_wrap (area+point)
pt_oilgas_wrapv2_only	pt_oilgas (area+point)	pt_oilgas_wrapv4_only	pt_oilgas
pt_oilgas_wrapv2	pt_oilgas_NOwrap (area+point)	pt_oilgas_wrapv4	
rail_wrapv2	rail	rail_wrapv4	Rail
rwc_wrapv2	rwc	rwc_wrapv4	Rwc
aircraft (area+point)	aircraft (same as base)	aircraft 2028 (area+point)	CARB-aircraft
Area	Area	Area 2028	CARB-area
FertNH3_gentpro	FertNH3_gentpro	FertNH3_gentpro 2028	
LivestockNH3_gentpro	LivestockNH3-gentpro	LivestockNH3-gentpro 2028	CARB-Ag
OGV_Area	OGV_Area (same as base)	OGV_Area 2028	CARB-OGV
OgvPorts (point only)	OgvPorts (same as base)	OgvPorts 2028 (point only)	
onroad	onroad	onroad 2028	CARB-onroad
Point (point)	Point (same as base)	Point 2028 (point)	CARB-Point
RoadDust_Paved	RoadDust_Paved	Roaddust_Paved 2028	CARB-Roaddust
RoadDust_Unpaved	RoadDust_Unpaved		
RWC	RWC	RWC 2028	CARB-RWC

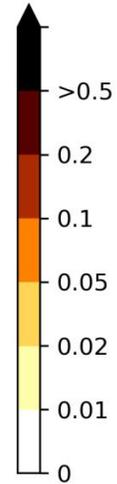
Extinction Weighted Resident Time

- **MEVE Residence Time**

MEVE1 - 20% Most Impaired Days
Allm Distance Weighted Residence Times (%)

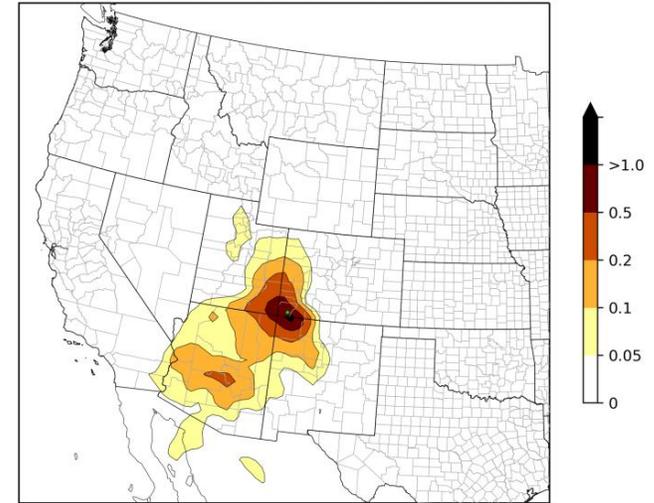


B_{AmmNO3}

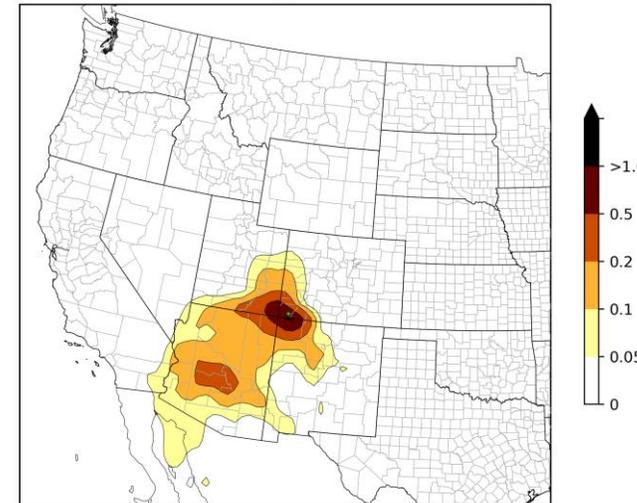


B_{AmmSO4}

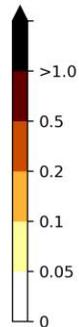
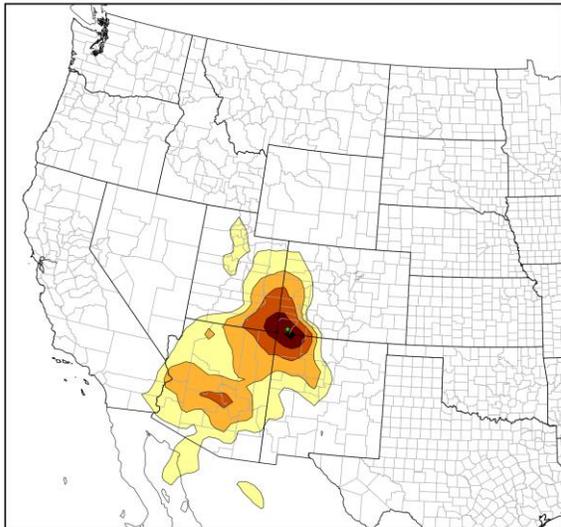
MEVE1 - 20% Most Impaired Days
Allm NO3 Extinction Weighted Residence Times (%)



MEVE1 - 20% Most Impaired Days
Allm SO4 Extinction Weighted Residence Times (%)



MEVE1 - 20% Most Impaired Days
Allm NO3 Extinction Weighted Residence Times (%)



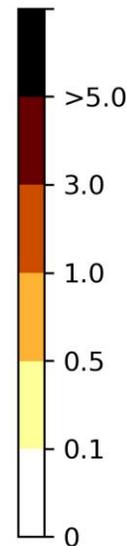
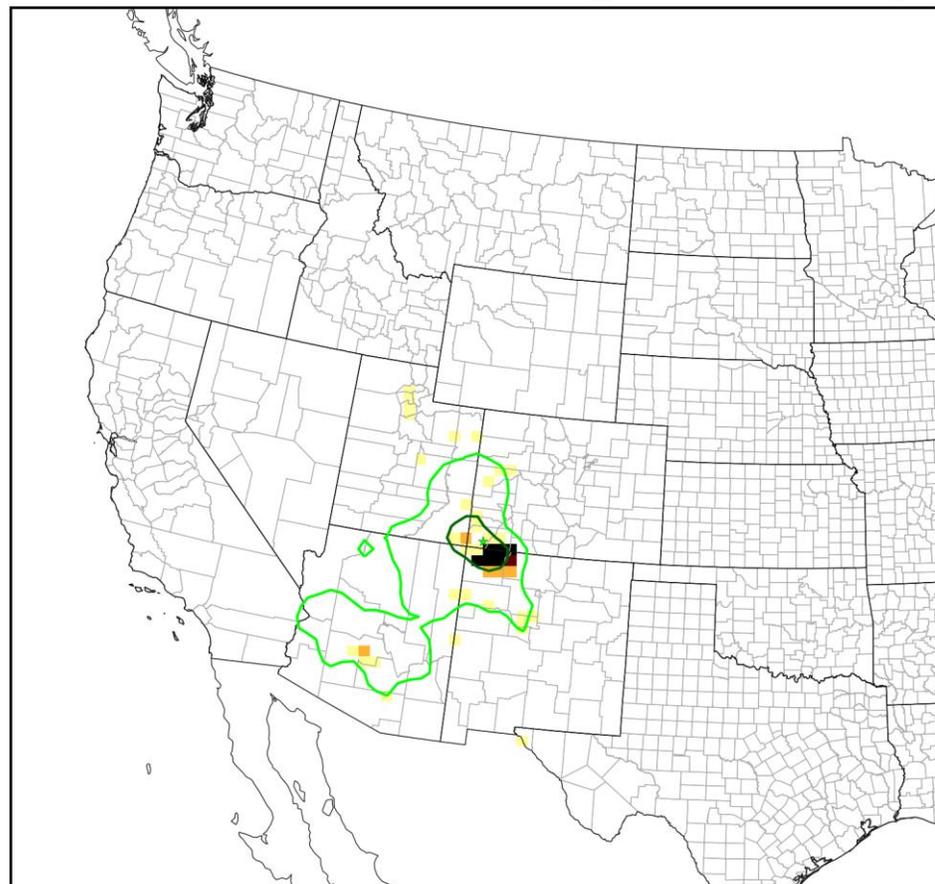
B_{AmmNO_3}
EWRT

=

Weighted Emissions Potential (WEP)

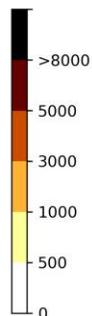
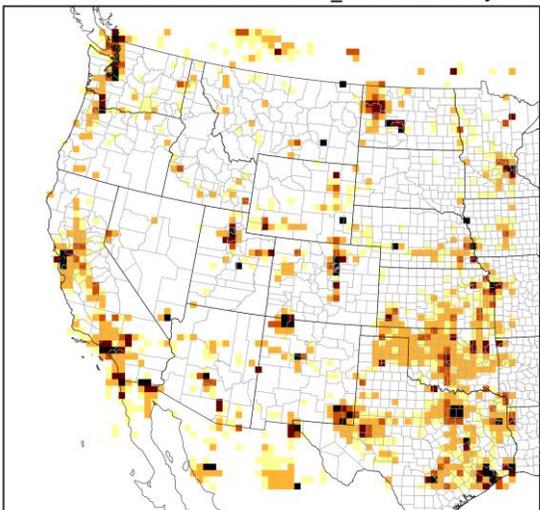
MEVE NOx WEP All Anthro

MEVE1 - 20% Most Impaired Days Allm - EWRT
total_anthro NOx Emission Weighted Distance (%)



+

Gridded NOx Emissions - total_anthro (tons/year)

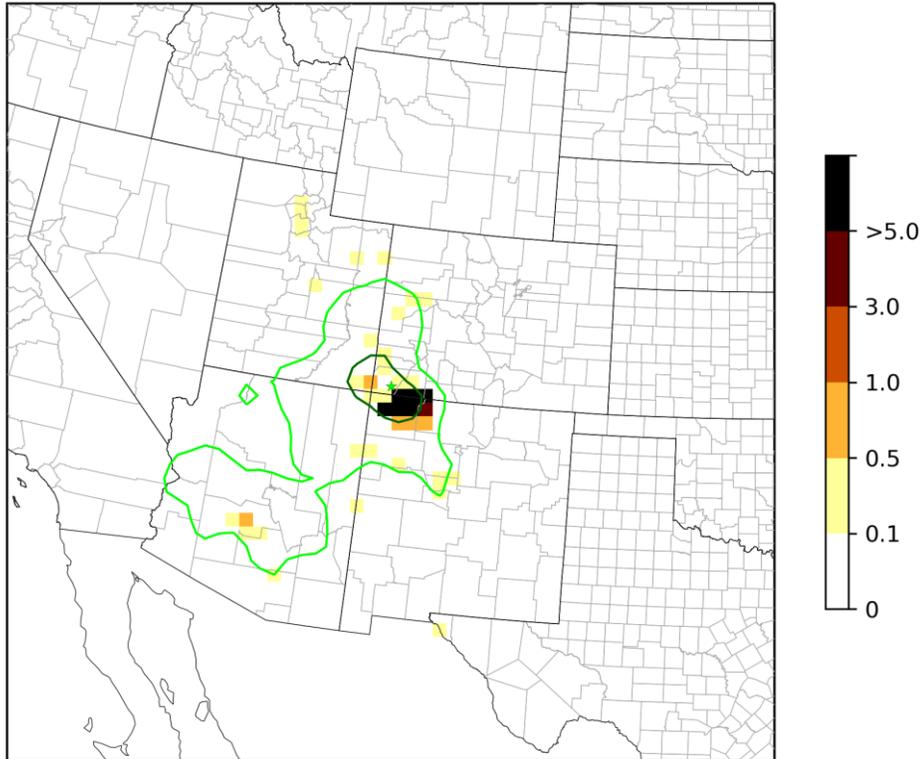


Total
Anthro NOx
Emissions

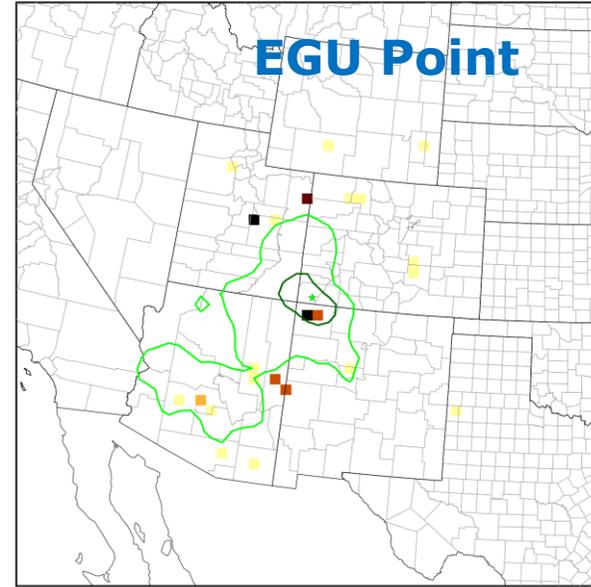
MEVE WEP NOx

Total Anthropogenic

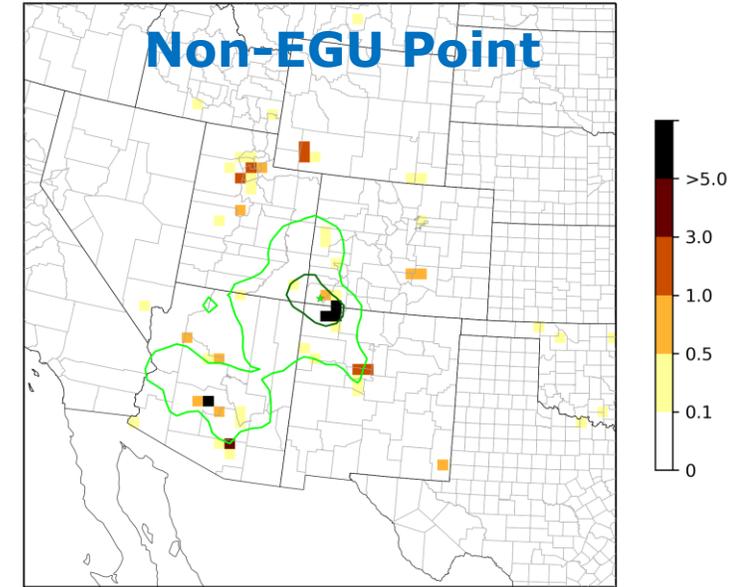
MEVE1 - 20% Most Impaired Days Allm - EWRT
total_anthro NOx Emission Weighted Distance (%)



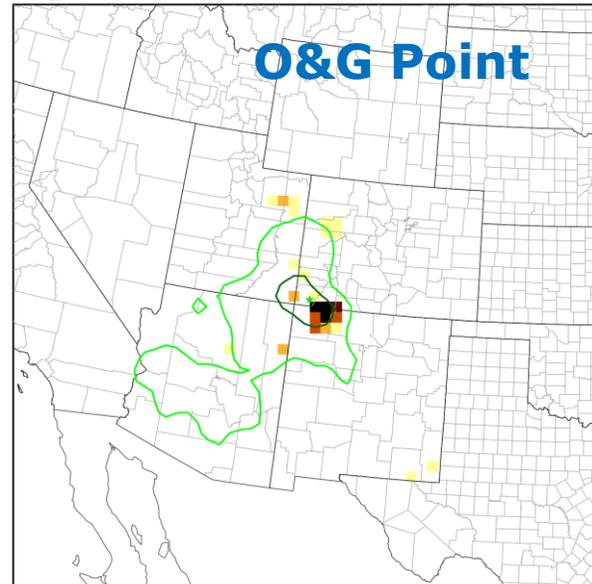
MEVE1 - 20% Most Impaired Days Allm - EWRT
ptegu NOx Emission Weighted Distance (%)



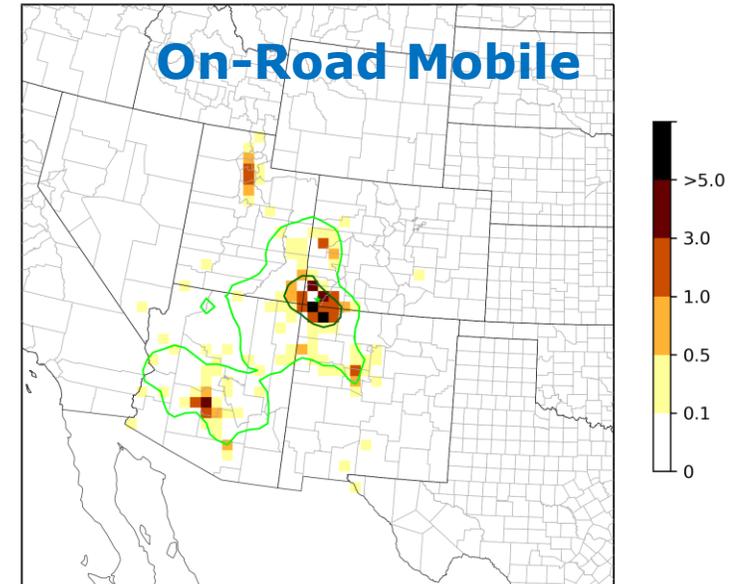
MEVE1 - 20% Most Impaired Days Allm - EWRT
ptnonimp NOx Emission Weighted Distance (%)



MEVE1 - 20% Most Impaired Days Allm - EWRT
pt_oilgas NOx Emission Weighted Distance (%)



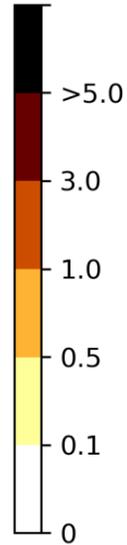
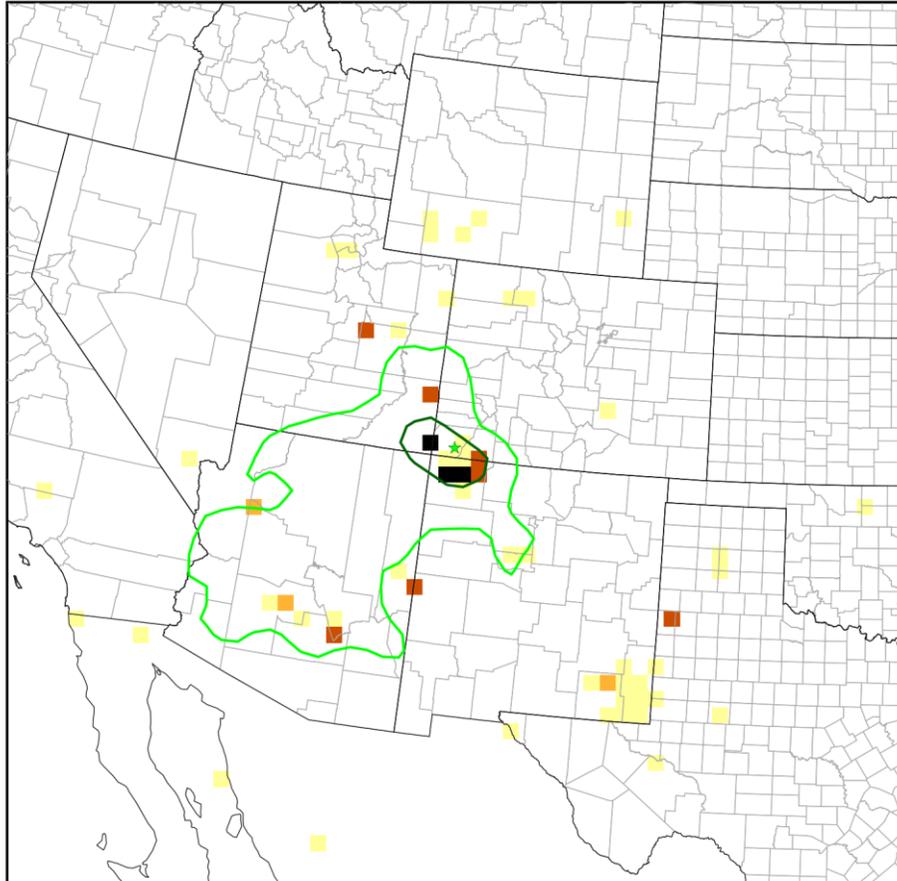
MEVE1 - 20% Most Impaired Days Allm - EWRT
onroad NOx Emission Weighted Distance (%)



MEVE WEP SO2

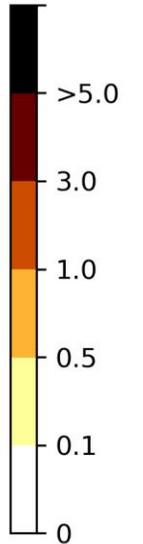
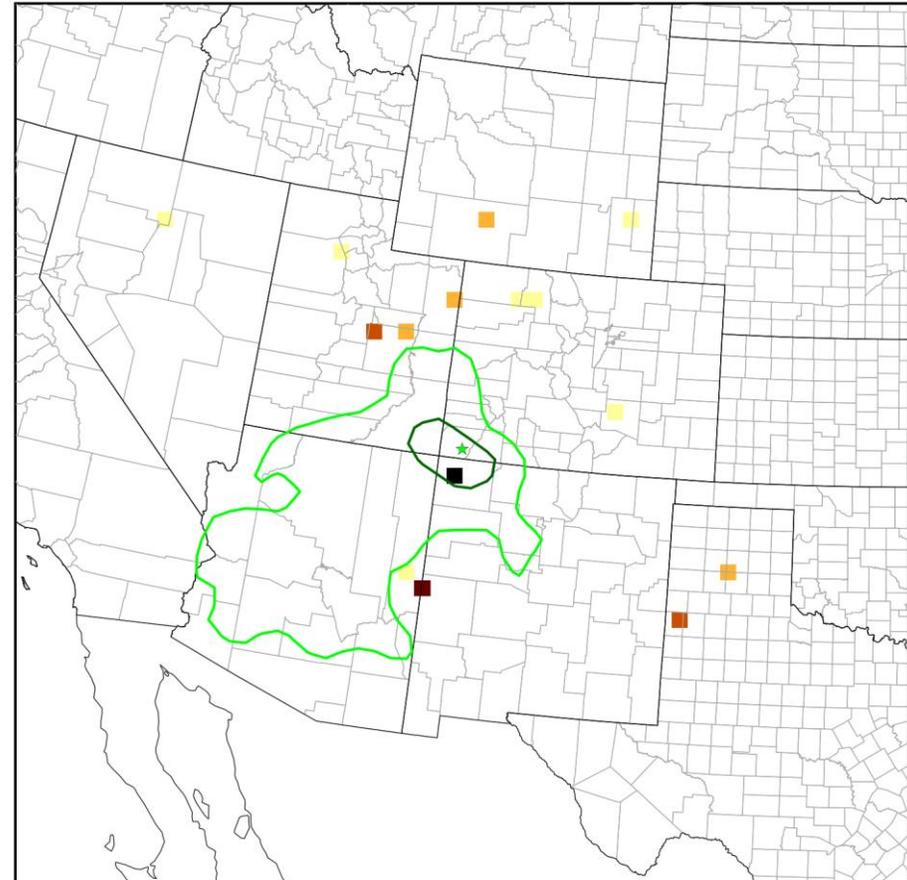
- **Total Anthropogenic**

MEVE1 - 20% Most Impaired Days Allm - EWRT
total_anthro SO2 Emission Weighted Distance (%)



- **Point EGU**

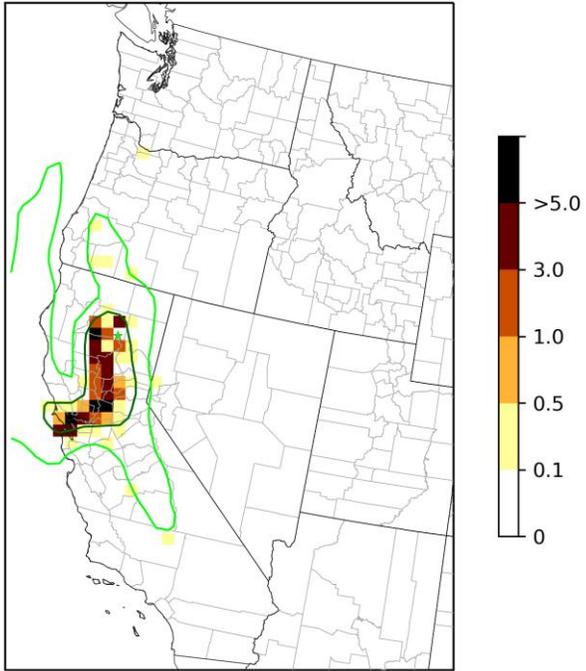
MEVE1 - 20% Most Impaired Days Allm - EWRT
ptegu SO2 Emission Weighted Distance (%)



LAVO1 - 20% Most Impaired Days Allm - EWRT
total_anthro NOx Emission Weighted Distance (%)

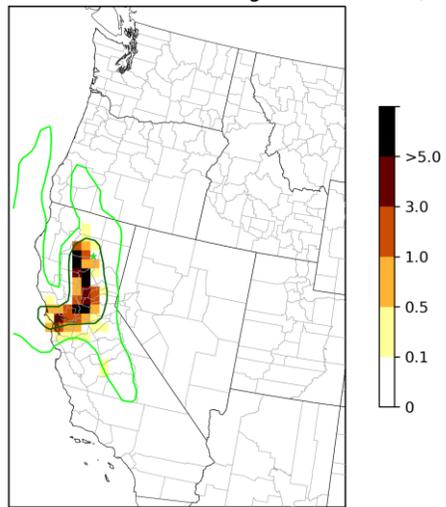
Next Steps WEP Analysis

- Upload basic WEP/AOI Plots to TSS/IWDW Website
 - All Class I Areas (IMPROVE sites)
 - Just total anthropogenic emissions for now
 - Combined trajectory heights
- Wait for California ARB split of low-level source categories for Source Sector plots
 - ARB provided almost all low-level emissions together so not separated
 - Need to re-SMOKE California emissions
 - Needed for 2028 Source Apportionment anyway
 - Will provide more accurate source sector plots



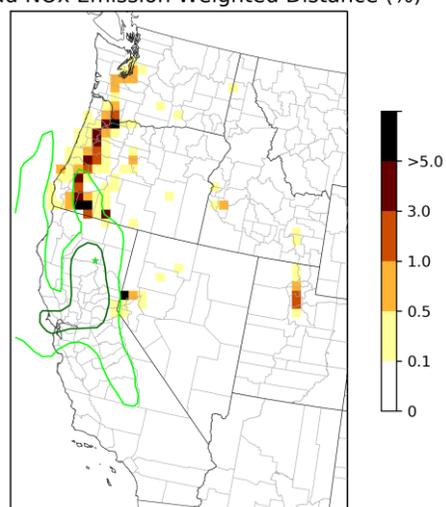
California

LAVO1 - 20% Most Impaired Days Allm - EWRT
CARB-onroad NOx Emission Weighted Distance (%)



Non-California

LAVO1 - 20% Most Impaired Days Allm - EWRT
onroad NOx Emission Weighted Distance (%)



2028 Visibility Projection White Paper

- Purpose:
 - Document potential approaches for projecting the observed 2014-2018 IMPROVE Most Impaired Days (MID) visibility to 2028 using the WRAP 2014 current and 2028 future year CAMx modeling results
 - WRAP also investigating other ways for using the modeling results to better understand the relationship between reductions in U.S. anthropogenic emissions and progress in reducing visibility impairment at Class I Areas that will be discussed in the future



ENVIRONMENT
& HEALTH

WHITE PAPER

Potential Procedures for Making 2028 Visibility Projections using the WRAP 2014 Modeling Platform

March 11, 2020

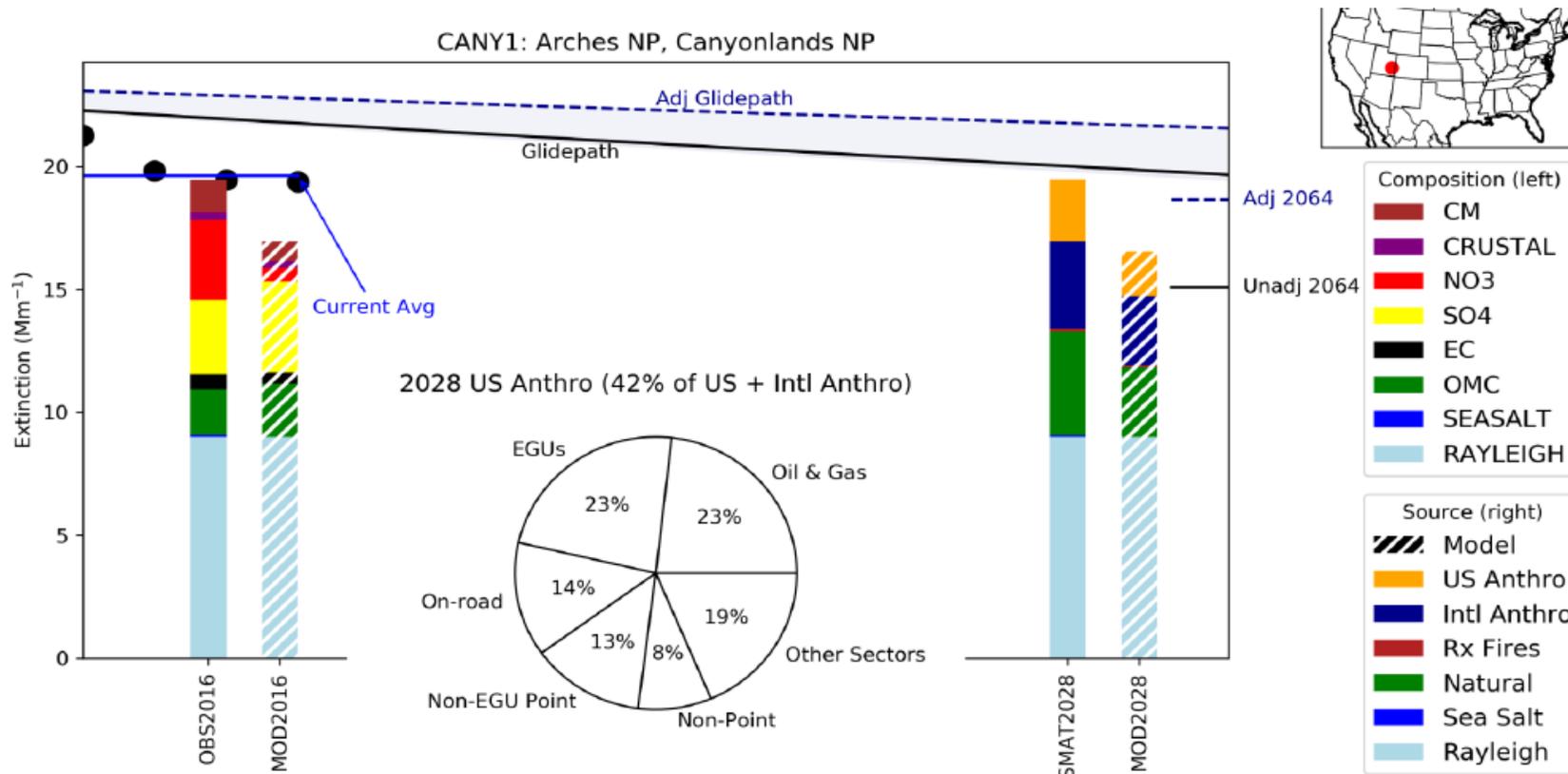
INTRODUCTION

The Western Regional Air Partnership (WRAP) has developed a 2014 Photochemical Grid Model (PGM) modeling platform that is being used to support the development of western states' regional haze State Implementation Plans (SIPs) due in July 2021. One important use of the WRAP 2014 PGM modeling platform is to make 2028 visibility projections for comparison with the Uniform Rate of Progress (URP) Glidenath. The URP Glidenath is a straight line of visibility impairment (in derisview) from the 2000-



Example URP Glidepath from EPA National Modeling

- URP Glidepath: observed 2000-2004 IMPROVE MID visibility to Natural Conditions in 2064
 - Use current and 2028 future year modeling results to project observed 2014-2018 IMPROVE MID visibility to 2028 (SMAT2028) for comparison with URP Glidepath



Basic 2028 Visibility Projection Approach

- IMPROVE Most Impaired Days (MID) uses a statistical approach that attempts to identify natural and episodic natural conditions with the remainder assumed to be anthropogenic impairment and the 20% most impaired defining the MID
 - High OA concentrations used to filter out days with wildfire impacts
 - High Soil concentrations used to filter out days with high dust impacts
- Species-specific Relative Response Factors (RRFs) are used to scale the observed concentrations from the 2014-2018 IMPROVE MID to 2028:
 - $PM_{2028} = RRF \times PM_{2014-2018}$
- RRFs are defined as the ratio of the future year to current year modeling results and are Class I Area (IMPROVE site) and species-specific (i.e., SO₄, NO₃, EC, OA, Soil and CM)
 - For example: $RRF(SO_4) = (1/N) \times \sum Model(SO_4)_{2028} / Model(SO_4)_{2014}$
- The subject of how to pick the N days used to defined the RRFs is discussed in the White Paper

WRAP 2014 Modeling Platform Results

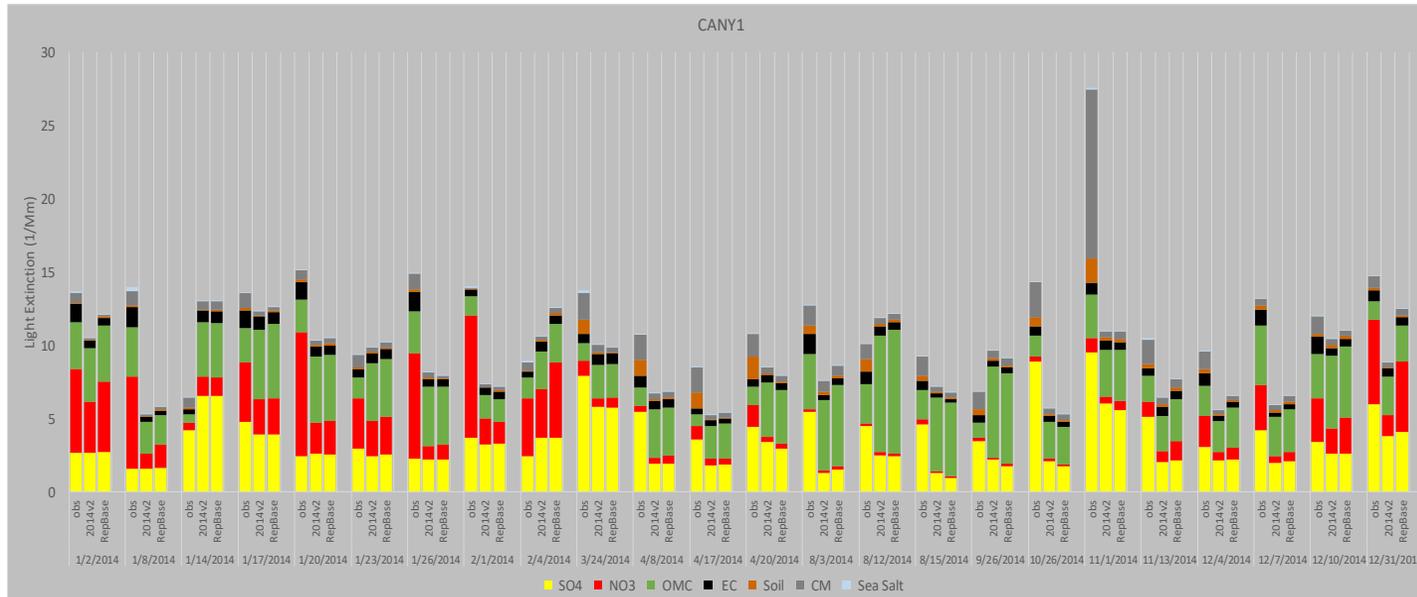
- CAMx photochemical modeling for the 2014 annual period and several emission scenarios:
 - 2014v2: 2014 actual emissions, including actual fires
 - Representative Baseline (RepBase): Anthropogenic emissions representative of the 2014-2018 period. RepBase fires from WRAP FSWG.
 - 2028OTB: U.S. anthropogenic emissions projected to 2028 assuming On-the-Book (OTB) controls, natural emissions kept constant at 2014 levels, two types of fires used:
 - 2028OTBa use RepBase fires
 - 2028OTBb use 2014v2 actual fires
- Results in two sets of CAMx current and 2028 future year emission scenarios that can be used to make 2028 visibility projections:
 - RepBase/2028OTBa using RepBase fires
 - 2014v2/2028OTBb using 2014v2 actual fires

EPA (2018) Recommended 2028 Visibility Projection Approach

- For each aerosol species (SO₄, NO₃, EC, OA, Soil and CM),
 - Calculate Relative Response Factor (RRF) using modeled aerosol concentration:
 - Use modeling results for the days in 2014 IMPROVE MID.
 - Calculate average model concentrations on MID for 2014v2 and 2028OTBb.
 - Calculate average RRF for each species average model concentrations.
 - $RRF = 2028OTBb \text{ divided by } 2014v2$.
 - Apply average RRF for each aerosol species to aerosol concentration for every MID in 5-year period 2012-2016. Define 2028OTB progress for daily MID.
 - Convert daily concentration to extinction and sum extinction across aerosol species for daily MID aerosol extinction.
- Convert total extinction to deciview for daily MID.
 - Average deciview across MID in each of the 5 years.
 - Average deciview MID across 5 years.
- Compare Most Impaired Days for 2028OTBb with 2014v2 fire to 2028 point on URP Glidepath.

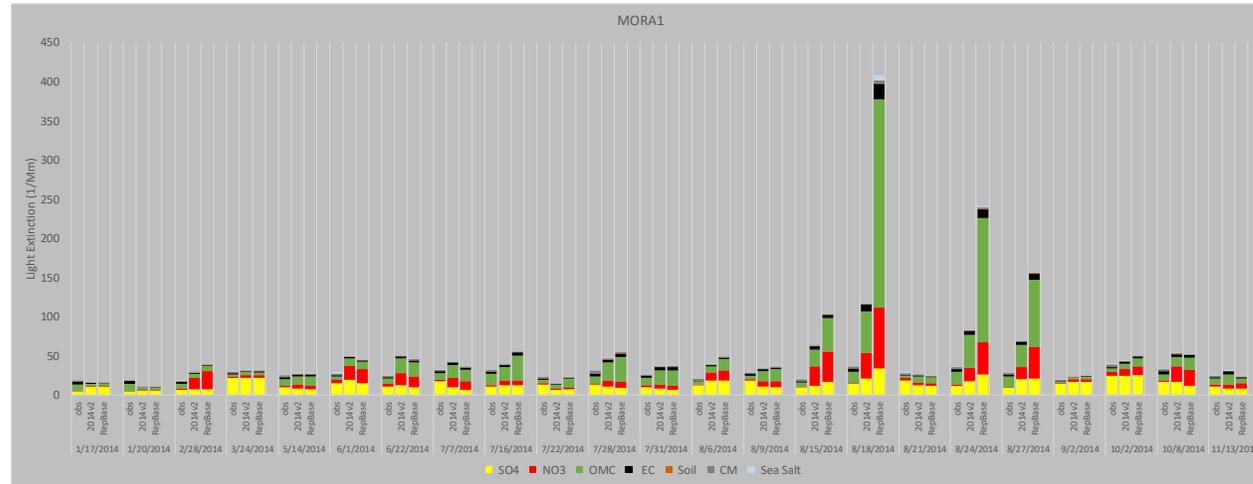
Discussion EPA Recommended Visibility Projection Approach

- The EPA approach develops RRFs using modeling results from the 2014 IMPROVE MID
 - If model has wildfire impacts on 2014 IMPROVE MID that would cause the RRFs to be stiff and underestimate visibility improvements in 2028
 - In theory, RRFs using CAMx 2014v2/2028OTBb modeling results should not have this problem as they use actual 2014 fires so modeled wildfires days should have been screened out of the 2014 IMPROVE MID
 - However, since the RepBase are hypothetical not actual 2014 fires they could have fire impacts on 2014 IMPROVE MID
- Bar Chart of Observed, 2014v2 & RepBase at CANY1 2014 IMPROVE MID – No WF Impacts

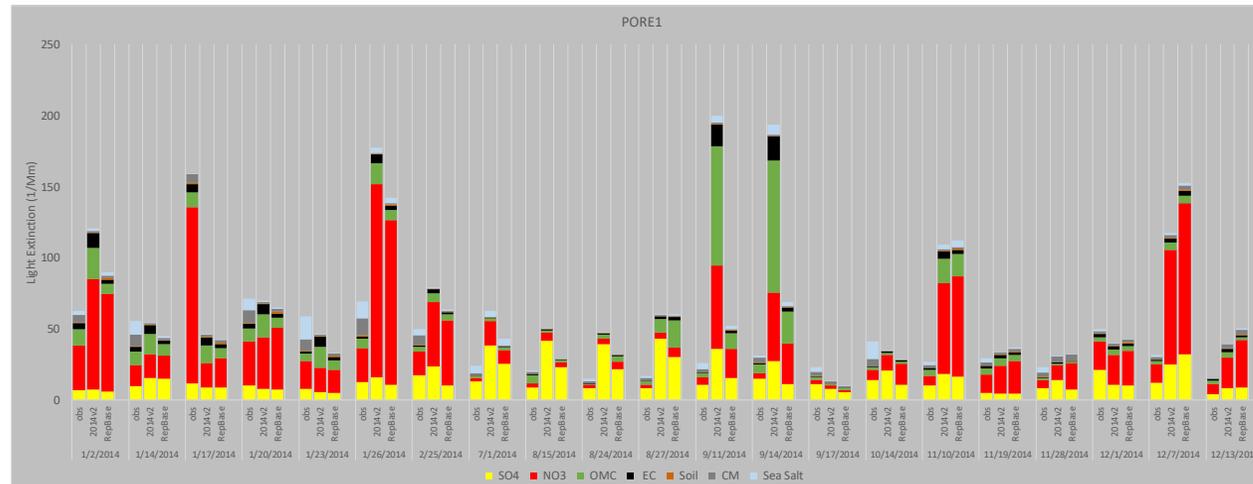


Discussion EPA Recommended Visibility Projection Approach

- Observed, 2014v2 and RepBase at MORA1 for 2014 IMPROVE MID – WF Impacts in RepBase

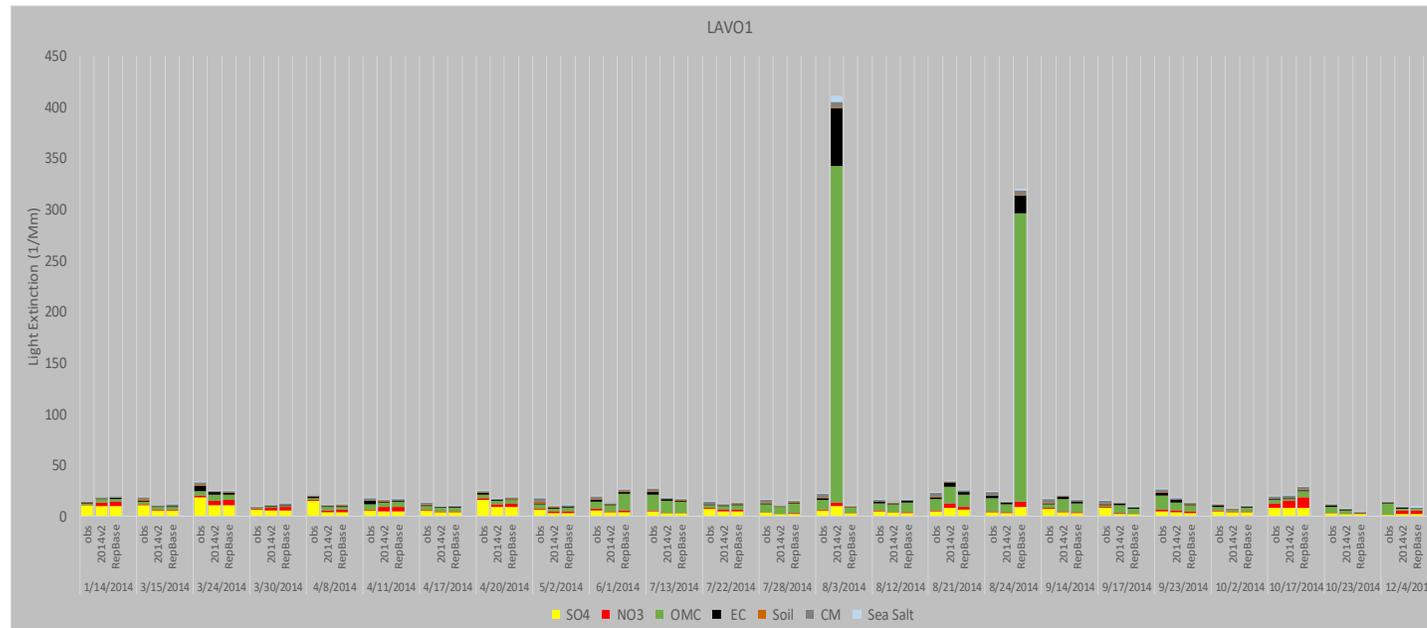


- Observed, 2014v2 and RepBase at PORE1 for 2014 IMPROVE MID – WF Impacts in 2014v2



Discussion EPA Recommended Visibility Projection Approach

- Both CAMx 2014v2 and RepBase have fire impacts at CIAs on the 2014 IMPROVE MID
 - RRFs using EPA approach will not represent MID and be stiff (i.e., close to 1.0) understating the 2028 visibility improvements on the MID
- Alternative to EPA approach (EPAwoF) that screens days with obvious modeled fire impacts
- For example, at LAVO1 below RRFs using 2014v2/2028OTBb would eliminate 8/3/2014 and using RepBase/2028OTBb would eliminate 8/24/2014



Accounting for MPE in RRFs

- Only use days in the RRF that achieve some level of Model Performance Evaluation (MPE)
- Focus on MPE for SO₄ and NO₃
 - Don't use modeled data for RRFs on days in which the observed and modeled SO₄ and/or NO₃ do not achieve some level of MPE (e.g., < 20%)
 - Likely use different acceptance criteria for SO₄ than NO₃
- Would need to include minimum number of days used as don't want RRFs just based on a few days

Modeled Most Impaired Days (ModMID) Approach

- Use RepBase Source Apportionment results to identify the 20% of days without fire and dust impacts that have the highest U.S. anthropogenic emissions visibility impairment
- Summary of Potential 2028 Visibility Projection Approaches:
 - EPA: Use RRFs based on modeled concentrations on the 2014 IMPROVE MID (i.e., EPA recommended approach that is codified in SMAT).
 - EPAwoF: Like EPA approach, only don't use days in the 2014 IMPROVE MID that have obvious modeled fire impacts.
 - ModMID: Use the modeled days with the most U.S. anthropogenic emissions impairment either from all days (ModMID-ALL) or just days with IMPROVE measurements (ModMID-IMP).
 - MPE: Except for ModMID-ALL, the above projection approaches can be adjusted to only use days with a level of SO₄ and NO₃ model performance (EPA-MPE, EPAwoF-MPE, ModMID-IMP-MPE).

Additional Use of Modeling Results

- The EPA, and related projection approaches, uses just a small fraction (up to 24 days or < 7%) of the annual modeling results and WRAP is exploring other options for using modeling results to better understand the relationship between changes in U.S. anthropogenic emissions and changes in visibility impairment over time
 - For example, the 2002 Dynamic Evaluation and RepBase and 2028 Source Apportionment modeling results will allow the estimation of visibility impairment due to U.S. anthropogenic emissions for three time periods:
 - Past 2002 (Dynamic Evaluation)
 - Current 2014-2018 (RepBase)
 - Future 2028 (2028OTB)
 - The trend in U.S. anthropogenic emissions contribution to visibility impairment at CIAs from 2002 to 2028 can be compared with Regional Haze goal of no U.S. man-made impairment in 2064

Questions on 2028 Visibility Projection Approaches

Run Specification Sheets available on IWDW

- Five Run Specification Sheets are currently available on the IWDW Website
 - RepBase and 2028 On-the-Books (2028OTB) Modeling
 - Natural (NAT) and No International (ZROW) GEOS-Chem/CAMx
 - RepBase Source Apportionment Modeling (NAT/ANT & U.S./Intl)
 - Dynamic Evaluation CAMx 2002 Modeling
 - WEP/AOI Analysis
- Additional Run Specification Sheets are under development
 - For Example, 2028 Source Apportionment simulation

Next Steps in WRAP 2014 Modeling

- Upload initial set of WEP products to TSS/IWDW
- CAMx 2028OTBb (w/ actual 2014 fires) about to start
- CAMx RepBase Source Apportionment simulations to start in a couple days
- Finishing 2002 emissions development for Dynamic Evaluation over next week or so
 - Then start CAMx 2002 36/12-km simulation
- Integrate comments into 2028 Visibility Projection White Paper
- Work on Webpage documentation on IWDW
 - 2014v2 Model Performance Evaluation
 - WEP/AOI Analysis technical description
- Process California disaggregated emissions prepared by ARB
- Begin preparing for 2028 Source Apportionment simulation
 - 2028 SA Run Specification Sheet