Rocky Mountain National Park

TSS Modeling and Projections Tools

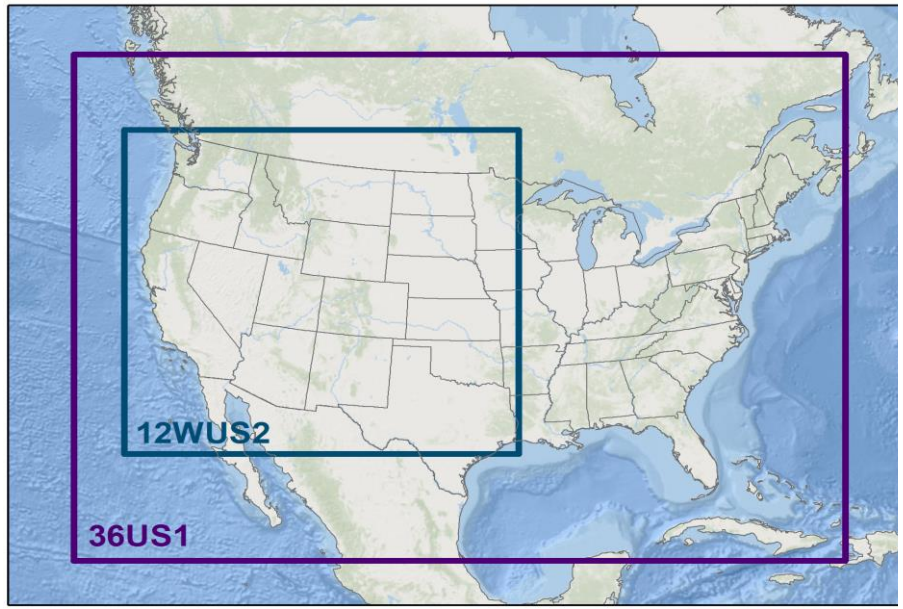
June 23, 2020 WRAP Webinar

Demonstrate TSS tools to support Regional Haze SIPs

I. Case Study: Rocky Mountain National Park
II. TSS navigation: Yellowstone National Park
    a. Model Scenarios compared to Observations
    b. 2028 OTB projections
    c. RepBase Source Apportionment
III. Response to questions

Today's objective is to illustrate navigation for the Modeling and Projection tools

WRAP CAMx 12-km and 36-km domains



RAMBOLL

views.cira.colostate.edu/tssv2/Express/ModelingTools.aspx

WRAP Technical Support System

ANALYSIS DATA HELP

Modeled Data Analysis - Express Tools

The "express" tools below provide the quickest and easiest way to generate data products. They are designed with minimal UI in order to be simple
below corresponds to a single tool that produces a unique report. Make your selections from the dropdown menus and then click the Submit button

Modeled Data Analysis Charts

#	Product	Filters	URL	Actions
1	Annual Extinction MPE (N scenarios) DRAFT	State: Colorado; Group: Most Impaired Days; Model Scenario: 2014v2		Submit
2	Daily Extinction MPE (N scenarios) DRAFT	State: Colorado; Group: Most Impaired Days; Model Scenario: 2 selected		Submit
3	Visibility Projection Methods - Extinction DRAFT	State: Colorado; Group: Most Impaired Days; Model Scenario: 2014v2		Submit
4	URP glidepath with visibility projections DRAFT	IMPROVE Site: YELL2; Parameter: DV		Submit
5	Light Extinction by Source, Horizontal Bars DRAFT	State: Colorado; Group: Most Impaired Days; Parameter: 7 selected		Submit
6	Light Extinction by Source, Vertical Bars DRAFT	State: Colorado; Group: Most Impaired Days; Parameter: 7 selected		Submit
7	Total Source Contributions by Pollutant DRAFT	State: Colorado; Group: Most Impaired Days; Parameter: 7 selected		Submit
8	Daily Modeled Source Contributions DRAFT	State: Colorado; Group: Most Impaired Days; Parameter: AmmSO4		Submit
9	Daily Modeled Extinction Composition DRAFT	State: Colorado; Group: Most Impaired Days; Model Scenario: RepBase		Submit

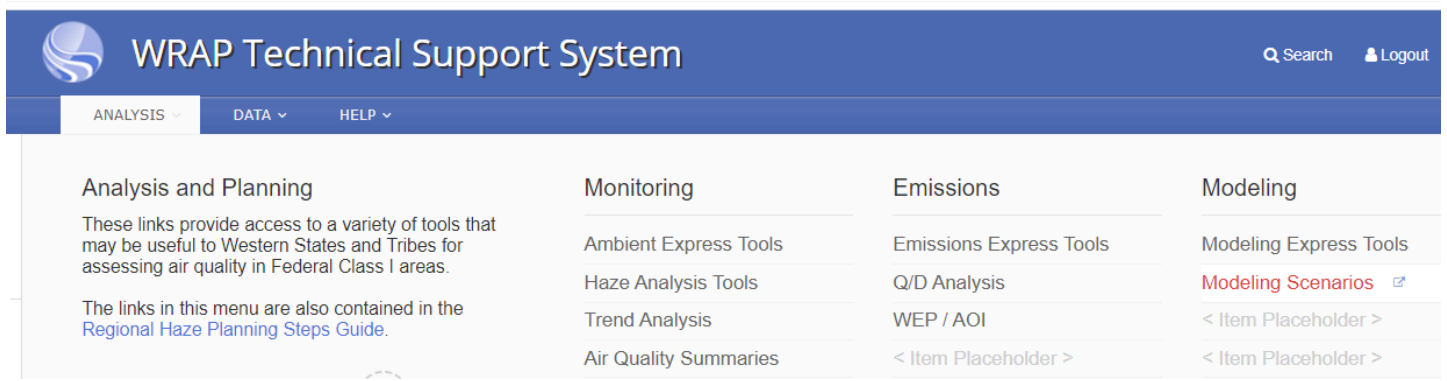
Will add Summary Tables and additional results as available

WESTAR-WRAP Emissions and Modeling Scenarios – Display and Comparison Specifications

draft – *June 11, 2020 update* – draft

highlighted text: blue – complete, green – priority to complete/deliver in June, purple – July and after

Scenario Name	Shakeout v1 & Model Performance Evaluation v2 (2014 emissions / BCs / meteorology)	Representative Baseline (emissions inputs from 2014 through 2018, uses 2014 meteorology)	Regional Haze Planning Goals 2028 Projections (2014 meteorology)	Alternate Outcomes and Contribution Scenarios (2014 meteorology)
Code	A1, A2	B	C1, C2, C3, C4	D1, D2, D3, D4
Timing	April 2019, Jan. 2020	February	March - May	June - August
IWDW	Display emissions, model results, and site-level MPE results) Compares to B, C1-3	Display emissions, model results Compare to A2, C2-3, D1-4	Display emissions, model results Compares to A2, B, C1-3, D1-4	Display emissions, model results Compares to B, C1-4, D4 stand-alone
TSS	Display emissions, model results Compares to B, C1	Display emissions, model results Compare to A2, C2-3, D1-4	Calculate and Display 2028 RPGs Display emissions, model results Compares to A2, B, C1-4, D1-4	Calculate and Display 2028 RPGs Display emissions, model results Compares to A2, B, C1-4, D4 stand-alone
CAMx Modeling Scenarios *(italicized scenarios not yet in contract, or not funded or confirmed)*	A1) 2014v1 (no data display or distribution	B) Representative Baseline w/RepFire[1], also high-level CAMx source apportionment (PSAT / APCA) & zero-out runs	C1)* 2028OTBb w/14fire [2]	D1)** 2028OTBw/ RepFire_SOxNOxPSAT and ozone precursor APCA state by source sector
	A2) 2014v2		C2)* 2028OTBa w/RepFire [1]	D2)* 2028OTB_WildfireFuture [3]
			C3)* 2028PotentialAddtlControls #1 w/ Rep Fire [4]	D3)* 2028OTB_RxFireFuture [4]
			C4)** 2028PotentialAddtlControls #2 w/ Rep Fire [3]	D4)* Dynamic Modeling results and results displays
			C5optional) 2028AsAdoptedAddtlControls w/ Rep Fire [5]	
CMAQ	*A2optional) 2014v2*		*C1optional) 2028OTBb w/14fire [1]*	



Modeling methods are defined in the Modeling Scenario Spec Sheets, hosted on IWDW, now linked on TSS Analysis menu

views.cira.colostate.edu/iwdw/docs/WAQS_and_WRAP_Regional_Haze_spec_sheets.aspx

MODELING EMISSIONS MONITORING WIKI DOCS NEWS HELP

WRAP/WAQS Regional Haze Modeling Scenario Specification Sheets

June 19 update: Listed below are current technical descriptions of Regional Haze modeling. These Modeling Scenario Specification Sheets define modeling simulations conducted using the Western Regional Air Partnership (WRAP)/Western Air Quality Study (WAQS) Regional Haze photochemical grid modeling platform:

Modeling Scenarios for Estimating Reasonable Progress Goals

- Representative Baseline and 2028OTB: Representative Baseline emissions scenarios represents emissions from the 2014-2018 period including using representative fire emissions developed by the Fire and Smoke Work Group (FSWG). Two 2028 On-the-Book emissions scenarios are being developed with 2028OTBa using the FSWG representative baseline fire emissions and 2028OTBb using the 2014 actual fire emissions.
- Dynamic Evaluation 2002 Simulation: The 2014v2 U.S. anthropogenic emissions are being backcast to 2002 and a CAMx 2002 simulation conducted in order to compare modeled and observed changes in visibility between the 2000-2004 Baseline and the 2014-2018 5-year planning periods.

Source Apportionment and Sector Contribution Modeling

- State/Source Sector Source Apportionment Modeling for Regional Haze and Ozone impacts using the 2028 On-the-Books Emissions Scenario
- Source Apportionment Simulations using Current Year Representative Baseline Emissions: The CAMx particulate (PSAT) and ozone (APCA) source apportionment tools will be used to analyze fire, natural, U.S. vs. International anthropogenic emissions and other source contributions to ozone and particulate matter/visibility impairment for the Representative Baseline current year emissions scenario.
- Natural (NAT) and No International Anthropogenic Emissions (ZROW): Paired 2014 GEOS-Chem global and CAMx Representative Baseline emissions regional photochemical model simulations (Geos-Chem provides Boundary Conditions to CAMx) are being carried out that zero-out portions of the anthropogenic emissions inventory: (a) NAT eliminates all anthropogenic emissions world-wide in the GEOS-Chem and CAMx simulations; and (b) ZROW eliminates all non-U.S. (International) anthropogenic emissions (Zero-out Rest of World, ZROW).
- 2028 Weighted Emissions Potential (WEP) / Area of Influence (AOI) *(updated May 15, 2020)*: : HYSPLIT back trajectories are being performed from IMPROVE monitoring sites representing Class I Areas on the IMPROVE Most Impaired Days (MID) during 2014-2018 to rank the source regions and point sources whose emissions would most likely contribute to visibility impairment at a Class I Area on the MID.
- Weighted Emissions Potential (WEP)/Area of Influence (AOI) analyses for Alaska and Hawaii Class I areas

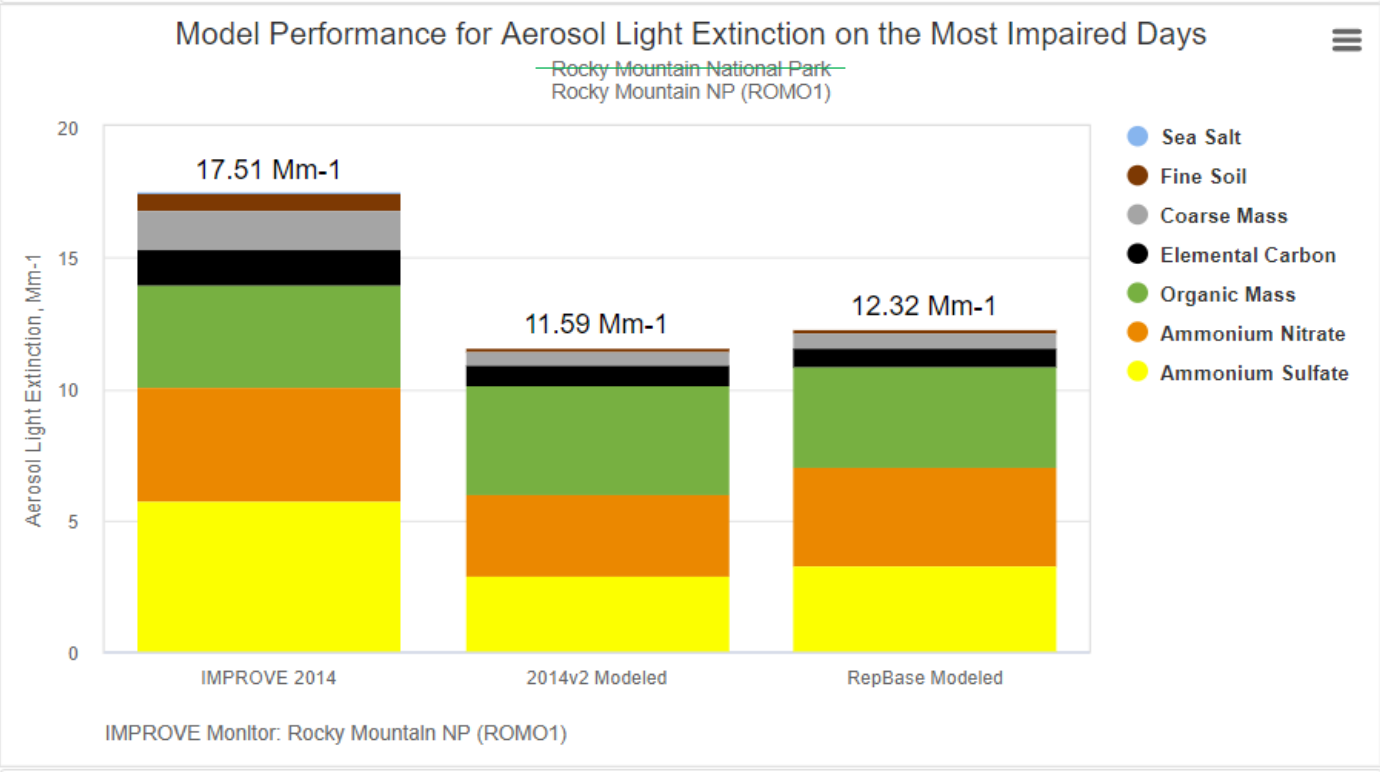
Modeling Chart # 1

Modeled Data Analysis Charts

#	Product	Filters	URL	Actions
1	Annual Extinction MPE (N scenarios) DRAFT	State: Colorado; Group: Most Impaired Days; Model Scenario: 2014v2		Submit

Evaluate model versus observations: average Most Impaired Days (MID)

- IMPROVE 2014 observations vs 2014v2 modeled: model performance
- 2014v2 modeled vs RepBase Modeled: model scenario comparison (e.g. add PAC1)



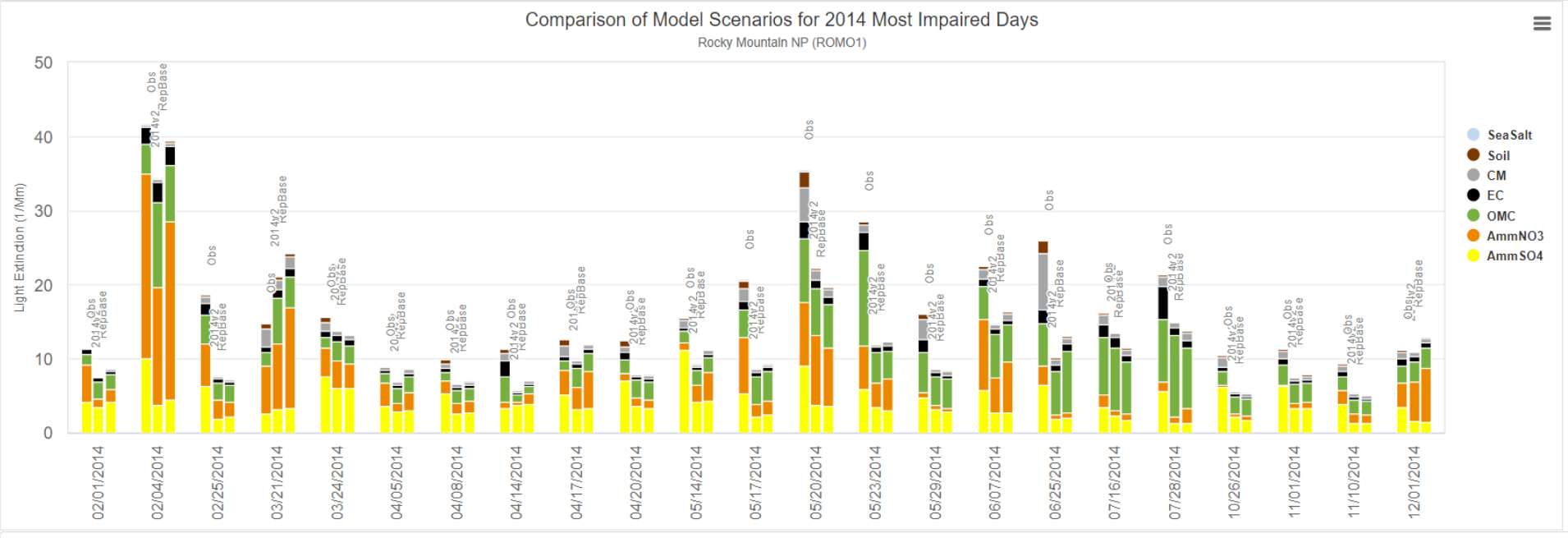
Disclaimer:
Still to finalize titles, labels, definitions for model scenarios and source categories.

Modeling Chart # 2
Evaluate model versus observations: daily Most Impaired Days (MID)

Modeled Data Analysis Charts

#	Product	Filters	URL	Actions
2	Daily Extinction MPE (N scenarios) DRAFT	State: Colorado; Group: Most Impaired Days; Model Scenario: 2 selected		Submit

- IMPROVE 2014 observations vs 2014v2 modeled
- 2014v2 modeled vs RepBase modeled
- Look at 2014 daily model performance and possible outliers (e.g. fire)
- At Rocky Mountain National Park, 2014 most impaired days occurred Feb-July, Nov-Dec



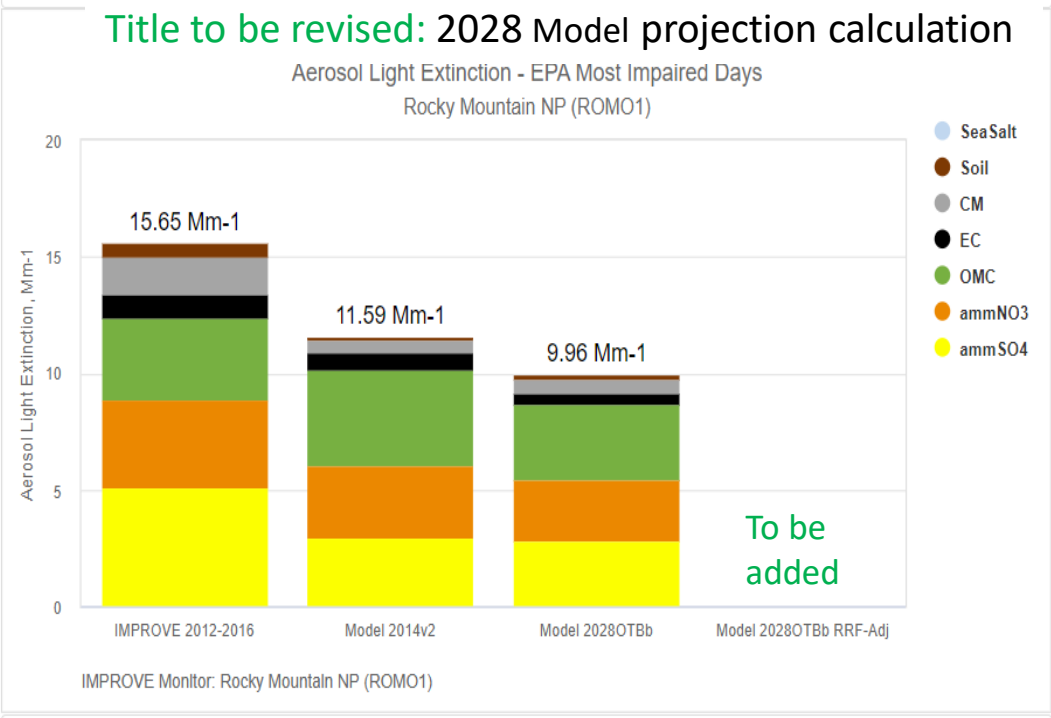
Modeling Chart # 3

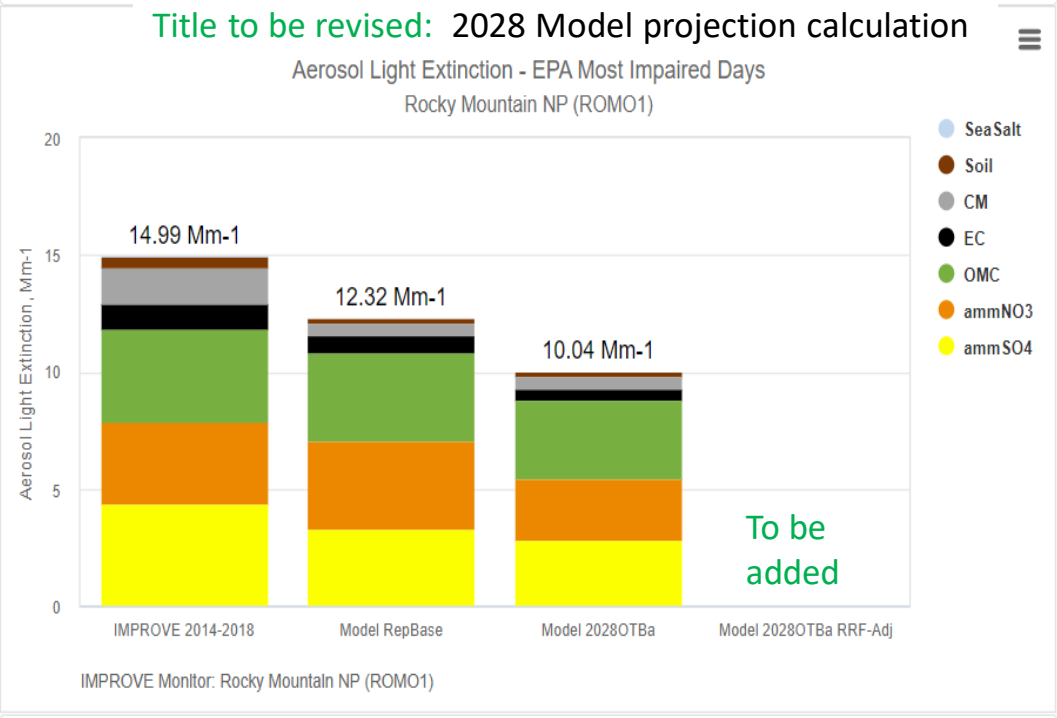
Modeled Data Analysis Charts

#	Product	Filters	URL	Actions
3	Visibility Projection Methods - Extinction DRAFT	State: Colorado; Group: Most Impaired Days; Model Scenario: 2014v2		Submit

Illustrates methods, defined in EPA guidance,[1] to project future visibility

- Adjust IMPROVE observations by the relative response factor between modeled base year and modeled future year values for each aerosol species for most impaired days in representative 5-year period.





[1]Modeling Guidance for Demonstrating Air Quality Goals for Ozone, PM*2.5*, and Regional Haze, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Air Quality Assessment Division, November 2018 (*https://www3.epa.gov/ttn/scram/guidance/guide/O3-PM-RH-Modeling_Guidance-2018.pdf*).

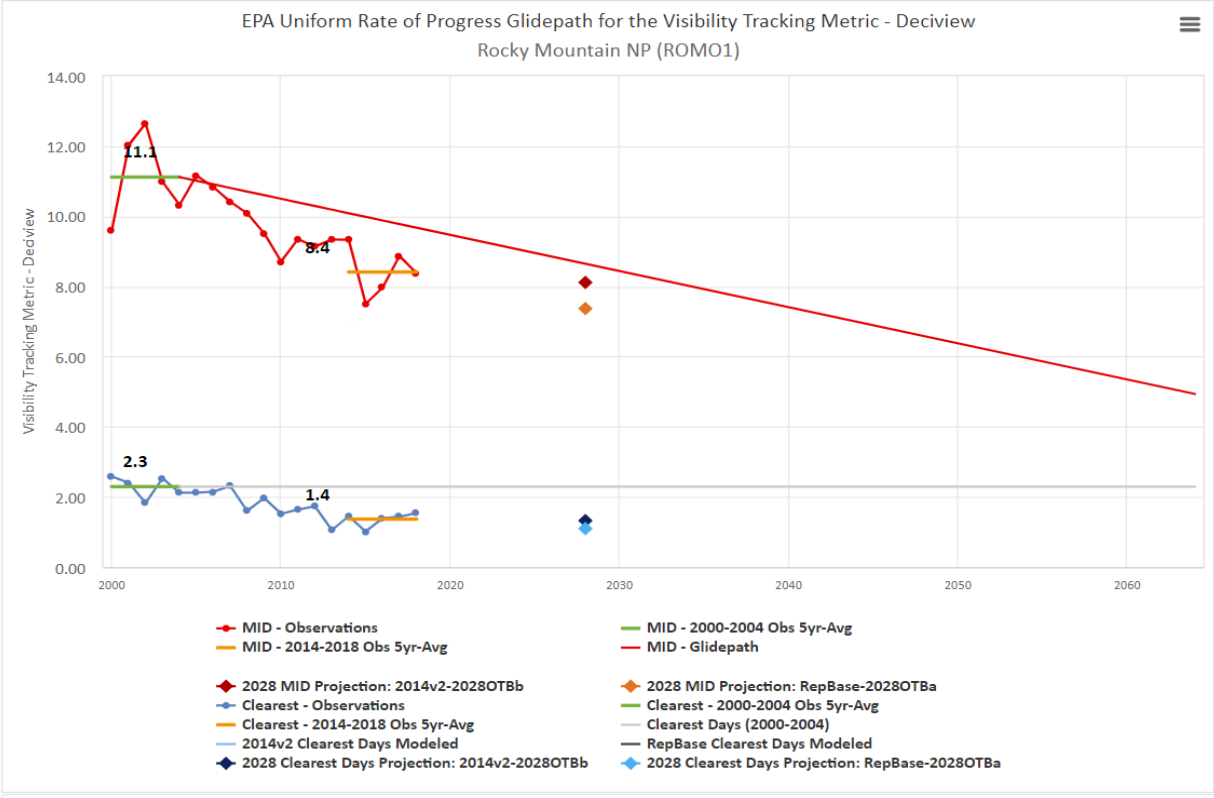
Modeling chart # 4

EPA projection method: 2028 On the Books

Modeled Data Analysis Charts

#	Product	Filters	URL	Actions
4	URP glidepath with visibility projections DRAFT	IMPROVE Site: YELL2 Parameter: DV		Submit

Rocky Mountain National Park



A. 2000-2018 IMPROVE data for annual average most impaired days (MID) and Uniform Rate of Progress visibility glidepath are same as in Monitoring chart # 5.

B. Add 2028OTBa and 2028OTBb RRF-adjusted projections

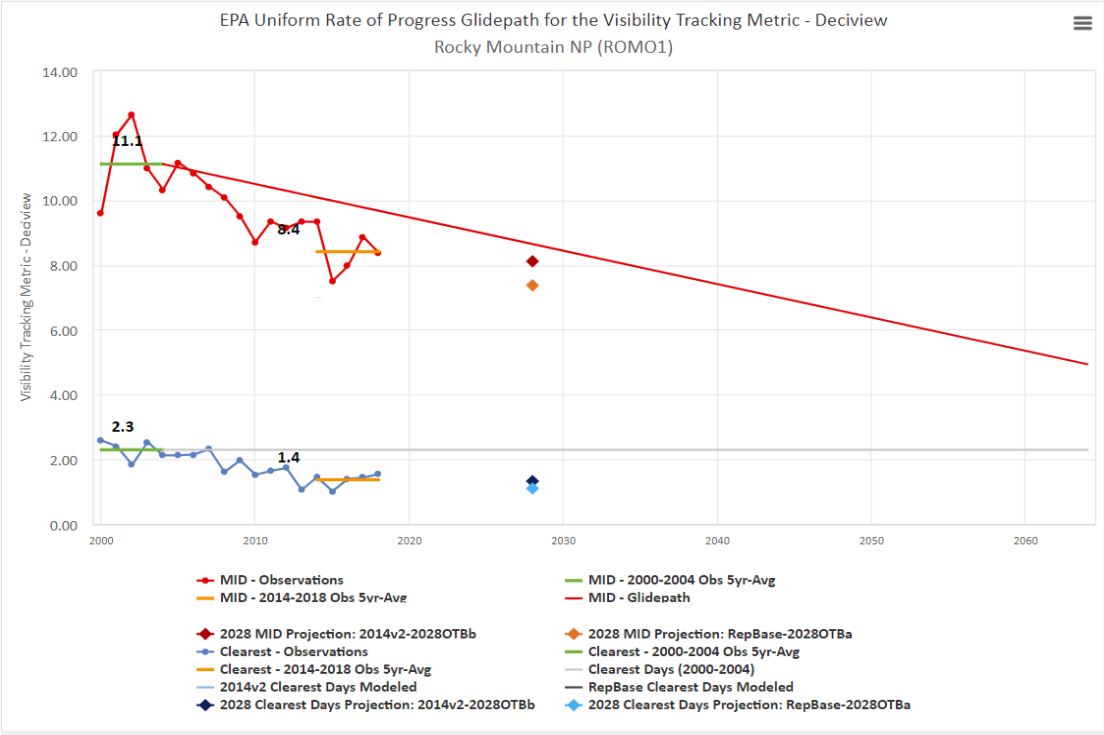
C. Why are 2028OTBa and b different? Look at calculation methods in Modeling Chart # 4.

D. Coming: summary tables/charts for aerosol light extinction for each projection

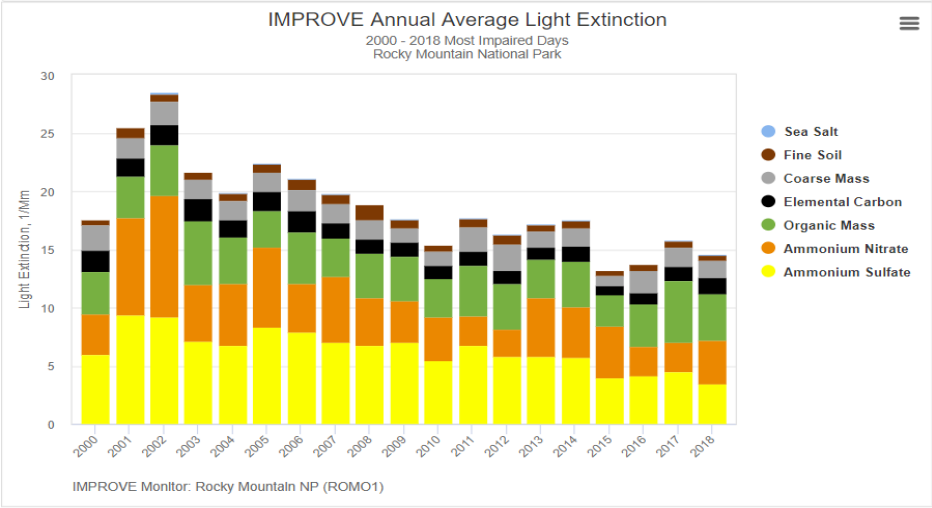
Review from Apr 29 RTO call

How to interpret Modeling chart # 4
EPA projection method: 2028 On the Books

Rocky Mountain National Park



A. Use Monitoring chart # 2, annual average MID aerosol extinction, to interpret 2000-2018 aerosol dv trends

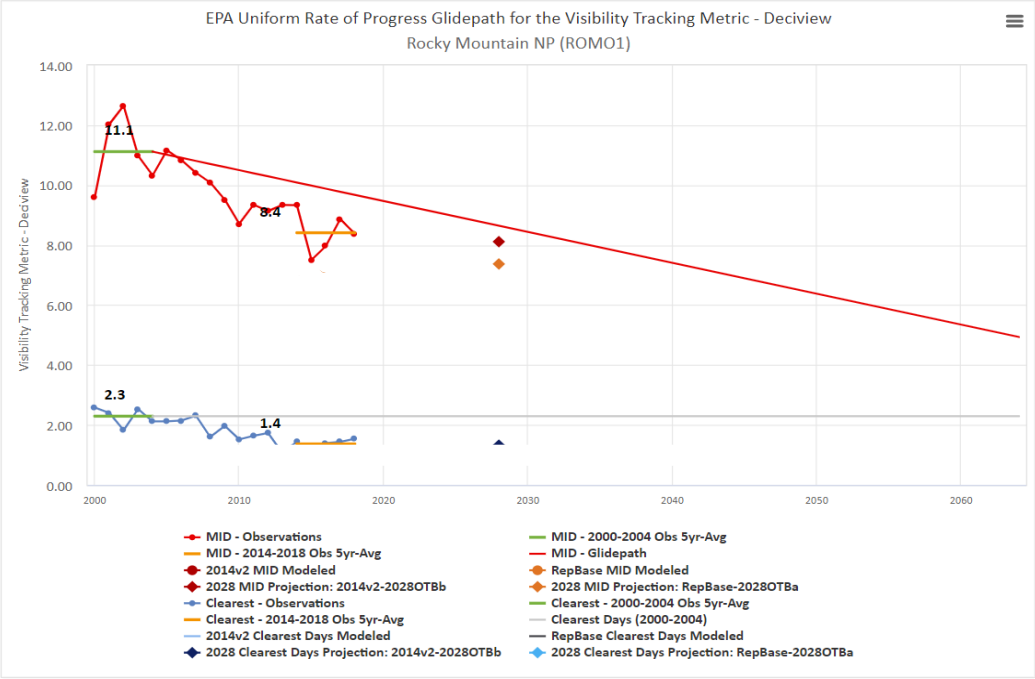


B. Use Modeling chart # 3 for 2028OTBa and 2028OTBb RRF-adjusted projections in aerosol extinction (to be added to) to evaluate aerosol changes contributing to 2028OTB model scenario results in deciview.

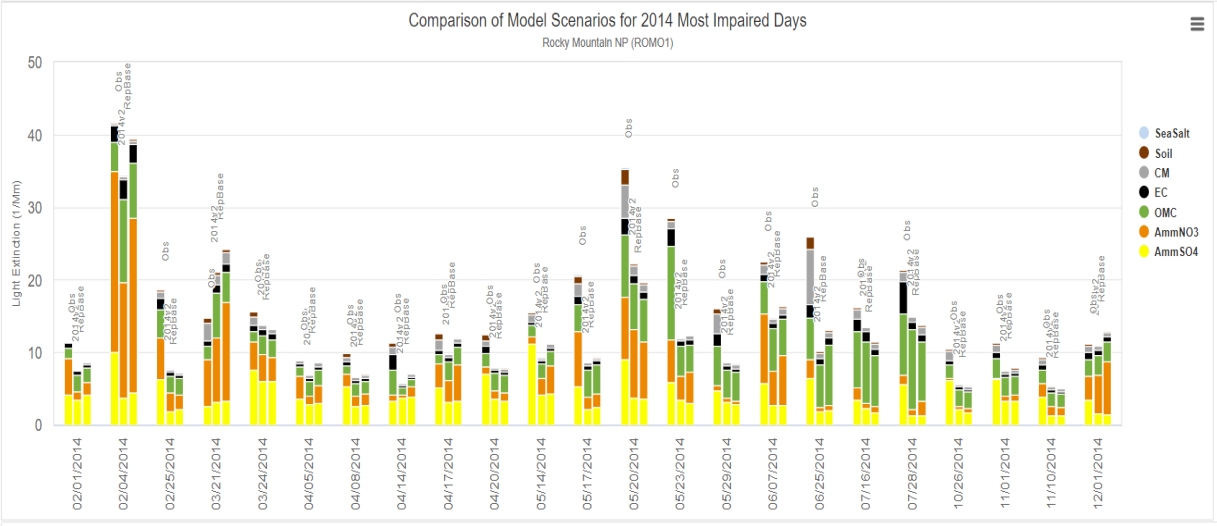
Review from Apr 29 RTO call

How to interpret Modeling chart # 4
EPA projection method: 2028 On the Books

Rocky Mountain National Park



C. Use <u>Modeling chart # 2</u> to consider 2014 daily MID model performance (model scenario 2014v2) and possible outliers (e.g. MID with high fire impact)



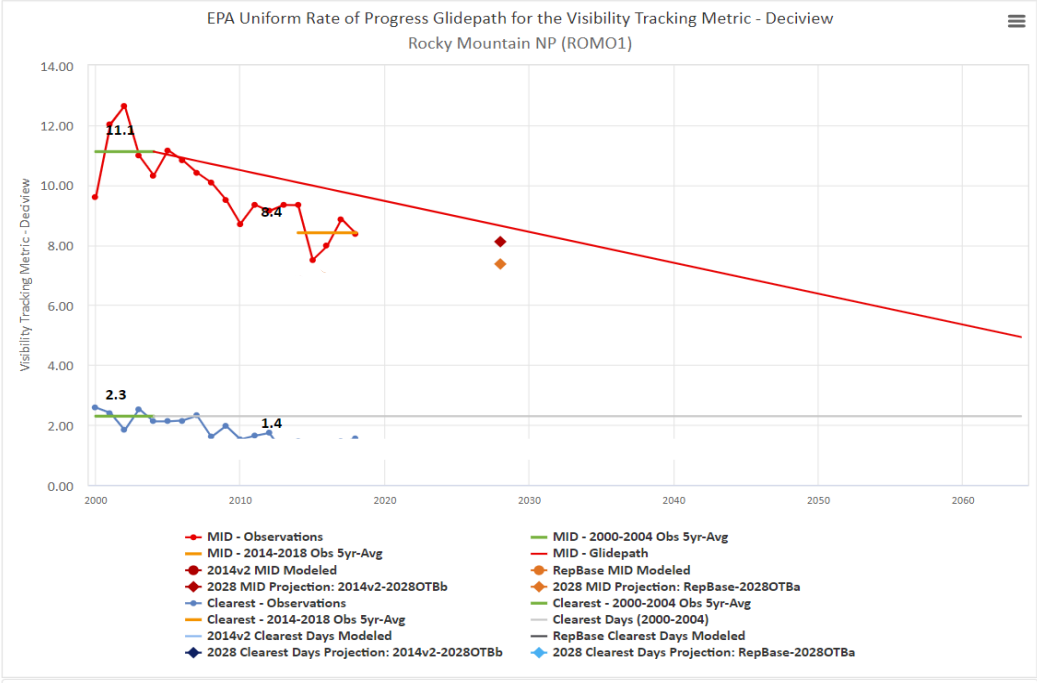
At ROMO, 2014v2 model exhibits fairly good performance.

No obvious outliers on most impaired days.

Review from Apr 29 RTO call

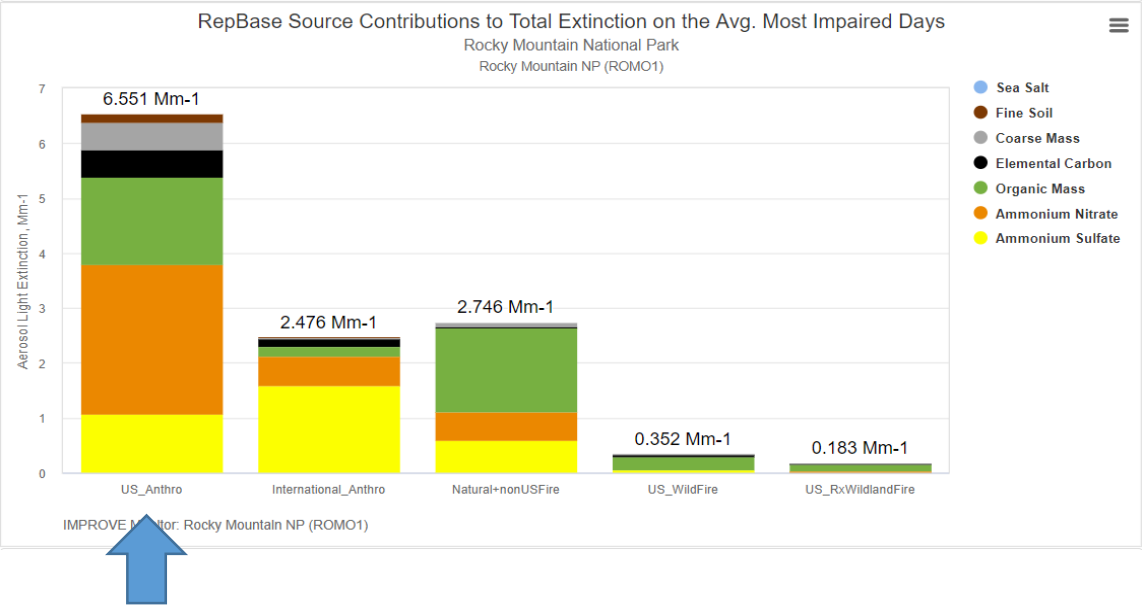
How to interpret Modeling chart # 4
EPA projection method: 2028 On the Books

Rocky Mountain National Park



D. Future: Use <u>Modeling chart # ?</u> to consider source sector contributions to 2028 OTBa projections.

E. Today, use RepBase source apportionment to demonstrate future application.



RepBase High-level Source Apportionment

RUN SPECIFICATION SHEET

SOURCE APPORTIONMENT OF ANTHROPOGENIC AND BIOGENIC SOURCES FOR THE REPRESENTATIVE BASELINE EMISSIONS SCENARIO

WRAP 2014 Modeling Study
Revised March 31, 2020

Run Name:	**Task 1.8: Anthropogenic/Natural RepBase Source Apportionment**
Model:	CAM v7.0
Domains:	36US1 and 12WUS2 two-way nesting
Period:	2014v2 annual period
Emissions:	Representative Baseline
Boundary Conditions:	WRAP 2014 GEOS-Chem stratified by international anthropogenic, U.S. anthropogenic and natural sources
Source Apportionment:	Particulate Matter (PSAT) and Ozone (APCA)
Purpose:	Obtain PM and ozone source contributions by anthropogenic, natural and fire emission source categories and by U.S. versus International sources.

Copied from Modeling scenarios: https://views.cira.colostate.edu/iwdw/docs/WAQS_and_WRAP_Regional_Haze_spec_sheets.aspx

RepBase and 2028OTBa Source Apportionment: Source categories

Source Group	**RepBase** + 2028OTBa **High-level Source Apportionment**	2028OTBa Source-Sector Apportionment
US Anthropogenic	**US Anthropogenic**	EGU Point
		AllOther Point
		Oil&Gas Point + Nonpoint
		Mobile Non-Road + On-Road, including rail, airports, and commercial marine
		AllOther US Anthro: • Agricultural (NOx only) • Fugitive Dust • Residential Wood • Remaining Nonpoint
		US Agricultural Fire
	US Wildland Prescribed fire	US Wildland Prescribed fire
Natural	**US Wildfire**	US Wildfire
	Natural + Non-US fire	Non-Fire Natural (everything else plus Canada/Mexico fires)
International Anthropogenic	Canada- Anthro	Canada-Anthro
	Mexico- Anthro	Mexico- Anthro
	Commercial Marine	Commercial Marine
	Boundary-International	Boundary-International

Source Apportionment Spec Sheets: https://views.cira.colostate.edu/iwdw/docs/WAQS_and_WRAP_Regional_Haze_spec_sheets.aspx

Modeling chart # 6

Modeled Data Analysis Charts

#	Product	Filters	URL	Actions
6	Light Extinction by Source, Vertical Bars DRAFT	State: Colorado; Group: Most Impaired Days; Parameter: 7 selected		Submit

RepBase High-Level Source Apportionment – Rocky Mountains NP

Methods:

Assign daily light extinction for each aerosol species to:

- U.S. Anthro
- International Anthro (Can., Mex., Comm.Marine)
- Natural+Can/Mex fires
- U.S. Wildfire
- U.S. Wildland Prescribed fire

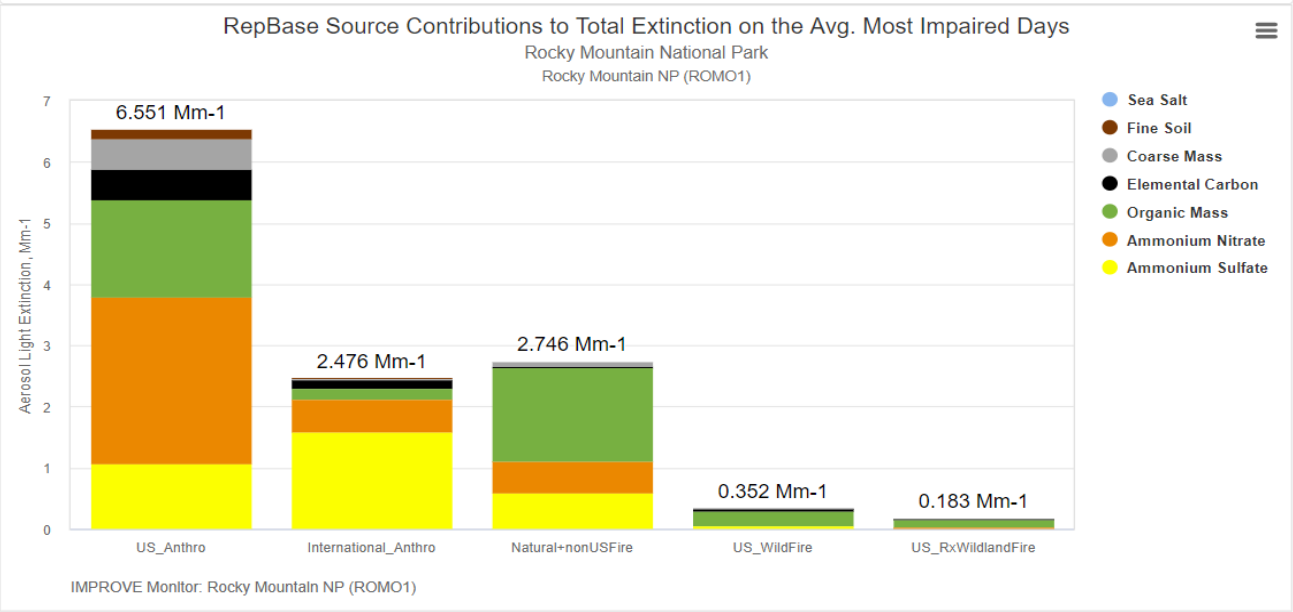
User may select single species or total aerosol extinction

Results:

A. At ROMO, AmmNO3 is dominated by U.S. Anthro

B. AmmSO4 includes contributions from International Anthro, U.S. Anthro, and Natural

C. Organic Carbon Mass is dominated by Natural + non-US fire and US Anthro



Modeling chart # 7
RepBase High-level Source Apportionment – Rocky Mountain NP

Modeled Data Analysis Charts

#	Product	Filters	URL	Actions
7	Total Source Contributions by Pollutant DRAFT	State: Colorado; Group: Most Impaired Days; Parameter: 7 selected		Submit

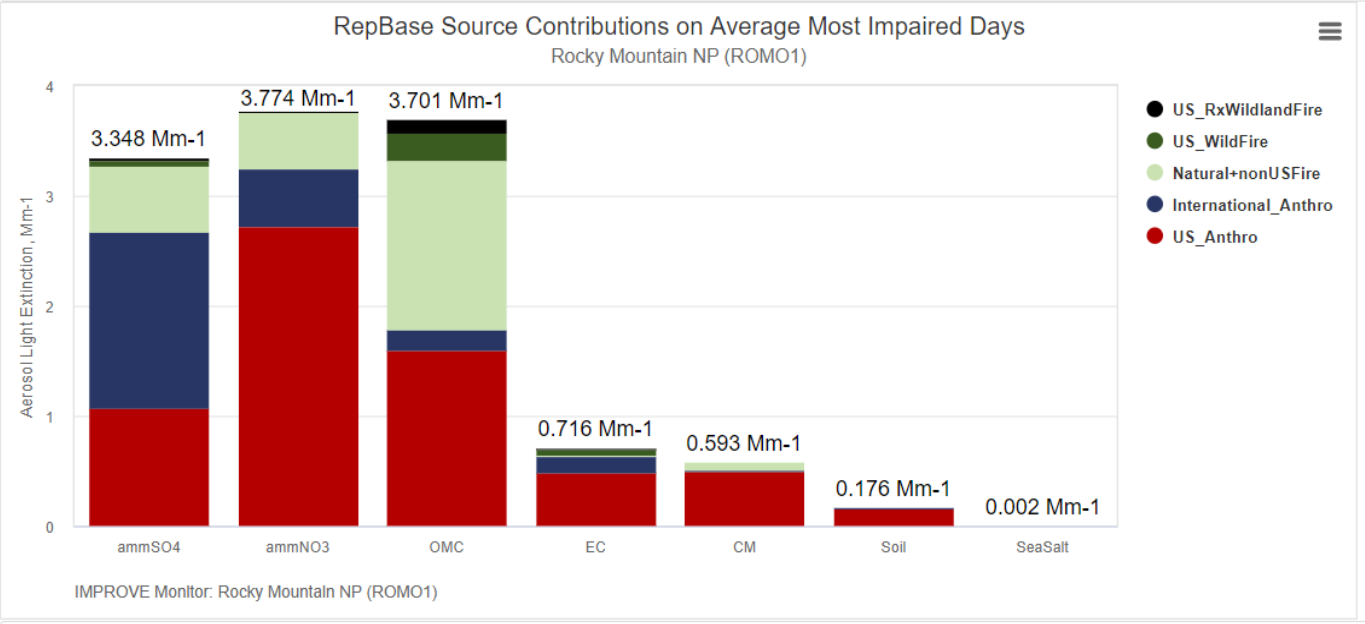
Methods:

Assign daily light extinction for each aerosol species to:

- U.S. Anthro
- International Anthro (Can., Mex., Comm.Marine)
- Natural+Can/Mex fires
- U.S. Prescribed wildland fire
- U.S. Wildfire

Application:

- RepBase High-level Source Apportionment is an indicator of relative source contributions for 2028OTBa.
- International boundary conditions, natural, and fire emissions were held constant between RepBase and 2028OTBa.
- Canada Anthro, Mexico Anthro, Commercial Marine, and US Anthro emissions changed from RepBase to 2028OTBa



Future table: Change in US Anthro contribution

Aerosol Extinction, Mm^{-1}	RepBase US Anthro	2028OTBa US Anthro
AmmSO4		
AmmNO3		
OMC		
EC		
Coarse		
Fine Soil		
SeaSalt		

Modeling Express chart # 5
RepBase High-Level Source Apportionment – average MID

Modeled Data Analysis Charts

#	Product	Filters	URL	Actions
5	Light Extinction by Source, Horizontal Bars DRAFT	State: Colorado; Group: Most Impaired Days; Parameter: OMC		Submit

Methods:

Assign daily light extinction for each aerosol species to:

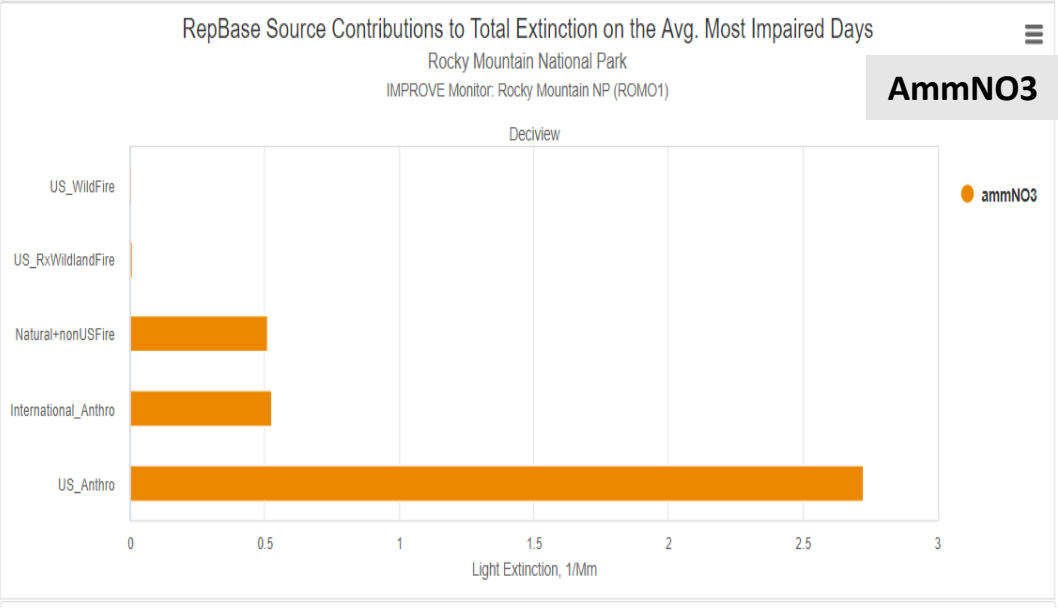
- U.S. Anthro
- International Anthro (Can., Mex., Comm.Marine)
- Natural+Can/Mex fires
- U.S. Wildland Prescribed fire
- U.S. Wildfire

Results: Rocky Mountain National Park:

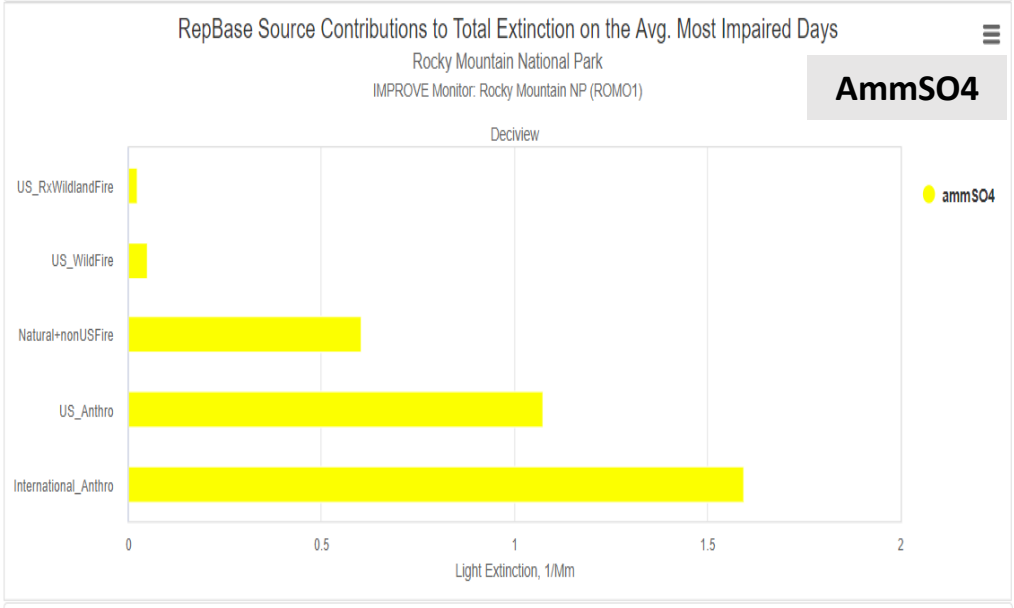
A. At ROMO, AmmNO3 is dominated by U.S. Anthro

B. AmmSO4 includes U.S. Anthro, International Anthro and Natural (oceanic);

A.



B.

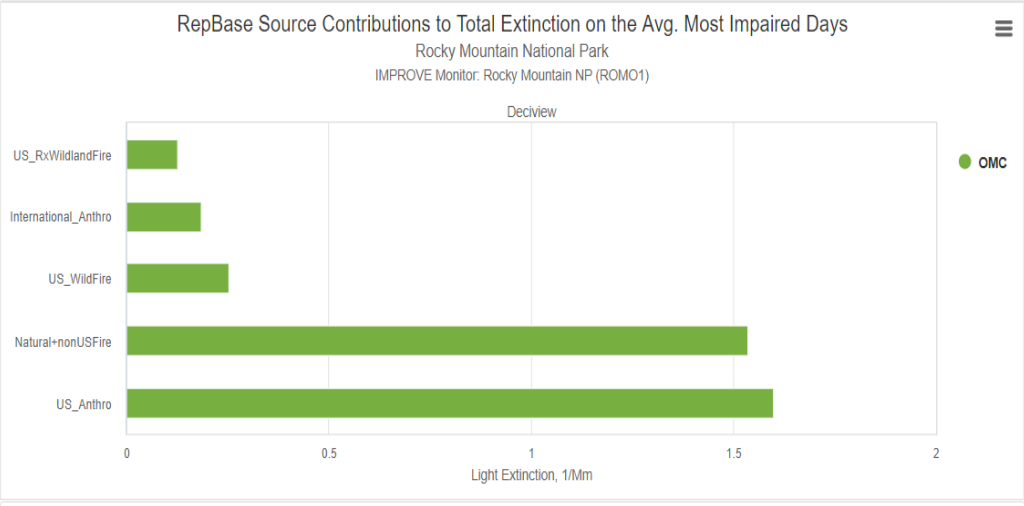


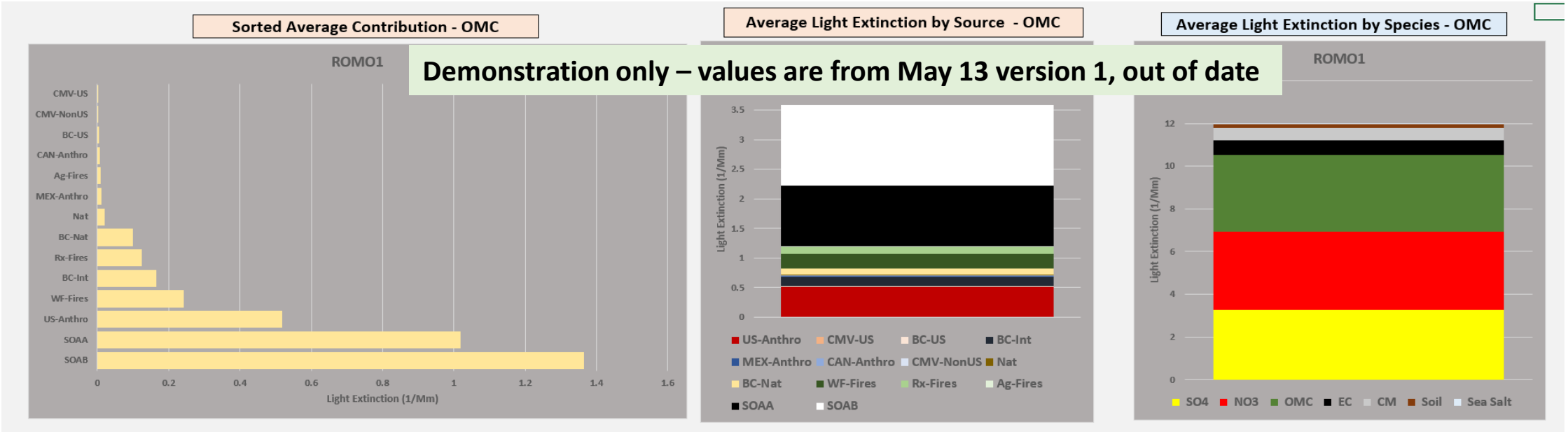
Current: 5 High-level source categories on **TSS Tools**

Future: results for detailed source categories will be available on **IWDW**

Modeled Data Analysis Charts

#	Product	Filters	URL	Actions
5	Light Extinction by Source, Horizontal Bars DRAFT	State: Colorado; Group: Most Impaired Days; Parameter: OMC		Submit





Demonstration only – values are from May 13 version 1, out of date

Modeling chart # 9
RepBase High-Level Source Apportionment– Rocky Mountain NP

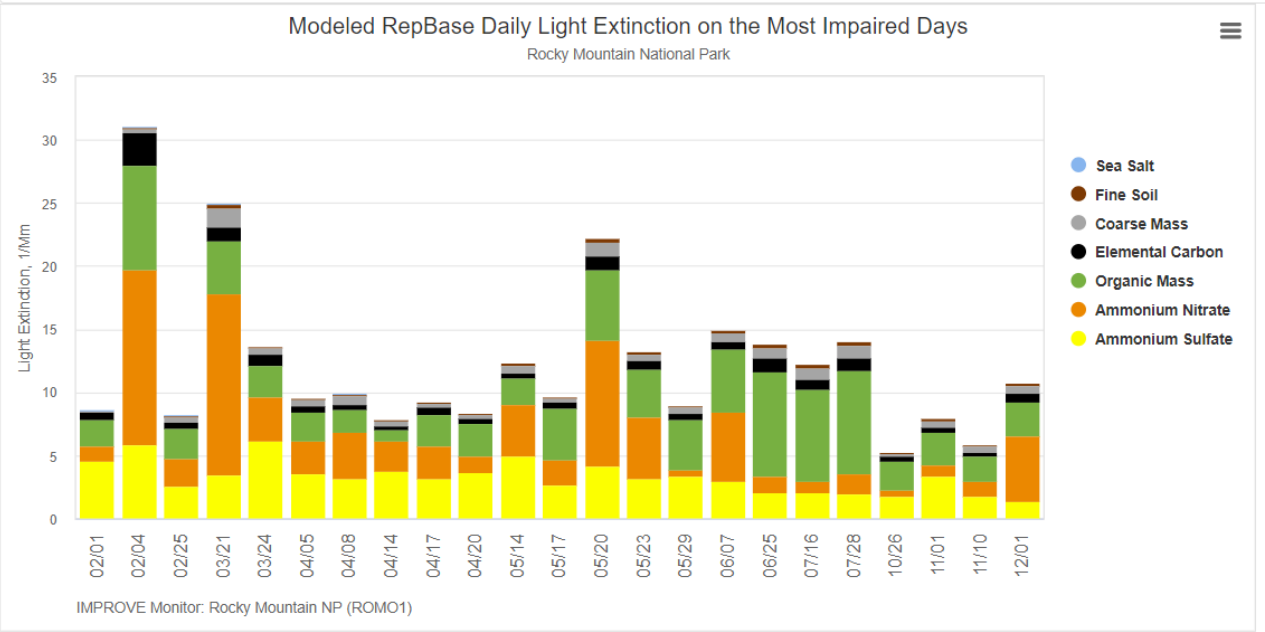
Modeled Data Analysis Charts

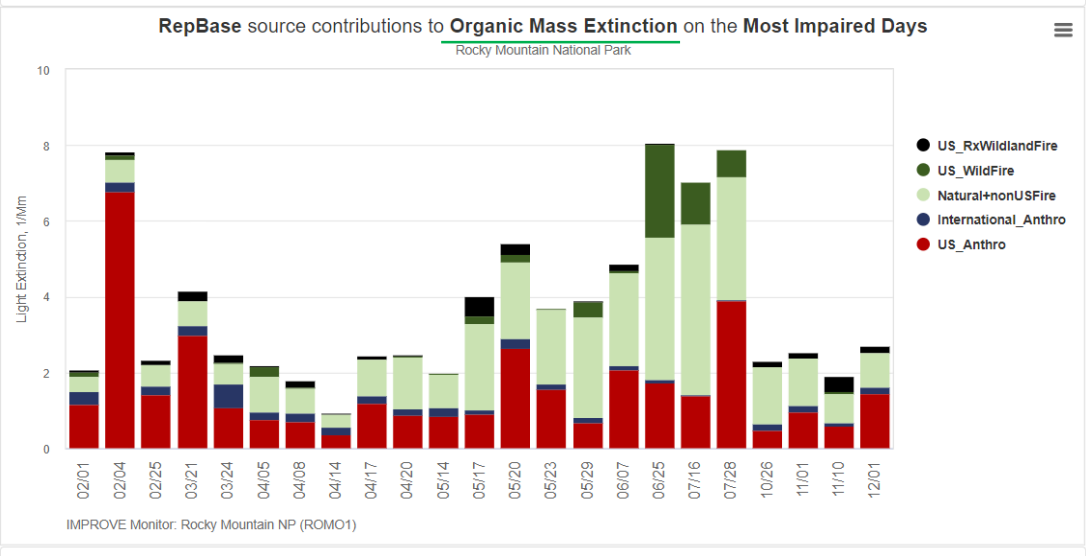
#	Product	Filters			URL	Actions
9	Daily Modeled Extinction Composition DRAFT	State: Colorado	Group: Most Impaired Days	Model Scenario: RepBase		Submit

Methods:
Same data for RepBase is also available at
Modeling chart # 2

Application:

A. At Rocky Mountain National Park, 2014 most impaired days occurred Feb-July, Nov-Dec
B. Use Modeling chart # 8, daily RepBase Source categories to evaluate daily contributions
C. Organic Carbon is predominantly US Anthro in winter, natural and fire dominate summer days





Modeling Express chart # 8
RepBase High-Level Source Apportionment– Rocky Mountain NP

Modeled Data Analysis Charts

#	Product	Filters			URL	Actions
8	Daily Modeled Source Contributions DRAFT	State: Colorado	Group: Most Impaired Days	Parameter: AmmSO4		Submit

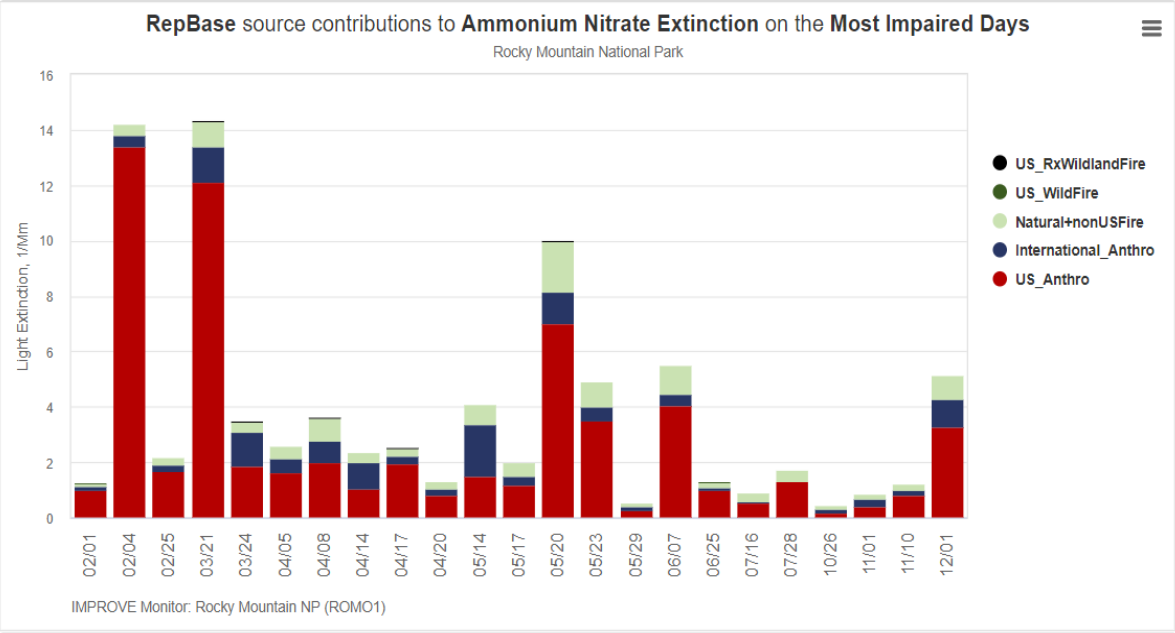
Methods:

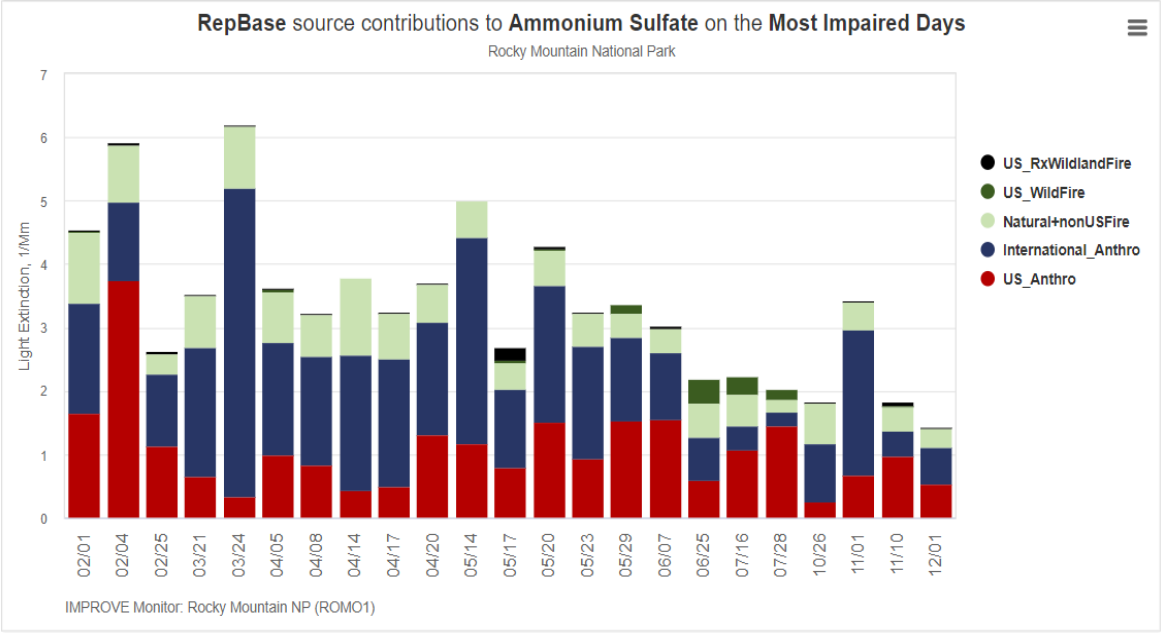
Assign daily light extinction for each aerosol species to:

- U.S. Anthro
- International Anthro (Can., Mex., Comm.Marine)
- Natural+Can/Mex fires
- U.S. Prescribed wildland fire
- U.S. Wildfire

Results:

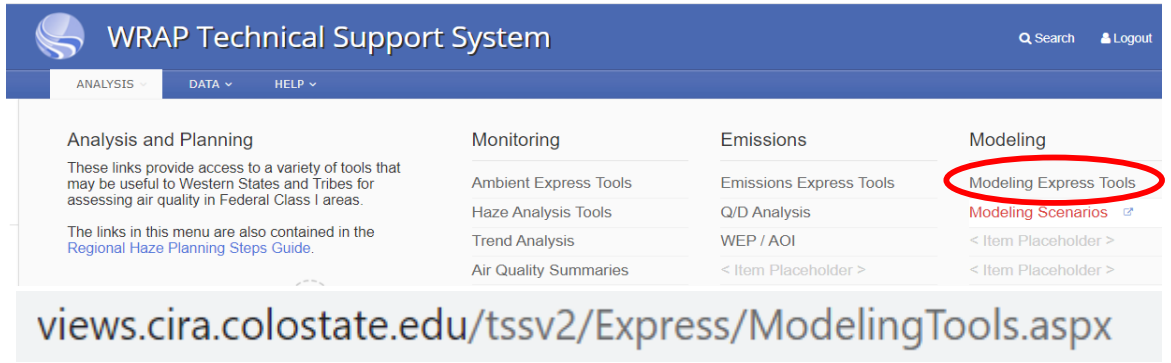
A. At ROMO, AmmNO3 is dominated by U.S. Anthro
B. AmmSO4 includes International Anthro, U.S. Anthro, and Natural





Additional 2028 model scenarios and Source Apportionment results to be added over summer 2020

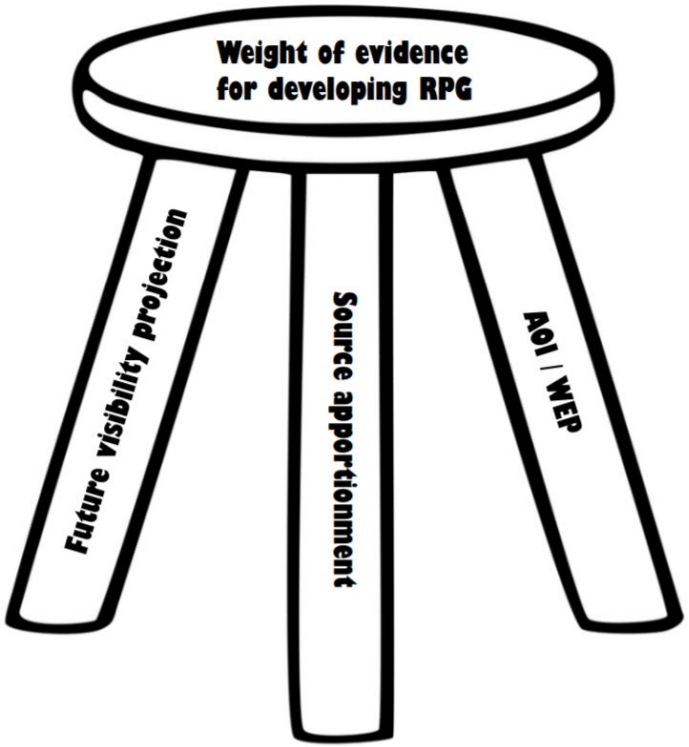
- Modeling Summary Tables
- URP Glidepath adding PAC#1 and Fire Sensitivities
- Stacked Aerosol Extinction: adding 2028OTBa+PAC1 to RepBase, 2028OTBa
- Stacked Aerosol Extinction: adding 20228OTBa+Wildfire, 2028OTBa+Rxfire to RepBase, 2028OTBa,
- 2028OTBa Source Contributions, High-level and State by Source Sector
- APCA ozone source apportionment charts will be available on IWDW



Leaving Rocky Mountain National Park…….

June 23 drive through – Yellowstone National Park

Jun 23, 2020 WRAP Modeling tools introduction is a preview for Jun 25 Webinar that will demonstrate how to use these tools for Regional Haze SIP Planning

Weight of Evidence for Developing Reasonable Progress Goals using WRAP Modeling Products

- Future Visibility projection
  - How does haze respond to changes in potential future emissions controls? – Ralph Morris
  - Using Dynamic Modeling to define the visibility response to changes in US Anthropogenic emissions – Gail Tonnesen
- Source apportionment (photochemical grid model)
  - What are the contributions from international or wildland prescribed fire emissions? – Mike Barna
  - Which states and sectors are contributing to haze? – Kevin Briggs
- Weighted Emissions Potential – Ross Beardsley and Tom Moore
  - For 2014-2018 most impaired days, use back trajectories to define residence time for upwind geographic areas – Area of Influence
  - Weight residence time by extinction (AmmNO3 or AmmSO4) - EWRT
  - Weighted Emissions Potential – Weight EWRT by emissions divided by distance – leads to AOI map showing key grid cells
  - Rank upwind point sources