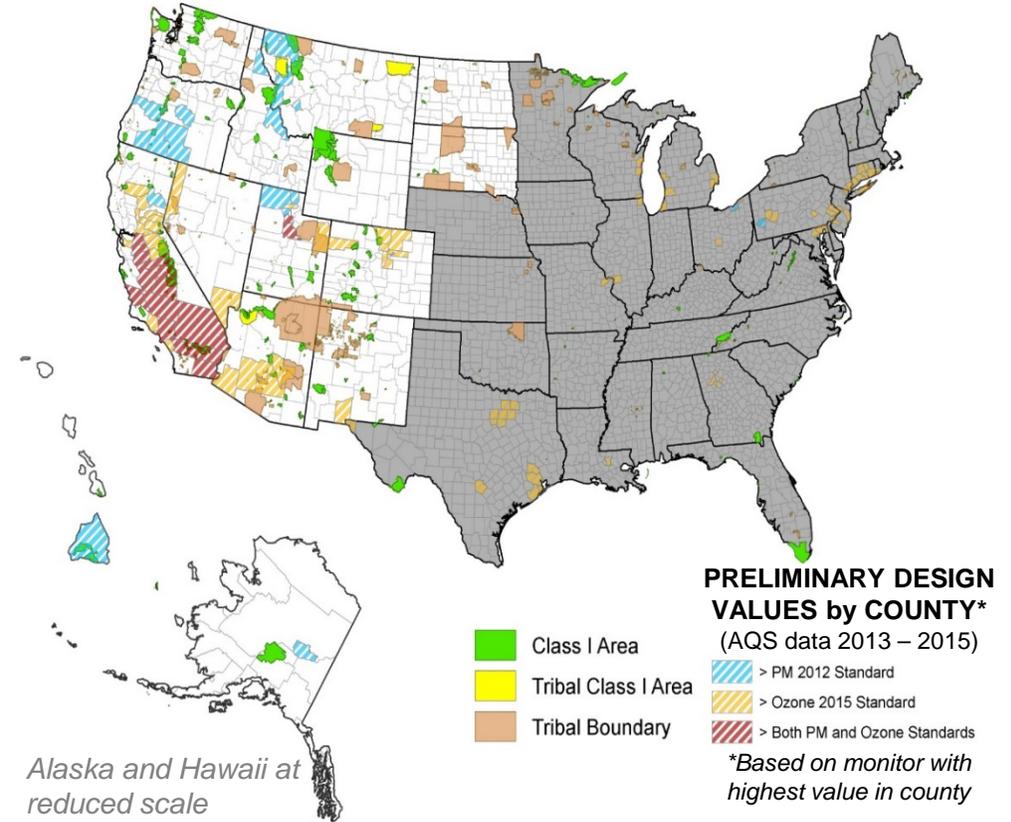


WESTAR-WRAP

- regional haze analysis and ozone transport assessment addressing EPA guidance
- regional emissions and modeling platform for WESTAR-WRAP members
- regional analysis support for Haze SIPs due July 2021
 - ↓ Anthropogenic Emissions → “Reasonable Progress”
Effects of mobile, international, and uncontrollable emissions
Profound impacts of fire and smoke on visibility / air quality
Evaluation of “rules-on-the-books” and consideration of potential additional Reasonable Progress controls
- Related analysis of ozone background and transport
Affecting both urban and rural monitoring sites
- [2018-19 WRAP Workplan update](#) (April 3, 2019)



Related studies:

- EPA working with states and regional organizations to build a 2016 emissions platform with future year projections
- EPRI and WEST sponsoring 2016-based International Haze study

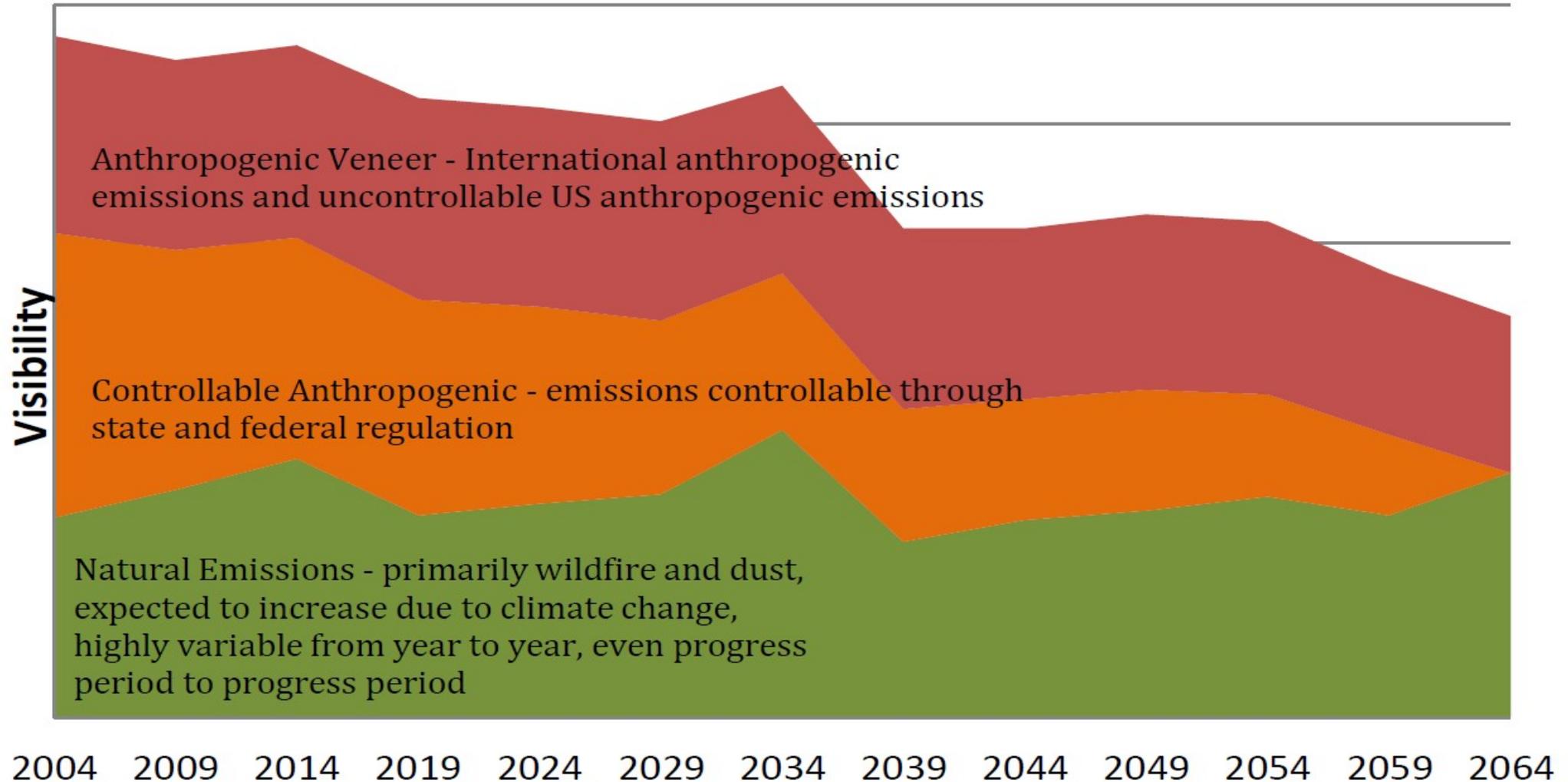


Mandatory Class I Areas



* Rainbow Lake, WI and Bradwell Bay, FL are Class 1 Areas where visibility is not an important air quality related value

Trend in emission types – western U.S.



Emissions sources – western U.S. air quality planning

	Source	Controllability	Trend	Variability
Anthropogenic	US Anthropogenic	Some emissions are controllable	Downward as sources are controlled	Relatively stable
		Some emissions will remain after all reasonable controls implemented	Could rise because of population increases	Relatively stable
	International Anthropogenic	Not controllable by state or federal regulations	Likely increasing due to increased development worldwide and rising population	Relatively stable
Natural	Fire, Dust, Sea Salt	Natural, not controllable	Increases due to <u>climate change</u>	Highly variable
	Volcanic	Natural, not controllable	Unpredictable	Highly variable
	Other Natural Sources	Not controllable	Potentially affected by climate change, e.g., changes in temperature	Relatively stable

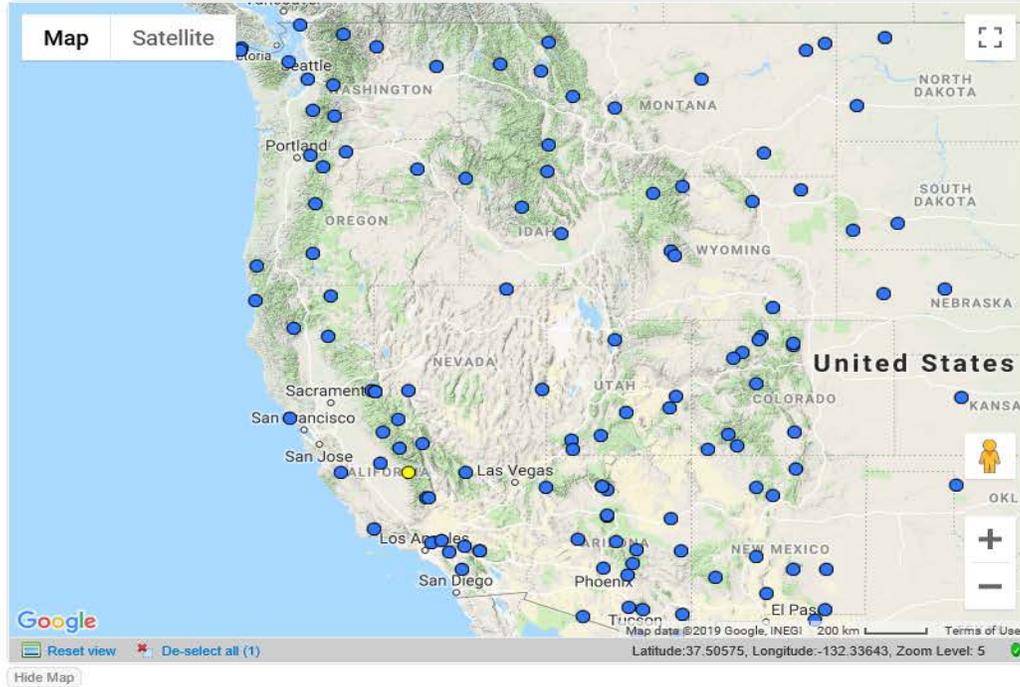
Table Note: Shaded areas represent emissions that states cannot control.



What is monitored to (officially) track haze, where can you get and investigate data?



Regional Haze Analysis, Comparing Metrics from First vs. Second Planning Periods



- Daily, All Days
- Daily, Group Days
- Monthly
- Seasonal
- Annual
- Glide Path
- Anthro vs. Natural, Annual
- Anthro vs. Natural, Daily

Set the year for the report: 2017

- Select Parameters:
- Ammonium Nitrate Extinction
 - Ammonium Sulfate Extinction
 - Elemental Carbon Extinction
 - Coarse Mass Extinction
 - Deciview
 - Impairment
 - Organic Mass Extinction
 - Sea Salt Extinction
 - Soil Extinction

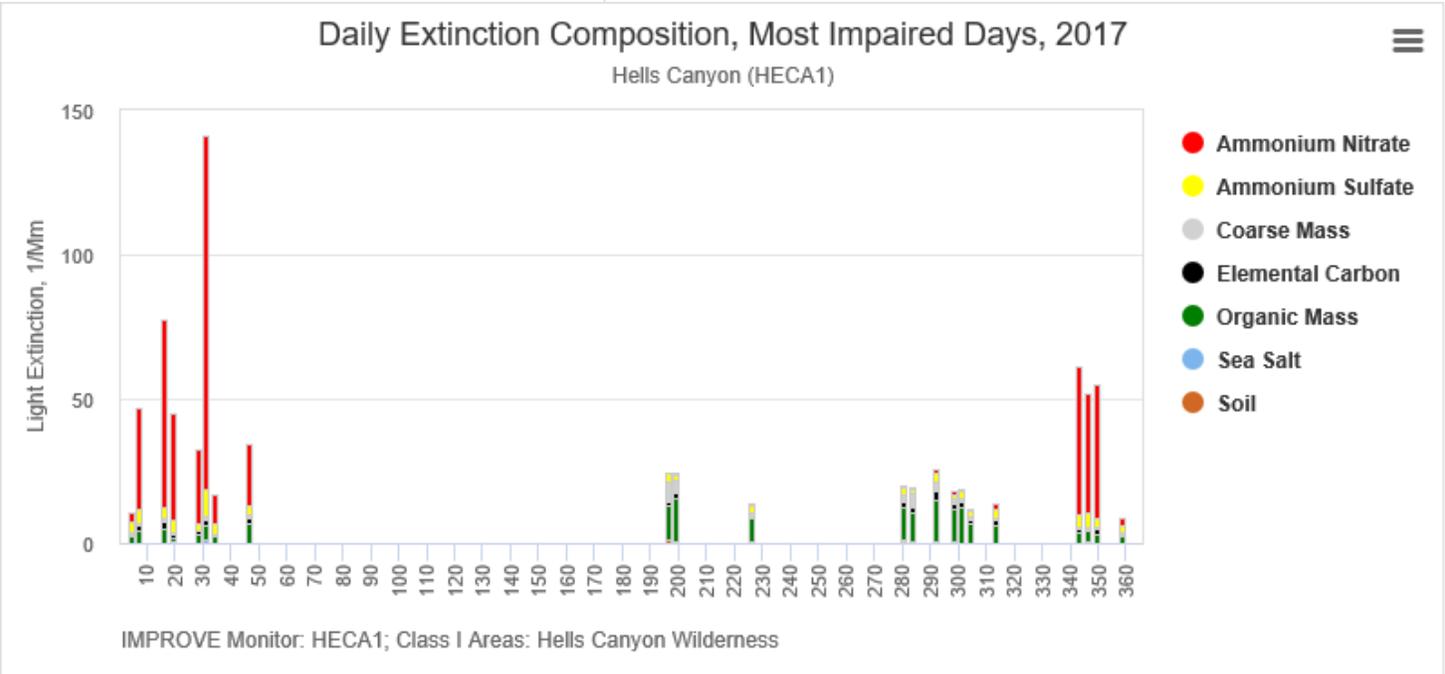
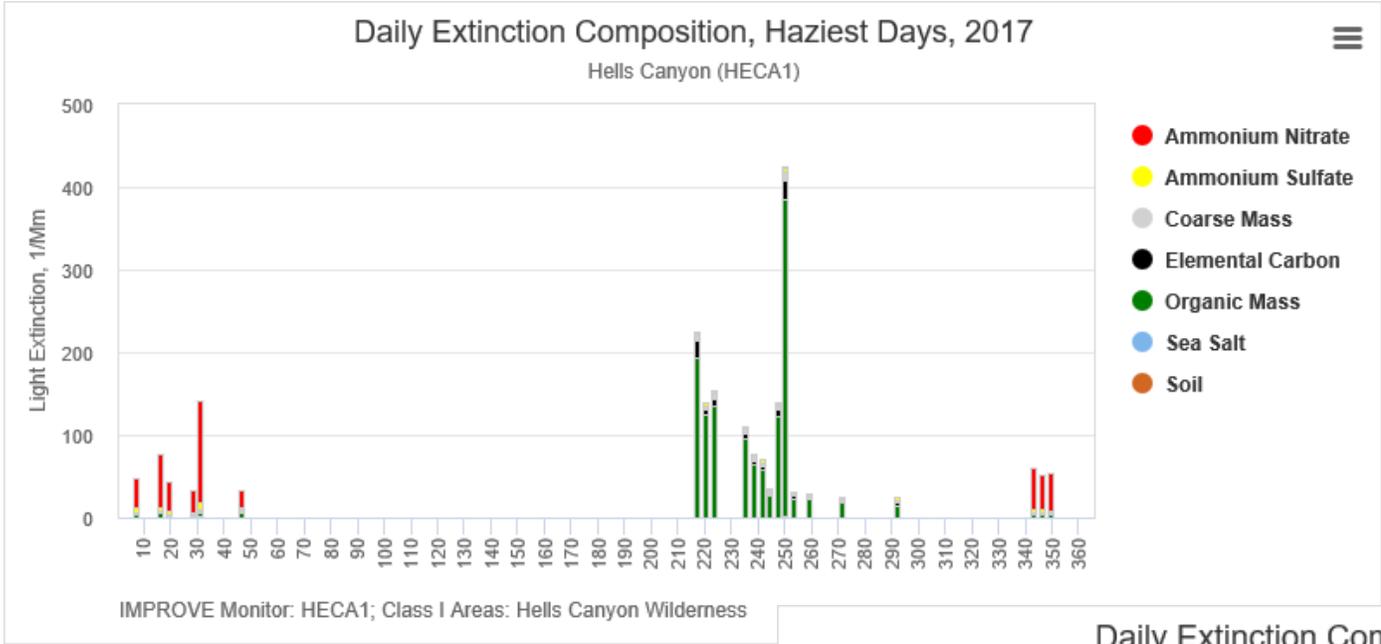
Un-dock dashboard

Daily Extinction Composition, All Days - Metric Comparison (DRAFT)

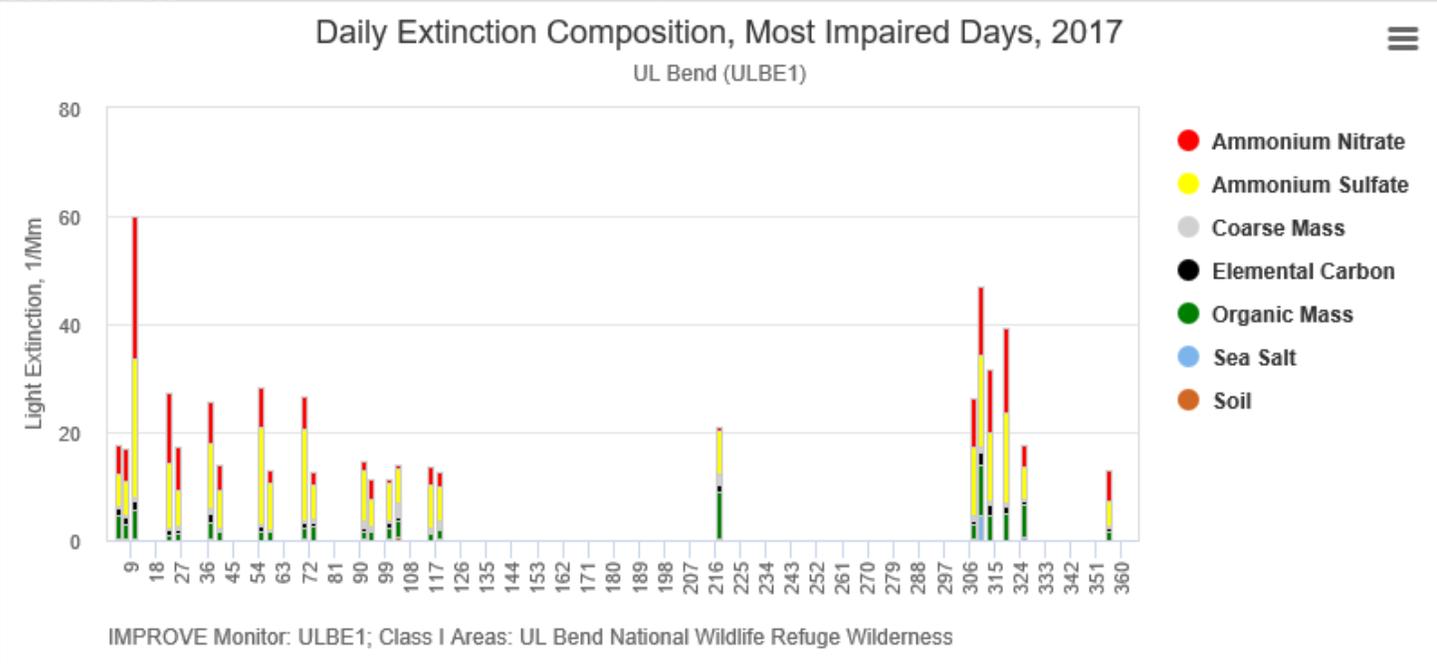
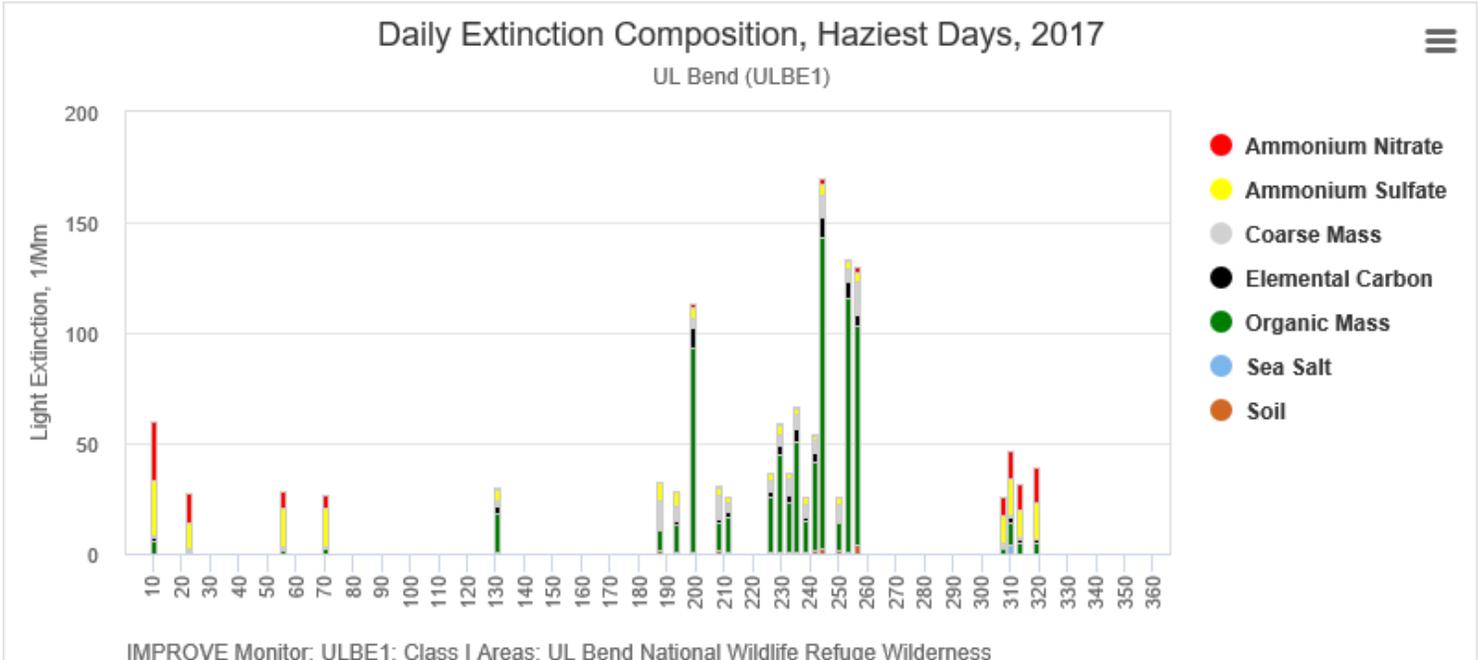
Daily Extinction Composition Sorted by Date - All Days (2017)

<http://views.cira.colostate.edu/tssv2/>

Haziest vs. Most Impaired Days

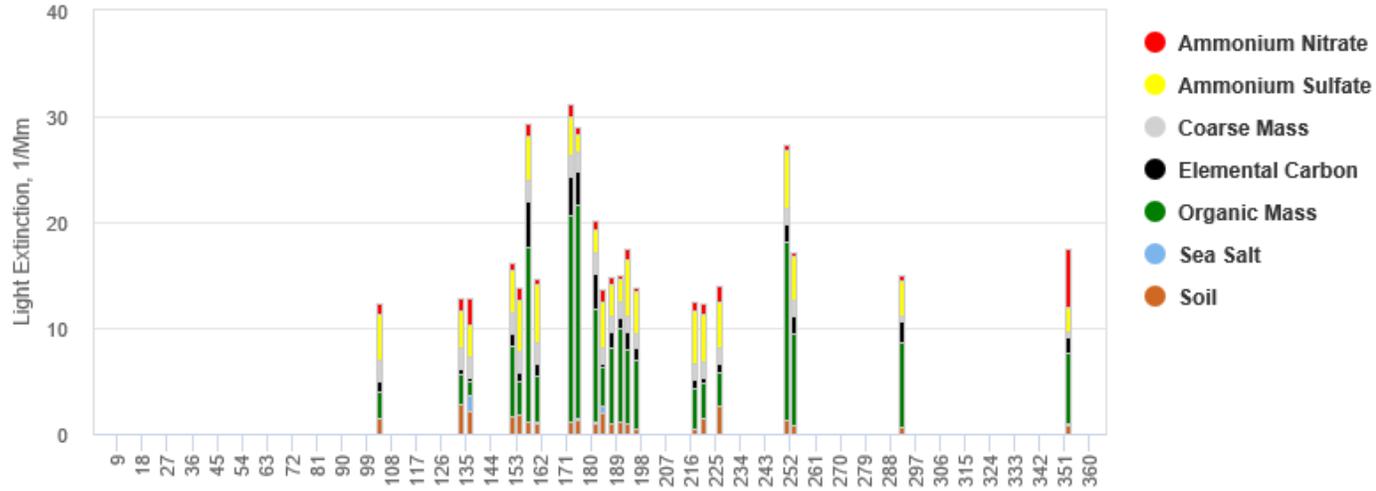


Haziest vs. Most Impaired Days



Daily Extinction Composition, Haziest Days, 2017

Hance Camp at Grand Canyon NP (GRCA2)

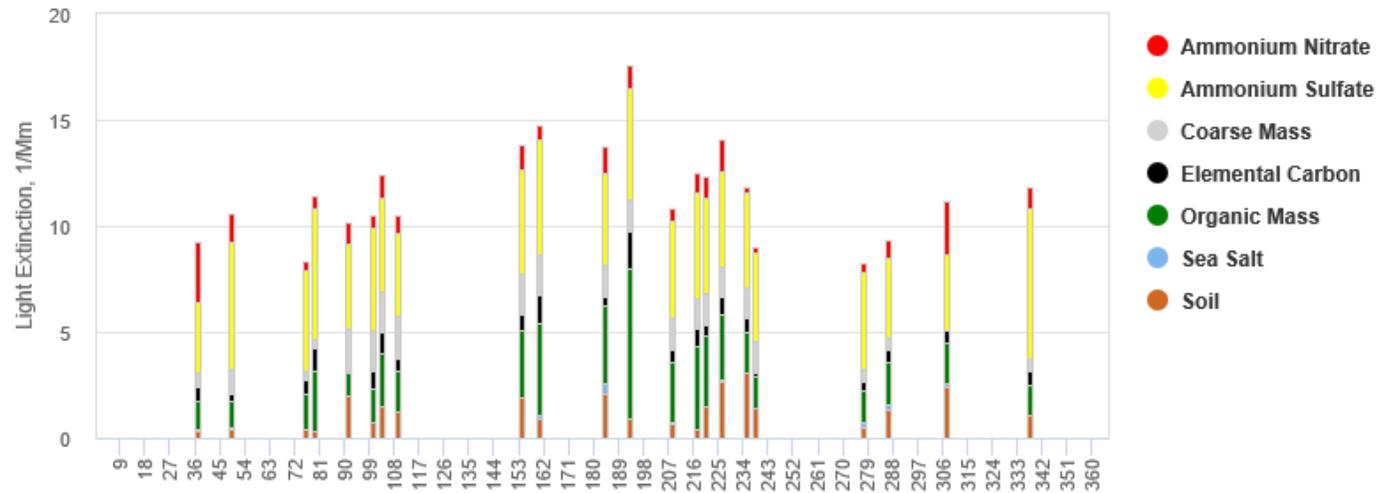


IMPROVE Monitor: GRCA2; Class I Areas: Grand Canyon National Park

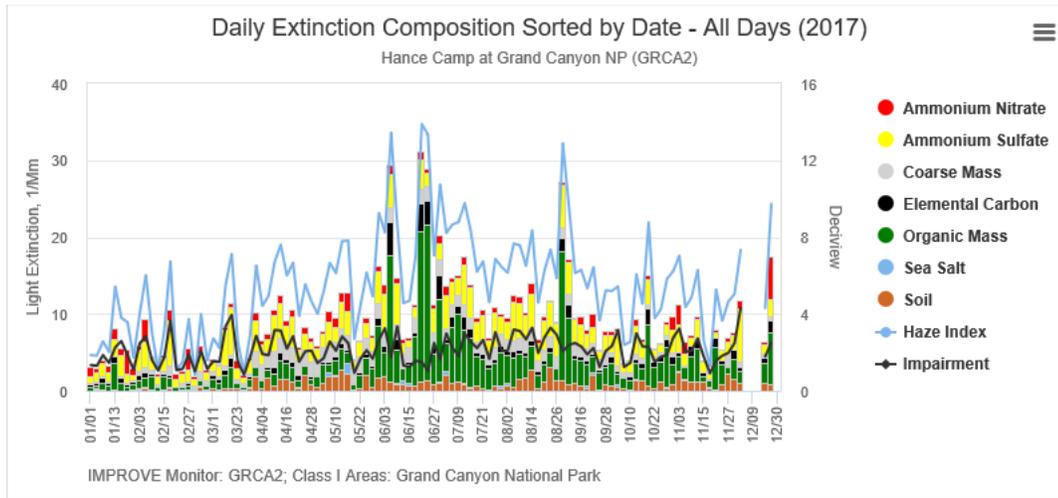
Haziest vs. Most Impaired Days

Daily Extinction Composition, Most Impaired Days, 2017

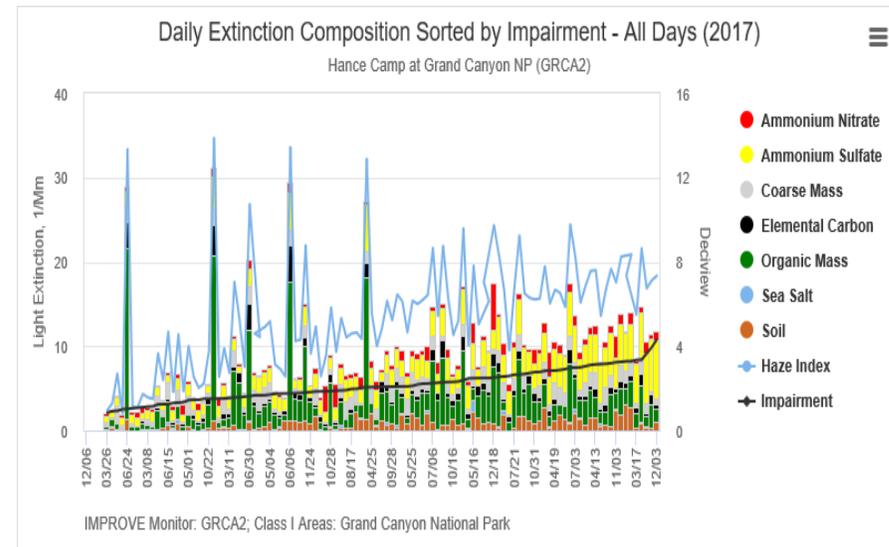
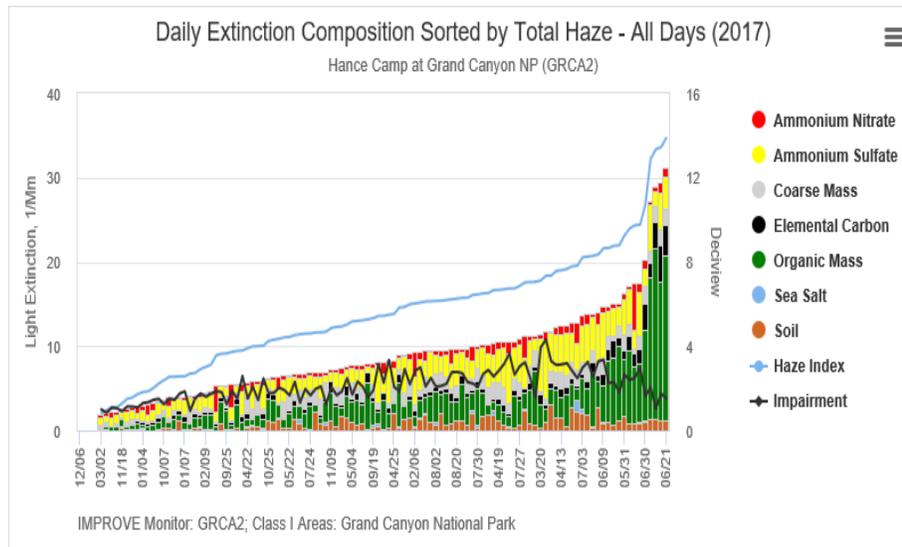
Hance Camp at Grand Canyon NP (GRCA2)



IMPROVE Monitor: GRCA2; Class I Areas: Grand Canyon National Park



Complex sorting of mass values by species to derive light extinction results



Regional emissions and modeling studies for Regional Haze planning

Emissions for Air Quality Planning – What Pollutants? What Sources? What about Fires?

Fires typically largest part of emissions pie

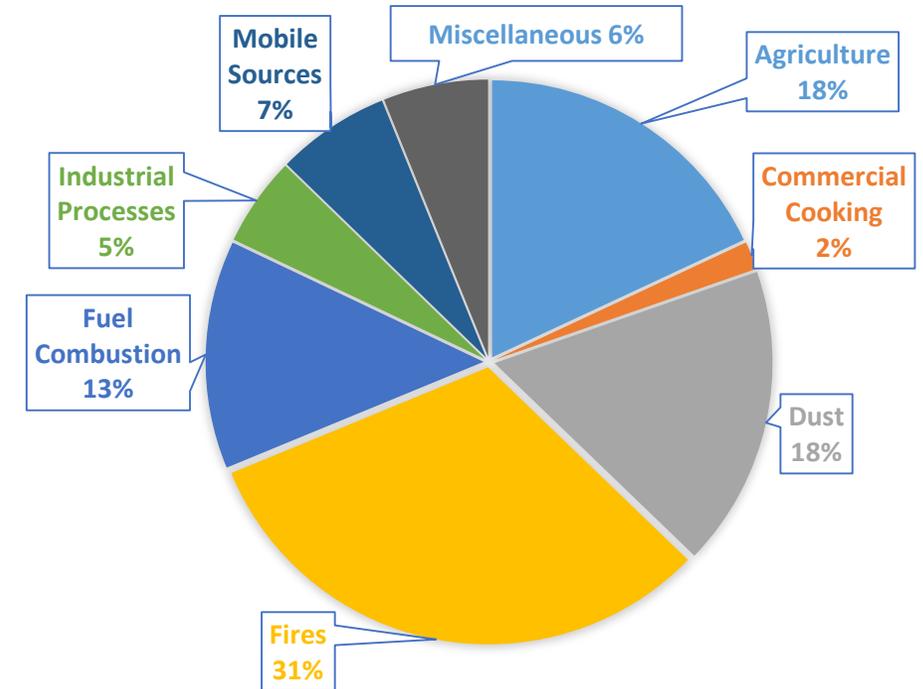
What are the important emissions for determining what is formed downwind?

- Which source categories impair visibility now and in the future?
- Primary PM vs. secondary precursors
- Will fire activity and smoke impacts overwhelm expected future anthropogenic emissions reductions?

Changing nature of wildland fires and fuels

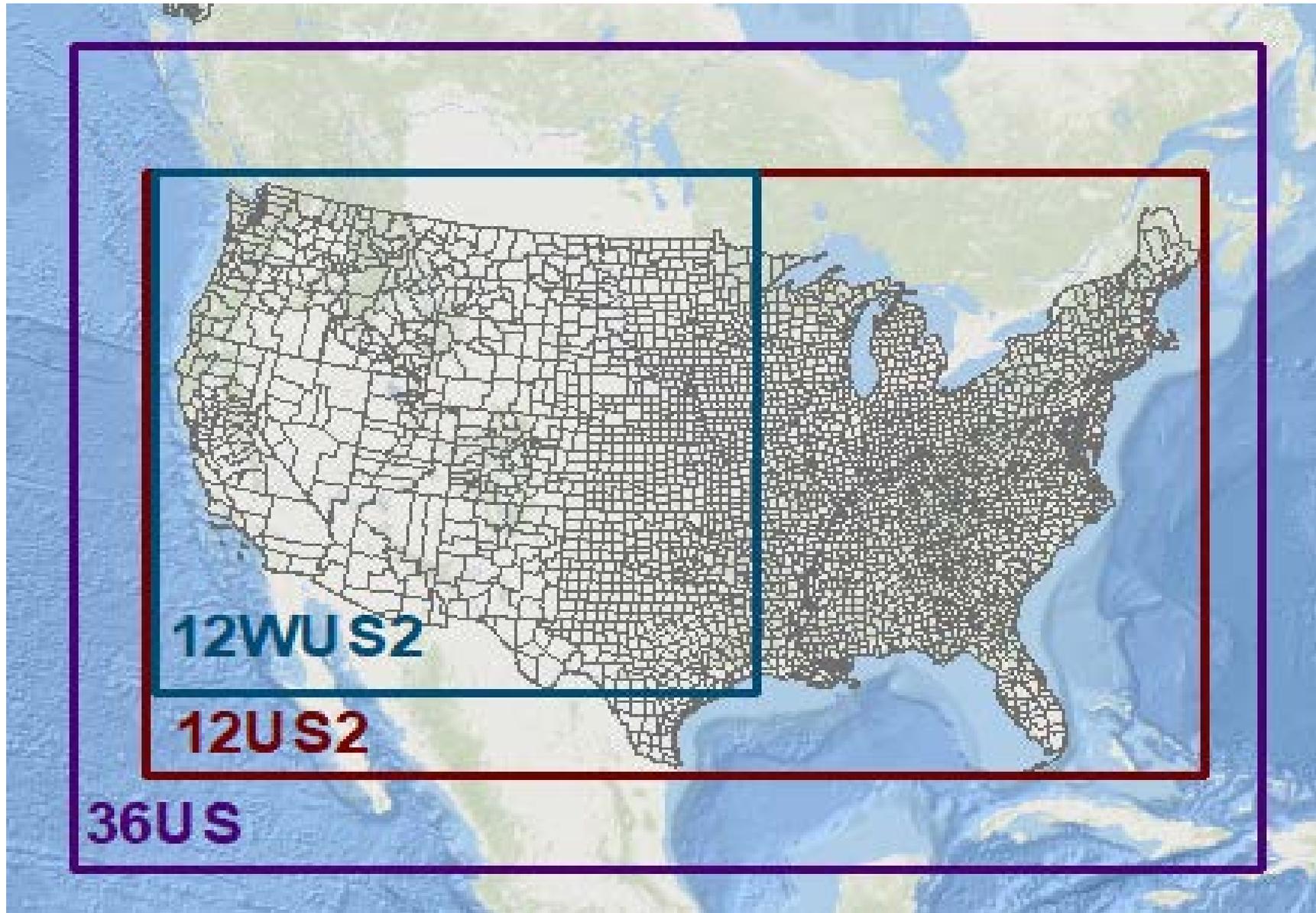
How do we optimize / manage for least air quality impacts of prescribed fire?

PM_{2.5} emissions in the 2014 NEI*

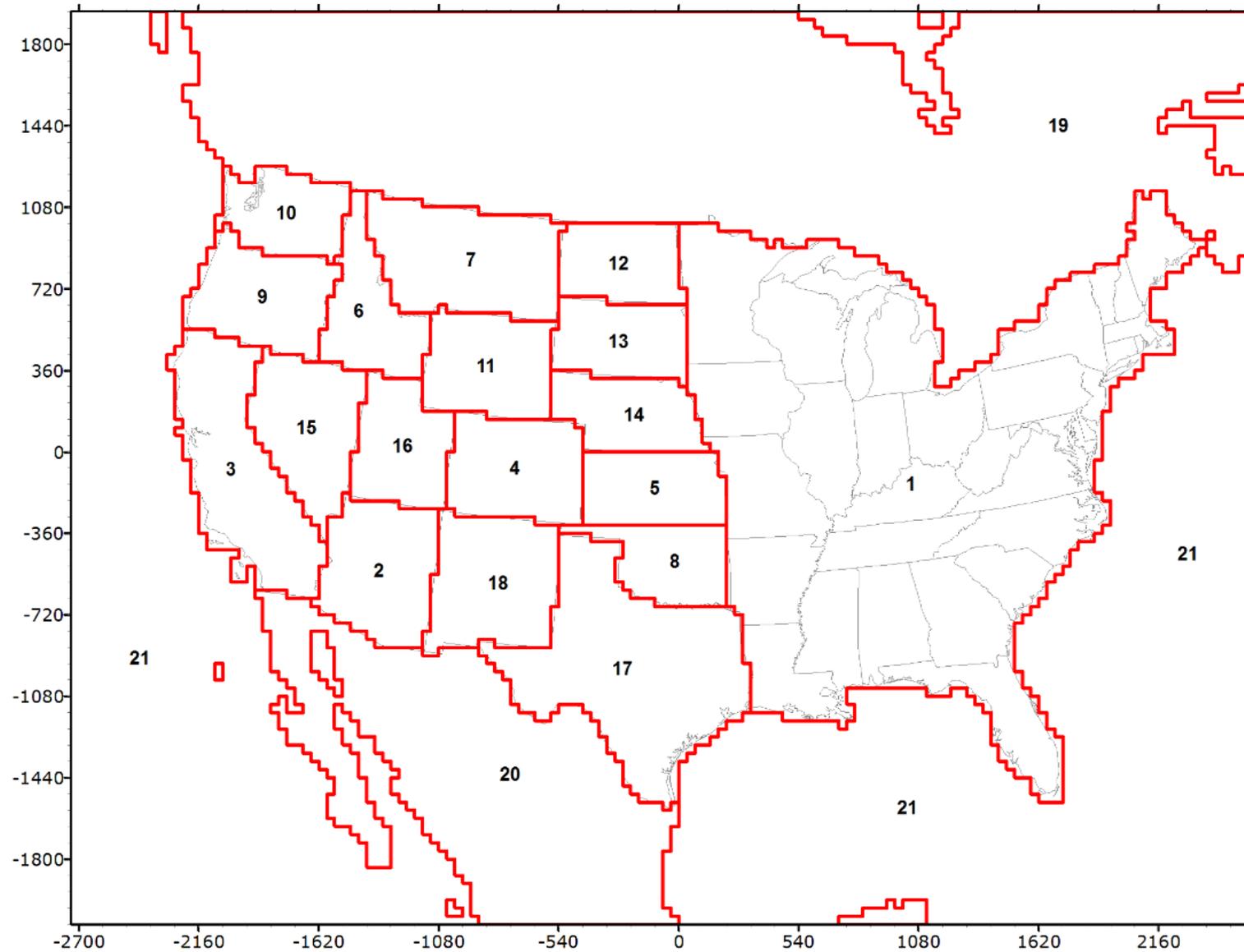


* - base year inventory for western regional haze analysis

Existing information used for a 2014-based photochemical modeling platform for western U.S.



Example Particulate Source Apportionment regional map





Aligning Long-Term Progress Tracking with Planning Decisions to be made by mid-2021

Four Factor Analysis Process:

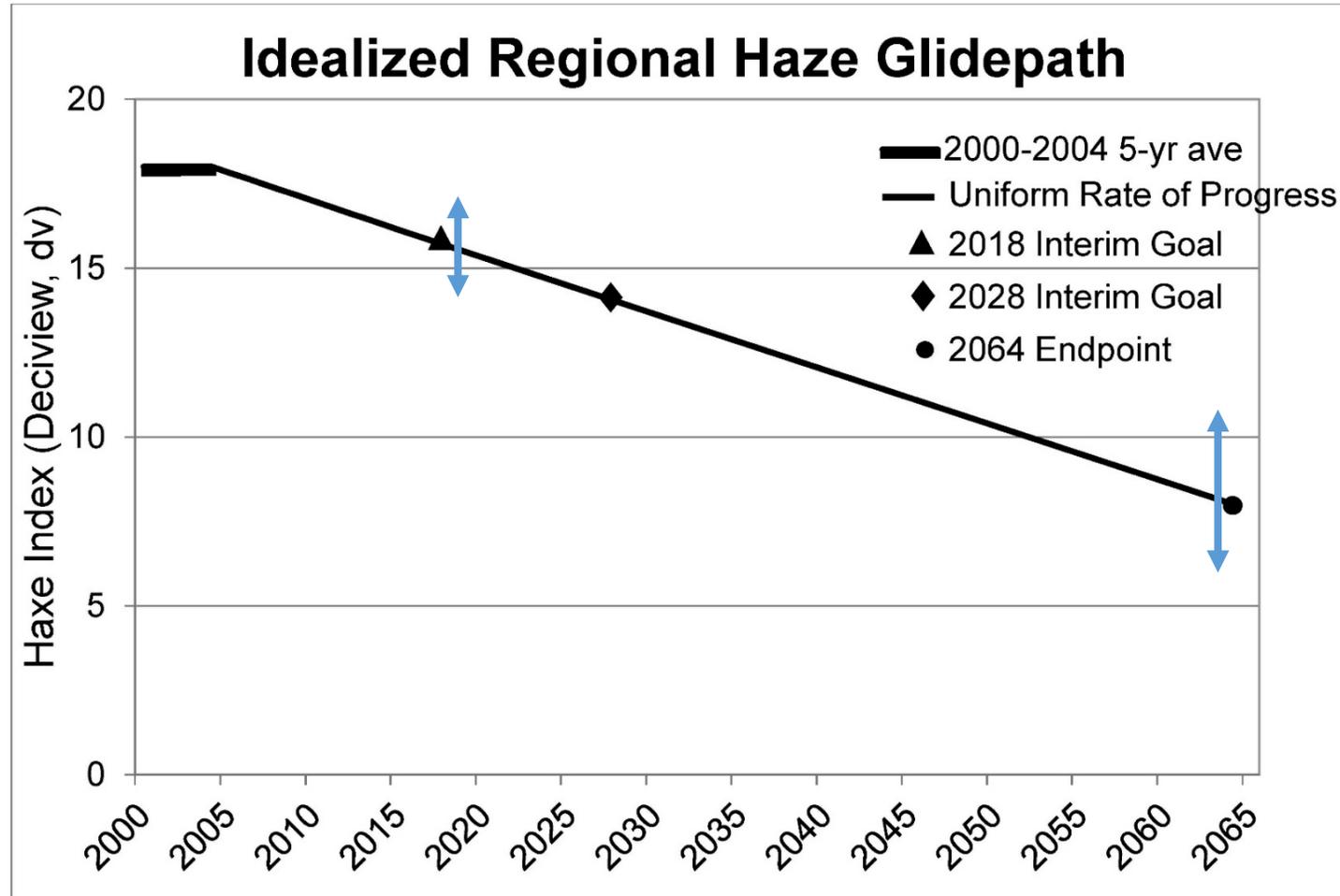
Under 40 CFR 51.308(f)(2)(i), states must consider the four statutory factors to decide what emission control measures are necessary to make reasonable progress toward natural visibility conditions at Class I areas. This obligation applies equally to states with Class I areas and states with sources that contribute to impairment at Class I areas in other states.

The four statutory factors from the Clean Air Act are:

- 1) The costs of compliance.
- 2) The time necessary for compliance.
- 3) The energy and non-air quality environmental impacts of compliance.
- 4) The remaining useful life of any potentially affected major or minor stationary source or group of sources.

Regional Haze Regulatory Construct

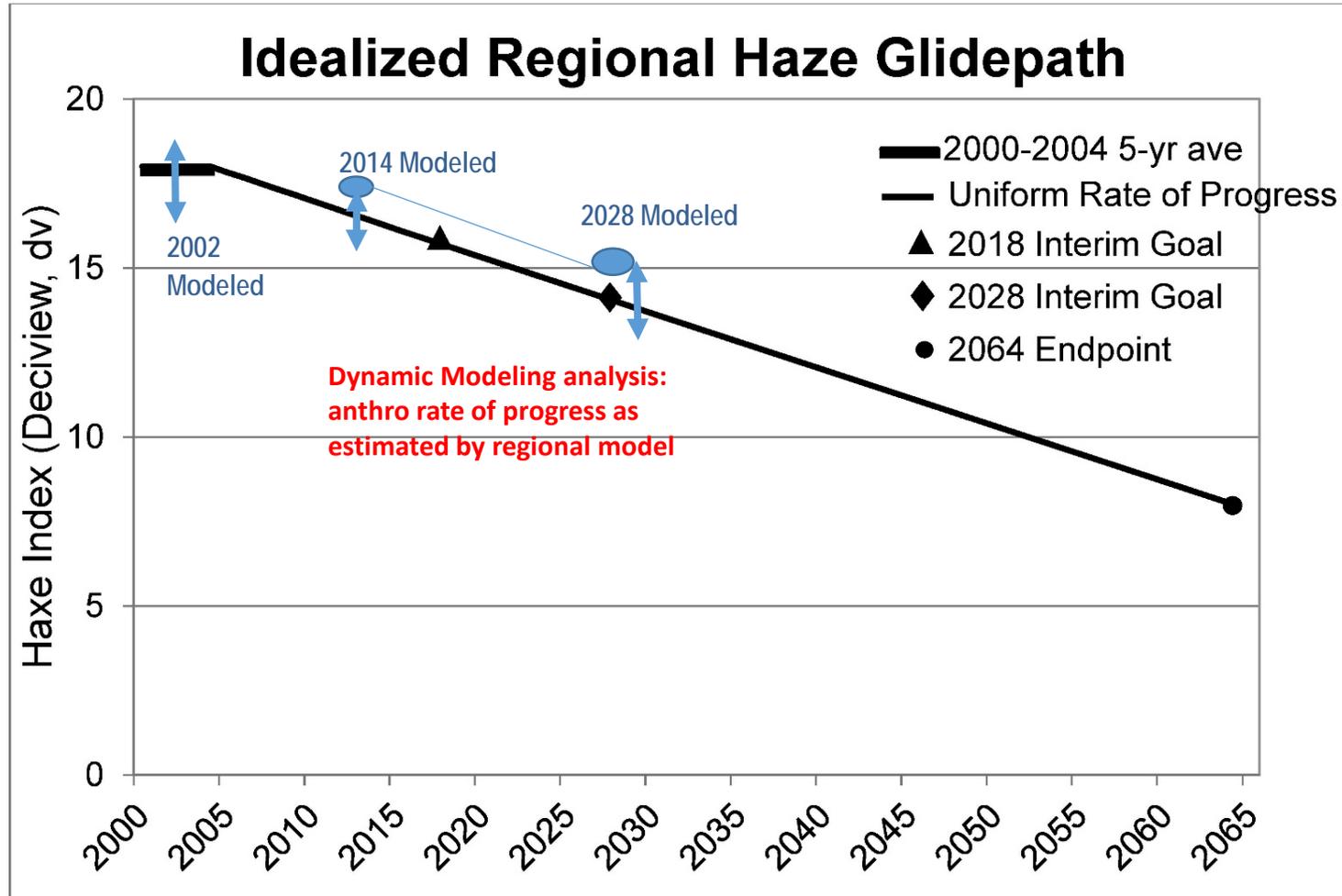
but there is uncertainty in the assumptions for natural vs anthropogenic and assumptions for natural conditions in 2064. Can we bound uncertainty?



If modeled U.S. anthropogenic contributions differ from EPA estimated total anthropogenic contributions, there can be a disconnect between modeled rate of progress and the uniform rate of progress, even if both methods are correct.

Regional Haze Regulatory Construct: Round 2

by EPA technical guidance, photochemical grid models were used to define **2018 Reasonable Progress Goals (RPG)** for haziest days and will be used to set 2028 RPG for most impaired days. Uncertainties due to emissions and model performance affect the projected glidepath



Regional Haze Regulatory Construct: Round 2

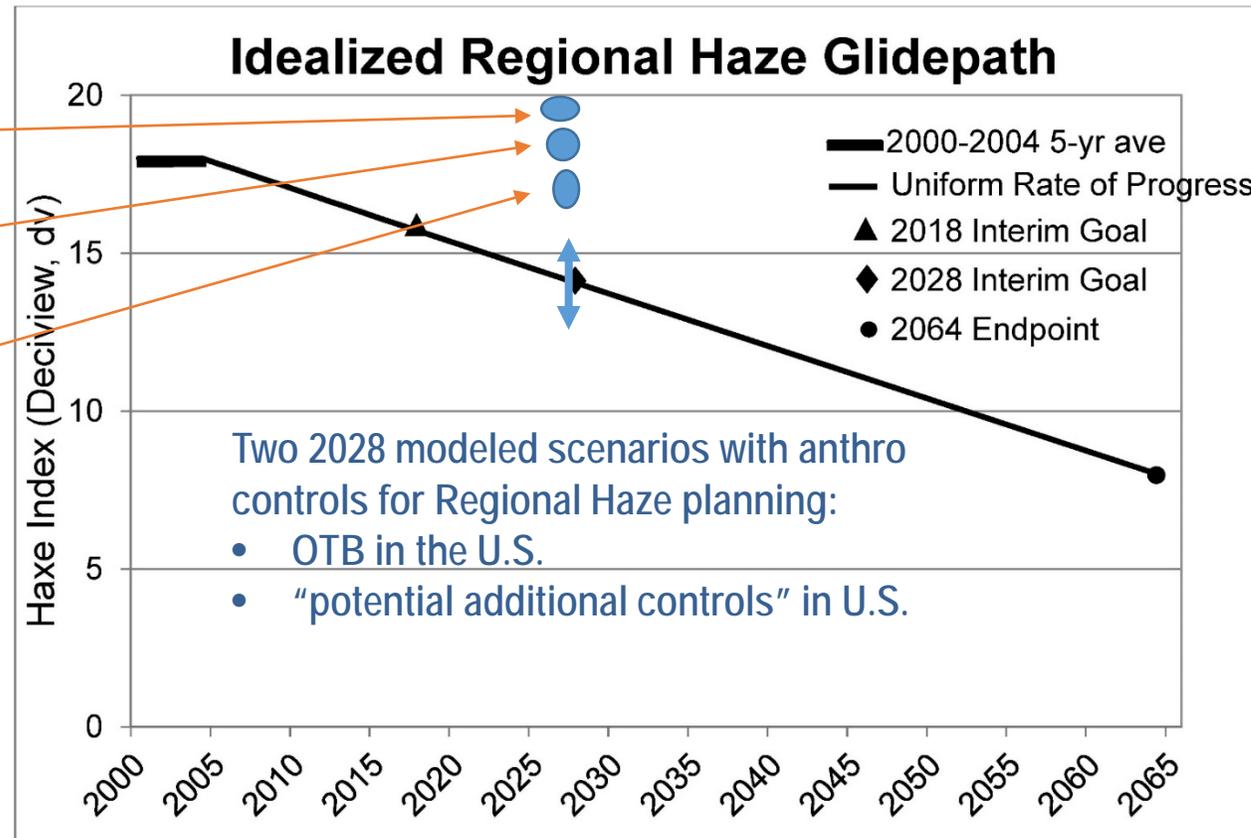
Photochemical grid model results estimate 2028 RPG for most impaired days. What monitored days offer best model performance by site? What are possible effects of international transport, wildfire, and prescribed fire scenarios on possible 2028 RPGs?

Visibility in 2028:

100% wildfire
increase

OTB international
emissions

100% prescribed fire
increase





What do the remote sensors see?

How are those data integrated so they are usable for Clean Air Act programs?

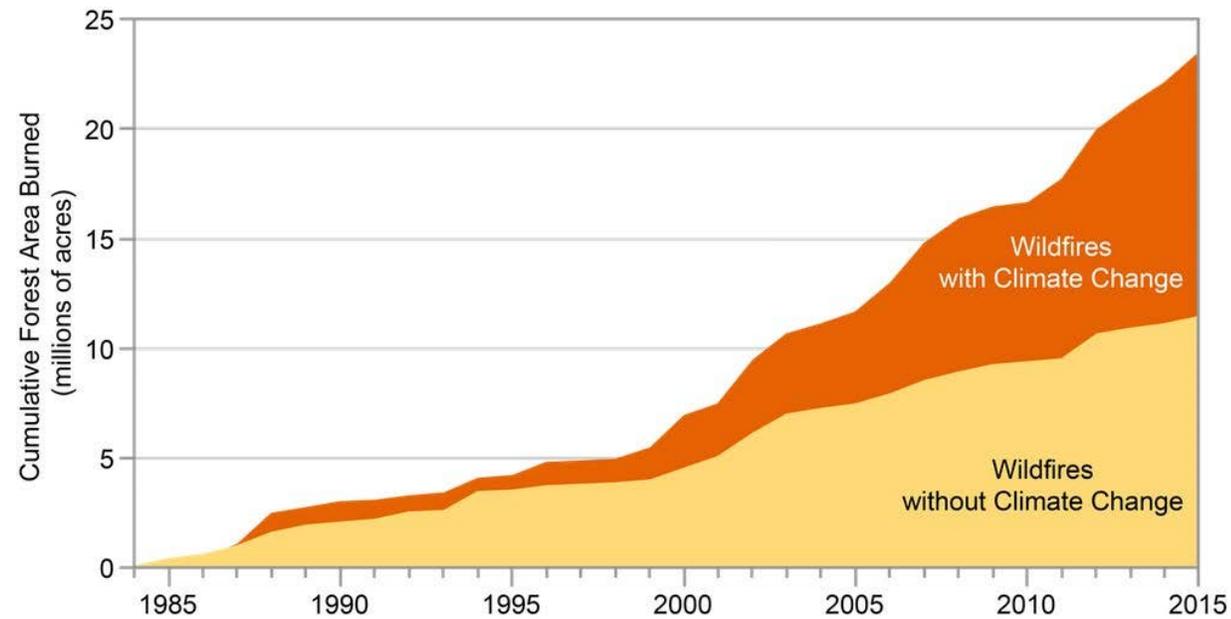


9 $\mu\text{g}/\text{m}^3$, 20-21 deciviews

unplanned natural?! wildfire



planned prescribed fire



Climate change is driving wildfires in the western U.S., and not just in California

Adapted from Reference #99 in USGCRP, 2018: *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II* [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 1515 pp. doi: 10.7930/NCA4.2018.

Fire and Smoke Work Group

Analysis and Planning Activities

- Improve activity data to support emission inventory development for fires
- Assess present and range of future contributions by smoke
- Review treatment of fire emissions in modeling studies
- Evaluate Smoke Management Programs
- Compile information about EE assessment efforts
- Improve coordination between state, tribal, and federal agencies

Outcome

- WRAP Tools/FETS update and operation
- Evaluation of Smoke Management Plans
- Historic and future fire activity and emissions
- Exceptional Events: identification of key data to collect for demonstrations
- Wildfire coordination between states/Tribes on wildfire response and smoke management



WESTAR-WRAP-WEST Associates - EGU Emissions Analysis project

Emissions Data for western interconnect + Dakotas

2014 Western EGU Emissions	SO ₂ (tons)	NO _x (tons)	Avg. NO _x Rate (lb/MMBtu)
Coal	221,476	321,306	0.253
Natural Gas	520	12,017	0.016
Coal %	100%	96%	Coal = NG x 16
Natural Gas %	0%	4%	

13 Western State EGU Emissions

	SO ₂ (tons)	NO _x (tons)
2014 to 2017	-38%	-33%



Colorado State University



Thank you.

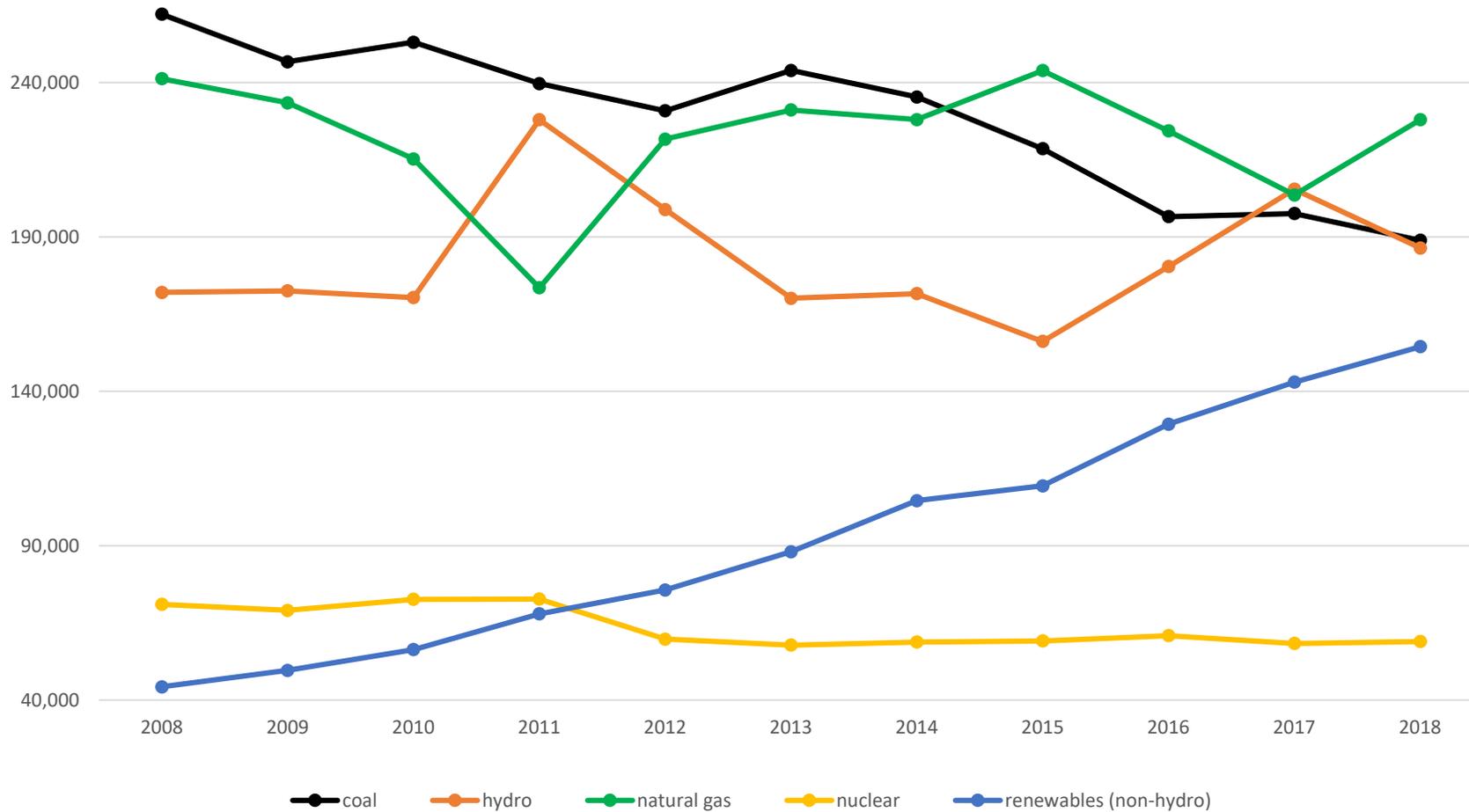
Tom Moore

WRAP Air Quality Program Manager, WESTAR

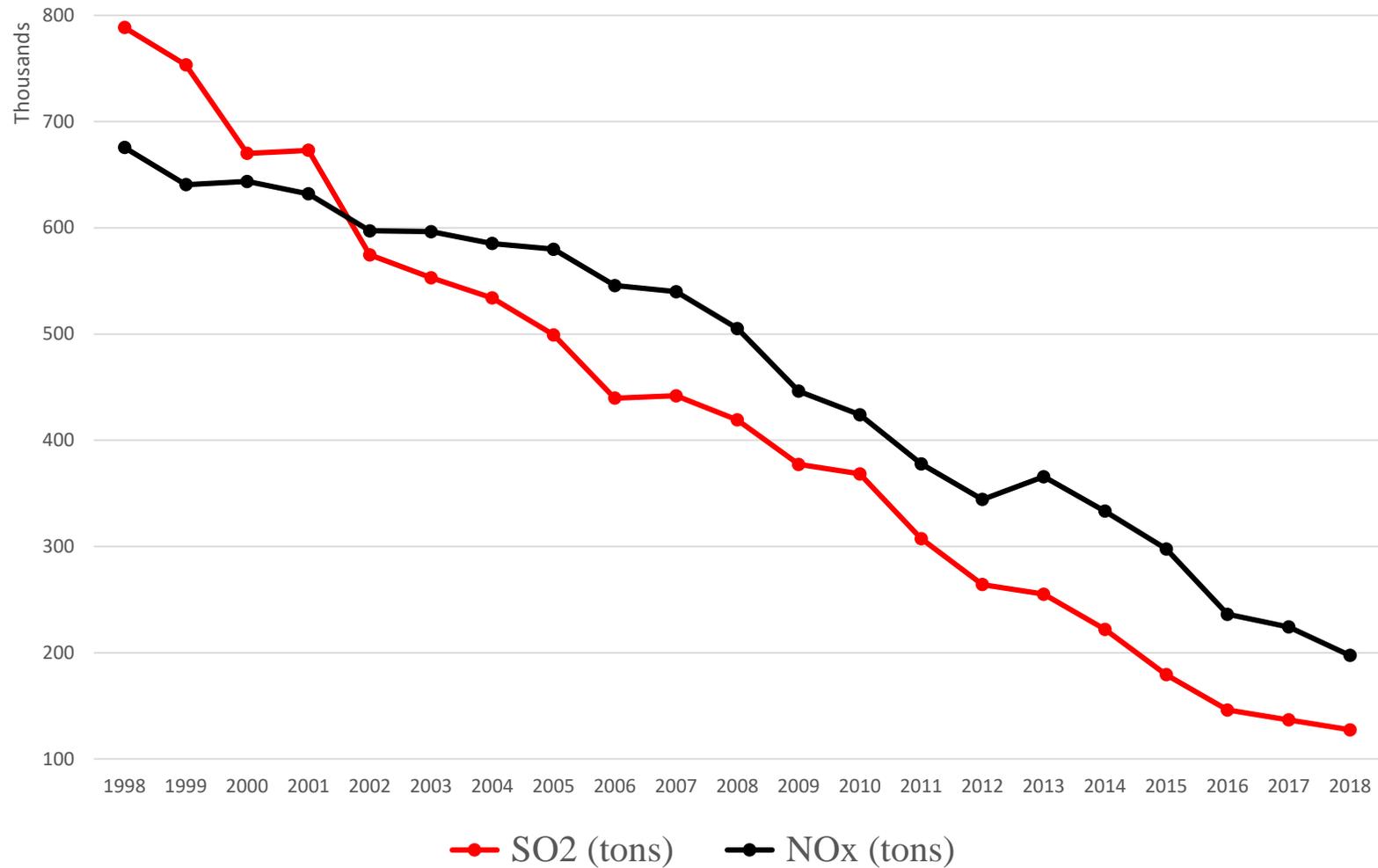


extra slides

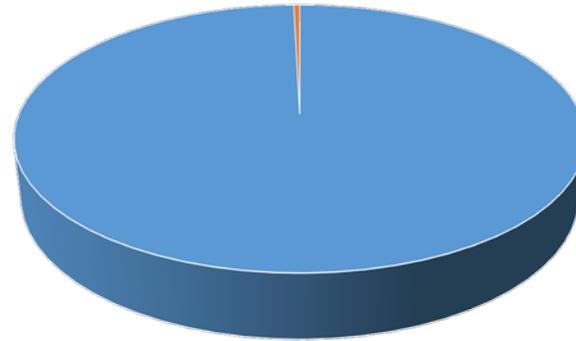
Net Generation for All EGU Sources 13-State contiguous WESTAR-WRAP region



SO₂ & NO_x Emissions from Western Power Plants 13-State Region - EPA CAMD (tons)

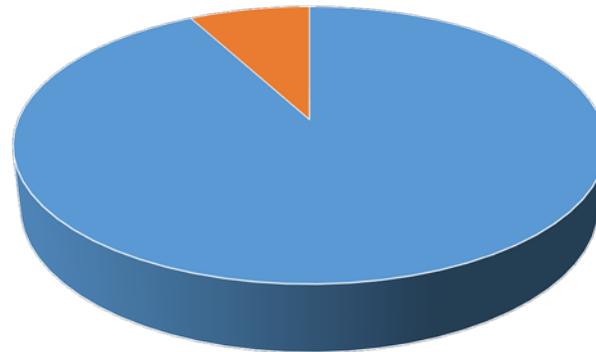


2018 EGU SO₂ Emissions 13 - Western States (EPA CAMD)



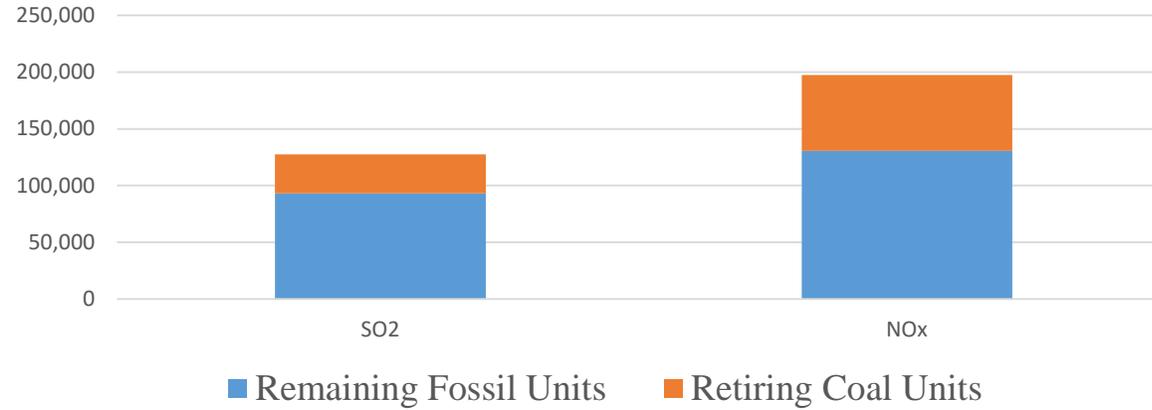
- Coal (n = 84) 99.6%
- Gas (n= 253 units > 10 TPY) 0.4%

2018 EGU NO_x Emissions 13 - Western States (EPA CAMD)

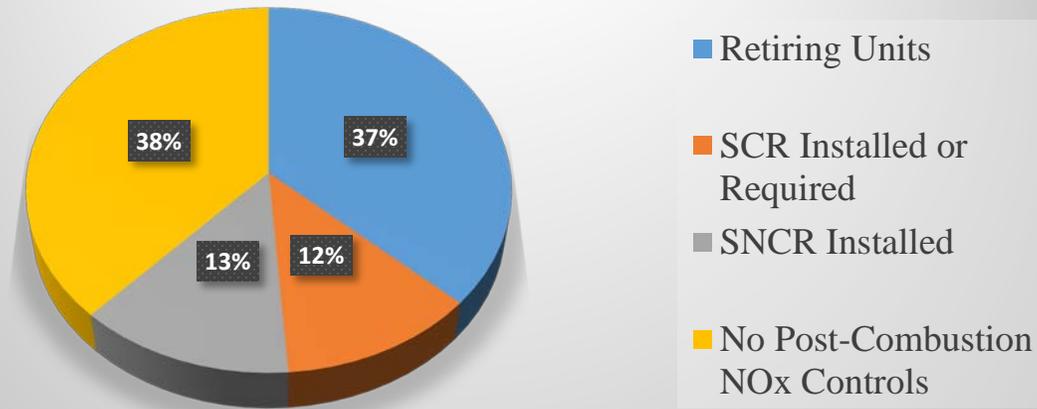


- Coal (n = 84) 92%
- Gas (n= 253 units > 10 TPY) 8%

**2018 EGU Emissions - 13 Western States
28 Coal Units Retiring by 2028**



**2018 NOx Emissions from
Coal Units in 13-Western States**



Methodology for 2028 EGU Emissions Scenarios

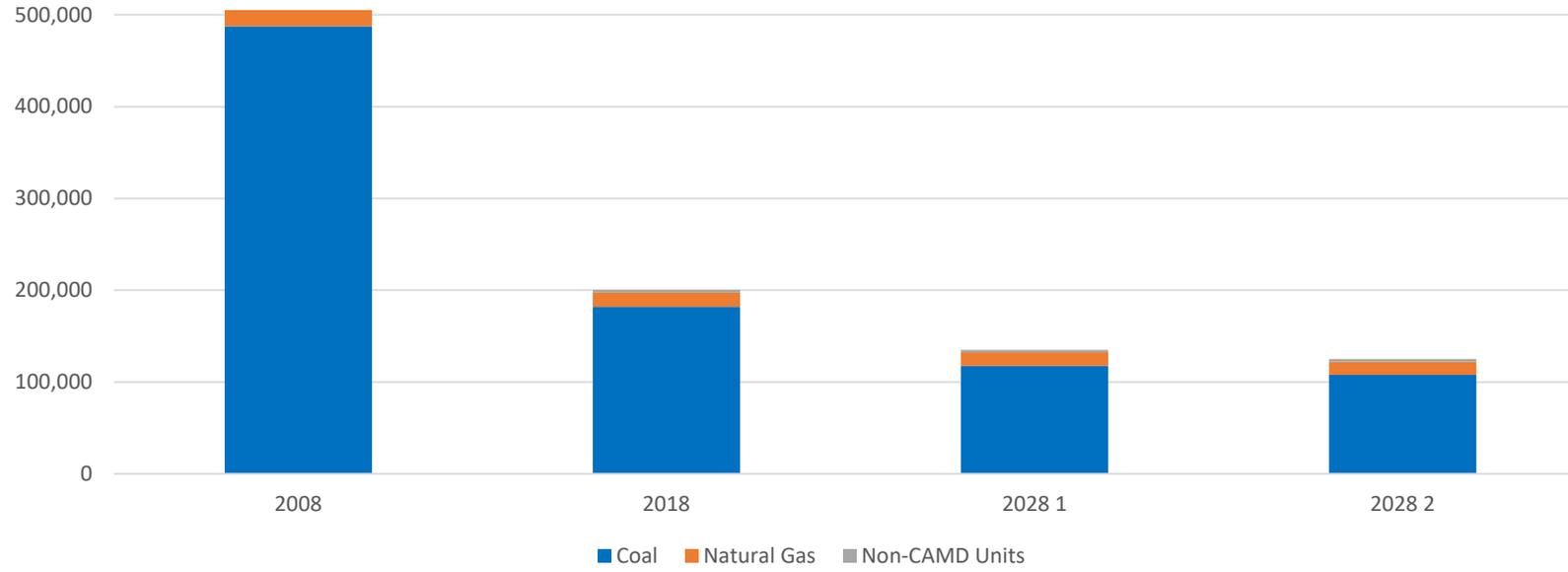
- #1) Zero out coal units that will retire by 2028
- #2) Incorporate 2018 data for remaining coal units
- #3) Calculate 2016-18 average and heat rate for each unit
- #4) Two capacity factor scenarios
 - 2016-18 average capacity factor
 - 2016-18 highest year capacity factor
- #5) Select emission rate for each unit
 - 2016-18 average or max used if no new controls over this period
 - 2018 (or expected/permitted) rate if new emission controls

Then: 2028 Tons Per Year = MWhrs x Heat Rate x Emission Rate

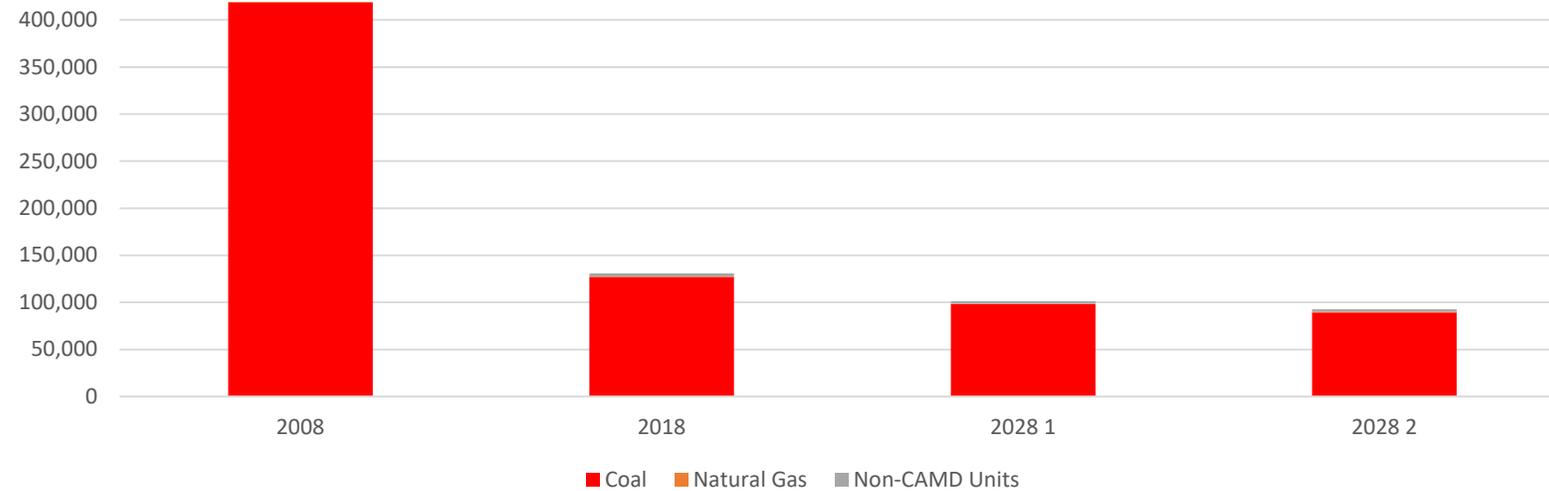
- #6) Add emissions from gas plants at 2018 actuals

	MWHr	NOx (TPY)	SO2 (TPY)	
arizona	15,998,537	8,247	7,318	2016-18 Avg
arizona	17,975,816	9,283	8,134	2016-18 Max
colorado	22,001,631	10,707	9,197	2016-18 Avg
colorado	23,892,415	11,778	10,020	2016-18 Max
montana	10,837,604	8,046	4,766	2016-18 Avg
montana	11,730,562	8,672	5,177	2016-18 Max
nevada	1,079,600	261	159	2016-18 Avg
nevada	1,162,858	281	171	2016-18 Max
new mexico	1,325,534	2,320	835	2016-18 Avg
new mexico	1,402,342	2,454	883	2016-18 Max
navajo nation	7,511,207	2,836	1,773	2016-18 Avg
navajo nation	8,636,076	3,265	2,041	2016-18 Max
utah	18,430,041	20,311	6,752	2016-18 Avg
utah	19,744,159	21,797	7,227	2016-18 Max
wyoming	35,530,521	23,055	21,517	2016-18 Avg
wyoming	38,674,831	25,271	23,505	2016-18 Max
north dakota	28,047,531	30,770	36,261	2016-18 Avg
north dakota	30,643,428	33,804	39,996	2016-18 Max
south dakota	2,275,369	1,022	890	2016-18 Avg
south dakota	2,455,317	1,102	961	2016-18 Max
Total		107,574	89,467	2016-18 Avg
Total		117,707	98,114	2016-18 Max

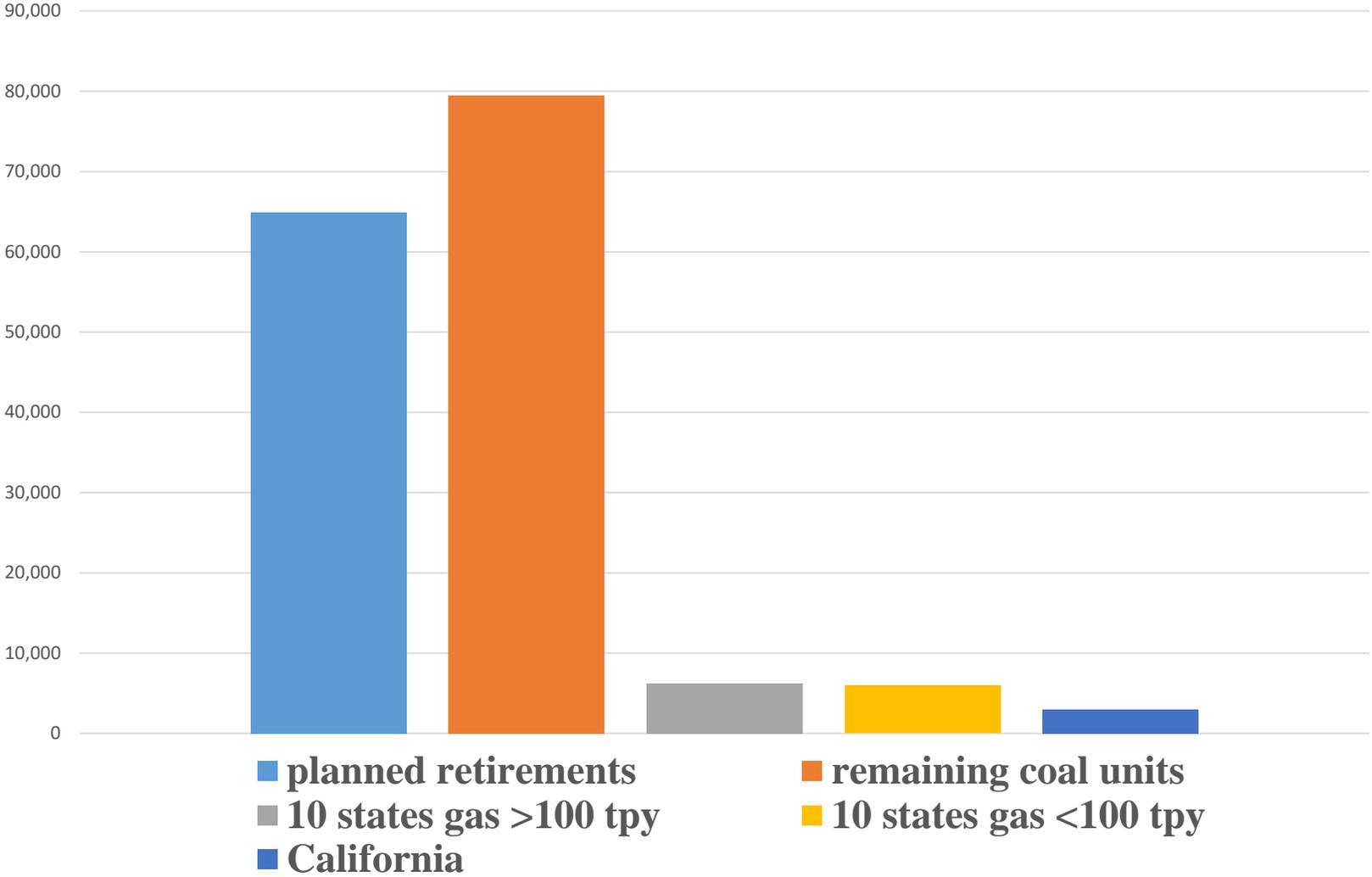
NOx



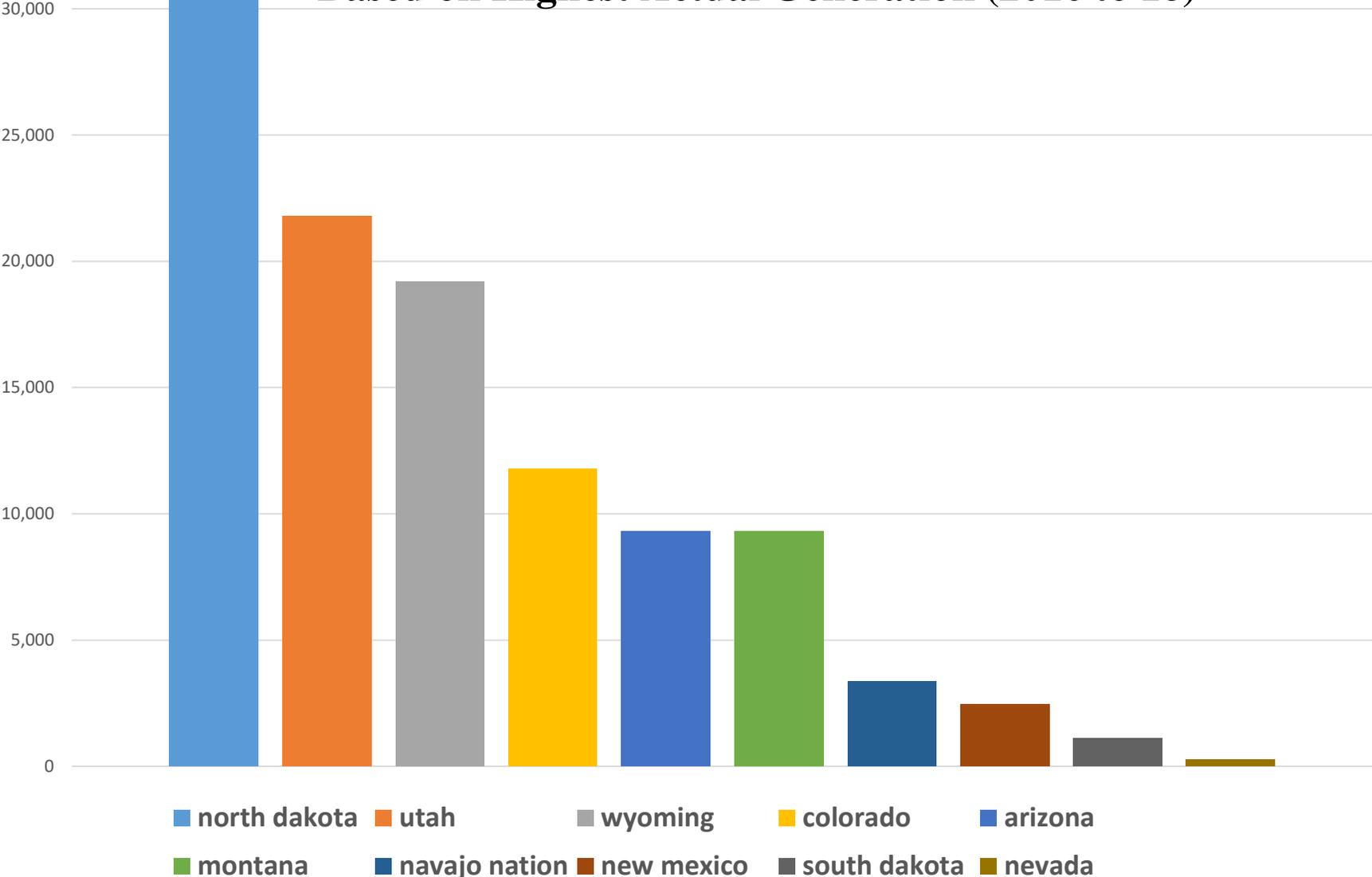
SO2



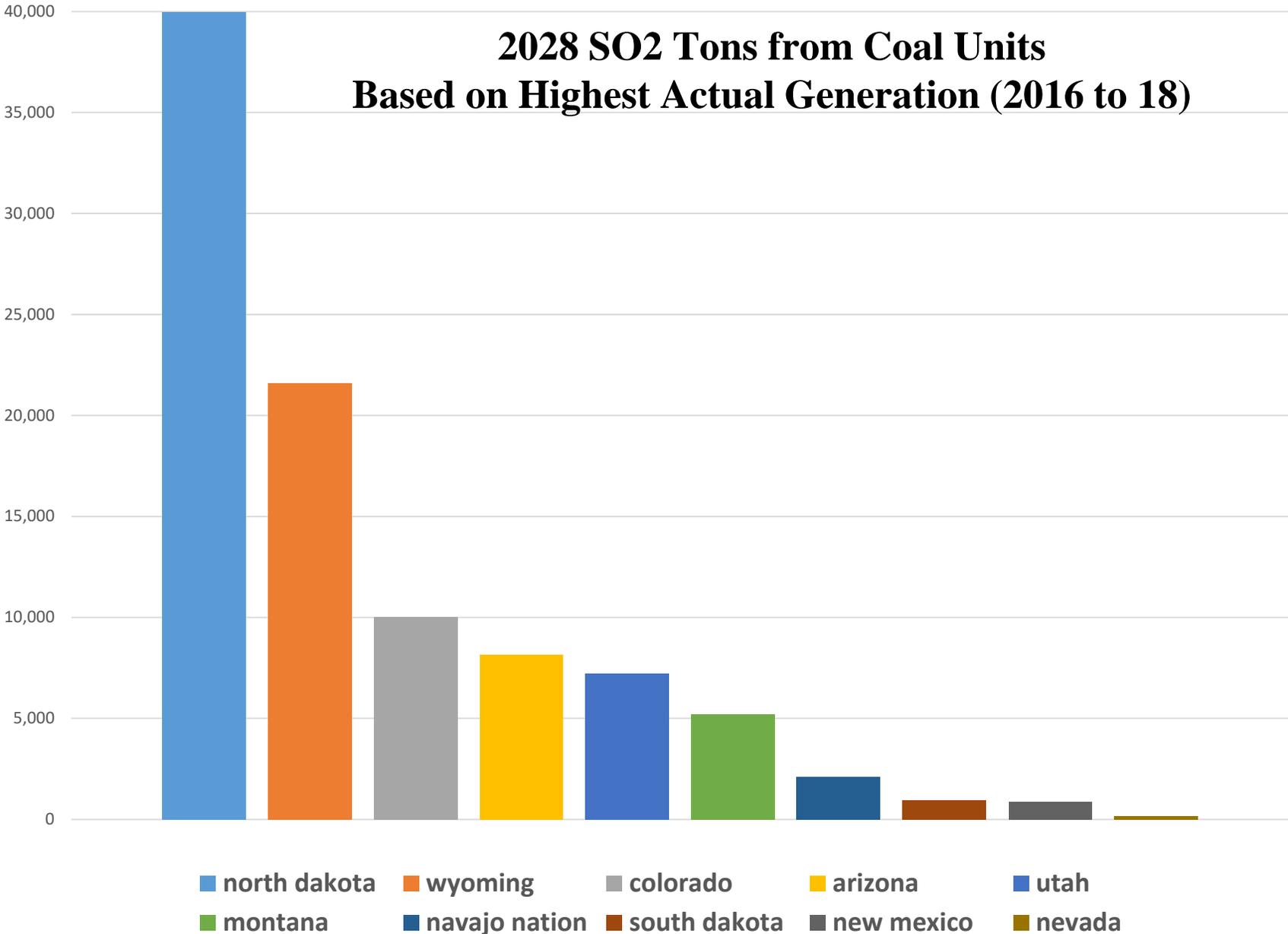
Western 11-state Interconnection - 2018 NOx (tons)



2028 NOx Tons from Coal Units Based on Highest Actual Generation (2016 to 18)

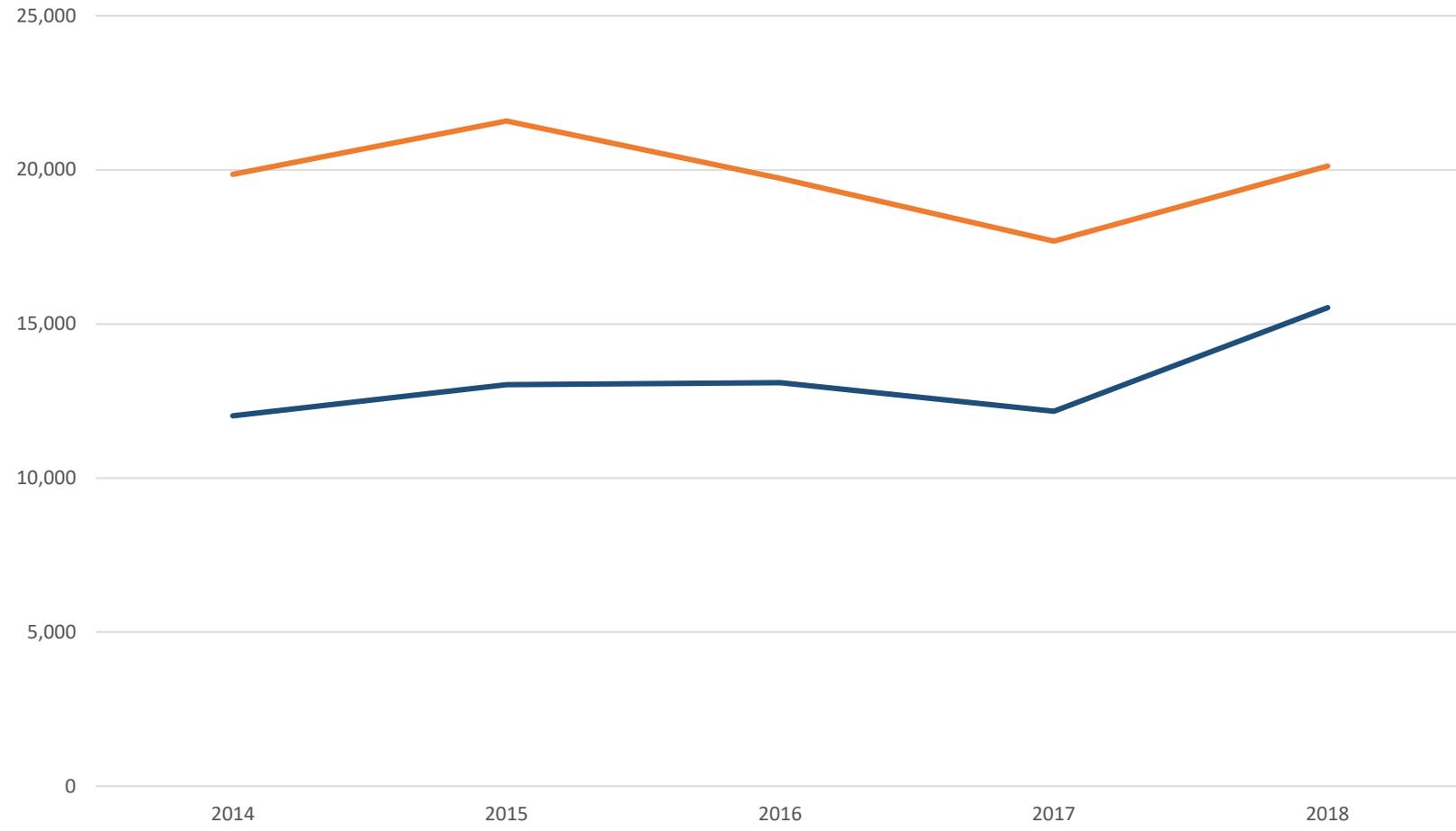


2028 SO2 Tons from Coal Units Based on Highest Actual Generation (2016 to 18)





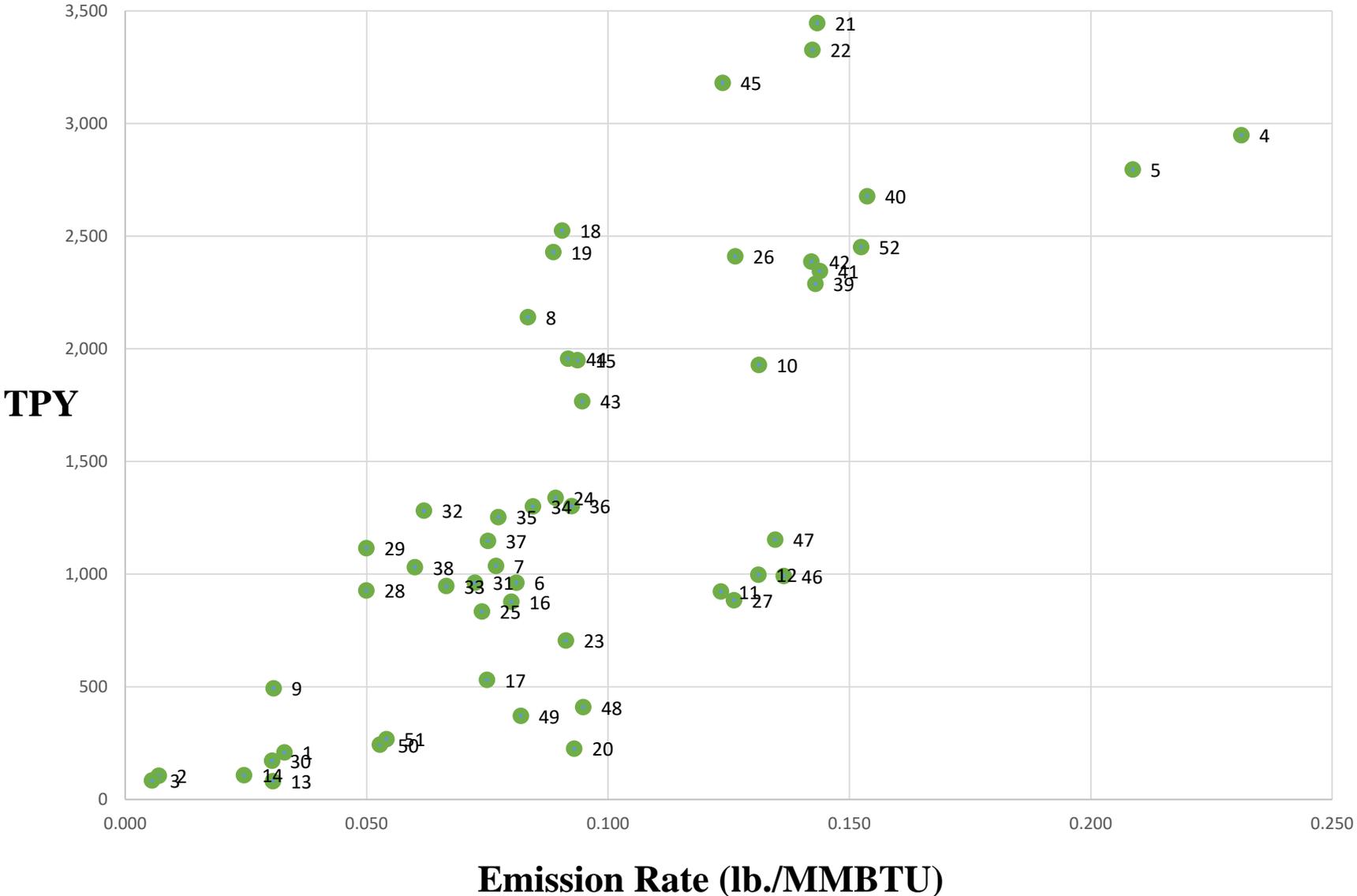
Natural Gas Trends-Generation and NOx emissions 13 Western States Total - 2014-18



— Gross Load (MW-h)/10,000 — NOx (tons)



SO2 Profiles for Remaining Coal Units





NOx Profiles for Remaining Coal Units

