

Dust from Gobi Desert, tracked by satellite, April 1998



Thunderstorm cell causes zero-visibility haboob cloud (2000 ft. tall, July 2012) during Arizona's monsoon season (June-September, one to three times a year)

UNDERSTANDING UNCONTROLLABLE CONTRIBUTIONS TO REGIONAL HAZE



King Fire, Sept.-Oct. 2014, burns 97,717 acres, multi-directional plume



Arctic haze: tracking species and seasonal causes back to sources indicate regional pollutants move to "sink" near and in Alaska



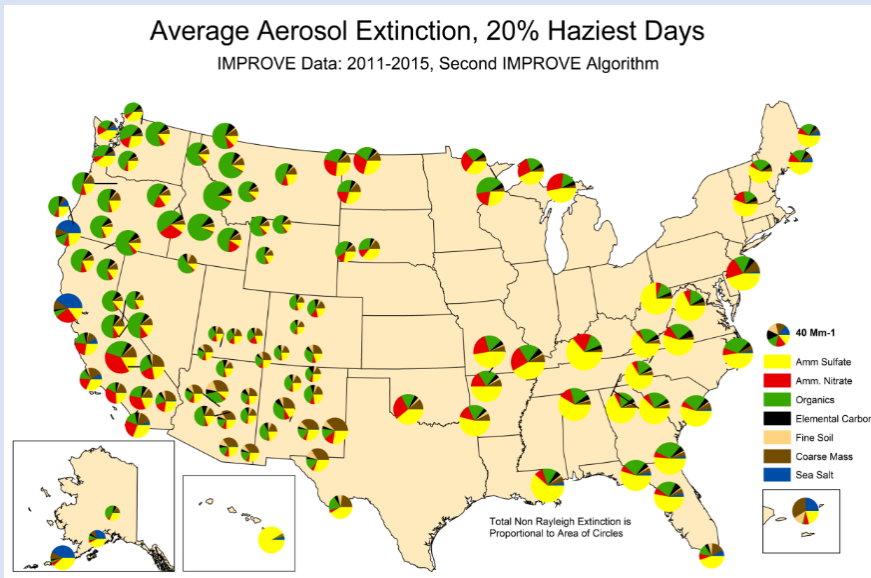
Volcanic sources: Hawaii and Pacific Rim activity can be constant or sudden, producing lava, gas, ash, all traveling and reacting on surface and in atmosphere

**WESTAR-WRAP
Regional Haze
Planning
Workshop**

**December 5, 2017
Denver, Colorado**

Origin of Terms

Controllable vs. Uncontrollable



FIRST Planning Period WORST DAYS

- States needed to know where the species at IMPROVE monitors came from to develop a control strategy that improved visibility
- Western States inventory mix of anthropogenic haze precursors does not explain causes of haze at the IMPROVE monitors on WORST DAYS
- Western states have large inventory of natural emissions causing haze on WORST DAYS in comparison to anthropogenic emissions
- Air masses from outside United States also bring haze precursors and species into the country
- Also need to know how the sources AND their relative contributions might change in the future

SOURCE	In-Country	Out-of-Country
Anthropogenic	Potentially Controllable	not controllable
Natural	not controllable	not controllable

Sources of Visibility Impairment

- Thought exercise for identifying what causes haze and how much might impact each Class 1 Area... Relative Contributions will vary throughout the Country
- Quantifying and forecasting source types includes modeling and estimating

	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 climate change and other human changes to the environment	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.

- **GOAL:** to identify anthropogenic emissions that can be controlled in each planning period to get steady improvement of visibility at Class I Areas

Classify and Quantify Uncontrollables

NATURAL (In-State, Out-of-State and International)

- Biogenic Emissions
- Geogenic Emissions (includes hot springs, fumaroles, geysers)
- Wildfires
- Dust storms
- Volcanoes
- Lightning NOx
- Dimethyl Sulfide (DMS) (ocean, tidal origins)
- Sea Salt

INTERNATIONAL EMISSIONS (adjacent and global)

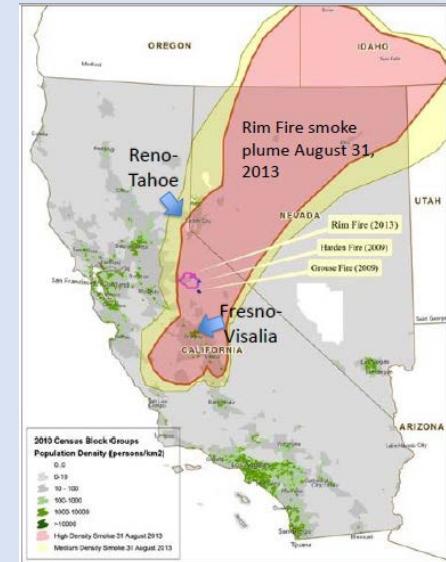
- International Anthropogenic
- International Natural (see above)

U.S. ANTHROPOGENIC EMISSIONS THAT STATES DO NOT HAVE CONTROL OVER

- On-Road and Non-Road Mobile Sources (e.g., roads, airports, railroads, shipping lanes)
- Federal Facilities
- In-state emissions for which we do not yet have feasible or reasonable technical controls

MIXED CONTROL AUTHORITIES

- State Fleet Rules for Mobile Sources
- International treaties for fuels used by Ocean-Going Vessels (OGV)
- California Mobile Source control program, MOUs, and near-shore OGV rules

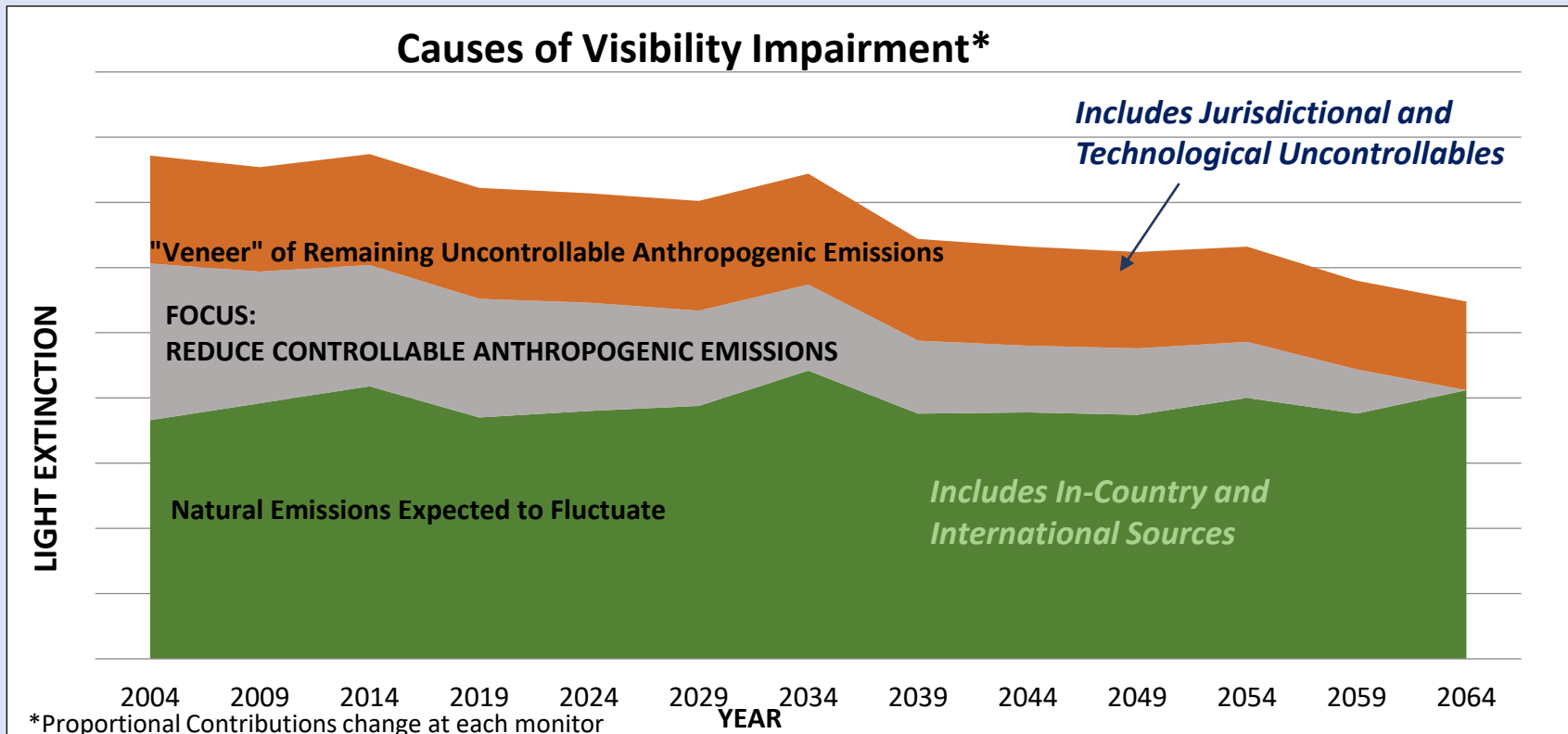


Contributions Change Over Time

Need Good estimates of both Natural and Anthropogenic Emissions Inventory for:

- Reconstructing the baseline years (2000-2004)
- Preparing the Base Year for Modeling
- Forecasting 2028 to develop Reasonable Progress Goals
- Recreating the 2064 Endpoint for Idealized Glide Path

Ultimately need to isolate what might be controllable in each planning period to reduce anthropogenic impairment



Focus: Controllable Precursor Emissions

- Air mass movement and pollutant transport important – harder to tease out in complex terrain of the West with uneven populations and source distribution
- Need Modeling to Differentiate Source Origin
- Moving from Inventory to Strategy
 - Evaluate anthropogenic precursor sources of key haze-driving species at monitor
 - Need to know relative contribution of Natural Source emissions to haze
 - Need to differentiate which anthropogenic sources are subject to whose regulatory jurisdiction
 - Not all anthropogenic sources will be “controllable” in the planning period due to regulatory jurisdiction or technological feasibility (and “reasonableness”)
- Forecast emissions ... Growth might offset control for some sources

SOURCE	In-State	Out-of-State	International
Anthropogenic	Potentially Controllable	Potentially controllable	Potentially controllable
Natural	not controllable	not controllable	not controllable

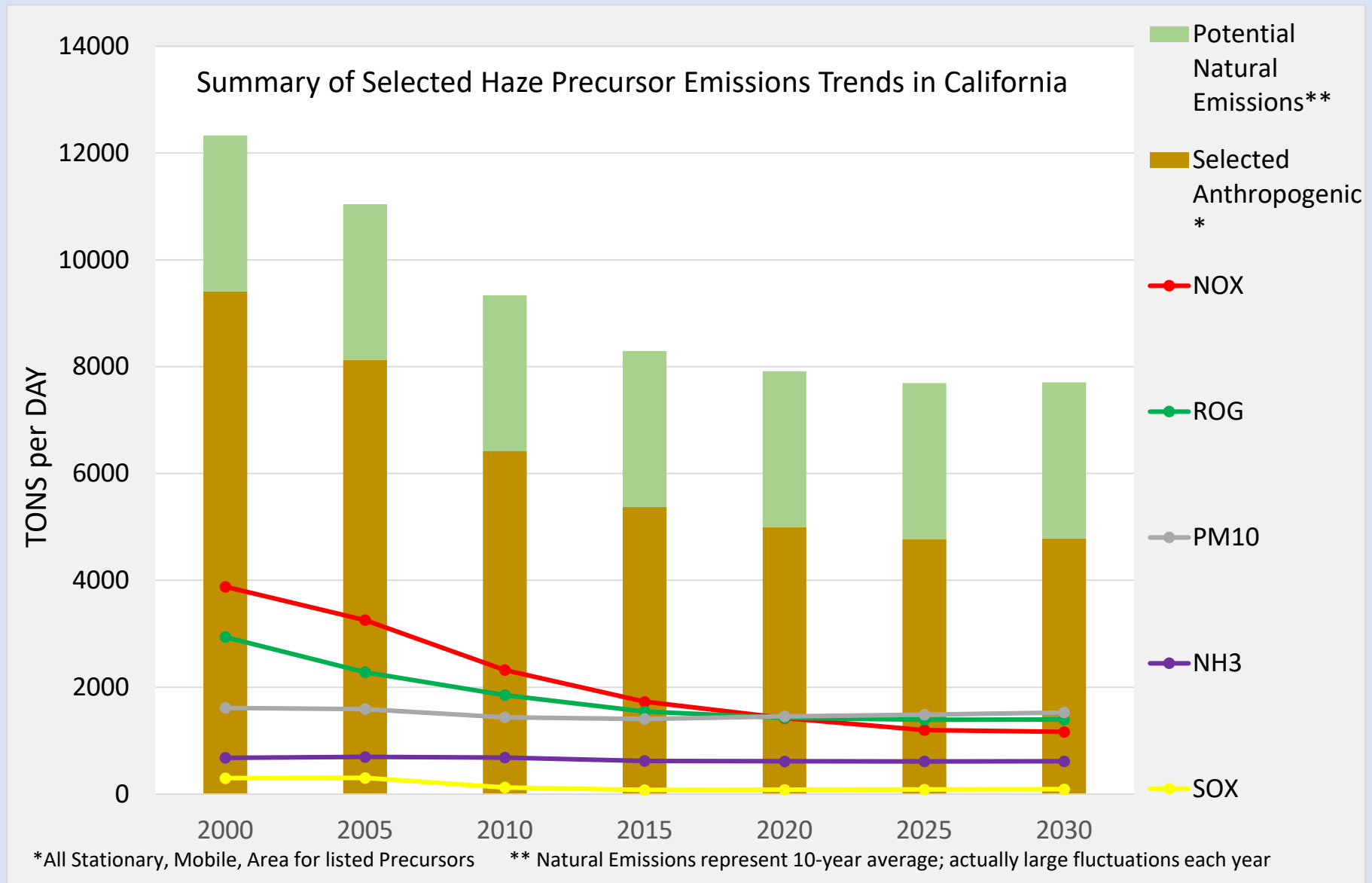
Four-Factor Analysis Consultation Federal Negotiation

Modeling Critical for Inventory and Forecasts

Source: WRAP training from first planning period. Colored Boxes indicate possible updates!

	SO ₂	NO _x	OC	CM
Emission Sources	Anthro/Natural mix depends on location. <i>Ratio changing for second planning period</i>	Mostly anthropogenic. <i>Mix of combustion and mobile sources</i>	Diverse. <i>Mix of anthro, fire, and biogenic VOCs.</i>	Diverse. <i>Very difficult to partition windblown dust into nat./anthro.</i>
Emissions Data Quality	Very good overall. <i>Activity data less good for area sources.</i>	Good. <i>Activity data less good, some coding concerns w/ smaller point, area, and O&G sources.</i>	Fair. <i>Good activity data & conf. in PM_{2.5} emissions, but uncertain spec. of PM_{2.5} & bio. VOCs.</i>	Poor, except for some locales. <i>Categorically complete but accuracy very uncertain.</i>
Emission Projections	Very good. <i>Uncertain about area sources.</i>	Good. <i>Uncertain about offshore and O&G.</i>	Fair. <i>What to expect from fire?</i>	Fair. <i>What to expect from windblown dust?</i>
Atmospheric Science Quality	Very good. <i>Meteorology probably largest uncertainty.</i>	Fair. <i>Chemistry more complex, but meteorology too.</i>	Fair. <i>Most complex, least understood, but model perf. OK.</i>	Fair. <i>No major chemistry, but model resolution, met. insufficient.</i>
WRAP Tools	Emission Inv. CMAQ Proj. PSAT Apport.	Emission Inv. CMAQ Proj. PSAT Apport.	Emission Inv. CMAQ Proj. PMF, WEP.	Emission Inv. Causes of Dust WEP.

Need Natural Source Inventory Refinements



Mutual Benefits from Anthropogenic Controls

FUTURE THOUGHTS.....

about sources, emissions, impacts, focus for controls, integrating programs for mutually beneficial purposes

