

Use of CAMx in Evaluating Impacts for the Regional Haze Rule

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Overview

- > Regional Haze Background
- > Historical Modeling for BART
- > Reasonable Progress and BART Evaluations Now
- > CALPUFF Limitations
- > CAMx Modeling for Regional Haze
 - ❖ Methodologies
 - ❖ Change in Model-Predicted Impacts
- > Conclusions

Regional Haze Background

- > 1977 CAA - National goal for 156 federally mandated Class I areas to be restored to pristine conditions
- > 1999 RHR - Comprehensive visibility protection for Class I areas
 - ❖ 40 CFR 51, Subpart P, 7/1/1999 (64 FR 35714)
- > First Implementation Plan for RH/BART
- > Reasonable Further Progress Requirements

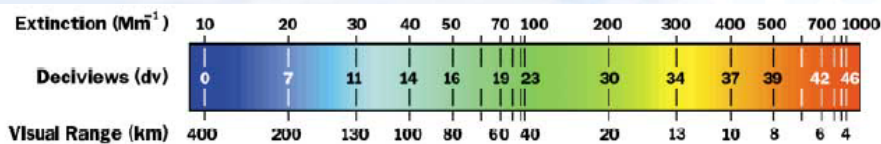


Expressing Haze

- > Light Extinction - Inverse megameters (Mm^{-1})
- > Visual Range - length (mi or km)
- > Deciviews (dv) - “perceptible changes”

$$VR(km) = \frac{3.912}{b_{ext}(km^{-1})} = \frac{3912}{b_{ext}(Mm^{-1})}$$

$$dv = 10 \ln(b_{ext} / 10 Mm^{-1})$$



Source: Malm (1999) *Introduction to Visibility*



Reconstructing Light Extinction

$$\begin{aligned} b_{ext} = & 2.2 \times f_S(RH) \times [Small\ Sulfate] \\ & + 4.8 \times f_L(RH) \times [Large\ Sulfate] \\ & + 2.4 \times f_S(RH) \times [Small\ Nitrate] \\ & + 5.1 \times f_L(RH) \times [Large\ Nitrate] \\ & + 2.8 \times [Small\ Organic\ Mass] \\ & + 6.1 \times [Large\ Organic\ Mass] \\ & + 10 \times [Elemental\ Carbon] \\ & + 1 \times [Fine\ Soil] \\ & + 1.7 \times f_{SS}(RH) \times [Sea\ Salt] \\ & + 0.6 \times [Coarse\ Mass] \\ & + \text{Rayleigh Scattering (Site Specific)} \\ & + 0.33 \times [NO_2(ppb)] \end{aligned}$$

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Calculating Haze Index

$$\text{Deciview Haze Index (dv)} = 10 \times \ln \left(\frac{b_{ext} [Mm^{-1}]}{10 [Mm^{-1}]} \right)$$

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Historical Modeling for BART

- > EPA recommended the CALPUFF modeling system for making BART applicability and control determinations
- > EPA preserved agencies' discretion to use other models such as CMAQ or CAMx, which
 - ❖ "may be helpful in providing a relative sense of the source's visibility impact and can aid in informing the BART decision."

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Fast Forward → Reasonable Progress and BART Evaluations Now

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CALPUFF Limitations for Regional Haze

- > Outdated Model Versions and Met Data
- > Distance limitation
- > Constant ammonia background
- > Nitrate over-prediction
- > Single source model
- > Clean background
- > Removed from App W

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CALPUFF vs CAMx for Regional Haze

	CALPUFF	CAMx
Model Type	Lagrangian Puff Model	Eulerian Photochemical Grid Model
Distance Limitation	Overpredicts at large distances	Regional
Source Options	Single Source	All Source Categories & Sources of Emissions
Background	Clean Background	Dirty Background
Chemistry	Simple Chemistry - Mesopuff	Full Chemistry Plume-in-Grid (PIG) Complex Chemistry + Secondary Formation
Post-Processing	Calpost – Method 8	Varying methods

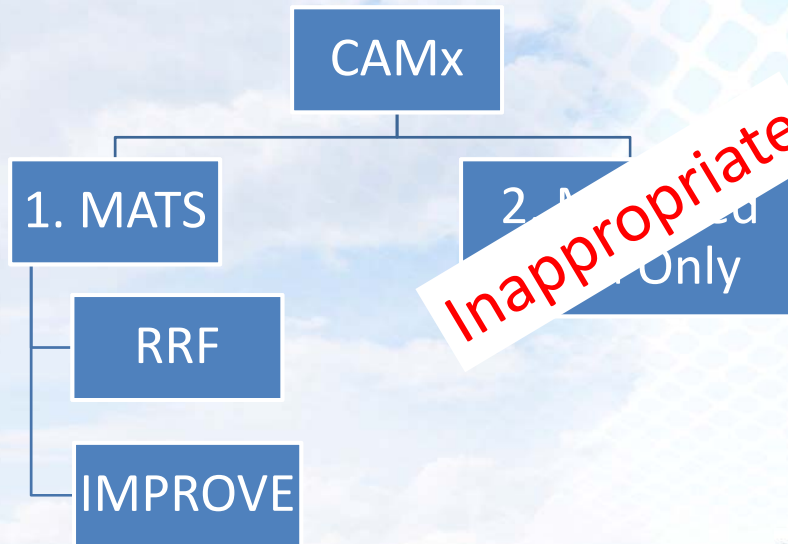
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CAMx Modeling Inputs

- > Emissions Data → Sparse Matrix Operator Kernel Emissions (SMOKE) pre-processor
 - ❖ BART: Base to Changes from Base
 - ❖ RP: Base to Future Case
- > Other Data → meteorological data, land-use files, albedo-haze-ozone inputs, photolysis rates, boundary and initial conditions
 - ❖ From agency base files if available

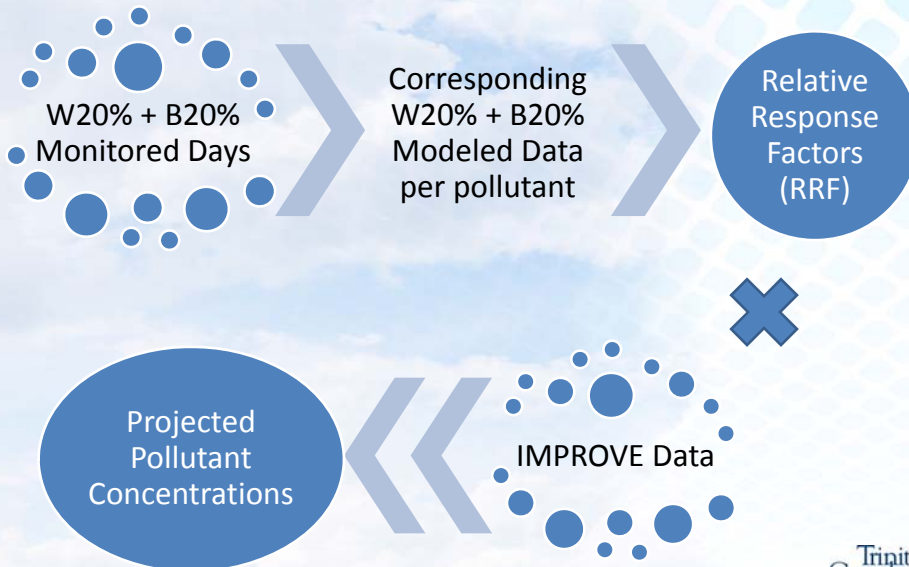
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Post-Processing



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1. MATS: RRF + IMPROVE



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Calculate Projected Light Extinction

$$\begin{aligned} b_{ext} = & 2.2 \times f_s(RH) \times [Small\ Sulfate] \\ & + 4.8 \times f_L(RH) \times [Large\ Sulfate] \\ & + 2.4 \times f_s(RH) \times [Small\ Nitrate] \\ & + 5.1 \times f_L(RH) \times [Large\ Nitrate] \\ & + 2.8 \times [Small\ Organic\ Mass] \\ & + 6.1 \times [Large\ Organic\ Mass] \\ & + 10 \times [Elemental\ Carbon] \\ & + 1 \times [Fine\ Soil] \\ & + 1.7 \times f_{SS}(RH) \times [Sea\ Salt] \\ & + 0.6 \times [Coarse\ Mass] \\ & + Rayleigh\ Scattering\ (Site\ Specific) \\ & + 0.33 \times [NO_2(ppb)] \end{aligned}$$

&

Calculate Haze Index

$$Deciview\ Haze\ Index\ (dv) = 10 \times \ln\left(\frac{b_{ext}\ [Mm^{-1}]}{10\ [Mm^{-1}]}\right)$$

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2. Modeled Data Only

- > Maximum modeled for all days

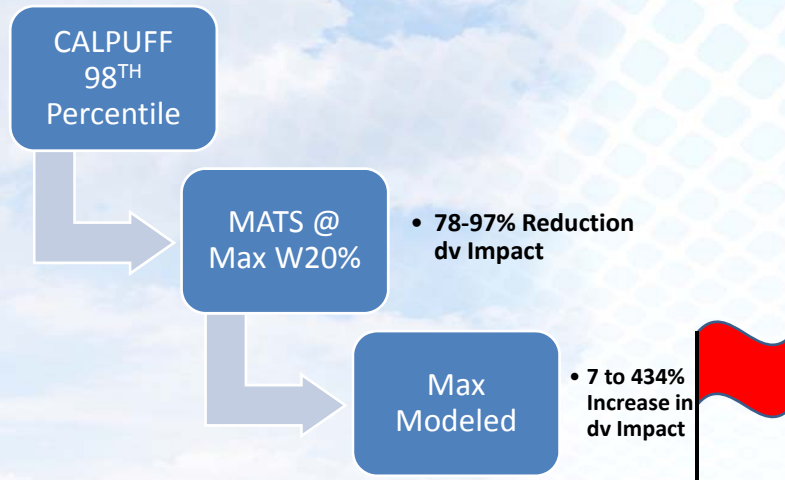
Inappropriate if...



- > No tethering to monitored data
- > No model performance for season-specific variations and speciated emissions
- > No removal of outliers

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Change in Predicted Impacts



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Long-Term Strategies & RPGs

- > Compare URP to monitored data
- > Assess naturally occurring/international emissions on W20%
- > Tether CAMx model predictions with assessment of additional RP controls
 - ❖ Cost of Compliance
 - ❖ Energy and Non-Air Quality Environmental Impacts
 - ❖ Remaining Useful Life
 - ❖ Time Necessary for Compliance

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Conclusion

- > Single-source modeling with CALPUFF not appropriate
- > CAMx best tool for BART/RP Analyses
 - ❖ RRF + IMPROVE
 - ❖ Correlation between reconstructed light extinction and monitored data
 - ❖ Useful benchmark for URP/glide path & assessment of RPGs / Regional Haze SIP

Questions?