Best Available Retrofit Technology (BART)

CALPUFF Modeling Protocol
for the
State of Minnesota

Modeling Schedule

- October 10th: Complete version 1 draft protocol Draft.
- October 21st: Receive comments on draft protocol.
- October 21st: Receive Meteorological data.
- October 24th: Incorporate comments.
- November 30th: Complete BART-eligible source exemption modeling.
- April 30th: Complete BART-control visiblity change modeling

Steps in BART Modeling

1. Determine BART-eligible sources.
2. Obtain physical characteristics of sources.
3. Determine Class I areas to assess.
4. Choose appropriate air quality model.
5. Conduct & post-process modeling, and evaluate results.
6. Identify sources Subject-to-BART, providing inputs (if desired) to facilities.
7. Calculate and model visibility improvements associated with controls.

BART-Eligible Source Summary

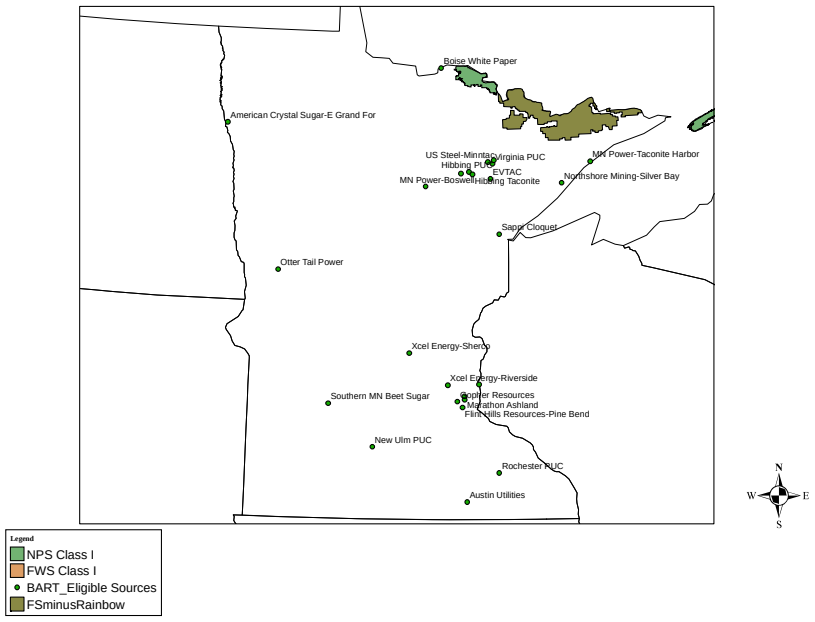
- Fossil Fuel-fired Steam Electric Plants greater than 250 MMBtu/hour (EGUs)
  - 11 Facilities (14 emission units)
- Petroleum Refineries
  - 2 Facilities (39 emission units)
- Taconite Ore Processing Plant
  - 6 Facilities (565 units)
- Fossil Fuel Fired Boilers more than 250 MMBtu/hour
  - 2 Facilities (3 units)

BART-Eligible Source Summary

Continued

- Kraft Pulp Mills
  - 2 Facilities (5 units)
- Iron and Steel Mill Plants
  - 1 Facility (one unit)
- Secondary Metal Production Facilties
  - 1 Facility (3 units)

BART-Eligible Minnesota Sources & Class I Areas



Physical Characteristics of BART-eligible Sources

- Emissions
  - NO_x , SO_2, PM_{10}, $PM_{2.5}$
- Stack Parameters
  - Stack height
  - Stack diameter
  - Exit flow rate
  - Exit gas temperature
  - Stack location coordinates

Class I Areas to Assess

- **Boundary Waters Canoe Area MN**
- Hercules-Glades Wilderness MO
- Isle Royale National Park MI
- Mingo National Wildlife Refuge MO
- Seney National Wildlife Refuge MI
- **Voyageurs National Park MN**
- Badlands National Park SD
- Wind Cave National Park SD
- LostWood National Wildlife Refuge ND
- Theodore Roosevelt National Park ND

BART-Class I Areas Assessed

Choose an AQ Model

- CALPUFF
  - Consistency with other states. All—except perhaps Texas—using CALPUFF;
  - Limited scope of this modeling
    - Who must conduct engineering analysis of control options;
    - Perceived visibility difference with controls
  - Lack of plume-in-grid feature in CAMx (Texas contracting) & increased effort for running PSAT in CAMx
  - Additional BART control modeling as part of Regional Haze SIP with CAMx

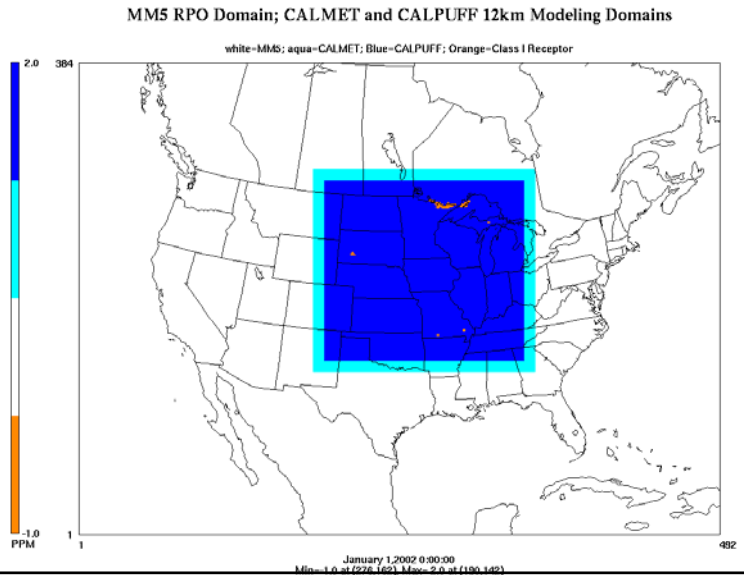
CALPUFF Modeling Components

	Version	Level
CALMM5	2.0	021111
CALMET	5.53a	040716
CALPUFF	5.771a	040716
POSTUTIL	1.4	040818
CALPOST	5.51	030709

Meteorological Data (CALMET)

- 36km MM5 data developed and extensively quality assured, used for Regional Haze modeling
  - 2002 data developed by Iowa DNR
  - 2003 and 2004 data developed by LADCO
- MM5 data interpolated down to 12km and 4km domains
  - 12km domain by Iowa DNR
  - 4km domain by Minnesota PCA
- No Obs option controversy
- Bug in CALMM5 delays Meteorology until late October.

Iowa DNR 12km Domain



AQ Model (CALPUFF)

- CALPUFF used for all source to Class I area distances.
  - Sources within 50 km in 4 km grid
  - Sources beyond 250 km; may invoke puff-splitting if nessessary
- Dispersion Coefficients
  - AERMOD

Species Modeled

Species Name	Modeled	Emitted	Dry Deposited
SO_2	Yes	Yes	Computed-gas
SO_4	Yes	No	Computed-particle
NO_X	Yes	Yes	Computed-gas
HNO_3	Yes	No	Computed-gas
NO_3	Yes	No	Computed-particle
$PM_{2.5}$	Yes	Yes	Computed-particle

Dry Deposition--$PM_{2.5}$ defaults for PM_{10}

CALPUFF default particle size for dry deposition is for $PM_{2.5}$.

Where $PM_{2.5}$ emissions are available, default value may be appropriate.

Default $PM_{2.5}$ values with PM_{10} emissions may underestimate deposition of particles and overestimate particulate contribution to visibility.

Ozone, Ammonia, H_2O_2—Domain Seasonal Average in ppb

	Jan-Mar	Apr-Jun	Jul-Sept	Oct-Dec
Ozone				
12km	27.06	38.16	36.70	23.22
4km	tbd	tbd	tbd	tbd
NH_3				
12km	0.59	1.11	1.16	1.09
4km	tbd	tbd	tbd	tbd
H_2O_2				
12km	0.32	2.23	3.54	0.47
4km	tbd	tbd	tbd	tbd

Receptors

- 4km Domain
  - Boundary Waters & Voyageurs
    - 1km receptor spacing throughout Class I areas
- 12km Domain
  - Boundary Waters & Voyageurs
    - 2km receptor spacing throughout Class I areas
  - All Class I areas in domain
    - Grid-center throughout entire domain

Post-Processing (POSTUTIL)

- Ammonia availability for nitrate formation determined based on receptor concentrations of total sulfate and total nitrate from CALPUFF rather than puffs (within CALPUFF).
  - Ammonia preferentially scavenged by sulfate.
  - Nitrate formation limited by availability of ammonia.
  - Within CALPUFF background ammonia available to each puff for nitrate formation.
    - Signifiantly overestimates available ammonia

Post-Processing (CALPOST)

- Performs visibility calculations using concentration file processed through POSTUTIL and relative humidity data
- Light Extinction: Sum of wet—sulfate and nitrate—and dry components—PM2.5—and Rayleigh scattering
  - Method 6 used
    - Uses monthly Class I area specific relative humidity adjustment factors applied to sulfate and nitrate concentrations

Monthly Average *f*(RH)

Class I Area	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Boundary Waters Canoe Area	3.0	2.6	2.7	2.4	2.3	2.9	3.1	3.4	3.5	2.8	3.2	3.2
Hercules-Glades	3.2	2.9	2.7	2.7	3.3	3.3	3.3	3.3	3.4	3.1	3.1	3.3
Isle Royale National Park	3.1	2.5	2.7	2.4	2.2	2.6	3.0	3.2	3.8	2.7	3.3	3.3
Mingo	3.3	3.0	2.8	2.6	3.0	3.2	3.3	3.5	3.5	3.1	3.1	3.3
Seney	3.3	2.8	2.9	2.7	2.6	3.1	3.6	4.0	4.1	3.4	3.6	3.5
Voyageurs National Park	2.8	2.4	2.4	2.3	2.3	3.1	2.7	3.0	3.2	2.6	2.9	2.8
Badlands Wilderness	2.6	2.7	2.6	2.4	2.8	2.7	2.5	2.4	2.2	2.3	2.7	2.7
Wind Cave	2.5	2.5	2.5	2.5	2.7	2.5	2.3	2.3	2.2	2.2	2.6	2.6
LostWood	3.0	2.9	2.9	2.3	2.3	2.6	2.7	2.4	2.3	2.4	3.2	3.2
Theodore Roosevelt	2.9	2.8	2.8	2.3	2.3	2.5	2.4	2.2	2.2	2.3	3.0	3.0

Visibility Impacts

- Perceived visibility change related to natural background in deciviews
  - Derived from light extinction coefficient
  - 98 percentile value: 22nd ranked deciview change of 0.5 deciviews or more over 3-modeled years (2002, 2003, 2004)
- Natural visibility conditions debate
  - Compare to natural visibility conditions, or
  - Compare to 20% best visibility days

Average Annual Natural Background ($\mu g/m^3$)

Class I Area	Region	SO_4	NO_3	OC	EC	Soil	Coarse Mass
Boundary Waters Canoe Area	EAST	0.23	0.10	1.40	0.02	0.50	3.00
Hercules-Glades	EAST	0.23	0.10	1.40	0.02	0.50	3.00
Isle Royale National Park	EAST	0.23	0.10	1.40	0.02	0.50	3.00
Mingo	EAST	0.23	0.10	1.40	0.02	0.50	3.00
Seney	EAST	0.23	0.10	1.40	0.02	0.50	3.00
Voyageurs National Park	EAST	0.23	0.10	1.40	0.02	0.50	3.00
Badlands Wilderness	WEST	0.12	0.10	0.47	0.02	0.50	3.00
Wind Cave	WEST	0.12	0.10	0.47	0.02	0.50	3.00
LostWood	WEST	0.12	0.10	0.47	0.02	0.50	3.00
Theodore Roosevelt	WEST	0.12	0.10	0.47	0.02	0.50	3.00

Next Steps

- Identify sources Subject-to-BART
  - Facilities conduct engineering analyses on control strategies
- Model visibility improvements due to BART controls
  - Same BART protocol
  - Future year strategy w/ regional scale models