
Regional Haze: Modeling with Particulate Source Apportionment Technology (PSAT)

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PSAT Applications

Tracks emissions from source to area of impact.

- Consultation. Indicates geographic extent of contributors to Regional Haze and whom to consult;
- Emissions Reductions. Helps focus on emissions source categories; and
- Weight of Evidence. Provides insight to whether modeling comports with data analysis; and why two organizations modeling same area may have different results.

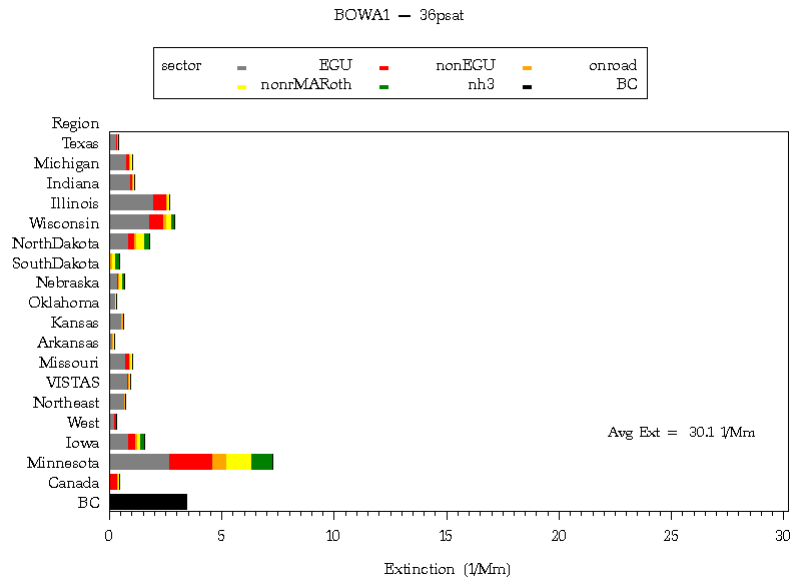
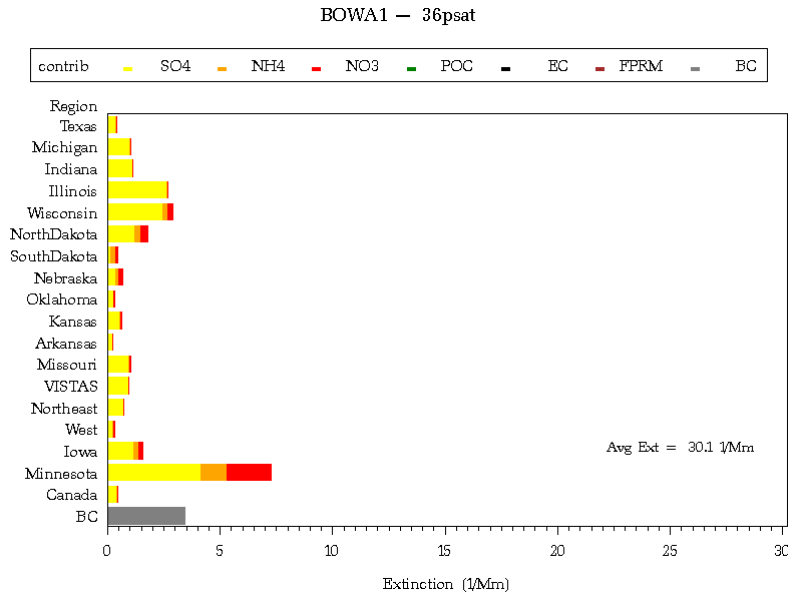
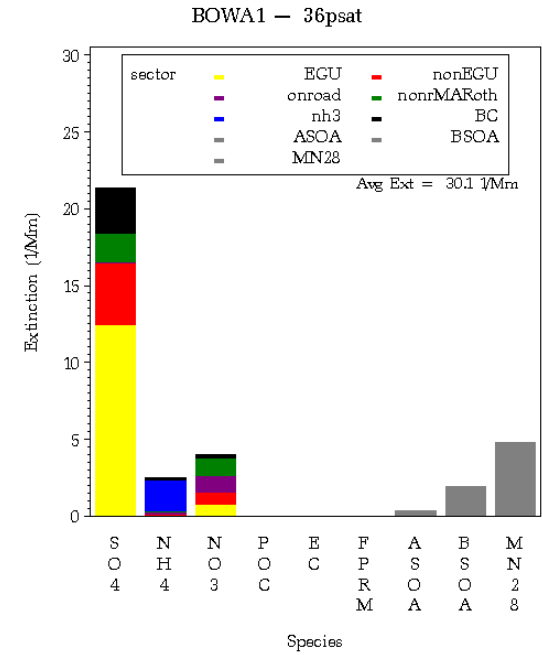
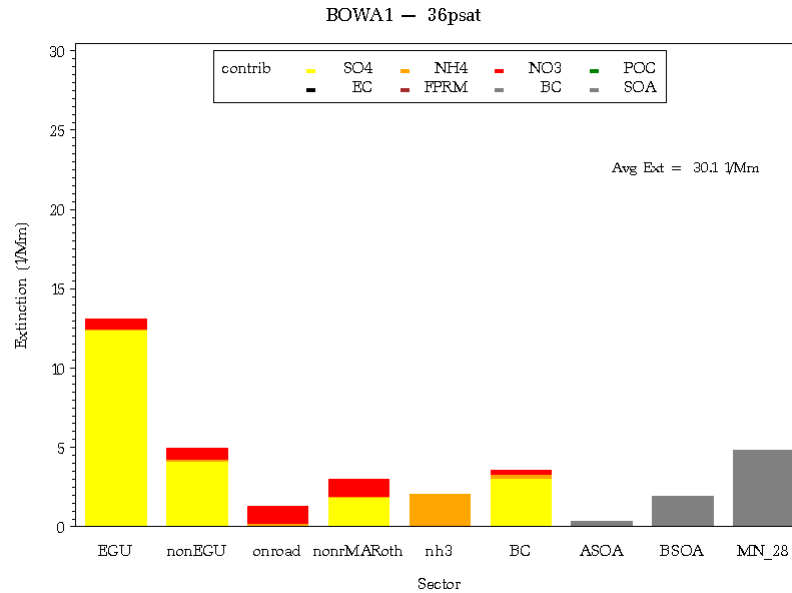
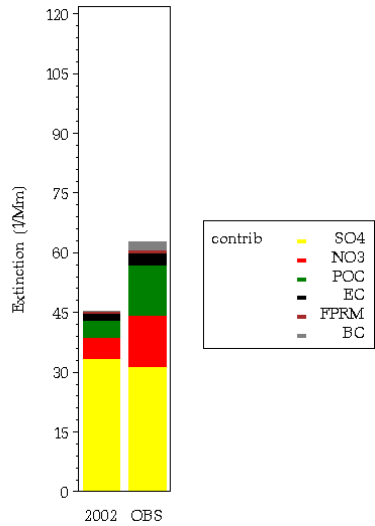


Remarks

- Source apportionment is not a control strategy run and gives no information about how the model will respond to emissions changes;
- Any errors in emissions are tracked and apportioned;
- Results are presented in an “absolute” sense, rather than a “relative” sense (no monitored values introduced); and
- See “Regional Haze in Upper Mid-West: Summary of Technical Information”, pp. 20-24



Boundary Waters, MN 2002

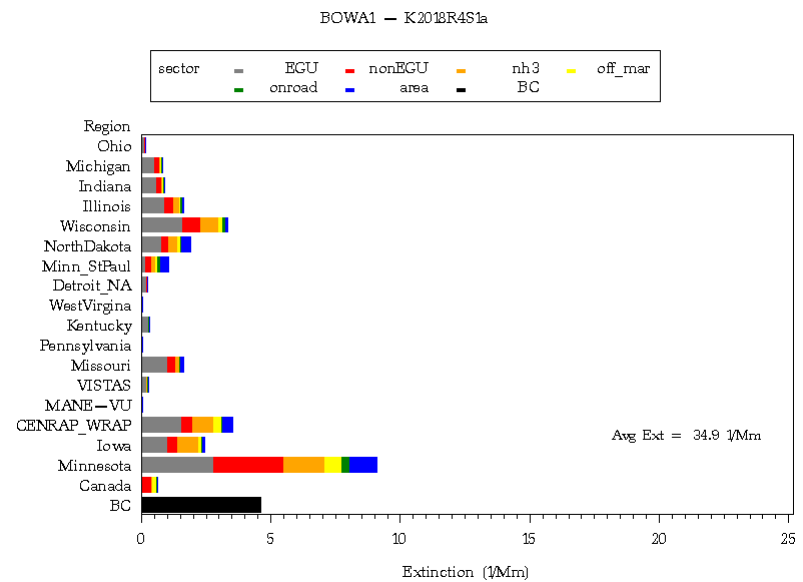
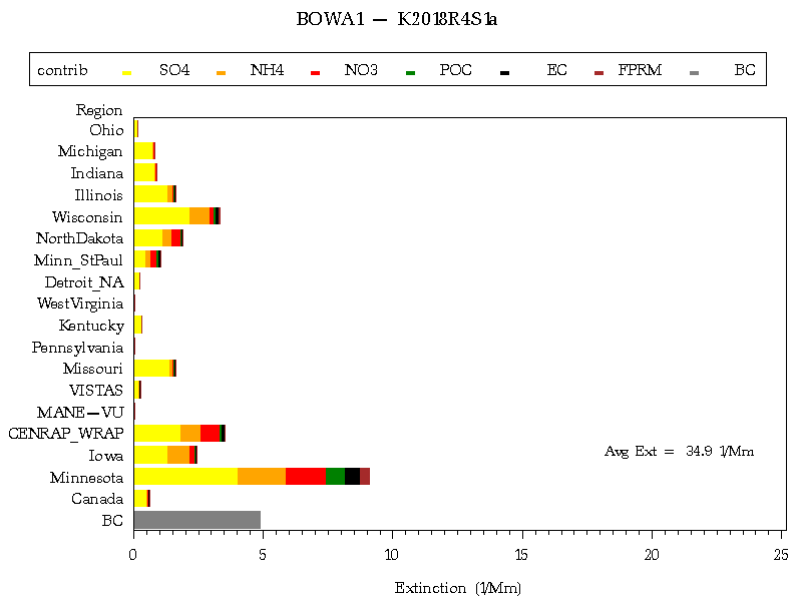
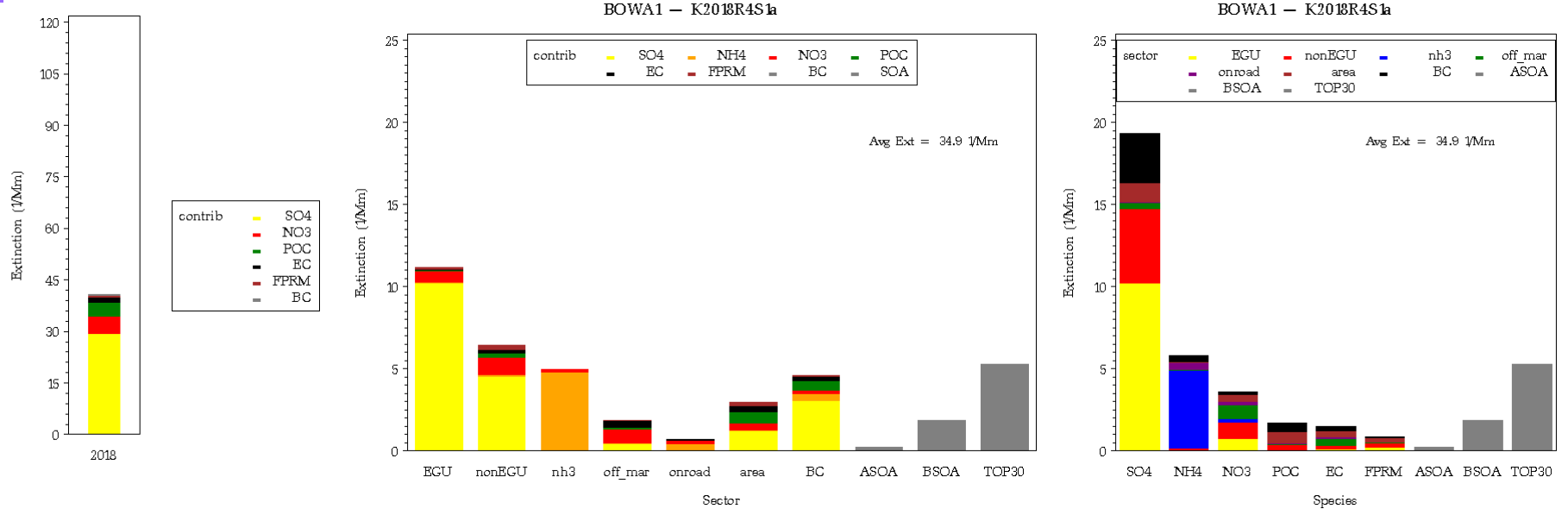


2002 base K - 20% worst day avg - MPCA



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Boundary Waters, MN 2018



2018 round 4s1a – 20% worst day avg - MRPO

What Did PSAT Provide?

- Minnesota is largest contributor to Boundary Waters & Voyageurs, and limit consultation with immediate neighboring states;
- Emissions Reductions emphasis on EGU and other industrial point sources, which contribute much of the light scattering at the northern Class I areas;
- Confidence in modeling as 2002 PSAT results comport with data analysis conclusions – “home” state + immediate neighbors; and
- Culpability similar in 2002 and 2018.



MPCA Additional Analysis

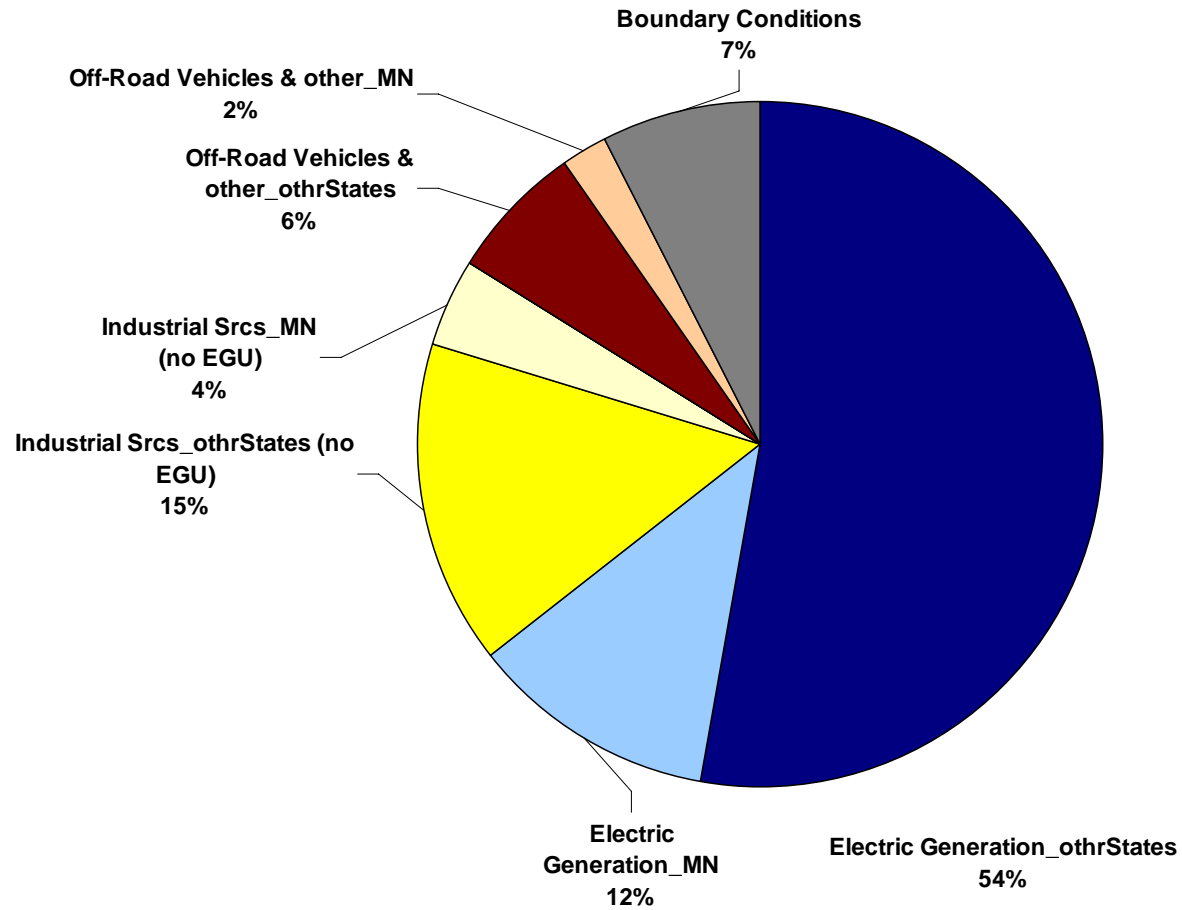
- Closer look at Minnesota
- Examined 2002 PSAT results in terms of high model sulfate and nitrate days rather than 20% worst observed days
- One advantage to this additional evaluation is that poor model performance for nitrate on 20% worst days *may be minimized*



Percent Sulfate Contribution - Minnesota v. Other States/Regions Boundary Waters Canoe Area

36km Grid - 2002 - Mwrpo BaseK

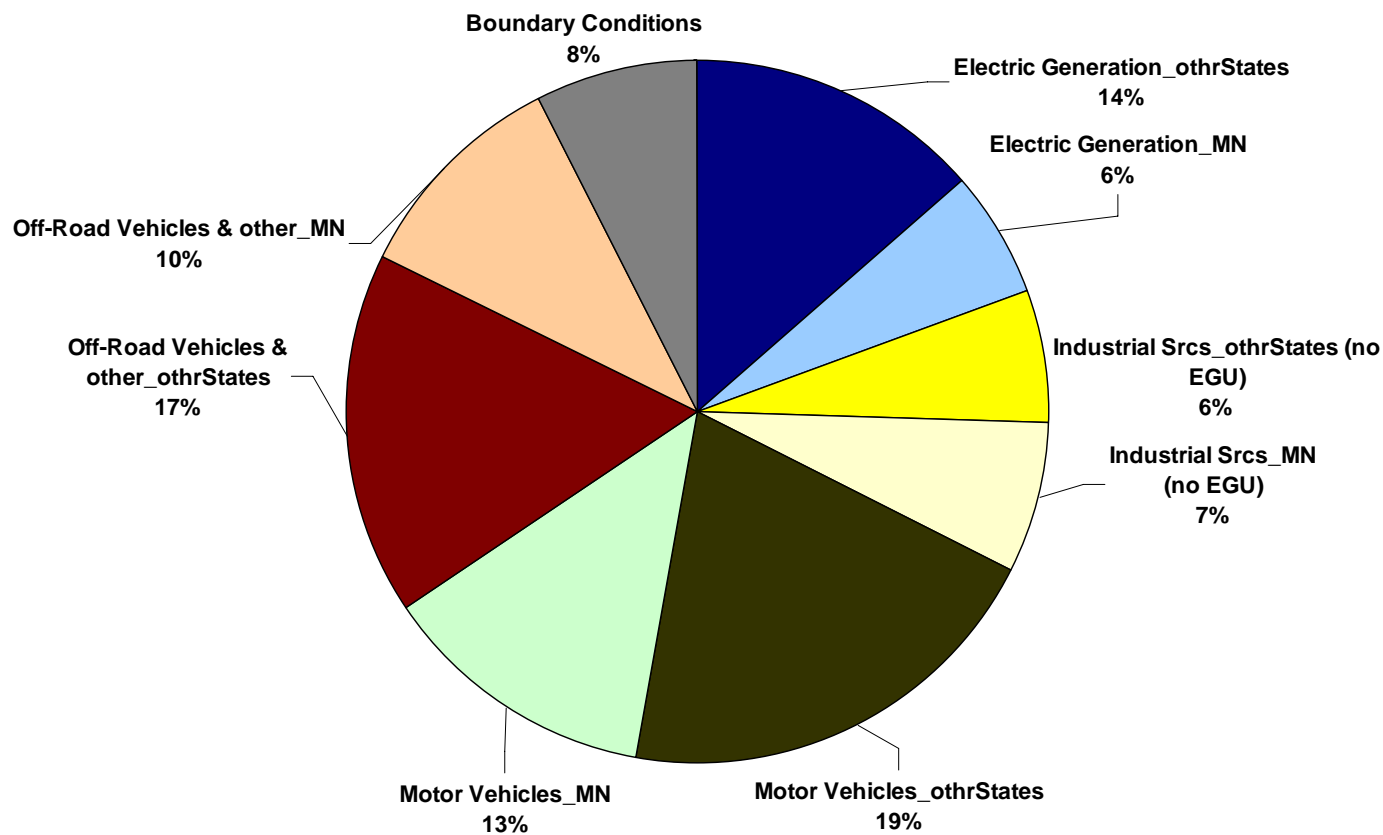
Total Sulfate Concentration =
5.2 ug/m3



Percent Nitrate Contribution - Minnesota v. Other States/Regions Boundary Waters Canoe Area

36km Grid - 2002 - Mwrpo BaseK

Total Nitrate Concentration =
2.9 ug/m3



2002 base K – High **nitrate** day avg - MPCA

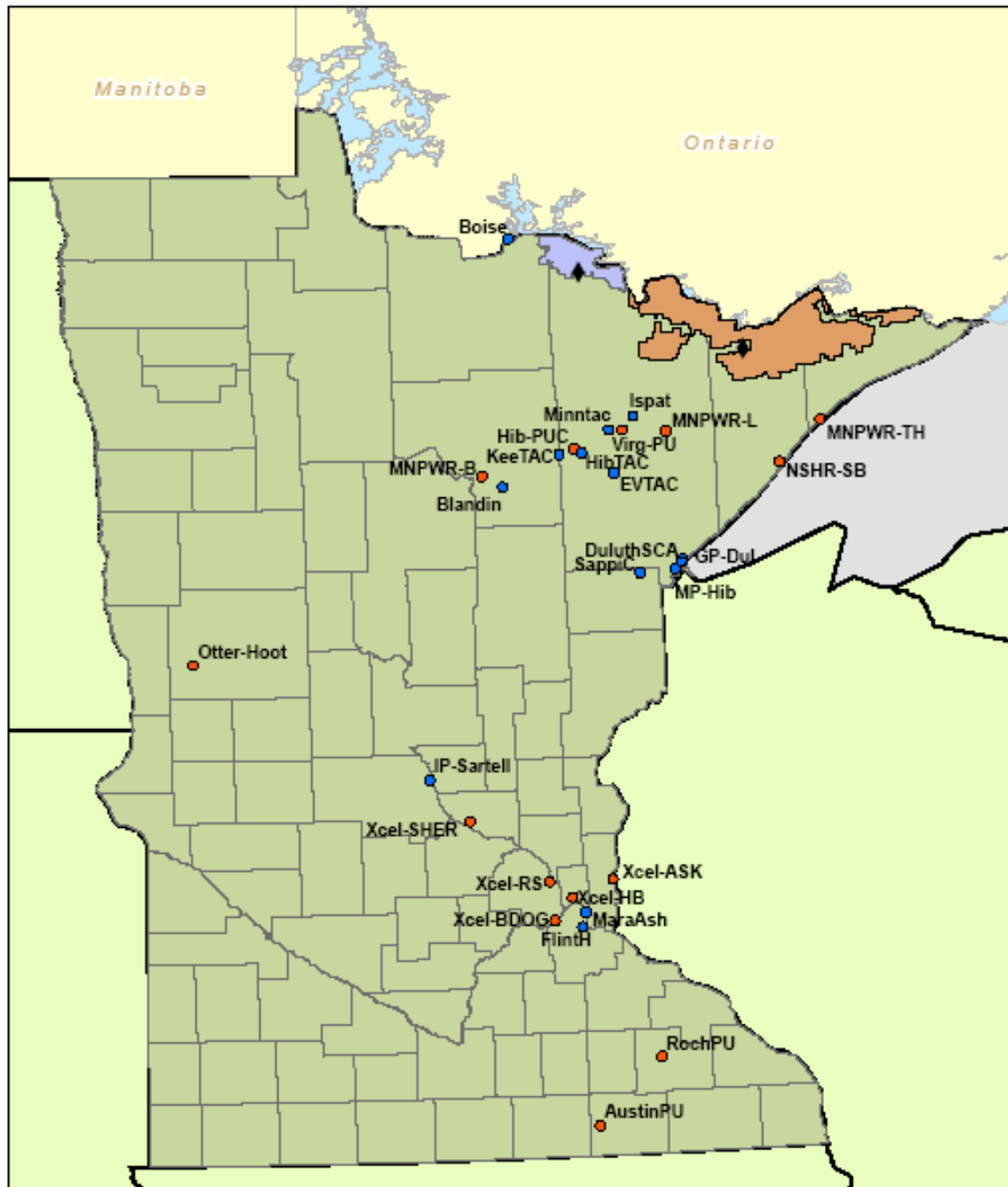


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Minnesota Individual Source Contribution

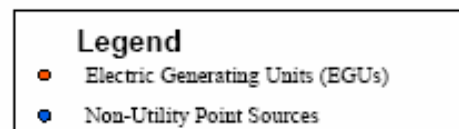
- Purposes:
 - Focus control strategy analysis (i.e. ECR Contract)
 - Gain understanding whether any facilities stand out as contributors
- Criteria for 28 Sources Chosen
 - Top SO₂ and NO_x emitters in 2002; and
 - Smaller emitters with close proximity to Boundary Waters and Voyageurs



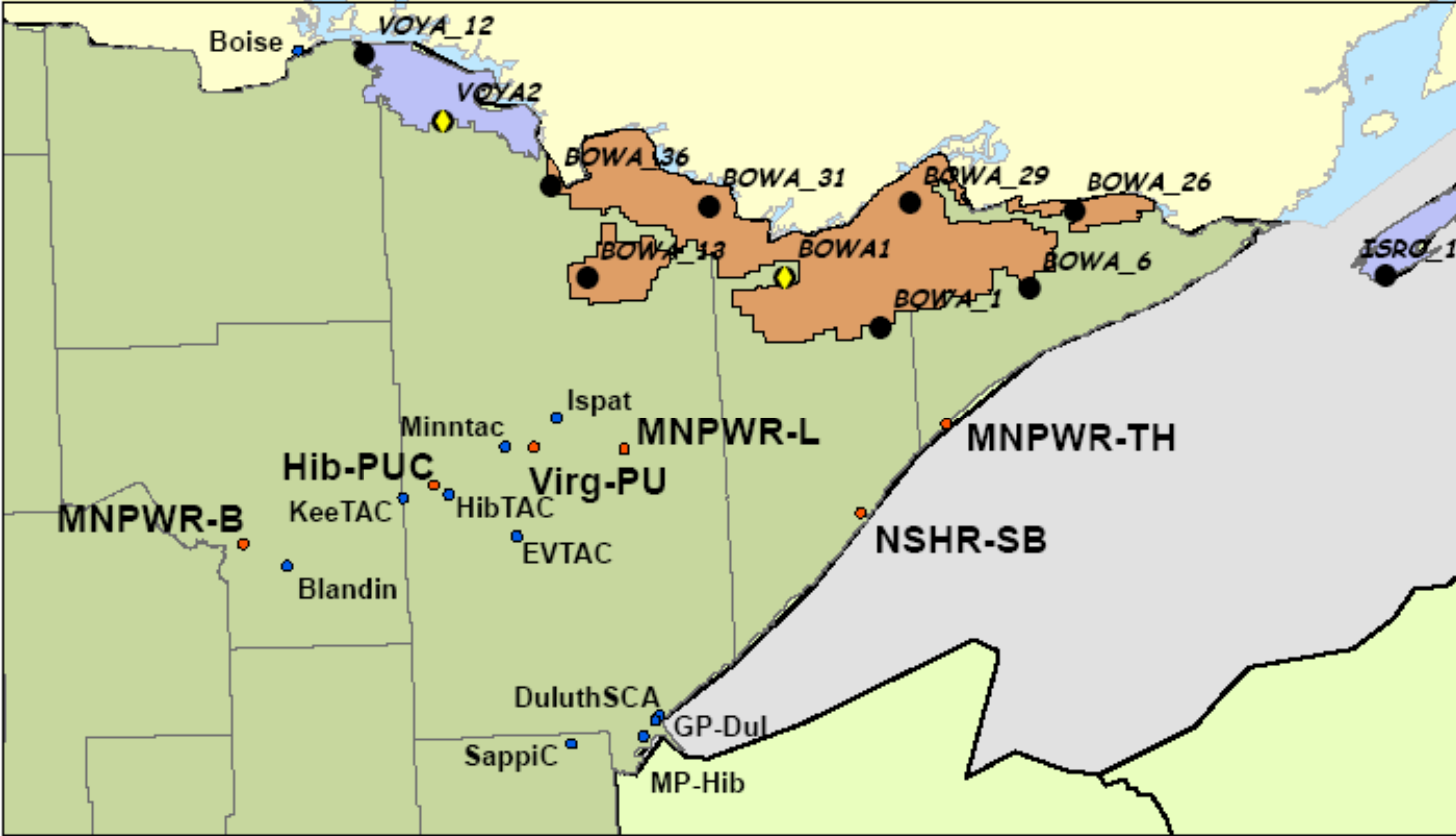


Facilities Modeled with Particulate Source Apportionment Technology (PSAT) for Regional Haze Contributions.

Facility Names in 2002

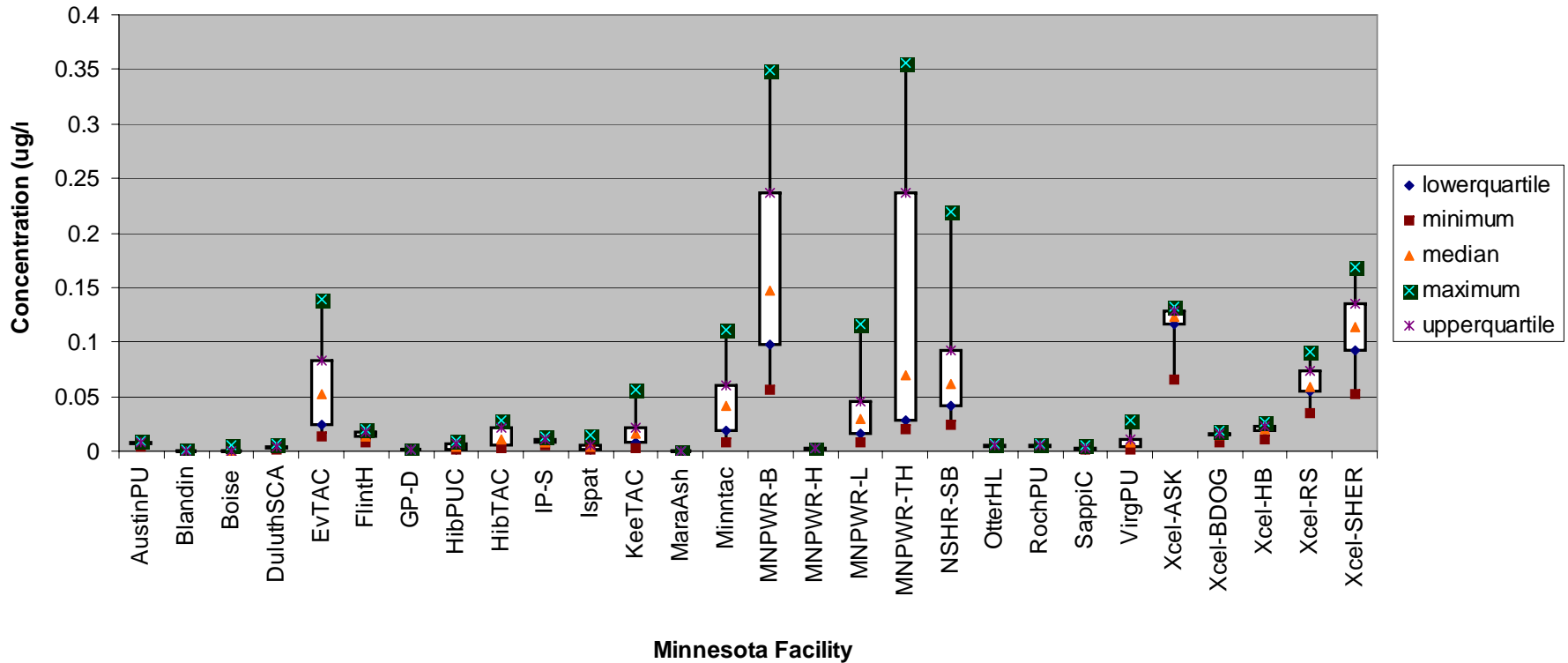


**Facilities Modeled with Plume-in-Grid (PiG) and
Particulate Source Apportionment Technology (PSAT)
for Regional Haze Contributions.**



Legend
● Electric Generating Units (EGUs)
● Non-Utility Point Sources

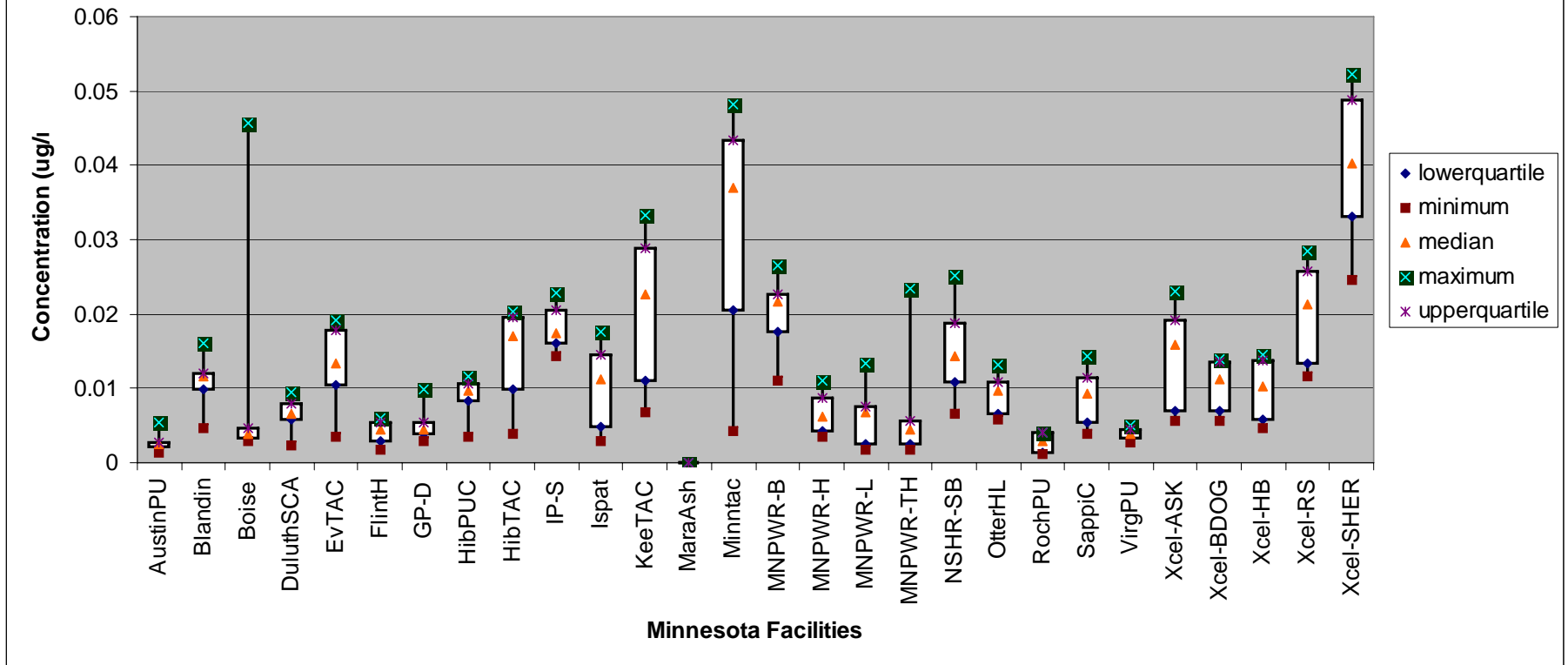
**Sulfate Contributions of Individual Minnesota Facilities to
Voyageurs, Boundary Waters and Isle Royale Class I Areas
2002 - 12km Minnesota w/ PiG - MWrpo baseK**



Average Concentration Apportioned: **5.19 – 5.75 ug/m3**

Between **24** and **44** values above concentration threshold of **3.0 ug/m3** at **11** receptor locations

**Nitrate Contributions of Individual Minnesota Facilities to
Voyageurs, Boundary Waters and Isle Royale Class I Areas
2002 - 12km Minnesota w/ PiG - MWrpo baseK**



Average Concentration Apportioned: **2.72 – 3.26 ug/m3**

Between **5** and **10** values above concentration threshold of **1.5 ug/m3** at **11** receptor locations

2002 Extinction at Boundary Waters from Individual MN Sources

Sum of Bext (1/Mm)	Class Area							
Source	BOWA_1	BOWA_13	BOWA_26	BOWA_29	BOWA_31	BOWA_36	BOWA_6	BOWA1
AustinPU	0.02703	0.03499	0.02151	0.02317	0.02553	0.03277	0.0251	0.02586
Blandin	0.01158	0.0134	0.01012	0.01048	0.01046	0.01134	0.00979	0.01219
Boise	0.00986	0.01101	0.01487	0.01711	0.01705	0.01661	0.01141	0.01083
DuluthSCA	0.02371	0.02226	0.01428	0.01525	0.01724	0.01817	0.0184	0.02108
EvTAC	0.22981	0.76636	0.09236	0.16423	0.35563	0.49192	0.11876	0.29109
FlintH	0.05368	0.0753	0.03898	0.04357	0.05066	0.07272	0.04944	0.04927
GP-D	0.01549	0.02132	0.01127	0.01235	0.01472	0.01807	0.0125	0.01538
HibPUC	0.0472	0.06231	0.04282	0.04163	0.04346	0.05517	0.04511	0.04572
HibTAC	0.08011	0.22415	0.03605	0.06219	0.11404	0.16248	0.04397	0.10299
IP-S	0.01949	0.01916	0.01658	0.01752	0.01725	0.017	0.01735	0.01914
Ispat	0.06071	0.1375	0.02927	0.05076	0.08538	0.08468	0.03365	0.08032
Keetac	0.15439	0.41235	0.06639	0.12503	0.22412	0.26924	0.08342	0.20128
MaraAsh	0.04862	0.04273	0.03806	0.03807	0.03198	0.03947	0.04363	0.04318
Minntac	0.30428	0.89282	0.12812	0.2397	0.44951	0.54858	0.16177	0.40313
MNPWR-B	0.47444	0.6893	0.31496	0.45179	0.54146	0.65914	0.35686	0.55707
MNPWR-H	0.01706	0.01682	0.01015	0.01137	0.01214	0.01358	0.01255	0.01524
MNPWR-L	0.23401	0.35926	0.07671	0.143	0.3093	0.17029	0.10384	0.27222
MNPWR-TH	1.12844	0.04931	0.84026	1.14029	0.11615	0.04832	1.64796	0.3006
NSHR-B	0.6484	0.24822	0.23256	0.33958	0.32893	0.17751	0.42692	0.5621
OtterHL	0.03177	0.03278	0.02811	0.03204	0.03347	0.03196	0.02871	0.03351
RochPU	0.0234	0.0288	0.01896	0.02076	0.02271	0.02644	0.02195	0.02394
SappiC	0.03092	0.0349	0.01767	0.02071	0.02154	0.02428	0.02344	0.02783
VirgPU	0.04555	0.15627	0.0206	0.03478	0.0707	0.09792	0.02502	0.05844
Xcel-ASK	0.59106	0.7462	0.43634	0.45496	0.50283	0.6784	0.56881	0.52119
Xcel-BDOG	0.06723	0.07255	0.04789	0.05511	0.05709	0.07228	0.06017	0.06171
Xcel-HB	0.08691	0.10496	0.0619	0.07024	0.07686	0.10287	0.07728	0.08139
Xcel-RS	0.23377	0.2879	0.16832	0.19085	0.20982	0.30039	0.20781	0.21702
Xcel-SHER	0.43186	0.47146	0.30975	0.36957	0.40138	0.43106	0.35986	0.42836
Grand Total	5.13078	6.03439	3.14486	4.19611	4.16141	4.67266	4.59548	4.48208

Overall extinction apportioned for BOWA1 = 30 Mm⁻¹ on 20% worst days



Individual MN facility Tracking Insights

- Composite of many individual facilities contribute to regional haze; and
- Near location of several Minnesota facilities and size of Boundary Waters Class I Area suggests need for smaller grid resolution and more receptors for showing advances toward reasonable progress goals.



Minnesota Modeling -Next Steps

- Continue with same emissions set;
- Adjustments of EGU and industrial point source 2018 emissions (R4S1a) to reflect known emission increases and decreases
 - Minnesota
 - Neighboring states
- Incorporating smaller grid resolution and more receptors for establishing relative reduction factors.



Acronyms

- ASOA – anthropogenic secondary organic aerosol
- BSOA – biogenic secondary organic aerosol
- BC – Boundary Conditions
- FPRM – primary particulate (i.e. soil, crustal, metals)
- EGU – Electric Generating Unit
- MAR – Marine, Aircraft, Recreational

