Reasonable Progress Goal

2018 Planning Period

Lye Brook Wilderness Area

!! DRAFT !!

Considerations and Recommendations

VT APCD

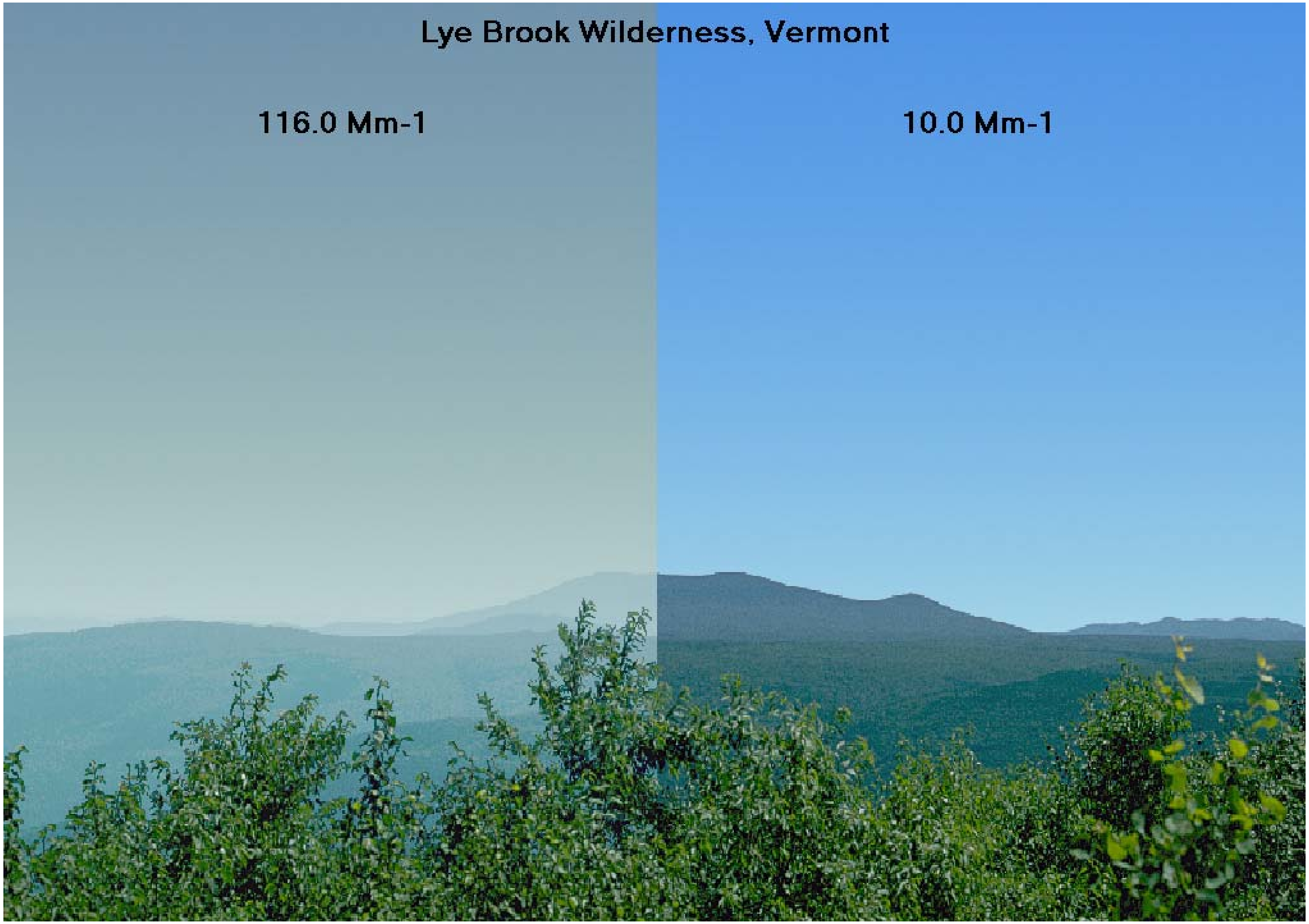
MID-ATLANTIC NORTHEAST VISIBILITY UNION
(MANE-VU)
BOARD MEETING

Pittsburgh, Pennsylvania
May 10, 2006

Achieving a Reasonable Progress Goal for Improved Visibility

---- We Believe the <u>Most Efficient Strategy</u> to be ----

Prioritized Sulfur Emissions Reductions from Upwind EGUs



Regional Haze SIP for Lye Brook Wilderness Area
Vermont's Obligations for Reasonable Progress Goals

1. RH SIP : due early in 2008.
2. BART-eligible sources: none identified in Vermont.
3. Long-Term Strategy should include a variety of enforceable control activities leading to emission reductions of pollutants causing regional haze in Lye Brook Wilderness area.
4. Ultimate goal is achievement of natural background visibility in Lye Brook Wilderness area by 2064, with progress measured during a series of 10 year planning periods, the first of which ends in 2018.
5. Reasonable Progress Goals must be set for each planning period:

   a) Goal for improvement of worst 20% visibility days must be consistent with a line projecting a "uniform rate of progress" from visibility measured in deciviews at baseline conditions (2000 to 2004) to visibility projected for natural background in 2064.

   b) Goal is to also maintain best 20% visibility days.

Baseline LYE BROOK WILDERNESS Visibility Situation

1. Baseline visibility data is available from IMPROVE monitoring site.
2. Current estimates of Natural Background and Actual Conditions are:

Average Natural Background Visibility :	**DV = 7.41**	**B_{ext}= 20.98 Mm^{-1}**
Average 20% Worst Day Visibility :	**DV = ~ 25.0**	**B_{ext}=121.82 Mm^{-1}**

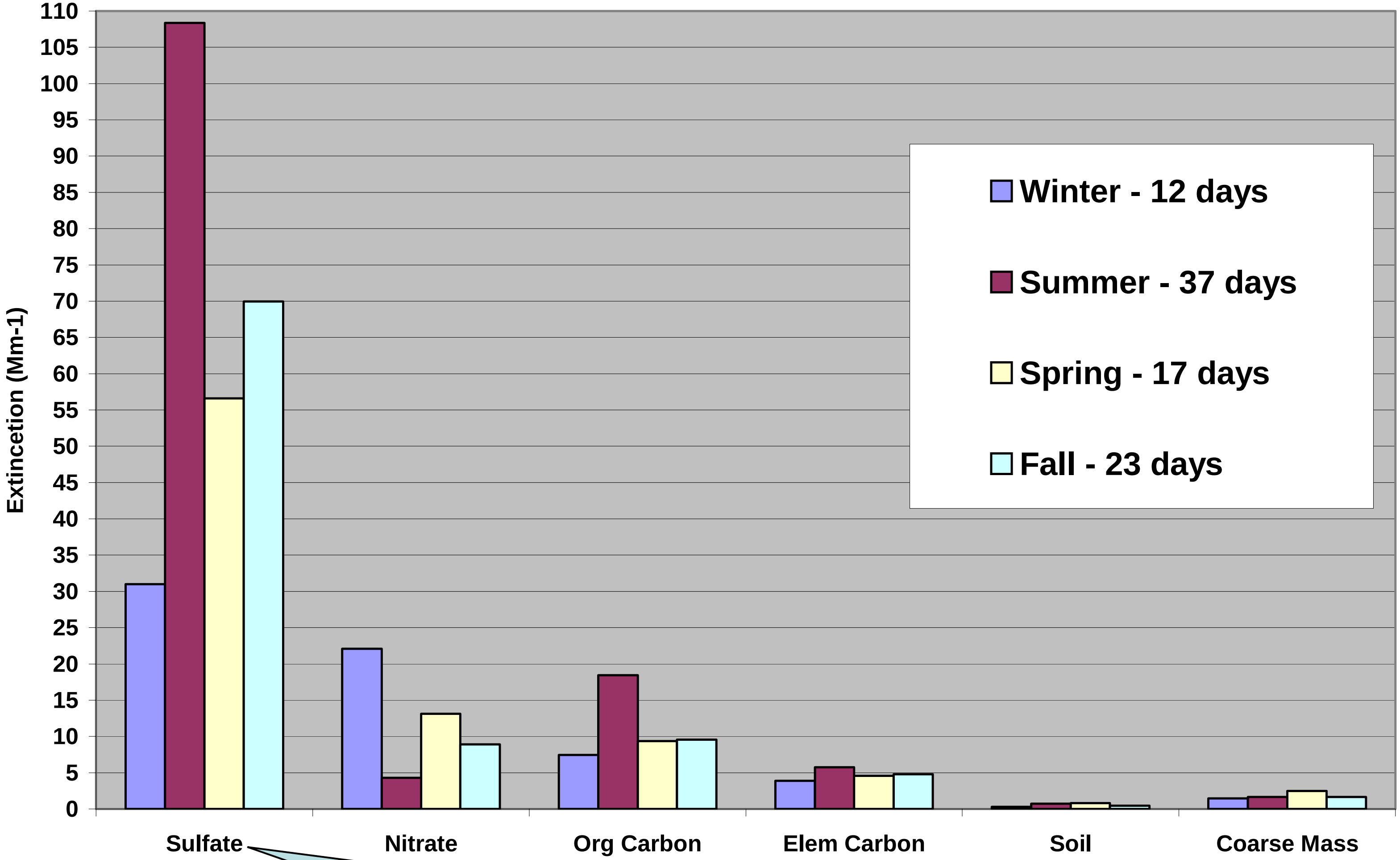
3. SULFATE is the primary aerosol species affecting Lye Brook Wilderness Visibility, especially during worst visibility episodes.

   (See next two slides developed by Tom Downs of Maine DEP)

4. Therefore 2018 strategy should focus on reducing impacts of sulfate aerosol, with more attention to other aerosol contributors during following planning periods.
5. CALPUFF regional scale modeling identifies EGUs external to Vermont as the most significant contributors to visibility reducing sulfate aerosol at Lye Brook Wilderness area. **(See slides 5 through 9)**
6. Modeling of SO_2 emissions from ALL Vermont PT Srcs shows no significant ambient SO_4 ion impacts on Lye Brook Wilderness area.

Seasonal Analysis of the 20% Worst 2000-2003 Visibility Days at Lye Brook, VT

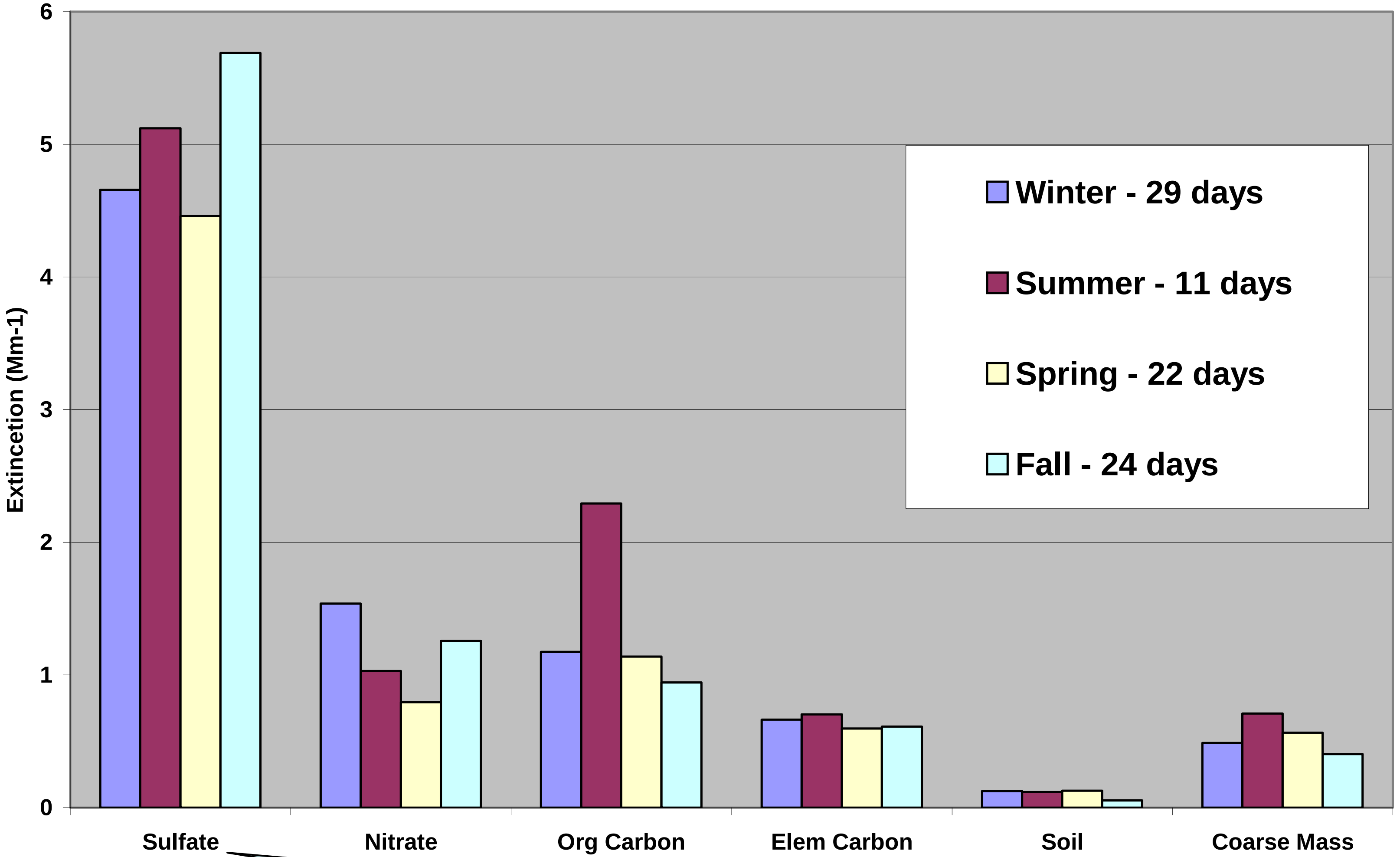
Courtesy of Tom Downs, Maine DEP



VTAPCD Comment: Except for winter nitrate, <u>on worst visibility days</u>, **SO_4** is at least 5 times and generally 10 times as responsible for light extinction as other components.

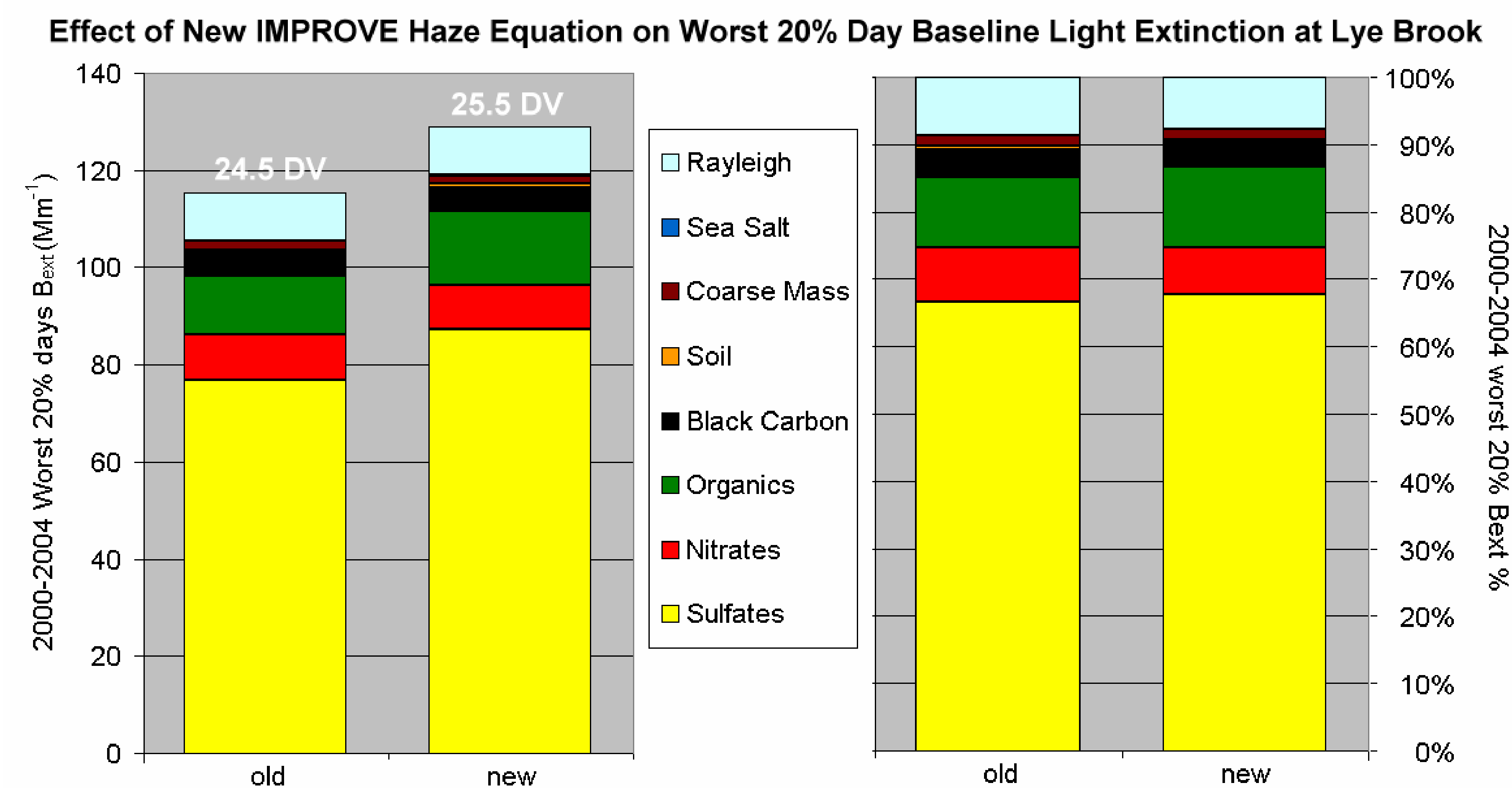
Seasonal Analysis of the 20% Best 2000-2003 Visibility Days at Lye Brook, VT

Courtesy of Tom Downs, Maine DEP



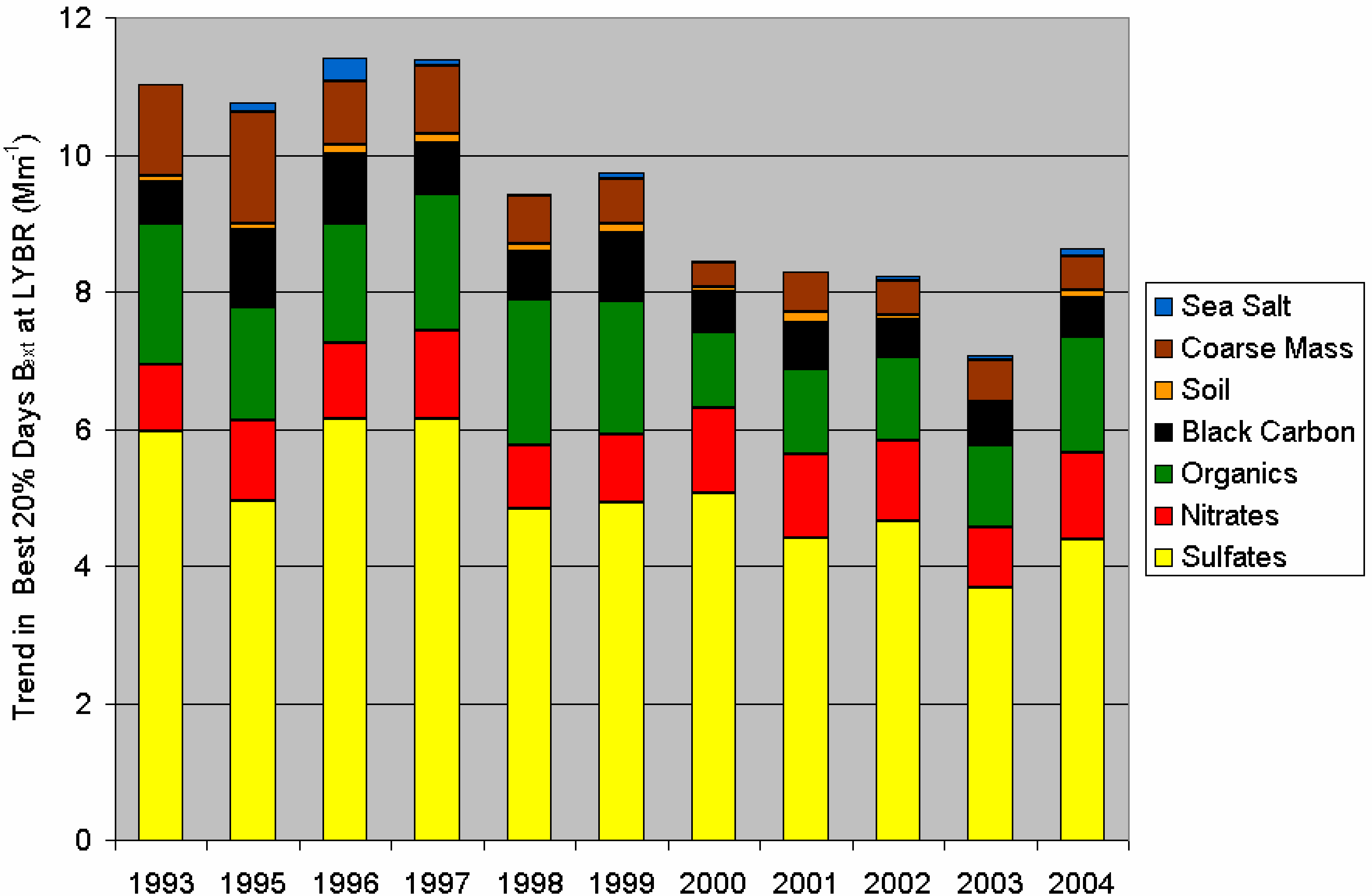
VTAPCD Comment: Even on best visibility days, **SO_4** is at least twice and generally 5 times as responsible for light extinction as other components.

New IMPROVE Haze Equation Results in 1 DV Increase on Haziest Days (from 24.5 to 25.5 DV at Lye Brook on Worst 20% Days 2000-2004)

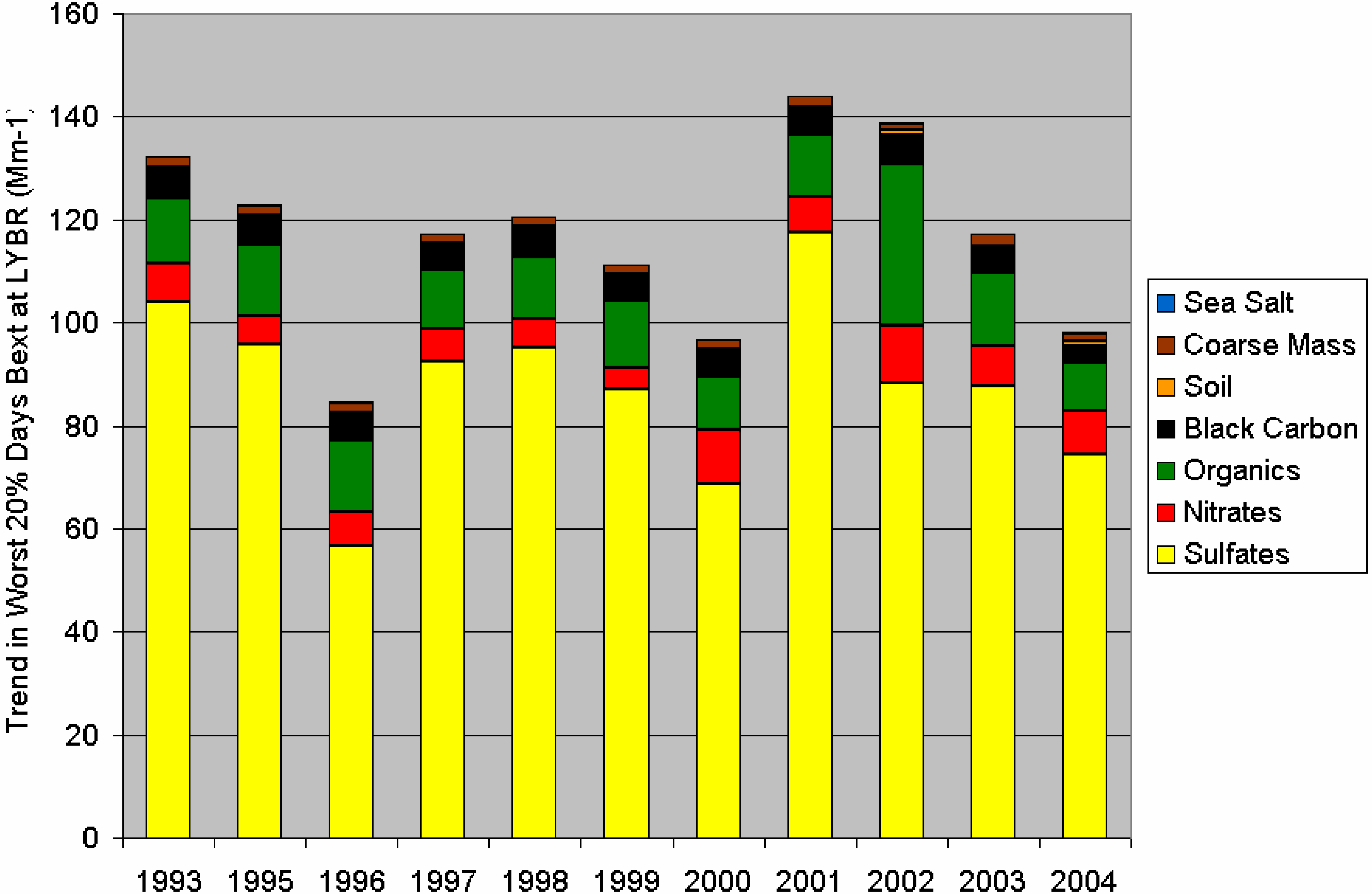


But Contribution of SO4 Remains Unchanged at 67% (73% of non-Raleigh)

Trend of Improving Visibility (from decreased Sulfate) on Cleanest 20% Days



…But No Improving Trend in Visibility (or Sulfate) on Worst 20% Days



VTDEC CALPUFF MODELING RESULTS for LYE BROOK WILDERNESS

State-by-State ANNUAL SO_4 Impact Ranked from Largest to Smallest

STATE	Annual SO4 Ion (~ ug/m3) CEMS PT	Non-CEMS PT	Small PT	On-Road	Non-Road	Area	TOTAL	CEMS PT % of Total
PA	0.19176	0.02092	0.00462	0.00097	0.00349	0.01239	0.23416	81.89
OH	0.21083	0.01114	0.00010	0.00000	0.00129	0.00034	0.22370	94.25
NY	0.06369	0.02643	0.00243	0.00280	0.01110	0.04466	0.15110	42.15
* CN	0.00000	0.12108	0.00000	0.00000	0.00000	0.00000	0.12108	0.00
IN	0.10387	0.01112	0.00083	0.00000	0.00012	0.00100	0.11695	88.82
MI	0.08405	0.01042	0.00089	0.00000	0.00094	0.00315	0.09945	84.51
WV	0.08523	0.00305	0.00480	0.00000	0.00053	0.00032	0.09393	90.74
KY	0.06466	0.00378	0.00373	0.00000	0.00149	0.00161	0.07528	85.89
IL	0.04731	0.01678	0.00054	0.00000	0.00041	0.00008	0.06512	72.65
WI	0.02285	0.02897	0.00037	0.00000	0.00048	0.00019	0.05286	43.23
NC	0.04239	0.00443	0.00438	0.00000	0.00133	0.00023	0.05276	80.34
MD	0.04519	0.00223	0.00030	0.00037	0.00118	0.00249	0.05176	87.31
VT	0.00000	0.00060	0.00001	0.00103	0.03579	0.01306	0.05050	0.00
VA	0.02949	0.00256	0.00627	0.00000	0.00040	0.00038	0.03910	75.42
TN	0.02807	0.00620	0.00031	0.00000	0.00229	0.00093	0.03780	74.26
IA	0.01505	0.01735	0.00012	0.00000	0.00009	0.00000	0.03261	46.15
GA	0.02700	0.00077	0.00078	0.00000	0.00026	0.00080	0.02960	91.22
MA	0.01055	0.00323	0.00079	0.00061	0.00166	0.01018	0.02702	39.05
MN	0.01304	0.00567	0.00052	0.00000	0.00044	0.00029	0.01996	65.33
(a) MO	0.01911	0.00000	0.00000	0.00000	0.00000	0.00000	0.01911	100.00
AL	0.01506	0.00121	0.00112	0.00000	0.00011	0.00043	0.01793	83.99
NJ	0.00707	0.00154	0.00020	0.00040	0.00268	0.00204	0.01394	50.72
SC	0.00882	0.00191	0.00183	0.00000	0.00078	0.00051	0.01384	63.73
(a) KS	0.01153	0.00000	0.00000	0.00000	0.00000	0.00000	0.01153	100.00
NH	0.00716	0.00052	0.00013	0.00007	0.00060	0.00134	0.00982	72.91
(a) OK	0.00858	0.00000	0.00000	0.00000	0.00000	0.00000	0.00858	100.00
DE	0.00448	0.00096	0.00070	0.00006	0.00034	0.00026	0.00680	65.88
CT	0.00149	0.00039	0.00005	0.00026	0.00106	0.00244	0.00569	26.19
(a) AR	0.00533	0.00000	0.00000	0.00000	0.00000	0.00000	0.00533	100.00
ME	0.00012	0.00188	0.00007	0.00015	0.00037	0.00122	0.00382	3.14
(a) NE	0.00273	0.00000	0.00000	0.00000	0.00000	0.00000	0.00273	100.00
(a) SD	0.00137	0.00000	0.00000	0.00000	0.00000	0.00000	0.00137	100.00
RI	0.00000	0.00000	0.00000	0.00004	0.00057	0.00069	0.00129	0.00
MS	0.00000	0.00019	0.00021	0.00000	0.00022	0.00000	0.00063	0.00
DC	0.00011	0.00015	0.00000	0.00002	0.00002	0.00022	0.00052	21.15
TX	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00
TOTALS	1.17799	0.30548	0.03610	0.00678	0.07004	0.10125	1.69767	

Notes: * 52 Canadian Point Sources > 250 Tons/Yr SO2 Emission during 2002 (from Canadian NPRI)
(a) Only CEMS Sources in that portion of state within the RPO Modeling Domain were modeled.

There are 869 EGUs in the model domain for which CEMS hourly emissions of SO_2 are available.

In 2002 these EGUs emitted 64% of all SO_2 in Modeling Domain

CALPUFF Modeling identifies large EGUs as primary contributors to SO_4 aerosol at Lye Brook.

What is a reasonable way to target controls to obtain the largest beneficial effect on visibility at Lye Brook?

One straight-forward way is by ranking large upwind EGUs for significance of 24-Hr SO_4 impact.

Two Options for Definition of Significant Impact

1. MANE-VU position identifies a range of **0.1 DV - 0.2 DV** on a 24-Hr ave basis (Comments to EPA BART rulemaking (July 14, 2004))

2. **1st option** for Vermont was to use a level of **0.15 DV** from a single source.

   0.15 DV change on a 24-Hr basis at LYBR is equivalent to:

   0.027 ug/m^3 **24-Hr Ave ambient sulfate ION impact at Ave Natural Background**

   *This represents our current thinking regarding the **most stringent definition** of Significant Impact.*

3. **2nd option:** An argument can be made whether any single source impact under natural background conditions is possible. Vermont therefore decided to use a level of **0.10 DV** change at 20% Worst Day Visibility.

   0.10 DV change on a 24-Hr basis at LYBR is equivalent to:

   0.100 ug/m^3 **24-Hr Ave ambient sulfate ION impact at Ave Worst 20% Visibility**

   *This represents our current thinking regarding the **most lenient definition** of Significant Impact.*

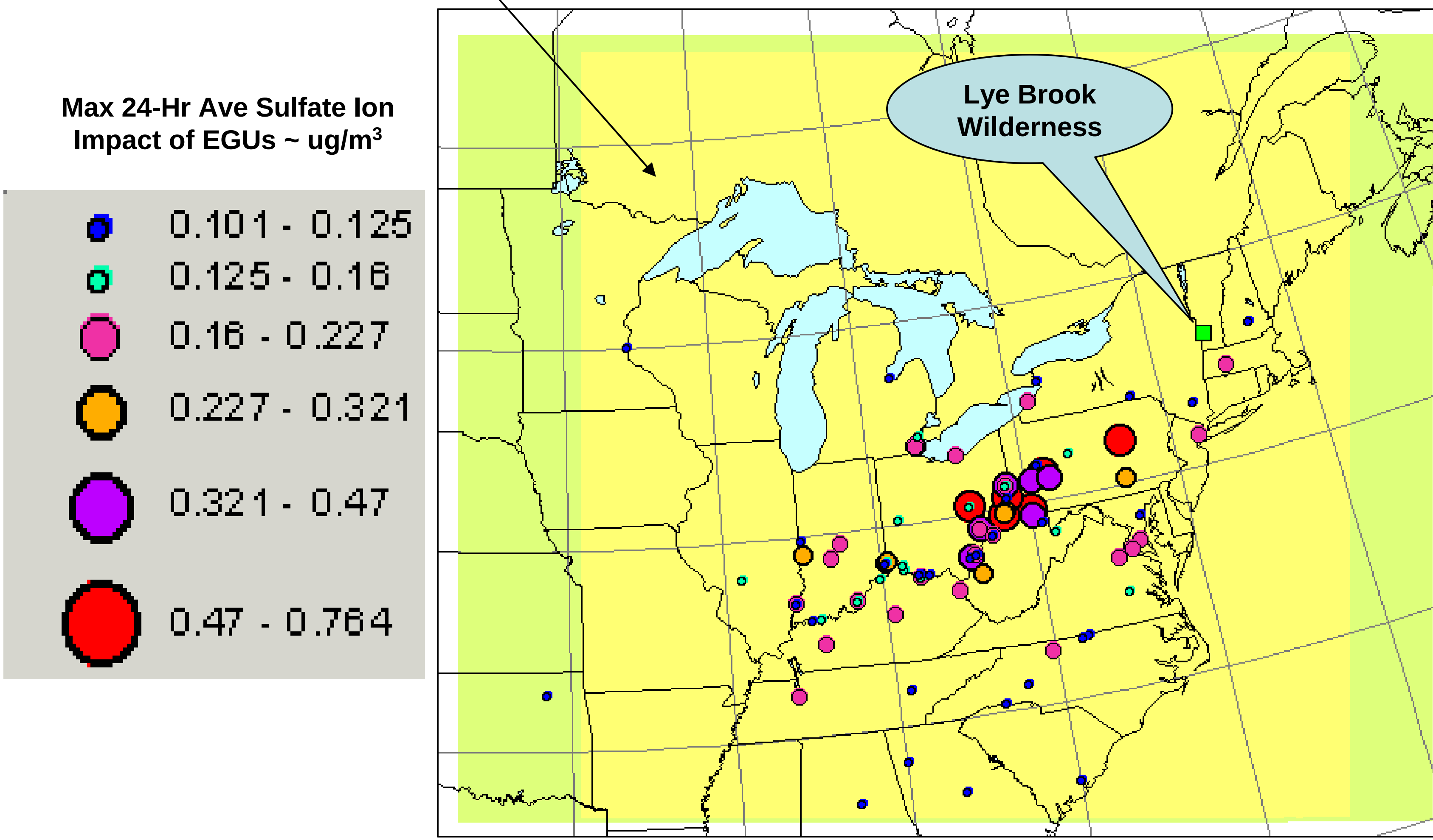
These calculations use the Deciview/Extinction relationship in natural log form
DV= 10*ln(B_{ext}/10) and assume $(NH_4)^2SO_4$ dry ext. eff. and wet f(RH) = 3.0 & 2.91 respectively

Using **0.027 ug/m³** SO_4 ION impact as the criteria, **356 EGUs** in the CALPUFF modeling domain had a significant impact on visibility at Lye Brook Wilderness area during 2002.

Using **0.100 ug/m³** SO_4 ION impact as the criteria, **106 EGUs** were identified.

(These 106 EGUs are shown below in the domain used for modeling.)

Max 24-Hr Ave Sulfate Ion Impact of EGUs ~ ug/m³



20% Worst Visibility Modeled Days in 2002 Model Year

CALPUFF MODEL results for ALL sources in the domain:

(EGUs, non-EGU point sources, area sources, and on-road as well as off-road mobile sources)

1) Results arranged sequentially from date of highest SO_4 ion impact at Lye Brook Wilderness to date of lowest SO_4 ion impact.

2) The **top 72 dates of modeled impact** (~ 20% worst modeled SO_4 ion daily impacts) **included all but 3** of the top 106 EGU maximum 24-Hour Ave SO_4 ion impacts at Lye Brook Wilderness modeled for the year.

3) The **top 106 EGU maximum 24-Hr SO_4 ion impacts** at Lye Brook Wilderness **occurred on only 25 days during the year**, most of which were in the subset of Modeled 20% Worst Visibility Days for 2002.

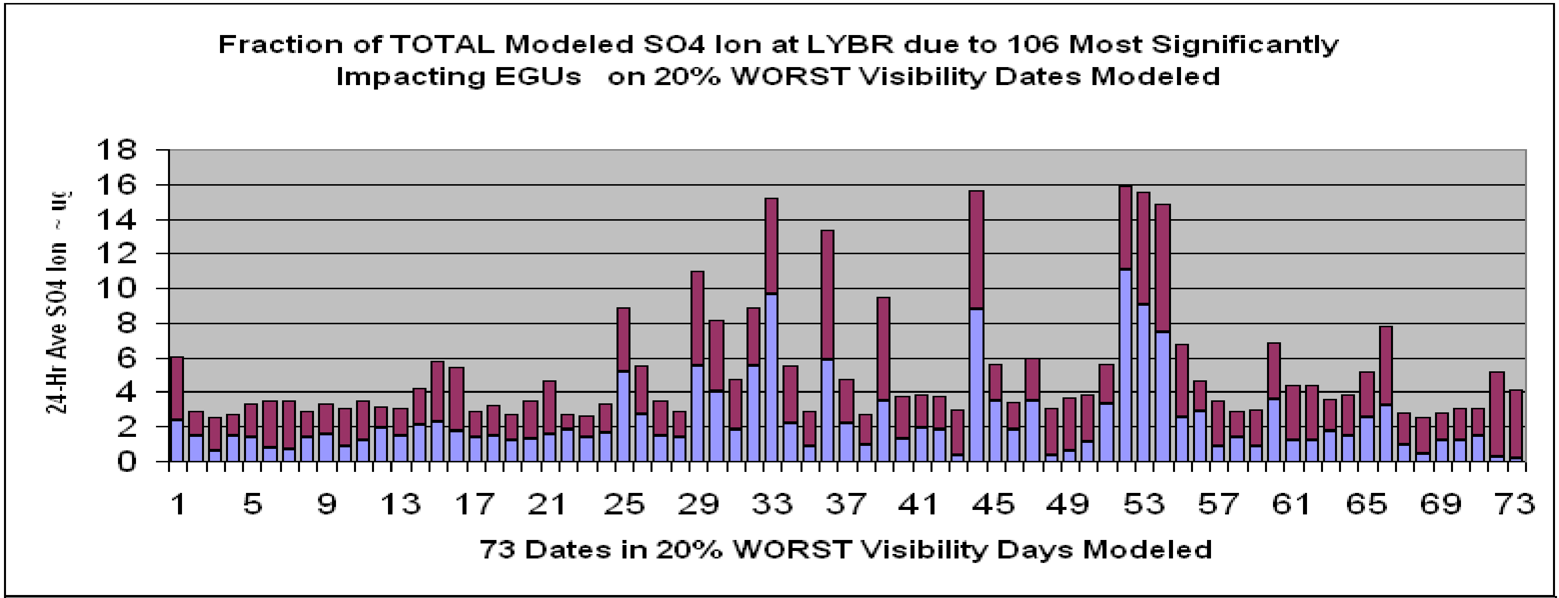
The tables following show the top 52 most significantly impacting EGUs on Lye Brook Wilderness Area

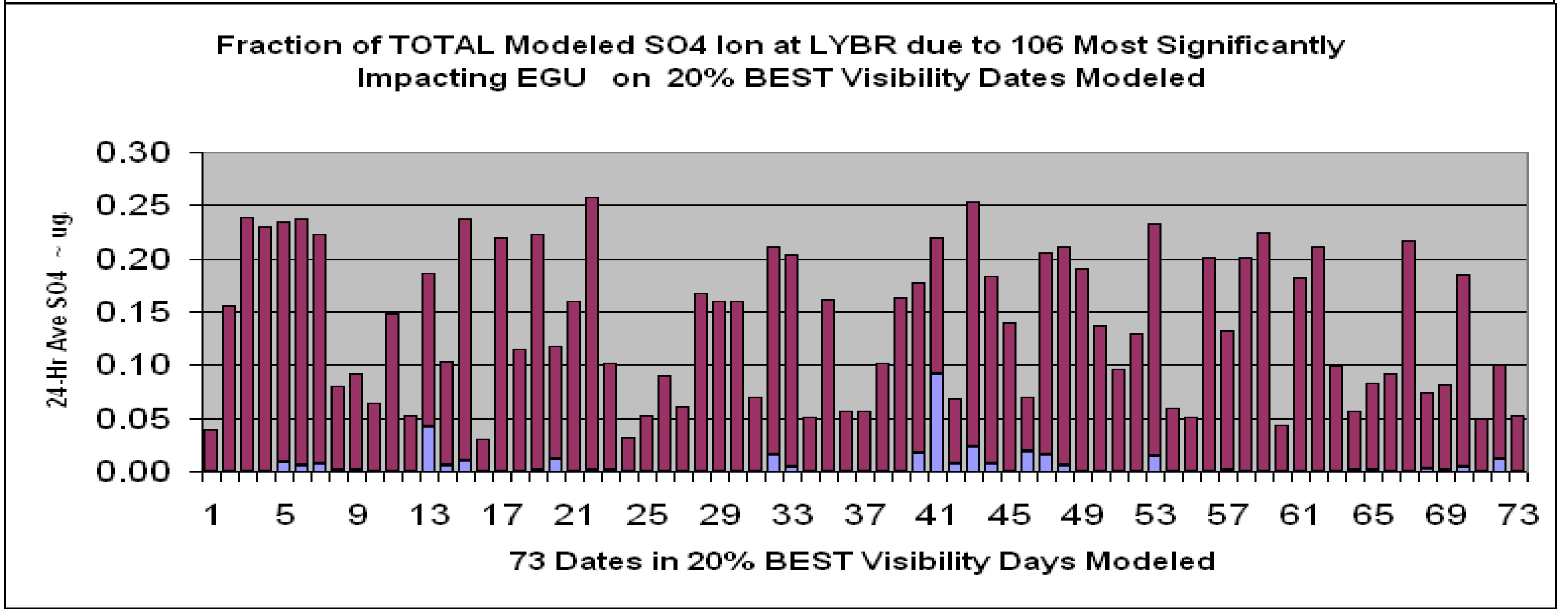
EGU	Latitude	Longitude	Facility	Max SO_4	24Hr Date
D031361	40.6522	-79.3425	KEYSTONE	0.764	06/24/02
D031362	40.6522	-79.3425	KEYSTONE	0.689	06/24/02
D028404	40.1842	-81.8811	CONESVILLE	0.680	08/13/02
D03179C01	39.8500	-79.9167	HATFIELD'S FERRY	0.598	08/13/02
D031492	41.0700	-76.6664	MONTOUR	0.576	06/23/02
D031491	41.0700	-76.6664	MONTOUR	0.557	06/23/02
D03948C02	39.8297	-80.8153	MITCHELL	0.543	08/13/02
D028281	40.2522	-80.6486	CARDINAL	0.539	08/13/02
D082261	40.5375	-79.7917	CHESWICK	0.470	06/24/02
D02876C01	38.9161	-82.1281	KYGER CREEK	0.463	08/14/02
D031222	40.5142	-79.1969	HOMER CITY	0.444	08/13/02
D039432	39.7000	-79.9167	FORT MARTIN	0.409	08/13/02
D039431	39.7000	-79.9167	FORT MARTIN	0.405	08/13/02
D031221	40.5142	-79.1969	HOMER CITY	0.402	08/13/02
D02872C04	39.5908	-81.6797	MUSKINGUM RIVER	0.377	08/13/02
D028667	40.5328	-80.6331	W H SAMMIS	0.370	08/13/02
D01010C05	39.5278	-87.4222	WABASH RIVER	0.321	07/03/02
D031403	40.1333	-76.7167	BRUNNER ISLAND	0.312	06/23/02
D00988U4	39.0806	-84.8608	TANNERS CREEK	0.311	07/03/02
D03935C02	38.4731	-81.8233	JOHN E AMOS	0.282	03/17/02
D028327	39.1111	-84.8042	MIAMI FORT	0.282	08/14/02
D01733C12	41.8911	-83.3444	MONROE	0.267	07/10/02
D03140C12	40.1333	-76.7167	BRUNNER ISLAND	0.262	06/23/02
D02864C01	39.9092	-80.7606	R E BURGER	0.257	08/13/02
D03947C03	39.8464	-80.8189	KAMMER	0.255	08/13/02
D039353	38.4731	-81.8233	JOHN E AMOS	0.238	05/28/02

EGU	Latitude	Longitude	Facility	Max SO_4	24Hr Date
D01733C34	41.8911	-83.3444	MONROE	0.227	07/10/02
D01571CE2	38.5639	-76.6806	CHALK POINT	0.205	07/23/02
D01353C02	38.1686	-82.6208	BIG SANDY	0.200	08/14/02
D02866C01	40.5328	-80.6331	W H SAMMIS	0.199	08/13/02
D060041	39.3678	-81.2958	PLEASANTS	0.197	08/13/02
D01572C23	38.2083	-77.4694	DICKERSON	0.194	07/23/02
D07253C01	39.3672	-86.5208	RICHARD GORSUCH	0.193	08/13/02
D080421	36.2811	-80.0603	BELEWS CREEK	0.190	08/15/02
D0283612	41.5042	-82.0500	AVON LAKE	0.189	07/23/02
D028725	39.5908	-81.6797	MUSKINGUM RIVER	0.188	08/13/02
D0099070	39.7122	-86.1975	ELMER W STOUT	0.184	06/12/02
D015731	38.3611	-76.9861	MORGANTOWN	0.181	07/15/02
D015732	38.3611	-76.9861	MORGANTOWN	0.180	07/15/02
D062641	38.9794	-81.9344	MOUNTAINEER (1301)	0.177	08/14/02
D06113C03	38.3589	-87.7783	GIBSON	0.172	03/07/02
D013783	37.2608	-86.9783	PARADISE	0.172	06/13/02
D03406C10	36.0278	-87.9861	JOHNSONVILLE	0.171	10/03/02
D024032	40.7500	-74.0750	HUDSON	0.170	03/16/02
D028501	38.6364	-83.7422	J M STUART	0.170	08/14/02
D028502	38.6364	-83.7422	J M STUART	0.170	08/14/02
D01008C01	38.2631	-85.8378	R GALLAGHER	0.169	06/13/02
D080422	36.2811	-80.0603	BELEWS CREEK	0.168	08/15/02
D016061	42.2806	-72.6056	MOUNT TOM	0.168	06/21/02
D02866C02	40.5328	-80.6331	W H SAMMIS	0.168	08/13/02
D02554C03	42.4919	-79.3469	DUNKIRK	0.167	09/11/02
D01355C03	37.7911	-84.7147	E W BROWN	0.165	06/27/02

% OF DAILY 2002 Modeled SO_4 Ion Impact @ LYBR

due to 106 most significantly impacting EGUs





Outline of Vermont Long-Term Strategy

Current Draft Recommendation for meeting 2018 RPG in VT RH SIP

1. Vermont should establish in **SIP regulation** a **24-Hr ambient Sulfate ION Significant Concentration Impact Level** for Lye Brook Wilderness Area **for stationary sources of SO_2**.
2. Vermont should adopt **New Source Review SIP regulations** requiring all new and existing stationary sources of SO_2 in Vermont to demonstrate they meet the significant ambient concentration impact level for Sulfate ION.

   Failing to meet level would require control of SO_2 emissions at BACT/LAER level.
3. **BART controls** should be applied, as determined by each state, on all BART-eligible sources identified in the MANE-VU states. Ambient SO_4 ION impact on Lye Brook Wilderness area should be a factor in decision-making. MANE-VU should request that other RPOs also consider the same level of significance of impact from their BART-eligible sources.
4. **CAIR SIPs** submitted to EPA should be evaluated with respect to whether individual EGUs identified as having a significant impact on Lye Brook Wilderness in the VT RH SIP will have actual SO_2 emission reductions consistent with meeting the ambient Sulfate ION significance level in the VT RH SIP by 2018. If not, these EGUs should be required to meet that threshold level by 2018 to remain in compliance with CAA Section 110(a)(2)(E)(i).
5. A **regionally applicable (MANE-VU) low-sulfur residential and commercial heating oil program** should be implemented (reducing S in fuels from maximum of 2500 ppm to maximum of 500 ppm) by 2009.

How do we determine what level of significance for individual upwind EGUs will achieve our RPG?

Preliminary Analysis of what 90% control applied to all 106 EGUs would get us at LYBR

re: DV change in 2018 from Baseline (2002)

Baseline from IMPROVE Data:

Worst 20% days in 2002 = Ave DV of **24.5**

(Glide Path implies something like 3.0 DV change needed by 2018)

Modeled BASE case CALPUFF result for SO4 Ion:

Worst 20% days in 2002 = Ave DV of **17.8 (Model Underpredicts SO4)**

Modeled CONTROL case CALPUFF result for SO4 Ion:

(Control Case is to put 90% Control on all 106 Significantly Impacting EGUs by 2018)

Worst 20% days in 2018 = Ave DV of **12.4**

Change in DV = 5.4 DV which appears to be enough to reach glide path.

(However, this calculation ***has not incorporated the change from the actual worst 20% DV level measured****, only from the modeled result for SULFATE and therefore is not likely to be correctly predicting the deciview change that would occur under an assumption of control only on these 106 EGUs)*

Adjusted Analysis of what 90% control applied to all 106 EGUs would get us at LYBR

re: DV change from Baseline Worst 20% Days Measured by IMPROVE

DV = 24.5 Equivalent to B_{ext} = 115.880 Mm^{-1}

	Worst 20% Days **Base Case (2002)** **ALL SRCS Modeled**	Worst 20% Days **Future 2018 Case** **ALL SRCS Modeled w/106 EGUs controlled at 90%**
$(NH4)_2$ SO4	6.778 ug/m3	3.951 ug/m3
B_{ext}	59.168 Mm^{-1}	34.489 Mm^{-1}
Correction**	56.712 Mm^{-1}	56.712 Mm^{-1}
	115.880 Mm^{-1}	**91.201 Mm^{-1}**

DV level for worst 20% days in 2018 = $10 * \ln (B_{ext} / 10)$ = 22.10

Change in DV due to Control on 106 EGUs = 24.5-22.10 → **2.4 DV**

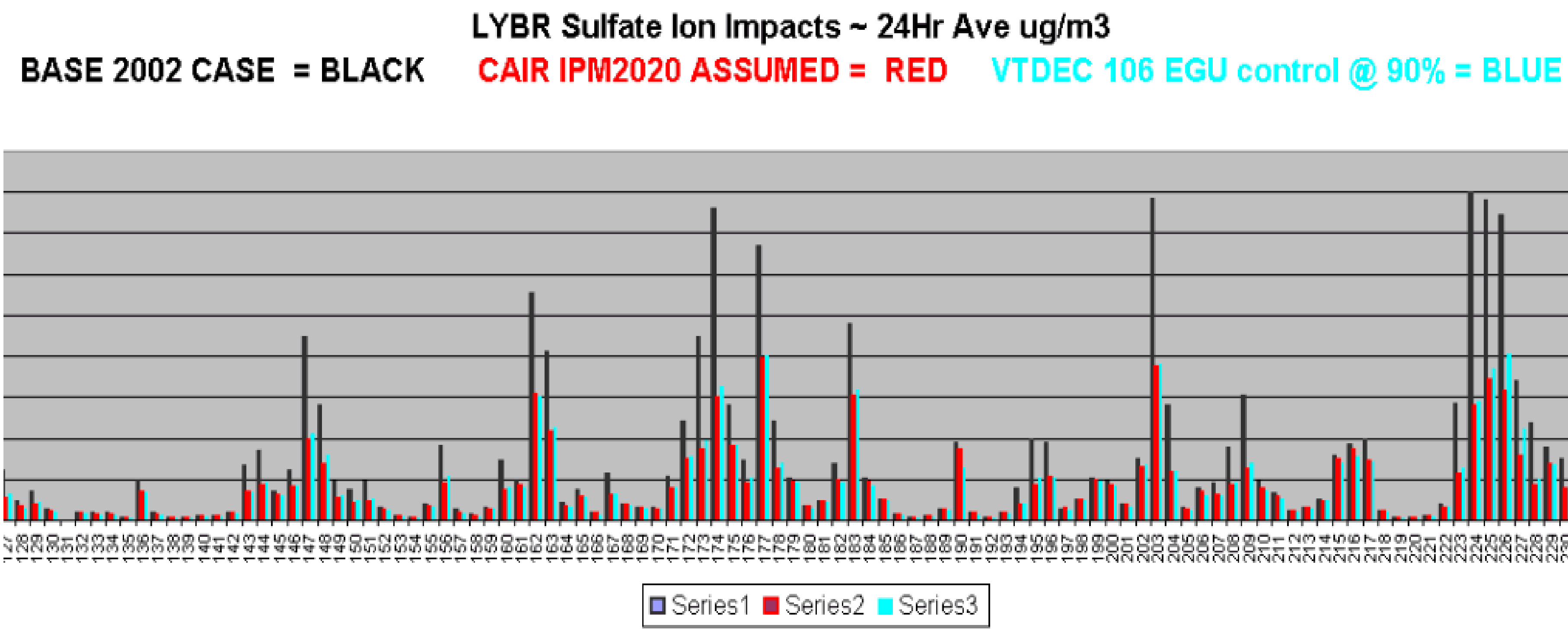
(Probably NOT QUITE ENOUGH to achieve Glide Path)

Note: **Correction** is due to model underprediction of B_{ext} because of only including Sulfate Aerosol component of extinction and also due to some model underprediction of Sulfate itself.

90% Control of 106 “Significant” Impact EGUs (3.4 MM Ton Reduction)

Has Very Similar Benefit at Lye Brook as

CAIR Estimated EGU Reductions by 2020 (4.0 MM Ton Reduction from more than 400 EGUs projected to have some control actually applied)

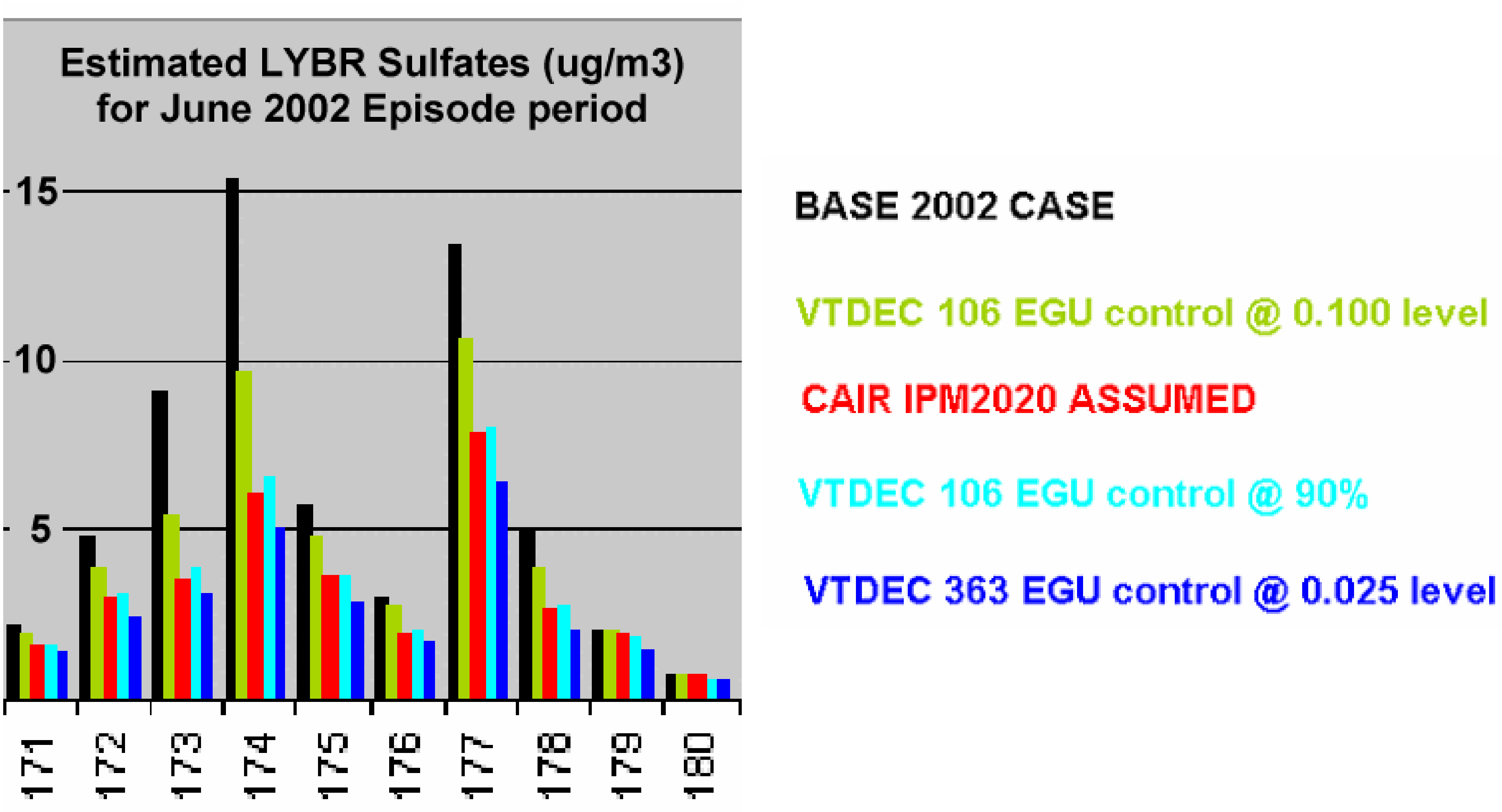


CAIR Estimates From: EPA submission to Senator Jeffords’ Hearing

IPM Model estimates of 2020 SO2 emissions from EGUs

Examining 4 Different Ways to Specify Controls

Modeled LYBR Sulfates from Four Alternative Control Approaches during June, 2002 Events



Note: Range of "Significant" source impacts from 0.025 to 0.100 ug/m3 $(NH_4)_2SO_4$ reflects 0.1-0.15 DV change for natural background or Worst 20% days respectively

Reduction from BASE CASE SO_2 Emissions
For 5 Scenarios Testing
Control on Targeted EGUs in CALPUFF Domain
(Number in Red Indicates # EGUs Controlled)

	Median SO2 Control Pct	Domain SO2 Tons	Reduction Tons SO2
2002 BASE CASE	------------	7,770,520	-------------
CAIR-IPM 2020 (400+)	76.0 %	3,750,197	4,020,323
106 at uniform 90% control	90.0 %	4,334,157	3,436,363
106 at level 0.100 ug/m^3	37.5 %	6,046,380	1,724,140
149 at level 0.075 ug/m^3	38.0 %	5,442,474	2,328,046
363 at level 0.025 ug/m^3	57.6 %	3,036,118	4,734,402

- **CAIR Control is uncertain, being based on IPM model prediction of various fuel costs and supply/demand situations from present until 2020 as well as the difficulty in predicting where trading credits will be utilized instead of actual control.**
- **Maximum Control Levels are between 87% to 98% in all these scenarios**

Preceding Analyses based on use of Significant Impact level Alternatives for Prioritizing EGU Sources Targeted for Control

Falling between:

1) A "lenient" definition of "Significant Impact" (0.1 Deciview change on Worst 20% Days = 0.1 ug/m3 SO_4 & 106 Sources)

2) A more stringent definition of "Significant Impact" targeting more sources (0.15 DV change from Natural Background = 0.025 ug/m3 SO_4 & 363 Sources)

If CAIR is not enough (or not certain enough or soon enough), or if there are opportunities to enhance CAIR (+), then

Prioritized SO_2 Reductions for EGUs with Maximum SO_4 Impacts in many Class I Areas would be the most efficient way to maximize benefits