

**CEM Temporal Profile Improvements
&
Impact of NH₃ Emission Inventory Improvements
on CMAQ Model Performance in the Southeastern US**



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Overview

- **Use of CEM-based temporal profiles**
 - vs. generic profiles... how different are they?
- **NH₃ inventory**
 - Initial vs. Revised
 - Impact on CMAQ model performance



VISTAS EGU Emissions

- **VISTAS Phase I**
 - Generic temporal profiles
- **VISTAS Phase II**
 - CEM-based temporal profiles



VISTAS EGU Emissions

- **Through Clean Air Markets Division website, unit-level hourly emissions data by State were obtained**
 - **Used in developing temporal allocation factors**
 - **State, facility name, facility identification (ORISPL), unit identification code**
 - **Date and hour of record**
 - **SO₂, CO₂, and NO_x mass (in lbs per hour), heat input (MMBtu), and NO_x emission rate (lbs/MMBtu)**

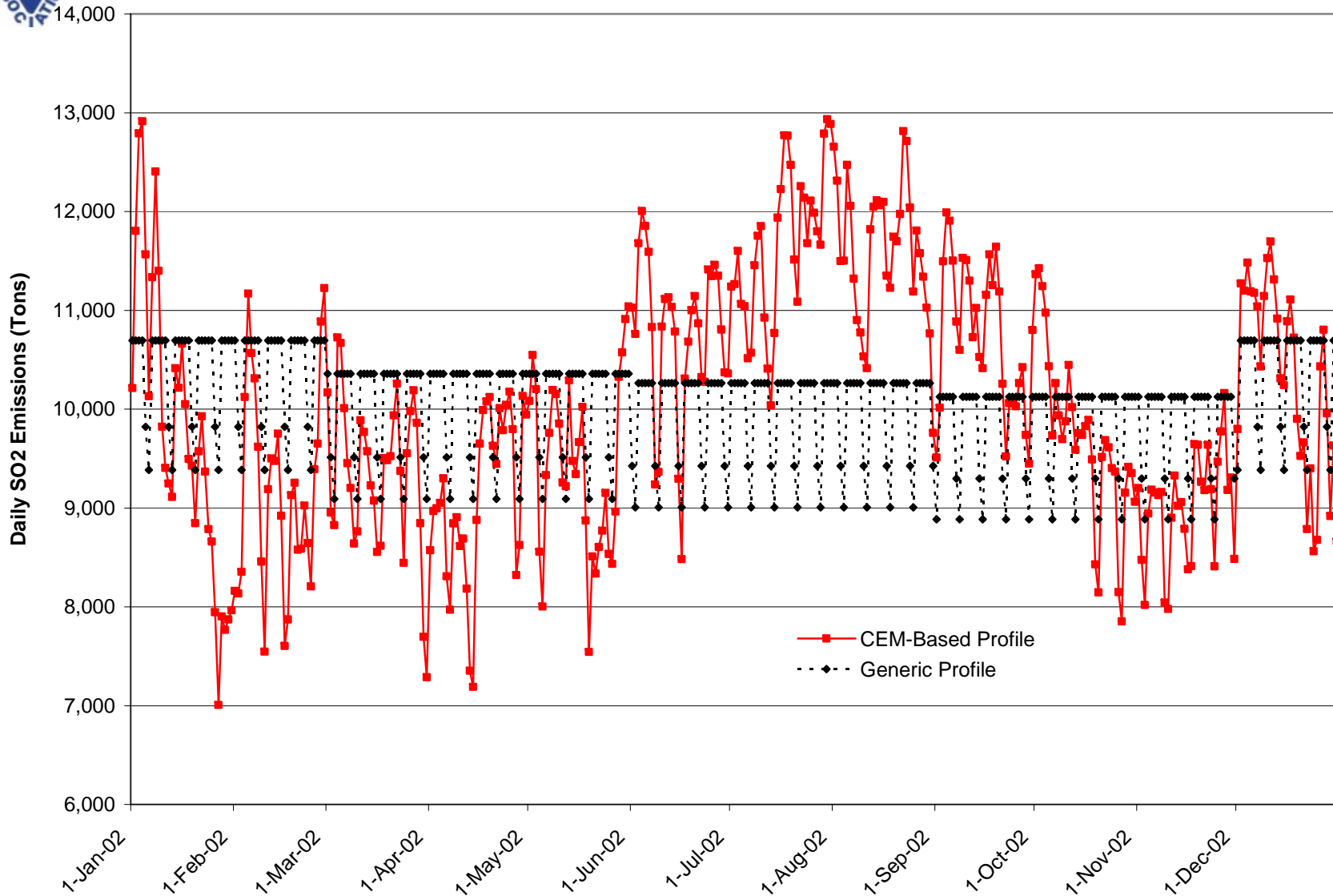


VISTAS EGU Emissions

- Ratios required to be matched to existing 2002 base year inventory
 - Unit, facility, or State-level
- In VISTAS States:
 - 3.7 million tons SO₂
(99.95% captured w/ match)
 - 1.5 million tons NO_x
(99.46% captured w/ match)
 - 861 units/boilers in CEM database
(650 captured w/ match)

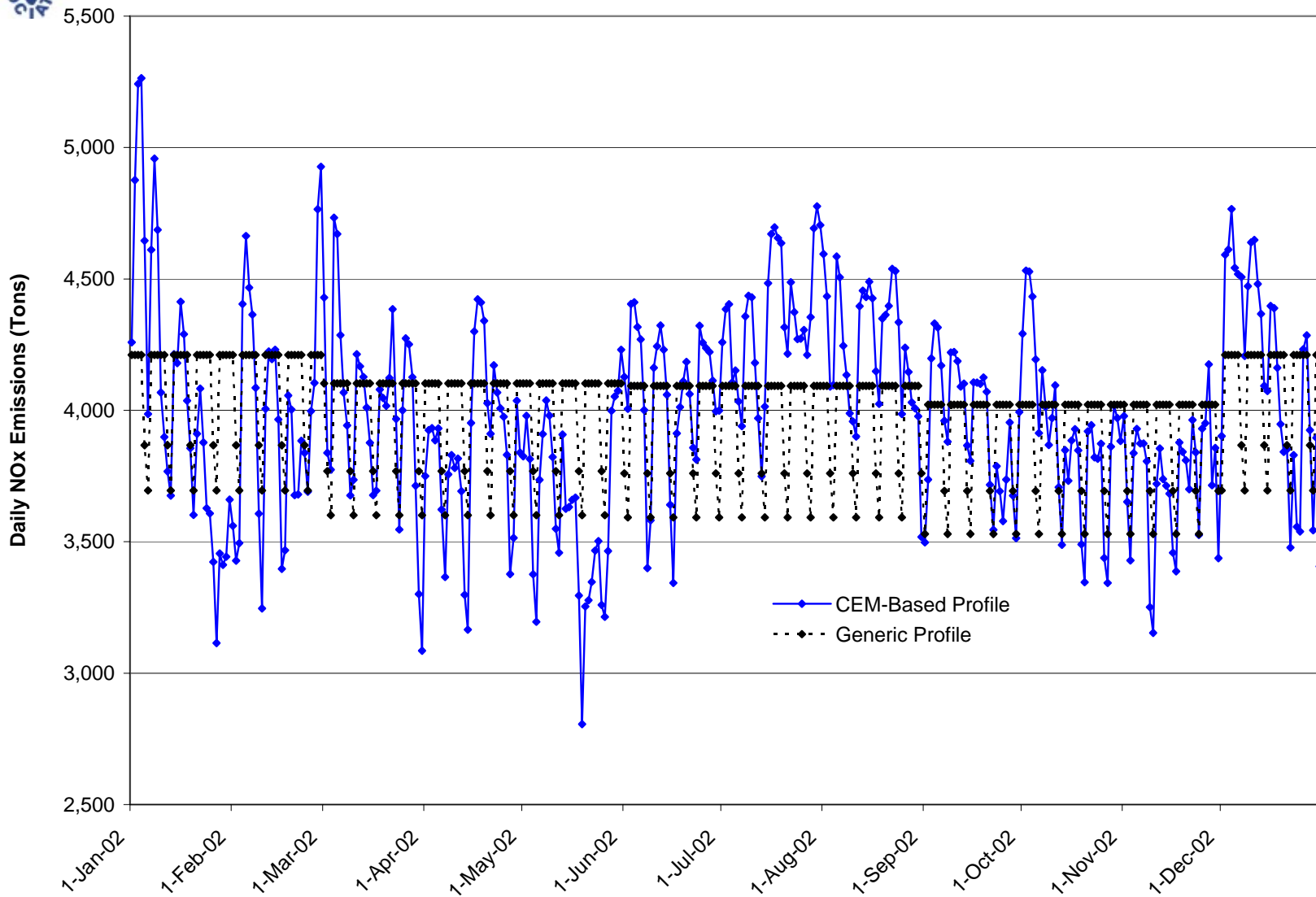


VISTAS EGU SO2 Emissions for 2002 Base Year Modeling





VISTAS EGU NOx Emissions for 2002 Base Year Modeling





VISTAS EGU Emissions

- Application of the CEM-based temporal profiles to annual emission totals in the VISTAS domain exhibit the uniqueness of individual sources and their operating characteristics
- This hourly distribution of emissions greatly enhanced the inputs provided to the air quality model and improved model performance in more than one season and sub episode



VISTAS EGU Emissions

- Our research with the VISTAS inventories and other studies has demonstrated that the use of actual hourly emissions is indeed valuable
- However, today's mechanisms and procedures for collecting and reporting these emissions and associated data are limited to a few source types



VISTAS EGU Emissions

- **The utilization of CEM-based temporal profiles allows for this best modeling practice with respect to EGU emissions**
- **Enhances the reliability of chemical transport model predictions**
- **Provides technical support for policy makers increased confidence in decisions on future strategies based on air quality simulations**



Visibility Improvement State and Tribal Association of the Southeast

VISTAS NH₃ Inventory and NO₃ Performance



VISTAS Area Emissions (Preliminary NH₃)

- Updated 1999 NEIv2 with state/local data as available
- Supplemented activity and growth data
 - CMU NH₃ model (v.3.1)
- Forecast to 2002 w/ growth factors
- Gilliland/Pinder temporal profiles



VISTAS Area Emissions (Revised NH₃)

- Annual 2002 files via CERR
- Supplemented activity and temporal data
 - CMU NH₃ model (v.3.6)
- Decreases annual NH₃ emissions by 11% in VISTAS domain
 - ~60% decrease in January
 - ~10% decrease in July



2002 Change in NH3 Emissions (Tons) [Revised - Preliminary]

VISTAS States

FIPSSST	State	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
01	AL	-3,361	-3,310	-805	2,791	139	859	41	324	585	1,498	-1,538	-2,820	-5,562
12	FL	-1,267	-1,239	-188	1,057	289	94	4	317	1,029	932	-190	-1,023	-165
13	GA	-4,035	-4,096	-2,422	1,175	-340	298	602	1,184	1,230	1,653	-1,793	-3,192	-9,700
21	KY	-1,678	-1,544	528	3,480	653	1,221	198	547	1,017	1,989	-47	-1,606	4,775
28	MS	-1,928	-1,869	1,125	4,061	1,171	4,266	-132	877	1,056	2,228	-450	-1,466	8,960
37	NC	-4,106	-3,664	-319	4,910	1,977	-1,742	-368	1,746	2,818	6,854	-921	-1,876	5,371
45	SC	-870	-711	385	1,328	272	272	323	387	345	817	-353	-627	1,577
47	TN*	-7,011	-6,963	-5,502	-4,404	-5,306	-6,474	-6,050	-5,782	-5,646	-5,136	-6,291	-6,791	-71,333
51	VA	-2,269	-2,240	-813	1,643	300	78	-77	97	295	1,248	-802	-1,840	-4,361
54	WV	-497	-501	-50	621	18	236	81	83	73	54	-241	-417	-535
VISTAS Total		-27,021	-26,137	-8,062	16,661	-826	-892	-5,378	-219	2,802	12,137	-12,625	-21,658	-70,972

Note: Majority of temporal delta attributed to fertilizer application improvements

***University of Tennessee provided original NH3 inventory which was different from how rest of the initial VISTAS NH3 inventory was generated.**



2002 Change in NH3 Emissions (Percent) [(Revised-Preliminary)/Preliminary]

VISTAS States

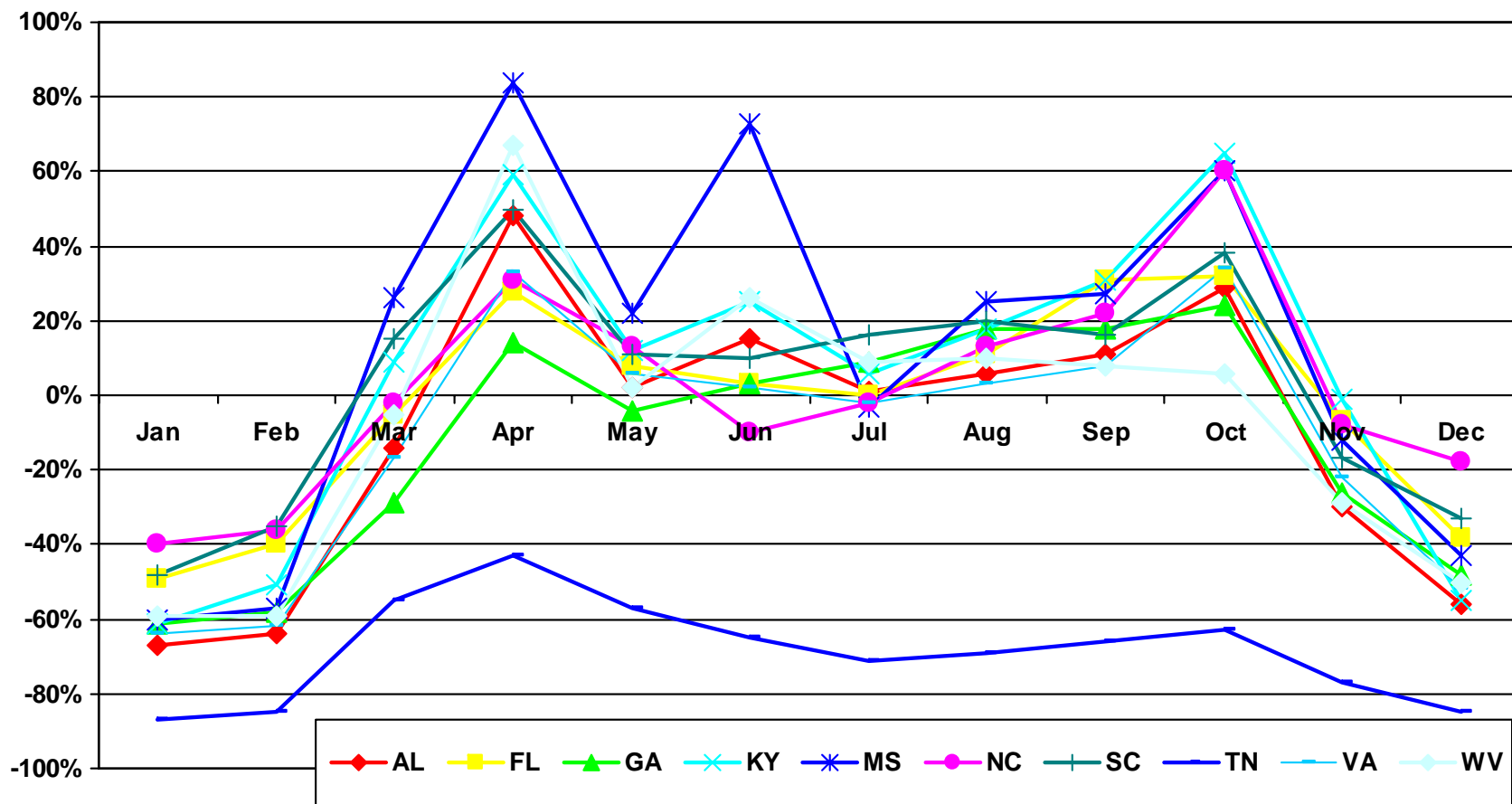
FIPSST	State	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
01	AL	-67%	-64%	-14%	48%	2%	15%	1%	6%	11%	29%	-30%	-56%	-9%
12	FL	-49%	-40%	-5%	28%	8%	3%	0%	11%	31%	32%	-7%	-38%	0%
13	GA	-61%	-58%	-29%	14%	-4%	3%	9%	18%	18%	24%	-26%	-48%	-11%
21	KY	-61%	-51%	9%	59%	12%	25%	6%	18%	31%	65%	-1%	-55%	10%
28	MS	-60%	-57%	26%	84%	22%	73%	-3%	25%	27%	60%	-12%	-43%	18%
37	NC	-40%	-36%	-2%	31%	13%	-10%	-2%	13%	22%	60%	-8%	-18%	3%
45	SC	-48%	-35%	15%	50%	11%	10%	16%	20%	16%	38%	-17%	-33%	6%
47	TN*	-87%	-85%	-55%	-43%	-57%	-65%	-71%	-69%	-66%	-63%	-77%	-85%	-68%
51	VA	-64%	-62%	-17%	33%	6%	2%	-2%	3%	8%	34%	-22%	-52%	-9%
54	WV	-59%	-59%	-5%	67%	2%	26%	9%	10%	8%	6%	-29%	-50%	-5%
VISTAS Total		-60%	-56%	-13%	26%	-1%	-1%	-10%	0%	5%	25%	-26%	-48%	-11%

Note: Majority of temporal delta attributed to fertilizer application improvements

*University of Tennessee provided original NH3 inventory which was different from how rest of the initial VISTAS NH3 inventory was generated.



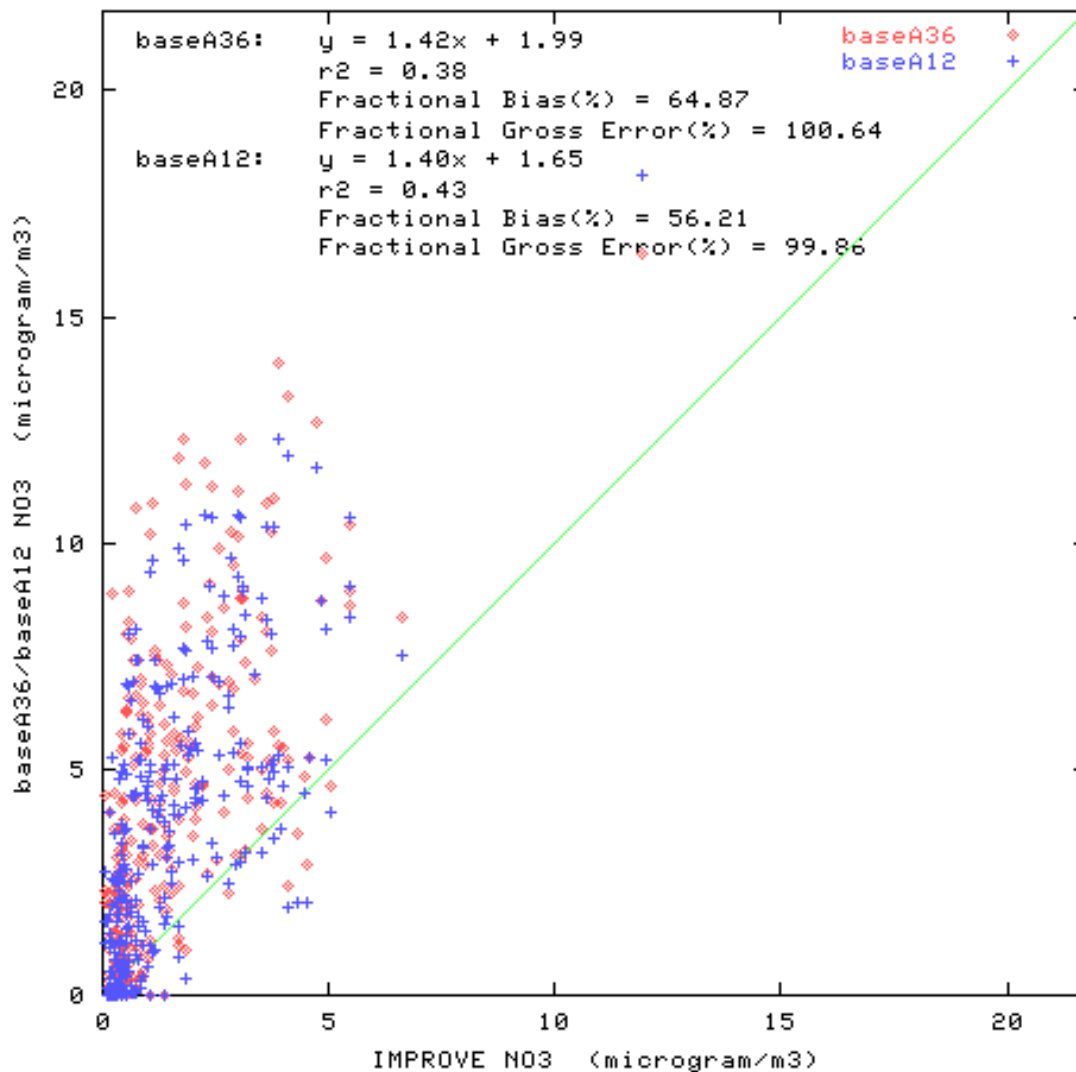
Changes in Ammonia Emissions between Initial and Revised CMAQ Base Case Simulations





CMAQ Model Performance at IMPROVE sites Before NH3 improvements

IMPROVE vs. baseA36/baseA12 N03 at 33 stations on 2002001-2002031



January 2002
Nitrate (NO3)

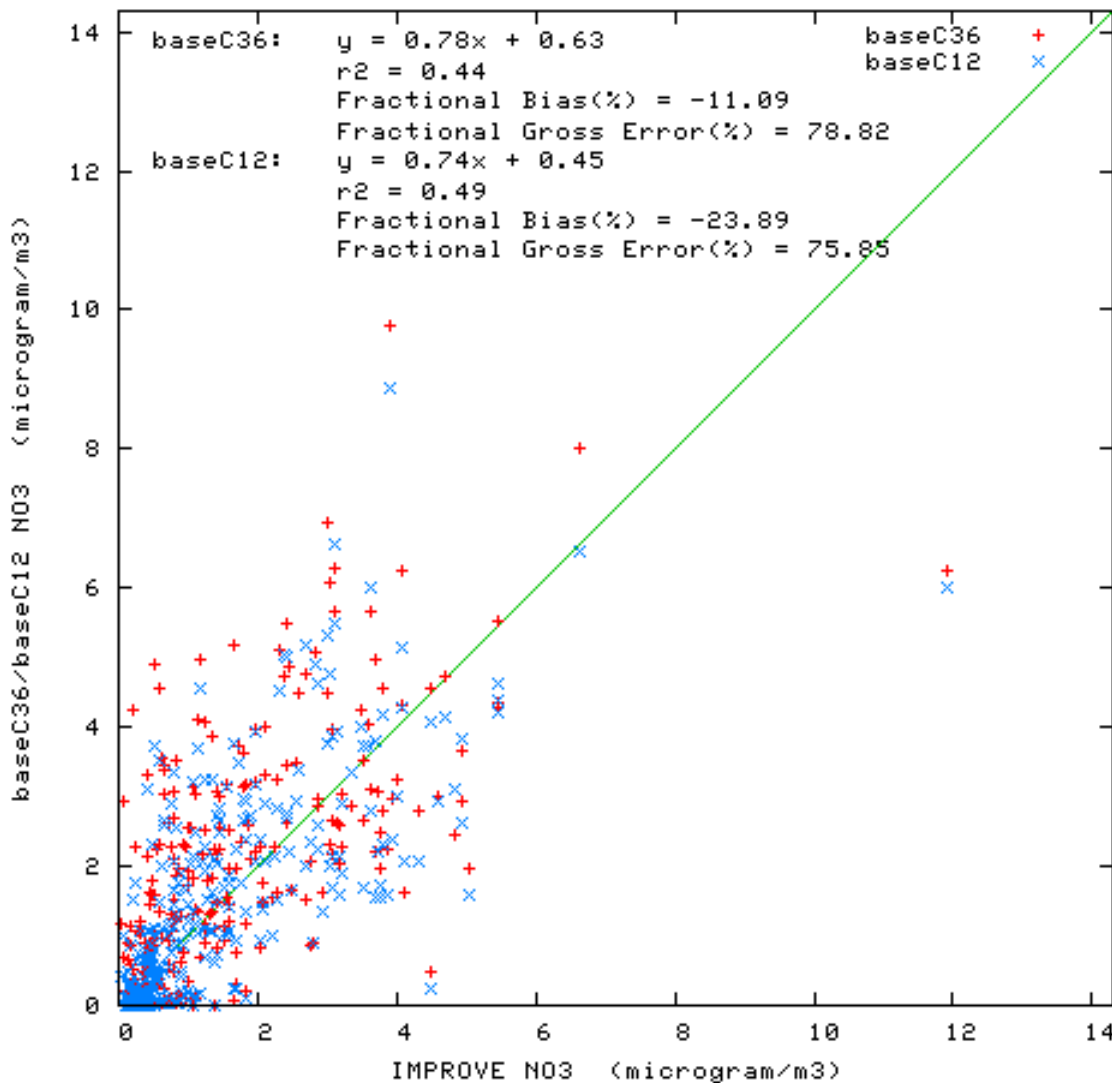
Red = 36 km
FB = 64.8

Blue = 12 km
FB = 56.2



CMAQ Model Performance at IMPROVE sites *After* NH3 improvements

IMPROVE vs. baseC36/baseC12 NO3 at 33 stations on 2002001-2002031



January 2002
Nitrate (NO3)

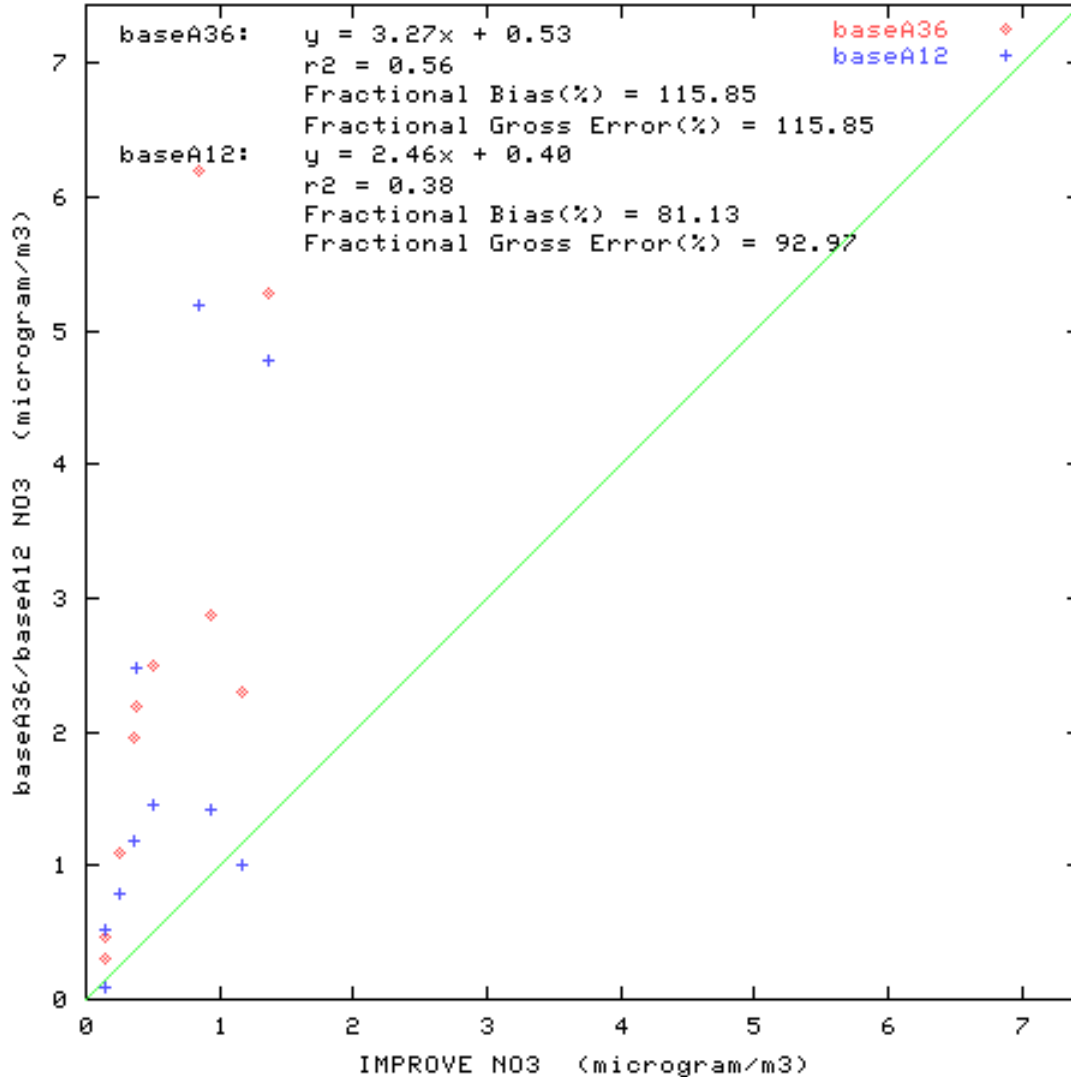
Red = 36 km
FB = -11.0

Blue = 12 km
FB = -23.8



CMAQ Model Performance at Dolly Sods Before NH3 improvements

IMPROVE vs. baseA36/baseA12 NO3 at station DOS01 on 2002001-2002031



January 2002
Nitrate (NO3)

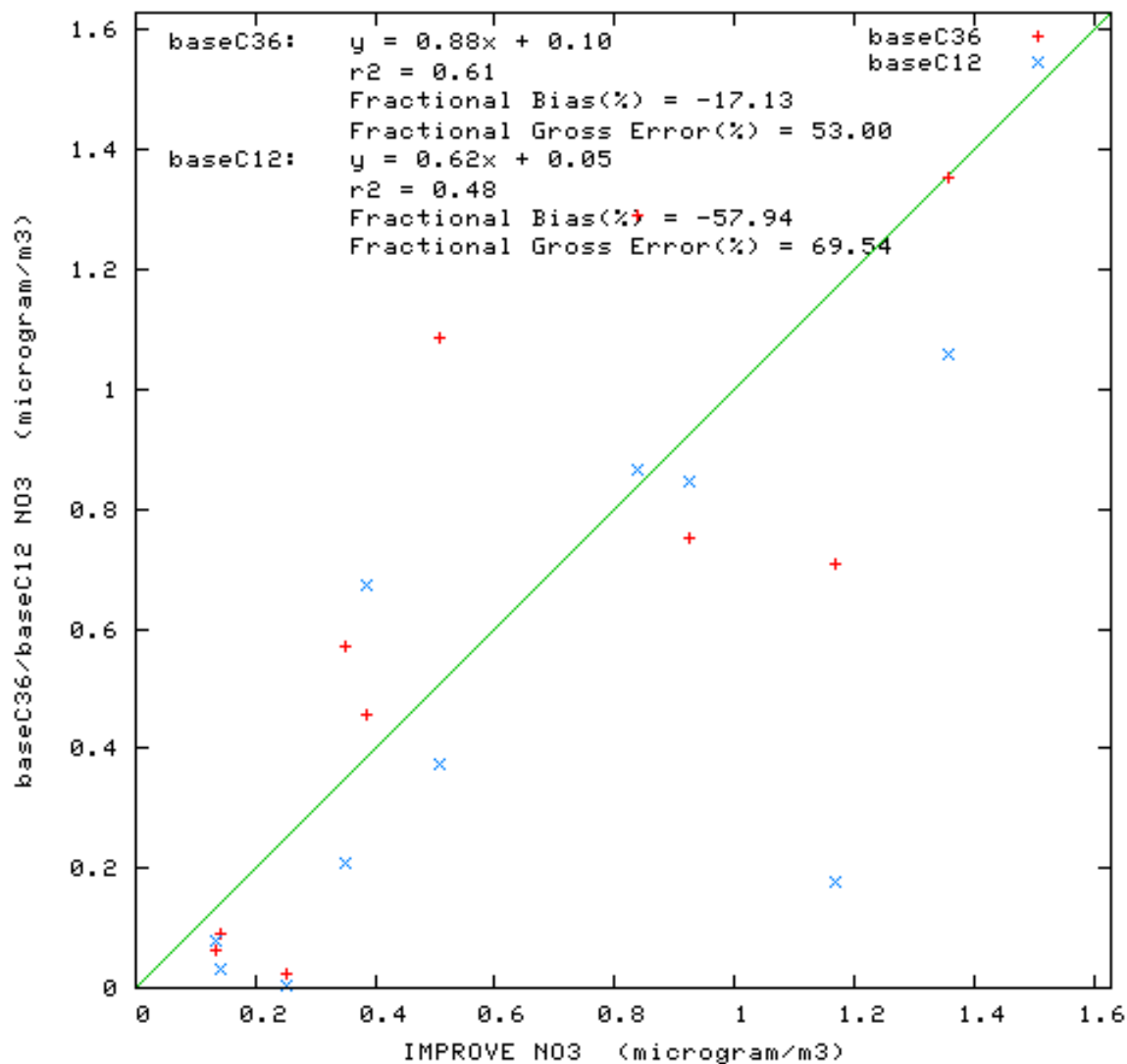
Red = 36 km
FB = 115.8

Blue = 12 km
FB = 81.1



CMAQ Model Performance at Dolly Sods After NH3 improvements

IMPROVE vs. baseC36/baseC12 NO3 at station DOS01 on 2002001-2002031



January 2002
Nitrate (NO3)

Red = 36 km

FB = -17.1

Blue = 12 km

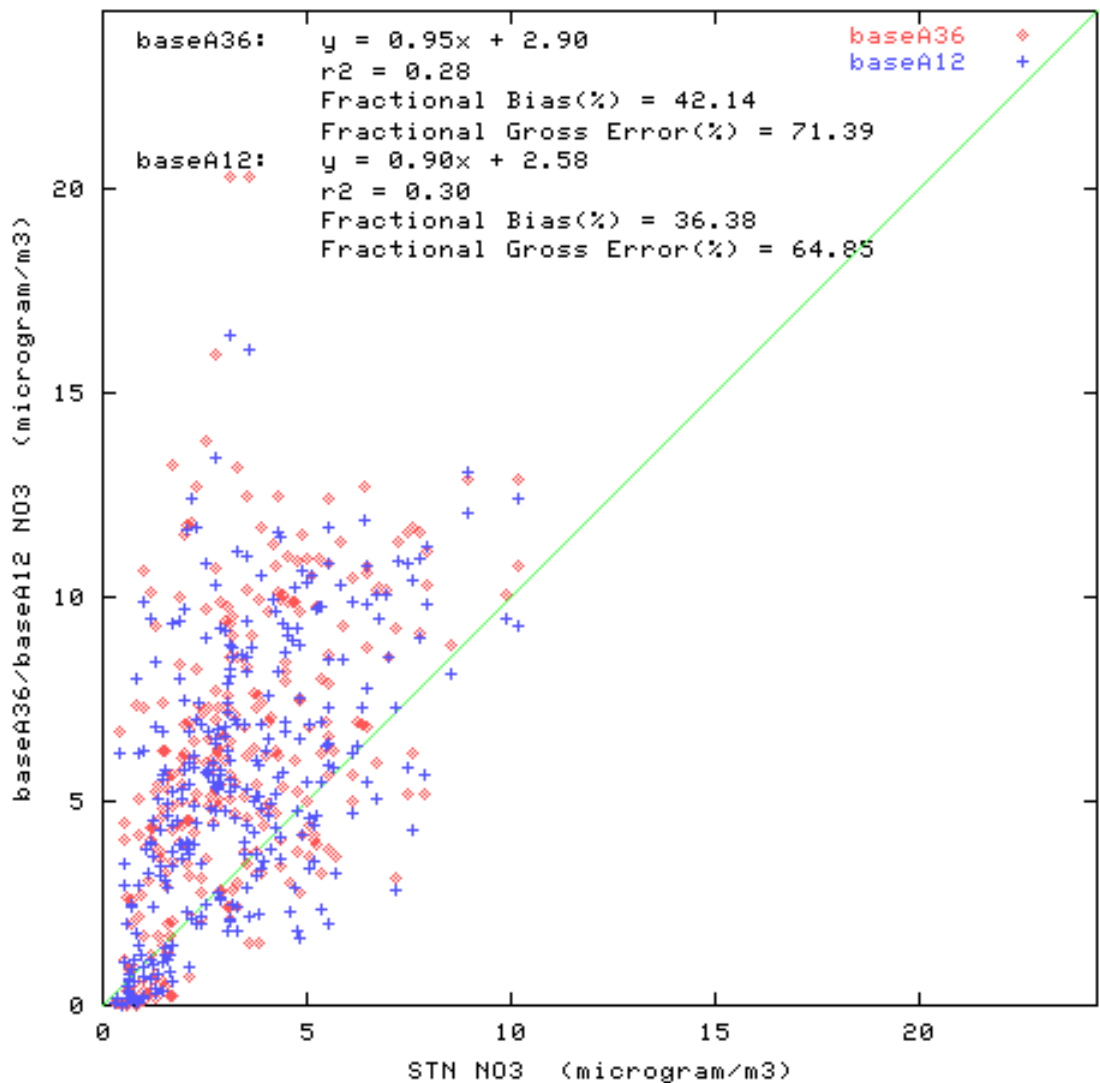
FB = -57.9

Note scale change
from previous slide!



CMAQ Model Performance at STN sites Before NH3 improvements

STN vs. baseA36/baseA12 NO3 at 36 stations on 2002001-2002031



January 2002
Nitrate (NO3)

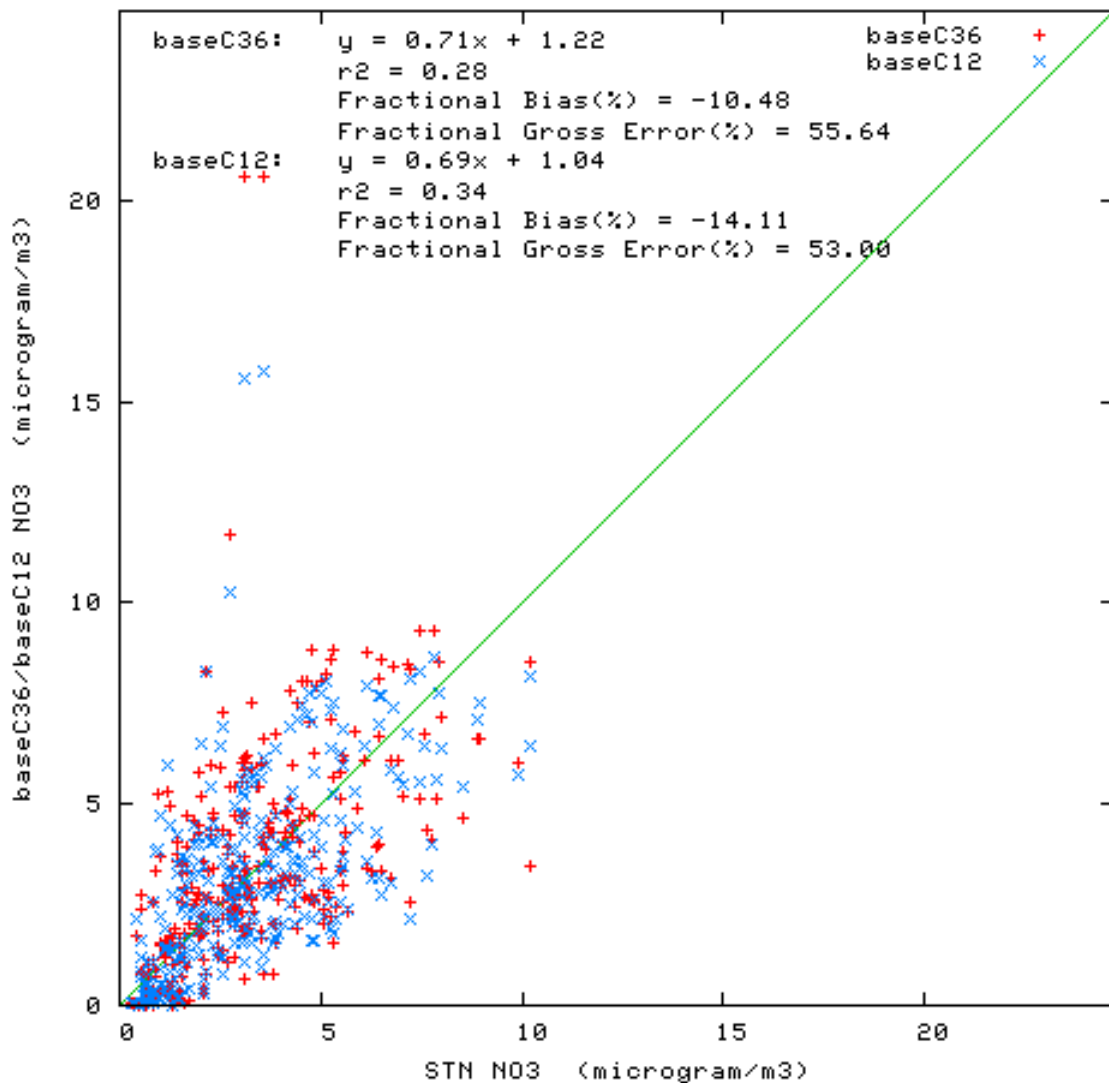
Red = 36 km
FB = 42.1

Blue = 12 km
FB = 36.3



CMAQ Model Performance at STN sites After NH3 improvements

STN vs. baseC36/baseC12 NO3 at 36 stations on 2002001-2002031



January 2002
Nitrate (NO3)

Red = 36 km

FB = -10.4

Blue = 12 km

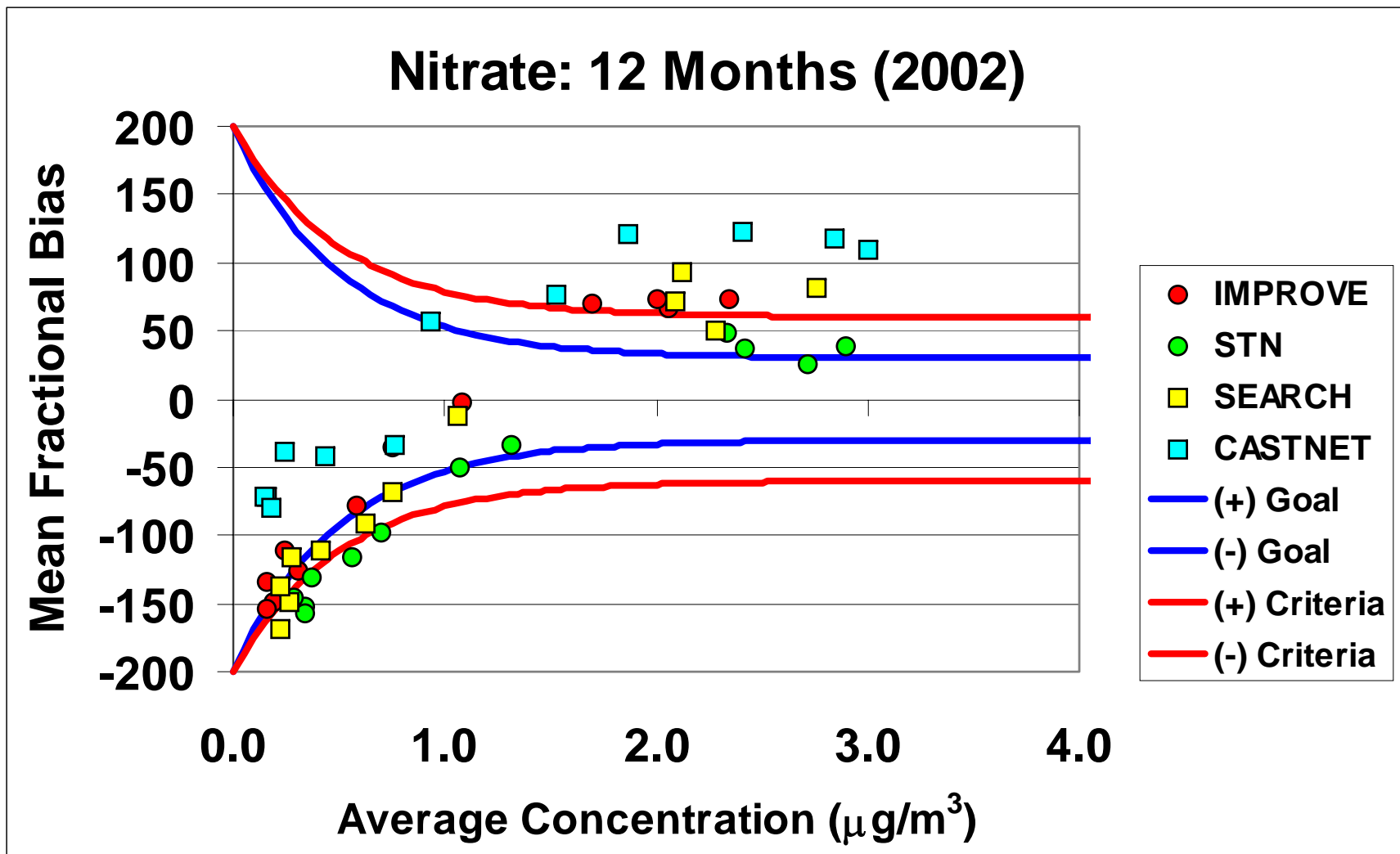
FB = -14.1



NO3 Bugle Plots – VISTAS States

All Months, Mean Fractional Bias

Before NH3 improvements

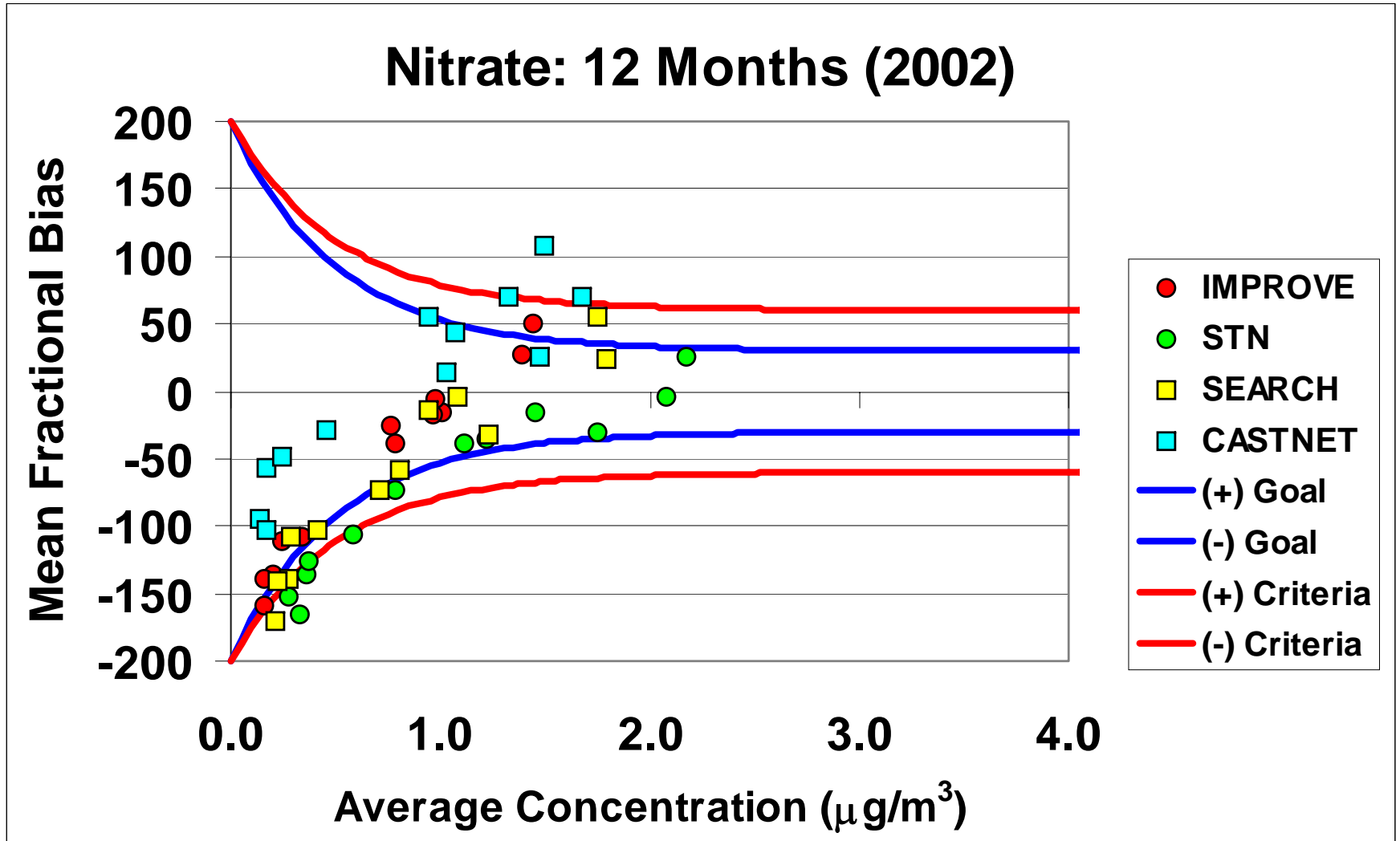




NO3 Bugle Plots – VISTAS States

All Months, Mean Fractional Bias

After NH3 improvements





VISTAS Air Quality Modeling

Nitrate Performance summary

Before revised/improved NH₃ emission estimates

- Large winter NO₃ overestimation and summer underestimation bias
 - Summer underestimation bias not important because both modeled and observed NO₃ very low

After revised/improved NH₃ emission estimates

- Winter NO₃ overestimates are now slight underestimates
 - Not perfect, but acceptable



Summary

- **CEM temporal profiles improved overall AQ model performance**
- **Nitrate performance now acceptable in winter in Southeastern US thanks to revised/improved NH₃ estimates**
- **But how do the NH₃ inventory improvements (and subsequent NO₃ MPE improvements) impact Relative Reduction Factors (RRFs) on 20% best/worst days for Regional Haze?**



Acknowledgements

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VISTAS on the web

- <http://vistas-sesarm.org/>
- <http://pah.cert.ucr.edu/vistas/vistas2/>