

Emission Sensitivities for VISTAS

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2018 Emission Sensitivities for VISTAS Class I Areas

Introduction

- Georgia Tech performed emission sensitivities using CMAQ on the VISTAS 12 km modeling domain
- Model simulations for two episodes
 - July 13-27, 2001 and January 1-20, 2002
 - 2018 OTB and 2018 OTW
 - Episode days are weighted using CART to best represent 20% best and worst days
 - Can only use days with measurements (1 of 3)
 - Each site will use 1 – 5 days to represent each metric

Approach

- Brute-force sensitivities performed by reducing specific emissions by 30%
- Modeling results used in a relative fashion rather than absolute fashion

$$\Delta C = (M_{\text{future}} - M_{\text{base}}) * O_{\text{base}} / M_{\text{base}}$$

- Scaling is based on “typical” base year modeling
- Equivalent to applying day specific RRFs to each component of PM.
- Goal is to evaluate the relative importance of various emission reductions

Emission Sensitivities

- Actual & Typical Baseyear (36 km and 12 km)
- 2018 OTB & OTW (36 km and 12 km)
- All SO₂ (OTB & OTW)
 - All Point SO₂ (OTB & OTW)
 - VISTAS Coal Power Plants (OTB & OTW)
 - VISTAS Other Power Plants (OTB & OTW)
 - VISTAS Non Power Plants (OTB & OTW)
 - Non-VISTAS Point (OTB & OTW)
 - All Ground SO₂ (OTB & OTW)
 - All Boundary SO₂ (OTB & OTW)
 - All Boundary SO₄ (OTB & OTW)

Other Emission Sensitivities

- All NH₃ (OTB & OTW)
- All NO_x (OTB & OTW)
- All Primary Carbon (OTB)
- All Man-Made VOCs (OTB)
- All Biogenic VOCs (OTB)
- All SO₂/NO_x (OTB)
- All SO₂/NH₃ (OTB)
- All NO_x/NH₃ (OTB & OTW)
- All SO₂/NO_x/NH₃ (OTB)

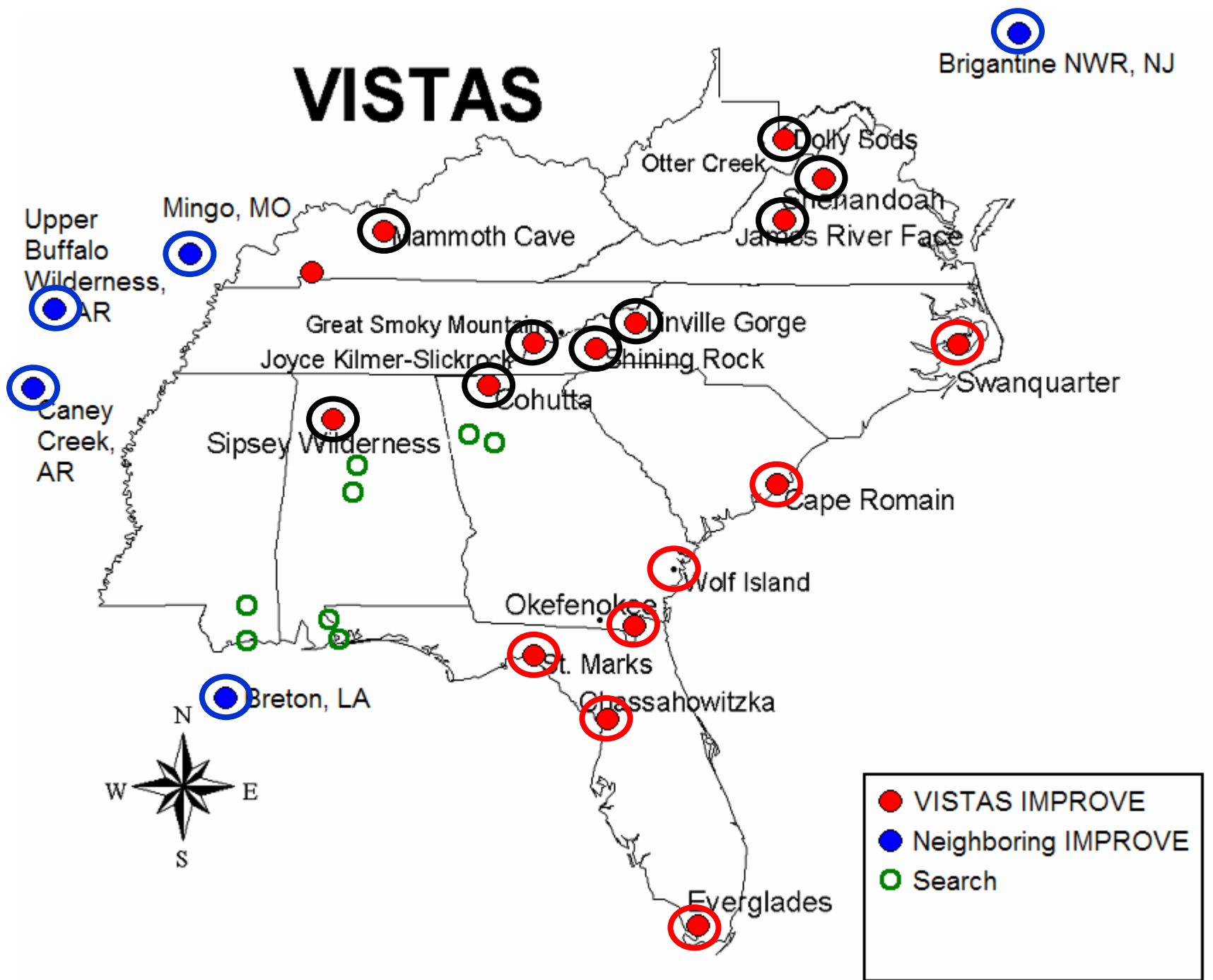
Level 1 Sensitivity Acronyms

- **OTB-TYP** → 2018 OTB - 2002 Typical
- **OTW-OTB** → 2018 OTW - 2018 OTB
- **ASO2** → 30% reduction in all SO₂ domain-wide
- **ANOX** → 30% reduction in all NO_x domain-wide
- **ANH3** → 30% reduction in all NH₃ domain-wide
- **ASO2NOXNH3** → 30% reduction in all SO₂/NO_x/NH₃ domain-wide
- **AMVOC** → 30% reduction in all Anthropogenic VOCs domain-wide
- **ABVOC** → 30% reduction in all Biogenic VOCs domain-wide
- **APRIC** → 30% reduction in all Primary Carbon domain-wide

Level 2&3 Sensitivity Acronyms

- **GSO2ALL** → 30% reduction in all ground SO₂ domain-wide
- **ESO2ALL** → 30% reduction in all point SO₂ domain-wide
- **ESO2VCPP (CPP)** → 30% reduction in all VISTAS point coal-fired power plant SO₂
- **ESO2VNPP (NPP)** → 30% reduction in all VISTAS point non power plant SO₂
- **ESO2VOPP (OPP)** → 30% reduction in all VISTAS point non coal-fired power plant SO₂
- **ESO2nonV** → 30% reduction in all non VISTAS point SO₂
- **BCSO2** → 30% reduction in all SO₂ boundary conditions
- **BCSO4** → 30% reduction in all SO₄ boundary conditions

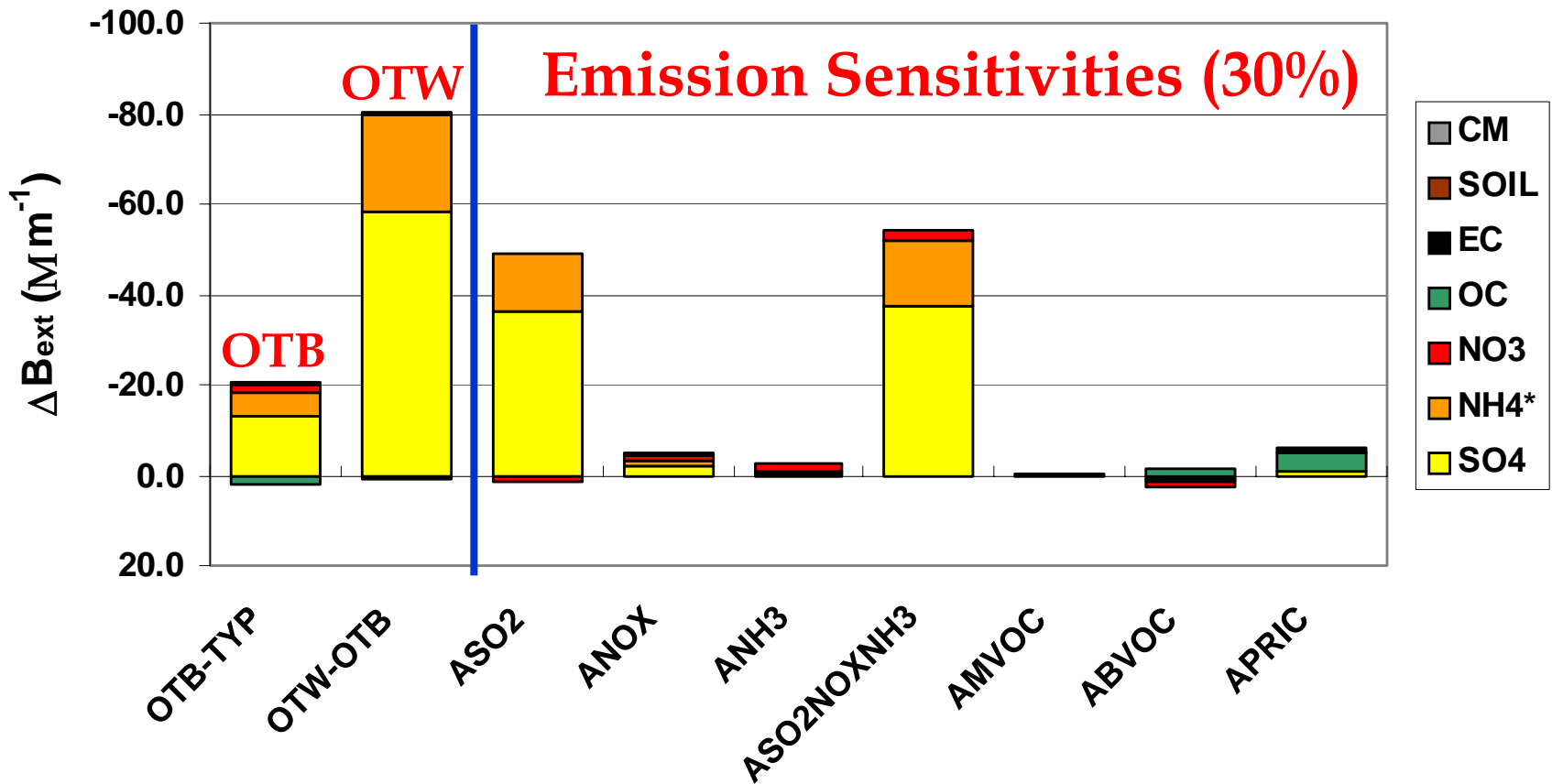
VISTAS



Mountain Sites

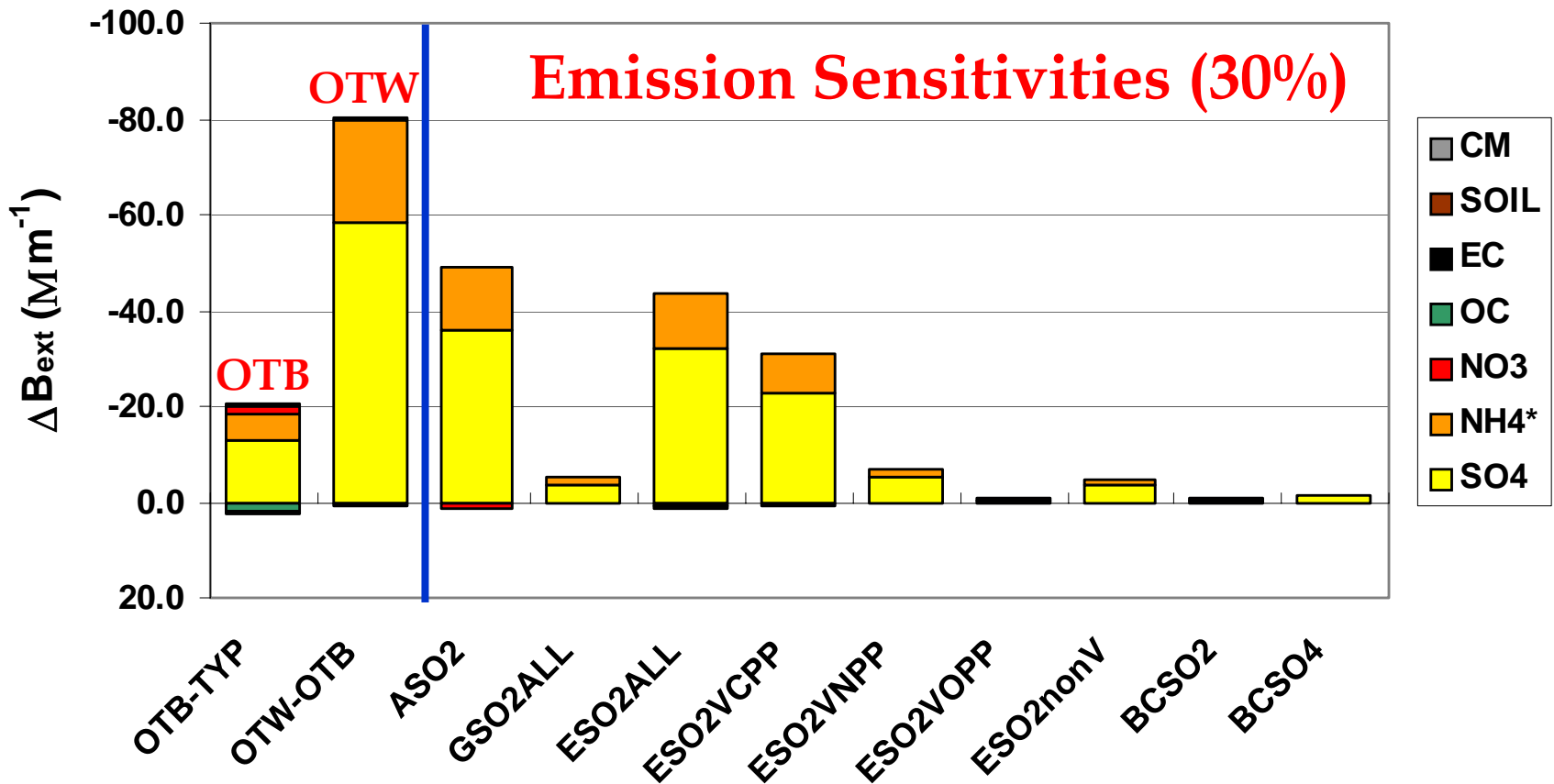
Mammoth Cave (KY) - 4 days

Weighted B_{ext} Response at Site to Reductions in
OTB Emissions: Worst 20%



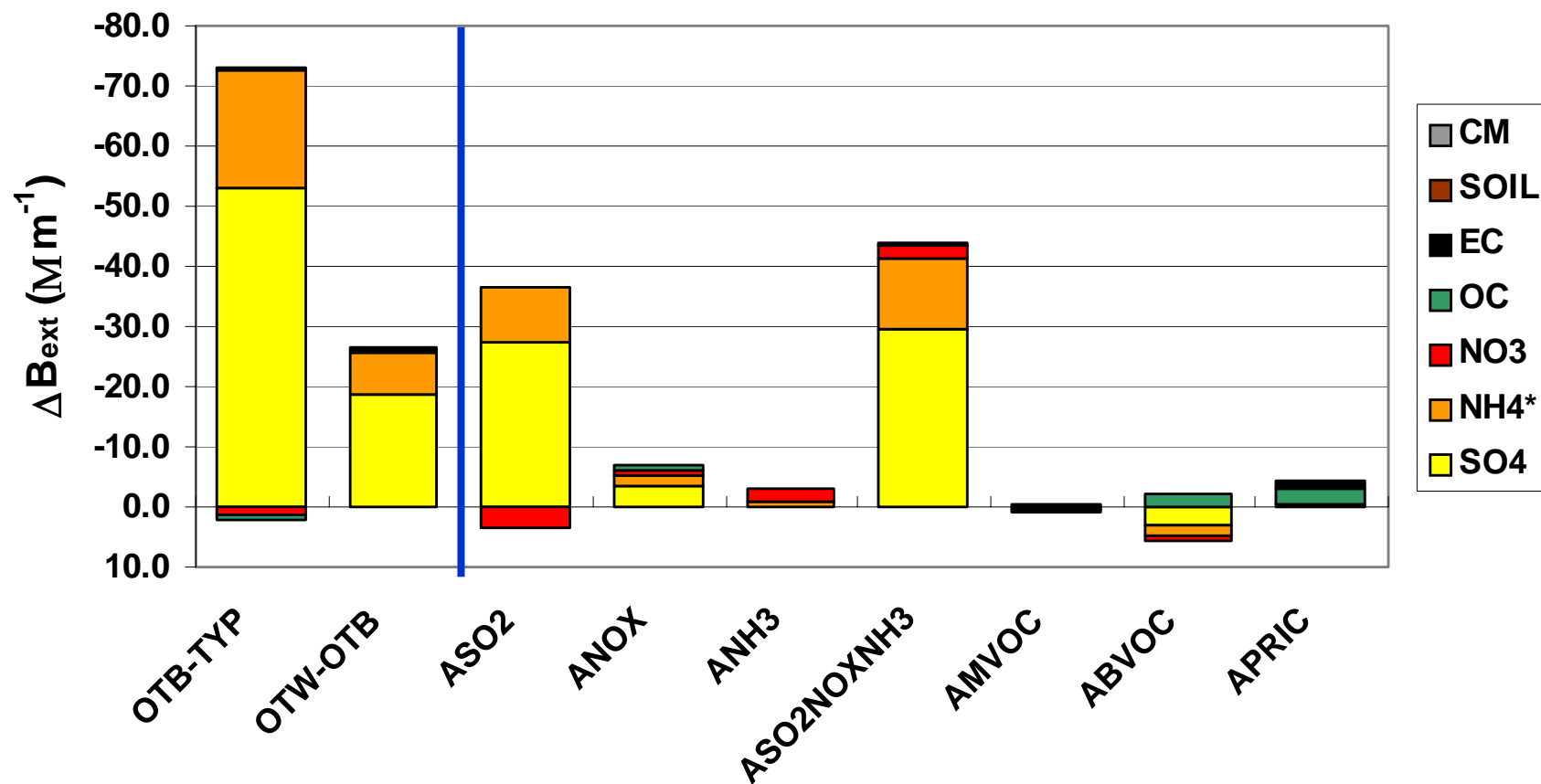
Mammoth Cave (KY) - 4 days

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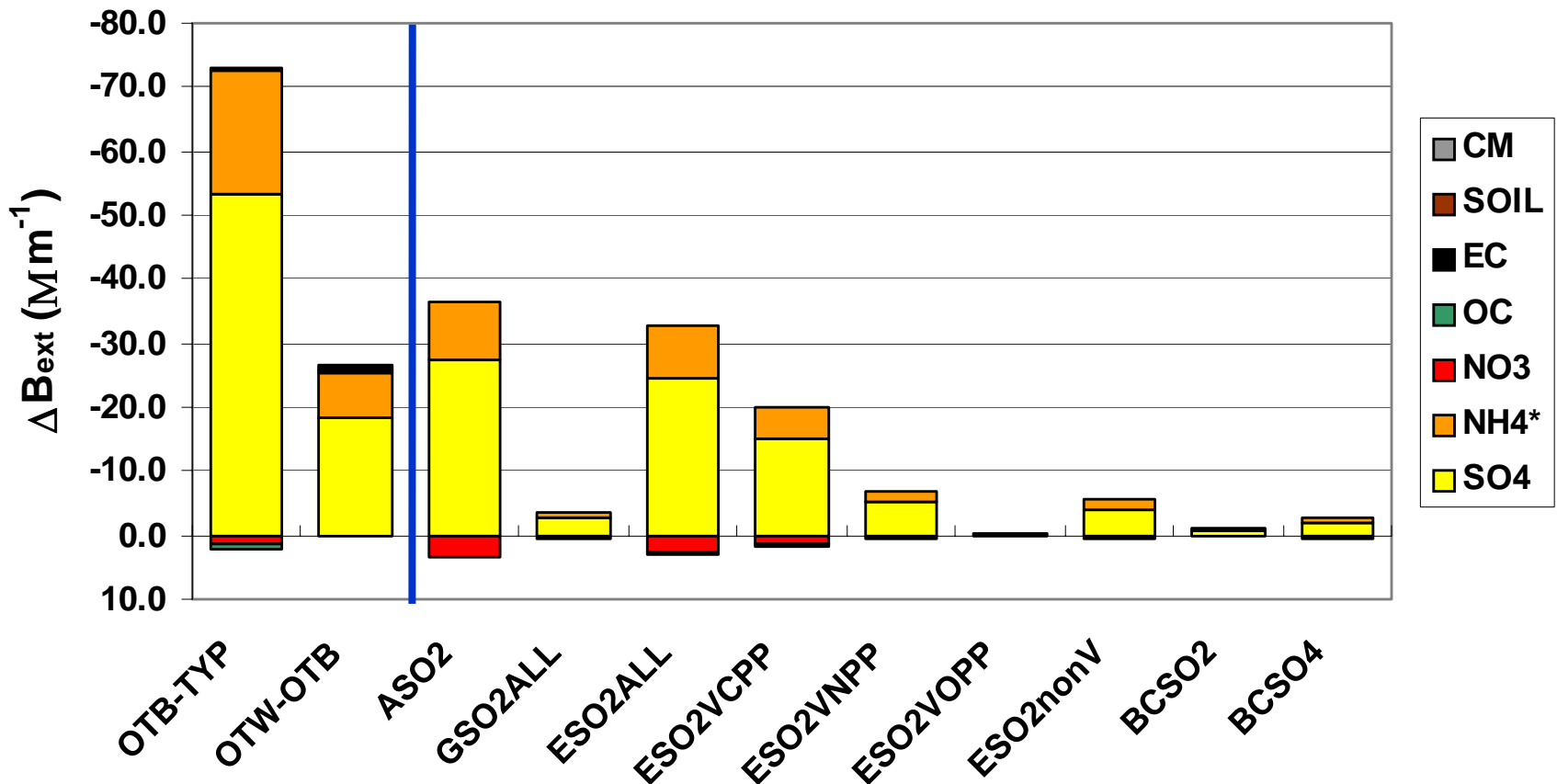
Great Smoky Mtns (TN) - 2 days

Weighted B_{ext} Response at Site to Reductions in
OTB Emissions: Worst 20%



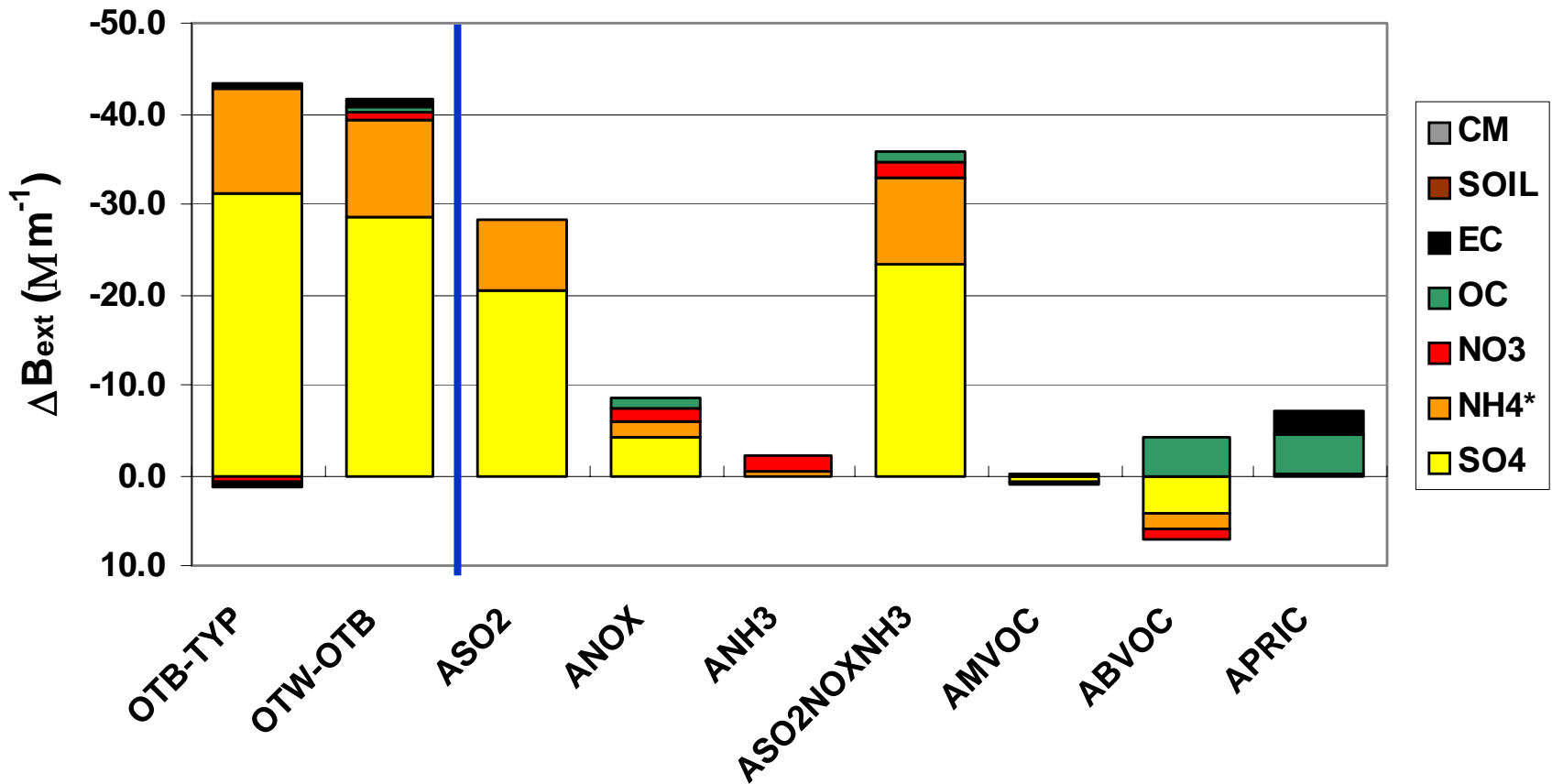
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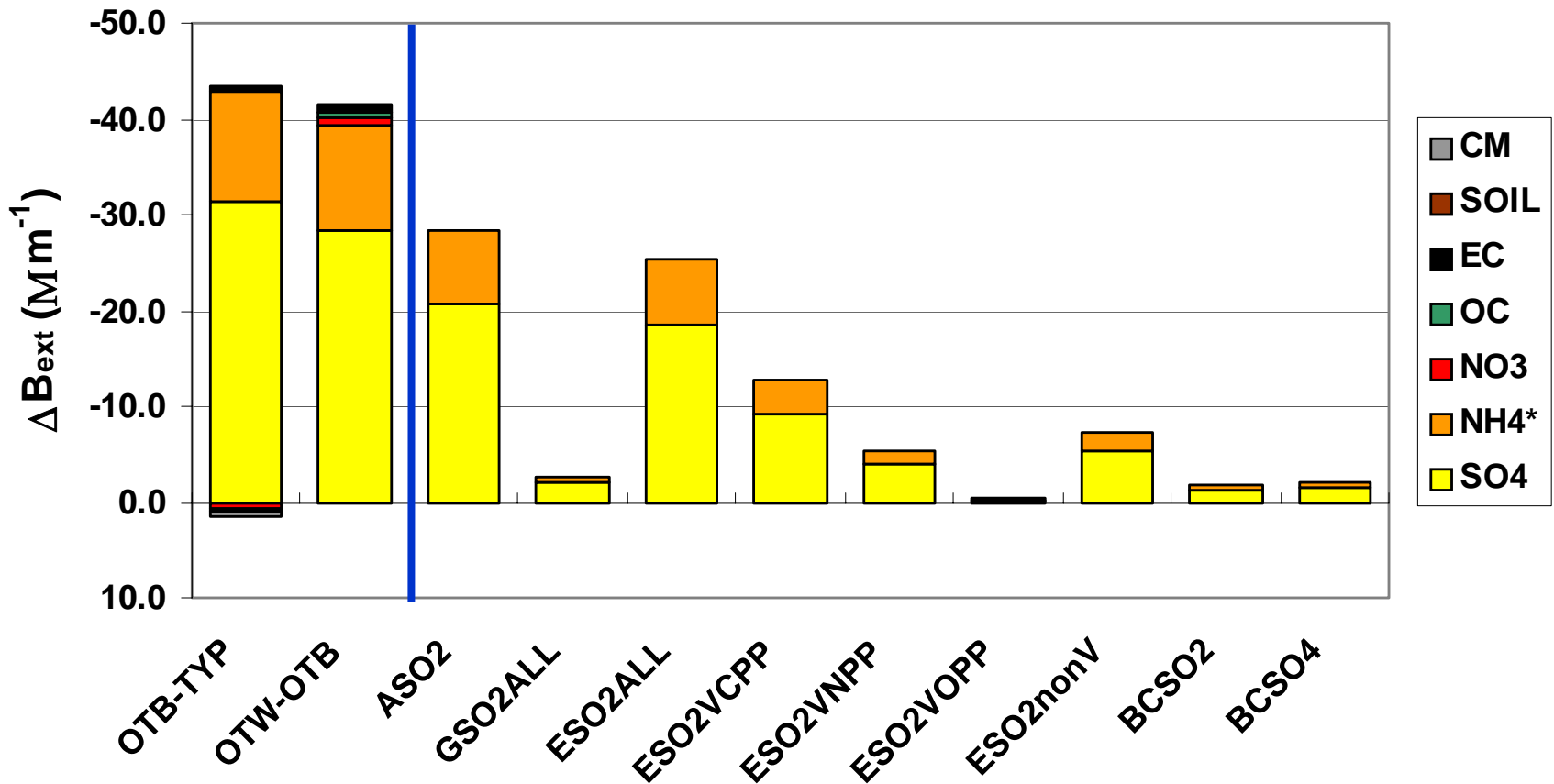
Sipsey (AL) – 3 days

Weighted B_{ext} Response at Site to Reductions in
OTB Emissions: Worst 20%



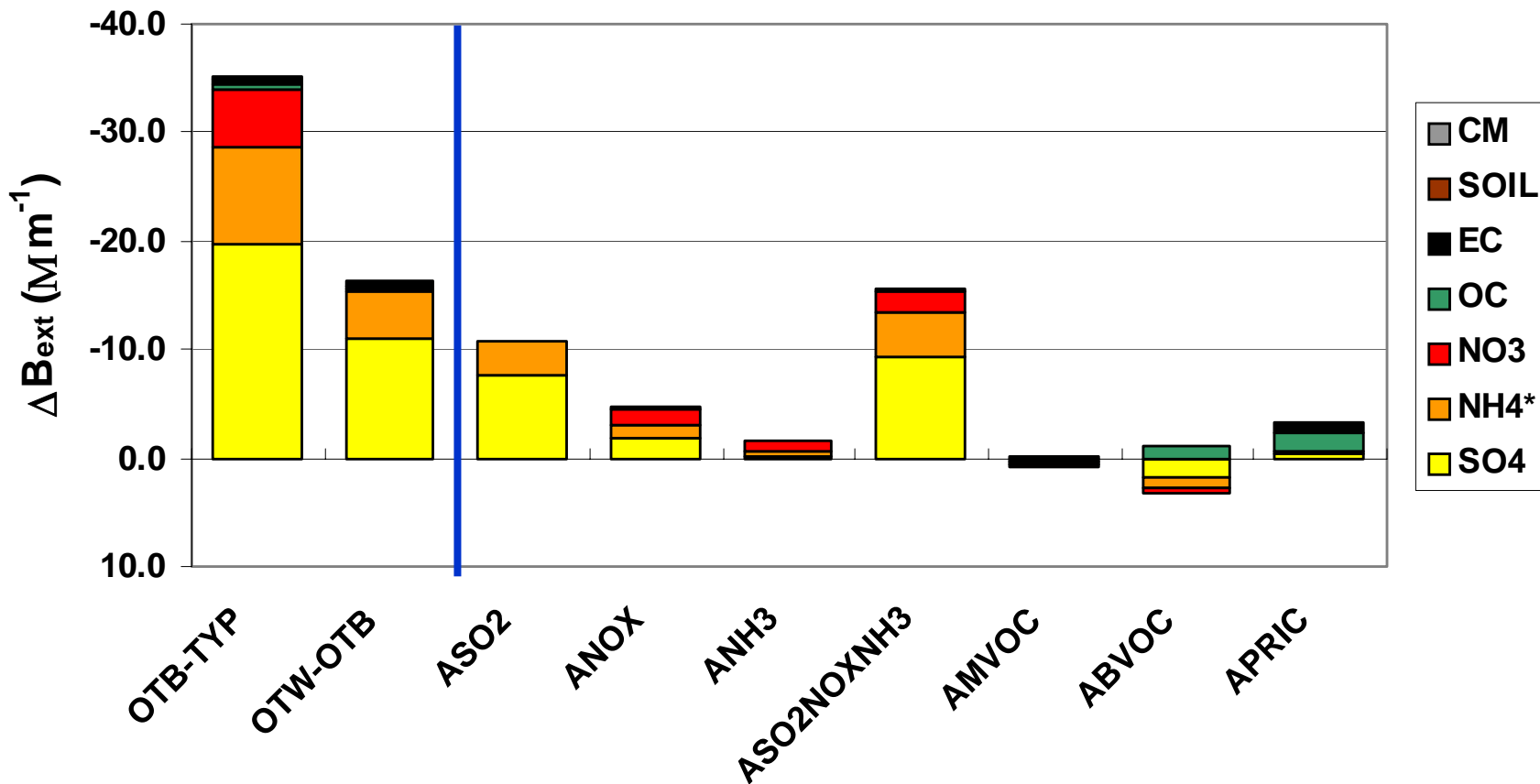
Sipsey (AL) - 3 days

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OTB Emissions: Worst 20%



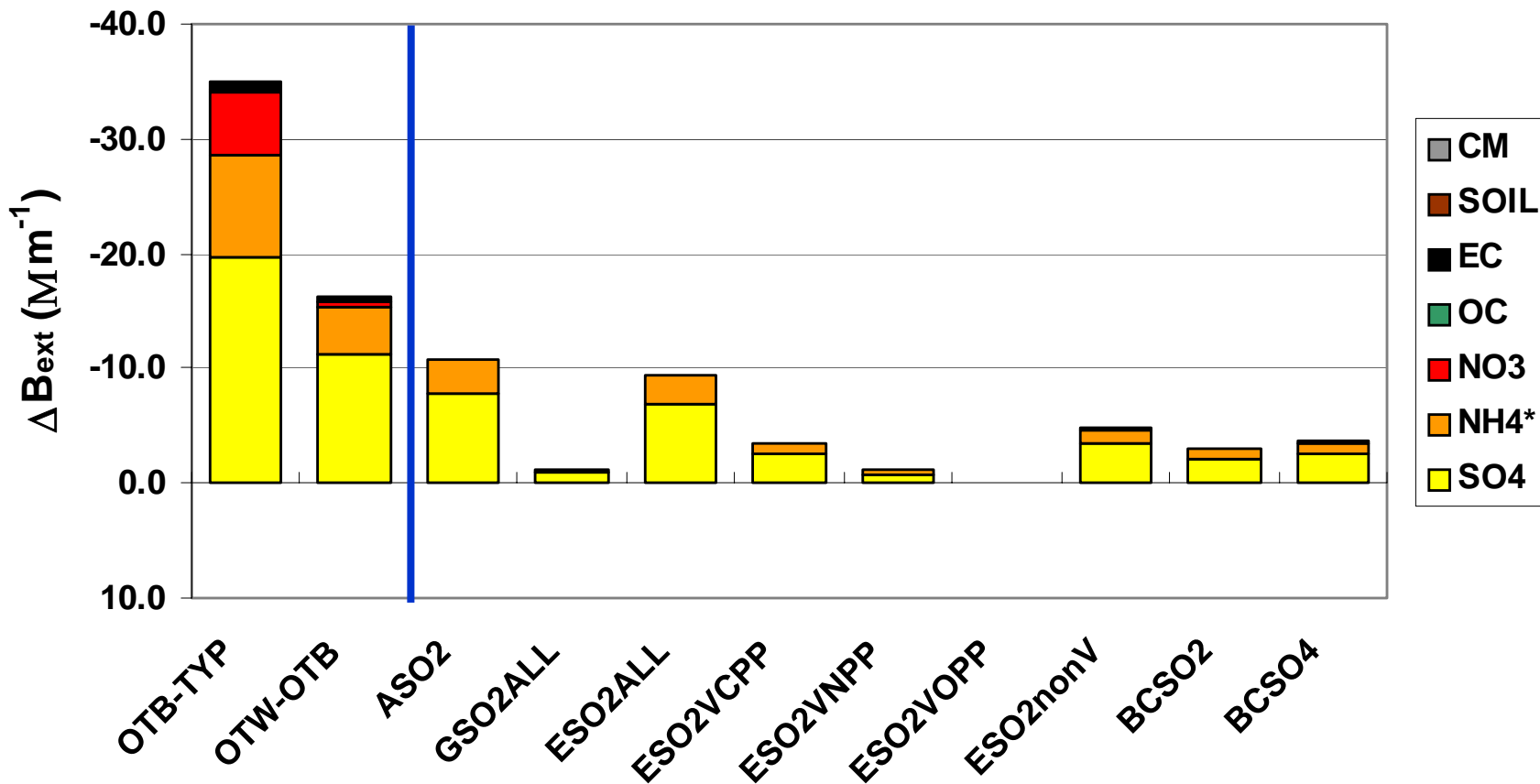
Shenandoah (VA) – 3 days

Weighted B_{ext} Response at Site to Reductions in
OTB Emissions: Worst 20%



Shenandoah (VA) – 3 days

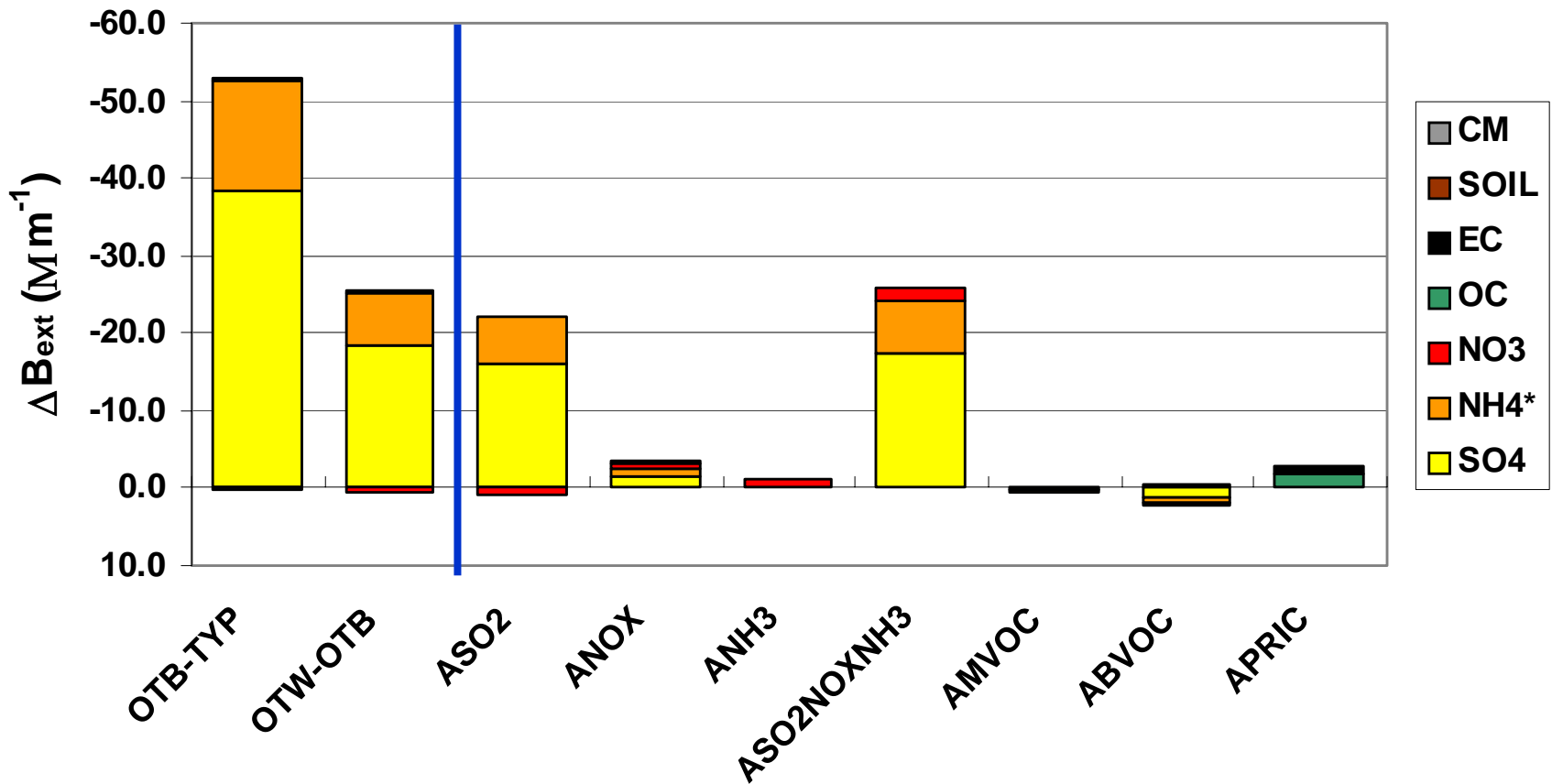
Weighted B_{ext} Response at Site to Reductions in
OTB Emissions: Worst 20%



Southern and Coastal Sites

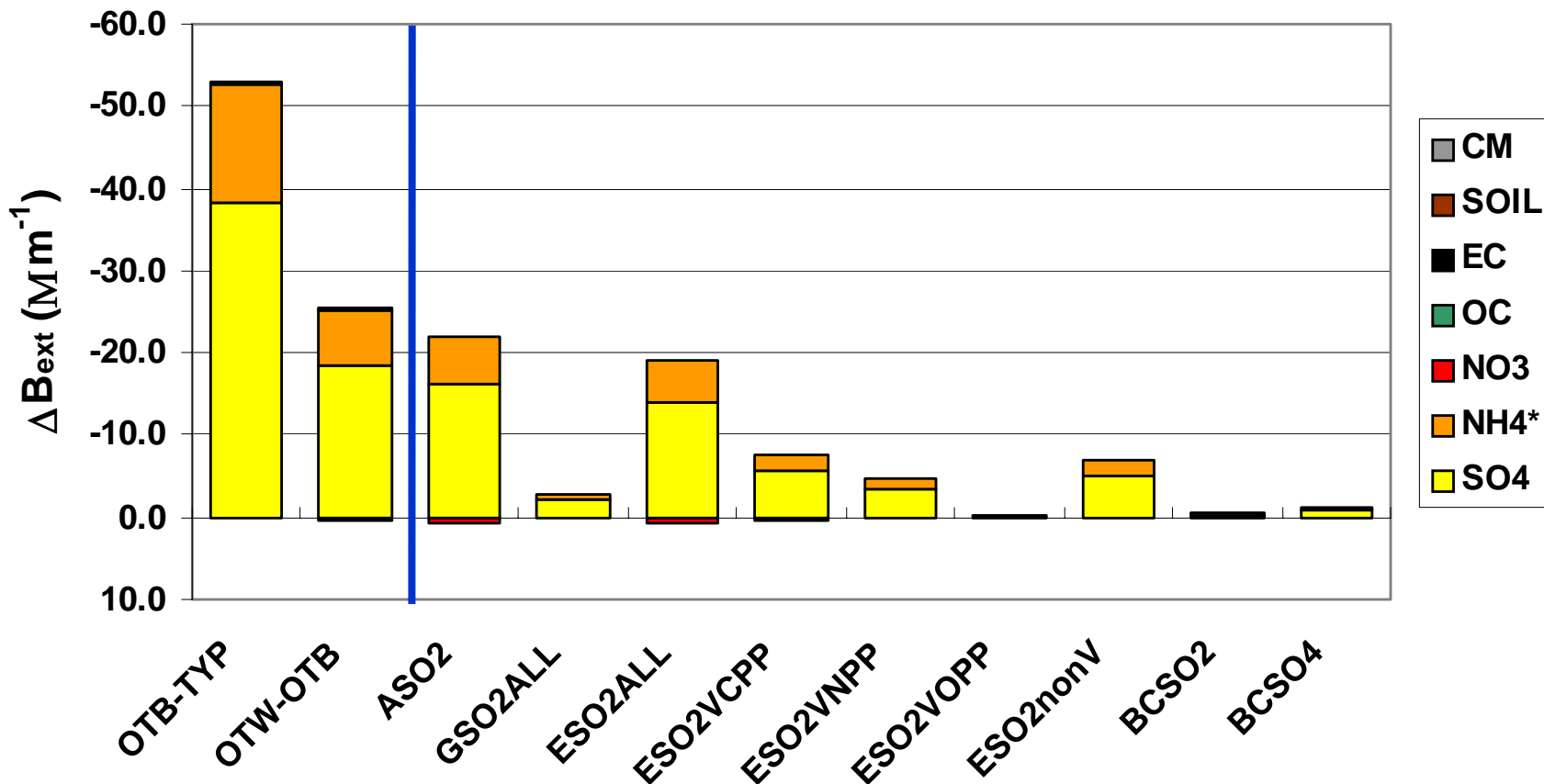
St. Marks (FL) – 2 days

Weighted B_{ext} Response at Site to Reductions in
OTB Emissions: Worst 20%



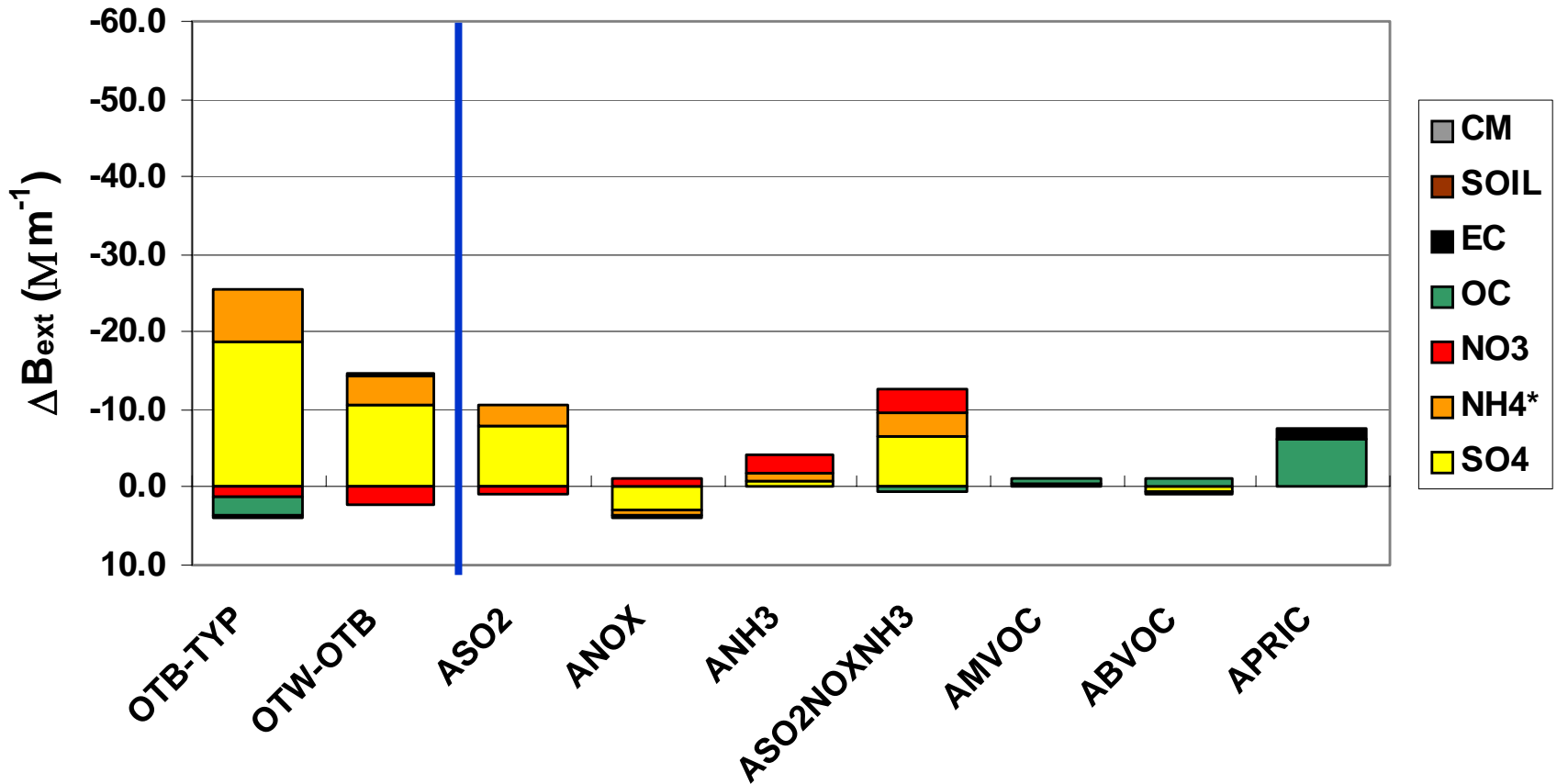
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OTB Emissions: Worst 20%



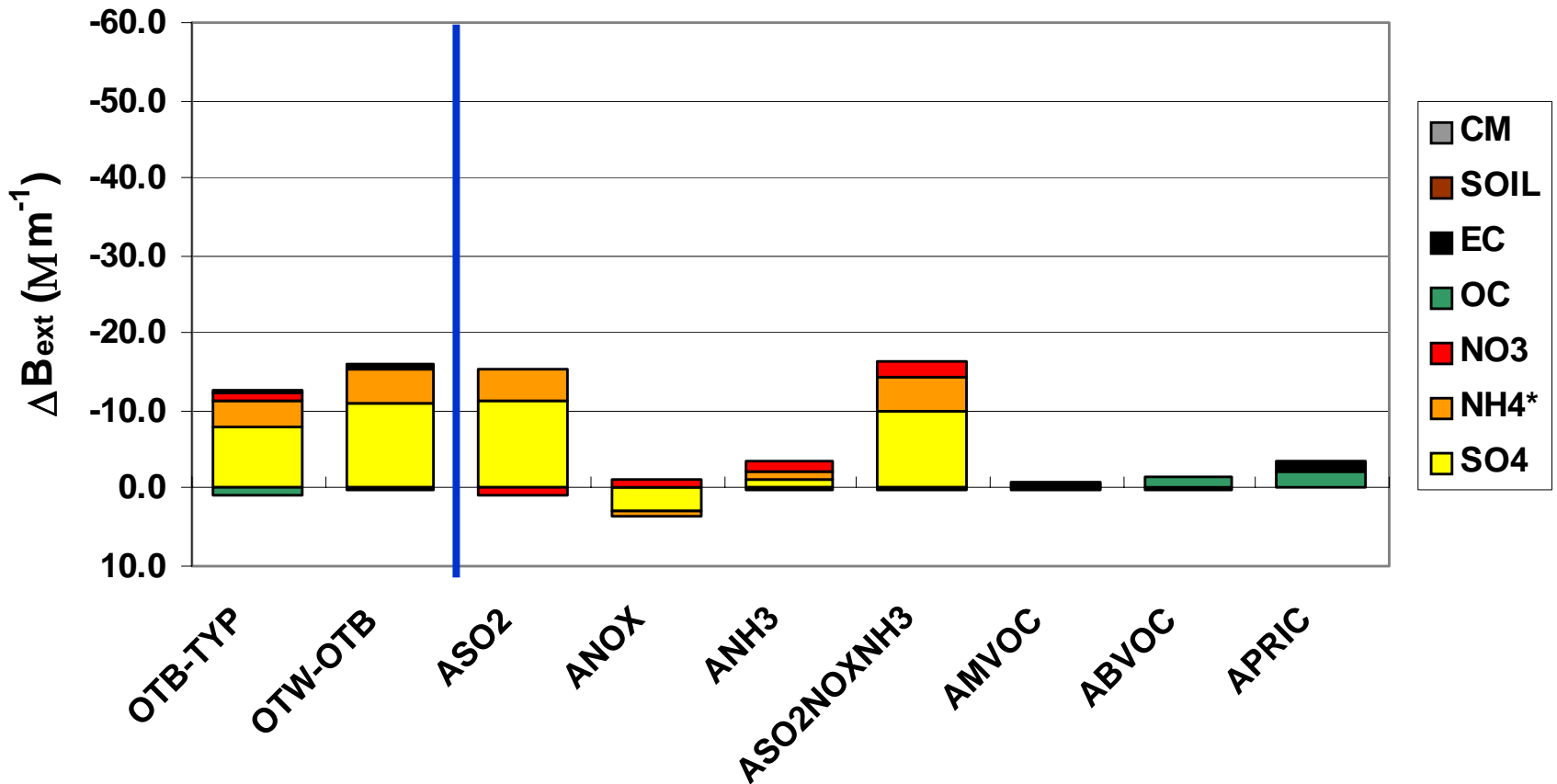
Chassahowitzka (FL) - 2 days

Weighted B_{ext} Response at Site to Reductions in
OTB Emissions: Worst 20%



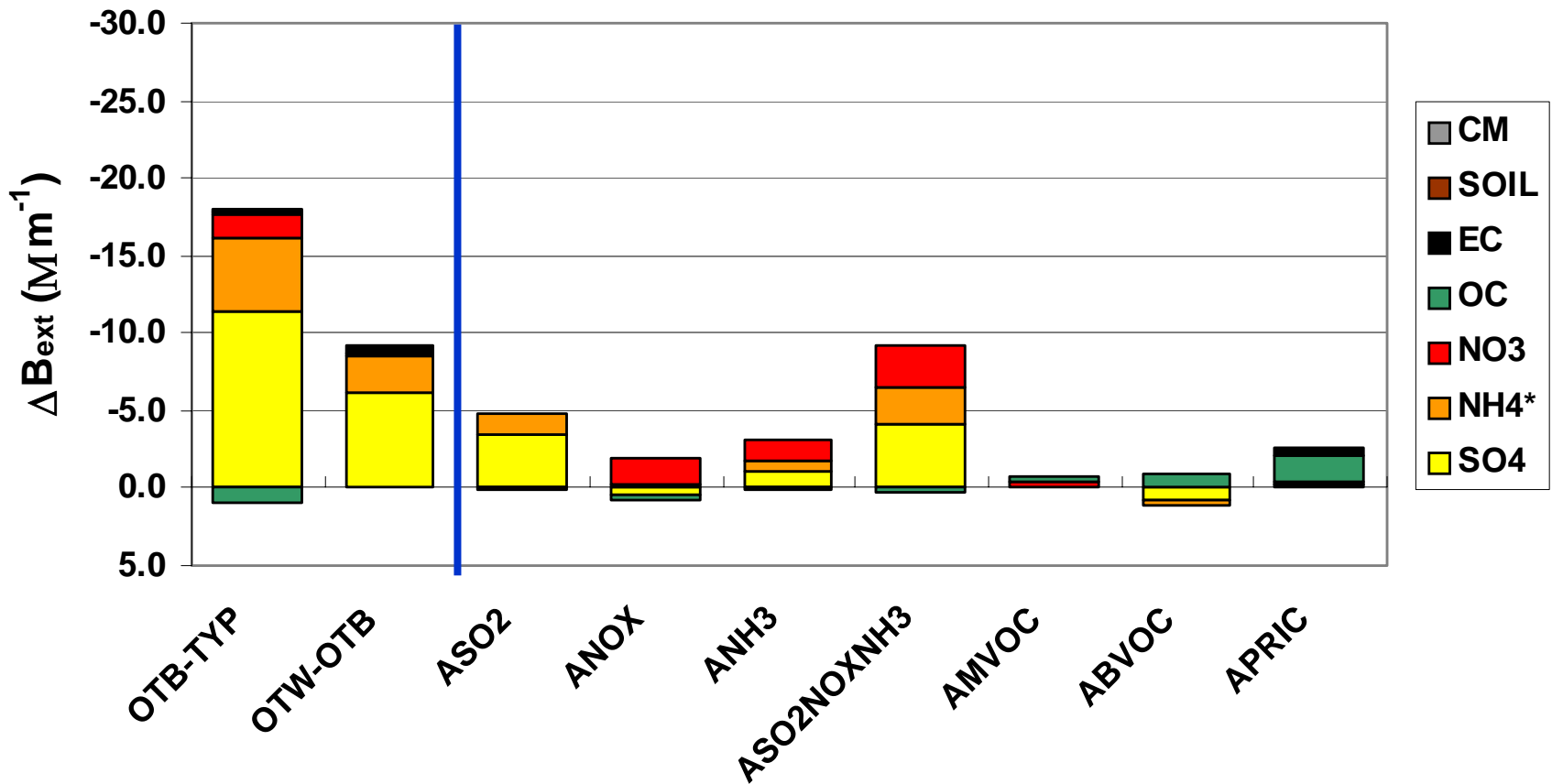
Cape Romain (SC) - 2 days

Weighted B_{ext} Response at Site to Reductions in
OTB Emissions: Worst 20%



Swanquarter (NC) – 3 days

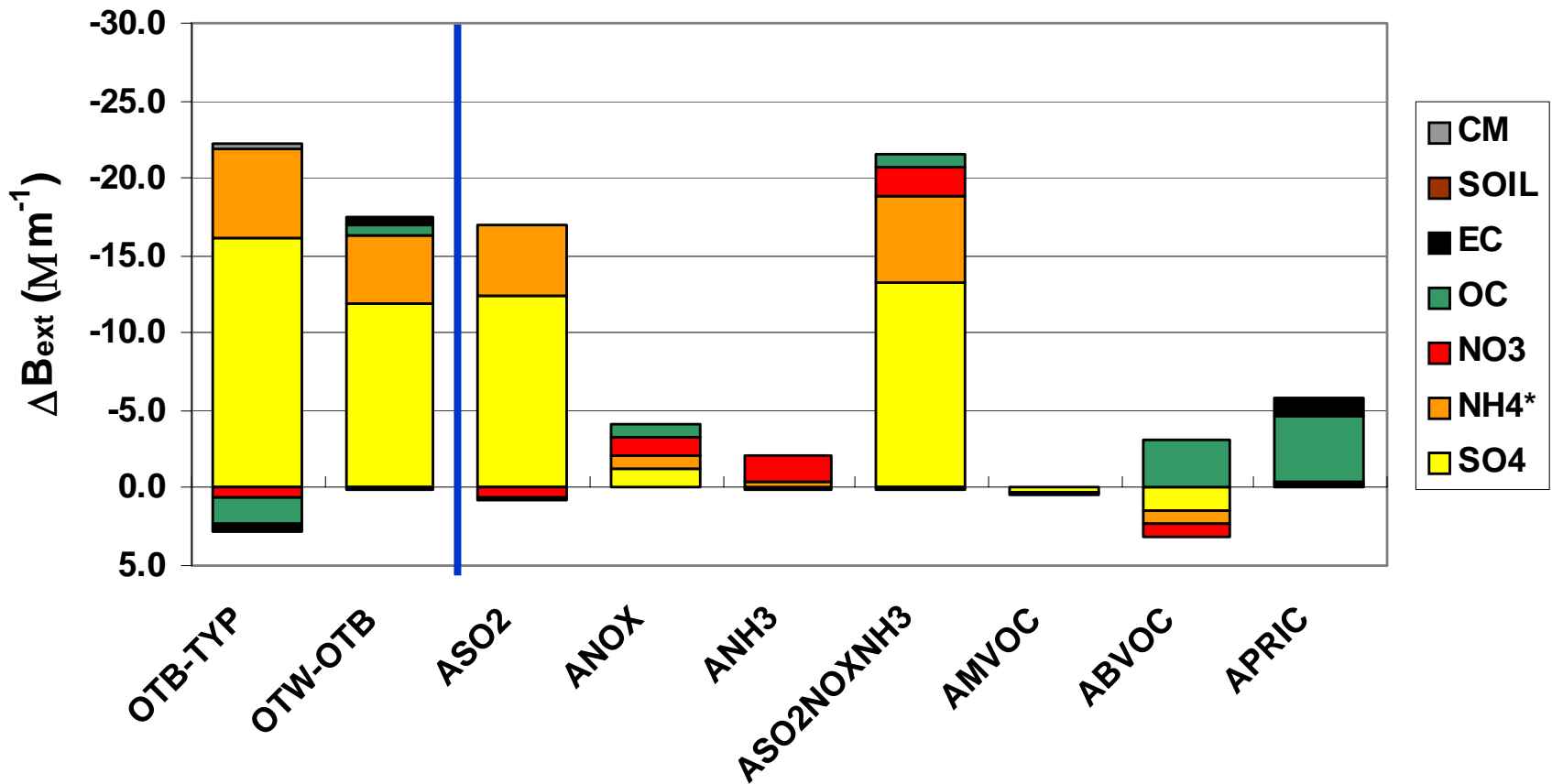
Weighted B_{ext} Response at Site to Reductions in
OTB Emissions: Worst 20%



Non-VISTAS Sites

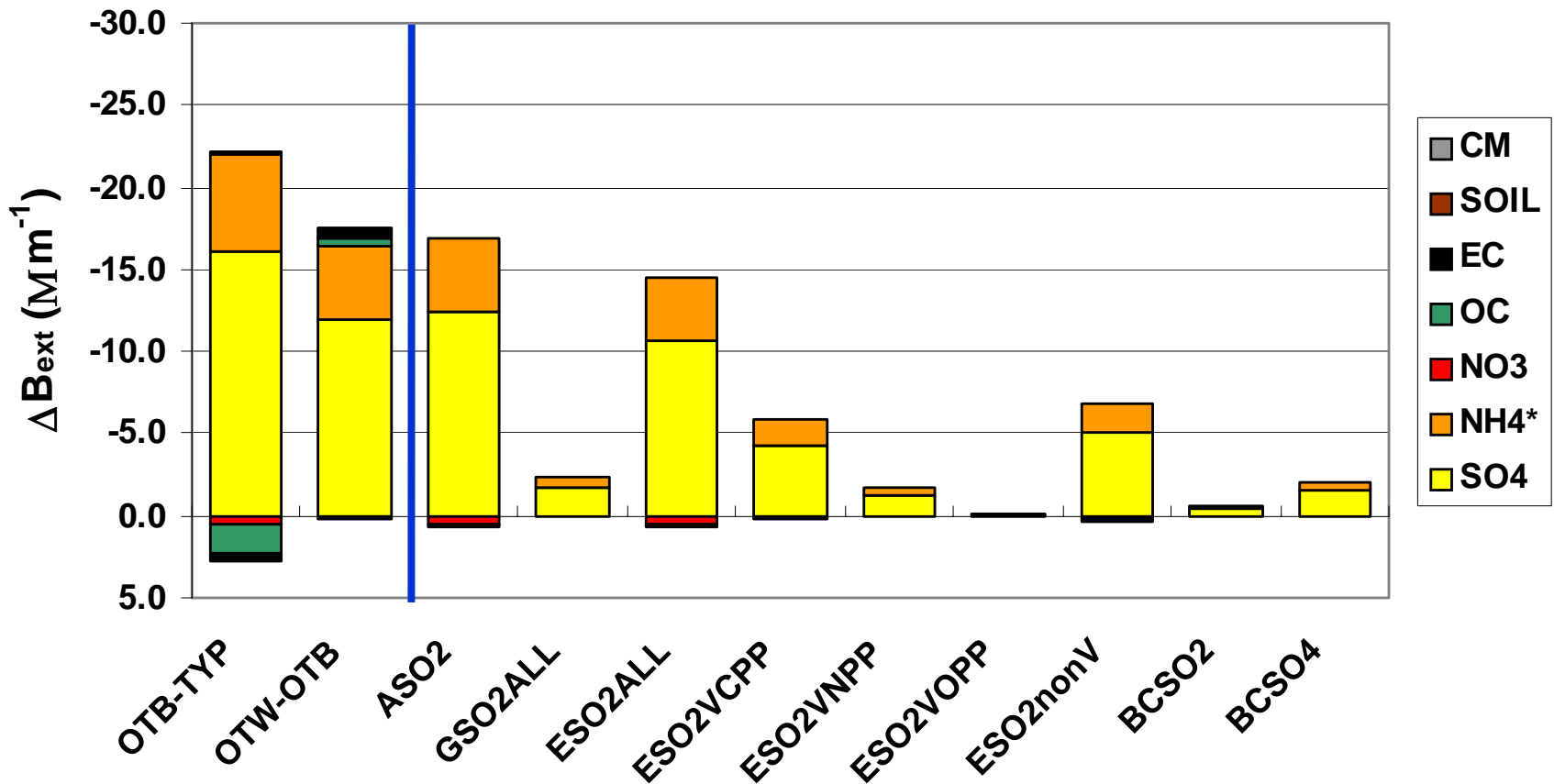
Caney Creek (AR) - 5 days

Weighted B_{ext} Response at Site to Reductions in
OTB Emissions: Worst 20%



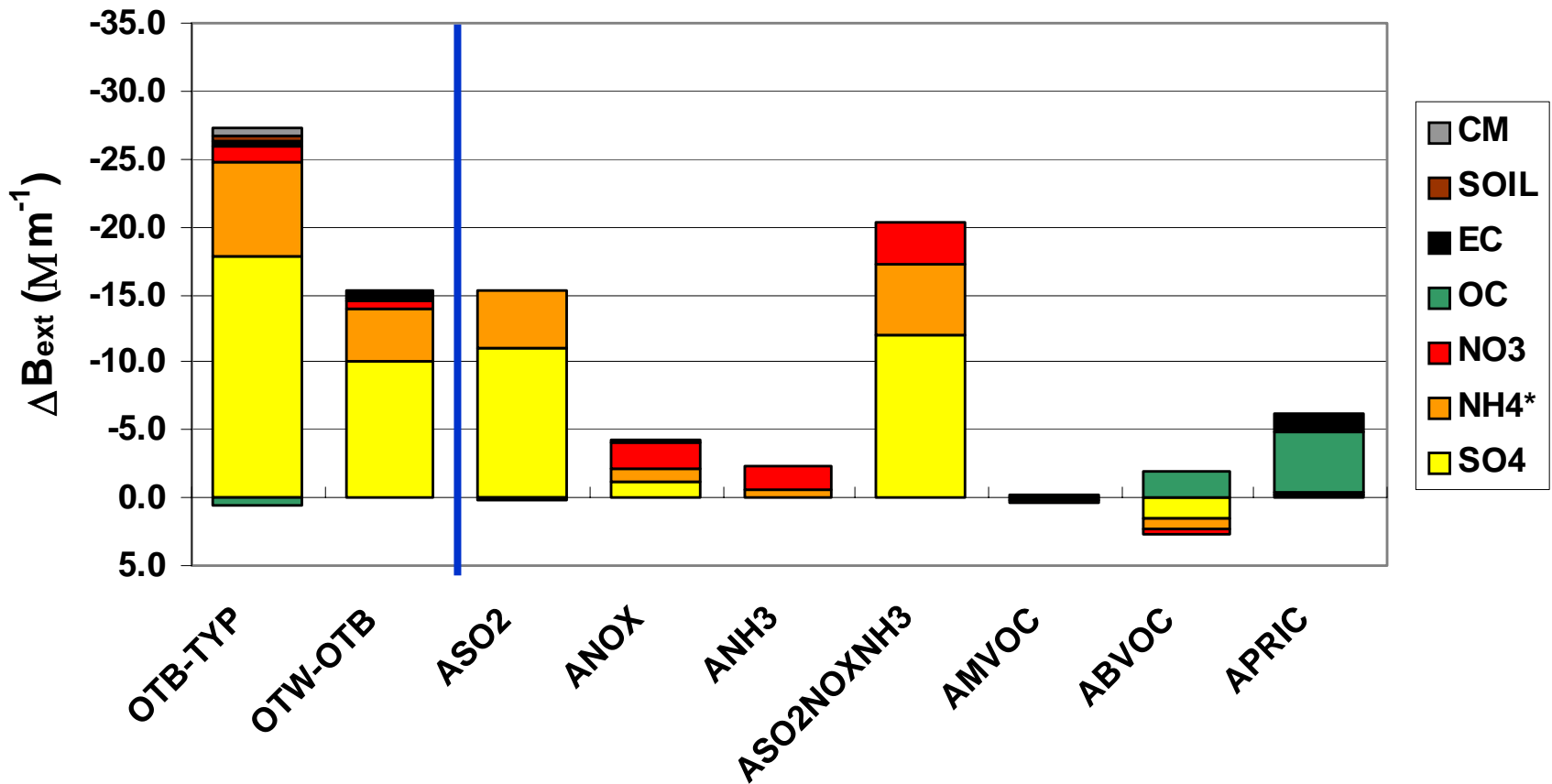
Caney Creek (AR) - 5 days

Weighted B_{ext} Response at Site to Reductions in
OTB Emissions: Worst 20%



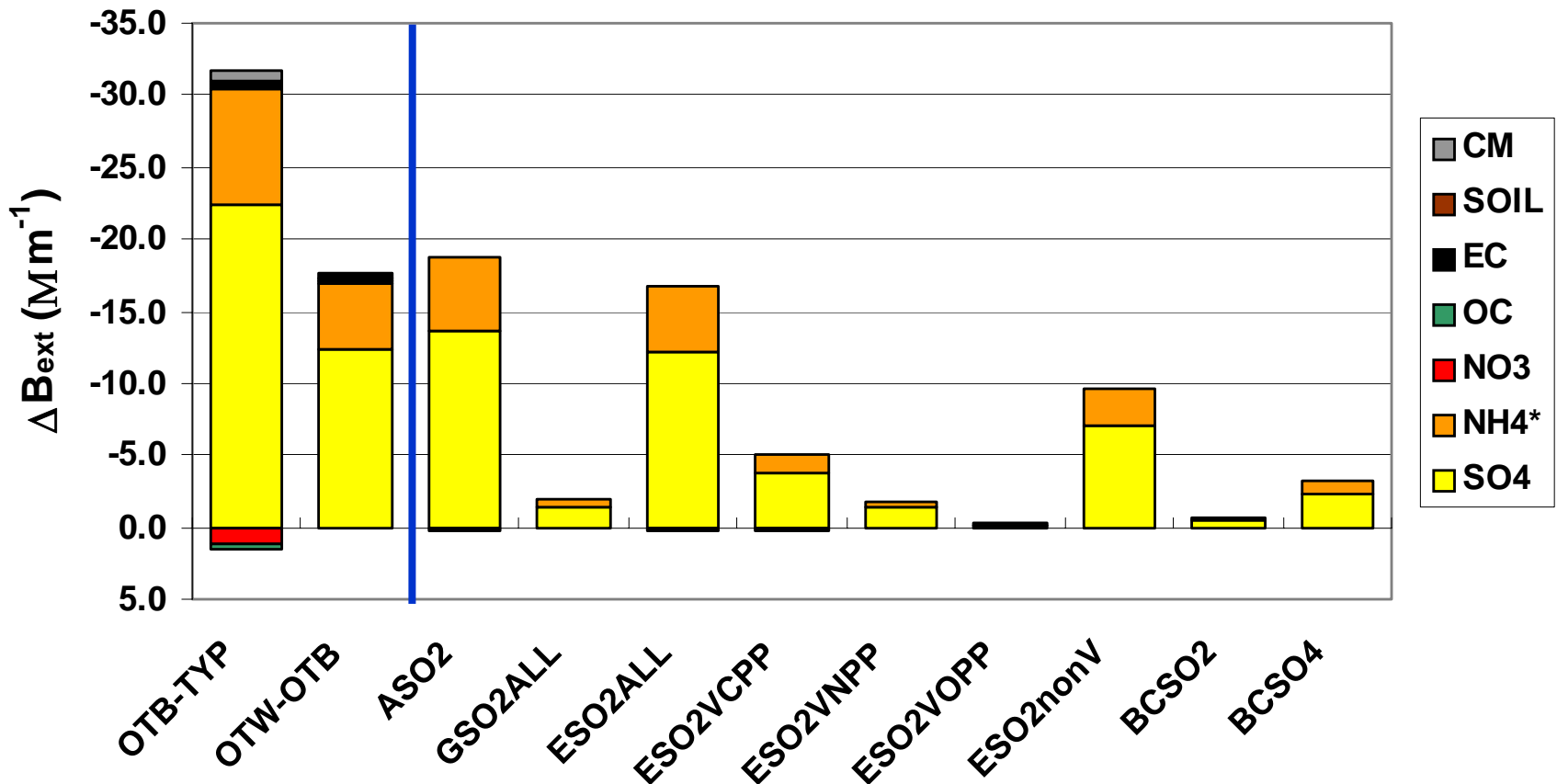
Hercules Glades (MO) - 5 days

Weighted B_{ext} Response at Site to Reductions in
OTB Emissions: Worst 20%



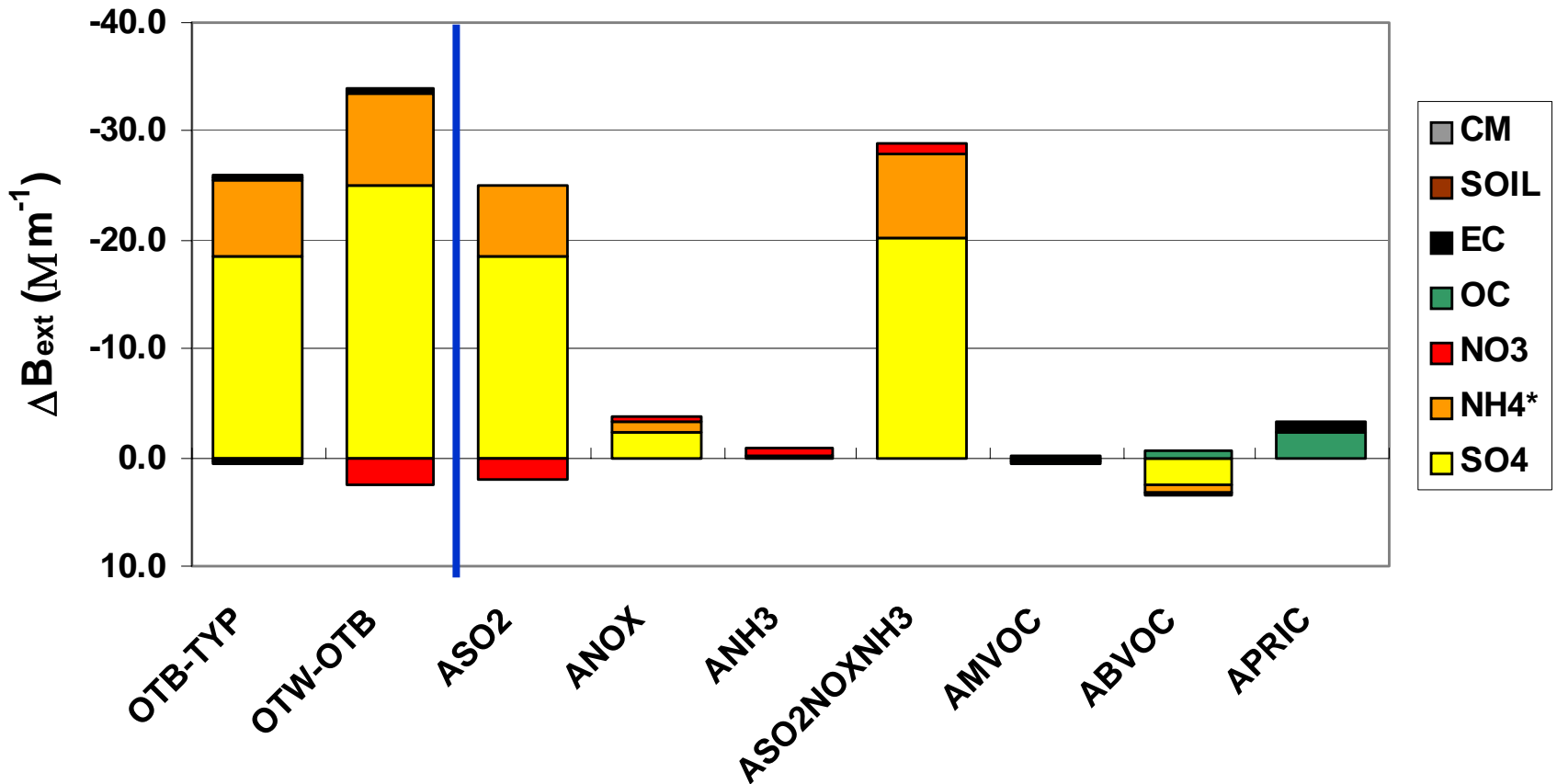
Hercules Glades (MO) - 4 days

Weighted B_{ext} Response at Site to Reductions in
OTB Emissions: Worst 20%



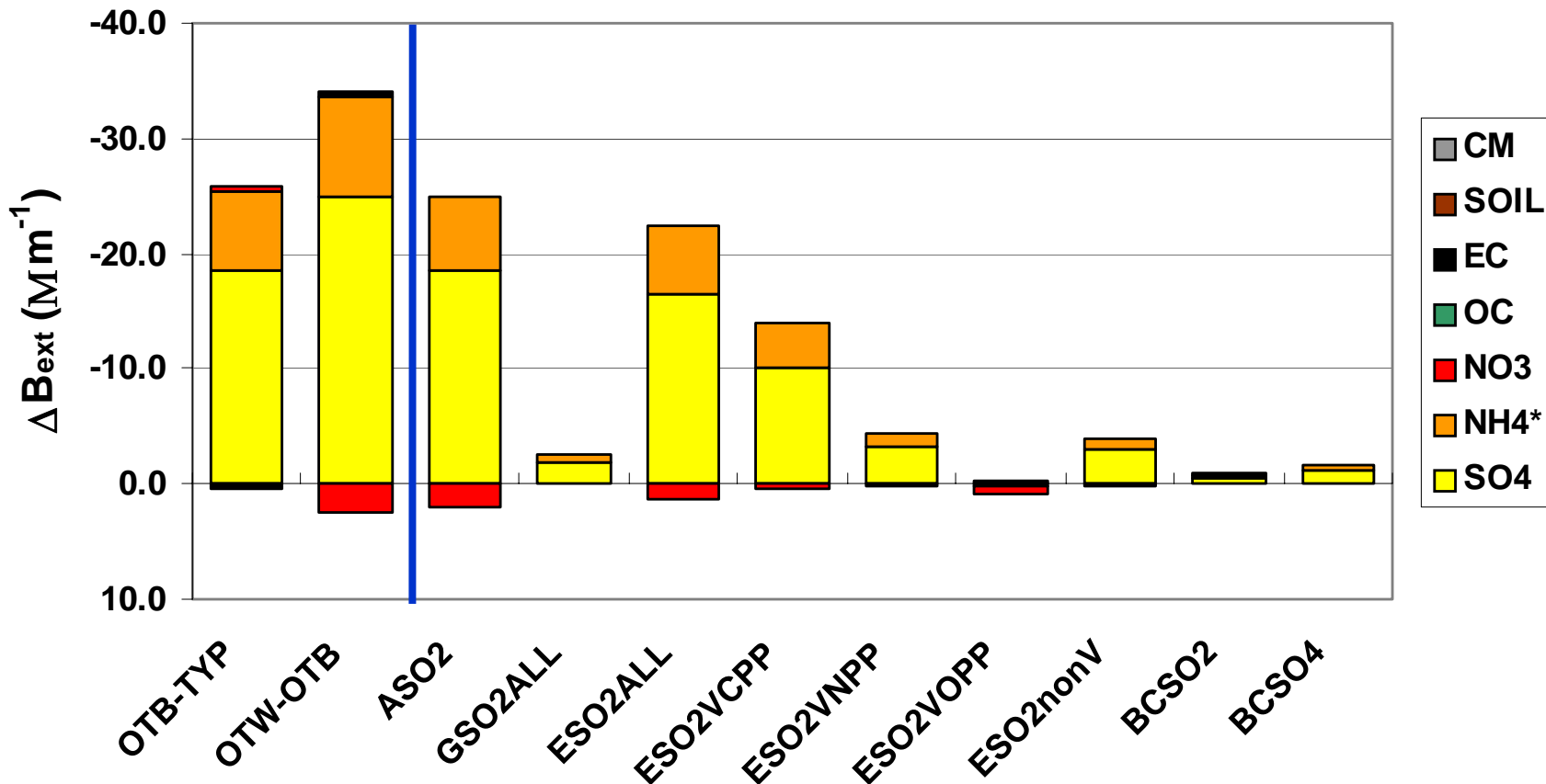
Breton (LA) - 2 days

Weighted B_{ext} Response at Site to Reductions in
OTB Emissions: Worst 20%



Breton (LA) - 2 days

Weighted B_{ext} Response at Site to Reductions in
OTB Emissions: Worst 20%



Preliminary Observations and Conclusions

20% Worst Days

- SO₂ reductions showed the largest benefits at all sites
- NO_x and Primary Carbon sensitivities show the second largest benefits at most sites
- NH₃ sensitivities had significantly smaller impacts on visibility
- Manmade and biogenic VOC sensitivities showed negligible changes in visibility

20 % Worst Days

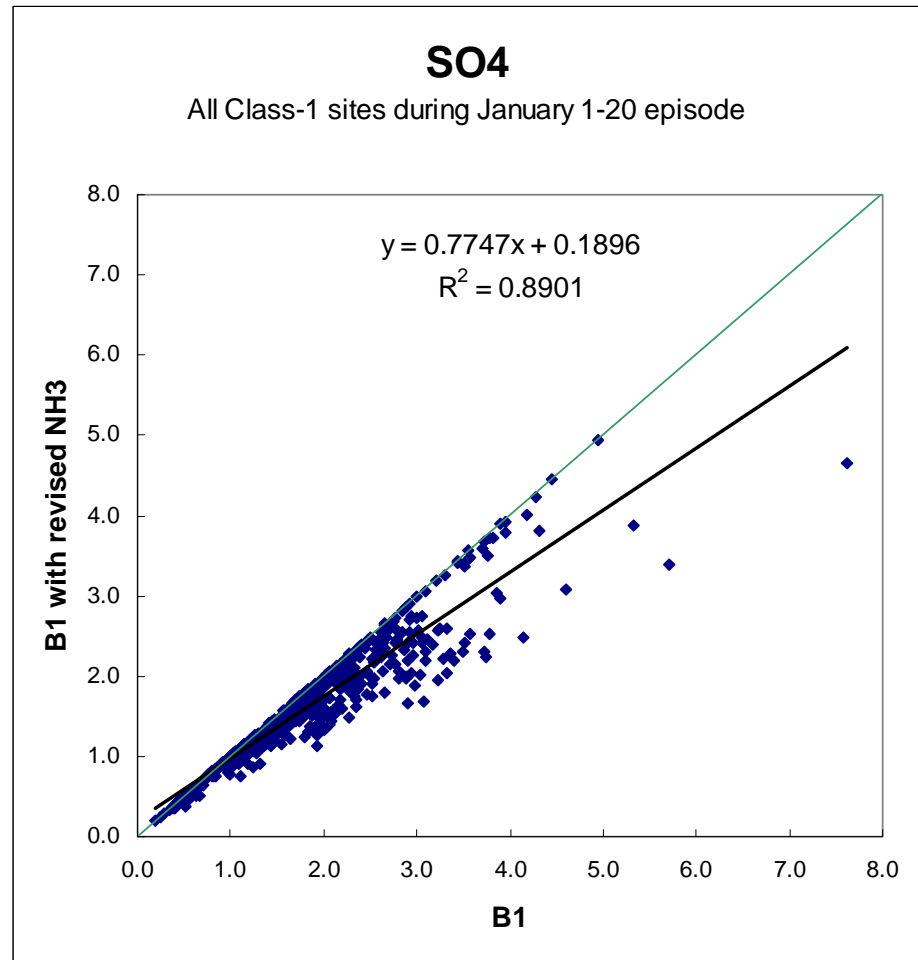
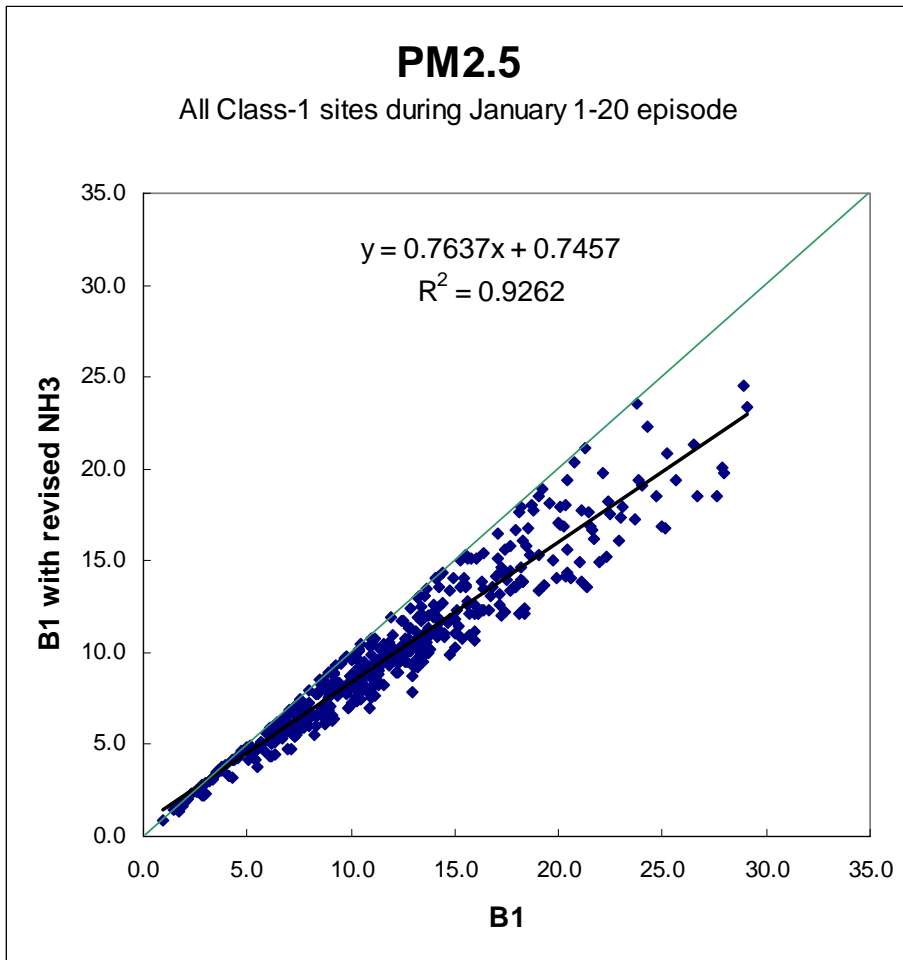
- Reductions in elevated SO₂ point sources were significantly more effective than ground level SO₂ sources
- Of these elevated SO₂ sources, VISTAS coal fired power plants (CPP) showed the most benefit in the VISTAS Class I areas
 - VISTAS non-power plant (NPP) SO₂ and non-VISTAS Elevated Point SO₂ each showed about 25% of the VISTAS CPP response
- In the Non-VISTAS Class I areas (except BRET), non-VISTAS Elevated Point SO₂ showed greatest response followed by VISTAS CPP
 - Transport from outside 12 km domain more important

Revised NH₃ Sensitivities

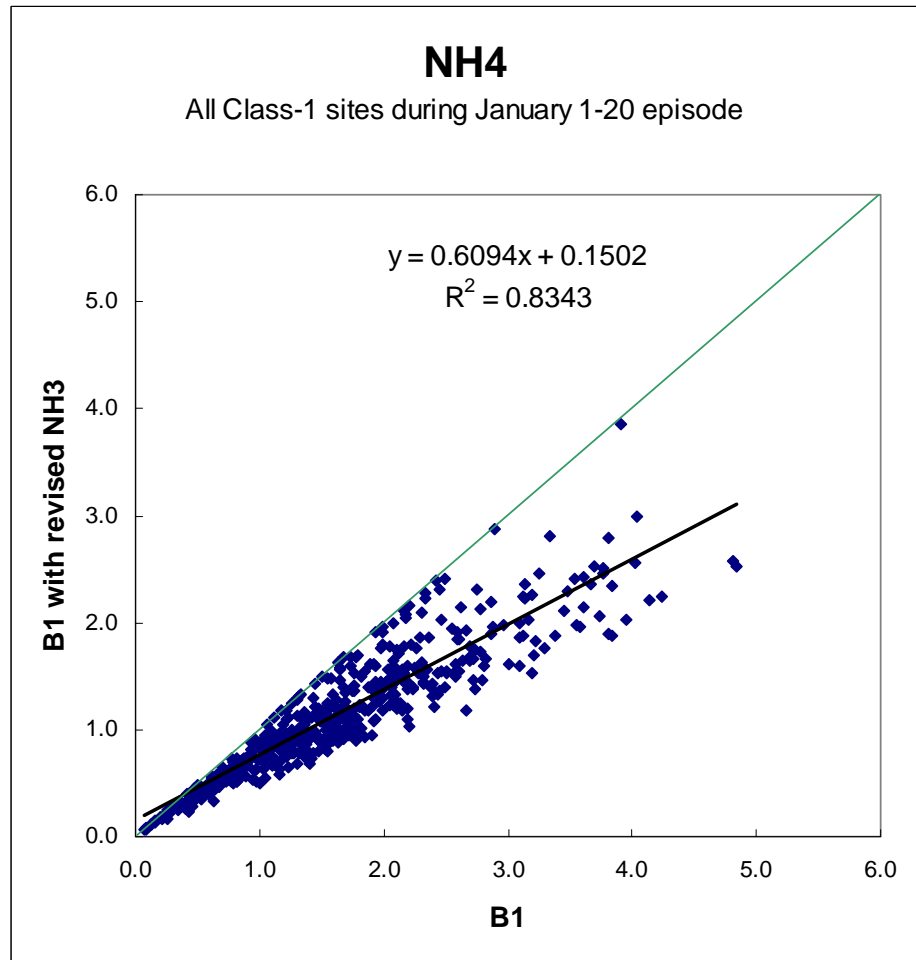
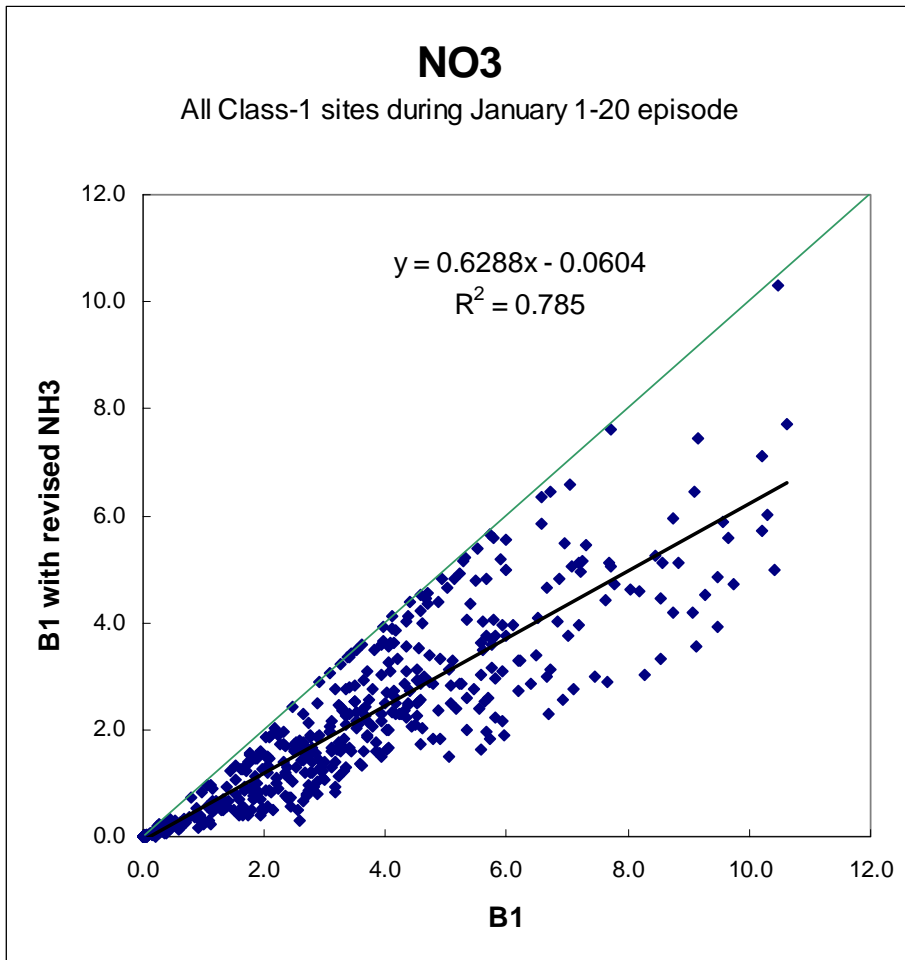
Revised NH₃ Sensitivities

- Purpose was to evaluate how the scaled model responses changed with more accurate NH₃ emissions in the January episode
- New emission profiles show that NH₃ emissions should be approximately 60% lower
 - Reduced NH₃ emissions on a state-by-state basis
 - Boundary NH₃ and NH₄ unchanged
- New Simulations
 - 2002 actual, 2002 typical, 2018 OTB
 - 30% SO₂, 30% NO_x, 30% NH₃

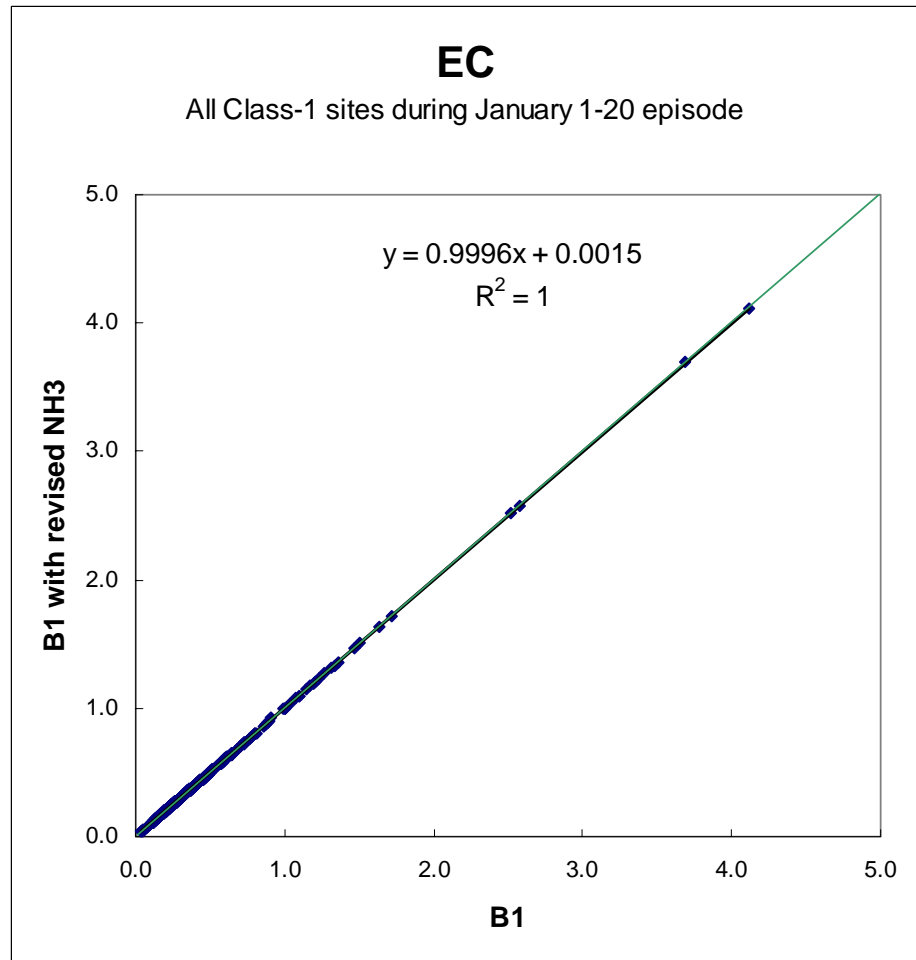
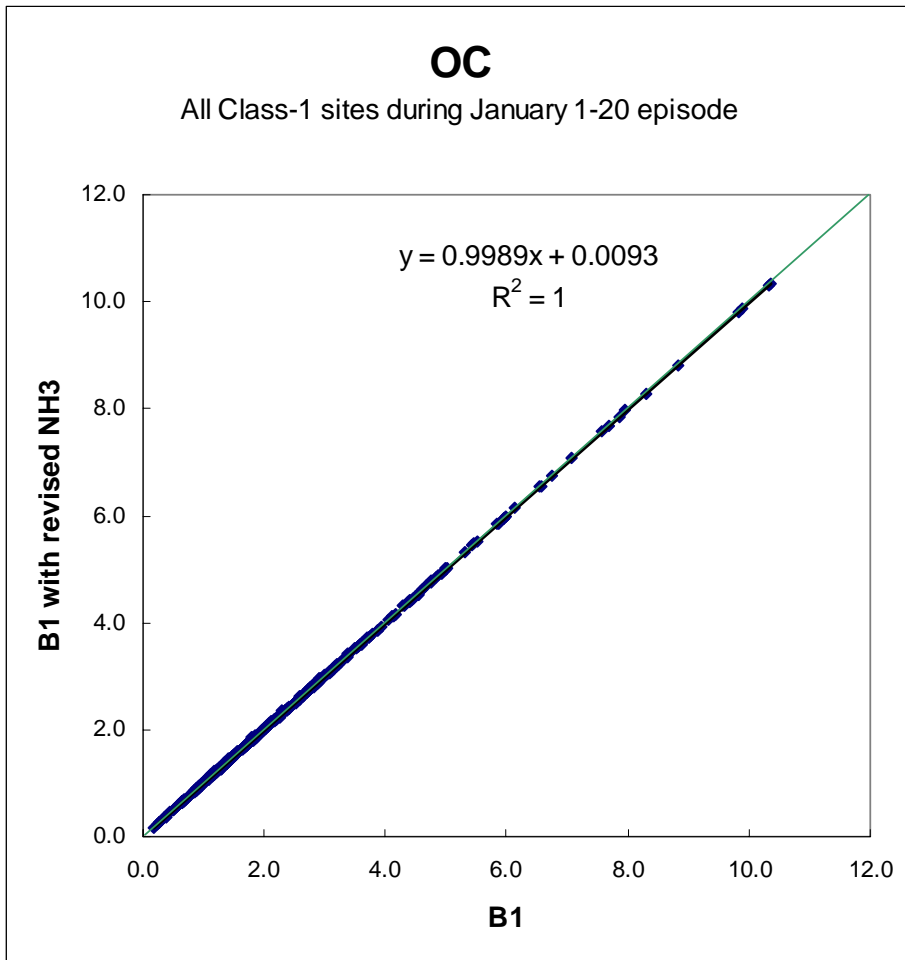
OTB vs. OTB with Revised NH₃



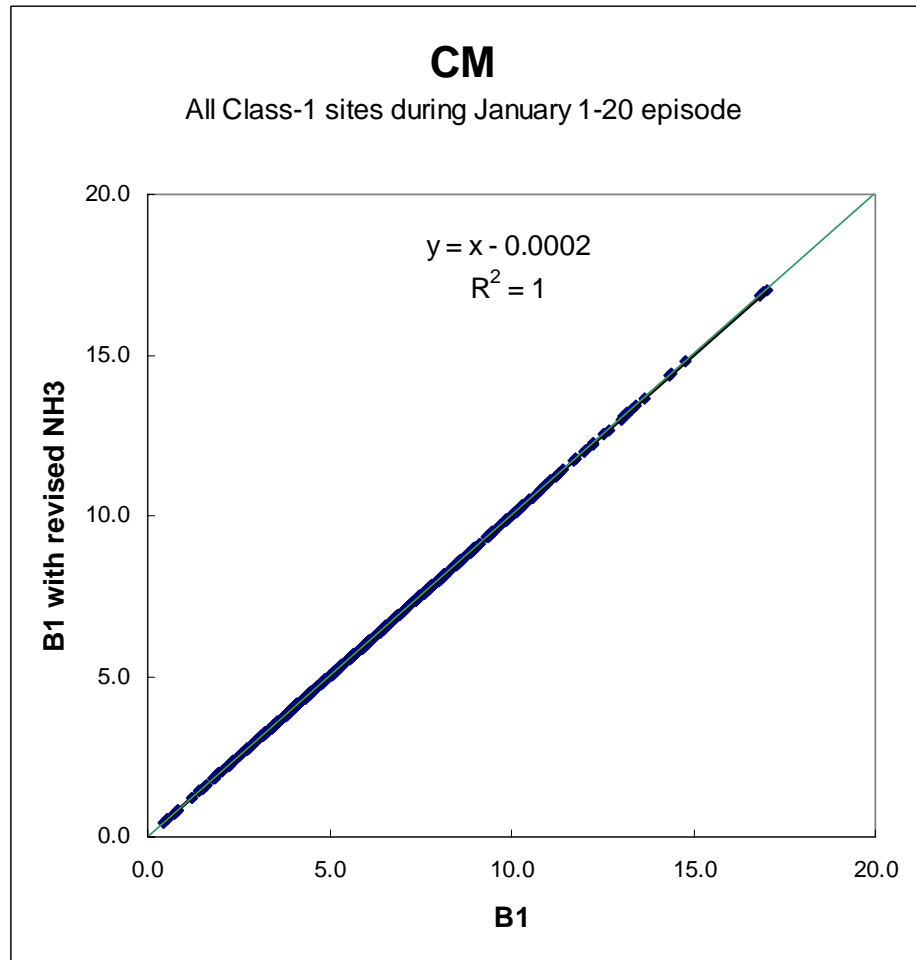
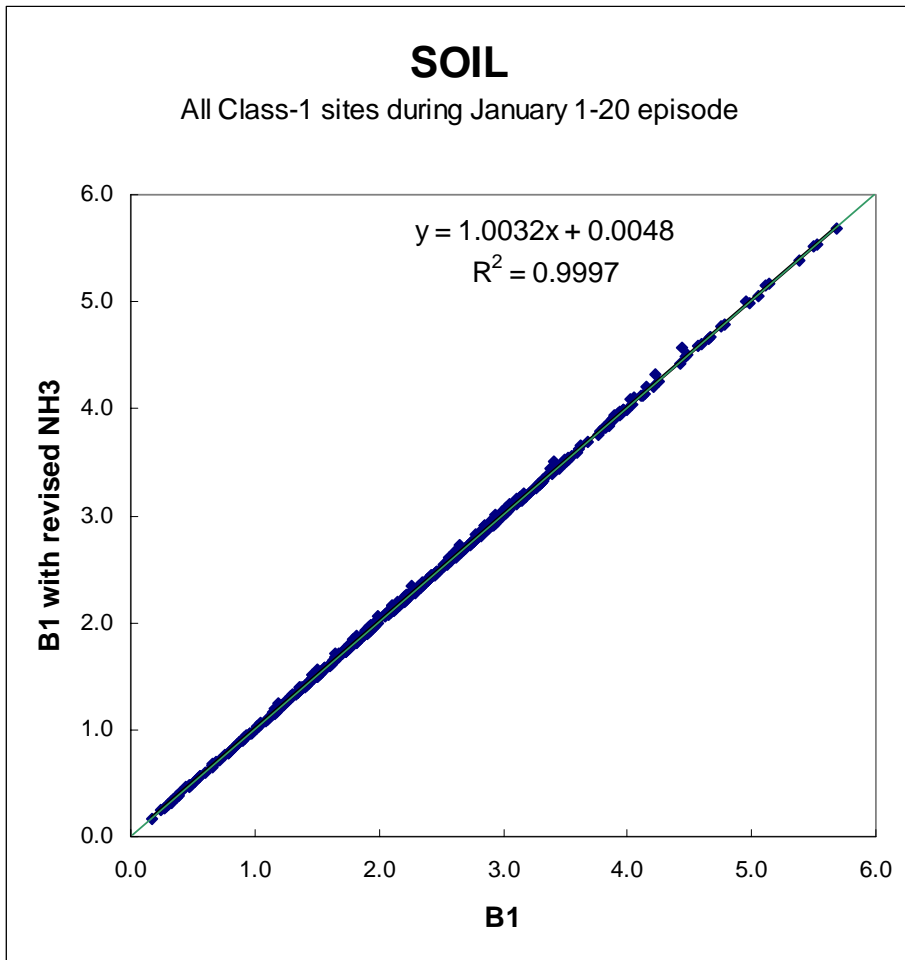
OTB vs. OTB with Revised NH₃



OTB vs. OTB with Revised NH₃

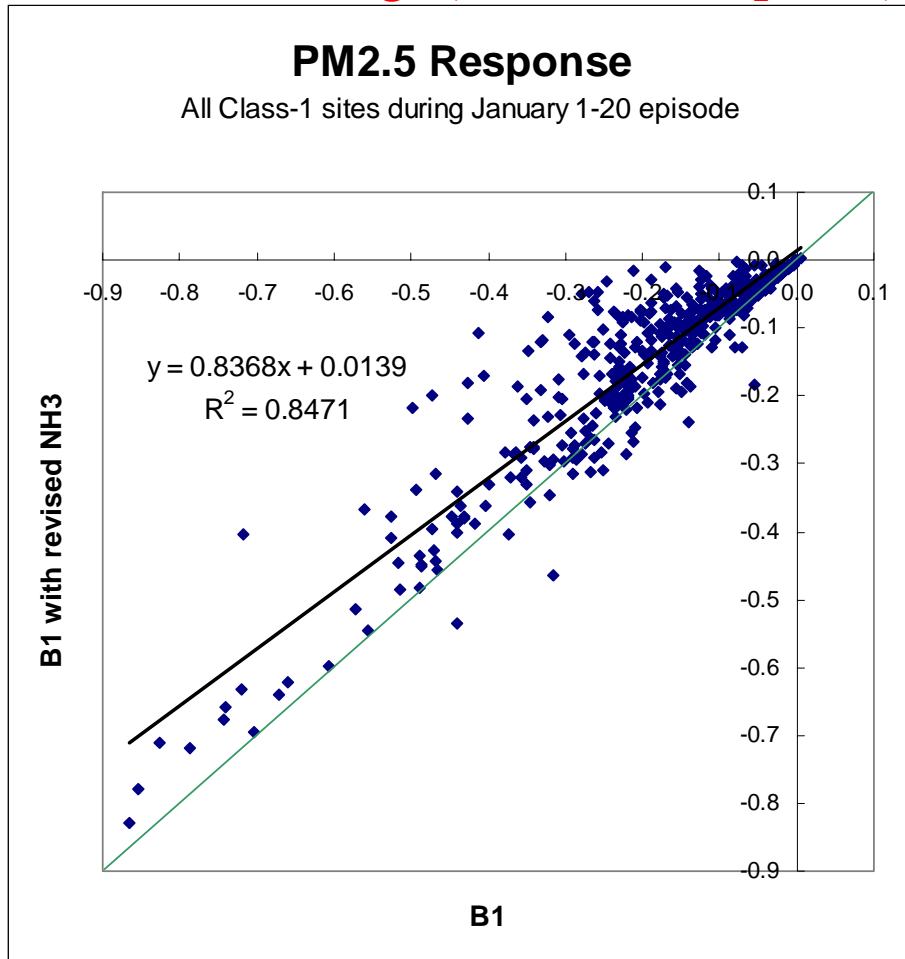


OTB vs. OTB with Revised NH₃

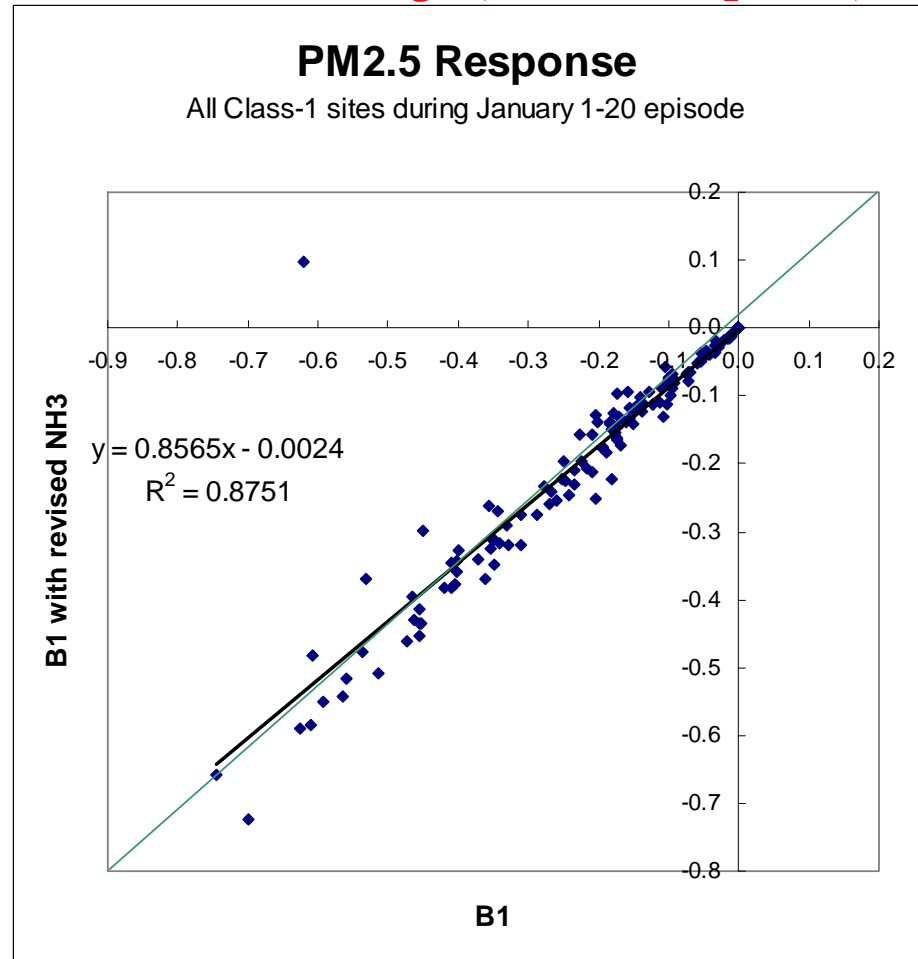


30% SO₂ Reduction

Absolute Change (Unscaled Response)

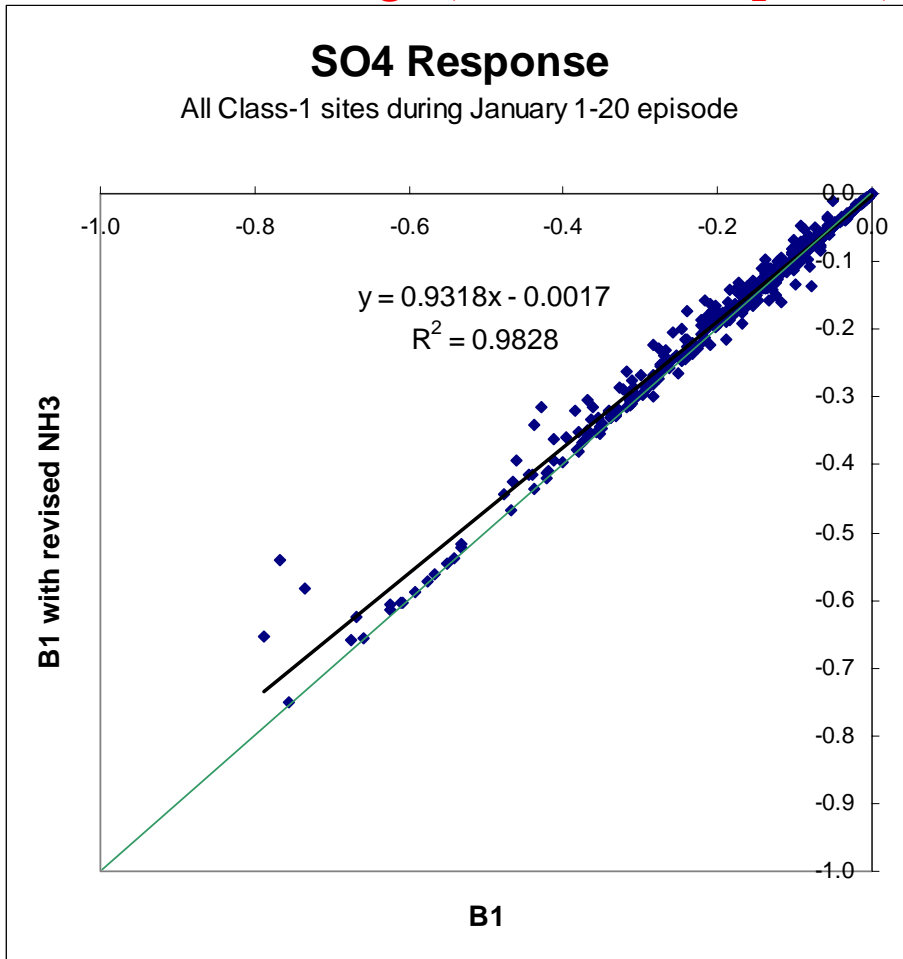


Relative Change (Scaled Response)

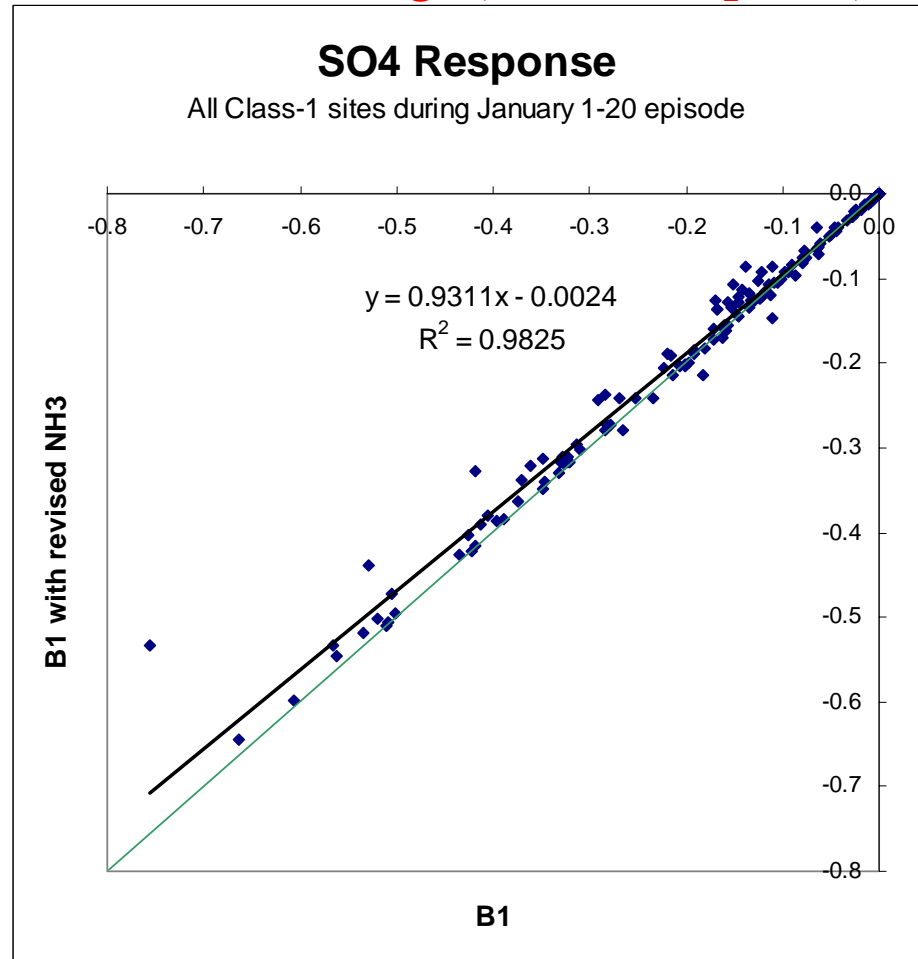


30% SO₂ Reduction

Absolute Change (Unscaled Response)

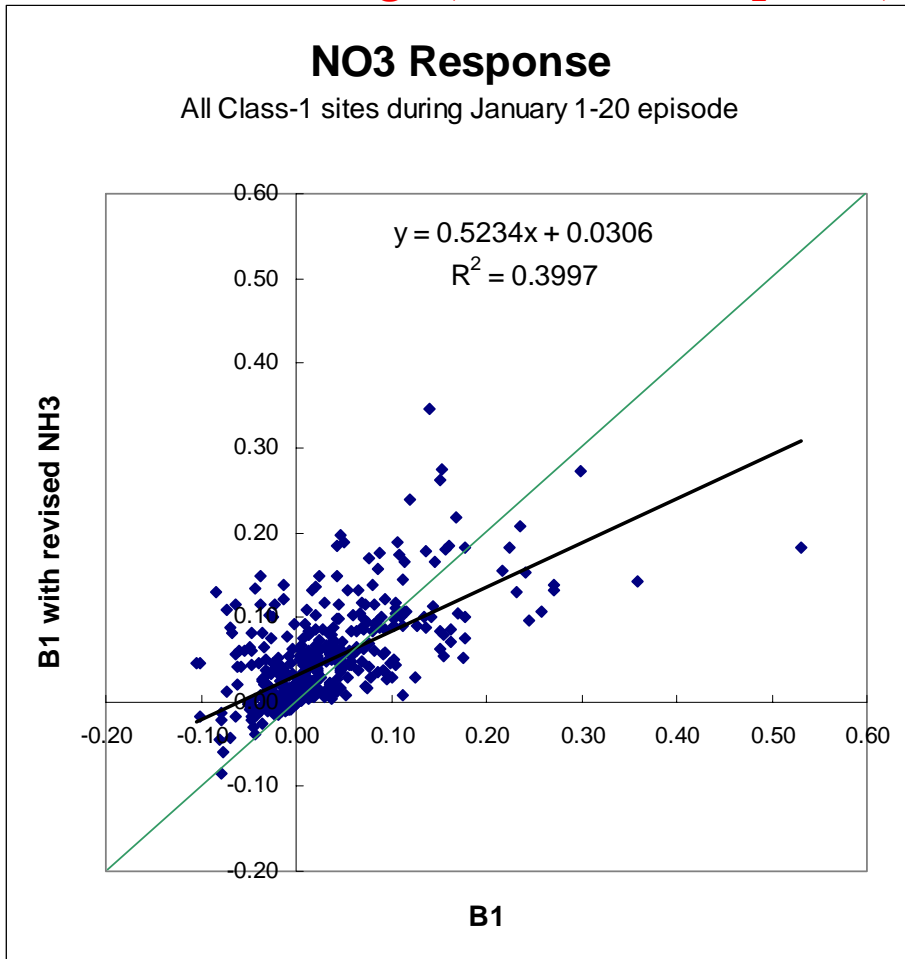


Relative Change (Scaled Response)

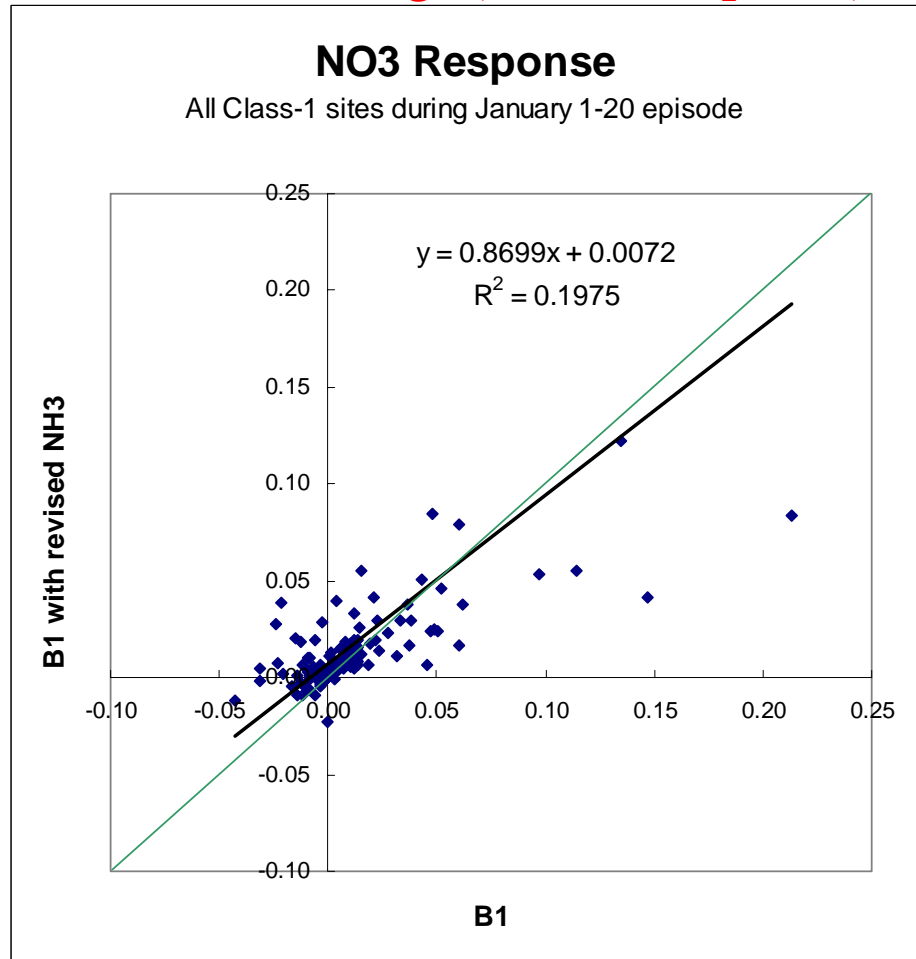


30% SO₂ Reduction

Absolute Change (Unscaled Response)

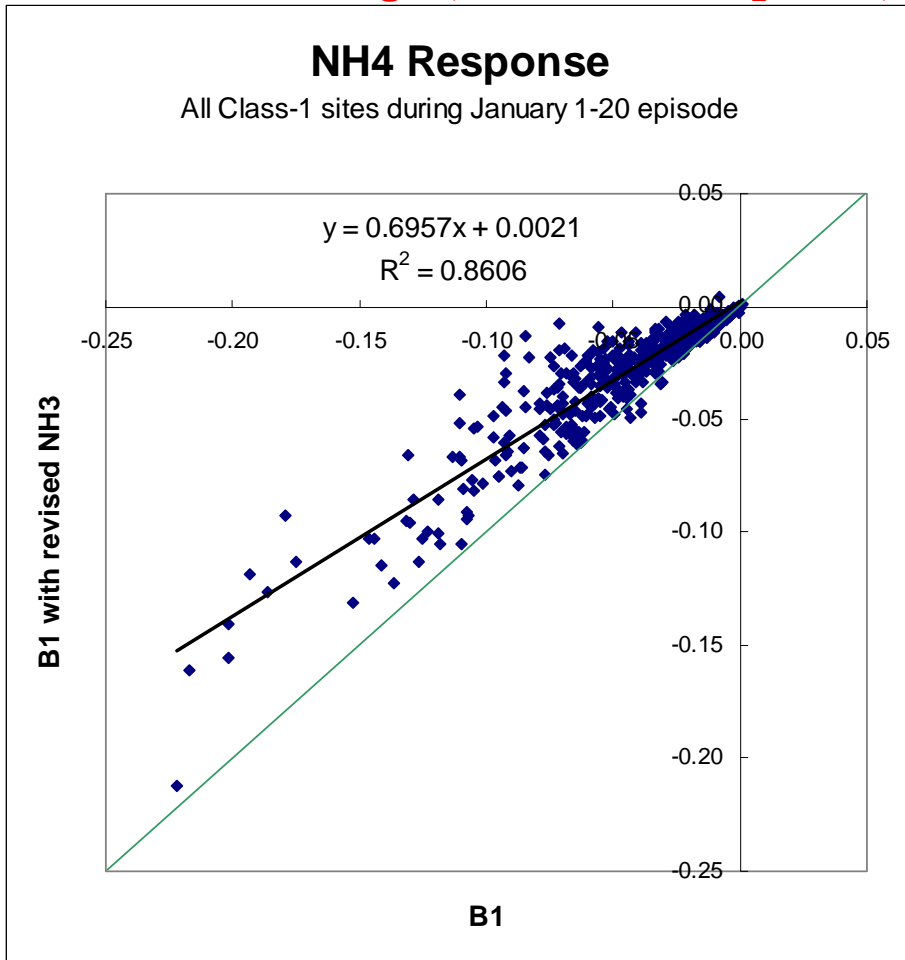


Relative Change (Scaled Response)

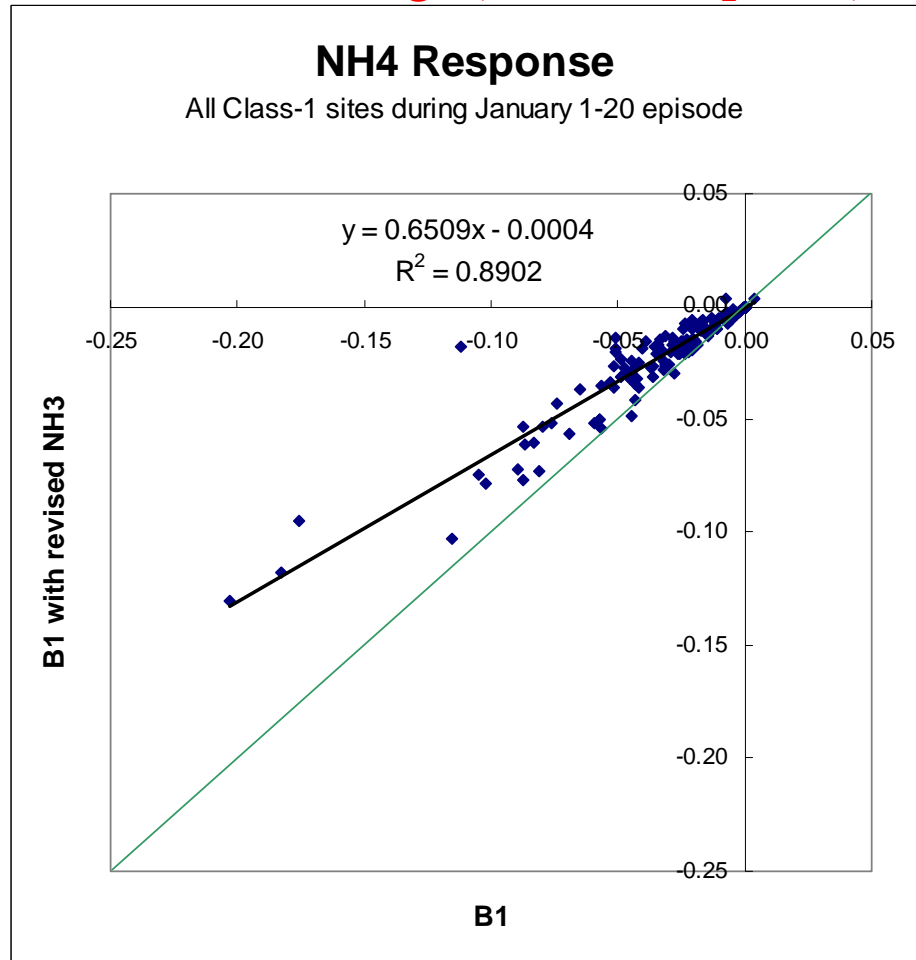


30% SO₂ Reduction

Absolute Change (Unscaled Response)

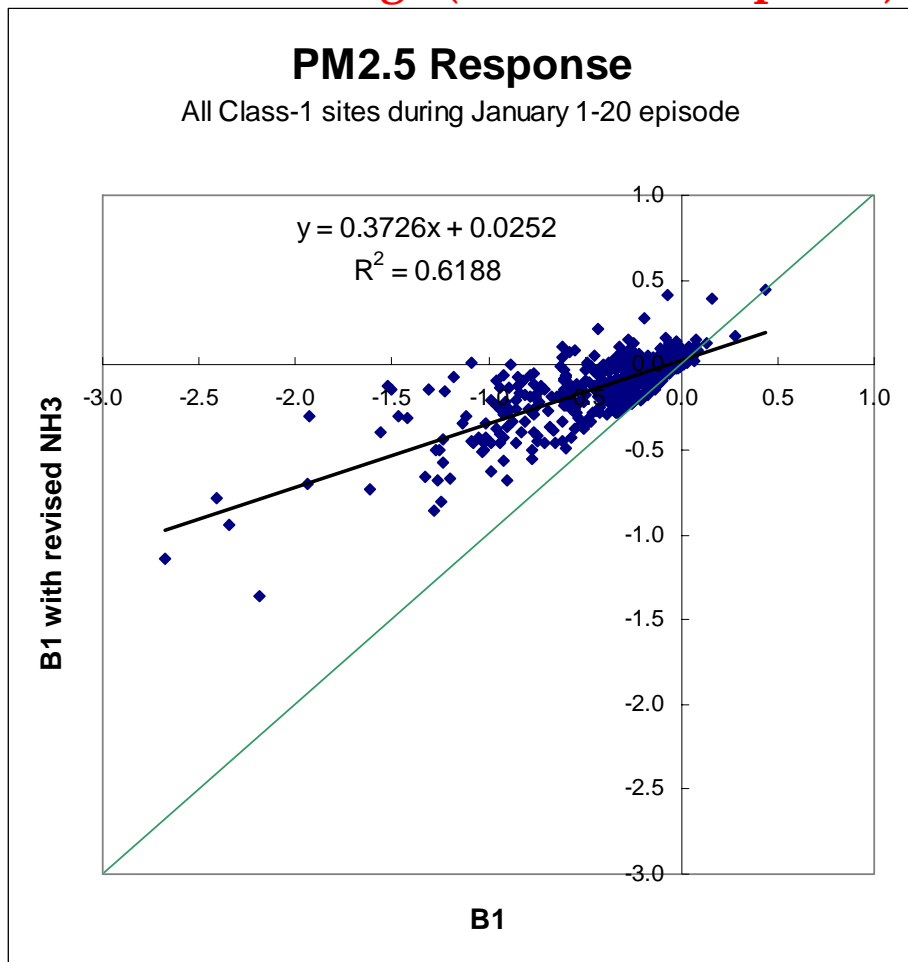


Relative Change (Scaled Response)

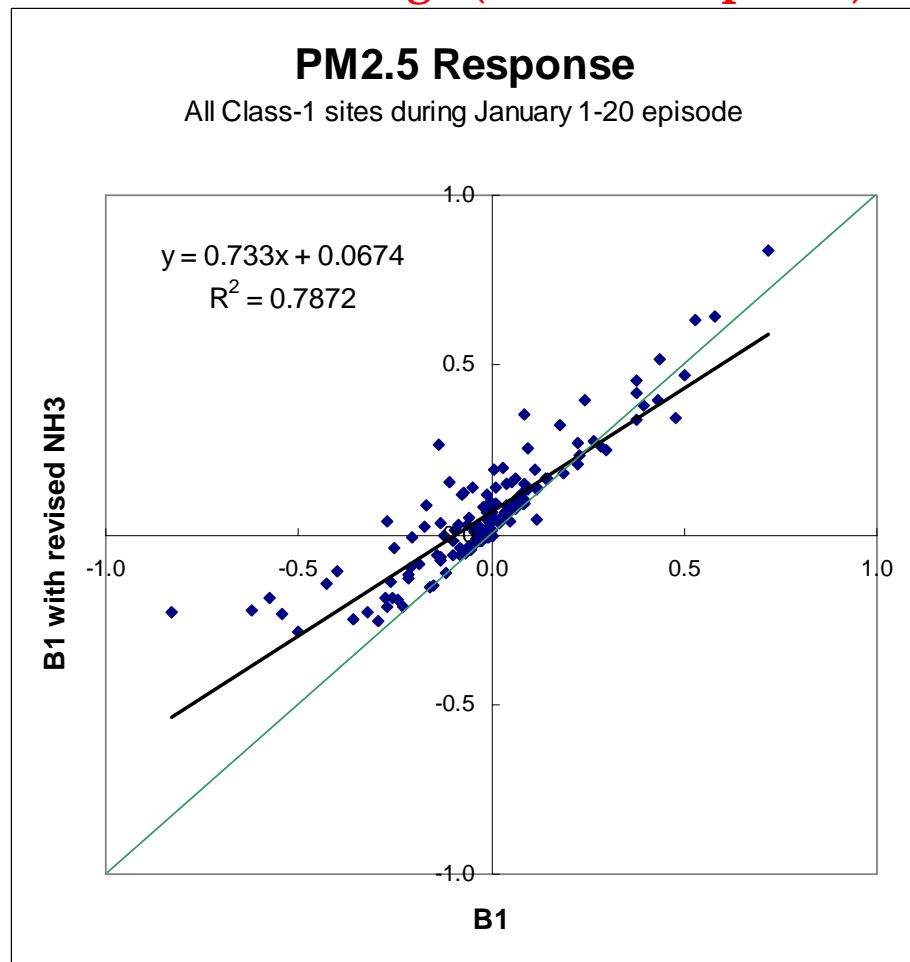


30% NO_x Reduction

Absolute Change (Unscaled Response)

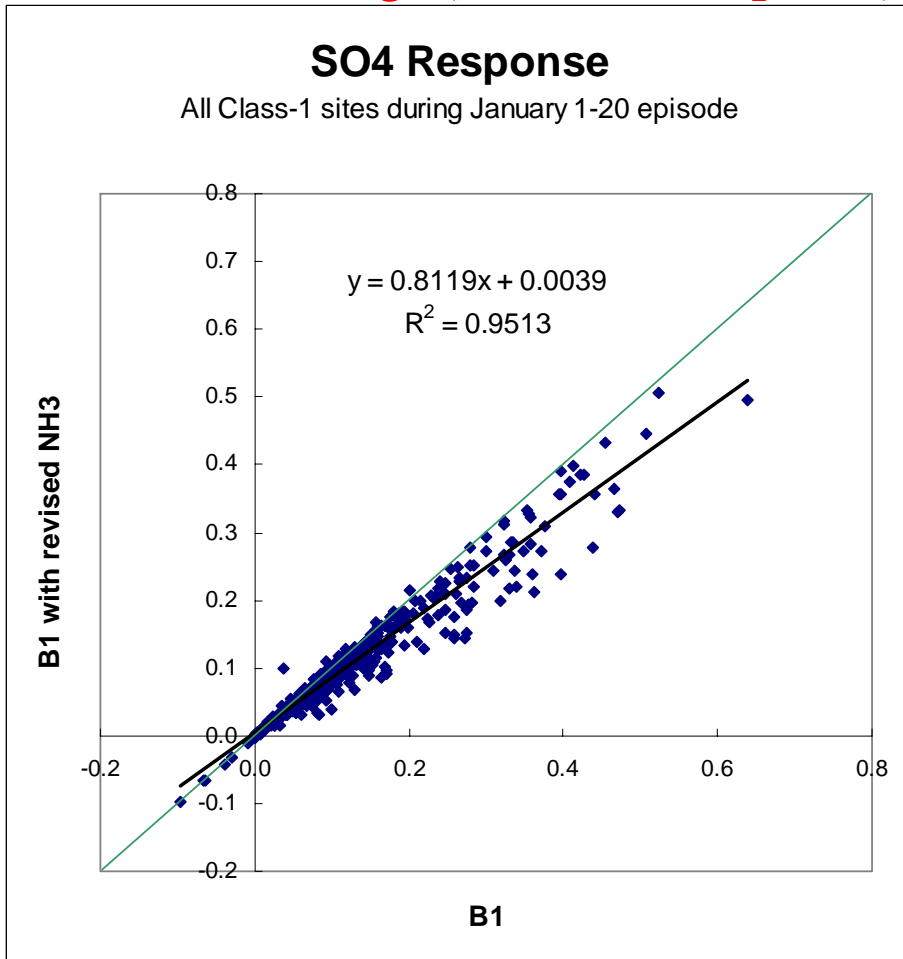


Relative Change (Scaled Response)

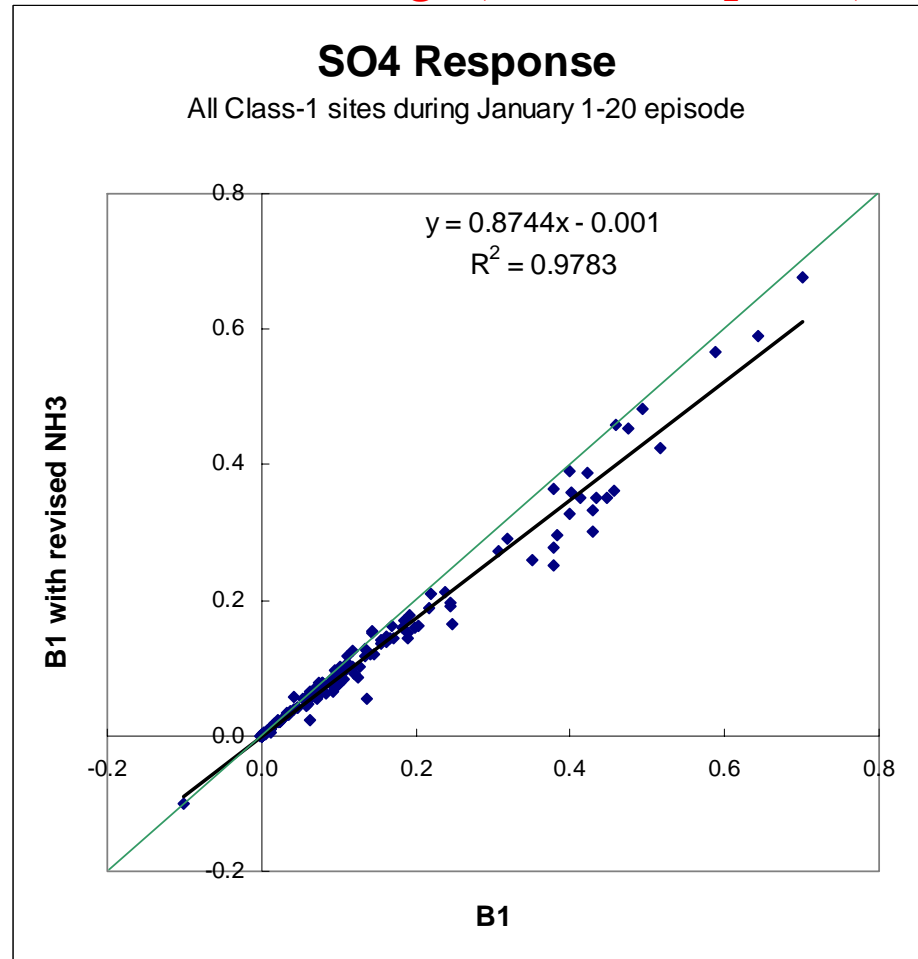


30% NO_x Reduction

Absolute Change (Unscaled Response)

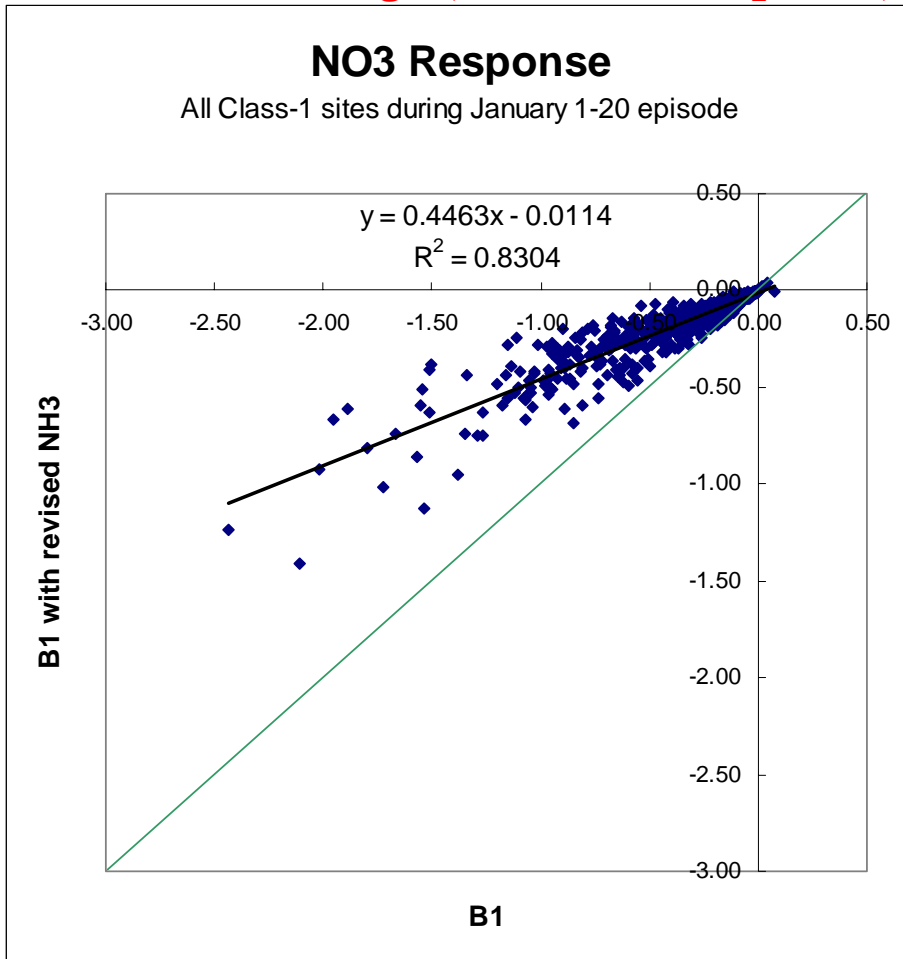


Relative Change (Scaled Response)

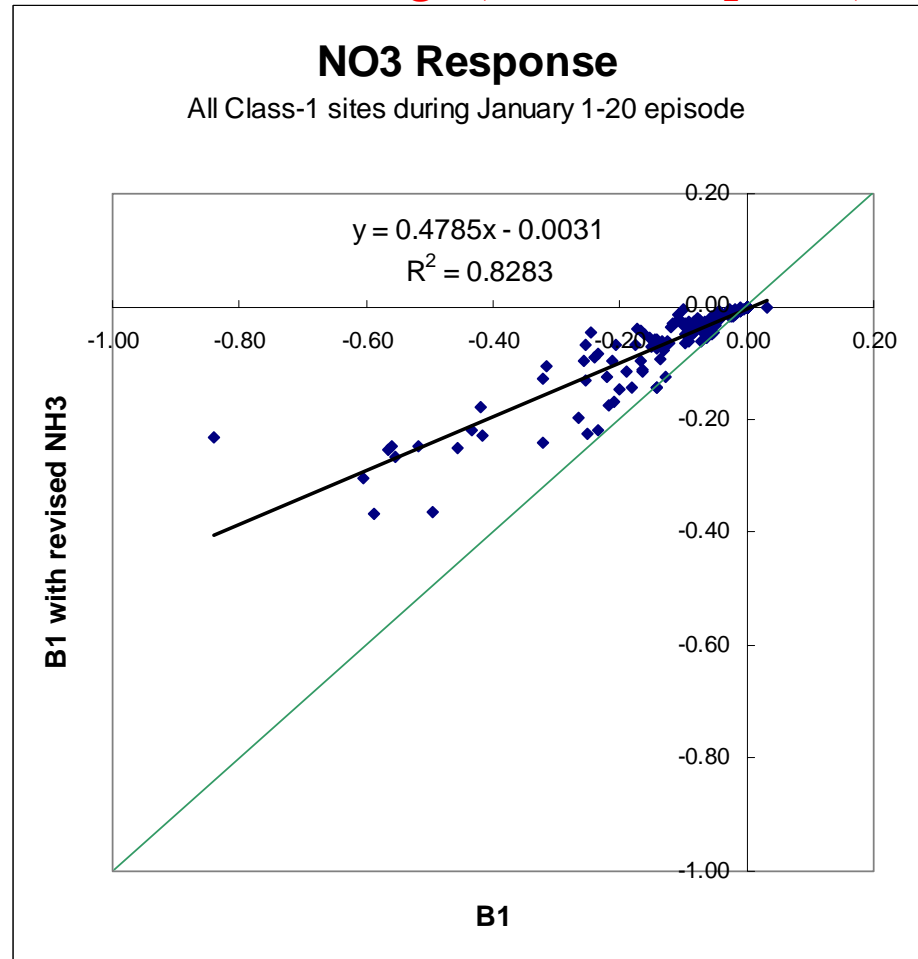


30% NO_x Reduction

Absolute Change (Unscaled Response)

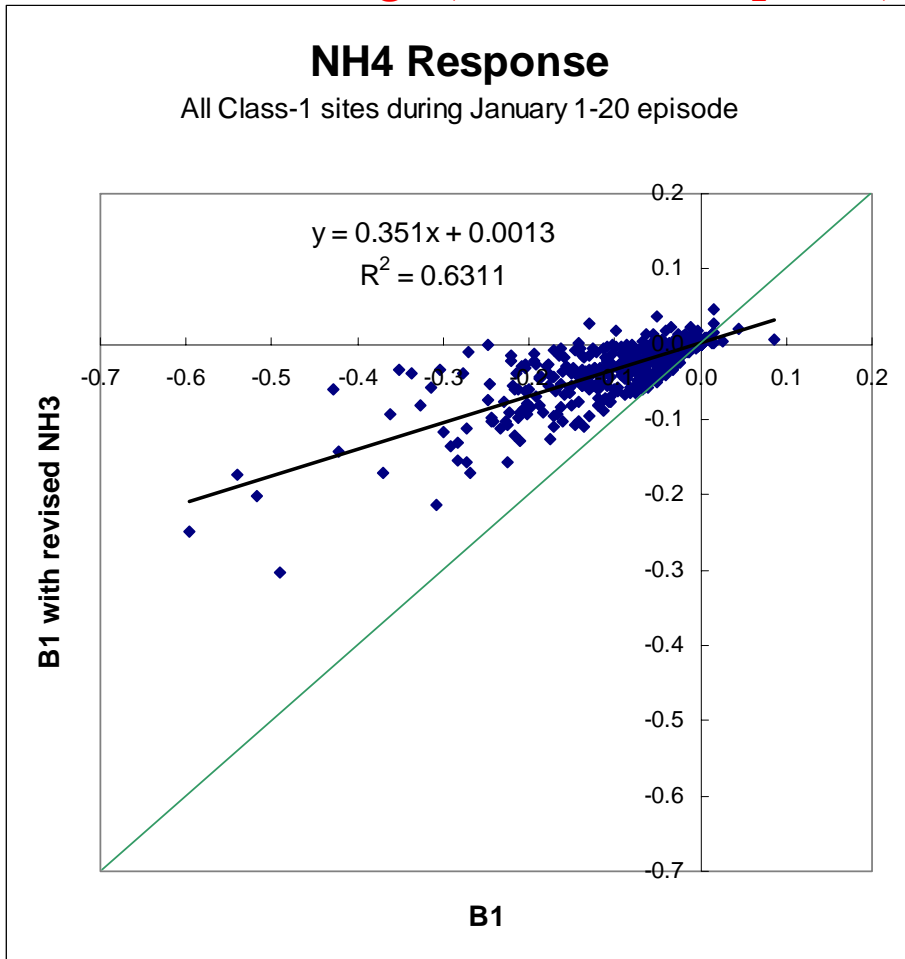


Relative Change (Scaled Response)

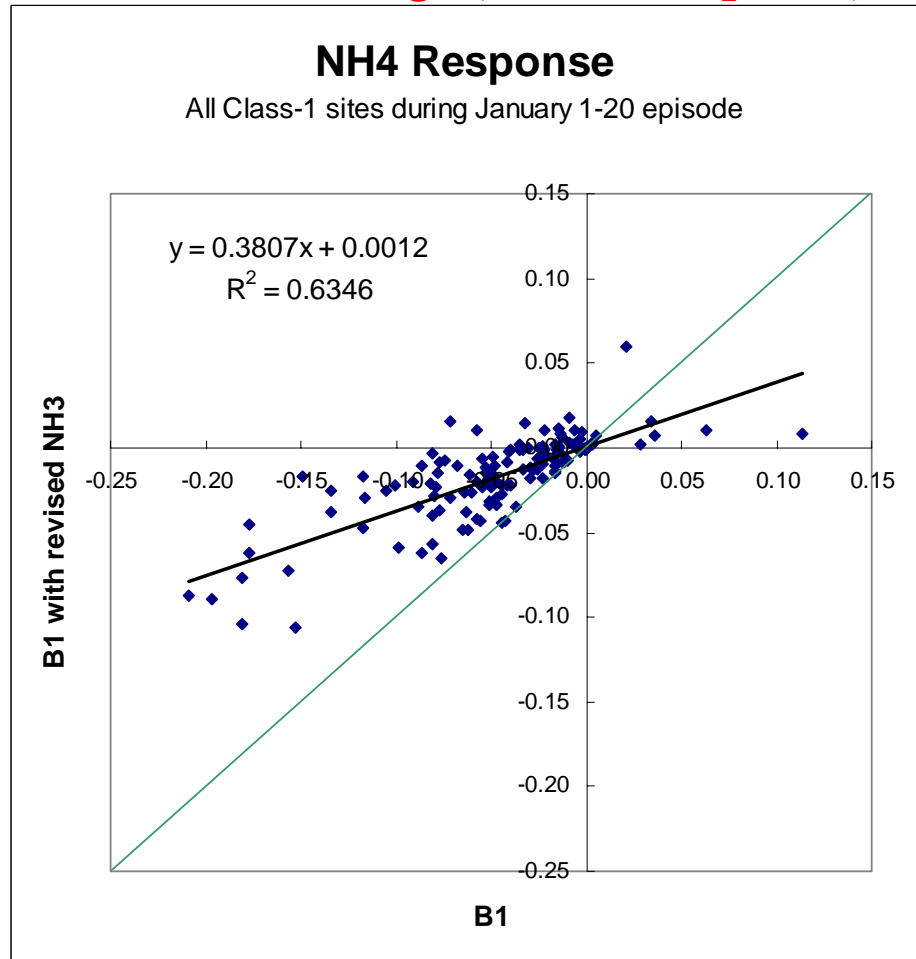


30% NO_x Reduction

Absolute Change (Unscaled Response)



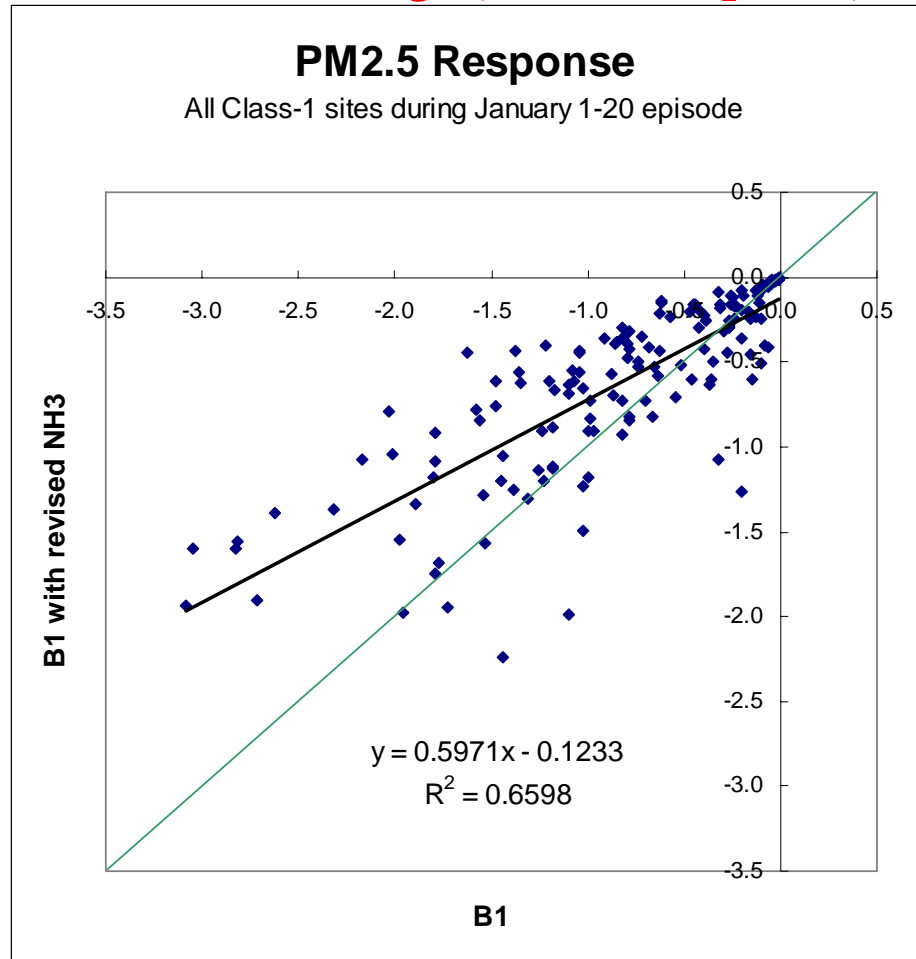
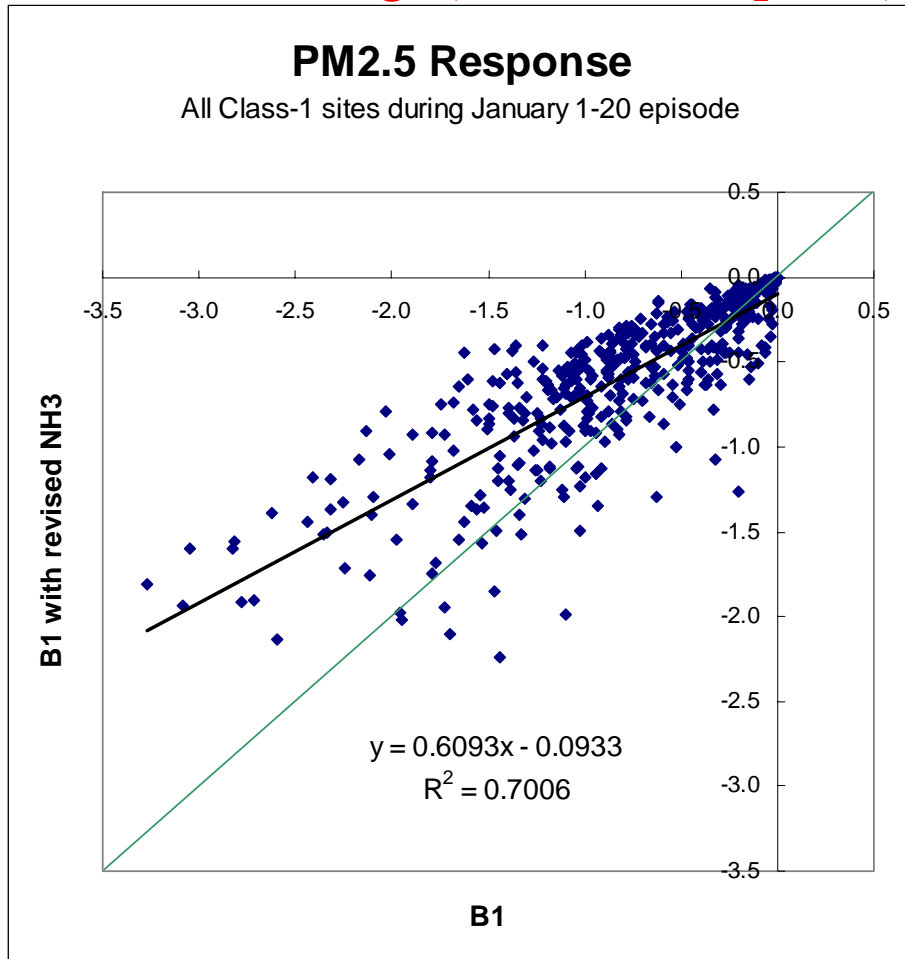
Relative Change (Scaled Response)



30% NH₄ Reduction

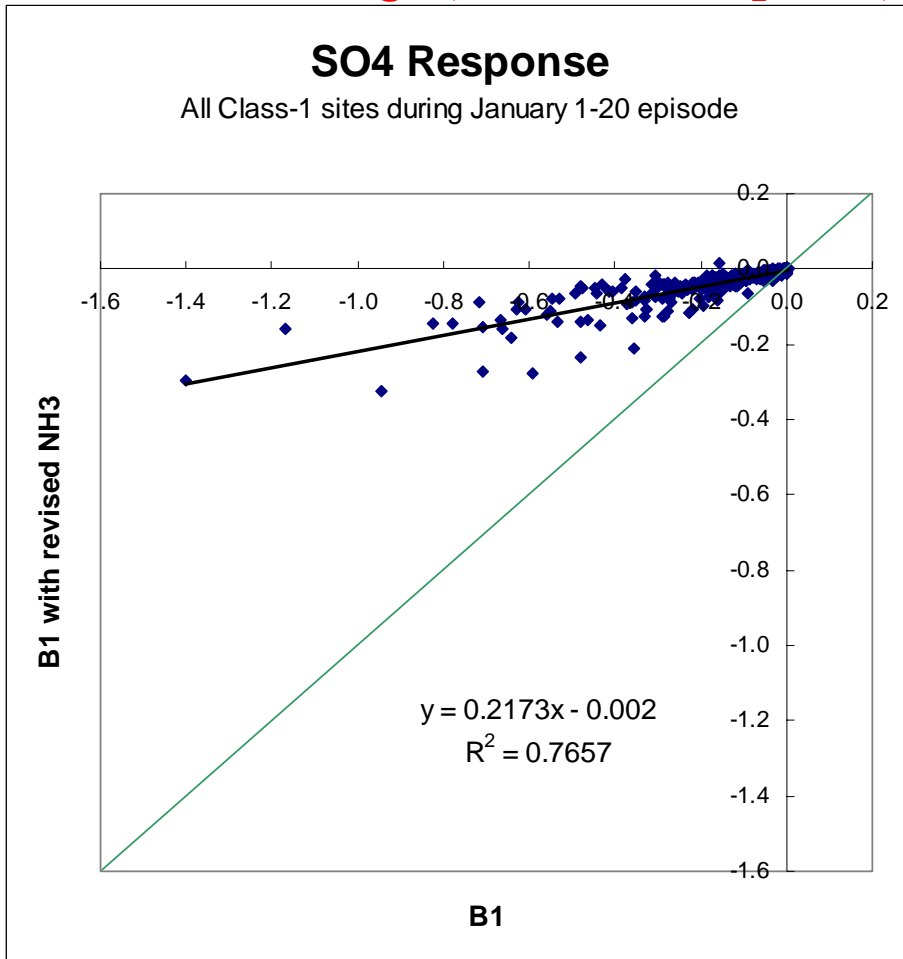
Absolute Change (Unscaled Response)

Relative Change (Scaled Response)

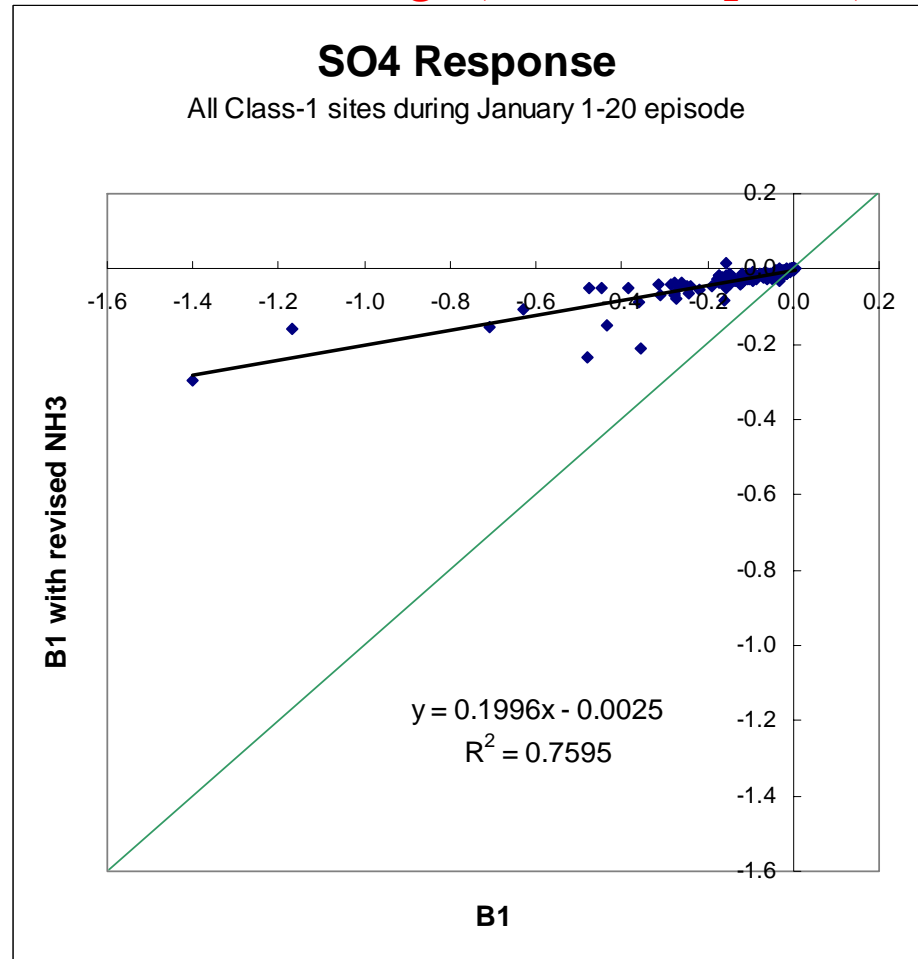


30% NH₄ Reduction

Absolute Change (Unscaled Response)

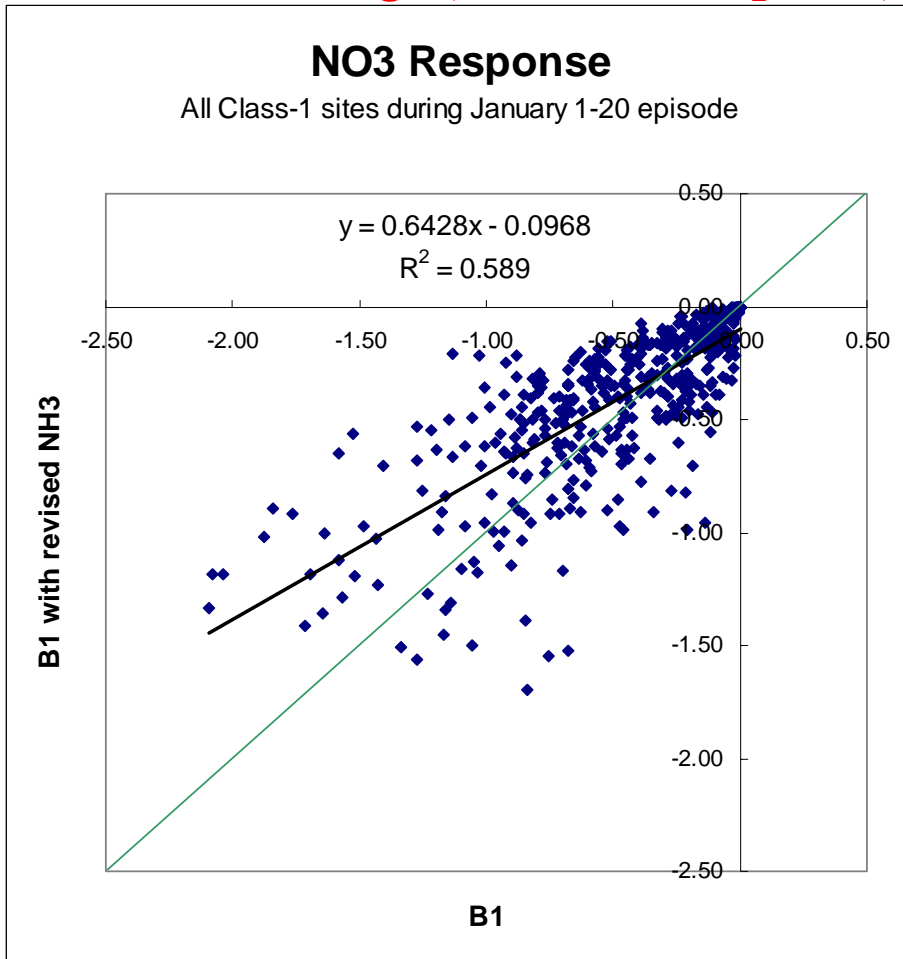


Relative Change (Scaled Response)

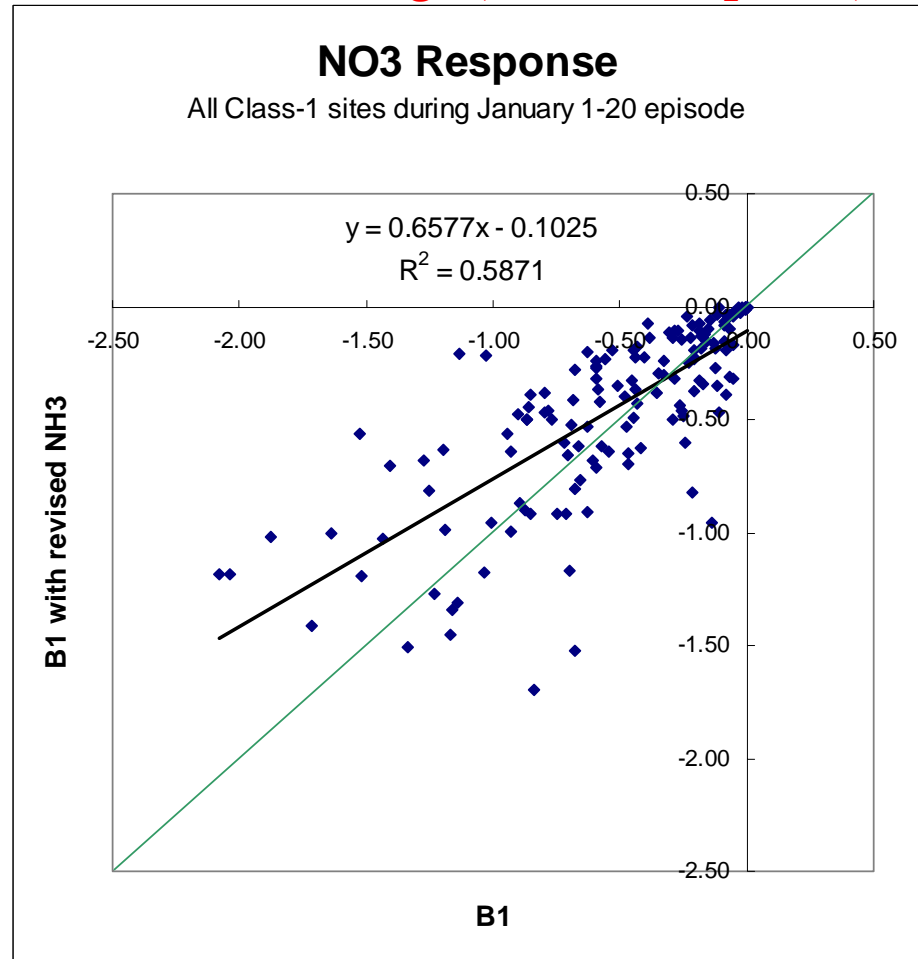


30% NH₄ Reduction

Absolute Change (Unscaled Response)

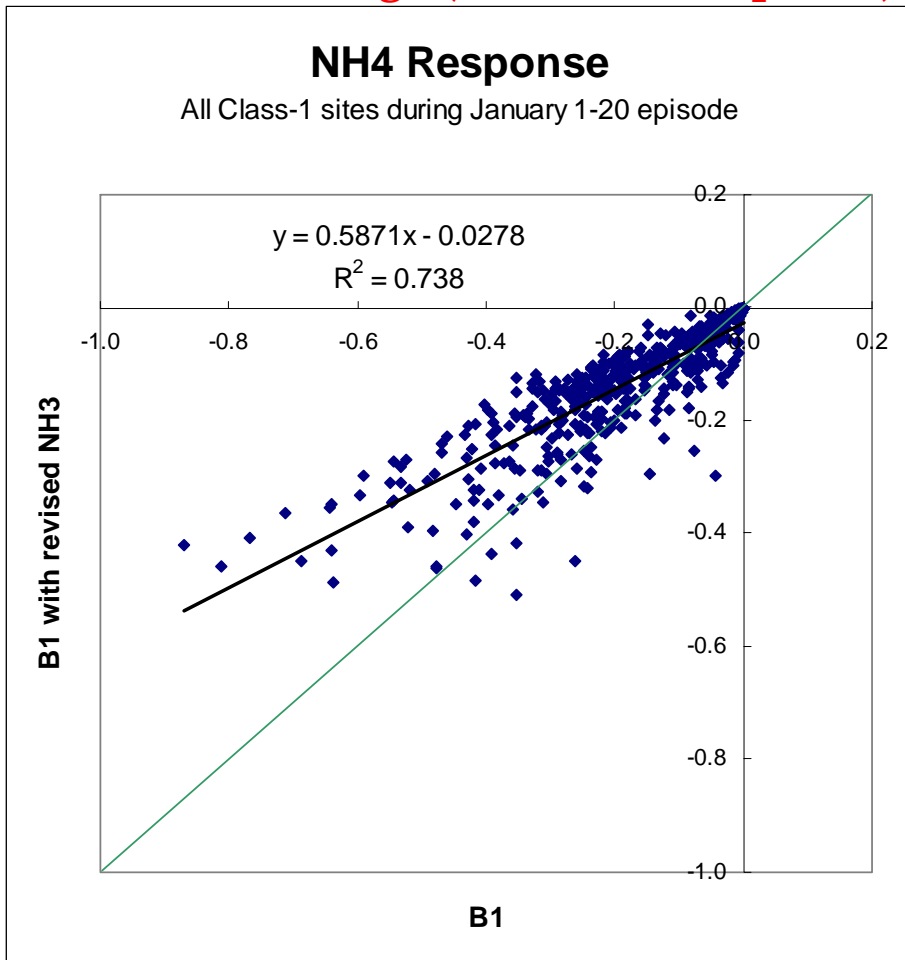


Relative Change (Scaled Response)

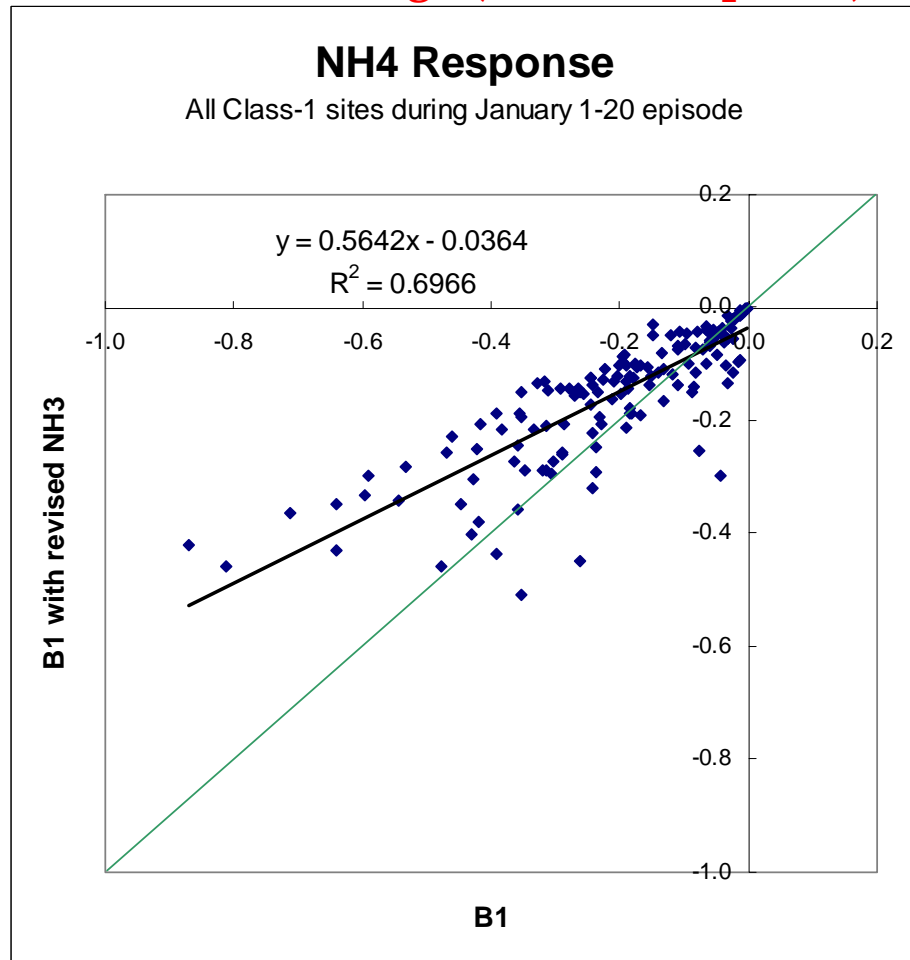


30% NH₄ Reduction

Absolute Change (Unscaled Response)

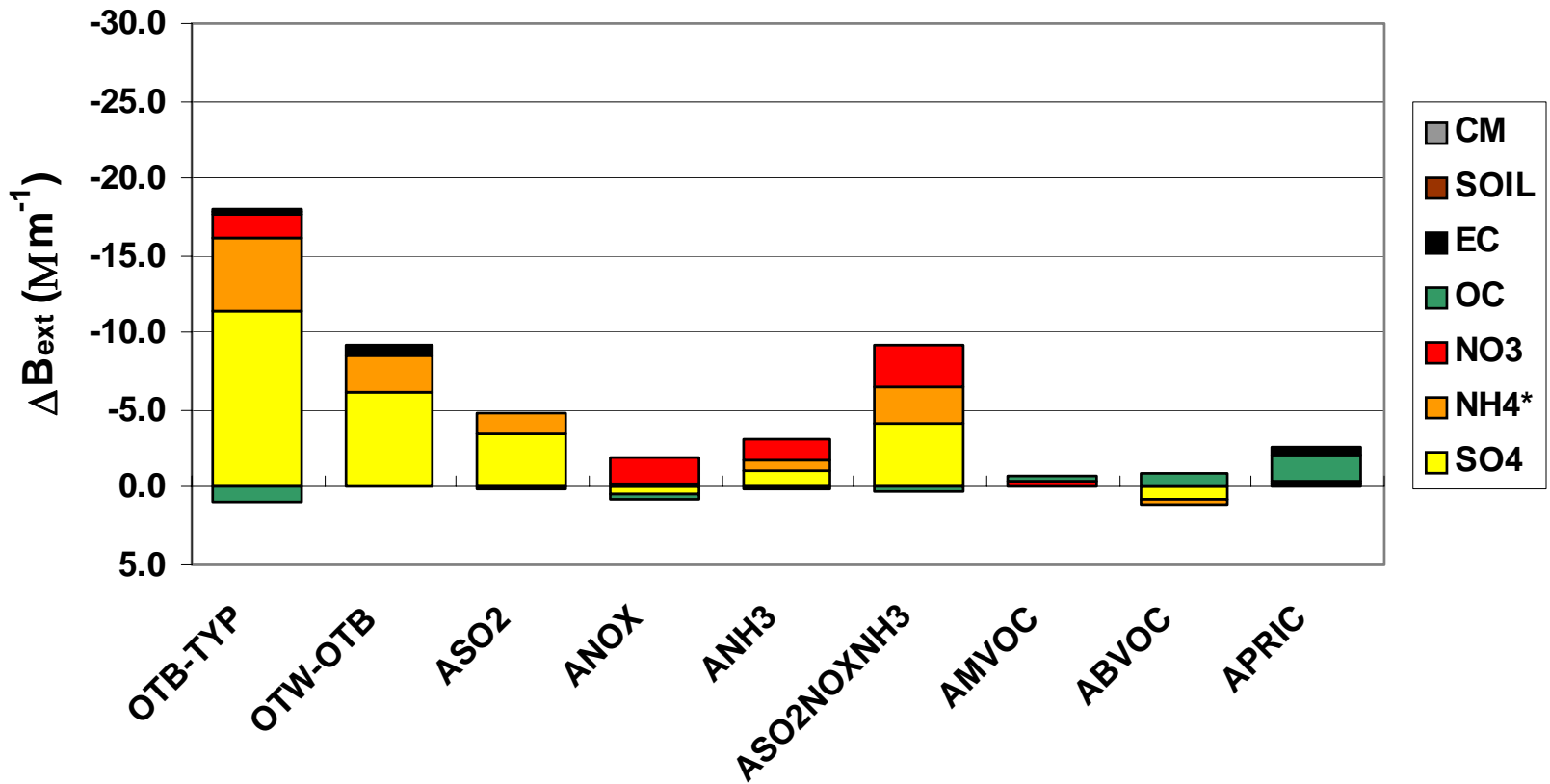


Relative Change (Scaled Response)



Swanquarter (NC)

Weighted B_{ext} Response at Site to Reductions in
OTB Emissions: Worst 20%

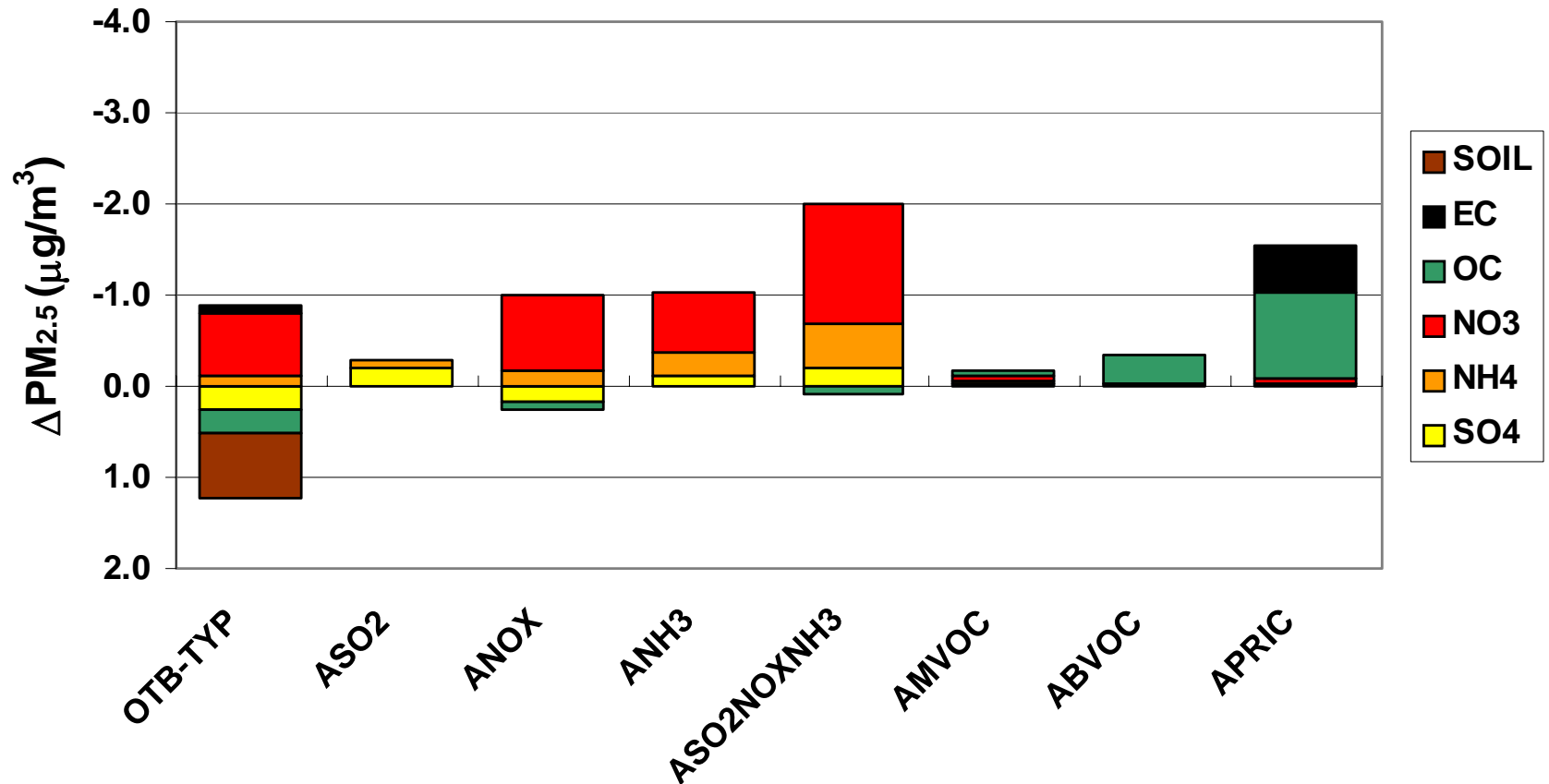


Improved NH₃ Summary

- At VISTAS Class I areas in the winter:
 - Minimal impact on SO₂ sensitivities
 - Slight impact on NO_x sensitivities
 - Significant impact on NH₃ sensitivities
 - Largest impact at BRIG and EVER
- Will not alter control strategy development on 20% Worst Days at most Class I areas
- Larger impact on 20% Best Days, but does not change conclusions
- May impact control strategies for annual PM_{2.5} attainment (see next two slides)

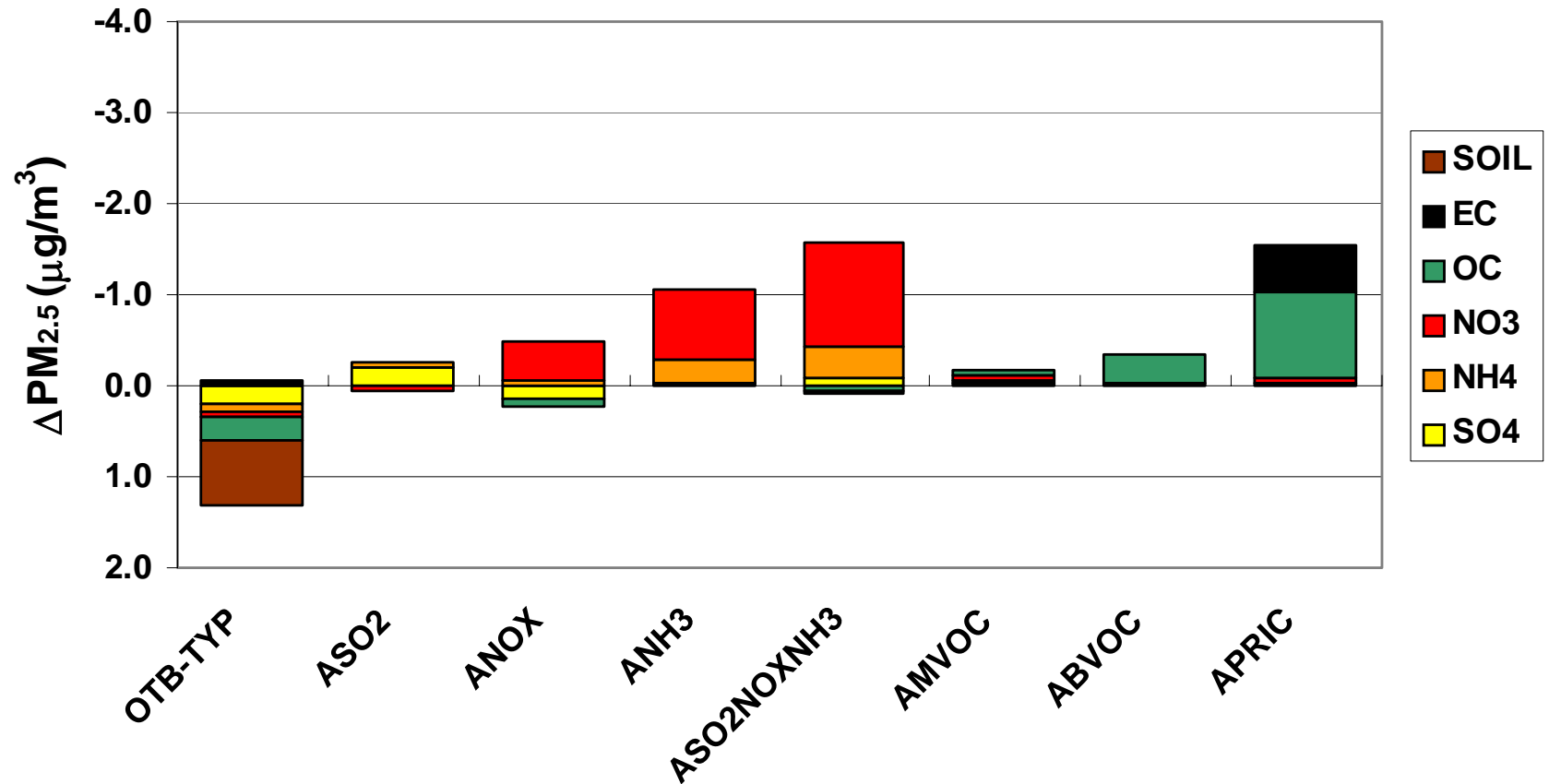
Atlanta PM_{2.5} (Winter) - old NH₃

**Weighted PM_{2.5} Response at Site to 30% Reductions
in OTB Emissions: Winter**



Atlanta PM_{2.5} (Winter) - new NH₃

**Weighted PM_{2.5} Response at Site to 30% Reductions
in OTB Emissions: Winter**



Questions?

