# *CMAQ Discussion Support Slides*

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For Integrated Nitrogen Committee

EPA Science Advisory Board

Conference Call

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# *CMAQ Model*

**Model uses "1st principles" parameterizations of the physics and chemistry that are generalized.**

National in scope (run anywhere with same physics and chemistry)

Inputs: Hourly

Meteorology from a Weather Model

Emissions from the EPA National Inventory

**Air Quality Model: CMAQ**

- Transport
- Transformation:
  - Gas Chemistry
  - Aqueous Chemistry
- Loss Processes

Outputs: Hourly

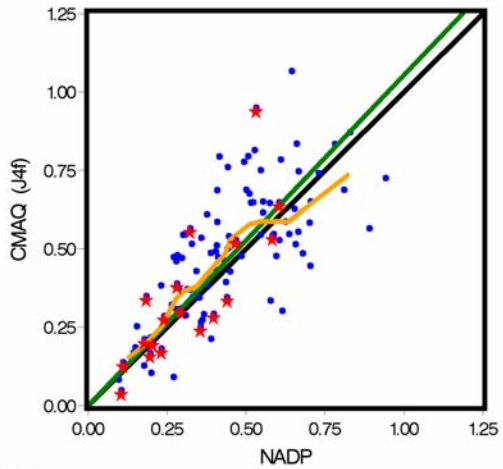
**Air Concentrations**

$O_3$
$PM_{2.5}$

**Wet and Dry Deposition**

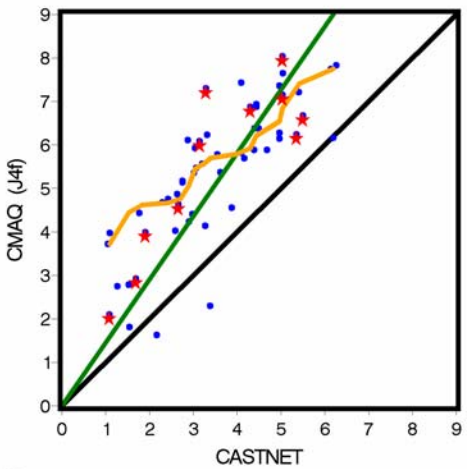
| | |
|---|---|
| $SO_2$ gas | NO |
| $SO_4$ aerosol | $NO_2$ |
| $SO_4$ **wet** | $N_2O_5$ |
| $Hg^0$ | $HNO_3$ gas |
| RGM | $NO_3$ aerosol |
| Hg(part.) | Organic $NO_3$ |
| Hg **wet** | $NO_3$ **wet** |
| | PAN's |
| | $NH_3$ gas |
| | $NH_4$ aerosol |
| | $NH_4$ **wet** |

WET OXIDIZED NITROGEN DEPOSITION (N–KG/HA)
CMAQ (J4f)
VS. NADP (2001–2003 AVERAGED)
LIMITED TO SITES IN THE EASTERN U.S.
WINTER



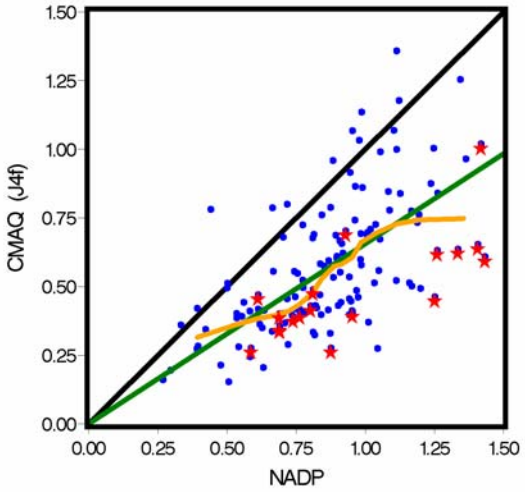

LEGEND
REGRESSION THROUGH ORIGIN
RUNNING MEDIAN SMOOTH LINE
NADP SITES IN CHESAPEAKE BAY

(NO3 + HNO3) AIR CONCENTRATION (UG/M3)
CMAQ (J4f)
VS. CASTNET (2001–2003 AVERAGED)
LIMITED TO SITES IN THE EASTERN U.S.
WINTER

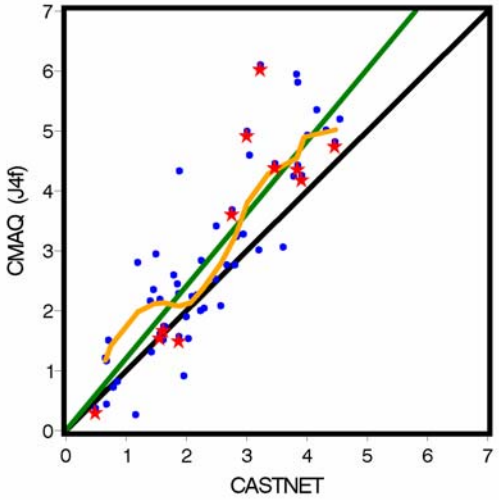



LEGEND
REGRESSION THROUGH ORIGIN
RUNNING MEDIAN SMOOTH LINE
CASTNET SITES IN CHESAPEAKE BAY

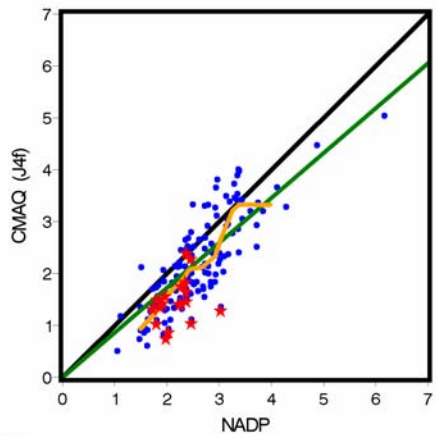
SUMMER




SUMMER

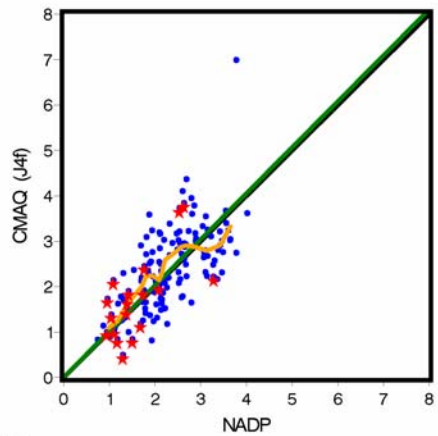


WET OXIDIZED NITROGEN DEPOSITION (N–KG/HA)
CMAQ (J4f)
VS. NADP (2001–2003 AVERAGED)
LIMITED TO SITES IN THE EASTERN U.S.
ANNUAL



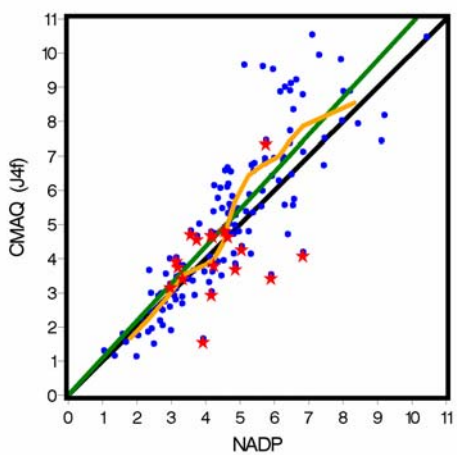

LEGEND
REGRESSION THROUGH ORIGIN
RUNNING MEDIAN SMOOTH LINE
NADP SITES IN CHESAPEAKE BAY

WET REDUCED NITROGEN DEPOSITION (N–KG/HA)
CMAQ (J4f)
VS. NADP (2001–2003 AVERAGED)
LIMITED TO SITES IN THE EASTERN U.S.
ANNUAL

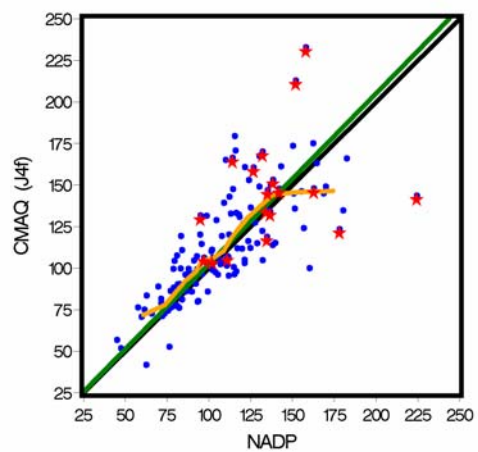



LEGEND
REGRESSION THROUGH ORIGIN
RUNNING MEDIAN SMOOTH LINE
NADP SITES IN CHESAPEAKE BAY

WET SULFUR DEPOSITION (S–KG/HA)
CMAQ (J4f)
VS. NADP (2001–2003 AVERAGED)
LIMITED TO SITES IN THE EASTERN U.S.
ANNUAL

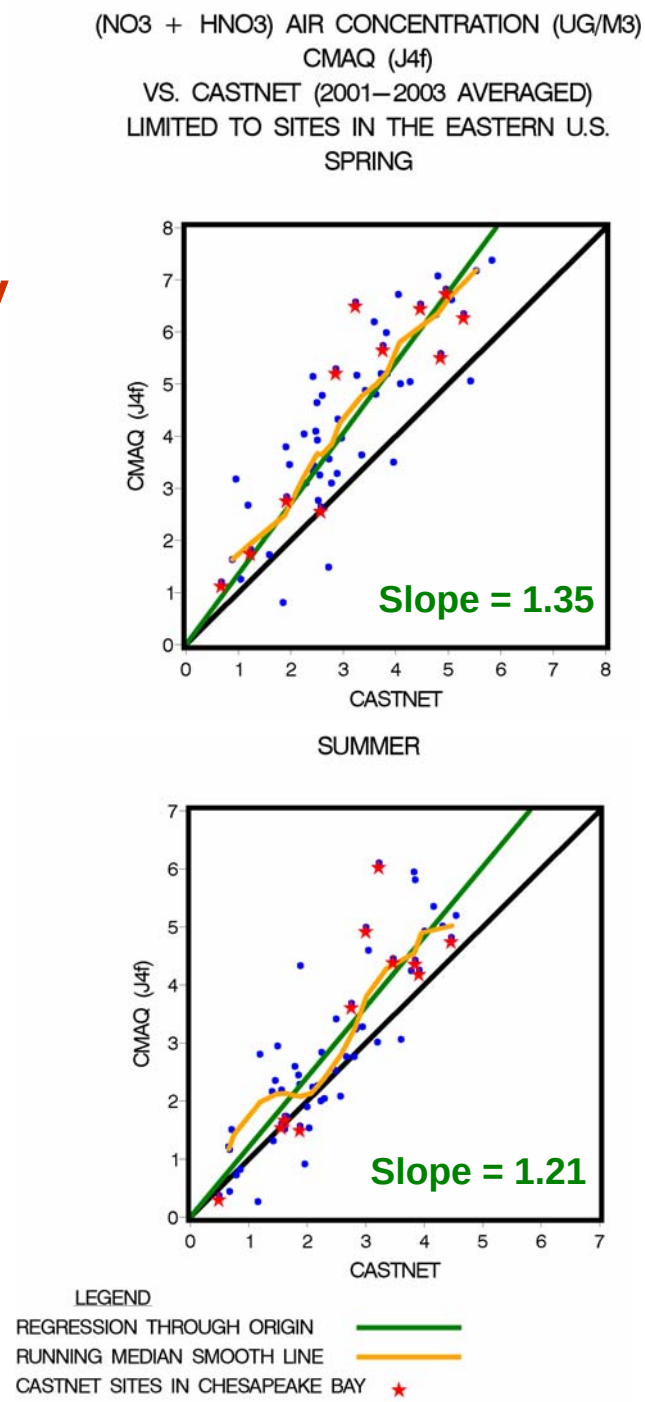


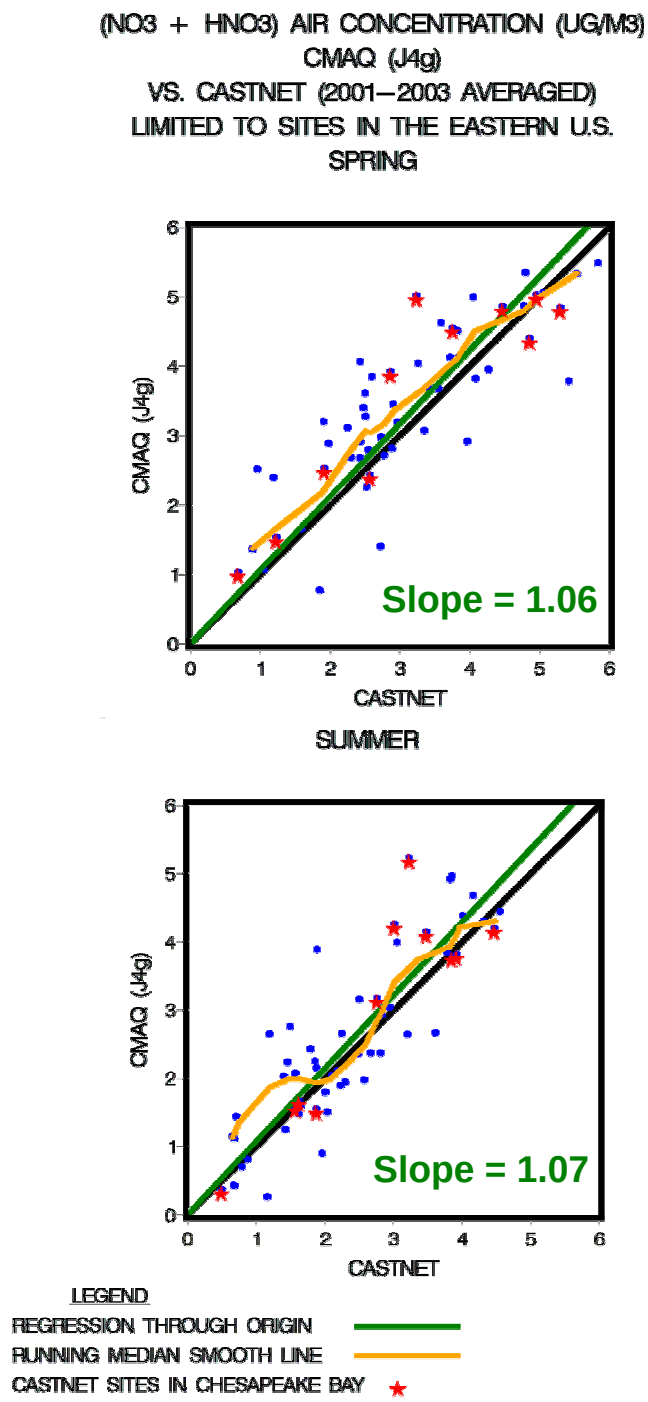

PRECIPITATION (cm)
CMAQ (J4f)
VS. NADP (2001–2003 AVERAGED)
LIMITED TO SITES IN THE EASTERN U.S.
ANNUAL



## $N_2O_5$ Sensitivity (/7

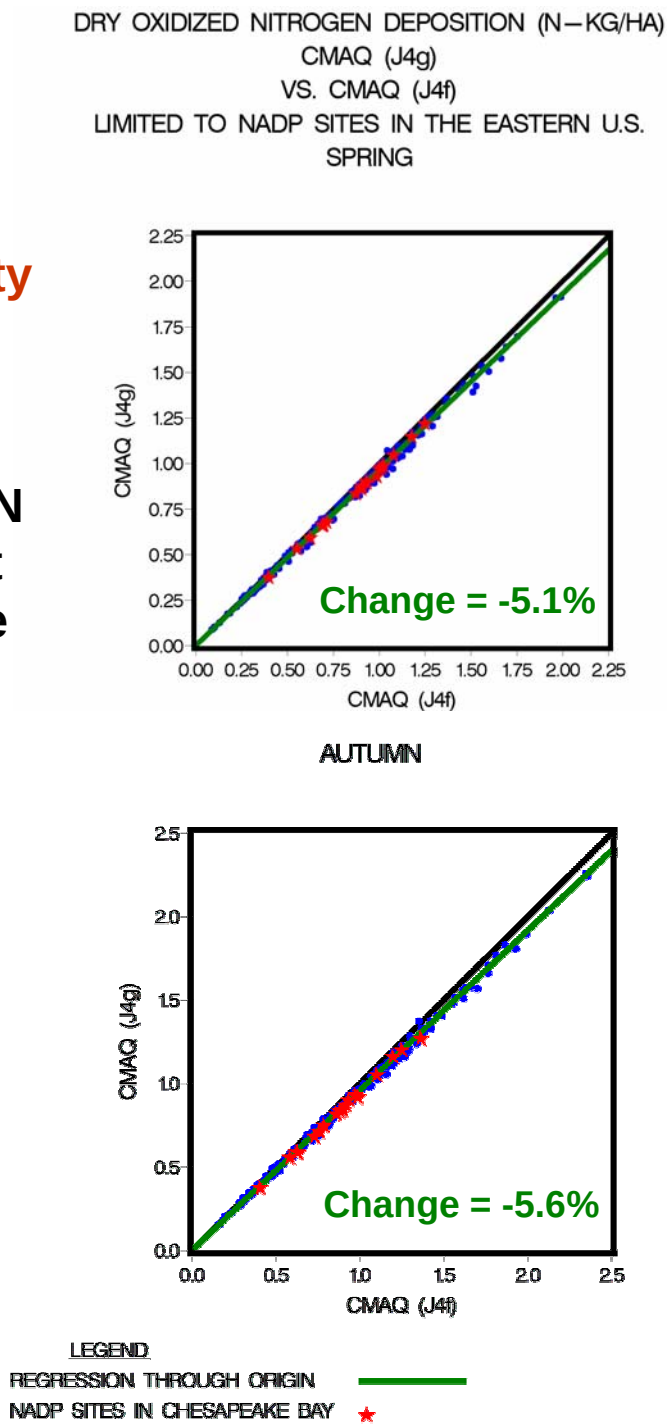
**(/7 produced marked improve-ment in CMAQ simulation of total-Nitrate**

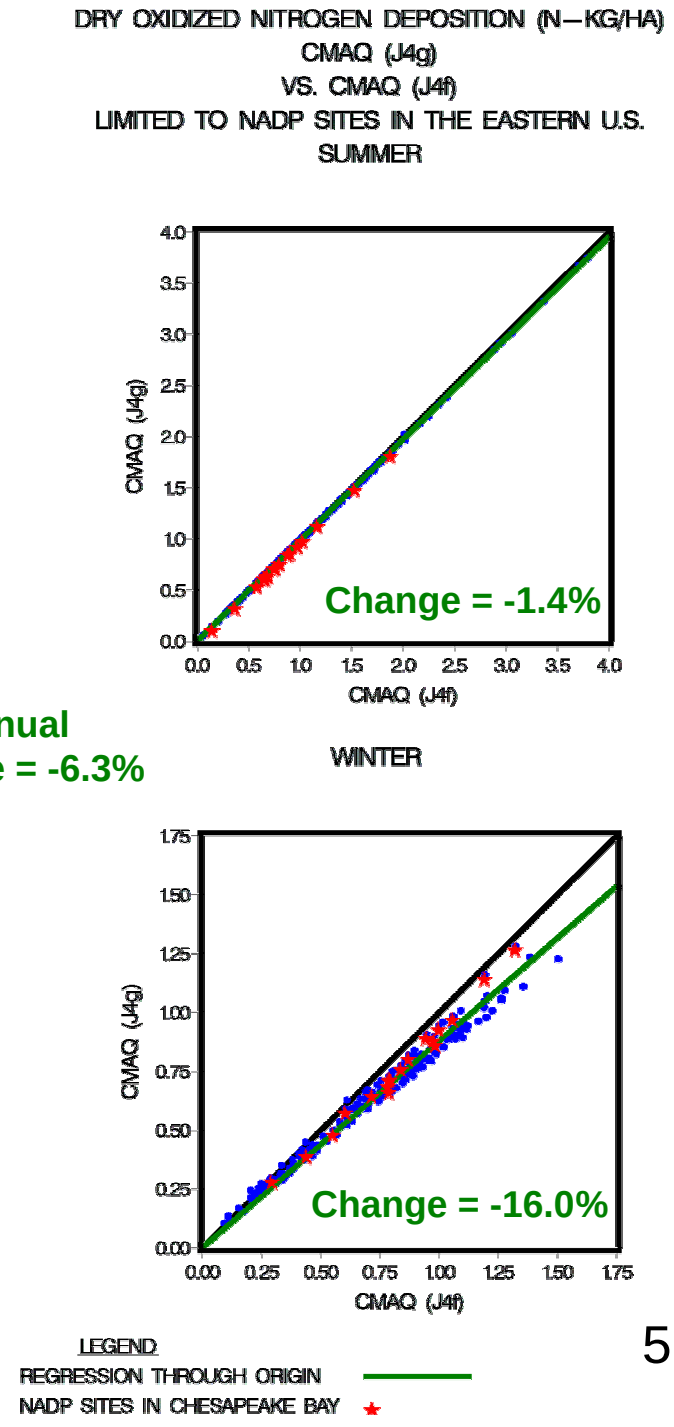


## $N_2O_5$ Sensitivity (/7

**Change in ox-N deposition not nearly as large as change in total-Nitrate**



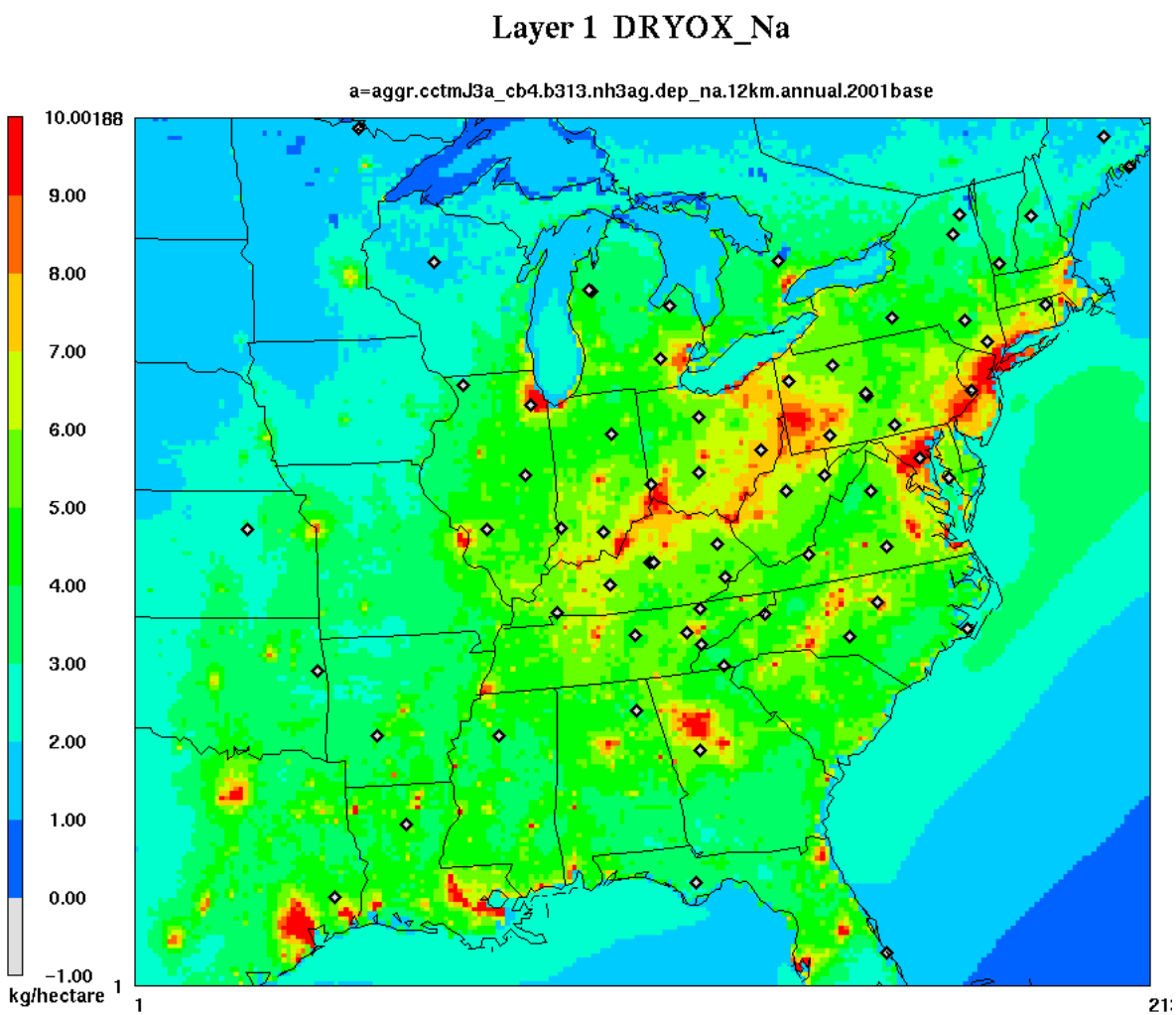

**Annual Change = -6.3%**

NITROGEN DEPOSITION TO THE CHESAPEAKE BAY (LAND + WATER)
CMAQ 36km - J4f and J4g
NO BIAS ADJUSTMENTS

| | ANNUAL | Base J4f (lbs) | Sensitivity J4g (lbs) | |
|---|---|---|---|---|
| MAIN | SPECIES | | | |
| 1) DRYOX_N | DRYNO2_N | 31,967,088 | 34,243,019 | (7.1%) |
| | DRYNO_N | 9,273,265 | 9,597,669 | (3.5%) |
| | DRYN2O5_N | 8,671,448 | 16,414,557 | (89.3%) |
| | DRYHNO3_N | 121,266,418 | 99,518,580 | (-17.9%) |
| | DRYHONO_N | 262,290 | 271,378 | (3.5%) |
| | DRYNO3T_N | 3,577,350 | 2,652,012 | (-25.9%) |
| | DRYORGNO3T_N | 3,627,020 | 3,713,229 | (2.4%) |
| | DRYPANT_N | 11,920,777 | 12,189,141 | (2.3%) |
| | --- | --- | --- | |
| 1) DRYOX_N | | 190,565,657 | 178,599,585 | (-6.3%) |
| 2) WETOX_N | WETN2O5_N | 6,803 | 11,798 | |
| | WETNO3T_N | 108,311,822 | 105,550,661 | |
| | --- | --- | --- | |
| 2) WETOX_N | | 108,318,625 | 105,562,458 | (-2.5%) |
| 3) TOTALOX_N | TOTALOX_N | 298,884,282 | 284,162,044 | (-4.9%) |

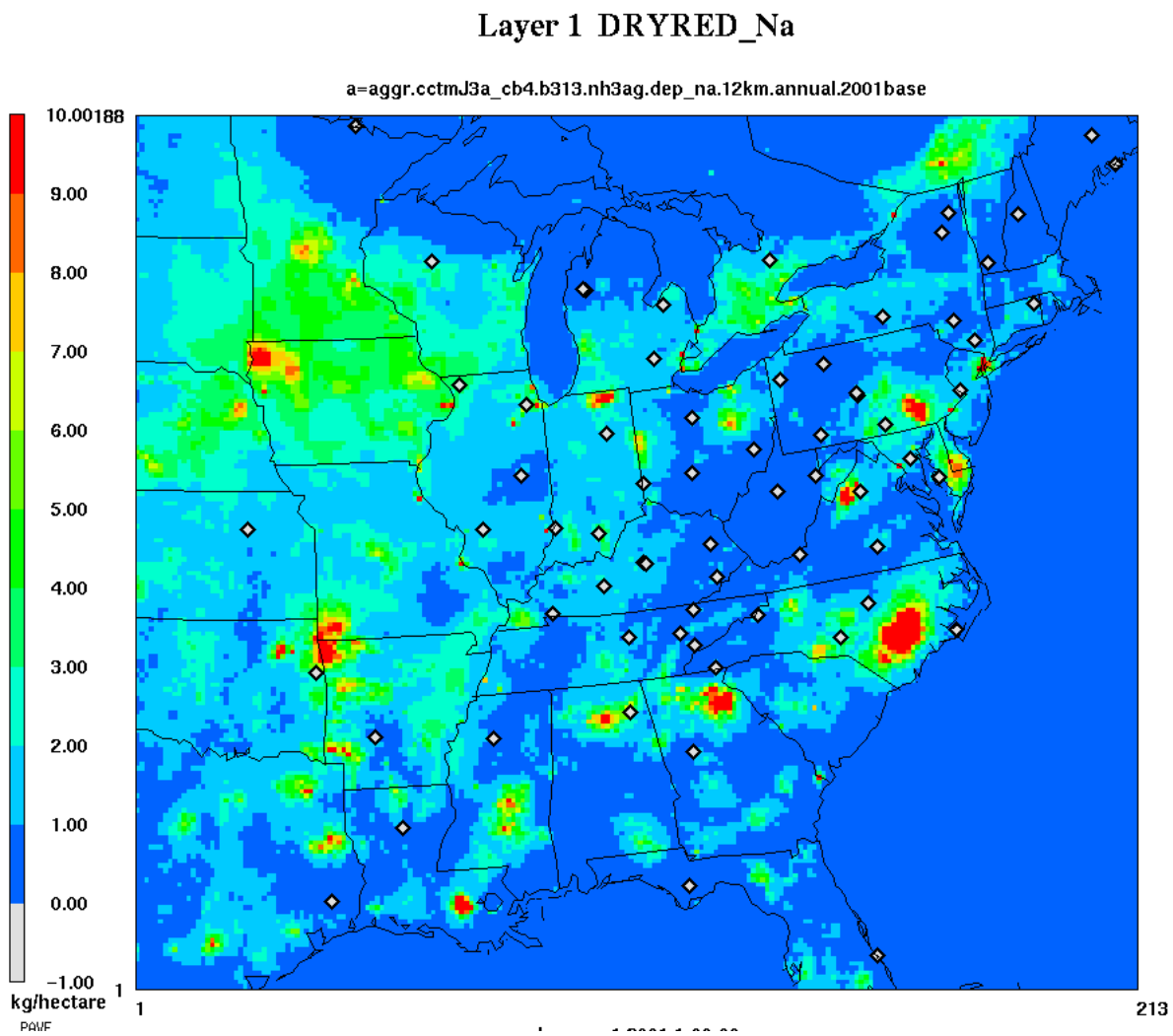


RESEARCH & DEVELOPMENT
Building a scientific foundation for sound environmental decisions




Monitoring Has Incomplete Species Set For Ox-N Dry Deposition

Poor Spatial Coverage; It is Not Representative




Poor Spatial Coverage;
It is Not Representative

# *Dry Deposition of Reactive N is Important*
# *Important Fraction of Dry Deposition Not Being Measured*

**Numbers for Chesapeake Bay Watershed and Bay**

| | Specie | Kg-N ($x10^6$) |
|---|---|---|
| Dry Ox-N | NO | 4.22 |
| | $NO_2$ | 14.53 |
| | PAN's | 5.42 |
| | Other | 5.71 |
| | $HNO_3$ | 55.12 |
| | $aNO_3^-$ | 1.63 |
| | | |
| Dry Ox-N | Total | 86.62 |
| Wet Ox-N | Total | 57.25 |
| | | |
| Dry Red-N | $NH_3$ | 34.75 |
| | $aNH_4^+$ | 7.52 |
| | | |
| Dry Red-N | Total | 42.27 |
| Wet Red-N | Total | 45.79 |

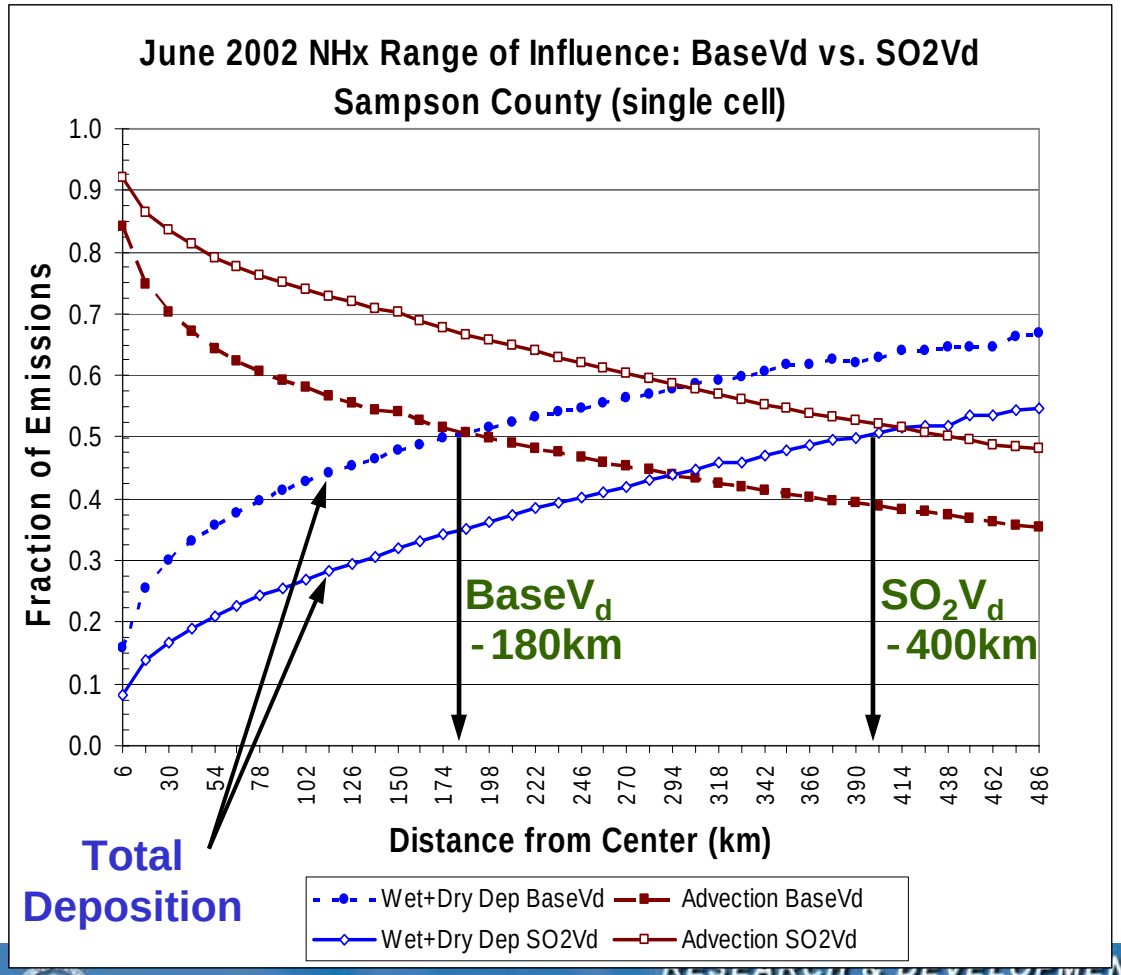
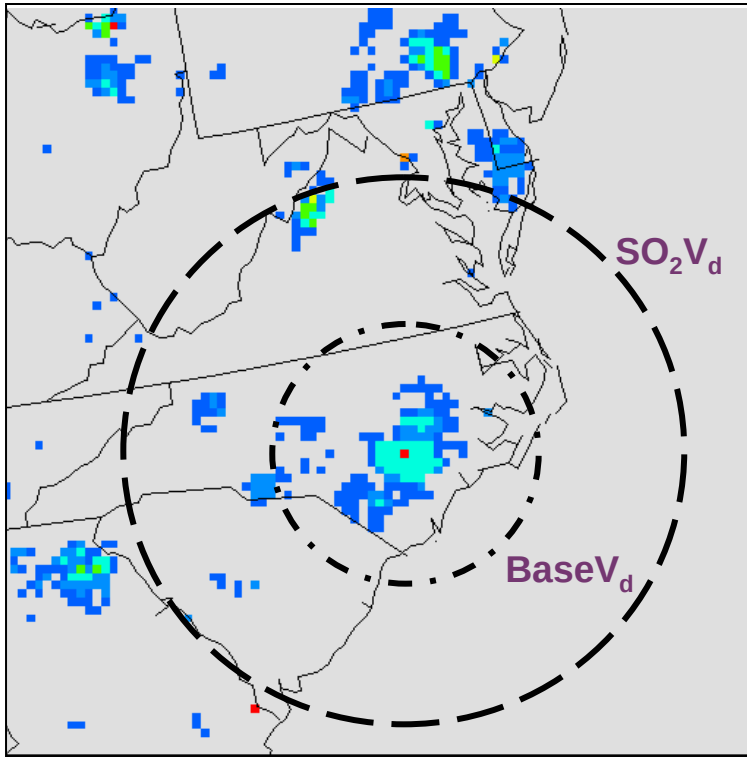
Not Being Measured (34%)

Dry Ox-N > Wet Ox-N

Not Being Measured (82%)

Dry Red-N < Wet Red-N

# *A Modest Reduction in $NH_3$ $V_d$ by 30% Makes a Difference*

## *Uncertainty Response for Single NC Maximum Cell*

We define the Range of Influence as the distance by which 50% of the emissions attributable to that source deposit. (This is consistent with earlier work)