SEMAP 2018 Ozone Projections and Sensitivity to NO_x & VOC Emissions

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Outline

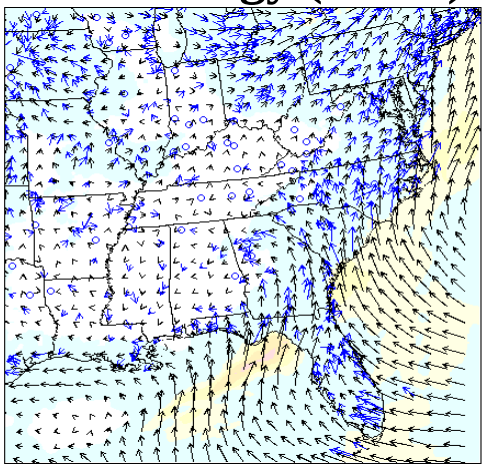
- Project Overview
- 2007 and 2018 Emission Inventories
- 2018 Ozone Projections
- NOx and VOC Sensitivities
  - Absolute
  - Relative
  - Normalized
- Interstate Contributions
- Next Steps

SEMAP Project

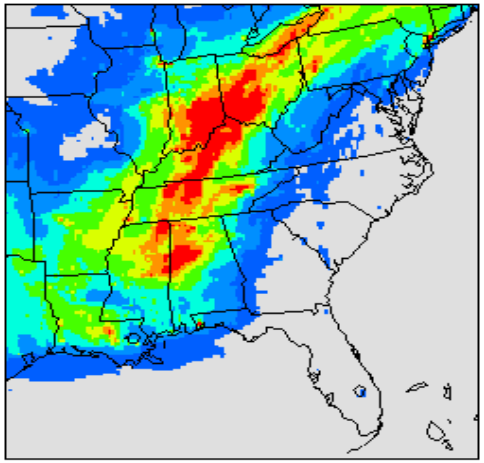
- **S**outh**E**astern **M**odeling, **A**nalysis, and **P**lanning (SEMAP) Project
  - Managed through SESARM
    - Technical Analysis Workgroup, Meteorological Workgroup, Emission Inventory Workgroup, Emissions and Air Quality Modeling Workgroup
    - Special Sub-Groups: Fires, EGUs, MOVES
  - Same group of states that were involved with SAMI, VISTAS, and ASIP
    - AL, FL, GA, KY, MS, NC, SC, TN, VA, WV

Air Quality Modeling System

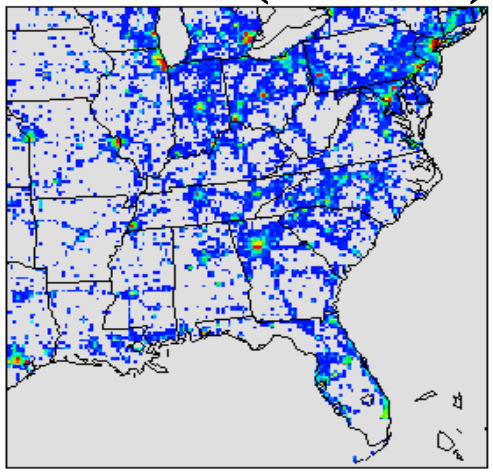
Meteorology (WRF)



Air Quality (CMAQ)



Emissions (SMOKE)



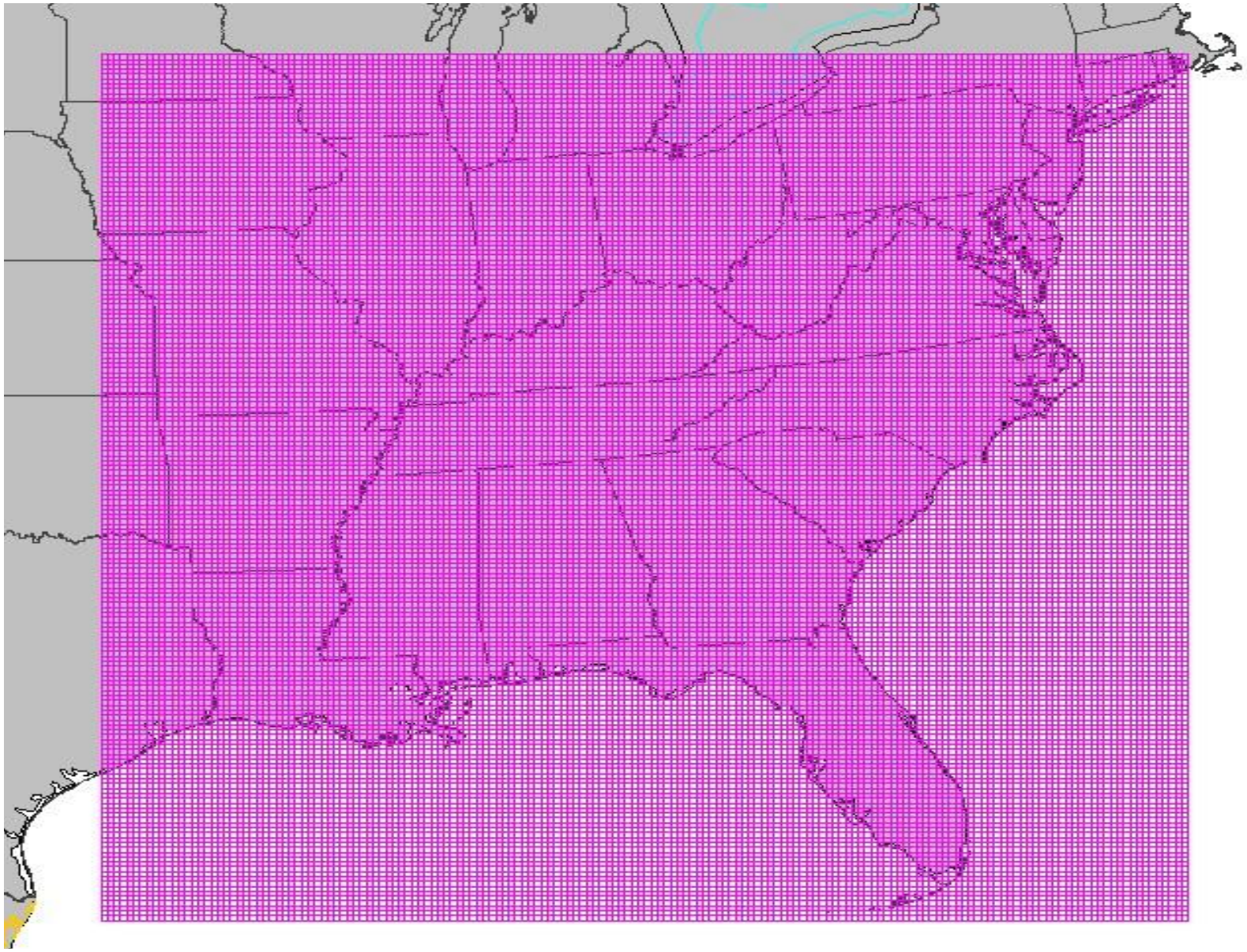
Emissions Inventory (NIF)

MOVES Rates

Modeling Overview

- 2007 and 2018 annual modeling with CMAQv5.01
  - 36 km (CONUS) and 12 km grids
  - Updated mixing coefficients
  - Updated land-water interface
  - Acceptable model performance
- 2018 future year projections with MATS software (RRFs and DVFs)
  - Ozone - presented here
  - $PM_{2.5}$ - will be available soon…
  - Regional Haze - will be available soon…

SEMAP 12-km Modeling Domain



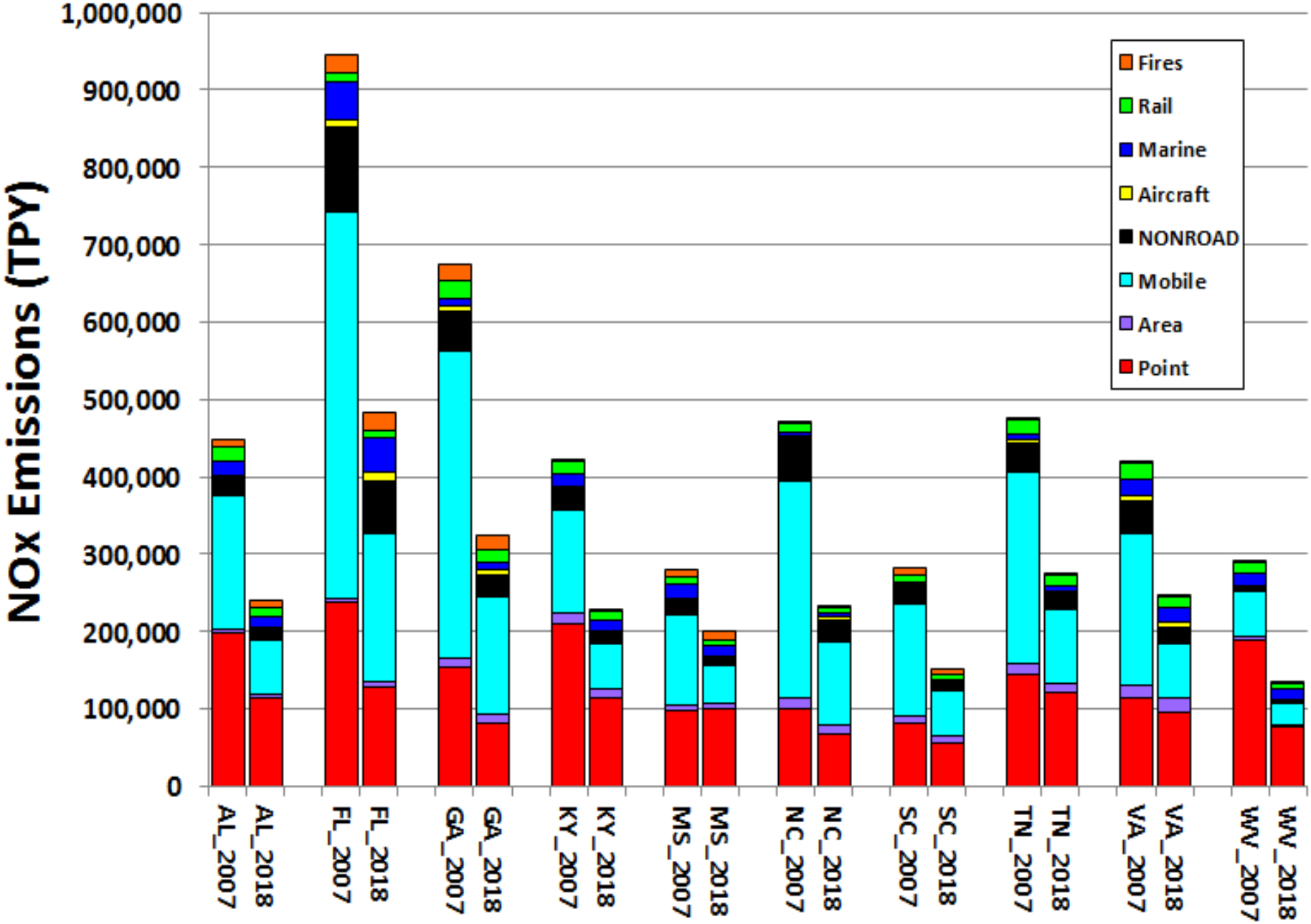
2007 Emission Inventory

- SEMAP Emissions Inventory
  - AMEC/Alpine ➔ Point source (EGU and non-EGU), fire, and on-road mobile (MOVES2010a)
  - SC&A, Inc. ➔ Area and non-road/MAR
  - "Actual" Emission Inventory (2007)
    - Used for model performance evaluations
  - "Typical" Emission Inventory (2006-2008)
    - Fires only (not EGUs)
    - Used for RRF calculations
- Non-SEMAP Emissions Inventory
  - 2007 MARAMA, 2007 LADCO, 2008v2 NEI

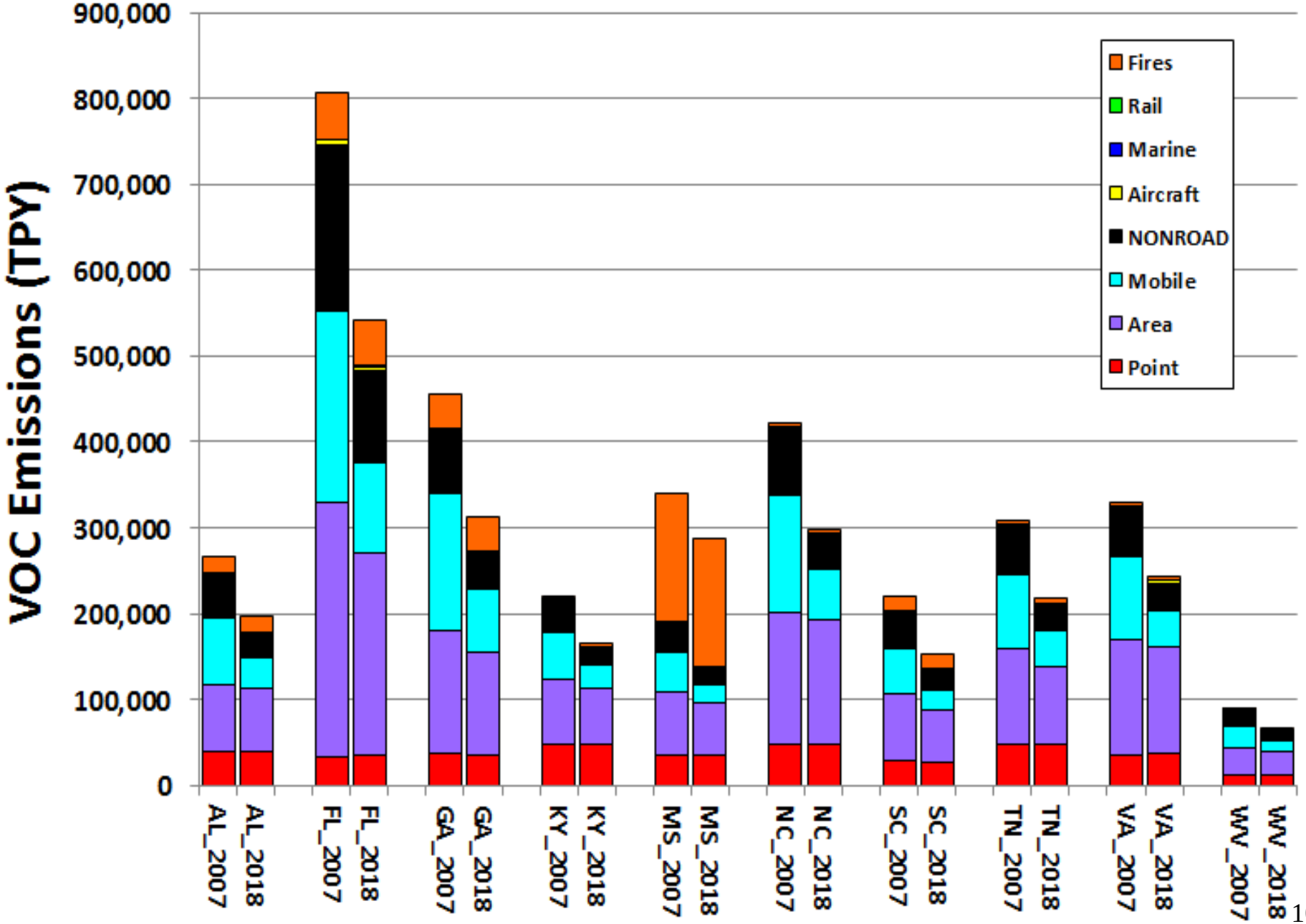
2018 Emission Inventory

- SEMAP Point, Area, and MAR
  - Applied growth & control factors (2017-2025)
- SEMAP Non-road Mobile
  - Reran NONROAD model for 2018
- SEMAP On-road Mobile
  - Scaled hourly SMOKE-MOVES outputs with 2018/2007 ratios based on 2007 and 2018 inventory mode runs
    - Vary by pollutant, state/county, annual/month, SCC
  - Does not include Tier 3 controls
- SEMAP Fires
  - Same as 2007 typical
- Non-SEMAP Emissions
  - 2017 MARAMA (w/ existing controls)
  - 2007 LADCO and 2008v2 NEI for area sources
  - EPA 2017 Projections for point and mobile (on-road and non-road)

SEMAP NOx Emissions



SEMAP VOC Emissions



Calculation of DVF

- Ran MATS with 2007 typical as “baseline” and 2018 base-case as “forecast” to get RRFs
  - RRF = ($2018_{base}/2007_{typ}$)
- DVF = DVC $\times$ RRF
- Calculated four different ways:
  - Design Value Current (DVC)
    - 2007 DV (2005-2007)
    - 5-year (2005-2009) weighted average
  - Relative Response Factor (RRF)
    - **Monitor (1 x 1) cell**
    - **3 x 3 cell maximum**

2007

95	80	80
80	84	80
80	80	85

➔

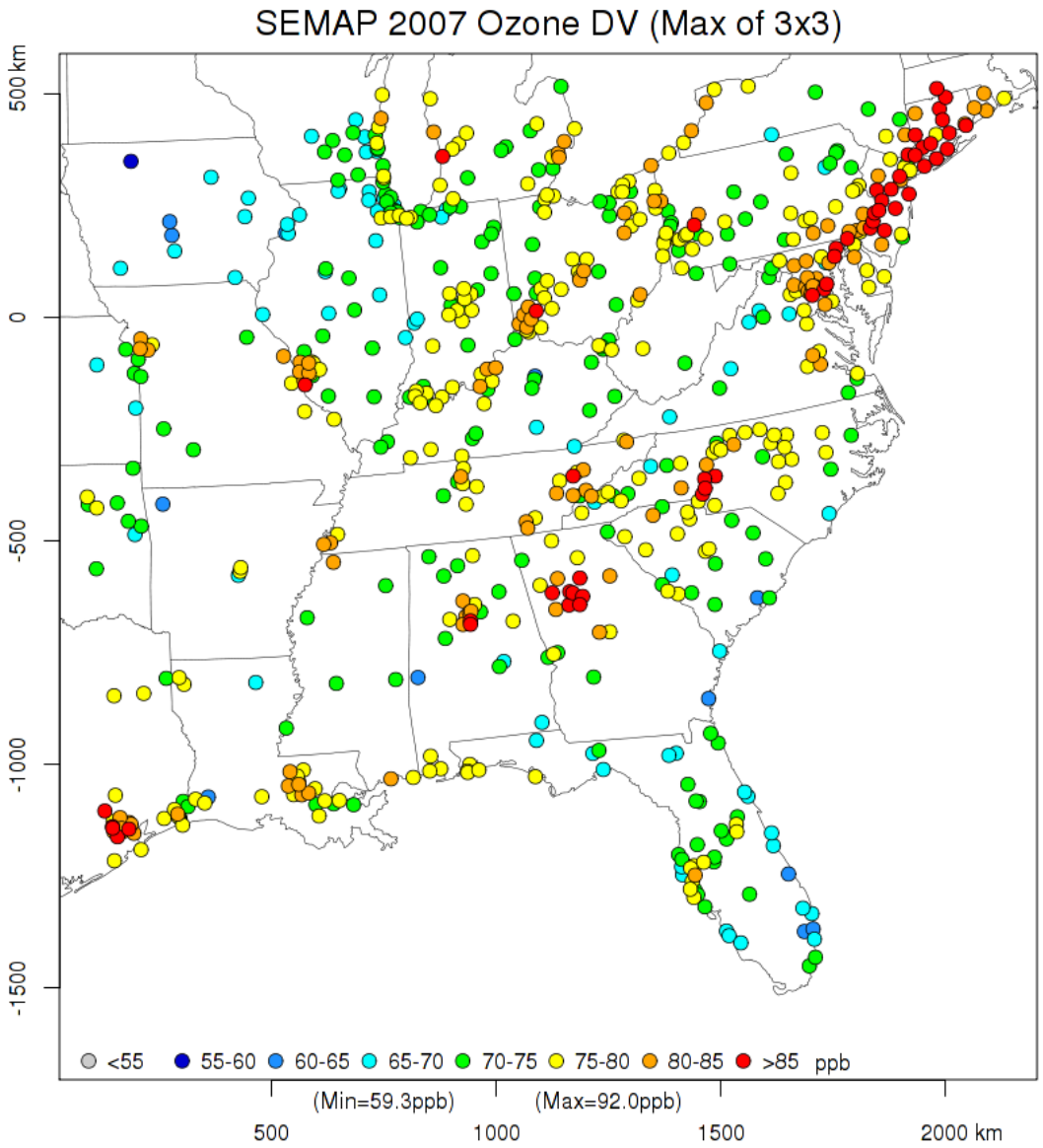
2018

75	70	75
70	79	75
75	75	80

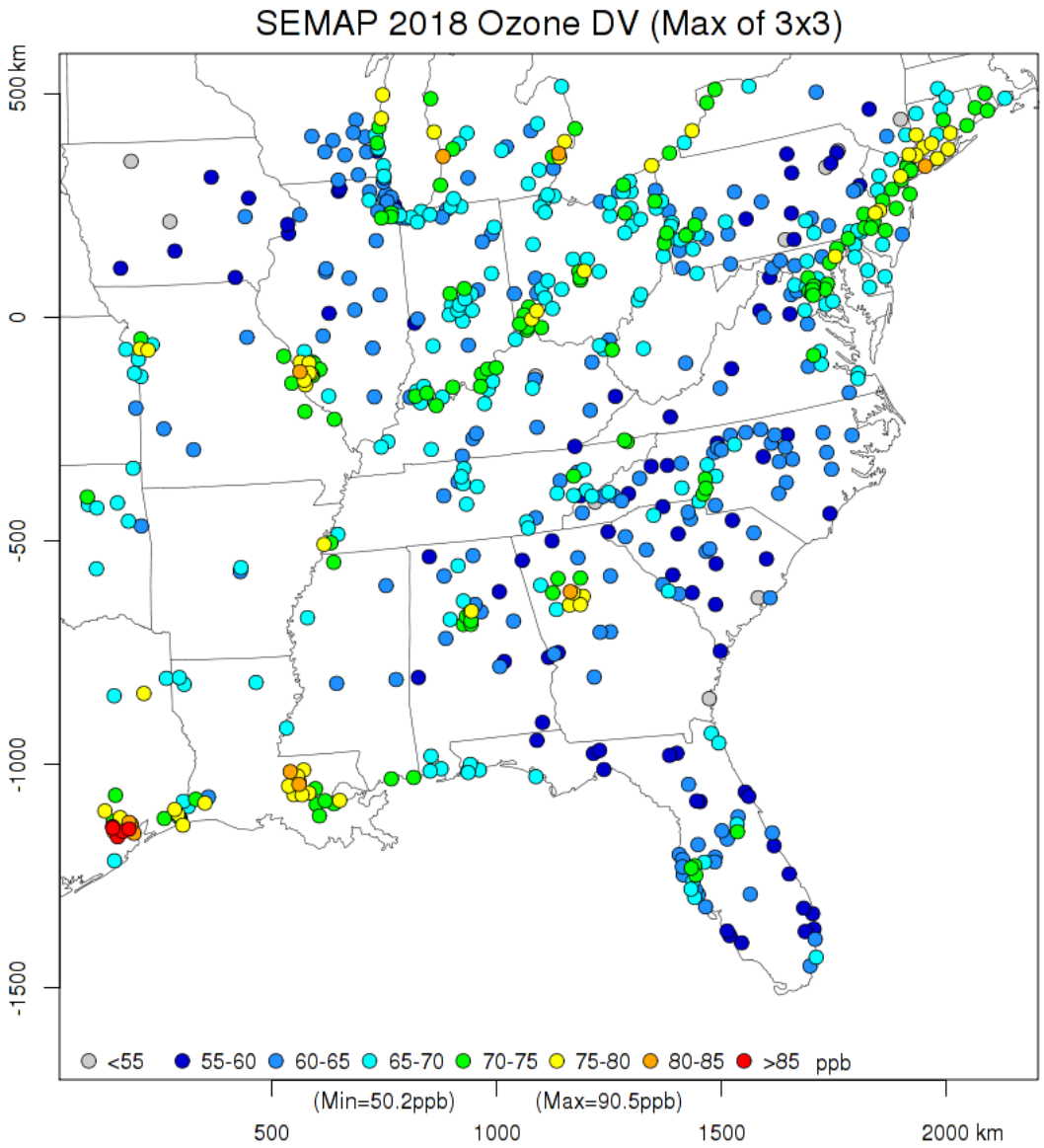
DVF RRF Thresholds

- RRF thresholds based on modeled 2007 baseline daily 8-hour maximum ozone concentration
  - Initial threshold value (ppb) = 75
  - Minimum number of days in baseline at or above threshold = 10
  - Minimum allowable threshold value (ppb) = 65
  - Min number of days at or above minimum allowable threshold = 5

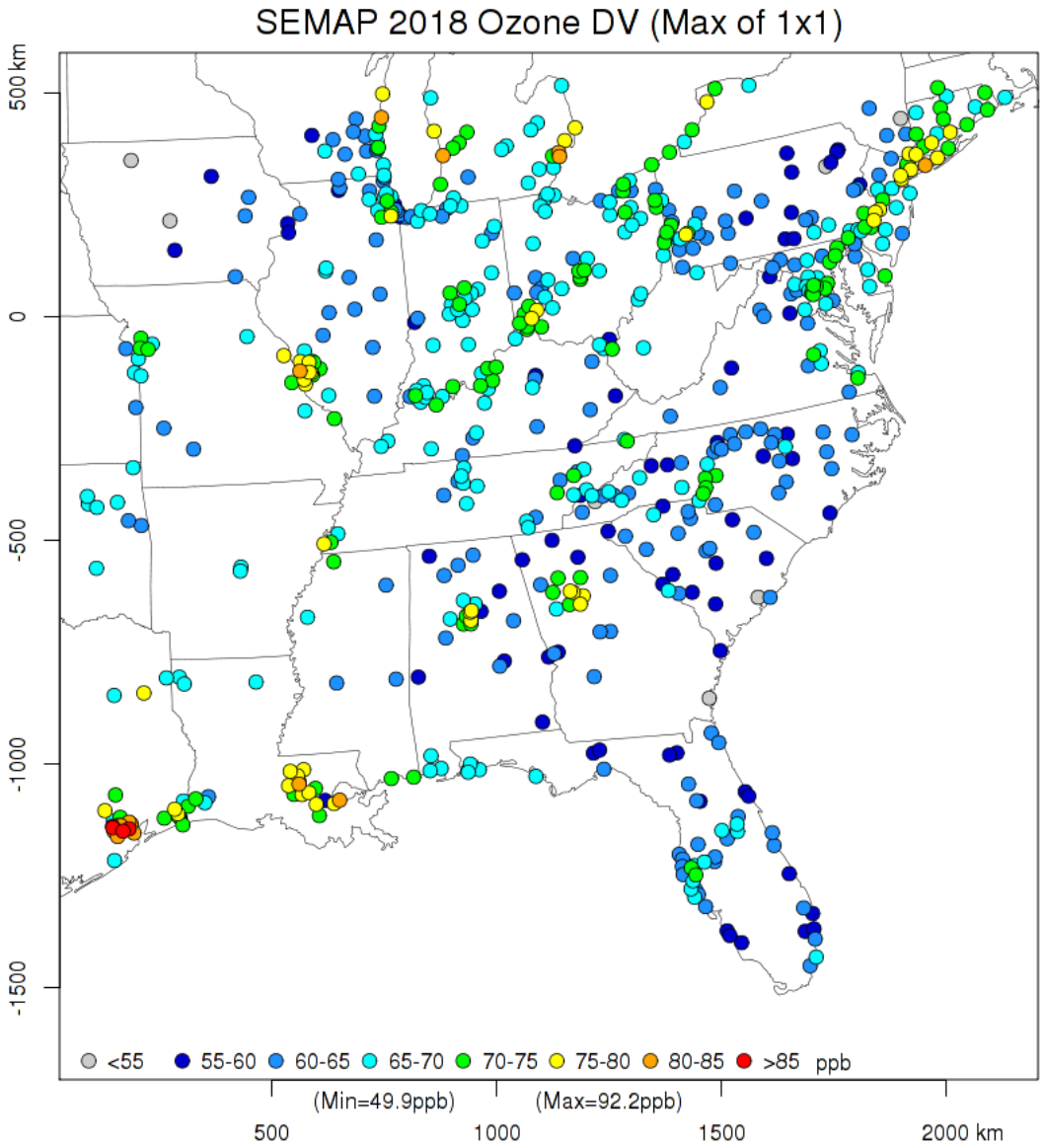
5-Year Weighted DVC (2005-2009)



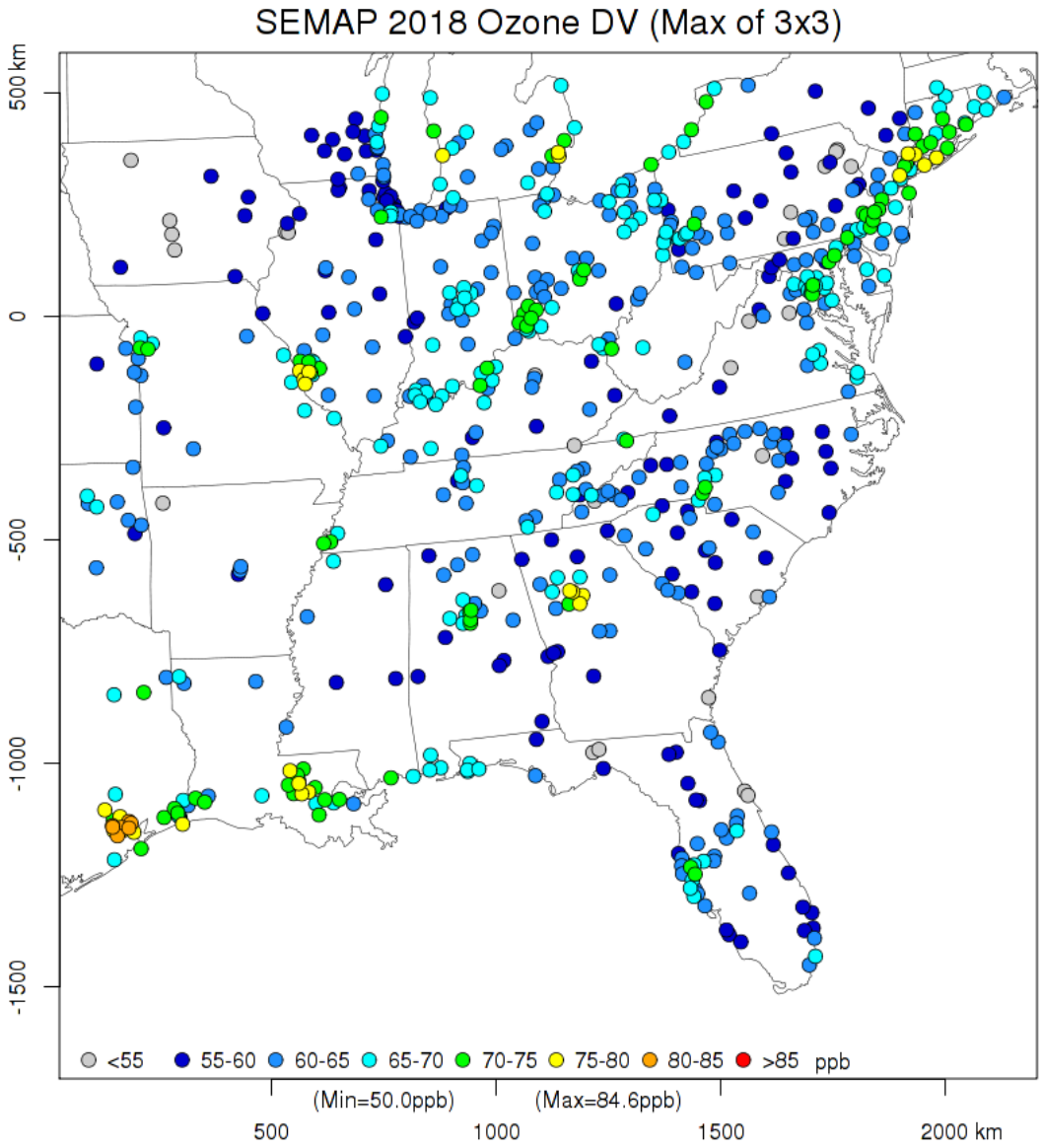
2018 DVFs: 3×3 RRF & 2007 DVC



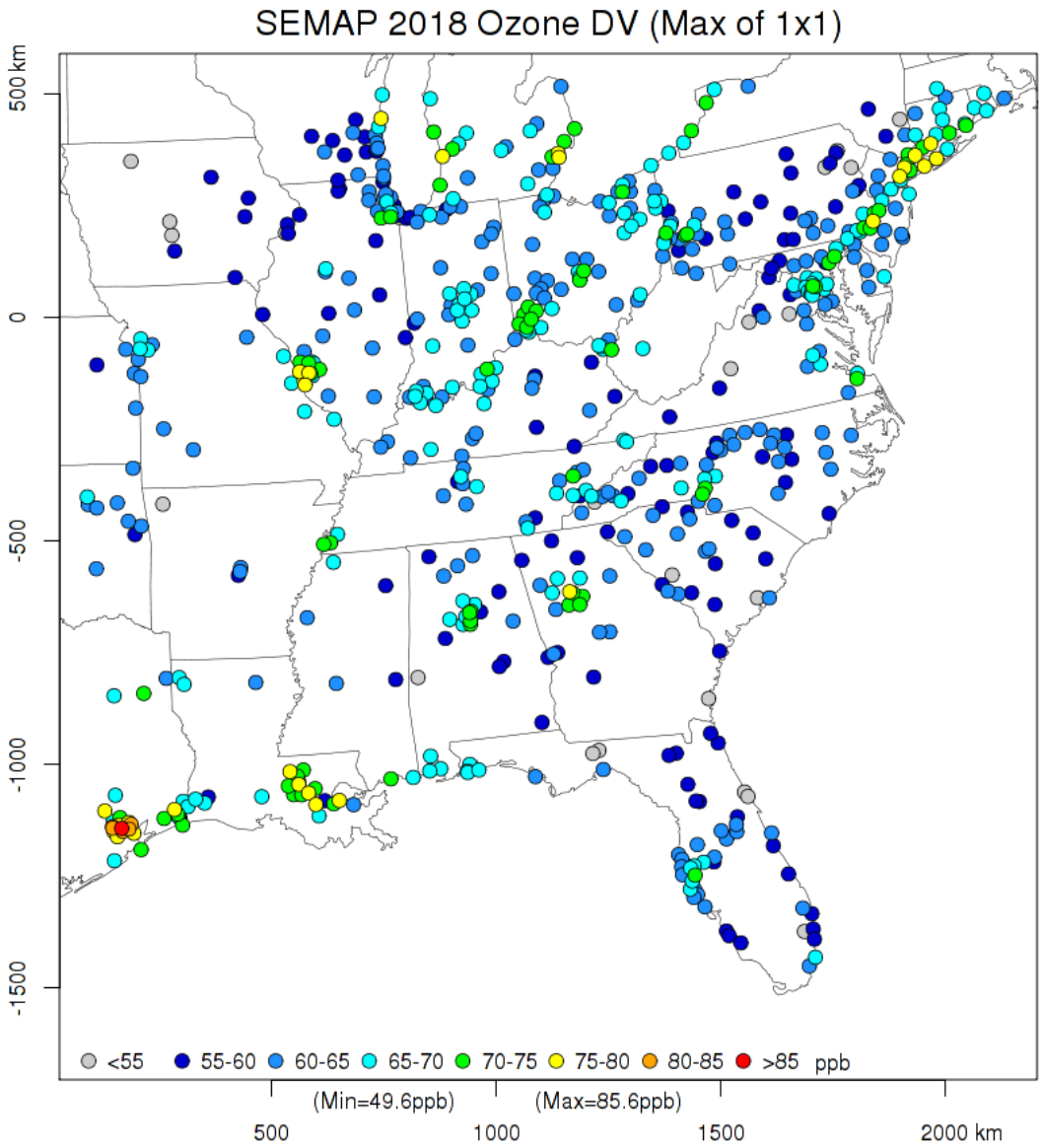
2018 DVFs: 1x1 RRF & 2007 DVC



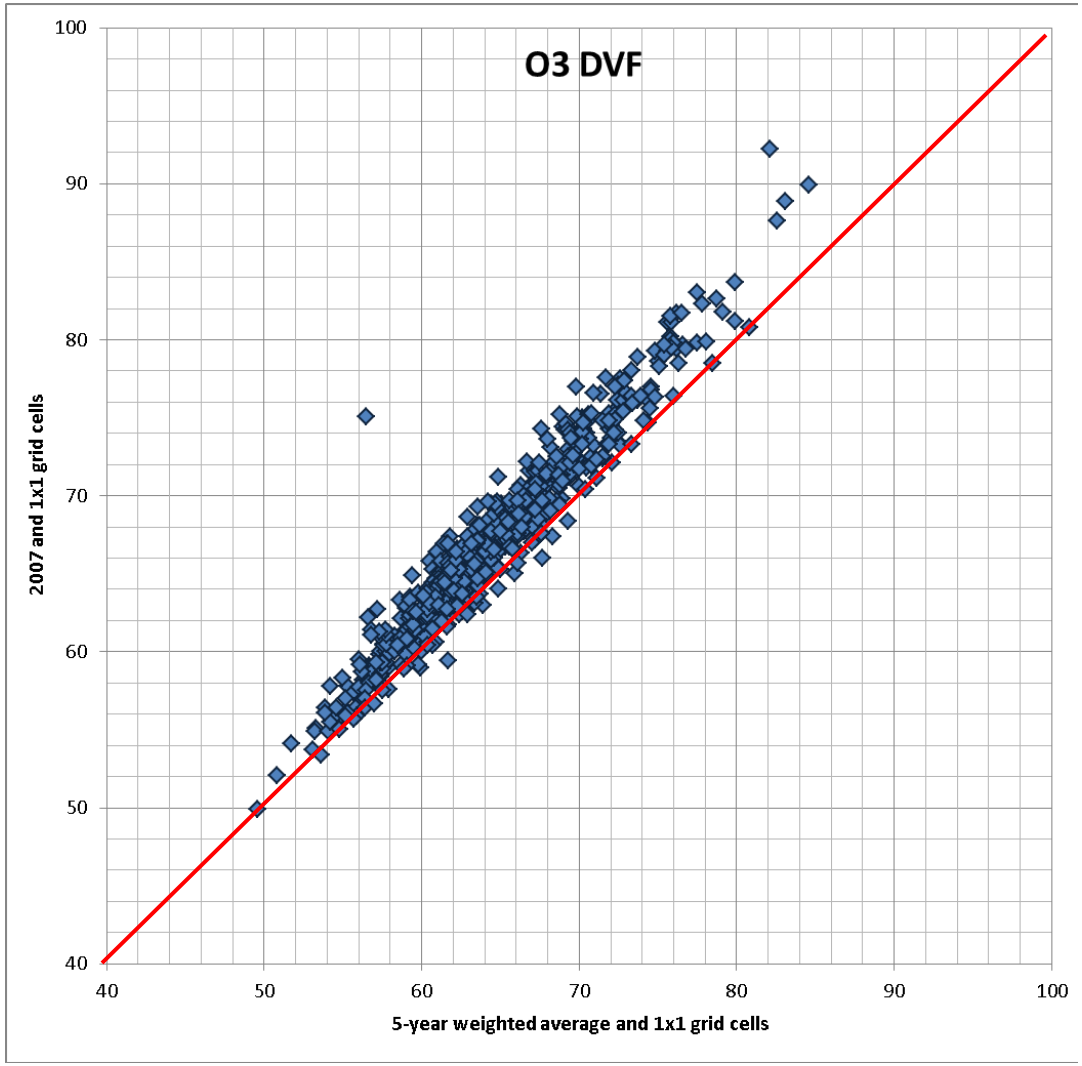
2018 DVFs: 3×3 RRF & 2005-2009 DVC



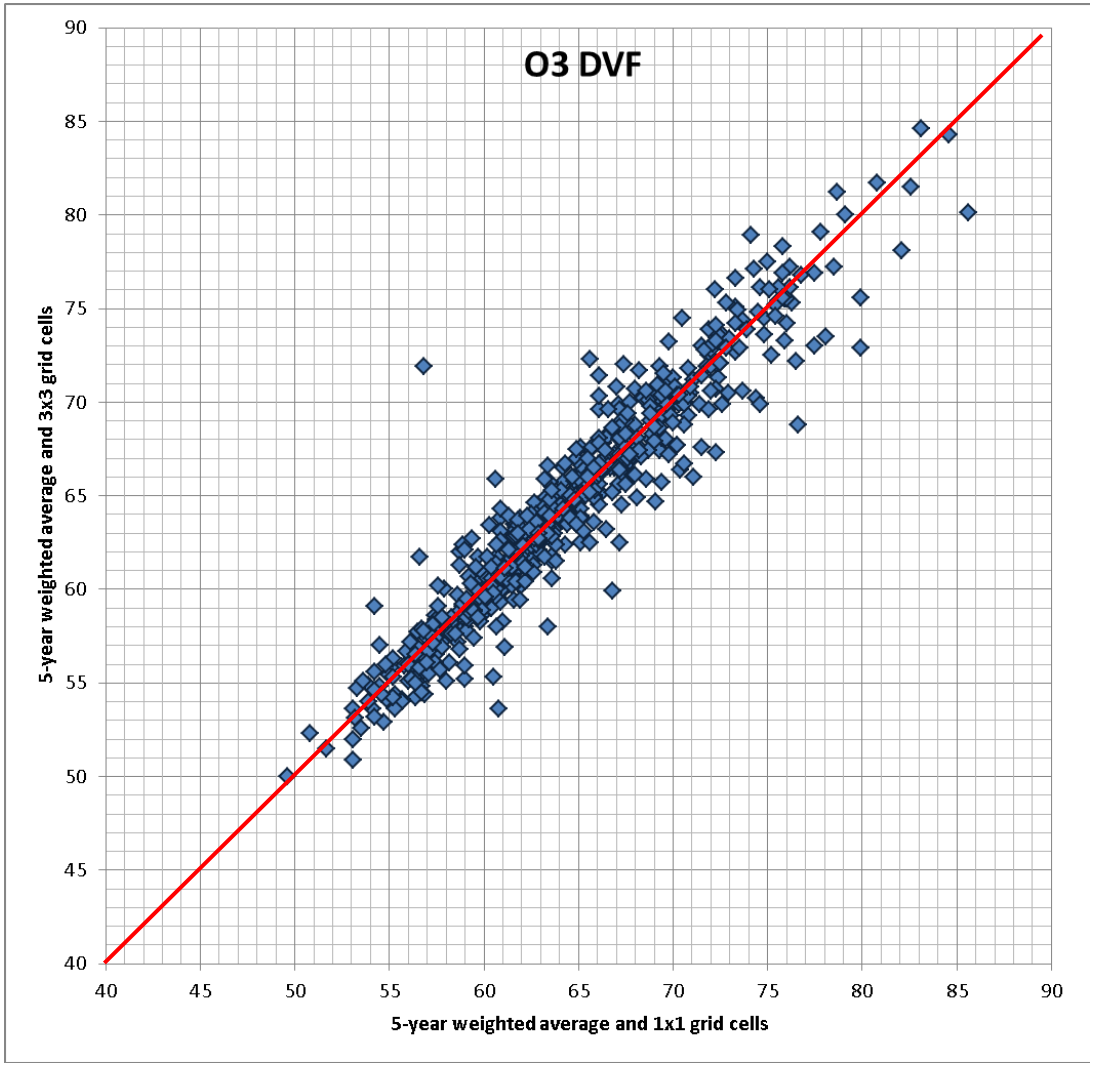
2018 DVFs: 1×1 RRF & 2005-2009 DVC



2007 vs. 5-year weighted DVC



3×3 Max vs. 1×1 Cell RRFs



2018 Ozone "Nonattainment"

- DVF ≥ 75 ppb based 2005-2009 DVC
  - 3x3 max and/or 1x1 cell

STATE	AIRS ID	DVC	3x3 MAX	1x1 CELL
CT	90010017	86.3	76	75.1
CT	90013007	87	74.6	75.4
GA	130890002	90.7	77.1	74.3
GA	131210055	90.3	77.2	76.2
GA	131510002	92	76.1	74.6
GA	132470001	91.7	75.1	73.3
LA	220050004	81.7	75.3	76.3
LA	220330003	83	76.1	76.2
LA	220470012	81.3	75.3	72.8
LA	220511001	79.3	72.9	79.9
LA	220770001	82	77.5	75
LA	220930002	74	68.8	76.6
MI	260050003	86.7	75.4	75.6
MI	260991003	81.3	76.9	75.8
MI	261630019	81.7	75.6	79.9
MO	290990012	86	77.2	78.5
MO	291890004	82	76.1	75.6
MO	291890014	82.3	75.5	75.9
MO	295100086	83.5	76.9	77.5
NJ	340070003	87.5	74.2	76
NJ	340170006	85	75.2	75.4

STATE	AIRS ID	DVC	3x3 MAX	1x1 CELL
NY	360610135	76	72.5	75.2
NY	361030002	85.3	78.3	75.8
NY	361030009	88	76.8	76.8
NY	361192004	86.3	76.6	73.3
TX	480391004	86.7	81.2	78.7
TX	482010024	83.3	78.9	74.1
TX	482010026	80.3	80	79.1
TX	482010029	86.7	75.5	76
TX	482010051	81	75.6	75.8
TX	482010055	90.3	84.3	84.6
TX	482010062	81	78.1	82.1
TX	482010066	86.7	81.5	82.6
TX	482010070	75.7	73	77.5
TX	482010075	76.3	73.5	78.1
TX	482010416	83.5	80.1	85.6
TX	482011015	82	81.7	80.8
TX	482011034	78	75.1	
TX	482011039	87	84.6	83.1
TX	482011050	81.3	79.1	77.8
TX	482450009	78.3	73.3	75.9
TX	482450101	79	76	72.2
WI	551170006	83.3	72.2	76.5

2018 Ozone "Maintenance"

- DVF < 75 ppb based 2005-2009 DVC
- DVF ≥ 75 ppb based 2007 DVC
  - 3x3 max and/or 1x1 cell

STATE	AIRS ID	DVC	3x3 MAX	1x1 CELL
AL	10730023	86	72.9	76.1
AL	10732006	89	74.3	75.6
AL	10736002	89	75.8	76.1
AR	50350005	89	76.6	76.6
CT	90011123	94	75.7	73.7
CT	90019003	87	75.4	73.3
CT	90093002	93	78.9	77
GA	131130001	89	75.8	71.8
IL	170310001	82	73.2	75.1
LA	220190002	81	76.4	69.2
LA	220330013	81	75.4	75.3
LA	220331001	84	78.6	77.5
LA	220470007	86	79.6	78.9
LA	220470009	81	75	74.3
LA	220890003	77	70	75.2
LA	221210001	83	76.7	77.1
MD	240251001	94	75.5	74.6
MI	260990009	86	77	76.6
MI	261210039	88	75.6	75
MI	261470005	85	74.9	76.5

STATE	AIRS ID	DVC	3x3 MAX	1x1 CELL
MO	290470005	87	76.4	74.6
MO	290470006	87	75.1	74.2
MO	291130003	87	74.5	75.1
MO	291831002	89	79	79.3
MO	291831004	89	78.8	77.6
MO	295100085	84	77.3	78
NY	360130006	86	75.8	74.7
NY	360290002	86	74.8	77.4
NY	360810124	79	72	76.8
NY	360850067	89	74.1	77
NY	361030004	90	76.6	73
OH	390071001	90	76.5	71.6
OH	390490029	87	76	74.9
OH	390610006	86	75.1	76.3
OH	391650007	88	75.5	75.4
PA	420030010	83	71	75.2
PA	420170012	92	75.8	75.6
PA	421010024	91	77.4	75.9
TX	481830001	84	76.4	75.3
TX	482011035	79	76.1	
TX	482450018	83	76.4	76.4
WI	550710007	86	75.8	75.2

Ozone Sensitivities

- Start with 2018 modeling results
- Perform emission sensitivity runs
  - Ozone season (5 months) on 12-km grid
  - Statewide 30% emission reductions
    - NO_x and VOCs individually
    - Point, area, mobile, NONROAD, MAR
  - 14 geographic regions
    - Ten individual SEMAP states
    - Maryland
    - MANE-VU (minus MD), LADCO, CENRAP
  - 2 precursors x 14 regions = 28 model runs

VOC/NO_x Sensitivity Updates

Previous Sensitivity Modeling	New Sensitivity Modeling
CMAQv4.4	CMAQv5.01
1-Month summer episode	5-Month ozone season
VISTAS 2009 OTW BaseD	SEMAP 2018
SEMAP-wide VOC reductions	State-wide VOC reductions
County/state NO_x reductions	State-wide NO_x reductions
MOBILE6	MOVES
Absolute difference	Absolute difference <u>and</u> RRF approach (MATS)
>70 ppb cutoff (based on modeled base year values)	>70 ppb cutoff (based on modeled future year values)

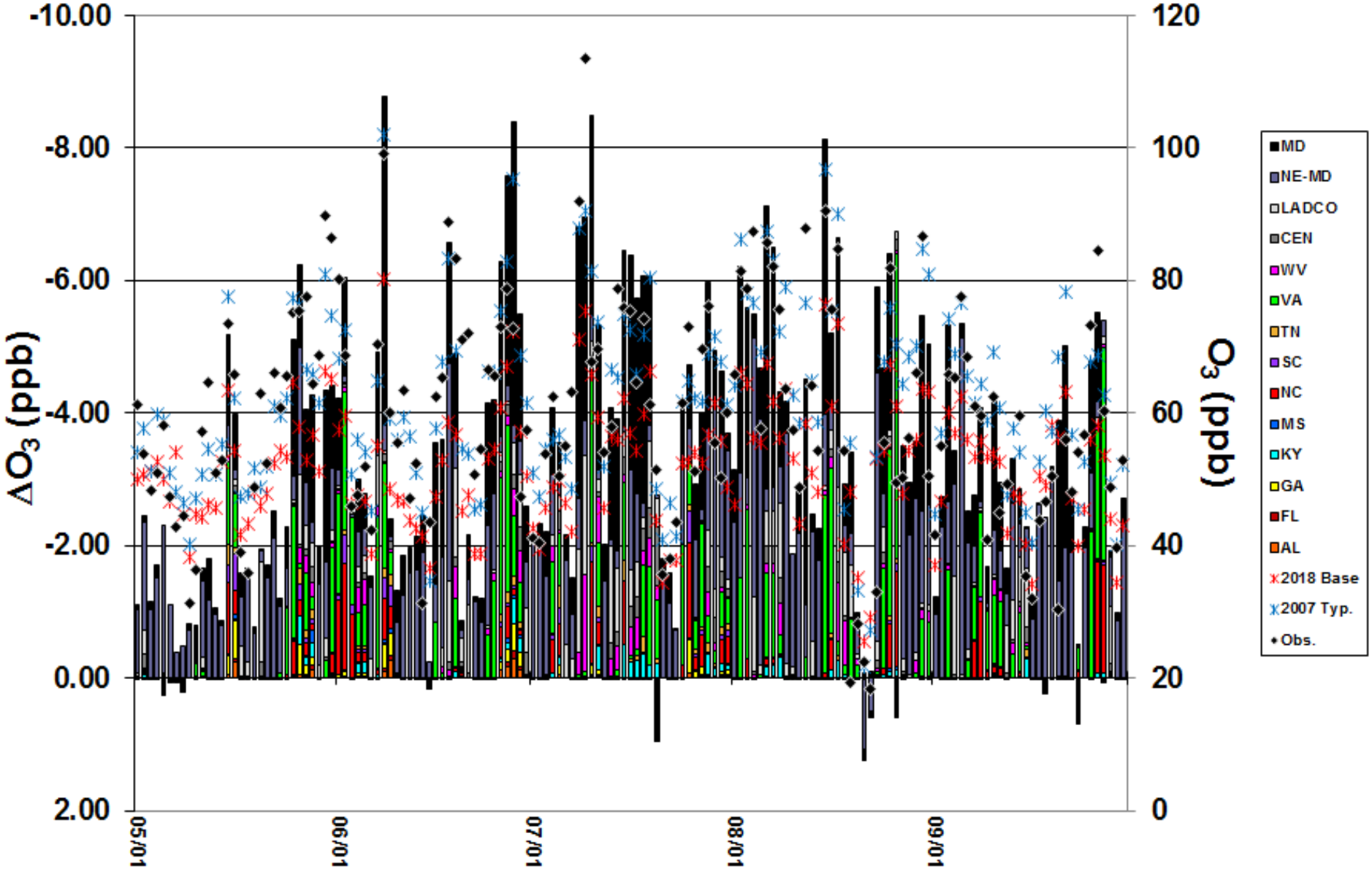
Calculation of ΔO_3

- "Absolute Sensitivity"
- Difference of daily max. 8-hr O_3 between 2018 sensitivity case and 2018 base case
  - $\Delta O_3 = 2018_{sens} - 2018_{base}$
- Averaged over days with 2018_{base} daily max. 8-hr O_3 above 70 ppb

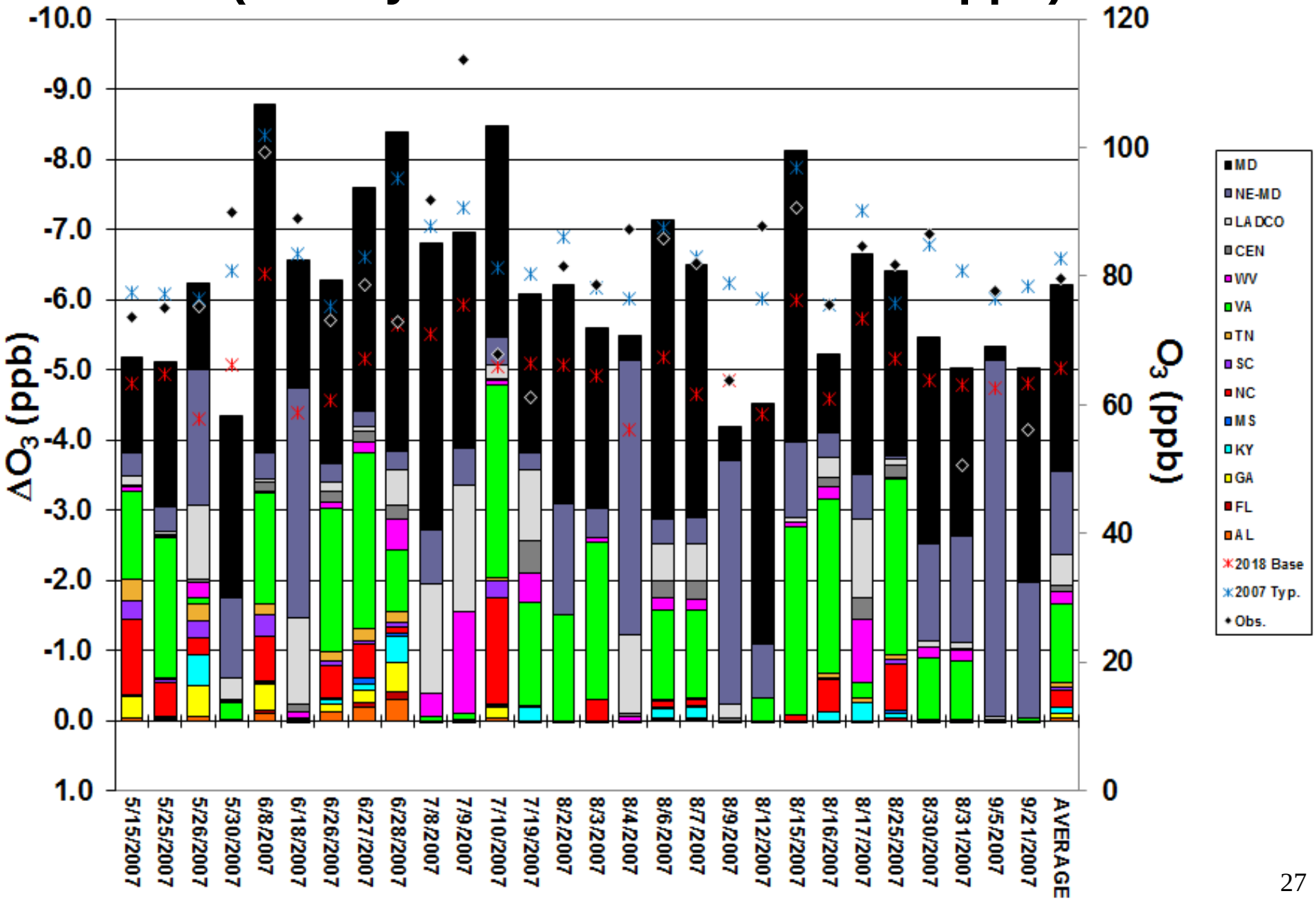
Site-by-Site Absolute Sensitivities

- For each of the 674 ozone monitoring sites in the domain
- NO_x and VOC sensitivities
  - All days
  - Days above 75 ppb in 2007
    - Used for 2007 to 2018 projections
  - Days above 70 ppb in 2018
    - Used for 2018 sensitivities
- Here:
  - 13-121-0055 (Confederate Ave., Atlanta, GA)
  - 24-025-1001 (Baltimore, MD)
- All other sites:
  - ***http://semap.ce.gatech.edu/node/1841***

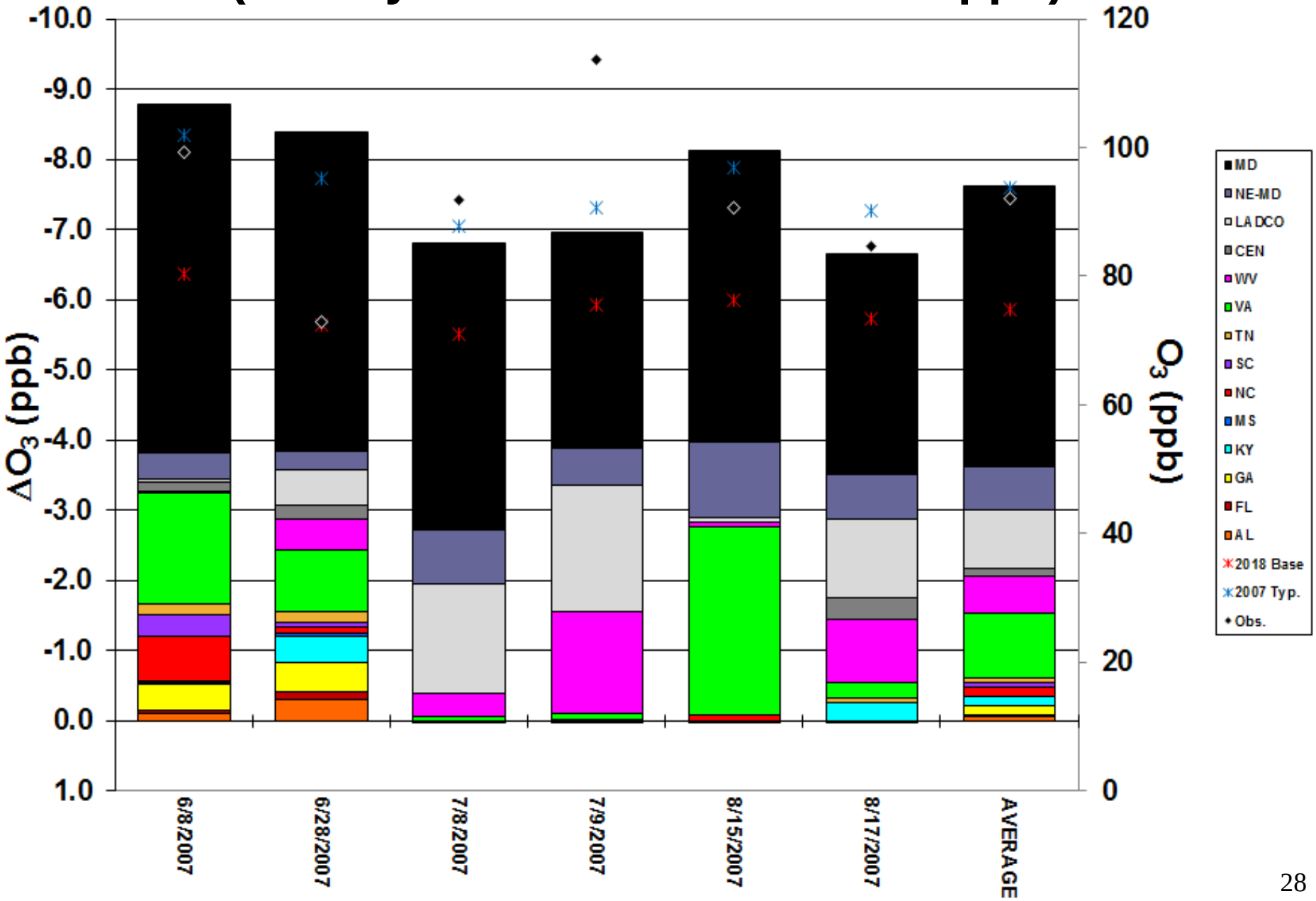
24-025-1001 Response to 30% NOx Reductions (All Days)



24-025-1001 Response to 30% NOx Reductions
(All Days with 2007 model > 75 ppb)



24-025-1001 Response to 30% NOx Reductions
(All Days with 2018 model > 70 ppb)



State Summaries

- State summaries were created for each of the 31 states in the domain
  - Includes sites with 2018 model days above 70 ppb
  - ***http://semap.ce.gatech.edu/node/1841***
- NO_x and VOC sensitivities
  - Absolute Sensitivity
    - ΔO_3 averaged over 2018 days above 70 ppb
  - Relative Sensitivity
    - ΔDVF using MATS (see next slide)
  - Normalized Relative Sensitivity
    - ΔDVF/Emissions (see next section)

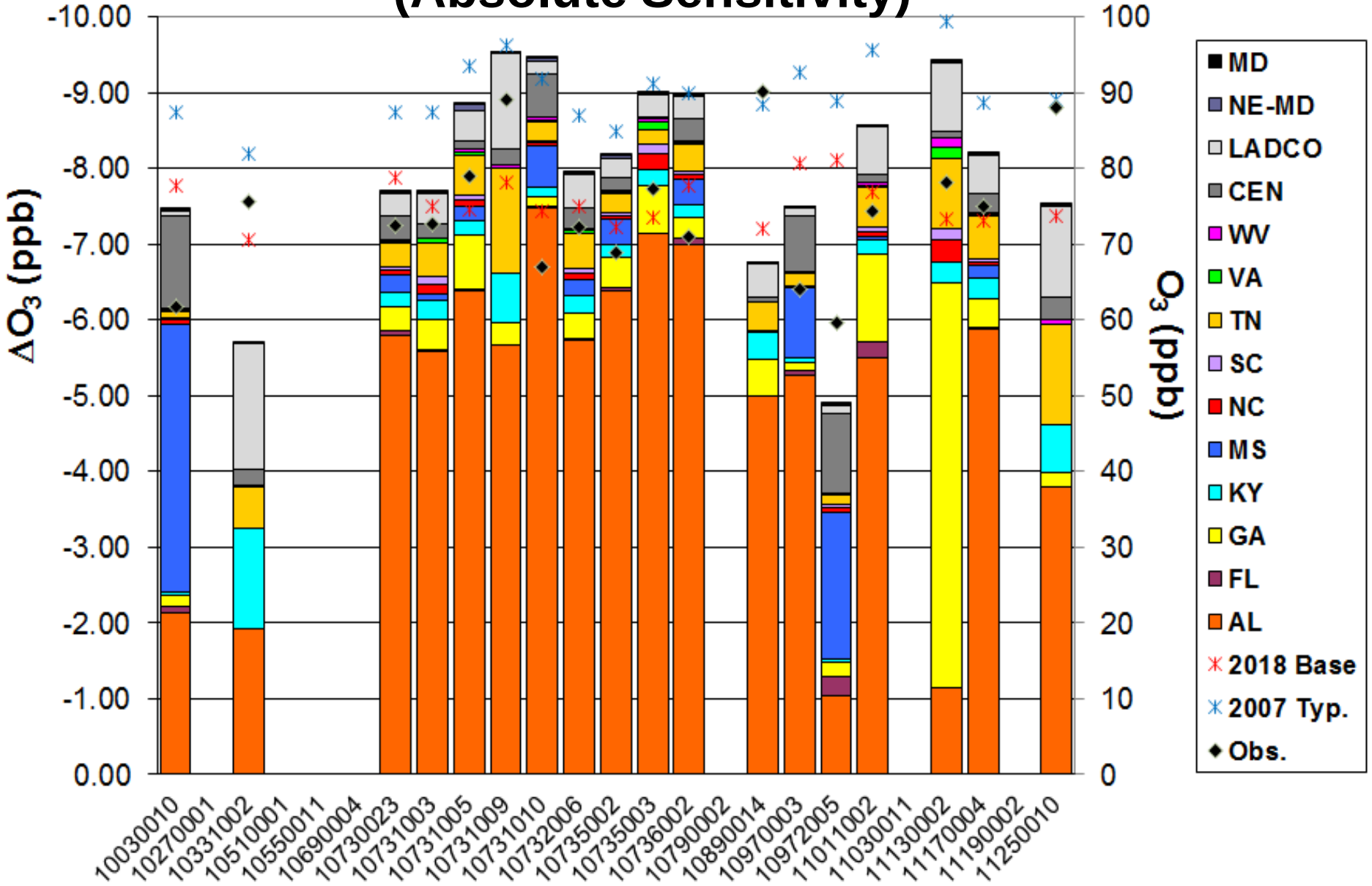
Calculation of ΔDVF

- "Relative Sensitivity"
- Ran MATS
  - 2018 base case as "baseline" and 2018 sensitivity as "forecast"
  - Starting DVF based on 5-year weighted average DVC and monitor (1×1) cell RRF
  - Includes sites with at least one 2018 model day above 70 ppb
- $RRF = (2018_{sens}/2018_{base})$
- $\Delta DVF = (DVF*RRF) - DVF = DVF*(RRF-1)$

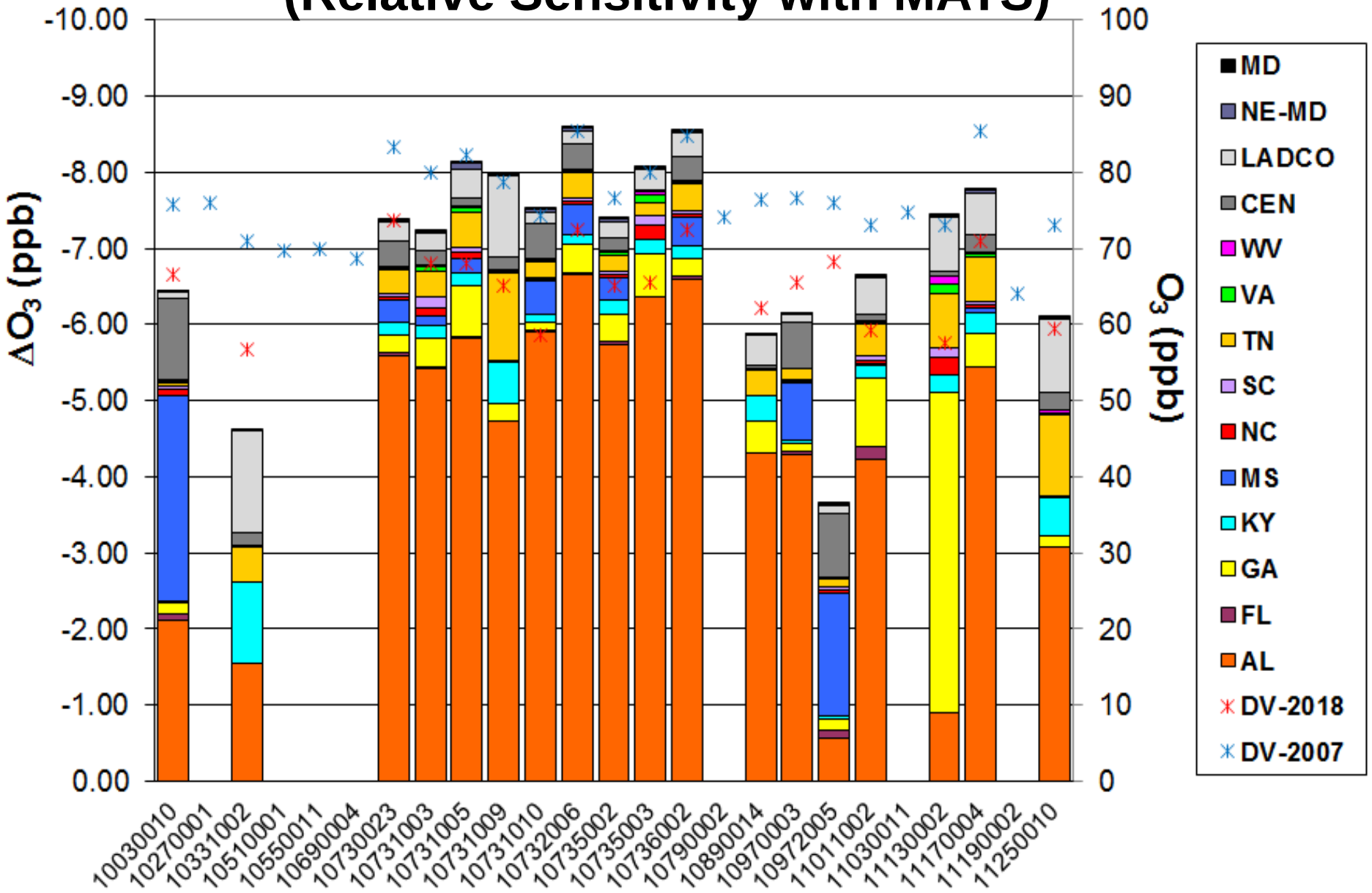
ΔDVF RRF Thresholds

- RRF thresholds based on modeled 2018 baseline daily 8-hour maximum ozone concentration
  - Initial threshold value (ppb) = 75
  - Minimum number of days in baseline at or above threshold = 10
  - Minimum allowable threshold value (ppb) = 70
  - Min number of days at or above minimum allowable threshold = 1

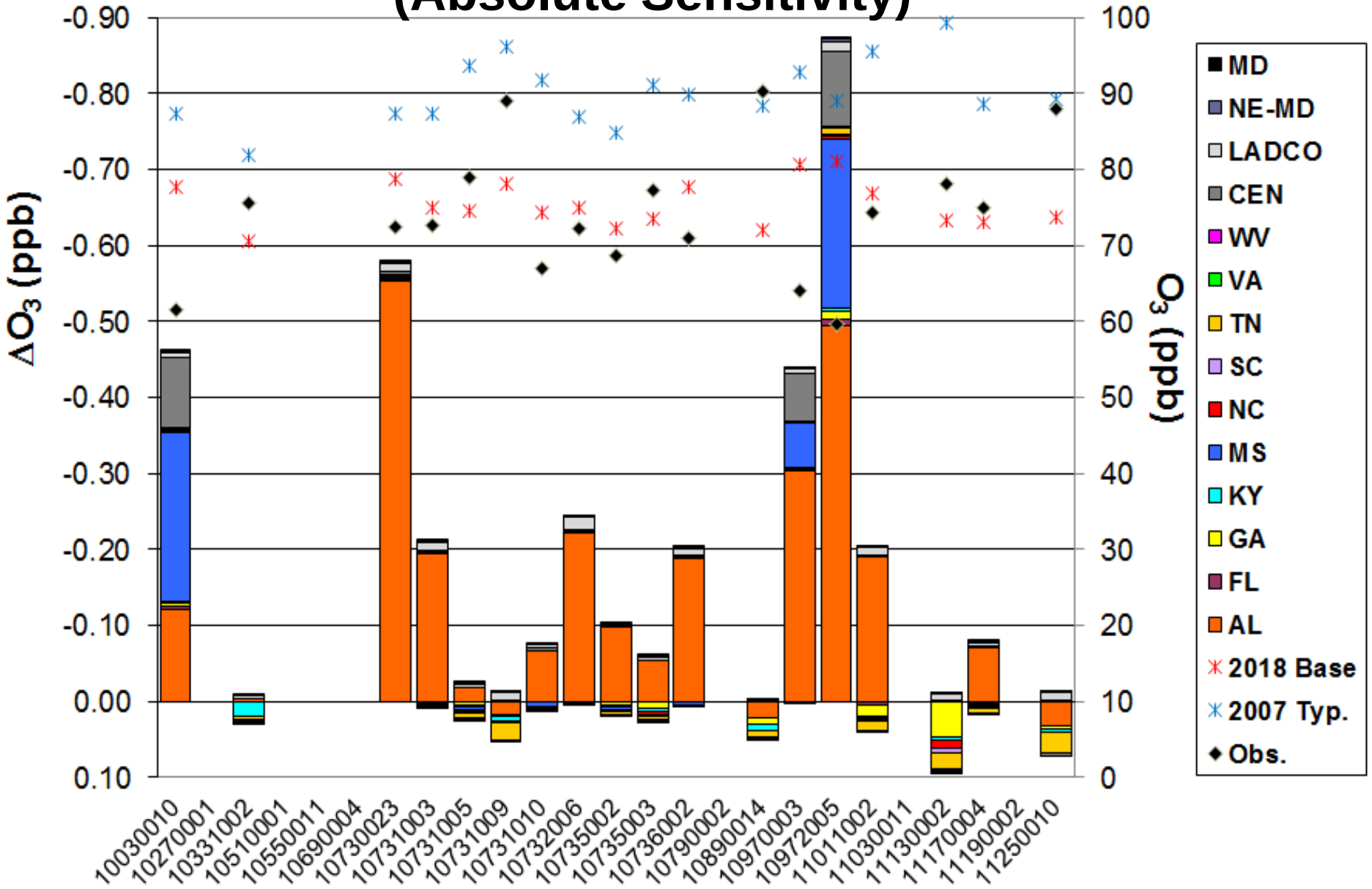
AL Responses to 30% NO_x Emission Reductions (Absolute Sensitivity)



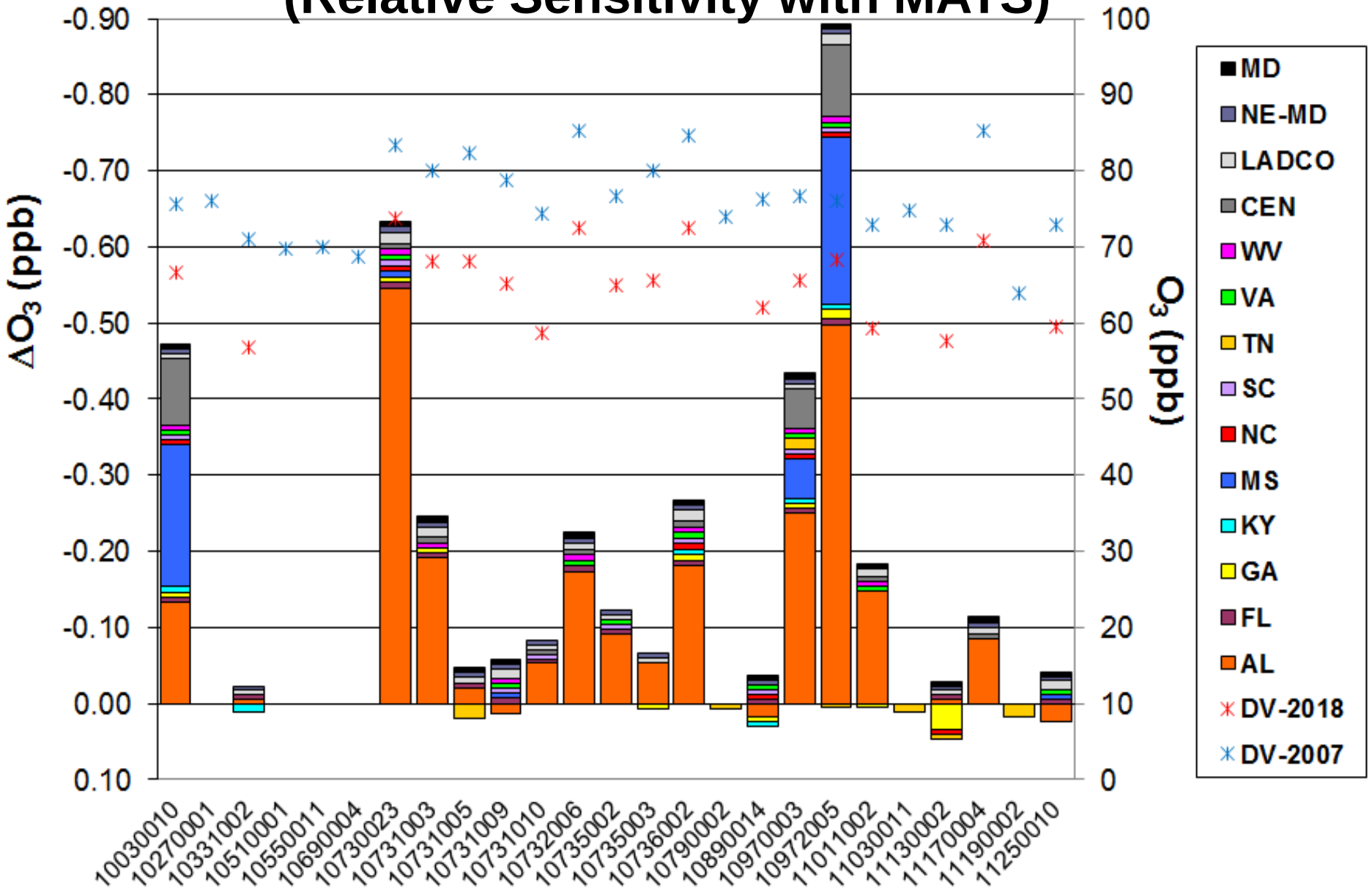
AL Responses to 30% NO_x Emission Reductions (Relative Sensitivity with MATS)



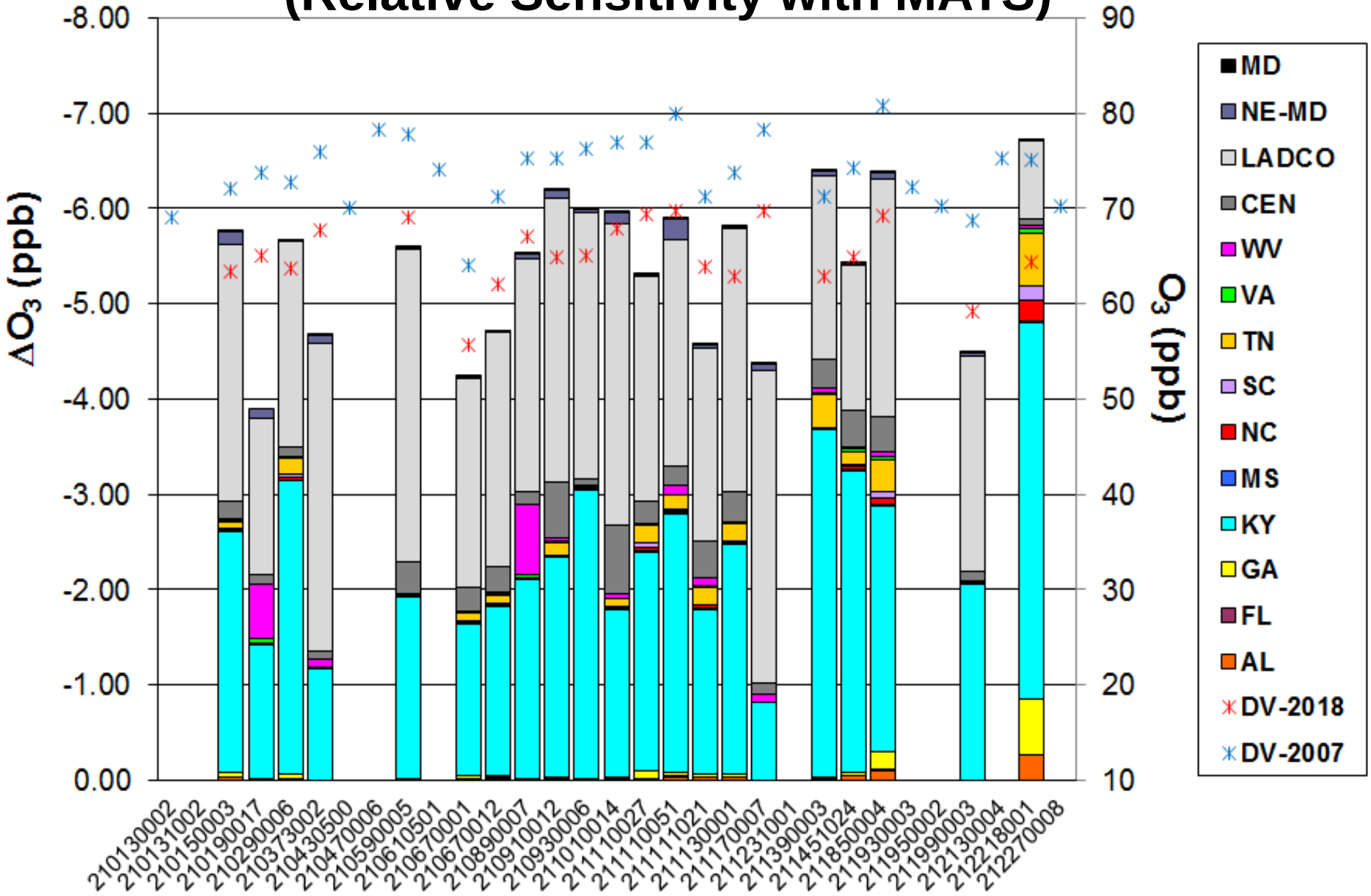
AL Responses to 30% VOC Emission Reductions
(Absolute Sensitivity)



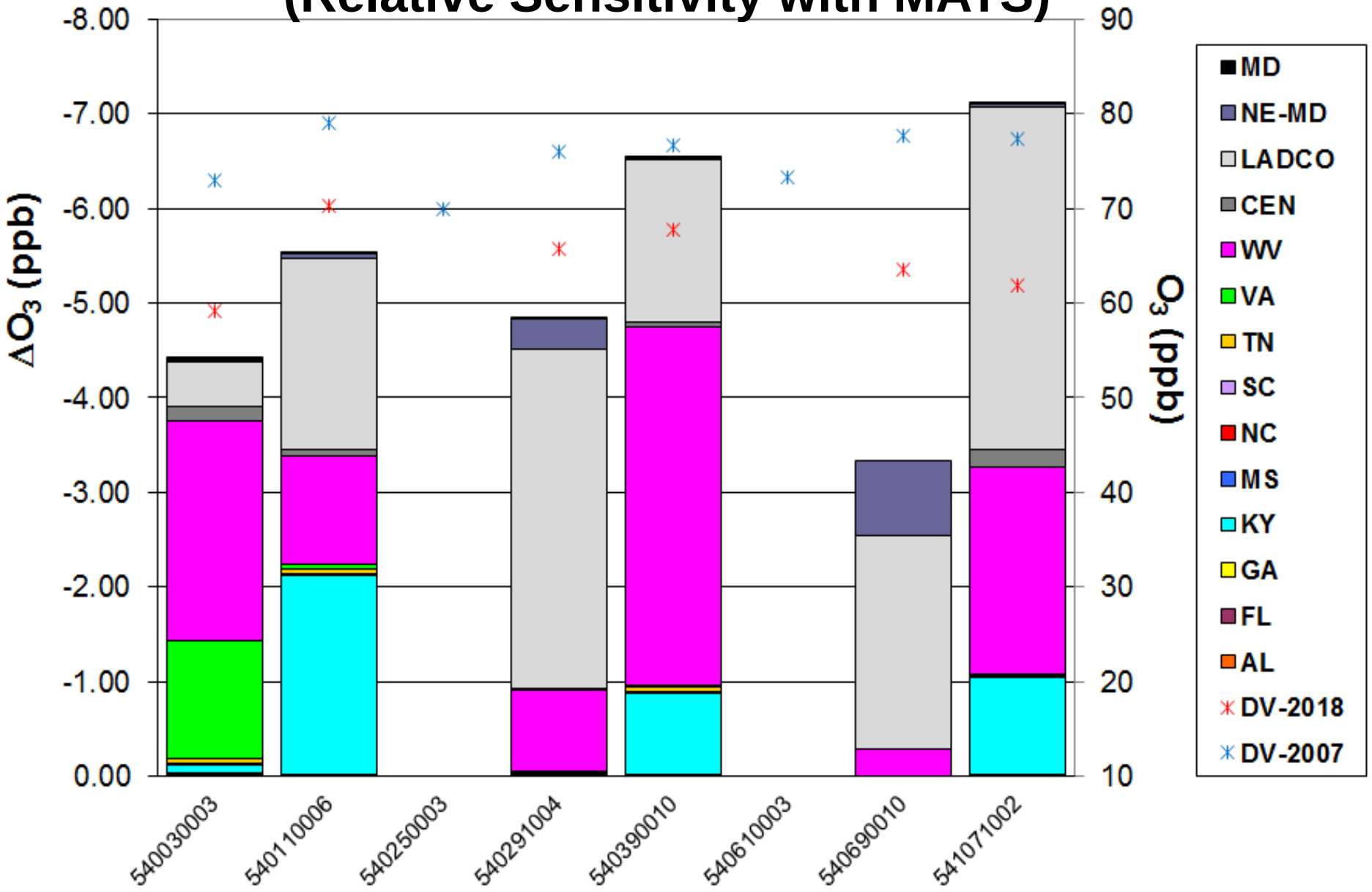
AL Responses to 30% VOC Emission Reductions
(Relative Sensitivity with MATS)



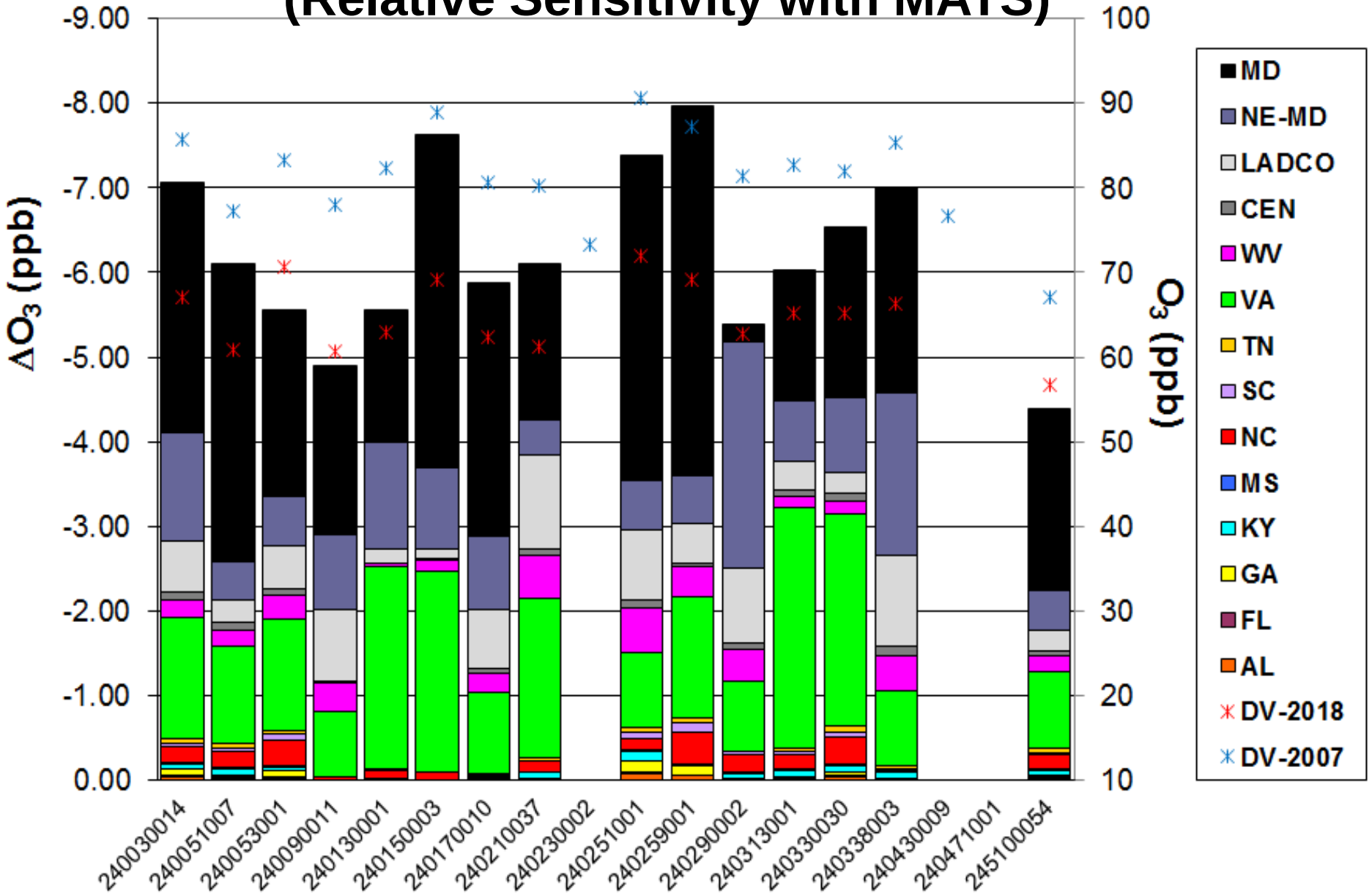
KY Responses to 30% NO_x Emission Reductions
(Relative Sensitivity with MATS)



WV Responses to 30% NO_x Emission Reductions (Relative Sensitivity with MATS)



MD Responses to 30% NO_x Emission Reductions (Relative Sensitivity with MATS)



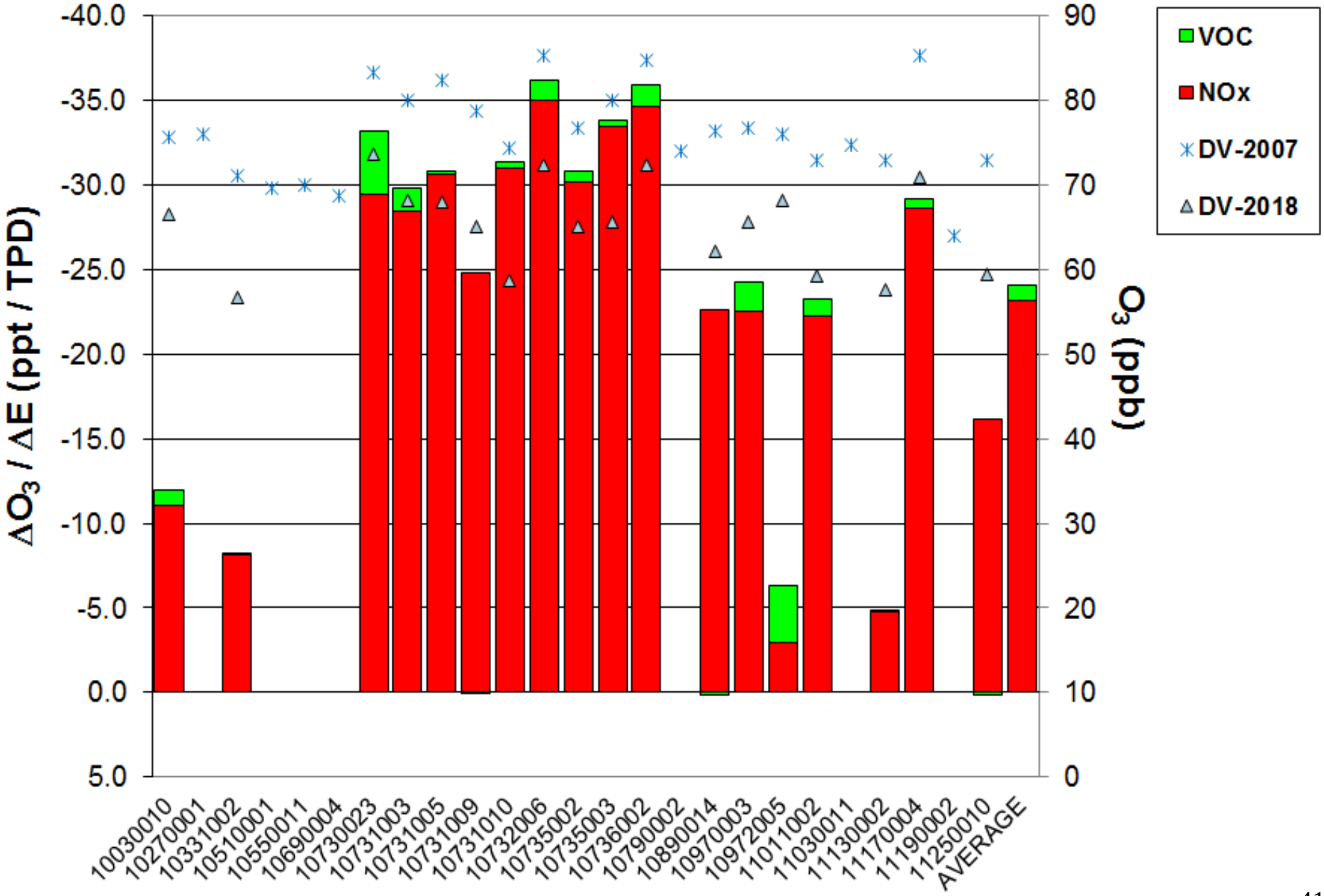
Normalized Sensitivities

- Divided the relative sensitivity from MATS for the home state by the annual average emissions reduction (ppt/TPD)
  - $(\Delta DVF_{NOx} \times 1000)/TPD_{NOx}$
  - $(\Delta DVF_{VOC} \times 1000)/TPD_{VOC}$
- Created stacked bar charts of normalized NOx and VOC sensitivities for each monitor
- Calculated state average normalized NOx and VOC sensitivities
- Calculated ratio of normalized NOx sensitivity to normalized VOC sensitivity for each monitor

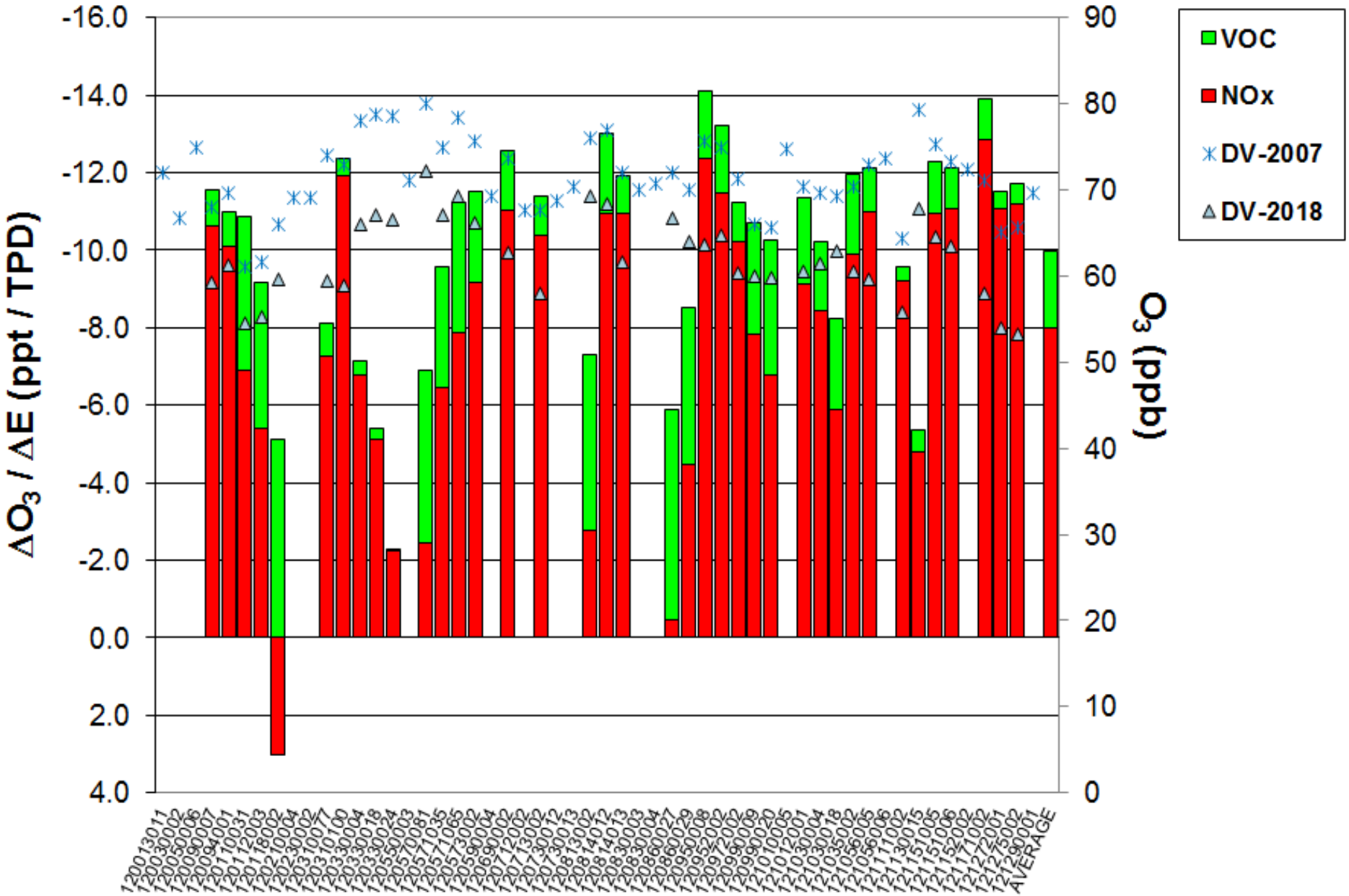
Emission Reductions (30%)

	NOx (TPD)	VOC (TPD)
Alabama	190	146
Florida	378	403
Georgia	251	223
Kentucky	185	133
Mississippi	156	113
North Carolina	190	242
South Carolina	119	112
Tennessee	223	174
Virginia	201	197
West Virginia	111	53

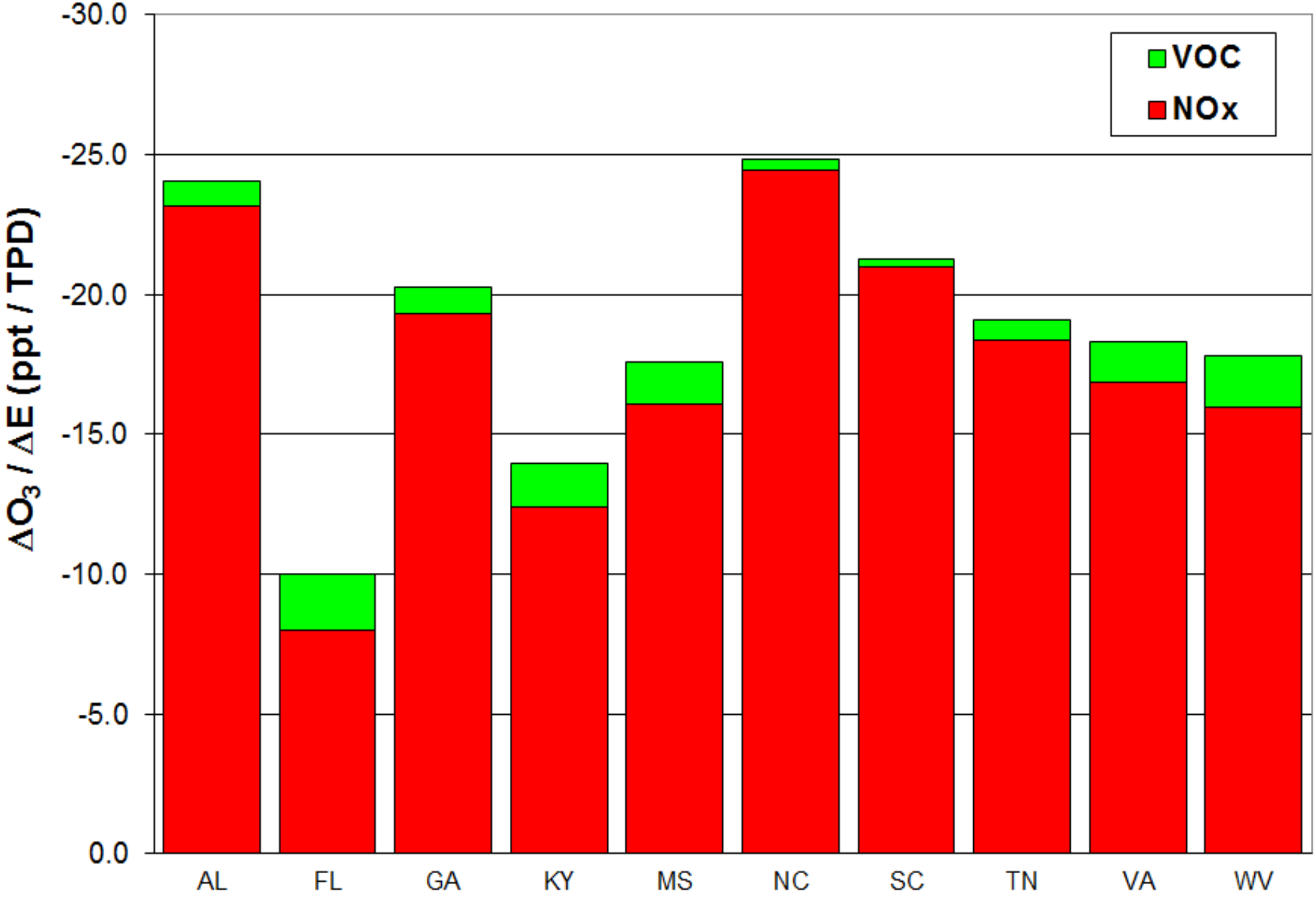
AL Responses Per TPD Emission Reduction



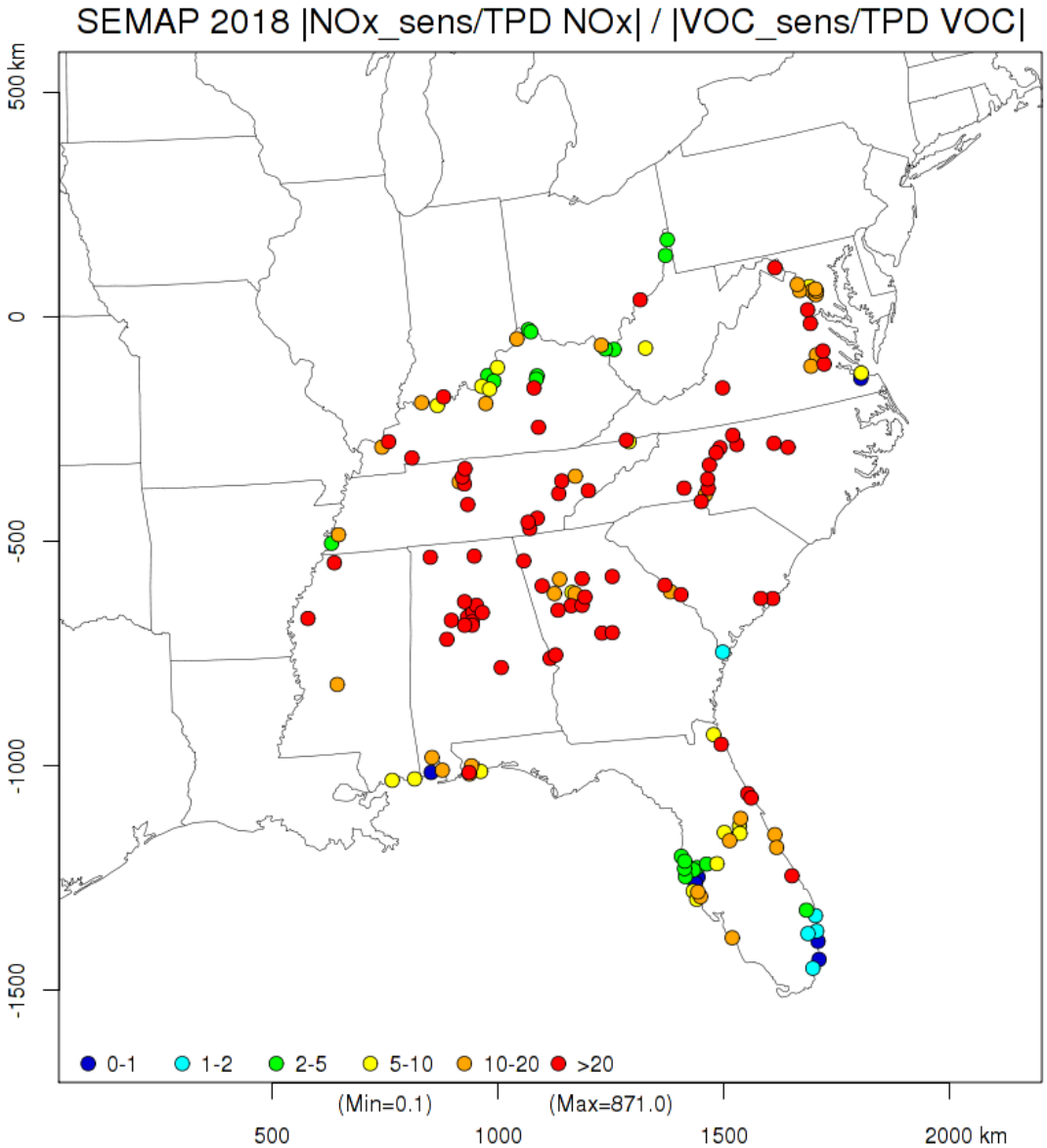
FL Responses Per TPD Emission Reduction



SEMAP Responses Per TPD Emission Reduction



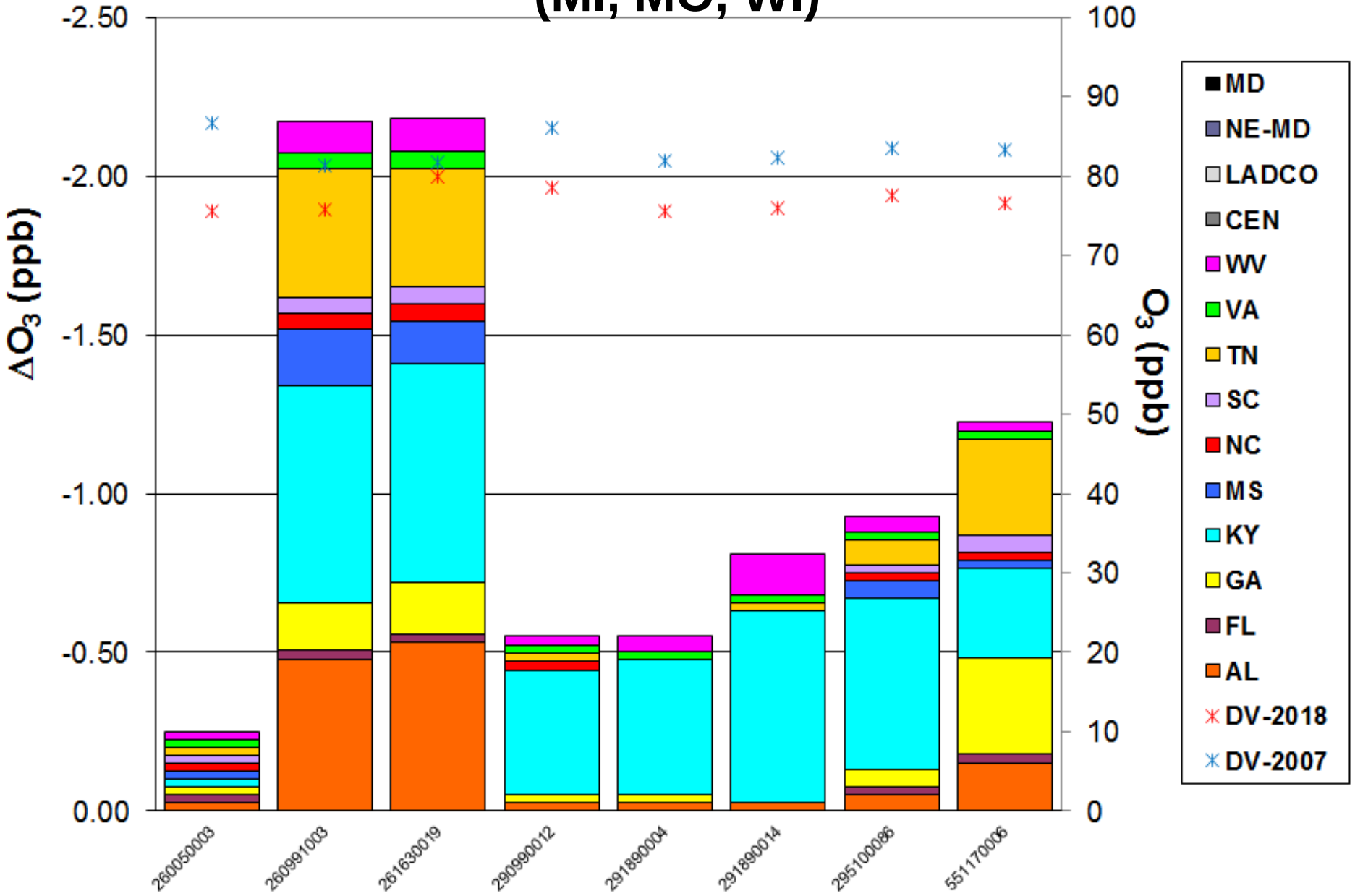
NOx vs. VOC Ratios



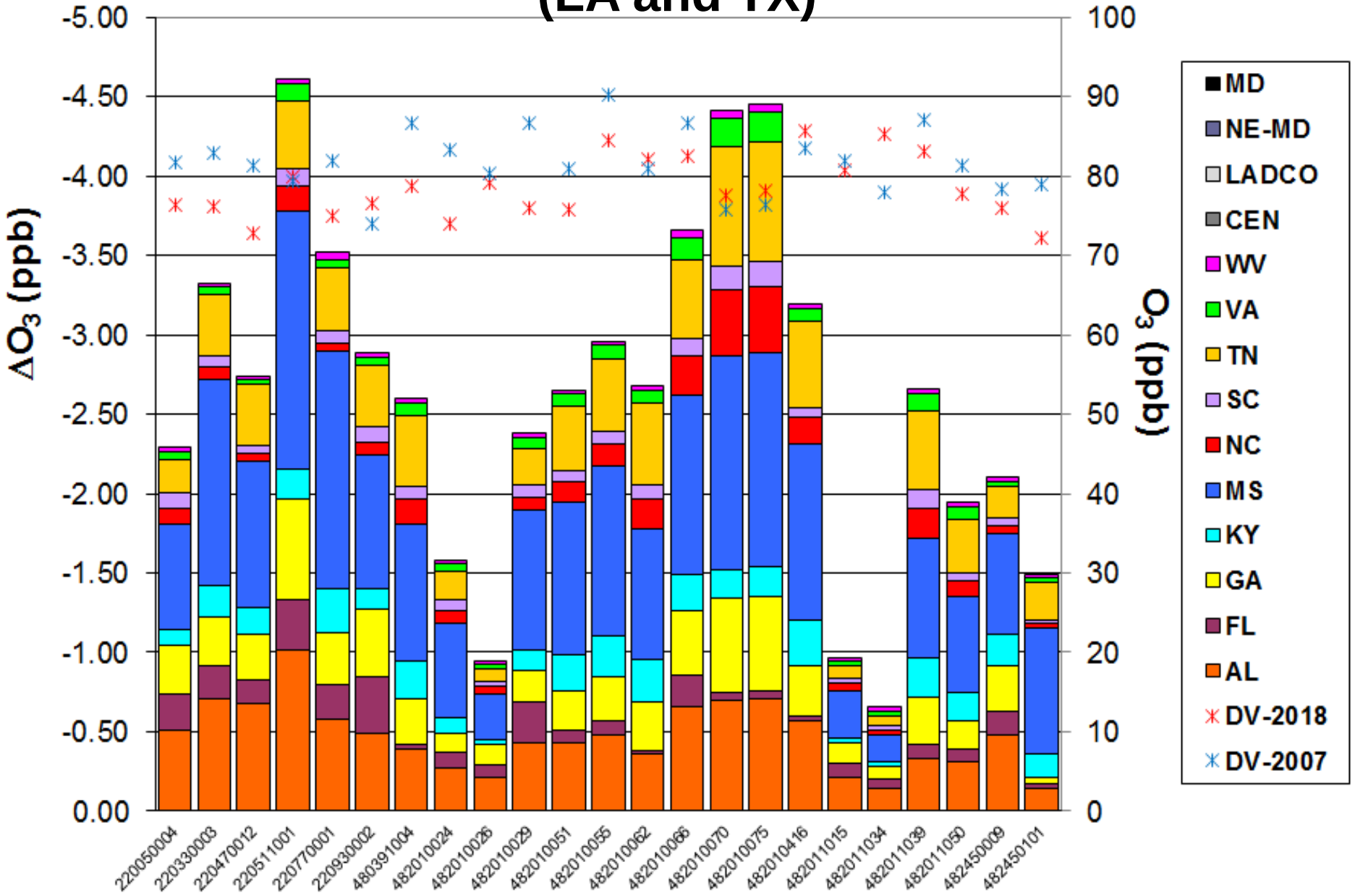
Interstate Contributions

- Examined state-by-state contributions at downwind sites with DVF $\geq$ 75 ppb in 2018
- Divided state-by-state 30% NOx contributions from MATS by 0.3 to obtain 100% NOx contribution from each state
  - Assumes NOx sensitivities are linear to 100%
- Removed contributions from non-SEMAP states and from home states
- Identified SEMAP states that contributed more than various thresholds:
  - 1.0 ppb
  - 0.75 ppb

NAA Responses to 100% NO_x Emission Reductions (MI, MO, WI)



NAA Responses to 100% NO_x Emission Reductions (LA and TX)



NAA State Contributions

STATE	Site	DV-2007	DV-2018 (1x1)	AL	FL	GA	KY	MS	NC	SC	TN	VA	WV
CT	90010017	86.3	75.1	-0.075	-0.025	-0.125	-0.100	-0.050	-0.426	-0.100	-0.125	-1.427	-0.350
CT	90013007	87	75.4	-0.075	-0.025	-0.126	-0.126	-0.050	-0.553	-0.126	-0.126	-1.885	-0.377
GA	130890002	90.7	74.3	-1.214	-0.050		-0.743	-0.297	-0.347	-0.248	-1.337	-0.198	-0.099
GA	131210055	90.3	76.2	-0.483	-0.025		-0.914	-0.127	-0.737	-0.432	-1.245	-0.305	-0.305
GA	131510002	92	74.6	-0.845	-0.050		-0.547	-0.224	-0.348	-0.199	-1.243	-0.224	-0.149
GA	132470001	91.7	73.3	-1.222	-0.049		-0.366	-0.538	-0.220	-0.122	-1.735	-0.122	-0.098
LA	220050004	81.7	76.3	-0.509	-0.229	-0.305	-0.102	-0.661	-0.102	-0.102	-0.203	-0.051	-0.025
LA	220330003	83	76.2	-0.711	-0.203	-0.305	-0.203	-1.295	-0.076	-0.076	-0.381	-0.051	-0.025
LA	220470012	81.3	72.8	-0.679	-0.146	-0.291	-0.170	-0.922	-0.049	-0.049	-0.388	-0.024	-0.024
LA	220511001	79.3	79.9	-1.012	-0.320	-0.639	-0.186	-1.625	-0.160	-0.107	-0.426	-0.107	-0.027
LA	220770001	82	75	-0.575	-0.225	-0.325	-0.275	-1.500	-0.050	-0.075	-0.400	-0.050	-0.050
LA	220930002	74	76.6	-0.485	-0.357	-0.434	-0.128	-0.843	-0.077	-0.102	-0.383	-0.051	-0.026
MI	260050003	86.7	75.6	-0.025	-0.025	-0.025	-0.025	-0.025	-0.025	-0.025	-0.025	-0.025	-0.025
MI	260991003	81.3	75.8	-0.480	-0.025	-0.152	-0.682	-0.177	-0.051	-0.051	-0.404	-0.051	-0.101
MI	261630019	81.7	79.9	-0.533	-0.027	-0.160	-0.692	-0.133	-0.053	-0.053	-0.373	-0.053	-0.107
MO	290990012	86	78.5	-0.026	0.000	-0.026	-0.392	0.000	-0.026	0.000	-0.026	-0.026	-0.026
MO	291890004	82	75.6	-0.025	0.000	-0.025	-0.428	0.000	0.000	0.000	0.000	-0.025	-0.050
MO	291890014	82.3	75.9	-0.025	0.000	0.000	-0.607	0.000	0.000	0.000	-0.025	-0.025	-0.126
MO	295100086	83.5	77.5	-0.052	-0.026	-0.052	-0.542	-0.052	-0.026	-0.026	-0.077	-0.026	-0.052
NJ	340070003	87.5	76	-0.127	-0.025	-0.127	-0.127	-0.076	-0.253	-0.051	-0.177	-0.633	-0.456
NJ	340170006	85	75.4	-0.025	-0.025	-0.101	-0.126	-0.025	-0.528	-0.126	-0.050	-1.332	-0.327
NY	360610135	76	75.2	-0.100	-0.025	-0.075	-0.150	-0.075	-0.351	-0.075	-0.125	-1.529	-0.401
NY	361030002	85.3	75.8	-0.051	-0.025	-0.101	-0.076	-0.025	-0.556	-0.101	-0.076	-2.375	-0.354
NY	361030009	88	76.8	-0.026	-0.026	-0.051	-0.077	-0.026	-0.282	-0.051	-0.026	-1.562	-0.282
NY	361192004	86.3	73.3	-0.098	-0.049	-0.147	-0.147	-0.073	-0.513	-0.122	-0.147	-1.295	-0.415
TX	480391004	86.7	78.7	-0.393	-0.026	-0.289	-0.236	-0.866	-0.157	-0.079	-0.446	-0.079	-0.026
TX	482010024	83.3	74.1	-0.272	-0.099	-0.123	-0.099	-0.593	-0.074	-0.074	-0.173	-0.049	-0.025
TX	482010026	80.3	79.1	-0.211	-0.079	-0.132	-0.026	-0.290	-0.053	-0.026	-0.079	-0.026	-0.026
TX	482010029	86.7	76	-0.431	-0.253	-0.203	-0.127	-0.887	-0.076	-0.076	-0.228	-0.076	-0.025
TX	482010051	81	75.8	-0.430	-0.076	-0.253	-0.227	-0.960	-0.126	-0.076	-0.404	-0.076	-0.025
TX	482010055	90.3	84.6	-0.479	-0.085	-0.282	-0.254	-1.072	-0.141	-0.085	-0.451	-0.085	-0.028
TX	482010062	81	82.1	-0.356	-0.027	-0.301	-0.274	-0.821	-0.192	-0.082	-0.520	-0.082	-0.027
TX	482010066	86.7	82.6	-0.661	-0.193	-0.413	-0.220	-1.129	-0.248	-0.110	-0.496	-0.138	-0.055
TX	482010070	75.7	77.5	-0.698	-0.052	-0.594	-0.181	-1.343	-0.413	-0.155	-0.749	-0.181	-0.052
TX	482010075	76.3	78.1	-0.703	-0.052	-0.599	-0.182	-1.354	-0.417	-0.156	-0.755	-0.182	-0.052
TX	482010416	83.5	85.6	-0.571	-0.029	-0.314	-0.285	-1.113	-0.171	-0.057	-0.542	-0.086	-0.029
TX	482011015	82	80.8	-0.215	-0.081	-0.135	-0.027	-0.296	-0.054	-0.027	-0.081	-0.027	-0.027
TX	482011034	78	85.4	-0.142	-0.057	-0.085	-0.028	-0.171	-0.028	-0.028	-0.057	-0.028	-0.028
TX	482011039	87	83.1	-0.332	-0.083	-0.305	-0.249	-0.748	-0.194	-0.111	-0.499	-0.111	-0.028
TX	482011050	81.3	77.8	-0.311	-0.078	-0.182	-0.182	-0.596	-0.104	-0.052	-0.337	-0.078	-0.026
TX	482450009	78.3	75.9	-0.481	-0.152	-0.278	-0.202	-0.632	-0.051	-0.051	-0.202	-0.025	-0.025
TX	482450101	79	72.2	-0.144	-0.024	-0.048	-0.144	-0.794	-0.024	-0.024	-0.241	-0.024	-0.024
WI	551170006	83.3	76.5	-0.153	-0.025	-0.306	-0.280	-0.025	-0.025	-0.051	-0.306	-0.025	-0.025

MAINT State Contributions

STATE	Site	DV-2007	DV-2018 (1x1)	AL	FL	GA	KY	MS	NC	SC	TN	VA	WV
AL	10730023	83.3	73.7		-0.123	-0.762	-0.590	-0.983	-0.123	-0.098	-1.056	-0.074	-0.049
AL	10732006	85.3	72.4		-0.097	-1.231	-0.410	-1.351	-0.145	-0.145	-1.062	-0.097	-0.048
AL	10736002	84.7	72.4		-0.097	-0.772	-0.603	-1.255	-0.145	-0.121	-1.207	-0.072	-0.072
AR	50350005	82.3	70.9	-1.323	-0.024	-0.520	-1.465	-1.536	-0.236	-0.142		-0.142	-0.189
CT	90011123	88.7	69.5	-0.093	-0.046	-0.069	-0.162	-0.093	-0.417	-0.069	-0.139	-1.251	-0.324
CT	90019003	85.3	71.9	-0.072	-0.024	-0.096	-0.120	-0.048	-0.455	-0.120	-0.120	-1.558	-0.383
CT	90093002	87.3	72.3	-0.048	-0.024	-0.048	-0.120	-0.024	-0.193	-0.024	-0.072	-1.253	-0.265
GA	131130001	87.5	70.5	-0.047	-0.023		-0.917	-0.023	-0.682	-0.376	-1.010	-0.470	-0.282
IL	170310001	77	70.6	-0.024	0.000	-0.024	-0.071	-0.047	0.000	0.000	-0.024	0.000	-0.024
LA	220190002	76.7	65.6	-0.131	0.000	-0.044	-0.197	-1.815	-0.022	-0.022	-0.328	-0.022	-0.022
LA	220330013	77.3	71.9	-0.168	-0.240	-0.096	-0.096	-0.503	-0.048	-0.048	-0.168	-0.024	-0.024
LA	220331001	78.7	72.6	-0.387	-0.266	-0.290	-0.097	-0.774	-0.073	-0.073	-0.242	-0.048	-0.048
LA	220470007	80.3	73.7	-0.958	-0.295	-0.442	-0.221	-1.081	-0.098	-0.074	-0.368	-0.074	-0.025
LA	220470009	78.3	71.9	-0.575	-0.120	-0.312	-0.288	-1.055	-0.096	-0.072	-0.431	-0.072	-0.024
LA	220890003	74	72.3	-0.892	-0.289	-0.506	-0.169	-1.566	-0.120	-0.096	-0.361	-0.072	-0.024
LA	221210001	78	72.5	-1.281	-0.024	-0.024	-0.677	-3.262	0.000	-0.024	-0.507	0.000	-0.024
MD	240251001	90.7	72	-0.240	-0.096	-0.432	-0.384	-0.072	-0.432	-0.216	-0.216	-2.952	-1.728
MI	260990009	82	73	-0.049	-0.024	-0.316	-0.584	-0.073	-0.024	-0.049	-0.170	-0.024	-0.073
MI	261210039	82.3	70.2	-0.023	0.000	-0.023	-0.023	-0.023	0.000	0.000	-0.023	-0.023	-0.023
MI	261470005	79.3	71.4	-0.071	-0.024	-0.286	-0.524	-0.095	-0.048	-0.071	-0.214	-0.024	-0.095
MO	290470005	80.7	69.2	-0.138	-0.023	-0.046	-0.092	-0.208	-0.023	-0.023	-0.231	-0.023	-0.046
MO	290470006	81.3	69.3	-0.115	-0.023	-0.046	-0.069	-0.185	-0.023	-0.023	-0.231	-0.023	-0.046
MO	291130003	81	69.9	0.000	0.000	0.000	0.000	-0.023	0.000	-0.023	0.000	-0.023	0.000
MO	291831002	84	74.8	-0.050	-0.025	-0.050	-0.474	-0.050	-0.025	-0.025	-0.100	-0.025	-0.050
MO	291831004	82.3	71.7	-0.024	0.000	-0.024	-0.526	-0.024	-0.024	-0.024	-0.096	-0.024	-0.096
MO	295100085	79	73.3	-0.049	-0.024	-0.049	-0.513	-0.049	-0.024	-0.024	-0.073	-0.024	-0.049
NY	360130006	83	72.1	-0.024	-0.024	-0.024	-0.024	-0.024	-0.024	-0.024	-0.024	-0.024	-0.024
NY	360290002	81	72.9	-0.024	0.000	-0.024	-0.996	-0.024	-0.024	-0.024	-0.389	-0.024	-0.073
NY	360810124	76.7	74.6	-0.075	-0.025	-0.099	-0.099	-0.050	-0.572	-0.099	-0.124	-1.741	-0.323
NY	360850067	80.7	69.8	-0.093	-0.023	-0.116	-0.116	-0.047	-0.535	-0.140	-0.116	-1.768	-0.302
NY	361030004	86	69.8	-0.023	-0.023	-0.047	-0.116	-0.023	-0.163	-0.023	-0.047	-1.954	-0.186
OH	390071001	84.7	67.4	-0.045	-0.022	-0.067	-0.382	-0.045	-0.022	-0.022	-0.112	-0.045	-0.202
OH	390490029	84	72.3	-0.193	-0.024	-0.434	-1.494	-0.024	-0.072	-0.096	-0.386	-0.072	-0.193
OH	390610006	84.3	74.8	-0.075	-0.025	-0.374	-3.291	-0.050	-0.125	-0.100	-0.723	-0.050	-0.324
OH	391650007	85	72.8	-0.121	-0.024	-0.631	-2.791	-0.049	-0.194	-0.170	-0.922	-0.049	-0.340
PA	420030010	78	70.6	0.000	0.000	0.000	-0.024	0.000	0.000	0.000	0.000	-0.047	-1.035
PA	420170012	90.7	74.5	-0.099	-0.025	-0.149	-0.074	-0.050	-0.571	-0.099	-0.149	-2.483	-0.472
PA	421010024	88	73.4	-0.147	-0.024	-0.147	-0.098	-0.073	-0.636	-0.122	-0.196	-2.324	-0.514
TX	481830001	79	70.8	-0.425	-0.071	-0.472	-0.094	-0.543	-0.283	-0.118	-0.378	-0.118	-0.024
TX	482011035	75.3	82.5	-0.137	-0.055	-0.082	-0.027	-0.165	-0.027	-0.027	-0.055	-0.027	-0.027
TX	482450018			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WI	550710007	78.7	68.8	-0.046	-0.023	-0.023	-0.183	-0.092	-0.023	-0.023	-0.161	-0.023	-0.023

Summary

- In general, absolute sensitivities (ΔO_3) and relative sensitivities (ΔDVF) are very similar.
- Anthropogenic NO_x emission reductions are much more effective at reducing 8-hour ozone concentrations compared to anthropogenic VOC emission reductions.
  - Some sites in Florida show comparable benefits from VOC and NOx reductions.
- The home state typically has the largest impact on its own monitors. Neighboring states have the next largest impact.
- Five of the ten SEMAP states have < 0.75 ppb contribution to monitors with 2018 DVF $\geq$ 75 ppb.

Next Steps

- Run MATS to generate SEMAP 2018 projections for $PM_{2.5}$ and Regional Haze
- Replicate EPA 2011 and 2018 modeling
  - May adjust 2018 EGUs based on ERTAC model
  - May replace SMOKE-MOVES emissions with inventory mode MOVES
  - May adjust VOC emissions from fires
  - May perform NOx emission sensitivities
- Create 2028 emission inventory and perform 2028 modeling for Regional Haze

Contact Information

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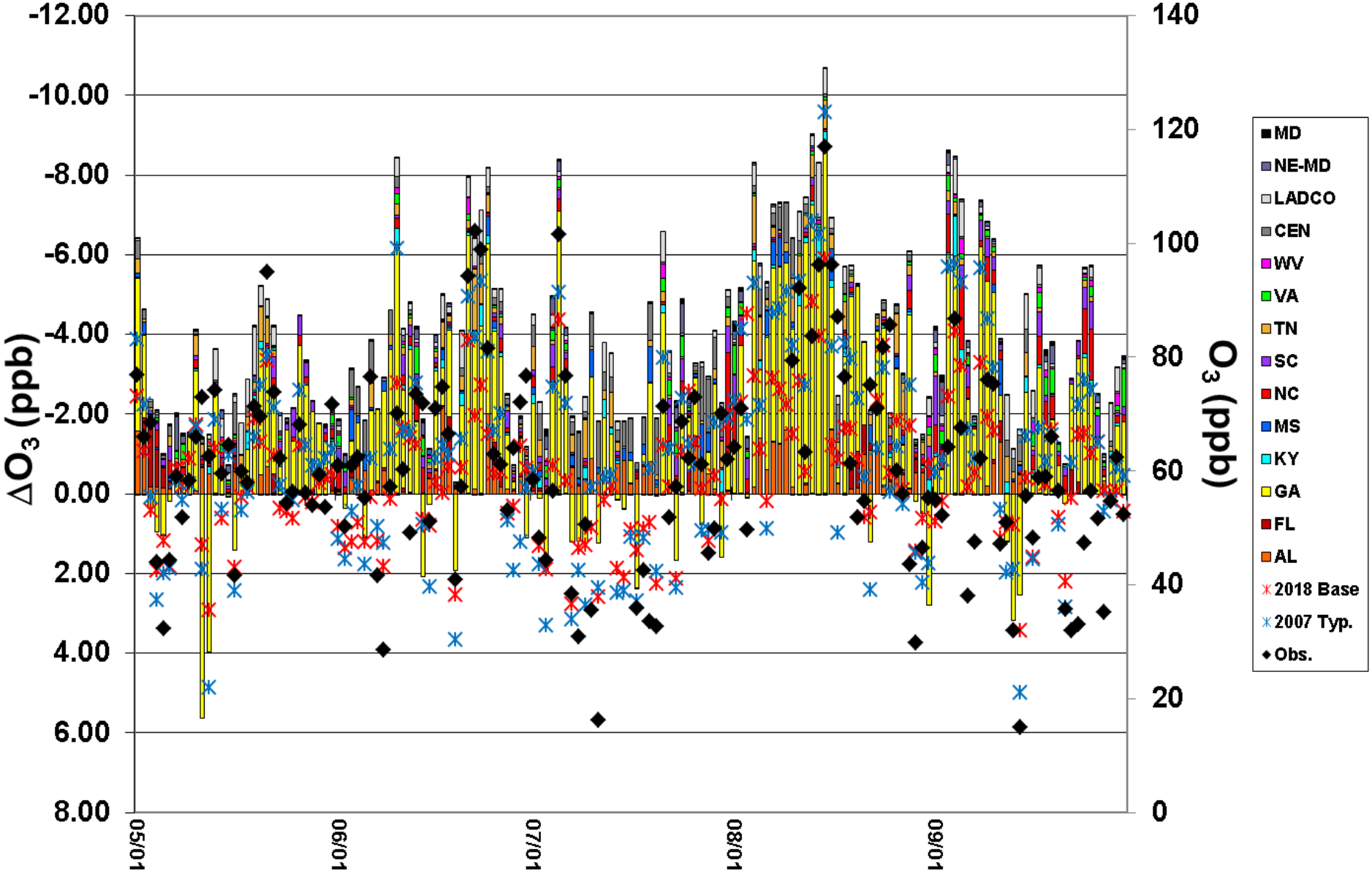
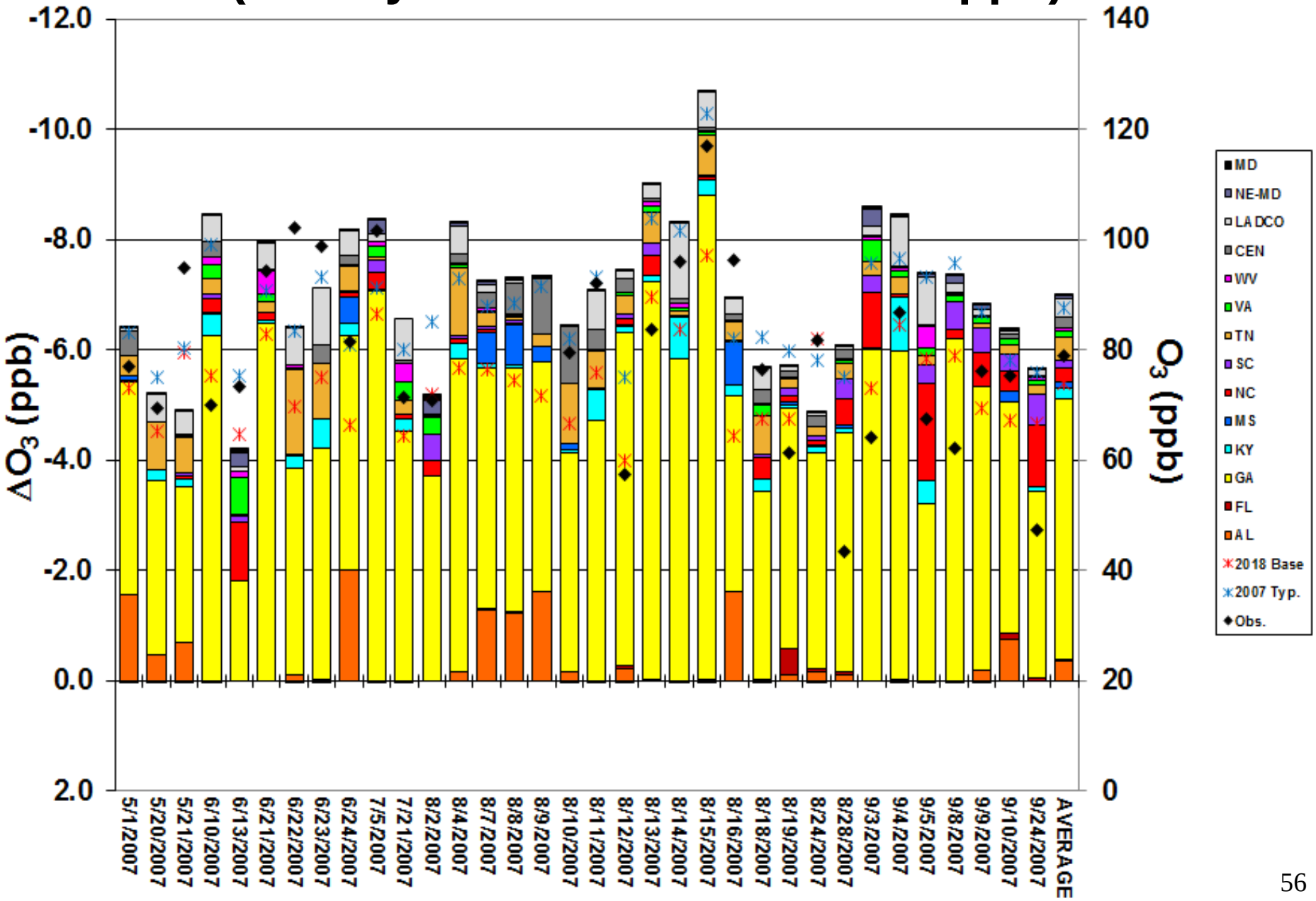
Appendix
(Additional Slides)

Atlanta, GA
Absolute Sensitivities

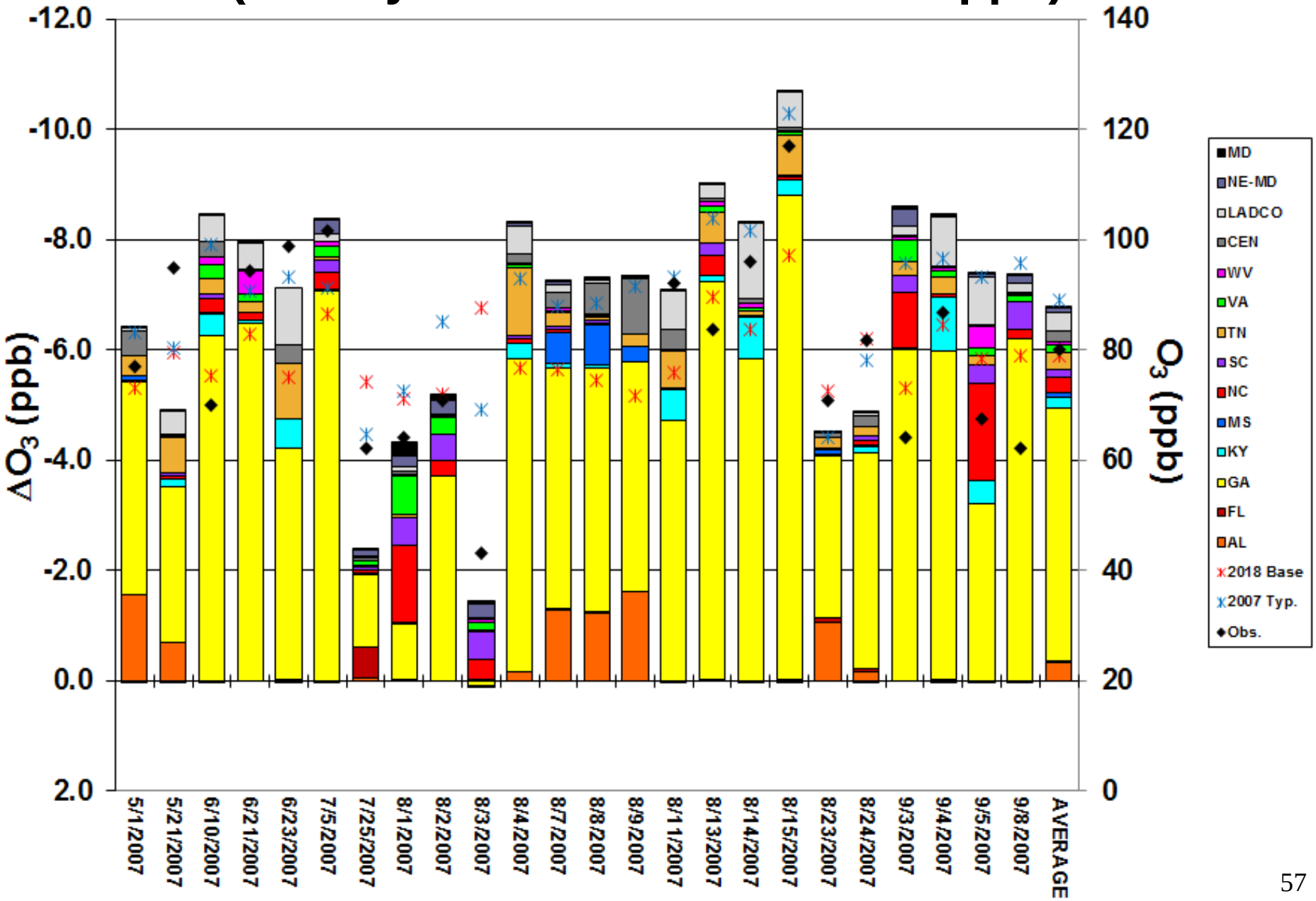
13-121-0055 Response to 30% NOx Reductions (All Days)



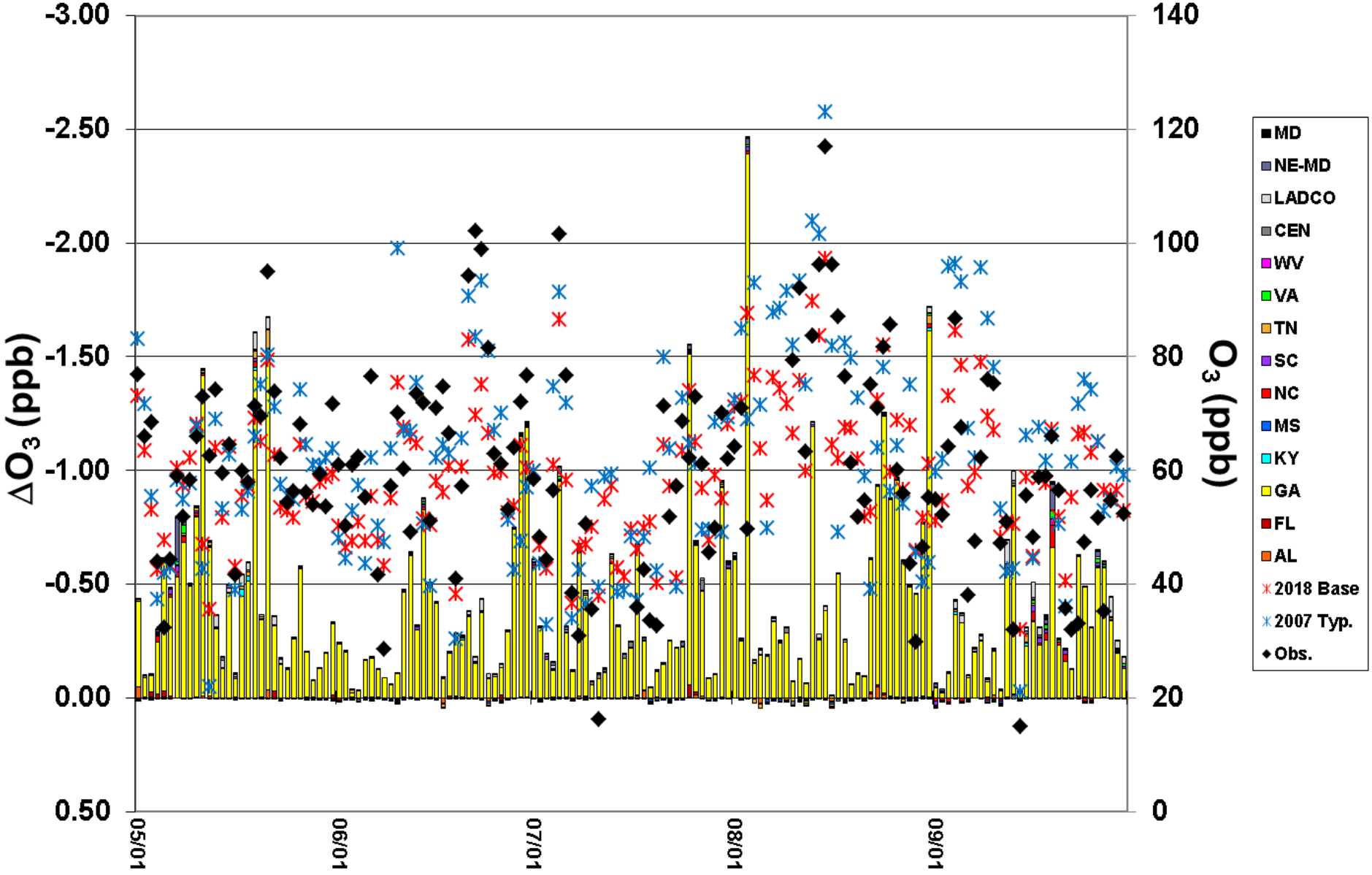
13-121-0055 Response to 30% NOx Reductions
(All Days with 2007 model > 75 ppb)



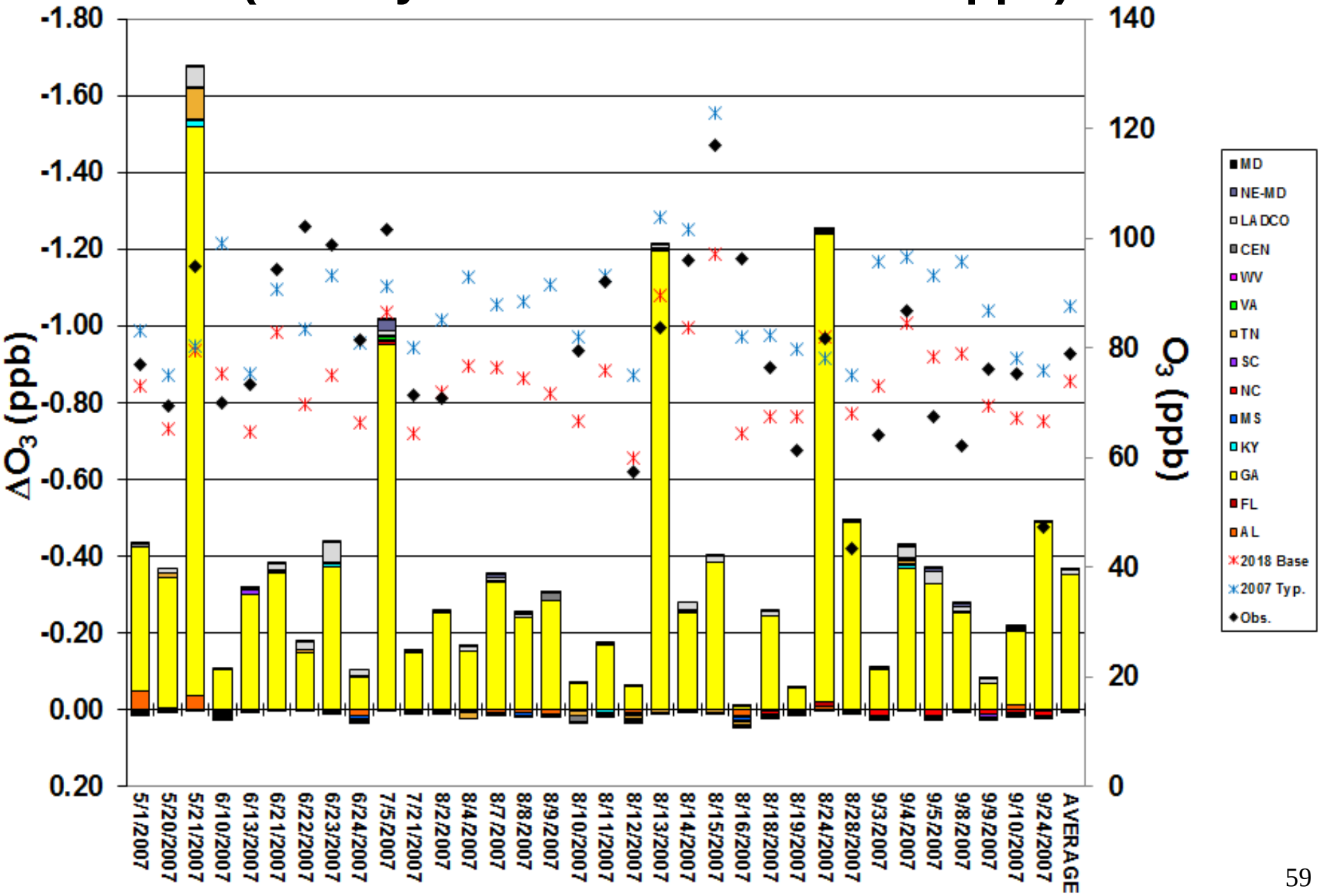
13-121-0055 Response to 30% NOx Reductions
(All Days with 2018 model > 70 ppb)



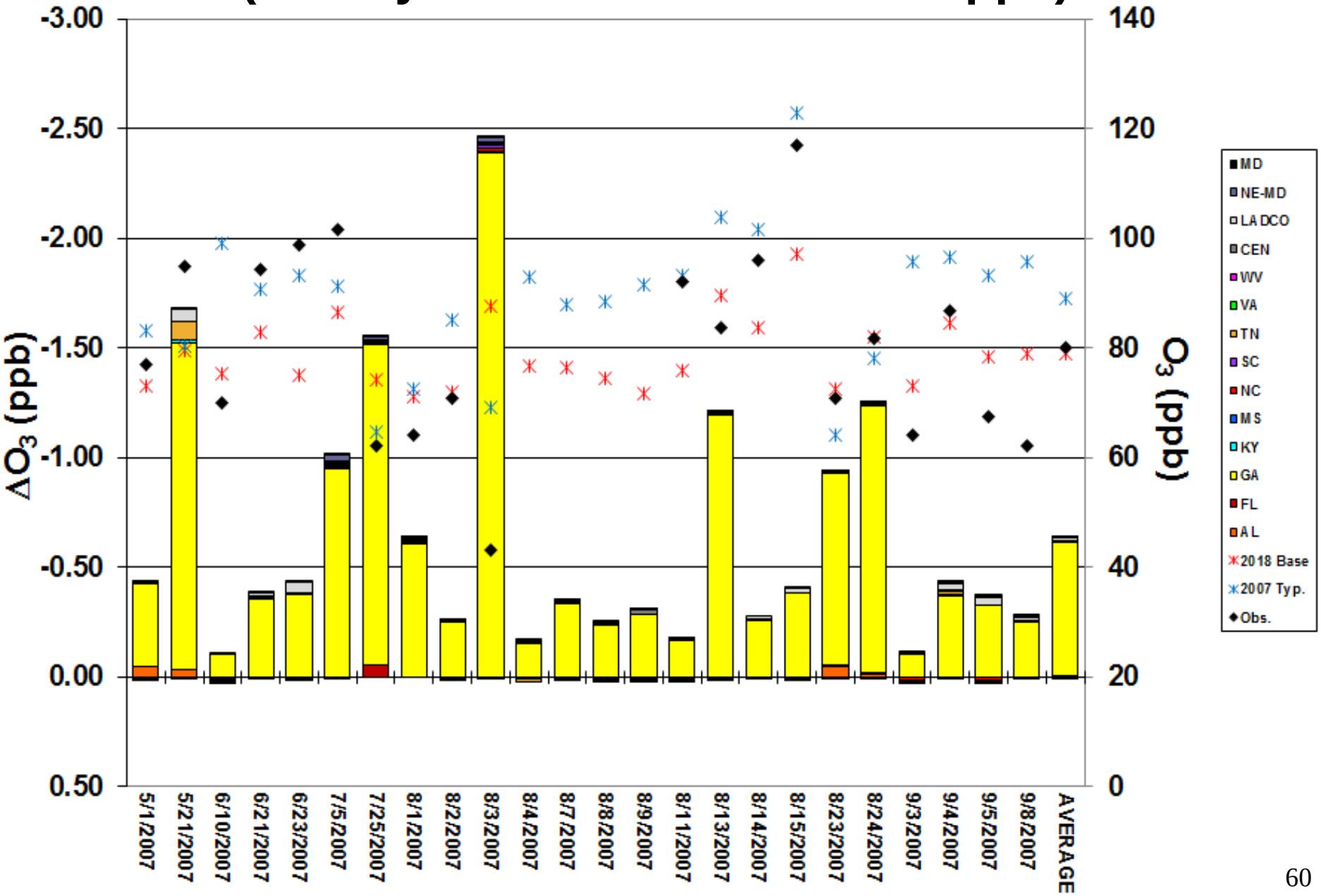
13-121-0055 Response to 30% VOC Reductions (All Days)



13-121-0055 Response to 30% VOC Reductions
(All Days with 2007 model > 75 ppb)

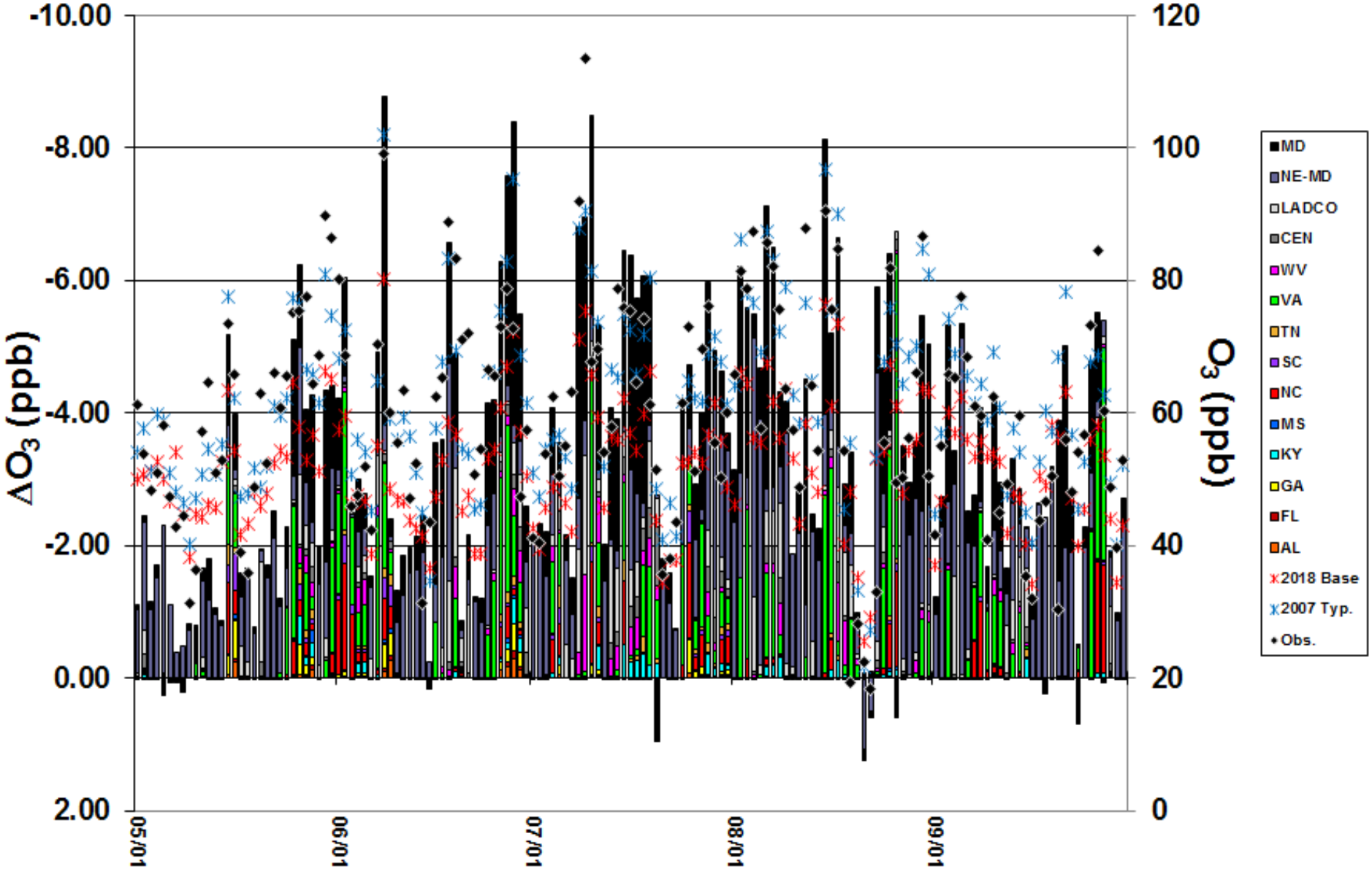


13-121-0055 Response to 30% VOC Reductions
(All Days with 2018 model > 70 ppb)

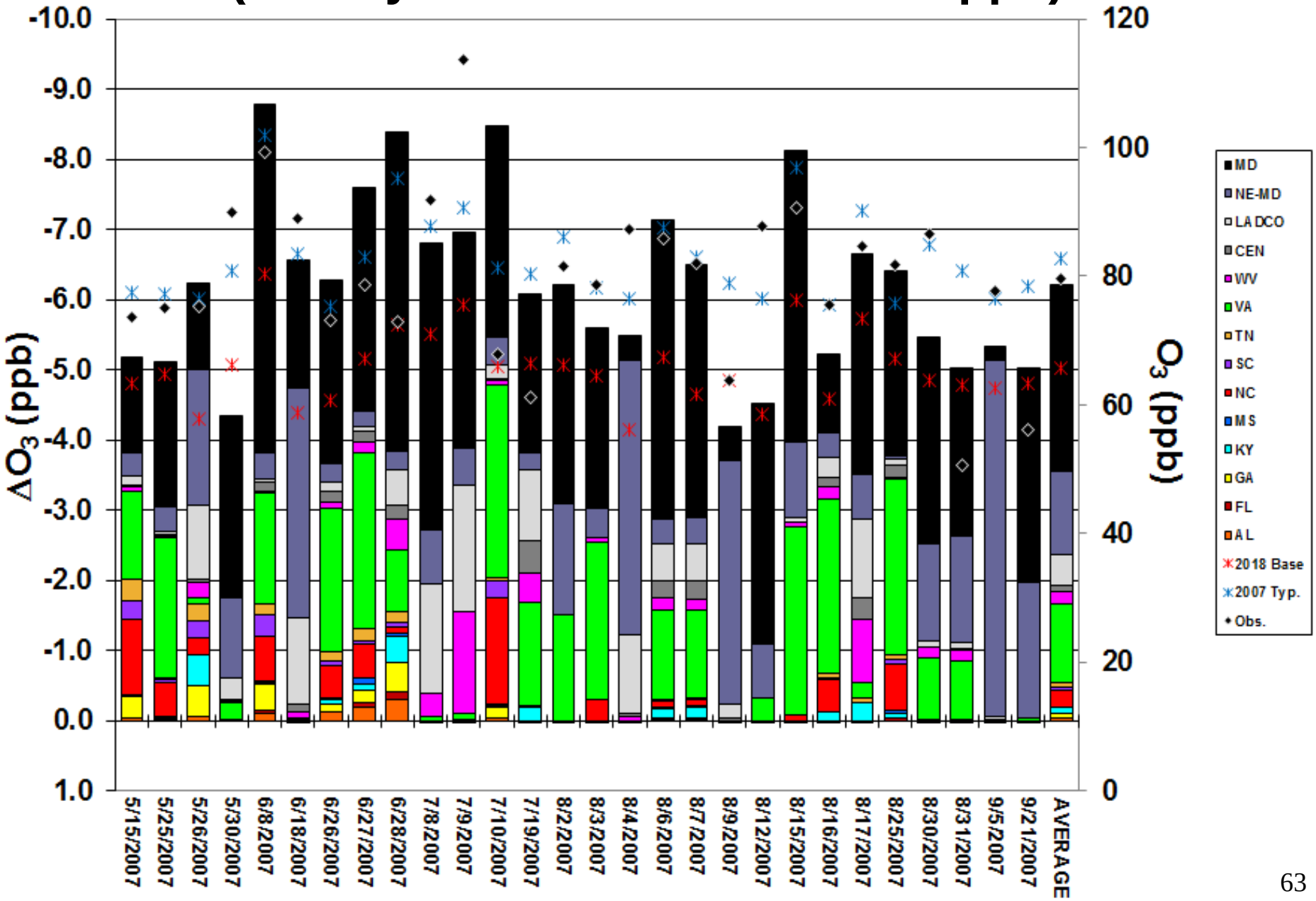


Baltimore, MD
Absolute Sensitivities

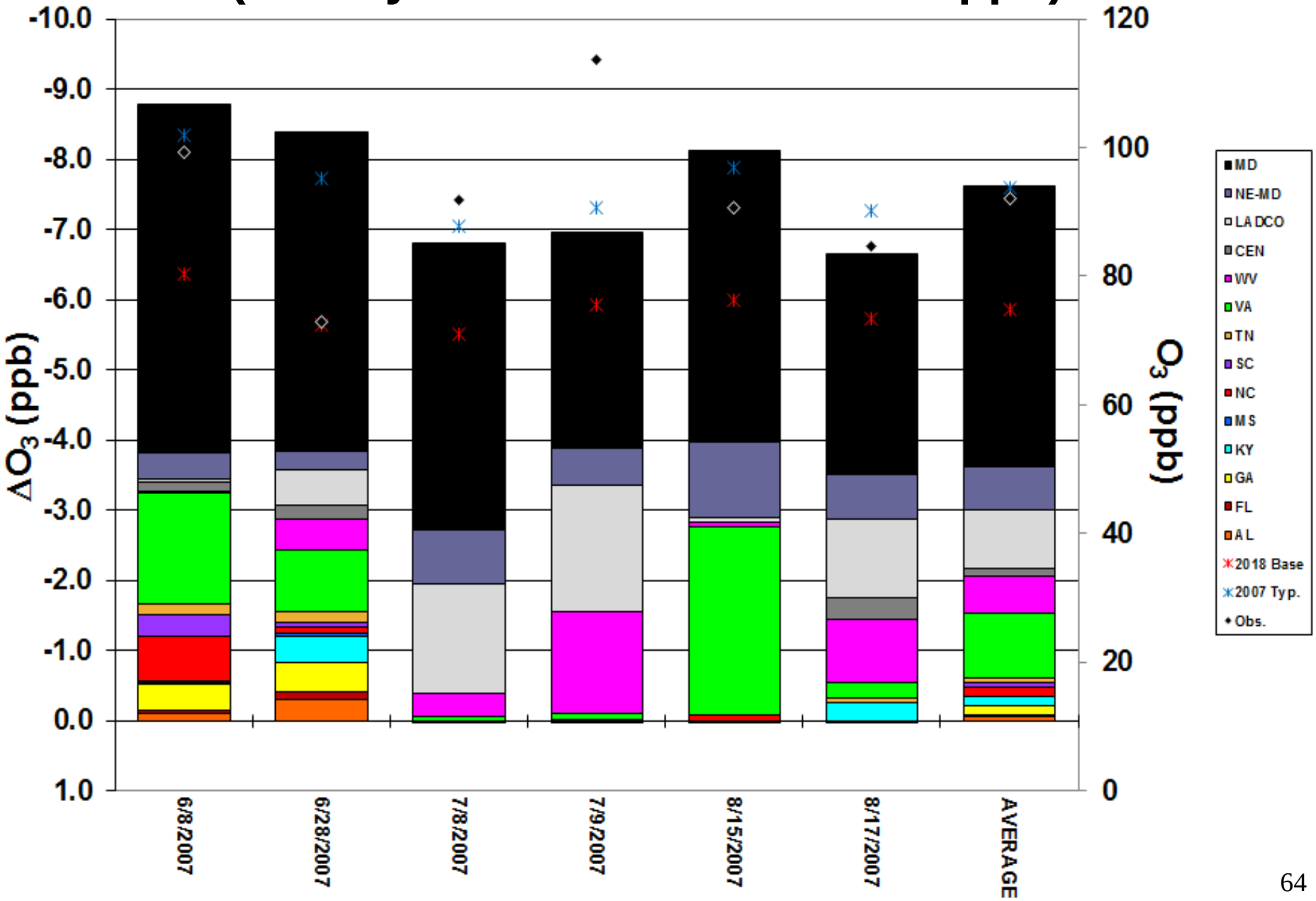
24-025-1001 Response to 30% NOx Reductions (All Days)



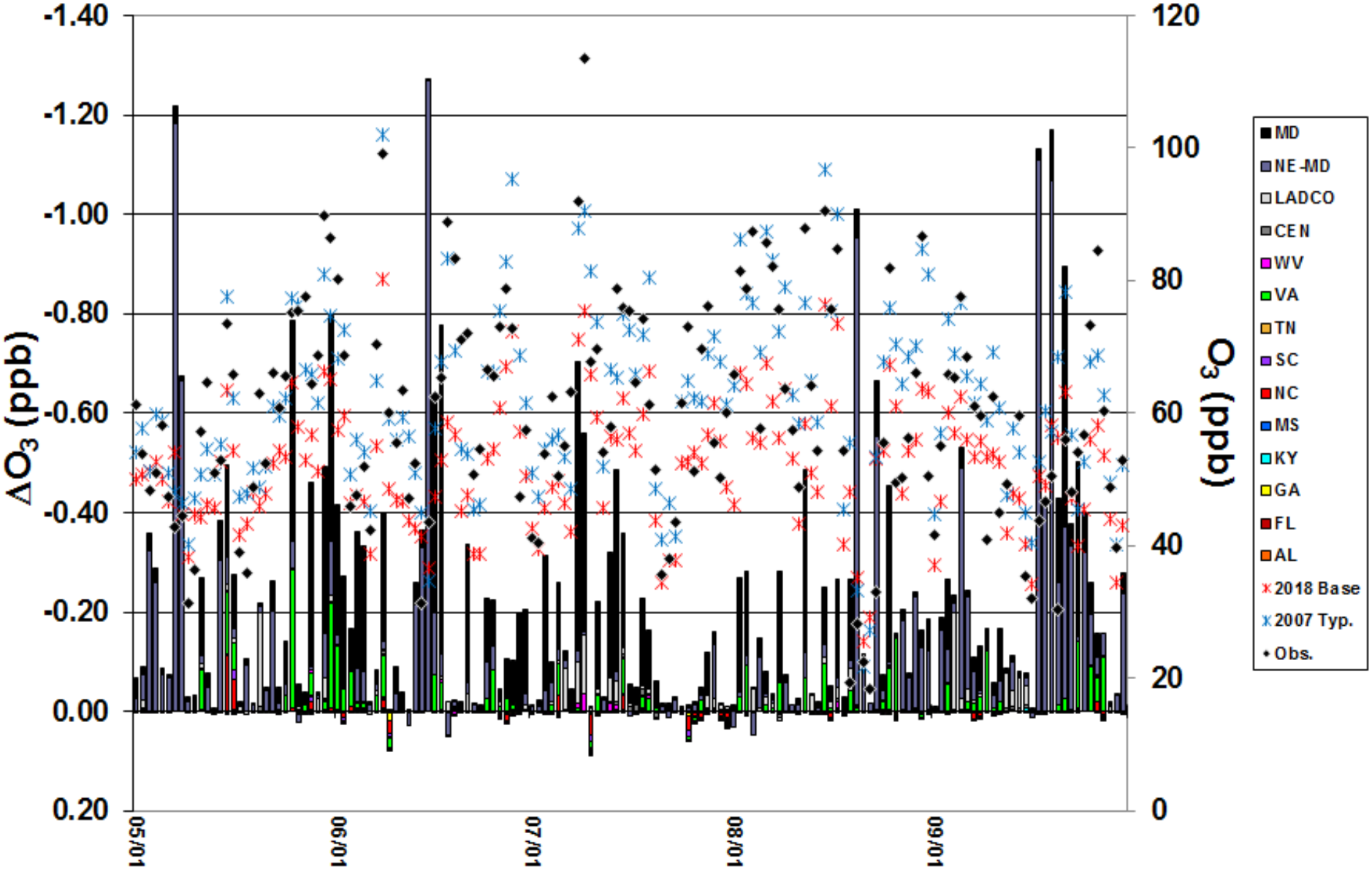
24-025-1001 Response to 30% NOx Reductions
(All Days with 2007 model > 75 ppb)



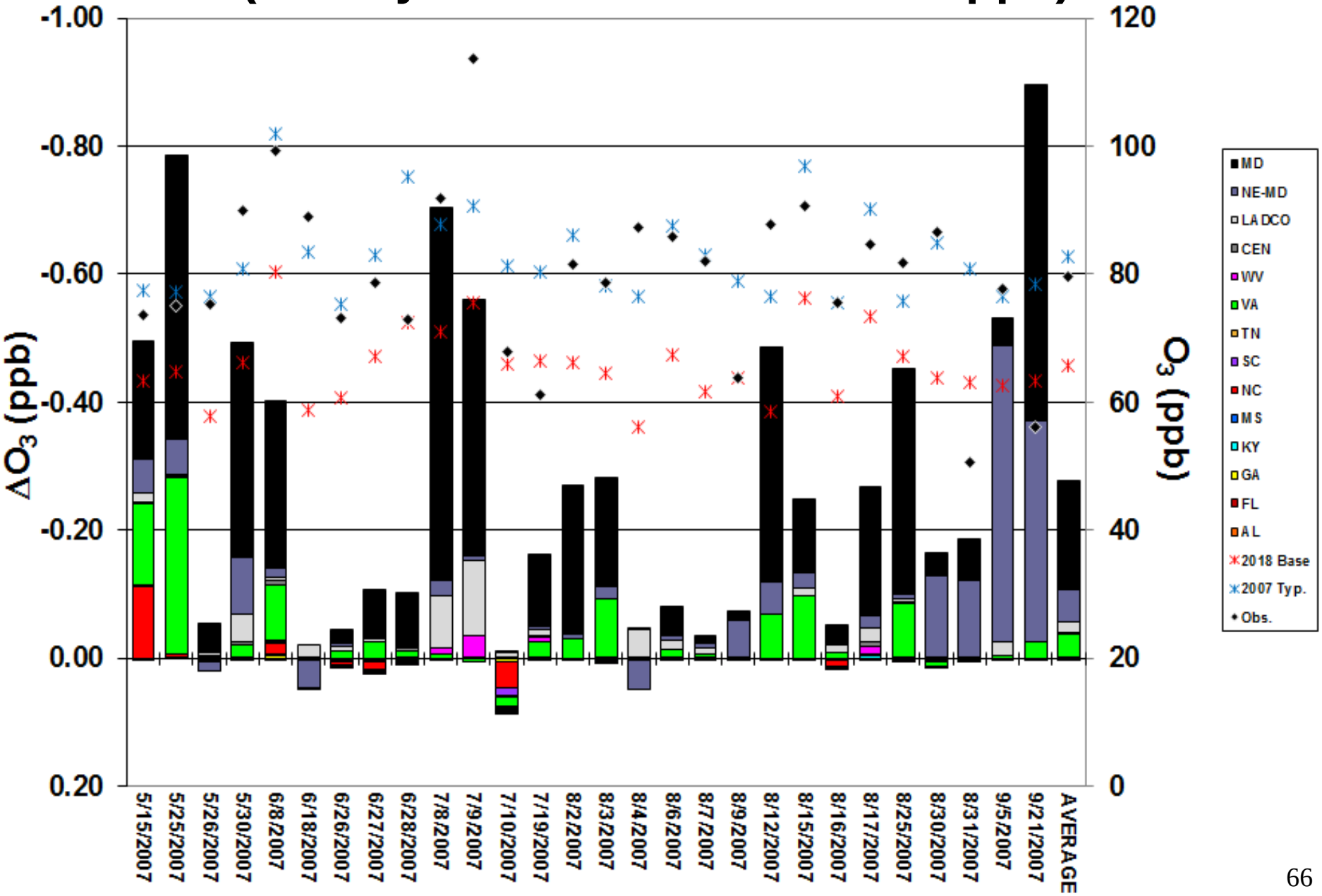
24-025-1001 Response to 30% NOx Reductions
(All Days with 2018 model > 70 ppb)



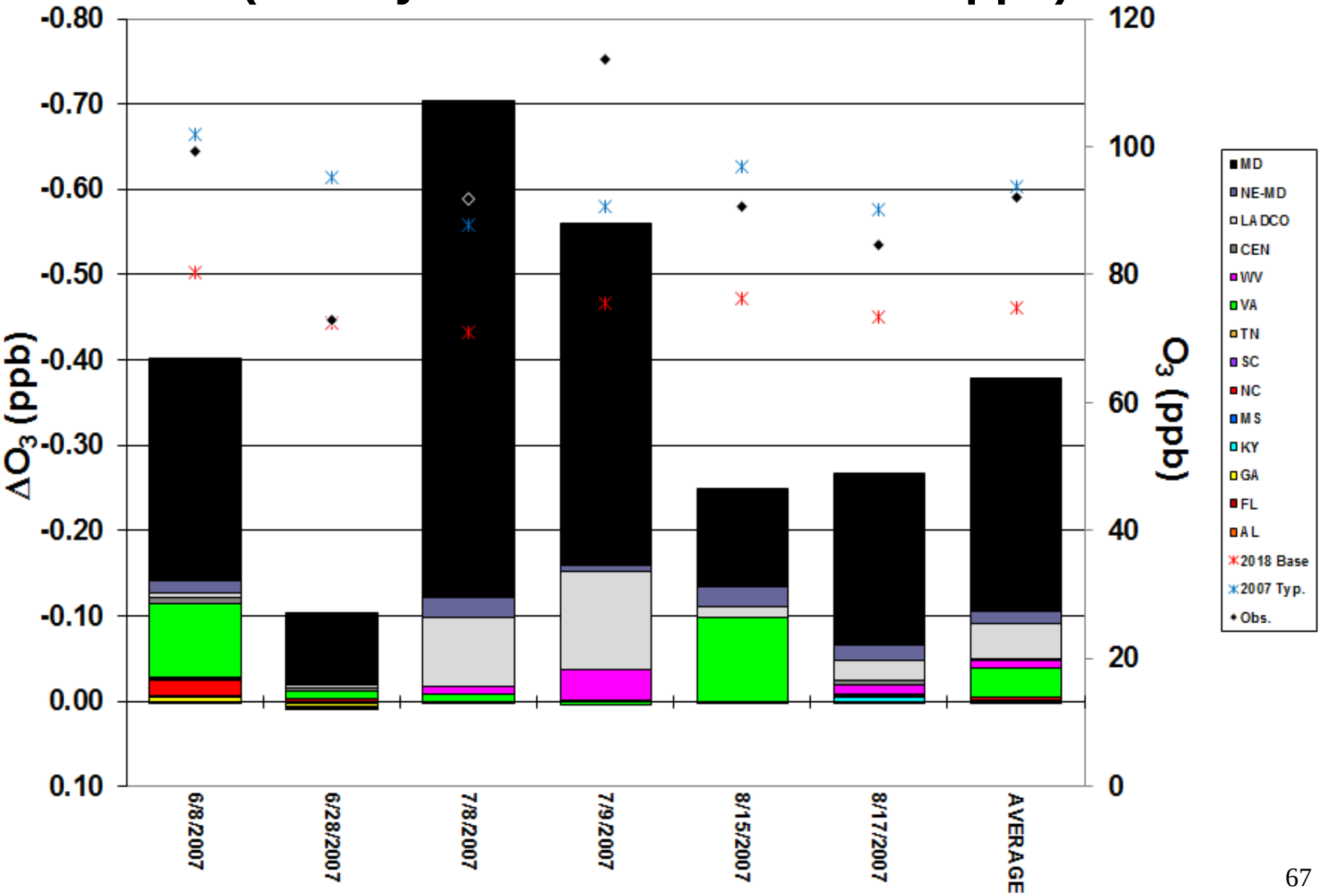
24-025-1001 Response to 30% VOC Reductions (All Days)



24-025-1001 Response to 30% VOC Reductions
(All Days with 2007 model > 75 ppb)

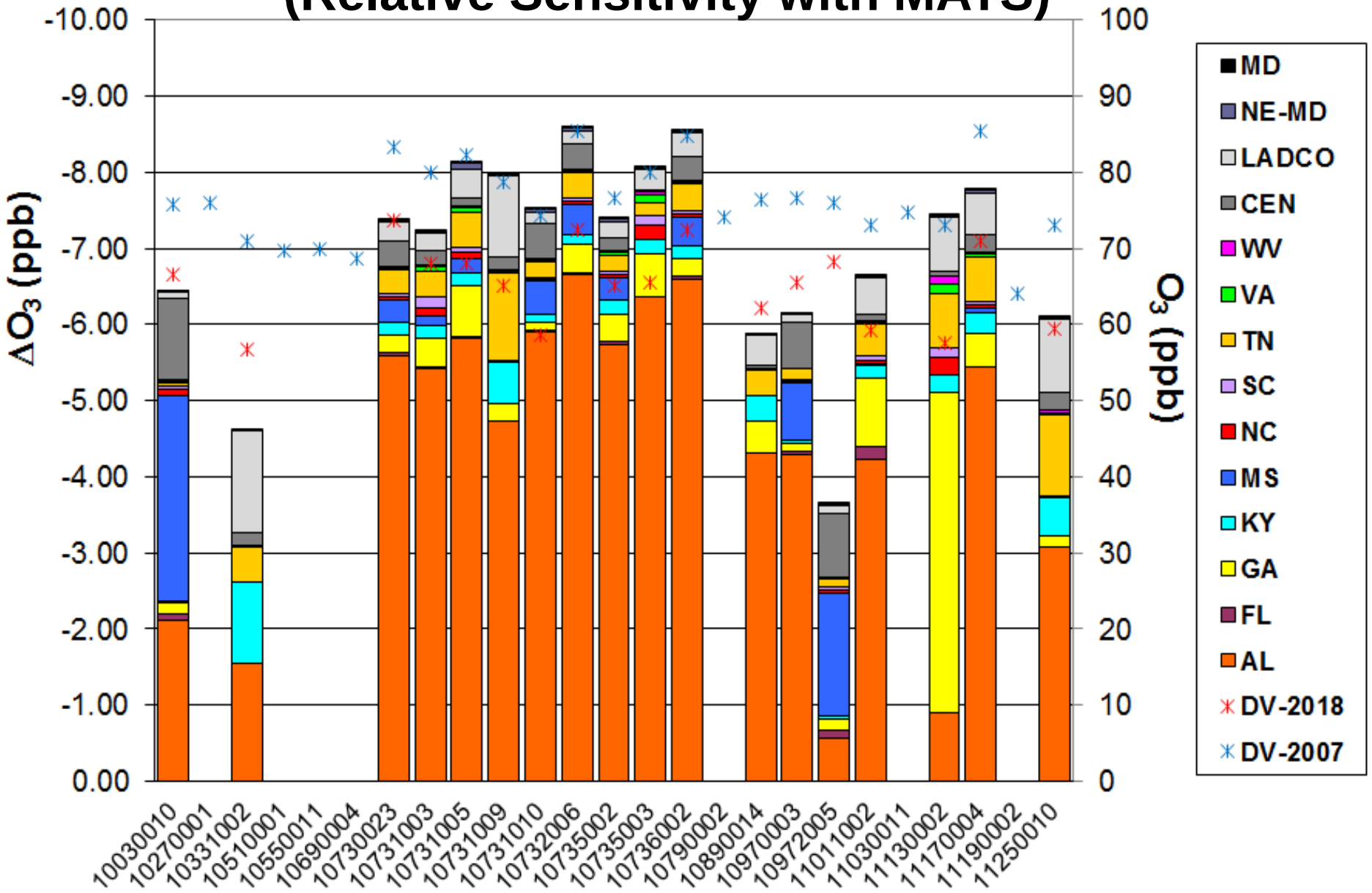


24-025-1001 Response to 30% VOC Reductions
(All Days with 2018 model > 70 ppb)

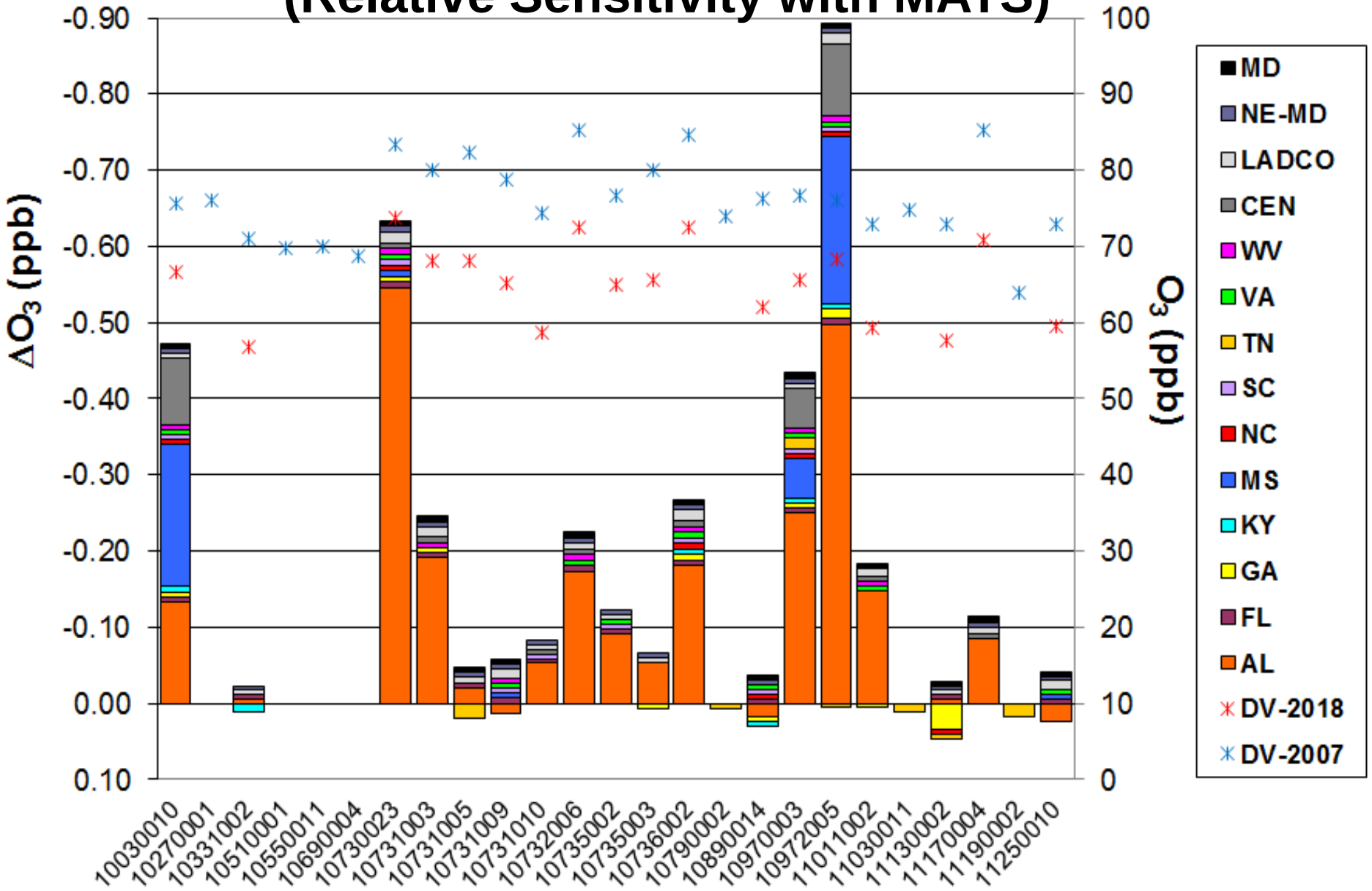


Relative Sensitivity State Summary

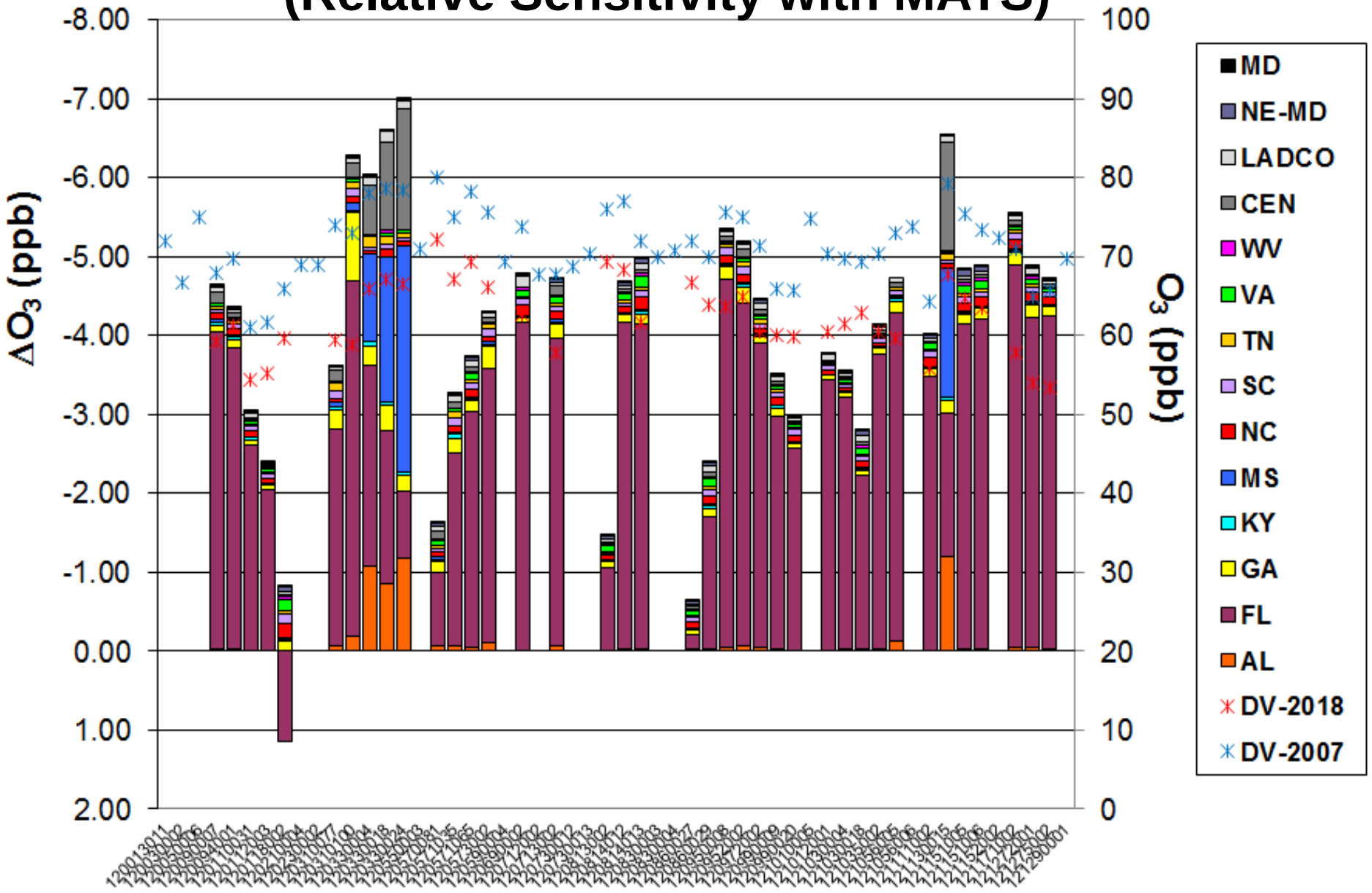
AL Responses to 30% NO_x Emission Reductions (Relative Sensitivity with MATS)



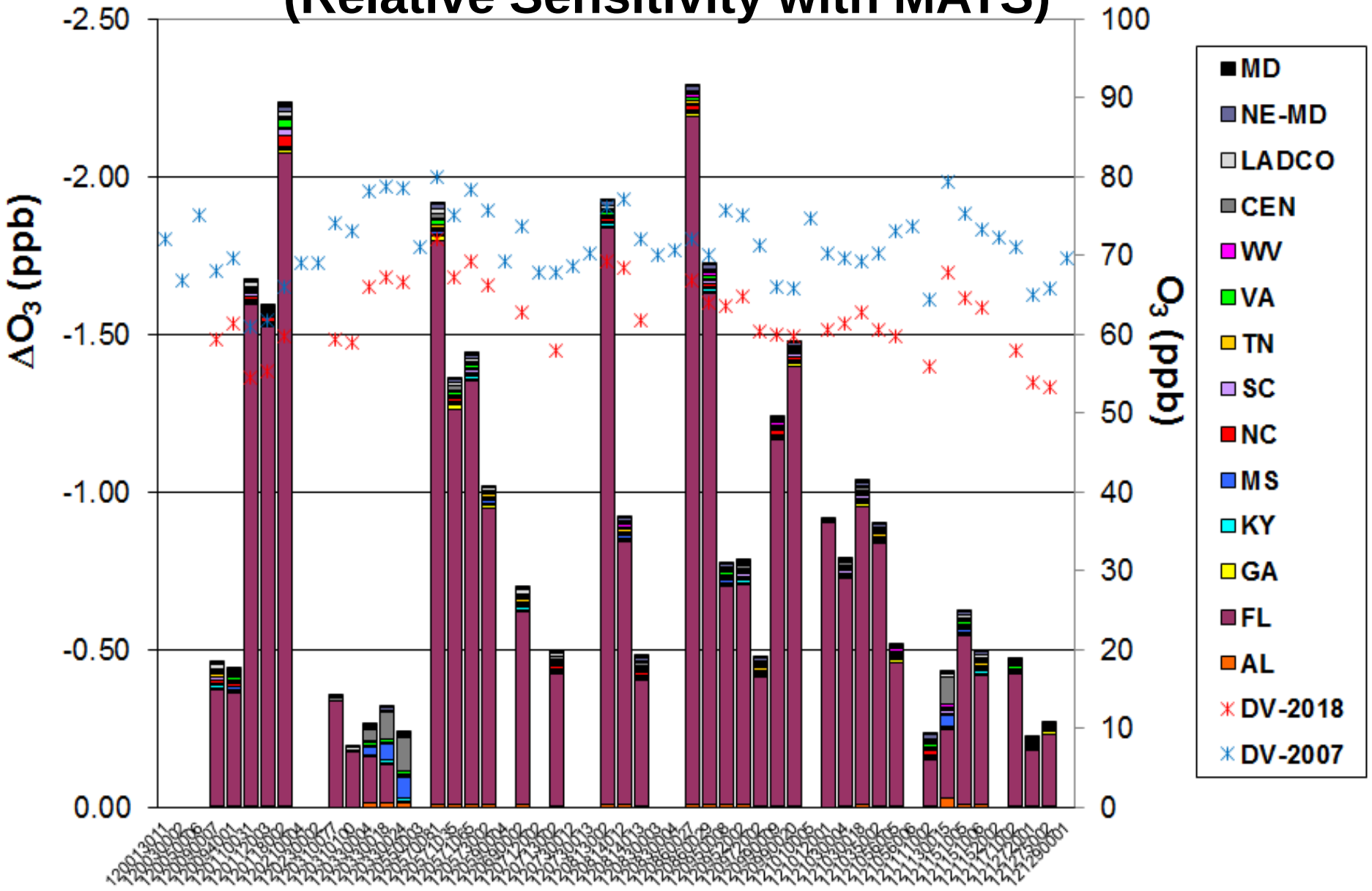
AL Responses to 30% VOC Emission Reductions
(Relative Sensitivity with MATS)



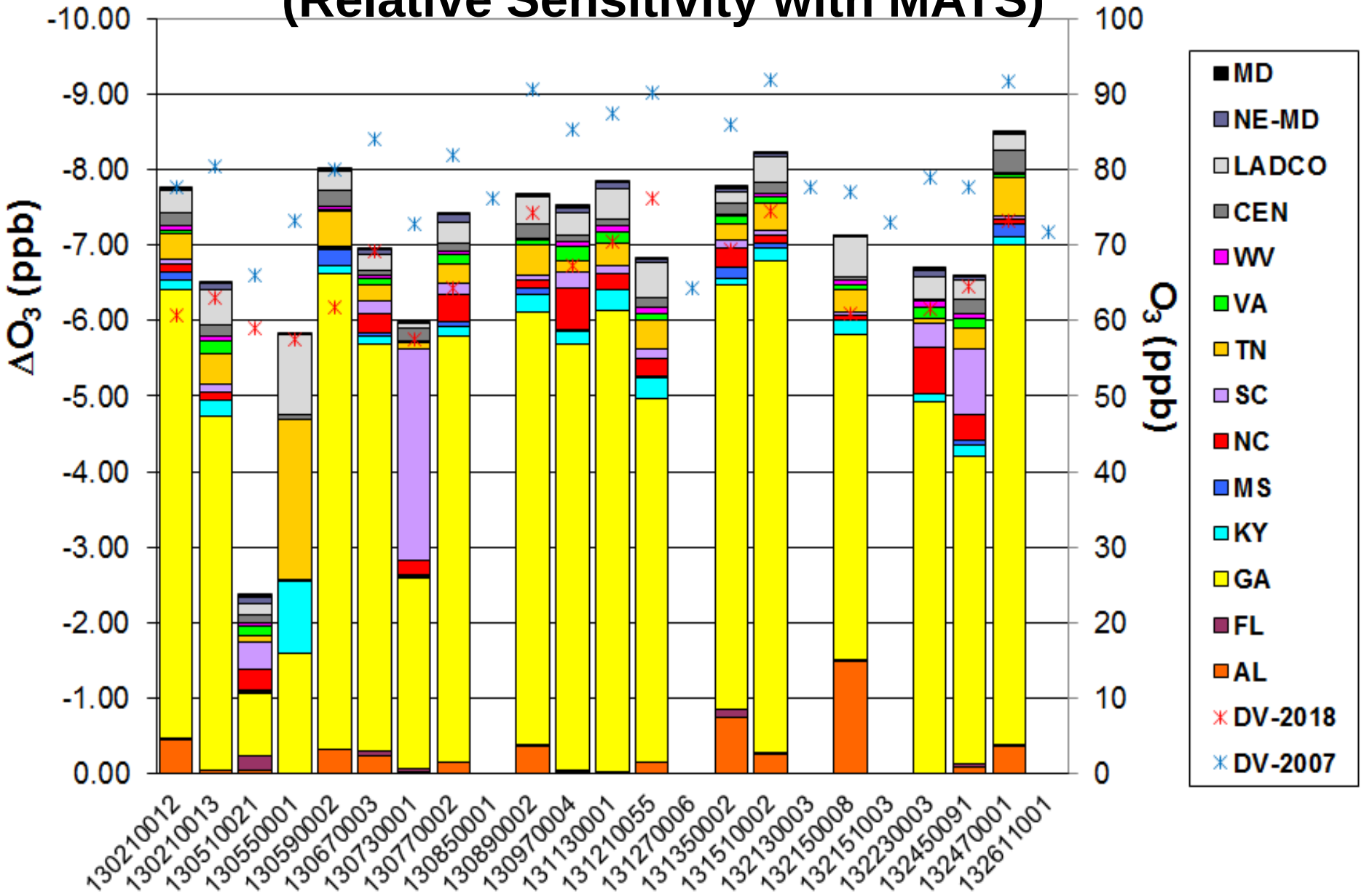
FL Responses to 30% NO_x Emission Reductions
(Relative Sensitivity with MATS)



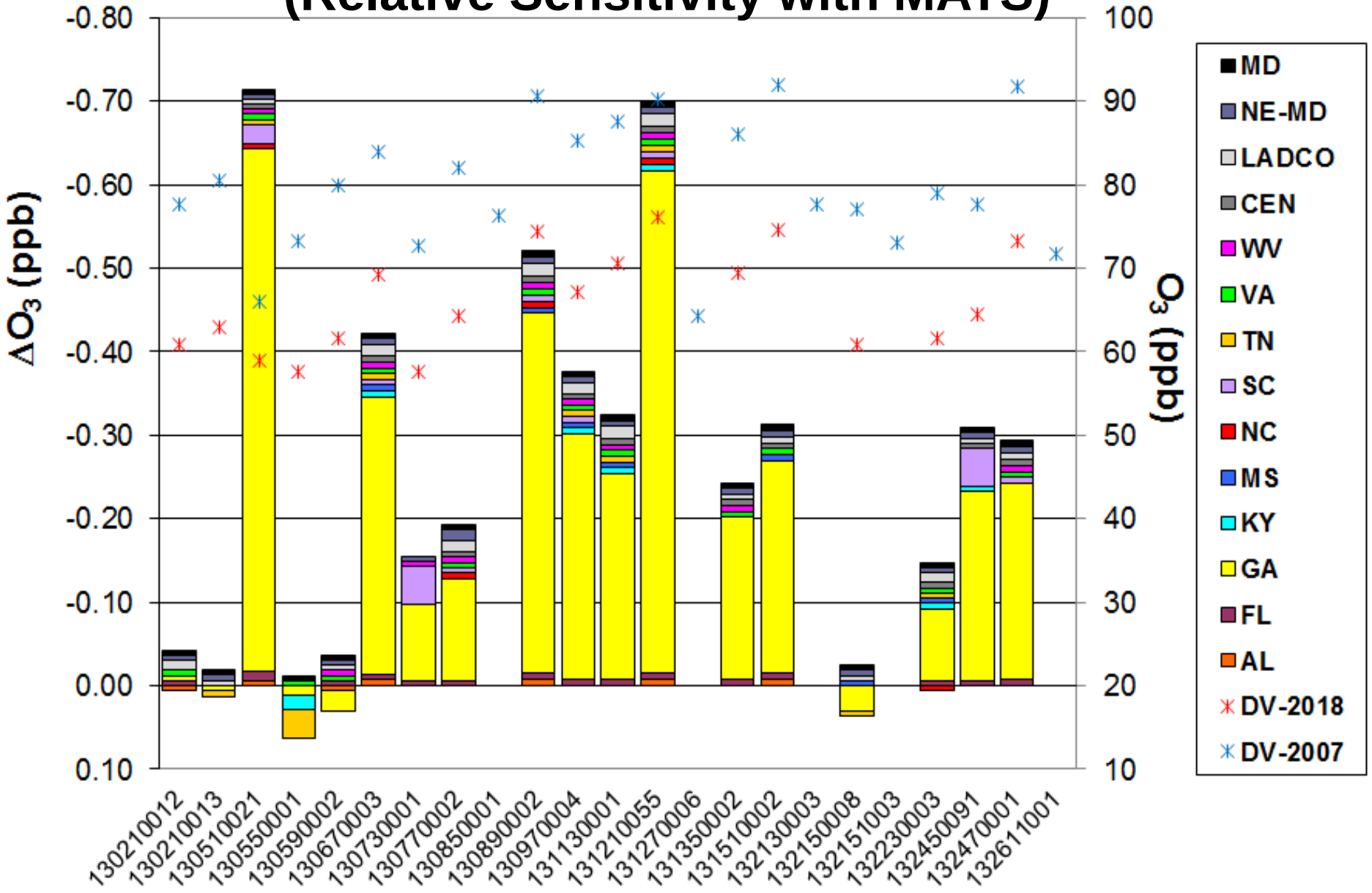
FL Responses to 30% VOC Emission Reductions
(Relative Sensitivity with MATS)



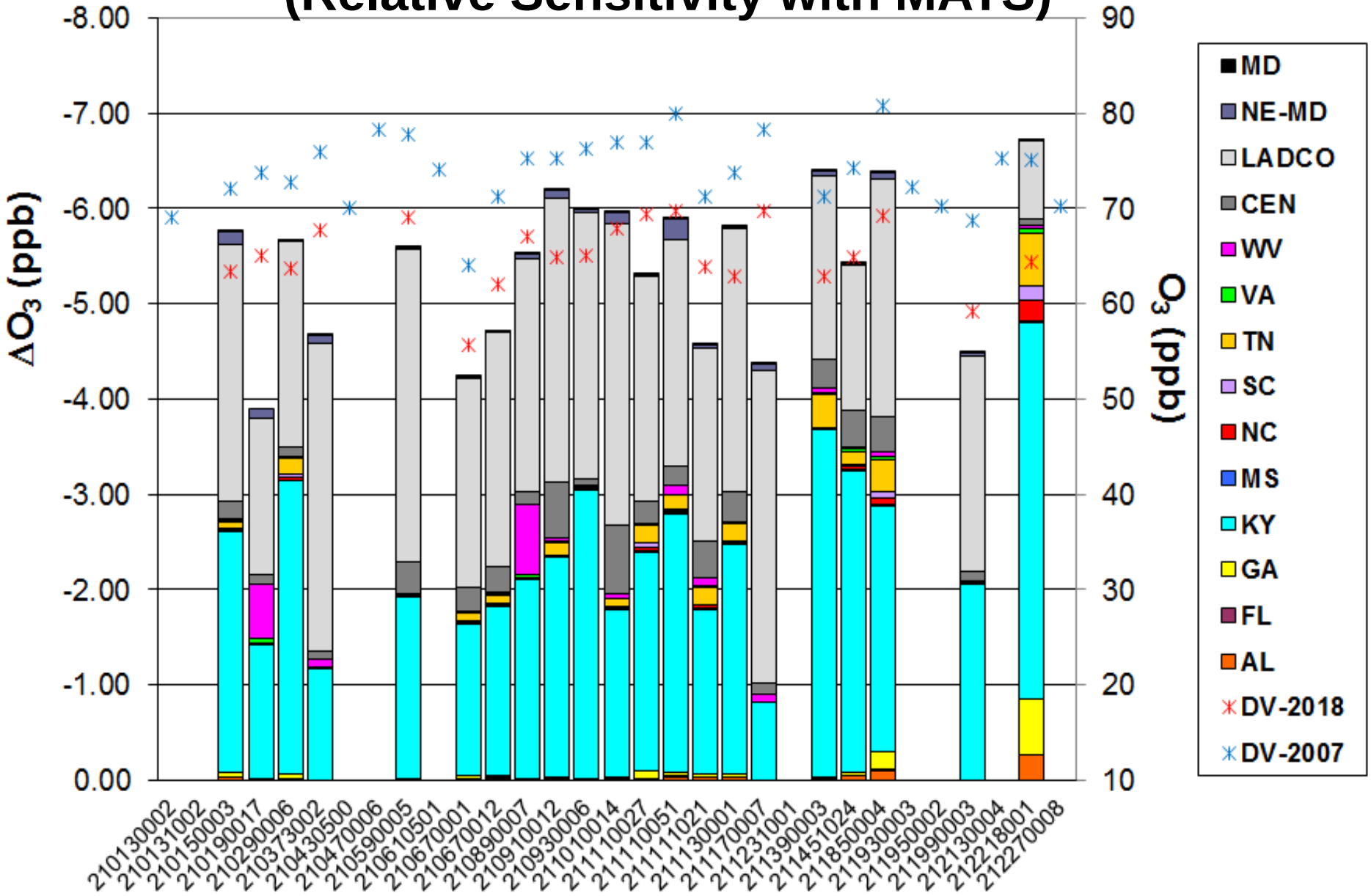
GA Responses to 30% NO_x Emission Reductions (Relative Sensitivity with MATS)



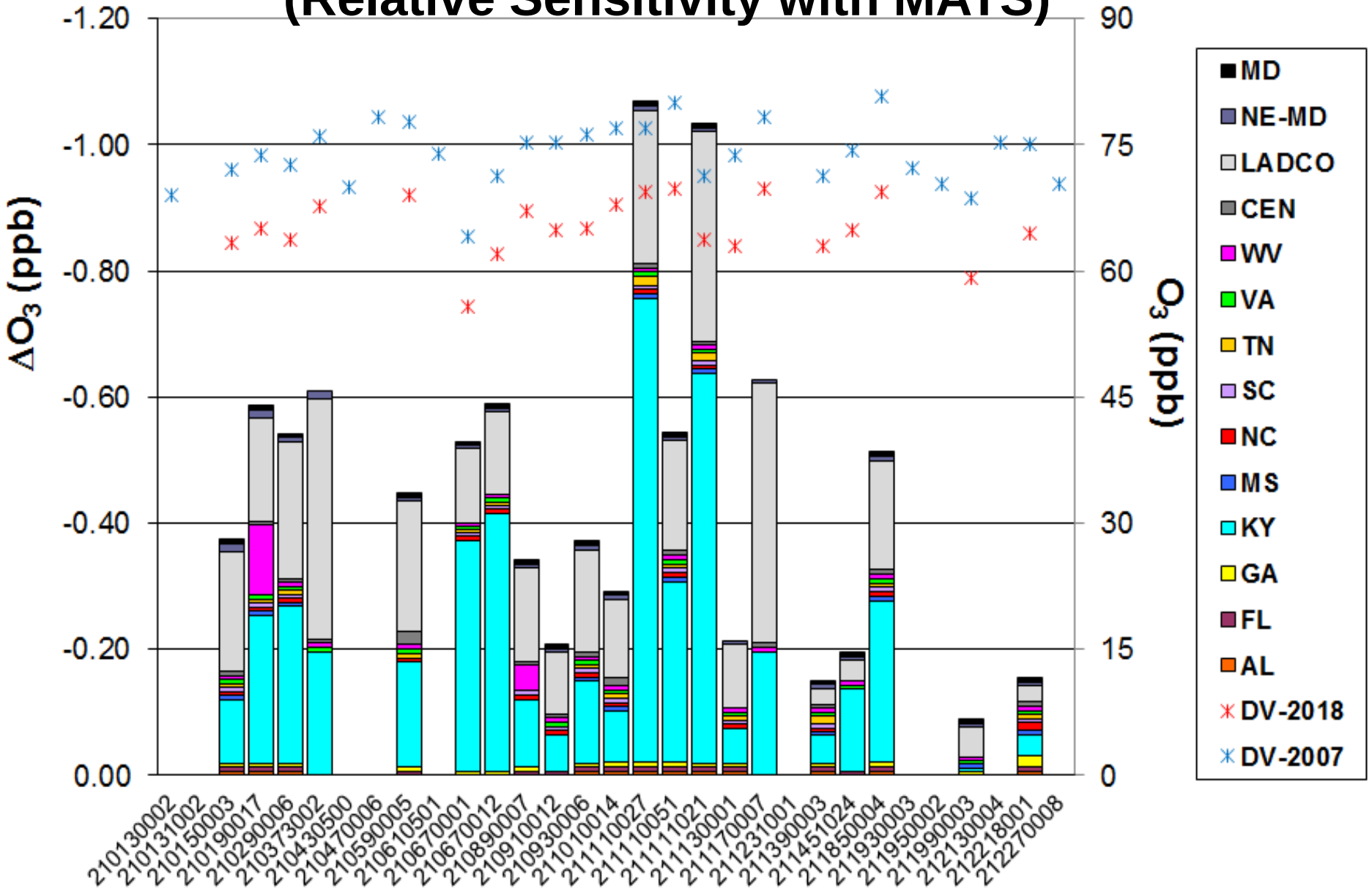
GA Responses to 30% VOC Emission Reductions
(Relative Sensitivity with MATS)



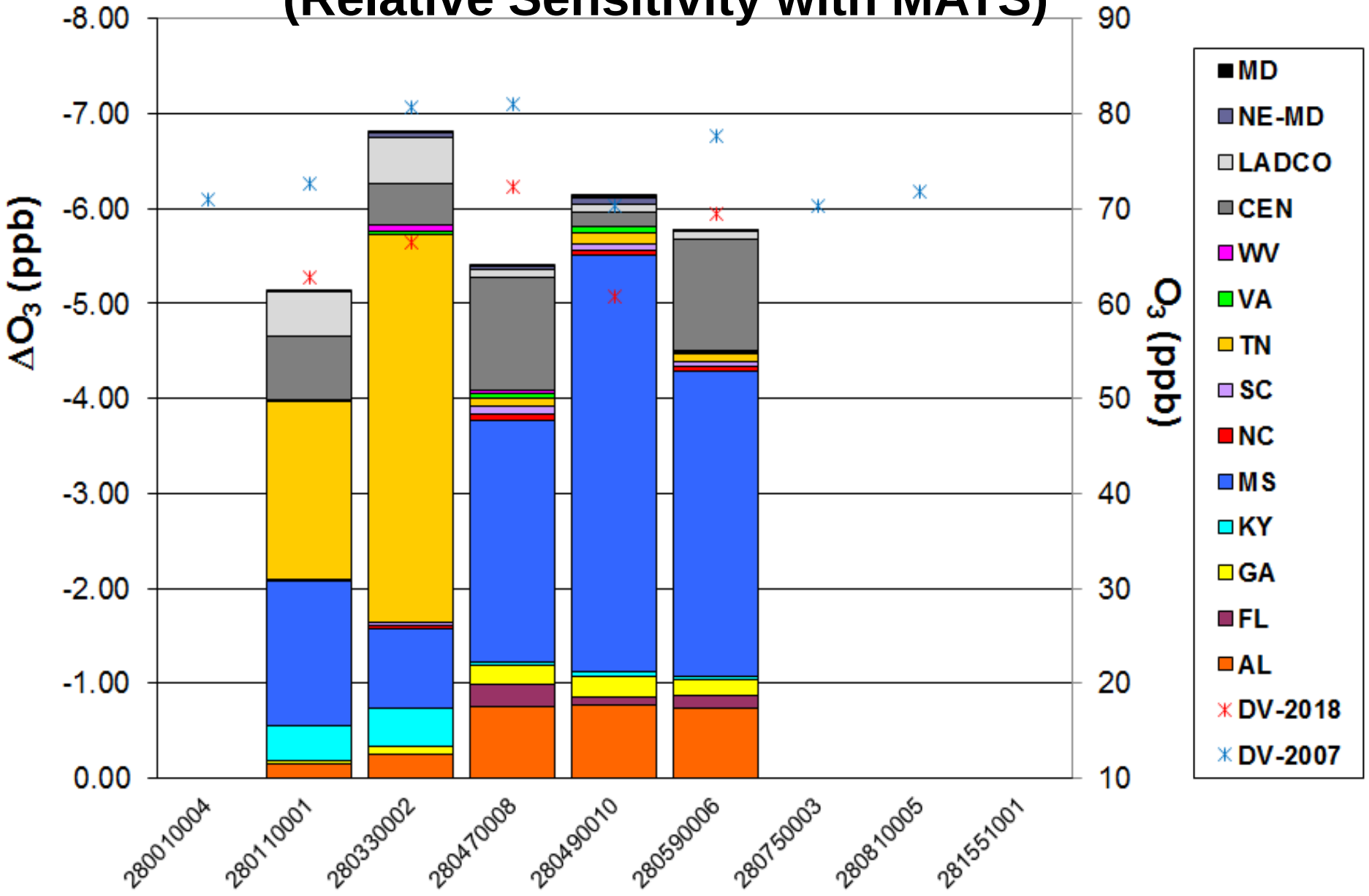
KY Responses to 30% NO_x Emission Reductions
(Relative Sensitivity with MATS)



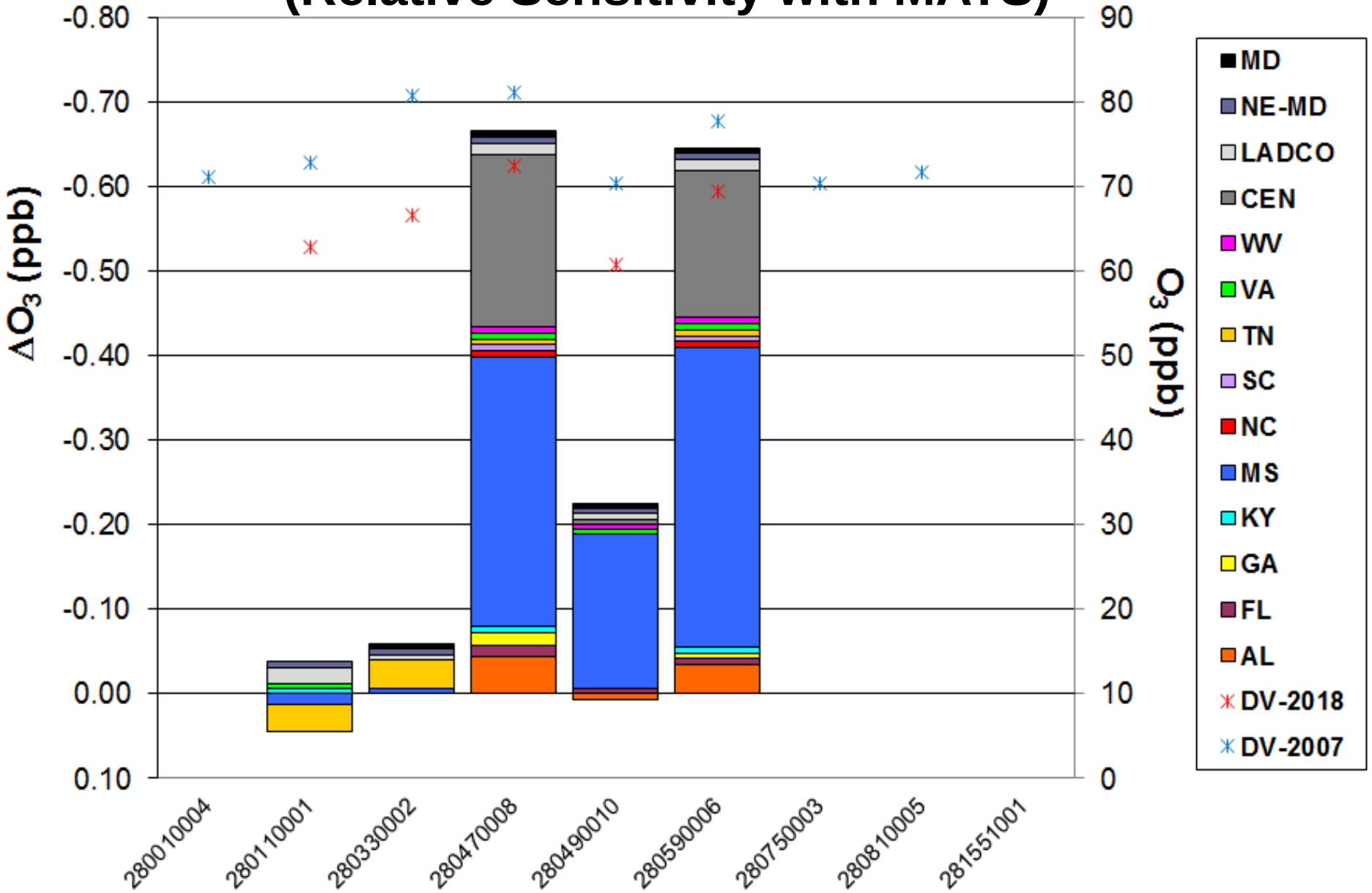
KY Responses to 30% VOC Emission Reductions
(Relative Sensitivity with MATS)



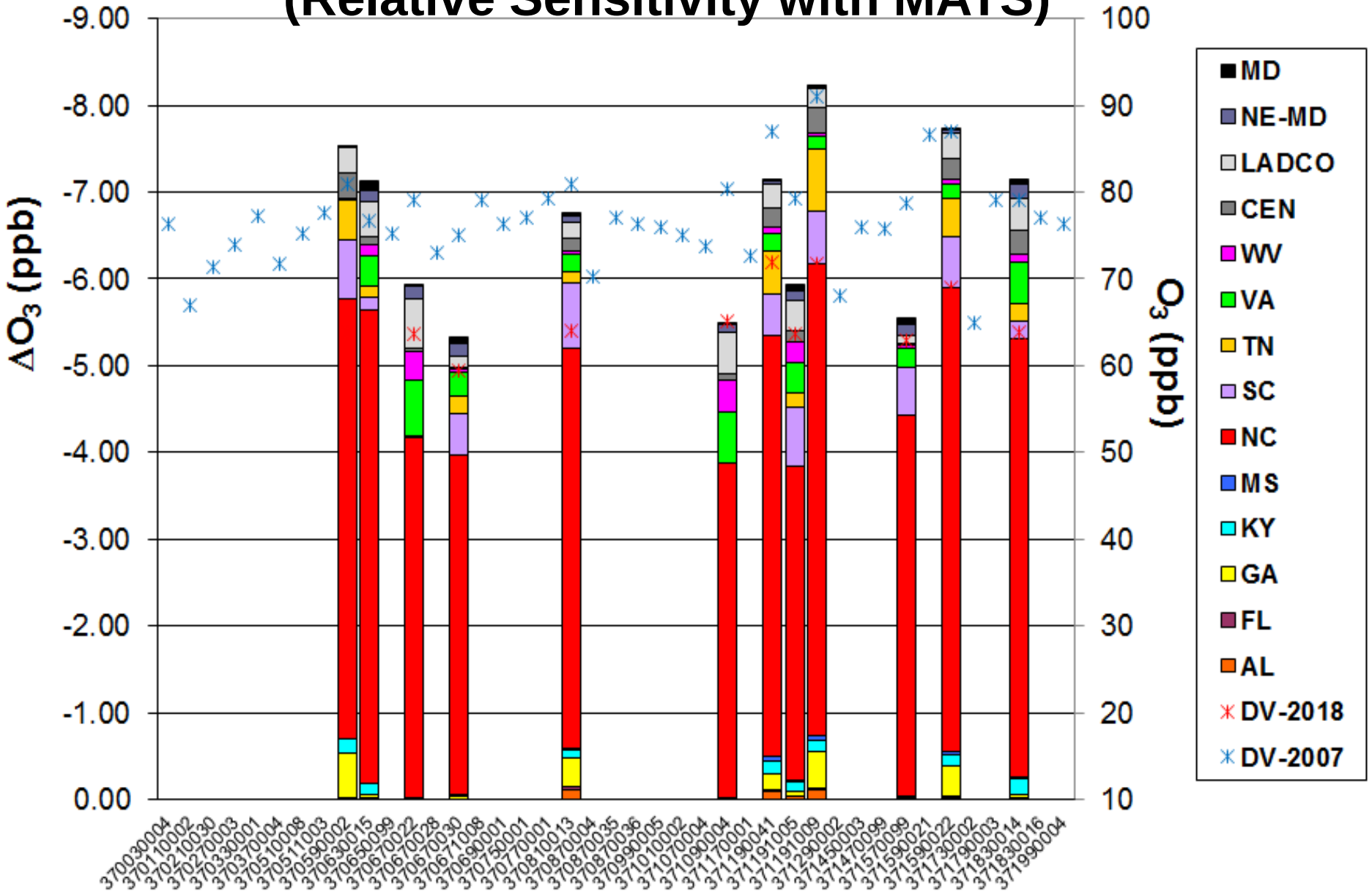
MS Responses to 30% NO_x Emission Reductions
(Relative Sensitivity with MATS)



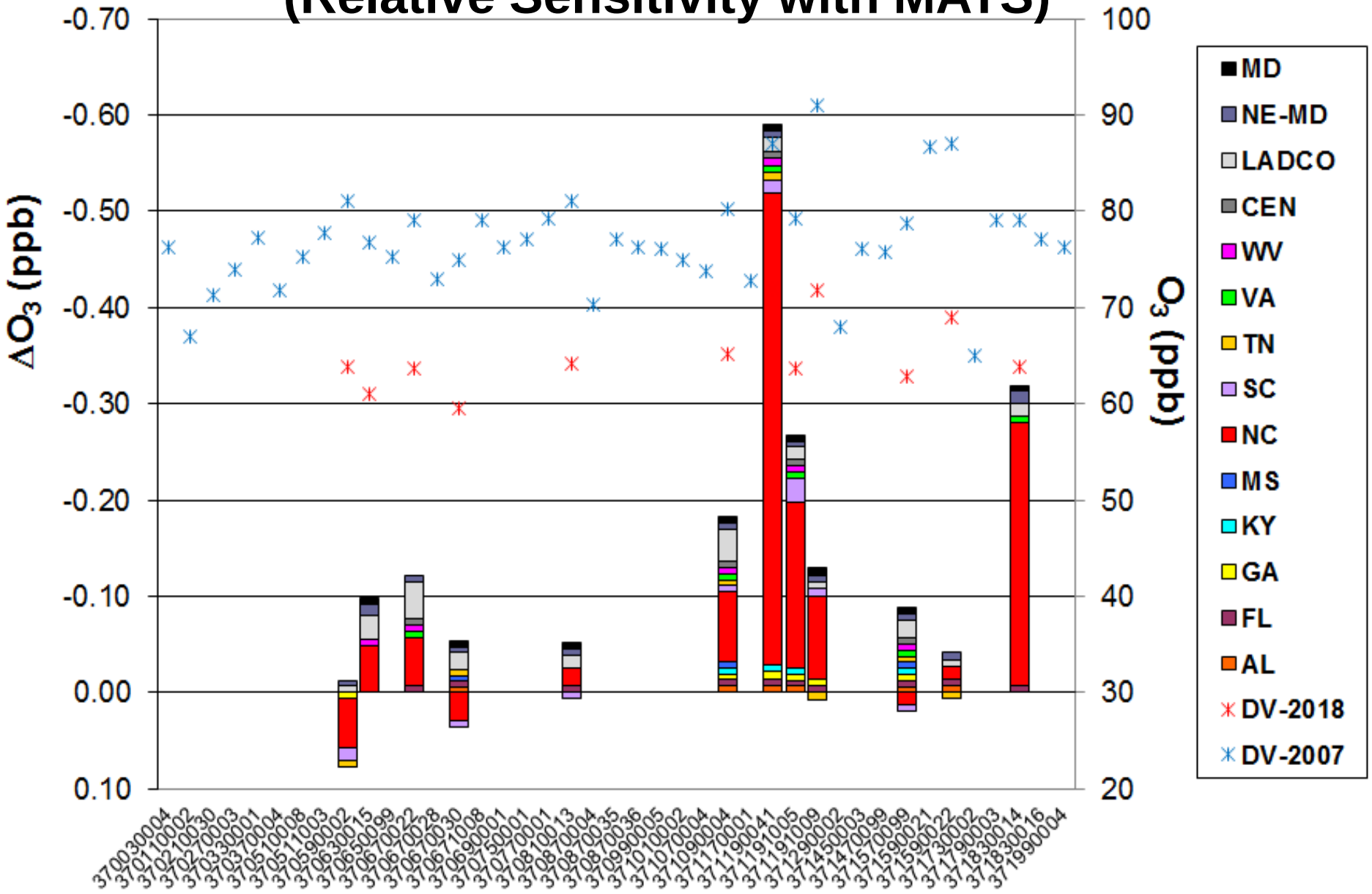
MS Responses to 30% VOC Emission Reductions
(Relative Sensitivity with MATS)



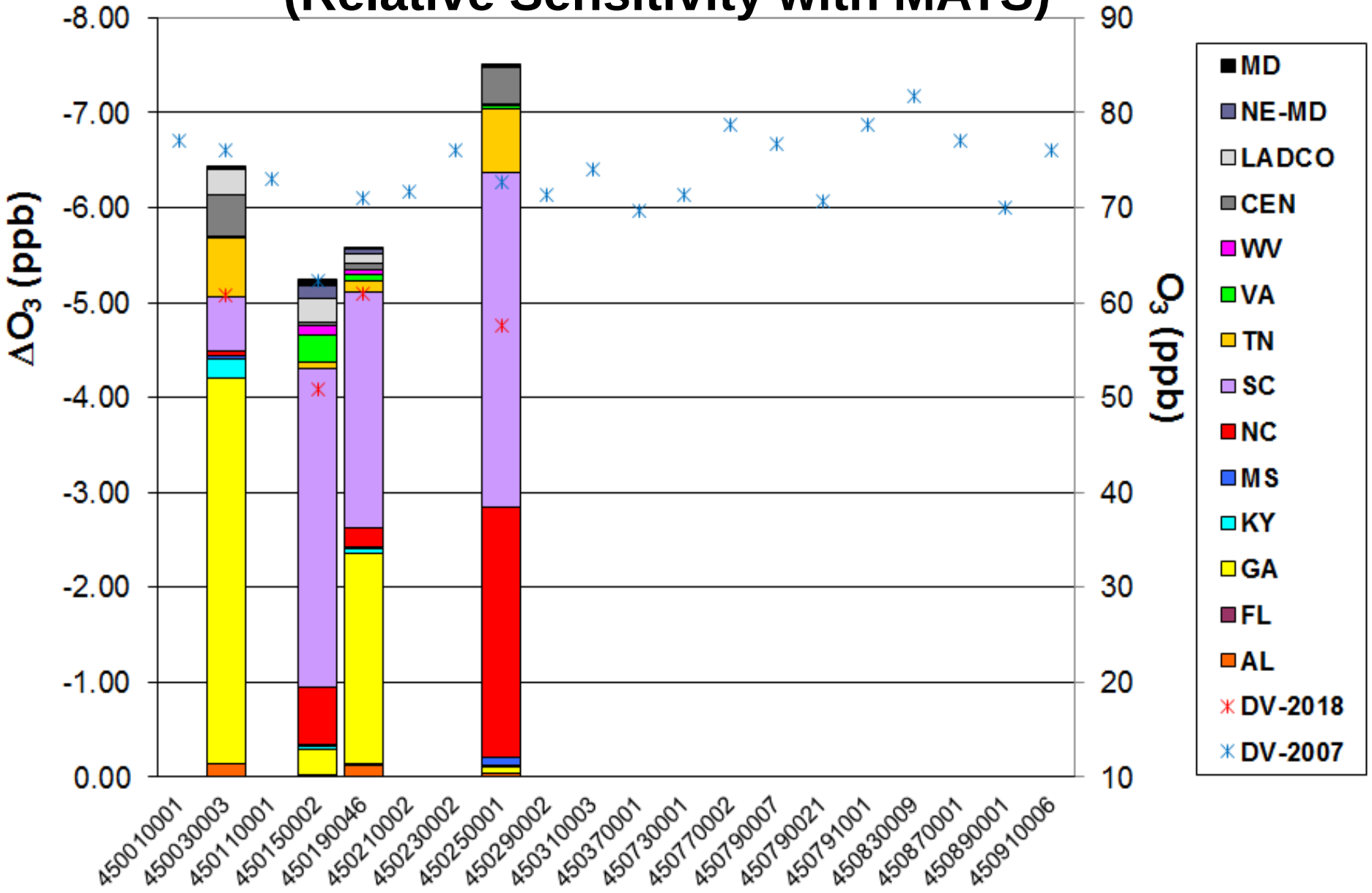
NC Responses to 30% NO_x Emission Reductions (Relative Sensitivity with MATS)



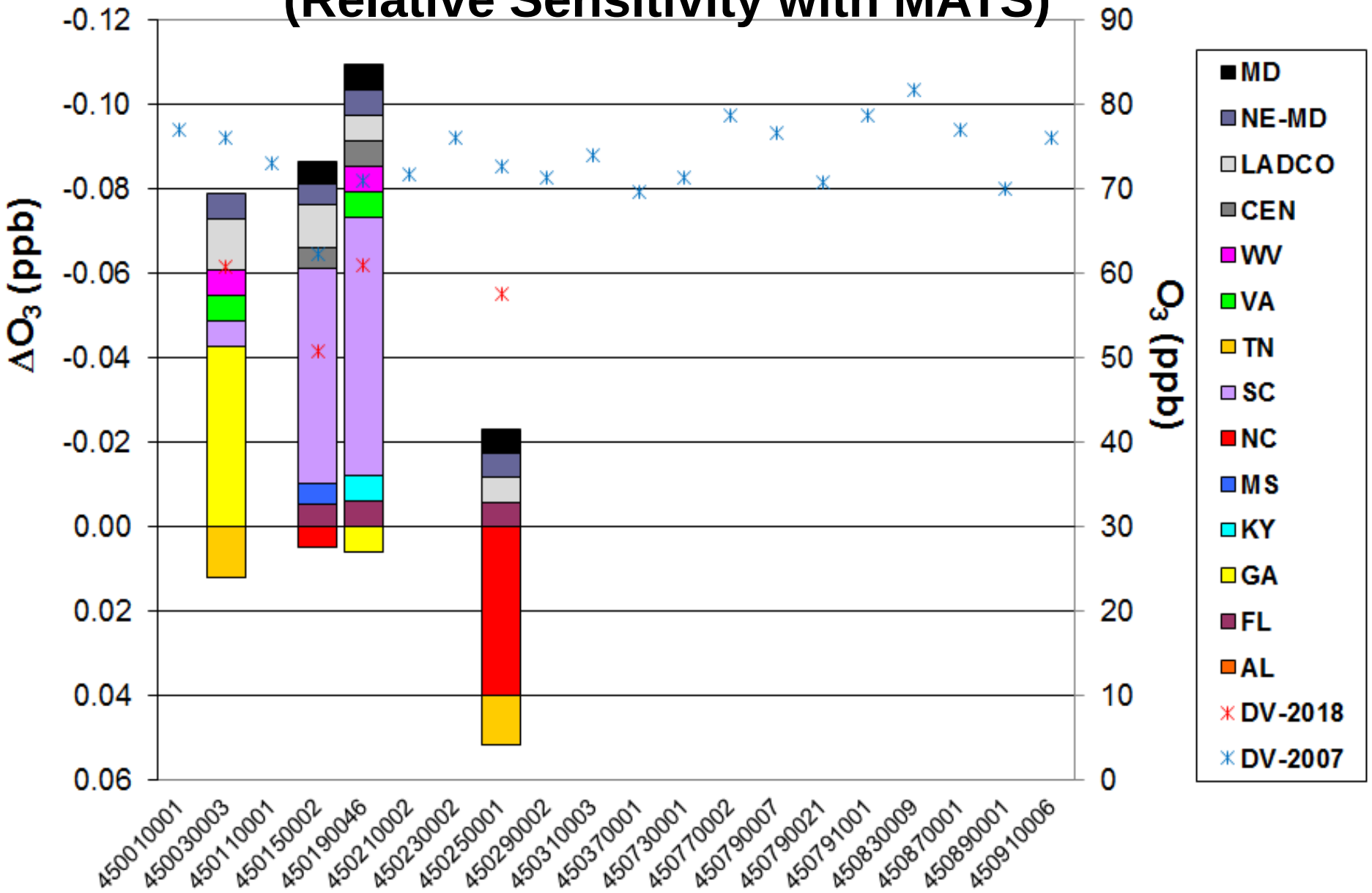
NC Responses to 30% VOC Emission Reductions
(Relative Sensitivity with MATS)



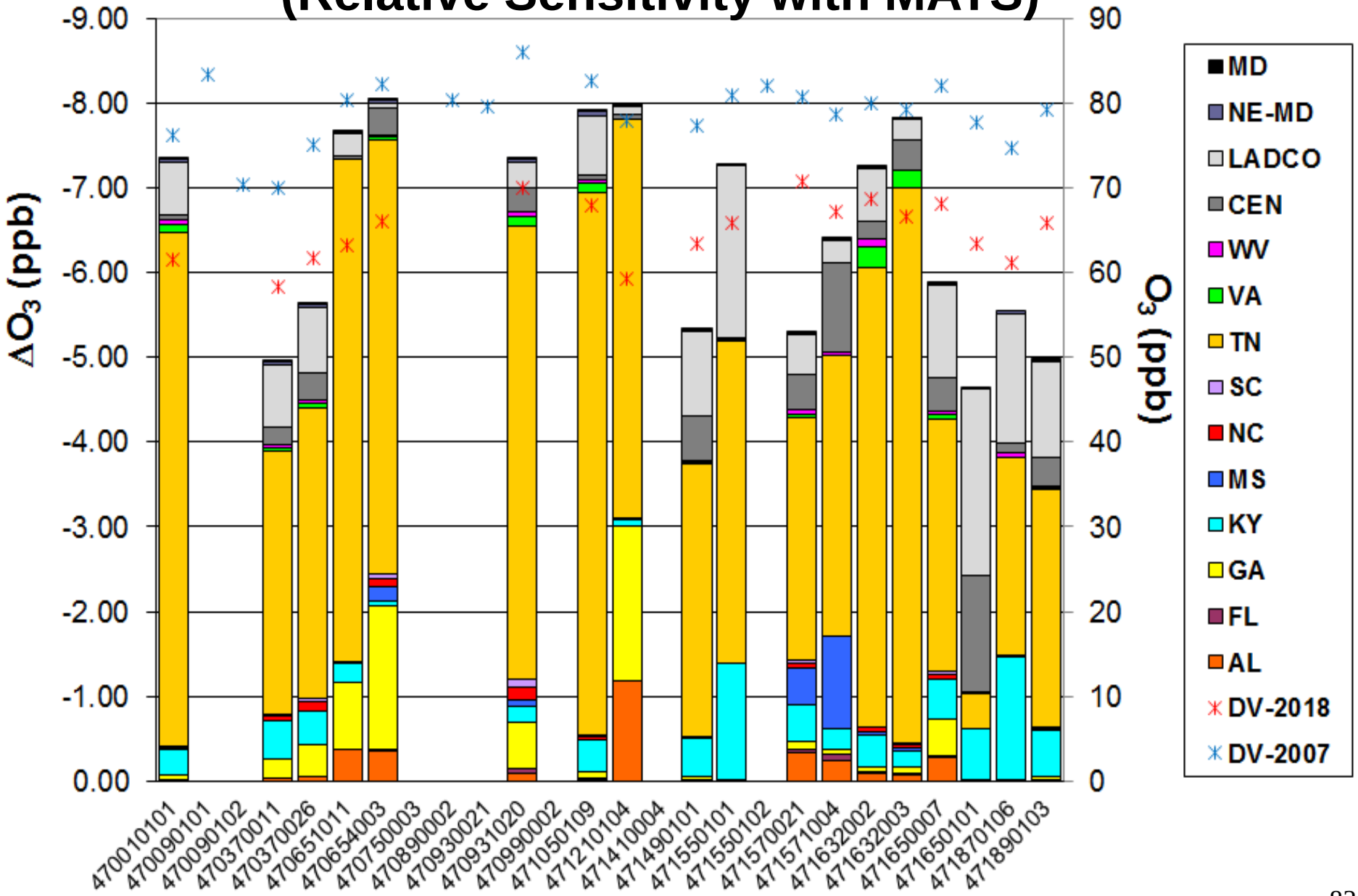
SC Responses to 30% NO_x Emission Reductions
(Relative Sensitivity with MATS)



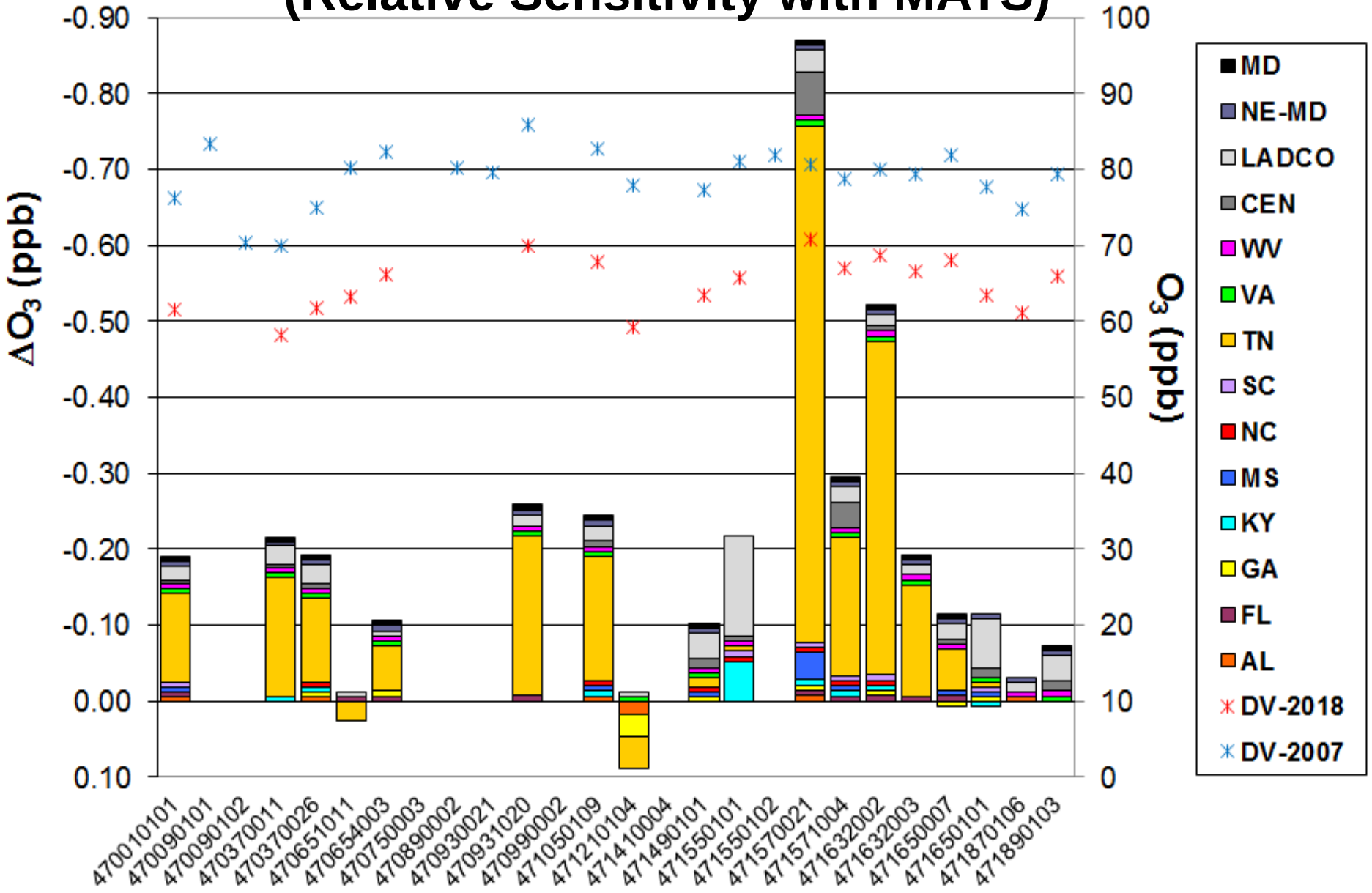
SC Responses to 30% VOC Emission Reductions
(Relative Sensitivity with MATS)



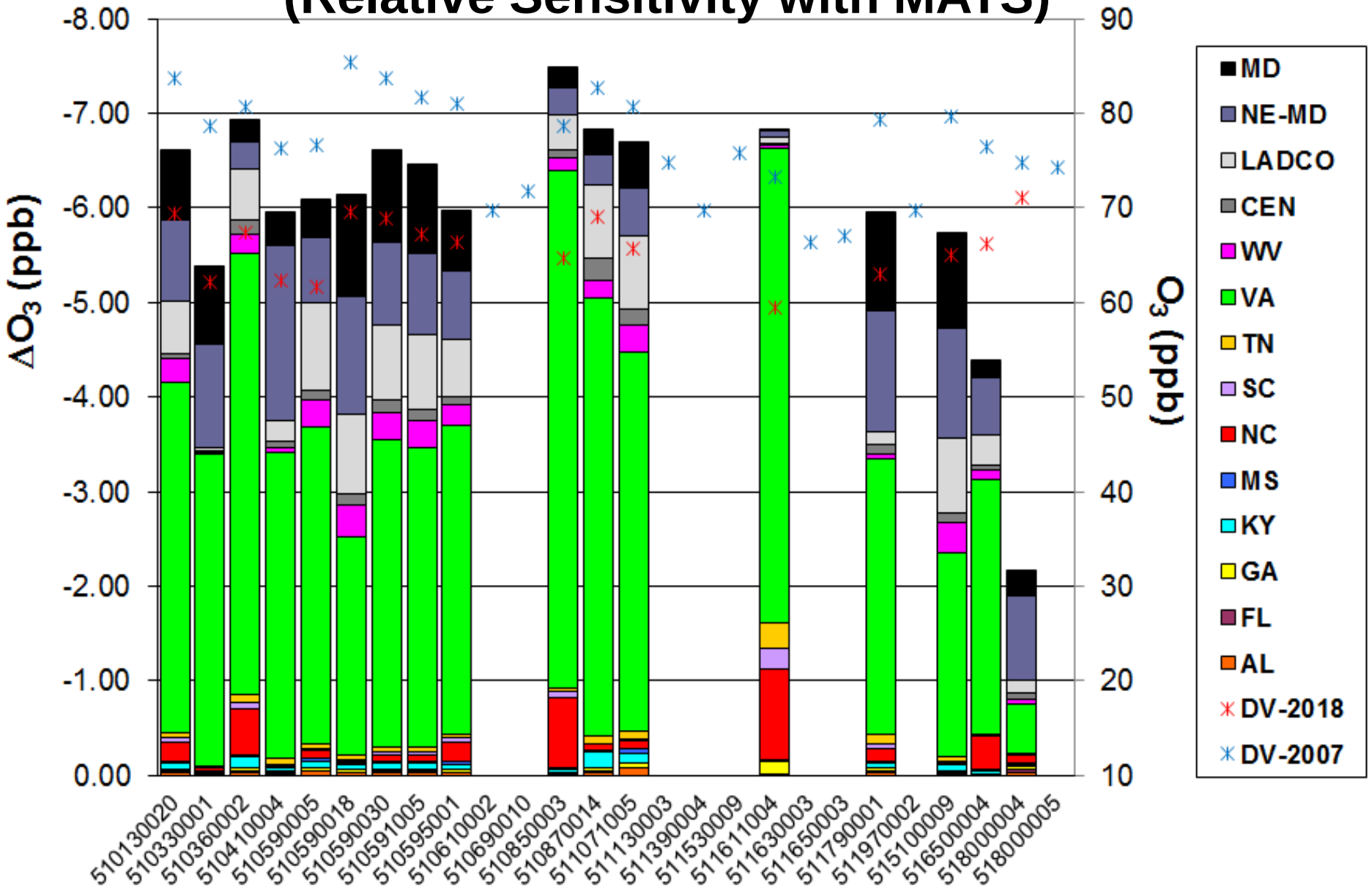
TN Responses to 30% NO_x Emission Reductions (Relative Sensitivity with MATS)



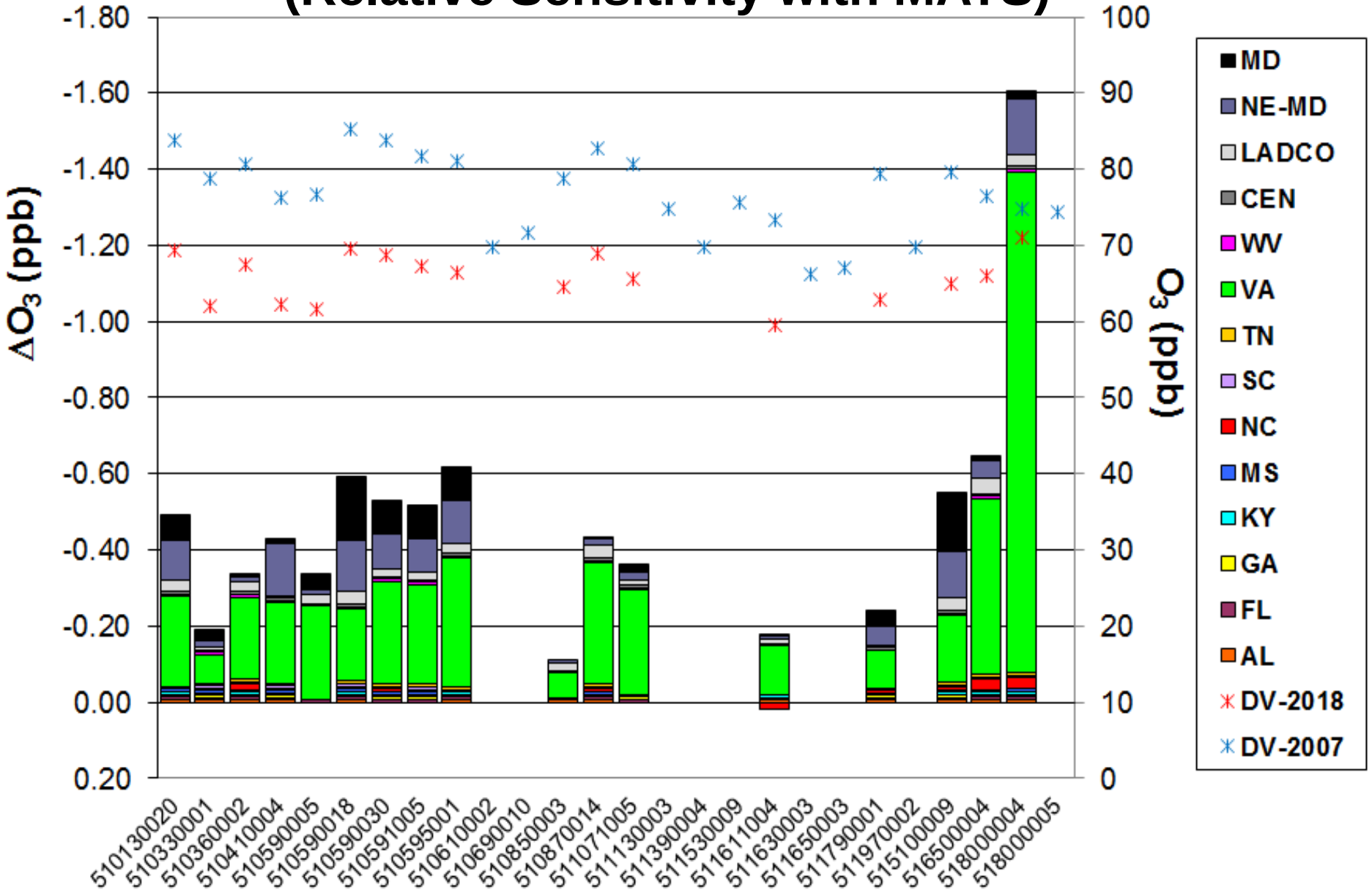
TN Responses to 30% VOC Emission Reductions
(Relative Sensitivity with MATS)



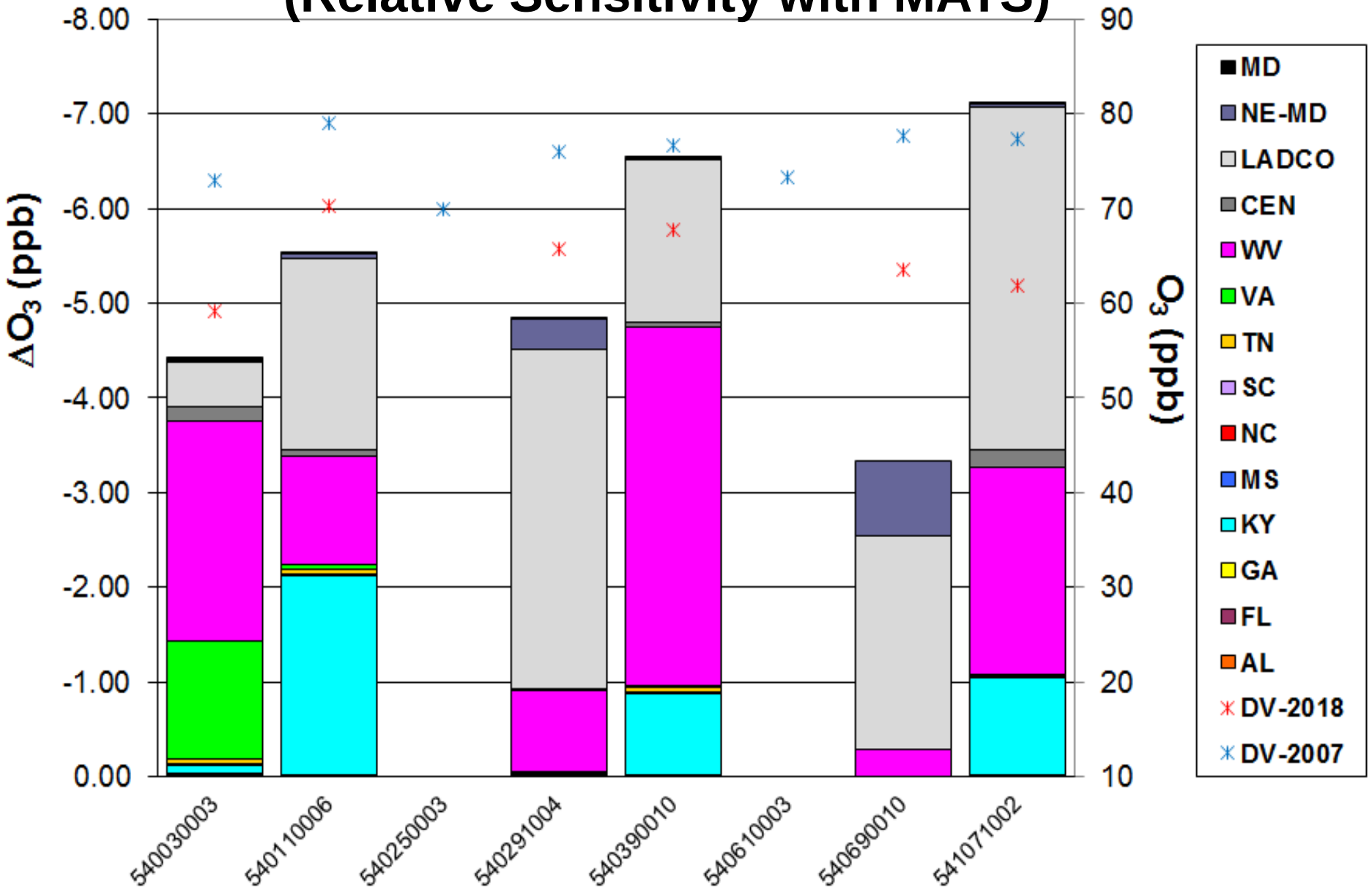
VA Responses to 30% NO_x Emission Reductions
(Relative Sensitivity with MATS)



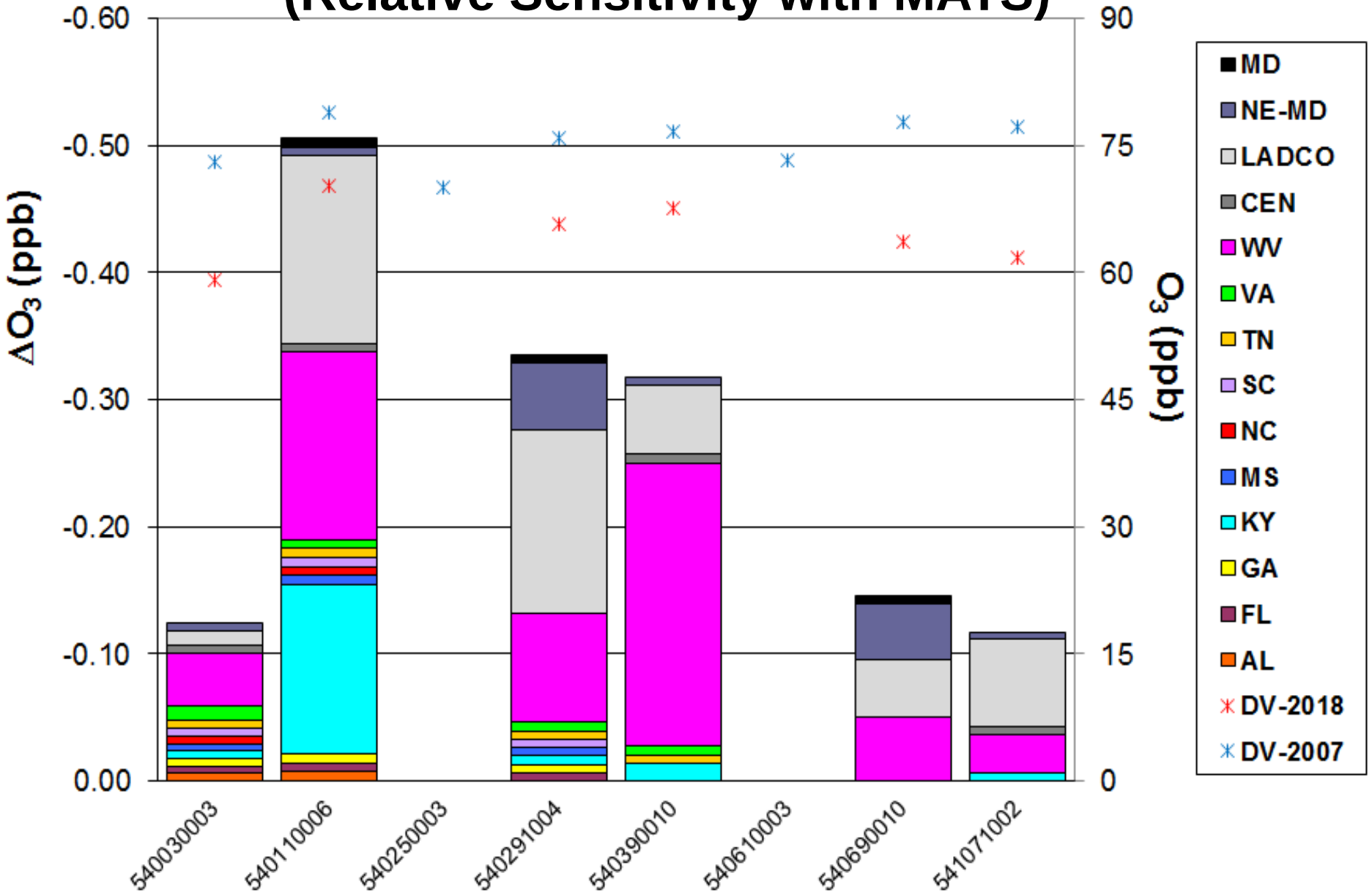
VA Responses to 30% VOC Emission Reductions
(Relative Sensitivity with MATS)



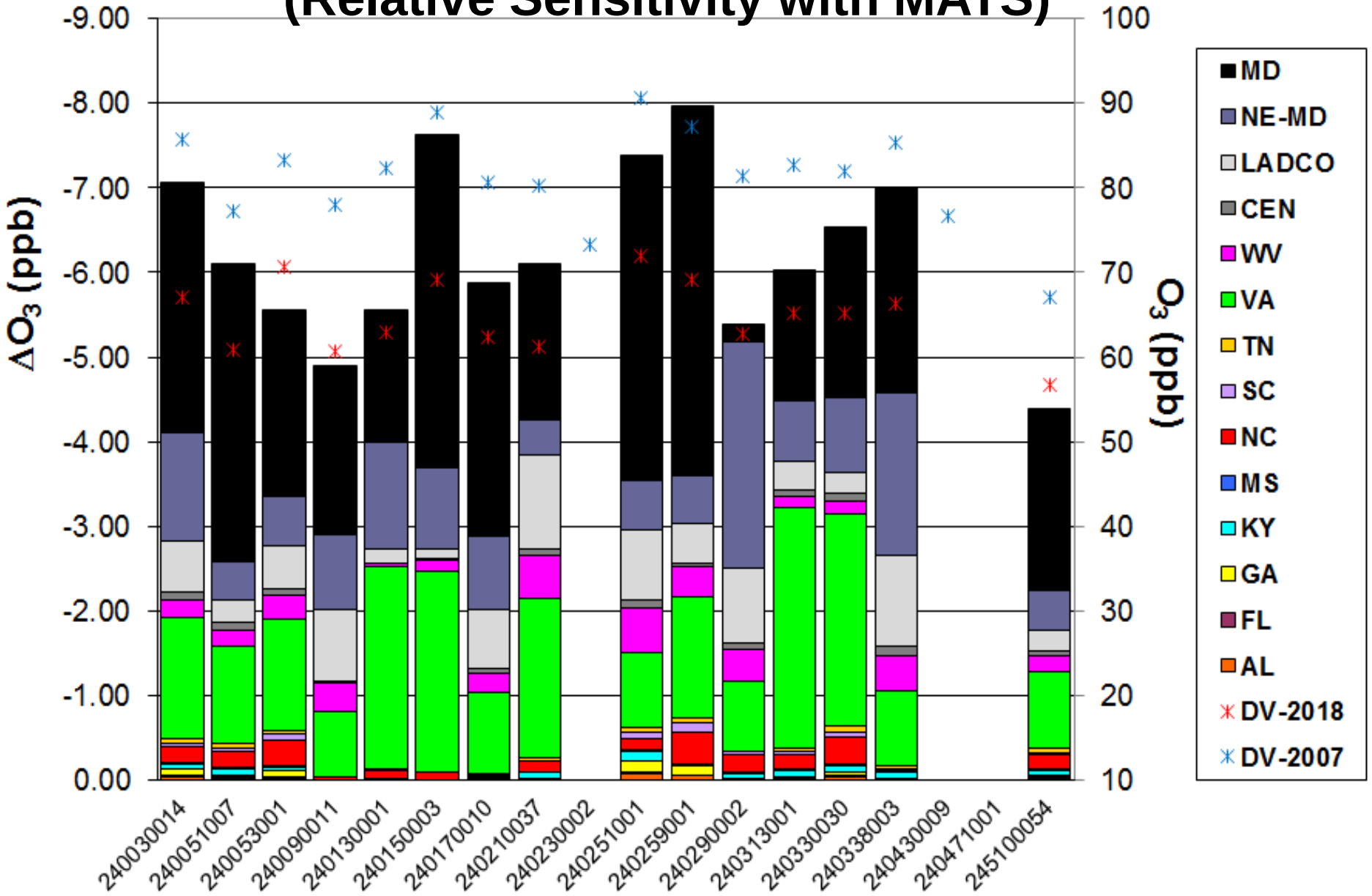
WV Responses to 30% NO_x Emission Reductions (Relative Sensitivity with MATS)



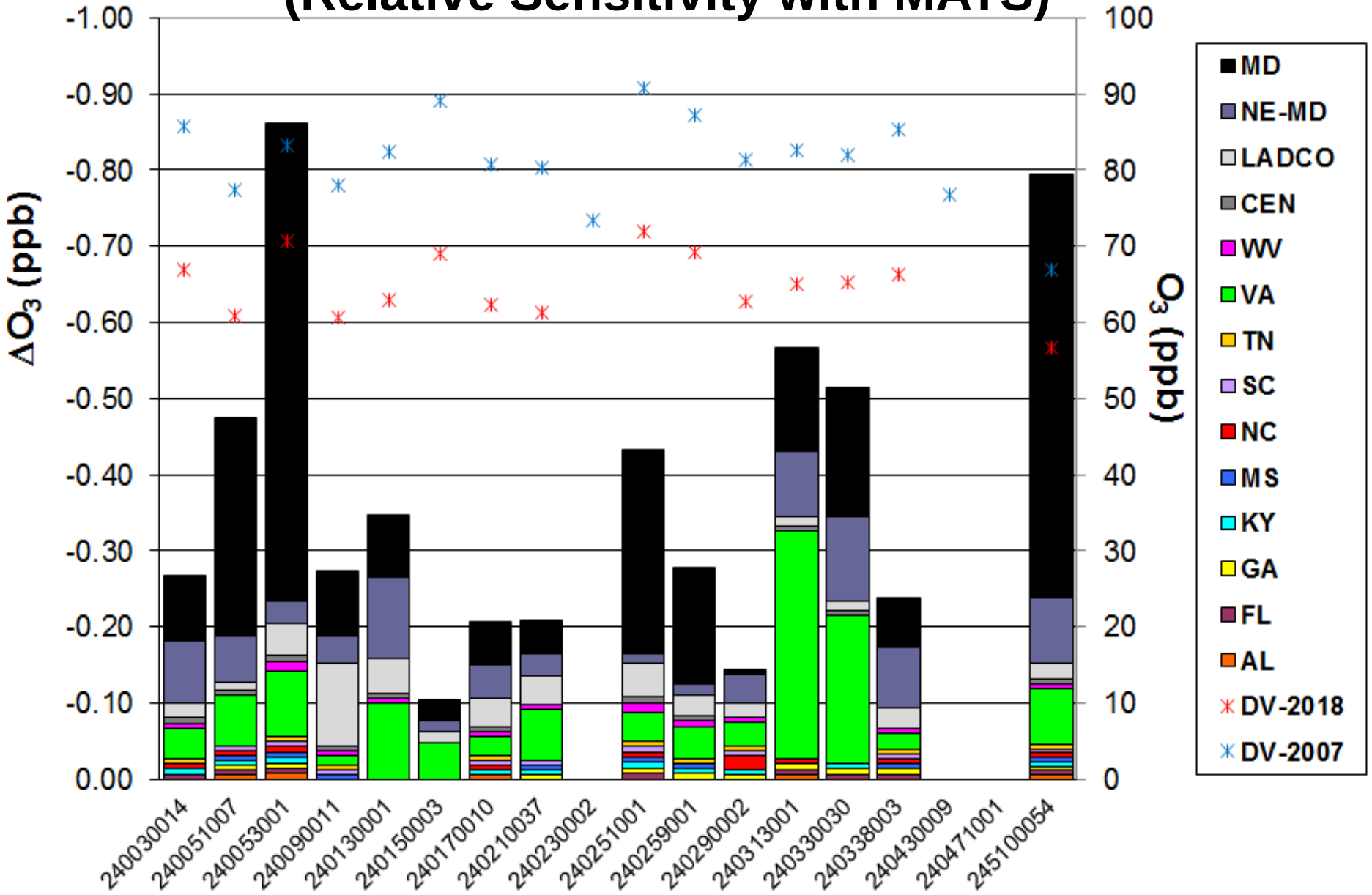
WV Responses to 30% VOC Emission Reductions
(Relative Sensitivity with MATS)



MD Responses to 30% NO_x Emission Reductions (Relative Sensitivity with MATS)

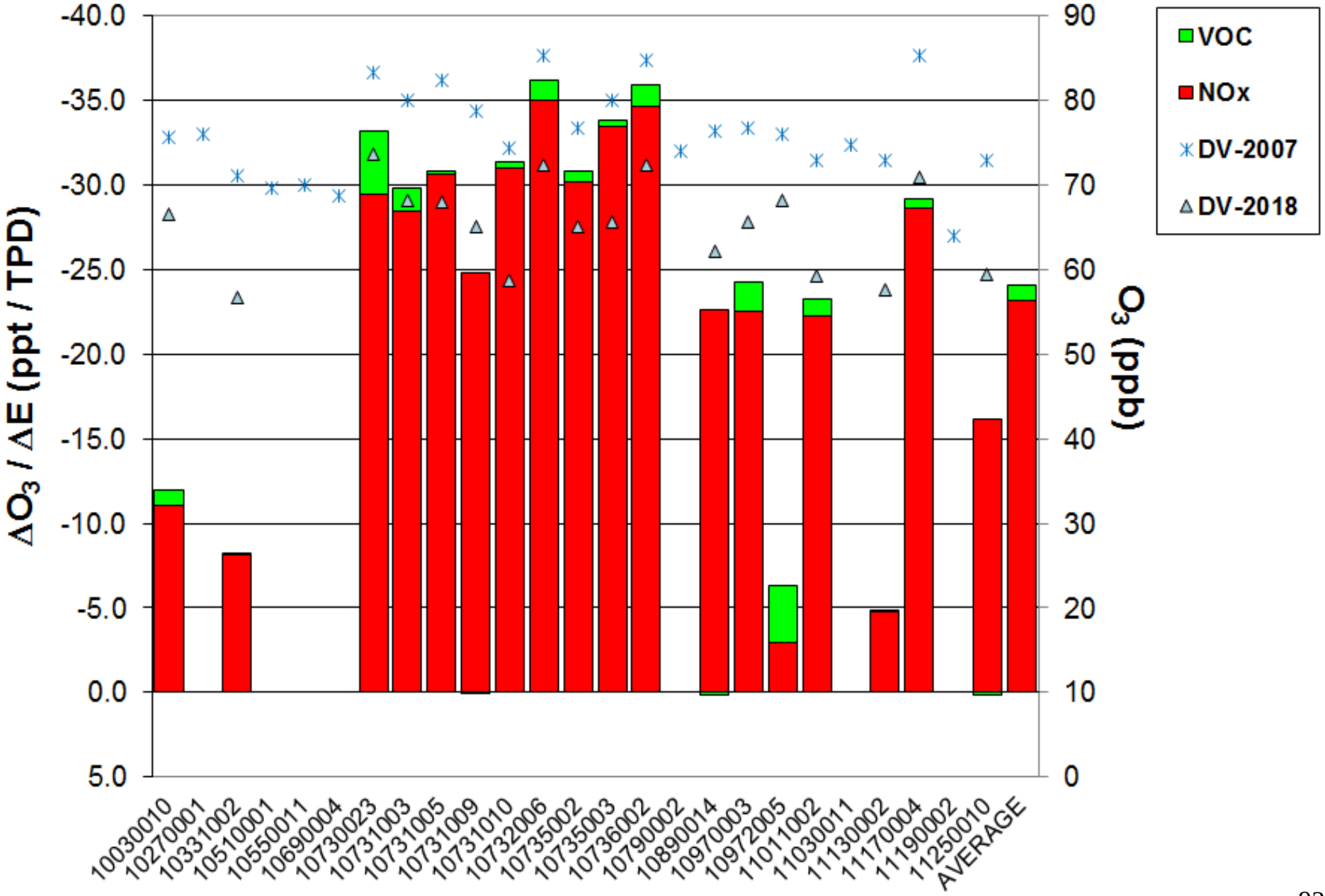


MD Responses to 30% VOC Emission Reductions
(Relative Sensitivity with MATS)

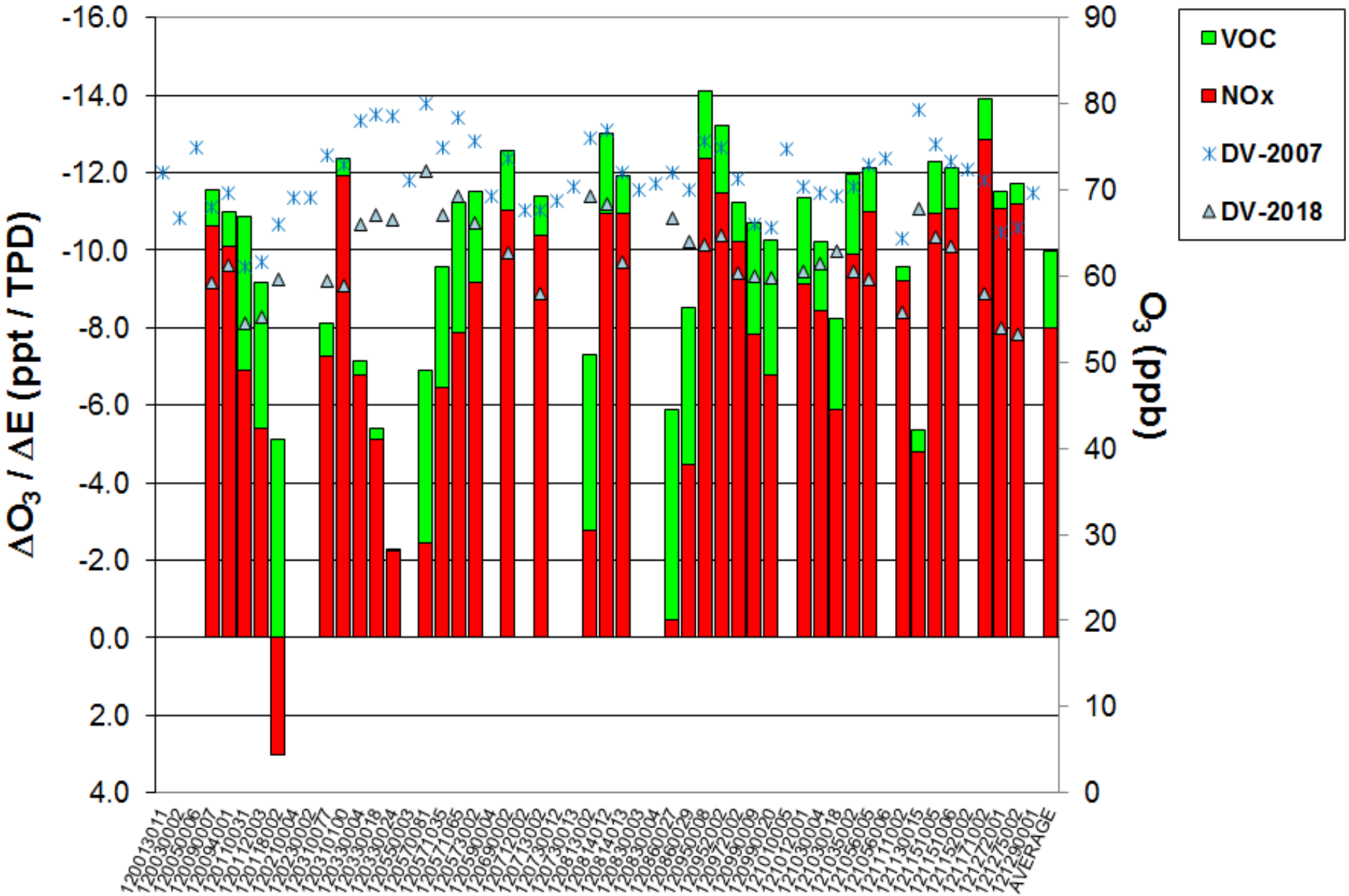


Normalized Sensitivity State Summary

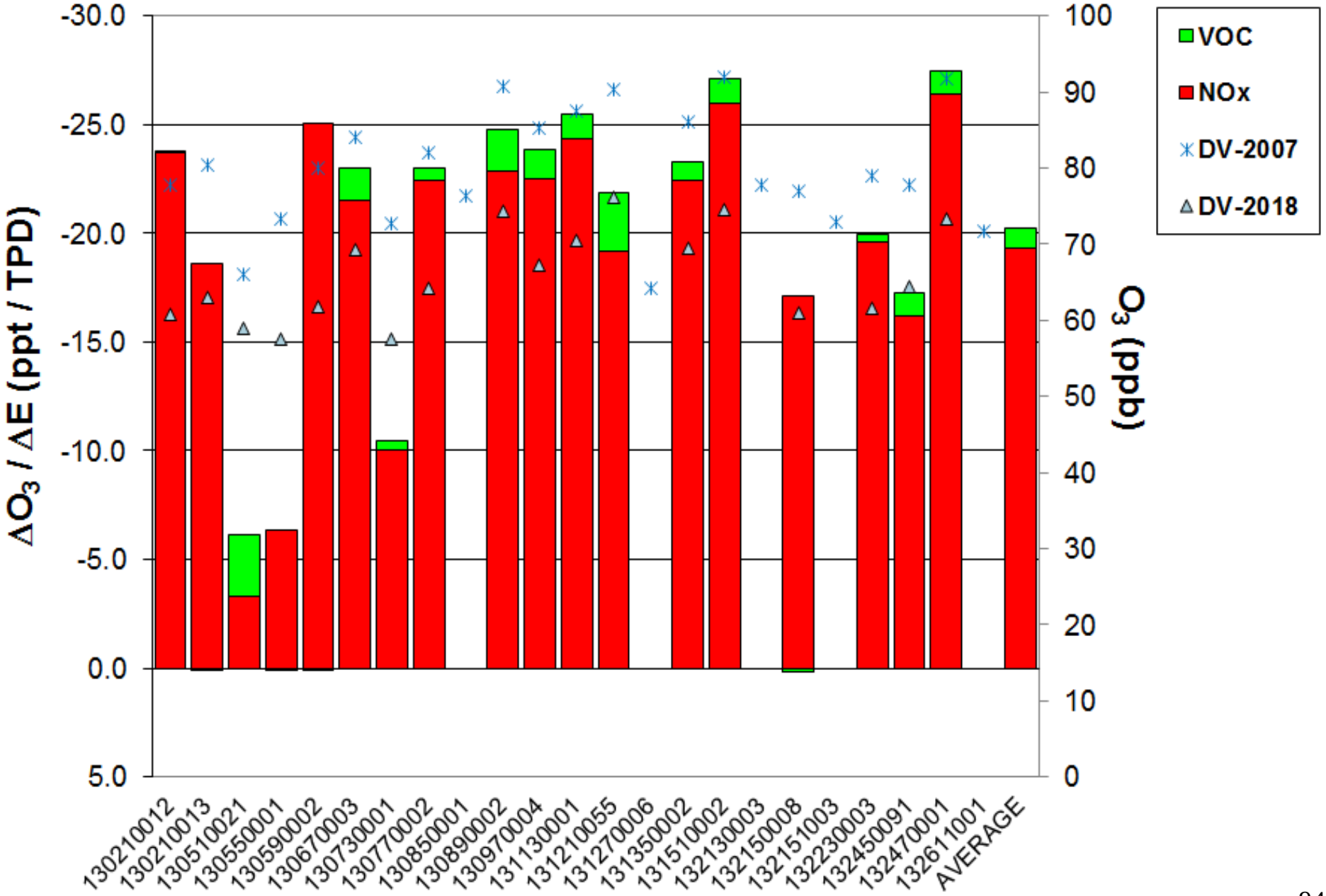
AL Responses Per TPD Emission Reduction



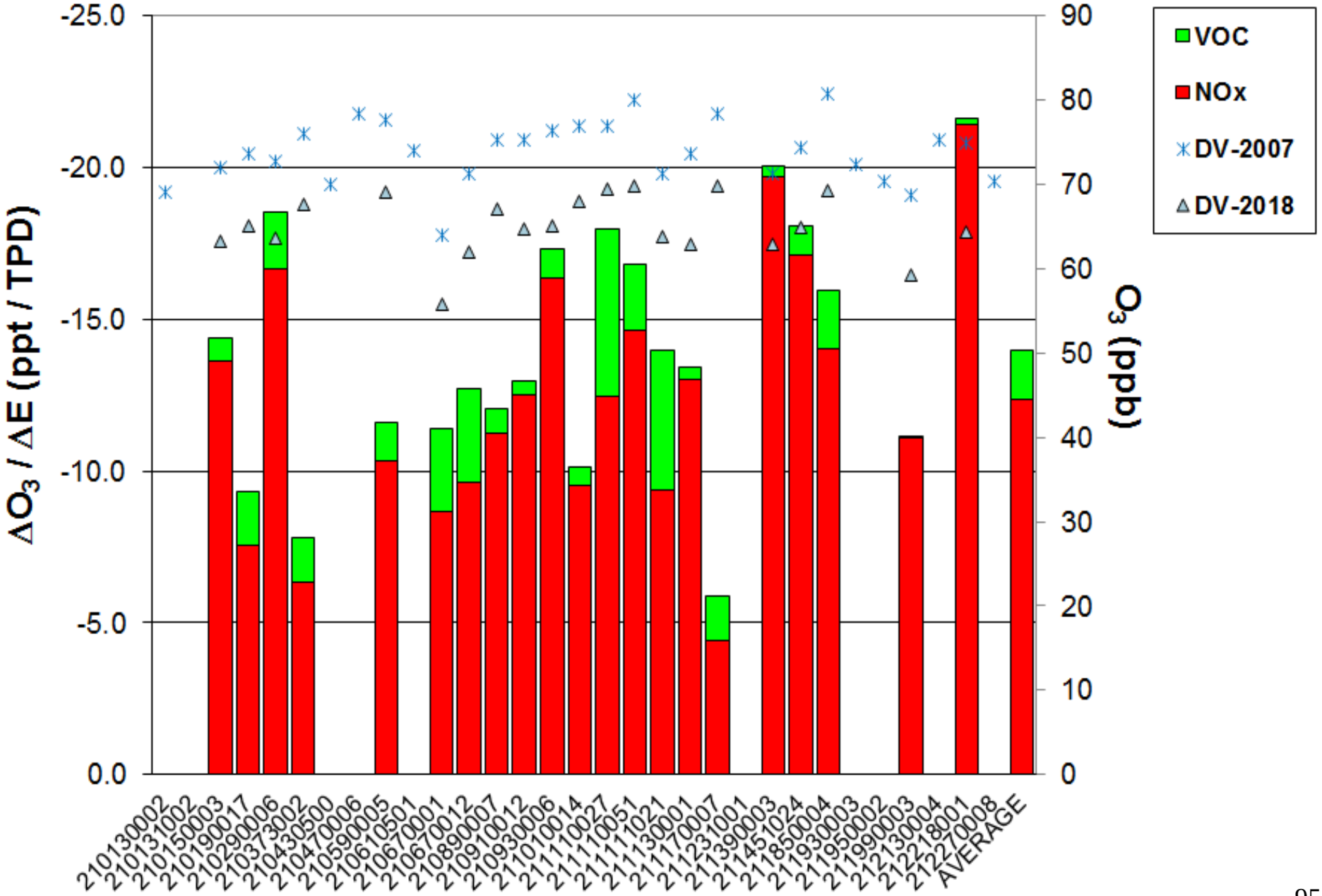
FL Responses Per TPD Emission Reduction



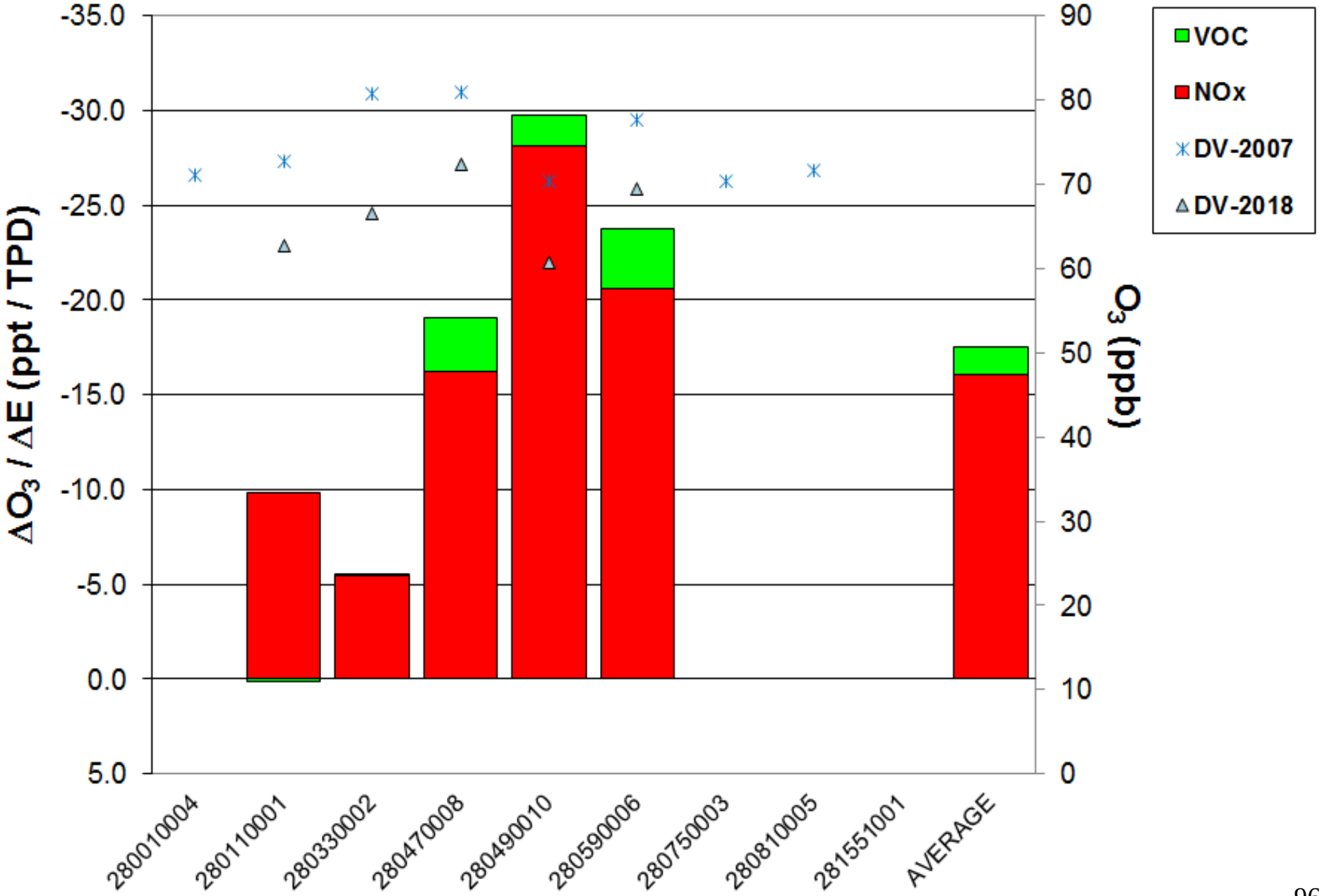
GA Responses Per TPD Emission Reduction



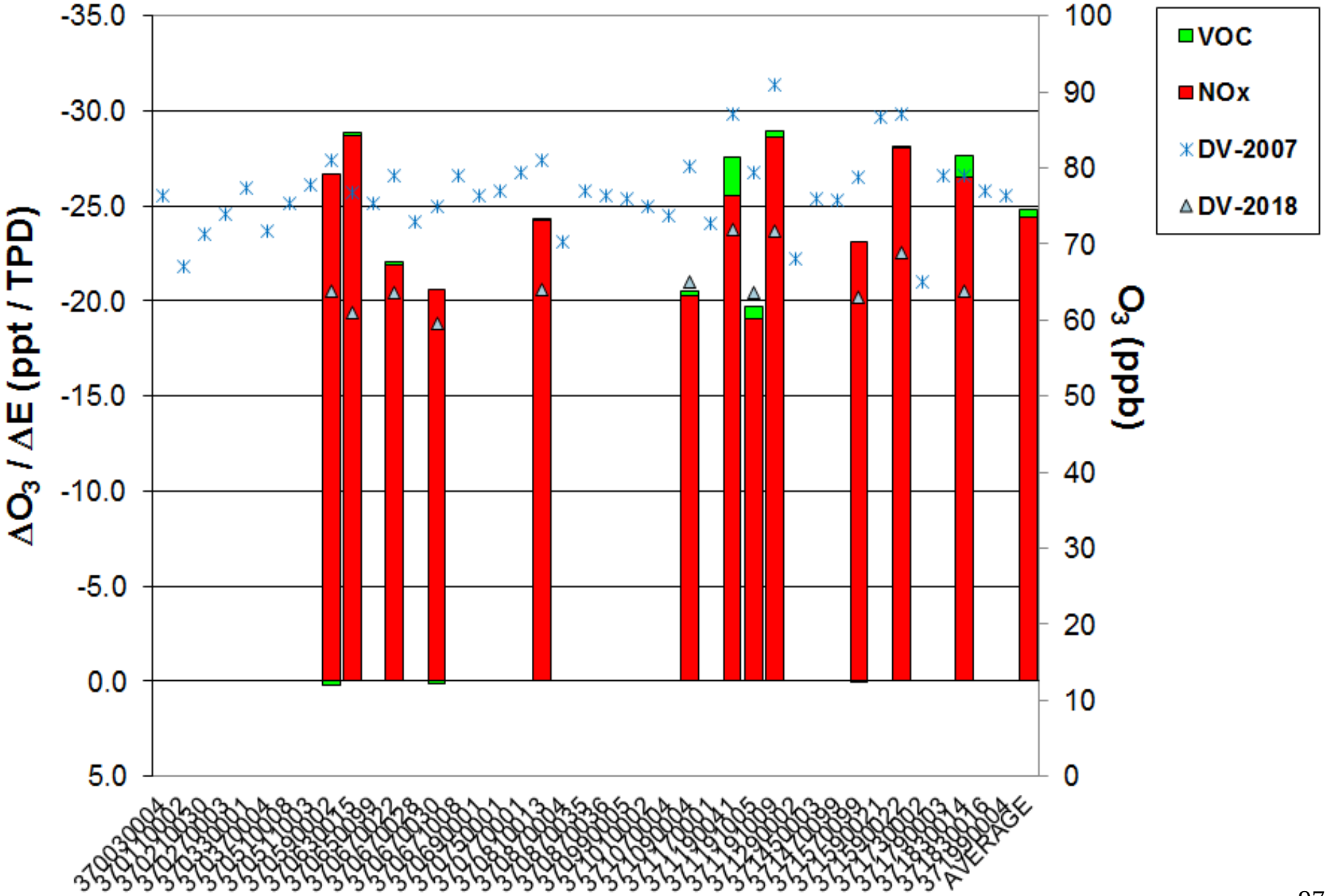
KY Responses Per TPD Emission Reduction

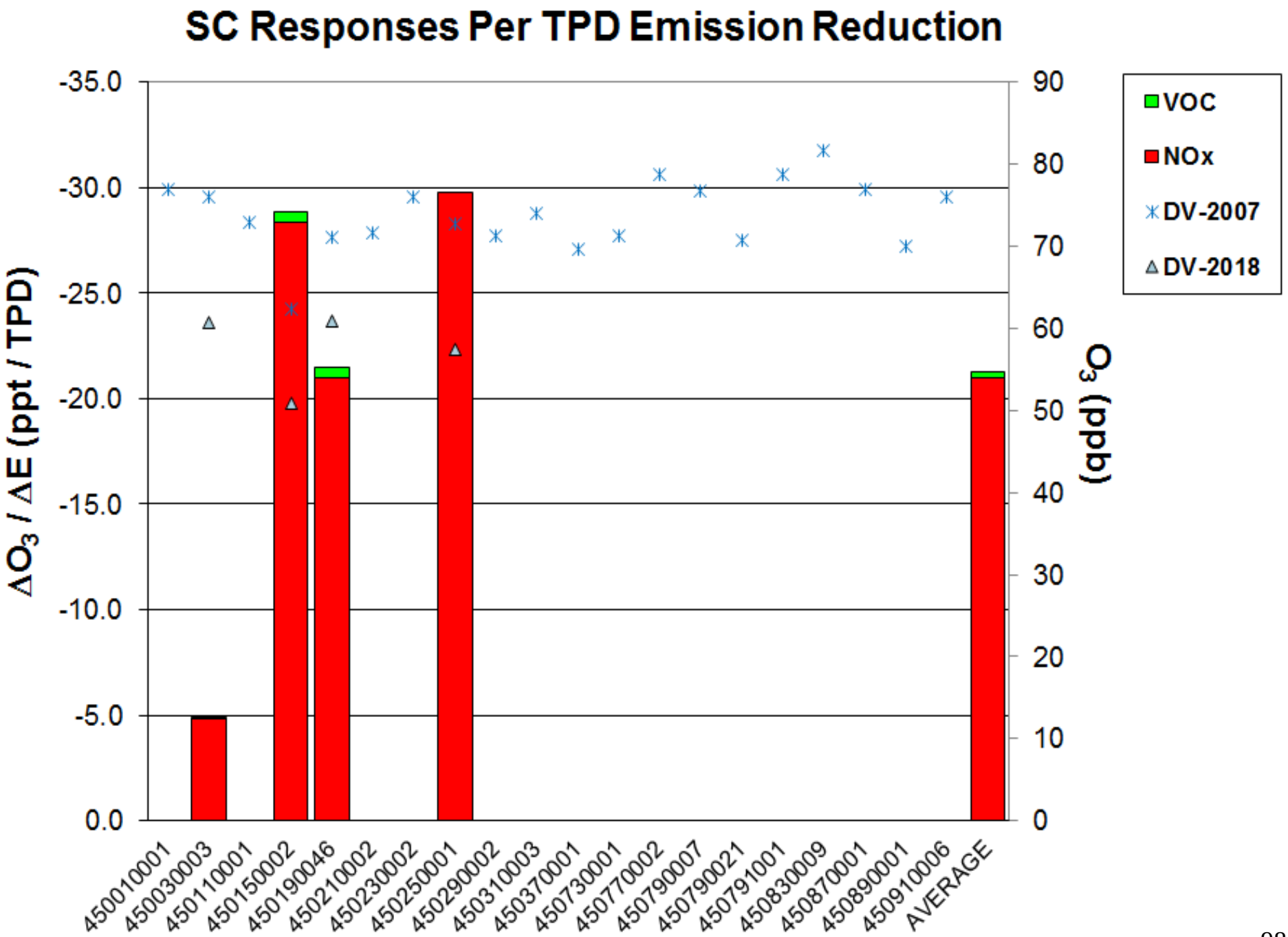


MS Responses Per TPD Emission Reduction

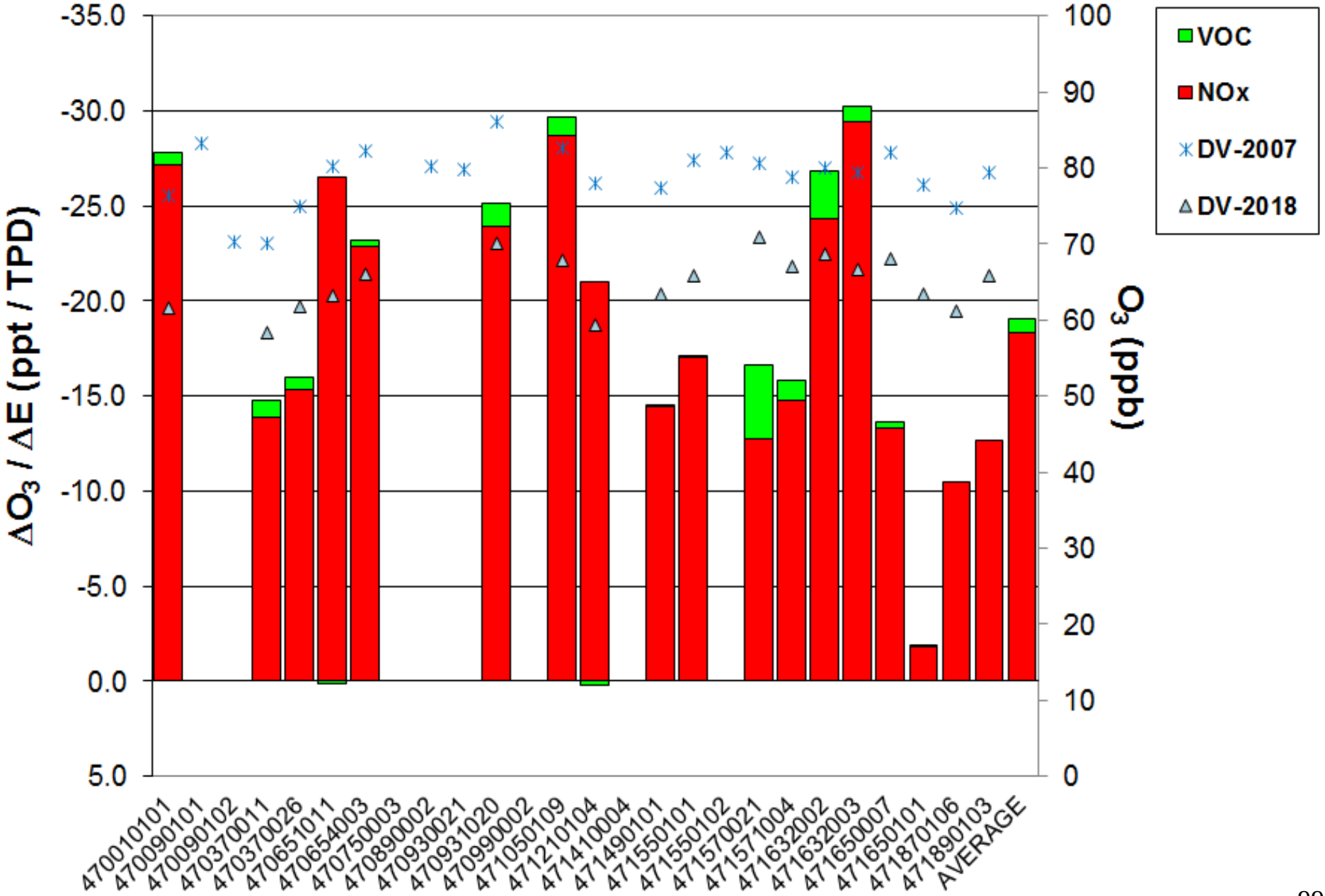


NC Responses Per TPD Emission Reduction

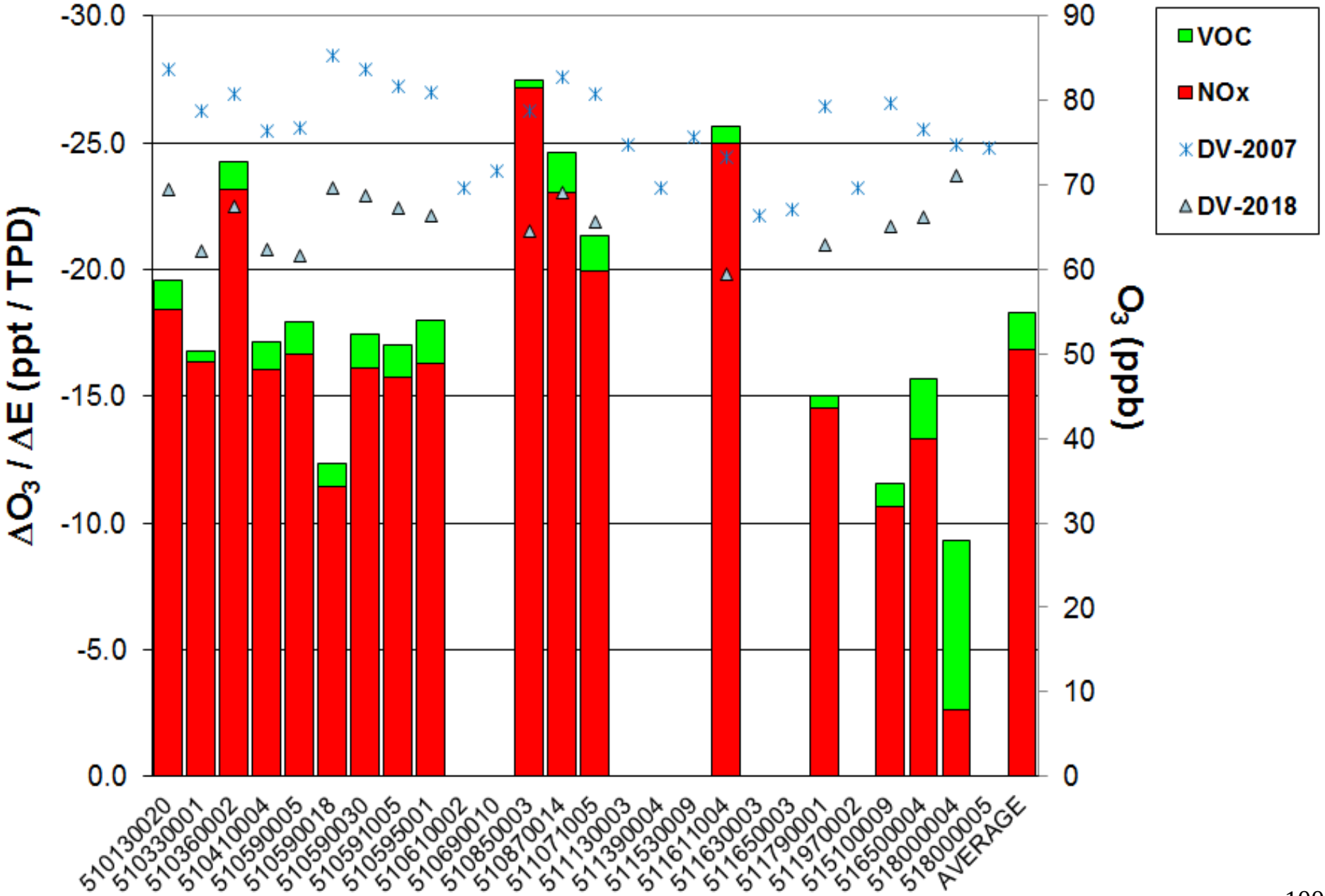


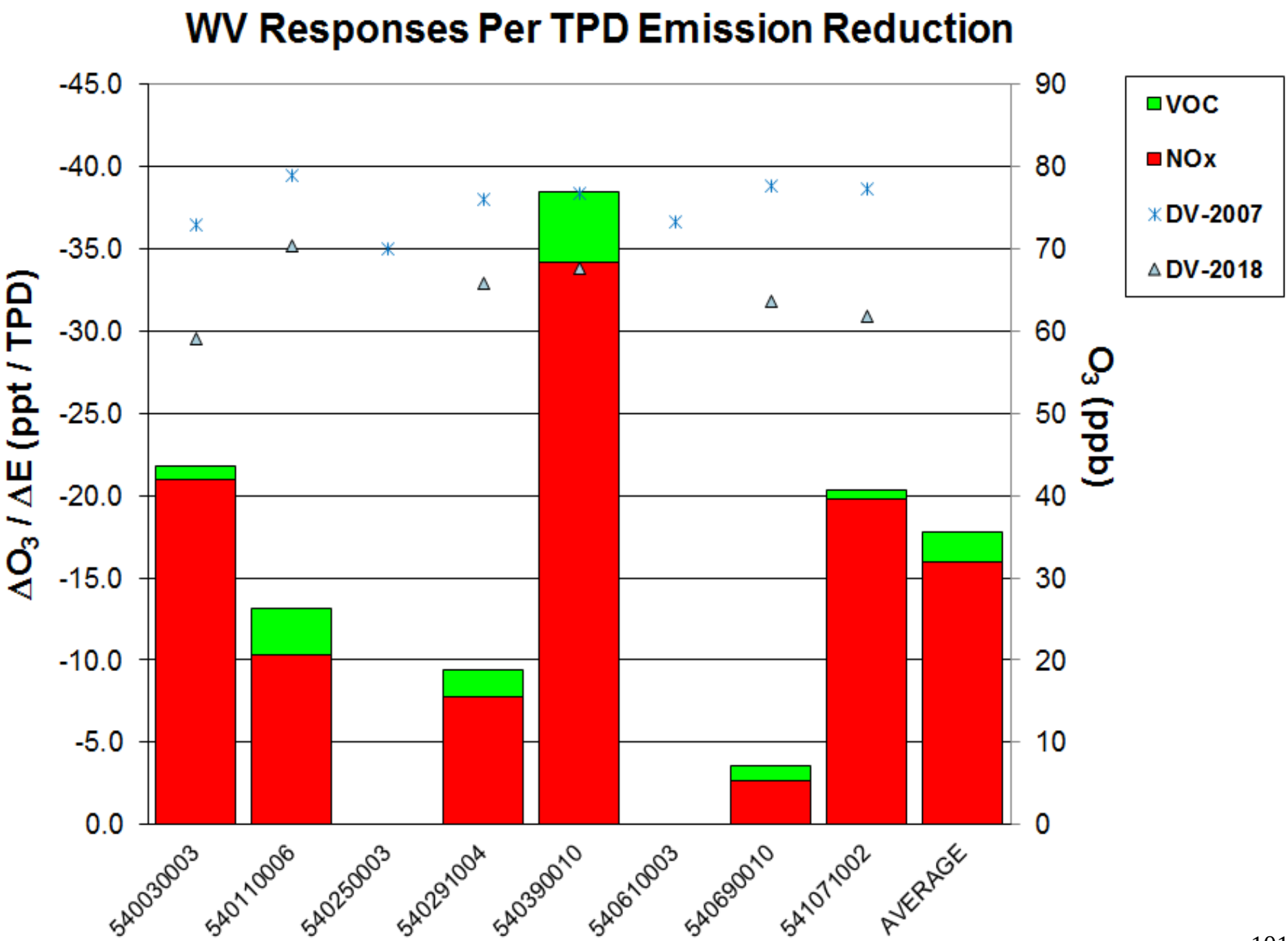

SC Responses Per TPD Emission Reduction
ΔO3 / ΔE (ppt / TPD)
O3 (ppb)
-35.0
-30.0
-25.0
-20.0
-15.0
-10.0
-5.0
0.0
90
80
70
60
50
40
30
20
10
0
VOC
NOx
DV-2007
DV-2018
450010001
450030003
450110001
450150002
450190046
450210002
450230002
450250001
450290002
450310003
450370001
450730001
450770002
450790007
450790021
450791001
450830009
450870001
450890001
450910006
AVERAGE

TN Responses Per TPD Emission Reduction



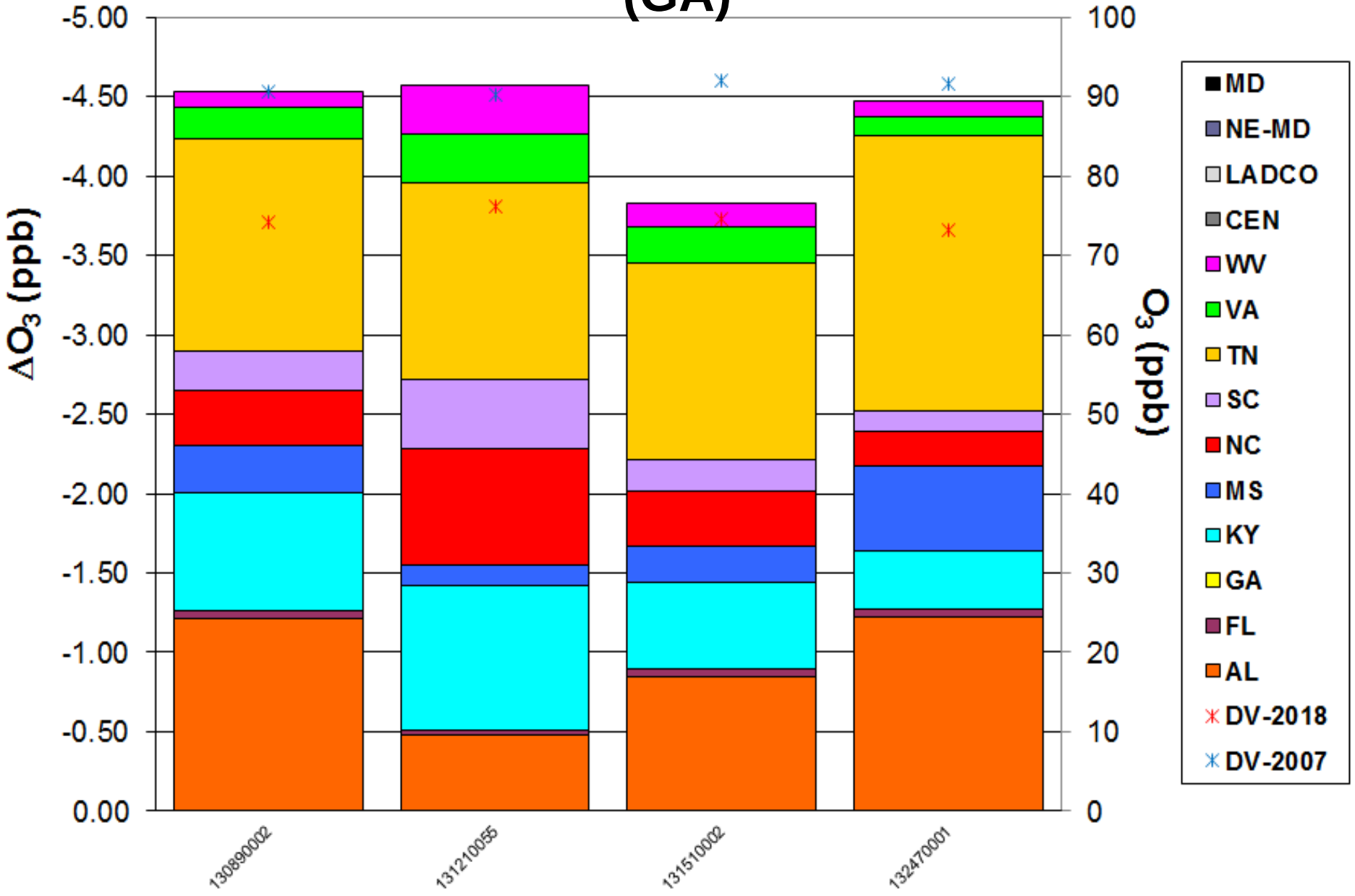
VA Responses Per TPD Emission Reduction



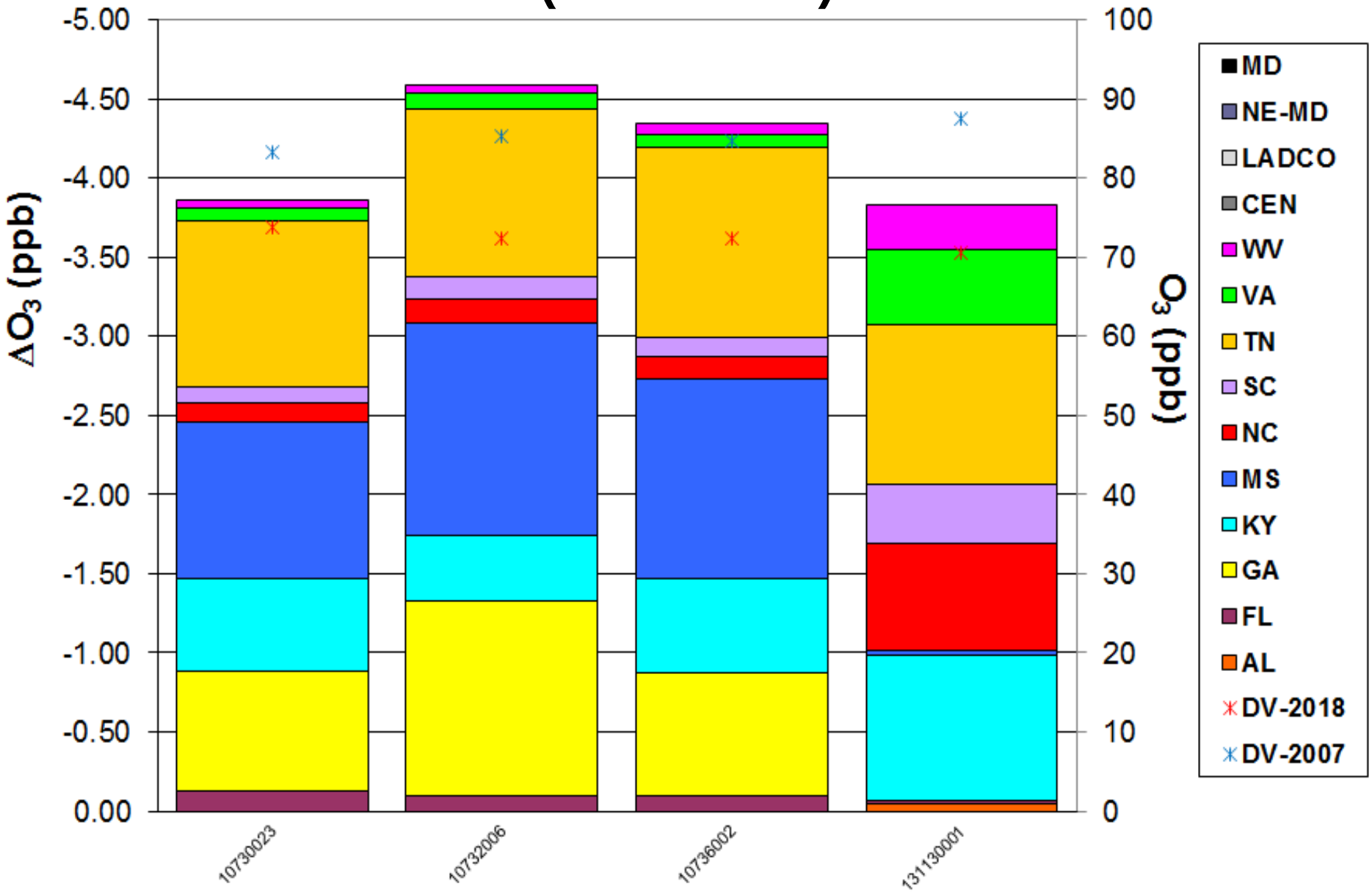

WV Responses Per TPD Emission Reduction
ΔO3 / ΔE (ppt / TPD)
O3 (ppb)
-45.0
-40.0
-35.0
-30.0
-25.0
-20.0
-15.0
-10.0
-5.0
0.0
90
80
70
60
50
40
30
20
10
0
VOC
NOx
DV-2007
DV-2018
540030003
540110006
540250003
540291004
540390010
540610003
540690010
541071002
AVERAGE

Interstate Contributions Bar Charts

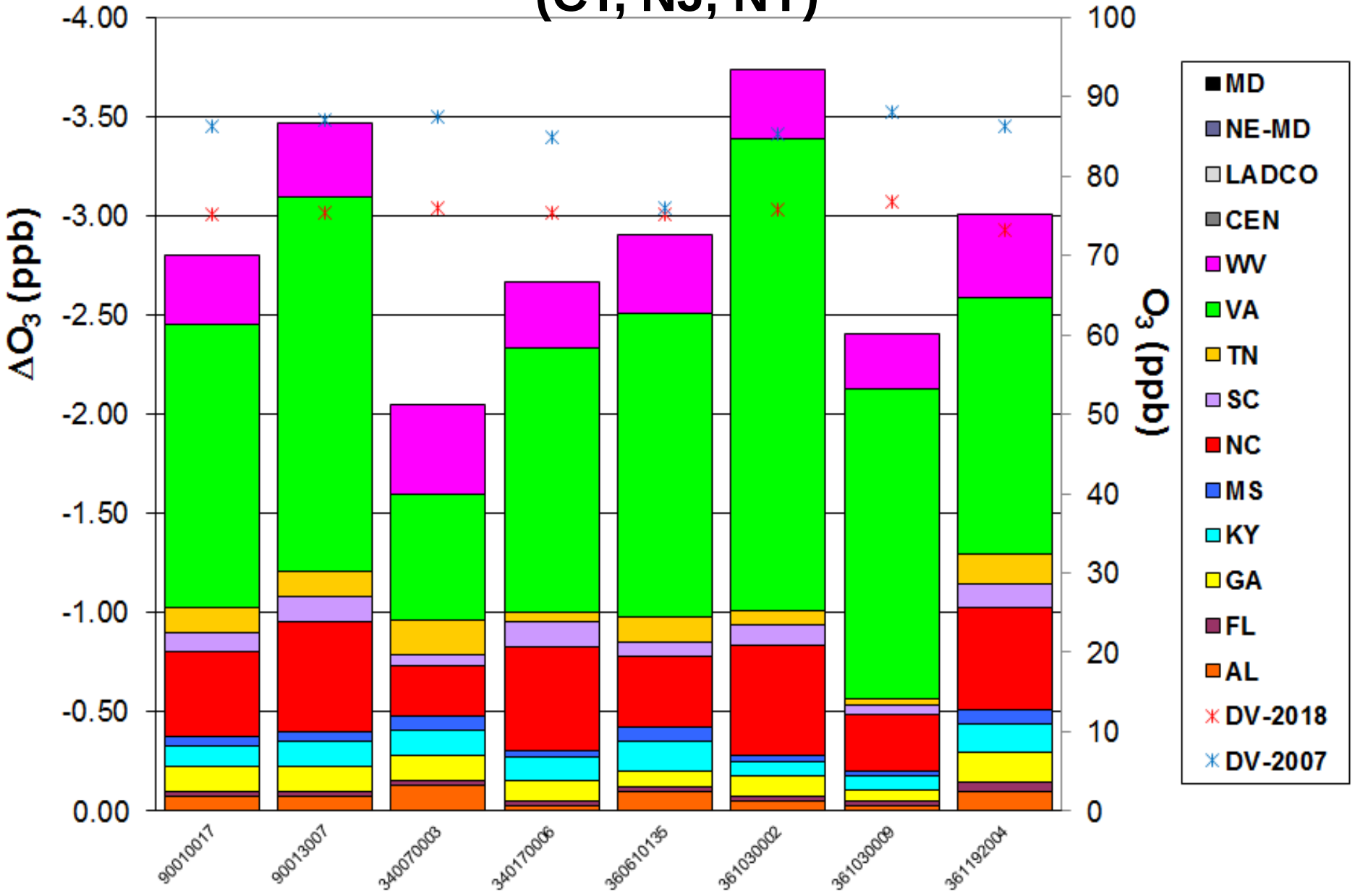
NAA Responses to 100% NO_x Emission Reductions (GA)



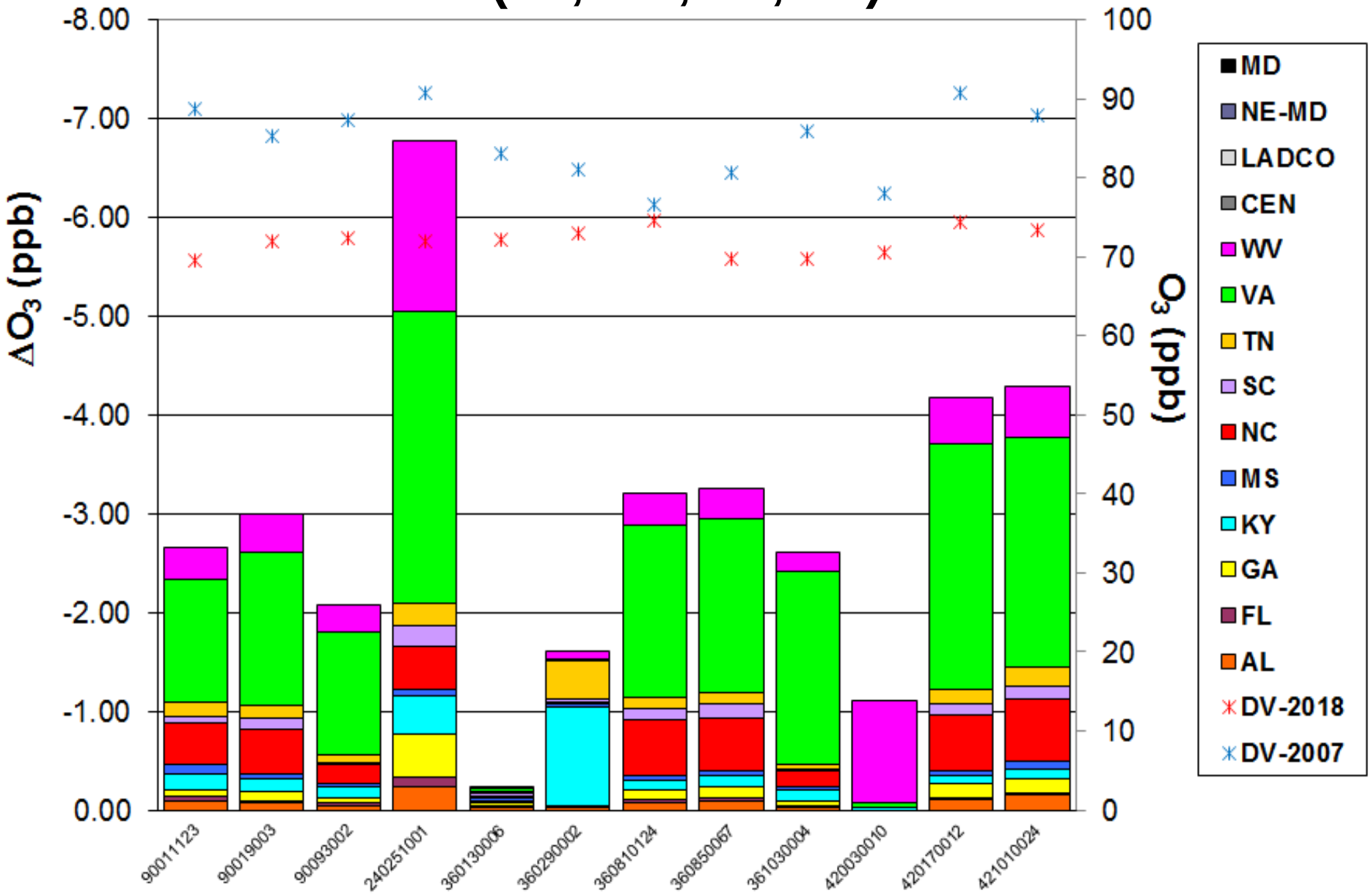
MAINT Responses to 100% NO_x Emission Reductions (AL and GA)



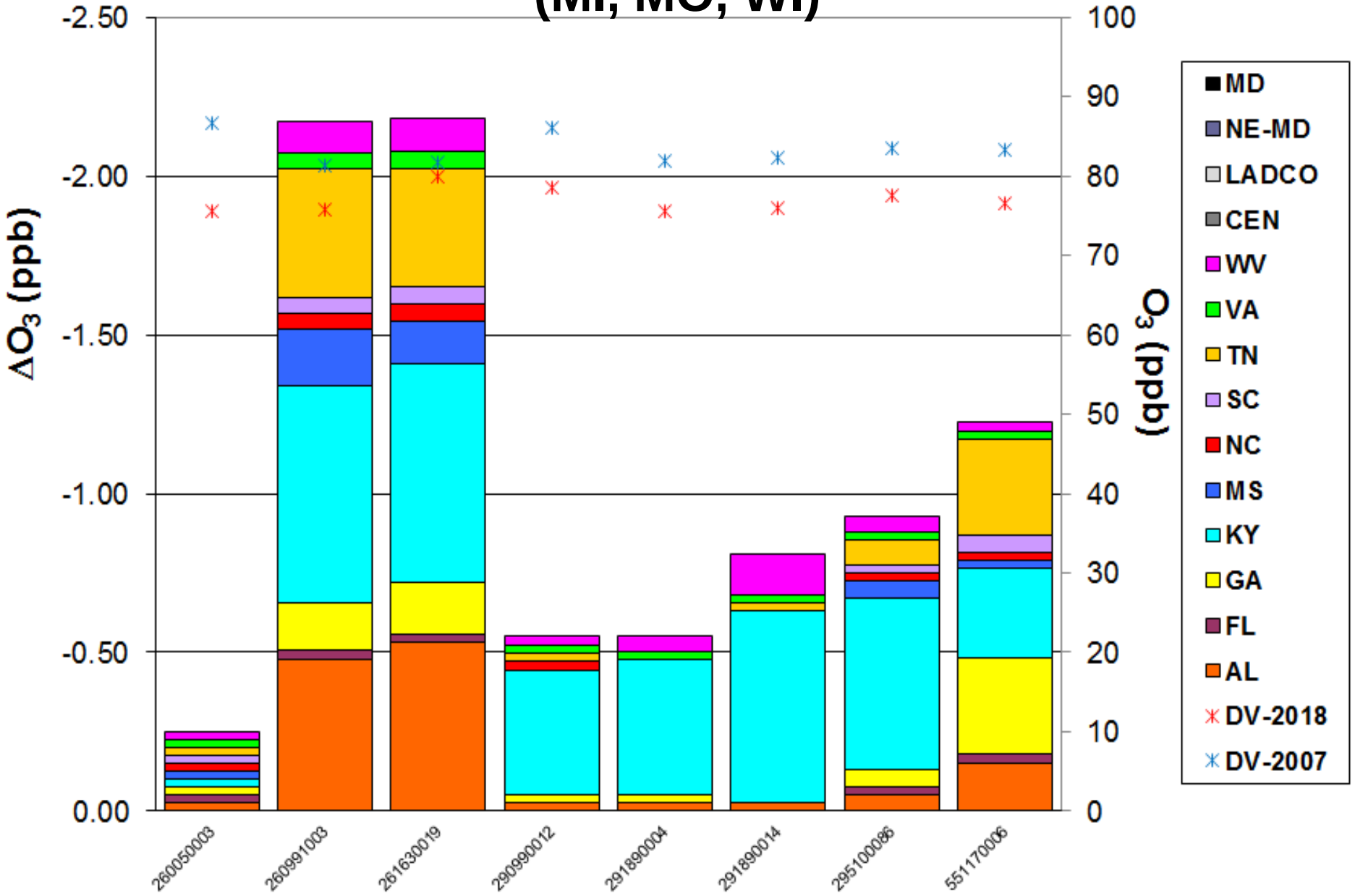
NAA Responses to 100% NO_x Emission Reductions (CT, NJ, NY)



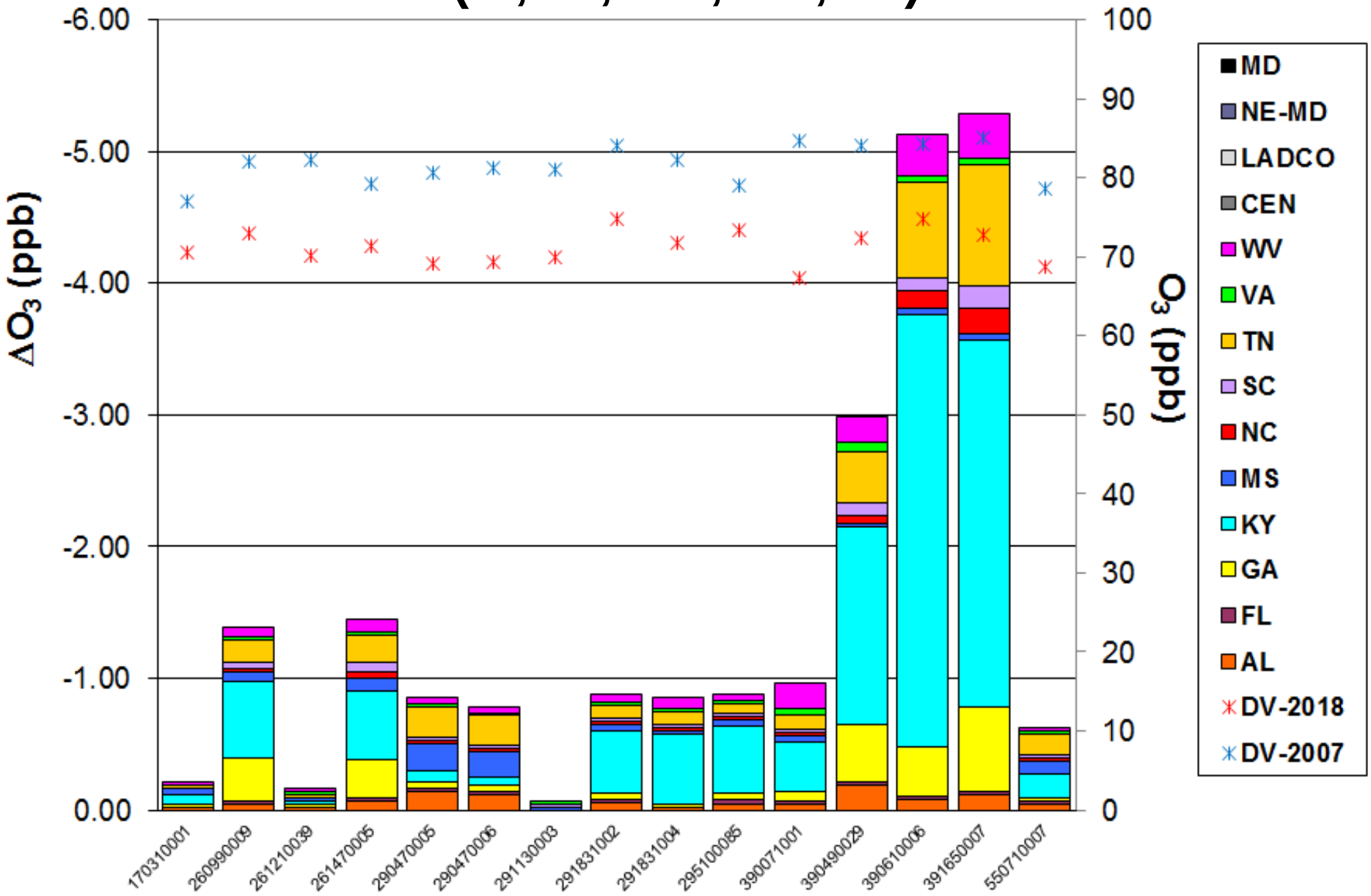
MAINT Responses to 100% NO_x Emission Reductions (CT, MD, NY, PA)



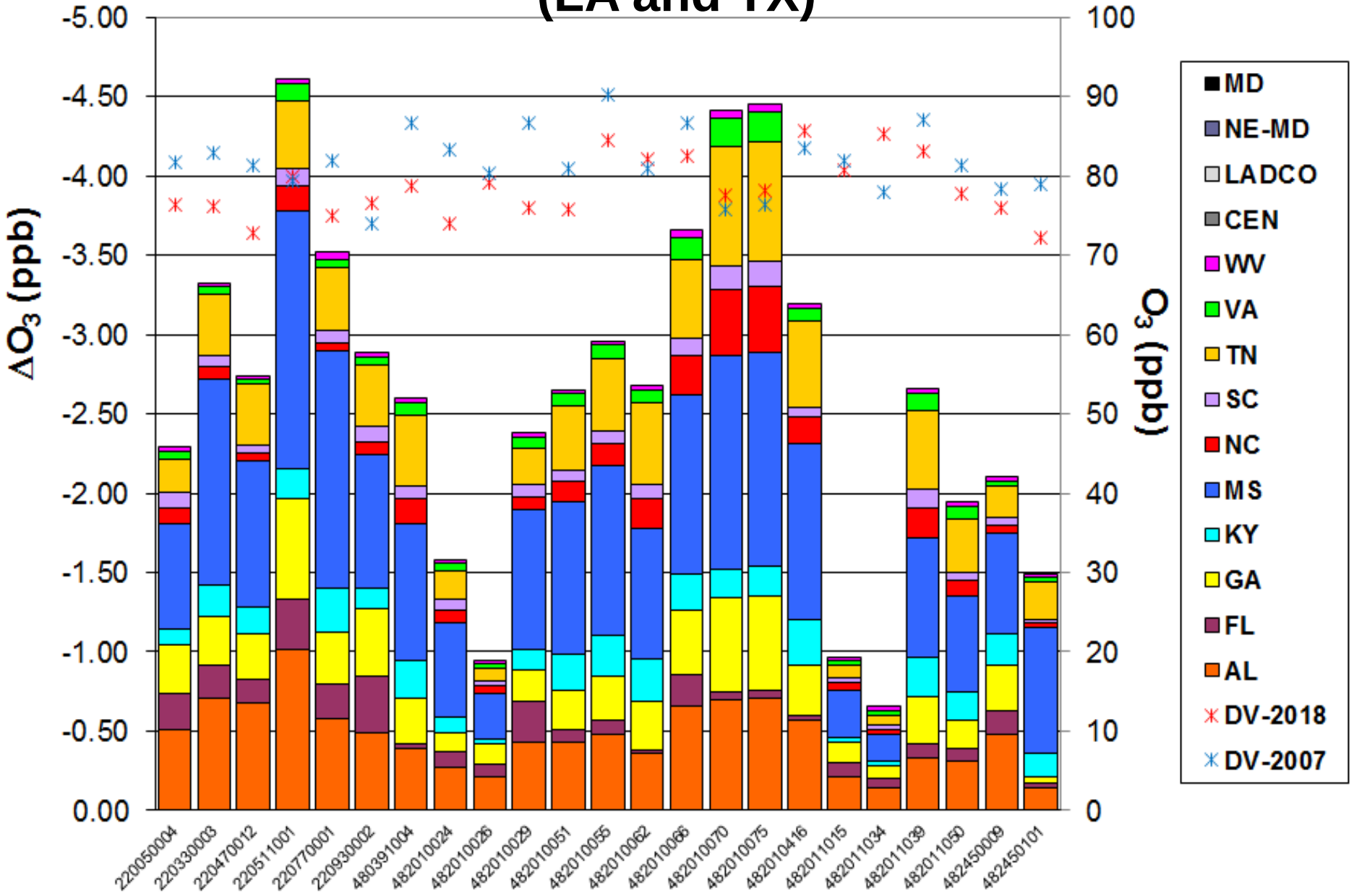
NAA Responses to 100% NO_x Emission Reductions (MI, MO, WI)



MAINT Responses to 100% NO_x Emission Reductions (IL, MI, MO, OH, WI)



NAA Responses to 100% NO_x Emission Reductions (LA and TX)



MAINT Responses to 100% NO_x Emission Reductions (AR, LA, TX)