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MEMORANDUM | June 14, 2010

TO Jim DeMocker, EPA

FROM Tyra Walsh, Henry Roman, and Jim Neumann, Industrial Economics, Inc. (IEc)

SUBJECT Description of the Adjustment to the Primary Particulate Matter Emissions Estimates and the Modeled Attainment Test Software Analysis (MATS) Procedure for the 812 Second Prospective Analysis

INTRODUCTION

The 812 Project Team recently revised its primary fine particulate matter ($PM_{2.5}$) emissions estimates generated for the Section 812 Second Prospective analysis of the 1990 Clean Air Act Amendments (CAAA) following the identification of analytical issues that resulted in biased estimates of the impact of the CAAA on emissions of primary particles (in some cases the impact was overestimated and in others it was underestimated).[1] The adjustments affected two major source categories of primary PM: area sources, including construction, paved and unpaved roads, residential wood combustion and fuel combustion; and non-electric generating unit (non-EGU) industrial point sources, including boilers, cement kilns, process heaters, and turbines.[2] These emissions changes affect subsequent steps in the 812 project analytical chain – namely, air quality modeling and health benefits estimates.

EPA tasked the 812 Project Team with developing an approach for estimating the effects of these changes that would approximate the magnitude of the adjustment without needing to re-run the Community Multi-scale Air Quality (CMAQ) model, which would have required substantial additional time and resources. This memo describes the adjustment process developed by the 812 Project Team and presents the results of this process in the form of speciated PM bar charts representing the output of EPA's Modeled Attainment Test Software (MATS) pre- and post-adjustment.

The 812 Project Team calculated adjustment factors that could be applied to the original CMAQ results based on a comparison of the adjusted emissions estimates to the original values. The Project Team then used EPA's MATS to adjust the CMAQ results using ambient monitoring data. The MATS output was then translated into revised air quality grids that were re-run through BenMAP to generate updated health benefits incidence and monetary valuation results.

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[1] "Primary" PM emissions refer to those that are essentially chemically unchanged from what is released at the source. "Secondary" PM has undergone transformations in the atmosphere causing the chemical and/or physical nature of what is measured to be different from what is emitted. USEPA (2007). *Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for ozone, $PM_{2.5}$ and Regional Haze*. EPA-454/B-07-002.

[2] Area sources are also commonly referred to as nonpoint sources.

The original primary PM emissions estimates generated for area and non-EGU point sources were found to be inaccurate due to two issues:

- The first issue relates to the differences in emissions estimation methods for primary PM emissions in the two emissions inventories from which EPA derives its *with-CAAA* and *without-CAAA* scenario estimates.[3] The *with-CAAA* area and non-EGU point source emission estimates are projected from EPA's 2002 National Emissions Inventory (NEI), while the *without-CAAA* scenario emissions are projected from EPA's 1990 NEI.[4] The 2002 NEI estimates were generated using improved emissions estimation methods for primary particles. For some emissions categories (e.g., construction) the 1990 estimates (and thus the *without-CAAA* estimates) were biased high, leading to overestimates of the CAAA impact; for some other sources (e.g., commercial cooking) the 1990 emissions estimates were biased low because emissions estimation methods did not exist in 1990 for those categories, leading to erroneous estimates of disbenefits in these source categories when compared to the *with-CAAA* scenario, and exerting a downward bias on the overall impact of the CAAA.
- The second issue, which only affected area sources, was that the original emissions estimates did not include application of transport factors (TFs). These are county-specific adjustment factors that are applied to specific types of emissions estimates to account for the fact that only a fraction of total fugitive dust emissions remain airborne and are available for transport away from the vicinity of the source after localized removal (i.e., some of the particles are captured by the local vegetation or other surface obstructions).[5] This issue affected both the *with-* and *without-CAAA* scenario estimates for area sources.[6]

This memo describes the methodology employed by the Project Team to adjust the primary $PM_{2.5}$ estimates and the CMAQ data. We then provide a general description of the MATS procedure and explain how it was applied in the Second Prospective analysis. Finally, we explore the effect of the emissions adjustments as well as the choice of monitoring data on the MATS output. We also include three appendices to the memo. Appendix A consists of a memo by E.H. Pechan and Associates that describes the specific adjustments made to the area source emissions to correct for overestimation bias in some Source Classification Codes (SCCs) in the 1990 NEI. Appendices B and C include stacked bar graphs that compare both the total and speciated $PM_{2.5}$ concentrations estimated by CMAQ and MATS to monitoring data.

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[3] EPA expected that the 1990 NEI would provide the best representation of 1990 base year emissions for important source categories under the *without-CAAA* scenario. EPA believes this remains a reasonable expectation for source categories other than those for which the adjustments described herein have been applied. EPA also believes the 2002 NEI provides the most reasonable emissions estimates for the *with-CAAA* scenario, the first target year of which is 2000.

[4] EPA conducts the NEI every three years. For further information, see: http://www.epa.gov/oar/data/neidb.html.

[5] Pace, T.J. (2005). "Methodology to Estimate the Transportable Fraction of Fugitive Dust Emissions for Regional and Urban Scale Air Quality Analyses." US EPA. Available at: http://www.epa.gov/ttn/chief/emch/dustfractions/.

[6] Note that TFs are only relevant for emission source categories that are associated with fugitive dust, such as unpaved and paved roads, commercial and residential construction and agricultural tilling. Therefore, the Project Team only applied TFs to specific Source Classification Codes (SCCs) within each county.

METHODOLOGY

This section outlines the methodology used by the Project Team to adjust the original primary $PM_{2.5}$ emissions estimates. We first made the necessary adjustments to the primary $PM_{2.5}$ emissions estimates for both area and non-EGU point sources, focusing on the $PM_{2.5}$ species that contribute most significantly to primary PM emissions: elemental carbon (EC), organic carbon (OC), and crustal material. We then calculated species-specific adjustment factors for the CMAQ data and applied them. Each of these procedures is discussed in further detail below.

ADJUSTMENTS TO PRIMARY PM EMISSIONS ESTIMATES

The process for adjusting the primary PM emissions estimates differed by source (area or non-EGU point) as well as by scenario (*with-CAAA* versus *without-CAAA*). Table 1 provides a summary of the various adjustments that the Project Team made to the original primary PM emissions estimates, indicating what bias each adjustment was intended to correct and the scenario and target year combination to which the adjustment corresponds. Below we describe in more detail the adjustments made for each source/scenario combination.

Area Sources

The available area source emissions data consisted of a total $PM_{2.5}$ emissions estimate as well as a set of allocation factors indicating the fraction of the total $PM_{2.5}$ that is comprised of each specific species. [7] These data were specific to a particular county and SCC. We generated revised emissions estimates in two steps: (1) we made the adjustments described below and in Table 1 to the total $PM_{2.5}$ emissions value for each county/SCC combination; and (2) we applied the SCC-specific allocation factors to the adjusted total $PM_{2.5}$ emissions values to generate revised emissions estimates for EC, OC and crustal $PM_{2.5}$.[8] These two steps are discussed in further detail below.

Adjustments to Total $PM_{2.5}$ Emissions Estimates

***With*-CAAA Scenario**

We decreased the primary $PM_{2.5}$ area source emissions estimates under the *with-CAAA* scenario by applying county-specific TFs to the emissions in each county that are associated with fugitive dust (e.g., commercial construction). This step provided adjusted values of emissions by county associated with transportable fugitive primary PM.

Without-CAAA Scenario

We made three types of adjustments to the primary $PM_{2.5}$ area source emissions estimates under the *without-CAAA* scenario.

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[7] ftp://ftp.epa.gov/EmisInventory/emch_latest_ancillary/smoke_format/.

[8] The speciation profile for area sources also included emissions estimates for sulfates and nitrates. However, these made up a very small portion of the total primary PM emissions. Therefore, we only made adjustments to EC, OC and crustal species.

TABLE 1. SUMMARY OF ADJUSTMENTS MADE TO THE PRIMARY PM EMISSIONS ESTIMATES FOR THE 812 SECOND PROSPECTIVE ANALYSIS

ADJUSTMENT	PURPOSE OF ADJUSTMENT	2000		2010		2020	
		WITH-CAAA	*WITHOUT-CAAA*	*WITH-CAAA*	*WITHOUT-CAAA*	*WITH-CAAA*	*WITHOUT-CAAA*
AREA SOURCES							
Applied Transport Factors (TFs)	Correct for overestimation of fugitive dust emissions	X	X	X	X	X	X
Adjusted year 2000 emissions estimates downward for some SCCs (specific adjustments differ by SCC – see Appendix A for details). Applied growth factors to revised 2000 estimates to generate adjusted 2010 and 2020 estimates.	Correct for overestimation of emissions in 1990 NEI for construction, paved and unpaved roads, residential wood burning and industrial combustion SCCs		X		X		X
Set *without-CAAA* emissions estimates equal to the *with-CAAA* values	Correct for underestimation of emissions in 1990 NEI due to omission of specific SCCs (e.g., commercial cooking)		X		X		X
NON-EGU POINT SOURCES							
Set *without-CAAA* emissions estimates equal to the *with-CAAA* values	Correct for errors in the 1990 NEI resulting in potential net overestimation of emissions reductions in this category.		X		X		X

1. **Adjust some of the area source emissions estimates to account for overestimation bias** – as noted above, the emissions estimation procedures in the 1990 NEI led to a substantial overestimation in estimates in the *without-CAAA* scenario for several emissions source categories (i.e., construction, paved roads, unpaved roads, residential wood burning, and industrial combustion).[9] The Project Team first decreased the year 2000 estimates, as described in Appendix A.[10] Then we applied growth factors based on the economic growth assumptions between target years to the revised 2000 estimates, to generate revised emissions estimates for target years 2010 and 2020 for these SCCs.[11]

2. **Adjust additional SCCs for underestimation bias as necessary** - the lack of emissions estimation methods for some SCCs in the 1990 NEI led to underestimation bias in those categories in the *without-CAAA* scenario. In these cases, the Project Team set the *without-CAAA* scenario values equal to the *with-CAAA* values for each target year. This approach implicitly assumes away the benefits of CAAA programs for these sources. While eliminating erroneous estimates of disbenefits in these categories resulting from emissions inventory methods changes, this approach likely still results in an underestimation bias because CAAA programs either directly or indirectly resulted in overall reductions in these emissions that cannot be estimated.

3. **Apply TFs where necessary –** as in the *with-CAAA* scenario, we applied TFs to emissions in each county that are associated with fugitive dust.

Speciating the Adjusted Total $PM_{2.5}$ Emissions Estimates

The second step in our adjustment process for area sources involved generating emissions estimates for the three main PM components that comprise primary PM: EC, OC, and crustal. We did this by multiplying the adjusted total $PM_{2.5}$ emissions estimate by SCC-specific allocation factors for these three species. The result was adjusted emissions estimates of EC, OC and crustal PM species.

Non-EGU Point Sources

The non-EGU point source emissions data consisted of estimates at the county level for total primary $PM_{2.5}$ as well as the PM species EC and OC. In order to generate emissions estimates for crustal material, we assumed that this species would be equal to the remaining portion of the total primary $PM_{2.5}$ after subtracting the EC and OC emissions estimates. Therefore, our adjustment procedure for non-EGU point sources consisted of first generating the crustal emissions estimates for both the *with-* and *without-CAAA* scenarios. We then made adjustments to the original emissions estimates for EC, OC, and crustal as described below.

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[9] See Appendix A for further detail about the specific adjustments made to these source categories.

[10] Though 1990 is the base year for the analysis, 2000 is the first of the target years for which differential outcomes under the *with-CAAA* and *without-CAAA* cases are estimated. This is why year 2000 is used as the foundation year for the *without-CAAA* adjustments.

[11] These growth factors are described in further detail in *Emission Projections for the Clean Air Act Second Section 812 Prospective Analysis* (March 2009), and are based on the Department of Energy's *Annual Energy Outlook* 2005 forecasts. The growth factors are the same as those applied to the original emissions estimates.

With-CAAA Scenario

No adjustments were needed for the non-EGU point emissions estimates for the *with-CAAA* scenario.

Without-CAAA Scenario

The emissions estimation procedure for this category applied in the 1990 NEI led to a likely net overestimate of emissions reductions from non-EGU point sources due to the CAAA. To address this, the Project Team opted to set the *without-CAAA* scenario values equal to *with-CAAA* values for each target year. The CAAA-related PM emissions changes for this source category, while likely overestimated, were minimal compared to other categories. Therefore, we opted to take a conservative approach of assuming no impact of the CAAA, rather than generating more precise corrections.

CALCULATING CMAQ ADJUSTMENT FACTORS

Once we updated all of the original emissions data for both area sources and non-EGU point sources, we then calculated a set of species-specific adjustment factors (AFs) to apply to the CMAQ results:

$$AF_{i,j,k,l}$$

Where: i = county

j = PM species (EC, OC, or crustal)

k = target year (2000, 2010, or 2020)

l = *with*-CAAA or *without*-CAAA scenario

We calculated AFs for each of the combinations of j, k and l, for a total of 18 factors for each county.

We performed the following calculations to derive the CMAQ adjustment factors:

1. Calculate the "old" area and non-EGU point emissions estimates for EC, OC, and crustal PM. For area sources, this required speciating the old primary PM estimates using the SCC-specific allocation factors and then summing across all of the SCCs in a particular county. For non-EGU point sources, we were able to use the existing county-level speciated data.
2. Calculate "new" adjusted emissions estimates for EC, OC, and crustal (as described in the previous section of this memo).
3. Calculate ratios of the "new" emissions estimates to the "old" estimates to derive adjustment factors to be applied to CMAQ data for EC, OC, and crustal species.

APPLYING ADJUSTMENT FACTORS TO CMAQ DATA

After calculating the adjustment factors, we then applied them to the CMAQ results. For each county, target year, and scenario, we employed the following procedure:

1. **Calculate the fraction of EC, OC, and crustal $PM_{2.5}$ that is primary** - the CMAQ data for each species includes both primary and secondary emissions. However, the adjustment factors are only applicable to primary PM. For EC and

crustal, we assumed that 100 percent of the emissions were primary. For OC, we estimated the primary fraction by applying quarterly EPA Region-level data generated by ICF International from the ADVISOR database.[12]

2. **Calculate the portion of primary EC, OC, and crustal $PM_{2.5}$ generated by area and non-EGU point sources –** since the adjustment factors are calculated using emissions from area and non-EGU point sources only, the Project Team estimated the portion of each PM species originating from these two sources by applying fractions produced by ICF International using 2010 CMAQ Particle and Precursor Tagging Methodology (PPTM) results.[13] We applied the 2010 fractions to all three target years.

3. **Apply corresponding adjustment factors to values from Step 2**.

4. **Recompile adjusted EC, OC, and crustal $PM_{2.5}$ values for input into MATS -** this included adding the "new" source-specific primary PM values to the "old" values for the remaining sources as well as the secondary PM fraction.

MATS

The Project Team applied EPA's MATS to the CMAQ model output. The advantage of this post-processing step is to generate air quality modeling projections for $PM_{2.5}$ species that are consistent with monitoring data. This helps to reduce uncertainty from known limitations and biases associated with CMAQ (e.g., underestimation of secondary aerosol formation) and to create more accurate air quality estimates. The MATS output formed the basis for the air quality grids that were used to estimate health benefits in BenMAP.

MATS OVERVIEW

MATS is a tool that was designed for use by entities required to submit State or Tribal Implementation Plans (SIPs or TIPs) to assess whether a particular emissions control strategy will lead to attainment of the National Ambient Air Quality Standards (NAAQS) for $PM_{2.5}$ and ozone.[14] MATS uses a combination of observed ambient monitoring data and air quality modeling estimates to generate predicted future-year pollutant concentrations using a three-step process:

1. Perform a spatial interpolation of ambient monitoring data;

2. Adjust the spatially interpolated monitor data using information derived from the air quality modeling output; and

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[12] These data were specific to scenario and target year. The ADVISOR database (Access™ Database for the Visualization and Investigation of Strategies for Ozone Reduction) is an interactive tool that contains information for review, comparison, and assessment of the CMAQ simulations. For further information, see the *Second Prospective Analysis of Air Quality in the U.S.: Air Quality Modeling*, Draft Report – September 20, 2008.

[13] The PPTM is designed to provide detailed, quantitative information about the contribution of selected source categories to simulated $PM_{2.5}$ concentrations. Emissions of precursor pollutants from specific source categories are numerically tagged and tracked throughout a CMAQ simulation. The contribution from each tag to the resulting simulated concentration of the $PM_{2.5}$ concentration or $PM_{2.5}$ component species can be quantified. For further information, see the *Second Prospective Analysis of Air Quality in the U.S.: Air Quality Modeling*, Draft Report – September 20, 2008.

[14] USEPA (2007). *Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for ozone, $PM_{2.5}$ and Regional Haze*. EPA-454/B-07-002.

3. Generate future year concentration estimates by extrapolating the values generated in step 2 based on a comparison of future year and base year air quality modeling data.

APPLICATION OF MATS TO $PM_{2.5}$ FOR THE 812 SECOND PROSPECTIVE ANALYSIS

The Project Team applied MATS to create $PM_{2.5}$ air quality concentration predictions for each target year of the 812 analysis, using 2002 ambient monitoring data adjusted by CMAQ modeling results. Below we provide additional detail on the MATS procedure and how it was applied in the Section 812 Second Prospective Analysis.

Because $PM_{2.5}$ is a mixture of different components that can behave independently of one another and relate to one another in a complex way, the MATS process for this pollutant is performed separately for each major PM species and is referred to as the Speciated Modeled Attainment Test (SMAT).[15] The total $PM_{2.5}$ mass is divided into the following categories: sulfates, nitrates, ammonium, OC, EC, crustal material, particle bound water and salt. In addition, MATS incorporates a blank mass component of 0.5 $\mu g/m^3$.

Step 1: Interpolate Ambient Monitor Data

The first step of the MATS process involves spatially interpolating ambient monitoring data for $PM_{2.5}$ from a time period that is representative of the base year of the analysis. This process allows for an estimation of pollutant concentrations at monitors as well as in areas between monitors. This creates a "spatial field" of air quality concentrations across a study area for the base year. The spatial field is comprised of air pollution estimates for the center of each grid cell in the air quality modeling domain. For example, CMAQ employs 36 km x 36 km grid cells. Therefore, the spatial field in the Second Prospective analysis consisted of a set of air pollution concentrations for each 36 km grid cell in the study area.

The Project Team used 2002 ambient monitoring data for the MATS analysis. This included quarterly $PM_{2.5}$ data from 1,232 Federal Reference Method (FRM) monitors, which provide concentrations of total $PM_{2.5}$. Most FRM monitors (about 75 percent) are not co-located with a speciation monitor.[16] Therefore, we also used data providing speciated PM mass from the Speciated Trends Network (STN) and the Interagency Monitoring of Protected Visual Environments (IMPROVE) monitors. The MATS analysis used speciated data from 273 STN or IMPROVE monitors with at least two valid quarters of speciated data in 2002.[17]

One thing to note is that the FRM monitors do not measure the same components and do not retain all of the $PM_{2.5}$ that is measured by the speciation monitors.[18] Therefore, it is necessary to reconstruct the measured species components so that they add up to the

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[15] Ibid.

[16] Abt Associates (2009). *Modeled Attainment Test Software User's Manual*. Prepared for the US EPA's Office of Air Quality Planning and Standards, March.

[17] A "valid" quarter included speciated data from at least 11 days.

[18] FRM mass measurements do not retain all ammonium nitrate and other semi-volatile materials and includes particle bound water associated with sulfates, nitrates, and other hygroscopic species. This results in concentrations (and percent contributions to $PM_{2.5}$ mass) that may be different than the ambient levels of some $PM_{2.5}$ species. USEPA (2007). *Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for ozone, $PM_{2.5}$ and Regional Haze*. EPA-454/B-07-002.

measured FRM mass. The SMAT procedure achieves this by using an FRM mass construction methodology called "Sulfate, Adjusted Nitrate, Derived Water, Inferred Carbonaceous material balance approacH" (SANDWICH).[19] The result of applying this methodology is reduced nitrates (relative to the amount measured by the speciation monitors), higher mass associated with sulfates, and a measure of OC that is derived from the difference between measured $PM_{2.5}$ and its non-carbon components. This characterization of $PM_{2.5}$ mass also reflects crustal material and other minor constituents. See EPA's *Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$ and Regional Haze* (2007) for information on the specific calculations performed in MATS for each species.

In order to create the "spatial field" of PM species concentrations for each 36 km CMAQ grid cell, the Project Team applied the Voronoi Neighborhood Averaging (VNA) technique in MATS to interpolate the PM monitoring data. This is an algorithm that identifies a set of monitors close to the grid cell (called "neighbors") and then estimates the PM species concentration in that grid cell by calculating an inverse-distance weighted average of the monitor values (i.e., the concentration values at monitors closer to the grid cell are weighted more heavily than monitors that are further away).[20] This process is performed for both the total $PM_{2.5}$ concentration, using the FRM data, and the speciation data from the STN or IMPROVE monitors. Concentrations for each $PM_{2.5}$ component are then generated by multiplying the interpolated $PM_{2.5}$ concentration in a grid cell by the fractional composition of each species, obtained from the interpolated speciated monitor data in that grid cell.

Step 2: Adjust the Monitoring Data with Modeling Data

The second step in the MATS procedure consists of adjusting the spatial field of concentrations generated in Step 1 by using "spatial gradients" generated by the CMAQ model. A spatial gradient is the ratio of the mean model values at an unmonitored location to the mean model values at a monitor. This process adjusts the monitor concentrations upwards in areas where the model predicts relatively high concentration levels and adjusts monitor concentration downwards in areas where the model predicts relatively low concentration levels, rather than using absolute model concentrations. The result is a prediction of more accurate concentrations in grid cells without monitors. For instance, rural areas may be overly influenced by high monitored concentrations near urban areas. Therefore, these areas would be adjusted downward based on the model predictions. In addition, the model can help identify unmonitored areas that could contain large sources of primary PM emissions and therefore should be adjusted upwards. The result of this step is referred to as a "gradient-adjusted spatial field."

Step 3: Generate Future Year Concentrations

The final step in the MATS process generates future year PM species concentrations for each target year by multiplying the gradient-adjusted spatial field for the base year (generated in step 2) by grid cell-level relative response factors (RRFs) derived from

[19] Frank, N. (2006). Retained Nitrate, Hydrated Sulfates, and Carbonaceous Mass in Federal Reference Method Fine Particulate Matter for Six Eastern U.S. Cities. *Journal of the Air and Waste Management Association* 56: 500-511.

[20] See the MATS user's manual for further information: Abt Associates (2009). *Modeled Attainment Test Software User's Manual*. Prepared for the US EPA's Office of Air Quality Planning and Standards, March.

comparing a future year model concentration to a base year model concentration for a given PM species. For each species and grid cell, the following calculation is performed:

$$C_{Target} = C_{Baseline} \text{ x RRF}$$

Where:

$C_{Baseline}$ = the grid cell-level baseline concentration of a particular PM species (generated in step 2);

RRF = the relative response factor. This is the ratio of the target year concentration predicted in a specific grid cell to the baseline concentration predicted in that grid cell for a particular PM species. The Project Team used the 2000 *with-CAAA* CMAQ results as the baseline.

C_{Target} = the predicted grid cell-level concentration of a particular PM species in the target year (2000, 2010, or 2020).

The Project Team used this process for each target year and scenario, with the exception of the 2000 *with-CAAA* scenario. In this case, Steps 1 and 2 were performed on the 2002 monitoring data. However, instead of calculating the 2000 values by temporally adjusting the monitoring data using the RRF, we assumed that the 2002 interpolated monitoring data provided an accurate representation of the 2000 *with-CAAA* scenario.

EFFECT OF PM ADJUSTMENT AND CHOICE OF MONITORING DATA ON MATS RESULTS

The Project Team generated stacked bar graphs to demonstrate the effect of MATS on the CMAQ output in terms of the total $PM_{2.5}$ concentration levels as well as the relative contributions of each PM species. Appendices B and C contain the graphs as well as additional detail on how the graphs were generated.

Each graph represents a specific monitoring location and includes two bars representing: 1) the total $PM_{2.5}$ concentrations measured at the FRM monitors; and 2) a stacked bar depicting the speciated $PM_{2.5}$ concentrations measured at the co-located STN monitor. The 23 graphs included in Appendix B also include an additional set of stacked bars representing the original CMAQ output based on the unadjusted PM emissions estimates, the CMAQ output derived from the adjusted emissions estimates, and the MATS output based on the adjusted CMAQ results for each target year and scenario. The second set of 10 graphs in Appendix C include bars for the original and adjusted CMAQ results as well as three sets of MATS results based on the following: 1) the original CMAQ data and monitoring data from 2002, 2003, and 2004 (MATS #1); 2) the original CMAQ data and 2002 monitoring data (MATS #2); and 3) the adjusted CMAQ data and 2002 monitoring data (MATS Final). This second set of graphs show the impact on the MATS results of restricting the monitoring data to a single year and of applying the adjustment factors to the CMAQ data for 2000 and 2010.

The following general observations emerge from analysis of the two sets of graphs:

- As seen in the graphs, applying the adjustment factors to the original CMAQ results corrects for the overestimation of the proportion of the total $PM_{2.5}$ concentration that is made up of crustal material. The adjustments made to the emissions data tend to reduce the crustal portion and therefore, the adjusted CMAQ results better reflect the proportion measured at the monitors.

- In general, it appears that the effect of applying MATS to the CMAQ output provides $PM_{2.5}$ concentrations that are more reflective of the relative proportions of the various PM species that were measured at the STN monitors. In addition, the 2000 *with-CAAA* scenario MATS output is a better match with the total $PM_{2.5}$ concentration measured at the FRM monitors than the CMAQ output.
- Comparing MATS #1 and MATS #2, it appears that using only 2002 monitoring data, as opposed to using data from 2002-2004, has only a modest effect on the MATS results.
- Comparing MATS #2 to MATS Final indicates that that the effect of applying the adjustment factors to the CMAQ data has a nominal effect on the total PM concentration, tending to result in slight decrease. However, the MATS Final estimates for both scenarios and target years do appear to have a smaller proportion of crustal material compared to MATS #2, which better reflects the composition measured at the monitors. This increases our confidence that the MATS results relying on the adjusted CMAQ data provide more realistic estimates of $PM_{2.5}$ composition than the MATS results based on the unadjusted CMAQ data.
- In the majority of locations evaluated, the MATS estimates for the 2000 *with-CAAA* scenario appear to correspond well to the 2002 monitor data. In the Bronx, Los Angeles, and Manhattan however, the MATS estimates for the 2000 *with-CAAA* scenario appear to be slightly lower than the total PM monitor concentrations. We note, however, that the Los Angeles and Manhattan results are based on only two quarters of monitoring data in 2002, compared to a full year in most other locations.

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APPENDIX A

PECHAN

E.H. Pechan & Associates, Inc.

MEMORANDUM

Date: March 10, 2010

To: Jim Neumann, IEc

From: Jim Wilson, Andy Bollman, Maureen Mullen

Subject: Revised Section 812 Nonpoint Source $PM_{2.5}$ Emission Estimates
Work Assignment 0-1, TD #3

The Section 812 Project Team identified the need to refine the "without-CAAA" scenario emissions previously developed for the following nonpoint $PM_{2.5}$ emission source categories:

Category	2000 $PM_{2.5}$ Emissions (tons per year)		
	Without CAAA	With CAAA	Difference
1. Construction	1,134,719	237,780	896,939
2. Paved Roads	634,762	202,706	432,056
3. Unpaved Roads	1,103,413	835,152	268,261
4. Residential Wood Combustion	260,121	428,044	-167,924
5. Fuel Combustion Industrial/Coal/Other	3,584	154,045	-150,512

These are the nonpoint categories with the largest differences between the 2000 with- and without-CAAA scenario emission estimates. While the 2000 with-CAAA nonpoint source emission estimates are taken directly from the U.S. Environmental Protection Agency's (EPA's) 2002 nonpoint source National Emissions Inventory (NEI), the 2000 without-CAAA scenario nonpoint source emissions represent estimates projected from 1990 NEI emissions. Because of discrepancies in the emission estimation procedures for these categories, Pechan recalculated these categories' 1990 and 2000 without-CAAA scenario emission estimates so that these categories' estimates would rely on procedures comparable to those used in the 2002 NEI. In addition, Pechan developed revised 2010 and 2020 without-CAAA emission estimates for these categories by applying previously generated growth factors to the 2000 without-CAAA emissions. The balance of this memorandum describes how each category's emissions were recalculated, and reports the updated with- and without-CAAA $PM_{2.5}$ emissions for each nonpoint source category.

A. METHODS FOR RECALCULATING WITHOUT-CAAA EMISSIONS

The following sections discuss the methods used for each of the five priority area source categories to recalculate the without-CAAA scenario emissions.

1. Construction

For the 2002 NEI, EPA developed emission estimates for three of the eight possible construction Source Classification Codes (SCCs). Emissions for other construction SCCs were supplied by local and/or state air quality agencies. Because of the minor contribution of these SCCs to total construction $PM_{2.5}$ emissions (~ 2.5 percent), Pechan calculated revised without-CAAA emission estimates for the state/local agency-supplied categories by applying year-specific uncontrolled/controlled emission ratios calculated from the emissions for the three categories for which EPA developed estimates.

Pechan computed revised without-CAAA emission estimates for the following specific SCCs, which are the three major components of construction emissions:

- 2311010000 – Residential Construction;
- 2311020000 – Nonresidential Construction; and
- 2311030000 – Road Construction.

First, Pechan recalculated the 2000 without-CAAA scenario emissions for each SCC by removing the 50 percent $PM_{2.5}$ emission reduction assumption that was applied to PM_{10} nonattainment area counties in the 2002 NEI. This control efficiency represents the Best Available Control Measure (BACM) controls on fugitive dust construction activity for these counties. Because state/local agencies also supplied emission estimates to the 2002 NEI for these SCCs, directly relying on the resulting emission estimates would have led to without-CAAA emission estimates that are not directly comparable to the with-CAAA scenario emissions. Therefore, Pechan computed values representing the ratio of EPA method-derived uncontrolled 2002 $PM_{2.5}$ emissions to EPA method-derived 2002 controlled $PM_{2.5}$ emissions. These ratios were computed as 1.206 (Residential Construction), 1.136 (Nonresidential Construction), and 1.128 (Road Construction), and each value multiplied by the 2000 with-CAAA scenario emissions to yield the without-CAAA scenario 2000 emission estimates.

An analogous procedure was used to estimate 1990 emissions. For Residential and Nonresidential Construction, Pechan utilized EPA's 2002 NEI estimation procedure for each SCC, but replaced the 2002 emissions activity values (e.g., number of housing starts) with 1990 values and removed the 50 percent emission reduction assumption for PM_{10} nonattainment area counties.[21] Pechan then computed values representing the ratio of EPA method-derived uncontrolled 1990 $PM_{2.5}$ emissions to EPA method-derived 2002 uncontrolled $PM_{2.5}$ emissions. These ratios were computed as 0.767 (Residential Construction) and 1.020 (Nonresidential Construction), and these values were applied to the 2000 without-CAAA emissions to yield 1990 emission estimates. For Road Construction, less detailed road construction expenditure data were available for 1990 than were used in developing emissions for EPA's 2002 NEI. Therefore, Pechan computed a ratio using more aggregate road construction expenditure data for each year, and this ratio was applied to the 2002 expenditures to estimate comparable 1990 expenditure data.[22] Using the same methods that were used to develop a 2002-specific

[21]The NEI methods were only replicated at the national level. To follow them exactly would have required obtaining 1990-specific data for allocating activity/emissions to counties. In the interest of time, we relied on the 2002 allocation data to also represent 1990 allocations.
[22]In the 2002 NEI, it was possible to exclude resurfacing and minor bridge rehabilitation expenditures from the emissions activity data. The ratio of 1990 to 2002 total outlays was used to estimate 1990 expenditure data consistent the expenditure data used by EPA to develop road construction emissions for the 2002 NEI.

conversion factor, Pechan computed a 1990-specific factor for converting the 1990 construction expenditures to number of acres disturbed. Pechan also removed the 50 percent emission reduction assumption for PM_{10} nonattainment area counties in calculating initial 1990 emission estimates for Road Construction. Pechan then computed the ratio of 1990 emissions to 2000 without-CAAA emissions (0.596) for application to the 2000 without-CAAA scenario emissions to yield estimates of 1990 emissions.

For 2010 and 2020, Pechan applied the growth factors that had previously been applied in preparing without-CAAA emission projections. These growth factors, which reflect regional output projections for the construction sector, were multiplied by the 2002 without-CAAA emission estimates that were computed in this effort, with the result representing estimates of national without-CAAA emissions in 2010 and 2020.

2. Paved Roads

The previous 2000 without-CAAA estimates were based on growing 1990 paved road emissions to 2000, while the 2000 with-CAAA estimates were taken from the 2002 NEI. Paved road emissions in the 2002 NEI reflect a combination of EPA emission estimates and emission estimates submitted by state/local agencies. To keep consistency with the previous emissions modeling, no changes were made to any of the previous Section 812 with-CAAA emission estimates. Because it was not possible to replicate the mix of EPA and state/local agency emission estimation methods that comprise the 2002 NEI, it was necessary for Pechan to estimate without-CAAA emission estimates by applying ratios to the with-CAAA emission estimates.

Paved road emissions were recalculated as part of this effort to be consistent with the calculation methodology and inputs that EPA used for the 2002 NEI. The without-CAAA emissions were re-estimated using the same general data inputs as the EPA used in developing estimates for the 2002 NEI (i.e., paved road vehicle miles traveled and AP-42 emission factor equation). Because the 2000 with-CAAA emission estimates include the effects of paved road controls in PM nonattainment areas, it was necessary to remove the effects of these controls in calculating without-CAAA emissions. In the 2002 NEI, EPA applied a control efficiency of 79 percent to urban and rural roads in serious PM nonattainment areas, and urban roads in moderate PM nonattainment areas (this corresponds to vacuum sweeping on paved roads twice per month). Rule penetration values varied by road type and nonattainment area classification (serious or moderate).

Between the time that the 1990 and 2002 NEI's were prepared, EPA made substantial changes to the paved road emission factor equation (the 2002 NEI uses the current AP-42 emission factor equation). Therefore, in recalculating the 1990 paved road dust emissions, Pechan multiplied the recomputed 2002 without-CAAA paved road $PM_{2.5}$ emissions by the ratio of 1990 paved road vehicle miles traveled (VMT) to 2002 paved road VMT. The paved road VMT ratios were developed at the state and roadway type level of detail.

The 2000 without-CAAA fugitive road dust emissions from paved roads were projected to 2010 and 2020 using the same county-level population-based growth factors that were applied in the previous Section 812 projections. These factors were applied to the 2000 without-CAAA emissions to provide revised estimates of 2010 and 2020 without-CAAA emissions.

3. Unpaved Roads

A review of the $PM_{2.5}$ emission estimates in the 2002 NEI indicates that EPA was responsible for developing estimates for only one of the three SCCs under which unpaved road emissions were reported. Emissions for other unpaved road SCCs were supplied by local and/or state air quality agencies. Because of the minor contribution of these SCCs to total unpaved road $PM_{2.5}$ emissions (~ 0.2 percent), Pechan calculated revised without-CAAA emission estimates for these two categories by applying year-specific uncontrolled/controlled emission ratios calculated from the emissions for the SCC for which EPA developed estimates (i.e., SCC 2294000000 – All Paved Roads/Total: Fugitives). The remainder of this section describes how Pechan recalculated the without-CAAA emissions for this SCC.

Because the 2002 NEI that forms the basis of the current 2000 with-CAAA unpaved road emissions represents a mixture of EPA and state/local agency data, it was not possible to replace the existing without-CAAA unpaved road emissions with updated values. Instead, Pechan calculated an updated without-CAAA emission value by first developing new with- and without-CAAA emission estimates for 2002, and then applying the resulting without- to with-CAAA emissions ratio to the 2002 NEI emissions that represent the 2000 with-CAAA scenario emissions.

Pechan used the same EPA data inputs, unpaved road VMT, and AP-42 emission factor equation that was used in the 2002 NEI in the updated emission calculations. However, without-CAAA emissions removed the unpaved road emission controls from the calculations. The EPA-developed unpaved road estimates in the 2002 NEI incorporated a control efficiency of 80 percent with a rule penetration rate of 75 percent for urban roads in serious PM nonattainment areas, a 50 percent control efficiency with 50 percent rule penetration rate for rural roads in serious PM nonattainment areas, and a 96 percent control efficiency with a 50 percent rule penetration for urban roads in moderate PM nonattainment areas. The ratio of newly calculated without- to with-CAAA emission estimates (1.01) was then applied to the existing national with-CAAA $PM_{2.5}$ emission estimate.

The 1990 NEI was the source for the original Section 812 1990 unpaved road emissions. To be consistent with the methods used to calculate unpaved road emissions in the 2002 NEI, the 1990 unpaved road dust emissions were recalculated by first computing 1990 unpaved road emissions using the same methods as the uncontrolled 2002 unpaved emissions, but with 1990 unpaved VMT data replacing 2002 unpaved VMT data (these data were developed at the state and roadway type level of detail). Next, Pechan summed the 1990 and 2002 emission estimates to the national level, and computed the ratio of 1990 to 2002 unpaved emissions. This ratio (1.007) was then applied to the newly calculated 2000 without-CAAA $PM_{2.5}$ emission estimate that was computed as described above.

The 2000 without-CAAA unpaved road emissions that were directly re-computed in this effort were projected to 2010 and 2020 using the same regional unpaved road VMT growth factors that were previously applied in calculating the 2010 and 2020 with-CAAA emission estimates.

4. Residential Wood Combustion

As part of the original Section 812 effort, Pechan performed a sector-specific analysis of emissions activity and controls for all but 2 of the 12 residential wood combustion (RWC) source category SCCs with emissions in the 2002 NEI.[23] Much of the information compiled from that work was applied in this effort. Because the two SCCs that were not previously analyzed accounted for a small percentage of total category 2002 with-CAAA $PM_{2.5}$ emissions (0.08 percent), and will not have any significant CAAA reductions, Pechan did not attempt to refine the without-CAAA emission estimates for these two SCCs.

The first step in recalculating the 2000-without CAAA RWC emissions for the remaining ten SCCs was to identify the emission reductions attributable to lower-emitting wood heating units resulting from EPA's wood heater New Source Performance Standard (NSPS). The 2002 NEI that forms the basis for the 2000 with-CAAA scenario emissions assumed the following proportions of total residential wood consumption: 92 percent in non-EPA certified units; 5.7 percent in EPA certified non-catalytic units; and 2.3 percent in EPA certified catalytic units. EPA's RWC forecast year proportions were calculated by adjusting the 2002 year proportions using an annual 2 percent RWC unit turnover rate computed from 1992-2005 data. This adjustment accounts for non-EPA certified units being replaced by NSPS compliant EPA-certified units. Therefore, by year 2020, it is assumed that 64.4 percent of residential wood consumption in woodstoves and fireplaces with inserts will occur in non-EPA certified units, 25.4 percent in EPA certified non-catalytic units, and 10.2 percent in EPA certified catalytic units.

For the four SCCs that represent heating units that meet EPA emission requirements, the ratio of non-CAAA to CAAA emissions was computed by dividing the 2002 NEI emission factor for conventional units by the 2002 NEI emission factor for EPA-certified units. Two SCCs are specific to non-EPA-certified units and therefore have no CAAA emission reductions (2104008001 and 2104008010). Two SCCs do not specify EPA certification status (2104008000-Total Fireplaces and Woodstoves and 2104008001-Total Fireplaces). For these SCCs, it was necessary to develop a 2002 weighted emission factor from the EPA-certified and non-EPA-certified unit emission factors. Each emission factor was weighted by the proportion of RWC that is estimated to have occurred in the particular type of unit (as noted above, the 2002 NEI provided this information). Each SCC's ratio of non-CAAA emissions to CAAA emissions was computed by dividing the emission factor for conventional units by the given weighted emission factor. The 2000 without-CAAA emissions were computed by multiplying the 2000 with-CAAA emissions by the appropriate adjustment ratio.

Pechan used the back-cast factors that were developed in the earlier Section 812 analysis to back-cast the 2000 with-CAAA emissions to 1990. These back-cast factors were computed based on SCC-level 2002 and 1990 residential wood consumption estimates. To calculate 1990 consumption, Pechan first calculated the ratio representing national 1990 residential wood consumption relative to 2002 consumption (1.85), and then multiplied this ratio by 2002 year regional residential renewable (wood) energy consumption. Next, Pechan applied values representing the estimated 1990 year proportions of total residential wood consumption attributable to each of the following unit types: woodstoves, fireplaces with inserts, and fireplaces without inserts. Next, we allocated the general unit-level consumption estimates to individual SCCs. For 1990, this step assumed that zero residential wood consumption would occur in EPA-certified units because 1992 was the first year of certification. Finally, we calculated the back-cast/forecast year growth factors by dividing estimated 1990 consumption by estimated 2002 year consumption.

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[23]These two SCCs were 2104009000-Residential/Firelog/Total: All Combustor Types, and 2199008000-Total Area Source Fuel Combustion/Wood/Total: All Boiler Types.

The final step was to apply the 2010 and 2020 growth factors from the previous Section 812 analysis to the 2000 without-CAAA emissions to yield estimates of 2010 and 2020 without-CAAA emissions.

5. Fuel Combustion Industrial/Coal/Other

Pechan did not identify any CAAA emission controls that affect $PM_{2.5}$ emissions for this category. Therefore, Pechan set the without-CAAA emissions for 2000, 2010, and 2020 equal to the with-CAAA emissions for each year. For 1990, Pechan was unable to replicate the 2001 emission calculations that underlie the EPA developed industrial coal combustion estimates for the 2002 NEI[24] because the NEI methods reflect the effects of point source subtractions that eliminate double counting of emissions reported in EPA's point source inventory. Therefore, 1990 emissions were estimated by applying the ratio of 1990 to 2001 emissions activity for this category to the NEI emissions. The emissions activity for this category is the volume of non-coke plant coal consumed by the industrial sector.[25] Pechan calculated the national ratio of 1990 coal consumption to 2001 coal consumption (1.170), and then multiplied this ratio by the national emissions in 2000 to estimate 1990 emissions.

B. SUMMARY OF REVISED EMISSION REDUCTIONS ATTRIBUTABLE TO CAAA

Table 1 displays the final with- and without-CAAA emissions for each of the source categories analyzed. Overall, the CAAA are estimated to reduce $PM_{2.5}$ emissions for these categories by approximately 4 percent, 9 percent, and 10 percent in 2000, 2010, and 2020, respectively.

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[24] The 2002 NEI industrial coal emissions were based on the most recent data available at the time, which was 2001.

[25] Because Pechan only recalculated bituminous/sub-bituminous coal combustion, and not anthracite coal combustion, it was also necessary to estimate the portion of total consumption from bituminous/sub-bituminous coal. Pechan implemented this adjustment by applying the 2001 year state-specific bituminous to total coal consumption ratios that were compiled for the 2002 NEI. The 2001 ratios were used because analogous 1990 data were not available.

Table 1. Summary of Updated Section 812 Second Prospective $PM_{2.5}$ Emission Estimates for Five Nonpoint Source Categories (tons per year)

Category	1990	2000		2010		2020	
		Without CAAA	With CAAA	Without CAAA	With CAAA	Without CAAA	With CAAA
Construction	200,082	270,473	237,780	327,378	252,815	355,450	312,317
Paved Roads	162,436	210,409	202,706	226,196	217,706	245,903	236,673
Unpaved Roads	849,408	843,503	835,152	793,147	786,853	720,534	716,237
Residential Wood Combustion	786,697	460,003	428,043	529,172	438,225	573,504	431,195
Fuel Comb. Industrial/Coal/Other	180,361	154,095	154,095	153,289	153,289	147,870	147,870
Subtotal	2,178,984	1,938,484	1,857,776	2,029,183	1,848,888	2,043,261	1,844,291
% Reduction			4.2%		8.9%		9.7%

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APPENDIX B

Memorandum

To: Henry Roman and Jim Neumann, Industrial Economics Inc.

From: Leland Deck, Stratus Consulting Inc.

Date: May 27, 2010

Subject: Stacked bar charts of estimated $PM_{2.5}$ at 23 Speciation Trend Network monitor locations for the §812 Second Prospective Project

This memorandum conveys a series of 23 stacked bar chart diagrams showing the estimated composition of fine particulate matter ($PM_{2.5}$) air quality estimates for the §812 second prospective project. The diagrams present observed 2002 monitor data, as well as estimates for each of the six §812 scenarios. The estimates were prepared directly by CMAQ ("Orig. CMAQ"), the results of the adjustments made in April and May, 2010 to the CMAQ estimates ("Adj. CMAQ"), and the estimates prepared using EPA's Monitor Attainment Test Software (MATS, ver. 2.1.1), using the adjusted CMAQ files as modeled input. The principal adjustment to the CMAQ estimates involved revising the crustal component, although adjustments were also made to a portion of the EC and OC estimates.

Each diagram presents a stacked bar for each of 21 different estimates of annual mean $PM_{2.5}$ levels. There is a diagram for 23 Speciation Trend Network (STN) monitor locations. The 23 monitors were selected to present a range of locations throughout the contiguous United States, including monitors in densely populated areas, coastal and inland areas, and more rural locations with STN monitors.

The first three stacked bars shown on each diagram are:

1) The Federal Reference Method (FRM) measure of 2002 annual mean $PM_{2.5}$ at the STN monitor location.
2) A Reconstructed Fine Mass (RCFM) estimate prepared by EPA for the STN monitor.
3) The bar labeled "2002 STN" presents 8 components derived from the STN monitor data: sulfate (SO_4) retained nitrate (NO_3), ammonium (NH_4), blank-adjusted organic carbon (OC), elemental carbon (EC), crustal material, salt, and particular bound water (H2O) estimated using the Aerosol Inorganic Model (AIM).

The data for each of these three stacked bars comes from the MATS input file ("Species-for-fractions-0205-v2.csv") supplied with MATS.

The other 18 stacked bars on each diagram include three stacked bars for each of the six §812 scenarios. Each scenario has a stacked bar for original CMAQ estimates, the adjusted CMAQ estimates, and the MATS estimate. Each stacked bar is designated by the scenario's year, whether the scenario includes the Clean Air Act Amendments of 1990, or not (for example "2010 No ____" is the No CAAA scenario for 2010), and which model was used to prepare that estimate. The original and adjusted CMAQ estimates have six species components (SO4, NO3, NH4, EC, OC and Crustal). The MATS estimates have 9 components: SO4, NO3, NH4, EC, OC, Crustal, water, salt (a very small component on many diagrams), and a blank mass component (set as a constant 0.5 $\mu g/m^3$ throughout the CMAQ domain).

Note that the MATS estimates were made using the Gradient Adjustment (GA) option, which estimates the $PM_{2.5}$ levels at the center of each CMAQ grid cell rather than at the exact location of the STN monitor. These MATS GA estimates are presented in the stacked bar diagrams, and are also used in the §812 health analyses. In some locations, especially where the FRM monitor is near an edge of a CMAQ cell and there are other FRM monitors relatively nearby, there is a modest difference between the MATS estimate and either the STN or FRM monitor level.

Also note while most of the STN locations presented in the diagrams have complete data for 2002, four of the STN monitors have fewer than 4 quarters of STN data. Los Angeles, Manhattan and Lawrence County, TN have STN data for only the third and fourth quarters of 2002, and Tucson, AZ has data for three quarters. MATS prepares a separate estimate for each quarter, using available monitor data in that quarter. Thus the estimated annual mean species concentrations at these three STN locations are MATS estimates using less than 4 quarters of available STN data from that grid cell, and interpolated quarterly data from other STN monitors for the missing quarters. All other locations presented in a diagram have complete STN data (defined as at least 11 valid days of data in each quarter).

Figure 1 Atlanta, GA

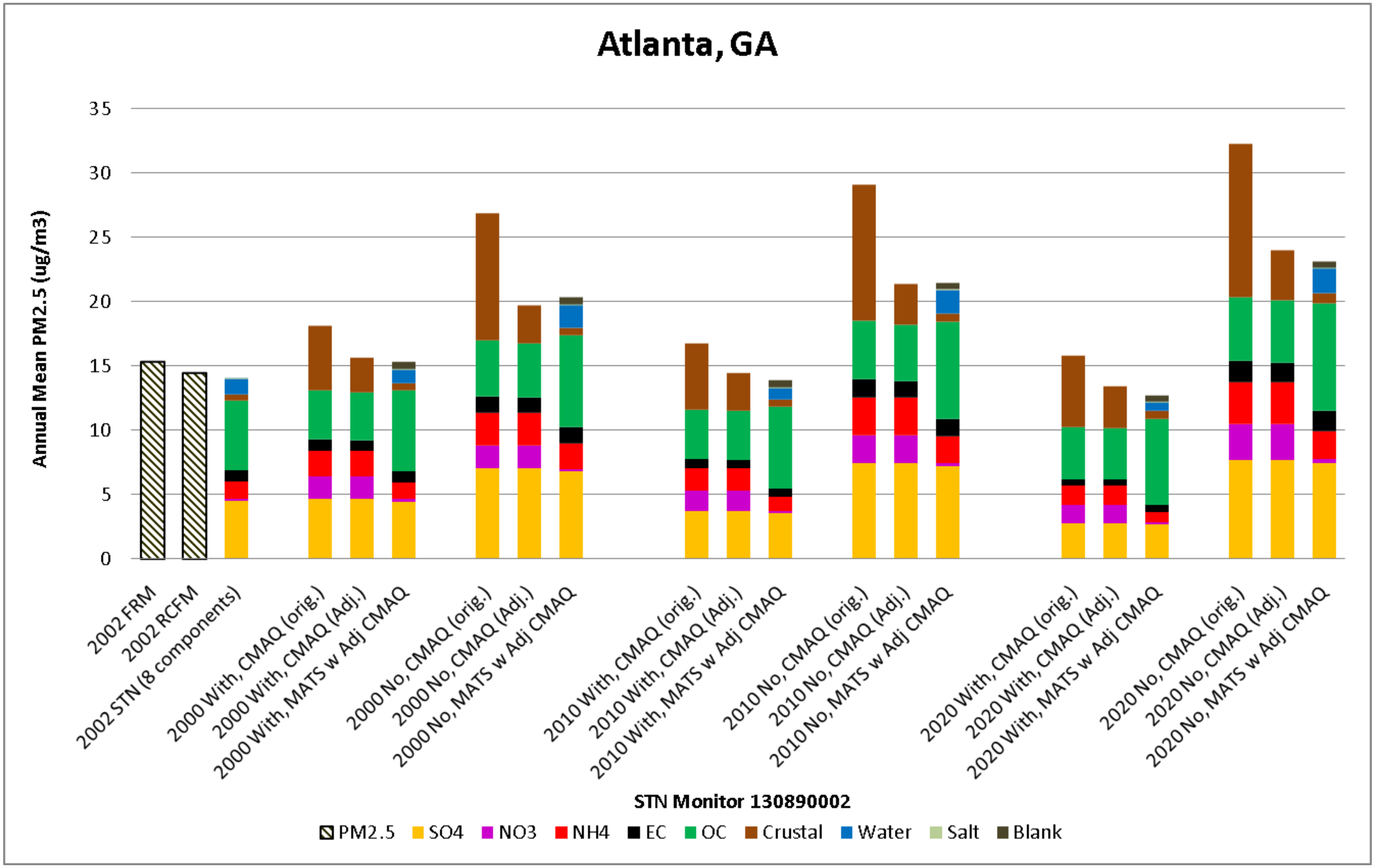


Figure 2 Baltimore County, MD

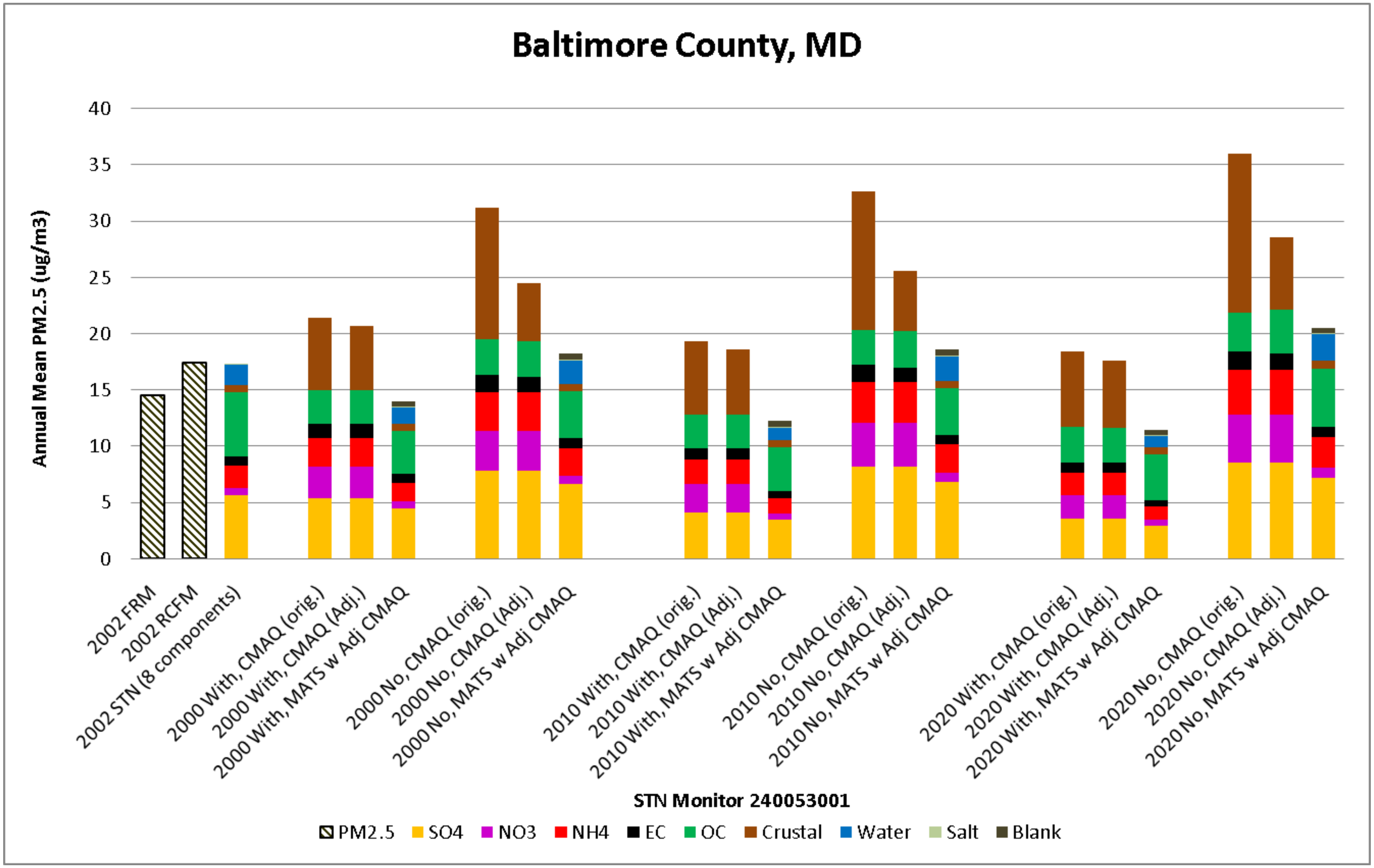


Figure 3 East Baton Rouge, LA

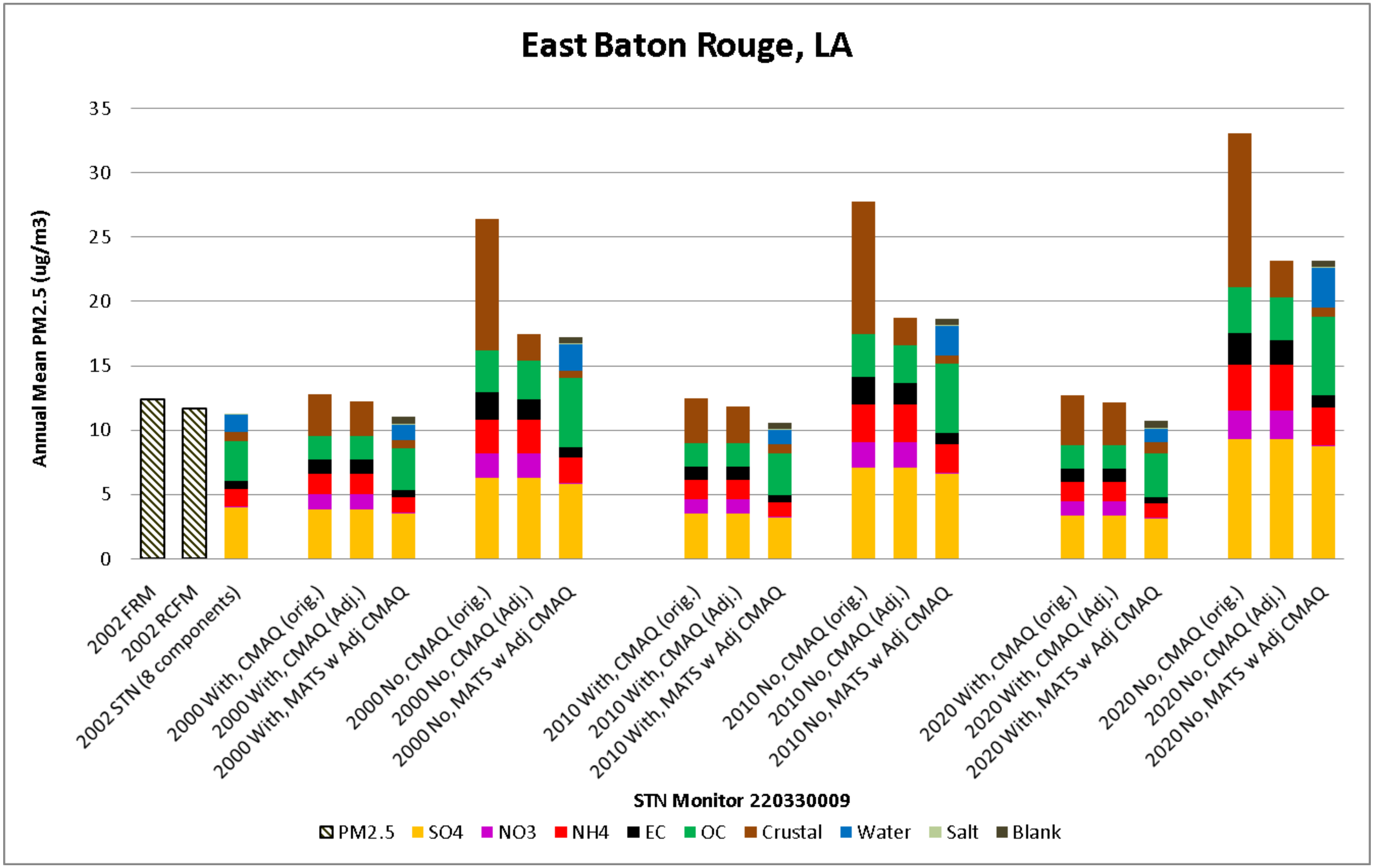


Figure 4 Boston, MA

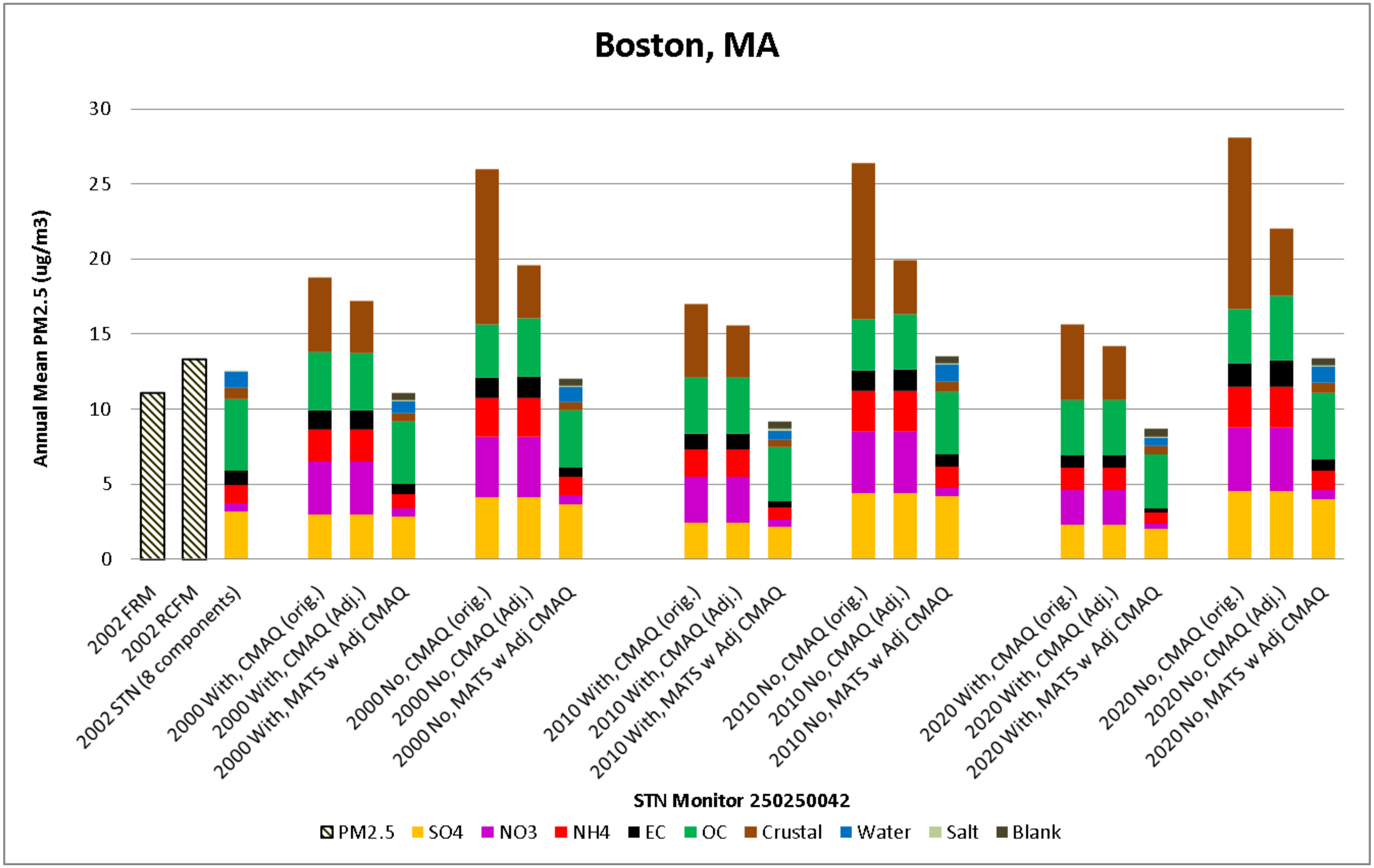


Figure 5 The Bronx, NY

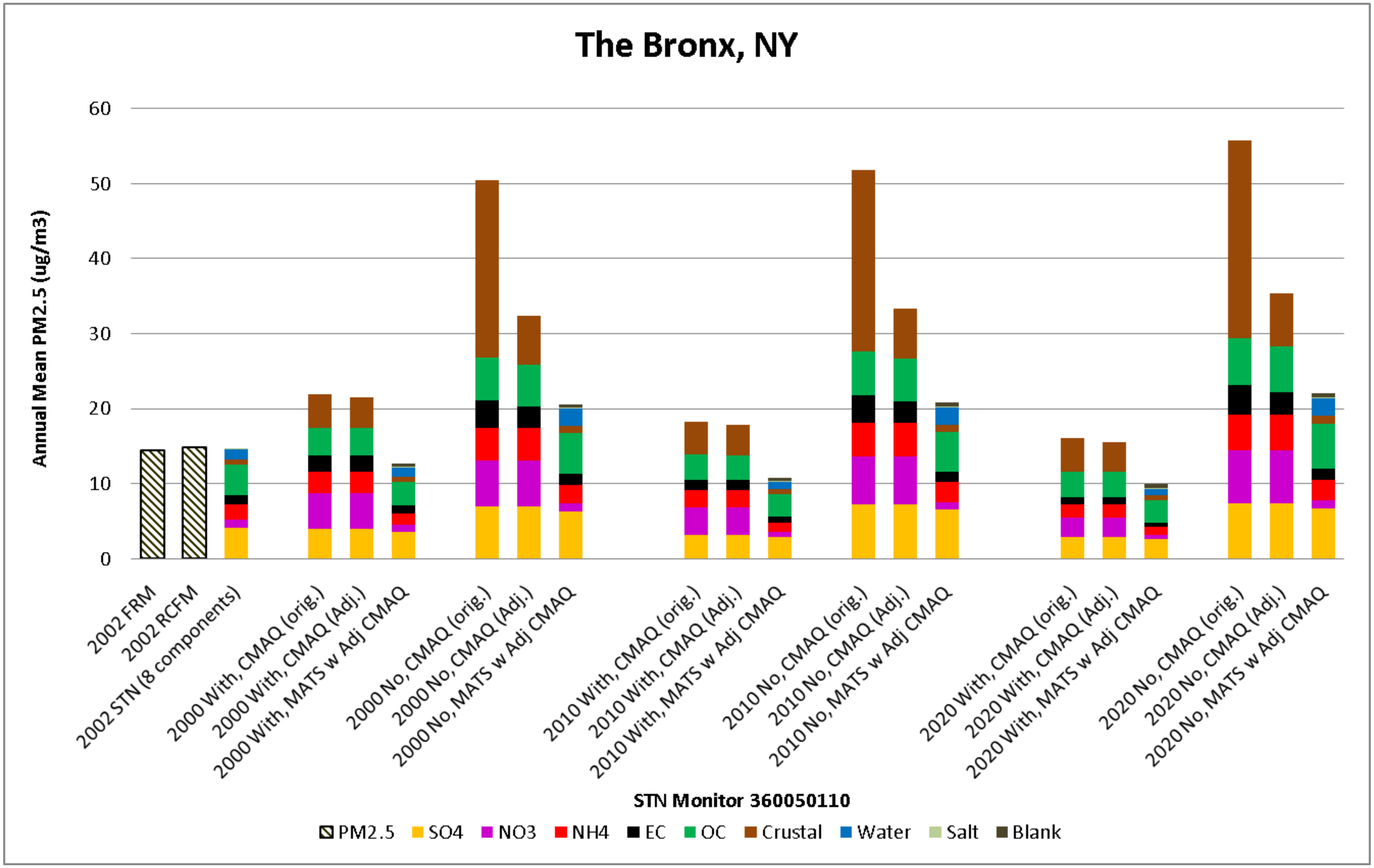


Figure 6 Chicago, IL

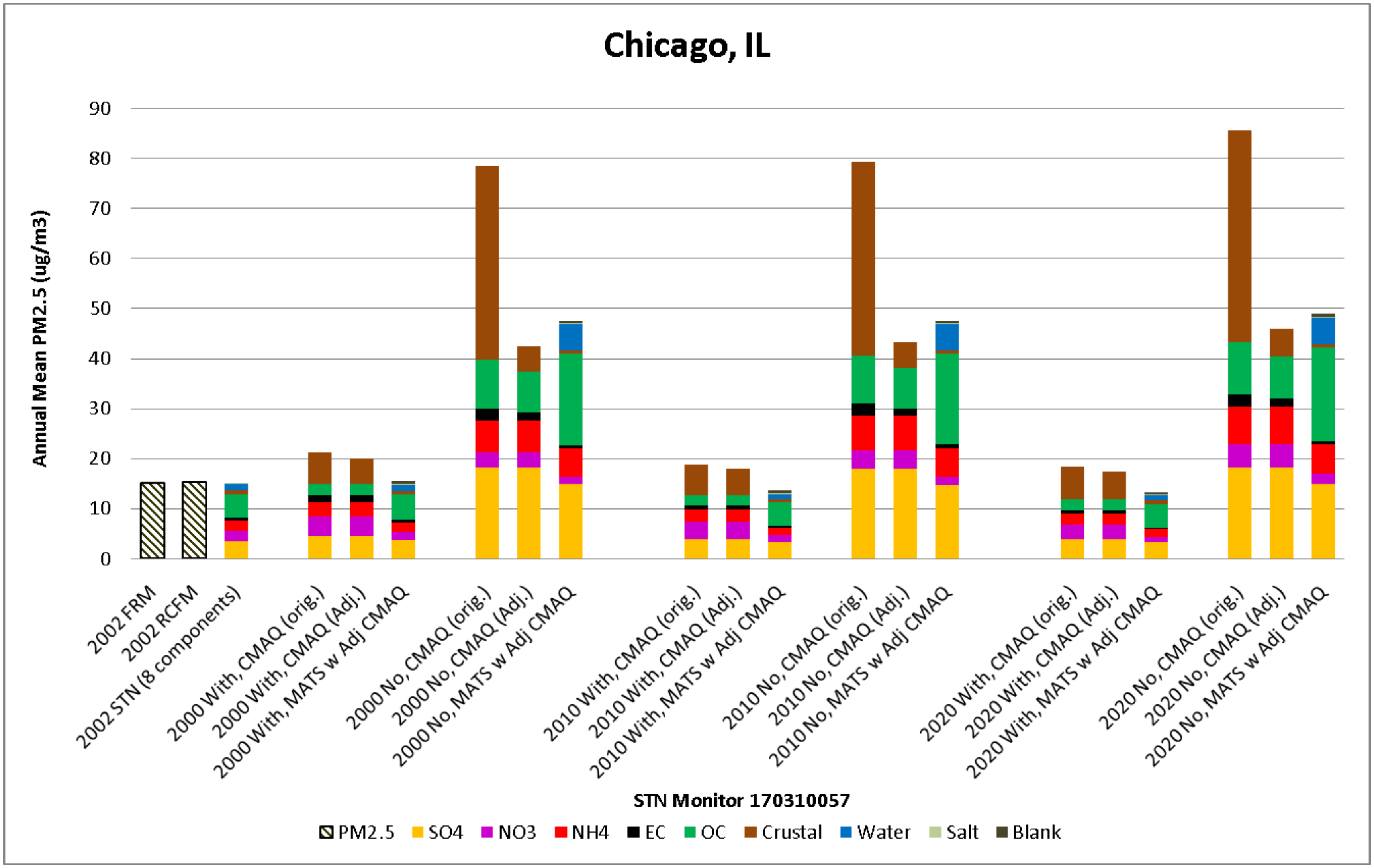


Figure 7 Dallas, TX

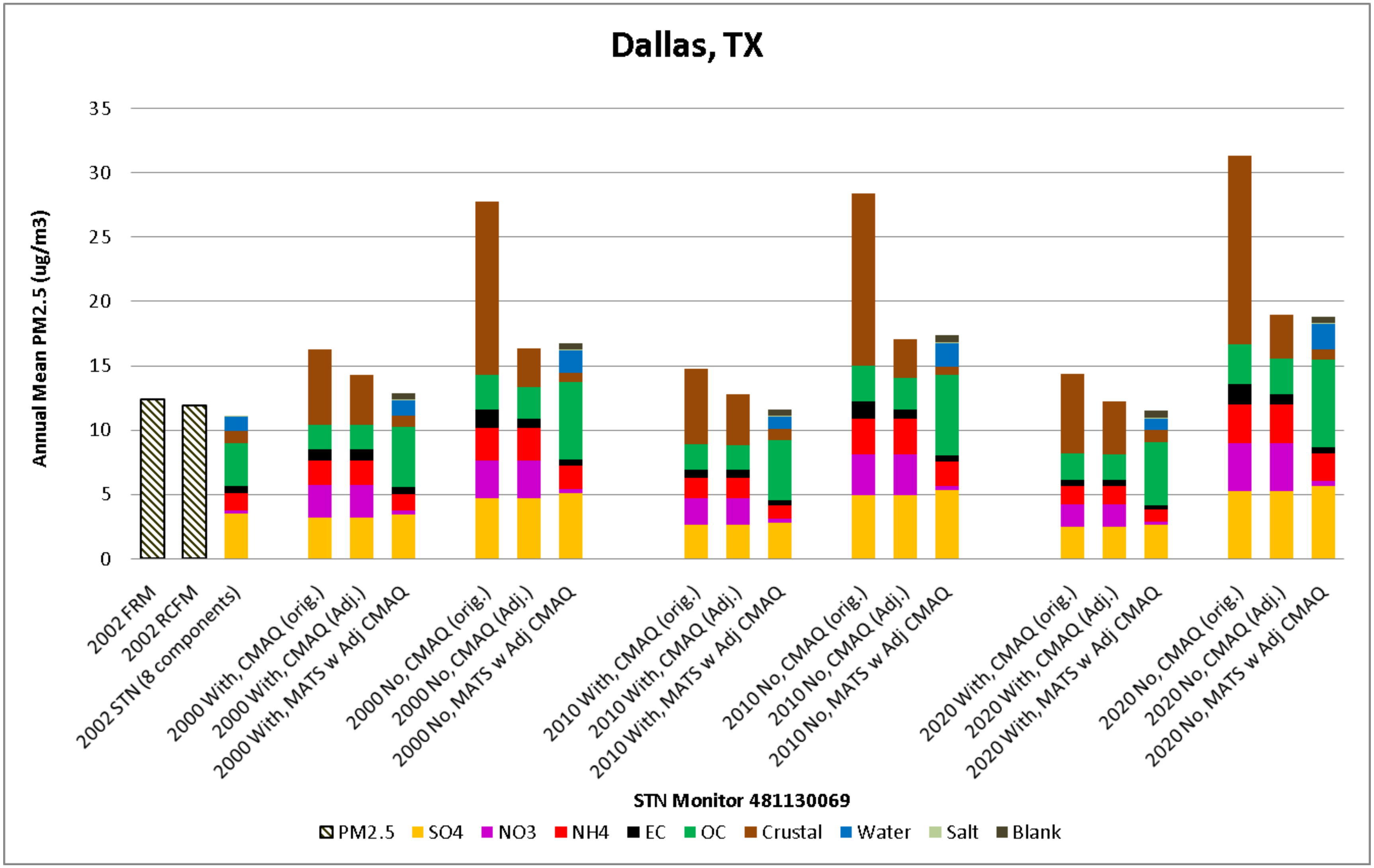


Figure 8 Denver, CO

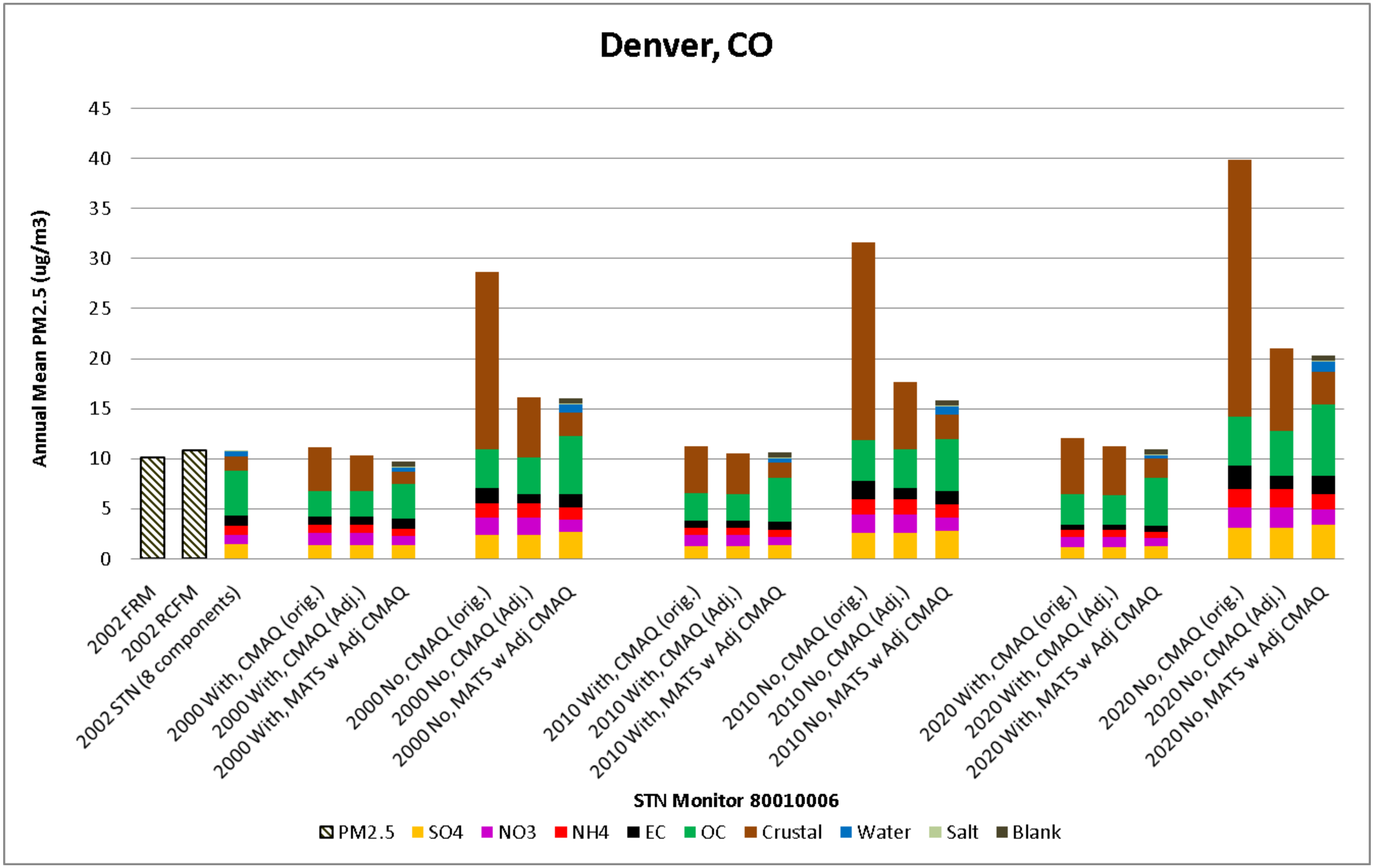


Figure 9 Detroit, MI

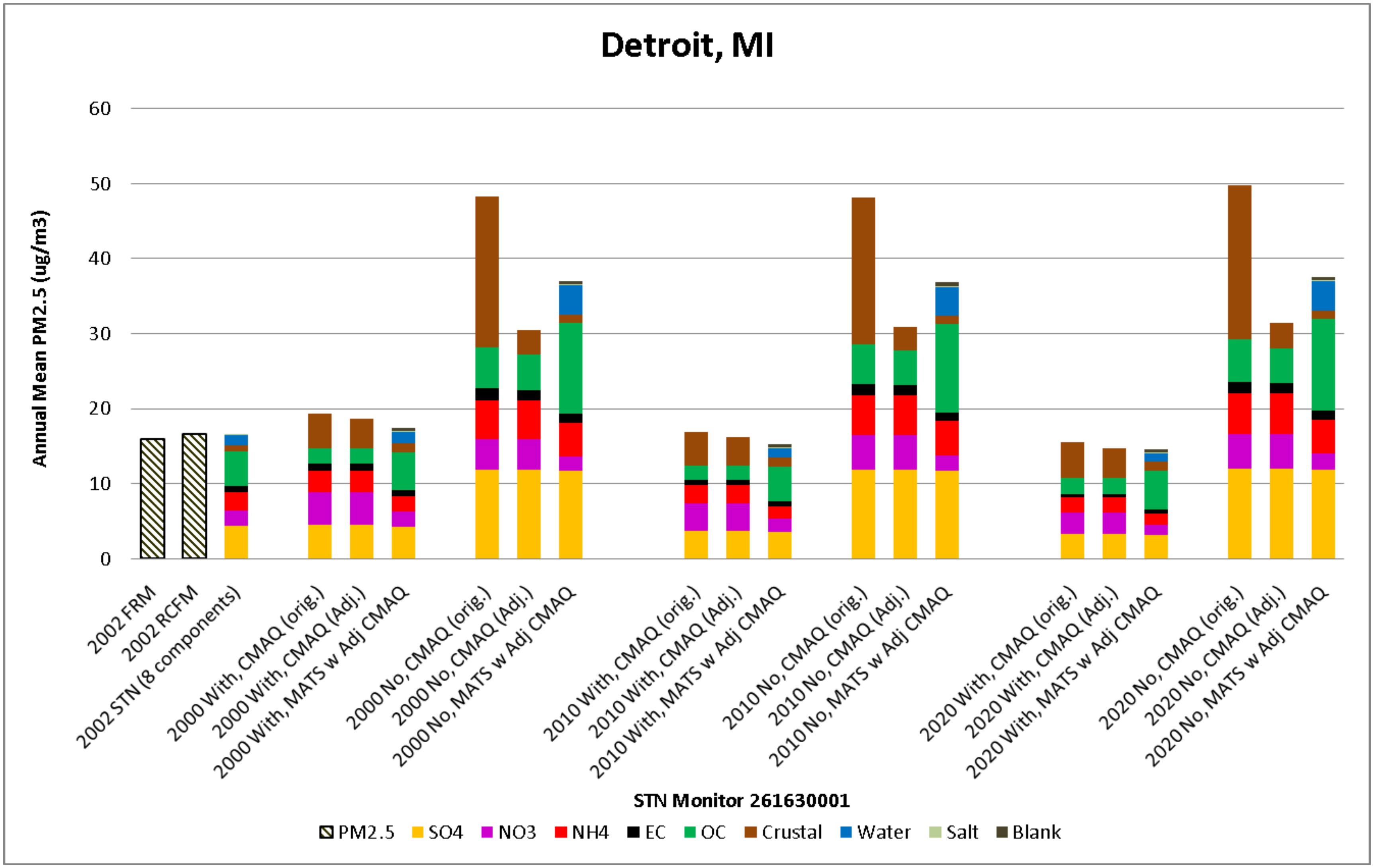


Figure 10 Kern County, CA

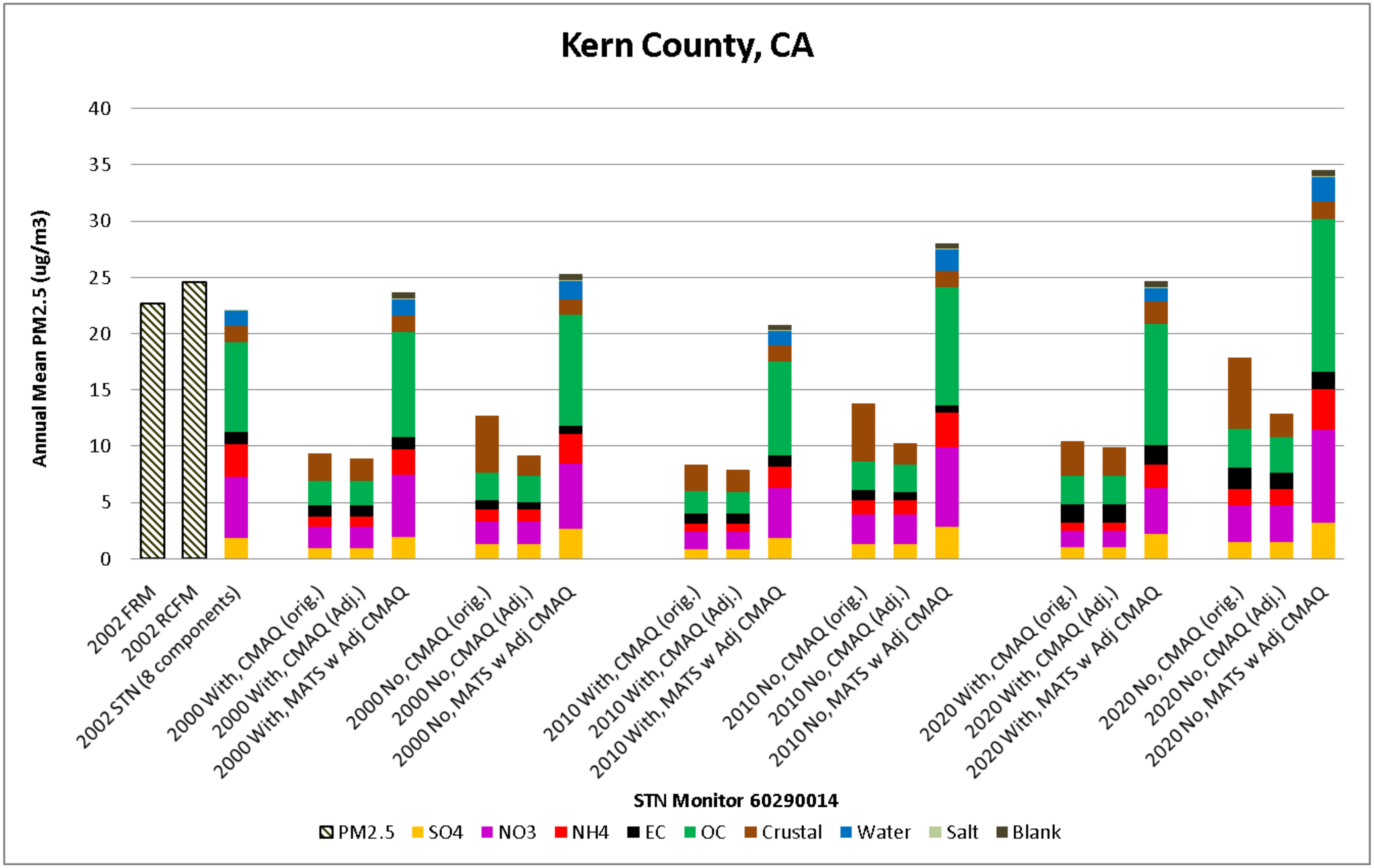


Figure 11 Lawrence County, TN

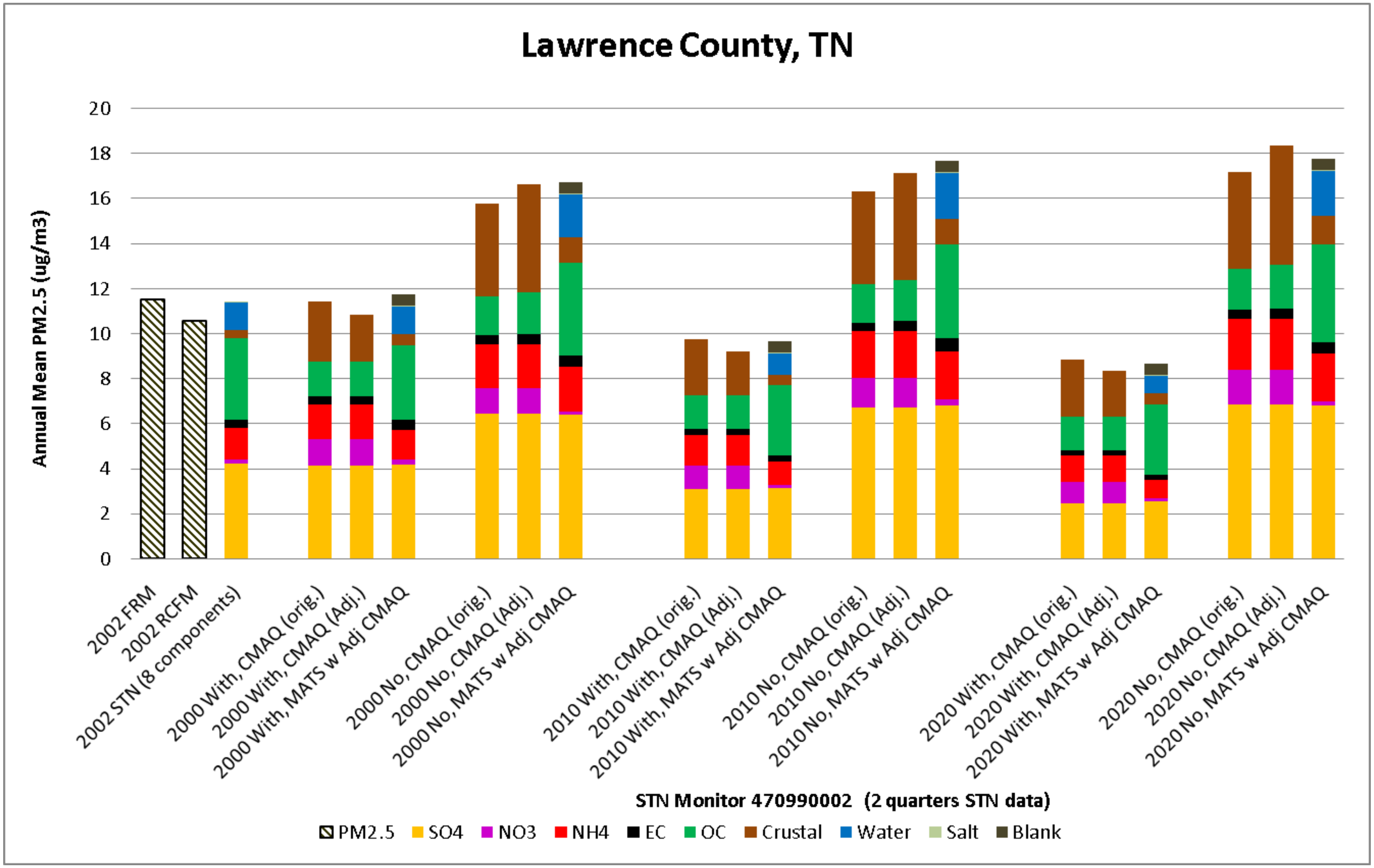


Figure 12 Los Angeles, CA

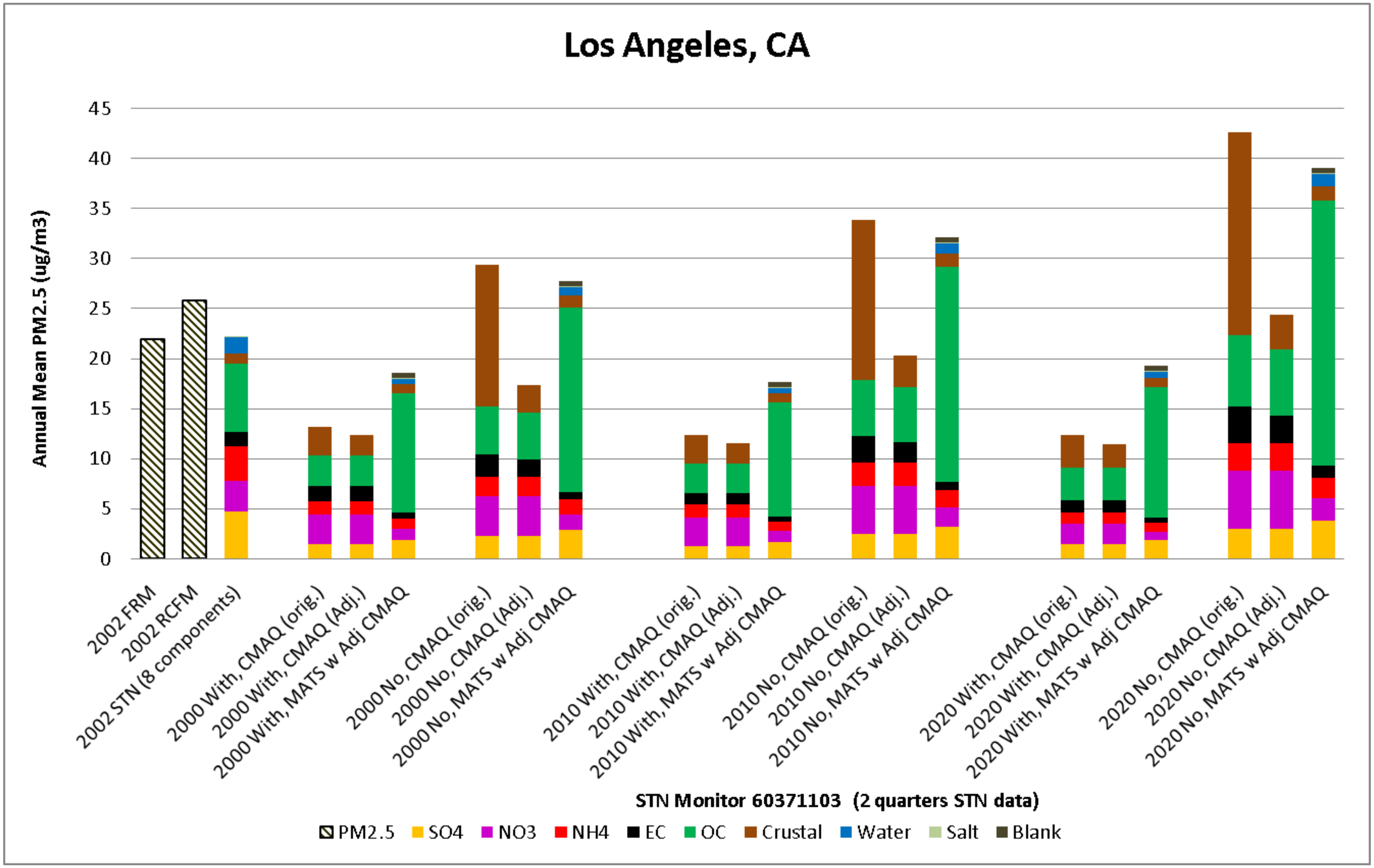


Figure 13 Manhattan, NY

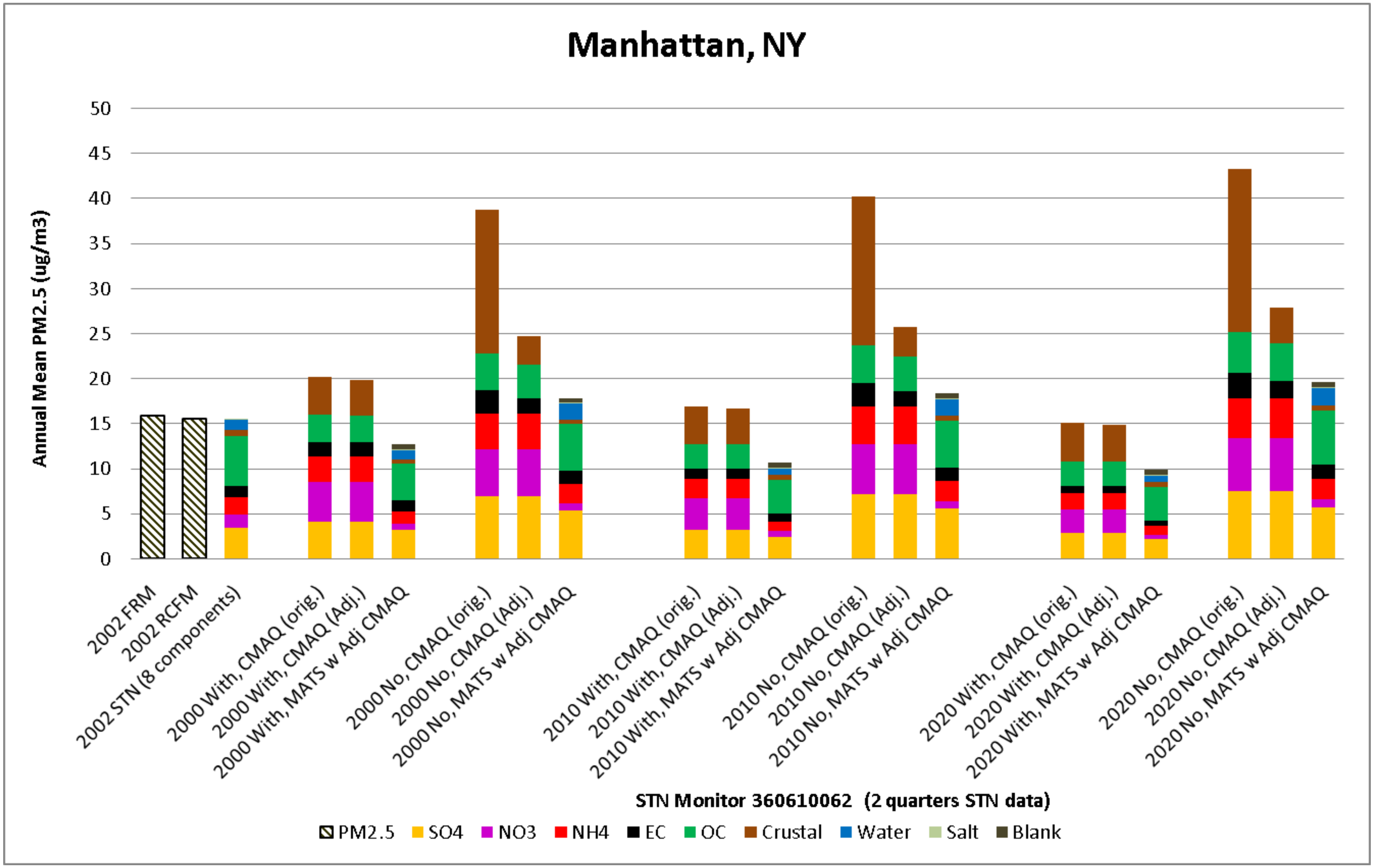


Figure 14 Miami, FL

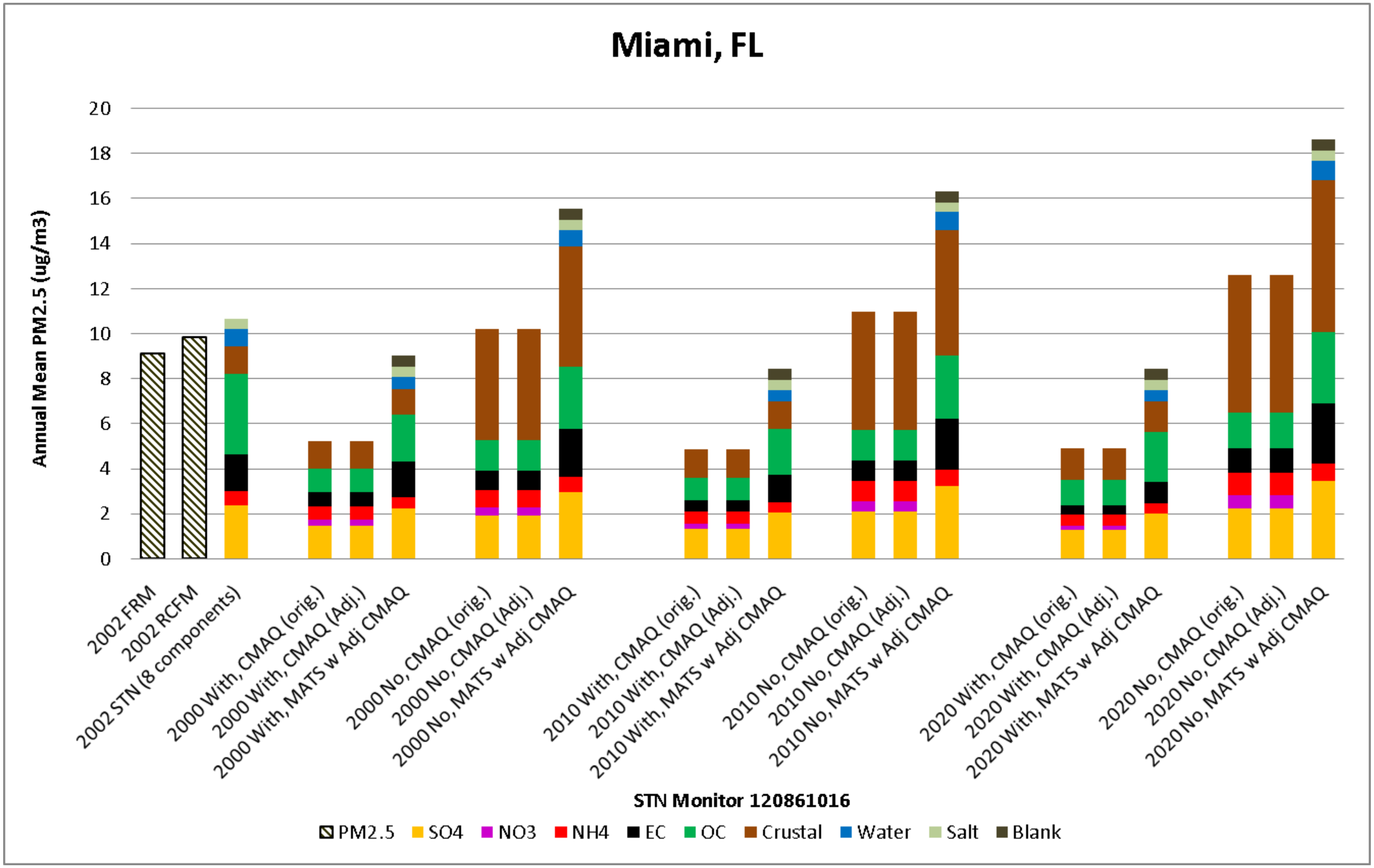


Figure 15 Minneapolis, MN

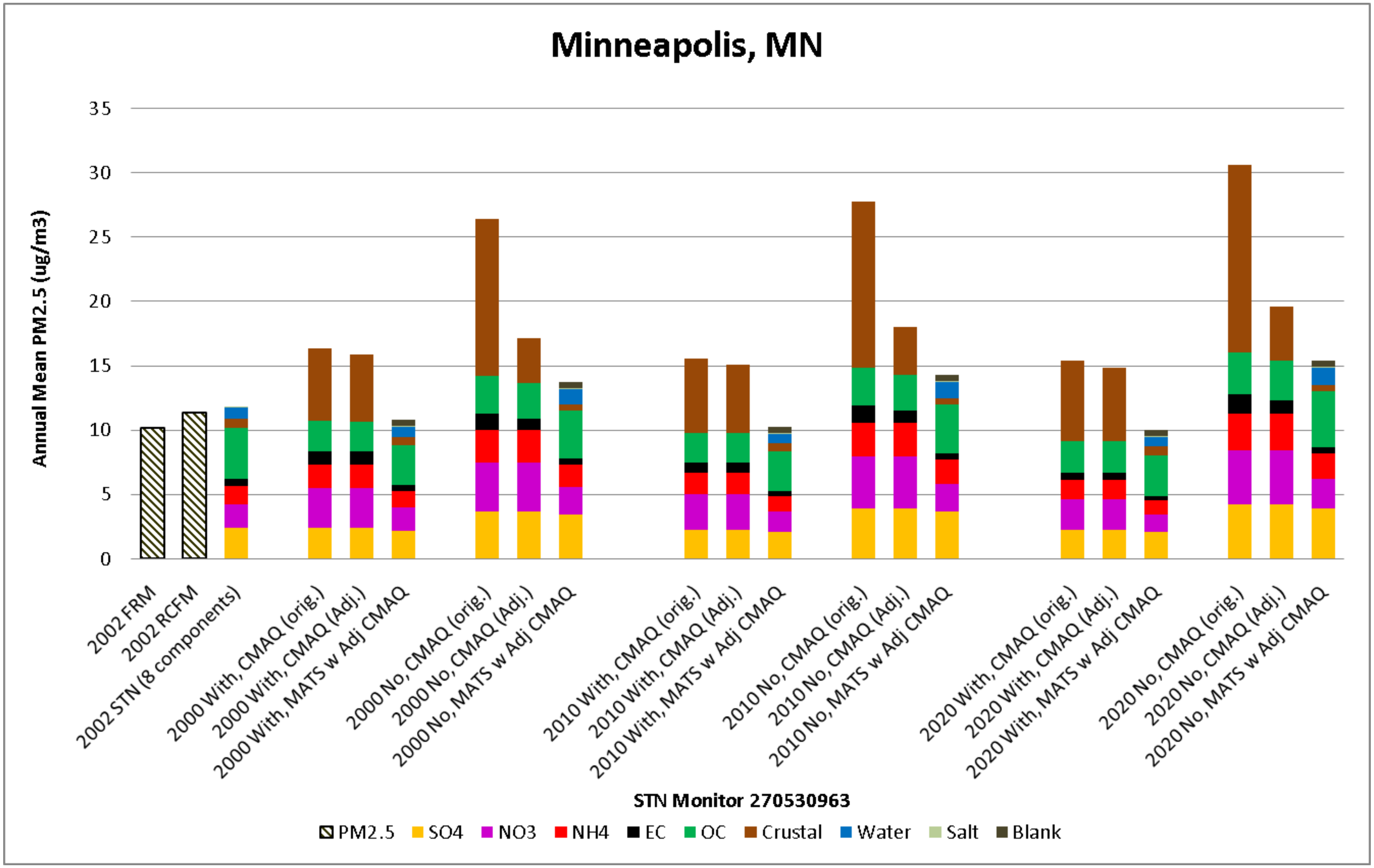


Figure 16 Morris County, NJ

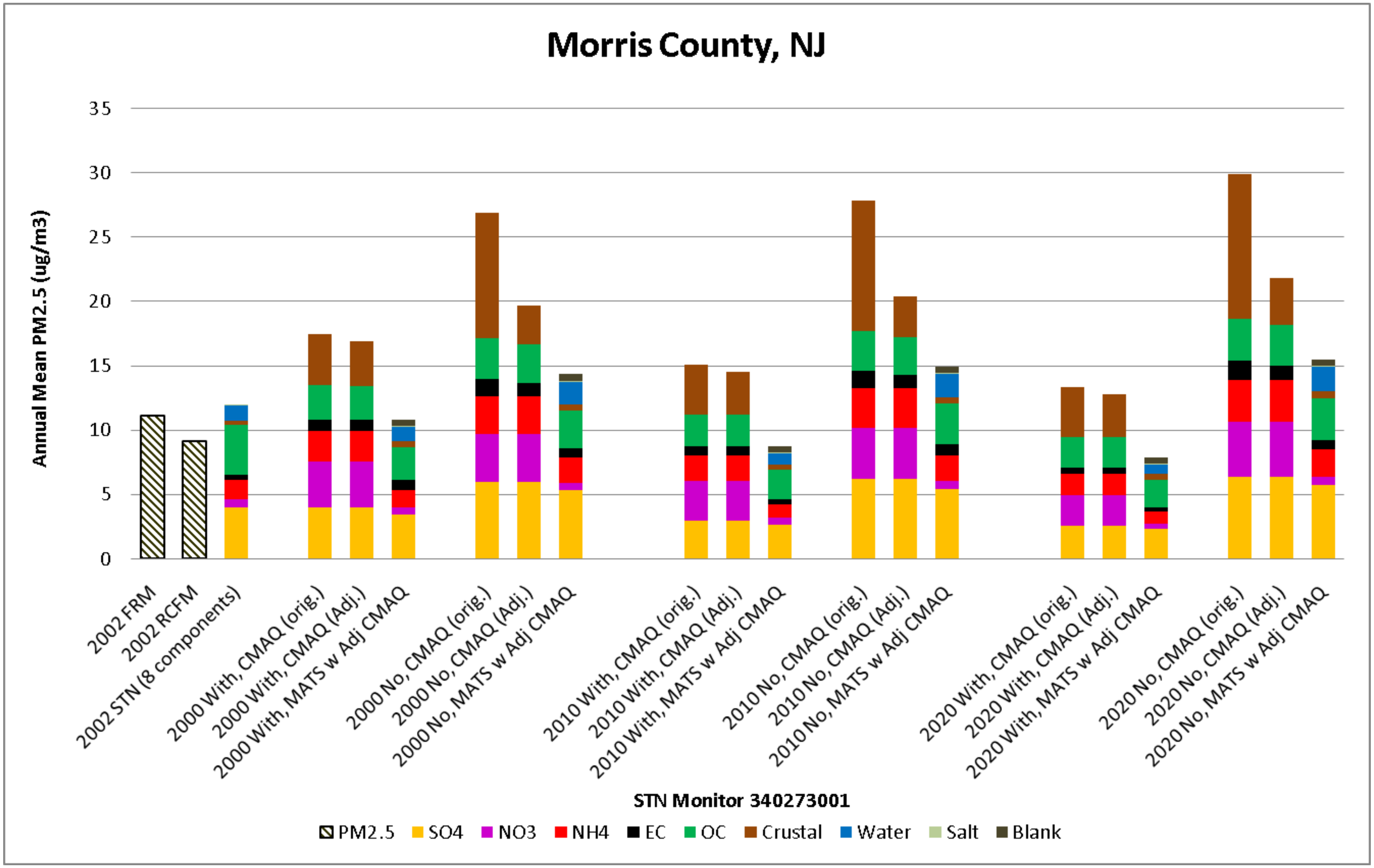


Figure 17 Philadelphia, PA

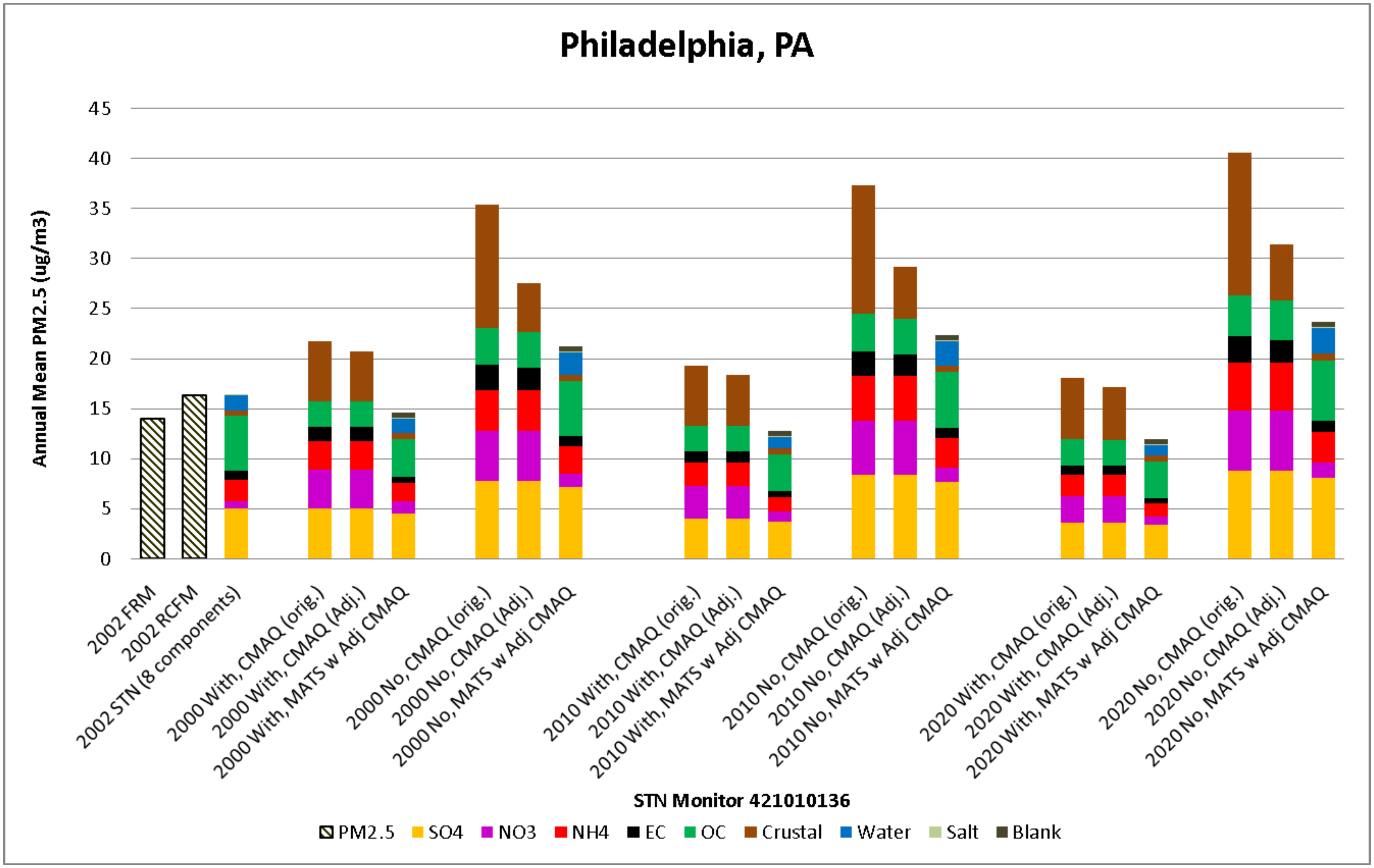


Figure 18 Pittsburgh, PA

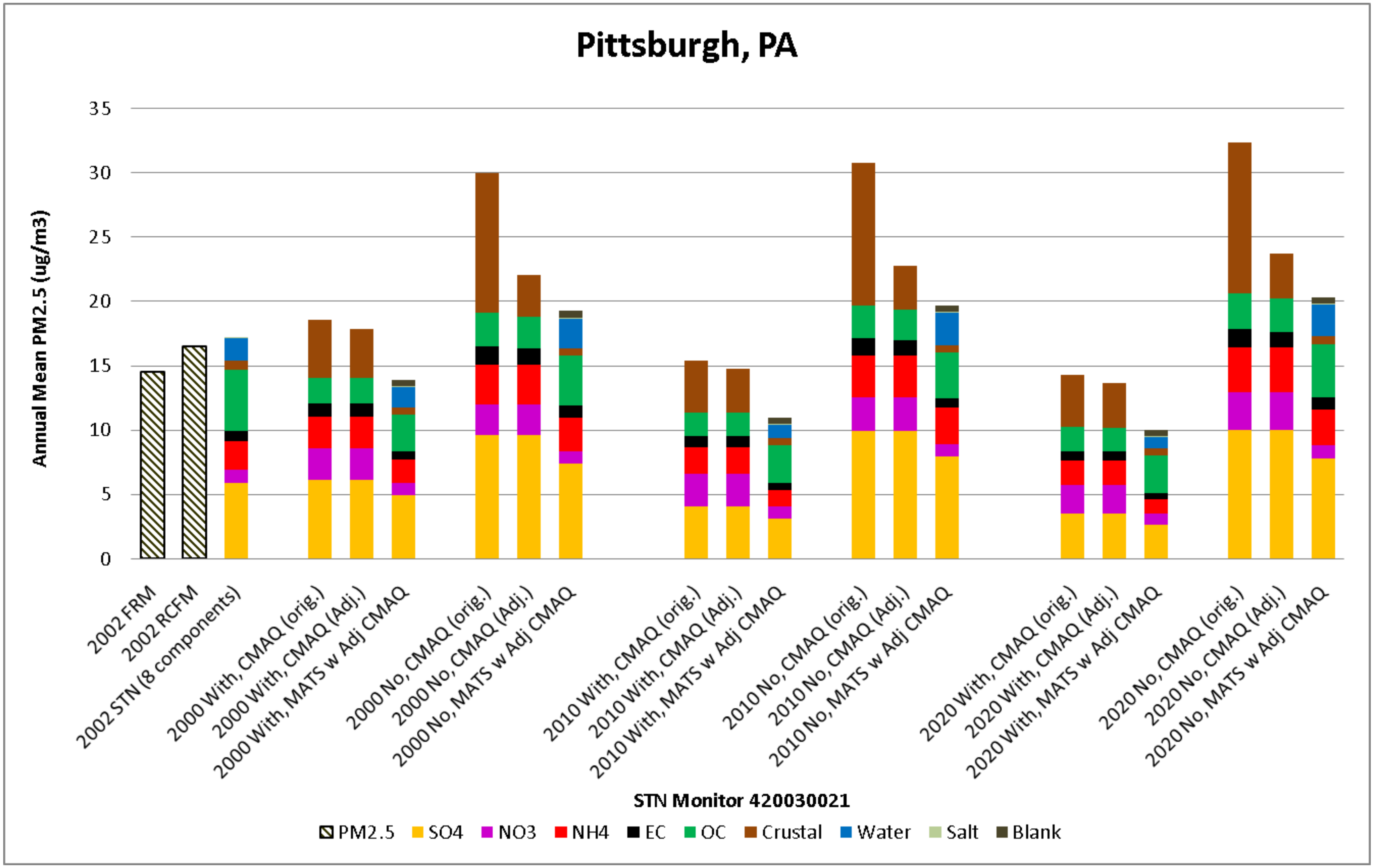


Figure 19 Riverside, CA

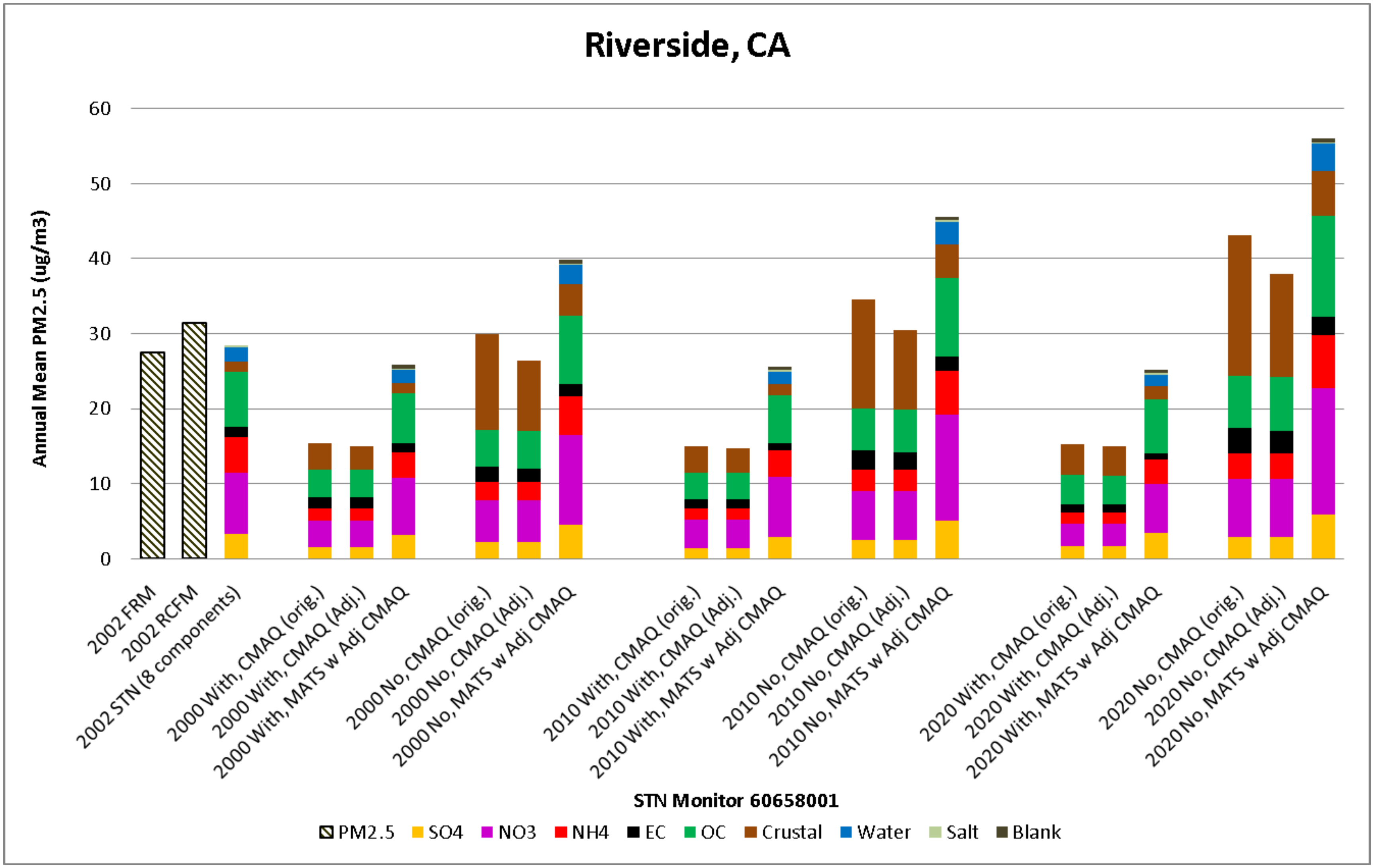


Figure 20 Salt Lake City, UT

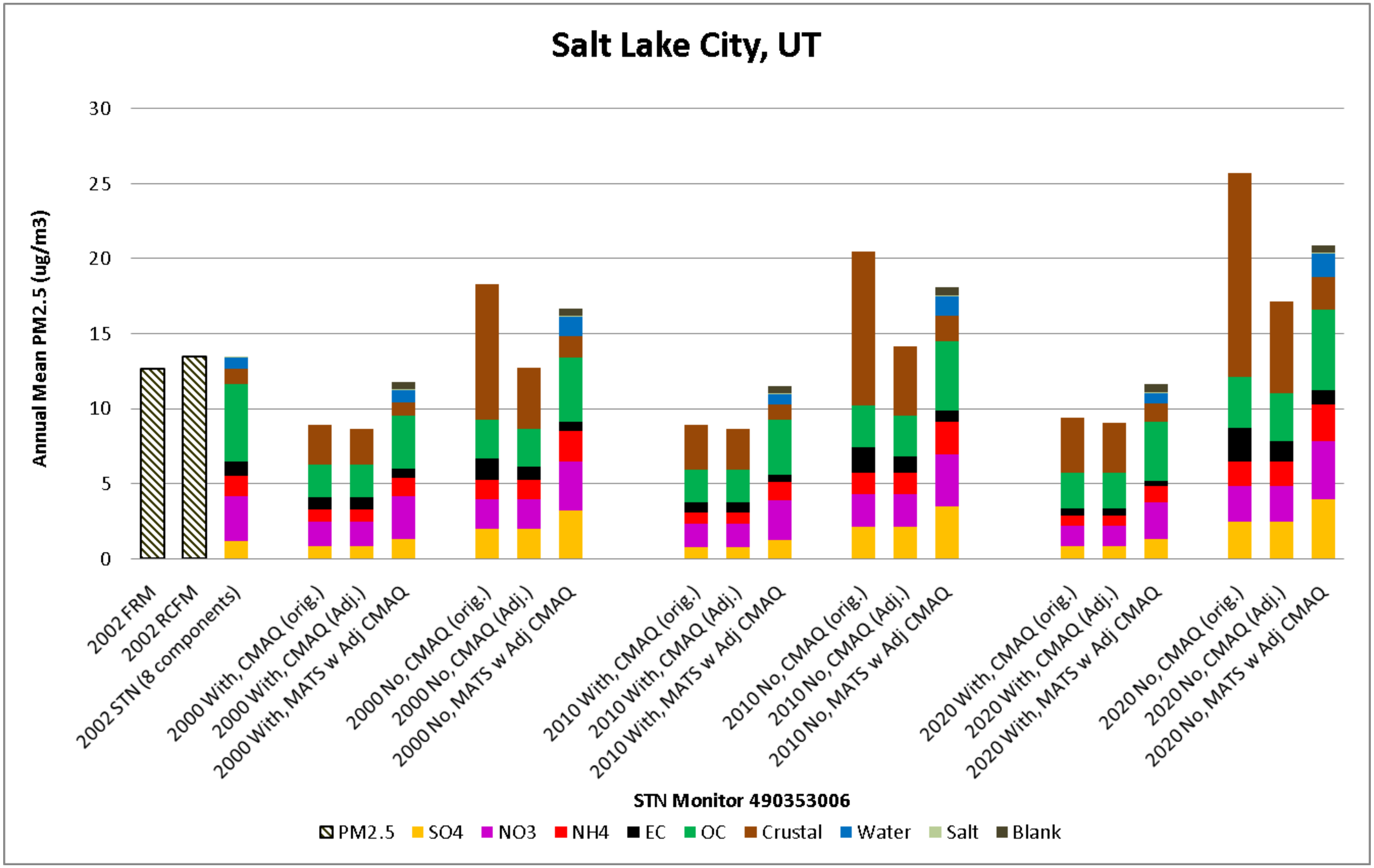


Figure 21 Tulare County, CA

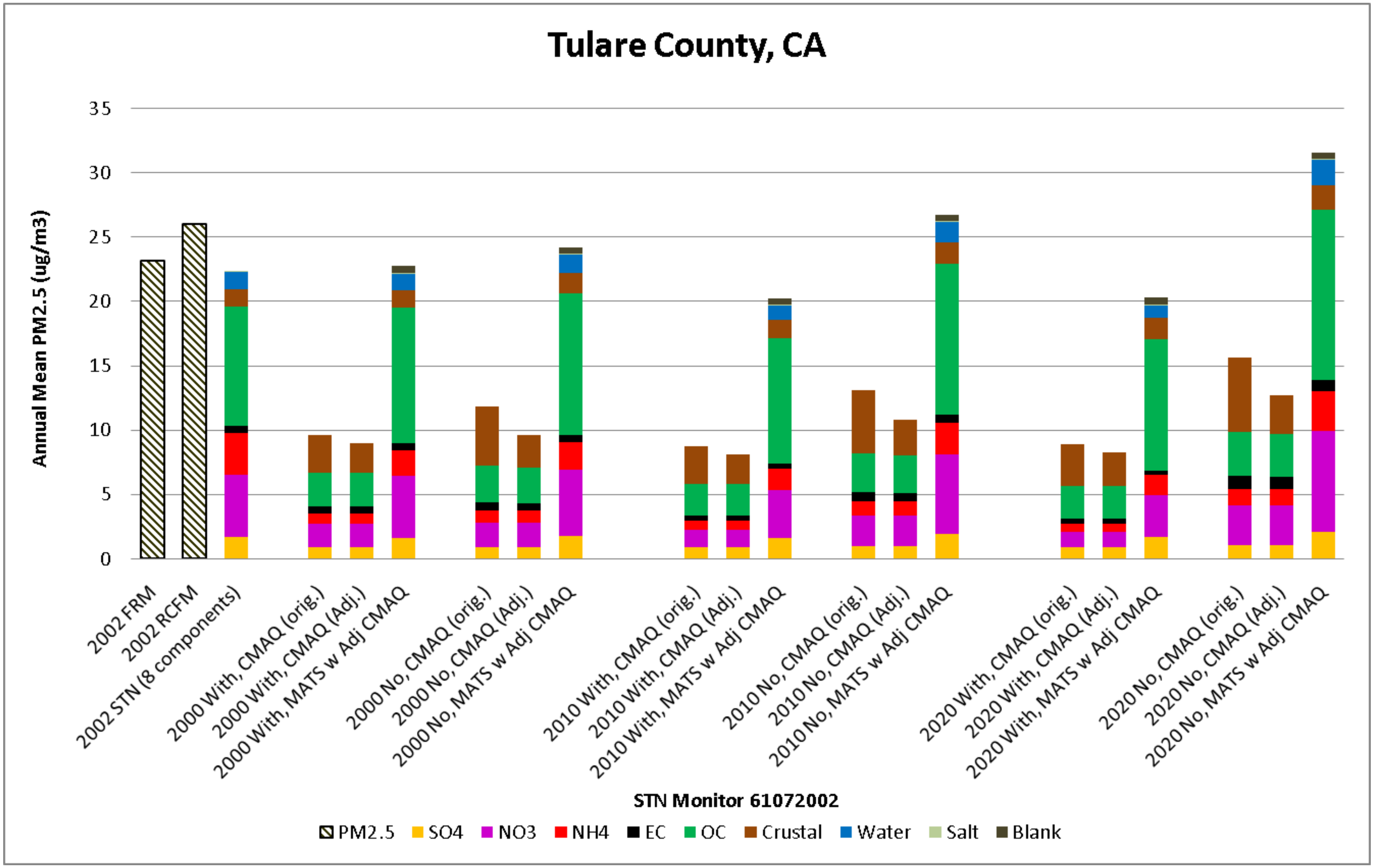


Figure 22 Tucson, AZ

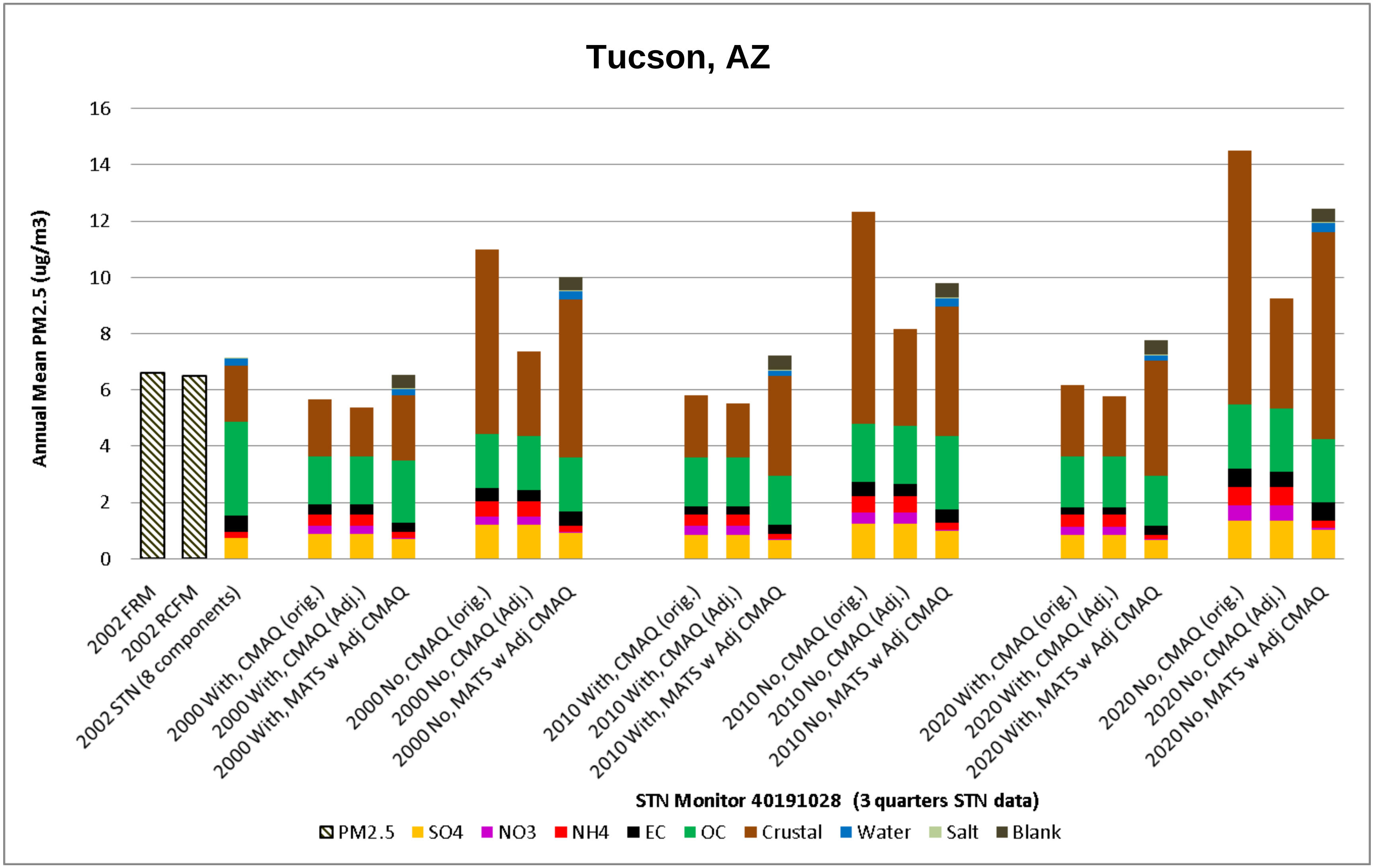
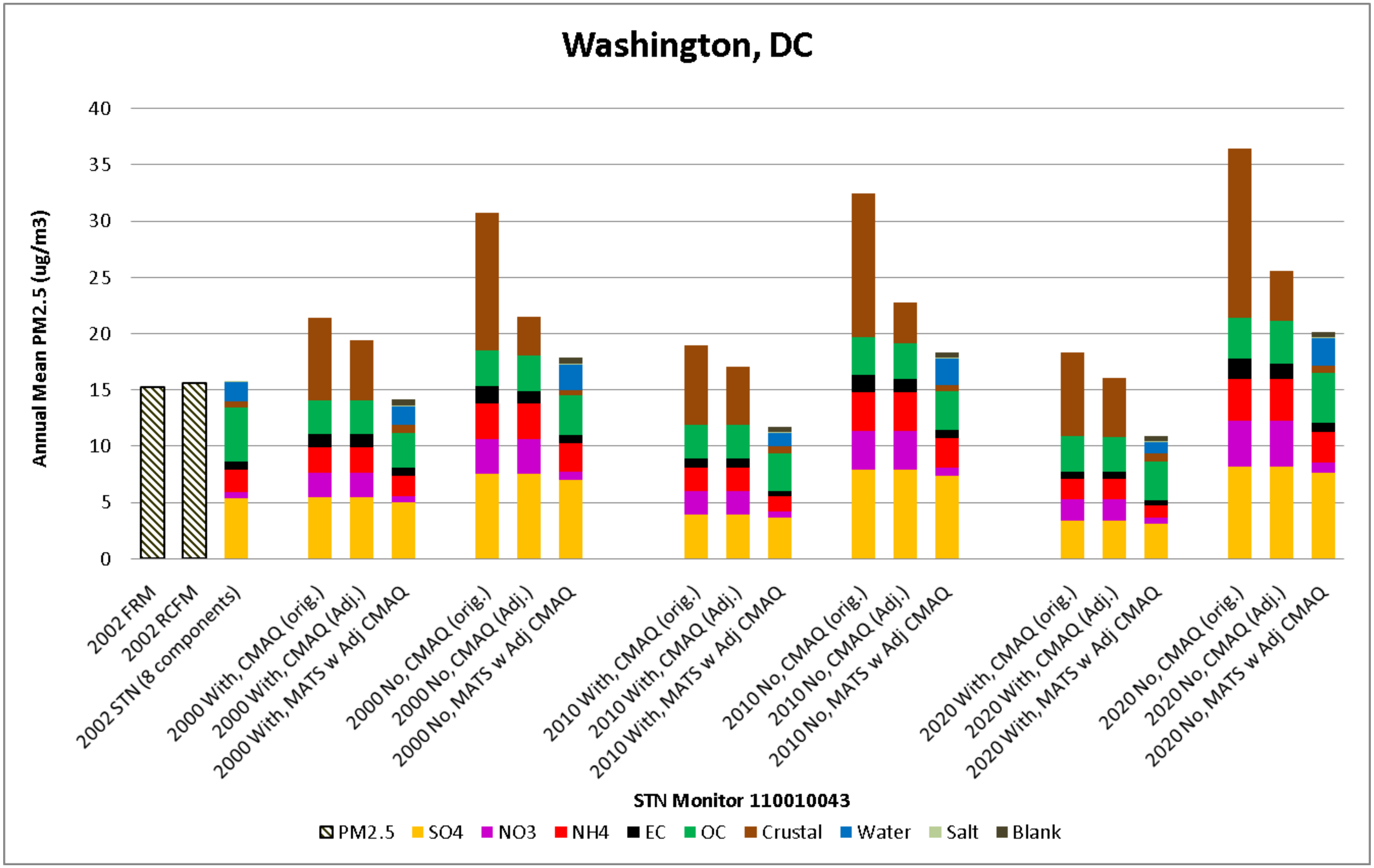


Figure 23 Washington, DC



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APPENDIX C

Memorandum

To:	Henry Roman and Jim Neumann, Industrial Economics Inc.
From:	Leland Deck, Stratus Consulting Inc.
Date:	May 27, 2010
Subject:	Impact of using only 2002 monitors in MATS for the §812 second prospective project

This memorandum conveys a series of 10 stacked bar chart diagrams showing the impact of the project team's decision to use only 2002 monitors when preparing estimates of $PM_{2.5}$ using EPA's Monitor Attainment Test Software (MATS, ver. 2.1.1).

In the preliminary results previously prepared for the §812 project, we used multiple years of monitor data in MATS. The preliminary MATS analysis used Federal Reference Method (FRM) monitor data of quarterly average $PM_{2.5}$ for 2001 thorough 2003, and quarterly species-specific Speciation Trend Network (STN) and IMPROVE monitor data from 2002-2004.

The final $PM_{2.5}$ estimates for the §812 project revised the selection of years; only 2002 data from FRM, STN and IMPROVE monitors were used in the MATS.

In addition to the change in monitor years, the final MATS analysis also used certain adjustments to the species-specific air quality modeling (CMAQ) estimates. Therefore the methods used to prepare the final $PM_{2.5}$ estimates differed from the preliminary estimates in two (unrelated) ways.

The decision to change to using only 2002 monitor data in MATS was motivated by two considerations.

1) The CMAQ analysis used for the "2000 with Clean Air Act Amendments" scenario was conducted using the 2002 estimated emissions inventory and 2002 meteorological data.
2) Because more STN monitors were becoming operational throughout the period 2002 to 2004, the preliminary MATS analysis using the multiple years of STN data was effectively weighted towards 2004. In the first quarter of 2002, the MATS monitor input dataset had 259 STN or IMPROVES monitors with sufficient species data. By the second quarter of 2004 there were 365 STN or IMPROVE monitors.

The combination of these two factors lead the 812 project team to decide to use only the 2002 monitors, concluding 2002 was a better basis than using multiple (and mis-matched) year monitors for conducting the MATS analysis because it is most representative of the 2000 With Clean Air Act Amendments scenario. The "2000 With" scenario was the baseline scenario used for the "Without" and future MATS analyses.

A series of stacked bar diagrams for a sample of 10 STN monitors present the impact of changing from multiple monitor years in MATS to using only 2002 monitors. The ten monitors were selected to present a range of locations throughout the contiguous United States, including monitors in densely populated areas, coastal and inland areas, and more rural locations with STN monitors.

Each diagram presents a stacked bar for each of 23 estimates of annual mean $PM_{2.5}$ levels. The first three stacked bars shown on each diagram are:

4) The Federal Reference Method (FRM) measure of 2002 annual mean $PM_{2.5}$ at the STN monitor location.
5) A Reconstructed Fine Mass (RCFM) estimate prepared by EPA for the STN monitor in 2002.
6) The bar labeled "2002 STN" presents 8 components derived from the STN monitor data fro 2002: sulfate (SO_4) retained nitrate (NO_3), ammonium (NH_4), blank-adjusted organic carbon (OC), elemental carbon (EC), crustal material, salt, and particular bound water (H2O) estimated using the Aerosol Inorganic Model (AIM).

The data for each of these three stacked bars comes from the MATS input file ("Species-for-fractions-0205-v2.csv") supplied with MATS.

The diagram also presents a set of stacked bars for each of four scenarios:

1) The "2000 With Clean Air Act Amendments" scenario
2) The "2000 Without (No) Clean Air Act Amendments" scenario
3) The "2020 With Clean Air Act Amendments" scenario
4) The "2020 Without (No) Clean Air Act Amendments" scenario

Within each scenario there are 5 stacked bars:

1) The original CMAQ estimate
2) The adjusted CMAQ estimate
3) The MATS estimate using the original CMAQ estimate and multiple monitor years (labeled "MATS # 1")
4) The MATS estimate using the adjusted CMAQ estimate and multiple monitor years (labeled "MATS # 2")
5) The final MATS estimate using the adjusted CMAQ estimate and 2002 monitor data.

The original and adjusted CMAQ estimates have six species components: SO4, NO3, NH4, EC, OC and crustal. The MATS estimates have 9 components: SO4, NO3, NH4, EC, OC, crustal, water, salt (a very small component on many diagrams), and a blank mass component (set as a constant 0.5 $\mu g/m^3$ throughout the CMAQ domain).

Note that the MATS estimates were made using the Gradient Adjustment (GA) option, which estimates the $PM_{2.5}$ levels at the center of each CMAQ grid cell rather than at the exact location of the STN monitor. These MATS GA estimates are presented in the stacked bar diagrams, and are also used in the §812 health analyses. In some locations, especially where the FRM monitor is near an edge of a CMAQ cell and there are other FRM monitors relatively nearby, there is a modest difference between the MATS estimate and either the STN or FRM monitor level.

Also note while most of the STN locations presented in the diagrams have complete data for

2002, three of the STN monitors have fewer than 4 quarters of STN data in 2002 (all had complete STN data in 2003 and 2004). Los Angeles and Manhattan have STN data for only the third and fourth quarters of 2002, and Tucson, AZ has data for three quarters of 2002. MATS prepares a separate estimate for each quarter, using available monitor data in that quarter. Thus the estimated annual mean species concentrations at these three STN locations are MATS estimates using less than 4 quarters of available STN data from that grid cell, and interpolated quarterly data from other STN monitors for the missing quarters. All other locations presented in a diagram have complete STN data (defined as at least 11 valid days of data in each quarter).

As can be seen from the diagrams, in most locations the decision to use only 2002 monitors had relatively little impact compared with using multiple-year monitor data. The adjustment process used on the CMAQ data had a larger impact than the change to single monitor year data. The largest impacts occur for the "2020 Without (No) Clean Air Act Amendments" scenario, where the significantly larger emissions estimates make the impacts more visible.

Figure 1 Atlanta, GA

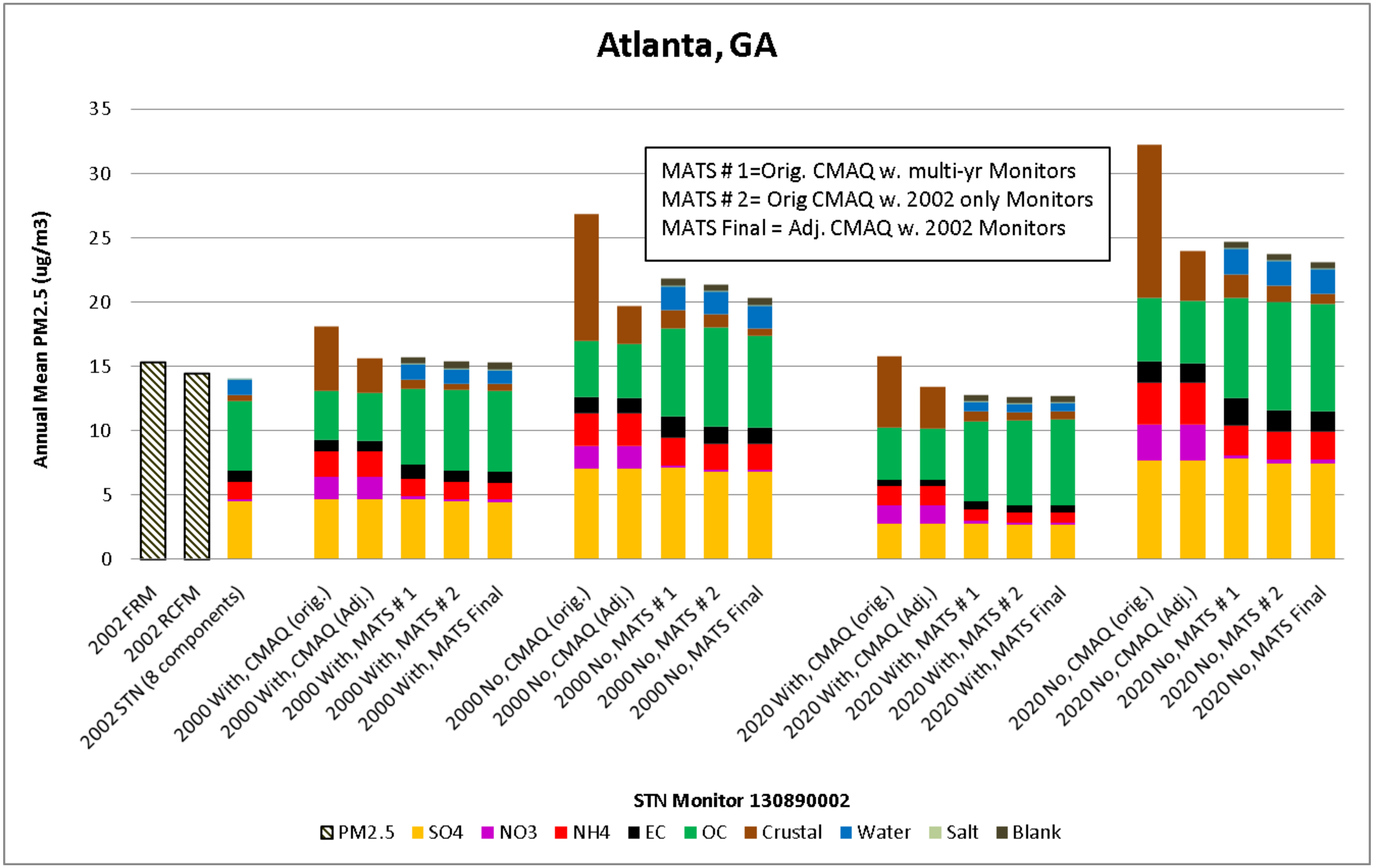

Figure 2 East Baton Rouge, LA

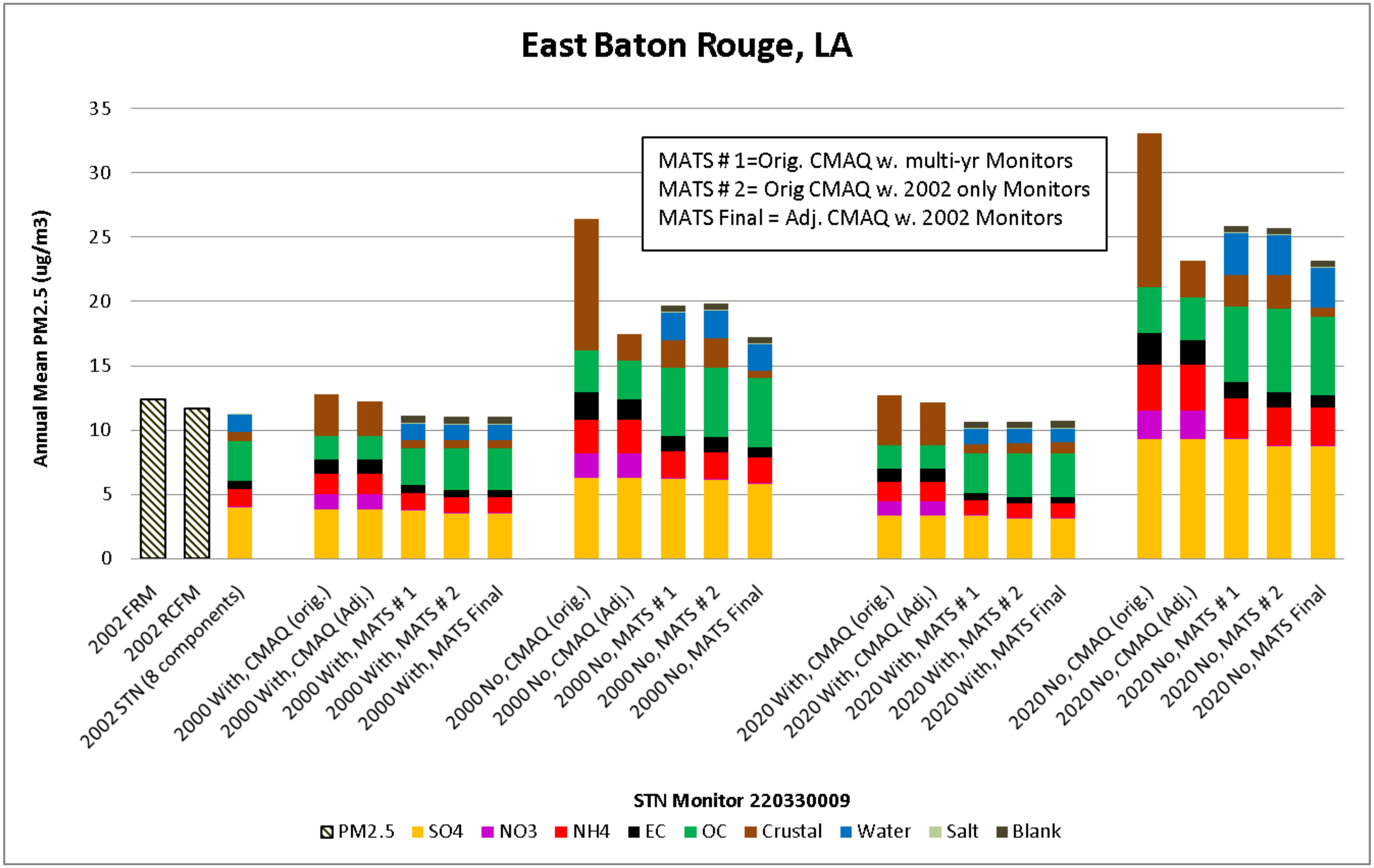

Figure 3 The Bronx, NY

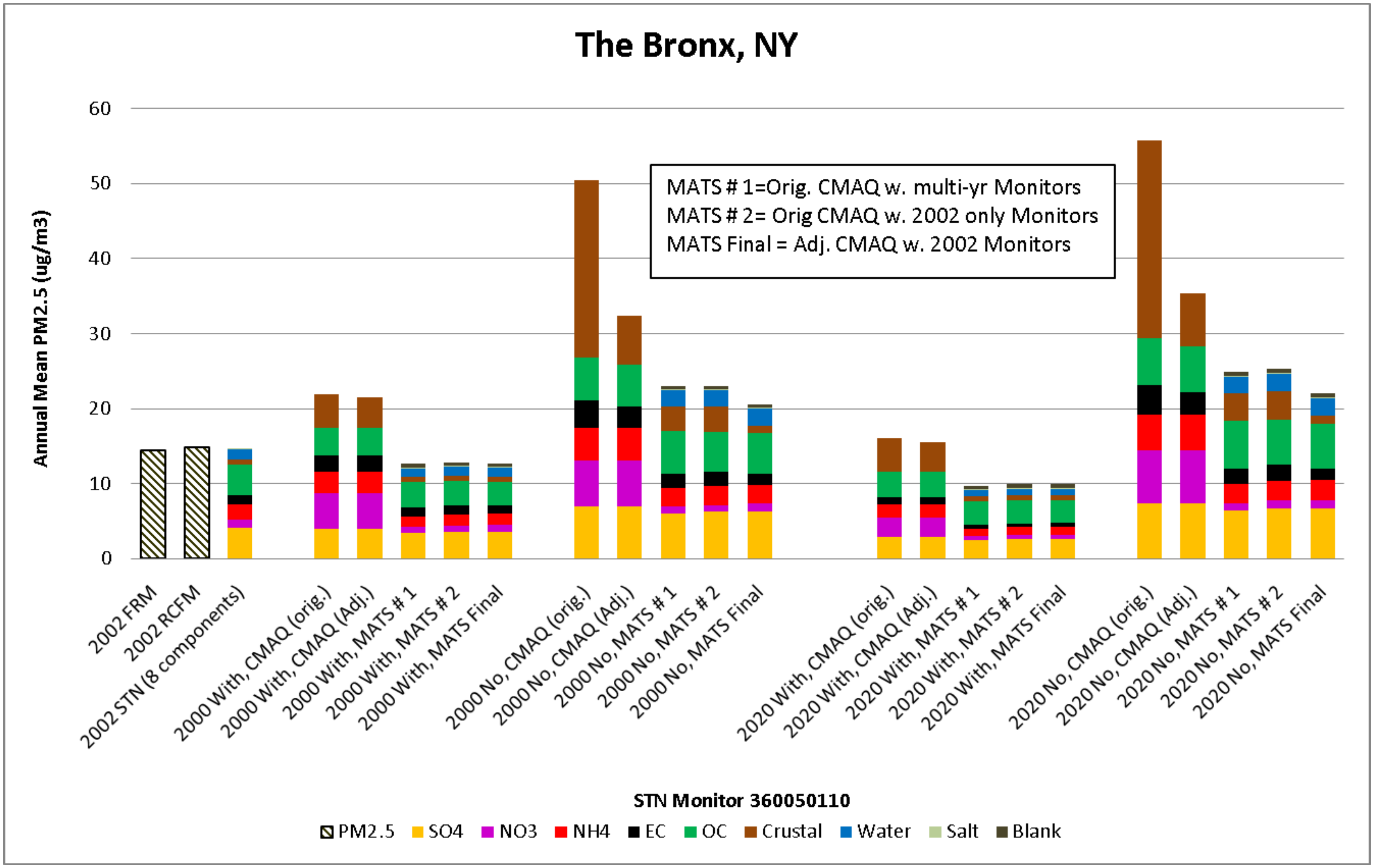

Figure 4 Chicago, IL

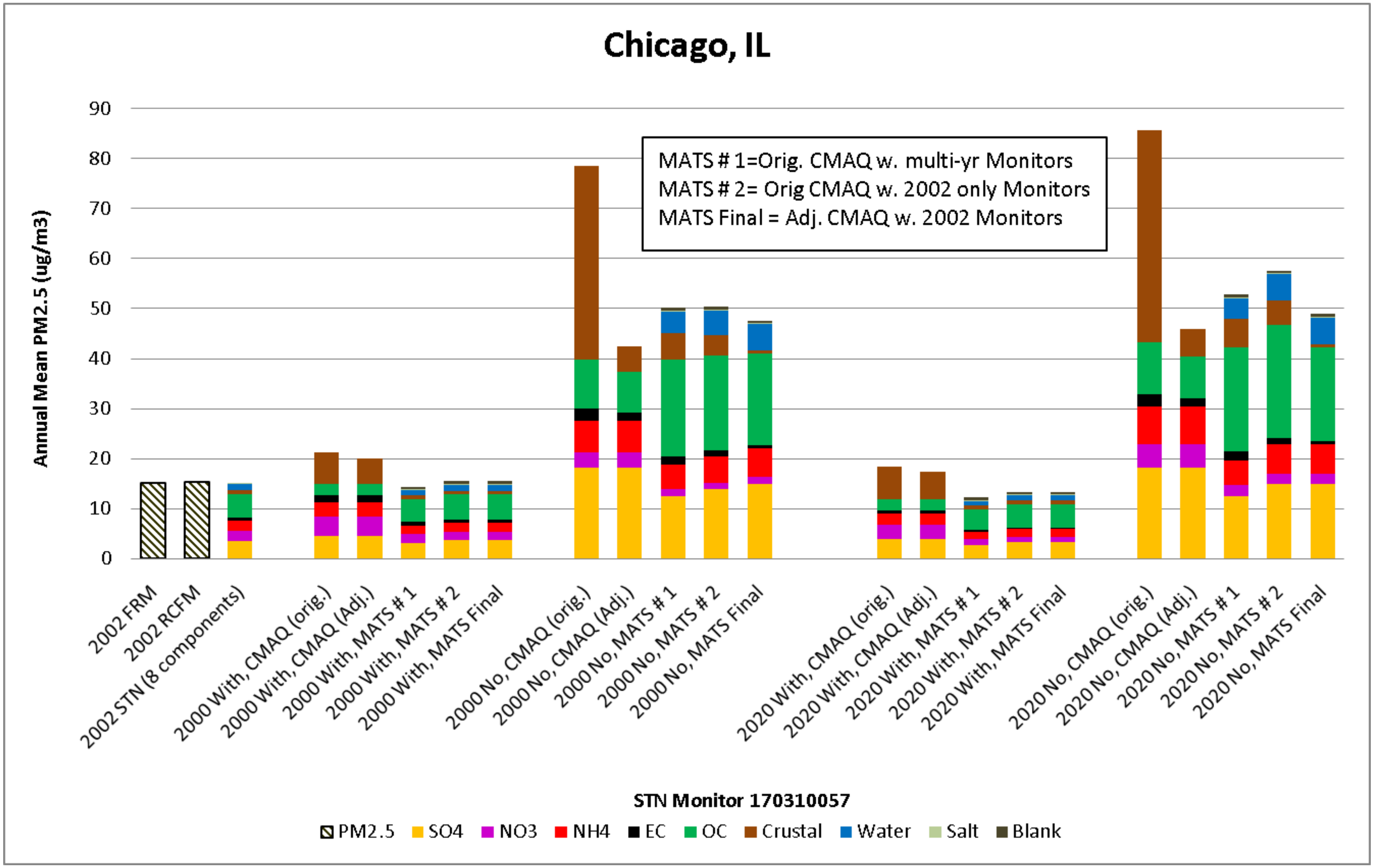

Figure 5 Los Angeles, CA (only 2 quarters of 2002 STN data)

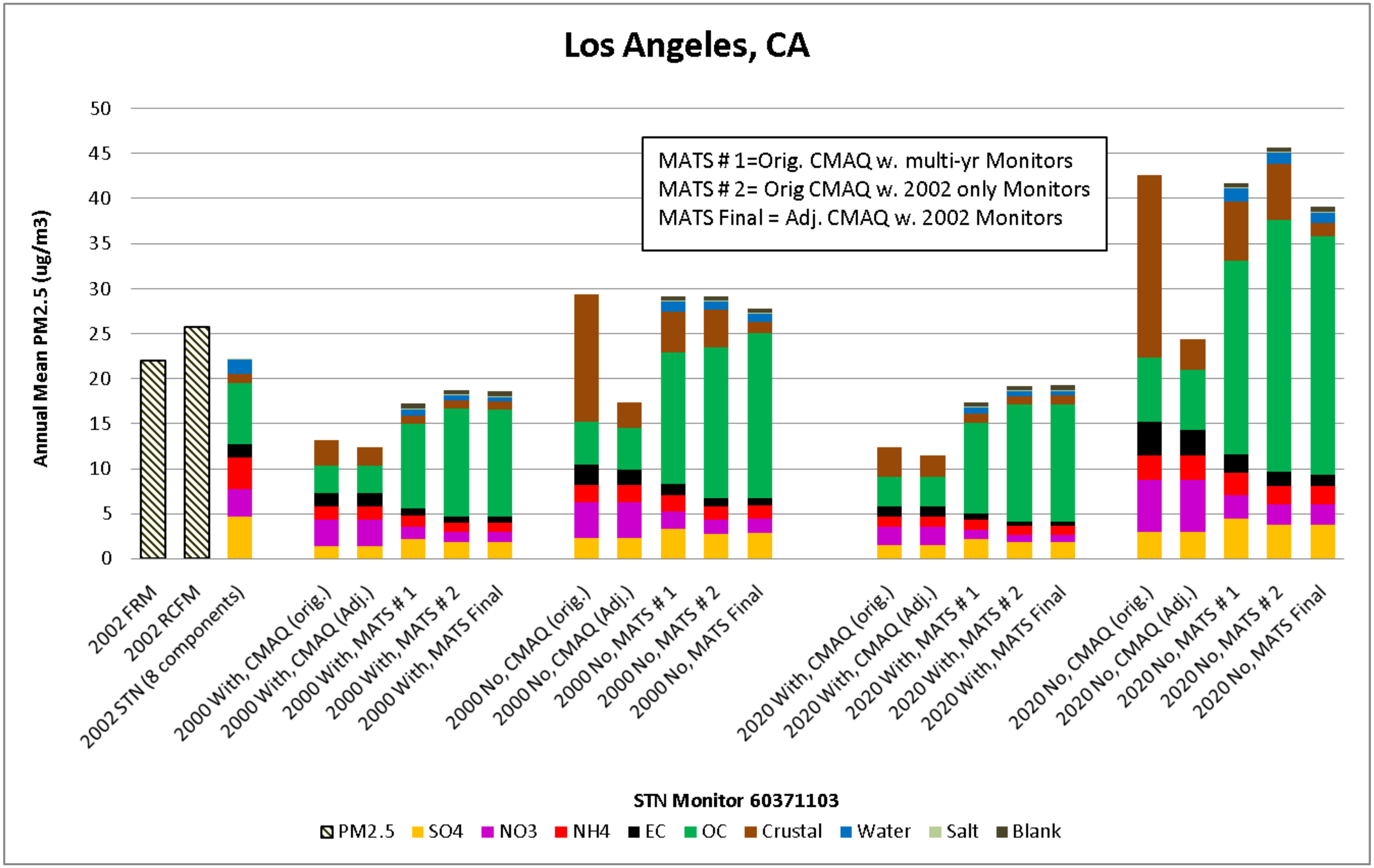

Figure 6 Manhattan, NY (only 2 quarters of 2002 STN data)

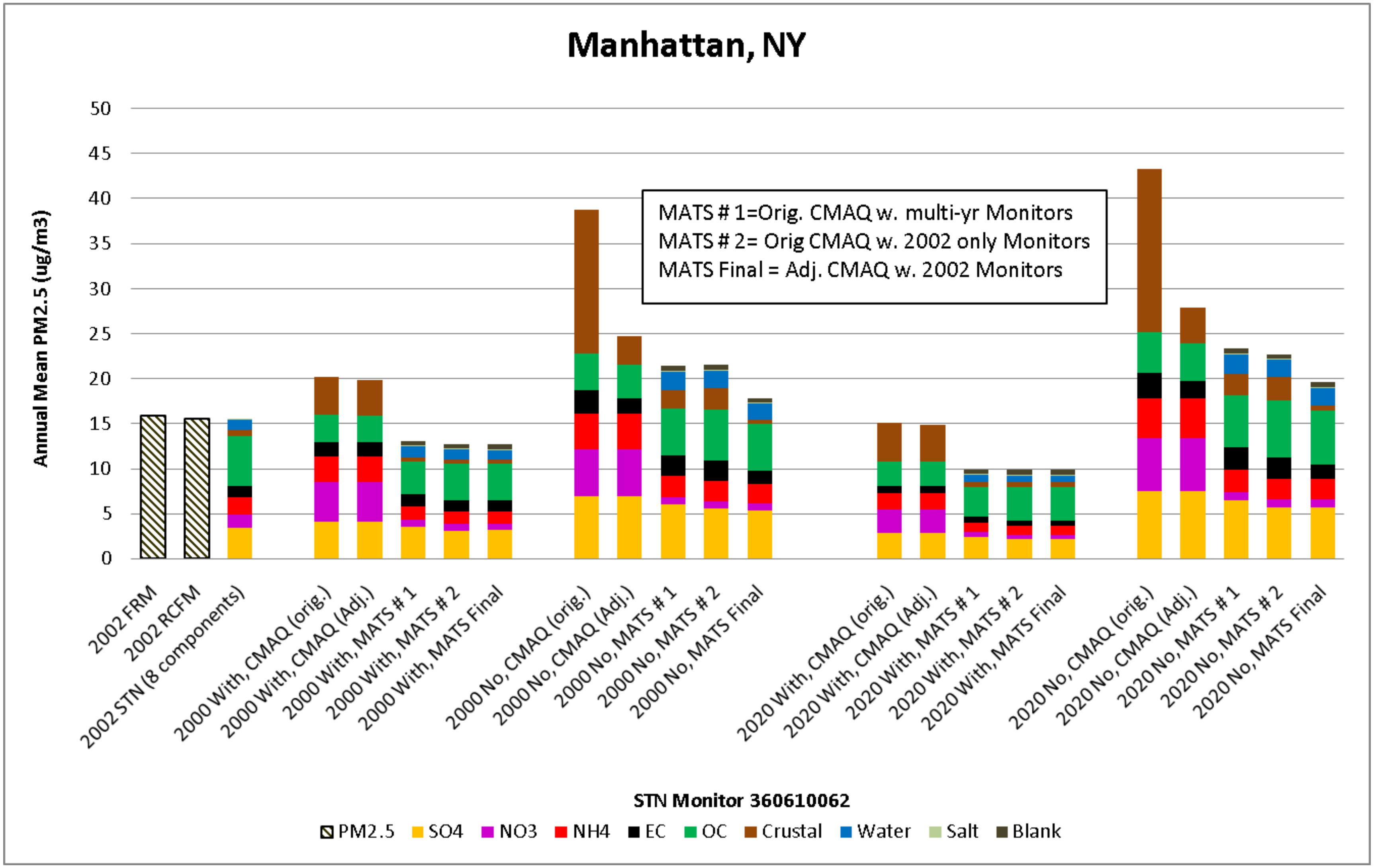

Figure 7 Miami, FL

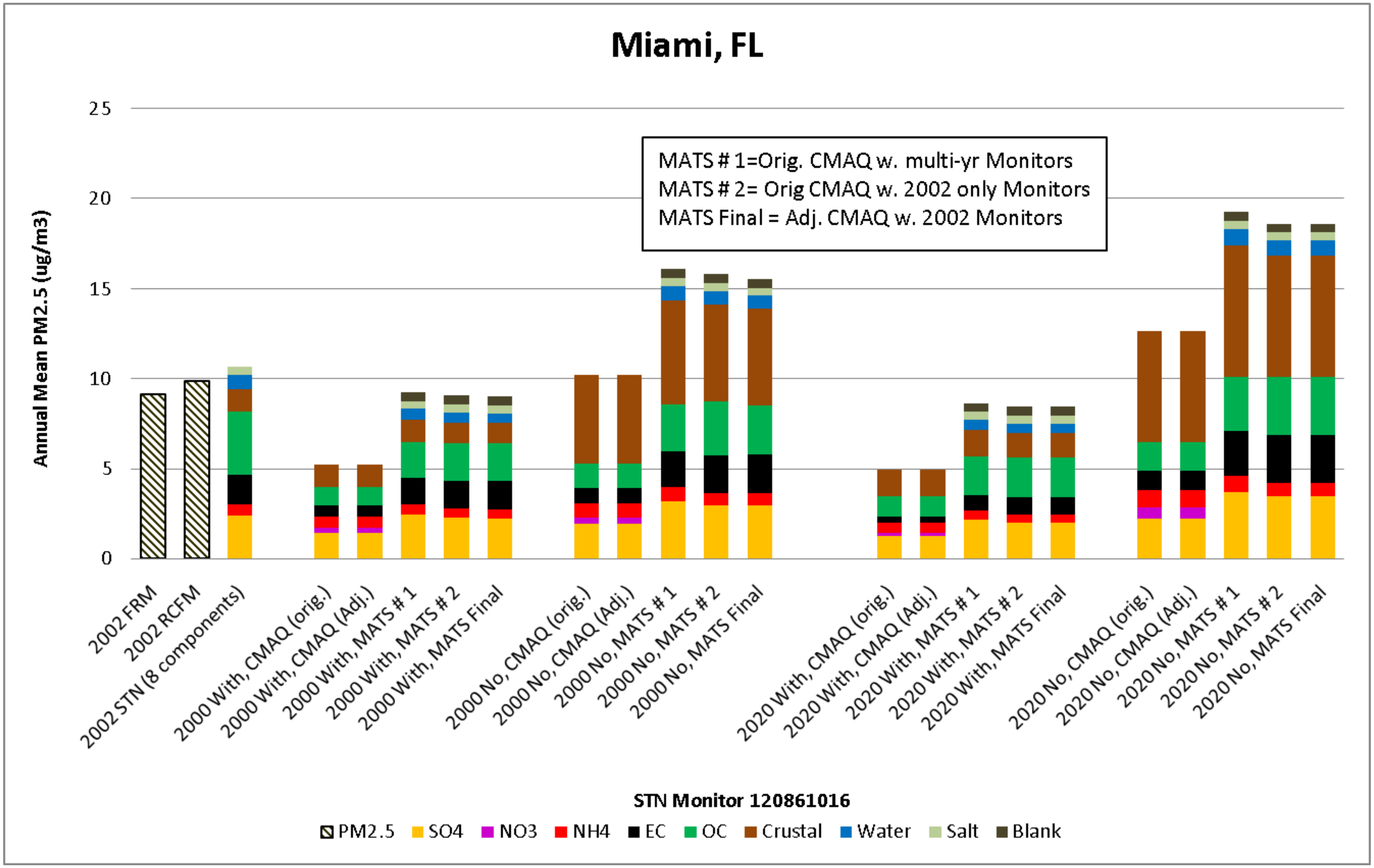

Figure 8 Philadelphia, PA

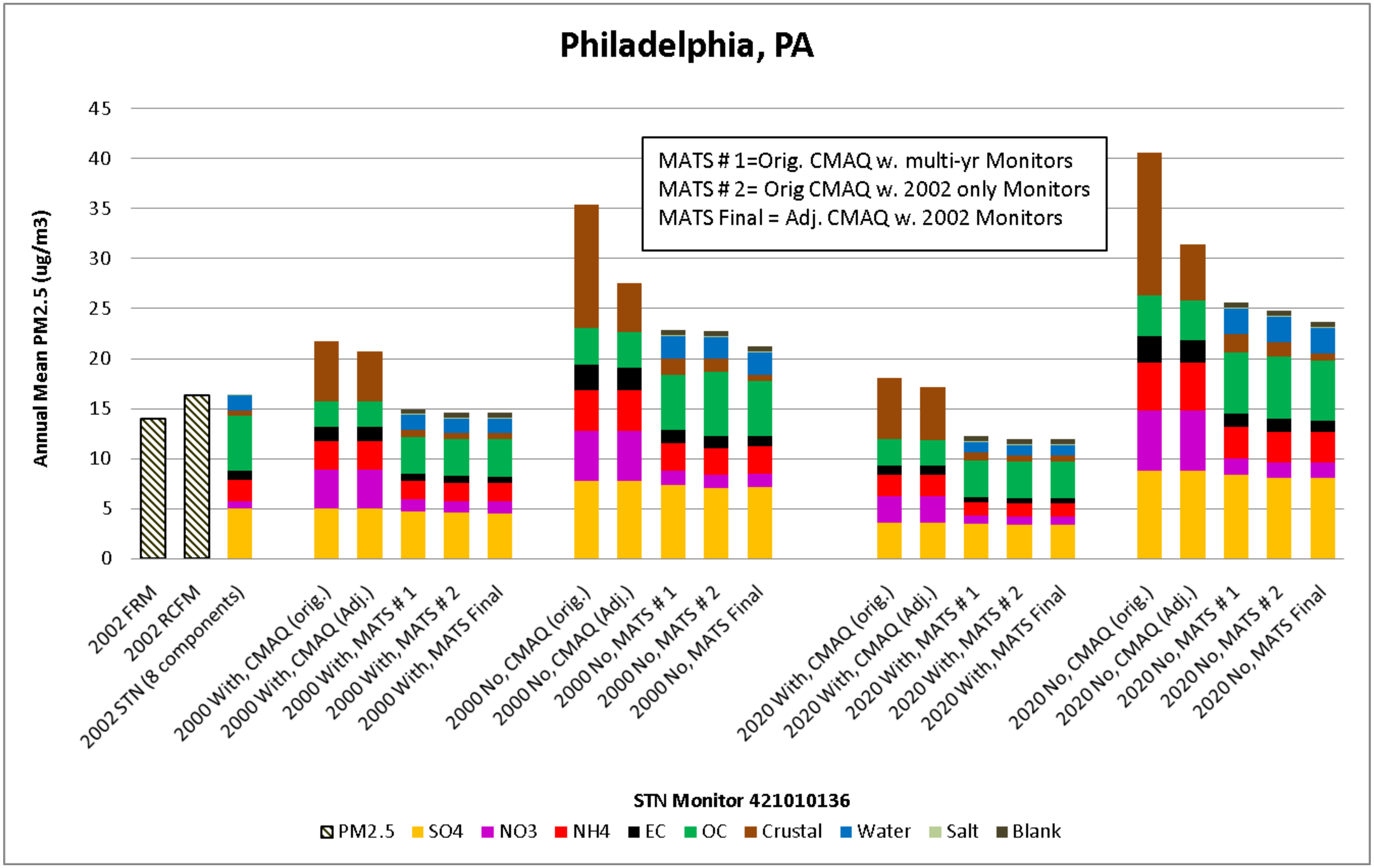

Figure 9 Tulare County, CA

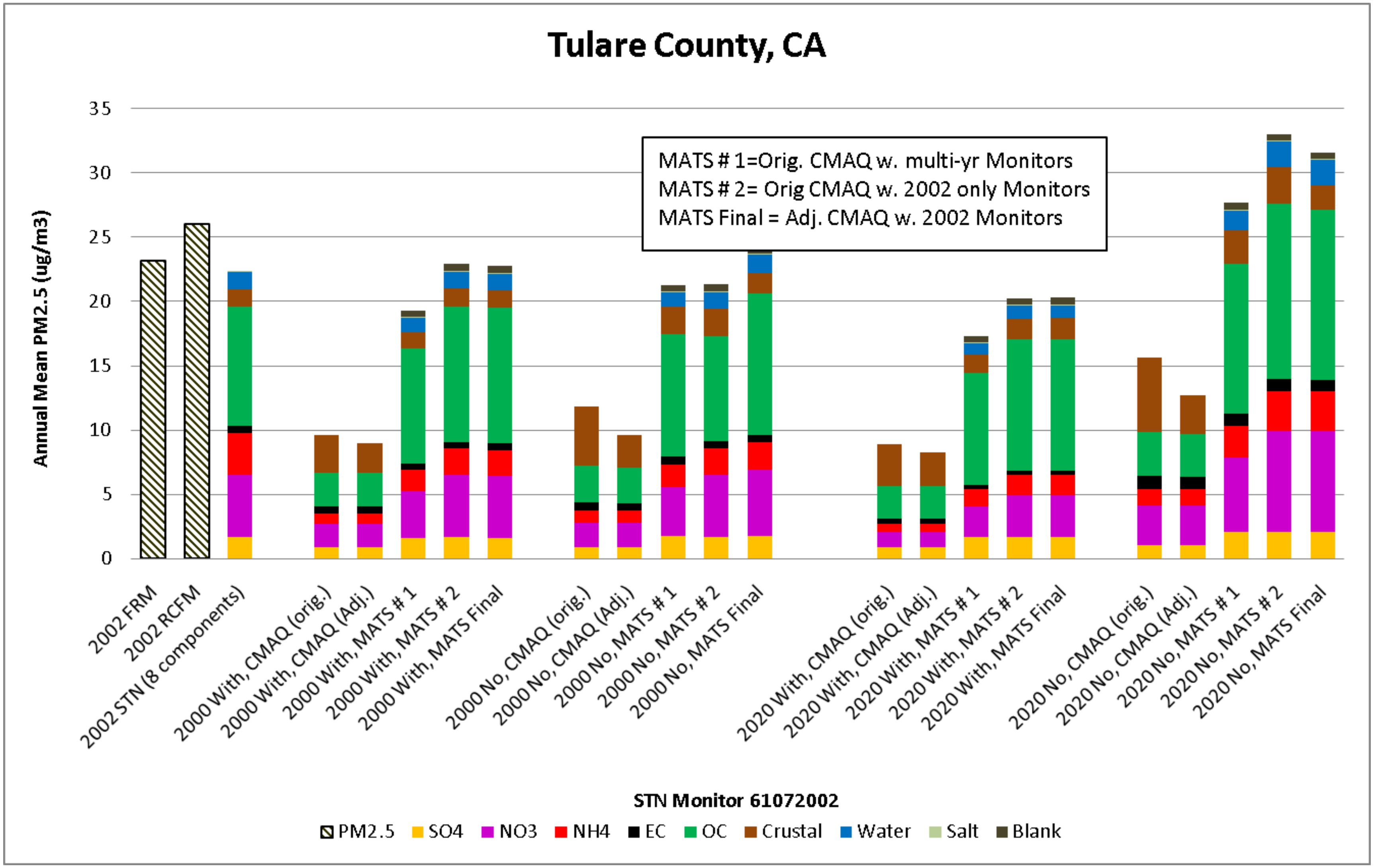

Figure 10 Tucson, AZ (only 3 quarters of 2002 STN data)