EVALUATION OF 2009 EMISSION REDUCTION FOR NORTHEAST OHIO

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1. Overview

Selected regions in the Cleveland region were found to be in moderate-non attainment of the 8-hour ozone standards for the future year 2010, the year set by the EPA for attainment demonstration for moderate non-attainment regions. An earlier modeling analysis with future year 2009 emissions grown from 2002 emissions inventory showed this region in non-attainment despite imposition of control strategies and a decline of economic activity in that region. NOACA believes that the growth factors projected by LADCO in some source categories for this earlier run may be overestimated in the Cleveland region. On the basis of consultations with NOACA and Ohio EPA, the Air Quality Center of Ohio University decided on a set of preliminary emission reductions from 2002 emissions inventory to grow emissions for 2009. As an educated first guess, some of the future emissions projections have been based on the following:

- Linear trends in reduction of Title V Non-EGU Point Sources
- Linear trends in decline of aircraft
- Economic indicators such as employment and population growth in northeastern Ohio

The results from this preliminary analysis were used to come up with a list of alternative realistic "base case assumptions" for the future 2009 base case emissions inventory for northeastern Ohio based on the current emissions reductions trends in case of Title V sources and the percent change in the economic indicators for some categories of area sources.

Meanwhile, the Midwest Regional Planning Organizations (RPO) states restructured their point, area and mobile source inventories and revised growth and control factors for future year modeling. The mid-western RPO LADCO updated emission growth factors and these revised growth estimates were lower than the previous growth rates for the Cleveland region. These amended and improved emissions are called Base K emissions.

Ohio University obtained the 2002 and 2009 Base K emissions from LADCO. The non-EGU point, area and agricultural future projections estimates are usually made using EPA's model EGAS. In this case, some of the source categories in 2002 Base K were projected to 2009 by Ohio University based on the "new approximations" stated above. The modified 2009 emissions inventory was compared to LADCO's original 2009 emissions inventory to see if there are significant differences between the two. If the emissions of the changed 2009 emissions were appreciably lower, it would indicate that LADCO might still have overestimated growth factors in the base K emissions.

2. Title V sources

Title V of the federal Clean Air Act requires major stationary sources of air pollution and a limited group of non-major sources to obtain operating permits that assure compliance with all applicable federal air pollution control requirements. Major stationary sources of air pollutants are subject to the Title V Program. A major source is defined as a source that has the potential to emit the following amounts:

- 100 tons per year or more of any pollutant
- 25 tons per year or more of either reactive organic compounds or nitrogen oxides
- 10 tons per year or more of a single Hazardous Air Pollutant (HAP)
- 25 tons per year or more of a combination of HAPs

A Title V operating permit provides a means of implementing federal maximum achievable control technologies (MACT) standards and acid rain requirements.

2a. Data analysis of Title V sources

Ohio EPA provided Ohio University with a list of Title V sources for the years 2002, 2003, 2004. The source categories consisted of major point electrical power generating units (EGU) units and non-electricity generating unit (non EGU) point sources. EGU stationary sources are the major NO_x emitters. EPA uses the Integrated Planning Model (IPM) to analyze the projected impact of environmental policies on the electric power sector (EGU sources) in the contiguous United States. Therefore, this analysis consisted of assessment of emission trends for non EGU point sources only in northeastern Ohio. The results were used to calculate approximate projected emissions for the future base case of 2009 for non EGU point sources.

2b. Methodology

The non-EGU point sources were broadly classified in different source categories based on their source classification codes termed as SCC codes. To accomplish this task, the different reporting facilities with similar SCC codes were first assembled together for each year. Then the SCC codes of the entire group were matched with the list of corresponding SCC codes from EPA's website http://www.epa.gov/ttn/chief/codes/.

The emissions from these sources were the calculated daily NO_x rate and VOC rates which were estimated as follows:
Daily emissions (pounds/day) = Emissions (tons/year) * seasonal adjustment factor * daily factor where the seasonal adjustment factor is June-August% / 25%
and the daily factor = 1 / (number of days/week) / (number of weeks/year)

2c. Results and discussion

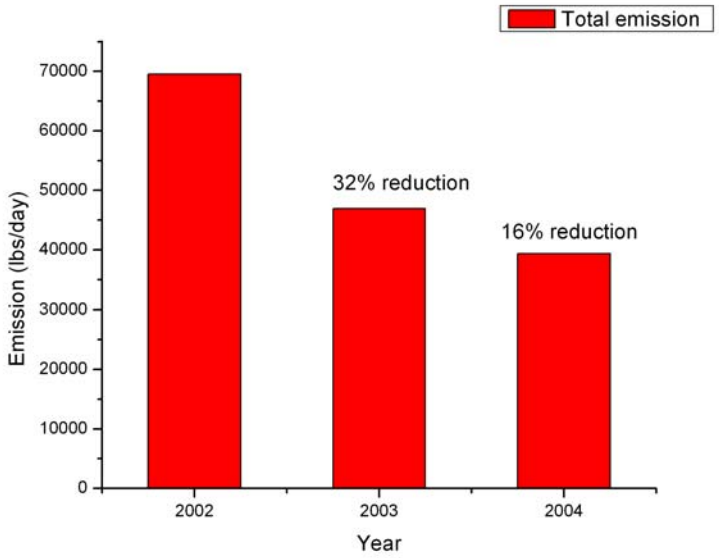

Figure1. Total NOx emissions

From Figure 1 it is seen that there is a decrease of 32% of emissions from 2002 to 2003 and a further 16% reduction in emissions from 2003 to 2004. The large decline from 2002 to 2003 was caused by the shut-down of an external combustion boiler source. After consultations it was concurred that the linear trend in reductions of NOx emissions is approximately 25% from 2002 to 2004 and that this would even out in future years. A similar assumption was made for the decline of VOC emissions from non-EGU Title V sources. Therefore, the NOx and VOC emissions from these source categories were reduced by 25% to grow these emissions to 2009.

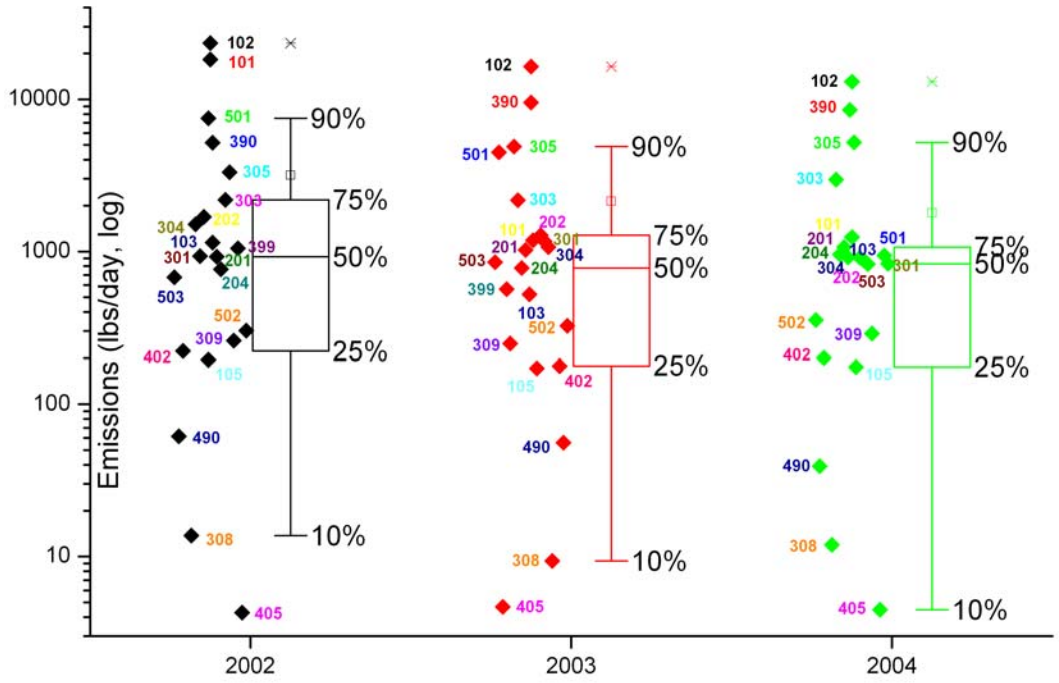

Figure 2. Box-Whiskers plot of NOx emissions (lbs/day) of NEGU for the years of 2002, 2003, and 2004. The left dots indicate data distribution and the right box-whiskers indicate maximum, 90th, 75th, 50th, 25th, 10th, mean, and minimum

A more detailed analysis of the Title V sources revealed that the largest contribution to the decline in emissions have come from the sources in the 90th percentile range which are the high emitters and in the 50-75th percentile range which are the medium emitters. Hence, these medium emitters also play an important role while determining potential control strategies.

3. Mobile sources

- Mobile source emissions

-Not modified since they are computed by transportation model

4. Area Sources

The area source categories represent individual sources that are numerous yet small in magnitude. They are not classified as point, mobile, or biogenic sources. The area sources are grouped so they can be estimated collectively using one methodology. They consist of area "other" source emissions, area "mar" sources (aircrafts, ships and locomotives), and area non-road emissions.

4a. Change categories

The changes made to these area source categories in the 2002 base K emission inventory to grow to 2009 emissions were as follows:

- Area sources "other" emissions

  - Not changed since the economic indicators could not be used as surrogates here.

- Area sources " mar" (ships, locomotives, and aircraft) emissions

  - Emissions from ships and locomotives have not been modified since the current trends were not available.

  - A 28% reduction was applied to 2002 base K aircraft emissions based on current trends (NOACA). The relative contribution of emissions generated by aircrafts is approximately 3 % in this sector. Emissions from marine vessels were the chief contributors (around 70% in this category) followed by emissions from locomotives (around 27 %)

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- Area sources "non-road" such as agriculture, commercial and residential emissions

  -Emissions from agricultural category were not modified.

  -In case of commercial category such as construction equipment: employment trends were used as a surrogate. A 25% reduction was applied in this category.

  -For residential non-road mobile emissions such as lawn mowers: county-based population growth estimates were applied.

4b. Emission reduction methodology

In the case of emission projections from 2002 base K emissions to 2009 the following methods were used:

- **Selective reduction strategies for low point sources and area non-road sources such as aircraft**

E2009 new =E2009original - (E2009original × %contribution of source emissions × % area occupied by each county in each grid cell) + (1-%reduction) × E2002 ×

%contribution of source emissions × %area occupied by each county in each grid cell

- **Selective growth of emissions from 2002 to 2009 based on county-based population surrogates (varying from -3% in Cuhayoga to increments of (1-3)% in all other counties with an increase of 11% in Portage county**)

  E2009 new =E2009original - (E2009original × %contribution of source emissions × %area occupied by each county in each grid cell) + (1 + %growth in population) × E2002 × %contribution of source emissions × %area occupied by each county in each grid cell

5. Results and discussion

Results of VOC emissions reduction evaluation are shown in Figures 3 to 5. In Figure 3, LADCO emission reductions between 2002 and 2009 are shown for each grid. As an example, 22% emission reduction means that emission is decreased by 22% between 2002 and 2009. In Figure 4, NOACA/OU emission reductions between 2002 and 2009 are shown for each grid. As shown Figure 3, the percentage reduction difference (the LADCO percentage difference shown in Figure3 – the NOACA/OU percentage difference shown in Figure 4) is shown for each grid. Negative value means NOACA/OU emission reduction is greater than LADCO emission reduction, in other words, the NOACA/OU emission decrease will be greater than the LADCO emission decrease between 2002 and 2009. An example is given in Figure 5' table. Results of NOx emissions reduction evaluation are shown in Figures 6 to 8. Table 1 shows statistical differences for NOx and VOC reductions.

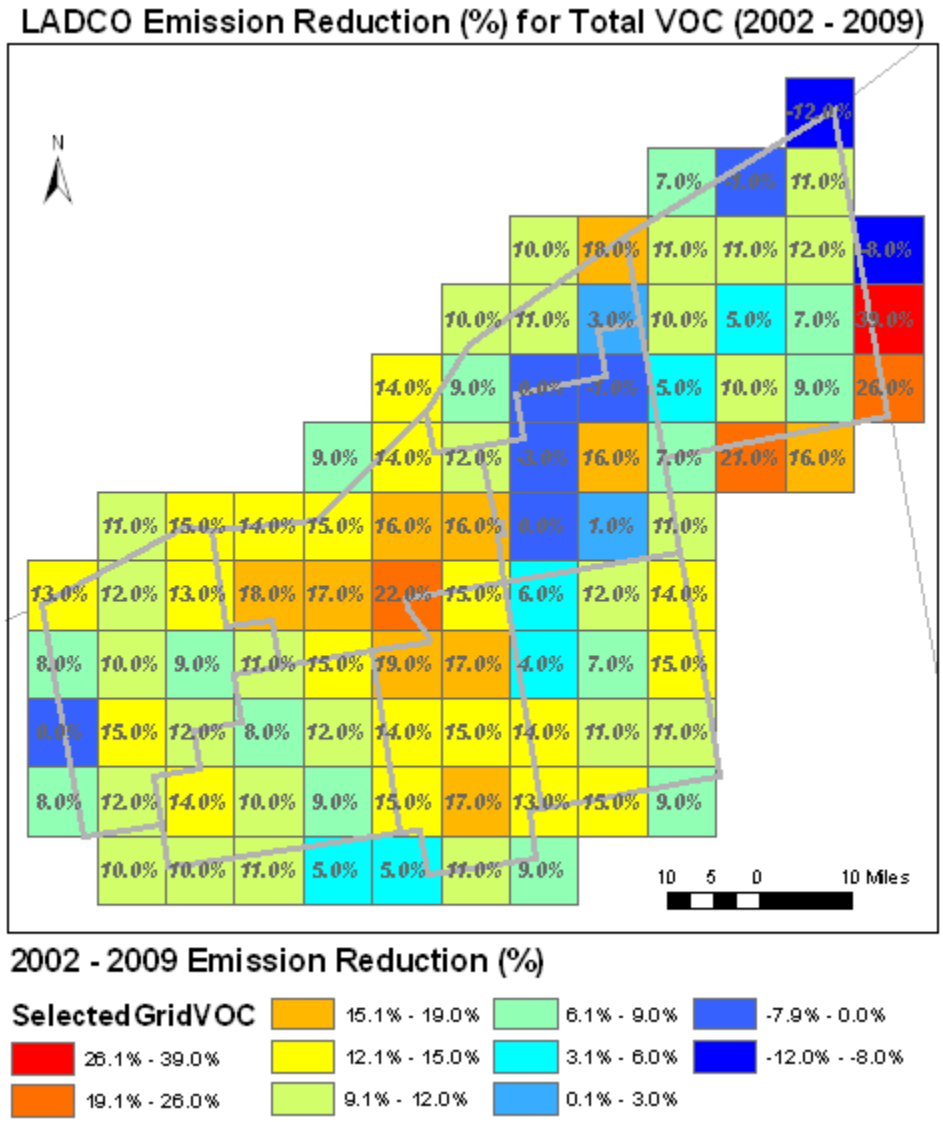

Figure 3. LADCO emission reduction (%) for Total VOC (2002 – 2009). 22% reduction means emission is decreased by 22% between 2002 and 2009. (emission in 2002 – emission in 2009) / emission in 2002 * 100.

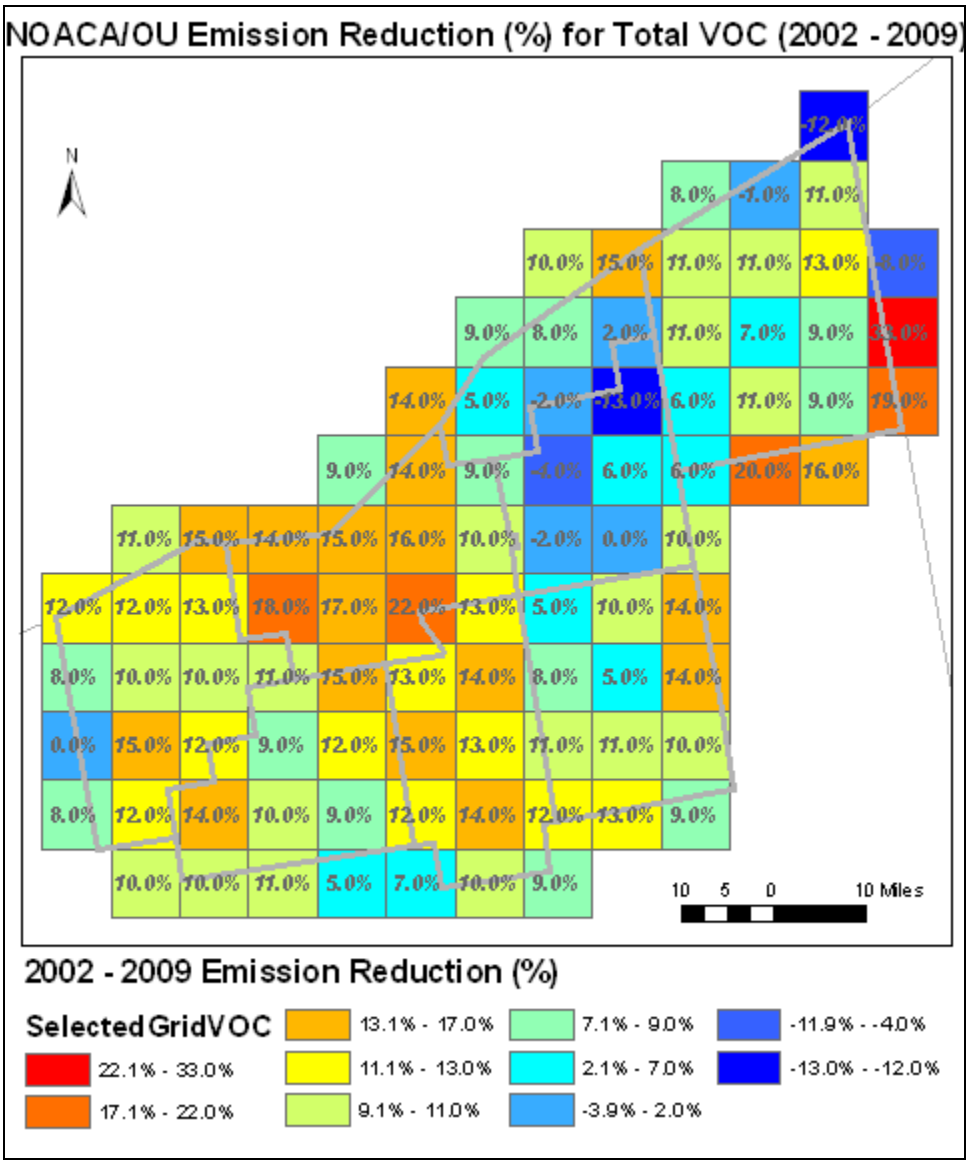

Figure 4. NOACA/OU emission reduction (%) for Total VOC (2002 – 2009). 22% reduction means emission is decreased by 22% between 2002 and 2009. (emission in 2002 – emission in 2009) / emission in 2002 * 100.

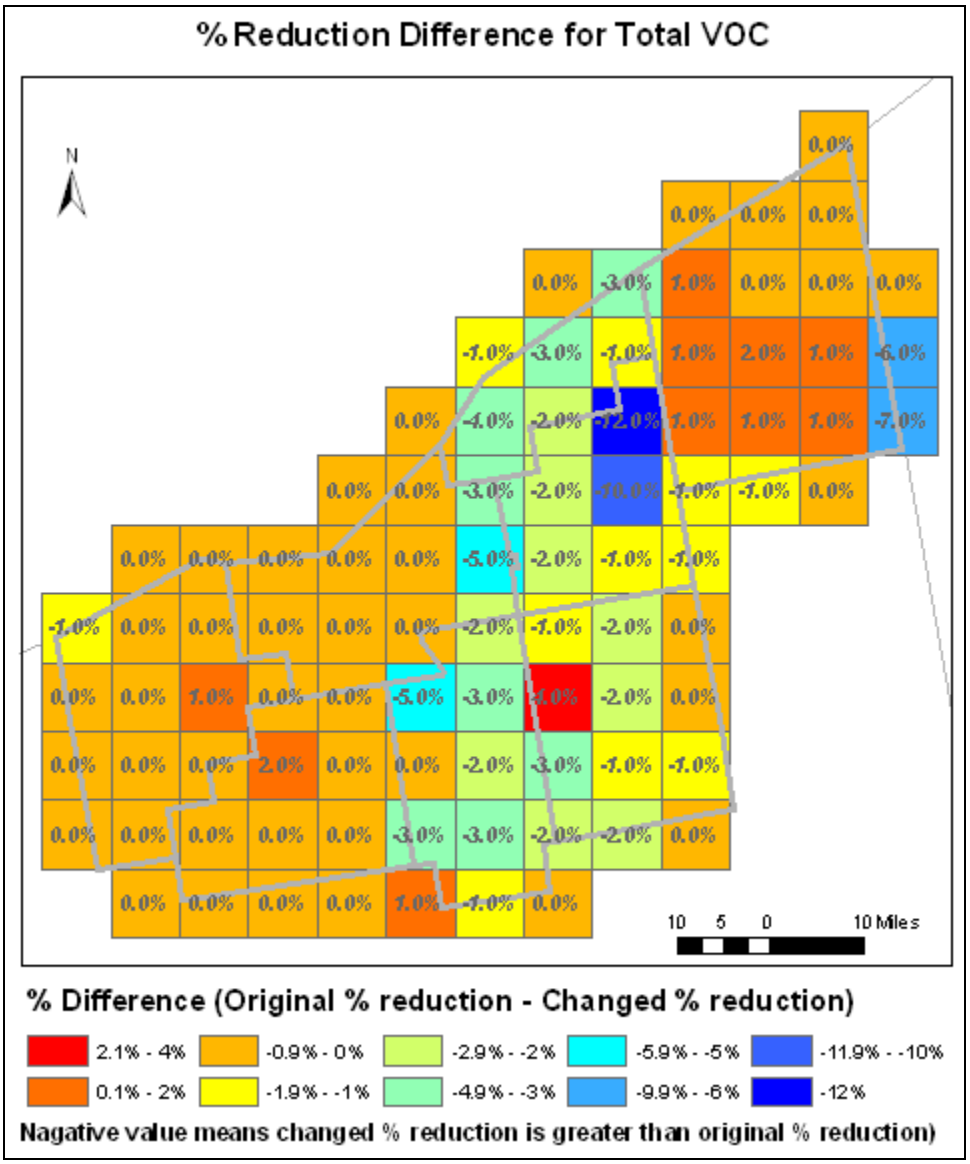

Figure 5. Percentage reduction difference (%) (LADCO reduction vs. NOACA/OU reduction) for Total VOC (2002 – 2009). Negative value means NOACA/OU emission reduction is greater than LADCO emission reduction. An example is given as following table:

	2002	2009	Reduction	% Reduction
LADCO	120 t/day	110 t/day	**10** t/day	(120-110)/120 = 9 %
NOACA/OU	120 t/day	100 t/day	**20** t/day	(120-100)/120 = 16 %
% Difference				**-7** %

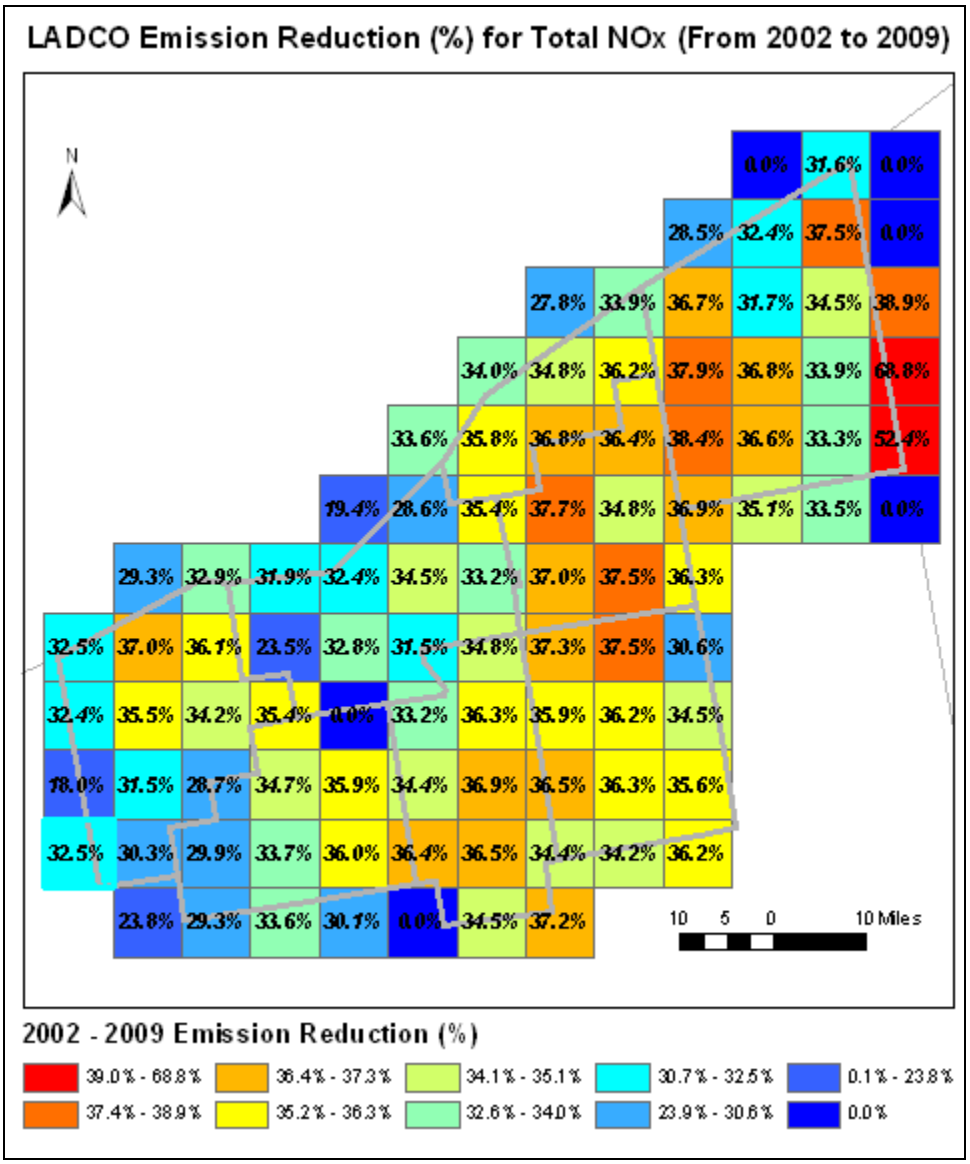

Figure 6. LADCO emission reduction (%) for Total NOx (2002 – 2009). 22% reduction means emission is decreased by 22% between 2002 and 2009. (emission in 2002 – emission in 2009) / emission in 2002 * 100.

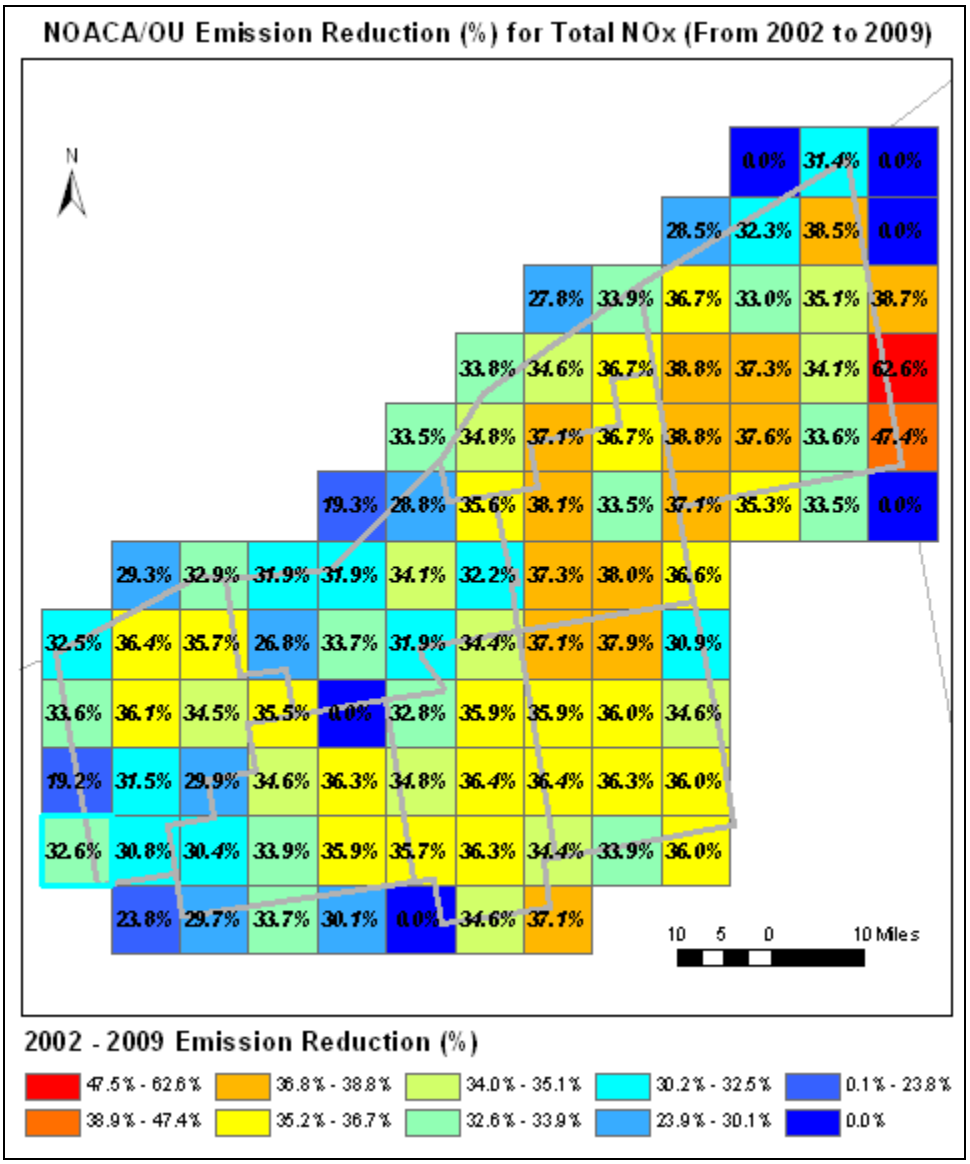

Figure 7. NOACA/OU emission reduction (%) for Total NOx (2002 – 2009). 22% reduction means emission is decreased by 22% between 2002 and 2009. (emission in 2002 – emission in 2009) / emission in 2002 * 100.

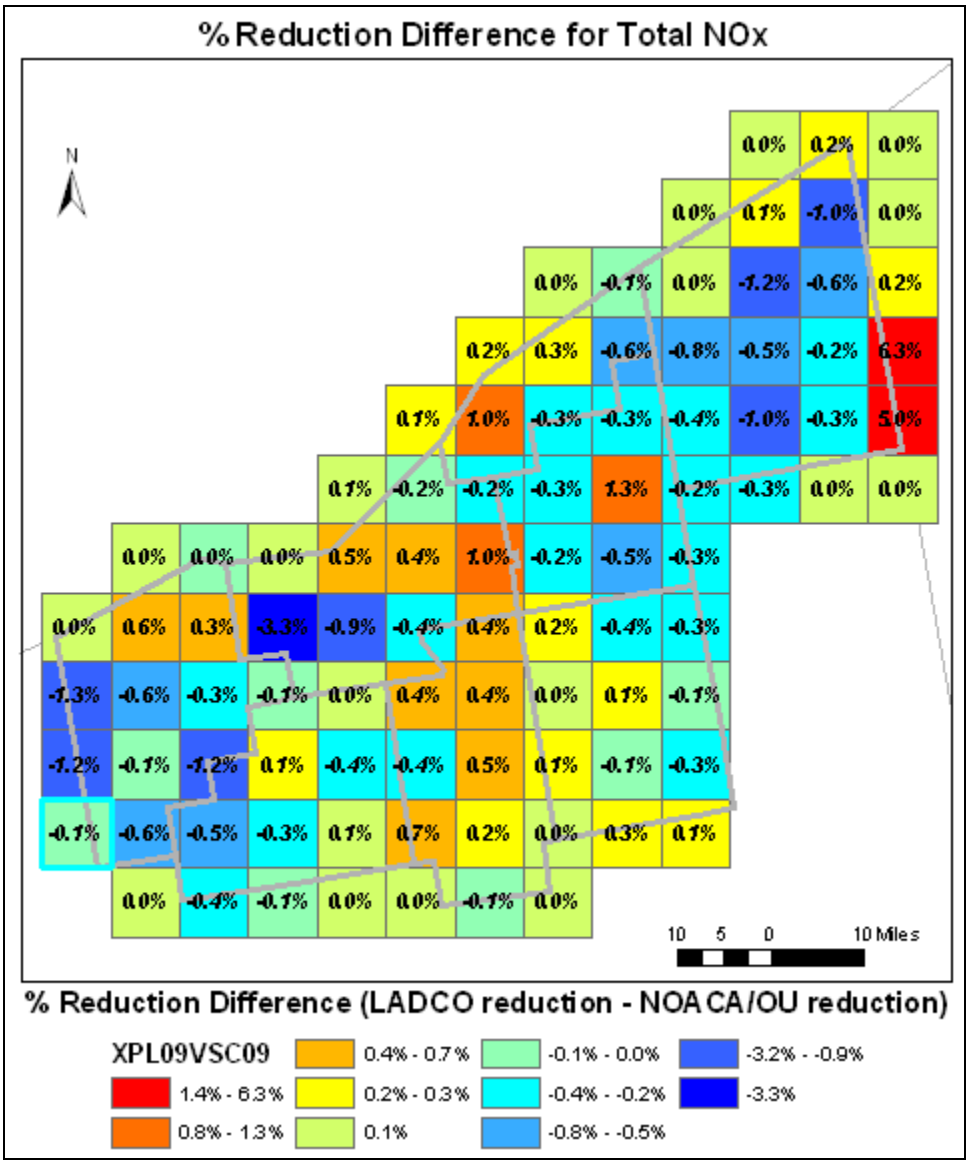

Figure 8. Percentage reduction difference (%) (LADCO reduction vs. NOACA/OU reduction) for Total NOx (2002 – 2009). Negative value means NOACA/OU emission reduction is greater than LADCO emission reduction. An example is given in the following table:

	2002	2009	Reduction	% Reduction
LADCO	120 t/day	110 t/day	**10** t/day	(120-110)/120 = 9 %
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% Difference				-7 %

Table 1. Summary of emission reduction difference for total VOC and total NOx

	Total VOC	Total NOx
No. of cells with +	11	38
No. of cells with -	34	52
Max	4.0 %	6.27 %
Min	-12.0 %	-3.3 %
Sum	-83 %	-1.87 %
Average	-0.93 %	-0.02 %

As shown Figure 5, Figure 8, and Table 1, the plots of differences in both VOC and NOx across the Northeast non-attainment area appear to indicate that the NOACA/OU alternative 2009 base case would be significantly different from the LADCO 2009 projected Base case. While it appears that the absolute difference in tons may not be as much as was expected, the redistribution of emissions alone would warrant a look.

In this case, different may not guarantee 'better' in terms of a lower future design value, although it appears to have that potential due to the lowering of the Cuyahoga County emissions in NOx. If running photochemical modeling improves the modeled design values significantly, NOACA and OU will refine the inventory estimates and create a weight of evidence worthy model run.

Future work

- Evaluate emission reduction based on gridded population growth instead of county-based population growth as shown in Figure 9.
- Evaluate modeling performance with finer grid domain for 12km and 4km

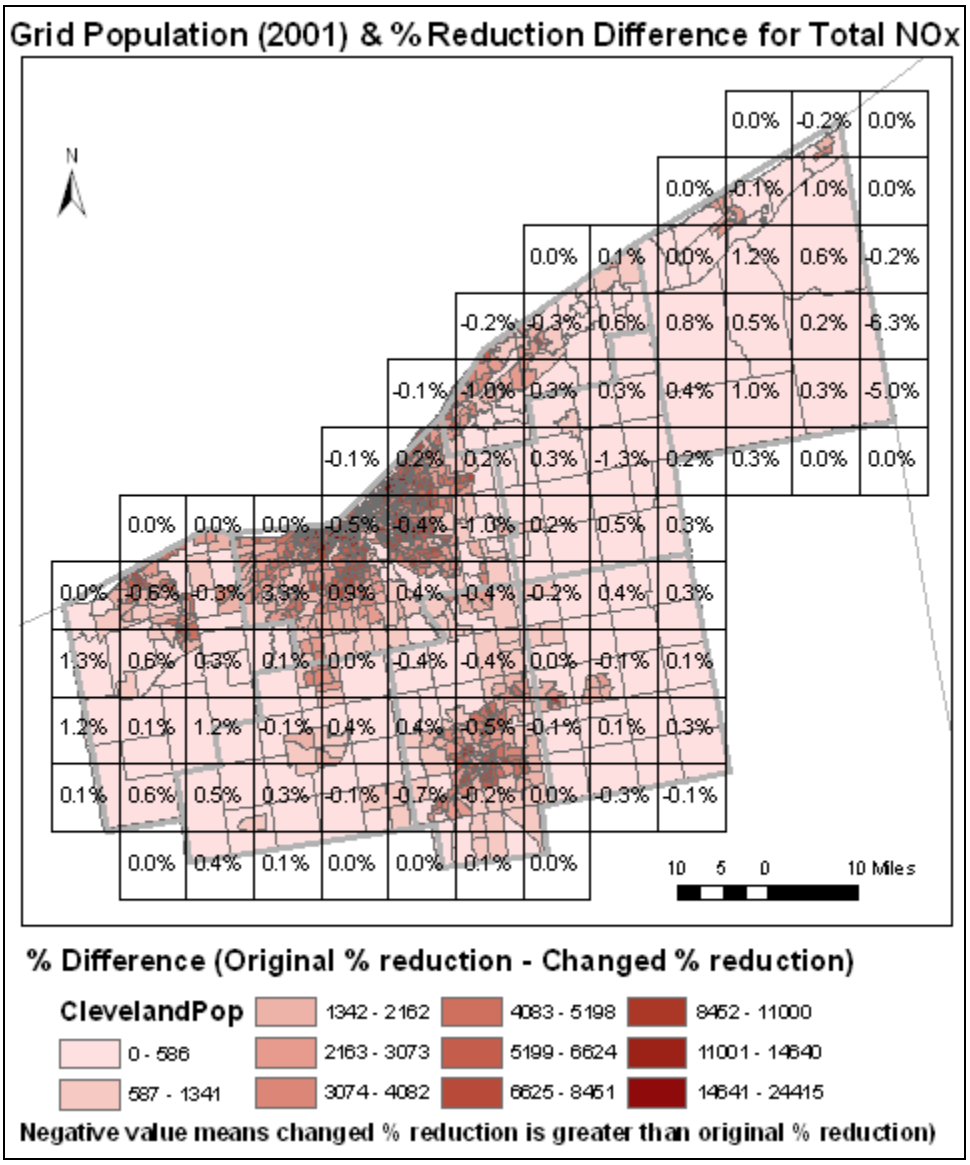

Figure 9. Gridded population density overlaid with total NOx % reduction difference.