# Florida Trends and Conditions

# 2001 – 2002




## Trends in the Emission of Air Pollutants from On-Road Motor Vehicles in Florida

*Prepared for:*
Florida Department of Transportation

*Contract No.:*
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*Prepared by:*

Anthony James Catanese Center
FOR URBAN & ENVIRONMENTAL SOLUTIONS
AT FLORIDA ATLANTIC UNIVERSITY

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Contract No. BD-171
Trends and Conditions Research

*Prepared for:*
Florida Department of Transportation

*Prepared by:*

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# Table of Contents

# List of Tables and Figures

# Executive Summary

As part of the *Trends and Conditions* research performed for the Florida Department of Transportation (FDOT), the Anthony James Catanese Center for Urban and Environmental Solutions (formerly known as the FAU/FIU Joint Center for Environmental and Urban Problems) produced a report on trends in the emission of air pollutants from on-road motor vehicles in 2000. A review of this report by the Federal Highway Administration (FWHA) found that the trends presented in the report did not coincide with the trends that were reported by some Metropolitan Planning Organizations (MPOs) in Florida. Subsequent research showed that the discrepancies were attributable to dramatic differences between the 2000 and 2001 federal datasets for vehicle miles traveled (VMT) by vehicle type.

As part of the 2002 quick response task that is part of FDOT's *Trends and Conditions* project, the Catanese Center was asked to revise the 2001 report. This report is a revision of the 2001 Joint Center report and uses 2000, 2001 and 2002 datasets for VMT by vehicle type. The report calculates the total emissions of Carbon Monoxide, Hydrocarbons and Nitrogen Oxides from on-road motor vehicles for the period 1990 to 1998 for each dataset. Comparison of the three datasets shows that although there are differences in all three sets, the differences between the 2000 and 2002 datasets are relatively minor compared to the 2001 dataset. After a discussion of the differences between the three datasets, the most recent dataset is used to calculate the emission of air pollutants by on-road motor vehicles in Florida between 1990 and 2000. Finally, an attempt is made to predict trends in emissions in Florida at the county level through 2005. The trends are not extended beyond 2005 since, although the differences in the 2000 and 2002 data are relatively small, beyond 2005, these differences would still lead to significant differences in the trends.

Based on the most recent data, the report shows that emissions from on-road motor vehicles have generally declined for Florida in the past decade and will continue to decline. The report shows that in most areas, improvements in on-road motor vehicle emission rates have offset increases in VMT, changes in vehicle composition and increases in population. The modeling results show that these trends are likely to continue in the next 5 years. The report also shows that some areas in Florida that have traditionally not had air quality problems, such as the panhandle, are experiencing a substantial growth in emissions from on-road motor vehicles.

Given the time and financial constraints of the quick response task, this report does not provide an in-depth discussion of all the issues that are pertinent to the modeling of the emission of air pollutants. However, the authors feel that the model that is used in this report warrants additional development and research. It would be especially helpful to compare the results of the model with the results obtained by more detailed modeling efforts, such as the MOBILE emission factors model developed by the U.S. Environmental Protection Agency and widely used by transportation planners. While the model that is used in this report will probably not perform as well as MOBILE in calculating exact levels of emissions, its transparency, relatively simple form and calculation methods seem a perfect fit for the calculation of trends for policy makers. Furthermore, the model illustrates clearly that the emission of air pollutants by on-road motor vehicles is influenced by four separate variables over which the transportation sector has varying control: VMT, emission factors, traffic flow and population changes.

## Air Pollution by On-Road Motor Vehicles

The most profound negative environmental effects of on-road motor vehicles are on air quality, especially the ambient concentration of Carbon Monoxide (CO), Nitrogen Oxides ($NO_x$), Volatile Organic Compounds (VOCs), Ozone ($O_3$) and Carbon Dioxide ($CO_2$). Table 1 shows that according to the EPA, on-road motor vehicles are responsible for 51 percent of the total CO emission, 34 percent of the total $NO_x$ emission, 29 percent of the total VOC emission and 1 percent of particulate matter emission. The table shows that total contribution of transportation to the emission of air pollutants is even more significant when non-road vehicles and engines are included.[1]

**Table 1:** Contribution of on-road vehicles to air pollution (based on EPA 2001[2])

| Pollutant | 1999 Transportation Emissions (1000 short tons) | 1999 On-road Emissions (1000 short tons) | 1999Total Emissions (1000 short tons) | On-road as a Percentage of Total Emissions | Transportation as a Percentage of Total Emissions |
|---|---|---|---|---|---|
| CO | 75,151 | 49,989 | 97,441 | 51% | 77 % |
| VOC | 8,529 | 5,297 | 18,145 | 29% | 47 % |
| NOx | 14,105 | 8,590 | 25,393 | 34% | 56 % |
| PM-10 | 12,088 | 295 | 23,679 | 1% | 51 % |

## On-Road Modeling of Emissions to the Air

The calculation of emissions from on-road motor vehicles is extremely complex since the fleet of on-road vehicles consists of vehicles of different makes and models, different ages, different conditions, and different engine sizes. Calculations are further complicated by differences in fuel types, driving behavior and travel activity.[3] The Mobile Source Emission Factor model (MOBILE) is the main tool for calculating emissions from on-road motor vehicles. The model was developed by the U.S. Environmental Protection Agency (EPA) in 1978 as a tool for estimating aggregate regional emissions. Since then its uses have expanded to *“determining the conformity of transportation projects with requirements of State Implementation Plans and assessing the emission* *impacts of transportation-control measures."* [4] MOBILE has gone through 9 revisions and the most current model is MOBILE6.[5] MOBILE calculates the emission factors in grams per mile. Local planners then use these emission factors to calculate the total emission of air pollutants in a specific area by multiplying the emission factors with the VMT for the area.[6]

The primary use of MOBILE is to calculate on-road motor vehicles emission rates for CO, VOCs and $NO_x$. In order to do this, MOBILE requires data on such items as: composition of the vehicle fleet, vehicle age, ambient temperature, and vehicle speed. MOBILE allows users to use local data or national default settings that are included with the model.

A problem with the MOBILE model is that it creates a false sense of accuracy that is not warranted by the assumptions that are inherent to the model. Research by Pollack et al., for instance, shows that the use of vehicle registration information at different spatial levels can affect the outcome of emission calculations by as much as 10 percent.[7] Other factors that are poorly accounted for in MOBILE are variations in vehicle speed, fleet characteristics, fleet age, and road grades.[8] According to a 2000 report by the National Academy of Sciences, the model is especially sensitive to assumptions regarding vehicle age, composition of the vehicle fleet, vehicle speeds and ambient temperature.[9] Furthermore, the relationship between the emission of air pollutants and actual air quality is extremely complex and depends on characteristics of the pollutant in question and local climate conditions.

## A Simplified Model

MOBILE is the only model that is accepted for showing compliance with federal regulations, but it is not a very transparent model. Besides its uncertainties in estimating emission factors, it fails to show decision-makers what the main trends are that influence the emission of air pollutants from on-road motor vehicles. To show more clearly what the underlying trends are, this report uses a highly simplified model to represent trends in emissions from on-road motor vehicles in Florida. It is important to realize that the results showed in this report can never replace the results that are calculated with MOBILE, but they do serve to show the general direction of trends and the factors that influence these trends.

The general form of the model used in this report is simple:

$$\Sigma \text{ [Average National Emission Rate by Vehicle Type] X [VMT by Vehicle Type] = Total Emission}$$

The average national emission rates were derived from the *2000 National Transportation Statistics* published by the US Department of Transportation.[10] The national VMT data was derived from the *2002 Inventory Of U.S. Greenhouse Gas Emissions And Sinks*, which is published annually by the EPA.[11] For the calculation at the state level, the same model was used with VMT data from the Florida Department of Highway Safety and Motor Vehicles' *2000 Florida Crash Facts*.[12] Since this data did not contain VMT per vehicle category, the composition of the national vehicle fleet for each year from 1990-2000 was calculated. This information was then used to estimate the VMT per vehicle type in Florida.

For the calculation of future trends in emissions at the county level, 1990-2000 trends in emission rates were extrapolated to 2010. Next, the emission per capita was calculated. These numbers indicated for a theoretical person how many miles that person would drive in each vehicle type. These numbers were then multiplied with population data from *Florida Population Studies*, published by the Bureau of Economic and Business Research.[13]

An important shortcoming of the model is that it is based on extrapolation of observed trends in VMT, emission rates and population growth in the past, and therefore underestimates the effects of regulatory decisions on future trends. The model also assumes that the vehicle fleet in Florida is similar to the composition of the national fleet. Finally, the model uses average national emission rates, which might be significantly different from Florida's emission rates. Since this report is interested in showing general trends in emissions over time rather than the exact emission of a specific pollutant in a particular location at a particular time, these assumptions pose no serious problems for the results. For instance, although the warm weather conditions in Florida have an effect on average emission rates, this effect does not vary over different years. Therefore, it does not affect the trends in emissions over time.

## Average Emission Rates

The emission of air pollutants for individual vehicles is improving. Figure 1 gives the trends in average emission rates between 1990 and 2000. Displayed in this figure are six graphs depicting the national average emission rate by vehicle type and fuel type for Carbon Monoxide (CO), Hydrocarbons (HC) and Nitrogen Oxides ($NO_x$).[14] Table 2 gives the overall reduction between 1990 and 2000 for each pollutant by vehicle type.

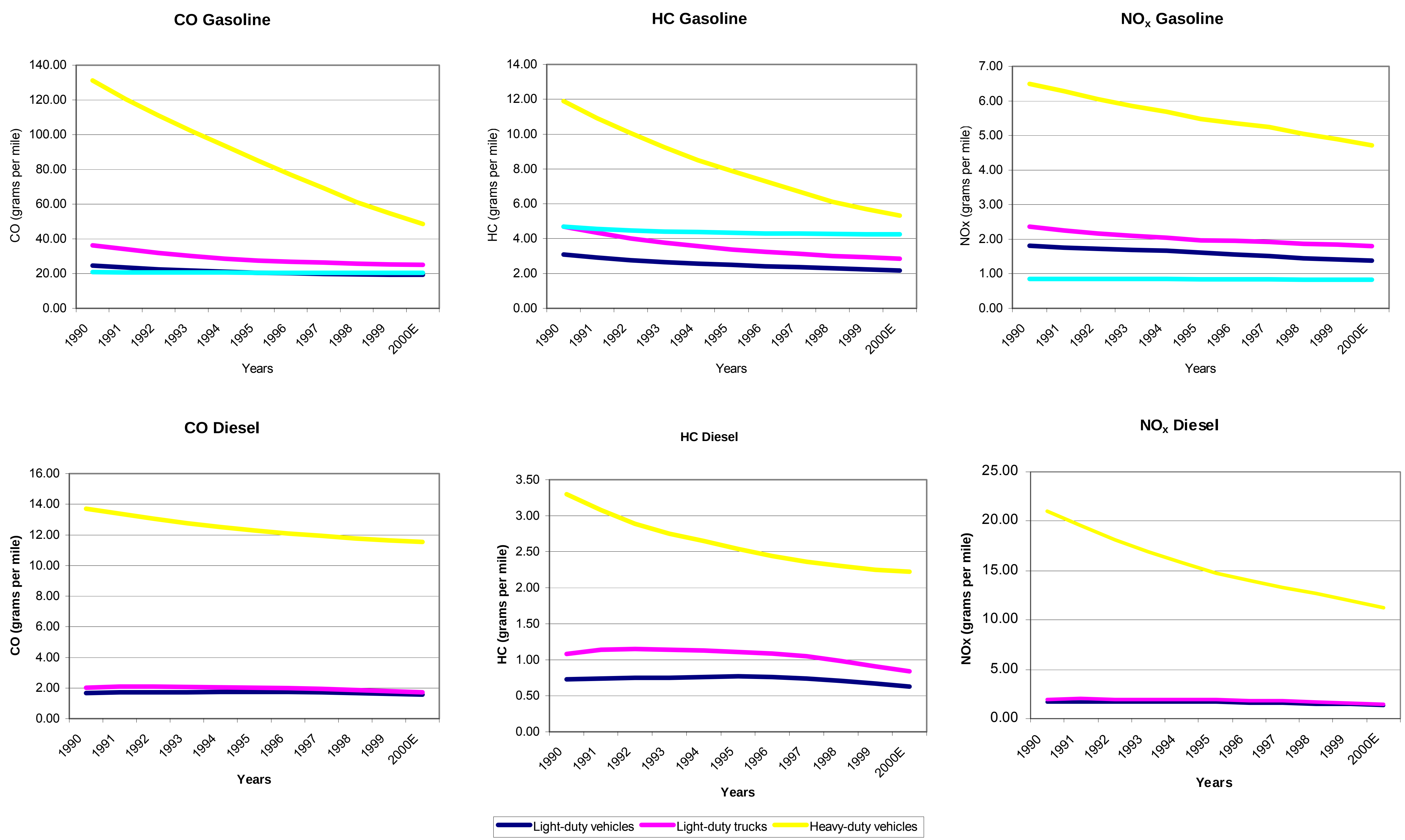
**Table 2:** Reduction in average emission rates for CO, HC and $NO_x$ by vehicle type and fuel type between 1990 and 2000[15]

| | Light-duty vehicles | | Light-duty trucks | | Heavy-duty vehicles | | Motorcycles |
|---|---|---|---|---|---|---|---|
| | Gasoline | Diesel | Gasoline | Diesel | Gasoline | Diesel | Gasoline |
| CO | 22 % | 7 % | 31 % | 15 % | 63 % | 16 % | 3 % |
| HC | 30 % | 14 % | 39 % | 22 % | 55 % | 33 % | 9 % |
| $NO_x$ | 24 % | 19 % | 24 % | 26 % | 27 % | 46 % | 3 % |

Figure 1 and Table 2 show that there has been a significant reduction in average emission rates for both diesel and gasoline engines for all vehicle types except motorcycles.

Based on the graphs in Figure 1 and Table 2, it can be concluded that the US is fairly successful in reducing the emission rates from on-road motor vehicles.

**Figure 1:** 1990-2000 National Average Emission Rates for CO, HC and $NO_x$ by Fuel and Vehicle Type in grams per mile[16]



## Vehicle Miles Traveled at the National Level

While the average emission rates have decreased, the total VMT has increased between 1990 and 2000. Due to previous comments by the FWHA regarding the validity of VMT used in a previous study for FDOT, VMT data from three different years (2000, 2001 and 2002) were compared.

Figure 2 presents the total VMT (aggregated for all vehicle types) for each year between 1990 and 1998.[17] All three datasets show an increase in VMT over the period. The 2000 and 2001 datasets are almost identical until 1996, but after 1996 the 2001 dataset shows higher VMT than the 2000 dataset. The aggregate VMT according to the 2002 data is about 73 billion miles lower compared to the other two datasets between 1990 and 1996. After 1996, the 2000 and 2002 dataset converge while the difference between the 2001 and 2002 dataset remains fairly constant.

Although there are differences between the aggregate VMT for the three datasets, the differences in VMT per vehicle category are more substantial. Since the average emission rate varies significantly for each category, this will lead to substantial differences in the calculation of the emission of each pollutant.

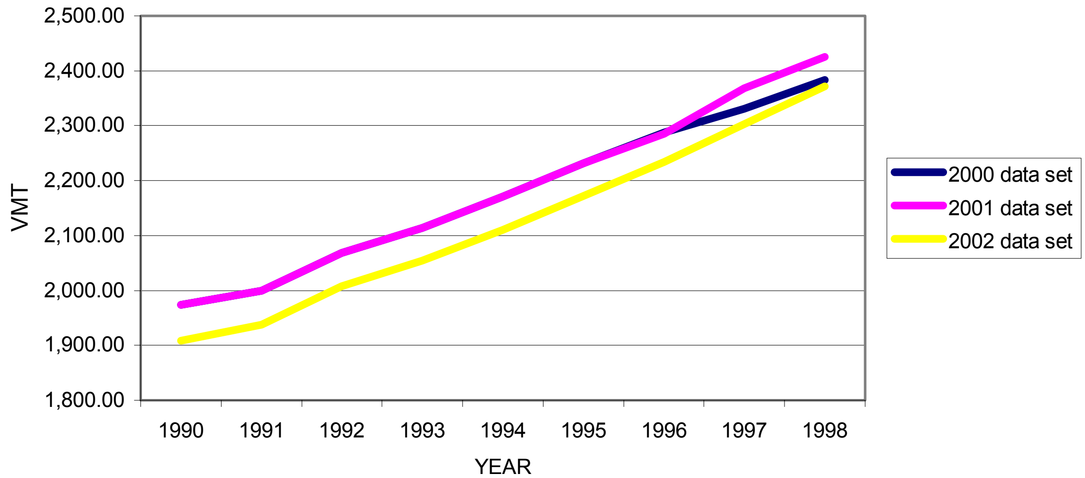
All three datasets show that light-duty vehicles have been responsible for 58 to 68 percent of the total annual VMT during the period 1990-1998. In the same time period, light-duty trucks were responsible for 27 to 33 percent, heavy-duty vehicles for 8 to 12 percent and motorcycles for less than half a percent.

Figure 3 shows, for all three datasets, changes in VMT by vehicle type between 1990 and 1998. In all three graphs, 1990 is used as the reference year. The advantage of this graph is that it shows the relative increase in VMT for each vehicle type. The graphs clearly show that there are substantial differences between the three datasets. While the graphical representation of the 2000 and 2002 datasets make intuitive sense, the graph of the 2001 dataset shows that there might be some problems with this dataset. According to the 2001 data, there was a sudden dramatic increase in the amount of VMT attributable to heavy-duty vehicles between 1995 and 1996 (approximately 50%).

At the same time there was a sudden decrease in the VMT attributable to light-duty trucks (approximately 8 %), while the VMT attributable to light-duty trucks had been increasing until that year. There are only relatively minor differences between the graphs for the 2000 and 2002 datasets. Both datasets show that there has been an increase of about 50 percent in VMT for light-duty trucks, between 30 and 35 percent for heavy-duty vehicles, and a little over 10 percent for light-duty vehicles. There is a rather substantial difference between the two datasets for the VMT for motorcycles (7 versus 18 percent). The increase in total aggregate VMT varies from a 21 percent increase according to the 2000 dataset to a 24 percent increase according to the 2002 dataset.

It is clear that there are substantial differences in the three datasets. While the 2000 and 2002 datasets are very similar for light-duty trucks and heavy-duty vehicles, the 2002 data shows a substantially lower VMT for passenger cars than the 2000 data. The 2000 and 2001 data are almost identical from 1990 to 1995, but starting in 1996 the datasets show very significant differences for heavy-duty vehicles and, to a lesser extent, light-duty trucks.

**Figure 2:** Aggregate National VMT 1990-1998 (miles $10^9$)




Based on the comparison of the three datasets and the sudden shift in trends for heavy-duty vehicles and light-duty trucks between 1995 and 1996, according to the 2001 dataset, it was determined that this dataset was unreliable. Since the 2002 dataset contains information through the year 2000, while the 2000 dataset only contains information through 1998, it was consequently decided to use the 2002 dataset.

**Figure 3:** 1990-2000 National Vehicle Miles ($10^9$) Traveled by Vehicle Type using 2000, 2001 and 2002 FHWA data

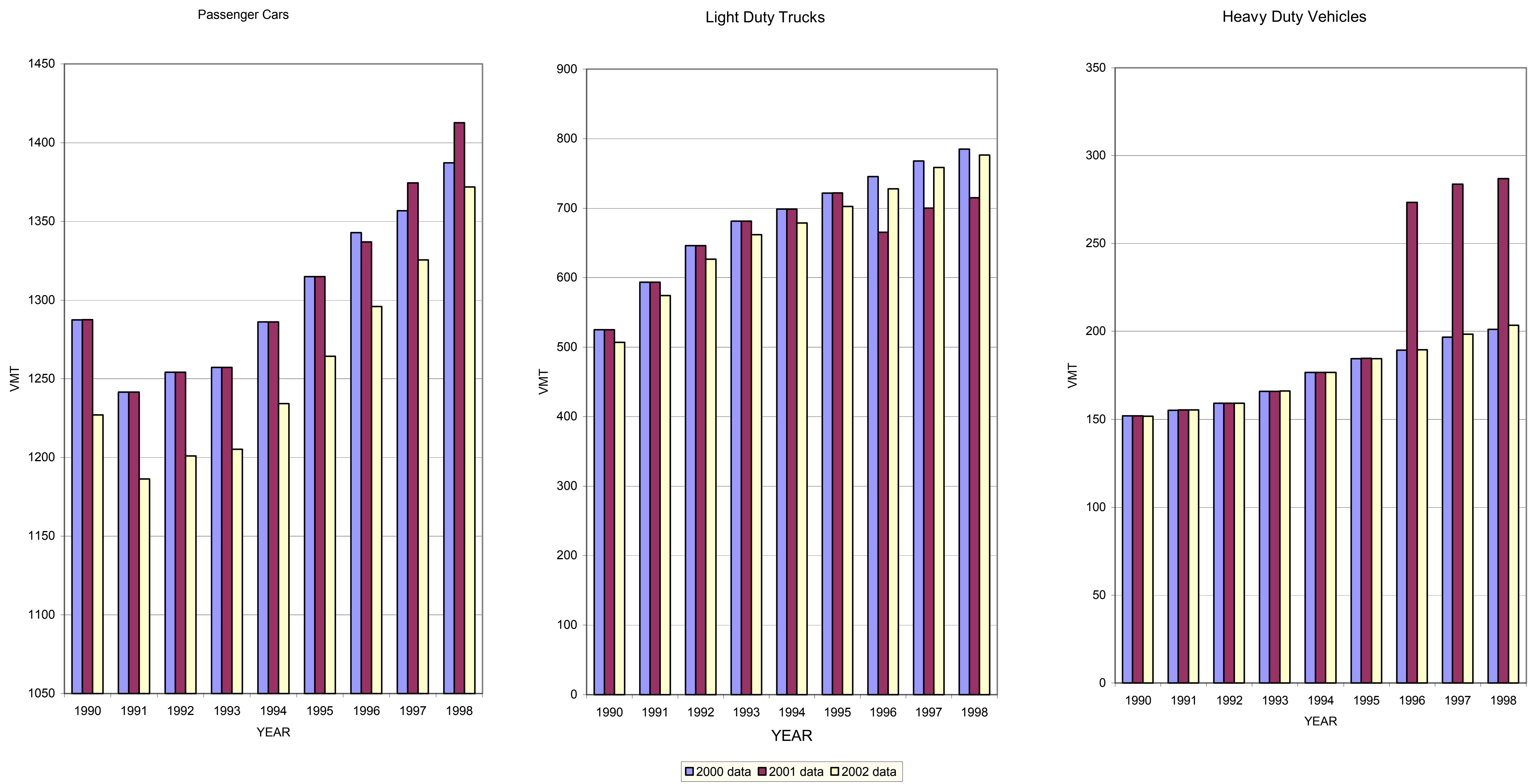
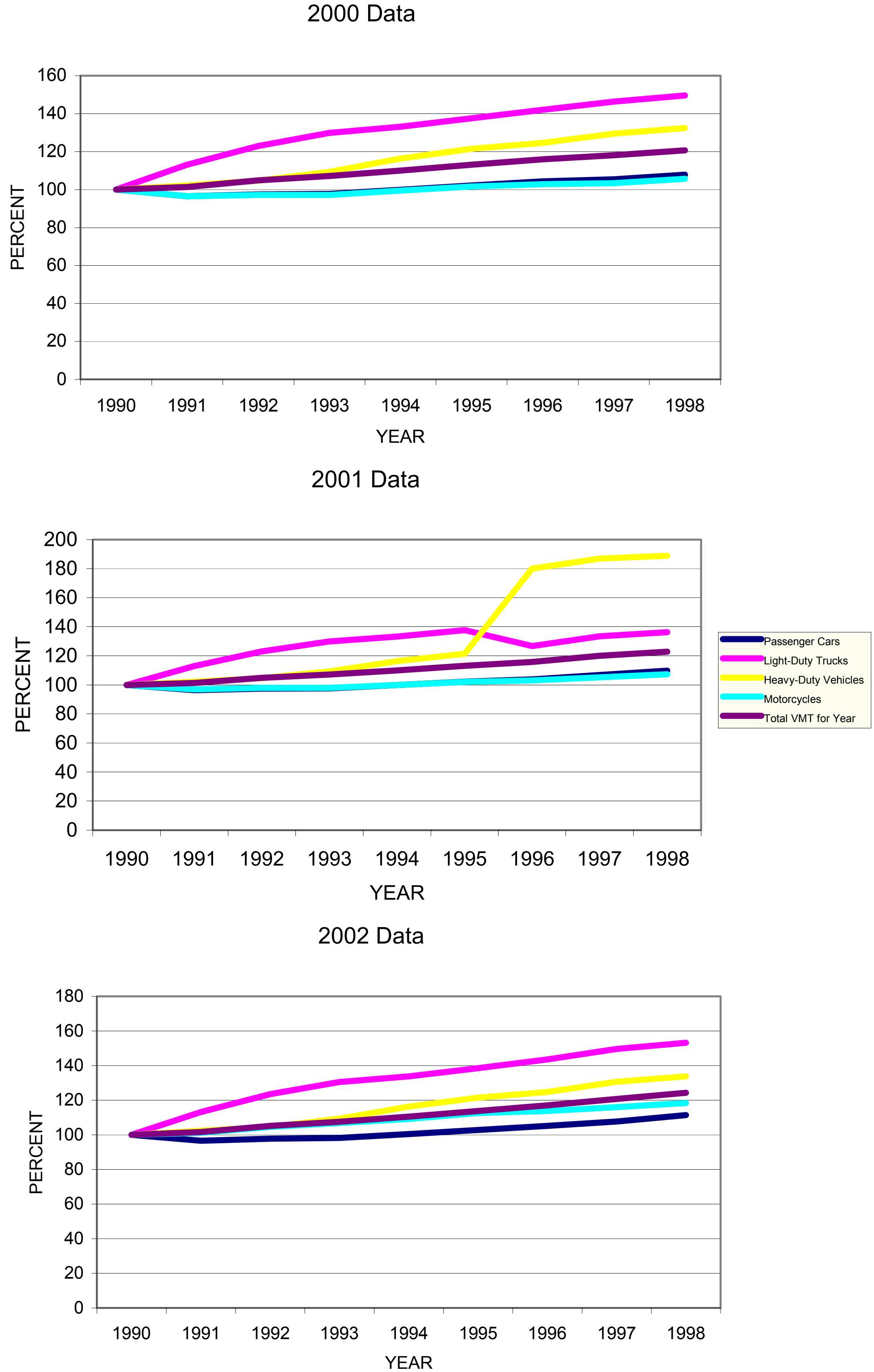


**Figure 4:** Comparison of increases in VMT for 1990-1998



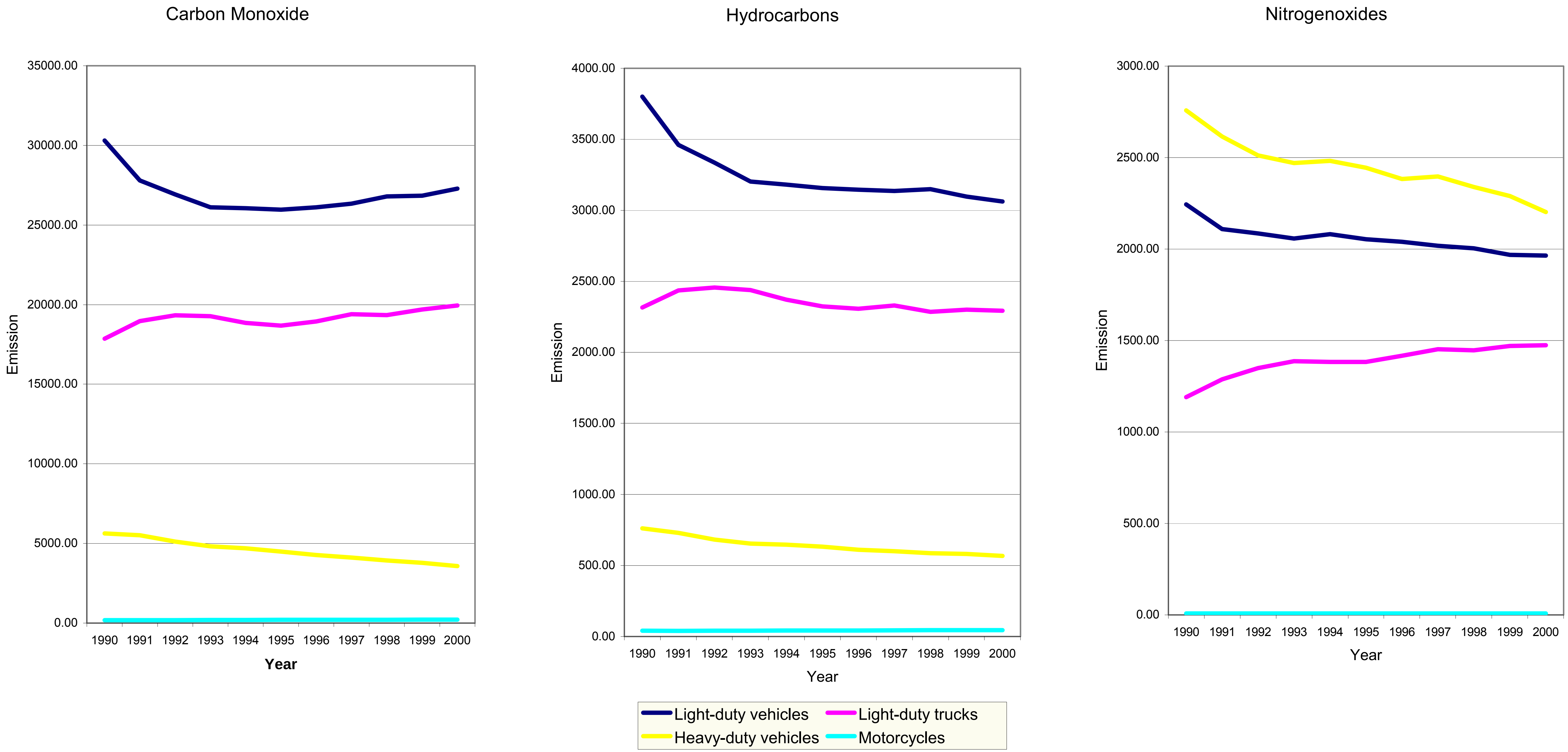
The graphs in Figure 5 show the total national emission from each vehicle type. The data for the graphs were calculated by multiplying the average annual emissions for each vehicle type from Figure 1 with the total VMT for each vehicle type from Figure 2.

Table 3 gives the aggregate emission for each pollutant in 1990, 1995 and 2000, as well as the percentage change between 1990 and 2000, and 1995 and 2000. The table shows that the aggregate national emission in 2000 was lower than in 1990. The emission of hydrocarbons has decreased the most with 14 percent, nitrogen oxides have decreased by 9 percent and carbon monoxide by 5 percent. The table also shows that carbon monoxide emission have actually increased between 1995 and 2000, while the emission decrease for hydrocarbons was substantially lower between 1995 and 2000 than between 1990 and 1995. It should be clear that the actual decrease in emissions is lower than the decreases in average emission rates that were reported in Table 2. This shows that the decrease in emission rates for hydrocarbons and nitrogen oxides has been offset partly by the increase in VMT and changes in composition of the vehicle fleet. At the same time, increases in VMT and changes in vehicle composition completely offset the improvements in emission rates for carbon monoxide.

**Table 3:** Change in the aggregate emission of CO, HC and $NO_x$ between 1990, 1995 and 2000 at the national level

| Pollutant | 1990 (grams $10^9$) | 1995 (grams $10^9$) | 2000 (grams $10^9$) | Percent Change 1990-2000 | Percent Change 1995-2000 |
|---|---|---|---|---|---|
| CO | 53986.63 | 49331.91 | 51040.17 | - 5 % | + 3 % |
| HC | 6918.39 | 6154.12 | 5967.18 | - 14 % | - 3 % |
| $NO_x$ | 6199.00 | 5889.27 | 5649.34 | - 9 % | - 4 % |

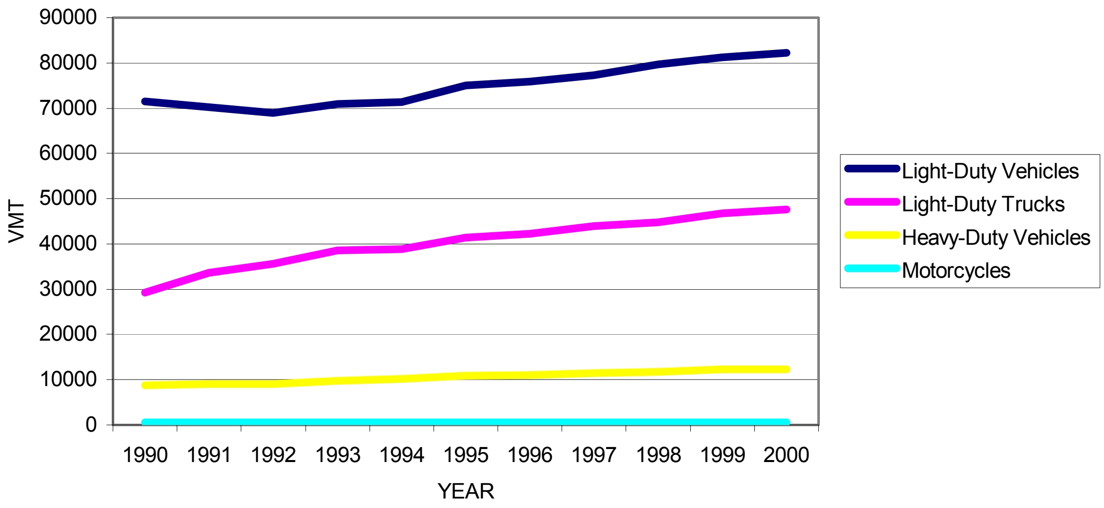
**Figure 5:** 1990-2000 Total National Emissions by Vehicle Type for CO, HC, and $NO_x$, in grams $10^9$



## Florida Emissions

Florida has been experiencing some of the same trends as those seen at the national level. The average emission rates for Florida vehicles were not available at the time of this report. Therefore, the national average emission rates for passenger cars, light-duty trucks, heavy-duty vehicles, and motorcycles from Figure 1 were used. Although using the national average emission rates could lead to some inaccuracies with the calculation of the exact emissions, these inaccuracies are unimportant since we are not interested in the exact levels of emission but rather in the trends over the past ten years. Figure 6 shows the total VMT by vehicle type for Florida during the period of 1990-2000.

**Figure 6:** Florida Vehicle Miles Traveled by Vehicle Type (miles $10^6$)




The trends in Florida are similar to the trend at the national level, with similar increases in VMT for each vehicle type as at the national level. To enable better comparison with the national data, Figure 7 shows the percentage increase in VMT for each vehicle type based on the index year 1990. The figure shows that between 1990 and 2000, there has been a 63 percent increase in the VMT for light-duty trucks, 41 percent for heavy-duty vehicles, 21 percent for motorcycles and 15 percent for light-duty vehicles. The aggregate VMT over the period 1990-2000 has increased by 30 percent. These numbers are slightly higher than the national increases that were shown earlier.

**Figure 7:** Increases in Florida VMT by vehicle type compared to base year 1990

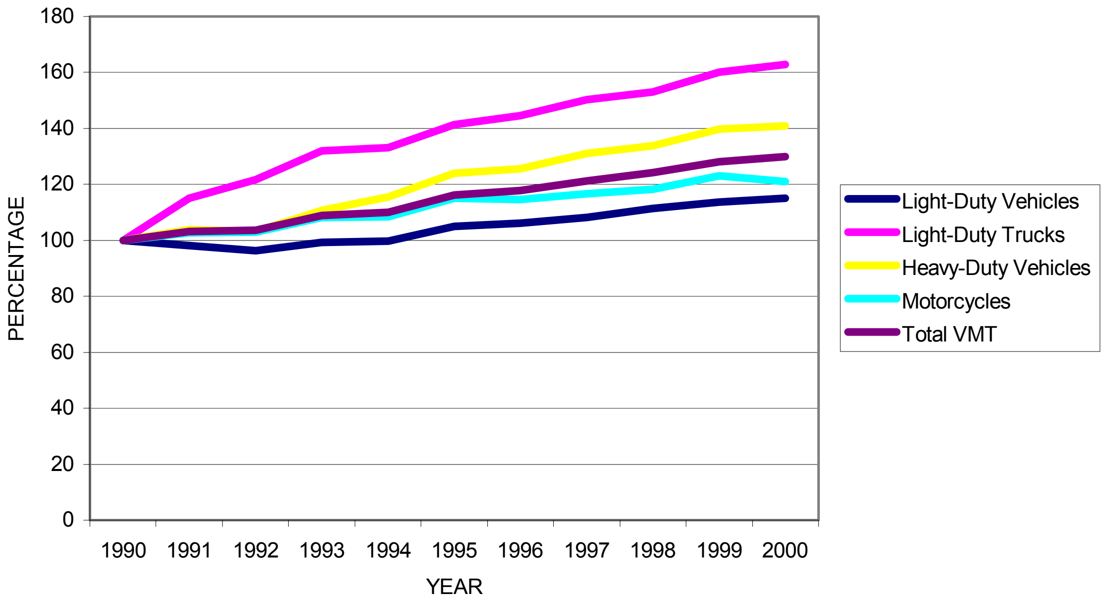



Figure 8 shows the emissions in Florida by vehicle type in grams for the three primary pollutants: CO, HC and $NO_x$. This was done using the same method as for the national emission by multiplying the national average emission rates with Florida VMT by vehicle type. Table 4 summarizes the results for 1990, 1995 and 2000.

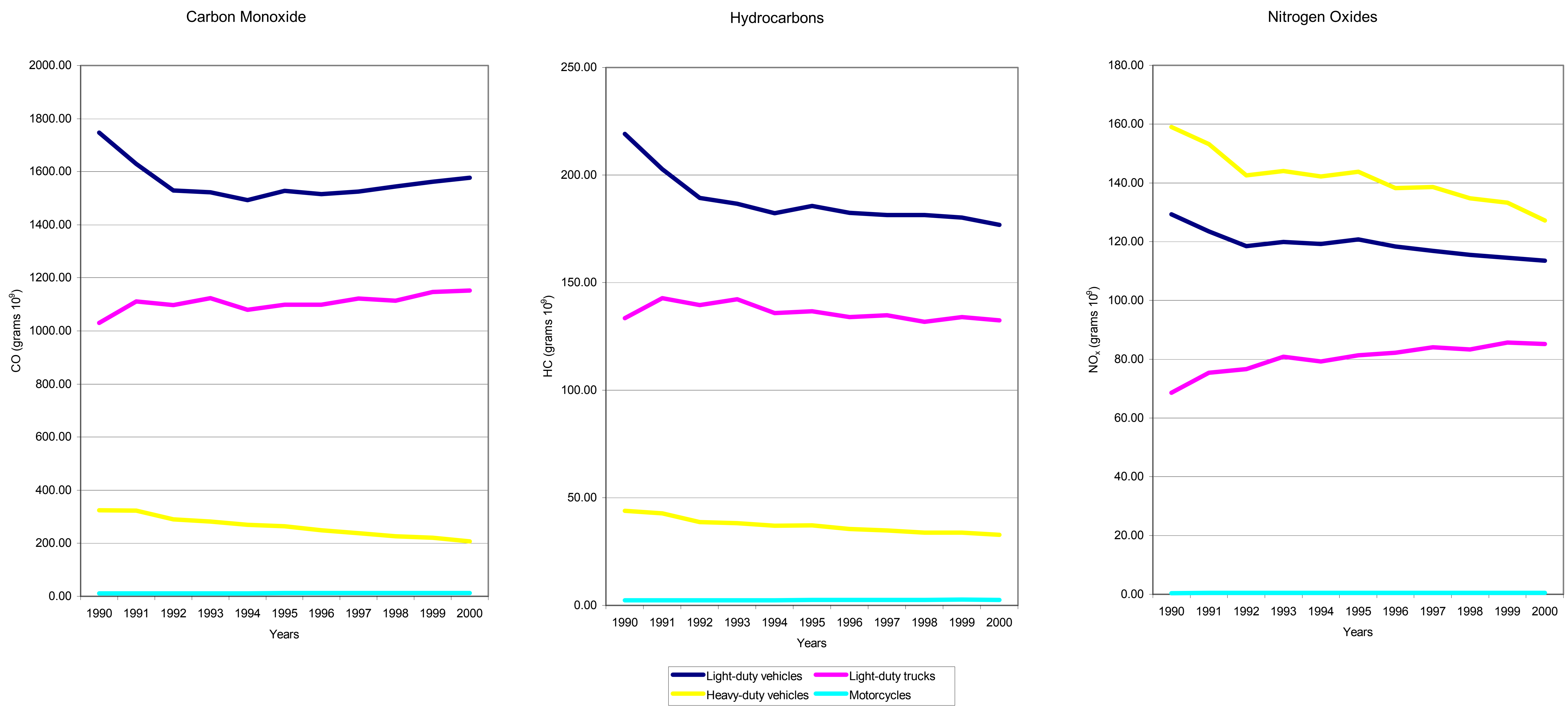
The trends seen in Figure 8 are very similar to those at the national level, with decreases in emissions in Florida slightly below or above the nationwide numbers, 11 percent for HC (nationwide, 14 percent), 7 percent for CO (nationwide, 5 percent) and 3percent for $NO_x$ (nationwide, 9 percent). Most of the decrease in emission can be attributed to improvements in the average emission rates for heavy-duty vehicles with reductions in total emissions of 36 percent for CO, 25 percent for HC and 20 percent for

$NO_x$. The emission of light-duty vehicles has also improved and is lower for all three pollutants, 10 percent for CO, 10 percent for HC and 12 percent for $NO_x$. The emission from motorcycles is also significantly lower, 18percent for CO, 10 percent for HC and 18 percent for $NO_x$. At the same time, the emissions from light-duty trucks have only slightly dropped, with 1 percent, for HC, while they have increased with 12 percent for CO and 24 percent for $NO_x$.

**Table 4:** Change in the aggregate emission of CO, HC and $NO_x$ between 1990, 1995 and 2000 in Florida

| Pollutant | 1990 (grams $10^9$) | 1995 (grams $10^9$) | 2000 (grams $10^9$) | Percent Change 1990-2000 | Percent Change 1995-2000 |
|---|---|---|---|---|---|
| CO | 3111.86 | 2902.28 | 2949.19 | - 7 % | + 2 % |
| HC | 398.79 | 362.06 | 344.79 | - 11 % | - 5 % |
| $NO_x$ | 357.32 | 346.29 | 326.43 | - 3 % | - 5 % |

**Figure 8:** 1990-2000 Florida Emissions by Vehicle Type for CO, HC, and $NO_x$, in grams $10^9$



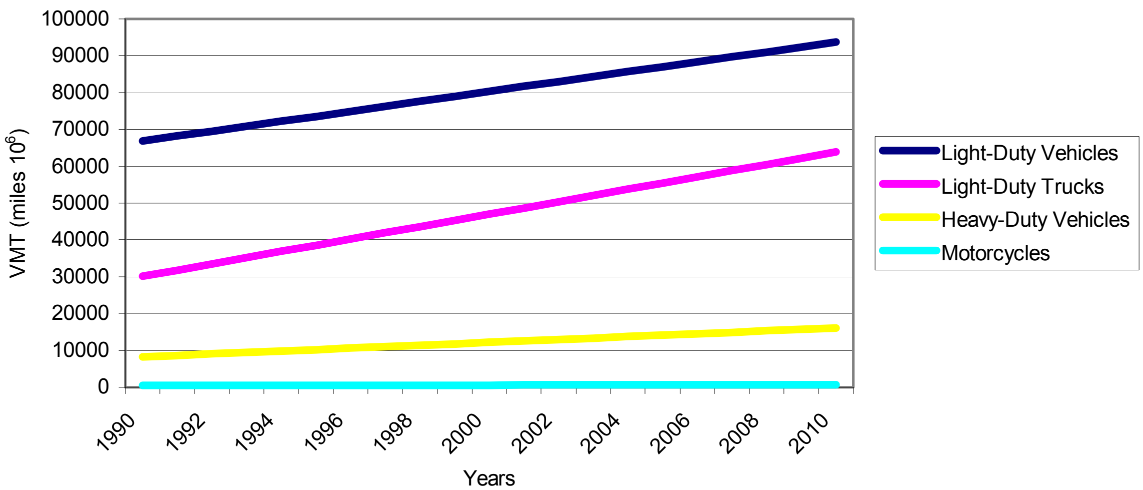
## Florida Projections

The following is a list of assumptions made while developing the trend models that were used for the remainder of this report.

- The trends seen for the years 1990-2000 are sufficient enough to produce rough estimates of the future trends.
- The technology advancements during the years 2001-2005 will not dramatically decrease the emission rates of standard vehicles.
- Replacement rates for cars will remain the same as they have been over the past ten years.
- Future policy changes will not change significantly enough to have a dramatic affect on aggregate vehicle emissions by 2005.
- The national emission data trends are relatively similar to those seen in Florida.

Since the vehicle fleet is comprised of vehicles of different ages, even dramatic changes in the emission rates of new vehicles do not immediately have a significant impact on the overall emission of air pollutants. Figure 9 gives the projected Florida VMT for the years of 1990-2010, by vehicle composition, using the stated assumptions.

**Figure 9:** Projected Florida Vehicle Miles Traveled 2000-2010



The model that was constructed used the 1990-2000 trends to create formulas that provided the closest fits for the trends that were observed. For all three pollutants, Figure 10 shows the observed emissions and the emissions calculated with our models. All models were able to predict between 60 and 98 percent of the variation in emissions for each pollutant over the 1990-2000 time period.[18] The only problem was with CO from light-duty vehicles, this model was only able to predict 20 percent of the variation in emission. The reason for this is that the emission of CO by light-duty vehicles decreases in the period 1990-1994 and increases in the period 1994-2000. After 1996, the model for CO therefore slightly underestimates the emission of CO by light-duty vehicles. If different models are calculated for 1990-1994 and 1995-2000, much better fits are achieved. Given the limited scope of this quick response report, it was decided to use the original model but the model is probably underestimating the contribution of CO from light-duty vehicles.

**Figure 10:** Observed trends versus modeled trends

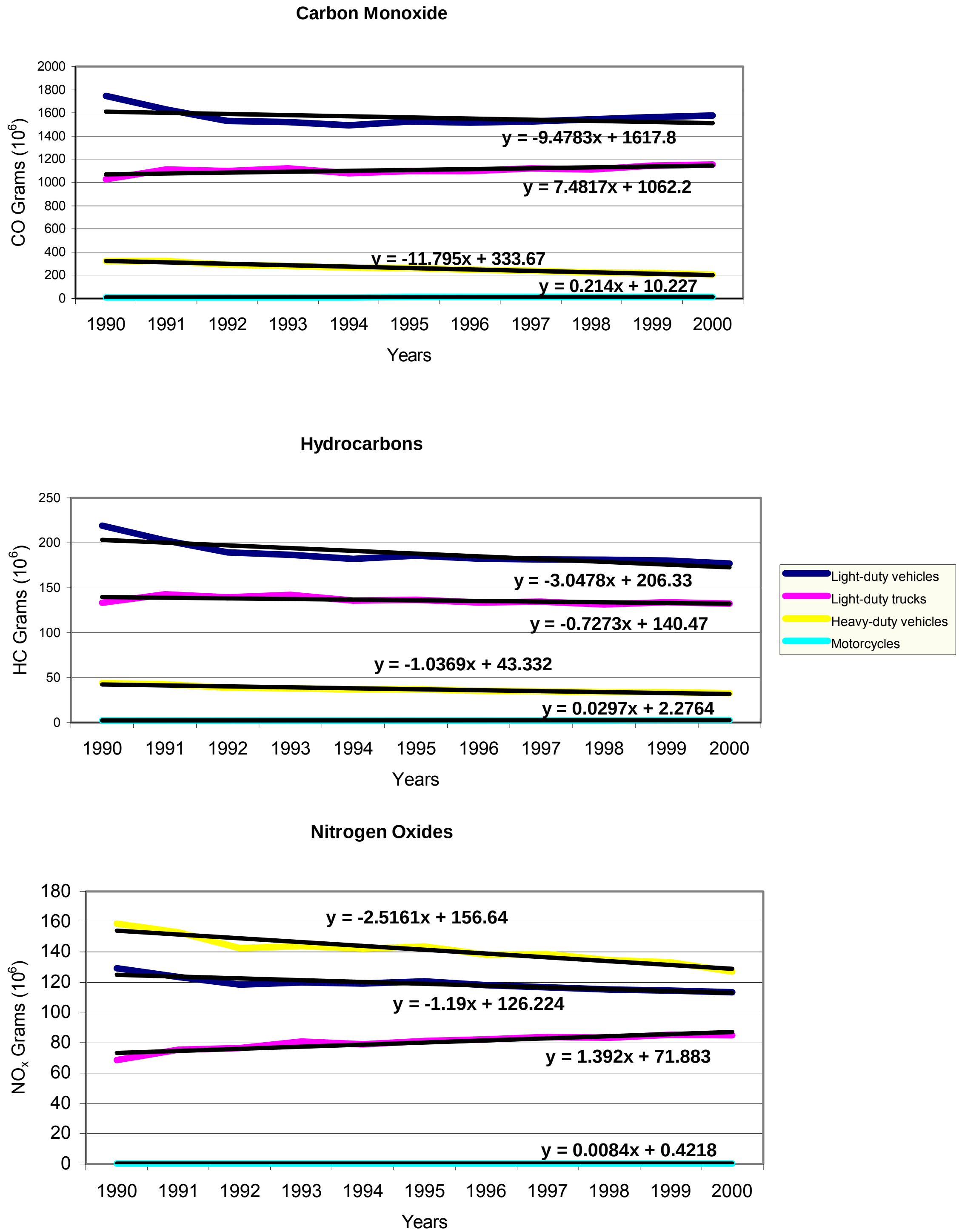
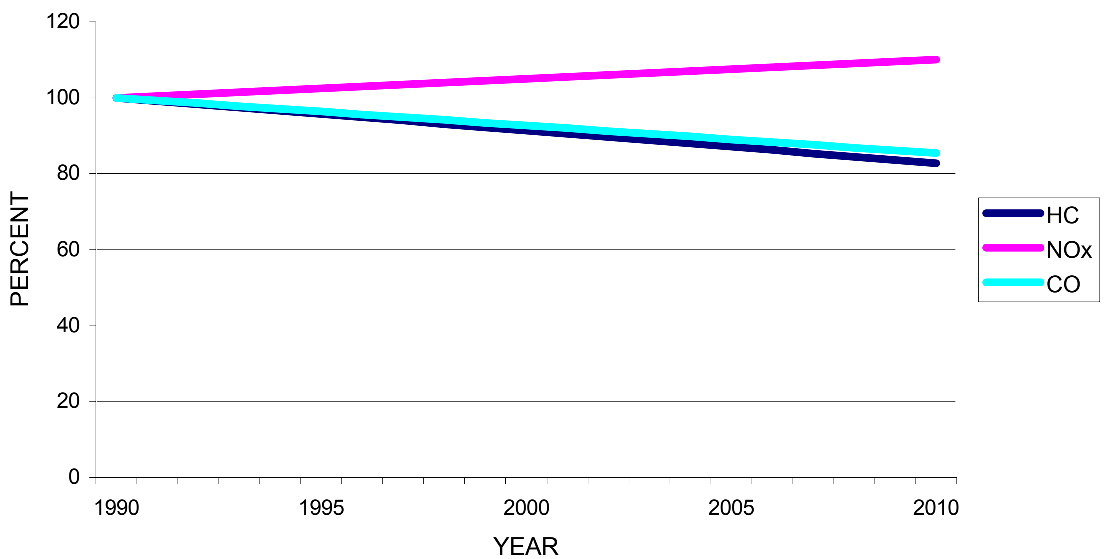


Figure 11 gives a prediction of the total emission of CO, HC and $NO_x$ for Florida. In order to easily compare the trends for all three pollutants, the year 1990 was used as the index year. The figure shows that statewide, regardless of increases in VMT and changes in vehicle composition, the emissions of CO and HC are decreasing. Again, it is important to realize that the model underestimates the contribution of light-duty vehicles to CO emissions and therefore the decrease in CO emission is probably less than the graph suggests. The figure also shows that the total emission of $NO_x$ is increasing.

**Figure 11:** Prediction of aggregate CO, HC and $NO_x$ Emissions for Florida




The graphs in Figure 12 give a more detailed picture of the future trends in emission by pollutant and vehicle type.

Based on the model and the medium population projection from the Bureau of Economic and Business Research (BEBR)[19], calculations were made for the emission of CO, HC and NOx for all 67 Florida counties. Figures 13 and 14 give the emission by county for 1990, 2000 and 2005, as well as the percentage change for each county between 2000 and 2005.

**Figure 12:** 1990-2010 Prediction of Florida Emissions by Vehicle Type for CO, HC, and $NO_x$, in grams $10^9$

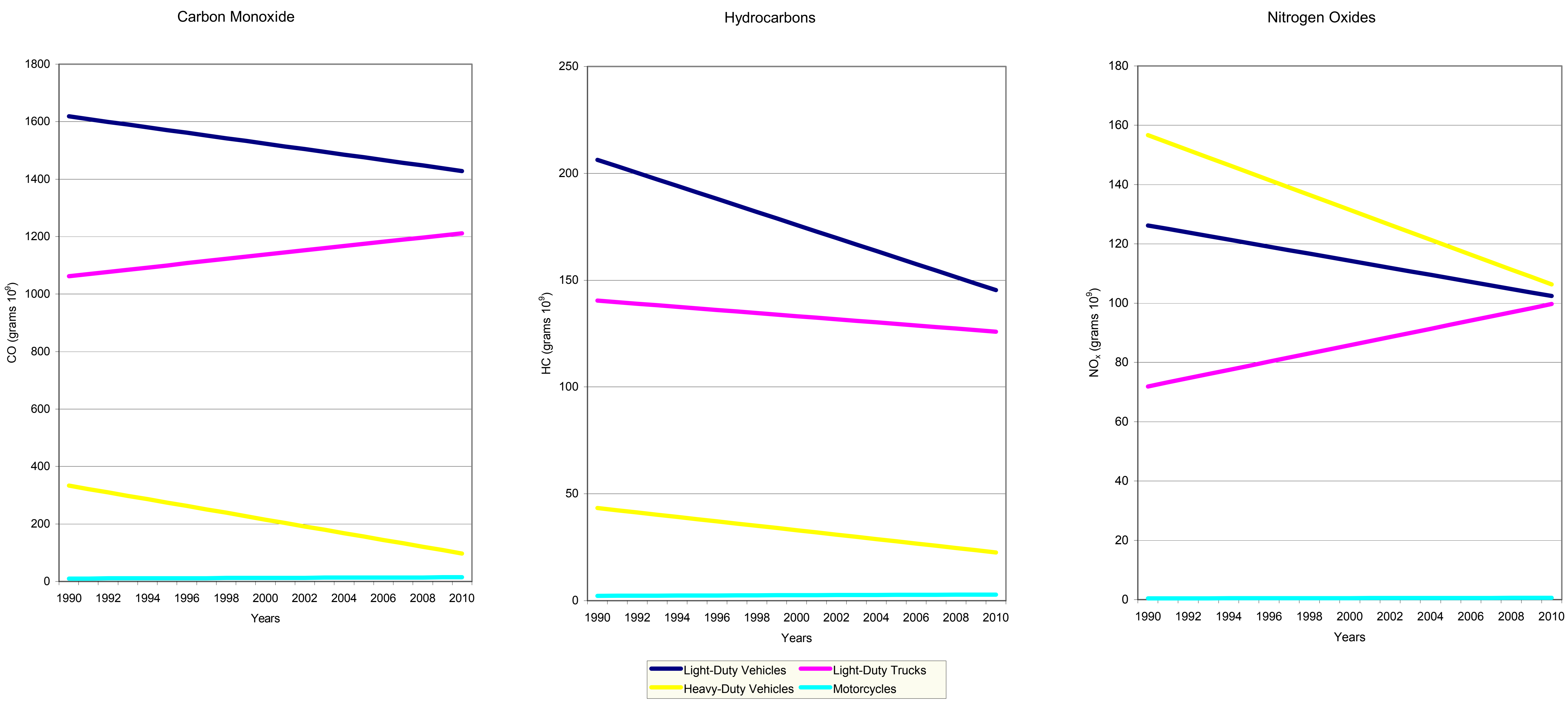


**Figure 13:** 1990 and 2000 Emissions for CO, HC, and $NO_x$, in grams $10^6$ per square mile by county

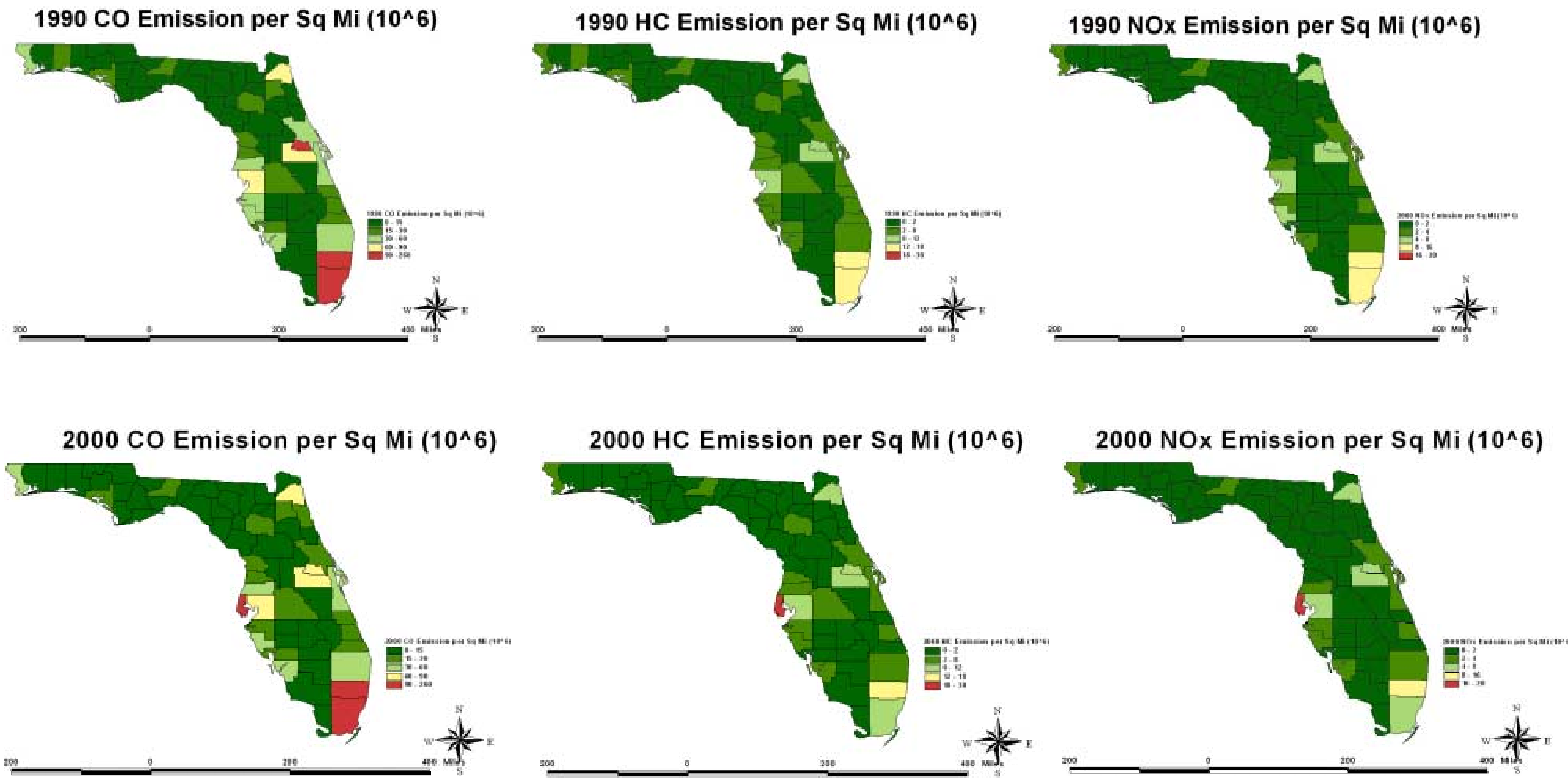
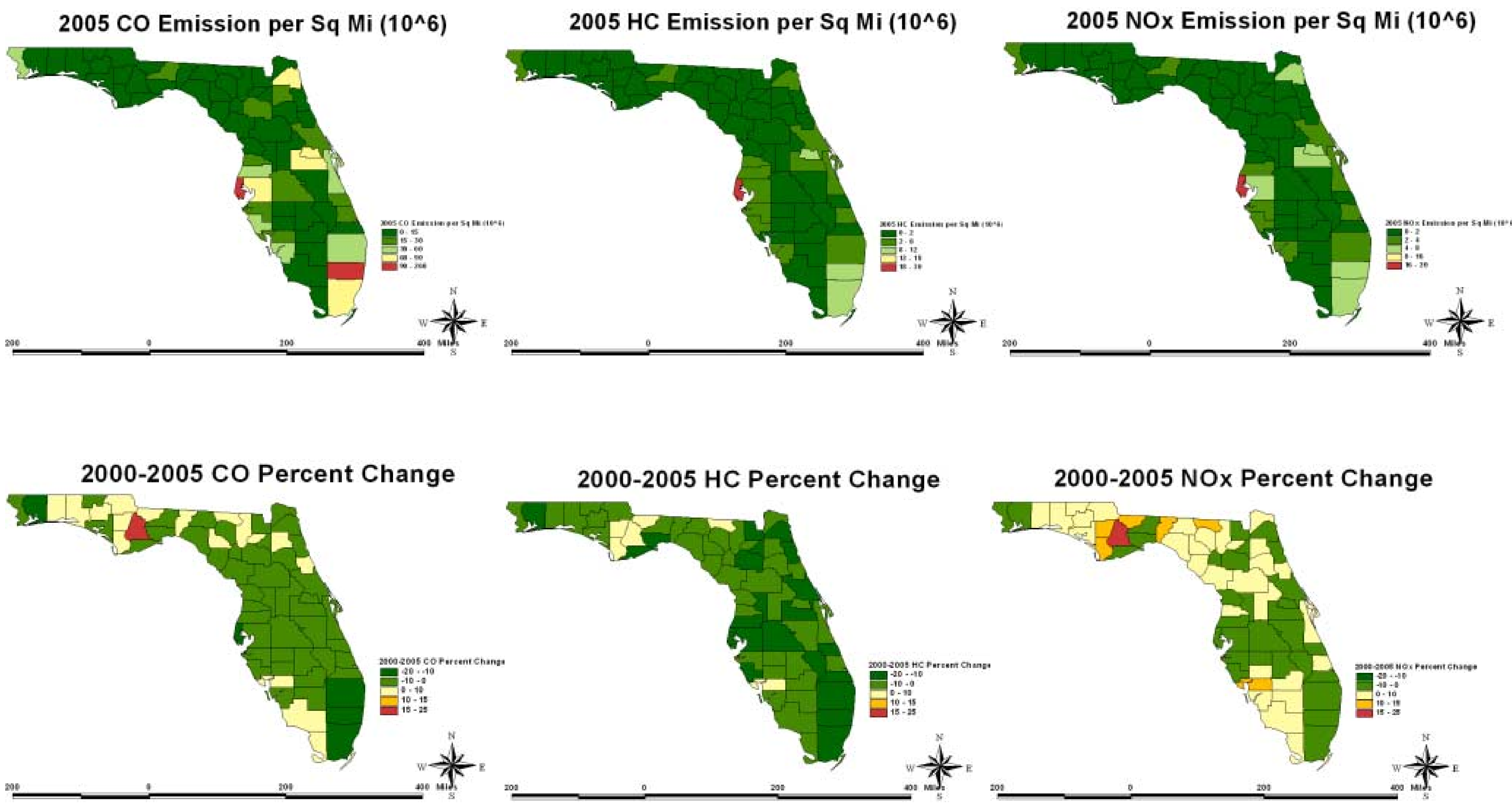


**Figure 14:** 2005 Emissions for CO, HC, and $NO_x$, in grams $10^6$ per square mile by county and percentage change compared to 2000



The maps show the emissions per square mile of CO, HC and $NO_x$ are highest in the counties of Miami-Dade, Broward, Hillsborough and Pinellas. Table 5 shows the total emission per county for the ten counties with the highest emission of CO, HC and $NO_x$. The table shows that in all ten counties the emissions have decreased between 1990 and 2000, and that emissions are projected to continue to decrease in the study period.

**Table 5:** Total emission ($10^6$ grams) for counties with highest emissions in 1990

| County | CO | | | HC | | | $NO_x$ | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2000 | 2005 | 1990 | 2000 | 2005 | 1990 | 2000 | 2005 |
| Miami-Dade | 208443 | 180816 | 158947 | 26331 | 20467 | 17041 | 16285 | 14125 | 12955 |
| Broward | 135393 | 130235 | 114793 | 17103 | 14741 | 12307 | 10578 | 10173 | 9356 |
| Palm Beach | 93339 | 90769 | 81174 | 11791 | 10275 | 8703 | 7292 | 7091 | 6616 |
| Pinellas | 91749 | 73942 | 65138 | 11590 | 8370 | 6984 | 7168 | 5776 | 5309 |
| Hillsborough | 89688 | 80158 | 73797 | 11330 | 9073 | 7912 | 7007 | 6262 | 6015 |
| Orange | 73437 | 71925 | 67609 | 9277 | 8141 | 7249 | 5738 | 5619 | 5511 |
| Duval | 72619 | 62499 | 57320 | 9173 | 7075 | 6145 | 5674 | 4882 | 4672 |
| Polk | 43691 | 38831 | 36356 | 5519 | 4395 | 3898 | 3414 | 3033 | 2963 |
| Brevard | 43251 | 38214 | 36713 | 5464 | 4326 | 3936 | 3379 | 2985 | 2992 |
| Volusia | 40117 | 35575 | 32569 | 5068 | 3492 | 2795 | 3134 | 2779 | 2655 |

It is important to realize again that the relation between emissions and ambient air quality is complex and that there is no direct relationship between the two. High emissions in southeast Florida cause relatively few problems since local weather conditions quickly disperse pollutants over a large area. However, that same level of emissions could lead to air quality problems in Orange County where weather conditions are substantially different. Therefore comparison of emission between different areas can be misleading and it is more useful to look at changes over time for one particular location. The last series of graphs in Figure 14 show that increases in the emission of air pollutants from on-road motor vehicles occurs mostly in areas that traditionally have had relatively low emissions at Florida's southwest coast and northern Florida. On the other hand, area emissions are generally declining in areas that traditionally have seen high emissions. Table 6 gives the ten counties with the highest percentage increase in emission for $NO_x$ between 2000 and 2005. The table shows that for five of these counties, although there is an increase in the emissions of CO and $NO_x$, there is a decrease in the emission of HC. Furthermore, comparison of Table 6 with the first set of graphs in Figure 14 shows that the emission per square mile for all these counties is still relatively low.

**Table 6:** Percentage increase between 2000 and 2005 for counties with highest percentage increase

| County | CO | HC | $NO_x$ |
|---|---|---|---|
| Liberty | 15.6 % | 9.4 % | 20.6 % |
| Gadsden | 9.9 % | 4.1 % | 14.7 % |
| Gulf | 9.3 % | 3.5 % | 14.0 % |
| Hamilton | 8.7 % | 2.9 % | 13.4 % |
| Calhoun | 6.6 % | 0.9 % | 11.2 % |
| Charlotte | 5.7 % | 0.1 % | 10.3 % |
| Jefferson | 5.5 % | **- 0.1 %** | 10.1 % |
| Collier | 3.1 % | **- 2.4 %** | 7.5 % |
| Okaloosa | 3.0 % | **- 2.4 %** | 7.5 % |
| Washingon | 2.7 % | **- 2.7 %** | 7.2 % |
| Walton | 2.7 % | **- 2.7 %** | 7.2 % |

# Conclusion and Discussion

This report has described trends in the emission of air pollutants in the past decade and provided estimates of emissions until 2005. The report has shown that between 1990 and 2000, there has been a general decrease in the emissions of pollutants from on-road motor vehicles statewide. Model calculations showed that the emissions of CO and HC will continue to decline in the next five years. On the other hand the model showed that the total emission of $NO_x$ from on-road motor vehicles will increase slightly. Calculations by county showed that the emissions in those counties that have traditionally seen relatively high emissions are slowly declining. At the same time there are increases in the emission of CO, HC and NOx in counties that have traditionally not had air pollution problems particularly on the southwest coast of Florida and the panhandle. Given the complex relation between the emission of air pollutants and ambient concentrations, it is difficult to determine the effect of these changes in emissions on air quality. However, the results could indicate that there will be a shift in the location of air quality problems in Florida.

It is important to realize that the model that was used in this report is a gross simplification of a very complex issue. This simplification makes it possible to compare trends in emissions over time for many locations. The model cannot make any predictions about ambient air quality since this is influenced by many other factors. The strength of the model is that it is very transparent since it uses just four variables: VMT, average emission rates, fleet composition and population. The model allows the user to quickly calculate the impact of changes in any of the four variables on overall emissions. We suggest that FDOT does further research to compare the results of the model used in this report with results obtained with MOBILE6.

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[17] The 2000 dataset only covers 1990-1998, while the 2001set cover 1990-1999 and the 2002 set covers 1990-2000. For comparison reasons, the graphs only cover the period 1990-1998

[18] The data bases that are attached to the electronic version of this document contain $R^2$ for each pollutant by vehicle type. If you want an electronic version of this document please send an e-mail to jvos@fau.edu.

[19] Bureau of Economic and Business Research (2001), *Florida Population Studies.*