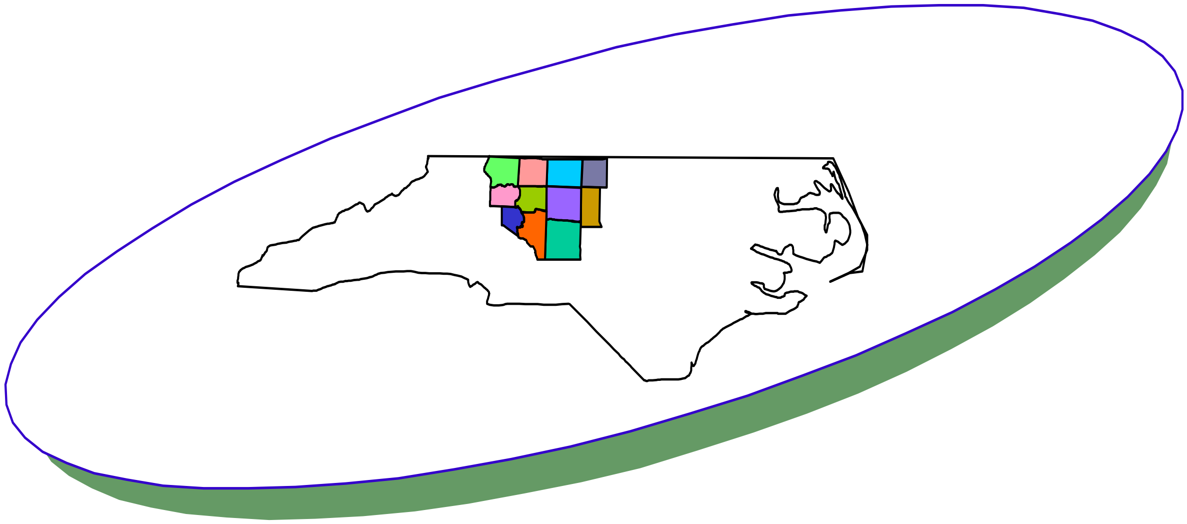

Triad
Early Action Compact
Ozone Action Plan

An initiative of 11 counties and 20 municipalities in the Piedmont Triad Region of North Carolina and The North Carolina Department of Environment and Natural Resources, Division of Air Quality with guidance from USEPA Region 4.

March 31, 2004

TRIAD EARLY ACTION PLAN

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1 INTRODUCTION

1.1 Background

As a requirement of the Triad Early Action Compact (EAC), the Local Early Action Plan (Local EAP) due March 31, 2004, must include measures that are specific, quantified, permanent and enforceable as part of the SIP or TIP once approved by EPA. The Local EAP also details specific implementation dates for adopted local controls. This report includes updated air quality emission inventories and modeling results for future year 2010 in Sections 4 and 6. Also included in this report is an overview of the air quality in the Triad area, the health effects and sources of ozone, Federal and State control measures, and emissions modeling and results. The Triad area includes Alamance, Caswell, Davidson, Davie, Forsyth, Guilford, Randolph, Rockingham Stokes, Surry and Yadkin Counties.

1.2 Modeling Background

The modeling analysis is a complex technical evaluation that begins by selection of the modeling system and selection of the meteorological episodes. North Carolina Division of Air Quality (NCDAQ) decided to use the following modeling system:

- Meteorological Model: MM-5 – This model generates hourly meteorological inputs for the emissions model and the air quality model, such as wind speed, wind direction, and surface temperature.

- Emissions Model: Sparse Matrix Operator Kernel Emissions (SMOKE) - This model takes daily county level emissions and temporally allocates across the day, spatially locates the emissions within the county, and transfers the total emissions into the chemical species needed by the air quality model.

- Air Quality Model: MAQSIP (Multi-Scale Air Quality Simulation Platform) – This model takes the inputs from the emissions model and meteorological model and predicts ozone hour by hour across the modeling domain, both horizontally and vertically.

The modeling system being used for this demonstration and the episodes being modeled were discussed in detail in the June 30, 2003 progress report (see Appendix B).

The following historical episodes were selected to model because they represent typical meteorological conditions in North Carolina when high ozone is observed throughout the State:

- July 10-15, 1995
- June 20-24, 1996
- June 25-30, 1996
- July 10-15, 1997

The meteorological inputs were developed using MM5 and are discussed in detail in Appendix B.

The precursors to ozone, Nitrogen Oxides (NOx), Volatile Organic Compounds (VOCs), and Carbon Monoxide (CO) were estimated for each source category. These estimates were then spatially allocated across the county, temporally adjusted to the day of the week and hour of the day and speciated into the chemical species that the air quality model needs to predict ozone. The emission inventories used for the current year and future year modeling are discussed in detail in Section 4.

The State, Federal and Local control measures currently in practice and those being implemented in the future to reduce point and mobile (highway and nonroad) source emissions are discussed in Section 5.

The status of the modeling work is discussed in Section 6.

1.3 Stakeholders Involvement

The Triad Stakeholders Group was organized in January and February 2003, following adoption of the EAC resolution by 11 counties and 21 municipalities in December 2002. There was no predecessor regional group to logically assume these responsibilities. Therefore, the two councils of governments (COGs), Piedmont Triad Council of Governments and Northwest Piedmont Council of Governments, assumed this role. On behalf of their member governments, the COGs appointed a broad range of local government, business, industry, transportation, and environmental representatives to comprise the EAC Stakeholders Group.

Between March 2003 and March 2004, the work of the Stakeholders Group fell roughly into three phases:

- March – June 2003 Building a cohesive group encompassing diverse points of view; becoming educated on ozone issues; and considering hundreds of reduction strategies
- July – December 2003 Conducting 15 public forums and local government meetings to educate and receive input from citizens and elected officials; and developing consensus on strategies for the Triad Early Action Plan.
- January – March 2004 Refining strategies, eliminating those deemed nonproductive; developing a system to measure and account for local government progress; and quantifying emissions reductions where possible.

In addition to the Piedmont Triad COG and the Northwest COG, other organizations have played a leadership role in the Triad EAC:

Forsyth County Environmental Affairs Department
PART (Piedmont Authority for Regional Transportation, regional transportation planning and service agency)
Greensboro Chamber of Commerce
Winston-Salem Chamber of Commerce
Guilford County Advisory Board for Environmental Quality

4 MPOs serving the 11-county region

Representatives of these agencies, recommended strategies and helped assess their implications. The Guilford County Advisory Board for Environmental Quality (ABEQ) was particularly helpful in devoting three meetings to potential strategies and developing criteria to measure those with greatest potential for adoption and success. In addition, the ABEQ hosted a large public meeting in December 2003 with participation from citizens and members of the environmental community.

The Stakeholders Group met fourteen times between March 2003 and March 2004. Meetings were and continue to be highly interactive with excellent attendance from the 35 group members. Meetings are advertised on the web pages of the Piedmont Triad Council of Governments and the Northwest Piedmont Council of Governments. Additionally, meetings are publicized by the Winston-Salem and Greensboro Chambers of Commerce, in the Triad Sierra Club newsletter, and in e-mails to local and statewide environmental groups. There is extensive coverage of each Stakeholder meeting in the Greensboro News and Record. The combination of publicity and participation from the environmental and business community may account for frequent calls from interested citizens asking if they can attend Stakeholder meetings. They are always invited and placed on the e-mail list.

The following pages contain a sample of newspaper articles illustrating excellent coverage of the EAC process in this Region and work of the Stakeholders Group.

Sample of EAC-Related News Articles

March 2003-March 2004

Demonstrating: Stakeholder Activities, Local Commitment and Public Education

1. Regional Panel Aims For Cleaner Air

Officials hope to reduce ozone pollution three years before a federal deadline

By Paul Muschick, Staff Writer N*ews and Record, Tuesday, March 4, 2003*

Business, government and transportation officials from across the Triad began discussing Monday how to cut air pollution and escape federal penalties.

Eleven counties have agreed to cooperate on a plan that would reduce ozone, a type of pollution caused by burning fuels ... such as from power plants, factories and cars ... that can cause breathing difficulties.

The Environmental Protection Agency is expected to rule next year that the region will violate new, tougher ozone rules, potentially limiting the construction of new factories and new roads that could add even more ozone. The EPA will require a cleanup plan to be written by 2007. It will require that ozone be reduced by 2010.

But the Triad, along with three other parts of the state, has entered a program to start cleaning up its air now, before the new law takes effect. If it succeeds, the Triad will cut its ozone to acceptable levels by 2007, three years earlier than required.

By June 16, the region needs to submit a list of suggestions for how to reduce the pollution. Suggestions could include proposals to better enforce speed limits and encourage carpooling and transit use, all of which could reduce pollutants from cars; to limit open burning; to promote energy conservation; and to reduce urban sprawl, which some experts say increases traffic.

`We need to come up with things that are feasible, or the EPA's not going to buy it,'' said Bob Fulp of the Forsyth County Department of Environmental Affairs.

Everything from power plants, factories and airports to cars, farm machinery, construction equipment and lawn mowers will come under scrutiny.

``The challenge is to clean up something we cannot see, smell or touch,'' said Ginger Booker, assistant director of the Piedmont Triad Council of Governments, which is helping to coordinate the effort.

Participants include businesses such as Duke Power, R.J. Reynolds and Cone Mills; chambers of commerce in Greensboro and Winston- Salem; governments in Greensboro, High Point, Winston- Salem, Kernersville, Eden, Clemmons and Burlington; Piedmont Triad International Airport; the Piedmont Authority for Regional Transportation; the Forsyth County Department of

Environmental Affairs; the N.C. Division of Air Quality; the American Lung Association; and the Blue Ridge Environmental Defense League.

The members decided Monday to also invite representatives of the gasoline, road-building, construction, trucking, railroad and farming industries.

Pollution can be reduced, Fulp said. New laws will take effect in the next few years to reduce emissions from factories and power plants, and cleaner burning fuels and cars are on the way. A tougher car inspection program also is in the works.

The Asheville, Fayetteville and Hickory areas are going through the same process.
The Triangle chose not to start reducing air pollution earlier than required.
The Charlotte area is not eligible because it already is violating existing ozone laws.

2. Local Officials Working to Meet Pollution Limits

4-1-03 By PAUL MUSCHICK, Staff Writer, News & Record

KERNERSVILLE -- New technology and state and federal laws will cut one air pollutant 64 percent in the Triad, a good start toward meeting stricter air quality limits, a state analyst said Monday.

If local governments do their part, too, the region should be in compliance by 2007.

"We're seeing significant reduction in those emissions," said Sheila Holman of the N.C. Division of Air Quality. "We think you have a real chance at being able to show attainment."

Holman on Monday briefed a group of business leaders, politicians, planners and environmentalists who represent 11 counties and 20 towns that have agreed to work together to cut ozone pollution.

Ozone is caused by burning fuels -- such as from power plants, factories, airports and cars -- and can cause breathing difficulties.

Holman said that by 2007, nitrogen oxide, one component of ozone, will drop 64 percent compared to 1997 levels because of state and federal laws taking effect in the next few years that limit emissions from power plants and factories; require the use of low-sulfur gasoline; require tougher car inspections; and produce cleaner-burning engines.

Still, the region needs to do more at the local level to cut nitrogen oxide if it wants to meet the new federal limit.

The planning group intends to discuss possible alternatives over the next few months and submit a preliminary list to the Environmental Protection Agency by June 16.

The work is in anticipation of an EPA ruling next year that the region will be in violation of new, tougher ozone rules. The Triad would have until 2010 to clean up the air or face penalties that could include limiting the construction of new factories and roads that could add even more ozone.

But the Triad, along with three other parts of the state, has entered a program that it hopes will clean up the air by 2007. Over the next few months, the local panel will study a list of pollution-cutting ideas used in places such as Winston-Salem; Charlotte; Atlanta; San Antonio, Texas; and Austin, Texas.

Among the options are requiring contractors working on government jobs such as road projects to use equipment with clean-burning engines; increasing public transportation options to reduce the number of cars on the road; and cracking down on cars that clearly are blowing out too much exhaust.

Bob Fulp of the Forsyth County Environmental Affairs Department cautioned the panel not to limit itself to the list of ideas provided to members Monday.

"Be creative," Fulp said. "There are probably some things out there that are pretty darn good ideas that nobody's even thought of yet." Fulp and other panel members also said compiling a list of ideas by June will be difficult because the state has not yet provided information about how much ozone each option may reduce.

Holman said that information will not be available until late summer, still in plenty of time for the panel to put together its final list of ideas by March 2004.

The technology and laws already on the way will result in a 91 percent reduction of daily nitrogen oxide emissions from power plants, Holman said. Emissions from factories should drop by about half, and emissions from traffic should drop by 41 percent.

Holman suggested the group focus on pollution sources that upcoming technology and laws will not have much effect on by 2007, such as smaller factories, airports, construction equipment, trains, boats and smaller engines such as lawn mowers.

3. AREA LEADERS TACKLE AIR POLLUTION

ELEVEN TRIAD COUNTIES ARE WORKING TOGETHER TO REDUCE OZONE DATE: Tuesday, April 8, 2003 PAUL MUSCHICK Staff Writer

Kernersville - Using equipment with cleaner-burning engines at landfills, sewage plants and road-construction projects could help toward meeting tougher federal air pollution laws, Triad leaders said Monday.

Making that happen may not be easy, though, if private companies don't want to spend the money to upgrade their trucks, bulldozers and other vehicles.

The idea was one of many discussed Monday by elected officials, business leaders, planners and environmentalists from 11 counties in their ongoing work to reduce ozone pollution.

The planning group will discuss ideas in the next few months and submit a preliminary list to the Environmental Protection Agency by June 16.

The work is in anticipation of an EPA ruling next year that the region will be in violation of new, tougher ozone rules. The Triad would have until 2010 to clean up the air or face penalties that could include limiting the construction of new factories and roads that could add even more ozone.

But the Triad, along with three other parts of the state, has entered a program that it hopes will clean up the air by 2007.

The first thing the group did Monday was agree on what likely would not work here - many of them items that would cost residents money by making it more expensive to drive. Cars and trucks created about 28 percent of the Triad's ozone in 1997, the most recent year for which data is available.

Among the ideas discarded Monday were increasing fuels taxes; charging vehicle registration fees based on how many miles people drive and how much pollution their type of car creates; or limiting the number of vehicles that could be registered.

The group also discussed efforts already under way that could cut ozone - park-and-ride lots, regional buses, van pools and other services of the Piedmont Authority for Regional Transportation.

The dilemma the pollution prevention planners face is they do not know exactly how much ozone they must cut to meet the lower federal limit. The state has not finished computing that yet.

Bob Harkrader, Burlington's planning director, said he'll need to know the benefits of any ideas before asking Burlington leaders to support them, especially those that could be politically painful."

One idea under consideration is requiring road builders to use cleaner-burning equipment on future contracts, an idea that state transportation officials already are discussing, said Sheila Holman of the N.C. Division of Air Quality.

Road builders likely would lobby against the plan, warned Bob Fulp, director of the Forsyth County Environmental Affairs Department. ``Don't expect they're going to be real thrilled about it,'' he said.

And if local leaders endorse such a plan, Fulp said, the Triad's cities and government should consider upgrading their equipment at landfills and sewage plants, too, to do their part.

4. Panel sifts through pollution solutions

5-20-03 By PAUL MUSCHICK, Staff Writer

Business, political, environmental and transportation officials on Monday whittled down options to reduce the Triad's ozone pollution and avoid federal air quality penalties.

The panel discussed nearly 200 options, agreeing to keep some for further discussion while discarding those that were unrealistic -- such as "no drive days" -- or could be politically unpopular, such as higher taxes and fees on those who drive the most.

The panel has until June 16 to submit a broad list of ideas to the Environmental Protection Agency for how the Triad could reduce ozone, a colorless gas created when pollutants from cars, power plants, airplanes, lawn mowers, construction equipment and other sources of burning fuel are heated by the sun.

Among the ideas still being considered include persuading people to conserve energy and reducing traffic by offering more public transit and permitting people to work and do things like pay bills over the computer from home.

The panel suggested steps such as providing electrical connections at truck stops, so trucks would not have to idle to have power inside. Also recommended were steps toward the use of cleaner burning fuels and vehicles.

The panel could approve the list in two weeks. It then would have about another year to decide which of the ideas to actually implement. Some could require state or local legislation.

Ozone can cause breathing problems, according to the EPA. The American Lung Association reported this month that the Triad has the 17th-worst ozone pollution in the United States, although some have criticized the study as flawed.

The area is not expected to meet new federal guidelines for ozone next year. The panel that met Monday is working on a plan to meet the new limits by 2007. If panelists fail, penalties could include limits on new industry and the withholding of road construction and other transportation money in 2010.

The panel discarded about 70 ideas Monday. Some were impractical. Some were sure to meet political, business or public opposition. Some just couldn't be done in time.

For example, some governments are studying the effectiveness of building car-pool lanes on major highways, but that is a decade-long process. Significant transit improvements also are about that far off.

Ideas for requiring auto emissions inspections statewide were shot down because panelists believed state lawmakers would not sign off.

Other ideas had the potential to infringe on businesses, such as motivating car dealers to keep a certain percentage of hybrid or alterative-fuel vehicles in stock; restricting where heavy-duty diesel vehicles could drive at certain times; and mandating tougher controls on industry.

Some panelists suggested the EPA would be more likely to approve the area's list of options if the list is short.

"That conveys to the EPA that we have sat down and done a serious analysis and not just put down things willy-nilly," said Bob Fulp, director of the Forsyth County Environmental Affairs Department.

Others, including Hoy Bohanon of the environmental affairs department at R.J. Reynolds Tobacco Co., said the list should be broad so no options are prematurely eliminated.

5. COUNTY LOCKS IN ENERGY SAVINGS

June 12. 2003 12:00AM BY ERIC FRAZIER, ***The Lexington Dispatch***

Some say it takes money to make money, but the Davidson County commissioners have found a way to save money without having to spend any first.

They approved a guaranteed energy savings contract with Johnson Controls Tuesday night. Under the contract, Johnson Controls will conduct an evaluation of 17 public buildings in the county to identify conservation measures. When implemented, the measures should save enough on energy costs to pay for both the study and the equipment the company will install. If not, Johnson Controls must pay for the work.

"It sounds too good to be true," said Dwayne Childress, purchasing director for the county, "but the companies that do this are regulated by the state."

Such projects are enabled in North Carolina through legislation passed by the General Assembly in the 1980s and overseen by the N.C. Local Government Commission.

Typical work includes installation of high-efficiency heating and air conditioning equipment, automated temperature controls, water conservation and also energy management training for building staff.

After building inspections and a preliminary review of utility bills, Johnson Controls estimated the county could save from $100,000 to $139,000 per year.

A typical contract –the company calls them partnerships -would be set up for 12 years. Over that period, the firm estimated $1.2 million to $1.67 million in savings. The package of improvements is financed like any other capital project and paid out over the 12 years.

Childress said the savings to the county begin in the first year because the annual contract amount is required to be less than what the energy firm has projected in savings.

Johnson Controls is a 115-year-old energy services company that has completed such projects in schools across the state. It began a similar guaranteed energy savings program at Davidson County Community College in 2001.

County Manager Robert Hyatt reported to the commissioners that local community college officials are pleased with the contracted work that has been performed so far.

"They´re at the point where the rubber meets the road – the savings generated by the Childress said one of his concerns was whether the improvements would outlast the 12 years needed to pay for them. He said Scott Rickard, assistant maintenance director, had inspected the work performed at the college and was satisfied with the quality.

After Johnson Controls performed the preliminary study, the county asked for competitive proposals from two other companies, Ameresco Inc. and Honeywell International. Then, an independent engineer reviewed all three proposals and ranked Johnson Controls best. Now the company will prepare a final study that will contain the actual design specifications for all construction.

The cost of the final study is $36,540, but that amount will be rolled into the final agreement with Johnson Controls. No cash outlay will be needed unless the county for some reason decides not to continue with the program.

The final study will produce the 12-year performance contract that governs the construction, financing and payment schedules for the project.

6. Council ponders energy upgrades

9-3-03 By SUE SCHULTZ, Staff Writer *News & Record*

HIGH POINT -- City Council members considered Tuesday $1.2 million in upgrades aimed at lowering energy costs at city hall while generating savings for the city. Jeff Moore, the director of the city's finance department, told council members that what the city saves on its energy bills during the next 12 years can be used to pay the costs of the upgrades.

The upgrades, which will take about six months to complete, will include replacing lighting with more energy-efficient bulbs and switching from electric boilers to gas-operated boilers. The project will update the building's 30-year-old heating and cooling systems, venting system and lighting.

"This is a creative way to replace an outdated mechanical system with a new, updated, energy-efficient system," said city Manager Strib Boynton. "Our current one is held together by chewing gum, duct tape and wires."

The city will borrow the money for the project from Koch Financial Corp. and pay off the debt over 12 years through a lease-purchase program. Like other government agencies, High Point has to qualify for the program and get state approval before entering into the contract. Tuesday, council members recommended the city submit its application for the program with a state board, which will meet in October.

Under the energy savings program, the city anticipates saving about $136,000 a year on its energy bills. Using that money, the city would pay more than $132,000 in lease and debt payments for the upgrades each year for the next 12 years.

But Moore told council members that after the debt is paid off, the city will be able to keep the savings. The council will discuss further action on the energy savings program later in the month.

7. Ozone in Triad climbs 56 percent in past decade

8-20-03By PAUL MUSCHICK, Staff Writer *News & Record*

The Triad has one of the fastest-growing ozone pollution problems among the nation's largest and most-polluted regions, according to a report released Tuesday.

The number of days with unhealthy ozone levels rose 56 percent in the Triad during the past decade, according to the Surface Transportation Policy Project, a Washington-based organization lobbying for transportation reform.

The Triad averaged 13 days of unhealthy ozone from 1993 to 1997 and nearly 20 days from 1998 to 2002. The increase was the fourth-highest of the 49 places studied.

That does not mean, however, that the Triad's ozone grew at the fourth-fastest rate in the nation. The report does not include information from other metro areas that do not have a history of poor air quality, though they could have had larger percentage increases in ozone.

 To read the report, go to www.transact.org

The Triad and other Southeast areas such as Charlotte and Raleigh may stand out in the study because of weather patterns during the decade when the comparisons were made.

The first half of the decade was relatively dry and cool, when ozone typically doesn't form. The second half of the decade was hot, dry and perfect for ozone, leading to large increases.

"There's a big caveat because it's a weather-related thing," said Lewis Weinstock of the Forsyth County Environmental Affairs Department, the region's air-monitoring leader.

Still, he said, Tuesday's report is more evidence that the region still has not solved its ozone problem, one that is expected to land the Triad in violation of federal limits next year. That could bring restrictions on business and road building.

The Surface Transportation Policy Project issued the report because cars and trucks create ozone and other pollution. The group is calling on Congress, as members debate a new transportation spending law, to provide more money for public transportation that can reduce traffic.

Transportation is a major contributor to the unhealthy air that we breathe," said Anne Canby, the organization's president and a former transportation director in New Jersey and Delaware.

Nationally, she said, it is responsible for more than half of all carbon monoxide pollution and about one-third of the pollutants that create ozone.

Enlarging road capacity, promoting loops to carry commuters farther from city centers and starving public transportation for operating dollars is not going to clear the air in North Carolina or protect our health and our tourism economy," said Eva Ritchey, president of Citizens for Transportation Planning and a member of the N.C. Alliance for Transportation Reform.

Ozone, a main component of smog, forms when pollutants from burning fuel are heated in the sun. It can cause breathing problems, according to the Environmental Protection Agency. In a similar study earlier this year, the American Lung Association said the Triad has the 17th-worst ozone pollution in the United States.

Nearly half of all Americans are breathing unhealthy air, according to Tuesday's report, which links air pollution to asthma, heart attacks and even early death.

The public health impact of air pollutants from cars and trucks is enormous," said Dr. Howard Frumkin, an Emory University professor and representative of the American Public Health Association. "Transportation policies that clean up our air are essential public health policy."

Triad leaders are encouraging increased use of public transportation, cleaner-burning fuels and more-efficient engines as part of a plan to reduce ozone.

Eleven Piedmont Triad counties and 20 cities have signed an agreement with the EPA to work toward cleaning up the air by 2007 -- sooner than required -- through an early action compact.

The Triad, however, is not expected to meet tougher ozone limits to be enacted next year.

8. Rural counties may get commuter park-ride lots

11-13-03 By PAUL MUSCHICK, Staff Writer *News & Record*

The Piedmont Authority for Regional Transportation is considering whether to build park-and-ride lots in suburban counties, which could put the first pressure on those counties to begin financially supporting the authority.

The authority, known as PART, represents six Piedmont Triad counties, but only Guilford and Forsyth pay for its activities, which are centered in those two counties. Guilford and Forsyth levy a 5 percent tax on rental cars to raise money for regional buses and other services.

PART is planning its first park-and-ride lots, to be largely paid for by a $4.4 million federal grant. The first lots are proposed in Greensboro, High Point and Winston-Salem. But PART board members said Wednesday that lots should also be built in the suburbs so the thousands of commuters in those counties could have a place to meet and form carpools. Successful carpool locations could become stops on PART's bus route if it expands in the future.

More than 20,000 people drive from Randolph County to Guilford County for work, with another 15,000 coming from Davidson County, 12,000 from Rockingham County and 6,000 from Alamance County, according to the U.S. Census Bureau.

Providing opportunities for those people to carpool could reduce traffic, air pollution and the risk of accidents, PART Executive Director Brent McKinney told the board.

PART has enough money to build about 20 lots, he said. Local governments would have to pay 10 percent of the cost of each lot, with the federal grant and state covering the rest.

"These lots are not going to cost us a lot of money," McKinney said. "We can put up a lot of these out in the rural areas."

The local payments for the Guilford and Forsyth lots would come from the car rental taxes raised there. The suburban communities would have to raise their own money -- about $10,000 per lot -- if they wanted PART to build lots there, McKinney said. Or they could provide land or other services, such as fencing, lights, maintenance and real estate transaction fees.

Bob Landreth, a PART board member and Guilford County commissioner, said this means it is time for suburban counties to begin financially supporting PART.

David Isley, a PART board member and Rockingham County commissioner, said he would like to explore building a lot in his county. He said he doubts his commissioners would enact a rental car tax because it could hurt car dealerships, which rent a lot of cars to customers whose cars are being repaired.

He said the lot's location would be important because Rockingham commuters may not drive 15 minutes to a park-and-ride lot to form a carpool and head to Greensboro when the direct trip is only 30 minutes.

John Patterson, a PART board member and Alamance County commissioner, said he believes his county could come up with a one-time $10,000 payment to build a lot in Alamance, possibly by the county donating land.

"I feel like Alamance County will come up with its part," Patterson said.

PART should build the suburban lots even if those governments refuse to pay their part, suggested PART board member and Greensboro Mayor Keith Holliday. He said Greensboro and Guilford County would benefit by making commutes easier because commuters spend money in the city and county while they are here.

That may not be fair to the governments that already are paying for PART, said Sandy Carmany, a Greensboro councilwoman and PART member.

9. Air quality hot topic for county

By J.D. Walker Staff Writer, The Courier-Tribune

ASHEBORO - Air quality will be a hot topic for area municipal and county government officials in December.

That's when a draft proposal from the Triad Air Quality Early Action Compact (EAC) will be submitted for their approval. The proposal will detail ways by which governments, industries and local citizens can meet Environmental Protection Agency (EPA) ozone standards before a December 2007 deadline.

At stake could be EPA restrictions on new industries in the area and state mandates on enforcement, among possible repercussions.

The EAC represents 11 counties and their municipalities, including Alamance, Caswell, Davidson, Davie, For-syth, Guilford, Randolph, Rockingham, Stokes, Surry and Yadkin counties.

At a joint government meeting Monday that was open to the public, officials were updated on what EPA standards are, how the EAC operates and the consequences for failure to comply. The meeting was attended by roughly 30 people, including Southwestern Randolph High School environmental science teacher Brenda Daniels and two of her students, Katie Jo Hinshaw and Carla Smith.

Daniels plans to use some of the material and information gathered at the meeting for upcoming lesson plans on air quality in her science class.

For local leaders, the meeting was more than a lesson plan. It was a wake-up call to take action before state and federal officials step in to make decisions for them.

The presentation was made by Ginger Booker from the Piedmont Triad Council of Governments (COG). She said if area governments can present a plan of action to EPA officials for consideration by January 2004, they might forestall a judgment on air quality until December 2007.

If the EAC does not come up with a workable plan to reduce ozone emissions throughout the 11-county area, local leaders can expect to get a judgment of "non-attainment." That's because early tests indicate the area already exceeds the government standard of ozone levels that are less than .085 parts per million.

A judge of non-attainment could mean: Stricter enforcement mandated by state officials; a loss of federal highway development and maintenance funding, and EPA restrictions on new industries moving into the area.

Participants were given an opportunity to offer suggestions to be taken to the EAC for review on Nov. 3. John Ogburn, Asheboro city manager, said his government has already had city buildings evaluated and updated to make them more energy efficient. He said city leaders will review bids for a new garbage truck soon. "We will have to consider our options carefully there," he said. "We have to be smart consumers."

Booker pointed out that Randolph County has been proactive in its land use plan by encouraging developments with green spaces and compact neighborhoods.

The draft proposal that is expected to be submitted to area governments will ask for voluntary compliance. It will provide numerous suggestions but will not mandate any one plan of action for individual towns or counties. It will be up to local leaders to determine the best options for their areas based on need and budgetary concerns.

"But I don't think we have a choice," said Phil Kemp, Randolph County commission chair.

In the end, said Daniels, the final proof of success or failure will be in the ozone measures taken by EPA.

10. Air-quality plan moves ahead

12-22-03 By Paul Muschick Staff Writer *News & Record*

The 31 local governments that promised a year ago to work together to reduce ozone pollution have followed through and all endorsed a plan to send to the Environmental Protection Agency early next year.

Want to know more?
To read more about the Piedmont Triad's ozone problem and potential solutions, go to www.ptcog.org/eac.html or www.nwpcog.org/EAC/

Elected officials in the 11 counties and 20 cities and towns have voted over the past month to support the plan, which if approved by the EPA could help the region escape penalties for its pollution.

"It's a big step," said Ginger Booker, assistant director of the Piedmont Triad Council of Governments, which coordinated the effort. "I have been very pleased with the level of commitment."

The EPA did not require that all of the governments stick with the process, but if a large community such as Greensboro or Guilford County had dropped out, it could have scuttled the effort because those areas are large contributors to the ozone problem.

The region is expected to be among several in the state that could violate stricter ozone limits that will be enforced early next year. Failure to clean up the air could result in penalties such as restrictions on new industry or the expansion of industry, and the loss of federal road money.

Last December, the 31 local governments signed an agreement with the EPA that could spare them from those potential penalties. The governments agreed to write a plan showing how they would collectively reduce ozone to acceptable levels by 2007. If the plan works and ozone pollution drops, the EPA will not punish the region.

The plan endorsed by local leaders calls for steps such as reducing traffic, conserving energy, using cleaner-burning engines and fuels and reducing emissions from factories. Among the actions that it has triggered is an application by Guilford County Schools for a state grant to retrofit bus engines to run on cleaner-burning, low-sulfur diesel fuel, Booker said.

"It would significantly lower the emissions that these buses have," Booker said.

Preliminary projections by state scientists show that new state and federal requirements, such as tougher car inspections in some North Carolina counties, would decrease ozone to acceptable levels by 2007 at all but one of the region's monitors -- at Cooleemee in Davie County.

Solving pollution there is problematic because some of the ozone measured at that site is actually produced in the Charlotte area and blown north, the state says. Local leaders have no way to enforce pollution regulations in Charlotte.

The next step will be for local leaders to measure how much ozone pollution would be reduced by their plan, and to factor that into the future ozone estimates.

Ozone is caused when pollutants from sources of burning fuel such as cars, airplanes and factories are heated by the sun.

Gases emitted naturally by trees also contribute to the problem.

Ozone pollution can cause breathing problems, according to the EPA. Earlier this year, the American Lung Association ranked the Piedmont Triad as having the 17th-worst ozone pollution in the nation.

In addition to the 31 governments that signed the EPA agreement, several other local governments have also endorsed the pollution-reduction plan as a show of support.

"It's been very well-received," said Matthew Dolge, executive director of the Northwest Piedmont Council of Governments, which also is coordinating the ozone effort.

11. Coal-fired plant cuts pollutants

2-9-04 By Tim Yeadon Staff Writer *News & Record*

BELEWS LAKE — Five years ago, the Belews Creek Steam Station ranked third nationwide in the amount of emissions causing smog and acid rain.

Many people hope those days have ended with the completion of a $450 million project at the coal-fired power plant that Duke Power says will reduce such emissions by 80 percent.

The project is required by federal legislation related to the Clean Air Act. Now complete after a nearly two-year project, the “selective catalytic reducers,” or SCR, are a pair of 30-story steel structures built next to the plant’s twin boilers. In all, it took more than 900 workers and a $55 million payroll to build the structures at the plant, located northeast of Winston-Salem on Belews Lake in Stokes County.

“Cleaning up those smoke stacks is critical for Greensboro to have cleaner air,” said Michael Shore, an Asheville-based air-quality manager for Environmental Defense, the nationwide environmental lobbying group. “It’s been a longtime coming in reducing power plant pollution.”

During the May to September ozone season, exhaust from the plant’s two coal-burning boilers will be routed through a pair of giant catalytic converters, where an ammonia solution will be added – turning the nitrogen oxide into harmless amounts of nitrogen and water.

Duke Power will not be forced to use the “selective catalytic reducers,” or SCR’s, year-round until 2007, when regulations from the North Carolina “Clean Smokestacks Agreement” take effect. The plan calls for a sharp reduction in emissions from the state’s 14 coal-fired plants without raising the cost of electricity.

That agreement, signed by Gov. Mike Easley in 2002, will force Duke Power to begin the installation at the Belews Creek plant of chemical filters and “scrubbers” to further reduce emissions of nitrogen oxide and sulfur dioxide.

Nitrogen oxide reacts with organic emissions, such as unburned fuel from car engines or paint fumes, to create smog and dust that hangs in the atmosphere and torments those with allergies and asthma. Another byproduct is acid rain.

Kris Knudsen, a senior technical air compliance technician for Duke Power, said that the scrubber project will be complete at the Belews Creek plant before 2009. “It’s something that a lot of people have been asking for,” Knudsen said.

The Belews Creek plant and other large polluters – coal-fired power plants, cement kilns and other large boiler operations – have long been on the Environmental Protection Agency's list of plants where emissions can be reduced at a relatively low cost.

The Belews Creek plant was built in 1974. At peak capacity it burns 19,000 tons of coal a day in its two units to power 2.5 million households in North Carolina and South Carolina. It was built for $357 million – about $100 million less than the current project.

But cheap power has long had an environmental price.

In 2001, the plant released 12.3 million pounds of toxic chemicals into the environment, according to the most recent figures reported in the EPA's Toxics Release Inventory database. Statewide, only one other plant, Carolina Power & Light's Roxboro Steam Electric Plant in Person County, emitted more toxic tonnage.

But Duke Power spokesman Tom Williams says headlines that consistently declared the Belews Creek Steam Station as the Triad's most prolific polluter are not fair. "We're are a bit sensitive to that," Williams said. "We are proud of that plant."

Duke Power officials contend that in the long run, greater levels of pollution have been avoided by using large coal-fired power plants that they say use less coal to produce the same amount of energy than a group of smaller, similar plants.

The project that Duke Power just completed at Belews Creek targeted nitrogen oxide, of which the plant produced 68,252 pounds in 1999, ranking it the then-third worst polluting plant in the country.

By 2001, upgrades to "burner tips" that regulate coal combustion within the boilers helped cut the emission tonnage in half, or about 34,000 pounds.

Duke Power estimates the new equipment could reduce the plant's current nitrogen oxide emission by an additional 80 percent, or to an annual total of about 6,700 pounds, without affecting the price of electricity.

12.

Power plant job done

Tuesday, February 10, 2004 12:00AM EST **The Associated Press**

BELEWS LAKE -- Duke Power has completed a $450 million project at the Belews Creek Steam Station in Stokes County that the utility says will reduce by 80 percent emissions that cause smog and acid rain.

Federal legislation related to the Clean Air Act requires the project at the coal-fired power plant that five years ago ranked third nationwide in the amount of those emissions.

Now complete after nearly two years of work, the "selective catalytic reducers" are a pair of 30-story steel structures next to the plant's twin boilers. It took more than 900 workers and a $55 million payroll to build the structures at the plant, northeast of Winston-Salem on Belews Lake.

"Cleaning up those smokestacks is critical for Greensboro to have cleaner air," said Michael Shore of Asheville, an air-quality manager for Environmental Defense, the nationwide environmental lobbying group. "It's been a long time coming in reducing power-plant pollution."

During the ozone season from May to September, exhaust from the plant's two coal-burning boilers will be routed through a pair of giant catalytic converters, where an ammonia solution will be added, turning the nitrogen oxide into harmless amounts of nitrogen and water.

Duke Power will not be forced to use the new structures year-round until 2007, when state "clean smokestacks" regulations take effect. The plan calls for a sharp reduction in emissions from the state's 14 coal-fired plants.

13. School buses to run cleaner

3-30-04 By Paul Muschick Staff Writer *News & Record*

Guilford County Schools is one of five systems in the state to win a grant to improve bus engines so they create less air pollution.

The system will receive $100,000 from the N.C. Department of Environment and Natural Resources to add pollution filters to its buses. Depending on how much the parts cost, the grant could cover between 50 and 100 buses, up to one-sixth of the county's fleet.

The equipment -- similar to catalytic converters that are standard on cars -- superheat pollutants and burn them away before they can escape into the air.

"Our job is to safely move the students," said Jim Moen, the schools' transportation director. "Safely doing it, I think, includes emissions controls."

Moen intends to pursue other grants to upgrade more of the fleet. The school system already has a policy to turn off the engines of buses while they are parked outside of schools, conserving fuel and reducing emissions.

The grant is among the first evidence of the region following through on a promise to reduce air pollution.

Eleven counties and 20 cities in the Piedmont Triad have signed an agreement with the Environmental Protection Agency to reduce ozone by 2007.

Next month, the EPA expects to declare part or all of the region in violation of a tougher ozone law, but it has agreed to forego penalties if local authorities clean up the air. Penalties could include restrictions on new industry and the loss of federal road money.

A committee of business, transportation, environmental and elected leaders has been working for about a year on an ozone-reduction plan. It intends to submit that final plan later this week, using the county schools grant as an example of one of its suggestions being carried out.

"I just think it's important that we all work together to improve our air quality," said Allen Purser, a senior vice president at the Greensboro Chamber of Commerce and a member of the pollution planning committee.

Improving bus engines could reduce ozone-causing emissions up to 5 percent, according to the school system's grant application. The new equipment could have a greater impact on reducing particle pollution, said Tom Mather, a spokesman for the N.C. Division of Air Quality.

To maximize the number of buses that can be improved, the school system intends to install the equipment itself and use the grant money for parts, not labor. Moen said the parts could be added this summer in time for the next school year.

The N.C. Department of Environment and Natural Resources distributed $350,000 in grants statewide.

Other winners include school systems in Wake, Mecklenburg, Iredell and Cumberland counties.

The money comes from state gasoline taxes. Since 1995, the state has awarded 78 grants totaling $5.7 million. It did not award any grants in 2002 and 2001 because of the state budget crisis.

2 Overview of Air Quality In The Triad Area

The U.S. Environmental Protection Agency (EPA), under the authority of the Federal Clean Air Act, regulates outdoor air pollution in the United States. The EPA sets National Ambient Air Quality Standards (NAAQS) for six "criteria pollutants" that are considered harmful to human health and the environment.[1] These six pollutants are carbon monoxide, lead, ozone, nitrogen dioxide, particulate matter and sulfur dioxide. Particulate matter is further classified into two categories: PM 10, or particles with diameters of 10 micrometers or less, and fine particulate (PM 2.5), particles with diameters of 2.5 micrometers or less. Levels of a pollutant above the health-based standard pose a risk to human health.

The NCDAQ monitors levels of all six criteria pollutants in the Triad area and reports these levels to the EPA. According to the most recent data, the Triad area is meeting national ambient standards for four of the pollutants, but is not meeting the Federal 8-hour standard for ground-level ozone and fine particulate matter. This report focuses on the 8-hour ground level ozone only.

Federal enforcement of the ozone NAAQS is based on a 3-year monitor "design value". The design value for each monitor is obtained by averaging the annual fourth highest daily maximum 8-hour ozone values over three consecutive years. If a monitor's design value exceeds the NAAQS, that monitor is in violation of the standard. The EPA may designate part or all of the metropolitan statistical area (MSA) as nonattainment even if only one monitor in the MSA violates the NAAQS,.

There are nine ozone monitors in Triad EAC area. These monitors are: Bethany, located in Rockingham County; Cherry Grove, located in Caswell County; McLeansville, located in Guilford County; Sophia, located in Randolph County; Cooleemee, located in Davie County; and Hattie Ave, Pollirosa, Shiloh Church and Union Cross, all located in Forsyth County. The location of these monitors are shown in Figure 2-1.

Figure 2-1: Triad EAC Area's 8-hour Ozone Monitor

For the 3-year periods 2000 –

2002 and 2001 – 2003, all but one monitor, Pollirosa, is violating the 8-hour ground-level ozone NAAQS, see Table 2.1. The historical ozone monitoring data, including the year for which the design values are based on, is listed in Table 2.2. Monitor design values are dependant on which three year period the 4th highest 8-Hour ozone concentrations are averaged. Data gaps in early year in Table 2.2 mean monitors were not installed during these years.

Table 2.1 Ozone Monitor Design Values in parts per million (ppm)

Monitor Name	County	00-02	01-03
Bethany	Rockingham	0.090	0.091
Cherry Grove	Caswell	0.091	0.088
Cooleemee	Davie	0.095	0.093
Hattie Avenue	Forsyth	0.094	0.093
McLeansville	Guilford	0.093	0.089
Pollirosa	Forsyth	0.084	0.082
Shiloh Church	Forsyth	0.092	0.088
Sophia	Randolph	0.088	0.085
Union Cross	Forsyth	0.092	0.089

Table 2.2 Historical 4th Highest 8-Hour ozone values (1994-2003)

Monitor Site	4th Highest 8-Hour Ozone Values (ppm)									
	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Bethany	0.093	0.073	0.092	0.089	0.087	0.081	0.082	0.094	0.096	0.083
Cherry Grove	0.083	0.086	0.088	0.095	0.096	0.091	0.092	0.087	0.095	0.083
Cooleemee			0.084	0.092	0.102	0.100	0.094	0.094	0.098	0.089
Hattie Ave.	0.081	0.090	0.080	0.093	0.100	0.099	0.090	0.094	0.099	0.087
McLeansville	0.086	0.089	0.084	0.084	0.097	0.096	0.089	0.086	0.104	0.079
Pollirosa	0.072	0.080	0.082	0.083	0.087	0.082	0.082	0.082	0.088	0.078
Shiloh Church			0.088	0.079	0.094	0.086	0.086	0.096	0.094	0.074
Sophia								0.085	0.092	0.078
Union Cross	0.088	0.086	0.091	0.092	0.095	0.096	0.089	0.094	0.093	0.081

The Forsyth County Environmental Affairs Department (FCEAD) forecasts ozone levels, as well as fine particulate levels, on a daily basis year round for the Triad area. This forecast is issued to the public using EPA's Air Quality Index (AQI) color code system. Table 2-3 lists the ozone regulatory standard and AQI breakpoints with their corresponding health risks.

Table 2-3: Air Quality Index Color Code System

Pollutant/ Standard	Standard Value	Pollutant concentration (ppm) ranges for AQI color codes				
		Green AQI 0– 50 Good	**Yellow AQI 51-100 Moderate**	**Orange AQI 101-150 Unhealthy for Sensitive Groups**	**Red AQI 151-200 Unhealthy**	**Purple AQI 201-300 Very Unhealthy**
Ozone/ 8-hour average	0.08 ppm averaged over 8 hours	0-0.064	0.065-0.084	0.085-0.104	0.105-0.124	0.125-0.374

The AQI color codes standardize the reporting of different pollutants by classifying pollutant concentrations according to relative health risk, using colors and index numbers to describe pollutant levels. The AQI is also used to report the previous day's air quality to the public. In the Triad area, the forecast and previous day air quality reports appear on the weather page of local newspapers and FCEAD's website: http://www.co.forsyth.nc.us/envAffairs/DlyAirQualRpt.htm. Additionally, the ozone forecast is broadcasted during the local news on television and radio.

3 Ozone And Its Health Effects And Sources

3.1 Overview of Ozone

Ozone (O_3) is a tri-atomic ion of oxygen. In the stratosphere or upper atmosphere, ozone occurs naturally and protects the Earth's surface from ultraviolet radiation. Ozone in the lower atmosphere is often called ground-level ozone, tropospheric ozone, or ozone pollution to distinguish is from upper-atmospheric or stratospheric ozone. Ozone does occur naturally in the lower atmosphere (troposphere), but only in relatively low background concentrations of about 30 parts per billion (ppb), well below the NAAQS. The term "smog" is also commonly used to refer to ozone pollution. Although ozone is a component of smog; smog is a combination of ozone and airborne particles having a brownish or dirty appearance. It is possible for ozone levels to be elevated even on clear days with no obvious "smog".

In the lower atmosphere, ozone is formed when airborne chemicals, primarily nitrogen oxides (NOx) and volatile organic compounds (VOCs), combine in a chemical reaction driven by heat and sunlight. These ozone-forming chemicals are called precursors to ozone. Man-made NOx and VOC precursors contribute to ozone concentrations above natural background levels. Since ozone formation is greatest on hot, sunny days with little wind, elevated ozone concentrations occur during the warm weather months, generally May through September. In agreement with EPA's guidance, North Carolina operates ozone monitors from April 1 through October 31 to be sure to capture all possible events of high ozone.

3.2 Ozone Health Effects

The form of oxygen we need to breathe is O_2. When we breathe ozone, it acts as an irritant to our lungs. Short-term, infrequent exposure to ozone can result in throat and eye irritation, difficulty drawing a deep breath, and coughing. Long-term and repeated exposure to ozone concentrations above the NAAQS can result in reduction of lung function as the cells lining the lungs are damaged. Repeated cycles of damage and healing may result in scarring of lung tissue and permanently reduced lung function. Health studies have indicated that high ambient ozone concentrations may impair lung function growth in children, resulting in reduced lung function in adulthood. In adults, ozone exposure may accelerate the natural decline in lung function that occurs as part of the normal aging process. Ozone may also aggravate chronic lung diseases such as emphysema and bronchitis and reduce the immune system's ability to fight off bacterial infections in the respiratory system.

Asthmatics and other individuals with respiratory disease are especially at risk from elevated ozone concentrations. Ozone can aggravate asthma, increasing the risk of asthma attacks that require a doctor's attention or the use of additional medication. According to the EPA, one reason for this increased risk is that ozone increases susceptibility to allergens, which are the most common triggers for asthma attacks. In addition, asthmatics are more severely affected by the reduced lung function and irritation that ozone causes in the respiratory system. There is increasing evidence that ozone may trigger, not just exacerbate, asthma attacks in some individuals. Ozone may also contribute to the development of asthma. A recent study published in the British medical journal *The Lancet* found a strong association between elevated ambient ozone levels and the development of asthma in physically active children.[2]

All children are at risk from ozone exposure because they often spend a large part of the summer playing outdoors, their lungs are still developing, they breathe more air per pound of body weight, and they are less likely to notice symptoms. Children and adults who frequently exercise outdoors are particularly vulnerable to ozone's negative health effects, because they may be repeatedly exposed to elevated ozone concentrations while breathing at an increased respiratory rate.[3]

3.3 Ozone Sources

Ozone-forming pollutants, or precursors, are nitrogen oxides (NOx) and volatile organic compounds (VOCs).

3.3.1 Volatile Organic Compounds

Volatile organic compounds (VOCs) are a class of hydrocarbons, and therefore are sometimes referred to as hydrocarbons. However, it is important to note that hydrocarbons, as a class of chemical compounds, include less-reactive compounds not considered VOCs. In other words, although all VOCs are hydrocarbons, not all hydrocarbons are VOCs.

In North Carolina, large portions of precursor VOCs are produced by natural, or biogenic, sources, which are primarily trees. Man-made, or anthropogenic, VOCs also contribute to ozone production, particularly in urban areas. Sources of anthropogenic VOCs include unburned gasoline fumes evaporating from gas stations and cars, industrial emissions, and consumer products such as paints, solvents, and the fragrances in personal care products.

3.3.2 Nitrogen Oxides

Nitrogen oxides (NOx) are produced when fuels are burned, and result from the reaction of atmospheric nitrogen at the high temperatures produced by burning fuels. Power plants, highway motor vehicles, the major contributor in urban areas, and off-road mobile source equipment, such as construction equipment, lawn care equipment, trains, boats, etc., are the major sources of NOx.

Other NOx sources include "area" sources (small, widely-distributed sources) such as fires (forest fires, backyard burning, house fires, etc.), and natural gas hot water heaters. Other residential combustion sources such as oil and natural gas furnaces and wood burning also produce NOx, but these sources generally do not operate during warm-weather months when ground-level ozone is a problem. In general, area sources contribute only a very small portion of ozone-forming NOx emissions.

Generally, North Carolina, including the Triad area, is considered "NOx-limited" because of the abundance of VOC emissions from biogenic sources. Therefore, current ozone strategies focus on reducing NOx. However, VOC reduction strategies, such as control of evaporative emissions from gas stations and vehicles, could reduce ozone in urban areas where the biogenic VOC emissions are not as high.

3.3.3 Sources of NOx and VOCs

The following lists the sources, by category, what contribute to NOx and VOC emissions.

Biogenic: Trees and other natural sources.

Mobile: Vehicles traveling on paved roads: cars, trucks, buses, motorcycles, etc.

Nonroad: Vehicles not traveling on paved roads: construction, agricultural, and lawn care equipment, motorboats, locomotives, etc.

Point: "Smokestack" sources: industry and utilities.

Area: Sources not falling into above categories. For VOCs, includes gas stations, dry cleaners, print shops, consumer products, etc. For NOx, includes forest and residential fires, natural gas hot water heaters, etc.

4 Emissions Inventories

4.1 Introduction

Emissions modeling performed by NCDAQ estimates NOx and VOC emissions for an average summer day, given specific meteorological and future year conditions and using emission inputs based on emission inventories that include anticipated control measures. The biogenic emissions are kept at the same level as the episodic biogenic emissions since these emissions are based on meteorology and the meteorological conditions in the future years are kept the same as the episodic meteorology.

There are various types of emission inventories. The first is the base year or episodic inventory. This inventory is based on the year of the episode being modeled and is used for validating the photochemical model performance.

The second inventory used in this project is the “current” year inventory. For this modeling project it will be the 2000 emission inventory, which is the most current. This inventory is processed using all of the different meteorological episodes being studied. The photochemical modeling is processed using the current year inventory and those results are used as a representation of current air quality conditions for the meteorological conditions modeled.

Next is the future base year inventory. For this type, an inventory is developed for some future year for which attainment of the ozone standard is needed. The future base year projections for 2007 take into account all State and Federal control measures expected to operate at that time, including Federal vehicle emissions controls, NOx SIP Call controls, and North Carolina Clean Smokestacks controls. For this modeling project the attainment year is 2007 and the additional years for which a showing of continued maintenance of the 8-hour ozone standard are 2012 and 2017. An additional year, 2010, was modeled since this is the year for which the Charlotte/Gastonia and Raleigh/Durham areas must demonstrate attainment of the 8-hour ozone standard. It is the future base year inventories that control strategies and sensitivities are applied to determine what controls, to which source classifications, must be made in order to attain the ozone standard.

The base year inventories used for each source classifications are discussed in Appendix B. In the sections that follow, the inventories used for the current and the future years are discussed. Emission summaries by county for 2000 and 2007 (entire State) are in Appendix A.

4.2 Current Year Inventories

For the large utility sources, year specific Continuous Emissions Monitoring (CEM) data is used for base year episode specific modeling. However, it did not make sense to use 2000 CEM data for the current year inventory since the meteorology used for the current year modeling runs are the 1995, 1996, and 1997 episode specific meteorology. The concern is that the utility day specific emissions for 2000 would not correspond to the meteorology used in the modeling. After discussing this issue with EPA, the decision was made to continue to use the episodic CEM data for the current year inventory. Since only CEM NOx emissions are reported to the EPA, Acid Rain Division (ARD), the CO and VOC emissions are calculated from the NOx emissions using emission factor ratios (CO/NOx and VOC/NOx) for the particular combustion processes at the utilities.

The inventory used to model the other point sources is the 1999 National Emissions Inventory (NEI) release version 2.0 obtained from the EPA's Clearinghouse for Inventories and Emission Factors (CHIEF) website (http://www.epa.gov/ttn/chief/net/1999inventory.html). In addition, North Carolina emissions for forest fires and prescribed burns are treated as point sources and are episode specific similar to CEM data. These emissions were kept the same as the episodic emissions.

Similar to the other point source emissions inventory, the inventory used to model the stationary area sources is the 1999 NEI release version 2.0 obtained from the EPA's CHIEF website. The exception to this is for North Carolina where a 2000 current year inventory was generated by NCDAQ following the current methodologies outlined in the Emissions Inventory Improvement Program (EIIP) Area Source Development Documents, Volume III (http://www.epa.gov/ttn/chief/eiip/techreport/volume03/index.html).

For the nonroad mobile sources that are calculated within the NONROAD mobile model, a 2000 current year inventory was generated for the entire domain. The model version used is the Draft NONROAD2002 distributed for a limited, confidential, and secure review in November 2002. A newer draft version of this model (NONROAD2002a) was released by the EPA in June 2003. A comparison was done between the results from the two models and the differences were not significant for NOx emissions, however they were large for CO. Since CO does not play a large role in ozone formation, it is not believed that these differences will impact the ozone concentrations in the air quality model. However, since there are differences, when the final State Implementation Plan (SIP) modeling is carried out the updated emissions will be used.

The nonroad mobile sources not calculated within the NONROAD model include aircraft engines, railroad locomotives and commercial marine vessels. The 2000 current year inventory used for these sources is the 1999 NEI release version 2.0 obtained from the EPA's CHIEF website. The exception to this is for North Carolina where a 2000 current year inventory was generated by NCDAQ following the methodologies outlined in the EPA guidance document EPA-450/4-81-026d (Revised), Procedures for Inventory Preparation, Volume IV: Mobile Sources.

In order to accurately model the mobile source emissions in the EAC areas, the newest version of the MOBILE model, MOBILE6.2, was used. This model was released by EPA in 2002 and differs significantly from previous versions of the model. Key inputs for MOBILE include information on the age of vehicles on the roads, the speed of those vehicles, what types of road those vehicles are traveling on, any control technologies in place in an area to reduce emissions for motor vehicles (e.g., emissions inspection programs), and temperature. The development of these inputs is discussed in detail in Appendix B.

Biogenic emissions used in the 2000 current year modeling are the same as those used in the base year episodic modeling. This is due to the use of the same meteorology for the current year modeling runs. The development of this source category is discussed in detail in Appendix B.

The emissions summary for the 2000 current year modeling inventories for the Triad EAC area is listed in Table 4.2-1. These emissions represent typical weekday emissions and are reported in tons per day.

Table 4.2-1 2000 Current Year Modeling Emissions

Source	**CO**	**NOX**	**VOC**
Point	25	381	75
Area	75	5	71
Nonroad Mobile	443	39	34
Highway Mobile	999	166	94
Biogenic	0	2	446
Total Emissions	1542	593	720

4.3 Future Year Inventories

The inventory used for the preliminary 2007 point source inventory is the EPA's May 1999 release of the NOx SIP call future year modeling foundation files, obtained from the EPA Office of Air Quality Planning and Standards (OAQPS). This is a 2007 emissions inventory, projected from a 1995 base year inventory and controlled in accordance to the NOx SIP call rule. The decision to use this inventory for initial 2007 future year modeling runs was made since all of the point sources required to have controls due to the NOx SIP call rule making are reflected in this inventory. The exception to this is for North Carolina. For the major North Carolina utility sources, NCDAQ obtained estimated future year hour specific data for the two largest utility companies within North Carolina, Duke Energy and Progress Energy. Additionally, the day specific forest fires and prescribed fires inventory were the episodic emissions.

The final modeling runs for the 2007 future year point source inventory uses the EPA's 1999 NEI inventory grown to 2007 using growth factors from the EPA's Economic Growth Analysis System (EGAS) version 4.0. The exception to this is for North Carolina, where State specific growth factors, and where available source specific growth factors, were used to grow the North Carolina 1999 inventory. Additionally, NCDAQ created a new control file that reflect how the states surrounding North Carolina plan to implement the NOx SIP call rule as well as all other rules that are on the The 2012 future year point source inventory was generated using this same methodology.

The inventory used to model the stationary area sources for 2007 and 2012 is the 1999 NEI release version 2.0 obtained from the EPA's CHIEF website and were grown to 2007 using growth factors from the EPA's Economic Growth Analysis System (EGAS) version 4.0. The exception to this is for North Carolina, where the 2000 current year inventory was grown using a mixture of EGAS growth factors and state-specific growth factors for the furniture industry.

For the nonroad mobile sources that are calculated within the NONROAD mobile model, a 2007 and 2012 future years inventoriesy was were generated for the entire domain using the same model used to generate the current year inventory. In the final modeling, the NONROAD2002a model will be used to create the nonroad inventory. The remaining nonroad mobile source categories, the 1999 NEI release version 2.0 obtained from the EPA's CHIEF website and were grown to 2007 and 2012 using growth factors from the EPA's Economic Growth Analysis System (EGAS) version 4.0. The exception to this is for North Carolina, where the 2000 current year inventory was grown with EGAS growth factors.

The same MOBILE model was used to create the 2007 and 2012 future years highway mobile source inventories. The vehicle miles traveled (VMT) were projected using the methodologies prescribed by EPA. The exception to this was for North Carolina. In the urban areas of North Carolina VMT from travel demand models (TDM) for future years was available. The future years VMT were estimated by interpolating between the TDM future year estimates. Additionally, estimated future year speeds were obtained from the North Carolina Department of Transportation (NCDOT).

Biogenic emissions used in the future years modeling are the same as those used in the base year episodic modeling. This is due to the use of the same meteorology for the future year modeling runs. The development of this source category is discussed in detail in Appendix B.

The emissions summary for the 2007 and 2012 future years modeling inventories for the Triad EAC area is listed in Table 4.3-1. These emissions represent typical weekday emissions and are reported in tons per day.

Table 4.3-1 Future Year Modeling Emissions

Source	**2007**			**2012**		
	CO	**NOX**	**VOC**	**CO**	**NOx**	**VOC**
Point	34	55	100	26	74	74
Area	80	5	74	85	5	77
Nonroad Mobile	512	38	28	524	36	22
Highway Mobile	620	101	60	458	58	41
Biogenic	0	2	446	0	2	446
Total Emissions	1246	201	708	1093	175	660

Note that in the maintenance year 2012 the emissions are expected to be lower than the attainement year 2007, therefore continued maintenance of the 8-hour ozone standard is expected.

4.4 Comparison of 2000 and 2007 Inventories

The total predicted NOx emissions for the Triad area decreased by 66%, from 593 tons per day (TPD) in 2000 to 201 TPD in 2007. This data is tabulated in Table 4.4-1. This same data is displayed in Figures 4.4-1 and 4.4-2 as pie charts with the percent contribution by each source category.

Table 4.4-1: Estimated NOx and VOC emissions, in tons per day

Source	NOx Emissions		VOC Emissions	
	2000	2007	2000	2007
Point	381	55	75	100
Area	5	5	71	74
Nonroad	39	38	34	28
Mobile	166	101	94	60
Biogenic	2	2	446	446
Total Emissions	2593	2208	2720	2715

Figure 4.41: 2000 Triad Area NOx Emissions by Source

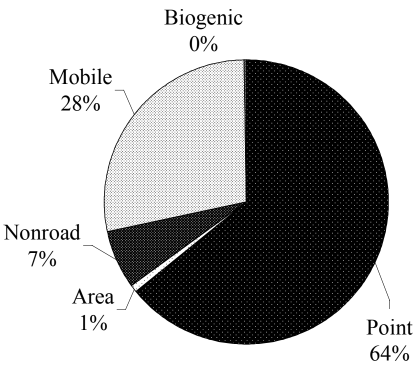
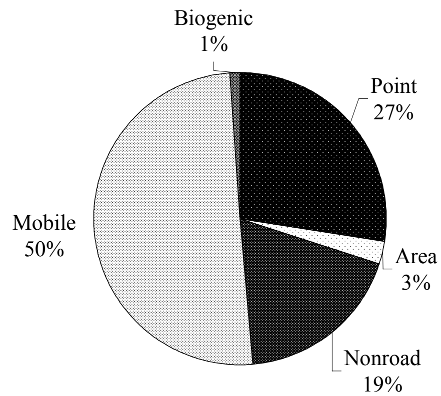


Figure 4.4-2: 2007 Triad Area NOx Emissions by Source



The total predicted VOC emissions for the Triad area decreased by 1.6%, from 720 TPD in 2000 to 708 TPD in 2007. This data is also tabulated in Table 4.4-1. This same data is displayed in Figures 4.4-3 and 4.4-4 as pie charts with the percent contribution by each source category.

Figure 4.4-3: 2000 Triad Area VOC Emissions by Source

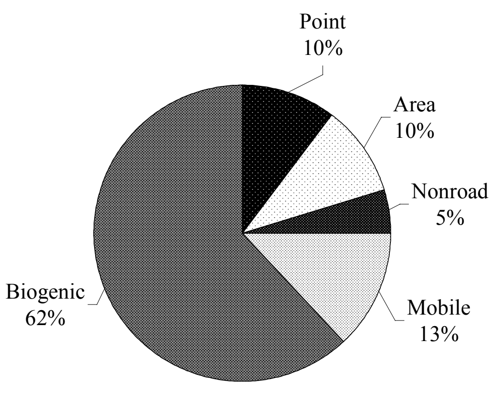
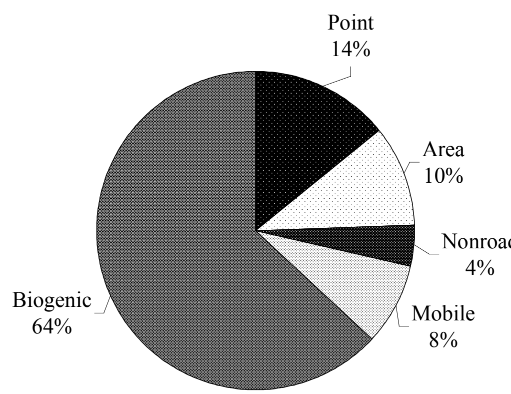


Figure 4.4-4: 2007 Triad Area VOC Emissions by Source



There are few VOC control measures expected for area and point sources in the Triad area, so the continue to grow. However, since the Triad area contains the largest power plant in North Carolina, the point source NOx emissions decrease significantly due to the NOx SIP Call rule. Additionally, there are significant decreases in both highway and nonroad mobile source VOC and NOx emissions. Thus the overall region has a decrease in both NOx and VOC emissions.

For both, highway and nonroad mobile sources, diesel vehicles contribute the majority of NOx emissions. Figures 4.4-5 and 4.4-6 show the relative contributions of vehicle types for the highway mobile source category in 2000 and 2007 for the Triad area. As shown in these figures, the relative contributions from vehicle types change slightly between 2000 and 2007, with heavy duty diesel vehicles still contributing more than 50% of the overall emissions. The estimated emissions for each vehicle type is tabulated in Table 4.4-2.

Figure 4.4-5: 2000 Triad Area
Highway Mobile NOx Sources

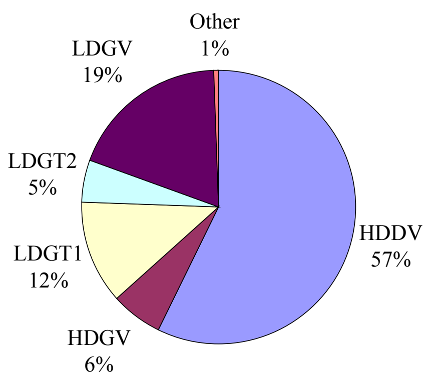
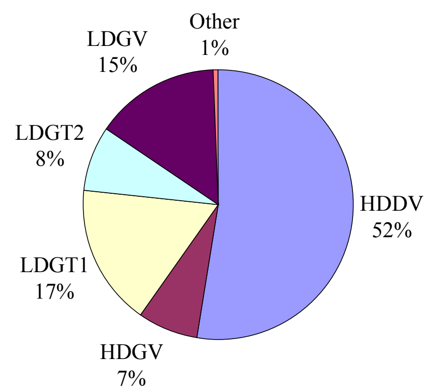


Figure 4.4-6: 2007 Triad Area
Highway Mobile NOx Sources



HDDV = Heavy-duty diesel vehicles (trucks)
HDGV = Heavy-duty gasoline vehicles (trucks)
LDGT (1&2) = Light-duty gasoline trucks
LDGV = Light-duty gasoline vehicles
Other = Motorcycles, light-duty diesel vehicles & trucks

Table 4.4-2: Estimated Highway NOx Emissions, by vehicle type

Source	NOx Emissions in TPD	
	2000	2007
Heavy-duty diesel vehicles	95	53
Light-duty gasoline vehicles	32	15
Light-duty gasoline trucks(1)	20	17
Light-duty gasoline trucks(2)	8	8
Heavy-duty gasoline vehicles	10	7
Other	0.8	0.6
Total	332	202

Figures 4.4-7 and 4.4-8 show the relative contributions of equipment types for the nonroad mobile source category in 2000 and 2007 for the Triad area. As can be seen in these figures, diesel construction equipment contributes the majority of the nonroad mobile source NOx emissions for both years.

Figure 4.4-3: 2000 Triad Area Nonroad Equipment NOx sources

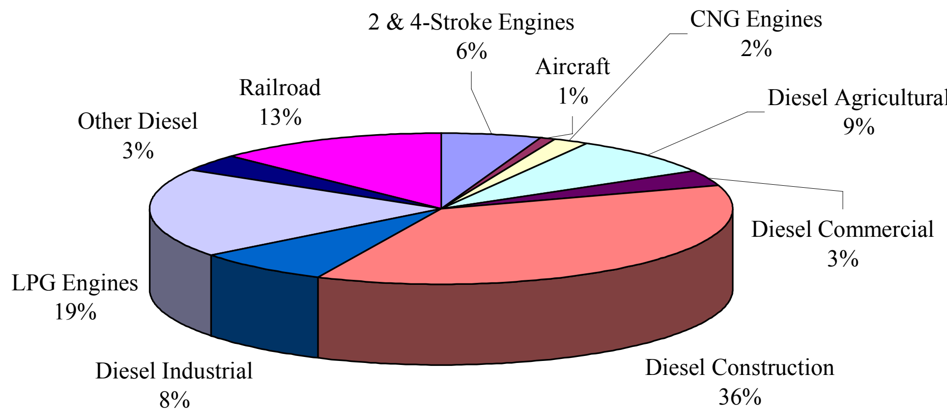
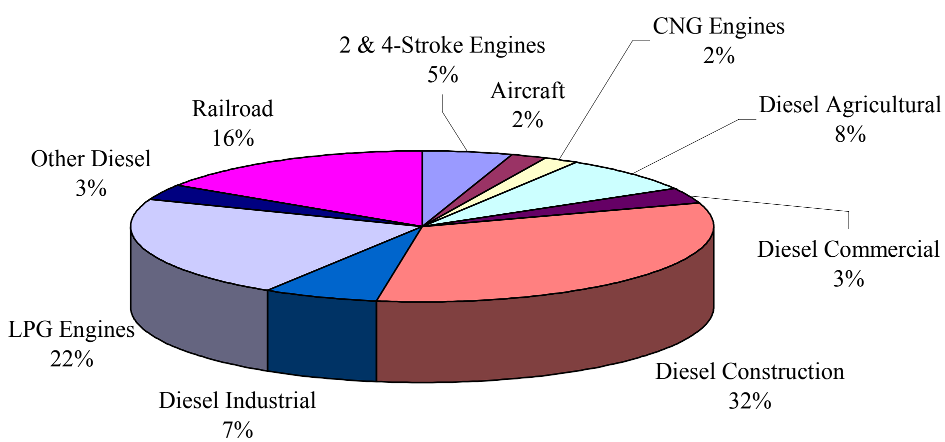


Figure 4.4-4: 2007 Triad Area Nonroad Equipment NOx sources



4.5 Comparison of 2000 and 2010 Inventories

North Carolina developed the 2010 future year emissions inventory as an intermediate year between 2007, where attainment of the 8-hr Ozone standard is to be demonstrated, and 2012 where continued maintenance of the standard is required. This year was chosen since it is the year that the Charlotte/Gastonia area must show attainment of the 8-hour ozone standard.

The inventory used for the 2010 point source inventory is EPA's 2010 emission inventory used for their heavy duty diesel rule making. The decision to use this inventory for the 2010 future year modeling runs was made since all of the point sources required to have controls due to the NOx SIP call rule making are reflected in this inventory. The exception to this is for North Carolina. For the major North Carolina utility sources, NCDAQ obtained estimated future year hour specific data for the two largest utility companies within North Carolina, Duke Energy and Progress Energy. Additionally, the day specific forest fires and prescribed fires inventory were the episodic emissions.

The inventory used to model the stationary area sources is also the EPA's emission inventory used for the heavy duty diesel engine rule making. The exception to this is for North Carolina, where the 2000 current year inventory was grown using a mixture of EGAS growth factors and state-specific growth factors for the furniture industry.

For the nonroad mobile sources that are calculated within the NONROAD mobile model, a 2010 future year inventory was generated for the entire domain using the same model used to generate the current year inventory. The remaining nonroad mobile source categories, EPA's 2010 emission inventory used for their heavy duty diesel engine rule making was used.

The same MOBILE model was used to create the 2010 future year highway mobile source inventory. The vehicle miles traveled (VMT) were projected using the methodologies prescribed by EPA. The exception to this was for North Carolina. In the urban areas of North Carolina VMT from travel demand models (TDM) for future years was available. The 2010 VMT was estimated by interpolating between the TDM future year estimates. Additionally, estimated future year speeds were obtained from the North Carolina Department of Transportation (NCDOT).

Biogenic emissions used in the 2010 future year modeling are the same as those used in the base year episodic modeling. This is due to the use of the same meteorology for the future year modeling runs.

The emissions summary for the 2010 future year modeling inventories for the Triad EAC area is listed in Table 4.5-1. These emissions represent typical weekday emissions and are reported in tons per day.

Table 4.5-1: Estimated NOx and VOC emissions, in tons per day

Source	NOx Emissions			VOC Emissions		
	2000	2007	2010	2000	2007	2010
Point	381	55	45	75	100	59
Area	5	5	5	71	74	71
Nonroad	39	38	37	34	28	27
Mobile	166	101	67	94	60	44
Biogenic	2	2	2	446	446	446
Total Emissions	2593	2208	156	2720	2715	647

The total predicted NOx emissions for the Triad area decreased by ~74%, from 593 tons per day (TPD) in 2000 to 156 TPD in 2010. The total predicted VOC emissions for the Triad area decreased by ~10%, from 720 TPD in 2000 to 647 TPD in 2010. The 2010 mobile emissions show a continuing decrease even from the 2007 emission levels for both NOx and VOC. Similarly, with the full implementation of the North Carolina's Clean Smokestacks Act, the utility emissions decrease from the 2007 levels.

4.5 2017 Future Year Inventory

The State is in the process of developing the 2017 future year emission inventories for purposes of showing continued maintenance of the 8-hour ozone standard. The air quality modeling runs will be completed in the next couple of months and will be part of the final State submittal in December 2004.

5 Control Measures

Several control measures already in place or being implemented over the next few years, will reduce point, highway mobile, and nonroad mobile sources emissions. These control measures were modeled for 2007 and are discussed in the Sections below.

5.1 State Control Measures

5.1.1 Clean Air Bill

The 1999 Clean Air Bill expanded the vehicle emissions inspection and maintenance program from 9 counties to 48, phased in between July 1, 2002 through January 1, 2006. Vehicles will be tested using the onboard diagnostic system, an improved method of testing, which will indicate NOx emissions, among other pollutants. The previously used tailpipe test did not measure NOx. The inspection and maintenance program will be phased in from July 1, 2002 through July 1, 2005, in the Triad area. Table 5.1.1-1 lists the phase in dates for the Triad area.

Table 5.1.1-1 Phase-In Dates for the Triad Area

County	Phase-In Date	County	Phase-In Date
Alamance	January 1, 2004	Randolph	January 1, 2004
Davidson	July 1, 2003	Rockingham	July 1, 2004
Forsyth	July 1, 2002	Stokes	July 1, 2005
Guilford	July 1, 2002	Surry	July 1, 2005

5.1.2 NOx SIP Call Rule

North Carolina's NOx SIP Call rule will reduce summertime NOx emissions from power plants and other industries by 68% by 2006. The North Carolina Environmental Management Commission adopted rules requiring the reductions in October 2000.

5.1.3 Clean Smokestacks Act

In June 2002, the N.C. General Assembly enacted the Clean Smokestacks Act, requiring coal-fired power plants to reduce annual NOx emissions by 78% by 2009. These power plants must also reduce annual sulfur dioxide emissions by 49% by 2009 and by 74% in 2013. The Clean Smokestacks Act could potentially reduce NOx emissions beyond the requirements of the NOx SIP Call Rule. One of the first state laws of its kind in the nation, this legislation provides a model for other states in controlling multiple air pollutants from old coal-fired power plants.

5.1.4 Open Burning Bans

In June 2004, the Environmental Management Commission should approve a new rule that would ban open burning during the ozone season on code orange and code red ozone action days for those counties that receive ozone forecasts, either from NCDAQ or FCEAD. NCDAQ will determine what rule penetration and rule effectiveness would be most appropriate to use for this rule.

5.2 Federal Control Measures

5.2.1 Tier 2 Vehicle Standards

Federal Tier 2 vehicle standards will require all passenger vehicles in a manufacturer's fleet, including light-duty trucks and Sports Utility Vehicles (SUVs), to meet an average standard of 0.07 grams of NOx per mile. Implementation will begin in 2004, and most vehicles will be phased in by 2007. Tier 2 standards will also cover passenger vehicles over 8,500 pounds gross vehicle weight rating (the larger pickup trucks and SUVs), which are not covered by current Tier 1 regulations. For these vehicles, the standards will be phased in beginning in 2008, with full compliance in 2009. The new standards require vehicles to be 77% to 95% cleaner than those on the road today. Tier 2 rules will also reduce the sulfur content of gasoline to 30 ppm by 2006. Most gasoline currently sold in North Carolina has a sulfur content of about 300 ppm. Sulfur occurs naturally in gasoline but interferes with the operation of catalytic converters in vehicle engines resulting in higher NOx emissions. Lower-sulfur gasoline is necessary to achieve Tier 2 vehicle emission standards.

5.2.2 Heavy-Duty Gasoline and Diesel Highway Vehicles Standards

New EPA standards designed to reduce NOx and VOC emissions from heavy-duty gasoline and diesel highway vehicles will begin to take effect in 2004. A second phase of standards and testing procedures, beginning in 2007, will reduce particulate matter from heavy-duty highway engines, and will also reduce highway diesel fuel sulfur content to 15 ppm since the sulfur damages emission control devices. The total program is expected to achieve a 90% reduction in PM emissions and a 95% reduction in NOx emissions for these new engines using low sulfur diesel, compared to existing engines using higher-content sulfur diesel.

5.2.3 Large Nonroad Diesel Engines Proposed Rule

The EPA has proposed new rules for large nonroad diesel engines, such as those used in construction, agricultural, and industrial equipment, to be phased in between 2008 and 2014. The proposed rules would also reduce the allowable sulfur in nonroad diesel fuel by over 99%. Nonroad diesel fuel currently averages about 3,400 ppm sulfur. The proposed rules limit nonroad diesel sulfur content to 500 ppm in 2007 and 15 ppm in 2010. The combined engine and fuel rules would reduce NOx and particulate matter emissions from large nonroad diesel engines by over 90 %, compared to current nonroad engines using higher-content sulfur diesel.

5.2.4Nonroad Spark-Ignition Engines and Recreational Engines Standard

The new standard, effective in July 2003, will regulate NOx, HC and CO for groups of previously unregulated nonroad engines. The new standard will apply to all new engines sold in the US and imported after these standards begin and large spark-ignition engines (forklifts and airport ground service equipment), recreational vehicles (off-highway motorcycles and all-terrain-vehicles), and recreational marine diesel engines. The regulation varies based upon the type of engine or vehicle.

The large spark-ignition engines contribute to ozone formation and ambient CO and PM levels in urban areas. Tier 1 of this standard is scheduled for implementation in 2004 and Tier 2 is scheduled to start in 2007. Like the large spark-ignition, recreational vehicles contribute to ozone formation and ambient CO and PM levels. They can also be a factor in regional haze and other visibility problems in both state and national parks. For the off-highway motorcycles and all-terrain-vehicles, model year 2006, the new exhaust emissions standard will be phased-in by 50% and for model years 2007 and later a 100%. Recreational marine diesel engines over 37 kW are used in yachts, cruisers, and other types of pleasure craft. Recreational marine engines contribute to ozone formation and PM levels, especially in marinas. Depending on the size of the engine, the standard for will begin phase-in in 2006.

When all of the standards are fully implemented, an overall 72% reduction in HC, 80% reduction in NOx, and 56% reduction in CO emissions are expected by 2020. These controls will help reduce ambient concentrations of ozone, CO, and fine PM.

5.3 Local EAC Control Measures

Triad EAC strategies are set forth in detail in Appendix C. Quantifications, where feasible, for emissions reductions produced by these measures have been developed by the Forsyth Environmental Affairs Department and are shown on the Strategies Chart.. Assumptions, methods and calculations can be found at
http://www.co.forsyth.nc.us/envaffairs/msb/other/eac.htm

The EAC wishes to highlight the following strategies:

A1- A4 — Development of on-line data base and reporting system for vehicle replacements. This will be done by EAC staff assisted by the Forsyth County Environmental Affairs Department and City of Greensboro MIS. The goal is to have **verifiable information** on which to base emissions reductions calculations. In addition, this system of regularly providing information to EAC member governments will **encourage accountability** for the vehicle replacement policies they agreed to.

A5 — Lower Emissions Fuel - Greensboro's conversion to biodiesel for all on- and off-road vehicles is significant. The City uses approximately 1.5 million gallons annually. This conversion took place between November 2002 and spring 2003 as the EAC was developing its list of control measures. Percentage reductions are listed in the Strategies Chart.

A6 - A13 — Regional Transportation Services and Planning, Park and Ride, Regional Inter-City Rail. These initiatives of PART are **strategically linked with EAC goals and reduction in VMTs**. For detailed information see:

PART Homepage (Piedmont Authority for Regional Transportation)
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PART Annual Report
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See also **PART Land Use and Transportation Policies** adopted by 27 local governments in the EAC, **page 38** following. .

B1-B8 Business and industry Strategies - The **Triad Ad Hoc Air Quality Business and Industry group has played a key role** in the EAC process. Representatives of this group have assisted others in calculating emissions reductions, provided crucial data on plant closings to DAQ, and urged their own employers to adopt additional improvement measures**. Note emissions reductions quantified in Appendix C Strategies Chart.**

C5 & C8 Diesel Retrofits on School Buses and Idling - The **Guilford County School system,** supported by the Ad hoc Business and Industry Air Quality Group and the EAC was successful in obtaining **$100,000 for school bus retrofits**. This is reported in a **news article** cited in this document #13, **page 16.**
The Guilford County School system also has a **strict idling policy** (C8) enacted specifically to reduce emissions while buses wait for students to load after school.

F5- F13 These measures all relate to **smart growth policies adopted by local governments.** Following this narrative, there is a **list of websites for comprehensive plans, unified development ordinances, and intermodal transportation plan** updates for Greensboro, Winston-Salem/Forsyth County and other jurisdictions that have **incorporated smart growth into their future growth models.** By way of example, web pages are also included for **Davie County and Randolph County, two urban fringe counties with particularly strong plans and ordina**nces. Time and space do not permit a full explanation of the progress being made in these areas and the impetus provided by the EAC process. Hopefully, an indication can be seen by checking out several of these web sites.

Maintenance In addition to the strategies listed in Appendix C, the EAC will, as required submit semi-annual reports to EPA until 2007. Modeling will be performed for 2012, and the EAC commits to continue modeling for the year2017, ten years after the designation date. The EAC, in conjunction with the Region's 4 MPOs will continue to monitor and report on accomplishments beyond 2007. These reviews and updates will be incorporated into the MPOs' long range transportation plan updates.

2025 Policies and Actions for Regional Growth.

Developed by PART and Adopted by 27 Local Governments in EAC

Coordinate long-range land use / transportation planning on a regional and local basis.

- Designate targeted growth areas through a comprehensive regional land use plan and coordinate these areas with transportation investments.
- Work towards implementation of Adopted Thoroughfare plans.
- Use future transportation improvements to stimulate desirable land use patterns and the converse.
- Monitor land development trends and match transportation facilities with land use generated travel patterns.
- Conduct both an Inter-City and Regional Rail Study.
- Invest in effective intelligent transportation technologies.
- Reward and foster the increased use of tele-commuting and flexible work hours.
- Explore ways to make transit more attractive.

Encourage redevelopment of infill and "underdeveloped" areas.

- Conduct studies of "under invested" areas (such as CBD's and brownfields) to determine why they are "under invested", and undertake ameliorative actions.
- Provide financial incentives through public/private funding pool for neighborhood redevelopment.
- Revise zoning regulations to encourage mixed land uses in existing industrial and downtown areas.

Integrate land use planning with infrastructure development.

- Place a higher emphasis on coordinated regional land use planning through better use of resources.
- Use water and sewer expansion policy to manage growth in targeted areas.
- Coordination among local planning staffs to more precisely achieve the stated policy.
- Develop public parking management strategies to encourage increased transit use.
- Encourage joint-use easements (utility and non-motorized use) for transportation and open space where possible.
- Consistently participate in right-of-way corridor protection.

Direct a significant portion of future land use development to existing and proposed targeted nodes and transit corridors to support transit.

- Encourage open space preservation
- Increase allowable densities in selected corridors.
- Implement a mixture of land uses so that a person may live near where they work.
- Work towards the expansion and integration of local transit services.
- Implement "nodal development" which will provide opportunities for implementation of efficient transportation systems.
- Implement alternative transportation services such as sidewalks, bikeways, greenways and transit conveniences as part of the land use development.
- Enhance provisions for safe bicycle and pedestrian improvements.
- Consistently participate in right-of-way corridor protection.

List of Web Sites
for

Land Use Plans, Development Ordinances and Transportation Plans
with
Smart Growth, Anti-Sprawl Provisions

That Will Have the Effect of Reducing Vehicle Miles Traveled

1. PART Homepage (Piedmont Authority for Regional Transportation)
   Error! Objects cannot be created from editing field codes.

2. PART Annual Report
   Error! Objects cannot be created from editing field codes.

3. Greensboro MPO 2030 Long Range Transportation Plan Update
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   Error! Objects cannot be created from editing field codes.

4. Greensboro DOT - Public Transportation Mobility Plan
   Error! Objects cannot be created from editing field codes.

5. Greensboro Pedestrian and Bicycle Planning
   Error! Objects cannot be created from editing field codes.

6. Greensboro Comprehensive Plan - Connections 2025
   Error! Objects cannot be created from editing field codes.

7. Greensboro Unified Development Ordinance which includes, among other smart growth provisions, a TND district at Section 30-4-1
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   Error! Objects cannot be created from editing field codes.

8. Guilford County Comprehensive Plan
   Error! Objects cannot be created from editing field codes.

9. Guilford County Uniform Development Ordinance, including Rural Preservation District, Section 4-11
   Error! Objects cannot be created from editing field codes.

10. Winston-Salem/Forsyth County Urban Area 2025 Multi-Modal Long Range Transportation Plan
    Error! Objects cannot be created from editing field codes.

11. Winston-Salem/Forsyth County Urban Area Street and Highway Plan
    Error! Objects cannot be created from editing field codes.

12. Legacy Development Guide and Comprehensive Plan for Forsyth County and Its Municipalities
    Error! Objects cannot be created from editing field codes.

13. Winston-Salem/Forsyth County Unified Development Ordinances and Traditional Neighborhood Development Design Guidelines
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    Error! Objects cannot be created from editing field codes.

14. Davie County Land Development Plan
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    Error! Objects cannot be created from editing field codes.

15. Randolph County Growth Management Plan
    Error! Objects cannot be created from editing field codes.

16. Randolph County Uniform Development Ordinance
    Error! Objects cannot be created from editing field codes.

17. Land Use Plan for the High Point Planning Area
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18. High Point Development Ordinance
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6 ATTAINMENT DEMONSTRATION

6.1 Status of Current Modeling

Modeling completed to date include: the base case model evaluation/validation runs, the current year modeling runs and the preliminary 2007 future year modeling runs. The results of these modeling runs can be viewed at the NCDAQ modeling website:

http://www.cep.unc.edu/empd/projects2/NCDAQ/PGM/results/

NCDAQ will complete the final 2007 future year modeling run with the updates described in the emissions inventory section. Additionally, the continued maintenance demonstration modeling runs for 2012 and 2017 will be completed in the following months. The results of these modeling runs will be part of the State's submittal in December 2004.

Some errors were found in the base year modeling inventories outside of North Carolina. The magnitude of the errors will be evaluated and, if warranted, the base year model evaluation/validation runs may be re-run.

6.2 Preliminary Modeling Results

The base case model runs for all three episodes met the validation criteria set by the EPA. The model evaluation statistics can be viewed at the NCDAQ modeling website cited above.

Figures 6.2-1 and 6.2-2 display the modeling results for 8-hour ozone episodic maximum for the 2000 current year and the 2007 future year, respectively, for the 1996 modeling episode. One can see a significant decrease in the 8-hour ozone episode maximum between the current year and the future year. This is better visualized with Figure 6.2-3, the difference plot between the 2007 future year and the 2000 current year 8-hour ozone episodic maximum for the 1996 episode (i.e., 2007 modeling result minus 2000 modeling results). In this figure cool colors, the blues and greens, represents decreases in the 8-hour ozone episodic maximum. These decreases were the results of the all of the State and Federal control measures listed in Section 5 that are expected to be in place by 2007.

The 1997 episode shows similar results. Figures 6.2-4 through 6.2-5 are the 8-hour ozone episodic maximum for the 2000 current year and the 2007 future year, respectively, for the 1997 episode and Figure 6.2-6 is the difference plot between the 2007 future year and the 2000 current year 8-hour ozone episodic maximum for the 1997 episode.

Although the modeling demonstrating continued maintenance of the 8-hour ozone standard into 2012 and 2017 has not been completed to date, modeling has been completed for future year 2010 for a project outside of the EAC modeling. These results can be used to show continued decrease in expected ozone formation beyond the 2007 attainment year. Additionally, this modeling exercise demonstrates that the Cooleemee monitoring site, which is significantly influenced by the Charlotte/Gastonia area, will demonstrate attainment by the time the Charlotte/Gastonia area must demonstrate attainment of the 8-hour ozone standard, i.e. 2010.

Modeling results for the 1996 and 1997 episodes using the 2010 future year inventory does continue to show attainment and further reduction in ozone levels compared to the 2007 modeling. Figure 6.2-7 and 6.2-8 display the modeling results for the 1996 episode using the 2010 emissions inventory, showing the 8-hour ozone episodic maximum and the difference plot between 2010 future year and the 2000 current year 8-hour ozone episodic maximum, respectively. In the 2010 difference plots, cool colors of blue and green represent decreases in the 8-hour ozone episodic maximum. Figures 6.2-9 and 6.2-10 display the 8-hour ozone episodic maximum and difference plot, respectively, for the 1997 episode as modeled for future year 2010 (compared to current year 2000). These results are consistent with the 1996 episode results.

Figure 6.2-1 2000 current year 8-hour ozone episodic maximum for the 1996 episode.

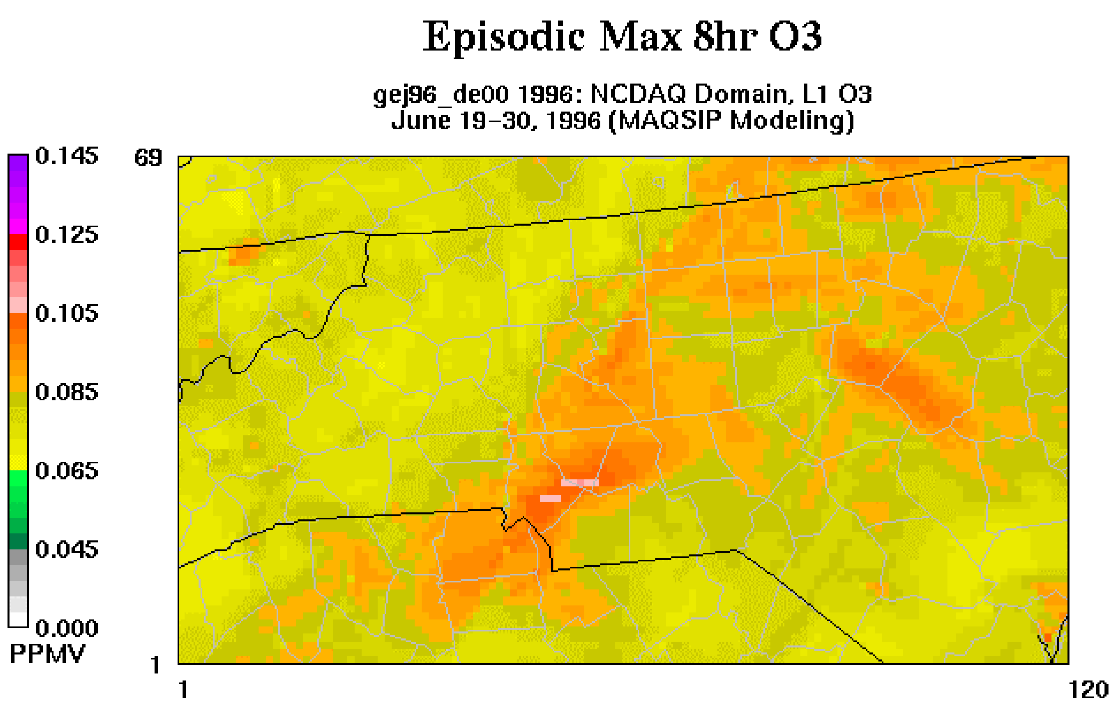


Figure 6.2-2 2007 future year 8-hour ozone episodic maximum for the 1996 episode.

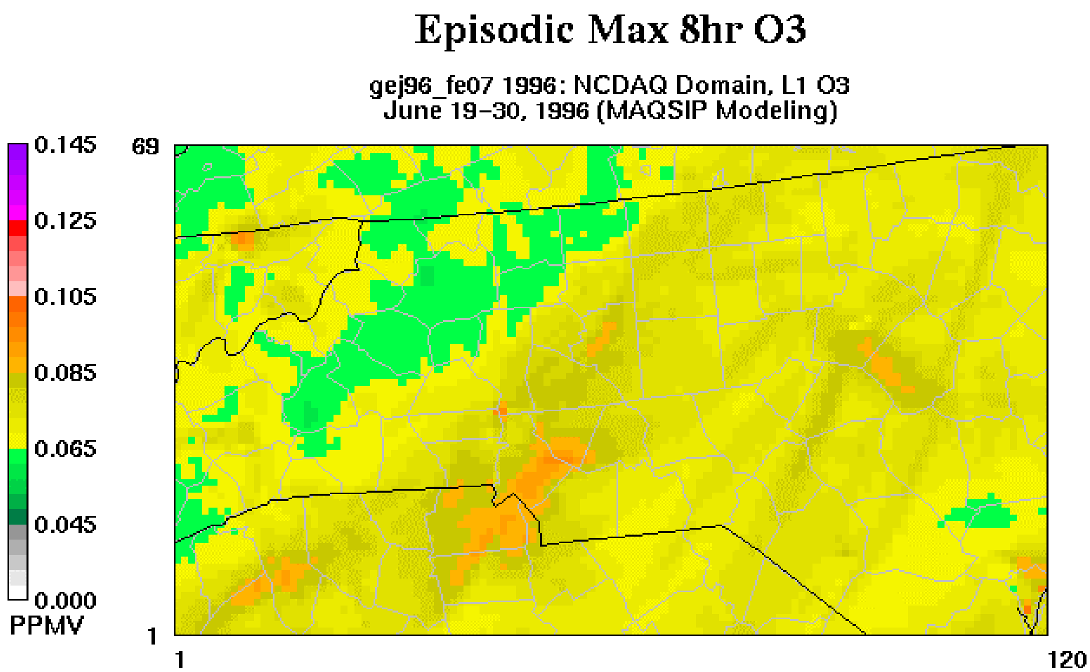


Figure 6.2-3 Difference plot between the 2007 future year and the 2000 current year 8-hour ozone episodic maximum for the 1996 episode.

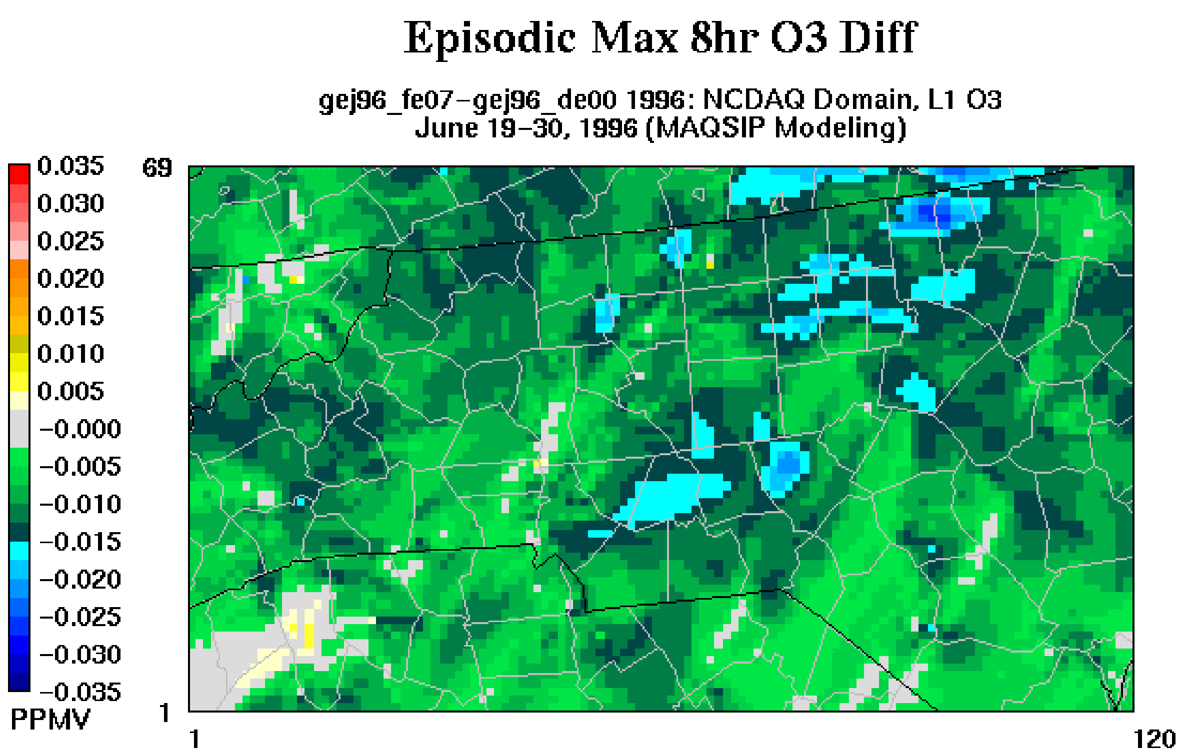


Figure 6.2-4 2000 current year 8-hour ozone episodic maximum for the 1997 episode.

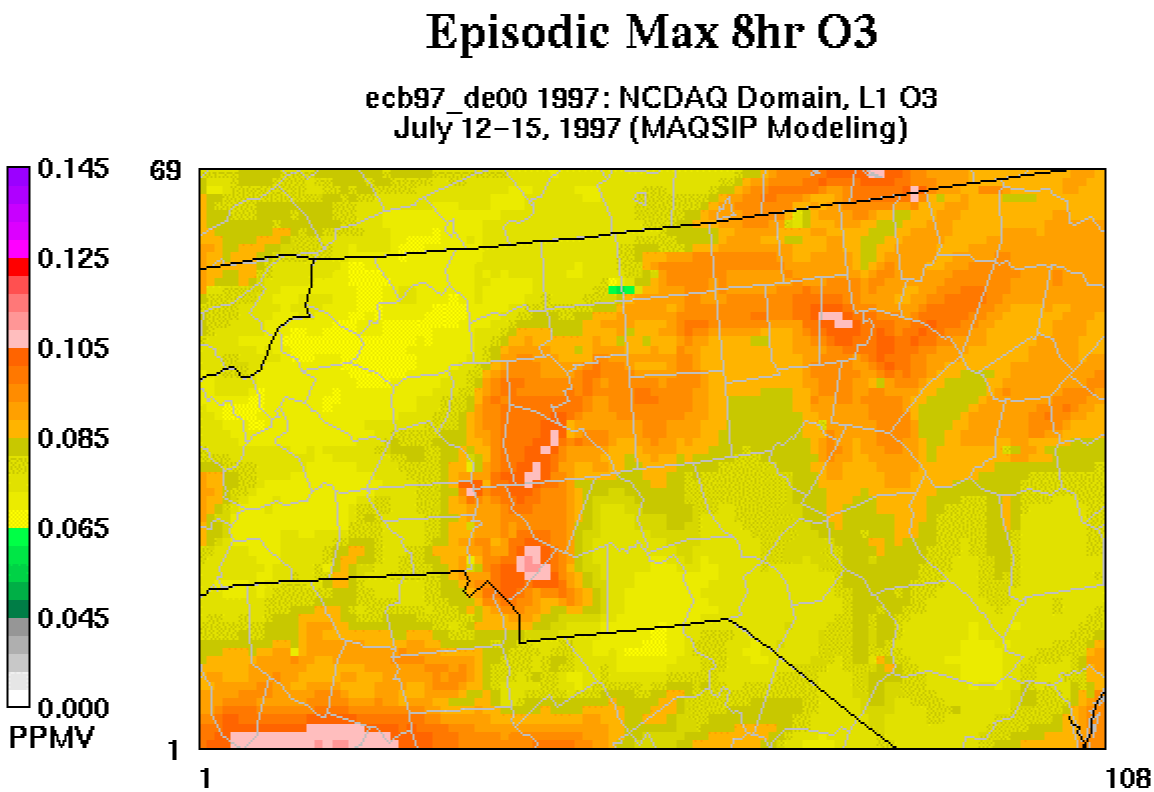


Figure 6.2-5 2007 future year 8-hour ozone episodic maximum for the 1997 episode.

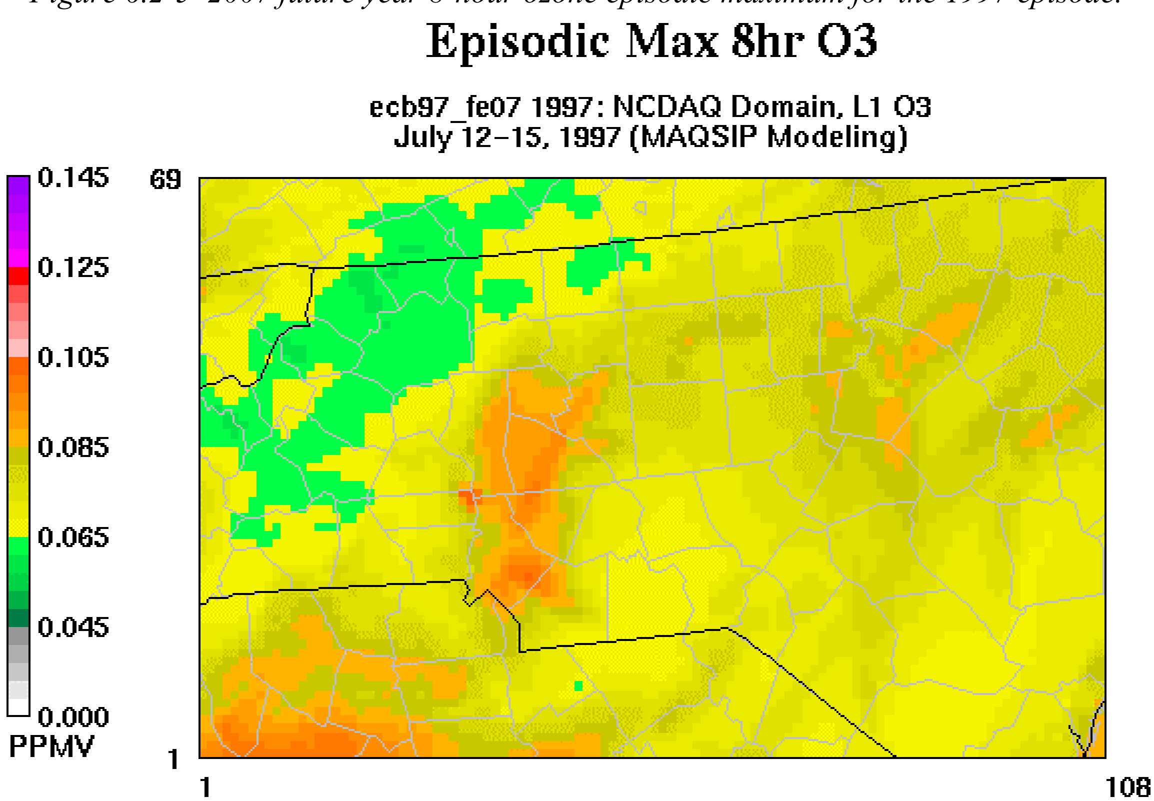


Figure 6.2-6 Difference plot between the 2007 future year and the 2000 current year 8-hour ozone episodic maximum for the 1997 episode.

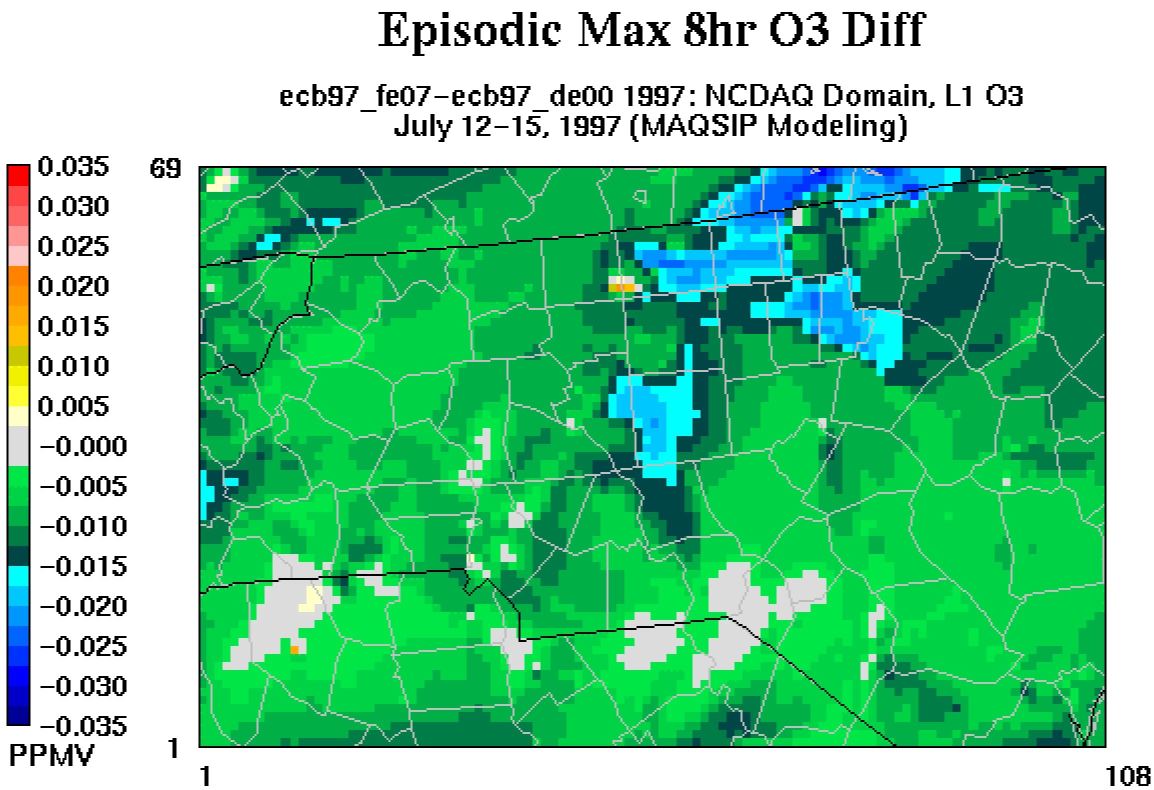


Figure 6.2-7 2010 future year 8-hour ozone episodic maximum for the 1996 episode.

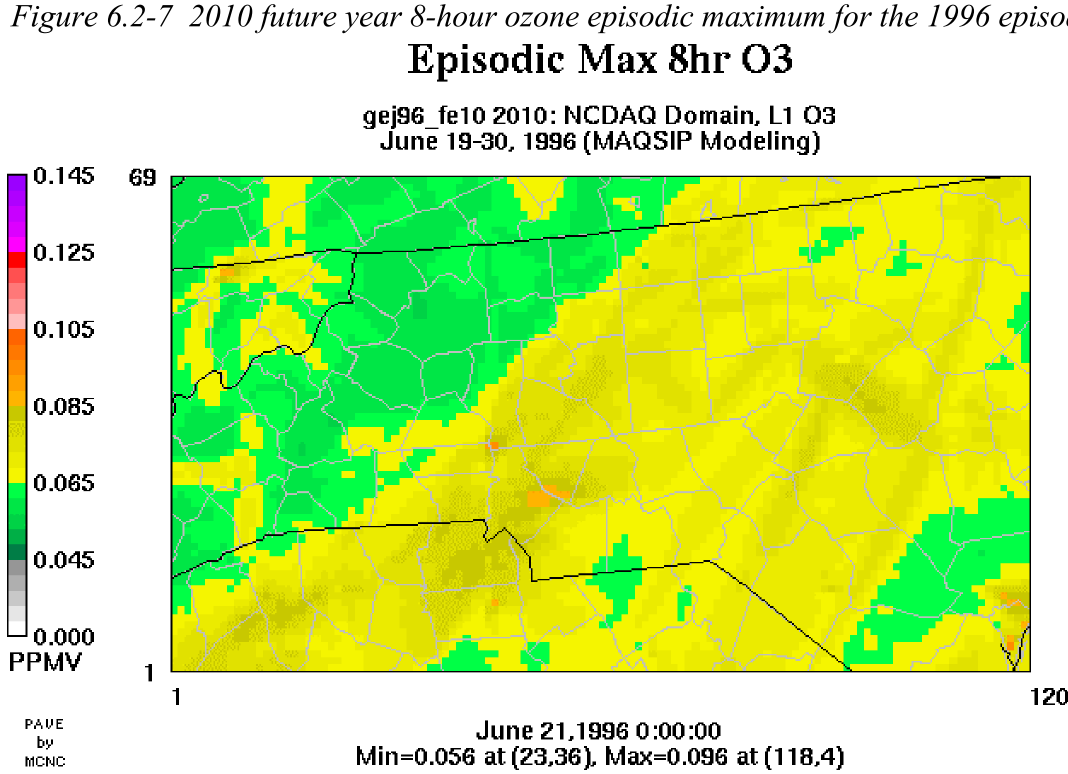


Figure 6.2-8 Difference plot between the 2010 future year and the 2000 current year 8-hour ozone episodic maximum for the 1996 episode.

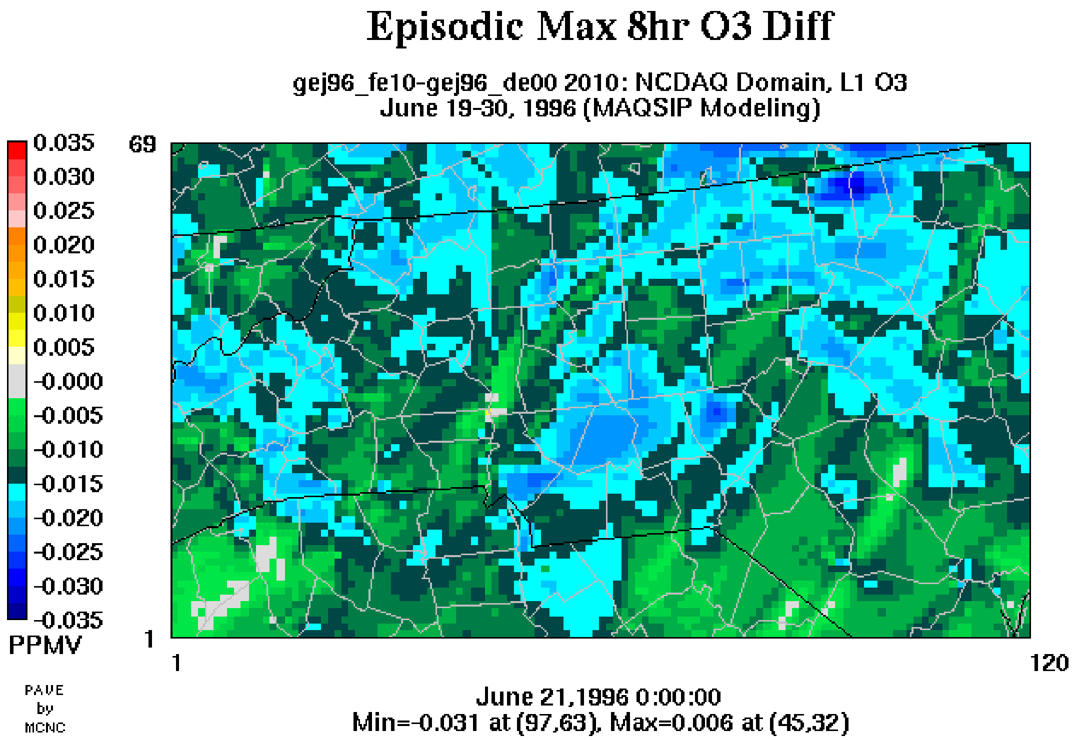


Figure 6.2-9 2010 future year 8-hour ozone episodic maximum for the 1997 episode

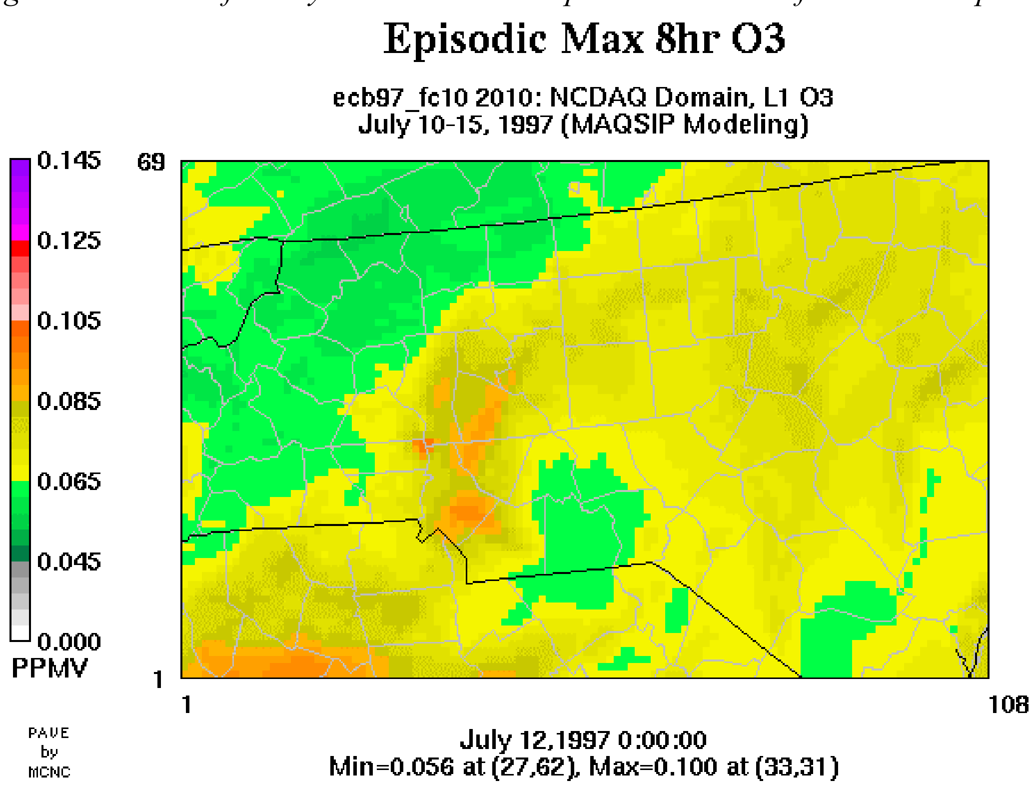
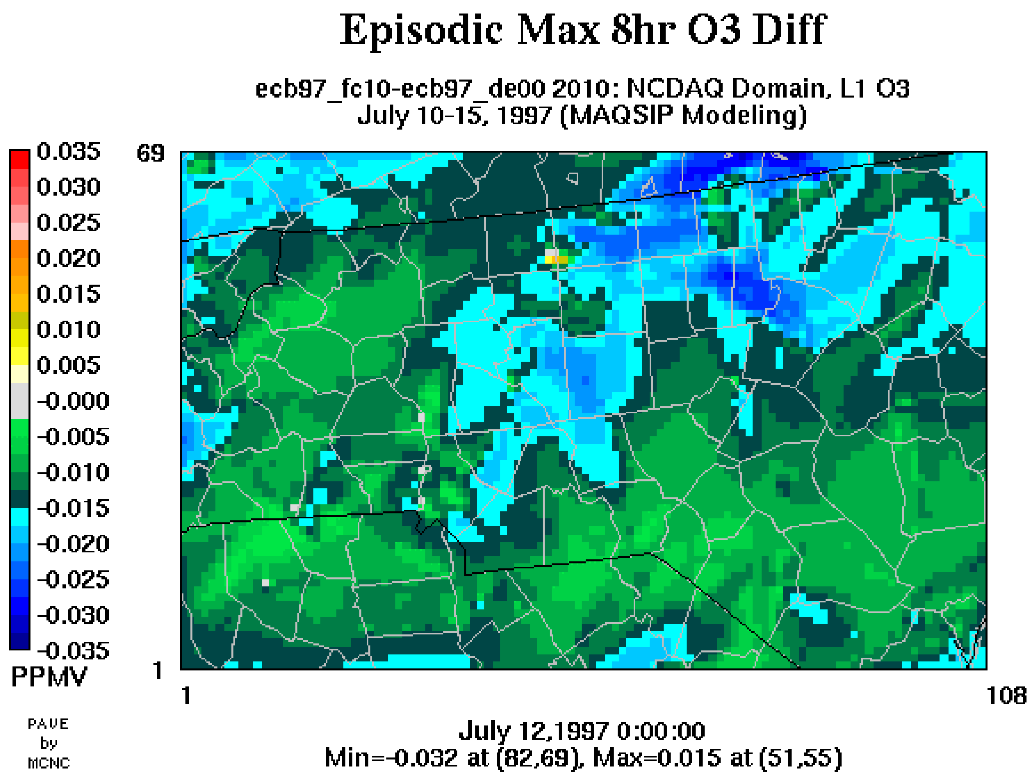


Figure 6.2-10 Difference plot between the 2010 future year and the 2000 current year 8-hour ozone episodic maximum for the 1997 episode



6.3 Geographic Area Needing Further Controls

The current draft version of EPA's attainment test was applied to the modeling results. In very basic and general language the attainment guidance states if the future year design value for a given monitor is below 0.085 parts per million (ppm) then the monitor passes the attainment test. The future year design value of a monitor is calculated by multiplying the current year design value of a monitor by a relative reduction factor (Equation 6.3-1).

$$DVF = DVC \times RRF \qquad \text{Equation 6.3-1}$$

Where DVF is the Future year Design Value,
DVC is the Current year Design Value, and
RRF is the relative reduction factor.

The Current year Design Value (DVC) in the attainment test framework is defined as the higher of: (a) the average 4th highest value for the 3-yr period used to designate an area "nonattainment", and (b) the average 4th highest value for the 3-yr period straddling the year represented by the most recent available emissions inventory. In this exercise, the DVC used to designate an area nonattainment will be 2001-2003 and the DVC straddling the year represented by the most recent available emissions inventory is 1999-2001. The higher of those two values is shown in Table 6.3-1 as the DVC.

The relative reduction factor (RRF) is calculated by taking the ratio of the future year modeling 8-hour ozone daily maximum to the current year modeling 8-hour ozone daily maximum "near" the monitor averaged over all of the episode days (Equations 6.3-2).

$$RRF = \frac{\text{mean future yr. 8-hr daily max "near" monitor "x"}}{\text{mean current yr. 8-hr daily max "near" monitor "x"}} \quad \text{Equation 6.3-2}$$

The results of applying the attainment test showed all monitors but one in the Triad EAC area in attainment of the 8-hour ozone NAAQS in 2007. These results are displayed in Table 6.3-1 below. The one monitor still not showing attainment of the standard is Cooleemee. This monitor is located in the southern portion of Davie County and borders the Charlotte, NC MSA. In general, this monitor is influenced by emissions generated in the Charlotte area on a significant number of days. NCDAQ is still investigating possible solutions to bring this monitor into attainment, including working with the Charlotte area to determine controls the area is planning on implementing by 2007.

Table 6.3-1 2007 Attainment Test Results for the Triad EAC Area

Monitor Name	DVC (ppm)	RRF	DVF (ppm)
Bethany	0.091	0.880	0.080
Cherry Grove	0.090	0.860	0.077
Cooleemee	0.096	0.910	0.087
Hattie Avenue	0.094	0.880	0.082
McLeansville	0.090	0.860	0.077
Pollirosa	0.082	0.880	0.072
Shiloh Church	0.089	0.870	0.077
Sophia	0.085	0.870	0.073
Union Cross	0.093	0.870	0.080

Table 6.3-2 shows the results of applying the attainment test for the EAC monitors in 2010. These preliminary results indicate that the expected State and Federal control measures already in place by 2010 results in all monitors in the Triad EAC area attaining the 8-hour ozone NAAQS; including the Cooleemee monitor which was still above the 0.085 ppm threshold with the 2007 modeling. In fact, all of the expected future year design values dropped between the 2007 and 2010 modeling runs, indicating that continued maintenance of the standard in 2012 would be expected.

Table 6.3-2 2010 Attainment Test Results for the Triad EAC Area

Monitor Name	DVC (ppm)	RRF	DVF (ppm)
Bethany	0.091	0.82	0.074
Cherry Grove	0.090	0.81	0.072
Cooleemee	0.096	0.85	0.081
Hattie Avenue	0.094	0.83	0.078
McLeansville	0.090	0.83	0.074
Pollirosa	0.082	0.83	0.068
Shiloh Church	0.089	0.83	0.073
Sophia	0.085	0.82	0.069
Union Cross	0.093	0.83	0.077

6.4 Additional Technical Analyses to Support Demonstration of Attainment

NCDAQ acknowledges in Section 6.3 of this report that in the preliminary modeling the Cooleemee monitor is not in attainment by 2007 when the current draft version of EPA's attainment test is applied to the modeling results. In this case, however, the modeled future design value is close enough to attaining that NCDAQ used additional technical analyses to show attainment.

Some of these additional technical analyses are described in the U.S. EPA's Draft Guidance On The Use Of Models And Other Analyses In Attainment Demonstrations For The 8-Hour Ozone NAAQS ("*Draft 8-hour Ozone Guidance*"). The *Draft 8-hour Ozone Guidance* proposes a series of core corroborative analyses that further support the suggested modeled attainment and screening tests and provide more evidence that the modeled control strategy is sufficient to meet the NAAQS within the required timeframe. The *Draft 8-hour Ozone Guidance* also suggests using additional corroborative analyses to supplement the core set. NCDAQ identified and implemented several of these corroborative analyses, both from the core set and the additional set to support the hypothesis that the existing strategy will lead to attainment in the area of concern. The methods and their results are summarized in greater detail in the following sections.

6.4.2 EPA's Core Corroborative Analyses - Air Quality Modeling Metrics

Introduction

The *Draft 8-hour Ozone Guidance* recommends the following types of corroborative analyses: application of air quality models, observed air quality trends and estimated emission trends, and outcome of observational models.

In Chapter 4, Section 4.1.1 Air Quality Models, the *Draft 8-Hour Ozone Guidance* describes various aspects of air quality models, modeled performance, and uncertainties associated with the length of modeled episodes and limited observational datasets. A series of three additional air quality modeling outputs or metrics is recommended to provide assurance that passing or nearly passing the suggested modeled attainment and screening tests indicates attainment. These three additional metrics reflect various relative changes in predicted air quality.

Methodology

The computation of the recommend three additional air quality modeling metrics introduced in the previous section are only applicable in portions of the modeled domain that are passing or nearly passing the suggested modeled attainment and screening tests. The *Draft 8-Hour Ozone Guidance* further proposes that these metrics should not be applied in cases where the future design value for a particular region is in excess of 0.09 ppm. For the purposes of this particular corroborative analysis report, the Triad Early Action Compact (Triad EAC) region is the only portion of the air quality modeled domain that is considered, primarily based on the calculated and nearly passing future design value at the Cooleemee monitoring site within the region. The Triad EAC region consists of Surry, Stokes, Rockingham, Caswell, Yadkin, Forsyth, Guilford, Alamance, Davie, Davidson, and Randolph Counties of North Carolina and includes the cities of Burlington, Greensboro, High Point, and Winston-Salem.

A modeling domain mask of these eleven counties was created and applied to the current and future modeling outputs of three air quality simulations. The three air quality simulations were selected based on the modeling selection criteria proposed in the *Draft 8-Hour Ozone Guidance*, shaped and sized to reflect air quality conditions in the major metropolitan regions of North Carolina, and cover high ozone episodes during the summers of 1995, 1996, and 1997. Projected air quality data from within this masked area were collected from the preliminary 2000 current year, 2007 future attainment year, and 2010 future year modeling outputs. The future year of 2010 was selected based on prescribed changes in the emissions inventories across North Carolina occurring just prior to this future year.

As described in Section 4.1.1 of the *Draft 8-Hour Ozone Guidance*, the collected modeling data from the 2000, 2007, and 2010 modeling output masks were applied to the following metrics:

1. Relative change in surface grid-hours > 84ppb.
2. Relative change in the number of grid cells with predicted 8-hr daily maxima > 84ppb.
3. Relative change in the total difference (ppb-hr) of hourly predictions > 84ppb.

The relative change from both 2000 to 2007 and 2000 to 2010 was considered in the computation of the three metrics.

In addition to the three recommended metrics, two additional metrics were computed for these periods to create a comprehensive corroborative analysis for the Triad EAC region. The two additional metrics are:

4. Relative change in the total difference (ppb-hr) of the predicted 8-hr daily maxima > 84 ppb.
5. Air Quality Index counts of the Green, Yellow, Orange, and Red categories for the 2000, 2007, and 2010 modeling output masks.

Recommended and Additional Air Quality Modeling Metrics

The five air quality modeling metrics introduced above were given unique titles in the North Carolina modeling exercise. These unique titles are Persistence-Hr, Persistence-Max, Severity-Hr, Severity-Max, and Air Quality Index Counts, respective to the order of appearance. These five air quality modeling metrics are further described and defined below:

1. Persistence-Hr (# Grid-hours) is defined as the number of grid-cells in a given region with predicted hourly 8-hr O3 concentrations > 84 ppb. The relative change in Persistence-Hr is presented as a percent reduction computed for all episode days from the future year case to the current year case.

2. Persistence-Max (# Grid-hours) metric is similar to Persistence-Hr, but uses the modeled daily maximum 8-h concentrations > 84 ppb instead of the hourly 8-hr O3 concentrations. The relative change in Persistence-Max is also presented as a percent reduction computed for all episode days from the future year case to the current year case.

3. Severity-Hr (# Grid-hour-ppb) is defined as the sum of all grid-cells with predicted hourly 8-hr O3 concentrations > 84 ppb. Given the definition of Persistence, this Severity could be considered as a weighted form of the Persistence metric. The relative change in Severity is also presented as a percent reduction computed for all episode days from the future year case to the current year case.

4. Severity-Max (# Grid-hour-ppb) metric is similar to Severity-Hr, but uses the modeled daily maximum 8-hr concentrations > 84 ppb instead of the hourly 8-hr O3 concentrations. The relative change in Severity-Max is also presented as a percent reduction computed for all episode days from the future year case to the current year case.

5. Air Quality Index Counts (AQI Counts) metric is a count of the number of grid-cells with predicted maximum 8-hr O3 concentrations sorted within each of the Code Green, Yellow, Orange and Red categories, as defined by the U.S. EPA's AQI Index. AQI Counts are presented as percentages of the total number of grid-cells within the study region.

Conclusions drawn from Air Quality Modeling Metrics

The results from each of the five air quality modeling metric calculations demonstrated significant or very large relative reductions of greater than 90% in future (2007) air quality conditions above the NAAQS. In each metric, the very large relative reductions were demonstrated in each of the three modeled episodes and also in the combined data across all modeled episodes. Considering the future (2010) air quality modeling, the relative reductions nearly reached 100% in all portions of the Triad EAC region. It is important to note that the relative reductions in all metrics well surpassed the *Draft 8-Hour Ozone Guidance* recommendation of 80% for these particular calculations.

Figures 6.4.2-1, 6.4.2-2, 6.4.2-3, and 6.4.2-4 present the relative reductions calculated in the first four metrics described in the previous section, respectively. Each of these four figures have very similar relative reductions in each modeled episode and also have almost identical relative reductions in the combined data across all modeled episodes. The combined data demonstrates reductions greater than 95% across the Triad EAC region. Equating this 95% relative reduction to real air quality conditions in the modeling, Figure 6.4.2-5 demonstrates a drop from 2,406 grid cells in excess of the NAAQS (Orange or Red AQI Counts) during the current (2000) episodes to only 100 exceeding grid cells during the future (2007) episodes. This tremendous reduction in exceeding grid cells is further improved to only 7 exceeding grids cells during the future (2010) episodes. These substantial grid cell counts are even more impressive when spatially plotted. Figures 6.4.2-6, 6.4.2-7, and 6.4.2-8 present the location and count of grid cells exceeding the NAAQS hourly and daily in the future (2007) episodes. The Triad EAC region is lightly shaded in gray on each of the spatial plots.

Throughout this air quality modeling metrics analysis for the Triad EAC region, each set of results consistently demonstrate relative reductions well beyond the recommended 80% mark that is considered appropriate for concluding that a proposed strategy would meet the NAAQS. Given a variety of additional emissions reductions that were not included in this modeling exercise and that will occur throughout the Triad EAC and surrounding regions before 2007, it is reasonable to conclude that the extremely small number and short duration of remaining exceeding grid cells in the future year modeled episodes will be below the NAAQS in both 2007 and 2010.

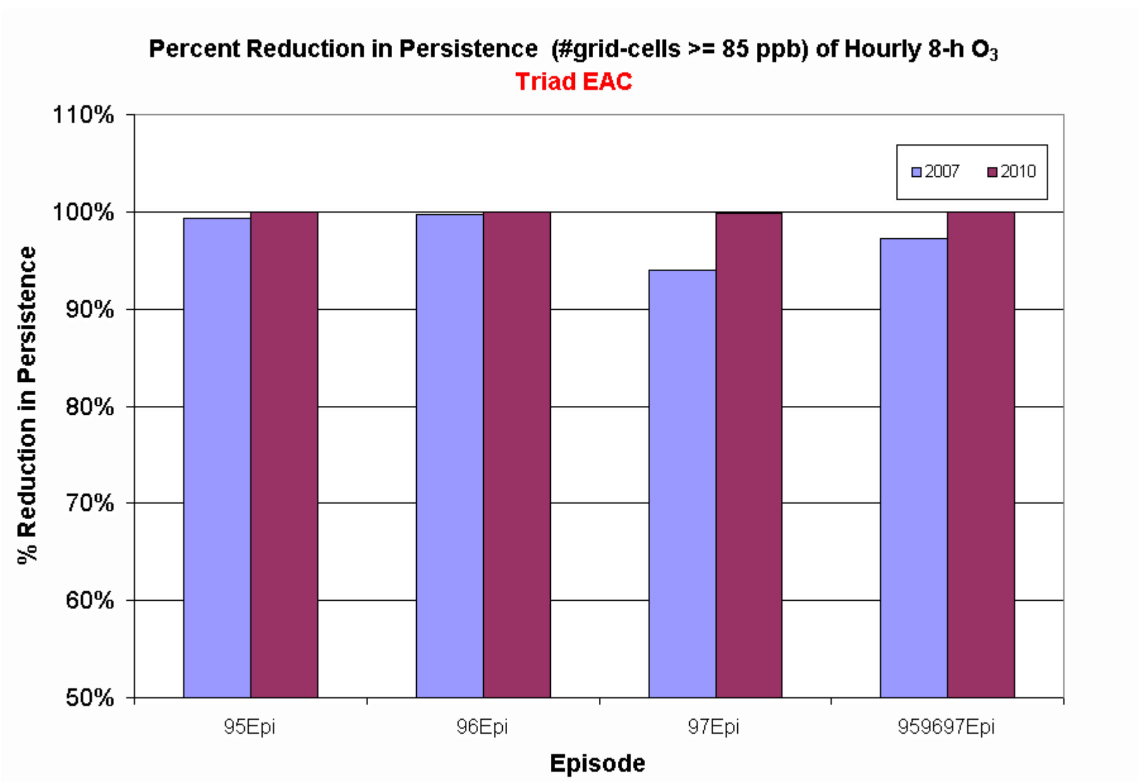


Figure 6.4.2-1 Persistence-Hr

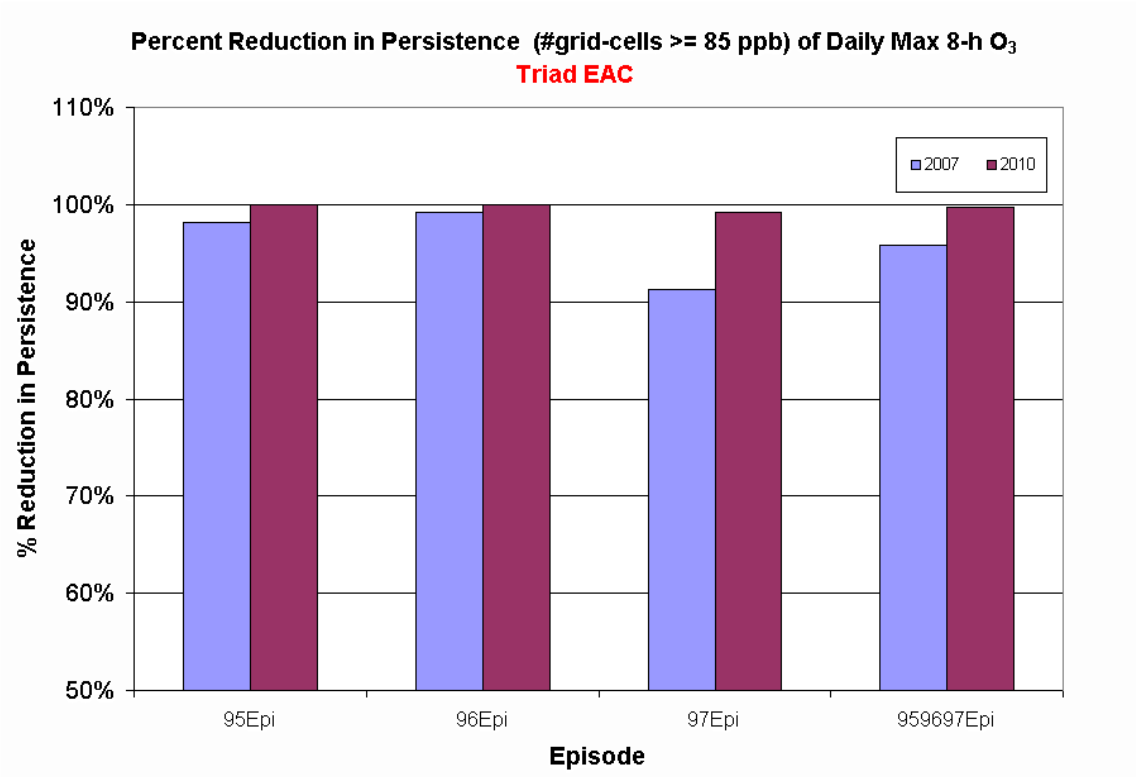


Figure 6.4.1-2 Persistence-Max

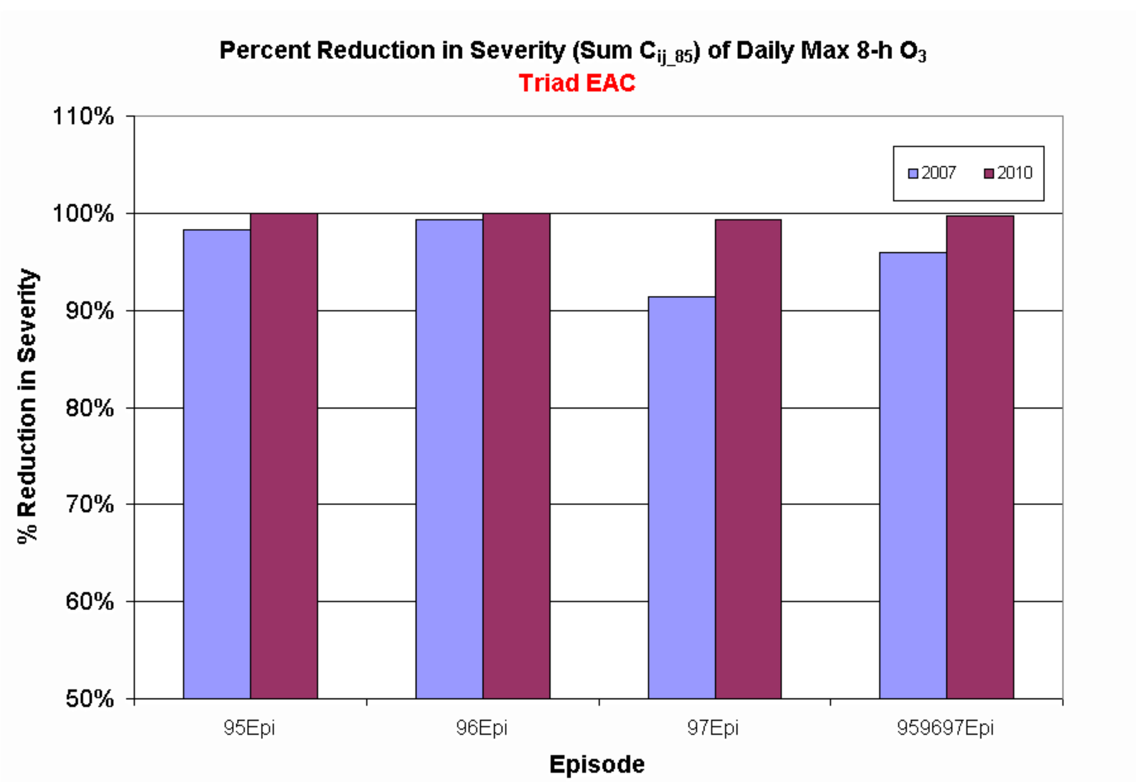


Figure 6.4.2-3 Severity-Hr

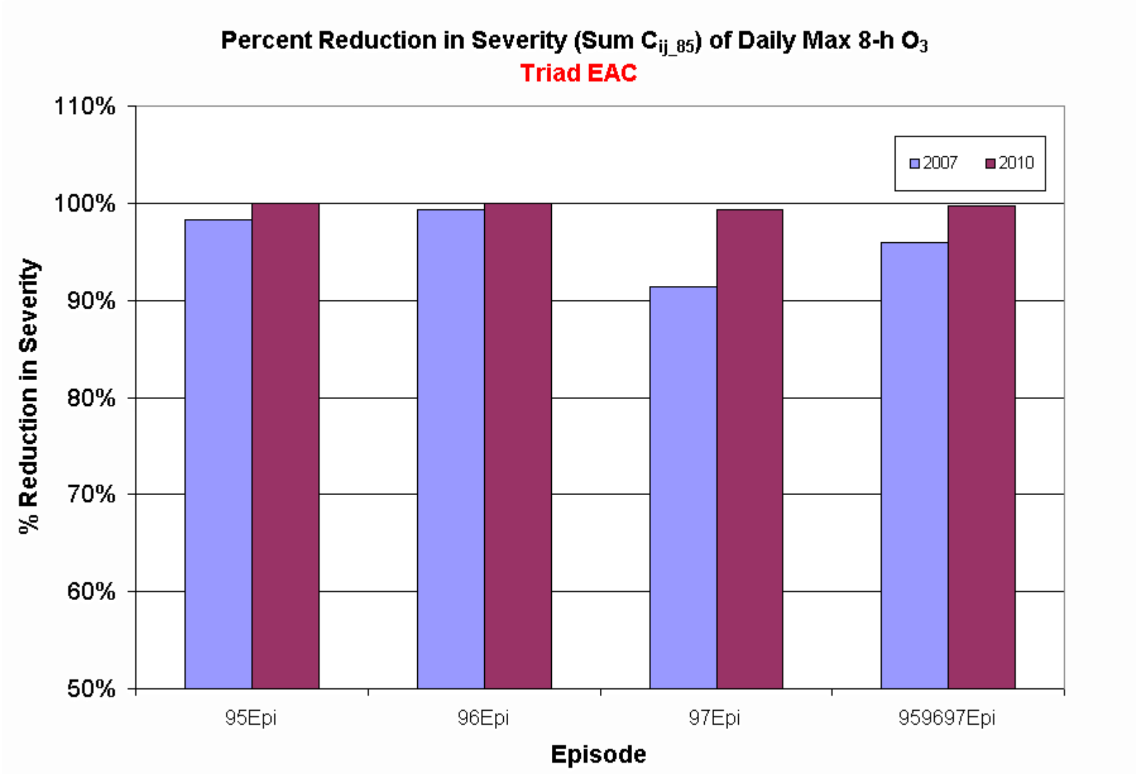


Figure 6.4.2-4 Severity-Max

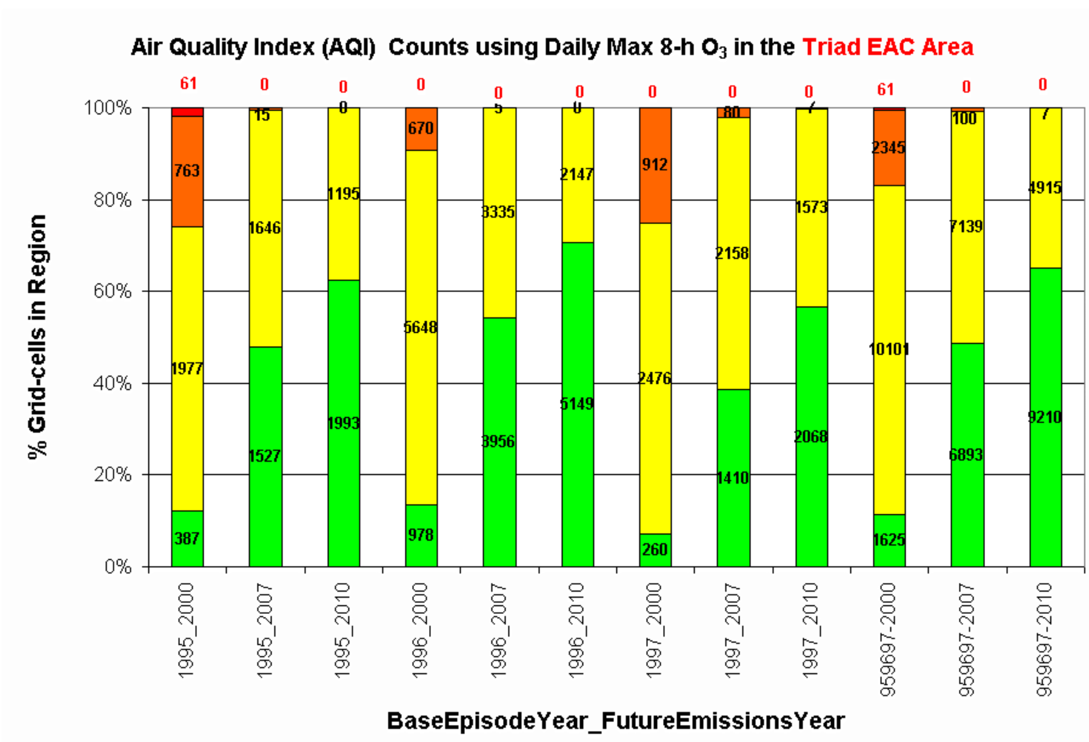
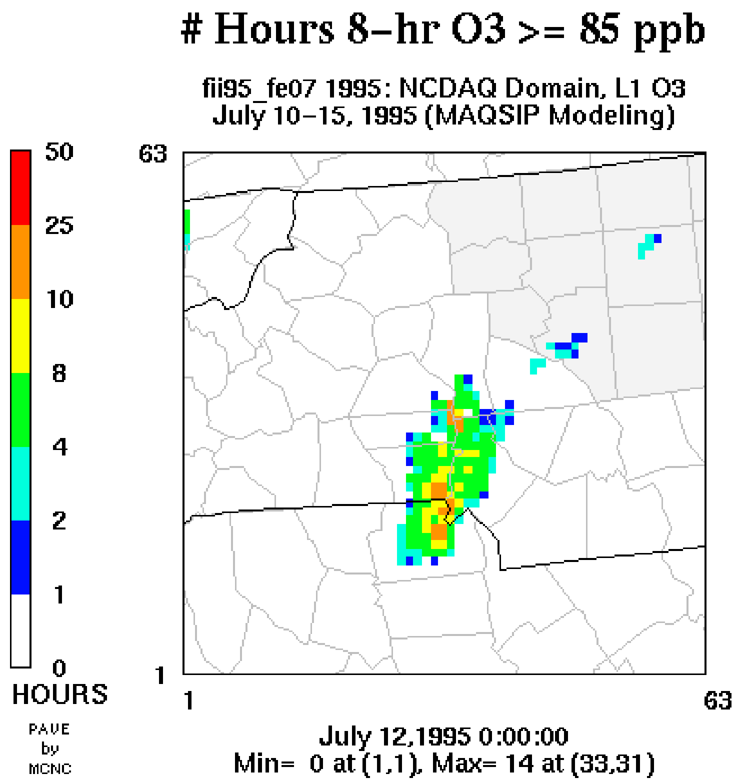


Figure 6.4.2-5 AQI Counts



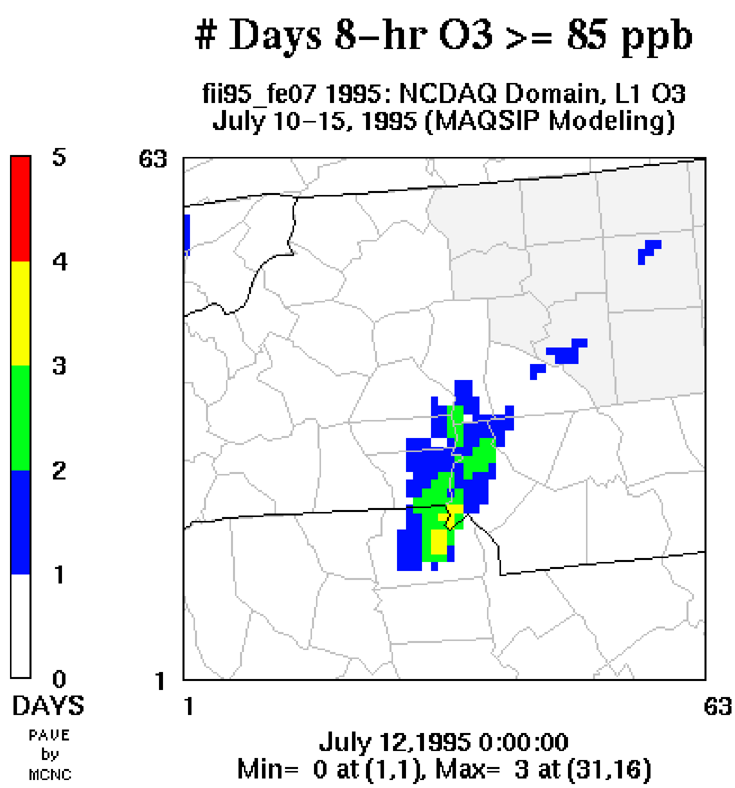


Figure 6.4.2-6 1995 Persistence (Hourly and Daily Max)

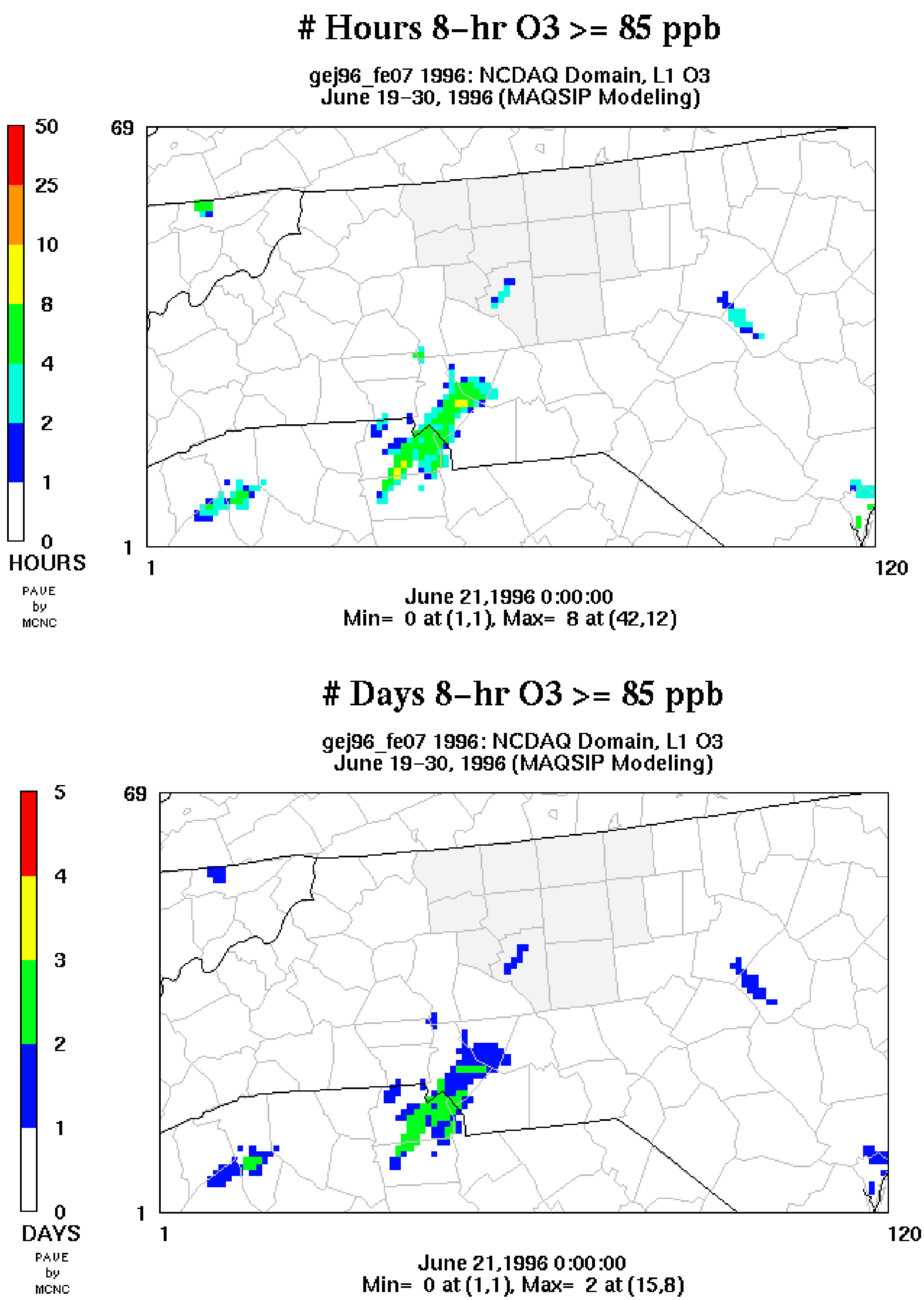
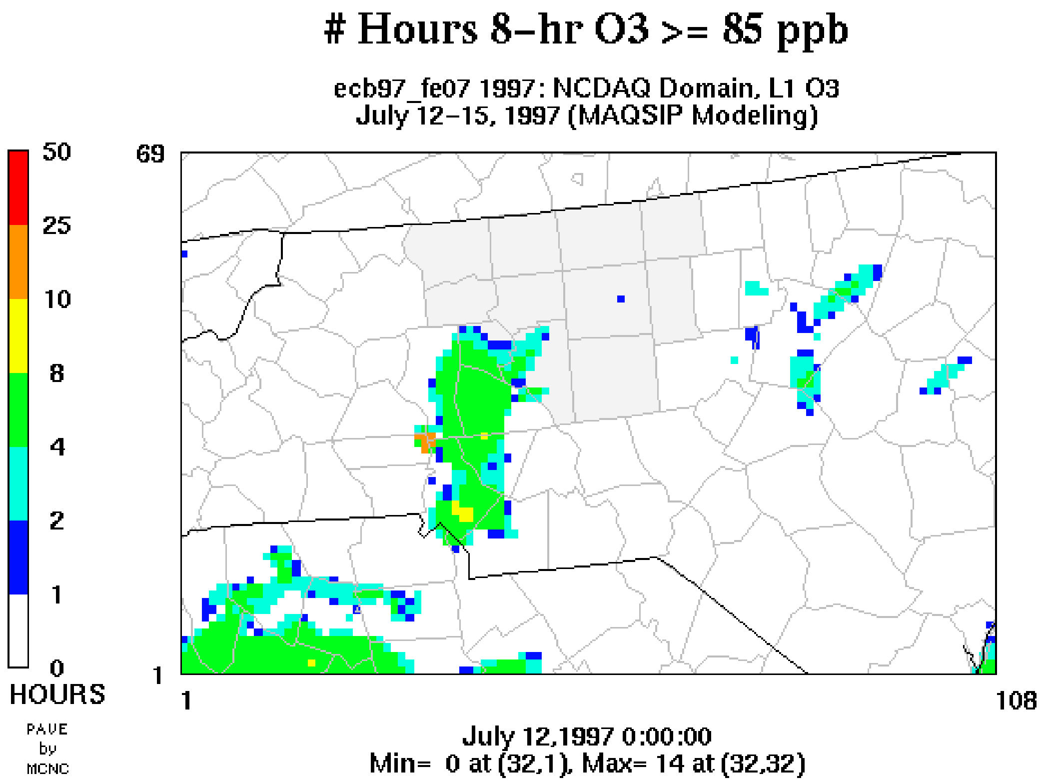


Figure 6.4.2-7 Persistence (Hourly and Daily Max)



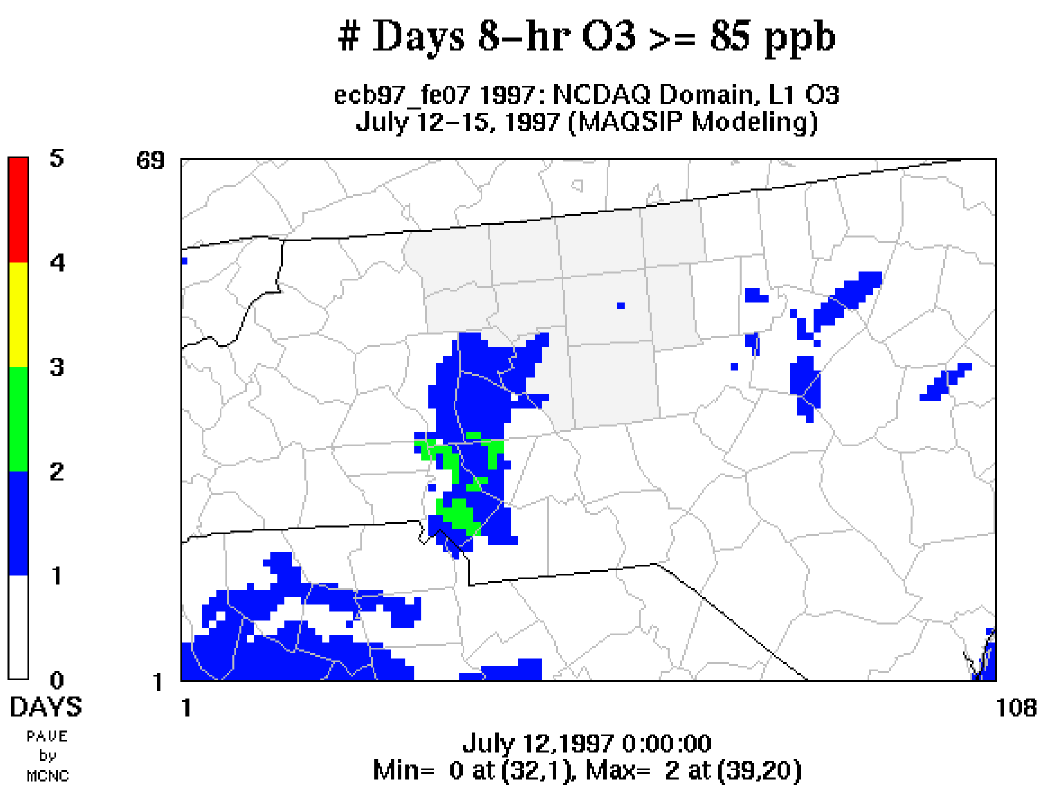


Figure 6.4.2-8 Persistence (Hourly and Daily Max)

6.4.3 Additional Corroborative Analyses - Alternative Methods for Applying the Modeled Attainment Test

Introduction

This analysis examines three different alternatives for applying the modeled attainment test. The first alternative is to choose use a different DVC in the modeled attainment test. The final two analyses involve using alternative criteria for selection of episode days to apply the modeled attainment test. Each of these analyses are described in greater detail in the Methodology section.

Methodology

1) Choosing the 3-year period to designate an area "nonattainment" as the most appropriate for use in the modeled attainment test

This alternative is explored because one of the 3-year periods suggested in the original form of the attainment test spans a period where significant reductions in precursor emissions took place in North Carolina.

Recall, the original form of the attainment test suggests using the higher of (a) the 3-year period "straddling" the year represented by the most recent available emissions inventory (for NC's EAC modeling this span is 99-01, for a 2000 inventory), and (b) the 3-year period used to designate an area "nonattainment" (01-03). In this alternative analysis, NCDAQ believes it is inappropriate to use any observed ozone data from years prior to 2000 due to a significant reduction in NOx emissions between 1999 and 2000 from the utility sector. The total annual NOx emissions from utilities in 1999 was 197,956 tons/yr, while in 2000 they were over 42,000 tons lower at 155,724 tons/yr. These dramatic decreases in NOx emissions are most likely due to Title IV reductions that were required by 2000. The 4th highest 8-hour daily maximum ozone concentration in 1999 was the second highest on record (1998 is the highest) at the Cooleemee monitor. The 4th highest 8-hour daily maximum ozone concentrations for 2000 through 2003 have been between 2 and 12 percent lower than 1999, showing an obvious link to the decrease in NOx emissions from the utility sector. Table 6.4.3-1 below presents the NOx emissions and Cooleemee ozone data. Even though meteorological variability is not considered in this analysis, NCDAQ believes the drop in NOx emissions between 1999 and 2000 is too large to ignore. Also, the significant reduction in utility NOx emissions between "current" levels and 2007 is noteworthy. One can reasonably infer from this emissions data that future ozone values in this NOx limited environment will be below the NAAQS.

Table 6.4.3-1 NC Utility NOx emissions and Cooleemee 4th highest ozone concentrations

	1999	2000	2001	2002	2003	2007*
NOx Emissions (tpy)	197,956	155,724	140,216	142,565	n/a	58,506
Cooleemee 4th high 8-hour ozone (ppb)	0.100	0.094	0.094	0.098	0.089	

*Projected

Given the reasoning stated above, and the fact that NOx emissions have not changed substantially since 2000, the 1999 ozone data was not considered in the 3 alternative tests explained here. The first test used the higher of 00-02 DVC and the 01-03 DVC. The spirit of the attainment test is preserved with this methodology. The 00-02 DVC includes the year of the "current" emissions year (2000) and the 01-03 DVC was used in the 8-hour ozone nonattainment designations. At the Cooleemee monitor, the 00-02 DVC is 95 ppb and the 01-03 DVC is 93 ppb. Taking the higher of the 2 DVCs (95 ppb) and the relative reduction factor of 0.91 results in a calculated future design value at the Cooleemee monitor of 86 ppb. This is *lower* than the 87 ppb acquired when applying the original attainment test.

The second test used the 01-03 DVC. NCDAQ believes this is an appropriate alternative DVC to use given its importance in not only determining nonattainment boundaries, but also the severity of the nonattainment classification. At the Cooleemee monitor, the 01-03 DVC is 93 ppb and the relative reduction factor is 0.91. The resulting future design value at the Cooleemee monitor is therefore **84 ppb**.

The third test used a DVC calculated from 4 years of 4th highest 8-hour daily maximum concentrations. This DVC uses data from 2000 through 2003. NCDAQ believes this is an appropriate alternative given the relatively consistent precursor emissions in each of these years. Additionally, a longer-term average, given relatively consistent emissions, may help stabilize the impact of meteorological variability on DVCs. At the Cooleemee monitor, the 00-03 DVC is 93 ppb and the relative reduction factor is 0.91. The resulting future design value at the Cooleemee monitor is therefore **84 ppb**.

2) Exclusion of episode days with observed *max 8-hour average concentrations of < 70 ppb*

This analysis uses the *observed* air quality conditions to refine the basis for calculating relative reduction factors and their corresponding future design values. Recall, the original form of the attainment test suggests that States need not consider any day for which the *modeled* current maximum 8-hour daily maximum concentration at a nearby grid cell is < 70 ppb. In this alternative analysis, days with *observed* 8-hour daily maximum concentrations <70 ppb were excluded from the relative reduction factor calculations and their corresponding future design values. This method excluded 5 days that were in the original test and included 1 day that was excluded in the original test. Removing/adding these days lowered the RRF at the Cooleemee monitor from 0.91 to 0.90. Table 6.4.3-2 shows the original episode days and whether they were selected or eliminated based on the < 70 ppb criteria. As a result, the corresponding future design value at the Cooleemee monitor is reduced from 87 ppb in the original test to 86 ppb in this alternative test. Furthermore, if one uses the *most recent* DVC (01-03), summarized as the most appropriate DVC in the above section, the resulting 2007 future design value at Cooleemee is **83 ppb.**

Table 6.4.3-2 Maximum observed 8-hour ozone concentration at Cooleemee on episode days

Episode Day	**Maximum Observed 8-hour Average (ppm)**	**Excluded**
7/12/1995	*	Yes
7/13/1995	*	Yes
7/14/1995	*	No
7/15/1995	*	No
6/21/1996	0.062	Yes
6/22/1996	0.079	No
6/23/1996	0.069	Yes
6/24/1996	0.089	No
6/27/1996	0.084	No
6/28/1996	0.096	No
6/29/1996	0.085	No
6/30/1996	0.066	Yes
7/12/1997	0.087	No
7/13/1997	0.078	No
7/14/1997	0.088	No
7/15/1997	0.087	No

* The Cooleemee monitor was not in operation during the 1995 episode. Because this exclusion of days depends on observed data, NCDAQ operated on the assumption that the 7/14/95 and 7/15/95 days were the only days that would have observed >70 ppb. This assumption was based on observations taken at nearby monitors.

3) Exclusion of episode days when observed max 8-hour average concentration is not within +/- 10 ppb of DVC used for episode selection.

Episode days were excluded for the modeled attainment test when their observed max 8-hour average concentration was not within +/- 10 ppb of the design value used for episode selection. For the 1995 episode days, the design values for episode selection were based on observations made from 1994 to 1996. For the 1996 episode days, the design values for episode selection were based on observations made from 1995 to 1997. For the 1997 episode days, the design values for episode selection were based on observations made from 1996 to 1998. Table 6.4.3-3 shows the available days to apply the +/- 10 ppb criteria to and if they were excluded. Removing the days that did not meet the criteria described resulted in a lowering of the RRF from 0.91 to 0.90. The corresponding future design value at the Cooleemee monitor is reduced from 87 ppb in the original test to 86 ppb in this alternative test. Furthermore, if one uses the *most recent* DVC (01-03), summarized as the most appropriate DVC in the above section, the resulting 2007 future design value at Cooleemee is **83 ppb**.

Table 6.4.3-3 Cooleemee ozone concentrations and design values

Epidsode Day	Maximum Observed 8-hour Average	Design Value Used for Episode Selection	Excluded
7/12/1995	*	*	Yes
7/13/1995	*	*	Yes
7/14/1995	*	*	No
7/15/1995	*	*	No
6/21/1996	0.062	0.088	Yes
6/22/1996	0.079	0.088	No
6/23/1996	0.069	0.088	Yes
6/24/1996	0.089	0.088	No
6/27/1996	0.084	0.088	No
6/28/1996	0.096	0.088	No
6/29/1996	0.085	0.088	No
6/30/1996	0.066	0.088	Yes
7/12/1997	0.087	0.092	No
7/13/1997	0.078	0.092	Yes
7/14/1997	0.088	0.092	No
7/15/1997	0.087	0.092	No

*The Cooleemee monitor was not in operation during the 1995 episode. Because this exclusion of days depends on observed data, NCDAQ operated on the assumption that the 7/14/95 and 7/15/95 days were the only days that would have observed concentrations within +/- 10 ppb of the design value used for episode selection. This assumption was based on observations taken at nearby monitors.

Conclusions drawn from Alternative Methods for Applying the Modeled Attainment Test

Additional corroborative analyses involving alternative methods for applying the modeled attainment test at the Cooleemee monitor further supports the conclusion that the proposed strategy is adequate. Seven alternative tests were applied and all showed 2007 future design values lower than what was calculated using the original form of the attainment test. The average and median of the alternative tests indicate attainment of the 8-hour ozone NAAQS at Cooleemee. A summary of the tests is provided in Table 6.4.3-4 below.

Table 6.4.3-4 Summary of Additional Corroborative Analyses

Test Name	2007 Future Design Value (ppb)
Original Attainment Test	87
Higher DVC 00-02 & 01-03	86
DVC 01-03	84
DVC 00-03	84
obs <70 original test	86
obs <70 w/ DVC 01-03	83
+/- 10 original test	86
+/- 10 DVC 01-03	83
AVERAGE	**84**
MEDIAN	**84**

It is important to note that these analyses and their results are based on EPA's Modeling Guidance. The elements of the analyses that are not explicitly covered in the *Draft 8-hour Ozone Guidance* are based on like principles and should be given similar credibility.

6.4.4 Additional Corroborative Analyses - Analysis of Other Source Regions

Introduction

The intent of analyzing other source regions is to show how frequently and to what degree particular areas impact Cooleemee on days when ozone concentrations were high. It is the experience of NCDAQ meteorologists that Cooleemee is often affected by pollution originating from either the Triad or Charlotte metropolitan areas. On days when the prevailing wind flow is from the south and southwest, the Charlotte region would be expected to have the greatest impact on Cooleemee. On days when the wind flow is more northerly or northeasterly, the Triad region would be expected to have a greater impact on Cooleemee. There are days when the wind flow is such that neither the Triad nor Charlotte regions wo uld have the most significant impact on Cooleemee, such as moderate easterly or westerly flow. NCDAQ hypothesizes that analysis of these other source regions will show that the Charlotte region was the predominant area of influence on Cooleemee. As such, emissions reductions that will take place in the Charlotte region would lead to reductions in ozone concentrations (future design values) at Cooleemee.

Methodology

An examination of back trajectories for five years (1999-2003) was made at the Cooleemee ozone monitor site in Davie County, North Carolina. Specifically, days when the observed 8-hr average ozone concentrations was greater than 84 ppb were analyzed to determine the probable source regions for transported ozone and its precursors. Back trajectories were created using the National Oceanic and Atmospheric Administration Air Resource Laboratory (NOAA ARL) HYbrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT; Draxler and Rolph, 2003) model version 4. The 80 km EDAS data was used as the data set for the trajectory analysis.

Using the criteria that the observed 8-hr average ozone concentrations was greater than 84 ppb, a total of 78 days from 1999 through 2003 met the criteria for the Cooleemee monitor. Of those 78 days, three days were eliminated from the back trajectory analysis due to missing data in the EDAS data set. Individual back trajectories were run for each of the remaining 75 days using the HYSPLIT model. The first analysis of these trajectories used visual inspection to determine the most likely source region for the pollution measured at the Cooleemee site for each day. The possible source region(s) could be Charlotte, the Triad, some other region, or any combination of the three. The second analysis separated the trajectories based on observed ozone concentration at the Cooleemee site in order to relate the observed concentration of ozone to the source region.

Results

From the analysis based on source region, it was determined that the Charlotte region was the most likely source on 36 of the days, the Triad region on 15 of the days, other region on 11 of the days, and a combination of the Charlotte and Triad regions on 10 of the days (Table 6.4.4-1).

There were also three days when Charlotte and other or Triad and other were determined to be the source regions. Figure 6.4.4-1 shows the composite of the trajectories at the 10-meter level of the 36 days when the Charlotte region was determined to be the predominant source region. There is a clear distinction of southerly and westerly flow through the Charlotte region.

Cooleemee Trajectory Analysis Results

Date		Charlotte	Triad	Other
5/21/1999	87	X	X	
5/29/1999	86			X
5/30/1999	85	X		
6/9/1999	110		X	
6/10/1999	100	X	X	
7/6/1999	90	X	X	
7/16/1999	86	X	X	
7/28/1999	88			X
7/31/1999	87			X
8/4/1999	91		X	
8/5/1999	86	X	X	
8/6/1999	91		X	
8/7/1999	110	X	X	
8/10/1999	87	X		X
8/11/1999	90	X		
8/12/1999	91		X	
8/13/1999	138	X		
8/14/1999	89	X		
8/17/1999	87	X		
8/18/1999	97			X
8/19/1999	95		X	
8/28/1999	94		X	
9/8/1999	91	X		
9/13/1999	88		X	X
5/19/2000	89	X		
6/2/2000	98	N/A	N/A	N/A
6/9/2000	89	X		
6/10/2000	93	X		
6/11/2000	93	X		
6/12/2000	95	X		
6/13/2000	94	X		
6/24/2000	88	N/A	N/A	N/A
7/2/2000	93	X		
7/8/2000	88			X
7/10/2000	96	X		
7/18/2000	98			X
7/19/2000	92	X		
7/28/2000	89	X		
8/7/2000	88			X
8/17/2000	86		X	
9/14/2000	85	X		
5/4/2001	87	X		
5/15/2001	87			X
Total Days		**25**	**14**	**10**

Date		Charlotte	Triad	Other
5/19/2001	87	X		
6/19/2001	87	X	X	
6/20/2001	94	X	X	
6/21/2001	102	X		
7/17/2001	90	X		
8/3/2001	86	X		
8/9/2001	98	X		
8/23/2001	104	X		
8/25/2001	85		X	
5/24/2002	86			X
6/4/2002	100	X		
6/5/2002	96	N/A	N/A	N/A
6/10/2002	91	X	X	
6/11/2002	112	X		
6/13/2002	93	X		
7/2/2002	92	X	X	
7/8/2002	88	X		
7/9/2002	94	X		
7/16/2002	86		X	
7/17/2002	95		X	
8/1/2002	90		X	
8/2/2002	96		X	
8/9/2002	90		X	
8/10/2002	88	X		
8/11/2002	98	X		
8/12/2002	97	X		X
8/13/2002	99	X		
8/21/2002	85			X
8/22/2002	90	X		
8/23/2002	98			X
9/5/2002	89		X	
6/10/2003	89	X		
6/24/2003	89		X	
6/25/2003	106	X		
6/26/2003	100	X		
Total Days		**23**	**12**	**4**

Charlotte = 48
Triad = 26
Other = 14
CLT&Triad= 10

Charlotte only = 36
Triad only = 15

Table 6.4.4-1. Trajectory source regions for days when the observed 8-hr ozone concentration at Cooleemee was 85 ppb or greater from 1999 through 2003. An "X" indicates that the region was determined to be potential source region for ozone and precursor pollutants on that day. "N/A" indicates that the EDAS data needed to run the trajectory for that day was not available, and therefore no trajectory was available for analysis.

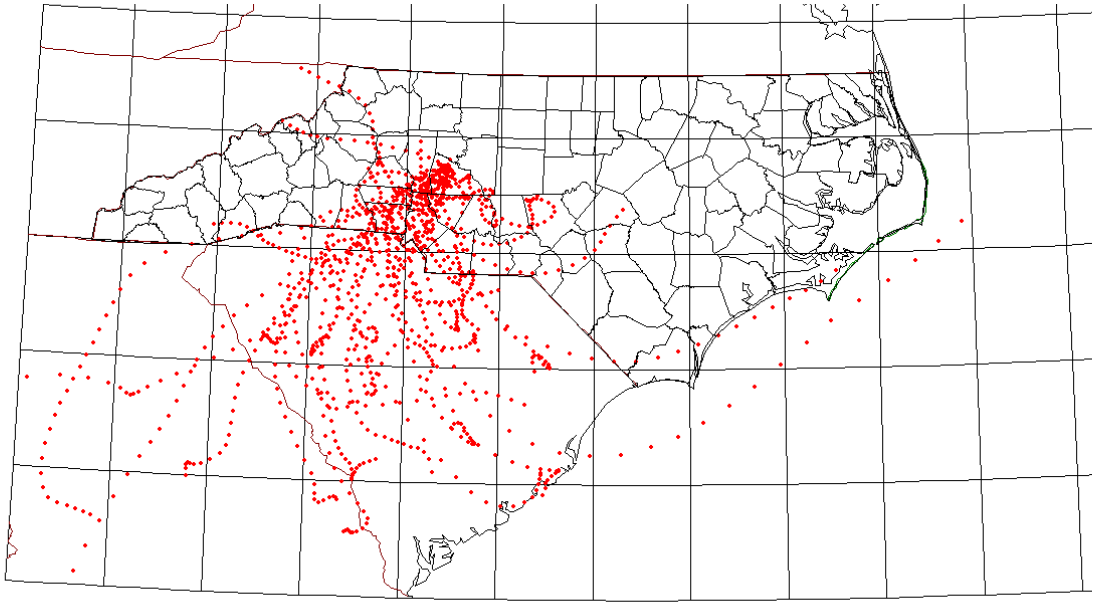


Figure 6.4.4-1. Composite image of back trajectories at the 10-meter level for the 36 days (1999-2003, 85 ppb or greater) when the Charlotte region was identified as the predominant source region.

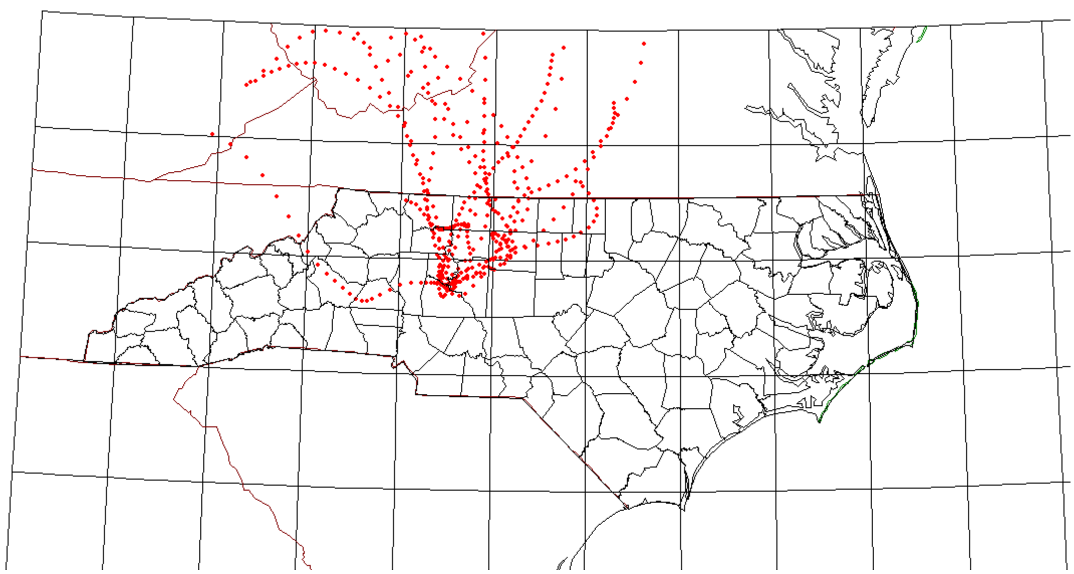


Figure 6.4.4-2. Composite image of back trajectories at the 10-meter level for the 15 days (1999-2003, 85 ppb or greater) when the Triad region was identified as the predominant source region.

Figure 6.4.4-2 shows a similar composite for those days when the Triad region was determined to be the predominant source region. On these days, there is a clear distinction of northerly and northeasterly flow through the Triad region. Figure 6.4.4-3 shows the composites for those days when both the Charlotte and Triad regions were determined to impact the Cooleemee monitor. There appears to be a favored southwest flow at the 10-meter level, while at 300 and 1000 meters (not shown), the southwest flow is not as evident. The predominance of southwest flow at the lowest level may be an indicator of the influence of low-level NO_x sources originating from the Charlotte region and impacting the Cooleemee site.

For those days when neither the Charlotte nor the Triad regions were determined to impact the Cooleemee site, the wind flow is generally westerly to northwesterly, although on several days there is an obvious easterly component to the flow. In these cases, influence from the Charlotte and Triad regions on Cooleemee would be minimal, but could still play some minor influence on local pollution concentrations near the monitor.

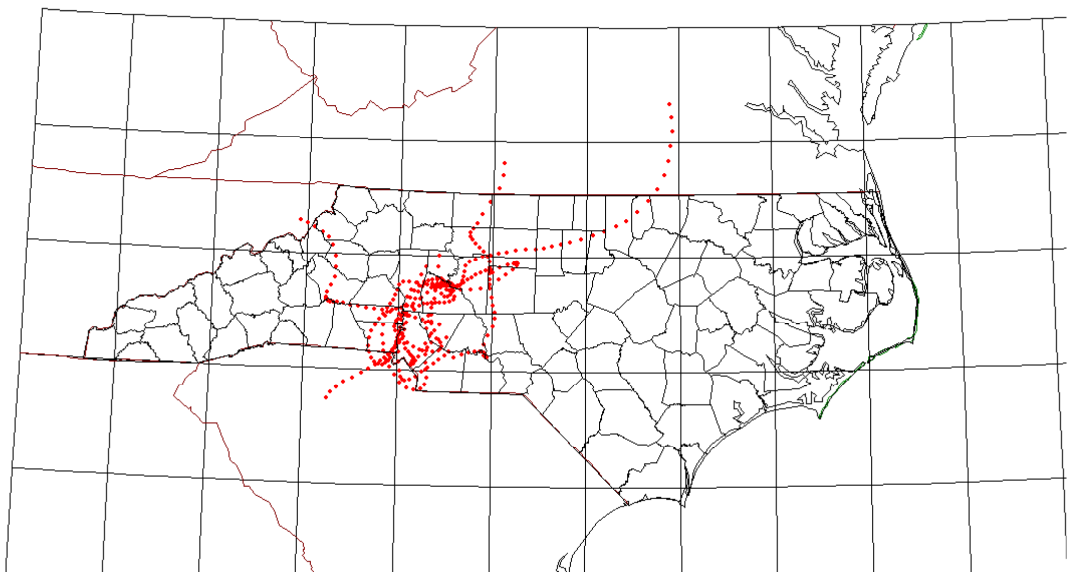


Figure 6.4.4-3. Composite image of back trajectories at the 10-meter level for the 11 days (1999-2003, 85 ppb or greater) when both the Charlotte and Triad regions were identified as the predominant source regions.

The second analysis that was performed was a separation of the trajectories based on observed ozone concentration. Specifically, four separate bins were created: 85-87 ppb, 88-90 ppb, 91-95, and above 95 ppb. There were 19 days in each of the bins except for the 91-95 ppb bin, which only contained 18 days. While in none of the bins is there an absence of influence from either the Charlotte or the Triad regions, there does appear to be a predominant southwest flow through the Charlotte region in both the 85-87 ppb bin and the above 95 ppb bin (Figures 6.4.4-4 and 6.4.4-5, respectively), especially at the 10-meter level for the above 95 ppb bin. The latter is significant, since it suggests that on those days when the ozone concentration at Cooleemee was highest the main contributor of ozone and precursor pollutants is the Charlotte region. For the 88-90 ppb and 91-95 ppb bins (not shown) there appears to be a greater split in the trajectories between the Charlotte and Triad regions than the other bins, suggesting there is not a favored wind flow direction for ozone concentrations in those ranges.

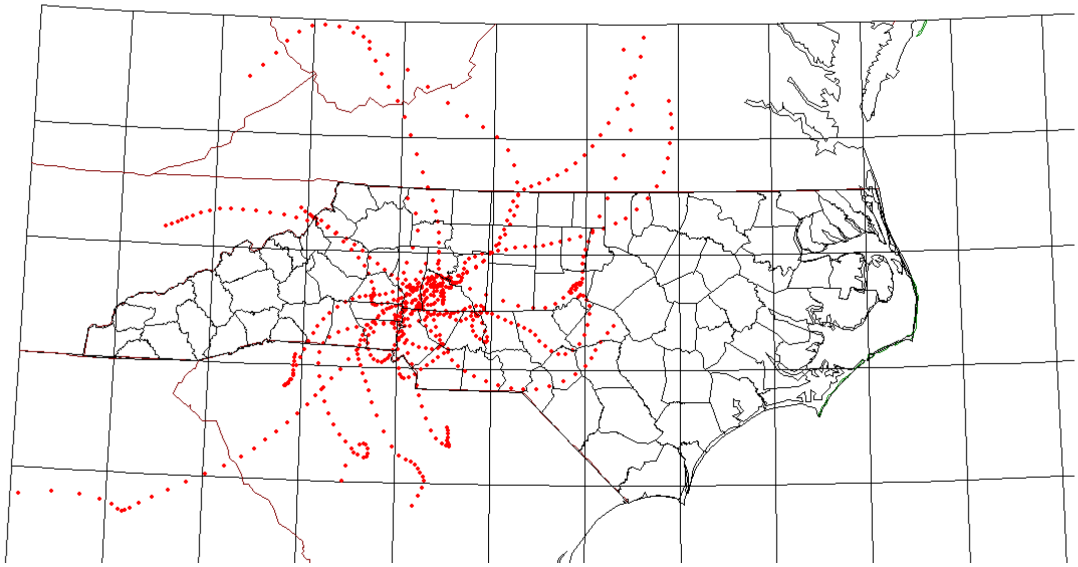


Figure 6.4.4-4. Composite image of back trajectories at the 10 meter level for the 19 days (1999-2003) when the observed 8-hr ozone concentration at the Cooleemee monitor site in Davie County was 85 to 87 ppb.

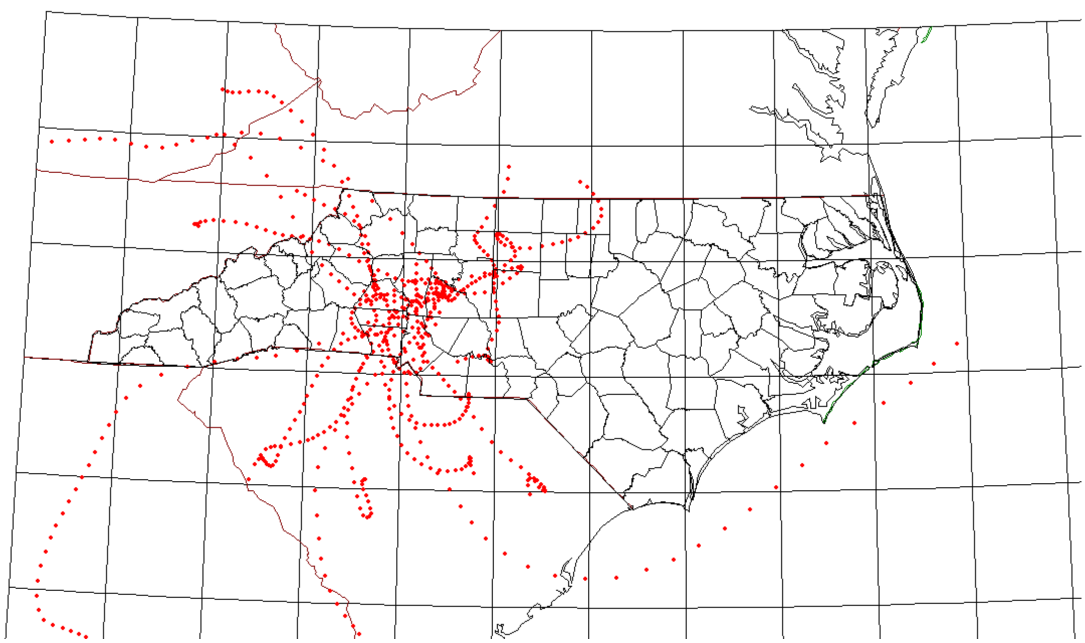


Figure 6.4.4-5. Composite image of back trajectories at the 10 meter level for the 19 days (1999-2003) when the observed 8-hr ozone concentration at the Cooleemee monitor site in Davie County was greater than 95 ppb.

Conclusions drawn from Analysis of other Source Regions

The above analysis suggests that the Cooleemee monitor is influenced more often by transported ozone and precursor pollutants from the Charlotte region (36 of 75 days, 47%) as opposed to the Triad region (15 of 75 days, 20%). Also, an analysis of back trajectories based on observed ozone concentration indicates that on those days when the ozone concentration at Cooleemee is greater than 95 ppb, the predominant region of influence is also the Charlotte region. Together these analyses suggest that the majority of time the Cooleemee monitor may be more representative of pollution originating from the Charlotte region rather than the Triad region.

The result of this conclusion is that DAQ expects local pollution control measures that will be implemented in the Charlotte region, which to date have not been included in the current modeling, will lead to larger reductions of pollution in the Triad, and specifically at Cooleemee. Given that well over 50% of the days in the last five years that Cooleemee exceeded the ozone standard a region other than the Triad was the predominant region of influence, emissions controls that will take place outside of the Triad will no doubt have a significant impact on reducing pollution at Cooleemee.

6.4.5 Final Modeling Inventory Changes

With the update to the 2007 modeling inventory a number of emission reductions take place. The Statewide point source emissions inventory decreases from the previous version. Included in these point source decreases is 2 tons per day of NOx from RJ Reynolds fuel switching proposed as a local control and over 7 tons per day of NOx reduction from the Duke Energy Marshall facility putting on controls ahead of schedule.

The mobile source updates results in approximately 100 tons per day NOx emissions decreases across the State. Additionally, applying the open burning ban will result in some NOx decreases, the amount of which will be dependent on the rule effectiveness and rule penetration settled upon.

NCDAQ is also working with the Charlotte area and Duke Energy to see if any other emission reductions from downwind of the Triad area are possible.

These additional reductions of NOx emissions in and around the Triad area are expected to bring the Cooleemee monitor into attainment in the final modeling analysis.

6.4.6 Additional Technical Analyses - Conclusions

When looking at additional technical analyses for the Cooleemee monitor in the Triad EAC area, NCDAQ believes that there is substantial evidence that this monitor will attain the standard in 2007.

The air quality modeling metrics suggested by EPA demonstrates very large relative reductions (90%); a percentage much larger than what EPA recommends to demonstrate future attainment. It has been demonstrated that the current design value used in the attainment test has an impact on if a monitor is expected to attain. NCDAQ believes that the model may be less responsive to emission reductions than reality. If this is the case, then using the most current design value may be more appropriate.

Back trajectory analysis shows a large impact from the Charlotte region. As NCDAQ and Charlotte begin to address this regions 8-hour ozone problem, the Cooleemee monitor will benefit from the resultant decreases in ozone. To the extent possible, emission reductions expected in the Charlotte area will be included in the final modeling that the State submits in December 2004.

References

1. U.S. EPA. National Ambient Air Quality Standards. http://www.epa.gov/airs/criteria.html.

2. McConnell et al. 2002. Asthma in exercising children exposed to ozone: a cohort study. Lancet 359: 386-391.

3. U.S. EPA. "Smog – Who Does It Hurt? What You Need to Know about Ozone and Your Health" http://www.epa.gov/airnow/health/index.html.

4. Draxler, R.R. and Rolph, G.D., 2003. HYSPLIT (HYbrid Single-Particle Lagrangian Integrated Trajectory) Model access via NOAA ARL READY Website (http://www.arl.noaa.gov/ready/hysplit4.html). NOAA Air Resources Laboratory, Silver Spring, MD.

7 Anticipated Resource Constraints

The resource constraint of most concern is the funding needed to implement some of the local control measures. NCDAQ and the local EAC areas are both looking for grant opportunities to help fund EAC initiatives.

APPENDIX A

Stationary Point Sources Emissions in tons/day

County	2000			2007		
	CO	NOx	VOC	CO	NOx	VOC
Alamance	0.68	0.66	1.60	0.07	0.76	1.03
Alexander	0.03	0.04	1.38	0.02	0.00	1.66
Alleghany	0.00	0.01	0.03			
Anson	0.13	0.46	0.38	0.00	0.00	0.00
Ashe	0.23	0.16	0.34	0.03	0.01	1.23
Avery	0.00	0.01	0.00			
Beaufort	0.04	0.20	0.30	1.48	2.48	0.34
Bertie	0.69	0.36	0.57	0.18	0.27	1.04
Bladen	0.40	1.19	0.49	0.23	2.33	0.58
Brunswick	14.55	6.64	3.87	4.78	9.81	2.79
Buncombe	1.25	53.32	3.60	13.78	13.79	3.10
Burke	2.55	0.84	5.18	7.87	0.61	13.73
Cabarrus	0.82	3.03	4.06	0.18	2.10	3.60
Caldwell	1.35	1.19	21.88	0.51	0.16	28.09
Camden	0.00	0.00	0.00			
Carteret	0.15	0.22	0.30	0.01	0.11	0.00
Caswell						
Catawba	4.16	96.23	18.81	13.14	51.84	20.46
Chatham	4.51	21.19	2.21	7.90	4.72	2.16
Cherokee	0.02	0.02	0.22			
Chowan	0.03	0.21	0.37	0.03	0.15	0.01
Clay						
Cleveland	0.82	1.70	1.04	0.80	4.46	1.62
Columbus	20.82	15.41	6.93	15.75	9.05	2.53
Craven	4.94	4.21	3.73	4.54	4.94	1.85
Cumberland	1.22	3.16	4.08	0.51	3.76	6.86
Currituck	0.08	0.01	0.00			
Dare	0.05	0.19	0.01	0.01	0.34	0.00
Davidson	3.31	12.16	15.05	3.02	6.34	20.47
Davie	0.17	0.20	1.98	0.09	0.04	3.79
Duplin	0.24	1.10	0.14	1.11	2.41	0.02
Durham	1.00	1.58	1.19	0.30	1.03	5.73
Edgecombe	0.49	5.95	0.90	0.43	7.29	0.02
Forsyth	2.09	6.15	9.76	1.96	6.78	19.96
Franklin	0.28	0.21	1.71	0.01	0.13	0.12
Gaston	3.67	86.48	5.40	21.44	38.21	7.51
Gates	0.08	0.03	0.10			
Graham	0.09	0.08	1.29	0.02	0.02	1.38
Granville	0.34	0.36	1.79	0.37	0.13	1.92
Greene	0.00	0.07	0.00			

Stationary Point Sources Emissions in tons/day

County	2000			2007		
	CO	NOx	VOC	CO	NOx	VOC
Guilford	1.59	1.83	18.13	0.17	0.88	39.44
Halifax	6.22	10.72	1.71	17.11	12.80	0.41
Harnett	0.20	0.33	1.12	0.23	0.63	0.62
Haywood	7.85	12.48	5.00	9.26	16.05	2.44
Henderson	0.25	0.31	3.79	0.03	0.43	4.53
Hertford	1.33	0.47	1.13	0.02	0.17	0.24
Hoke	0.08	0.25	0.40	34.24	1.00	10.35
Hyde	0.00	0.04	0.00			
Iredell	3.58	9.98	20.42	3.63	11.15	4.37
Jackson	0.60	0.52	0.38	0.00	0.05	0.00
Johnston	0.80	0.46	1.80	0.02	0.15	2.46
Jones						
Lee	1.37	0.42	1.27	1.14	0.28	0.75
Lenoir	0.63	2.27	1.30	0.14	3.10	0.23
Lincoln	0.76	5.82	2.73	8.90	14.26	2.18
McDowell	2.12	1.04	3.87	0.78	0.71	1.33
Macon	0.11	0.08	0.05			
Madison	0.02	0.07	0.00			
Martin	10.72	10.38	3.24	31.74	9.97	3.18
Mecklenburg	5.49	2.30	11.99	3.32	3.73	23.26
Mitchell	0.41	0.50	2.49	0.13	0.02	2.09
Montgomery	0.24	0.32	1.99	0.05	0.01	0.02
Moore	0.17	0.14	2.29	0.02	0.00	1.74
Nash	9.02	0.97	2.67	0.50	1.06	0.56
NewHanover	35.65	31.96	6.52	46.31	49.30	6.49
Northampton	1.10	0.30	0.86	0.14	0.30	0.10
Onslow	0.34	1.77	0.16	0.09	1.22	0.02
Orange	2.86	1.80	0.37	3.37	0.78	0.01
Pamlico						
Pasquotank	0.10	0.07	0.07	0.01	0.02	0.03
Pender	0.00	0.00	0.05	0.02	0.03	0.01
Perquimans						
Person	5.79	205.34	1.36	13.83	32.70	1.22
Pitt	1.06	0.88	1.95	0.37	0.75	1.11
Polk	0.02	0.03	0.00			
Randolph	0.53	0.38	4.01	0.02	0.07	2.33
Richmond	0.33	0.26	0.17	323.38	11.45	10.71
Robeson	0.92	17.43	1.12	1.64	13.56	2.28
Rockingham	5.60	34.09	16.65	17.02	16.47	8.01
Rowan	2.28	37.52	8.27	15.19	19.17	11.65
Rutherford	3.24	49.60	2.56	4.66	13.67	3.45
Sampson	0.24	0.23	0.22			
Scotland	0.38	6.14	3.60	0.57	8.50	7.33

Stationary Point Sources Emissions in tons/day

County	2000			2007		
	CO	NOx	VOC	CO	NOx	VOC
Stanly	26.81	1.15	1.79	17.59	1.36	1.94
Stokes	8.15	324.10	1.01	5.16	22.79	0.62
Surry	3.28	1.09	6.10	6.10	1.06	4.12
Swain	0.00	0.00	0.12			
Transylvania	0.21	5.00	2.83	0.25	7.01	2.55
Tyrrell						
Union	0.81	0.68	1.81	0.03	0.17	2.54
Vance	0.34	1.52	1.16	0.04	1.45	0.00
Wake	1.59	1.49	4.24	0.27	0.94	10.08
Warren	0.18	0.08	0.07			
Washington	0.00	0.00	0.00	0.00	0.01	0.00
Watauga	0.17	0.18	0.13	0.02	0.05	0.00
Wayne	5.08	19.84	3.38	24.50	27.43	1.85
Wilkes	1.88	0.97	5.69	3.68	0.83	6.11
Wilson	0.51	1.48	3.74	0.22	2.51	1.99
Yadkin	0.01	0.03	0.26	0.00	0.00	0.03
Yancey						

Stationary Area Sources Emissions in tons/day

County	2000			2007		
	CO	NOx	VOC	CO	NOx	VOC
Alamance	6.21	0.47	5.78	6.65	0.50	6.17
Alexander	3.26	0.20	2.96	3.42	0.21	2.93
Alleghany	1.00	0.08	0.79	1.03	0.08	0.81
Anson	3.83	0.16	1.40	4.14	0.17	1.47
Ashe	2.29	0.17	1.42	2.36	0.17	1.50
Avery	1.61	0.12	0.85	1.66	0.13	0.90
Beaufort	22.68	0.30	5.75	25.28	0.31	5.93
Bertie	6.46	0.16	3.25	7.09	0.17	3.20
Bladen	5.37	0.25	3.08	5.79	0.25	3.13
Brunswick	5.25	0.39	3.12	5.47	0.40	3.26
Buncombe	5.74	0.55	8.11	5.91	0.58	8.66
Burke	4.02	0.32	3.48	4.15	0.33	3.64
Cabarrus	5.81	0.38	5.88	6.26	0.41	6.52
Caldwell	3.19	0.25	3.91	3.32	0.25	4.05
Camden	7.54	0.05	1.35	8.43	0.05	1.40
Carteret	5.22	0.20	2.96	5.67	0.20	3.10
Caswell	3.96	0.18	1.69	4.24	0.19	1.71
Catawba	7.04	0.43	11.22	7.48	0.44	11.37
Chatham	4.82	0.34	2.46	5.18	0.36	2.58
Cherokee	2.29	0.19	1.15	2.35	0.20	1.19
Chowan	2.70	0.09	1.61	2.96	0.09	1.65

Stationary Area Sources Emissions in tons/day

County	2000			2007		
	CO	NOx	VOC	CO	NOx	VOC
Clay	0.83	0.08	0.46	0.85	0.08	0.51
Cleveland	8.89	0.43	4.45	9.53	0.45	4.70
Columbus	10.62	0.41	5.37	11.52	0.42	5.36
Craven	6.34	0.28	4.92	6.87	0.29	5.06
Cumberland	6.32	0.51	11.54	6.76	0.54	12.12
Currituck	8.37	0.14	1.61	9.27	0.14	1.71
Dare	0.86	0.08	1.21	0.89	0.08	1.30
Davidson	9.36	0.65	7.74	9.81	0.67	7.96
Davie	4.37	0.19	1.76	4.69	0.20	1.87
Duplin	17.79	0.37	5.91	19.65	0.38	5.95
Durham	2.25	0.35	7.67	2.42	0.39	8.18
Edgecombe	4.60	0.25	5.60	4.96	0.26	5.50
Forsyth	3.94	0.40	11.46	4.18	0.44	12.21
Franklin	7.51	0.36	3.18	8.19	0.37	3.25
Gaston	5.05	0.52	6.85	5.35	0.56	7.35
Gates	1.82	0.08	1.14	1.95	0.09	1.12
Graham	0.75	0.06	0.35	0.77	0.06	0.37
Granville	7.05	0.27	3.27	7.65	0.28	3.34
Greene	5.83	0.15	2.95	6.40	0.16	2.88
Guilford	10.99	0.95	19.33	11.77	1.04	20.36
Halifax	9.79	0.30	5.16	10.73	0.31	5.19
Harnett	8.91	0.51	5.74	9.49	0.52	5.80
Haywood	2.44	0.21	2.08	2.51	0.21	2.18
Henderson	4.02	0.37	3.51	4.14	0.38	3.72
Hertford	5.54	0.13	2.34	6.11	0.13	2.38
Hoke	3.54	0.16	1.85	3.82	0.16	1.88
Hyde	4.91	0.05	1.45	5.48	0.05	1.45
Iredell	9.47	0.51	6.14	10.19	0.54	6.46
Jackson	2.45	0.21	1.23	2.52	0.21	1.30
Johnston	12.71	0.73	9.46	13.78	0.76	9.42
Jones	4.70	0.08	1.81	5.20	0.09	1.78
Lee	4.54	0.21	2.57	4.90	0.22	2.68
Lenoir	8.28	0.26	5.44	9.09	0.27	5.45
Lincoln	6.50	0.30	2.82	7.01	0.31	3.04
McDowell	2.28	0.20	1.30	2.35	0.21	1.37
Macon	1.85	0.14	0.98	1.90	0.14	1.02
Madison	1.87	0.18	1.41	1.93	0.18	1.42
Martin	5.52	0.23	3.59	5.93	0.24	3.54
Mecklenburg	4.61	0.99	25.87	4.97	1.12	28.14
Mitchell	1.47	0.11	0.91	1.52	0.11	0.93
Montgomery	2.44	0.18	1.81	2.53	0.19	1.83
Moore	4.97	0.35	3.49	5.20	0.37	3.66
Nash	9.24	0.42	7.76	10.02	0.44	7.75

Stationary Area Sources Emissions in tons/day

County	2000			2007		
	CO	NOx	VOC	CO	NOx	VOC
NewHanover	0.77	0.12	6.04	0.79	0.13	6.51
Northampton	5.09	0.16	2.65	5.55	0.17	2.60
Onslow	6.21	0.34	5.99	6.59	0.35	6.29
Orange	5.03	0.40	4.54	5.42	0.43	4.79
Pamlico	6.27	0.10	1.38	6.95	0.11	1.44
Pasquotank	12.97	0.14	3.18	14.47	0.14	3.37
Pender	5.90	0.28	2.47	6.30	0.29	2.61
Perquimans	6.91	0.09	1.76	7.68	0.09	1.79
Person	6.29	0.23	2.42	6.85	0.24	2.49
Pitt	9.95	0.46	9.13	10.78	0.47	9.36
Polk	1.57	0.13	0.70	1.61	0.13	0.74
Randolph	10.44	0.66	9.38	11.07	0.68	9.47
Richmond	2.58	0.20	2.01	2.71	0.21	2.11
Robeson	28.32	0.70	9.95	31.17	0.72	10.19
Rockingham	8.86	0.46	4.47	9.48	0.48	4.64
Rowan	9.50	0.46	5.66	10.28	0.49	6.08
Rutherford	4.44	0.31	2.68	4.64	0.33	2.96
Sampson	17.24	0.43	7.57	18.96	0.44	7.53
Scotland	7.55	0.17	2.36	8.33	0.17	2.47
Stanly	8.31	0.32	3.28	9.01	0.33	3.42
Stokes	4.56	0.26	2.42	4.82	0.27	2.45
Surry	6.15	0.37	4.01	6.47	0.38	4.16
Swain	1.22	0.10	0.50	1.26	0.10	0.52
Transylvania	1.75	0.16	1.08	1.80	0.17	1.14
Tyrrell	10.04	0.03	1.72	11.27	0.04	1.79
Union	23.79	0.55	7.20	26.31	0.58	7.68
Vance	4.19	0.19	2.43	4.52	0.19	2.51
Wake	10.49	1.24	24.71	11.31	1.35	26.08
Warren	4.18	0.16	1.44	4.52	0.16	1.47
Washington	12.80	0.08	2.51	14.34	0.09	2.60
Watauga	2.41	0.20	1.82	2.48	0.20	1.91
Wayne	16.32	0.48	7.91	17.91	0.49	8.07
Wilkes	4.79	0.37	3.35	4.95	0.38	3.49
Wilson	5.47	0.29	6.51	5.92	0.30	6.46
Yadkin	6.30	0.23	2.77	6.82	0.23	2.85
Yancey	1.67	0.12	0.90	1.72	0.13	0.92

Nonroad Mobile Sources Emissions in tons/day

County	2000			2007		
	CO	NOx	VOC	CO	NOx	VOC
Alamance	29.54	2.98	2.37	33.64	2.91	2.04
Alexander	4.00	0.51	0.37	4.36	0.53	0.33
Alleghany	2.49	0.36	0.18	2.78	0.33	0.14
Anson	4.19	1.13	0.50	4.55	0.95	0.39
Ashe	3.91	0.44	0.41	4.54	0.43	0.44
Avery	5.37	0.52	0.59	6.39	0.47	0.65
Beaufort	13.85	2.81	2.74	15.07	2.51	2.30
Bertie	6.43	1.66	1.12	6.78	1.48	0.88
Bladen	8.96	1.81	1.44	10.50	1.59	1.66
Brunswick	27.00	2.10	4.70	30.90	1.88	4.16
Buncombe	48.93	4.51	4.43	57.45	4.28	4.27
Burke	14.79	2.10	1.51	16.50	2.05	1.51
Cabarrus	44.68	4.19	3.28	51.35	3.78	2.38
Caldwell	16.55	2.38	1.77	18.65	2.34	1.89
Camden	2.84	0.41	0.99	2.90	0.39	0.80
Carteret	49.17	1.82	14.18	54.95	1.90	12.43
Caswell	2.26	1.07	0.23	2.51	0.85	0.17
Catawba	47.03	5.15	4.20	53.29	5.17	3.95
Chatham	12.91	1.83	1.40	14.40	1.68	1.09
Cherokee	3.99	0.40	0.56	4.58	0.40	0.57
Chowan	4.05	0.47	1.14	4.45	0.46	1.03
Clay	2.19	0.15	0.43	2.72	0.14	0.54
Cleveland	21.51	2.13	1.75	24.58	2.08	1.52
Columbus	9.85	2.12	1.11	11.13	1.89	1.00
Craven	24.08	2.20	2.66	27.45	1.94	1.98
Cumberland	59.31	6.51	4.85	68.38	5.86	3.84
Currituck	15.63	0.77	4.69	17.55	0.77	4.24
Dare	46.18	1.33	18.14	49.76	1.54	15.68
Davidson	30.96	4.24	2.64	35.03	3.90	2.24
Davie	6.77	0.61	0.88	8.20	0.61	1.12
Duplin	10.19	2.36	0.97	11.18	2.13	0.73
Durham	70.50	9.63	6.04	79.17	9.06	5.09
Edgecombe	11.11	2.57	0.97	12.27	2.28	0.78
Forsyth	91.57	6.94	6.70	105.60	6.76	5.27
Franklin	8.37	1.05	0.78	9.71	0.93	0.70
Gaston	54.10	4.77	3.98	61.82	4.70	3.33
Gates	1.58	0.50	0.21	1.69	0.45	0.16
Graham	1.40	0.13	0.25	1.55	0.12	0.20
Granville	13.73	1.39	1.23	15.64	1.32	1.03
Greene	2.31	0.70	0.21	2.52	0.64	0.16
Guilford	194.02	14.69	14.06	226.39	13.97	10.89
Halifax	8.68	2.13	0.92	9.77	1.86	0.83

Nonroad Mobile Sources Emissions in tons/day

County	2000			2007		
	CO	NOx	VOC	CO	NOx	VOC
Harnett	22.07	1.84	1.65	25.33	1.72	1.21
Haywood	11.35	1.08	1.15	13.38	1.00	1.19
Henderson	31.53	2.07	3.82	38.22	1.95	4.41
Hertford	4.08	0.54	0.48	4.74	0.50	0.48
Hoke	3.35	0.64	0.28	3.61	0.62	0.24
Hyde	25.38	1.93	11.68	25.59	1.94	9.56
Iredell	21.67	2.88	2.10	24.69	2.78	1.97
Jackson	6.55	0.51	0.75	7.75	0.46	0.76
Johnston	35.04	3.41	2.84	40.55	3.09	2.26
Jones	1.83	0.46	0.15	2.05	0.41	0.12
Lee	16.81	2.46	1.35	18.80	2.29	1.07
Lenoir	16.43	2.14	1.31	18.63	2.00	1.01
Lincoln	14.00	1.49	1.27	16.03	1.38	1.10
McDowell	7.93	1.84	1.14	9.18	1.61	1.36
Macon	10.89	0.53	0.97	12.89	0.50	0.91
Madison	1.73	0.56	0.17	1.96	0.45	0.13
Martin	4.71	1.32	0.51	5.37	1.16	0.51
Mecklenburg	351.64	23.31	24.93	298.78	21.99	18.42
Mitchell	3.61	1.02	0.51	4.27	0.85	0.61
Montgomery	4.89	0.71	0.58	5.34	0.66	0.48
Moore	27.52	1.89	1.95	31.86	1.73	1.41
Nash	21.77	2.69	1.71	24.83	2.47	1.32
NewHanover	58.02	4.59	5.80	67.25	4.20	4.55
Northampton	4.56	0.97	0.71	5.20	0.86	0.65
Onslow	26.34	3.52	3.92	29.60	3.21	3.31
Orange	31.55	3.66	3.18	37.13	3.19	3.09
Pamlico	9.11	0.88	3.58	9.63	0.85	3.09
Pasquotank	9.56	0.93	1.42	10.86	0.88	1.12
Pender	13.17	1.02	1.77	15.00	0.95	1.44
Perquimans	3.95	0.65	1.27	4.10	0.60	1.02
Person	8.34	0.85	0.80	9.41	0.82	0.64
Pitt	25.16	4.26	1.98	28.79	3.78	1.53
Polk	2.69	0.46	0.22	3.03	0.39	0.17
Randolph	27.23	2.82	2.20	30.77	2.85	1.94
Richmond	14.38	4.66	1.43	15.38	4.02	1.05
Robeson	19.63	5.97	1.91	21.45	5.21	1.62
Rockingham	15.35	2.44	1.55	17.39	2.26	1.63
Rowan	28.37	5.47	2.59	31.85	4.75	2.11
Rutherford	13.10	2.19	1.27	14.86	2.00	1.27
Sampson	10.67	2.15	0.92	11.89	1.96	0.70
Scotland	8.59	1.82	0.75	9.46	1.64	0.63
Stanly	16.77	2.09	1.54	19.02	1.96	1.29
Stokes	8.18	0.68	0.72	9.54	0.61	0.64

Nonroad Mobile Sources Emissions in tons/day

County	2000			2007		
	CO	NOx	VOC	CO	NOx	VOC
Surry	30.76	1.96	2.43	35.44	1.98	2.05
Swain	4.84	0.35	1.35	6.47	0.32	1.88
Transylvania	15.89	0.68	2.79	20.28	0.67	3.77
Tyrrell	6.72	0.61	2.94	6.76	0.61	2.38
Union	47.65	3.89	3.56	55.34	3.56	2.71
Vance	6.24	1.24	0.75	6.84	1.14	0.62
Wake	242.05	18.83	17.61	281.90	17.33	12.59
Warren	3.51	0.70	0.58	3.85	0.56	0.43
Washington	5.43	1.03	1.44	5.68	0.95	1.16
Watauga	9.79	0.50	1.19	12.02	0.48	1.41
Wayne	26.05	3.51	2.10	29.98	3.27	1.71
Wilkes	16.62	1.37	1.38	19.09	1.32	1.17
Wilson	23.57	2.99	1.95	27.15	2.67	1.56
Yadkin	6.59	0.89	0.52	7.45	0.83	0.40
Yancey	7.75	0.37	0.87	9.32	0.34	0.94

Highway Mobile Sources Emissions in tons/day

County	2000			2007		
	CO	NOx	VOC	CO	NOx	VOC
Alamance	93.84	13.48	8.34	54.81	9.52	5.01
Alexander	15.87	1.75	1.41	10.67	1.27	1.02
Alleghany	6.87	0.74	0.61	3.84	0.45	0.37
Anson	22.65	2.93	1.90	14.23	2.00	1.25
Ashe	15.28	1.61	1.36	8.98	1.03	0.86
Avery	13.78	1.66	1.18	7.98	1.05	0.73
Beaufort	31.89	3.55	2.81	19.36	2.35	1.81
Bertie	19.81	2.38	1.70	12.41	1.61	1.14
Bladen	29.89	3.22	2.65	18.60	2.18	1.78
Brunswick	67.90	8.19	5.82	39.68	5.53	3.69
Buncombe	149.98	23.51	13.10	87.96	16.25	7.83
Burke	65.51	12.34	5.64	36.98	7.79	3.38
Cabarrus	69.09	12.04	6.19	50.62	8.59	4.20
Caldwell	44.10	5.01	3.89	25.98	3.41	2.48
Camden	7.47	0.90	0.64	4.68	0.61	0.43
Carteret	43.77	5.41	3.74	22.53	3.19	2.10
Caswell	16.69	2.00	1.44	10.41	1.34	0.95
Catawba	113.03	15.57	10.08	66.68	10.71	6.25
Chatham	45.51	5.79	3.85	27.65	4.01	2.55
Cherokee	17.05	2.25	1.42	12.85	1.73	1.15
Chowan	8.16	0.92	0.72	4.87	0.60	0.45
Clay	6.05	0.68	0.53	3.81	0.46	0.36
Cleveland	68.95	10.19	5.97	37.44	6.17	3.49

Highway Mobile Sources Emissions in tons/day

County	2000			2007		
	CO	NOx	VOC	CO	NOx	VOC
Columbus	43.72	5.12	3.80	27.16	3.52	2.47
Craven	57.77	6.75	5.06	34.07	4.53	3.19
Cumberland	197.16	28.43	17.85	108.27	18.56	10.31
Currituck	21.48	2.50	1.86	14.09	1.77	1.33
Dare	37.56	4.27	3.27	20.22	2.55	1.89
Davidson	105.57	17.25	9.73	61.60	11.04	6.06
Davie	32.17	7.98	2.67	20.32	5.05	1.78
Duplin	46.97	8.80	4.00	32.00	6.34	2.86
Durham	130.59	24.00	11.93	90.71	14.51	7.74
Edgecombe	41.11	4.72	3.61	23.96	3.17	2.28
Forsyth	188.14	33.73	18.97	125.17	19.34	12.44
Franklin	32.41	3.79	2.81	19.70	2.63	1.89
Gaston	87.61	16.61	8.66	56.34	9.20	5.28
Gates	8.85	1.12	0.75	5.30	0.73	0.47
Graham	4.84	0.50	0.43	3.31	0.39	0.32
Granville	48.49	9.82	5.02	27.96	5.43	3.29
Greene	14.77	1.63	1.30	9.41	1.14	0.89
Guilford	274.08	47.66	27.88	179.81	26.94	18.09
Halifax	48.63	11.44	4.09	31.41	7.19	2.75
Harnett	58.38	9.34	5.01	34.75	6.19	3.25
Haywood	58.30	14.16	4.81	33.85	8.92	2.99
Henderson	59.39	10.05	5.15	34.27	6.56	3.17
Hertford	15.08	1.71	1.32	9.26	1.14	0.87
Hoke	18.56	2.22	1.60	12.36	1.62	1.13
Hyde	4.39	0.48	0.39	2.61	0.32	0.25
Iredell	119.96	29.26	10.08	71.75	18.66	6.42
Jackson	36.42	4.77	3.04	23.49	3.29	2.08
Johnston	123.04	28.31	10.21	81.29	19.92	7.25
Jones	14.67	1.89	1.23	8.62	1.19	0.76
Lee	39.67	4.49	3.51	23.25	3.03	2.21
Lenoir	44.38	4.70	4.04	23.50	2.85	2.31
Lincoln	37.27	4.27	3.28	21.48	2.82	2.08
McDowell	42.05	9.85	3.48	26.32	3.48	2.37
Macon	24.61	3.09	2.08	15.13	2.02	1.37
Madison	13.33	1.64	1.14	8.25	1.10	0.75
Martin	25.08	3.06	2.15	15.47	3.65	1.34
Mecklenburg	341.23	67.76	34.75	222.60	36.34	21.26
Mitchell	9.55	1.09	0.83	5.95	0.75	0.55
Montgomery	26.55	3.60	2.27	18.18	2.61	1.66
Moore	53.39	5.90	4.73	29.76	3.77	2.87
Nash	93.59	17.62	7.97	53.90	10.92	4.94
NewHanover	81.67	9.12	7.49	48.41	6.14	4.72
Northampton	23.32	4.79	1.95	13.92	2.79	1.24

Highway Mobile Sources Emissions in tons/day

County	2000			2007		
	CO	NOx	VOC	CO	NOx	VOC
Onslow	67.91	7.55	6.03	35.66	4.56	3.41
Orange	62.40	18.80	5.30	44.95	11.91	3.63
Pamlico	9.21	0.93	0.83	5.79	0.64	0.56
Pasquotank	17.53	1.94	1.57	11.15	1.36	1.03
Pender	40.59	8.15	3.41	28.50	5.88	2.53
Perquimans	9.69	1.24	0.82	6.19	0.86	0.54
Person	21.02	2.25	1.89	12.96	1.51	1.23
Pitt	78.82	8.47	7.05	43.54	5.36	4.24
Polk	19.00	4.60	1.56	13.94	3.39	1.19
Randolph	97.79	13.69	8.46	57.60	9.14	5.31
Richmond	40.70	4.98	3.52	24.96	3.35	2.22
Robeson	107.26	20.38	9.20	61.34	12.86	5.62
Rockingham	66.14	7.51	5.82	37.21	4.86	3.57
Rowan	89.79	17.34	7.75	53.43	11.46	4.96
Rutherford	40.07	4.52	3.53	20.79	2.69	2.01
Sampson	51.06	8.35	4.42	32.73	5.69	2.97
Scotland	29.90	3.44	2.64	18.93	2.37	1.73
Stanly	37.66	4.01	3.39	20.69	2.53	2.03
Stokes	24.78	2.82	2.17	13.71	1.79	1.32
Surry	64.94	12.67	5.54	37.68	7.79	3.49
Swain	13.82	1.69	1.18	7.71	1.01	0.70
Transylvania	22.41	2.47	1.99	14.04	1.68	1.33
Tyrrell	3.78	0.49	0.32	2.31	0.33	0.20
Union	56.79	7.70	5.15	39.75	5.00	3.48
Vance	33.57	6.29	2.89	22.07	4.29	1.95
Wake	306.82	59.29	27.61	224.96	39.69	18.67
Warren	15.84	3.56	1.32	10.53	2.39	0.92
Washington	11.19	1.43	0.94	6.82	0.95	0.60
Watauga	25.14	3.08	2.17	15.08	2.02	1.34
Wayne	68.83	7.28	6.20	39.66	4.84	3.87
Wilkes	47.93	5.55	4.18	25.57	3.39	2.45
Wilson	61.49	10.12	5.37	35.49	6.44	3.32
Yadkin	34.98	7.13	2.92	21.93	4.42	1.92
Yancey	11.33	1.45	0.96	6.74	0.93	0.60

APPENDIX B

State Portion

of

June 30, 2003 Triad EAC Progress Report

TRIAD EARLY ACTION COMPACT

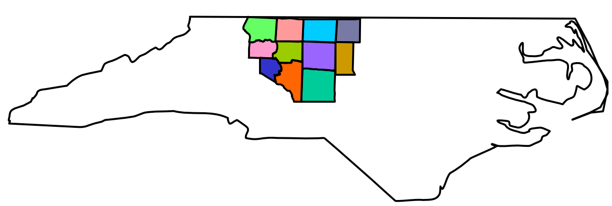
TRIAD EARLY ACTION COMPACT

June 30, 2003 Progress Report

June 30, 2003 Progress Report

State Portion

State Portion



TRIAD EARLY ACTION COMPACT

STATE PORTION - JUNE 30, 2003 PROGRESS REPORT

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MODELING

Section 1 - INTRODUCTION

As a requirement of the Triad Early Action Compact (EAC), the progress report due June 30, 2003, must include a status report regarding the air quality modeling. This report satisfies this requirement. Discussed in this report are the photochemical model selection, episode selection, meteorological model, emissions inventory development, and the modeling status.

The modeling analysis is a complex technical evaluation that begins by selection of the modeling system and selection of the meteorological episodes. NCDAQ decided to use the following modeling system:

- Meteorological Model: MM-5 – This model generates hourly meteorological inputs for the emissions model and the air quality model, such as wind speed, wind direction, and surface temperature.

- Emissions Model: Sparse Matrix Operator Kernel Emissions (SMOKE) - This model takes daily county level emissions and temporally allocates across the day, spatially locates the emissions within the county, and transfers the total emissions into the chemical species needed by the air quality model.

- Air Quality Model: MAQSIP (Multi-Scale Air Quality Simulation Platform) – This model takes the inputs from the emissions model and meteorological model and predicts ozone hour by hour across the modeling domain, both horizontally and vertically.

The following historical episodes were selected to model because they represent typical meteorological conditions in North Carolina when high ozone is observed throughout the State:

- July 10-15, 1995
- June 20-24, 1996
- June 25-30, 1996
- July 10-15, 1997

The meteorological inputs were developed using MM5 and are discussed in detail in Section 4.

The precursors to ozone, Nitrogen Oxides (NOx), Volatile Organic Compounds (VOCs), and Carbon Monoxide (CO) were estimated for each source category. These estimates were then spatially allocated across the county, temporally adjusted to the day of the week and hour of the day and speciated into the chemical species that the air quality model needs to predict ozone. The development of the emission inventories are discussed in detail in Section 5.
The status of modeling work and issues that have been encountered are discussed in Section 6.

Section 2 - MODEL SELECTION

2.1 Introduction

To be useful in a regulatory framework, photochemical grid models and their applications must be defensible. Not only must the U.S. Environmental Protection Agency (EPA) be convinced of this, but members of the regulated community (stakeholders) as well. Failure to convince EPA can result in rejection of an implementation or maintenance plan. Failure to convince the regulated community can lead to diminished rule effectiveness and litigation. In none of these cases is the state's air quality goals advanced.

To ensure that a modeling study is defensible, care must be taken in the selection of the models to be used. The models selected must be scientifically appropriate for the intended application and be freely accessible to all stakeholders. Scientifically appropriate means that the models address important physical and chemical phenomena in sufficient detail, using peer reviewed methods. Freely accessible means that model formulations and coding are freely available for review and that the models are available to stakeholders, and their consultants, for execution and verification at no or low cost.

In the following sections we outline the criteria for selecting a modeling system that is both defensible and capable of meeting the study's goals.

2.2 Selection of Photochemical Grid Model

2.2.1 Criteria

For a photochemical grid model to qualify as a candidate for use in an attainment demonstration of the 8-hour ozone National Ambient Air Quality Standards (NAAQS), a State needs to show that it meets several general criteria.

- The model has received a scientific peer review
- The model can be demonstrated applicable to the problem on a theoretical basis
- Data bases needed to perform the analysis are available and adequate
- Available past appropriate performance evaluations have shown the model is not biased toward underestimates
- A protocol on methods and procedures to be followed has been established
- The developer of the model must be willing to make the source code available to users for free or for a reasonable cost, and the model cannot otherwise be proprietary

2.2.2 Overview of MAQSIP

The photochemical model selected for this study is the Multiscale Air Quality Simulation Platform (MAQSIP). MAQSIP is a fully modularized three-dimensional system with various options for representing the physical and chemical processes describing regional- and urban-scale atmospheric pollution. The governing model equations for tracer continuity are formulated in generalized coordinates, thereby providing the capability of interfacing the model with a variety of meteorological drivers. The model employs flexible horizontal grid resolution with multiple multi-level nested grids with options for one-way and two-way nesting procedures. In the vertical, the capability to use non-uniform grids is provided. Current applications have used horizontal grid resolutions from 18-80 km for regional applications and 2-6 km for urban scale simulations, and up to 30 layers to discretize the vertical domain.

The MAQSIP framework with the detailed gas-phase and aerosol model provides a modeling system that can be used for investigating the various processes that govern the loading of chemical species and anthropogenic aerosols at various scales of atmospheric motions from urban, regional to intercontinental scales. For example, MAQSIP has been used to support the Southeastern States Air Resources Management (SESARM) project to produce seasonal simulations of ozone over eastern United States. The gas-aerosol version of the MAQSIP (hereinafter the MAQSIP-PM) has been used in urban-to-regional-scale applications over the eastern and western United States, and western Europe, to study the production and distribution of fine and coarse PM, and its effects on visibility and the radiation budget.

For regulatory application, a specific configuration of MAQSIP has been used in this study. This configuration of MAQSIP follows a series a sensitivity tests to determine the best performing modules. This configuration has the following components:

- Horizontal Coordinate System: *Lambert Conformal Projection*
- Vertical Coordinate System: *Non-Hydrostatic Sigma-Pressure Coordinates*
- Gas Phase Chemistry: *Carbon Bond IV with Isoprene updates*
- Aqueous Phase Chemistry: *Included in cloud package*
- Chemistry Solver: *Modified QSSA*
- Horizontal Advection: *Bott*
- Cloud Physics: *Kain-Fritsch parameterization and explicit, as needed*
- Horizontal Turbulent Diffusion: *Fixed* K_h
- Vertical Turbulent Diffusion: *K-Theory*
- Photolysis Rates: *Madronich*
- Dry Deposition: *Resistance*
- Wet Deposition: *Included in cloud package*

2.3 Selection of Meteorological Model

2.3.1 Criteria

Meteorological models, either through objective, diagnostic, or prognostic analysis, extend available information about the state of the atmosphere to the grid upon which photochemical grid modeling is to be carried out. The criteria for selecting a meteorological model are based on both the models ability to accurately replicate important meteorological phenomena in the region of study, and the model's ability to interface with the rest of the modeling systems -- particularly the photochemical grid model. With these issues in mind, the following criteria were established for the meteorological model to be used in this study:

- Non-Hydrostatic Formulation
- Reasonably current, peer reviewed formulation
- Simulates Cloud Physics
- Publicly available on no or low cost
- Output available in I/O API format
- Supports Four Dimensional Data Assimilation (FDDA)
- Enhanced treatment of Planetary Boundary Layer heights for AQ modeling

2.3.2 Overview of MM5

The meteorological model selected for this study is the nonhydrostatic PSU/NCAR Mesoscale Model Version 5 (MM5). MM5 (Dudhia 1993; Grell et al. 1994) is one of the leading three-dimensional prognostic meteorological models available for air quality studies. It uses an efficient split semi-implicit temporal integration scheme and has a nested-grid capability that can use up to ten different domains of arbitrary horizontal resolution. This allows MM5 to simulate local details with high resolution (as fine as ~1 km), while accounting for influences from great distances, using horizontal resolutions ranging to about 200 km.

MM5 uses a terrain-following nondimensionalized pressure, or "sigma", vertical coordinate similar to that used in many operational and research models. In the nonhydrostatic MM5, the sigma levels are defined according to the initial hydrostatically balanced reference state so that these levels are also time-invariant. The meteorological fields also can be used in other photochemical grid models with different coordinate systems by performing a vertical interpolation followed by a mass-consistency reconciliation step.

The model contains two types of planetary boundary layer (PBL) parameterizations suitable for air-quality applications, both of which represent subgrid-scale turbulent fluxes of heat, moisture, and momentum. A modified Blackadar PBL (Zhang and Anthes 1982) uses a first-order eddy diffusivity formulation for stable and neutral environments and a nonlocal closure for unstable regimes. The Gayno-Seaman PBL (Gayno, 1994) uses a prognostic equation for the second-order turbulent kinetic energy, while diagnosing the other key boundary layer terms. This is referred to as a 1.5-order PBL, or level-2.5, scheme (Mellor and Yamada 1974).

Initial and lateral boundary conditions are specified for real-data cases from mesoscale 3-D analyses performed at 12-hour intervals on the outermost grid mesh selected by the user. Surface fields are analyzed at three-hour intervals. A Cressman-based technique is used to analyze standard surface and radiosonde observations, using the National Meteorological Center's spectral analysis, as a first guess (Benjamin and Seaman 1985). The lateral boundary data are introduced using a relaxation technique applied in the outermost five rows and columns of the coarsest grid domain.

For most traditional (1-hour standard) high-ozone episodes, precipitation is not the dominant factor. On the other hand, precipitation events may have a greater impact on 8-hour average ozone episodes. The MM5 contains five convective parameterization schemes (Kuo, Betts-Miller, Fritsch-Chappell, Kain-Fritsch, and Grell). It also has an explicit resolved-scale precipitation scheme (Dudhia 1989) that solves prognostic equations for cloud water/ice (q_c) and larger liquid or frozen hydrometeors (q_r). In addition the model contains a short- and long-wave radiation parameterization (Dudhia 1989).

2.4 Selection of Emissions Processing System

2.4.1 Criteria

The principal criterion for an emissions processing system is that it accurately prepares emissions files in a format suitable for the photochemical grid model being used. The following list includes clarification of this criterion and additional desirable criteria for effective use of the system.

- File System Compatibility with the I/O API
- File Portability
- Ability to grid emissions on a Lambert Conformal projection
- Report Capability
- Graphical Analysis Capability
- MOBILE6 Mobile Source Emissions
- BEIS-2 Biogenic Emissions
- Ability to process emissions for the proposed domain in a day or less.
- Ability to process control strategies
- No or low cost for acquisition and maintenance
- Expandable to support other species and mechanisms

2.4.2 Overview of SMOKE

The emissions processing system selected for this study is the Sparse Matrix Operator Kernel Emissions (SMOKE). SMOKE was developed to reduce the large processing times required to prepare emissions data for photochemical grid models. SMOKE processes both anthropogenic and biogenic emissions. Biogenic emissions are processed using an implementation of BEIS-3.

The modular structure of SMOKE (see Appendix A) removes much of the redundant processing found in other systems. This will provide even greater savings of CPU time and disk space when SMOKE is used to process control strategies. Unlike other emission processing systems, SMOKE's structure makes each process (i.e., gridding, speciation, temporal allocation, and control application) independent from the others. For example, to run a new control strategy, only the control model must be rerun, and the time-stepped emissions multiplied by the matrices. This whole process takes only a few minutes to process a new point source strategy and a few additional minutes if area and mobile sources are also changed.

SMOKE has undergone an extensive process of testing and validation. It has been validated on a regional scale against EMS-95 using the OTAG 1990 inventory, and on a large urban scale against EPS 2.0 using North Carolina's State Implementation Plan (SIP) inventory. SMOKE can be driven with inputs in EMS-95, EPS 2.0 or IDA format, and it can produce photochemical grid model-ready emissions in forms suitable to drive UAM-IV, UAM-V, MAQSIP, CMAQ and SAQM. SMOKE has adopted the Models-3 Input/Output Application Program Interface (I/O API) so the emissions files created by SMOKE are directly readable by Models-3, MCNC's MAQSIP, and the supporting analysis tools developed for these systems.

Section 3 - EPISODE SELECTION

3.1 Introduction

The episode selection process is critical to the success of the modeling study. Correctly identifying representative ozone episodes to model for several areas in North Carolina allows us to evaluate with confidence various control strategies for maintaining the NAAQS for ozone. Several factors influenced episode selection for this modeling study. In the following sections we outline the factors and considerations for episode selection, and then outline in detail the episodes selected for this modeling study.

3.2 Factors Influencing Episode Selection

Several factors influenced episode selection for this modeling study. The primary factor influencing episode selection was the promulgation of an 8-hour standard for ozone and the litigation that followed. This led to uncertainties surrounding the implementation of the standard. Also, the form of the new 8-hour standard makes it less dependent on extreme events than the 1-hour standard. Therefore, meteorological scenarios associated with 8-hour exceedances were reviewed and considered for modeling. A combination of these factors led to choosing episodes where both the 1-hour and 8-hour standards were exceeded.

The EPA issued a new ambient air quality standard based on the daily maximum 8-hour averaged concentration for ozone in July 1997. In June of 1998, EPA revoked the 1-hour standard in North Carolina since all areas of the state had attained that standard. However, in the 1998 ozone season, North Carolina experienced its first violation of the 1-hour ozone standard since 1990 in the Charlotte area. Later, in May 1999, a D.C. District Court ruling instructed EPA that an intelligible principle for the setting of the new 8-hour standard had to be defined and that enforcement of the 8-hour standard was prohibited by the court until EPA had done so. In 1999, EPA reinstated the old 1-hour standard. The result of all of the changing policy and litigation is that the modeling study must shift its primary focus from a traditional analysis solely targeted at 1-hour averaged ozone values, to an analysis of both 1-hour and 8-hour averaged values. Analysis of episodes with exceedances of 1-hour and 8-hour standards will also allow an assessment of the differences that two standards may have on control strategy development and will indicate whether control strategies designed to meet the 8-hour standard will also be effective at reducing ozone levels below the 1-hour standard. The "dual" need to model 1-hour and 8-hour exceedances was a primary criterion in the episode selection process.

A second factor affecting the selection process was the form of the new standard. The 1 hour standard allowed 1 exceedance per year in a region on average with the design value being the 4th highest 1 hour value in that region over 3 years. This means that, in theory, only the 3 worst case episodes in a 3-year period can be removed from consideration for modeling. The design value under the 8-hour standard is calculated differently. It is the yearly 4th highest 8-hour value at each monitor, averaged over 3 years. With the new standard it is possible to "throw out" the 3 worst case episode days of each year, or approximately 9 days over 3 years for each monitor. Because the 4th high value is determined for each individual monitor, discarding days with higher values can result in the removal of more than 9 worst case days if the high readings for all monitors do not occur on the same days. For example, exceedances may be measured north of a city during days when the wind blows predominately from the south, but measured at monitors south of the city on other days when winds are northerly. Discarding days above the 4th highest measurement in this example could result in removal of more than 9 worst case episode days in three years. This makes the standard less dependent on extreme events.

3.3 Episode Selection Considerations

The methodologies suggested in EPA's draft guidance for episode selection is the same for both the 1-hour and 8-hour standards. These methodologies were applied to the extent possible when attempting to choose episodes. The episode selection criterion was compromised to some extent by the need to simultaneously model multiple areas in North Carolina.

First, we considered a mix of episodes reflecting a variety of meteorological scenarios which frequently correspond with observed 8-hour daily maxima > 84 ppb at different monitoring sites. An analysis of each ozone episode was made using several sources of air quality and meteorological data to determine the episodes that would contribute the most to the modeling effort.

Secondly, we considered periods in which observed 8-hour daily maximum concentrations were within ±10 ppb of each area's design value. Because modeling for the new 8-hour standard may capture some 1-hour exceedances, 8-hour averaged ozone concentrations were given primary consideration. The 8-hour design values were calculated statewide, with a focus on the three major urban areas of NC; Charlotte/Gastonia, Greensboro/Winston-Salem (the Triad), and Raleigh/Durham (RDU), using monitored values from 1994-2002. The average of each year's fourth highest daily 8-hour averaged maximum concentration for each monitor statewide was calculated and used as a guide for determining the episodes with concentrations within ±10 ppb of the area's design value.

Finally, the temporal and spatial distribution of ozone throughout NC was also an important consideration. The new 8-hour standard brings areas such as Asheville, Fayetteville, Greenville/Rocky Mount/Wilson (Down East), Hickory, and other various areas into non-attainment. Therefore, it was necessary to choose episodes affecting those areas as well as the three major urban areas mentioned above. Episodes containing widespread ozone exceedances were given priority over those containing isolated exceedances. Also, the need to study the cumulative effects of ozone build-up over a number of days was recognized, so episodes of extended duration were given preference over single day exceedances.

Meeting all of the criteria in all areas is sometimes difficult. The episode selection criterion was compromised to some extent by the need to simultaneously model multiple areas. For example, during many "moderate" ozone events, ozone exceedances are not widespread throughout NC. Selection of these episodes can dramatically increase the number of modeled episodes needed to complete a thorough analysis of all non-attainment areas across the state. On the other hand, episodes with exceedances in all non-attainment areas often contain scattered extreme values.

To reduce the number of episodes to a manageable number, while also performing a complete analysis on each major urban area of NC, we made some compromise in the selection criteria. Ideally, no days with concentrations well above an area's design value would have been included in the selected episodes. However, on some days concentrations in one or two areas were found to be ideal for modeling while another area had observed concentrations well above its' ozone design value. Days such as these were included in the selected episodes due to the days' overall positive attributes.

3.4 Episode Selection Procedures

Ambient data was used to determine the days that exceedances of the 1-hour and/or 8-hour standard occurred in any of the major urban areas of NC from 1995 through 1997. These days were grouped into episodes and evaluated using the selection criteria discussed in the preceding section. An analysis of each ozone episode was made using several sources of air quality and meteorological data to determine the episodes that would contribute the most to the modeling effort.

Sets of ambient ozone data from 1995-1997 for the eastern US were plotted using Voyager Viewer software. The data were plotted for the eastern US using both hourly and 8-hour peak ozone concentrations. This permitted easy assessment of the spatial and temporal distribution of ozone throughout North Carolina as well as other areas of the eastern US and made it possible to easily determine whether the event was regional, sub-regional, or local in nature. These plots combined with meteorological plots also indicated the potential for recirculation. In one episode, shifts in wind direction corresponded to shifts in the location of ozone peaks in the Charlotte area, suggesting that recirculation may have contributed to exceedances of both ozone standards.

In addition to the ambient data plots, several surface and upper air meteorological data sets were used to assess the atmospheric conditions contributing to the build-up of ozone in each episode. Local Climatological Data sheets were used to collect diurnal data on temperatures, precipitation, and wind speed and direction. Daily weather maps were used to determine the location of surface fronts, troughs, and ridges as well as daily peak temperatures, precipitation, and the location of high and low pressure areas. Analysis charts (0000 Z and 1200 Z) for the surface, 850 mb, 700 mb, and 500 mb levels from the NOAA-NCEP ETA meteorological computer model were also used to assess conditions such as surface and upper air wind fields, temperatures, moisture, and the location of ridges and troughs. The conditions contributing to high levels of ozone were determined through chart analysis, and the type of meteorology was used to group episodes.

3.5 Episode Selection

All days with ozone exceedances in any of the major urban areas of NC were considered in the episode selection process. These days were divided into episodes based on the distribution of measured ozone and the meteorological conditions that occurred throughout the period of exceedance. The meteorological characteristics of each episode were studied using the tools outlined in the previous section. All episodes will have some common characteristics. Warm temperatures, little or no precipitation, and relatively light winds are needed to produce ozone episodes. Typically, those conditions are characteristic of a surface high-pressure area. The differences in the position, strength, and movement of the surface high-pressure areas, along with differences in the mid-to-upper level wind patterns, allow us to discern several meteorological scenarios in which ozone episodes are likely. These meteorological scenarios are discussed in the following paragraphs.

Conditions that traditionally lead to large-scale exceedances of the 1-hr standard result from the development of a broad surface high pressure area sprawled over the eastern third of the US and a large mid-to-upper level high pressure area near the Midwest (Scenario 1 – Eastern Stacked High). The mid-to-upper level ridge blocks the movement of fronts into the Eastern US and often results in very hot temperatures, little precipitation, and the buildup of high 1-hr and 8-hr ozone concentrations over much of the Midwest, Northeast, and South. As the mid-to-upper level ridge slowly slides eastward, it situates itself over the surface high-pressure creating a "stacked high" over the Eastern US. The resulting large-scale subsidence leads to very low vertical mixing heights prohibiting dispersion of precursor pollutants. The stagnant air mass from the "stacked high" scenario is prime for ozone episodes in the Eastern US. A trough can develop in east/central NC during this scenario producing south-southwesterly flow east of the trough and causing a large ozone concentration gradient. The presence of the trough can limit ozone readings east of the trough axis below the 1-hour and 8-hour standards throughout the episode. (An example of these conditions is recorded in the July 14, 1995 Daily Weather Map [Figure 3.5-1]. The 500-mb chart clearly shows the presence of a large high pressure area over the Midwest.)

The most frequently occurring meteorological scenario (Scenario 2 – Frontal Approach) is characterized by the movement of cold fronts toward NC and the presence of high pressure to the south or southwest of the state. Cold fronts often move toward NC during the summer months but are typically not strong enough to move completely through the state. They commonly become east-west oriented and stall as far south as southern Virginia or northern sections of NC. The front may dip into northern portions of NC and then retreat as a warm front creating wind shifts or re-circulation patterns. A southwesterly surface flow predominates as the front approaches, but as the front moves into northern sections of NC, winds become more northerly. When the front retreats back to the north as a warm front, southwesterly winds return to the entire state. In the meantime, a zonal flow exists in the mid-to-upper levels. High temperatures range from the low to upper 90's and dew points are in the upper 60's to mid 70's. Scattered exceedances of the 1-hour standard and widespread exceedances of the 8-hour standards may be realized in NC during these conditions. (These conditions can be seen in the June 23, 1996 Daily Weather Map in [Figure 3.5-2]. Note the presence of a stationary front along the NC/VA border.)

A third meteorological scenario (Scenario 3 – Canadian High) resulting in high buildups of ozone in NC is characterized by a surface high-pressure area building in from the north, and a mid-to-upper level ridge that builds and sprawls to the west of NC in the Mid-Mississippi Valley area. The position of the mid-to-upper level ridge produces a northerly flow aloft throughout this scenario. As the Canadian-born surface high-pressure builds into NC, it brings with it milder and drier air by means of a north-northeasterly breeze. These conditions can lead to scattered exceedances of the 8-hour standard in NC. Temperatures are typically in the low to mid 80's (with dew points in the low to mid 60's) during the beginning of this type of episode. However, as the center of the surface high-pressure slides into NC, and the winds become light and variable, highs may reach the upper 80's to low 90's (with dew points in the upper 60's to low 70's). Scattered exceedances of the 1-hour standard and widespread exceedances of the 8-hour standards may be realized in NC during these conditions. (An example of these conditions is shown in Figure 3.5-3 [June 28, 1996].)

The fourth meteorological scenario (Scenario 4 – Modified Canadian High with slight Tropical Influence), initially, is very similar to Scenario 3 above. Canadian born surface high-pressure builds into NC delivering lower dew points and milder temperatures with a light north-northeasterly wind. This cool down is short-lived however. As the high-pressure center moves south of NC, a light southwesterly flow dominates, temperatures soar, and dew points increase. A mid-to-upper level ridge slowly sprawls eastward across the country, resulting in a very weak flow aloft. Occasionally, when the mid-to-upper level flow is very weak along the East Coast during the mid-to-late summer, tropical systems that work their way across the Atlantic Ocean can approach the Southeast US. Although it does not occur frequently, a tropical system lurking off the Carolina coast may influence conditions over NC in the form of subsidence in the mid-to-upper levels. Subsidence is usually distributed over a wide area away from tropical systems, and leads to cloudless skies and hot dry weather. The strength and proximity of the tropical system will influence the magnitude and extent of the subsidence and its' role in ozone formation in NC. (An example of these conditions is shown in Figure 3.5-4 [July 14, 1997].)

Meteorological scenarios other than the four identified above can result in ozone episodes. These "other" episodes, however, commonly do not meet the temporal or spatial requirements of the episode selection criteria for modeling defined in the U.S. EPA Draft Modeling Guidance for Ozone Attainment Demonstrations. One-day ozone episodes can occur during a progressive meteorological pattern (Scenario 5 – Continental High in a progressive pattern). A surface high-pressure area moving across the US and into NC for one day characterizes this scenario. This results in clear skies, light winds, and isolated 8-hour ozone exceedances.

An initial analysis of ambient data and Daily Weather Maps was used to place each of the ozone episodes into one of the four meteorological scenarios identified above. A list of the number of monitors with exceedances of the 8-hour standard in each of the major urban areas was compiled and reviewed. This information was used to exclude those episodes from each category that did not have sufficient spatial or temporal distribution to justify further study. A more detailed analysis of each of the remaining episodes was made using all sources of air quality and meteorological data to select the episodes that would best meet modeling objectives.

To better understand the impact of emission controls under the full range of meteorological conditions, one episode from each meteorological scenario was selected for modeling. The four episodes were selected because they represented a good cross-section of events from both an air quality and meteorological perspective. They were also selected because observed ozone concentrations were close to the areas design value, and high ozone values were widespread throughout NC. One episode was selected from 1995 (Scenario-1), two from 1996 (Scenario-2 & Scenario-3), and one from 1997 (Scenario-4). The two episodes selected from 1996 were separated by only two days during which time a strong cold front cleaned out the atmosphere as it passed through the state. The two episodes will be modeled simultaneously. This presents a good opportunity to test the ability of the air quality model to produce clean conditions in the middle of an episode.

These episodes provide a wide range of conditions that will provide the basis for a thorough analysis of the variety of factors that lead to ozone exceedances in NC. Control strategies can be tested under conditions that range from short duration ozone peaks above the 1-hour standard to extended periods of moderate levels of ozone producing widespread exceedances of the 8-hour standard. These episodes also range from multi-regional to exceedances confined primarily to the state of NC.

The first episode (Episode-E1) is a 3-day episode that occurred from June 13 – 15, 1995. (See the July 14 Daily Weather Map in Figure 3.5-1.) This episode was modeled by the Northeast Modeling Center as part of the OTAG study of ozone transport. This episode is a traditional ozone episode with high 1-hour and 8-hour averages throughout almost all areas of the South, East, and Midwest. A very strong upper level ridge developed to the west of NC and moved slowly to the east throughout the episode. On July 15th, the 1-hour peak reached 166 ppb in Atlanta, 179 ppb in Baltimore, and 154 ppb near Chicago. The highest readings were recorded in NC on July 14th; 129 ppb in Charlotte (99 ppb 8-hour) and 130 ppb in the Triad area (112 ppb 8-hour). A trough developed in eastern NC on July 14th producing south-southwesterly flow east of the trough and causing a large ozone concentration gradient. Although a 1-hour peak of 129 ppb was measured in Charlotte, the peak ozone was only 39 ppb 100 miles to the east. The presence of the trough kept ozone readings in the Raleigh/Durham area below the 1-hour and 8-hour standards throughout the episode. The trough moved to the west on July 15th and dropped 1-hour averages in Charlotte and the Triad below the standard; however, 8-hour concentrations remained above 0.085 ppm.

The first 1996 episode (Episode-E2) occurred June 21 – 24 1996. It is primarily a NC episode. (See the June 23 Daily Weather Map in Figure 3.5-2.) Concentrations in most other areas of the South and East were lower than those in NC. This episode is dominated by the presence of a front to the north and high pressure to the southwest of the state. The movement of the front and the monitored ozone readings indicate possible recirculation during the episode. Light southwesterly flow was present on 22 June and resulted in a 1-hour/8-hour peak of 133/110 ppb and 113/99 ppb northeast of Charlotte and Durham, respectively. As the front moved into northern portions of NC on the 23rd, winds became more northerly and concentrations in the Triad and Raleigh/Durham area's fell. Ozone and precursor pollutants were pushed back into Charlotte and resulted in exceedances of the 1-hour and 8-hour standard at all three Mecklenburg county ozone monitors. On the 24th, the front retreated north as a warm front and southwesterly winds returned to the entire state. Ozone levels increased throughout northern portions of NC and 8-hour averaged concentrations between 90 and 100 ppb were recorded in the major urban areas of the Piedmont. One exceedance of the 1-hour standard (134 ppb) was measured at the Rockwell site, northeast of Charlotte.

A stronger front moved toward NC on the 25th touching off storms and dropping ozone readings. The front passed through the state by the 26th and concentrations remained low. An upper level ridge began to build to the west of NC and surface high pressure over Canada moved southward throughout episode (Episode-E3) (June 27 – 29, 1996) and settled into western NC by the 29th. (See the June 28 Daily Weather Map in Figure 3.5-3.) Northerly winds were predominant at the surface and upper levels. High temperatures remained 90 and below in NC and much of the eastern half of the US during this period. Dew point temperatures were relatively low and winds were light enough to produce 8-hour exceedances in many areas of NC on the 28th and 29th. As high pressure remained over western NC, ozone concentrations continued to rise throughout the episode. Exceedances of the 1-hour standard were measured at two monitors in Charlotte on the 29th.

The final episode selected for analysis (Episode-E4) occurred July 11 – 15, 1997. (See the July 14 Daily Weather Map in Figure 3.5-4.) The previous three episodes did not capture typical ozone behaviors in the center city areas of the Triad and the Triangle. The selection of this episode also was driven by the need to model an episode that captured ozone events in areas such as Greenville, Fayetteville, and Hickory. The most distinctive aspect of this episode, however, is that a 1-hour exceedance occurred in the Triangle area on the July 14th. No other episode captures a 1-hour exceedance in this region. On the first three days of the episode, meteorological conditions were very similar to those in episode E3. On the 14th and 15th, however, the surface high-pressure center moved over NC, the mid-to-upper level flow relaxed, and a tropical depression off the NC coast strengthens into Tropical Storm “Claudette”. It is possible that the tropical system influenced conditions in NC (especially Eastern NC) on the 14th and 15th. Temperatures soared into the mid 90’s with dew points in the mid-to-upper 60s. The backward air parcel trajectories from Rocky Mount, NC (shown in Figure 3.5-5), illustrates the possible influence from the tropical system (Note the subsidence at mid-levels from 0Z –20Z on the 14th.) Exceedances of the 8-hour standard were recorded in North Carolina, South Carolina and Virginia as the surface high-pressure center moved over NC, the mid-to-upper level flow aloft weakened, and the tropical system made it’s nearest approach.

Figure 3.5-1 Daily Weather Maps for July 14, 1995

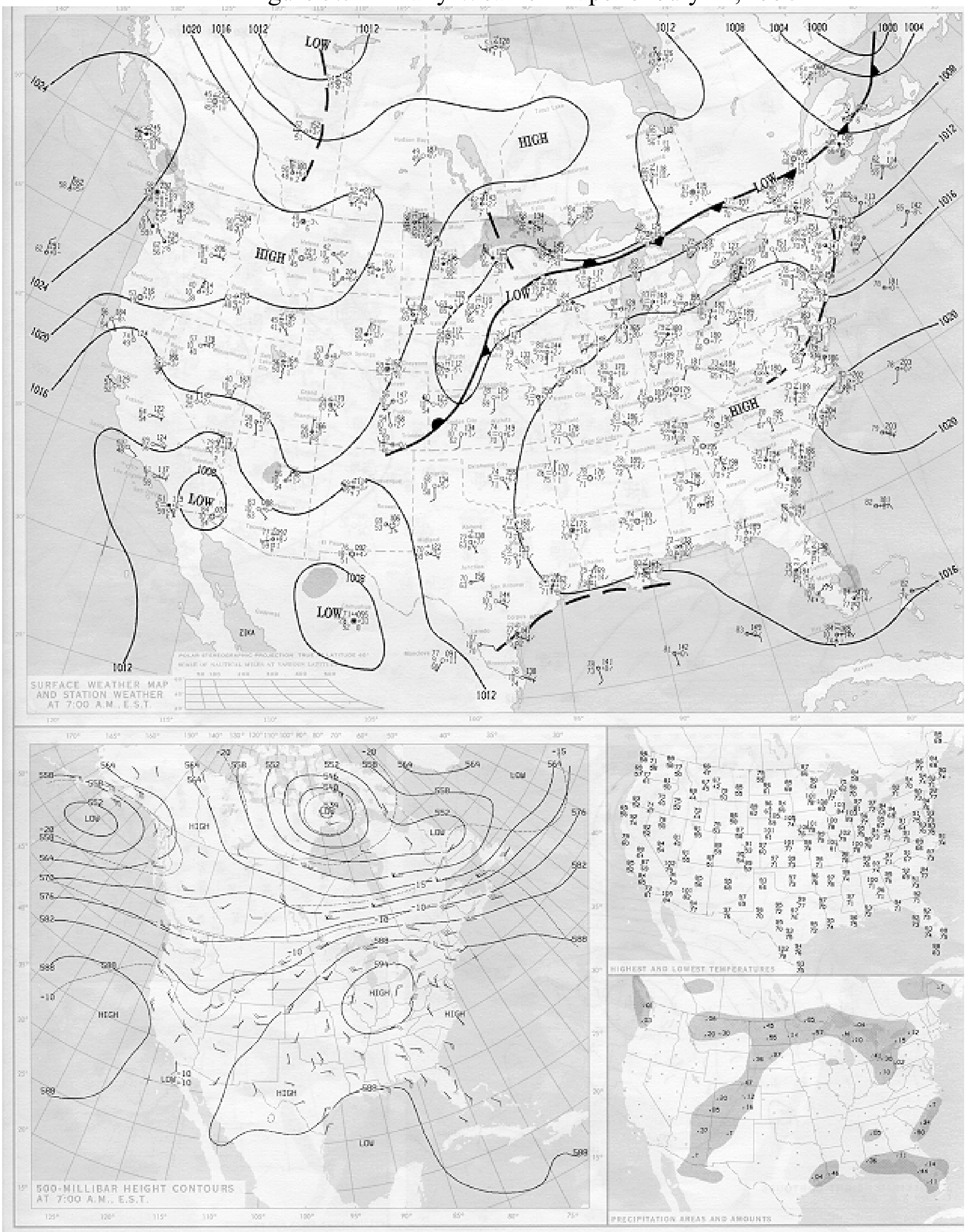


Figure 3.5-2 Daily Weather Maps for June 23, 1996

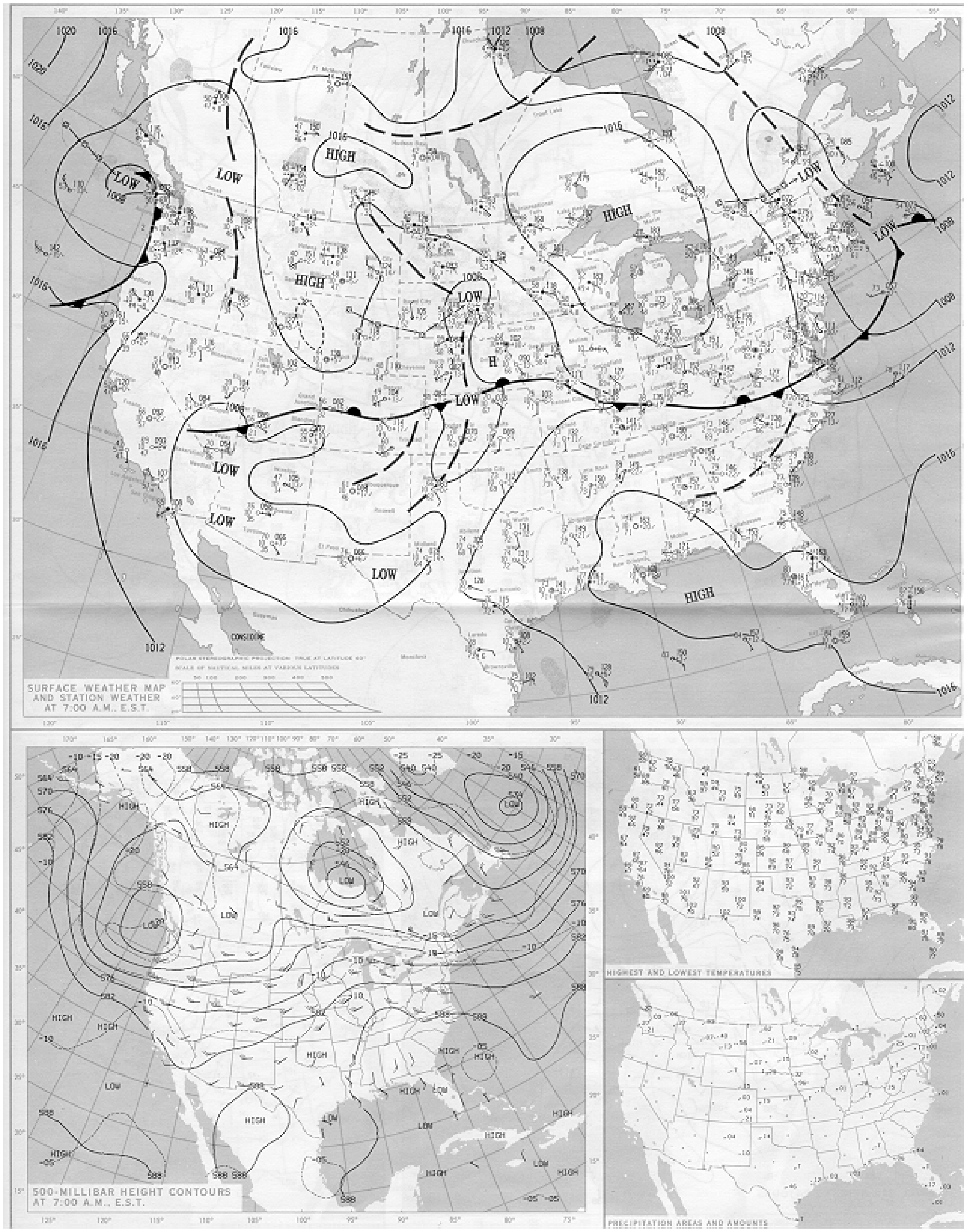


Figure 3.5-3 Daily Weather Maps for June 28, 1996

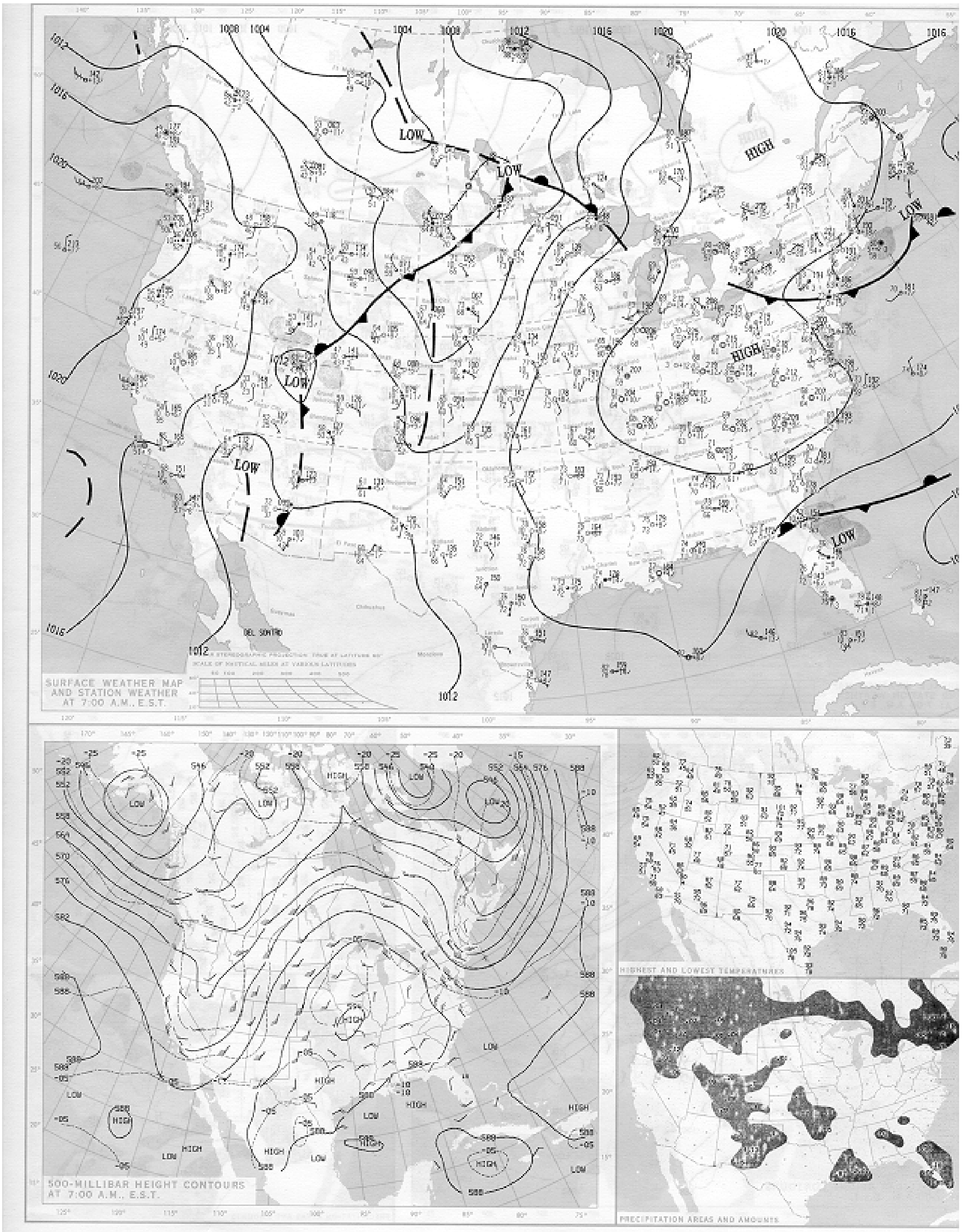


Figure 3.5-4 Daily Weather Maps for July 14, 1997

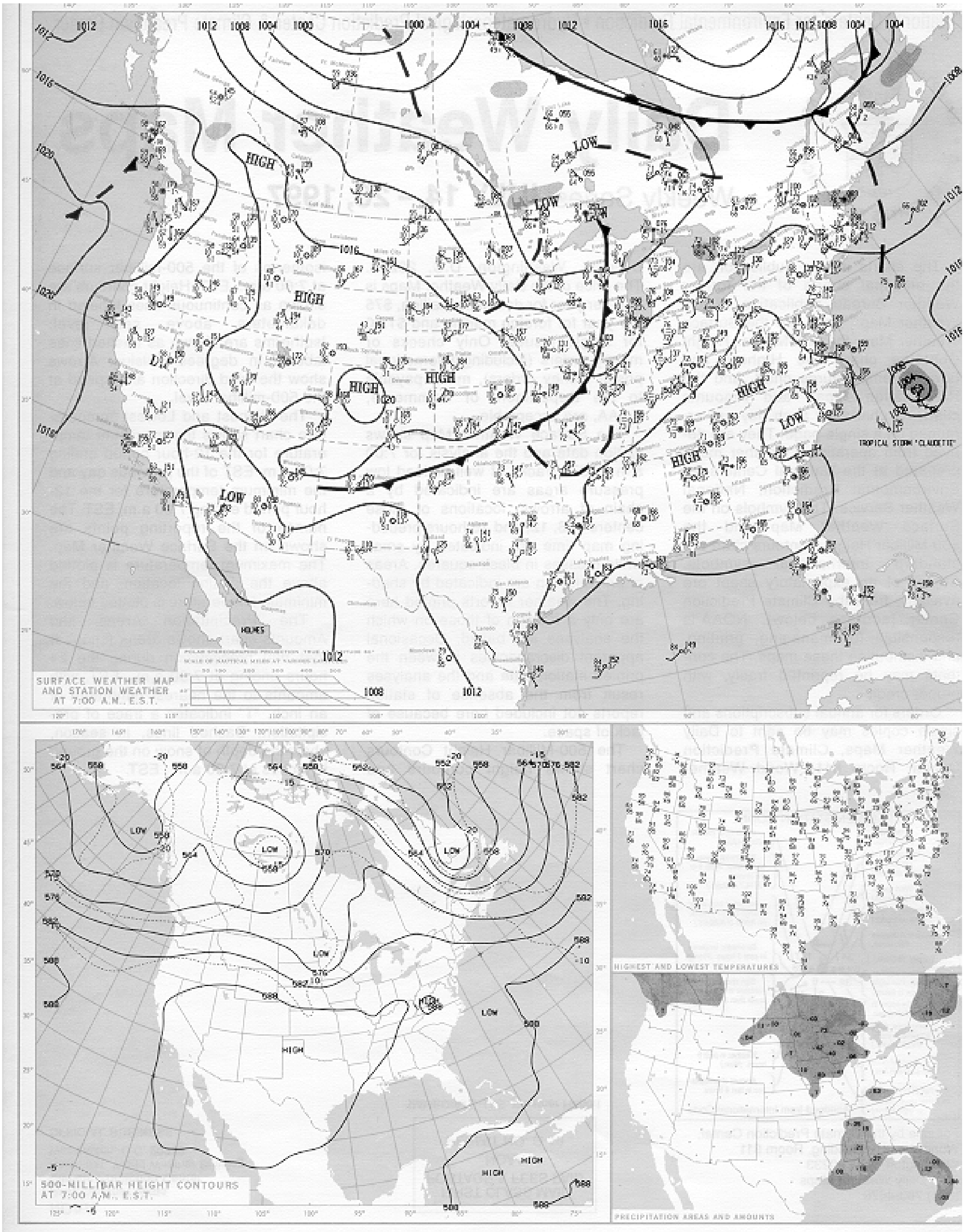


Figure 3.5-5 Backward Air Parcel Trajectories for July 14, 1997

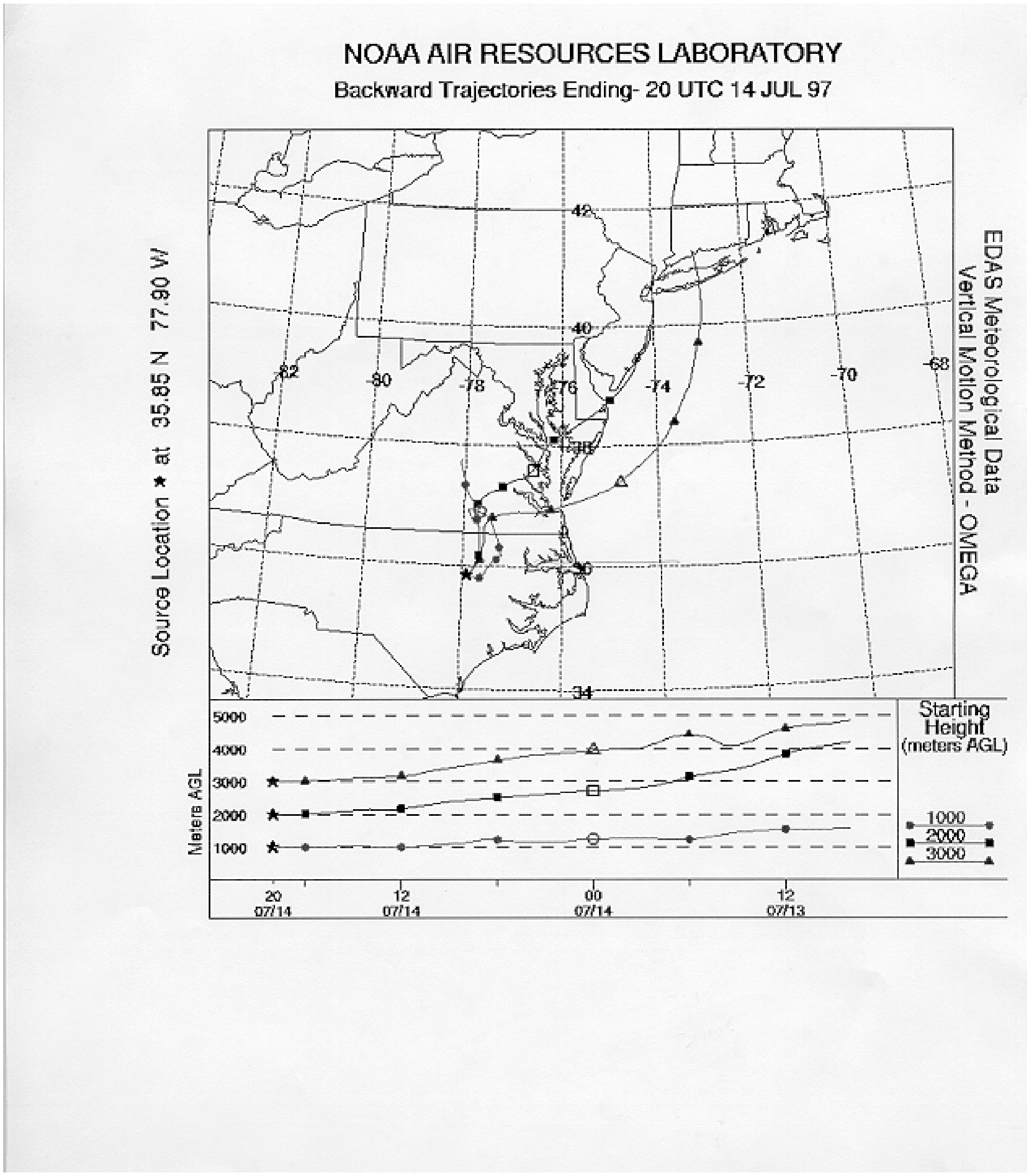


Table 3.5-1 Features of Each Selected Episode

	E1	E2	E3	E4
Synoptic Features	Large blocking upper level High over Midwest slides eastward over the large surface High over Eastern US.	Front to the north. High pressure center SW of NC. Front moves into NC, then retreats as a warm front.	Canadian surface High moves south into NC. Upper level ridge over middle of country.	Canadian surface High moves south of NC. Upper level flow weakens. Possible influence from tropical system of the coast.
Scale	Multi-regional exceedances of 1-hr & 8-hr standard.	Primarily NC.	Primarily NC.	Multi-regional exceedances of 1-hr and 8-hr standard.
Temperatures	Mid - upper 90's in NC. 90's to 100's throughout MW, NE, & South.	Low - mid 90's in NC and South. mid 80's - low 90's MW & NE.	Upper 80's in NC. Mid - upper 80's NE & MW. Low 90's in South.	Initially upper 80's, then mid-to-upper 90's for NC and Mid-Atlantic.
Dew Pt Temps	Upper 60's - low 70's in NC. As high as low 80's NE & MW.	Low 70's.	Low-to-mid 60's.	Upper 60's – low 70's in NC and Mid-Atlantic.
Local Features	North to South trough over east/central NC. Clean air east of trough effects O3 in CLT & RDU.	Front dips into northern NC & retreats as warm front creating wind shifts and re-circulation patterns.	Influence of Canadian High. Dry air & northerly winds at surface & upper levels.	Stagnating winds throughout atmosphere. Possible influence from tropical system in eastern NC.
Ozone Conc's	1-hr around 130 in GSO, CLT. 170's in Baltimore, 160's in Atlanta, 150's in MW.	Multi-day exceedances of 8-hr in 3 major areas of NC. 1-hr exceedances on 3 days in CLT.	Multi-day exceedances of 8-hr in 3 major areas of NC. 1-hr exceedances in GSO & CLT on last day.	Multi-day exceedances of 8-hr in all major NC metro areas. 1-hr exceedances on 2 days (1 RDU & 1 CLT).

Section 4 - METEOROLOGICAL MODELING

4.1 Introduction

Meteorological data needed for the MAQSIP application were obtained from the MM5 modeling system. Numerical meteorological models solve the governing equations of atmospheric physics over time and space in order to provide cell-specific meteorological inputs into the photochemical model.

Prognostic models such as MM5 are particularly advantageous (as opposed to objective/diagnostic techniques for meteorological input development) over domains in which atmospheric circulation not adequately characterized by existing data networks play an important role in pollutant transport. Within the modeling domain topographical flow, sea breeze circulation, and the effects of differential UV attenuation due to clouds will need to be accurately simulated in order to successfully model ozone formation, transport, and destruction within the airshed.

4.2 Grid Definition

Table 4.2-1 lists the specifications of each of the four MM5 nested grids. Figure 4-1 through 4-3 illustrates the MM5 domains utilized for the modeling. Grids 01 (108 km) and 02 (36 km) are more expansive than the outermost MAQSIP grid and are intended to capture the broad, synoptic scale meteorological features of the episodes. Grids 03 (12 km) and 04 (4km) encompass the corresponding fine-mesh domains within MAQSIP and are required to capture the mesoscale elements of pollutant transport within the airshed. Since the 4km-domain configuration varies with each episode, the numbers in Table 4.2-1 for D 04 represent the differing specifications, starting with the 1995 case.

Table 4.2-1. MM5 Grid Specifications

Grid	Resolution (km)	East-West Cells (#)	North-South Cells (#)	Time Step (s)
D 01	108	54	42	300
D 02	36	60	60	100
D 03	12	81	63	36
D 04	4	69, 126, 114	69, 75, 75	12

Figure 4.2-1 The 1995 MM5 Modeling Domain and Grids

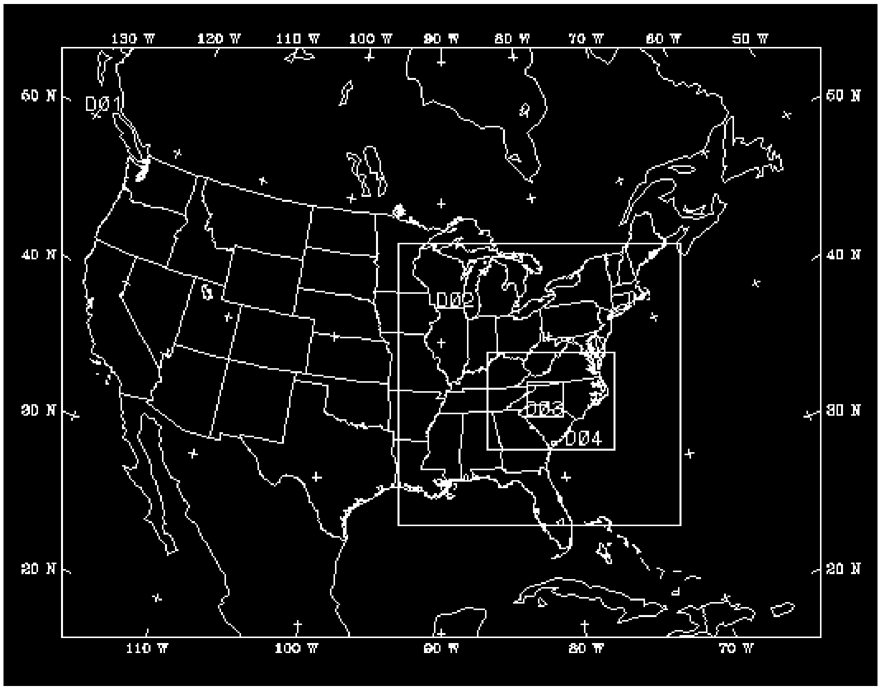


Figure 4.2-2 The 1996 MM5 Modeling Domain and Grids

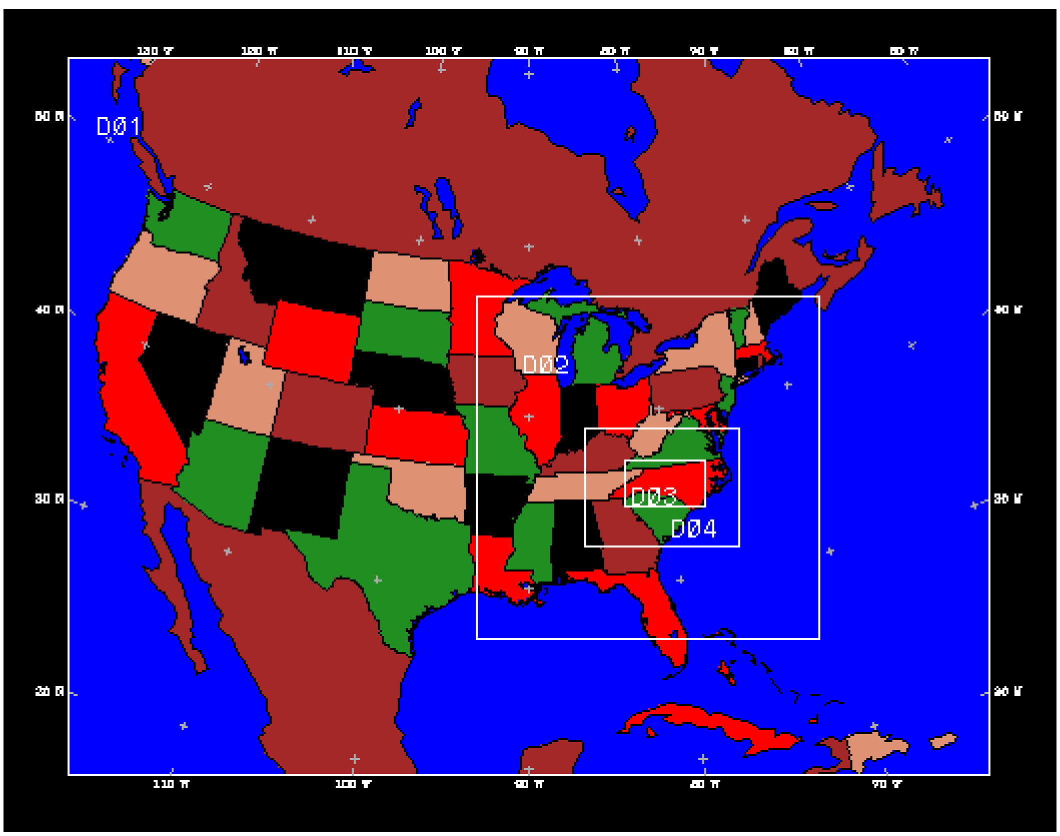
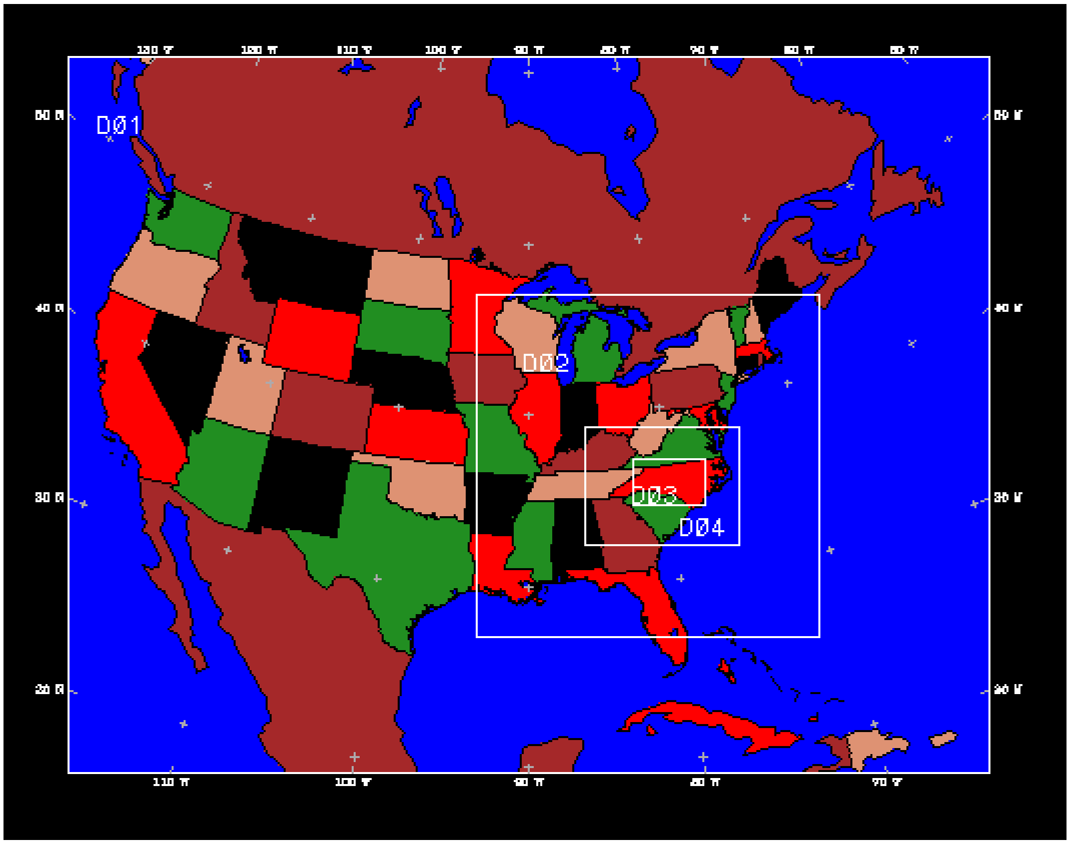


Figure 4.2-3 The 1997 MM5 Modeling Domain and Grids



Given that the emphasis of the meteorological modeling is mid-latitudinal, a Lambert Conformal map projection has been chosen. The horizontal grid uses an Arakawa-Lamb B-staggering of the wind vector components; scalar variables are defined at cell centers. In the vertical, 26 layers are modeled using terrain following coordinates (sigma coordinates). With the exception of vertical velocity, all state variables are defined at half-sigma levels (i.e., the midpoint of layer depth). The pressure at the top of the model is 100 millibars.

Table 4.2-2 shows an estimated vertical grid resolution for the meteorological model assuming standard atmosphere.

Table 4.2-2. Vertical Grid Resolution for the Meteorological Model (MM5)

Level		Pressure (mb)	Height (m)	Thickness (m)
0	1.000	1000.0	**0.0**	0.0
1	0.995	995.5	**38.0**	38.0
2	0.987	988.3	**99.2**	61.1
3	0.974	976.6	**199.3**	100.1
4	0.956	960.4	**339.5**	140.2
5	0.936	942.4	**497.5**	158.1
6	0.913	921.7	**682.4**	184.8
7	0.887	898.3	**895.4**	213.0
8	0.857	871.3	**1146.8**	251.4
9	0.824	841.6	**1430.8**	284.0
10	0.790	811.0	**1732.0**	301.2
11	0.750	775.0	**2098.3**	366.3
12	0.700	730.0	**2576.1**	477.8
13	0.650	685.0	**3078.3**	502.2
14	0.600	640.0	**3607.9**	529.6
15	0.550	595.0	**4168.6**	560.7
16	0.500	550.0	**4764.7**	596.1
17	0.450	505.0	**5401.6**	636.9
18	0.400	460.0	**6086.2**	684.6
19	0.350	415.0	**6827.3**	741.0
20	0.300	370.0	**7636.3**	809.1
21	0.250	325.0	**8529.1**	892.8
22	0.200	280.0	**9528.0**	998.8
23	0.150	235.0	**10665.7**	1137.7
24	0.100	190.0	**12021.8**	1356.1
25	0.050	145.0	**13742.3**	1720.5
26	0.000	100.0	**16094.8**	2352.5

The meteorological model used for the 1995 modeling episode, MM5 version1, used the post-processor Meteorology Chemistry Interface Processor (MCIP) to prepare the MAQSIP model inputs. This post-processor could collapse some of the meteorological layers so that the MAQSIP model could run with fewer layers and reduce the processing time. North Carolina ran a number of sensitivity runs, collapsing some of the upper layers, to see if the air quality predictions were adversely affected. From this analysis, it was determined that the minimum number of layer that the MAQSIP model could run with was 16 layers without differing significantly from running the model with all 26 layers. The first 12 layers of the meteorological model are mapped directly and the upper 14 MM5 layers are collapsed into 4 MAQSIP layers. The estimated vertical grid resolution for the MAQSIP model for the 1995 modeling episode is shown in Table 4.2-3.

Table 4.2-3. Vertical Grid Resolution for MAQSIP for the 1995 Episode

	Height (m)	**Thickness (m)**
0	**0.0**	0.0
1	**38.0**	38.0
2	**99.2**	61.1
3	**199.3**	100.1
4	**339.5**	140.2
5	**497.5**	158.1
6	**682.4**	184.8
7	**895.4**	213.0
8	**1146.8**	251.4
9	**1430.8**	284.0
10	**1732.0**	301.2
11	**2098.3**	366.3
12	**2576.1**	477.8
13	**4168.6**	1592.5
14	**6827.3**	2658.7
15	**10665.7**	3838.4
16	**16094.8**	5429.1

For the 1996 and 1997 modeling episodes, newer versions of the meteorological model were used. The post-processor for the new versions is Meteorology-Coupler (MCPL) and it cannot collapse the meteorological data into a format that the MAQSIP model can use. Therefore, the photochemical model runs with 26 layers, mapping the meteorological data directly, for the 1996 and 1997 episodes.

4.3 MM5 Physics Options

One-way nested grids
Non-hydrostatic dynamics
Four-dimensional data assimilation (FDDA):

- analysis nudging of wind, temperature, and mixing ratios every 12 hours
- nudging coefficients range from $1.0 * 10^{-5}$ s^{-1} to $3.0 * 10^{-4}$ s^{-1}
- No initial FDDA for 12 km and 4 km grids

Explicit moisture treatment:

- 3-D predictions of cloud and precipitation fields
- simple ice microphysics
- cloud effects on surface radiation
- moist vertical diffusion in clouds
- normal evaporative cooling

Boundary conditions:

- relaxation inflow/outflow (Grid 01)

- time-dependent (Grids 02, 03, & 04)
- rigid upper boundary

Cumulus cloud parameterization schemes:

- Anthes-Kuo (Grid 01)
- Kain-Fritsch (Grids 02 and 03) 1995 & 1996 episodes, Grell (Grids 02 and 03) 1997
- no cumulus parameterization (Grid 04)

Full 3-dimensional Coriolis force
Drag coefficients vary with stability
Vertical mixing of momentum in mixed layer
Virtual temperature effects
Planetary boundary layer process parameterization:

- Modified Blackadar scheme (Grids 02, 03 and 04) for 1996 and 1997 episodes and Grid 02 for 1995 episode; Gayno-Seaman scheme (Grids 03 and 04) for 1995 episode.

Surface layer parameterization:

- fluxes of momentum, sensible and latent heat
- ground temperature prediction using energy balance equation
- 13 land use categories

Atmospheric radiation schemes:

- Simple cooling
- Long- and short-wave radiation scheme

Several application specific modifications:

- m5_dry.mods -- lowers MM5 soil moisture when appropriate locally
- mavail_adj.mods -- changes soil moisture as a function of soil type as needed
- m5_flyer.mods -- modifications to optimize on NCSC CRAY T-90
- kfbm_edss.mods -- writes special Kain-Fritsch meteorological data
- m5_height.mods -- calculates MM5 layer heights correctly for non hydrostatic
- m5_epafiles.mods -- writes additional data out to air quality model
- m5_blkdr_hts.mods -- modifies PBL height calculations to a VMM scheme

4.4 Inputs

Table 4.4-1 describes the terrain and land use fields input into MM5 for the modeling.

Table 4.4-1 Terrain and Land Use Inputs to MM5

Grid	Terrain origin	Terrain resolution	Land use origin	Land use resolution
G 01	PSU/NCAR	30 minute	PSU/NCAR	30 minute
G 02	GDC	10 minute	PSU/NCAR	10 minute
G 03*	GDC	5 minute	PSU/NCAR	5 minute
G 04*	GDC	5 minute	PSU/NCAR	5 minute

*Land use data were slightly modified in the Charlotte area to minimize the number of cells characterized as urban. Also, several cells along the NC/SC coastline were modified to reflect mixed forest - wetland as opposed to water.

The TOGA (2.5 by 2.5 degrees) data set was used to provide a first-guess interpolation of meteorological data to the horizontal modeling grid. Climatological averages of sea-surface temperature were used to characterize ocean temperatures. Three- and six-hourly NWS data (first-order) were used to develop the surface analysis fields. Standard twice-daily rawinsonde data from the NWS were used in the preparation of aloft FDDA analysis fields.

4.5 Performance Evaluation

The standard set of objective metrics to evaluate model performance for various meteorological parameters were generated for this project. The basic methodology employed used the base variables that were available for observational nudging. These variables include temperature, water vapor mixing ratio, east-west wind and south-north wind. Note that only the wind components are actually used for observational nudging. The observed winds have been rotated to the model projection (Lambert Conformal). The model/obs pairs are matched on a grid cell basis; no bilinear interpolation is performed. If more than one observation lies within a cell, the observations are averaged and the value is treated as if it were a single observation. For the wind components and mixing ratio, layer 1 (~38m) values are used. Temperatures are adjusted to 1.5 meters by logarithmically interpolating between the layer 1 temperature and the "skin" temperature. The results of this interpolation were compared with a more sophisticated methodology in which the interpolation varies with stability class, and we found little significant differences between the two. Since observational nudging was employed only at 12-km and 4-km resolutions, performance statistics were produced only for those grids.

A limited sample of the performance metrics for each episode is provided in Figures 4.5-1 through 4.5-7 below. For an exhaustive review of the meteorological modeling results, please visit: http://www.emc.mcnc.org/projects/NCDAQ/PGM/results/index.htm

Figure 4.5-1 Temperature performance metric – 1995 episode - 4km domain

Figure 4.5-2 Example Temperature Metric - 1995 episode - 12 km domain

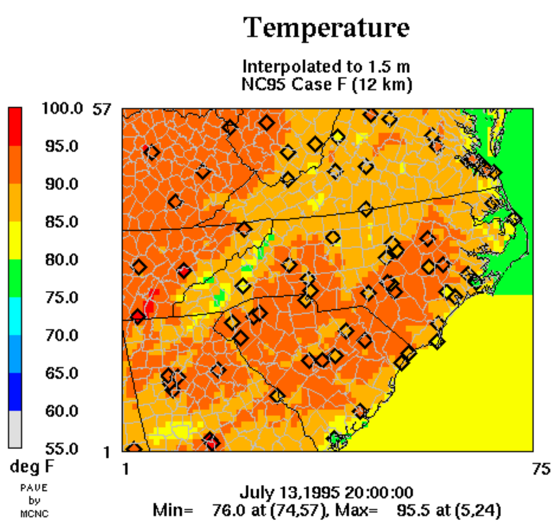


Figure 4.5-3 Temperature performance metric – 1996 episode - 4km domain

Figure 4.5-4 Example Temperature Metric - 1996 episode - 12 km domain

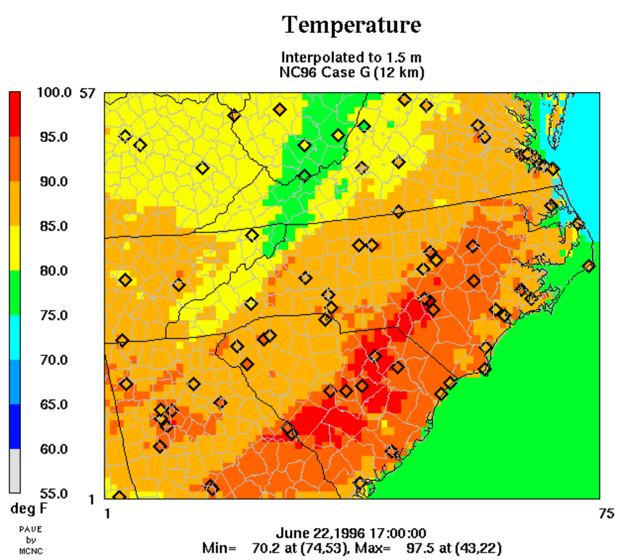
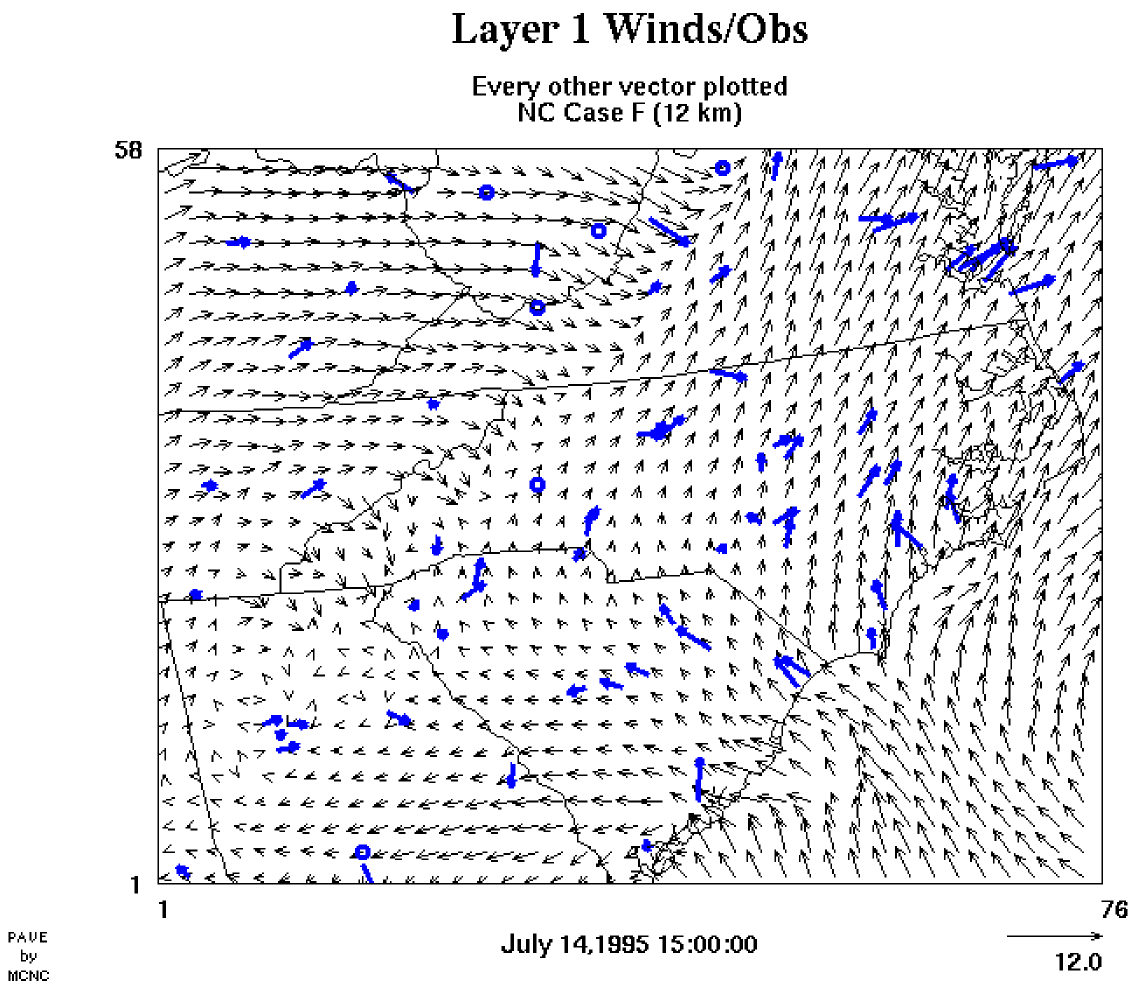


Figure 4.5-5 Temperature performance metric – 1996 episode - 4km domain

Figure 4.5-6 Example Temperature Metric - 1997 episode - 12 km domain

Figure 4.5-7 Example Layer 1 Wind Vector Metric - 1995 episode - 12 km domain
Blue vectors=observations, black vectors=model



Currently, there is no accepted standard by which to judge meteorological model performance. Modelers usually calculate the basic statistics such as bias, error, or index of agreement and compare their results with the same quantities from prior and similar modeling exercises. The problem with such an approach is that these numbers are a function of the domain size modeled, the length of the simulation, and the meteorology being modeled. In this modeling study, the modeling team, including a number of air quality meteorologists, examined all of the meteorological modeling output both quantitatively through statistical metrics and qualitatively through a series of graphical metrics.

When passing final judgment regarding the accuracy of a meteorological simulation, the modeling team concluded that the results satisfactorily address the following questions:

A. *Do the model results fit our conceptual understanding?* The model replicates the observed synoptic pattern, placing surface pressure systems in the proper location and matches the upper air pattern.

B. *Are diurnal features adequately captured?* The diurnal cycle is adequately represented in the model. For example, the mixing heights increase during the day and collapse at night in a reasonable way. Similarly temperatures, summertime convection, and winds show diurnal variation.

C. Is the vertical mixing appropriate? The PBL depth and evolution is well modeled.

D. *Are clouds reasonably well modeled?* Secondary quantities such as clouds are particularly useful to analyze since they are not "nudged" to the observations. We see that on a synoptic scale the model clouds will generally match the observations. Convective clouds are unlikely to occur precisely in the right place and at the right time, but the general region/time of convective development is adequate.

E. Do the wind fields agree with the observations? The model adequately captures the observed wind fields so that transport in the subsequent air quality runs is done correctly.

G. Do the temperature and moisture fields generally match the observations? These first order scalar quantities are well captured by the model.

H. Do the meteorological fields produce acceptable air quality results? While air quality models can have problems of their own, many times poor air quality modeling results occur due to problems with the input meteorological fields. This is often a good test to determine whether the meteorological model adequately predicts the fields to which the air quality model is most sensitive. A number of air quality runs were conducted to test the sensitivity to different meteorological inputs.

Section 5 - EMISSIONS INVENTORY

5.1 Introduction

There are five different emission inventory source classifications, stationary point and area sources, off-road and on-road mobile sources, and biogenic sources.

Stationary point sources are those sources that emit greater than a specified tonage per year and the data is provided at the facility level. Stationary area sources are those sources whose emissions are relatively small but due to the large number of these sources, the collective emissions could be significant (i.e., dry cleaners, service stations, etc.) These type of emissions are estimated on the county level. Off-road mobile sources are equipment that can move but do not use the roadways, i.e., lawn mowers, construction equipment, railroad locomotives, aircraft, etc. The emissions from these sources, like stationary area sources, are estimated on the county level. On-road mobile sources are automobiles, trucks, and motorcycles that use the roadway system. The emissions from these sources are estimated by vehicle type and road type and are summed to the county level. Biogenic sources are the natural sources like trees, crops, grasses and natural decay of plants. The emissions from these sources are estimated on a county level.

In addition to the various source classifications, there are also various types of emission inventories. The first is the base year or episodic inventory. This inventory is based on the year of the episode being modeled and is used for validating the photochemical model performance.

The second inventory used in this project is the “current” year inventory. For this modeling project it will be the 2000 emission inventory, which is the most current. This inventory is processed using all of the different meteorological episodes being studied. The photochemical modeling is processed using the current year inventory and those results are used as a representation of current air quality conditions.

Next is the future year base inventory. For this type, an inventory is developed for some future year for which attainment of the ozone standard is needed. For this modeling project the future years will be 2007 and 2012. It is the future year base inventories that control strategies and sensitivities are applied to determine what controls, to which source classifications, must be made in order to attain the ozone standard.

In the sections that follow, the base year inventories used for each source classifications are discussed. Emission summaries by county for the entire State are in Appendix A.

5.2 Stationary Point Sources

Point source emissions are emissions from individual sources having a fixed location. Generally, these sources must have permits to operate and their emissions are inventoried on a regular schedule. Large sources having emissions of 100 tons per year (tpy) of a criteria pollutant, 10 tpy of a single hazardous air pollutant (HAP), or 25 tpy total HAP are inventoried annually. Smaller sources have been inventoried less frequently. The point source emissions data can be grouped into the large electric utility sources and the other point sources.

5.2.1 LARGE UTILITY SOURCES

The inventory used for the large utility sources is the May 1999 release of the NOx SIP call base year modeling foundation files obtained from the USEPA Office of Air Quality Planning and Standards (OAQPS). The base year for this utility data is 1996. This data is provided in EMS 95 format. The emissions data for the utilities is episode specific CEM data and is specific for each source for each hour of the modeling episode. This data comes from the USEPA Acid Rain Division (ARD). Since only NOx emissions are measured, the CO and VOC emissions are calculated from the NOx emissions using emission factor ratios (CO/NOx and VOC/NOx) for the particular combustion processes at the utilities.

5.2.2 Other Point Sources

The inventory used to model the other point sources is the May 1999 release of the NOx SIP call base year modeling foundation files obtained from the USEPA OAQPS. This data is based on 1995 emissions and is provided in EMS 95 format. For the 1996 and 1997 modeling episode, emissions were grown using Bureau of Economic Analysis (BEA) growth factors. The North Carolina sources were an exception. These emissions are true 1996 emissions for the larger VOC and NOx sources. In addition, emissions for forest fires and prescribed burns are treated as point sources and are episode specific similar to CEM data.

The emissions summary for the 1996 episodes for the counties in the Triad EAC area is listed in Table 5.2-1. These emissions represent a typical weekday, Thursday's (June 20^{th}), emissions and are in tons per day. In some instances a county may not have had emissions for the 20^{th} but did have emissions during the modeling episode due to forest fires or prescribed burns that were treated as point sources.

Table 5.2-1 Stationary Point Source Emissions

County	CO	NOx	VOC
Alamance	0.061	0.676	0.960
Caswell	0.000	0.000	0.000
Davidson	2.466	12.859	23.927
Davie	0.078	0.039	3.841
Forsyth	1.917	8.835	20.874
Guilford	0.158	1.829	40.535
Randolph	0.021	0.058	2.528
Rockingham	5.954	33.903	7.896
Stokes	7.872	341.620	0.945
Surry	5.356	0.942	5.817
Yadkin	0.000	0.000	0.092
Total	23.883	400.760	107.413

5.3 Stationary Area Sources

The base year inventory for the stationary area sources is the May 1999 release of the NOx SIP call base year modeling foundation files obtained from the USEPA OAQPS. This data is based on 1995 and is provided in EMS 95 format. For the 1996 and 1997 base years, the NOx SIP call foundation files will be grown to the respective year by use of Bureau of Economic Analysis (BEA) growth factors or projected population growth obtained from the US Census Bureau.

The exception to this is for North Carolina where a 2000 base year inventory was generated by NCDAQ following the current methodologies outlined in the Emissions Inventory Improvement Program (EIIP) Area Source Development Documents, Volume III (http://www.epa.gov/ttn/chief/eiip/techreport/volume03/index.html). This data was backcasted to the base years via growth factors developed with EPA's Economic Growth Analysis System (EGAS) version 4.0.

The emissions summary for the 1996 episodes for the counties in the Triad EAC area is listed in Table 5.3-1. These emissions represent a typical weekday, Thursday's (June 20th), emissions and are in tons per day.

Table 5.3-1 Stationary Area Source Emissions

County	NOx	VOC	CO
Alamance	0.74	7.71	3.51
Caswell	0.23	1.65	2.46
Davidson	1.35	10.66	6.02
Davie	0.26	2.57	2.52
Forsyth	1.54	14.36	5.33
Guildford	4.13	26.45	10.27

Randolph	0.78	9.82	5.89
Rockingham	1.03	5.91	6.30
Stokes	0.27	2.65	2.26
Surry	0.25	6.09	3.87
Yadkin	0.16	3.54	2.82
Total	10.75	91.42	51.24

5.4 Off-Road Mobile Sources

The off-road mobile sources can be broken down into two types of sources; those calculated within the USEPA NONROAD mobile model and those that are not. For the sources that are calculated within the NONROAD mobile model, a base year inventory was generated for the entire domain for each of the base years. The model version used is the Draft NONROAD2002 distributed for a limited, confidential, and secure review in November 2002. If the final version or any newer draft versions of this model is released by the USEPA, an assessment of the difference in the emission estimations will be made to determine if a new inventory must be generated and processed through the photochemical model.

The sources not calculated within the NONROAD model include aircraft engines, railroad locomotives and commercial marine vessels. The base year inventory for these sources was the May 1999 release of the NOx SIP call base year modeling foundation files obtained from the USEPA OAQPS. This data is based on 1995 and is provided in EMS 95 format. For the 1996 and 1997 base years, the NOx SIP call foundation files were grown to the respective year by use of Bureau of Economic Analysis (BEA) growth factors.

The exception to this was for North Carolina where a 1995 base year inventory was generated by NCDAQ for aircraft engines and railroad locomotives. This data was then grown to the other base years via BEA growth factors or other State specific data.

The emissions summary for the 1996 episodes for the counties in the Triad EAC area is listed in Table 5.4-1. These emissions represent a typical weekday, Thursday's (June 20th), emissions and are in tons per day.

Table 5.4-1 Off-Road Mobile Source Emissions

County	**NOx**	**VOC**	**CO**
Alamance	2.58	2.59	29.18
Caswell	0.40	0.22	2.26
Davidson	3.43	2.88	30.28
Davie	0.70	0.84	7.20
Forsyth	6.50	7.62	89.05
Guildford	13.51	16.09	182.94
Randolph	2.79	2.43	27.26
Rockingham	1.80	1.54	15.60

Stokes	0.61	0.77	7.77
Surry	1.76	2.63	28.71
Yadkin	0.75	0.58	6.52
Total	34.83	38.19	426.77

5.5 Highway Mobile Sources

In order to accurately model the mobile source emissions in the EAC areas, the newest version of the MOBILE model, MOBILE6.2, was used. This model was released by EPA in 2002 and differs significantly from previous versions of the model. Key inputs for MOBILE include information on the age of vehicles on the roads, the speed of those vehicles, what types of road those vehicles are traveling on, any control technologies in place in an area to reduce emissions for motor vehicles (e.g., emissions inspection programs), and temperature. Baseline estimates were created for the episode June 19 – July 1, 1996.

5.5.1 Speed Assumptions

Emissions from motor vehicles vary with the manner in which the vehicle is operated. Vehicles traveling at 65 mph emit a very different mix of pollutants than the car that is idling at a stoplight. In order to estimate emissions from vehicles for a typical day, North Carolina Department of Transportation (NCDOT) provided speeds for each of the urban areas across the state and in some cases for different times of the day. To reflect the most current assumptions on the speed of vehicles in different areas across the state, the latest conformity report was used which reflected speeds developed through travel demand modeling for the urban areas. Separate speed profiles were created for Wake County (covering Durham and Orange Counties) Greensboro, Winston-Salem, Mecklenburg County (covering Gaston County), and “rest of state”. In Wake, Durham, Orange, Mecklenburg and Gaston Counties, a profile was created based on a morning traffic peak, an afternoon traffic peak, and an offpeak for the remainder of the day. In Wake, Durham, and Orange Counties the morning peak covered the period from 6 am – 10 am, and the afternoon peak from 4 pm – 8 pm. In Mecklenburg and Gaston Counties the morning peak covered the period from 6 am – 9 am, and the afternoon peak covered the period from 4 pm – 7 pm. These assumptions were provided by the Metropolitan Planning Organizations (MPOs) in each of the areas. For the rest of the state, NCDAQ chose to use the Wake County speed profile developed in 1998. This was assumed to be a conservative estimate of speeds in areas that do not have a travel demand model.

Table 5.5-1 provides a summary of the speeds used in this episode run.

Table 5.5-1: 1996 Speed Assumptions for Mobil Model

Wake, Durham, Orange Counties (based on 1995 speeds)			
Road Type	**Morning Peak**	**Afternoon Peak**	**Offpeak**
Urban Interstate	55	55	55
Urban Freeway	48	47	54
Urban Other P. Art	38	39	44
Urban Minor Art	40	40	43
Urban Collector	36	36	36
Urban Local	36	36	37
Rural Interstate	56	59	64
Rural Other P. Art	53	52	57

Wake, Durham, Orange Counties (based on 1995 speeds)			
Rural Minor Art	48	47	50
Rural Major Coll	46	46	46
Rural Minor Coll	43	43	43
Rural Local	44	44	44

<u>Greensboro</u>
(based on 1994 speeds)

Road Type	Speed
Urban Interstate	41
Urban Freeway	46
Urban Other P. Art	27
Urban Minor Art	30
Urban Collector	31
Urban Local	33
Rural Interstate	56
Rural Other P. Art	53
Rural Minor Art	41
Rural Major Coll	44
Rural Minor Coll	44
Rural Local	44

<u>Winston-Salem</u>
(based on 1994 speeds)

Road Type	Speed
Urban Interstate	55
Urban Freeway	48
Urban Other P. Art	29
Urban Minor Art	22
Urban Collector	29
Urban Local	24
Rural Interstate	55
Rural Other P. Art	55
Rural Minor Art	44
Rural Major Coll	41
Rural Minor Coll	39

Winston-Salem (based on 1994 speeds)	
Road Type	**Speed**
Rural Local	26

Mecklenburg and Gaston			
Road Type	**Morning Peak**	**Afternoon Peak**	**Offpeak**
Urban Interstate	55	55	55
Urban Freeway	48	47	54
Urban Other P. Art	38	39	44
Urban Minor Art	40	40	43
Urban Collector	36	36	36
Urban Local	36	36	37
Rural Interstate	56	59	64
Rural Other P. Art	53	52	57
Rural Minor Art	48	47	50
Rural Major Coll	46	46	46
Rural Minor Coll	43	43	43
Rural Local	44	44	44

Rest of State			
Road Type	**Morning Peak**	**Afternoon Peak**	**Offpeak**
Urban Interstate	60	61	63
Urban Freeway	55	59	61
Urban Other P. Art	34	35	32
Urban Minor Art	34	35	34
Urban Collector	35	34	33
Urban Local	30	37	37
Rural Interstate	49	62	67
Rural Other P. Art	38	41	42
Rural Minor Art	49	50	53
Rural Major Coll	32	46	46
Rural Minor Coll	33	41	44
Rural Local	42	45	42

5.5.2 VEHICLE AGE DISTRIBUTION

The vehicle age distribution comes from annual registration data from the NCDOT. NCDOT has provided registration data specific to the area. For this analysis, the data was from 2000. NCDOT provides the data by vehicle type; however, these types do not match the EPA MOBILE types. Therefore, the data is manipulated to match the input requirements as follows:

- NCDOT provides at least 25 years for all vehicle types, however MOBILE5 only recognizes 12 years for motorcycles. Therefore, the first 13 years are combined into one number.
- If more than 25 years are provided, the early years are combined and included in the 25th model year.
- NCDOT does record model years beyond the year of the report, for this set of data, 2001 model year was added to the 2000 model year information.
- The same registration distribution by age must be entered for Light Duty Gasoline Vehicles (LDGV), Light Duty Diesel Vehicles (LDDV), and for Light Duty Gasoline Trucks 1 and 2 (LDGT1 and LDGT2) according to the MOBILE5 User's Guide.

Then using the MOBILE6.2 utility provided by EPA the vehicle types were distributed across the 16 types in MOBILE6.2. A separate age distribution was created for each of the urban areas and for the rest of the state (see Appendix B).

5.5.3 VEHICLE MIX ASSUMPTIONS

For all of North Carolina, vehicle mix has incorporated the increase in sales of sport utility vehicles and minivans for all years of evaluation.

To calculate the vehicle mix to account for the large percentage of sport utility vehicles and minivans being purchased, NCDAQ used the following documentation from EPA: Fleet Characterization Data for MOBILE6: Development and Use of Age Distributions, Average Annual Mileage Accumulation Rates, and Projected Vehicle Counts for Use in MOBILE6 (EPA420-P-99-011). This document includes a breakdown by year from 1983 to 2050 of the number of light duty vehicles (according to MOBILE6 five vehicle types) on the roads on a national basis. NCDAQ used this data and combined vehicle types to reflect the three MOBILE5 light duty vehicle types. These calculated values for LDGT1 and LDGT2 are used for all road types. No changes were made to this file for this modeling effort because of the way in which the SMOKE model has incorporated MOBILE6.2. Table 5.5-2 provides the vehicle mix for North Carolina.

Table 5.5-2: 1996 North Carolina Vehicle Mix

Rural	LDGV	LDGT1	LDGT2	HDGV	LDDV	LDDT	HDDV	MC
Interstate(-0.001)	0.458	0.174	0.062	0.031	0.002	0.002	0.266	0.005
Oth Prin Art(+0.001)	0.557	0.211	0.075	0.04	0.002	0.002	0.109	0.004
Minor Ar(-0.001)	0.571	0.219	0.078	0.045	0.003	0.003	0.076	0.005
Major Col (+0.001)	0.591	0.225	0.08	0.044	0.002	0.002	0.052	0.004
Minor Col	0.591	0.225	0.08	0.042	0.002	0.002	0.053	0.005
local	0.589	0.227	0.081	0.049	0.003	0.003	0.042	0.006

Urban	LDGV	LDGT1	LDGT2	HDGV	LDDV	LDDT	HDDV	MC
Interstate (-0.002)	0.534	0.201	0.072	0.033	0.002	0.002	0.152	0.004
Oth Freeway	0.583	0.218	0.078	0.035	0.002	0.002	0.079	0.003
Oth Prin Art(+0.001)	0.6	0.224	0.08	0.036	0.002	0.002	0.053	0.003
Minor Art(-0.001)	0.614	0.229	0.082	0.035	0.002	0.002	0.032	0.004
Collectors(-0.001)	0.622	0.231	0.082	0.033	0.002	0.002	0.025	0.003
local (+0.001)	0.602	0.228	0.081	0.041	0.002	0.002	0.038	0.006

HDGV – Heavy Duty Gasoline Vehicles, LDDT – Light Duty Diesel Trucks, HDDV – Heavy Duty Diesel Vehicles, MC - Motorcycles

5.5.4 Temperature Assumptions

Temperatures are extracted from the MM5 meteorological model files.

5.5.5 Vehicle Inspection and Maintenance Program Assumptions

In the early 1990's, North Carolina adopted emissions inspection requirements for vehicles in 9 urban counties. This program tests emissions at idle for 1975 and newer gasoline powered light duty vehicles. The program is a basic, decentralized tailpipe test for Hydrocarbon (HC) and CO only. The waiver rates are consistent with the SIP. However, the compliance rates have been changed to more accurately reflect what is happening at the stations. Compliance rates have been changed from 98 percent in the SIP to 95 percent. In addition, the inspection stations are required to administer an anti-tampering check to ensure that emissions control equipment on any vehicle 1968 and newer has not been altered.

5.5.6 RVP ASSUMPTIONS

Reid vapor pressure (RVP) reflects a gasoline's volatility, so as a control measure North Carolina has adopted the Phase II RVP of 7.8 psi in the 1-hour ozone maintenance counties.

The emissions summary for the 1996 episodes for the counties in the Triad EAC area is listed in Table 5.5-4. These emissions represent a typical weekday, Thursday's (June 20th), are in tons per day.

Table 5.5-4 Highway Mobile Emissions

County	CO	NOx	VOC
Alamance	107.43	14.92	9.43
Caswell	18.33	1.95	1.65
Davidson	150.84	27.56	12.92
Davie	37.20	8.36	3.07
Forsyth	207.45	32.63	20.60
Guilford	274.51	44.36	27.54
Randolph	122.08	17.26	10.75
Rockingham	77.73	7.94	7.21
Stokes	28.49	2.87	2.57
Surry	78.33	12.38	6.98
Yadkin	39.27	7.03	3.44
Total	1141.65	177.25	106.14

5.6 Biogenic Emission Sources

Biogenic emissions will be prepared with the SMOKE-BEIS3 (Biogenic Emission Inventory System version3) preprocessor. SMOKE-BEIS3 is basically the Urban Airshed Model (UAM)-BEIS3 model but also includes modifications to use Meteorological Model version 5 (MM5) data, gridded land use data, and one important science update. The emission factors that are used in SMOKE-BEIS3 are the same as the emission factors in UAM-BEIS3.

The emission rates within SMOKE-BEIS3 are adjusted for environmental conditions prevailing during the episode days with meteorological data supplied by the MM5 model. The gridded data used from MM5 include the estimated temperature at 10 meters above the surface and short-wave radiation reaching the surface. Ten meters temperatures will be used instead of the ground temperatures because it is believed that 10 meters above the surface is a good approximation of the average canopy height. The use of 10 meters temperatures was discussed with and approved by the USEPA Office of Research and Development (ORD).

The gridded land use data has been obtained from Alpine Geophysics at the 4-km resolution for the entire domain. The basis for the gridded data is the county land use data in the Biogenic Emissions Landcover Database version 3 (BELD3) provided by the USEPA. A separate land classification scheme, based upon satellite (AVHRR, 1 km spatial resolution) and census information, aided in defining the forest, agriculture and urban portions of each county. The 12-km and 36-km domains will be created by aggregating the 4-km resolution data up to the respective grid sizes.

The emissions summary in for the 1996 episodes for the counties in the Triad EAC area is listed in Table 5.6-1. These emissions represent a normalized emission and are in tons per day.

Table 5.6-1 Biogenic Emissions

County	**NOx**	**VOC**
Alamance	0.4	73.9
Caswell	0.3	57.2
Davidson	0.4	78.6
Davie	0.4	55.4
Forsyth	0.4	59.3
Guildford	0.5	78.7
Randolph	0.5	109.1
Rockingham	0.4	64.3
Stokes	0.4	64.1
Surry	0.5	71.2
Yadkin	0.4	58.1
Total	4.6	769.9

Section 6 - MODELING STATUS

6.1 Status of Current Modeling

NCDAQ realized that the May 31, 2003 date for completing the base case model evaluation was not realistic due to the issues described in Section 6.2 below. Sheila Holman sent a letter to Kay Prince requesting an adjustment to the modeling schedule due to these issues. Ms. Holman's letter and Ms. Prince's response are included in Appendix C. NCDAQ continues to believe that completing the four 2007 base year modeling runs is achievable by August 29, 2003.

6.2 Issues Being Encountered

There have been a number of issues encountered during this modeling effort. The first was the integration of MOBILE6.2 into SMOKE. It is a requirement of the EAC that MOBILE6.2 be used to estimate the mobile emissions and if transportation conformity is ever needed in the EAC areas, it will be based on the emission estimates from this modeling effort. It took much longer than anticipated to get the integration completed.

Another issue was porting SMOKEv1.5 to the NCDAQ HP UNIX workstation. Compiling on the HP was not very straight forward and actually turned up some errors in the SMOKEv1.5 code. It took several weeks before the code was completely compiled and tested on the HP workstation and was ready for the NCDAQ emissions staff to use.

The next issue encountered dealt with the installation and use of MIMS. MIMS is a gui interface that aids the user in choosing the files that will be used in SMOKE to process the emissions. Since most of the NCDAQ emissions staff is not very familiar with the UNIX environment, it was believed that the MIMS interface would aid in processing the emissions. NCDAQ was never able to get MIMS to work on their system and therefore had to use scripts to process the emissions.

Another issue was the discovery of errors in the mobile and point source emissions during the quality assurance (QA) of the emissions data. For the mobile inventory, VMT was inadvertently left off for two of the urban counties, Guilford and Forsyth Counties. For the point source inventory, it was discovered that stack data for some of the utilities did not read in correctly and default stack parameters were used. This would result in the emissions being dumped into the lower layer of the model. These errors resulted in the emissions having to be reprocessed through SMOKE and re-merged with the other data.

6.3 Geographic Area Needing Further Controls

At this point in the project, NCDAQ is unable to identify the geographic area that will need controls beyond what is already in North Carolina's rules. The controls that will be included in the base 2007 emissions inventory are the NOx SIP Call, a NOx Inspection and Maintenance (I/M) program that will cover 48 counties in North Carolina and the North Carolina Clean Smokestacks Act that requires year-round controls on the major utilities in North Carolina.

By the December 2003 Progress Report, NCDAQ should be able to provide modeling results that show where additional controls are needed over what geographic area.

6.4 Anticipated Resource Constraints

The resource constraint of most concern is the funding needed to implement some of the local control measures. NCDAQ and the local EAC areas are both looking for grant opportunities to help fund EAC initiatives.

APPENDIX A

EMISSION SOURCES BY COUNTY

Stationary Point Sources Emissions

County	CO	NOx	VOC
Alamance Co	0.061	0.676	0.960
Alexander Co	0.014	0.004	2.099
Ashe Co	0.030	0.006	1.289
Beaufort Co	1.162	1.969	0.859
Bertie Co	0.162	0.227	1.101
Bladen Co	0.181	1.857	0.520
Brunswick Co	3.758	7.786	3.453
Buncombe Co	1.336	57.016	3.135
Burke Co	5.753	0.516	12.838
Cabarrus Co	0.173	2.867	5.213
Caldwell Co	0.444	0.139	30.539
Carteret Co	0.008	0.083	0.000
Catawba Co	4.192	112.800	22.153
Chatham Co	7.014	20.487	3.800
Chowan Co	0.028	0.137	0.010
Cleveland Co	0.687	3.790	2.486
Columbus Co	12.211	6.987	3.885
Craven Co	3.585	4.175	4.196
Cumberland Co	0.412	2.956	7.072
Dare Co	0.008	0.271	0.004
Davidson Co	2.466	12.859	23.927
Davie Co	0.078	0.039	3.841
Duplin Co	0.888	1.978	0.017
Durham Co	0.301	1.046	5.706
Edgecombe Co	0.347	5.818	0.020
Forsyth Co	1.917	8.835	20.874
Franklin Co	0.009	0.101	0.122
Gaston Co	3.083	70.313	8.958
Graham Co	0.017	0.020	1.450
Granville Co	0.294	0.105	2.661
Guilford Co	0.158	1.829	40.535
Halifax Co	12.957	11.343	1.002
Harnett Co	0.204	0.563	0.464
Haywood Co	6.879	11.915	4.067

County	CO	NOx	VOC
Henderson Co	0.023	0.400	5.133
Hertford Co	0.017	0.148	0.828
Hoke Co	0.004	0.019	3.829
Iredell Co	2.927	8.949	5.109
Jackson Co	0.004	0.045	0.000
Johnston Co	0.018	0.145	2.218
Lee Co	0.971	0.235	1.403
Lenoir Co	0.110	2.429	0.592
Lincoln Co	0.118	2.551	2.368
Mc Dowell Co	0.645	0.609	2.221
Martin Co	23.577	9.479	6.539
Mecklenburg Co	2.616	2.914	22.978
Mitchell Co	0.113	0.015	2.193
Montgomery Co	0.047	0.008	0.017
Moore Co	0.015	0.003	1.826
Nash Co	0.442	0.928	0.491
New Hanover Co	36.352	76.530	5.676
Northampton Co	0.123	0.273	0.195
Onslow Co	0.073	0.955	0.016
Orange Co	3.223	0.748	0.009
Pasquotank Co	0.011	0.018	1.122
Pender Co	0.012	0.022	0.007
Person Co	5.063	188.510	1.706
Pitt Co	0.322	0.624	1.549
Randolph Co	0.021	0.058	2.528
Richmond Co	0.025	0.101	0.002
Robeson Co	0.612	18.817	1.994
Rockingham Co	5.954	33.903	7.896
Rowan Co	1.290	30.602	10.634
Rutherford Co	1.890	41.944	3.548
Scotland Co	0.501	7.276	5.356
Stanly Co	14.149	1.178	2.002
Stokes Co	7.872	341.620	0.945
Surry Co	5.356	0.942	5.817
Transylvania Co	0.183	5.212	2.858
Union Co	0.030	0.152	2.483
Vance Co	0.035	1.242	0.000
Wake Co	0.237	0.810	10.774
Washington Co	0.001	0.004	0.000
Watauga Co	0.015	0.051	0.001

County	CO	NOx	VOC
Wayne Co	6.873	37.740	3.048
Wilkes Co	3.232	0.731	7.472
Wilson Co	0.177	2.020	2.376
Yadkin Co	0.000	0.000	0.092
State total	**196.096**	**1172.466**	**357.102**

Stationary Area Sources Emissions

County	CO	NOx	VOC
Alamance Co	3.51	0.74	7.71
Alexander Co	1.47	0.15	2.95
Alleghany Co	0.50	0.09	0.89
Anson Co	2.62	0.53	2.24
Ashe Co	1.25	0.14	1.50
Avery Co	0.81	0.11	1.02
Beaufort Co	17.77	0.61	12.42
Bertie Co	2.12	0.14	2.90
Bladen Co	4.26	0.42	4.46
Brunswick Co	5.08	0.64	4.57
Buncombe Co	4.71	1.31	14.23
Burke Co	3.15	0.55	6.27
Cabarrus Co	3.80	1.07	6.84
Caldwell Co	2.53	0.31	4.78
Camden Co	4.87	0.08	2.55
Carteret Co	10.09	0.61	6.93
Caswell Co	2.46	0.23	1.65
Catawba Co	4.60	0.90	12.14
Chatham Co	2.46	0.50	3.65
Cherokee Co	1.14	0.13	2.15
Chowan Co	1.63	0.10	1.42
Clay Co	0.40	0.08	0.56
Cleveland Co	5.14	0.84	7.25
Columbus Co	6.50	0.41	7.36
Craven Co	5.04	0.77	6.98
Cumberland Co	15.31	3.34	22.74
Currituck Co	4.30	0.13	2.46
Dare Co	1.65	0.13	2.13
Davidson Co	6.02	1.35	10.66
Davie Co	2.52	0.26	2.57
Duplin Co	8.32	0.45	6.68
Durham Co	2.61	1.88	16.40

County	CO	NOx	VOC
Edgecombe Co	5.67	1.22	5.88
Forsyth Co	5.33	1.54	14.36
Franklin Co	5.19	0.29	3.63
Gaston Co	4.10	1.76	12.04
Gates Co	1.18	0.09	1.34
Graham Co	0.45	0.08	0.45
Granville Co	3.50	0.38	3.15
Greene Co	6.06	0.17	3.11
Guilford Co	10.27	4.13	26.45
Halifax Co	3.57	0.91	4.17
Harnett Co	6.80	0.78	6.02
Haywood Co	2.06	0.32	4.36
Henderson Co	3.44	0.75	5.20
Hertford Co	1.17	0.12	1.90
Hoke Co	3.32	0.20	2.29
Hyde Co	6.38	0.07	3.63
Iredell Co	5.28	0.99	8.84
Jackson Co	1.49	0.23	2.00
Johnston Co	9.60	1.08	10.43
Jones Co	1.44	0.11	1.48
Lee Co	2.19	0.75	4.24
Lenoir Co	7.82	0.41	6.24
Lincoln Co	3.17	0.48	4.09
Mc Dowell Co	1.81	0.72	3.06
Macon Co	1.31	0.14	1.95
Madison Co	1.05	0.30	1.46
Martin Co	3.28	0.38	2.69
Mecklenburg Co	13.05	11.58	32.00
Mitchell Co	0.81	0.40	1.00
Montgomery Co	1.55	0.14	1.91
Moore Co	3.76	0.57	5.33
Nash Co	5.64	0.97	7.73
New Hanover Co	2.25	1.00	7.77
Northampton Co	2.75	0.39	1.91
Onslow Co	4.81	0.34	8.71
Orange Co	3.91	0.87	6.69
Pamlico Co	8.65	1.87	4.18
Pasquotank Co	9.77	0.13	5.21
Pender Co	4.66	0.21	3.74
Perquimans Co	4.64	0.10	3.12

County	CO	NOx	VOC
Person Co	4.45	0.41	2.74
Pitt Co	13.70	0.82	10.06
Polk Co	0.99	0.20	1.09
Randolph Co	5.89	0.78	9.82
Richmond Co	3.11	1.75	3.17
Robeson Co	19.68	1.45	16.70
Rockingham Co	6.30	1.03	5.91
Rowan Co	6.17	1.16	7.78
Rutherford Co	2.60	0.68	4.32
Sampson Co	10.48	0.36	7.84
Scotland Co	3.44	0.46	3.01
Stanly Co	5.11	0.29	4.81
Stokes Co	2.26	0.27	2.65
Surry Co	3.87	0.25	6.09
Swain Co	0.65	0.10	0.86
Transylvania Co	1.15	0.21	1.70
Tyrrell Co	7.03	0.07	3.50
Union Co	12.04	0.83	10.72
Vance Co	2.70	0.52	3.21
Wake Co	14.01	6.55	30.98
Warren Co	2.03	0.21	1.97
Washington Co	9.82	0.30	4.33
Watauga Co	1.38	0.15	2.71
Wayne Co	15.36	2.66	12.00
Wilkes Co	3.08	0.25	4.23
Wilson Co	7.26	1.30	6.96
Yadkin Co	2.82	0.16	3.54
Yancey Co	0.83	0.14	1.19
State Total	**479.96**	**79.33**	**596.72**

Nonroad Sources Emissions

County	CO	NOx	VOC
Alamance Co	29.18	2.58	2.59
Alexander Co	4.11	0.51	0.40
Alleghany Co	2.58	0.39	0.21
Anson Co	4.38	1.08	0.52
Ashe Co	3.94	0.45	0.42
Avery Co	5.29	0.53	0.59
Beaufort Co	13.65	2.50	2.76
Bertie Co	6.31	1.67	1.15

County	CO	NOx	VOC
Bladen Co	8.67	1.55	1.32
Brunswick Co	26.98	1.99	4.76
Buncombe Co	47.91	4.18	4.76
Burke Co	14.94	1.72	1.54
Cabarrus Co	41.70	3.18	3.69
Caldwell Co	16.69	2.25	1.78
Camden Co	2.96	0.43	1.01
Carteret Co	46.96	1.84	14.15
Caswell Co	2.26	0.40	0.22
Catawba Co	46.58	4.65	4.49
Chatham Co	12.56	1.83	1.51
Cherokee Co	4.23	0.40	0.57
Chowan Co	3.97	0.48	1.13
Clay Co	2.18	0.19	0.39
Cleveland Co	21.14	2.04	1.92
Columbus Co	9.81	1.62	1.14
Craven Co	23.26	2.57	2.93
Cumberland Co	64.62	7.58	11.71
Currituck Co	14.97	0.74	4.58
Dare Co	45.32	1.27	17.81
Davidson Co	30.28	3.43	2.88
Davie Co	7.20	0.70	0.84
Duplin Co	9.94	2.50	1.04
Durham Co	67.33	8.78	6.52
Edgecombe Co	10.95	2.23	1.03
Forsyth Co	89.05	6.50	7.62
Franklin Co	7.82	0.98	0.81
Gaston Co	49.26	4.61	4.29
Gates Co	1.56	0.52	0.23
Graham Co	1.40	0.18	0.25
Granville Co	12.71	1.42	1.31
Greene Co	2.43	0.75	0.25
Guilford Co	182.94	13.51	16.09
Halifax Co	8.66	1.97	0.95
Harnett Co	21.12	1.83	1.88
Haywood Co	11.23	1.05	1.18
Henderson Co	29.86	2.02	3.64
Hertford Co	4.12	0.57	0.49
Hoke Co	3.44	0.65	0.31
Hyde Co	24.88	1.87	11.57

County	CO	NOx	VOC
Iredell Co	23.40	2.81	2.31
Jackson Co	6.85	0.57	0.78
Johnston Co	32.64	3.23	3.13
Jones Co	1.82	0.46	0.17
Lee Co	16.36	2.29	1.51
Lenoir Co	15.84	2.08	1.48
Lincoln Co	13.58	1.27	1.36
Mc Dowell Co	7.94	1.27	1.03
Macon Co	10.84	0.52	1.03
Madison Co	1.72	0.38	0.18
Martin Co	4.61	1.07	0.50
Mecklenburg Co	325.41	21.42	29.31
Mitchell Co	3.54	0.70	0.45
Montgomery Co	4.99	0.66	0.60
Moore Co	27.58	1.63	2.28
Nash Co	21.08	2.60	1.94
New Hanover Co	56.62	4.38	6.90
Northampton Co	4.28	1.14	0.69
Onslow Co	25.81	3.32	4.08
Orange Co	29.41	3.04	3.25
Pamlico Co	13.05	2.63	5.40
Pasquotank Co	9.74	0.90	1.51
Pender Co	12.46	1.01	1.85
Perquimans Co	3.91	0.64	1.28
Person Co	8.34	0.87	0.88
Pitt Co	23.98	3.16	2.19
Polk Co	2.89	0.44	0.25
Randolph Co	27.26	2.79	2.43
Richmond Co	14.22	5.12	1.60
Robeson Co	19.58	4.99	1.97
Rockingham Co	15.60	1.80	1.54
Rowan Co	27.64	4.01	2.72
Rutherford Co	12.77	1.67	1.25
Sampson Co	10.29	2.05	1.01
Scotland Co	8.52	1.21	0.91
Stanly Co	15.92	1.89	1.62
Stokes Co	7.77	0.61	0.77
Surry Co	28.71	1.76	2.63
Swain Co	4.71	0.32	1.13
Transylvania Co	14.82	0.69	2.40

County	CO	NOx	VOC
Tyrrell Co	6.53	0.63	2.92
Union Co	45.86	3.07	4.03
Vance Co	6.31	1.16	0.79
Wake Co	233.68	18.06	23.23
Warren Co	3.44	0.80	0.59
Washington Co	5.57	1.21	1.47
Watauga Co	9.95	0.51	1.16
Wayne Co	28.10	4.55	2.84
Wilkes Co	16.07	1.28	1.50
Wilson Co	22.44	2.68	2.14
Yadkin Co	6.52	0.75	0.58
Yancey Co	7.33	0.34	0.84
State Total	**2411.63**	**235.13**	**293.64**

Highway Mobile Sources Emissions

County	CO	NOx	VOC
Alamance Co	107.43	14.92	9.43
Alexander Co	21.16	2.17	1.83
Alleghany Co	8.95	0.90	0.78
Anson Co	26.77	3.05	2.46
Ashe Co	19.45	1.89	1.72
Avery Co	17.39	1.87	1.56
Beaufort Co	38.64	3.91	3.54
Bertie Co	24.72	2.65	2.22
Bladen Co	37.65	3.75	3.29
Brunswick Co	74.31	8.08	6.67
Buncombe Co	178.76	27.37	15.47
Burke Co	80.26	13.91	6.89
Cabarrus Co	63.42	11.80	5.86
Caldwell Co	53.96	5.51	5.05
Camden Co	9.34	1.00	0.84
Carteret Co	55.26	6.04	5.06
Caswell Co	18.33	1.95	1.65
Catawba Co	122.92	15.90	11.16
Chatham Co	43.63	4.87	4.01
Cherokee Co	19.38	2.22	1.78
Chowan Co	10.51	1.07	0.95
Clay Co	6.42	0.67	0.55
Cleveland Co	77.65	10.50	6.91
Columbus Co	50.24	5.25	4.60

County	CO	NOx	VOC
Craven Co	64.58	6.80	6.10
Cumberland Co	223.26	30.32	20.98
Currituck Co	21.99	2.38	1.85
Dare Co	49.33	5.11	4.33
Davidson Co	150.84	27.56	12.92
Davie Co	37.20	8.36	3.07
Duplin Co	51.46	8.29	4.53
Durham Co	142.33	24.90	12.74
Edgecombe Co	45.16	4.52	4.15
Forsyth Co	207.45	32.63	20.60
Franklin Co	34.03	3.57	3.01
Gaston Co	90.70	17.44	8.71
Gates Co	10.46	1.17	0.95
Graham Co	5.44	0.52	0.49
Granville Co	48.29	9.91	4.14
Greene Co	16.62	1.68	1.46
Guilford Co	274.51	44.36	27.54
Halifax Co	60.25	12.55	5.15
Harnett Co	70.89	10.13	6.33
Haywood Co	67.59	14.74	5.71
Henderson Co	64.43	10.18	5.67
Hertford Co	19.29	2.00	1.70
Hoke Co	20.66	2.23	1.85
Hyde Co	5.58	0.57	0.48
Iredell Co	135.50	30.72	11.44
Jackson Co	35.85	4.13	3.18
Johnston Co	131.26	27.54	11.23
Jones Co	16.28	1.83	1.50
Lee Co	44.31	4.53	4.19
Lenoir Co	52.16	5.06	4.96
Lincoln Co	40.85	4.19	3.69
Mc Dowell Co	47.19	10.22	4.03
Macon Co	26.13	2.85	2.35
Madison Co	15.11	1.64	1.35
Martin Co	26.79	2.83	2.48
Mecklenburg Co	392.69	73.30	38.40
Mitchell Co	11.18	1.14	1.02
Montgomery Co	29.30	3.61	2.59
Moore Co	61.28	6.19	5.59
Nash Co	104.62	17.95	9.32

County	CO	NOx	VOC
New Hanover Co	87.27	9.11	8.50
Northampton Co	28.88	5.33	2.48
Onslow Co	80.37	8.05	7.73
Orange Co	62.77	18.46	5.55
Pamlico Co	10.44	0.97	0.94
Pasquotank Co	20.29	2.00	1.98
Pender Co	47.14	8.32	4.10
Perquimans Co	10.17	1.13	0.94
Person Co	24.33	2.42	2.22
Pitt Co	91.52	8.97	8.59
Polk Co	21.35	4.74	1.83
Randolph Co	122.08	17.26	10.75
Richmond Co	39.91	4.17	3.80
Robeson Co	127.44	22.67	11.10
Rockingham Co	77.73	7.94	7.21
Rowan Co	102.00	17.76	9.08
Rutherford Co	49.44	5.02	4.50
Sampson Co	61.77	8.73	5.44
Scotland Co	34.46	3.59	3.21
Stanly Co	42.33	4.14	3.95
Stokes Co	28.49	2.87	2.57
Surry Co	78.33	12.38	6.98
Swain Co	16.94	1.88	1.50
Transylvania Co	23.80	2.44	2.13
Tyrrell Co	4.24	0.48	0.39
Union Co	54.05	7.20	5.23
Vance Co	38.11	6.67	3.34
Wake Co	306.80	57.16	27.42
Warren Co	17.90	3.68	1.54
Washington Co	13.77	1.55	1.27
Watauga Co	33.04	3.63	3.10
Wayne Co	81.79	7.98	7.66
Wilkes Co	56.78	5.89	5.12
Wilson Co	71.21	10.72	6.54
Yadkin Co	39.27	7.03	3.44
Yancey Co	13.30	1.48	1.22
State Total	**6138.89**	**924.70**	**559.38**

APPENDIX B

Conversion of MOBILE5 Registration Fractions to MOBILE6-Based Registration Fractions

Mecklenburg County

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*Convert MOBILE5 Registration Fractions to MOBILE6-Based Registration Fractions
*
*Calendar Year:        1996.000User-Input
*
*MOBILE5b Reg Fractions
*       0.114  0.097  0.086  0.083  0.077  0.084  0.069  0.062  0.051  0.044
*       0.040  0.039  0.033  0.027  0.022  0.016  0.012  0.007  0.004  0.003
*       0.003  0.004  0.003  0.002  0.018
*       0.090  0.080  0.076  0.075  0.062  0.066  0.066  0.048  0.040  0.037
*       0.034  0.042  0.040  0.035  0.033  0.024  0.021  0.013  0.009  0.008
*       0.008  0.012  0.012  0.009  0.060
*       0.123  0.148  0.096  0.088  0.065  0.071  0.054  0.039  0.023  0.021
*       0.030  0.034  0.031  0.021  0.021  0.020  0.013  0.008  0.007  0.006
*       0.007  0.012  0.010  0.010  0.042
*       0.123  0.104  0.061  0.093  0.060  0.077  0.058  0.046  0.025  0.023
*       0.023  0.030  0.047  0.027  0.025  0.023  0.018  0.008  0.008  0.009
*       0.009  0.014  0.011  0.009  0.069
*       0.114  0.097  0.086  0.083  0.077  0.084  0.069  0.062  0.051  0.044
*       0.040  0.039  0.033  0.027  0.022  0.016  0.012  0.007  0.004  0.003
*       0.003  0.004  0.003  0.002  0.018
*       0.090  0.080  0.076  0.075  0.062  0.066  0.066  0.048  0.040  0.037
*       0.034  0.042  0.040  0.035  0.033  0.024  0.021  0.013  0.009  0.008
*       0.008  0.012  0.012  0.009  0.060
*       0.155  0.141  0.081  0.100  0.066  0.083  0.056  0.041  0.030  0.032
*       0.055  0.048  0.027  0.028  0.016  0.014  0.008  0.004  0.003  0.002
*       0.002  0.003  0.002  0.001  0.002
*       0.141  0.111  0.088  0.081  0.074  0.061  0.049  0.035  0.027  0.017
*       0.015  0.301  0.000  0.000  0.000  0.000  0.000  0.000  0.000  0.000
*       0.000  0.000  0.000  0.000  0.000
*
*
* MOBILE6 Vehicle Classes:
*  1  LDV    Light-Duty Vehicles (Passenger Cars)
*  2  LDT1   Light-Duty Trucks 1 (0-6,000 lbs. GVWR, 0-3750 lbs. LVW)
*  3  LDT2   Light Duty Trucks 2 (0-6,000 lbs. GVWR, 3751-5750 lbs. LVW)
*  4  LDT3   Light Duty Trucks 3 (6,001-8500 lbs. GVWR, 0-3750 lbs. LVW)
*  5  LDT4   Light Duty Trucks 4 (6,001-8500 lbs. GVWR, 3751-5750 lbs. LVW)
*  6  HDV2B  Class 2b Heavy Duty Vehicles (8501-10,000 lbs. GVWR)
*  7  HDV3   Class 3 Heavy Duty Vehicles (10,001-14,000 lbs. GVWR)
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*  8  HDV4   Class 4 Heavy Duty Vehicles (14,001-16,000 lbs. GVWR)
*  9  HDV5   Class 5 Heavy Duty Vehicles (16,001-19,500 lbs. GVWR)
* 10  HDV6   Class 6 Heavy Duty Vehicles (19,501-26,000 lbs. GVWR)
* 11  HDV7   Class 7 Heavy Duty Vehicles (26,001-33,000 lbs. GVWR)
* 12  HDV8A  Class 8a Heavy Duty Vehicles (33,001-60,000 lbs. GVWR)
* 13  HDV8B  Class 8b Heavy Duty Vehicles (>60,000 lbs. GVWR)
* 14  HDBS   School Busses
* 15  HDBT   Transit and Urban Busses
* 16  MC     Motorcycles (All)
*
REG DIST
*                RESULTING MOBILE6-BASED REGISTRATION FRACTIONS
*
*MOBILE6 REGISTRATION FRACTIONS BY VEHICLE CLASS AND AGE
* LDV        M5 LDGV
     1  0.114  0.097  0.086  0.083  0.077  0.084  0.069  0.062  0.051  0.044
        0.040  0.039  0.033  0.027  0.022  0.016  0.012  0.007  0.004  0.003
        0.003  0.004  0.003  0.002  0.018
* LDT1       M5 LDGT1
     2  0.090  0.080  0.076  0.075  0.062  0.066  0.066  0.048  0.040  0.037
        0.034  0.042  0.040  0.035  0.033  0.024  0.021  0.013  0.009  0.008
        0.008  0.012  0.012  0.009  0.060
* LDT2       M5 LDGT1
     3  0.090  0.080  0.076  0.075  0.062  0.066  0.066  0.048  0.040  0.037
        0.034  0.042  0.040  0.035  0.033  0.024  0.021  0.013  0.009  0.008
        0.008  0.012  0.012  0.009  0.060
* LDT3       M5 LDGT2
     4  0.123  0.148  0.096  0.088  0.065  0.071  0.054  0.039  0.023  0.021
        0.030  0.034  0.031  0.021  0.021  0.020  0.013  0.008  0.007  0.006
        0.007  0.012  0.010  0.010  0.042
* LDT4       M5 LDGT2
     5  0.123  0.148  0.096  0.088  0.065  0.071  0.054  0.039  0.023  0.021
        0.030  0.034  0.031  0.021  0.021  0.020  0.013  0.008  0.007  0.006
        0.007  0.012  0.010  0.010  0.042
* HDV2B       M5 HDVs (Combined HDGV and HDDV)
     6  0.137  0.120  0.070  0.096  0.063  0.080  0.057  0.044  0.027  0.027
        0.037  0.038  0.039  0.027  0.021  0.019  0.013  0.007  0.006  0.006
        0.006  0.009  0.007  0.006  0.040
* HDV3       M5 HDVs (Combined HDGV and HDDV)
     7  0.137  0.120  0.070  0.096  0.063  0.080  0.057  0.044  0.027  0.027
        0.037  0.038  0.039  0.027  0.021  0.019  0.013  0.007  0.006  0.006
        0.006  0.009  0.007  0.006  0.040
* HDV4       M5 HDVs (Combined HDGV and HDDV)
     8  0.137  0.120  0.070  0.096  0.063  0.080  0.057  0.044  0.027  0.027
        0.037  0.038  0.039  0.027  0.021  0.019  0.013  0.007  0.006  0.006
        0.006  0.009  0.007  0.006  0.040
* HDV5       M5 HDVs (Combined HDGV and HDDV)
     9  0.137  0.120  0.070  0.096  0.063  0.080  0.057  0.044  0.027  0.027
        0.037  0.038  0.039  0.027  0.021  0.019  0.013  0.007  0.006  0.006
        0.006  0.009  0.007  0.006  0.040
* HDV6       M5 HDVs (Combined HDGV and HDDV)
```

10 0.137 0.120 0.070 0.096 0.063 0.080 0.057 0.044 0.027 0.027
0.037 0.038 0.039 0.027 0.021 0.019 0.013 0.007 0.006 0.006
0.006 0.009 0.007 0.006 0.040
* HDV7 M5 HDVs (Combined HDGV and HDDV)
11 0.137 0.120 0.070 0.096 0.063 0.080 0.057 0.044 0.027 0.027
0.037 0.038 0.039 0.027 0.021 0.019 0.013 0.007 0.006 0.006
0.006 0.009 0.007 0.006 0.040
* HDV8a M5 HDVs (Combined HDGV and HDDV)
12 0.137 0.120 0.070 0.096 0.063 0.080 0.057 0.044 0.027 0.027
0.037 0.038 0.039 0.027 0.021 0.019 0.013 0.007 0.006 0.006
0.006 0.009 0.007 0.006 0.040
* HDV8b M5 HDVs (Combined HDGV and HDDV)
13 0.137 0.120 0.070 0.096 0.063 0.080 0.057 0.044 0.027 0.027
0.037 0.038 0.039 0.027 0.021 0.019 0.013 0.007 0.006 0.006
0.006 0.009 0.007 0.006 0.040
* HDBS M5 HDVs (Combined HDGV and HDDV)
14 0.137 0.120 0.070 0.096 0.063 0.080 0.057 0.044 0.027 0.027
0.037 0.038 0.039 0.027 0.021 0.019 0.013 0.007 0.006 0.006
0.006 0.009 0.007 0.006 0.040
* HDBT M5 HDDVs
15 0.155 0.141 0.081 0.100 0.066 0.083 0.056 0.041 0.030 0.032
0.055 0.048 0.027 0.028 0.016 0.014 0.008 0.004 0.003 0.002
0.002 0.003 0.002 0.001 0.002
* Motorcycles M5 MC
16 0.141 0.111 0.088 0.081 0.074 0.061 0.049 0.035 0.027 0.017
0.015 0.301 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000

<u>Triad</u>

*Convert MOBILE5 Registration Fractions to MOBILE6-Based Registration Fractions
*
*Calendar Year: 1996.000User-Input
*
*MOBILE5b Reg Fractions
* 0.101 0.080 0.075 0.073 0.070 0.081 0.066 0.063 0.054 0.048
* 0.045 0.046 0.040 0.034 0.028 0.021 0.016 0.009 0.005 0.004
* 0.004 0.005 0.004 0.004 0.024
* 0.077 0.066 0.065 0.066 0.054 0.062 0.067 0.047 0.043 0.037
* 0.034 0.045 0.044 0.039 0.039 0.027 0.025 0.016 0.012 0.010
* 0.010 0.014 0.014 0.012 0.075
* 0.081 0.089 0.078 0.078 0.065 0.080 0.064 0.050 0.033 0.032
* 0.037 0.041 0.038 0.030 0.031 0.029 0.018 0.011 0.009 0.009
* 0.006 0.014 0.013 0.012 0.052
* 0.078 0.079 0.049 0.062 0.058 0.080 0.051 0.041 0.033 0.027
* 0.034 0.043 0.040 0.031 0.038 0.029 0.018 0.013 0.011 0.016
* 0.014 0.020 0.016 0.015 0.104
* 0.101 0.080 0.075 0.073 0.070 0.081 0.066 0.063 0.054 0.048
* 0.045 0.046 0.040 0.034 0.028 0.021 0.016 0.009 0.005 0.004
* 0.004 0.005 0.004 0.004 0.024

```
*       0.077  0.066  0.065  0.066  0.054  0.062  0.067  0.047  0.043  0.037
*       0.034  0.045  0.044  0.039  0.039  0.027  0.025  0.016  0.012  0.010
*       0.010  0.014  0.014  0.012  0.075
*       0.170  0.141  0.087  0.100  0.074  0.079  0.067  0.042  0.032  0.027
*       0.033  0.032  0.029  0.024  0.018  0.014  0.010  0.004  0.004  0.003
*       0.002  0.002  0.002  0.001  0.003
*       0.134  0.102  0.072  0.070  0.071  0.051  0.049  0.041  0.027  0.021
*       0.018  0.344  0.000  0.000  0.000  0.000  0.000  0.000  0.000  0.000
*       0.000  0.000  0.000  0.000  0.000
*
*
* MOBILE6 Vehicle Classes:
*  1  LDV    Light-Duty Vehicles (Passenger Cars)
*  2  LDT1   Light-Duty Trucks 1 (0-6,000 lbs. GVWR, 0-3750 lbs. LVW)
*  3  LDT2   Light Duty Trucks 2 (0-6,000 lbs. GVWR, 3751-5750 lbs. LVW)
*  4  LDT3   Light Duty Trucks 3 (6,001-8500 lbs. GVWR, 0-3750 lbs. LVW)
*  5  LDT4   Light Duty Trucks 4 (6,001-8500 lbs. GVWR, 3751-5750 lbs. LVW)
*  6  HDV2B  Class 2b Heavy Duty Vehicles (8501-10,000 lbs. GVWR)
*  7  HDV3   Class 3 Heavy Duty Vehicles (10,001-14,000 lbs. GVWR)
*  8  HDV4   Class 4 Heavy Duty Vehicles (14,001-16,000 lbs. GVWR)
*  9  HDV5   Class 5 Heavy Duty Vehicles (16,001-19,500 lbs. GVWR)
* 10  HDV6   Class 6 Heavy Duty Vehicles (19,501-26,000 lbs. GVWR)
* 11  HDV7   Class 7 Heavy Duty Vehicles (26,001-33,000 lbs. GVWR)
* 12  HDV8A  Class 8a Heavy Duty Vehicles (33,001-60,000 lbs. GVWR)
* 13  HDV8B  Class 8b Heavy Duty Vehicles (>60,000 lbs. GVWR)
* 14  HDBS   School Busses
* 15  HDBT   Transit and Urban Busses
* 16  MC     Motorcycles (All)
*
REG DIST
*             RESULTING MOBILE6-BASED REGISTRATION FRACTIONS
*
*MOBILE6 REGISTRATION FRACTIONS BY VEHICLE CLASS AND AGE
* LDV        M5 LDGV
    1  0.101  0.080  0.075  0.073  0.070  0.081  0.066  0.063  0.054  0.048
       0.045  0.046  0.040  0.034  0.028  0.021  0.016  0.009  0.005  0.004
       0.004  0.005  0.004  0.004  0.024
* LDT1       M5 LDGT1
    2  0.077  0.066  0.065  0.066  0.054  0.062  0.067  0.047  0.043  0.037
       0.034  0.045  0.044  0.039  0.039  0.027  0.025  0.016  0.012  0.010
       0.010  0.014  0.014  0.012  0.075
* LDT2       M5 LDGT1
    3  0.077  0.066  0.065  0.066  0.054  0.062  0.067  0.047  0.043  0.037
       0.034  0.045  0.044  0.039  0.039  0.027  0.025  0.016  0.012  0.010
       0.010  0.014  0.014  0.012  0.075
* LDT3       M5 LDGT2
    4  0.081  0.089  0.078  0.078  0.065  0.080  0.064  0.050  0.033  0.032
       0.037  0.041  0.038  0.030  0.031  0.029  0.018  0.011  0.009  0.009
       0.006  0.014  0.013  0.012  0.052
* LDT4       M5 LDGT2
    5  0.081  0.089  0.078  0.078  0.065  0.080  0.064  0.050  0.033  0.032
```

0.037 0.041 0.038 0.030 0.031 0.029 0.018 0.011 0.009 0.009
0.006 0.014 0.013 0.012 0.052
* HDV2B M5 HDVs (Combined HDGV and HDDV)
6 0.118 0.106 0.065 0.079 0.065 0.079 0.058 0.042 0.032 0.027
0.033 0.038 0.035 0.028 0.029 0.022 0.015 0.009 0.008 0.010
0.009 0.012 0.010 0.009 0.060
* HDV3 M5 HDVs (Combined HDGV and HDDV)
7 0.118 0.106 0.065 0.079 0.065 0.079 0.058 0.042 0.032 0.027
0.033 0.038 0.035 0.028 0.029 0.022 0.015 0.009 0.008 0.010
0.009 0.012 0.010 0.009 0.060
* HDV4 M5 HDVs (Combined HDGV and HDDV)
8 0.118 0.106 0.065 0.079 0.065 0.079 0.058 0.042 0.032 0.027
0.033 0.038 0.035 0.028 0.029 0.022 0.015 0.009 0.008 0.010
0.009 0.012 0.010 0.009 0.060
* HDV5 M5 HDVs (Combined HDGV and HDDV)
9 0.118 0.106 0.065 0.079 0.065 0.079 0.058 0.042 0.032 0.027
0.033 0.038 0.035 0.028 0.029 0.022 0.015 0.009 0.008 0.010
0.009 0.012 0.010 0.009 0.060
* HDV6 M5 HDVs (Combined HDGV and HDDV)
10 0.118 0.106 0.065 0.079 0.065 0.079 0.058 0.042 0.032 0.027
0.033 0.038 0.035 0.028 0.029 0.022 0.015 0.009 0.008 0.010
0.009 0.012 0.010 0.009 0.060
* HDV7 M5 HDVs (Combined HDGV and HDDV)
11 0.118 0.106 0.065 0.079 0.065 0.079 0.058 0.042 0.032 0.027
0.033 0.038 0.035 0.028 0.029 0.022 0.015 0.009 0.008 0.010
0.009 0.012 0.010 0.009 0.060
* HDV8a M5 HDVs (Combined HDGV and HDDV)
12 0.118 0.106 0.065 0.079 0.065 0.079 0.058 0.042 0.032 0.027
0.033 0.038 0.035 0.028 0.029 0.022 0.015 0.009 0.008 0.010
0.009 0.012 0.010 0.009 0.060
* HDV8b M5 HDVs (Combined HDGV and HDDV)
13 0.118 0.106 0.065 0.079 0.065 0.079 0.058 0.042 0.032 0.027
0.033 0.038 0.035 0.028 0.029 0.022 0.015 0.009 0.008 0.010
0.009 0.012 0.010 0.009 0.060
* HDBS M5 HDVs (Combined HDGV and HDDV)
14 0.118 0.106 0.065 0.079 0.065 0.079 0.058 0.042 0.032 0.027
0.033 0.038 0.035 0.028 0.029 0.022 0.015 0.009 0.008 0.010
0.009 0.012 0.010 0.009 0.060
* HDBT M5 HDDVs
15 0.170 0.141 0.087 0.100 0.074 0.079 0.067 0.042 0.032 0.027
0.033 0.032 0.029 0.024 0.018 0.014 0.010 0.004 0.004 0.003
0.002 0.002 0.002 0.001 0.003
* Motorcycles M5 MC
16 0.134 0.102 0.072 0.070 0.071 0.051 0.049 0.041 0.027 0.021
0.018 0.344 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000

<u>Wake County</u>

*Convert MOBILE5 Registration Fractions to MOBILE6-Based Registration Fractions
*
*Calendar Year: 1996.000User-Input

*
*MOBILE5b Reg Fractions
*   0.114 0.091 0.085 0.080 0.075 0.083 0.069 0.063 0.052 0.047
*   0.042 0.040 0.034 0.029 0.023 0.017 0.012 0.007 0.004 0.003
*   0.003 0.003 0.003 0.002 0.019
*   0.090 0.081 0.080 0.083 0.060 0.066 0.069 0.049 0.037 0.037
*   0.034 0.041 0.039 0.034 0.037 0.025 0.021 0.013 0.009 0.008
*   0.006 0.011 0.010 0.009 0.051
*   0.101 0.117 0.083 0.095 0.057 0.121 0.069 0.048 0.034 0.034
*   0.025 0.037 0.032 0.019 0.018 0.017 0.010 0.007 0.004 0.005
*   0.006 0.010 0.008 0.007 0.036
*   0.109 0.076 0.057 0.088 0.069 0.088 0.049 0.041 0.041 0.030
*   0.036 0.039 0.035 0.027 0.028 0.026 0.016 0.009 0.007 0.009
*   0.010 0.014 0.012 0.010 0.074
*   0.114 0.091 0.085 0.080 0.075 0.083 0.069 0.063 0.052 0.047
*   0.042 0.040 0.034 0.029 0.023 0.017 0.012 0.007 0.004 0.003
*   0.003 0.003 0.003 0.002 0.019
*   0.090 0.081 0.080 0.083 0.060 0.066 0.069 0.049 0.037 0.037
*   0.034 0.041 0.039 0.034 0.037 0.025 0.021 0.013 0.009 0.008
*   0.006 0.011 0.010 0.009 0.051
*   0.163 0.137 0.087 0.103 0.067 0.074 0.044 0.035 0.032 0.054
*   0.040 0.044 0.029 0.026 0.018 0.016 0.010 0.004 0.004 0.003
*   0.002 0.002 0.001 0.001 0.004
*   0.138 0.105 0.080 0.070 0.068 0.053 0.053 0.041 0.029 0.021
*   0.022 0.320 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
*   0.000 0.000 0.000 0.000 0.000
*
*
* MOBILE6 Vehicle Classes:
* 1 LDV   Light-Duty Vehicles (Passenger Cars)
* 2 LDT1   Light-Duty Trucks 1 (0-6,000 lbs. GVWR, 0-3750 lbs. LVW)
* 3 LDT2   Light Duty Trucks 2 (0-6,000 lbs. GVWR, 3751-5750 lbs. LVW)
* 4 LDT3   Light Duty Trucks 3 (6,001-8500 lbs. GVWR, 0-3750 lbs. LVW)
* 5 LDT4   Light Duty Trucks 4 (6,001-8500 lbs. GVWR, 3751-5750 lbs. LVW)
* 6 HDV2B Class 2b Heavy Duty Vehicles (8501-10,000 lbs. GVWR)
* 7 HDV3   Class 3 Heavy Duty Vehicles (10,001-14,000 lbs. GVWR)
* 8 HDV4   Class 4 Heavy Duty Vehicles (14,001-16,000 lbs. GVWR)
* 9 HDV5   Class 5 Heavy Duty Vehicles (16,001-19,500 lbs. GVWR)
* 10 HDV6   Class 6 Heavy Duty Vehicles (19,501-26,000 lbs. GVWR)
* 11 HDV7   Class 7 Heavy Duty Vehicles (26,001-33,000 lbs. GVWR)
* 12 HDV8A Class 8a Heavy Duty Vehicles (33,001-60,000 lbs. GVWR)
* 13 HDV8B Class 8b Heavy Duty Vehicles (>60,000 lbs. GVWR)
* 14 HDBS   School Busses
* 15 HDBT   Transit and Urban Busses
* 16 MC   Motorcycles (All)
*
REG DIST
*   RESULTING MOBILE6-BASED REGISTRATION FRACTIONS
*
*MOBILE6 REGISTRATION FRACTIONS BY VEHICLE CLASS AND AGE
* LDV   M5 LDGV

```
   1  0.114  0.091  0.085  0.080  0.075  0.083  0.069  0.063  0.052  0.047
      0.042  0.040  0.034  0.029  0.023  0.017  0.012  0.007  0.004  0.003
      0.003  0.003  0.003  0.002  0.019
* LDT1       M5 LDGT1
   2  0.090  0.081  0.080  0.083  0.060  0.066  0.069  0.049  0.037  0.037
      0.034  0.041  0.039  0.034  0.037  0.025  0.021  0.013  0.009  0.008
      0.006  0.011  0.010  0.009  0.051
* LDT2       M5 LDGT1
   3  0.090  0.081  0.080  0.083  0.060  0.066  0.069  0.049  0.037  0.037
      0.034  0.041  0.039  0.034  0.037  0.025  0.021  0.013  0.009  0.008
      0.006  0.011  0.010  0.009  0.051
* LDT3       M5 LDGT2
   4  0.101  0.117  0.083  0.095  0.057  0.121  0.069  0.048  0.034  0.034
      0.025  0.037  0.032  0.019  0.018  0.017  0.010  0.007  0.004  0.005
      0.006  0.010  0.008  0.007  0.036
* LDT4       M5 LDGT2
   5  0.101  0.117  0.083  0.095  0.057  0.121  0.069  0.048  0.034  0.034
      0.025  0.037  0.032  0.019  0.018  0.017  0.010  0.007  0.004  0.005
      0.006  0.010  0.008  0.007  0.036
* HDV2B       M5 HDVs (Combined HDGV and HDDV)
   6  0.133  0.102  0.070  0.095  0.068  0.082  0.047  0.039  0.037  0.040
      0.038  0.041  0.032  0.027  0.023  0.022  0.014  0.007  0.006  0.006
      0.007  0.009  0.007  0.006  0.043
* HDV3       M5 HDVs (Combined HDGV and HDDV)
   7  0.133  0.102  0.070  0.095  0.068  0.082  0.047  0.039  0.037  0.040
      0.038  0.041  0.032  0.027  0.023  0.022  0.014  0.007  0.006  0.006
      0.007  0.009  0.007  0.006  0.043
* HDV4       M5 HDVs (Combined HDGV and HDDV)
   8  0.133  0.102  0.070  0.095  0.068  0.082  0.047  0.039  0.037  0.040
      0.038  0.041  0.032  0.027  0.023  0.022  0.014  0.007  0.006  0.006
      0.007  0.009  0.007  0.006  0.043

* HDV5        M5 HDVs (Combined HDGV and HDDV)
   9  0.133  0.102  0.070  0.095  0.068  0.082  0.047  0.039  0.037  0.040
      0.038  0.041  0.032  0.027  0.023  0.022  0.014  0.007  0.006  0.006
      0.007  0.009  0.007  0.006  0.043
* HDV6       M5 HDVs (Combined HDGV and HDDV)
  10  0.133  0.102  0.070  0.095  0.068  0.082  0.047  0.039  0.037  0.040
      0.038  0.041  0.032  0.027  0.023  0.022  0.014  0.007  0.006  0.006
      0.007  0.009  0.007  0.006  0.043
* HDV7       M5 HDVs (Combined HDGV and HDDV)
  11  0.133  0.102  0.070  0.095  0.068  0.082  0.047  0.039  0.037  0.040
      0.038  0.041  0.032  0.027  0.023  0.022  0.014  0.007  0.006  0.006
      0.007  0.009  0.007  0.006  0.043
* HDV8a       M5 HDVs (Combined HDGV and HDDV)
  12  0.133  0.102  0.070  0.095  0.068  0.082  0.047  0.039  0.037  0.040
      0.038  0.041  0.032  0.027  0.023  0.022  0.014  0.007  0.006  0.006
      0.007  0.009  0.007  0.006  0.043
* HDV8b       M5 HDVs (Combined HDGV and HDDV)
  13  0.133  0.102  0.070  0.095  0.068  0.082  0.047  0.039  0.037  0.040
      0.038  0.041  0.032  0.027  0.023  0.022  0.014  0.007  0.006  0.006
```

0.007 0.009 0.007 0.006 0.043
* HDBS M5 HDVs (Combined HDGV and HDDV)
14 0.133 0.102 0.070 0.095 0.068 0.082 0.047 0.039 0.037 0.040
0.038 0.041 0.032 0.027 0.023 0.022 0.014 0.007 0.006 0.006
0.007 0.009 0.007 0.006 0.043
* HDBT M5 HDDVs
15 0.163 0.137 0.087 0.103 0.067 0.074 0.044 0.035 0.032 0.054
0.040 0.044 0.029 0.026 0.018 0.016 0.010 0.004 0.004 0.003
0.002 0.002 0.001 0.001 0.004
* Motorcycles M5 MC
16 0.138 0.105 0.080 0.070 0.068 0.053 0.053 0.041 0.029 0.021
0.022 0.320 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000

North Carolina

REG DIST
*Convert MOBILE5 Registration Fractions to MOBILE6-Based Registration Fractions
*
*Calendar Year: 1995.000User-Input
*
*MOBILE5b Reg Fractions
* 0.064 0.057 0.066 0.063 0.067 0.065 0.074 0.064 0.061 0.052
* 0.048 0.046 0.049 0.044 0.037 0.031 0.025 0.019 0.011 0.006
* 0.005 0.005 0.007 0.006 0.028
* 0.060 0.052 0.056 0.055 0.060 0.049 0.054 0.059 0.045 0.038
* 0.036 0.035 0.045 0.046 0.042 0.043 0.033 0.031 0.021 0.014
* 0.013 0.011 0.018 0.017 0.067
* 0.245 0.038 0.057 0.040 0.046 0.028 0.059 0.034 0.023 0.016
* 0.017 0.012 0.018 0.016 0.009 0.009 0.008 0.005 0.004 0.002
* 0.002 0.003 0.005 0.004 0.300
* 0.118 0.032 0.027 0.020 0.031 0.024 0.031 0.017 0.015 0.015
* 0.011 0.013 0.014 0.012 0.010 0.010 0.009 0.006 0.003 0.003
* 0.003 0.004 0.005 0.004 0.563
* 0.064 0.057 0.066 0.063 0.067 0.065 0.074 0.064 0.061 0.052
* 0.048 0.046 0.049 0.044 0.037 0.031 0.025 0.019 0.011 0.006
* 0.005 0.005 0.007 0.006 0.028
* 0.060 0.052 0.056 0.055 0.060 0.049 0.054 0.059 0.045 0.038
* 0.036 0.035 0.045 0.046 0.042 0.043 0.033 0.031 0.021 0.014
* 0.013 0.011 0.018 0.017 0.067
* 0.115 0.095 0.110 0.060 0.083 0.057 0.067 0.052 0.040 0.029
* 0.029 0.041 0.041 0.040 0.034 0.024 0.023 0.018 0.007 0.007
* 0.006 0.005 0.006 0.003 0.008
* 0.223 0.028 0.024 0.018 0.016 0.016 0.012 0.012 0.009 0.007
* 0.005 0.630 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
* 0.000 0.000 0.000 0.000 0.000
*
*
* MOBILE6 Vehicle Classes:

```
*  1  LDV    Light-Duty Vehicles (Passenger Cars)
*  2  LDT1   Light-Duty Trucks 1 (0-6,000 lbs. GVWR, 0-3750 lbs. LVW)
*  3  LDT2   Light Duty Trucks 2 (0-6,000 lbs. GVWR, 3751-5750 lbs. LVW)
*  4  LDT3   Light Duty Trucks 3 (6,001-8500 lbs. GVWR, 0-3750 lbs. LVW)
*  5  LDT4   Light Duty Trucks 4 (6,001-8500 lbs. GVWR, 3751-5750 lbs. LVW)
*  6  HDV2B  Class 2b Heavy Duty Vehicles (8501-10,000 lbs. GVWR)
*  7  HDV3   Class 3 Heavy Duty Vehicles (10,001-14,000 lbs. GVWR)
*  8  HDV4   Class 4 Heavy Duty Vehicles (14,001-16,000 lbs. GVWR)
*  9  HDV5   Class 5 Heavy Duty Vehicles (16,001-19,500 lbs. GVWR)
* 10  HDV6   Class 6 Heavy Duty Vehicles (19,501-26,000 lbs. GVWR)
* 11  HDV7   Class 7 Heavy Duty Vehicles (26,001-33,000 lbs. GVWR)
* 12  HDV8A  Class 8a Heavy Duty Vehicles (33,001-60,000 lbs. GVWR)
* 13  HDV8B  Class 8b Heavy Duty Vehicles (>60,000 lbs. GVWR)
* 14  HDBS   School Busses
* 15  HDBT   Transit and Urban Busses
* 16  MC     Motorcycles (All)
*
*                  RESULTING MOBILE6-BASED REGISTRATION FRACTIONS
*
*MOBILE6 REGISTRATION FRACTIONS BY VEHICLE CLASS AND AGE
* LDV         M5 LDGV
      1  0.064  0.057  0.066  0.063  0.067  0.065  0.074  0.064  0.061  0.052
         0.048  0.046  0.049  0.044  0.037  0.031  0.025  0.019  0.011  0.006
         0.005  0.005  0.007  0.006  0.028
* LDT1        M5 LDGT1
      2  0.060  0.052  0.056  0.055  0.060  0.049  0.054  0.059  0.045  0.038
         0.036  0.035  0.045  0.046  0.042  0.043  0.033  0.031  0.021  0.014
         0.013  0.011  0.018  0.017  0.067
* LDT2        M5 LDGT1
      3  0.060  0.052  0.056  0.055  0.060  0.049  0.054  0.059  0.045  0.038
         0.036  0.035  0.045  0.046  0.042  0.043  0.033  0.031  0.021  0.014
         0.013  0.011  0.018  0.017  0.067
* LDT3        M5 LDGT2
      4  0.245  0.038  0.057  0.040  0.046  0.028  0.059  0.034  0.023  0.016
         0.017  0.012  0.018  0.016  0.009  0.009  0.008  0.005  0.004  0.002
         0.002  0.003  0.005  0.004  0.300
* LDT4        M5 LDGT2
      5  0.245  0.038  0.057  0.040  0.046  0.028  0.059  0.034  0.023  0.016
         0.017  0.012  0.018  0.016  0.009  0.009  0.008  0.005  0.004  0.002
         0.002  0.003  0.005  0.004  0.300
* HDV2B       M5 HDVs (Combined HDGV and HDDV)
      6  0.117  0.059  0.062  0.037  0.053  0.038  0.046  0.032  0.025  0.021
         0.018  0.025  0.025  0.024  0.020  0.016  0.015  0.011  0.005  0.005
         0.004  0.004  0.005  0.004  0.327
* HDV3        M5 HDVs (Combined HDGV and HDDV)
      7  0.117  0.059  0.062  0.037  0.053  0.038  0.046  0.032  0.025  0.021
         0.018  0.025  0.025  0.024  0.020  0.016  0.015  0.011  0.005  0.005
         0.004  0.004  0.005  0.004  0.327
* HDV4        M5 HDVs (Combined HDGV and HDDV)
      8  0.117  0.059  0.062  0.037  0.053  0.038  0.046  0.032  0.025  0.021
         0.018  0.025  0.025  0.024  0.020  0.016  0.015  0.011  0.005  0.005
```

0.004 0.004 0.005 0.004 0.327
* HDV5 M5 HDVs (Combined HDGV and HDDV)
9 0.117 0.059 0.062 0.037 0.053 0.038 0.046 0.032 0.025 0.021
0.018 0.025 0.025 0.024 0.020 0.016 0.015 0.011 0.005 0.005
0.004 0.004 0.005 0.004 0.327
* HDV6 M5 HDVs (Combined HDGV and HDDV)
10 0.117 0.059 0.062 0.037 0.053 0.038 0.046 0.032 0.025 0.021
0.018 0.025 0.025 0.024 0.020 0.016 0.015 0.011 0.005 0.005
0.004 0.004 0.005 0.004 0.327
* HDV7 M5 HDVs (Combined HDGV and HDDV)
11 0.117 0.059 0.062 0.037 0.053 0.038 0.046 0.032 0.025 0.021
0.018 0.025 0.025 0.024 0.020 0.016 0.015 0.011 0.005 0.005
0.004 0.004 0.005 0.004 0.327
* HDV8a M5 HDVs (Combined HDGV and HDDV)
12 0.117 0.059 0.062 0.037 0.053 0.038 0.046 0.032 0.025 0.021
0.018 0.025 0.025 0.024 0.020 0.016 0.015 0.011 0.005 0.005
0.004 0.004 0.005 0.004 0.327
* HDV8b M5 HDVs (Combined HDGV and HDDV)
13 0.117 0.059 0.062 0.037 0.053 0.038 0.046 0.032 0.025 0.021
0.018 0.025 0.025 0.024 0.020 0.016 0.015 0.011 0.005 0.005
0.004 0.004 0.005 0.004 0.327
* HDBS M5 HDVs (Combined HDGV and HDDV)
14 0.117 0.059 0.062 0.037 0.053 0.038 0.046 0.032 0.025 0.021
0.018 0.025 0.025 0.024 0.020 0.016 0.015 0.011 0.005 0.005
0.004 0.004 0.005 0.004 0.327
* HDBT M5 HDDVs
15 0.115 0.095 0.110 0.060 0.083 0.057 0.067 0.052 0.040 0.029
0.029 0.041 0.041 0.040 0.034 0.024 0.023 0.018 0.007 0.007
0.006 0.005 0.006 0.003 0.008
* Motorcycles M5 MC
16 0.223 0.028 0.024 0.018 0.016 0.016 0.012 0.012 0.009 0.007
0.005 0.630 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000 0.000

APPENDIX C

TRIAD EARLY ACTION PLAN

STRATEGIES AND CONTROL MEASURES

Appendix C: Local Control Strategies

Triad Early Action Compact

	Emissions Reduction Strategy	Assumptions/Explanation	NOx Reduction Tons/Yr for 2007	VOC Reduction Tons/Yr for 2007	Geographic Area	Implementation Date
A	**LOCAL GOVERNMENT INITIATIVES: Buy Low Emissions Fuel, Vehicles and Equipment**					
A1.	Replace, As Needed, Gasoline Powered Vehicles for On-Road Fleets and/or Reduce Dependence on Old Higher Emissions Vehicles (i.e. cars and trucks).	78.84 State vehicles per county 33.3 VMT/day 14 vehicles per county per year turnover. Source: 1999 NC Senate Bill 953 Calculation Method: CACPS No estimates yet on local vehicles EAC will design an on-line database and reporting system to account for local government vehicle replacements. This will be used to calculate emissions reductions due to retirement of old vehicles and replacement with lower emissions vehicles.	0.9	1.1	11 County region	Beginning January 2004.
A2.	Replace, As Needed, Aging Equipment In Heavy Duty Non-Road Diesel Fleets and/or Reduce Dependence on Old Higher Emissions Equipment (i.e. bulldozers, excavators, backhoes, graders, forklifts and similar machinery).	Purchase equipment with new engine technology being introduced in 2001 - 2005 (Tier 2) and 2006 - 2008 (Tier 3). State mandated measure	N/A State mandated measure	N/A State mandated measure	Same as above	Same as above
A3.	Replace, As Needed, Vehicles In Heavy Duty On-Road Diesel Fleets and/or Reduce Dependence on Old Higher Emissions Vehicles (i.e. dump trucks, garbage trucks, busses).	Purchase vehicles with new engine technology scheduled for introduction in 2004 and 2007.	N/A State mandated measure	N/A State mandated measure	Same as above	Same as above
A4.	Replace, As Needed, Gasoline Powered Equipment and/or Reduce Dependence on Old Higher Emissions Equipment. (i.e. chainsaws, lawnmowers, and generators).	Purchase new equipment that meets California standards.	N/A State mandated measure	N/A State mandated measure	Same as above	Same as above
A5.	Purchase Lower Emission Fuel	Between November 2002 and the Spring of 2003 Greensboro converted all diesel vehicles, on and off-road, to biodiesel. The city now uses close to 1.5 million gallons annually of biodiesel. Reductions are: -30% total unburned hydrocarbons -20% carbon monoxide -22% particulate matter +2% NOx -20% sulfates -13% PAH -50% nPAH				
	LOCAL GOVERNMENT INITIATIVES: Reduce Emissions on Large Public Construction Projects					
A6.	Specify Emissions Reductions For Heavy Duty Off-Road Road Equipment In Construction Contracts – Develop and implement contract incentives and other policies for use of lower-emission off-road vehicles and equipment in major construction projects, especially road construction, and including NCDOT.	Local implementation will depend on State DOT taking the initiative for major highway projects. State DOT staff is developing a proposal for contract requirements and/ or incentives for heavy equipment emissions reductions to submit to the State Board of Transportation.	Quantification not possible at this time	Quantification not possible at this time	11 county region	*Include only if we think it will be implemented by state DOT*
	LOCAL GOVERNMENT INITIATIVES: Use and Support Public Transportation					
A7	Support a regional transportation service and planning entity - In 2003 PART was granted authority by Guilford and Forsyth counties to impose a tax following a 1-year trial period to support the PART regional work program.	Newly authorized funding provided about $2.5 million in 2003. In addition, PART secured nearly $7 million in sate and federal funds.				

	Emissions Reduction Strategy	Assumptions/Explanation	NOx Reduction Tons/Yr for 2007	VOC Reduction Tons/Yr for 2007	Geographic Area	Implementation Date
A8.	Increase ridership on municipal and regional bus services (PART Express) – Piedmont Authority for Regional Transportation (PART) and local governments to provide all feasible increases in services, coupled with local government and private sector support for these services. See narrative for PART funding information. See also www.partnc.org See also http://www.ci.greensboro.nc.us/gdot/public_trans/mobility/draft_plan.htm __ for information on Greensboro bus ridership	600 1-way trips 15 VMT/trip 9000 current VMT 50% increase per year Source: PART Calculation Method: CACPS (The regional bus service travels from downtown transit centers in Greensboro, Winston-Salem and High Point to the PART regional transfer facility. There, shuttles travel to business and hotels in the airport area and to the airport itself. In 2003 PART Express averaged 10,000 monthly one-way passenger trips, yielding a 350,000-mile monthly reduction in miles traveled on the region's road network.	7.3	8.9	Guilford and Forsyth counties	Ongoing
A9.	Park and Ride – Create park and ride lots with safe parking areas and enhancements. PART has a Federal Transit Adm. grant to establish multiple regional park and ride lots by 2007. See related newspaper article # 8, Page 11 See also www.partnc.org	15 VMT/trip 10% increase / 5 years Source: PART and NCDOT Calculation Method: DOT Spreadsheet PART has funds on hand to build 20 park and ride lots. Plans are underway for construction of several lots in Greensboro, Winston-Salem and High Point. Others will be built in surrounding counties, contingent upon 10% local match.	3.2	1.6	Urban core area first – Guilford and Forsyth and Alamance counties.	Minimum of 5 built or leased in core urban area 2004. Additional lots to be built or leased in 3 outlying counties 2004.
	LOCAL GOVERNMENT INITIATIVES: Promote Options to Single Occupancy Vehicles					
A10.	Expand PART Ride Sharing and Vanpooling of the Piedmont (RSVP) – Provides vanpool and ride-match services to employers and employees. See www.partnc.org	20 vans currently Add 5 vans per year 12 persons / van 30 VMT / person / day Source: PART Calculation Method: CACPS Program has served commuters in region for 10 years.	0.7	0.7	Guilford and Forsyth counties	Beginning January 2004
A11.	Carpool – Expand carpooling through PART website sign-ups, promotions, and advertisements. See www.partnc.org for on-line sign-up and 1-800 number	Conservative assumption based on 5.73% carpool population 30 VMT / person / day 1% increase per year based on current trend Source: 2000 Census Calculation Method: CACPS	19	23.2	Same	Beginning January 2004
A12.	HOV Lanes - Determine feasibility of developing HOV / HOT lanes along I-40 (main east-west corridor through the Triad.	PART is partnering with NC A&T University and UNC Chapel Hill on accessibility and engineering feasibility of this incentive for using multiple occupancy vehicles . Project is funded by US DOT.	N/A		Alamance, Guilford, Forsyth counties	Feasibility study is ongoing as of 3/31/04
A13.	Plan for implementation of regional rail or bus rapid transit	PART is in Phase II of a Mobility Major Investment Study. It has produced feasibility data on 2 groups of rapid transit technologies for the region, bus and rail. The PART Board will determine whether to begin with bus or to move directly into planning for inter-city rail. 4 potential corridors have been studied and a priority East West Corridor has been chosen. Implementation will be based on land use policies of activity centers, village centers and infill in designated centers along the corridor.				
	LOCAL GOVERNMENT INITIATIVES: Additional Public Transportation Measures					

<table>
<tr><th></th><th>Emissions Reduction Strategy</th><th>Assumptions/Explanation</th><th>NOx Reduction Tons/Yr for 2007</th><th>VOC Reduction Tons/Yr for 2007</th><th>Geographic Area</th><th>Implementation Date</th></tr>
<tr><td>A14.</td><td>Mass Transit Enhancements - Improve existing transit systems with bus shelters, web based schedules, etc.</td><td>N/A</td><td>Quantifications included in A6 and A7</td><td>Quantifications included in A6 and A7</td><td>Same</td><td>Late 2004.</td></tr>
<tr><td>A15.</td><td>More Bus Stops - Add bus stops for municipal bus systems at employers. (This is in addition to employers served by PART Express, the regional bus service.)</td><td>N/A</td><td>Quantifications included in A6 and A7</td><td>Quantifications included in A6 and A7</td><td>Same</td><td>Depends on ridership; currently down due to manufacturing job losses.</td></tr>
<tr><td>A16.</td><td>Mass Transit Passes or Allowance - Promote purchase and use of bus passes to minimize use of individual vehicles. Consider employer purchase or allowance for ozone season bus passes to give unlimited use of bus service on ozone hazard days.</td><td>N/A</td><td>Quantifications included in A6 and A7</td><td>Quantifications included in A6 and A7</td><td></td><td>Already implemented by Greensboro for city employees</td></tr>
<tr><td>B.</td><td colspan="6">EMISSIONS REDUCTIONS REPORTED AND IN PROCESS BY INDUSTRIES & UTILITIES: Reduce Emissions from Boilers</td></tr>
<tr><td>B1.</td><td>The ad hoc Triad Business and Industry Air Quality Group recommends that DAQ's model take into account updated and most likely conditions for stationary emissions sources, from Duke Power and R.J. Reynolds Tobacco Company</td><td>Duke Power communicated to DAQ its likely NOx emissions rate for Belews Creek --------
R. J. Reynolds communicated to DAQ its likely ozone season NOx emissions rate for Tobaccoville site (including boilers) on 10/6/03.</td><td>This recommendation improves the accuracy of the Division of Air Quality (DAQ) model. While we believe the likely emissions are less than DAQ's default projection, this recommendation does not include an enforceable emission reduction.</td><td></td><td>11 county region</td><td>Immediate</td></tr>
<tr><td>B2</td><td>DAQ should remove from the future projected (2007) source inventory any businesses that have closed during the unprecedented downturn in NC's manufacturing sector.</td><td>No one anticipates that any of the closed businesses will re-open.

List of closed facilities transmitted to DAQ on 11/5/03</td><td>Of closed facilities in the Triad, RJRT Bailey Plant, downtown Winston-Salem, had the highest emissions.. The boilers were retired in 1997. Since the modeling is based on the 1995 inventory, these boilers should be removed. Projected 2007 NOx emissions are 1.33 tons per day. -------
Several other Triad facilities have closed. Their closures should be accounted for in the model by updating growth factors for the respective industry sectors.</td><td></td><td>Forsyth County</td><td>More information available by March 2004.</td></tr>
<tr><td>B3.</td><td>R. J. Reynolds Tobaccoville facility in Forsyth County will eliminate use of coal-fired boilers identified in Title 15A, North Carolina Administrative Code Chapter 2D, Section 1416 during the ozone seasons in 2004 through 2007. The "ozone season" shall be those defined in Title 15A of the North Carolina Administrative Code Chapter 2D Section 1401(a)(18) as "the period beginning May 31 and ending September 30</td><td colspan="3">Ozone Season NOx Emissions – RJRT Tobaccoville<table><tr><th>NOx SIP seasonal tons</th><th>2004</th><th>2005</th><th>2006</th><th>2007</th><th>2008</th></tr><tr><td>Boiler 1</td><td>194</td><td>243</td><td>64</td><td>64</td><td>64</td></tr><tr><td>Boiler 2</td><td>218</td><td>273</td><td>64</td><td>64</td><td>64</td></tr></table></td><td>Forsyth County</td><td>Emission reduction will take place before the 2004 ozone season.</td></tr>
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<tr><th></th><th>Emissions Reduction Strategy</th><th>Assumptions/Explanation</th><th>NOx Reduction Tons/Yr for 2007</th><th>VOC Reduction Tons/Yr for 2007</th><th>Geographic Area</th><th>Implementation Date</th></tr>
<tr><td></td><td>1401(a)(18) as “the period beginning May 31 and ending September 30 for 2004 and beginning May 1 and ending September 30 for all other years.” The Facility’s NOx allocations listed in Title 15A of the NC Administrative Code, Chapter 2D, Section 1417 that will not be needed for compliance purposes may be traded in the NOx trading program in accordance with requirements of Section 1419.</td><td colspan="3"><table>
<tr><td>Boiler 3</td><td>178</td><td>223</td><td>64</td><td>64</td><td>64</td></tr>
<tr><td>Boiler 4</td><td>190</td><td>238</td><td>64</td><td>64</td><td>64</td></tr>
<tr><td>Total</td><td>780</td><td>977</td><td>256</td><td>256</td><td>256</td></tr>
<tr><td>Days per season</td><td>122</td><td>153</td><td>153</td><td>153</td><td>153</td></tr>
<tr><td>SIP tons per day</td><td>6.39</td><td>6.39</td><td>1.67</td><td>1.67</td><td>1.67</td></tr>
<tr><td>Max. emissions gas boilers</td><td>0.95</td><td>0.95</td><td>0.95</td><td>0.95</td><td>0.95</td></tr>
<tr><td>Reductions tons per day</td><td>5.44</td><td>5.44</td><td>0.72</td><td>0.72</td><td>0.72</td></tr>
</table></td><td></td><td></td></tr>
<tr><td></td><td colspan="6">EMISSIONS REDUCTIONS REPORTED AND IN PROCESS BY INDUSTRIES & UTILITIES: Reduce Emissions at Specific Business and Industry Sites (Boiler and non-boiler)</td></tr>
<tr><td>B4.</td><td><u>Syngenta Crop Protection:</u>
1) Delivery vehicles are not allowed to idle in shipping and receiving area during deliveries or during pick ups.
2) Instituted temperature adjustments to reduce operations of the boilers since 2001. Temperatures are raised in the buildings after hours during the summer months. Temperatures are lowered in the buildings after hours during the winter months.
3) Improved the efficiency of boiler operations and removed one of the boilers from one of the buildings in 2001.
4) Boilers go through annual tunings as part of the preventive maintenance program to increase the efficiency of operations.</td><td></td><td>Not available at this time. Reductions will not be significant but do support the overall direction of EAC strategies.</td><td></td><td>Guilford County</td><td>Completed between 2001 and 2003</td></tr>
<tr><td>B5.</td><td><u>Energizer Battery Company, Inc.</u>
1) Reduced fleet of vehicles by 57%.
2) 90% of fork lift trucks are now battery powered.
3) Planning to use the smaller of two natural gas fired boilers during the months of June through October as the weather permits.
4) Test diesel powered fire pumps and natural gas powered emergency generators during the cooler morning hours only.</td><td></td><td>Not available at this time. Reductions will not be significant but do support the overall direction of EAC strategies.</td><td></td><td>Randolph County</td><td>#1,2,4 complete

#3 To be implemented June 2004</td></tr>
<tr><td>B6</td><td><u>Duke Energy</u> Mobile meter reading program will yield a reduction of 56 pick-up trucks per day that would normally be running or idling 6 out of 8 hours per day.</td><td></td><td>1308 pounds of NOx per ozone season. (56 routes eliminated@ 90 miles per day) NOx emissions per vehicle: 1.1grams per mile (per DAQ estimate for Forsyth County for 2003 based on MOBILE6 2)Ozone Season May 1-September 30 = 153 days. Week days=153 x 5/7 = 109 days. NOx reduced = 12 pounds per day x 109 days = 1308 pounds</td><td></td><td>11 counties</td><td>Completed</td></tr>
<tr><td>B7.</td><td><u>Duke Energy</u> - Plans to institute idling reduction guidelines in addition to the mobile meter reading program.</td><td></td><td>Estimate 133 diesel truck engines and 483 gasoline truck engines reduce 30 minutes per day of idling.</td><td></td><td>11 counties</td><td>Summer 2004</td></tr>
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			Reduced idling is assumed to produce an overall benefit in the form of lower NOx emissions but the extent can not be quantified based on available information at this time. DAQ does not have any reliable emissions factor but does recommend idling reduction as directionally correct with ozone attainment planning.			
B8.	Plans expected to be submitted: Thomas Built Buses; Forsyth Medical Center; Degussa Stockhausen; Winston-Salem/Forsyth County Schools				Guilford and Forsyth counties	To be determined
C.	**SUPPORT FOR REGIONAL INITIATIVES: Enforce State Regulations**					
C1.	Open Burning_– Enforce and strengthen open burning restrictions.	Statewide rule to prohibit open burning on code red and code orange days will go into effect for 2004 ozone season.	NC Division of Air Quality is developing data on estimated NOx and PM2.5 emissions from open burning.		11 counties	EACs and DAQ begin cooperating on open burning outreach Feb. 2004
C3.	Support Our Regional Consortium_- Continue the Triad EAC as a regional air quality consortium involving county and municipal governments, environmental interests, business and industry to develop and carry out initiatives to improve air quality in the region.		Nonquantifiable		11 counties	Ongoing
C4.	Partner with adjacent Triangle region and state DAQ to participate in a regional Clean Cities program.	Fist joint venture is an AFV road show to be conducted in Greensboro and Winston-Salem on April 21, 2004. Programming and outreach provided by Triangle Clean Cities program, City of Greensboro and City of Winston-Salem.	Nonquantifiable		11 counties	2004, depending upon level of local government interest.
	SUPPORT FOR REGIONAL INITIATIVES: Participate in State Initiated Pilot Projects					
C5.	Diesel Retrofits on School Busses – Encourage school systems in the region to apply to state DAQ for retrofit grants for school busses. If this is done, the following estimated tonnage reductions can be anticipated. See news article #13 Page 16	0.128% buses / person 51250 VMT / day 160 school days / year 30% buses eligible Source: Guilford County Schools Annual Report 2003 Calculation Method: EPA Retrofit Calculator Quantifications for regional use only – not for inclusion in SIP Guilford County School System has just been awarded $100,000 for retrofits of 50-100 busses.	23 Quantifications for regional use only – not for inclusion in SIP	17 Quantifications for regional use only – not for inclusion in SIP	11 counties, especially Guilford County	2004 if funds received
C6.	Diesel Retrofits on Other Vehicles - Promote pollution control retrofits on other diesel vehicles in public and private sector.	0.073 vehicles / person 30.8 VMT / day 38.2% fleet diesel 30% vehicles eligible Source: Forsyth County Fleet Winston-Salem Fleet 2003 Mobile Maintenance Plan	10 Quantifications for regional use only – not for inclusion in SIP	7.0 Quantifications for regional use only – not for inclusion in SIP	11 counties	To be determined

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		Calculation Method: EPA Retrofit Calculator Quantifications for regional use only – not for inclusion in SIP				
C7.	Idling Reduction Efforts (State) – Division of Air Quality to seek grant funds to install idling-reduction systems on trucks. Each fleet can choose which system will work best for them, whether it is an auxiliary power unit, a generator, an inverter-charger paired with an electrical HVAC system, or something else. "Shore power connections" allow truckers to utilize AC power at truck stops and terminals.		Depending upon grant funding and idling reduction equipment installed, emissions reductions in the Triad can be quantified. However, this would be a pilot program and emissions reductions would be small.		To be determined	Implementation date depends on grant funds.
C8.	Idling Reduction Efforts (Local) - Local systems to enact policies to reduce school bus idling.	Guilford County School system has instituted a no idling policy for all school buses. "When the temperature is 50 degrees or higher, upon arrival at school sites while awaiting afternoon boarding, school bus engines will be turned off and not restarted until loading is completed and buses are ready to begin the routes."				
D.	**Air Quality Education and Outreach: Expand Air Quality Education in the Region**					
D1.	Support and Expand Existing Programs - Supplement regional services provided through the Forsyth County Environmental Affairs Department and the Triad Air Awareness Program - On a county level implement outreach programs with added emphasis on ozone season (May – September) and ozone episodes	Education and outreach programs under leadership of Triad Air Awareness Program located in the offices of the Forsyth County Department of Environmental Affairs	Nonquantifiable		11 counties	Ozone season 2004
D2.	PSAs - Place PSAs on ozone reduction methods and green products in movie theaters, TV		Nonquantifiable		Same	Same as above
D3.	Ads and Special Events - Place media ads and develop special events highlighting ozone reduction strategies and green products.		Nonquantifiable		Same	Same as above
D4.	Targeted Outreach - Develop special communications designed for Hispanic outreach program		Nonquantifiable		Same	Same as above
D5.	Go into the Schools – Develop school based outreach to educate children, who, in turn can inform their families. Similar to the approach that worked when children educated their families about recycling.		Nonquantifiable		Same	Same as above.
D6.	Media Reports - Increase Air Quality reports to TV, radio, newspaper, web sites, air bulletins		Nonquantifiable		Same	Same as above.
E.	**CONTEXT ISSUES: Operate Energy Efficient Buildings and Systems**					
E1.	Implement energy efficiency in operation and design of facilities, purchase and use of equipment. (e.g. Guilford County Schools, Davidson County Public Buildings energy savings contracts) • Use design and construction standards for energy efficient buildings • Retrofit public buildings and schools for energy efficiency • Seek out and purchase energy efficient products. • Use programmable thermostats and lighting to lessen use when the office is closed. • Practice energy efficient vehicle operating tips: shut off engine when parked; limit idling; operate vehicle only as needed; avoid travel through congested areas. • Reschedule nonessential operations (lawn maintenance, outdoor painting, paving) to non-peak ozone times	See news articles #5 and #6 in Section 1.5 of Text re: energy savings programs in High Point municipal buildings and Davidson County buildings. A pilot program in the Guilford County schools is being expanded, and the City of Asheboro (Randolph County) has already completed an energy saving audit with measurable results.	Include in 3% reduction allowed for voluntary measures	Include in 3% reduction allowed for voluntary measures	2 counties currently; others later	Completed, as noted above, in public buildings in several counties and school systems. To be implemented in other locations throughout 2004 and 2005.

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	• Promote solar water heating, passive solar design, photovoltaic and other renewable energy • Green Buildings - Promote environmentally sustainable and healthy building practices. Green buildings encourage reduction of air pollution through energy efficiency, renewable non-polluting energy, protection of existing landscapes, native plant conservation, and low VOC finishes.					
	CONTEXT ISSUES: Other Energy Savings, Emissions Reduction Strategies					
E2.	E-government / increase available locations. Provide telephone and web-based services, both for information and transactions and/or multiple locations for payments, etc	Implemented in 2003 in City of Thomasville in Davidson County. Others with telephone and electronic e-billpay are being identified. Assumed to be nonquantifiable			Ongoing in several counties	Strategies implemented at various levels throughout the region.
E3.	Intelligent Transportation Systems (ITS) – Local transportation departments to use detection loops and other systems which monitor traffic. The system provides drivers with information such as lane closures, traffic delays and is used to reduce non-recurring congestion and associated emissions.	Already implemented in Greensboro, Winston-Salem and High Point; incorporated into their long-range transportation updates. Assumed to be nonquantifiable			On-going in Winston-Salem and Greensboro	Implemented at various levels throughout the region
E4.	Employer Programs to Reduce Commuting - Encourage employers to establish voluntary bus and carpool programs with vehicle miles traveled goals and incentives.	Strategies E4 – E7 mandated in 1999 NC Senate Bill 953 40 MPH average commute 20% state government employees in Triad eligible to participate Source: 2000 US Census; NC commuting trends Calculation Method: CACPS	E4,5,6,7 154.6	E4,5,6,7 188.9	11 counties	Implemented at various levels throughout the region
E5.	Flex or compressed work time - Promote compressed work weeks or flexible work hours across work sectors. Reduces congestion during peak driving hours and provides flexibility for time needed to ride mass transit.					
E6.	Employer Tax Credits – Promote use of federal tax credit for employer offered tax-free transit/vanpool benefits.					
E7.	Telecommuting - Promote telecommuting as an option to allow employees to perform job tasks from home or a designated telework center.					
E8.	Direct Deposit - Offer employees direct deposit which saves at least one vehicle errand per pay period.	N/A	Nonquantifiable	Nonquantifiable	11 counties	Ongoing
F.	**MAINTENANCE STRATEGIES (implications after 2007): Continue to Promote Automobile Alternatives**					
F1.	Proceed with Plans for Commuter and Intercity Rail – PART has completed a Major Investment Study for regional commuter rail in the urban area. NC DOT is studying feasibility of intercity rail from eastern to western NC, through the Triad. Initiatives will be implemented post 2007.	Mobility Major Investment Study studied 2 groups of rapid transit technologies - bus and rail. PART Board of Directors has not determined whether to begin with bus or rail. 4 corridors were studied and the East West Corridor has been chosen as the priority corridor. This Study incorporates land use policies of activity centers, village centers and infill in designated centers along the corridor.	Significant future impact		11 counties	Ongoing
F2.	Encourage Non-Motorized Transportation - Shifts from automobile to nonmotorized transportation can impact energy conservation and emission reductions by reducing short motor vehicle trips which have high per-mile fuel consumption and emission rates. (e.g. Winston-Salem and Greensboro bike patrol and bike commuters)	0.89% population participation 30 VMT / day /person (vehicle mileage removed from circulation) Source: US Census Calculation Method: CACPS	228.5	279.4	11 counties	Ongoing

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F3.	Encourage walking and cycling by improving pedestrian and bike infrastructure – Provide sidewalks, crosswalks, paths and bike lanes, and improve maintenance.					
F4.	Increase bicycle parking and create changing facilities.		..		11 counties	Future plans
F.	**MAINTENANCE STRATEGIES (implications after 2007): Coordinated and Pedestrian Friendly Land Use**					
F5.	Correct hazards – Repair roadway hazards specific to nonmotorized transport.	Throughout the Region Triad local governments have adopted and are formulating new comprehensive development plans and unified development ordinances that incorporate smart growth principles. Comprehensive plans, and ordinances that reflect these plans have been adopted in: Greensboro High Point Winston-Salem/Forsyth County Randolph County Davie County Lexington Elon Asheboro Franklinville Burlington All of these plans and ordinances provide for street connectivity, more sidewalks, TND, mixed use and infill development, and landscaping Land Use and transportation planning are linked in land use plans and in the 4 MPO multi modal transportation plan updates. 27 local governments have also adopted PART's Land Use and Transportation Principles as a local and regional guide to link land use and transportation planning. These measures are discussed more fully in the narrative and, by way of example, web site links are provided to 17 ordinances and plans.	Quantification included in A6, A7, A8, A9, A10		11 counties	Ongoing
F6.	Provide Street Furniture – such as benches and design features such as human-scale street lights		Quantification included in A6		11 counties	Ongoing
F7.	Security - Address security concerns of pedestrians and cyclists.		Quantification included in A6		11 counties	Ongoing
F8.	Pedestrian Commercial Streets - Make pedestrian-oriented commercial streets where driving is discouraged or prohibited.		Quantification included in A6		11 counties	Ongoing
F9.	Non-auto Park Access – Design parks that encourage or require non-automotive access.		Quantification included in A6		11 counties	Ongoing
F10.	PART Coordinated Land Use Plan – Continue regional transportation initiatives based on the Coordinated Land Use and Transportation Policies adopted by PART and endorsed by 27 jurisdictions		Quantification included in A6		11 counties	Ongoing
F11.	Adopt Planned Growth Measures Including Pedestrian Friendly and Sound Transportation Strategies - Continue to apply these principles throughout jurisdictions in the region, thereby intentionally altering the urban environment to improve air quality. Principles include: • Transportation-related land use strategies that reduce VMTs.and promote multi-modal mobility including biking and walking • Increase infill development • Strengthen downtowns • Balance location of housing and employment opportunities. • Provide for transit oriented development, locating high-density development around transit stations). • Locate employment, retail and public services close together in walkable commercial centers • Revise land use ordinances to put maximums on parking lot size • Plan subdivisions with streets that interconnect – encourage walking, biking – minimize driving		Quantification included in A6			Ongoing
F12.	Manage Traffic to affect the relative speed, convenience and safety of nonmotorized transportation. Principles include: • Traffic Calming - roadway design features that reduce vehicle traffic speeds and volumes. • Roundabouts replace stop signs and traffic signals to improve traffic flow. • Traffic signal timing to limit stop-and-go driving that reduces vehicle efficiency • Manage roadway access by limiting number and location of curb cuts and driveways. Consolidate access to multiple businesses to reduce congestion, vehicle delay and emissions.		Quantification included in A6, A7, A8, A9, A10		Guilford & Forsyth counties	Ongoing
F13.	Green communities - Promote tree ordinances, open space, greenways and significant landscaping/buffer requirements in all jurisdictions. Establish minimum tree preservation and planting standards; and promote strategic tree planting, street trees, and parking lot trees and buffers, increase acreage for greenways and open space.		Quantification included in E1		11 counties	Ongoing