PETITION

PURSUANT TO SECTION 126 OF THE CLEAN AIR ACT, 42 U.S.C. § 7426

To the United States Environmental Protection Agency For Relief From Certain Emissions From Large Electric Generating Units in the Following States: Alabama, Georgia, Illinois, Indiana, Kentucky, Maryland, Michigan, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia and West Virginia.

Submitted by the State of North Carolina

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Petition Pursuant to Section 126 of the Clean Air Act to the United States Environmental Protection Agency for Relief from Certain Emissions from Large Electric Generating Units in the Following States: Alabama, Georgia, Illinois, Indiana, Kentucky, Maryland, Michigan, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia and West Virginia.

The State of North Carolina ("the State"), through Attorney General Roy Cooper and undersigned counsel, hereby petitions the United States Environmental Protection Agency ("EPA") pursuant to section 126 of the Clean Air Act ("CAA"), as amended, 42 U.S.C. §§ 4201, 4216 (2004). As demonstrated and discussed more fully below, the State is entitled to relief from certain emissions of sulfur dioxide (SO_2) and oxides of nitrogen (NO_X) from large electric generating units ("EGUs")[1] in the states of Alabama, Georgia, Illinois, Indiana, Kentucky, Michigan, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia and West Virginia. These emissions contribute significantly to nonattainment in, and interfere with maintenance by, the State with respect to the national primary and secondary ambient air quality standards ("NAAQS") for fine particulate matter ("$PM_{2.5}$"). Further, the State is entitled to relief from emissions of NO_X from EGUs in the states of Georgia, Maryland, South Carolina, Tennessee and Virginia, that contribute significantly to nonattainment in, and interfere with maintenance by, the State with respect to the NAAQS for ozone (eight-hour standard).

SO_2 and NO_X emissions from EGUs are prime contributors to downwind $PM_{2.5}$ and ozone pollution. Like many other states, North Carolina currently has sites that are not attaining the relatively new $PM_{2.5}$ and eight-hour ozone NAAQS, and still other areas that may have difficulty sustaining compliance. In 2002, North Carolina enacted the Clean Smokestacks Act, 2002 N.C. Sess. L. 4,[2] the purpose of which is to substantially reduce actual emissions of SO_2 and NO_X from the State's large EGUs. The State has gone beyond federal requirements in order to reduce the contribution of in-state EGU emissions to $PM_{2.5}$ and ozone problems. By this petition, North Carolina seeks EPA's assistance by requiring upwind EGUs to equitably reduce their share of downwind pollution.

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[1] The term "EGUs," as used in this petition, means all facilities meeting the criteria described at *Rule to Reduce Interstate Transport of Fine Particulate Matter and Ozone (Interstate Air Quality Rule) (Proposed Rule*), 69 Fed. Reg. 4566, 4610 (Jan. 30, 2004).

[2] The environmental provisions of the Clean Smokestacks Act are codified primarily at N.C.G.S. § 143-215.107D (2004).

I. STATUTORY AND REGULATORY REQUIREMENTS OF SECTION 126 AND THE NATIONAL AMBIENT AIR QUALITY STANDARDS

A. The Clean Air Act

1. The Good Neighbor Provision

Several provisions of the CAA, including sections 110 and 126, address the transport of pollutants across state lines. 42 U.S.C. §§ 7410, 7426(b). Section 110(a)(2)(D), the so-called "good neighbor provision" of the CAA, requires each state to include provisions in its state implementation plan ("SIP") that prohibit emissions within the state that contribute significantly to another state's nonattainment of, or interfere with another state's maintenance of, a NAAQS.[3] Pursuant to section 110(a)(2)(D), each SIP:

> shall --
>
> (D) contain adequate provisions--
>
> (i) prohibiting, consistent with the provisions of this subchapter, any source or other type of emissions activity within the state from emitting any air pollutant in amounts which will--
>
> (I) *contribute significantly to nonattainment in, or interfere with maintenance by, any other State* with respect to any such national primary or secondary ambient air quality standard ..., [and]
>
> (ii) *insuring compliance with the applicable requirements of sections 126* and 115 of this title (relating to interstate and international pollution abatement)[.]

CAA § 110(a)(2)(D), 42 U.S.C. § 7410(a)(2)(D) (emphasis added). When EPA determines a SIP is substantially inadequate in this regard, the agency must require revisions of the SIP; that is, EPA must issue a "SIP call," such as the *Rule to Reduce Interstate Transport of Fine Particulate Matter and Ozone (Interstate Air Quality Rule) (Proposed Rule)*, 69 Fed. Reg. 4566 (Jan. 30, 2004) ("*IAQR*"). CAA § 110(k)(5), 42 U.S.C. § 7410(k)(5).

2. Section 126

Pursuant to section 126(b), any downwind state or political subdivision "may petition the Administrator for a finding that any major source or group of stationary sources emits or would emit

[3] Unless otherwise specified, the terms "nonattainment" and "maintenance" as used in this petition refer to an actual failure to attain or difficulty maintaining a NAAQS, regardless of whether the area has been formally designated a "nonattainment area" or a "maintenance area," as explained more fully in Part I.A.2 of this petition.

any air pollutant in violation of the prohibition of section 110(a)(2)(D)([i]) or this section."[4] 42 U.S.C. § 7426(b). A petition under section 126 is the mechanism for downwind states to ask for direct federal regulation of upwind sources of air pollution. *Appalachian Power Co. v. EPA*, 249 F.3d 1032, 1037 (D.C. Cir. 2001). Section 110 requires states to revise their SIPs to meet limits established by EPA, but the means used to meet the limits are left within each state's discretion. Section 126, on the other hand, gives states the authority to petition the Administrator and gives EPA the power to regulate directly upwind sources of air pollution that contribute to the petitioning state's nonattainment of the NAAQS. 42 U.S.C. § 7426(b). "Congress provided section 126 to downwind states as a critical remedy to address pollution problems ... otherwise beyond their control." *Appalachian Power*, 249 F.3d at 1047 (*quoting Findings of Significant Contribution and Rulemaking on Section 126 Petitions for Purposes of Reducing Interstate Ozone Transport (Final Rule)*, 65 Fed. Reg. 2674, 2681/1 (Jan. 18, 2000)).

The 1990 amendments to the CAA, *see* Pub. L. 101-549, 104 Stat. 2399 (Nov. 15, 1990), included several provisions addressing transboundary air pollution. In particular, Congress strengthened sections 110 and 126. Prior to the 1990 amendments, the two provisions, read together, prohibited emissions from "any stationary source" which would "*prevent* attainment or maintenance by any other State of any [NAAQS] ...." *New York v. EPA*, 852 F.2d 574, 576 (D.C. Cir. 1988) (emphasis added), *cert. denied*, 489 U.S. 1065 (1989). The revised standard allows a petition so long as emissions from any major source *or group of stationary sources contribute significantly* to nonattainment in, or *interfere with* maintenance by, any other state with respect to any NAAQS. CAA §§ 110(a)(2)(D)(i)(I), 126(b), 42 U.S.C. §§ 7410(a)(2)(D)(i)(I), 7426(b). The effect of these changes was to clarify the standard under section 126 in order to render it a more viable remedy for interstate pollution.[5]

Section 126(b) allows EPA to find that "any major source or group of stationary sources emits or would emit any air pollutant in violation of *the prohibition of section 110(a)(2)(D)([i])* or this section." 42 U.S.C. § 7426(b) (emphasis added). The "prohibition" is the actual "functional prohibition" of section 110(a)(2)(D)(i) upon emissions of pollutants that subsequently cross state lines. *Appalachian Power*, 249 F.3d at 1045-46. Consequently, the determination of whether the "prohibition" on excessive interstate transport of air pollutants is being violated is the same under sections 110 and 126. Therefore, if EPA determines that a state's SIP is not adequate to meet the requirements of section 110(a)(2)(D)(i), it necessarily follows that the prohibition of section 126 is also violated and grounds for a section 126 petition exist as to the sources and groups of sources

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[4] Section 126(b) contains a "scrivener's error." Despite the actual statutory text, the correct cross reference is to § 110(a)(2)(D)(*i*), rather than to § 110(a)(2)(D)(*ii*). *Appalachian Power Co. v. EPA*, 249 F.3d 1032, 1041-44 (D.C. Cir. 2001).

[5] "Since it may be impossible to say that any single source or group of sources is the one which actually prevents attainment, the bill changes 'prevent attainment or maintenance' to 'contribute significantly to nonattainment or interfere with maintenance by,' thus clarifying when a violation occurs." S. Comm. on Envt. & Pub. Works, 103d Cong. 1st Sess., *A Legislative History of the Clean Air Act Amendments of 1990* at 8361 (Comm. Print 1993).

identified in the SIP call. Specifically, EPA's proposed findings in the *IAQR* would also apply under section 126.

The United States Court of Appeals for the District of Columbia Circuit further clarified the relationship between these specific provisions in *Appalachian Power*. The court affirmed EPA's position that the two provisions are independent statutory tools to address the problem of interstate pollution transport. Consequently, EPA may use them separately or in tandem. *Appalachian Power*, 249 F.3d at 1048.

3. The Ozone Transport Assessment Group ("OTAG") Section 126 Rule

In 1999, EPA made its first and only determinations under section 126 as revised by the 1990 amendments upon petitions by several northeastern states regarding downwind ozone nonattainment. *See Findings of Significant Contribution and Rulemaking on Section 126 Petitions for Purposes of Reducing Interstate Ozone Transport*, 64 Fed. Reg. 28,250 (May 25, 1999) ("*OTAG 126 Rule*"). In that section 126 rulemaking, EPA developed a methodology for making "significant contribution" determinations. Primarily, EPA developed comprehensive emissions inventories for the downwind and upwind states and projected those inventories out to the planning year. EPA then used photochemical modeling to determine the collective impact of the emissions in each upwind state on ozone levels in each downwind state. In particular, EPA used zero-out modeling to assess the total impact of all sources in each individual state. The impacts were evaluated according to several metrics, which were designed to assess the frequency and magnitude of the upwind sources' contributions. If the modeling showed that emissions from one upwind state's sources contributed significantly to the attainment problems of any petitioning state, EPA considered the sources in that upwind state to collectively violate section 126 to the extent that the emissions could be eliminated through the application of cost-effective controls. *See Findings of Significant Contribution and Rulemaking on Section 126 Petitions for Purposes of Reducing Interstate Ozone Transport (Notice of Proposed Rulemaking)*, 63 Fed. Reg. 56,292 (Oct. 21, 1998).

EPA's process for the final *OTAG 126 Rule* logically carried forward its findings made in support of the "*NO_X SIP Call*." *See Finding of Significant Contribution and Rulemaking for Certain States in the Ozone Transport Assessment Group Region for Purposes of Reducing Regional Transport of Ozone*, 63 Fed. Reg. 57,356 (Oct. 27, 1998) ("*NO_X SIP Call*"). The Court of Appeals for the District of Columbia Circuit upheld EPA's methodology in *Michigan v. EPA*, 213 F.3d 663 (D.C. Cir. 2000), *cert. denied*, 532 U.S. 904 (2001). In the direct challenge to the section 126 rulemaking, the court permitted EPA to use the *NO_X SIP Call* data to make section 126 findings concerning an individual source, or group of sources, in the same states. *Appalachian Power*, 249 F.3d at 1048-51. In the *IAQR*, EPA properly proposes to use the *OTAG 126 Rule* methodology and North Carolina applies that methodology in this petition.

EPA made clear in the *OTAG 126 Rule* that formal nonattainment designations are not required in advance of a section 126 finding. EPA interprets "nonattainment" as it is used in sections 110(a)(2)(D)(i)(I) and 126(b) as a reference to actual air quality, rather than to formal designation

status. *NO_X SIP Call*, 63 Fed. Reg. at 57,370-72; *see also OTAG 126 Rule*, 64 Fed. Reg. at 28,286-87. Notably, the term "area" does not appear anywhere in section 110(a)(2)(D). This is in contrast to other CAA provisions which use the term "area" explicitly when referring to areas formally designated as nonattainment. *Id.* at 28,286. For the same reason, the term "maintenance" in a separate clause of section 110(a)(2)(D)(i)(I) is interpreted by EPA to refer to air quality condition, not formal designation status.[6] *NO_X SIP Call*, 63 Fed. Reg. at 57,372 n.19.

Therefore, when a downwind state's data shows actual present or predicted future nonattainment of a NAAQS then, regardless of its current formal designation status, EPA can make a section 126 finding. EPA's interpretation was upheld by the D.C. Circuit in *Appalachian Power*. 249 F.3d at 1066. In upholding EPA's interpretation, the court emphasized the fact that section 110(a)(2)(D)(i) speaks simply of emissions that contribute significantly to nonattainment and contains no language suggesting that a formal designation is critical to the determination. *Id.*

This interpretation is consistent with EPA's position that modeling of future nonattainment is sufficient to support a section 126 finding. By necessary implication, section 126 contemplates the use of modeling to assess significant contribution. *OTAG 126 Rule*, 64 Fed. Reg. at 28,286. Section 126(b) provides that any State may petition for a finding that any source or group of sources "emits or *would* emit" (emphasis added) in violation of section 110. In order to determine whether sources violate the provision now *or would* do so *in the future*, modeling is simply necessary. This anticipation of prospective significant contribution is likewise implicit in section 126(a), which provides for notice in advance of construction of major new sources or the modification of existing sources that would have the same effect. *Id.* at 28,287-88. Hence, a designated "nonattainment area" or "maintenance area" is not a prerequisite for EPA to make a positive finding under section 126.

B. The $PM_{2.5}$ Standard

Particulate matter includes both solid particles and liquid droplets found in air. This petition regards only the NAAQS for those particles that are less than 2.5 micrometers in diameter ("$PM_{2.5}$"). The $PM_{2.5}$ NAAQS is comprised of an annual primary (health based) standard of 15 micrograms per cubic meter and a 24-hour primary standard of 65 micrograms per cubic meter. The secondary (welfare based) standard is identical. 40 C.F.R. § 50.7; *see generally National Ambient Air Quality Standards for Particulate Matter*, 62 Fed. Reg. 38,652 (July 18, 1997) ("*$PM_{2.5}$ NAAQS Rule*"); *American Trucking Ass'ns v. EPA*, 283 F.3d 355, 360 (2002) ("*ATA II*").

EPA based the $PM_{2.5}$ standards on the link between ambient particles and serious health problems. *$PM_{2.5}$ NAAQS Rule*, 62 Fed. Reg. at 38,654-61. As the D.C. Circuit acknowledged, "[t]he

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[6] For convenience, the State refers primarily in this petition to the "significant contribution" of sources in upwind states to North Carolina's "nonattainment." However, this petition applies equally to "interference" by sources in upwind states with North Carolina's "maintenance" of the NAAQS, and any references to "significant contribution" and/or "nonattainment" are intended to include "interference" and/or "maintenance," unless otherwise indicated.

growing empirical evidence demonstrating a relationship between fine particle pollution and adverse health effects amply justifie[d] establishment of new fine particle standards." *American Trucking Ass'ns v. EPA*, 175 F.3d 1027, 1059 (1999), *rev'd*, 531 U.S. 457 (2001) (upholding NAAQS). "$PM_{2.5}$ is associated with a range of adverse health effects such as coughing; shortness of breath; aggravation of existing respiratory conditions like asthma and chronic bronchitis; increased susceptibility to respiratory infections; and heightened risk of premature death." *ATA II*, 283 F.3d at 359.

In addition, elevated concentrations of $PM_{2.5}$ impair visibility, thereby reducing people's sense of "well-being ..., where they live and work, and in places where they enjoy recreational opportunities," such as parks and wilderness areas. *$PM_{2.5}$ NAAQS Rule*, 62 Fed. Reg. at 38,680. Haze can also deter tourism in areas where vistas may be obscured, thereby negatively impacting the economy. Other environmental problems associated with $PM_{2.5}$ include soot, which stains and damages stone and other materials, and atmospheric deposition of particles on ground or water. The effects of this settling can change the nutrient balance in coastal waters and large river basins, deplete nutrients in soil, damage sensitive forests and farm crops, make lakes and streams too acidic and affect the diversity of ecosystems. *See* www.epa.gov/air/urbanair/pm/index.html (March 1, 2004).

As noted in the proposed *IAQR*, "EPA has estimated that attainment of the $PM_{2.5}$ standards would prolong tens of thousands of lives and prevent tens of thousands of hospital admissions each year, as well as hundreds of thousands of doctor visits, absences from work and school, and respiratory illnesses in children." *IAQR*, 69 Fed. Reg. at 4571/2. Furthermore, studies indicate that for at least certain segments of the population, "there is no clear threshold below which adverse health effects are not experienced ...." *Id.* For those people who are particularly sensitive to fine particles, negative effects may occur from exposure at levels even below those set for the annual and 24-hour standards. Individuals particularly sensitive to fine particle exposure include "older adults, people with heart and lung diseases, and children." *Id.*; *see generally $PM_{2.5}$ NAAQS Rule.*

C. The Eight-Hour Ozone Standard

EPA also took final action to revise the NAAQS for ozone in 1997. *National Ambient Air Quality Standards for Ozone,* 62 Fed. Reg. 38,856 (July 18, 1997) ("*Ozone NAAQS Rule*"). Ground level ozone, a primary harmful constituent in smog, forms when NO_X and volatile organic compounds ("VOCs") interact with sunlight in the earth's atmosphere. *NO_X SIP Call*, 63 Fed. Reg. at 57,359. Power plants and vehicles are major anthropogenic sources of ozone precursors. Ozone is a secondary pollutant formed downwind of sources of NO_X and VOCs and hence can be more severe many miles from these sources. *See id.*

EPA's studies show that ground-level ozone is a non-threshold pollutant. *Ozone NAAQS Rule*, 62 Fed. Reg. at 38,863. The standards EPA promulgated in 1997 for primary and secondary ozone are identical: the three-year average of the fourth highest daily maximum eight-hour average ozone concentration cannot not exceed 0.08 parts per million ("ppm"). 40 C.F.R. § 50.10; *see generally Ozone NAAQS Rule*, *supra*; *ATA II*, 283 F.3d at 360 . The revised standard is more

protective of public health and the environment and more stringent than the pre-existing one-hour standard. *Id.*

Both short-term (one- to three-hour) and prolonged (six- to eight-hour) exposures to ozone have been linked to a number of adverse health effects. *IAQR*, 69 Fed. Reg. at 4571. "Significant health effects associated with ozone pollution include coughing; throat irritation; aggravation of existing conditions such as asthma, bronchitis, heart disease, and emphysema; and lung tissue damage." *ATA II*, 283 F.3d at 359. Among those particularly susceptible to the effects of ozone are children and adults who are active outdoors and people with respiratory illnesses. Ozone also affects vegetation and ecosystems, leading to reductions in agricultural crop and commercial forest yields and increased plant susceptibility to disease, pests, and harsh weather. *Id.*

Ozone and $PM_{2.5}$ are closely linked, not only by a pollutant that contributes to their formation (*i.e.* NO_X), but by emission sources and NAAQS implementation schedules. *IAQR*, 69 Fed. Reg. at 4580. Both are serious public health concerns. The attainment of both standards as expeditiously as practicable is a paramount goal of North Carolina. *See* CAA §§ 172, 181, 42 U.S.C. §§ 7502, 7511.

II. EMISSIONS FROM FACILITIES IN UPWIND STATES CONTRIBUTE SIGNIFICANTLY TO NONATTAINMENT IN AND INTERFERE WITH MAINTENANCE BY THE STATE OF NORTH CAROLINA WITH THE $PM_{2.5}$ AND EIGHT-HOUR OZONE STANDARDS[7]

A. Areas in North Carolina Are Not Attaining the $PM_{2.5}$ Standard

1. North Carolina's Monitoring Efforts

North Carolina has been collecting various ambient particulate data since the early days of the federal Clean Air Act in the 1970s. These efforts began with sampling of only total suspended particulates ("TSP"). In the mid-1980s, North Carolina began sampling PM_{10}. The North Carolina network has experienced only one exceedance of the PM_{10} standard, which was caused by an exceptional forest fire event near the subject monitor. Due to the promulgation of the $PM_{2.5}$ standard, the State has largely scaled back its sampling of TSP and PM_{10}.

North Carolina began sampling $PM_{2.5}$ in January 1999 with approximately thirty-three Rupprecht & Patashnick Company, Inc. ("R&P") Federal Reference Method ("FRM") samplers.[8]

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[7] Unless otherwise specified, all data and information presented in Part II of this petition was collected, analyzed and/or provided by the North Carolina Division of Air Quality ("NC DAQ"). All supporting data and information is on file at NC DAQ.

[8] The locations of most of the monitors have been stable. NC DAQ lost adequate permission regarding some sites due to changes in ownership of the site or rescission of the authority to use the site.

All selected statewide sites were not immediately established as EPA could only supply a limited number of samplers to each state on a nationwide basis.

The sites were selected using EPA guidance, and thus were located near where people eat, sleep, work and engage in recreational activities. The State avoided so-called "fence line monitors," which are located nearby large, potential sources of precursors of $PM_{2.5}$, such as industrial combustion processes and EGUs. The majority of the samplers were sited to correspond to the most densely populated areas of the State according to the 1990 census. Samplers were required in certain large metropolitan areas (*i.e.* Charlotte, Greensboro, Raleigh-Durham and Winston-Salem) as these locations exceeded a threshold population level. The State then ranked other areas by population and placed monitors in the larger, more densely populated areas, but avoided siting samplers where a duplication of effort would result.

Following EPA guidance, North Carolina also selected some background and pollutant transport sites. Background sites are not close to large metropolitan or industrial areas generating particulate matter. Transport sites are locations in North Carolina that primarily measure transport of particulates into North Carolina from other states. For example, a sampler was sited in Bryson City, which is a town of less than 1,500 people (according to the 2000 U.S. Census) located in rural western North Carolina. It is within 10 miles of the Tennessee border, within 35 miles of Georgia and about 40 miles from the South Carolina line. All selected sites were collecting data by the middle of 2000.

EPA validates the State's $PM_{2.5}$ data in two ways. It first conducts a systems audit of the paperwork. EPA also performs a complete system check of the State's samplers using a series of co-located samplers administered by different technicians and using a different laboratory. Data from the North Carolina Division of Air Quality's ("NC DAQ") monitoring network has proven to be well within desired variances when compared to data from EPA's co-located samplers. The State administers additional monitors that also validate data collected from the FRM network. These are R&P Tapered Equilibrium Oscillating Microbalance ("TEOM") Series samplers and Met One Instruments, Inc. SuperSASS speciation samplers.

2. Current $PM_{2.5}$ Levels in North Carolina

Data for the period from 2000 to 2003 show that six of North Carolina's $PM_{2.5}$ monitors are currently, or were recently, not attaining the annual NAAQS.[9] The design values for those monitors are as follows:

[9] The listing of data here does not indicate North Carolina's judgment that any county in which a monitor currently is not attaining should be designated a "nonattainment area" in its entirety. The process for and consequence to local communities of a "nonattainment area" designation are distinct from those that apply under section 126.

County	2000-02 Design Value	2001-03 Design Value
Cabarrus	15.1 $\mu g/m^3$	14.9 $\mu g/m^3$
Catawba	16.4	15.5
Davidson	16.8	15.8
Forsyth	15.6	14.6
McDowell	15.6	14.2
Mecklenburg	15.8	14.9

EPA, *Air Quality Data Analysis Technical Support Document for the Proposed Interstate Air Quality Rule* at 79 (Jan. 2004) ("*Data TSD*").[10] In addition, the 2000-02 design value for Guilford County was 15.1 $\mu g/m^3$, but the county did not meet the completeness criteria and was not able to take advantage of the approved data substitution technique. *Id.* at 81. Design values in excess of 15.0 $\mu g/m^3$ are not attaining the $PM_{2.5}$ annual NAAQS.

The following monitors exhibited design values in both periods within ten percent (1.5 $\mu g/m^3$) of the $PM_{2.5}$ standard:

County	2000-02 Design Value	2001-03 Design Value
Alamance	14.4 $\mu g/m^3$	13.8 $\mu g/m^3$
Buncombe	14.2	14.1
Caswell	14.0	13.7
Cumberland	14.7	14.4
Durham	14.7	14.2
Gaston	14.7	14.5
Haywood	14.6	14.4
Mitchell	14.8	14.1
Orange	13.6	13.5
Wake	14.6	14.2
Wayne	14.6	14.2

Data TSD at 83.

3. EPA Modeling Shows Future Nonattainment

To support its proposed *IAQR*, EPA modeled future design values for $PM_{2.5}$. The development of emissions inventories, the details of the model, evaluation of model performance and other relevant topics are discussed at length in the preamble to the *IAQR*, EPA's *Technical Support Document for the Interstate Air Quality Rule: Air Quality Modeling Analysis* (Jan. 2004)

[10] For $PM_{2.5}$ and ozone, design values for 2001-03 are based on data on file with NC DAQ. For $PM_{2.5}$, the 2001-03 design values for Alamance, Buncombe, Cabarrus, Caswell, Cumberland, Durham, Gaston, Haywood and Mitchell Counties were calculated from the fourth quarter of 2000 through the third quarter of 2003. The 2000-02 design value for Davidson County in the *Data TSD* appears to include an erroneous data point. The table includes the State's corrected value.

("*Modeling TSD*"), and related and referenced literature.[11] The State refers EPA to those documents and will not summarize EPA's own technical work here. The State submits that EPA's modeling is the most comprehensive and detailed modeling performed to date regarding $PM_{2.5}$ attainment and therefore clearly deserves great weight in the evaluation of this petition. Only the relevant results are presented here.

EPA found that for the base case, Catawba, Davidson and Mecklenburg Counties were projected to be nonattainment in 2010. The respective design values for these counties were projected to be 15.26 $\mu g/m^3$, 15.52 $\mu g/m^3$ and 15.18 $\mu g/m^3$. The three other counties that exceeded the standard in 2000-02 are projected to be below the $PM_{2.5}$ NAAQS in 2010: Cabarrus (13.68 $\mu g/m^3$), Forsyth (14.44 $\mu g/m^3$) and McDowell (14.54 $\mu g/m^3$). *Modeling TSD* at F-2.

With EPA's suite of approximated local measures applied, including North Carolina's Clean Smokestacks Act, Catawba, Davidson and Mecklenburg Counties appear to be projected to attain by 2010. *IAQR*, 69 Fed. Reg. at 4637-38; *Modeling TSD* at L-1 to L-2. Of course, this does not obviate the legal foundation for a petition under section 126. A petition may be granted so long as out-of-state sources contribute significantly to current downwind nonattainment. Moreover, sites initially designated nonattainment will be required to assure maintenance in the future. Also, localities with design values close to, but not exceeding, the NAAQS may have difficulty with maintaining their compliant status. In either case, upwind sources in other states that account for ambient concentrations of $PM_{2.5}$ above the threshold amount of 0.15 $\mu g/m^3$, *see* Part II.C.4.a, are interfering with downwind maintenance. EPA must recognize this status and grant relief under the prohibition of section 126 against interfering with maintenance by the downwind state.

B. Areas in North Carolina Are Not Attaining the Eight-Hour Ozone Standard

1. North Carolina's Monitoring Efforts

The State began monitoring ground-level ozone in the 1970s in order to assess compliance with the original federal photochemical oxidants NAAQS and then with the one-hour ozone NAAQS. In addition to the many sites maintained and operated by NC DAQ, the local programs of the Mecklenburg County Department of Environmental Protection, Forsyth County Environmental Affairs Department, and Western North Carolina Air Pollution Control Agency independently operate ozone monitoring sites and report data to the State.

The total number of ozone monitoring sites operating throughout the State, including local programs, has grown in recent years from 45 to 47 monitors and from 33 to 35 counties. The North Carolina network has only minimal fluctuations in number of sites and counties with monitors and

[11] The State intends to submit comments to EPA regarding the *IAQR* that discuss EPA's modeling in more detail. Based on an initial evaluation of data and information released by EPA, the State has identified a few key issues of concern. For example, the 2010 base case inventories appear to assume emission levels for EGUs that differ from plans submitted pursuant to the State's Clean Smokestacks Act, which may result in changes to future projected design values.

so is considered stable. Overall, the State has one of the most extensive, well-maintained ozone monitoring networks in the country.

All State and local program monitoring sites employ Thermo Environmental Instruments, Inc. ("TEI") Continuous Ozone Monitors. TEI monitors were placed in service at all State-operated sites in 1997. These TEI devices were designated by EPA as an Equivalent Method for the measurement of ambient ozone concentration. Ozone concentration data is recorded each minute for twenty-three hours each day. The remaining hour is reserved for daily auto-calibration of the instrument, which occurs in the early morning when ozone concentrations are low.

The ozone monitoring network is designed to satisfy four specific objectives: to determine (1) maximum population exposure, (2) maximum concentration, (3) maximum emissions impact and (4) urban background concentration. Monitor locations are selected to fulfill at least one of these objectives. The actual monitor locations must not be impacted by nearby sources or sinks. Monitors in North Carolina comply with EPA placement criteria, which require separation from obstructions, roadways and trees, and which establish specific sampling probe placement criteria. All monitor locations have been approved by EPA. In addition, NC DAQ annually performs a complete review of the monitoring network and reports its results to EPA.

NC DAQ has developed, and EPA has approved, the State's Ozone Monitoring Quality Assurance Plan and Standard Operating Procedure ("QA/SOP"), which establishes the operation, performance, and data review criteria for the ozone monitors. The purpose of the QA/SOP is to insure the highest quality data possible. The local programs also have developed and submitted QA/SOPs to the EPA for approval. In accordance with the QA/SOP, NC DAQ reviews all data and operational procedures from each site, including monitors maintained by the local programs.

2. Current Eight-Hour Ozone Levels in North Carolina

For the period 2001 through 2003, design values for monitors in twenty counties in North Carolina exceeded the eight-hour ozone standard. The highest design value in the State -- 0.100 ppm -- was recorded in Rowan County, just downwind from the State's largest city, *i.e.* Charlotte.

On July 15, 2003, North Carolina submitted to EPA its proposed designations for nonattainment areas for the eight-hour ozone standard, and on February 6, 2004, the State updated these recommendations using the most recent data. The State recommended the creation of six nonattainment areas. Several of these encompassed more than one monitor. The table below indicates the highest design value for the monitors in each area.

Area[12]	Highest Design Value 2000-02	2001-03
Charlotte-Gastonia-Rock Hill	0.102 ppm	0.100 ppm
Cumberland County	0.087	0.087
Edgecombe County	0.088	0.089
Great Smoky Mountains National Park/ Haywood County	0.087	0.085
Greensboro-Winston-Salem-High Point	0.095	0.093
Hickory-Morganton	0.091	0.088
Raleigh-Durham-Chapel Hill	0.094	0.094

Data TSD at 118. In practice, the NAAQS for ozone requires a design value less than 0.085 ppm. Of the remaining counties in North Carolina in which the State maintains monitors, all but one had a 2001-03 design value within ten percent of the NAAQS. The following table indicates the design values for those North Carolina counties that are below the NAAQS for the most recent period but within ten percent of the standard.

County	2000-02 Design Value	2001-03 Design Value
Avery	0.079 ppm	0.078 ppm
Buncombe	0.085	0.078
Duplin	0.081	0.079
Lenoir	0.081	0.081
Martin	0.081	0.081
New Hanover	0.079	0.078
Northampton	0.084	0.084
Pitt	0.083	0.082
Yancey	0.087	0.083

Id. at 128.

3. EPA Modeling Shows Future Nonattainment

EPA modeling for the *IAQR* projects that many of the monitors that have current design values in excess of the eight-hour ozone NAAQS will be in attainment by 2010. However, the model indicated that Mecklenburg will have a 2010 base case design value of 0.085 ppm.[13] In addition, monitors in six counties will be within ten percent of the NAAQS (Davie, Franklin, Granville, Lincoln, Rowan and Wake). In 2015, monitors in two counties are projected to remain

[12] As discussed also in footnote 9, the nonattainment area names used here are for identification purposes only. These identifiers do not necessarily fully and completely describe the scope of the nonattainment area. For example, North Carolina recommended that the Edgecombe County nonattainment area not include all of Edgecombe County.

[13] Mecklenburg is projected to have a design value of 0.086 ppm in 2010 *after* the application of the *IAQR* interstate transport remedy. *See* footnote 17.

within ten percent of the attainment value (Mecklenburg and Rowan). *Modeling TSD* at D-4 to D-5; *IAQR*, 69 Fed. Reg. at 4640.

C. EGUs in Upwind States Are Contributing Significantly to North Carolina's Nonattainment

Ample evidence demonstrates that EGUs outside North Carolina are contributing significantly to nonattainment and maintenance problems within the State. This includes the Southern Appalachian Mountains Initiative evaluation, North Carolina's further evaluation of that analysis as well as other technical work performed by the NC DAQ. EPA's own modeling, discussed in detail in the preamble to the proposed *IAQR* and the associated technical support documents, has confirmed the State's conclusion.

1. Southern Appalachian Mountains Initiative

The Southern Appalachian Mountains Initiative ("SAMI") is a public-private voluntary partnership lead by eight southeastern states: Alabama, Georgia, Kentucky, North Carolina, South Carolina, Tennessee, Virginia and West Virginia. It was formed in 1992 as a reaction to the growing concerns regarding the permitting of new emissions sources near federal Class 1 areas in the southern Appalachian Mountains. SAMI, *Final Report* at 1.1 (Aug. 2002). The visibility problems in these natural areas are now well documented. The geographic scope of the SAMI analysis, however, was not limited just to the federal Class 1 areas. The emissions inventories covered the eastern two-thirds of the United States. *Id.* at 2.1. The finest grid of SAMI's advanced, integrated photochemical model encompassed the western half of North Carolina and included all six areas identified above as not attaining the $PM_{2.5}$ standard in 2000-02. *See id.* at 3.5. All aspects of the SAMI inventories, modeling, results, *etc.* are presented in detail in the *Final Report*. Only the relevant technical aspects of the *Final Report* are summarized and discussed here.[14]

The first step in the SAMI analysis was to create an emissions inventory. The inventory included emissions from all major source categories: Utilities, industrial point sources, mobile sources (*i.e.* highway vehicles), nonroad engines and area sources. The pollutants inventoried were the precursors to particulates and ozone, *i.e.* NO_X, SO_2, VOCs and ammonia (NH_3). SAMI also accounted for direct emissions of fine and coarse particulates ($PM_{2.5}$ and PM_{10}), and naturally occurring precursors. *Final Report* at 2.1.

The SAMI inventory drew from the data collection done by the Ozone Transport Assessment Group ("OTAG"). The OTAG inventory contained 1990 data for source categories and pollutants of importance to SAMI. OTAG also covered the same geographic region of interest to SAMI and

[14] The focus of the SAMI assessment was visibility impacts. The formation of particulate matter played a more prominent role in the analysis than did compliance with federal ozone standards. Therefore, SAMI's work is discussed in this petition primarily as it relates to $PM_{2.5}$, but SAMI's efforts also support the State's conclusions with regard to the interstate transport of NO_X and the downwind formation of ozone.

the emissions data was provided by the states themselves. In 1998 and 1999, EPA relied on this data to draw conclusions regarding interstate transport of NO_X in the *NO_X SIP Call* and the *OTAG 126 Rule*. Other data of interest to SAMI was gleaned from EPA's 1990 National Emissions Trends Inventory. Once the inventory was initially compiled, it was circulated to the stakeholders (including the utility sector) for review, and was revised several times before being finalized. Although confidence in the inventory varies by source and pollutant, the most certainty exists with regard to the largest point sources. Thus, SAMI is most confident regarding its inventory of NO_X and SO_2 from EGUs. *Final Report* at ch. 2.

SAMI then projected emissions for the short and long term using the years 2010 and 2040. Scenario "A2" included many controls that were projected to be implemented throughout this period, even though such controls had not yet been implemented or even reduced to final regulatory form. These controls included the Tier II highway vehicle and fuels rules, and the *NO_X SIP Call*. *Final Report* at 2.4-2.8.

Although the starting point for the SAMI emissions inventory was 1990 data, and there was some uncertainty regarding future control requirements, the values developed appear to be fairly accurate. EPA developed a similar emissions inventory for the *IAQR*. For the 2010 base case, EPA found that emissions of SO_2 in the eight SAMI states would total 2.94 million tons. *IAQR*, 69 Fed. Reg. at 4589-90. The *Final Report* predicts emissions of 3.27 million tons for the same sources in the same states. *Final Report* at 2.6. It is expected that EPA projections would be lower than those of SAMI because North Carolina's Clean Smokestacks Act was included in EPA's calculations.

The SAMI modeling used nine meteorological episodes of varying characteristics and durations, for a total of sixty-nine model days. SAMI brought together a meteorological model (Regional Atmospheric Modeling System 3b), an emissions model (Emissions Modeling System), and SAMI's own three-dimensional photochemical model -- the Urban-to-Regional Multiscale - One Atmosphere Model ("URM-1ATM"). The URM-1ATM was evaluated by comparing modeled values to observed data. The model generally met SAMI's performance criteria. The model performed well with regard to $PM_{2.5}$, sulfates and organic carbon. Because sulfates and organic carbon are the two largest sources of $PM_{2.5}$, use of the model to evaluate sensitivities to changes in emissions resulting in transported fine particles is appropriate. Despite the fact that the model was designed to assess conditions in the federal Class 1 areas, it is noteworthy that the model also performed well in urban areas. *Final Report* at 3.1-3.7.

SAMI's geographic sensitivity analyses assessed the effects in the SAMI region of reductions of specific pollutants from designated SAMI states and regions outside those states. Of particular concern, SAMI evaluated the impact of ten percent reductions of SO_2 emissions in each SAMI state individually for particular meteorological episodes. *Final Report* at 3.13-3.17. Because SO_2 is primarily emitted by utilities, the ten percent reduction in overall SO_2 emissions evaluated in the 2010 A2 scenario could be achieved by EGUs alone if such facilities were to reduce SO_2 emissions by only fourteen percent. Thus, evaluating the impacts of a ten percent cutback, while highly instructive for identifying significant contributions, underestimates the total impact of EGU

emissions. By comparison, in evaluating the interstate contribution for the *NO_X SIP Call*, the *OTAG 126 Rule* and the proposed *IAQR*, EPA and OTAG performed "zero-out" modeling, which assessed the impacts of a one hundred percent reduction from all sources.

The model runs showed that a collective ten percent reduction in SO_2 emissions in the upwind SAMI states would result in reduction of the ambient level of $PM_{2.5}$ of over 0.15 $\mu g/m^3$ in nonattaining areas in North Carolina. NC DAQ also approximated the effects of a thirty percent reduction in SO_2 emissions in the upwind SAMI states and regions. Such controls in Tennessee alone would account for a reduction of over 0.15 $\mu g/m^3$ in North Carolina's $PM_{2.5}$ nonattaining areas. This reduction exceeds the significance level identified by EPA above which contributions are considered significant (before considering cost). *See* Part II.C.4.a.

NC DAQ's supplemental analysis of individual modeled days demonstrates the contribution that each state makes to ambient $PM_{2.5}$ levels in North Carolina. For example, for the July 15, 1995 and July 31, 1991 episodes, a ten percent reduction in SO_2 emitted in Virginia would have resulted in a lowering of the $PM_{2.5}$ level of greater than 0.1 $\mu g/m^3$ in North Carolina. The same is true for sources in the Midwest Region (Illinois, Indiana, Michigan, Ohio and Wisconsin). Similar reductions in West Virginia on the July 15, 1995 and July 27, 1991 episode days also show a lowering of the $PM_{2.5}$ level of greater than 0.1 $\mu g/m^3$. The contributions from Tennessee are greater than or equal to the other states' contributions on all days discussed above. The other SAMI states contribute as well, although at lower levels. Nonetheless, a cumulative ten percent reduction in SO_2 from out-of-state sources on the episode days frequently equates to reductions in North Carolina in excess of 0.15 $\mu g/m^3$, the EPA threshold for significant contribution (before considering cost).

In short, the SAMI effort clearly shows the interstate character of $PM_{2.5}$ formation in North Carolina. To reiterate, the contributions discussed here resulted from only a ten percent reduction in SO_2 emissions, which is approximately only a fourteen percent reduction in EGU emissions. Had SAMI used zero-out modeling, as practiced by the EPA, the contributions from individual states and from the upwind EGUs collectively would have been far more sizeable. The SAMI modeling is not intended to suggest, for example, that only a ten or thirty percent reduction in upwind emissions is necessary. To the contrary, the demonstrable impacts from these relatively modest overall reductions indicates the need for sizable cuts in upwind emissions. The sensitivity of North Carolina air quality even to relatively small reductions of these pollutants in upwind states is amply demonstrated.

To combat the problem of interstate $PM_{2.5}$ pollution, SAMI recommended strong national controls specifically on emissions of SO_2 and NO_X from EGUs. *Final Report* at 10.5. EPA agreed that SAMI's work "support[s] a regional control approach" for SO_2. *IAQR*, 69 Fed. Reg. at 4607/2. In addition, EPA indicated that the SAMI results are "very consistent [with] and supportive of" EPA's modeling in that they show that "[h]igh concentrations of $PM_{2.5}$ at sensitive downwind receptors are ... heavily influenced by emissions in adjacent States as well as emissions from States in other regions." *Id.*

2. Back Trajectory Analysis

In order to further evaluate the possible source areas of contributions to elevated particulate matter levels in North Carolina, NC DAQ analyzed back trajectories from the Catawba and Davidson County monitors. These two locations were selected because they recorded the highest annual average $PM_{2.5}$ values in the State. Using the National Oceanic and Atmospheric Administration Air Resource Laboratory Hybrid Single-Particle Lagrangian Integrated Trajectory ("HYSPLIT") model, NC DAQ developed back trajectories for days between January 1, 1999 and June 30, 2002 for which the highest $PM_{2.5}$ values were recorded at the endpoints (*i.e.* the monitor sites).

Between the two sites, NC DAQ identified and evaluated 72 high-$PM_{2.5}$ days. For each day, based on the trajectory for that day, NC DAQ determined the most likely primary and secondary contributing states. For well over a third of the high-$PM_{2.5}$ days (39%), states other than North Carolina were listed as primary contributors.[15] On 15 of those days (21%), only states other than North Carolina were found to be primary contributors, whereas on 13 days (18%), NC DAQ determined that North Carolina and another state primarily contributed. Not surprisingly, sources in South Carolina, Tennessee and Virginia contributed more frequently than other upwind states to elevated $PM_{2.5}$ levels at both the Catawba and Davidson County sites.

NC DAQ also determined the residence times for trajectories in upwind states. These calculations showed that for high-$PM_{2.5}$ days, air masses lingered in nearby upwind states before entering North Carolina. For example, on high-$PM_{2.5}$ days in Davidson County for which the incoming trajectory passed over South Carolina, the air mass lingered over South Carolina on average for 19.9 hours of the 36-hour trajectory. Residence times for events involving Tennessee and Virginia were slightly less but still substantial (15.1 and 14.5 hours, respectively). Similar results were obtained regarding the Catawba County data. On high-$PM_{2.5}$ days involving South Carolina, the air mass lingered over South Carolina on average for 18.8 hours; for Tennessee, 18.4 hours; and for Kentucky, 14.4 hours. These represent substantial durations during which the air mass would acquire some of the characteristics of the resident ambient air. Among these characteristics appear to be elevated levels of $PM_{2.5}$ and its precursors. NC DAQ's back trajectory analysis is attached at Appendix A.

3. Overall Trends in the Region

Broader data indicate a substantial connection between out-of-state sources and $PM_{2.5}$ levels across North Carolina. NC DAQ collected from EPA's Acid Rain Program SO_2 emissions data for utilities in the following eight states: Georgia, Kentucky, North Carolina, Ohio, South Carolina, Tennessee, Virginia and West Virginia. The data show a decreasing trend in SO_2 emissions across

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[15] North Carolina sources were a primary contributor 79% of the time. This percentage includes the number of days on which North Carolina and another state were both determined to be primary contributors. Through North Carolina's enactment of mandatory reductions in the Clean Smokestacks Act, the State is addressing its share of the problem.

the region. The most significant absolute reductions occurred in Kentucky, Ohio, Tennessee and West Virginia. Smaller reductions occurred in South Carolina. EGU emissions of SO_2 actually increased slightly in Georgia and Virginia. Significantly, emissions in North Carolina were fairly steady over this period, whereas total regional emissions dropped from about 4.5 million tons in 1999 to about 3.9 million tons in 2002. The following table indicates the SO_2 emissions from utilities in and near North Carolina for the specified years.

State	1999	2000	2001	2002
Georgia	512,226	518,752	489,634	512,494
Kentucky	678,801	586,909	537,667	484,129
North Carolina	457,943	453,442	449,656	462,993
Ohio	1,308,935	1,209,358	1,124,155	1,132,067
South Carolina	214,651	200,176	198,954	199,118
Tennessee	443,478	424,973	356,608	333,576
Virginia	225,739	214,232	217,435	230,846
West Virginia	694,516	593,315	498,056	507,106
Total	4,536,290	4,201,157	3,872,166	3,862,329

During the same period, average annual $PM_{2.5}$ concentrations in North Carolina for the entire $PM_{2.5}$ monitoring network has shown a downward trend from 2000 to 2002. The average annual concentrations for all sites from 1999 to 2002 are:

Year	Annual Concentration
1999	15.16 $\mu g/m^3$
2000	15.30
2001	13.51
2002	13.17

This trend supports the conclusion that out-of-state SO_2 reductions contribute to decreases in $PM_{2.5}$ levels in North Carolina. These data are particularly persuasive with regard to sources in Kentucky, Ohio, Tennessee and West Virginia. Emissions data for sources in the other states named in this petition regarding $PM_{2.5}$ show a similar trend.

The cause of the recent decreases in SO_2 emissions from utilities is not clear. It is possible that this trend is the result of the Acid Rain Program, but nonregulatory causes may also explain the trend at least in part. If SO_2 emissions continue to decrease across the region, North Carolina expects its in-state $PM_{2.5}$ levels to drop as well. The relief sought by this petition will ensure that both of these trends continue.

4. EPA Modeling and Other Studies Demonstrate the Contributions from Upwind Sources

In the *Modeling TSD*, EPA presented detailed results from its zero-out modeling of both SO_2 and NO_X. As the modeling itself is discussed in detail in the preamble to the proposed *IAQR* and in the *Modeling TSD*, North Carolina will here present only the relevant results.

a. $PM_{2.5}$ Modeling

EPA's modeling of SO_2 and NO_X emissions showed the impact on $PM_{2.5}$ levels in North Carolina. The following table indicates the reduction in annual $PM_{2.5}$ levels in 2010 in Mecklenburg and Davidson Counties resulting from zeroing out anthropogenic emissions from sources in individual states. The table includes all upwind states for which sources contribute at least 0.10 $\mu g/m^3$ to either North Carolina county. EPA has proposed that a group of EGUs in an individual state contributes significantly to downwind nonattainment (before considering cost) if the contribution from sources in that state to a downwind receptor equals at least 0.15 $\mu g/m^3$. *IAQR*, 69 Fed. Reg. at 4608. Only the sources in the states in bold type face meet this criterion and are the subject of this petition with respect to $PM_{2.5}$.

State	Davidson	Mecklenburg
Alabama	0.27 $\mu g/m^3$	0.33 $\mu g/m^3$
Florida	0.11	0.14
Georgia	0.54	0.74
Illinois	0.28	0.25
Indiana	0.29	0.26
Kentucky	0.28	0.24
Maryland/DC	0.13	0.12
Michigan	0.16	0.14
Ohio	0.51	0.42
Pennsylvania	0.29	0.26
South Carolina	0.38	0.66
Tennessee	0.38	0.38
Texas	0.13	0.14
Virginia	0.32	0.24
West Virginia	0.25	0.21

Modeling TSD at H-2 to H-6. North Carolina to date has not performed $PM_{2.5}$ modeling of these sources. However, NC DAQ has examined the values derived by EPA. Based in part on data discussed above and also on NC DAQ's experience and expertise in this field, NC DAQ has concluded that the values are reasonable and credible.

The projected 2010 design values for Davidson and Mecklenburg Counties are 15.52 $\mu g/m^3$ and 15.18 $\mu g/m^3$, respectively. *Modeling TSD* at 60. The 2010 contributions for sources in each

state are, at a maximum, over four times the amount by which the downwind North Carolina monitor exceeds the NAAQS (*i.e.* sources in Georgia contributing to Mecklenburg). At the very least, sources in each individual state subject to this petition account for over thirty percent of the downwind monitor's annual exceedance (*i.e.* sources in Michigan contributing to Davidson).

b. Ozone Modeling

EPA modeled the impacts of emissions from each state on downwind ozone levels using CAMX zero-out modeling and CAMX source apportionment. The zero-out modeling shows the modeled effect in North Carolina of eliminating all anthropogenic sources of NO_X and VOCs in each upwind state individually. Source apportionment modeling assesses impacts in North Carolina by tracking emissions from upwind states. Because neither technique has been shown to be superior, EPA used both. *IAQR*, 69 Fed. Reg. at 4600. As with the $PM_{2.5}$ modeling, NC DAQ has examined the values derived by EPA and concluded that the values are reasonable and credible.

The results for Mecklenburg County are shown below. The table includes all states for which sources passed EPA's "screening" criteria. States in bold type face are those in which are located sources that are the subject of this petition. The assessment of contributions to ozone nonattainment is complicated by the fact that ozone uses an hourly standard, whereas $PM_{2.5}$ employs and annual standard. The various "metrics" assessed by EPA are presented in the columns in the tables below. For example, for zero-out modeling, EPA summed the amounts (in parts per billion ("ppb")) by which the downwind area exceeded the NAAQS and then determined the percentage of those aggregate exceedances attributable to each upwind state. This is the "Total Ozone Contribution Relative to the Base Case Exceedance Metric" and is shown in the first numeric column of the zero-out table. The "Frequency of Contribution Metric" indicates the number of times that sources in an upwind state collectively contributed two ppb or more to an exceedance in the downwind area (third column). The Frequency of Contribution Metric is also expressed as a percentage of total exceedances in the downwind area that were modeled, *i.e.* 23 for Mecklenburg County (fourth column). Other metrics are discussed in more detail in the *Modeling TSD* at 25-27.

CAMX Zero-Out Modeling

State	Percent Total Ppb Reduced	Percent Population-Weighted Total Ppb Reduced	No. Reduced >= 2 Ppb	Percent Reduced >= 2 Ppb	Max. 8-hour Ppb Contribution
South Carolina	76%	69%	19	83%	20.6
Georgia	33%	27%	10	43%	11.9
Virginia	8%	7%	4	17%	9.3
Maryland	1%	1%	1	4%	4.7
Tennessee	15%	15%	4	17%	3.0
Pennsylvania	1%	1%	1	4%	2.4

CAMX Source Apportionment Modeling

State	Avg. 4-Episode % Contribution	Highest Daily Avg.	Highest Daily Avg. Percent	No. Reduced >= 2 Ppb	Percent Reduced >= 2 Ppb	Max. 8-hour Ppb Contribution
South Carolina	14%	22	25%	89	82%	22
Georgia	5%	12	15%	71	66%	14
Virginia	3%	8	9%	31	29%	9
Maryland	1%	7	8%	8	7%	7
Tennessee	2%	3	4%	23	21%	4
Pennsylvania	1%	4	5%	10	9%	5

Modeling TSD at Appendix G. EPA's criteria for evaluating these data indicate that sources in Georgia, Maryland, South Carolina, Tennessee and Virginia contribute significantly to nonattainment in North Carolina (before considering cost). *Id.* at 27-36.

Mecklenburg County's projected base case design value in 2010 is 0.085 ppm. *Id.* at D-5. Contributions of the frequency and magnitude as those presented above certainly will threaten to increase the ozone level on days that are critical to the determination of the design value. The contributions are significant in the context of the area's ability to attain and maintain the standard.

c. Other Studies

EPA also performed other studies and analyzed other data, including correlating satellite data to ground-based data and evaluating back trajectories, that demonstrate the existence of significant interstate contributions to nonattainment and interference with maintenance of the NAAQS. This work is discussed in the preamble to the proposed *IAQR* and documented in EPA's *Data TSD*. NC DAQ has reviewed the preamble and the *Data TSD* and submits that the work contained therein further supports the conclusion that EGUs in the named states emit SO_2 and NO_X in violation of the prohibition of section 126.

5. EGUs Are Prime Contributors of SO_2 and NO_X

The foregoing analysis demonstrates the contribution of out-of-state SO_2 and NO_X emissions to $PM_{2.5}$ and ozone pollution in North Carolina. However, this petition requests relief only from emissions from EGUs. The SAMI inventory indicates that in 1990, emissions from the utility sector accounted for 79% of all SO_2 emissions in the SAMI states. The 2010 A2 case included all reasonably certain regulatory controls, and indicated that utilities still would emit 70% of all SO_2 in the region. The next most voluminous source category in either 1990 or the 2010 A2 case was industrial point sources. That sector accounts for only 11% and 15% in 1990 and the 2010 A2 case, respectively. Therefore, for example, under the 2010 A2 case, a 90% reduction in EGU emissions would result in about five times more SO_2 removed from the atmosphere than a similar reduction

from industrial point sources. Using the 1990 inventory, SO_2 emissions reductions would be seven times that of industrial reductions. *Final Report* at 2.6-2.7.

Similarly, the SAMI 1990 inventory for SAMI states shows that utilities emit more NO_X than any other source sector in the region, comprising 37% of total NO_X emissions. Utility NO_X emissions are 23% higher than the next largest group (motor vehicles). These ratios were generally maintained under the 2010 A2 scenario as well. *Id.*

Section 126 permits a state to petition EPA regarding "*any* major source or group of stationary sources [that] emits or would emit any air pollutant in violation of the prohibition of section 110(a)(2)(D)(ii) or this section." (Emphasis added.) Based on the technical information presented in this petition, North Carolina has concluded that SO_2 and NO_X emissions from the EGUs are the most prevalent contributors to the State's nonattainment issues. In its discretion under section 126, the State elects to petition against such sources at this time. *See IAQR*, 69 Fed. Reg. at 4609-10.

6. Highly Cost Effective Controls Exist for EGUs

Above, North Carolina demonstrated that emissions from EGUs in upwind states meet the threshold for a finding of significant contribution (before considering cost). In order to determine the extent of the significant contribution, it is necessary to evaluate what emissions may be eliminated through the application of highly cost effective controls.

In the preamble to the *IAQR*, EPA discussed the cost of controls necessary to reduce emissions of SO_2 initially to 50% of the levels established by Phase II of the federal Acid Rain Program and then to 35% of the Phase II allowance as a final remedy. EPA projected that the average cost per ton of SO_2 eliminated in the first stage would be $700 and the marginal cost would be $800. In stage two, the average cost per ton would be $800 and the marginal cost $1000. EPA then applied the methodology first used in the *NO_X SIP Call*. By comparing the costs of the proposed program to the costs of reducing SO_2 from other programs, EPA determined that the proposed reduction level could be achieved through technologies that were cost effective. *IAQR*, 69 Fed. Reg. at 4613. Therefore, at the least, excess emissions from EGUs in the named states above 35% of the Title IV Phase II allowance contribute significantly to nonattainment in or interfere with maintenance by North Carolina and must be eliminated.

EPA's research similarly showed that a certain level of NO_X controls are highly cost effective as well. EPA evaluated the cost of limiting NO_X emissions from EGUs to a rate of 0.15 lbs/mmBtu and 0.125 lbs/mmBtu. *See IAQR*, 69 Fed. Reg. at 4618. The average cost of such controls, if they applied only during the ozone season, would be $1100 per ton of NO_X removed and $1500 per ton, respectively. Marginal costs would be $2200 and $2600 per ton. These costs compared favorably to the average costs of several existing and proposed NO_X control rules. The average cost under these other programs was approximately $1400 to $1500 per ton. However, these programs address annual NO_X reductions and not ozone-season only reductions. When the proposed budgets are

assessed on an annual basis,[16] the costs are reduced to $800 and $700 per ton on average, and $1300 and $1500 marginal cost per ton, for the 0.15 lbs/mmBtu and 0.125 lbs/mmBtu control levels, respectively. *IAQR*, 69 Fed. Reg. at 4614-15. Because the control levels of 0.15 lbs/mmBtu and 0.125 lbs/mmBtu are highly cost effective, emissions in excess of those levels from EGUs in the states identified by this petition contribute significantly to nonattainment in or interfere with maintenance by North Carolina and must be eliminated.

EPA has prepared budgets that identify the total quantities of NO_X and SO_2 that would be emitted from EGUs in each state after the application of the highly cost effective controls discussed above. The budgets for EGUs in the states identified by this petition are presented in Appendix B.

D. EPA Has Already Proposed to Determine that EGUs in Upwind States Are Making a Significant Contribution

North Carolina's conclusion that EGUs in the named states are contributing significantly to nonattainment in North Carolina has been expressly affirmed by EPA. On January 30, 2004, EPA's Proposed *IAQR* was published in the *Federal Register*. In that proposal, EPA stated:

> The EPA has evaluated current scientific and technical knowledge and conducted a number of air quality data and modeling analyses regarding contribution of pollutant emissions to interstate transport .... The EPA proposes to find, after considering relevant information, that SO_2 and NO_X emissions in ... the following ... States significantly contribute to nonattainment in a downwind State with respect to the $PM_{2.5}$ NAAQS: Alabama, ... Georgia, Illinois, Indiana, ... Kentucky, ... Michigan, ... Ohio, Pennsylvania, South Carolina, Tennessee, ... Virginia, [and] West Virginia .... The EPA also proposes to find, after considering relevant information, that NO_X emissions in ... the following ... States significantly contribute to nonattainment in a downwind State with respect to the 8-hour ozone NAAQS: ... Georgia, ... Maryland, ... South Carolina, Tennessee, [and] Virginia ....

IAQR, 69 Fed. Reg. at 4570. The preamble to the *IAQR* and the technical support documents indicate that the conclusions regarding significant contribution of sources in the states named above are based in part on downwind impacts in North Carolina. Although EPA proposes to make this finding for the purposes of a section 110 SIP call, the operative legal standard under sections 110 and 126 is identical, as discussed above. Therefore, EPA recognized in its proposed rule that the record in support of the *IAQR* would also support findings of interstate contribution pursuant to a section 126 petition such as this. *See IAQR*, 69 Fed. Reg. at 4580.

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[16] Sources in all but one state that are the subject of this petition for ozone-season NO_X controls also are contributing significantly to $PM_{2.5}$ nonattainment and maintenance problems in North Carolina, and therefore should be subject to year-round NO_X controls. North Carolina is petitioning against sources in Maryland only with regard to downwind ozone contributions. Regardless, ozone-season only NO_X controls at the level proposed by EPA are cost effective.

E. North Carolina Has Sought Commitments for Reductions for Contributing Sources

In the summer of 2002, the North Carolina General Assembly enacted the Clean Smokestacks Act. Clean Smokestacks requires substantial actual reductions in emissions of NO_X and SO_2 from the fourteen largest fossil fuel burning electric generating plants in the State. Significantly, Clean Smokestacks mandates that the State-required reductions be achieved without the acquisition of pollution control allowances. Duke Energy and Progress Energy are the owners of these fourteen plants. Each has begun the process of implementing the Clean Smokestacks mandate. NO_X must be reduced to the final Clean Smokestacks limit by 2009 and final SO_2 controls are mandated by 2013. N.C.G.S. § 143-215.107D.

As part of the Clean Smokestacks reform, the General Assembly expressed its intent that the State work to achieve similar reductions on a similar schedule in upwind states. 2002 N.C. Sess. L. 4, § 10. As discussed above, North Carolina already had for years worked alongside the seven other SAMI states to evaluate impacts of pollution regionwide on western North Carolina. Part of SAMI's mandate was to assess the impacts of control strategies. SAMI completed its work in August 2002 with the publication of the *Final Report*, in which SAMI evaluated the costs and benefits of several regional strategies. This report demonstrated the existence of feasible control strategies that would result in tangible benefits.

In light of the Clean Smokestacks mandate, in the fall of 2002 North Carolina officials at various levels contacted their counterparts in other states in the region and the Tennessee Valley Authority ("TVA"). The State urged those states and TVA to consider a control program similar to that of Clean Smokestacks, and requested data so that the State could further assess the impact of emissions from sources in those states in North Carolina. The State also presented the Clean Smokestacks Act at various meetings and conferences attended by personnel from our upwind neighbors. Although the State received some positive feedback from other states and TVA, none were able to establish firm, legally binding commitments to the types of controls necessary to abate the contribution of sources in those states to North Carolina's attainment issues.

The TVA has embarked on a plan to effect sizable reductions of emissions of SO_2 and NO_X from some of its coal-fired facilities primarily in Tennessee. TVA plans to reduce SO_2 emissions by approximately 45% from 1998 levels by 2007, and over the same period intends to reduce annual NO_X emissions also by 45%. From 1993 -- a recent peak emissions year for SO_2 -- TVA plans to reduce SO_2 emissions 66% by 2007. TVA's NO_X emissions peaked in 1995. The projected 2007 levels represent a 58% reduction from that year. These cuts are, while very positive steps, not the same levels of reductions as North Carolina is requiring of its own sources.

The State is pleased that TVA has attacked this problem and is moving forward. Even so, TVA's plan is voluntary and addresses only a part of the regionwide problem. The State is also just beginning to see efforts in other states. For example, the Virginia General Assembly currently has before it a Clean Smokestacks bill much like that enacted in North Carolina. *See* H.B. 1472 (Va.

2004). However, the State understands that this bill is only in the early stages of consideration by the Virginia legislature. The State is also aware that South Carolina has been negotiating with several sources to achieve reductions there. The State sincerely hopes that these efforts resolve into binding commitments.

North Carolina has demonstrated its willingness to take the lead on this issue, and the desire to work with other states to achieve regional reductions. The State files this petition only after those efforts were not able to assure upwind reductions nor achieve the same in a time frame similar to that of Clean Smokestacks.

F. Conclusion

The discussion above clearly indicates that monitors in North Carolina currently are not attaining the eight-hour ozone and $PM_{2.5}$ standards, that some of those same monitors are projected to remain in nonattainment or perilously close to the NAAQS through 2010, that EGUs in other states contribute to such nonattainment in such quantities that the contributions are significant according to the prevailing methodology, and that a part of those emissions can be eliminated through the application of highly cost effective controls. Therefore, North Carolina has demonstrated that EGUs in each of the named states violate the provisions of section 126 with respect to the NAAQS for $PM_{2.5}$ and eight-hour ozone. As required by section 126, the State respectfully requests that EPA take action to abate these unlawful emissions.

III. SECTION 126 REQUIRES ABATEMENT OF EMISSIONS THAT CONTRIBUTE SIGNIFICANTLY TO NONATTAINMENT IN OR INTERFERE WITH MAINTENANCE BY NORTH CAROLINA

A. The Proposed *IAQR* Budgets Would Meet the Requirements of this Petition

Based on EPA's demonstration of interstate contribution, which takes into account the cost effectiveness of controls on upwind sources, EPA has proposed an EGU budget for each state within the scope of the *IAQR*. For reference, those proposed budgets relevant to the groups of sources subject to this petition are set out in Appendix B. North Carolina submits that these budgets are supported by the *IAQR* record and by the further data and studies submitted with and discussed in this petition. Therefore, the State concludes that compliance with the emissions budgets for NO_X and SO_2 for EGUs in the named states proposed in the *IAQR* would satisfy the requirements of this petition. The State does not oppose the flexibility discussed by EPA to allow equivalent reductions from other source categories in a given state, *see IAQR*, 69 Fed. Reg. at 4622, so long as those reductions are real and enforceable.

B. Interstate Trading of Emissions Allowances Cannot Be Allowed to Deprive North Carolina of the Actual Elimination of Emissions That Significantly Contribute to Nonattainment or Interfere With Maintenance of the NAAQS

North Carolina recognizes the value of allowing sources flexibility to eliminate their contribution to any violations of section 126 in the most cost effective manner consistent with the statute. However, trading of pollution allowances between facilities in different states may deprive North Carolina of the benefits of any remedy. The State submits that EPA cannot allow interstate trading of emissions allowances to thwart North Carolina's remedy under section 126.

In the Clean Smokestacks Act, the North Carolina General Assembly established emissions limits for two groups of EGUs. Implementation of the Act indicates that each group consists of seven large coal-fired utility plants in the State. N.C.G.S. § 143-215.108D(a)-(e). Significantly, the legislature did not specify the level or type of controls to be installed on each individual facility within those groups of sources. *Id.* § 143-215.108D(f). Implicit in this scheme is the recognition that costs to the utilities and the ratepayers can be reduced by permitting the utilities flexibility in designing and installing control equipment. There is no reason to deny the utilities and the ratepayers the benefit of this flexibility if to do so would have no significant effect on whether the ultimate goals can be achieved, *i.e.* compliance with the Clean Smokestacks emissions limits and with the federal NAAQS and protection of public health and welfare. But a regional trading program may defy this principle under the circumstances.

North Carolina's evidence and EPA's own modeling demonstrate that emissions from groups of sources within specific upwind states contribute significantly to nonattainment in or maintenance by North Carolina. Notably, EPA did not find that the twenty-nine state region (*i.e.* the twenty-eight states plus the District of Columbia that are subject to the proposed *IAQR*) as a whole was contributing significantly to nonattainment in or interfering with maintenance by North Carolina. Instead EPA separately found that groups of EGUs, delineated by state boundaries, were each separately violating the "good neighbor" provision of section 110 (which is incorporated into section 126). North Carolina's own evidence supports these state-by-state contribution findings. For example, both North Carolina's evidence and EPA's modeling indicate that EGUs in Tennessee significantly contribute to nonattainment of the $PM_{2.5}$ standard in North Carolina. EPA indicates that two North Carolina counties that are not attaining the $PM_{2.5}$ standard each receive 0.38 $\mu g/m^3$ of $PM_{2.5}$ on an annual average basis from EGUs in Tennessee. *See Modeling TSD* at H-6. On the other hand, these counties each receive legally insignificant contributions from states such as Connecticut, Minnesota, Montana and New Jersey. *Id.* at H-2 to H-4.

Because the findings are state specific, EPA is bound to implement reductions for source groups on a state-specific basis. Section 126 applies to any "major source or group of stationary sources ...." 42 U.S.C. § 7426(b). Based on the evidence, North Carolina has petitioned regarding state-specific groups of sources, that is, EGUs in each of several upwind states. EPA has proposed to find that such defined groups each contribute significantly to nonattainment in North Carolina

separately from any other group of sources. North Carolina specifically requests this finding and submits that the evidence of record undeniably supports such a finding.

At this time, it is unclear whether the proposed remedy apparently to be offered by EPA in the *IAQR* -- the regional trading program -- will guarantee emissions reductions by sources in the particular subset of states that contributes to nonattainment in North Carolina sufficient to eliminate the significant contribution from those sources. For example, EPA proposes to allocate to Massachusetts 82,585 tons of SO_2 allowances in 2010 and 57,810 tons in 2015. However, EPA projects that all EGUs combined in Massachusetts will only emit 15,600 tons of SO_2 in 2010. Florida and the District of Columbia also immediately will have excess allowances as well. If, continuing the example, sources in Virginia obtained the 66,915 allowances from Massachusetts that EPA projects will be available in 2010, over fifty percent of the SO_2 emissions from Virginia that EPA already has determined violate section 126 in 2010 will not actually be eliminated. *See IAQR*, 69 Fed. Reg. at 4589-90, 4619. The fact that emissions are lower in Massachusetts is no comfort to North Carolina citizens because EPA has proposed (and North Carolina agrees) that sources in Massachusetts do not contribute to North Carolina's $PM_{2.5}$ nonattainment and maintenance issues anyway.

Under a regionwide trading program, EGUs in states surrounding North Carolina could emit at amounts EPA *already* has proposed to determine to be a significant downwind contribution simply by purchasing such pre-existing allowances or other allowances created by EGUs in other states that over-control.[17] Even trades of allowances between sources both of which contribute significantly to nonattainment in North Carolina may be problematic because, for example, one ton of emissions from Michigan may not have the same effect in North Carolina as one ton of emissions from Georgia. The effect depends on distance and meteorology, among other factors. Section 126(c) mandates a remedy once a group of sources is found to violate the good neighbor provision of section 110(a)(2)(D). An unrestricted regionwide trading program that would have the net result of permitting actual emissions that significantly contribute to downwind nonattainment clearly would be irrational because EPA would have granted the State's petition and made the technical finding of contribution without requiring a real remedy.

In the alternative, the same conclusion is inevitably reached even if EPA were to find that sources in a certain set of upwind states collectively contribute to North Carolina, but that sources outside those states do not. Reductions in states outside North Carolina's upwind set of contributors would not remedy the interstate contribution to North Carolina. So the net conveyance of allowances from sources in non-contributing states to sources within North Carolina's upwind contribution region would rob the State of its remedy. If a regionwide interstate trading program permits this result, it cannot assure an appropriate remedy for North Carolina.

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[17] The design value for eight-hour ozone for the Charlotte area is projected to *increase* with the application of the *IAQR* regional control strategy. EPA's modeling indicates that in the 2010 base case, Mecklenburg County sees a design value of 0.085 ppm, but with the application of the NO_X regional control strategy, this value increases to 0.086 ppm. The cause of this anomaly is not made clear from the *IAQR* docket. The State will request in its comments on the *IAQR* that EPA explain this anomaly.

NC DAQ recently studied the impact of certain specific industrial sources in South Carolina on the Charlotte area. The Charlotte region has registered the highest eight-hour design value in the State (0.100 ppm). It was also the last area in the State to attain the one-hour ozone standard and continues to register exceedances of that standard. In order to evaluate causes of Charlotte's excess ozone, NC DAQ's study focused on a group of five specific industrial sources in South Carolina.[18] In short, NC DAQ's modeling showed that these five facilities together contribute to ozone nonattainment in such amounts and at such a frequency that the facilities should be considered to contribute significantly according to EPA criteria (before considering cost).[19]

The existence of such a small group of sources that contributes significantly to nonattainment for ozone in an adjacent state clearly demonstrates the problem created by interstate trading. *See also* Part III.C. It is likely that situations similar to the South Carolina non-EGU contributions exist involving EGUs with other states that border North Carolina and in many instances throughout the *IAQR* region. At best, a broad trading program is only likely to alleviate such cross-border pollution, but in no way does such a program mandate the directed remedy required by section 126.

Therefore, an interstate trading program designed in a way that could operate to deprive North Carolina of the actual elimination of emissions that significantly contribute to nonattainment in or interfere with maintenance by North Carolina of the NAAQS would be illogical and arbitrary.[20] Such a trading program would not constitute a lawful remedy under section 126 because it would not effect the mandate of that statute.

C. Remedies Regarding "Hot Spots" Must Be Preserved

The unrestricted trading of pollution credits in the twenty-nine state region may lead to the development of "hot spots." A hot spot occurs when a source or group of sources complies with the budget on paper by purchasing credits and not by making actual reductions. Under certain conditions

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[18] The sources are:

Facility	SIC	County
Bowater	2611 (Pulp Mill)	York
Celenese Acetate	2823 (Cellulose Manmade Fibers)	York
Guardian	3211 (Flat Glass)	Chester
Owens Corning	3229 (Pressed/Brown Glass)	Anderson
Union Camp	2621 (Paper Mill)	Richland

Technical documents for this modeling are on file at NC DAQ.

[19] The State has elected not to petition under section 126 against these sources at this time but reserves the right to do so in the future.

[20] In the *NO_X SIP Call* (and therefore in the *OTAG 126 Rule* as well), EPA found that a regionwide trading program with substantial limitations on trading would result in emissions reductions costs "fairly close" to the costs of the less restrictive trading program that EPA actually adopted. *NO_X SIP Call*, 63 Fed. Reg. at 57,401. Thus, reasonable restrictions on trading would not have upset the economics of the remedy.

(considering timing and type of emissions, atmospheric conditions, *etc.*), these paper reductions may fail to provide relief to the downwind area, creating a hot spot of increased ambient pollution.

The State disagrees with EPA's finding that under the Title IV Acid Rain Program, hot spots were not a significant problem. *See IAQR*, 69 Fed. Reg. at 4629-30. The example discussed above regarding sources in South Carolina supports the existence of hot spots. *See* Part III.B. The significant contribution by five sources to ozone nonattainment in the Charlotte area demonstrates that although ozone pollution is generally regarded as a regional problem, more localized situations do exist. Further, EGUs in North Carolina purchased substantial SO_2 allowances in order to meet their Title IV limits. As SAMI recognized, reductions of emissions present the greatest opportunity for air quality improvements within the state in which the reductions occur. To address the continuing problems of SO_2 emissions from EGUs within North Carolina, the State had to take action beyond that required by the Acid Rain Program by enacting the Clean Smokestacks Act. The State understands that market forces may result in reductions distributed in such a way as to eliminate the significant contribution of all upwind states to all downwind states, and hopes that this will be the case, but our experience indicates that hot spots are both technically possible and historically demonstrated.

The North Carolina General Assembly understood that the $PM_{2.5}$ and ozone air pollution problems associated with EGU emissions will be mitigated by statewide controls. However, the legislature also recognized that statewide reductions may not entirely eliminate the excess contributions of these facilities. Therefore, the General Assembly ensured that the State retained authority to address localized pollution problems regardless of the utilities' compliance with the Clean Smokestacks emissions caps. N.C.G.S. § 143-215.108D(f). Clean Smokestacks also requires annual reporting regarding the desirability of further controls, which must consider, among other things, costs and health and environmental impacts. *See* Clean Smokestacks Act § 11, 2002 N.C. Sess. L. 4.

The same approach that North Carolina implemented on a statewide basis is necessary under section 126 on a regional scale. Therefore, North Carolina requests that EPA review emissions levels, budgets, transfers of allowances, downwind nonattainment, cost effectiveness of controls, *etc.* on a regular basis (*e.g.*, once every five years) and adjust the remedy as necessary to assure the elimination of upwind significant contributions. In addition, the State notes that if the remedy resulting from this petition fails to adequately address legally cognizable interstate pollution, section 126 permits future petitions, which may be used to clarify sources' responsibilities. The continuing vitality of the section 126 remedy is essential to the balanced, cooperative approach of the Clean Air Act.

D. North Carolina Supports a Phased Approach to Compliance

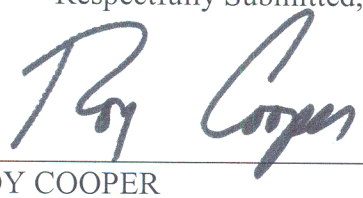
The Clean Smokestacks Act required reductions of SO_2 and NO_X to occur in two stages. The first phase for SO_2 mandates a 49% reduction in actual SO_2 emissions from 1998 levels and the second phase requires a cumulative 74% cut. For NO_X, a 76% reduction is required in the interim

and a cumulative 78% reduction is established for the final phase. *See* N.C.G.S. § 143-215.107D(b)-(e). North Carolina supports a stepwise approach to regional reductions. Such a compliance schedule is consistent with the requirement that a section 126 remedy "contain[] increments of progress ...." CAA § 126(c), 42 U.S.C. § 7426(c).

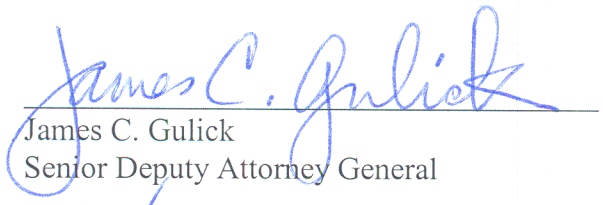
IV. CONCLUSION

For all of the foregoing reasons, EPA should find that EGUs in the named states contribute significantly to nonattainment in and interfere with maintenance by North Carolina with respect to the NAAQS for $PM_{2.5}$ and eight-hour ozone, as specified above. Consistent with the mandate of section 126, EPA should permit the continued operation of such sources only to the extent that the EGUs in each named state do not contribute significantly to nonattainment in or interfere with maintenance by North Carolina with these NAAQS.

Respectfully Submitted,



ROY COOPER
Attorney General



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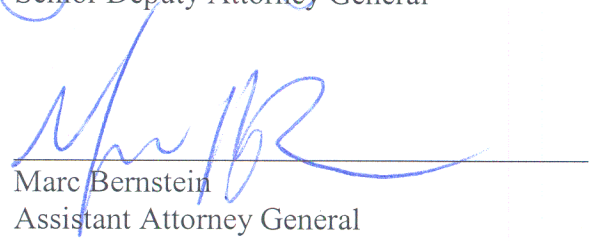

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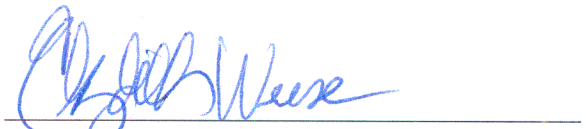

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APPENDIX A

NC DAQ Back Trajectory Analysis

NOTE: The original, color versions of the attachments to the NC DAQ Back Trajectory Analysis were delivered to the EPA Administrator only. All other distribution copies were reformatted for black-and-white reproduction. The color version will be available on or about March 19, 2004 at http://daq.state.nc.us.

Catawba and Davidson Counties HYSPLIT Back-Trajectory Analysis to Determine $PM_{2.5}$ Source Regions

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March 8, 2004

1. Introduction

The purpose of this analysis is to access the source regions, in particular according to state boundaries, which contribute significantly to elevated daily Fine Particulate Matter ($PM_{2.5}$) levels in North Carolina. The North Carolina Division of Air Quality (NC DAQ) has identified a specific need to know the regions, specifically according to state boundaries, which contribute significantly to primary and secondary $PM_{2.5}$ in North Carolina. The Environmental Protection Agency (EPA) has established standards for $PM_{2.5}$ at 15 $\mu g/m^3$ for the annual standard and 65 $\mu g/m^3$ for the 24-hour standard.

2. Methodology

An analysis of the National Oceanic and Atmospheric Administration Air Resource Laboratory (NOAA ARL) HYbrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT; Draxler and Rolph, 2003) model back trajectories was performed in order to access the sources that contribute to elevated $PM_{2.5}$ levels in North Carolina. An analysis of observed 24-hour average $PM_{2.5}$ values throughout from North Carolina's $PM_{2.5}$ monitor network determined that the two monitors with the highest annual $PM_{2.5}$ values in North Carolina are located in Catawba and Davidson Counties. The monitors located in these counties are Federal Reference Method (FRM) monitors and sample $PM_{2.5}$ every three days. Because these monitors had the two highest annual-average $PM_{2.5}$ values, the monitors located in these two counties were chosen as the endpoints for the HYSPLIT back trajectories. The specific location of Catawba County monitor is 35.73°N, 81.36°W, while the Davidson County monitor is located at 35.81°N, 80.26°W.

$PM_{2.5}$ data from January 1, 1999 through June 30, 2002 was analyzed to identify days when the 24-hour average $PM_{2.5}$ value was greater than or equal to 27.9 $\mu g/m^3$. This concentration was chosen since it represents the midpoint of the yellow AQI range (15.5$\mu g/m^3$ – 40.4$\mu g/m^3$) for $PM_{2.5}$, and conversations with EPA representatives have indicated that values above this point could pose a significant health risk. From the three and half years of available $PM_{2.5}$ data from those two monitors, there were a total of 41 days from the Catawba County monitor and 32 days from the Davidson County monitor where the 24-hour average $PM_{2.5}$ value was greater than or equal to 27.9 $\mu g/m^3$. The dates and observed 24-hour average $PM_{2.5}$ of these days are shown in Table 1.

For the days indicated above, HYSPLIT back trajectories were run. Thirty-six hour back trajectories ending at 17UTC, noon Eastern Daylight Time, were run separately for each

monitor using the model vertical velocity option. The trajectories were run at three separate heights, specifically 10, 300 and 1000 meters above ground level (AGL). The 10 and 300-meter trajectory levels are heights of lower level circulations, while the 1000-meter trajectory level represents the top of the mixed layer and is generally a transport level. The choice of these levels is based on the experience of NC DAQ meteorologists, who use the HYSPLIT model trajectories as a routine part of their ozone and $PM_{2.5}$ forecast process. 17UTC (Noon EDT) was chosen as the ending time of the trajectories because it represents a time when significant mixing of the boundary and residual layers has occurred, but significant contributions from local-secondary production has not occurred.

3. Results

Table 1 shows the results of the analysis of the back trajectories. Columns 4 and 5 in Table 1 identify the primary and secondary source regions. The primary source region identifies the most significant region(s) contributing to the $PM_{2.5}$ in that county on that day, as determined by the meteorologists. The secondary source region identifies a region(s) that, while is not a primary contributor, does appear to contribute to a significant portion of the $PM_{2.5}$ on that day. Note that while there is always a primary source identified for a given day, there may not be secondary source identified.

Figures 1-4 show composites of the back trajectories originating from the Catawba County site at 10, 300, and 1000 meters AGL for those days when $PM_{2.5}$ concentrations were high. Note that the trajectories are relatively short, indicating regional stagnation and recirculation. Figures 5-8 show similar composites for the Davidson County site.

Analysis of the HYSPLIT back trajectories showed that on the majority of the days the primary source region of the back trajectory was North Carolina. Table 2 shows the distribution of both primary and secondary source regions for the trajectories for both Catawba and Davidson counties. Of the 41 days for which back trajectories were run for the Catawba County monitor, 31 (76%) of them were considered to have North Carolina as the primary source region (Figure 9). Tennessee and Virginia were considered to be primary sources on 9 (22%) and 6 (15%) days, respectively. Significant secondary sources were South Carolina, Tennessee, and Georgia, which contributed on 9 (22%), 8 (20%), and 7 (17%) days respectively (Figure 10). Figure 11 shows the percent of the days in which each region was identified as either a primary or secondary source, or both.

There were 27 (66%) days when North Carolina was identified to be the only primary source region, while there were 4 (10 %) days when North Carolina and another state(s) was identified to be the source region, and 10 (24%) days when North Carolina was not identified as part of the source region. This result is significant, since it indicates that nearly 35 percent of the days when $PM_{2.5}$ was greater than or equal to 27.9 $\mu g/m^3$, back-trajectory analysis indicates transport from neighboring states, in particular Tennessee, Virginia, Georgia and South Carolina.

For the Davidson county monitor, 26 (81%) of the 31 days for which the trajectories were run indicated North Carolina as the primary source (Table 2, Figure 12). Note that there was one day for which a trajectory could not be run due to missing data. Other significant primary sources were Virginia, with 7 (23%) days, and South Carolina and Tennessee, each with 4 (13%) days. Significant secondary sources were South Carolina, Tennessee, and Virginia, each with 5 (16%) days, and Ohio with 4 (13%) days (Figure 13). Of the 31 days for which the back trajectories were run, 17 (55%) of them indicated North Carolina as the only primary source region, while on 14 (45%) days trajectories indicated another state as the primary source region. As with the Catawba County analysis, there were a significant percentage of days when trajectory analysis indicates transport from neighboring states on days when $PM_{2.5}$ was greater than or equal to 27.9 $\mu g/m^3$. The percent of days in which each region contributed as a primary or secondary source (or both), is shown in Figure 14.

Another interesting analysis is examining the 24-hour average $PM_{2.5}$ value and the associated primary source region. The trajectories run for each monitor were divided into an upper third, a middle third, and a lower third based on the observed $PM_{2.5}$ concentration. For the Catawba County monitor the upper third consists of a $PM_{2.5}$ range between 32.8 and 54.7 $\mu g/m^3$, the middle third from 30.0 and 32.7 $\mu g/m^3$, and the lower third from 28.1 to 29.6 $\mu g/m^3$. Note that there are 14 days included in the upper and middle thirds, and only 13 days included in the bottom third (Tables 3-5).

For the upper third of the days for the Catawba County monitor site, North Carolina was the primary source on 10 days, followed by Tennessee and Virginia with 2 days each. South Carolina, Tennessee, Virginia and Georgia are common secondary source regions. For total days (primary and secondary combined), North Carolina was identified on 10 days, followed by Tennessee on 5 days and South Carolina, Virginia, and Georgia each on 3 days. The results for the middle and lower third of the days are similar to those for the upper third. The same analysis for the Davidson County monitor site yields similar results. Note also that 11 days are included in the upper and middle thirds, while only 10 days are included in the bottom third.

Another analysis that was performed using the back trajectories was to quantify the residence time that the trajectories spent in each state, other than North Carolina. This was accomplished by analyzing each trajectory individually and recording the amount of time the trajectory spent in each individual state. Since trajectories were run at multiple heights, to avoid double counting, only the maximum time that all trajectory heights spent in any one state are reported. Obviously, since the end points of the trajectories are within North Carolina, some time for each trajectory must be spent in North Carolina. The results of the analysis for Davidson and Catawba counties are shown in Tables 6 and 7 respectively. Note that this analysis contains seven events in 2002 for Catawba County and four events in 2002 for Davidson County that are not included in the previous analysis of the trajectories.

For Catawba County, the maximum number of hours the trajectories spent in another state for all events was 258 in Tennessee (recall that an event is a day where the PM2.5

concentration exceeded 27.9 $\mu g/m^3$ at the monitor in that county). This represents 15.6 percent of the total trajectory time (36 hours/event * 46 events = 1656), with an average of 18.4 hours per event. The average represents the average hours the trajectory spent in each state for only those events where the trajectory spent at least some amount of time in the state (zero hour events are not included in the average). Other results include 207 hours (12.5% of total) for South Carolina, with an average of 18.8 hours per event, and 201 hours (12.1% of total) for Kentucky, with an average of 14.4 hours per event.

For Davidson County, the maximum number of hours the trajectories spent in another state for all events was 278 in South Carolina. This was 22.7 percent of the total trajectory time (36 hours/event * 34 days), with an average of 19.9 hours spent in South Carolina for each event. Virginia had a total of 275 hours (22.5% of total) with an average of 14.5 hours per event. Tennessee had a total of 166 hours (13.6 % of total) with an average of 15.1 hours per event.

4. Discussion

Analysis of HYSPLIT back trajectories from two $PM_{2.5}$ monitor locations in North Carolina on days when 24-hour average $PM_{2.5}$ levels were 27.9 $\mu g/m^3$ or greater indicates that while North Carolina is the primary source region for the majority of those days, states neighboring and near North Carolina (including Kentucky, West Virginia, and Ohio) were shown through the trajectory analysis to be potential sources of transported pollution. Back trajectories run from points in Catawba and Davidson Counties in North Carolina show a significant percentage of days for which neighboring states could be considered primary sources for transported pollution. Significant secondary states include South Carolina, Tennessee, and Virginia. Other states with slightly fewer days when back trajectories indicated potential transport include Georgia, Kentucky, and the Ohio Valley.

REFERENCES

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.

County	Date	PM 2.5	Primary	Secondary	Notes
Davidson	1/1/2000	46.8	NC (Millenium Celebration)		**Low**: NC (calm conditions) and CLT; **Mid and Upper**: Upstate SC and GA
Davidson	8/13/1999	44.8	NC / SC		**Low**: NC and Eastern SC; **Mid:** SC and NC; **Upper**: NC and Upstate SC
Davidson	6/21/2001	41.6	NC	Central SC	**Low and Mid**: NC and Central SC; **Upper:** NC, Northeast TN and SW Virginia (minor)
Davidson	7/23/1999	40.5	E. KY, SW. VA	Ohio Valley	**Low and Mid:** SW Virginia and E. KY; **Upper:** long transport from Ohio Valley
Davidson	1/5/2002	39.2	NC / TN		**Low**: NC and NE TN; **Mid**: NC and Eastern TN; **Upper:** TN
Davidson	7/17/1999	38.9	NC	Central SC	**Low**: NC (CLT); **Mid**: NC and SC; **Upper**: NC and SW Virginia
Davidson	12/11/2000	38.7			Missing Data
Davidson	10/21/2000	37.7	SW. VA / E. TN	NC	**Low**: NC and Upstate SC; **Mid**: Eastern TN: **Upper**: SW VA and Eastern TN
Davidson	7/18/2001	37.7	NC / SC	SE. TN / N. GA	**Low**: SC and some NC; **Mid**: NC and Northern GA; **Upper**: NC, Eastern TN, N. GA
Davidson	7/5/1999	36.6	NC	Eastern TN (significant)	**Low**: All in NC; **Mid**: Origin in NE TN; **Upper**: Crosses KY, WV, VA
Davidson	6/2/2000	34.9	NC	Eastern TN	Missing Data
Davidson	6/29/2000	34.1	NC / N. GA / N. SC	Aloft from Ohio Valley	**Low**: NC, SC, and GA; **Mid**: NC and GA (ATL); **Upper**: Ohio Valley
Davidson	8/7/1999	33.8	NC	SW. VA	**Low**: NC; **Mid**: NC and SW VA; **Upper**: NC (CLT)
Davidson	7/2/2000	32.7	NC (CLT)	North Central SC	**Low**: Completely in NC; **Mid**: NC and Upstate SC; **Upper**: NC and Upstate SC
Davidson	8/28/1999	32.1	NC	SW. VA (less sig)	**Low**: NC; **Mid**: NC and SW VA; **Upper** NC and SW VA
Davidson	11/11/1999	31.8	TN		**Low, Mid, and Upper**: Long transport from Tennessee
Davidson	8/16/2000	31.2	NC / VA	Ohio Valley	Missing Data
Davidson	8/19/1999	31.1	NC / VA	Ohio Valley	**Low**: NC, VA, and WV; **Mid**: Eastern VA; **Upper**: NC, SW VA, and Ohio Valley
Davidson	10/27/2000	31.1	VA		**Low, Mid, and Upper**: Virginia
Davidson	1/21/1999	31.0	NC (CLT, I-85)	Upstate SC	**Low**: All in NC; **Mid and Upper**: long transport from the west
Davidson	11/8/2000	30.7	NC		**Low:** Short over NC; **Mid and Upper**: Long transport from the south (SC, GA, FL)
Davidson	7/20/1999	30.6	NE. TN, SW. VA, NC		**Low**: NC and Upstate SC; **Mid**: E. TN and NC **Upper**: VA, KY, and TN
Davidson	8/16/1999	30.1	NC		**Low, Mid, and Upper**: All completely in NC (short trajectories)
Davidson	6/11/1999	29.8	NC (PP, I-40)	Tidewater of VA (minimal)	**Low, Mid, and Upper** all over NC and originate in the Atlantic
Davidson	2/9/2000	29.4	NC	I-95 Virginia	**Low**: NC and VA; **Mid**: NC and VA; **Upper**: NC (over the mountains)
Davidson	5/30/1999	29.1	NC (CLT)	NC	**Low, Mid, and Upper** all in NC and very northern SC
Davidson	8/8/2001	29.0	Ohio Valley	WV / VA / NC	**Low**: NC and SW VA; **Mid**: VA and WV; **Upper:** VA, WV and Ohio Valley
Davidson	10/30/1999	28.5	NC		Missing Data
Davidson	8/17/2001	28.5	NC / SC	GA (ATL)	**Low**: NC (CLT) and SC; **Mid**: Mostly SC, some NC; **Upper**: NC and GA (ATL)
Davidson	7/8/1999	28.4	NC	Upstate SC, Eastern TN (3rd)	**Low**: NC; **Mid**: Upstate SC; **Upper**: NE Tennessee
Davidson	10/18/2000	28.0	NC	Eastern TN	**Low**: Completely in NC; **Mid**: Completely in NC; **Upper**: long transport from TN
Davidson	8/14/2001	27.9	NC / VA	WV	**Low**: NC and SW VA; **Mid**: NC, Central VA, and WV; **Upper**: VA, WV, and Ohio Valley

Table 1. Days when observed $PM_{2.5}$ values in Catawba and Davidson Counties was above 27.8 ug/m^3. Indicated in the table is the county, date, $PM_{2.5}$ observed value, the primary and secondary sources as determined by the NC DAQ meteorologists, and any notes made by the meteorologists concerning that days trajectories. Purple shading indicates observed values greater than 39.9 ug/m^3, red shading between 35.0 ug/m^3 and 39.9 ug/m^3, orange shading between 30.0 ug/m^3 to 34.9 ug/m^3, yellow shading between 27.9 ug/m^3 and 29.9 ug/m^3. Blue shading indicates known fire events in North Carolina. On days with missing EDAS data, surface maps were used to determine the source region(s).

County	Date	PM 2.5	Primary	Secondary	Notes
Catawba	11/2/2000	54.7	NC (Fire Event)	Ohio Valley	**Low and Mid**: Completely in NC; **Upper**: Long transport from the Ohio Valley
Catawba	11/8/2000	50.1	NC (Fire Event)	SC / E. GA / FL (minor)	**Low, Mid, and Upper**: Short trajectories in NC, then long transport from the south
Catawba	1/21/1999	41.0	NC	Upstate, North Central GA	**Low**: all in NC; **Mid**: NC, Upstate SC, and N. GA; **Upper**: long transport from the southwest
Catawba	6/21/2001	40.0	NC	SC (minor)	**Low**: NC and Upstate SC; **Mid**: Completely NC; **Upper**: All NC except for couple hours in TN
Catawba	10/21/2000	38.0	NC	N. SC and E. TN	**Low**: NC and Upstate SC; **Mid**: Eastern TN and N. GA; **Upper**: Central TN and Northern MS
Catawba	10/27/2000	36.7	SW. VA / WV	Southern Ohio Valley	**Low**: SW VA and Eastern KY; **Mid and Upper**: SW VA, Western WV, Southern Ohio Valley
Catawba	7/23/1999	36.1	NE. TN / OV / SW. VA		**Low and Mid**: Northern TN; **Upper**: long transport from the northwest
Catawba	8/7/2000	34.2	NC	Eastern TN, GA (ATL)	**Low and Mid**: NC and Northern GA; **Upper**: Eastern TN and Northern GA
Catawba	3/31/1999	30.0	NC	Northern SC	**Low**: NC; **Mid**: NC, minor SC and VA; **Upper**; Upstate SC
Catawba	2/9/2000	33.5	NC	Eastern TN, Northern GA	**Low**: NC and very minor VA; **Mid**: NC and very minor SC; **Upper**: NC, E. TN, and N. GA
Catawba	6/5/1999	33.2	NC		**Low, Mid, and Upper**: NC (CLT and Triad)
Catawba	8/7/1999	33.1	NC	SW. VA	**Low and Mid**: Mostly NC, few hours in SW VA; **Upper**: Mostly in NC, few hours in NE TN
Catawba	1/1/2000	33.0	Millenium		**Low, Mid, and Upper**: NC and transport from the west
Catawba	2/21/2001	32.8	Eastern TN	Northern GA	**Low**: Eastern TN and Northern GA; **Mid**: NE TN, SW VA (minor), and TN; **Upper**: TN and KY
Catawba	7/8/2000	32.7	NC		**Low and Mid**: Completely in NC; **Upper**: NC and Upstate SC (minor, mostly NC)
Catawba	7/17/1999	32.3	NC	Upstate SC	**Low and Mid**: NC and Upstate SC; **Upper**: All in NC
Catawba	8/2/2001	32.0	NC		**Low, Mid, and Upper**: Trajectories completely in NC
Catawba	6/8/1999	31.7	NE. TN / SW. VA / KY		**Low**: NE TN and SW VA; **Mid and Upper**: NE TN, SW VA, KY;
Catawba	8/16/1999	31.1	NC		**Low and Mid**: Completely in NC; **Upper**: NC and Upstate SC (CLT area)
Catawba	8/13/1999	31.0	NC	SC	**Low**: Completely in NC; **Mid**: NC and Upstate SC (CLT); **Upper**: NC
Catawba	6/2/2000	31.0	Eastern TN	N. GA and NC	missing data
Catawba	7/20/1999	30.9	NC / E. TN		**Low**: Completely in NC; **Mid and Upper**: Eastern TN
Catawba	5/3/2000	30.8	NC	VA and SC	**Low**: majority NC and VA; **Mid**: NC (half), VA (half); **Upper**: mostly NC, minor SC
Catawba	7/23/2000	30.6	NC		**Low, Mid, and Upper**: Completely in NC
Catawba	9/7/2001	30.4	NC	NE. TN	**Low and Mid**: Completely in NC; **Upper**: NC and NE Tennessee
Catawba	8/26/2001	30.2	NC	Eastern TN and SC (minor)	**Low**: Completely in NC; **Mid**: Mostly in NC, few hours in Upstate SC; **Upper**: Eastern TN
Catawba	1/30/1999	30.0	NC		**Low, Mid, and Upper**: NC and VA (few hours);
Catawba	2/17/1999	30.0	NC / N. GA / Upstate SC		missing data
Catawba	8/19/1999	29.6	Ohio Valley / SW. VA		**Low**: NC, SW VA, and WV; **Mid**: NC, VA, and WV; **Upper**: NC, NE TN, SW VA, and E. KY
Catawba	7/2/2000	29.4	NC	SC	**Low**: NC (CLT); **Mid**: NC and Upstate SC; **Upper**: NC and Central SC
Catawba	7/18/2001	29.3	NC	SE. TN and N. GA	**Low**: NC and Northern GA; **Mid and Upper**: Southeast TN and Northest MS
Catawba	7/5/2000	29.1	Eastern and Central TN		**Low, Mid, and Upper**: Transport from Central and Eastern Tennessee
Catawba	11/18/2001	29.0	NC	VA / Ohio Valley (upper)	**Low and Mid**: NC and VA; **Upper**: SW VA, KY, and Southern Ohio Valley
Catawba	8/10/1999	28.4	NC	E. TN	**Low and Mid**: All in NC; **Upper**: transport from KY and TN
Catawba	6/4/2002	28.4	SC	NC	**Low**: Upstate SC and NC; **Mid**: SC and NC; **Upper**: SC and NC
Catawba	7/5/1999	28.2	NE. TN	SW. VA / KY	**Low**: NE TN; **Mid**: NE TN and SW VA; **Upper**: SW VA and KY
Catawba	6/11/2000	28.2	NC / NE. TN / SC		**Low and Mid**: Majority Upstate SC, some NC; **Upper**: NC and some NE TN and Upstate SC
Catawba	8/16/2000	28.2	NE. TN / SW. VA	KY	missing data
Catawba	10/18/2000	28.2	NC	NE and Central TN	**Low**: Completely in NC; **Mid and Upper**: Eastern and Central TN
Catawba	8/4/1999	28.1	NC / VA		**Low, Mid, and Upper**: NC and SW VA
Catawba	9/31/01	28.1	NC	SW. VA and E. KY	**Low and Mid**: Completely in NC; **Upper**: SW VA and SE KY

Table 1 Continued

Table 2. Number of days that the HYSPLIT back trajectories indicated a region as a primary or secondary source for locations in Catawba and Davidson Counties in North Carolina.

Catawba County					***Davidson County***			
State/Area	**Primary (days)**	**Secondary (days)**	**Total (days)**		**State/Area**	**Primary (days)**	**Secondary (days)**	**Total (days)**
North Carolina	31	2	33		North Carolina	26	2	28
South Carolina	3	9	12		South Carolina	4	5	9
Tennessee	9	8	17		Tennessee	4	5	9
Virginia	6	5	11		Virginia	7	5	12
Georgia	1	7	8		Georgia	1	2	3
Kentucky	1	3	4		Kentucky	1	0	1
Ohio Valley	2	3	5		Ohio Valley	1	4	5
NC Only	27				NC Only	17		
NC + Other	4				NC + Other	9		
No NC	10				No NC	5		

Table 3. Number of days in the highest one-third of 24-hour average $PM_{2.5}$ values for all days for which HYSPLIT trajectories were run. Specific $PM_{2.5}$ values were 32.8 – 54.7 $\mu g/m^3$ for Catawba County and 34.9 – 46.8 $\mu g/m^3$ for Davidson County.

Catawba County – Upper Third					***Davidson County – Upper Third***			
State/Area	**Primary (days)**	**Secondary (days)**	**Total (days)**		**State/Area**	**Primary (days)**	**Secondary (days)**	**Total (days)**
North Carolina	10	0	10		North Carolina	8	1	9
South Carolina	0	3	3		South Carolina	2	2	4
Tennessee	2	3	5		Tennessee	2	3	5
Virginia	2	1	3		Virginia	2	0	2
Georgia	0	3	3		Georgia	0	1	1
Kentucky	0	0	0		Kentucky	1	0	1
Ohio Valley	1	1	2		Ohio Valley	0	1	1

Table 4. Number of days in the middle one-third of 24-hour average $PM_{2.5}$ values for all days for which HYSPLIT trajectories were run. Specific $PM_{2.5}$ values were 30.0 – 32.8 μg/m^3 for Catawba County and 30.6 – 34.1 μg/m^3 for Davidson County.

Catawba County – Middle Third					***Davidson County – Middle Third***			
State/Area	**Primary (days)**	**Secondary (days)**	**Total (days)**		**State/Area**	**Primary (days)**	**Secondary (days)**	**Total (days)**
North Carolina	10	0	10		North Carolina	9	0	9
South Carolina	1	4	5		South Carolina	1	2	3
Tennessee	3	2	5		Tennessee	2	0	2
Virginia	2	1	3		Virginia	4	2	6
Georgia	1	0	1		Georgia	1	0	1
Kentucky	1	0	1		Kentucky	0	0	0
Ohio Valley	1	0	1		Ohio Valley	0	3	3

Table 5. Number of days in the lowest one-third of 24-hour average $PM_{2.5}$ values for all days for which HYSPLIT trajectories were run. Specific $PM_{2.5}$ values were 28.1 – 29.6 μg/m^3 for Catawba County and 27.9 – 30.1 μg/m^3 for Davidson County.

Catawba County – Lower Third					***Davidson County – Lower Third***			
State/Area	**Primary (days)**	**Secondary (days)**	**Total (days)**		**State/Area**	**Primary (days)**	**Secondary (days)**	**Total (days)**
North Carolina	8	1	9		North Carolina	9	2	11
South Carolina	2	1	3		South Carolina	1	1	2
Tennessee	4	3	7		Tennessee	0	1	1
Virginia	3	3	6		Virginia	1	3	4
Georgia	0	1	1		Georgia	0	1	1
Kentucky	0	2	2		Kentucky	0	0	0
Ohio Valley	1	1	2		Ohio Valley	1	0	1

Table 6. Total number of hours back trajectories spent in states other than North Carolina for all events for the Davidson County $PM_{2.5}$ monitor. Hours are based on the maximum of all trajectory heights, and therefore do not double count. Percent of total hours based on maximum hours of all events (1224 hours). Average hours based on average of each event, excluding zero hour events.

Davidson County									
Date	***PM2.5***	***SC (hrs)***	***GA (hrs)***	***TN (hrs)***	***VA (hrs)***	***KT (hrs)***	***WV (hrs)***	***OH (hrs)***	***MAX***
1/21/1999	31.0	12	8						36
5/30/1999	29.1	20							36
6/11/1999	29.8								36
7/5/1999	36.6				6	16	12		36
7/8/1999	28.4	23	10	20					36
7/17/1999	38.9	22			22				36
7/20/1999	30.6			22	12	11			36
7/23/1999	40.5			18	13		7	4	36
8/7/1999	33.8				7				36
8/13/1999	44.8	23							36
8/16/1999	30.1								36
8/19/1999	31.1				28		13	8	36
8/28/1999	32.1				25				36
11/11/1999	31.8		15	9					36
1/17/2000	N/A								36
2/9/2000	29.4				13				36
6/2/2000	34.9								36
6/29/2000	34.1	10	16		6	18		6	36
7/2/2000	32.7	21							36
10/18/2000	28.0			25					36
10/21/2000	37.7	16	9	10	6	6			36
10/27/2000	31.1				34				36
11/8/2000	30.7	14	9						36
12/11/2000	38.7				12				36
6/21/2001	41.6	28		10	3	3			36
7/18/2001	37.7	29	11	14					36
8/8/2001	29.0				20	14	18		36
8/14/2001	27.9				20		11		36
8/17/2001	28.5	17	16						36
1/5/2002	39.2			20		4			36
7/1/2002	31.1	23			18				36
7/16/2002	33.1				6		12	12	36
8/12/2002	36.9	20		12	19				36
12/7/2002	43.7			6	5	9			36

Total Hours	**278**	**94**	**166**	**275**	**81**	**73**	**30**	**1224**
% of Total	**22.7**	**7.7**	**13.6**	**22.5**	**6.6**	**6.0**	**2.5**	
Avg. Hours	**19.9**	**11.8**	**15.1**	**14.5**	**10.1**	**12.2**	**7.5**	

Table 7. As in Table 6, except for Catawba County.

Catawba County									
Date	***PM2.5***	***SC (hrs)***	***GA (hrs)***	***TN (hrs)***	***VA (hrs)***	***KT (hrs)***	***WV (hrs)***	***OH (hrs)***	***MAX***
1/21/1999	31.0	12	10						36
1/30/1999	30.0				10		3		36
3/31/1999	30.0	9			6				36
5/30/1999	29.1								36
6/8/1999	31.7				7	25			36
7/5/1999	28.2			25	15	21			36
7/17/1999	32.3	20							36
7/20/1999	30.9			28					36
7/23/1999	36.1			30		12			36
8/4/1999	28.1				17		2		36
8/7/1999	33.1								36
8/10/1999	28.4			10		26			36
8/13/1999	31.0	31							36
8/16/1999	31.1								36
8/19/1999	29.0				6	12	16		36
1/1/2000	33.0								36
2/9/2000	33.5	6	15	12	4				36
5/3/2000	30.8	4			21	7			36
6/2/2000	31.0								36
6/11/2000	28.2	25							36
7/2/2000	29.4	24							36
7/5/2000	29.1			34					36
7/8/2000	32.7								36
7/23/2000	30.6								36
8/7/2000	34.2		26	6					36
8/16/2000	28.2								36
10/18/2000	28.2			31		6			36
10/21/2000	38.0		19	13	3	6			36
10/27/2000	36.7				13	13	10	12	36
11/2/2000	54.7								36
11/8/2000	50.1								36
2/21/2001	32.8		6	9		13			36
6/21/2001	40.0	20							36
7/18/2001	29.3		16	10					36
8/2/2001	32.0								36
8/26/2001	30.2			34					36
9/7/2001	30.4			10					36
9/13/2001	28.1				6	26			36
11/18/2001	29.0				12		15	5	36
6/4/2002	28.4	31							36
7/1/2002	33.5	25			9	16			36
7/7/2002	28.3				8				36
7/16/2002	33.5				11		15	15	36
8/3/2002	30.0								36
8/12/2002	40.7				20	8			36
12/7/2002	29.2			6		10			36
12/31/2002	28.9	12	19						36
Total Hours		**207**	**92**	**258**	**168**	**201**	**61**	**32**	**1656**
% of Total		**12.5**	**5.6**	**15.6**	**10.1**	**12.1**	**3.7**	**1.9**	
Avg. Hours		**18.8**	**15.3**	**18.4**	**10.5**	**14.4**	**10.2**	**10.7**	

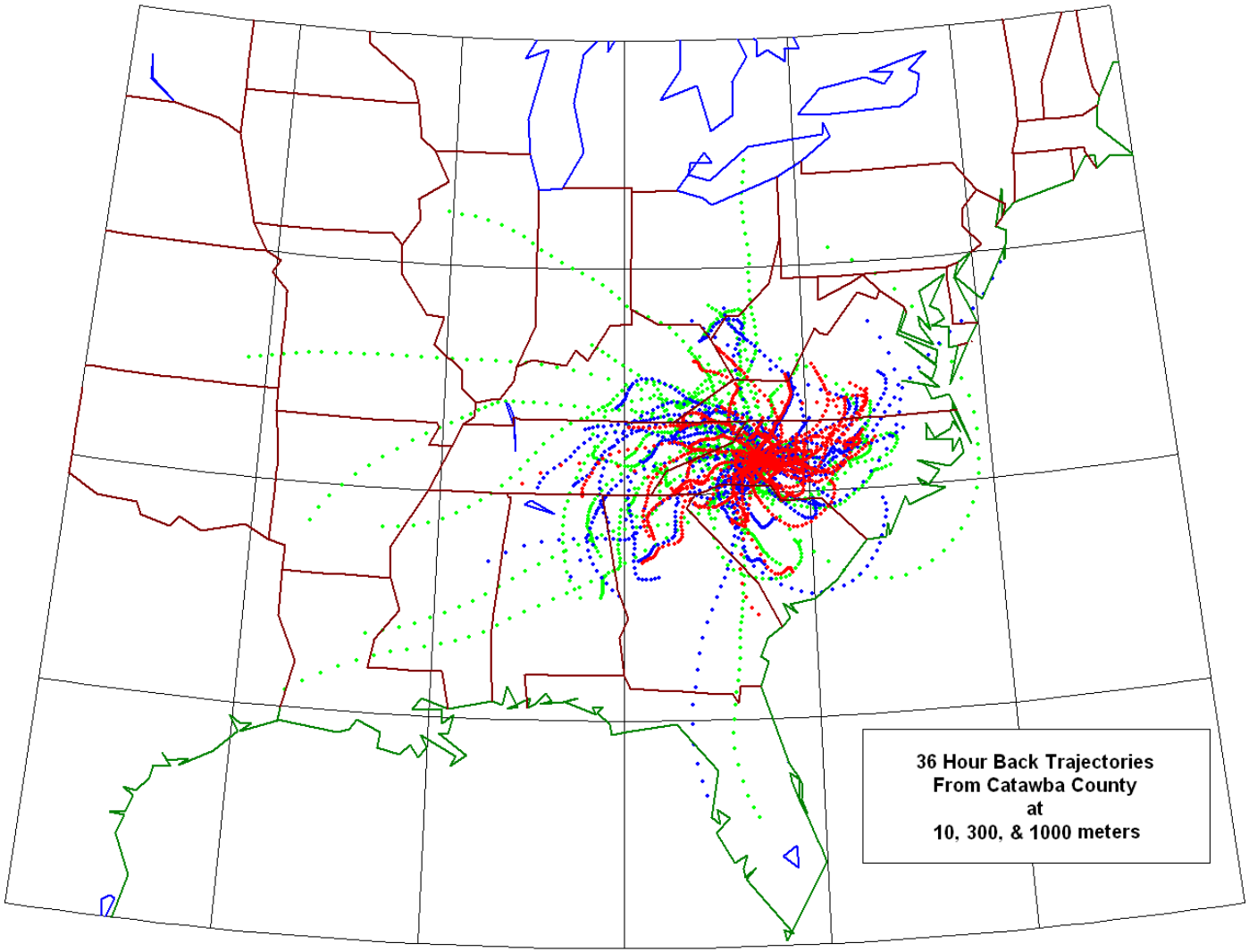

FIG 1. 36-hour back trajectories at 10 meters (red), 300 meters (blue) and 1000 meters (green) from the Catawba County site for days when the $PM_{2.5}$ concentration was high.

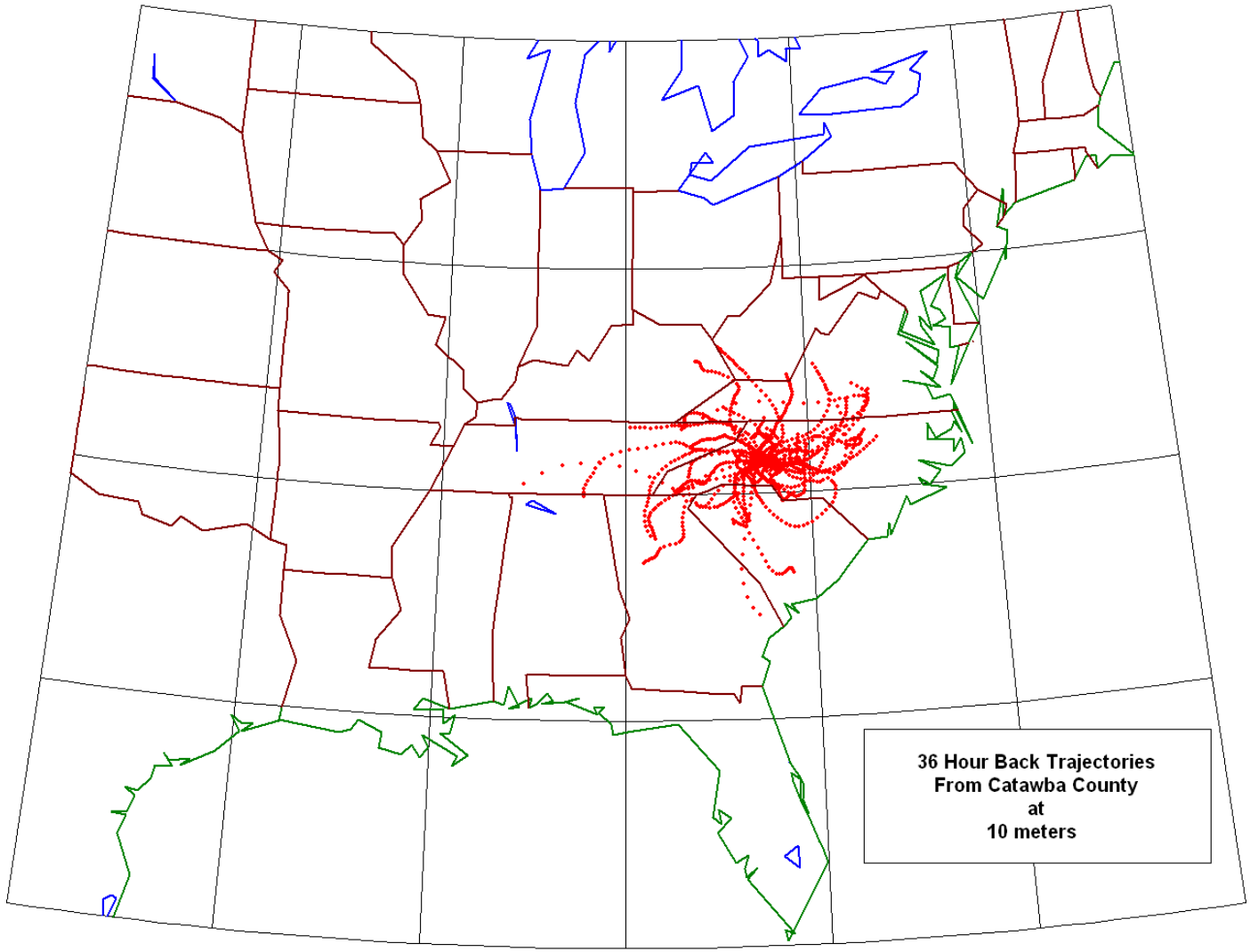

FIG 2. 36-hour back trajectories at 10 meters from the Catawba County site for days when the $PM_{2.5}$ concentration was high.

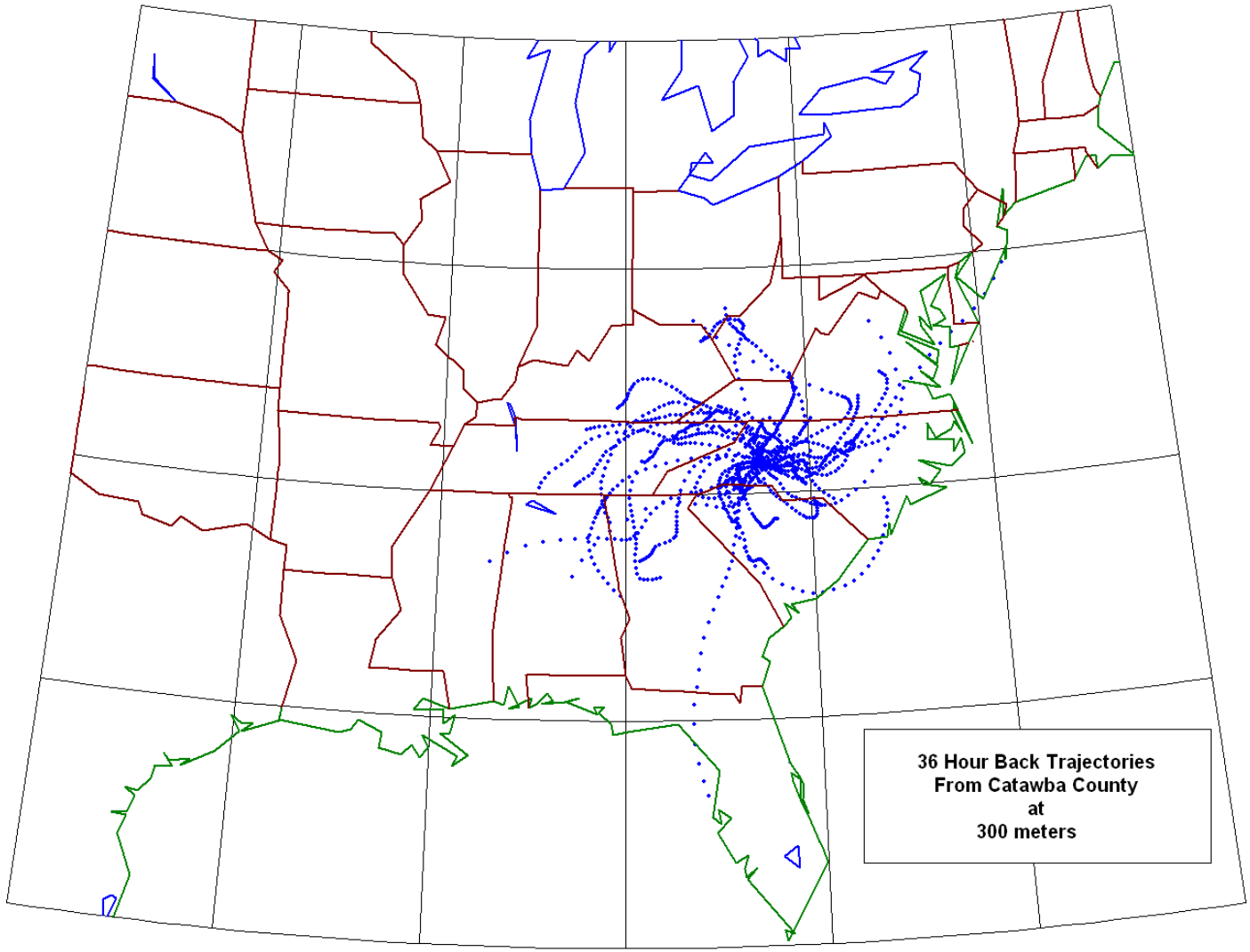

FIG 3. 36-hour back trajectories at 300 meters from the Catawba County site for days when the $PM_{2.5}$ concentration was high.

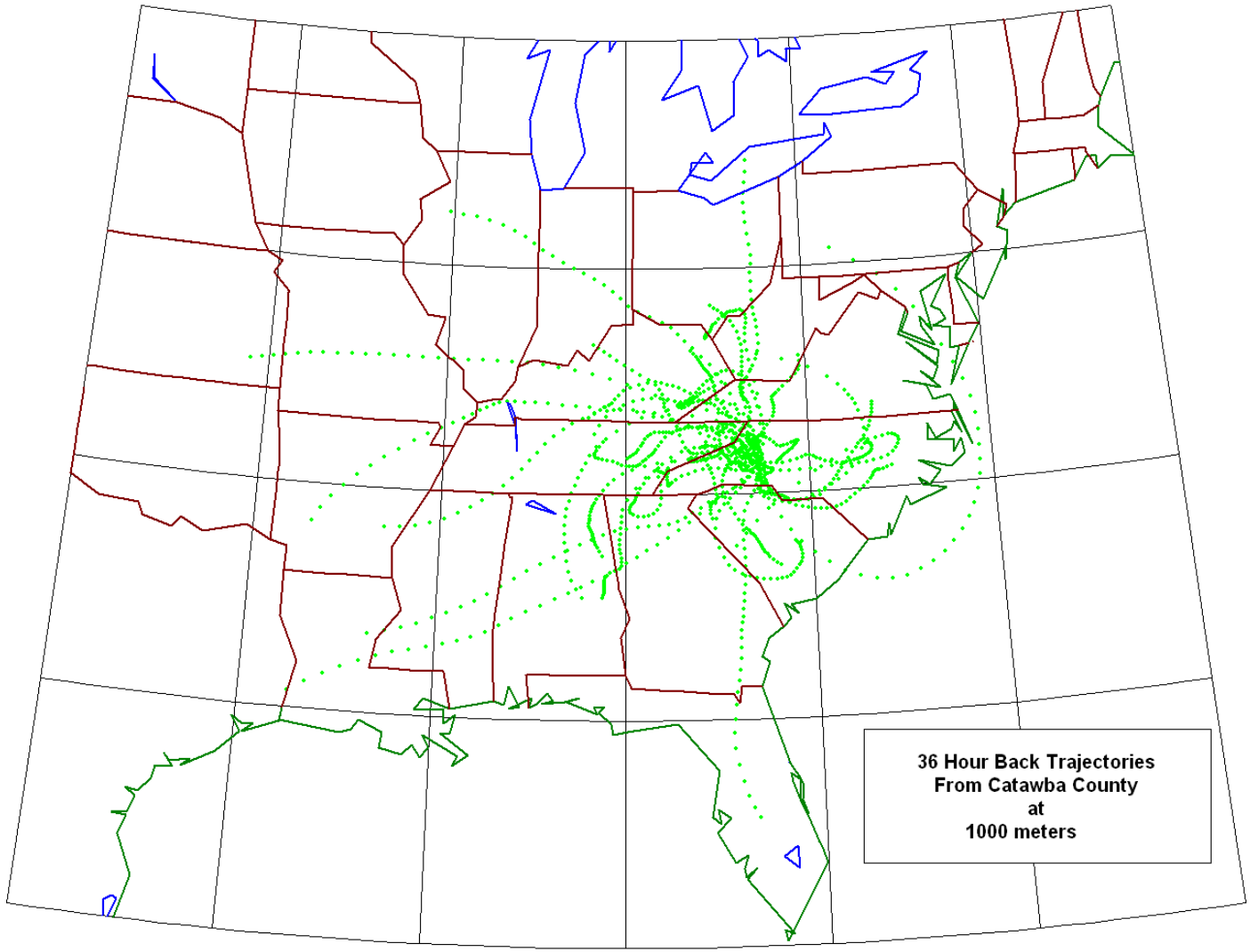

FIG 4. 36-hour back trajectories at 1000 meters from the Catawba County site for days when the $PM_{2.5}$ concentration was high.

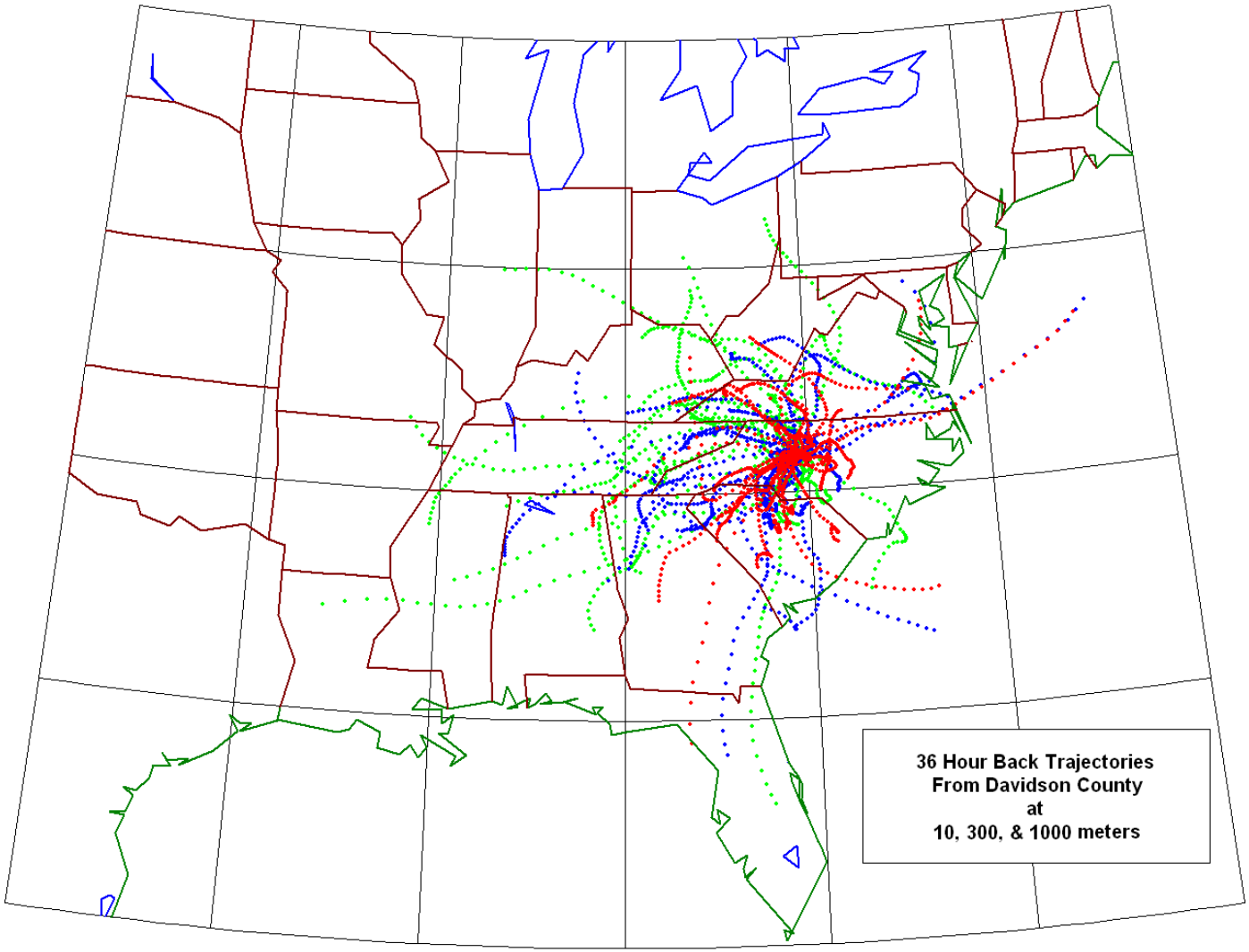

FIG 5. As in Figure 1, except for Davidson County.

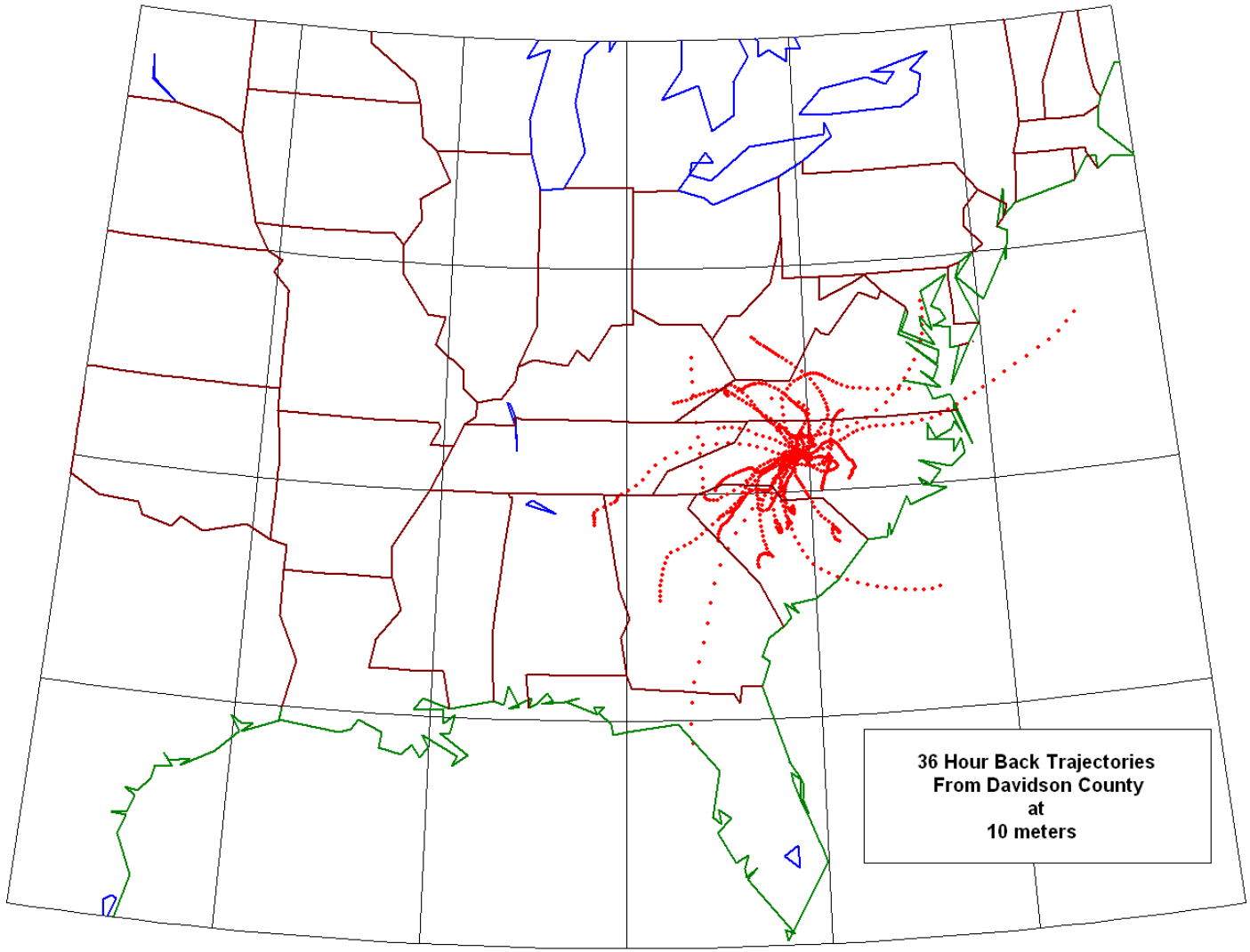

FIG 6. As in Figure 2, except for Davidson County.

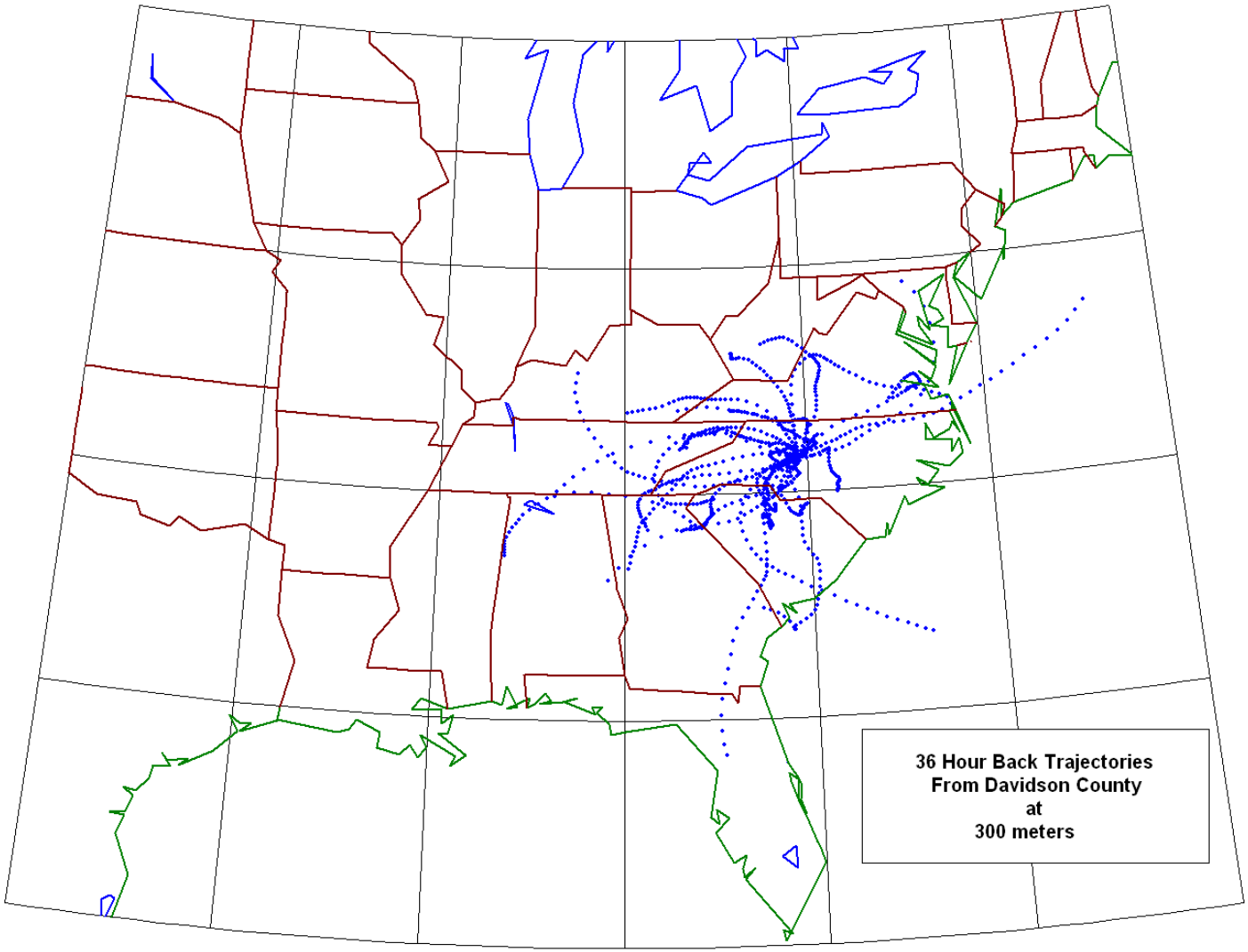

FIG 7. As in Figure 3, except for Davidson County.

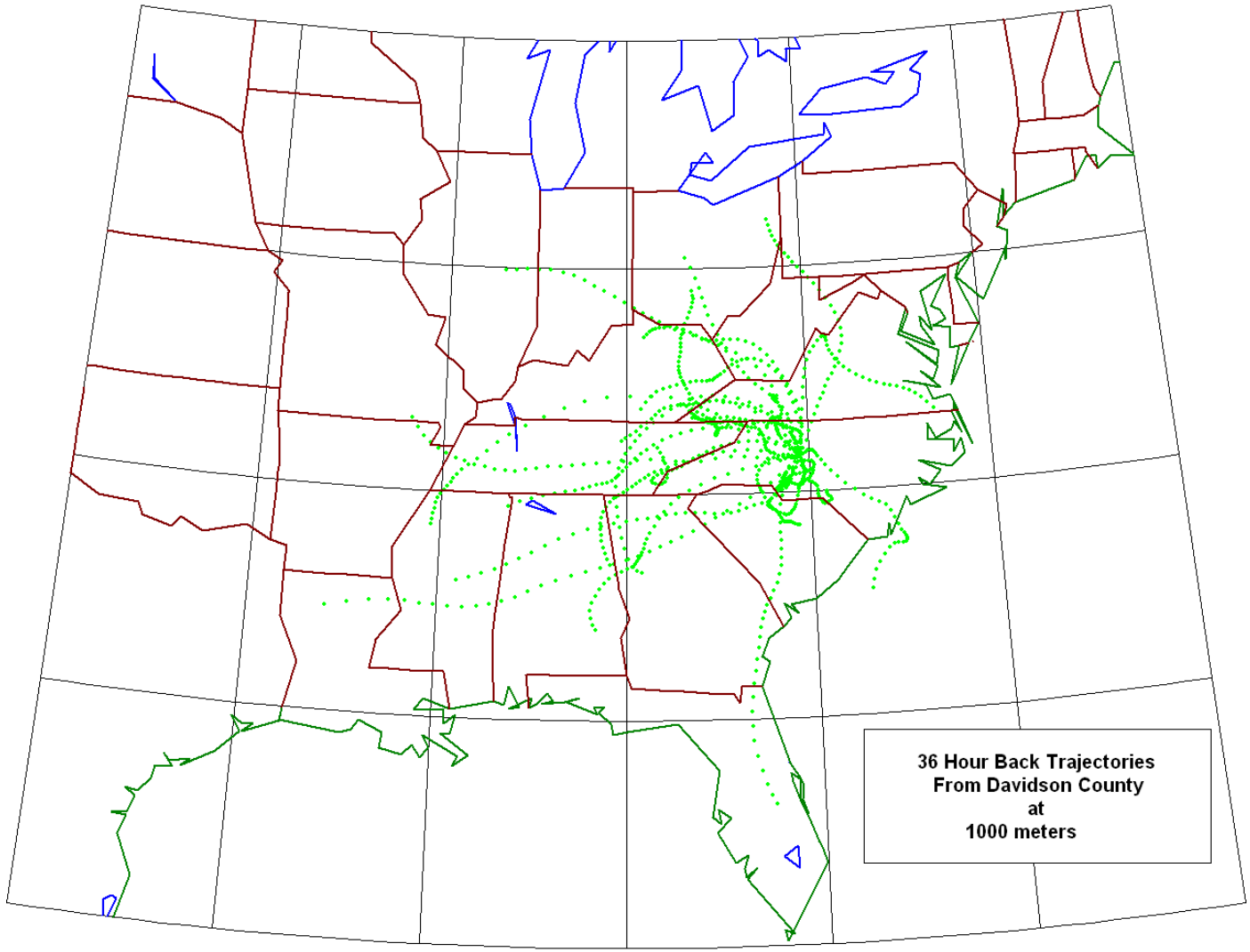

FIG 8. As in Figure 4, except for Davidson County.

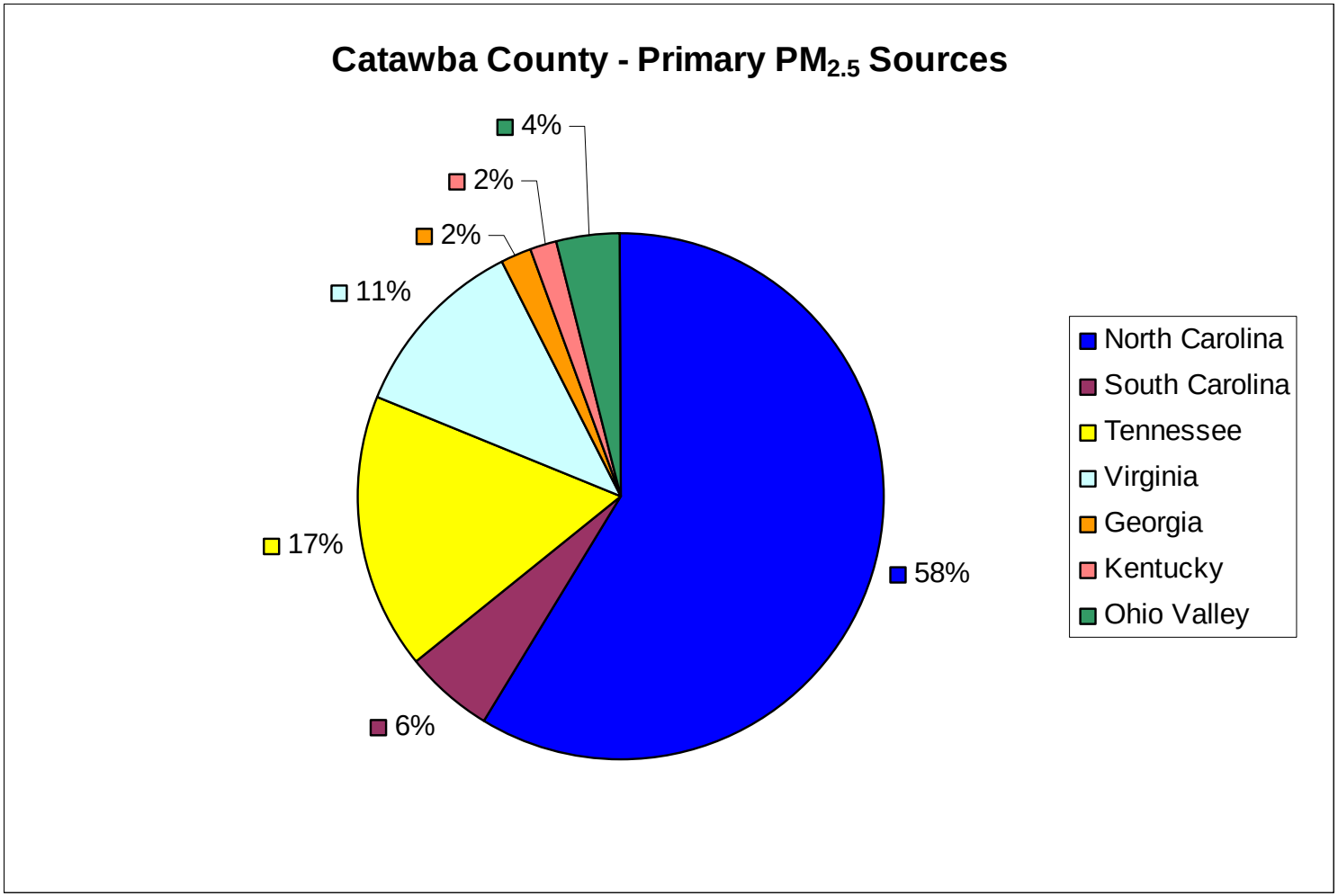

FIG 9. Percent of the days for which HYSPLIT back trajectories were run for the Catawba County $PM_{2.5}$ monitor for which each region was determined to be a primary source. Dark Blue: North Carolina; Burgundy: South Carolina; Yellow: Tennessee; Light Blue: Virginia; Orange: Georgia; Pink: Kentucky; Green: Ohio Valley.

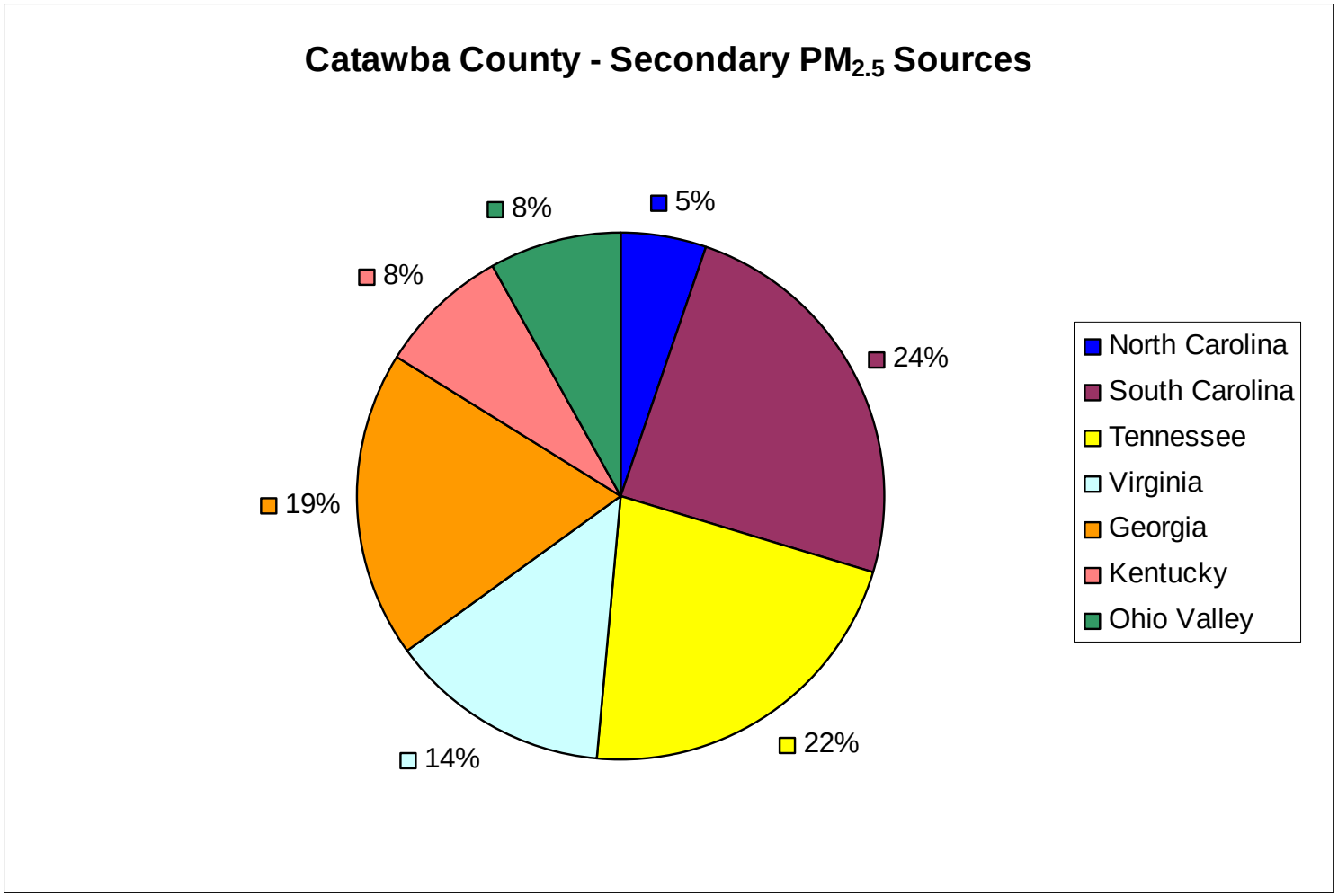

FIG 10. Percent of the days for which HYSPLIT back trajectories were run for the Catawba County $PM_{2.5}$ monitor for which each region was determined to be a secondary source. Dark Blue: North Carolina; Burgundy: South Carolina; Yellow: Tennessee; Light Blue: Virginia; Orange: Georgia; Pink: Kentucky; Green: Ohio Valley.

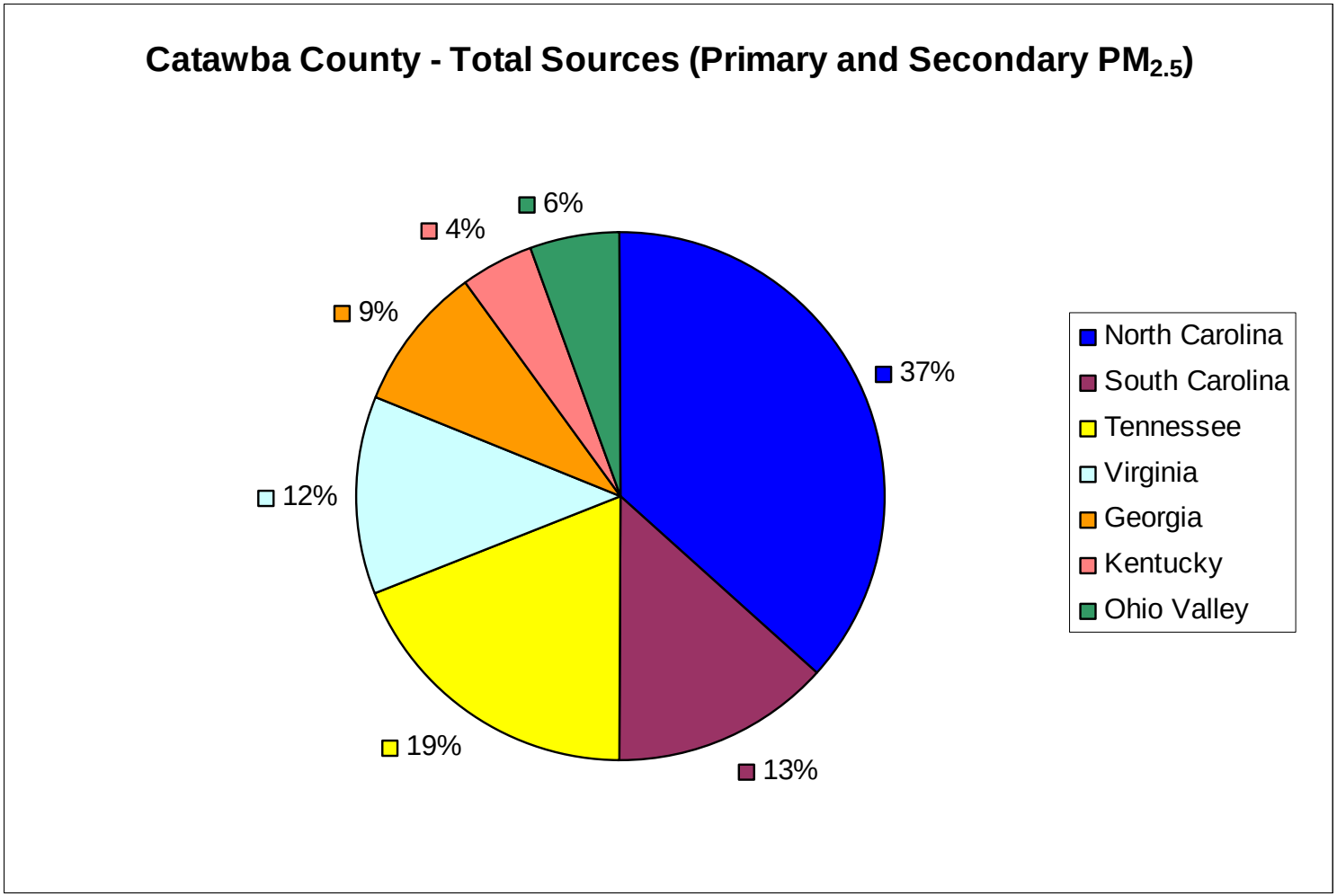

FIG 11. Percent of the days for which HYSPLIT back trajectories were run for the Catawba County $PM_{2.5}$ monitor for which each region was determined to be a primary source, secondary source, or both. Dark Blue: North Carolina; Burgundy: South Carolina; Yellow: Tennessee; Light Blue: Virginia; Orange: Georgia; Pink: Kentucky; Green: Ohio Valley.

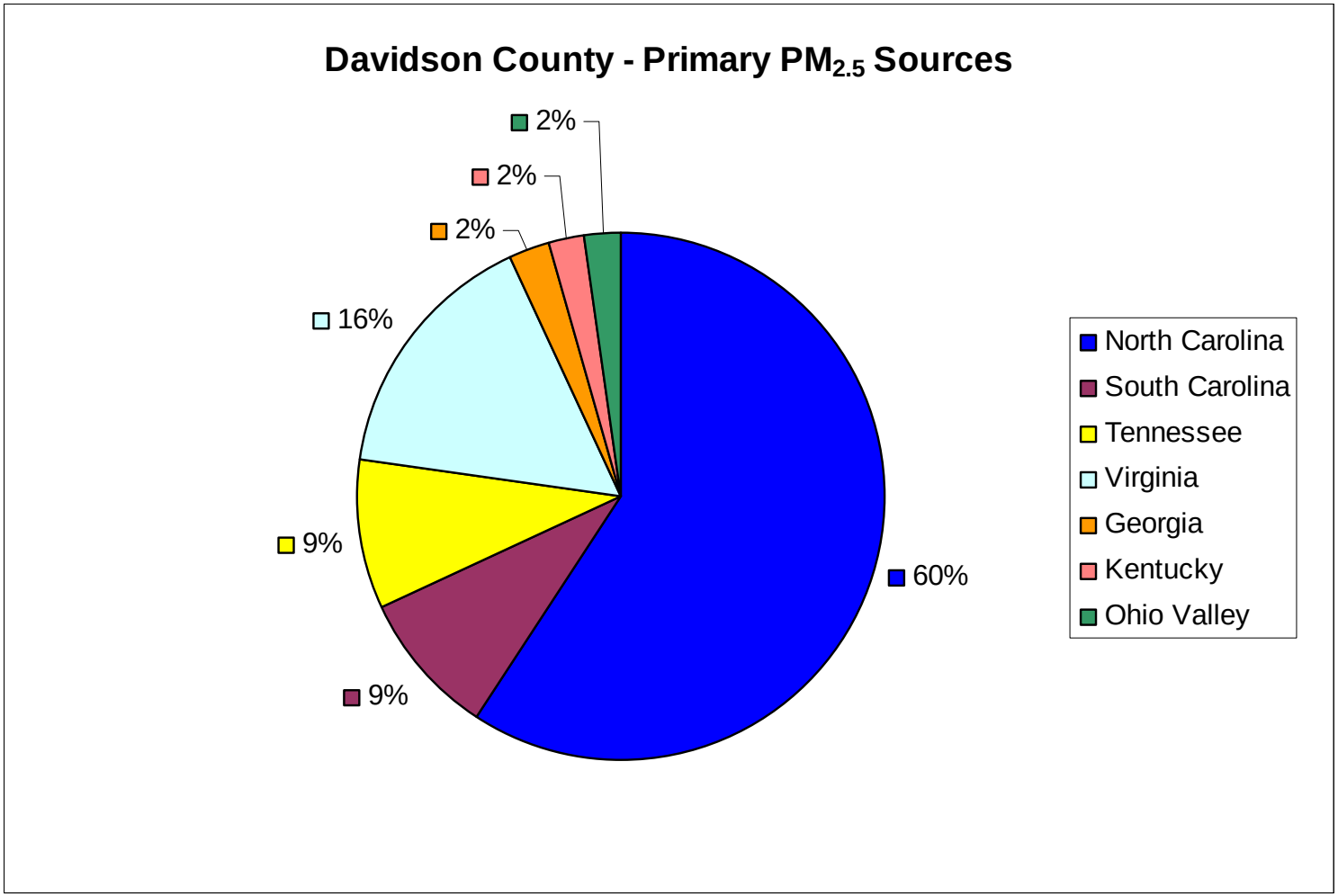

FIG 12. Percent of the days for which HYSPLIT back trajectories were run for the Davidson County $PM_{2.5}$ monitor for which each region was determined to be a primary source. Dark Blue: North Carolina; Burgundy: South Carolina; Yellow: Tennessee; Light Blue: Virginia; Orange: Georgia; Pink: Kentucky; Green: Ohio Valley.

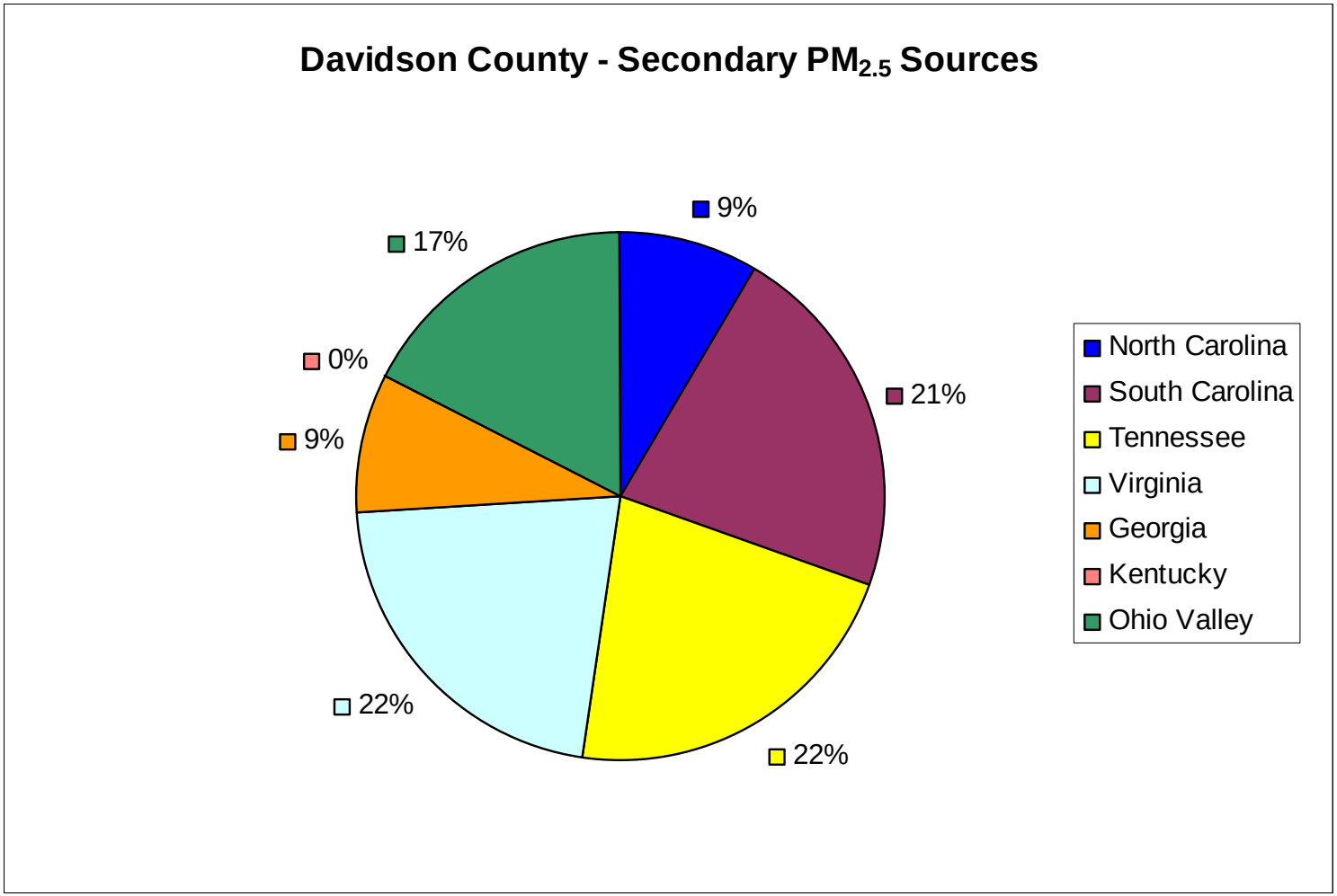

FIG 13. Percent of the days for which HYSPLIT back trajectories were run for the Davidson County $PM_{2.5}$ monitor for which each region was determined to be a secondary source. Dark Blue: North Carolina; Burgundy: South Carolina; Yellow: Tennessee; Light Blue: Virginia; Orange: Georgia; Pink: Kentucky; Green: Ohio Valley.

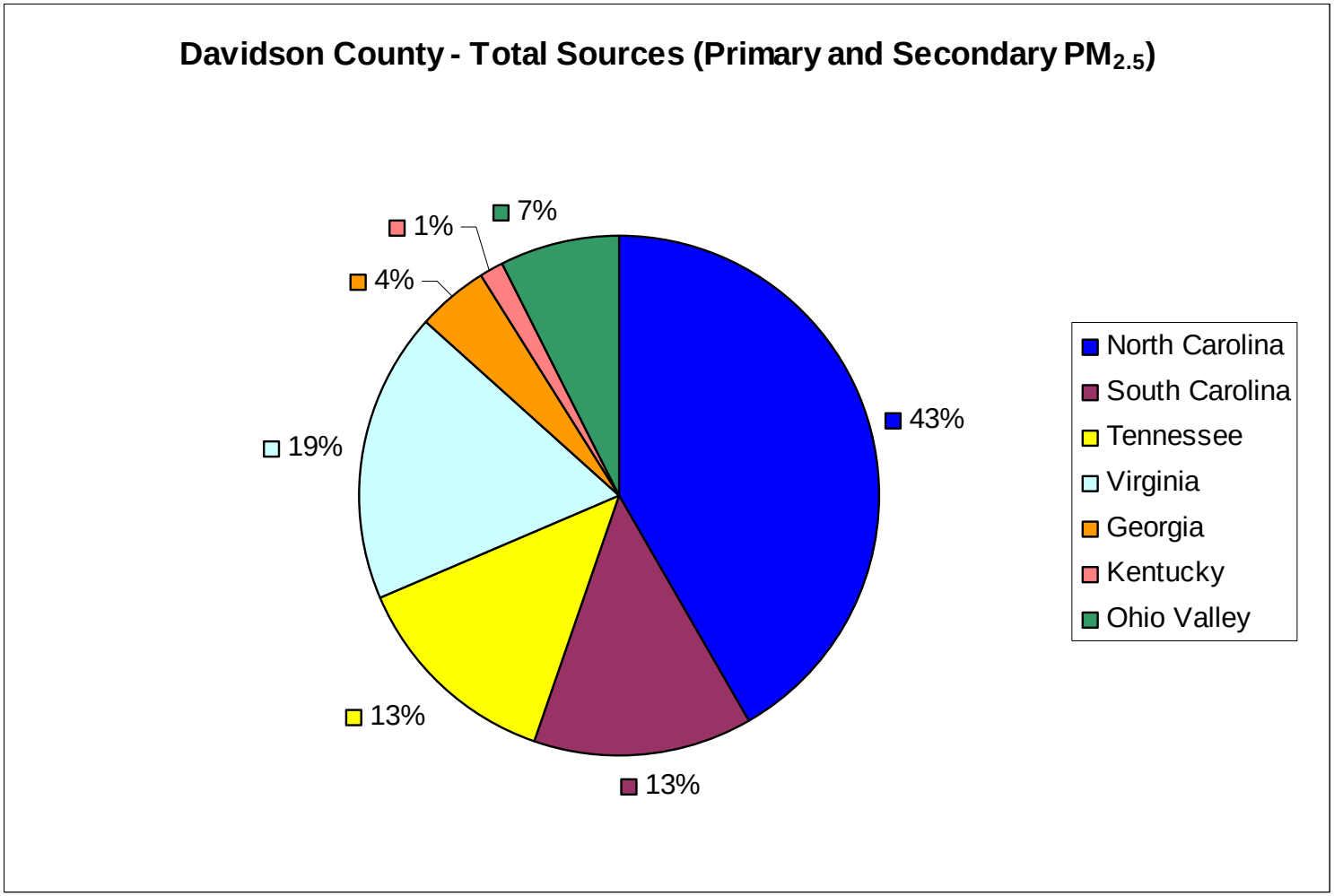

FIG 14. Percent of the days for which HYSPLIT back trajectories were run for the Davidson County $PM_{2.5}$ monitor for which each region was determined to be a primary source, secondary source, or both. Dark Blue: North Carolina; Burgundy: South Carolina; Yellow: Tennessee; Light Blue: Virginia; Orange: Georgia; Pink: Kentucky; Green: Ohio Valley.

APPENDIX B

IAQR Budgets for SO_2 and NO_X from EGUs in Upwind States

IAQR Annual SO_2 Budgets (In Tons)[1]

State	Interim	Final
Alabama	157,629	110,340
Georgia	213,120	149,184
Illinois	192,728	134,909
Indiana	254,674	178,272
Kentucky	188,829	132,180
Michigan	178,658	125,061
Ohio	333,619	233,533
Pennsylvania	276,072	193,250
South Carolina	57,288	40,101
Tennessee	137,256	96,079
Virginia	63,497	44,448
West Virginia	215,945	151,162

IAQR Annual NO_X Budgets (In Tons)[2]

State	Interim	Final
Alabama	67,414	56,178
Georgia	63,567	52,973
Illinois	73,613	61,344
Indiana	102,283	85,235
Kentucky	77,929	64,940
Michigan	60,199	50,165
Ohio	101,692	84,743
Pennsylvania	84,542	70,452
South Carolina	30,892	25,743
Tennessee	47,734	39,778
Virginia	31,083	25,903
West Virginia	68,227	56,856

[1] *IAQR*, 69 Fed. Reg. at 4619.

[2] *Id.* at 4620.

IAQR **Ozone-Season NO_X Budgets (In Tons)**[3]

State	Interim	Final
Maryland	12,504	10,420

[3] *Id.* at 4620. Because the State has concluded that emissions from EGUs in Maryland contribute significantly to nonattainment for ozone but not for $PM_{2.5}$, only an ozone-season budget is appropriate. The State calculated this budget by using the ratios for ozone-season to annual budgets proposed for the State of Connecticut. *Id.* at 4621.