

# **Spatially Allocating Airport-related Emissions for Air Quality Modeling: New Approach And New Data**

Madeleine Strum and Laurel Driver

Office of Air Quality Planning and Standards, Emissions, Monitoring and Analysis Division, U.S.  
Environmental Protection Agency, Research Triangle Park, NC, 27711

[strum.madeleine@epa.gov](mailto:strum.madeleine@epa.gov)

Richard Mason\*

Atmospheric Sciences Modeling Division, Air Resources Laboratory, National Oceanic and  
Atmospheric Administration, Research Triangle Park, NC, 27711

James D. Smith

Air Quality Analysis Branch, Air Protection Division, U.S. Environmental Protection Agency,  
Region III, 1650 Arch St., Philadelphia, PA 19103-2023

Richard Billings

Eastern Research Group, Inc., 1600 Perimeter Park, Morrisville, NC 27560

## **ABSTRACT**

Up until now, there have been inconsistencies in the approaches and geographic data used by emission inventory developers and air quality modelers when they develop and spatially allocate aircraft emissions. While such inconsistencies are not deemed to have a significant impact on large scale regional modeling for ozone or particulate modeling, they can have a significant effect on higher resolution modeling such as that done for modeling toxic air pollutants in urban areas.

A new approach has been developed for allocating aircraft and other airport-related emissions inventoried at the county level that utilizes information on airport location and activity data that is generally consistent with the 1999 National Emission Inventory. This approach has been incorporated in the Emission Modeling System for Hazardous Air Pollutants (EMS-HAP) Version 3.0 and Sparse Matrix Operator Kernel Emissions (SMOKE) 2.0 emission processors.

This paper describes this new approach for airport-related emissions. It discusses how an application of the approach for a local scale assessment uncovered inconsistencies in the various data sources, and how a generally consistent set of data to use with the approach was developed. This paper emphasizes the importance of inventory developers working with air quality modelers and provides recommendations to improve the inventory development process for airport-related sources which will further improve the spatial treatment of these sources in air quality models.

## **INTRODUCTION**

There are numerous airport-related emission source categories in the National Emission Inventory (NEI). These include the aircraft emission source categories, such as commercial aircraft (Source category code [SCC]=227502000) and airport service equipment categories such as off-highway vehicle gasoline, 4-stroke; airport ground support equipment (SCC=2265008005). In the non-point inventory of the 1999 NEI for hazardous air pollutants (HAPs), there is also a category for storage and transport; petroleum and petroleum product storage; airports: aviation gasoline; stage 1: total (SCC=2501080050). In the 1999 and previous versions of the NEI, emissions for these categories have been provided at the

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\* On Assignment to the Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency

county level. Documentation on how the 1999 NEI emission estimates for these categories were derived can be found at <http://www.epa.gov/ttn/chief/net/1999inventory.html>.<sup>1,2</sup>

For air quality modeling purposes, county-level emissions must be spatially allocated to accommodate the needs of the air quality models. Often the spatial allocation requires county-level emissions to be disaggregated at a resolution finer than the county (e.g., sub-county). Grid models such as the Community Multiscale Air Quality Model (CMAQ)<sup>3</sup> require allocation to grid cells, whereas the Assessment System for Population Exposure Nationwide (ASPEN)<sup>4</sup> model requires allocation to census tracts.

Spatial data used for this allocation are referred to as spatial surrogates. Emission processors use surrogates for spatial allocation of emissions based on the premise that the geographic distribution of a particular surrogate is similar to the geographic distribution of emissions from particular source categories. For regional/national scale modeling, the spatial data are generally obtained from shape files containing national-level data. Shapefiles are the native format for ArcView<sup>®</sup> and store all of the necessary geometric, locational and attribute information of geographic features (points, lines or polygons). These data are then gridded in a geographic information system (GIS) such as ArcView<sup>®</sup> and grid cell (or census tract) ratios are computed. The resulting files are formatted so that they can be input to an emission processor which performs the spatial allocation step by multiplying county level emissions by grid cell or tract ratios to produce grid cell or tract-level emissions. There are numerous sources of data that can be used to allocate emissions from airport-related emission categories. These were identified in a study<sup>5</sup> to update the spatial surrogates that EPA provides at the emission modeling clearinghouse ([www.epa.gov/ttn/chief/emch](http://www.epa.gov/ttn/chief/emch)). Data sources identified in the study include airport facility locations (points) or runways (lines) from the Bureau of Transportation Statistics, airport boundaries from Geographic Data Technology (which is supplied with the Environmental Systems Research Institute (ESRI) CD for ArcView<sup>®</sup>), and airport runways or facility locations from the Federal Emergency Management Agency.

An alternative approach for spatially allocating county-level airport-related emissions was developed as part of the first national scale modeling of 1996 air toxics emissions which was performed as part of the National Air Toxics Assessment ([www.epa.gov/ttn/atw/nata](http://www.epa.gov/ttn/atw/nata)). This alternative allocation approach was incorporated into the emission processor built for the ASPEN model, EMS-HAP, Version 1.1.<sup>6</sup> The approach was refined in EMS-HAP Version 2.0<sup>7</sup> which adds the capability of processing NEI emissions for input into the Industrial Source Complex Short Term Version 3 (ISCST3) model<sup>8</sup> for a local scale assessment. During an application of the EMS-HAP/ISCST3 system for a toxics assessment of the Philadelphia area, an inconsistency was discovered between the State and County Federal Information Processing Standards (FIPS) code assigned to the aircraft emissions in the NEI and the data used by the allocation approach. A complete investigation of both data sets revealed additional discrepancies in the FIPs codes assigned to airports between the inventory and data used in the allocation approach. These discrepancies were resolved, and a new database, which is consistent with the NEI data base, was developed. This new database is used for to spatially allocate airport-related emissions in EMS-HAP version 3.0<sup>9</sup> and SMOKE 2.0<sup>10</sup>.

This paper describes the alternative approach for spatially allocating airport-related emissions for air quality modeling in EMS-HAP and SMOKE. It discusses why inconsistencies in airport locations exist between the data sets used to develop the inventories and spatial allocation approach. It also demonstrates the impact of such an inconsistency on the Philadelphia study, a local scale air toxics modeling assessment. We discuss the development of a consistent spatial database for allocating airport-related emissions. Finally, we make recommendations to improve the inventory development process for airport-related sources which will further improve the spatial treatment of these sources in air quality models.

## BODY

### A discrete allocation approach for airport-related emissions

EMS-HAP (Versions 1.1, 2.0 and 3.0)<sup>6, 7, 8</sup> is the first and only emission processor developed to prepare a national toxics inventory for national scale modeling using ASPEN and for local scale modeling using ISCST3<sup>8</sup>. In EMS-HAP Version 1.1, a routine was developed to replace the typical spatial allocation of county-level emissions to census tracts for aircraft emissions with one that would discretely allocate these emissions to airport locations. This feature replaces one that would treat aircraft emissions as pseudo-point sources in ASPEN, which, once allocated from the county-level to census tracts, are spread out over the tracts and modeled as point sources at various locations. It was felt that modeling these aircraft emissions at airport locations, rather than spread out over the tracts, would result in better concentration estimates from the ASPEN model.

The approach EMS-HAP Version 2.0 uses to prepare aircraft emissions for the air quality model is to extract specific (hard-coded) SCCs that represent commercial or general aviation categories from the inventory and allocate them to locations representing specific airports. These SCCs were the only airport-related SCCs in the July 2001 version of the 1996 National Toxics Inventory (which was used for the 1996 NATA), and EMS-HAP's design was in part based on this inventory. As documented in Appendix D of the EMS-HAP Version 2.0 user's guide, we developed an allocation file using airport latitudes and longitudes for about 18,000 airports in the U.S., Puerto Rico and the Virgin Islands from a database compiled by Gregory Rigamer and Associates which contained commercial and noncommercial airports. We assigned a county-level allocation factor to each airport in the data set such that:

- If a county has both commercial and noncommercial airports, then emissions are only allocated to the commercial airports (even if the SCC is for general aviation);
- If multiple commercial airports are located in the county, then emissions are divided among the commercial airports based on passenger data for 1996, obtained from a Federal Aviation Administration data set; and,
- If a county has multiple noncommercial airports, then emissions are divided equally among them.

EMS-HAP Version 3.0<sup>9</sup> utilizes the same basic concept in Version 2.0 of extracting emission sources and assigning them to specific locations within a county based on allocation factors. However, the approach was generalized in Version 3.0 to allow the user to choose the particular SCCs to assign to airport locations. The 1999 NEI contains many more airport-related SCCs than the inventory used for the 1996 NATA (which, for example, did not contain discrete categories for airport support equipment emissions), and the new approach allows these SCCs to be assigned to airport locations in addition to the aircraft SCCs. In addition, the generalization of the routine in EMS-HAP Version 3.0 allows its potential future use for other nonroad mobile sources, such as port-related emissions. In Version 3.0, we allow the use of multiple allocation factor files so that the user can provide different locations and/or provide different allocation factors based on the SCC. We prepared ready-to-use allocation factor files specific to four aircraft operations: commercial aviation, general aviation, air taxi, and military aviation. These files contain latitudes and longitudes for airports and allocation factors that are specific to one of the four particular operations. The allocation factor represents the fraction of activity for a particular airport relative to all other airports in that county. The allocation factors are based on itinerant data pertaining to the specific aircraft operation. Itinerant operations are defined as aircraft take-offs whereby the aircraft leaves the airport vicinity and lands at another airport, or aircraft landings whereby the aircraft has arrived from outside the airport vicinity. The following equation shows the calculation of the general aviation allocation factor, Factor  $I_{GA}$  for airport  $I$ .

$$\text{Factor}_{I, GA} = \text{IT}_{GA, I} / \text{IT}_{GA, \text{county}}$$

where:

$\text{Factor}_{I, GA}$  = allocation factor for airport I, for general aviation emissions

$\text{IT}_{GA, I}$  = itinerant data for general aviation for airport I

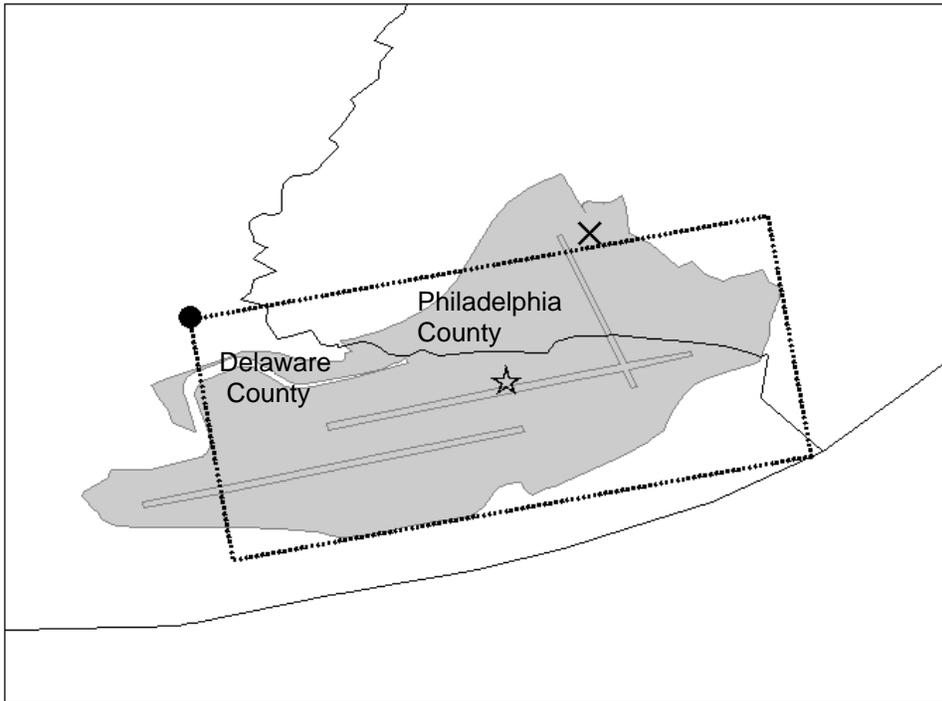
$\text{IT}_{GA, \text{county}}$  = Sum of itinerant data for general aviation for all airports in the county where airport I resides

The same airports are included in all four allocation files; the only difference is the allocation factor assigned to each airport. For example, if in a particular county, an airport has high commercial aviation activity relative to other airports in that county and low general aviation activity, then the allocation factor may be high in the commercial aviation file, but low in the general aviation file.

The allocation cross-reference file was developed by assigning all airport-related SCCs (including airport service equipment) to one of the four files. The particular data sources of itinerant and locational data that were utilized to develop the allocation factor files are discussed later in the paper. The ultimate sources of data were chosen to reduce inconsistencies found between geographic information for aircraft emissions in the NEI and the original geographic information developed for EMS-HAP.

Once the emissions are allocated to specific locations, EMS-HAP adds the necessary identification variables used for point sources so that they can be processed with the other point sources through the EMS-HAP point source programs. When processing emissions using EMS-HAP for ISCST3 model, the user can model all airport-related emissions as ISCST3 area sources defined by a rectangular area with a distinct angle. The user is responsible for providing the dimensions of the rectangle and angle for each airport in the domain or can provide a set of default dimensions/angle to be applied to all airports in the domain. EMS-HAP will compute the southwest corner of the ISCST3 area source based on these user-supplied parameters and the latitude and longitude from the allocation factor file.

Figure 1 shows how we approximate a rectangular area source to represent the Philadelphia International Airport, which is the shaded area in the figure. The latitude and longitude represented by the star in the figure is provided in the allocation factor files for EMS-HAP. The “X” represents an alternative latitude/longitude value discussed later in the paper. The curved line that traverses the rectangular box represents the border of Delaware (south) and Philadelphia (north) counties in Pennsylvania.



**Figure 1. ISCST3 area source representation for the Philadelphia International Airport in EMS-HAP**

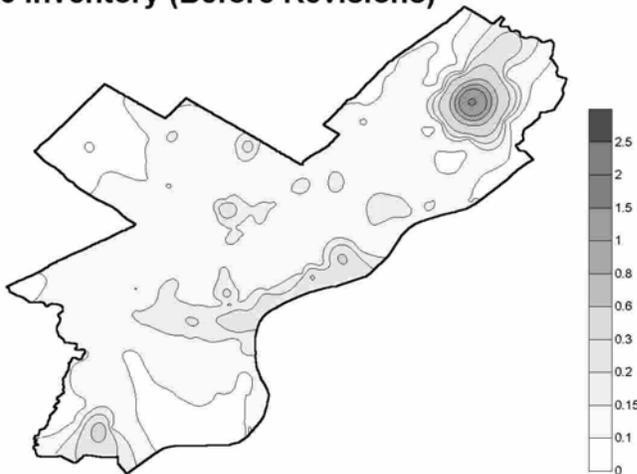
When using the EMS-HAP/ISCST3 system, the user is responsible for developing the dimensions and angle for each airport in the modeling domain, or providing a set of default dimensions/angle to be applied to all airports in the domain. EMS-HAP will compute the southwest corner of the area source based on these user-supplied parameters and the latitude and longitude from the allocation factor file.

This alternative spatial allocation approach was also incorporated into Version 1.5 and higher of the SMOKE system and is documented in the User's Guide<sup>10</sup> as the "area-to-point" approach. The approach is very similar to that used in EMS-HAP, however, in SMOKE, the allocated airport-related sources are not treated as point sources. This treatment was designed to best accommodate the needs of the gridded air quality models for which SMOKE processes emissions. The allocated airport-related emissions stay in the area/nonroad source inventory from which they originate. SMOKE will place the emissions in the grid cells containing the latitude and longitude of the particular airports to which the emission sources are allocated. If multiple airports are in a county, SMOKE adds sources to the inventory and splits the county-total emissions among the locations based on the allocation factor. Also, in SMOKE, the cross-reference between SCCs and geographic/allocation factor information is contained in the same file whereas in EMS-HAP, separate files are used for the cross reference and the geographic/allocation factor information. Note that in SMOKE, this approach allows an airport to be associated with only one grid cell based on a single airport latitude and longitude. Thus, for large airports covering multiple grid cells (e.g., in the case of a fine grid), a user may choose to use an approach that will allocate emissions based on the area of the airport in each grid cell. In this case, the user can choose to skip the area-to-point approach for the particular county. However, considering that the air quality model treats the emission as uniformly distributed over the grid cell, it may be more valid to model the emissions in the grid cell containing the airport runways rather than spreading them over multiple grid cells that are intersected by the airport boundaries.

## Use of the EMS-HAP Approach for a Local-Scale Modeling Assessment: Discovering the Data Inconsistency and Impacts

The EMS-HAP/ISCST3 system is being used to model several air toxics from 1996, 1999 and a projected 2010 inventory over a 107 by 107 km domain centered around Philadelphia County. The 1996 results show a significant hot spot in the northern part of Philadelphia County for a number of the air toxics. Figure 2 shows 1,3-butadiene concentrations obtained from the EMS-HAP/ISCST3 system using the original (EMS-HAP Version 2.0) airport allocation data.

**Total Butadiene Concentrations (ug/m3)  
1996 Inventory (Before Revisions)**



**Figure 2: Concentrations of 1,3 Butadiene in Philadelphia County Using the Original EMS-HAP Allocation File**

The hot spot is centered at the Northeast Philadelphia Airport (PNE). The PNE has no significant commercial operations; therefore, we surmised that aircraft emissions from the Philadelphia International Airport (PHL), which crosses into both Philadelphia and Delaware counties, were incorrectly allocated to PNE. The EMS-HAP airport allocation file originally used for this application contains only one airport in Philadelphia County: PNE. Thus, EMS-HAP allocated all of the Philadelphia County commercial aircraft emissions in the NEI (plus all other airport-related SCCs within the county) to PNE. The allocation file associated the Philadelphia International Airport (PHL) with Delaware County, whereas the inventory associates this airport with Philadelphia County.

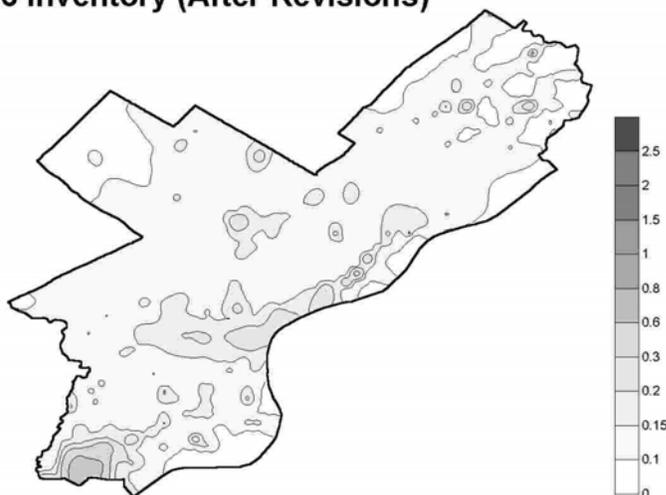
To confirm and correct this allocation inconsistency, we used data from an auxiliary file, *county\_air.mdb*, which is provided with the 1999 NEI nonroad mobile data along with other GIS data used in developing the NEI. This file can be accessed at: <ftp://ftp.epa.gov/pub/EmisInventory/finalnei99ver3/haps/datafiles/nonroad/auxiliary/>. It can be found within the airport subdirectory within a zipped file called *gis\_data*. The file *county\_air.mdb* provides geographic information (State and County FIPS code, latitude, longitude) for each airport for which emissions were computed by EPA (it does not include state-generated airport emissions), and it provides the data used to compute emissions for each airport including the itinerant data for the commercial aircraft, air taxi, general aviation and military operations that are used to allocate emissions to the airports in the file. Table 1 shows select fields from *county\_air.mdb* for the airports, PHL and PNE, that the 1999 NEI associated with Philadelphia County. The X and Y coordinates (last column in Table 1) are shown in Figure 1 as the “X”; this is the reason for this airport being associated with Philadelphia County.

Table 1. Philadelphia County Airports from *county\_air.mdb*, a data file provided with the 1999 NEI

| NEI airport information: From <i>county_air.mdb</i> |                        |          |           |              |       |       |               |              |               |                |           |          |
|---|------------------------|----------|-----------|--------------|-------|-------|---------------|--------------|---------------|----------------|-----------|----------|
| LOC_ID  | APORT_NAME             | FIP S ST | FIPS CNTY | CITY         | STATE | YEA R | SumOf ITN_A C | SumOf ITN_AT | SumOf ITN_G A | SumOf ITN_MI L | X_COORD   | Y_COORD  |
| PHL   | PHILADELPHIA INTL      | 42       | 101       | PHILADELPHIA | PA    | 1999  | 279431        | 146511       | 48214         | 4241           | -75.23713 | 39.88206 |
| PNE   | NORTHEAST PHILADELPHIA | 42       | 101       | PHILADELPHIA | PA    | 1999  | 0             | 0            | 117209        | 13665          | -75.00883 | 40.08391 |

The fields titled “SumOfITN\_XX”, where XX is AC (commercial aircraft), AT (air taxi), GA (general aviation) or MIL (military) contain the itinerant data which were used to reallocate the NEI Philadelphia county airport-related emissions to both PHL and PNE. Once the misallocation was fixed, the model was rerun. Figure 3 shows the impact of the correction on ISCST3 estimated concentrations.

**Total Butadiene Concentrations (ug/m3)  
1996 Inventory (After Revisions)**



**Figure 3: Concentrations of 1,3 Butadiene in Philadelphia County Correcting the Emission Allocation**

### Inconsistencies in Airport Data and Construction of a Consistent Airport Allocation Factor File

The discrepancy in the counties associated with the Philadelphia International Airport was found at the time the data were being developed to process the 1999 NEI through EMS-HAP Version 3.0. We checked for other discrepancies between the *county\_air* database and the EMS-HAP allocation data. We found two issues: 1) there were 36 airports for which *county\_air* and EMS-HAPs airport allocation data had assigned different counties, and 2) the EMS-HAP allocation data contained significantly more airports.

Both issues were surprising since the original airport allocation data used in EMS-HAP and the airport data used for the 1999 NEI came from the same basic sources. The airports, along with their operation-specific allocation factors for commercial aviation, general aviation, air taxi and military aviation are from the Federal Aviation Administration Terminal Area Forecast System (TAF) (<http://www.apo.data.faa.gov/faatafall.HTM>). The TAF contains both historical and future year itinerant information for airports in the U.S., Puerto Rico and Virgin Islands. We ran the model for the base-year 1999 in August 2002. Our resulting database contained nearly 3500 airports. The NEI database

contained about 2400 airports. We are not sure why there is such a large discrepancy, but we do notice that if the TAF model is run at different times (even choosing the same year) different results occur.

The TAF does not have information on airport locations (other than city and state). Both the NEI and EMS-HAP developers used Bureau of Transportation Statistics geographic information to assign locations to the airports. However, we suspect that these data were used differently. EMS-HAP developers obtained a shape file from the Bureau of Transportation Statistics (BTS) National Transportation Atlas Data, and determined the county FIPS code by overlaying, in a geographic information system (GIS), county boundaries using a census county boundary file (1:100,000 resolution). The BTS shape file containing year 2001 data was downloaded (September 2002) from [http://www.bts.gov/gis/download\\_sites/ntad01/maindownload.html](http://www.bts.gov/gis/download_sites/ntad01/maindownload.html). We selected “Entire United States” and “Airports” point layer and we removed airports that were not in our domain of interest. This resulted in 19,728 airports. The BTS data provides the name of the county for which each airport is located; however, we did not use this information. In some cases (e.g., the Philadelphia International Airport) we noticed that the BTS-designated county conflicts with the county we determined from the BTS latitude longitude via GIS. In some cases the county determined from the BTS latitude longitude via GIS conflicts with that determined using a slightly different resolution in GIS.

In order to allocate aircraft emissions consistently with the method for which they were determined in the inventory, we constructed a new set of EMS-HAP and SMOKE airport allocation data. We used the *county\_air.mdb* database as the core data. However, we made some changes to the data to account for some of the inconsistencies. We found that the inconsistencies can be grouped into two categories: (1) Inconsistent FIPS due to the airport existing in two different nearby counties, close to a county border, or close to a private airstrip in a nearby county that was wrongly classified as the airport in question, and (2) Inconsistent FIPS due to gross errors in airport locations (e.g., BTS says airport is in Louisiana, *county\_air.mdb* airport data says it is in California). In constructing the allocation file, the only changes we made to the core data from *county\_air.mdb* were to correct gross errors (category 2) in airport locations, and to change the geographic coordinates for the Philadelphia International Airport (category 1) to the BTS coordinates (shown as the star in Figure 1). Note that we left the FIPS code for that airport in Philadelphia county.

Prior to constructing the allocation file, we analyzed each of the inconsistencies to determine the “correct” geographic information for the airports in question. We obtained latitude/longitude information from the airnav.com website (<http://www.airnav.com/airports/>), and compared coordinates with those from *county\_air.mdb* and the BTS shapefile. The airnav.com website has no county information for the airports, but it allows us to compare geographic coordinates and the county could be determined based on the latitude/longitude information. We also used GIS airport boundary data from the ESRI CD (Data & Maps Media Kit, [www.esri.com](http://www.esri.com)) which is supplied with the ArcView<sup>®</sup> software. We overlaid the airport boundaries with county boundaries from the census to determine the county (or counties) that intersect the airport boundaries. We also used other information, such as maps available from the Internet, to corroborate what we determined to be the correct county for the airport. The airnav.com website and BTS were fairly consistent; however in some cases the GIS airport boundary plots did not agree with BTS or other information we found.

Table 2 contains some of the category 1 inconsistencies in which the airport is located close to the border of a county or the airport is in two counties. All sixteen of these category 1 inconsistencies are documented in the EMS-HAP Version 3.0 User’s Guide (Appendix C). In this table, the most correct county is in bold. Because the Atlanta Airport (including runways) straddle both Fulton and Clayton counties such that it is difficult to tell which county the majority of the emissions would be in, neither county is in bold. As stated earlier, in constructing the allocation file, we used the NEI airport data (i.e., data in *county\_air.mdb*) for all airports listed Table 2, except that the geographic coordinates were

modified for the Philadelphia International Airport from the *county\_air.mdb* latitude/longitude (-75.23713, 39.88206) to the airnav.com and BTS latitude and longitude (-75.2411408, 39.8719528).

**Table 2. Airports close to county borders that result in inconsistent FIPS**

(county in bold is the proper county based on the corroborating information, if definitive)

| Location ID | Airport Name                          | State | NEI-FIPS              | BTS-FIPS              | GIS airport boundary plot (ESRI data)  | Other Corroborating information   |
|-------------|---------------------------------------|-------|-----------------------|-----------------------|--|---|
| ATL         | THE WILLIAM B HARTSFIELD ATLANTA INTL | GA    | 13121 Fulton          | 13063 Clayton         | terminals and most of runways are in Clayton, although a large runway (8L) is in Fulton  | airport diagram from <a href="http://www.naco.faa.gov/content/naco/online/airportdiagrams/00026AD.pdf">http://www.naco.faa.gov/content/naco/online/airportdiagrams/00026AD.pdf</a> compared with GIS picture shows approximate runway locations with regard to county boundaries  |
| PXE         | PERRY-HOUSTON COUNTY                  | GA    | 13153 Houston         | <b>13225 Peach</b>    | 13153 – but ESRI data are incorrect based on other corroborating information. See next column.   | map of Perry, Georgia from <a href="http://www.mapblast.com">www.mapblast.com</a> shows the airport to be in Peach County. This was also confirmed by calling the airport at (478) 987-3713. It appears that <i>county_air.mdb</i> geographic data (and GIS) is for a privately owned air strip which is about 15 –20 miles south of PXE. |
| DTN         | SHREVEPORT DOWNTOWN                   | LA    | 22017 Caddo           | <b>22015 Bossier</b>  | airport right on county borders, county borders very curvy. Vast majority of airport is in Bossier, but small portion is Caddo. Result highly dependent on resolution of county borders. |   |
| UUV         | SULLIVAN REGIONAL                     | MO    | 29055 Crawford        | <b>29071 Franklin</b> | Airport totally within Franklin county, although it is less than 5 miles (north) of Crawford county  | <a href="http://www.mapblast.com">www.mapblast.com</a> confirms it in Franklin County. Looks like <i>county_air.mdb</i> lat/lon is in error (by about 5 miles)  |
| GQQ         | GALLION MUNI                          | OH    | 39033 (Crawford)      | <b>39139 Richland</b> | GIS shows an airport in Crawford, however it is not GQQ.   | <a href="http://www.mapblast.com">www.mapblast.com</a> (Gallion, OH shows the airport to be located in Richmond (location of airplane) but airport runway feature looks like it is in Crawford. Called 419 468-8487 and receptionist said that most of the airport is in Richland county, and that most of the runways are in Richland.   |
| PHL         | PHILADELPHIA INTL                     | PA    | 42101 (Philadelphia)  | <b>42045 Delaware</b> | GIS shows airport in both counties, but most is in Delaware County   |   |
| DAN         | DANVILLE REGIONAL                     | VA    | <b>51590 Danville</b> | 51143 Pittsylvania    | GIS shows airport to be in Danville county but on the border, BTS lat/lon is a good average location for this airport.   | <a href="http://www.mapblast.com">www.mapblast.com</a> (Danville, VA) shows airport to be in Danville, but on border with Pittsylvania.   |

Mapblast.com ([www.mapblast.com](http://www.mapblast.com)), an MSN (Microsoft) website product, was particularly helpful corroborating information in that it showed the location of an airport (airplane) and the names of the counties on the map. Figure 4 shows how we determined that PERRY-HOUSTON COUNTY airport (PXE, 2<sup>nd</sup> row of the above table) is in Peach County, and not Houston County, Georgia. An airstrip (gray area) can be seen in Houston County, and it is presumed that the GIS data contained with the ESRI CD assigned this airstrip to Perry-Houston County Airport.

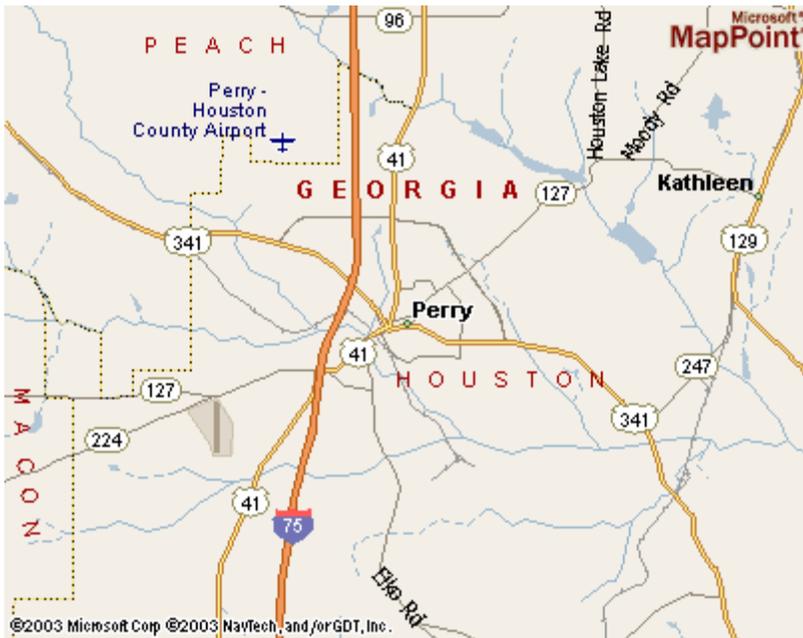


Figure 4. Map of Perry, Georgia from [www.mapblast.com](http://www.mapblast.com)

Table 3 shows a few of the significant inconsistencies between NEI airport location data and BTS data resulting in changes to the *county\_air.mdb* airport location data. All twenty are contained in the EMS-HAP Version 3.0 User’s Guide. For the twenty airports with this inconsistency, we constructed the airport allocation files using the BTS geographic coordinates for the airports, FIPS codes based on these coordinates (shown in column 3), and the *county\_air.mdb* airport itinerant data associated with the specific airports. We also adjusted the 1999 NEI for HAPs prior to modeling with the EMS-HAP/ASPEN system for the 1999 NATA assessment. (The assessment results have not been released as of the date of this paper).

**Table 3. Airports in which location data from *county\_air* were modified prior to developing the allocation factor file**

| Location ID | Airport Name   | Corrected FIPS               | Geographic Problem and Fix   | Corroborating information   |
|-------------|----------------|------------------------------|--|---|
| P34         | MIFFLINTOWN    | Juniata County, PA (42067)   | <i>county_air.mdb</i> had this airport located in 04001, and inventoried its emissions in there. We changed the allocation file to move this airport from 04001 to 42067, and changed the emission inventory to move P34 emissions from 04001 to emissions in 42067. | <a href="http://www.mapblast.com">www.mapblast.com</a> (Mifflintown, PA) clearly shows airport in Juniata   |
| O18         | BUZZARDS ROOST | Mayes County OK (40097)      | <i>county_air.mdb</i> had this airport allocated in 06031, and inventoried its emissions there. We changed the allocation file to move this airport from 06031 to 40097, and changed the emission inventory to move O18 emissions from 06031 to 40097.               | <a href="http://www.mapblast.com">www.mapblast.com</a> (Inola, OK) clearly shows airport in Mayes   |
| O00         | LUFKER         | Suffolk County, NY (36103)   | <i>county_air.mdb</i> had this airport allocated in 06049, and inventoried its emissions there. We changed the allocation file to move this airport from 06049 to 36103 and moved O00 emissions from 06049 to 36103.   | <a href="http://www.air.gen.ny.us/Airports/AirportInfo?identifier=4NY7">http://www.air.gen.ny.us/Airports/AirportInfo?identifier=4NY7</a> confirms Suffolk county |
| L32         | JONESVILLE     | Catahoula Parish, LA (22025) | <i>county_air.mdb</i> had this airport allocated in 06073, and inventoried its emissions there. We changed the allocation file to move this airport from 06073 to 22025 and moved L32 emissions from 06073 to 22025.   | <a href="http://www.mapblast.com">www.mapblast.com</a> (Jonesville, LA) confirms Catahoula  |
| L39         | LEESVILLE      | Vernon Parish, LA (22115)    | <i>county_air.mdb</i> had this airport allocated in 06073, and inventoried its emissions there. We changed the allocation file to move this airport from 06073 to 22115 and moved L39 emissions from 06073 to 22115.   | <a href="http://www.mapblast.com">www.mapblast.com</a> (Leesville, LA) confirms Vernon.   |

Table 4 contains a summary of the major data sources used to create, check and correct data for the development of the airport allocation file supplied with EMS-HAP and SMOKE.

**Table 4. Summary of Data Sources Used to Create a Consistent Airport Allocation File**

| Data Source   | Data element(s) used to support airport allocation file development   | Comments   |
|---|---|--|
| Federal Aviation Administration (FAA) Terminal Area Forecast (TAF) Model ( <a href="http://www.apo.data.faa.gov/faatafall.HTM">http://www.apo.data.faa.gov/faatafall.HTM</a> ).   | Itinerant data for military aviation, commercial aircraft, general aviation and air taxi                                      | Database does not contain airport locations other than city information. Be aware that the location ID and names of airports can change over time.   |
| Bureau of Transportation Statistics (BTS), National Transportation Atlas Data (NTAD) ( <a href="http://www.bts.gov/gis/download_sites/ntad01/newusdownloadform.html">http://www.bts.gov/gis/download_sites/ntad01/newusdownloadform.html</a> )                              | Geographic coordinates  | We found situations in which the county information in this file is not consistent with geographic coordinates. We recommend determining county based on overlaying geographic coordinates with county boundaries. Be aware that the location ID and names of airports change over time. |
| <i>county_air.mdb</i> , file obtained from <i>gis_data.zip</i> , which can be downloaded from <a href="ftp.epa.gov/pub/EmisInventory/finalnei99/ver3/haps/datafiles/nonroad/auxiliary/">ftp.epa.gov/pub/EmisInventory/finalnei99/ver3/haps/datafiles/nonroad/auxiliary/</a> | Geographic coordinates, county information, itinerant data for the airport-specific airport emissions estimated by EPA in NEI | This is the data used to create airport-specific emission estimates for the 1999 NEI. This database uses data from FAA TAF and BTS/NTAD. Some erroneous data.  |
| Aircraft website ( <a href="http://www.airnav.com/airport/">http://www.airnav.com/airport/</a> )  | Geographic coordinates and links to additional information on specific airports   | Must search airports individually to get geographic coordinates; does not contain county information.  |
| GIS airport boundary data from the ESRI CD <a href="http://www.esri.com">www.esri.com</a> (Data & Maps Media Kit), published by Geographic Data Technology  | Airport boundaries – can overlay with county boundaries to determine the county (counties) airport is located in.             | We have found some private airstrips to be misclassified as regional/municipal airports.   |
| Mapblast.com website ( <a href="http://www.mapblast.com">www.mapblast.com</a> )   | Map displays location of airport with respect to county   | Search website using city containing airport (from airnav.com website) and find proper resolution that identifies airport and counties   |

### Other Airport-Related Emissions and State-supplied Data

The airport allocation factor files created for use with EMS-HAP and SMOKE were designed to be used with all types of airport-related emissions, even though they were developed to be consistent with the approach EPA used to create the NEI for aircraft emissions. Thus, these files are not necessarily consistent with State-supplied airport-related emissions or EPA-estimates of airport-related emissions from the NONROAD model. The NONROAD model estimates county-level emissions of airport support equipment. The model currently utilizes employment information in the airport sector to allocate national emissions to the county.<sup>11</sup> Because employment information may not be related to locations of airports, we did not choose to be consistent in the sub-county spatial allocation of these emissions.

The approach we have chosen to allocate airport support equipment and state-submitted emissions is to use the same airport allocation factor files for general aviation, commercial aviation, air taxi and military aircraft. Thus, these emission sources are allocated only to the same airports for which aircraft emissions were estimated in the NEI (i.e., those airports in *county\_air.mdb*.) The allocation factors we chose to use for the airport ground support equipment are based on commercial aircraft itinerant operations.

## CONCLUSIONS

We have developed an approach to allocate airport-related emissions to locations of airports and incorporated it into EMS-HAP and SMOKE, and provide data that is generally consistent with the data used by EPA emission inventory developers to compute county-level aircraft emissions in the NEI. We have identified errors in some of the NEI geographic data, and have found that even the use of similar sources of data is not sufficient to assure consistency. We have found that inconsistencies can have a significant impact on a local scale assessment. These inconsistencies have been addressed in EMS-HAP version 3.0 and SMOKE version 2.0.

We have also concluded that spatial data needs to be quality assured by using multiple data sets and documented for transparency and reproducibility. The *county\_air.mdb* file provides excellent documentation on the development of the county-level aircraft emissions. It would also be helpful to have the underlying data used to build that file. We have found, for example, that although some of the underlying data are from the FAA TAF for a base-year of 1999, that different data are obtained for the same base-year if the TAF is run at different times. The BTS also updates airport information files as airport names and identification codes change. For airport data, BTS has proven to be a good source of data for latitudes and longitudes, but not for determining FIPS codes. For determining FIPS codes to associate with the particular latitude/longitudes, high resolution GIS is needed. If it is found that the airport is close to a county border, corroborating data such as the [www.airnav.com](http://www.airnav.com) (which provides information on airports individually) and [www.mapblast.com](http://www.mapblast.com) may be needed. The airport boundary data provided on the ESRI CD is also useful for the major airports, but may contain errors for the smaller municipal airports. We have identified several situations in which private airstrips have been mistakenly classified as municipal airports.

We did not resolve the issue of consistency between non-EPA generated airport-related emission data and airport allocation data. When a state, local or tribal agency (SLT) reports airport-related emissions in its submittal to the NEI, these data replace the EPA-generated estimates. The SLT data are provided at the county level. The SLT do not provide information that corresponds to the type of geographic airport information in the *county\_air.mdb* file. As a result, we cannot determine the particular airports for which the state based its county level submittal. We therefore recommend that airport-related emissions be inventoried and submitted by SLT with the particular latitude and longitudes and airport names for which they are associated.

If airport-related emissions are inventoried at particular latitude and longitudes, a spatial allocation approach would no longer be needed, and there would no longer be the possibility for inconsistent data sets. Also, because year-specific data are used to perform the allocation of emissions to specific airports, it makes more sense to perform the allocation in the inventory rather than in the emissions processor. This may be accomplished by treating airport-related emissions as point sources, or adding latitude/longitude fields to the nonroad or non-point inventories.

A general recommendation we have is that staff involved in developing spatial techniques to allocate any county-level source category's emissions understand the procedure and data used for computing these emissions. In some cases, the very same data sets can be used for developing the NEI as can be used for modeling the NEI.

## DISCLAIMER

This paper has been reviewed in accordance with the U.S. EPA peer and administrative review policies and approved for presentation and publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for their use.

## REFERENCES

1. Documentation For Aircraft, Commercial Marine Vessel, Locomotive, and Other Nonroad Components of the National Emissions Inventory, October 7, 2003.  
[ftp://ftp.epa.gov/pub/EmisInventory/finalnei99ver3/criteria/documentation/nonroad/99nonroad\\_v011\\_oct2003.pdf](ftp://ftp.epa.gov/pub/EmisInventory/finalnei99ver3/criteria/documentation/nonroad/99nonroad_v011_oct2003.pdf)
2. Documentation Non Road Model Criteria Air Pollutant Component of the NEI for the For Base Years 1970-2001 - October 2003.
3. Community Multiscale Air Quality (CMAQ), <http://www.epa.gov/asmdnerl/models3/>
4. U.S. EPA, *User's Guide for the Assessment System for Population Exposure Nationwide (ASPEN, Version 1.1) Model*, Office of Air Quality Planning and Standards, Research Triangle Park, NC, 2000; EPA-454/R-00-017
5. Spatial Allocation Information Improvements, Technical Memorandum, Review of Existing Data Sources, January 18, 2002, prepared by DynTel (now Computer Sciences Corporation) under Work Order 25.6. Available at <http://www.epa.gov/ttn/chief/emch/spatial/newsurrogate.html>, under "Documentation" section.
6. U.S. EPA, *User's Guide for the Emissions Modeling System for Hazardous Air Pollutants (EMS-HAP, Version 1.1)*, Office of Air Quality Planning and Standards, Research Triangle Park, NC, 2000; EPA-454/R-00-018
7. U.S. EPA, *User's Guide for the Emissions Modeling System for Hazardous Air Pollutants (EMS-HAP, Version 2.0)*, Office of Air Quality Planning and Standards, Research Triangle Park, NC, 2002; EPA-454/B-02-001.
8. U.S. EPA, *User's Guide for the Industrial Source Complex (ISC3) Dispersion Models*, Office of Air Quality Planning and Standards, Research Triangle Park, NC, 1995; EPA-454/B-95-003a.
9. U.S. EPA, *User's Guide for the Emissions Modeling System for Hazardous Air Pollutants (EMS-HAP, Version 3.0)*, Office of Air Quality Planning and Standards, Research Triangle Park, NC, *in progress*.
10. Carolina Environmental Program, SMOKE User Manuals and Other Documentation, User Manual, Version 2.0 (current draft), downloaded March 2003,  
<http://www.cep.unc.edu/empd/products/smoke/SMOKEDOCS.shtml#manual>
11. U.S. EPA, *Geographic Allocation of State Level Nonroad Engine Population Data to the County Level*, Office of Transportation and Air Quality, Ann Arbor, MI, 2002; EPA420-P-02-009.

## KEYWORD

emission modeling  
EMS-HAP  
SMOKE  
Spatial Allocation

Spatial Surrogates  
Aircraft emissions