

## **6.0 CONCEPT NONROAD Source Model**

### **Table of Contents**

- 6.1 NONROAD Model Overview
- 6.2 Functionality
  - 6.2.1 Project and Scenario Initialization
  - 6.2.2 Import the Scenario Control File
  - 6.2.3 Import the NONROAD Setup Files
  - 6.2.4 Run the Nonroad Source Model
    - 6.2.4.1 Make the NONROAD Model Input Options Files
    - 6.2.4.2 Execute the NONROAD Model
    - 6.2.4.3 Import the Weekday County Level Emissions Estimates Generated by NONROAD Model
    - 6.2.4.4 Generate the NEI-like Records
    - 6.2.4.5 Temporal Adjustment of Emissions Estimates
    - 6.2.4.6 Speciation
    - 6.2.4.7 Spatial Allocation
  - 6.2.5 Import Meteorological Data
  - 6.2.6 Make Hourly Temperature Adjustments
  - 6.2.7 Output the Air Quality Model Files
- 6.3 Control Variable Options
- 6.4 Input File Structures
- 6.5 Lookup and Cross-Reference File Requirements

## 6.1 NONROAD MODEL OVERVIEW

The purpose of the Nonroad Source Model is to generate air quality model-ready gridded, hourly, speciated emissions estimates for the specified modeling episode and domain. The Nonroad Source model executes the EPA NONROAD Model to generate county level weekday emission estimates for those counties for which the user has specified the required modeling parameters. These daily emission estimates are temporally allocated, speciated and spatially allocated. Next the hourly emissions are adjusted for temperature variations.

The user will provide to the model:

- EPA NONROAD Model county level parameters
- EPA NONROAD Model input data files
- Temporal cross-reference and lookup tables
- Spatial allocation cross-reference and lookup tables
- Chemical speciation mechanism (ie, CBIV, SAPRC)
- Chemical speciation cross-reference and lookup tables
- Modeling episode
- Modeling grid definitions
- Required model output format (CMAQ or CAMx)

Of the above list, many have standard default files which have been provided as part of the CONCEPT installation package. You are only required to modify these standard defaults if more specific or detailed local information is available.

For details about the EPA NONROAD Model please refer to:  
<http://www.epa.gov/OMSWWW/nonrdmdl.htm>

The concept script commands to run the nonroad source model are:

```
concept import_nonroad      -n PROJECTNAME -s SCENARIOName -d DIRECTORY [-t]
concept run_nonroad_model  -n PROJECTNAME -s SCENARIOName -d DIRECTORY
concept adj_nonroad_tmpr   -n PROJECTNAME -s SCENARIOName
concept run_nonroad_output -n PROJECTNAME -s SCENARIOName -d DIRECTORY
```

The CONCEPT distribution contains, in the concept directory, an example script (nonroad\_beta4.sh) that runs the area source model for project = beta4, scenario = scenario1.

## 6.2 FUNCTIONALITY

The CONCEPT Nonroad Source Model is comprised of database programs, command line shell scrips, Perl scripts, the NONROAD Model Fortran executable, and a Fortran driver that generates a temperature adjustment table. The Nonroad Source Model is only one component of the CONCEPT system. As such, some of the required steps outlined below may be completed under another process and hence, would not need to be repeated. These “completed” steps are described in far more detail in previous sections of this document.

### 6.2.1 Project and Scenario Initialization

Prior to generating the nonroad source emissions a project and scenario must be defined in the CONCEPT model. This is discussed in detail in Section 1.6.

### 6.2.2 Import the Scenario Control File

The scenario control file is described in detail in Section 1.4. , and should have been imported during the setup and initialization of the scenario. If not, be sure it is imported before beginning the nonroad processing

### 6.2.3 Import the NONROAD Setup Files

Through the CONCEPT script run `import_nonroad_control`. This requires the project name, scenario name and the directory where the nonroad control files are located.

Example:

```
concept import_nonroad -n beta4 -s scenario1 -d ../concept_projects/beta4/scenario1/nonroad
```

The nonroad source model will read and import the input files: `nonroad_control`, `nonroad_nrm_infiles`, `nonroad_parameters`, `nonroad_fips_xref`, all of which are located in the directory identified by the `-d` flag in the concept command. Section 6.4 shows the details of the required file formats.

### 6.2.4 Run the Nonroad Source Model

Through the CONCEPT script run `run_nonroad_model`. This requires the project name, scenario name, and the directory where the NONROAD Model input options files and output files will be written.

Example:

```
concept run_nonroad_model -n beta4 -s scenario1 -d  
../concept_projects/beta4/scenario1/nonroad
```

The following steps happen as a result of this command.

#### 6.2.4.1 Make the NONROAD Model Input Options Files

For each valid record of the `nonroad_parameters` file a NONROAD Model input options file is generated and written to the specified directory. The filename is `SSCCC_YYYYMonth.OPT`, where `SSCCC` is the state/county FIPS code from the `nonroad_parameters.txt` file, `YYYY` is the four digit year, and `Month` is the full month name. This options file specifies a weekday estimate for the `run_control` episode month and year. If the modeling episode spans a month and/or year, then an options file is generated for each modeling episode month and year for each `nonroad_parameter` record. The temperatures required by the NONROAD Model are set to be

68 degF minimum, 84 degF maximum, and an average 75 degF. The emissions produced based on these temperatures are later adjusted for the hourly gridded meteorology.

#### 6.2.4.2 Execute the NONROAD Model

A NONROAD Model run is made for every options file that exists in the user specified directory. The standard NONROAD Model output files are generated, emission estimates and a message file, and written to the same directory with a similar file name to the options file using the filename extensions “.OUT” and “.MSG” (instead of “.OPT”). The NONROAD Model can be a time consuming process, depending on the number of counties being processed. A message is displayed indicating which options file is being processed.

#### 6.2.4.3 Import the Weekday County Level Emissions Estimates Generated by NONROAD Model

All files in the specified directory with the “.OUT” file name extensions are imported into the CONCEPT database. Prior to import it is verified that the data are tons per typical weekday for a valid month. The NONROAD output specifies emissions by state/county, SCC, and horsepower. The horsepower detail is not utilized in CONCEPT emissions modeling so the data is summed over horsepower to optimize processing times.

#### 6.2.4.4 Generate the NEI-like Records

In order to maintain consistency in emissions modeling, the nonroad source emissions, are reformatted to the internal database table format that is consistent with the NEI processing format. That is, each of the NONROAD records which contains multiple pollutants produces multiple “NEI-like” records, each of a single pollutant. At this step the weekend day emissions records are generated using the conversion factors in the global file nonroad\_weekday\_to\_weekend.txt, THC is converted to VOC utilizing the global file factors nonroad\_thc\_to\_voc.txt, and ammonia emissions are estimated based on fuel consumption utilizing the global file nonroad\_fuelcon\_to\_nh3.txt.

#### 6.2.4.5 Temporal Adjustment of Emissions Estimates

As the nonroad source model only contains daily emission estimates for a particular month and year in the modeling episode all of the records are processed. The time zone is determined based on the specification in the lookup table of state/county FIPS codes. An hourly shift is applied based on the difference of the modeling time zone (specified in run\_control) and the state/county time zone. No monthly or weekly profiles are required for the NONROAD weekday estimated emissions. These daily totals only require hourly distribution and a potential shift based on the time zone. The daily profiles are determined using the RPO temporal lookup table rpo\_ts. The indicated profile is then extracted from the RPO daily profile file rpo\_td and applied. If there is no match in either of the rpo files a flat 24 hour distribution is applied.

#### 6.2.4.6 Speciation

The input criteria pollutants are then speciated based on the run\_control chemical mechanism. For each record, the best matched (most criteria satisfied) speciation profile is retrieved from the

RPO speciation profile cross reference file rpo\_cr. The matching fields include country, state/county FIPS, tribal code, SCC, emissions mode and pollutant. If no profile is found, then the emissions are dropped and a detailed message is logged in the nonroad\_dropped\_speciation table.

The profile definitions are retrieved from the lumped profile table rpo\_lp. The run\_control chemical mechanism, the profile code and the criteria pollutant are all used to retrieve the applicable speciation. The speciated emissions are computed as source emissions \* split factor / divisor, where the split factor and divisor are from the lumped profile table.

#### 6.2.4.7 Spatial Allocation

The hourly, speciated county level emission estimates are then distributed to the applicable grid cells. The spatial allocation surrogates are retrieved from the rpo\_ss table by country, state/county FIPS, tribal code and SCC. The best, most detailed matches are found. If no match is found, then a default SCC profile is retrieved. If no match is found for the default SCC then a population surrogate is assigned. The allocation factors are retrieved based on the best match of country, state/county FIPS, and tribal code for the spatial surrogate code. If the spatial surrogate code is not found then it is defaulted to the population surrogate code. Multiple records (grid cells) may be assigned to each county. The county level emissions are assigned to grid cells by applying the individual cell ratio and surrogate weight factor.

### **6.2.5 Import Meteorological Data**

Through the CONCEPT script run import\_metdata if it has not been done previously. This step is required in order to adjust some of the nonroad emission estimates for hourly temperature variations. Section 1.9 discusses the details of the meteorological file.

### **6.2.6 Make Hourly Temperature Adjustments**

Through the CONCEPT script run adj\_nonroad\_tmpr. This requires the project and scenario name parameters. Prior to executing this step it is verified that the met data has been imported. If the met data file does not exist in the database then a message is displayed and the script is aborted.

#### 6.2.6.1 The First step of the Temperature Adjustments Deals with 4-stroke Gas Exhaust Emissions

Adjustments are made to CO, NO<sub>x</sub> and TOG pollutants. The adjustment factor is based on the difference between the hourly temperature (per grid cell) and the average ambient temperature specified in the NONROAD Model run (set to 75 degF) which is used to estimate the exhaust emissions. The coefficients of the adjustment were extracted from the NONROAD Model emsadj.f subroutine.

Adjustment Factor =  $\exp(A * (T - 75.))$   
 where T is the hourly temperature in degF

and A is one of the following coefficients

	CO	NO <sub>x</sub>	TOG
if T > 75. degF	.00375	-0.00873	.00132
if T < 75. degF	.0015784	-0.00892	-0.00240

#### 6.2.6.2 Adjustments are Also Made to the Diurnal Emission Estimates

The NONROAD Model diurnal estimates are based on the minimum and maximum temperatures that the user specifies in the options file. For our purposes these are specified as 68 and 84 degF. The NONROAD Model subroutine caludi.f is utilized to estimate the diurnal emissions temperature adjustment. For each RVP, and minimum and maximum hourly temperatures diurnal estimates are calculated through a call to the caludi routine.

Diurnal emissions exist only if the temperature is increasing; that is, if the next hour temperature is greater than this hour temperature. The hourly adjustment factor is computed as: caludi results at current and next hour temperatures / caludi results at NONROAD MODEL run min/max temperatures \* daily diurnal emission estimate.

#### **6.2.7 Output the Air Quality Model Files**

Through the concept script run run\_nonroad\_outputs to generate the gridded, speciated hourly emissions in CAMx-like format. This requires the project name, scenario name, and the directory where the output and report files will be written. The file contains all required data for CAMx modeling in an ASCII formatted file. It must be converted to a binary formatted file for input to the CAMx model.

In addition, report files are automatically generated for:

- total speciated pollutants by hour
- county total speciated emissions by day and hour
- gridded emissions hourly sum total by speciated pollutant
- gridded emissions hourly sum total for each episode day by speciated pollutant
- hourly totals by criteria pollutant
- hourly county totals by criteria pollutant and episode day

#### **6.3 CONTROL VARIABLE OPTIONS**

The control file fields that are required for the nonroad source model include the StartDate, NumDays, TimeZone, ChemicalMechanism, OutputFormat, and Pollutants. In addition, the grid definition fields are required for generating the output gridded, speciated, hourly emissions.

#### **6.4 INPUT FILE STRUCTURES**

**nonroad\_control.txt** This file is required for executing the EPA NONROAD Model. It indicates the name and location of the executable and the location of the NONROAD Model data directory. Rather than requiring the program and data files to reside in a particular place this gives you the flexibility to install NONROAD where you want.

Nonroad Control							
Nonroad Module Control File				nonroad_control.txt			
Element	Element Description	Type	Size	Begin	End	Key	Mandatory
EXECUTABLE FILE	NONROAD Model executable full path and name	Character	80	1	80		TRUE
DATA DIRECTORY	The full path to the NONROAD Model /data directory	Character	120	81	200		TRUE

**nonroad\_nrm\_infiles.txt** This file lists the names of the NONROAD Model input data files. Generally this file will not be changed once it has been set up. It does allow the flexibility of using a NONROAD Model input file other than the defaults supplied with the NONROAD Model.

Nonroad Parameters							
NONROAD Model Input Files				nonroad_nrm_infiles.txt			
Element	Element Description	Type	Size	Begin	End	Key	Mandatory
PACKET IDENTIFIER	NONROAD Model input options file packet name	Character	20	1	20		TRUE
FILE TYPE	The keyword descriptor for the specified NONROAD Model input file	Character	20	21	40		TRUE
FILE NAME	The NONROAD Model input file name, path relative to the /data directory	Character	80	41	120		TRUE

The next two files, nonroad\_fips\_xref and nonroad\_parameters, are the files that determine the course of the NONROAD Model. The nonroad\_fips\_xref file indicates all of the counties for which to estimate nonroad source emissions (columns 1-5). Each unique FIPS code is followed by a controlling FIPS code (columns 6-10). This second code is found in the nonroad\_parameters file. Therefore, multiple counties from a single state which have the same set of fuel specifications will be processed in the same NONROAD run. For each record in the nonroad\_parameters file at least one NONROAD Model run will be made (maybe more depending on the modeling episode). For those familiar with the NONROAD Model options file, the nonroad\_parameters entries are used to set the fields in the /OPTIONS/ packet. While the nonroad\_fips\_xref is used to set the /COUNTY/ packet.

**nonroad\_fips\_xref.txt** Defines the unique list of FIPS for which to generate nonroad source emission estimates. Also indicates the FIPS code to map to the fuel parameters file.

Nonroad Parameters							
County Cross Reference List				nonroad_fips_xref.txt			
Element	Element Description	Type	Size	Begin	End	Key	Mandatory
STATE/COUNTY CODE	The FIPS for each county to process	Character	5	1	5		TRUE
STATE/COUNTY CODE	The FIPS code for the representative parameters	Character	5	6	10		TRUE

**nonroad\_parameters.txt** Specifies the fuel parameters and equipment population file required for the NONROAD Model. All counties that are mapped to one of the state/county FIPS codes

in this file must have valid population data in the corresponding population file and share the same fuel parameters.

<b>Nonroad Parameters</b>							
<b>NONROAD Model Parameters File</b>			<b>nonroad_parameters.txt</b>				
<b>Element</b>	<b>Element Description</b>	<b>Type</b>	<b>Size</b>	<b>Begin</b>	<b>End</b>	<b>Key</b>	<b>Mandatory</b>
STATE/COUNTY CODE	State/County FIPS code	Character	5				TRUE
POPULATION FILE	Name of the NONROAD Model input population file	Character	80				TRUE
TITLE 1	First user defined title for NONROAD run	Character	80				FALSE
TITLE 2	Second user defined title for NONROAD run	Character	80				FALSE
FUEL RVP	Fuel RVP for gasoline	Number	6				TRUE
OXYGEN WT	Oxygen weight percent for gasoline	Number	9				TRUE
GAS SULFUR CONTENT	Percent sulfur for gasoline	Number	9				TRUE
DIESEL SULFUR CONTENT	Percent sulfur for diesel	Number	9				TRUE
CNG/LPG SULFUR CONTENT	Percent sulfur for CNG/LPG fuels	Number	9				TRUE
ALTITUDE	High or Low altitude region	Character	4				TRUE
STAGE II	Percent control factor for stage II	Number	9				TRUE

## 6.5 LOOKUP AND CROSS-REFERENCE FILE REQUIREMENTS

The nonroad model requires lookup and cross-reference tables for temporal, spatial, and species allocation. During the set-up of the CONCEPT model, the import\_rpo and import\_global options allow the user to import external datasets from existing text files. The formats of the external lookup files are defined by the RPO data exchange protocol. See Section 1.7 and 1.8 of the User's Guide for detailed file specifications. Note that the spatial and speciation profiles can also be generated from inside CONCEPT (see sections 7 and 8).