Use of the National Mobile Inventory Model (NMIM) for Photochemical Modeling Applications in Texas

17th International Emission Inventory Conference

Portland, Oregon

Use of NMIM for Photochemical Modeling Applications in Texas

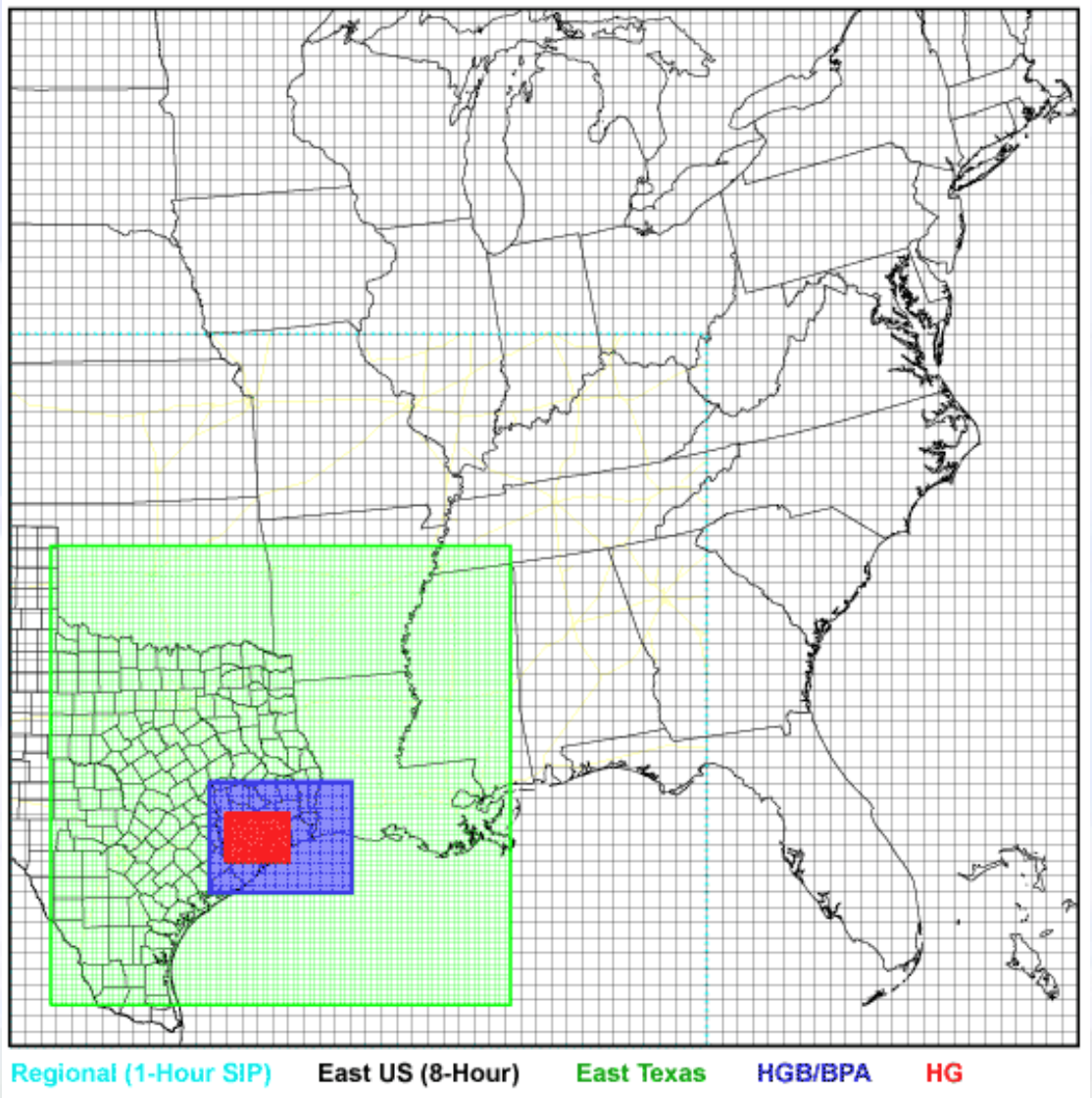
- NMIM overview and operation
- Texas photochemical modeling domain
- NMIM capabilities for on-road and non-road
- Projecting vehicle miles traveled (VMT) for NMIM
- Texas on-road emissions used to develop pollutant specific hourly profiles by day-of-week
- Spatial allocation of on-road emissions
- FTP and web sites with additional resources

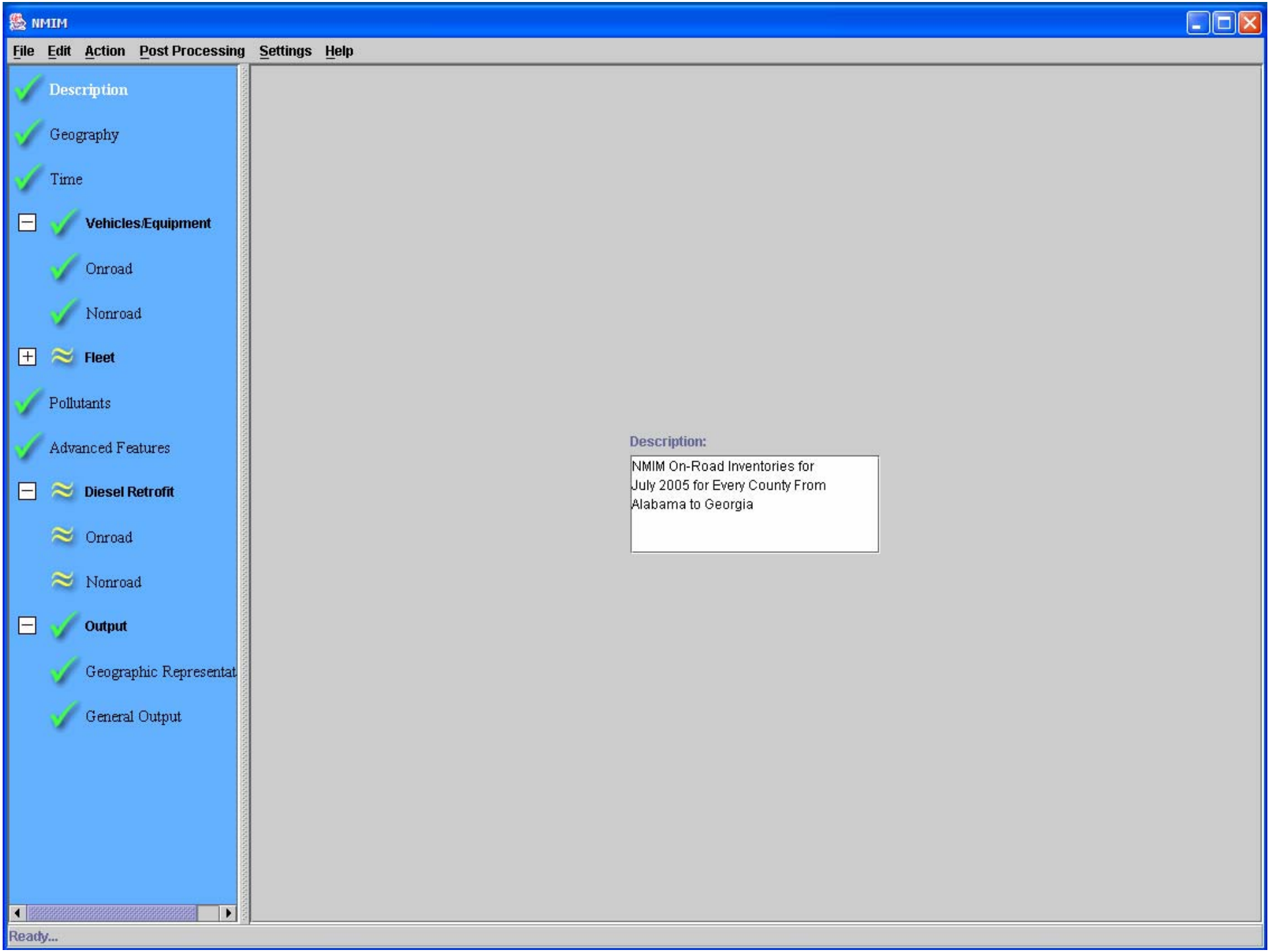
NMIM Overview

- Graphical user interface (GUI) that runs both MOBILE6.2 and NONROAD models
- Both on-road and non-road emission estimates
- Any year from 1999-2050
- Any county in the U.S.
- Satisfactory quality
- Relatively quick turnaround
- Little or no cost other than staff time

Texas Photochemical Modeling Domain

- 2 km “fine” grid cells near 8-County Houston/ Galveston/Brazoria (HGB)
- 12 km “medium” grid cells in rest of Texas and surrounding states
- 36 km “coarse” grid cells for states several hundred miles from HGB




NMIM
File
Edit
Action
Post Processing
Settings
Help
Description
Geography
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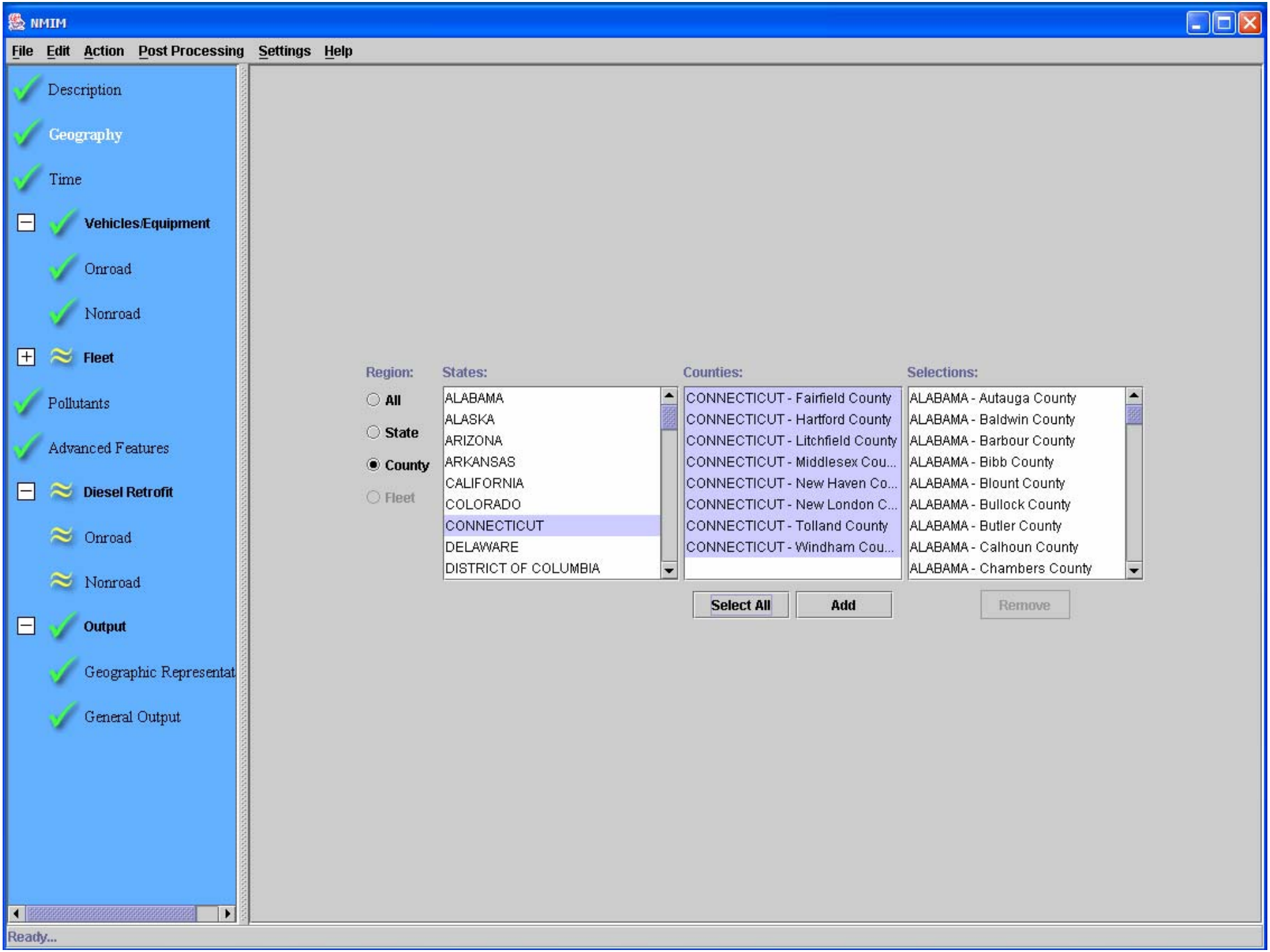
Vehicles/Equipment
Onroad
Nonroad
Fleet
Pollutants
Advanced Features
Diesel Retrofit
Onroad
Nonroad
Output
Geographic Representat
General Output
Description:
NMIM On-Road Inventories for
July 2005 for Every County From
Alabama to Georgia
Ready...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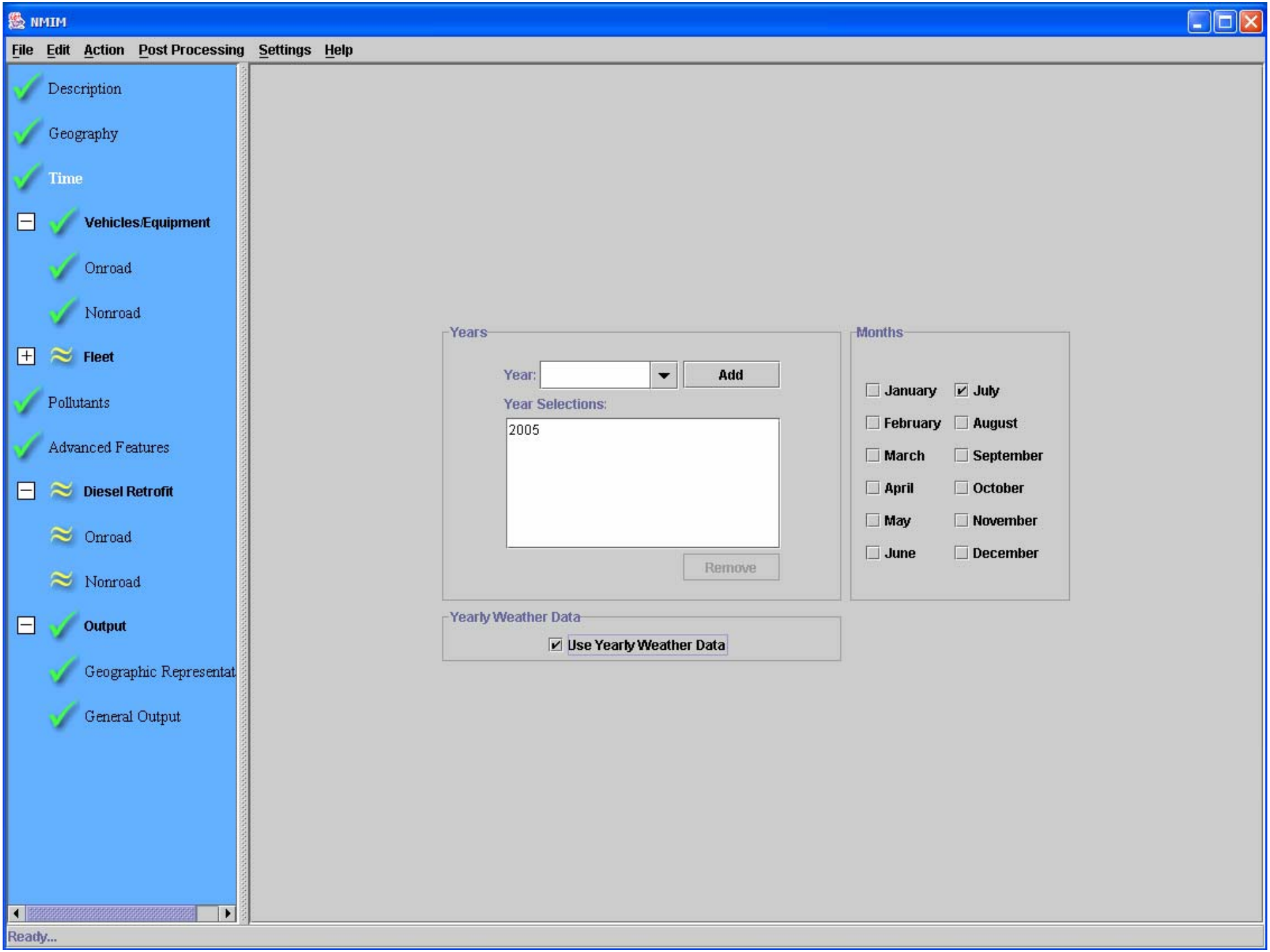
Vehicles/Equipment
Onroad
Nonroad
Fleet
Pollutants
Advanced Features
Diesel Retrofit
Onroad
Nonroad
Output
Geographic Representat
General Output
Region:
All
State
County
Fleet
States:
ALABAMA
ALASKA
ARIZONA
ARKANSAS
CALIFORNIA
COLORADO
CONNECTICUT
DELAWARE
DISTRICT OF COLUMBIA
Counties:
CONNECTICUT - Fairfield County
CONNECTICUT - Hartford County
CONNECTICUT - Litchfield County
CONNECTICUT - Middlesex Cou...
CONNECTICUT - New Haven Co...
CONNECTICUT - New London C...
CONNECTICUT - Tolland County
CONNECTICUT - Windham Cou...
Selections:
ALABAMA - Autauga County
ALABAMA - Baldwin County
ALABAMA - Barbour County
ALABAMA - Bibb County
ALABAMA - Blount County
ALABAMA - Bullock County
ALABAMA - Butler County
ALABAMA - Calhoun County
ALABAMA - Chambers County
Select All
Add
Remove
Ready...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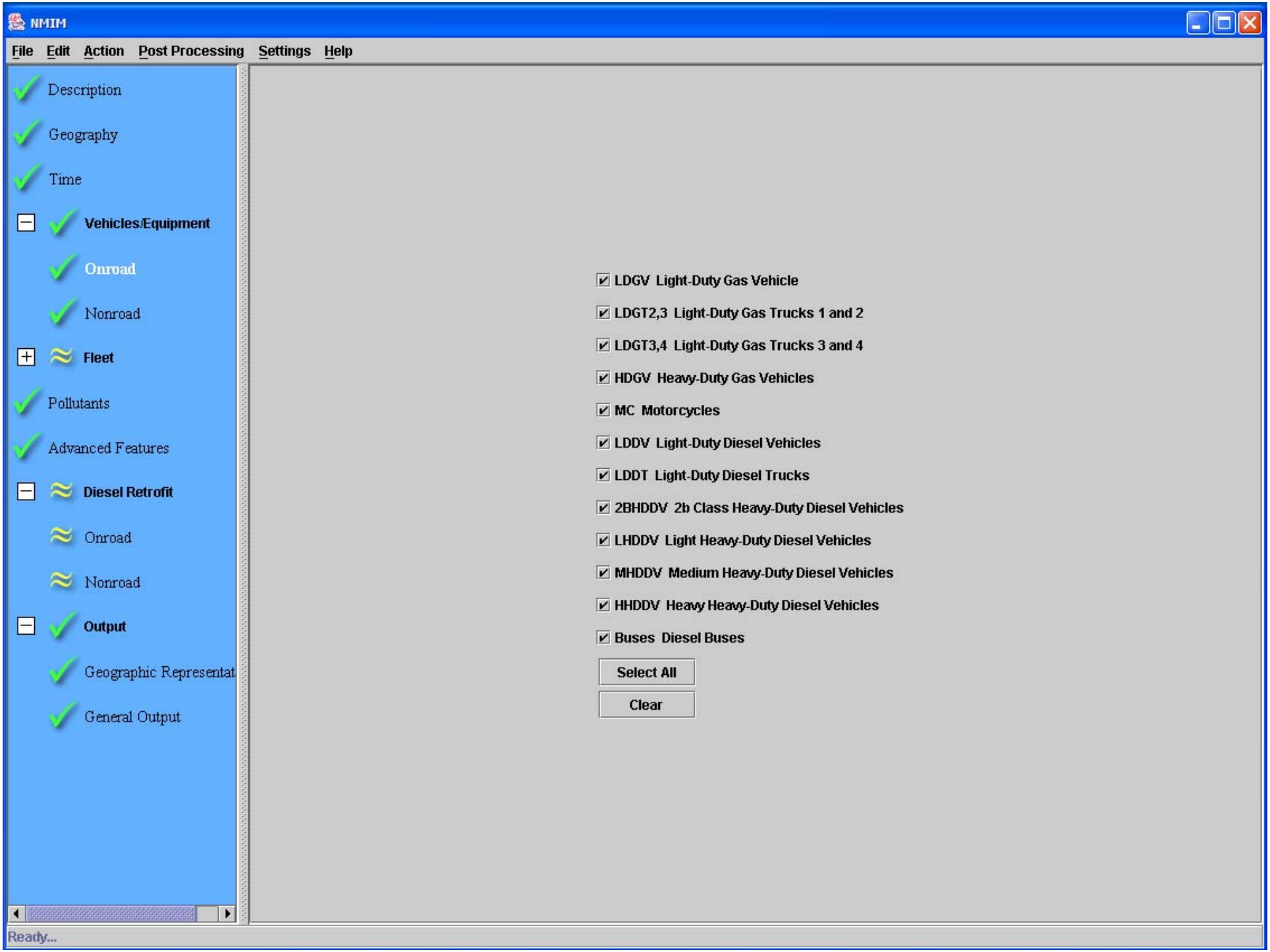
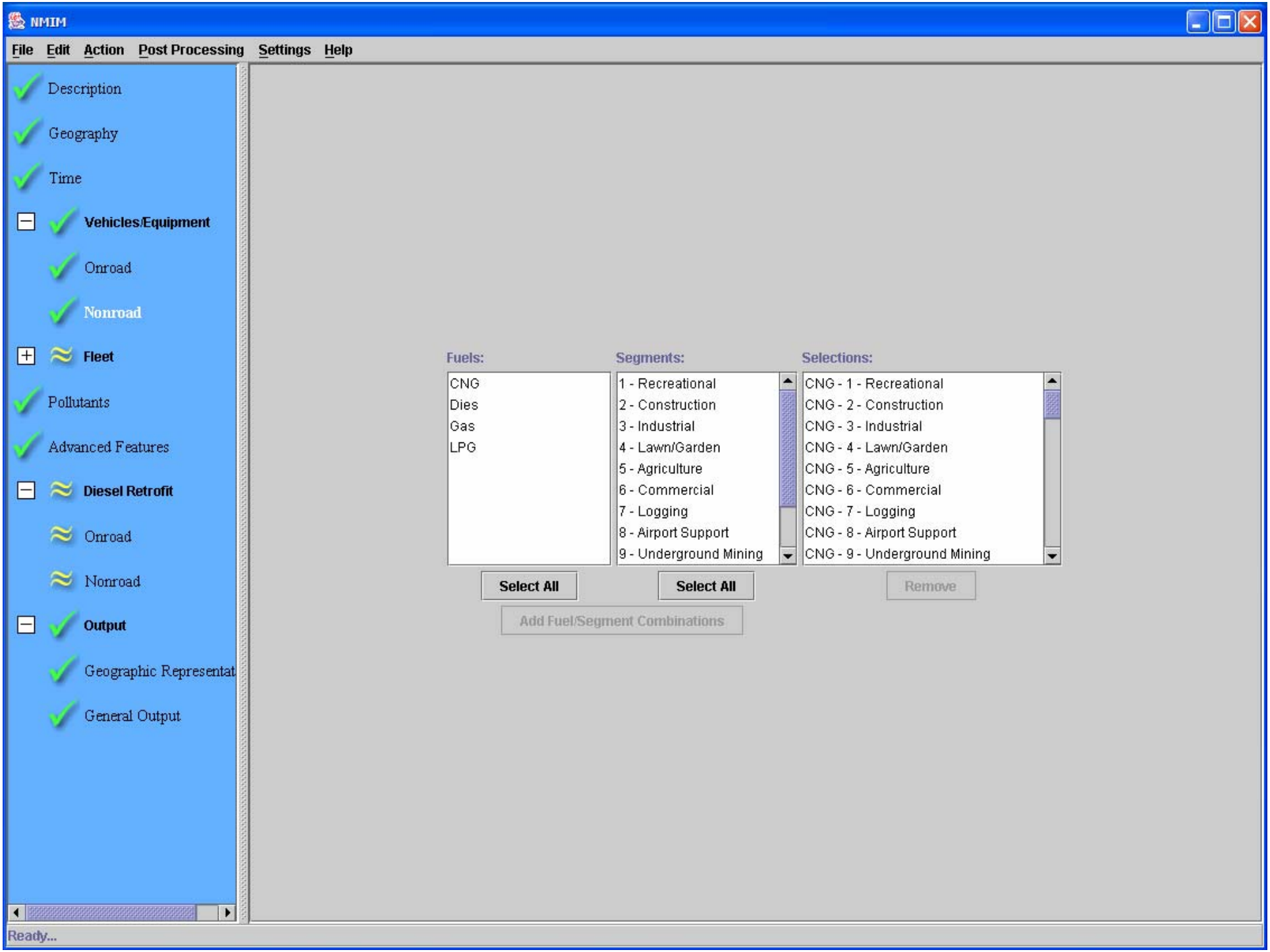
Vehicles/Equipment
Onroad
Nonroad
Fleet
Pollutants
Advanced Features
Diesel Retrofit
Onroad
Nonroad
Output
Geographic Representat
General Output
Years
Year:
Add
Year Selections:
2005
Remove
Months
January
July
February
August
March
September
April
October
May
November
June
December
Yearly Weather Data
Use Yearly Weather Data
Ready...


NMIM
File Edit Action Post Processing Settings Help
Description
Geography
Time
Vehicles/Equipment
Onroad
Nonroad
Fleet
Pollutants
Advanced Features
Diesel Retrofit
Onroad
Nonroad
Output
Geographic Representat
General Output
LDGV Light-Duty Gas Vehicle
LDGT2,3 Light-Duty Gas Trucks 1 and 2
LDGT3,4 Light-Duty Gas Trucks 3 and 4
HDGV Heavy-Duty Gas Vehicles
MC Motorcycles
LDDV Light-Duty Diesel Vehicles
LDDT Light-Duty Diesel Trucks
2BHDDV 2b Class Heavy-Duty Diesel Vehicles
LHDDV Light Heavy-Duty Diesel Vehicles
MHDDV Medium Heavy-Duty Diesel Vehicles
HHDDV Heavy Heavy-Duty Diesel Vehicles
Buses Diesel Buses
Select All
Clear
Ready...


NMIM
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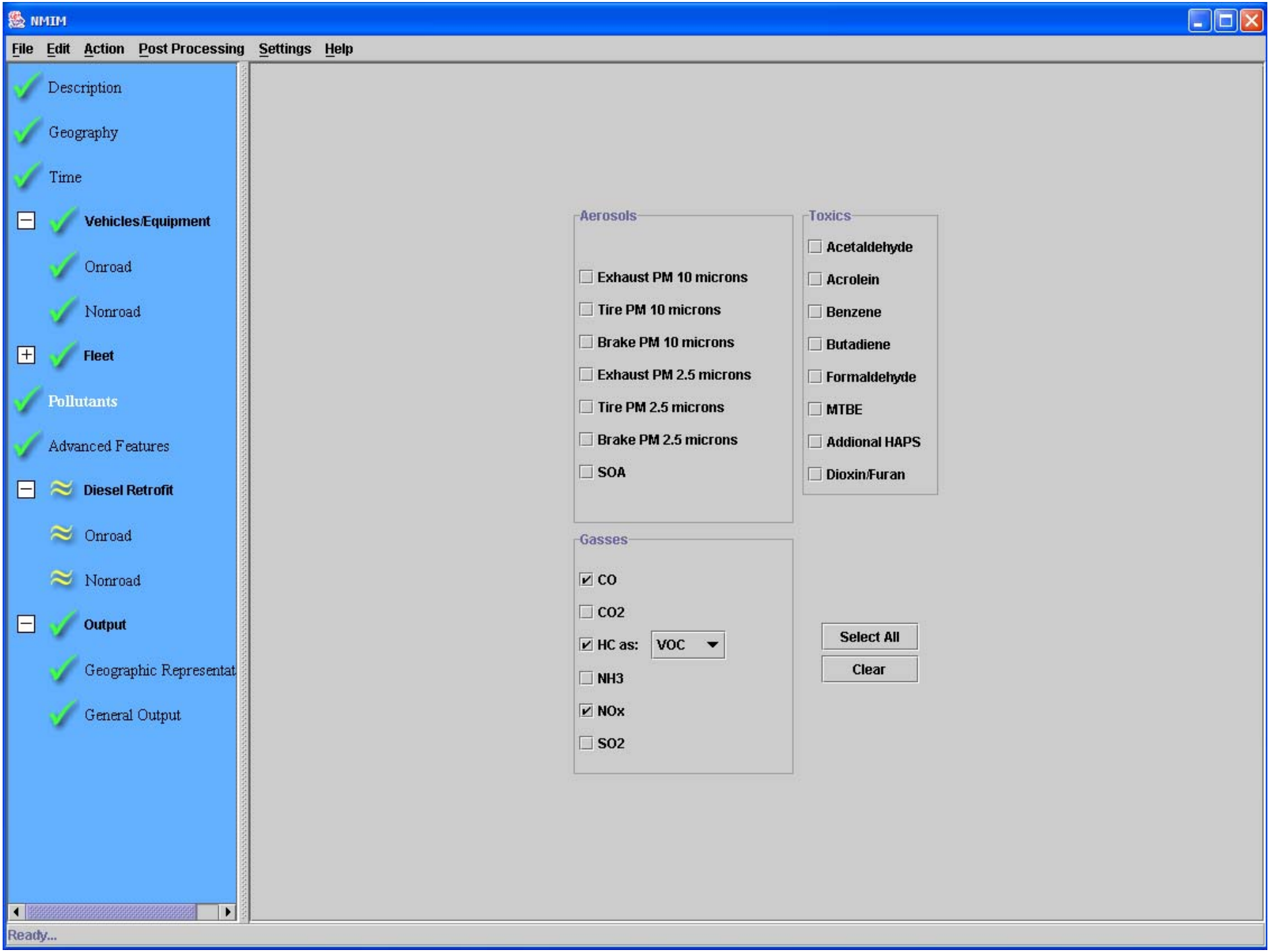
Help
Description
Geography
Time
Vehicles/Equipment
Onroad
Nonroad
Fleet
Pollutants
Advanced Features
Diesel Retrofit
Onroad
Nonroad
Output
Geographic Representat
General Output
Fuels:
CNG
Dies
Gas
LPG
Segments:
1 - Recreational
2 - Construction
3 - Industrial
4 - Lawn/Garden
5 - Agriculture
6 - Commercial
7 - Logging
8 - Airport Support
9 - Underground Mining
Selections:
CNG - 1 - Recreational
CNG - 2 - Construction
CNG - 3 - Industrial
CNG - 4 - Lawn/Garden
CNG - 5 - Agriculture
CNG - 6 - Commercial
CNG - 7 - Logging
CNG - 8 - Airport Support
CNG - 9 - Underground Mining
Select All
Select All
Remove
Add Fuel/Segment Combinations
Ready...


NMIM
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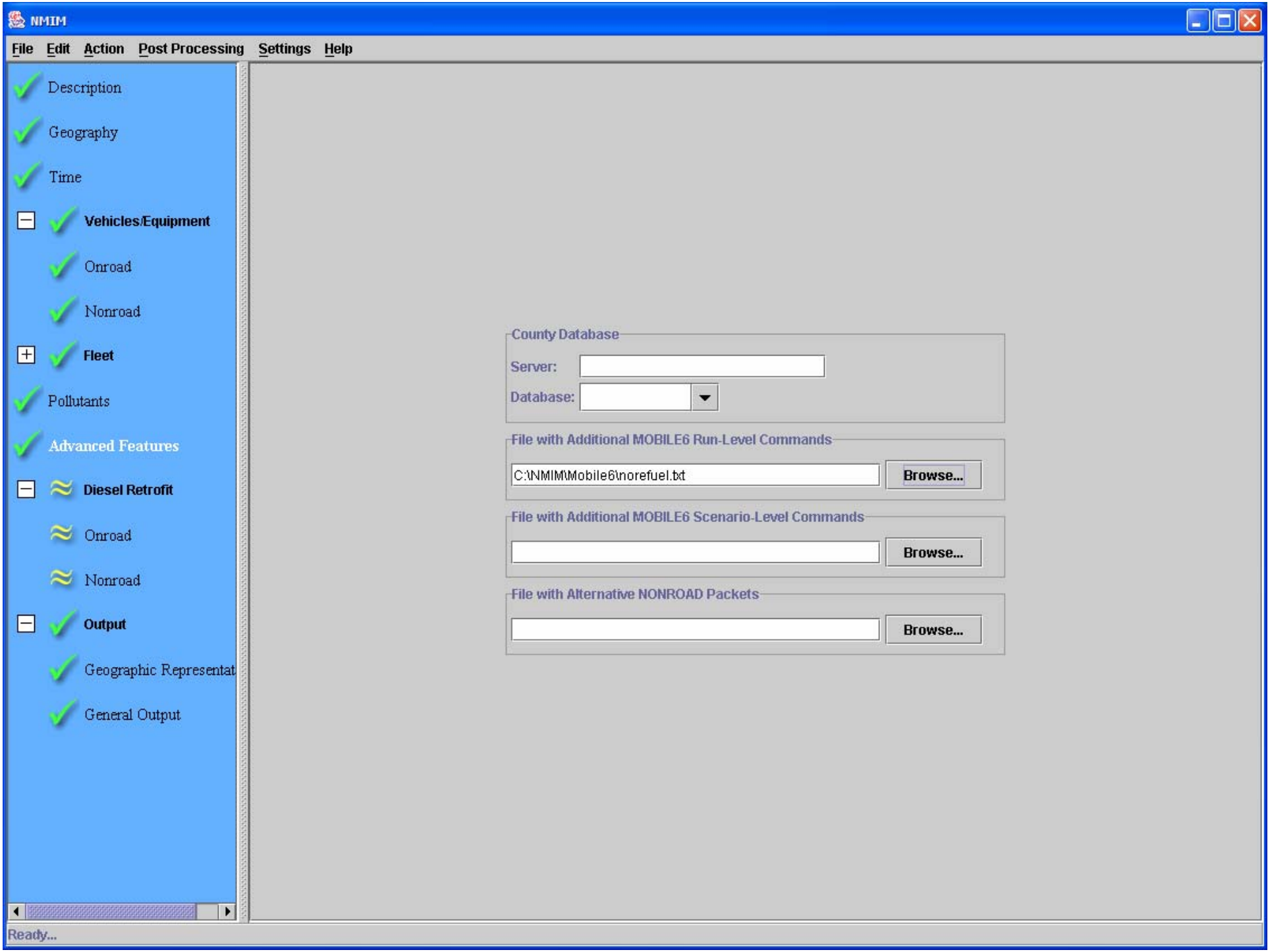
Time
Vehicles/Equipment
Onroad
Nonroad
Fleet
Pollutants
Advanced Features
Diesel Retrofit
Onroad
Nonroad
Output
Geographic Representat
General Output
Aerosols
Exhaust PM 10 microns
Tire PM 10 microns
Brake PM 10 microns
Exhaust PM 2.5 microns
Tire PM 2.5 microns
Brake PM 2.5 microns
SOA
Toxics
Acetaldehyde
Acrolein
Benzene
Butadiene
Formaldehyde
MTBE
Addional HAPS
Dioxin/Furan
Gasses
CO
CO2
HC as:
VOC
NH3
NOx
SO2
Select All
Clear
Ready...


NMIM
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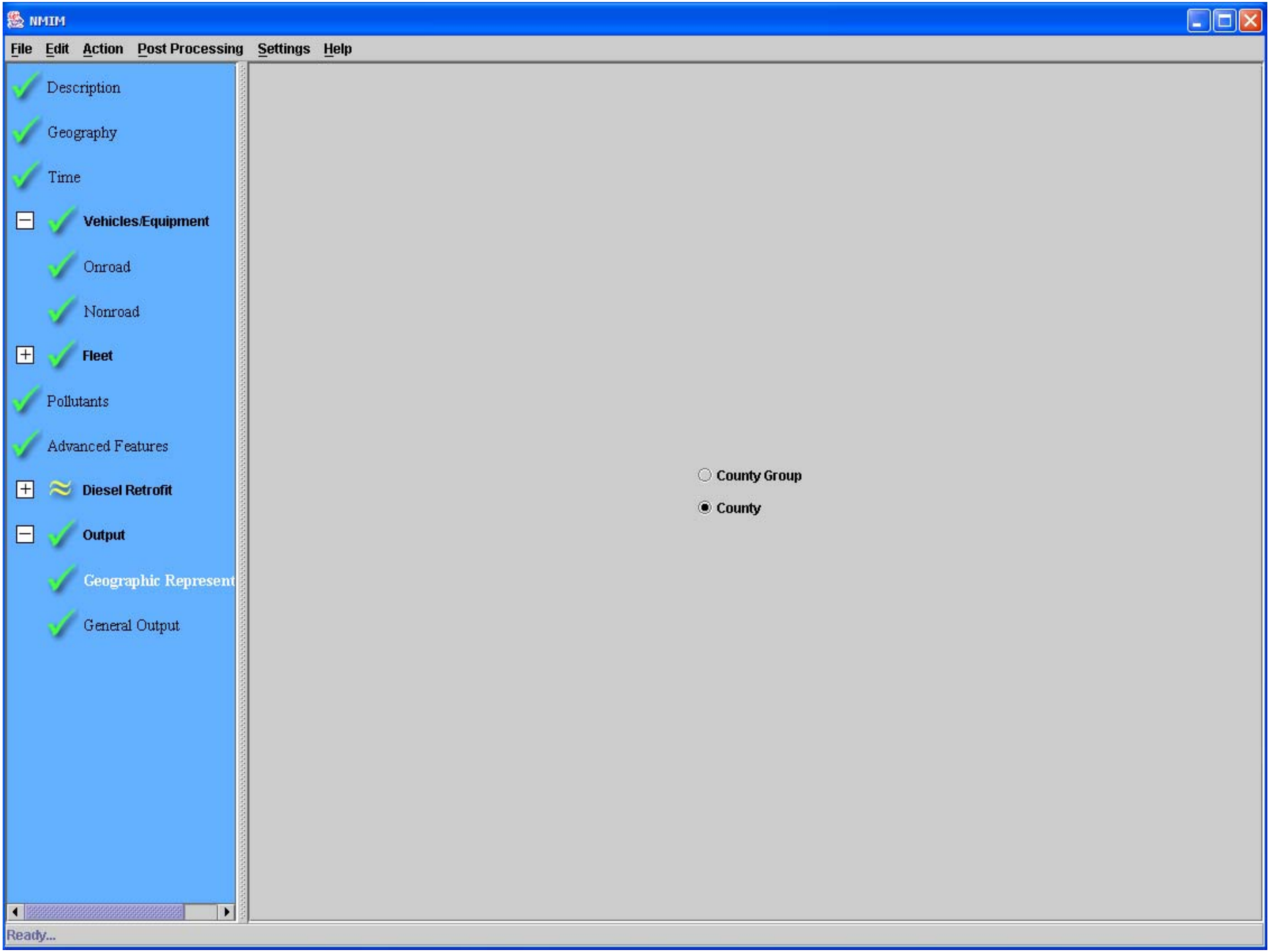
Vehicles/Equipment
Onroad
Nonroad
Fleet
Pollutants
Advanced Features
Diesel Retrofit
Onroad
Nonroad
Output
Geographic Representat
General Output
County Database
Server:
Database:
File with Additional MOBILE6 Run-Level Commands
C:\NMIM\Mobile6\norefuel.txt
Browse...
File with Additional MOBILE6 Scenario-Level Commands
Browse...
File with Alternative NONROAD Packets
Browse...
Ready...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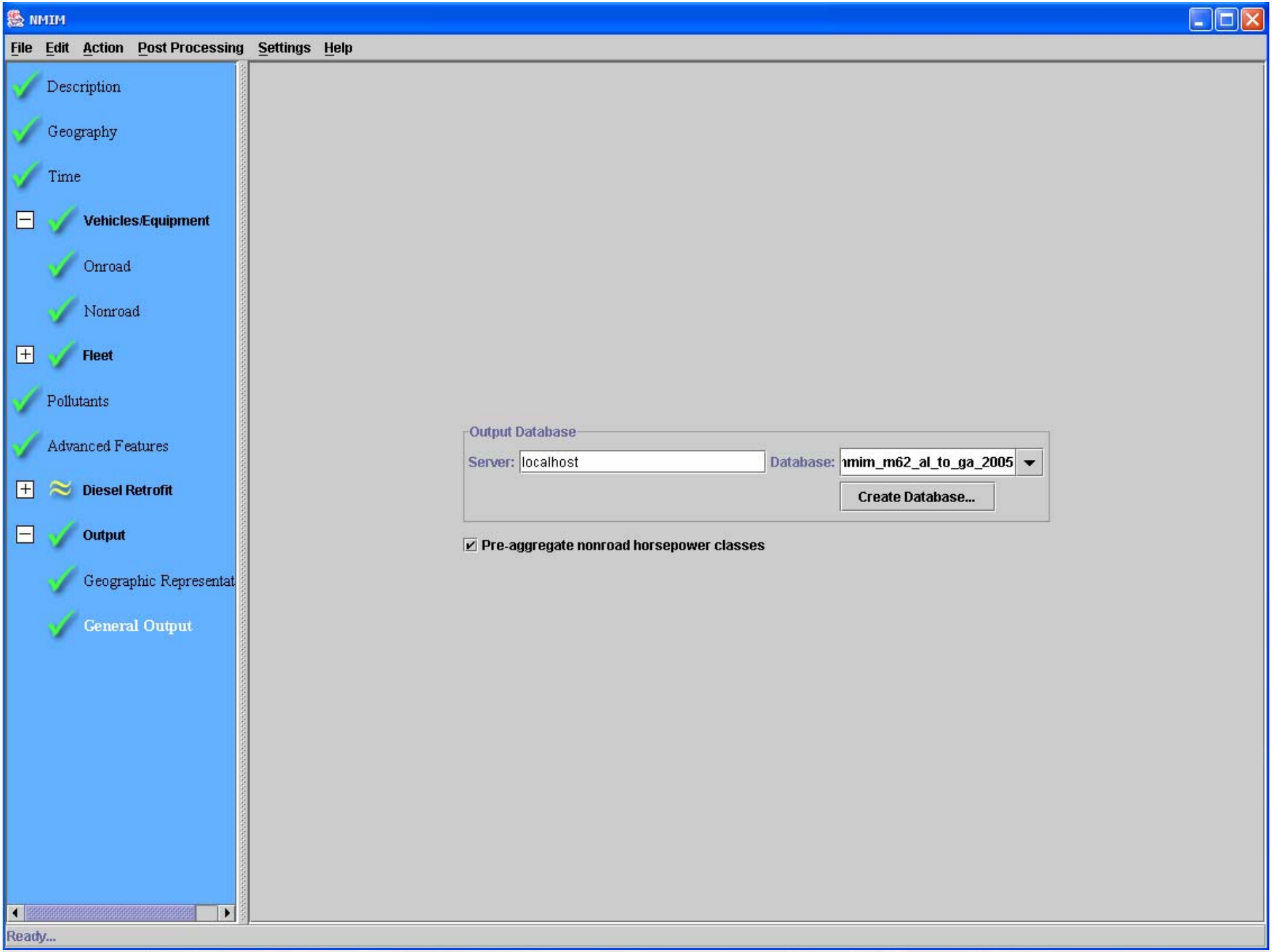
Vehicles/Equipment
Onroad
Nonroad
Fleet
Pollutants
Advanced Features
Diesel Retrofit
Output
Geographic Represent
General Output
County Group
County
Ready...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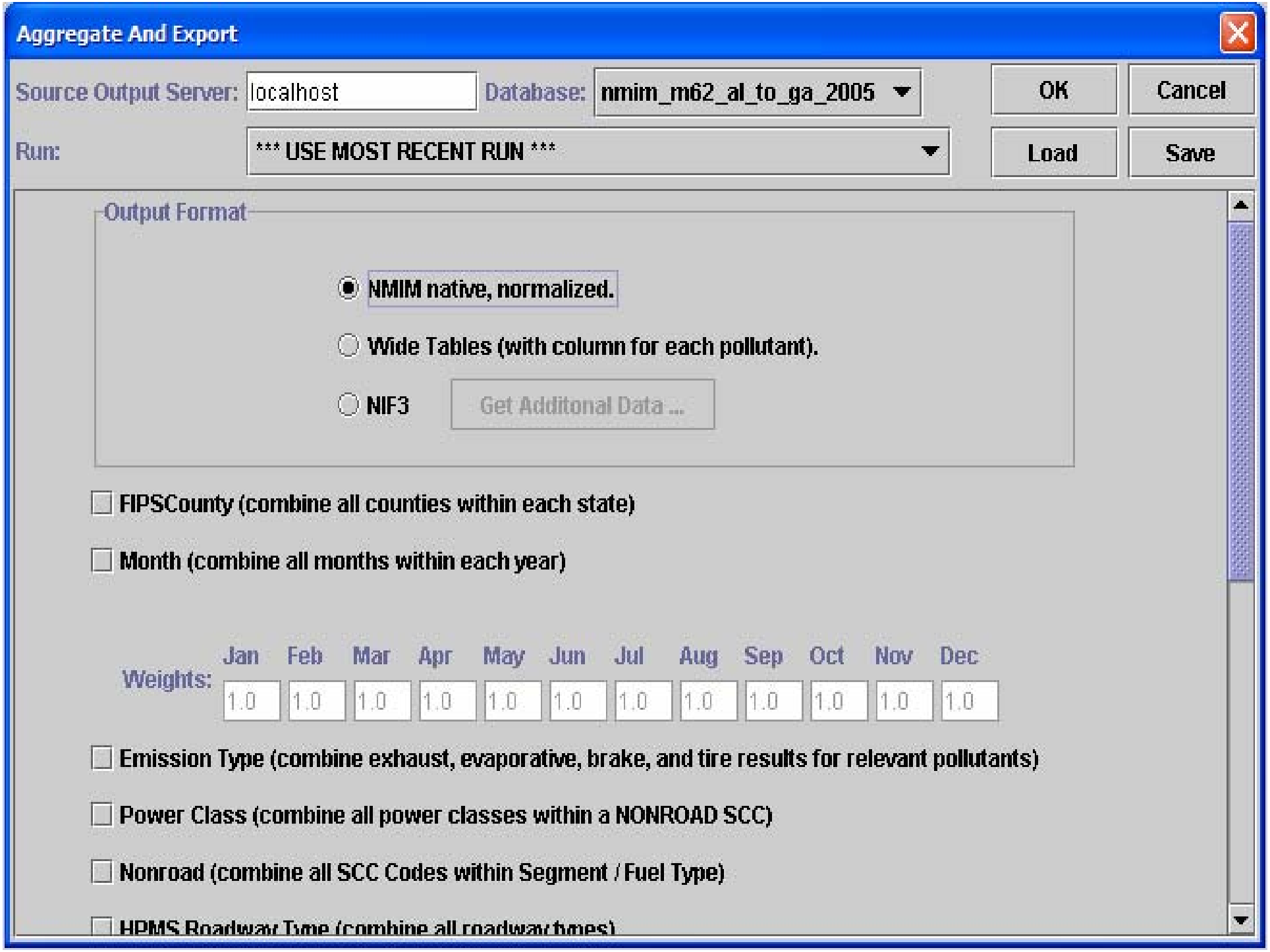
Vehicles/Equipment
Onroad
Nonroad
Fleet
Pollutants
Advanced Features
Diesel Retrofit
Output
Geographic Representat
General Output
Output Database
Server:
localhost
Database:
nmim_m62_al_to_ga_2005
Create Database...
Pre-aggregate nonroad horsepower classes
Ready...


Aggregate And Export
Source Output Server:
localhost
Database:
nmim_m62_al_to_ga_2005
OK
Cancel
Run:
*** USE MOST RECENT RUN ***
Load
Save
Output Format
NMIM native, normalized.
Wide Tables (with column for each pollutant).
NIF3
Get Additonal Data ...
FIPSCounty (combine all counties within each state)
Month (combine all months within each year)
Weights:
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
Emission Type (combine exhaust, evaporative, brake, and tire results for relevant pollutants)
Power Class (combine all power classes within a NONROAD SCC)
Nonroad (combine all SCC Codes within Segment / Fuel Type)
HPMS Roadway Type (combine all roadway types)

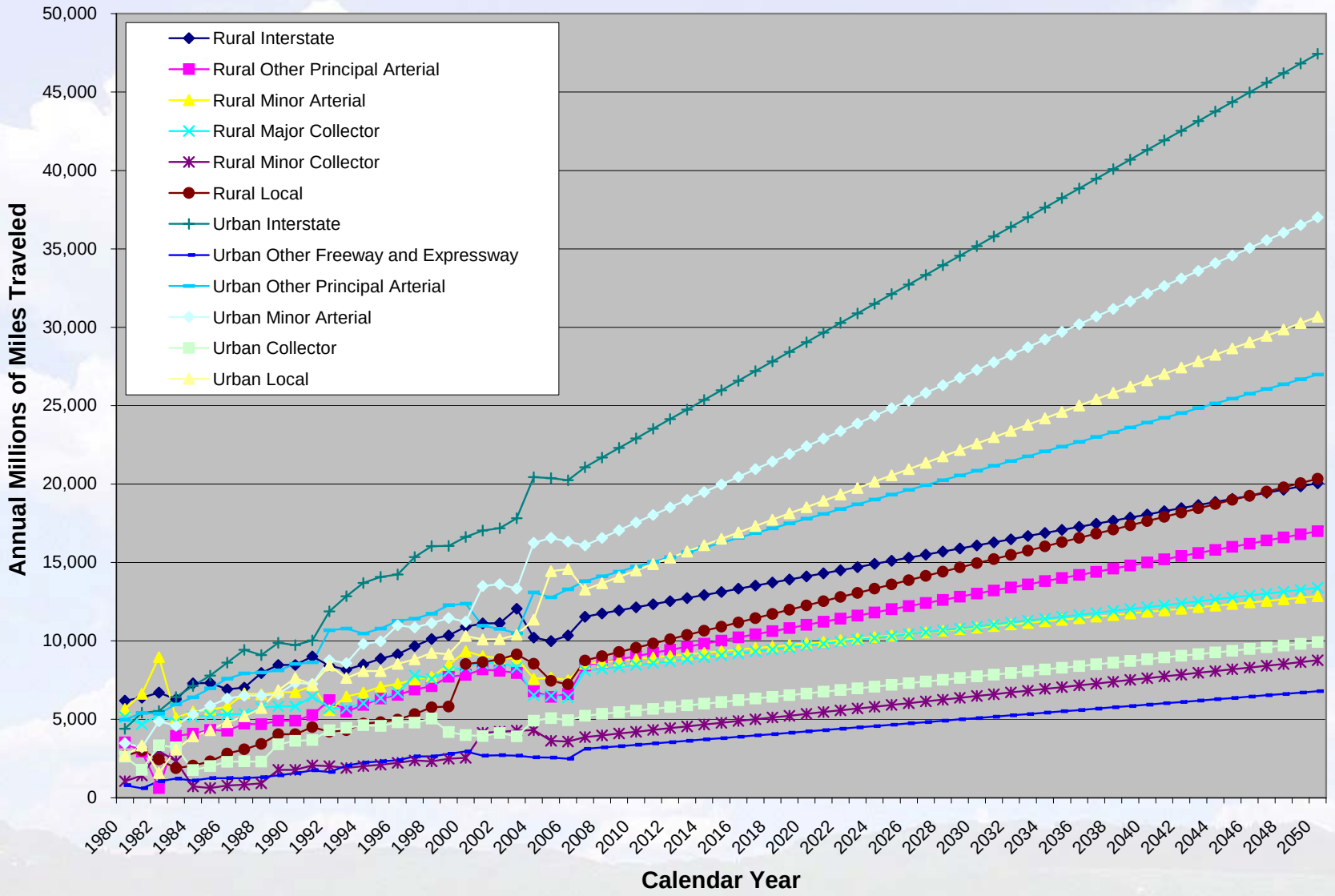
NMIM Capabilities

- Non-road emission estimates for 1999-2050 are easy to obtain because NONROAD model accounts for both emission rates and activity data
- MOBILE6.2 only calculates emission rates by vehicle type
- NMIM database contains vehicle miles traveled (VMT) estimates by county for 1999 and 2002
  - NMIM will interpolate VMT between two "end points"
  - User must supply VMT for years beyond 2002
- Federal Highway Administration (FHWA) Highway Statistics Series:
  - http://www.fhwa.dot.gov/policy/ohpi/hss/index.htm
  - Annual VMT by state and roadway type from 1980-2006
- TCEQ staff established trends from 1980-2006 to project 2007-2050 VMT
  - Excel spreadsheet entitled "us-vmt-nmim-1980-2006.xls" available at ftp://ftp.tceq.state.tx.us/pub/OEPAA/TAD/Modeling/Mobile_EI/NMIM/

NMIM Roadway Types Based on Highway Performance Monitoring System (HPMS)

Area Type	*HPMS Code*	*Roadway Type*
Rural	110	Interstate
	130	Other Principal Arterial
	150	Minor Arterial
	170	Major Collector
	190	Minor Collector
	210	Local
Urban	230	Interstate
	250	Other Freeways and Expressways
	270	Other Principal Arterial
	290	Minor Arterial
	310	Collector
	330	Local

2007-2050 Projected VMT for Georgia by HPMS Roadway Type Based on 1980-2006 FHWA Data



Projecting VMT Beyond 2002

- Use Excel spreadsheet to develop VMT ratios by state and roadway type (e.g., 2005 / 2002)
- Perform MySQL query on NMIM database to export 2002 VMT data (1,082,592 records)
- SAS code imports both 2002 VMT data and 2005/2002 ratios, then exports 2005 VMT
- Import “new” 2005 VMT records into NMIM database
- Recommend Slides 60-66 of Harvey Michaels “NMIM Training” from May 15, 2006:

  http://www.epa.gov/ttn/chief/conference/ei15/training/nmimcourse2006.pdf
- SAS code used to convert “native” NMIM output format into area and mobile source (AMS) emissions format for Emissions Processor System (EPS3), which is available at:
  - ftp://ftp.tceq.state.tx.us/pub/OEPAA/TAD/Modeling/Mobile_EI/NMIM/

Texas On-Road Inventory Development

On-Road Inventory Development Parameter	*Texas Metropolitan Areas*	*Texas Rural Areas*	*Non-Texas States/Counties*
VMT Source	Travel Demand Models (TDMs)	HPMS Data Sets	NMIM Database
VMT Resolution	Roadway "Links" From TDM	19 Roadway Types	12 Roadway Types
Season Types	School and Summer (i.e., non-School)	Summer Only	Summer Only
Day Types	Weekday, Friday, Saturday, and Sunday	Weekday, Friday, Saturday, and Sunday	Weekday, Friday, Saturday, and Sunday
Hourly VMT	Yes	Yes	No
VMT Mix Variation By Day/Time Period?	Yes	Yes	No
Roadway Speed Distribution	Varies by Hour and Link	Varies by Hour and Roadway Type	MOBILE6.2 Default
Spatial Resolution	Excellent	Very Good	Good
Temporal Resolution	Excellent	Very Good	Good
MOBILE6.2 Vehicle Types	28	28	12
Temperature/Humidity Diesel NO_X Correction	Yes	Yes	No
"Eighteen-Wheeler" Idling Emissions Separation	Yes	No	No

Texas 2005 Summer Weekday On-Road Emissions by Day Type

Day Type	On-Road Emissions (tons)			Ratio to Weekday		
	NO_X	VOC	CO	NO_X	VOC	CO
Weekday	1,510.95	560.03	6,612.93	100.0%	100.0%	100.0%
Friday	1,678.72	648.13	7,648.43	111.1%	115.7%	115.7%
Saturday	1,169.22	480.28	6,110.09	77.4%	85.8%	92.4%
Sunday	961.71	421.07	5,374.24	63.6%	75.2%	81.3%

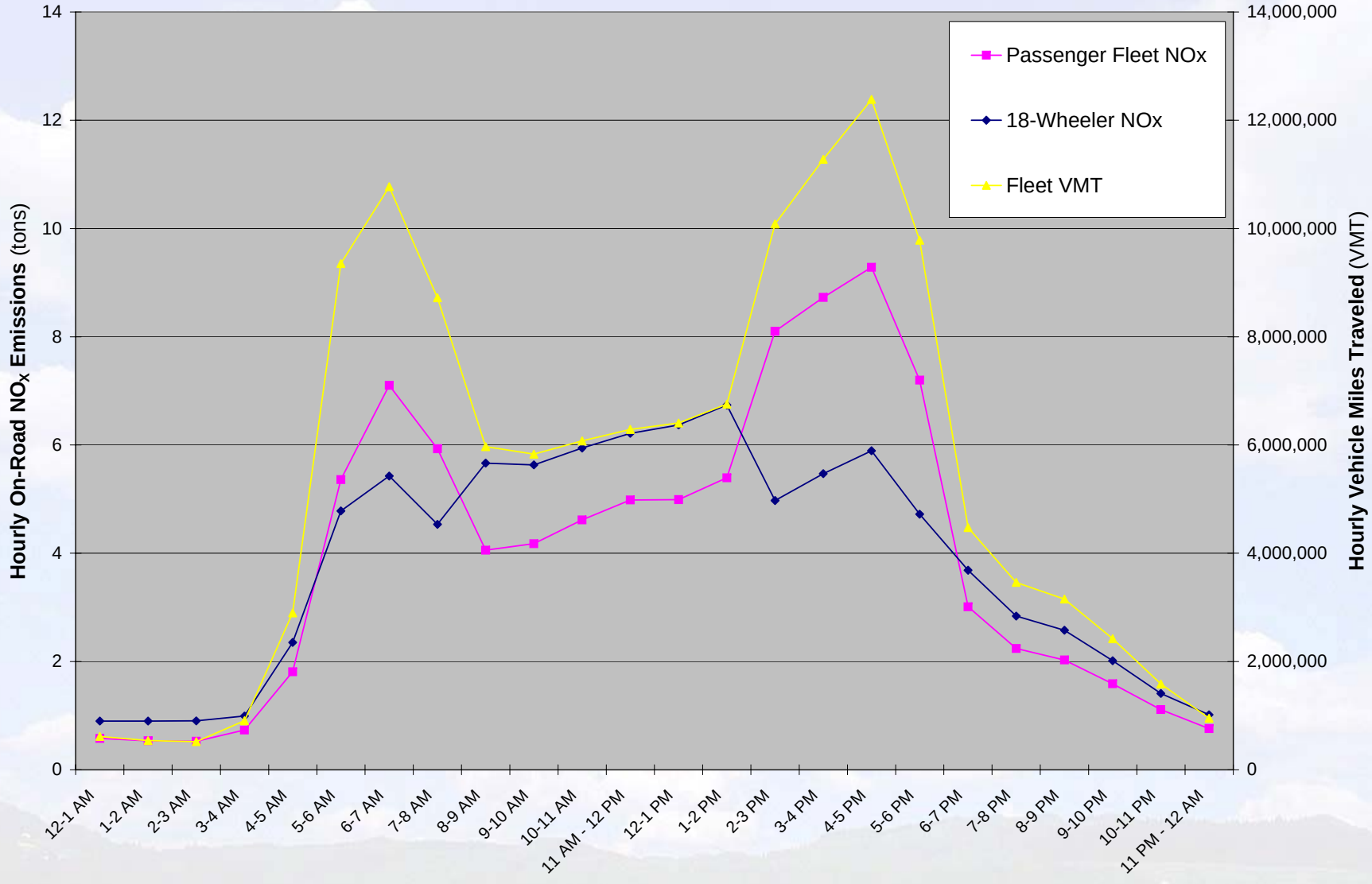
Texas 2005 Summer Weekday Hourly On-Road Emissions Distribution

Hour *(CST)*	***On-Road Emissions*** *(tons)*			***Hourly Distribution***		
	NO_X	*VOC*	*CO*	*NO_X*	*VOC*	*CO*
12-1 AM	12.72	7.95	55.73	0.8%	1.4%	0.8%
1-2 AM	11.47	7.72	51.80	0.8%	1.4%	0.8%
2-3 AM	10.96	7.59	49.91	0.7%	1.4%	0.8%
3-4 AM	14.44	8.18	62.33	1.0%	1.5%	0.9%
4-5 AM	30.07	10.86	113.50	2.0%	1.9%	1.7%
5-6 AM	65.90	21.74	266.47	4.4%	3.9%	4.0%
6-7 AM	92.75	36.75	456.63	6.1%	6.6%	6.9%
7-8 AM	82.66	33.32	396.57	5.5%	5.9%	6.0%
8-9 AM	76.06	26.64	326.00	5.0%	4.8%	4.9%
9-10 AM	78.35	28.06	337.17	5.2%	5.0%	5.1%
…	…	…	…	…	…	…
Total	1,510.95	560.03	6,612.93	100.0%	100.0%	100.0%

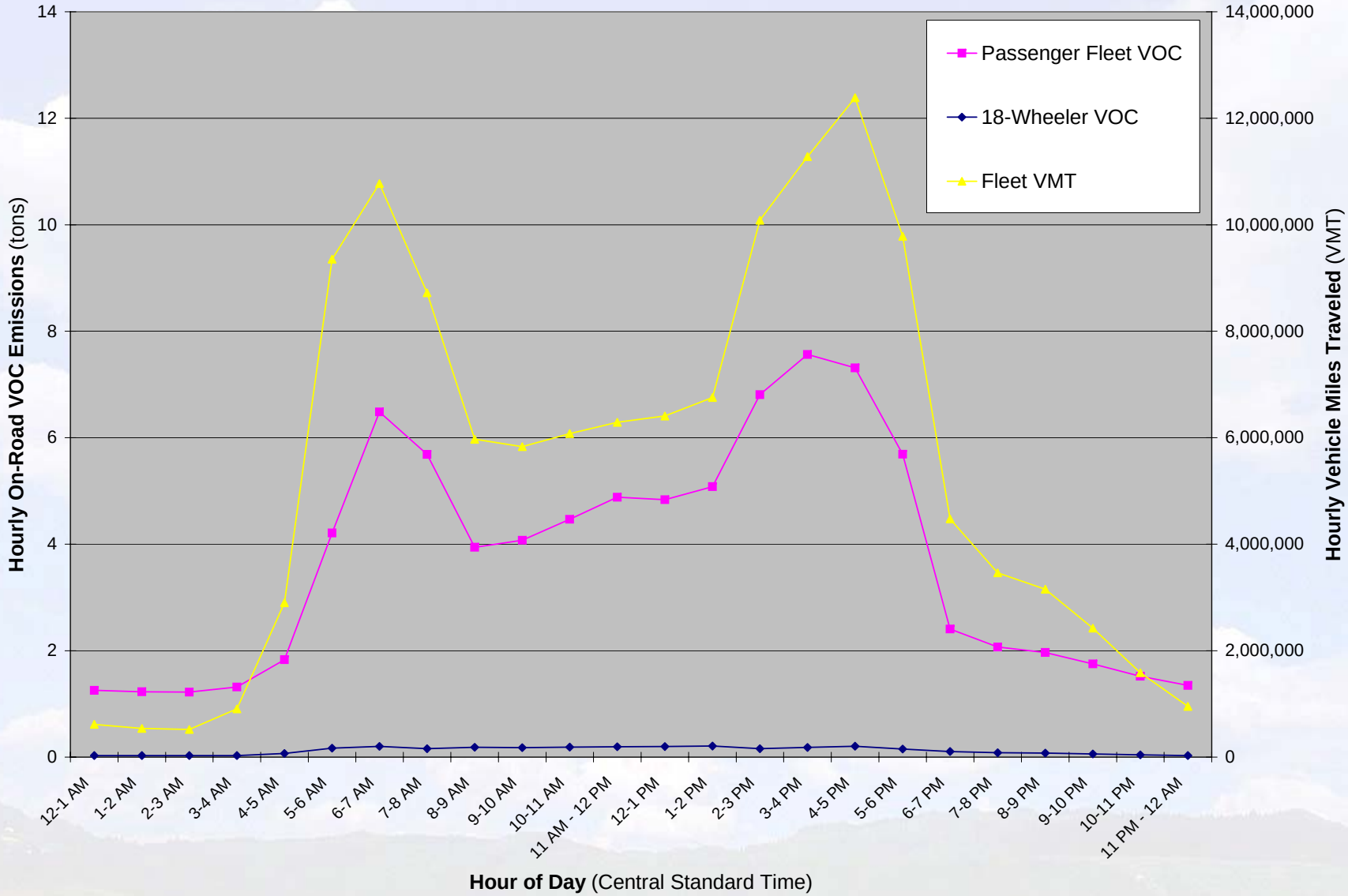
2005 HGB Summer Weekday On-Road Emissions Contributions by Vehicle Category

Vehicle Category	***VMT Contribution***	***On-Road Pollutant Contribution***		
		NO_X	*VOC*	*CO*
Passenger Fleet	91.0%	42.8%	93.5%	96.4%
Eighteen-Wheelers	4.2%	41.5%	3.1%	1.3%
Other Vehicles	4.8%	15.7%	3.4%	2.2%
Total Fleet	100.0%	100.0%	100.0%	100.0%

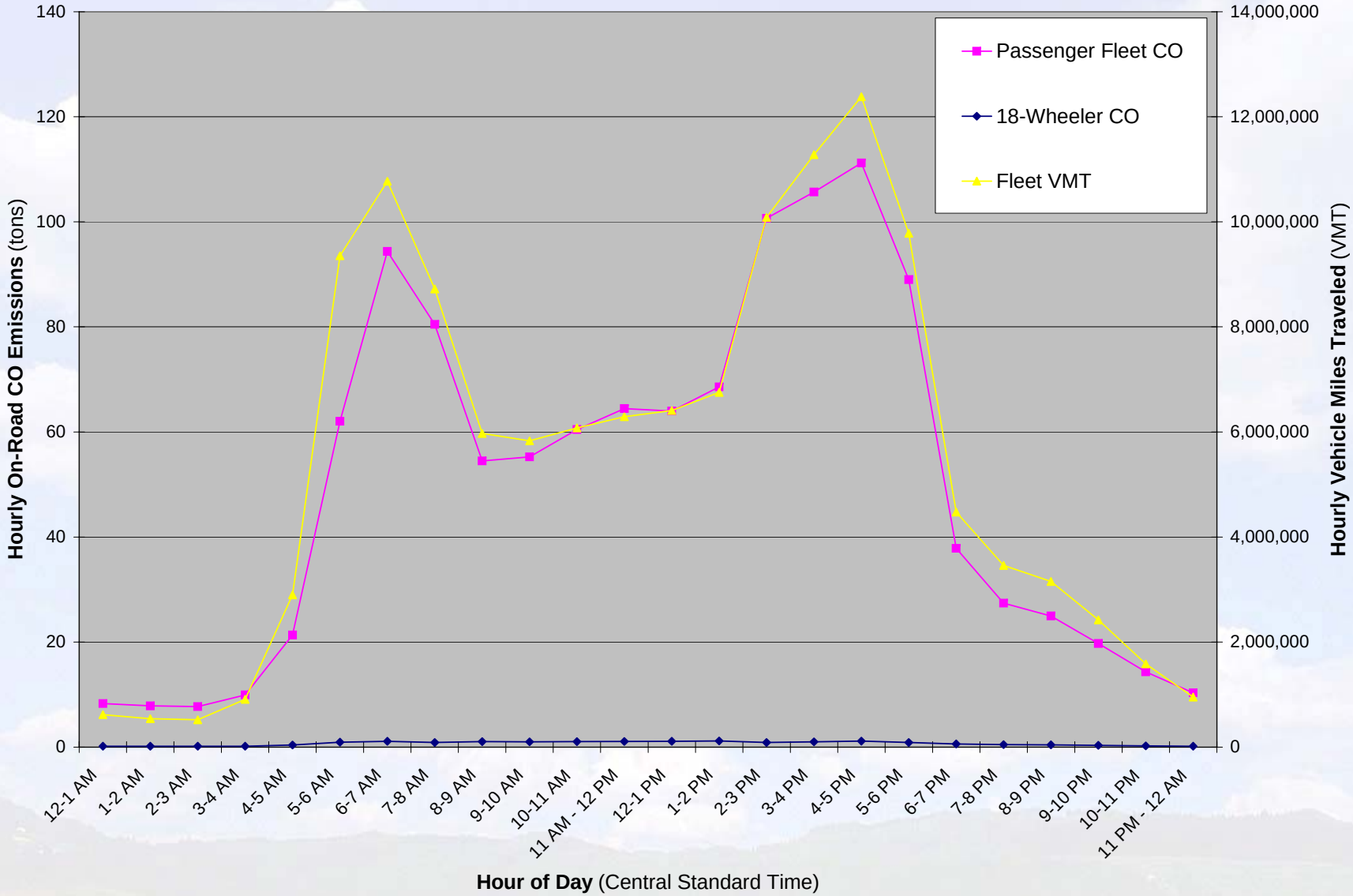
2005 HGB Summer Weekday Hourly On-Road NO_X Emissions Distribution



2005 HGB Summer Weekday Hourly On-Road VOC Emissions Distribution



2005 HGB Summer Weekday Hourly On-Road CO Emissions Distribution

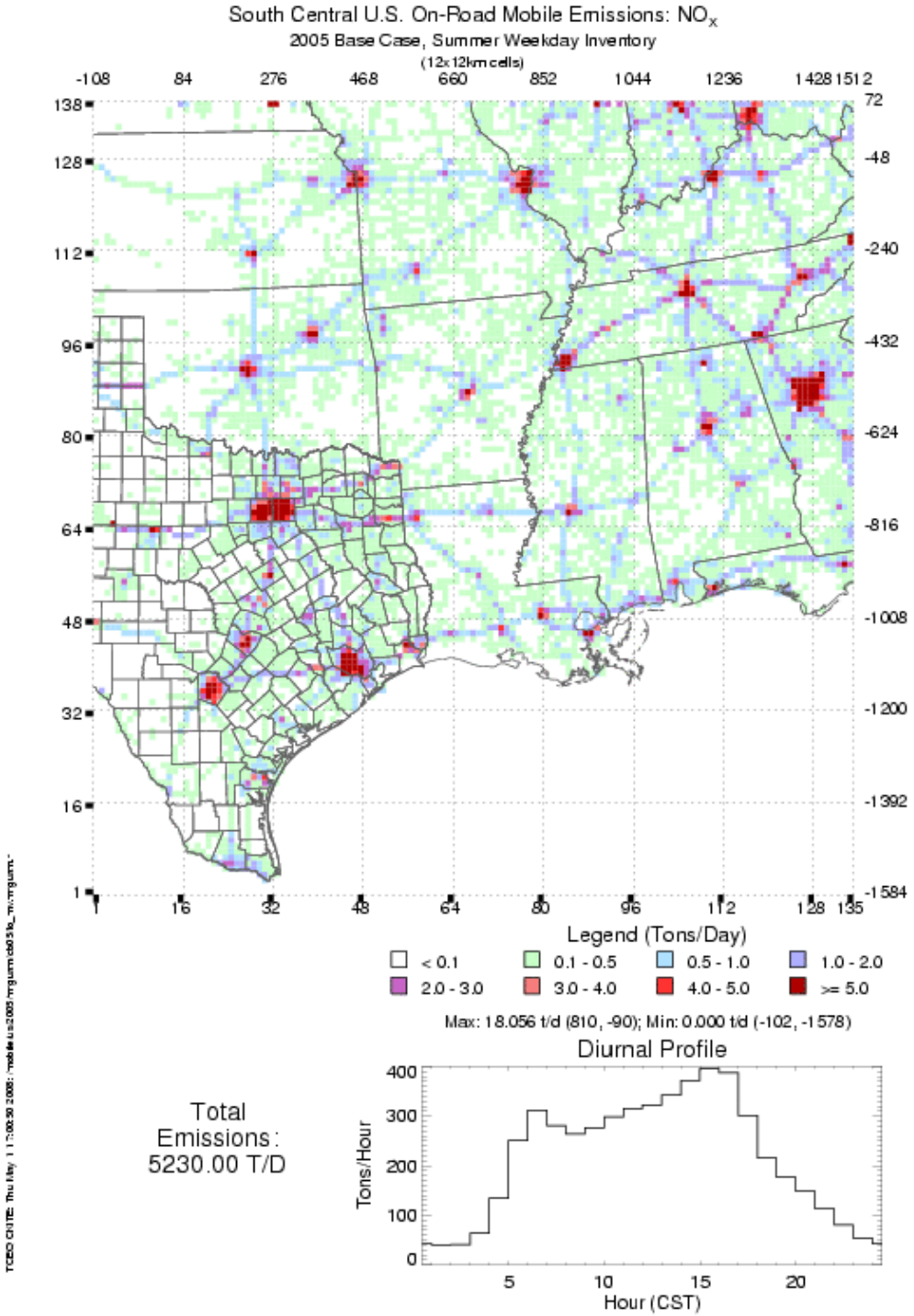


Sample On-Road Spatial Allocation for Fulton County, Georgia

FIPS County Code	Grid Cell From Origin		Spatial Allocation Fractions			
	X (km)	Y (km)	Interstates	Highways	Arterials	Population
13121	1,404	-564	16.45%	6.08%	5.13%	6.96%
13121	1,404	-552	33.16%	16.68%	5.89%	28.52%
13121	1,404	-540	17.25%	11.77%	14.64%	22.81%
13121	1,404	-528	8.46%	19.21%	3.86%	8.59%

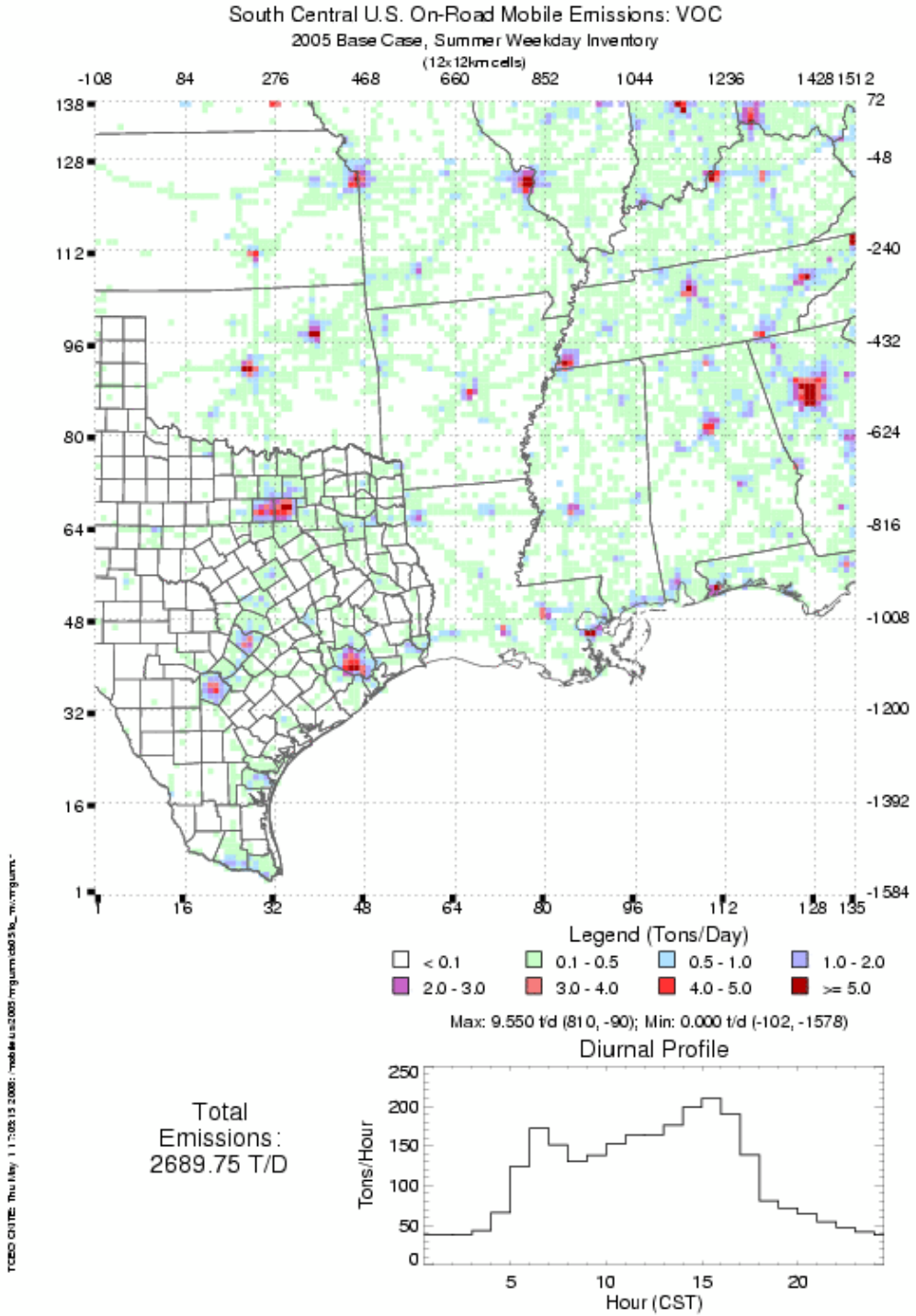
South Central U.S. Weekday On-Road NO_X

- Spatial surrogates used for grid cell allocation
- Non-Texas hourly distribution based on Texas on-road inventory
- Standard Time (not Daylight Time) used for consistency with meteorological modeling
- Peak morning rush hour from 6-7 AM CST (is 7-8 AM CDT)



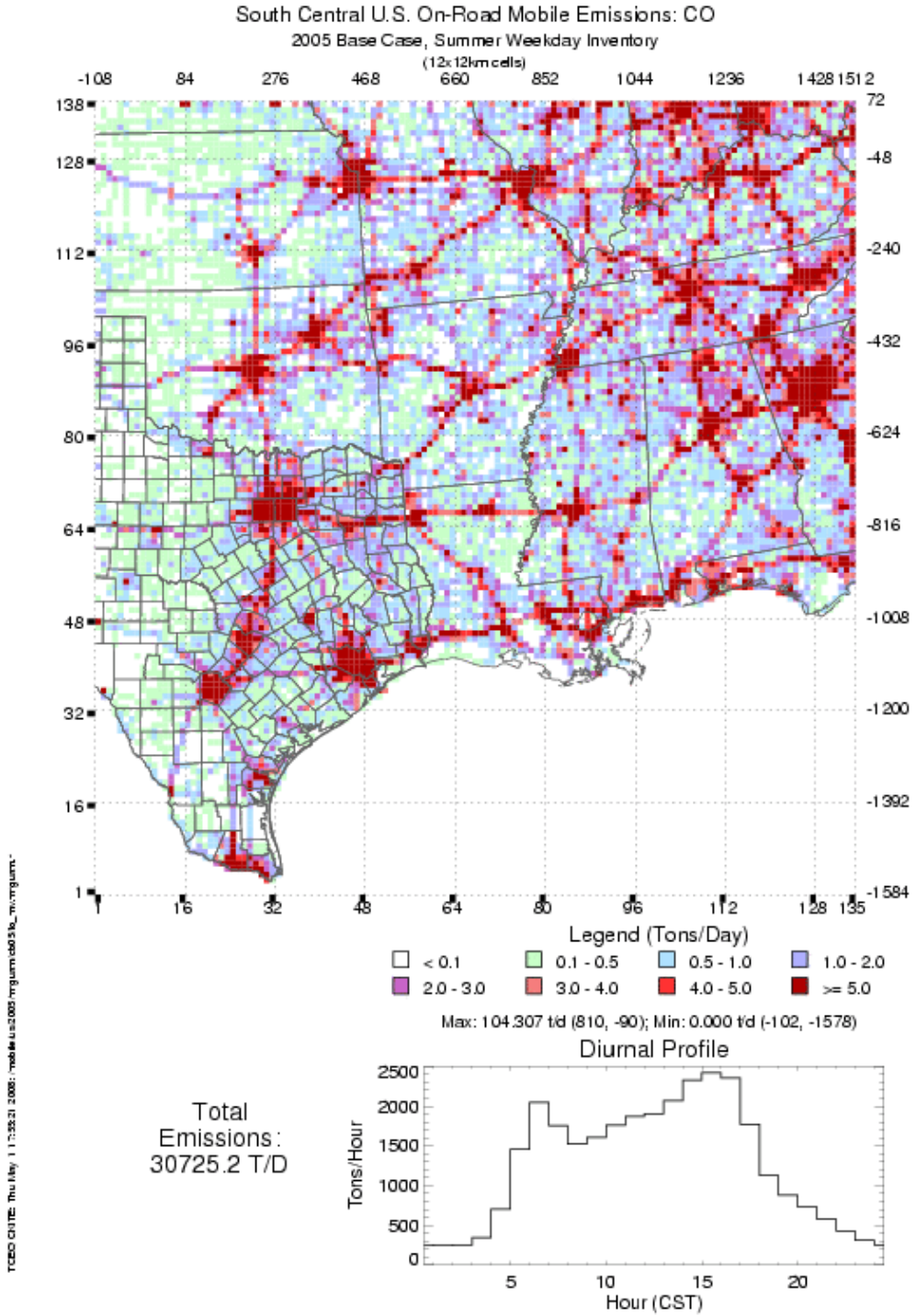
South Central U.S. Weekday On-Road VOC

- VOC emissions dominated by gasoline-powered passenger fleet
- Exhaust and evaporative emissions included



South Central U.S. Weekday On-Road CO

- CO emissions dominated by gasoline-powered passenger fleet
- CO emissions from tailpipe only
- Compared with NO_X and VOC, CO hourly distribution most closely tracks with overall VMT



Additional NMIM Resources

- EPA's NMIM website
  - http://www.epa.gov/otaq/nmim.htm
- NMIM training presentations
  - http://www.epa.gov/ttn/chief/conference/ei15/index.html
  - http://www.epa.gov/ttn/chief/conference/ei16/index.html
- TCEQ on-road mobile FTP site
  - ftp://ftp.tceq.state.tx.us/pub/OEPAA/TAD/Modeling/Mobile_EI