Preparation of Mexico National Emissions Inventory 2005 for Air Quality modeling using WRF-chem in Mexico

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1. INTRODUCTION

The National Emissions Inventory (NEI) was updated for base year 2005 in order to be useful and comparable among US and Canada inventories. It considers seven different pollutants (PM_{10}, $PM_{2.5}$, CO, NOx, SO_2, VOC and NH_3), there are four different source types, point, area, mobile and natural sources. Emissions are allocated spatially in the 2,454 municipalities.

Several categories are used for different sources 17 for point sources, 34 for area, 28 for mobile.

Spatial allocation was made using population density at AGEB level; forest and agricultural land use type were used to allocate the fire forest and agricultural emissions. Highways and streets were used for mobile emissions.

Temporal distribution was based on the source classification codes (SCC) as well the chemical speciation, for the aggregation to photochemical categories. The NEI for modeling contains for RADM2 mechanism 37 different species, 25 gas phase and 12 for particle and aerosol emissions. For SAPRC99 mechanism 55 different species, 43 gas phase and 12 for particle and aerosol emissions. The intermediate files are in ascii and the final file is in netcdf format.

This work presents the methodology used in order to convert MNEI 2005 for air quality modeling using WRF-chem.

2. MOTIVATION

Actions for reducing pollutant concentrations in Mexico such as changes in fuel composition for industry and cars, closure of large emitters, inclusion of new technologies among others, have to be evaluated before its application. In order to do that the use of information and tools like emissions inventories and air quality modeling are fundamental.

In this work an update of emissions inventory useful for WRF-chem model is presented.

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The NEI 2005 was published on December 2011. This new emissions inventory is an update of the NEI 1999, considers more categories and some filed surveys in order to improve mobile and area source emissions.

3. METHODOLOGY

The NEI contains different categories, there are 17 for point sources, 34 for area, 28 for mobile, and those were tied into the source classification codes (SCC). The Figure 1 presents the steps used in the conversion of the NEI in an emissions inventory for modeling:

1) Spatial distribution.
2) Temporal distribution..
3) Chemical Speciation distribution.
4) Lumping Chemical Speciation for RADM2 or SAPRC99 mechanism
5) Emissions Storage

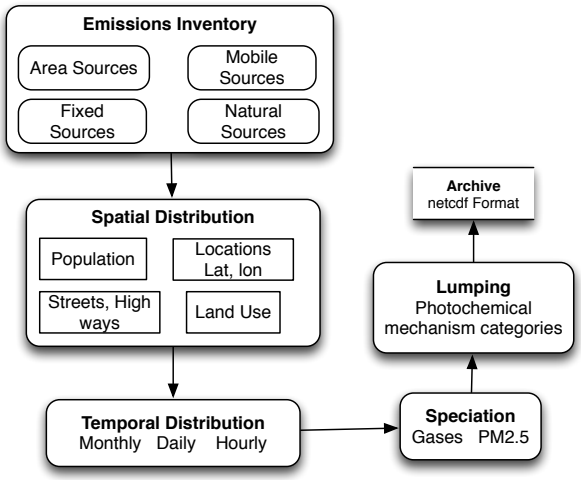

Fig. 1. The emissions procedure conversion.

3.1 Spatial Distribution

The grid selected covers Mexico Country, the grid size is 3 km by 3km, and for this work two areas are considered that covers the second and third largest cities in Mexico. The first domain considers all the state of Jalisco where Guadalajara city is located and the second

considers the Monterrey Metropolitan Area in Nuevo Leon state. Figure 2 presents the selected domains. There are 141 by 142 grid cells in Jalisco domain and 50 by 50 for Monterrey area.

Information from land use, population, high way and streets comes from the National Institute of Statistics and Geography database (INEGI, 2010). This information is used to allocate emissions in the selected domains.

Fig. 2. Grid used in the inventory and selected domains for Jalisco state (lower left square) and Monterrey city (upper right).

For point sources using climatological data the effective stack height is computed and located in the corresponding layer.

3.2 Temporal Distribution

The temporal distribution profiles are selected by the SCC code for monthly, weekly and hourly distribution. Due to the extent of the country there are three different time zones, those are considered at municipality level.

3.3 Speciation

Volatile Organic Compounds (VOC) category includes a set of different chemical species; the chemical composition set varies depending of the source category. The identification of the profile speciation is by using the SCC code for each source category, the EPA speciation (EPA, 2002) and the Improved Chemical Speciation Database (Carter, 2011), for gases and $PM_{2.5}$.

3.4 Lumping

Chemical species are not used, as is it in photochemical models, the common method is a lumped category that considers different chemical species as one single set. RADM2 mechanism has 37 different species, 25 gas phase and 12 for particle and aerosol categories. For SAPRC99 mechanism there are 50 different species, 38 gas phase and 12 for particle and aerosol categories.

The lumping was made using the aggrupation proposed by Carter (2011).

3.5 Storage

The emissions inventory is stored in netcdf format (Rew et al 1997). The structure of the file, the dimension and the variables names are those that WRF-chem (Grell et al. 2005) requires for anthropogenic and biogenic emissions.

In output files for RADM2 there are 42 emissions variables, 12 are particle matter, 5 biogenic and 25 gas phase. For SAPRC99 there are 55 species 12 are particle matter and 5 biogenic and 38 gas phase.

4. RESULTS

An emissions inventory useful for WRF-chem modeling for 2005 was produced. It is possible to generate any day or period in 2005, as example of emissions is presented in Figure 3 for Jalisco.

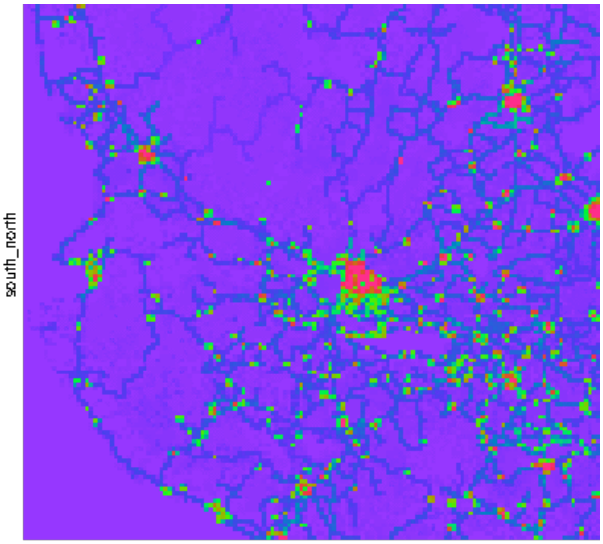

Fig. 3. CO Emission for Jalisco and surrounding states. The second largest city in Mexico it is near the central domain.

In addition the emission at metropolitan scale is presented in Figure 4 for Monterrey Metropolitan Area (MMA). In this case is also included a neighbor city, Saltillo which in some cases can have emissions interaction with MMA.

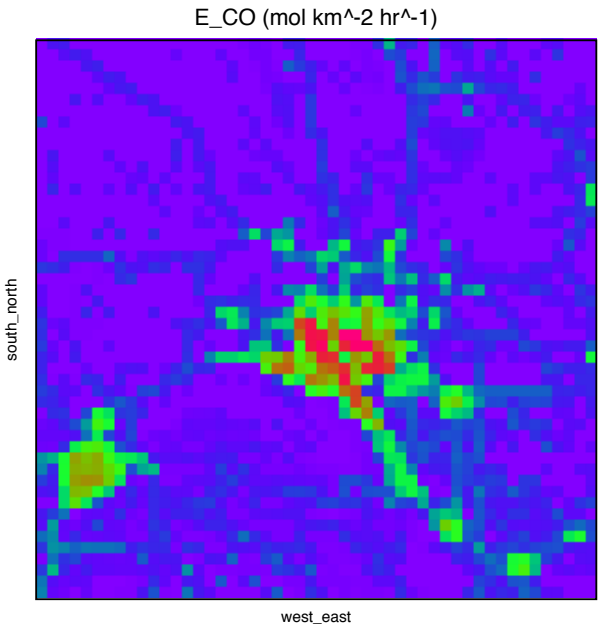

Fig. 4. CO Emission for Monterrey and surrounding states. The third largest city in Mexico is in center and Saltillo city is in the bottom left.

The temporal distribution of emissions it is presented in Figure 5, for a central location in Jalisco and for a week period. In this case it is possible to observe reductions during the weekend.

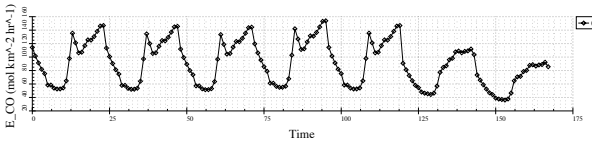

Fig. 5. CO temporal distribution for a week on April

5. CONCLUSIONS

This emissions inventory for 2005 is the latest up to now in Mexico for modeling.

The number of emissions categories and species made this EI suitable to be use in coupled chemistry meteorology models like WRF-chem, and for two different photochemical mechanisms (RADM2 and SAPRC99).

Emissions consider speciation for PM2.5 in this speciation elemental carbon is included.

The product of this work made possible to do an air quality management in cities other than Mexico City and also at national level.

This procedure can be applied to the next national emissions inventory for 2008 year when it will be released.

6. REFERENCES

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