DEVELOPMENT OF A CMAQ-READY EMISSIONS INVENTORY FOR SOUTHEAST BRAZIL

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Introduction

In the last decades growing levels of urbanization in Brazil have resulted in increasing air pollution due to higher activity in the transportation, energy, and industrial sectors in metropolitan areas. Population growth in large cities leads to air quality degradation at local and regional scale, among other problems. Toxic trace gases emitted to the troposphere and their oxidation products represent a direct human health risk (Alonso et al., 2010).

The southeast of Brazil has three of the major Brazilian metropolitan areas, Metropolitan Areas of São Paulo (MASP), Rio de Janeiro (MARJ) and Belo Horizonte (MABH), which are notable for their economic importance. These are the most populated regions in Brazil, concentrating 12% of the national vehicle fleet and a large number of industries. This region has a complex terrain, is effected by the Atlantic Ocean atmospheric conditions and it is influenced by air pollutant emissions from anthropogenic and biogenic sources. These emissions associated with meteorology conditions and chemistry will affect the regional air quality.

This study will focus on winter time because it is the dry season of this area. Emissions are developed using PREP-CHEM-SRC (v.1.5) developed by Brazilian scientific groups, that considered the most recent emissions database for particles and gases emitted from urban/industrial, biogenic emissions, biomass burning, volcanic, biofuels use and burning of agricultural waste sources. PREP-CHEM-SRC does not build emissions inventory ready for CMAQ model, so this work aims to convert the PREP-CHEM-SRC emissions inventory to apply into CMAQ model in a regional domain.

Methods

WRF for Southeast of Brazil

Meteorological fields were modelled using the Weather Research and Forecasting model WRFv3.9 for the august 2015 using National Center for Environmental Prediction NCEP GDAS/FNL (Final) operational global analysis and forecast data as initial and boundary condition with 0.25° x 0.25° grid resolution. The domains are centered at 19.816 °S, 43.954°,in Belo Horizonte. Figure 1 show the domains over the area of interest

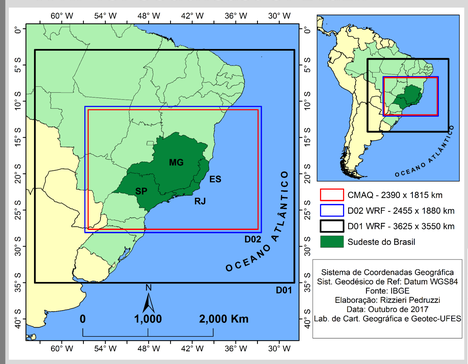

Figure 1. Two nested domains used in WRF

Spatial Parameters		
Domain	D01	D02
Grid resolution	25 km	5 km
Number of columns (km)	145 (3625)	491 (2455)
Number of lines (km)	142 (3550)	376 (1880)
Vertical levels	32 sigma level	

- The work just have started, so the first simulations with WRF will use the Pedruzzi (2016) best set of parametrizations, which were WSM3, RRTM, Dudhia, Revised MM5 Monin-Obukhov, Noah land-surface model, BouLac, Betts-Miller-Janjic;
- The model performance will be done according Emery et al. 2001, and the authors intend to do more simulations changing the landuse/landcover, topography and testing other options to solve physics in the model.
- Figure 2 show the processed topography by WRF using GMTED2010 with 30" resolution

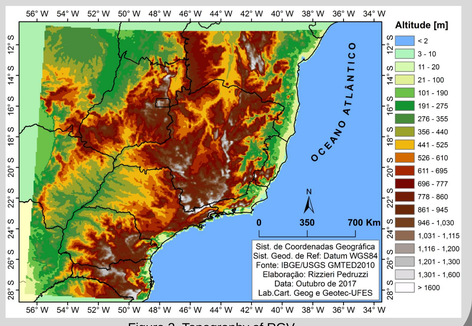

Figure 2. Topography of RGV

Building emissions for Southeast of Brazil

To build emissions for Southeast were applied the PREP-CHEM-SRC v.1.5 (Freitas et al. 2011) the global database:

- RETRO/EDGAR for anthropogenic emissions:
- 3BEM biomass burning emissions;
- MEGAN for biogenic emissions;
- GOCART aerossol and backgroud particles; and
- Yevich e Logan (2003) for burning biofuel and agricultural waste.

The global databse are available with PREP-CHEM-SRC repository (http://brams.cptec.inpe.br/downloads/) and the sources of wild fire for 2015 were requested to Brazil's National Institute of Spacial Research (INPE).

In addition to this base, Alonso et al.(2010) have developed a update for South America emissions, tool that also were applied to the scenarios.

The build of CMAQ ready emissions from PREP-CHEM-SRC were made in Python3 language using the **PseudoNetCDF** (http://github.com/barronh/pseudonetcdf), a tool that incorporate many python functions, including I/O API for CMAQ applications;

Steps to build CMAQ ready emissions:

1. First compile the PREP-CHEM-SRC with both chemical mechanism, RADM_WRF_FIM, where the aerosols are extracted and CB07 where the gases are extracted. A way of match with CMAQ's mechanism
2. Second it is need to run PREP-CHEM for each day for you domain(MCIP) and then convert the output to NetCDF format;
3. With both files converted to NetCDF, it is need to set your options, pointing files and path and set the diurnal profile in Python3 code:
4. The script gets the aerosol and gases from each cell processed by PREP-CHEM-SRC, build a domain based on GRIDCRO2D from MCIP, apply diurnal weight in emissions, put emissions in the first layer(characteristic of PREP-CHEM) and apply I/O API conventions to output;
5. The codes produces a daily emissions file with 25 time steps. To run more than a day, it is only necessary to concatenate the daily emissions files to one file;

Results

The shown results are only for August first, a preliminary simulation for the major case.

- Figure 3(CO) and Figure 4(PM_{10}) show only the Anthropogenic emissions from PREP-CHEM. It still has another type of emissions in output file, like biomass burning, biogenic, etc. It can be seen from the scenario that in area which has Alonso et.al. update, the emissions are higher resolution than the others.
- Figure 5(CO) and Figure 6(PM_{10}) are the daily mean emissions from August first. These figures were extracted from CMAQ ready emissions with one layer.
- Figure 7(CO) and Figure 8(PM_{10}) are average from August first 00h until 06h. These scenarios are a preliminary result for CMAQ simulation over Southeast of Brazil.

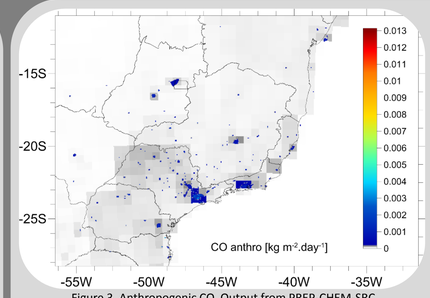

Figure 3. Anthropogenic CO. Output from PREP-CHEM-SRC

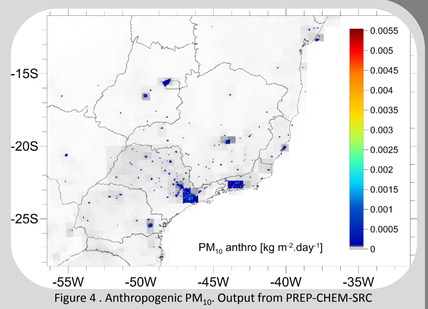

Figure 4 . Anthropogenic PM_{10}. Output from PREP-CHEM-SRC

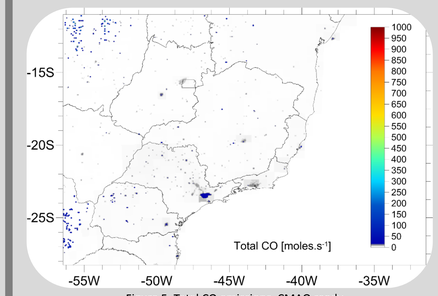

Figure 5. Total CO emissions. CMAQ ready

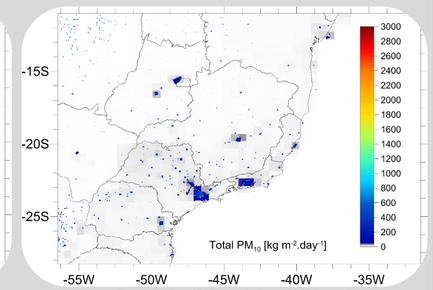

Figure 6 . Total PM_{10}. emissions. CMAQ ready

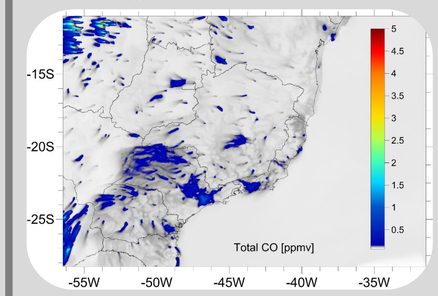

Figure 7. Scenario of CO dispersion. CMAQ Average Concentration

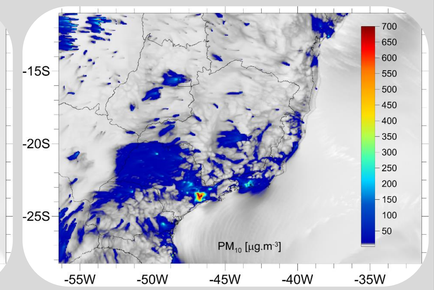

Figure 8 . Scenario of CO dispersion. CMAQ Average Concentration

Conclusions

- the emissions conversion tool proved to be effective in converting emissions from PREP-CHEM to CMAQ, applying the conversions of the chemical species, time profile in cells and maintaining the I/O API format required by the CMAQ.
- The possibility of generating the emissions in PREP-CHEM and applying them in the CMAQ is extremely important and is a great contribution to air quality studies and community. It is now possible to generate emissions for several areas of the globe, especially South America, and to apply them in dispersion studies with CMAQ.
- The next steps are evaluating emissions for Southeast, find the best WRF simulation and run CMAQ scenarios for for entirely month (August 2015)

ACKNOWLEDGMENTS

The authors thank CNPq, CAPES, FAPESB and UFMG for the partial financial support of this work, the GPAMA group at UFMG which provided the computational infrastructure for executing the WRF, PREP-CHEM-SRC and CMAQ models, the INPE for data from wild fire data. A special thankyou for Doctor Barron Henderson for helping me at the emissions conversion from PREP-CHEM-SRC to CMAQ.

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