Utilizing the reduced complexity model InMAP to analyze emission reductions scenarios in Bogotá, Colombia

#23

22nd Annual CMAS Conference, Oct. 16-18, 2023 | Chapel Hill, NC

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Introduction

GOAL

- To determine the potential for emission reduction scenario assessment at the urban scale of the reduced complexity model InMAP.

MOTIVATION

- Having a tool that offers quick (but reasonable) responses to emission reduction policies could be useful for policy makers.

TOOL

- WRF-Chem: Instead of using a global model to inform InMAP we use a 1 year run at 3km x3 km as input using information from a local emission inventory

Methods

Compiling InMAP

- InMAP requires 3D hourly data from a full Chemical Transport Model as input
- Other studies have used global models to run InMAP.
- However, the topography and high population density of Colombian cities makes the use of CTM data unsuitable

WRF-Chem → InMAP: INTERVENTION MODEL FOR AIR POLLUTION

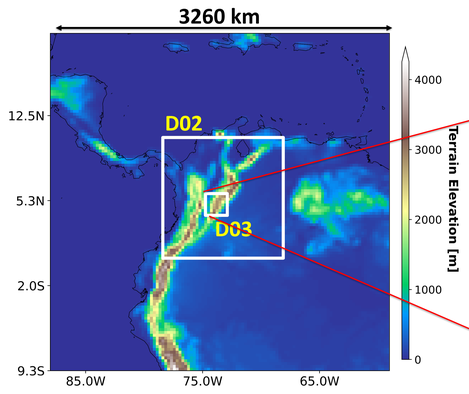


FIGURE 1. Location of the modeling domains. Three nested domains were used down to a 3km x 3km resolution

Local emissions

- For the urban area of Bogota we use a 1x1 km local emission inventory

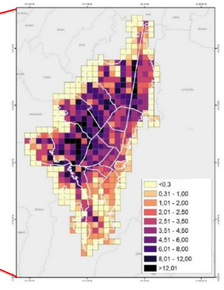


FIGURE 2. Local emission inventory at 1km x 1km spatial resolution.

2. WRF-Chem model configuration and experimental design

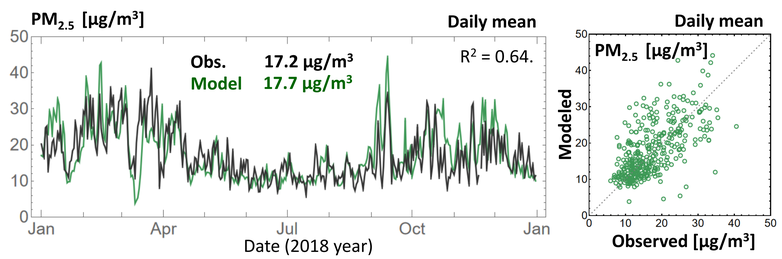
Physics Options	
Microphysics	Lin et al (1983)
LSM	Noah LSM
Cumulus	Grell-Devenyi
Radiation	RRTMG
Chemistry Options	
Aerosols	MADE-VBS
Gas phase Chem.	RACM
Boundary Conditions	
Chemistry	CAM-Chem
Meteorology	FNL (1° x 1°)
Emissions	
Anthorpog.	EDGAR 4.3.1 + Loca
Biogenic	MEGAN
Biomass burning	FINN v 1.5

Table 1. Configuration of the WRF-Chem model

- Model configuration was chosen based on previous studies performed in the city of Bogotá [6].
- Modelling period was selected as 2018 since this is the most recent year for which a local emission inventory is availablebased on highest PM concentrations and driest period.
- Experimental design compromise of 4 runs using different chemical options and emissions configurations (Table 2)

Results

3. Base run evaluation



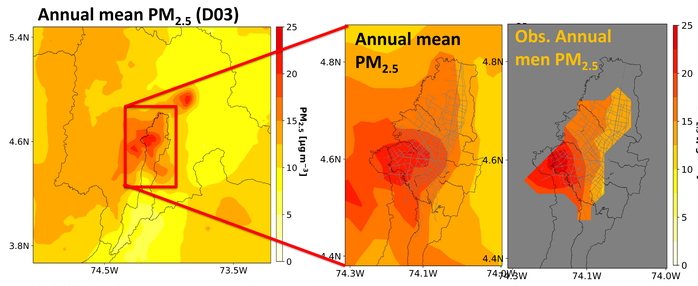
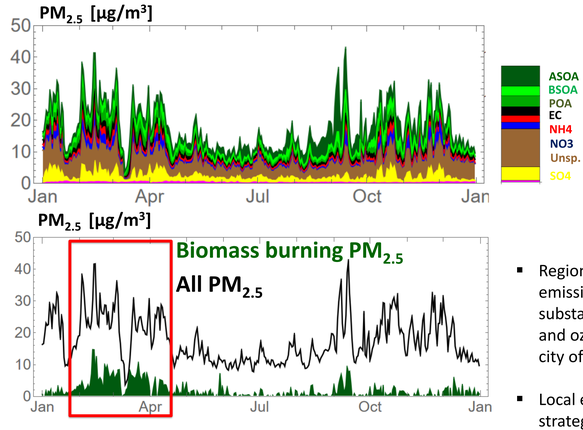


FIGURE 3. Ground level PM2.5 for (a). D03 domain, (b) the city of Bogotá, and (c) PM2.5 from the local monitoring system in Bogotá

- The WRF-Chem model captures the main feaures of the in the city of Bogota
- Variations at daily, weekly and monthly scales are well captured
- The NW-to-SE PM2.5 concentration gradient observed in Bogotá is captured by the modeled fields.

4. Biomass burning limits the impact of local emission reductions



- Organic aerosols account for **35%** of $PM_{2.5}$
- EC in the model is only **7.6%** of $PM_{2.5}$
- Unspeciated $PM_{2.5}$ from RMP is a key component.

- Close to 8.3% of annual mean $PM_{2.5}$ in Bogotá is attributable to regional BB
- For February and March, BB contribution is 22.1% and 25.6% respectively

- Regional biomass burning emissions contribute substantially to particulate and ozone pollution in the city of Bogota
- Local emission reduction strategies could still have a large positive impact in air quality improvement

InMAP scenarios

We analyzed several hypothetical reduction scenarios and run them through InMAP:

- **No_diesel:** simulation excluding mobile sources that use dieses as fuel
- **No_gasoline:** simulation excluding mobile sources that use gasoline as fuel
- **No_RMP:** simulation excluding resuspended material

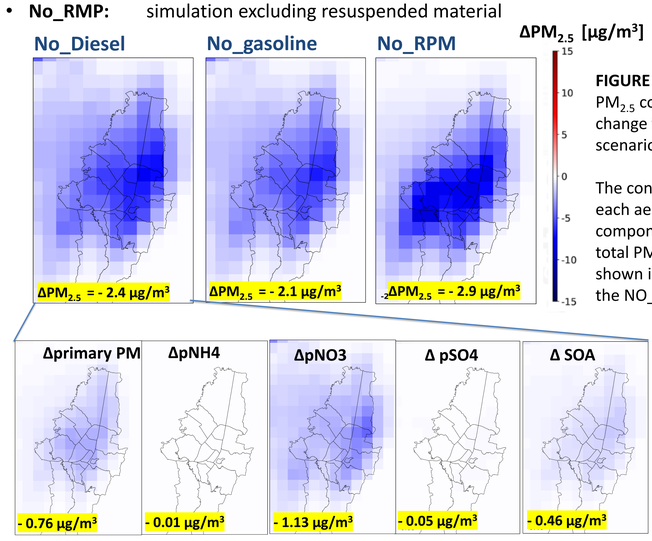


FIGURE 5. Simulated $PM_{2.5}$ concentration change for each scenario using InMAP.

The contribution of each aerosol component to the total $PM_{2.5}$ change is shown in deatil for the NO_Diesel case

Concluding remarks

- A CTM simulation was shown to capture correctly the magnitude, variability and spatial distribution of ground level $PM_{2.5}$ in the city of Bogota
- Regional biomass burning sources are shown to be key in explaining the annual $PM_{2.5}$ concentration cycle in the city of Bogota
- The InMAP reduced complexity model was implemented using as input a WRF-Chem simulation
- Several emission reduction scenarios were tested. Run time for each simulation was < 20 minutes in a desktop computer
- InMAP seems to overpredict the changes in NOx and inorganic aerosols
- Ongoing work is reproducing the scenarios with the full CTM to validate the InMAP concentration fields.

Acknowledgements

- This project was partially funded by a Fulbright Visiting Scholar grant for Ricardo Morales.
- Local emissions inventories provided by Secretaria Distrital de Ambiente de Bogota, Colombia. Contract 1467/2013 for the implementation of an air quality model in Bogotá.