CONTRIBUTION OF WILDLAND AND AGRICULTURAL FIRES FROM NORTHERN SOUTH AMERICA TO PM2.5 and PM10 IN COLOMBIAN CITIES

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Introduction

GOAL

- To assess the seasonal contribution of biomass burning emissions from natural and agricultural fires to particulate matter (PM) levels in the central region of Colombia using an atmospheric regional chemical transport model.

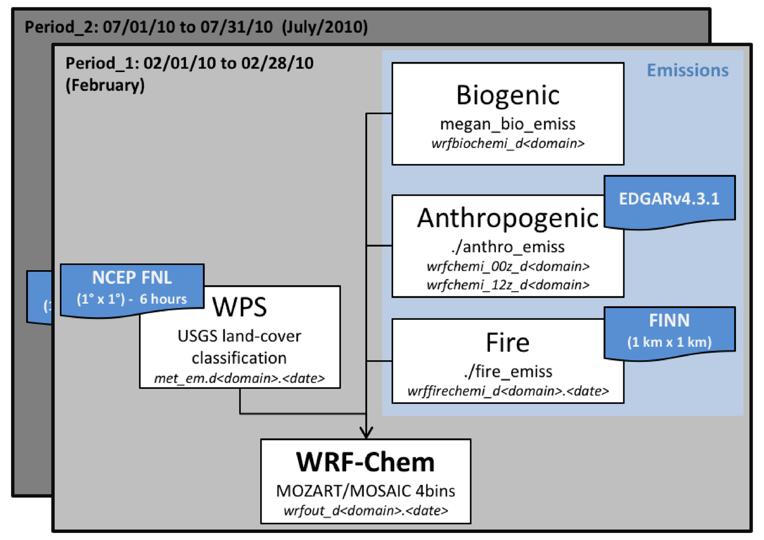
TOOLS

- HYSPLIT and WRF-Chem V3.9.1

MOTIVATION

- Contribution of biomass burning emissions to local and regional air quality are not well understood.

FIGURE 1. Modelling process.



Methods

Previous Work:

- We found an association between the seasonality of number of fires (N_f) and PM_{10}.
- Anomalously high PM_{10} concentrations (Nov-Apr) are more prevalent when air masses came from the northeastern region of South America (NESA). Fires are typically clustered in NESA [1]

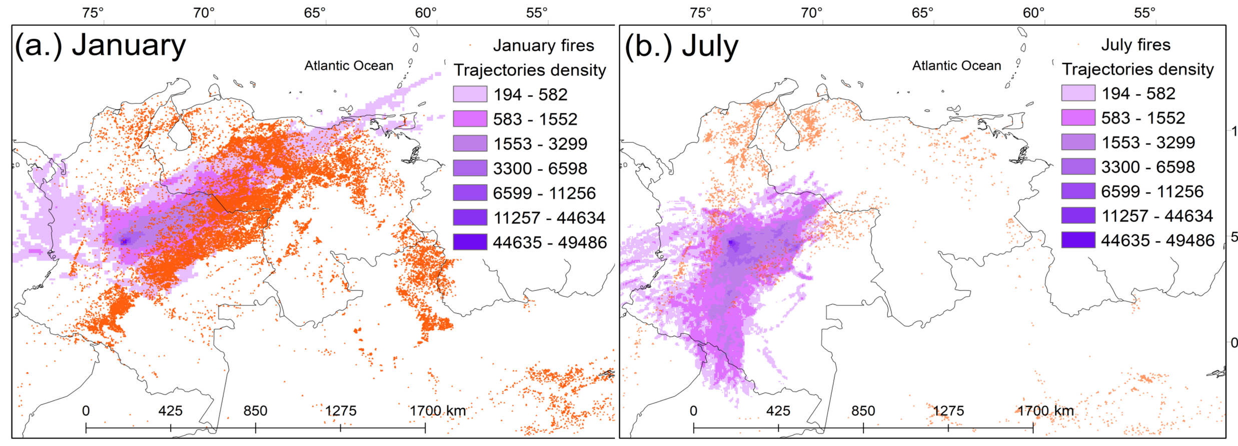


FIGURE 2. HYSPLIT back trajectories density and MODIS Hot spots (orange dots) for the period 2006 -2016. The arrival point for the back trajectories is Bogotá at 500m AGL. (a.) January. (b.) July [1]

1. Experimental design – Choosing analysis periods

FIGURE 3. Number of fires per year.*

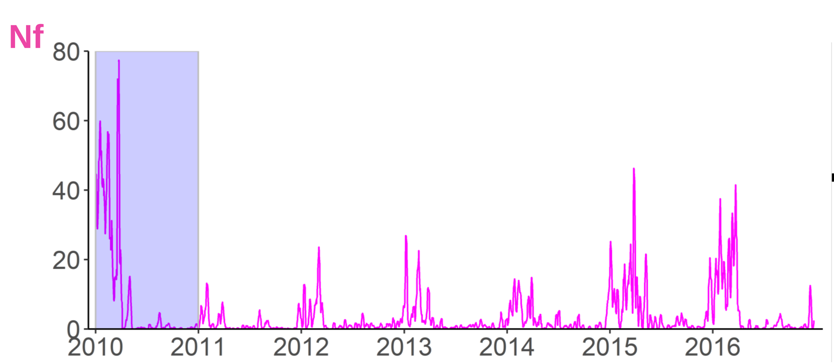
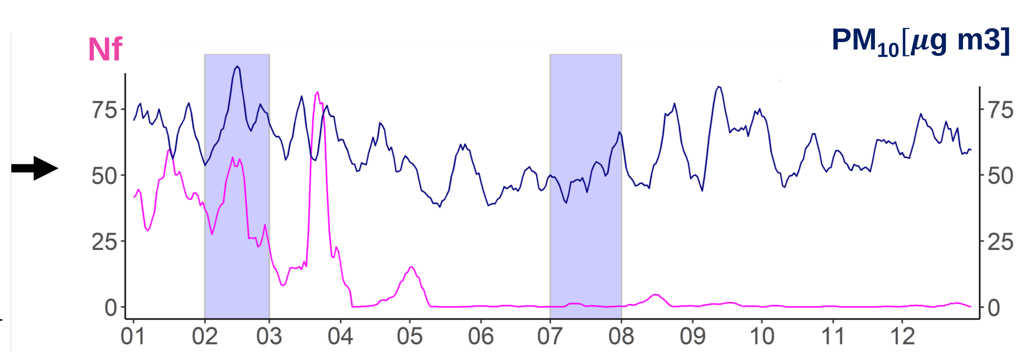


FIGURE 4. Time series of number of fires (Nf) and PM10**



*Centered moving average of a variable x with a window of 7 days

2. WRF-Chem model configuration

FIGURE 5. Model domain centered in Colombia (lat. 5.194, long. -73.522) .

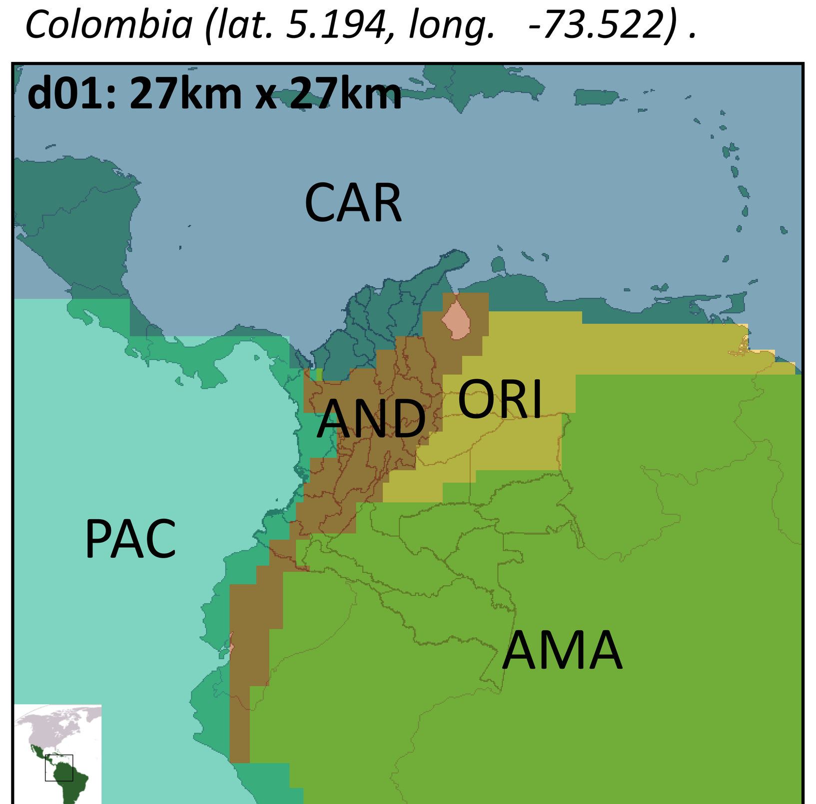


TABLE 1. Seven scenarios using different biomass burning emissions spatial distribution.

Scenarios	Fire Emissions
NOFIRE	No fire emissions
FIRE	All domain
ORI	Orinoco Only
AMA	Amazonian only
CAR	Caribbean only
AND	Andean only
PAC	Pacific only

TABLE 2. Selected physics and chemical options for WRF-Chem

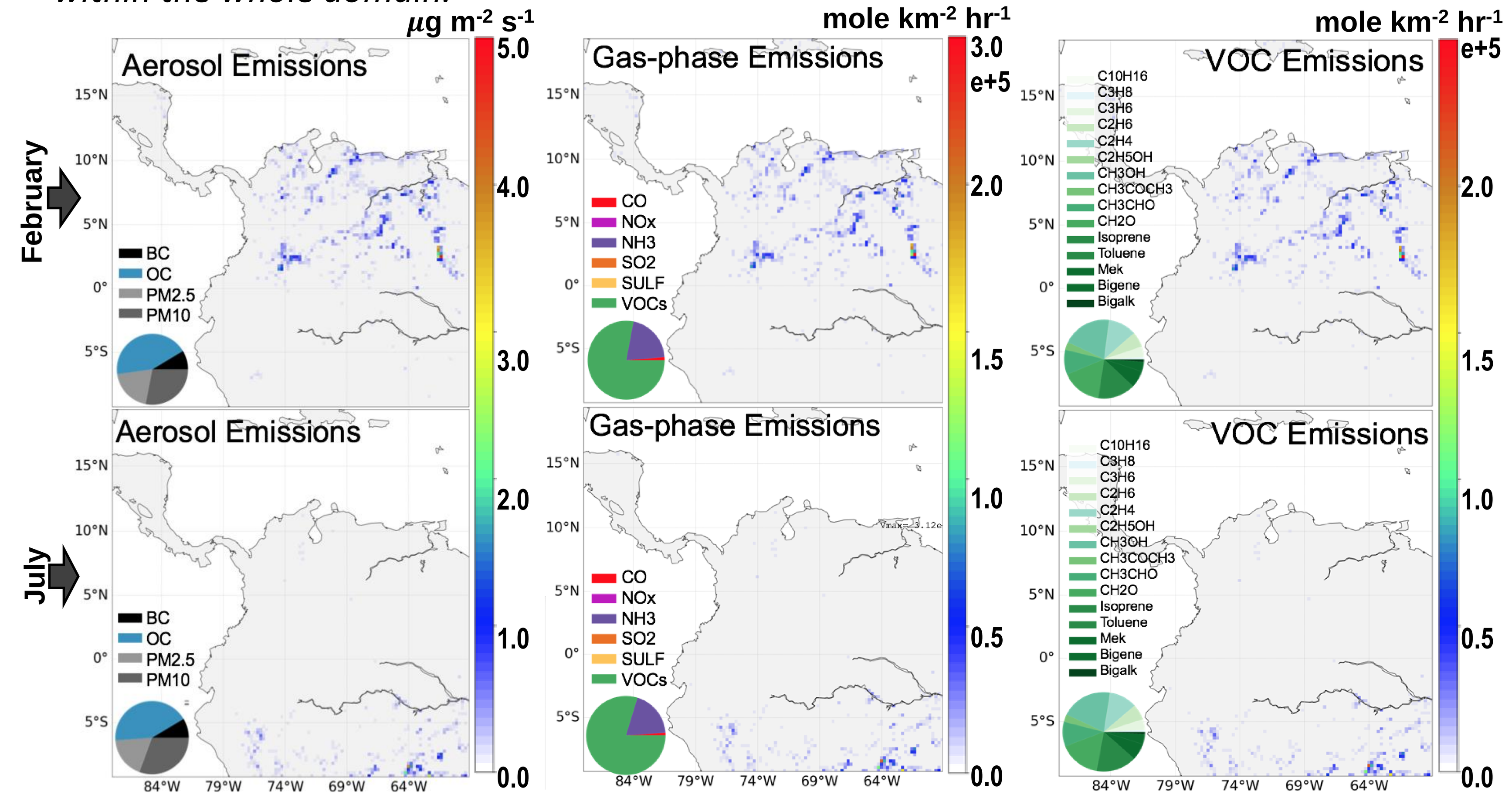
Parametrizations	
Microphysics	Lin et al., (1983)
L/W Surface	Noah LSM
Cu. param.	Grell-Devenyi
Gas-ph chem	MOZART
Aerosol sche.	MOSAIC-4Bins

- **121 x 121 grid cells & 41 vertical levels.**
- 24 hours spin-up.
- MOZART4 was used for chemical boundary and initial conditions.

Results

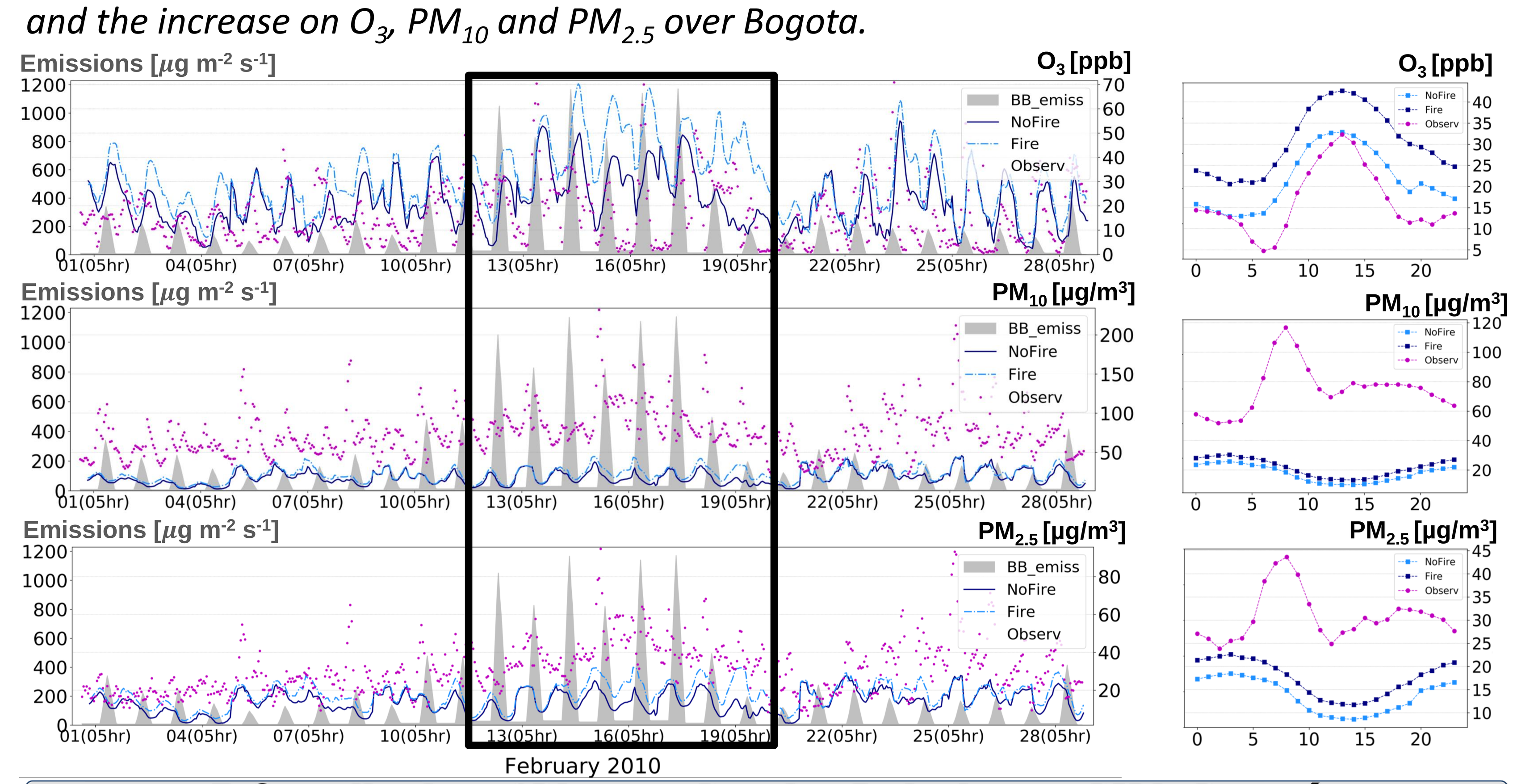
3. Biomass Burning Emissions (BBE)

FIGURE 6. Monthly averaged biomass burning emissions in µg m^{-2} s^{-1} of aerosols and mole km^{-2} hr^{-1} of Gases. February 2010 (top) and July 2010 (bottom). Composition of emissions within the whole domain.



4. Comparison with observations

FIGURE 7. Time series show correlation between the high BB events during Februery2010 and the increase on O_3, PM_{10} and $PM_{2.5}$ over Bogota.



5. Contribution of Biomass Burning Emissions to PM in Bogotá

FIGURE 8. SOA can explain ~20% of the difference between FIRE and NOFIRES simulations in Bogotá.

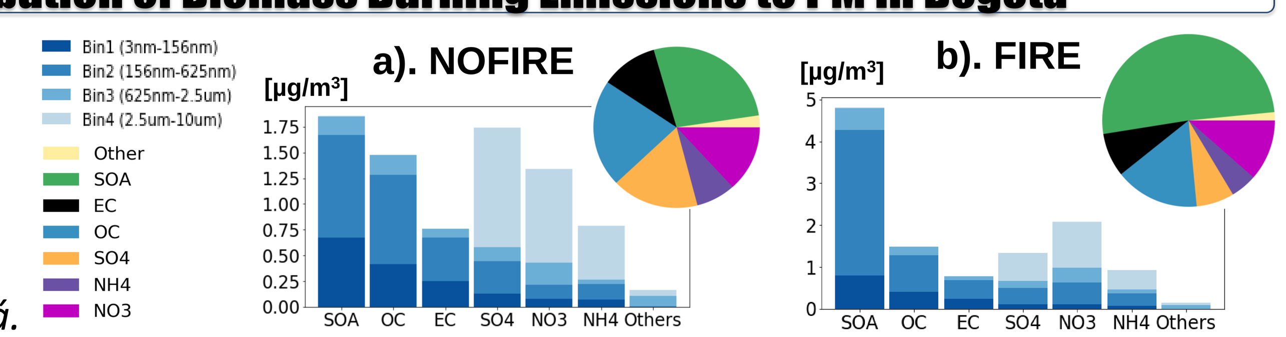
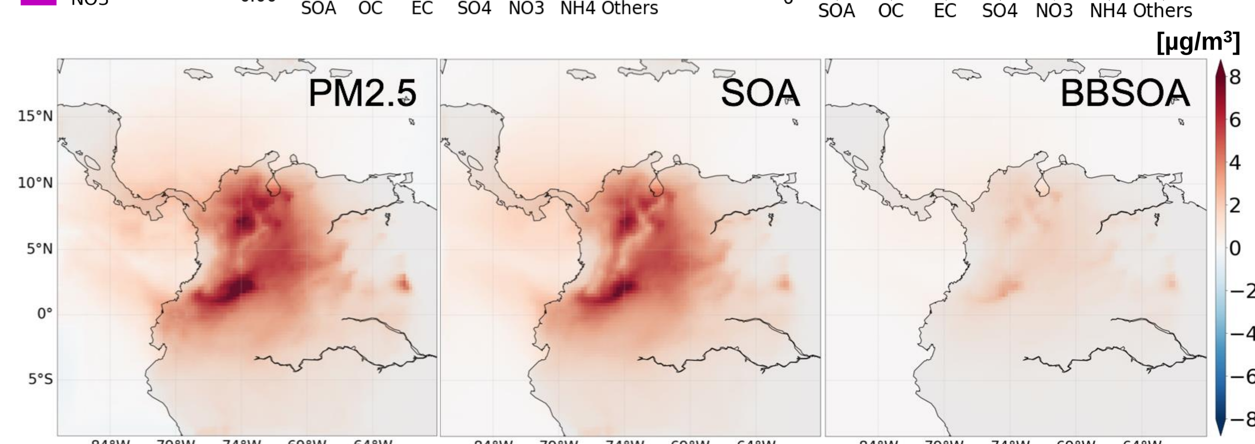


FIGURE 9. Differences between FIRE-NOFIRE of $PM_{2.5}$, SOA, and BBSOA concentrations.



5. Contribution of PM from Biomass Burning Emissions

FIGURE 10. Spatial attribution of the SOA contribution in different Colombian cities.

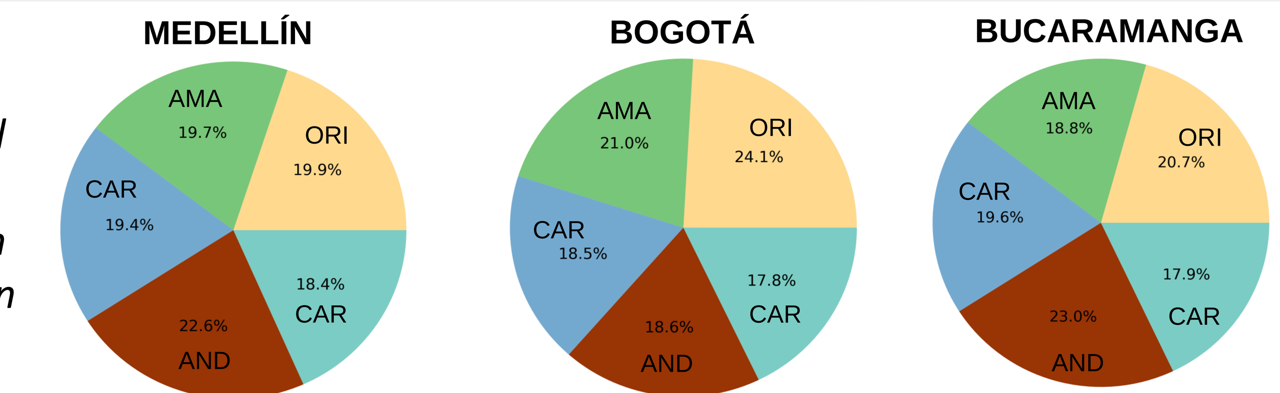
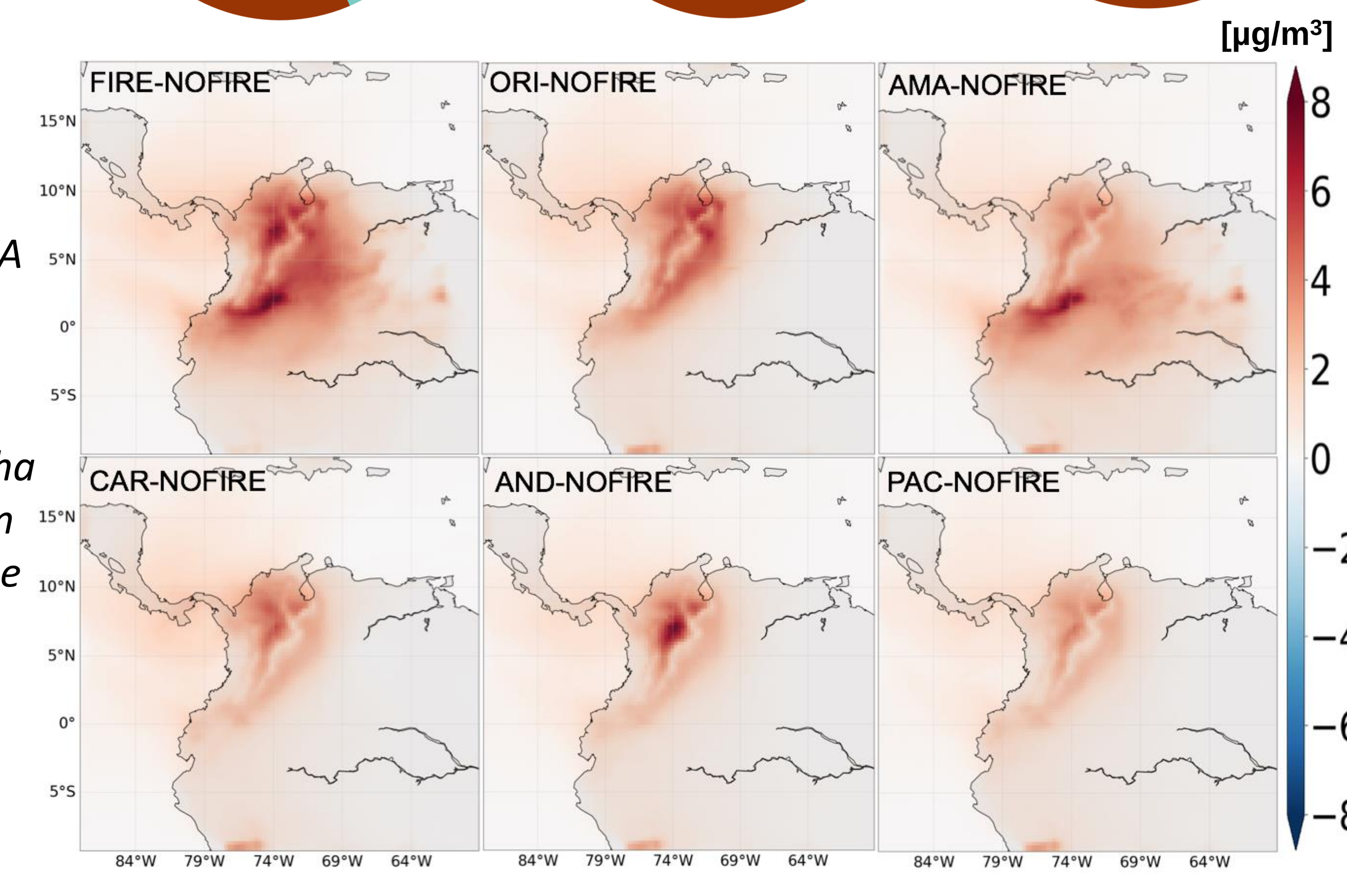
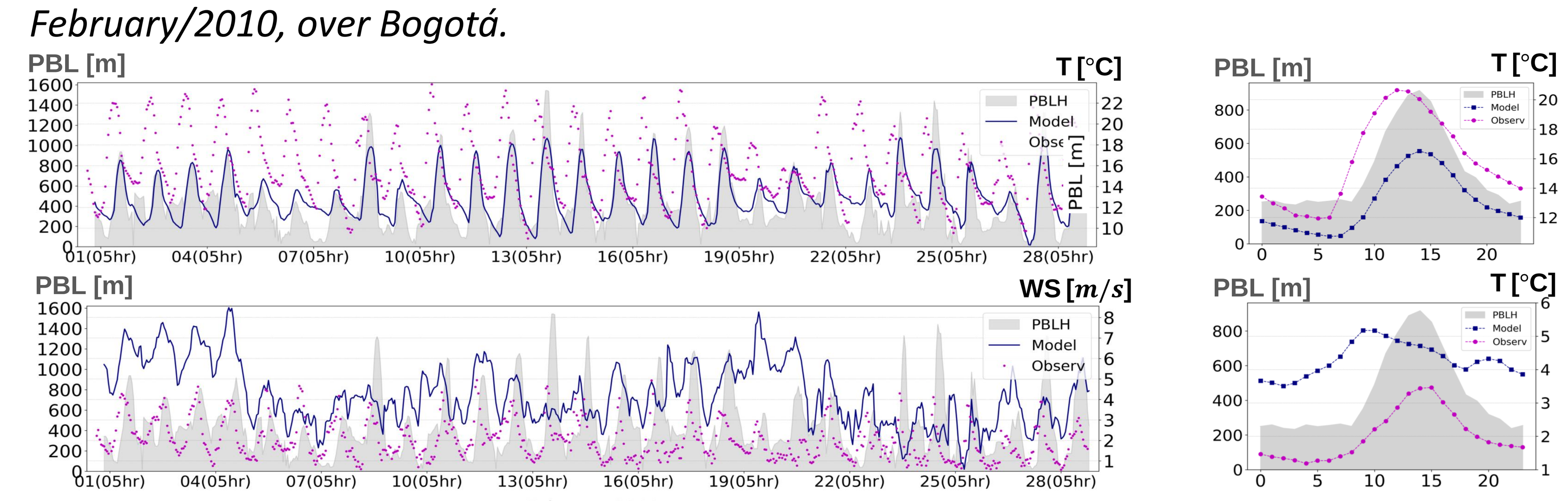


FIGURE 11. SOA differences between SCENARIO-NOFIRE show tha the contribution of PM cannot be only explain by BBSOA.



6. Meteorological Performance

FIGURE 12. Time series comparison shows that simulations underpredict temperature and overpredict wind speed (right). Hourly average of temperature and wind speed (left). During February/2010, over Bogotá.



Concluding remarks

- Biomass burning emissions are a significant source of SOA in Bogotá.
- Our results show an increase of 23% and 27% of the total mass concentration of PM_{10} and $PM_{2.5}$ respectively during burning periods (February/2010) in Bogotá.
- Meteorological behaviors are well represented by the model. PM behavior is highly influenced by PBL height.
- Further evaluation to determine the cause of vertical structure of aerosol is needed.
- WRF-Chem was implemented using the reviewed version of global emissions inventory EDGAR HTAP 2010 by Pena-Perez.

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