Monitoring the behavior of atmospheric aerosols during a biomass burning event

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ABSTRACT

- Global aerosol characterizations generally show that aerosols emitted by anthropogenic activities and aerosols from biomass burning represent the higher percentage of emissions in North, South Asia, South America, and South Africa.
- This work aims to characterize the aerosols from the agricultural burning of sugar cane throughout the Valle del Cauca. The characterization considers the patterns of weather variables and the topography of the region. The work was carried out collaboratively with entities such as ASOCAÑA, Cenicaña, and the Universidad del Valle. In this way, it was possible to access historical data on controlled burns, access to data from meteorological stations, and PM10, PM2.5 stations. The characterization was based on the results of multivariate analysis, identification of PM10 Concentration, and trajectory analysis with Hysplit.

OBJECTIVES

- To detect spatial patterns on PM10 data during controlled sugarcane burning events.
- • To identify the role of the wind (speed and direction) on the PM spatial and temporal patterns.

STUDY ZONE AND DATA

- Sugarcane burning is a practice still used in the Cauca Valley. In this valley, there is around 250,000 ha of sugarcane crops, almost 70% of the total sugarcane area in Colombia. The Cauca Valley is a plateau in the middle of Central and Western mountain range, located in the west of Colombia. Sugarcane burning is a practice used for making harvest most accessible for people in charge of manual cutting. In 1993, Cenicaña installed a weather network to monitor wind conditions and make decisions about the correct time for burning. Furthermore, Cenicaña administers a Particulate Matter (PM) network that registers PM10 and PM2.5 in six locations along the valley (Fig. 1). The data available at each station corresponds to hourly registers of PM 10, temperature, precipitation, solar radiation, and wind speed and direction.

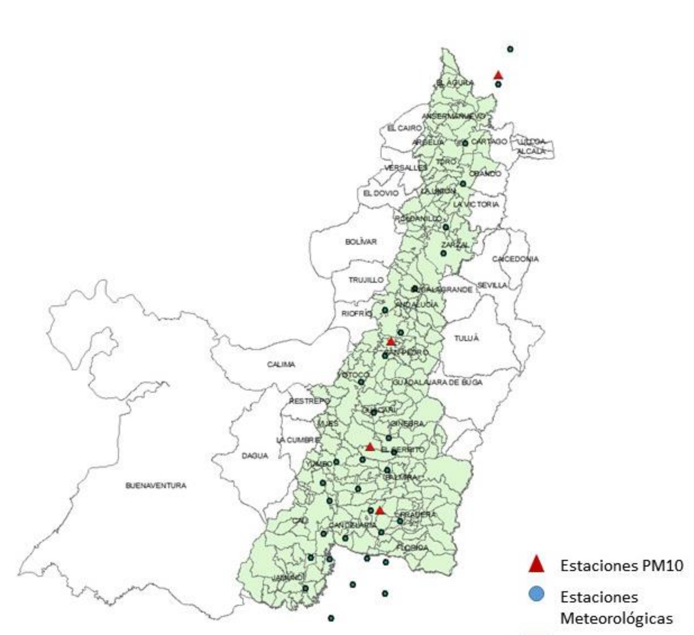

Fig. 1..Distribution of PM10 stations and meteorological stations in the study area.

METHODS

The methodology was divided into 4 stages (Fig. 2). In a first stage, the information corresponding to: records of controlled burns and fires supplied by Asocaña, PM10 and PM2.5 records were provided by the Autonomous Corporation of the West CVC and meteorological data was provided by Cenicaña. The different records were stored in a Database, with the compatible structure to work in R with the Openair library.

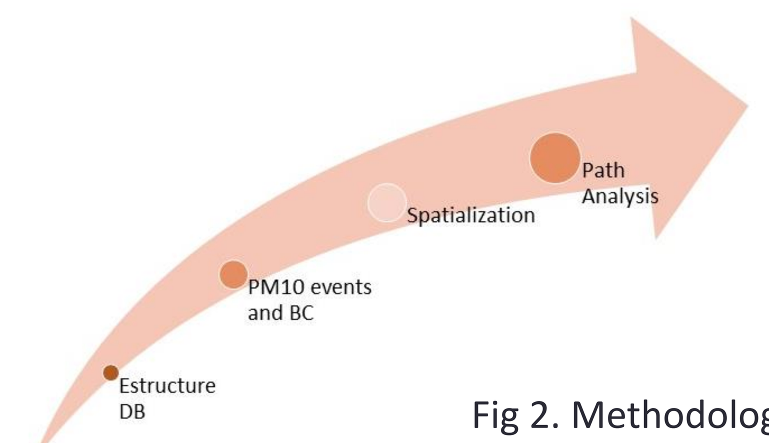

Fig 2. Methodology

- To identify PM10 events and their relationship with CB, different descriptive and multivariate statistical analysis methods were used, with time series, average behavior and trends from the Theilsen method, this allowed analysis by year, month, day, and time, for each variable. All these processes were carried out with the Openair de R library.
- The spatialization of PM10 events was performed in QGIS, for them it was necessary to structure a database including the coordinates of each of the PM10 stations and meteorological stations, allowing queries for each event. Wind maps were developed in ArcGIS.
- The analysis of trajectories was carried out with the Hysplit trajectory set option, for a time of 24 hours once the event started.

RESULTS AND DISCUSSION

The trend graphs Figure. 3, shows a decrease in controlled cane burning and an increase in PM10 during the analysis period 2013-2019.

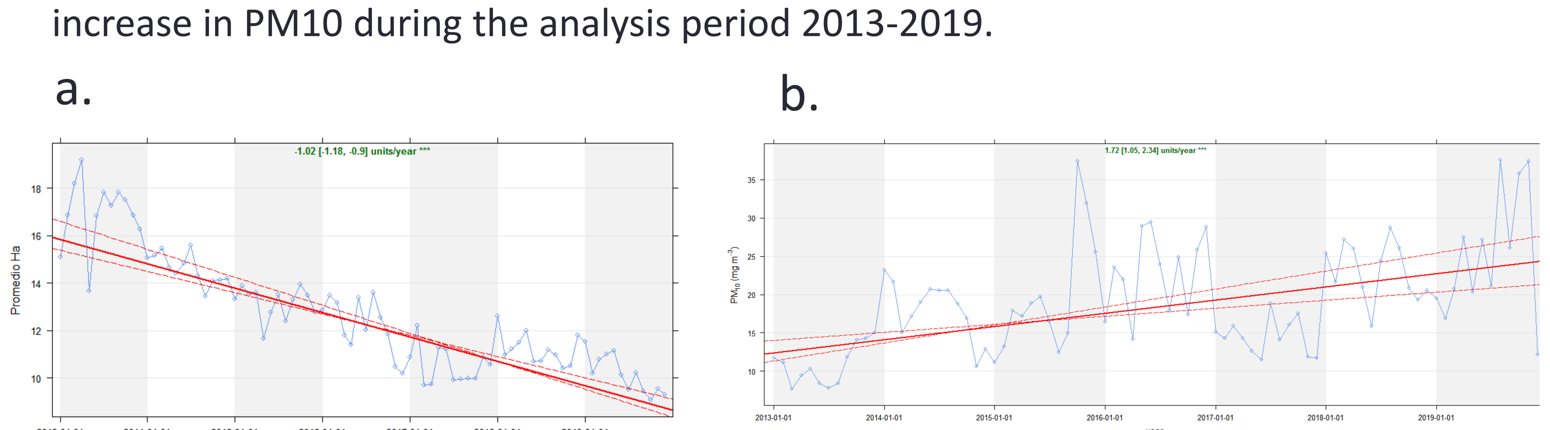

Fig. 3-a. Controlled Cane Burning trend behavior. In Fig. 3-b, PM10 trend behavior.

The study identifies PM10 events and whether they are related to Controlled Burns. Fig. 4 shows a PM10 event presented on 12-09-2013, starting at 17 UTC. Having coincidence with CB carried out on the same dates.

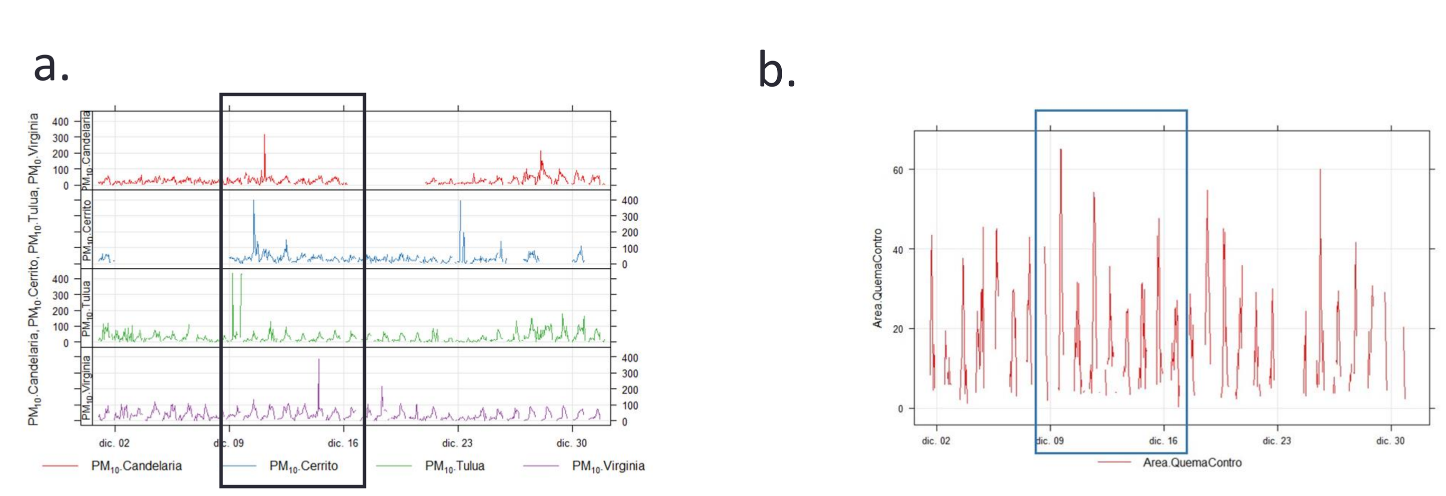

Fig. 4-a. PM event recorded in the second week of December 2013. 4-b. Controlled Burning (CB) carried out in the second week of December 2013.

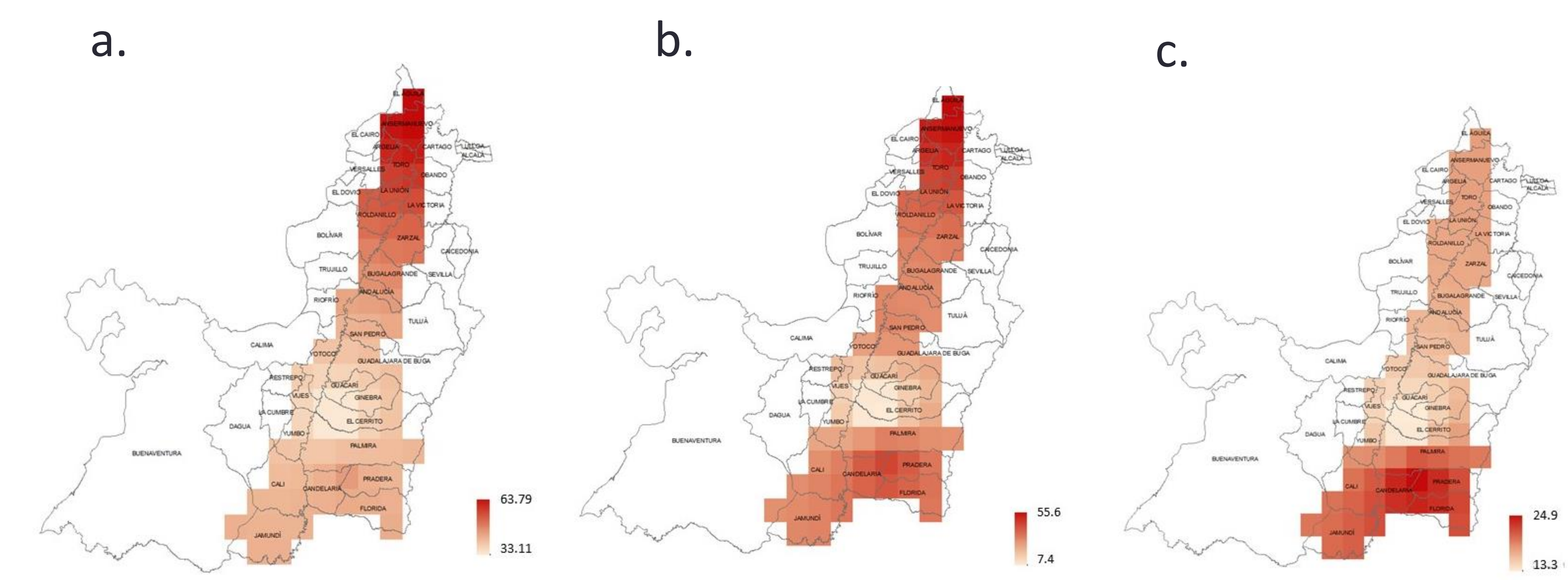

Fig. 5-a. PM10-17UTC behavior. 5-b. PM10 Behavior - 21 UTC, 5-c. PM10 behavior - 23 UTC. The maps are made from the interpolation of the data from the PM10 stations located In-situ.in situ.

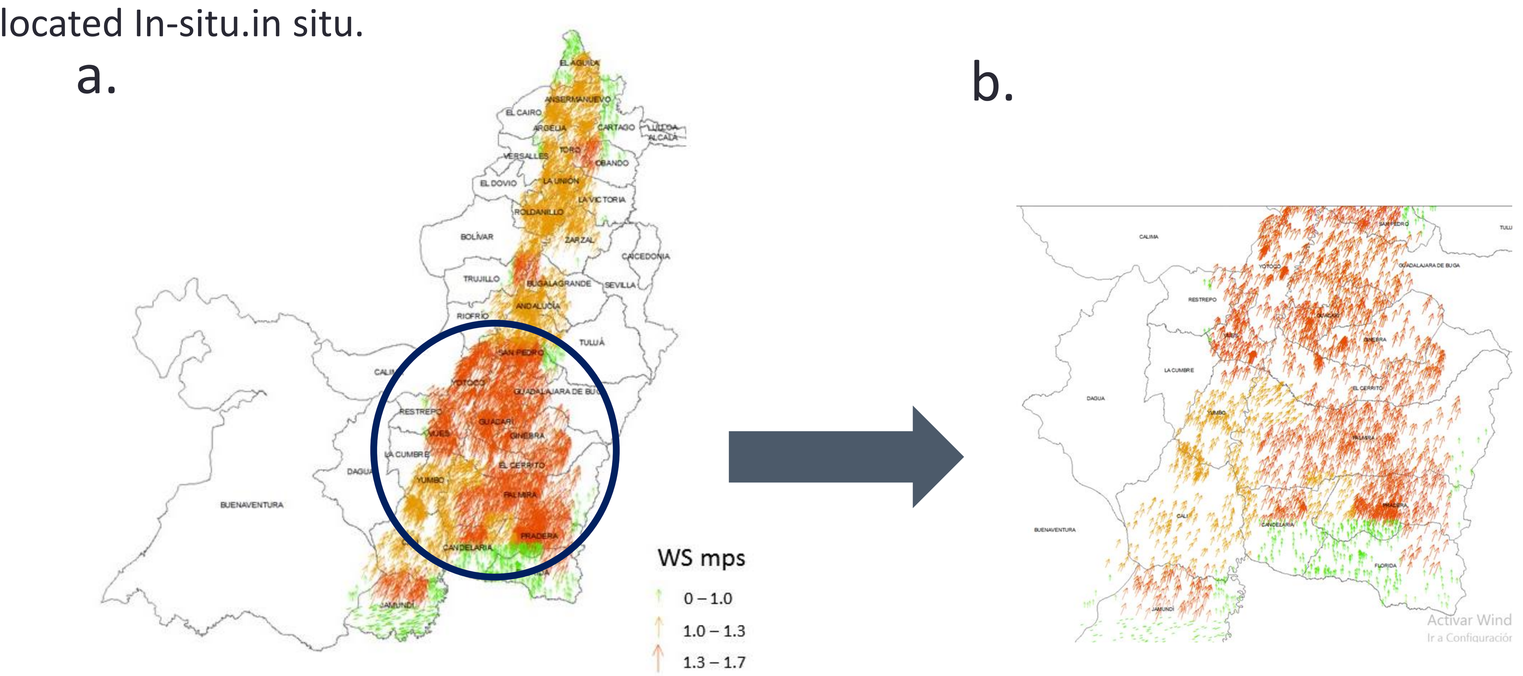

Fig. 6-a. Direction Behavior and Wind Speed 6h after the event started. 6-b. Wind behavior approach, wind direction SN.

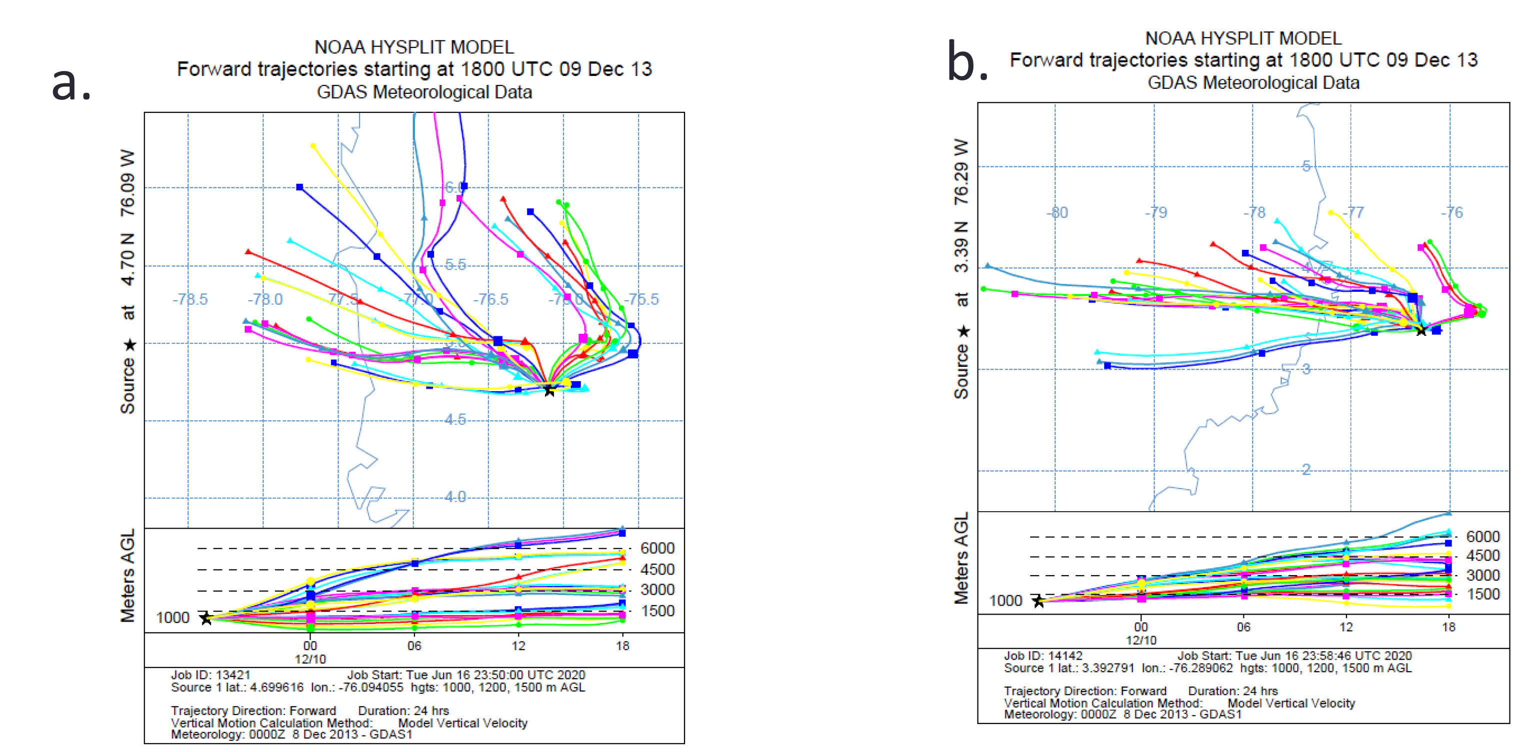

Fig. 7-a. Trajectories of the winds in 24 hours, in the area where the CB started. 7-b. Wind path in a 24h period in the area where the second concentration of PM10 occurs. Source: https://ready.arl.noaa.gov/

CONCLUSIONS

The particulate material from controlled cane burning lasts for 4 hours. This is due to the topography that is the geographic valley of the Cauca River, and the winds. However, for this study, the trajectory analysis was very important, because it allows visualizing the directions of the winds in much longer periods. In Fig. 7 it is visualized how in the two concentration points of PM10, a group of wind trajectories move towards the West and another group of trajectories go to the East, hitting the mountain range and heading Northwest. This allows for a comprehensive complement to the study that has been carried out.