Quantification of emission sources apportionment to the concentration of PM2.5 in Temuco, Chile, using receptor model.

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ABSTRACT

In this study the composition of particulate matter was characterized in relation to it's sources from concentrations of compounds it is formed. The registry samples were obtained in the monitoring station of monitoring called Las Encinas, located in Temuco's City, Chile. Fifty samples were collected, from August 18th to October 6th, during part of winter and spring time in 2008. Also, 51 samples were collected between January 27th and March 21st in 2009, during summer season in Chile. Software UNMIX was used to identify and quantification of main sources of PM10 and PM2.5 during monitoring period, by receptor model and multivariable analysis. During period of Winter-Spring a high correlation between potassium and calcium was found, as well as between potassium and rubidium. On the other side, during summer a distinguished correlation between chlorine and sodium was observed. The results of exploration analysis predict that the vegetal material combustion or wood burning plus suspended particulate are the principal sources of PM2.5 in Winter-Spring in 2008. In addition, 3 sources for PM2.5 were found, being two of them the mentioned before, plus a third which represent salt material because of Na and Cl results, in summer of 2009.

Finally, the conclusions obtained were confirmed with simulation of wind direction and speed in Temuco's city, using WRF model meteorology. The marine source mentioned before was validated by this way. Also, this study showed the air emission inventories in Temuco, Chile, have to be compared with receptor model studies on this area.

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INTRODUCTION

Air pollution by particulate matter in the South of Chile is observed during winter season, especially during low temperature periods. Temuco, located in Region of Araucania is one of the cities where that situation takes place, with a lot of frequency of overcoming of the national standard limit. World of Health Organization considers Temuco is actually in the list of 20th cities with the most air quality problem in America.





Figure 1. Location of Temuco, Chile, in South Hemisphere In that city, measurements of particulate matter (PM10) have been done since 1997, changing to continuous monitoring since 2000. The zone was declared as saturated by PM10 because of the high levels of that pollutant obtained during that period. By other side, an air decontamination plan for PM2.5 was elaborated by authorities and was approved recently in 2015. Many studies were developed since 2000, including air emission inventories in 2005. According to that, 90 % of contribution to PM2.5 can be related to residential wood combustion. The second source was agricultural burning, which only 2 % of contribution. Those results were questioned by some considerations and high uncertainty. The continuous monitoring showed a high contribution of these sources especially during winter, but the real input information was not available for other seasons.

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METHODOLOGY

The first action was to measure particulate matter during diferent time periods to stablish any variation on its characterization. IMPROVE sampler and Teflon filter of 25 mm were used to monitoring samples. The elements were detected by spectrometryXRF in Crocker Nuclear of Davis UC Laboratory. The elemental species of the measurements were as following: Na, Al, Mg, Si, P, S, Cl, K, Ca, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, As, Pb, Se, Br, Rb, Sr y Zr.

Usually, receptor models are used to identify and quantify the contributions of sources to particulate matter and organic volatile compounds, based on its chemical composition. The stages developed in this study are observed in figure 2.

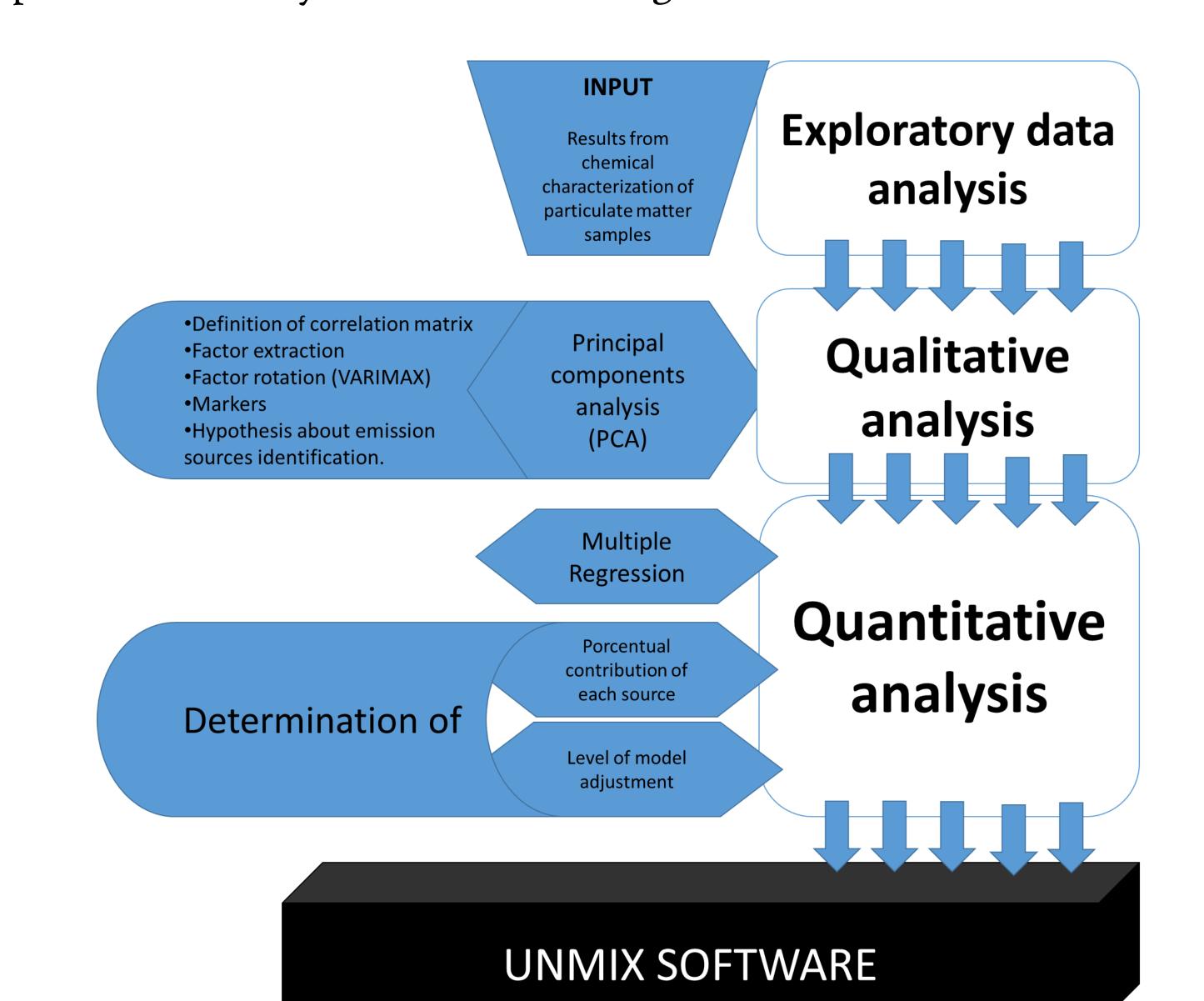
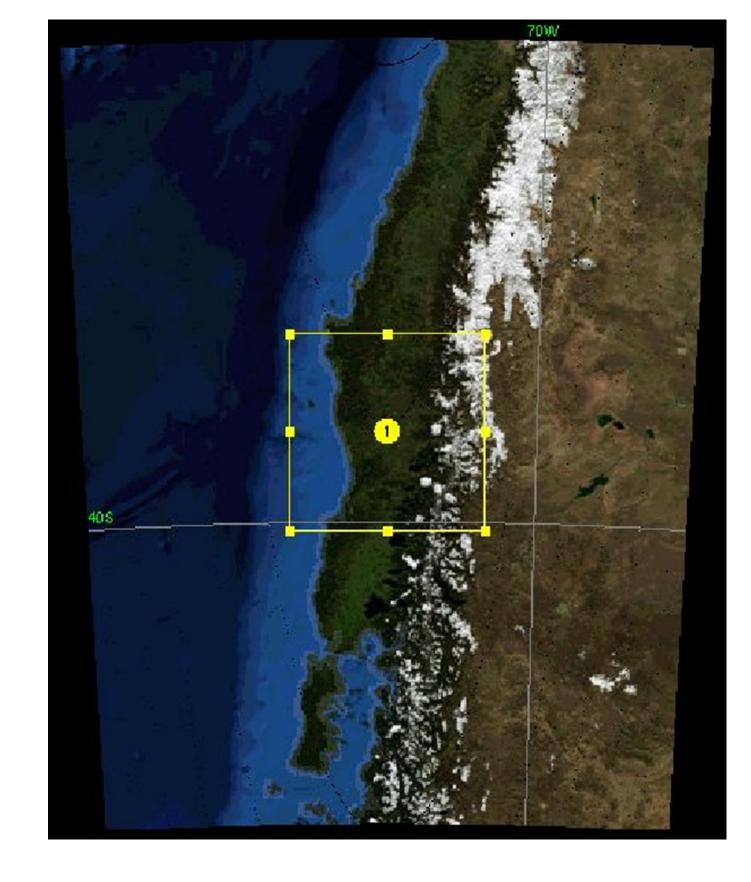


Figure 2. Process to obtain the input data to analyze in receptor model.

Multivariable model UNMIX, developed by USEPA in 2000, applies different algorithms to obtain the pollutant distribution in the atmosphere. This method is able to identify a high number of sources, using a big data sample from the particulate matter chracterization stage as a requirement (Henry, 2005).

UNMIX model considers constant the composition of emission sources throw the monitoring time. Also, the sources profiles are linearity independent and the chemical species do not react each other (linerity principle). The number of sources or categories must be less or equal to the number of analyzed species to use UNMIX. (Bruinen de Bruin, 2006).



WRF inputs

Map Projection	Lambert
Latitude	38.749 ^o South
Longitude	72.621 ^o West
Grid Size	9 km x 9 km
Micro physics	Single-moment 3-class and 5-class Schemes
ca_lw_physics	Dudhia
a_sw_physics	RRTM
sf_sfclay_physics	MM5 Similarity Scheme
sf_surface_physics	Unified Noah Land Surface Model
ol_pbl_physics	Yonsei University Scheme (YSU)
cu_physics	Kain-Fritsch Scheme

Figure3 Map Projection used in WRF.

Table 1 WRF model physics options

Meteorological conditions in Temuco, were simulated using WRFV3.5.3.1 model. It's results showed information about wind direction and speed, correlated with real values. Las Encinas Station is located in the coordinates showed in table 1.

Results obtained using UNMIX model showed two sources during Spring - Winter (2008) period in Temuco, Chile. In other way, the data for Summer 2009 concluded the particulate matter is generated from 3 emission sources.



Figure 4 Number of emission sources to PM2.5 in Temuco, Chile

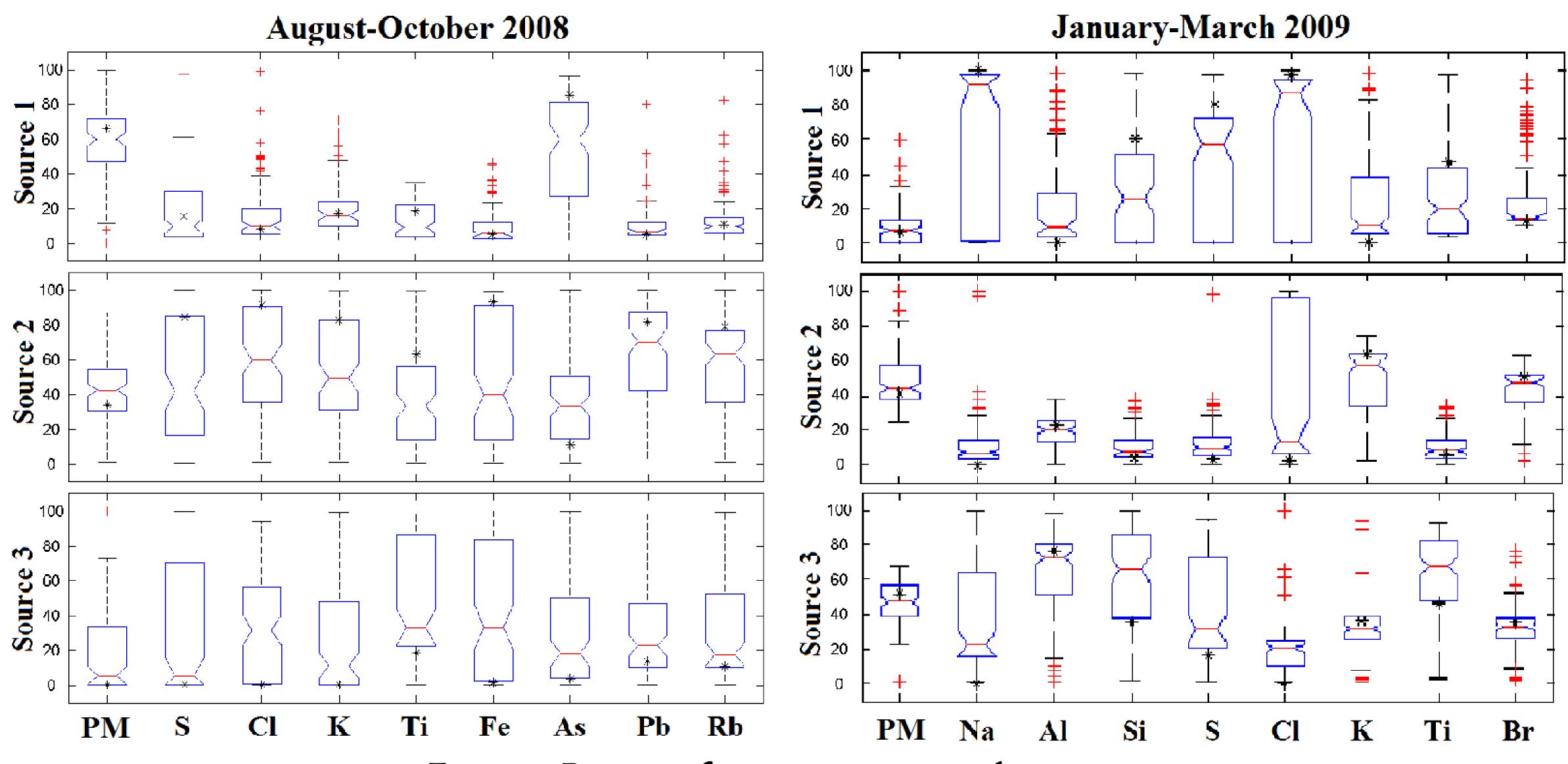
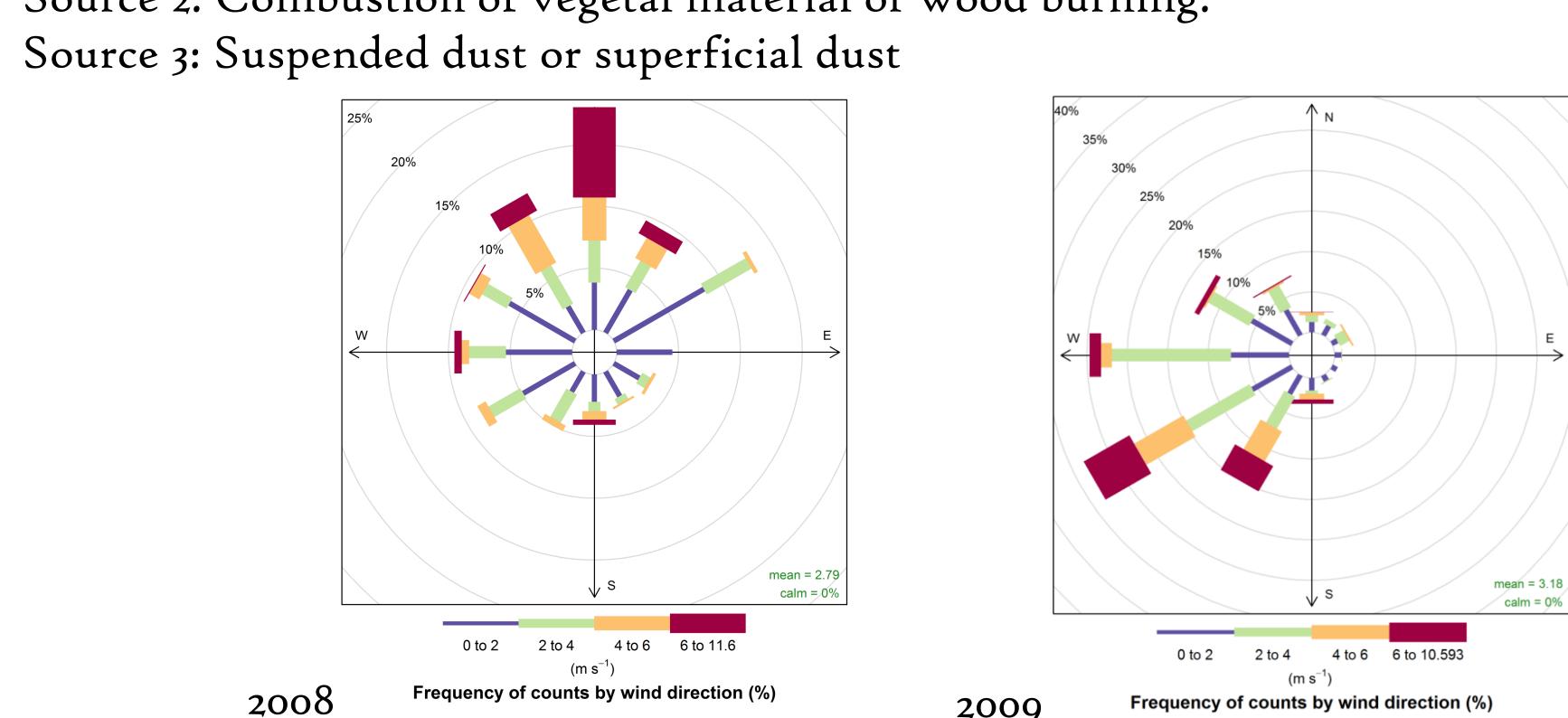


Figure 5. Percent of species apportioned to source.

Studying the chemical profile of the particulate matter observed in figure 5, the main sources are: .2008

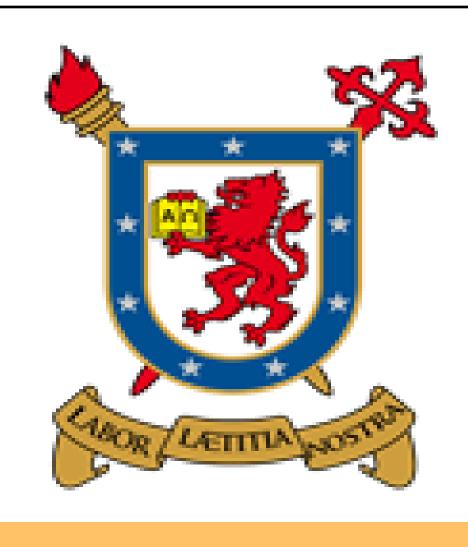
.2009

Source 1: Combustion of vegetal material or wood burning. Source 2: Suspended dust or superficial dust. Source 1: Marine dust or salt material. Source 2: Combustion of vegetal material or wood burning.



The chemical characterization of particulate matter samples brings information about the quantification of the emission sources of air pollution in Temuco City. In this case, the antropogenic activities plus geography and meteorological conditions imply the main factors to consider. In this study, the meteorological simulation using WRF model y, represented an initial step to obtain air quality modelling for future studies in this city of Chile.

• Henry, R. (2005). Duality in multivariate receptor models. Chemometric and intelligent Laboratory Systems. • Bruinen de Bruin, K. Y.-T. (2006). A review of: source apportionment techniques and marker substances available for identification of personal exposure, indoor and autdoor sources of chemicals. JRC-European Commission



RESULTS AND DISCUSSION

Figure 6. Windrose obtained using WRF model.

CONCLUSIONS

REFERENCES