

The contribution of large-scale atmospheric patterns to pollution with PM10: the new Saharan Oscillation Index

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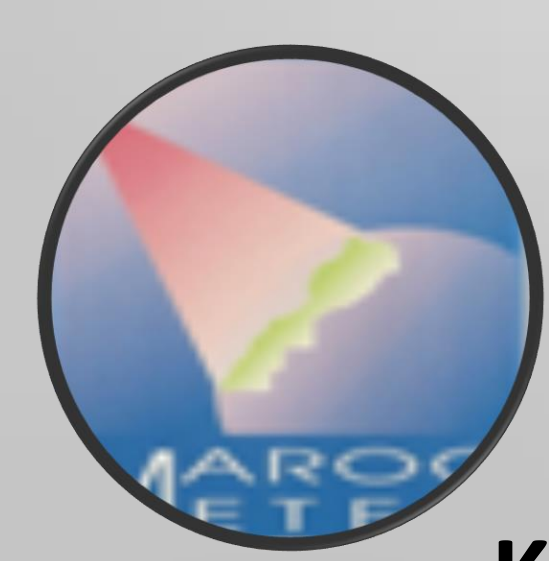
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Abstract

PM10 has natural and anthropogenic sources, it is an urban air pollutant from desertic areas or emitted by industry and traffic activities, it reduces visibility and threatens human wellbeing mainly in big cities. Casablanca concentrates many industrial units and a large vehicle fleet. The rate of urbanization in the metropolis and the population density are the highest in Morocco. Marrakech is one of the most populated cities in the country where the motorization rate has increased during recent years. The present work is based on PM10 daily measurements between 2013 and 2016. The main objective is to assess the concentrations of PM10 in Casablanca and Marrakech and study their relationship with the atmospheric circulation. First, we assessed PM10 correlations with climate indexes (NAO and MO), then we characterized the contribution of large-scale atmospheric patterns related to PM10 extreme events. The novelty of this research is the creation of a new climate index to characterize the oscillation, in the country's southern desert, between the Saharan depression and the Azores high. The time series of the new Saharan Oscillation Index (SaOI) were calculated. This study has demonstrated the relationship between MO and PM10 averages and has shown that particulate pollution in the study area is partly induced by continental northeasterly to southwesterly flow. This flow is triggered by the Saharan trough and managed by the high-pressure area in the north. The assessed correlations related to the SaOI confirm the relationship between this index, PM10 averages, and MO and NAO indexes mainly in winter. The Saharan Oscillation is the new relevant key to understand worldwide pollution by fine particles.



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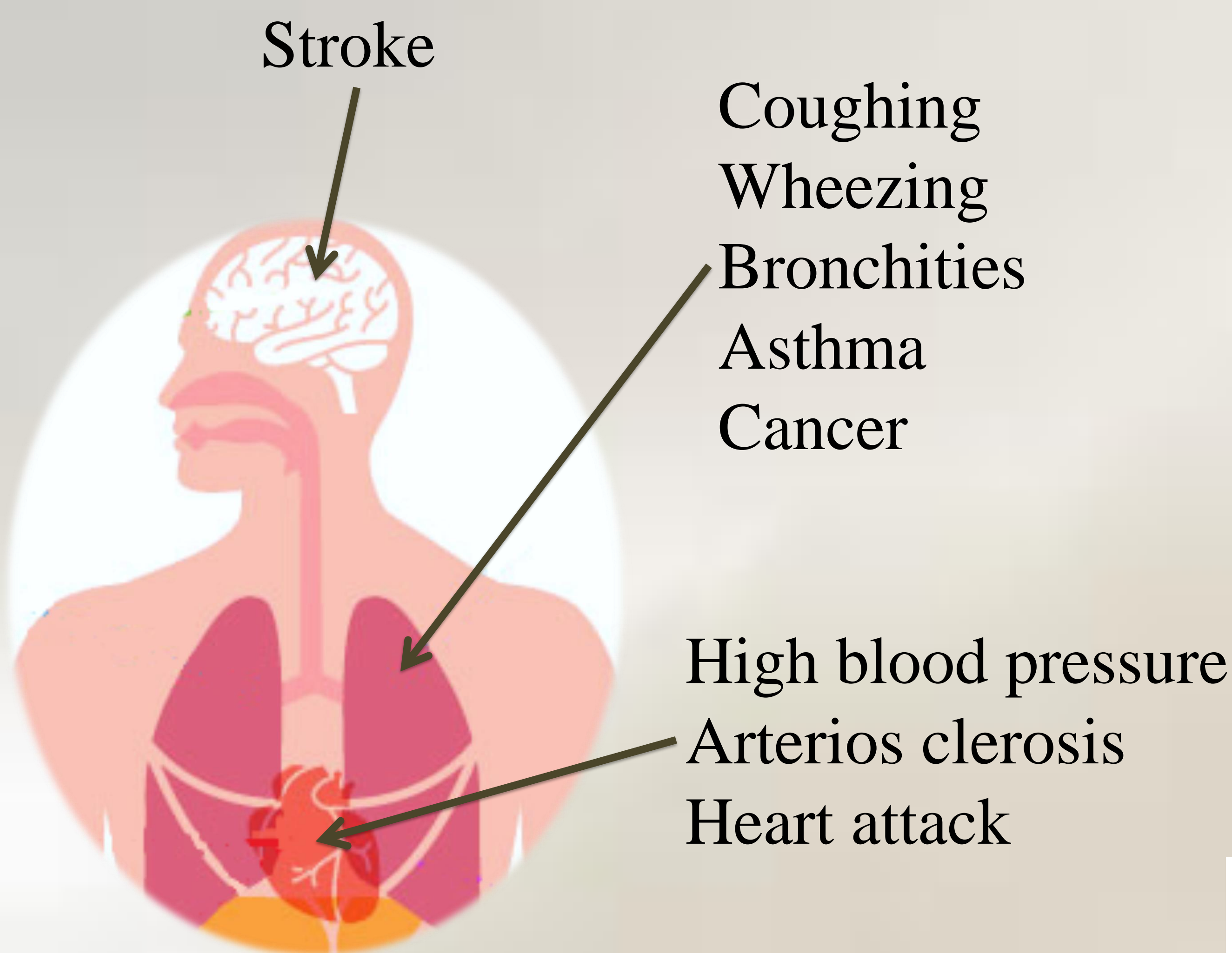
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The Matter



Particule
Pollution



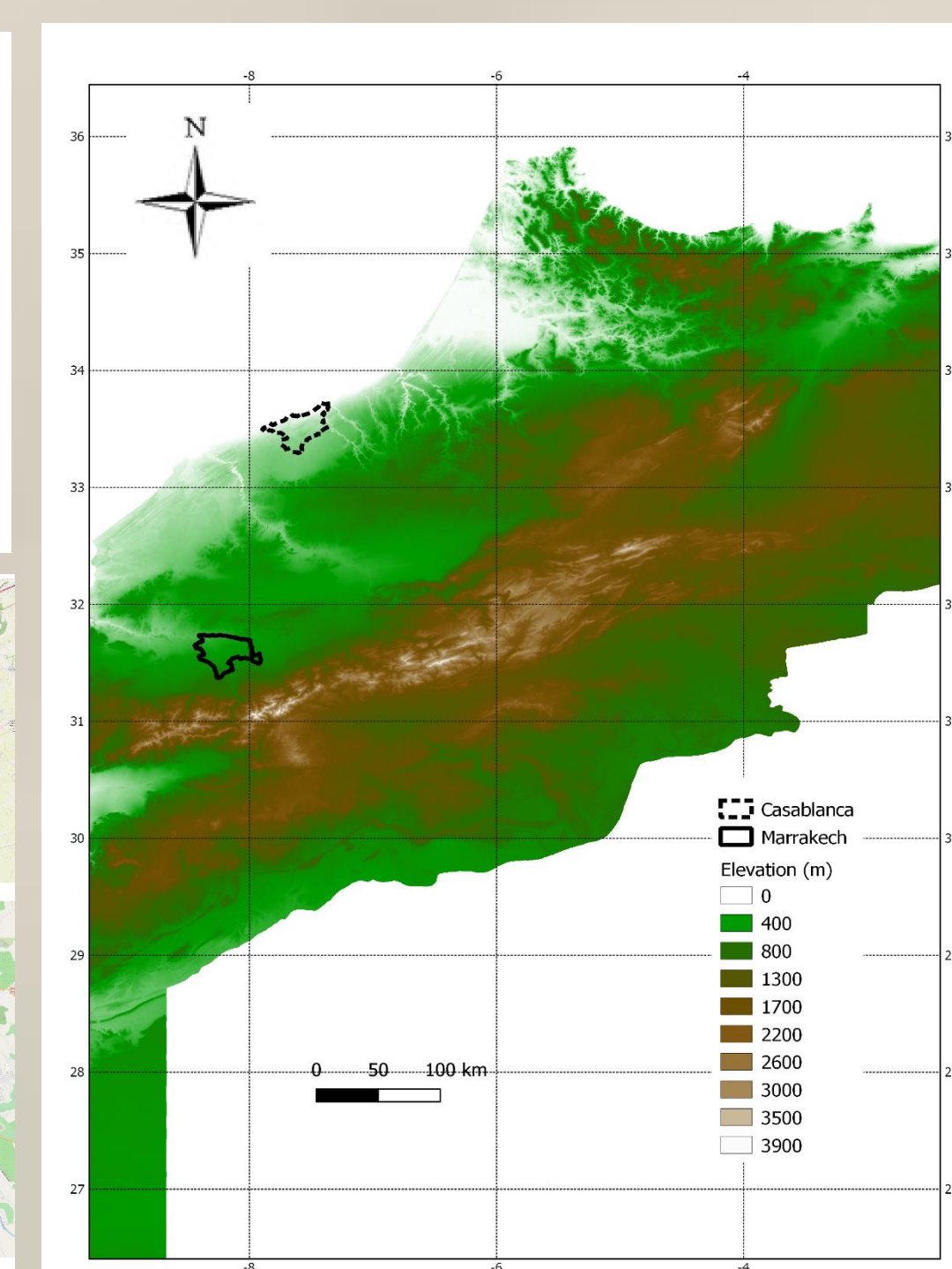
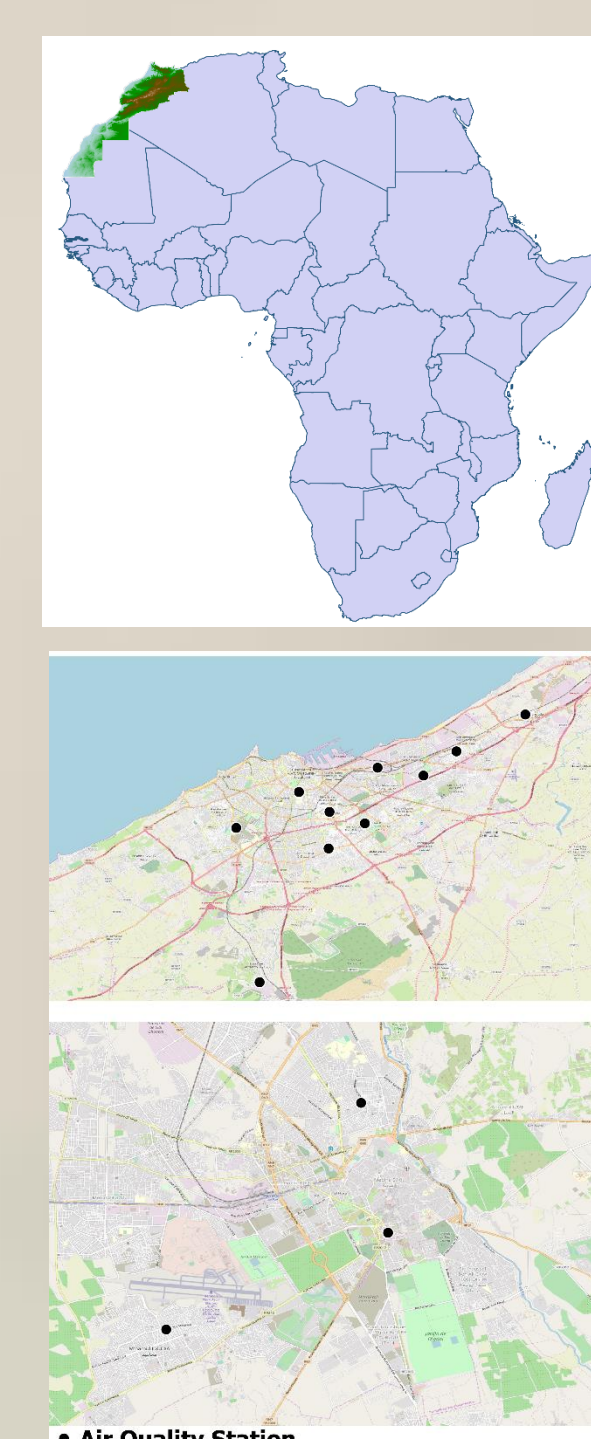
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The Aim

The assessment of the PM₁₀ concentrations in Morocco and the study of their relationship with climate indexes and the general circulation, in order to better understand and handle their effects on human health.

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The Area



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The Tools

- Daily Means of PM₁₀ concentrations;
- Annual data of NAO and MO indexes;
- Sea Level Pressure (SLP) data;
- Statistical approach.

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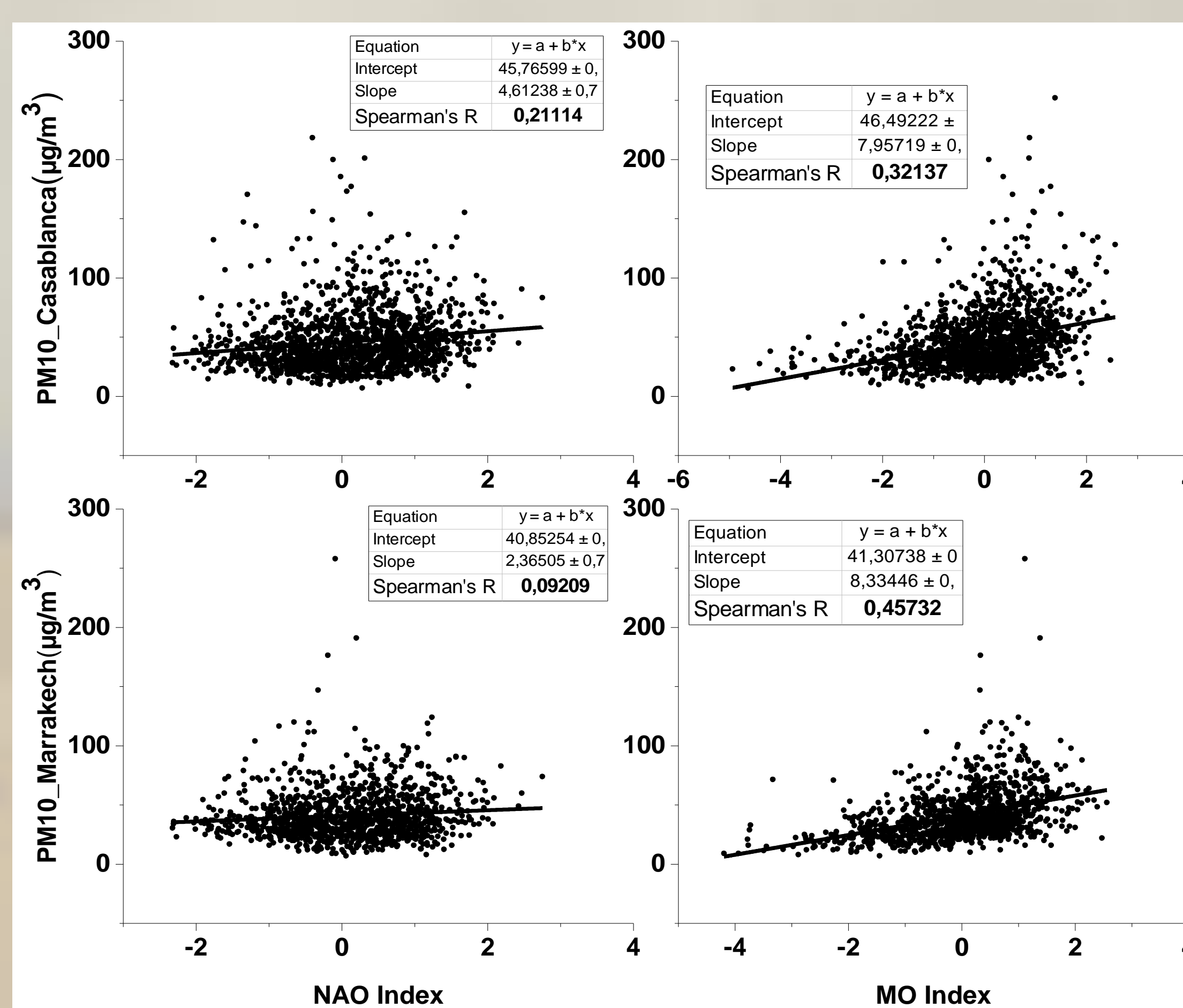
The Period

The study was performed on daily basis between 2013 and 2016.

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The Results

PM₁₀ concentrations depend on the city, PM local sources and seasonal meteorological parameters.

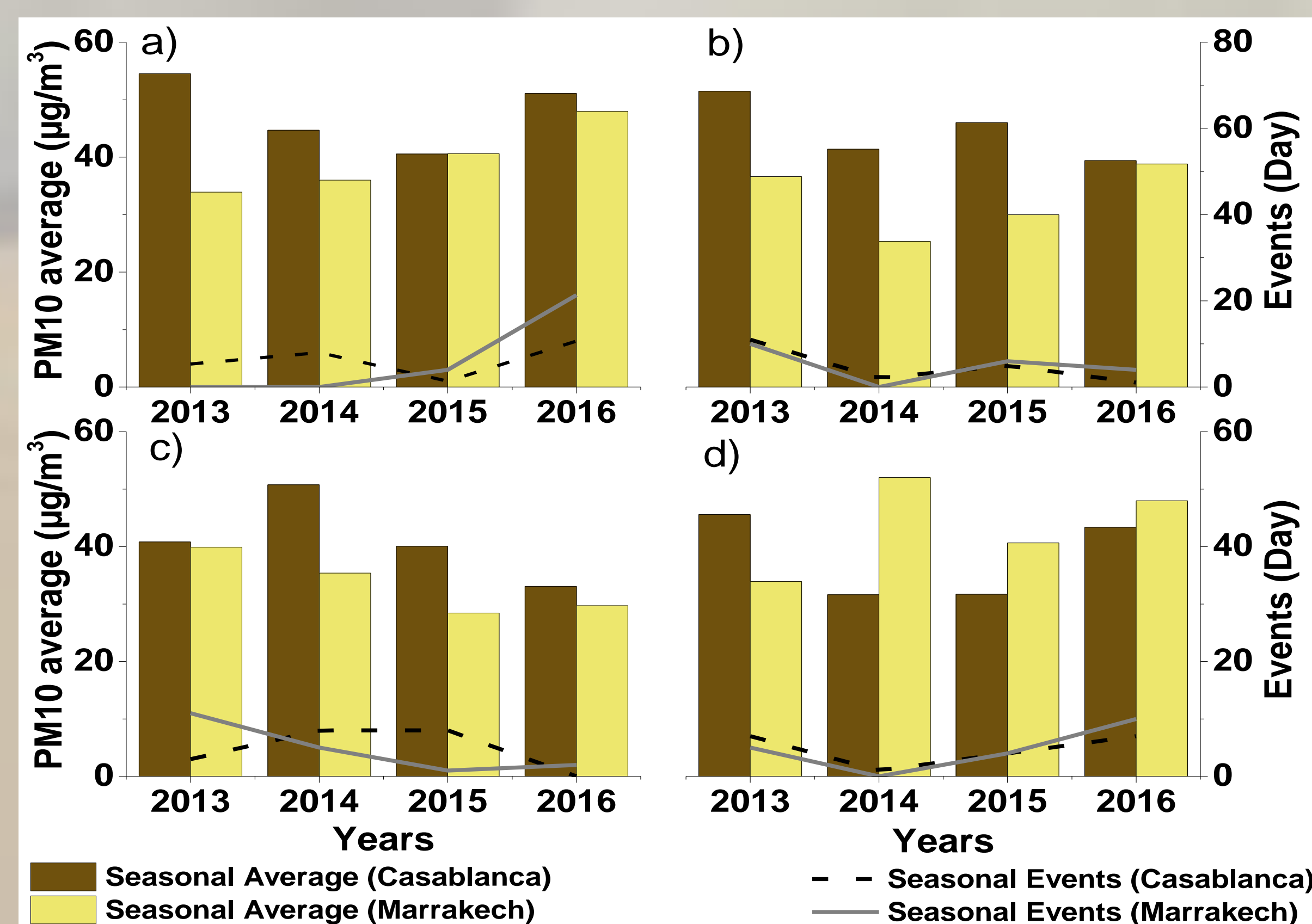


Correlation between annual NAO, MO and PM10 averages
Spearman's coefficient is significant in all cases

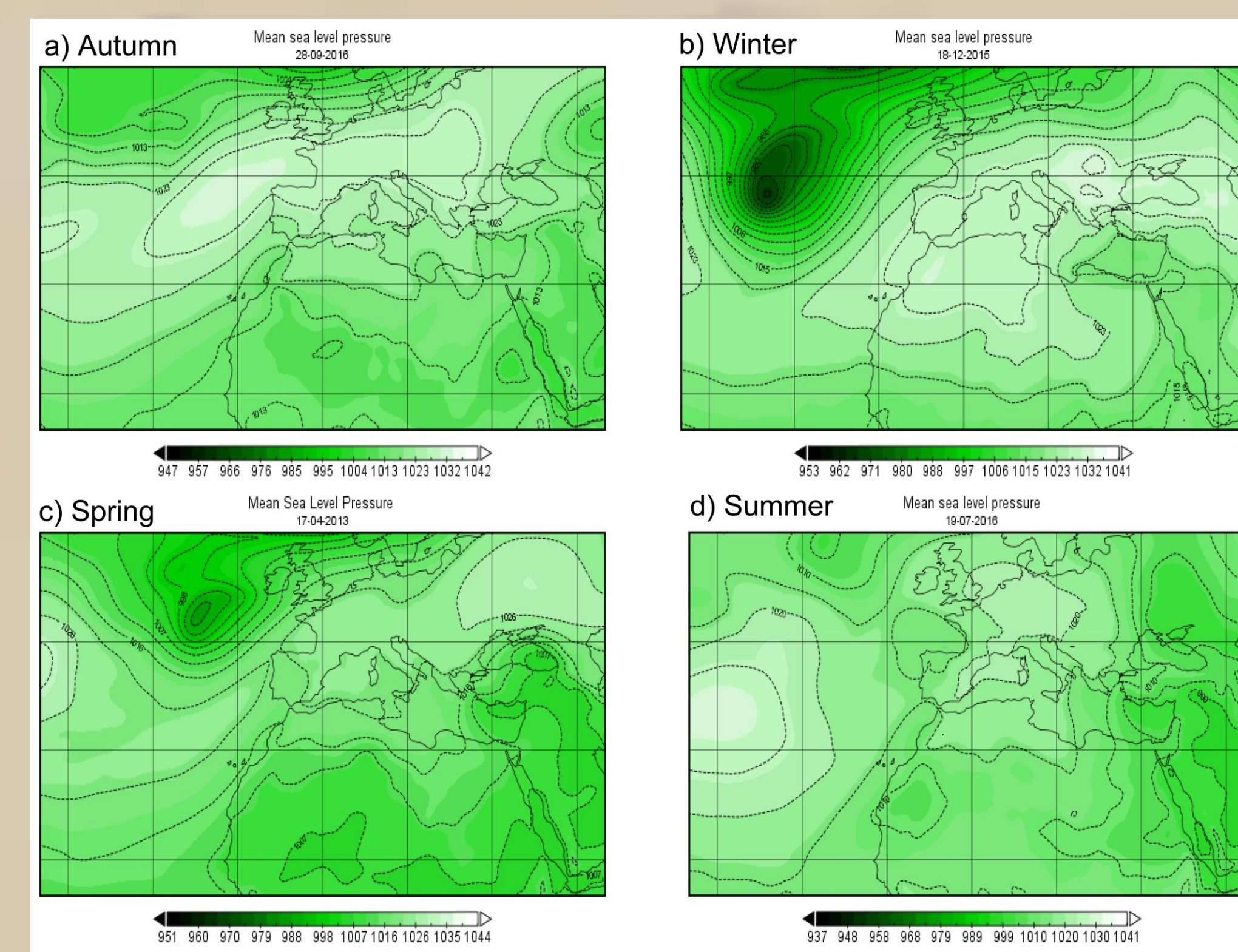
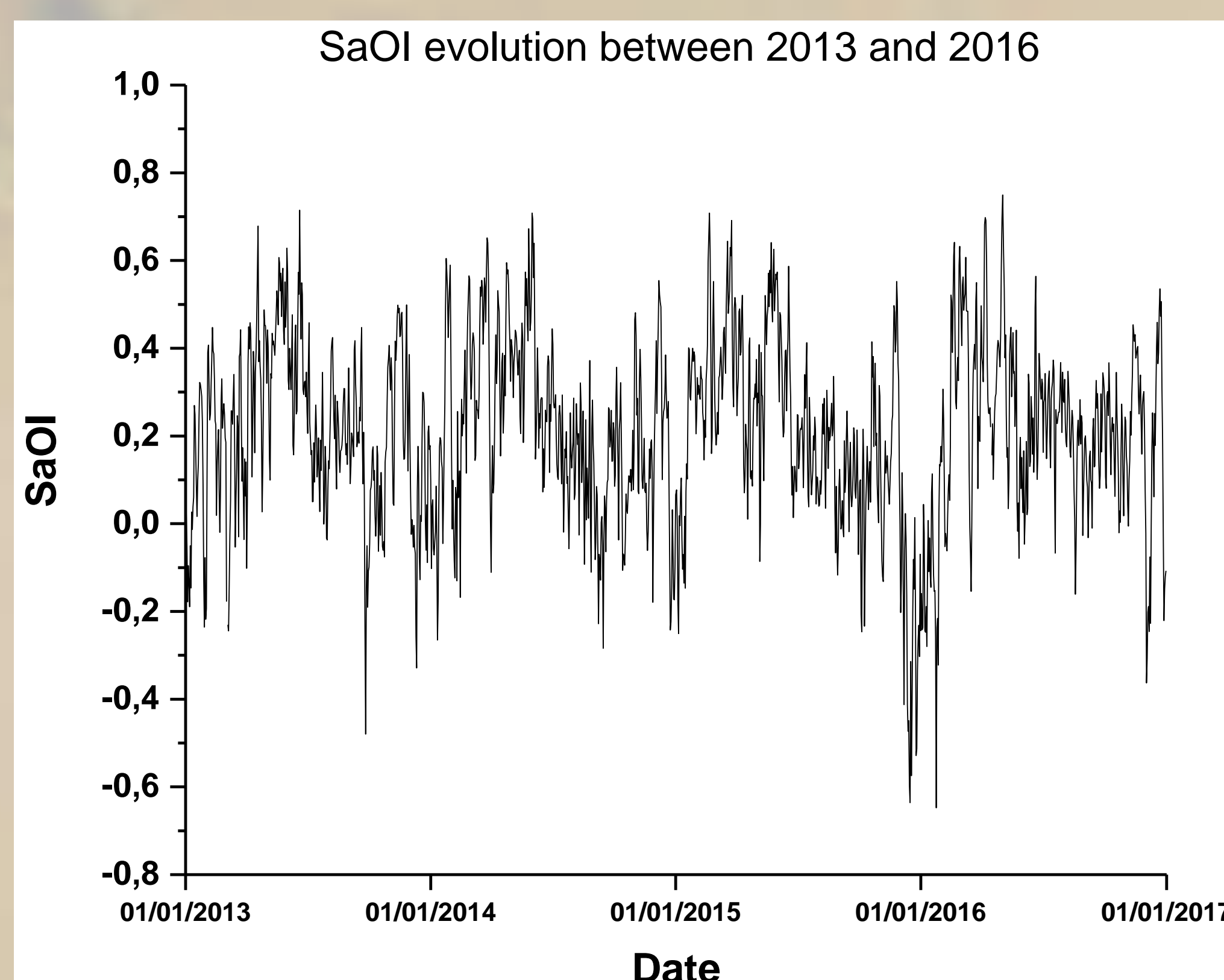
NAO and MO relate to PM₁₀ averages in both cities.

MO plays a major role in particle pollution in Morocco.

The Dipole between the Azores High and the Saharan Depression (the Saharan Oscillation (SaO)) may also play a role.



Evolution of seasonal PM10 averages and extreme events
a) autumn, b) winter, c) spring, d) summer



$SaOI_d = Pn_d(Azores) - Pn_d(Niamey)$
SaOI_d: daily Saharan Oscillation Index
Pn_d: daily normalized pressure between 2013 and 2016
Formulation of the new Saharan Oscillation Index (SaOI)

7 The References

Khoms, K., Najmi, H., Chelhaoui, Y., & Souhaili, Z. (2020). Assessment of the large-scale atmospheric patterns to pollution with PM10: the contribution of the new Saharan Oscillation Index. Submitted to: Aerosol and Air Quality Research Journal

Spearman coefficient of correlation between annual and seasonal PM₁₀ averages and Climate Indexes (NAO, MO and SaOI)
Bold Character: Coefficient is statistically significant, Significance level = 0.05

Site	Annual			Autumn			Winter			Spring			Summer		
	NAO	MO	SaOI	NAO	MO	SaOI	NAO	MO	SaOI	NAO	MO	SaOI	NAO	MO	SaOI
Casablanca	0.21	0.32	-0.17	0.12	0.42	0.13	0.00	0.56	-0.42	0.15	0.31	-0.13	0.07	0.35	0.01
Marrakech	0.09	0.46	-0.26	0.16	0.46	0.03	0.06	0.53	-0.52	0.10	0.40	-0.18	0.12	0.29	-0.07
NAO	-	-	0.19	-	-	0.31	-	-	0.24	-	-	0.23	-	-	0.26
MO	-	-	-0.04	-	-	0.04	-	-	-0.24	-	-	0.10	-	-	0.03