

# Influence of the WeMO and NAO decadal trends on the airborne pollen levels recorded in Catalonia (NW Mediterranean basin)

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## Abstract

Airborne pollen records constitute a powerful tool for different purposes. First, in studies of dispersion and source identification of pollen grains, which, incorporated into the atmosphere by anemophilous plants, produce allergic symptoms in a part of the population sensitive to it. On the other hand, aerobiological databases provide useful information for the understanding of the trends induced by the climate change. The decadal series allow the extraction of patterns with intra-annual variability (seasonality of the events and their relationship with the atmospheric transport patterns) and inter-annual variability (inter-annual trends and its possible relationship with climatic variability indexes). The longer the aerobiological monitoring series the better the understanding of the effects of climate change on pollination trends.

The aim of this study is to explore the influence of climate change on the airborne pollen series recorded in Catalonia during the period 1994-2012 by the analysis of its correlation with both, the North Atlantic Oscillation (NAO) and the new regional teleconnection Western Mediterranean Oscillation (WeMO) defined within the synoptic framework of the western Mediterranean basin [1].

**Keywords:** climate change, atmosphere, NAO, WeMO; airborne pollen records.

## 1. Introduction

It is well known that aerobiological databases provide useful information to study the trends induced by climate change [2] and that the Iberian Peninsula is strongly influenced by the NAO (North Atlantic Oscillation) as well as by the new index WeMO (Western Mediterranean Oscillation), defined using the dipole Cadiz, (Spain) – Padua (Italy). A WeMO positive phase coincides with more important rainfall episodes in the Spanish Cantabric coast than in the Mediterranean one, being the fluxes over Catalonia mostly from the N. A WeMO negative phase is produced when an anticyclone is situated in central Europe and the N of Italy and low pressures occur in the SW Iberian Peninsula. In this negative phase, fluxes over Catalonia are predominantly from the Mediterranean Sea and N Africa and wetter conditions occur over the eastern coast of the Iberian Peninsula and the Ebro basin.

The influence of climate change on the airborne pollen series recorded in Catalonia during the 18-year period 1994-2011 is explored by the analysis of its correlation with both, the NAO index and the new regional teleconnection WeMO index, defined within the synoptic framework of the western Mediterranean basin [1].

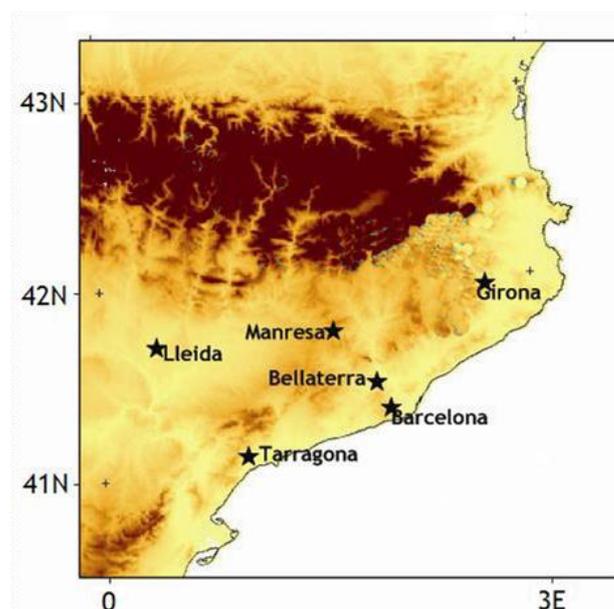
## 2. Methodology & Data

### 2.1. Pollen record

Airborne pollen data were recorded for the period 1994 – 2011 by the Aerobiological Network of Catalonia (XAC) using standardized samplers [3] and analysis methods [4] at the six stations located in Barcelona, Bellaterra, Girona, Lleida, Manresa, and Tarragona (Figures 1&2). Eleven relevant pollen taxa from the landscape point of view were tested: *Pinus*, Total *Quercus*, *Quercus* evergreen type, *Quercus* deciduous type, *Betula*, *Fagus*, *Corylus*, *Pistacia*, *Artemisia*, Poaceae and Chenopodiaceae/Amaranthaceae.



*Figure 1. An automatic volumetric spore trap*



*Figure 2. Six stations of the Aerobiological Network of Catalonia (XAC)*

## 2.2. Statistical methods

The *Spearman's rank correlation coefficient* and the *Kendall's  $\tau$  test* were applied to detect the correlations between airborne pollen data and the NAO and WeMO indices, annual and winter (DJFM), as well as between NAO and WeMO indices

## 3. Results

The NAO and WeMO indices in winter had a positive bivariate correlation with significance at the 0,01 level. Weakly and non-significant positive correlation resulted between their annual values.

*Table 1. Significant correlations between airborne pollen data and the NAO and WeMO indices*

		Barcelona				Bellaterra				Girona				Lleida				Manresa				Tarragona			
		WeMO		NAO		WeMO		NAO		WeMO		NAO		WeMO		NAO		WeMO		NAO		WeMO		NAO	
		W	A	W	A	W	A	W	A	W	A	W	A	W	A	W	A	W	A	W	A	W	A		
<i>Pinus</i>	K	n		n							n														
	S	n		n							n														
Total <i>Quercus</i>	K			n		n		n																	
	S	n		n		n	n	n																	
<i>Quercus</i> evergreen type	K					n																			
	S	n				n																			
<i>Quercus</i> deciduous type	K		n	n				n						n				n	n	n					
	S			n				n	n					n				n		n					
<i>Fagus</i>	K																								
	S																								
<i>Betula</i>	K																								
	S																								
<i>Corylus</i>	K							p	p					p				p					p		
	S					p	p	p	p					p				p					p		
<i>Pistacia</i>	K																n								
	S																								
<i>Artemisia</i>	K	n																n							
	S	n																n							
Pocaceae	K							p																	
	S		p					p																	
Chenopod./Amarantaceae	K		p						p										n						
	S		p						p	p															

n significant at the level 0,01  
n significant at the level 0,05  
 p: positive correlation  
 n: negative correlation  
 K: Kendall  
 S: Spearman  
 W: winter (DJFM)  
 A: annual

### 3.1. Pollen correlations with the NAO index in winter

- Were **negative** for most of the pollen taxa: *Pinus*, Total *Quercus*, *Quercus* evergreen t., *Quercus* deciduous t., *Fagus*, *Betula* (except Girona Kendall) and Pocaceae (except Bellaterra Kendall/Spearman).
- Pistacia*, *Artemisia*, and Chenopod./Amaranthaceae presented positive/ negative correlations depending on the station.
- Corylus* correlated **positively** in all the stations.
- Correlations were only **significant** for *Pinus*, Total *Quercus*, *Quercus* deciduous t., *Corylus* and Chenopod./Amaranthaceae (Table 1)

### 3.2. Pollen correlations with the annual NAO index

- Showed the same **negative** correlations than winter NAO for *Pinus*, Total *Quercus*, *Quercus* evergreen t., *Quercus* deciduous t., *Betula* (except Bellaterra Kendall), *Artemisia* (except Girona Kendall).
- Corylus* in all stations (Figure 1) and *Pistacia* (except in Lleida) showed **positive** correlations. For the remaining taxa, the sign of the correlations depended on the station. Correlations were **significant** only for *Corylus* (Table 1).

### 3.3. Pollen correlations with the WeMO index in winter

- Most of the pollen taxa (*Pinus*, Total *Quercus* (Figure 2), *Quercus* evergreen t., *Quercus* deciduous t., *Pistacia*, *Artemisia*, *Pocaceae* and *Chenopod./ Amaranthaceae*) had a **negative** correlation in all the stations.
- *Betula* and *Corylus* presented **positive** correlations (except in Lleida for *Betula*). *Fagus* presented also positive correlations (except Barcelona and Lleida).
- All the **significant** correlations were **negative** (*Pinus*, Total *Quercus*, *Quercus* evergreen t., *Quercus* deciduous t., *Artemisia*, and *Chenopod./ Amaranthaceae*) with the exception of *Corylus* that was **positive** (Table 1).

### 3.4. Pollen correlations with the annual WeMO index

- *Pinus*, Total *Quercus*, *Fagus*, *Betula* and *Corylus* had **negative** correlations in all the stations. *Artemisia* was **positively** correlated (except Tarragona).
- For the other taxa, the sign depended on the stations.
- **Significant negative** correlations: *Pinus*, Total *Quercus*, *Quercus* deciduous t. and *Pistacia*.
- *Pocaceae* and *Chenopod./ Amaranthaceae* had **significant positive** correlation (Table 1).

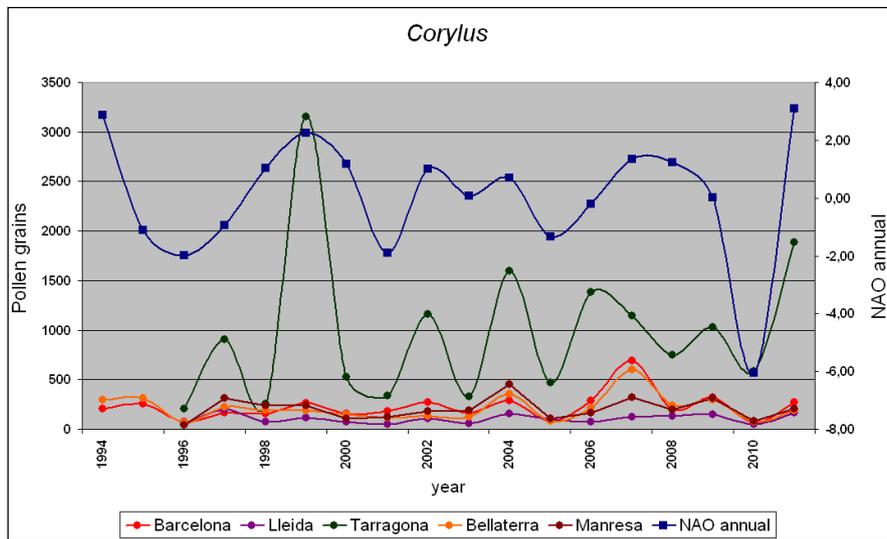


Figure 3. *Corylus* and annual NAOi dynamics

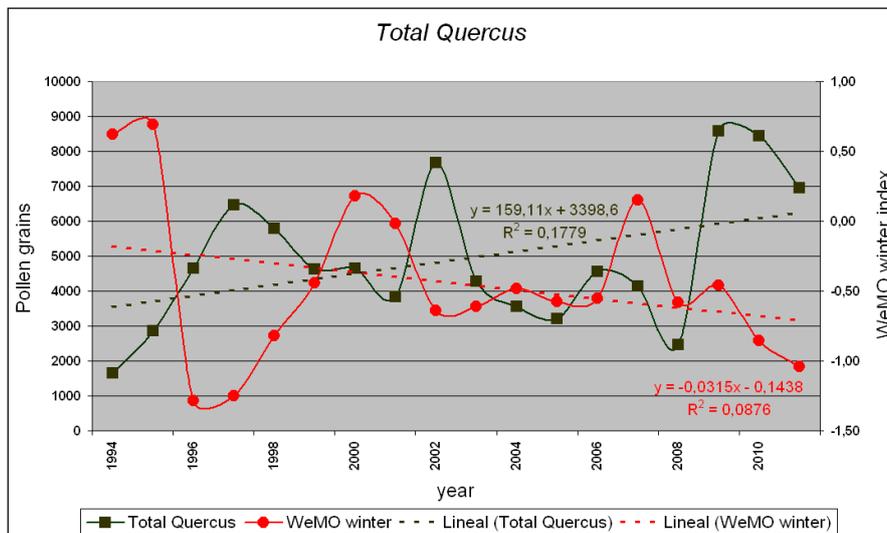


Figure 4. Total *Quercus* (Barcelona) and WeMOi in winter dynamics

#### 4. Conclusions

Airborne pollen levels measured in Catalonia correlated better with the WeMOi than with the NAOi, and these correlations were, both, stronger for the winter than for the annual indices.

The negative correlations exhibited by most of the taxa with the NAOi and the WeMOi are consistent with the wetter conditions associated with the negative mode of both indices in the eastern peninsular fringe, comprising Catalonia.

The positive correlation obtained for *Corylus*, *Betula*, *Fagus* and *Artemisia* could be due to a major influence of the long/medium range transport attributed in previous studies to some peaks detected in Catalonia for these taxa.

If the negative trend exhibit by WeMOi in winter in the last 30 years [1] was sustained, airborne concentrations of most of the studied taxa will increase. However, longer pollen series are needed to confirm this assumption.

#### 5. References

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