

Influence of wind on daily airborne pollen counts in Catalonia (NE Iberian Peninsula)

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INTRODUCTION

Airborne pollen is a seasonal air pollutant related to the phenological phases of plants and is influenced by meteorological elements. In Catalonia (Northeast Iberian Peninsula) the pollination of most of the indigenous species lasts from the beginning of February until the end of October, with a maximum at spring. The suspension of pollen grains in the atmosphere is a phenomenon that is

related to the biological function of these particles, since the wind is the mode of pollen transport for many flowering plants. **The aim** of the present work is to study the correlation between wind (speed and direction) and pollen concentrations during the pollination period for 22 pollen taxa collected at 6 aerobiological stations in Catalonia for the period 2004 - 2014.

METHODOLOGY & DATA

Pollen and meteorological data record

- Airborne pollen data were recorded for the period 2004 - 2014 by the Aerobiological Network of Catalonia (XAC) at six stations located in Barcelona, Bellaterra, Girona, Lleida, Manresa and Tarragona (Figure 1 and Table 1).
- Data were obtained daily using Hirst samplers (Hirst, 1952) and analysed following the standardized Spanish method (Galán et al., 2007) for 22 relevant pollen taxa (Table 2).
- Meteorological data were provided by the Spanish Agency of Meteorology (AEMET). We work with mean daily wind speed and direction only for days without precipitation during the pollination period of each taxa.

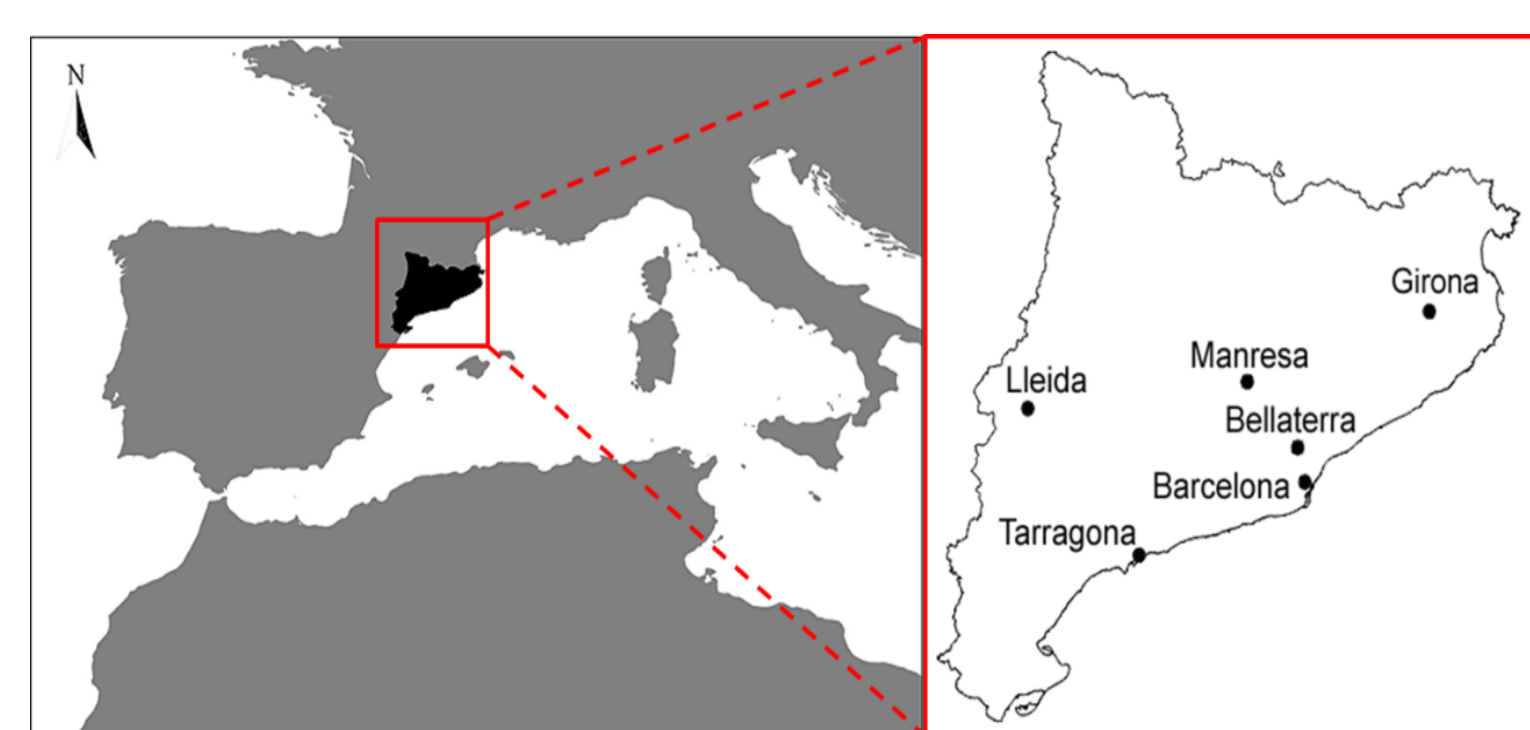


Figure 1: Catalonia is located in the Northeast of the Iberian Peninsula

Stations	Geographical characteristics				Climatic characteristics	
	Altitude (m a.s.l.)	Lat.	Long.	Environment	Mean annual Temperature (°C)	Annual rainfall (mm)
Barcelona	12	41° 24' N	02° 09' E	urban	16.4	593
Bellaterra	190	41° 33' N	02° 06' E	rural/urban	15.2	594
Girona	70	41° 59' N	02° 50' E	urban	15.0	740
Lleida	221	41° 37' N	02° 38' E	urban	15.1	385
Manresa	238	41° 44' N	02° 30' E	rural	13.6	619
Tarragona	20	41° 07' N	02° 15' E	urban	15.8	478

Table 1: Geographical and climatic characteristics of sampling stations in Catalonia, Spain.

TAXA	Plant type			Plant biogeography					Plant use				
	T	B	H	BA	ES	SM	M	Cm	S	R	C	O	
TOTAL POLLEN	T	B	H	BA	ES	SM	M	Cm	S	R	C	O	
Alnus	T				ES				S	R	C	O	
Betula	T				BA	ES			S	R	C	O	
Castanea	T					SM			S	R	C	O	
CUPRESSACEAE/TAXACEAE	T	B			ES		M		S	R	C	O	
Fagus	T				ES				S	R	C	O	
Fraxinus	T				ES	SM			S	R	C	O	
Olea	T						M		S	R	C	O	
Pinus	T				BA	ES	SM	M	S	R	C	O	
Platanus	T						SM	M	S	R	C	O	
Quercus total	T	B			ES	SM	M		S	R	C	O	
Quercus deciduous	T				ES	SM	M		S	R	C	O	
Quercus evergreen	T	B					M		S	R	C	O	
Ulmus	T				ES				S	R	C	O	
Corylus	B				ES				S	R	C	O	
Pistacia	B						M		S	R	C	O	
Ambrosia L.	H							M	S	R	C	O	
Artemisia	H							Cm	S	R	C	O	
CHENOPODIACEAE-AMARANTHACEAE	H								S	R	C	O	
POACEAE	H								Cm	S	R	C	O
Plantago	H								Cm	S	R	C	O
POLYGONACEAE	H								Cm	S	R	C	O
URTICACEAE	H								Cm	S	R	C	O

Table 2: 22 pollen taxa under study

Plant type	Plant use
T - tree	S - silvestre or wild (not urban)
B - bush	R - rural
H - herb	C - cultivated (agriculture & forestry)
	O - ornamental

Methodology

The mean daily wind direction was classified in 8 sectors: N, NE, E, SE, S, SW, W and NW. For each sector, the Spearman's rank correlation coefficient between the daily pollen concentration and the mean daily wind speed was calculated. In order to support these correlations, radar charts of wind speed and pollen concentration have been drawn. Finally, the correlations obtained have been compared with the distribution of mean daily wind speed represented in wind rose plots.

RESULTS

- The results show a high variability depending on the pollen taxa and the sampling station.
- Tarragona and Lleida were the stations with more significant correlations followed by Bellaterra, Manresa, Barcelona and Girona (Table 4).
- On the other hand, *Artemisia* was the taxon most correlated with mainly negative values, and *Pistacia* and *Quercus* total were the least (Table 5).
- The S wind direction showed the largest number of significant correlations, being mostly negative. The N wind direction was the least.
- Poaceae was the taxa that showed only positive correlations in all directions.

- Table 3a and Figure 2a show significant positive correlations between daily pollen concentration of *Artemisia* in Tarragona and wind speed coming from W and NW sectors. They might be interpreted as a contribution of pollen from a localized source in the west of the city and inland of Catalonia. On the other hand, negative correlations with the wind coming from SE and SW sectors might be interpreted as a cleaning and dispersion effect over the station due to winds coming from the sea.
- Table 3b and Figure 2b show a negative correlation between daily pollen concentration of *Platanus* in Lleida and wind speed coming from the W sector. This correlation might be interpreted as a cleaning and dispersion effect over the pollen in the station due to strong winds coming from the W sector often associated to frontal situations.

Tarragona (<i>Artemisia</i>)							
N	NE	E	SE	S	SW	W	NW
			-0,212		-0,223	0,219	0,244

Table 3a: Significant correlations (p<0,05) between the daily pollen concentration of *Artemisia* and wind speed for each sector in Tarragona.

Lleida (<i>Platanus</i>)							
N	NE	E	SE	S	SW	W	NW
						-0,367	

Table 3b: Significant correlations (p<0,05) between the daily pollen concentration of *Platanus* and wind speed for each sector in Lleida

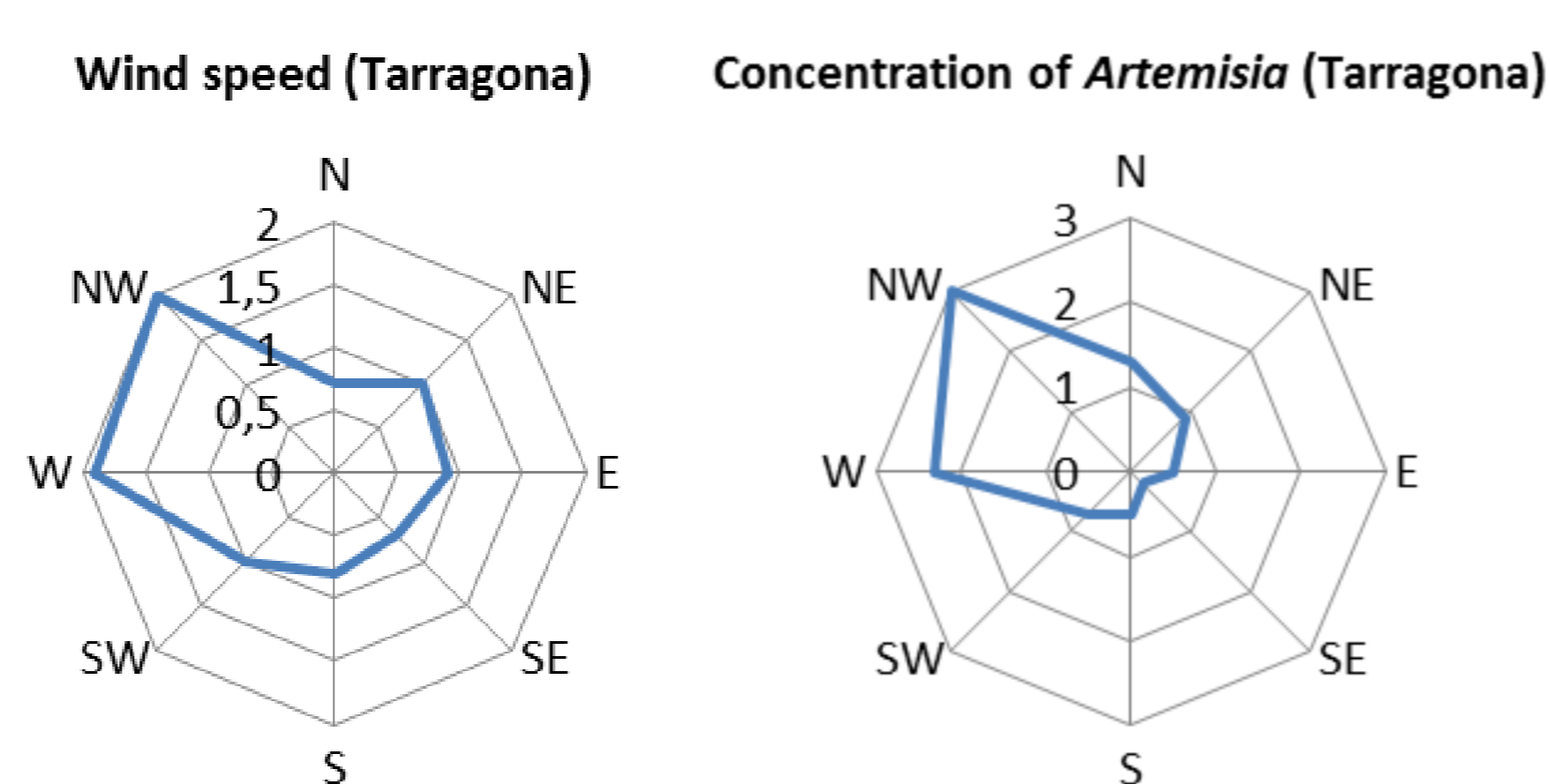


Figure 2a: Radar charts of mean daily wind speed (m/s) and mean daily concentration (m³) for *Artemisia* in Tarragona

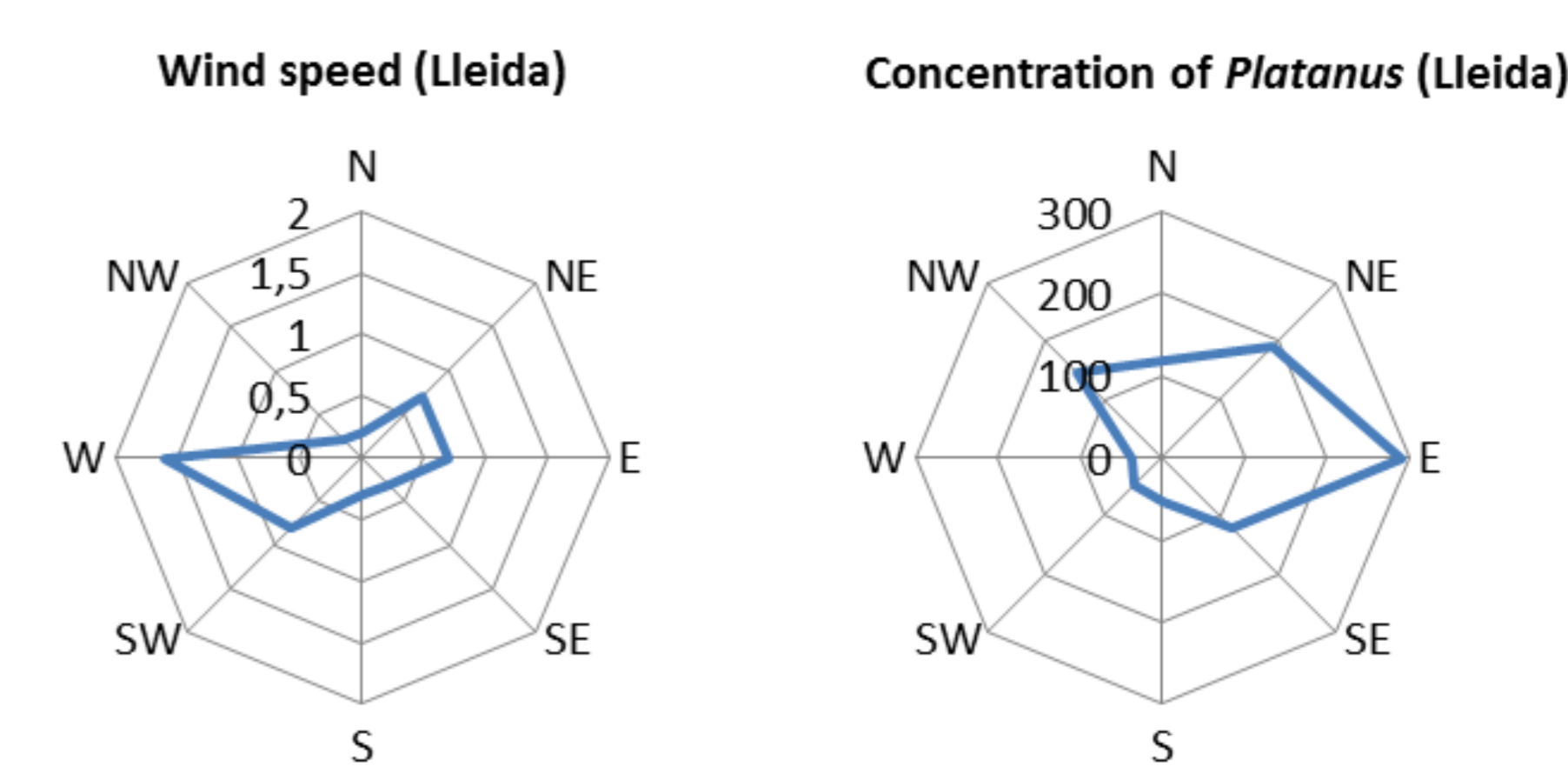


Figure 2b: Radar charts of mean daily wind speed (m/s) and mean daily concentration (m³) for *Platanus* in Lleida

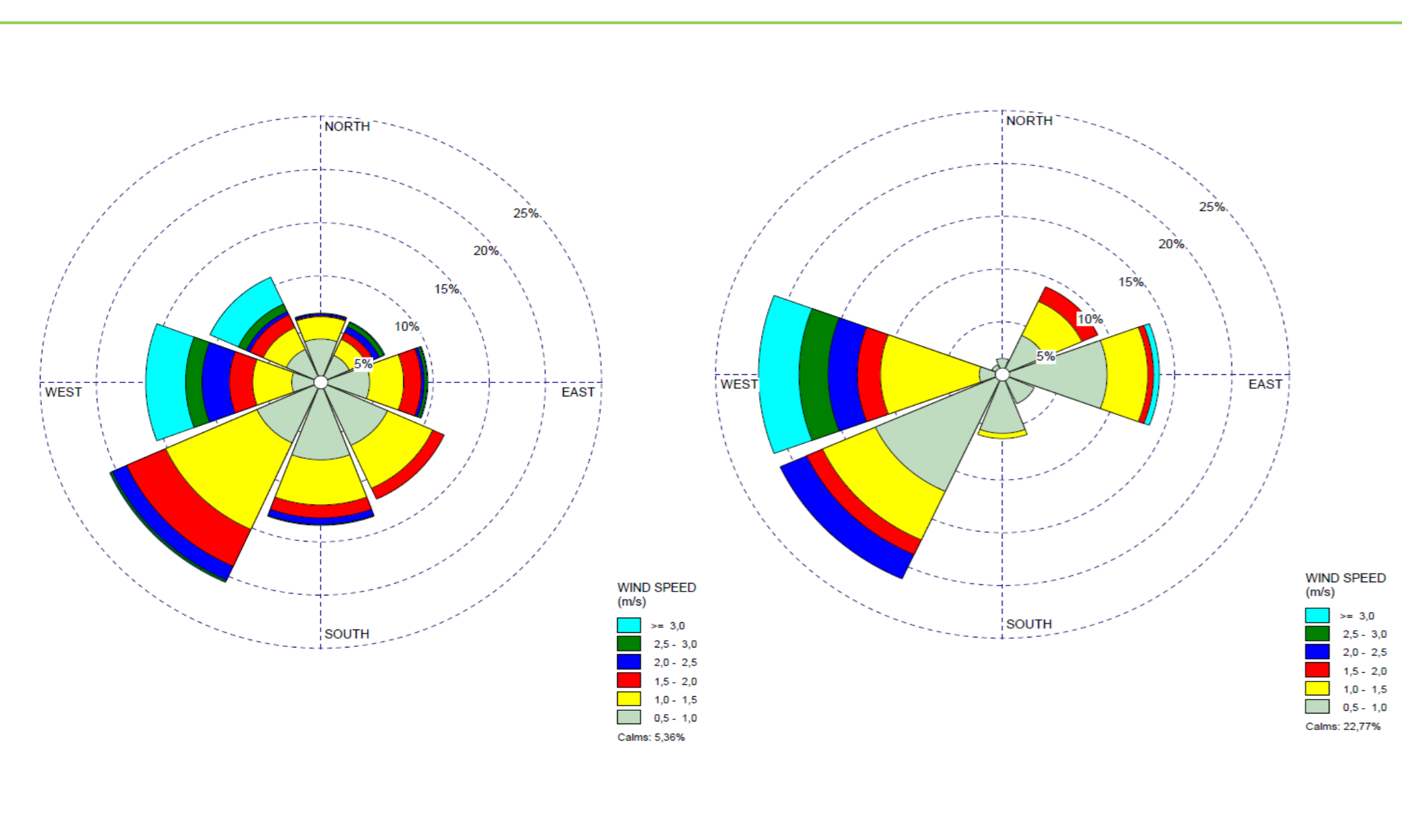


Figure 3: Wind rose plots of daily wind speed (m/s) for the pollination periods of *Artemisia* in Tarragona (left) and *Platanus* in Lleida (right)

Sector	Station															
	Barcelona		Bellaterra		Girona		Lleida		Manresa		Tarragona					
Correlation	P	N	P	N	P	N	P	N	P	N	P	N	P	N	Total	
N	-	-	-	-	-	-	-	1	-	-	-	-	1	-	2	2
NE	-	-	-	-	3	-	2	1	-	-	-	-	-	5	1	6
E	-	-	1	1	-	1	2	-	1	-	2	1	6	3	9	
SE	-	2	1	3	-	-	3	1	1	2	-	1	5	9	14	
S	-	2	-	6	-	2	1	-	1	4	1	2	3	16	19	
SW	-	-	1	2	-	-	2	1	1	3	2	3	6	9	15	
W	1	-	2	-	-	-	2	2	1	-	3	1	9	3	12	
NW	6	1	-	-	-	-	3	-	-	2	4	-	13	3	16	
Total	7	5	5	12	3	3	15	6	5	11	12	9	47	46	93	
	12		17		6		21		16		21					

Table 4: Significant correlations between daily pollen concentration and daily wind speed for all the taxa for each sector in each sampling station (P means positive and N means negative correlation)

Taxon	Sector																				
	N	NE	E	SE	S	SW	W	NW	P	N	Total										
Correlation	P	N	P	N	P	N	P	N	P	N	Total										
Artemisia	-	1	-	1	-	1	-	4	-	5	-	2	1	-	2	1	3	15	18		
Corylus	-	-	-	-	1	1	-	-	1	2	-	1	-	-	-	-	2	4	6		
Cupressaceae	-	-	2	-	1	-	-	1	-	2	-	3	-	3	2	-	1	-	6	8	14
Olea	-	-	-	-	-	-	1	2	-	1	-	1	-	-	2	-	-	3	4	7	
Pinus	-	-	-	-	1	-	-	-	-	2	-	-	2	1	1	-	4	3	7		
Pistacia	-	-	2	-	-	-	-	-	-	1	-	-	-	-	-	1	2	2	4		
Platanus	-	-	-	-	-	1	-	-	-	2	-	-	-	1	1	-	1	4	5		
Plantago	-	-	-	-	-	-	-	-	-	1	2	-	1	-	1	-	4	1	5		
Poaceae	-	-	-	-	1	-	2	-	1	-	2	-	1	-	2	-	9	-	9		
Quercus total	-	-	-	-	1	-	1	-	1	-	-	-	-	-	2	-	3	1	4		
Urticaceae	-	1	1	-	1	-	2	-	-	3	1	2	1	1	1	1	10	4	14		
Total	-	2	5	1	6	3	5	9	2	17	7	8	9	3	13	3	47	46	93		
	2		6		9		14		19		15		12		16						

Table 5: Significant correlations between daily pollen concentration and daily wind speed for all the stations for each taxa and each sector (P means positive and N means negative correlation)

CONCLUSIONS

- This study could be used to identify and locate airborne pollen sources near the sampling station.
- The wind coming from the sea has a cleaning and dispersion effect over the pollen. This is observed over the coastal stations (Barcelona, Bellaterra and Tarragona) due to the wind induced by the breeze effect (SW and SE) and over the inland stations (Lleida and Manresa) when westerly frontal synoptic situations are produced.

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