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SILAM IN SOUTH OF EUROPE: APPLICATION TO BIRCH POLLEN EPISODES IN CATALONIA (NE SPAIN)

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Abstract: Most of allergenic pollen types are anemophilous (wind-pollinated) and can be transported by air thousands of kilometers. For this reason, the use of dispersion models giving to the pollen grains a similar treatment to that of the particulate matter is a good tool to study and understand the mechanisms that contribute to abrupt high concentrations of pollen grains in areas with usual low local influence or out of the usual pollination period. This behavior has been observed for birch pollen in Catalonia (NE of Spain). The modeling of long-range transport within an air quality modeling system prepared to forecast pollen concentrations would be an important improvement in the assessment for that population that suffers annoying health effects due to pollen in the air.
In this work, SILAM model is used to study an intrusion of birch (Betula) pollen from central Europe towards the South in spring 2006 and 2007. In order to get more precise simulations from the model, the distribution and quantification of birch trees in the territory have been updated with data from the Third National Forest Inventory from Spain. The airborne pollen measurements at eight stations situated in North-East Spain (Catalonia) have been used to validate the model.
Key words: *birch pollen, SILAM, long-range transport, pollen simulation*

INTRODUCTION

The biogenic contribution to pollution has been studied for a long time, but little attention has been given to the extra-regional influence in the levels of allergenic pollen measured at a given station. Most of allergenic pollen types are anemophilous (wind-pollinated) and can be transported by air thousands of kilometers. For this reason, the use of a dispersion model giving to the pollen grains a similar treatment to that of the particulate matter is a good tool to study and understand the mechanisms that contribute to abrupt high concentrations of pollen grains in areas with usual low local influence or out of the usual pollination period.

Pollen grains are particles related to the sexual reproduction of flowering plants. In anemophilous plants, pollen comes into the atmosphere and a sector of the population experiences allergic symptoms in its presence. Birch (*Betula*) pollen is one of the important causes of respiratory allergy in Northern and Central Europe due to the abundance of birch trees in forests. This allergy is rare in Southern Europe, where birch trees are not frequent, grow only in mountain landscapes (between 800 and 2000 m.a.s.l.), and give rise to low pollen concentrations. Nevertheless, punctual pollen peaks are observed in Southern Europe (Catalonia) due to the long-range transport from North to South under concrete meteorological circumstances.

Similar to air quality forecast systems, the modeling system prepared to forecast pollen concentrations would be an important improvement in the assessment for that population that suffers annoying health effects caused by pollens in the air. We will focus on the study of birch pollen season in Catalonia for years 2006 and 2007.

METHODOLOGY: DATA AND MODEL

Airborne pollen data are recorded by the Aerobiological Network of Catalonia (from here onwards XAC) at eight aerobiological stations located in the Catalan localities of: Barcelona, Bellaterra, Girona, Lleida, Manresa, Roquetes, Tarragona and Vielha (Figure 1). Samples are obtained daily from Hirst samplers (Hirst, 1952) -the standardized method in European aerobiological networks and analyzed following the standardized Spanish method (Galán *et al.* 2007).

Birch pollen levels at the XAC stations are low, except in Vielha, located in Pyrenees, where a different behavior is observed. Nevertheless some peaks with high concentrations are observed simultaneously in practically all stations and we attribute them to the long-range transport from the Northern areas. For this study we have chosen the episodes of years 2006 and 2007.

SILAM model (Sofiev *et al.*, 2006a; 2006b) (http://silam.fmi.fi) was applied in its Eulerian mode, in the domain with longitudes comprised between -12º and 18º and latitudes between 35º and 60º. The grid resolution was 15 km. The meteorological input data were from ECMWF. The total amount of pollen emitted from a cell with 100% of its area covered by birch trees was estimated in $2x10^9$ grains m^{-2}. The percentage of area occupied by birch trees was supplied with SILAM model in a map of Europe (from now onwards this map will be referred as base map of birch trees). An update for the Iberian Peninsula was added into this base map with data from the Third National Forestry Inventory (IFN3) of Spain. Two simulations were performed for each year one using base map and the other using the map derived from IFN3 (see Figure 2). The simulations extended from 1st March to 15th June 2006 and from 1st March to 15th May 2007.

Figure 1. The situation of Catalonia in Europe is shown with a black square (left panel) and the locations (right panel) of the 8 monitoring stations of the Aerobiological Network of Catalonia (XAC).

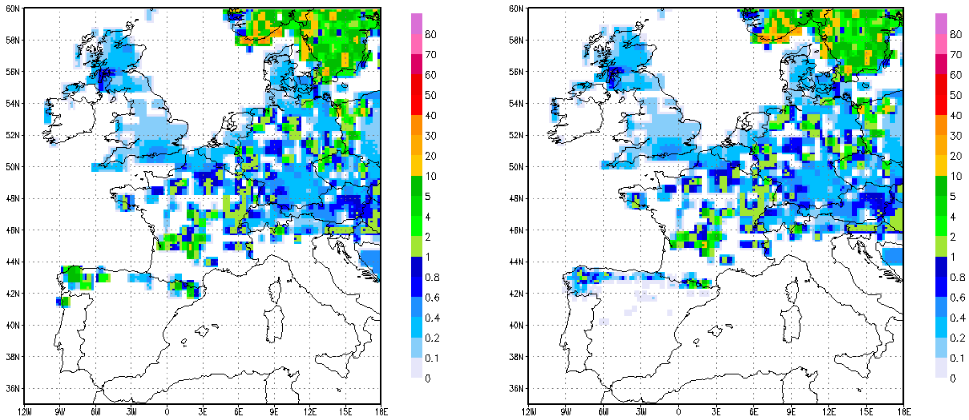

Figure 2. Map of the percentages of area covered with birch trees in Europe (%): left panel shows the base map within SILAM, and right panel shows the updated map (IFN3 map) with Iberian Peninsula modifications.

SEASONS STUDIED

In 2006, the beginning of the birch pollen detection was 20th March in Vielha, 24th March in Bellaterra as can be seen in Figure 3. With the exception of Vielha, the rest of stations started birch pollen season with low values (< 20 grains/m^3) but they increased considerably around 26th-27th April and 29th April (30th in Barcelona and Bellaterra). These peaks are attributed to long-range transport because of their huge value in comparison with the precedent days and the simultaneity in the territory.

In 2007 (see Figure 4), first detection of birch pollen was on 10th March in Manresa, but it was not until 27th March that the values became continuous in time. As in 2006, low values were measured with the exception of some days. The days with attributed long-range transport were 15th and 19th-20th April.

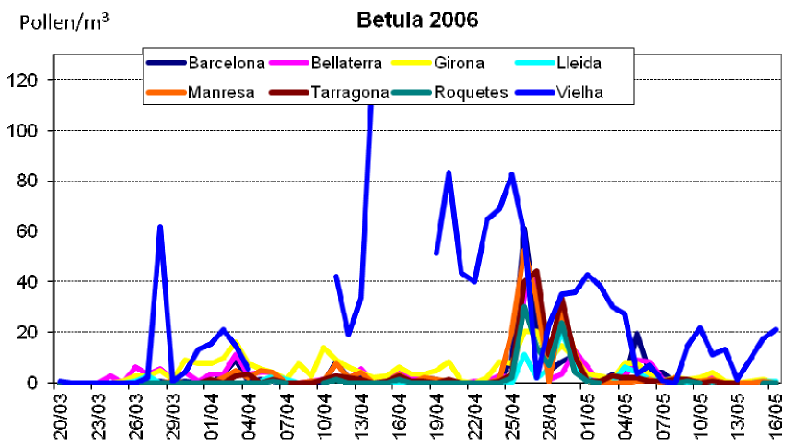

Figure 3. Mean daily airborne birch pollen concentration in the Catalan stations from 20th March to 16th May in 2006.

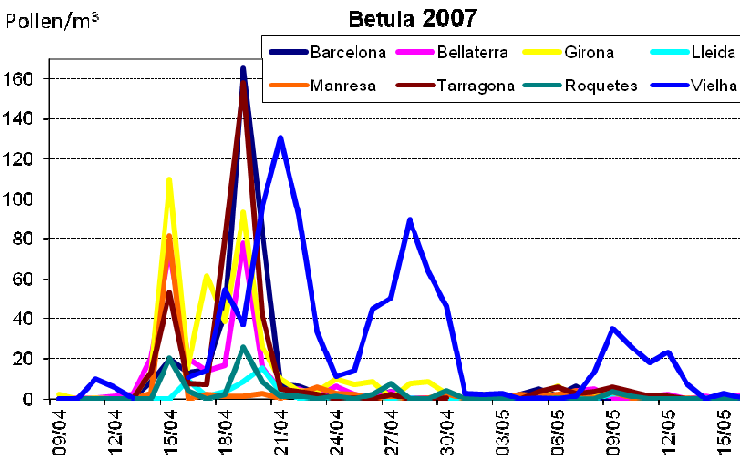

Figure 4. Mean daily airborne birch pollen concentrations in the Catalan stations from 9th April to 15th May in 2007.

RESULTS AND DISCUSSION

Model results include hourly birch pollen concentrations. Some examples are shown in Figure 5 for the two years simulated. On 29th April 2006 and 17th April 2007, the effect of the transport over areas where there are no birches, such as the Mediterranean sea or the Atlantic ocean can be observed. The same occurs in some land regions, such as NE of the Iberian Peninsula, where the advection from central Europe under favorable meteorological conditions can be the major contributor to the measured pollen concentrations.

The measurements obtained in the aerobiological stations seem to agree with that reproduced by models, low values in most of the period and some peaks with higher pollen concentrations. In 2006, the peaks on 26th-27th April where reproduced by the model, at least one of the two days, in all the stations (not shown). The peak on 29th April was partially reproduced by the model. In 2007, the peak on 15th April was not reproduced, but the peak on 19th -20th April was enough well reproduced; in some cases there was a delay of a day in the model. Differences between the two simulations are important in the local contribution (see Figures 6 and 7), where IFN3 simulation (green) seems to make and improvement, avoiding the extra peaks that appear in base simulation (red).

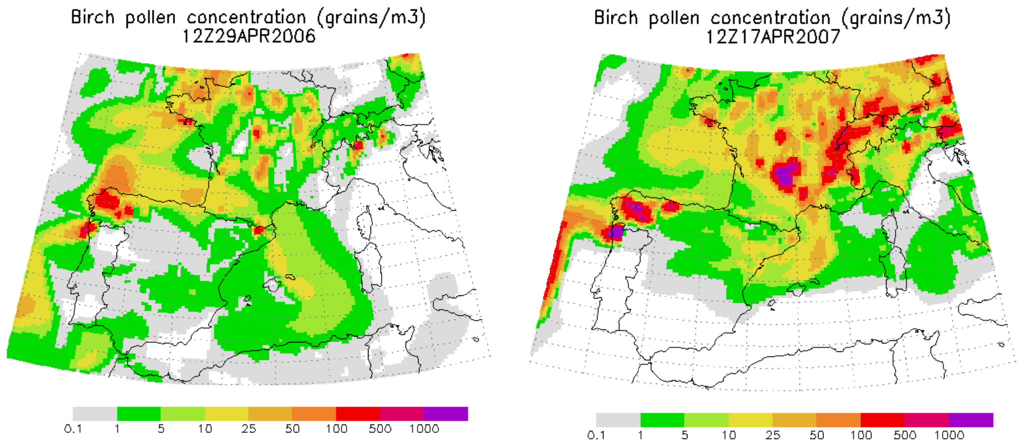

Figure 5. Birch pollen concentration (grains/m^3) on 29th April 2006 (left panel) and on 17th April 2007 (right panel) from base simulation at 12 UTC.

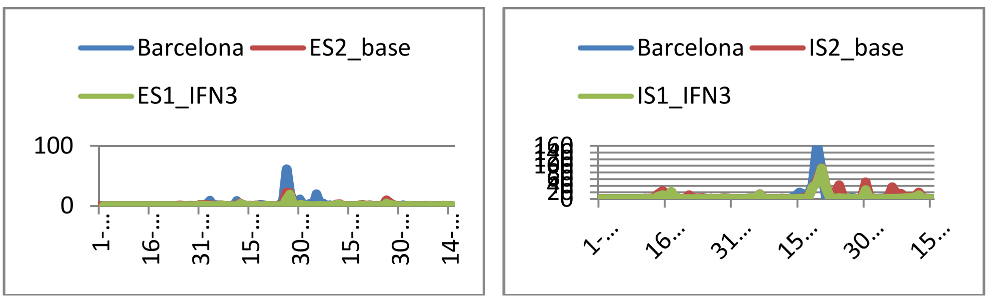

Figure 6. Mean daily pollen concentrations measured in Barcelona station (blue), base simulation (red) and IFN3 simulation (green) in 2006 (left panel) and 2007 (right panel).

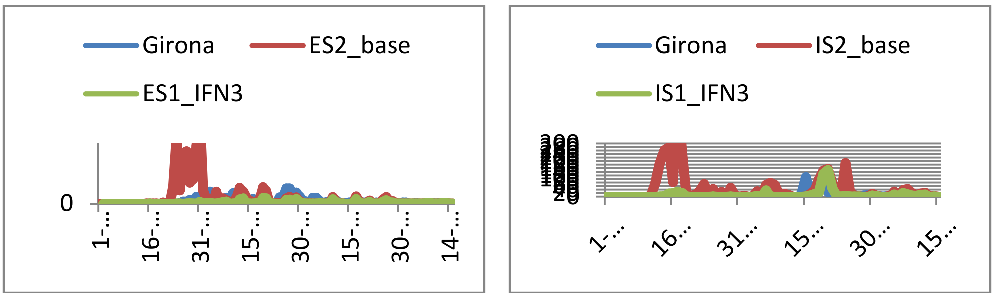

Figure 7. Mean daily pollen concentrations measured in Girona station (blue), base simulation (red) and IFN3 simulation (green) in 2006 (left panel) and 2007 (right panel).

Another point of analysis can be the annual index (AI) (see Table 1), the sum of the average daily concentrations in the periods studied. In terms of that parameter AI, more agreement exists in base simulation for year 2006 than in IFN3 simulation, with the exception of Girona. In general, 2006 simulations presented AI lower than those observed in Catalonia and they were much lower in IFN3 simulation than in base simulation. In 2007 base simulation presented again higher values for AI than IFN3 simulation, but the results from IFN3 adjusted better with measurements.

Table 1. Annual Index in 2006 and 2007 from measurements (XAC), from base model (SILAM-BASE) and from IFN3 model (SILAM-IFN3).

AI (grains/m^3)	XAC (measured) 2006	SILAM-BASE 2006	SILAM-IFN3 2006		XAC (measured) 2007	SILAM-BASE 2007	SILAM-IFN3 2007
Barcelona	200	108	67		391	591	351
Bellaterra	216	136	48		290	969	308
Girona	309	798	103		458	3320	635
Lleida	79	37	15		63	347	89
Manresa	210	101	41		132	858	166
Tarragona	186	34	20		404	227	161
Roquetes	88	19	13		88	255	222
Vielha	1290	1275	561		944	1393	601

In summary, the two simulations show similar behavior in front of long-range transport but local differences in concentrations appear, as it was expected. From the comparison with the observations in the eight measurement points in Catalonia for years 2006 and 2007 we can derive that the update of the birch fraction map in Spain improves the behavior of the model in the measurement-sites. Nevertheless, more years should be analyzed in order to obtain a stronger conclusion.

ACKNOWLEDGEMENTS
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REFERENCES
Hirst, J.M. (1952). An automatic volumetric spore trap. Ann Appl Biol 39, 257-265.

Galán, C., Cariñanos, P., Alcázar, P., Domínguez,, E. 2007. Manual de calidad y gestión de la Red Española de Aerobiología. Universidad de Córdoba, Spain.

Sofiev, M., Siljamo, P., Valkama, I., Ilvonen, M., Kukkonen, J., 2006(a). A dispersion modelling system SILAM and its evaluation against ETEX data. Atmospheric Environment, 40, 674-685. doi: 10.1016/j.atmosenv.2005.09.069

Sofiev, M., Siljamo, P., Ranta, H., Rantio-Lehtimäki, A., 2006 (b). Towards numerical forecasting of long-range air transport of birch pollen: Theoretical considerations and a feasibility study. International Journal of Biometeorology, 50, 392-402. doi: 10.1111/j.1365-2222.2007.12771.x