SILAM in South of Europe: application to birch pollen episodes in Catalonia (NE Spain)

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INTRODUCTION

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 (Figure 1) is one of the important causes of respiratory allergy in Northern and Central Europe (Figure 2) due to the abundance of birch trees in forests. In Southern Europe, birch trees are not frequent, they 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) (Figure 3) due to the long-range transport from North to South under concrete meteorological circumstances.

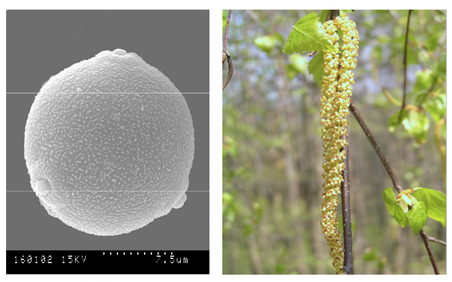


Figure 1. SEM image of a birch pollen grain (left panel) and male flowers of birch (right panel).

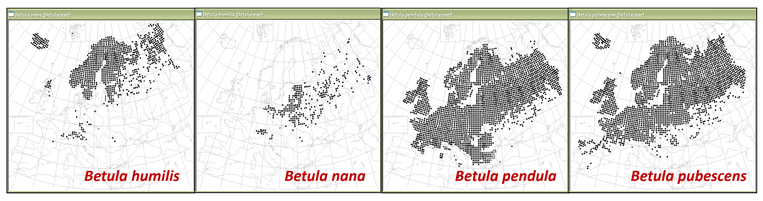


Figure 2. Distribution maps showing the presence of the main birch species in Europe

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.

Figure 3. 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).

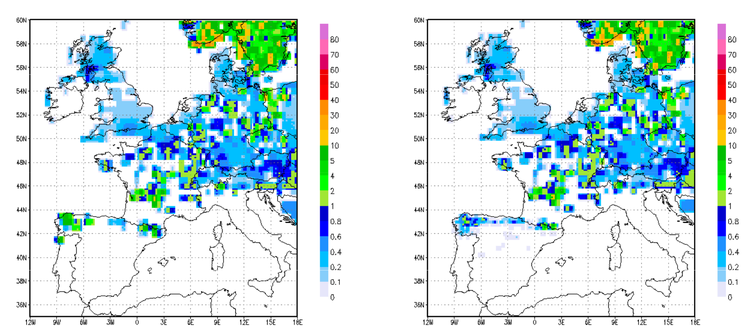


Figure 4. Map showing the percentages of area covered with birch trees in Europe (%): left panel shows the base map within SILAM, and right panel shows the updated map (IFN3 map) with Iberian Peninsula modifications.

AIMS OF THE STUDY

To run two different simulations, one with SILAM birch map (base map) and the other with an update of data in Spain (IFN3 map).

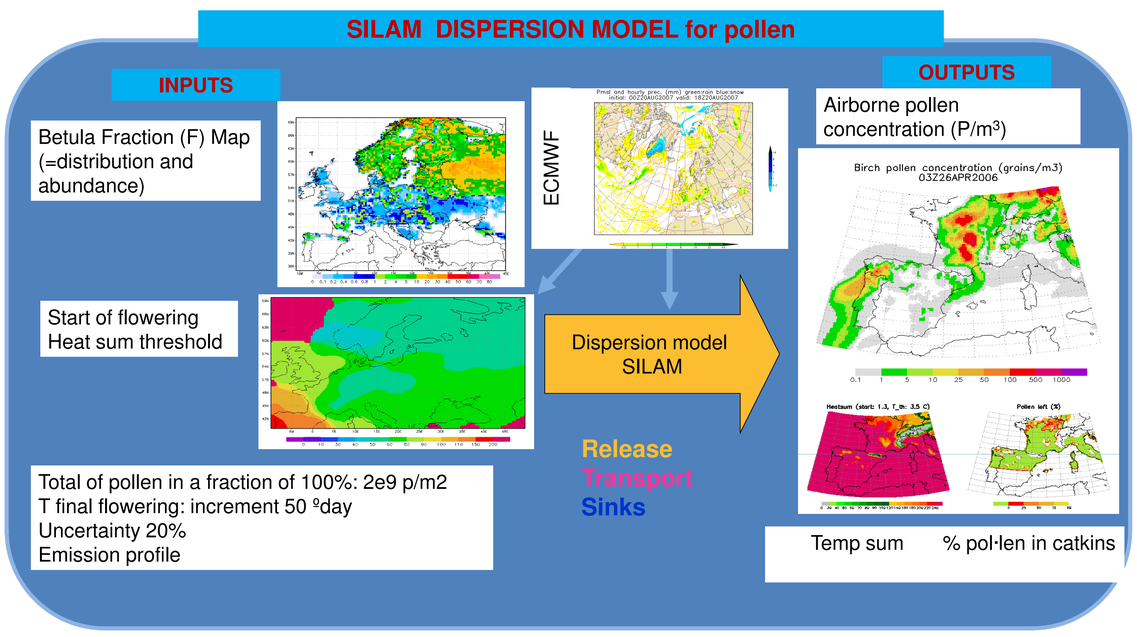
SILAM simulations				
Name	**Base simulation**		**IFN3 simulation**	
Periods	1st March to 15th June 2006	1st March to 15th May 2007	1st March to 15th June 2006	1st March to 15th May 2007
Birch Fraction	Base map (left panel Figure 4)		IFN3 map (right panel Figure 4)	
Meteo	ECMWF			
Domain	Lon (-12º, 18º) & Lat (35º, 60º)			
Other	Heat sum threshold map determines release of pollen.			

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 3). 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) (see scheme below) 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 2×10^9 grains m^{-2}. The percentage of area occupied by birch trees was supplied with SILAM model in a map of Europe (onwards this map will be referred as base map of birch trees). An update for the Iberian Peninsula was done 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 4). The simulations extended from 1st March to 15th June 2006 and from 1st March to 15th May 2007.



RESULTS AND DISCUSSION

Model results include hourly birch pollen concentrations. Some examples are shown in Figure 5 for the two years simulated. On day 29th April 2006 and 19th April 2007, it can be observed the effect of the transport over areas where there are no birches, as the Mediterranean sea or the Atlantic ocean. 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 (blue lines in Figure 6) 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 Figure 6), where IFN3 simulation (green) seems to make and improvement, avoiding the extra peaks that appear in base simulation (red).

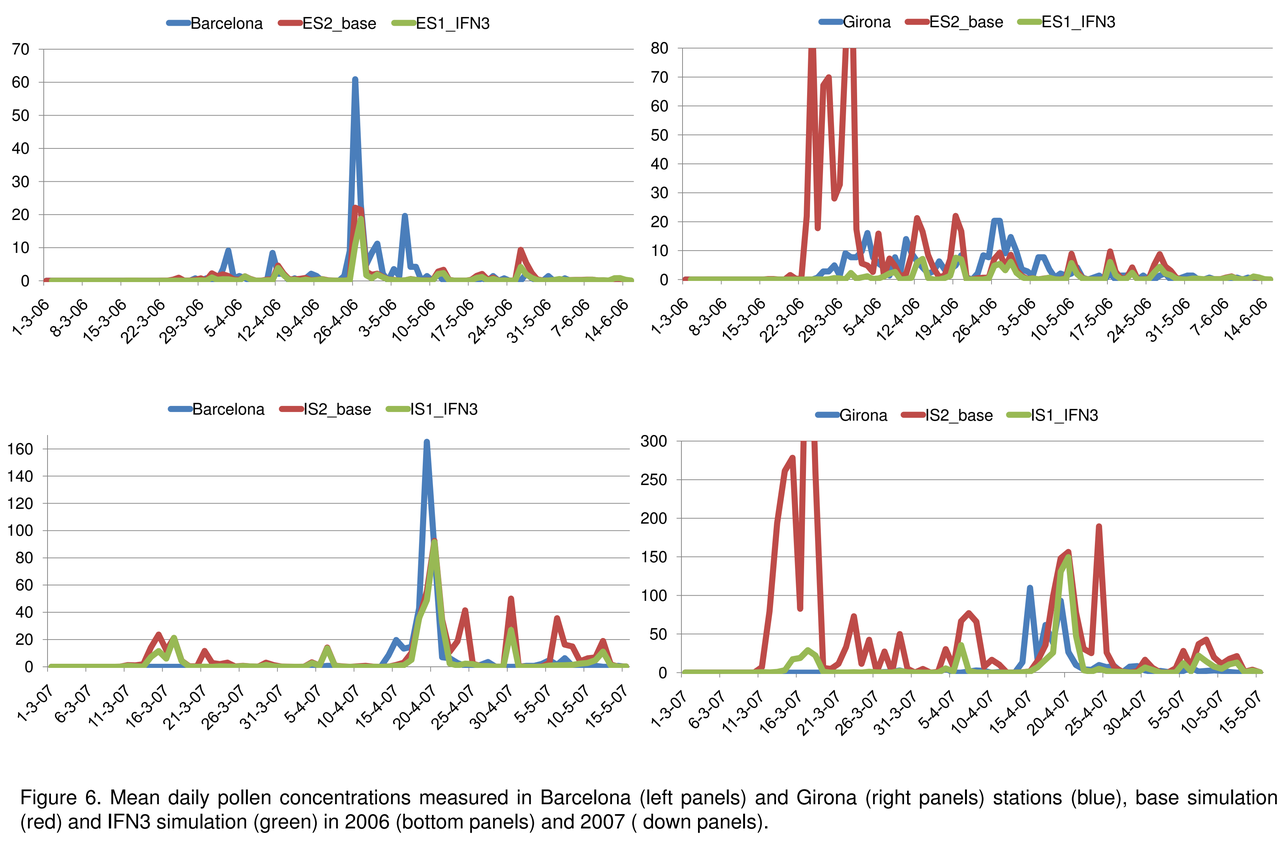


Figure 6. Mean daily pollen concentrations measured in Barcelona (left panels) and Girona (right panels) stations (blue), base simulation (red) and IFN3 simulation (green) in 2006 (bottom panels) and 2007 (down panels).

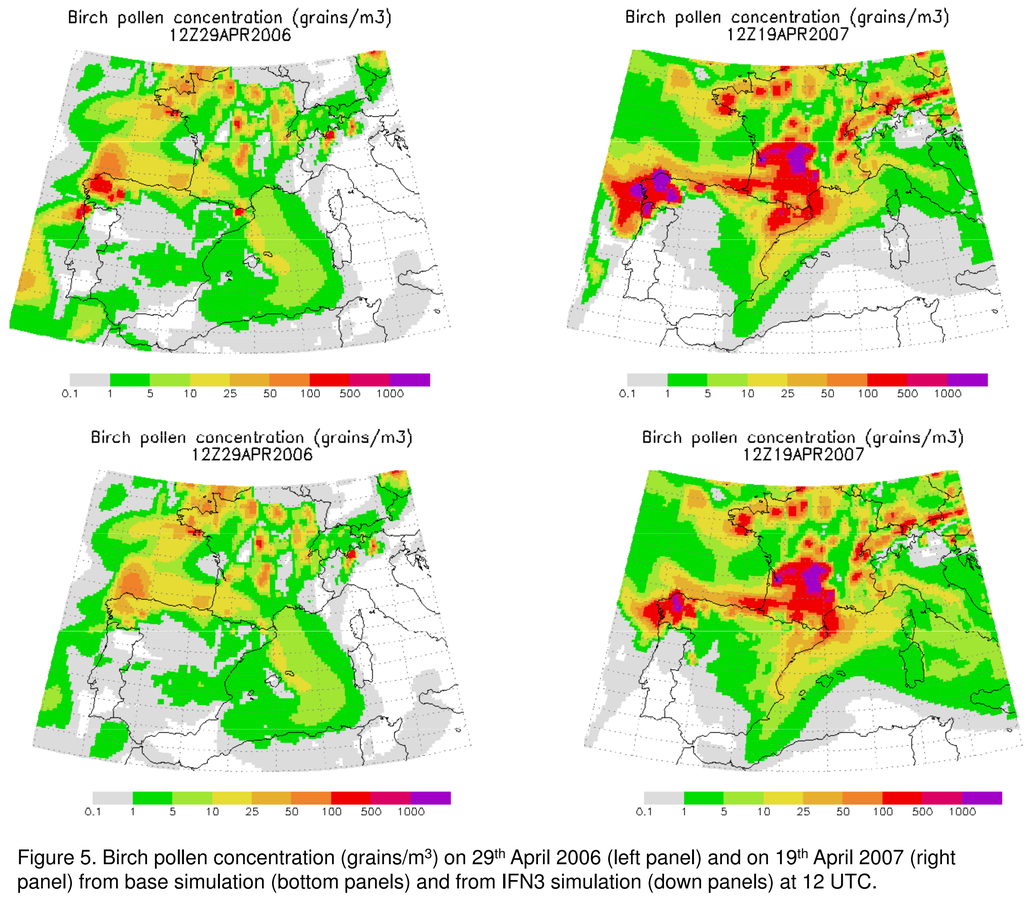


Figure 5. Birch pollen concentration (grains/m^3) on 29th April 2006 (left panel) and on 19th April 2007 (right panel) from base simulation (bottom panels) and from IFN3 simulation (down panels) at 12 UTC.

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 derived that the update of the birch fraction map in Spain improves the behavior of the model in the measurement-sites

CONCLUSIONS

This work shows the application of a dispersion model (SILAM) to the study of Betula pollen distribution in South of Europe. The model takes into account a European map fraction of birch, since some uncertainty existed in the central and south part of Europe from initial map a modification in the Spanish territory was done with IFN3 data. The birch fraction map affects to the location of pollen emissions and to the amount of pollen emitted, so it is relevant to determine the pattern of distribution of pollen. Other factors of importance are the moment of the start of flowering or release of pollen, the transport determined by wind and other meteorological conditions, and the sinks like the dry or wet deposition.

Two pollen seasons have been reproduced and evaluated with airborne pollen data recorded at XAC for both input maps. In general, model results are closer to measurements in the simulation with the IFN3 birch map. The model shows agreement in reproducing most of observed peaks but it fails in the concentration. Nevertheless, the two years studied show that the apportionment to the birch peaks was originated in France, which could be infer as a necessity of a revision in the birch fraction for France. The evaluation of the model should be extended to other regions in order to obtain more general conclusions.

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