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Models for forecasting airborne Cupressaceae pollen levels in southwest Iberian Peninsula

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Introduction. Cupressaceae family includes an important number of species cultivated as ornamental in the urban environment and it is an anemophilous (wind pollinated) family. In the Iberian Peninsula includes 7 natural species in two genera, *Juniperus* (6) and *Tetraclinis* (1), being six ornamental species the most frequent in urban environment: *Cupressus sempervirens, C. arizonica, C. macrocarpa, Platycladus orientalis, Chamaecyparis lawsoniana, x Cupressocyparis leilandii*. They pollinated essentially in winter and their pollen is captured by aerobiological samplers mainly in two months. The main objective is to model the *Cupressaceae* pollen concentration (CC) from of the relation with the temporal distribution of different climatic variables for 21 years (t) of continuous recording.

Methods. Daily concentration of airborne pollen concentration were obtained by using a Hirst type pollen trap located at the roof of a building at the University of Extremadura of Extremadura in Badajoz (SW Spain). Data were provided in daily pollen grains concentration for cubic meter. *Cupressaece* data from the period 1993-2013 were compared using time series analysis. Climate parameters as rainfall (R), relative humidity (RH), maximum (T_{max}), mean (T_{mean}) and minimum temperature (T_{min}) were studied with a proposed parametric model which was calibrated with the genetic algorithm SCEM-UA (Vrugt et al, 2003) using RMSE as optimization function.

Results. The model proposed to forecast the airborne pollen concentration is described by the eq. (1)

$$CC^t = a \cdot \frac{\sum_{i=t-10}^{i=t} CC^i}{10} + CC^{t+1}\ \left(b \cdot {T_{max}}^t + c \cdot {T_{mean}}^t + d \cdot {T_{min}}^t + e \cdot \frac{\sum_{i=t-10}^{i=t} {T_{mean}}^t}{10} + f \cdot R^t + g \cdot \sum_{i=t-10}^{i=t} R^t + h \cdot RH^t \right) \quad (1)$$

where a, b, c, d, e, f, g and h are the coefficients to be calibrated for our time series of climatic and airborne pollen concentration, and is composed by the integration of the different climatic variables for each time step regarding to the actual airborne pollen concentration value join to the mean concentration value of the previous 10 days for each time step. Beside the value of each variable is evaluated for each time step, it has been added the aggregated variables of the mean temperature for 10 previous days as well as the cumulative rainfall of the 10 previous days to analysis the

adfa, p. 1, 2011.

influence of the temporal variation of these variables over the airborne pollen concentration.

Regardless the degree of influence of some climatic variables could be previously neglected by its apparently low relevance, it has been therefore considered appropriate to maintain them due the range of variations of are different among them as well as its mean value. In the Table 1 are shown the values obtained for each parameter for the 20 years analyzed, and the value obtained of the coefficient of determination (R^2) and the efficiency Nash-Sutcliffe criterion (NS).

Table 1. Parameters and statistical analysis of the model proposed to predict airborne pollen concentration.

Parameters	*Value*	*Parameters*	*Value*	*Statistical Analysis*	
a	0,933	e	-0,083	$\overline{CC_{obs}}$	49,71
b	0,038	f	0,012	$\overline{CC_{sim}}$	48,48
c	0,014	g	-0,001	R^2	0,3
d	0,016	h	0,033	NS	0,44

Conclusion. The main advantage of the model proposed is the integration of more climatic variables than conventional models in Aerobiology, even accumulative values of the climatic variables to add a register of the inertial of the temporal distribution of the airborne pollen concentration. This model represents a good approach for a continuous balance model of the CC concentration, being corroborated by the closest between observed and predicted mean concentration. The low values of the R^2 and NS are conditioned by the non-linearity behavior of the CC concentration regarding to climatic conditions in the cases of very high concentration of it, highlighting the necessity to improve the predictability for these scenarios.

Reference

Vrugt, J. A., H. V. Gupta, W. Bouten, and S. Sorooshian (2003), A Shuffled Complex Evolution Metropolis algorithm for optimization and uncertainty assessment of hydrologic model parameters, Water Resour. Res., 39, 1201, doi:10.1029/2002WR001642, 8.