Atmospheric dispersal of maize pollen over the Aquitaine region

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Summary

The on-going introduction of genetically modified maize is generating research on the possibilities for coexistence. Following recent experimental evidence for the presence of maize pollen in the atmosphere up to heights of about 1-2 km, a modelling tool has been developed to simulate long-range pollen dispersal and deposition. Here we present the model basis and preliminary results confirming the measurements performed from an instrumented aircraft.

1 Introduction

The recent and growing introduction of genetically modified (GM) crops has generated a host of research efforts aimed at investigating the possibilities for coexistence between GM, conventional and organic crops. This is particularly true for maize, that is extensively grown in France. A series of experimental and modelling studies have shown that most pollen grains emitted by a source field deposit within a short distance from the latter, and that the observed dispersal functions have long fat tails, making it possible for pollen to contaminate plants at rather long distances. This has been confirmed by airborne measurements of pollen concentration and viability performed throughout the atmospheric boundary layer (ABL) by Brunet et al. (2004). An approach for simulating long-range dispersal of pollen and its deposition at a regional scale has been developed to better understand these processes. The presentation of this approach is the object of the present paper.

2 Methods

Maize pollen dispersal and meteorological fields are simulated over the Aquitaine region (South-West France) using the mesoscale atmospheric model MesoNH. Pollen dispersal in the atmosphere is modelled through an advection-diffusion equation. Pollen emission from the surface follows a Gaussian daily variation and the deposition rate is modelled by a deposition velocity.

3 Results

A preliminary simulation has been carried out to test pollen dispersal and deposition with MesoNH on July 10, 2003, during which several flights were performed to measure the ABL pollen concentration under anticyclonic conditions favourable to long-distance pollen transport. A single 12-km square maize source plot was considered for this simulation. MesoNH was run in a two-way

nested configuration including three nested computational domains down to a 2-km horizontal resolution. The simulation confirms the observations: close to the ground surface pollen concentration decreases rapidly with height and distance from the source, due to the large settling velocity of maize pollen. In the middle of the day significant concentration values of the same order as the measurements are observed throughout the ABL (a few grains m^{-3} over the maize region). They result from the convective activity that allows pollen mixing and transport over several km from the source, up to about 80 km at the end of the day (fig. 1). The accumulated deposition downwind from the source exhibits a long tail spanning over five orders of magnitude (fig. 2).

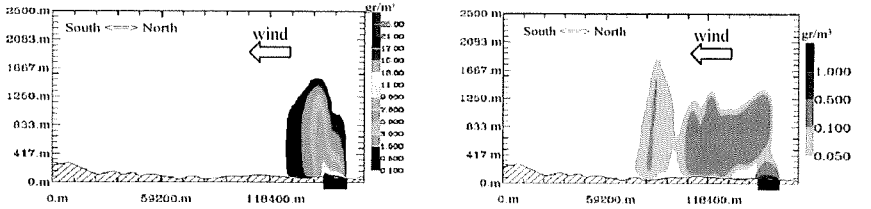

Fig. 1. Concentration of pollen (grains m^{-3}) on a South-North vertical cross section at 12h UTC (left) and 18h UTC (right). The black rectangle represents the maize source plot.

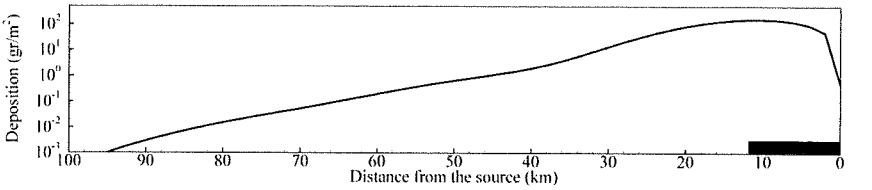

Fig. 2. Accumulated deposition curve downwind from the source (black rectangle).

4 Conclusions

The next step consists in accounting for all the maize fields of the region using a GIS database, and in validating the pollen concentration fields and its viability rate, as simulated by MesoNH, against the airborne measurements performed by Brunet et al. (2004) on various days during the pollination period. This study will be later extended to various climatic conditions, and several land-use scenarios will be tested to evaluate the risks of long-distance deposition of viable pollen.

References

Brunet, Y., Foueillassar, X., Audran, A., Garrigou, D., Dayau, S. (2004). Evidence for long-range transport of viable maize pollen. 16th Conference on Biometeorology and Aerobiology, Vancouver, Canada, 23-27 August 2004, 2 p.