



Mesoscale dispersal of maize pollen and implications for gene flow

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A summary of recent findings

Brunet et al. (in prep.)

- ▶ *Aircraft measurements in the first 2000 m*
 - ◆ Pollen is present in the first 2000 m, with well-marked changes in time and height and exhibits a fairly high viability

- ▶ *Chamber measurements of pollen viability*
 - ◆ Life duration depends on air saturation deficit. The thermodynamic conditions in the ABL increase pollen life duration to several hours

- ▶ *Observations in small isolated white-kernel maize plots*
 - ◆ Evidence for fecundation at several km of nearest maize fields (~ 0.1-0.2 % with no tassels, ~ 0.01-0.04 % with tassels)





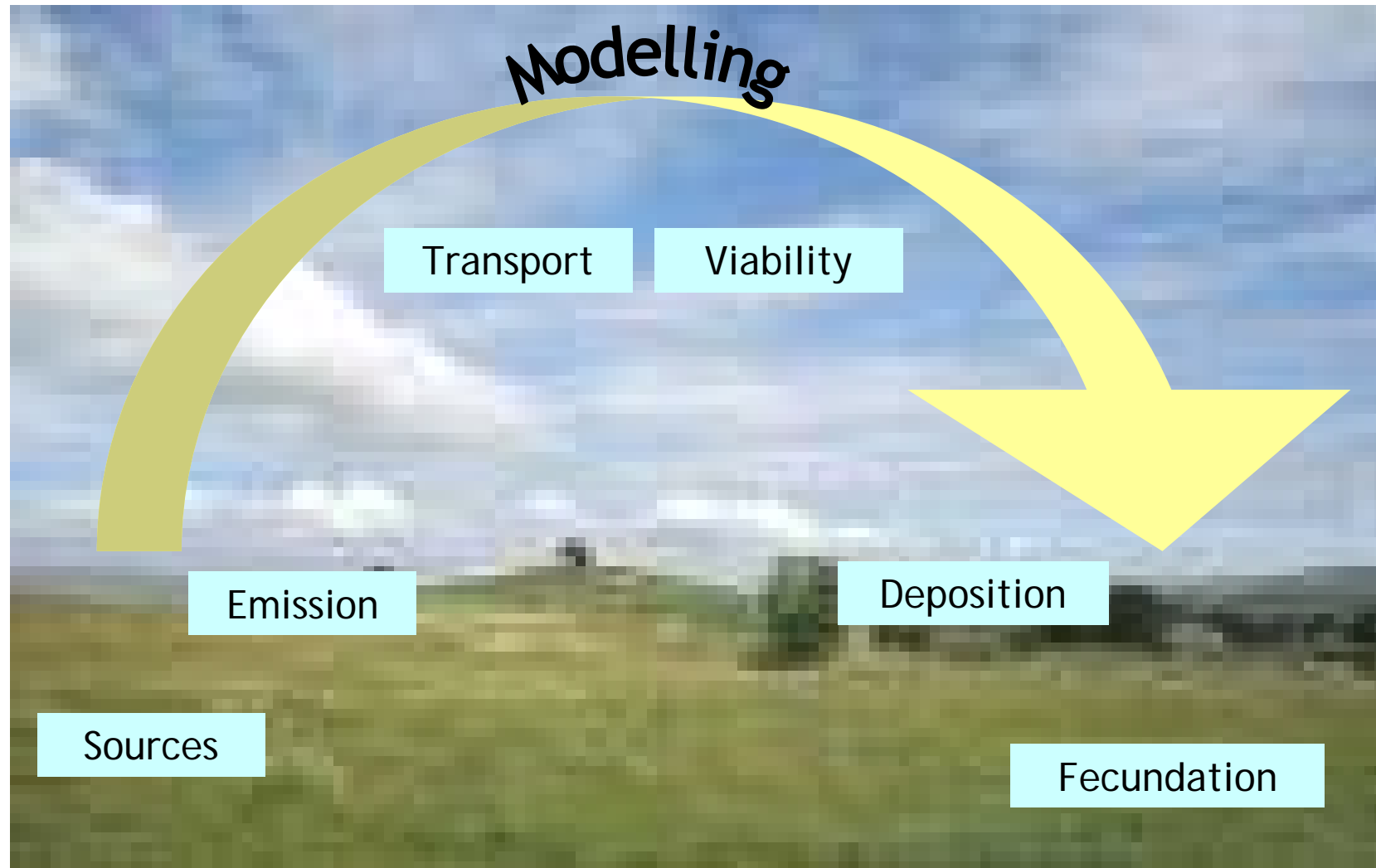
Where does viable pollen go?

- ▶ *Need for modelling at regional scale*
 - ◆ Investigate dispersal and deposition of viable pollen over a range of atmospheric conditions and landuse patterns (resolution ~ 1 km, domain ~ 300 km)
 - ◆ Investigate whether regional landuse management may be a tool to improve coexistence possibilities





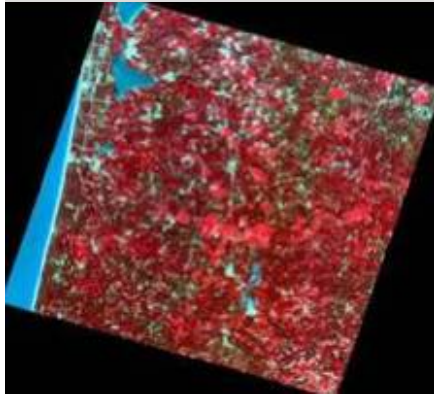
Need for integrated modelling



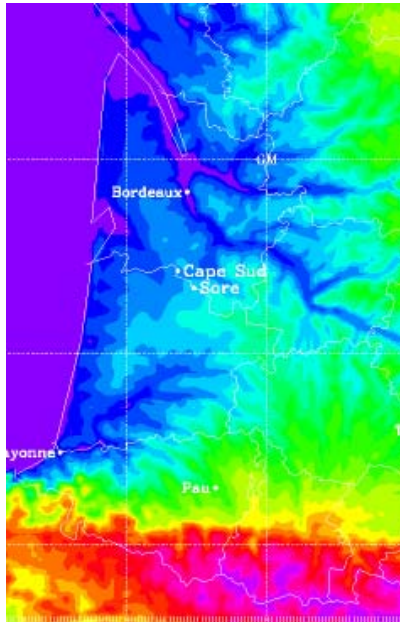
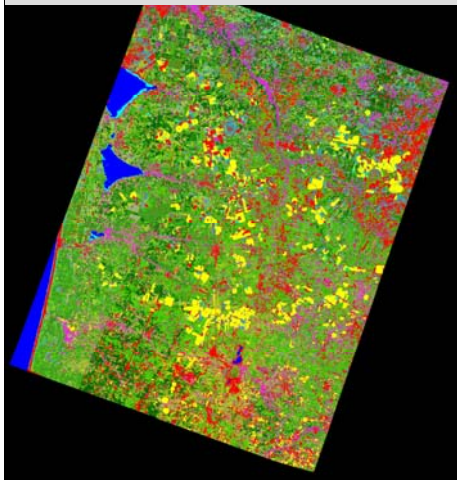


RS / GIS-based identification of maize fields

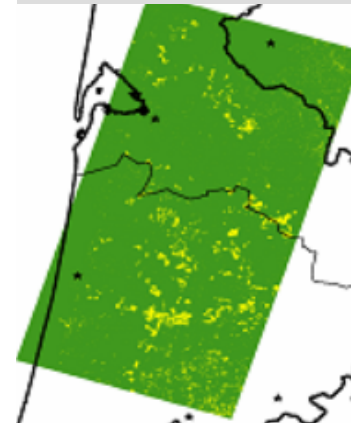
SPOT images



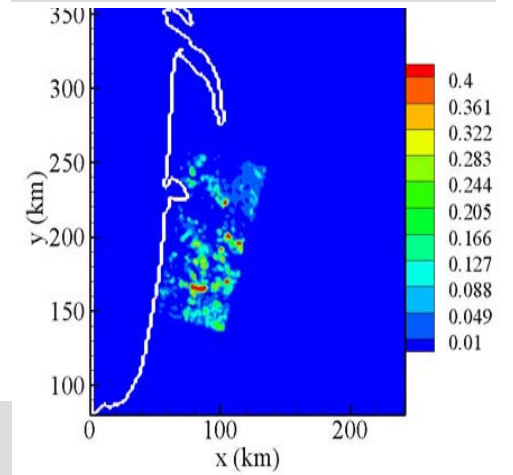
Landuse classes



Map of maize fields



% Maize area





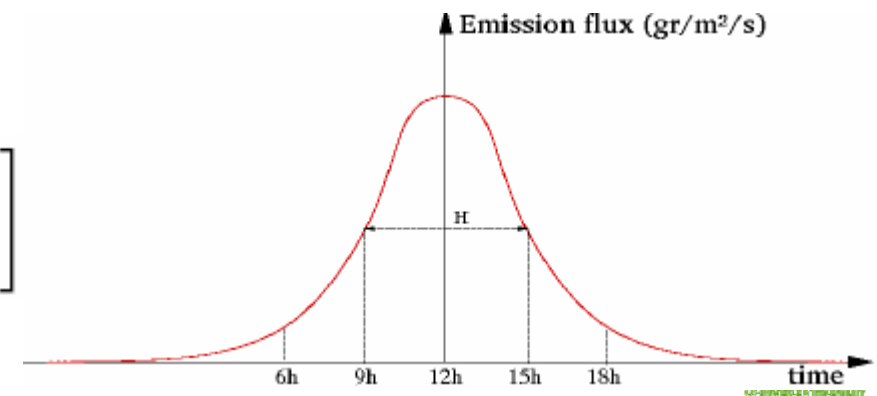
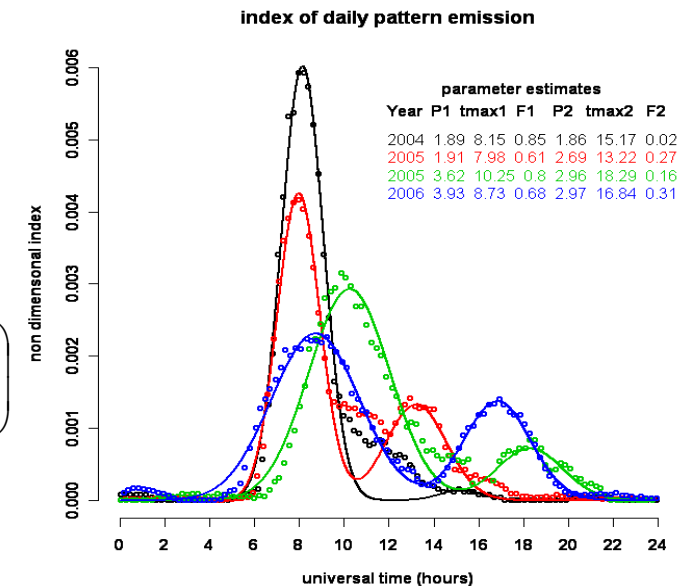
Modelling pollen emission

- ▶ A bimodal model (Marceau and Huber, 2007)

$$I_B(t)_d = \frac{Q_d(t)}{Q_d^{tot}} = \frac{F1_d}{P1_d \times \sqrt{\pi/2}} \times \exp\left(-2\left(\frac{t-t_{max1_d}}{P1_d}\right)^2\right) + \frac{F2_d}{P2_d \times \sqrt{\pi/2}} \times \exp\left(-2\left(\frac{t-t_{max2_d}}{P2_d}\right)^2\right)$$

- ▶ Here: a simple unimodal model

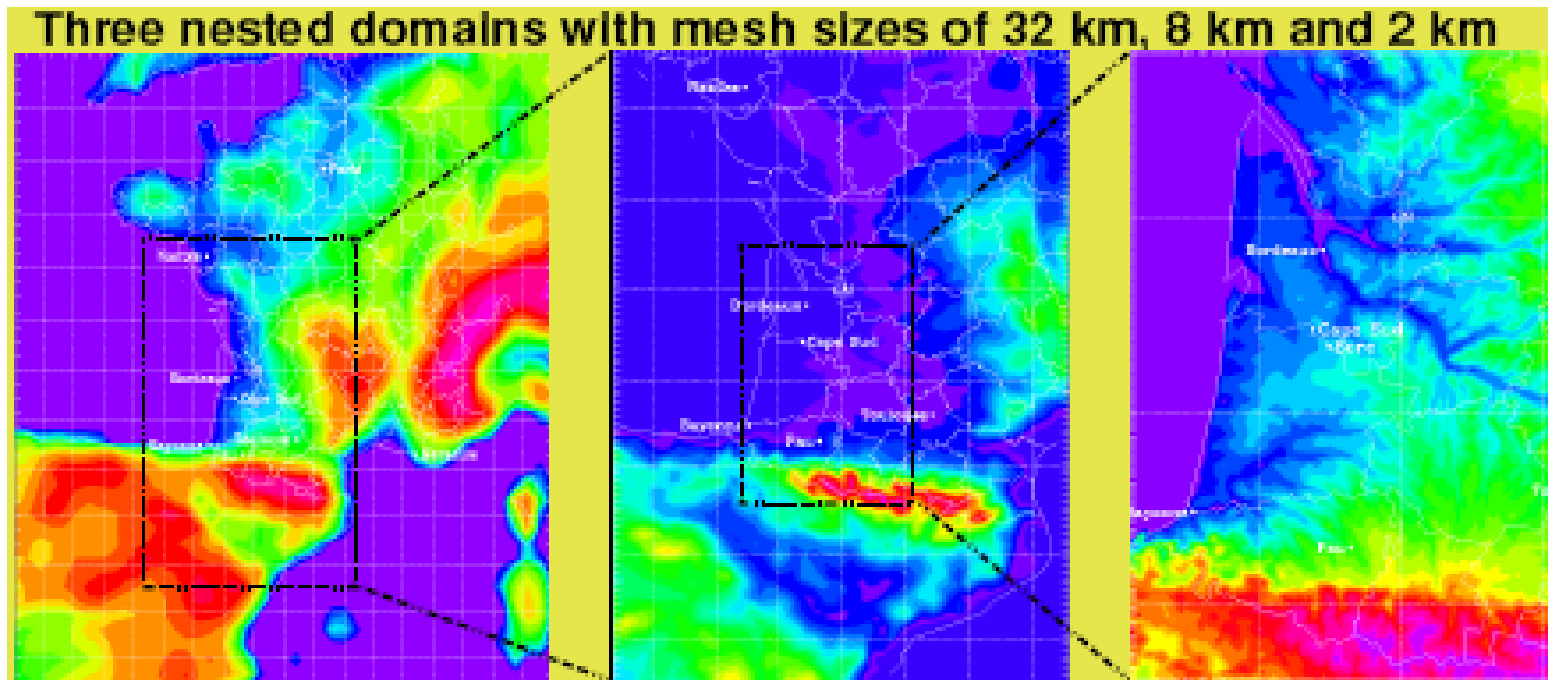
$$E^{alive} = r_m G(\theta_0^E) E_{max} \exp\left[-4 \log(2) \frac{(t - t_E)^2}{H_E^2}\right]$$





A mesoscale atmospheric transport model

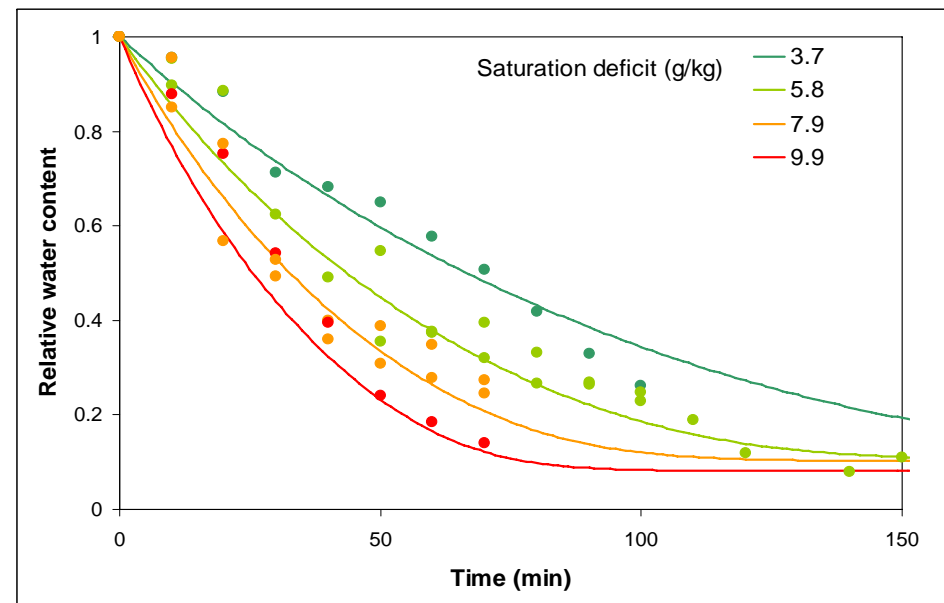
- ▶ *Simulating regional transport with Meso-NH*
 - ◆ A 3D non-hydrostatic mesoscale atmospheric model developed by Météo-France and Laboratoire d'Aérodynamique
 - ◆ Work performed with the help of S. Delage (July 2006 - December 2007) and M. De Luca (December 2008 - March 2009), Co-Extra post-docs





Inclusion of Eulerian pollen transport

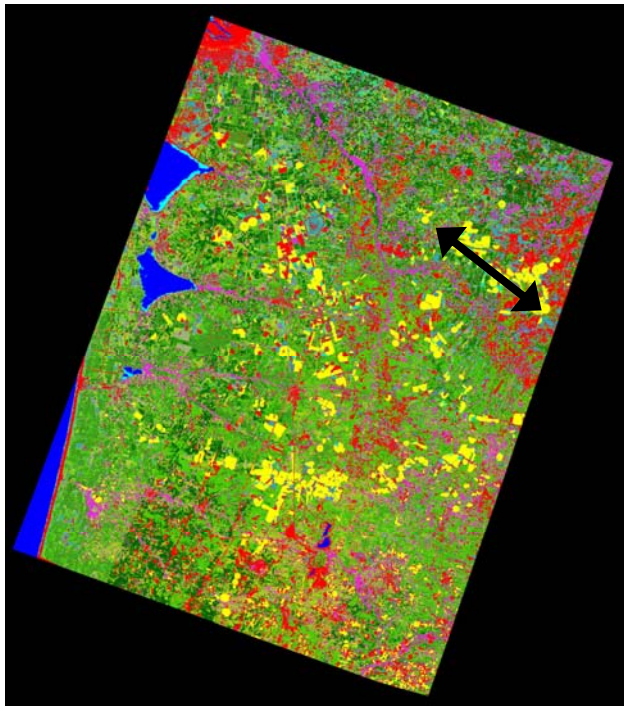
- ▶ *Add conservation equations in Meso-NH for alive and dead pollen:*
 - ◆ Pollen concentration
 - ◆ Pollen water content
- ▶ *Express new terms (gravity, evaporation, mortality rate) as a function of pollen water content*
- ▶ *For this: a new model for pollen dessication*



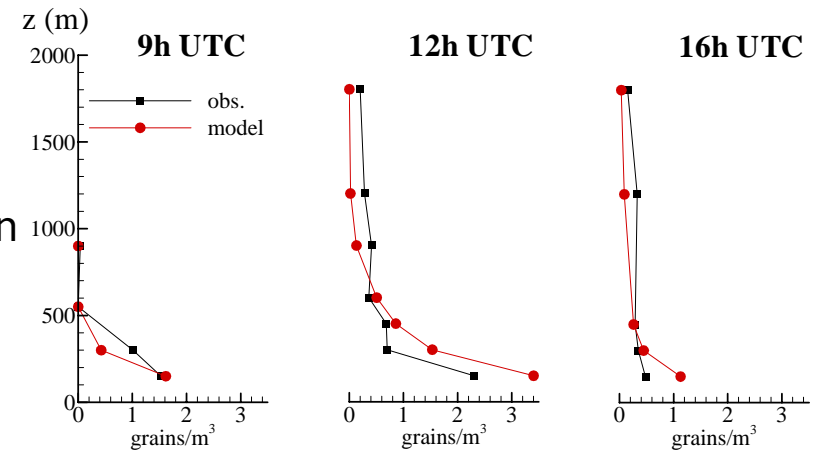


Model evaluation

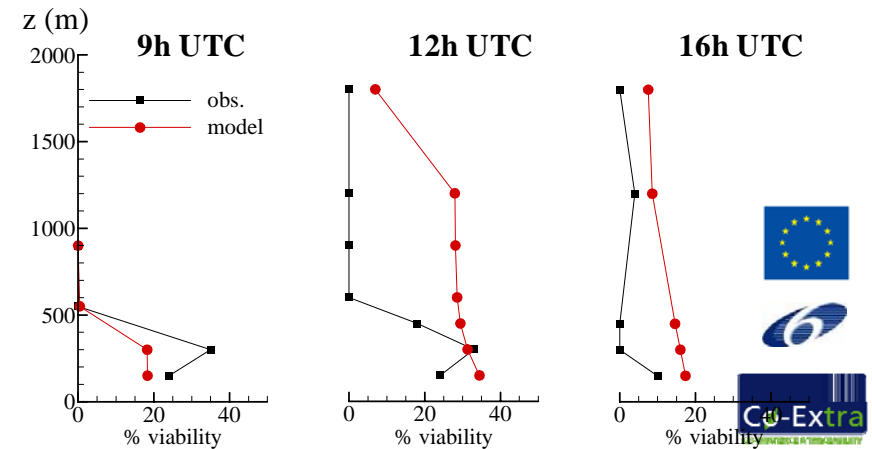
- ▶ Test model results over transects with aircraft measurements at various heights and times (e.g. 12 July 2003)



Pollen concentration

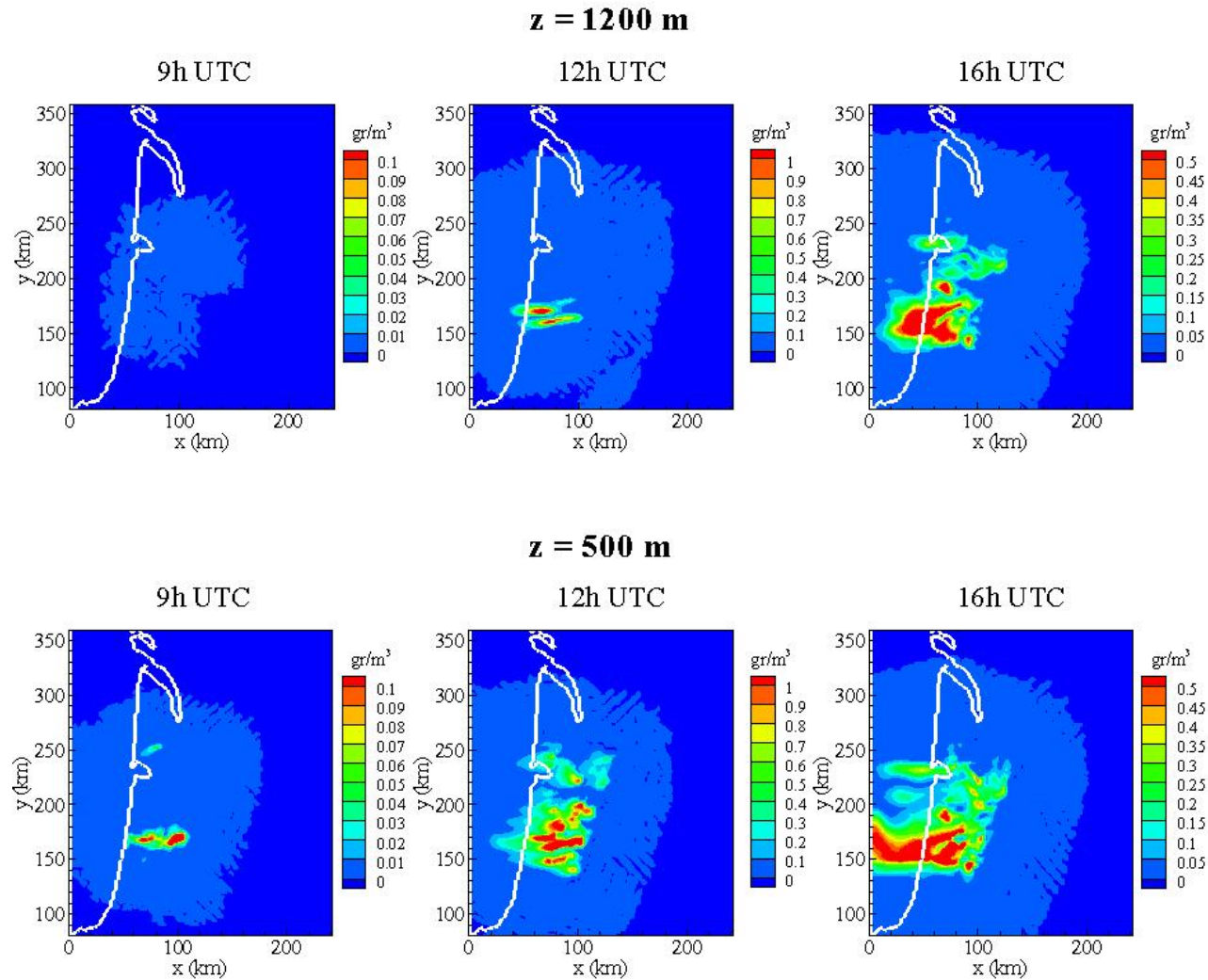


Pollen viability (previous model)



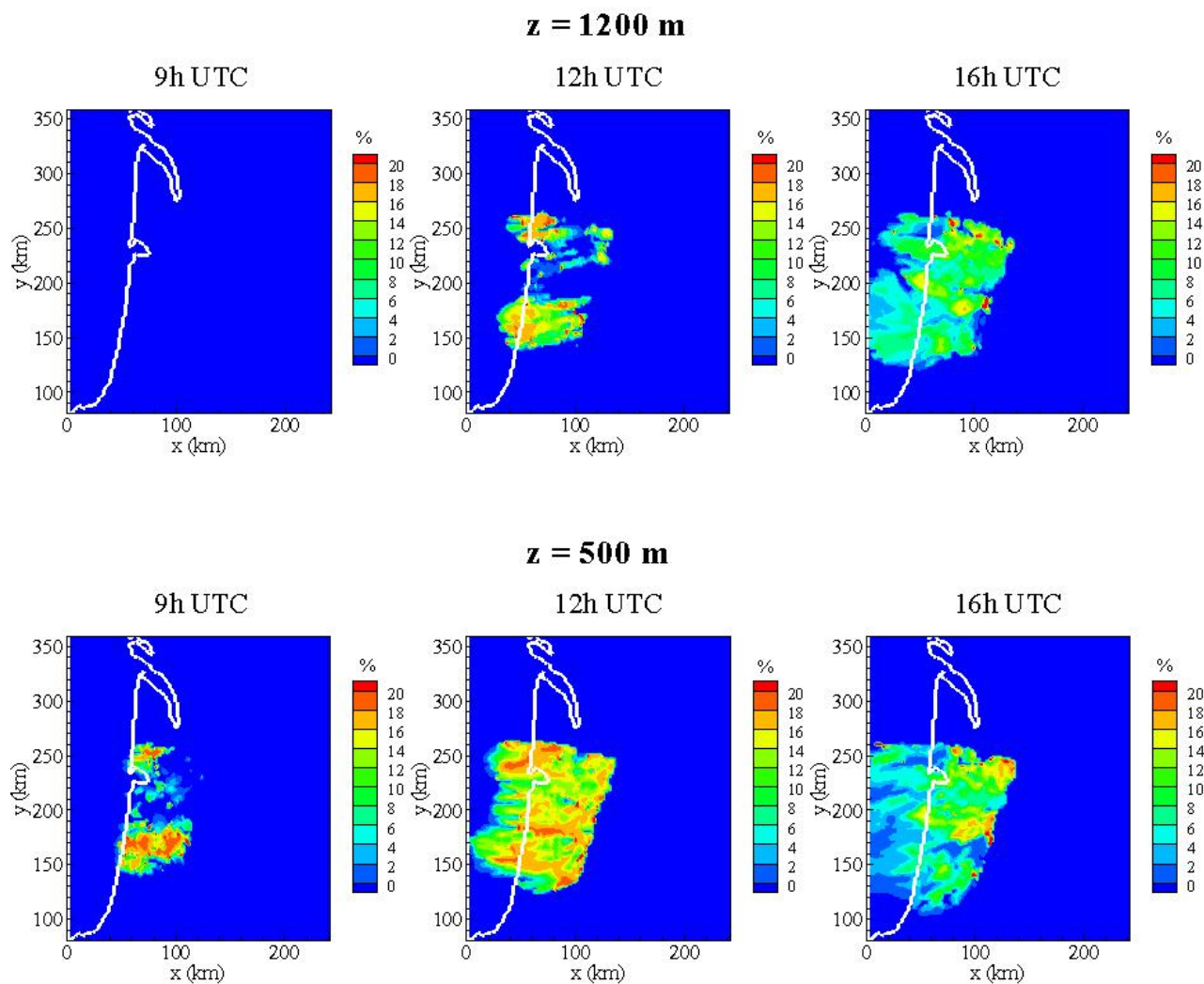


The regional pollen plume





Regional pollen viability

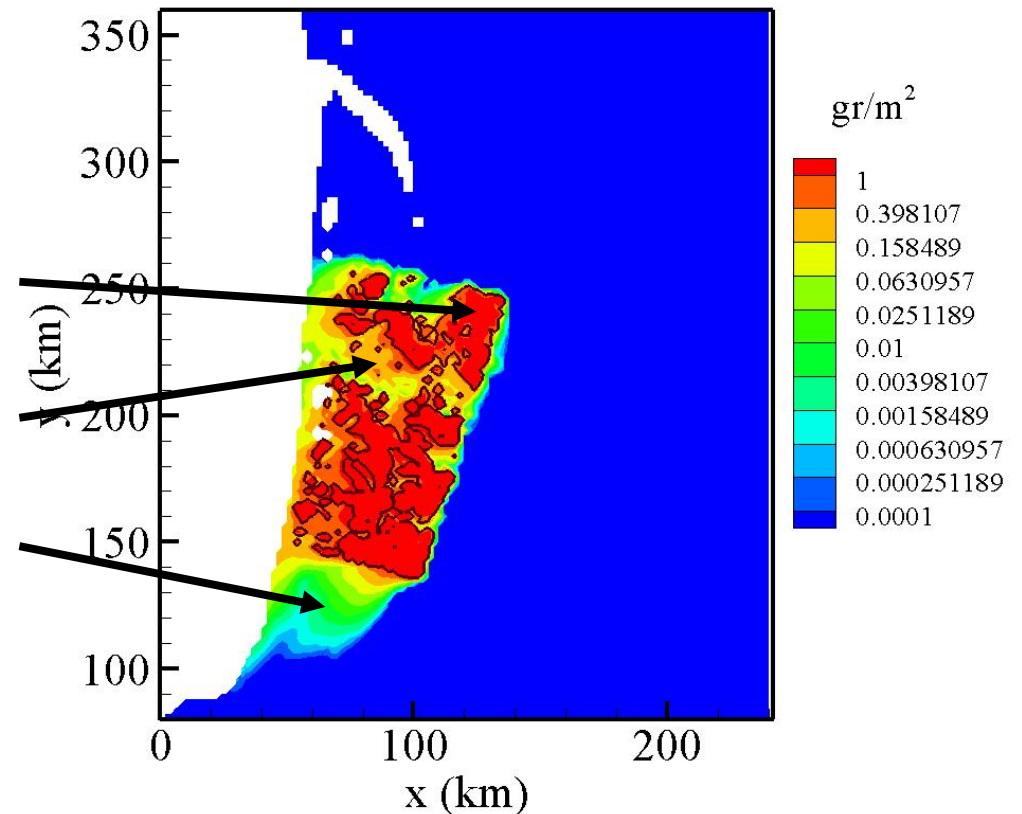




Regional deposition of viable pollen

- ▶ *Large deposition over maize areas*
- ▶ *Background levels in enclosed regions*
- ▶ *Steady decrease outside maize regions*

Daily accumulated deposition





Conclusions

- ▶ *A tool based on mesoscale modelling, remote sensing, GIS*
- ▶ *The results confirm experimental data on the presence and viability of maize pollen in the atmospheric boundary layer (first 2 km)*
- ▶ *The results show the existence of (very) long-distance deposition of viable pollen*
- ▶ *In a maize region the background levels of daily accumulated deposition of viable pollen (i.e., several km from the nearest fields) are of the order of 0.01 to 100 gr/m²*
- ▶ *These levels are compatible with observed long-distance outcrossing rates*





Perspectives

- ▶ *Need to introduce effective pollination (under investigation)*
- ▶ *Further evaluation: all days with aircraft measurements to be processed, with new pollen emission and desiccation models*
- ▶ *Use of the model to test the influence of atmospheric conditions, land use patterns, management practices*
- ▶ *Possible use in other domains of Aerobiology:*
 - ◆ pollen transport related to allergies
 - ◆ pathogens (spores, fungi...)
 - ◆ atmospheric microbiology





Thank you



**Co-Extra International
Conference
2-5 June 2009 Paris**