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Influence of boundary-layer dynamics on pollen dispersion and viability

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Adoption of genetically modified (GM) crops has raised concerns that GM traits can accidentally cross into conventional crops or wild relatives through the transport of wind-borne pollen. In order to evaluate this risk it is necessary to account both for dispersion of the pollen grains and environmental influences on pollen viability. The Lagrangian approach is suited to this problem because it allows tracking the environmental temperature and moisture that pollen grains experience as they travel. Taking advantage of this capability we have combined a high-resolution version of the WRF meteorological model with a Lagrangian particle dispersion model to predict maize pollen dispersion and viability. WRF is used to obtain fields of wind, turbulence kinetic energy, temperature, and humidity which are then used as input to the Lagrangian dispersion model. The dispersion model in turn predicts transport of a statistical sample of a pollen cloud from source plants to receptors. We also use the three-dimensional temperature and moisture fields from WRF to diagnose changes in moisture content of the pollen grains and consequent loss of viability. Results show that turbulent motions in the convective boundary layer counteract the large terminal velocity of maize pollen grains and lift them to heights of several hundred meters, so that they can be transported long distances before settling to the ground. We also found that pollen lifted into the upper part of the boundary layer remains more viable than has been inferred using surface observations of temperature and humidity. This is attributed to the thermal and moisture structure that typifies the daytime atmospheric boundary layer, producing an environment of low vapor pressure deficit in the upper boundary layer which helps maintain pollen viability.