PIV Measurements of Atmospheric Turbulence and Pollen Dispersal Above a Corn Canopy

Weihong Zhu, Luksa Luznik, René van Hout, Joseph Katz  
Department of Mechanical Engineering, The Johns Hopkins University  
Baltimore, MD 21218 USA  
E-mail: wzh1@titan.me.jhu.edu; vanhout@pegasus.me.jhu.edu; katz@titan.me.jhu.edu  
webpage: http://www.me.jhu.edu/~lefd/BioComp/Main.htm

Abstract

Dispersion of pollen grains by wind and gravity (Anemophilous) is one of the oldest means of plant fertilization available in nature. Recently, the growth of genetically modified foods has raised questions on the range of pollen dispersed in order to limit cross-fertilization between genetically grown and transgenic crops. The distance that a pollen grain can travel once pollinated is an important parameter. Knowledge of their displacement through statistical correlation results in the fluid velocity field. Advantage over point measurements: whole field, velocity information in spatial domain.  

Experimental Setup

PIV Setup

• Two Dalsa SMD CCD cameras, 2kx2k, 12 bits, auto-correlation, hardware based image shift, 4 frame/second, 
• Data streamed over 70 m to 240 GB disk arrays
• Seeding of the flow by two Rosco 1600 smoke generators.
• Hydraulic Platform: System can be lifted up to 10 meters

Light Source

• Dual-head Flashlamp Pumped-dye Laser  
  • Rhodamine 6G dye, 350 mJ/pulse at 594 nm, 2 ms pulse length  
  • Up to 15 pulse-pairs/s with unlimited in-pair delay  
  • Max output: 120 mJ/pulse before damage to fibers

PIV data

• Instantaneous vector map  
• Correlation map of one vector  
• Correlation Peak  

Field Experiment

Mean Velocity Profiles

Velocity Fluctuation Vectors and Vorticity Distribution

Convergence RMS u’, w’, and Reynolds stress u’w’ (3.45 m)

Particle Image Velocimetry (PIV)

• Imaging of tracer particles in the flow at two different time instants. Knowledge of their displacement through statistical correlation results in the fluid velocity field.  

Basic description of Particle Image Velocimetry (PIV)

• Non-intrusive measurement technique  

ADVANTAGE: huge fetch (400m).

DISADVANTAGE: only measuring at specific wind directions.

ADVANTAGE: Guaranteed pollen dispersion.

DISADVANTAGE: some of the equipment needs to be moved when irrigation arm comes over.

Easy access to field site.

Flat terrain, obstructions far away.

Particle Image Velocimetry (PIV)  
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Pollen samplers  
M. Thronenburg, G. Brush

Sonic anemometers/Meteorological station  
J. Ekker, M. Parlanje

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