Microbes travel through the air; it would be good to know how and where

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Shane Ross, left, assistant professor of engineering science and mechanics, and David Schmale, III, right, associate professor of plant pathology, physiology and weed science, both at Virginia Tech, are using autonomous aircraft to study how airborne microbes might ride massive air systems to travel long distances across regions. Credit: Virginia Tech

Preliminary research on *Fusarium*, a group of fungi that includes devastating pathogens of plants and animals, shows how these microbes travel through the air. Researchers now believe that with improvements on this preliminary research, there will be a better understanding about crop security, disease spread, and climate change.

Engineers and biologists are steering their efforts towards a new aerobiological modeling technique, one they think may assist farmers in the future by providing an early warning system for high-risk plant pathogens. It will also provide the basis for more effective management strategies to address the spread of infectious diseases affecting plants, domestic animals, and humans.

Using initial studies on the efficient movement and subsequent atmospheric dispersal of these microbes, Shane Ross, an assistant professor of engineering science and mechanics, and David Schmale III, associate professor of plant pathology, physiology and weed science, both at Virginia Tech, have received close to half a million dollars from the National Science Foundation to use autonomous unmanned aerial vehicles (UAVs) to collect new samples of *Fusarium* in the lower atmosphere. They believe their work, combining the study of biology with engineering dynamics, will allow the prediction of atmospheric transport barriers that might govern the motion of *Fusarium* between habitats.

In preliminary work leading to their new study, also funded by the National Science Foundation, but through a different project led by Schmale and Ross, more than 100 airborne samples of *Fusarium* were obtained using UAVs. "The resulting information has led to strong evidence that specific atmospheric structures play a role in determining atmospheric concentrations of *Fusarium*," Ross said. This work was published on line Sept. 9, 2011 in the American Institute of Physics' journal *Chaos*.

In engineering terms, the atmospheric structures are called Lagrangian coherent structures, named after the 18th Century Italian-French mathematician Joseph Lagrange. He introduced a point of view into the study of fluids, like the atmosphere, which the research will employ.

Ross and Schmale will be able to compute, track, and predict atmospheric transport barriers governing the motion of microorganisms such as *Fusarium* between habitats, using engineering methods including the Lagrangian methods.

"By comparison with results of microbiological analysis, we expect to reveal how dynamical structures partition and mix airborne populations of microorganisms, and relatedly, how mixtures of microorganisms might encode their recent history of large-scale atmospheric mixing," they said.

For microbes to move through the atmosphere to a new habitat, they must pass through a series of 'layers'- the laminar boundary layer, the surface boundary layer, and the planetary boundary layer. The surface boundary layer often contains strong vertical gradients in wind speed, temperature, and humidity, accounting for the turbulence. "The small-scale motion can be characterized as random," Ross added.

If the microbes make it above this surface boundary layer, and enter the second layer of the atmosphere, defined as being at a height of about 50 meters to about three kilometers above the ground, they can be transported over long distances. In this second layer, known as planetary boundary layer, "there are a lot of uncertainties in the trajectory computations," Ross explained.

With Ross and Schmale's research they hope to reduce some of these uncertainties. Schmale has already published his findings about reliable methods for collecting and studying populations of *Fusarium* in the lower atmosphere. (see: http://onlinelibrary.wiley.com/doi/10.1002/rob.20232/abstract and http://www.springerlink.com/content/d203130563348570/

Using UAVs, Schmale has collected data that shows the lower atmosphere is "teeming with *Fusarium*." Schmale has DNA sequence data for hundreds of strains of *Fusarium* collected from the atmosphere, and they have preliminary data validating the important role that atmospheric transport barriers play in the transport of the microorganisms.

Ross said their work should allow them to make more predictable assessments of the transport of the microbes.

"In the future our work may be able to assist farmers by providing an early warning systems for high risk plant pathogens," Ross said. "It might also pave the way for more effective management strategies for the spread of infectious diseases affecting plants, domestic animals, and humans."

Provided by Virginia Tech

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