A new look at the eye of the hurricane

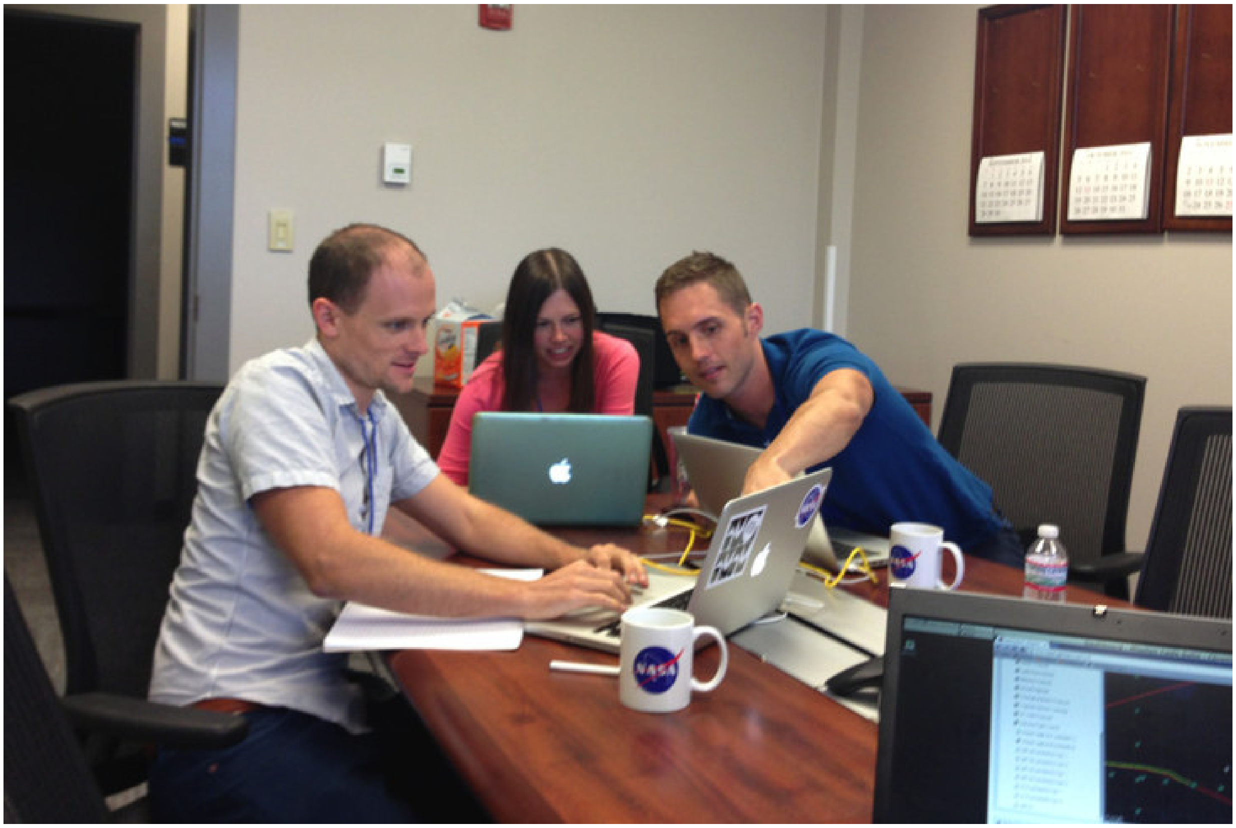
April 13 2016, by Liam Jackson

A Global Hawk unmanned aerial vehicle, or drone, takes flight to collect hurricane data. Penn State meteorology graduate students served on this NASA project, which aimed to use drones to collect data from inside hurricanes. Credit: NASA

Most 5-year-olds relish the chance to build sandcastles and play in the waves during a family trip to the beach. But for Erin Munsell, television coverage of Hurricane Emily trumped the excitement of the ocean. The hurricane was developing over the Atlantic Ocean and, Munsell recalls, it had a 1 percent chance of hitting the New Jersey beach where she and her family were on vacation.

"As a 5-year-old, I apparently thought it was the most fascinating thing ever. I sat in front of the television and watched the Weather Channel all weekend," said Munsell. "My dad always tells this story that he let me stay up until midnight so I could watch the coverage. When my brother and cousins went off to the beach, all I wanted to do was stay in and keep watching Hurricane Emily."

Emily did not make landfall, but it did leave an indelible mark on Munsell, who tracked hurricanes and other meteorological phenomena through grade school and made meteorology the focus of her college career. After receiving a B.S. in earth, atmospheric and planetary science from the Massachusetts Institute of Technology, Munsell chose Penn State for graduate school because of the meteorology program's strengths in both theoretical and applied science. Not only were faculty trying to understand the underlying physical reasons that hurricanes and other phenomena were developing, but also they were using that knowledge to predict when the next hurricane would hit land.



Graduate students help track the path of Hurricane Edouard as part of NASA's Hurricane and Severe Storm Sentinel project. L-R: Pete Finocchio, Ph.D. student from the University of Miami; Erin Munsell, Penn State meteorology Ph.D. student; and Christopher Melhauser, Penn State meteorology Ph.D. student. Credit: Erin Munsell

Through her experience as a Penn State graduate student, Munsell was selected to participate in NASA's Hurricane and Severe Storm Sentinel (HS3) project—the first time that NASA tested the use of drones to collect hurricane data.

Predicting the intensity of the next hurricane

When Hurricane Edouard was developing in 2014, Munsell and three other graduate students avidly watched the path of the growing storm as it traversed the Atlantic. Stationed at the Wallops Flight Facility in Virginia, the team of graduate students—which included two others from Penn State, Christopher Melhauser and Ben Green—were helping the HS3 team track Edouard's movement.

The goal of HS3 was to investigate the processes underlying hurricane formation and intensification in the Atlantic Ocean. By using multiple types of drones, the project team hoped to collect important information about hurricane development—temperature and wind speed, primarily—to improve forecasts of future hurricanes.

When predicting the impact of a hurricane, researchers focus on two key aspects: path and intensity. Over the past few decades, hurricane path predictions have improved steadily. Predicting the intensity, however, has been much more challenging. Knowing a storm's intensity could help people better predict and prepare for damage a hurricane might inflict.

Four graduate students who went to the Wallops Island Facility to help NASA use drones to collect hurricane data stand for a photo next to a Global Hawk drone. L-R: Pete Finocchio, Ph.D. student from the University of Miami; Erin Munsell, Penn State meteorology Ph.D. student; Ben Green, Penn State meteorology Ph.D. student during the project, who now works at the National Oceanic and Atmospheric Administration's Earth System Research Laboratory; and Christopher Melhauser, Penn State meteorology Ph.D. student. Credit: Erin Munsell

"Intensity prediction is more difficult because it depends on a small region around center of the storm. Those processes that control the inner core of the cyclone are more chaotic and harder to predict," Munsell says.

The main way that NASA and the National Oceanic and Atmospheric Administration (NOAA) collect data on hurricanes now is through 'hurricane hunters.' These are aircrews that fly specialized planes, equipped with tracking equipment and sensors, into the eye of the storm. Data they collect is used in statistical hurricane prediction models that attempt to gauge the path and size of developing storms.

Drones doing what humans can't do

Hurricane hunter data has vastly improved hurricane prediction models. Hurricane hunters are limited, however, by the fact that the hurricane has to be within flying distance. As a result, they typically do not capture data during all stages of a hurricane's development. Drones do not have the same limitations.

"Typical hurricane hunters leave from Tampa or the Caribbean islands, and they can only stay out for five or six hours, making only one pass through the hurricane before returning for fuel," says Munsell. "The Global Hawk drones we were testing could stay out for up to 30 hours and could make multiple passes through the hurricane."

The HS3 drones made crisscross, butterfly patterns through the hurricanes, allowing the team to collect data from the inner core of the hurricane as well as the area surrounding the storms.

Munsell and the other graduate students helped the NASA teams that were remotely piloting the drones know where the storm would move to next.

"We needed to make sure we collected data right from the eye of the storm, and it took one to two hours between times we crossed through the eye. During this time, the storm was moving, so we needed to keep track of its path. We were using all the latest satellite imagery," says Munsell. "It was important for the mission and it was fun."

The team collected unprecedented data during the major stages, from tropical depression through hurricane, of Hurricane Edouard. They also collected data during periods of rapid intensification, which Munsell says is critical for improving understanding of how storms increase wind speed.

"Those periods of rapid intensification are dominated by the inner core processes, and data we gather during these times can help us understand the fundamental processes at work," she says.

Provided by Pennsylvania State University