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Unmanned science takes flight

Pilotless craft poised to fly over forest fires, into hurricanes

By Todd Neff, Camera Staff Writer
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Boulder researchers are leading a movement to enlist unmanned aircraft for scientific missions too long or dangerous for human pilots.

Such data-gathering excursions, lasting 30 hours or longer and capable of covering half the circumference of the globe, could improve weather and hurricane forecasting and even help fight forest fires.

In tests led by NASA and the National Oceanic and Atmospheric Administration in 2005, remote-controlled aircraft proved their mettle over the California coast and in the maelstrom of Tropical Storm Ophelia. This year, the two agencies are pushing ahead with the scientific use of the traditionally military technology, and they are now poised to fly over a western wildfire and into the fiercest winds of an Atlantic hurricane.

In addition, NASA is set this fall to receive two Global Hawk unmanned aircraft being retired from the Air Force. They are the size of a Boeing 737 and capable of flying at an altitude of 65,000 feet for 40 hours.

Such craft could gather atmospheric data from above hurricanes and improve hurricane track and intensity prediction, NOAA scientists say. Or they could fly places too distant for manned planes to dare.

"I think the key thing about unmanned aircraft is they can do things that other systems like manned aircraft or satellites can't do," said Sandy MacDonald, director of NOAA's Earth System Research Laboratory in Boulder.

MacDonald would like to see unmanned aircraft sample the Arctic, among other places. The global-warming hot spot is home to complicated interactions among land, water, ice and air that still elude scientific understanding. Part of the problem is gathering data, which is dangerous work.

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Previous Science
- Saturday, Aug 19
- Friday, Aug 18
- Thursday, Aug 17
- Wednesday, Aug 16
- Sunday, Aug 13

"If you have a manned flight and it has trouble over the Arctic Ocean, it would almost be a death sentence," MacDonald said.

Over land

NOAA atmospheric physicist James Elkins' scientific instrument is scheduled to sniff air over wildfires from Aug. 29 to Sept. 30.

The device, custom-built by Elkins' Earth System Research Laboratory team, will detect temperature, humidity and trace gases such as ozone, methane, nitrous oxide and carbon monoxide, all of which have an impact on atmospheric chemistry and hence weather and climate. The instrument also will sense water vapor, hydrogen and sulfur hexafluoride — a trace gas emitted from power transmission.

NASA's main goal for the Altair Western States Mission is to see if it can sense hot spots for firefighters to extinguish.

Elkins' team will be at California's Gray Butte Airfield. They were there last week for test flights of an Altair unmanned aircraft system.

The $5 million Altair is a modified General Atomics Predator B unmanned aerial vehicle. NASA and NOAA tested the aircraft over the California coast last year.

NASA took possession of the Altair, America's first major civilian unmanned aircraft system, in July.

The Altair trolls at about 200 mph at an altitude of 43,000 feet and can stay aloft for more than 30 hours.

"You don't know where the fire's going to be," Elkins said. "This plane has long enough range that it can cover a large portion of the U.S."

Over sea

Another, far smaller unmanned aircraft, developed by a company founded by National Center for Atmospheric Research hurricane researcher Greg Holland, will be hunting hurricanes in September.

The craft has a 10-foot wingspan and carries, at highway speeds, instruments to measure weather, wind, humidity and sea-surface temperature. It travels in a golf bag-sized container, is launched from a roof rack of a car or truck, and will fly for 18 hours straight from Key West Naval Air Station in Florida.

"The idea was to develop an aircraft that could go to remote locations, and dangerous locations and do things other aircraft can't do," Holland said. "I basically wanted the aircraft so I could do science, and I couldn't find anybody else to build it."

Joe Cione, a researcher with NOAA's Atlantic Oceanographic and Meteorological Laboratory, is leading the effort. He also led the successful test flight last September, when an Aerosonde flew into Tropical Storm Ophelia and returned well washed but otherwise unscathed.

Flying into a hurricane at altitudes of 500 to 2,500 feet is a suicidal move for a piloted craft. But that's where winds are strongest and the air-sea interactions that fuel hurricanes are happening, a critical phenomenon that remains poorly understood.

Cione said a fleet of four to five of the $50,000 remote-controlled Aerosondes will be dispatched into as many hurricanes as rumble within about 500 miles

of Key West before the end of September. An Aerosonde "pilot" will command the aircraft via a Web interface at Miami's National Hurricane Center.

"The hurricane center's job is to say what the strongest winds are," Cione said. "We're flying right down into them."

Cione's driving interest is in improving scientists' understanding of how hurricanes derive their power, which happens when heat is released from the sea. He wants future Aerosondes to carry lightweight equipment capable of measuring that heat release, which scientists call flux. Such data is critical to improve models that predict hurricane intensity — and destructiveness.

Holland sold Aerosonde Pty Ltd. in June and is concentrating on his science, he said.

He envisions a swarm of Aerosondes plunging into hurricanes for hours at a time, offering unprecedented understanding of the behavior at the base of hurricanes over days. That could translate into more accurate hurricane forecasting and enormous savings by fostering more complete evacuations and preparation on coasts.

"Having another 24 hours to know whether to evacuate is worth billions," said David Fahey, a Boulder NOAA research physicist.

Unmanned science

Scientists are still figuring out how to use unmanned aircraft, said Fahey, a project scientist on last year's Altair missions.

"No scientist has had a platform and been able to say, 'Go away for 30 hours and sample the atmosphere,'" Fahey said.

Unmanned aircraft systems don't need fires and storms to contribute to science. Fahey said he wants to understand atmospheric processes.

"Clouds and chemistry are a major source of uncertainty, and clouds are these sort of pathologically complex things," Fahey said. "They have life cycles. They are not stationary. With a UAS, you could go and stay for the life cycle."

Improving such understanding over the Pacific, where a great deal of America's weather is born, could help make seven-day forecasts as reliable as three-day forecasts, NOAA scientists say.

In July testimony before the U.S. Senate, NOAA Administrator Conrad Lautenbacher listed climate, weather, ocean and atmospheric research; fire, ecosystems and endangered-species monitoring; mapping and charting, satellite calibration and verification; and monitoring of fisheries and marine sanctuaries among the possibilities.

There are still hurdles. The Altair costs twice as much per hour to operate as a comparable manned aircraft. The Federal Aviation Administration is playing it safe with unmanned aircraft and has yet to approve either the forest-fire or hurricane missions.

Still, the outlook for the technology is tantalizing.

Unmanned aircraft "have the potential to alter how we monitor and respond to changes in the Earth's environment, much like radar and satellites did in the 1950s and 1960s," Lautenbacher said.

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