A nursery for Hurricanes

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Every hurricane season, about 100 low-pressure weather disturbances whirl westward out of West Africa and over the Atlantic Ocean, but less than one-fifth of them become tropical depressions, storms or hurricanes.

University of Utah meteorology Professor Ed Zipser is chief scientist of a National Aeronautics and Space Administration mission to study why some African weather disturbances become storms and hurricanes, many of which hit the United States.

He says the question is, "How do we tell the difference between weather disturbances that are going to develop into tropical depressions, storms or hurricanes, and those that do not?"

So on Monday, Aug. 14, Zipser will leave Salt Lake City for the mission's base of operations in Santa Maria, Cape Verde, an island nation 350 miles offshore from Senegal in West Africa. Once there, he will ride a NASA research airplane into developing weather disturbances, some of which may become hurricanes.

The mission is named NAMMA 2006, which stands for NASA African Monsoon Multidisciplinary Analyses. It will run from Aug. 15 to mid-September.

Zipser says the mission is part of a large, multiyear field program to understand the West African monsoon and weather associated with it. The program includes scientists from the United States, France, Great

Britain and many African nations. This year's mission involves scientists from NASA, the National Oceanic and Atmospheric Administration (NOAA) and a variety of universities.

Out of Africa: The Evolution of Storms and Hurricanes

The West African monsoon is a seasonal reversal of winds that provides the only rain that ever falls in the Sahel, the region of northern Africa between the Sahara Desert to the north and a rainy belt to the south. The Sahel includes Senegal, Mali, Mauritania, Niger, Burkina Faso, Chad and Sudan.

Most of the time, dry winds blow out of the Sahara from the east or northeast. But from June through September, monsoon winds blows from the southwest, moving from the tropical Atlantic and onto the Sahel. Heavy rains fall closer to the southern edge of the Sahel. There is less rain closer to the Sahara, but more violent thunderstorms.

"There are millions and millions of people whose livelihood and survival depend on that seasonal rainfall, and they have suffered a multidecade drought that started in the 1970s," Zipser says. "One of the overall goals of this program is to try to understand whether this is a permanent climate change, which would be disastrous – the word desertification comes to mind – or whether it's part of a long-term cycle."

During the monsoon, the contrast between hot Sahara air and cooler air to the south gives rise to the African easterly jet stream, which blows from east to west.

"It forms and blows essentially through the monsoon season, and it is disturbances on that jet that move into the Atlantic," Zipser says. "Perhaps half of the major hurricanes that hit the United States have their origin in those disturbances."

Zipser describes a disturbance as "a cyclonic curl of the winds, a counter-clockwise wind circulation, an ordinary, weak low-pressure system." These disturbances peeling off from Africa into the Atlantic are large, often nearly 1,000 miles across.

There are two main theories of why some of the West African weather disturbances intensify to become tropical depressions, storms or hurricanes, says Zipser:

-- "One is that the stronger the parent disturbance coming out of Africa, the more likely it is to further intensify."

-- The other theory is that it depends on the nature of a weather disturbance's "mesoscale convective systems," which are large organized groups of perhaps 100 thunderstorms or rainstorms. The idea is that ones with "convective blowups or bursts" of intense storm activity are more likely to become tropical storms or hurricanes.

Zipser says some scientists believe strong West African weather disturbances will generate tropical depressions, storms or hurricanes "regardless of the details of the convective storms inside. The other school of thought is that, yes, you need a large-scale disturbance, but you also need an intense blowup of convective storms – perhaps several times – within the disturbance."

Meteorologists can predict accurately the tracks of hurricanes, "but the state of the art is primitive for predicting hurricane intensity and changes in intensity," he adds. "The ultimate problem is predicting the formation of a hurricane from a disturbance."

Of the 100 disturbances per year that move from West Africa into the Atlantic, scientists estimate 10 percent to 20 percent become named depressions, storms or hurricanes. A recent master's thesis by University

of Utah meteorology student Kantave Greene found the proportion was 13 percent during a recent four-year period, Zipser says.

NASA says: "Atlantic hurricanes usually start as weak tropical disturbances off of West Africa and intensify into rotating storms with weak winds, called tropical depressions. If the depression continues to intensify and reaches wind speeds of 39 mph, they are classified as tropical storms. Hurricanes have winds greater than 73 mph."

Four destructive hurricanes hit Florida in 2004, followed by the devastation of New Orleans and other areas in 2005 by Katrina, Rita and Wilma. The NAMMA mission will help scientists better understand how African weather disturbances intensify into hurricanes, and "whatever we can learn about hurricane intensity change is going to help us with understanding extreme events such as category 5 storms," Zipser says.

NAMMA, Will Your Babies Grow Up to be Hurricanes?

The mission will study weather disturbances off West Africa using NASA's DC-8 aircraft, a variety of satellites and weather stations on the ground.

Zipser will ride aboard the DC-8 some of the time as instruments on the aircraft measure water and ice particles in clouds, wind speeds and directions, rainfall, temperature, pressure and relative humidity. The DC-8 also will carry other remote-sensing instruments that are candidates for observing storms from future NASA satellites.

Every four or five days, an "African easterly wave" spins off of Africa – a weather disturbance that might become a depression, tropical storm or hurricane.

"Once we identify a good candidate, we want to fly into it as often as

possible," says Zipser. "That will get us detailed information on the vertical structure of wind, temperature and humidity over time" to help reveal why some disturbances intensify.

The NASA DC-8 likely won't fly into a hurricane because hurricanes typically don't develop until the rotating disturbance reaches the mid-Atlantic. But NOAA planes flying from Barbados will follow any storms from the mid-Atlantic westward.

Zipser says that onboard the DC-8, "I will be mostly trying to direct the flight and optimize what we learn from it by watching the evolution of those mesoscale convective storms, which are pretty tricky to spot in real time." The aircraft will be aided by observations by radars, satellites, scientists on the ground – and Zipser's judgment.

"I've had a lot of experience in doing this kind of thing," he says. "My whole career has been aircraft observations of storms in the tropics and elsewhere."

The mission also will study how the formation of hurricanes is inhibited by hot, dust-laden air layer that flows off the Sahara on easterly winds and inhibits rainfall.

"Hot dry air aloft is death to thunderstorms, or at least we think it is," Zipser says.

NASA's NAMMA mission website is at:
namma.msfc.nasa.gov/index.html

Source: University of Utah