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Satellites assisting look into hurricanes

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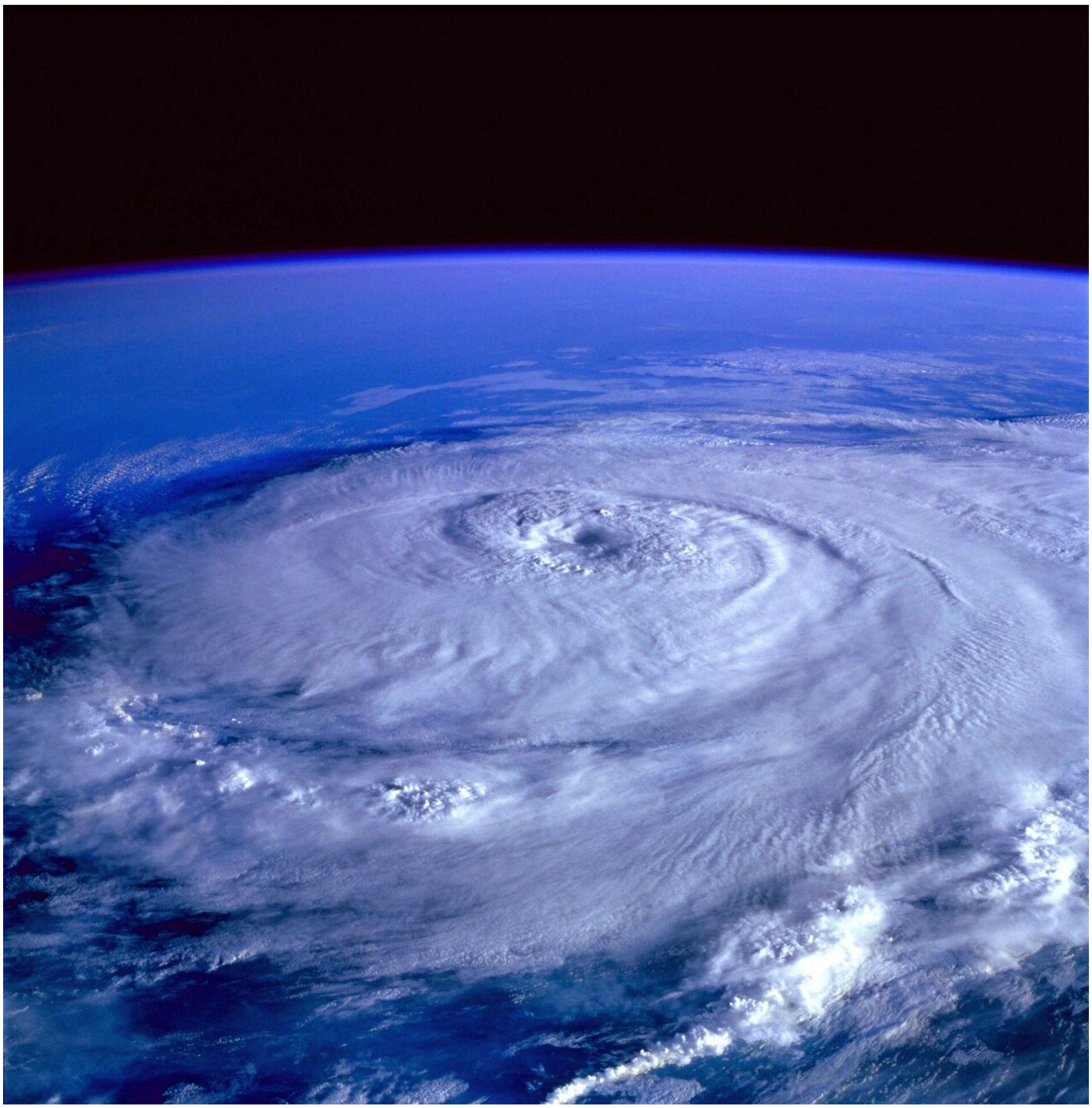

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A mission to probe winds deep inside hurricanes, where most satellites cannot see and few aircraft venture, is showing signs of success despite an unexpected obstacle linked to tensions in the Middle East.

A constellation of eight microsatellites has harvested data that—if folded into the National Oceanic and Atmospheric Administration's (NOAA's) weather models—could have sharpened forecasts of several recent hurricanes, including Michael, a category-5 storm that hit Florida last year. "We're finally getting stuff that really looks useful," says Frank Marks, who leads hurricane researchers exploring the data at NOAA's Atlantic Oceanographic and Meteorological Laboratory (AOML) in Miami, Florida. But the progress was hard-won for scientists on NASA's $157 million Cyclone Global Navigation Satellite System (CYGNSS), who discussed early results at a meeting last week, just as another Atlantic hurricane season kicked off.

With its flotilla of satellites crisscrossing the tropical oceans, CYGNSS can see through the thick clouds of cyclones. The satellites collect radio signals beamed from standard GPS beacons after they bounce off the ocean's surface. The reflections are influenced by sea's roughness, which depends on wind speed. But a month after launch in December 2016, the team noticed the GPS signals were wavering. "We assumed they are constant," says Christopher Ruf, CYGNSS's principal investigator and an atmospheric scientist at the University of Michigan in Ann Arbor. "And they're not."

The U.S. military runs the GPS system, and in January 2017, it began to boost the radio power on 10 of its GPS satellites as they passed over a broad region centered on northern Syria. The power boosts, which can thwart jamming, have recurred without warning, each lasting several hours. "It's an opaque situation, obviously, because it's a classified military situation," Ruf says. The swings don't interfere with other scientific uses of GPS. But they threw off the constellation's measurements of high winds by 5 meters a second or more—the difference between a category-2 and category-3 hurricane.

After 2 years of work, the CYGNSS team has compensated by reprogramming its satellites on the fly. The satellites carry large antennas to catch reflected GPS signals, but they also have small antennas that receive direct GPS signals, for tracking time and location. The team repurposed the small antennas to measure the signal strength of the GPS satellites, making it possible to correct the wind speed measures. "It works," Ruf says. "We've been testing it for a number of months."

Even before that fix, the wind data were good enough to improve some hurricane forecasts, says Bachir Annane, an atmospheric scientist at AOML. In the case of Michael, NOAA's forecast models failed, Annane says: They predicted it would track too far west, close to Alabama rather than Florida, and underestimated its ferocious winds. When he reran the models with CYGNSS winds, Annane found that the storm's forecasted early track and its intensity stayed closer to reality. The wind data would have improved track forecasts for two other recent hurricanes, Harvey and Irma, as well, he says.

The satellites are also giving scientists a view of the winds underlying the Madden-Julian oscillation, a large cluster of storms that periodically forms in the Indian Ocean and marches around the equator, influencing global weather. "Seeing under the rain was a big draw for us," says Eric Maloney, an atmospheric scientist at Colorado State University (CSU) in Fort Collins, because scientists have long debated what fuels the storms. Last week at the CYGNSS meeting, Bohar Singh, an atmospheric scientist who works with Maloney at CSU, described evidence from CYGNSS that persistent winds boost ocean evaporation under a 3000-kilometer-wide set of rainstorms, sustaining them. That finding could help scientists forecast how the storm belt will change in a warmer climate, Maloney says.

After a few tweaks, CYGNSS can now look at land, too. Its antennas are capturing signs of soil moisture, says Clara Chew, a remote sensing hydrologist at the University Corporation for Atmospheric Research in Boulder, Colorado. Although not as capable as a single dedicated satellite, CYGNSS's multiple satellites make more frequent measurements, which could help it monitor flood risks and track how different soils retain rain. "You can start to quantify how long the soil remembers," Chew says.

NOAA scientists hope the new GPS fix will unleash the microsatellites' full potential for looking into storms, perhaps revealing new insights into why some hurricanes suddenly intensify. NOAA isn't likely to start using the CYGNSS data in its routine forecasts, Marks says. The satellites don't belong to the weather agency, and they are unlikely to last more than 7 years before failing. But he thinks their success against the odds could help persuade NOAA to launch its own wind-monitoring constellation.

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