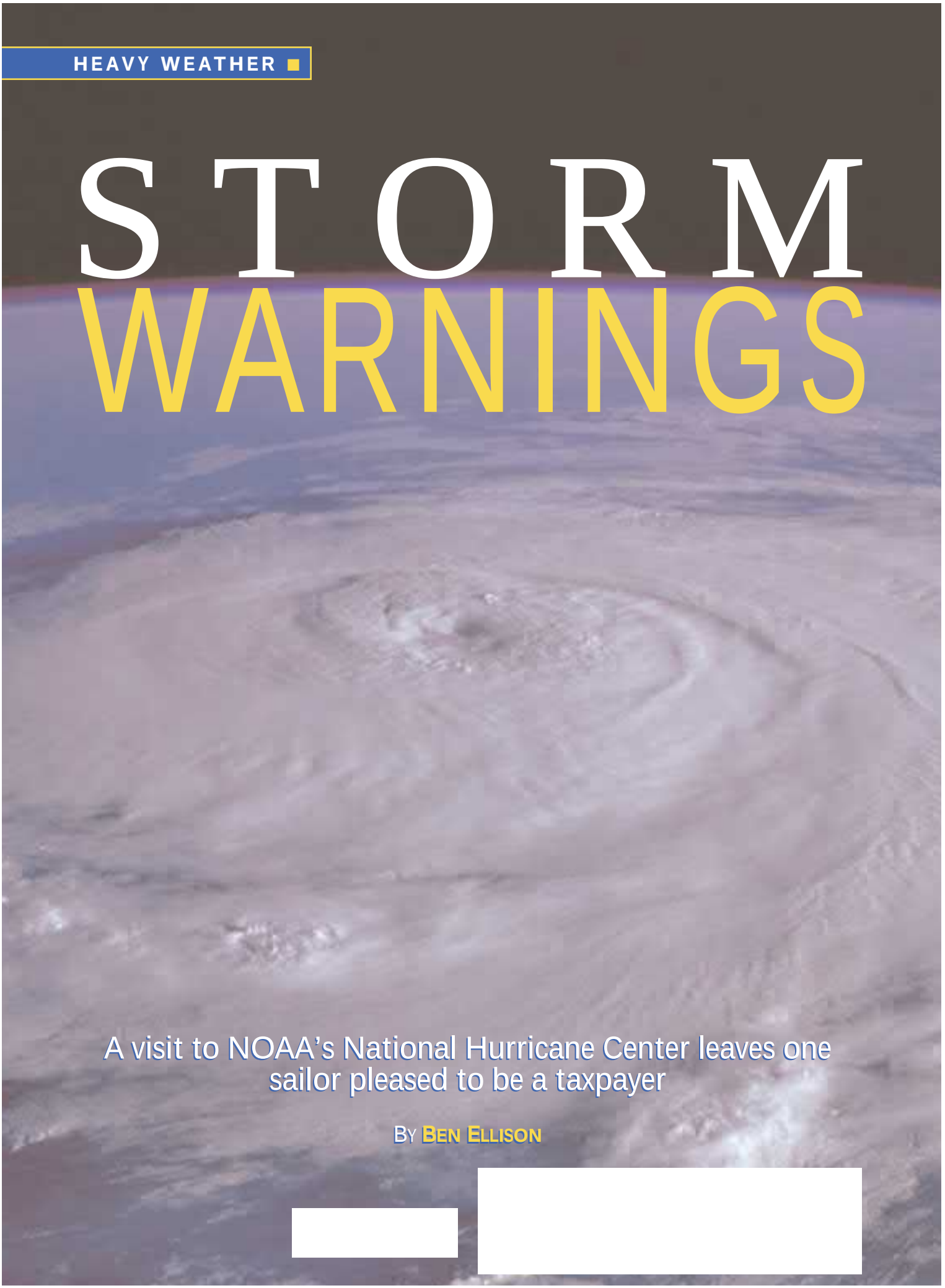
STORM WARNINGS

A visit to NOAA's National Hurricane Center leaves one sailor pleased to be a taxpayer

By Ben Ellison



Hurricane season this year started much earlier than usual (the first named storm, Ana, appeared on April 20, just south of Bermuda), and now, as the heart of the season approaches, almost every saltwater sailor in North America must be mindful of these awesome phenomena. Only sailors north of Los Angeles are immune, while those on both coasts of Central America, in the Caribbean, and in the southeastern U.S. are particularly vulnerable. These storms, spawned from the moist heat of tropical oceans, can generate nearly incomprehensible power—think cement blocks blowing around like gum wrappers. Yet, like jumpy Chuck Berry teens, they "have no particular place to go" and thus are steered—often drunkenly—by all sorts of other phenomena. A hurricane not only punches like Ali, but feints and spins like a butterfly. At some point this season, many of us will feel the anxiety of a seeing a storm head for the bit of coast our boat calls home, and a few will experience the total mental focus of sharing an ocean with one.

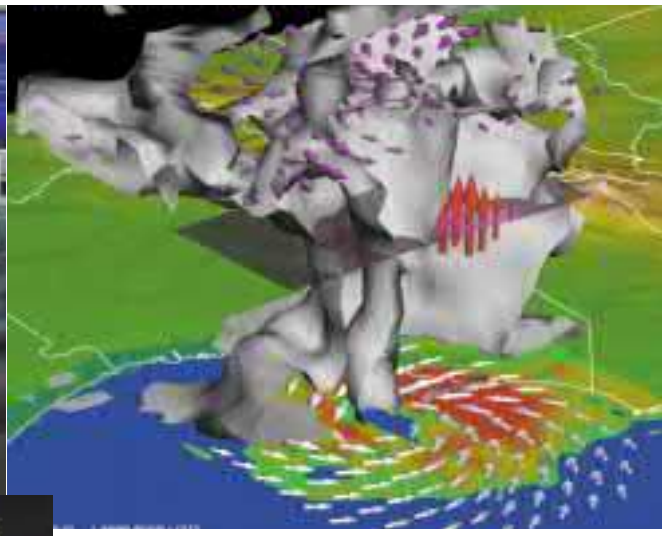
Thankfully, our government addresses the intensity of hurricanes with an equally intense vortex of technology and brain power. Its eye is a serious-looking one-story concrete building located on the campus of Florida International University about 12 miles west of downtown Miami. This is the Tropical Prediction Center, or TPC, and it's worth understanding where it sits on NOAA's immense organization chart. The exercise will hurt a little, as NOAA has a bureaucratic weakness for acronyms, but knowing at least some of them will help you find your way among the agency's invaluable resources.

The TPC is one of nine National Centers for Environmental Prediction (NCEP) that provide the National Weather Service (NWS) with large-area analysis and prediction. The TPC and its sister, the Ocean Prediction Center (OPC) in Camp Springs, Maryland (until recently called the Marine Prediction Center), together produce almost all the familiar bluewater weather products, like faxes and high-seas voice forecasts. (NWS offices in Hawaii and Alaska fill in some ocean areas, and local U.S. NWS stations do coastal predictions). There are two forecasting departments within the TPC, the Tropical Analysis and Forecast Branch (TAFB) and the National Hurricane Center (NHC). The TAFB (and OPC) operate 24/7/365 with successive shifts of meteorologists. During the Eastern Pacific and North Atlantic hurricane seasons, from May 15 to November 30, an additional group of specialists moves into the TPC's large workroom and follows tropical cyclones as they arise, aided by TAFB staff. The TPC (and OPC) are quietly oriented to serving the marine world, though the NHC does become very high profile when predicting landfalls of monster storms (which it then turns over to another NCEP office).

The way information courses in and out of the TPC is akin to the way a hurricane collects energy from vast stretches of ocean, spins it furiously, and blows it out in all directions. One look at the array of antennas atop the building supports this metaphor. On the incoming side is about every form of raw and interpreted weather data you've ever heard of, plus some you haven't. Particularly important are outputs from numerous hurricane and global-weather models that run on supercomputers in Washington, D.C., and ingest even more raw data than the TPC. There are also "reconnaissance" transmissions coming in from the daredevil NOAA and Air Force Reserve crews who fly WC-130 and WP-3D "Hurricane Hunter" planes full of rugged instruments and strong-stomached scientists right into the storms.

Meanwhile, the TPC works year-round sending out all the regular TAFB products, plus hurricane discussions, advisories, strike-probability statements, graphics, and more during the storm season. All are disseminated freely, enthusiastically, and by any means possible to the public, the media, and other weather professionals. The TPC even offers automated e-mail and WAP-enabled cell-phone warnings these days, and there's a little TV studio set up right in among the NHC work stations.

Independent meteorologists and forecasters do sometimes disagree with the NHC's forecasts, but they use raw data from NOAA in their analyses and invariably qualify alternative forecast scenarios as being simply that. Private weather router Ken McKinley of Locus Weather



tells me that while he may offer tailor-made guidance to sailors struggling to stay clear of hurricanes, he also makes sure his clients are well informed about TPC forecasts. In short, it's hard to overstate how much the inhabitants of this one building in Miami help us all cope with hurricanes.

So, of course, one of my first questions to TAFB chief Chris Burr was what happens when a big storm finally hits Miami. He acknowledged that possibility with a wry smile, but told me that once the steel shutters go down, "this place is virtually impregnable." Besides, forecasters can, if necessary, jet to a backup office at the OPC in Maryland. I visited in February, so Burr first let me peer over the shoulders of the TAFB staff on duty, then let me nose around the vacant NHC area. I've never seen so many computer monitors in my life. Imagine Circuit City, except with all the screens alive with various numerical and graphic weather feeds, some quite arcane, along with the specialized software that the forecasters use to create their charts. There are even end-user displays, like an Inmarsat-C terminal downloading high-seas text forecasts (which now include NHC advisories). As Burr explained, they like to see that their handiwork is actually getting out there.

But the more I hung around, the more I realized that the real story here is the humans in the system. The small team of meteorologists on duty may seem overshadowed by the cyclone of data and technology around them, but actually it's all there to serve their trained brains and gut instincts. Over in one corner, for instance, I found lead forecaster Wally Barnes head down over a printout working intently with highlighters and colored pens.

The man's got a tidal wave of bits and bytes at his fingertips, and he's doodling with markers! Much of what Barnes was drawing was already on his screen, but he

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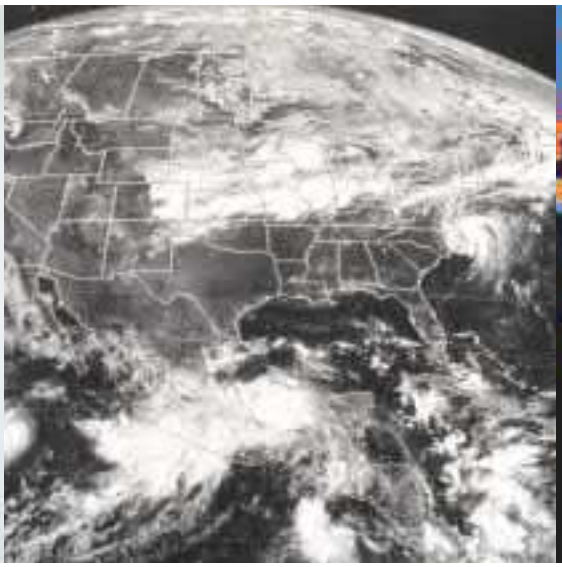
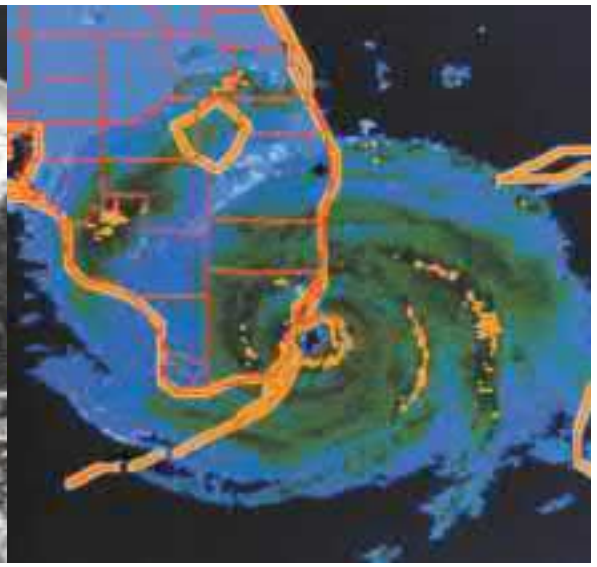




Sunset in the eye of a hurricane left and Spectacular eye and eye wall photograph taken from NOAA P-3.

explained that highlighting certain structures and drawing in his own isobars helps him really feel what the airmasses are up to. Then he's more able to resolve conflicts and make forecasts. "The model showed 4-to-6-foot seas out to here," he said, pointing into the middle of his doodle, "but I had a couple of higher ship reports this morning over here, and we're starting to see that trough deepening there, so I changed it."

Burr assured me that the same intuitive process goes on at the NHC's end of the room. A supercomputer may have beaten the world's best chess player, but chess is checkers compared to weather analysis. There are now numerous powerful computer models for predicting how a tropical cyclone will behave, and they're being tweaked constantly,

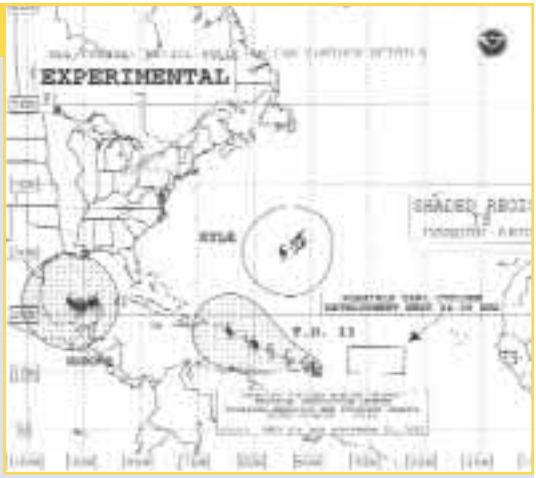
SONDES IN THE EYE

Until recently it has been nearly impossible to collect high-quality windspeed data close to the ocean under hurricanes, so scientists made presumptions based on data collected in less dire conditions. Thanks to a clever device called a GPS dropwind sonde (that's French for "sounding line"), this has changed. A sonde is a small instrument-packed cylinder that is dropped from Hurricane Hunters flying high in the eye wall. The gizmo takes a wild parachute ride while sending back position, pressure, humidity, and other readings every half second—or about every 15 feet of altitude—and thus creates a highly detailed "sounding" of the storm right to the sea surface (just before its fatal crash).

Three hundred such sondes dropped through 15 hurricanes have produced data so startling that it warranted a NOAA press release and coverage in science journals. Apparently, the drag coefficient of hurricane seas presumed to reduce wind speeds at and near the ocean surface is significantly less than what was extrapolated from readings taken at 50 knots or less. In other words, it's much worse under there than anyone realized. What did the scientists fail to account for? Foam, lots and lots of foam! Confronted with the new data, researchers now theorize that the aerated cauldron of a hurricane-whipped sea acts as a lubricant, letting extreme winds maintain velocity even over very large waves. (Pity the sailor who has experienced this little quirk of nature firsthand.)

This new knowledge will not only help meteorologists better predict surface wind speeds and wave heights, but will help researchers more accurately model the evaporation process that fuels storms. Thus those poor little expendable sondes will eventually improve long-range predictions. Sonde data is also valuable in real-time hurricane analysis, as it is transmitted to the supercomputers and NHC forecasters mere minutes after it is collected.

THE 1-2-3 OF HURRICANE AVOIDANCE



Most of us are familiar with the so-called navigable semi-circle of a hurricane. The idea is that when a storm is moving at a good clip, the apparent-wind speed is reduced by the motion of the storm on one side and increased on the other and that it is better to be on the former. Upon actually contemplating life at sea in 85 knots of wind, as compared to 115 knots, this logic may seem like a macabre old joke: Why run away from an attacking grizzly bear? So you have something to do in the last 20 seconds of your life.

The ever-improving ability of the TPC/NHC to track hurricanes makes it possible to adopt a simpler strategy. Just stay away. Two related rules of thumb have emerged to help sailors accomplish this. One is the notion that 34 knots of wind defines a threshold past which the average vessel's freedom of motion begins to significantly deteriorate. Thus, you'll find radii values of "winds of 34 knots or greater out to xx miles" described in many types of hurricane advisories.

The 1-2-3 rule of thumb is based

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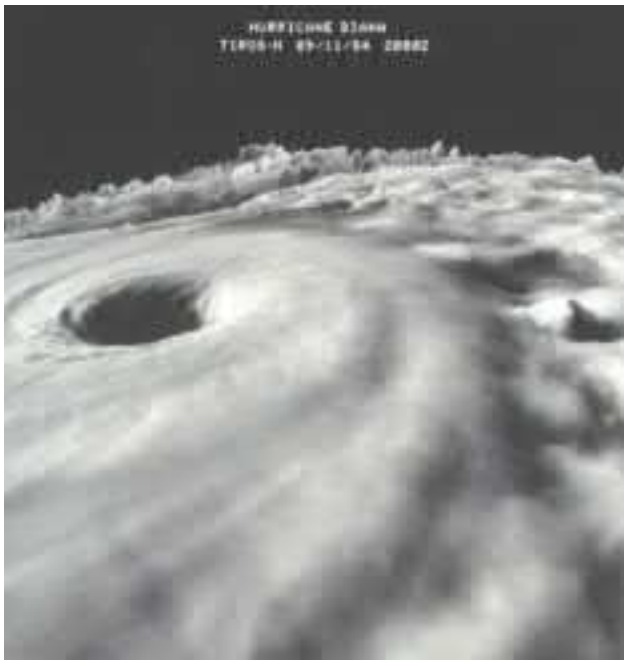
roughly on the NHC's assiduously kept record of track-forecasting error. On average, predicted positions of hurricanes are off by 100 nautical miles in one day, 200 in two days, and 300 in three days. So you plot the predictions, then the circles described by the 34-knot radii, and then finally the 100-, 200-, and 300-mile radii of potential error. When you run tangents alongside the final circles—known as "circles of uncertainty"—you end up with a fair drawing of where you do not want to be.

These days the NHC's prediction record is considerably better than the 1-2-3 rule of thumb, but you should also consider above-average errors, which are particularly evident early and late in the season. Also note that a couple of years ago the NHC started issuing a 1-2-3–based fax/Internet product called the Tropical Cyclone Marine Graphic, which saves you the chore of plotting. Ultimately, the key to hurricane avoidance is acquiring foreknowledge of what can happen and vigilantly keeping up with what is happening. Local weather stations, even the NWS VHF marine broadcasts, tend not to discuss hurricanes until they are fairly imminent, but you can easily get NHC predictions on the Web at www.nhc.noaa.gov, via weatherfax or SSB high-seas forecasts, and in numerous other ways.

but none have yet outsmarted the forecasters. And these guys keep track. The TPC and other researchers regularly back-test human and model predictions against actual storm tracks. The meteorologists are not so much competing with the models—well, maybe they are a little—as trying to evaluate their usefulness.



TIROS-N three dimensional cloud-top image of Hurricane Diana as it was strengthening from a Category III storm to a Category IV storm. This was one of the earliest three dimensional images of a hurricane from data obtained from satellite.

The back-testing also documents the NHC's overall prediction record over the years, and the improvement is impressive. In fact, better prediction has precipitated some particularly good news this year. As of May 15, NHC hurricane predictions have been extended from three days to five. The change comes after two years of rigorous experiments generating five-day forecasts and back-testing them to be sure such long-range predictions have value. In fact, the five-day forecasts should be as accurate as three-day forecasts were 15 years ago, with a specific average track error of 323 nautical miles in the North Atlantic and 191 miles in the Eastern Pacific.

When NHC director Max Mayfield announced the advent of the five-day hurricane forecasts, he gave credit not only to his meteorologists but to numerous technicians, programmers, and researchers inside and outside NOAA. I too felt thankful as I departed the TPC. It certainly appears that our tax dollars are working hard to minimize hurricane damage to us and our boats. And my metaphor survived. In the blare and glare of the Miami flatlands I realized just how calm and intense it had been back inside, in the center of all that tightly focused mental and digital activity, in the eye of hurricane prediction.

Contributing editor **Ben Ellison** gleefully follows storm forecasts from an impregnable bunker in Camden, Maine.

For a great tour of Web resources pertaining to hurricane tracking and prediction, go to sailmagazine.com.