set this specific problem aside by the time his thesis work began.

Ma sought help from Columbia administrators and others to stop publication of the paper. But few could understand the text, and nearly all the mathematicians Ma contacted sided with Phong. They told Ma that his thesis work was inadequate, and that he was wrong to claim that the Phong-Stein paper, which *Acta Mathematica* published in November 1997, was plagiarized.

At Ma's insistence, graduate school dean Eduardo Macagno looked into the case, reviewing comments by Phong, Stein, two other Columbia mathematicians, and a Harvard mathematician. Macagno concluded that no plagiarism had occurred. The math department told Ma that he would have to apologize to Phong before he would get a new mentor and that without a mentor, he would have to leave. Ma refused, and Columbia dismissed him in 1997. For a time, Ma says, he worked at a Subway sandwich shop. But, with two master's degrees in math from Columbia, he found a computer-related job. He filed suit in 1998. Mathematician Lawrence Alan Shepp of Rutgers University in New Brunswick, New Jersey, is supporting Ma's case but says others must judge whether Ma's work is correct.

Phong declined to comment. Stein says that Ma's argument is "without merit." It was Ma who used his professor's ideas, Stein says, not the other way around: Ma's "got it upside down." He recalls that Phong tried to get Ma to work on a different and difficult subset of the problem the two professors were working on, but that Ma, making no progress, decided to try to duplicate their efforts.

Columbia is asking to have the suit dismissed because it claims to have made a "diligent, complete, and unbiased" investigation before rejecting the complaint. The university also argues that Ma is trying to involve the court in "purely academic decisions" which New York has "repeatedly held to be beyond judicial review." Finally, the university suggests that mathematical principles cannot be plagiarized in any case because they "simply cannot be copyrighted."

If the case does go to trial, it could create a unique problem: The judge, and possibly a jury, might be asked to rule in a few days on who contributed what to a complex scientific proof—the kind of controversy that can take years to resolve among mathematicians.

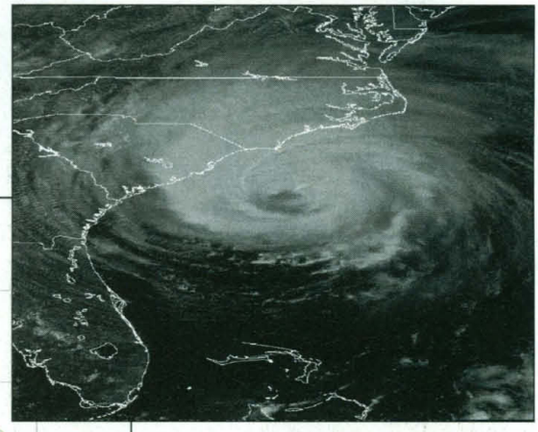
–ELIOT MARSHALL

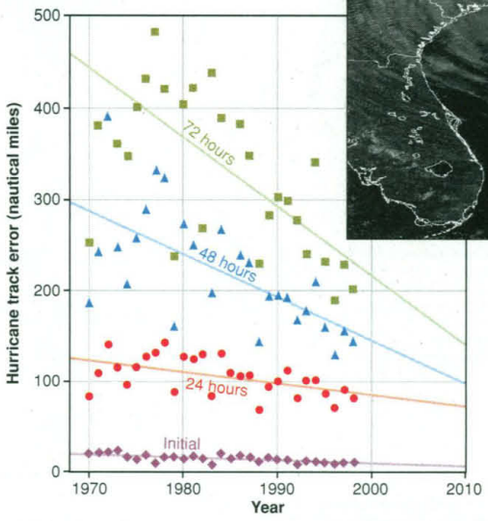
SOURCE: COLIN MCADIE/NHC

WEATHER

Forecasters Learning to Read a Hurricane's Mind

Hurricane forecasting has come a long way since one sneaked up unannounced on Galveston Island, Texas, in 1900 and killed 8000 people. Nowadays, meteorologists know when a storm is on its way, but predicting just where it will hit land still isn't easy. For most of the past half-century, forecasters have struggled to narrow their predictions of a hurricane's next move, but as recently as the 1970s, guesses of a hurricane's position 24 hours ahead of time were off by an average of more than 200 kilometers. Now hurricane researchers finally have something to celebrate.





Shrinking errors. Forecasters have been predicting the path of hurricanes like 1996's Fran (photo) with increasing accuracy, especially since mid-decade.

"It's been a pretty exciting 5 years," says hurricane specialist Russell Elsberry of the Naval Postgraduate School in Monterey, California. Better observations of the streams of winds that carry hurricanes toward land are feeding new computer models for predicting how those winds will shift. And, as recent analyses—including one in last month's *Bulletin of the American Meteorological Society*—show, these new tools are getting results. "It's quite clear that the [U.S.] National Hurricane Center has been making much improved track forecasts" of future storm movement, says Elsberry. The new forecasting skill means that crowded coasts will have more time to prepare for storms, and warnings can be limited to smaller sections of coast, saving millions of dollars on unnecessary evacuations.

Hurricane forecasting has spent a long time in the doldrums. In the 35 years after record keeping was begun in 1954, forecasts of a storm's position 24 hours in the future improved by only about 1 kilometer per year, even after satellite images made it easier to track the position, winds, and extent of a hurricane. One problem was that neither satellite images nor the scattered data from weather buoys and ships offered many clues about the stream of air surrounding a storm, which determines its speed and direction.

"There is no substitute for in situ observations," says meteorologist Kerry Emanuel of the Massachusetts Institute of Technology. For 15 years, researchers had been collecting those observations by flying aircraft near the storms and releasing instrumented packages called dropwindsondes—a sort of weather balloon in reverse that radios back wind speed and direction, temperature, pressure, and humidity as it falls. But those efforts were sporadic until 1997, when the National Weather Service (NWS) made such observations routine and introduced a new dropwindsonde that tracks itself using the satellite-based Global Positioning System, allowing more precise wind mapping. The NWS also acquired a Gulfstream-IV jet, which could fly higher and faster around storms than the traditional hurricane-hunter aircraft, probing more of the nearby atmosphere.

In the March *Bulletin of the American*

Meteorological Society, Sim Aberson and James Franklin of the National Oceanic and Atmospheric Administration's (NOAA's) Hurricane Research Division in Miami, Florida, describe the payoff: The 1997 dropwindsonde observations improved storm-track forecasts by 31% 24 hours ahead, by 32% at 36 hours, and by 12% at 48 hours, they report, compared to computer forecasts made without the observations. The tropics were relatively quiet in 1997, prompting just five missions by the Gulfstream-IV, so "you don't want to make too much of the numbers," says Franklin. Still, he says, "we're fairly confident '98 will be like '97."

Along with better data, forecasters have better tools for interpreting the information. Their primary aid is computer modeling that incorporates the latest observations to create a picture of the storm and its surroundings and calculates how the storm will move and develop. "There has been a quantum increase in the skill of the models," says Stephen Lord, a deputy director at the NWS's National Centers for Environmental Prediction in Camp Springs, Maryland.

The prime example has been the hurricane model developed by Yoshio Kurihara, Morris Bender, and Robert Tuleya of NOAA's Geophysical Fluid Dynamics Laboratory (GFDL) in Princeton, New Jersey. The GFDL model works on two scales. Like standard global atmospheric models, it simulates the atmosphere in broad strokes to capture the river of air, thousands of kilometers across, that sets the hurricane's overall course. But it also zooms in on the hurricane's vortex, using the latest satellite and in situ data to model the storm and the way it interacts with its surroundings in fine detail.

In tests prior to becoming operational at the National Hurricane Center (NHC) in 1995, the GFDL model outperformed its predecessor, logging average track errors that were about 12%, 24%, and 28% better at 24, 48, and 72 hours, respectively. Since then, "it's been the best performer" of the half-dozen models that NHC forecasters consult before issuing an official forecast, according to James Gross of the NHC.

Even so, it can be hard to tell whether better data and models are actually improving the official forecasts, because the improved tools are new and forecasters have always had good seasons and bad, depending on the nature of the storms. But meteorologist Colin McAdie of the NHC thinks track forecasts are improving at an accelerating pace. His recent analysis shows that at all forecast times, the predictions improved twice as fast during 1992 to '96, the period when the GFDL model debuted, as they had during the previous 2 decades. The routine dropwindsonde observations that began in 1997 seem to have helped sustain that progress.

Such improvements should allow the NWS to target its hurricane warnings more precisely. When the weather service issues a hurricane warning, prompting an evacuation, it generally includes a stretch of coast three times longer than the section that eventually suffers high winds, just to be sure—which means that hundreds of kilometers are cleared but suffer little damage. With costs averaging half a million dollars per kilometer of evacuated coast, according to the NWS, not to mention a toll in public goodwill, that's an expensive insurance policy. If the improvements of the '90s can be continued, averting hurricane disasters should be cheaper and less disruptive.

–RICHARD A. KERR

BUDGET RESOLUTION

R&D Takes a Hit, But Don't Count It Out

Dividing along party lines, Congress narrowly approved a Republican budget resolution on 15 April that would hold the line on federal spending and, in the process, slash most civilian R&D budgets. The $1.7 trillion budget for fiscal year 2000, which begins 1 October, would channel surplus revenue into tax cuts and the Social Security program while requiring steep reductions in future "discretionary" domestic programs. Over the next 5 years, according to an estimate by the American Association for the Advancement of Science (AAAS, which publishes *Science*), the cuts would range from 6% for the National Institutes of Health (NIH) to 14% at the National Science Foundation (www.aaas.org/spp/dspp/rd/bdgres.htm). But the gloomy resolution comes with a silver lining: There is almost no chance that Congress will stick to its numbers.

Congressional leaders took great pride in getting the budget resolution approved early, only the second time in 12 years that they have met the deadline of 15 April. But legislators are already planning ways of getting around a measure that presents a politically unpalatable set of fiscal options. The first opportunity may arrive in a few weeks as Congress takes up an emergency bill to pay for current U.S. military operations in Kosovo. This "veto-proof" supplemental spending bill could become a vehicle for other budget-busting military ex-

ScienceScope

Diplomatic Overture The State Department wants to have some frank and fruitful exchanges with leading scientists. Under a proposal outlined by Under Secretary Frank Loy last week, members of the diplomatic corps would join with experts in a particular area—such as genetically modified crops—for roundtable discussions designed to increase the envoys' understanding of technical controversies.

The idea is one of five early responses to the findings of a National Academy of Sciences review panel, which last fall concluded that U.S. diplomats lack science savvy. Other potential improvements include appointing a special science ambassador to advise the secretary of state and beefing up science training for the agency's 25,000 employees, of whom 5% hold technical degrees. "We have heard the criticism," Loy said at a Washington conclave sponsored by AAAS, publisher of *Science*.

The plans—which Loy says are moving ahead—please panel leader Robert Frosch of Harvard University. "Sounds like a promising beginning," he says. His committee hopes to release its final communiqué on the issue this fall.

Deep Impact: The Sequel A year after astronomers had to humbly retract one warning of a possible catastrophic asteroid impact with Earth, another doomsday asteroid report has scientists up in arms. The flap began earlier this month, when Benny Peiser, who runs an electronic mailing list on neocatastrophism, found a Web preprint of a paper by Italian astronomer Andrea Milani. Milani concluded that there is a remote chance that asteroid 1999 AN_{10}, discovered last January, will slam into Earth in August 2039. In a press release, Peiser accused Milani's group of hiding the news, "instead of informing the interested public about their potentially explosive findings." The story made headlines around the world, although many reporters emphasized the one-in-a-billion odds of impact.

The attack on Milani and the ensuing coverage have outraged many astronomers. In posting the unpublicized preprint for other researchers to review, "Milani did the right thing," says David Morrison of NASA's Ames Research Center in Mountain View, California. But astronomers could use guidance on how to handle predictions and the press, he adds. He and others will try to hammer out guidelines for releasing potentially scary news at a meeting in Turin, Italy, in June. Says Morrison: "We're still in a learning process."