EYES ON THE STORMY SEASON

SCIENTISTS PLOT NEW DEFENSES AGAINST HURRICANES

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Meteorologists in recent years have made great strides in their ability to predict which way hurricanes will move across the ocean, resulting in more timely warnings to coastal cities. They have even learned to predict the overall intensity of a hurricane season months in advance (this year's is supposed to be a big one, according to the National Weather Service). But there is still a lot they don't know about just how these massive storm systems work -- knowledge that might someday make it possible to actually slow the raging fury of an oncoming storm.

In a Cambridge laboratory, an unlikely team of scientists is trying to unlock the mystery of exactly how hurricanes derive their energy -- and how that flow of energy might be curtailed. Using a device that looks a bit like an oversized blender, and a concept that originated more than two centuries ago, they are learning more about what happens in the crucial boundary zone between air and water, where a hurricane's devastating power originates.

Everyone involved in this research project, begun by MIT chemical engineer Robert Langer, Children's Hospital cancer researcher Judah Folkman, and MIT atmospheric scientist Kerry Emanuel, agrees that it's a long shot, with slim odds of success. ``We're going out on a limb,'' Emanuel says.

But the potential impact of such a technology is so great that even a tiny chance of success makes it a project well worth pursuing, researchers say. After the multibillion-dollar impacts of hurricane Andrew on Florida in 1992 and hurricane Mitch on Central America last year, it is clear that even a slight moderation of an advancing major storm could save both money and lives.

Even if this particular idea doesn't work, the research might lead to other variations or entirely new possibilities. As Emanuel explained in an interview last week, ``we have almost no understanding of air-sea interactions at high wind speeds,'' because measurements are so difficult to make in the midst of the huge waves, powerful winds and churning waters of a large storm system. For now, he said, ``we've decided to take a highly experimental approach to the problem.''

Others are attacking the problem of trying to gain a better understanding of hurricanes, Earth's deadliest weather systems, in different ways. A team in Florida, for example, is setting up 10 monitoring stations in homes in the hope that they will eventually wind up inside the track of a hurricane and provide unprecedented details about how the winds affect buildings.

Even with the slim odds, the MIT effort is the only project that has any hope of not just understanding storms, but also doing something about them.

The idea is a simple one, with roots that go back to an experiment carried out by Benjamin Franklin in 1765. If it works, it could spare coastal communities lives as well as billions of dollars worth of damage.

In experiments at an English lake, Franklin was the first to make detailed measurements of an extraordinary phenomenon: Certain kinds of oil, when placed on a body of water, almost instantly spread out over a large area. Franklin was able to calculate that when he dropped a teaspoon of olive oil on the lake, the resulting layer of oil was incredibly thin -- just 25 Angstroms (one ten-millionth of an inch) thick.

Although the concept of atoms and molecules was decades away, experiments done in 1917 helped scientists eventually determine that such a layer of oil spreads until it becomes exactly one molecule thick. What's more, the individual chainlike oil molecules in the resulting ``monomolecular film'' are arrayed in a neat pattern, standing vertically like stalks of wheat in a field.

Experiments back in the 1960s showed that such films, spread over the surface of water reservoirs, could slow the rate of evaporation by at least half. The potential for preserving scarce water resources is significant: the total amount of water evaporated from the surfaces of lakes, streams and reservoirs in the United States each year is equal to the total water consumption of all the nation's cities and towns.

But if evaporation can be slowed in a reservoir, what about the turbulent open ocean? It turns out that a typical hurricane is driven by energy that equals the total power consumption of the world for several weeks, and all of that energy comes from the evaporation of water from the sea surface. If the evaporation rate could be slowed down, then the hurricane could be deprived of its ``fuel'' and quickly dissipate, or at least weaken severely. That's exactly what happens when a hurricane moves over land and runs out of steam.

Langer and Folkman, both of whom devote their professional lives to biomedical research, became interested in this unlikely subject while discussing a different problem. Cancer specialist Folkman was trying to find a way to prevent discomfort for patients who were being fitted with casts, which heat up as they harden. With large casts and young patients, heat sometimes causes swelling, which can impair circulation.

Folkman discussed the problem with his friend Langer, who holds more patents than any other MIT faculty member and who specializes in inventing medical devices. They soon found a way of solving the problem by adding a simple chemical, urea, that cooled the plaster, allowing the cast to harden just as fast -- but without heating up.

The two researchers then started thinking about other issues that involve heat transfer from one object to another. Langer, Folkman said, wondered out loud: ``How much urea do you think it would take to drop into a hurricane from an airplane to make it go away?''

Such cross-disciplinary discussions are not unusual in Langer's freewheeling lab. ``I have a very open kind of attitude,'' Langer says. ``I want to just encourage people to explore grand ideas, taking them through to reality.'' In the kind of biomedical research he does -- he has devised artificial skin and drug-releasing implants, among other things -- Langer says that ``I found that if you want to make a new tissue or do a drug implant, it really takes a diverse group.''

He and Folkman discussed the idea with Emanuel, a renowned hurricane expert, who in the course of the discussion suggested that there might be a more efficient way of accomplishing the same thing: Slowing evaporation from the sea surface by using an oil film.

MIT visiting engineer Moshe Alamaro was already working with Langer on a different idea -- how to prevent summer water shortages in New England by stockpiling snow during the winter. He quickly became involved in the new project and took on the task of carrying out laboratory experiments to try to find just the right kind of substance to do the trick.

Alamaro emphasizes that all of the substances being tested are biodegradable and would have a negligible impact on the environment because such small quantities would be needed. Only 10 pounds of the material -- just over a gallon -- could cover a square mile of ocean, and 50 tons, perhaps two airplane loads, would cover 10,000 square miles. That might be enough to quell an advancing hurricane, if the idea works. (By comparison, about 3,500,000 tons of petroleum-based oil are spilled into the oceans every year, mostly from routine ship operations).

The idea of spreading oil on the water to retard hurricanes has been suggested before -- it was one of several schemes proposed over the last few decades to moderate storms. Soviet scientists even carried out experiments on the idea in the Pacific Ocean in the 1970s, but those results had been classified and have only just been released. Piles of documents detailing those experiments are now at MIT and in the process of being translated, but so far it is not clear what information they may contain.

The concept first originated with Robert Simpson in the 1960s, when he was director of the National Hurricane Center. Simpson and his wife Joanne, also a meteorologist, carried out detailed calculations on how much oil would be needed and how to deliver it and spread it where needed. ``If you could somehow cut off the flow of heat from the ocean to the air, you could pretty much snuff out the hurricane,'' he said in an interview.

They found that the quantities needed could feasibly be carried by planes to where they were needed, and that the costs would not be unreasonable. Interest waned when other research showed that as soon as the wind speed exceeded 25 m.p.h., the wind would break up the film and prevent it from working. ``We didn't carry it any further at that point,'' Simpson said.

Alamaro is convinced that with the right substance, that problem can be overcome. With the help of MIT graduate students, he is carrying out experiments in a container that simulates the agitation of water in a storm, trying out hundreds of different substances to see how well they curtail evaporation under turbulent conditions.

According to Emanuel, there may be a completely different approach to slowing the transfer of heat from the ocean to the storm above, depending on exactly how hurricanes really derive most of their energy -- something that scientists don't yet know. Instead of retarding evaporation, a different material might be used to cause the churning sea to form much smaller water droplets, which would evaporate by absorbing heat from the air, not the sea below. Larger droplets, by contrast, do transfer heat from the sea to the air.

If it turns out that hurricanes derive most of their energy from droplets rather than the sea surface itself, Emanuel said, then the research might turn from monomolecular films to soap-like materials that could be used to reduce droplet size. Either way, the net effect would be to slow the buildup of energy.

If laboratory tests yield a promising substance, further tests could be carried out in a doughnut-shaped wind tunnel at Woods Hole Oceanographic Institution, built to simulate storm conditions over the sea, and then eventually on the open ocean. If all those tests work, an experiment under actual hurricane conditions might be attempted.

Hugh Willoughby, the National Hurricane Center's director, has been following the effort closely. ``If we could actually find a chemical'' that would work in high winds, he said in an interview, ``then absolutely, it would work. But there's much virtue in `if'. Nobody's come up with a chemical that would work.''

The impact of such a discovery could be so great, Willoughby said, that the research is worth pursuing. It has been calculated that if hurricane Andrew had moved a few miles further north and hit Miami directly, it would have caused $70 billion in damages.

``If this could be made to work, it could have tremendous impact,'' agreed MIT chemical engineering professor Daniel Blankschtein. ``It is an exciting idea. Whether it will work or not remains to be seen. But I'm fascinated by it.''

Langer cautioned in an interview that the work is at ``an extremely early stage. We're on the first step of a very long road.''

The teaming up of a biomedical engineer, a medical researcher, and a mechanical engineer with an atmospheric scientist on a project involving hurricanes may seem improbable, but it makes a certain kind of sense: The key common element is a desire to spare people from suffering. As Langer puts it, ``if we can make a difference in people's lives, I'm interested in doing it.''