Hurricane prediction: Catching the waves

Hundreds of tropical weather disturbances form each year, but only about one in 10 gathers enough power to become a hurricane. New research supports the theory that a developing storm must encounter huge atmospheric pressure "waves" 7 to 9 miles above the sea to gain hurricane force.

"Ultimately, we expect that this could lead to a better forecasting of hurricane development and hurricane intensification," says atmospheric scientist Richard L. Pfeffer of Florida State University in Tallahassee.

The theory, which Pfeffer proposed in 1980, holds that well-organized, wave-like pressure disturbances in the upper troposphere help to spin rising air columns into hurricanes. He likens the action to stirring a cup of coffee, creating a depression in the center. The tropospheric waves whirl the air up and out of the top of a column, lowering air pressure at the sea surface. The low pressure draws more air and moisture into the system. Condensing water vapor releases heat, which causes air in the center to rise faster, fueling a hurricane.

The waves are only one ingredient in the hurricane recipe, but Pfeffer thinks they're essential. Other ingredients include warm seas and a site at least 5° latitude from the equator, because the Earth's rotation helps spin up the storm.

In the early 1980s, tests using two-dimensional computer models supported Pfeffer's theory. But those models neglect many variations in wind, temperature and pressure that play an important part in Pfeffer's theory. Now Pfeffer and Malakondayya Challa have tested the theory with a three-dimensional computer model of hurricanes developed by Rangarao V. Madala and others at the Naval Research Laboratory in Washington, D.C.

The computer model averaged data collected from real hurricanes and storm systems in the Atlantic. Pfeffer and Challa found that cloud clusters and depressions required tropospheric waves in order to form into hurricanes in the model. When the researchers removed the effects of the waves, the weather system models didn't develop into hurricanes. Their findings will appear early next year in the Journal of the Atmospheric Sciences. Next, Pfeffer hopes to test his theory against specific data collected from individual storms.

Atmospheric scientist John Molinari at the State University of New York at Albany has already applied Pfeffer's theory to satellite data collected as Hurricane Elena churned the Gulf of Mexico in 1985. In the April 15 Journal of the Atmospheric Sciences, Molinari reports the hurricane indeed encountered a trough of low pressure in the upper troposphere 30 hours before it intensified. But while he thinks such troughs do boost hurricane intensity, he remains unconvinced that they are essential for hurricane genesis. Using Pfeffer's model to predict whether a storm will become a hurricane may be difficult, he says, because the tropospheric waves are too high for tracking planes to measure and may not show up in satellite data. *– D.E. Loupe*

RNA researchers earn chemistry Nobel

For basic biochemical studies that have opened windows onto ancient life and that one day could spawn practical payoffs such as antiviral therapies, two U.S. scientists will share this year's Nobel Prize in Chemistry.

The Karolinska Institute in Stockholm, Sweden, last week named chemist Thomas R. Cech of the University of Colorado in Boulder and Canadian-born molecular biologist Sidney Altman of Yale University as recipients of the award for their independent discoveries that ribonucleic acid (RNA) not only passively carries genetic information in living cells, but also performs active enzyme-like functions. Their work toppled the dogma that proteins held a complete monopoly in biochemical catalysis. Moreover, scientists trying to understand how life began now look to catalytic RNA molecules, or ribozymes, as likely biochemical ancestors that evolved into the DNA-RNA-protein progression of modern cells (SN: 6/17/89, p.372).

"That RNA can act as an enzyme is one of the more important findings in chemistry in the last decade or maybe two," comments molecular biologist Gerald F. Joyce of the Research Institute of Scripps Clinic in La Jolla, Calif. "When you hear 'enzyme,' you reflexively think of protein" and not RNA, he says. "Maybe this Nobel Prize will liberalize people's thinking about what an enzyme is."

While studying common bacterial cells in the late 1970s and early 1980s, Altman found an unusual enzyme made of both protein and RNA components. At first he regarded the unexpected RNA as a contaminant. But Altman found that separating the complex's two components destroyed its enzymatic function, showing for the first time that RNA was necessary for the enzyme to work. By 1983 Altman and his colleagues showed that RNA alone (under complex test-tube conditions) can function as an enzyme. In cells, enzymatic activity probably requires protein as well as RNA, he says.

At about the same time, Cech discovered that certain RNA molecules in single-celled organisms called *Tetrahymena thermophila* are capable of unassisted catalytic activity in test tubes. He found that the RNA could cut away extraneous segments of itself and then splice its remaining fragments into a genetically more meaningful RNA molecule. In 1982, he published the first account of such catalytic RNA molecules.

Joyce says the work of Cech and Altman has led to a new scientific field called RNA enzymology and may lead to new biotechnologies with payoffs as grand as curing the common cold. *– I. Amato*

Physics Nobel: Traps, clocks, quantum leaps

The Nobel Prize in Physics has often gone to researchers pondering the debris from atom-smashing experiments. The 1989 prize, however, honors a gentler approach to physics research, involving finely tuned masers and techniques for trapping a single electron or ion for long periods of time – an ideal situation for making high-precision measurements and testing physical principles.

Half the prize goes to Norman F. Ramsey of Harvard University, who in 1949 improved an important technique for inducing atoms to shift from one energy level to another. Ramsey's approach of imposing two separate, oscillating electromagnetic fields on an atomic beam to induce energy-level transitions formed the basis for the cesium atomic clock, which sets the present time standard.

In the 1950s, Ramsey helped develop the hydrogen maser, in which excited hydrogen atoms fed into a cavity are carefully tuned to emit microwave radiation of a specific frequency. Because the hydrogen maser is more stable than the cesium clock over short periods of time, it is useful as a secondary time standard and for making high-precision frequency measurements.

Wolfgang Paul of the University of Bonn in West Germany shares the second half of the prize with Hans G. Dehmelt of the University of Washington in Seattle. Starting in the 1950s, Paul developed an electromagnetic trap capable of holding a small number of ions for long periods of time. The so-called Paul trap and its cousin, the Penning trap, play an important role in modern spectroscopy.

Dehmelt used ion-trap spectroscopy to study electrons and other charged particles. In 1973, he became the first to observe a single electron in a trap, opening the door to precise measurements of key electron properties (SN: 1/21/89, p.38). Similar techniques allowed Dehmelt and his collaborators to observe a quantum jump in a single ion (SN: 6/21/86, p.388). *– I. Peterson*