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A calculated guess on weather

By Robert Irion
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MILWAUKEE—Climate researchers may not know when the heat wave and drought in the Midwest will end, but they do know that the sky is not as wild and unpredictable as it once seemed.

Using a complex branch of mathematics known as "chaos theory," scientists are finding order behind what seem like random seethings of the atmosphere. They've discovered that the Earth's climate follows recognizable patterns over hours, decades and millions of years.

With more work, some of these theories could help meteorologists forecast the weather more accurately for weeks or months in advance.

"There is some sort of simplicity in the atmosphere," said Anastasios Tsonis, an atmospheric scientist at the University of Wisconsin in Milwaukee. "If we can describe it, we have taken the first step toward predicting the weather better."

Currently, computer forecasts are reliable for only three to five days. After that, the atmosphere changes too quickly for meteorologists to use scientific models.

Instead, they must use past weather trends for their monthly or seasonal outlooks. But these long-range forecasts, produced by the Climate Analysis Center in Washington, are accurate only 55 or 60 percent of the time.

"We'll never be able to predict the weather perfectly," said chaos theory founder Edward Lorenz of the Massachusetts Institute of Technology. "And I doubt that we'll ever predict a month ahead of time which day it will rain. But we'll probably do a pretty good job at predicting if an entire season will be warmer or colder than normal."

Contrary to its usual definition, "chaos" means "order" for most scientists. If something moves in a chaotic way, it follows certain rules of motion, or equations. By knowing where an object starts and what laws of motion it obeys, a scientist can predict where it might end up.

For instance, a ball on the end of a string will always move a certain way, and after a while it will always stop at the same place. A more complex example is an electrical circuit, in which the current can move in several ways.

In 1963, Lorenz showed that he could describe the motion of a hot liquid over a surface with just three equations.

The fluid's motion seemed completely random after a while. But it was still obeying the three simple equations, Lorenz found.

Because the atmosphere is just a thin, heated ocean of air over the Earth's surface, Lorenz thought its motion might also obey simple equations. Recent research supports this idea.

In 1984, scientists examining records of the Earth's average temperature, preserved in ocean sediments, found that it fluctuates over millions of years in a way described by three equations. In 1987, other researchers found that daily barometric pressure, a basic indicator of fair or foul weather, varies over several years according to six or seven equations.

And just two weeks ago, Wisconsin's Tsonis published an article in the journal Nature showing that vertical wind speeds in the atmosphere, measured every 10 seconds for 11 hours, follow a pattern described by eight equations.

Scientists don't yet know how to solve these equations. Until they do, chaos theory will remain an interesting fact of nature rather than a practical tool for weather forecasters to use.

But Tsonis thinks that, perhaps within a decade, his labors may bear fruit in more accurate long-range forecasts.

"No one will risk their reputations to predict when this drought will break," he said. "But I personally believe we'll be able to make such predictions in the near future." To make them, Tsonis said, researchers must make better measurements of the current state of the atmosphere. For example, Tsonis said it is impossible to keep track of the world's weather patterns without accurate measurements over the oceans, which cover 70 percent of the globe.

"Try to make a picture when you're missing 70 percent of the pieces," he said. "It can't be done."

But chaos theory also states that no matter how accurate the measurements, even small errors will grow.

"Edward Lorenz said that the flap of a fly's wing will change the course of the weather forever, and theoretically he's correct," said Steve Tracton, a research meteorologist with the Climate Analysis Center. "Even with almost perfect initial measurements, it is mathematically impossible to predict how the atmosphere will evolve."