Chaos theory thwarts 100 percent accuracy in weather forecasting

By How Stuff Works, adapted by Newsela staff on 08.08.19
Word Count **667**
Level **880L**

Hunter Anderson (center), a meteorology student at St. Cloud State University in Minnesota, monitors a developing supercell thunderstorm outside Limon, Colorado, May 8, 2017. Scientists and meteorologists from the Center for Severe Weather Research try to get close to supercell storms and tornadoes to better understand tornado structure and strength and learn more about tornado formation. Photo by: Drew Angerer/Getty Images

Most scientists are admired for making sense of our universe. Yet meteorologists are often criticized. How can we put a person on the moon, but still fail to correctly predict the weather?

Weather forecasters have made big improvements over the last 20 years, though. Today's three-day forecasts are much better than the one-day forecasts of the past. Meteorologists have been able to double the lead times for tornado warnings. They can now also give people an extra 40 minutes to escape flash floods.

Modern meteorologists use mathematical equations to predict the weather. Such forecasting requires powerful computers and lots of observational data. A single weather station would never be able to collect enough information. Instead, the data is collected from many linked stations on land, sea, and air. Some of these stations contain wind gauges, rain collectors, and temperature sensors. Other weather stations are strapped to floating buoys far out at sea. Some even collect

data as they travel on passenger planes and cargo ships. Weather satellites and balloons provide information from high in the atmosphere. Satellites take pictures of Earth's weather from their orbit in space. Balloons track air data over a particular location.

Supercomputers Aid Forecasts

Together, all of these sensors and gauges produce more than 1 million weather-related observations every day. A normal computer cannot handle all of this data. Luckily, meteorologists can rely on supercomputers. These machines are very fast. In the United States, these computers are housed at the National Centers for Environmental Prediction (NCEP). The organization is located in Camp Springs, Maryland. There, weather data streams into a supercomputer's brain. The computer plugs the data into mathematical equations. Based on the answers, the computer can predict how weather conditions might change over time. The computer's output helps shape almost every weather forecast across America.

However, not even the NCEP's supercomputers are always correct. The reason is they must take several unpredictable events into account. For example, they must consider how the sun will heat the Earth's surface or how air pressure differences will form winds. They even have to try to find the effects of the planet's rotation in space. Small changes in any one event can have big effects on future weather.

In the 1960s, MIT meteorologist Edward Lorenz came up with a way to describe this problem. He called it the butterfly effect. The name came from the idea that a butterfly flapping its wings in Asia could change the weather in New York City. Today, Lorenz is known as the father of chaos theory. This theory is applied to very complicated systems, such as weather systems. In these kinds of systems, small changes in starting conditions radically change the final results. Because of chaos, there is a limit to how correct weather forecasts can be. Lorenz set this limit at two weeks.

Taming Chaos

Modern meteorologists use state-of-the-art technology and methods to tame chaos. One of these ways is to create several different forecasts. Each of the forecasts is based on a slightly different starting point. If each prediction looks the same, then the weather is likely to "behave." If any prediction looks very different, then the weather is more likely to "misbehave."

Meteorologists also rely on Doppler radar to watch weather conditions and improve forecasts. Doppler radar uses a transmitter to send radio waves into the sky. The waves strike atmospheric objects and bounce back. Clouds moving away from the transmitter return different kinds of waves than clouds moving toward the transmitter. A computer in the radar changes the signal into pictures. These pictures show clouds, rain, and wind speeds and direction.

This technology allows meteorologists to predict the weather better than ever. Unfortunately, thanks to chaos, they will never be able to predict the weather with complete certainty. Surprise

storms, tornadoes, and floods may still come with little warning. It's a good idea to always carry an umbrella.

Quiz

1 Read the section "Supercomputers Aid Forecasts."

Which sentence from this section supports the conclusion that predicting the weather requires a large amount of information?

(A) Together, all of these sensors and gauges produce more than 1 million weather-related observations every day.

(B) In the United States, these computers are housed at the National Centers for Environmental Prediction (NCEP).

(C) For example, they must consider how the sun will heat the Earth's surface or how air pressure differences will form winds.

(D) The name came from the idea that a butterfly flapping its wings in Asia could change the weather in New York City.

2 Read the following paragraph from the section “Taming Chaos.”

Meteorologists also rely on Doppler radar to watch weather conditions and improve forecasts. Doppler radar uses a transmitter to send radio waves into the sky. The waves strike atmospheric objects and bounce back. Clouds moving away from the transmitter return different kinds of waves than clouds moving toward the transmitter. A computer in the radar changes the signal into pictures. These pictures show clouds, rain, and wind speeds and direction.

Which of the following is an accurate explanation of what this paragraph means?

(A) Doppler radar is where all of the different weather observations are sent to create new weather forecasts.

(B) Shooting radio waves into clouds helps scientists figure out what direction the clouds are moving.

(C) Using radar and supercomputers meteorologists are not able to accurately predict storms up to two weeks.

(D) Doppler radar is a tool meteorologists use to create pictures of what is happening with the weather.

3 Read the following sentence from the section ”Supercomputers Aid Forecasts."

The computer plugs the data into mathematical equations.

Which answer choice uses "plugs" in the SAME way as the sentence above?

(A) The drain and tub needed new plugs before the house was sold.

(B) She plugs the password into her phone to get online.

(C) The coffee maker and TV both have broken plugs.

(D) The celebrity actress plugs her new show on the radio.

4 Read the following selection from the section "Supercomputers Aid Forecasts."

> *However, not even the NCEP's supercomputers are always correct. The reason is they must take several unpredictable events into account.*

What is the meaning of the word "unpredictable" as it is used in the selection above?

(A) crazy

(B) certain

(C) random

(D) dependable