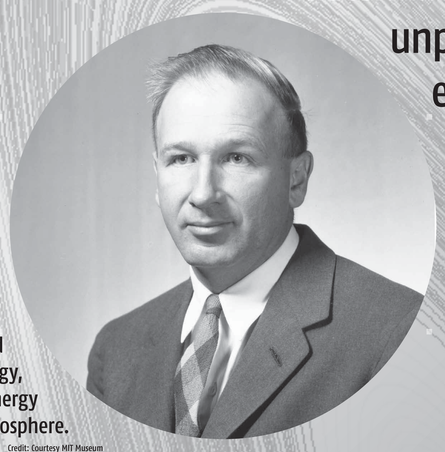
(1917–2008)

# EDWARD NORTON LORENZ

## *Pioneer of Chaos Theory*

In the early 1960s, MIT meteorology professor Edward Lorenz was running simple, computer-based weather simulations when he made a surprising discovery. When he used input data that had been rounded to a few decimal places he obtained dramatically different results from previous runs. Lorenz had hit upon deterministic chaos, or chaos theory: the idea that nonlinear systems such as weather are practically unpredictable despite their deterministic evolution. This theory was popularized as "the butterfly effect," the idea that small changes can have large consequences. Lorenz's discovery not only revolutionized the understanding of fluid turbulence and weather, but also led to advances in mathematics, the natural sciences, and engineering.



This photo of Lorenz was taken in 1956, a year after he published his first major paper in the journal *Tellus*. The article explored how storms get their energy, mapping the flow of energy through the atmosphere.

Credit: Courtesy MIT Museum

*"Chaos means something that looks random but is not random. The theory of chaos deals with sensitive dependence on initial conditions in non-linear dynamical systems, which is responsible for the apparent randomness. The Earth's atmosphere, plus its surroundings, is chaotic."*

—From a 1996 interview with Lorenz by WMO Bulletin

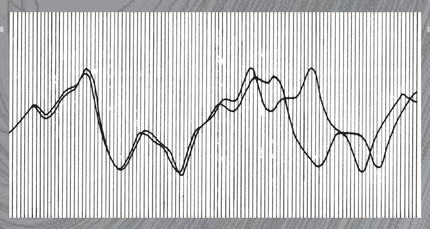

Lorenz arrived at MIT in 1942 to train as a weather forecaster for the U.S. Army. He went on to receive his master's and doctoral degrees from the Department of Meteorology, and then joined the faculty in 1948. This postcard shows MIT around 1940.

Lorenz, shown here in the White Mountains of New Hampshire with his wife, Jane, was an avid hiker throughout his life. "I go to the mountains whenever I can," he once said. "I have always loved the mountains and one cannot be [there]... and not be aware of the weather."

Credit: Biogr. Mems Fell. R. Soc. 2009

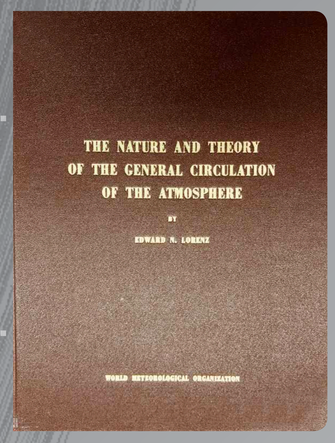
$$\dot{x} = \sigma\left(y - x\right),$$
$$\dot{y} = x\left(\rho - z\right) - y,$$
$$\dot{z} = xy - \beta z.$$

The Lorenz system, the three differential equations shown here, is one of the fundamental systems studied in chaos theory.



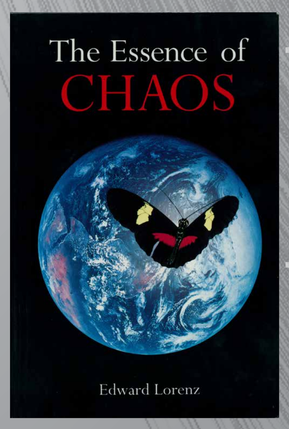
From almost the same starting point, Lorenz saw his simulated weather patterns grow apart.

Credit: Reproduced from Lorenz's 1961 printouts




Lorenz's treatise on the dynamics of the atmosphere, published in 1967, is considered a classic work of scientific literature. It is still required reading today.

Credit: Lorenz, E.N. (1967), World Meteorological Organization

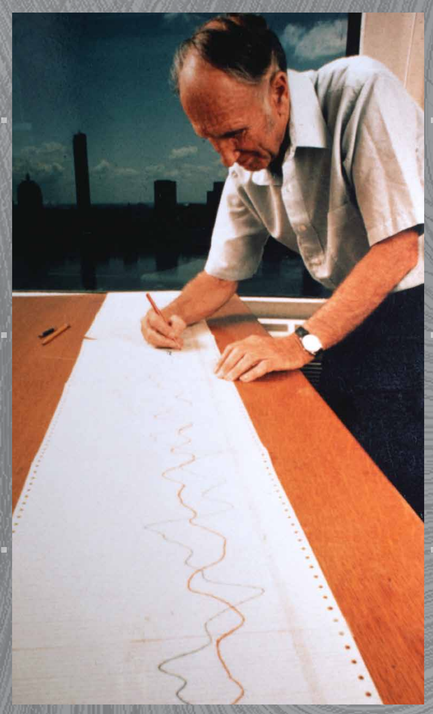



In *The Essence of Chaos*, published in 1993 and aimed at a general audience, Lorenz provided an overview of deterministic chaos and its relevance to global weather, and also described the scientific community's growing awareness of chaotic systems in other fields.

Credit: Used with permission, *University of Washington Press*

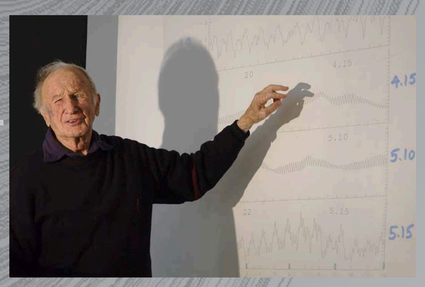
By nature, Lorenz was modest, shy, and soft spoken. He was also a beloved teacher, the winner of the department's teaching award many times over. In this 1979 photo, he poses with the Fast Eddies, his softball team comprised of graduate students.

Credit: Courtesy the Lorenz Family



Lorenz, shown at his desk in the 1960s, wrote about chaos theory in a landmark 1963 article for the *Journal of Atmospheric Sciences*. In 1969, Lorenz demonstrated that the nonlinear interaction among motions of many different scales could lead to loss of predictability even when the model is perfect and the initial errors are vanishingly small.

Credit: Courtesy of the Inamori Foundation; 1991 Kyoto Prize Laureate in Basic Sciences




Lorenz was a vital member of MIT for over 60 years, serving as head of Meteorology from 1977 to 1981. After becoming a professor emeritus in 1987, he lived close to campus, continued to conduct research, and give lectures, contributing until the end. In 2011 MIT created the Lorenz Center in his honor, dedicated to furthering the basic understanding of climate science.

Credit: Omari Stephens / Doppler Photo

The recipient of many awards, Lorenz won the prestigious Kyoto Prize in 1991, shown here at the award ceremony. His discovery of deterministic chaos, observed the prize committee, "revolutionized our understanding of nature in all of the sciences and beyond."

Credit: Courtesy the Lorenz Family

*"If the flap of a butterfly's wings can be instrumental in generating a tornado, it can equally well be instrumental in preventing a tornado."*

—From a presentation by Lorenz at the American Association for the Advancement of Science, 1972

Background image: Solution plot of the Lorenz system resembling a butterfly.

**1910**

**1917:** Born May 23 in West Hartford, Connecticut. Lorenz's father was a mechanical engineer, and his mother did social work.

**1920**

**1928:** Carl-Gustaf Rossby founded the country's first meteorology program at MIT in Course XVI Aeronautics and Astronautics.

**1930**

**1931:** MIT meteorologists instrumented a monoplane and performed six months of daily flights from East Boston (now Logan) Airport.

**1938:** Graduated from Dartmouth College with a bachelor's degree in mathematics.

**1940**

**1940:** Received a master's degree in mathematics from Harvard University working with G.K. Birkhoff.

**1940:** Radar Lab formed.

**1941:** Dept of Meteorology created as Course XIV led by Sverre Petterssen.

**1942–69:** Henry Houghton chaired the department.

**1943:** Awarded a master's degree from the Department of Meteorology at MIT.

**1946:** Course number changed to XIX.

**1948:** Received his doctorate from MIT, exploring the prediction of the motion of storms, working with James Austin.

**1950**

**1955:** Published "Available Potential Energy and the Maintenance of the General Circulation." Became an assistant professor at MIT and a full professor in 1962.

**1957:** Meteorology moved from the School of Engineering to the School of Science.

**1960**

**1963:** Published "Deterministic Nonperiodic Flow."

**1964:** Meteorology moved from Building 24 to the Cecil and Ida Green Building, 54.

**1967:** Published "The Nature and Theory of the General Circulation of Atmosphere."

**1968:** Joint Program in oceanography created between MIT and the Woods Hole Oceanographic Institution.

**1969:** Received the Carl-Gustaf Rossby Research Medal from the American Meteorological Society.

**1970**

**1970–74:** Norman Phillips chaired the department.

**1972:** Lecture popularized term "butterfly effect."

**1974–77:** Jule Charney chaired the department.

**1975:** Elected to the National Academy of Sciences.

**1976:** Published "Nondeterministic Theories of Climate Change."

**1977–81:** Edward Lorenz chaired the department.

**1977:** Headed MIT's Department of Meteorology, stepping down in 1981.

**1980**

**1981–1983:** Chaired by Peter Stone.

**1983:** Merged with Course XII to become the present Department of Earth, Atmospheric and Planetary Sciences (EAPS, XII). The Center for Meteorology and Physical Oceanography established.

**1983:** Shared the Crafoord Prize of the Royal Swedish Academy of Sciences with former MIT Professor Henry M. Stommel.

**1987:** Retired from his professorship but remained active as an MIT professor emeritus.

**1990**

**1991:** Received the Kyoto Prize for "the development of the theoretical basis of numerical study in meteorology and the discovery of deterministic chaos."

**1997:** The Center for Meteorology and Physical Oceanography changed its name to the Program in Atmospheres, Oceans and Climate (PAOC).

**2000**

**2008:** Died April 16, Cambridge, MA.

**2010**

**2011:** The Lorenz Center opened in EAPS.