# Butterfly Effect

(A very simple understanding of this complex effect )

Actually this effect has something to do with advanced Physics and much burning the Chaos theory .

The **butterfly effect** is a metaphor that encapsulates the concept of *sensitive dependence on initial conditions* in chaos theory; namely that small differences in the initial condition of a dynamical system may produce large variations in the long term behavior of the system. Although this may appear to be an esoteric and unusual behavior, it is exhibited by very simple systems: for example, a ball placed at the crest of a hill might roll into any of several valleys depending on slight differences in initial position. The butterfly effect is a common trope in fiction when presenting scenarios involving time travel and with "what if" scenarios where one storyline diverges at the moment of a seemingly minor event resulting in two significantly different outcomes.

The "Butterfly Effect" is often ascribed to Lorenz. In a paper in 1963 given to the New York Academy of Sciences he remarks:

*One meteorologist remarked that if the theory were correct, one flap of a seagull's wings would be enough to alter the course of the weather forever.*

By the time of his talk at the December 1972 meeting of the American Association for the Advancement of Science in Washington, D.C. the sea gull had evolved into the more poetic butterfly – the title of his talk was:

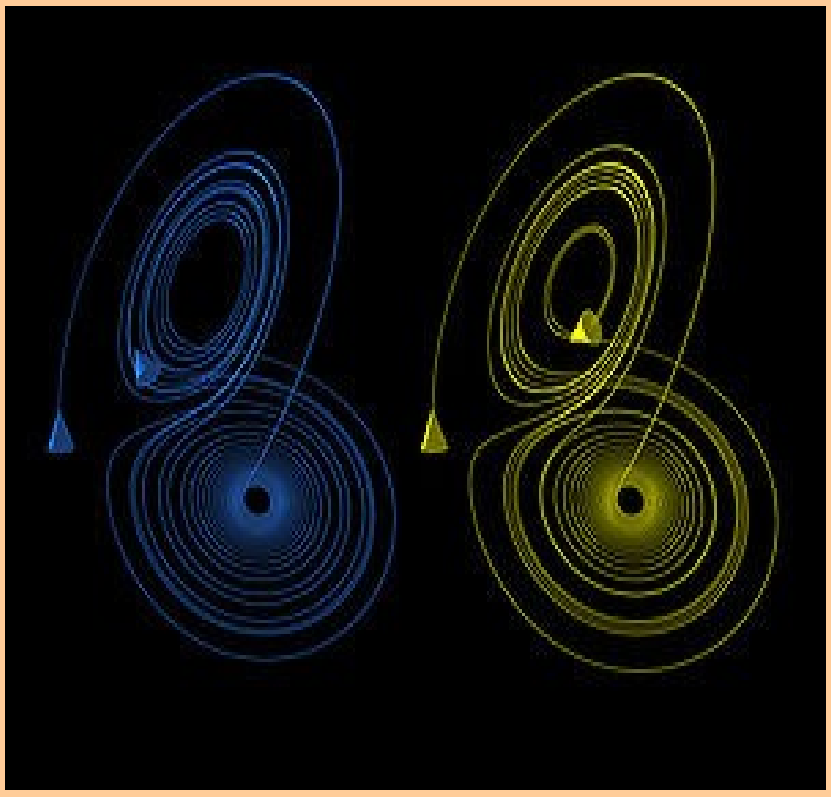
*Predictability: Does the Flap of a Butterfly's Wings in Brazil set off a Tornado in Texas?*

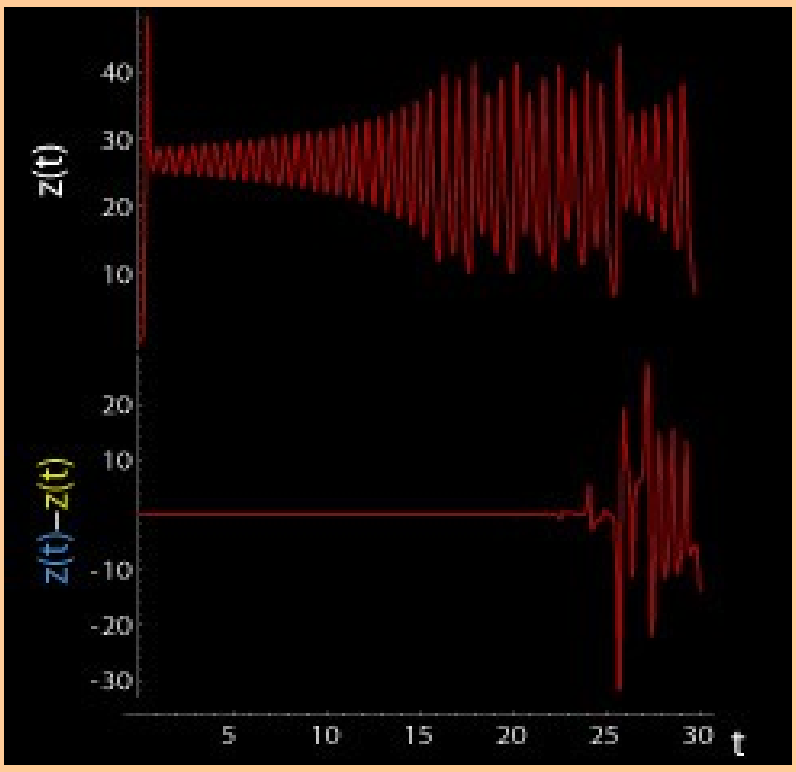
The phrase refers to the idea that a butterfly's wings might create tiny changes in the atmosphere that may ultimately alter the path of a tornado or delay, accelerate or even prevent the occurrence of a tornado in a certain location. The flapping wing represents a small change in the initial condition of the system, which causes a chain of events leading to large-scale alterations of events . Had the butterfly not flapped its wings, the trajectory of the system might have been vastly different. While the butterfly does not "cause" the tornado in the sense of providing the energy for the tornado, it does "cause" it in the sense that the flap of its wings is an essential part of the initial conditions resulting in a tornado, and without that flap that particular tornado would not have existed.

## Origin of the term :)

he term "butterfly effect" itself is related to the work of Edward Lorenz, and is based in chaos theory and sensitive dependence on initial conditions, already described in the literature in a particular case of the three-body problem by Henri Poincaré in 1890. He even later proposed that such phenomena could be common, say in meteorology. In 1898 Jacques Hadamard noted general divergence of trajectories in spaces of negative curvature, and Pierre Duhem discussed the possible general significance of this in 1908. The idea that one butterfly could eventually have a far-reaching ripple effect on subsequent historic events seems first to have appeared in a 1952 short story by Ray Bradbury about time travel although Lorenz made the term popular. In 1961, Lorenz was using a numerical computer model to rerun a weather prediction, when, as a shortcut on a number in the sequence, he entered the decimal .506 instead of entering the full .506127 the computer would hold. The result was a completely different weather scenario.

Lorenz published his findings in a 1963 paper for the New York Academy of Sciences noting that "One meteorologist remarked that if the theory were correct, one flap of a seagull's wings could change the course of weather forever." Later speeches and papers by Lorenz used the more poetic butterfly. According to Lorenz, upon failing to provide a title for a talk he was to present at the 139th meeting of the American Association for the Advancement of Science in 1972, Philip Merilees concocted *Does the flap of a butterfly's wings in Brazil set off a tornado in Texas?* as a title. Although a butterfly flapping its wings has remained constant in the expression of this concept, the location of the butterfly, the consequences, and the location of the consequences have varied widely.






These figures show two segments of the three-dimensional evolution of two trajectories (one in blue, the other in yellow) for the same period of time in the Lorenz attractor starting at two initial points that differ only by $10^{-5}$ in the x-coordinate. Initially, the two trajectories seem coincident, as indicated by the small difference between the $z$ coordinate of the blue and yellow trajectories, but for $t>23$ the difference is as large as the value of the trajectory. The final position of the cones indicates that the two trajectories are no longer coincident at $t=30$.