WEATHER FORECASTING

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WEATHER FORECASTING

- Weather forecasting is the application of science and technology to predict the conditions of the atmosphere for a given location and time.

- It is a crucial aspect of daily life for countless people globally, as it helps us plan our activities, brace ourselves for unfavorable weather conditions, and alleviate the consequences of severe events.

WEATHER FORECASTING HISTORY

- Predicting Weather has been in practice for over thousands years, but officially

  it is called "weather forecasting" since the 19th century.

- It is believed that the very first weather forecast was published on August 1,

  1861, in the English newspaper Times by the English meteorologist Robert

  Fitzroy

SCIENCE BEHIND WEATHER FORECASTING

OBSERVATION

ANALYSIS

COMMUNICATION

OBSERVATION

- Initial stage of weather forecasting, involves gathering information about the current weather conditions.

- Range of tools and techniques are employed to collect weather data (ex. weather stations, radar, satellites, and weather balloons)

- These tools provide measurements of various weather variables, including temperature, pressure, humidity, wind speed and direction, and precipitation(The Conversation).

ANALYSIS

- Weather forecasters employ diverse techniques and tools, including computer models, to generate an accurate picture of the current state of the atmosphere.

- Analysis involves scrutinizing the collected data, and synthesizing it into a cohesive picture of the prevailing weather conditions (The Conversation)

COMMUNICATION

- Weather forecasting is communication, which involves disseminating the predicted weather information to the public, weather-sensitive organizations, and emergency management agencies.

- Various channels, such as TV and radio broadcasts, websites, social media, and mobile applications, are utilized to convey weather-related updates. (The Conversation).

DIFFERENTIAL EQUATION
&
WEATHER FORECASTING

PARTIAL DIFFERENTIAL EQUATION

- The advection equation; it is a partial differential equation of the first order. This equation explains the motion of fluid and the conveyance of atmospheric factors like moisture and heat.

- The key variables in weather forecasting are fluid velocity ,V, (with three components: u for eastward, v for northward, and w for upward), pressure (p), density (ρ), temperature (T), and humidity (q). By applying Newton's laws of motion and the principles of conservation of energy and mass, we can derive a system of equations that can be solved using initial conditions.

At the heart of this system are the Navier–Stokes equations, which govern fluid motion. These equations are typically written in vector form as:

$$\partial V \partial t + V \cdot \nabla V + 2\Omega \times V + 1\rho \nabla p = F + g'$$

Here, ∇V and ∇p represent the gradient of the velocity and pressure fields, respectively, and Ω represents the rotation rate of the Earth. The term F represents external forces acting on the fluid, such as gravity and friction, while g' represents the effect of gravity on the horizontal pressure gradient. Partial differential equations (PDEs) are a crucial mathematical tool for meteorologists in weather forecasting. They provide a framework for understanding the intricate behavior of the atmosphere, which is necessary for generating accurate and reliable weather forecasts.

VIDEOS EXPLAINING PARTIAL EQUATION

- https://youtu.be/ly4S0oi3Yz8

- https://youtu.be/AuJdjhnWRWw
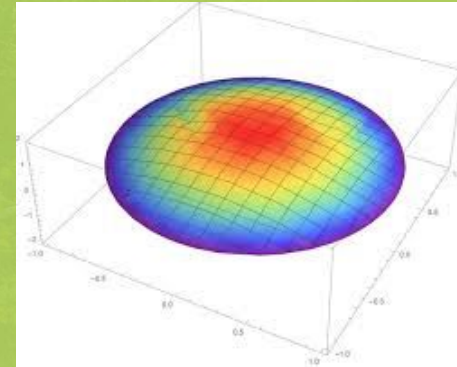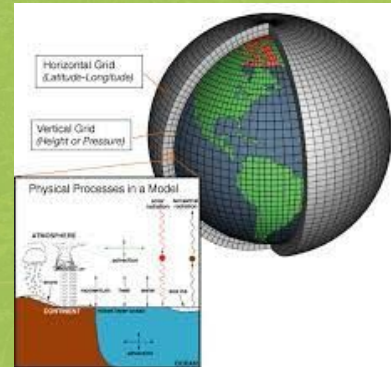
LORENZ EQUATION

In the 1960s, Edward Lorenz developed the Lorenz equations - a set of three nonlinear differential equations that aimed to model atmospheric convection and the Earth's weather dynamics. The equations comprise variables x, y, and z, which describe the state of the system over time, while parameters σ, ρ, and β determine the system's behavior.
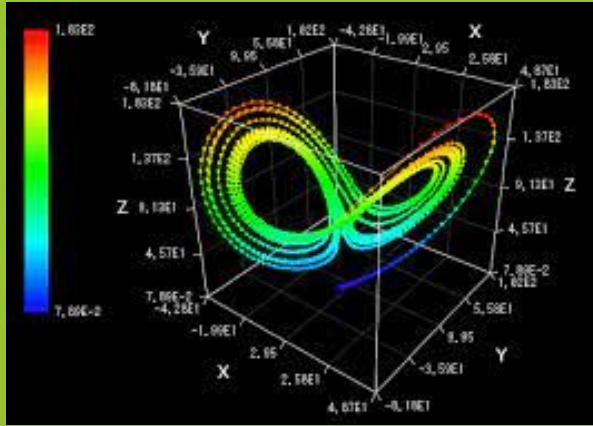
$dx/dt = \sigma(y - x)$ Eqn I

$dy/dt = x(\rho - z) - y$ Eqn II

$dz/dt = xy - \beta z$ Eqn III

The equations are notable for their chaotic behavior, where small changes in initial conditions can lead to significantly different outcomes - known as the "butterfly effect".The Lorenz System oftens comes out in a butterfly shaped plot. The Lorenz equations have been used to model diverse phenomena such as fluid dynamics, chemical reactions, and stock market behavior, among others.

EXTRA SOURCES FOR LORENZ EQUATION

- https://medium.com/geekculture/lorenz-attractor-weather-forecast-explained-93703ad0ec6

- https://www.sciencedirect.com/topics/engineering/lorenz-equation

- https://ftp.emc.ncep.noaa.gov/mmb/sref/Doc/lorenz_fcst.pdf

- https://www.cfm.brown.edu/people/dobrush/am34/Mathematica/ch3/lorenz.html

- https://www-users.cse.umn.edu/~mcgehee/Seminars/ClimateChange/presentations/20081007.pdf

- https://www.aps.org/publications/apsnews/200301/history.cfm

- Simulating the Lorenz System in Matlab

A QUICK JOKE BREAK

Why did the cloud break up with the lightning bolt?

Because it couldn't handle the shocking relationship!

SOURCES

- [The Forecast Process: Observing and Analysis](#)
- [What is a weather forecast and how does it work. Meaning, duration, accuracy, more - Windy.app](#)
- [The Challenges and Complexities of Weather Forecasting, by Mark Bloomer](#)
- [Numerical Weather Prediction](#)
- [https://www.chegg.com/homework-help/questions-and-answers/help-solving-matlab-simulink-q101872474](#)

MLA FORMAT

1. "The Forecast Process: Observing and Analysis." *National Weather Service*, https://www.weather.gov/rah/virtualtourfcstobsanalysis. Accessed 7 May 2023.

2. "What is a weather forecast and how does it work. Meaning, duration, accuracy, more." *Windy.app*, https://windy.app/blog/what-is-a-weather-forecast-and-how-it-works.html. Accessed 7 May 2023.

3. "The Challenges and Complexities of Weather Forecasting, by Mark Bloomer." *National Weather Service*, https://www.weather.gov/car/weatherforecasting. Accessed 7 May 2023.

4. "Solved 1. SIMULATION OF A CHAOTIC SYSTEM: LORENZ'S EQUATIONS." *Chegg*, https://www.chegg.com/homework-help/questions-and-answers/help-solving-matlab-simulink-q101872474. Accessed 8 May 2023.

THANK YOU !