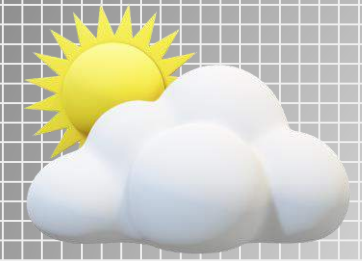
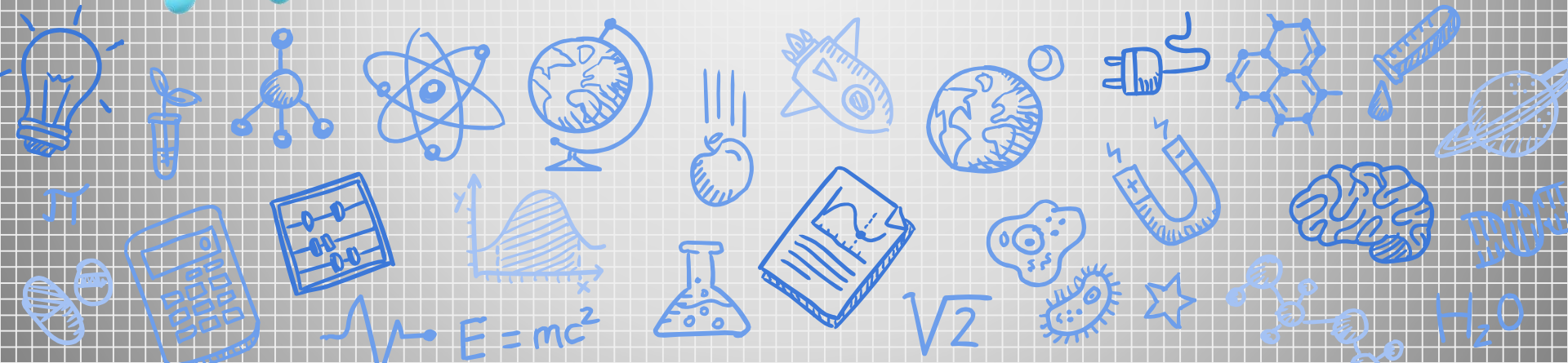


WEATHER FORECAST

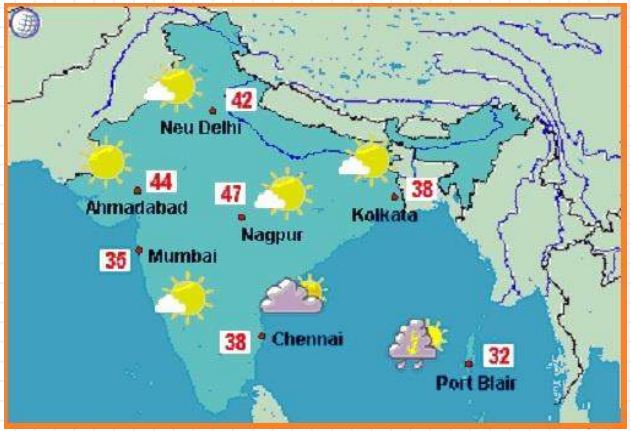


INDEX..

INTRODUCTION

WHAT IS WEATHER FORECASTING?

- Weather Forecast is the application of science and technology to predict the conditions of the atmosphere for a given location and time.
- People have attempted to predict the weather informally for millennia and formally since the 19th century.
- It has influenced people's lives for thousands of years.
- There are now more than 70 weather departments all over the world.



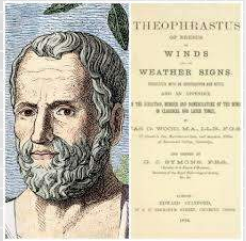
BEFORE CALCULUS...

WEATHER FORECAST BEFORE CALCULUS

Earliest scientific approach was around 300 BC documented in Aristotle's work "meteorological" where he explained the relation between earth, air, water and fire to predict weather.

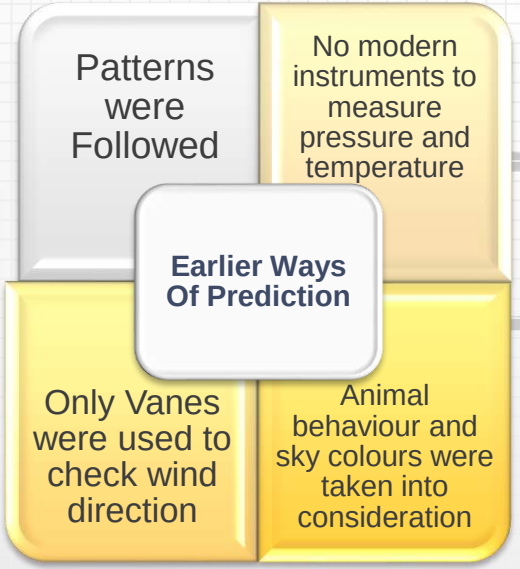
Later his pupil Theophrastus wrote "The book of signs" which included colours of sky , rings, halos and even sounds. This was followed for about 2000 years

Ancient weather forecasting methods usually relied on observed patterns of events, also termed pattern recognition. Not all of these predictions prove reliable, and many of them have since been found not to stand up to rigorous statistical testing.



Calculated by hand based mainly upon changes in barometric pressure, current weather conditions, and sky condition or cloud cover.

WHY CALCULUS??



Errors due to it and reasons to introduce calculus

- Predictions were not accurate
- Disasters couldn't be Known a number of days before
- With satellites large data had to be calculated to predict weather
- The predictions would be invalid if the patterns broke
- Animal behaviour cannot be always trusted

Lewis Fry Richardson

Who introduced Calculus In The Field?

Vilhelm Bjerknes & Lewis Fry Richardson

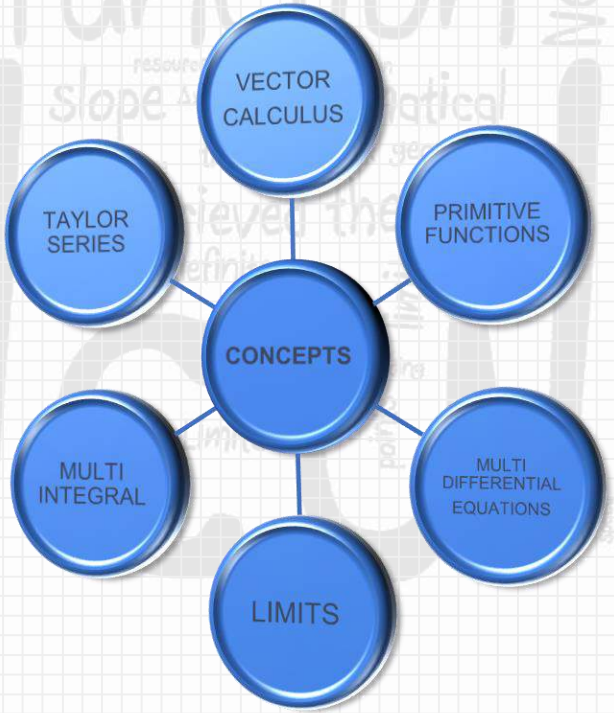
He introduced the numerical method of weather prediction in 1922

THE BEGINNING .....

- British scientist Lewis Fry Richardson was the first to put the numerical weather prediction to use
- It took him 6 weeks to finish the calculations to predict weather pattern
- Lewis , in order to solve differential equations , he invented the method of finite differences , which produces highly accurate results
- Numerical weather prediction was at a standstill until 1948 until a group of meteorologists at New Jersey's Institute developed the first computer that was used to complete the mathematical equations
- The computer was known as the Electronic Numerical Integrator and computer (ENIAC)

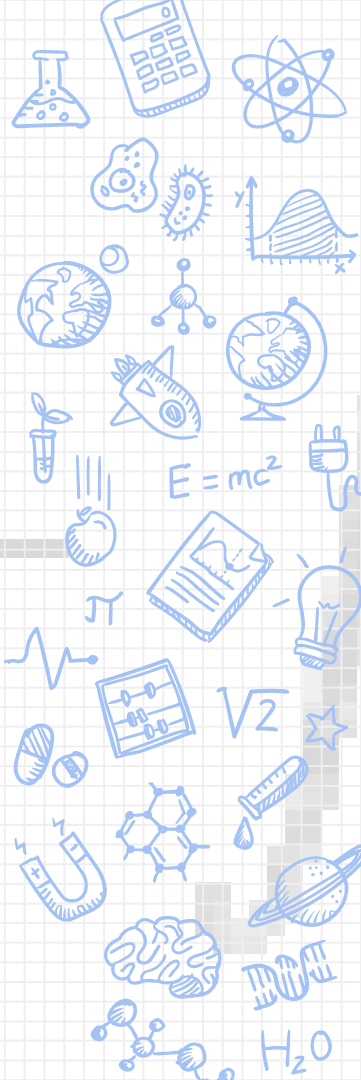
AFTER CALCULUS...

CONCEPTS OF CALCULUS INTRODUCED



PRIMITIVE EQUATIONS

- Primitive Equations are used to approximate global atmospheric flow.
- It is a set of six non linear differential equations
- There are 3 main sets of primitive equations
  - Conservation of momentum
  - Thermal energy equation
  - Continuity equation



Primitive Equations

$$\frac{du}{dt} - fv = -\frac{1}{\rho}\frac{\partial p}{\partial x}$$

x-component momentum equation

$$\frac{dv}{dt} + fu = -\frac{1}{\rho}\frac{\partial p}{\partial y}$$

y-component momentum equation

$$\frac{dp}{dz} = -\rho g$$

hydrostatic equation

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z} = -\frac{1}{\rho}\frac{d\rho}{dt}$$

continuity equation

$$c_p \frac{dT}{dt} - \alpha \frac{dp}{dt} = Q$$

thermodynamic energy equation

$$p = \rho RT$$

equation of state

6 equations with 6 dependent variables: u, v, w, p, ρ, T

DERIVATION

$$\rho\left(\frac{\partial v_x}{\partial t}+v_x\frac{\partial v}{\partial x}+v_y\frac{\partial v}{\partial y}+v_z\frac{\partial v}{\partial z}\right)=-\frac{\partial p}{\partial x}+\mu\left(\frac{\partial^2 v_x}{\partial x^2}+\frac{\partial^2 v_x}{\partial y^2}+\frac{\partial^2 v_x}{\partial z^2}\right)+\rho g_x$$

$$\rho\left(\frac{\partial v_y}{\partial t}+v_x\frac{\partial v}{\partial x}+v_y\frac{\partial v}{\partial y}+v_z\frac{\partial v}{\partial z}\right)=-\frac{\partial p}{\partial y}+\mu\left(\frac{\partial^2 v_y}{\partial x^2}+\frac{\partial^2 v_y}{\partial y^2}+\frac{\partial^2 v_y}{\partial z^2}\right)+\rho g_y$$

$$\rho\left(\frac{\partial v_z}{\partial t}+v_x\frac{\partial v}{\partial x}+v_y\frac{\partial v}{\partial y}+v_z\frac{\partial v}{\partial z}\right)=-\frac{\partial p}{\partial z}+\mu\left(\frac{\partial^2 v_z}{\partial x^2}+\frac{\partial^2 v_z}{\partial y^2}+\frac{\partial^2 v_z}{\partial z^2}\right)+\rho g_z$$

$$\rho(rho)=density,\mu(mu)=viscosity,p=pressure$$

$$g_x=gravitational\ force\ along\ x-axis,$$

$$g_z=gravitational\ force\ along\ z-axis$$

$$g_y=gravitational\ force\ along\ y-axis$$

$$v_x=velocity\ along\ x\ direction$$

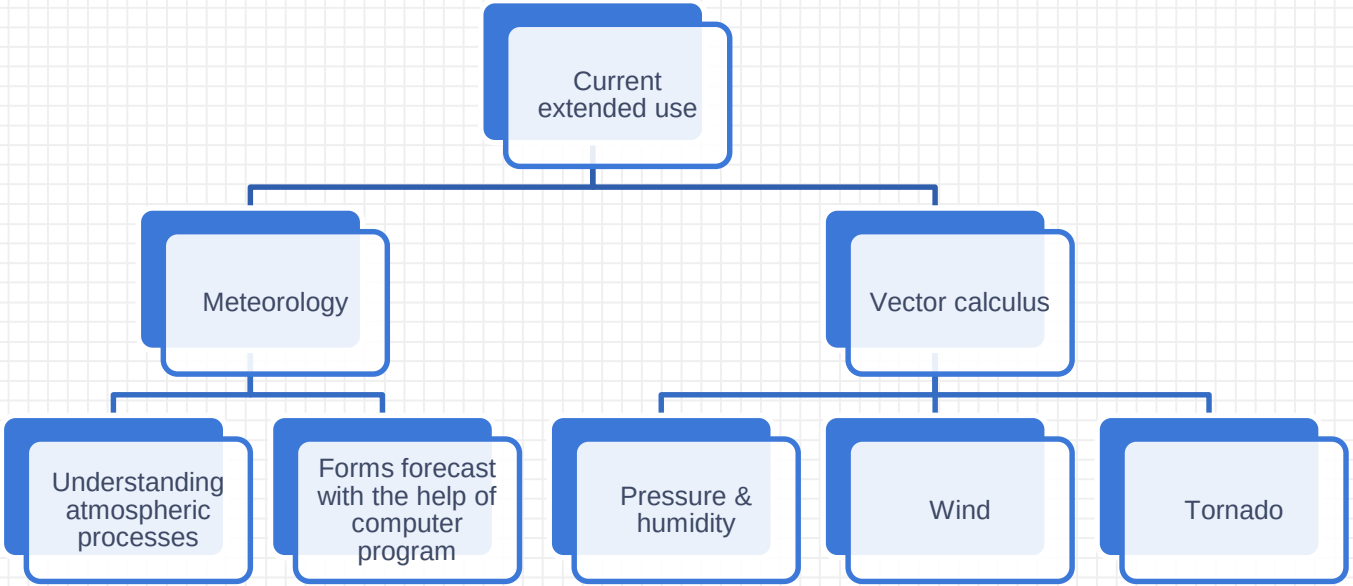
$$v_y=velocity\ along\ y\ direction$$

$$v_z=velocity\ along\ z\ direction$$

How Calculus Changed The Field ??

- Before introduction of calculus weather could be predicted only for a few days but now with calculus we can predict weather for a couple of months.
- Supercomputers use satellite images to predict the weather with the help of mathematical derivations formulated by the mathematics and thus prevent loss of life
- With the help of application of calculus in computers it became easier to handle and calculate the huge amount of data collected

CURRENT EXTENDED USE


Current extended use
Meteorology
Vector calculus
Understanding atmospheric processes
Forms forecast with the help of computer program
Pressure & humidity
Wind
Tornado

THANK YOU !!!

Presentation by –
RICHA RANE
KHUSHI MORZARIA
SALONI BERA
RIYA ANADA
KARAN RATHOD