Lecture Notes on Numerical Weather Prediction

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Abstract
Notes of Lectures and addional information from books.

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Contents

1. Lecture 1 06/01/2025

Numerical Weathering Problem (NWP) was first proposed by Bjerkives around 1900. It is mathematical initial value problem (IVP).

Initial value Problem (IVP) $\rightarrow$ simple pendulum.

$$\ddot{\theta} + \omega^2 \theta = 0 \tag{1}$$

$$\frac{d^2\theta}{dt^2} + \omega^2 \theta = 0 \tag{2}$$

$$\theta(t) = A\cos(\omega t) + B\sin(\omega t) \tag{3}$$

Eq.(1) and (2) are second order linear ordinary differential equation, whose solution Eq.(3) has 2 constants of integration A and B. Here θ and t are tge dependent and independent variable since Eq.(1) and (2) have only one independent variable.

Values of A and B will depend on initial condition.

Since ODE is second order, 2 initial condition are needed at initial time, say $t = 0$. Which are:

$$\left.\begin{aligned} \theta(t=0) &= 1 \\ \frac{\theta(t=0)}{dt} &= 0 \end{aligned}\right\} \tag{4}$$

Eq.(2) and initial conditions Eq.(4) are together called **Mathematical IVP**. For any physical system the following two requirements are needed:

1. The equation (ODE or PDE) that governs the evolution of the above system.
2. The initial state of the system.

7 independent variables **(u,v,w,T,ρ,p,q)**.

Surface area of Earth = $4\pi R^2 = 4\pi(6.37 \times 10^{12}) \approx 5.1 \times 10^{14}$ m^2