Chapter 1 Introduction

1.1 Fundamental Laws

- Fundamental laws of geophysical fluid dynamics (GFD) and thermodynamics are applied to describe the

(a) atmospheric motions, (u, v, w) [Mechanics]
(b) states of the atmosphere, (ρ, p, T)
[Thermodynamics]

The relationship among different branches of Fluid Dynamics

Fluid Dynamics

+stratification | +rotation

GFD

Dynamic Meteorology	Dyn./Phy. Oceanography	Outer Core Dynamics	Dyn. Planet. Atmos.
(+moisture)	(+salinity)	(+magnetic & electric forces)	e.g., (+dust for Mars)

By assuming the atmosphere as a continuous fluid medium, a set of partial differential equations (PDE) governing the atmospheric motions are then derived.

Flow motion and states are then expressed by a set of PDE's:

flow motion: u, v, w *(velocities in x, y, & z directions, resp.)*

fluid state: ρ, T, p *(density, temperature, & pressure)*

physical variables: humidity, water vapor, cloud water, rain, ice, snow, hail, air pollutants, chemical species, etc.

- Objectives: to understand the mechanisms for atmospheric motions and processes and to help predict the weather.

- Approaches
  - Solve PDEs analytically by making approx. ➡

    Dynamic Meteorology
  - Solve PDEs approximately by computers ➡

    Numerical Weather Prediction
  - Combination of the above approaches ➡

    Synoptic-Dynamic Meteorology

The relationship among different branches of Atmospheric Sciences and Meteorology