CHAPTER I

INTRODUCTION

Weather forecasting is the most important application of Dynamic Meteorology which is study of those motions of the atmosphere associated with weather and climate. For all such motions the atmosphere can be regarded as a continuous fluid medium. The various physical quantities which characterize the state of the atmosphere - pressure, density, temperature, and velocity are assumed to have unique values at each point in the atmospheric continuum. Moreover, these fields variables and their derivatives are assumed to be continuous functions of space and time.

Weather forecasting is not a new science; it has long history because of the importance of weather in human activity. The weather affects our lives in a multitude of ways through agriculture, industry, transportation, communication, etc. As in other fields, certain events, inventions, and scientific innovations marked the important advance in weather prediction.

A Brief History of Forecasting

The invention of the barometer in 1643 by Torricelli is considered by many to be the beginning of meteorology as a science [Haltiner and Williams, 1979]. But an important milestone was the recognition by V. Bjerknes in 1904 that forecasting is fundamentally an initial-value problem in Mathematical Physics and moreover, that the basic system of equations to be solved was already known, at the least general form. But Bjerknes realized that this system of highly nonlinear partial differential equations

did not possess closed solutions, except possibly in grossly simplified forms that had no direct use in forecasting. In addition the data were inadequate to determine the initial conditions. During and immediately World War I, L. F. Richardson sought to solve the system of equation numerically using desk calculators. The discouraging results of his pioneering effort, published in book form in 1922,gave pressure changes an order of magnitude greater than observed. Few people realized the fundamental importance of Richardsons work and no one seems to care to repeat the months of calculations to determine the cause of the failure.

Theoretical research continued with important contributions by Rossby, Eady, Petterssen, J. Bjerknes, Charney, Eliassen, Fjortoft, Obukkov, and others that led to some direct applications to practical problems and more importantly laid the foundation for a radical departure from pure empiricism. But, it was another invention, the electronic computer in the late 1940, that stimulated a new breakthrough. Using the recently invented computer Charney, Fjortoft, and Von Neumann produced the first successful dynamical-numerical forecasting at 500 hPa with an equivalent-barotropic vorticity model. Their accuracy was nearly comparable to that achieved by highly skilled forecasters using subjective and empirical techniques. Thus dawned the age of dynamical forecasting by numerical methods, commonly referred to as numerical weather prediction (NWP), which soon became the primary basis for modern weather prediction.

Outline of Thesis

The purpose of this thesis is to study Atmospheric Physics, especially in application of the Lorenz model to the atmospheric circulation. We study how to construct the Lorenz model for the atmospheric circulation from the quasi-geostrophic vorticity [Charney, 1979] which bases on the basic laws of Physics such as the *laws of conservation of momentum, mass and energy* and the *equation of state*, and then apply this model to explain behaviour of the atmospheric circulation.

In the next chapter, we review some basic theories of Physics which govern the circulation of the atmosphere and then some of the features of the atmospheric circulation as revealed by observations will be described in chapter III. In chapter IV, we turn our attention to the Lorenz model which is designed to represent a convective motion of fluid. In chapter V, we apply the Lorenz model to the circulation of the atmosphere and then present the results, including discussions and conclusions in the last chapter.