CHAPTER I

INTRODUCTION

Weather forecasting is the most important application of Dynamic Meteorology which is the 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, or continuum. 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 field variables and their derivatives are assumed to be continuous functions of space and time.

Weather forecasting is not a new science; it has a 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 advances 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 least general form. But Bjerknes realized that this system of highly nonlinear partial differential equations did not posses closes solutions, except possibly in grossly simplified forms that had little direct use in forecasting. In addition the data were wholly inadequate to determine the initial conditions. During and immediately following 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 Richardson's work and no one seemed to care to repeat the months of calculations to determine the cause of the failure.

Theoretical research continued with important contributions by Rossby, Petterssen, J. Bjerknes, Charney, Eady, 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 forecast 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.

Weather Forecasting in Thailand

Currently (Chareonwong and others,1992), there are no numerical weather prediction models for practical use in Thailand. The TMD (Thailand Meteorological Department) uses the numerical weather prediction products from the national

meteorological centres of many other countries for daily use. These products can not fully support the information needs of the forecasters on continuous and area-wide basis. Furthermore, the impacts of heavy rainfalls over Bangkok in 1988 and the typhoon "Gay" in the southern Thailand in 1989, a group of scientists in many areas of specialization have co-operated in developing the numerical weather prediction model for Thailand. The primary objectives are to be used in preparing the severe weather warnings, such as the movement of a tropical storms in the region and the impacts of the movement of cold air mass from the midlatitude region.

Outline of Thesis

The purpose of this thesis is to study Atmospheric Physics, especially in application of Dynamic Meteorology to weather forecasting. We study the procedure in construction of weather forecasting model from basic laws of physics such as the momentum equation, the conservation of mass, the conservation of energy and the equation of state and then apply the two-level model (Holton,1972) to forecast the weather by using Krishnamurti's theory and techniques (Krishnamurti,1986) as a basis for developing the mathematical equation systems and numerical solutions.

In the next chapter, we review some basic theory of Physics used to construct the weather forecasting model. In order to gain physical insight into the fundamental nature of atmospheric motion, we consider pure wave motion in the atmosphere in chapter III. In chapter IV, we introduce some weather forecasting models . In chapter V, we apply two-level model to forecast the real weather and then presents the results, including discussions and conclusions in the last chapter.