CHAPTER 1

INTRODUCTION

1.1 GENERAL

The most horrifying and hence the most unwelcome natural phenomena of the tropical regions are the tropical cyclones which are one of the nature's most violent manifestations and potentially deadliest of all the meteorological phenomena. According to Simpson and Riehl (1981), the tropical life which is otherwise pleasant due to good vegetation and frequent rains to sustain the plant cover is interrupted starkly by these unwelcome tropical cyclones. The word 'cyclone' was derived from the Greek word 'cyclos', meaning coils of a snake.

Tropical cyclones are essentially the offspring of ocean and the atmosphere, powered by heat from the sea, driven by the easterly trades and temperate westerlies, the high planetary winds, and their own fierce energy. In their cloudy surroundings with calm center, winds blow with lethal velocity and the ocean develops an inundating surge leading to heavy floods. In the advancing wall of strong winds and thunderstorm clouds, tornadoes also occur now and then. But compared to extra-tropical system, tropical cyclones are of moderate size. Their wind speed may reach 250 km/h and their life span is measured in days or weeks. They form over all the tropical oceans except over the South Atlantic and South Pacific, east of about 140 °W.
Depending on their place of origin, tropical cyclones are also known as typhoons, hurricanes. In Indian Ocean, they are called as tropical cyclones. There are two distinct tropical cyclone seasons in the Bay of Bengal, one is pre-monsoon, during April and May and the other one is post monsoon season during October to December (Ramage 1971). Though sea surface temperature (SST) is one of the most important factors for the cyclone formation, other factors such as large Coriolis force, low level relative vorticity, weak vertical wind shear, mid troposphere relative humidity and convective instability (Gray 1968) are responsible for the formation and intensification of cyclones.

The India Meteorological Department (IMD) provides all the satellite based weather information for the Indian Ocean region. IMD uses various techniques like Climatology, Synoptic, Satellite (Dvorok) to predict the intensity of cyclones. Also, Doppler Weather Radars (DWR) and Automatic Weather Stations, installed at various locations all over the country provide vital information for cyclone monitoring and prediction (http: www.imd.gov.in/sec/nhac/dynamic/faq/FAQP.htm).

Numerical weather prediction (NWP) models such as T-254 model of NCMRWF, MM5 mesoscale model, Quasi-Lagrangian Limited Area Model (QLM), Weather Research and Forecast (WRF) mesoscale model are used for cyclone intensity and track prediction. These NWP models create forecast by solving mathematical equations to simulate atmosphere. Many processes and parameters, like convection, which are considered to be important in improving accuracy of tropical cyclone intensity predictions, could not be factored due to inherent resolution limitations of the model. Hence, intensity predictions using NWP models, have shown limited success in intensity predictions by DeMaria et al. (2005).
Statistical models have been found to be more promising and accurate in forecasting the tropical cyclone intensity. The first operational intensity prediction model, Statistical Hurricane Intensity Forecast (SHIFOR) was developed in 1979, for the Atlantic basin (Jarvinen and Neumann 1979). SHIFOR used climatological and persistence factors to predict the intensity changes up to 72 hours. Scientists from the Atlantic basin attempted to further improve the predictions by incorporating synoptic information (Pike 1985; Merill 1987). Statistical Hurricane Intensity Prediction System (SHIPS) model (DeMaria et al. 1994) predicts intensity up to 72 hours in the Atlantic and in the eastern north Pacific basin. This model uses four predictors comprising of climatology, persistence and synoptic information. SHIPS model was further upgraded to reduce the forecast errors (DeMaria et al. 1999; 2005). Similarly western North Pacific Ocean has its own intensity prediction model, called Typhoon Intensity Prediction System (TIPS) to predict intensity up to 48 hours (Fitzpatrick 1997).

Very few studies have been carried out so far in the Indian ocean region on tropical cyclone intensity prediction (Roy Bhowmik et al. 2007; Kotal et al. 2008). The statistical cyclone intensity prediction model, developed by Kotal et al. for the Bay of Bengal, used various dynamical and physical parameters as predictors such as change in intensity in 12 hours, storm motion speed, initial storm intensity, initial storm latitude position, SST, VWS, vorticity and divergence.

In this study an attempt has been made to improve the model by considering relative humidity as one of the parameters in addition to above and also take into account periodic change in intensity of dependent cyclones (instead of 12 hour change alone), so as to improve the long range accuracy (beyond 48 hours) of the prediction model.
1.2 NEED FOR THE STUDY

Accurate intensity and track prediction is a challenging task for the forecasters and research scientists, as our ability to observe tropical cyclone inner core dynamics in real time is extremely limited. Though there are numerous weather prediction models in use, the skill of intensity prediction has not improved yet (Elsberry et al. 2007). Presently, there is only one statistical cyclone intensity prediction model available for the Bay of Bengal using various dynamical and physical parameters as predictors. According to DeMaria et al. (1999), the statistical cyclone intensity prediction model for one basin may vary from another. Further, the data need to be constantly updated with the new inputs from recent cyclones and the model also should be recomputed so that the accuracy level of the model is either improved or maintained. Hence, there is a need to update the work carried out by Kotal et al. (2008) so that the such model is capable of predicting the storm intensity accurately. This thesis is one of such attempts.

1.3 OBJECTIVES

The main objective of the research is to predict the cyclone intensity up to 72 hours at every 12 hours interval using multiple linear regression method.

The specific objectives of the research include:

- To find out the influence of various oceanic and atmospheric parameters on tropical cyclone intensity.
- To demonstrate the use of Hybrid coordinate ocean model (HYCOM) on tropical cyclone study in the Bay of Bengal.
To emphasize the potential use of National Centre for Environmental Prediction (NCEP) and European Centre for Medium Range Weather Forecasting (ECMWF) data in tropical cyclone intensity forecasting.

1.4 STRUCTURE OF THESIS

The present thesis is elaborated in seven chapters.

- Chapter 1 deals with the general introduction and backgrounds based on literature reviews, lays down the need for carrying out the study and its objectives.
- Chapter 2 deals with the review of literature related to tropical cyclones in the Bay of Bengal, the influence of various oceanic and atmospheric parameters such as sea surface temperature, tropical cyclone heat potential, vertical wind shear, vorticity and divergence, relative humidity on tropical cyclone intensity and development of statistical cyclone intensity prediction model.
- Chapter 3 contains the description of the study area as well as data and material used in this research.
- Chapter 4 discusses the methodology used in this research. This includes multiple linear regression technique to predict the intensity of cyclone up to 72 hours.
- Chapter 5 presents analysis of the data.
- Chapter 6 presents and discusses the results arising from the statistical cyclone intensity prediction model and the testing of the model.
- Chapter 7 describes the summary of results, conclusion, and further scope of the study.