CERTAIN DYNAMICAL ASPECTS OF MONSOON CIRCULATION AND ITS PREDICTION

THESIS

BY

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CERTIFICATE

This is to certify that the thesis entitled ' CERTAIN DYNAMICAL ASPECTS OF MONSOON CIRCULATION AND ITS PREDICTION' by RATTAN.K. DATTA for the award of the degree of DOCTOR OF PHILOSOPHY, is a record of the original bonafide research work carried out by him. He has worked under our joint guidance and supervision and has fulfilled the requirements for the submission of this thesis. The results presented in this thesis have not been submitted in part or full to any other University or Institute for award of any degree/diploma.

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PREFACE

No other phenomenon, influences so intimately the economical, cultural and social human activities over South-East Asia in general, and Indian sub-continent in particular, as the Monsoon circulation. References to various festivals associated with different phases of monsoon exist in our classical literature. Famous Sanskrit poet Kalidas has also depicted the rhythms in the movement of the monsoon clouds metaphorically in his classical epic "Meghdoot". Strange enough the name "MONSOON" is not of Indian origin but has been coined, a few centuries ago by Arab traders navigating on the Indian seas. It has been derived from an Arabic word "MAWSIM", which means Season, and traders used this information on the seasonal reversal of wind system over the Arabian sea for navigation.

Scientific study of Monsoon, however started with the establishment of Indian Meteorological Services in 1875. Large amount of meteorological information has since been collected, and based on that, meteorologists now have adopted a broader meaning of monsoon. It now refers to the atmospheric circulation which is seasonal in character and is related to the seasonal migration of the planetary pressure systems and associated wind belts in continental areas of the globe. The following objective criteria have been evolved to delineate the monsoonal region over the globe (Ramage, 1971).

(i) The prevailing wind shifts by atleast 120° between January and July.

(ii) The average frequency of prevailing wind directions in January and July exceeds 40%.

(iii) The mean resultant winds in atleast one of the months exceed 3 m sec^{-1}.

(iv) Fewer than one cyclone-anticyclones alteration occurs every two years in either month in a 5° latitude-longitude rectangle.

The region which climatologically satisfies all the above criteria broadly lies between 35°N to 25°S and 30°W to 170°E. Indian sub-continent forms part of this area, and is under the influence of Monsoon circulation during most parts of the year. The monsoons of Indian sub-continent is rather spectacular. Firstly, the change over from winter circulation to summer circulation is not only confined to low levels but takes place atleast upto 100 mb level. Secondly, onset of summer monsoon is rather dramatic.

In general, Indian sub-continent encounters two types of monsoons, viz.

(i) The summer monsoon (well known as South-West monsoon because of the prevailing south-westerly winds) : This type of monsoon influences Indian sub-continent from the beginning of June to middle of September ;

(ii) The winter monsoon (known as North-East monsoon) : This monsoon influences Indian sub-continent from October to December.

The South-west monsoon both from economic and scientific considerations, is more important of the two. Firstly, because it is during this spell of about 100 days (June to September), practically over whole of the continent life giving rain falls and accounts for over 70% of the total annual rainfall. Secondly, from the scientific considerations, the large scale monsoon circulation constitutes a large fraction of the variance of the global field of motion. It is therefore necessary to include explicitly the dynamic processes governing the monsoon circulation into general circulation models to simulate properly the global behaviour of the atmosphere. Henceforth to avoid confusion, Monsoon will refer to the Summer Monsoon or South-West Monsoon until and unless specified otherwise.

The present thesis describes various studies conducted by the author for the better understanding of different aspects of the monsoon circulation. Studies reported in this thesis have been divided into eleven chapters.

Chapter I provides a back-ground information on the various aspects of monsoon circulation leading to the various questions which the author has proposed for their detailed studies.

With the advent of fast computer, electronic data processing and analysis has assumed a great importance in the field of modern scientific research. So, the chapter II of this thesis has been devoted to the description of the system developed for data processing and analysis of meteorological data. This system is first of its nature in India, which meets the real-time processing needs of meteorological data processing and analysis.

Diagnostic studies are very important to understand the physical processes that run the monsoon circulation. Chapter III describes synoptic-dynamic studies pertaining to the onset processes. Chapter IV provides details of the studies conducted by the author to understand break situation. Chapter V is devoted to the discussion on the dynamics and structure of monsoon depressions. In Chapter VI, two studies undertaken by the author are discussed i) on simulation of certain circulation features of tropics with heat sources and sinks as main forcing and ii) on transport of water vapour over Indian continent during monsoon. The Chapter VII discusses the monsoonal features of the region of Lake Victoria in East Africa and also provides the possible dynamics of rainfall forming processes over the regions of Lake Victoria as well as some representative stations in India. Chapters VIII to X contain description of different synoptical, statistical and dynamical models developed to predict monsoon flow

and monsoon rainfall at various time scales. The last Chapter provides a brief resume of the salient results of the studies described in earlier Chapters.

We hope the work presented in this thesis would contribute to some extent in better understanding of the vagaries of the monsoon circulation and its prediction.

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