CUMULUS CLOUD PARAMETERIZATION IN DIFFERENT PHASES OF THE SUMMER MONSOON

by

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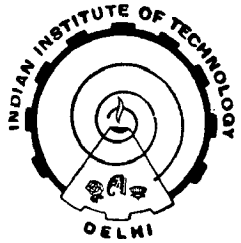
Thesis submitted
in fulfilment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY



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December, 1986

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TO

THOSE WHO HAVE INSPIRED ME

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ABSTRACT

Numerical experiments with the general circulation models show that the Asian summer monsoon is very sensitive to cumulus convection. There have been however, very few attempts to investigate the impact of cumulus convection in different phases of the summer monsoon. In addition to the diagnostic works on cumulus convection, it is also essential to examine the prognostic capability of a cumulus parameterization scheme separately before implementing it into an operational numerical weather prediction model. The research work reported in this thesis is aimed to bridge the gaps in these two areas. Special upper air observations collected during MONSOON-77 and MONEX-79 have been used to determine the influence of cumulus convection in four different phases of the summer monsoon. These phases include a preonset, an onset, a break in monsoon and a formative period of the monsoon depression.

Budget studies on kinematic and convective structure of the atmosphere have been carried out. Results of the present study suggest that the onset of the monsoon and the formation of monsoon depression are associated with very high heating of the atmosphere due to the release of latent heat in organised deep cumulus convection. The convection

is generally suppressed during a break in monsoon. Diagnostic study on the cloud cluster properties reveals that the nature of clouds undergoes considerable variation during the different monsoon phases. Within the framework of these results, two types of cumulus parameterization schemes have been investigated which differ considerably in their basic designs.

In the first kind, several versions of the Kuo-type cumulus parameterization schemes have been studied in a semi-prognostic way. The performance of each scheme has been examined during different epochs of the monsoon. These studies suggest that a modified Kuo scheme with the moistening parameter defined similar to the one proposed by Anthes provides better results when it is tuned for the monsoon.

In the second kind, the well known Arakawa-Schubert cumulus parameterization has been investigated. Special observations of the four periods have been used to determine the large scale forcing, the cloud base mass flux, cumulus warming, drying and precipitation rates. Many sensitivity experiments have been conducted with the cloud ensemble model. The quasi-equilibrium hypothesis has been found to hold good during all the phases of the monsoon.

Finally, a comparison of the performance of the two types of parameterization schemes has been carried out. The ability of predicting cumulus warming, drying and precipitation rates by the two schemes vary according to the synoptic situations. In general, the modified Kuo's scheme as defined earlier is found to provide better results.

CERTIFICATE

This is to certify that the thesis entitled "CUMULUS CLOUD PARAMETERIZATION IN DIFFERENT PHASES OF THE SUMMER MONSOON", being submitted by Mr.Someshwar Das 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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ACKNOWLEDGEMENTS

I express my deepest sense of gratitude to my advisors Dr. U.C. Mohanty and Dr. O.P. Sharma for their painstaking guidance and constant encouragement throughout this research work.

I am extremely grateful to Prof. M.P. Singh, Head, Centre for Atmospheric Sciences for his immense help and ceaseless encouragement during the course of this work.

I express my most sincere gratitude to Prof. K.Gambo (TOKYO University) for his encouragement, enlightening discussion and invaluable suggestions during the course of this work. I am also grateful to Prof. P.K.Das for his comments which were of immense value in this work.

This research would not have been possible without the moral support and encouragement provided by my parents and elder brothers during those long years of absence from home.

I am grateful to the Ministry of Education, Government of India, for providing me the financial support. The computer facility at IIT Delhi and at the National Informatics Centre, New Delhi, was used for the research carried out in this thesis.

Upper air data of MONEX-79 were obtained from the India Meteorological Department. For all these, I am very grateful.

Many friends, faculty members and staff of CAS have helped me during the course of this work. I wish to express my cordial thanks to all of them in particular, Wg.Cdr. R.K. Paliwal, Dr. L.Harendu Prakash,K.J.Ramesh, Alexander John, N.Mohan Kumar, A.K.Mitra,Ch.Bangaru Papa and Rafiqul Islam for their assistance in various forms.

Thanks are also due to Mr. P.Gulati for tracing some of the diagrams. Ms Neelam Dhody deserves special appreciation for her excellent and skillful typing.

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