MESOSCALE CIRCULATION OVER THE ANDAMAN ISLANDS : NUMERICAL SIMULATIONS

by

SARAT CHANDRA KAR

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TO MY PARENTS

CERTIFICATE

This is to certify that the thesis entitled "Mesoscale Circulation over the Andaman Islands: Numerical simulations", being submitted by Sarat Chandra Kar for the award of degree of DOCTOR OF PHILOSOPHY, is a record of the original bonafide research work carried out by him. He has worked under my 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.

(N. Ramanathan)

Senior Scientific Officer-I
Centre for Atmospheric Sciences
Indian Institute of Technology, New Delhi

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ABSTRACT

Mesoscale atmospheric circulations such as air flow over islands are induced by the temperature contrast between the land and the surrounding oceans. These circulations are the characteristics of the location of the land mass and the prevailing atmospheric conditions. No mesoscale studies exist for any island in the Indian subcontinent. Inorder to identify various components of the mesoscale flow over a tropical island, namely the Andaman islands, numerical simulation studies were carried out.

A hydrostatic primitive equation mesoscale model was adopted for the purpose. This model uses a terrain following coordinate system and has detailed planetary boundary layer parameterisation. Atmospheric heating and cooling due to radiative flux divergence is considered.

Two dimensional numerical studies of the air flow over the Andaman islands indicated that the boundary layer air flow was not affected by the presence of an absorption layer at the model top. The model simulated better results when observed upper air wind was used to initialise the model. The land and sea breezes over the islands were simulated with and without topography. The depth of the sea breeze was about 500 m. The inland penetration of the sea breeze increased when topography was included.

A large scale precipitation scheme was included to simulate the effects of condensation on the mesoscale air flow. Two cases (a synoptically clear day and a rainy day) were considered. The latent heat release due to precipitation intensified the sea

breeze over the island. The model under-estimated the rainfall. The boundary layer wind was stronger than the observed one.

A multi-layer soil and a single level vegetation parameterisation schemes were described. In the soil scheme, soil moisture is computed by a prognostic equation assuming continuity at the air soil interface. Surface albedo is approximated as a function of available soil moisture. The foliage intercepts the insolation and re-radiates in longer wave lengths. The boundary layer is modified by the changes in the sensible and latent heat fluxes in the presence of vegetation. One dimensional sensitivity studies were carried out to test the schemes and various parameters of the model for Indian data.

These schemes were incorporated into the mesoscale model and two dimensional simulation of air flow over the Andaman islands were carried out to study the influences of moisture and heat fluxes upon the mesoscale circulations. The simulated lower level wind compared well with the available observation, when the forest cover was included in the model. A statistical analysis of the errors in the simulated results was made to test the applicability of the model. The magnitude of the errors reduced when the model physics was improved.

Three dimensional air flow over the south Andaman islands was studied. The sea and land breezes were more intense where the island is the widest and the terrain height is maximum. A comparison of the two and three dimensional simulations with observations showed that the three dimensional model produced better results.

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