TAO, Vol.4, No.2, 179-200, June 1993

Semigeostrophic Invertibility Experiments with TAMEX Data

HUNG-CHI KUO[1] and SHU-WU CHEN[1]

(Manuscript received 31 March 1992, in final form 30 April 1993)

ABSTRACT

The balanced atmospheric response to a squall line as a moving heat source is computed. Specifically, we consider the permanent modifications to the large-scale balanced flow (geostrophy) rather than the transient gravity-inertia wave motion. The potential vorticity anomaly, horizontal and vertical wind shears in terms of a dimensionless parameter α and swept-through distance of the squall line are presented. The physical meanings of the parameter α are discussed. Observational cases from mid-latitude, subtropics and tropics are given in terms of the squall line speed and α. This classification is based on the balanced atmospheric response that the squall line induced. Namely, we emphasize the concept of potential vorticity and balanced dynamics to classify the squall lines. The α–c classification will provide a measure of the squall line force in dynamic models. The computed balanced solutions give a reference base to monitor the geostrophic adjustment processes. Moreover, the α-c observations enable us to interpret the model result related to different observational squall lines. The invertibility computations from squall lines during Taiwan Area Mesoscale EXperiment (TAMEX) are shown. The implication of the results and future research are discussed.

1. INTRODUCTION

The semigeostrophic system is a filtered set of equations providing remarkably accurate descriptions of many phenomena which lie beyond description by the quasi-geostrophic equations. Traditionally, the phenomena studied include surface and upper tropospheric fronts, jets and occluding baroclinic waves. The first exploitation of the semigeostrophic system was the two-dimensional frontogenesis studies of Hoskins (1971) and Hoskins and Bretherton (1972). Imposing a horizontal deformation field to force the frontogenesis as in the study made by Hoskins (1972), the semigeostrophic system is able to generate infinite temperature gradient at the surface in less than 12 hours. This is owing to the feedback of geostrophic relative vorticity ζ_g and the ageostrophic secondary circulation in the semigeostrophic system, which is missing in the quasigeostrophic system. By combining the geostrophic momentum

[1] Department of Atmospheric Sciences, National Taiwan University, Taipei, Taiwan, R.O.C.