NUMERICAL EXPERIMENTS

ON THE

DYNAMIC-OROGRAPHIC INFLUENCE IN THE TROPICS

by

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A B S T R A C T

A primitive divergent barotropic model including bottom topography is used to investigate the dynamic-orographic phenomenon in the tropics. The x,y,z,t spherical coordinate system is used during the investigation of the problem. In some experiments, additional horizontal diffusion terms are included in the equations of motion for the purpose of suppressing the chess-board type of computational instability.

The spatial finite differencing scheme is analogous to the one adopted in the Mintz-Arakawa 2-level general circulation model (1971). Rigid lateral walls are assumed in the numerical formulation of the north-south boundary conditions. The forecast domain extends from 55^{o}N to 55^{o}S, and round the globe in the zonal direction. Time integration is performed with the "Leap Frog" scheme with the first step forward. A time interval of 10 minutes is chosen for the time steps and it satisfies the Courant-Freidrich-Lewy (C.F.L) criterion for linear computational stability.

In experiments 1,2 and 3 different versions of the time averaging method of Edelmann (1971b) are tested for the purpose of suppressing high frequency gravitational modes. In experiments 4,5,6 and 7 we investigate the influence of varying the zonal slopes

of an idealized mountain profile. Experiment 8 serves the purpose of determining the influence of varying the initial state. Stationary solutions using an idealized mountain profile are obtained in experiment 9. Finally, in experiment 10 we obtain stationary solutions using the real orography of Africa.

The results show that the time averaging method proposed by Edelmann (1971b) for the purpose of damping high frequency gravitational modes during short range numerical barotropic forecasts over high latitudes in the presence of mountains is appropriate for the tropics as well. However, gravitational disturbances with very long wavelengths of about 9000 km are not damped satisfactorily by time averaging. These disturbances have to be eliminated initially possibly by other conventional initialization procedures.

Results of the experiments in which the gradients of the east-west slopes of the idealized mountain are varied show that the intensity of the disturbances generally increases with the east-west spatial extent of the mountain. The wavelength and phase velocity of the free oscillations in the westerly flow are found to be independent of the east-west spatial extent of the mountain. Also, an equatorial trough observed over the mountain is anchored to the region of highest elevation

and its intensity increases with the size of the mountain.

The intensity of the disturbances is found to be determined during their passage over and around the mountain and is proportional to the intensity of the embryonic current.

Stationary solutions obtained by using the iterative time averaging method of Edelmann (1971c) using idealized bottom topography shows a quasi-stationary equatorial trough over the mountain. Highs are found to lie to its sides. A wave in the longitudinal band of the mountain is attributed to the complex meridional mountain profile which was used. The stationary wind field has no meridional velocity component along the equator and it has a westerly maximum within the equatorial trough. A centre of convergence is found at the front of the equatorial trough and one of divergence to its rear. Disturbances located away from the equator have quasi-geostrophic tendencies.

Stationary solutions associated with smoothed orography of the African continent show a height field distribution qualitatively in agreement with the observed quasi-stationary equatorial trough over the African continent.

During the experiments the domain invariants are found to be conserved.