

Response of the Tropical Atmosphere to Local, Steady Forcing

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ABSTRACT

A theoretical analysis is made of the large-scale, stationary, zonally asymmetric motions that result from heating and the orographic effect in the tropical atmosphere. The release of latent heat dominates the sensible and radiational heating and the latter two effects are ignored. The first linear model is a continuous stratified atmosphere in solid westward rotation with no dissipation. Of all the modes, only the rotationally trapped Kelvin wave exhibits a significant response. Because the Kelvin wave response does not compare well with the observed flow, we concluded that the neighboring westerlies in the real atmosphere are important even if the forcing is in low latitudes.

The second linear model is a two-layer numerical model including parameterized dissipation and realistic basic currents. Realistic forcing is considered, following an analysis of the response to especially simple forms of heating and orographic forcing. Dissipative effects close to the Equator are very important in this model. The dominant forcing at very low latitudes is the latent heating; at higher latitudes, the advective terms and the effects of rotation become more important and the influences of orography and heating are more nearly equal. A study of the energetics shows that the response near the Equator is due to both local latent heating and the effect of steady, forced motions at subtropical latitudes.

Comparison of the response of the model with observed motion fields and with the results of other studies suggests that most of the time-independent circulation of low latitudes is forced by heating and orography within the Tropics and subtropics. In the subtropics, however, forcing from higher latitudes must be of importance.