2.3 Model Diabatic Forcing

A limitation of using prescribed forcing is that the flow field cannot exert any influence on it. In other words, the forcing acts on the model atmosphere altering its structure, though the circulation that results is not able to communicate its new state back to the forcing. If feedback from the circulation does not significantly change the "net effect" of the forcing, then this interaction could be neglected in a first approximation when large-scale features are of interest. Under this rationale we proceed forward with a prescribed diabatic forcing designed to resolve the net effect from an ensemble of convective cloud complexes (a general upward transport of mass). Thus, the multi-scale structure described in section 1.2 will not be captured, which is consistent with regard to scale when circulation feedbacks are not present.

$c_p = 1004$ J kg^{-1} K^{-1}	$\beta = 2\Omega/a$	$\bar{c} = 41.25$ m s^{-1}	$y_0 = 0$ or 450 km
$R = 287$ J kg^{-1} K^{-1}	$p_0 = 1010$ hPa	$\epsilon = 507.3$	$Q_0/c_p = 12$ K day^{-1}
$\Omega = 7.292 \times 10^{-5}$ s^{-1}	$z_T = 1.619$	$a_0 = 1250$ km	$c = 5$ m s^{-1}
$a = 6370$ km	$\Gamma = 23.79$ K	$b_0 = 450$ km	$\alpha = (4 \text{ days})^{-1}$

Table 2.1: Constants.

Since the diabatic forcing is due to an eastward propagating region of deep convection, a suitable zonal structure is a sinusoid function of $x - ct$, where $c > 0$ is the constant propagation speed of the cloud cluster. The exact form of the horizontal structure is given by

$$\hat{Q}(x,y,t) = \tfrac{1}{2} Q_0 \exp\left[-\left(\frac{y-y_0}{b_0}\right)^2\right] \begin{cases} 1 + \cos(\pi\xi/a_0) & |\xi| \le a_0, \\ 0 & |\xi| \ge a_0, \end{cases} \tag{2.15}$$

$\xi = x - ct$, y_0 its center, a_0 its half-width in x, b_0 its e-folding width in y, and Q_0 its peak amplitude. The values chosen for these parameters are listed in Table 2.1. The choices for a_0, b_0, and y_0 were based on reanalysis studies discussed in section 1.2, the value for Q_0 was based on observations during TOGA-COARE, discussed in section 2.2. A plot of (2.15) with $Q_0 = 1$ J kg^{-1}s^{-1} is shown in Fig. 2.2. It is interesting to note that the area integral

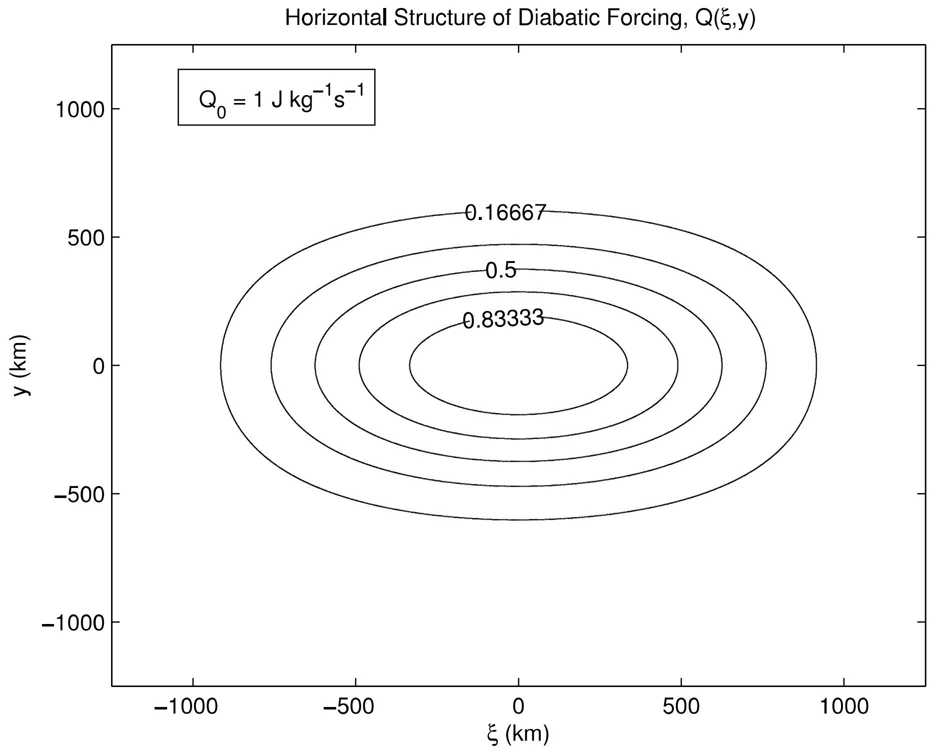

Figure 2.2: Contour plot of the diabatic forcing horizontal structure with Q_0 set to 1 J kg^{-1}s^{-1}.

of (2.15) yields $\iint \hat{Q}(\xi, y)\, dxdy = \pi^{\frac{1}{2}} Q_0 a_0 b_0$, so that our variation of the parameter y_0 has no effect on the total diabatic heating rate, $\pi^{\frac{1}{2}} Q_0 a_0 b_0$.

2.4 Horizontal Structure Problem

Our interest is in observing the flow field around the eastward moving constant source once all transient effects have ended. If we assume that it does reach a steady state, then viewing it from a reference frame that is moving at the same speed as the source would allow us to study the unchanging response pattern, versus watching the evolution of a particular region as the source passes through it. From this vantage point a change in time is proportional to a change in zonal position of the earth-relative steady state circulation. The shallow water equations (2.14) are converted to a system that is valid in this moving frame of reference by transforming both time and zonal derivatives to derivatives of the