MODELLING PROBLEMS #3

Consider the general circulation described by Stommel's (1948) simple model for a rectangular basin:

$$\psi = F\sin(\frac{\pi y}{b})(pe^{Ax} + qe^{-Bx} - 1)$$

where $F = 1 \text{ km}^2/\text{sec}$, $b = 5 \times 10^3 \text{ km}$, p = 0.05, q = 0.95. A = $2 \times 10^{-4} \text{ km}^{-1}$, $B = 1.3 \times 10^{-3} \text{ km}^{-1}$ and the streamfunction is defined by $u = \psi_v$ and $v = -\psi_x$.



A passive tracer is introduced at a point and the steady velocity field advects and diffuses the tracer according to

$$\phi_t + u\phi_x + v\phi_y = k(\phi_{xx} + \phi_{yy}) + S(x, y)$$

where S(x, y) is the source. There is no flux of tracer through any of the boundaries. Suppose S(x, y) = 1 unit of the tracer/hour added at x = 3000 km, y = 1000 km and $k = 10^{-2}$ km²/s. Solve numerically for the time history of the tracer distribution using any scheme that you wish provided you discuss its errors and generally tell me what you have done.

Once the model is running, try placing the source at 3000 km and y = 4000 km. Can you explain the difference? What happens if the diffusion k is decreased or increased by a factor of 10?