Book: Dynamical Oceanography
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Chapter: 7, Exercise: 7.5: Topography and Rossby waves
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A Rossby wave with wavenumbers $k = k_0$ and $l = 0$ propagates (at 45°N) over a seamount with a spatial distribution

$$h_b(x, y) = h_0 e^{-((x-x_0)^2+(y-y_0)^2)/L^2}$$

where (x_0, y_0) is a point in the middle of the basin.

a. Sketch the deviation of the lines of constant phase caused by the presence of the topography.

The dimensional dispersion relation for these barotropic Rossby waves in a layer with a sloping bottom (with slope s) on the β plane was given in (7.48), i.e.

$$\sigma = \frac{-k_0(\beta_0 + f_0 s/L)}{k_0^2 + f_0^2/C_0^2}$$

Curves of constant phase θ_0 are given by

$$\theta = k_0 x - \sigma t = \theta_0$$

North of y_0, the layer becomes deeper in northward direction and hence the slope $s < 0$ whereas south of y_0, the layer becomes shallower northward and hence $s > 0$. North of y_0 the phase speed is smaller than south of y_0. As the phase lines are defined as

$$x = \frac{\theta_0}{k_0} + \frac{\sigma}{k_0} t$$

the phase lines deviate to the east north of y_0 and to the west south of y_0.

b. At which side of the seamount can stationary Rossby waves occur?

Stationary waves ($\sigma = 0$) can only occur when

$$\beta_0 + f_0/sL = 0 \rightarrow s = -\beta_0 L/f_0$$

and because $s < 0$ is a necessary condition, they can only occur north of y_0.