Assignment 5

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1 Problem 1

In this assignment we continue with the scenario of assignment 4, but this time we take a look at the temporal evolution and the balances that establish before and after the propagation of inertial waves. The temporal evolution is given by eq. (2.335)-(2.337) for one vertical mode:

$$\begin{aligned} v(x,y,t) = &-\frac{\tau^x}{\rho_0 f}\, a \left[\theta(t)\theta(y)\left(1-\cos(ft)\right) - \frac{sig(y)}{2}\theta(t-\lambda|y|)\right. \\ &\left.\left(e^{-\frac{|y|}{R}} - \cos ft + \frac{|y|}{R}\sqrt{\frac{2}{f\pi t}}\cos\left(f\sqrt{t^2-\lambda^2y^2}+\frac{\pi}{4}\right)\right)\right], \end{aligned} \tag{1}$$

$$\begin{aligned} u(x,y,t) = &\frac{\tau^x}{\rho_0}\, a \left[\theta(t)\theta(y)\frac{\sin(ft)}{f} + \frac{sig(y)}{2}\theta(t-\lambda|y|)\right. \\ &\left.\left(te^{-\frac{|y|}{R}} - \frac{\sin ft}{f} + \frac{|y|}{Rf}\sqrt{\frac{2}{f\pi t}}\sin\left(f\sqrt{t^2-\lambda^2y^2}+\frac{\pi}{4}\right)\right)\right], \end{aligned} \tag{2}$$

$$p(x,y,t) = \frac{\tau^x}{\rho_0}\, a\frac{R}{2}\theta(t-\lambda|y|)\left(tfe^{-\frac{|y|}{R}} - \sqrt{\frac{2}{f\pi t}}\sin\left(f\sqrt{t^2-\lambda^2y^2}+\frac{\pi}{4}\right)\right). \tag{3}$$

(a) Recall the geostrophic and the Ekman balance. Write down the equation systems and describe their meanings.

(b) What balance establishes at position y before the inertial waves propagate through? Verify that eq. (1)-(3) fulfill the governing equation system.

(c) Which balance establishes after the inertial waves propagated through? Again, verify the solution.

Hints: Recall that the wind stress X is given by:

$$X = \frac{\tau^x}{\rho_0} a\theta(y)\theta(t). \tag{4}$$

Neglect the last complicated sine and cosine terms which have their origin in the approximations of the Bessel functions.