Problem Set #4 on Chapter 9

OCEA/EART 172/272: Geophysical Fluid Dynamics

Tuesday, May 14, 2020

Read the Analytic portion of Chapter 9.

1. Cushman-Roisin (2nd Edition), Analytical Problems 9.1. (1st edition, problem 6-1)
2. (15 points as opposed to the usual 10) Consider the shallow water Rossby wave dispersion relation with zero meridional wavenumber
$$\omega = \frac{-\beta k}{k^2 + 1/R^2}$$
   (a) For what (if any) wavelengths does the Rossby wave phase propagate eastward? Westward?
   (b) What is the wavenumber of maximum westward velocity?
   (c) What is the maximuim eastward phase speed? Westward?
   (d) For what (if any) wavelengths does the Rossby wave group propagate eastward? Westward?
   (e) What is the wavenumber of maximum eastward group velocity? westward group velocity?
   (f) What is the maximum eastward group velocity? Westward?
   (g) How does R vary with latitude? Qualitatively, how do Rossby wave phase speeds and group velocities vary with latitude?
3. Cushman-Roisin (2nd Edition), Analytical Problems 9.6. (1st edition, problem 6-6)
4. Cushman-Roisin (2nd Edition), Analytical Problems 9.9. (Not in 1st edition)
5. Cushman-Roisin (2nd Edition), Analytical Problems 9.14. (Not in 1st edition)
6. Extra Credit: Cushman-Roisin (2nd Edition), Analytical Problems 9.4 modified as follows: Derive the wave solutions that can exist within this channel. Start with the equations used in the derivation of Poincaré waves, but then modify the problem by considering the correct boundary conditions. The presence of channel walls prevents wave solutions in x. Instead, look for waves in y and t with some amplitude function in x. Derive an appropriate dispersion relation for waves propagating within this channel and the phase speed. In words, desribe the phase speed of these waves in short and long wave limits.