Problems - 1 Due: 20 Sept. 2018

You are welcome (in fact, encouraged) to discuss problem sets with your classmates. However, each of you must turn in your own problem-set answers.

1. In the shallow-water model, Thompson (1961) arrives at an approximate condition for a wave's phase speed under the further assumption that

$$(\bar{u} - c)^2 \ll g\bar{h}$$

Specifically, he shows that

$$(c - \bar{u}) = -\frac{\beta + f^2\bar{u}/g\bar{h}}{k^2 + f^2/g\bar{h}}$$

(Note that Thompson uses α to represent the wavenumber k, but k is more common.)

Recognizing that k = 2π/L, where L is the wavelength of the wave, compute $(c - \bar{u})$ for several wavelengths between L = 10^5 m – L = 10^7 m with sufficient resolution to plot $(c - \bar{u})$ as a function of L.

(a) Do this for a midlatitude case, using

f = 10^{-4} s^{-1} β = 1.6 x 10^{-11} m^{-1}s^{-1} g = 9.8 m s^{-2} $\bar{u}$ = 10 m s^{-1} $\bar{h}$ = 10^4 m

(b) Which wavelengths would have retrograde motion?

(c) Suppose $\bar{u}$ = 30 m s^{-1}. How does that change the plot, and what wavelengths now have retrograde motion?

(d) Do this for an equatorial case (plot on the same graph), using

f = 0 β = 2.3 x 10^{-11} m^{-1}s^{-1} g = 9.8 m s^{-2} $\bar{u}$ = 10 m s^{-1} $\bar{h}$ = 10^4 m

(e) Which waves move more rapidly [have larger magnitude of $(c - \bar{u})$]?

(f) Now consider these waves on Mars, plotting on the same graph. Use

f = 10^{-4} s^{-1} β = 3.0 x 10^{-11} m^{-1}s^{-1} g = 3.7 m s^{-2} $\bar{u}$ = 10 m s^{-1} $\bar{h}$ = 1.5 x 10^4 m

(g) How do Martian wave speeds compare with Earth's?