

Solution to homework 4.2

We have the balanced flow equation:

$$\frac{U^2}{R} + fU = fU_g,$$

which we can divide by f and rearrange:

$$U_g = U\left(1 + \frac{U}{fR}\right) = U(1 + Ro).$$

The quantity $\frac{U}{fR}$ is the Rossby number Ro .

$$\frac{U}{U_g} = \frac{1}{1 + Ro}.$$

The gradient wind should differ by less than 10% from the geostrophic wind:

$$\left|\frac{U}{U_g} - 1\right| < 0.1,$$

$$\left|\frac{U}{U_g} - 1\right| = \left|\frac{1}{1 + Ro} - 1\right| = 1 - \frac{1}{1 + Ro} < 0.1.$$

$$\frac{Ro}{1 + Ro} < 0.1,$$

$$Ro < \frac{0.1}{1 - 0.1} = 0.11(1),$$

$$U = Ro f R = 5.55 \frac{\text{m}}{\text{s}},$$

$$U_g = U(1 + Ro) = 6.17 \frac{\text{m}}{\text{s}}.$$