Homework 4

Problem 1 (30 pts). In the Southern Hemisphere, over a large domain of the subtropical gyre, the currents in the ocean interior layer also flow towards the Equator as shown in Figure 1. Explain such phenomenon based on the wind patterns (trade winds and westerlies), Ekman transports and vertical motions using the potential vorticity conservation theorem.

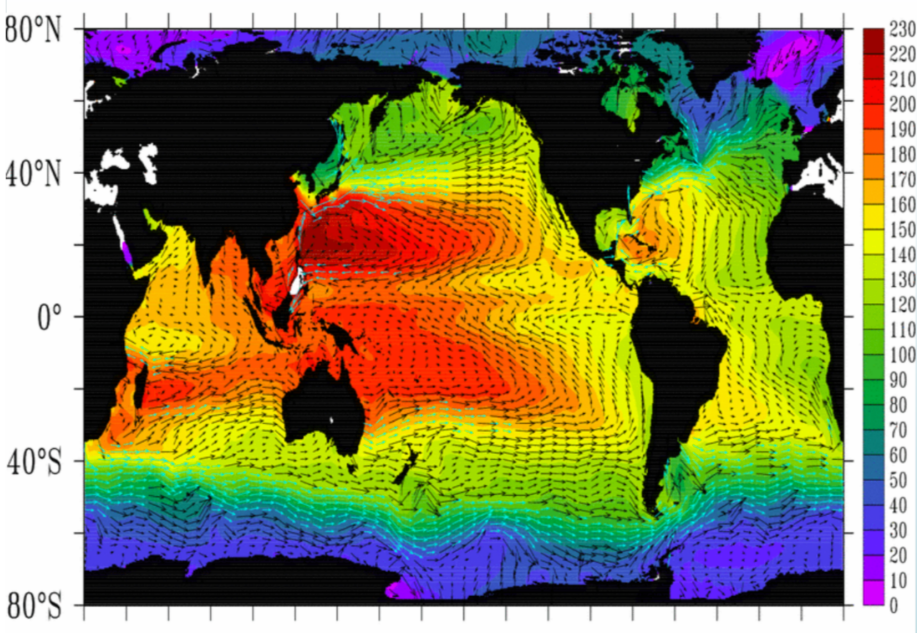

Figure 1. The patterns of subtropical gyres in the ocean.

Problem 2 (20 pts). An air column at 60°N with relative vorticity of zero initially stretches from the surface to a fixed tropopause at 10km height. If the air column moves until it is over a mountain barrier with a height of 2.5 km at 45°N, what are its absolute vorticity and relative vorticity assuming that the flow satisfies the homogenous potential vorticity equation?

Problem 3 (50 pts). As shown in Figure 2, a vertically uniform but laterally sheared coastal current must climb a bottom escarpment. Assuming that the jet velocity still vanishes offshore, determine the velocity profile and the width of the jet downstream of the escarpment using h_1 =200m, h_2 =160m, U_1 =0.5m/s (maximum velocity in the area with depth h_1), L_1 =10km and f $=10^{-4}$ s^{-1}. (that is, you should obtain U_2 and L_2, and plot the velocity profile). What would happen if the downstream depth were only 100m?

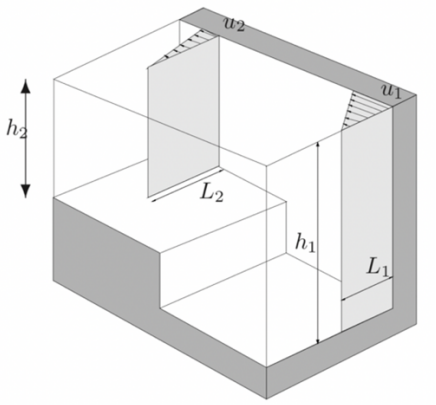

Figure 2: A sheared coastal jet negotiating a bottom escarpment.