Problem Set #7

ADVANCED SYNOPTIC METEOROLOGY

METR 5413

Spring 2020

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Handed out: Tues., 21 April 2020

Due: Tues., 28 April 2020

1. Problem 2.26 in Vol. II.

2. Derive a differential equation in isentropic coordinates that relates the tangential wind field v(r,  ) of a vortex to the distribution of potential vorticity P(r,  ). Assume circular symmetry and cyclostrophic balance. Neglect diabatic heating and friction. What is the ellipticity condition?

3. Consider a negative IPV anomaly in the middle troposphere. Assume gradient-wind balance, and adiabatic, frictionless flow.

(a) Make a qualitative sketch of a vertical cross section of  and v (as in Fig. 15 of Hoskins et al. 1985).

(b) Suppose that the anomaly is stationary, and that a uniform wind current blows from east to west at the tropopause, above the IPV anomaly. (There is no basic current at the level of the IPV anomaly.) Diagnose the vertical motion field qualitatively, using both the vorticity and thermodynamic equations in pressure coordinates.

4. Suppose there is a series of positive and negative IPV anomalies aligned in the east – west direction near the tropopause. Suppose that the basic current is weak and westerly, that the wavelength of the anomalies is relatively *long*, and that the penetration depth is 80 K. Suppose also that at the ground there is a south – north temperature gradient (i.e., it is warmer to the north and colder to the south), with no disturbances initially. Is the flow baroclinically unstable? Will surface cyclones and anticyclones form and subsequently grow in intensity? Why or why not? Use IPV thinking; ignore friction and diabatic heating.