AOS 311 Lecture 11 “Potential Vorticity”

**Brief description**
In this lecture we derived an approximate form of Ertel potential vorticity, and then explored some of the uses of potential vorticity.

**New Terminology**

**Auto barotropic:** A flow along an isentropic surface, where density can only vary with pressure.

**Bjerknes circulation theorem:** A circulation theorem that assumes an inviscid flow and states that changes in absolute circulation only occur from baroclinic effects.

**Dynamic tropopause:** The location of the tropopause as defined by a strong gradient of potential vorticity in the vertical.

**Ertel potential vorticity:** A form of potential vorticity derived from assuming a flow is isentropic (and therefore adiabatic) and inviscid.

**Topics covered**
1. In an isentropic flow density only varies with pressure, and the flow is thus auto barotropic. This was proven by substituting the ideal gas law into the equation for potential temperature.
2. When a form of the Bjerknes circulation theorem \( \frac{DCa}{Dt} = -\frac{f}{\rho} Dp \) is applied to an isentropic and inviscid flow, it is seen that absolute circulation is conserved. This leads to the equation \( Ca = Ce + Cr = \text{constant} \), and when translated into vorticity form \( fA + \zeta A = \text{constant} \). To solve for area hydrostatic balance was assumed, leading to the equation \( P = -g(f + \zeta) \frac{d\theta}{dp} \), which is approximately Ertel potential vorticity (PV), and only differs from the true form due to assuming hydrostatic balance in the derivation.
3. PV can be used to locate the dynamic tropopause, which is defined by a strong gradient of PV in the vertical. Diabatic heating can also be diagnosed with PV, since diabatic heating is the most likely cause of non-conservation of PV. We also briefly covered how PV can tell us a lot about balanced structures, and that four simple PV structures can be superimposed on one another to form just about any PV structure possible in the troposphere.

**Reading:** ?