AOS 311 Lecture 12 “Ertel Potential Vorticity”

**Brief description**
In this lecture, we continued to investigate Ertel’s Potential Vorticity (PV) equation. We looked at two principles of PV, conservation and invertibility, and examples of PV anomalies.

**New terminology**
**potential vorticity inversion**: The process of solving for three-dimensional distribution of the hydrostatic temperature (mass) and wind field subject to a wind-mass balance constraint (e.g., geostrophic or gradient wind) associated with a three-dimensional distribution of PV and boundary conditions.

**anomaly**: The deviation of a variable from its time or space average

**Topics covered**
1. Introduced two PV principles:
   a. **PV conservation** - In the absence of gradients of diabatic heating \( \dot{\theta} = \frac{D\theta}{Dt} \) or curls in the friction force \( \mathbf{F}_r \), PV is conserved. The Lagrangian time rate of change of \( q \) is \( \frac{Dq}{Dt} = \frac{\vec{\omega}_a \cdot \nabla \theta}{\rho} + (\nabla \times \mathbf{F}_r) \cdot \nabla \theta \). If we assume that the absolute vorticity vector is dominated by the vertical component, and that that component is dominated by the planetary vorticity, then \( \vec{\omega}_a = f\mathbf{k} \). As a consequence, there is generation (destruction) of PV below (above) a maximum in diabatic heating. It was stated that for the mass weighted, volume integral of PV over a volume for which the heating and friction do not occur on the boundaries, PV is conserved. As a consequence, generation/destruction of PV are actually redistributions of PV.
   b. **PV inversion** – PV anomalies \( (q') \) for which \( f q' > 0 \ (f q' < 0) \) are identified as cyclonic (anticyclonic) PV anomalies. Cyclonic (anticyclonic) anomalies are associated with cyclonic (anticyclonic) vorticity. Beneath (above) cyclonic PV anomalies, the temperature anomalies are cold (warm). Beneath (above) anticyclonic PV anomalies, the temperature anomalies are warm (cold). The strongest winds associate with a PV anomaly occur at the level of the PV anomaly and decrease with distance away from the anomaly. Cyclonic (anticyclonic) PV anomalies are associated with negative (positive) geopotential height anomalies.