RELATIVE VORTICITY

In general terms, vorticity is a measure of the local rotation of the flow; and applies to any environmental fluid flow. In terms of meteorology, flow refers to winds.

Relative vorticity, $\vec{\omega}$, is a microscopic measure of the vorticity in a flow.

It is a differential, vector property of the flow.

- Relative vorticity is defined in terms of spatial wind components, $\vec{v} = (u, v, w)$, as

$$\vec{\omega} = \nabla \times \vec{v} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ u & v & w \end{vmatrix} = \vec{i}\left(\frac{\partial w}{\partial y} - \frac{\partial v}{\partial z}\right) = \vec{j}\left(\frac{\partial u}{\partial z} - \frac{\partial w}{\partial x}\right) + \vec{k}\left(\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}\right)$$

- Relative vorticity has units of s^{-1}; from dimensional analysis of equation
- Vorticity is defined as *positive* in the *counterclockwise* direction.
- Because horizontal winds are usually larger than the vertical winds at synoptic scales (Section 3.1.2), we approximate the relative vorticity as its vertical component, ζ :

$$\zeta = \vec{\omega} \cdot \vec{k} = \frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}$$

- *Horizontal wind components cannot be assumed to be much larger than the vertical wind component in thunderstorms or mesoscale systems.*

Absolute vorticity is the vector combination of relative vorticity and Earth vorticity:

$$\vec{\omega}_a = \nabla \times \vec{v}_a = \vec{\omega} + 2\vec{\Omega}$$

Once again, for synoptic flows we usually consider only the vertical component, η or ζ_a:

$$\zeta_a = \zeta + f$$