

A disadvantage of the Lagrangian analysis of the absolute vertical vorticity equation (i.e., application of Eq. 8.17) is that interpretation of the analysis results requires one to assimilate information from numerous different parcels, or else choose a parcel that appears “representative” of others. An alternative approach (employed, for example, by Weisman and Davis 1998, and Trapp and Weisman 2003) is provided by the time-dependent circulation equation, analyzed in an *Eulerian* sense.

Develop this equation:

$$\begin{aligned}\frac{\partial \Gamma}{\partial t} &= \frac{\partial}{\partial t} \int \zeta_a dA \\ &= \oint \left(-\zeta \vec{V}_H - f \vec{V}_H + w \vec{\omega}_H \right) \cdot \hat{n} dl\end{aligned}$$

by integrating a form of Eq. (8.16) over some *fixed*, horizontal control area A , and then applying the divergence theorem. Here, the line integral circumscribes A , and assumes a unit normal vector \hat{n} that is directed outward from A .

Interpret the three contributions to this absolute circulation tendency, and then compare each to terms in Eq. (8.16).