

Energy Integrals

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$$\rho c_p \frac{dT}{dt} = \omega + Q$$

$$\rho \frac{d\underset{\sim}{V}}{dt} = -\nabla p - f\underset{\sim}{k} \times \rho \underset{\sim}{V} - g\underset{\sim}{k}\rho \tag{3.1}$$

$$\begin{aligned} \rho \frac{dK}{dt} &= -\underset{\sim}{V} \cdot \nabla p - gw\rho \\ &= -\omega + \frac{\partial p}{\partial t} - gw\rho \\ &= -\omega + \frac{\partial p}{\partial t} - \rho \frac{d\Phi}{dt} \end{aligned} \tag{3.2}$$

$$\rho \frac{d}{dt}(K + \Phi) = -\omega + \frac{\partial p}{\partial t} \tag{3.3}$$

$$\rho \frac{d}{dt}(K + \Phi + c_p T) = \frac{\partial p}{\partial t} + Q \tag{3.4}$$

$$\frac{\partial}{\partial t}\left[\rho\left(K + \Phi + c_p T - \frac{p}{\rho}\right)\right] + \nabla \cdot [\rho \underset{\sim}{V}(K + \Phi + c_p T)] = Q \tag{3.5}$$

$$\frac{\partial}{\partial t}[\rho(K + \Phi + c_v T)] + \nabla \cdot [\rho \underset{\sim}{V}(K + \Phi + c_p T)] = Q \tag{3.6}$$