Static Stability

The difference between the dry adiabatic process rate and the observed lapse rate,

$$\left(\frac{\alpha}{c_p} - \frac{\partial T}{\partial p}\right),$$

is a measure of the static stability. Both are positive. So, if the environmental lapse rate does not exceed the dry adiabatic process rate, then the stability is always positive. A large difference corresponds to greater stability, while a smaller difference corresponds to less stability. An adiabatic layer has zero stability, which is often called neutral stability.

The **static stability parameter**, σ, is defined as,

$$\sigma = \frac{R}{p}\left(\frac{\alpha}{c_p} - \frac{\partial T}{\partial p}\right),$$

which makes equation (1) appear as,

$$\frac{\partial T}{\partial t} = -\left(u\frac{\partial T}{\partial x} + v\frac{\partial T}{\partial y}\right) + \omega\sigma\frac{p}{R} + \frac{1}{c_p}\frac{dQ}{dt}. \qquad (2)$$

When a layer of air is forced to move vertically, the resulting temperature change is proportional to the stability. A rising layer will cool because ω is negative. An adiabatic layer, zero stability, will not change temperature as a result of vertical displacement.