The thermodynamic energy equation

This is just to complete the set. After this we have derived the full set of equations used in studying atmospheric motions, on large scales

1st law of thermodynamics $dQ = c_p dT - V dp$

- now if motion is NOT adiabatic, but instead heat is being applied (or removed) from the parcel at a rate $\dot{Q}$ (think of some examples of what $\dot{Q}$ might represent), then:

$$\dot{Q} = c_p \frac{dT}{dt} - \frac{RT}{p} \underbrace{\frac{dp}{dt}}_{\omega}$$

or

$$\boxed{\frac{dT}{dt} = \frac{\kappa T}{p} \omega + \frac{\dot{Q}}{c_p}}$$

so, note that for $\dot{Q} > 0$, we get either $\omega < 0$ (rising) or $dT/dt > 0$ (T↗ following the parcel) or some combination of both, which makes sense.