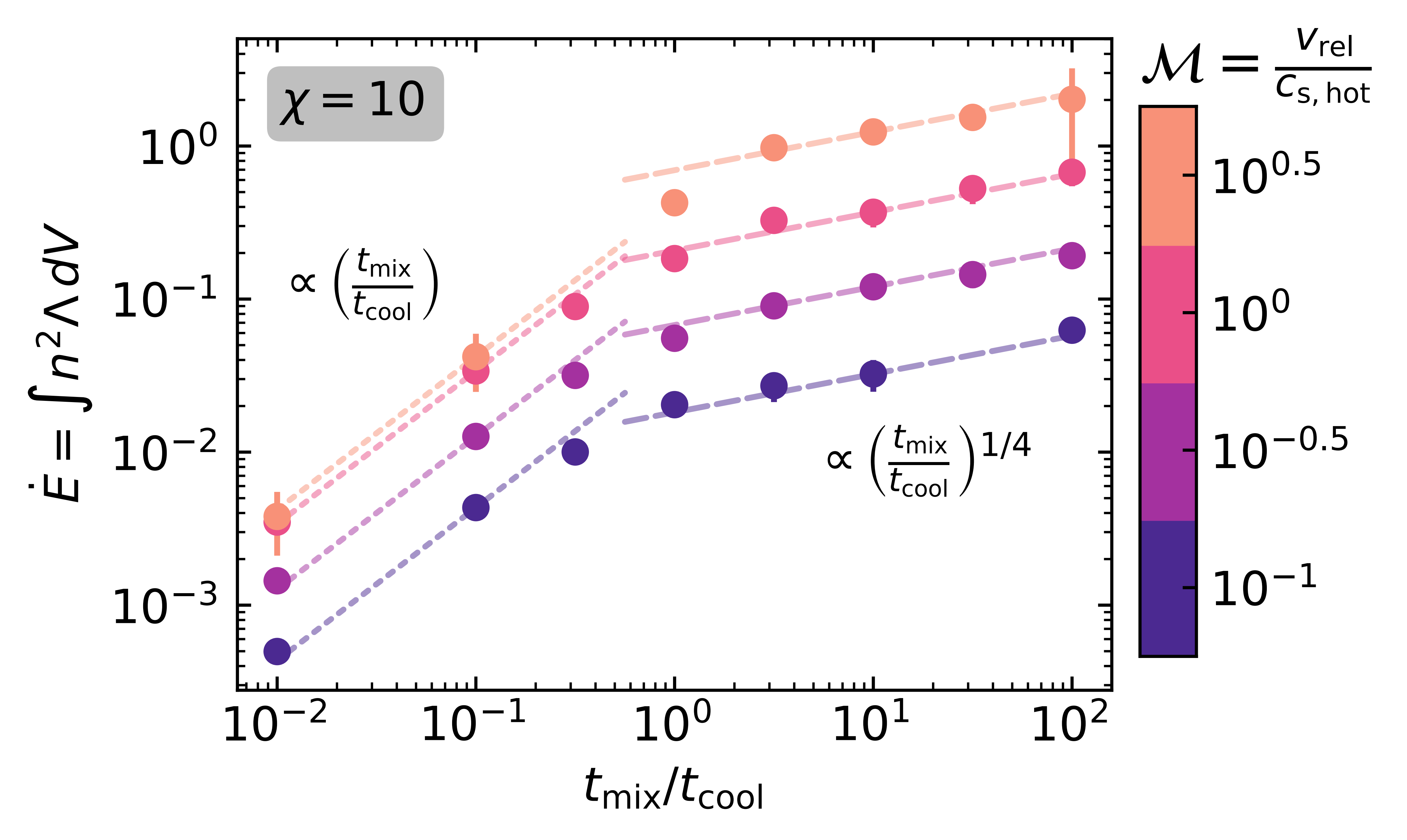
Entrainment, acceleration, & cooling

Rapid cooling limit, i.e. when $t_{mix}/t_{cool} \gtrsim 1$:

$$\dot{E}_{cool} \propto (t_{mix}/t_{cool})^{1/4}\ \mathrm{Mach} \sim \left(\frac{\chi^{1/2} L}{v_{rel}\, t_{cool}}\right)^{1/4} \left(\frac{v_{rel}}{c_s}\right) \propto \frac{L^{1/4} v_{rel}^{3/4}}{t_{cool}^{1/4}}$$

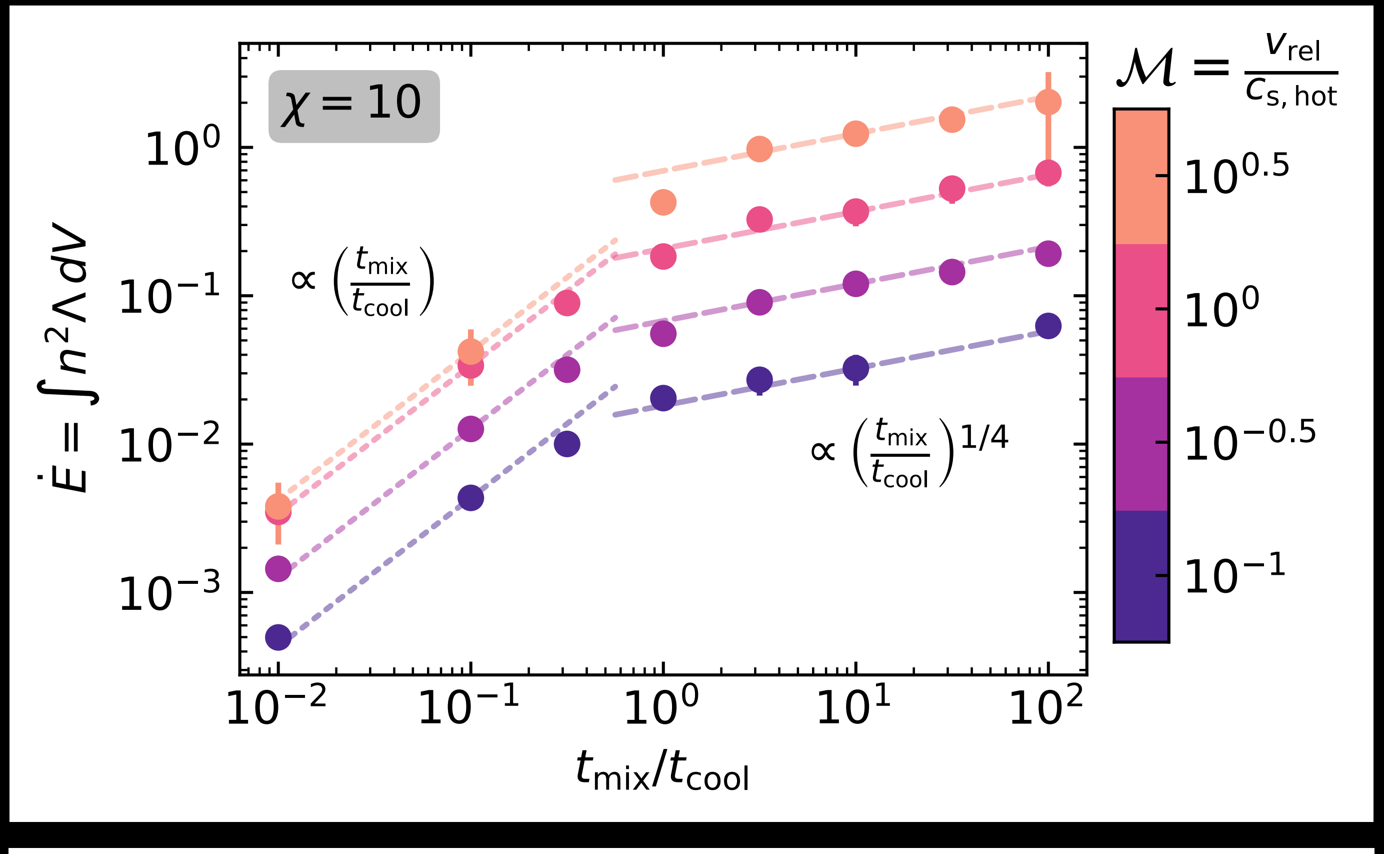


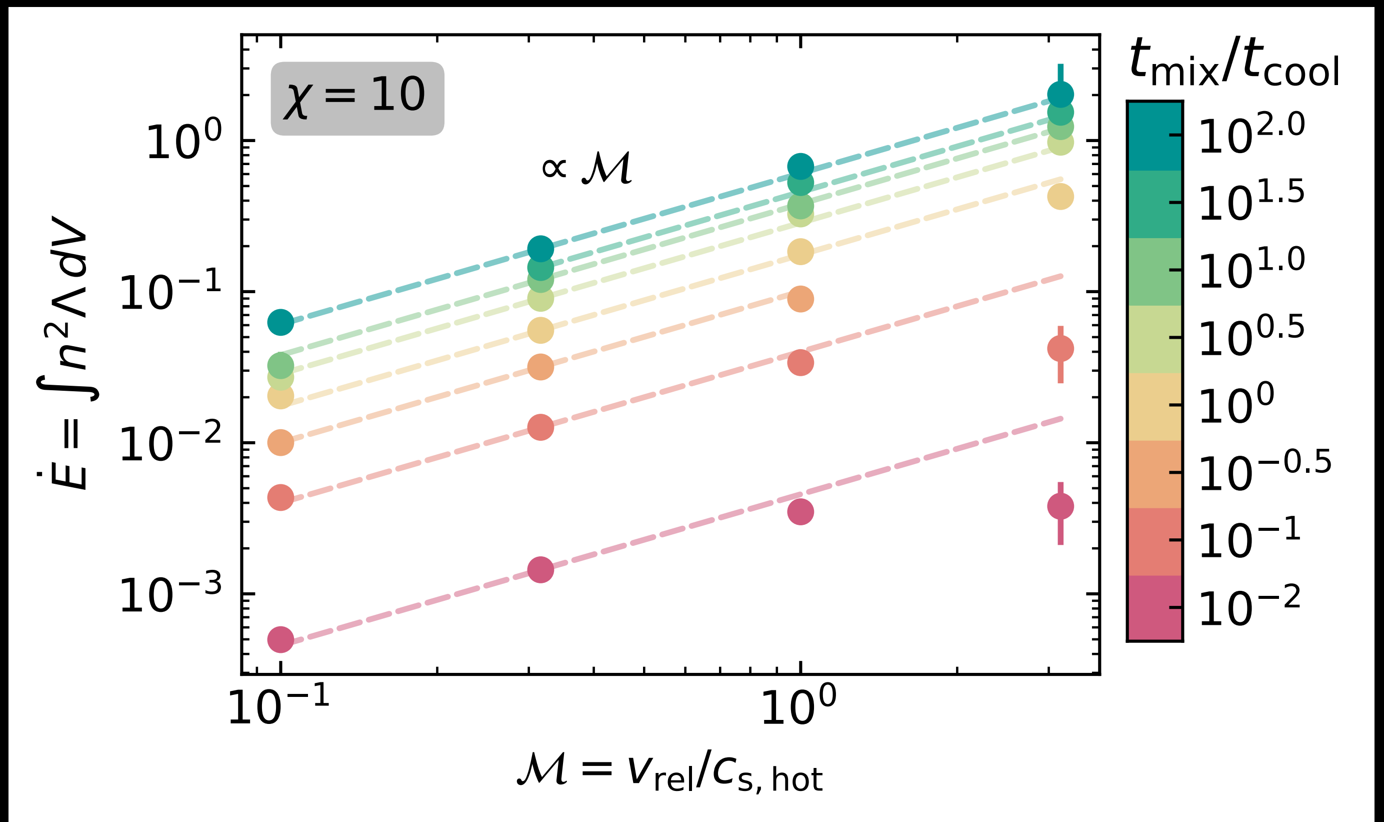
Does this really depend on L in this way
To test this I should do strong cooling simulations
With fixed Δx and vrel and tcool, but I need to get at
Least a range of 16 in L to get a factor 2 difference
In Edot_cool, but if I do a L=1 sim with 128, then going
4x larger gives me 512, which is probably too big to
afford. So first I need to see if using a L=1 with 64 is
Converged (enough) to use. However then going the
Other way to a L = 1/4, means I have only 16 cells
Across which is probably too small…..
Maybe I can get a way with a range of 8 in L, which
Corresponds to a 1.68 change in Edot_cool.

Entrainment, acceleration, & cooling

Inflow of high enthalpy gas replenishes cooling losses:

$\dot{E}_{cool} \propto v_z$





In the slowly cooling limit, simple interpretation of the energy equation gives the right scaling:

$$\frac{\partial}{\partial z}\frac{\gamma}{\gamma-1}Pv_z\left(1+\frac{\mathrm{Mach}^2}{2(\gamma-1)}\right) = \dot{\varepsilon}_{cool} = \frac{1}{\gamma-1}\frac{P}{t_{cool}}$$

Approximately reduces to

$$v_z \approx \frac{h}{t_{cool}},$$

which, since $t_{mix} < t_{cool}$, $h \sim \sqrt{v_{rel} L t_{mix}} \sim L$, gives

$\dot{E}_{cool} \propto 1/t_{cool}$