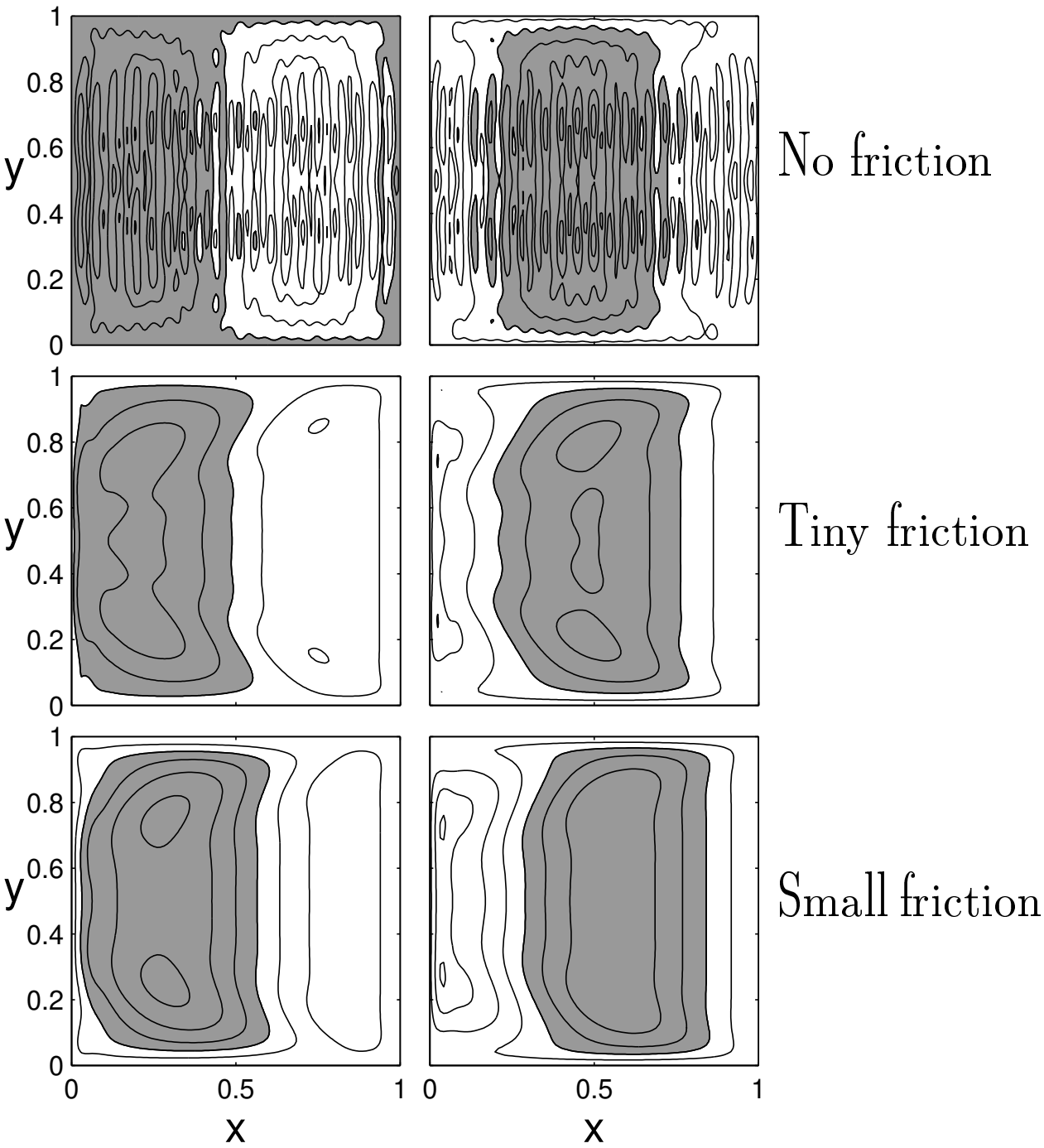
The QG limit

$$q_t + \beta\eta_x = r\nabla^2\eta, \qquad q \equiv \nabla^2\eta - g'H/f_o^2\eta,$$

with B.C. $\eta = \eta_0(t)$ + mass conservation.



The phase-lines are almost N-S, and there is no WBL.