Derivation of Shallow Water Equations

1 Dimensional Analysis

We begin by considering the Navier-Stokes equations

$$\nabla \cdot \boldsymbol{u} = 0 \tag{1}$$

$$\boldsymbol{u}_t + \nabla \cdot (\boldsymbol{u}\boldsymbol{u}) = -\frac{1}{\rho}\nabla p + \frac{1}{\rho}\nabla \cdot \sigma + \boldsymbol{g} \tag{2}$$