Two-phase model

The two-dimensional two-phase model of water and air is given by

$$\begin{aligned} \partial_t u + \partial_x uu + \partial_z wu - fv &= -(\partial_x p)/\rho && (1)\\ \partial_t v + \partial_x uv + \partial_z wv + fu &= 0 && (2)\\ \partial_t w + \partial_x uw + \partial_z ww &= -(\partial_z p)/\rho - g && (3)\\ \partial_x u + \partial_z w &= 0 && (4) \end{aligned}$$

which holds both in water with $\rho = \rho_o$ and air with $\rho = \rho_a$, and $\rho = c\rho_o + (1-c)\rho_a$.

Solve this with two level discrete time step. Knowing u^n and w^n from previous time step, first calculate intermediate solution u^* and w^* from

$$\frac{u^* - u^n}{\Delta t} = -(\partial_x uu + \partial_z wu)_d \ , \ \frac{w^* - w^n}{\Delta t} = -(\partial_x uw + \partial_z ww)_d - g \ , \quad (5)$$

Then take divergence and calculate pressure p such that

$$\partial_z u^* + \partial_z w^* = -\Delta t(\partial_x(\partial_x p)/\rho + \partial_z(\partial_z p)/\rho) \quad (6)$$

This is solved for p with conjugate gradient solver with preconditioner, and so

$$u^{n+1} = u^* - \Delta t(\partial_x p)/\rho \ , \ w^{n+1} = w^* - \Delta t(\partial_z p)/\rho \quad (7)$$

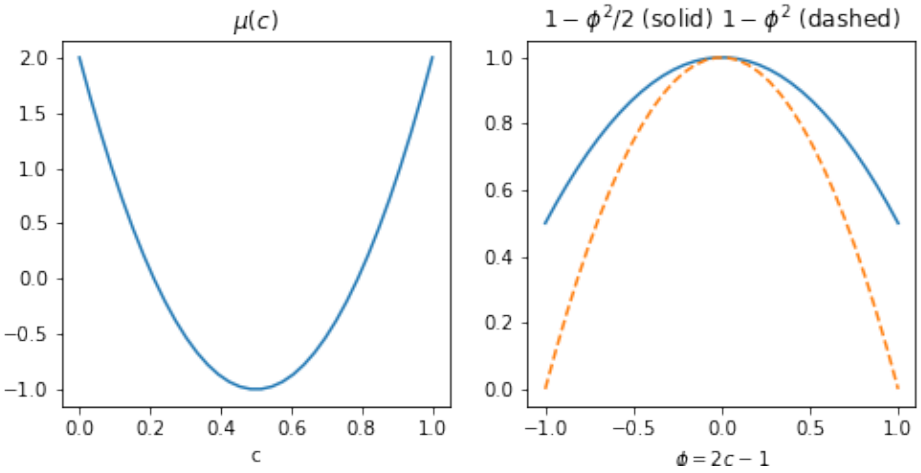
such that next time step u^{n+1} and w^{n+1} is also free of divergence.

Concentration c with $c = 1$ in water and $c = 0$ in air given by

$$\partial_t c + \partial_x uc + \partial_z wc = \partial_z M(c)\partial_z \mu \ , \ 0 < c < 1 \quad (8)$$

with chemical potential μ and mobility parameter M given by

$$\mu = 12c^2 - 12c + 2 \ , \ M_c(1 - \gamma\phi^2) \ , \ \phi = 2c - 1 \ , \ -1 < \phi < 1 \quad (9)$$



and $M_c = 10^{-4}$

Discretisation

Discretisation is on a C-grid.

Options

The configuration is controlled in the template subroutines SET_PARAMETER and INITIAL_CONDITIONS. One example is provided.

A number of switches can be set to either true or false.

name	default	meaning
enable_upwind3_advection	false	
enable_dst3_advection	false	
enable_superbee_advection	false	
enable_multidim_advection	false	
enable_AB3_time_stepping	false	
enable_particles	false	
enable_v_velocity	false	