

This data package contains MATLAB code for a one-dimensional, depth- and width- integrated tidewater glacier model and idealized line plume model. The glacier model is based on that of Enderlin et al. (2013), while the plume model is based on that of Jenkins (2011). The model was developed to study the impacts of bedrock topography on subglacial discharge and submarine melting during tidewater glacier retreat (Amundson and Carroll, in press.)

The model code consists of several MATLAB m-files:

1. **spinup.m**: Sets some of the model parameters and runs `tidewater_glacier_spinup.m`. In setting the domain and initial geometry, it calls two functions, `bedmodel.m` and `initial_glacier.m`. If the glacier retreats off of the sill during spin-up, the model starts over with a lower equilibrium line altitude (i.e., colder climate).
2. **bedmodel.m**: Creates a glacier bed with a sill and/or constriction. The width and amplitude of the sill and constriction are specified as input. This code can be easily modified to create different bedrock topographies.
3. **initial\_glacier.m**: Creates an initial glacier domain and velocity vector.
4. **tidewater\_glacier\_spinup.m**: Function that solves glacier velocity, changes in surface elevation, and changes in glacier length. In doing so it calls `track_glacier_terminus.m` and (if needed) `track_grounding_line.m` in order to adjust the grid. It calls `U_convergence.m`, which solves the momentum balance equation. `tidewater_glacier_spinup.m` differs from `tidewater_glacier_retreat.m` in that it breaks if the terminus retreats off the sill; this is done so as to speed up the spin-up process (see comment about `spinup.m`).
5. **track\_glacier\_terminus.m**: Uses interpolation to adjust the grid so that the last data point falls on the terminus.
6. **track\_grounding\_line.m**: Uses interpolation to adjust the grid so that a grid point falls on the grounding line. This is necessary for stability if the terminus goes afloat.
7. **U\_convergence.m**: Iterates to solve for the glacier velocity on the grid points. This is where the boundary conditions are applied.

Running `spinup.m` will create a mat file that contains structure arrays describing the bedrock geometry, glacier geometry, and velocity. Once the model is spun up, retreat can be simulated using `runmodel.m`.

8. **runmodel.m**: Analogous to `spinup.m`, but used to set-up and initiate a retreat using a specified initial steady-state configuration. An example has been provided (`spinup.example.mat`). Retreat is initiated by slightly increasing the ELA from the initial value. If the perturbation to the ELA doesn't cause the terminus to retreat past the sill, then the ELA is raised again. This is done so as to initiate retreat from a very close to steady-state configuration. The m-file creates similar solution matrices to those produced by `spinup.m`.
9. **tidewater\_glacier\_retreat.m**: Similar to `tidewater_glacier_spinup.m`, but it allows the terminus retreat to continue past the sill. It also contains several lines of code that can be uncommented to turn on the plume model, which is stored in `./code/plume_model/`

The main call to the line plume model is through the function `line_plume.m`, which calls a few smaller functions that do things like set-up MATLAB's ode solver and calculate the mean and max of vectors that contain NaN values. `line_plume.m` also requires temperature and salinity profiles. Some idealized profiles are provided in the `./code/initial_TS/` directory.

References:

Amundson, J.M., and D. Carroll (in press). Effect of topography on subglacial discharge and submarine melting during tidewater glacier retreat, *J. Geophys. Res.*

Enderlin, E., I. Howat, and A. Vieli (2013), High sensitivity of tidewater outlet glacier dynamics to shape, *Cryosphere*, 7, 1007–1015, doi:10.5194/tc-7-1007-2013.

Jenkins, A. (2011), Convection-driven melting near the grounding lines of ice shelves and tidewater glaciers, *J. Phys. Oceanogr.*, 41, 2279–2294.