Peridynamics:

Peridynamics is a modeling scheme for continuum solids. It uses nodes to compute forces and torques internal to the material. The stress between nodes represents the stress on the bond between the two material nodes. If model limitations are exceeded, the bond breaks and a crack forms.

Peridynamics is a strictly continuum technique, but by virtue of the discretized system of equations, it can be solved in a molecular dynamics simulator (LAMMPS). Bonds are parameterized via material properties such as density, yield strength, bulk modulus, etc.

Because the PD slab approximation of an ice floe does not have external forcing, terms for buoyancy and environmental stress momentum transfer are required.

Buoyancy currently uses a spherical approximation for each peridynamical node. This is done to remove orientation as a parameter in computation of displaced water for the computation of buoyancy. An assumption about water intrusion into the system seems to be not required but may have a bearing on drag considerations.

A still ocean is assumed leading to oceanic drag of the form ( Fdw = ½\*Cdw\*rho,w\*A\*v^2). Bulk forcing to be accomplished by atmospheric wind of the form (Fda = ½\*Cda\*rho,a\*(Va – v)^2).

Model is to be initiated using Matlab script. This is used to ensure that initial condition is isostatic. Additionally, it enables easy perturbation of the model’s inputs and is “easy” for me to code in.

Attached Figures:

Fig 1. Demonstration of buoyancy in the model. Each line represents a starting position for a particle in the simulation. Calculations of Buoyancy are calculated based on centroid’s position relative to z=0 (water line). Gravitation is included resulting in longer durations below water than above. The solution at the center (horizontal bold face line) represents a particle placed initially at the calculated equilibrium point. Drag is removed for this calculation to show the periodic solution as particles oscillate on the water’s surface.

Fig 2. Demonstration of ocean drag’s effect on damping the same oscillations from Fig. 1. By including the drag in the formulation, energy is removed from the system decreasing the amplitude of oscillations over time.

Fig 3. Demonstration of ridge state after 100,000 time-steps (note that none of the parameters that have been used are physical in any way). There are 21,600 nodes in the simulation and took 2 hours to run on a laptop. The particles are normally distributed with a mean radius of 0.5 m and a standard deviation of 0.01 m. With careful choices for parameterization in the simulation, the results can be improved.