**Arctic Connectivity Modelling**

-etreml, jpfay. June-August 2016

**note**: I am early into model testing and benchmarking, everything is preliminary and not to be believed. These are basic methods, thoughts, and caveats.

**I. Physical oceanography**

* Current velocities derived from Polar Science Center's PIOMAS ocean circulation data. We have 1978 through 2013. most much less than 5cm/s (jpfay for details)
* Ocean/Land boundary based on PIOMAS model mesh interpolated to a 25x25 km model grid using original projection of NSIDC EASE Grid North (jpfay for details)
* I removed the Gulf of Alaska and the Sea of Okhotsk because they were both disconnected from the Bering Sea and Arctic due to our domain.
* I tweaked original shoreline habitat patches (jpfay for details) and renumbered. We now have 134 potential source/destination patches.
* **Thought**: We should explore alternative or additional ocean velocity data, if possible. Ice flow is slower than underlying currents and constrained by the density of ice. You can see in the ‘Retention’ and dispersal simulations that larvae pile up in the middle of the ocean. I believe this is because as ice moves off shore and into the centre, it slowly piles up and stops moving (so the current velocities tend towards zero as well!). Because I have no density dependence in the larval model, I allow larvae to be concentrated in ocean cells with no bound. I wonder if Susan Lozier has any more ideas on what is available – she’s done a lot up in the N Atlantic.
* **Thought**: We should explore the implications of the regularised spline in interpolating PIOMAS data to our grid. It seems current velocities are reduced several orders of magnitude as the values get interpolated to the shoreline and sometime switch directions (sign). We may want to add shoreline points based on our regular grid to the PIOMAS data before interpolating to ensure nearshore current velocities do not switch sign and to keep velocities more reasonable in the nearshore. You can see in the animations that the larval densities just sit in some of these areas (e.g., west Beaufort Sea).

**II. Biology**

* I am benchmarking two simulations, one released on 15Feb1978, one released on 15Sep1978 to just start benchmarking and testing. For each connectivity simulation, the following parameters were used:
  + releaseDate = [1978 09 15 12 0 0]; %or [1978 02 … ]
  + maxPLD = 100;
  + simulationTimeStep = 1/6; % 4-hr time-step
  + summarizationPeriod = 6;
  + All to start settling around day 20
  + settlementRate = 0.90;
  + diffusivity = 500;
  + mortality = 0%/day
  + animation outputs:
    - ***Arctic\_Feb1978\_100day\_Test\_out.avi***
    - ***Arctic\_Sep1978\_100day\_Test\_out.avi***
  + connectivity network based on ‘migration matrix’, or for every destination patch, what proportion of settled larvae came from each upstream source. Directionality is implied by following the arc in a clockwise direction:
    - ***Arctic\_Sep1978\_100d\_ShpNet.shp***
    - ***Arctic\_Feb1978\_100d\_ShpNet.shp***
  + Quick maps:
    - ***Arctic\_Feb1978\_100d\_ShpNet.pdf***
    - ***Arctic\_Sep1978\_100d\_ShpNet.pdf***
* I also ran two simulations where I released larvae from every ocean cell and let them disperse and accumulate based on currents. I call these ‘retention’ simulations. There is only one ‘source’ patch (all water cells) and no connectivity matrix. It is used to simply visualise the retention and advective zones. Look at the movies – the hot spots are areas of accumulation or retention. Similar parameters as above, but I do not allow larvae to settle, essentially.
  + Animation output:
    - ***Arctic\_Ret\_Feb1978\_100day\_Test\_out.avi***
    - ***Arctic\_Ret\_Sep1978\_100day\_Test\_out.avi***

**Further thoughts for group:**

1. Running a 100-day simulation for all 134 patches at a 4hr time-step takes < 15 min to complete. In short: it is super-fast and we can easily run 1000s of simulations if needed on our HPC (I am currently doing this for my other projects)
2. Obviously, we can run different biological parameters from these reefs, including much longer simulations. I’ve run 365-day simulations for similar models, depending on the questions
3. It might be informative to identify potential oil exploration sites and run a dispersal simulation from there to identify shorelines most at risk (dependent on ‘appropriate’ current data, caveats, etc.)
4. We have the capacity to look at spatial patterns (both retention simulations and connectivity simulations) through time to explore the impact of the arctic oscillation, etc.
5. We can quantify connectivity among geopolitical units (Treml & Halpin 2012)
6. Are there MPAs existing or proposed? We could identify connectivity among and/or upstreamconnections.

Note to self:

1. ArcticDataToSimDir.m: Create SimDir, currents.mat, structure
2. ArcticDataLoadHydroToSimDir.m: reformats \*.ASC (jpfay) to \*.mat in SimDir
3. ArcticTestRun.m: controller for running dispersal code
4. ArcticMakeMovie.m: dirtball \*.avi code
5. ArcticCalcCon.m: calculate connectivity matrix (Mmat) based on PLD & mortality
6. ArcticConMat2ShapeArcs.m: Mmat to shapefile of dispersal network.