11:628:320 Dynamics of Marine Ecosystems 2009

Homework 2

Due Monday October 5, 2009

1. The website http://clover.ocean.washington.edu/~neil/NPZvisualizer has a set of simulation models for coastal marine ecosystems. Read the all questions/tasks below before you start.

   Open the URL above in a web browser. You will need a reasonably up-to-date version of Internet Explorer, Firefox or Safari, with JavaScript enabled. The NPZvisualizer should immediately start running a simple marine ecosystem box model.

   (a) List the model *state variables*.

   (b) Sketch a diagram similar to the model showing the state variables and arrows connecting them. To each arrow between variables add a brief label describing the *principal process* to which the arrow corresponds.

   (c) Allow the NPZ model to run and watch the graphs in the lower right. You can slow it down with the "days/sec" slider in the upper left area. [If you need to start over at the beginning, click the "rewind" button in the upper left, or the "reload" button in your browser.]

      i. Describe the time variability of the ecosystem
      ii. What has happened by about day 10 day?

   (d) Decrease the *P max growth rate* slider on the right to about 0.2 day^{-1}. Describe the new ecosystem equilibrium.

   (e) Reset the parameters, then increase the Z max growth rate to 1.2 doublings per day. Describe and explain what is now happening in the model ecosystem.

   (f) Go to http://coast.ocean.washington.edu/~neil/npz12 and select the "less simple" model

      i. Describe the added complexity of this model compared to the previous simple model above.

      ii. The default upwelling cycle frequency is 0, meaning steady upwelling. Increase this to about 0.05 cycles/day. What happens?

      iii. Can you find a set of parameters than make this ecosystem go to a steady equilibrium?

2. Sketch a **3-dimensional** cartoon of a northern hemisphere coastal upwelling region where the ocean is to the west of the coast, i.e. an eastern boundary current regime. Indicate the upwelling favorable wind direction, the Ekman currents, temperature and/or density patterns, and the location and direction of the coastal jet. Label features clearly and/or write a caption that explains the features you depict. Pay attention to displaying the correct location of currents with respect to temperature/density patterns.

   a) Describe how this system is important for silica cycling and sedimentation in the ocean.

3. The biological pump moves carbon and nutrients into the deep sea. The biological pump is driven by surface productivity. The community evolution of the spring blooms is different in the Atlantic and Pacific. This has an impact on the transport (flux) between the surface and deep reservoirs.

   a) In both the Atlantic and Pacific, the spring bloom progresses from a eutrophic system to an oligotrophic system. The Pacific is more stratified in winter than the Atlantic. Describe the community evolution for **both** Atlantic and Pacific.

   b) Describe the flux of carbon at the beginning, middle, and end of the spring bloom (that is, across the progression from eutrophic to oligotrophic you described above) for **both** the Atlantic and Pacific.

   c) Compare and contrast the fluxes you described in each ocean for each phase of the spring bloom above. Be sure to explain why they are different or the same at each time.

   d) At which phase will the "silica pump" be most effective and why?