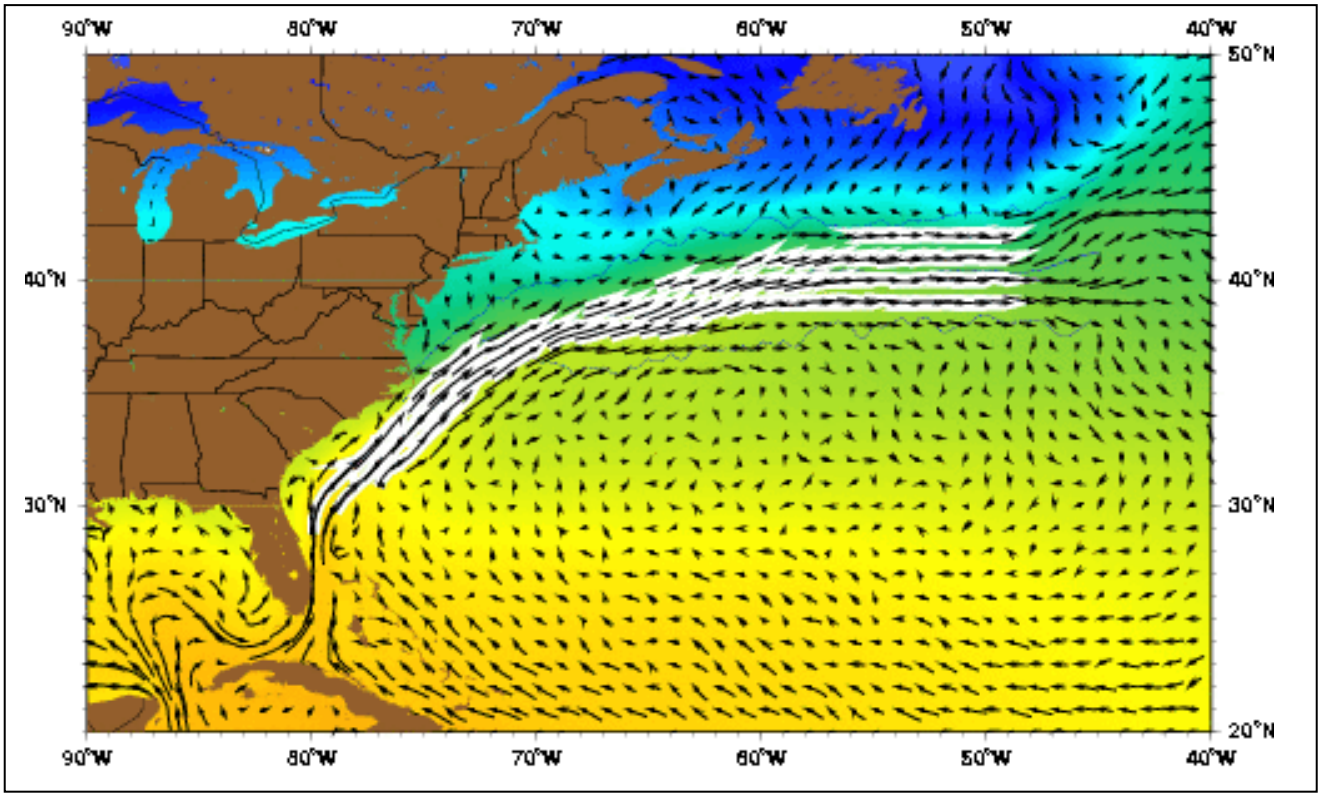
Wind Driven Oasis

Adapted from the activity 'Cold one day warm the next' developed by Kent Hathaway, Research Oceanographer from the U.S. Army Corps of Engineers Field Research Facility from http://www.vims.edu/bridge/archive1003.html

The original activity was developed to show the link between upwelling and wind direction at Kitty Hawk, NC. This is an Oregon version of the activity. This activity ties into the eutrophication activity and the current concerns about climate change and how it will manifest itself. If you and your club members are interested, doing the East coast version, it would be a good opportunity to examine the differences between the oceans off the two coasts. The external resources I listed for the eutrophication activity could also be used and discussed in this activity.

Background

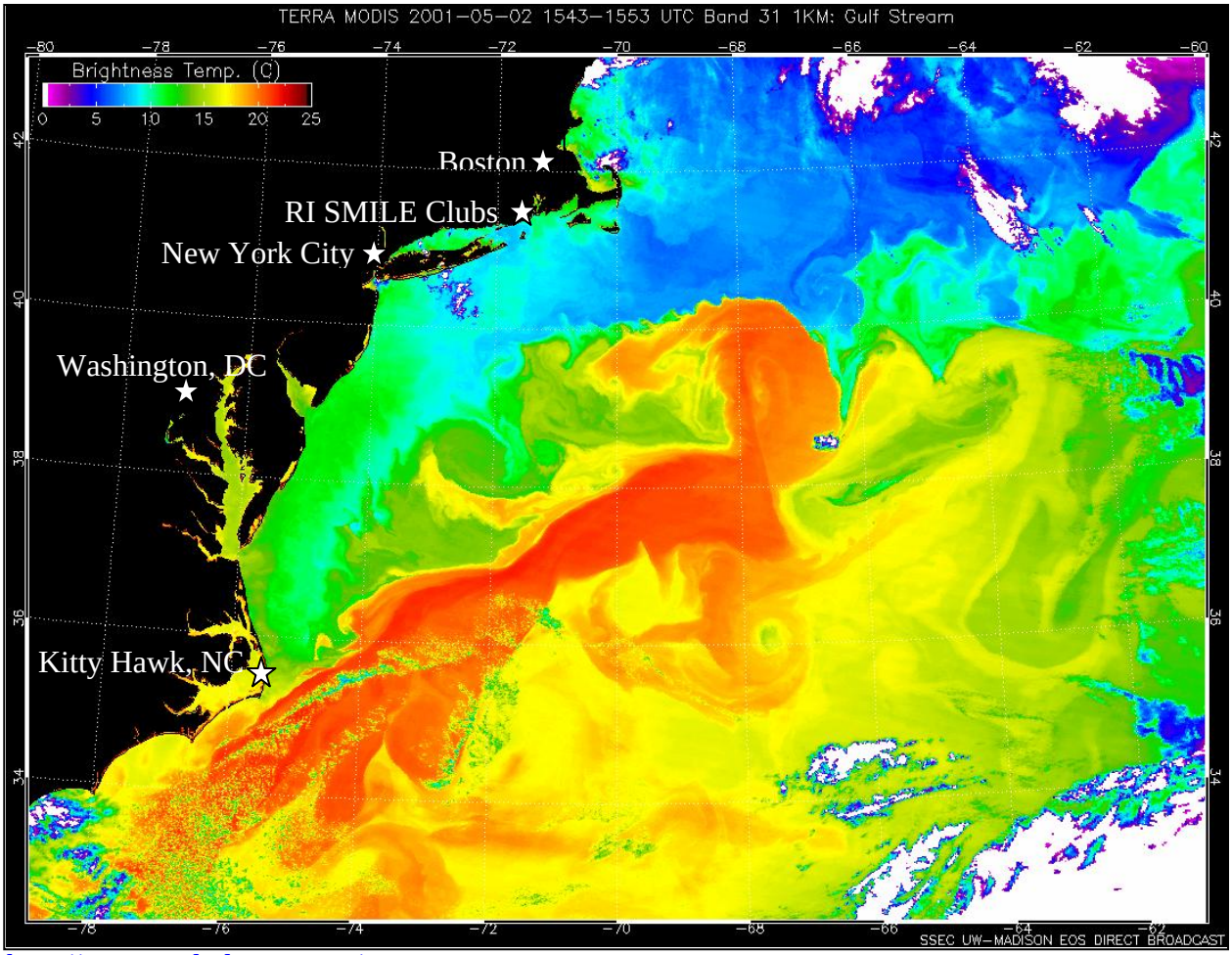
On the East coast water temperature is controlled by the interaction among the Gulf Stream (warm and salty traveling North), the Labrador Current (cold and fresh traveling South), and local winds. Satellite images of the sea surface temperature, and water speed are the best way to locate these currents. This is a mathematical model of the Gulf Stream.



http://oceancurrents.rsmas.miami.edu/atlantic/gulf-stream.html

The arrows are velocity vectors – the direction represents the direction of the current, and the length represents the speed of the current. The colors represent water temperature (yellow is the

warmest and blue is the coldest) The Gulf Stream pumps warm salty water from the Gulf of Mexico up into the North Atlantic.

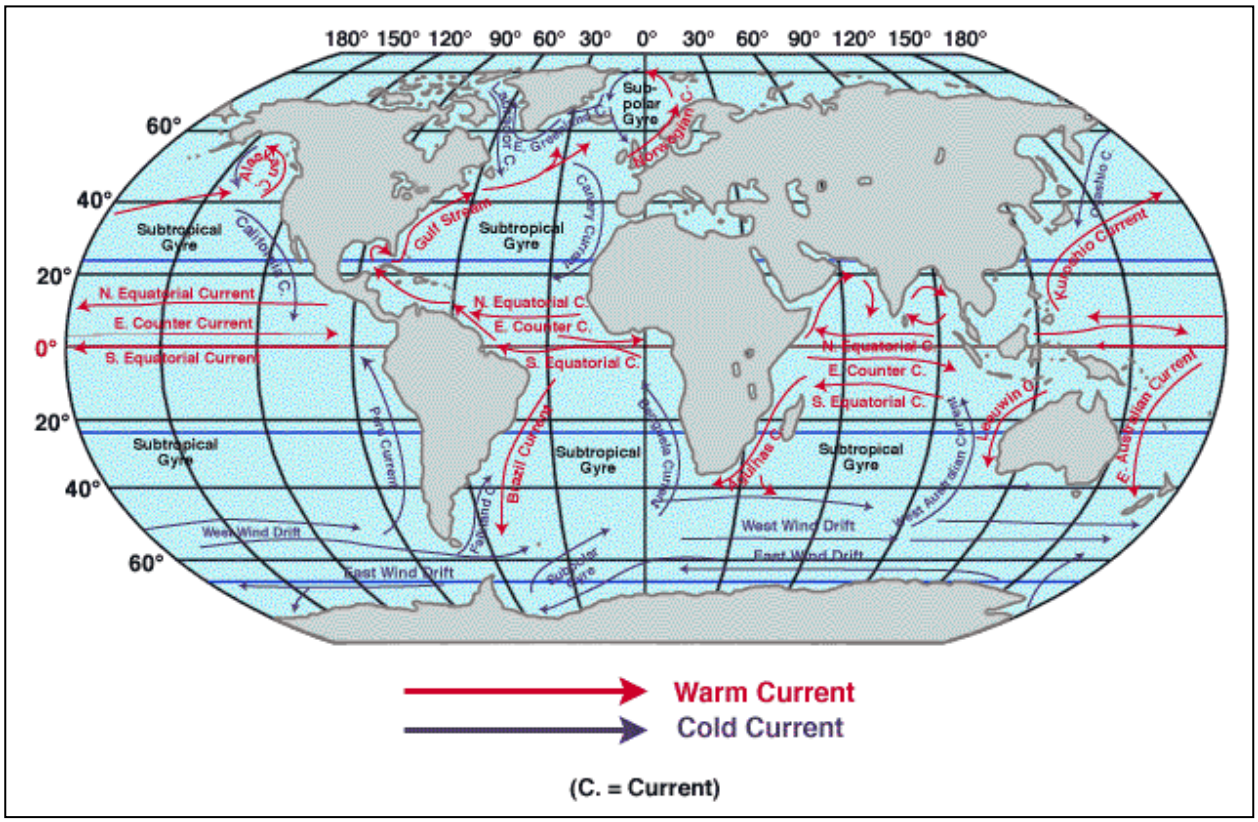


http://www.osdpd.noaa.gov/

Here's an actual satellite image of the Atlantic Ocean and the East Coast from May 2, 2001. Have club members compare an actual image to the idealized model output. Notice that the actual Gulf Stream is less distinct and is not in exactly the same place as in the model. This image also has a nice example of a 'cold core ring' (it's the circle just East of the Gulf Stream around Kitty Hawk, NC). This is an eddy of water that has spun off of the Gulf Stream and has trapped a core of cold water in a circle of hot water. These rings are productive areas that draw dolphins and other marine mammals to feed.

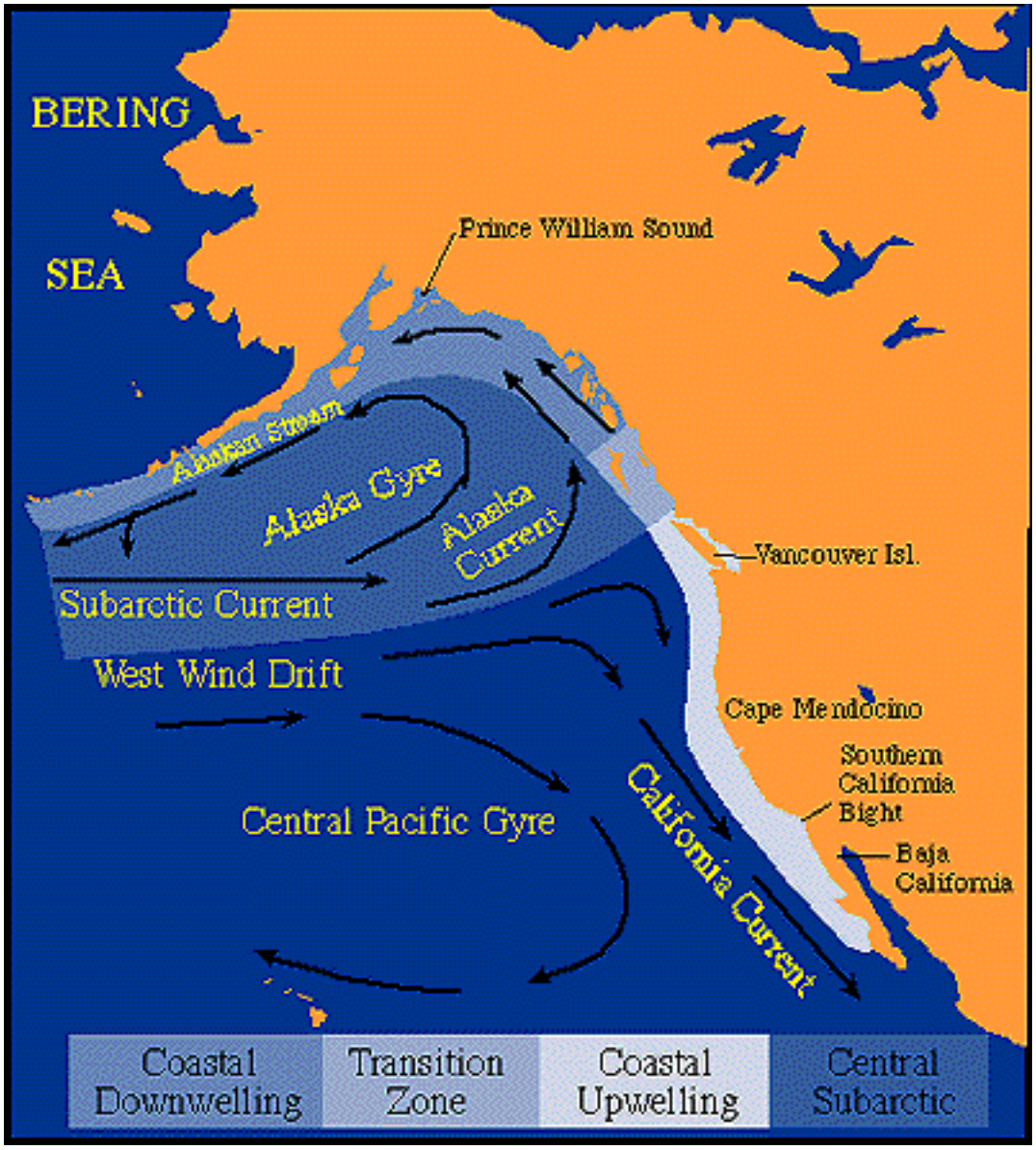
This satellite image only shows sea surface temperature. Note the scale bar in the upper left corner of the image – purple represents the coldest temperatures and red the hottest. This is a late spring image, so the waters are relatively warm. Can you identify the clouds in the image? Remember that clouds are colder than the surrounding water. See if the SMILE club members

can find the Gulf Stream in this image (it's in red). Have them consult the world ocean currents map if they need some help.



http://www.bigelow.org/shipmates/hc_currents_lg.gif

While the East coast has the Gulf Stream warming the water off their coast, the West coast has the California Current that cools waters off our coast. This is why you can swim in the ocean in Maine, but not in Oregon, even though the two are roughly the same latitude (equally as far North). Have club members find the California Current on the world map. The California Current is not as easy to see in satellite images as the Gulf Stream is because it isn't as strong a current. Because of the way the earth rotates, currents on the west side of oceans are stronger than those on the eastern side. Have club members compare the western boundary currents (like the Gulf Stream) to the eastern boundary currents (like the California Current) do they notice any patterns?



http://globec.oce.orst.edu/groups/nep/nepsummary.html figure from Fisheries production domains and general circulation in the North Eastern Pacific Ocean (From Ware and McFarlane, 1989).

Activity

This activity uses data from the COAST (Coastal Ocean Advances in Shelf Transport) Data Report and satellite images of SST (sea surface temperatures) from a COAST web site at COAS (College of Oceanic and Atmospheric Sciences) at OSU. Supplementary data can be accessed at http://www.damp.coas.oregonstate.edu/coast/ follow the link to satellite data and then you can click on the satellite images on this page to get to larger versions of the SST image. This data set is from 2001.

The SMILE Program
Summer Teachers' Workshop, 2005
Wind Driven Oasis

We will be comparing wind data with ocean temperature data from moorings and from satellite images looking for upwelling conditions.

This data report is designed for scientists, so there are a few conventions that you need to know about before you can use the data.

First, the dates are listed as Julian dates (1 = January 1st and 365 = December 31st). You'll need to convert the Julian dates into Gregorian dates (regular calendar dates) before you can use them. There's a spreadsheet to help you convert from numerical dates (Julian) to the Gregorian calendar dates. More information on the origin of the two calendars can be found at http://aa.usno.navy.mil/data/docs/JulianDate.html

Second, the times are in GMT (Greenwich Mean Time). GMT is the time it is in Greenwich, England where the Prime Meridian is (0° longitude) and where all time zones start from. GMT does not change for day light savings time. In the summer, western Oregon is GMT – 7, and when it's not daylight savings time western Oregon is in GMT – 8. Meaning that the time in Oregon is 7 hours behind GMT in the summer and 8 hours behind in the winter. That is why the times may seem a bit off. More information about GMT, time zones, etc. can be found at http://wwp.greenwichmeantime.com/

What are upwelling and downwelling?

Upwelling and downwelling refer to the vertical direction the water is moving. Upwelling occurs when the surface water is pushed out of the way (usually by wind) and cold sub-surface water rises up to take the place of the warm surface. Sub-surface waters have more nutrients that support phytoplankton growth. Downwelling occurs when surface water is piled up on top of itself and warm surface water is pushed down to deeper depths. Downwelling conditions are not good for phytoplankton because surface waters usually have low concentrations of nutrients.

Which winds create upwelling situations and which winds create downwelling situations and can you see it in satellite images?

Examine the wind data and the water temperature data for the Julian days 154-208. Find the days when upwelling is occurring and the days when downwelling are occurring by looking at the temperature profiles. Warm temperatures = downwelling, cold temperatures = upwelling. Examine the wind direction and strength (longer arrows = stronger winds) and see if you can determine a relationship between wind direction and strength and upwelling. Can you see the upwelling and downwelling in the satellite images? You can also look in the images from 2000 from the "Seeing Satellite Data".