Date …………… Name ………………………………………..

Ocean–116 (Oceanography Lab)

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Oceanic Circulation

Sources:

http://geosci.sfsu.edu/courses/geol103/labs/labs.html and
http://athena.wednet.edu/curric/oceans/drifters/drftprc.html

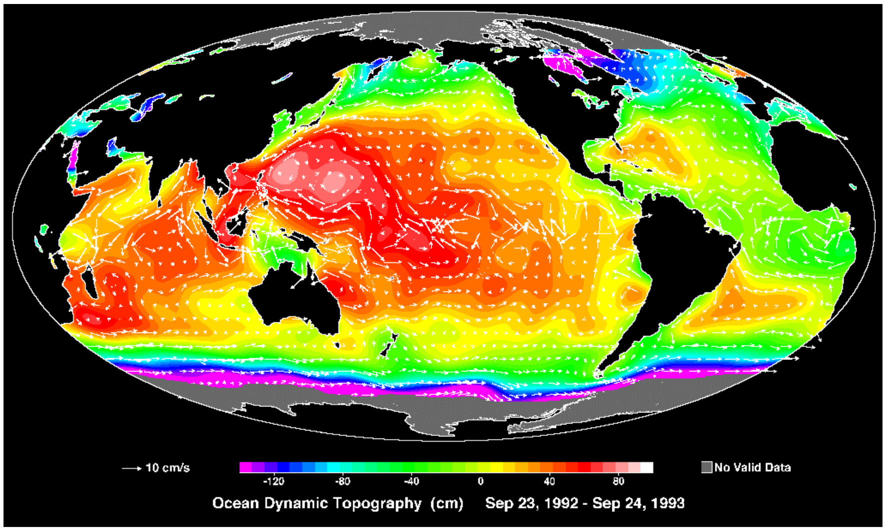
Purpose

- To view the drifter and satellite data that illustrate how the ocean circulates.
- To identify the basic layers of the equatorial ocean, based on vertical profiles of ocean temperature measurements.
- To learn how to use the Internet as a source for real and current data, information and research.

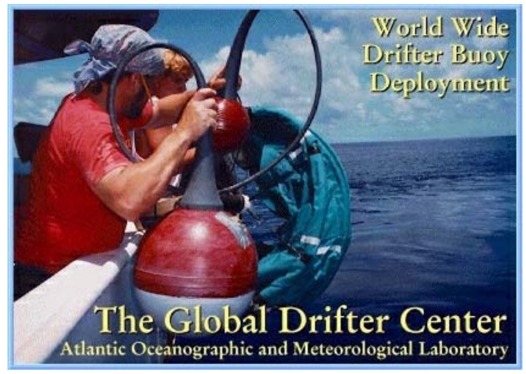
Description

The objective of this lab is to view data that illustrate how the ocean circulates. Oceanic circulation greatly influences climate, which affects us all. The atmosphere and ocean work together to absorb heat and redistribute it from one part of the globe to another. Otherwise, the tropics would get hotter and hotter, and the polar regions would get colder and colder. The ocean circulates by surface currents that are driven mainly by the wind, and by deep currents that are driven mainly by density contrasts in the water produced by temperature and salinity variations. Because the wind drives surface currents, we must also look at how the atmosphere circulates. In this lab we will primarily investigate evidence of surface currents. Because of the large scale of oceanic currents, observations from satellites are often used to study their characteristics and variations.

The map below, downloaded from the JPL/NASA site on dynamic ocean topography located at the URL: http://topex-www.jpl.nasa.gov/discover/dyn_topo_arrows.html shows large systems of highs and lows (liquid hills and valleys) that develop on the oceans' surface as a result of ocean currents. These highs and lows are permanent features of ocean circulation; their existence and basic structure do not change, but the details of these systems are constantly changing. Scientists measure these changes by defining the oceans' dynamic (changing) topography as a measure of sea level relative to Earth's geoid, a surface on which Earth's gravity field is uniform. This map, based on the TOPEX/Poseidon data that oceanographers use to monitor ocean circulation in much the same way as meteorologists have used atmospheric pressure maps to predict weather for decades, ocean currents are shown by white arrows. The longer the arrow, the greater the speed of the current. Speeds >10 cm/sec are represented by thick arrows.



In the northern hemisphere, ocean current flow clockwise around highs in ocean topography and counterclockwise around the lows. This process is reversed in the southern hemisphere.



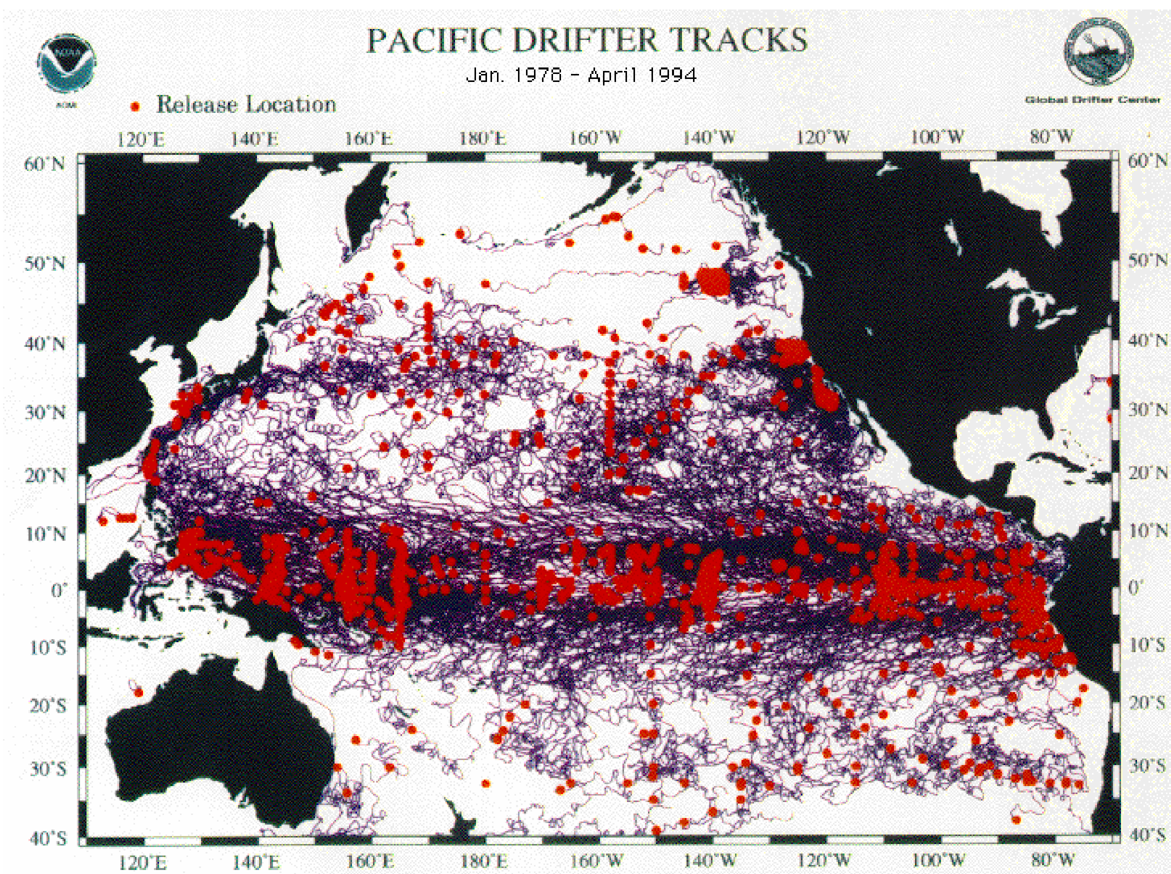
Buoys offer a means for the surface mapping of ocean currents. For information and details on the Global Drifter Program, go to its home page at

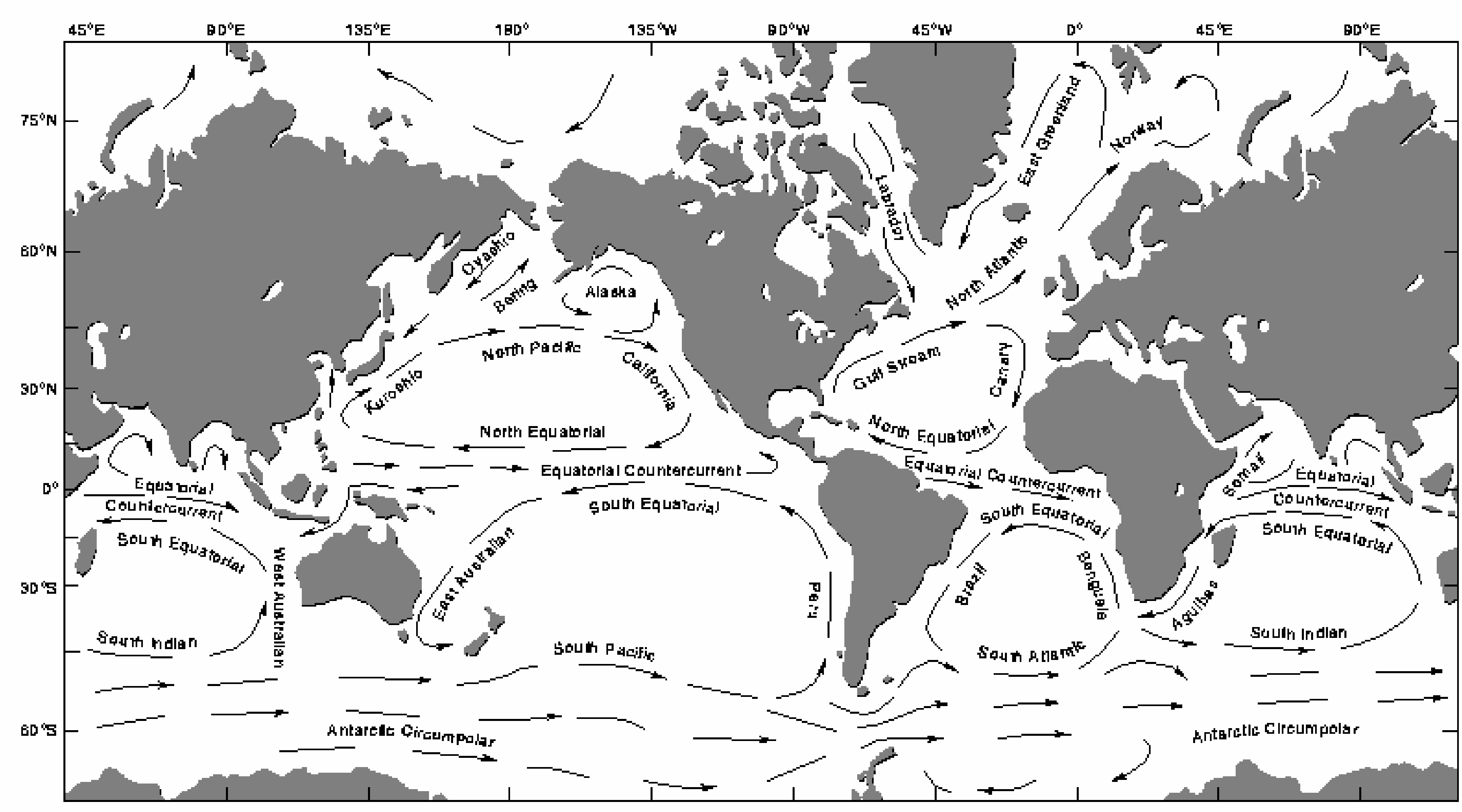
http://www.aoml.noaa.gov/phod/dac/gdp.html

or try the web-site

http://www.aoml.noaa.gov/phod/dac/gdc.html

Here, the floater at the top of the buoy sits at the surface of the water and holds an antenna for sending data to a satellite above. Drogues well below the surface cause the ocean currents to take the buoy along instead of the surface wind. Released into the ocean, the buoys float with the currents and take measurements of the water with built-in instruments. They are tracked by satellites in orbits far above Earth and transmit data several times a day. Ships and airplanes can drop these low cost (~$4500) and durable buoys into the sea. When released by ships, they have a 98% survival rate; from the air, survival drops to 78%. About half of the drifters lose their ability to communicate with the satellite, for one reason or another, after 440 days. Other buoys last longer and transmit their information for several years. The map below, downloaded from http://www.aoml.noaa.gov/phod/graphics/pacifictraj.gif shows the Pacific drifter tracks for the Jan 1978 - April 1994 period.

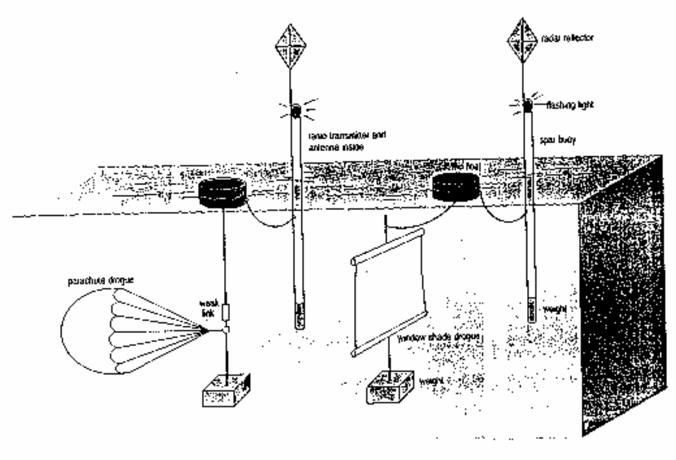




The major surface currents in the world's oceans are caused by prevailing winds. The currents may be cold, as in the instance of the West Wind Drift, or warm, as the Gulf Stream. Currents circulate in paths called gyres, moving in a clockwise direction in the northern hemisphere and a counterclockwise direction in the southern hemisphere.

http://www.acl.lanl.gov/GrandChal/GCM/currents.html

The Figure alongside is an example of freely drifting surface buoys. It shows two different types of drogues used to move with the surface currents and reduce the effects of the wind. The two types of drogues are the parachute drogue and the window shade drogue. The buoy also holds electronic instruments for measuring sea surface temperatures (SST), submergence, irradiance (for sunlight) and barometric pressure. At the top is another device for measuring temperature and conductivity (used to calculate salinity).



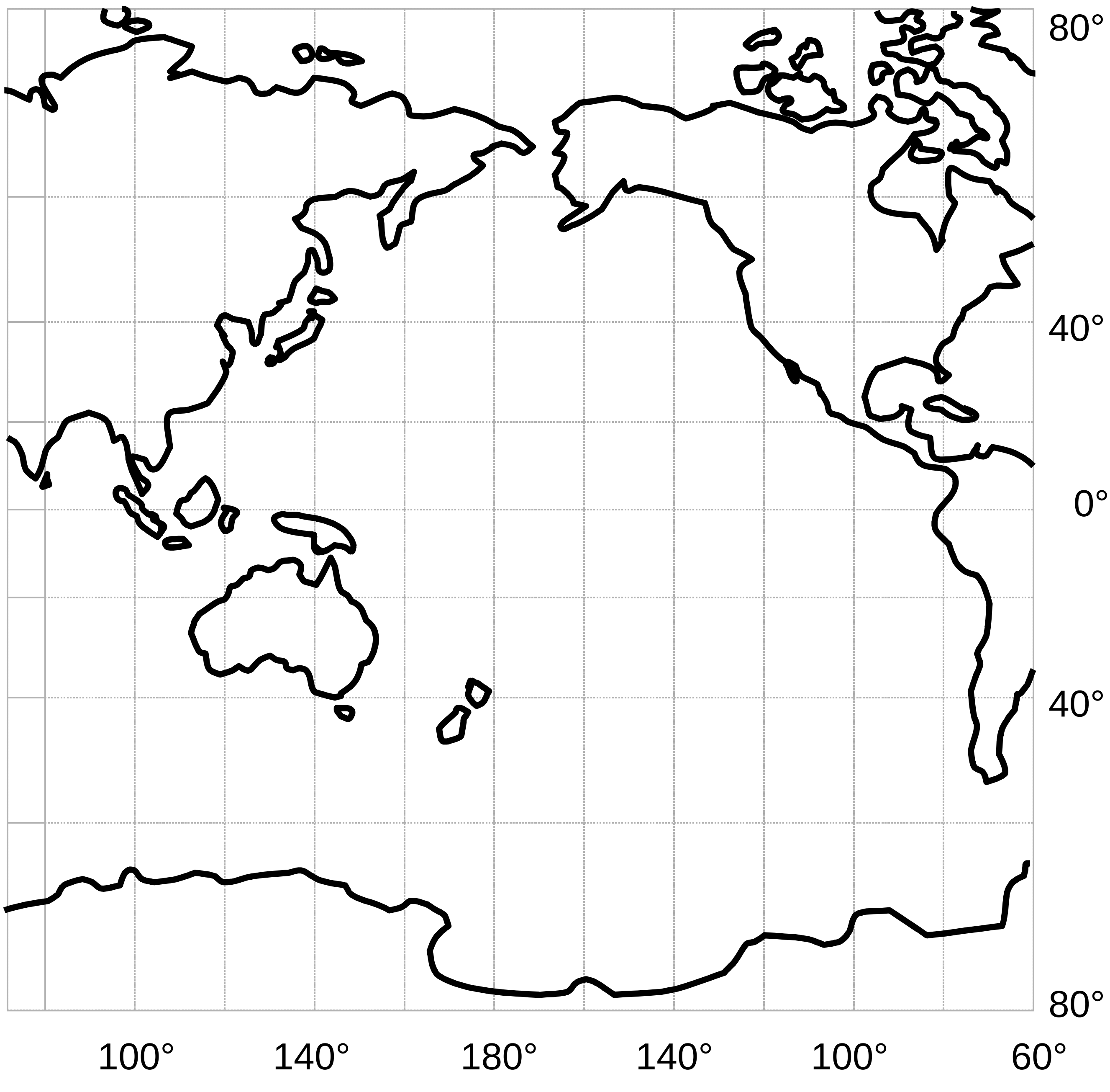
The Data: Below are some of the data obtained from the buoys.

Buoy No. 12410		
Date	**Latitude**	**Longitude**
27 Feb 95	30.1	-123.7
28 Mar 95	27.5	-121.8
22 Apr 95	25	-124.6
22 May 95	23.6	-128
24 June 95	22.5	-133.9
24 July 95	23.1	-138.4
26 Aug 95	20.5	-145.4
25 Sept 95	20	-147.6
20 Nov 95	17.9	-155.3
18 Dec 95	21.4	-159.5

Buoy No. 15022		
Date	**Latitude**	**Longitude**
25 Feb 95	10.7	162
27 Mar 95	10.5	152.1
23 Apr 95	11.6	145.5
20 May 95	12.4	137.6
25 June 95	17	131.1
22 July 95	21.7	127.8
27 Aug 95	33	141.6
23 Sept 95	37	147.8
23 Oct 95	39.3	152
25 Nov 95	40.1	154.5
31 Dec 95	37.6	160.4

Buoy No. 22217		
27 Feb 95	51.2	-162.7
27 Mar 95	50.4	-165.3
24 Apr 95	48.7	-159.5
29 May 95	50.7	-155.1
26 June 95	50.4	-151.7
24 July 95	51.5	-149.3
28 Aug 95	51	-145
25 Sept 95	53.1	-143.8
23 Oct 95	55.2	-139.1
27 Nov 95	57.1	-141.4
18 Dec 95	56.9	-141.7

Plot these data on the map of the Pacific below.



Refer to the map of surface currents shown below.

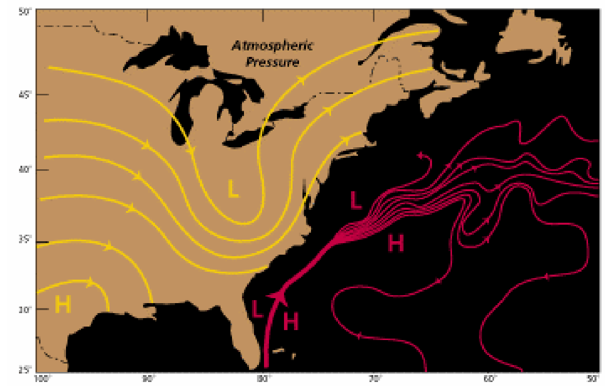
What are the names of the surface currents that moved the buoys whose courses you plotted?

Buoy 12410: ………………………………………………………………………………………

Buoy 15022: ………………………………………………………………………………………

Buoy 22217: ………………………………………………………………………………………

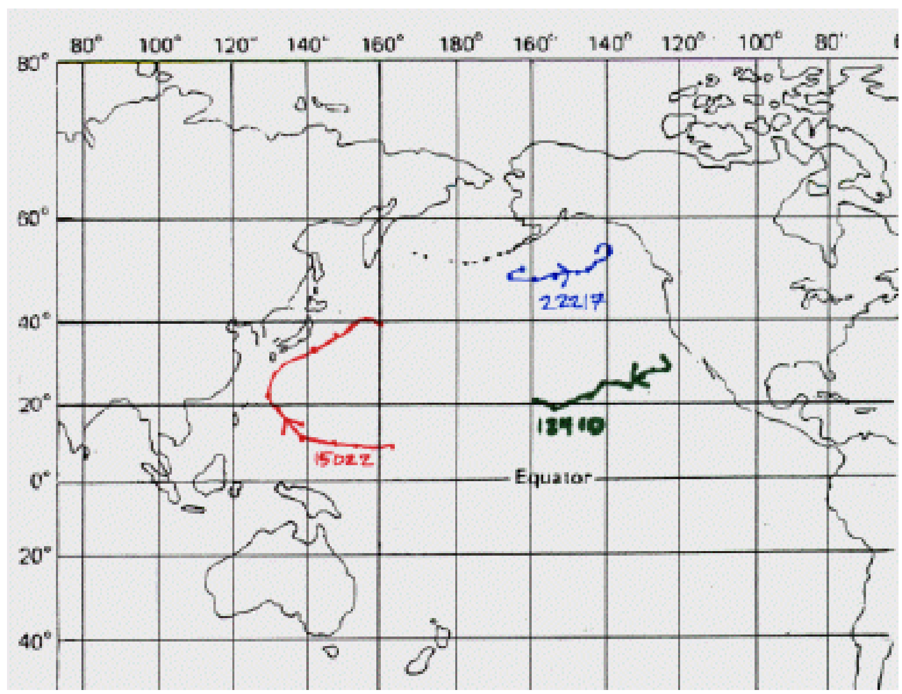
Volumes of Water Moving in Currents



Gulf stream

Oceanographers express current flow in "millions of cubic meters per second," a term difficult for most people to comprehend. A large current, such as the Gulf Stream south of Nova Scotia, transports more than 150 million cubic meters per second, and typical transports for the smaller deep western boundary currents are 10 to 20 million cubic meters per second. Various dense overflows from marginal seas such as the Mediterranean are even smaller, 1 to 3 million cubic meters per second. For comparison, the sum of all the rivers flowing into the Atlantic is about 0.6 million cubic meters per second. The Amazon contributes about a third of that total, while the Mississippi River, whose rampages plagued the midwest last summer, accounts for only about 0.02 million cubic meters per second, roughly one ten-thousandth of the Gulf Stream's transport!

You can check your plottings with this map of the plotted buoy data.



The currents you have plotted in this exercise are all part of the North Pacific gyre, a clockwise-moving current that redistributes heat in the North Pacific.

What is the name of the current that moves water past the coast of California?

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Does it carry warm or cold water past the coast of California?

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What force or forces drive this current and how?

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