TRACK A YOTO DRIFTER

For many years scientists have used ocean drifters to track currents and learn about the ocean. Modern technology now allows us to use satellite communications to relay the position of these drifters and track them in almost real time. And through the global network provided by the internet, you too can have access to this exciting and important data. Do you know where ocean currents flow? What if an oil spill occurred in the Caribbean Sea, would Florida beaches be at risk from floating oil? Can drifter data be used to predict where icebergs are to prevent ships from hitting them? Do ocean currents transport heat as well as water, and does this play a role in our climate and weather? What role do currents play in the world's fisheries? To answer these and other exciting questions about the ocean, track a YOTO drifter. Follow the simple activity directions to learn how to plot drifter positions on a chart, draw drifter tracks, and calculate their speed and direction of movement. Then see if you can answer some of the questions given at the end of the activity.

Materials needed for track-a-drifter activity:
Activity text with sample drifter data, a ruler with mm/cm scale, pencil, calculator and YOTO Drifter Tracking Chart (download a page size version from the website, order one by fax at 303-202-4693, or call 1-800-USA-MAPS for a poster size version at and ask for the YOTO Drifter Tracking Chart, USGS publication # TBA).

1. LEARNING HOW TO USE LATITUDE AND LONGITUDE TO PLOT DRIFTER POSITIONS ON A CHART.

Where are you???????

Before you can plot drifter positions on a chart, it is crucial to understand the concept of location as a function of latitude and longitude. A latitude or longitude is similar to an x or y coordinate on a graph or grid, except in this case the grid overlays the spherical Earth. Because the Earth is round, we use an angular distance, rather than a straight distance to measure from a point of origin (usually 0,0 on a graph). On the Earth, the origin or 0,0 point is the center point of the Earth (fig. 1). Where then on the Earth, would the distance from the origin in a north-south direction be zero? It is along the east-west circle at the equator, we call this zero latitude. Both latitude and longitude are measured in degrees, minutes and seconds. There are 360 degrees in a circle, 60 minutes in a degree and on a chart, 100 seconds in a minute. Latitude is measured as the angular distance in degrees north or south of the equator, the north and south pole are located at 90 degrees north and south latitudes respectively. East - West running circles on a globe which connect points of equal latitude are called parallels of latitude.

Where on the Earth is the east - west distance from the origin equal to zero? Along a circle that goes through and intersects at the poles, but which one? A long time ago it was decided that the zero circle would be at the line which passes through Greenwich, England. This is often called the Prime Meridian, or the zero longitude line. Longitude is measured as the angular distance east or west of the zero longitude line. North - South running circles which connect points of equal longitude are called longitudinal meridians.

On a flat grid or graph we define a location by an x and y coordinate. On the Earth's surface we can define a location by a latitude and a longitude. On figure 1, point p is located at 40 degrees north latitude and 60 degrees west longitude.

On a graph we can measure or calculate the distance between two points, the same is true on the Earth's surface, using the latitude and longitude system. On the Earth's surface, 1 degree of latitude equals 111 km or 60 nautical miles. Longitude is a bit more complicated because the distance between meridians decreases to zero at the poles. However, at the equator, 1 degree of longitude also equals 111 km or 60 nautical miles.

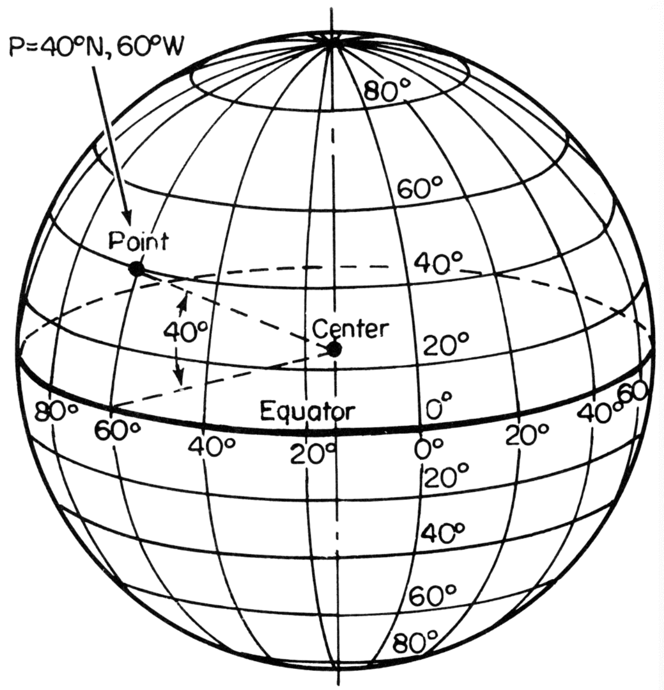


Figure 1: Diagram of latitude, longitude grid on a spherical Earth (After Charton, 1988).

IS IT A MAP OR A CHART?????

Should you bring a map with you on a boat or a chart? Is there a difference? We tend to think of maps for use on land, to help find your way around when driving, hiking or just looking for a neat location (link to geographic). A chart is used to desribe areas that are mainly overlain by water. So if you were going out on a boat and wanted to avoid hitting a reef, you would want to bring along a good chart of the area. Maps and charts are a bit inexact because they take a 3-dimensional object, the surface of the Earth, and display it in a 2-dimensional picture. However, it is a lot more convienent to carry a map or chart in your pocket than a whole globe!

Practice your skills using latitude and longitude on the following problems.

A. Listed below are pairs of latutude and longitude, can you find these locations on the YOTO Drifter Tracking Chart.?

Latitude	**Longitude**	**Where are you?**
26°N	80°W	
15°N	90°W	
42°30’N	71°W	

B. Listed below are some places on the tracking chart, use latitude and longitude to describe their location.

Place	**Latitude**	**Longitude**
New Orleans, Lousiana		
The island of Martinique		
Key West, Florida		

2. PLOTTING DRIFTER POSITIONS AND DRAWING TRACKS
Before using real-time YOTO data, practice with data from drifters used in the past.

A. Example data from two drifters are given below. Split into 2 groups and plot these positions using latitudes and longitudes on the YOTO tracking chart provided (page-size charts may be downloaded directly from the website or ordered via fax from 303-202-4693 and a poster-size chart for the classroom can be obtained by calling 1-800-USA-MAPS and requesting publication # TBA). Each position should be plotted by a dot or pin (in the poster); if possible, label the date next to each position.

Example Drifter Data

Drifter #1

Date	Latitude (°N)	Longitude (°W)	Time Interval (days)	Distance (nm)	Speed (mph)	Direction
8-25-96	15°32’00”	-74°49’00”	0			
8-28-96	14°40’00”	-75°48’00”	3			
9-2-96	14°14’00”	-76°45’00”	3			
9-5-96	14°07’00”	-77°50’00”	3			
9-8-96	15°12’00”	-79°10’00”	3			
9-11-96	16°44’00”	-80°04’00”	3			
9-14-96	17°49’00”	-81°03’00”	3			
9-17-96	18°53’00”	-82°01’00”	3			
9-20-96	19°40’00”	-82°47’00”	3			
9-23-96	20°02’00”	-82°58’00”	3			

Drifter #2

Date	Latitude (°N)	Longitude (°W)	Time Interval (days)	Distance (nm)	Speed (mph)	Direction
10-4-96	28°12’00”	-80°00’00”	0			
10-7-96	30°20’00”	-80°02’00”	3			
10-11-96	30°51’00”	-79°49’00”	4			
10-14-96	32°18’00”	-77°55’00”	3			
10-17-96	32°23’00”	-78°01’00”	3			
10-20-96	33°01’00”	-77°06’00”	3			
10-23-96	33°18’00”	-77°03’00”	3			
10-26-96	35°17’00”	-74°53’00”	3			
10-29-96	37°54’00”	-69°54’12”	3			
11-1-96	37°00’00”	-67°39’96”	3			

After plotting each position, connect the points. This is a **drifter track.**
Have the two groups plot their positions and tracks on the poster size chart.
Are they the same or different? Go on to explore why the tracks are different by learning how to calculate drifter speed and direction.

3. CALCULATING DRIFTER SPEED AND DIRECTION

Speed is a measure of how fast an object (including people) moves across a given distance. To calculate speed we take the distance covered and divide by the time it took to cross that distance:

Speed (m/s) = Distance (m) ÷ Time (s)

The units used to describe speed can vary. For instance, if you are calculating the speed of a train, you may want to use mph (miles per hour) or kph (kilometers per hour). However, if you are tracking the path of a snail you may want to use cm/h or inches/h.

Practice calculating speed using different units for the examples given below.

Object	Distance	Time	Speed
Airplane	700 miles	2 hours	
Snail	1.2 cm	1.5 hours	
Whale	25 nm*	5 hours	
Cheetah	24 miles (38 km)	15 minutes (.25 hours)	

* nautical miles

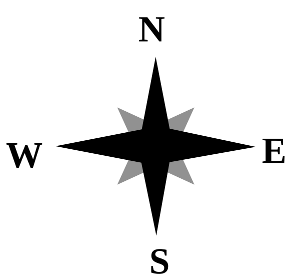
Sometimes we use an arrow to represent speed, with the size of the arrow being proportional to the speed. If 1 cm = 1 mph, then the Airplanes speed could be represented by an arrow that is 350 cm long. Yikes! that is a long arrow, in this case it would be better to use 1 cm = 35 mph and our arrow would be only 10 cm long.
If we use 1 cm = 1mph, then the snails arrow would only be 0.8 cm long, that is a pretty short arrow. Using 1 cm = 10 mph, draw below the arrows which would represent the speeds of the whale and cheetah.

Whale	

Cheetah	

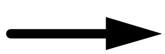
Speed describes how fast or slow an object moves, but it does not tell us anything about the direction of movement. If we combine the speed and direction of an object, it is called velocity. Velocity can be shown using a vector (an arrow which shows direction and speed).

On maps and charts there is usually some sort of compass rose which shows direction on the map, below is an example:



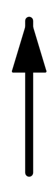
N = North, S = South, W = West, E = East

If a direction is between 2 of the major directions (N,S,E and W), then the directions are combined. An arrow pointing to a direction between North and East, would be pointing Northeast (NE). What direction are the arrows below pointing, write it below each arrow.

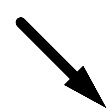


East

Example



a.



b.

For each of the arrows below, measure its length and using a scale of 1 cm = 10 mph, determine what speed it represents and name the direction it is pointing (this is its velocity).

a West (20 mph)

b.

c.

Draw arrows which represent the speed and direction for the following velocities.

a. 20 mph, south

b. 30 mph, southwest

Now go back to the data tables for Drifters 1 and 2. In the spaces provided, measure or calculate the distance betwen drifter locations, calculate the drifters speed and for each time interval name the direction it is traveling on the chart. On the chart provided there is a scale to use to measure the distance between each drifter location and a compass rose to judge its direction of movement. On the drifter tracking chart, 1 cm = approximately 125 nm.

4. AVERAGING AND DRIFTER TRACKS

When analyzing Drifter tracks, it is very important to understand the concept of averaging and how averaging will affect your results. You have just calculated the speed of the Drifter over a set of 3 day intervals, each speed is therefore a 3-day average. If the satellite got jammed for 2 days, and we only got a position once over a 5 day period and calculated speed over that time, it would be a 5-day average.

Because water movement in the ocean is not necessarily a steady process (having constant speed or direction), the length of time we use in averaging can produce very different results. In the table below recalculate Drifter 1 and 2 speeds based on the given time intervals. To calculate distance, be sure to measure between the correct dates.

Drifter #1

Date	Latitude	Longitude	Time	Distance	Speed	Direction

	(°N)	(°W)	Interval (days)	(nm)	(mph)	
8-25-96	15°32'00"	-74°49'00"	0			
9-2-96	14°14'00"	-76°45'00"	6			
9-11-96	16°44'00"	-80°04'00"	9			

Drifter#2

Date	Latitude (°N)	Longitude (°W)	Time Interval (days)	Distance (nm)	Speed (mph)	Direction
10-4-96	28°12'00"	-80°00'00"	0			
10-11-96	30°51'00"	-79°49'00"	7			
10-26-96	35°17'00"	-74°53'00"	15			

Are your results different from the first time you calculated speed and direction for these Drifters ? Why?

ANALYSIS OF RESULTS

1. These Drifters are tracking ocean currents. What is the general location of these currents and what is the main direction they are moving? Is the direction of daily drift different from the direction over a longer time scale ?

2. Do both Drifters behave the same or differently? What might make the currents (drifters) speed up, slow down or change direction?

3. Did the number of days used to calculate the speed and direction make a big difference?

4. Do you think you could predict the position of a Drifter in the future, for instance 3 days after your last position plotted ?

5. Give one example of why it is important to understand how ocean currents flow.

REAL TIME YOTO DRIFTER DATA

Now that you are an expert at plotting ocean Drifters and their tracks, click into the YOTO Drifter data or tracks to obtain data from drifters deployed in 1998. Plot their positions, calculate their speed, direction and try to predict where they are going each day or week. Learn at the same time as real scientists where ocean currents are flowing, and how sea surface temperatures are changing.

YOTO Drifter Questions

1. These drifters are tracking ocean currents. What is the general location of these currents and what is the main direction they are moving? Is the direction of daily drift different from the direction over a longer time scale ?

2. Do the number of days used to calculate the speed and direction make a big difference?

3. Go back to your chart and record the temperature next to each point. Do you see any changes in temperature along the Drifter tracks? What could cause temperature at the sea surface to change?

What role do sea surface temperatures play in climate and weather patterns?

4. Many organisms in the sea have young that begin life as small floating creatures, called plankton. Even those organisms who in their adult forms are strong swimmers or live on the bottom, may begin as plankton and drift with the ocean currents. Understanding ocean currents is therefore very important to our ability to assess the population size, location, and breeding grounds in numerous marine species. For instance, the spiny lobster, an important species in reef environments and a commercial fishery, begins its life as a small, flattened skelton-like creature, known as a phyllosome. As it develops, it can drift for months in the ocean currents. Once it becomes a juvenile, looking much more like the adult version; it settles to the sea floor and begins its journey into adulthood. In South Florida spiny lobster are commercially fished in some areas and protected in others, like the Florida Keys National Marine Sanctuary. Scientists are studying currents in an attempt to determine where Florida lobsters originate, thereby providing answers to questions such as: is there a local source of lobster larvae and do circular currents which keep them within the area, or do larvae come from a distant upstream source somewhere in the Caribbean ?

Using data from YOTO Drifters, you might be able to help answer this important question.
If a lobster were to spawn just south of Jamaica in the Caribbean Sea, and small phyllosomes began their journey as plankton, where would they drift? In three months where would the closest land and reef habitat be on which they might settle ?

5. An oil tanker in the Gulf of Mexico collides with a pleasure yacht just north of the western tip of Cuba in the Gulf of Mexico. If oil starts seeping from the tanker where would the ocean currents carry it? If the oil cannot be cleaned up while at sea or a big storm makes it impossible to contain the spill, use Drifter data to predict which coastal communities should make preparations to prevent damage to their local environment.

6. Scientists use data from satellites to obtain a view of the oceans which would otherwise be impossible. With remotely sensed data (satellite imagery), we can see large sections of the ocean at one time. But how do we know that these images are accurate? Scientists do something called ground-truthing. Ground-truthing is when ocean data are collected in the same time and location as the image. Drifter data can be used to ground-truth satellite images of sea surface temperature and ocean color. Look at YOTO Drifter temperature data and compare these results to the images of sea surface temperature provided. Would the date of comparison make a difference?