TRACK A YOTO DRIFTER
TEACHERS KEY

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

A. Listed below are pairs of latitude and longitude, can you find these locations on the <u>YOTO Drifter Tracking Chart.</u>

Latitude	**Longitude**	**Where are you?**
26°N	80°W	**Miami, FL**
15°N	90°W	**Guatemala**
42°20’N	71°W	**Boston, MA**

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

Place	**Latitude**	**Longitude**
New Orleans, Louisiana	**30°N**	**90°W**
The island of Martinique	**15°N**	**61°W**
Key West, Florida	**24°30’ N**	**81°50’W**

2. PLOTTING DRIFTER POSITIONS AND DRAWING TRACKS

Before using real-time YOTO data, practice with data from drifters used in the past.

Drifter #1 - **Distance can be measured directly on tracking chart where 1 cm = roughly 150 nm (in this case the answers will probably be ± 20 the answers given below) or they can be calculated using 1 degree of latitude or longitude (as an estimate here) = 60 nm.**

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	**81**	**1**	**SW**
9-2-96	14°14’00”	-76°45’00”	3	**60**	**0.83**	**W**
9-5-96	14°07’00”	-77°50’00”	3	**63**	**0.88**	**W**
9-8-96	15°12’00”	-79°10’00”	3	**115**	**1.6**	**NW**
9-11-96	16°44’00”	-80°04’00”	3	**98**	**1.4**	**NW**
9-14-96	17°49’00”	-81°03’00”	3	**86**	**1.2**	**NW**
9-17-96	18°53’00”	-82°01’00”	3	**86**	**1.2**	**NW**
9-20-96	19°40’00”	-82°47’00”	3	**59**	**0.82**	**NW**
9-23-96	20°02’00”	-82°58’00”	3	**38**	**0.53**	**NW**

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	**125**	**1.7**	**N**
10-11-96	30°51’00”	-79°49’00”	4	**36**	**0.38**	**NE**
10-14-96	32°18’00”	-77°55’00”	3	**154**	**2.1**	**NE**
10-17-96	32°23’00”	-78°01’00”	3	**28**	**0.39**	**NW**
10-20-96	33°01’00”	-77°06’00”	3	**74**	**1.03**	**NE**
10-23-96	33°18’00”	-77°03’00”	3	**11**	**0.15**	**NE**
10-26-96	35°17’00”	-74°53’00”	3	**192**	**2.67**	**NE**
10-29-96	37°54’00”	-69°54’00”	3	**331**	**4.6**	**NE**
11-1-96	37°00’00”	-67°39’00”	3	**139**	**1.93**	**SE**

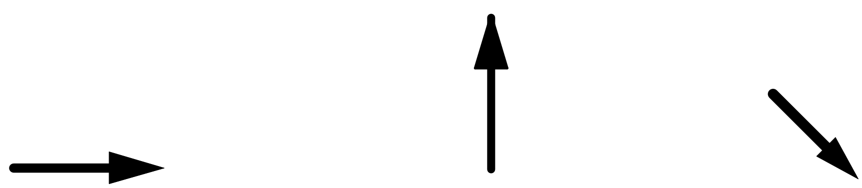
3. CALCULATING DRIFTER SPEED AND DIRECTION

Practice calculating speed for the examples given below.

Object	Distance	Time	Speed
Airplane	700 miles	2 hours	**350 mph**
Snail	1.2 cm	1.5 hours	**0.8 cm/h (.0005 mph)**
Whale	25 nm	5 hours	**5 mph**
Cheetah	24 nm	15 minutes (.25 hours)	**96 mph**

Whale	**Arrow should be 0.5 cm long**
Cheetah	**Arrow should be 9.6 cm long**

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.



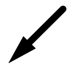
East

a. **North**

b. **Southeast**

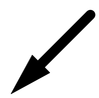
Example

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. **Southwest (10 mph)** c. **South (23 mph)**

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



2 cm long arrow **3 cm long arrow**

a. 20 mph, south b. 30 mph, southwest

4. AVERAGING AND DRIFTER TRACKS

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			
9-2-96	14°14’00”	-76°45’00”	6	**137**	**0.95**	**SW**
9-11-96	16°44’00”	-80°04’00”	9	**256**	**1.19**	**NW**

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	**147**	**0.86**	**NE**
10-26-96	35°17’00”	-74°53’00”	15	**298**	**0.83**	**NE**

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 ?

One drifter is in the Caribbean Sea and the other is in the North Atlantic Ocean just off the southeast U.S. coast (it is in the Gulf Stream). The main current in the Caribbean Sea flows to the west, becoming more northwesterly at the western side of the Sea. In the southeastern U.S., the Gulf Stream flows principally north, becoming more northeasterly near North Carolina.

The direction of daily drift may be different from that measured over longer time periods. Small scale features such as eddies (circular currents) or meanders (bends in a current stream) may effect the relatively short-term drifter tracks, but their long term drift is typically in the direction of the main or large-scale current system in the region. The large scale current systems of the ocean are a function of factors such as the distribution of land masses, climate, ocean bathymetry, water density, global wind patterns, and the coriolis force.

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

The drifters do not behave the same because they are in different ocean regions within different current systems. Regional ocean currents are strongly dependent on local conditions such as the pattern of larger-scale flow, bathymetry (depth), morphology of the region (configuration of land masses), and wind. Wind at the surface can make drifters speed up or slow down by intensifying currents (if the wind is in the same direction as water movement) or reducing currents (when the wind is in the opposite direction of water movement). Small eddies, meanders or changes in depth can also make currents change speed or direction.

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

Yes, the speed and direction of the drifter changes depending on how many days are used in averaging. Using a greater number of days to calculate your average means that you are determining longer term flows (typically larger-scale currents). Small-scale features can be recognized using smaller intervals for averaging of drifter positions.

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

Sometimes

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

Transport of materials within the sea, such as larvae, sediment, pollutants, and heat (climate), ship travel, etc. - see website

REAL TIME YOTO DRIFTER DATA

Now that you are an expert at plotting ocean Drifters and their tracks, click into the YOTO Drifter position and tracks or data to obtain information on 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 ?

See answer #1 above

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

Yes, same as #2 above

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?

Yes and No, sometimes the temperature changes along the drifter tracks or between drifter positions. Sea surface temperatures typically decrease from the Caribbean Sea and tropical Atlantic northward. On a global scale, on the western side of an ocean basin surface currents tend to transport warm water from southerly latitudes

northward. As surface water flows northward it is cooled by the surrounding air, which becomes cooler as you move north toward higher latitudes. Sea surface temperatures can also be decreased by wind mixing or through the addition of cooler river water or other colder ocean waters.

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

The ocean plays a very important role in the Earth's climate and weather patterns as dramatically illustrated by the 1997 - 1998 El Nino. Ocean water has a high heat capacity, thus it tends to store heat. In areas of warm sea surface temperatures, high evaporation and convection often produce thunderstorms and rain over nearby land masses. Warm currents like the Gulf Stream warm nearby coastal regions that otherwise would be relatively cool and dry. Warm ocean waters are also an important source of energy for developing hurricanes, this is one reason why during the summer months, the tropical Atlantic ocean is a breeding ground for hurricanes. When hurricanes move over cool water or land, they tend to decrease in strength.

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 skeleton-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, called eddies, 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 ?

The answer to this depends on whether the larvae get caught in small scale eddies or meanders, drift landward, or remain in the flow of large scale current systems. The phyllosome could end up settling near Jamaica or as far away as the Florida Keys.

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.

The answer to this is dependent on when the spill occurs as current patterns in the Gulf of Mexico change throughout the year. Base the answer on the latest drifter patterns and discuss previous tracks and possibilities.

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 at the same time and in the same 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 at the sites provided. Would the date of comparison make a difference?

Sometimes, 1) it depends on where you are making comparisons, 2) slight seasonal changes do occur in large scale sea surface temperatures, and 3) eddies, meanders, river inflows, and storms could effect the data.

7. Predictability, Choose 1 or 2 Drifters and try to predict where they will be 1 week later. Compare your prediction with the real Drifter position, were you right ? If not why?