

## NUMB3RS Activity: Riding the Waves Episode: "Undercurrents"

**Topic:** Vector fields

**Grade Level:** 9 - 12

**Objective:** Students will use the TI-Navigator™ system to explore vector fields and make predictions.

**Time:** 25 minutes

**Materials:** TI-83/84 Plus graphing calculators, TI-Navigator system, and the activity settings files *VectorFieldA.act*, *VectorFieldB.act*, and *VectorFieldC.act*.

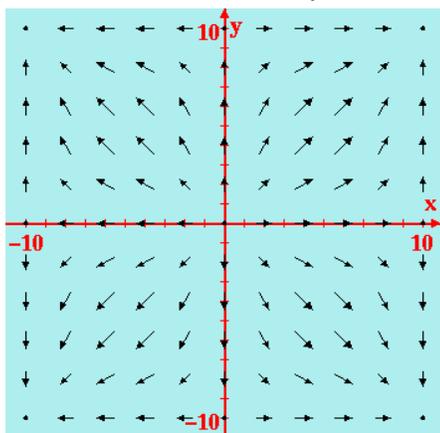
To download these files, go to <http://education.ti.com/exchange> and search for "6926."

### Introduction

In "Undercurrents," the body of a dead woman washes up on the Los Angeles shore. To determine where the body entered the water, Charlie attempts to trace the path the body traveled using oceanic fluid dynamics and current flow equations. Charlie analyzes the current flow equations by dropping a large number of small buoys (known in fluid dynamics as "tracers") into the water and mapping how they approach land. Through this process, he is able to determine the vector fields that tell him where the body most likely originated. This activity will use the TI-Navigator system to explore vector fields and show how they can be used to make predictions.

### Part I: Vector Fields and Drains

- Students should work individually during this part of the activity.
  - Launch TI-Navigator on the computer and press **Begin Class** to start the session.
  - Have students log into NavNet on their calculators.
- Load the *VectorFieldA.act* activity settings file into Activity Center. The figure below will be shown in Activity Center. This also sets up Activity Center so that students can mark one point.



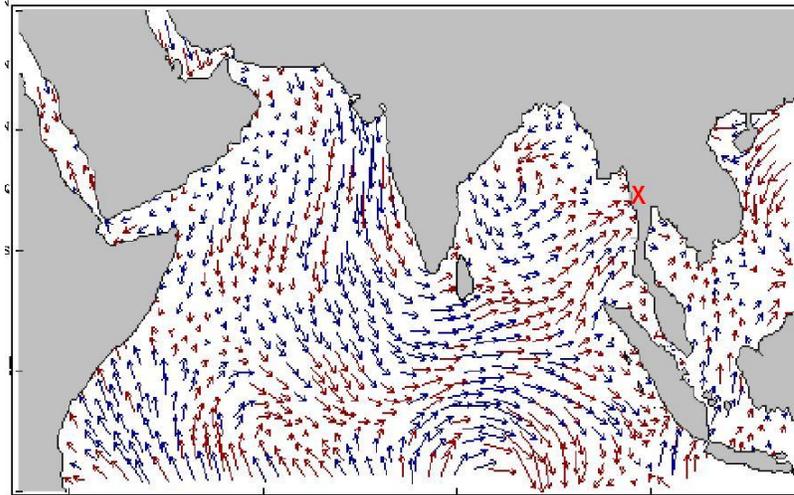
[Source: <http://www.ee.byu.edu/em/embook/ch3/demo3.13.html>]

- Press **Start Activity**. Tell students that the figure is a vector field, and it represents the movement of water. If a soap bubble was located in the water at  $(3, -1)$  where would it leave the vector field?

- c. Have students start with their cursor on the point  $(3, -1)$ , and follow the path of the soap bubble with their cursor as it leaves the vector field. Have students **Mark** the point where they think the soap bubble leaves the vector field, and **Send** it to Activity Center.
- d. Press  and discuss students' answers.
- e. Now, repeat this process with other points in the other quadrants of the graph. Go to **Edit > Clear Activity Data** and click **Yes**. Press  and repeat step 2c.
- f. Press .

### **Part II: Vector Fields and Ocean Currents**

3. a. Students should work in pairs during this part of the activity.
- b. Load the **VectorFieldB.act** activity settings file into Activity Center. The following map will be shown in Activity Center.



[Source: Adapted from <http://www.coaps.fsu.edu/nscat/images/nndn199630821.gif>]

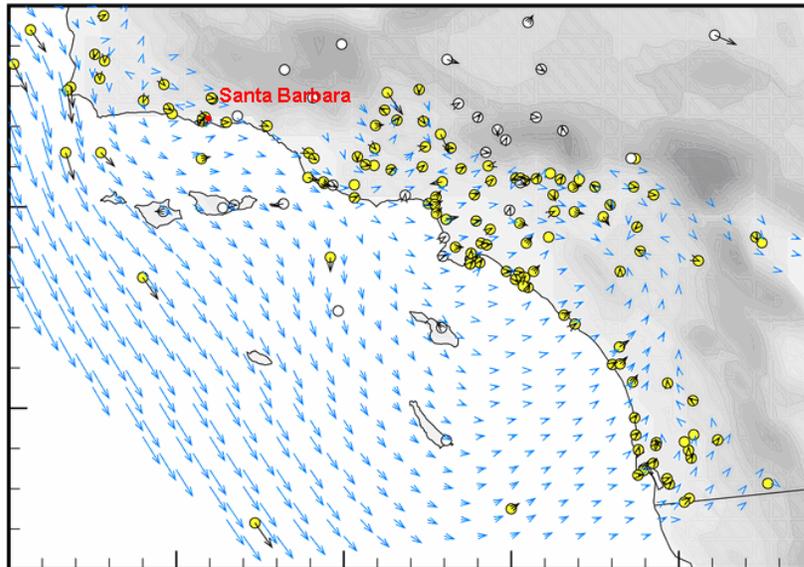
This is a map of the Indian Ocean. Land is shown by gray regions and water is shown by white regions. The arrows describe the directions of the water currents. Suppose that a bottle with a message in it washed ashore at the red X. In this activity, students will try to determine where the bottle might have been dropped in the ocean. Activity Center is set up so that each pair of students can submit up to 10 points.

- c. Go to **Edit > Clear Activity Data** and click **Yes**. Press , and click the 'List - Graph' tab in Activity Center.
- d. Have each pair of students start with their cursor *on the red X*. Then have students **Mark** a path of up to 10 points that leads to the location where they believe the bottle was dropped in the ocean. After students have marked all of their points, have students **Plot** them.
- e. When all pairs of students have plotted their paths, press . From the 'List - Graph' tab, click on **Display Name** to sort the data. You can select the students' names shown in bold to show the various starting points for the bottle chosen by each pair of students. You can also sort the data by students' names, and display each student's path separately. (Note: It is not recommended to select all of the points and show all possible paths at the same time.) Discuss with students why some of their paths may be similar or different. What other paths and starting points are possible?

*The goal of this activity is to give your students a short and simple snapshot into a very extensive math topic. TI and NCTM encourage you and your students to learn more about this topic using the extensions provided below and through your own independent research.*

## Extensions

- The same concept of predicting the path of an object can be applied to air and wind currents. Load the **VectorFieldC.act** activity settings file into Activity Center. The following map will be shown in Activity Center.



[Source: Adapted from <http://www.nawcwpns.navy.mil/~weather/mugu/mesodata/analysis.html>]

This is a map of the wind currents in the Southern Coast of California. Land is shown by gray regions and water is shown by white regions. The arrows describe the directions of the wind currents (and the yellow circles represent reporting stations). Suppose that a balloon was let into the air in Santa Barbara. Repeat Part II of the activity using this map. Have students start their cursors at Santa Barbara and **Mark** a path they think the balloon will follow.

- Additional NUMB3RS activities for "Undercurrents" can be downloaded for free from the Web sites listed below.

[http://www.cbs.com/primetime/numb3rs/ti/activities/Act1\\_WheresTheSource\\_Undercurrents\\_final.pdf](http://www.cbs.com/primetime/numb3rs/ti/activities/Act1_WheresTheSource_Undercurrents_final.pdf)

[http://www.cbs.com/primetime/numb3rs/ti/activities/Act2\\_IChing\\_Undrecurrents\\_final.pdf](http://www.cbs.com/primetime/numb3rs/ti/activities/Act2_IChing_Undrecurrents_final.pdf)

[http://www.cbs.com/primetime/numb3rs/ti/activities/Act3\\_NarrowingTheSearch\\_Undercurrents\\_final.pdf](http://www.cbs.com/primetime/numb3rs/ti/activities/Act3_NarrowingTheSearch_Undercurrents_final.pdf)

- If you would like to learn more about TI-Navigator, visit <http://education.ti.com/navigator>.