

## Sampling Strategy Challenge: Get My Drift!

Below is an interactive “Sampling Strategy Challenge” activity to help you to understand the process behind planning an oceanographic cruise. You will become familiar with the tools scientists can use (both before and during the cruise) to more wisely choose the drop-off (deployment) locations for each instrument while maximizing data coverage for the SPURS sampling site. Specifically, you will use the JPL Trajectory Tracking tool to walk through this process and become familiar with the challenges scientists face in conducting research on the open ocean. This tool uses a sophisticated computer model that allows scientists to run tracking simulations to determine the best areas to drop off (deploy) equipment in order to accomplish their science goals on SPURS cruises.

*Note: This tool only uses water currents and circulation data from August 1, 2011, until October 31, 2011, based on the assumption that scientists have made that circulation patterns would be similar from year-to-year in this area.*

The goals of the following activity are to:

- Introduce a mathematical model,
- Illustrate how one example model works,
- Demonstrate how models can be used in real-life science research, and,
- Give insight into the process of planning an oceanographic cruise.

As you go through the exercises, answer the **bolded questions (Q1, Q2, etc.)** in each section in the space provided below the question.

### **Activity Introduction:**

- 1.) Go to the JPL Trajectory Tracking Tool website (<http://ourocean3.jpl.nasa.gov/SPURS/drifters.jsp>) to get the ‘lay of the land’ (ocean?!). You will see the Atlantic Ocean and the SPURS sampling site (red box).
- 2.) Use the “+” button in the top left-hand corner to zoom in until the box is large enough to fill most of the viewing window.

## Part 1: What is a model and how does it work?

Goal: This part of the Challenge will introduce you to a model that simulates movements of oceanographic equipment in a specific area, getting you with how some models work, the different types of data they use and the outputs they deliver.

- 1.) Select the “Single Drop Mode” option in the JPL Trajectory Tracking Tool controls in the top right corner of the window.
- 2.) Move the cursor into the red box and click. Each click will place a drifter to be tracked (colored balloon). Place a total of eight drifters within the SPURS sampling site.
- 3.) Record the longitude (“lon”; e.g., 45 degrees W) and latitude (“lat”; e.g., 30 degrees N) coordinates of each drifter from “Drifter List” box on the right – you will need this information for the following steps.
  - a. *Digital shortcut: With your mouse, highlight all the info in the Drifter List box, and then copy/paste the info into a separate place on your computer, such as a Word or Notes file.*

Longitude (lon)	Latitude (lat)	Longitude (lon)	Latitude (lat)
1.		5.	
2.		6.	
3.		7.	
4.		8.	

- 4.) Click the “Compute and Plot” button underneath the map to run the model simulation.
- 5.) Take a “screen grab” image (use combinations of buttons: Mac = Command+Shift+4, PC = “PrtSc” button or “snipping tool”) of the model output for this drifter simulation and save it for the following steps. Alternatively, sketch the model results in the box below.



**Q1: Explain what the model output is showing.**

- 6.) Click on the “Clear” button below the map to reset the tool.
- 7.) Manually enter the same lon/lat coordinates in the Location window.

**Q2: Make a prediction about what you will see in this second output.**

- 8.) Click the “Compute and Plot” button underneath the map to run the model simulation.
- 9.) Take a “screen grab” image or sketch the second output in the box below:



- 10.) Compare the outputs of the first and second drifter track simulations.

**Q3: Are there differences between the outputs of the first and second drifter track simulations? Explain why or why not?**

- 11.) Clear the simulation.
- 12.) Place two drifters side-by-side at the far right side of the sampling area and run the simulation. Take a screen grab or sketch the output in the box below:



- 13.) Now place one drifter in the upper right corner of the box and another at the bottom right corner of the box and run the simulation. Take a screen grab or sketch the output in the box below:



**Q3: Do the side-by-side drifters go in the same path? Why or why not?**

**Q4: What oceanographic processes might be influencing drifter paths? Do they influence drifters the same in all area of the sampling site? Why or why not?**

**Q5: Define a model. Can you think of any models that we rely upon in our everyday lives?**

**Q6: Based on the results of your experiments” above, briefly explain how this model works and the types data you think it uses.**

## Part 2: How do scientists use models?

Goal: Now that we know a little more about how this model works and the data it's using, we want to explore how scientists use them as tools for planning a research cruise and in their experimental design. Scientists are exploring the salinity patterns in this area at different scales, so they need to maximize data for different regions of the sampling area.

- 1.) Using the cursor, determine and record the lon/lat coordinates for each corner of the SPURS sampling site (red box). Note: Coordinates are only shown in the "Location" box when your cursor is placed **within** the red box.
- 2.) Determine and record the lon/lat coordinates for the center of each side of the sampling site.
- 3.) Determine and record the lon/lat coordinate nearest the center of the entire SPURS sampling area ("SPURS center point"). When finished, you will have a total of nine lon/lat coordinates (four corner coordinates, four "boundary center point" coordinates and one "SPURS center point" coordinate).

Corner Longitude	Corner Latitude	Boundary Center Longitude	Boundary Center Latitude
1.		5.	
2.		6.	
3.		7.	
4.		8.	
Sampling Area Center Longitude	Sampling Area Center Latitude		
9.			

### Q1: Define longitude and latitude.

- 4.) Using the "Single Drop Mode" option, drop 12 drifters within the northwest (NW) quadrant (see white square at upper left in the figure below) of the SPURS sampling area. **Remember, you are trying to place the drifters so that they cover the most geographic space within the NW quadrant sampling area to maximize your data in that area.**

The screenshot shows a web-based interface for simulating drifters. On the left is a map with a red rectangular boundary and a white square in the top-left corner. On the right is a control panel with the following elements:

- Mode selection:  Single Drop Mode,  Multiple Drop Mode
- Instruction: (Click on the map or type in a lat and lon to add a drifter)
- Drifter List: An empty rectangular box.
- Instruction: (Click on the map or type in a lat and lon to add a drifter)
- Location input: Lon:  Lat:  Add Drifter
- Start Time (GMT): 2011-08-01
- End Time (GMT): 2011-10-31
- Map controls: Satellite  Normal
- Buttons: Compute & Plot, Clear, Download Trajectory File

- 5.) Take a screen grab (or sketch it in the box below) of the **starting arrangement of drifters**.



- 6.) Run the simulation and take a screen grab of the output and save it or sketch it in the box below.



- 7.) Clear this run and repeat steps 4-6 with a new arrangement of drifters in the NW quadrant. Take a screen grab or sketch the starting arrangements and final outputs below.



**Starting Arrangement**



**Final Output**

**Q2: Did one arrangement of drifters work better than the other to sample the NW quadrant? Explain why this might be.**



- 8.) Clear this run.
- 9.) Select the “Multiple Drop Mode” option.
- 10.) Within the “Number of Drifters” control, put four in the X dimension and three in the Y dimension. This is called a “4-by-3 arrangement”.
- 11.) To create a sampling box, place the cursor at a desired spot within the sampling area and click once to get your initial corner coordinate (a red “push pin” icon will appear). Drag the box out to create the total release area for your drifters.

**Q3: What is the difference between the “Single” and “Multiple” drop modes? Do you think this will affect sampling ability?**

- 12.) Run the simulation and save a screen grab of the output or sketch it below:



- 13.) Repeat the simulation again in the NW quadrant using the “Multiple Drop Mode” option with a 5-by-5 arrangement of drifters this time. Save a screen grab of the output or sketch it below:



**Q4: Did the drifters sample the NW quadrant better in a 4-by-3 arrangement or in a 5-by-5 arrangement? Explain your answer.**

**Q5: How can the number of drifters deployed change the scale at which you might be gathering data?**

**Q6: Compare and contrast the sampling ability of the “Single Drop” and “Multiple Drop” options. What are the pros and cons of each option?**

**Q7: Can you think of a reason you would use one option over the other?**

### Part 3: Plan a Cruise!!

Goal: In this section you need to think like a scientist to plan a sampling strategy to maximize data gathering in specific areas of SPURS sampling site. You also have to think about how much a trip like this might cost. For this exercise, it costs \$100 to deploy one drifter and you have a budget of \$2000 for each sampling region (see a-d, below). You should be familiar with the model now and the different methods you can use to sample, so plan accordingly!!

- 1.) Use either the “Single Drop Mode” or the “Multiple Drop Mode” to maximize sampling in these regions:
  - a. The entire SPURS sampling area.
  - b. A 20 x 20-mile square around the Woods Hole Oceanographic Institution (WHOI) mooring in the middle of the sampling area. (This will require you to determine the distance between different lon/lat coordinates to find a 20 x 20-mile box. There are on-line converters or, if you’re up for a challenge, there is some good algebra behind the calculation, which you can also find on-line!).
  - c. The southwest (SW) quadrant.
  - d. The southernmost part of the sampling area: the region covering the width of the red box *below* 22 degrees north latitude.

*Note: Make sure to have a few pages of sketch boxes (last page) to use to compare your outputs if you are not using screen grabs. Make sure to label them accordingly so you don’t get them mixed up!*

**Q1: Which arrangement of drifters best samples each of the above regions?**

- a.
- b.
- c.
- d.

**Q2: What are some of the challenges or limitations to using modeling tools in planning cruises or sampling strategies?**

**Q3: How does changing the size of your sampling area affect your ability to gather data? How does it change the information you gather about the oceanography an area?**

**Q4: What other types of considerations or challenges might scientists need to account for when planning a cruise or sampling strategy?**

