

## ***Data Scavenger Hunt: Investigating Water Temperature and Environmental Phenomena at NERR Reserves***

### **Overview**

Students begin their exploration of real-time environmental data in the form of a “scavenger hunt” using the NERR data portal to collect information on current air and water temperatures being recorded at NERRS across the coastal US. They graph and interpret these data and offer explanations for the change in temperatures as one moves further away from the equator, as well as offering explanations for the difference between water temperatures on the east vs. west coast. A deeper dive into the NERR data portal and the information available in the form of archived (i.e. previously collected) water quality and weather data is provided as they “seek and find” specific dates and parameters associated with environmental phenomena (e.g., solar eclipse, hurricanes). With this new knowledge of navigating archived data on the NERR data portal, students explore, collect and interpret larger datasets of water temperature at four NERRS Reserves located on the east and west coasts. Students may remember some of these locations from a previous activity (i.e. Mystery Locations) where they compared a year of air temperatures data at multiple NERRS. Using these data, students combine reasoning and conceptual knowledge to construct evidence-based explanations for climate patterns found in locations across the US. Other key benefits of this activity is that it demonstrates how to support preliminary exploration of large, complex and professionally-collected of datasets, use these data to foster conceptual understanding of environmental and climatic phenomena, and enhance data literacy.

### **Learning Objectives**

Students will be able to:

- Access and navigate the NERR data portal and collect real-time weather and water quality data;
- Describe, using evidence, how coastal water temperatures differ on east vs. west coasts of the US, and how water temperature changes with distance from the equator (i.e. latitude).
- Use the interactive map and CDMO graphing tool to generate graphs of water temperature at four reserves representing a broad geographic scope; and
- Build the basic skills that will allow students to navigate through online data portals and investigate data-based questions.

### **Grade Levels**

Middle and high school

## Materials Needed

### For the instructor

- Answer Key - Water Temperatures DataSearch

### For the class

- PowerPoint presentation
- Digital/data projector
- Whiteboard or flip chart paper and pens

### For Online Data Scavenger Hunt and Environmental Forensics Activity

#### For every student

- NERR Data Scavenger Hunt A or B version (See Preparation of Materials)

#### For pairs

- NERR Data Scavenger Hunt\_StudentData (Excel spreadsheet)

### For Archived Data Activity: Analyzing surface water data from different coastal Reserves

#### For every student

- 1 copy of Homework Handout: Water temperature data search

#### For groups of 3-4

- NERR Water Temperature Graphs (one for each group)
- Student Data Sheet for NERR Water Temperatures

## Preparation of Materials

1. **For Online Data Scavenger Hunt.** Decide which version of the Scavenger Hunt handout (A or B) you will use. Version A does not have the students collect latitude of each reserve and is suggested for middle school students or those with less experience graphing or exploring online data. Version B of the handout requires students to go a bit deeper into the data portal and collect latitude of each reserve. These data can help with more advanced interpretation of geographic differences in temperature data, as well as allow for more advanced data visualizations and analyses (e.g., regression of water temperature vs. latitude).
2. **For Environmental Forensics Activity.** Examples of “data events” are provided, but it may be beneficial for each educator to identify other locally-relevant or newsworthy events that are familiar to their students, or that rely on concepts and knowledge that have been covered previously (e.g., daily winds, daily rains, local flooding, king tides, storm events, etc).

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### 3. For Archived Data Activity: Analyzing surface water data from different coastal Reserves.

The data collection part of this activity can be done ahead of time as homework, or during class working in pairs (refer to Homework Handout: Water Temperature Data Search). The students will use the CDMO NERR Data Portal to generate graphs of water temperature throughout the year at four reserves located across the country. If completed as homework, students will bring in water temperature graphs to interpret in class during the following session (a copy of these graphs is also provided in case students can't print it out or don't bring a copy).

### 4. Duplicate Handouts

- a. For every student, 1 copy each,
  - i. NERR Data Scavenger Hunt A or B version
  - ii. Homework Handout: Water temperature data search
- b. For groups of 3-4, 1 copy each
  - i. NERR Water Temperature Graphs (one for each group)
  - ii. Student Data Sheet for NERR Water Temperatures
- c. For pairs, 1 copy each
  - i. NERR Data Scavenger Hunt\_StudentData (Excel spreadsheet)

## Session At a Glance

<b>A. Activity:</b> <i>Online Data Scavenger Hunt &amp; Environmental Forensics</i>	Students conduct an exploration of real-time environmental data in the form of a scavenger hunt on the NERR data portal where they search for specific water quality information. They then “seek and find” specific dates in NERR data to identify and offer explanations for specific environmental phenomena.	45 minutes
<b>B. Archived Data Activity:</b> <i>Analyzing surface water data from different coastal Reserves</i>	Students interpret water temperature data from coastal reserves collected for homework (or in class). They construct explanations for differences between Reserves and patterns they observe. Students compare two different data parameters (i.e. air and water temperature) and discuss the evidence collected to answer a question about the ocean as a heat reservoir..	50 minutes

## Session Details

**Educator Note:** *Some of the pros and challenges of using online data with secondary students include:*

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*Pros: Students can explore and work with data like scientists do; online datasets can support student-led inquiry when the students are able to choose what aspects of the data to use; students who are computer savvy who enjoy working online bring this skillset to the group investigation; students have great empowerment or ownership of the data if they access it themselves.*

*Challenges: Many students may find it difficult to navigate data portals as they are often built for scientists rather than general users; the large datasets can be overwhelming; there can be lots of natural variability in authentic data as the data has not been “cleaned” to remove the natural variability, making interpretation of patterns potentially difficult if you are not used to look at variation in data; the context of the data and how it were collected can sometimes be difficult to find an/or understand.*

### **A. Activity: Online Scavenger Hunt & Data Forensics**

#### **Online Scavenger Hunt**

- 1. Introduce Online Data Scavenger Hunt.** Tell students that they will work in pairs and conduct an exploration of real-time environmental data in the form of a scavenger hunt using the National Estuarine Research Reserve (NERR) data portal. Explain that they will begin by searching for basic data about the reserves and how these vary geographically using a version of the “NERR Data Scavenger Hunt” Handout. They will then conduct a “NERR data forensic” investigation by finding phenomena in the NERR data and using evidence and reasoning to come up with explanations. Goals of this activity are:
  - a. Have students become familiar with navigating the NERR Central Data Management Office (CDMO) web portal and collecting real-time data on current conditions,
  - b. Explore and interpret archived data from the NERR data portal that are associated with specific environmental events, and
  - c. Collect water temperature data from east and west coast reserves, plot temperature on a bar graph, and draw conclusions regarding water temperature and the effect of the adjacent ocean basin (i.e. Atlantic vs Pacific) and distance from equator (Ocean as a heat reservoir).
- 2. Turn and Talk: Students make predictions.** Have students turn to someone next to them and discuss their predictions about how they think water temperatures will change as one moves north along either coast or differ between east vs. west coasts. You may want to prompt them by asking if they have ever gone swimming or surfing in the Atlantic or Pacific ocean, or have other sources of evidence that would help with their predictions or claims. If students are unfamiliar with the concept of uneven heating of the planet, you may want to briefly review this concept, or

## ACLIPSE Climate & Data Literacy Activities

just let the data answer their questions. Ultimately you want to have students make specific claims that they can then test with real-time water quality data to gather evidence to support their claim.

3. **Record predictions.** Record the students' predictions (e.g. "Water will get colder as you go north." or "I think the Pacific ocean is colder"), on the board. Tell them that they will now be testing these predictions with data as evidence.
4. **Distribute handout and begin scavenger hunt.** Distribute a *Data Scavenger Hunt* handout (version A or B) to each student and have them work in pairs collecting water quality data at twelve different reserves from the east and west coasts. For each coast, the northern and southernmost have been provided already. Their task is to navigate through the NERR data portal and collect water and air temperatures. (Air temperatures are not used in this activity, but could be incorporated into advanced hypothesis testing and/or data analysis such as looking at correlations between air and water temperature across Reserves).
5. **Graphing data.** When pairs have completed the data collection for their scavenger hunt worksheets, tell them they can either begin graphing their data by hand at the bottom of the worksheet or using Excel. Note: If you are using Excel to graph data, use the *Data Scavenger Hunt Student Data* (excel spreadsheet) and populate the fields with air and water temperature to generate a graph of how these parameters change along a north-south gradient and how they differ between east and west coasts.
6. **Interpreting and Synthesizing data.** Use the *Three Levels of Engagement with Data* as you walk the students through interpreting and synthesizing the data using the graphs as evidence to test the claim(s) they proposed at the beginning of the session. Complete this activity by asking everyone if they are able to confirm (or reject) their predictions and what evidence they used to arrive at that conclusion.

### NERR Data Forensics Exploration

1. **Introduce NERR Data Forensics Exploration:** Describe to students that they will conduct a deeper dive into the NERR data portal and the information available in the form of archived (i.e. previously collected) water quality and weather data. They will be given specific dates and

## ACLIPSE Climate & Data Literacy Activities

parameters associated with environmental phenomena and then navigate to these datasets and visualizations. Using patterns in the data as evidence, they will engage in “environmental forensics” to come up with an explanation for the event or otherwise determine what natural phenomena has been captured by the data. (See chart below for examples of “Data Events”.)

**Educator Note:** *Examples of “Data Events” are provided below, but it may be beneficial for each educator to identify other locally-relevant or newsworthy events that are familiar to their students, or that rely on concepts and knowledge that have been covered previously (e.g., daily winds, daily rains, local flooding, king tides, storm events, etc).*

2. **Model initial investigation with entire class.** Tell students they will work through the initial investigation together in whole group. (See **Facilitation Note** below.) If students are using their own laptops and tablets, check in to make sure they are able to keep up by asking, “Can everyone see the same thing that I have projected on the screen?”. If not, assist each student or encourage others in the class to assist or offer suggestions. Use prompting questions to provide purpose to their exploration (also called hypothesis-driven exploration). For example:
  - a. once they have plotted PAR associated with the solar eclipse, ask them if they remember what happened to the air temperature during the eclipse? If they didn’t observe the eclipse directly, ask them what they think would happen to air temperature?
  - b. Then encourage them to test their hypotheses or confirm their observations by plotting air temperature data.

**Facilitation Note:** *Facilitation of this activity may depend on the time available, or the level of support students need navigating the NERR data portal and interpreting data. It may be helpful to conduct an initial investigation. Options include:*

- a. *provide the complete list of “data events” to each student and have them work in pairs finding and interpreting the data and coming up with explanations,*
- b. *assign pairs of students one event each and have them report out their data and explanation to the rest when they are finished, or*
- c. *navigate to the data using a laptop and projector and work through sense making and explanations with the entire class. Begin by working through the “Three Levels of Engagement” from the data literacy framework, and facilitate a discussion by encouraging observations, novel ideas, and alternative explanations.*

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### Examples of Data Events to use with Environmental Forensics

<u>Date(s)</u>	<u>NERR Reserve</u>	<u>Station</u>	<u>Parameters</u>	<u>Event/Phenomena</u>
8/21/17	Padilla Bay South Slough San Francisco Bay Tijuana River	Any MET station	Total solar radiation (PAR), air temperature	2017 solar eclipse on the west coast, with intensity higher near path of totality in Oregon.
8/20/17 - 8/21/17	Grand Bay Weeks Bay GTM Jobos Bay	Any MET station	Total solar radiation (PAR)	2017 solar eclipse on the east coast.
9/7/17 - 9/11/17	GTM NERR	Pellicer Creek MET Station	Barometric pressure, max wind speed	Hurricane Irma as it passes through northern Florida and GTM
9/7/13 - 9/13/17	North Inlet Winyah Bay	Oyster Landing MET station	Barometric pressure, max wind speed	Hurricane Irma passing through coastal South Carolina.
9/7/13 - 9/13/17	North Inlet Winyah Bay	Oyster Landing WQ station	salinity, water depth	Storm surge and freshwater input from Hurricane Irma
8/24/17- 8/25/17	Mission Aransas	MET station	barometric pressure, max wind speed	Hurricane Harvey. Data were recorded until MET station failed.
6/1/18 - 6/4/18	Kachemak Bay	Homer MET station	solar radiation, wind direction	Daily winds associated with uneven heating and cooling of the ocean and mountains

3. **Homework:** For homework (or in class during the next session), students will use the CDMO NERR Data Portal to generate graphs of water temperature throughout the year at four reserves located across the country (Homework Handout: Water temperature data search). Students will bring in water temperature graphs to interpret in class during the next session (a copy of these graphs (*NERR Water Temperature Graphs*) is also provided in case your students can't print it out or don't bring a copy). Goals of the homework activity are:
  - a. Use the interactive map and CDMO graphing tool to generate graphs of water temperature at four reserves representing a broad geographic scope; and
  - b. Build the basic skills that will allow students to navigate through online data portals and investigate data-based questions.

## B. Activity: Analyzing surface water data from different coastal Reserves

**Educator Note - Activity preparation:** The data collection part of this activity can be done ahead of time as homework, or during class working in pairs (refer to Homework Handout: Water temperature data search). The students will use the CDMO NERR Data Portal to generate graphs of water temperature throughout the year at four reserves located across the country. If completed as homework, students will bring in water temperature graphs to interpret in class during the following session (a copy of these graphs is also provided in case students can't print it out or don't bring a copy). Goals of the homework activity are:

- a. Use the interactive map and CDMO graphing tool to generate graphs of water temperature at four reserves representing a broad geographic scope; and
- b. Build the basic skills to navigate through online data portals and investigate data-based questions.

1. **Introduction and concept review.** Have students reflect back to the Mystery Locations activity where they discussed factors influencing air temperature data from three different locations (i.e. Jacques Cousteau Reserve (NJ), North Inlet/Winyah Bay (SC) and Urbana (IL)). In this new activity, students extend this exploration of authentic environmental data to include water temperature at four different National Estuarine Research Reserves, located on the east and west coasts of the United States.
2. **Data assignments.** Have students convene in their groups of four and share their NERR water temperature graphs. Make sure each group has all four reserves represented (i.e. Tijuana River (CA), Winyah Bay (SC), Elkhorn Slough (CA), Jacques Cousteau Reserve (NJ)). (Note: data printouts can be printed using the “NERR Water Temperature Graphs” file.)

Student Data Sheet  
Exploring Water Temperatures at Four National Estuarine Research Reserves

Step 1. Use the four graphs of water temperature generated online to complete the data table below:

Reserve Name:	Elkhorn Slough (CA)	Jacques Cousteau Reserve (NJ)	Tijuana River (CA)	North Inlet (SC)
Station name: Where and data collected?				
Location East or west coast?				
Nearest urban				
Highest and lowest value on the y-axis?				
Highest temperature recorded in dataset				
Lowest temperature recorded in dataset				
Annual temperature range (high - low)				
Other observations?				

What other observations did you make when working with the temperature data from the four Reserves?

When everyone in your group has completed the data table above, turn the paper and work together to answer the remaining questions.

3. **Working with the data to answer the questions.** Once each group has all four graphs, hand out copies of the “Student Data Sheet - Exploring Water Temperatures at four National Estuarine Research Reserves” and have students work together to complete the data table by collecting data from their water temperature graphs. The worksheet also has questions which they will work together to answer, including:

**Data Orientation Questions:**

- a. What kind of graph is being used to display the data? What type of data are represented by the x- and y-axis of the figures? [*line chart or scatter chart; x-axis is time, y-axis is water temperature (C)*]
- b. How do you think water temperature data were measured and recorded? [*Answers will vary. Water temperatures are collected using a submerged sensor deployed at each site and transmitted via remote cellular connection to the database server.*]

**Data Interpretation Question:**

- c. Did the timing of periods of warm and cold water differ among the four reserves? Explain. [*Answers will vary. Confirm that claims and interpretations are based on evidence from the data in the graphs. Temperatures are generally warmer/colder in summer/winter months.*]

**Data Synthesis Questions:**

- d. Warming of surface waters occurs later in Oregon than the other east coast reserves. What do you think might explain this pattern? [*Answers will vary and depend on prior knowledge. The earlier warming of east coast waters is associated with the influence of the warm Gulf Stream current, as well as shallow waters across the continental shelf that warm more quickly during spring and summer. Coastal Oregon is influenced by cold, deep Pacific ocean water that takes longer to warm as the summer progresses.*].
- e. Compare the different temperature scales (i.e. y-axis) on the four graphs. How did this influence your interpretation of patterns and making comparisons among the Reserves? [*Answers will vary*].

Example of entries for the Data Table

<b>Reserve Name</b>	<b><i>Jacques Cousteau Reserve</i></b>	<b><i>Winyah Bay/North Inlet</i></b>
Station:	<i>Lower Bank</i>	<i>Oyster Landing</i>
Location	<i>East Coast (New Jersey)</i>	<i>East coast (South Carolina)</i>
Nearest ocean	<i>Atlantic Ocean</i>	<i>Atlantic Ocean</i>
Highest temperature recorded	<i>31.4 °C</i>	<i>34 °C</i>
Lowest temperature recorded	<i>0 °C</i>	<i>2 °C</i>
Annual temperature range (high – low)	<i>31.4 °C</i>	<i>32 °C</i>
Other observations?	<i>Looks like the water froze in January and there was a spike in water temp in September</i>	<i>Similar to Jacques Cousteau reserve, but water never got to freezing</i>

4. **Making explanations, more data synthesis:** Students will further explore the patterns in their graphs. *(Note to instructor: this is considered ‘synthesis’ as the students are thinking about what could be drivers and explanations of what is happening based on information they already know.)* Provide students with the following prompt **“How do you think the following factors might explain differences in annual water temperatures at the four reserves?”** Have them discuss two factors from the list below and encourage them to use evidence in their explanations whenever possible.
  - a. Location on the east vs. west coast
  - b. Latitude of the reserve
  - c. Season
  - d. Surface or deep ocean currents
  
5. **Comparing air and water temperature data, more data synthesis:** Have students return to their explanations from the “Three Corners Mystery Locations Activity” where they identified the location of three air temperature datasets. Have them discuss the following prompt: **“Does the water temperature data from Jacques Cousteau Reserve and North Inlet Winyah Bay provide additional evidence in support of your claims regarding the location where air temperature data from Location A and Location B were collected?”**
  
6. **Turn and Talk about data activity.** After students have completed the data activity, have them turn and talk to a neighbor about the following prompts. Depending on the time available, you may want to have students choose two to discuss and then share out with the rest of the class.
  - o What skills did you use to compare the air and water temperature data to look for relationships? [*recognize components of graph to read it, attention to scale of variables, attention to how data collected, comparing maximum and minimum values, looking at and comparing patterns from two graphs, using patterns in data to support explanations, relate patterns to prior knowledge and broader concepts, add a new data source in to make further sense of the data*].
  - o Did these comparisons provide further evidence for the importance of the ocean in regulating air temperature? Explain. [*Answers will vary. One explanation is that the similarity in maximum and minimum temperatures - as well as the total temperature range - are similar when air and water data are compared for any given reserve. This suggests ocean temperature is regulating air temperature*].
  - o What additional information about these two reserves did you learn from looking at the air temperature data for a second time (e.g., what did you see/understand this time that

you didn't last time)? *[Answers will vary]*.

7. **Whole group sharing.** After 5 minutes, ask students to share their ideas with the whole group about any of the three prompts above. Encourage other students to engage with their classmates and actively participate in the conversation. As the discussion slows down highlight for the students that working with data and developing confidence in working with data is something that takes a lot of practice and repetition for all levels of learners.