Ocean Convergence: Let's Get Together

Materials

For the leader:
Projector
Computer
Palmer Station Area Map
Dry erase pens (or something to
draw on the Palmer Station Area Map)

For the activity:
Pie pans (clear if possible)
Play-doh
Confetti (hole punches)
Straws
Surface Current Maps
Student Worksheets

Overview

Surface waters move in multiple complex patterns. Convergence and divergence zones are areas where air or water currents come together or move apart, respectively. For water currents, these zones can be observed in rivers, estuaries, lakes, coastal ocean areas, and the open ocean. Convergence and divergence zones occur across multiple scales and can range in size from the Intertropical Convergence Zone, an atmospheric convergence zone that stretches around the Earth near the equator, to as small as areas where two water masses meet in an estuary. Convergence zones can occur where water builds up against a coastline, or where two currents come together, which is called a linear convergence zone.

In a linear convergence zone, also known as a front, the properties of the water (e.g., temperature, salinity, productivity) are often different on either side on the convergence zone and there is often a large collection of surface debris, seaweed, and foam. These fronts are often regions of elevated nutrient concentrations and sites of high biological production. Therefore, convergence zones could greatly influence the surrounding ecology by concentrating phytoplankton, which results in an increase in zooplankton, which attracts top predators to preferentially forage in the area.

Motivating Questions:

- **What are convergence zones and where can they be found?**
- **How can convergence zones impact the ecology of an area?**

Take Home Message

Ocean convergence zones occur where water comes together in a specific area due to the meeting of two ocean currents or when the water meets the coastline. This often causes a build up in height of the surface. Anything floating at the surface collects in a convergence zone.

Structure

The students will participate in a hands-on activity to explore how convergence zones collect particles in the water. Students will then look at Surface Current maps from Antarctica to find patterns in where convergence zones occur in the Palmer Deep area.

Time Required

One 45-minute class period

Activity Outline

Engage: Students will explore how convergence zones collect particles in the water column to specific areas.	10 minutes
Explore: Students will be presented a Surface Velocity map from the West Antarctic Peninsula to explore where convergence zones may occur.	25 minutes
Make Sense: Through a class discussion students hypothesize the impact that	10 minutes

convergence zones would have on the ecology of the area.	
Total:	**45 minutes**

Audience

Middle and early high school students (6^{th}-9^{th} grade).

Preparation (30 minutes)

1. Prepare the play-doh "coastline" for each pie pan.
2. Add the confetti to the pan and spread it out around the entire area.
3. Make sure Surface Currents and Surface Currents & Convergence Zone maps[1] for the groups (at the end of the write-up) are ready to go.
4. Make a copy of the worksheet for each student.
5. Write the motivating questions on the board:

   Q. What are convergence zones and where can they be found?
   Q. How can convergence zones impact the ecology of an area?

6. Set up the computer and projector to be able to project Lesson PowerPoint.

Engage (10 minutes)

1. As the students come into class have them sit with a partner at each of the pie pans filled with confetti and the play-doh. Project the set-up of the activity with Slide #2. Explain to the students that you are about to pass out straws to each person. The students need to sit across from one another, so that they line up on two sides. The students will gently blow through the straw for 10 seconds and observe the movement and final location of the confetti. The students then need to draw on their worksheet what happened to the confetti.

   * NOTE – If you have more time at the end of the lesson an extension could be to challenge the students to move around the pie pans and adjust the time and force with which they blow through the straws to create different convergence (e.g., open ocean, along shoreline) and divergence zones.

2. Ask if there are any clarifying questions about what the students should do. After taking their questions, have one member from each partner group come forward for their straws and "Ocean Convergence: Let's Get Together – Student Worksheets." Once they have drawn the BEFORE image of the pattern in the confetti they get their straws from you to begin the demonstration.
3. After they have completed their drawings, have the students talk with the partner group next to them about what observations they made about the motion of the confetti and where it ended up at the end (Slide #3).
4. After two minutes, or when the conversations slow down, bring the whole class back together and have volunteers share with the class what observations they made about the confetti. As the students are describing their observations write them down on the board (in their exact words).

[1] The metadata for this figure has been altered to align with the Penguin Habitat Use map to achieve the student learning objectives of data orientation and simulating scientific decision-making.

* NOTE – The purpose of this activity is to have students explain the phenomenon that they observed in their own words before learning the definitions that oceanographers use to explain convergence zones.

* NOTE - Convergence zones are not always wind driven, as some may conclude from this activity. They may also occur due to tidal currents, underlying topography, or a combination of tides, winds, and topography aligning under the right conditions.

Explore (25 minutes)

1. After the students have completed sharing their observations, lead the students in a reflection and brainstorm activity to review what they just observed and how it applies to what happens in the ocean. Ask the students the following questions (Slide #4):
    a. Do you think something similar could happen with water and things floating in the water in the ocean to what we observed with the confetti? – *Yes*.
    b. Where could something like this happen on the Earth? – *It happens along coastlines and where two currents (air or water) meet.*
    c. How could we, or scientists in general, know that this is happening in the ocean? What kind of data could we collect? – *We can look at satellite data of currents, surface current data, aerial images of phytoplankton, etc.*

    * NOTE – Be accepting of all answers as this is a brainstorming activity. The answers have been provided for your knowledge, not in an expectation that the students will or should give those answers.
2. At the end of the discussion make sure the students understand that:
    a. The students demonstrated convergence zones with their confetti demonstrations. Convergence zones occur where currents meet (come against one another) or where wind drives water against a coastline (which the students may have seen if confetti was stuck up against the play-doh). These are areas where the water is collected into one specific area (aka it converges).
3. Continue to lead the discussion to make sure the students understand that scientists can use satellite data of water conditions or chlorophyll (to see phytoplankton) to look at large scale patterns in the ocean. Show the students the satellite images on of chlorophyll around the Falkland Islands and point out areas of convergence zones in the images. Phytoplankton blooms occur often in the South Atlantic Ocean due to the convergence zone when two strong ocean currents meet (warm waters from the south-flowing Brazil Current and cold waters from north-flowing part of Antarctic Circumpolar Current, Slide #5) or along coastlines (Slide #6).
4. Explain that convergence zones also occur on smaller scales, so scientists can use High Frequency (HF) radar to look at surface currents at a much smaller and more localized scale and in near real time (Slide #7). HF radar measures the speed and direction of ocean surface currents. As you are discussing HF radar with the students project Slide #8 and talk through the components with them. On the left, the white lines represent surface currents measured using HF Radar in Monterey Bay, CA. The colors on the map show the speed of the surface currents in meters per second (red is fast and blue is slow). On the right (Slide #9), the black lines represent the surface currents. The maroon/red areas indicate convergence zones (where the water is coming together) and the navy/blue areas indicate divergence zones (where the water is moving away).

5. To check that your students understand how to read a convergence/divergence current map, have the students tell you how their demonstrations with confetti relate to the projected map (Slide #10).
    a. Where would the confetti be collecting in the map? – *The confetti would be collecting in the top right corner in the dark red area of convergence.*
6. Explain to the students that they will now be working in small groups to interpret the surface current maps from the Palmer Station area in Antarctica. Project Slide #11-14 to orient the students to Antarctica, the Western Antarctic Peninsula, and Palmer Station area.
7. Each group will be given different maps (Slide #15). The students need to work together to understand and interpret their map and determine where, and if, the convergence zone is in the map (they should draw on the map the location of the convergence zone). The students will present their map to the class at the end of their five minutes.
8. Pass out the Surface Currents and Surface Currents & Convergence Zone maps to each small group (make sure that a group has the same time period for both maps).
9. Project the prompting questions to guide the students interpretations of their map (Slide #16):
    a. When was their map created (what time and date did the data come from)?
    b. Was there a convergence zone (two darkest orange colors) on the map? If so, where?
10. As the students are talking through their maps, circulate and answer questions as needed.
11. After five minutes have passed (or the students begin to wrap-up their work), have each group report to the class what they were interpreting and their responses to the prompting questions:
    a. When was their map created (what time and date did the data come from)?
    b. Was there a convergence zone (two darkest orange colors) on the map? If so, where?
12. As the students are presenting their maps, on a projected class map at the front (Slide #17) draw on outline of the group's convergence zone labeled with the date and time on the projection of the Palmer Station area. At the end of the share-out, you will have an image of the Palmer Station area with the different convergence zones outlined across the 24-hour period.

Make Sense (10 minutes)

1. Have the students talk with their partner about what observations they see in the similarities or differences of the location and/or size of convergence zones from the different data maps of the Palmer Station area.
2. After a minute or so, bring the students back together and have volunteers share what they were talking about with respect to convergence zones over time.

    NOTE - The important take away is that there are differences in location and size over time. It does not matter what the pattern is or how it changes, but that they understand that it does change over time (i.e., the ocean is a dynamic system).
3. Once the discussion slows down, point to the first motivating question and review with the students (Slide #18):

    Q. What are convergence zones and where can they be found? – *Convergence zones occur where currents meet (come against one another) or where wind drives water against a coastline. These are areas where the water is collected into one specific area (aka it converges).*

4. Then ask the students:
    a. In terms of the ocean, what kind of things would concentrate in convergence zones (like the paper did in their demonstrations)? – *Convergence zones collect plankton, nutrients, natural and manmade pollution, or anything else in the water into the specific area (aka they converge).*
    b. NOTE – It is VERY easy for the students to get stuck on pollution as the only thing that can collect on convergence zones. Make sure to emphasize that it is a natural process and that many aspects of food webs rely on convergence zones to collect food sources.
5. Once the discussion slows down, point to the second motivating question and ask (Slide #19):

    Q. How can convergence zones impact the ecology of an area? – *Convergence zones collect plankton, nutrients, natural and man-made pollution, or anything else in the water into the specific area (aka they converge), therefore predators of those plankton would likely also move to the area to feed on their food sources.*
6. Ask students to think to themselves about the question. After a minute, ask volunteers to share the ideas with the entire class. Be accepting of all responses from the students as this is a brainstorming activity of how the information they learned in today's activity will apply forward to the next activity. The students may bring up something like:
    a. Many items that collect in the convergence zone are at the base of the food web. If their location moves over time, with the movement of the convergence zone, then the location of where the predators of the items in the convergence zone forage for food also would move.
7. Ask if the students have any final questions about the activities and presentations of the day.

Common Core State Standards Connections: ELA/Literacy and/or Math (Middle School)

English Language Arts

WHST.6-8.9	Draw evidence from informational texts to support analysis, reflection, and research.
RST.6-8.1	Cite specific textual evidence to support analysis of science and technical texts.
RST.6-8.7	Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

Mathematics

MP.2	Reason abstractly and quantitatively.

Next Generation Science Standards (Middle School)

Matter and Energy in Organisms and Ecosystems, MS-LS2-4 – Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

Science & Engineering Practice	Disciplinary Core Ideas	Crosscutting Concepts
Engaging in Argument from Evidence - Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.	*LS2.C: Ecosystem Dynamics, Functioning, and Resilience* – Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations.	*Stability and Change* – Small changes in one part of a system might cause large changes in another part.

New Jersey Core Curriculum Content Standards – Science (Middle School)

Content Area	Cumulative Progress Indicator (CPI)	CPI#
Science Practices: Understand Scientific Explanations	Use mathematical, physical, and computational tools to build conceptual based models and to pose theories.	5.1.8.A.2
Science Practices: Generate Scientific Evidence Through Active Investigations	Gather, evaluate, and represent evidence using scientific tools, technologies, and computational strategies.	5.1.8.B.2
	Use qualitative and quantitative evidence to develop evidence-based arguments.	5.1.8.B.3
Science Practices: Reflect on Scientific Knowledge	Monitor one’s own thinking as understandings of scientific concepts are refined.	5.1.8.C.1
	Revise predictions or explanations on the basis of discovering new evidence, learning new information, or using models.	5.1.8.C.2
	Generate new and productive questions to evaluate and refine core explanations.	5.1.8.C.3
Science Practices: Participate Productively in Science	Engage in multiple forms of discussion in order to process, make sense of, and learn from others’ ideas, observations, and experiences.	5.1.8.D.1
	Engage in productive scientific discussion practices during conversations with peers, both face-to-face and virtually, in the context of scientific investigations and model-building.	5.1.8.D.2
Earth Systems Science: Biogeochemical Cycles	Illustrate global winds and surface currents through the creation of a world map of global winds and currents that explains the relationship between the two factors.	5.4.6.G.1

New York Science Learning Standards (Middle School)

Standard Area	Key Idea	KI#
Standard 1: Analysis, Inquiry, and Design (Mathematical Analysis)	Use inductive reasoning to construct, evaluate, and validate conjectures and arguments, recognizing that patterns and relationships can assist in explaining and extending mathematical phenomena.	M2.1
Standard 1: Analysis, Inquiry, and Design (Scientific Inquiry)	Construct explanations independently for natural phenomena, especially by proposing preliminary visual models of phenomena.	S1.2
	Represent, present, and defend their proposed explanations of everyday observations so that they can be understood and assessed by others.	S1.3
	Seek to clarify, to assess critically, and to reconcile with their own thinking the ideas presented by others, including peers, teachers, authors, and scientists.	S1.4
	Interpret the organized data to answer the research question or hypothesis and to gain insight into the problem.	S3.2
Standard 6: Interconnectedness: Common Themes (Equilibrium & Stability)	Describe changes within equilibrium cycles in terms of frequency or cycle length and determine the highest and lowest values and when they occur.	4.2
Standard 6: Interconnectedness: Common Themes (Patterns or Change)	Observe patterns of change in trends or cycles and make predictions on what might happen in the future.	5.2