My NASA Data - Lesson Plans

Air Temperature vs. Sea Surface Salinity

Lesson Duration

- 50 minutes

Sphere(s)

- Atmosphere
- Hydrosphere

Phenomenon

- Changing Air Temperatures
- Ocean Circulation Patterns

NGSS Disciplinary Core Ideas

- PS3B: Conservation of Energy and Energy Transfer
- ESS1C: The History of Planet Earth

Science and Engineering Practices

- Asking Questions and Defining Problems
- Developing and Using Models
- Analyzing and Interpreting Data
- Constructing Explanations and Designing Solutions

NGSS Crosscutting Concepts

- Patterns
- Cause and Effect

NGSS Performance Expectation

- MS-ESS2-1: Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.
- MS-ESS2-6: Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.
- HS-ESS2-1: Develop a model to illustrate how Earth’s internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.

- HS-ESS2-2: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.
- HS-ESS2-4: Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.

Common Core Math

- Geometry

Related Resources

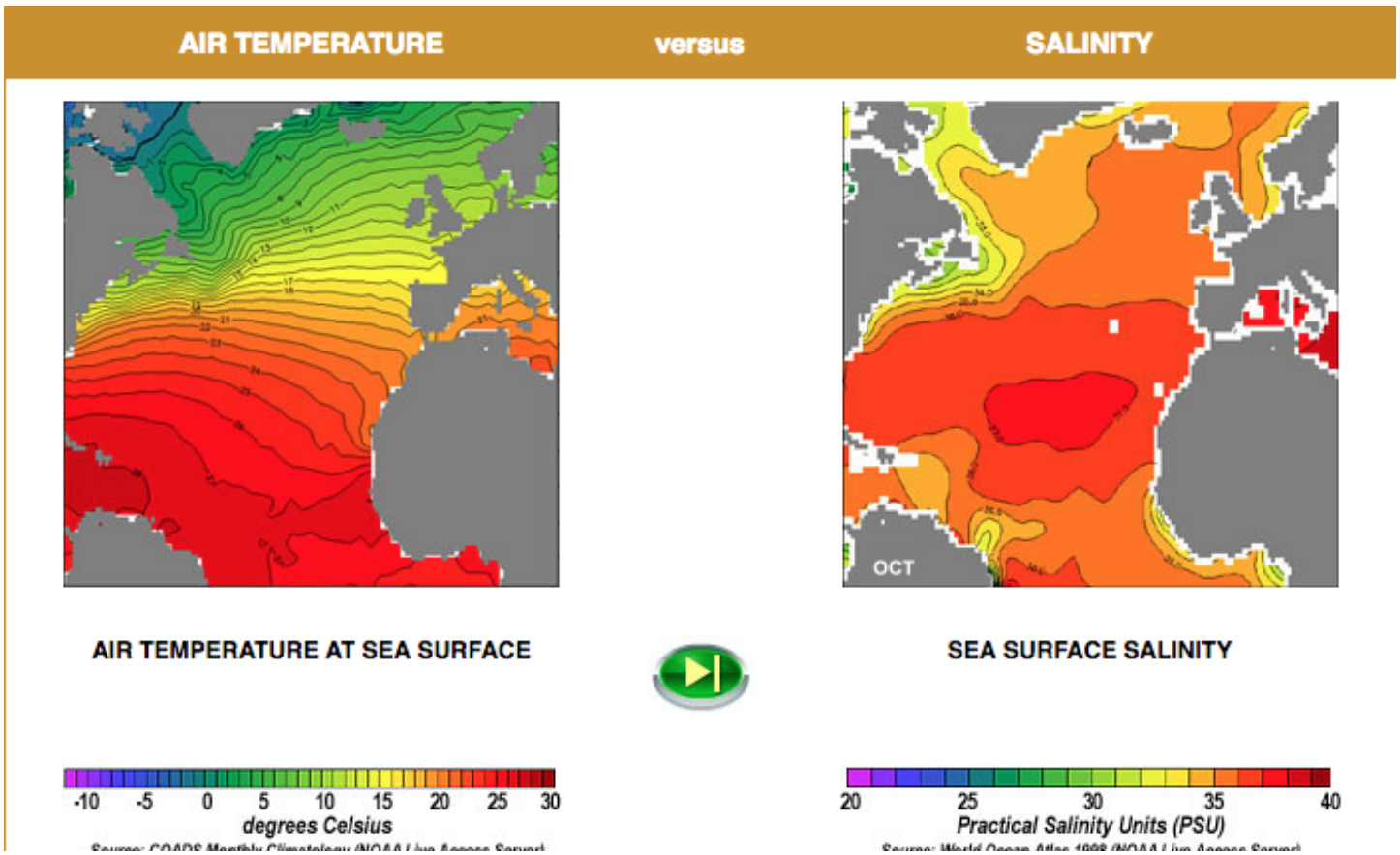
- Education: Analyzing Monthly Environmental Data
- Aquarius

Student Handout(s)

- airtemp_indepth.pdf

Key Vocabulary

- Sea Surface Temperature
- Evaporation
- Precipitation
- Evaporation minus Precipitation
- Air Temperature
- Sea Surface Salinity



Purpose

Analyzing monthly environmental data from the North Atlantic Ocean will help you to learn more about how the water cycle affects sea surface salinity. Your challenge is to find the data set that most closely corresponds to sea surface salinity patterns. A Data Analysis Sheet will help you keep track of your findings and respond to the Key Question for each data set.

Learning Objectives

-Students will analyze five pairs of data maps to identify the data that is most closely connected to sea surface salinity patterns.

NASA Phenomenon Connection

Salt. Most people view it first and foremost as the most common condiment. It comes in many forms and has thousands of uses, from preserving food to manufacturing pharmaceuticals. But salt also plays an important role in how the Earth system functions. And just as salt flows through our veins, it also flows through Earth's ocean, the lifeblood of Earth's climate system. The ocean is roughly 3.5% salt and the concentration of dissolved salts in the ocean is referred to as salinity, which varies across the globe and over time.

Just as too much or too little salt in our diets affects our health, so too do high and low salinity have profound effects on how the ocean circulates, how freshwater cycles around Earth and how our climate works. The concentration of salt on the ocean surface — the part of the ocean that actively exchanges water and heat with Earth's atmosphere — is a critical driver of ocean processes and climate variability.

To better understand the regional and global processes that link variations in ocean salinity to changes in the global water cycle - and how these variations influence ocean circulation and climate - NASA built and launched Aquarius, the primary instrument aboard the international Aquarius/Satélite de Aplicaciones Científicas (SAC)-D observatory.

Credit: NASA

Essential Questions

- How does the environmental data of the Atlantic Ocean vary over time?
- How do changes in one of the Earth's systems affect the others?

Materials Required

- Data Analysis Sheet
- Computer with internet access (one per group or one to one)
    - or

- Copies of Monthly images in PDF format: Air Temperature (2.2 MB)
- Copies of Monthly images in PDF format: Salinity (1.4 MB)

Technology Requirements

- One-to-a-Group

Background Information

Aquarius data have revealed interesting features in the global ocean, including a salty patch of water in the North Atlantic Ocean. Evaporation of water from this area leaves behind large amounts of salt, contributing to a high-salinity region.

Near the equator in the North Pacific Ocean, one of the wettest regions on the planet, heavy rainfall adds an abundance of water to the sea surface. This results in a band of low salinity water off the coast of Central America.

Rivers also influence the amount of salt on the sea surface. At the mouth of the Amazon River, millions of gallons of freshwater flow into the Atlantic Ocean, resulting in a plume of low-salinity water.

At high latitudes, the seasonal melting of sea ice causes a sharp decrease in sea surface salinity. In spring and summer, surface currents in the Labrador Sea transport low salinity water south, where it meets warmer, saltier water carried north by the Gulf Stream.

The waters surrounding the Indian subcontinent vary in salinity due to geography and climate. To the west, an arid climate and lack of freshwater input yields the salty Arabian Sea. To the east, monsoon rains and freshwater outflow from the Ganges River keep the Bay of Bengal far less salty.

Without satellite observations, these global changes would be largely invisible to us. Aquarius data are helping scientists to better understand our vast ocean, including how changes in ocean circulation and the water cycle may impact Earth's climate.

Procedure

Analyzing monthly environmental data from the North Atlantic Ocean will help students learn more about how the water cycle affects sea surface salinity (SS).

1. Challenge students to find the data set that most closely corresponds to sea surface salinity patterns. Data to view include air temperature at the ocean surface (AT), sea surface temperature (ST), evaporation (EV), precipitation (PT), and evaporation minus precipitation (EP).

Other Data Sets

- Sea Surface Temperature (ST)
- Evaporation (EV)
- Precipitation (PT)
- Evaporation minus Precipitation (EP)

2. Prior to students' analysis, have them predict which data type most closely resembles SS patterns by selecting one.

AT ST EV PT EP

3. Have them explain why they selected this data set.

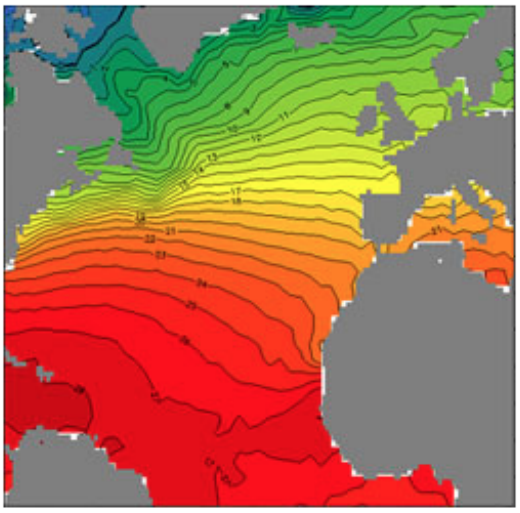
4. Review the Key Questions guiding the image analysis:

KEY QUESTIONS

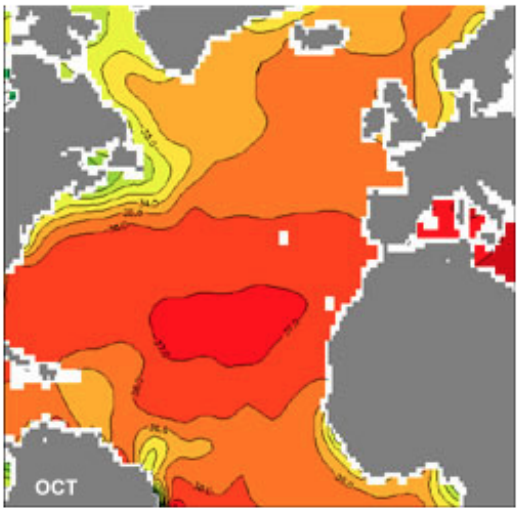
- AT-SS: Which type of data map exhibits more monthly variation over the year? Can you guess why?
- ST-SS: Does the warmest surface water have the highest salinity? Is this surprising? Why or why not?
- EV-SS: Do the highest evaporation rates occur over waters of the highest salinity? Is this surprising? Why or why not?
- PT-SS: Do the highest precipitation rates occur over waters of the lowest salinity? Is this surprising? Why or why not? (Bonus: When does the highest precipitation occur over the equator?)
- EP-SS: What is the environmental significance of the "0" line on the E-P map (i.e., dark line between the yellow and green areas)? (Bonus: How is E-P determined?)

5. Students should work alone or in groups to review the data sets of monthly images in PDF format: Air Temperature and Salinity (or through the animation on the website)

AIR TEMPERATURE versus SALINITY



AIR TEMPERATURE AT SEA SURFACE



SEA SURFACE SALINITY