What Can NASA Data teach us about the Hydrosphere?

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Eyes on Earth: Teaching Earth Science from Space

Spheres Lesson Plan 2

Grade/ Grade Band: 6 Science	**Topic:** The Earth is a system of spheres. The Hydrosphere (and water cycle) relate to these other spheres. We can monitor how biogeochemical cycles in Earth's sphere are changing using Nasa satellites.	This is designed as a six-part lesson, if fifty minute class periods. It can also cover two to three block periods of 90 min classes, depending on length of discussions.

Brief Lesson Description: Students often enter the Sixth grade with basic knowledge of the water cycle. In the past, I have chosen to review the water cycle only briefly as an introduction to the Biogeochemical Cycles. This year I plan to deepen the students' knowledge of the water cycle using NASA Data.
The original goals of this lesson were to plan with NASA data for "Earth's Energy Budget," to use the data cubes and to condense my 5E lessons to a day-two, instead of the units I have planned in the past. I also wanted to integrate more "traditional" activities into my lessons for "In person" days. We are in a hybrid environment and I see the students once per week in person and once per week remotely. I am excited to have completed a lesson that I feel I can use right away in this hybrid learning environment. The students this year get excited to complete the more traditional "paper" activities and use colored pens/pencils. Therefore, the resources here can be printed out and used or assigned via online platform.

We begin the lesson with an image as a phenomenon (NASA's IMERG data showing world-wide precipitation) and read the article together, "When It Comes to Water, You Have to Think Global" and complete note-catcher. Teacher introduces the Earth as a System of Systems and students make a foldable or slides to define and describe the following: Sphere, Atmosphere, Hydrosphere, Cryosphere, Geosphere, and Biosphere. Students leave room in the foldable or slide deck to add more information during later phases of the lesson. Class focuses on the Hydrosphere. Students read text on the water cycle and use a NASA website to add information about how each sphere interacts with the water cycle in their foldable or on their slides. Students then use prior knowledge, the text and the NASA website to label the mechanisms of the water cycle on a paper diagram.

The Elaborate and Evaluate phases further narrow the water cycle down to data analysis of the relationship between fresh water and salt water. Students use data cubes to analyze data from GRACE on freshwater movement collected for the past 15 years as well as on Antarctica's contribution to sea level rise.

Students finish this lesson with a PEAL paragraph, which is my school's version of the CER, on how freshwater and saltwater are related and how they affect other spheres.

Performance Expectation(s):

MS-ESS2-4	Modeling in 6-8 builds on K-5 experiences and progresses to developing and revising models to describe, test and predict more abstract phenomenon and design systems.
MS-LS2-1.	Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
MS-LS2-3.	Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
MS-ESS3-	

5.	Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.
MS-ESS3-2.	Analyze and interpret data on natural hazards to forecast future catastrophic event s and inform the development of technologies to mitigate their effects.

Specific Learning Outcomes:

- We will discover what NASA data shows us about the Hydrosphere.
- We will connect the hydrosphere to the other spheres.
- We will identify the mechanisms of the water cycle.
- We will use Data Cubes to analyze the relationship between freshwater and saltwater in the water cycle?

Narrative / Background Information

Prior Student Knowledge:
Knowledge of the basic functioning of the water cycle.

Science & Engineering Practices:	**Disciplinary Core Ideas:**	**Crosscutting Concepts:**
Developing and Using Models Analyzing and Interpreting Data Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. • Analyze and interpret data to provide evidence for phenomena. (MS-LS2-1) Scientific Knowledge is Based on Empirical Evidence • Science disciplines share common rules of obtaining and evaluating empirical evidence. (MS-LS2-4) Asking Questions and Defining Problems Asking questions and defining problems in grades 6–8 builds on grades K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models. • Ask questions to identify and clarify evidence of an argument. (MS-ESS3-5) Analyzing and Interpreting Data Analyzing data in 6–8 builds on K–5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and	ESS2.C: The Roles of Water in Earth's Surface Processes • Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land. • Global movements of water and its changes in form are propelled by sunlight and gravity. ESS3.A: Natural Resources • Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes. (MS-ESS3-1) ESS3.B: Natural Hazards • Mapping the history of natural hazards in a region, combined with an understanding of	Patterns • Patterns can be used to identify cause and effect relationships. (MS-LS2-2) Cause and Effect • Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-LS2-1) Energy and Matter • The transfer of energy can be tracked as energy flows through a natural system. (MS-LS2-3) Stability and Change • Small changes in one part of a system might cause large changes in another part. (MS-LS2-4),(MS-LS2-5) Influence of Science, Engineering, and Technology on Society and the Natural World • The use of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of

basic statistical techniques of data and error analysis. • Analyze and interpret data to determine similarities and differences in findings. (MS-ESS3-2) Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. • Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (MS-ESS3-1) • Apply scientific principles to design an object, tool, process or system. (MS-ESS3-3) Engaging in Argument from Evidence Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s). • 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. (MS-ESS3-4)	related geologic forces can help forecast the locations and likelihoods of future events. (MS-ESS3-2) ESS3.C: Human Impacts on Earth Systems • Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3) • Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MS-ESS3-3),(MS-ESS3-4) ESS3.D: Global Climate Change • Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities. (MS-ESS3-5)	scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (MS-LS2-5) Scientific Knowledge Assumes an Order and Consistency in Natural Systems • Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. (MS-LS2-3) Science Addresses Questions About the Natural and Material World • Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes. (MS-LS2-5)

Possible Preconceptions/Misconceptions:
Understanding of how NASA collects data, what satellites do, the difference between NASA sending up people versus satellites as well as what the satellites are for.

The water cycle is the only cycle that moves matter.

LESSON PLAN – 5-E Model

1 50-minute class period- **ENGAGE: Opening Activity**

1) Teacher projects image ((NASA's IMERG data showing world-wide precipitation) from article, "When it Comes to Water, You have to Think Global" and tells students the title only. Class has discussion to figure out what they are seeing and where it came from. Use "Map Cube Questions" to analyze the map with the students
2) Class reads the article together. Teacher calls a different student for each paragraph.
3) Students complete note catcher as we read. Teacher pauses after each subtitle/section to summarize and allow time to complete chart.

Assessment: Informal (discussion/questioning to see what students think of the data represented in the image.) This will help the teacher plan the scaffolding needed for the next phases or how many days to extend or condense lesson based on prior knowledge assessment.

Attachment: Note catcher, Map Cube Questions

Sources https://www.nasa.gov/feature/when-it-comes-to-water-you-have-to-think-global
https://mynasadata.larc.nasa.gov/sites/default/files/2019-05/Final%2005242019.pdf

1 50-minute class period- **EXPLORE: Lesson Description**

1) Class navigates to the page, About the Earth as a System and reviews the information on the page with the class.
2) Students make a six-flap foldable to define and describe the following: Sphere, Atmosphere, Hydrosphere, Cryosphere, Geosphere, and Biosphere using the page. Teacher instructs students to save room to add information to the flaps or slides as we learn about other cycles of matter that move through the spheres.

Assessment: The last five minutes of class is the exit ticket for the day, Think-pair-share: Students choose which sphere they would like to know more about and why and share with partner (one-two minutes each). Teacher announces that the next class will focus on the Hydrosphere.

Attachment: PowerPoint of Slides Instructions and Template (can also be the 6 flap traditional foldable.)

Source https://mynasadata.larc.nasa.gov/basic-page/about-earth-system

1.5-2 50-minute class periods - **EXPLAIN: Concepts Explained and Vocabulary Defined:**
Introduction to Hydrosphere:

1) Students read text: https://read.activelylearn.com/#teacher/reader/authoring/preview/533673/notes

2) Students Use NASA website (text, video, image) to add information to foldable: Introduction text and video from Nasa

3) Students label a model of the water cycle using the correct mechanism names. Teacher and students use the above text and NASA website to discuss each mechanism.

Vocabulary:

- Spheres (Atmosphere, Hydrosphere, Cryosphere, Geosphere and Biosphere)
- Hydrologic Cycle (Water Cycle)
- Mechanisms (evaporation, condensation, transpiration, runoff, infiltration, precipitation , percolation, storage

Assessment: Teacher observes student labeling of the mechanisms of the water cycle to assess if students are building on the knowledge from elementary and to assess if students are able to find information about mechanisms using the data sources provided (text and website.) Teacher uses this assessment for small groups or scaffolding of information provided next. Option to take another day for instruction.

Attachment: Model of the Water Cycle to label/discuss. Use on digital whiteboard virtually for students to interact with or as a traditional paper diagram to label. http://wbo6science.weebly.com/water-cycle.html

Sources:

1) *https://mynasadata.larc.nasa.gov/basic-page/about-hydrosphere*
2) *Actively Learn Program for text and questions on the water cycle (can be read together in class or assigned through Actively learn as an assignment in Google Classroom.)* https://read.activelylearn.com/#teacher/reader/authoring/preview/533673/notes

1-2 50-minute class periods **ELABORATE: Applications and Extensions:**

Water exists as freshwater or saltwater- How are they connected? (Teacher note: because loss of freshwater at poles contributes to sea level= climate change= energy)

1) Analyze with 2 data sources from NASA *(students use data cubes to investigate)*

-Map of freshwater video to intro how NASA collects data----assess prior knowledge---freshwater movement tracked fro last 15 years, Gravity Recovery and Climate Experiments (GRACE) and twin satellites 2002

-Sea level rise. This is a complete mini-lesson from NASA on Antarctica's contribution to sea level rise. https://mynasadata.larc.nasa.gov/lesson-plans/data-literacy-cube-graph-data-antarctics-contribution-sea-level-rise-graph

Assessment: Question/Answers from data cubes. Discuss together the visualization of data and correct any misconceptions of data interpretation.

Attachment: Map Cube Questions

Sources

1) *https://youtu.be/bBzt9faOX04*
2) https://mynasadata.larc.nasa.gov/lesson-plans/data-literacy-cube-graph-data-antarctics-contribution-sea-level-rise-graph

1 50-minture class period **EVALUATE:**

PEAL paragraph: This is our school's version of the CER and used in our ELA classes. PEAL is described in the attachment directions. Allow for Peer Revision and final draft

1)Read the following text assignment on analyzing data on sea level rise
https://read.activelylearn.com/#teacher/reader/authoring/preview/1170641/notes

2) Summarize the article using PEAL (similar to CER.) Review the directions with the students, visually list resources we have used so to show where evidence will come from when writing.

3) Peer review summaries, if time. Finalize draft.

Attachment: PEAL assignment

Sources:
https://read.activelylearn.com/#teacher/reader/authoring/preview/1170641/notes

Enrichment: If time, or to differentiate, use this website to further analyze the relationship between seal level rise and climate change. Students could complete a true CER and use all the resources provided in this lesson to pull evidence from as they discuss the claim, “Sea level rise is related to climate change.”

Sources: Listed in each phase
My NASA Data
NGSS