**Welcome to GPM- an Important NASA mission!**

**Middle School Version**

**Lesson Overview**: This lesson plan is for GPM Pilot Teachers, Master Teachers, and GLOBE-GPM Fall Campaign teachers who want to introduce their students to the GPM mission. The lesson includes a PowerPoint presentation that welcomes your students to assisting NASA this school year, and gives them a little background science and technology information related to this Earth-observing mission. It is meant to be modified to meet the needs of your students and your time availability. This lesson has been designed to take about 30 to 45 minutes, depending on how much discussion you decide to have and if you do any extension activities.

**NGSS:** These indicators are not taught in full, but are introduced conceptually.

MS-LS2-3, MS-LS2-4, MS-ESS2-2, MS-ESS2-4, MS-ESS3-1, MS-ESS3-4

**Background Information**: As teachers who are involved with the GPM mission, your students will also be an integral part of this work. They will be able to try out new NASA educational materials, see new NASA-created videos, and engage in special activities that have been developed by NASA education specialists during this school year. This lesson was developed to share with your students to excite and inspire them as they learn that they are actually working closely with NASA this school year.

**Materials:**

* Computer with Internet access, if possible to view videos
* Plastic cup, eye-dropper, smaller cup for freshwater demo

**Engage**: Begin to share the PP with your students: slides 1 and 2. Some suggestions for beginning a dialog are listed below- the goal here isn’t to answer these questions, but rather to raise them as food for thought and discussion.

* (slide 1) What do you see in this slide? What do you notice? What do you wonder?
* (slide 2) Why might NASA want to work with teachers and students?
* (slide 2) What kind of things do you think we might do to help NASA improve their educational materials?
* (slide 2) What do you think a “NASA mission” is?
* (slide 3) What do you think NASA” does” What do they learn about? Does anyone know what “NASA” stands for? (National Aeronautics and Space Administration) and there are more suggestions for questions on the “notes” section of slide 3.

**Explore:** In this section, the students will explore their understanding of Earth as “the water planet” and discuss what water is and where it came from.

* (Slide 4) Explain to the students that NASA is also studying this planet, and have them identify which planet it is. Ask them to give specific observations that support their claim that this is the planet Earth. As they talk about how they know it is Earth, begin to steer their conversation to noting the presence of water on Earth. Ask if other planets have water, and talk about the importance of having water to the existence of life. Explain that as we look at other planets and moons for the existence of life, we search for places that have liquid water as life as we know it depends on having liquid water. Ask them to identify the different forms of water they see on Earth- liquid (oceans), gas (clouds), and solid (ice caps at North Pole).
* (Slide 5) It is an important concept to understand that our water isn’t produced by anyone- even though we know the “recipe” for water (two hydrogen atoms and one oxygen atom). We can’t make water, as it would be too dangerous to mix hydrogen and oxygen together. Ask if they know where our water came from, and explain that it came from asteroids and comets hitting Earth billions of years ago. Reinforce the fact that the water we drink and that is in our bodies is actually billions of years old and was created our in space when stars exploded. There is a good article that discusses this fact at <http://1.usa.gov/1pPFqPs> that students could read in class or as a homework assignment.

**Explain:** In this section, students will learn how much of Earth’s surface is covered by water, how much of that water is freshwater, and the difference between saltwater and freshwater to meet our needs. They will also learn about the water cycle and the GPM mission.

* (Slide 6) Show the “Blue Marble” image again, and this time ask them to estimate how much of Earth’s surface is covered by water. Help them understand that 70% to 75% is covered by water. Fill a clear cup up 70-75% full, and explain that this is how much of Earth’s surface that is covered by water (if the whole cup was a model of Earth’s surface volume). Take out one eye-dropper full of water, and put it in a smaller container, and tell them that if the cup represented how much of Earth’s surface was covered with water, then amount in the eye-dropper represents how much of that water is freshwater- only ~ 2.5 %. Then take out one drop of the freshwater, and put it on your hand, and tell them that only a small portion of freshwater, less than 1% of all water, is easily accessible to us. Another nice activity, to reinforce this concept and build some mathematics and science processes skills if you have time, is described in the “Extend/Elaborate” section of this teacher’s guide- the “*Plastic Globe*” activity.
* (Slide 7) Talk about the differences between salt water and freshwater. You could make a Venn diagram to show how they are different and alike. Ask what happens to the salt when water evaporates from the ocean, and help them to understand that the salt stays behind, and only the freshwater molecules evaporate. You can find out more about evaporation at <http://water.usgs.gov/edu/watercycleevaporation.html>. There is also a short lab activity to help students understand that salt water is denser than freshwater at <http://bit.ly/Y9Qspz>. This lab is more extensive and covers both temperature and salinity and how these impact the circulation of water in the oceans: <http://aquarius.umaine.edu/cgi/ed_act.htm?id=18>
* (Slides 8 and 9) These two slides use different types of graphs to illustrate the In the pie chart (slide 8), the top pie chart shows that over 99 percent of all water (oceans, seas, ice, most saline water, and atmospheric water) is not available for our uses. And of the remaining fraction of one percent (the small blue slice in the top pie chart), much of that is out of reach. Considering that most of the water we use in everyday life comes from rivers (the small dark blue slice in the bottom pie chart), you'll see we generally only make use of a tiny portion of the available water supplies. The bottom pie shows that the vast majority of the fresh water available for our uses is [stored in the ground](http://ga.water.usgs.gov/edu/watercyclegwstorage.html). This graphic can be confusing, which makes it kind of nice to use. Before explaining anything, ask students: “What do you notice?” and “What do you wonder?” Help them unpack the graphic to really understand it.
* (Slide 9) This graphic is also confusing at first glance, and needs some focused attention to unpack. The left-side bar shows where the water on Earth exists; about 97 percent of all water is in the [oceans](http://ga.water.usgs.gov/edu/watercycleoceans.html). The middle bar shows the distribution of that three percent of all Earth's water that is freshwater. The majority, about 69 percent, is locked up in [glaciers and icecaps](http://ga.water.usgs.gov/edu/earthglacier.html), mainly in [Greenland](http://ga.water.usgs.gov/edu/watercycleice.html) and Antarctica. Of the remaining freshwater, almost all of it is below our feet, as [groundwater](http://ga.water.usgs.gov/edu/earthgw.html). Of all the freshwater on Earth, only about 0.3 percent is contained in rivers and lakes—yet [rivers](http://ga.water.usgs.gov/edu/earthrivers.html) and [lakes](http://ga.water.usgs.gov/edu/earthlakes.html) are where most of the [water we use](http://ga.water.usgs.gov/edu/wateruse.html) in our everyday lives exists.
* (Slide 10) This pie chart shows how freshwater resources are used in the USA. You can see many more charts and more information looking at human appropriation of the world’s freshwater supply at <http://bit.ly/1l7ltF2>.
* (Slide 11) This short video, “*The Freshwater Connection*” (1:24) explains how the GPM mission is going to help us measure how much freshwater we have, and explains some of the reasons why measuring precipitation is important.
* (Slide 12). Use this graphic to talk about the water cycle and the journey a drop of water takes as it moves through Earth’s systems; help them to see the atmosphere, the biosphere, geosphere, and hydrosphere- talk about the interactions between these four systems and what happens as water moves through these systems- discuss evaporation, transpiration, precipitation, and condensation. Ask them what powers the water cycle (the sun).
* (Slide 13) The video is a little long (4:56), but it does a good job of showing how NASA satellites are studying Earth’s water cycle and the impact of humans on changing the water cycle. You can download it ahead of time by going to <http://1.usa.gov/VpUecj>.
* (Slide 14) Lead students in a discussion about each of these questions. Help them to understand that the water we drink comes from various sources- depending on where you live- but by and large it originates from precipitation which falls into rivers, lakes, and streams, and enters local reservoirs. Talk about how scientists, called meteorologists, measure how much precipitation falls in certain locations. You could show part of the daily weather clip if time permits, or show them the local paper’s weather report and tell them what it says about how much precipitation fell the day before. Talk about whether the precipitation would be in the form of rain or snow, depending on where you are located. You might talk about some of the extreme events related to precipitation- some places have too much sometimes (floods) and others have too little (drought).
* (Slide 15) This short video “*For Good Measure*” (1:54) ties up many of the things that were discussed in this lesson and explains why we need to study precipitation from space. The video can be downloaded ahead of time from <http://1.usa.gov/1lYuEmf>
* (Slide 16) Show them this image of the GPM satellite, and explain a few things to them about the Core Observatory. It is about as big as a fire engine, and has no people on it. People control it from Earth, using the high gain antenna to give signals and retrieve data. The satellite was launched in a rocket on Feb. 27th, 2014 from Japan, as Japan and the US are working together on this mission. GPM flies all day and all night, and is about 250 above Earth’s surface. They might be able to see it flying overhead at night if they stare at the sky for a while. You can tell if it is an airplane and not a satellite if it has lights on it, as satellites look more like stars that are moving across the sky in a steady motion, but have no lights that blink. The solar arrays use the sun’s energy to give the satellite power, and the star tracker helps it to know where it is going because there aren’t any street signs in space! GPM uses two main instruments to measure precipitation that is falling down to Earth- the GMI and the two DPR instruments.
* (Slide 17) This final slide explains the students’ involvement in helping NASA and GPM to make improvements to their educational resources.

**Evaluate:** As the goal of this presentation is merely to introduce the students to the GPM mission and the science and technology behind it, there is no formal evaluation for this lesson plan.

**Elaborate/Extend:**

* “*Plastic Globe Activity*” to help teach how much of Earth’s water is freshwater and reinforce math concepts (ratios, percentages, using tally marks) and science concepts (data collection, multiple trials, looking for patterns and trends):

 - Materials: plastic globe, pens for students to put a dot on a finger, chart paper to record results

 - Time needed: about 15 to 20 minutes to do all 100 trials (however, you can do fewer trials and it will take less time.)

 - Steps:

1. Tell the students that they are going to do a science experiment to determine how much of Earth’s surface is covered by water or land. Have them pick one of their fingers to be their “data collector” and they should put a dot using a pen on that finger.
2. Tell them they will do a series of trials, as a good scientific investigation needs multiple trials to be valid. Each trial will involve collecting 20 pieces of data. Therefore, they will gently pass the globe around 20 times, and each time someone gets it, they will check to see whether their data collector is on land or water. As they pass it, there may occasionally be a question about whether clouds count as water (they do) and whether ice caps in the North and South Poles count as water or land (water). As the person catches the globe, they call out either “water” or “land”, and the teacher makes tally marks under the correct heading on the chart paper. Once 20 pieces of data have been collected, stop and write the ratio of land to water on the chart, and help students to figure out the percentage for that trial.
3. Repeat the trials in the same way, doing all five trials to get 100 data points if time permits. Have students look at the patterns and trends in their data, and they can also use their math skills and determine the mean for all trials.
4. Generally, this investigation results in some pretty consistent data that shows that ~ 75% of Earth’s surface is covered by water, leaving ~ 25% covered by land.

**Teacher Notes:**

* If you don’t have Internet access in your classroom, you can save and embed the videos in the PP presentation.
* If you have slow Internet connectivity, it is helpful to download the videos and have them ready to show when you get to the slide.)
* We have a “*Droplet*” handout we can make available to you to give to your students. If we haven’t already told you we will mail them to you, please send dorian.w.janney@nasa.gov or Kristen.l.weaver@nasa.gov an email and give us your name, school, and the number of droplets you want. It may take up to two weeks to get to you, so please plan accordingly. You can always do this lesson first, and give the students their “*Droplets*” later. When you hand out these Droplets, take some time to read over the information with the students to help them understand the shape of the *Droplet*, what the little blue and yellow dots represent, why there are more than one satellites in the graphic, and what this mission is going to do. You can also show them the website at the bottom of the handout- under the QR code, that they can visit to learn more. Alternatively, the QR code will also take them directly to this website.