**Welcome to GPM-**

**High School/ College/Adult 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 some background science and technology information related to this Earth-observing mission. Feel free to modify it to meet the needs of your students, your curriculum, 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.

**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. Some suggestions for beginning a dialog are listed below.

* (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 “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 focus in on Earth as the “water planet” and that NASA is studying Earth in a myriad of ways- from space.

* (Slide 4) Explain that NASA also studies Earth. 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. 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 water 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.
* (Slide 5) Explain that NASA studies Earth in a myriad of ways- from space. The next slide shows the current NASA missions that are studying Earth. You can find out more by going to Earth Right Now at <http://www.nasa.gov/content/earth-right-now/>. There is also a neat app, also called “EarthNow” that is free, easy to understand, and has real-time data from many of these satellites.

“When most people think about NASA, Earth is not the first thing that comes to mind. Ours agency conjures up thoughts of leaving Earth behind, so it is usually Apollo astronauts, the Moon, Mars, and Hubble views of stars and galaxies that people associate most strongly with NASA’s brand. However, many astronauts have found the view back at Earth is as compelling as anything else they’ve seen. Nearly a half-century later, studying Earth from space is a critical part of NASA’s mission. There are currently sixteen Earth-observing satellites operating in orbit around our planet.” The oldest, the Tropical Rainfall Measuring Mission (TRMM) was launched in 1997; and the most recent was OCO-2 (Orbiting Carbon Observatory-2) which was launched on July 2, 2014- from EarthRightNow website

**Explain:** In this section, the focus is on how much of Earth’s surface is covered by water, how much of that water is freshwater, and how freshwater resources are not distributed equally around the globe. Then they will see how the GPM mission ties into freshwater availability.

* (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.
* (Slide 7) In the pie charts above, 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 even of the remaining fraction of one percent (the small brown 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) (the large grey slice in the second pie chart). http://ga.water.usgs.gov/edu/earthwherewater.html
* (Slide 8) Where is Earth's water located and in what forms does it exist? You can see how water is distributed by viewing these bar charts. 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. You might be surprised that of the remaining freshwater, almost all of it is below your feet, as [groundwater](http://ga.water.usgs.gov/edu/earthgw.html). No matter where on Earth you are standing, chances are that, at some depth, the ground below you is saturated with water. 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 9) 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 10) 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 11) This is the first of four slides that help explain why it is important for GPM to measure Earth’s precipitation. The first slide focuses on how the data will help us better understand Earth’s water cycle as it changes due to climate change. <http://earthobservatory.nasa.gov/Features/Water/page3.php>: “Among the most serious Earth science and environmental policy issues confronting society are the potential changes in the Earth’s water cycle due to climate change. The science community now generally agrees that the Earth’s climate is undergoing changes in response to natural variability, including solar variability, and increasing concentrations of greenhouse gases and aerosols. Furthermore, agreement is widespread that these changes may profoundly affect atmospheric water vapor concentrations, clouds, precipitation patterns, and runoff and stream flow patterns.”
* (Slide 12) TRMM launched in 1997 and is still collecting data. However, it only measures precipitation in the tropical regions. GPM will now extend that coverage to include the mid-latitude regions, allowing us to measure precipitation all over the globe, with the exception of the North and South Pole regions. This image shows TRMM data, and includes some mid-latitude data that was available from other sources. However, many sections of the map have no colors- indicating a lack of data for that area. As GPM begins to publish data, in mid-September, we will have more complete worldwide precipitation measurement maps.
* (Slide 13) This slide has an animation of GPM’s data that was recently collected in July 2014. If you are not using the latest version of PowerPoint, “ppxt”, then you will not be able to play the animation by clicking on it. Instead, you will want to upload the animation and either embed it in the PP before you show it, or simply have it ready to play on your desktop. You can download it or play it at this url: <http://svs.gsfc.nasa.gov/cgi-bin/details.cgi?aid=4186> “The five GPM passes over Arthur are the first time a precipitation-measuring satellite has been able to follow a hurricane through its full life cycle with high-resolution measurements of rain and ice. In the July 3 image, Arthur was just off the coast of South Carolina. GPM data showed that the hurricane was asymmetrical, with spiral arms, called rain bands, on the eastern side of the storm but not on the western side.”
* (Slide 14) The GPM mission has many benefits for society. “All life relies on the availability of water. Knowing when, where, and how much it rains or snows is vital to understanding how [weather and](http://pmm.nasa.gov/education/glossary%23weather) [climate impact our environment, and in turn human society. The movement of water and energy around Earth affects agriculture, fresh water availability, and the occurrence of natural disasters.](http://pmm.nasa.gov/education/glossary%23climate) In many parts of the world, rain is the only source of water for both drinking water and agriculture. Rain also recharges ground water aquifers, and spring snowmelt replenishes rivers and streams for the summer. Having too much or too little water often results in natural disasters for populations around the world, where tropical cyclones, floods, droughts, and landslides can wreak havoc on local communities. Having accurate information on rain and snow is critical for estimating when to plant crops, where to build houses, how to plan transportation routes, and to what extent we need assistance during extreme weather.” - from <http://pmm.nasa.gov/education/societal-applications>
* (Slide 15) There is a good article about the unequal distribution of freshwater resources and its impact on societies at <http://1.usa.gov/1uYba6L> For more information on this subject, you can go to <http://1.usa.gov/1t2Z78Em>.
* (Slide 16) When you click on the link on this slide, it will take you to a short video called, “Our Wet, wide World” (4:06) which gives a very good wrap up about why it is important to measure global precipitation, and it explains how GPM will be able to accomplish this feat. <http://1.usa.gov/1oWqW1d>
* (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:** There are many links included in the lesson plan that have a great deal of additional information if you or your students would like to find out more about any of the content presented here.

**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 “GPM lithograph” 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](mailto:dorian.w.janney@nasa.gov) or [Kristen.l.weaver@nasa.gov](mailto:Kristen.l.weaver@nasa.gov) an email and give us your name, school, and the number of lithographs 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 lithographs later.