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**No Place Like Home**

**Objective**

Guests will discuss the requirements for life on Earth. Different objects in our solar system will be discussed to see if it is possible for life to exist there and if it would be possible to humans to go there.

**Facilitation style:**

In the outline below questions are asked with audience response given. These responses represent one possible answer, but it is expected that the presenter will discuss these questions with guests to help them understand why these answers are correct. The flexibility of the exhibit allows for the presentation to be guest directed. Sample questions are used in the outline but it is expected that each facilitator uses their own knowledge and research to inform the presentation.

**Primary Datasets:**

Blue Marble <http://sos.noaa.gov/Datasets/dataset.php?id=82>

The Earth’s Moon <http://sos.noaa.gov/Datasets/dataset.php?id=220>

Mars <http://sos.noaa.gov/Datasets/dataset.php?id=224>

Venus <http://sos.noaa.gov/Datasets/dataset.php?id=215>

Jupiter <http://sos.noaa.gov/Datasets/dataset.php?id=238>

Europa <http://sos.noaa.gov/Datasets/dataset.php?id=246>

Io <http://sos.noaa.gov/Datasets/dataset.php?id=244>

The Sun <http://sos.noaa.gov/Datasets/dataset.php?id=266>

The Milky Way <http://sos.noaa.gov/Datasets/dataset.php?id=270>

**Research sources:**

The information in this outline represents the bare essentials for facilitating the exhibit. It is expected that facilitators spend time doing some research to add accurate detail. Since this program is meant to be very interactive, preparation for guest questions is essential. Each of the datasets has a page on the NOAA Science on a Sphere website. Here are some other useful links.

NOAA Science on a Sphere website: <http://sos.noaa.gov>

NASA Home: <http://www.nasa.gov/>

NASA Solar System: <http://www.nasa.gov/topics/solarsystem/index.html>

NASA JPL: <http://www.jpl.nasa.gov/index.cfm>

**Connection to Current Science News:**

Incorporate the latest information about NASA missions and discoveries about the solar system in to show as appropriate.

**Show Outline**

**A. NOAA Nod – Start with Blue Marble**

Welcome to MSI Earth Revealed.

All of this was developed by NOAA, who developed the technology called Science on a Sphere. Using data from satellites, as well as land- and sea-based measuring stations, NOAA scientists produce the Earth images you see here.

**B. Observing the Earth - Blue Marble**

*Objective: The Earth has many characteristics that make the existence of life possible. What is needed by all kinds of life, what is required for humans to survive?*

“This is our home. There is a large abundance of life on our planet – many different types of plants and animals. When we think of all the different kinds of variations of life on Earth, it is mind boggling. But, to date, Earth is the only place that we know of to have confirmed life. Why is that? What do living things need to live on Earth? What do you see on earth?”

 *Audience response: Water, Energy, Sunlight, Oxygen, Carbon Dioxide etc.*

(Discuss each response. Lead audience to LIQUID water being the common requirement for all life on Earth and get at the “Human Habitability Checklist:” need oxygen, food/energy, and liquid water)

“So we as human beings primarily need Oxygen, Food/Energy, and Water. However, everything that we know of that is alive needs water, specifically, to live. Let’s look beyond our planet and out to other objects in our solar system to see if we, or anything else, could live there.”

**C. Our Nearest Neighbor – The Moon**

*Objective: The moon is the only place we’ve been to other than Earth. The lack of a substantial atmosphere can be seen by all the craters. It appears to be a barren rock, but appearances can be deceiving.*

“What are we looking at now?”

 *Audience Response: the Moon!*

“That’s right, the moon! This is the only other place human beings have set foot on. So let’s go through our checklist to figure out how we could live there or if we might find life there.”

(Discuss the “Human Habitability Checklist” with the guests:

 ATMOSPHERE: No atmosphere and no oxygen

 FOOD/ENERGY: No life or food, but it does get sunlight. Its’ day is about a month long.

 LIQUID WATER: No liquid water)

“So our moon doesn’t meet the requirements for human habitability, and the lack of liquid water makes it incredibly unlikely we would find extraterrestrial life there. Thus it might seem that our moon is a barren little rock, but scientists have recently confirmed the presence of large quantities of FROZEN water on the moon. How could we as humans use that frozen water to survive on the moon?”

*Audience Response: Melt it, drink it, grow food with it, food produces oxygen, breathe it, break it apart into hydrogen and oxygen gas and burn it*

(Discuss each response and lead guests towards the less obvious uses for water)

“Great! So anywhere we as humans find water in any of its’ forms we can use it to drink, eat, breathe, and burn. Okay, so now we’re going to take a look a bit further out.”

**D. The Next Destination – Mars**

*Objective: Discuss human habitability on Mars and talk about evidence of liquid water found on its’ surface and the possibility of extraterrestrial life.*

Where are we now?

 *Audience Response: the Mars!*

“Exactly, we’re on Mars, the red planet. Let us again go through our habitability checklist to see if we could survive here!”

(Discuss the “Human Habitability Checklist” with the guests:

 ATMOSPHERE: Has an atmosphere. However, it is 1% as thick as our own making it equivalent to 20 miles above the surface of the earth. The atmosphere is composed of 95% CO2.

 FOOD/ENERGY: No food on the surface/no green colors. It does receive sunlight. This makes it dimmer and weaker, but enough energy for rovers and probes to use solar panels.

 LIQUID WATER: No oceans or stable bodies of water visible. In fact, because of the low atmospheric pressure bodies of water are all but impossible. Think about cooking directions and why it takes more time to cook things at higher elevations. Water boils at lower temperatures in lower atmospheric pressures. At the lowest elevations on mars liquid water would only exist between 0 C and 10 C (or 32 F and 50 F). [1] )

“This seems like a pretty inhospitable place. However, let’s take a look at the poles of Mars for a moment. What do these look like?”

 *Audience Response: Our north/south poles!*

“Absolutely, and they are made of a frozen material, but it is unfortunately not water. It is actually frozen carbon dioxide. That sounds like an exotic material, but I bet some of you have encountered this near the end of October. What is a more common name for Frozen CO2?”

 *Audience Response: Dry Ice!*

“Indeed, so that doesn’t help us right away, but we did land the Phoenix Lander up there at the North Pole. What do you think we found?”

 *Audience Response: Rocks, Dirt, Ice*

“Exactly, we found frozen water. So now we know that we have water on mars, it just doesn’t exist as a liquid. Humans could go there and use that water to drink, eat, breathe, and burn. But we also saw it snow, honest to goodness water snow. We know Mars has a very weak and bizarre water cycle. And we found opals. What are opals?”

 *Audience Response: Stone/Gem*

“Opals are a semiprecious stone found here on Earth. What is really exciting about opals is how they usually form. They form as sediment (silica) settles on the bottom of bodies of water over the course of millions of years. This, along with other geological evidence, tells us that mars may have a long history of being wet, and could have been wet as recently as 2 billion years ago. [2] So if we had liquid water there, what could have been there?”

 *Audience Response: Life!*

“Right, and keep in mind that the earliest fossils of primitive microbes on earth dates to 3 billion years ago.[3] If Mars had liquid water until 2 billion years ago, it is certainly possible we could find evidence that life once existed, or still might exist deep beneath the Martian surface. Let’s look at our other planetary neighbor.”

**E. The Earth’s Sister – Venus**

*Objective: Learn about CO2 in the atmosphere of Venus and how that relates to our CO2 here on earth.*

“Welcome to our sister planet! Does anyone want to guess what planet we’re looking at?”

 *Audience Response: Venus!*

“Now this doesn’t look like the Venus we know and love because this is actually a topographical map of the surface. Venus has a thick cloud covering that prevents us from seeing the surface using regular telescopes. Let’s take a look at how habitable our sister is.”

(Discuss the “Human Habitability Checklist” with the guests:

 ATMOSPHERE: Has an atmosphere that exerts 90 times as much pressure as our atmosphere does at sea level. It is composed of 96% CO2.[5]

 FOOD/ENERGY: No food and no sunlight would get down to the surface so we couldn’t grow plants.

 LIQUID WATER: No liquid water, due to the higher pressure it would boil at approximately 460 C/860 F.[4] However, the surface of Venus hovers right above that temperature.[5])

“Venus is the hottest planet in the solar system. That temperature of 460 C/860F is not only hot enough to boil even super pressurized water, but it would be hot enough to melt lead! However, this might seem pretty weird, because Venus is not the closest planet to the Sun. Anyone know which planet is?”

 *Audience Response: Mercury!*

“Right, but Mercury is actually cooler. The main difference is the atmosphere. Mercury does not have an atmosphere, but if you remember we were talking about the atmosphere being made mostly of CO2. Have you ever heard of CO2 here on earth?”

 *Audience Response: Greenhouse Gas/Climate Change*

“Yeah, it is known as a greenhouse gas which means it is a gas that traps heat in the atmosphere. The incredibly high percentage of the very thick atmosphere has given Venus a runaway greenhouse effect that has made it so hot. By contrast what percentage of our atmosphere do you think is made of CO2?”

 *Audience Responses: GUESSES!* Keep saying “lower” until you get to at least 1%

“Our atmosphere is made of 0.039% CO2 (4/21/2011).[6] This means that our atmosphere traps less heat, but by increasing CO2 in our atmosphere, we increase our planet’s heat trapping capabilities. All of this combines to make Venus a very inhospitable world to not only human life, but to any sort of earth-like life. And as one last note, there are droplets of sulfuric acid in the upper atmosphere of Venus.”

**F. Another World’s Moons – Io and Europa**

*Objective: Explore Jupiter’s moons to learn how tidal flexing causes intense enough heating to produce liquid water on Europa.*

(Start on Io)

“We are no longer looking at a planet; we are actually looking at something that goes around planets. What kind of object orbits planets?”

 *Audience Response: Moons*

“Great, this is a moon of Jupiter called Io. Io is one of the most volcanically active objects in our solar system. It produces volcanoes that shoot their volcanic matter 200 miles above its’ surface. To put that in perspective, that would reach half-way to the international space station. These volcanoes are caused by Jupiter. Jupiter, the largest planet in our solar system, is a big bully that is constantly pushing and pulling, squeezing and stretching everything around it. This is known as tidal flexing. The flexing causes so much friction and heat provides the energy necessary to keep the core of Io molten.”

(Switch to Europa)

“We are now looking at another moon of Jupiter called Europa. What does it look like? What does it remind you of?”

 *Audience Response: A Snowball/Ice*

“Right, the surface of Europa is composed almost entirely of H2O! That right there means that future explorers could use the ice on Europa to drink, eat, breathe, and burn. However, the same tidal flexing that was keeping Io’s core molten is in effect on Europa. However, Europa is covered in ice. Silly question, but what happens when we heat up ice?”

 *Audience Response: It Melts!*

“Exactly, there are currently theories that suggest that underneath the surface of Europa there very well could be a moon wide liquid ocean. And if there is liquid water on Europa, what could be there?”

 *Audience Response: Life!*

“Life! Currently, this is one of our best prospects for finding extraterrestrial life within our own solar system. To that end, there is a proposed joint NASA/ESA mission to Europa in 2020.[7]”

**G. The Sun**

*Objective: To see how ordinary our sun is, and yet how special it is to human beings on Earth.*

“And welcome to the star of the show, the center of attention. What are we looking at?”

 *Audience Response: the sun*

“Right, this is the sun! Are we going to find any water on the son? Of course not, it is a gigantic ball of plasma. It is incredibly hot, with a surface temperature just below 10,000 F[8] and an estimated core temperature of 41 million F.[9] It is also HUGE. It is 1,304,000 times the size of the Earth.[8] It only seems so small because it is so far away. But we owe our very existence to the sun here. Without its heat we would not have liquid water, and without its light we wouldn’t have plants and food. But what kind of an object is our sun?”

 *Audience Response: A Star*

“Yeah! Now is it the most unique and special star in the universe?”

 *Audience Response: Yes and No!*

“I agree with all of you. To us as human beings this is hands-down the most important star in the universe, but to the universe our sun is pretty average. It is a GV Type star which is neither the hottest or the coldest, nor the largest nor the smallest. There are quite literally COUNTLESS stars in our universe.”

**H. The Galaxy**

*Objective: Talk about the possibility of stars with earth like planets*

“Given how many stars there are in the universe. Is it *POSSIBLE* that somewhere out in the universe there could be another Earth like planet orbiting its’ parent star at just the right distance like we are? Almost certainly yes. The only question remains is it close enough to us that we can find it? And even if we find it, it will open up more questions. Does it have life? Could we survive there? How would we get there?”

(Return to Blue Marble)

With all that being said, it feels good to be back on our little blue marble. I always feel like goldilocks after we take this tour around our solar system. We’re not too wet, we’re not too dry. We’re not too close to the sun, we’re not too far away. We don’t have too much atmosphere, we don’t have too little atmosphere. Our planet is just right. Even if we found another place out there we could survive, it won’t be just like Earth, because in the entire universe there’s not going to be a place just like home.”

**Citations**

[1] <http://science.nasa.gov/science-news/science-at-nasa/2000/ast29jun_1m/>

[2] <http://dsc.discovery.com/news/2008/10/29/mars-opals-water.html>

[3] <http://physwww.mcmaster.ca/~higgsp/3D03/BrasierArchaeanFossils.pdf>

[4] <http://hyperphysics.phy-astr.gsu.edu/hbase/kinetic/vappre.html#c5>

[5] <http://science.nasa.gov/science-news/science-at-nasa/2001/ast20feb_1/>

[6] <http://www.esrl.noaa.gov/gmd/ccgg/trends/>

[7] <http://www.nasa.gov/topics/solarsystem/features/20090218.html>

[8] <http://nssdc.gsfc.nasa.gov/planetary/factsheet/sunfact.html>

[9] <http://imagine.gsfc.nasa.gov/docs/ask_astro/answers/981216a.html>