

## Elective 10 – Integrating NASA Data – Activity 1:

<https://spaceplace.nasa.gov/magic-windows/en/#/review/magic-windows/vis.html> Activity 2: Adapted from My NASA Data website resource

<https://mynasadata.larc.nasa.gov/mini-lessonactivity/describing-radiation-earths-energy-budget>

### Content:

This activity will be an intermediate lesson in my unit as a supporting lesson for the EM spectrum. The storyline unit I am using does not implicitly teach about the EM spectrum and I do not think most students have had prior lessons on it to fully understand the connections to the telescopes and instrumentation used to search for and find evidence of elements, compounds, and information about whether or not life would be supported in space or on other celestial bodies.

The use of the EM spectrum and waves is integral to the astrophysics and astrobiology I am trying to help connect to the chemistry of elements, compounds and molecules related to supporting life (before or now or in the future!) There is a real blurry line between physics and chemistry when discussing “space” and it might not be force or motion concepts, but it is physics/physical science 😊

### Reflection:

Pros/Cons – I must decide if this is a required activity for all students or an elective for those who are weaker in their comprehension of how the UV, IR, and Visible light are involved in how the telescopes and rovers and other instruments are collecting information and evidence about everything outside of earth! I think some students may find it too rudimentary, but I still want them to be able to answer in well thought out sentences and demonstrate their understanding of the application of the foundational science of wavelength and how useful it can be.

There are multiple parts included in this activity and it can be modified to allow students to explore and reflect or complete as a worksheet/assignment. I really like the visual resources, they are very clear, and are visually interesting, which I hope helps kids to gather information from them.

### Sources:

1. Butcher, G., & Mottar, J. (2011). *Tour of the Electromagnetic Spectrum*. (C. L. Parkinson & E. J. Wollack, Eds.) *Tour of the Electromagnetic Spectrum* (3rd, Third, 3e). United States Government Printing Office. Retrieved July 25, 2022, from <https://science.nasa.gov/ems>.
2. What is Earth's Energy Budget? Five Questions with a Guy Who Knows. (2017, April 10). NASA. Retrieved September 8, 2022, from <https://www.nasa.gov/feature/langley/what-is-earth-s-energy-budget-five-questions-with-a-guy-who-knows>

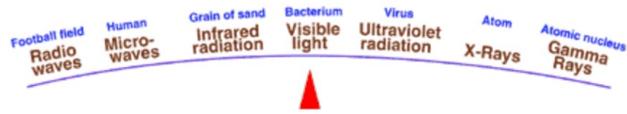
## Activity 1: EM Spectrum:

Explore the electromagnetic spectrum activity:

Click on the magic window after clicking on the link ([click here](#))

This is what you should see.

### The Magic Visible Light Window



Complete the data table below as you explore the 7 sections that make up the EM spectrum]

Wave	Size	Distance	Purpose/ source	Other important info
Radio				
Microwave				
Infrared				
Visible				
Ultraviolet				
Xray				
Gamma				

#### Sources:

- Butcher, G., & Mottar, J. (2011). *Tour of the Electromagnetic Spectrum*. (C. L. Parkinson & E. J. Wollack, Eds.) *Tour of the Electromagnetic Spectrum* (3rd, Third, 3e). United States Government Printing Office. Retrieved July 25, 2022, from <https://science.nasa.gov/ems>.
- What is Earth's Energy Budget? Five Questions with a Guy Who Knows. (2017, April 10). NASA. Retrieved September 8, 2022, from <https://www.nasa.gov/feature/langley/what-is-earth-s-energy-budget-five-questions-with-a-guy-who-knows>

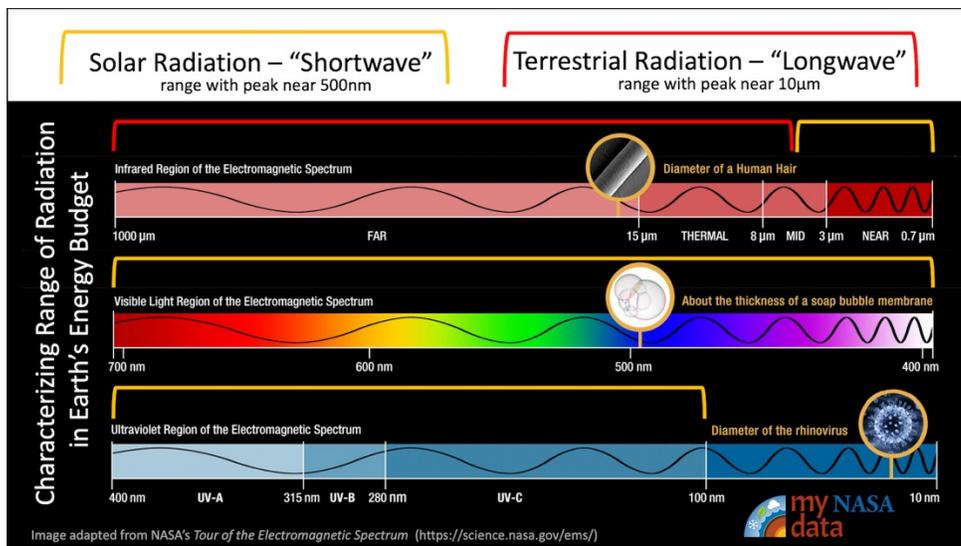
## Activity 2: Wavelength and Radiation

### Overview

Using an infographic, students describe differences in electromagnetic radiation that is part of a model of Earth’s energy budget by applying the defined terms of Shortwave Radiation and Longwave Radiation.

### Student Directions

Part 1: Review the infographic below, illustrating the differences between what scientists describe as “shortwave radiation” and “longwave radiation” involved in Earth’s energy budget. These are descriptors of electromagnetic waves with certain characteristics.



Ranges of radiation that define shortwave and longwave radiation. Source: *Tour of the Electromagnetic Spectrum - 3rd Edition* | [https://mynasadata.larc.nasa.gov/sites/default/files/inline-images/Short\\_long%20wave%20radiation.png](https://mynasadata.larc.nasa.gov/sites/default/files/inline-images/Short_long%20wave%20radiation.png)

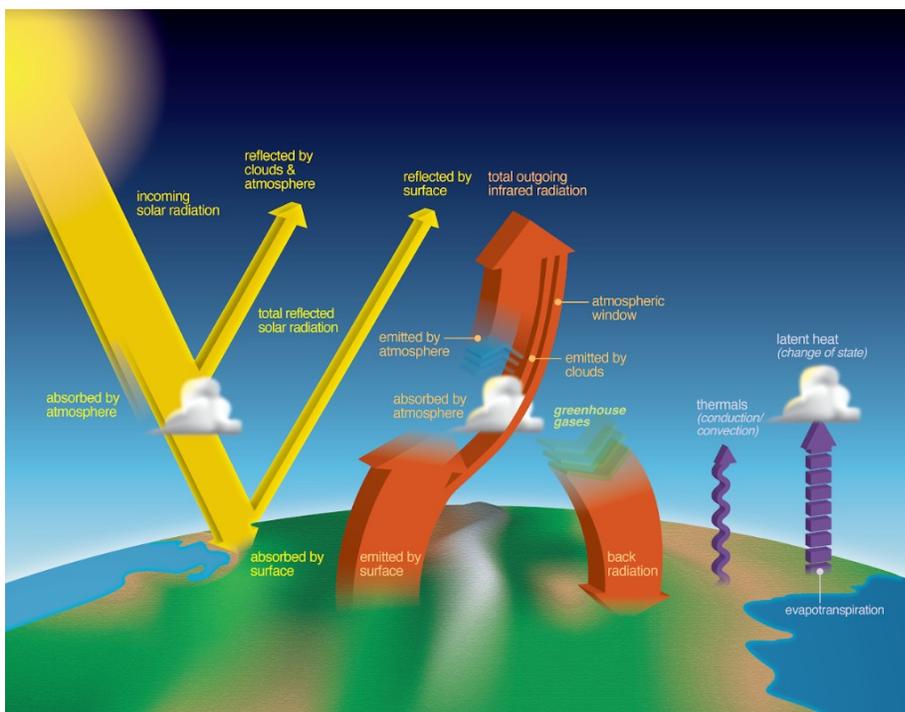
1. Identify the three distinct classifications of radiation (forms of electromagnetic energy) shown in the infographic.
2. Identify the measured value for each type of radiation. What units are used?

#### Sources:

1. Butcher, G., & Mottar, J. (2011). *Tour of the Electromagnetic Spectrum*. (C. L. Parkinson & E. J. Wollack, Eds.) *Tour of the Electromagnetic Spectrum* (3rd, Third, 3e). United States Government Printing Office. Retrieved July 25, 2022, from <https://science.nasa.gov/ems/>.
2. What is Earth's Energy Budget? Five Questions with a Guy Who Knows. (2017, April 10). NASA. Retrieved September 8, 2022, from <https://www.nasa.gov/feature/langley/what-is-earth-s-energy-budget-five-questions-with-a-guy-who-knows>

3. Explain why it is important to not simply compare the numerical values when comparing the measurements of each classification.
4. Describe the range of radiation characterized as “shortwave radiation.”
5. Describe the range of radiation characterized as “longwave radiation.”
6. Discuss how the energy associated with shortwave radiation compares to the energy associated with longwave radiation.

Part 2: Review the model of Earth's Energy Budget below, used to communicate the complex transfer of energy in the Earth system that ultimately drives the climate heat engine. Answer the following questions.



Earth Energy Budget Diagram. Source: Loeb et al., J. Clim. 2009 & Trenberth et al., BAMS, 2009 | [https://myasadata.larc.nasa.gov/sites/default/files/inline-images/Earth\\_energy\\_budget\\_Labels.png](https://myasadata.larc.nasa.gov/sites/default/files/inline-images/Earth_energy_budget_Labels.png)

7. Identify the source of “shortwave radiation.”
8. Identify the source of “longwave radiation.”
9. Describe how the Earth’s energy budget model distinguishes between shortwave and longwave radiation.

**Sources:**

1. Butcher, G., & Mottar, J. (2011). *Tour of the Electromagnetic Spectrum*. (C. L. Parkinson & E. J. Wollack, Eds.)*Tour of the Electromagnetic Spectrum* (3rd, Third, 3e). United States Government Printing Office. Retrieved July 25, 2022, from <https://science.nasa.gov/ems>.
2. What is Earth's Energy Budget? Five Questions with a Guy Who Knows. (2017, April 10). NASA. Retrieved September 8, 2022, from <https://www.nasa.gov/feature/langley/what-is-earth-s-energy-budget-five-questions-with-a-guy-who-knows>

10. Look closely at the model and describe the different interactions clouds have with shortwave radiation and longwave radiation.
11. Identify the heat illustrated in the model that is NOT characterized by either shortwave or longwave radiation.

Activity 2 Answer key:

1. Identify the three distinct classifications of radiation (forms of electromagnetic energy) shown in the infographic. **IR, Visible and UV**
2. Identify the measured value for each type of radiation. What units are used? **distance, in nm or  $\mu\text{m}$ .**
3. Explain why it is important to not simply compare the numerical values when comparing the measurements of each classification. **The application and interaction of different wavelengths is more complex than just its size.**
4. Describe the range of radiation characterized as “shortwave radiation.” **Anywhere from 100 to 700 um and 0.7 to 3 um in the IR.**
5. Describe the range of radiation characterized as “longwave radiation.” **5um to 1000 um in the IR range**
6. Discuss how the energy associated with shortwave radiation compares to the energy associated with longwave radiation. **most falls into the Shortwave range**
7. Identify the source of “shortwave radiation.” **Solar**
8. Identify the source of “longwave radiation.” **Terrestrial**
9. Describe how the Earth’s energy budget model distinguishes between shortwave and longwave radiation. **Color of the arrows and the size of the arrow as well.**
10. Look closely at the model and describe the different interactions clouds have with shortwave radiation and longwave radiation. **the**

**Sources:**

1. Butcher, G., & Mottar, J. (2011). *Tour of the Electromagnetic Spectrum*. (C. L. Parkinson & E. J. Wollack, Eds.)*Tour of the Electromagnetic Spectrum* (3rd, Third, 3e). United States Government Printing Office. Retrieved July 25, 2022, from <https://science.nasa.gov/ems>.
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clouds impact the terrestrial more than the solar, absorbing some of the energy.

11. Identify the heat illustrated in the model that is NOT characterized by either shortwave or longwave radiation. **change of state due to evapotranspiration**

**Sources:**

1. Butcher, G., & Mottar, J. (2011). *Tour of the Electromagnetic Spectrum*. (C. L. Parkinson & E. J. Wollack, Eds.)*Tour of the Electromagnetic Spectrum* (3rd, Third, 3e). United States Government Printing Office. Retrieved July 25, 2022, from <https://science.nasa.gov/ems>.
2. What is Earth's Energy Budget? Five Questions with a Guy Who Knows. (2017, April 10). NASA. Retrieved September 8, 2022, from <https://www.nasa.gov/feature/langley/what-is-earth-s-energy-budget-five-questions-with-a-guy-who-knows>