

# Educating Space Age Environmentalists: A Kindergarten-High School Standards-Based Curricular Approach

(Aligned to the Next Generation Science Standards for Earth and Space Science)

## GRADE 4



Robert S. Bachelder and Beverly B. Bachelder  
[www.protectouterspace.com](http://www.protectouterspace.com)

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## Grade 4

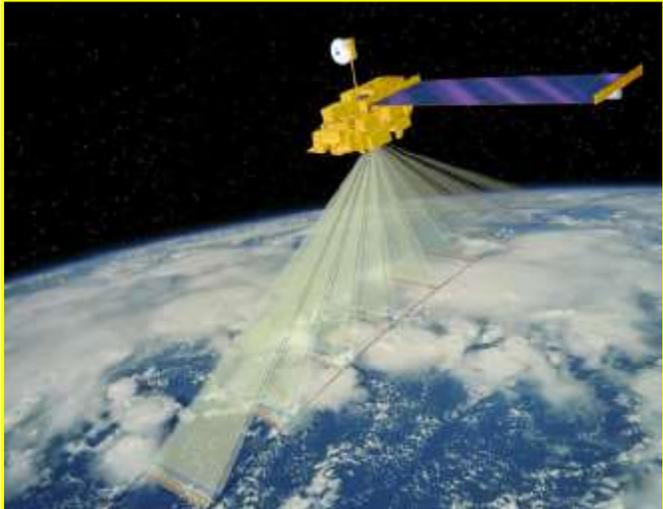
### Introduction:

Outer space is a valuable natural resource, serving as home to MISR (the Multi-angle Imaging Spectroradiometer). This instrument, housed on the Terra satellite, helps scientists understand how tsunamis interact with islands and coastlines, so that better models can be created to predict where and when a tsunami will hit. Valuable satellites such as Terra are now at risk from space debris, and if solutions are not found, data essential to human life and health may be lost.

Through a lesson on how satellites save lives in a tsunami, students learn how information provided by satellites provides early warning to people in the storm's path, thus providing time for them to move to safety. This lesson is aligned with **4-ESS3-2 (Earth and Human Activity)**. Students read an article about what causes a tsunami and view an animation of how a Pacific Ocean tsunami system works, thus gaining a deeper appreciation of the key role satellites play in saving lives. Two recommended story books, a NOVA-produced video on surviving tsunamis, and a *National Geographic Kids* page all help students to grasp more fully lessons learned from coping with natural disasters.

Extension 1 materials feature a book and an article that serve as resources for a research project on various types of spacecraft and their functions. In addition, two videos, additional activities, and games help students understand more clearly what satellites are and what they do, including how they transmit data. Students also design their own satellite book for younger students.

Extension 2 materials include a satellite fact sheet, a NASA article about how scientists search for space junk, a space debris graphic, and a "Space Junk Song" by the artists Rhett & Link - all reinforcing the importance of outer space as a valuable natural resource now under threat. Students write opinion pieces about the importance of protecting outer space, in alignment with the *Common Core State Standards for English Language Arts and Literacy in History/Social Studies, Science, and Technical Subjects* for grade 4. As a culminating activity, students design their own space debris poster.

<p><b>Next Generation Science Standards Alignment</b></p>	<p><b>Spacecraft Featured:</b> <i>TERRA Satellite/MISR</i></p>	<p><b>NASA Main Pages for Featured Spacecraft:</b> <a href="#">Click here</a> for MISR. <a href="#">Click here</a> for GOES.</p>
<p><b>Disciplinary Core Idea/Sub-Idea:</b> ESS3. Earth and Human Activity Natural Hazards (ESS3.B)</p> <p>Grade 4: Earth and Space Sciences</p> <p><b>ESS3. Earth and Human Activity</b></p> <p>4-ESS3-2. Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.</p>	 <p>Artist's concept of Terra satellite with MISR on board. Credit: NASA</p>	<p><i>"Most satellite instruments look only straight down, or toward the edge of the planet. To fully understand Earth's climate, and to determine how it may be changing, we need to know the amount of sunlight that is scattered in different directions under natural conditions. MISR is a new type of instrument designed to address this need – it views the Earth with cameras pointed at nine different angles."</i></p> <p><i>-From NASA website</i></p>

**NSTA-Vetted Lesson Plans – NGSS@NSTA**

Lesson/Instructional Resources: "Getting the Right Angle on the Story – How Satellites Can Save Lives in a Tsunami" (from NASA Space Place – NGSS-Aligned Lesson Plans for Grades 3-8) – (NSTA-vetted lesson)

Overview:

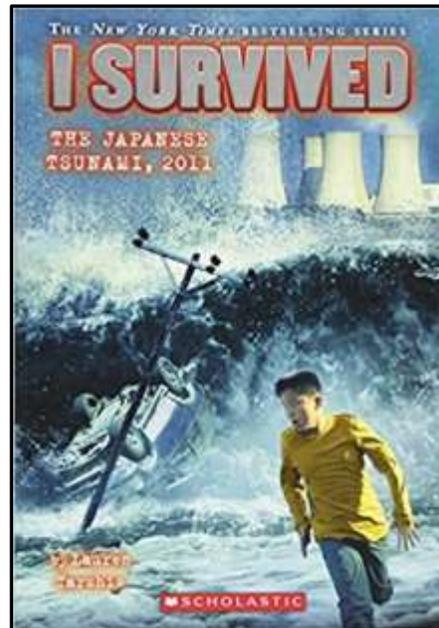
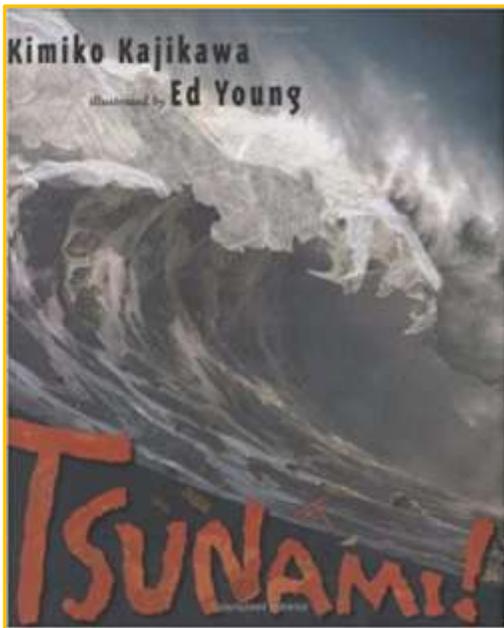
This lesson and accompanying instructional materials are designed to help students understand the key role weather satellites play in alerting the public to potentially severe weather, thus allowing time for people in the storm's path to prepare for the storm and take measures to stay safe. The article provided clearly explains what causes a tsunami, and describes how scientists use images from a MISR (Multi-angle Imaging Spectroradiometer) instrument on the Terra satellite to better understand how tsunamis interact with islands and coastlines, and to develop models that can predict where, when, and how severely a tsunami will hit – thus saving lives.

The animation – provided courtesy of the U.S. National Oceanic and Atmospheric Administration (NOAA) and the U.S. National Tsunami Hazard Mitigation Program – shows how a Pacific Ocean tsunami warning system works, and stresses the key role played in this system by a NOAA-operated Geostationary Operational Environmental Satellite (GOES).

[Click here](#) for a description of the materials, a full listing of alignment to NGSS, and suggested modifications to more fully align with the NGSS. An article and animation are also found at this site. [Click here](#) to go directly to the article and animation.

### Extension 1: Outer space is a valuable natural resource, serving as home to spacecraft that provide essential information and perspective for understanding Earth's Place in the Universe, Earth's Systems, and Earth and Human Activity.

**Instructional Focus:** *The Terra satellite's Multi-angle Imaging Spectroradiometer (MISR) helps scientists understand how tsunamis interact with islands and coastlines and assists them in making better predictions about when and where they will strike.*



Extension 1 materials feature three books, two videos, a Web Quest, and two articles.

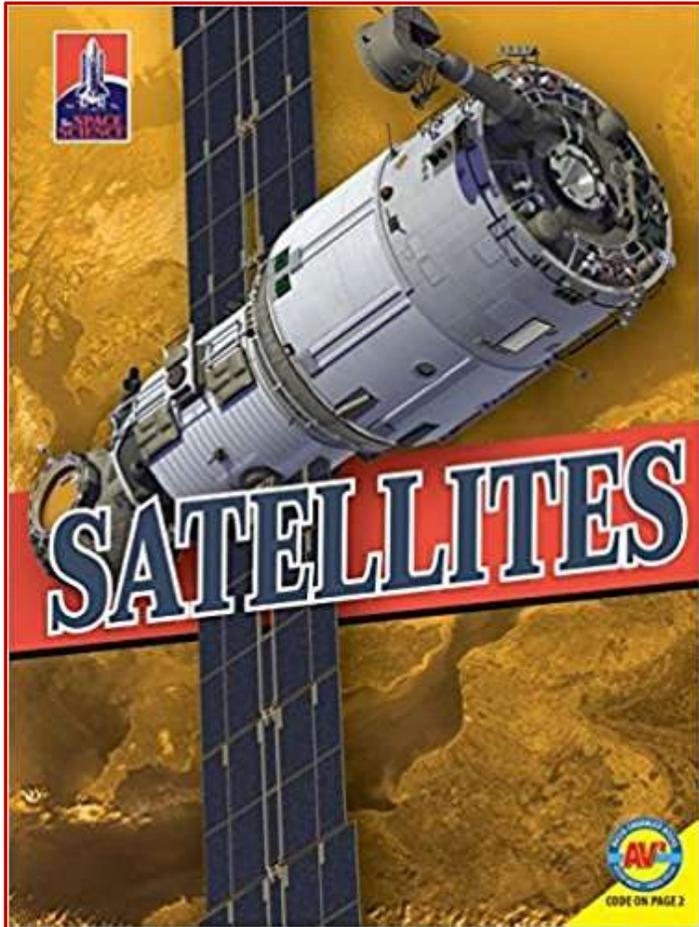
- **Book: Kajikawa, Kimiko and Ed Young. *Tsunami!*** New York: The Penguin Group, 2009. Print. ISBN: 978-0-399-25006-4. (Recommended by *School Library Journal* for Kindergarten-Grade 3/Stated Age Range: 3-5 years/Grade Level: Preschool-Kindergarten/Lexile Measure: NC620L.) Teachers report older children in grades 4 and 5 also enjoying this book.
- **Book: Tarshis, Lauren. *I Survived the Japanese Tsunami***. New York: Scholastic, Inc., 2013. Print. ISBN: 978-0-545-45937-2. (Appeals to 2<sup>nd</sup>-4<sup>th</sup> graders; Reading Level – Grade 4)



Credit: Clipart Panda

- **Video: *Surviving the Tsunami*** - This Nova video, produced by PBS, provides a fascinating look at tsunamis, particularly focusing on gripping personal stories of Japan after lessons learned from the tsunami in the wake of the earthquake that hit the northern coast of Japan on March 11, 2011. [Click here](#) for the video.

- **Article: “Tsunami Facts – Check Out the Mighty Wave.”** [Click here](#) for an excellent background article about tsunamis, found on the *National Geographic Kids* page.



- **Book: Baker, David and Heather Kissock. *Satellites (All About Space Science)*.** New York: AV2 by Weigl, 2016. Print. ISBN: 978-1489658319. (Age Range: 8-11 years/Grade Level: 4-6)

This book provides a helpful vehicle for introducing students to satellites and the range of benefits satellites provide. It is one of a series, *All About Space Science*. Quoting from the description posted on the Amazon.com website:

*“This series examines the history and science of space exploration. It also delves into the careers and technological advancements associated with this exciting field of study.”*

One excellent way to utilize this book would be to divide the class into teams, with each team researching a different type of satellite described in the book, based on the satellite’s function, including such areas as communications, navigation (GPS), earth imaging, weather, and research. Additional teams could be assigned to research and prepare a report or presentation on space telescopes – including the Hubble telescope, the soon-to-be-launched James Webb telescope, and satellites of the future. Each team could then prepare a report/oral presentation, and present their findings to the class. The project could also include a career component, in which each team could research a career associated with space exploration.



# Satellites Above

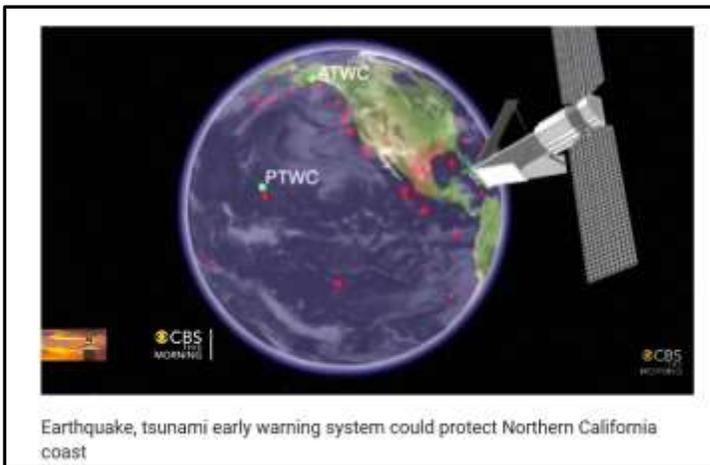


WebQuest for Grades 3-5  
Using MY NASA DATA

- **WebQuest – Create a Satellite Book:** Students create their own NASA Satellite book for younger students in Kindergarten through second grade. [Click here](#) for the directions, questions, resources, and assessment rubric.
- **Article - “What is a Satellite?”** (from the *NASA Knows: Gr. 5-8* series). [Click here](#) for the article and accompanying activities, including games.



**Left:** NASA has more than a dozen Earth science satellites in orbit. They help NASA study the oceans, land and atmosphere. **Below:** The Jason-2 satellite orbits Earth. It carries tools and sensors to help scientists study the oceans. **Credit: NASA**



(Left – from video: *Earthquake, Tsunami Early Warning System Could Protect Northern California Coast*)

- **Video – Earthquake, Tsunami Early Warning System Could Protect Northern California Coast - CBS newscast – (about 3 min.)**

This video depicts a tsunami, as well as how satellites play a key role in warning people of tsunamis. [Click here](#) for the video.

**Extension 2: The growing problem of space debris requires us to clean up the space environment – utilizing new technologies and public advocacy – before it becomes too dangerous to navigate.**

*Instructional Focus: Students write an opinion piece about the importance of tracking space debris in alignment with Common Core State Standards after learning from a NASA article how telescopes track debris. They also listen to a song about garbage men in space and draw a picture of what a space garbage truck might look like.*

**Standards Alignment**

***Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects***

**Grade 4 Reading Standards for Informational Text [RI]**

**Key Ideas and Details**

**CCSS.ELA – Literacy.RI.4.1**

1. Refer to details and examples in a text when explaining what the text states explicitly and when drawing inferences from the text.

**CCSS.ELA – Literacy.RI.4.2**

2. Determine the main idea of a text and explain how it is supported by key details; summarize the text.

**CCSS.ELA – Literacy.RI.4.3**

3. Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text.

**Craft and Structure**

**CCSS.ELA – Literacy.RI.4.4**

4. Determine the meaning of general academic and domain-specific words or phrases in a text relevant to a *grade 4 topic or subject area*.

**CCSS.ELA – Literacy.RI.4.5**

5. Describe the overall structure (e.g., chronology, comparison, cause/effect, problem/solution) of events, ideas, concepts, or information in a text or part of a text.

**Grade 4 Writing Standards [W]**

**Text Types and Purposes**

**CCSS.ELA – Literacy.W.4.1**

1. Write opinion pieces on topics or texts, supporting a point of view with reasons and information.

**CCSS.ELA – Literacy.W.4.1.A**

- a. Introduce a topic or text clearly, state an opinion, and create an organizational structure in which related ideas are grouped in paragraphs and sections to support the writer’s purpose.

**CCSS.ELA – Literacy.W.4.1.B**

- b. Provide reasons that are supported by facts and details.

**CCSS.ELA – Literacy.W.4.1.C**

- c. Link opinion and reasons using words and phrases (e.g., *for instance, in order to, in addition*).

**CCSS.ELA – Literacy.W.4.1.D**

- d. Provide a concluding statement or section related to the opinion presented.

**Production and Distribution of Writing**

**CCSS.ELA – Literacy.W.4.4**

- 4. Produce clear and coherent writing in which the development and organization are appropriate to task, purpose, and audience.

**CCSS.ELA – Literacy.W.4.5**

- 5. With guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, and editing.

**Language [L]**

**Conventions of Standard English**

**CCSS.ELA – Literacy. L.4.1**

- 1. Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.

**Vocabulary Acquisition and Use**

**CCSS.ELA – Literacy.L.4.6.**

- 6. Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases, including those that signal precise actions, emotions, or states of being (e.g., *quizzed, whined, stammered*) and that are basic to a particular topic (e.g., *wildlife, conservation, and endangered* when discussing animal preservation).

**Grade 4 Speaking and Listening Standards [SL]**

**Comprehension and Collaboration**

**CCSS.ELA – Literacy.SL.4.1**

- 1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 4 topics and texts, building on others' ideas and expressing their own clearly.

**CCSS.ELA – Literacy.SL.4.1.A**

- a. Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion.

**CCSS.ELA – Literacy.SL.4.1.B**

- b. Follow agreed-upon rules for discussions and carry out assigned roles.

**CCSS.ELA – Literacy.SL.4.1.C**

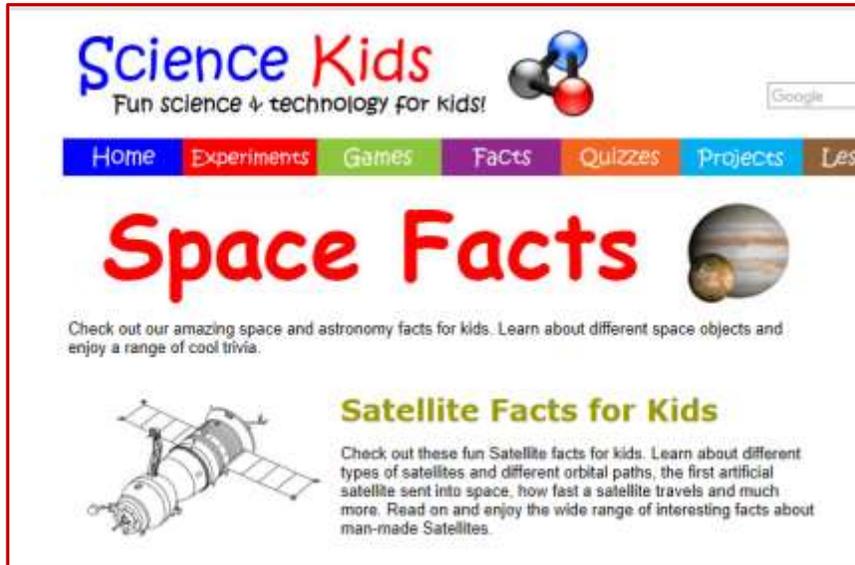
- c. Pose and respond to specific questions to clarify or follow up on information, and make comments that contribute to the discussion and link to the remarks of others.

**CCSS.ELA – Literacy.SL.4.1.D**

d. Review the key ideas expressed and explain their own ideas and understanding in light of the discussion.

Extension 2 materials feature a satellite fact sheet, a NASA article, a space debris graphic, a song, and a writing activity (opinion piece). As a culminating activity, students design their own space debris poster.

### 1. "Space Facts – Satellite Facts for Kids" sheet



Science Kids  
Fun science & technology for kids!

Home Experiments Games Facts Quizzes Projects Lessons

# Space Facts

Check out our amazing space and astronomy facts for kids. Learn about different space objects and enjoy a range of cool trivia.

## Satellite Facts for Kids

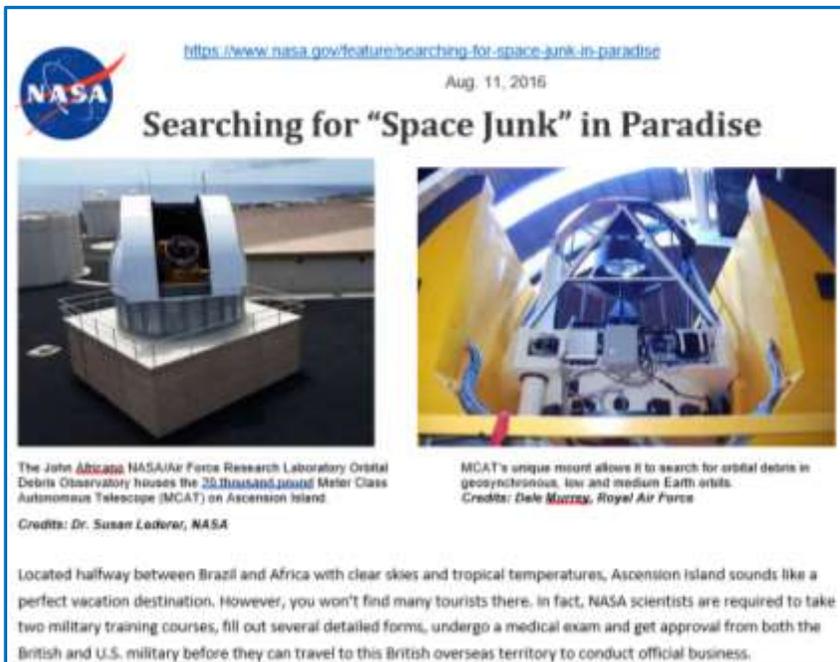
Check out these fun Satellite facts for kids. Learn about different types of satellites and different orbital paths, the first artificial satellite sent into space, how fast a satellite travels and much more. Read on and enjoy the wide range of interesting facts about man-made Satellites.

Following a discussion about the key role that weather satellites such as Terra play in alerting the public to potentially dangerous weather, distribute the **"Space Facts – Satellite Facts for Kids"** sheet. [Click here](#) for the "Space Facts" sheet.

This list of fun satellite facts for kids is very helpful in teaching students about the value of outer space as home to many different satellites. Several facts about the dangers of space debris and the threat this debris poses to satellites are also included. It's quick and handy "information in a nutshell." Quoting from the website:  
*Check out these fun satellite facts for kids. Learn about different types of satellites and different orbital paths, the first artificial satellite sent into space, how fast a satellite travels and much more. Read on and enjoy the wide range of interesting facts about man-made satellites.*

Review with the students the interesting facts about man-made satellites in this fact list. Note particularly the 19<sup>th</sup> and 20<sup>th</sup> bullet points about space debris. Review the subject-specific vocabulary words in this list.





## 2. Article: "Searching for 'Space Junk' in Paradise"

Next have students read this article, posted on Aug. 11, 2016. (attached)

This excellent article describes the new Meter Class Autonomous Telescope (MCAT) that NASA has located on Ascension Island to help track space debris. It provides a crucial service in covering a "blind spot" that other tracking instruments miss, thus giving scientists a more comprehensive view of orbital debris. Tracking debris is a crucial element in addressing the problem of space debris, and this article is very helpful in communicating this importance to students. The editors of protectouterspace.com have also formulated a list of questions based on the article, as well as standards-based writing activities to accompany the article (see appendix).

Once students have had time to define the vocabulary words, read the article, and answer the questions, review and discuss the article with them. Have students share their answers. Review with students the important functions that satellites perform from space, and why space debris is a threat to these satellites.



## 3. NASA space debris graphic

After students have read and discussed the article, show them the NASA space debris graphic. Explain that the little dots/objects represent pieces of space debris that are orbiting continuously around the Earth, and no longer serve a useful purpose; rather, this debris (or "junk") is endangering astronauts and spacecraft due to the risk of collisions. Explain the source of this debris, and provide specific examples, such as: discarded rocket parts, obsolete satellites that no longer work, leftover fuel tanks, old rocket boosters, bolts and screws, paint flecks, and items astronauts have lost out in space – such as tools and gloves.

Emphasize that this space junk must be cleaned up to keep astronauts and spacecraft safe. Compare this to the importance of keeping our environment clean here on Earth. Remind students they do this at home by keeping their rooms neat, cleaning up after themselves, and disposing of their trash correctly. Emphasize that it's also important to do this in space. Keeping outer space clean is very important so that astronauts can continue to work safely there, and spacecraft can continue to operate – providing us with important information to keep all living beings healthy and safe. Emphasize with students that space junk can destroy a spacecraft, and that even a paint fleck – traveling at a high rate of speed – can cause damage, as it did to a window in the International Space Station. [Click here](#) for the graphic. (Additional NASA space debris graphics are found by [clicking here](#).)



4. “Space Junk Song” video - (2 min.) - Artists: Rhett & Link (one of three videos they made for the Science Channel – July 6, 2009.

Next, introduce the “Space Junk Song” to students by showing the video and discussing the lyrics. As part of this discussion, pose this question:

“In the song, you saw the ‘space garbage men’ at work. What do you think an actual ‘space garbage truck’ might look like?” Once they have shared their ideas, emphasize that scientists are currently considering many different ideas for space junk cleanup, and that perhaps in the future, students may want to become aerospace engineers and design space debris solutions to help solve this problem. [Click here](#) for the song video. [Click here](#) for the song video lyrics.

(Left – from video: *Space Junk Song* – by Rhett & Link)

### 5. Writing Activity

Have students write an opinion piece, based on the following question: “Why is tracking space debris important for protecting spacecraft in outer space?” Back up your opinion with facts and details from the article (“Searching for ‘Space Junk’ in Paradise”). Include reasons for why tracking is important. Encourage students to share their pieces in partners or small groups, revising, editing, and finalizing – and then to share their final pieces with the class.

### 6. Space Debris Poster

As a culminating activity, have students design a space debris poster about the importance of cleaning up outer space, and removing the debris threat so astronauts and spacecraft can operate safely. Students might also wish to include their own ideas for a space debris cleanup solution. Materials needed for this project include poster board, pencils, crayons, colored pencils, markers, scissors, and rulers, as well as any other materials students may wish to use in decorating their posters. Prior to designing and creating the posters, provide students time – either as a class or working in small groups – to brainstorm ideas for the main slogan or message for their poster, as well as for the pictures they wish to include. (Cutouts of space debris objects are attached.)

If desired, hold a poster contest and enlist STEM professionals from your community as judges.

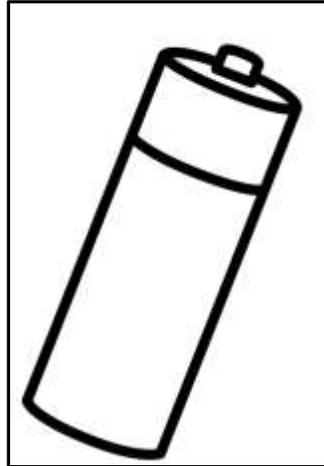


## Examples of Space Debris

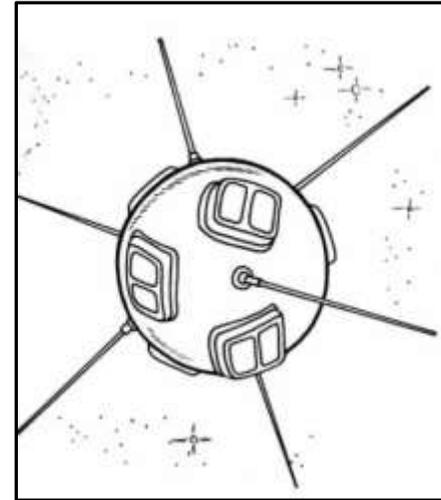
Paint Flecks



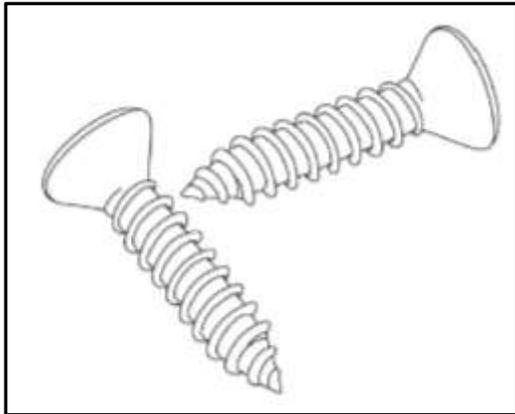
Old Battery



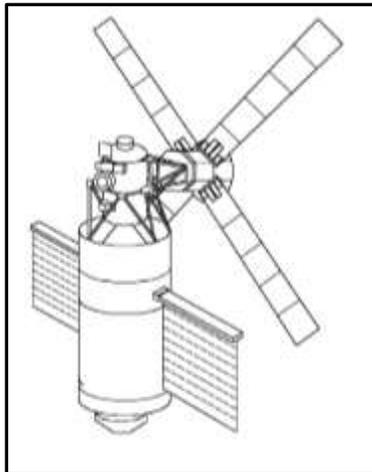
Explorer 1 Satellite - 1958



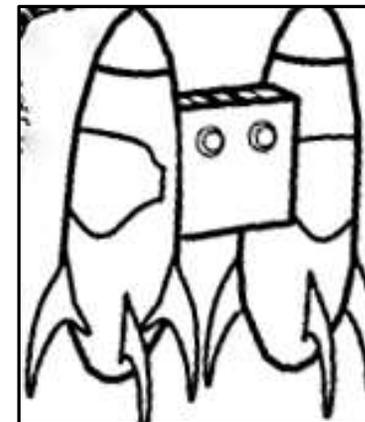
Screws



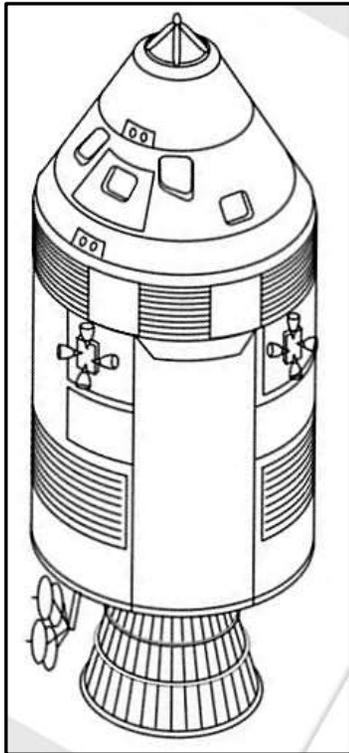
Old Satellite



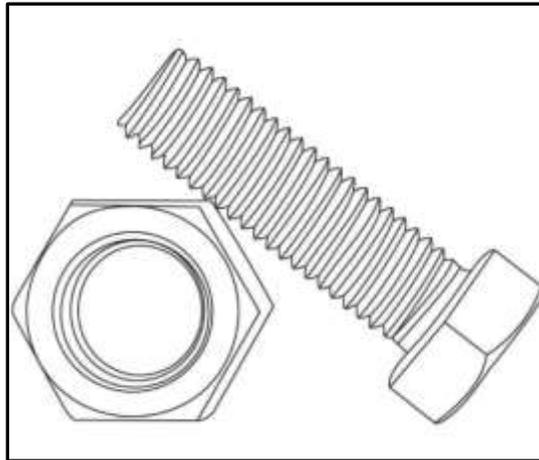
Leftover Fuel Tanks



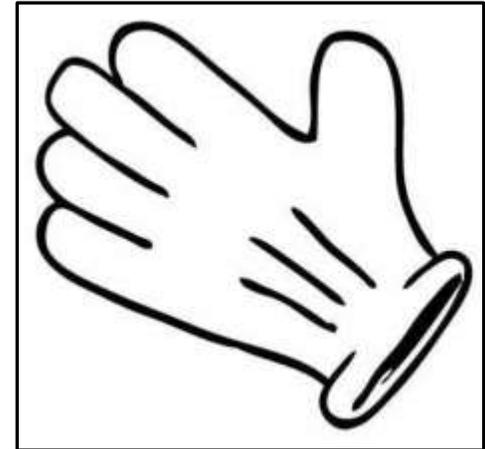
**Discarded Rocket**



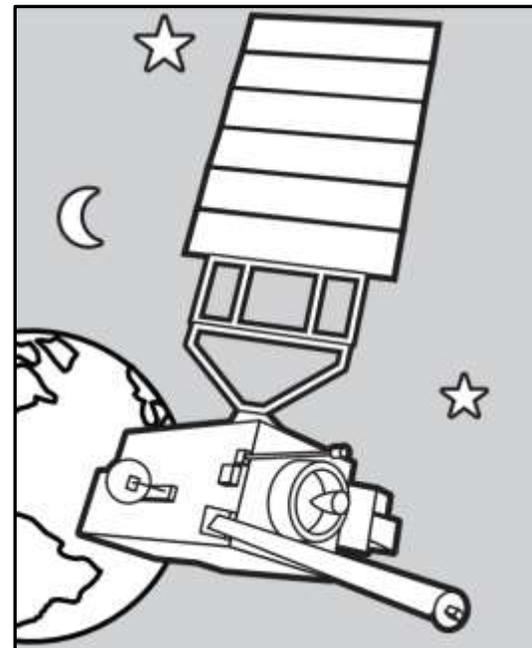
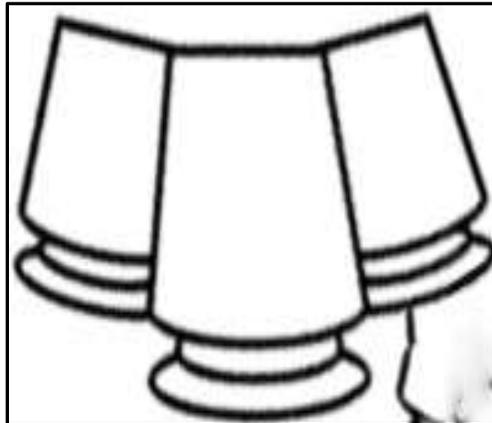
**Nuts and Bolts**



**Glove**



**Old Rocket Booster**



**GOES-R  
Satellite  
Coloring Page  
(from NASA  
GOES-R *Fun  
Activity Book*  
Page (from  
NASA))**



<https://www.nasa.gov/feature/searching-for-space-junk-in-paradise>

Aug. 11, 2016

## Searching for “Space Junk” in Paradise



The John Africano NASA/Air Force Research Laboratory Orbital Debris Observatory houses the 20 thousand pound Meter Class Autonomous Telescope (MCAT) on Ascension Island.

*Credits: Dr. Susan Lederer, NASA*



MCAT's unique mount allows it to search for orbital debris in geosynchronous, low and medium Earth orbits.

*Credits: Dale Murrey, Royal Air Force*

Located halfway between Brazil and Africa with clear skies and tropical temperatures, Ascension Island sounds like a perfect vacation destination. However, you won't find many tourists there. In fact, NASA scientists are required to take two military training courses, fill out several detailed forms, undergo a medical exam and get approval from both the British and U.S. military before they can travel to this British overseas territory to conduct official business.

It may then come as a surprise that NASA installed a brand-new telescope there.

The John Africano NASA/Air Force Research Laboratory Orbital Debris Observatory houses the 20,000-pound Meter Class Autonomous Telescope (MCAT) on Ascension Island. It is operated remotely by scientists in the Orbital Debris Program based in the Astromaterials Research and Exploration Science (ARES) Division, which performs physical science research at NASA's Johnson Space Center.

Although the location may seem a bit strange, there is a strong reason for choosing it.

“We selected Ascension Island for the location of the MCAT because it has great infrastructure, strong security and favorable trade winds,” Lisa Pace, the deputy chief of the ARES Division and former MCAT project manager, said. “But, the primary reason we chose it is because it covers a ‘blind spot’ in coverage that the Ground-Based Electro-Optical Deep Space Surveillance (GEODSS) assets, which track debris around the world, were missing.”

MCAT's construction and installation was completed in June 2015, and now the 1.3 meter (51-inch diameter) telescope's goal is to hunt in this blind spot for orbital debris, which is comprised of human-made objects in orbit about the Earth

that no longer serve a useful function. With that blind spot removed, MCAT will give NASA scientists as well as all spacecraft operators around the world a more comprehensive view of orbital debris.

The telescope is part of the ARES Division's Orbital Debris Program Office, whose mission is to determine the total amount of orbital debris and predict the risk it poses to spacecraft, including the International Space Station.

"Space debris poses a great risk to operating spacecraft, both manned and unmanned, so understanding this environment to avoid debris and design shields to protect from this debris is critical to NASA's ability to operate in space safely," Pace said.

The ARES Division will operate MCAT from JSC, combining the division's unique mix of remote sensing expertise, orbital debris knowledge and experience gleaned from fifty years of science operations in support of human and robotic space missions.

With over seven thousand metric tons and millions of individual pieces of "space junk" orbiting the Earth, this skill set will be needed to protect satellite and spacecraft. However, doing so can be a challenge: Orbital debris can move between one and 10 times faster than a bullet fired from a sniper rifle, so even a small piece can damage or possibly destroy satellites or spacecraft on impact.

MCAT has a unique feature that allows it to track these fast-moving debris: a double-horseshoe mount.

"MCAT's very unique mount, designed specifically for fast tracking of debris at low latitudes smoothly through the zenith, is one of the only two telescopes like it in the world," Susan Lederer, Ph.D., MCAT principal investigator and optical lead for NASA's Orbital Debris Program Office, said. "Most telescopes are incapable of doing what MCAT can do, and that gives NASA a distinct advantage in characterizing the debris environment around Earth."

This mount allows MCAT to search for debris in geosynchronous, low and medium Earth orbits, which will help the ARES Division continue to create models of the debris environment to guide the planning of space missions.

Ultimately, it may be difficult to imagine that a beautiful island in the middle of nowhere is home to a NASA telescope that monitors "space junk." However, Ascension Island and its role in the Orbital Debris Program Office are key to the preparation of future space missions with the goal of ensuring that satellites, spacecraft and the environment surrounding Earth are protected for years to come.

To learn more about the Astromaterials Research and Exploration Science Division, visit: <http://www.nasa.gov/centers/johnson/astromaterials>

Follow the division on [Facebook](#), [Twitter](#) or [Instagram @NASAastromaterials](#).

*Last Updated: Aug. 4, 2017*

*Editor: Mark Garcia*

Tags: [Johnson Space Center](#)

## Searching for “Space Junk” in Paradise

(Questions page created by the editors of [www.protectouterspace.com](http://www.protectouterspace.com),

based on NASA web page - posted Aug. 11, 2016 by the editors of [www.protectouterspace.com](http://www.protectouterspace.com))

<https://www.nasa.gov/feature/searching-for-space-junk-in-paradise>

Answer the following questions, based on the article.

### Vocabulary:

Autonomous	astromaterials	geosynchronous	infrastructure	trade winds
Surveillance	asset	comprehensive		

1. Where is Ascension Island located?
2. What is the name of the telescope NASA has installed on Ascension Island?
3. Where is the telescope housed?
4. Who operates the telescope?
5. Why was Ascension Island chosen as the location for this telescope?
6. What is orbital debris?
7. Describe the mission of the ARES Division’s Orbital Debris Program Office.
8. Why is tracking space debris so important?
9. How much space junk is orbiting the Earth?
10. Why can even a small piece of space debris damage or possibly destroy satellites or spacecraft?
11. How fast can space debris travel?
12. What kind of damage can space debris cause?
13. Describe the unique feature MCAT has that makes it so effective in tracking space debris.
14. How will scientists use the data from MCAT?

Assignment: Write an opinion piece, based on the following question: ***Is tracking space debris important for protecting spacecraft in outer space?*** Back up your opinion with facts and details from the article.

**Grade 4 Writing Standards (from the *Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects*)**

**CCSS.ELA – Literacy.W.4.1**

1. Write opinion pieces on topics or texts, supporting a point of view with reasons and information.

**CCSS.ELA – Literacy.W.4.1.A**

- a. Introduce a topic or text clearly, state an opinion, and create an organizational structure in which related ideas are grouped in paragraphs and sections to support the writer’s purpose.

**CCSS.ELA – Literacy.W.4.1.B**

- b. Provide reasons that are supported by facts and details.

**CCSS.ELA – Literacy.W.4.1.C**

- c. Link opinion and reasons using words and phrases (e.g., *for instance, in order to, in addition*).

**CCSS.ELA – Literacy.W.4.1.D**

- d. Provide a concluding statement or section related to the opinion presented.