National Aeronautics and Space Administration

# A View from the Top:
## Looking at Earth from Space

An Educator Guide
corresponding to the grades 5-8
Digital Learning Network Videoconference Expedition



| | |
|---|---|
| **Grades** | 5-8 |
| **Subject Areas** | Civics, Geography, Science, Social Studies |
| **Code** | DLN View From Top 5-8 Expedition 0409 |

# Table of Contents

# A View from the Top: Looking at Earth from Space

## Digital Learning Network (DLN) Expeditions

A DLN Expedition is a one time, live connection that allows students to experience NASA first-hand. Each expedition features an integrated educational package of grade-appropriate instruction and activities centered around a 50-minute videoconference. Students participate in a question and answer session with a NASA education specialist or a NASA subject matter expert. Details on equipment needed and how to request a videoconference may be found at: **http://dln.nasa.gov/dln/**

**Expedition Overview**
Many of us have marveled at the beautiful photographs of the Earth taken from the Space Shuttle and International Space Station. NASA collects data relating to climate change, weather events, pollution, and land use using Earth Observation Satellites. Join NASA's Digital Learning Network as we work together to develop interpretive skills and learn how to look at space-based photography the same way Earth observation scientists do at NASA.

**Grade Level(s)** 5-8

**Focus Question**
NASA scientists study images of Earth taken from space from geographic and scientific points of view. What can we learn by studying Earth imagery?

**Instructional Objectives**

- Students will describe how geographers use remote sensing data to answer questions about physical and human interactions on our planet through examination of NASA images.
- Students will explain the importance of using Earth Observation Satellites to obtain information about our dynamic planet.
- Students will describe how remote sensing instruments collect data.

**Outline for *A View from the Top* Videoconference**

I. Welcome
II. Introduction
III. How We get Images from Space
IV. Remote Sensing
V. Benefits of Using Images from Space
VI. Precipitation
VII. Urban Development
VIII. Pollution
IX. Ancient Civilizations
X. Careers
XI. Q & A
XII. Goodbye

## Expedition Videoconference Guidelines

**Teachers,** please review the following points with your students prior to the event:

- A videoconference is a two-way event. Students and NASA presenters can see and hear one another.
- Students are sometimes initially shy about responding to questions during a distance learning session. Explain to the students that this is an interactive medium and we encourage questions.
- Students should speak in a loud, clear voice. If a microphone is placed in a central location instruct the students to walk up and speak into the microphone.
- Teacher(s) should moderate students' questions and answers.
- Follow-up questions can be continued after the conference through email submitted by the teacher to the presenter.

## Teacher Event Checklist

| Date Completed | Pre-Conference Requirements (2-7 days before the videoconference) |
|---|---|
| | 1. Print a copy of the educator guide. |
| | 2. Have the students complete the pre-assessment. |
| | 3. Have students complete the pre-conference activity. |
| | 4. If students have questions for the presenter before the scheduled videoconference, they should write questions on an index card and have them ready for the interactive videoconference. |
| | 5. Student questions should be reviewed and discussed with the teacher prior to the videoconference. |
| | **Day of the Conference Requirements** |
| | 1. The students are encouraged to ask the NASA presenter questions about the concepts discussed during the program. |
| | **Post-Conference Requirements** |
| | 1. Have the students take the post-assessment to demonstrate their increased knowledge of the subject. |
| | 2. Use the answer key provided as a guideline for content and presentation criteria. |
| | 3. Feedback from you and some of your students would be appreciated using the online form at: http://dln.nasa.gov/dln/content/feedback/ |

# Background Information

**Electromagnetic Spectrum**

The Electromagnetic Spectrum is the arrangement of types of energy (such as light) by the length of its energy waves. Types of radiation range from those with short wavelengths (gamma rays) to ones with long wavelengths (radio waves). See Figure 1.

The unit of measurement of wavelength is the nanometer, abbreviated nm, which is one $1 \times 10^{-9}$ of a meter. That's smaller than tiny!

Typical aerial photography and infrared aerial photography are taken in the visible and photographic infrared bands. The **visible spectrum** (400 nm–700 nm) is a small portion of the Electromagnetic Spectrum which human eyes can detect. Energy in the **infrared spectrum** has longer wavelengths (720–1500 nm) than in the visible spectrum.

Electromagnetic waves radiate through space from some source. Earth's primary source of radiation is the Sun. When the energy encounters an object, even a very tiny one like a molecule of air, one of four actions occurs: 1) energy is reflected off the object, 2) energy is absorbed by the object, 3) energy is refracted off the object, or (4) energy is transmitted through the object.

In remote sensing, we are largely concerned with reflected radiation. Reflected radiation causes our eyes to see colors, causes infrared film to record vegetation, and allows radar images of the Earth to be created. The wave nature of electromagnetic radiation is characterized by wavelength and frequency as follows.

- **Wavelength** (symbol lambda, $\lambda$) is the distance between 2 successive wave crests or troughs.
- **Frequency** (*f or* $\nu$) is the number of wave crests or troughs (cycles) that pass a fixed point per second

Wavelength and frequency are related to the velocity of an electromagnetic wave (the speed of light) as shown below.

speed of light ($c$) = frequency ($f$) x wavelength ($\lambda$)

Lengths and frequencies of waves are inversely related. That is, more powerful energy waves have shorter wavelengths and higher frequencies while weaker energy waves have longer wavelengths and higher frequencies. This is shown when the equation above is expressed as:

$$\frac{c}{f} = \lambda \quad \text{OR} \quad \lambda \propto \frac{1}{f}$$

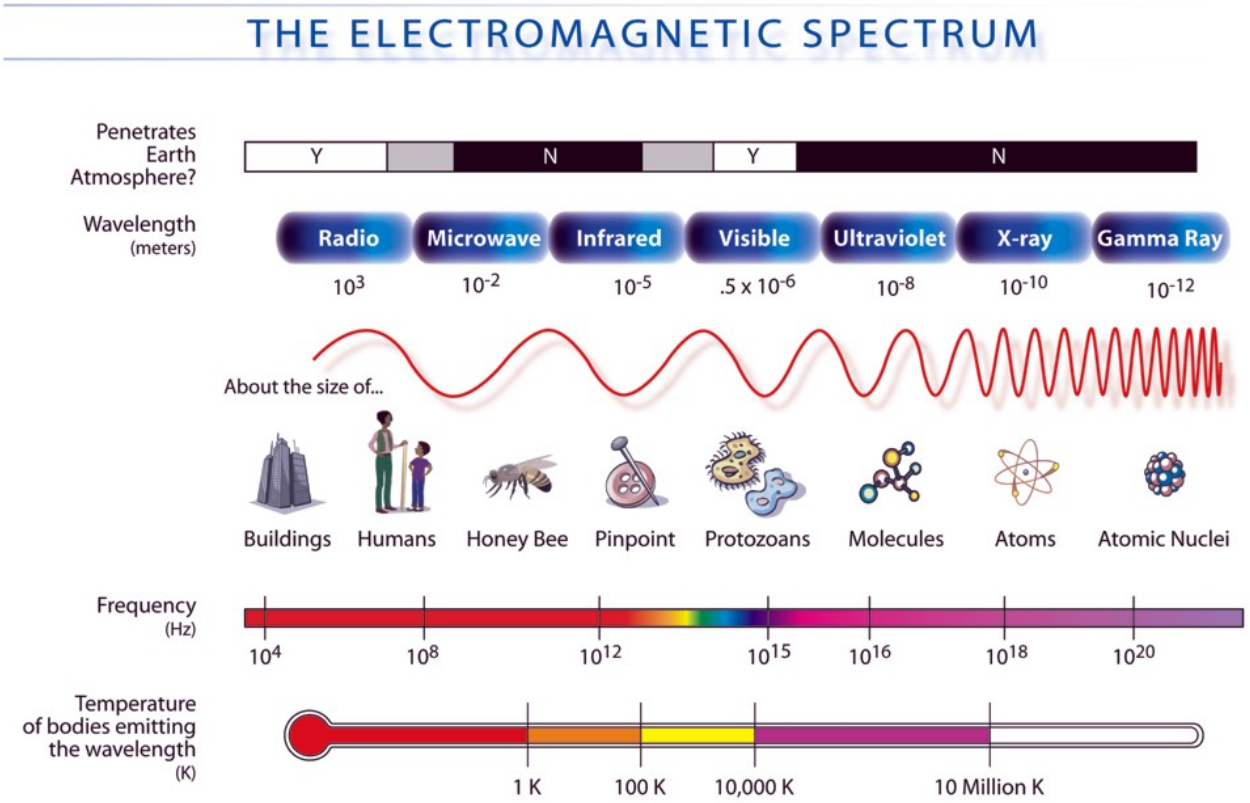



**Figure 1**. This Electromagnetic Spectrum diagram gives examples of the sizes of various energy waves. For instance, the wavelengths of the weaker radio and microwaves are the size of buildings and people, while the stronger X-rays and gamma rays are much shorter (submicroscopic in length).

## National Education Standards

**National Science Education Standards (NSES)**

**Content Standard D: Earth and Space Science**
**Structure of the earth system (5-8)**
Students' study of Earth's history provides some evidence about co-evolution of the planet's main features—the distribution of land and sea, features of the crust, the composition of the atmosphere, global climate, and populations of living organisms in the biosphere. Through direct observation and satellite images, students should be able to conclude that Earth has unique features that distinguish it from other planets in the solar system.

# National Education Standards (continued)

## National Science Education Standards (NSES)

### Content Standard F: Science in Personal and Social Perspectives Populations, Resources, and Environment (5-8)

Students learn about a population, its culture, its environmental surroundings, and risks from technologies resulting in environmental degradation through observation of lithographs of Earth taken from space. Analysis of lithographs will allow students to develop inference skills about the people who inhabit a particular area of Earth and learn about how technology and science can provide both positive and negative consequences on a society and its environment.

### Content Standard: Science and Technology (5-8)

The science and technology standards establish connections between the natural and designed worlds and provide students with opportunities to develop decision-making abilities. As a complement to the abilities developed in the science as inquiry standards, these standards call for students to develop abilities to identify and state a problem, design a solution—including a cost and risk-and-benefit analysis—implement a solution, and evaluate the solution. Science as inquiry is parallel to technology as design. Both standards emphasize student development of abilities and understanding.

## National Geography Standards

### Standard 4: The Physical and Human Characteristics of Places (5-8)

This standard covers how different physical processes shape places, how different human groups alter places in distinctive ways, and the role of technology in shaping the characteristics of places**.**

**Name** _____ **Circle One:** Pre Post **Date** _____

## Pre-/Post-Conference Assessment

1. What is the ISS EarthKAM? How is it unique?

2. List three ways scientists and geographers might use information they gather from space-based photography to understand changes on the Earth.

3. Define remote sensing.

4. What is the part of the electromagnetic spectrum that can be seen by the naked eye called?

5. What is the difference between a false color and a true color image?

# Pre-/Post-Conference Assessment (continued)

6. Why is it important to look for different wavelengths of energy in Earth studies?

7. Describe the relationship between the wavelength of a wave and the energy of a wave.

8. Describe how satellite images and maps are different and similar.

9. Identify at least one unusual use for remote sensing.

10. Identify five different features of land or water in the following images.

**Please print images 10a, b, and c in color (if possible) or project the images from the websites given below.**

**http://visibleearth.nasa.gov/view_rec.php?id=1159** (image size – 49.2KB)

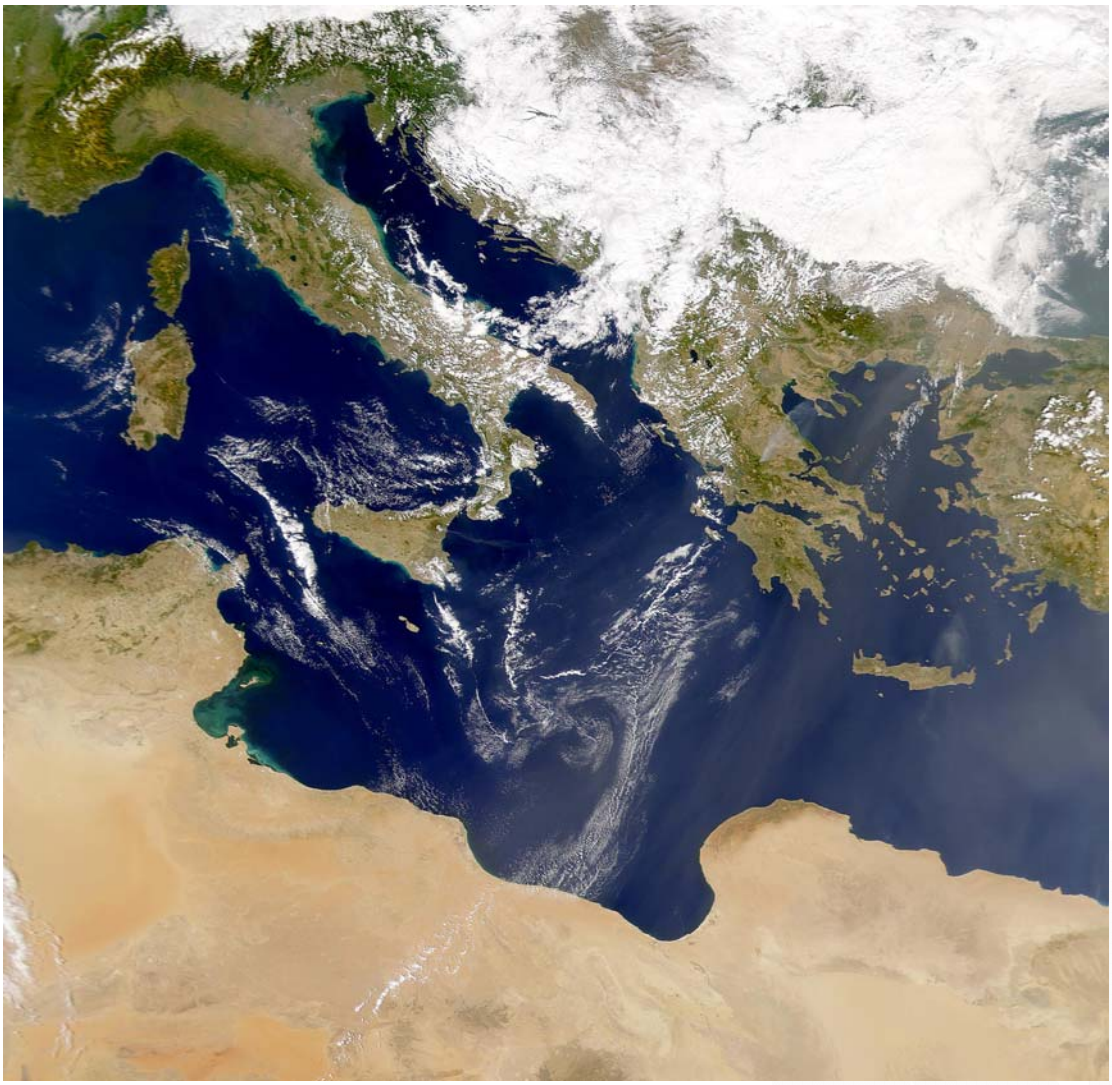
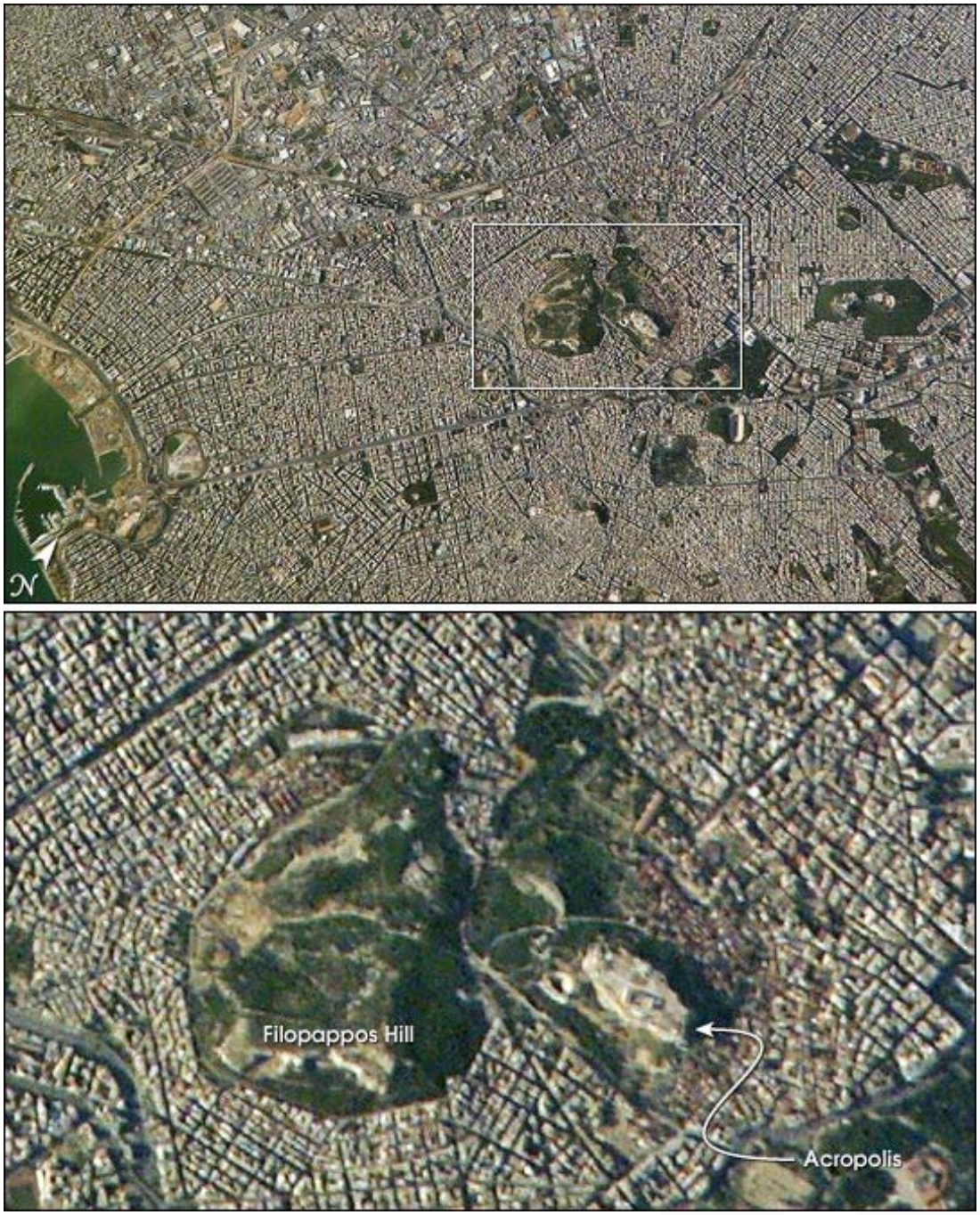


**Figure 10a.** This image, taken by the SeaWIFS spacecraft, shows the central Mediterranean on the first day of autumn of 2000. Mount Etna is sending an ash plume downwind while smoke from a fire in central Greece moves in a different direction. Dust continues to blow northward from Africa.

http://visibleearth.nasa.gov/view_rec.php?id=16307 (image size – 156.8 KB)




**Figures 10b and 10c.** These high-resolution photographs, taken by astronauts aboard the International Space Station, show details of Athens' historic ruins. Some of the most distinctive features of the Acropolis are the Parthenon and the Odeum of Herodes Atticus. Astronauts used a 400 mm lens to capture great details of this metropolitan city from their unique vantage point 136 km (220 miles) above the Earth.

# Pre-/Post-Conference Assessment ANSWER KEY

1. What is the ISS EarthKAM? How is it unique?

   International Space Station Earth Knowledge Acquired by Middle School Students. Students are able to request via the Internet that specific images be taken to support their classroom investigations.

2. List three ways scientists and geographers might use information they gather from space-based photography to understand changes on the Earth.

   For urban planning, studies of climate change, archaeology, agriculture, and weather patterns, topographic mapping, etc.

3. Define remote sensing.

   The science of gathering data on an object or area from a considerable distance, (e.g., using cameras, radar, infrared photography, or other sensors), to observe the Earth, a heavenly body, or any distant object.

4. What is the part of the electromagnetic spectrum that can be seen by the naked eye called?

   The visible spectrum (wavelengths between 380–760 nm long).

5. What is the difference between a false color and a true color image?

   False Color Image- Changing the colors of an image so that it looks different than the target being examined would to the naked eye (i.e., cold water might be represented by blue and warm water by red).

   True Color Image- An image that looks the same as the target would to the human eye: a green tree appears green, a blue ocean appears blue, etc.

6. Why is it important to look for different wavelengths of energy in Earth studies?

   Different types of information can be obtained from different wavelengths, permitting scientists to analyze additional properties of an object or place. For example, infrared wave-engths indicate heat (warmer water, deserts), while 380-760 nm are colors visible to the human eye, so vegetation and lakes are identifiable by their colors.

7. Describe the relationship between the wavelength of a wave and the energy of a wave.

   There is an inverse relationship between a wave's wavelength and its energy. In other words, shorter waves have more energy than longer waves.

8. Describe how satellite images and maps are different and similar (you could use a Venn diagram).

   Answers will vary. Maps were initially hand made to help people get from one place to another, including guiding landmarks. A map is usually made for limited purposes (e.g. navigation or to show the types of vegetation at different locations) so maps have a lot of blank spaces or big patches of the same color. Satellite images are made of data – e.g., temperature data throughout the world is changed into colors, so they can also have a lot of patches of the same color. Now that we can use satellite data to make maps, it's possible that satellite images and maps will become very similar.

9. Identify at least one unusual use for remote sensing.

   To learn more about: ancient civilizations (the Angkor Ancient Ruins), Dead Sea Scrolls, etc.

10. Identify five different features of land or water in the following image.

    Mountains, large body of water (Mediterranean Sea), vegetation, inlets, islands, peninsulas, etc.

# Pre-Conference Activity

## ISS EarthKAM and The Visible Earth

**Purpose**
This activity enables students to become familiar with what different geographical features look like from space.

**Duration**
One class period

**Materials**
Several computers with Internet access (no more than 3 students per computer) or teacher computer with a projector or hard copies of the images below.

**Procedure**

1. Please review the images on the **ISS EarthKAM** website

   http://www.earthkam.ucsd.edu/public/students/activities/landformations

   as well as the images described below from **The Visible Earth** website.

   a. Earth's City Lights
   http://visibleearth.nasa.gov/view_rec.php?id=1438

   This image of Earth's city lights was created with data from the Defense Meteorological Satellite Program (DMSP) Operational Linescan System (OLS). Originally designed to view clouds by moonlight, the OLS is also used to map the locations of permanent lights on the Earth's surface. The brightest areas of the Earth are the most urbanized, but not necessarily the most populated. (Compare western Europe with China and India.) Cities tend to grow along coastlines and transportation networks. Even without the underlying map, the outlines of many continents would still be visible.

   b. City Lights of Europe
   http://visibleearth.nasa.gov/view_rec.php?id=1513

   Growth in "mega-cities" is altering the landscape and the atmosphere in such a way as to curtail normal photosynthesis. By using data from The Defense Meteorological Satellite Program's Operational Linescan System, researchers have been able to look at urban sprawl by monitoring the emission of light from cities at night.

## Pre-Conference Activity (continued)

c. Chicago, IL
http://visibleearth.nasa.gov/view_rec.php?id=11090

This image, taken by the MODIS (Moderate-resolution Imaging Spectroradiometer) spacecraft, shows the densely populated area of downtown Chicago. Notice the urban development around a major natural feature, Lake Michigan, and how the population is spread out along the coastline.

d. Washington D.C. (Infrared)
http://visibleearth.nasa.gov/view_rec.php?id=1366

The White House, the Jefferson Memorial, and the Washington Monument with its shadow are all visible in this image of Washington, D.C. With its 15-meter spatial resolution, ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer) satellite, took this picture using three bands of the reflected visible and infrared wavelength region on June 1, 2000. The image covers an area 14 km (8.5 miles) wide by 13.7 km (8.2 miles) long.

2. Inform your class that they will be viewing images from cameras onboard the International Space Station (EarthKAM) as well as unmanned satellites orbiting around the Earth. Emphasize the importance of this imagery for scientists all over the world in such areas as meteorology, geology, urban development, geography, and biology.

3. Divide the class into teams of 3 to 5 students.

4. Explain that you would like your students to explore images from space by color, shape, and patterns. Students should familiarize themselves with characteristics that help observers recognize certain natural and human-made objects.

Color – vegetation, oceans, rivers, lakes, human-made objects (cities, roads, bridges)

Shapes – coastlines, rivers, lakes, mountain ranges, cities (homes vs. businesses)

Patterns – human-made vs. natural structures and objects

## Pre-Conference Activity (continued)

5. The activity from EarthKAM enables students to choose different geographical features and become familiar with what they look like in pictures from space. http://www.earthkam.ucsd.edu/public/students/activities/landformations/

   Students can click through the images on their own or you can direct them and discuss each picture. During the videoconference with the DLN, similar pictures will be shown and the students will be asked to identify various geographic features.

6. Next, have your students interpret the images described in step 1 above from NASA's The Visible Earth before the videoconference event. These pages have a small thumbnail picture with an image description. Click on the JPEG links to bring up larger images which students can observe on computer monitors (or you can distribute hard copies). Decide how much background to give your students about each image.

   a. Earth's City Lights
      http://visibleearth.nasa.gov/view_rec.php?id=1438
   b. City Lights of Europe
      http://visibleearth.nasa.gov/view_rec.php?id=1513
   c. Chicago, IL
      http://visibleearth.nasa.gov/view_rec.php?id=11090
   d. Washington D.C. (Infrared)
      http://visibleearth.nasa.gov/view_rec.php?id=1366

7. While your students are studying and analyzing the pictures, ask questions about what they observe in the images. Included below are some suggested questions. Please feel free to add you own questions to promote further discussion.

   a. What do you think this is a picture of?
   b. Do you recognize any of the features?
   c. What questions come to mind as you look at the picture?
   d. Is there something in the picture that you want to know more about?
   e. After studying the picture, what can you tell me about it?
   f. What do you think a geographer or an early scientist looks for in a picture like this?
   g. Would this be a good place for a city? Why?
   h. Are there problems with the environment in this area?
   i. What types of geographic features are located here?

# Vocabulary

**Agriculture:** The process of cultivating the soil, producing crops, and raising livestock.

**Climate:** The temperature, winds, and humidity patterns occurring year after year. For example, "Arizona has a desert climate. It's almost always very dry and gets extremely hot on summer days."

**Environment:** All the things and conditions that surround a person, animal, plant or object and affect its health, growth, development, or character in any way.

**False Color Image:** An image created by representing various types of environmental data as colors (for example, cities could be shown as yellow or warm water could be shown as red). A false color image doesn't look like what you'd see with the naked eye.

**Geography:** The science that deals with the location of living and nonliving things on Earth and the way they affect one another.

**Infrared:** Heat radiation that is beyond red in the color spectrum. Infrared rays cannot be seen by the naked eye, but can be detected with special cameras.

**International Space Station:** A spacecraft orbiting the Earth in which microgravity experiments are performed. Sixteen countries contribute to these scientific studies.

**Landform:** A natural feature of a land surface (e.g., mountains, glaciers, plains, rivers)

**Pollution:** The result or process of spoiling a place (the action of polluting) with substances that aren't normally present.

- Natural examples: smoke and ash fall.
- Human-made examples: acid rain; factory and human waste disposed of in bodies of water.
-

**Radiation:** The process in which energy is emitted (given off) as particles or waves. Examples of radiation are: light, infrared and ultraviolet radiation, and X-rays.

**Remote Sensing:** Using various forms of technology to observe something at a distance.

**Satellite:** An object that orbits the Earth, moon, or other heavenly body. Our moon is a satellite of the Earth.

**Sensor:** A device sensitive to light, temperature, radiation level, or the other property, that transmits a signal to a measuring or control instrument that converts the signal into understandable data.

**Urban Development:** The process of planning, building, and developing (adding to) a city.

**Weather:** The state of the atmosphere for a short time (e.g., temperature, humidity, cloudiness, rain, hurricanes, tornados, snowfall). For example, "The weather report says it will be rainy and cold tomorrow."

## Additional Resources

**NASA**
For information on exploratory missions, manned spaceflight, and more, please visit this website.
http://www.nasa.gov

**NASA Kids Club**
For activities, games, stories and more, visit this website specifically designed for kids that are interested in space and NASA.
http://www.nasa.gov/audience/forkids/kidsclub/flash/index.html

**NASA Education**
For information on curriculum, activities, and student programs for grades K-4, 5-8, and 9-12 respectively.
http://education.nasa.gov/

**PUMAS: Volcanoes and Urban Planning**
https://pumas.gsfc.nasa.gov/examples/index.php?id=92

**NASA Observatorium**
http://physics.ship.edu/~mrc/astro/NASA_Space_Science/observe.arc.nasa.gov/nasa/core.shtml.html

**SeaWiFS**
The purpose of the Sea-viewing Wide Field-of-view Sensor (SeaWiFS) Project is to provide quantitative data on global ocean bio-optical properties to the Earth science community.
http://oceancolor.gsfc.nasa.gov/SeaWiFS/

**Landsat**
http://landsat.usgs.gov/

## Contributors and Developers


| | |
|---|---|
| Nathan Lang | Johnson Space Center |
| Erin McKinley | Johnson Space Center |
| Michael Hare | Johnson Space Center |


Special thanks to: Dr. Marci Delaney, Goddard Spaceflight Center

National Aeronautics and Space Administration

# Certificate of Completion

*presented to*

_____

*for participation in*

## A VIEW FROM THE TOP: LOOKING AT EARTH FROM SPACE

A NASA Digital Learning Network Expedition

_____ _____

*Instructor* *Date*