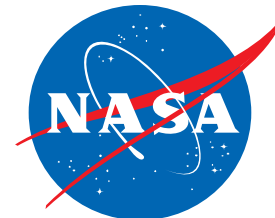




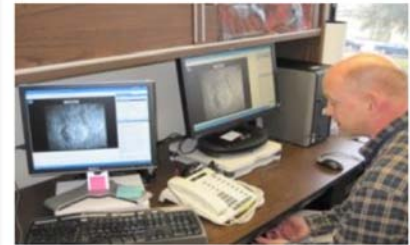
**Getting students actively involved with
NASA exploration and discovery.**



**STUDENT SCIENTIST GUIDEBOOK
INTRODUCTION**



Getting students actively involved with NASA exploration and discovery.





EXPEDITION EARTH AND BEYOND

STUDENT SCIENTIST GUIDEBOOK



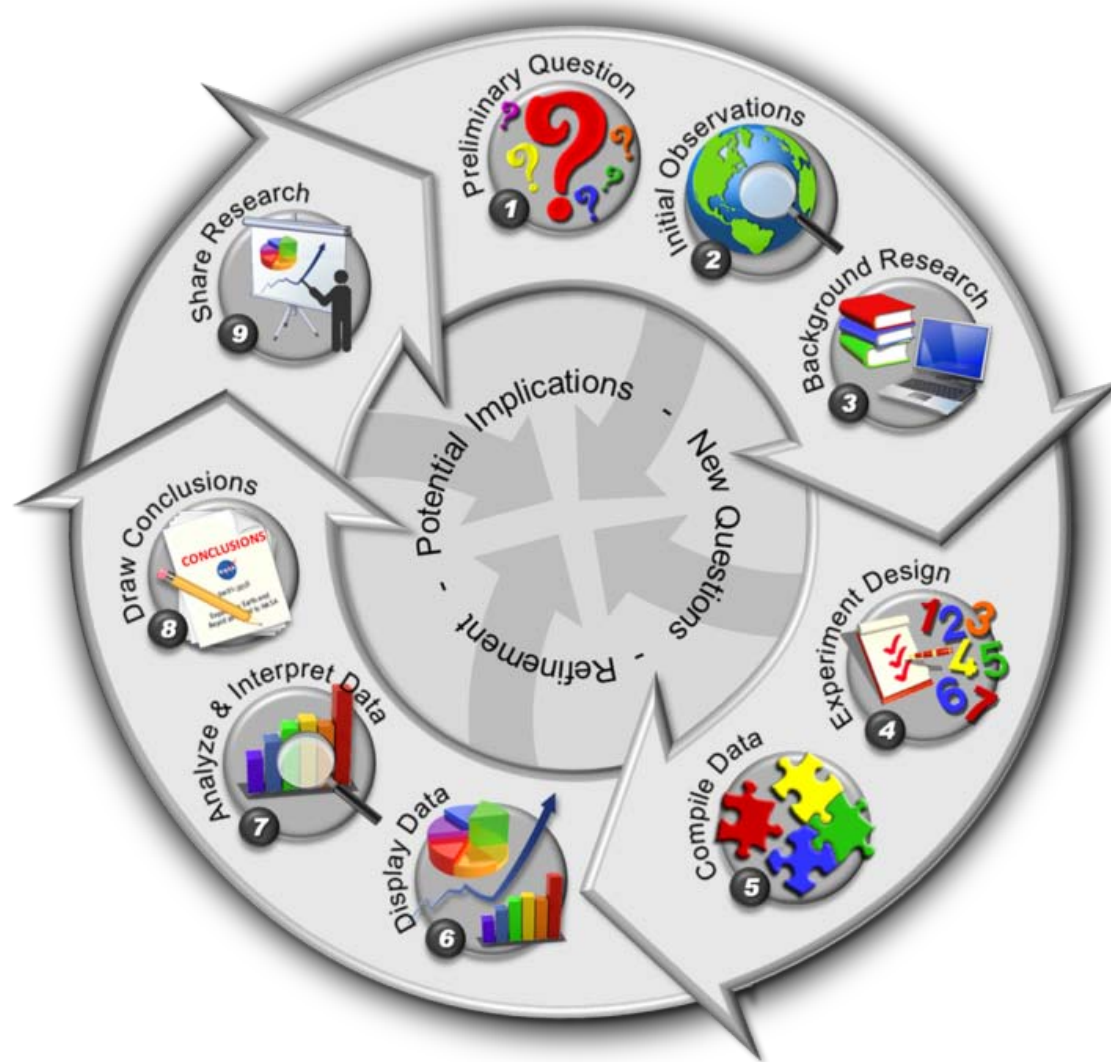


STUDENT OPPORTUNITIES

Participating Student Teams have the chance to:

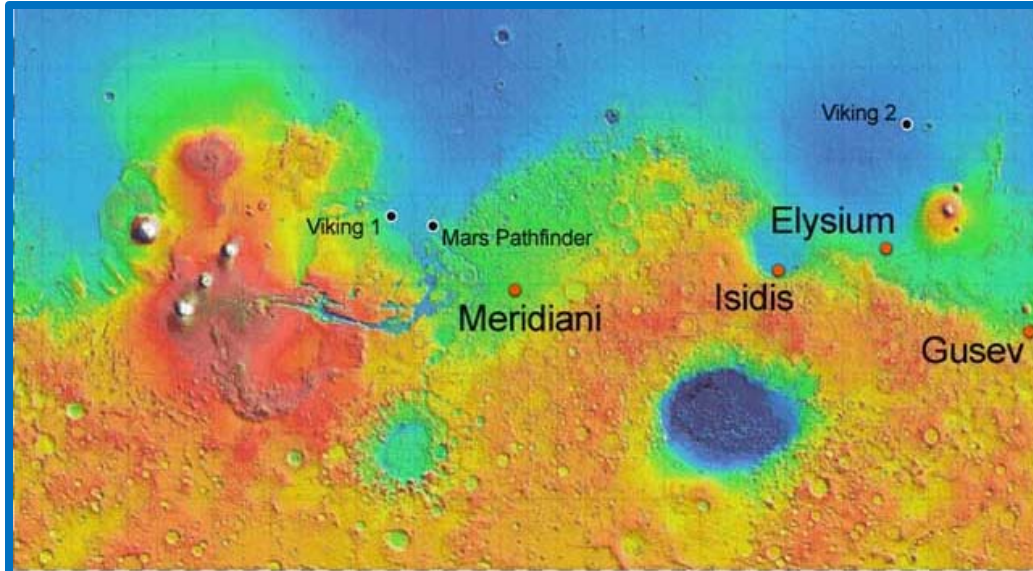
1. Research a question about our Earth (and possibly another planetary body) that interests you and your classmates.
2. Work with a mentor using the Expedition Earth and Beyond Team Workspace Wiki.
3. Request an astronaut take a new image of Earth for you and your classmates.
4. Present research to scientists and students in classrooms across the nation.

THE PROCESS OF SCIENCE



The **Student Scientist Guidebook** will guide you through this 9-step model of the process of science as you conduct your investigation.

WORKING AS A TEAM



Four candidate sites are under review for NASA's Mars Exploration Rovers. Potential landing zones for the robots are relatively near landing sites for Viking 1 and 2, and Mars Pathfinder. The data is from Mars Global Surveyor. CREDIT: NASA/JPL

Scientists and engineers on the Mars Exploration Rover (MER) team had to discuss, debate, and make decisions on a landing site for MER rovers Spirit and Opportunity. (Meridiani and Gusev were chosen as landing sites.)



Student scientist team working together on research investigation.

When working as a team, communication is important. Teams of professional scientists, and most likely your team of student scientists, will disagree with one another at times. One key to overcoming these challenges is learning to compromise. Compromise involves discussion and debate in order to come to a consensus.

STEP 1: PRELIMINARY QUESTION

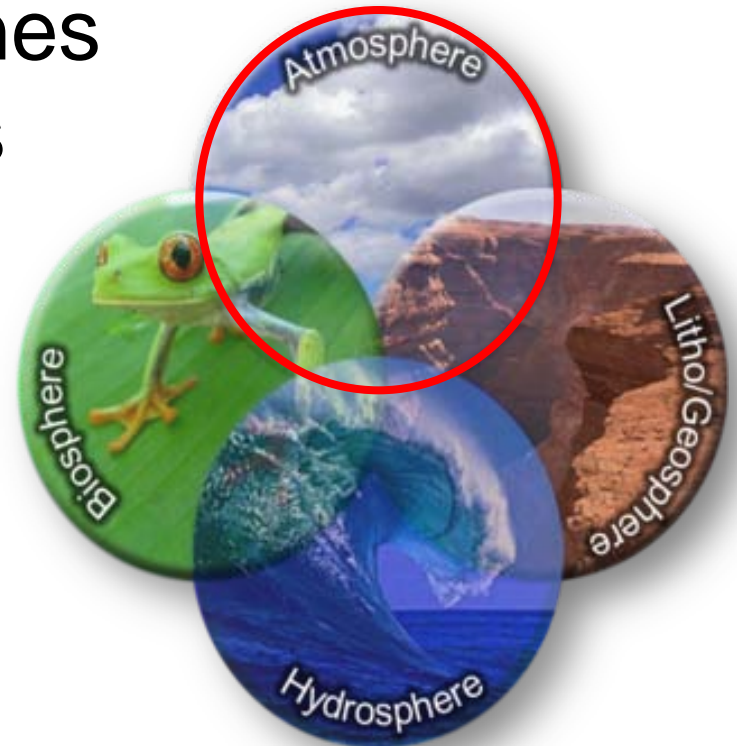
All Science Begins with Observations that lead to Questions



Questions may start out as broad questions but should eventually focus on features that are visible in astronaut photos. Visible features can be associated with one of these 4 Earth Systems.

ATMOSPHERE

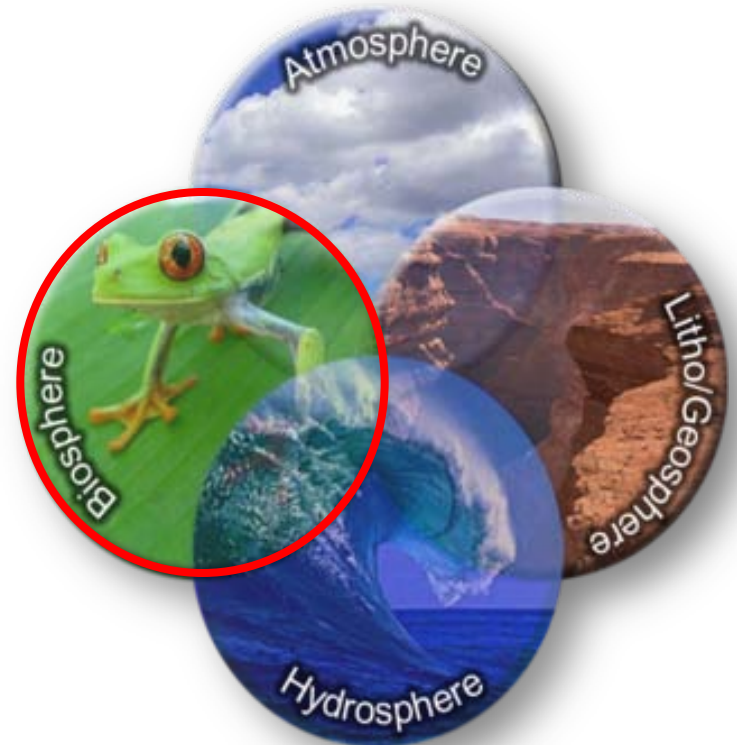
- Clouds
- Hurricanes and Cyclones
- Dust and Sand Storms
- Air Pollution/Aerosols
- Aurora



ATMOSPHERE: This system relates to meteorological features and phenomena such as weather, clouds, or aerosols (particles in the air).

BIOSPHERE

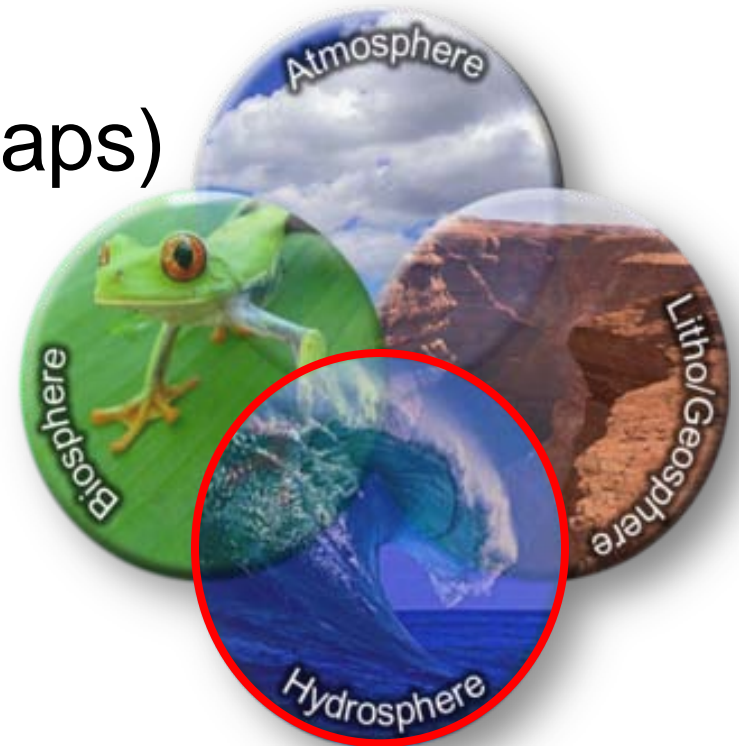
- Urban and Agricultural Ecosystems
- Coastal Biomes
- Forests
- Grasslands
- Deserts
- Tundra



BIOSPHERE: This system relates to or is associated with living systems such as biomes or ecosystems.

HYDROSPHERE

- Oceans
- Lakes and Rivers
- Ice Bergs (Polar Ice Caps)
- Glaciers



HYDROSPHERE: This system is associated with water in liquid or solid form.

LITHO/GEOSPHERE



▪ FLUVIAL & ALLUVIAL PROCESSES

- Deltas, River Channels/Canyons, Alluvial Fans

▪ VOLCANIC PROCESSES

- Volcanoes, Central Vent/Caldera, Volcanic Deposits

▪ IMPACT PROCESSES

- Impact Craters

▪ AEOLIAN PROCESSES

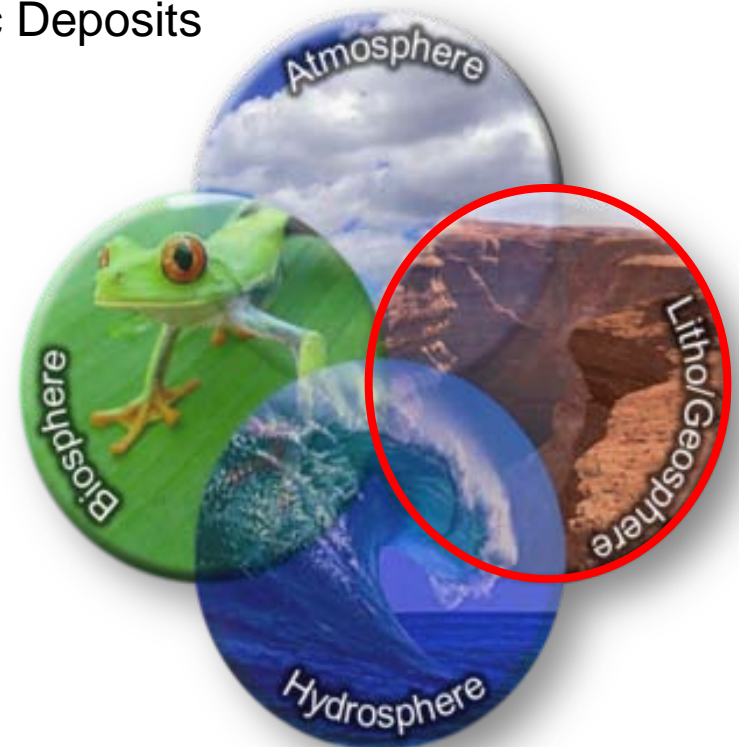
- Sand Dunes, Yardangs, Wind Streaks

▪ TECTONIC PROCESSES

- Folds, Faults, Mountains

▪ OTHER PROCESSES

- Mass Wasting, Erosion



LITHO/GEOSPHERE: This system relates to geologic features associated with the morphology or shape of the surface.



TYPES OF QUESTIONS

Descriptive Questions:

Questions that focus on identification or description of characteristics of features.

Examples:

1. What are the characteristics of deltas as seen from astronaut photography images?
2. Can you detect plankton blooms from astronaut photography images? What do they look like?
3. What types of clouds exist on Earth and which are visible in astronaut images?



TYPES OF QUESTIONS

Observational/Relational/Comparative Questions:

Questions that look at potential relationships or comparisons between one or more feature or a feature and a specific variable.

Examples:

1. Based on observations made from astronaut photographs, do glaciers in different parts of South America share similar characteristics?
2. Is there a relationship between types of sand dunes and geographic location?
3. Are sand dunes, wind streaks, or yardangs most common in the Sahara desert?

To answer this type of question you first need to be able to describe and identify the features you are focusing on. The observations you make about those features will allow you to establish relationships or lack of relationships between those features and/or variables.

The use of other datasets in addition to astronaut photographs will allow for a more comprehensive study.



TYPES OF QUESTIONS

Causal: Cause and Effect Questions:

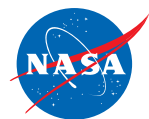
Questions that look to determine whether one or more variables or features cause or affect one or more outcome variables/features.

Example:

1. What visible effects do hurricanes have on coastal areas? What can be inferred about how future hurricanes will affect coastal areas?
2. Do changes in glaciers cause a visible change to the amount of visible icebergs in an area? What can we infer about how this relationship affects sea levels?
3. Does an increase in urban development cause an increase in local temperatures?

To answer this type of question you need to be able to 1) Describe and identify features you are researching, 2) Make observations and collect data to show if a relationship exists, and 3) Infer how this relationship may play a role in other situations.

The use of other datasets in addition to astronaut photographs will allow for a more comprehensive study.



DATA SETS

Astronaut Photographs:

<http://eol.jsc.nasa.gov>



*Images courtesy of the Image Science & Analysis Laboratory, NASA JSC:
ISS015-E-10704, ISS007-E-5697, STS077-718-54*

If your team plans to request a new astronaut photo to support your research, be sure you use astronaut photographs as one of your primary sources of data.

Gather data from other sources to help support your research.



DATA SETS

Global data sets available at NASA's Earth Observatory:

<http://earthobservatory.nasa.gov>

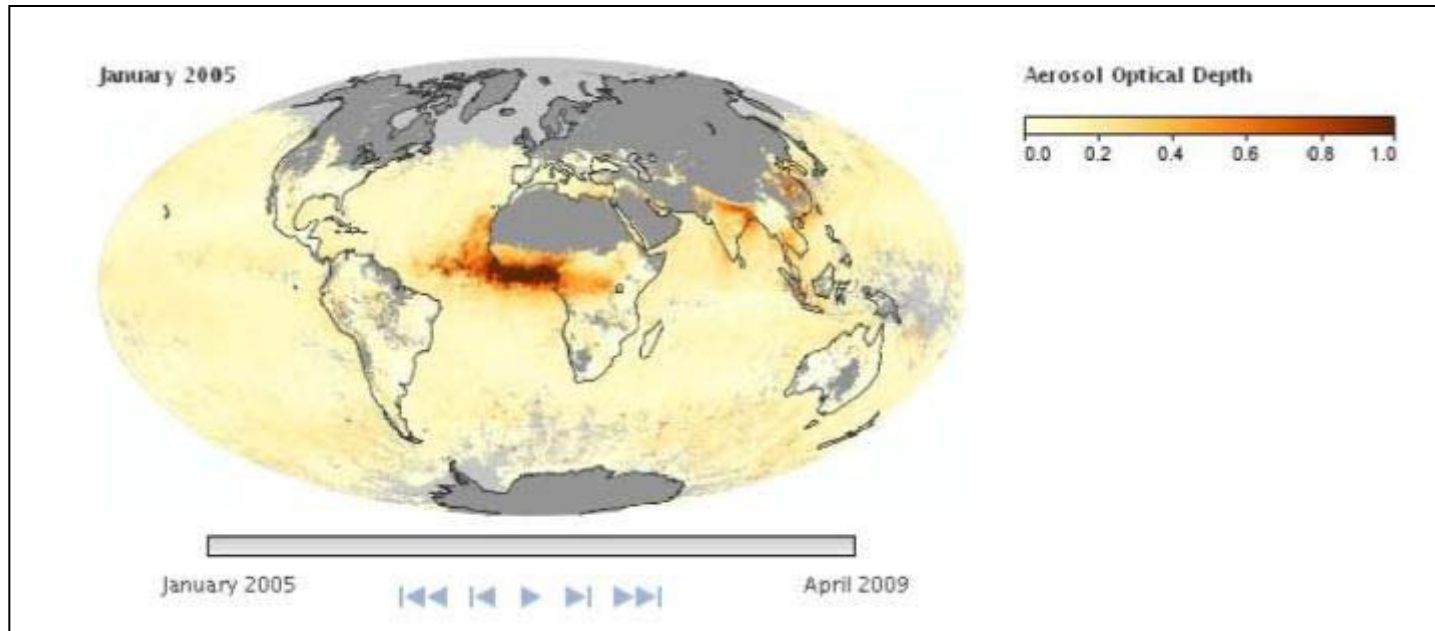


Image source: http://earthobservatory.nasa.gov/GlobalMaps/view.php?d1=MODAL2_M_AER_OD

Map showing average monthly aerosol amounts around the world based on observations from the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Terra satellite.

You can observe changes to data obtained for this map over time starting from February 2000.

DATA SETS

Global data sets available at NASA's Earth Observatory:

<http://earthobservatory.nasa.gov>

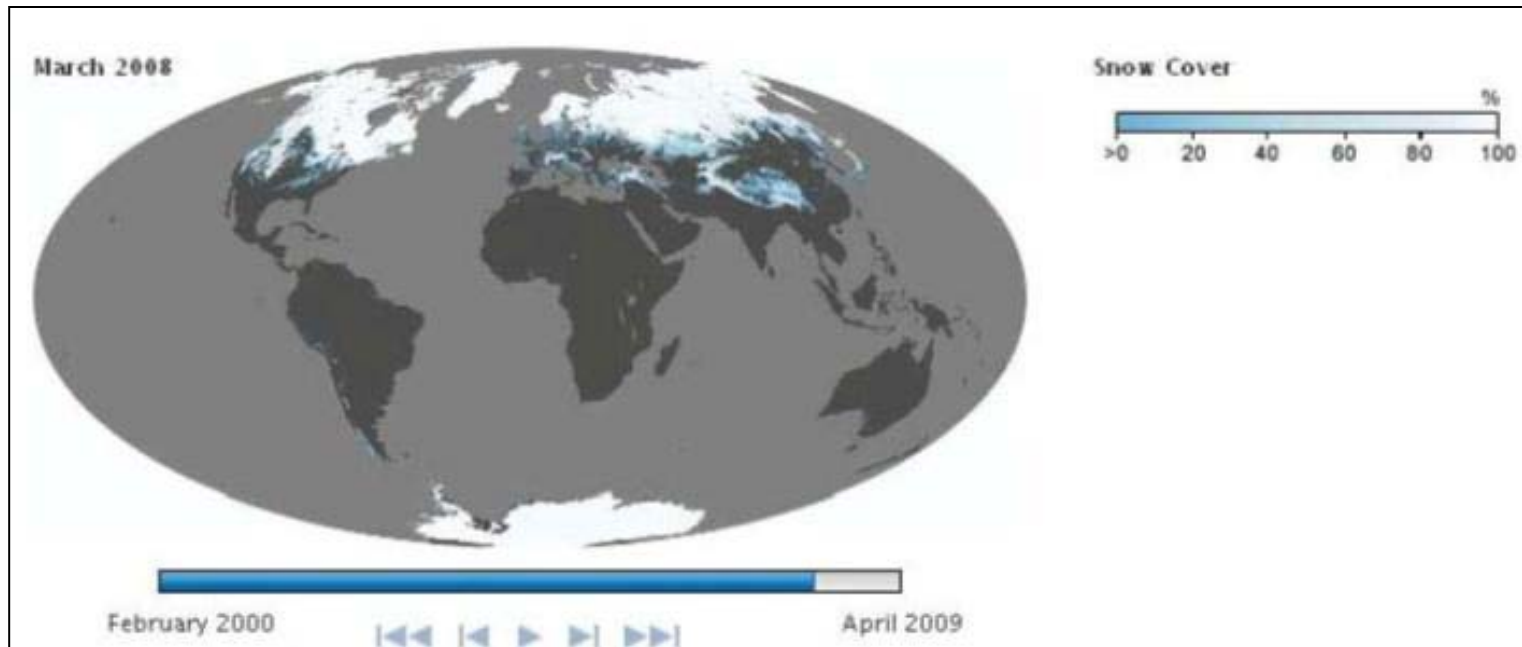


Image source: http://earthobservatory.nasa.gov/GlobalMaps/view.php?d1=MOD10C1_M_SNOW#

Snow cover map made from observations collected by the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Terra satellite.

You can observe changes to data obtained for this map over time starting from February 2000.

DATA SETS

Global data sets available at My NASA Data:

<http://mynasadata.larc.nasa.gov>

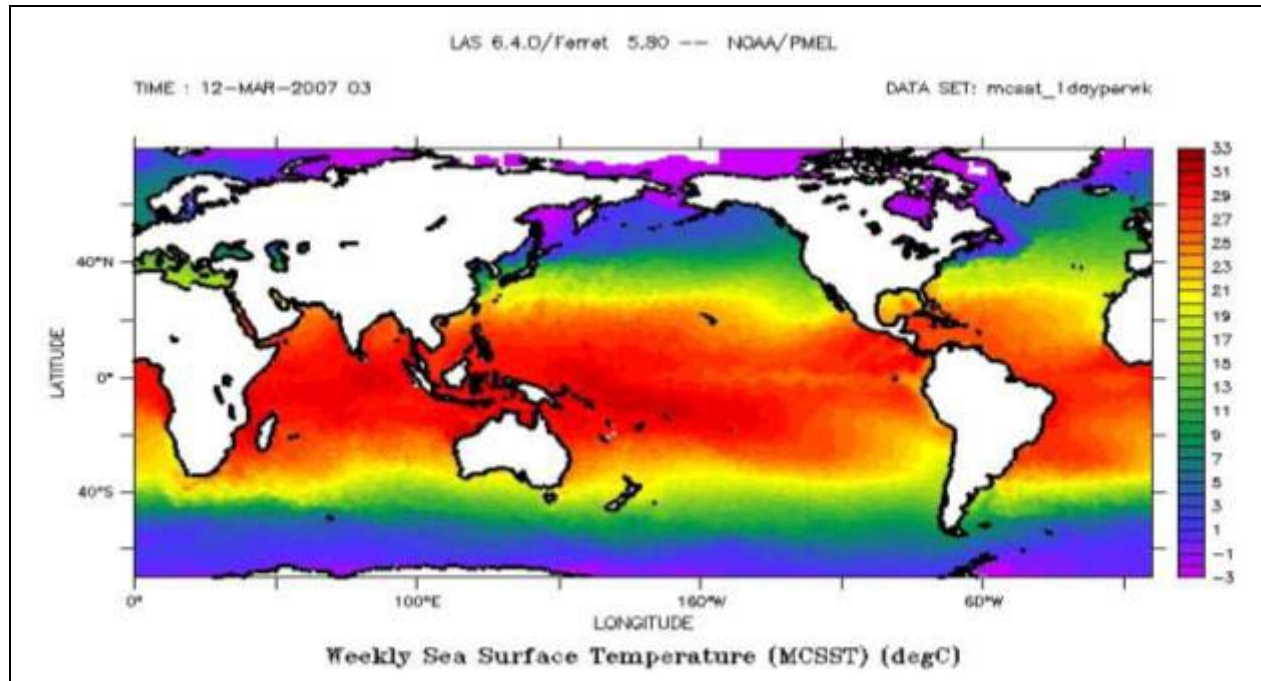


Image source: http://mynasadata.larc.nasa.gov/sample_images.php

Sample map showing weekly average sea surface temperature (SST) in degrees Celsius measured by NOAA's AVHRR instrument.

You can create your own map for a specific time frame of your choice.

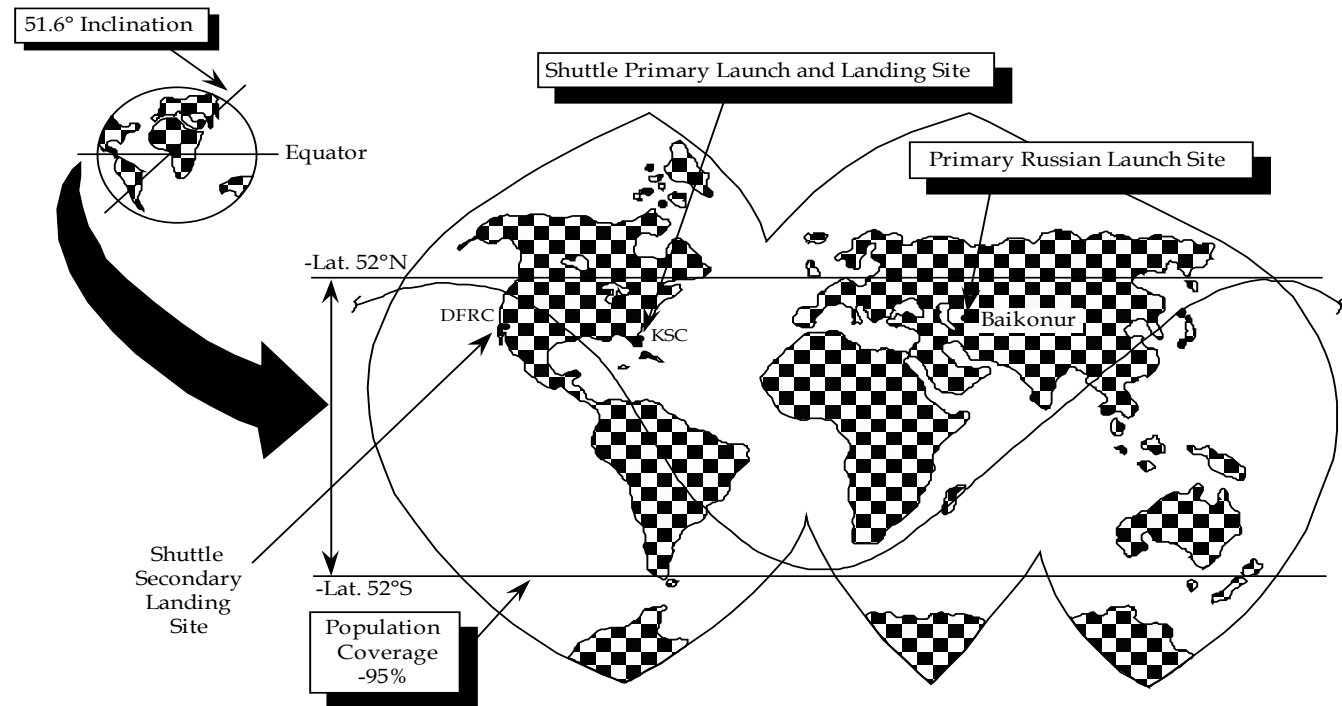
REQUESTING NEW DATA

Requirements:

1. Member of a participating team (class) of students
2. Submission of one *Data Request Form* per class

Image Request Challenges:

1. Orbit of ISS
2. Cloud cover
3. Astronaut tasks
4. Orbiting speed



Graphic illustrating orbit of International Space Station
Image Courtesy of NASA



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