Program 3: Announcing YOUR Results

First airs live April 23, 1996, 13:00-14:00 Eastern

This program will take the form of a highly interactive scientific symposium, oriented to students, announcing the first results achieved by *Live from the Hubble Space Telescope*. A live student audience of over one hundred will join Marc Buie and Heidi Hammel in STScI's main auditorium in Baltimore, with e-mail and CUSeeMe input from other students around the nation and the world. Heidi and Marc will share preliminary findings, and respond to comments based on the parallel work that's been done by students. We'll review the questions which initially motivated student interest in Pluto and Neptune during the the "Great Planet Debate," and see which have been answered and which require more analysis or research.

Live uplinks in America will include the Buhl Planetarium at the Carnegie Science Center in Pittsburgh, Pennsylvania (where students helped make our original planet selections via interactive technology) and Los Angeles, California, a school district making a major push to integrate the Internet into the curriculum. The program will provide considerable "give and take" between the Planet Advocates and their student "Co-Investigators," as students witness live the process of testing scientific hypotheses, verifying results and sharing new findings with peers to substantiate their significance.

Videotaped sequences will document "A Day in the Life…," taking us behind the scenes as Heidi Hammel works to transform raw planetary data into new knowledge: Heidi also plans to post a *Field Journal* of her image processing successes and (only temporary, we hope!) frustrations on-line. A second sequence documents the parallel process in one of our participating schools, where students employ user-friendly and freely accessible graphics packages to analyze the same data. To help explain the technical steps in image processing, we see how the stunning images of the Eagle Nebula (as seen in the co-packaged poster) ends up on the cover of *Time for Kids*. Footage from giant storms on Earth, and images from HST and other spacecraft, allow us to compare and contrast weather on Earth and our neighboring planets: we come to understand the dynamics underlying the images of (possible!) bright or dark clouds on Neptune, and seasonal changes (perhaps!) on Pluto.

The concluding tape sequence shows "What's Next?," describing the next HST Servicing Mission (slated for early 1997), plans for the first-ever spacecraft mission to study Pluto and Charon closeup, and initial concepts for a Next Generation Space Telescope, one of whose main functions would be to search for planets around other stars.

Viewers will be reminded about how to participate on-line, and how to utilize the project on tape after the live telecast.

Alex Storrs, Planning Scientist, Moving Targets, STScI

It's unfortunate the way a lot of basic science starts in schools these days with a list of facts to be memorized, and lists of experiments and discoverers…this guy discovered that and that gal discovered this other thing. This lends a sort of inevitability to the process when it's really quite haphazard. Its all by guess and by gosh, it's not planned at all. The chances of finding something new are present in any observation, whether it's with the Space Telescope, with a ground-based observatory, or made by somebody from their back yard. People discover comets from their back yards all the time.

There is a chance, in any observation made by any person, that you'll find something new, and all you have to do is have an inquiring mind, and be open, and be alert, and be aware and don't accept as a given everything that you've been told. Don't accept that the universe is understood, but rather that the universe is a big, beautiful mystery that we are all trying to unravel.

Question Marks

Space,
deep, dark hellish space,
Continuing light years of nothingness
No one can discern the oddities of space.

The planets
lands of barren matter,

The blazing, flaming colossal sun
Continues to burn,
and burn,
and burn.

Perhaps a herd of bizarre creatures,
and maybe nothing at all,

Perhaps another dimension,
and maybe nothing at all,

No one really knows how we got here,
and maybe we're nothing at all.

Stephen Smethers, Summit Middle School.

Activity 3A: The Universe in Living Color

Objective

Students will experiment with color filters and be guided towards deriving the process by which HST converts B&W images into color pictures.

Engage

Show students some of the stunning HST color images, such as those of M-16, the Eagle Nebula (which also appears on the poster co-packaged with this Guide.) Ask the students if they realize that the HST can only "see" in black and white. Ask them how they think such color images are created.

Materials (for each team: color filters may need to be shared)

- set of three color filters (red, green and blue), co-packaged with this Guide
- copies of the student worksheet, p. 31, providing simulated black and white views of a hypothetical planet, as if taken through red, green and blue filters
- black, red, green and blue paper or other test objects or material (matching their color as closely as possible to that of provided colored filters)
- markers and crayons of colors chosen to match the filters (see box below)

Note: since this Guide is only black and white, before beginning the Activity, please prepare the answer by coloring-in the hypothetical planet as suggested by the color code. "Please try to keep within the lines!"

Explore / Explain

Explain that scientists use computers to create color images from HST and other spacecraft by combining information from several black and white images taken through different colored filters. Explain that this is because objects reveal different aspects of their surfaces through filters of different colors. In this Activity, students will be able to explore this phenomenon for themselves, and then deduce the "real" colors of a hypothetical planet, working only from black and white images—just like NASA's computers. (To repeat, the planet is hypothetical and, for clarity's sake, composed only of primary colors but the same principles and procedures apply to any image of any color or hue.)

Procedure Use the sidebar (right) as necessary to help explain the theory of why objects look the colors they do under white light and through filters of different colors. Pass out the sets of red, green and blue filters to each team. Have students look through their filters at pieces of paper that are white, black, red, green and blue, and fill in the chart on their worksheets in which they describe the color these objects appear, with and without the filters.

When students have completed their charts, distribute red, green and blue marking pens. Explain that these show three images of the same simplified and hypothetical planet. All the images are black and white, but each appears as if taken through the different color filters, as indicated. Using marking pens and their chart as a guide, ask students to study the three black and white images carefully, and then draw an image in color showing what they think the planet really looks like. When they are done, show students the correct answer you have prepared in advance, and guide them to appreciate the reasons why.

Expand

Have students apply the principles of this Activity to create "Hidden Messages" which can only be detected using filters of the appropriate color.

FOR OPTIMAL RESULTS

Use *Crayola Crayons* (24 pack, UPC# 7166200024): cerulean blue, red and green with the co-packaged blue filter.

Use *Magic Marker Presentation Plus* (6 marker pack, UPC# 71662 00747): red, green, and blue markers with the co-packaged red and green filters.

Light, color and the effects of colored filters

We suggest you use the red, green and blue filters co-packaged with this Guide (and others you can obtain or borrow) to allow your students to explore the properties of light and filters for themselves, before you begin Activity 3A. Have them use the enclosed HST lithographs and other color images for their experiments. Guide them to discovering the principles they'll use to transform black and white data into color pictures.

Normal sunlight and most classroom lighting is "white light," meaning it contains all colors of the spectrum. Opaque objects appear the color they do when illuminated by white light because their surfaces scatter only certain colors back into our eyes. A white object appears white because it scatters all the colors which together make white light. A pure black object appears black because its surface absorbs all the light which falls on it and scatters none of it back into our eyes. An object looks red because it scatters only the red rays in white light back into our eyes.

Colored filters only allow light of their particular color to pass through. Thus a red filter only allows red light to pass through; a green filter only green light. So a white object (which scatters all colors of light), will look the color of whatever filter it is seen through: red through a red filter, green through a green filter. A black object scatters no light, so it will look black through any color filter. A red object will look red through a red filter, but black (or gray) through a green or blue filter, because the object only gives off red light. Similarly, a green object will look green through a green filter, but black (or gray) through a red or blue filter. A blue object will look blue through a blue filter but black (or gray) through a red or green filter.

Note: depending on the exact color of red, blue and green in the images you use, and the exact color of the markers, crayons or pencils available to students, you will get more or less the "ideal" results described above. A red object through the blue filter may appear gray rather than pure black, but students should still be able to grasp the basic principles.

Activity 3A: The Universe in Living Color

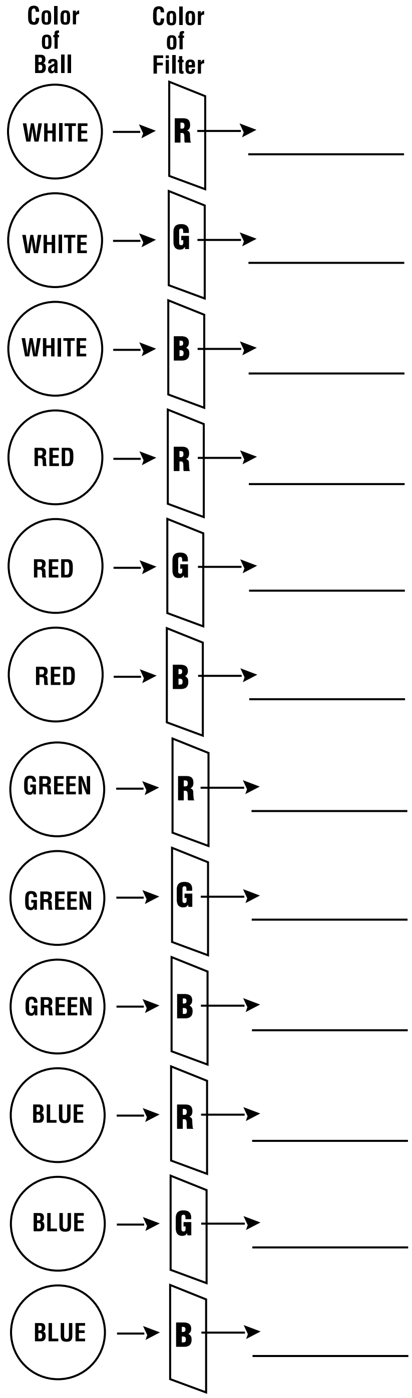
In this Activity, you and your Data Analysis Team are going to create a color image of a planet, beginning with just three black and white images as clues to its "real" appearance. It's a fancy piece of detective work. Your teacher will distribute color filters to your Team and ask you to examine samples of paper which are white, black, red, green and blue through the filters. Fill in the boxes in the Chart below with the color that each of these objects appears when seen through each of the different filters.

Study the diagram to the right. Each shows light from objects of a different color passing through different-colored filters. Apply what you learned from your "eyes-on" experiment, and fill in the blank space with the color which *you* think passes through the filter. This is the color the object will appear if it's seen through that filter. If you think that no color would pass through, write "none." This means the object would look **black** through that filter.

Below are three black and white images of a hypothetical planet. Each simulated image appears as if it was taken through the different color filter noted under the image. Examine these images carefully and applying the rules you generated, figure out the real colors of the planet's features. Using colored pens or markers, create a color drawing of the planet in the blank circle below.

FILTER COLOR

SAMPLE	RED	GREEN	BLUE
White			
Black			
Red			
Green			
Blue			

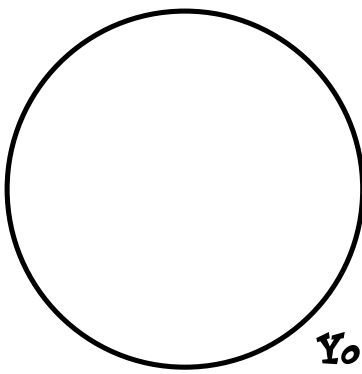


R = Red
G = Green
B = Blue

Red Filter

Green Filter

Blue Filter



Your planet to color

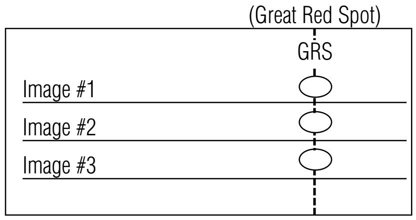
Activity 3B: Watching the Weather Move

Students will plot the movement of weather systems on Earth and other planets, compare/contrast and measure the size and speed of storms, supporting their conclusions with relevant data.

Objective

Engage

Have students collect and/or familiarize themselves with weather data in advance of this Activity, e.g. weather satellite images in newspapers, or by assigning them to watch television. In class, show students a picture of the weather taken by an Earth-orbiting satellite, as on the copy masters provided. Ask them to identify the geographical areas that are clear and cloudy. Ask them how the clouds move as weather systems develop and dissipate from day to day. Ask them if other planets have clouds and "weather" and, if so, do they think the clouds move there as well. (Does Mercury have weather? Does Pluto? Go on-line, and see what Planet Advocate Marc Buie has to say about weather and seasons on Pluto.) Ask them to suggest ways in which clouds can be used to monitor the direction and rate of motion of weather on a planet.



Materials (All to be found on the copy masters provided)

- Copies of Earth image #1 (without the dotted line on the clouds over the Northeast) and Earth image #2
- Copies of Jupiter images #1, #2, and #3
- Teacher version of Weather image #1

Explore / Explain

Explain that through the use of orbiting satellites and spacecraft, we are now able to see the weather over the entire Earth as well on other planets. Several satellites over the Earth's equator send us images every hour for a constant record of the Earth's weather. Other spacecraft like the two Voyager probes to the outer planets took images of the atmospheres of those remote worlds as they flew past in the 1970's and 1980's. But these images were all taken over brief periods of time, as if the newspaper printed a satellite image of Earth today, and no more for decades! The Hubble Space Telescope can image the weather of other worlds over time, looking for changes. It's for that reason that some call the Hubble an "interplanetary weather satellite."

Spacecraft cameras only take still images, but sequential images can be edited together by computer so we can see the weather in motion, as you typically see on the TV weather report, or in some of the dynamic images of Jupiter which Dr. Reta Beebe showed during *LHST* Program 1, "The Great Planet Debate." In this Activity, students will compare spacecraft images of the Earth and Jupiter and, by measuring the motion of the clouds, determine and contrast the speed of the particular weather systems shown.

Procedure Distribute copies of the images of Earth and Jupiter to your students. Begin with Earth. Ask them to identify the geographical area covered in the images and, for the first image, have them write a general description of where the atmosphere (the weather) is clear, and where it is cloudy. Next draw their attention to the second Earth image. Tell them that this image was taken 16 hours after the first image. Ask them if the general areas of clear and cloudy weather are the same. Suggest they look closely for changes.

Have them tape copies of Image #2 to a windowpane. Then carefully place Image #1 on top of it and line the pictures up. Holding the left margin of Image #2 in place, quickly cover and uncover Image #1. They will see the weather in motion.

Draw their attention to the large "comma-shaped" cloud formation over part of the eastern United States (a cold front), and have them notice, in particular, the line behind the front where clear skies are replacing cloudiness (indicated by a dashed line in the Teachers' Copy). In Image #1, have students mark 4 points along the "clearing line" (which we will call line "A") from Virginia down to Cuba and label them "A," "B," "C" and "D." Next, have them line up Image #2 on top of Image #1 and draw the position of the clearing line in Image #2 onto the clouds in Image #1. (See Teachers' Copy.) Call this line "B." Next, from points "A," "B," "C" and "D," have them draw straight lines perpendicular to line "A" until they intersect with Line "B." Mark these points of intersection "E," "F," "G" and "H." Using an atlas to measure scale, have them measure the distance between these pairs of points and, using the elapsed time of 16 hrs. between images, calculate the average speed of the clearing line.

Expand

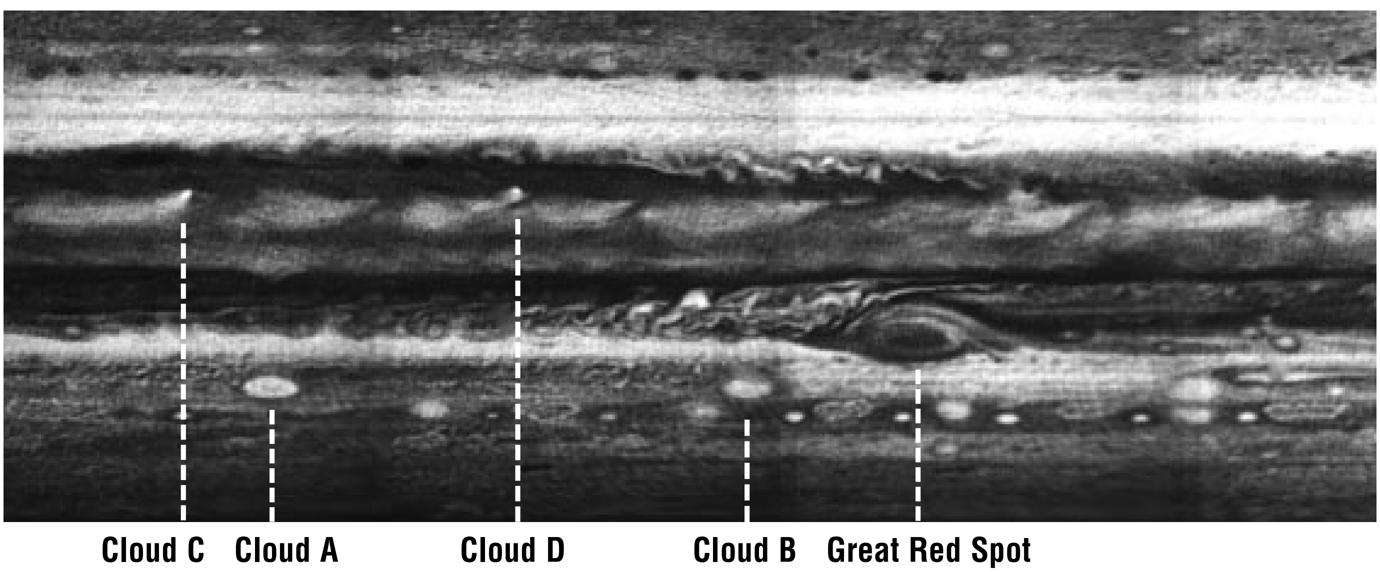
Jet streams are rapidly moving currents of air in a planet's atmosphere that steer and drive weather systems. Have students record the position of the jet stream from weather reports or newspapers for a few weeks and write a report on how the position and orientation of the jet stream caused the types of weather experienced during this time period.

Now call attention to the three images of Jupiter (taken by Voyager 1 in 1979.) Explain that in the first section of the Activity the students measured the speed of a cold front on Earth, relative to the ground. When we look at Jupiter, however, we see no solid surface for there is none, only the tops of clouds. In the second part of this Activity, students will measure the speed of cloud features at two different latitudes relative to the most distinctive "landmark" (sic) on the planet Jupiter's distinctive cloud feature, the Great Red Spot. In the process, students will be able to determine the speed of two of Jupiter's jet streams and compare their speeds to that of the cold front over the eastern U.S.

Explain that the images were taken on the dates and times noted. Jupiter's equator runs through the middle of each image. Jupiter's north pole runs across the top and the south pole across the bottom (thus these images are similar to Mercator map projections of Earth in that the size of features appears enlarged toward the poles).

Have the students proceed as follows:

1. Point out the Great Red Spot (GRS) in all three images. Ask the students to estimate the center of the GRS in each image, and place a small dot at these points.
2. Have students line up all 3 images of the GRS.
3. Draw a straight line through the dots drawn in step #1 that is perpendicular to the top of image #1 (as shown on p. 32) and tape the images to the desk top.
4. Point out the 2 white, oval-shaped clouds ("A" and "B" on your Teacher's Copy) on Image #1 and Image #3.
5. Have students carefully measure the distance in millimeters from the right edge of each of these clouds to the line drawn through the centers of the GRS.
6. Have students determine how many millimeters cloud A and cloud B have moved between the two images; then take an average.
7. Have students measure the east-west diameter of the GRS in millimeters.
8. The actual diameter of the GRS is about 20,000 kilometers. Have students determine the answer in kilometers to item #6. Then multiply by the "latitude conversion factor" (0.92). These images show clouds towards Jupiter's poles as *larger* than they really are, multiply the answer above by 0.92 to get the real answer.
9. Determine the total elapsed time in hours between Image #1 and Image #3.
10. Calculate the average speed of clouds A and B relative to the GRS in kilometers per hour (divide by 1.609 for the answer in miles per hour.)
11. Point out the white cloud features (marked "C" and "D" on your Teacher's Copy) on Image #1 and Image #2.
12. Carefully measure the distance in millimeters from the right edge of each of these clouds to the line drawn through the centers of the GRS.
13. Determine how many millimeters cloud C and cloud D moved between the two images; then take an average.
14. Again, using 20,000 kilometers for the east-west diameter of the GRS, convert the average movement of clouds C and D to kilometers. This time, for *this* latitude, the proper conversion factor is 1.07 (yes, 1.07 is correct).
15. Determine the total elapsed time in hours between Image #1 and Image #2.
16. Calculate the average speed of clouds C and D relative to the GRS in kilometers per hour (divide by 1.609 for the answer in miles per hour).
17. Compare the speed of these jet streams on Jupiter to the one on Earth calculated in the first part of this activity.



Activity 3B Watching the Weather Move

Carefully examine the two satellite images of the Earth that your teacher has given you. Briefly describe the portion of the world that they cover.

Take a look at Image #1. Write a general description of where the weather is clear and where it is cloudy.

Look at Image #2. Are the cloudy and clear areas generally the same? Do you notice some differences? This image was taken 16 hours after Image #1. By comparing the images, we can see where and how the weather has changed.

Tape Image #2 to a windowpane. Then place Image #1 on top of it and carefully line up the pictures. Next, hold Image #2 in place and tape the left margin of Image #2 in place. Holding the right margin of Image #2, quickly cover and uncover Image #1. You will see weather in motion.

Look, in particular, at the eastern portion of the United States that is shown in the images. The "comma shaped" cloud feature is a cold front and marks the leading edge of colder air advancing along the ground from west to east. We can determine how fast the front and its cold air is moving by carefully measuring the front's change in position from one image to the next, taking into account the time that elapsed between when the images were taken.

Using a pencil or pen, mark four points along the curved line where the air is clearing behind the front in Image #1. (Suggestion: Start in western Virginia and move down along the clearing line from there to southern Florida or western Cuba.) From north to south, mark these points A, B C, and D.

Next, from each of the four points, draw a straight line perpendicular to the clearing line at that point.

Now, carefully examine Image #2 and see where the clearing line is in this image. Draw the position of this clearing line over the top of the comma shaped cloud in Image #1. Notice where the four straight lines you drew through points A, B, C and D cross this curved line. Mark these four points E, F, G and H (from north to south).

In the time between when the two images were recorded, point A moved to point E, point B moved to point F, and so on. To find out how fast the clearing line moved, use the distance scale to measure from point A to E, from B to F, etc., and write your answer in the spaces below.

Distance in miles (kilometers) from :
A to E = ______
B to F = ______
C to G = ______
D to F =

Next calculate the average distance the clearing line moved. Do this by simply adding the four distances you measured above and dividing by 4. Write your answer below.

Average distance moved by the clearing line

____

Finally, determine the average speed of the clearing line. (How fast was that clear air moving in behind that cloudy front?)

____

You can determine the average speed at which something was moving if you know how far it traveled in a certain amount of time. Think about it. If a car travels 80 miles in 2 hours, what was its average speed? The answer is 40 miles an hours and you get the number by simply dividing the distance traveled by the time it took or

80 miles / 2 hours = 40 miles / hour.

The time between Image #1 and #2 was 16 hours. So divide the average distance you calculated above by 16 hours to get the average speed of the clearing line in miles or kilometers/hour. Write your answer here.

____

Objective

To observe a fundamental motion of air responsible for certain large cloud formations on Earth and other planets, and to report these observations.

Note: this Activity can be used as a Teacher Demonstration, if there are concerns for safety, or as a team hands-on activity for older students

Engage

Show students pictures or—even better—video of thunderstorm clouds billowing, or ask them to describe in detail a thunderstorm they have experienced. Ask them if they have ever seen a day (especially in summer) start out clear, but become cloudy with thunderstorms by afternoon.

Explore / Explain

Explain that clouds, especially thunderstorm clouds, can frequently be created when the Sun heats the surface of the Earth. The surface, in turn, heats the air in contact with it, which begins to rise. The air cools as it rises and the moisture in it condenses to form clouds. When the upward-moving air rises rapidly, it can mushroom into towering clouds over 12 miles (app 20 kilometers) high. As the air cools, it descends back down to the ground to be heated anew, thus setting up a cycle, or cell of air, known as a "convection cell."

In this Activity, students will examine spacecraft images of the Earth and Uranus to find such huge "convection cell" clouds, and create a small convection cell in which they can see the motion of air at different temperatures.

Materials (for every two students, or team)

- shoe box (or other box of similar size with a lid)
- short candle
- metal top from a jar (2 to 4 inches in diameter)
- piece of clear plastic wrap (larger than side of the box)
- cardboard tube from a roll of paper towels
- adhesive tape and a pair of scissors
- Earth and Uranus images from copy masters supplied
- atlas, with distance scale for North America

Procedure

Part 1 Finding and Measuring Large Cloud Features on Spacecraft Images

Pass out copies of spacecraft images of the Earth and Uranus. Have students briefly describe the geographical area covered in the Earth image, and identify which areas are cloudy and which are clear. Explain that this image was taken on July 25, 1993, and that many of the clouds they see are due to large rising cells of warm air in the process of forming thunderstorms. Ask them to see if they can find any thunderstorm activity over the following states: California, western Texas, Arkansas, northern Georgia.

When they arrive at the large, white area covering Iowa, as well as portions of Nebraska, Kansas, Missouri and Minnesota, tell them that this is a very large group of thunderstorms known as a "Mesoscale Convective Complex," (MCC). Using a distance scale from an atlas, have them measure its size.

Next, have them examine the HST image of Uranus. Contrast it to the image of Earth, and have them identify the two large cloud complexes they find. Given that the diameter of Uranus is 31,771 miles (51,120 kilometers), have them estimate the size of these cloud features. How does the size of these convection cloud features on Uranus compare with the one over Earth. How much of the U.S. would they cover if brought to Earth?

Part 2 Creating a Convection Cell

Have students cut out most of one of the long sides of their shoe boxes and cover it with clear plastic, making a window. Have them cut two holes in the lid just large enough for the sections of cut paper tube to fit through, as shown in the illustration. When ready, carefully light the candles and close the lid, making sure that the candle lies directly under one hole. Carefully place the smoking tip of a punk, or the smoking end of a tight curve of paper, near the top of cardboard tube #2. Smoke introduced over the right "roof chimney" will descend since it's cool, and travel across the length of the box to rise out of the "left chimney" because of the rising current of warm air from the candle.

(Note: a similar activity can also be done as a demonstration using a fish aquarium. Place room temperature water in the aquarium, filling it to about 3/4 of the way up. Place an aquarium heater at one end, and drape a plastic bag with ice cubes into the water at the other end. Allow the water to settle, then gently place a few drops of blue food coloring into the water near the ice cubes, and red food coloring near the base of the heater, using a long-nosed dropper. Within a few minutes, the food coloring will begin to trace out the cycle of currents in the water.)

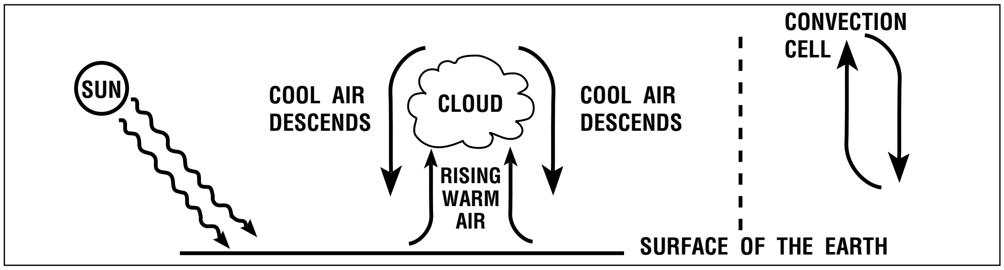
Pose the following questions to the students:

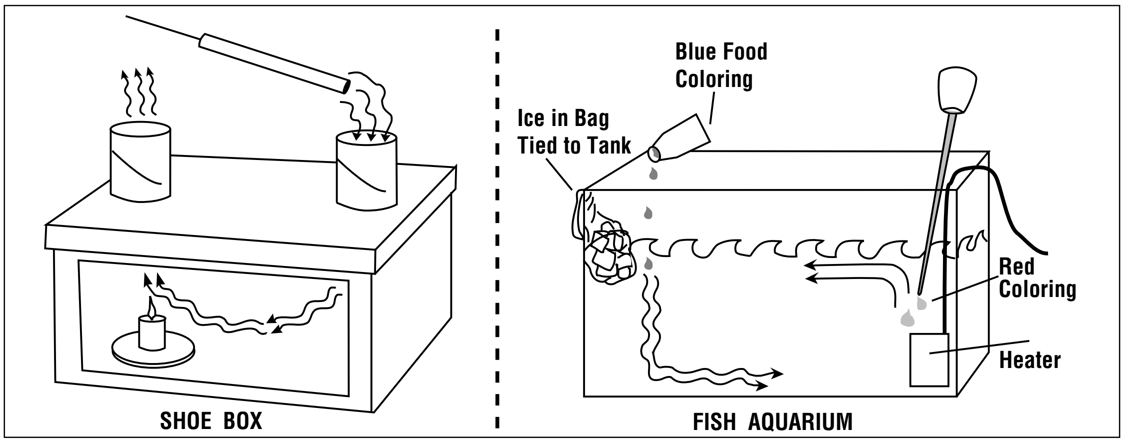
In the experiment you just completed, the candle supplied the heat causing the air to rise. What is the source of heat that causes air to rise and form clouds on Earth? What is the source of heat that does the same thing on the giant planets in our solar system like Uranus?

Expand

Go on-line and research the extensive weather-related materials which can be found there. The HST Home Page will provide some of the best links.

Send e-mail questions via *LHST*'s Researcher Q&A to astronomers and scientists who are awaiting your inquiries!





Activity 3D: The Interplanetary Weather Report

Objective

To compare/contrast weather on Earth and other planets in our solar system, and prepare a weather report similar to those on local newscasts, but interplanetary in scope.

Engage

Lead students in a discussion about weather, including how the weather is observed, recorded and forecast. Ask them about the role weather satellites play in allowing us to see and interpret the global weather situation every day. If possible, show a video tape of satellite images from last night's tv weather report, and explain what the satellite allows us to see: weather in motion. If you get cable TV, try to include a forecast segment that shows clouds over the entire Earth.

Explore / Explain

Ask students if they have ever seen a weather satellite image from another planet. If they say "no," show them an image of Jupiter or Neptune taken by the HST. Explain that as we have continued to explore, we have reached the point where we are starting to view and study the weather on other worlds. Tell them that for this project they are going to become meteorologists working for "The Interplanetary News Network." Their job: to issue the first TV weather forecasts for other worlds in our solar system.

Procedure Depending on students' backgrounds, use this Activity as an introduction to, or an extension of, the study of meteorology. Have students research the fundamentals of the Earth's weather including how it is measured and forecast. Draw attention to what can be measured at localized points around the globe (such as temperature, wind speed and direction, types of clouds, etc.) and what is more easily seen by looking at satellite images of large portions of the Earth including widespread areas of cloudiness, the location of jet streams, etc.

Assign students to study TV weather reports. To ensure they (and their parents) realize this is a serious assignment, ask them to record the channel # and call letters, name of weathercaster and length of report. Have them list topics shown or discussed in order of presentation: for example, Current Temperatures, Satellite Image, Weather Map, High Temperatures Tomorrow, Forecast, etc. What seems to be the important points about the weather which are covered? Did the weathercaster mention any severe weather? If so, what kind and where? Use this list to help students think about the topics that might be covered during a typical weathercast. Suggest students watch various channels, including the Weather Channel, to sample different styles and content. Notice how the weathercaster uses each visual, and what they say about each.

Divide students into teams and assign each the task of preparing a 5-7 minute TV weather report on a world other than Earth. Saturn's satellite, Titan and Neptune's companion, Triton, do have atmospheres and students may be challenged to take on some of this "moon meteorology" as well. Explain that in the case of other planets, there have been a few probes that have actually descended through some of their atmospheres to give a detailed set of readings at one or two locations (Venus, and more recently Jupiter). There have also been extensive satellite and spacecraft images of the planets from above. Challenge students to read about the weather on these other worlds and prepare a team weather report, dividing topic and presentation responsibilities among them. One member might want to report on overall temperatures, while another might give a special bulletin or update on some severe weather ("Over to you, Bob… Well, thanks, Jane…") Different students may want to act as if they are reporting from different places on the planets, or from different levels in its atmosphere ("I'm up here in Jupiter's clouds at about the height that the Galileo probe disintegrated, and let me tell you, Al…") Challenge them to make it fun but also informative. Assist them in preparing visuals to be used in their weathercast including charts and slides from various sources.

Again, you can provide a checklist to help them organize their thinking: Does your world have a thick atmosphere or a thin one? What is the atmosphere made of? Does the atmosphere allow us to see the surface of the planet or moon, or are there clouds or haze in the way? What's the surface like? What are temperatures in the upper parts of your world's atmosphere? At different levels in the atmosphere, or on the surface? What are the typical daytime highs on your world? Uniform, or different at different places? Typical nighttime lows? Are they different in different places?

Research the highest and lowest temperatures ever recorded in your region and across the Earth as a whole. How does your planet or moon compare? Does your world have seasons? How does this affect its weather? What is the air pressure deep in the atmosphere, or at the surface? Does the world have jet streams? How fast do they blow? Always in the same direction? How do these affect the weather? Is there rain, mist or fog? What is it made of, if not water, as on Earth? Does it snow? Is the snow made of frozen water like snow on Earth? Is there lightning? Are there storms? If so, what kind? Big or small compared to storms on Earth? Are there few, or many at one time? How long do the storms last? How does this compare to storms on Earth?

Ensure students have sufficient time to organize their research once they've collected it. Have them think about how to make it interesting and fun for others to hear and watch. What visuals would help? What props might be useful? Prepare a script or outline. Have each team member practice doing their part of the weathercast, alone at first, and then with the others on their team. Then, when they're ready … "The Weather on Other Worlds!"

Expand

Invite a local tv or radio meteorologist to speak about weather forecasting. Have the students prepare questions about the science of meteorology as well as how and why the guest speaker chose a career in this profession.

Go on-line and link from our homepage to "WeatherNet 4" to see how another NASA-funded IITA project has helped nearly 200 schools around Washington, DC, become real-time weather reporting stations. There are similar school-based weather networks in Houston and elswhere. Perhaps one of them will appeal to you, or your Administration, as an opportunity for ongoing weathercasting, on this planet, at least!