Ancient Observatories

Timeless Knowledge

Since the beginning of history, man has observed and tried to understand the movements of the sun, the moon and the stars. Around the world we have evidence of their efforts and continue to build on what they learned.

Sun-Earth Day • March 20, 2005 • http://sunearthday.gsfc.nasa.gov

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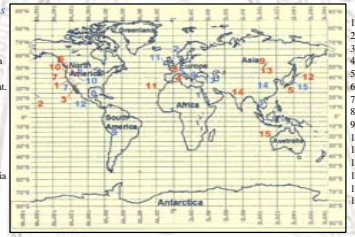

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The builders of Stonehenge must have had precise astronomical knowledge of the path of the Sun and must have known before construction began just where the Sun rose at dawn on midsummer's morning. This particular location was so important that stone circles and horseshoe arrangements were constructed to mark it and that some of the very large stones were dragged there from a great distance away. The famous stone circle and horseshoe arrangement were added later to the monument and are not essential to the lunar and solar observations.

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Numerous researchers have tackled the problem of what these possible alignments meant and how precisely the builders of Stonehenge understood the movements of the Sun and moon, but all agree that the site was used to express their interest in the sky.

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Its walls contained a number of circular structures called kivas, built into the ground with benches, a roof, a fire pit, wall holes and posts all of which were neatly aligned. The largest was 64 feet in diameter. Elements of the structure may have represented supernatural forces and the circular dome, the sky. A tremendous amount of effort went into the planning and construction in Chaco Canyon.

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Hovenweep Castle, built around 1200 A.D. in Utah by the Anasazi, was at least partly used as a solar observatory

The Anasazi built a number of small towers in the rough landscape of southeast Utah, structures unlike any others found in the southwest. The largest of these was called Hovenweep Castle. Although the towers seemed to have served some practical functions, a "solstice room" was added on. There, a careful observer on either of the solstices can still see a shaft of light pass through a small hole and strike a wall on the other side for only a few moments. On the equinoxes, the Sun lines up with a third entrance and an inside door. Little is known of the Anasazi and their knowledge, but they must have understood the movements of the Sun and attached significant meaning to them.

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At Hovenweep, the Anasazi Indians drew spirals on stones to mark where, in the shadows of rock slabs, shafts of light meet on the summer solstice.

Amazing Sites in Central and South America

In the civilization of the Incas, an entire city was built and structured on radial lines of sight, and several observatories were erected. In the capital city of Cuzco stood the Temple of the Sun, Coricancha, decorated with gold sun images. On the other side of the Andes stands the ruins of Machu Picchu, a large and interesting site in South America. High in the remote Andes Mountains in Peru stands the ruins of Machu Picchu. Building began in the 1460's and continued for the next 80 years or so until the Incan empire collapsed. A window in one of the central buildings seems to have been positioned to observe the winter solstice sunrise and related constellations that would be seen at the time.

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was possibly the source of careful observations of the extreme movements of Venus along the horizon. Venus, their god of war, was important to their culture. They offered sacrifices to Venus to obtain the bounties of nature.

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The Mayan pyramid of Castillo in Yucatan

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Like our ancestors from other cultures over thousands of years, modern scientists still cast their eyes up to the skies in the hopes of learning more about the Sun, moon, planets and stars. Although the ancient peoples lacked the modern tools that we possess today, they were able to observe and record and use that information to guide them and predict events.

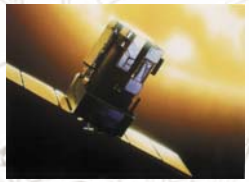
Today scientists rely on ground-based observatories around the world and a significant number of spacecraft to observe the sun, its effects on Earth, and stars. Over the years scientists have built on the knowledge gained from earlier generations, and with exciting new tools, they can gather new information about the universe that few could imagine possible just a hundred years ago. For example, sunspots were first observed by telescopes in the early 1600's. We have fairly good records of their numbers since then. In the mid-1800s astronomers discovered that when they tabulated and graphed them, their numbers increased and decreased over time in a repeatable cycle (the solar activity cycle or the sunspot cycle). Ancient Chinese astronomers also kept track of naked-eye sunspots 2,000 years ago, and that's how we know that sunspots have been a common feature of the Sun for millennia.

Credit: Paul Mentzell

The McMath-Pierce solar telescope on Kitt Peak, AZ is the world's largest solar telescope

We also know from the records that sometimes the Sun just stops making sunspots. This happened in the 1600s, also the time when Europe was in the grip of what they called a mini-Ice Age.

With spacecraft like SOHO (Solar and Heliospheric Observatory) launched in 1995, solar scientists can observe the Sun 24 hours a day. Its instruments can generate images of the Sun in ultraviolet light, can measure particles that emerge from it, and can even tell what is going on inside the Sun. Another spacecraft from NASA called TRACE can take close-up images of the Sun in different wavelengths of light to learn more about the activity on or just above its surface. Other spacecraft like ACE and Polar can detect and measure the impact of storms of particles from the Sun. Such storms can damage satellites, upset navigational equipment, and present a danger to astronauts.



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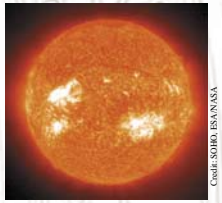


Credit: SOHO, ESA/NASA

The Sun in ultraviolet light in which the white areas show intense activty

Ground-based observatories also contribute to our understanding of the Sun. Their images and measurements from around the world are provided for everyone to use via the Internet. Great improvements have been made in the quality of their images so that new details never seen before can now be observed and studied.

Looking back, we can see that it all began with groups of people trying to learn more about the events that they were able to observe in the sky above them.

Hands-On Exercise: Finding Solar North

Context: A compass uses the Earth's magnetic field to find north and therefore points toward magnetic north, which is not in the same place as geographic or due north. A shadow plot can help you obtain a feel for how the Sun's path changes across the sky from day to day. During the course of only one day a shadow plot can help you determine which direction is due north at the location where the shadow plot is made.

Materials: pointed stick (example: skewer stick), 5 to 15 cm tall; piece of cardboard, at least 30 x 50 cm; cardboard box at 5 to 10 cm tall (example: lid to copier paper box works well); protractor and ruler; markers; glue; large paper, at least 30 x 50 cm; tape.

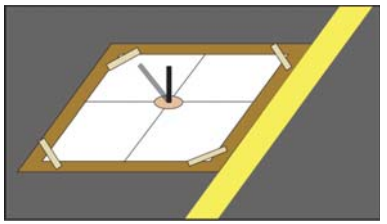
Set Up: Have students work in groups of 3 or 4.

Activity: Tape the larger piece of paper to the piece of cardboard. Mark the center of the paper with a dot using the marker. Through this dot draw two lines that are perpendicular to each other: one from top to bottom across the paper, and the other from left to right across the paper. Insert the pointed end of the stick through the center dot and into the cardboard. Use tape to secure the stick on the bottom of the box. Using the protractor, verify that the stick is straight. This is very important.

On a clear day, find a large open area outside (a parking lot area works best). Place the longest edge of paper along the edge of the parking lot or along a painted mark on the parking lot. (Remember this orientation of the box and the way your orientated your paper or tape the box to the ground.)

Starting as early in the morning as possible, trace the shadow of the stick every half hour until the end of the day, labeling the time after each tracing. Find two shadows that are the same length. They should be on different sides of the paper (either one towards the top and one towards the bottom, or one towards the left and one towards the right). Trace the angle of these two lines, then bisect the angle. On the original sun plot draw the bisector angle. When the plot is in its established position on the parking lot, this line points towards true solar north. Check the newspaper to find the times for sunrise and sunset; determine the midpoint between these two times. Check the midpoint on your plot to determine your accuracy.

This activity is part of the complete activity designed by NASA Connect for 2005 Sun-Earth Day. The complete activity can be found at -- **http://connect.larc.nasa.gov.**



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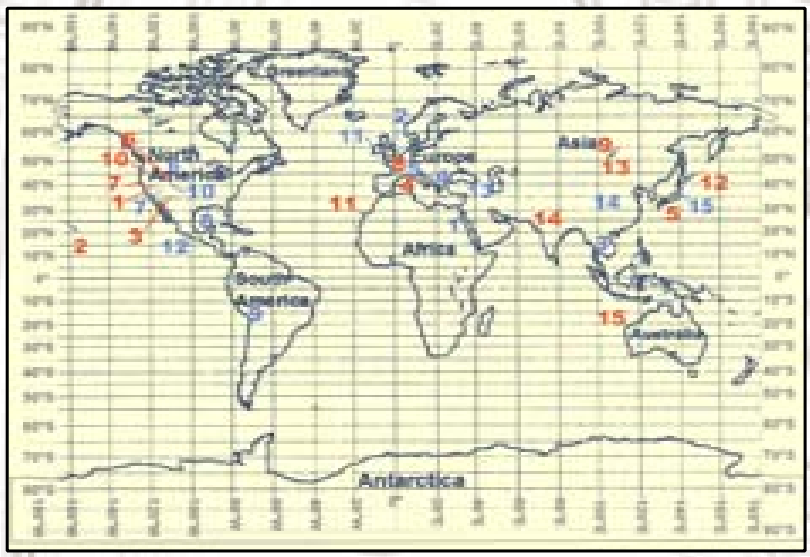

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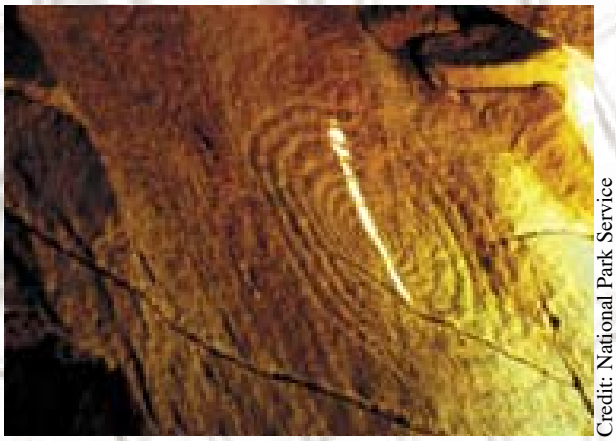

Credit: National Park Service

On a high butte in Chaco Canyon, the "Sun dagger" of light strikes through the middle of the large spiral on the summer solstice

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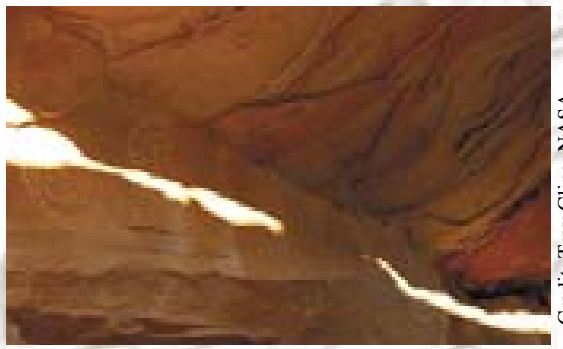

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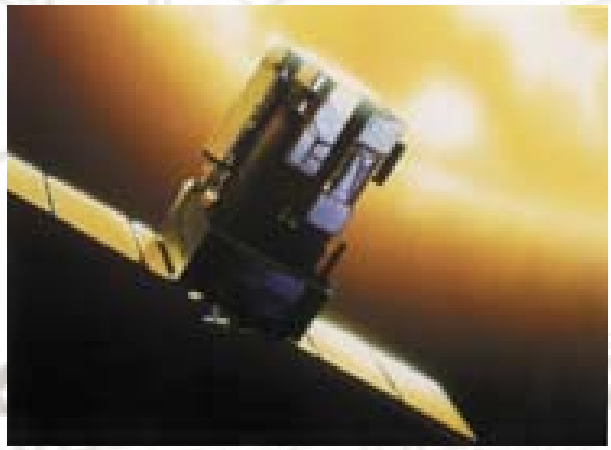

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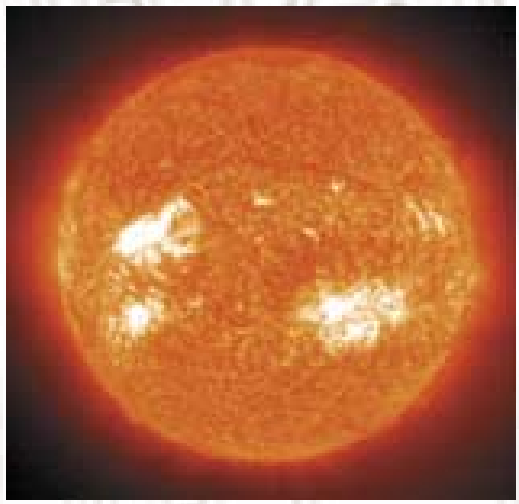
With spacecraft like SOHO (Solar and Heliospheric Observatory) launched in 1995, solar scientists can observe the Sun 24 hours a day. Its instruments can generate images of the Sun in ultraviolet light, can measure particles that emerge from it, and can even tell what is going on inside the Sun. Another spacecraft from NASA called TRACE can take close-up images of the Sun in different wavelengths of light to learn more about the activity on or just above its surface. Other spacecraft like ACE and Polar can detect and measure the impact of storms of particles from the Sun. Such storms can damage satellites, upset navigational equipment, and present a danger to astronauts.



Credit: SOHO, ESA/NASA

The Sun in ultraviolet light in which the white areas show intense activty

Ground-based observatories also contribute to our understanding of the Sun. Their images and measurements from around the world are provided for everyone to use via the Internet. Great improvements have been made in the quality of their images so that new details never seen before can now be observed and studied.

Looking back, we can see that it all began with groups of people trying to learn more about the events that they were able to observe in the sky above them.

Hands-On Exercise: Finding Solar North

Context: A compass uses the Earth's magnetic field to find north and therefore points toward magnetic north, which is not in the same place as geographic or due north. A shadow plot can help you obtain a feel for how the Sun's path changes across the sky from day to day. During the course of only one day a shadow plot can help you determine which direction is due north at the location where the shadow plot is made.

Materials: pointed stick (example: skewer stick), 5 to 15 cm tall; piece of cardboard, at least 30 x 50 cm; cardboard box at 5 to 10 cm tall (example: lid to copier paper box works well); protractor and ruler; markers; glue; large paper, at least 30 x 50 cm; tape.

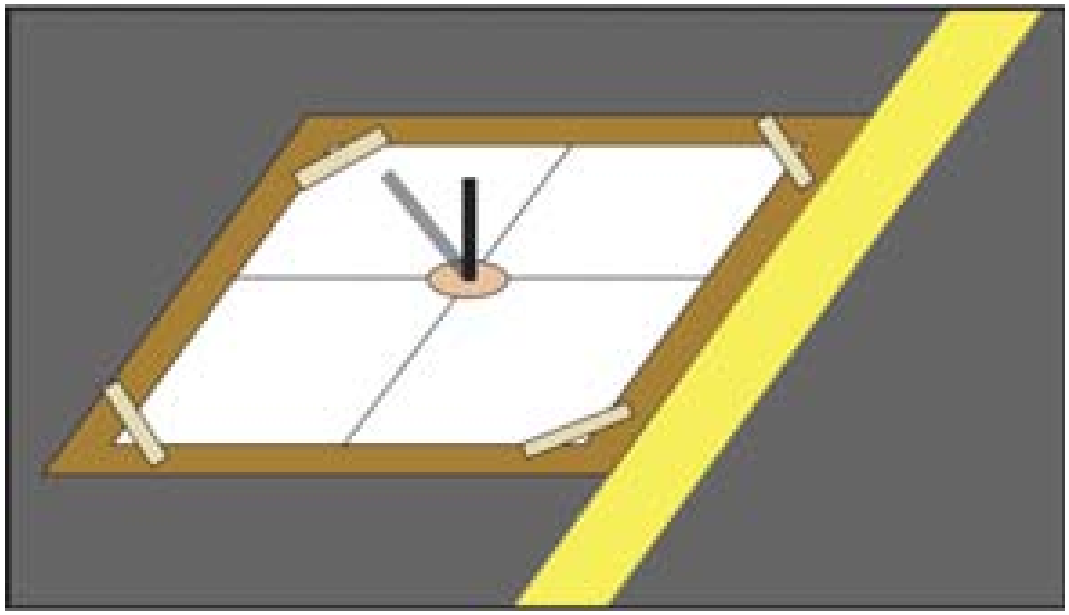
Set Up: Have students work in groups of 3 or 4.

Activity: Tape the larger piece of paper to the piece of cardboard. Mark the center of the paper with a dot using the marker. Through this dot draw two lines that are perpendicular to each other: one from top to bottom across the paper, and the other from left to right across the paper. Insert the pointed end of the stick through the center dot and into the cardboard. Use tape to secure the stick on the bottom of the box. Using the protractor, verify that the stick is straight. This is very important.

On a clear day, find a large open area outside (a parking lot area works best). Place the longest edge of paper along the edge of the parking lot or along a painted mark on the parking lot. (Remember this orientation of the box and the way your orientated your paper or tape the box to the ground.)

Starting as early in the morning as possible, trace the shadow of the stick every half hour until the end of the day, labeling the time after each tracing. Find two shadows that are the same length. They should be on different sides of the paper (either one towards the top and one towards the bottom, or one towards the left and one towards the right). Trace the angle of these two lines, then bisect the angle. On the original sun plot draw the bisector angle. When the plot is in its established position on the parking lot, this line points towards true solar north. Check the newspaper to find the times for sunrise and sunset; determine the midpoint between these two times. Check the midpoint on your plot to determine your accuracy.

This activity is part of the complete activity designed by NASA Connect for 2005 Sun-Earth Day. The complete activity can be found at -- **http://connect.larc.nasa.gov.**



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