Summary of Comments on SOHO 2002 slides

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Sequence number: 1
Author: SOHO
Date: 3/20/2002 1:13:04 PM
Type: Note

The SOHO project is a mission of international cooperation carried out by the European Space Agency (ESA) and the U.S. National Aeronautics and Space Administration (NASA). SOHO's major goal is to enable scientists to solve some of the most perplexing riddles about the Sun, including the internal structure of the Sun, the heating of its extensive outer atmosphere, and the origin of the solar wind. This slide set will offer some of the most compelling images from the mission.

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Sequence number: 1
Author: SOHO
Date: 3/20/2002 1:13:01 PM
Type: Note

SOHO studies the Sun 24 hours a day. It is the largest and most sophisticated solar observatory ever made. The spacecraft itself and some instruments were built in Europe, and several instruments were developed in the United States. Operational since early 1996, it will continue to operate for the forseeable future and hopefully could last for 10 or more years.

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Sequence number: 1
Author: SOHO
Date: 3/20/2002 1:12:59 PM
Type: Note

In the upper photo, the top of the spacecraft and instruments can be seen mounted on the side walls of SOHO. The two larger telescopes (on the left and top) are the Coronal Diagnostics Spectrometer (CDS) and the Ultraviolet Coronagraph Spectrometer (UVCS), respectively. In the bottom image the payload is undergoing tests before being mounted on the service module (fuel tanks and other supporting equipment).

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Sequence number: 1
Author: SOHO
Date: 3/20/2002 1:12:57 PM
Type: Note

SOHO's uninterrupted view of the Sun is achieved by positioning it at a special vantage point (known as the First Lagrangian Point). There, the gravitational pulls of the Earth and the Sun help keep the spacecraft in an orbit in which it follows the Earth around the Sun. It maintains a small, looping orbit around this Lagrangian Point, from where it sends its signals back through NASA's

Deep Space Network, which relays them to the operations center at Goddard Space Flight Center in Greenbelt, MD.

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Sequence number: 1
Author: SOHO
Date: 3/20/2002 1:12:54 PM
Type: Note

The image gives a basic overview of the Sun's parts. The cut-out shows the three major interior zones: the core (where energy is generated by nuclear reactions), the radiative zone (where energy travels outward by radiation through about 70% of the Sun), and the convection zone (where convection currents circulate the Sun's energy to the surface). The surface features (flare, sunspots and photosphere, chromosphere, and the prominence) are all clipped from actual SOHO images of the Sun.

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Sequence number: 1
Author: SOHO
Date: 3/20/2002 3:48:10 PM
Type: Note

The interior image from the Michelson Doppler Imager (MDI) instrument (upper right cut-out) illustrates the rivers of plasma discovered flowing under the Sun's surface. The surface image was taken with the Extreme ultraviolet Imaging Telescope (EIT) in light from Helium atoms. Both were superimposed on a Large Angle Spectroscopic Coronograph (LASCO) C2 image, in which the bright solar disk is blocked so that the corona can be viewed in visible light. To the right you see a large blast of plasma bursting out from the Sun.

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Sequence number: 1
Author: SOHO
Date: 3/20/2002 1:12:48 PM
Type: Note

Another way to measure the immensity of the Sun is its mass: the Sun is about about a million times more massive than the Earth. However, the Sun is about the size of an average star.

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Sequence number: 1
Author: SOHO
Date: 3/20/2002 3:48:41 PM
Type: Note

The four EIT images are given false colors for easy identification. Each color is showing the Sun in ultraviolet light at a different wavelength, measured in units of Ångstrom. The colors and wavelength are arranged as a rough analogy of the wavelengths in the visible spectrum: 304Å is about 1/20 of the wavelength of red light; 284Å is a yellow; 195Å is green, and 171Å is blue. Each one shows dfifferent features. The red shows material in the upper chromosphere at 60,000 degrees C; the blue, somewhat higher corona at 1 million degrees C; the green, even higher corona at 1.5 million degrees C; and yellow, the upper corona, where material is at its hottest at almost 3 million degrees C. The central image from the Michelson Doppler Imager (MDI) shows the sun in visible light, which reveals sunspots. All were taken on the same day.

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Sequence number: 1
Author: SOHO
Date: 3/20/2002 1:12:42 PM
Type: Note

For this image, three nearly simultaneous images from May 1998 were merged into one image, revealing the temperature structure of the Sun, with red showing the coolest areas, green/yellow is intermediate, and blue is the hottest.

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Sequence number: 1
Author: SOHO
Date: 3/20/2002 3:50:30 PM
Type: Note

This cutaway reveals the three basic interior regions inside the Sun. The pressure at the central core is immense and the temperature is about 15 million degrees C. This is where the nuclear fusion occurs, burning hydrogen into helium. In the large radiative zone, heat and energy are slowly transported outward over many thousands of years. In the convective zone the ovals suggest how the plasma is cycled up to the surface and back down again in a churning movement, akin to boiling water. The ovals are representative only–the churning seems to occur on all scales. The temperature at the surface is about 6,000 degrees C.

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Sequence number: 1
Author: SOHO
Date: 5/20/2002 2:58:19 PM
Type: Note

Just as scientists can use earthquake measuremens to determine conditions under the Earth's surface, instruments can sense waves of pressure to understand what is going on under the Sun's surface. In the red coloured layers in the solar interior, sound waves travel faster than predicted by the theories, implying that the temperature is higher than expected. This image is made from continuous observations over a period of 12 months beginning in May 1996.

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Sequence number: 1
Author: SOHO
Date: 3/19/2002 12:34:09 PM
Type: Note

Full disk images of the Sun's magnetic surface provide a way to study the emergence and decay of active regions. Darker and lighter areas indicate higher levels of magnetic activity with opposite magnetic polarity. A comparison of the magnetic image to the visible light (yellow) image shows that sunspots align closely with areas of intense magnetic activity.

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Sequence number: 1
Author: SOHO
Date: 3/19/2002 12:57:37 PM
Type: Note

Prominences are huge clouds of relatively cool dense plasma suspended in the Sun's hot, thin corona. At times, they can erupt, escaping the Sun's atmosphere. Ultraviolet emission in this spectral line produced by ions of helium shows the upper chromosphere at a temperature of about 60,000 degrees C. Generally, the hottest areas appear almost white, while the darker red areas indicate cooler temperatures.

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Sequence number: 1
Author: SOHO
Date: 3/19/2002 12:34:36 PM
Type: Note

Sunspots are formed when magnetic field lines just below the Sun's surface are twisted and poke through the solar photosphere. They are somewhat cooler (4,000 C) than the surface (6,000 C) and so appear darker by comparison. The twisted magnetic field above sunspots are sites where solar flares occur. During solar maximum there are many sunspots, and during solar minimum there are few.

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Sequence number: 1
Author: SOHO
Date: 3/20/2002 1:12:20 PM
Type: Note

Like all sunspots, this large sunspot group is rotating with the Sun. It seems to be growing from the first to the second image, but then gets smaller for the last two images.
The immense sunspot group, in the bottom image, unleashed a huge solar flare on April 4, 2001, a few days after this image was taken. The X-ray radiation from this was the strongest ever recorded.

Sequence number: 2
Author: Hill
Date: 3/20/2002 10:57:53 AM
Type: Line

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Sequence number: 1
Author: SOHO
Date: 3/20/2002 1:12:16 PM
Type: Note

The solar wind usually streams away from the Sun at about 350-450 kilometers per second. It goes out beyond the orbit of Pluto to the edge of the solar system, defining an area of solar influence we call the heliosphere. Though in actuality the density of the solar wind is slight, it exerts a substantial influence on the Earth's environment.

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Sequence number: 1
Author: SOHO
Date: 3/20/2002 1:12:13 PM
Type: Note

The loops of energized particles follow magnetic field lines that extend from below the surface, arc above it, and curve back into the Sun's surface. The highly energized plasma in these features is held in and guided by strong magnetic fields emanating from the Sun around an active region.

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Sequence number: 1
Author: SOHO
Date: 3/19/2002 12:36:30 PM
Type: Note

These prominences are some of the most dramatic that SOHO has observed. One of the largest eruptive prominences (upper right) extended over 35 Earths out from the Sun. Erupting prominences (when Earthward directed) can affect communications, navigation systems, even power grids, while also producing auroras visible in the night skies.

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Sequence number: 1
Author: SOHO
Date: 3/20/2002 4:03:03 PM
Type: Note

A coronal mass ejection on 26-27 February 2000 in which you can see the solar material as it is shot into space. A CME blasts a billion tons of particles traveling millions of km (or miles) an hour into space. This instrument observes iron stripped of some of its electrons heated to about 1 million degrees C in the corona.

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Sequence number: 1
Author: SOHO
Date: 3/19/2002 5:52:24 PM
Type: Note

The wave front driven by a CME travels at speeds of about 300 km/s. These images were formed in the emission lines of Fe XII, iron stripped of 11 of its electrons. These ions are formed at temperatures of about 1.5 million degrees. You are looking at the Sun's corona.

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Sequence number: 1
Author: SOHO
Date: 3/20/2002 3:51:49 PM
Type: Note

The Sun follows an 11-year cycle of activity. The chart of the current cycle as of January 2002 shows a second peak of solar activity has emerged, just as it did in the last two solar cycles. The rising level can be clearly seen in the comparison of EIT images along the bottom. The current cycle, Cycle 23, is the 23rd systematically recorded since routine sunspot observations began in the West in the 17th Century.

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Sequence number: 1
Author: SOHO
Date: 3/20/2002 3:52:08 PM
Type: Note

The Sun is near its sunspot maximum in the second image. These images are captured using Fe IX-X (iron stripped of 8 or 9 electrons) emission showing the solar corona at a temperature of about 1 million degrees C. Many more sunspots, solar flares, and coronal mass ejections occur during the solar maximum. The numerous active regions (brighter areas) and the number and size of magnetic loops in the 2001 image show a dramatic increase.

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Sequence number: 1
Author: SOHO
Date: 3/20/2002 1:11:46 PM
Type: Note

The numerous active regions with intense magnetic activity are greatest in the first and the last images when the Sun is at its maximum; the Sun at and around minimum almost completely lacks any of these features. Many more sunspots, solar flares, and coronal mass ejections occur during the solar maximum. These selected magnetic images, one per year, were taken by the Kitt Peak telescope, part of the National Solar Observatory.

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Sequence number: 1
Author: SOHO
Date: 3/20/2002 1:11:42 PM
Type: Note

The looping structures of the magnetic field lines are quite clearly defined here. Such clear images in the ultraviolet were not possible before the TRACE spacecraft began imaging the Sun in 1998. This false color image is light from Fe IX/X. The SOHO EIT (blue) full disk image from the same day gives an idea of the size perspective.

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Sequence number: 1
Author: SOHO
Date: 3/20/2002 3:52:51 PM
Type: Note

CMEs are caused by the breaking apart of magnetic field lines which, like rubber bands that have been twisted to the point of snapping, briefly slingshot charged particles into space. In the first image you can see an unusual twisting motion as the CME cloud expands. In the second image (upper right) the particles have broken away in a sweeping arc. The lower left image is a "difference image", highlighting what areas are changing quickly. This event is seen spreading out on all sides of the Sun, what we call a "halo" CME. The cloud is either heading right towards or away from Earth. Finally, in the last image a CME cloud is seen expanding to the right.

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Sequence number: 1
Author: SOHO
Date: 3/20/2002 1:11:35 PM
Type: Note

Fireworks in sequence from four instruments – This CME, part of a series of 5 CMEs in late November 2000, shows its progress from a sunspot group (MDI), to the flash of a flare (EIT 195Å), to a blasting CME seen 14 hours later in the corona (LASCO C2), and to a large expanding CME cloud over three hours later (LASCO C3). The ability to see an entire event with a number of instruments has contributed greatly to SOHO's success.

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Sequence number: 1
Author: SOHO
Date: 3/20/2002 1:11:32 PM
Type: Note

Solar storms, which occur frequently, can disrupt communication and navigational equipment, damage satellites, and even cause blackouts. The purple line indicates the bow shock, the outer edge of the magnetosphere; the blue lines surrounding the Earth represent its protective magnetosphere. The magnetic cloud of plasma can extend to 30 million miles wide by the time it reaches Earth. The magnetic field orientation of the CME is a major factor as to whether the Earth will suffer many consequences from any given CME.

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Sequence number: 1
Author: SOHO
Date: 3/20/2002 1:11:29 PM
Type: Note

If you look closely at the large image (left) of the Sun taken about the time of the CMEs, you can identify the likely sources of the two CMEs: the active regions at about the two o'clock and the eight o'clock positions. The field of view of the image extends nearly 4 million km from the Sun or about six solar radii. The two other images of strong CME's suggest the intensity and power of these solar storms.

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Sequence number: 1
Author: SOHO
Date: 3/20/2002 1:11:26 PM
Type: Note

In the first image the CMEs almost overlap with one heading up and the other to the right. In the second image, with a more distant perspective and taken four hours later, one event has almost disappeared, while the second is still well-defined .

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Sequence number: 1
Author: SOHO
Date: 3/20/2002 1:11:23 PM
Type: Note

This LASCO sequence shows a classically shaped CME cloud blasting out and spreading wider as it leaves the Sun and heads into space. This one was not directed towards Earth. CMEs can occur several times a day during the solar maximum period.

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Sequence number: 1
Author: SOHO
Date: 3/20/2002 3:59:32 PM
Type: Note

Known as the "Bastille Day" event 14 July 2001, this flare was very strong. The flare (seen as a sudden, rapid, and intense variation in brightness) occurred when magnetic energy that had built up in the solar atmosphere was suddenly released, launching material outward at millions of kilometers per hour. The Sun’s magnetic fields tend to restrain each other and force the buildup of tremendous energy, like twisting rubber bands, so much that they eventually break. At some point, the magnetic lines of force merge and cancel in a process known as magnetic reconnection, causing plasma to forcefully escape from the Sun. The flare was associated with a CME as well. The storm effects were felt on Earth for days and aurora were seen as far south as Florida and southern Europe. The storm also included a proton event in which high energy protons were blasted into space and were seen as white speckles hitting the spacecraft's detectors on their way towards Earth. Our magnetosphere protects us from this type of radiation.

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Sequence number: 1
Author: SOHO
Date: 3/20/2002 1:11:15 PM
Type: Note

In this sequence a CME blasts a billion tons of particles into space. The proton event was spawned by the combined effects of the CME and the preceding solar flare (not shown). The size and position of the Sun is indicated by the small white circle in the center of the occulting disk.

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Sequence number: 1
Author: SOHO
Date: 3/20/2002 1:11:13 PM
Type: Note

Comets, largely composed of ice and dust, characteristically have tails made of particles streaming out, away from the Sun. They can be found zooming around space quite frequently. In the far right, a pair of comets follow similar but not identical orbits and enter the tenuous outer atmosphere of the Sun. Soon after that the comets disappeared behind the occulting disks of the coronagraph, presumably melted and dispersed by the Sun. But the orbit of "Machholz-1" comet at bottom causes it to pass by the Sun about every five years. Amateur astronomers reviewing SOHO images on the Internet have made a large portion of SOHO's comet discoveries.

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Sequence number: 1
Author: SOHO
Date: 3/20/2002 1:11:10 PM
Type: Note

Of course, the word "visual" is stretching the truth a bit. Only with the help of sophisticated imaging equipment can we "see" the Sun's surface and CME in the first image or the ultraviolet activity in the Earth's atmosphere in the second. But anyone in the right place at night at the right time can see aurora. Those who have seen their colorful display say it is an experience not to be missed.

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Sequence number: 1
Author: SOHO
Date: 3/19/2002 12:47:53 PM
Type: Note

With the average CME dumping about double the power generating capacity of the entire U.S. into the magnetosphere, big changes can occur in the space around the Earth. The electrical inflow can wreak havoc on a world that depends on satellites, electrical power, and radio communication—all of which are affected by electric and magnetic forces. For the satellites dancing in and out of the radiation belts and the solar wind, CMEs and magnetic storms can be perilous. For astronauts, it is the potentially harmful radiation of X-rays, gamma rays and energetic particles that must be avoided.

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Sequence number: 1

Author: SOHO
Date: 2/20/2002 5:04:12 PM
Type: Note

SOHO has greatly advanced the study of the Sun and provided a stepping stone for future solar study missions. Scientists will be poring over its images and data in their search for answers for years to come.

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Sequence number: 1
Author: SOHO
Date: 3/20/2002 1:11:02 PM
Type: Note

Thanks for visiting with SOHO. Feedback and comments are welcome and should be sent to Dr. SOHO at letters@sohops.gsfc.nasa.gov. Please visit our web site for up-to-the-minute information, images and videos of the Sun. Again, that URL is soho.nascom.nasa.gov or soho.estec.esa.nl.