The Sun: The Second Greatest Influence on Earth

NAI Region 9 Workshop

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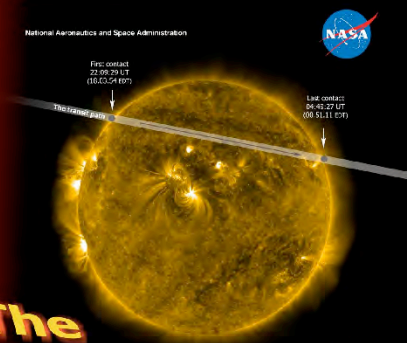
Get Ready For These Upcoming Events!

Annular Solar Eclipse

May 20, 2012

National Aeronautics and Space Administration



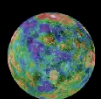
The Transit of Venus

June 5, 2012

Venus will cross in front of the Sun

On the 5th and 6th of June, Venus will pass across the face of the Sun—a rare event that in the 17th century permitted European scientists to determine the size of the Solar System. Join NASA in celebrating this last apparition of the transit till the year 2117!

Viewing the transit in North America



Venus Topography

Venus Cloud Cover

For further information, go to http://venustransit.nasa.gov

Professional Development Opportunities

Training Webinars:

- Thursday March 22, 2012 (11 am)
- Tuesday April 3, 2012 (11 am)

www.earthtosky.org

https://www1.gotomeeting.com/register/195583880

Professional Development Opportunities

ASTRONOMICAL SOCIETY OF THE PACIFIC

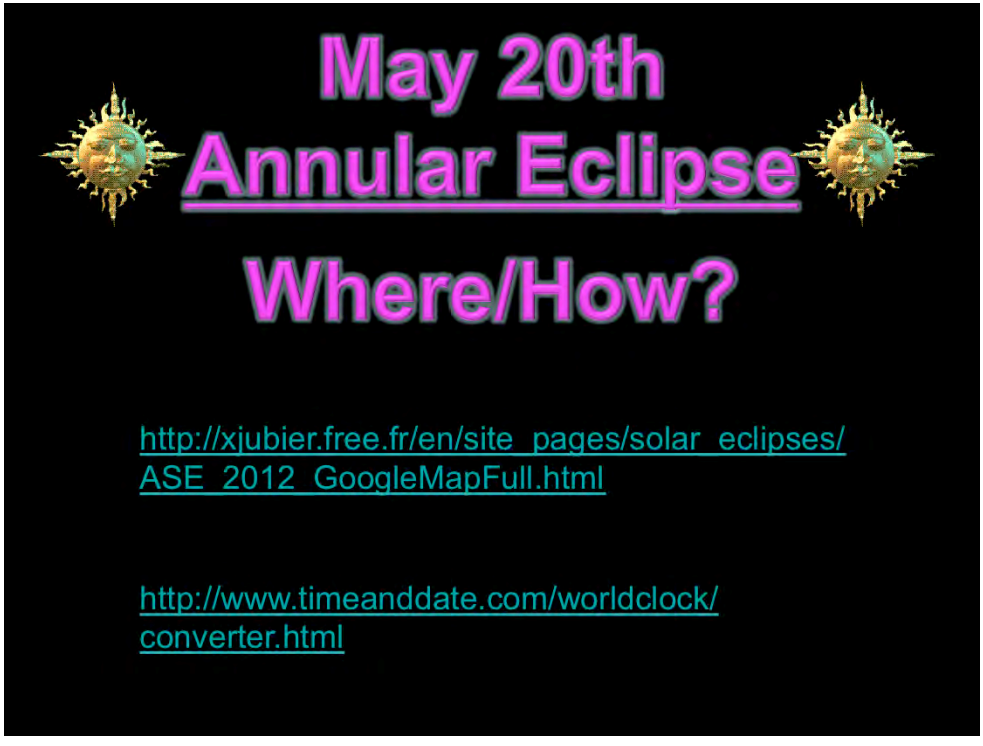
ASTRONOMY from the GROUND UP
An Educational Collaboration of ASP, NOAO & ASTC
Funded by the National Science Foundation

Sky Rangers Online Workshop

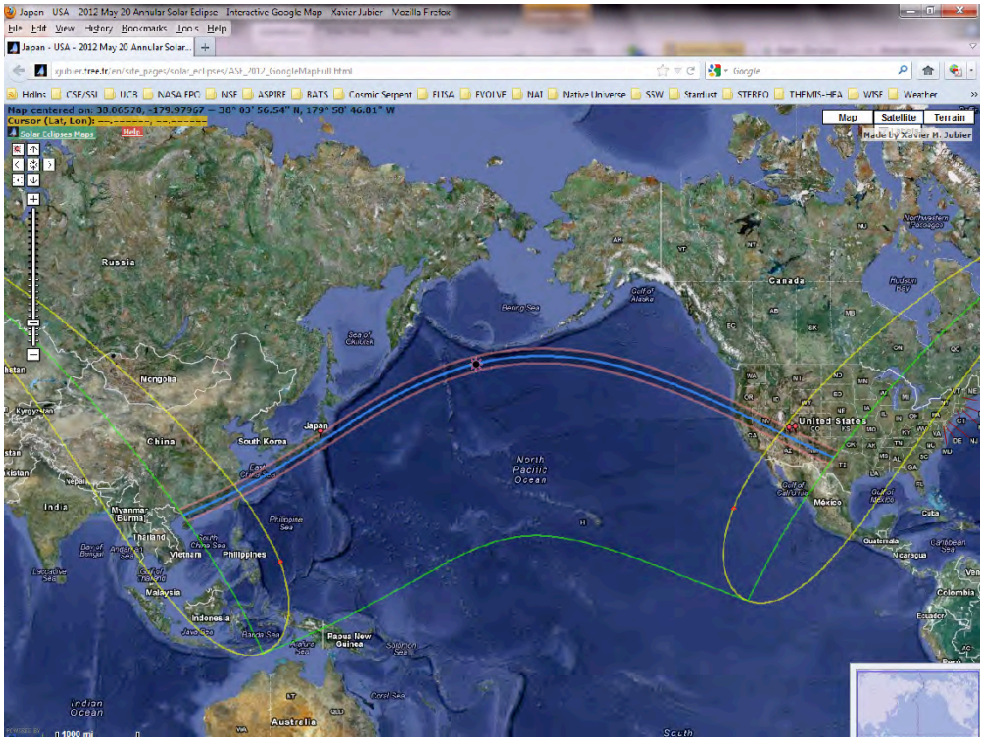
April 30 – May 11, 2012

www.afguonline.org

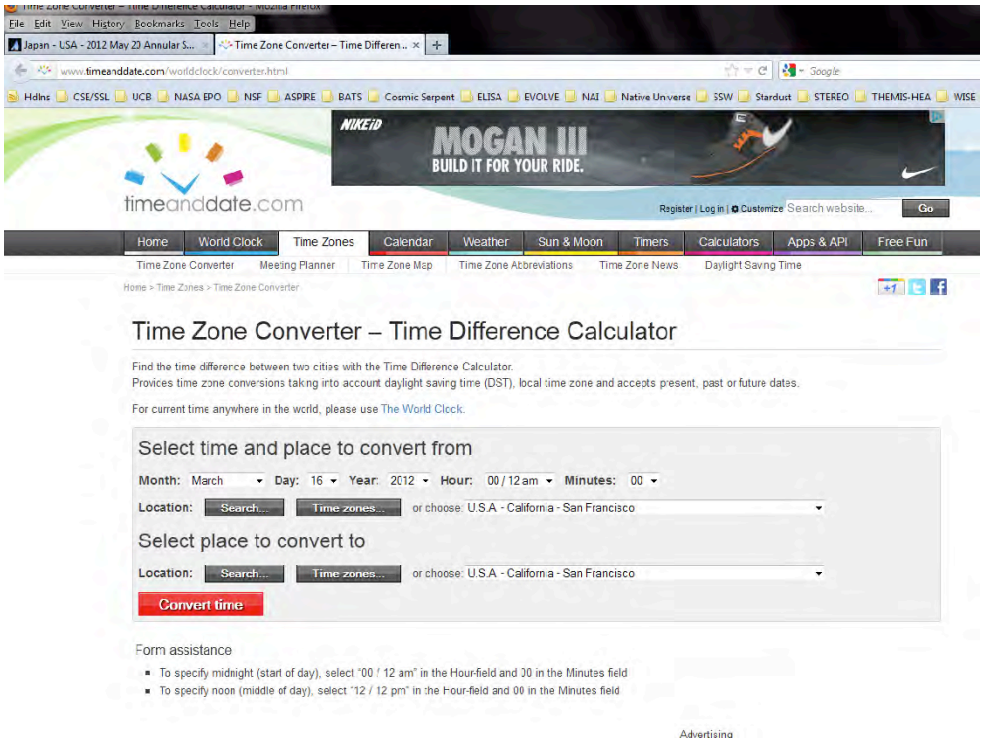
http://www.afguonline.org/mod/resource/view.php?id=1857



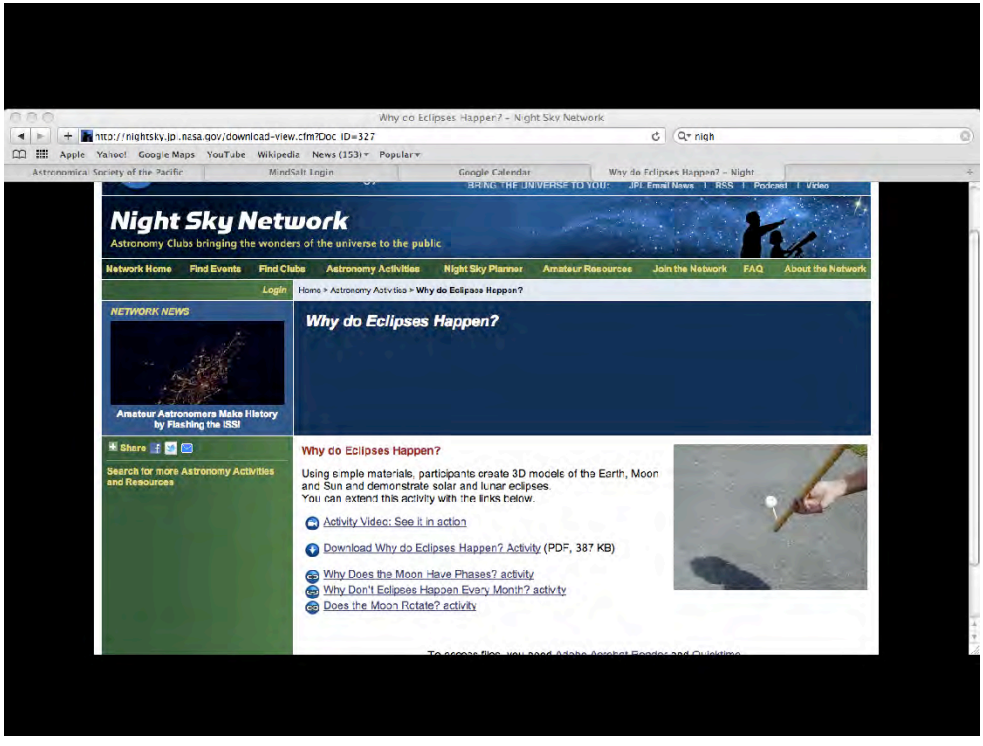
This is a Region 9 event! The best locations to see it are from the Northern California coast through Nevada, the farther East you go, the closer to sunset the event will be happening. Just click on the Google map and zoom in on your location to get the specifics. The times on this map are listed in Universal Time, so you can use the world clock time converter to find out what the time will be in your location. For Region 9, just subtract 7 hours if you're in PDT and 6 hours if you're in MDT (AZ would subtract 7 hours since they're on MST). Let's take a closer look.



This is a screen shot of the Google Map link.

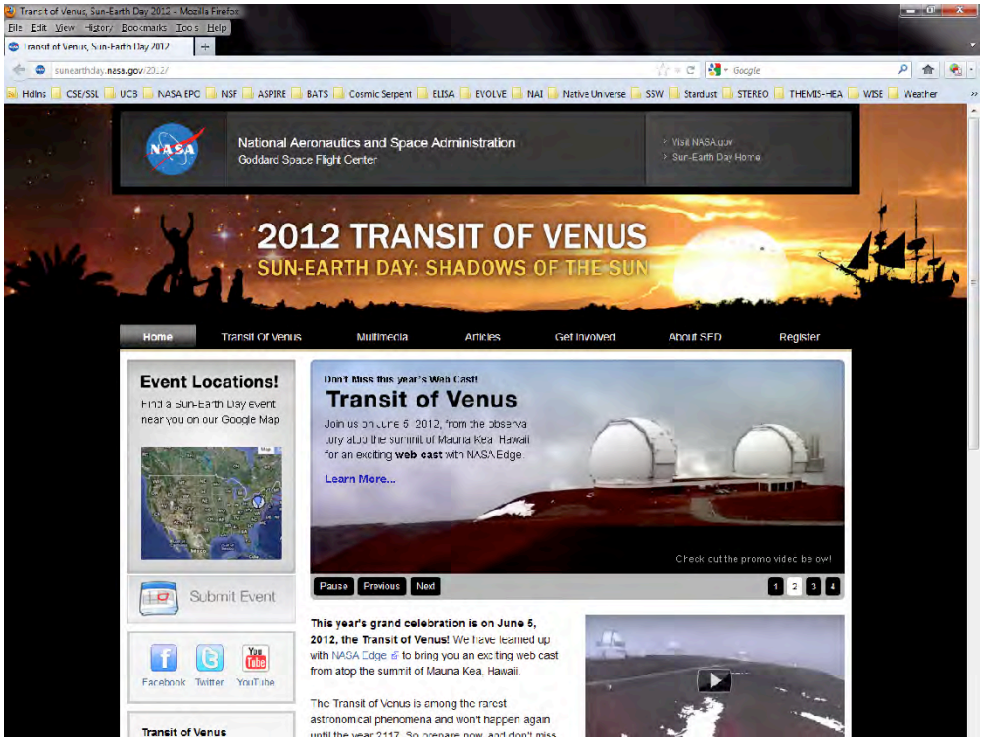


This is the UT time converter.



The Night Sky Network is an excellent source of activities to help demonstrate the phenomenon. This activity uses a yardstick, a one inch ball and a quarter inch bead to demonstrate how the earth, sun and moon align to make either a solar eclipse or a lunar eclipse. The write up was handed out and the activity demonstrated using the projector light as the sun, since it was cloudy during the workshop. The complete write up can be found here: http://nightsky.jpl.nasa.gov/download-view.cfm?Doc_ID=327

A transit of Venus is when the planet Venus moves between the Sun and Earth and is aligned so that it is silhouetted against the brilliant face of the Sun. It last happened in 2004 and won't happen again for another century. It is a twice in a lifetime event and for us, this is the last time any of us will be able to see it.



Historically, this is how we finally figured out how big the solar system is. Because of Kepler and Newton, we understood the relative separations of the planetary orbits but we didn't know the absolute distances. We called the distance from Earth to the Sun, one astronomical unit, but we didn't know how many miles or kilometers that was. We knew Mars was 1.5 times as far from the Sun as we are, but we didn't know the absolute number. Two newsletters for teachers were shared that include hands on activities to demonstrate the dynamics of a Venus and Mercury transit work:

http://www.astrosociety.org/education/publications/tnl/78/78.html

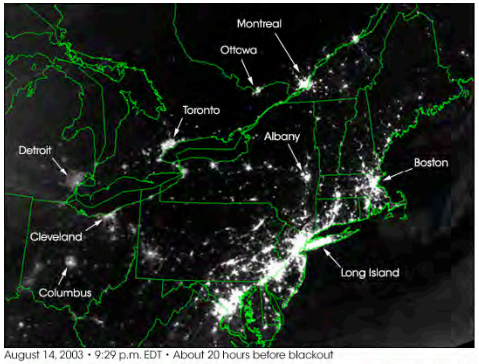
http://www.astrosociety.org/education/publications/tnl/69/mercury.html

For both events, safe solar viewing practices should be observed. Again, since it was snowing during the workshop, we shared this video to demonstrate safe viewing techniques:

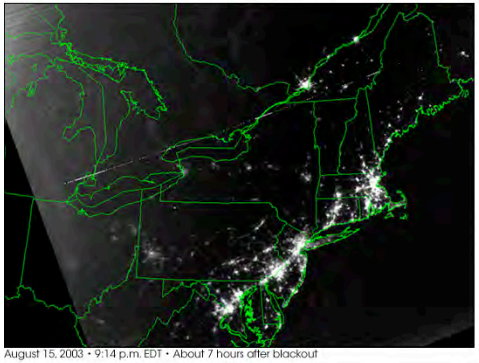
http://cse.ssl.berkeley.edu/cms/LearningResources/ViewingtheSunSafely/tabid/269/Default.aspx

Even after these events, the Sun is a great target for daytime astronomy events. The Astronomical Society of the Pacific has partnered with SSL to create a toolkit called Our Magnetic Sun. It will be distributed to both Night Sky Network amateur astronomy clubs and to park rangers and outdoor educators who take our two week online workshop. (See slide 4)

The rest of this presentation is the ppt that is a part of that toolkit. In addition to the ppt, there are hands on demonstrations that cover the same points.



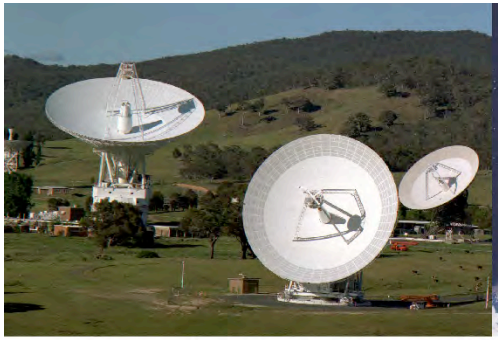
August 14, 2003 • 9:29 p.m. EDT • About 20 hours before blackout



August 15, 2003 • 9:14 p.m. EDT • About 7 hours after blackout

A massive blackout leaves millions of people without power

So, imagine this scenario…



Communications are disrupted between the ground and satellites, aircrafts and ships.

Satellite signals are disrupted around the world. Communications are disrupted from the ground to airplanes and ships.

Presenter’s notes

Airplanes and ships use the ionosphere to reflect shortwave radio signals

GPS signals are disrupted and magnetic compasses start pointing to a different location.

You can’t use Google Maps!

And the northern lights, or aurora are brilliantly shimmering as far south as the Caribbean!

Image Credits:

Upper Left: NASA/Warren Gammel

Lower Left: NASA/Shawn Malone

Upper Right: NASA

What could be causing this?

- ❑Terrorist attacks?
- ❑Earthquakes?
- ❑Tornados?
- ❑Hurricanes?
- ❑Alien Invasion?

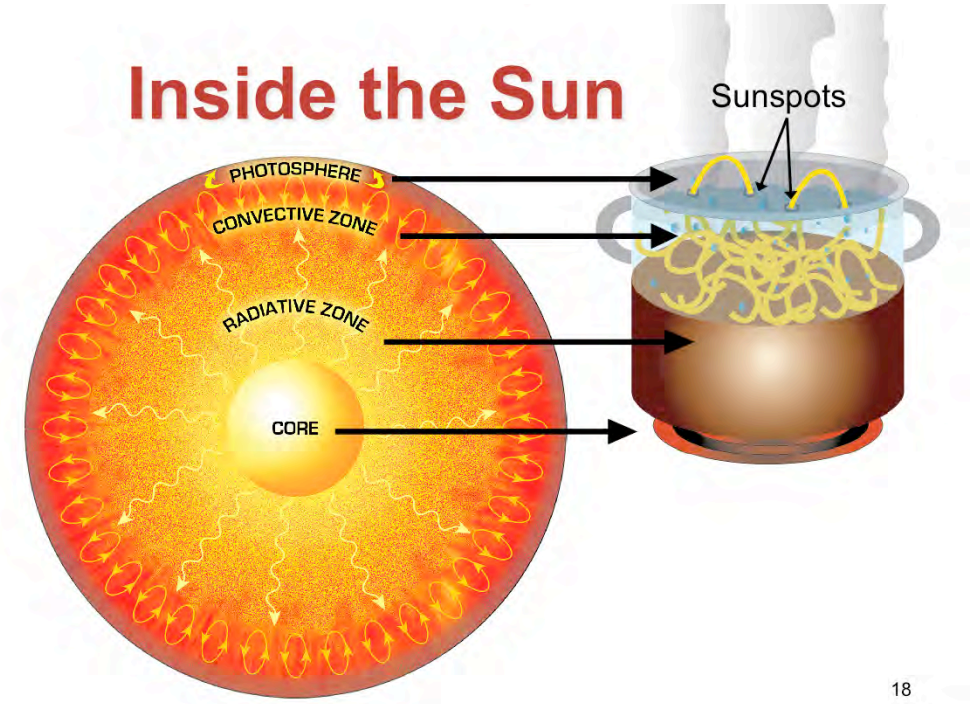
The Sun may look peaceful from here.

It turns out there's a bigger story.

What do you see on this image? (Dark spots?)

Right! Those dark patches are called sunspots. Would you believe all of that chaos is related to these innocent looking sunspots?

Let's explore the Sun together and find out what's lurking behind that peaceful surface.



We'll start at the center. <click>

Let's use a thick-bottomed pot sitting on a stove as a model for the interior of the Sun.

The pot is filled with boiling water and some strands of spaghetti.

You can think of the Sun's ***core*** <click> as the burner on the stove, generating energy.

The core blends into the ***radiative zone*** <click> where energy continues to be transferred outwards through radiation. Like the thick bottom of the pot, the material is still very dense – too dense to "boil" – but the heat still transfers up through the bottom of the pot.

Now we move out into the ***convective zone*** <click> where the density is low enough to allow the material to "boil," like water boiling in that thick pot. It's deep in Sun's boiling *convective zone* where magnetic field lines are generated. The magnetic field gets twisted up, kind of like the strands of spaghetti in the boiling pot of water.

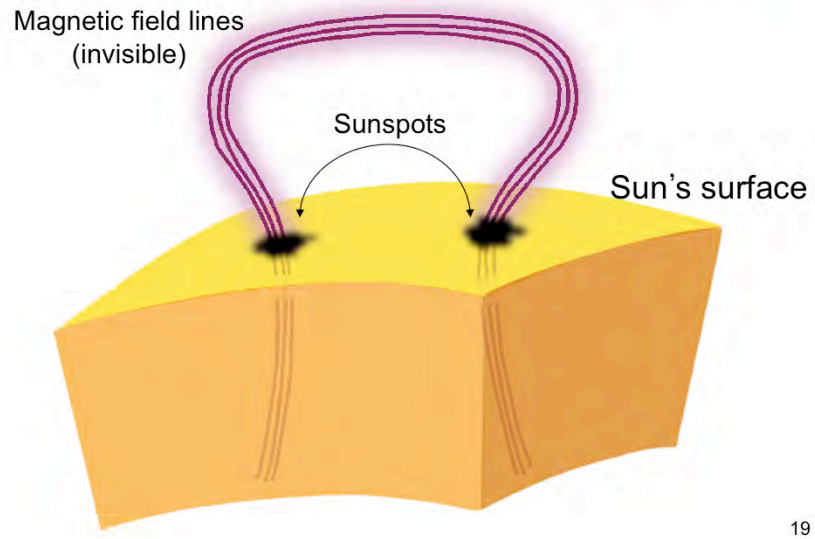
The Sun's ***Photosphere*** is represented by the surface of the boiling water. <click> This is the part that we see through a filtered telescope and the layer where nearly all the visible light that illuminates our sky comes from.

Now imagine a strand of the boiling spaghetti looping up through the surface of the water. <click> Sometimes the Sun's magnetic field lines pop through the surface <click> – and where they pop through the surface is where we see ***sunspots***.

So it's the convective zone has the primary role in generating those sunspots and also **magnetic activity**.

Extending the analogy:

What Makes Sunspots?



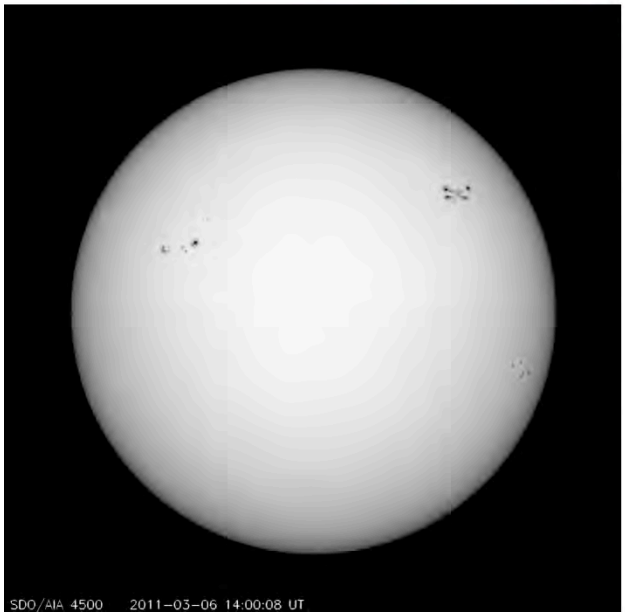
Let's take a closer look.
This is schematic of a magnetic field line popping through the surface of the Sun.
We can't actually *see* magnetic field lines, but we do see their footprints. Sunspots are the "footprints" of the coronal magnetic loops. They look dark compared to the surface of the Sun because they are not as hot as the rest of the surface.

Presenter's notes:
An electrified gas (plasma) like that of the Sun will create magnetic fields, generated within the convective zone. The coronal loops are made of plasma trapped in a very strong magnetic field. The gas in these loops are glowing from being bombarded by charged particles trapped on the magnetic loops. These charged particles are energized by different processes involving the magnetic field and heat the Corona, especially in these magnetic field regions.

These same magnetic field loops penetrates down into a region just below the photosphere called the convection zone and inhibits the convection of gas in that region. The inhibition of convection causes the gas below the photosphere to cool faster than the surrounding region.

The average strength of the magnetic fields in sunspots is around 1,000 Gauss (Gauss is a unit of magnetic field strength). The average field strength on the surface of Earth is about 0.5 Gauss, the average magnetic field strength on the surface of the Sun is about 1 Gauss, and the average magnetic field in the solar wind is 0.00005 Gauss (50 microGauss). The magnetic fields in sunspots are extremely strong.

The Visible Sun



Looking at the Sun in visible light reveals dark spots on its surface.

These magnetic *Sunspots* are connected to the mysterious events just described. 20

And that's what we see when we look at the Sun through a backyard telescope with a solar filter, like this.

We're looking at the sun's visible "surface" or the Photosphere.

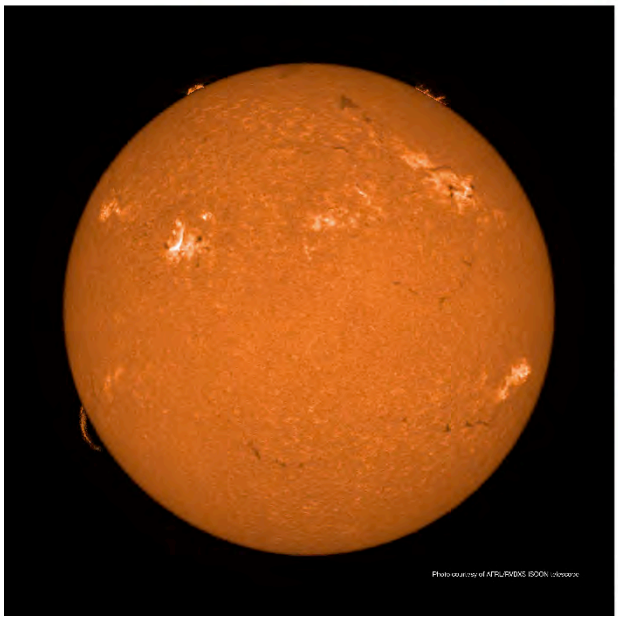
Dark sunspots are visible in telescope images. Images in white light are otherwise featureless.

But the magnetic field is lurking. Let's take a different look.

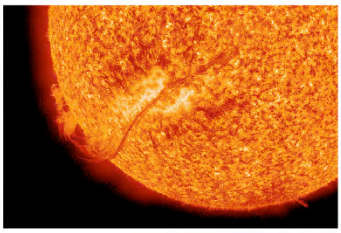
Presenter's Notes:

The "surface" of the Sun is where visible light streams freely away from the Sun. The density here is far less than that of Earth's atmosphere. Temperatures are around 5,800 C (10,000° F) and the gas is mostly ionized.

The Sun in H-alpha



In this specific color of red light we can see more details of the Sun's magnetic activity.



This image was taken on the same day, but in a different wavelength of light.

Looking at the Sun in different wavelengths reveals different parts of the Sun.

In this view of the Sun, we see the Chromosphere. You'll notice the loops on the side, called prominences.

When prominences are seen from above from our point of view, we call them fillaments, as you can see in the picture in the bottom right. They look like dark lines on the surface of the Sun. Just like sunspots, they appear dark against the surface because they are cooler than the surrounding material.

They are made from material from the Sun getting lifted off the surface by the magnetic activity of the Sun.

You can see these details through a special filter on a backyard telescope, called a hydrogen alpha filter.

Now keep an eye on one of those sunspot areas as we move to UV wavelengths.

Presenter's Notes

Sunspots and plage (rhymes with garage) also visible along with *prominences* and *filaments*

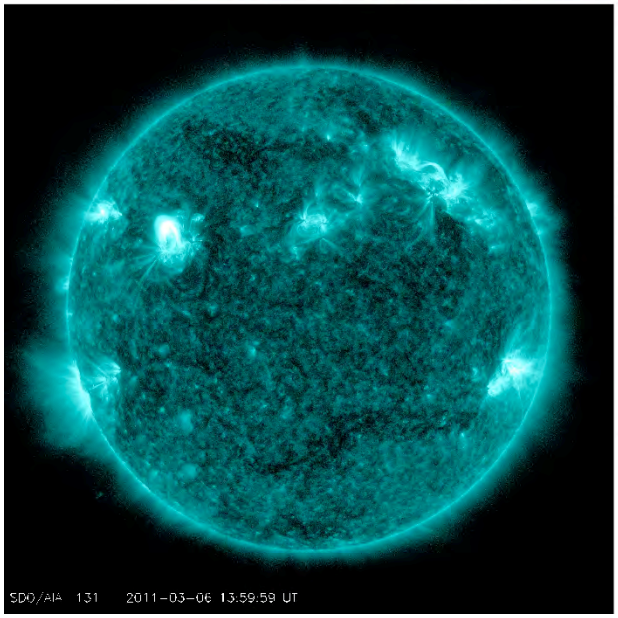
Sunspots usually appear dark in H-alpha images and the bright plage surrounding them are more prominent.

The chromosphere is just above the photosphere. It is transparent to visible light, but can be seen in a specific, red, color of visible light given off by hydrogen gas (H-alpha).

Visible light (H-α)

Wavelength = 656.3 nm

The Ultraviolet Sun



From space, we can observe the Sun in ultraviolet (UV) light and see hot gas trapped in magnetic fields on the Sun.

22

What do you see in the places where we previously saw sunspots? (Bright loops!)

The Ultraviolet or UV wavelength reveals the super hot gas in the atmosphere of the Sun.

The brightest spots are above sunspots. These loops are hot gas trapped in the magnetic field lines above the sunspots.

Let's see how these are connected…

Presenter's Notes

Views like this of the Sun are only possible from space since the Earth's atmosphere absorbs high energy UV light from the Sun. This image is from NASA's Space Dynamics Observatory (SDO) and shows gases heated to extreme temperatures in the atmosphere of the Sun, called the corona. These gases are suspended in magnetic fields and trace them out like iron filings around a bar magnet.

Extreme Ultraviolet light

Wavelength = 17.1 nm

The Dynamic Sun

23

Here you see a movie of four different views of the Sun over a period of 3 days.

As we saw in the last few slides, you can see sunspots on the chromosphere. Do you see what's happening where those spots are in the other views of the Sun?

At the end of the movie, you see a large solar storm on the top left side of the images.

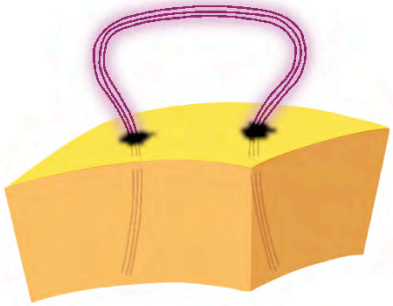
Presenter's Notes

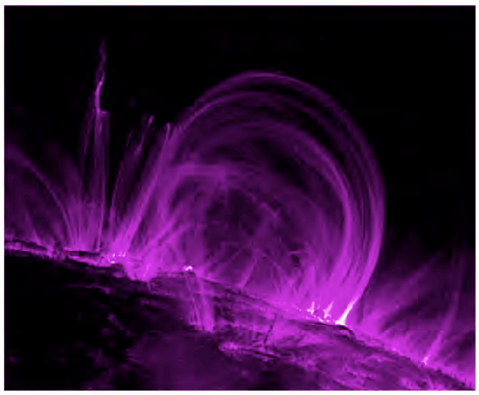
Movie repeats 2 more times or you can move to the next slide at any time.

You can watch and download this movie online here:

http://www.astrosociety.org/samplers/DynamicSun4Views.mov

The Magnetic Sun





Ultraviolet images of the Sun reveal loops of hot ionized gas trapped in magnetic fields above sunspots.

24

Here again on the left we see the schematic of a magnetic field line popping through the surface of the Sun.
We don't see the magnetic field lines, but we do see the charged material from the corona gathering around the magnetic loops.
That's what we're looking at in the image on the right. Sunspots are the "footprints" of the coronal magnetic loops.

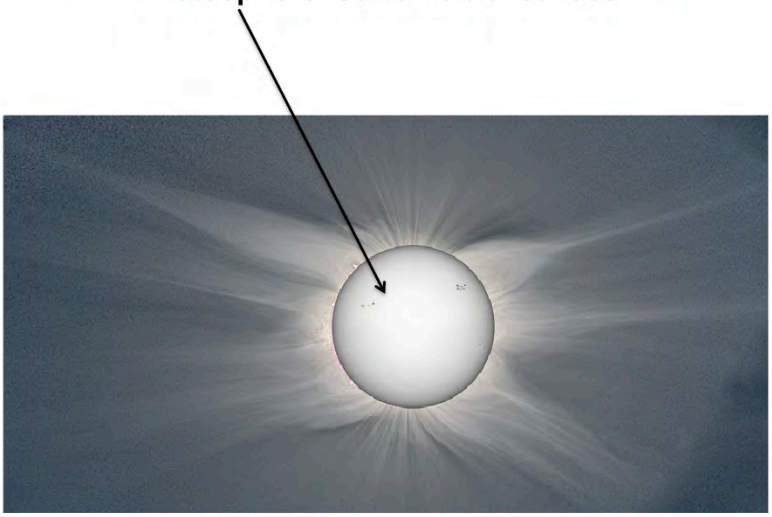
Presenter's Notes

On the right is an image of a coronal loop acquired from the TRACE satellite.

An electrified gas (plasma) like that of the Sun will create magnetic fields, generated within the convective zone.

The Different Parts of the Sun

Photosphere: Sun's visible "surface"



25

Let's review the different parts of the Sun. That visible surface of the Sun where we see sunspots is called the photosphere.

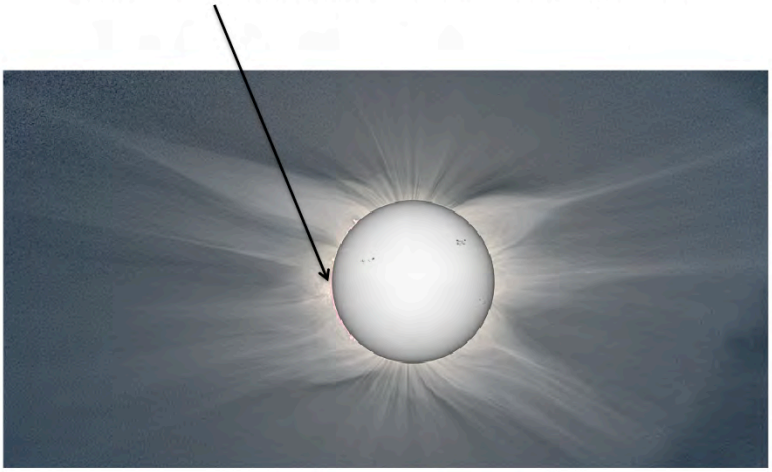
I know we've been seeing the sun in different colors – mainly to enhance the image to bring out certain features. But the true color of the Sun is white, like in this image.

Presenter's Notes

The temperature of the photosphere is about 6000 C (11,000 ° F)

The Different Parts of the Sun

Photosphere: Sun's visible "surface"
Chromosphere: Just above the Photosphere



26

The chromosphere is where we saw the prominences and filaments in the red image.

If the Sun were the size of an apple, the chromosphere would be thinner than the apple skin.

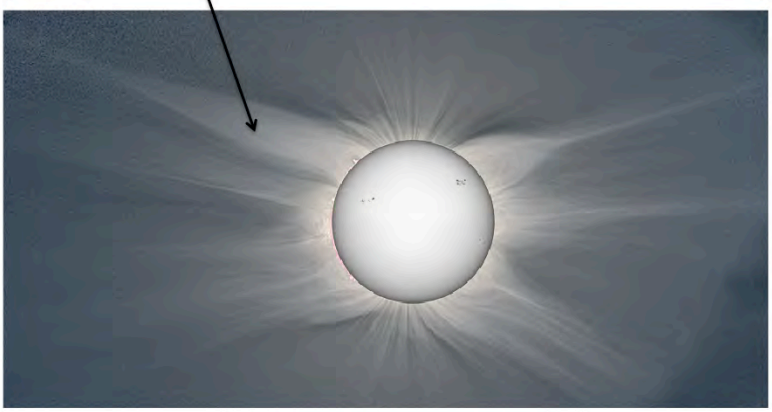
You can actually see this layer during a solar eclipse when the Moon covers the Sun.

Presenter's Notes

The chromosphere is very thin 10,000 miles (16,000 km) thick and very hot, around 10,000 C (18,000° F).

The Different Parts of the Sun

Photosphere: Sun's visible "surface"
Chromosphere: Just above the Photosphere
Corona: The Sun's outer atmosphere



The Corona extends far out into the Solar System, in fact we *live* in it!

27

One of the most amazing things you can see during an eclipse is the Sun's corona, or outer atmosphere.

The Sun's corona is over a million degrees, so hot that the atoms are ripped apart. The negatively charged electrons are separated from the positively charged nucleus, creating a charged solar wind called plasma.

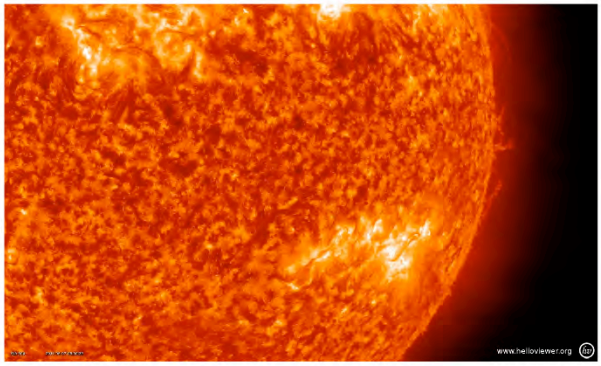
This shows the charged solar wind – the gentle breeze that constantly streams away from the sun – we live in it!

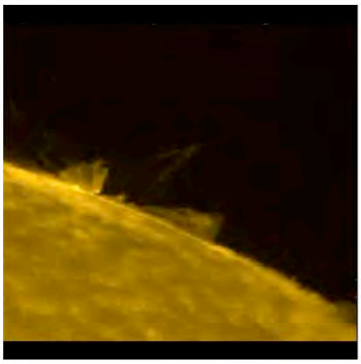
Presenter's notes

This is extremely hot, over 1 million C (or 2 million degrees F)

Solar Storms

Solar flares are explosions in the atmosphere of the Sun.
They release energy that is stored in magnetic fields.

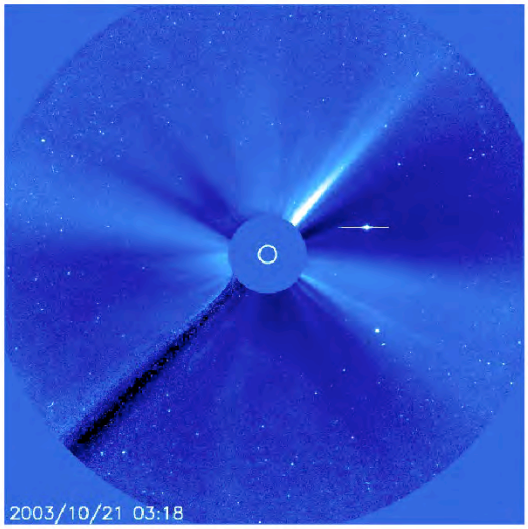




Sometimes the Sun is not so calm and peaceful.
Rather than simply gentle breezes, explosions on the surface of the Sun can create solar storms.
One type of explosion is called a flare. Let's see what that looks like. <Play first movie with click>
A flare releases a bright flash of visible light, as well as high energy radiation like X-rays.
Sometimes these are directed towards Earth. But down here on Earth's surface, we don't have to worry too much about it. We see the flash, but our atmosphere protects us from this high energy radiation.
But for astronauts on the moon or doing work outside the space station, this large dose of radiation can be very dangerous.
And there's no warning when a flare happens so astronauts can't protect themselves. The radiation from a flare takes only 8 minutes to travel from the Sun to Earth because it's traveling at the speed of light.
Let's take a look at the flare from the side. <Play second movie, with click>
Here we see the material caught up in the magnetic loop. Most of this material falls back onto the Sun. But that's not always the case…

Solar Storms

Coronal Mass Ejections (CMEs) occur when large-scale magnetic fields "break" throwing ***enormous amounts of matter into space.***



29

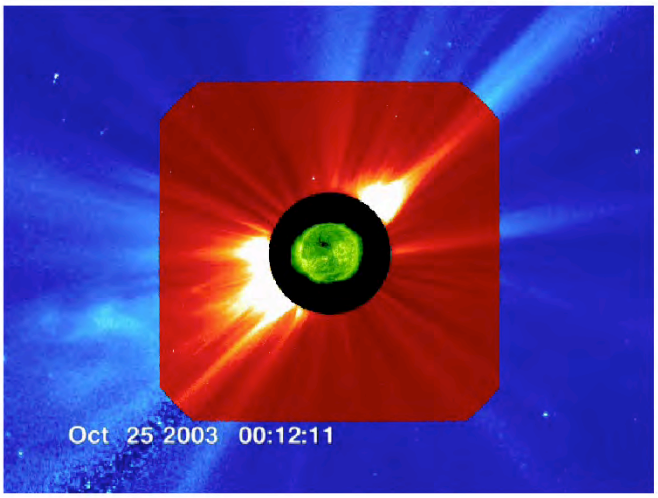
Sometimes these storms are so big and forceful that, in addition to light and radiation, they actually eject solar material from the Sun out into space. We call this a Coronal Mass Ejections, or CME for short. This solar material is so hot that the atoms' negative electrons are stripped from the positive nucleus.

In a matter of seconds, tons of charged gas is thrown out into space, as seen in this video. And it's traveling very fast.

Presenter's notes

The movie here is from the SOHO spacecraft. The sun in the center is blocked so we can see the much dimmer corona, much like in the solar eclipse we saw earlier. The white circle indicates the size of the Sun and the black area to the lower left is the arm that holds the occulting disk out in front of the camera. The bright, saturated object near the Sun is the planet Mercury.

Solar Storms and Earth



These large storms are sometimes directed at Earth.

It takes a few days for the material to arrive.

30

Sometimes that stream of light and matter is directed at the Earth. The light from the Sun takes only 8 minutes to reach us, so we can see when a big storm is happening almost immediately. It can take a couple of days for the stream of particles to hit us.

<play video>

In this video you will see a Solar Storm seem to surround the Sun (Oct 26th) and then a few days later the field of view becomes snowy (Oct 29th). This is a Solar Storm directed right at Earth. The first explosion was the light reaching us, 8 minutes after the explosion. The snow is high energy particles from the storm impacting the telescope a few days after the storm occurred on the Sun.

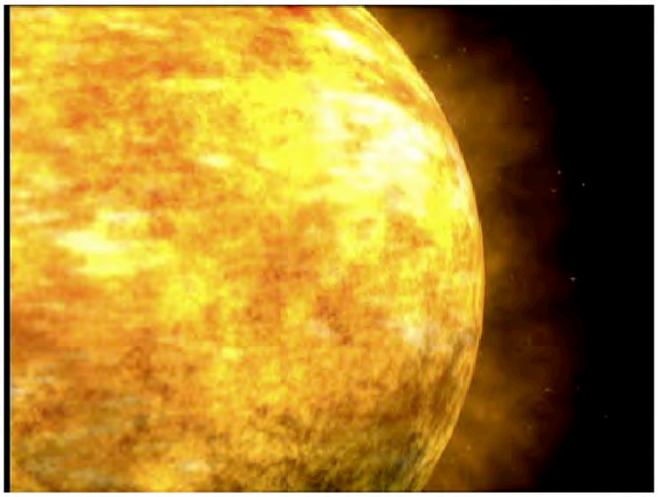
So how does that affect us here on Earth?

Presenter's notes

This is a composite of observations from several NASA instruments taken over a couple week period in late 2003. The Sun was extremely active during these two weeks, hurling many CMEs and producing some of the strongest solar flares ever observed.

Images from STEREO

Solar Storms and Earth



When a CME crashes into Earth's protective magnetic field it can excite atoms in our atmosphere.

31

Let's watch as a big Solar Storm hits Earth. <play> This animation shows the charged particles ejected form the Sun and traveling towards Earth.

Those lines around earth are our magnetic field. The solar storm warps the Earth's magnetic field. Moving magnetic fields generate a current that can enhance the beautiful aurora. This works much like a neon sign, where electrons bang into the oxygen and nitrogen atoms, causing them to emit lights of different colors.

Presenter's Notes

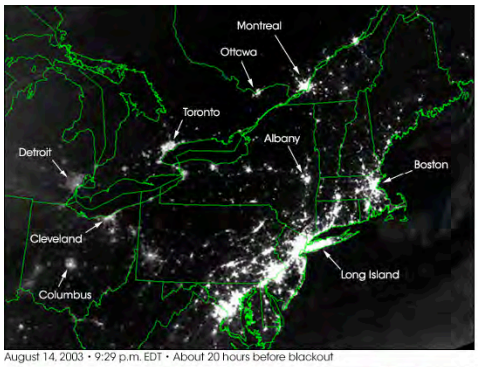
When a solar storm passes Earth, it can "drag" the magnetic tail far out into space.
Stretched magnetic lines can break and then reconnect into a different shape.
Moving magnetic fields generate an electrical current that excite the atoms in our atmosphere, enhancing the aurora.

Solar Storms can cause beautiful displays of the aurora 32

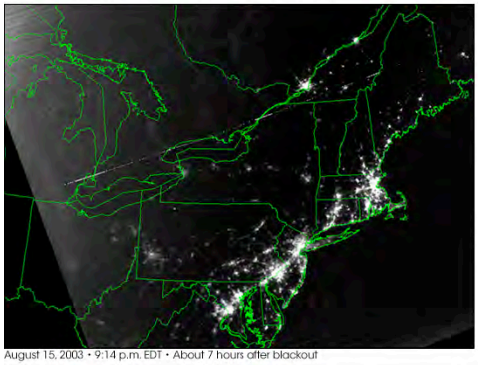
So that explains the aurora we were talking about in the beginning.

The magnetism on the Sun generates solar storms, which can intensify the aurora and make them appear at lower latitudes.

But what about the other less appealing scenarios we talked about earlier?



August 14, 2003 • 9:29 p.m. EDT • About 20 hours before blackout



August 15, 2003 • 9:14 p.m. EDT • About 7 hours after blackout

Solar Storms can cause massive power outages

33

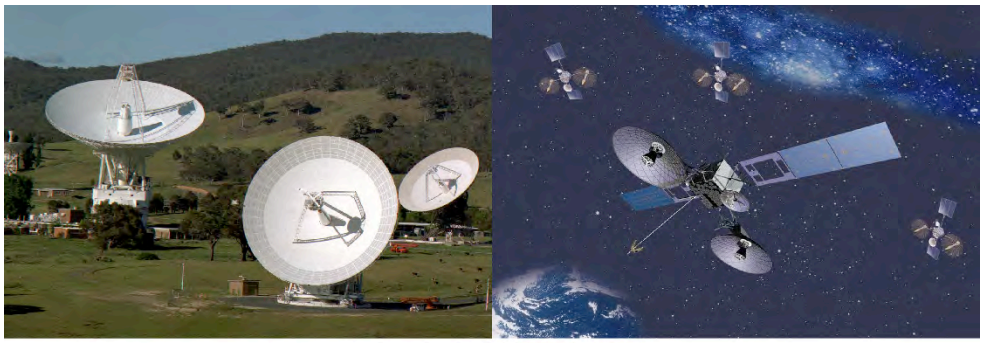
Solar storms can also increase electric currents in the ground, tripping the fuses of large power grids. This can and has plunged cities into darkness.

In March of 1989, a large solar storm tripped circuit breakers and a caused a power outage in eastern Canada for 9 very cold hours.

That blackout caused power companies around the world to implement monitoring systems and programs to reduce the likelihood of this happening again.

Presenter's notes

This image is not from a solar storm, but just an example of a large power outage from 2003.



Solar Storms can disrupt communications between the ground, satellites, and transportation

This bombardment of fast moving particles in a solar storm can affect our communication with satellites.

As you can imagine, this is especially important for aircraft communications.

Solar Storms

can disrupt GPS signals. Magnetic compasses won't necessarily point north.

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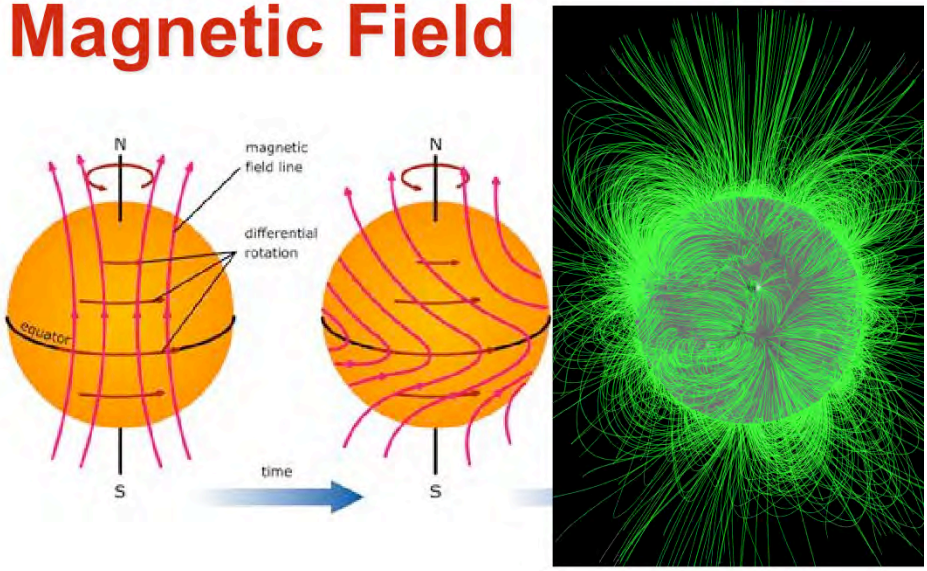
And last but certainly not least, we will all be lost!

The GPS that locates our phones can be thrown off by these Solar storms.

Google maps would not work and we'd all be lost.

Now that would be a tragedy!

The Sun's Magnetic Field



This isn't going on all the time. The Sun goes through cycles …

The Sun has an overall magnetic field much as Earth does. That's what you see in the image on the left.

But because the Sun is gaseous it does not rotate as a solid body like the Earth does. The equator rotates faster than the poles.

So the magnetic field gets twisted and wrapped up as a result of the different rotation rates of the Sun's material. <click>

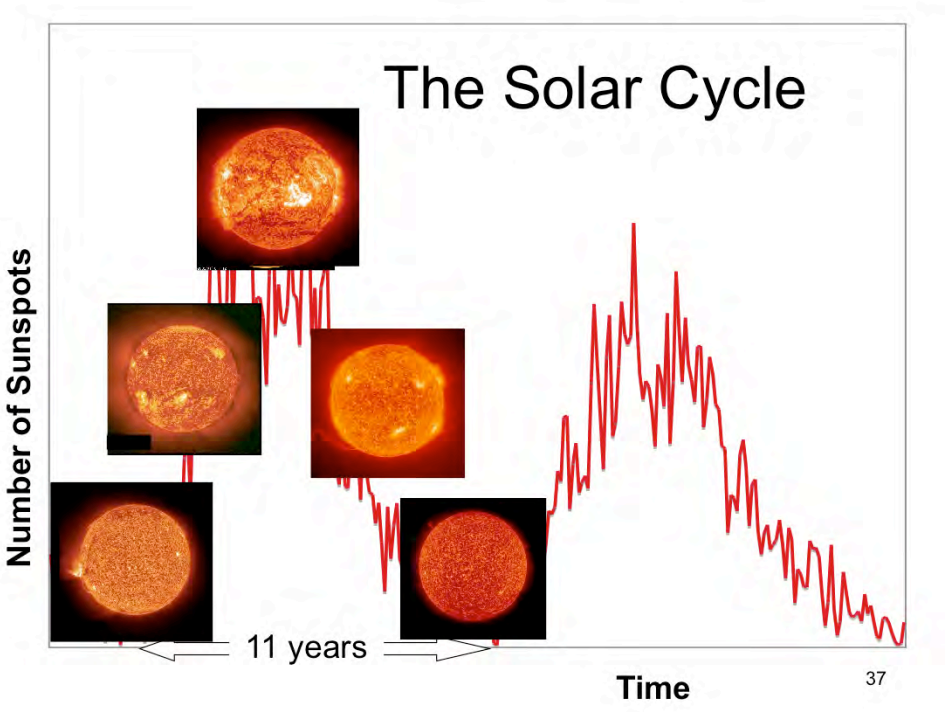
It can look something like this illustration. (pause)

Eventually, the field becomes so twisted that it essentially breaks and reforms back to its simpler north-south configuration.

This process is what is thought to be behind the observed solar cycle.

Green image:

This illustration shows convoluted magnetic field lines extending out all over the sun. **Credit:** NASA/SVS



This graph charts the number of sunspots seen each month <click>

As they occur over time <click>

At the solar minimum <click> we see very few sunspots.

But at Solar Maximum <click> you can often see many sunspots at once.

The number of sunspots increase and decrease on an approximately 11-year cycle. <click>

Here we see the increasing and decreasing magnetic activity over a solar cycle. More sunspots and solar storms occur during the solar maximum, at the top of the graph. The white areas are indicators of strong magnetic intensity.

(May want to mention where we are in the solar cycle now- we are near a maximum now)

So as we approach solar maximum, is there no way to avoid catastrophe?

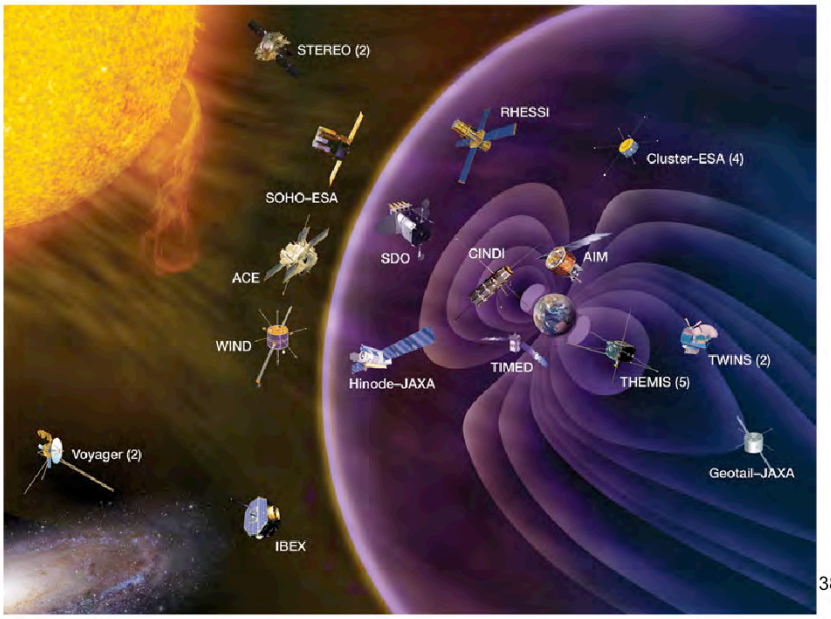
Presenter's Notes:

The polarity of the Sun's magnetic field flips about every 11 years, and so the complete solar cycle is actually around 22 years for the Sun to return to its original state.

Monthly numbers from NASA Marshall Space Flight Center from 1984-2007

The red images are captured using He II 304 emissions showing the solar corona at a temperature of about 60,000 degrees K. Many more sunspots, solar flares, and coronal mass ejections occur during the solar maximum. The increase in activity can be seen in the number of white areas in the images, i.e., indicators of strong magnetic intensity.

NASA's Heliophysics Missions



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Never fear!

We can't avoid solar storms…

But we can minimize the effects.

Our world is increasingly dependent on satellites for internet, TV, and phone communications.

And solar storms could affect all of these, as well as power grids, as we saw.

But scientists around the world are working on predicting solar weather so that we can better prepare ourselves for solar storms.

NASA currently operates over a dozen missions studying the physics of the Sun (Heliophysics). They are studying the Sun's effects on Earth and the Solar System. This suite of instruments has given us a full 360-degree view of the Sun and allows us to come very close to predicting Space Weather events and avoiding the damaging effects of solar storms.

Image credit:

NASA GSFC

The toolkit was featured in the March issue of the Reflector, the member magazine of the Astronomical League. A copy of the article can be found here: http://www.astrosociety.org/Ready_Transit_of_Venus.pdf

Additional Transit of Venus resources which were handed out can be found here:
http://www.astrosociety.org/tov/index.html

The complete list of links shared during the session are here:

Professional Development

1. NASA/NPS/USFWS ***Earth to Sky Program (***www.earthtosky.org)

To register for their upcoming Webinars for Interpreters and other outdoor educators on Thursday, March 22 and Tuesday April 3, 2012 (both at 11 am), go to https://www1.gotomeeting.com/register/195583880

2. Astronomy From the Ground Up (AFGU) Sky Rangers Program (www.afguonline.org and www.astrosociety.org/afgu)

To register for their upcoming online workshop April 30 - May 11, 2012 titled “Interpreting Our Magnetic Sun,” go to: http://www.afguonline.org/mod/resource/view.php?id=1857

Explanations/Facts/Resources/Discussions/Networking/Event Posting

1. Annular Eclipse Blog: http://scienceblogs.com/startswithabang/2012/03/weekend_diversion_preparing_fo_1.php
2. NASA 2012 Sun-Earth Day http://sunearthday.nasa.gov/2012/
3. Transit of Venus Pages: http://www.transitofvenus.org and http://transitofvenus.nl
4. SpaceWeather.Com: www.spaceweather.com

Preparing in Your Area

1. NPS Solar Eclipse Page: http://www.nature.nps.gov/features/eclipse/index.cfm
2. Interactive Annular Solar Eclipse Map for May 20, 2012: http://xjubier.free.fr/en/site_pages/solar_eclipses/ASE_2012_GoogleMapFull.html
3. UT Time Converter: http://www.timeanddate.com/worldclock/converter.html
4. Other Informative Maps and Information for the May 20th Annular Eclipse from Eclipse-Maps.Com: http://www.eclipse-maps.com/Eclipse-Maps/Gallery/Pages/Annular_solar_eclipse_of_2012_May_20_files/ASE2012_Stereographic_Magnitude_1.jpg

http://www.eclipse-maps.com/Eclipse-Maps/Gallery/Pages/Annular_solar_eclipse_of_2012_May_20.html

5. Safe Solar Viewing: http://www.youtube.com/watch?v=0TpbMemNx7w and http://cse.ssl.berkeley.edu/cms/Programs/MorePrograms/ViewingtheSunSafely/tabid/289/Default.aspx
6. Find an Amateur Astronomy Club Partner Near You (especially ones with H-Alpha Telescopes): http://nightsky.jpl.nasa.gov/club-map.cfm

Equipment

1. Sunspotters: http://astrosociety.org/astroshop/index.php?p=product&id=32&parent=0
2. Thousand Oaks Optical for Solar Filters: http://www.thousandoaksoptical.com/ecplise.html
3. Rainbow Symphony Eclipse Glasses: http://www.rainbowsymphonystore.com/overstock-3d-glasses.html
4. Scope City for H-Alpha Scopes: http://www.scopecity.com/

NAI Region 9, Spring Workshop

Yosemite National Park, March 16-18, 2012

Promised Links and Other Links of Possible Interest from:

Our Sun – the Second Biggest Influence on Earth

with Suzanne Gurton (sgurton@astrosociety.org) and Dan Zevin (dzevin@ssl.berkeley.edu)

NOTE: Most of the links below are to help you get ready for the May 20, 2012 Annular Solar Eclipse and the June 5, 2012 Transit of Venus

Professional Development

1. NASA/NPS/USFWS ***Earth to Sky*** Program (www.earthtosky.org)
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2. NASA 2012 Sun-Earth Day http://sunearthday.nasa.gov/2012/
3. Transit of Venus Pages: http://www.transitofvenus.org and http://transitofvenus.nl
4. SpaceWeather.Com: www.spaceweather.com

Preparing in Your Area

1. NPS Solar Eclipse Page (Note: they have a slight misstatement on the map, only 8 parks are in the path of annularity, not all 33): http://www.nature.nps.gov/features/eclipse/index.cfm
2. Interactive Annular Solar Eclipse Map for May 20, 2012:
   http://xjubier.free.fr/en/site_pages/solar_eclipses/ASE_2012_GoogleMapFull.html
3. UT Time Converter: http://www.timeanddate.com/worldclock/converter.html
4. Other Informative Maps and Information for the May 20th Annular Eclipse from Eclipse-Maps.Com:
   http://www.eclipse-maps.com/Eclipse-Maps/Gallery/Pages/Annular_solar_eclipse_of_2012_May_20_files/ASE2012_Stereographic_Magnitude_1.jpg
   http://www.eclipse-maps.com/Eclipse-Maps/Gallery/Pages/Annular_solar_eclipse_of_2012_May_20.html
5. Safe Solar Viewing: http://www.youtube.com/watch?v=0TpbMemNx7w and
   http://cse.ssl.berkeley.edu/cms/Programs/MorePrograms/ViewingtheSunSafely/tabid/289/Default.aspx
6. Find an Amateur Astronomy Club Partner Near You (especially ones with H-Alpha Telescopes):
   http://nightsky.jpl.nasa.gov/club-map.cfm

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2. Thousand Oaks Optical for Solar Filters: http://www.thousandoaksoptical.com/ecplise.html
3. Rainbow Symphony Eclipse Glasses: http://www.rainbowsymphonystore.com/overstock-3d-glasses.html
4. Scope City for H-Alpha Scopes: http://www.scopecity.com/