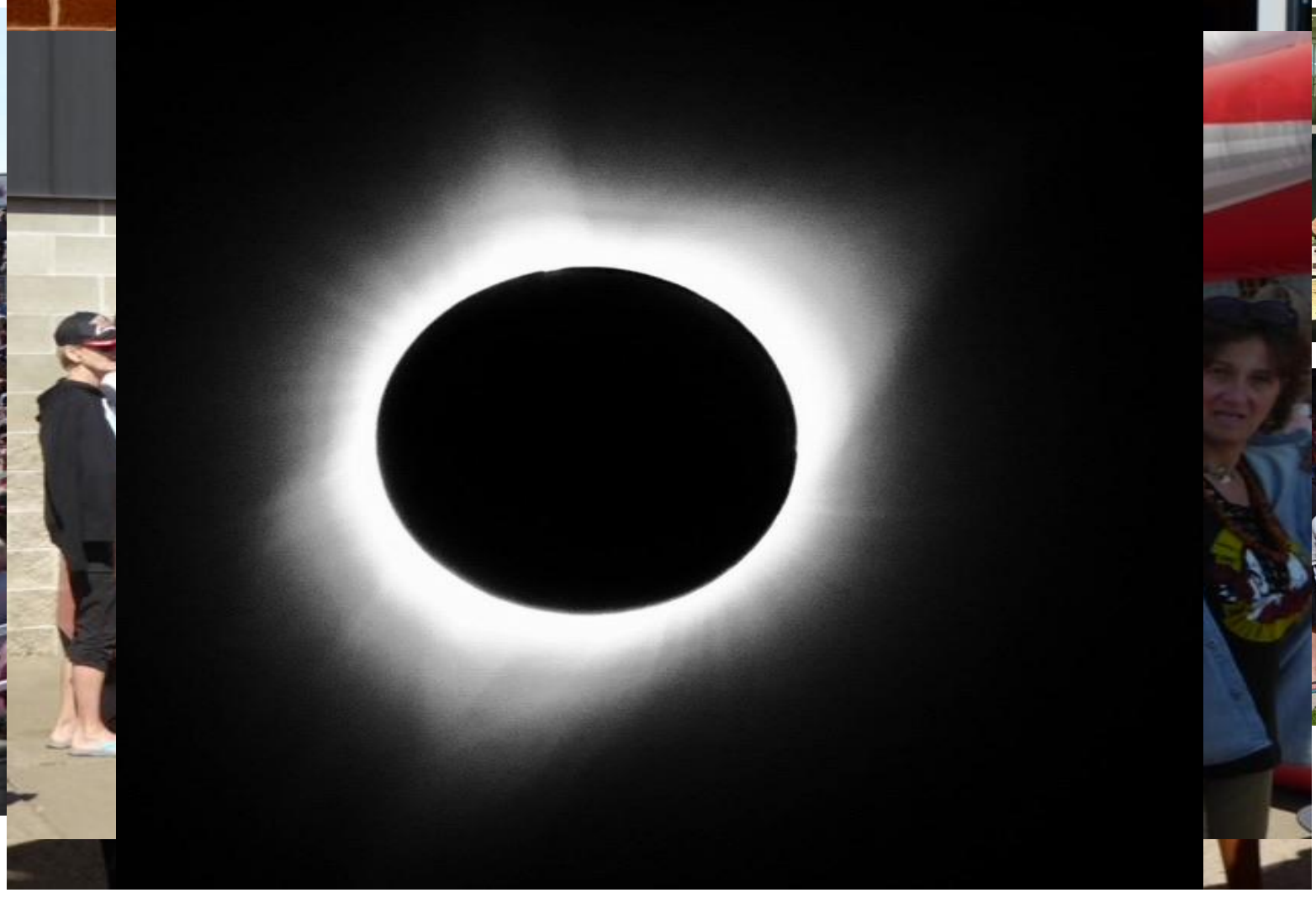
Credit: Dorian Janney

“X” Marks the Spot!

Deep in the Heart of Texas!

GLOBE EClipse



Credit: Michala Garrison and NASA/SVS, in collaboration with the NASA Heliophysics Activation Team (NASA HEAT), part of NASA's Science Activation portfolio. Eclipse calculations by Ernie Wright, NASA Goddard Space Flight Center. **Find More:** svs.gsfc.nasa.gov/5073

Image credit: NASA

What I want to share with you today:

- Eclipses 101: annular versus total solar eclipse
- NASA's research efforts
- Texas Master Naturalists' citizen science role
- Safety First!

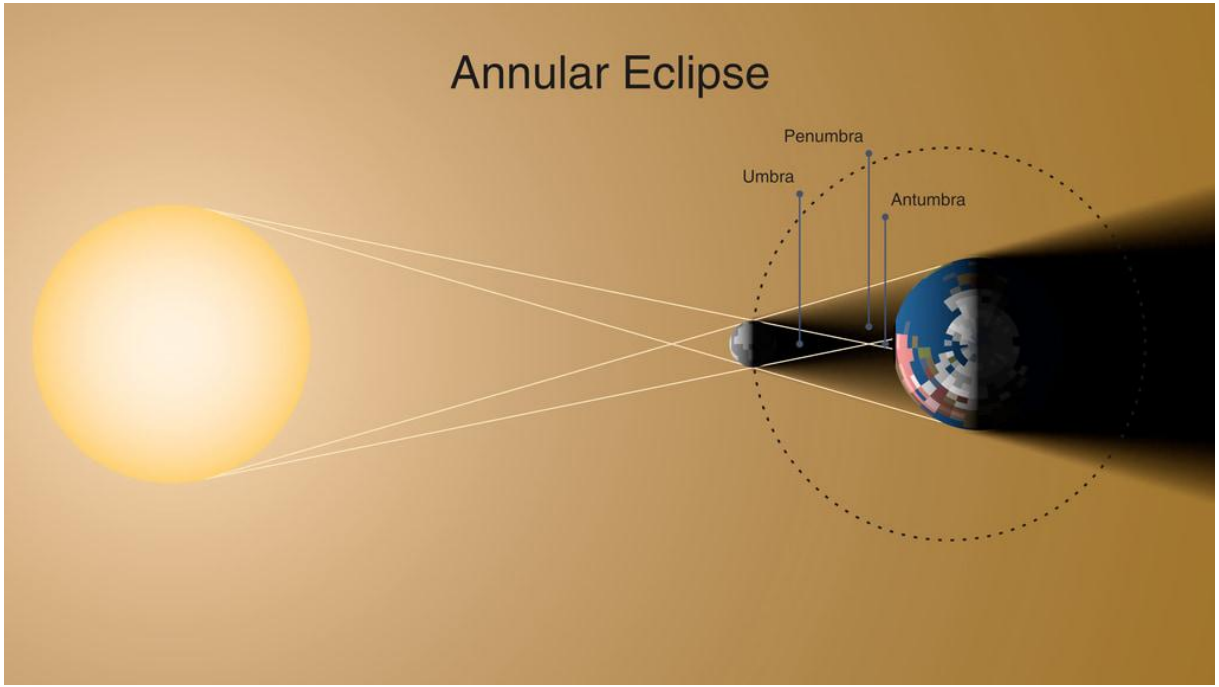
yCredit: Dorian Janney

Image Credit: Creative Commons

What is a “Solar Eclipse”?

Animation credit: NASA

Credit: NASA/Kristen Perrin



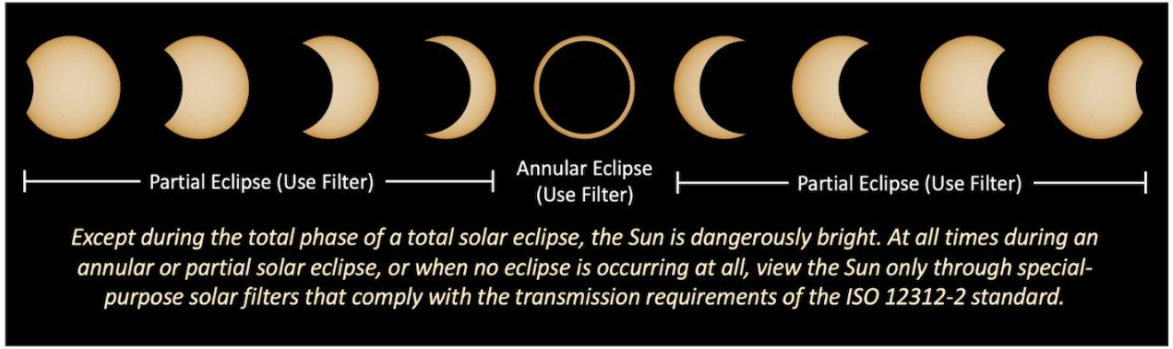
Credit: NASA


NASA
WHAT IS AN
ANNULAR ECLIPSE?

Annular Solar Eclipse Phases

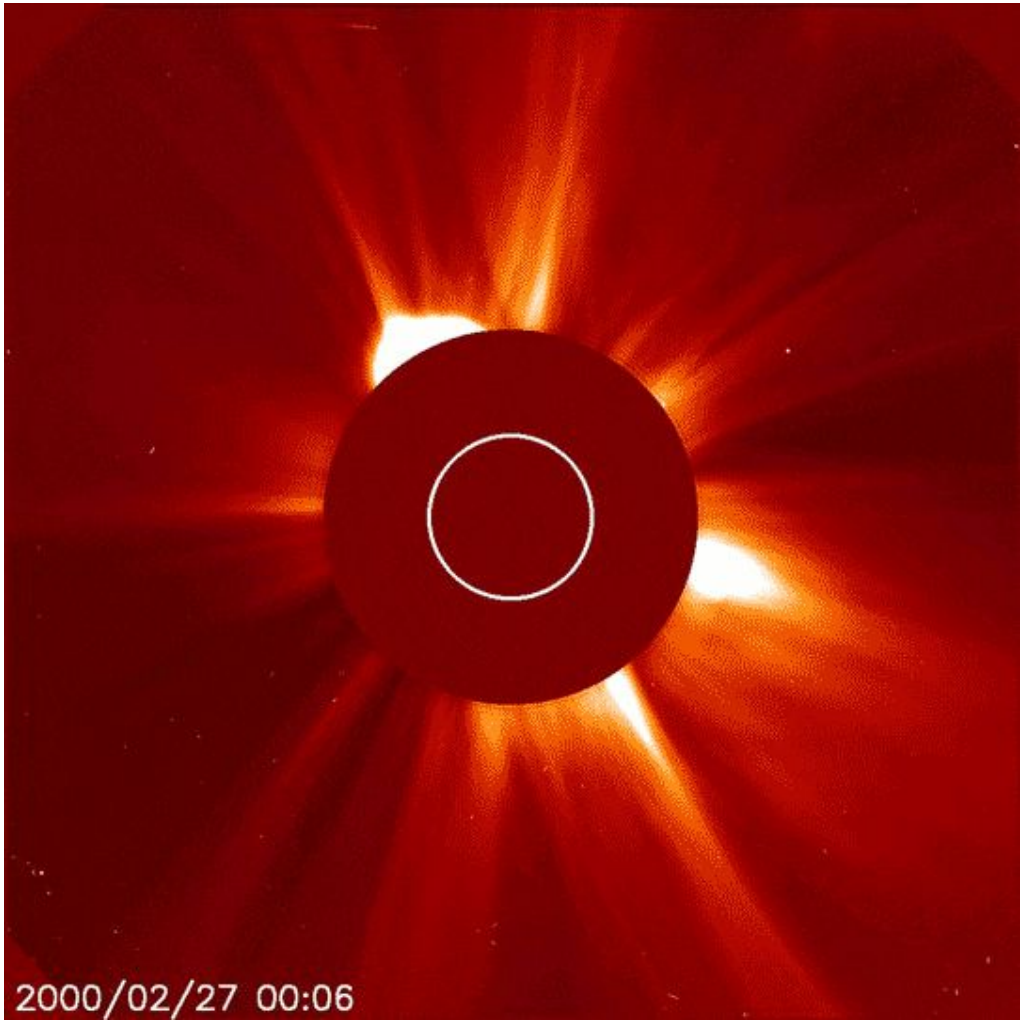
Points of Contact and Phases of an annular solar eclipse:

1st contact - Partial eclipse begins:	2nd contact - Full annularity starts:	Maximum eclipse (phase)	3rd contact - Annularity ends:	4th contact - Partial eclipse ends:
The Moon touches the Sun and takes its first tiny nibble out of the solar disk.	The ring of fire appears. For a few seconds Baily's Beads, which look like beads of light, may be visible at the edge of the Moon's silhouette.	The Moon covers the central part of the Sun but not the entire solar disk.	The Moon starts moving away from the disk of the Sun. Once again, Baily's Beads may be visible along the Moon's edge.	The Moon no longer covers any part of the solar surface. The eclipse is officially over.



Credit: AAS

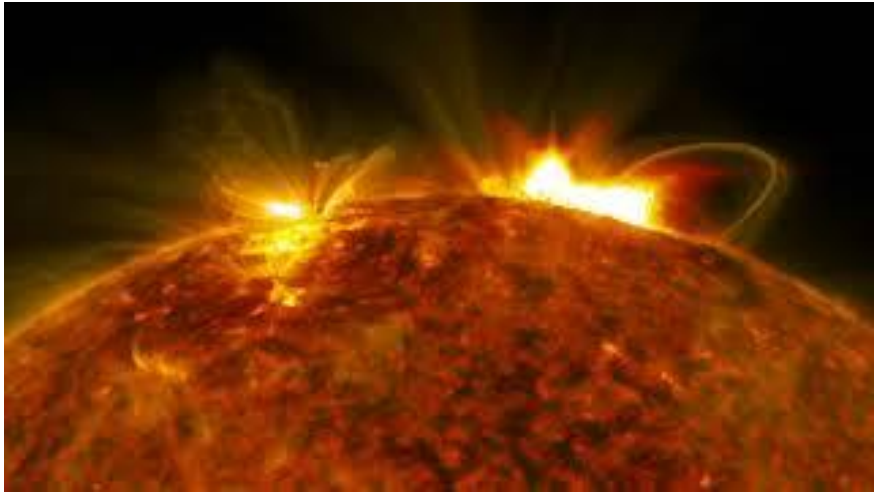
Slide credit: NASA HEAT

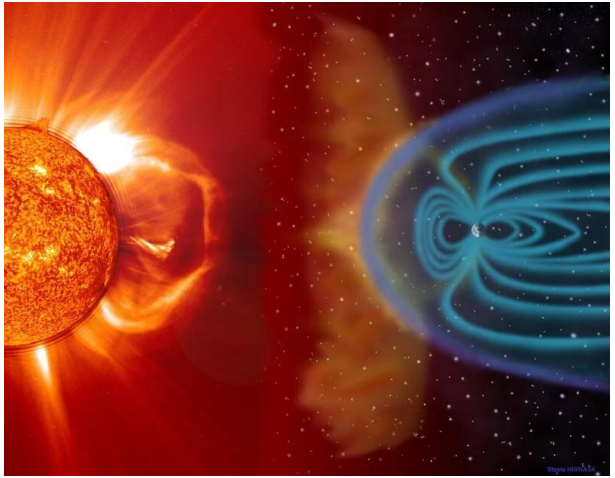


Solar eclipses offer great opportunities to do research!

- **Decipher Sun's structure**
- **Better understand Sun's corona**
- **Study solar wind**
- **Impact of localized blocking of Sun's energy**

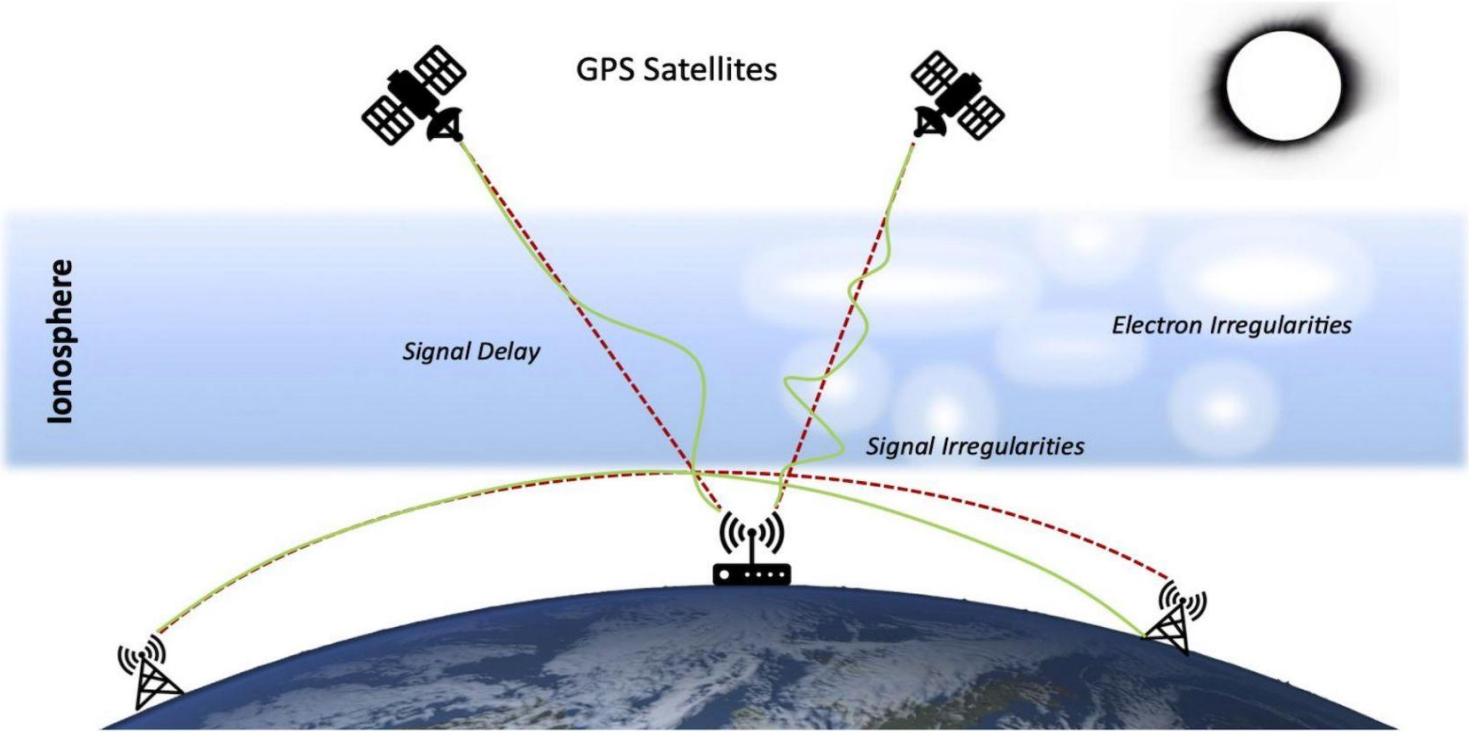
Credit: SOHO/ NASA)





Eclipses and the Ionosphere

Eclipses change the way the ionosphere passes signals between space and the ground.



Credit: Adapted from: Linty, Nicola et al. IEEE Transactions on Aerospace and Electronic Systems 55 (2019): 303-317

Slide credit: NASA HEAT

NASA Science for the 2023 Annular Solar Eclipse

During the annular solar eclipse various science experiments may be done to increase our understanding of the Sun-Earth-Moon relationship. It is a chance to observe the effects of what happens when the Sun is temporarily blocked, when viewed from a small area of Earth.

Credit: NASA/NOAA

During an annular solar eclipse, NASA is interested in:

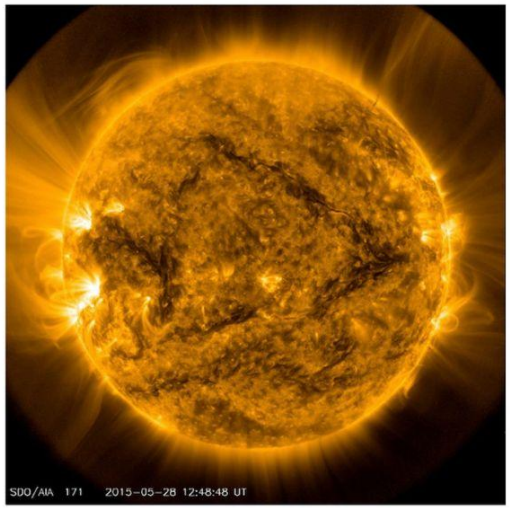
- Testing the design and manufacture of new hardware in the unique conditions during the total solar eclipse;
- Studying the ionosphere, thermosphere, and mesosphere as the eclipse passes over a location;
- Monitoring eclipse-induced changes in the atmosphere under the shadow of the Moon;
- Using satellites, sub-orbital rockets, high-altitude balloons, and other NASA assets to observe the eclipse and its effects.

Slide credit: NASA HEAT

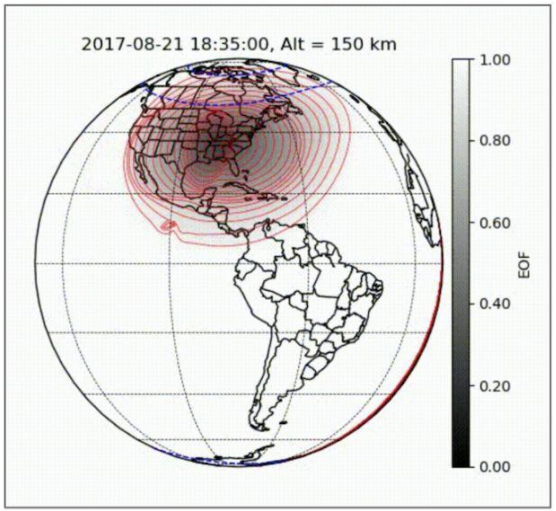
Eclipses and Ultraviolet Light

Extreme ultraviolet light from the Sun is blocked during an eclipse.

- The solar X-ray and extreme ultraviolet (EUV) radiation is almost completely absorbed within the thermosphere.
- During a total or partial solar eclipse, it is possible to map the contributions of specific active regions on the Sun to the overall heating and ionization of the thermosphere.
- Observations of solar EUV contributions help scientists to develop accurate satellite drag forecasts.



Credit: SDO/AIA



Credit: Sebastijan Mrak - pyEclipse; National Science Foundation grant AGS-13019141 and NASA grant 13018916.

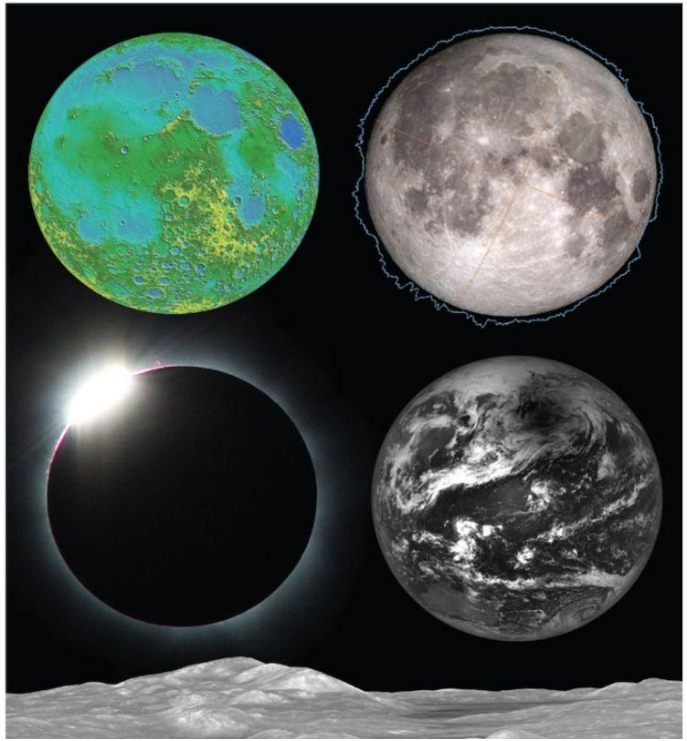
Slide credit: NASA HEAT

Studying the Moon During the Eclipse

NASA's Lunar Reconnaissance Orbiter (LRO) studies the Moon and will point its camera at Earth to observe the Moon's shadow during the eclipse.

Top left: Topography of the Moon, where cool colors represent low elevations and warm colors show areas with higher elevation. Credit: NASA/GSFC/LRO/LOLA

Bottom left: When sunlight peaks through the low points in the jagged lunar limb during a total solar eclipse, one can see phenomena known as Baily's Beads and the diamond ring effect. Credit: Rick Fienberg/TravelQuest/ International/Wilderness Travel



Top right: The blue line surrounding the Moon shows the outline of the Moon's topographic profile, exaggerated 20 times. Credit: NASA/SVS

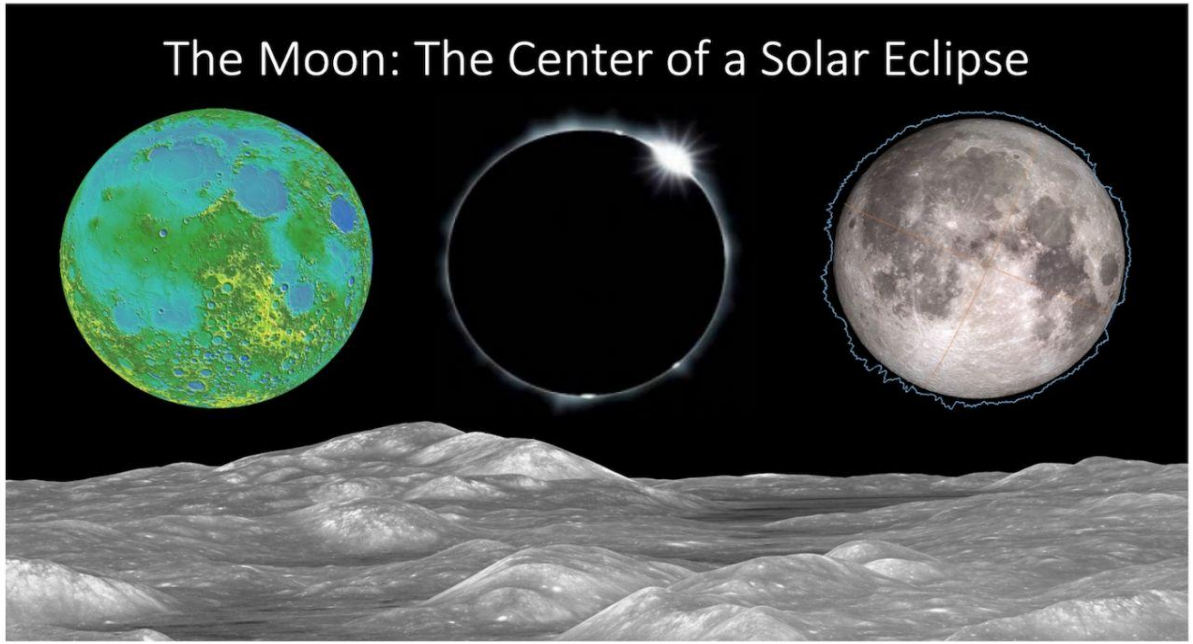
Bottom right: Using LRO's topography data, scientists can predict more precisely and accurately the location and duration of these phenomena, and the shape of the Moon's shadow on Earth. Credit: NASA/GSFC/ASU

Slide credit: NASA HEAT

Studying the Moon During the Eclipse

Thanks to the laser altimeter and high-resolution cameras onboard NASA's Lunar Reconnaissance Orbiter (LRO), we know the shape of the Moon better than any other Moon or planet in the solar system – including Earth.

At any given time and location, only a single, very small valley or saddle point on the limb is needed to create the diamond.



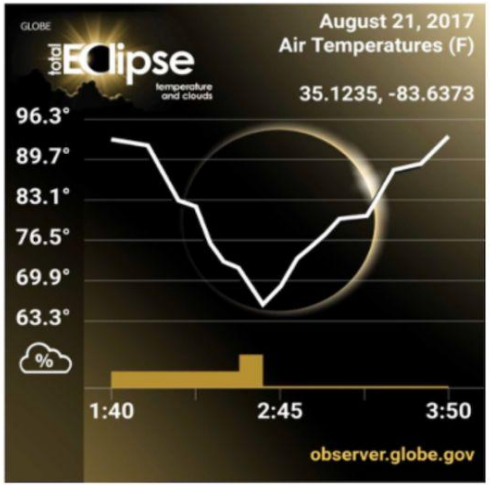
Baily's Beads are visible not only during a total solar eclipse but may also be visible during an annular eclipse, depending on the Moon's topography. Using LRO's topography data, scientists can predict the location and duration of these phenomena with remarkable precision and accuracy.

The bottom image shows an oblique view of the Orientale basin: an example of the rough topography found on the Moon.
Credit: NASA/GSFC/ASU

Slide credit: NASA HEAT

Citizen Science Efforts

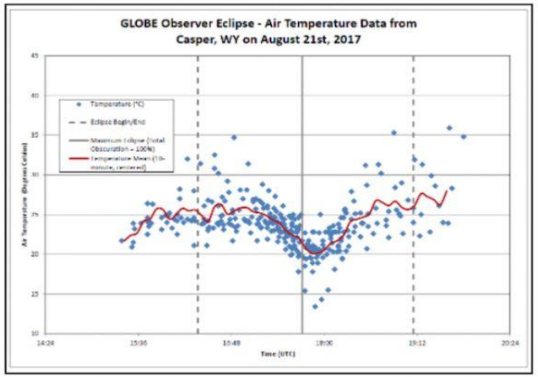
The NASA GLOBE Observer citizen science program helps scientists observe how the eclipse changes atmospheric conditions.



Example graph of temperature data collected by a single observer via the GLOBE Observer app during the eclipse on August 21, 2017. Credit: NASA/GLOBE

GLOBE Observer

- The public can contribute to a citizen science database used by scientists to study and publish the effects of eclipses on the atmosphere.
- Observers can provide comparison data even if they are not in the central eclipse path.
- Learn more about how citizen scientists can contribute in Part 4.



Aggregate temperature data from volunteer scientists in Casper, WY, on that date. Credit: NASA/GLOBE

Slide credit: NASA HEAT

Texas Master Naturalists Role

“***Eclipse Educators”*** virtual fair volunteer program: before, during and after eclipses

During Eclipses:

Impact of reduced sunlight and heat on living things: soundscapes, observations, data collection using GO Eclipse tool

Animal Behavior During Eclipses

During the 2017 eclipse, researchers from a zoo in S.C. noted the following changes in animal behavior:

- 76% exhibited unusual behaviors (13/17)
- Many had behavioral changes: anxiety, nocturnal behavior,
- Very interesting study! https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7222787/
- Need more research!!

Birds and Insects

- 1593: “birds fell from the sky:”
- 2017: Nilsson, data 143 Doppler radar stations, daytime behaviors not replaced by nighttime behaviors, but things “quieted down”
- Zone of totality: flurry of activity, :really short bursts” flying creatures, peaked during totality, birds confused? Insects?
- Sound recordings: McKenna (acoustic biologist, NPS), audio files from 14 parks, humans noisy! *Soundscapes*- Harvard, only just tapped the surface
- iNaturalist “*Life Responds*” project: 30 minutes before, once during, 30 minutes after; open-ended, ASP research; frogs called, flowers closed up, cicadas stopped singing

CNN video: "Help solve an ancient mystery about the eclipse: Figure out what the animals do"

Eye Safety During an Annular Eclipse

A solar eclipse watcher in Argentina in December 2020. Credit: Marta Kingsland

The Sun is never completely blocked by the Moon during an annular solar eclipse. Therefore, during an annular eclipse, it is never safe to look directly at the Sun without specialized eye protection designed for solar viewing.

A crowd uses handheld solar viewers and solar eclipse glasses to safely view a solar eclipse. Credit: National Park Service

View the eclipse with special solar viewing glasses

Regular sunglasses are not safe to view the eclipse

2023 Annular Solar Eclipse Safety

Observing the annular solar eclipse without eye protection can cause permanent eye damage. You will need to follow safety precautions and use special safety equipment to safely experience the eclipse.

Credit: NASA

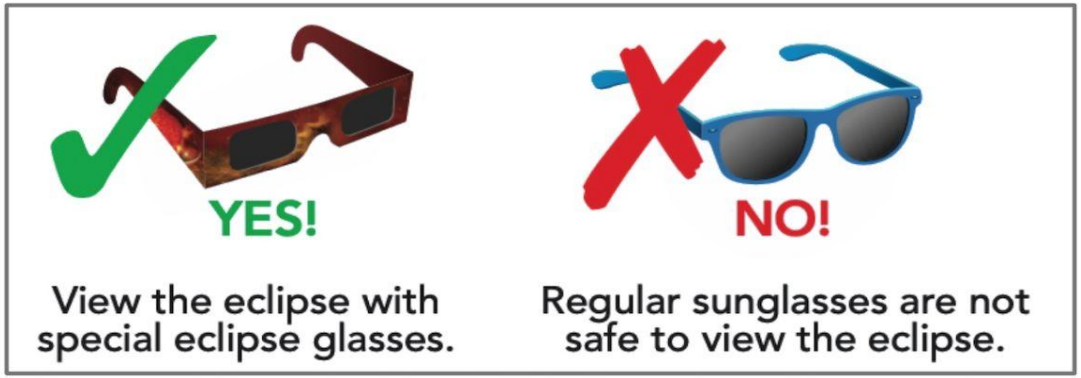
Use only eclipse glasses from reputable manufacturers that are verified to meet the **ISO 12312-2 international standard**.

Before each use, check the front and back of each lens for scratches, pinholes, or separation from the frame. If damaged, cut into small pieces and discard.

Slide credit: NASA HEAT

Eclipse Glasses

- You can look at the Sun and a solar eclipse through safe solar viewing glasses ("eclipse glasses") or other safe solar filter at any time. You can try out your eclipse glasses today!
- NEVER look directly at the uneclipsed or partially eclipsed Sun without appropriate eye wear. Sunglasses are not safe for viewing a solar eclipse or the Sun.
- **Do NOT use eclipse glasses or handheld viewers with cameras, binoculars, or telescopes.** Those require different types of solar filters.



Find More: go.nasa.gov/EclipseEyeSafety

Decorate your eclipse glasses any way you want to safely view the eclipse! This tiara add-on was created using heavy cardstock, scissors, markers, tape, and ribbon. Credit: NASA/Shannon Reed

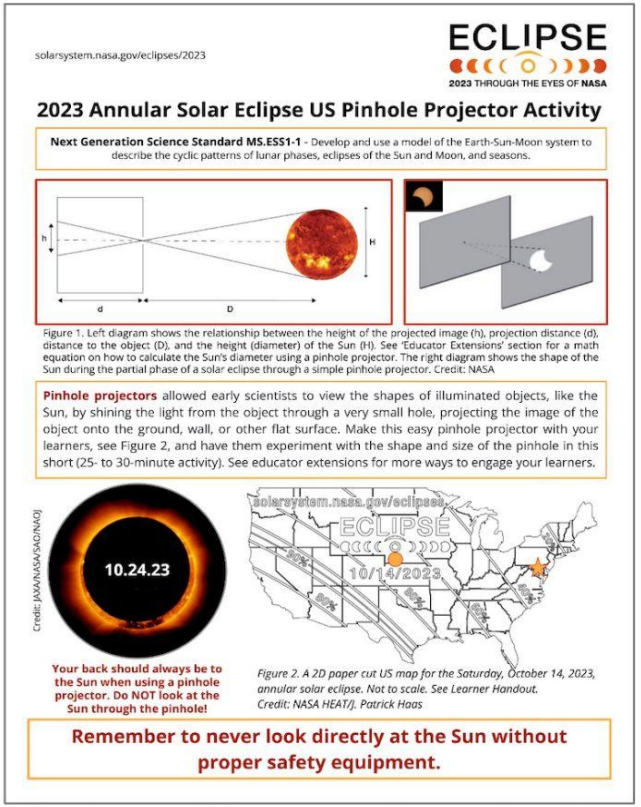
Slide credit: NASA HEAT

Safe Indirect Viewing Method

Pinhole projectors allowed early scientists to view the shapes of illuminated objects, like the Sun, by shining the light from the object through a very small hole, projecting the image of the object onto the ground, wall, or other flat surface. These are a great method for safe solar viewing. Be sure that when using, the Sun is always behind you.

Credit: NASA HEAT/J. Patrick Haas

You can learn how to make your own pinhole projector like the activity at this link https://nasa3d.arc.nasa.gov/detail/usa-eclipse-2023



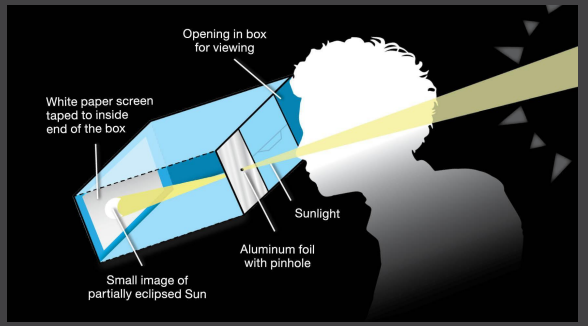
Credit: NASA HEAT/J. Patrick Haas

Slide credit: NASA HEAT

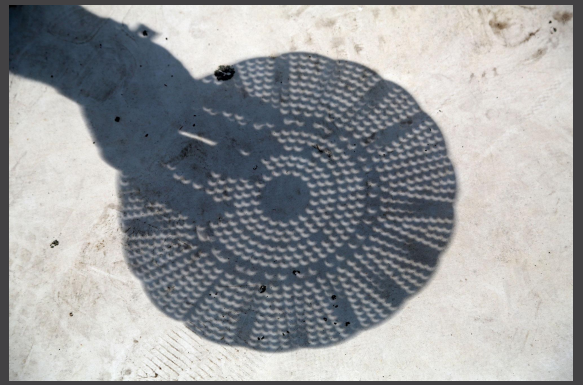
Indirect viewing methods

If you don't have eclipse glasses or a handheld solar viewer, you can use an indirect viewing method, which does not involve looking directly at the Sun. For example, a pinhole projector or a colander or other object with circular holes. The GLOBE Eclipse cards also have a place where a hole can be punched to serve as an indirect viewer.

Read more on [NASA's Eclipse Safety page.]



You can make your own eclipse projector using a cardboard box, a white sheet of paper, tape, scissors, and aluminum foil. Credit: NASA



Left: A GLOBE Eclipse card used to project the Sun onto the ground. Credit: GLOBE Above: The circular holes of a colander project crescent shapes onto the ground during the partial phases of a solar eclipse. Credit: Joy Ng

Additional Safety Tips:

- Extreme Heat
- Traffic Congestion
- COVID-19
- Big Crowds
- Weather Changes