

What about
clouds?



**Or individuals who
can't watch the
eclipses?**



What if I'm not in totality or annularity?

2023 Maximum Partial Observation (%)

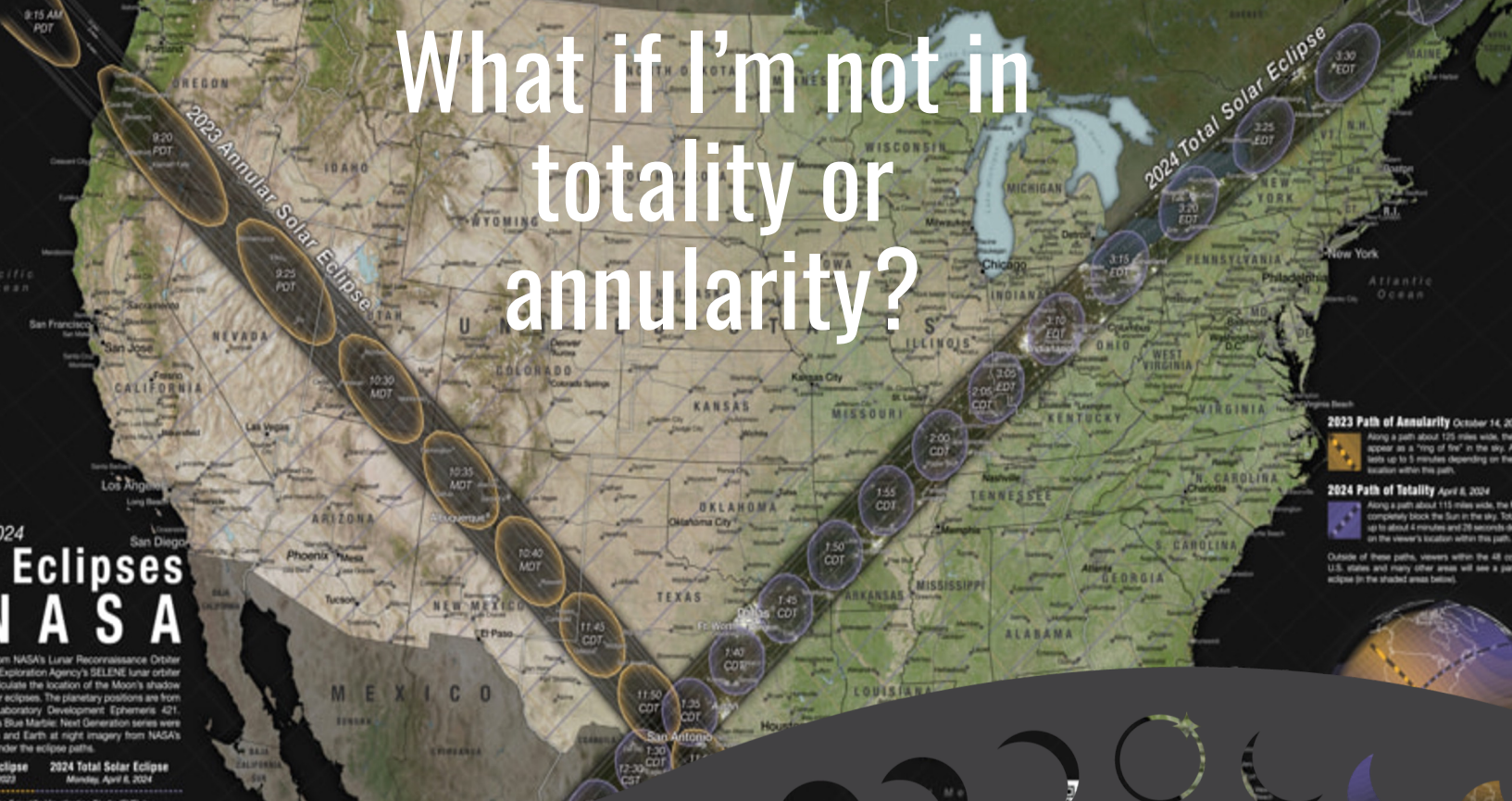
2024 Maximum Partial Observation (%)

The 2023 & 2024 Solar Eclipses through the eyes of NASA

Lunar topography data from NASA's Lunar Reconnaissance Orbiter and the Japan Aerospace Exploration Agency's SELENE lunar orbiter were used to precisely calculate the location of the Moon's shadow for the 2023 and 2024 solar eclipses. The planetary positions are from NASA's Jet Propulsion Laboratory Development Ephemeris (JPL-DE) Earth imagery from NASA's Blue Marble: Next Generation series were used to create the terrain and Earth at night imagery from NASA's Black Marble were used under the eclipse paths.

2023 Annular Solar Eclipse Saturday, October 14, 2023
2024 Total Solar Eclipse Monday, April 8, 2024

and the Scientific Visualization Studio (SVS), in partnership with the NASA Earth and Space Science Activation Team (NASA HEAT).



2023 Path of Annularity October 14, 2023

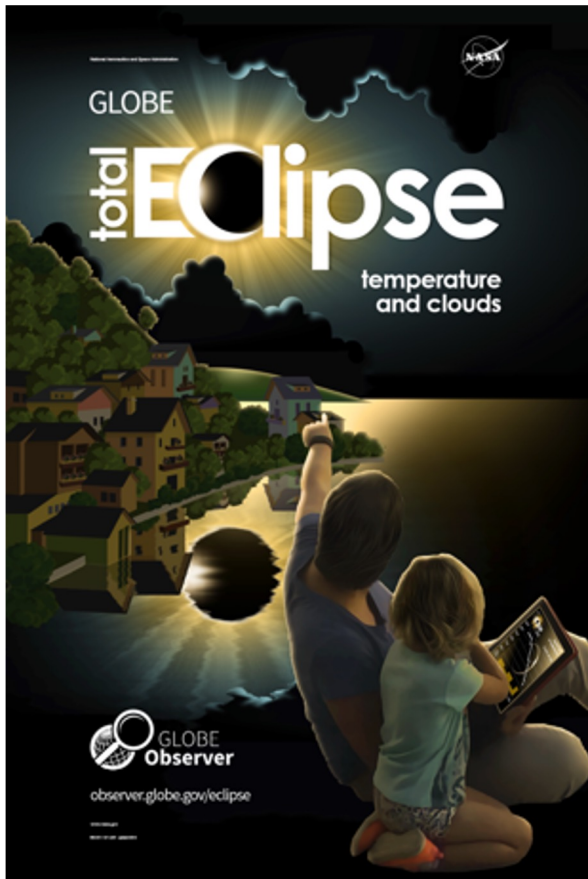
Along a path about 125 miles wide, the Sun will appear as a "ring of fire" in the sky. Annularity lasts up to 3 minutes depending on the viewer's location within this path.

2024 Path of Totality April 8, 2024

Along a path about 115 miles wide, the Moon will completely block the Sun in the sky. Totality lasts up to about 4 minutes and 28 seconds depending on the viewer's location within this path.

Outside of these paths, viewers within the 48 contiguous U.S. states and many other areas will see a partial solar eclipse (in the shaded areas below).





GLOBE Eclipse poster, available in the [Resource Library](#).

GLOBE Eclipse: NASA Citizen Science for Everyone

observer.globe.gov/eclipse



Using the GLOBE Eclipse tool, volunteer scientists are able to:

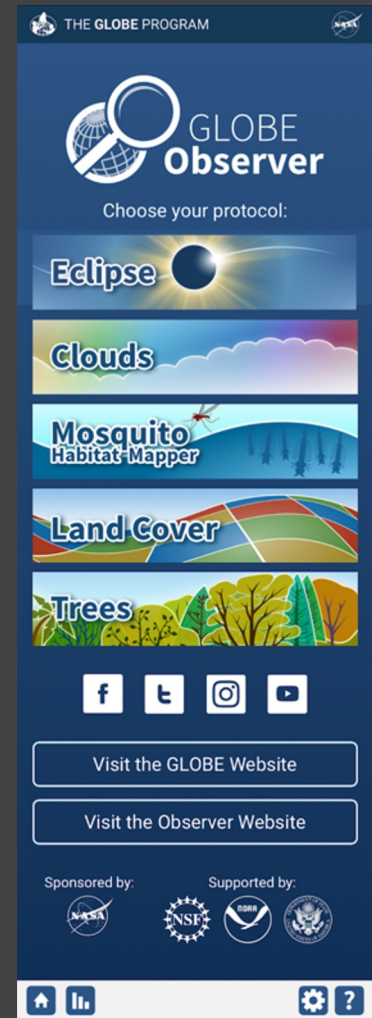
Observe how the eclipse changes atmospheric conditions near you by reporting on clouds and air temperature



Taking clouds observations using the Clouds tool, which is always available in the GLOBE Observer app, and is incorporated into the observation prompts for the Eclipse tool. Credit: GLOBE Clouds Team, NASA LaRC



Above: A simple thermometer that can be used to take air temperature measurements. Credit: GLOBE Observer team Right: An example of what the home screen of the GLOBE Observer app will look like when the Eclipse tool is available. Credits: GLOBE



The Earth Science Angle: Study eclipses as a volunteer observer with GLOBE

The Sun drives many processes in Earth's atmosphere.

National Aeronautics and Space Administration

Air Temperature
Energy from the Sun warms the surface of the Earth. Warmth from the Earth's surface heats the surrounding air, causing it to rise.

Clouds
Warm air cools as it rises, and water vapor condenses into puffy cumulus clouds.

Wind
Changes in temperature drive differences in air pressure, causing wind to form.

How will the eclipse affect these solar-powered processes?

Share your eclipse observations using the GLOBE Observer app.
Learn more at observer.globe.gov/eclipse

GLOBE Observer
the app of THE GLOBE PROGRAM

nasa.gov

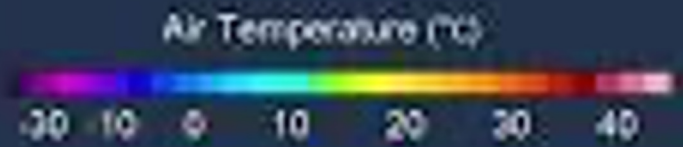
The infographic features a top section with a yellow banner and the NASA logo. Below is a row of six sun phases: a full sun, a partially obscured sun, a crescent moon, a thin crescent moon, a very thin crescent moon, and a completely eclipsed sun. A large blue arrow points from the sun phases down to a landscape illustration of a river and hills. A yellow arrow points from the sun down to the landscape, and a blue arrow points from the landscape up to the sun. A QR code is located in the bottom right corner.

Energy from the Sun warms our planet, and changes in sunlight can also cause changes in temperature, clouds, and wind. What happens when the Sun is blocked by the Moon during an eclipse? How will the eclipse affect these solar-powered processes?

Diagram from the front side of a one-page document outlining the changes that might be observed during a solar eclipse, which is available on the [GLOBE Observer Eclipse website](https://observer.globe.gov/eclipse).

Provide comparison data even if not on the path of maximum eclipse

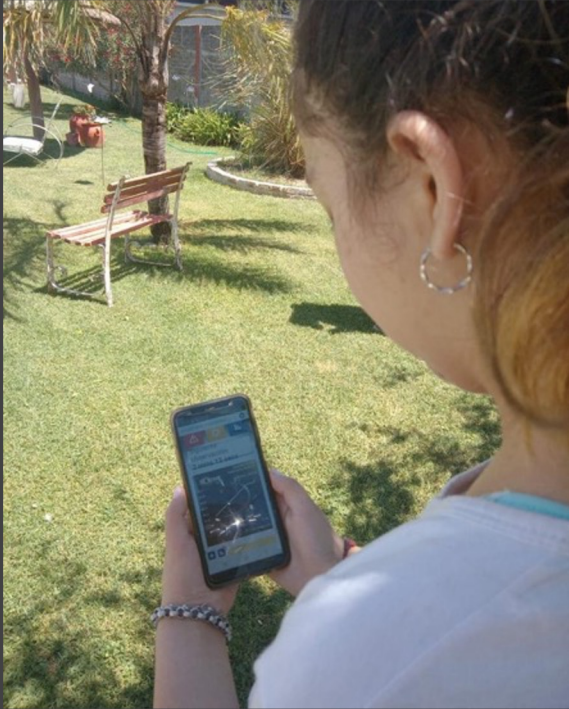
Eclipse shadow location is an estimation.



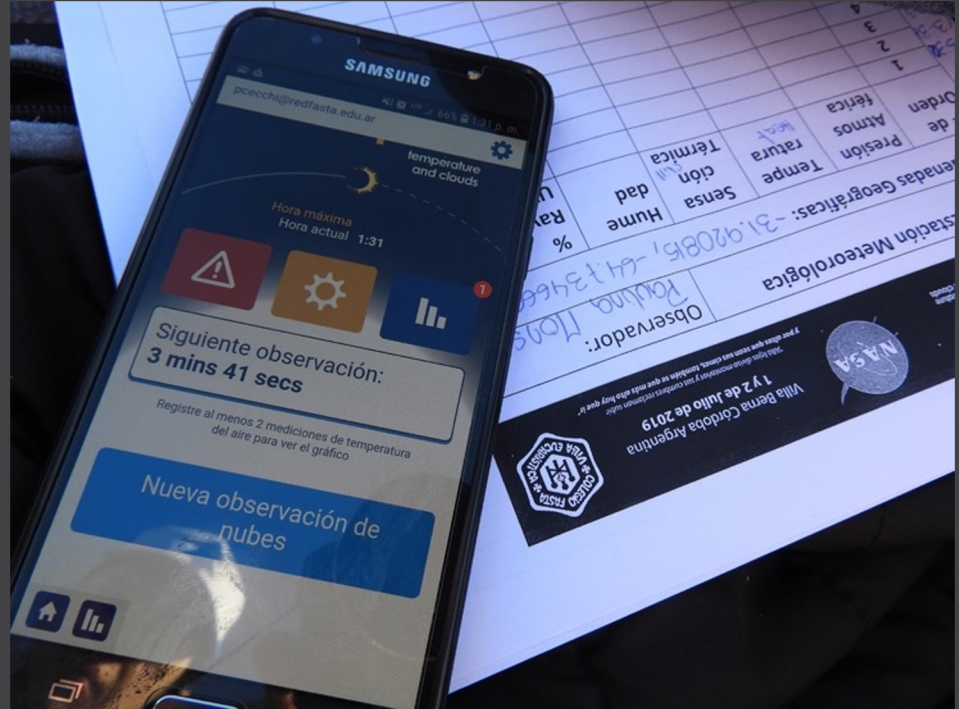
August 21, 2017 Eclipse
Air Temperature Measurements



Using the GLOBE Eclipse tool



Observer using the GLOBE Eclipse tool during the total eclipse in Argentina 14 Dec 2020. You can be offline during observations. Credit: Marta Kingsland



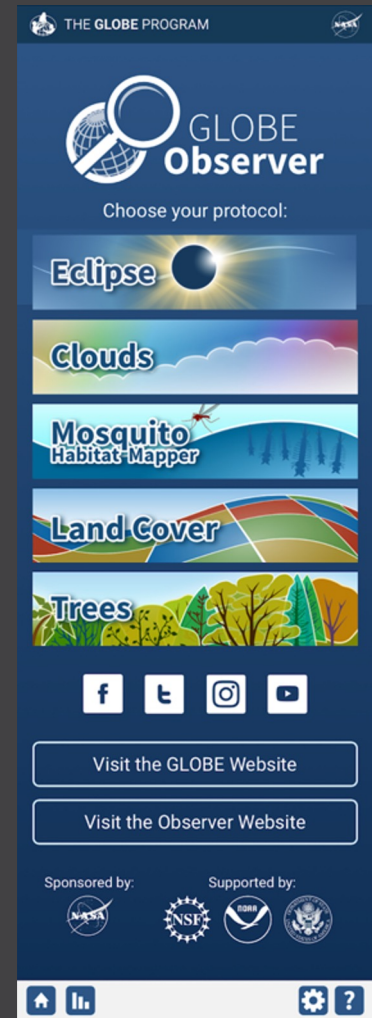
The app screen showing the countdown to the next observation, as well as an (optional) paper data sheet. Credit: Pablo Cecchi

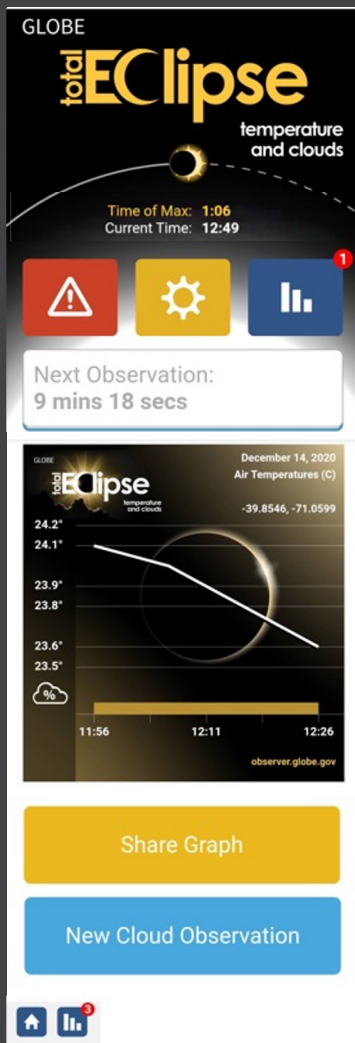
Supplies Required

- GLOBE Observer app: free on Google Play or in the App Store or paper data sheet (see observer.globe.gov/eclipse)
- Thermometer for measuring air temperature

Optional:

- Wind stick (you can make this!)
- Anemometer or weather station





GLOBE Eclipse Overview

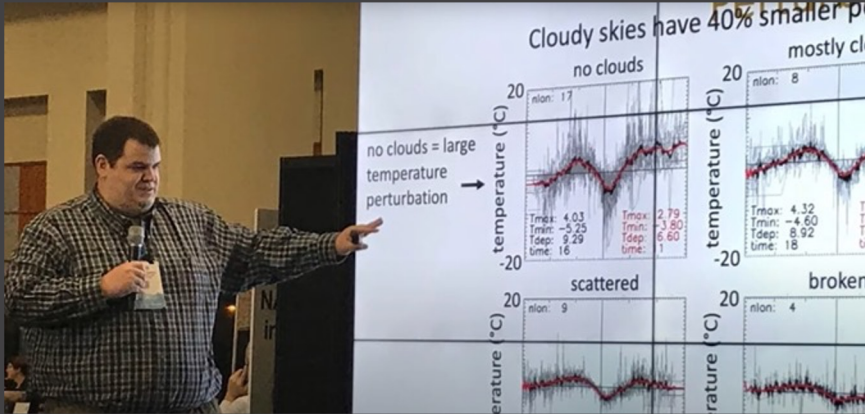
- Set up your site
- Report what is around you (land cover)
- Starting before first contact and through last contact, record the air temperature (every 5-10 minutes)
- Starting before first contact and through last contact photograph clouds when prompted (15-30 minutes), or when you see change
- Optional, photograph wind stick using land cover tool to report changes
- Submit data to GLOBE



Example thermometers. Credit: GLOBE
NOTE: A weather app does not count as “other” - you should have a separate physical thermometer.



Contribute to a public database (GLOBE Program) used by scientists and students to study the effects of eclipses on the atmosphere



Left: Dr. Brant Dodson (NASA Langley Research Center) presents his paper comparing the citizen science temperature data at different reported levels of cloud cover, doi.org/10.1175/JAMC-D-18-0297.1

2020 GLOBE International Virtual Science Symposium
EPY191345 - PUJATO - Santa Fe - ARGENTINA

Fecha	Horario	Categorías				Total de palomas en cada grupo
		Comen	Vuelan	Duermen	Vigilan	
1 de julio de 2019	17:30	1	3	2	6	
	17:35	3	4	1	8	
	17:40	1	2	4	7	
	17:45	1	4	1	6	
Totales		6	15	6	27	

Figura 33: Elograma de la observación del día 01/07/2019 de 17:30 a 17:45 horas realizado con Excel (2016).

A su vez, en la Figura 34 puede observarse el gráfico por categorías correspondientes a, elograma de la Figura 33, que también se encuentra en el An.

Gráfico correspondiente al Elogram de la observación de las palomas el 01-07-2019 el intervalo horario 17:30 - 17:45

Horario	Comen	Vuelan	Duermen	Vigilan
17:30	1	3	2	6
17:35	3	4	1	8
17:40	1	2	4	7
17:45	1	4	1	6

Figura 34: Gráfico correspondiente al Elograma de la observación de las palomas el 01-07-2019 el intervalo horario 17:30 a 17:45 horas elaborado con Excel (2016).

Todos los elogramas y pictogramas (diagramas de barras) e encuentran en la carpeta de campo de la investigación y en los controlaron manualmente las tablas y gráficos correspondientes a cabo, los cuales fueron tenidos en cuenta al realizar este informe solo se muestran estos ejemplos y se adjuntan Excel (2016).

Las tablas y gráficos realizados permitieron analizar los princ

Air Temperature (°C)	Surface Temperature (°C)
7	7.8
7	8.7
9	11.2
9	10.2
9	8.8
6	7.6
6	6.8
5	6.6
6	5.4
6	6.2
9	5.4
9	7.9
11	4.8
8	10.4
11	11.8
6	10.6
8	7.4
8	7.4
11	8
11	5.4
14	5.4

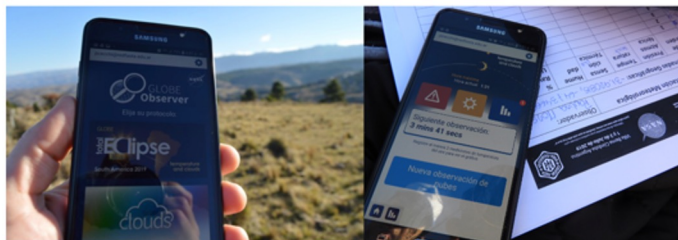
Air Temperature VS. Surface T

Right: Pages from several of the research reports submitted by students to the GLOBE International Virtual Science Symposia after the 2017, 2019 and 2020 eclipses, observer.globe.gov/eclipses#studentresearch

Colegio Fasta Villa Eucarística
Formando jóvenes con valores

Datos cargados a la plataforma de GLOBE Observer.
Nuestra ubicación se encuentra señalada con un círculo rojo:

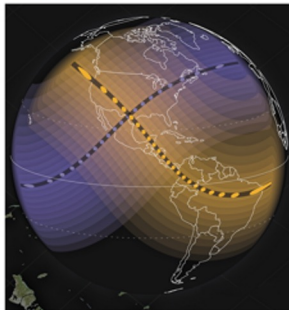
What is GLOBE Observer?



GLOBE Eclipse is a temporary tool in the GO app that will help you document air temperature and clouds during an eclipse. The tool is not visible in the app on a regular basis, but is only opened up when a solar eclipse is happening somewhere in the world. The Eclipse tool will prompt you to take air temperature measurements using a meteorological thermometer, as well as taking regular observations of sky conditions using the [Clouds](#) tool. For more details about equipment needed, how to take observations, and frequently asked questions, visit the [Taking Observations](#) page. Our [Resource Library](#) includes additional activities, references and videos.

Image source: GLOBE School *Colegio Fausta Villa Eucaristica* in Argentina, taken during the July 2019 eclipse.

On 14 October 2023, an annular eclipse ☾ will take place in North, Central and South America. The path of maximum eclipse will be across parts of the United States, Mexico, Belize, Honduras, Nicaragua, Costa Rica, Panama, Columbia and Brazil (the path from upper left to lower with yellow circles in the diagram below). A partial annular eclipse will be visible in Canada, and other parts of Central and South America. This map of the 2023 eclipse ☾ shows the percentage of obscuration for any location.



Find more details, including activity guides and extended opportunities for data collection, on the Eclipse page of the GLOBE Observer website, observer.globe.gov/eclipse

Questions?

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Photo copyright Colleen Pinski
<https://solarsystem.nasa.gov/resources/2771/new-mexico-annular-eclipse/>



GLOBE Eclipse Preparation

1. Download the GLOBE Observer app
2. Register for an account with an active email address
3. Take in-app training for clouds and land cover (less than 5 minutes)
4. Calibrate your thermometer by checking the temperature it records in an ice bath
5. Set up thermometer in a location that will be shaded during the eclipse
6. Optional: you could set up a GLOBE team so data collected by everyone at your observation site is collated in one location

Settings ✕

Please confirm your thermometer type:

Type of Thermometer: ▼

C F

Measurement Alarm: On

Location:
-39.8546, -71.0599

Do a Land Cover observation to characterize your location (include your thermometer in the down photo!)

Land Cover

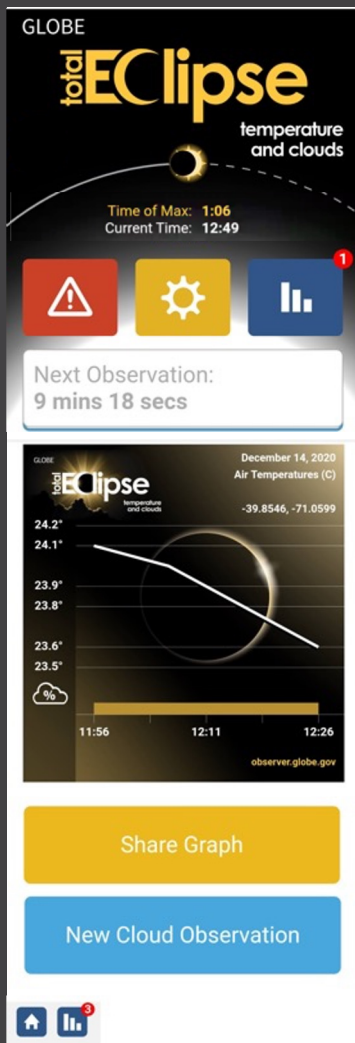
GLOBE Eclipse Starting your observations

Done once on site before the eclipse begins:

- Tell us what kind of thermometer you are using
- Choose Celsius or Fahrenheit
- Set alarm to notify you when to report temperature and clouds
- Set your location (fills in automatically, but can check accuracy)
- Take a Land Cover observation to show us the observing site. This involves taking 6 photos (N, S, E, W, up and down). Include the wind stick in one photo if you are using it.



Example thermometers. Credit: GLOBE
NOTE: A weather app does not count as “other” - you should have a separate physical thermometer.



Using the App: Data Collection Screen



Top portion shows the time of maximum eclipse based on the current location



Buttons navigate to safety/intro pages, configuration/ settings (see previous slide), and a listing of the already collected data, respectively

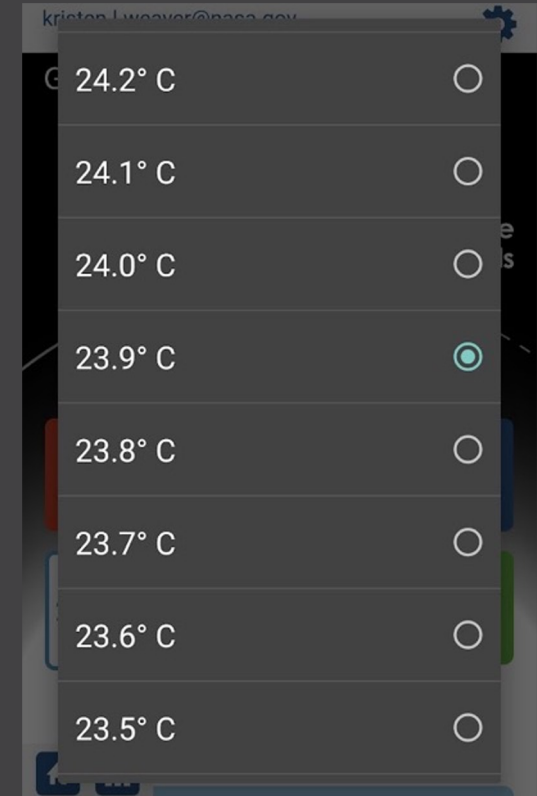


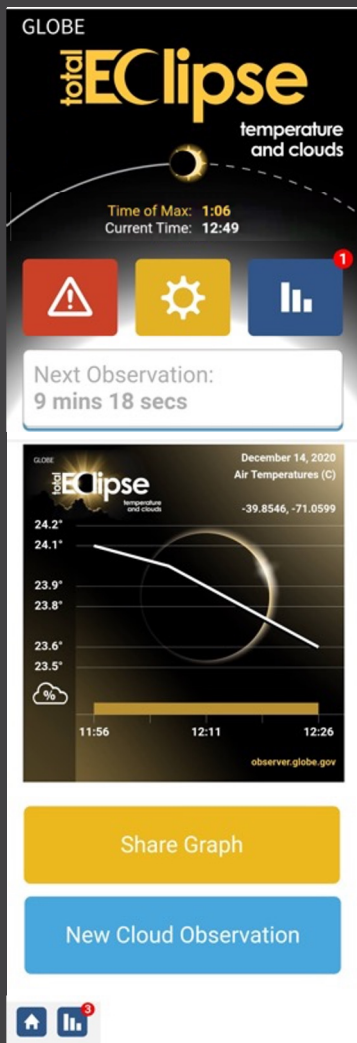
Using the App: Entering Temperature Data

Next Observation:
9 mins 18 secs

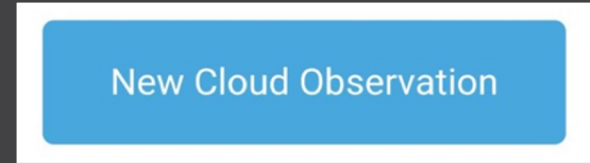
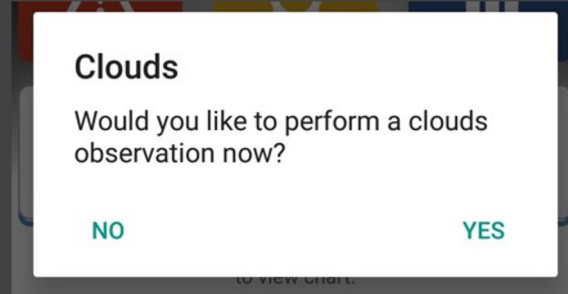
Enter Data Now:

Display shows a countdown to the time for the next observation, or “Enter Data Now” when it’s time to collect another air temperature measurement. Tapping “Enter Data Now” brings up a selection menu for temperature values (right).



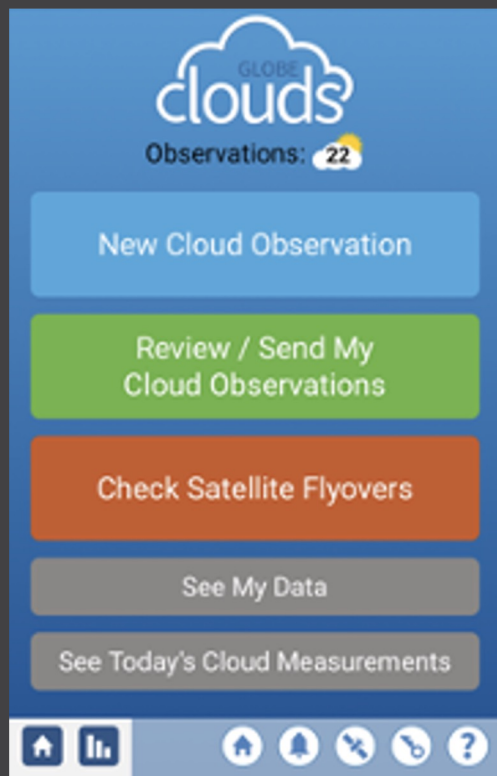


Using the App: Clouds Data



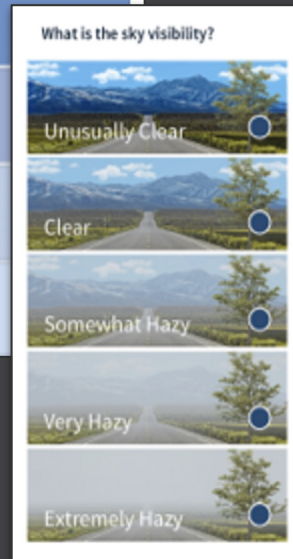
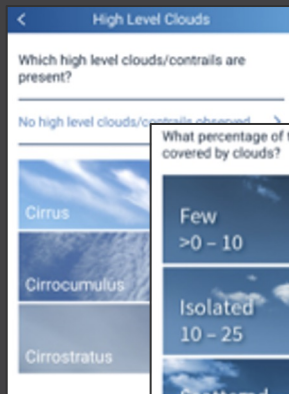
Periodically, the app will also pop up a reminder to take an observation of clouds, although users are also encouraged to take an observation at any time if they notice something changing in the cloud conditions (New Cloud Observation button).

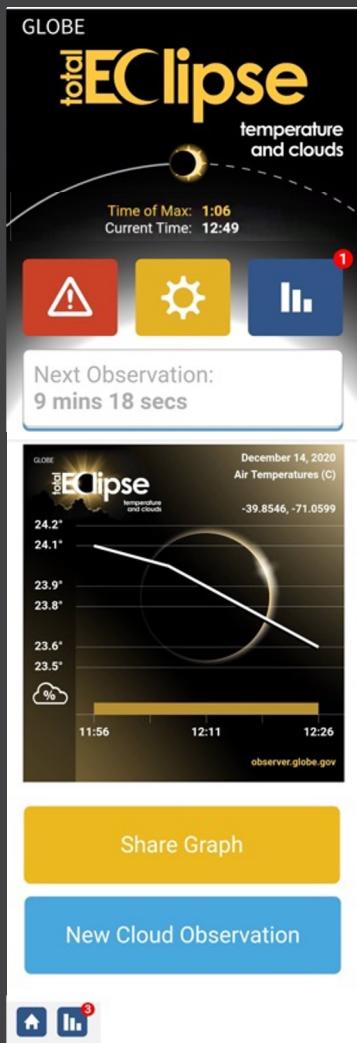
Taking a Clouds Observation



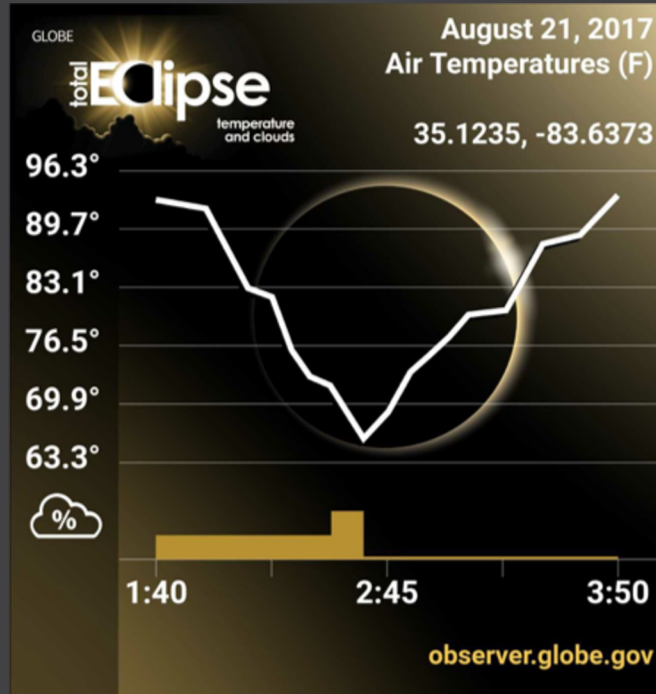
Steps to observe:

- Overall cloud cover
- Sky conditions
- Cloud types, cloud cover, and opacity by height
- Take photos

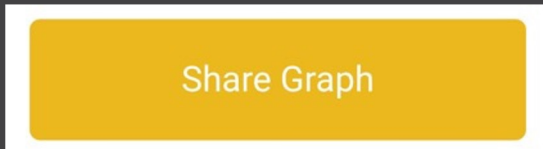




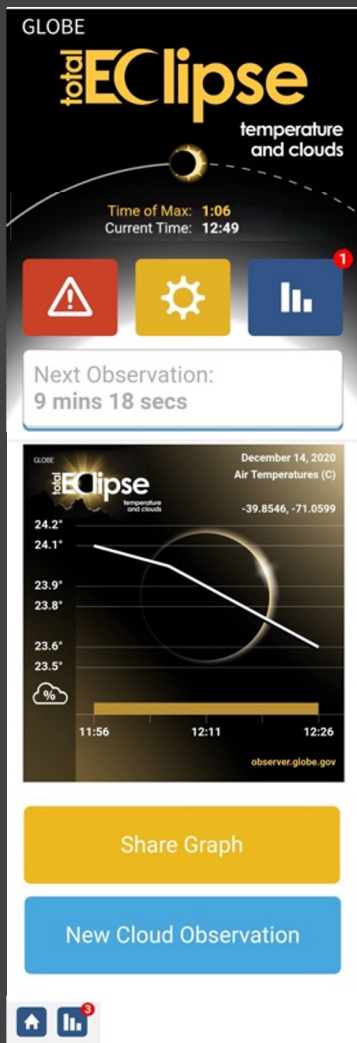
Using the App: Graphing the Data



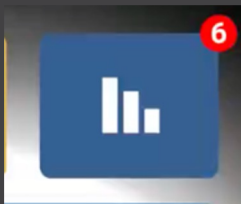
The graph will update as new data points are added, both for air temperature and overall cloud coverage.



The "Share Graph" button allows easy sharing to social media.



Using the App: Review/Edit Data



The graph icon goes to a listing of previously collected air temperature data, with options to edit or delete data points if needed.

Data

Air Temperature Observations

11:57 am	27.5° C		
12:07 pm	27.3° C		
12:17 pm	27.2° C		
12:27 pm	27.2° C		
12:37 pm	27.1° C		
12:42 pm	27.0° C		
12:48 pm	26.8° C		
12:53 pm	26.6° C		

Air Temperature Tips: Timing

- Ideally, take a measurement at least every ten minutes for two hours before and after maximum eclipse
- If you can, increase that to every five minutes for the half hour before and after totality or the maximum eclipse at your location.

Stop taking measurements during the maximum eclipse/totality to enjoy the experience!



Image of the solar corona taken in Argentina on 14 December 2020. Credit: Science Club Huechulafquen, Junín de los Andes, Argentina

- If you want the full temperature curve to appear in your graph, make sure you keep taking observations after the point of maximum eclipse.

Air Temperature Tips: Choosing a Thermometer

- Make sure you have a separate thermometer of some sort, whether digital or liquid-filled. Don't rely on a weather app on your phone, as that could be pulling data from a weather station some distance away.



Example thermometers.
Credit: GLOBE Observer team

- GLOBE has a [list of equipment suppliers for North America](#), but many available thermometers are acceptable. Look for one with with an accuracy of ± 0.5 °C (and 0.5 °C divisions for liquid filled models).

Air Temperature Tips: Accuracy of Measurements

- Using an instrument box is ideal, but if that isn't possible, make measurements in the shade (even your own shadow will help)



A mounted instrument box being checked by GLOBE students. Credit: GLOBE



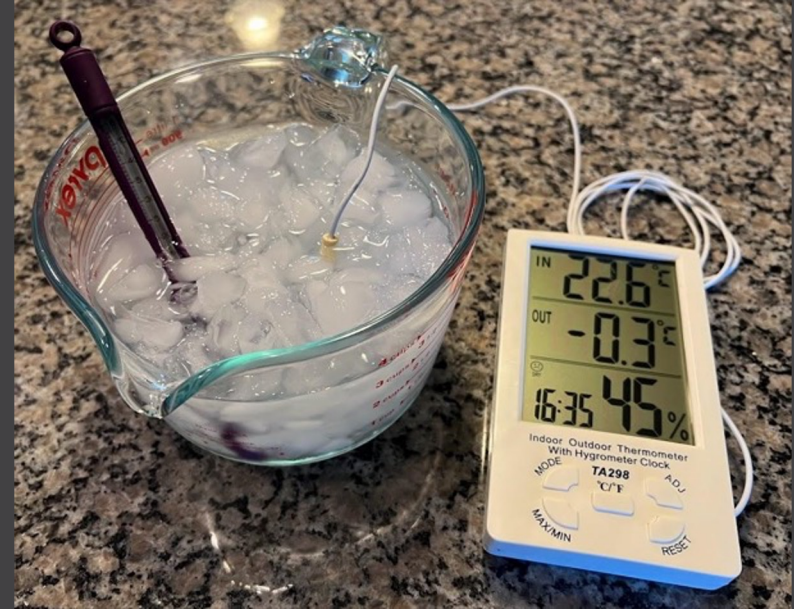
Examples of taking the current temperature in the shade: Holding a simple liquid-filled thermometer in your shadow (left) or propping up a digital thermometer in a tree (right). Credit: GLOBE



Air Temperature Tips: Thermometer Calibration

For maximum accuracy, check the calibration of your thermometer.

- Prepare a mixture of fresh water and crushed ice with more ice than water in a container.
- Put the thermometer in the ice-water bath and let sit for about 10 minutes.
- Read the thermometer. If it reads between -0.5°C and $+0.5^{\circ}\text{C}$, the thermometer is fine.



Testing the calibration of a liquid filled thermometer and a digital thermometer at the same time. Credit: GLOBE

Clouds Observations for the Eclipse

- Make observations about every 15-30 minutes, more often if you wish, especially any time you notice something changing.
- If you are also measuring air temperature, the eclipse tool will remind you with notifications to make your measurements about every third air temperature measurement.
- Feel free to add narrative comments to your photos about anything interesting you see happening.



Taking a Clouds observation with a mobile device. Credit: Lindsey Weaver



Students from Colegio Fasta Villa Eucarística, Córdoba, Argentina observing the July 2019 Eclipse. Credit: Pablo Cecchi

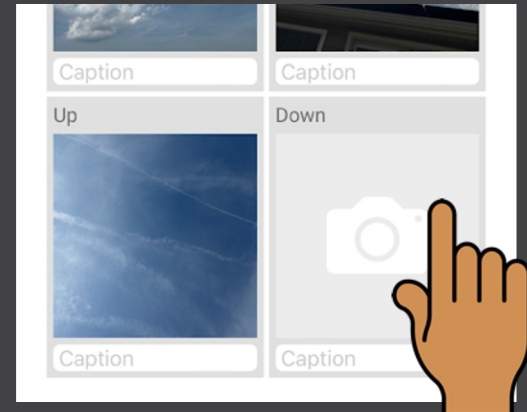
Basic Wind Observations

- A simple rod and a ribbon (a wind stick) can be a way to visually estimate if the wind is increasing or decreasing, or changing direction
- Include your stick in the down photo of any clouds observations you take to document the changes during the period of the eclipse.



Images of a wind stick showing progressively stronger wind from left to right.
Credit: AREN Project

Tip: Using the manual photo option for your down photo may make it easier to capture the wind stick fully.



Land Cover Observations

- We ask you do to a Land Cover observation as part of the initial setup when you open the Eclipse tool to help with research questions that may look at the effect of different types of surface cover on temperature changes during the eclipse.
- As part of that site setup, please include your thermometer in the down photo, which will allow us to confirm the type you are using for air temperature measurements.



A photo from a land cover observation. Credit: GLOBE



A person taking a land cover observation. Credit: GLOBE



A digital thermometer included in the down photo of a land cover observation. Credit GLOBE


General Notes

- You should download the app and set up your account ahead of time, but you don't need to have wifi or cellular signal to collect data (can collect and send later).
- Cloud and land cover observations are always available in the GLOBE Observer app, so you can practice those types of observations ahead of time. For basic app users, air temperature will become available closer to each eclipse.



Qualitative Observations

- In addition to adding narrative comments to the photos in a Clouds observation, or to the field notes in a Land Cover observation, we also have a paper Solar Eclipse Journal page available in the [Eclipse Resource Library](#) on the GLOBE Observer website.
- This can serve as an organizer for your thoughts or simply inspiration for creating your own style of eclipse journal page.


National Aeronautics and Space Administration 

Solar Eclipse Journal

Name: _____ Date: _____ Location: _____

What does the Sun look like? These circles represent the Sun. Shade in how much of the Sun is covered by the moon at different times.

Max Cover: %



Start Time: Max Time: End Time:

What is going on around you? Describe or draw other things you notice at different times during the eclipse. What are birds or other animals doing? What is the weather like (clouds, temperature, wind)?

At Start	Around Max	At End
<input type="text"/>	<input type="text"/>	<input type="text"/>

Share cloud and air temperature data with NASA during the eclipse with the GLOBE Observer app. [Learn More: observer.globe.gov](https://observer.globe.gov)

Safety First: It is never safe to look directly at the Sun. The only safe way to look at the Sun is through special-purpose solar filters, such as "eclipse glasses" or hand-held solar viewers.

www.nasa.gov

