Calculation of local solar noon

GLOBE		***Related SDGs:***	***Type of activity***
Spheres	**Protocols**		
All	Atmosphere protocols mainly, but it can be applied to all the spheres	13 (Climate action)	Exploratory

Overview

The local solar noon is decisive for many GLOBE measurements, mainly in the Atmosphere area. It is essential to know how to calculate it or to have the means to do so. Knowing the exact time of the local solar noon, we can know the two-hour window around it, when we have to perform the measurements so that they meet the GLOBE requirements.

Prerequisites
None

Time:

90 min.

School level
From the sixth year of Primary school and all Secondary school (12 to 18 years old).

Purpose

Students will learn about local solar noon, how to calculate it and how it differs from civil noon or local time.

Student outcomes

- To calculate the local solar noon using two different methods.
- To learn to use an application that calculates it automatically.
- To practice sexagesimal calculation

Introduction

Many of the GLOBE protocols require that they be performed at local solar noon, either because it is easier to compare data if all people take their measurements at approximately the same time in different parts of the world, or because, throughout the year, it is easier to compare data. Usually, the satellites make one of their paths or passages in the span of the

local solar noon and it is easier to compare when we have records of the satellites with which to check our measurements. The GLOBE Observer application allows us, for example, to set an alarm so that at the time of passage of a certain satellite (Aqua or Terra) we are notified so that we can go out to make our measurements at the same time it is passing over our observation point. It is also important for calculating the position of solar panels or collectors for energy saving, the location of the weather hut for taking measurements, the time of maximum sunlight incidence to protect livestock in summer, etc.

But what is local solar noon?
The local solar noon is not 12 o'clock noon, as some people believe, and it is not related to the time changes due to the advance or delay of the time in different countries to achieve energy saving. Nor is it related to universal time (Greenwich Mean Time or zero meridian).

Local solar noon is the instant when the solar azimuth is 0 somewhere on the globe; that is, when the sun has its maximum elevation above the horizon (time of transit of the sun) and the lengths of the shadows it produces are minimal because they coincide with the direction of the meridian. This solar time will vary with longitude, for example, on August 1, 2022, the transit time of the sun in Montevideo, Uruguay is 12:51 pm, while for Ezeiza, Buenos Aires, Argentina, it is 13:00 pm. This is due to the longitudinal distance between the two cities.

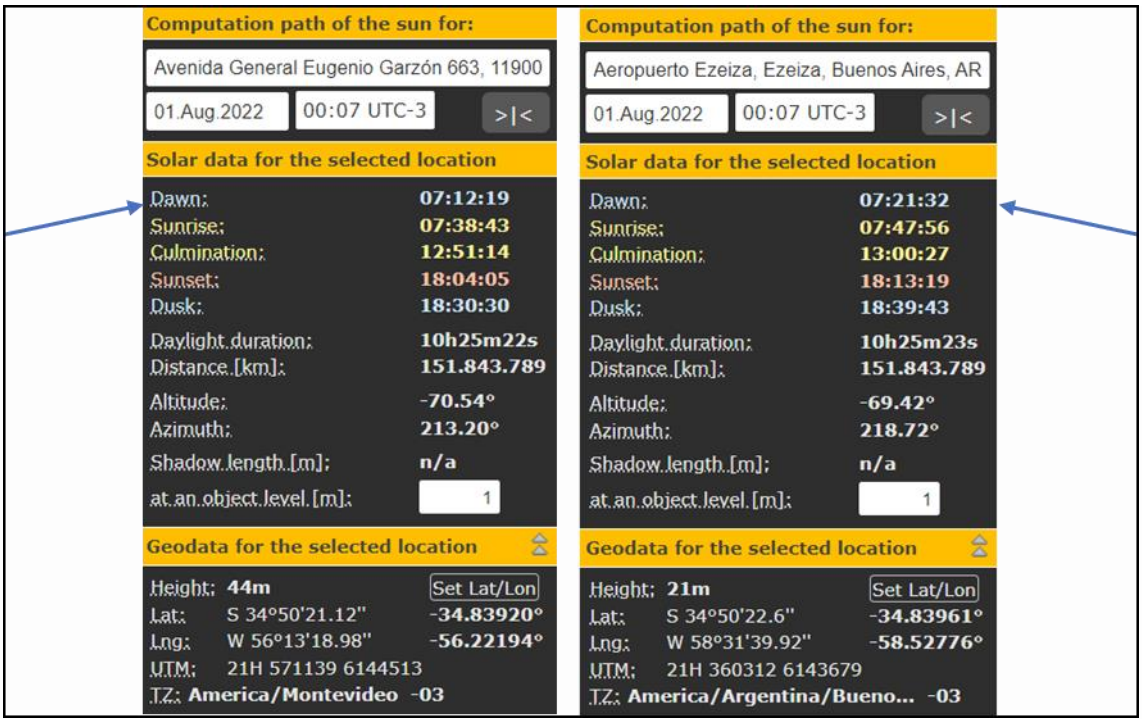


Fig. 1. https://www.suncalc.org

Only at certain times of the year the Sun is directly over your head at solar noon: at the Equator it occurs during the equinoxes, at the Tropic of Cancer (latitude 23° 26′11.4 ″ N) at the June solstice and at the Tropic of Capricorn (23° 26′11.4 ″ S) at the December solstice.

Guiding Research Questions

- Is 12 o'clock noon local solar noon?
- Does local solar noon occur at the same time every day in your location?
- How many hours of sunshine are there today for your geographic location? How can you find out?
- What other applications can have to know the local solar noon?
- What advantages do measurements taken at local solar noon have over measurements taken at other times of the day?
- How many hours of daylight are there usually in the month of the onset of winter and how many hours of daylight will there be in the month of the onset of summer? Does the local solar noon occur at the same time on those two days when the different seasons begin?

Science Concepts

- Solar noon vs. noon
- Latitude and longitude
- Mathematics / sexagesimal calculus

Materials and Tools

- *A world map*
- *Sunrise and sunset times for a given day*
- *Latitude and longitude for a chosen location*

What to Do and How to Do It

Beginning -

Instruct your students to research and bring as homework to class the sunrise and sunset times for that week. They can look on the Internet at weather websites, or get the data from the radio, television, daily news or the newspaper. Instruct them to record all the times on a spreadsheet and also to find the geographic location of their homes or school. This information can be obtained from Google Earth, by searching for their home address in the upper left window of the application, and it will give them the geographic location at the bottom right along with the altitude (Figure 2). Another way to do this is to download a GPS application from the Internet to their mobile devices and activate it at home or at the school to obtain the exact geographic location of the place.

You can review the concepts of latitude and longitude using the world map for this activity.

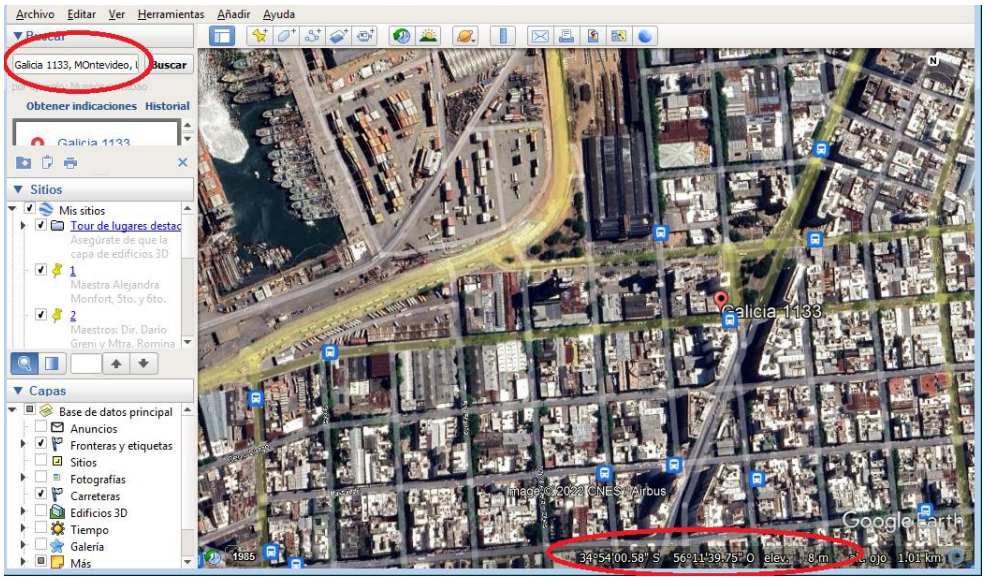


Fig. 2. Geographic location in Google Earth

Development -

In class, you will be taught three methods to calculate the local solar noon using sunrise and sunset times, two of them using calculations with the hours and the last one using a web page that calculates it automatically.

Method A. Assume we have the following data available:

Location: Cartagena de Indias, Colombia.

Geographical location: 10º23'35.62" N 75º28'59.63" S

Date: 01/08/2022

Time of sunrise: 5:51 a.m.

Time of sunset: 6.25 p.m.

They should subtract the sunrise time from the sunset time, divide the number of daylight hours we get by two, and the figure we get, add it to the sunrise time.

Note: Keep in mind that in this way the students will be making calculations with hours, so they will not use the centesimal method but the sexagesimal method.

Example:

18.25 (Sunset Time) **–** **5.51** (Sunrise Time) **=** **12hs. 34'** (Total daylight hours)

12 hs.34' / 2 = 6 hs.17' (Total daylight hours)

5.51 (Sunrise Time) **+** **6hs. 17' = 12 hs. 08'** (Local solar noon)

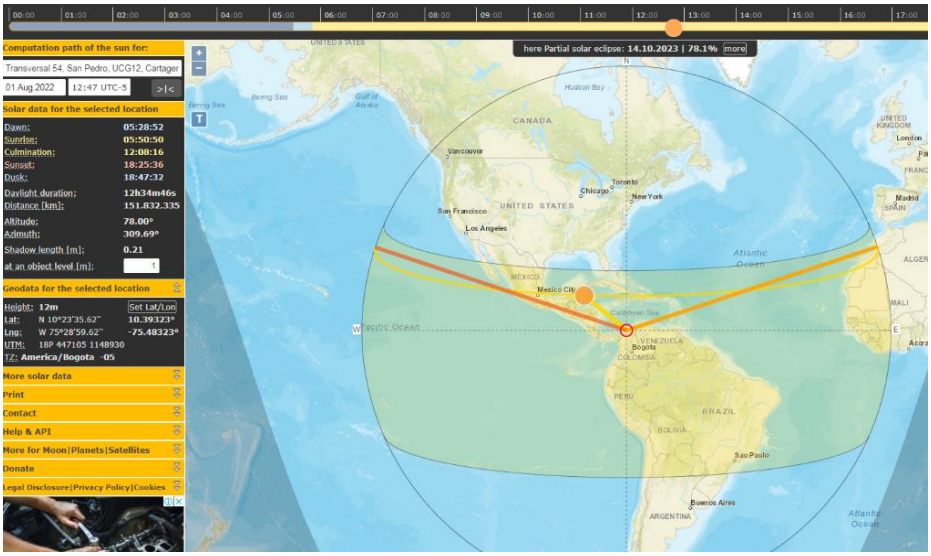
Method B: We must add the sunrise time to the sunset time and then divide the figure by two:

5.51 (Sunrise Time) **+** **18.25** (Sunset Time) **=** **24 hs. 16'**

24 hs. 16' / 2 = 12hs. 08'
Local solar noon

Method C: They will use the page www.suncalc.org, where they will enter the latitude and longitude of the geographic location to determine the local solar noon. They will enter it where it says: "Set. Lat/Lon" (red circle) in either of the following ways: degrees and tenths, or degrees, minutes and seconds. If you enter it in the latter form, it will be automatically converted to degrees and tenths. You will also have to enter the exact day for which you are looking to find out the solar noon. For the example, the same data from the previous examples will be used to check if the three methods match.

Where it says "Culmination" the app will automatically show you the solar noon time for your location on that day.



https://www.suncalc.org

In any of the three methods, the solar noon time obtained should be the same, and once we have already calculated it, the time available for measurements in this window will be from 11:08 to 13:08 hours (a window of two hours).

Ending - Once the students have understood the three methods of calculating local solar noon, give them the following exercises:

a) Find the local solar noon for Escola Minas Gerais (GLOBE school) for September 16, 2022. The geographic location data are as follows:

Latitude: -22.9538° S Longitude -43.1689° W
Which method would you use?
Answer: 11:49 a.m.

b) Find the local solar noon time for the Universidad Agraria La Molina (GLOBE University) for October 3, 2022 with the following data:

Sunrise time: 05:49 am.
Time of sunset: 18.03 hs.
Which method would you use?
Answer: 11:56 a.m.

Frequently Asked Questions:

What if we cannot take measurements within the local solar noon time frame? You can still take measurements, but those taken at local solar noon on other occasions or at other schools may not be comparable to yours because they were taken at other times. In addition, GLOBE indicates that there are protocols that are advised to be taken at local solar noon and others that can be taken at other times of the day. See Introduction to Atmosphere (https://www.globe.gov/documents/10157/381040/atmo_chap_es.pdf) pp. 11-12.

Suggested resources for further information:

https://www.suncalc.org