



Hot Air, Warm Soil – A Temperature Link

Organisation: Gozo College Agius de Soldanis Middle School

Student(s): GLOBE Team

Grade Level: 6th - 8th Grades (Middle School, ages 11-14)

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Report Type(s): International Virtual Science Symposium Report

Protocols: Pedosphere, Atmosphere

Presentation Type: Poster

Optional Badges: I am a Data Scientist, I am a STEM Professional, I am a Storyteller

Abstract:

This research explores the connection between air temperature and soil surface temperature carried out by GLOBE students attending Gozo College Agius de Soldanis Middle School as part of the GLOBE Malta Europe Direct Gozo Soil Project. The investigation aimed to understand how these temperatures relate to each other and what factors might influence the warmth or coolness of the soil surface.

To answer these questions, the students collected air temperature and soil surface temperature data during November and December. They also measured other weather parameters including air pressure, humidity, and cloud cover. Through their observations, the students identified patterns in temperature changes and discovered interesting links between the air and the soil beneath their feet.

This report provides an insightful exploration into the world of temperature dynamics, highlighting the importance of understanding these connections for the local environment. The students' efforts contribute to the broader understanding of climate science and emphasize the valuable role that young scientists can play in solving the mysteries of the natural world.

Key words: soil, air, temperature, clouds, environment, data collection.

Research Questions

- Is there a relationship between air temperature and soil surface temperature?
- Do weather parameters like cloud cover and rainfall affect soil surface temperature?
- What other parameters affect soil surface temperature?
- Why is soil temperature important?

Introduction

The study aims to find out if there is a relationship between air temperature and soil surface temperature. The Earth's soil is vital for supporting life on our planet. It forms the basis for plant growth, as plants rely on soil to obtain essential nutrients and to anchor themselves firmly with their roots. Moreover, soil plays a significant role in influencing our atmosphere, releasing gases such as carbon dioxide into the air. Various organisms including animals, fungi, and bacteria make their home in soil, highlighting its importance as a habitat. Additionally, the soil's role in cycling nutrients, such as carbon and nitrogen, is paramount for sustaining ecosystems. Soil is indispensable for maintaining the balance of life-sustaining processes on our planet.

Air temperature directly affects soil temperature, which influences soil health and productivity. Extreme temperatures can accelerate or slow down biological processes, affect soil structure, and impact nutrient availability for plants. For example, farmers need to pay attention to soil temperature to know when to plant the first crops. Soil holds heat better than air and is usually warmer than the air. Soil holds heat better than air and is usually warmer than the air. The heat energy from the sunlight gets trapped in the soil because soil particles are packed closely together, and they hold onto heat well. On the other hand, air is much lighter and less dense, so it doesn't hold onto heat as effectively.

Study site

Gozo College Middle School (GCMS) is situated on the smaller island of Gozo which is part of the Maltese Archipelago (Figure 1). The school is situated in Europe Street, Rabat or Victoria, the main town of the Island of Gozo, which is the second island in size of the Maltese Archipelago (Population of Gozo 37, 342 (2021), Average Population Density: 557/km²; max. length: 13.34km; max. width: 7.15km; Area 67.1km²).



Figure 1 Map of the Maltese Islands



Figure 2 Study site location

Before choosing the study site, the GLOBE team conducted a thorough examination of the outdoor area at the school. They considered various factors, including accessibility and other criteria specified by the GLOBE protocol. After careful assessment, they identified the optimal location, as indicated in Figure 2. The selected site has the coordinates 36.0447814 N, 14.2439122 E.

Methodology

Beginning on Monday 6th November, 2023, students engaged in cloud observations through the GLOBE Observer App and collected measurements of various weather parameters, including air temperature, air pressure, and humidity, using a data logger (Figure 3). They also reported occurrences of rainfall and assessed wind strength. Using an infrared thermometer, the students measured the soil surface temperature (Figure 4). The students used a data sheet to record data (refer to Appendix 1) and subsequently uploaded it to the GLOBE database. Unfortunately, the observation period had to be concluded on the 20th of December, 2023, due to the students' relocation to new premises, rendering it impractical for them to continue daily site visits for data collection.



Figure 3 GLOBE students measuring weather parameters using a data logger.



Figure 4 Measuring soil temperature using an Infrared thermometer

Results

The screenshots below show data uploaded on GLOBE website during observation period between November 2023 and December 2023 (Figures 5, 6, 7, 8, and 9). The students collected daily readings of soil temperature, air temperature, barometric pressure, humidity, and precipitation following GLOBE protocols. Using the Clouds tool on the GLOBE Observer (GO) App the students also observed and recorded cloud cover and type together with surface conditions. Figure 10 shows screenshots of the cloud observation from the GO App.

Soil Temperature

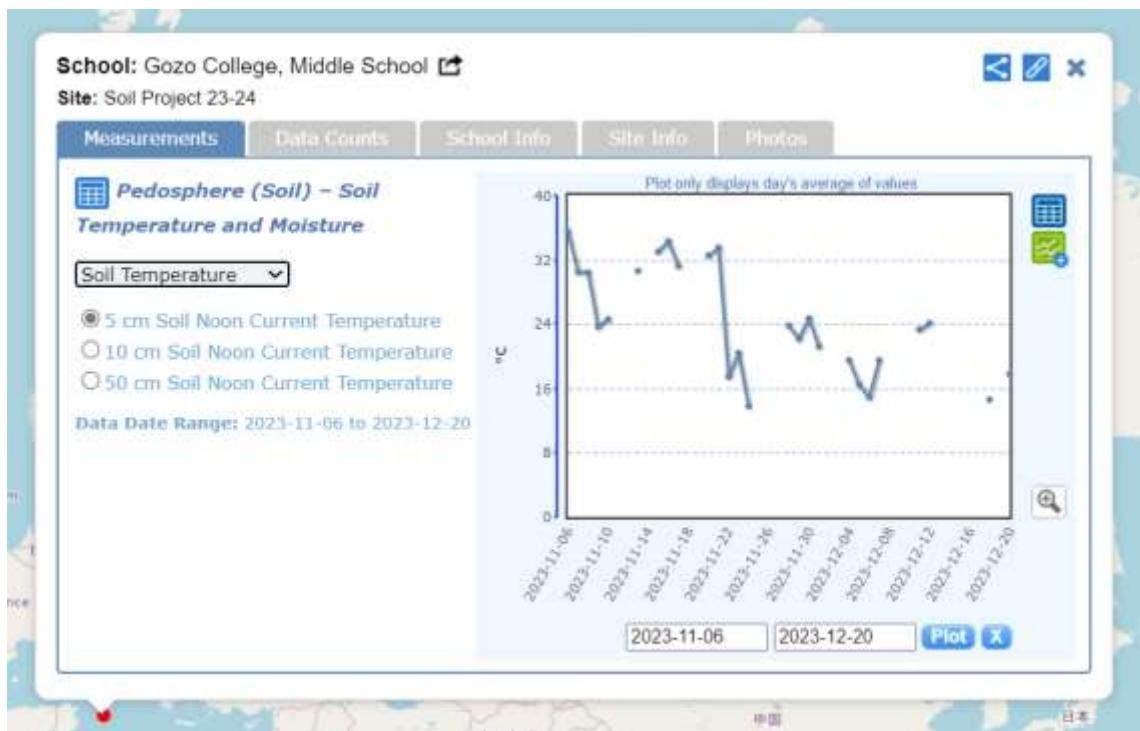


Figure 5 Soil Temperature plot of VIZ GLOBE

Air Temperature



Figure 6 Air Temperature plot of VIZ GLOBE

Precipitation

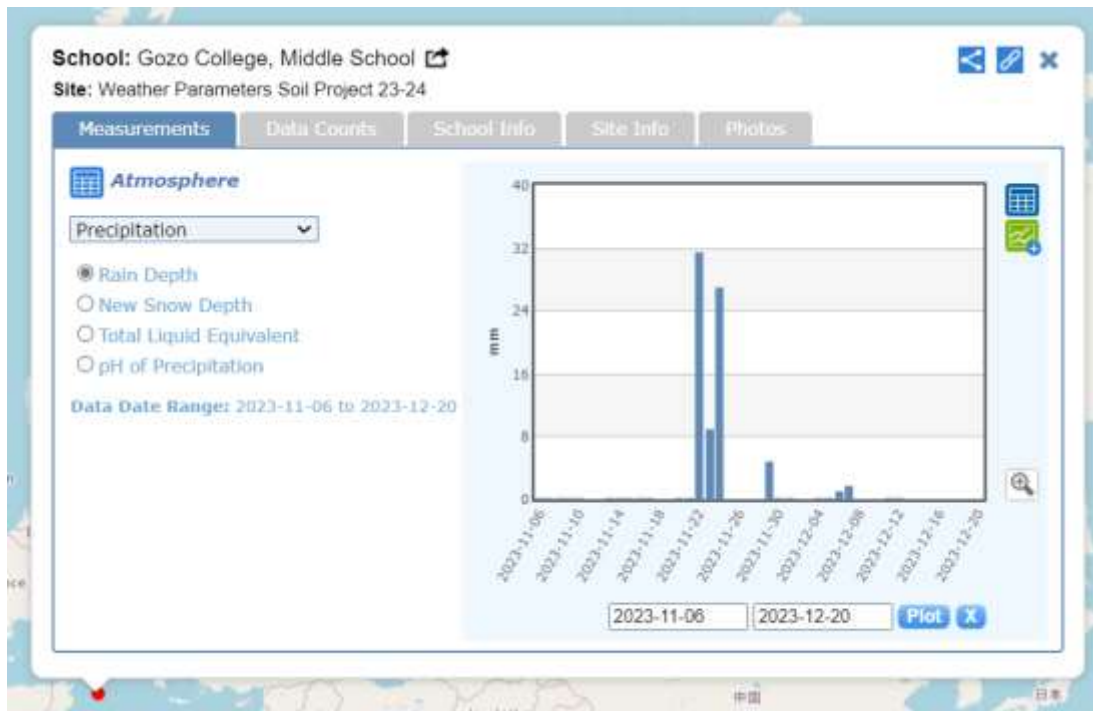


Figure 7 Precipitation plot of VIZ GLOBE

Barometric Pressure

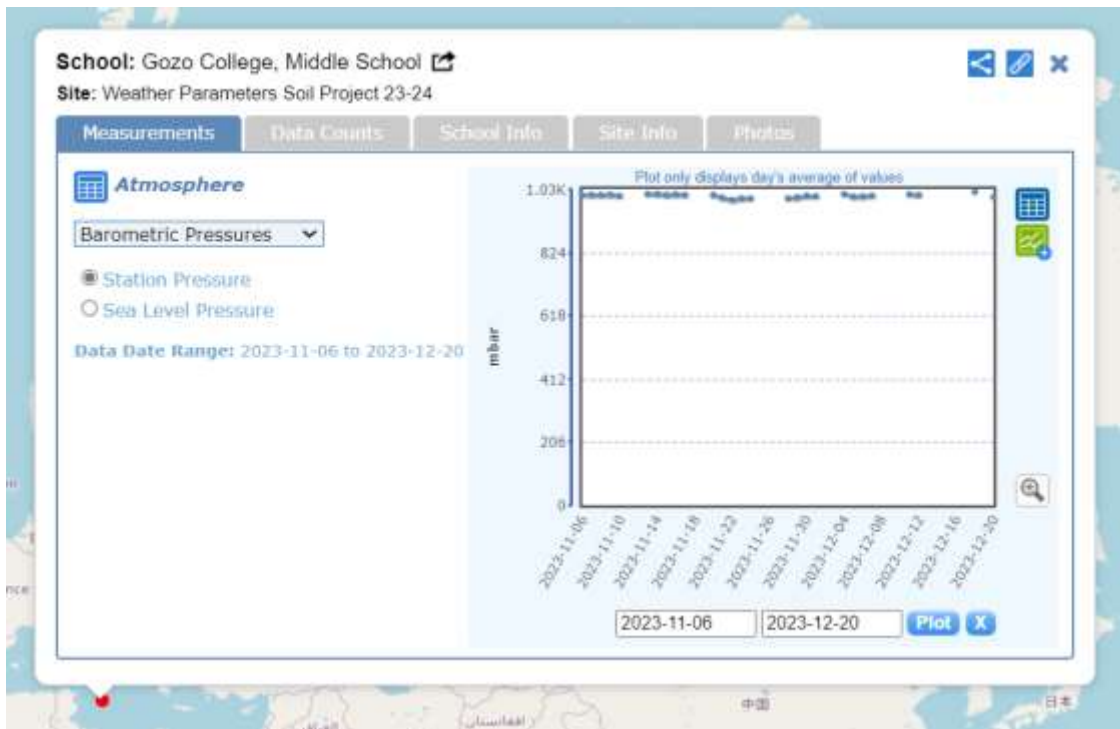


Figure 8 Barometric Pressure plot of VIZ GLOBE

Relative Humidities

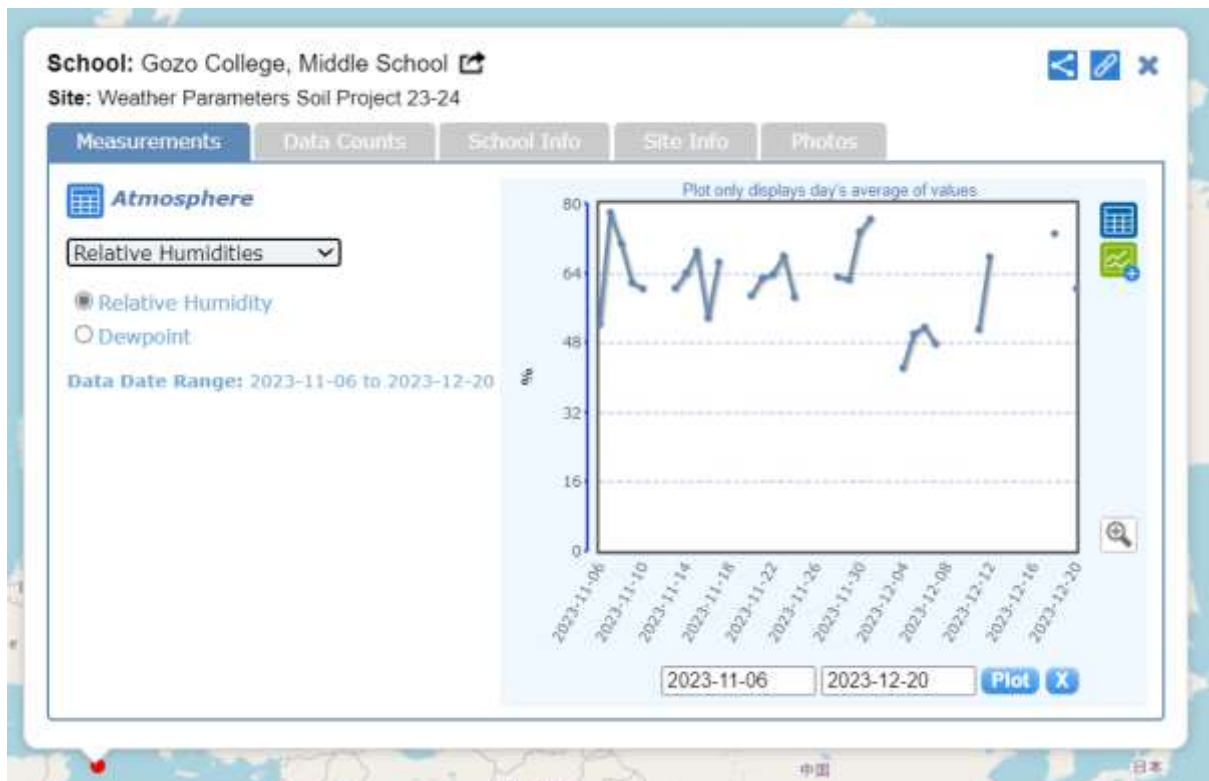


Figure 9 Relative Humidities plot of VIZ GLOBE

Cloud Cover

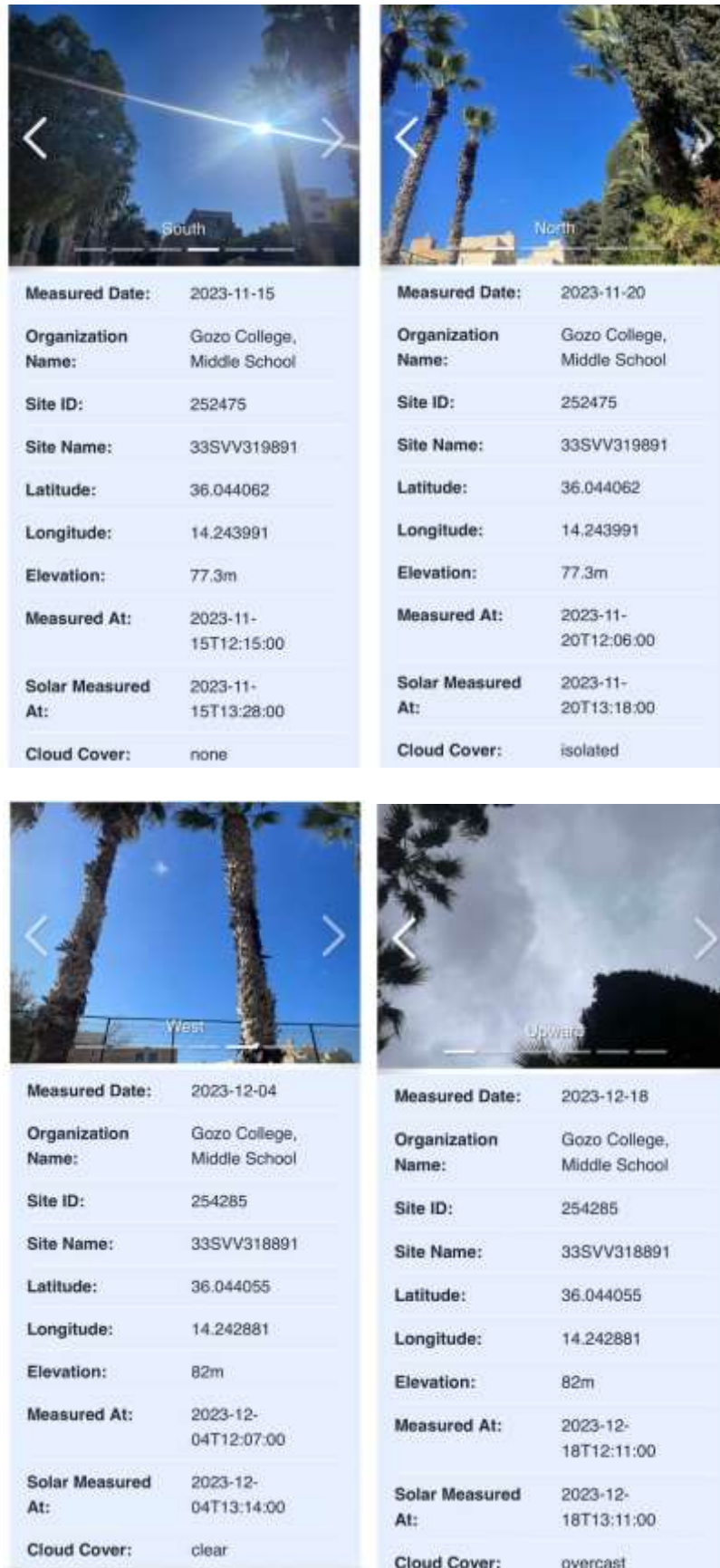


Figure 10 Cloud Cover observations from GLOBE Observer App

Conclusion

During the observation period spread over 2 months, the students observed air temperatures ranging from 18 to 24 degrees Celsius. In comparison, soil surface temperatures varied from 17 to 35 degrees Celsius. The highest soil surface temperatures were noted on the hottest days, indicating a direct relationship between air temperature and soil surface temperature. Soil holds heat better than air does. The heat in the soil is protected by the soil above it and the vegetation over it.

Rainfall was infrequent, occurring on only 10 days throughout the observation period. The average rainfall recorded was 5mm, except for 27mm on the 24th of November. The students noticed that rainfall events lowered soil surface temperatures temporarily due to the cooling effect of water on the soil. Therefore, it can be concluded that wetter soil tends to be cooler.

Other parameters such as cloud cover and wind strength may also influence soil surface temperature, though their specific impacts require further investigation. Soil temperature is crucial for various ecological processes, including seed germination, nutrient availability, and microbial activity. Understanding the factors influencing soil temperature helps us comprehend ecosystem dynamics and make informed decisions regarding land management and agriculture.

Overall, the investigation sheds light on the intricate relationship between weather parameters and soil surface temperature, emphasizing the importance of monitoring and understanding soil conditions for ecological and agricultural purposes.

References:

GLOBE Observer <https://observer.globe.gov/> (Accessed November 2023)

GLOBE teacher guide <https://www.globe.gov/> (Accessed October 2023)

GLOBE Visualization System <https://vis.globe.gov/GLOBE/> (Accessed February 2024)

Badge description

I am a Data Scientist: Students analysed their own data (from their measurements). They were able to analyse bar graphs to interpret the data. They also became aware of the limitations of the data and could only draw conclusions from the samples studied. From the data analysis, the students answered their research questions.

In the photos, GLOBE students are collecting data and uploading it to the GLOBE database.



I am a STEM Professional: GLOBE students participated in a webinar held on World Soil Day that explored the fascinating world beneath our feet! The highlight of the webinar included an insightful presentation by Mr. Yashraj Patil, an early scientist, who discussed the importance of soil and the impact of climate change on this vital resource. Additionally, Mr. Stephen Mifsud from EcoGozo, shared valuable insights about rubble walls, emphasizing their significance for soil health and their role as habitats for diverse flora and fauna. The students engaging in a Q&A session with the speakers, sparking insightful discussions.



I am a Storyteller: The students shared all the stages of their investigation, from data collection to participation in webinars, and findings to conclusions, with the whole school community during morning assemblies and the GLOBE noticeboard. They also reached out to the wider community by uploading updates with photos on the school Facebook page.




 **Gozo College Agius De Soldanis Middle School** 6 December 2023 · 🌐

To commemorate World Soil Day, our EkoSkola students attended a webinar organised by [GLOBE Malta](#)

During the webinar the students learned interesting facts about soil, the effects of climate change and the importance of rubble walls.

[Europe Direct Gozo](#) [The GLOBE Program](#) [EkoSkola Malta](#) [LEAF Learning about Forests Malta](#)



 **Gozo College Agius De Soldanis Middle School** 8 November 2023 · 🌐

Our EkoSkola/LEAF team has embarked on a new project investigating soil.

Students are, on a daily basis, observing and measuring weather parameters and taking soil temperature. Moreover, soil samples are collected every week to measure the soil water content.

[GLOBE Malta](#) [Europe Direct Gozo](#) [EkoSkola Malta](#) [LEAF Learning about Forests Malta](#) [#SDGs](#) [#LifeOnLand](#)

Appendix – Data sheets

Cloud Type, Atmospheric Conditions & Soil Surface Temperature Data Sheet

Date	Time	Cloud type			Air Temperature (°C)	Pressure (mb)	Humidity (%)	Rainfall		Wind			Soil Surface Temperature
		High	Mid	Low				Yes	No	Strong	Light	Calm	
6/11/2023	13:17				24.4	1010.7	52.2		✓		✓		35.5°C
7/11/2023	13:05		✓		24.7	1011.1	77.9		✓		✓		30.5°C
8/11/2023	13:08	✓		✓	25.2	1010.8	70.8		✓		✓		30.4°C
9/11/2023	13:04			✓	23.6	1011.8	61.8		✓			✓	22.7°C
10/11/2023	13:04		✓	✓	23.2	1007.7	60.4		✓				24.6
13/11/2023	13:06			✓	23.2	1013.7	60.5		✓		✓		30.6
14/11/2023	13:41	✓		✓	23.7	1014.0	64.0		✓			✓	35.1
15/11/2023	13:09				23.3	1010.6	69.0		✓			✓	33.0
16/11/2023	13:13				23.1	1012.7	53.7		✓			✓	34.3
17/11/2023	13:12			✓	23.0	1010.6	66.5		✓				31.2
20/11/2023	13:03			✓	23.3	1010.6	58.8		✓		✓		32.5
21/11/2023	12:59		✓	✓	23.3	1002.0	62.8		✓			✓	31.9
22/11/2023	13:13		✓	✓	21.6	994.5	63.7	✓	31.3			✓	17.5
23/11/2023	13:06		✓	✓	21.3	999.7	67.4	✓	8.8			✓	20.4
24/11/2023	13:03			✓	19.8	1011.3	58.4	✓	26.8			✓	13.8
25/11/2023													
27/11/2023													
28/11/2023	13:05		✓	✓	19.3	999.5	63.1	✓	23			✓	23.8
29/11/2023	13:05			✓	21.3	1002.2	62.5	✓	4.8		✓		24.07
30/11/2023	12:07				21.1	1008.1	73.4		✓			✓	21.2
1/12/2023	13:03	✓			19.8	1006.6	76.4		✓			✓	19.5
4/12/2023	13:02	✓			20.8	1013.4	42.1		✓			✓	16.5
5/12/2023	13:07			✓	19.2	1005.5	50.0	✓	0.3			✓	14.9
6/12/2023	13:10			✓	18.8	1006.6	51.5	✓	0.9			✓	19.5
7/12/2023	13:17				18.2	1003.6	47.7	✓	1.7			✓	

Weather

The GLOBE® Program Soil Project Ms R. Mercieca GLOBE Malta DC

Cloud Type, Atmospheric Conditions & Soil Surface Temperature Data Sheet

Date	Time	Cloud type			Air Temperature (°C)	Pressure (mb)	Humidity (%)	Rainfall		Wind			Soil Surface Temperature
		High	Mid	Low				Yes	No	Strong	Light	Calm	
✓ 11/12/2023	13:21				21	1012.5	51		✓				23.3
✓ 12/12/2023	13:22				20.8	1010.4	67.7		✓		✓		24.1
14/12/2023		School concert											
15/12/2023		School concert											
✓ 18/12/2023	13:08			✓	17.1	1020.6	73.0	✓	17.6	✓			14.6
19/12/2023	/	/	/	/	/	/	/	/	/	/	/	/	/
✓ 20/12/2023	13:09	✓		✓	18.6	1003.5	60.4	✓	1.0		✓		17.9
21/12/2023													
8/1/2024													
9/1/2024													
10/1/2024													
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