Hot Air, Warm Soil – A Temperature Link

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Summary

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.

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 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.

Research Methods

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 1. The selected site has the coordinates 36.0447814 N, 14.2439122 E.

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 2). They also reported occurrences of rainfall and assessed wind strength. Using an infrared thermometer, the students measured the soil surface temperature (Figure 2). The students used a data sheet to record data and subsequently uploaded it to the GLOBE database (Figure 3). 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 1 Aerial view of school with study site location circled in red.

Figure 2 GLOBE students measuring weather parameters using a data logger and soil temperature using an IRT

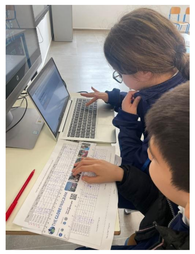
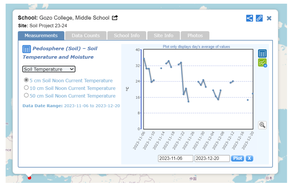


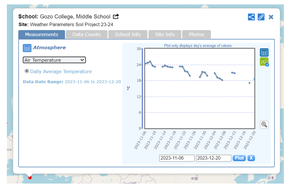
Figure 3 GLOBE students uploading data to the GLOBE database

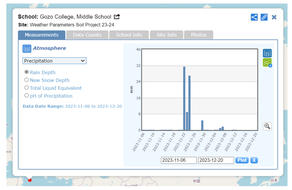
Results

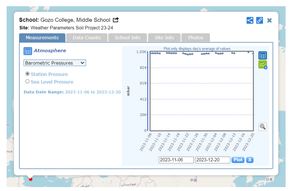
The screenshots below show data uploaded on GLOBE website during observation period between November 2023 and December 2023. The students collected daily readings of soil temperature, air temperature, barometric pressure, humidity, and precipitation following GLOBE protocols. Using the Clouds tool on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

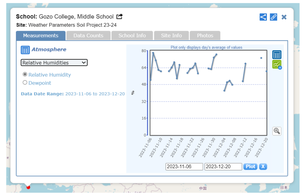
Soil Temperature, Air Temperature, Precipitation, Barometric Pressure and Relative Humidities
Plots of VIZ GLOBE



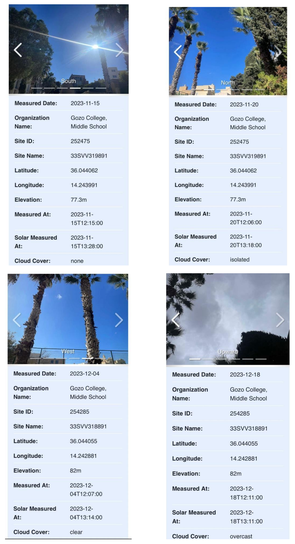








Cloud Observations from the cloud tool on the GLOBE Observer App



Conclusion

During the observation period spread over 2 months, we 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 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. We found that rainfall events lowered soil surface temperatures temporarily due to the cooling effect of water on the soil. Therefore, we can conclude 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, our 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 Vizualisation System https://vis.globe.gov/GLOBE/ (Accessed February 2024)