Comparison of soil and air temperatures with CobraSMARTsense

Biology | Ecology & environment | Ecosystems

Difficulty level	Group size	Preparation time	Execution time
easy	2	10 minutes	30 minutes

This content can also be found online at:

http://localhost:1337/c/5f4454875eef7d00031fcb0d

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Teacher information

Application

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Experiment set-up

How does the temperature of the air affect the temperature of the soil during the course of a day? A wide variety of microorganisms, worms, insects and even small mammals (e.g. moles) live in the soil. Plants also take up nutrients and water in the soil through their roots.

But how does the ground temperature change if the air temperature fluctuates during the course of the day? This experiment provides the answer to this question.

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Other teacher information (1/5)

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Prior knowledge

The students should have a rough understanding of the physical principles of heat transfer. They should also have a good basic knowledge of living organisms found in the soil.

Scientific principle

The pupils measure the air and soil temperature with the Cobra SMARTsense "Temperature" Sensor.

Other teacher information (2/5)

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Learning objective

Students should understand the temperature curve and how the soil adapts to the air temperature.

Tasks

Several times a day, the students measure the temperature above the ground and at depths of 1 cm and 10 cm.

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Other teacher information (3/5)

Result

- The deeper the measuring point below the soil surface, the flatter the curve (see table below).
- The temperature in the soil is delayed in relation to the air temperature. At a depth of 10 cm the maximum temperature is reached several hours after the air temperature.

Uhrzeit/°C	0	3	6	9	12	15	18	21
T(Luft)	7,8	5,6	5,2	11,4	35,4	38,4	19,6	11,4
T(-1cm)	14,5	12,8	11,8	12,4	21,2	24,9	21,1	16,9
T(-10cm)	16,4	15,1	14,0	13,4	14,8	18,0	19,7	18,1

Other teacher information (4/5)

Result

- The heat transfer is soil-dependent (soil water content and soil aggregate condition). In heavy soils (e.g. wet loam) a daily fluctuation at a depth of 10 cm is much less pronounced than in a sandy soil. From a certain soil depth the temperature does not change even during a whole year. This temperature then corresponds to the long-term average temperature of the site.
- The more airy the soil (e.g. dry soil, soil with a high proportion of (coarse) pores, sandy soil, peat soil), the more pronounced the temperature fluctuation.
- The experiment is most interesting on cloudless days, especially when the ground is dry. The temperature measured above the ground then fluctuates the most because of the night-time radiation and can reach 40°C during the day even in temperate latitudes. These pronounced fluctuations can then also be measured deep in the ground.

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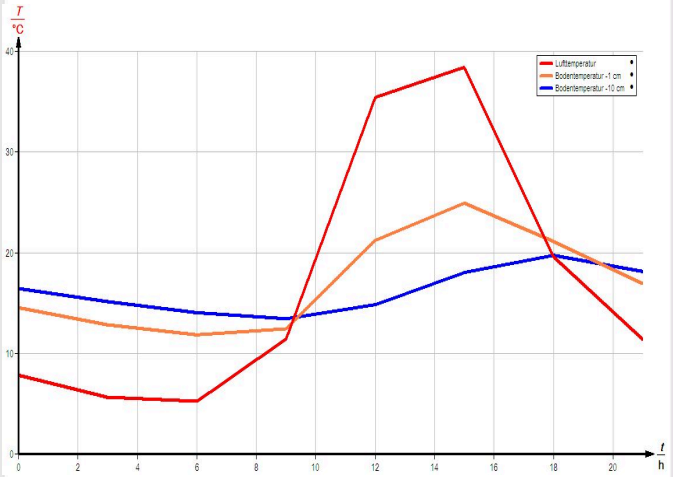
Other teacher information (5/5)

Result

- A didactic added value can be achieved by letting the students estimate the temperature curve in the soil before measuring, specifying an air temperature curve.
- On the webpage http://www.agrowetter.de/Agrarwetter/botemp_pr you can get an overview of the soil temperature profiles at several locations in Germany.



Temperature profile

Safety instructions

- The general instructions for safe experimentation in science teaching apply to this experiment.

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Student Information

Motivation

Experiment set-up

How does the temperature of the air affect the temperature of the soil during the course of a day? A wide variety of microorganisms, worms, insects and even small mammals (e.g. moles) live in the soil. Plants also take up nutrients and water in the soil through their roots.

But how does the ground temperature change if the air temperature fluctuates during the course of the day? This experiment provides the answer to this question.

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Tasks

Select the sensor "Temperature"

Investigate how the air temperature affects the ground temperature during the day.

The temperature is measured several times a day, above the ground and at depths of 1 cm and 10 cm.

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Equipment

Position	Material	Item No.	Quantity
1	Cobra SMARTsense - Temperature, - 40 ... 120 °C (Bluetooth)	12903-00	1
2	measureAPP - the free measurement software for all devices and operating systems	14581-61	1

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Set-up

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- Turn on the Cobra SMARTsense 'Temperature' by pressing the power button.
- Make sure that Bluetooth is enabled on the device.
- Open the PHYWE measure App and select the sensor "Temperature".
- The temperature sensor can be carefully pressed by hand into soft soil. You can use a tent nail to pre-drill a hole.
- The actual temperature-sensitive element is located in the tip of the 20 cm long corrosion-resistant sensor rod.
- It takes one minute until the sensor has reached the ambient temperature and the temperature can be read.

Procedure

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Note: It takes at least one minute for the sensor to reach the ambient temperature and the temperature can be read.

- Every three hours the temperature is measured above the ground (without shading), 1 cm below the ground surface in the upper root zone of the grass, and 10 cm below the ground surface.
- The temperature above the ground is measured first, since the heat transfer from the air to the Sensor Unit Temperature takes longer than from the ground to the sensor.
- In soft soil, the temperature sensor can be carefully pressed by hand. You can use a tent nail to pre-drill a hole.
- Wipe off any adhering soil from the temperature sensor.

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Report

Task 1

Choose the right answer.

- The heat transfer is always the same. Soil water content and soil aggregate condition have no influence.
- The heat transfer is soil-dependent (soil water content and soil aggregate condition). In heavy soils (e.g. wet loam) a daily fluctuation at a depth of 10 cm is much less pronounced than in a sandy soil.
- The heat transfer is soil-dependent (soil water content and soil aggregate condition). In light soils (e.g. sandy soils) a daily fluctuation at a depth of 10 cm is much less pronounced than in wet loam.

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Task 2

The temperature gradient in the ground, compared with that of the air, runs simultaneously.

○ True ○ Wrong

Check

The more airy the soil (e.g. dry soil, soil with a high proportion of (coarse) pores, sandy soil, peat soil), the more pronounced the temperature fluctuation.

○ True ○ Wrong

Check

Slide	Score / Total
Slide 16: Heat transfer	0/1
Slide 17: Multiple tasks	0/2

Total amount 0 / 3

Solutions Repeat

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