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Atmospheric measurements on the Great Taevaskoda clearing and the forest on the outcrop

Authors: Siim Paabo
Marie Elise Niinemets
Rebeka Roots
Romer Ojaveer
Ilya Vasilenko
Heidy-Elisabett Sõna
Helle Õunap

Supervisor: Valle Morel

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ABSTRACT

This study examines the relationship between atmospheric parameters—air humidity, air pressure, and surface temperature—at two measurement sites near the Great Taevaskoda sandstone cliff in southern Estonia. Measurements were taken at a clearing (*lagendik*) and a forested area (*metsaalune*) at different elevations (40.5 m and 68.5 m above sea level, respectively). Instruments included a barometer for air pressure, a psychrometer for humidity, and an infrared thermometer for surface temperature. Results showed that air humidity decreased by 11.2% and air pressure by 3 hPa with elevation, while surface temperature was 5.5°C lower in the forest. The study confirmed that temperature under tree cover is lower, humidity is higher near rivers, and pressure varies with elevation. Further research could involve more precise measurements, simultaneous data collection, and integrating biospheric and pedospheric data to explore vegetation and soil effects on atmospheric conditions.

INTRODUCTION

1. Introduction and literature review

The purpose of the task was to observe the changes caused by elevation. For the study, we used a barometer to measure air pressure, a psychrometer to measure air humidity, an infrared thermometer to measure surface temperature, and a cloud chart to identify clouds. We measured the surface temperature in a sandy area below and a mossy area above.

Previously, studies have examined the change in air pressure with elevation. Air pressure decreases rapidly in the lower atmosphere, by an average of 100 mmHg for every 100 meters. Barometers have been used to measure air pressure, with the unit being millibars. From an environmental standpoint, this topic is significant because air humidity and air pressure can affect the living conditions of local plants and animals. Surface temperature is also important from an environmental perspective, as plants require an appropriate living environment, including the right surface temperature. Globally, research on these topics is crucial because the findings can be applied to climate change studies. Measuring air humidity is also important because local wildlife and plants cannot cope with rapid and large fluctuations in humidity. Climate change could lead to a significant increase in air humidity, potentially accelerating the erosion of the Great Taevaskoda sandstone cliff (due to erosion and vegetation cover) (Center for Science Education, n.d.; Yale Environment 360, 2018; Kont et al., n.d.).

Previous atmospheric measurements at the Great Taevaskoda were not found.

2. Research questions and hypotheses

Atmospheric measurements were conducted at closely located measuring points with a 20-meter elevation difference. In addition, the measurement point above the cliff is covered by forest (see Figure 7, Figure 8, Figure 9, Figure 10), while the clearing has a grassy area with few trees (see Figure 2, Figure 3, Figure 4, Figure 5). A river runs between the measuring points, which may influence the atmospheric parameters measured at these locations. Based on this, research questions and hypotheses were formulated.

Four research questions were posed during the study:

1. How does air humidity depend on height?
2. How does air pressure depend on height?
3. How does the surface temperature differ between the clearing and the forest?
4. How do atmospheric temperature, air humidity, and air pressure change throughout the day?

The hypotheses formulated during the study were:

- The temperature is lower under the trees than in the sun.
- Air humidity is higher at lower elevations, near the river, than on the cliff above in the forest.
- The air pressure on the cliff is slightly lower than in the clearing by the river.
- In the evening, the temperature is lower than at noon.

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3. Research methods

To answer the research questions and confirm the hypotheses, two measurement sites were chosen: "Lagendik" (Figure 1) and "Metsaalune" (Figure 6)
The "Lagendik" measurement site is located in front of the Great Taevaskoda at an elevation of 40.5 meters above sea level (Coordinates: N 58.108003, E 27.050214).
The site has sandy soil.

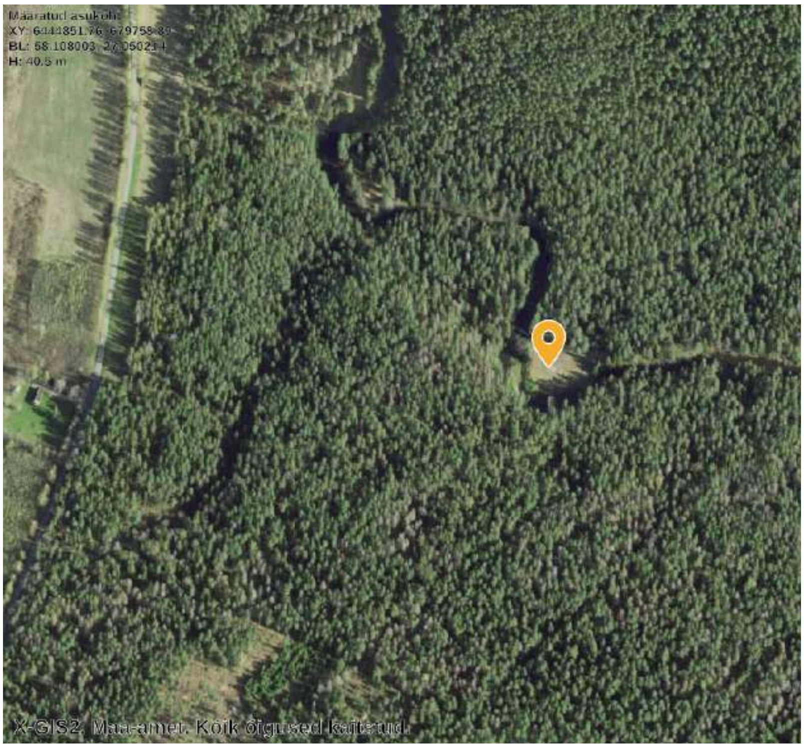

Figure 1. Location of “Lagendik”

Figure 2. Measurement site "Lagendik" view towards the north.

Figure 3. Measurement site "Lagendik" view towards the east.

Figure 4. Measurement site "Lagendik" view towards the south.

Figure 5. Measurement site "Lagendik" view towards the west.

The measurement site "Metsaalune" is located at the top of Suur Taevaskoda, under the forest, at an elevation of 68.5 meters above sea level (Coordinates: N 58.107506, E 27.049771). The site has a mossy ground surface.

Figure 6. Location of “Metsaalune”

Figure 7. Measurement site "Metsaalune" view to the North

Figure 8. Measurement site "Metsaalune" view to the east

Figure 9. Measurement site "Metsaalune" view to the south

Figure 9. Measurement site "Metsaalune" view to the vest

For measuring air pressure, a barometer was used, and the air temperature was obtained with the psychrometer (using the dry thermometer), along with the measurement of air humidity. The surface temperature was measured using an infrared thermometer. A cloud chart was utilized to determine cloud coverage.

We started the measurements at a height of 40.5 meters next to the Ahja River. We measured air humidity, air pressure, and surface temperature. We also used a cloud chart to identify the clouds in the sky. Then, we moved upwards to a height of 65 meters. At the higher location, we also measured air pressure, air humidity, and surface temperature. We made a total of three measurements at the higher point and three at the lower point.

When measuring humidity, it was essential to ensure that part of the psychrometer's cord was always kept wet. We also checked the air temperature on the psychrometer thermometer and recorded it. Air pressure was measured in hectopascals. At the beginning of the expedition (during the first two measurements), each data point was only measured once, but by the third measurement, we started taking multiple readings to calculate averages and achieve more accurate results. We also estimated the cloud cover percentage in the sky every time we were at the lower site.

Measurements were taken at intervals of about one hour at the measurement sites. The first measurement occurred at 14:33, and the last measurement took place at 17:33.

For repeated measurements of a single parameter, the arithmetic mean was calculated. To determine air humidity, a relative humidity table for the psychrometer was used.

4. Results

Table 1. Results of atmospheric measurements taken during fieldwork.

	Time of day	Atmospheric pressure	Surface temperature	Cloud coverage	Humidity	Air temperature
Lagendik	14:33	1021 hPa	26.3℃	20-40% (cu, ci)	50%	25℃
Metsaalune	15:00	1015 hPa	17℃	did not measure	66%	25℃
Lagendik	16:15	1023 hPa	23.3℃	25-50% (cu, ci)	64.5%	23℃
Metsaalune	16:00	1021 hPa	18.3℃	did not measure	57.5%	22℃
Lagendik	17:20	1023 hPa	21.1℃	1-10% (cu, ci)	78%	19℃
Metsaalune	17:33	1022 hPa	18.9℃	did not measure	57.5%	21.5℃

5. Discussion

The first research question was "How does air humidity depend on altitude?". Based on the measurements, it was found that the air humidity decreased on average by 11.2% for between 20 meters in altitude.

The second research question was "How does air pressure depend on altitude?". The air pressure decreased by an average of 3 hPa for between 20 meters in altitude.

The third research question was "How does surface temperature differ between the clearing and the forest?". At the forest site, the surface temperature was on average 5.5℃ lower than at the clearing.

The fourth research question was "How do atmospheric temperature, humidity, and air pressure change throughout the day?". Air temperature decreased by 3.5℃ during the measurements. Air humidity increased by 28 percentage points at the clearing during the day, while at the forest site humidity did not change significantly. Air pressure remained constant throughout the day.

The hypothesis "The temperature is lower under trees than in direct sunlight" was confirmed. At the forest site, the surface temperature was on average 5.5℃ lower than at the clearing. This temperature difference can be explained by the trees, which provide shade at the forest site. There was no significant temperature difference between the air temperatures at the measurement sites. The difference in surface types (sandy soil at the clearing and mossy soil at the forest) may also explain the temperature differences.

The hypothesis "Air humidity is higher at lower altitudes, near the river, than above the cliff in the forest" was confirmed. The air humidity at the clearing was on average 11.2 percentage points higher than at the forest site. The river near the clearing may increase the humidity, whereas the forest measurement site is located 20 meters higher and humidity may have decreased by that altitude.

The hypothesis "The air pressure is slightly lower at the cliff than at the clearing near the river" was confirmed. The air pressure at the forest site was on average 3 hPa lower than at the clearing. This difference can be explained by the altitude difference.

The hypothesis "The temperature is lower in the evening than at noon" was confirmed. The air temperature decreased by 3.5℃ during the measurements. The first and last measurements were taken three hours apart, with the first measurement occurring in the afternoon (14:33). With each subsequent measurement, the temperature had dropped by 1-2℃. This can be explained by the change in the angle of the sun’s rays.

Possible sources of error in the measurements may have been inaccurate instruments and the time intervals between comparative measurements. The temperature measurements were taken with a thermometer on the psychrometer, and the readings from this may not have been entirely precise. The devices used for measuring air pressure and humidity were moved between measurement sites, which could have prevented the readings from stabilizing. Moving between the measurement sites took about 15 minutes, during which weather conditions may have changed.

6. Conclusions

The topic is important from an environmental perspective because air humidity and air pressure can affect the living conditions of local plants and animals. Surface temperature is crucial for the environment as plants need the right habitat, including the appropriate ground temperature, to survive. On a global scale, the study of these issues is very important as the findings can be applied to the understanding of climate change. Measuring air humidity is essential because local flora and fauna may not cope well with rapid and large fluctuations in humidity. Climate change could lead to a significant increase in air humidity, which may accelerate the erosion and deterioration of the Great Taevaskoda sandstone cliff due to erosion and changes in vegetation cover.

This study can be further developed to obtain more precise results by measuring air temperature separately with a thermometer. Additionally, measurements could be taken simultaneously at both measurement sites. Repeating the measurements over the course of a year would help better capture the differences in atmospheric conditions at the sites. It would also be valuable to perform measurements over the course of a 24-hour period to track the changes in atmospheric parameters and compare them between the measurement sites.

Additionally, pedospheric measurements could be made at these sites, allowing for the investigation of soil's impact on surface temperature throughout the day. By adding biospheric measurements to the atmospheric data, such as canopy coverage measurements, it would be possible to compare the daily surface temperature under trees with and without leaves.

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