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SURFACE TEMPERATURE OF CONCRETE AND SHORT-GRASS: A COMPARATIVE STUDY

ABSTRACT

The purpose of this project was to find out whether concrete or short-grass would reflect less heat energy. The hypothesis was short-grass would be warmer than concrete. The GLOBE Program protocol for collecting surface temperature data was followed for nine days. Two data collection points were identified: concrete and short-grass. The data did not support the hypothesis four of the nine days. The data did show during the nine-day study there was only a 0.27 degrees Celsius difference in temperature between the two data collection points. This is statistically insignificant. Snow totally covered both data collection points during the entire nine-day collection period, leaving both surfaces with the same albedo (reflectivity of light energy). Also, the Lascar Data Loggers failed to collect data, resulting in using a Fluke 63 Infrared Thermometer (IRT) to collect surface temperature (as a back-up plan). Instead of collecting surface temperature data every 30 minutes for nine days, collecting surface temperature was restricted to once daily for the nine-day study period. Other relevant research can be done in the future such as different colors of concrete, which could be especially relevant to ease of snow removal during the winter months, and collecting surface temperature on different surfaces such as asphalt, water, or dirt fields.

PURPOSE

The purpose of this study was to determine which surface reflects less heat energy, concrete or short-grass.

By watching the news, we are told that the climate is changing, especially in the city. It is reported that it is caused by many different factors, one of which is the amount of concrete. Where in the country side, there is less concrete there. We just got a new patio in our backyard the fall of 2020. I am comparing our little backyard to the big cities. It got me thinking if it would make a change on our little patio. My parents wanted a place to watch us play while being outdoors, so we got a patio. I decided to make use of our patio before we got all the outdoor furniture and grill.

During the fall of this year, we had two large trees, one box elder (*Acer negundo*) and one silver maple (*Acer saccharinum*) removed from our yard. We also had a concrete patio poured along the back (east) side of our house.

When we first started having a little bit of snow, I noticed all the snow melted on the patio, but stayed on the short-grass of our back yard. This was confusing as the short-grass had a darker albedo (reflectivity of the sun) than the patio which looks almost white.

I also noticed the snow melted on the short-grass where the silver maple used to be, but stayed on the short-grass areas around where the tree used to be. I wanted to collect temperatures there, but couldn't. My parents bought a new van and parked our older van right where the silver maple used to be! Obviously, I could not collect temperatures there. Perhaps I'll look into this next year once we sell our old van.

I guess I'm glad we don't have a grill, a fire pit, or lawn furniture placed on our new patio yet and I have a clear space to collect temperatures.

MY QUESTION

Which surface reflects more heat energy, concrete or short-grass?

HYPOTHESIS

My hypothesis is short-grass will reflect more heat energy than concrete because short-grass (green) has a darker albedo than concrete (white).

CONTROL

- Infrared Thermometer (IRT)
- Temperature taken every 30 minutes with Data Loggers
- Only me taking temperatures with IRT

VARIABLE

- Two surfaces: concrete and short-grass
- When I take temperature with the IRT (4-hour window)

MATERIALS

- Fluke 63 IRT
- EL-USB-1 Temperature Data Logger
- Journal
- Pen
- Pencil
- GLOBE Program Flags
- Computer

METHODS

PREPARATION

1. Install the battery to Easy Log Data Loggers USB.
2. Install software and USB driver to computer.
3. Data Logger is NOW ready for use.

PLACING DATA LOGGERS

4. Place the two USBs, one the concrete and one on the short-grass.
5. If there is snow, put a GLOBE Program flag into the ground/snow so you know where the USBs are.

INFRARED THERMOMETER USAGE

1. Calibrate the IRT according to the GLOBE Program protocol.
2. At each site take nine readings.
3. Hold IRT perpendicular to the ground at arms-length to take each reading.
4. Wrap the IRT in an oven mitten to prevent thermal shock.

RESULTS

All temperatures are in degrees Celsius
Times are Eastern Standard Time

DAY 1 (February 8, 2021) 1540:

CONCRETE: -1.3, -1.7, -1.8, -2.6, -0.8, -1.4, -0.8, -0.7, -0.7
AVERAGE: -1.3

SHORT-GRASS: -0.9, -1.0, -2.2, -2.3, -2.0, -2.5, -2.3, -2.4, -2.5
AVERAGE: -2.0

DIFFERENCE: 0.7; CONCRETE IS WARMER

Snow was starting to melt next to the house.

DAY 2 (February 9, 2021) 1430

CONCRETE: -3.2, -2.8, -2.6, -2.4, -2.2, -1.8, -1.4, -1.6, -1.2
AVERAGE: -2.1

SHORT-GRASS: -0.6, -0.8, -0.6, -0.9, -0.2, -0.6, -0.8, -0.2, -0.6
AVERAGE: -0.5

DIFFERENCE: 1.6; SHORT-GRASS IS WARMER

Snowed overnight

DAY 3 (February 10, 2021) 1430

CONCRETE: -1.8, -0.6, -1.2, -1.6, -1.6, -1.6, -1.4, -0.8, -1.6
AVERAGE: -1.4

SHORT-GRASS: 3.6, -3.6, -3.4, -3.2, -3.4, -3.4, -3.2, -2.8, -2.6
AVERAGE: -3.2
DIFFERENCE: 1.8; CONCRETE IS WARMER

DAY 4 (February 11, 2021) 1230

CONCRETE: -5.0, -4.0, -4.2, -4.6, -4.2, -4.2, -3.8, -2.8, -3.0
AVERAGE: -4.0

SHORT-GRASS: -3.2, -3.0, -3.0, -3.2, -3.4, -2.8, -2.8, -2.6, -3.0
AVERAGE: -2.7

DIFFERENCE: 1.3; SHORT-GRASS IS WARMER

DAY 5 (February 12, 2021) 1530

CONCRETE: -5.4, -5.6, -5.6, -4.8, -4.2, -3.6, -4.2, -3.2, -4.6
AVERAGE: -4.6

SHORT-GRASS: -5.6, -5.4, -5.0, -5.2, -3.6, -4.4, -4.8, -3.8, -4.2
AVERAGE: -4.7

DIFFERENCE: 0.1; CONCRETE IS WARMER

DAY 6 (February 13, 2021) 1430

CONCRETE: -0.8, -1.6, -0.4, -1.4, -0.6, 0.0, -1.4, -1.2, -1.4
AVERAGE: -1.0

SHORT-GRASS: -0.2, -0.4, -0.8, -1.4, -0.4, -0.6, -0.8, -0.4, -0.2
AVERAGE: -0.6

DIFFERENCE: 0.4; SHORT-GRASS IS WARMER

DAY 7 (February 14, 2021) 1430

CONCRETE: -5.2, -4.8, -3.2, -4.4, -4.6, -4.6, -4.4, -4.2, -3.2
AVERAGE: -4.3

SHORT-GRASS: -3.4, -3.4, -3.8, -3.9, 3.2, -3.4, -3.2, -3.2, -3.8
AVERAGE: -3.4

DIFFERENCE: 0.9; SHORT-GRASS IS WARMER

DAY 8 (February 15, 2021) 1330

CONCRETE: -4.2, -4.8, -4.2, -4.4, -4.6, -4.6, -3.2, -3.8, -3.4
AVERAGE: -4.1

SHORT-GRASS: -4.2, -4.8, -5.2, -4.2, -4.7, -3.2, -4.8, -5.2, -4.8
AVERAGE: -4.6

DIFFERENCE: 0.5; CONCRETE IS WARMER

DAY 9 (February 16, 2021) 1440

CONCRETE: -5.0, -5.5, -6.0, -5.6, -4.4, -3.8, -3.6, -3.4, -3.8
AVERAGE: -4.6

SHORT-GRASS: -3.6, -3.6, -3.6, -3.2, -3.6, -3.4, -2.8, -2.8, -2.9
AVERAGE: -3.2

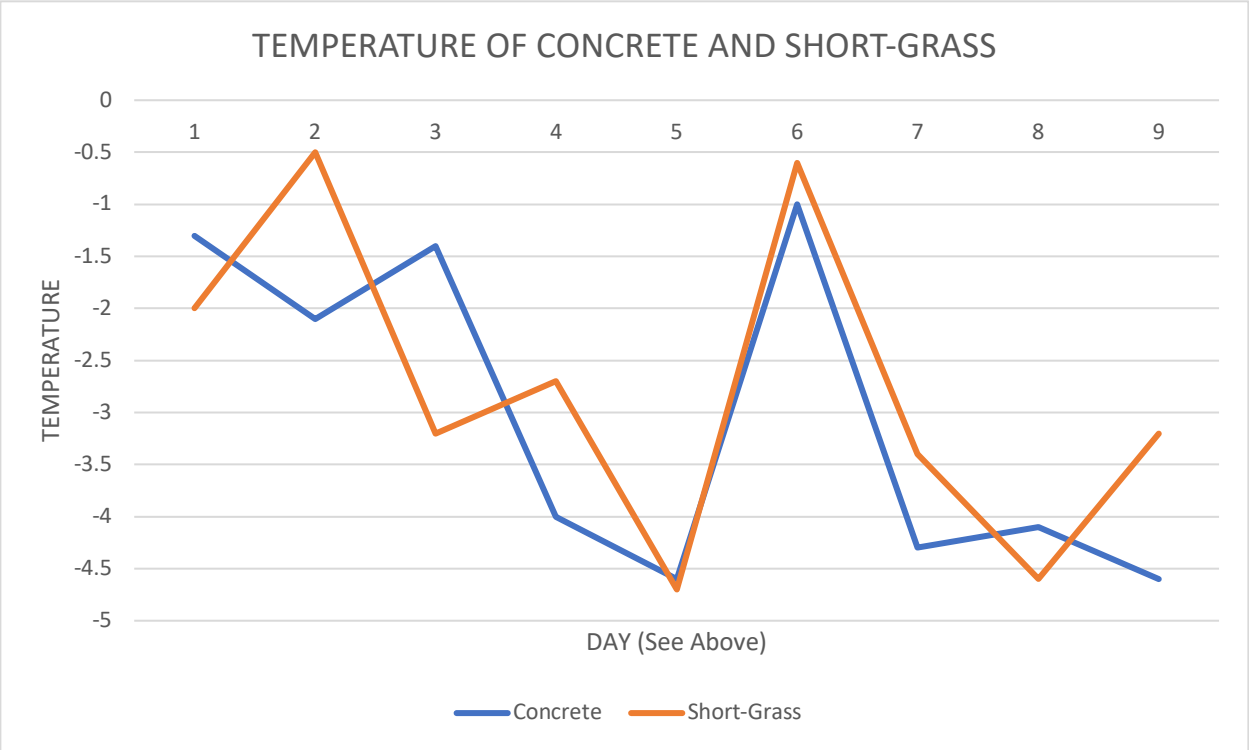
DIFFERENCE: 1.4; SHORT-GRASS IS WARMER

TOTALS (AVERAGE OVER THE NINE DAYS)

CONCRETE: -3.04

SHORT-GRASS: -2.77

DIFFERENCE: 0.27; SHORT-GRASS IS WARMER


TEMPERATURE OF CONCRETE AND SHORT-GRASS
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
-4
-4.5
-5
TEMPERATURE
1
2
3
4
5
6
7
8
9
DAY (See Above)
Concrete
Short-Grass

CONCLUSION

The data I collected does not support my hypothesis. Short-grass was not significantly warmer than concrete. Of the nine days data was collected, short-grass was warmer 5 of the nine days. However, over the course of nine days the average short-grass being warmer than concrete was only 0.27 Cº.

During my initial observations we would get a little snow, then it would melt. When I started my data collection, it snowed then did not melt. The concrete and short-grass areas remained 100% covered by snow the entire nine days of this study. It really did not surprise me that both the concrete and short-grass temperatures remained so close to each other as really the albedo ("snow white") was exactly the same for both areas.

Sometimes your parents are right. I know for some of you this may seem hard to believe! However, in this case they were right. I really wanted to use Data Loggers to collect my data. I could be sleeping, watching movies, or reading books and the Data Loggers would keep on collecting data for me. My dad suggested I go outside every day and physically take temperatures nine times for each area. Even though I really did not want to do this, it was the right thing to do. At the end of nine days the Data Loggers were put back into the computer to download their data and, lo and behold, no data had been taken. No matter what we did, there had been no data taken for nine days. This is why there is only one data for each day. Like I said, sometimes your parents are right!

NEXT STEPS

Obviously, I need to figure out how to get the Data Loggers to work properly. This also taught me to make sure I have a back-up plan.

I think this should have been done during the summer months when we will not have snow. I did learn it really does not matter what is under the surface, concrete, short-grass, or other surface. If it is totally covered by snow, snow now becomes the surface. This is evident, after nine days, the total difference in temperature between the two sites is only 0.27 ºC. Really, though, when you think about it, it really should be zero degrees difference since they were exactly the same surface (white snow).

I think it might also be interesting to have different colors of concrete to compare temperatures with. During winter it might help by dark colored concrete to help to melt snow.

There are many interesting studies which can be done using albedo if I took temperatures at different surfaces, like asphalt, water, or concrete sidewalk. Or, as I have been reading about, even different places like urban or rural.

ACKNOWLEDGEMENTS

I would like to thank my parents for helping me with this research project, especially insisting on me taking temperatures with an IRT and not totally relying on Data Loggers. I would like to thank my grandmother, Mimi, for proofreading my report. I would also like to thank everyone at the Ohio Academy of Science for allowing us to continue in spite of all the restrictions surrounding us this year.

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