

Objective: Students will evaluate the air temperature data from the schoolyard, compare the data to a reference site, and determine if it meets the EPA definition of an UHI.

Curriculum Standards:

- NGSS ESS3.C Human Impacts on Earths Systems
- MD E-Lit Standard 1 Topic A: Environmental Issue Investigation
 - Indicator 5: Use data and references to interpret findings to form conclusions

Materials Needed:

- Hourly temperature data from schoolyard and reference site.
- HOOD-CCWS logger data website
- Color pencils, if producing the graph manually

Information primarily taken from the USEPA Reducing Urban Heat Islands: compendium of Strategies. USPEA Urban Heat Island Compendium – Chapter 1 Urban Heat Island Basics. October 2008.

<https://www.epa.gov/heat-islands/heat-island-compendium>

The increase in temperature in developed and urban areas as compared to rural areas is known as the Urban Heat Island. The annual mean air temperature of a city with one million or more people can be 1.8 to 5.4°F (1 to 3°C) warmer than its surroundings, and on a clear, calm night, this temperature difference can be as much as 22°F (12°C). Even smaller cities and towns will produce heat islands, though the effect often decreases as city size decreases.¹

UHIs can be measured with **surface temperatures** or **atmospheric temperatures**. This lesson focuses on atmospheric temperatures.

Table 1: Basic Characteristics of Surface and Atmospheric Urban Heat Islands.¹

Feature	Surface UHI	Atmospheric UHI
Temporal Development	<ul style="list-style-type: none"> • Present at all times of the day and night • Most intense during the day and in the summer 	<ul style="list-style-type: none"> • May be small or non-existent during the day • Most intense at night or predawn and in the winter
Peak Intensity (Most intense UHI conditions)	<ul style="list-style-type: none"> • More spatial and temporal variation: <ul style="list-style-type: none"> ▪ Day: 18 to 27°F (10 to 15°C) ▪ Night: 9 to 18°F (5 to 10°C) 	<ul style="list-style-type: none"> • Less variation: <ul style="list-style-type: none"> ▪ Day: -1.8 to 5.4°F (-1 to 3°C) ▪ Night: 12.6 to 21.6°F (7 to 12°C)
Typical Identification Method	<ul style="list-style-type: none"> • Indirect measurement: <ul style="list-style-type: none"> ▪ Remote sensing 	<ul style="list-style-type: none"> • Direct measurement: <ul style="list-style-type: none"> ▪ Fixed weather stations ▪ Mobile traverses
Typical Depiction	<ul style="list-style-type: none"> • Thermal image 	<ul style="list-style-type: none"> • Isotherm map • Temperature graph

¹ USPEA Urban Heat Island Compendium – Chapter 1 Urban Heat Island Basics. October 2008. <https://www.epa.gov/heat-islands/heat-island-compendium>

<http://ccwsscience.org>

Heat Island intensity is most pronounced on clear calm nights when night time temperatures from urban areas as compared to rural can differ from 12.6 to 21.6F (7 to 12C).

DIRECTIONS: Using the Hood-CCWS Website (www.ccwsscience.org) or data summary sheet provided by your teacher, identify the following average temperatures for each logger during the logger deployment period:

Enter the dates that your class had the logger outside & collecting temperatures:

Logger Deployment Dates: _____

Daytime = sunrise to sunset hours
Nighttime = sunset to sunrise hours

- Using the dates above, set up the ccwsscience.org data graph for this date range.
- From the list on the left, select the appropriate air logger for your school and select the reference logger.
- Use the table below the graph toggle between daytime data, nighttime data, and all temperature data. Select the “Apply” button each time to refresh the calculations.
- Fill in the table below to compare air temperatures:

Enter the Average Temperatures in Celsius

Air Temperatures	Logger# _____ Schoolyard Air (°C)	Logger# _____ Reference (rural) Air (°C)	Difference
Average Temp over the entire deployment			
Average Daytime temp			
Average Nighttime Temp			

① *Scientists have observed Atmospheric UHI with **daytime temperature differences of 1 to 3°C** and **nighttime temperatures of 7-12°C** as compared to rural sites.*

Interpret your results:

Based on your research of atmospheric temperatures & the EPA definition of an Urban Heat Island, does your schoolyard act as an UHI? Explain your answer.

#2 Schoolyard Air Temperatures

Score your schoolyard's urban heat impact based on air temperature:

DAYTIME TEMP AVG

School

Reference

A. Enter the average DAYTIME air temperature difference between school and reference site:

°C

DAYTIME	
Temperature Difference °C	SCORE
0-1	3
1.1 - 2	2
2.1 - 3	1
>3.1	0

SCORE

NIGHTTIME TEMPS AVG

School

Reference

B. Enter the average NIGHTTIME air temperature difference between the school and reference site

°C

NIGHTTIME	
Temperature Difference °C	SCORE
0-2	4
2.1 - 5	3
5.1 - 9	2
9.1 - 12	1
>12.1	0

SCORE

Synthesize the information:

What are some root causes of elevated air temperatures	What are the environmental effects from this problem?	Who has the ability to influence change on this problem?
<p><i>Ex: policies, practices, phenomena</i></p>		