
My NASA Data - Lesson Plans

Unit: Urban Surface Temperatures and the Urban Heat Island Effects



National Aeronautics and Space Administration
Goddard Institute for Space Studies
New York, N.Y.

NASA Climate Change Research Initiative Applied Research STEM Curriculum Portfolio

CCRI Unit Plan

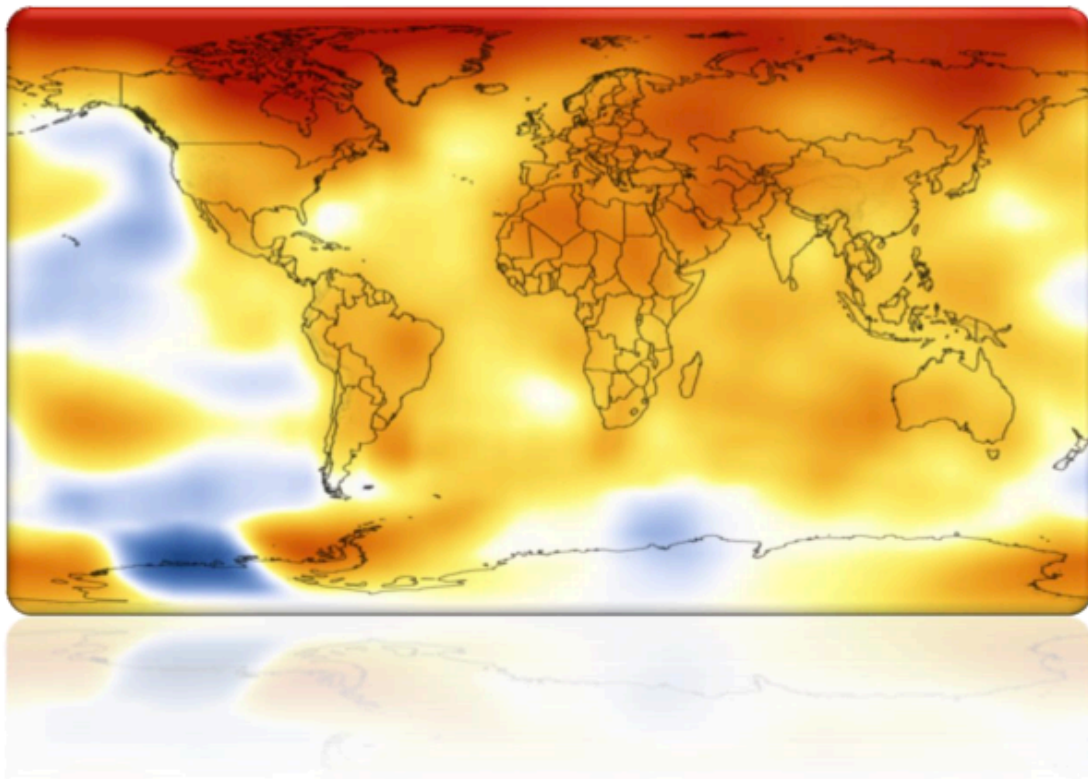
NASA Science Mission Directorate | Earth Sciences Division
NASA Goddard Institute for Space Studies
NASA Goddard Space Flight Center | Office of STEM Engagement

Unit Title: Urban Surface Temperatures and the Urban Heat Island Effects

Overarching Investigative Research Question: How does Urban Heat Island contributes to climate change?

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Cities that are growing at a fast pace are notable entities of innovation and city development. As population keeps growing in urban settings, the need to understand urban climates has awakened much interest and discussion among our society. Due to urbanization, land surface temperatures are intensifying with much warmer temperatures than surrounding areas, making cities experience the Urban Heat Island phenomenon.

This unit plan called “Urban Surface Temperatures and the Urban Heat Island Effects“ has the purpose to educate students how climate is changing in urban settings and produce mitigation solutions for city environmental concerns through the use of groundbreaking technology and authentic science learning experiences.

Students are exposed to real-world scientific experiences like the exploration of climate simulation models, global temperature profiles and climate change evidence analysis during the first lesson. Later, they learn about remote sensing and investigate instruments on climate satellites. Students are exposed to remote sensing imagery analysis and dive into the Urban Heat Island effects on the third lesson. Subsequently, they are immersed into land surface temperature data collection, analysis and review a scientific journal. The unit concludes by having students create a physical model that promotes the concept of the Urban Heat Island and mitigation factors to include human action towards climate in urban settings.

This unit plan has been created for high school students in an Earth Science class or related subject. It has been aligned with science standards from the Next Generation of Science Standards as well as the New York State Earth Science Standards and the Common Core State Standards. Furthermore, this curriculum has been aligned with NASA’s mission, vision and STEM resources to enhance scientific understanding of Earth as a system and its response towards natural and human-induced changes in order to improve our ability to predict climate, weather and natural hazards.

By the end of this unit plan comprised of four lessons and a capstone project, students will have a better understanding of the Urban Heat Island phenomenon and its recent and future effects on major cities around the world. In addition, students will have a better understanding of climate and remote sensing as the process to study climate-related issues, such as land surface temperatures.

Learning Objectives

Lesson 1: Making Earth Cool Again! What’s happening to Climate?”

- Define what is climate change individually and in groups.
- Discuss what is climate change in groups and as a class. To Identify climate change evidence and explain its significance.
- Observe the evidence for global climate change.
- Create a scientific explanation about climate change factors by using a claim, climate evidence and reasoning.
- Identify how climate has been altered before and after an event in different parts of the world by observing and analyzing different satellite images.
- Interpret and analyze satellite imaging related to climate change.
- Create a poster about a location on Earth that has been affected by climate change and provide feedback on classmates’ posters.

Lesson 2: Seeing From Another View Through Satellites

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- Simulate ground-based and satellite surface temperature recordings
 - Discuss the different methods to record physical characteristics of Earth's surface
 - Define remote sensing and its advantages
 - Read and reflect on TERRA and Landsat satellites and its instruments
 - Present about TERRA and Landsat satellites and their instruments
 - Investigate on climate satellites from Earth Now and analyze and explain their contribution to climate research
 - Investigate TERRA satellites from Earth Now and analyze their instruments and explain their contribution to climate research
 - Evaluate their knowledge by matching satellites and their instruments with their descriptions

Lesson 3: When Heat Is Trapped and Urban Heat Island Takes Over

- Observe remote sensing imagery from different cities.
- Discuss and make connections about temperature and vegetation in different locations.
- Read about the Urban Heat Island phenomenon.
- Create a poster and explain what is the Urban Heat Island and its effects.
- Investigate, access and download remote sensing imagery from EarthExplorer for New York City and a city of their choice.
- Analyze remote sensing imagery from EarthExplorer and reflect on the process and imagery characteristics.
- Calculate the land surface temperatures from the Earth Engine Apps specifications.

Lesson 4: Changing Land Surface Temperatures

- Predict what is the land surface temperature outside of school
- Discuss what factors influence land surface temperature changes
- Explore the land surface temperatures outside of school
- Use an infrared thermometer to record land surface temperatures
- Collect temperature data and upload it to the GLOBE platform
- Compare their land surface temperature results with other young scientists.
- Reflect on their results and the differences between their recordings.
- Analyze for any correlations between the land surface temperatures and the locations where they test temperatures.
- Describe the process of recording temperatures locally outside of school (give steps) and explain how this relates to how scientists do this in the field.
- Review a scientific journal paper that focuses on the land surface temperatures and Urban Heat Island effects.

Capstone Project/Lesson 5: Urban Heat Island City Physical Model

- Read about the type of roofs used for mitigation aspects in urban settings.
- Determine the ways in which green roofs benefit cities more than white roofs.
- Create a physical model of a city that is based on knowledge and understanding of the Urban Heat Island effects and remote sensing.
- Write a paper of the physical city model to explain city development and mitigation factors.
- Use research tools like EarthExplorer and Google Earth Engine App to gather data about the chosen city.
- Create a science poster about their group's capstone project.
- Present their science poster in a classroom symposium and participate in the science

classroom community poster session.

Essential Questions

- How does Urban Heat Island contribute to climate change?
- How can we use a climate simulation graph, images of change and evidence to analyze, explain and present how climate has changed over time?
- How do we learn more about climate satellites and their instruments and how do we use remote sensing to study Earth's climate like elements?
- What is the Urban Heat Island and how is it caused?
- How can we use an instrument to explore the land surface temperatures outside of school and analyze them and relate to Urban Heat Island?
- How can we use a climate simulation graph, images of change and other evidence to analyze, explain and present how climate has changed over time?

Materials Required

See *Teacher Guide* (or this [link](#)) for access to the details of the full unit, related worksheets, rubrics, and hyperlinks.

Lesson 1: Making Earth Cool Again! What's happening to Climate?"

- Markers
- Blank poster paper
- Provided worksheets
 - Temperature Recording from National Park Activity Worksheet
 - Twenty Years of Terra in Our Lives Worksheet
 - Earth-Now General Satellites and their Instruments Worksheet
 - TERRA Satellites Matching Satellites Activity Worksheet
- Worksheet Rubrics:
 - Temperature Recording from National Park Activity Worksheet Rubric
 - Twenty Years of Terra in Our Lives Worksheet Rubric
 - Earth-Now General Satellites and their Instruments Worksheet Rubric
 - TERRA Satellites Matching Satellites Activity Worksheet Rubric

Lesson 2: Seeing From Another View Through Satellites

- Provided worksheets
 - Urban Heat Island and Its Effects Worksheet
 - Urban Heat Island Poster Guidelines for Students
 - EarthExplorer Remote Sensing Imagery Analysis Worksheet
- Worksheet Rubrics:
 - Urban Heat Island and Its Effects Worksheet Rubric
 - Urban Heat Island Poster Guidelines for Students Rubric
 - EarthExplorer Remote Sensing Imagery Analysis Worksheet Rubric

Lesson 3: When Heat Is Trapped and Urban Heat Island Takes Over

- Markers
- Blank poster paper

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- Provided worksheets
 - Urban Heat Island and Its Effects Worksheet
 - Urban Heat Island Poster Guidelines for Students
 - EarthExplorer Remote Sensing Imagery Analysis Worksheet
 - Worksheet Rubrics
 - Urban Heat Island and Its Effects Worksheet Rubric
 - Urban Heat Island Poster Guidelines for Students Rubric
 - EarthExplorer Remote Sensing Imagery Analysis Worksheet Rubric

Lesson 4: Changing Land Surface Temperatures

- Provided worksheets
 - Surface Temperature Recording
 - GLOBE Data Submission
 - Science Journal Article
- Worksheet Rubrics
 - Outside of School LST Local Recording Analysis Worksheet Rubric
 - Journal Paper Reading, Analysis and Interpretations Worksheet Rubric
- Infrared thermometers

Capstone Project: Urban Heat Island City Physical Model

- Markers
- Blank poster paper
- Provided worksheets
 - Know and Wonder About Climate Change Worksheet
 - Time Machine Climate Simulation Worksheet
 - Scientific Explanation on Climate Change Worksheet
 - Images of Change Worksheet
- Worksheet Rubrics
 - Know and Wonder About Climate Change Worksheet Rubric
 - Time Machine Climate Simulation Worksheet Rubric
 - Scientific Explanation on Climate Change Worksheet Rubric
 - Images of Change Worksheet Rubric • Images of Change Poster Rubric For Students

Technology Requirements

- Internet Required
- One-to-One (tablet, laptop, or CPU)
- One-to-a-Group
- Teacher computer/projector only
- Visualization Tool Required

Teacher Background Information

Cities that are growing at a fast pace are notable entities of innovation and city development. As population keeps growing in urban settings, the need to understand urban climates has awakened much interest and discussion among our society. Due to urbanization, land surface temperatures are intensifying with much warmer temperatures than surrounding areas, making cities experience the Urban Heat Island phenomenon.

See this [link](#) for more information.

Prerequisites Student Knowledge

This unit's pre and post-standards are based on the Next Generation Science Standards (NGSS) for high school students. This assessment is targeted for an Earth Science class at the high school level. The purpose of this pre-assessment is to measure the student's prior knowledge on the topics and subject. This assessment includes content knowledge questions, but also includes questions from lab-skills and lab activities.

The questions in this assessment are open-ended so they can allow the teacher to have a better understanding of the student's knowledge and a better overview of where students stand in regards to the topics in this unit. This will also allow the teacher to know if there are any topics that need to be revisited and see how much students have processed the content covered in this unit. Teachers are encouraged to provide this assessment as pre-assessment and a post-assessment components of this unit plan.

1. What is remote sensing?
2. What is land surface temperature and what does it involve?
3. What is Landsat?
4. What is image analysis?
5. What is a satellite?
6. How have humans impacted temperatures on Earth?
7. What is the Urban Heat Island?
8. What are some of the effects of Urban Heat Island?
9. Why would an increase of population affect climate change?
10. Why is it important to know about surface temperatures and how they change?
11. What are some characteristics we might want to test for when analyzing the temperature of a city?
12. How do we access satellite data? How do we organize our data for analysis?

Procedure

See *Teacher Guide* (or this [link](#)) for access to the details of the full unit and related worksheets.

Lesson Overview:

- 1. Making Earth Cool Again! What's happening to Climate?"**
 - This lesson serves as an introduction to this unit plan which incorporates the 5E model template. It focuses on climate as well as the factors that influence it and are contributing to a changing climate on Earth.
- 2. Seeing From Another View Through Satellites**
 - This lesson focuses on remote sensing as well as satellites and their instruments to better understand how scientific research uses these resources to study Earth's climate.
- 3. When Heat Is Trapped and Urban Heat Island Takes Over**
 - This lesson focuses on the Urban Heat Island phenomenon and its effects on urban settings.
 - Students explore the Urban Heat Island phenomenon and its effect on cities and climate as a whole

4. Changing Land Surface Temperatures

- This lesson focuses on Urban Heat Island and its effects on cities such as changes in land surface temperatures. Students identify how land surface temperatures are different in several locations outside of school and analyze their meaning.

5. Capstone Project: Urban Heat Island City Physical Model

- This capstone project serves as the culminating task of this climate unit and it focuses on having students create a physical model of a city where they incorporate their knowledge of the Urban Heat Island, land surface temperature data and mitigation strategies.
- Students identify how climate has been altered before and after an event in different parts of the world by observing and analyzing different satellite images.