403 Heat Islands

Standards:

- 3.2.6-8.N Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample
- 3.2.6-8.R Develop and use a model to describe how waves are reflected, absorbed, or transmitted through various materials
- 3.3.6-8.M Apply scientific principles to design a method for monitoring and minimizing human impact on the environment.
- 3.3.6-8.O Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century
- 3.4.6-8.E Collect, analyze, and interpret environmental data to describe a local environment
- 3.2.9-12.W Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter
- 3.4.9-12.E Plan and conduct an investigation utilizing environmental data about a local environmental issue
- SEP Asking Questions & Defining Problems and Analyzing & Interpreting Data
- CCC: Cause & Effect, Energy & Matter, Stability & Change

Safety Considerations

1. Follow specific information about Infrared Thermometers
2. Follow your school or district outdoor safety plan

Materials *Teacher Provided

- Infrared Thermometers
- Calculator*
- Data sheet*
- Schoolyard map or satellite image*

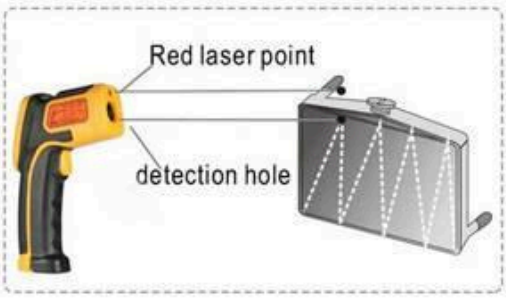
Lab Summary

Students investigate use infrared thermometers to investigate thermal energy and heat islands in their schoolyard. The kit includes a class set of infrared thermometers. Suggested timing 1+ class periods (45 minutes).

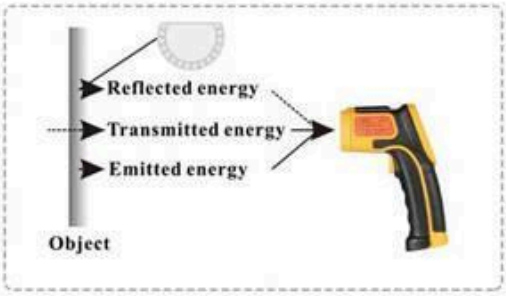
About Infrared Thermometers:

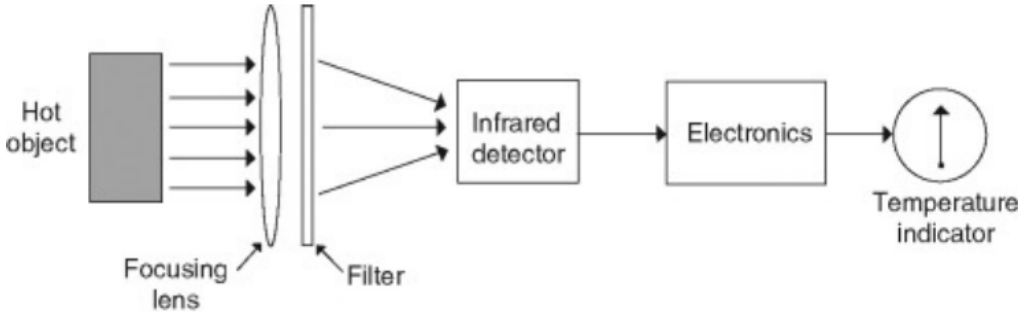
- Do not expose to moisture
- Do not drop
- The thermometer should acclimate to the measuring environment for 15-30 minutes. For this lab, place the thermometers outside about 30 minutes before use.
- Scan the surface of your object, hold down the trigger of the IR thermometer gun, and release to get live temperature readings between -58ºF and 1112ºF (-50ºC and 600ºC).
- These are not medical-grade thermometers, DO NOT USE TO TAKE HUMAN TEMPERATURES.

- Keep the lens free of debris and clean when needed – to clean use a damp soft cloth or cotton swab. DO NOT USE SOAP OR CHEMICALS AND DO NOT OVERCLEAN.
- IR thermometers have a distance-to-target ratio, it will take an average reading from a certain size area of the object you are pointing at. See the side of the device for the distance-to-target ratio.
- IR thermometers measure surface temperature and the accuracy is affected by many factors including the emissivity of the surface, type of material, transparency, color, and reflection.
- Emissivity is a measure of an object's ability to emit infrared radiation. Emissivity ranges from 0 (shiny mirror) to 1.0 (blackbody). The default emissivity setting for the IR thermometers is 0.95, you may need to adjust the emissivity when measuring shiny objects. Refer to the included emissivity table to determine the correct value for your object. To adjust the emissivity, press the "EMS" button and then use the left or right buttons to increase or decrease the value.

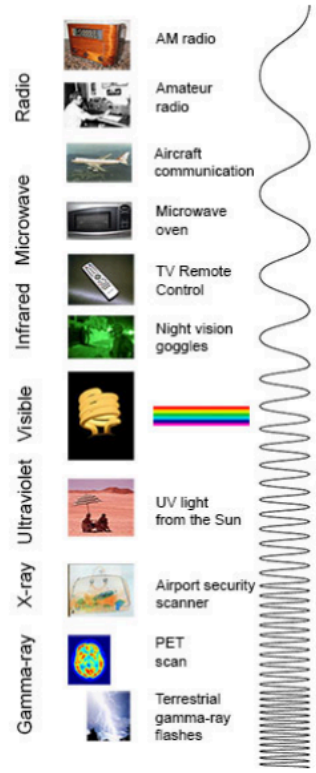








The Electromagnetic Spectrum:



The electromagnetic spectrum from lowest energy/longest wavelength (at the top) to highest energy/shortest wavelength (at the bottom). (Credit: NASA's Imagine the Universe)

Radio: Your radio captures radio waves emitted by radio stations, bringing your favorite tunes. Radio waves are also emitted by stars and gases in space.

Microwave: Microwave radiation will cook your popcorn in just a few minutes, but is also used by astronomers to learn about the structure of nearby galaxies.

Infrared: Night vision goggles pick up the infrared light emitted by our skin and objects with heat. In space, infrared light helps us map the dust between stars.

Visible: Our eyes detect visible light. Fireflies, light bulbs, and stars all emit visible light.

Ultraviolet: Ultraviolet radiation is emitted by the Sun and are the reason skin tans and burns. "Hot" objects in space emit UV radiation as well.

X-ray: A dentist uses X-rays to image your teeth, and airport security uses them to see through your bag. Hot gases in the Universe also emit X-rays.

Gamma ray: Doctors use gamma-ray imaging to see inside your body. The biggest gamma-ray generator of all is the Universe.

Investigating the Issue and Field Investigations:

1. View global land surface temperatures (current conditions map or timelapse video). NASA Earth Observations uses infrared data collected with instruments on the Terra and Aqua satellites.
2. Introducing the infrared thermometer.
3. Investigate Heat Islands in your schoolyard:
    a. Share a satellite image of your schoolyard with your students.
    b. Instruct students to predict the warmest and coolest places in the schoolyard. Students can mark up a digital image using a photo editing program, write on a printed satellite image, or use erasable markers on a laminated satellite image.
    c. Facilitate a student discussion to design an investigation to measure temperature around the schoolyard. Consider the following:
        i. Boundaries – where can the students work safely?
        ii. Locations – where will the students measure? Choosing the sample locations before going outside to collect data is recommended.
        iii. Sampling Technique – how close should the IR thermometer be to the measured object? How many measurements should be taken at each location?
    d. Data Table – What information should be recorded at each sample location? A data table might include

Sample Location with description (cloud cover; air temperature)	Temp 1	Temp 2	Temp 3	Average

Synthesis and Conclusions:

4. Data Analysis – How should the data be displayed? How should the data be compared? Students can calculate the average temperature at each sample location. Students may wish to combine data from similar locations to make fewer categories for analysis (grass field, turf field, black pavement, mulch, etc). Students can display the averages in graphs or report the values on the satellite map.
5. Explain – What does the data reveal about the schoolyard? Do microclimates exist in your schoolyard? Is there a relationship between the surface temperature and living things?

Stewardship and Civic Action:

6. Sustainability Engineering Extension – design cooler schoolyard spaces to address PA standard 3.2.6-8.M Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.
7. Participate in Citizen Science – follow the GLOBE Urban Heat Islands citizen science protocol – collect temperature in 9 similar locations within a grid-like pattern, collect air temperature and cloud data at the same time.

8. Educate your community - Calculate and share the benefits of trees in your community (refer to Appendix A: iTree Canopy).

Resources:

Teacher Slides to use with Lesson

Feel free to utilize the following resources to learn more about Heat Islands. It will be important to add/offer this background information to help teachers and students gain context.

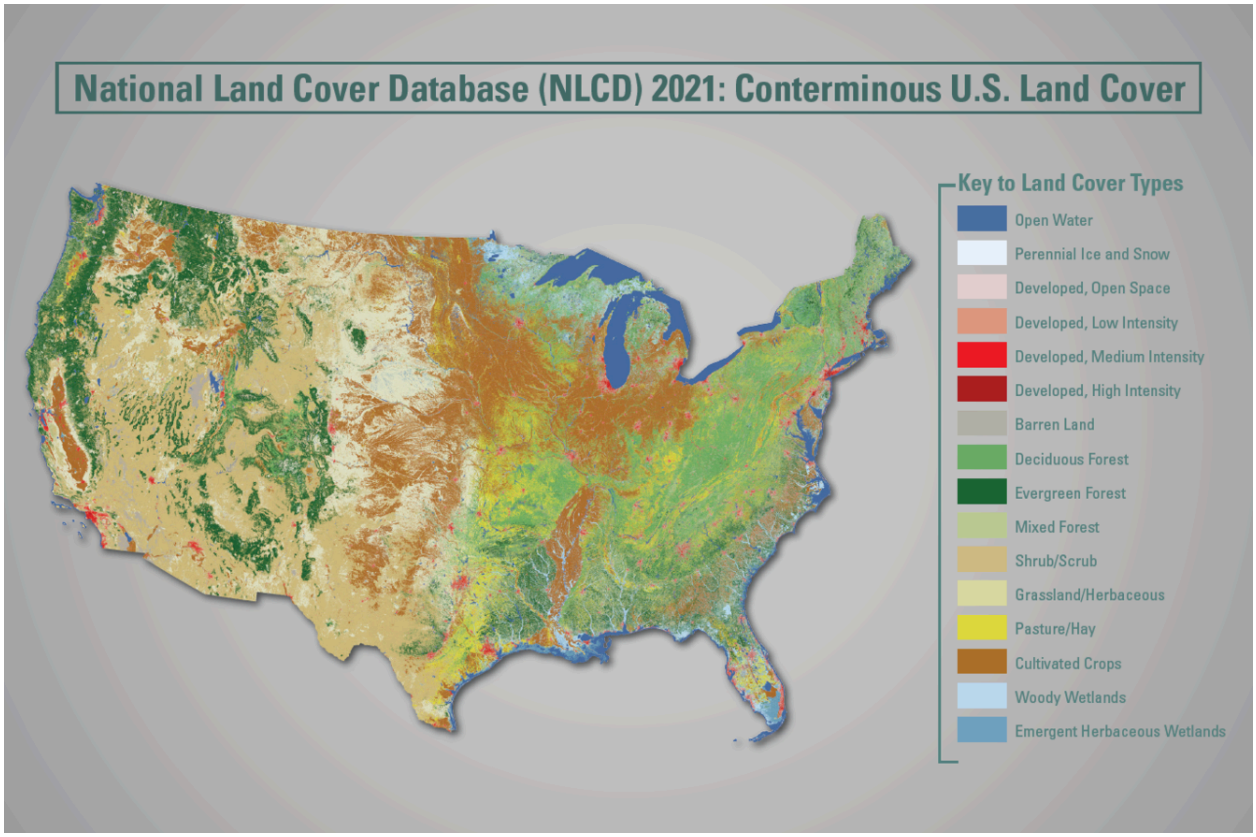
- Urban Heat Islands info from NASA for kids
- NASA Urban Heat Island Story Map
- EPA Heat Islands background
- https://www.treebaltimore.org/
- https://www.sciencejournalforkids.org/articles/do-hot-neighborhoods-affect-everyone-equally/

Career Connections

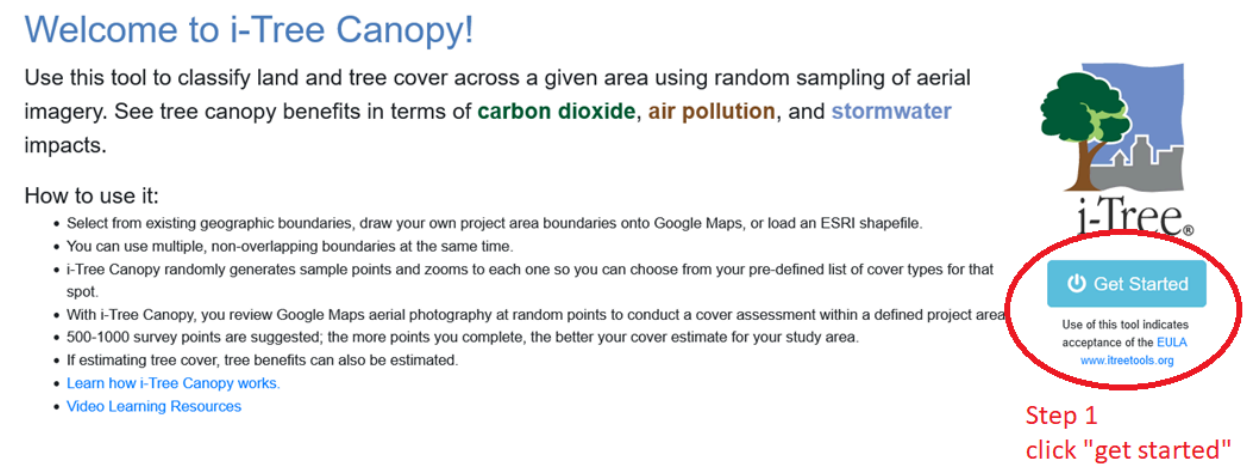
Students may also benefit from learning about career options connected to this MWEE or activity

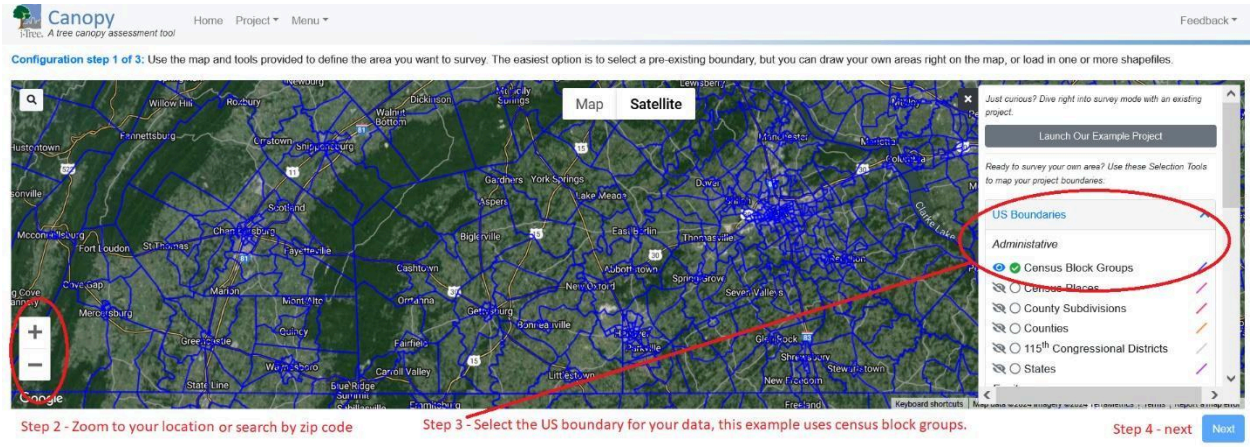
https://mynasadata.larc.nasa.gov/all-atmosphere-stem-career-connections

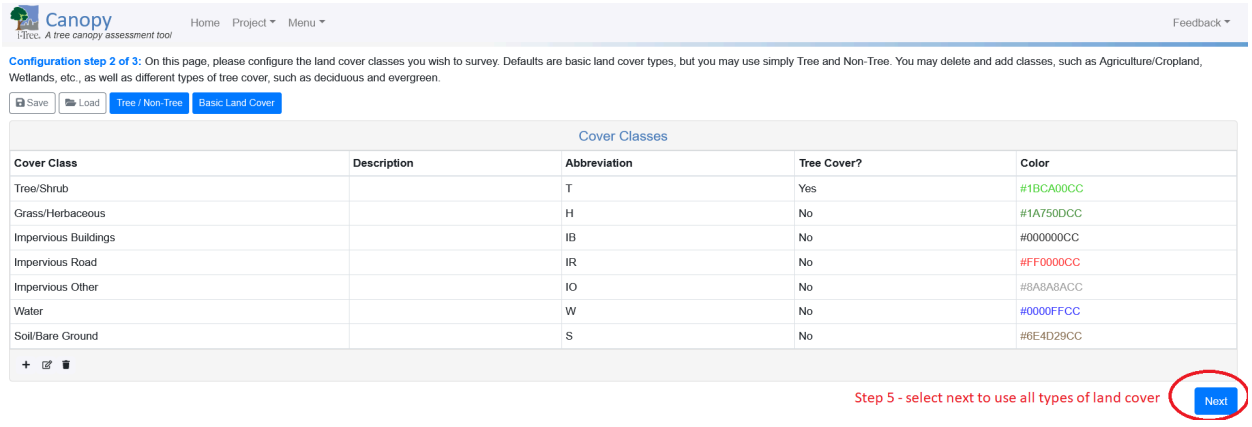
Albedo (%)	Surface
5% - 10%	Black Pavement
15% - 35%	Concrete
10% - 30%	Grass
80% - 95%	Snow
5%	Black Paint
80%	White Paint

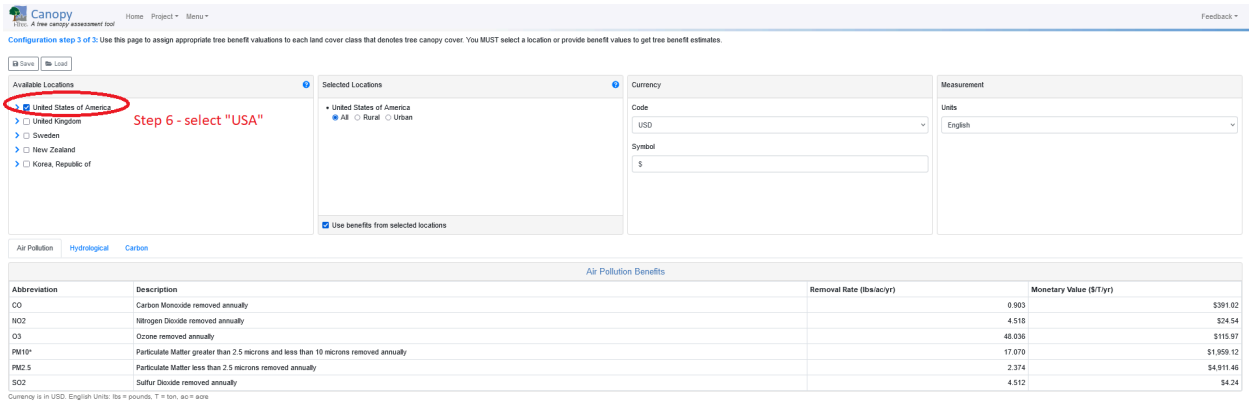


Appendix A: iTree Canopy

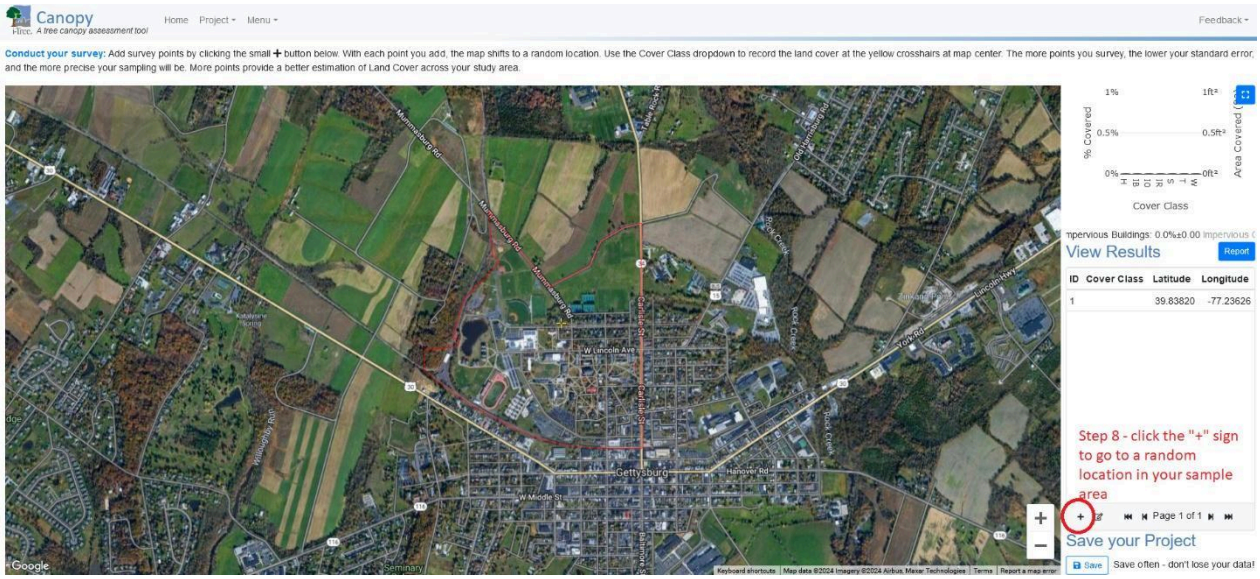








Step 7 - Next





Repeat steps 8-10 at least 10 times, more repetitions provide more accurate results. Then click the "report" option to view the land cover statistics for your study area.