# Lesson 2: What is special about cities compared to rural places and other regions overall?

## *HS Climate Unit*

**Previous Lesson….Where we've been:** We generated initial questions that we have about temperatures in Colorado and why they might be increasing, especially in cities.


**This Lesson….What we are doing now:** This lesson explores climate data at the local, national and worldwide level to determine that temperatures are changing all over the world, and that there are certain locations (like cities and other places in the world) where temperatures are warming faster than the global average.

| Lesson Question | Phenomena | Lesson Performance Expectation(s) | What We Figure Out (CCCs & DCIs), *New Questions* and **Next Steps** |
|---|---|---|---|
| **L2: What is special about cities compared to rural places and other regions overall?**<br><br>1 period<br><br>  <br><br><br>*Building toward* ↓ *NGSS PEs: HS-ESS3-5* | Climate Central Report PDF<br><br>Climate Central Report<br><br>Global Temperature change 1880-2016<br><br>Global temperature changes map | **Interpreting data** by comparing and contrasting data tables and representations to look at patterns to compare rate of temperature change between cities, states, and regions of the world. | Last class, we decided that we would we look at what's going on in the cities based on the Climate Central report.<br>We explore the website of the report and see that there is data for Denver, too. We decide to look at the Denver data from the report along with the three other cities and look for patterns and characteristics of the data.<br>We noticed that:<br>- The change is not the same everywhere since 1970.<br>- Some places are cooler or not experiencing much change.<br>- There is danger and extreme heat.<br>- It looks regional; those places are always hot.<br>- The data goes back to 1970.<br>- Heat is the number one weather related killer.<br>- The temperature is changing about 10 degrees Fahrenheit between then and now.<br>- Temperatures are changing even in places that we don't see as normally hot.<br>We have some initial ideas about what makes these cities different, but we have some more specific questions:<br><br>*Why is heat dangerous? I have air conditioning, why is this a threat? Why does heat kill more people?*<br>*Who are vulnerable populations? Why does this matter for health?*<br>*How do they make those predictions?*<br>*What does humidity feel like? What does a change feel like?*<br>*How many people live in these places that are getting hotter, fastest?*<br>*What's the scale? Are rural places included?*<br>*Are they just averaging the cities?*<br>*What do people have to do with this? Are people moving?*<br>*Is it happening just in the city, is it happening in the state, or is it everywhere?*<br><br>We decide we need to look at data more broadly. What's happening in the world?<br><br>We look at NASA and Live Science data and we figure out that in 2016 the biggest temperature changes are happening in the Arctic. But we don't think there's a lot of urban development happening there like there is in Denver. Why is the globe warming like that? We look at the Live Science data and see that this hasn't just been happening in 2016, but the temperature trend of the globe overall has been increasing.<br>We wonder why cities and other regions of the world getting hotter? There are places in the world that are getting hotter even though there aren't buildings or a lot of people there, why is that happening and we decide to look into that next class. |

**Next Lesson….Where we're going:** Next we will explore how albedo is a contributing factor to why the temperature in some places like cities are increasing at a faster rate; albedo is not the only factor.

# Getting Ready: Materials Preparation

## *Materials For Each Group*

- Link to Climate Central Report or copy of PDF of the report

## *Preparation of Materials (15 min.)*

- Create a set of the report for each group of 2-3 students in advance if you are printing the PDF of Denver focused Climate Report.
- Visible Driving Questions Board
- Review Student Activity Sheet Answer Key

## *Materials For Each Student*

- Student Activity Sheet

## *Safety*

# Getting Ready: Teacher Preparation

## *Background Knowledge*

**ESS3 from the FRAMEWORK: "Thus science and engineering will be essential both to understanding the possible impacts of global climate change and to informing decisions about how to slow its rate and consequences…"**

Rate of and region of change matters for understanding climate change. Cities are changing faster because of their characteristics - localized amplification because of things black tops, resulting in heat islands in cities. However, this isn't the entire explanation for climate change. Overall, regionally and globally human activities are increasing $CO_2$ and Greenhouse Gases, which result in global warming.

**ESS3.C from the FRAMEWORK:**
By the end of grade 8: Human activities have significantly altered the biosphere sometimes damaging or destroying natural habitats and causing the extinction of many other species. However, changes to earth's environment can have different impacts (negative and positive) for different living things. Typically, as human populations and per capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.

**ESS3.D from the FRAMEWORK:**
By the end of grade 8: Activities such as the release of Greenhouse Gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior, applying that knowledge wisely, decisions, and activities.

## *Alternative Student Conceptions*

Students may come into this lesson not being sure about where the cities are located, where Denver is in Colorado, or the regions in the country and their general climate trends e.g., Florida being hot, humid, and a vacation destination.

## *Linking Our Understanding to Scientific Terminology*

- Trend
- Temperature
- Humidity
- Climate
- Weather
- Danger Days
- Rate of Increase

# Learning Plan: What is special about cities compared to rural places and other regions overall? ( 55 min )

**Teacher Supports & Notes**

**1. (5 min) Begin with a Do Now discussion to get the class reoriented to the storyline, what the class decided to investigate first.**

**Suggested Prompts:**

- What do you know about Colorado that might help us figure out why temperatures are increasing?

**Ask students to share their ideas and create a class list of things we know about Colorado and questions we might have about the state.**

**Listen for and capture student responses, such as:**

- *Colorado has mountains.*
- *Colorado has many days of sun, more than most other places.*
- *Most people in Colorado live in the Denver metro area/the Front Range.*
- *Denver wasn't on the list of cities they talked about. I'm still wondering what's different because Denver is the biggest city.*
- *Where are those cities?*
- *More people are moving to CO, the population is increasing.*
- *My city is changing, neighborhoods are getting developed, there are more buildings. Things seem to be changing quickly in my community.*
- *What the report say about Denver*
- *Colorado has weird weather. It seems like we've been having more drastic weather events like when it flooded a few years ago.*

**2. (15 min) Remind students we decided at the end of last class to look at the report mentioned in the video. In groups of 2-3, ask students to go to the report online or give students a copy of the PDF (Denver focused).**

**Suggested Prompts:**

- What's going on in Denver, specifically?
- What patterns do you notice in cities getting hotter the fastest?
- When did they start collecting this data?
- How much is the temperature changing?
- What patterns do you see? What looks weird, what doesn't make sense in the report?

**Lead an Initial Ideas discussion about patterns and things students noticed in the report.**

**Suggested Prompts:**

- What did you notice?
- What did you figure out related to the question prompts?
  - What's going on in Denver, specifically?
  - What patterns do you notice in cities getting hotter the fastest?
  - When did they start collecting this data?
  - How much is the temperature changing?
  - What patterns do you see? What looks weird? What doesn't make sense in the report?
- What extreme things did you notice?
- What did you notice about Colorado in relation to the rest of the data?

**Listen for student responses and capture the ideas for everyone to see:**

- *The change is not the same everywhere since 1970.*
- *Some places are cooler or not experiencing much change.*
- *There is danger and extreme heat.*
- *It looks regional; those places are always hot.*
- *The data goes back to 1970.*
- *Heat is the number one weather related killer.*
- *The temperature is changing about 15 degrees.*
- *Temperatures are changing even in places that we don't see as normally hot.*

**Ask students what questions the report brings up so far that we need to add to the Driving Questions Board.**

**Suggested Prompts:**

- What questions should we add to our Driving Questions Board?
- Which questions should we prioritize now?

**Listen for student responses such as:**

- *Why is heat dangerous? I have air conditioning, why is this a threat? Why does heat kill more people?*
- *Who are vulnerable populations? Why does this matter for health?*
- *How do they make those predictions?*
- *What does humidity feel like? What does a change feel like?*
- *How many people live in the places that are getting hotter, the fastest?*
- *What's the scale? Are rural places included?*
- *Are they just averaging the cities?*
- *What do people have to do with this? Are people moving?*
- *Is this change just in the city, is it the in state, or is it everywhere?*

**3. (15 min) We decide we need to compare cities and states. In the same groups, give students the Student Activity Sheet and have them do Part A (see the Student Activity Sheet Answer Key for answers).**

**Suggested Prompts:**

- ➔ Before your group starts the Student Activity Sheet, look at the data table. What are they providing information about? What is being compared? What unit is being measured and over what time period? How long has this data been collected? What is the summer temperature pattern?

**After students have had a chance to answer the first 3 questions[A], facilitate a discussion to answer question 4 on the Student Activity Sheet.**

**Suggested Prompts:**

- ➔ As your group completes questions 1-3, what patterns do you see in the data?
- ➔ For question 4, let's discuss the temperature changes in Denver vs. Colorado as a whole class. What trends do you see in the data?

**Next, have students work in their groups to complete questions 5 and 6[B]. Finish up with a classroom discussion of each group's responses for these questions.**

**Suggested Prompts:**

- ➔ As your group now completes questions 5 and 6, what claims and evidence can you determine from the data? What ideas do you have about what is causing the data results? What ideas do you have on how we can investigate the causes of the data results?
- ➔ As a class, let's share responses for questions 5 and 6.
- ➔ Now, let's brainstorm ideas on how we can investigate what is causing the differences in average summer temperatures between Denver and Colorado.

**4. (5 min) Guide students in a Building Consensus Discussion.**

**Suggested Prompts**

- ➔ What have we figured out today? What questions do we still have?

**Listen for student responses:**

- ➔ *The temperature is changing faster in cities than it is in states.*
- ➔ *It seems like cities are warming faster because there are more people and more buildings.*
- ➔ *We are wondering: is this happening all over the world?*

**Supporting Students in Using Mathematics and Computational Thinking**

**A:** Depending on where your students are with math, you may need to use some differentiation or scaffolding strategies for questions 2 and 3 in the Student Activity Sheet. You could use heterogeneous grouping for the small groups or you could group students homogeneously and then provide targeted support for the students that need it. Additionally, you could do these questions on the board for everyone all together if there are enough students in the class that need the support.

**B: Further reading:**

Shepherd, M., "The Science Of Why Cities Are Warmer Than Rural Areas". Forbes. Dec. 25, 2015. https://www.forbes.com/sites/marshallshepherd/2015/09/25/the-science-of-why-cities-are-warmer-than-rural-areas/2/#139491851b42

Donegan, B., "Urban Heat Islands: Why Cities are Warmer than Rural Areas". The Weather Channel. July 20, 2016. https://weather.com/science/weather-explainers/news/urban-heat-island-cities-warmer-suburbs-cooler

**C: Further reading Q.7:**

Further reading:

Lynch, P. 2016 Climate Trends Continue to Break Records. NASA TV. July 19, 2016. https://www.nasa.gov/feature/goddard/2016/climate-trends-continue-to-break-records

Lewis, T. Polar Opposites: Why Climate Change Affects Arctic & Antarctic Differently. Oct 2, 2013. https://www.livescience.com/40125-climate-change-affecting-arctic-antarctic-differently.html

Kristyn Ecochard. What's causing the poles to warm faster than the rest of Earth?. Apr. 6, 2011.

**5. (10 min) Have students start Part B$^{C}$: What's going on in the world? Students should interpret the graphs and answer the question about each graph. Then finish class with a Building Consensus discussion.**

**Suggested Prompts:**

- ➔ What does temperature anomaly mean? What do we think it is telling us?
- ➔ Which regions are seeing the most change and which ones are seeing the least? What are the differences between land and ocean? Do you see any latitude dependence?
- ➔ What questions do you have about the city, state, and global data?

**Listen for student responses, such as:**

- ➔ *Temperature anomaly is a way to talk about how temperature is changing by showing the difference in the current temperature from the average temperature over a long period of time.*
- ➔ *Overall, the temperature in the world is getting hotter and it has been getting hotter since about the 1880s. However, the changes in temperature aren't the same across the world - for example, in the Arctic, the temperature is hotter than expected.*
- ➔ *We are wondering: why is this happening? Why is it getting hotter faster in some places than others and what does this have to do with the overall warming trend we saw in the graph?*
- ➔ *There are places in the world that are getting hotter even though there aren't buildings or a lot of people there; why is that happening?*

**6. (5 min) End the class with the following discussion to set up for next class:**

**Suggested Prompts:**

- ➔ What did we figure out today?
- ➔ What should we investigate next class?

**Listen for student responses that mimic the next row of the storyline:**

- ➔ *We figured out that temperatures are increasing worldwide but that cities seem to be increasing faster than states on average or rural areas.*
- ➔ *We wonder why cities and other regions of the world getting hotter? There are places in the world that are getting hotter even though there aren't buildings or a lot of people there; why is that happening?*

https://www.nasa.gov/topics/earth/features/warming poles.html
Further reading Q8:
Further reading:
Hansen, J., R. Ruedy, M. Sato, and K. Lo, 2010: Global surface temperature change. Rev. Geophys., 48, RG4004, doi:10.1029/2010RG000345.
Shukman, David. What is Climate Change? Oct.4, 2017. http://www.bbc.com/news/science-environment-24021772

# Alignment With Standards

## *Building Toward Target NGSS PE*

- **HS-ESS3-5:** Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts on Earth systems

## *Building Toward Common Core Standard(s)*

- **HSN.Q.A.1:** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
- **RST.11-12.7:** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g. quantitative data, video, multimedia) in order to address a question or solve a problem.