Grand Canyon Microclimatology: Summer and Winter Hiking Gradient

This is a preview of the published version of the quiz

Started: May 18 at 4:38pm

Quiz Instructions

Temperature gradient is a term to describe how temperature changes with altitude. You have likely encountered or will encounter this concept in this course.

This question will focus on the concept of temperature gradients with respect to the ground surface temperature, and how these temperatures change seasonally. The temperature of the ground is a decent proxy for actual air temperature, although the air temperature is going to alternate due to circulations inside the canyon and ground surface temperatures are influenced by surface cover (water, vegetation, etc.) and generally more extreme than air temperatures.

You should be familiar with the idea that complex topography is an important factor on determining the amount of sunlight that can reach the surface of the canyon. Sunlight that makes it to the surface heats the ground up, and warms the overlying air. However, seasonal changes in solar angles and surface heating will alter the temperature gradients between the bottom of the canyon and rim.

For example, the near-surface temperature gradient (air temperature we experience hiking) between rim and river can be as high as 8.2˚C per 1000 meters (5.5˚ per 1000 feet) in summer, but in winter, the temperature gradient lowers to around 5-6˚ C per 1000 meters. These values are just generalizations. The real near-surface lapse rate depends a lot on the complex topography.

So keep in mind that so much more influences the temperature you experience when you hike in the Grand Canyon or stroll around the rim. The list of factors includes: cloud cover, surface heating that occurs, reflectivity of

the surface, the moisture in the ground, how the surrounding topography and plants release or absorb heat, pooling of cold air in low spots, movement of air up and down the canyon, and movement of air upslope and downslope. These and other factors make the microclimatology of the Grand Canyon complex.

EXAMPLE QUESTION:
How does the surface temperature gradient change between the North Rim and Colorado River locations between summer and winter?

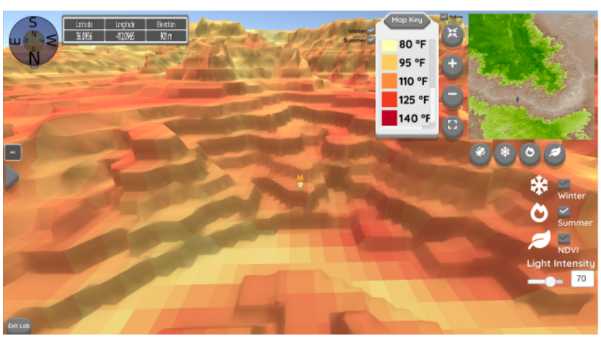
Fast Travel to the meteorological station at the bottom of the Grand Canyon, the Colorado River (36.0976° -112.0969°). For this example, we'll jump up just above the river to make our observations, because the we want to look at the surface temperature of the ground, not the river.

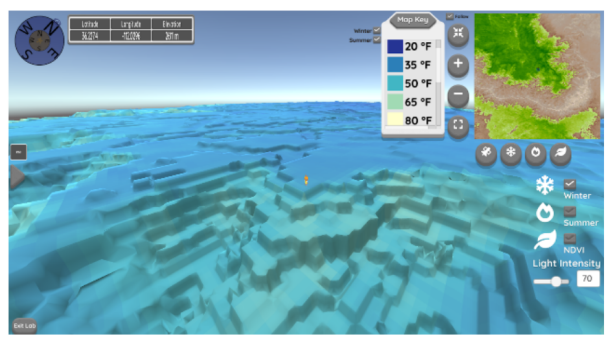
First, make a note of its elevation. Then, in the geovisualization, click on the summer and winter surface temperatures and measure the surface temperature where the avatar is standing using the temperature key.

You will be using the elevation and seasonal surface temperature for to estimate the lapse rate between the bottom of the Grand Canyon and the North Rim. Thus, you need to repeat these steps for the meteorological station on the North Rim, that you can get there via fast travel (36.2274° -112.0296°).

	Elevation (meters)	Summer Surface Temperature		Winter Surface Temperature	
Location 1		°F	°C	°F	°C
Location 2		°F	°C	°F	°C
Change from bottom to top of Grand Canyon		Change in °C:		Change in °C:	
Surface temperature gradient °C per 1000 m	---				

	Elevation (meters)	Summer Surface Temperature		Winter Surface Temperature	
Colorado River	721	125°F	51.6°C	50°F	10°C
North Rim	2611	95°F	35°C	35°F	1.7°C
Change from bottom to top of Grand Canyon	1890	Change in °C: 16.6		Change in °C: 8.3	
Surface temperature gradient °C per 1000 m	---	8.8C / 1000m		4.4C / 1000m	





EXAMPLE ANSWER:
The summer surface temperature gradient from the Colorado River to the North Rim is about 8.8˚C/1000 m, while the winter surface temperature gradient is lower, at about 4.4˚C/1000 m.

An incorrect answer would likely stem from dividing the temperature difference by 1890 instead of 1.89. This is a calculation for the temperature change per kilometer (1000m).

So what you should see is the change in temperature between the top and bottom of the canyon is greater during the summer than during the winter. Try to see if this is the case for your question, and think of the explanation for why this might be.

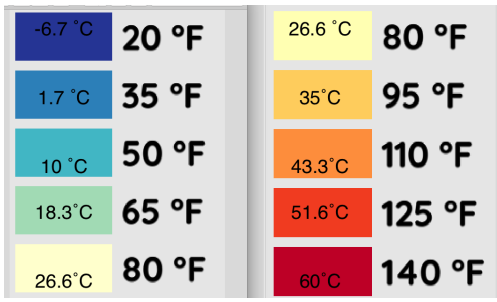
For this example, it's a bit more complicated. The location of the Colorado River is also influenced by the temperature and evaporation of the Colorado River itself, so the summer temperature especially is cooled by a several degrees. Hopefully by now, you've started to connect the influences of how seasonality and complex topography impact climate within the Grand Canyon. Keep thinking about this, as you'll look more in-depth at this concept in later sections.

Question 1

4 pts

How does the surface temperature gradient change seasonally between the North Rim (36.2274° -112.0296°) and Clear Creek (36.1023° -112.0084°) locations between summer and winter? This is the change in temperature with elevation you observe using the remotely sensed summer surface temperatures that can be found in the geovisualization.

Fast travel to these coordinates overlooking Clear Creek (36.1023° -112.0084°). First, make a note of its elevation. Then, from the geovisualization, record the summer and winter surface temperature where the avatar is standing.



Repeat these steps for the meteorological station on the North Rim (36.2274° -112.0296°). Determine the seasonal change in temperature gradient between the two elevations. **WARNING**: The most common error involves mixing ˚F and ˚C in making your lapse rate calculations. The second most common error involves division by the incorrect elevation difference.

When determining the temperature value, use the color that the character most stands upon - use your best judgement, don't worry - you won't be tricked in the Canvas question.

You can use this table, if you wish, to help you organize the observations and calculations:

	Elevation (meters)	Summer Surface Temperature		Winter Surface Temperature	
Location 1		˚F	˚C	˚F	˚C
Location 2		˚F	˚C	˚F	˚C
Elevation Difference (m)		Change in ˚C:		Change in ˚C:	
Surface temperature gradient ˚C per 1000 m	---				

- ◯ The summer surface temperature gradient is 12.8C/km while the winter surface temperature gradient is 6.3C/km
- ◯ The summer surface temperature gradient is 1.1C/km while the winter surface temperature gradient is 0.3C/km
- ◯ The summer surface temperature gradient is 18.8C/km while the winter surface temperature gradient is 4.4C/km
- ◯ The summer surface temperature gradient is 1.4C/km while the winter surface temperature gradient is 10.3C/km

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