

# Grand Canyon Microclimatology: Tutorial

⚠ This is a preview of the published version of the quiz

Started: May 18 at 4:36pm

## Quiz Instructions

The type of physical geography data displayed in the Grand Canyon Microclimate and Vegetation geovisualization are not what you will find via Google Earth. Your avatar interacts with three types of data that you will study to understand how the topography, surface temperature, precipitation, and vegetation abundance relate to one another.

Consider what you see when the geovisualization starts up. We've changed the inset map to a view that simulates an aerial photograph (actually specially processed Landsat data). But otherwise, what you see here are data you have access to.



The tutorial questions will start with this opening scene and then guide you to come to understand and interpret data in this geovisualization.

You can take this quiz 7 times. You will need to reach 100% correct in order to move onto the main labs. But please be aware that several of the tutorial questions are taken from large question banks, where you will be delivered random questions. So for most of the questions - you can learn the correct answer after the first taking. However, for some of them, we want to force you to actually turn on the geovisualization and learn about what you are seeing.

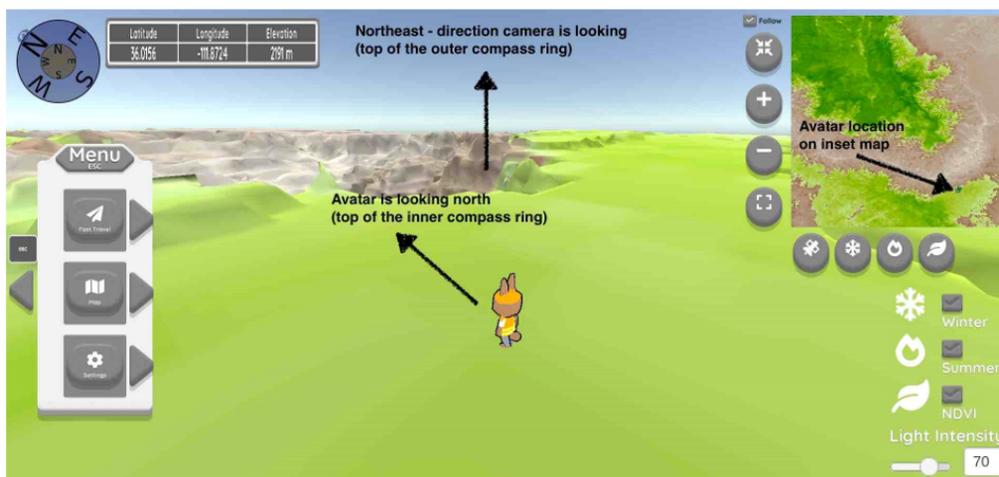
**Question 1**

**0.25 pts**



**QUESTION** Please open up the geovisualization. What direction is the camera looking? What direction is the avatar looking?

Yes. We know you already learned this. But this question emphasizes that the direction the topography faces is VERY important in this lab. Slopes that face north have very different microclimates than slopes that face south. So we want you to be very certain about how you are interpreting direction. This little graphic is intended for you to examine and think about the direction that a slope in the Grand Canyon faces.



- The avatar and the camera are both looking north
- The avatar and the camera are both looking west
- The avatar and the camera are both looking east
- The avatar and the camera are both looking south

**Question 2**

**0.25 pts**

**QUESTION:** In Fast Travel enter latitude 36.2200 and longitude -111.9558, and go to this location. Write down the elevation in meters pixel that the avatar is standing on. What is it?

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- Fourth - click on the fast travel paper airplane icon and go

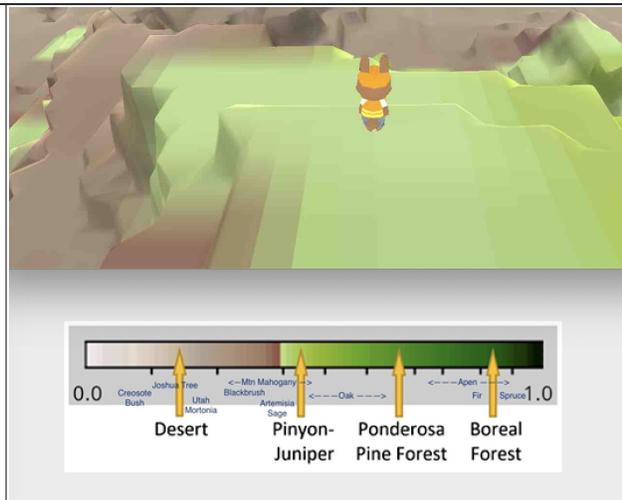
**WARNING:** There is a giant pool of questions and answers ... literally hundreds of questions in the pool. We are doing this giant pool in order to encourage students to actually go through this tutorial. In our experience, we know that students who skip the tutorial ... end up spending a lot more time being frustrated than those who go through all of these questions.

- 1571
- 1561
- 2489
- 2281

**Question 3**

0.5 pts

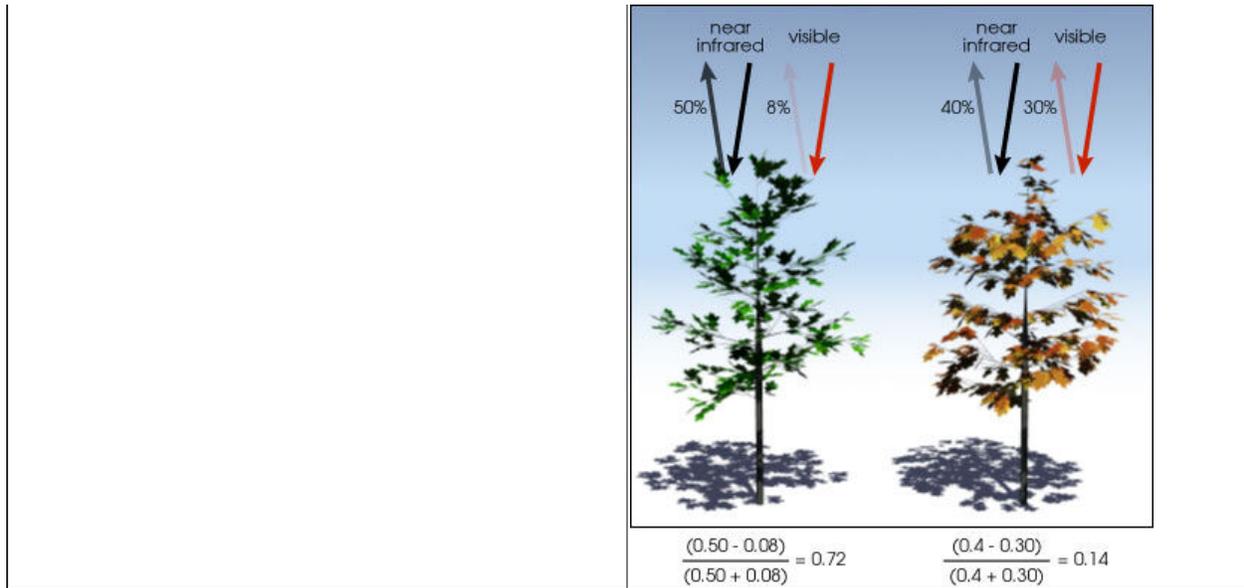
When the geovisualization starts up, your avatar is standing on a data layer, NDVI. This stands for normalized difference vegetation index. It is best thought of as the amount of vegetation present. In the Grand Canyon geovisualization, it is scaled from 0 to 1.0. The avatar is standing on a scrubland of pinyon and juniper dwarf conifer trees, staring out at the desert vegetation of the Grand Canyon.



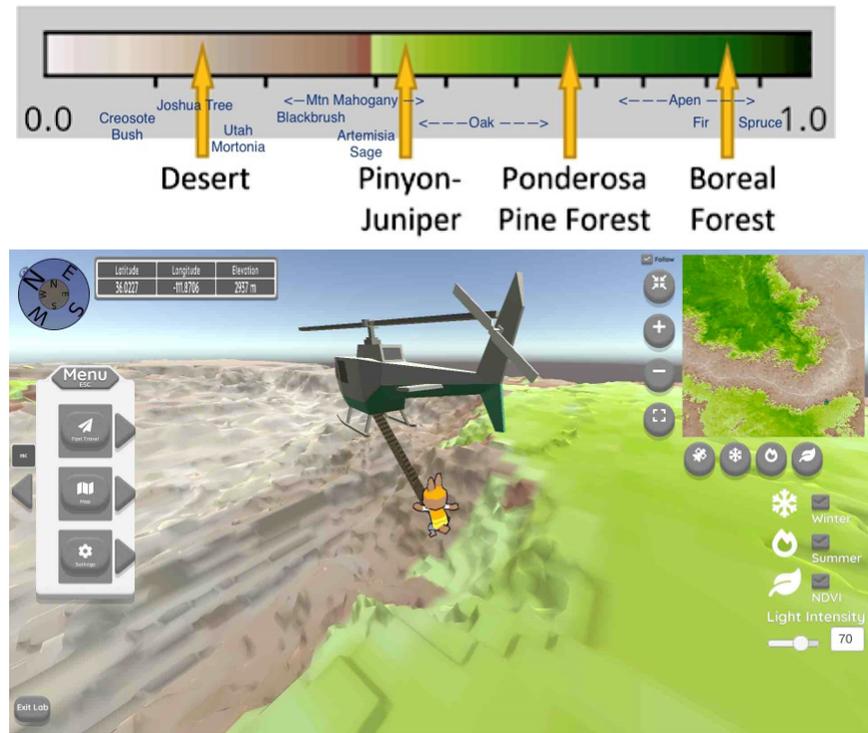
We took satellite data on reflected near infrared (NIR) light and reflected red light, and did simple math. We subtracted red from NIR in the numerator and added them in denominator.

$$NDVI = \frac{(NIR - Red)}{(NIR + Red)}$$

The image was from summer. If the image was taken in winter, the oak and other deciduous trees would have dropped their leaves and the NDVI would have been lower.



QUESTION: In a helicopter flight over the Grand Canyon, we took a screenshot in the area of where the game starts up. This allows you to see the south rim vegetation and then deep into the Grand Canyon via the NDVI. We think this helicopter scene will help you answer this question: **WHEN THE GAME STARTS UP, WHAT IS THE VEGETATION TYPE THAT THE AVATAR IS LOOKING AT, DOWN IN THE GRAND CANYON?** Hint: its a brown color.



- pinyon-juniper
- ponderosa pine
- boreal forest
- desert

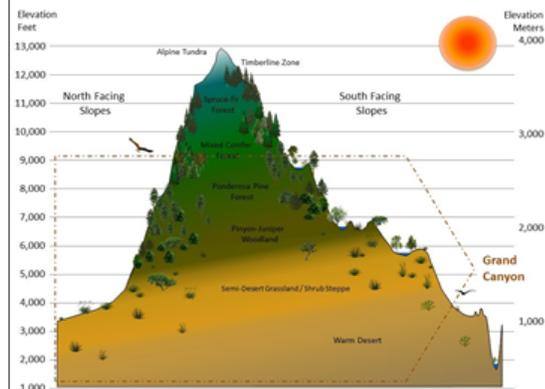
Question 4

0.5 pts

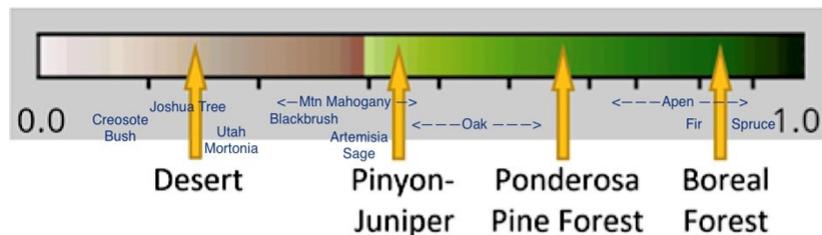
**BASIC CONCEPT OF TREELINE:** The lower limit of trees in mid-latitude settings like mountainous terrain of the western USA is typically controlled by a combination of the amount of precipitation, the seasonality of the precipitation, and how hot it gets in the summer. Also important is aspect (the direction a slope faces). The diagram shows how aspect influences the elevation of lower treeline.

Note: in Hawaii, the upper treeline is established by the paucity of rainfall above a certain elevation. But for the Grand Canyon, the lower rainfall is found at lower elevations.

Note that the treeline is HIGHER on south-facing slopes (with more sunlight) and LOWER on north-facing slopes (with less sunlight)



Take a good look at this screenshot from the game. Focus on the compass ring. The outer ring is the direction the camera is facing (northeast). The inner ring is the direction the avatar is facing ... and this is also the direction the SLOPE of the underlying Grand Canyon rim IS FACING.



**QUESTION: 1. What direction is the slope of the Grand Canyon facing. 2. What "rim" of the Grand Canyon is this scene from? [Hint: they are opposite]? Where is the treeline?**

- Do not put down this answer. Just focus on getting straight the idea that the direction that the slope faces will be important in interpreting treelines in this lab.
- 1. The slope is facing the same as the avatar, to the north.
- 2. Thus, this scene is over the South Rim of the Grand Canyon.
- 3. The treeline is just below the South Rim of the Grand Canyon

**Question 5**

0.25 pts

**QUESTION:** In Fast Travel enter latitude 36.0092 and longitude -112.0743, and go to this location. Write down the color of the NDVI pixel that the avatar is standing on. What is it? [Select the closest answer, even if you think the color description is slightly off.]

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- grey
- dark green
- dark red
- dark brown

**Question 6**

1 pts

**BASIC CONCEPT:** The sun rises in the east, is at its highest point at noon and sets in the west. In complex topography, southeast-facing slopes will heat up first in the morning with southwest-facing slopes heating up most in the afternoon. On flat surfaces, the amount of solar radiation peaks at noon. The temperature of surfaces also peaks at noon. However, the peak of air temperature lags by several hours. The reason is that the air temperature is a product of the emission of long-wave radiation and sensible heat from the surface.

If you want to visualize this, here's a short video (on an ASU server and public domain access):

[https://player.mediaamp.io/p/U8-EDC/qQivF4esrENw/embed/select/media/gOy\\_bhzvoJ\\_\\_?form=html](https://player.mediaamp.io/p/U8-EDC/qQivF4esrENw/embed/select/media/gOy_bhzvoJ__?form=html)  
([https://player.mediaamp.io/p/U8-EDC/qQivF4esrENw/embed/select/media/gOy\\_bhzvoJ\\_\\_?form=html](https://player.mediaamp.io/p/U8-EDC/qQivF4esrENw/embed/select/media/gOy_bhzvoJ__?form=html))

or National Park Service site: [https://www.nps.gov/audiovideo/grca/2C35FFB6-155D-451F-678201C028FFC38A/grca-YakiPtintersunrise\\_480x270.mp4](https://www.nps.gov/audiovideo/grca/2C35FFB6-155D-451F-678201C028FFC38A/grca-YakiPtintersunrise_480x270.mp4) ([https://www.nps.gov/audiovideo/grca/2C35FFB6-155D-451F-678201C028FFC38A/grca-YakiPtintersunrise\\_480x270.mp4](https://www.nps.gov/audiovideo/grca/2C35FFB6-155D-451F-678201C028FFC38A/grca-YakiPtintersunrise_480x270.mp4))

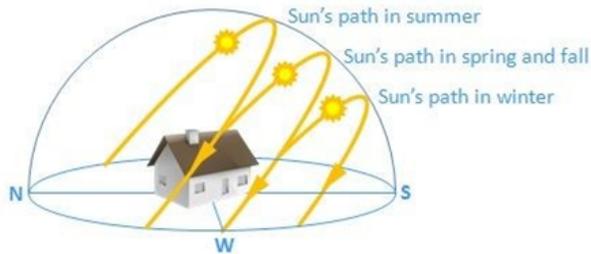
This question starts with you using the Fast Travel Menu to travel to the North Kaibab weather station. Remember, you have to hit ESCAPE to change from the game mode to getting access to the menu. Then, you need to expand the menu to access Fast Travel. All you need to do is to click on North Kaibab Station, and close the menu. Then,

hit escape to go back into game mode. Change the scene layer to winter temperature.



Then, move the camera around with the mouse so that you have a view like this one, where the camera is looking towards the Southwest. With this view, you are able to see the winter 10 am temperatures. You will see that the slopes facing one direction are much warmer than the slopes facing the opposite direction. I've removed the compass and key information in this view so you will have to do this in the video game.

This graphic should resonate with your life experience if you have lived in the lower 48 USA states. In winter, morning sun is in the southeast portion of the sky for most of the USA, and this graphic works for the Grand Canyon.



NOW HERE IS THE KEY PIECE OF INFORMATION FOR INTERPRETING THE SURFACE TEMPERATURE YOU ARE SEEING IN WINTER: **The Landsat thermal data was acquired at 10am in the morning.**

Select the best answer that fills in the blanks to complete this sentence. The slopes that face to the southeast are warmer than the slopes that are facing to the northwest in these data acquired near winter solstice at 10 am in the morning.

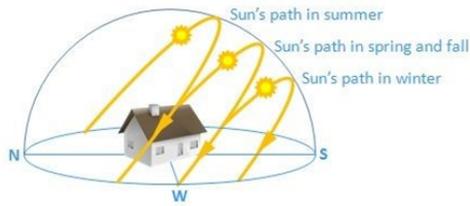
The reason why the slopes that FACE to the SOUTHEAST are warmer, is because in winter the sun comes up in the morning and is BLANK 1.

The slopes that face the northwest are steep and at 10am, they would have received BLANK 2.

- Blank 1: is in the northeast part of the sky

Blank 2: very little solar radiation between sunrise and when data were acquired at 10am.

SLOW DOWN AND THINK!! This is the Grand Canyon. It is in the north hemisphere, north of the Tropic of Cancer. Is the sun ever in the northern part of the sky? So is it even possible for this to be the correct answer? NO!! Do we often have wrong answers that are designed to see if the student comprehends a basic concept? YES!! Do we recommend that you read the answers carefully and think about them before clicking an answer? HECK YES!



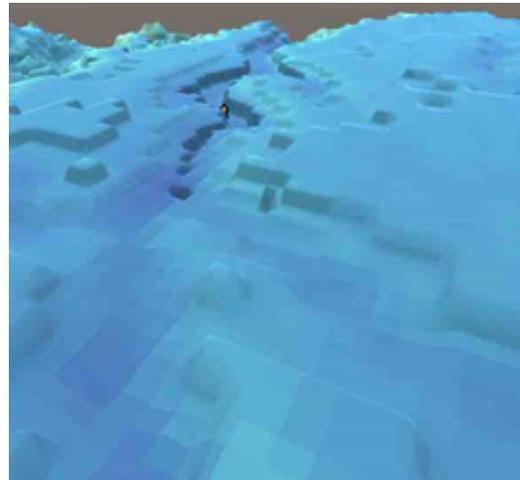
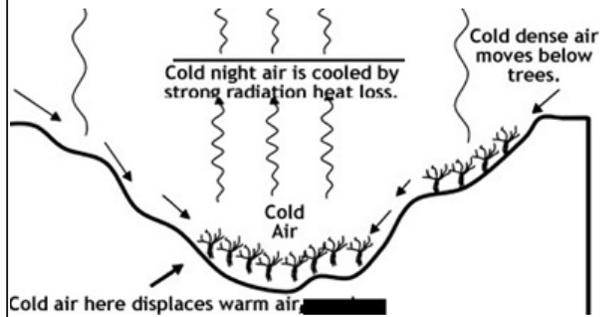
Blank 1: is in south and east part of the sky

Blank 2: very little solar radiation between sunrise and when data were acquired at 10am.

**Question 7**

1 pts

**A BASIC CONCEPT in Physical Geography:** cold air is dense and it slides down into low spots like shallow river valleys. This happens when there is not a lot of wind. You can see in the adjacent image what **cold air drainage** looks like in the game; shallow creeks on the Kaibab Plateau of the North Rim accumulate cold air at night and surfaces cool down.



In winter, on a plateau with only a little topography, where would you expect to find cold air drainage?

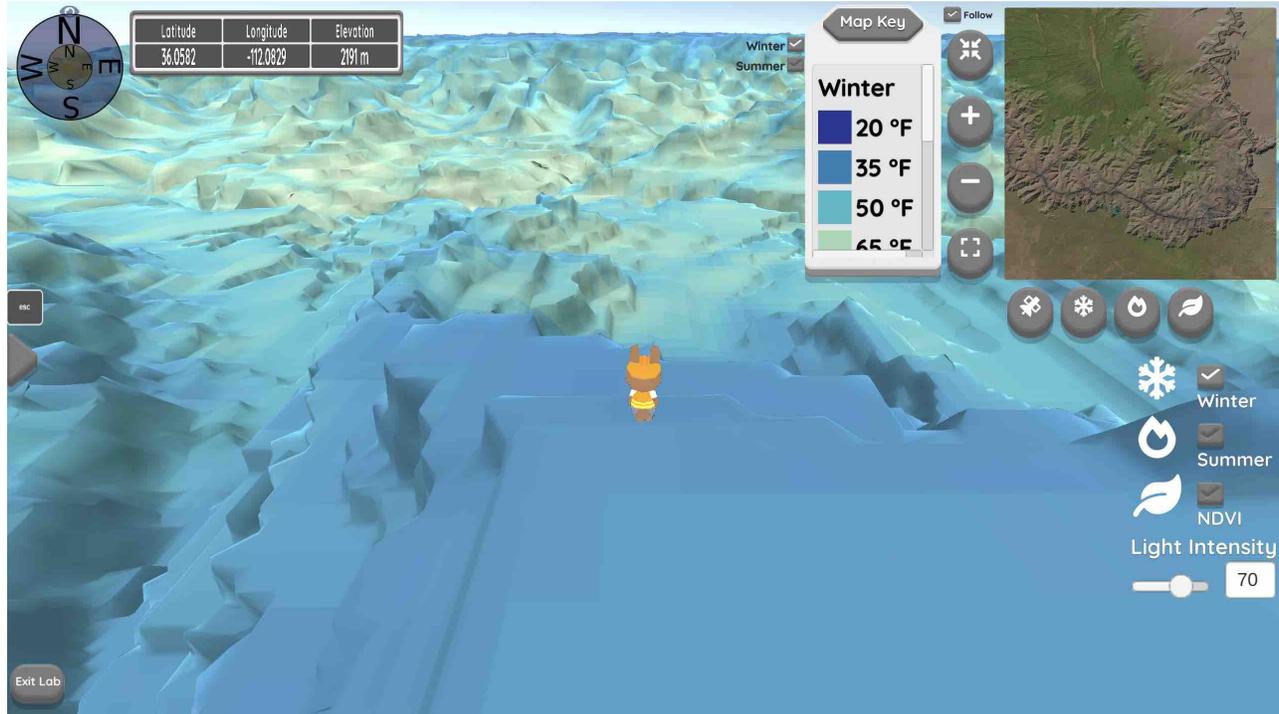
For fun, enjoy this winter scene of cold air drainage ... in an ASU link and a public domain

link: <https://player.mediaamp.io/p/U8-EDC/qQivF4esrENw/embed/select/media/nd1iDWiIVDr?form=html>  
 (<https://player.mediaamp.io/p/U8-EDC/qQivF4esrENw/embed/select/media/nd1iDWiIVDr?form=html>).

or National Park Service site: [https://www.nps.gov/audiovideo/grca/F80750E1-155D-451F-672713A304A31D33/grca-snowy-forest-1080\\_480x270.mp4](https://www.nps.gov/audiovideo/grca/F80750E1-155D-451F-672713A304A31D33/grca-snowy-forest-1080_480x270.mp4) ([https://www.nps.gov/audiovideo/grca/F80750E1-155D-451F-672713A304A31D33/grca-snowy-forest-1080\\_480x270.mp4](https://www.nps.gov/audiovideo/grca/F80750E1-155D-451F-672713A304A31D33/grca-snowy-forest-1080_480x270.mp4))

- sides of mountains
- small hills
- shallow creeks
- mountain tops

To prepare you for the question, please look at the winter temperature layer where the game starts up.



Click on the winter map key layer. The avatar is looking down into the Grand Canyon with a lot of greenish color in the range of 65°F surface temperatures. But up on the rim, its colder. Behind the avatar, the surface temperatures are in the range of 50°F. The avatar is standing on surface temperatures in the range of 35°F.

### Question 8

0.25 pts

**QUESTION:** In Fast Travel enter latitude 36.3926 and longitude -112.1521, and go to this location. Write down the color of the Winter Temperature pixel that the avatar is standing on. What is it? [Select the closest answer, even if you think the color description is slightly off.]

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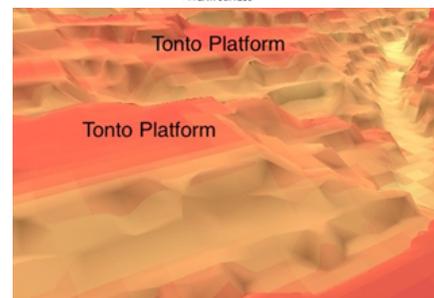
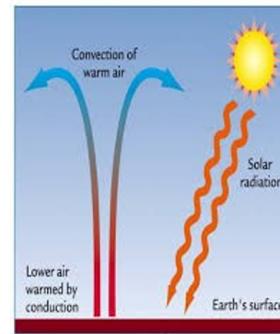
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- orange
- blue
- dark green
- light green

## Question 9

0.25 pts

**BASIC CONCEPT of HEAT ACCUMULATORS:** The relatively flat and rocky surfaces in the middle of the Grand Canyon accumulate a lot of short wave solar radiation. Then, as they heat up, they re-emit this energy in the form of sensible heat (that you feel), and also in the form of longwave radiation. Also, the air next to these hot surfaces are heated up and will rise creating convection of warm air from the hot surfaces into the atmosphere above. This is what these surfaces look like in the game. The Tonto Platform is a good example. Also note the cooler region around the Colorado River (light yellow color) from the plant evapotranspiration and river water evaporation.



If you want to visualize what these heat accumulators look like inside the Grand Canyon, here's some videos on an ASU server and also public domain

<https://player.mediaamp.io/p/U8-EDC/qQivF4esrENw/embed/select/media/M5IYTBghPgrN?form=html>  
 (<https://player.mediaamp.io/p/U8-EDC/qQivF4esrENw/embed/select/media/M5IYTBghPgrN?form=html>).

or National Park Service site: [https://www.nps.gov/audiovideo/grca/D9A07F64-155D-451F-674A30BA3BF4693C/grca-mule-riders-s-kaibab\\_480x270.mp4](https://www.nps.gov/audiovideo/grca/D9A07F64-155D-451F-674A30BA3BF4693C/grca-mule-riders-s-kaibab_480x270.mp4) ([https://www.nps.gov/audiovideo/grca/D9A07F64-155D-451F-674A30BA3BF4693C/grca-mule-riders-s-kaibab\\_480x270.mp4](https://www.nps.gov/audiovideo/grca/D9A07F64-155D-451F-674A30BA3BF4693C/grca-mule-riders-s-kaibab_480x270.mp4)).



## Question 10

0.25 pts

**QUESTION:** In Fast Travel enter latitude 36.4339 and longitude -112.2773, and go to this location. Write down the color of the Summer Temperature pixel that the avatar is standing on. What is it? [Select the closest answer, even if you think the color description is slightly off.]

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orange-red mix

orange

red

yellow

Not saved

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