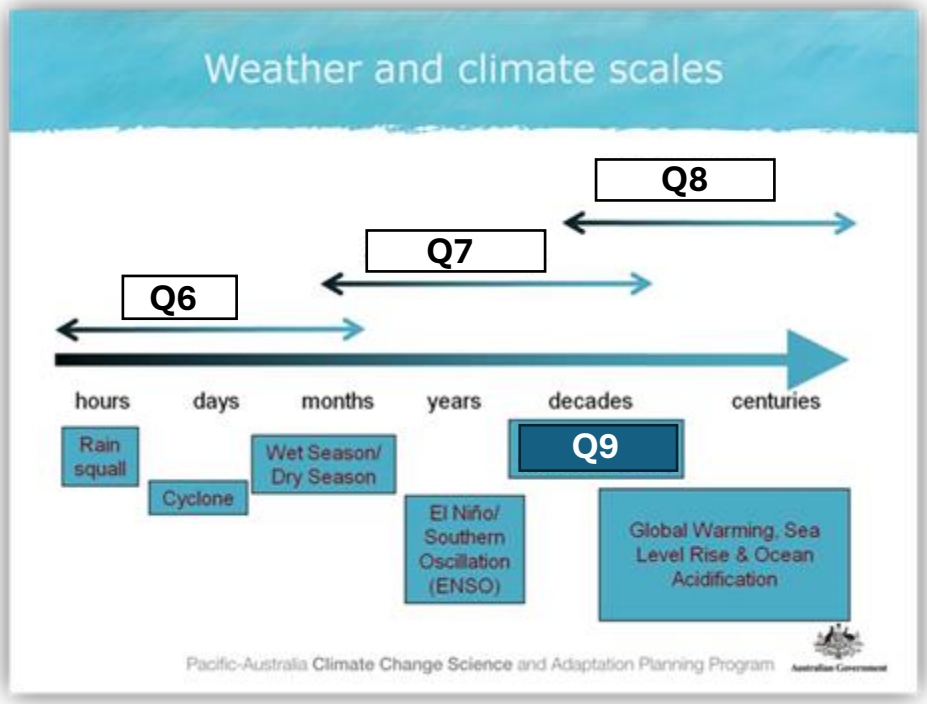
1. Climate data, like weather data, may be either _____ or _____.
    a. qualitative; quantitative
    b. short-term; long-term
    c. current; past
    d. projections; predictions

2. Statistical measures are often used to describe which of the following aspects of climate?
    a. Year-to-year variations
    b. Extreme events
    c. Seasonal cycles
    d. All of the above
    e. None of the above

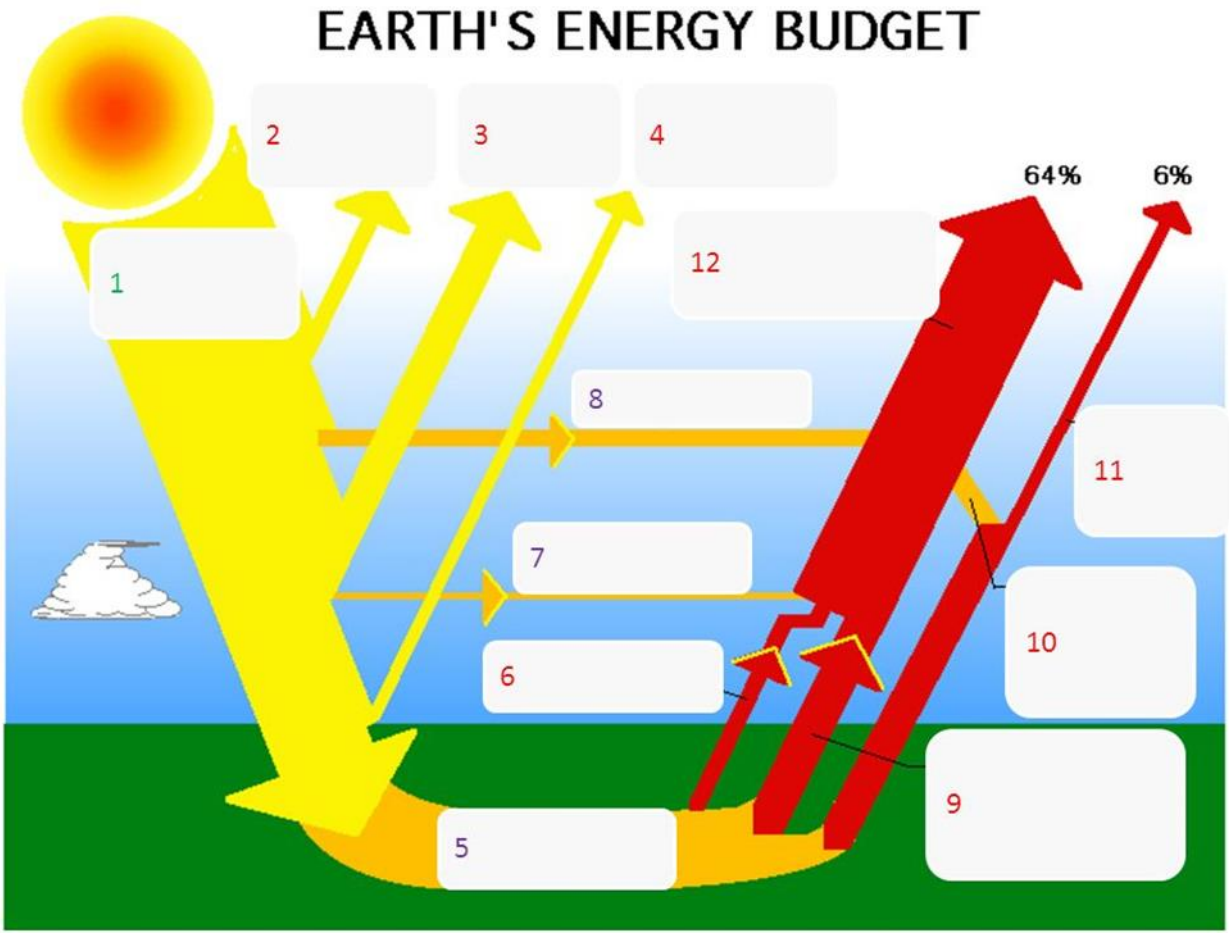
3. What are the most common *two* meteorological variables used to describe the climate of a location? (*Select both*)
    a. Prevailing wind direction
    b. Temperature
    c. Precipitation
    d. Humidity
    e. Percent possible sunshine

4. A common way of describing the difference between weather and climate is that "_____ is what you expect; _____ is what you get."
    a. climate; climate
    b. weather; weather
    c. weather; climate
    d. climate; weather

5. True (T) or false (F): Climate is always described in terms of 30-year intervals.




6. The types of variations labelled "Q6" in the diagram above are
    a. Climate variability
    b. Weather
    c. Climate change
    d. All of the above
    e. None of the above
7. The types of variations labelled "Q7" in the diagram above are
    a. Climate variability
    b. Weather
    c. Climate change
    d. All of the above
    e. None of the above
8. The types of variations labelled "Q8" in the diagram above are
    a. Climate variability
    b. Weather
    c. Climate change
    d. All of the above
    e. None of the above
9. The phenomenon labelled "Q9" would most likely be
    a. Water vapor feedback
    b. Pacific Decadal Oscillation
    c. Monsoons
    d. Milankovitch Cycles




1. Which side of the diagram depicts "shortwave radiation"?
    a. Left
    b. Right

2. Which number shows longwave energy radiated directly from the surface into space?
    a. 5
    b. 6
    c. 9
    d. 11

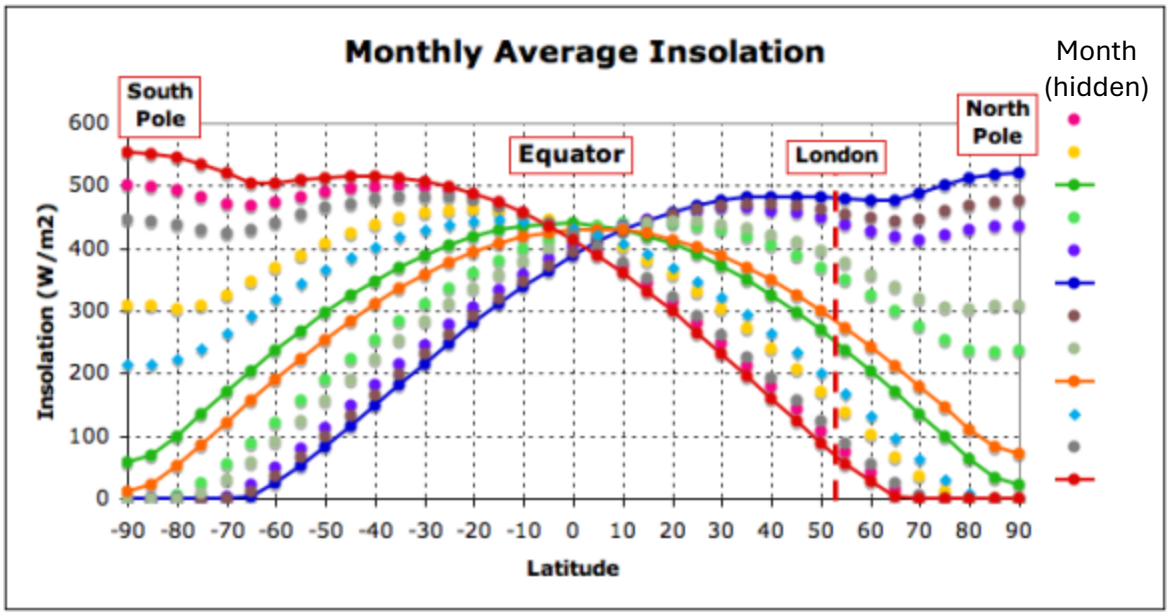
3. Which of the following formulas can be used to represent Earth's *albedo* using the labels from the diagram?

    a. $\frac{"11"+"12"}{"1"}$

    b. $"5" * "7" * "8"$

    c. $\frac{"2"+"3"+"4"}{"1"}$

    d. $\frac{"6"+"9"}{"12"}$




4. Which location receives the highest monthly average insolation at any point in the year?
    a. South Pole
    b. Equator
    c. London
    d. North Pole
    e. A and D

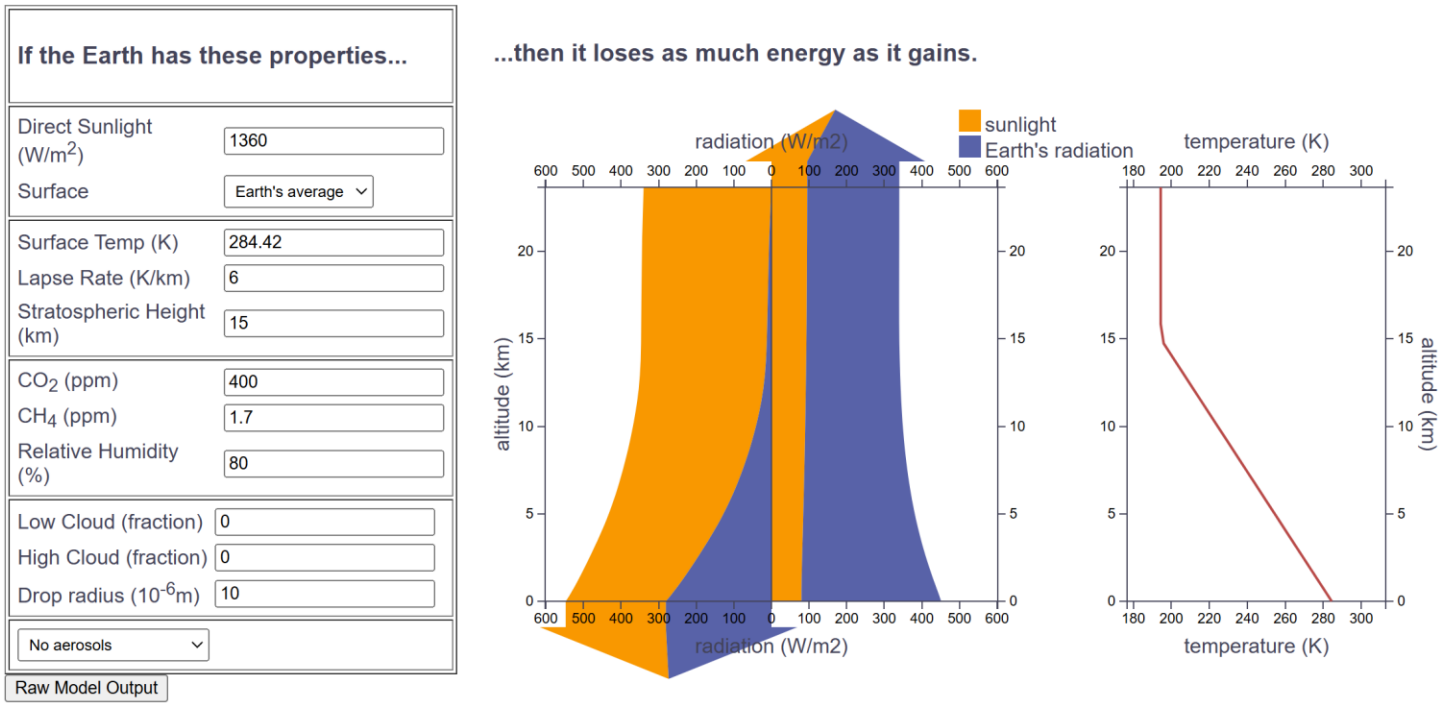
5. Which location receives the most insolation throughout the entire year?
    a. South Pole
    b. Equator
    c. London
    d. North Pole

6. Which color line represents the month of December?
    a. Green
    b. Blue
    c. Orange
    d. Red

7. Which color line represents the month of June?
    a. Green
    b. Blue
    c. Orange
    d. Red

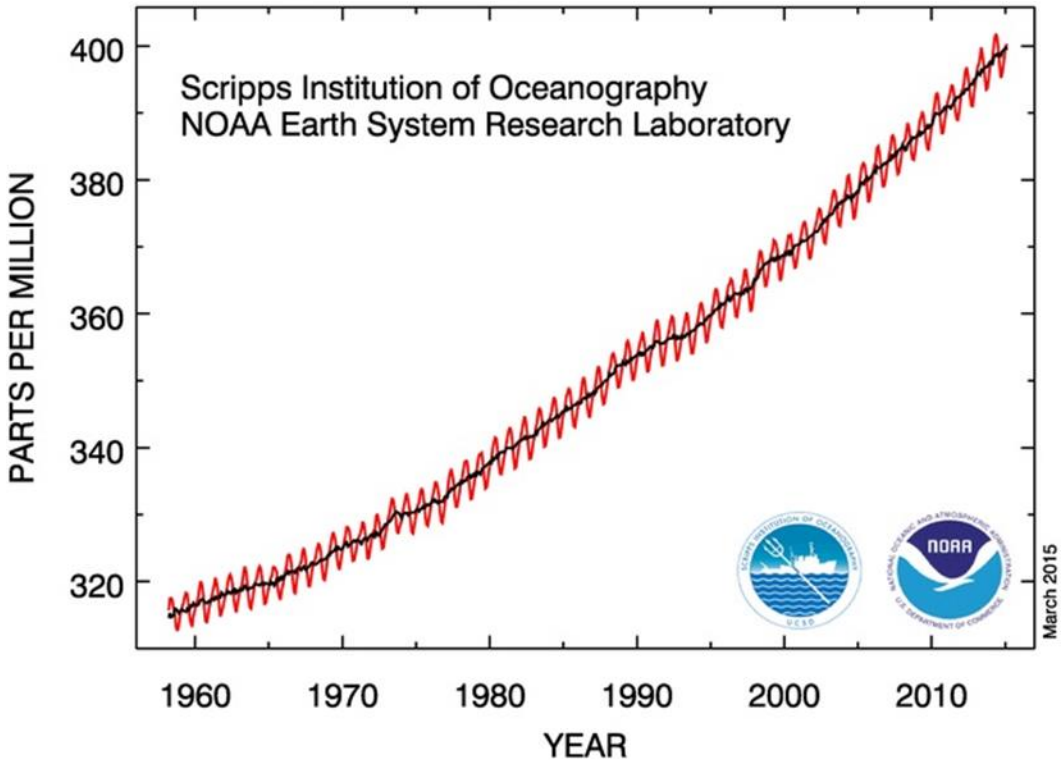
8. The months during which the equinoxes occur do not have identical profiles of monthly average insolation vs. latitude because
    a. Earth's axial tilt is increasing
    b. Earth's axial tilt is decreasing
    c. The Northern Hemisphere has more land area
    d. The equinoxes do not occur in the middle of the months

**Questions 9 & 10 refer to the RRTM model available online from University of Chicago. The default view of the model is shown below.**




9. What will happen if the amount of $CO_2$ and $CH_4$ are increased?
    a. The Earth will experience a net loss of energy at some rate
    b. The Earth will experience a net gain of energy at some rate
    c. The Earth will either experience a net loss or gain of energy, depending on which gas increases more
    d. None of the above

10. After that change from Question 9, how would the surface temperature need to change to return Earth to energy balance?
    a. The surface temperature would need to increase
    b. The surface temperature would need to decrease
    c. The surface temperature would need to increase or decrease, depending on which gas increases more
    d. Changing the surface temperature has no impact on the net gain or loss of energy

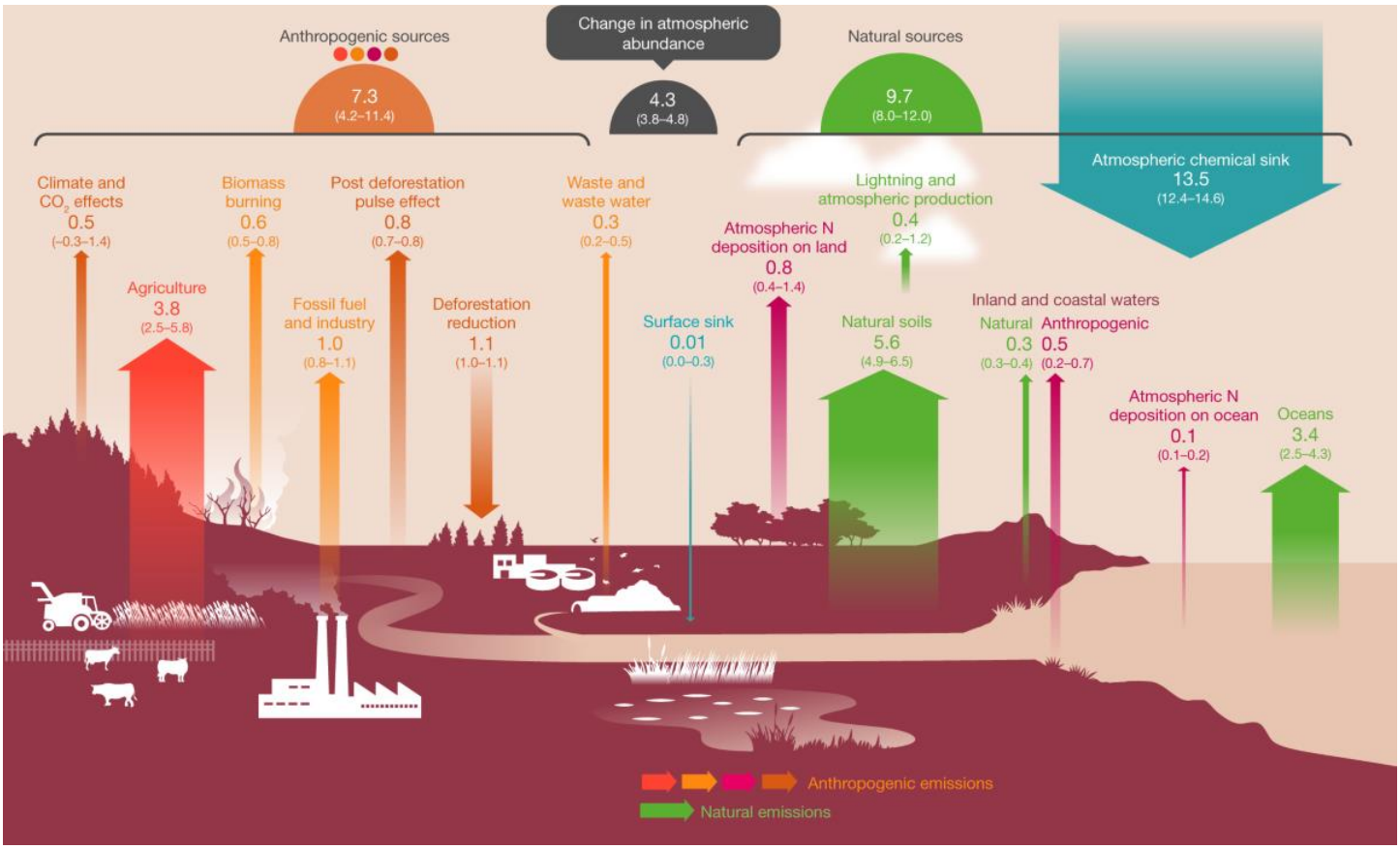



1. Data on which greenhouse gas is shown in the graph?
    a. Carbon dioxide
    b. Methane
    c. Nitrous Oxide
    d. Ozone
    e. None of the above

2. The concentration of this gas is cyclical. How long is one of its cycles?
    a. 6 months
    b. 1 year
    c. 2 years
    d. 4 years

3. Why does this gas have those cycles?
    a. This gas breaks down in warm temperatures
    b. Plant photosynthesis removes it from the atmosphere
    c. Increased respiration by organisms in winter
    d. Seasonal winds affect its dispersion in the atmosphere

4. At what rate did this gas increase in concentration between 2010 and 2015?
    a. 1 ppm / year
    b. 2.5 ppm / year
    c. 5 ppm / year
    d. 10 ppm / year

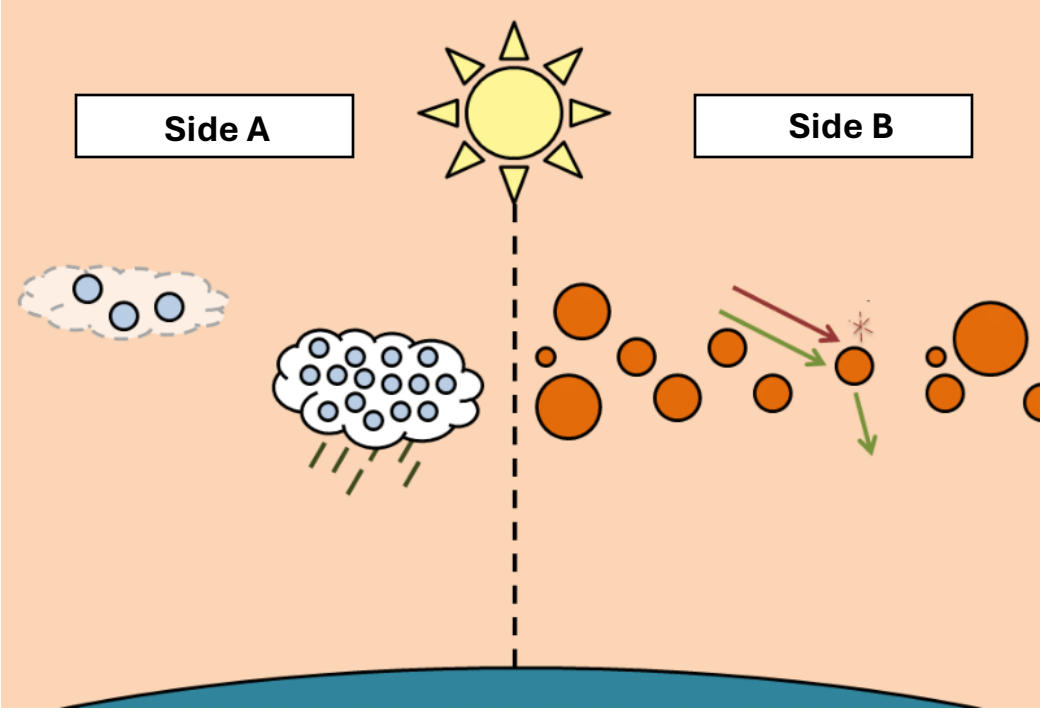



5. The diagram above shows sources and sinks for which greenhouse gas between 2007 and 2016?
    a. Carbon dioxide
    b. Methane
    c. Nitrous oxide
    d. Ozone
    e. None of the above

6. What is the largest anthropogenic (human-related) source of this gas?
    a. Fossil fuel burning
    b. Biomass burning
    c. Agriculture
    d. Deforestation

7. The source from Question 6 contributes roughly what percent of total anthropogenic sources of this gas?
    a. 25%
    b. 50%
    c. 75%
    d. 100%

8. Approximately what percent of sources of this gas are due to anthropogenic activities?
    a. 20%
    b. 40%
    c. 60%
    d. 80%




9. Which side of the diagram above shows what are known as “direct effects” of aerosols?
    a. Side A
    b. Side B
    c. Both sides
    d. Neither side

10. Do the “direct effects” of aerosols have a warming effect or a cooling effect on climate?
    a. Warming effect
    b. Cooling effect
    c. Neutral effect (neither warming nor cooling)
    d. Warming or cooling effect, depending on the composition of the aerosols

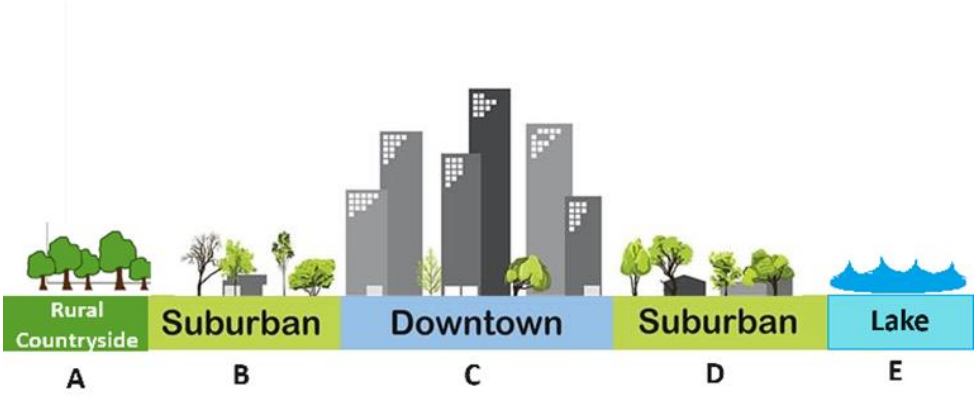
**Use the image of the Andes Mountains (yellow line) and surrounding areas shown to the right to answer questions 1-3.**


1. In the northern half of the image, which side of the Andes receives more precipitation?
    a. West side
    b. East side
    c. Both sides receive roughly the same amount
    d. It cannot be estimated from the provided information

2. What name do climatologists use to describe this phenomenon?
    a. Urban aridification effect
    b. Orographic desertification
    c. Altitudinal precipitation
    d. Rain shadow effect
    e. None of the above

3. Why does this phenomenon manifest differently in the southern half of this image?
    a. The equator is near the middle of this image (near Santiago, Chile), and as a result air flow is deflected in opposite directions due to the Coriolis effect
    b. A warm ocean current flows southwards along the coast of Chile, resulting high humidity and precipitation
    c. The coastline in the northern half of the image experiences reduced upwelling during El Niño, whereas the coastline in the southern half experiences enhanced upwelling
    d. The prevailing wind direction in the northern half of the image is from the east, whereas it is from the west in the southern half of the image
    e. None of the above

**Use the diagram and surface air temperature data below to answer questions 4-7.**



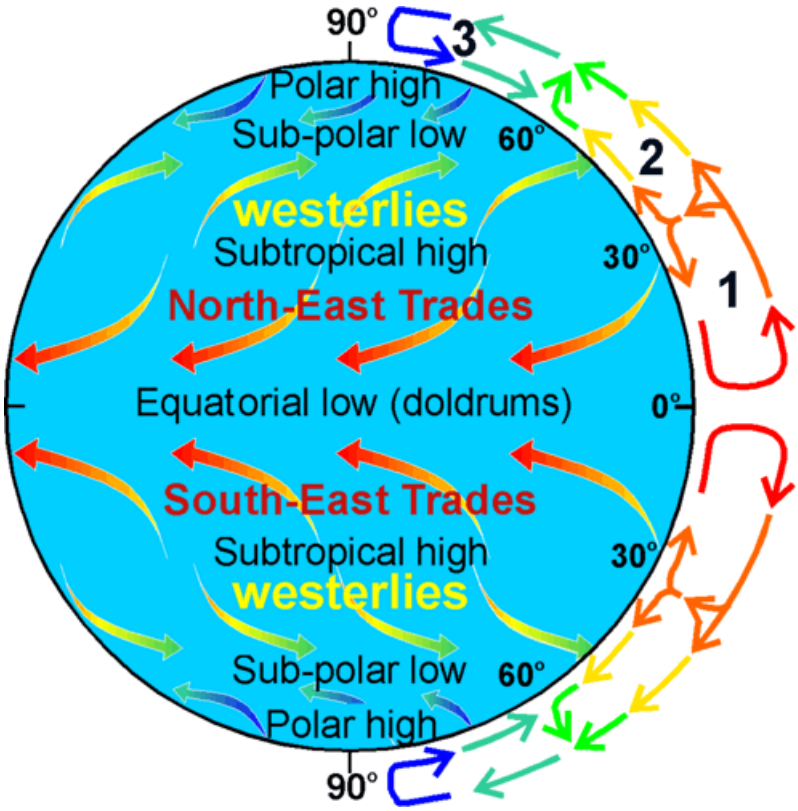

| Location | Temperature |
|---|---|
| A | 78°F |
| B | 83°F |
| C | 87°F |
| D | 82°F |
| E | 73°F |

4. The phenomenon by which downtown is experiencing much higher temperatures than surrounding areas is known as
    a. Continentality
    b. Urban heat island effect
    c. Micro-warming
    d. City-albedo feedback
    e. None of the above

5. Which of the following is the least likely to have contributed to the phenomenon from question 4?
    a. Reduced albedo due to land use changes
    b. Reduced vegetation cover
    c. Enhanced localized greenhouse effect due to fossil fuel burning
    d. All of the above likely contributed roughly equal amounts

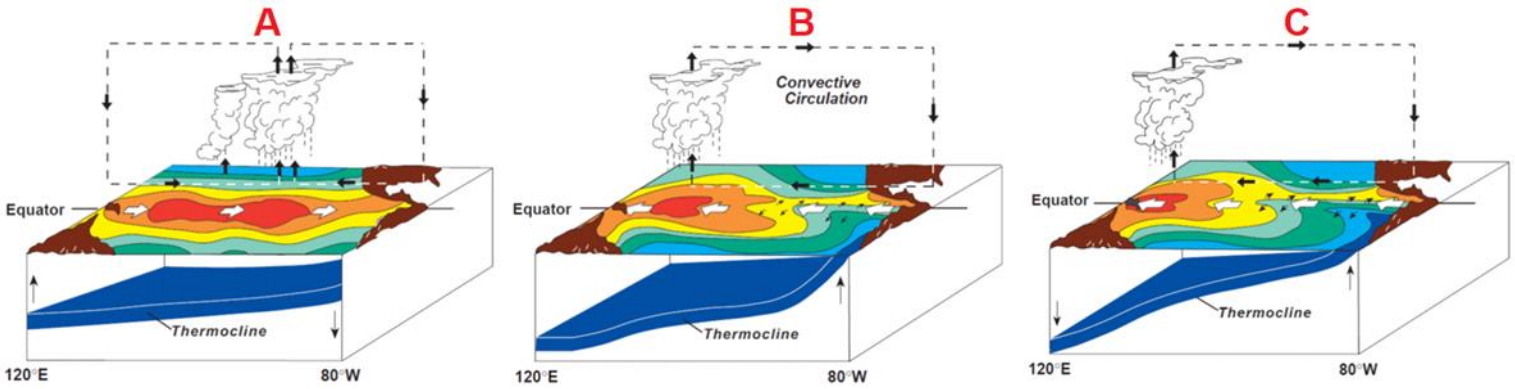
6. The air over the lake is much cooler than other locations in the diagram as a result of which of the following
    a. The high albedo of open water
    b. The sinking of air due to land breezes aloft
    c. The high heat capacity of water
    d. The greenhouse effect-reducing impact of water vapor
    e. None of the above

7. Using the data table provided, draw a graph of the temperature profile of the region shown in the diagram




1. Atmospheric circulation in each hemisphere tends to be organized into three circulation cells rather than one due to
    a. Latent heating
    b. Coriolis effect
    c. Cyclogenesis
    d. Latitude-temperature feedback

2. The pressure belts shown in the diagram above
    a. Are associated with clouds and frequent precipitation
    b. Occur where circulation cells tend to have sinking motion
    c. Typically shift in location throughout the year
    d. Tend to result in intense winds that move clockwise against the Earth's counterclockwise rotation




3. The convective circulation cell shown in these diagrams is known as the
    a. Rossby cell
    b. Ferrel cell
    c. Hadley cell
    d. Walker cell

4. Which diagram shows *El Niño* conditions?
    a. A
    b. B
    c. C

5. Which letter shows conditions that are associated with increased Atlantic hurricane activity?
    a. A
    b. B
    c. C

6. Which diagram shows conditions that often lead to elevated global surface temperatures?
    a. A
    b. B
    c. C

7. Which of the following is *FALSE* regarding the El Niño Southern Oscillation?
    a. It repeats at regular 7-year intervals
    b. It can have significant short-term effects on global climate
    c. It involves the periodic changes in wind patterns over the equatorial Pacific Ocean
    d. It is a form of internal climate variability