

Climate Change Exercises: Questions 1-7

Background

The planet's surface temperature is increasing due to human greenhouse gas emissions, and this global warming and carbon cycle disruption is wreaking havoc on natural systems. Living systems that depend on current temperature, weather, currents and carbon balance are jeopardized, and human society will be forced to contend with widespread economic, social, political and environmental damage as the temperature continues to rise. Although most countries recognize that global warming is a crisis and that humans must act to limit its effects, little action has been taken to limit or reverse human impact on the climate.

One limitation is the spread of misinformation related to climate change and its causes, especially the extent to which humans have contributed to global warming. In these exercises, we examine the relationship between global temperature changes, greenhouse gases and human carbon emissions using time series of actual atmospheric and ice core measurements from the National Oceanic and Atmospheric Administration (NOAA) and Carbon Dioxide Information Analysis Center (CDIAC).

Libraries and Data Import

```
library(tidyverse)
library(dslabs)
data(temp_carbon)
data(greenhouse_gases)
data(historic_co2)
```

IMPORTANT: These exercises use **dslabs** datasets that were added in a July 2019 update. Make sure your package is up to date with the command `update.packages("dslabs")`. You can also update all packages on your system by running `update.packages()` with no arguments, and you should consider doing this routinely.

Question 1

3.0/3.0 points (graded)

Load the `temp_carbon` dataset from **dslabs**, which contains annual global temperature anomalies (difference from 20th century mean temperature in degrees Celsius), temperature anomalies over the land and ocean, and global carbon emissions (in metric tons). Note that the date ranges differ for



temperature and carbon emissions.

Which of these code blocks return the latest year for which carbon emissions are reported?

Select ALL correct answers.



```
temp_carbon %>%  
  .$year %>%  
  max()
```



```
temp_carbon %>%  
  filter(!is.na(carbon_emissions)) %>%  
  pull(year) %>%  
  max()
```



```
temp_carbon %>%  
  filter(!is.na(carbon_emissions)) %>%  
  max(year)
```



```
temp_carbon %>%  
  filter(!is.na(carbon_emissions)) %>%  
  .$year %>%  
  max()
```



```
temp_carbon %>%  
  filter(!is.na(carbon_emissions)) %>%  
  select(year) %>%  
  max()
```



```
temp_carbon %>%  
  filter(!is.na(carbon_emissions)) %>%  
  max(.$year)
```



i Answers are displayed within the problem

Question 2

3.0/3.0 points (graded)

Inspect the difference in carbon emissions in `temp_carbon` from the first available year to the last available year.

What is the first year for which carbon emissions (`carbon_emissions`) data are available?

✓ Answer: 1751

Answer Code

```
temp_carbon %>%  
  filter(!is.na(carbon_emissions)) %>%  
  .$year %>%  
  min()
```

What is the last year for which carbon emissions data are available?

✓ Answer: 2014

Answer Code

```
temp_carbon %>%  
  filter(!is.na(carbon_emissions)) %>%  
  .$year %>%  
  max()
```

How many times larger were carbon emissions in the last year relative to the first year?

✓ Answer: 3285

Answer Code



```
carbon1 <- temp_carbon %>%
  filter(year == 1751) %>%
  .$carbon_emissions

carbon2 <- temp_carbon %>%
  filter(year == 2014) %>%
  .$carbon_emissions

carbon2/carbon1
```

Submit

You have used 1 of 10 attempts

i Answers are displayed within the problem

Question 3

3.0/3.0 points (graded)

Inspect the difference in temperature in `temp_carbon` from the first available year to the last available year.

What is the first year for which global temperature anomaly (`temp_anomaly`) data are available?

1880

✓ Answer: 1880

1880

Answer Code

```
temp_carbon %>%
  filter(!is.na(temp_anomaly)) %>%
  .$year %>%
  min()
```

What is the last year for which global temperature anomaly data are available?

2018

✓ Answer: 2018

2018

Answer Code

```
temp_carbon %>%
  filter(!is.na(temp_anomaly)) %>%
  .$year %>%
  max()
```



How many degrees Celsius has temperature increased over the date range?

0.93

✓ Answer: 0.93

0.93

Answer Code

```
temp1 <- temp_carbon %>%  
  filter(year == "1880") %>%  
  .$temp_anomaly  
  
temp2 <- temp_carbon %>%  
  filter(year == "2018") %>%  
  .$temp_anomaly  
  
temp2 - temp1
```

Submit

You have used 1 of 10 attempts

i Answers are displayed within the problem

Question 4

1/1 point (graded)

Create a time series line plot of the temperature anomaly. Only include years where temperatures are reported. Save this plot to the object `p`.

Which command adds a blue horizontal line indicating the 20th century mean temperature?

☐

```
p <- p + geom_vline(aes(xintercept = 0), col = "blue")
```

☐

```
p <- p + geom_hline(aes(y = 0), col = "blue")
```

☐

```
p <- p + geom_hline(aes(yintercept = 0, col = blue))
```





```
p <- p + geom_hline(aes(yintercept = 0), col = "blue")
```



Answer Code

```
p <- temp_carbon %>%  
  filter(!is.na(temp_anomaly)) %>%  
  ggplot(aes(year, temp_anomaly)) +  
  geom_line()  
  
p <- p + geom_hline(aes(yintercept = 0), col = "blue")  
p
```

Submit

You have used 1 of 2 attempts



Answers are displayed within the problem

Question 5

1/1 point (graded)

Continue working with `p`, the plot created in the previous question.

Change the y-axis label to be "Temperature anomaly (degrees C)". Add a title, "Temperature anomaly relative to 20th century mean, 1880-2018". Also add a text layer to the plot: the x-coordinate should be 2000, the y-coordinate should be 0.05, the text should be "20th century mean", and the text color should be blue.

Which of the following code blocks is correct?



```
p + ylab("Temperature anomaly (degrees C)") +  
  title("Temperature anomaly relative to 20th century mean, 1880-2018") +  
  geom_text(aes(x = 2000, y = 0.05, label = "20th century mean", col = "blue"))
```



```
p + ylim("Temperature anomaly (degrees C)") +  
  ggtitle("Temperature anomaly relative to 20th century mean, 1880-2018") +  
  geom_text(aes(x = 2000, y = 0.05, label = "20th century mean"), col = "blue")
```



```
p + ylab("Temperature anomaly (degrees C)") +  
  ggtitle("Temperature anomaly relative to 20th century mean, 1880-2018") +  
  geom_text(aes(x = 2000, y = 0.05, label = "20th century mean", col = "blue"))
```

```
p + ylab("Temperature anomaly (degrees C)") +  
  ggtitle("Temperature anomaly relative to 20th century mean, 1880-2018") +  
  geom_text(aes(x = 2000, y = 0.05, label = "20th century mean"), col = "blue")
```



```
p + ylab("Temperature anomaly (degrees C)") +  
  title("Temperature anomaly relative to 20th century mean, 1880-2018") +  
  geom_text(aes(x = 2000, y = 0.05, label = "20th century mean"), col = "blue")
```

Submit

You have used 1 of 2 attempts

i Answers are displayed within the problem

Question 6

3.0/3.0 points (graded)

Use the plot created in the last two exercises to answer the following questions. Answers within 5 years of the correct answer will be accepted.

When was the earliest year with a temperature above the 20th century mean?

1938

✓ Answer: 1940

1938

When was the last year with an average temperature below the 20th century mean?

1975

✓ Answer: 1976

1975



In what year did the temperature anomaly exceed 0.5 degrees Celsius for the first time?

1995

✓ Answer: 1997

1995

Answer Code

Here is the full code for generating the correct plot:

```
temp_carbon %>%  
  ggplot(aes(year, temp_anomaly)) +  
  geom_line() +  
  geom_hline(aes(yintercept = 0), col = "blue") +  
  ylab("Temperature anomaly (degrees C)") +  
  geom_text(aes(x = 2000, y = 0.05, label = "20th century mean"), col = "blue") +  
  xlim(c(1880, 2018)) +  
  ggtitle("Temperature anomaly relative to 20th century mean, 1880-2018")
```

Submit

You have used 1 of 10 attempts

❗ Answers are displayed within the problem

Question 7

1.5/1.5 points (graded)

Add layers to the previous plot to include line graphs of the temperature anomaly in the ocean (`ocean_anomaly`) and on land (`land_anomaly`). Assign different colors to the lines. Compare the global temperature anomaly to the land temperature anomaly and ocean temperature anomaly.

Which region has the largest 2018 temperature anomaly relative to the 20th century mean?

Land

✓ Answer: Land

Which region has the largest change in temperature since 1880?

Land

✓ Answer: Land

Which region has a temperature anomaly pattern that more closely matches the global pattern?

Ocean

✓ Answer: Ocean

Answer Code

Here is the full code for generating the correct plot:




```
temp_carbon %>%
  ggplot(aes(year, temp_anomaly)) +
  geom_line() +
  geom_line(aes(year, land_anomaly), col = "red") +
  geom_line(aes(year, ocean_anomaly), col = "blue") +
  ylab("Temperature anomaly (degrees C)") +
  xlim(c(1880, 2018)) +
  ggtitle("Temperature anomaly on land and ocean")
```

Submit

You have used 1 of 2 attempts

i Answers are displayed within the problem

The assessment continues on the following page. You will not need the temperature anomaly plot created above for future questions.

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