Climate Change Exercises: Questions 8-12

Assessment continues

The climate change exercises continue on this page. Use the libraries and datasets below.

Libraries and Data Import

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

Question 8

1.5/1.5 points (graded)

A major determinant of Earth's temperature is the greenhouse effect. Many gases trap heat and reflect it towards the surface, preventing heat from escaping the atmosphere. The greenhouse effect is vital in keeping Earth at a warm enough temperature to sustain liquid water and life; however, changes in greenhouse gas levels can alter the temperature balance of the planet.

The `greenhouse_gases` data frame from **dslabs** contains concentrations of the three most significant greenhouse gases: carbon dioxide (CO_2, abbreviated in the data as `co2`), methane (CH_4, `ch4` in the data), and nitrous oxide (N_2O, `n2o` in the data). Measurements are provided every 20 years for the past 2000 years.

Complete the code outline below to make a line plot of `concentration` on the y-axis by `year` on the x-axis. Facet by `gas`, aligning the plots vertically so as to ease comparisons along the year axis. Add a vertical line with an x-intercept at the year 1850, noting the unofficial start of the industrial revolution and widespread fossil fuel consumption. Note that the units for `ch4` and `n2o` are ppb while the units for `co2` are ppm.

```
greenhouse_gases %>%
    ggplot(aes(__________)) +
    geom_line() +
    facet_grid(__________, scales = "free") +
               +
    ylab("Concentration (ch4/n2o ppb, co2 ppm)") +
    ggtitle("Atmospheric greenhouse gas concentration by year, 0-2000")
```

What code fills the first blank?

year, concentration ✔ **Answer:** year, concentration **or** year,concentration

What code fills the second blank? Make sure to align plots vertically.

gas~. ✔ **Answer:** gas ~ . **or** gas~.

What code fills the third blank?

geom_vline(xintercept= ✔ **Answer:** geom_vline(xintercept = 1850) **or** geom_vline(xintercept=1850)

Submit You have used 3 of 10 attempts

Answers are displayed within the problem

Question 9

5.0/5.0 points (graded)

Interpret the plot of greenhouse gases over time from the previous question. You will use each answer exactly once `ch4`, `co2`, `n2o`, all, none).

Which gas was stable at approximately 275 ppm/ppb until around 1850?

co2 ✔ **Answer:** co2

Which gas more than doubled in concentration since 1850?

ch4 ✔ **Answer:** ch4

Which gas decreased in concentration since 1850?

none ✔ **Answer:** none

Which gas had the smallest magnitude change since 1850?

n2o ✔ **Answer:** n2o

Which gas increased exponentially in concentration after 1850?

all ✔ **Answer:** all

Answer Code

```
greenhouse_gases %>%
    ggplot(aes(year, concentration)) +
    geom_line() +
    facet_grid(gas ~ ., scales = "free") +
    geom_vline(xintercept = 1850) +
    xlab("year") +
    ylab("Concentration (ch4/n2o ppb, co2 ppm)") +
    ggtitle("Atmospheric greenhouse gas concentration by year, 0-2000")
```

Submit You have used 2 of 3 attempts

Answers are displayed within the problem

Question 10

3.0/3.0 points (graded)

While many aspects of climate are independent of human influence, and `co2` levels can change without human intervention, climate models cannot reconstruct current conditions without incorporating the effect of manmade carbon emissions. These emissions consist of greenhouse gases and are mainly the result of burning fossil fuels such as oil, coal and natural gas.

Make a time series line plot of carbon emissions (`carbon_emissions`) from the `temp_carbon` dataset. The y-axis is metric tons of carbon emitted per year.

Which of the following are true about the trend of carbon emissions?
Check all correct answers.

- [x] Carbon emissions were essentially zero before 1850 and have increased exponentially since then. ✔
- [ ] Carbon emissions are reaching a stable level.
- [ ] Carbon emissions have increased every year on record.
- [x] Carbon emissions in 2014 were about 4 times as large as 1960 emissions. ✔
- [x] Carbon emissions have doubled since the late 1970s. ✔
- [x] Carbon emissions change with the same trend as atmospheric greenhouse gas levels (`co2` , `ch4` , `n2o`) ✔

✔

Answer Code

```
temp_carbon %>%
    ggplot(aes(year, carbon_emissions)) +
    geom_line() +
    ylab("Carbon emissions (metric tons)") +
    ggtitle("Annual global carbon emissions, 1751-2014")
```

Submit You have used 2 of 2 attempts

ℹ Answers are displayed within the problem

Question 11

1.5/2.0 points (graded)

We saw how greenhouse gases have changed over the course of human history, but how has CO_2 (`co2` in the data) varied over a longer time scale? The `historic_co2` data frame in **dslabs** contains direct measurements of atmospheric `co2` from Mauna Loa since 1959 as well as indirect measurements of atmospheric `co2` from ice cores dating back 800,000 years.

Make a line plot of `co2` concentration over time (`year`), coloring by the measurement source (`source`). Save this plot as `co2_time` for later use.

Which of the following are true about `co2_time`, the time series of `co2` over the last 800,000 years?
Check all correct answers.

- [x] Modern `co2` levels are higher than at any point in the last 800,000 years. ✔
- [ ] There are natural cycles of `co2` increase and decrease lasting 50,000-100,000 years per cycle. ✔
- [x] In most cases, it appears to take longer for `co2` levels to decrease than to increase. ✔
- [ ] `co2` concentration has been at least 200 ppm for the last 800,000 years.

✱

Answer
Incorrect:
Try again. `co2` oscillates in a cyclical fashion.

Answer Code

```
co2_time <- historic_co2 %>%
    ggplot(aes(year, co2, col = source)) +
    geom_line() +
    ggtitle("Atmospheric CO2 concentration, -800,000 BC to today") +
    ylab("co2 (ppmv)")
co2_time
```

Submit You have used 2 of 2 attempts

Answers are displayed within the problem

Question 12

4.0/4.0 points (graded)

One way to differentiate natural `co2` oscillations from today's manmade `co2` spike is by examining the rate of change of `co2`. The planet is affected not only by the absolute concentration of `co2` but also by its rate of change. When the rate of change is slow, living and nonliving systems have time to adapt to new temperature and gas levels, but when the rate of change is fast, abrupt differences can overwhelm natural systems. How does the pace of natural `co2` change differ from the current rate of change?

Use the `co2_time` plot saved above. Change the limits as directed to investigate the rate of change in `co2` over various periods with spikes in `co2` concentration.

Change the x-axis limits to -800,000 and -775,000. About how many years did it take for `co2` to rise from 200 ppmv to its peak near 275 ppmv?

- 100
- 3,000
- 6,000
- 10,000 ✔

Answer Code

```
co2_time + xlim(-800000, -775000)
```

Change the x-axis limits to -375,000 and -330,000. About how many years did it take for `co2` to rise from the minimum of 180 ppm to its peak of 300 ppmv?

- 3,000
- 6,000
- 12,000
- 25,000 ✔

Answer Code

```
co2_time + xlim(-375000, -330000)
```

Change the x-axis limits to -140,000 and -120,000. About how many years did it take for `co2` to rise from 200 ppmv to its peak near 280 ppmv?

- 200
- 1,500
- 5,000
- 9,000 ✔

Answer Code

```
co2_time + xlim(-140000, -120000)
```

Change the x-axis limits to -3000 and 2018 to investigate modern changes in `co2`. About how many years did it take for `co2` to rise from its stable level around 275 ppmv to the current level of over 400 ppmv?

- 250 ✔
- 1,000
- 2,000

5,000

Answer Code

```
co2_time + xlim(-3000, 2018)
```

Submit You have used 1 of 3 attempts

Answers are displayed within the problem

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