Climate change dataset

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Climate change excercises

Loading the dataframe

```
library(tidyverse)
```

```
## -- Attaching packages ---------------------------------------- tidyverse 1.3.0 --

## v ggplot2 3.2.1     v purrr   0.3.3
## v tibble  2.1.3     v dplyr   0.8.4
## v tidyr   1.0.2     v stringr 1.4.0
## v readr   1.3.1     v forcats 0.4.0

## -- Conflicts ------------------------------------------- tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

```
library(dslabs)
data("temp_carbon")
data("greenhouse_gases")
data("historic_co2")
options(digits = 3)
```

Getting summary of temp_carbon data

```
str(temp_carbon)
```

```
## 'data.frame':    268 obs. of  5 variables:
##  $ year            : num  1880 1881 1882 1883 1884 ...
##  $ temp_anomaly    : num  -0.11 -0.08 -0.1 -0.18 -0.26 -0.25 -0.24 -0.28 -0.13 -0.09 ...
##  $ land_anomaly    : num  -0.48 -0.4 -0.48 -0.66 -0.69 -0.56 -0.51 -0.47 -0.41 -0.31 ...
##  $ ocean_anomaly   : num  -0.01 0.01 0 -0.04 -0.14 -0.17 -0.17 -0.23 -0.05 -0.02 ...
##  $ carbon_emissions: num  236 243 256 272 275 277 281 295 327 327 ...
```

```
summary(temp_carbon)
```

```
##       year       temp_anomaly   land_anomaly  ocean_anomaly  carbon_emissions
##  Min.   :1751   Min.   :-0.4   Min.   :-0.7   Min.   :-0.5   Min.   :   3
##  1st Qu.:1818   1st Qu.:-0.2   1st Qu.:-0.3   1st Qu.:-0.2   1st Qu.:  14
##  Median :1884   Median : 0.0   Median : 0.0   Median : 0.0   Median : 264
##  Mean   :1884   Mean   : 0.1   Mean   : 0.1   Mean   : 0.1   Mean   :1523
##  3rd Qu.:1951   3rd Qu.: 0.3   3rd Qu.: 0.3   3rd Qu.: 0.3   3rd Qu.:1432
##  Max.   :2018   Max.   : 1.0   Max.   : 1.5   Max.   : 0.8   Max.   :9855
##                 NA's   :129    NA's   :129    NA's   :129    NA's   :4
```

Getting summary of greenhouse_gases data

```
str(greenhouse_gases)
```

```
## 'data.frame':    300 obs. of  3 variables:
##  $ year         : num  20 40 60 80 100 120 140 160 180 200 ...
##  $ gas          : chr  "CO2" "CO2" "CO2" "CO2" ...
##  $ concentration: num  278 278 277 277 278 ...
```

```
summary(greenhouse_gases)
```

```
##       year          gas            concentration
##  Min.   :  20   Length:300         Min.   : 260
##  1st Qu.: 515   Class :character   1st Qu.: 270
##  Median :1010   Mode  :character   Median : 280
##  Mean   :1010                      Mean   : 416
##  3rd Qu.:1505                      3rd Qu.: 641
##  Max.   :2000                      Max.   :1703
```

Getting summary of historic_co2 data

```
str(historic_co2)
```

```
## Classes 'spec_tbl_df', 'tbl_df', 'tbl' and 'data.frame': 694 obs. of  3 variables:
##  $ year  : num  1959 1960 1961 1962 1963 ...
##  $ co2   : num  316 317 318 318 319 ...
##  $ source: chr  "Mauna Loa" "Mauna Loa" "Mauna Loa" "Mauna Loa" ...
```

```
summary(historic_co2)
```

```
##       year              co2         source
##  Min.   :-803182   Min.   :178   Length:694
##  1st Qu.:-470498   1st Qu.:207   Class :character
##  Median : -43278   Median :237   Mode  :character
##  Mean   :-219753   Mean   :246
##  3rd Qu.:  -8924   3rd Qu.:272
##  Max.   :   2018   Max.   :409
```

When the latest year when data was recorded in temp_carbon?

*** 2014**

```
latest_year <- temp_carbon %>% filter(!is.na(carbon_emissions)) %>%
                                          select(year) %>% max()
print(latest_year)
```

```
## [1] 2014
```

What is the value of co2 emission, first time recorded and last time recorded.

Year	Emission
1751	3
2014	9855

```
first_year <- temp_carbon %>%
    filter(!is.na(carbon_emissions) & year == min(.$year))
sprintf("First Year: %d" ,first_year$year)
```

```
## [1] "First Year: 1751"
```

```
last_year <- temp_carbon %>%
    filter(!is.na(carbon_emissions)) %>% filter(year == max(.$year))
sprintf("Last Year: %d" ,last_year$year)
```

```
## [1] "Last Year: 2014"
```

```
co2_increased <- last_year$carbon_emissions/first_year$carbon_emissions
sprintf("The co2 emissions has increasesd %d times", co2_increased)
```

```
## [1] "The co2 emissions has increasesd 3285 times"
```

Compare first and last entries for temp anomaly

Year	temp_anamoly
1880	-0.11
2018	0.82

```
first_year <- temp_carbon %>%
    filter(!is.na(temp_anomaly)) %>% arrange(year)
sprintf("The first year the data is available: %s with %s temp anomaly",
        first_year[1,]$year, first_year[1,]$temp_anomaly)
```

```
## [1] "The first year the data is available: 1880 with -0.11 temp anomaly"
```

```
sprintf("The last year the data is available: %s with %s temp anomaly",
        tail(first_year,1)$year, tail(first_year,1)$temp_anomaly)
```

```
## [1] "The last year the data is available: 2018 with 0.82 temp anomaly"
```

Timeseries plot for temp anomaly

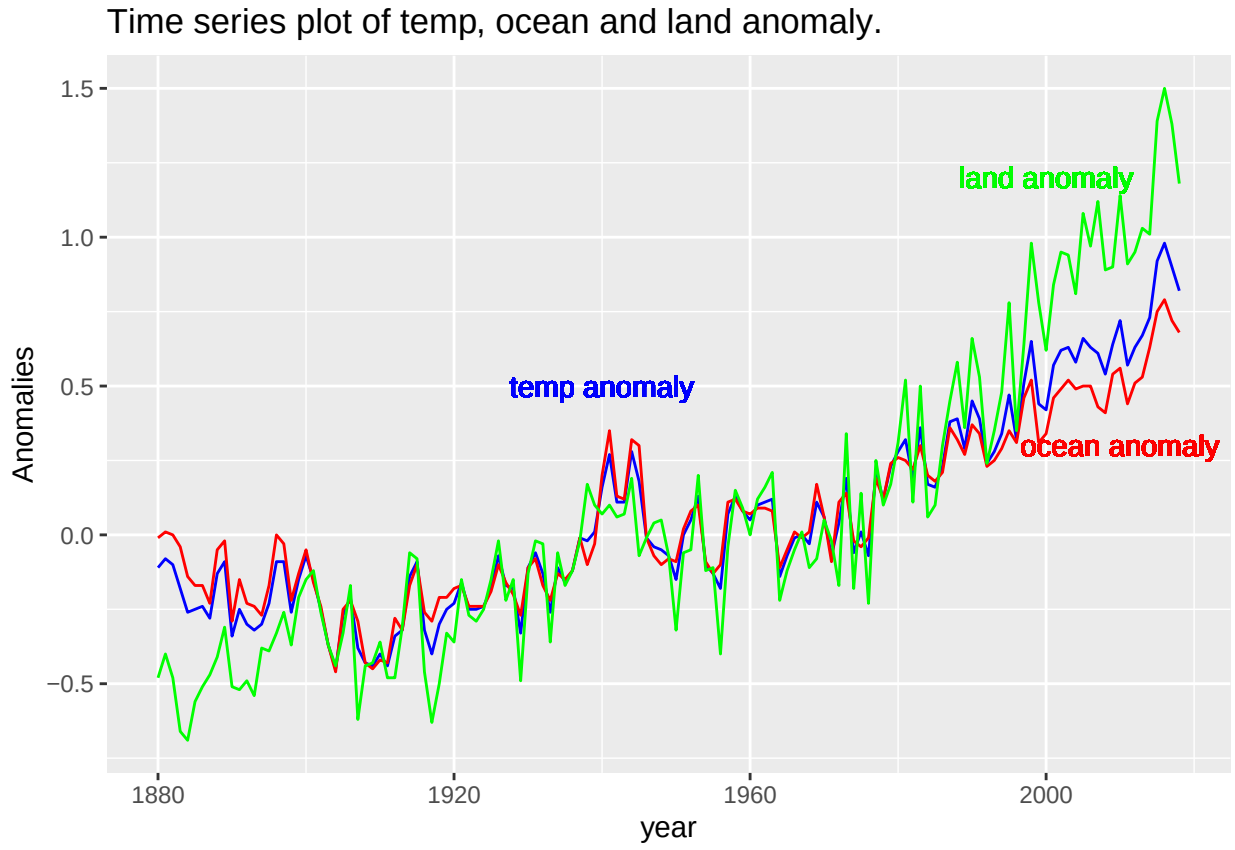
```
p <- temp_carbon %>% filter(!is.na(temp_anomaly)) %>%
    ggplot(aes(year, temp_anomaly)) + geom_line()
p <- p + geom_hline(aes(yintercept = 0), color = 'blue')
```

Adding labels

```
p <- 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")
```

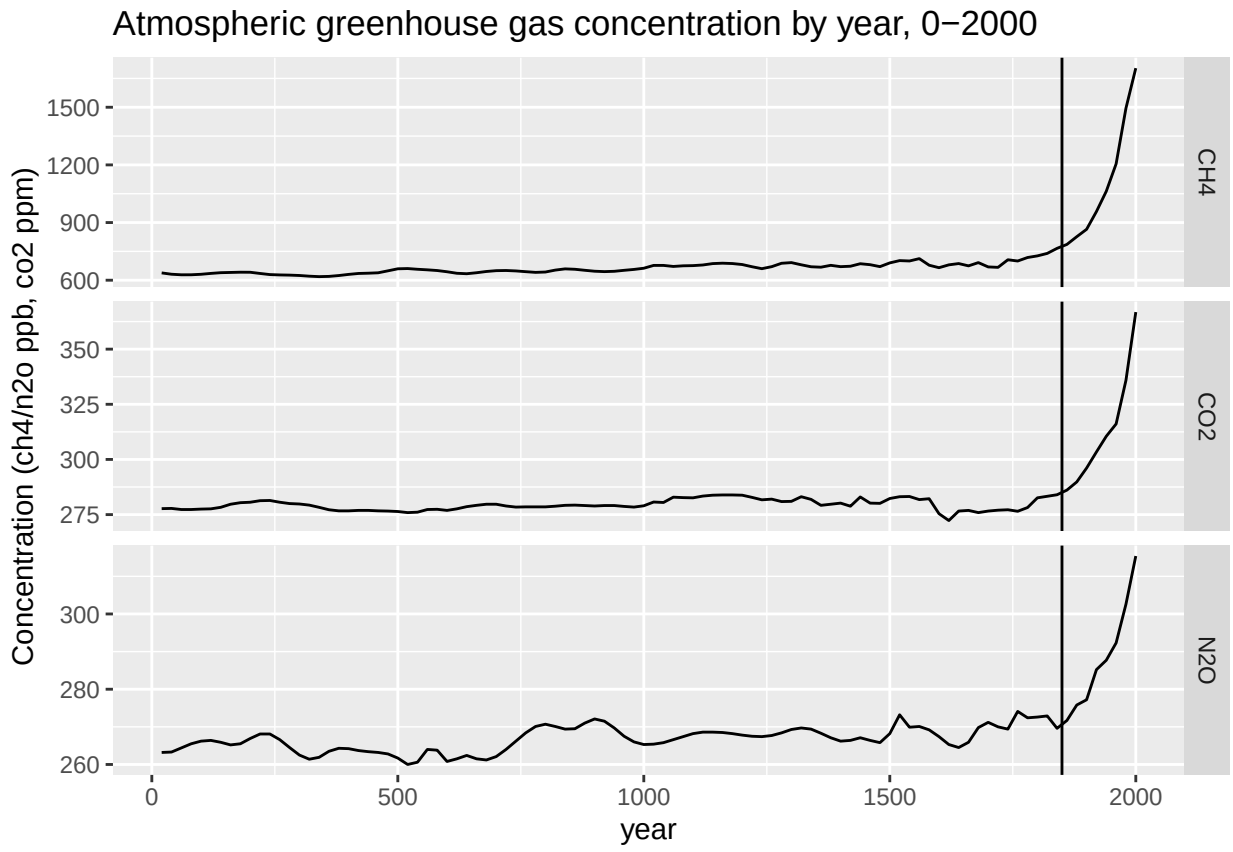
Adding land & ocean anomaly

```
q <- temp_carbon %>%
    filter(!is.na(temp_anomaly) & !is.na(land_anomaly) &
               !is.na(ocean_anomaly)) %>%
    ggplot(aes(x =year)) +
    geom_line(aes(y=temp_anomaly), color='blue') +
    geom_line(aes(y=ocean_anomaly), color='red') +
    geom_line(aes(y=land_anomaly), color='green') +
    ylab("Anomalies") +
    ggtitle("Time series plot of temp, ocean and land anomaly.") +
    geom_text(aes(x=2000, y = 1.2, label='land anomaly'), col = 'green') +
    geom_text(aes(1940, 0.5, label='temp anomaly'), col = 'blue') +
    geom_text(aes(2010, 0.3, label='ocean anomaly'), col = 'red')
q
```



Line plot for greenhouses gases such as co2, ch4, and n2o.

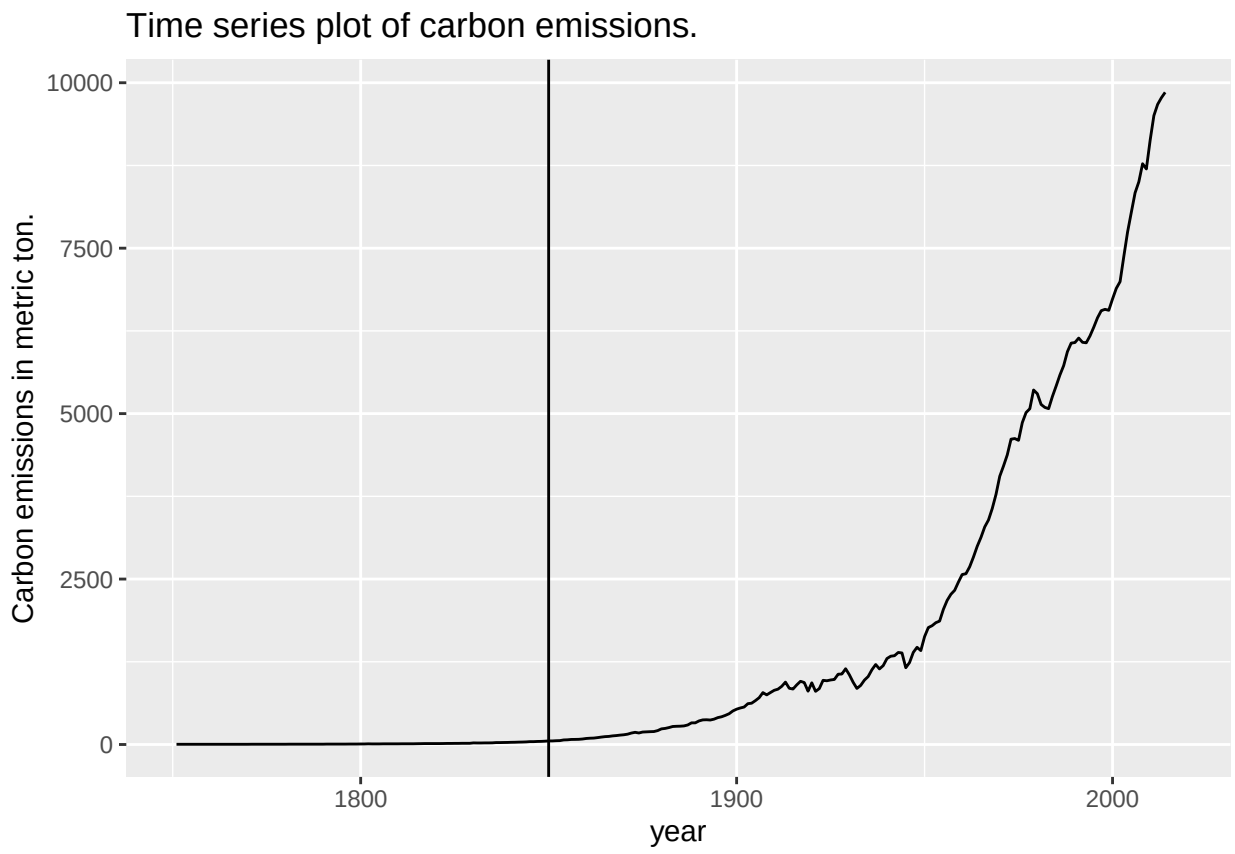
```
p <- greenhouse_gases %>%
    ggplot(aes(year, concentration)) +
    geom_line() +
    facet_grid(gas ~ ., scales = 'free') +
    geom_vline(aes(xintercept = 1850)) +
    ylab("Concentration (ch4/n2o ppb, co2 ppm)") +
    ggtitle("Atmospheric greenhouse gas concentration by year, 0-2000")
p
```



Carbon emissions time series plot

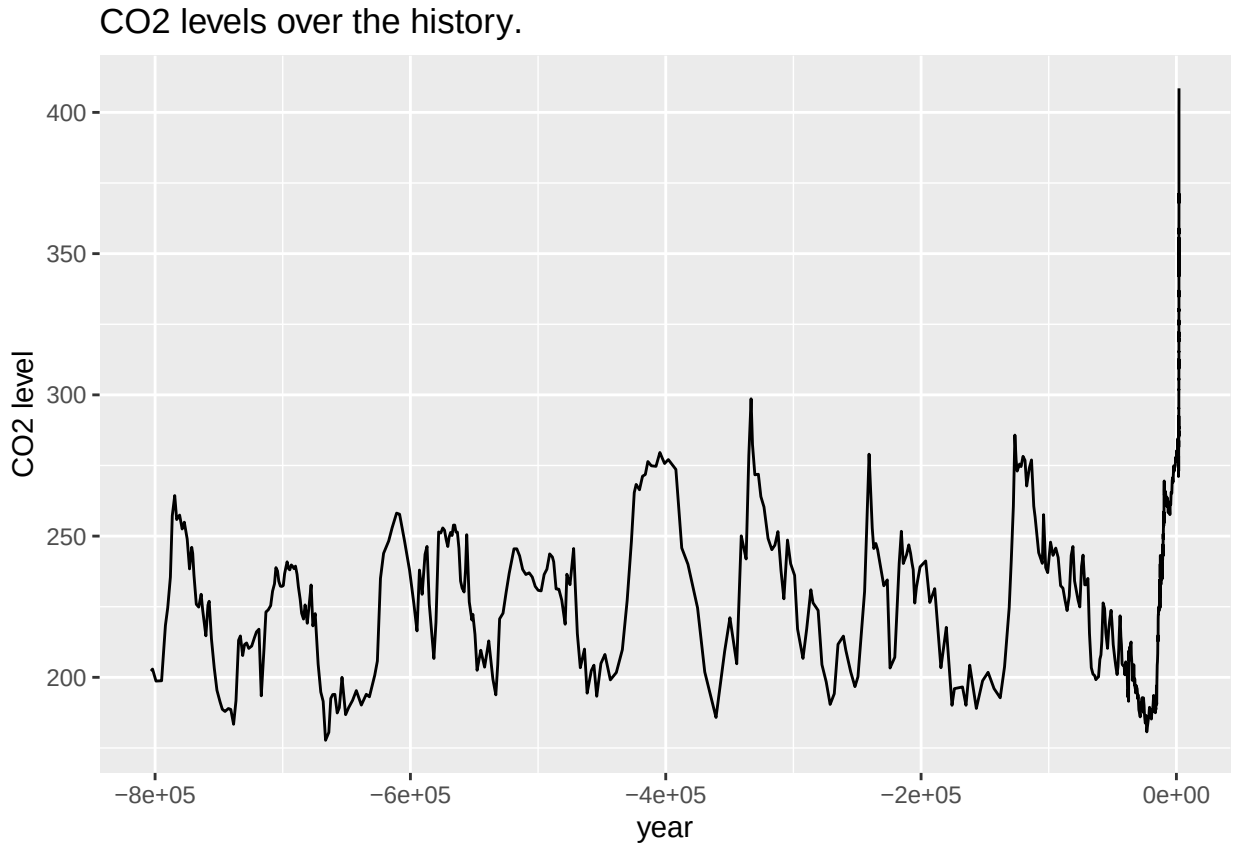
```
p <- temp_carbon %>%
    ggplot(aes(year, carbon_emissions)) +
    geom_line() +
    ylab("Carbon emissions in metric ton.") +
    ggtitle("Time series plot of carbon emissions.") +
    geom_vline(aes(xintercept = 1850))
p
```

```
## Warning: Removed 4 rows containing missing values (geom_path).
```



Plotting historic co2, dating back 800000 years, data from measurement of ice cores.

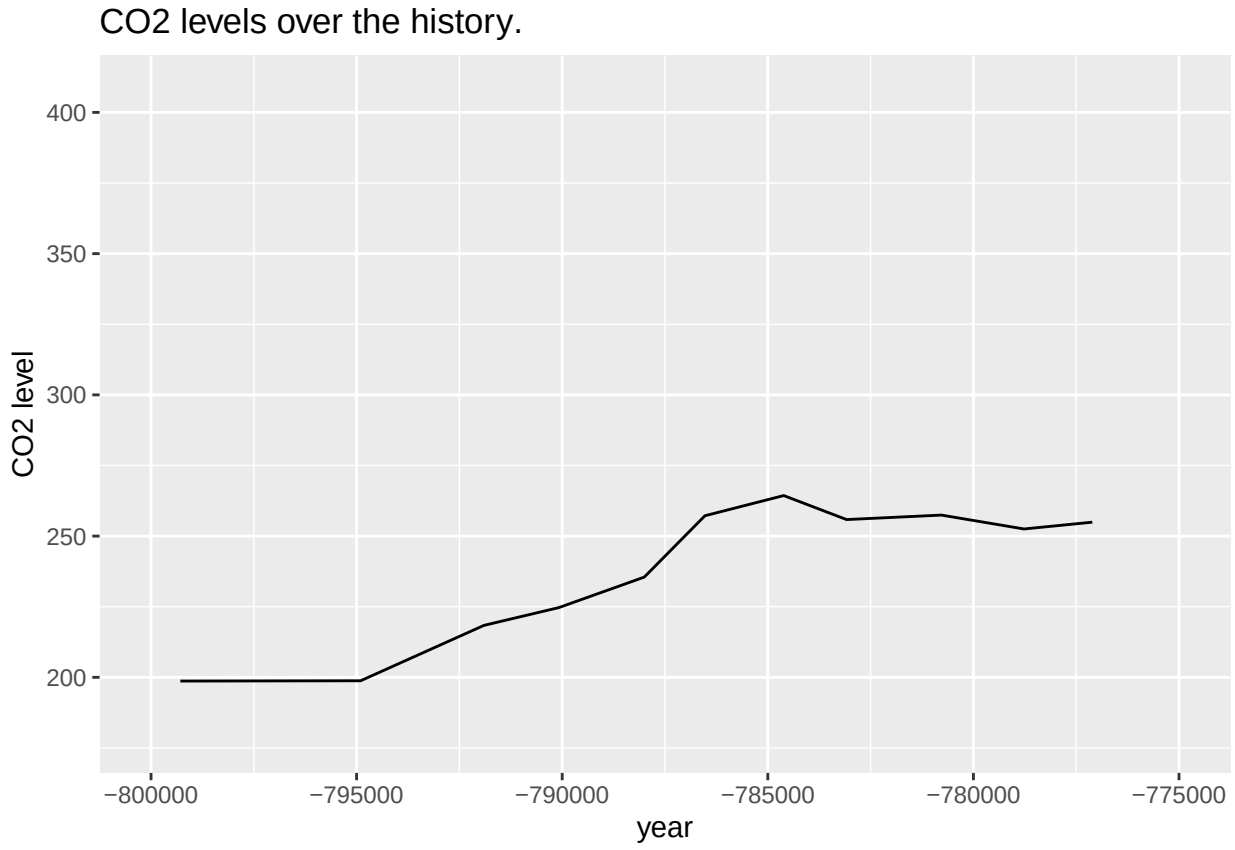
```
historic_co2 = as.data.frame(historic_co2)
co2_time <- historic_co2 %>%
    ggplot(aes(year,co2)) +
    geom_line() +
    ylab("CO2 level") +
    ggtitle("CO2 levels over the history.")
co2_time
```



playing with x-axis limits

```
co2_time1 <- co2_time +
    scale_x_continuous(limits = c(-800000, -775000))
co2_time1
```

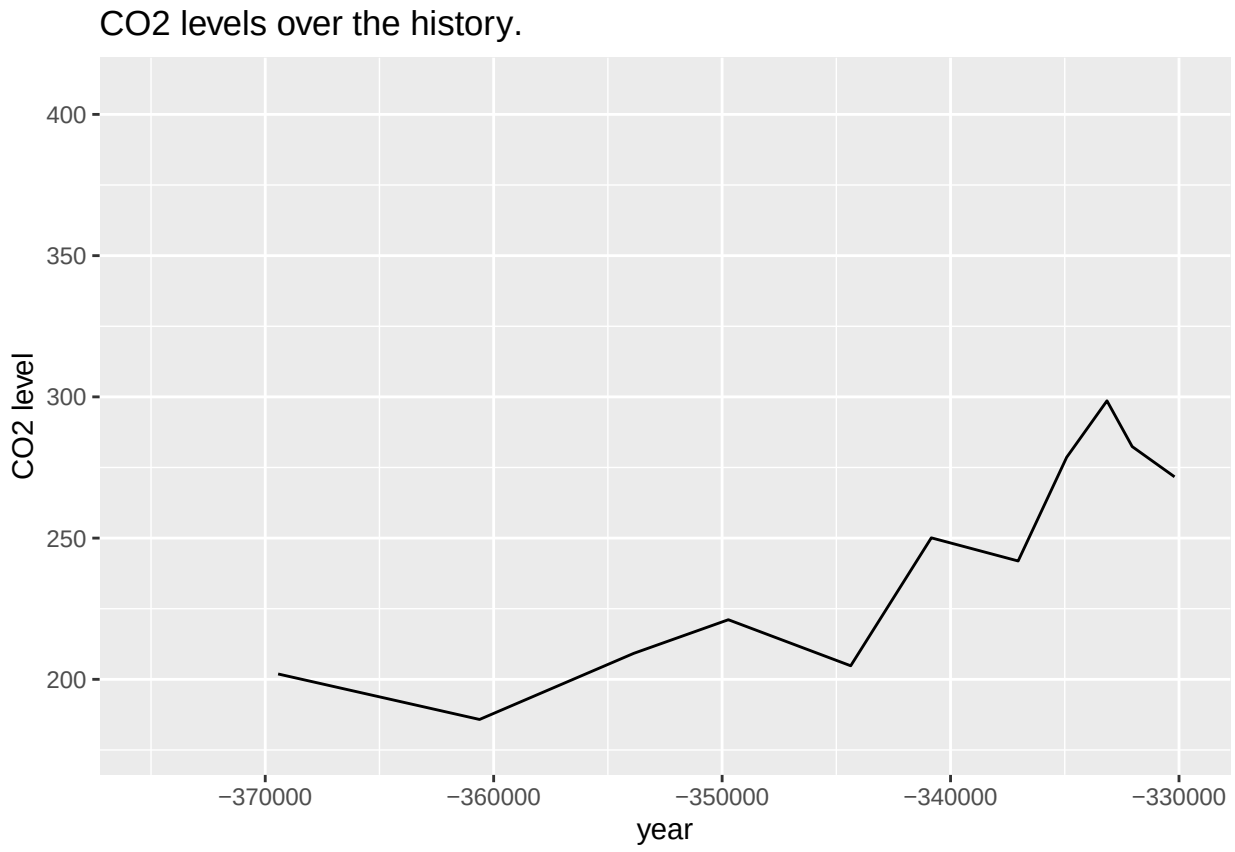
```
## Warning: Removed 683 rows containing missing values (geom_path).
```



- It took ~10,000 years for co2 level to rise from 200 pppmv to 275 ppmv

```
co2_time2 <- co2_time +
    scale_x_continuous(limits = c(-375000, -330000))
co2_time2
```

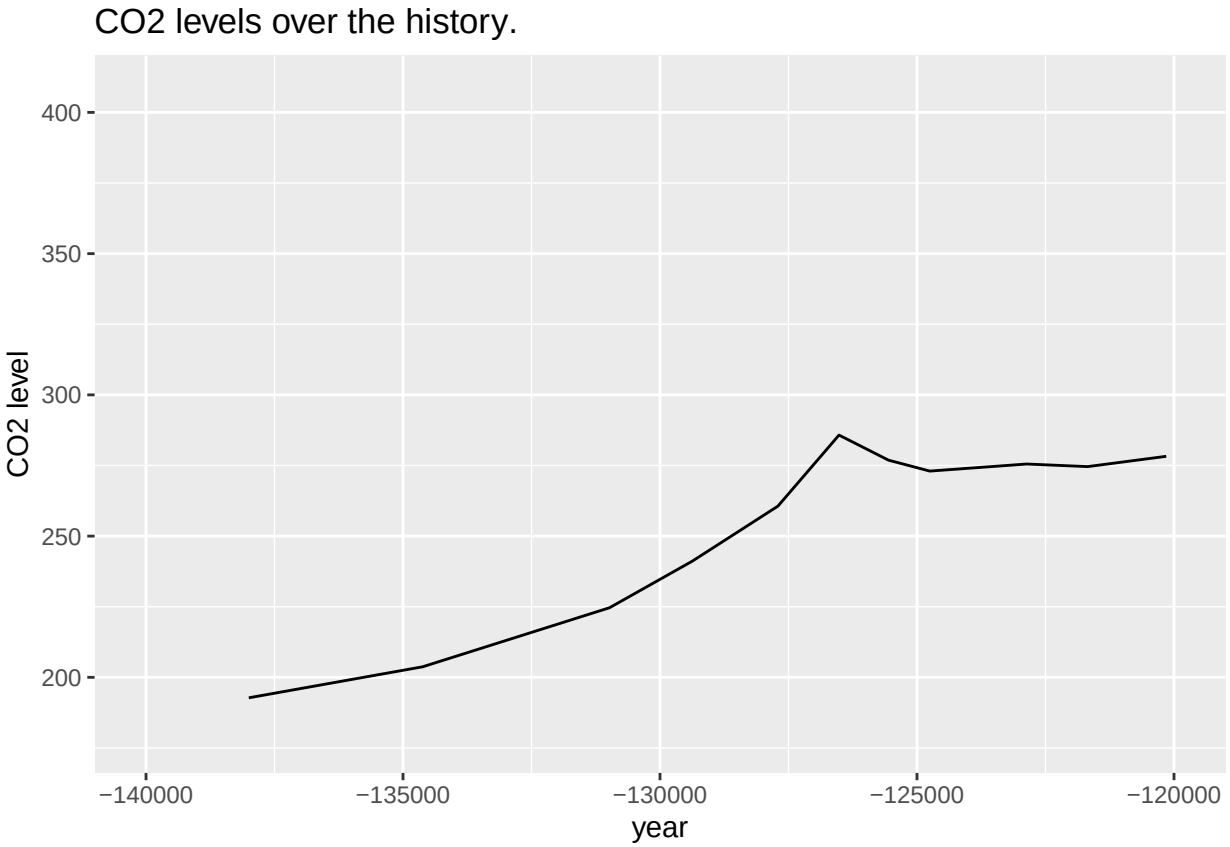
```
## Warning: Removed 683 rows containing missing values (geom_path).
```



- It took ~25,000 years for co2 level to rise from 180 pppmv to 300 ppmv

```
co2_time3 <- co2_time +
    scale_x_continuous(limits = c(-140000, -120000))
co2_time3
```

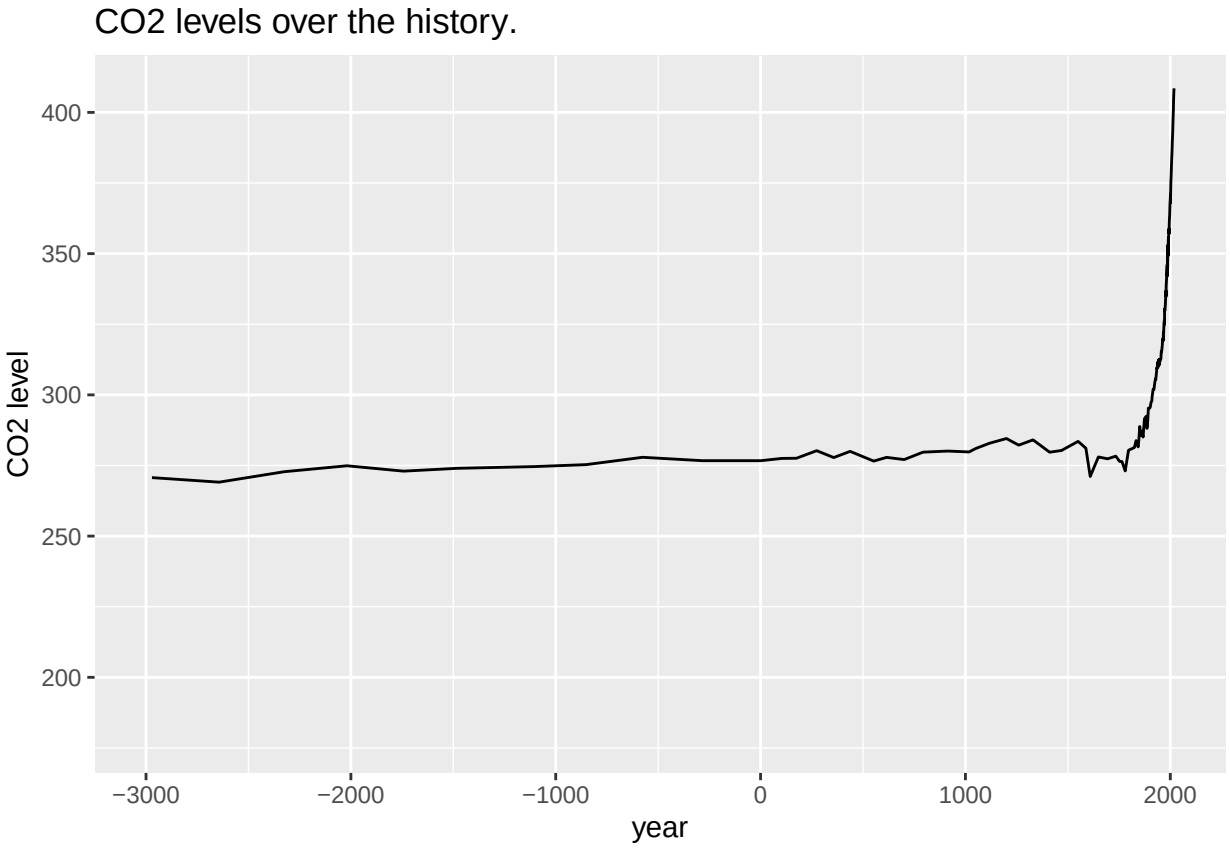
```
## Warning: Removed 683 rows containing missing values (geom_path).
```



- It took ~9,000 years for co2 level to rise from 200 pppmv to 280 ppmv

```
co2_time4 <- co2_time +
    scale_x_continuous(limits = c(-3000, 2018))
co2_time4
```

```
## Warning: Removed 539 rows containing missing values (geom_path).
```



- **It only took 250 years for co2 level to rise from 275 ppmv to 400 ppmv.**