

DOING DATA SCIENCE

INTRO TO TIDYVERSE

CLASS #4 | GEOG 215

Introduction to Spatial Data Science

Spring 2020

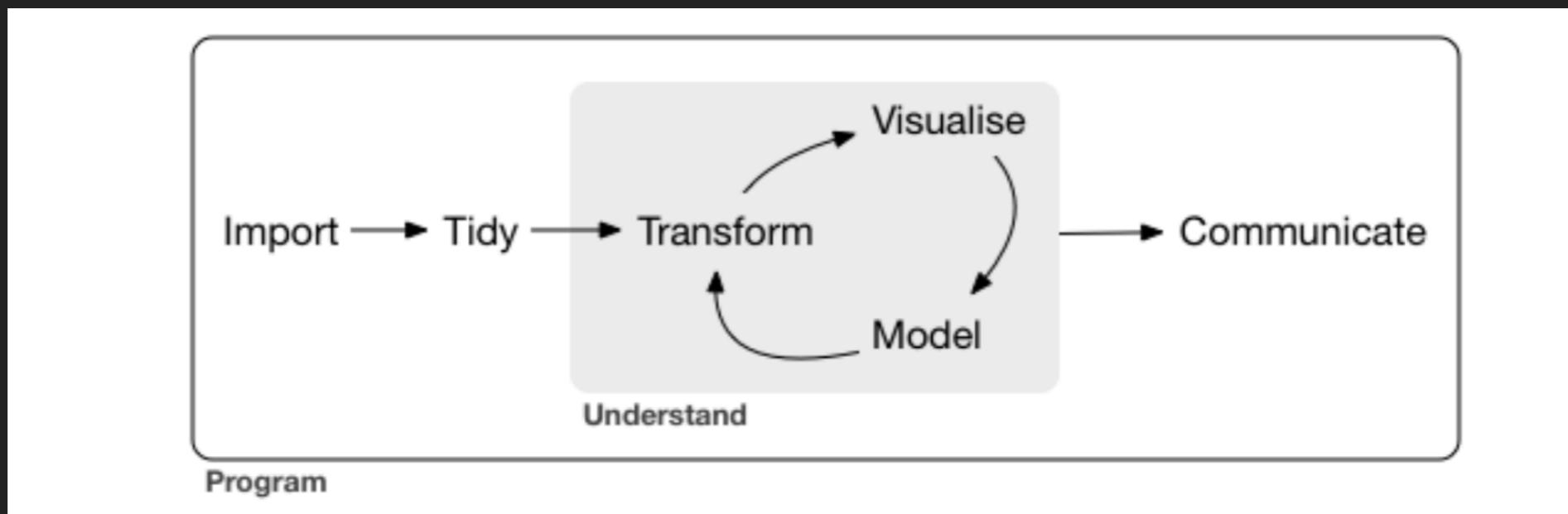
TODAY'S CLASS

- ▶ Lab recap
- ▶ Changes to future labs - Accessing DataCamp
- ▶ The Spatial Data Science Process - Your repo
- ▶ Introduction to Tidyverse
- ▶ Tidyverse In Action - Bushfires in Australia
- ▶ (If time remains) - start lab2

KEYWORDS

- ▶ Data Structures
 - ▶ Vector - Numeric, character, logical (data types)
 - ▶ Data Frame
- ▶ Factors (more later)
- ▶ Vector/data frame subsetting
- ▶ Indexing (positive, negative, logical, character)
- ▶ `class()`, `str()`, `summary()`

THE DATA SCIENCE PROCESS



Source: Wickham H., *R for Data Science*

WHAT WORDS COME TO YOUR MIND WHEN YOU THINK ABOUT SPATIAL DATA SCIENCE

WORD CLOUD

IMPORT

geography

TRANSFORM

statistics

distribution
computation

math

algorithms

sort coding

excel manipulation

programming

WORD CLOUD

VISUALIZE

mapping

visualization

magic

storytelling

WORD CLOUD

MODEL

exploration

explaining

analysis

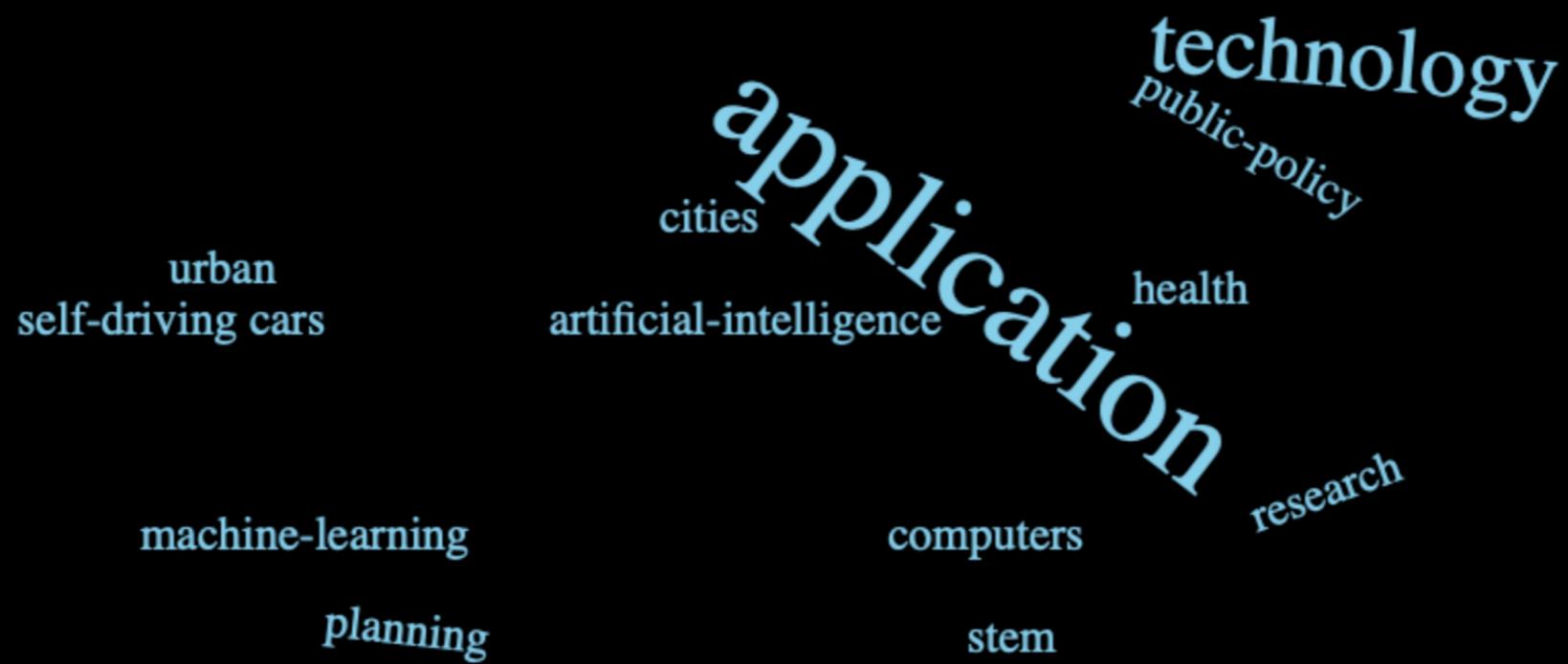
patterns

correlation

trends

WORD CLOUD

COMMUNICATE (APPLICATIONS)



WORD CLOUD

EMOTIONS ?

useful intimidating immersive

complicated

important

hard

exciting

huge

cool

effective
intense

convenient infinite
sophisticated

SO MANY THINGS, HOW DO WE BRING THIS ALL TOGETHER ?



Source: <https://giphy.com>

TIDYVERSE - SWISS ARMY KNIFE OF DOING DATA SCIENCE



Tidyverse

Packages Blog Learn Help Contribute

R packages for data science

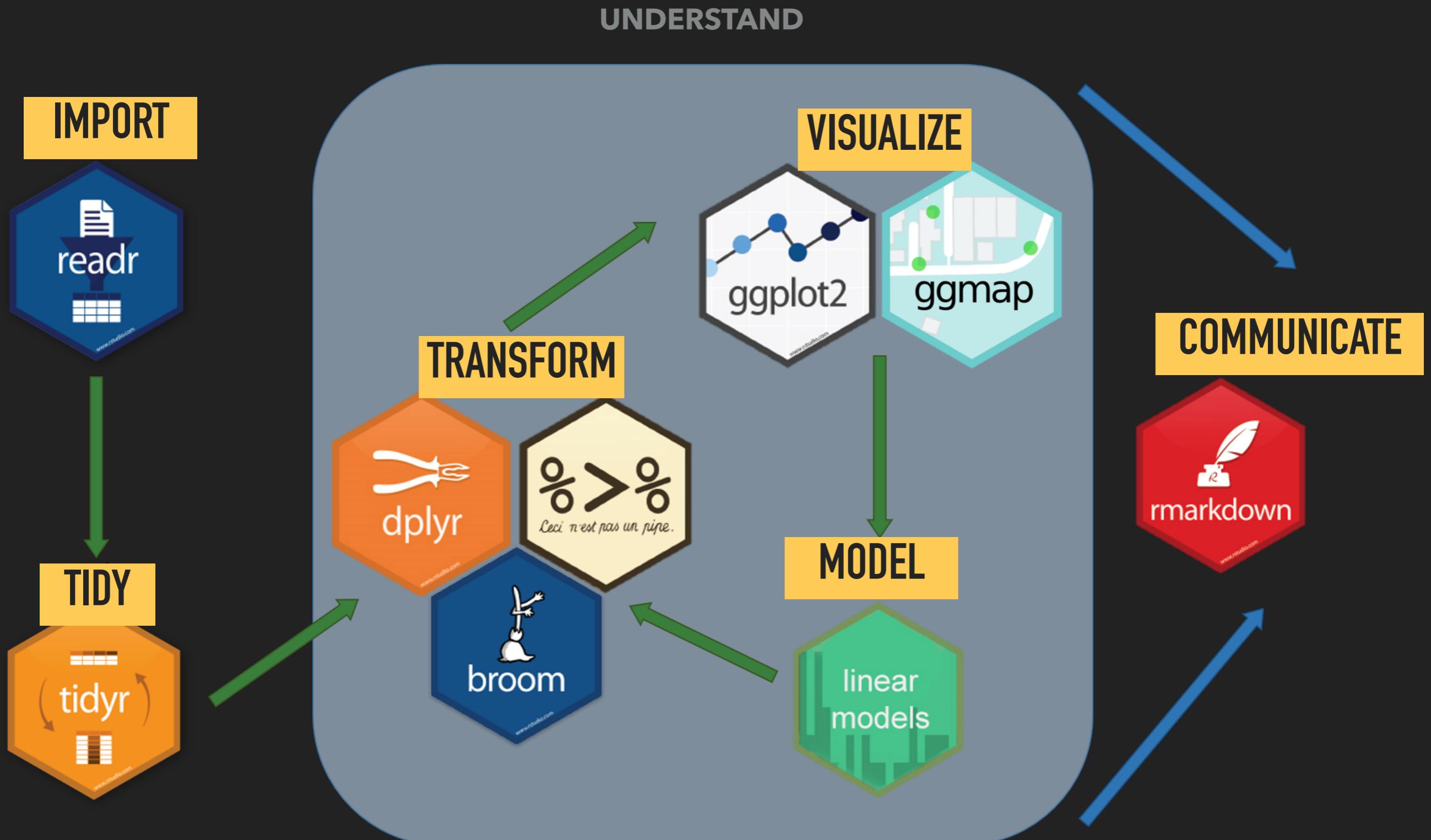
The tidyverse is an opinionated [collection of R packages](#) designed for data science. All packages share an underlying design philosophy, grammar, and data structures.

Install the complete tidyverse with:

```
install.packages("tidyverse")
```

Focus on **CONTENT**, not **CODE**

TIDYVERSE FRAMEWORK



ANALYZING THE AUSTRALIAN BUSHFIRES



QUESTIONS TO ASK

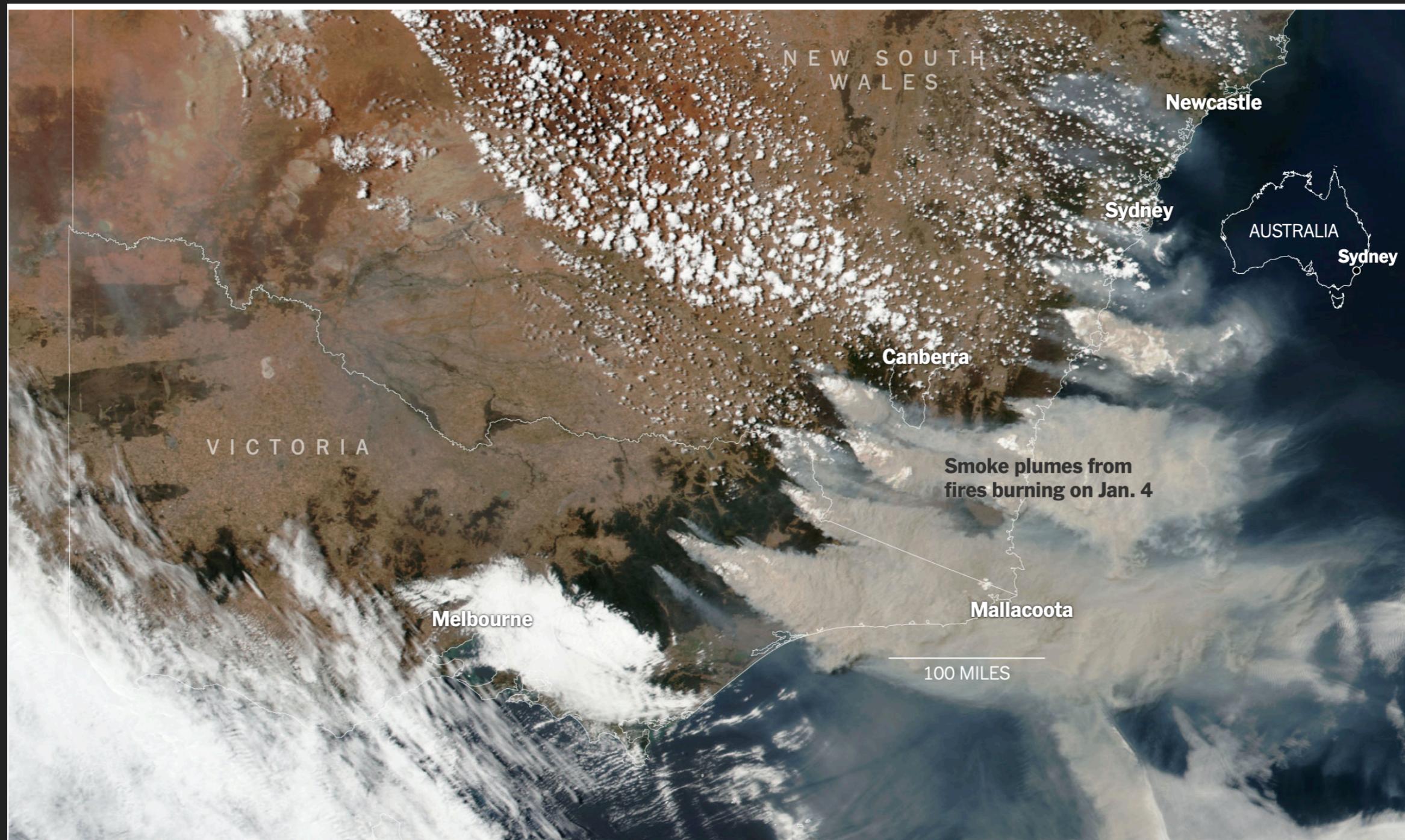
- ▶ Where (space) are they spreading (time)
- ▶ How bad are these fires relative to previous ones
- ▶ What is the relationship between the spread of these fires and climate conditions?
- ▶ How many people/wildlife is impacted
- ▶ Where can we direct resources to fight them?
- ▶ Can we predict the timing and location of future wildfires like this?

WHAT KIND OF DATA DO WE NEED ?

- ▶ Poll everywhere

<https://pollev.com/goelvarun553/>

BUSHFIRES DATA



Source NASA, from NYtimes

FIND, ASK, REQUEST)

NASA-FIRMS : Your Download Request Id - 99737 ➤

 **NASA FIRMS** <noreply@modaps.eosdis.nasa.gov>
to me ▾

Greetings!

Your NASA FIRMS Fire Archive Download request is completed. You can download the data from
https://firms.modaps.eosdis.nasa.gov/data/download/DL_FIRE_M6_99737.zip

Please note that your data will be available for up to 45 days on our server,
after which we may delete them.

Here's the summary of your request:

Download Id	:	99737
Data Source	:	MODIS C6
Start Date	:	2003-01-01
End Date	:	2020-01-21
Output Format	:	shp
Area of Interest	:	Australia

If you have any questions or comments, please contact us at support@earthdata.nasa.gov.
Please include the word "FIRMS" in the subject line.

Thank you,
NASA FIRMS Team

More information on NASA FIRMS can be found at <https://earthdata.nasa.gov/firms>.

FIND DATA

CLIMATE DATA

www.bom.gov.au/?ref=logo

Presentation Tidy Messy Data Sakai @ UNC... tidytuesday/re... Australia's offic... Sakai @ UNC... Inbox (23,952)... Sakai @ UNC... Mail - Goel, Var...

Australian Government Bureau of Meteorology

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Warnings current

NSW | VIC | QLD | WA | SA | TAS | ACT | NT Warning services

Rain radars
Satellite images
Weather maps
MetEye

BUREAU OF METEOROLOGY
WHATEVER THE WEATHER,
CHECK THE UV FORECAST

Advertisement

Forecast for Wednesday 22 January

City observations

Sydney	Melbourne	Brisbane	Perth	Adelaide	Hobart	Canberra	Darwin
Now 21.8° NW 2km/h	Now 15.2° NNE 9km/h	Now 25.5° CALM 0km/h	Now 18.6° S 22km/h	Now 25.6° N 11km/h	Now 14.4° N 9km/h	Now 14.6° CALM 0km/h	Now 24.0° W 30km/h
21° 29° Sunny.	15° 32° Windy. Late cool change then rain.	25° 34° Partly cloudy.	14° 25° Mostly sunny.	20° 26° Partly cloudy.	13° 28° Late rain.	13° 32° Sunny.	26° 29° Storms. Possible heavy falls.
0.2mm rain since 9am in Sydney.	0.0mm rain since 9am in Melbourne.	0.2mm rain since 9am in Brisbane.	0.0mm rain since 9am in Perth.	0.0mm rain since 9am in Adelaide.	0.0mm rain since 9am in Hobart.	0.0mm rain since 9am in Canberra.	32.8mm rain since 9am in Darwin.

PUBLIC SPATIAL DATA

 **Natural Earth**

Free vector and raster map data at 1:10m, 1:50m, and 1:110m scales

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Downloads

Data themes are available in three levels of detail. For each scale, themes are listed on Cultural, Physical, and Raster category pages.

Stay up to date! Know when a new version of Natural Earth is released by subscribing to our [announcement list](#).

Overwhelmed? The [Natural Earth quick start kit](#) (227 mb) provides a small sample of Natural Earth themes styled in an ArcMap .MXD document and in a QGIS document. Download all vector themes as [SHP](#) (279 mb), [SQLite](#) (222 mb), or [GeoPackage](#) (260 mb).

Natural Earth is the creation of many [volunteers](#) and is supported by [NACIS](#). It is free for use in any type of project. [Full Terms of Use »](#)

Large scale data, 1:10m



[Cultural](#) [Physical](#) [Raster](#)

The most detailed. Suitable for making zoomed-in maps of countries and regions. Show the world on a large wall poster.

1:10,000,000
1" = 158 miles
1 cm = 100 km

Medium scale data, 1:50m



[Cultural](#) [Physical](#) [Raster](#)

Suitable for making zoomed-out maps of countries and regions. Show the world on a tabloid size page.

1:50,000,000
1" = 790 miles
1 cm = 500 km

Small scale data, 1:110m



[Cultural](#) [Physical](#)

Suitable for schematic maps of the world on a postcard or as a small locator globe.

1:110,000,000
1" = 1,736 miles
1 cm = 1,100 km

IMPORT

```
#load important libraries  
library(tidyverse)  
library(sf)
```

IMPORT

```
# import rainfall and temperature
temp_raw <- read_csv("tidytuesday-master/data/2020/2020
-01-07/temperature.csv")
precip_raw <- read_csv("tidytuesday-master/data/2020/2020
-01-07/rainfall.csv")
```

Similar to `read.csv` but more elegant

Tells you what package the function is from
(Useful in case of functions with same names)

```
rainfall <- readr::read_csv('https://raw.githubusercontent.com/rfordatascience/tidytuesday/master/data/2020/2020
-01-07/rainfall.csv')
```

Can also read directly from internet
(Useful for real time data)

IMPORT

```
# Import data on Bushfire incidents
## two major sources - NASA FIRMS and NSW Rural Fire
Service
### reading geographic data
url <- "http://www.rfs.nsw.gov.au/feeds/majorIncidents
.json" # website where RFS data is stored
aus_fires <- st_read(url) # read Geographic data on fires
# Import downloaded real time fire shapefile ((A popular
format for storing geographic data from the internet))
nasa_fires_nrt <- st_read("./DL_FIRE_M6_99737/","fire_nrt
_M6_99737")
```

Read from Internet

Read from Computer

TIDY

TIDY

RAINFALL DATA IN WIDE FORMAT

Bureau of Meteorology station number	1-1-67	1/2/1967	1-3-67	1-4-67	1-5-67
9151	0	0.3	1	0	5
9152	0	2.5	2	0	0.7
9153	0	3.4	3	0	0
9154	0	0	4	1.2	0
9155	0	0	5	0	0
9156	0	NA	6	0	0
9157	0	21	7	0	0
9158	1967	1	8		

WEATHER STATION DATA IN LONG FORMAT

Bureau of Meteorology product IDCJMC0014. Australian stations measuring total monthly rainfall								Produced: 06 Jan 2020		
Site	Name	Lat	Lon	Start	End	Years	%	AWS		
1000	KARUNJIE	-16.2919	127.1956	Oct 1940	Aug 1981	24.9	61	N		
1001	OMBULGURRI	-15.1806	127.8456	Jan 1914	Jan 2011	56.4	58	N		
1003	PAGO MISSION	-14.1331	126.7158	Nov 1908	Apr 1940	31.5	100	N		
1004	KUNMUNYA	-15.4167	124.7167	Jan 1915	Dec 1948	34.0	100	N		
1005	WYNDHAM PORT	-15.4644	128.1000	Nov 1886	Mar 1995	101.2	93	N		
1006	WYNDHAM AERO	-15.5100	128.1503	Feb 1951	Dec 2019	35.7	52	Y		
1007	TROUGHTON ISLAND	-13.7542	126.1485	Sep 1956	Dec 2019	34.3	54	Y		
1008	MOUNT ELIZABETH OLD SITE	-16.3017	126.1825	Sep 1959	Nov 1977	18.1	99	N		
1009	KURI BAY	-15.4875	124.5222	Aug 1961	Mar 2012	45.8	90	N		
1010	THEDA	-14.7885	126.4963	Oct 1965	Dec 2019	52.3	96	N		
1011	PANTA DOWNS	-16.0497	124.9500	Dec 1966	Jan 1969	1.8	81	N		
1012	MITCHELL PLATEAU	-14.7925	125.8258	Jan 1968	Oct 1986	18.7	99	N		
1013	WYNDHAM	-15.4869	128.1236	Apr 1968	Dec 2019	51.8	100	N		
1014	EMMA GORGE	-15.9083	128.1286	Jan 1998	Feb 2019	16.9	80	N		
1016	CARSON RIVER STATION	-14.4861	126.7664	Dec 1970	Mar 1997	15.7	59	N		
1017	NULLA NULLA	-15.5000	127.8333	Apr 1923	Sep 1926	3.4	97	N		
1018	MOUNT ELIZABETH	-16.4181	126.1025	Feb 1973	Dec 2019	45.9	98	N		
1019	KALUMBURU	-14.2964	126.6453	Sep 1998	Dec 2019	21.3	100	Y		
1020	TRUSCOTT	-14.0900	126.3867	May 2004	Dec 2019	15.6	99	Y		
1021	KALUMBURU MISSION	-14.2961	126.6431	Sep 1941	Mar 2005	63.5	100	N		
1022	WYNDHAM SIX MILE HOTEL	-15.4997	128.1997	Jan 1900	Dec 1917	8.7	48	N		
1023	EL QUESTRO	-16.0086	127.9806	Dec 1967	Dec 2019	34.2	66	N		
1024	ELLENBRAE	-15.9572	127.0628	Jan 1987	Dec 2019	27.4	83	N		
1025	DOONGAN	-15.3797	126.3114	Jan 1988	Dec 2019	31.8	99	N		
1026	DRYSDALE RIVER STATION	-15.7031	126.3781	Jan 1988	Dec 2019	31.5	98	N		
1027	DIGGERS REST	-15.6394	128.0803	Jan 1971	Dec 2019	24.3	49	N		
1028	HOME VALLEY	-15.7231	127.8292	Aug 1991	Mar 2019	16.3	59	N		
1029	WYNDHAM NORTH	-15.4467	128.1075	Sep 1989	Feb 1995	4.5	82	N		
1030	KIMBERLEY COASTAL CAMP	-14.5786	125.9133	Nov 1995	Dec 2013	9.3	51	N		
1031	FARAWAY BAY	-13.9600	127.1964	Nov 1996	Dec 2019	22.3	96	N		

TIDYING DATA - WIDE TO LONG

table4a

Wide Data (table4a):

country	1999	2000
A	0.7K	2K
B	37K	80K
C	212K	213K

Long Data:

country	year	cases
A	1999	0.7K
B	1999	37K
C	1999	212K
A	2000	2K
B	2000	80K
C	2000	213K

key value

TIDY RAINFALL DATA

station_code	city_name	year	month	day	rainfall	period	quality	lat	long	station_name
9151	Perth	2019	1	15	0	NA	N	-31.96	115.79	Subiaco Wastewater Treatment Plant
9151	Perth	2019	1	16	0	NA	N	-31.96	115.79	Subiaco Wastewater Treatment Plant
9151	Perth	2019	1	17	0	NA	N	-31.96	115.79	Subiaco Wastewater Treatment Plant
9151	Perth	2019	1	18	0	NA	N	-31.96	115.79	Subiaco Wastewater Treatment Plant
9151	Perth	2019	1	19	0	NA	N	-31.96	115.79	Subiaco Wastewater Treatment Plant
9151	Perth	2019	1	20	0	NA	N	-31.96	115.79	Subiaco Wastewater Treatment Plant
9151	Perth	2019	1	21	0	NA	N	-31.96	115.79	Subiaco Wastewater Treatment Plant
9151	Perth	2019	1	22	0	NA	N	-31.96	115.79	Subiaco Wastewater Treatment Plant
9151	Perth	2019	1	23	0	NA	N	-31.96	115.79	Subiaco Wastewater Treatment Plant
9151	Perth	2019	1	24	0	NA	N	-31.96	115.79	Subiaco Wastewater Treatment Plant
9151	Perth	2019	1	25	4	1	N	-31.96	115.79	Subiaco Wastewater Treatment Plant
9151	Perth	2019	1	26	0	NA	N	-31.96	115.79	Subiaco Wastewater Treatment Plant
9151	Perth	2019	1	27	0	NA	N	-31.96	115.79	Subiaco Wastewater Treatment Plant
9151	Perth	2019	1	28	0	NA	N	-31.96	115.79	Subiaco Wastewater Treatment Plant
9151	Perth	2019	1	29	0	NA	N	-31.96	115.79	Subiaco Wastewater Treatment Plant
9151	Perth	2019	1	30	0	NA	N	-31.96	115.79	Subiaco Wastewater Treatment Plant
9151	Perth	2019	1	31	0	NA	N	-31.96	115.79	Subiaco Wastewater Treatment Plant
9151	Perth	2019	2	1	0	NA	Y	-31.96	115.79	Subiaco Wastewater Treatment Plant
9151	Perth	2019	2	2	0	NA	Y	-31.96	115.79	Subiaco Wastewater Treatment Plant
9151	Perth	2019	2	3	0	NA	Y	-31.96	115.79	Subiaco Wastewater Treatment Plant
9151	Perth	2019	2	4	0	NA	Y	-31.96	115.79	Subiaco Wastewater Treatment Plant
9151	Perth	2019	2	5	0	NA	Y	-31.96	115.79	Subiaco Wastewater Treatment Plant
9151	Perth	2019	2	6	0	NA	Y	-31.96	115.79	Subiaco Wastewater Treatment Plant
9151	Perth	2019	2	7	0.2	1	Y	-31.96	115.79	Subiaco Wastewater Treatment Plant
9151	Perth	2019	2	8	0	NA	Y	-31.96	115.79	Subiaco Wastewater Treatment Plant
9151	Perth	2019	2	9	0	NA	Y	-31.96	115.79	Subiaco Wastewater Treatment Plant

```
rain_tidy <- read_csv("rain_raw.csv") %>%
  janitor::clean_names() %>%
  gather(-bureau, key = year, value = rainfall)
```

TIDYING DATA - COMBINING MULTIPLE FILES

date	maximum temperature (degC)	site number	site name
1910-01-01	26.7	9021	PERTH AIRPORT
1910-01-02	27.0		
1910-01-03	27.5		
1910-01-04	24.0		
1910-01-05	24.8		
1910-01-06	24.4		
1910-01-07	25.3		
1910-01-08	28.0		
1910-01-09	32.6		
1910-01-10	35.9		
1910-01-11	33.9		
1910-01-12	38.6		
1910-01-13	35.1		
1910-01-14	32.9		
1910-01-15	30.3		
1910-01-16	25.8		
1910-01-17	25.7		
1910-01-18	25.4		
1910-01-19	26.1		
1910-01-20	32.6		
1910-01-21	36.0		
1910-01-22	27.0		

date	minimum temperature (degC)	site number	site name
1949-06-04	2.4	40842	BRISBANE AERO
1949-06-05	10.0		
1949-06-06	5.6		
1949-06-07	7.1		
1949-06-08	6.1		
1949-06-09	11.7		
1949-06-10	12.2		
1949-06-11	12.0		
1949-06-12	5.6		
1949-06-13	5.3		
1949-06-14	10.0		
1949-06-15	9.5		
1949-06-16	12.5		
1949-06-17	12.9		
1949-06-18	9.3		
1949-06-19	9.6		
1949-06-20	11.3		
1949-06-21	9.1		
1949-06-22	5.3		
1949-06-23	2.3		
1949-06-24	2.1		
1949-06-25	0.8		
1949-06-26	0.6		
1949-06-27	3.1		
1949-06-28	4.6		
1949-06-29	2.4		
1949-06-30	2.5		

COMBINED DATA

Apply (map) read file function to MULTIPLE FILES

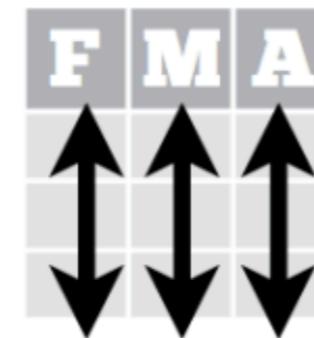
```
# Get Clean Temp Data -----  
-----  
clean_df <- read_file_list %>%  
  map(read_clean_temp_data) %>%  
  bind_rows()
```

Combine rows from MULTIPLE FILES TOGETHER

city_name	date	temperature	temp_type	site_name
PERTH	2019-05-31	26.3	max	PERTH AIRPORT
PERTH	2019-05-30	23.5	max	PERTH AIRPORT
PERTH	2019-05-29	23.6	max	PERTH AIRPORT
PERTH	2019-05-28	23.4	max	PERTH AIRPORT
PERTH	2019-05-27	22.2	max	PERTH AIRPORT
PERTH	2019-05-26	21.8	max	PERTH AIRPORT
PERTH	2019-05-25	21	max	PERTH AIRPORT
PERTH	2019-05-24	21.5	max	PERTH AIRPORT
PERTH	2019-05-23	21.9	max	PERTH AIRPORT
PERTH	2019-05-22	22.2	max	PERTH AIRPORT
PERTH	2019-05-21	21.6	max	PERTH AIRPORT
PERTH	2019-05-20	21.1	max	PERTH AIRPORT
PERTH	2019-05-19	21.2	max	PERTH AIRPORT
PERTH	2019-05-18	17.9	max	PERTH AIRPORT
PERTH	2019-05-17	17.1	max	PERTH AIRPORT
PERTH	2019-05-16	17.3	max	PERTH AIRPORT
PERTH	2019-05-15	29.7	max	PERTH AIRPORT
PERTH	2019-05-14	27.9	max	PERTH AIRPORT
PERTH	2019-05-13	22.6	max	PERTH AIRPORT
PERTH	2019-05-12	25.3	max	PERTH AIRPORT

WHAT IS TIDY DATA

In a tidy
data set:



Each **variable** is saved
in its own **column**

&



Each **observation** is
saved in its own **row**

country	year	cases	population
Afghanistan	1990	45	1837071
Afghanistan	2000	2666	2059360
Brazil	1999	37737	17206362
Brazil	2000	86488	17404898
China	1999	212258	127215272
China	2000	21366	128042583

variables

country	year	cases	population
Afghanistan	1999	45	1837071
Afghanistan	2000	2666	2059360
Brazil	1999	37737	17206362
Brazil	2000	86488	17404898
China	1999	212258	127215272
China	2000	21366	128042583

observations

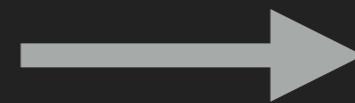
country	year	cases	population
Afghanistan	1999	45	1837071
Afghanistan	2000	2666	2059360
Brazil	1999	37737	17206362
Brazil	2000	86488	17404898
China	1999	212258	127215272
China	2000	21366	128042583

values

TRANSFORM

DAILY TEMPERATURE TO YEARLY TEMPERATURE ANOMALIES

city_name	date	temperature	temp_type	site_name
PERTH	2019-05-31	26.3	max	PERTH AIRPORT
PERTH	2019-05-30	23.5	max	PERTH AIRPORT
PERTH	2019-05-29	23.6	max	PERTH AIRPORT
PERTH	2019-05-28	23.4	max	PERTH AIRPORT
PERTH	2019-05-27	22.2	max	PERTH AIRPORT
PERTH	2019-05-26	21.8	max	PERTH AIRPORT
PERTH	2019-05-25	21	max	PERTH AIRPORT
PERTH	2019-05-24	21.5	max	PERTH AIRPORT
PERTH	2019-05-23	21.9	max	PERTH AIRPORT
PERTH	2019-05-22	22.2	max	PERTH AIRPORT
PERTH	2019-05-21	21.6	max	PERTH AIRPORT
PERTH	2019-05-20	21.1	max	PERTH AIRPORT
PERTH	2019-05-19	21.2	max	PERTH AIRPORT
PERTH	2019-05-18	17.9	max	PERTH AIRPORT
PERTH	2019-05-17	17.1	max	PERTH AIRPORT
PERTH	2019-05-16	17.3	max	PERTH AIRPORT
PERTH	2019-05-15	29.7	max	PERTH AIRPORT
PERTH	2019-05-14	27.9	max	PERTH AIRPORT
PERTH	2019-05-13	22.6	max	PERTH AIRPORT
PERTH	2019-05-12	25.3	max	PERTH AIRPORT



year	ave_temp	temp_diff
1910	16.66820	-0.732844049
1911	16.41932	-0.981731102
1912	16.75197	-0.649077882
1913	15.46903	-1.932020259
1914	16.64176	-0.759288180
1915	16.08553	-1.315521056
1916	15.48748	-1.913568939
1917	15.11370	-2.287341282
1918	15.82258	-1.578466262
1919	16.54446	-0.856581395
1920	15.67254	-1.728507429
1921	16.54782	-0.853223239

SUBSETTING BAD DATA, CREATE NEW COLUMNS

SUBSET by Quality and Year

Create new column with full date

```
temp_clean <- temp_raw %>%
  filter(quality == "Y") %>%
  filter(year >= 1900) %>%
  filter(year < 2020) %>%
  mutate(date = ymd(paste(year, month, day, sep = "-")))
```

GROUPING AND SUMMARIZING

Calculate average
temperature , and anomaly

Tell R to calculate Average
Temperature for EACH year

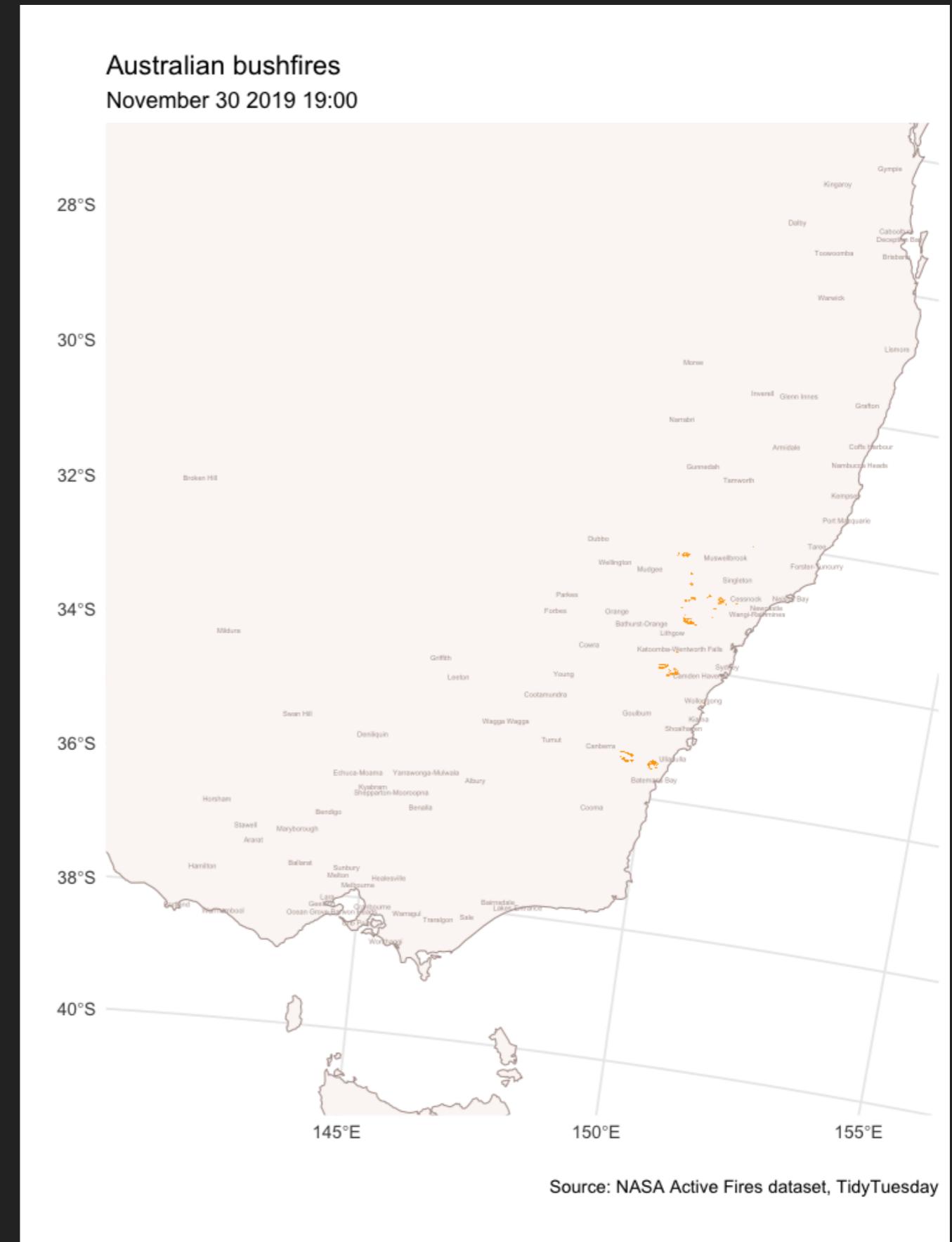
```
temp_year <- precip_clean %>%  
  group_by(year) %>%  
  summarize(ave_temp = mean(temp,na.rm=T),  
            temp_diff = ave_temp - ave_temp90_2019)
```



VISUALIZE/MODEL

VISUALIZE

Where and how fast are the bushfires spreading ?



VISUALIZE

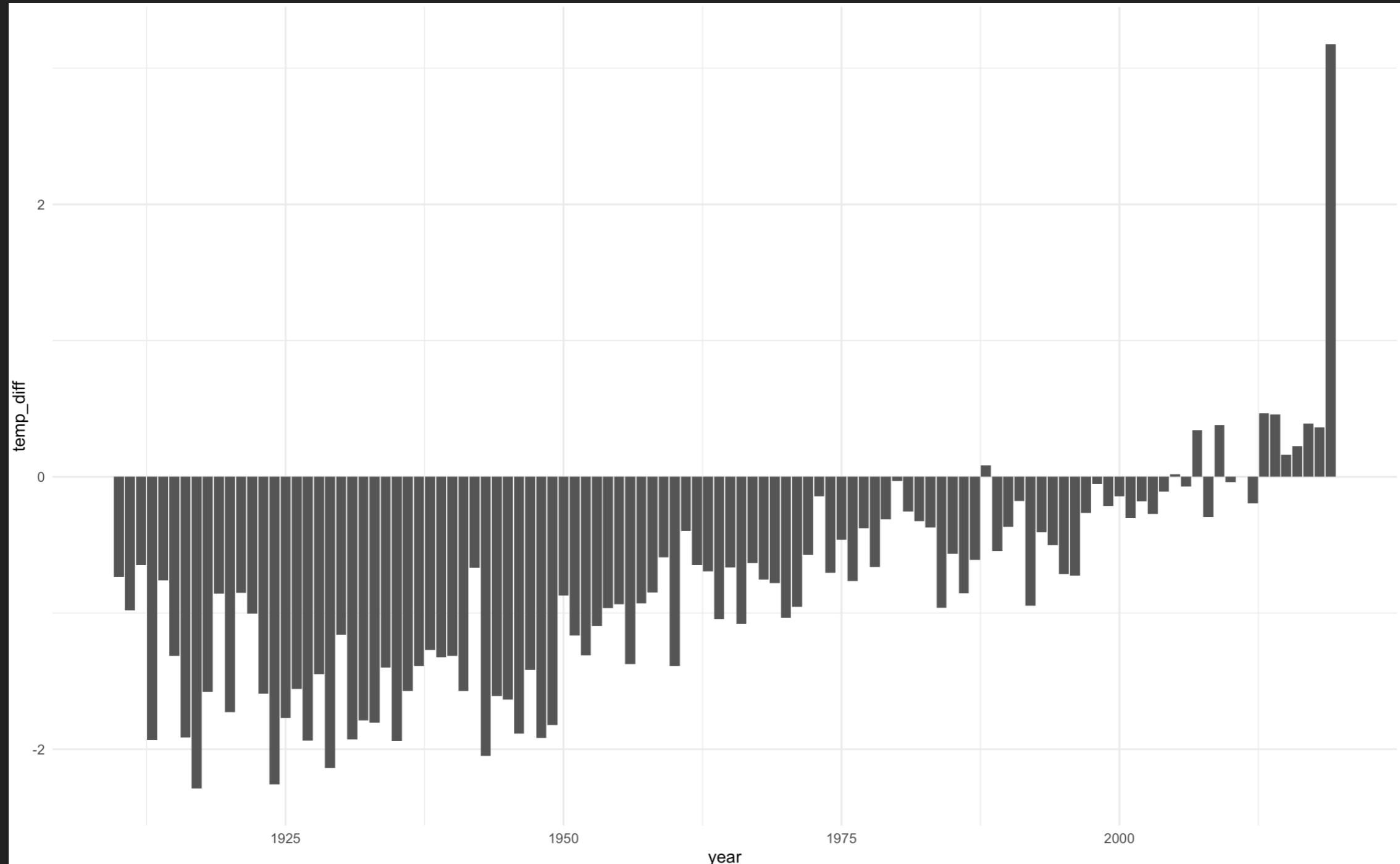


```
animated_fire <- ggplot() +  
  geom_sf(data = australia, fill = "#FBF7F5", color = "#B4A19D", alpha = 1) +  
  lims(x = c(790000, 2050000), y = c(-4500000, -3000000)) +  
  geom_text(data = cities, size = 2, color = "#B4A19D",  
            check_overlap = T,  
            mapping = aes(x = X, y = Y, label = name)) +  
  geom_point(  
    data = nasa_fire50,  
    mapping = aes(x = X, y = Y, group = id, color = brightness),  
    color = "orange",
```

VISUALIZE

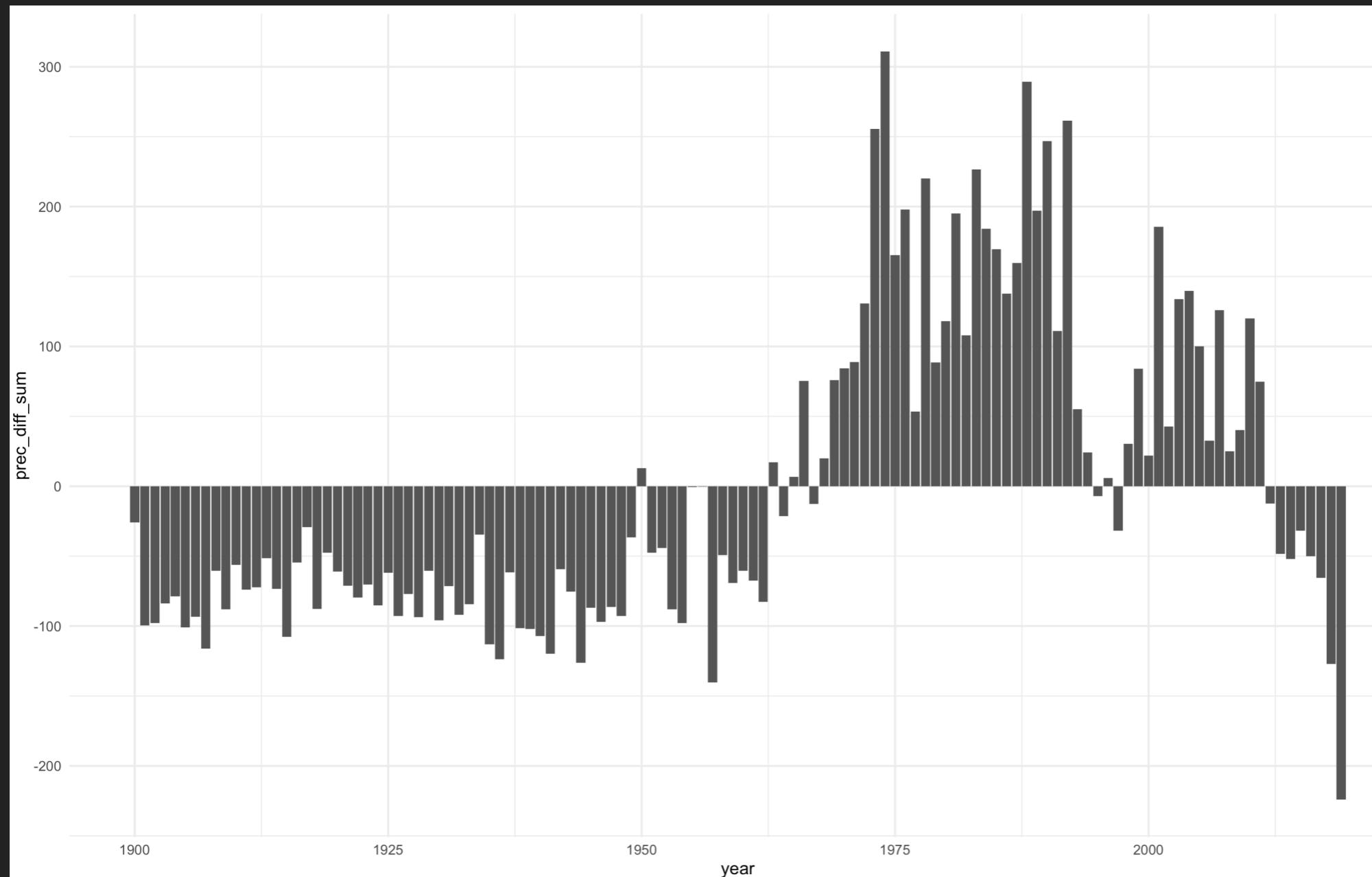
HOTTEST YEAR YET

```
ggplot(data = temp_ave_year,aes(x=year,y =temp_diff)) +  
  geom_bar(stat="identity") +  
  theme_minimal()
```

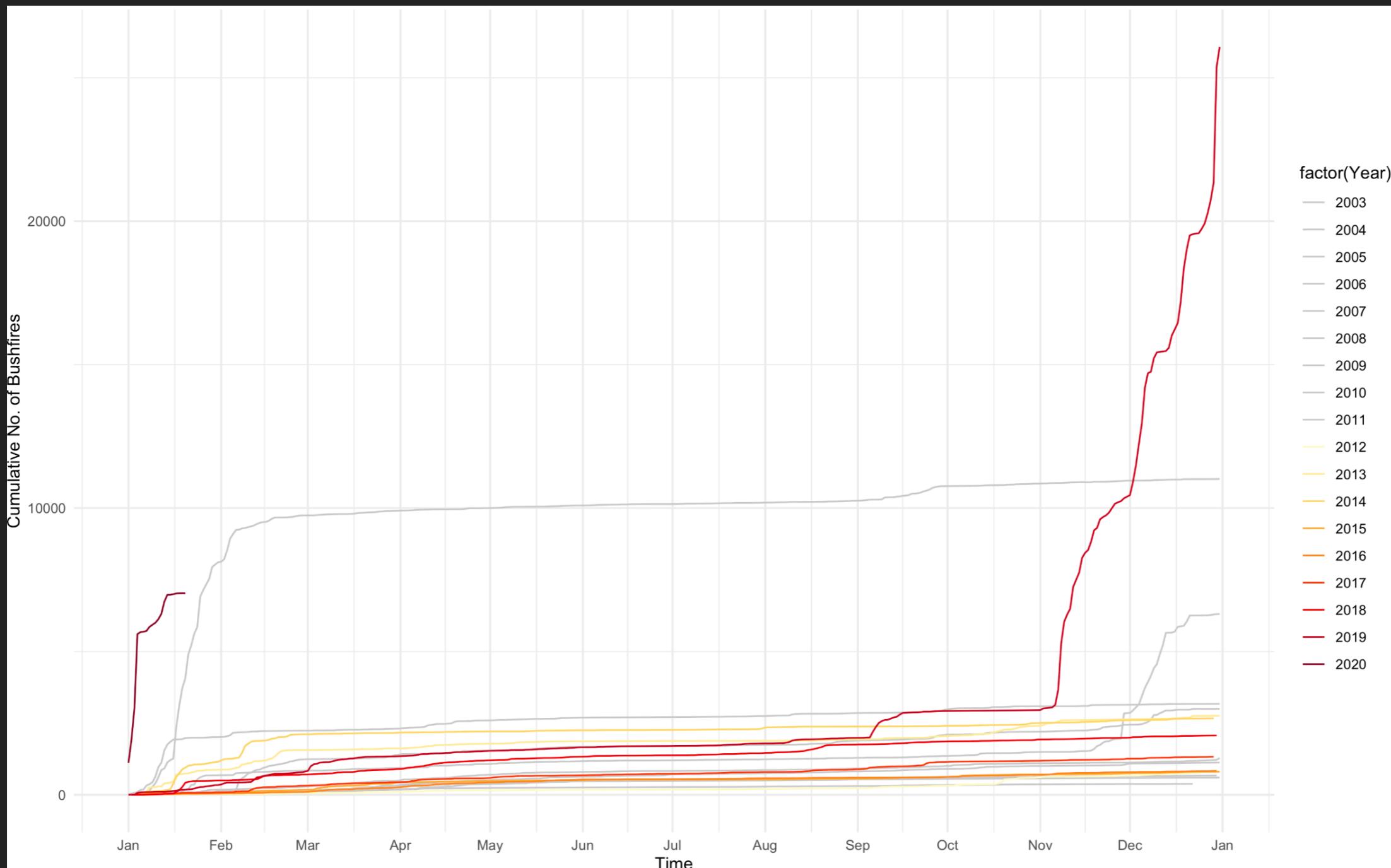


VISUALIZE

DRIEST YEAR YET



COMPARISON WITH OTHER BUSHFIRE SEASONS



CAUTION

HOW MUCH OF AUSTRALIA IS BURNING ?



i See Notice

This is Australia from a NASA Satellite. Pray for us please.



63

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HOW MUCH OF AUSTRALIA IS ACTUALLY BURNING ?



Here's Where Australia's Destructive Wildfires Are Burning

By [Nadja Popovich](#), [Denise Lu](#) and [Blacki Migliozzi](#) Updated Jan. 13, 2020

Following a devastating early start to the summer fire season in Australia, wildfires fueled by wind and scorching heat have [continued to burn](#) across the southeast, where most of the country's population lives.

Source: <https://www.nytimes.com/interactive/2020/01/02/climate/australia-fires-map.html>

