



VISUALISATION REPORT

2019-2020 AUSTRALIA FIRES

ABSTRACT

What has caused the bushfire that has done so much damage to Australia in summer of 2019 to 2020. Is it just due to the global warming? Visualisations of data acquired during the fire has been done to aid the understanding of what is the relationship between the climate and fire.

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Introduction

During the summer season from end of year 2019 to early 2020, there has been huge bush fire in Australia that has caused ginormous damage to the nature and to people. Many lives were lost, and huge amount of damage has been done economically. There have been multiple researches on the causes of such huge fire and most general opinion is that fire has been caused by the climate issue from global warming. In this summer season Australia experienced unprecedented heat with temperature reaching up to 49 degrees Celsius, which supports the idea of heat causing the fire. However, this heat also could have been possible due to burning heat from the fire. Rich and large data of these fire has been well collected by NASA from its satellites and are accessible. This data will be compared with climate data that has been recorded by Bureau of Meteorology of Australia. With this data visualisation can be done to present the data of the fire and climate easier to understand.

Aims

The aim of this report is to visualise the fire data acquired from NASA and find relationship between the fires that occurred in Australia and climate data such as rainfall and temperature that has been recorded in that area. This project aims to show how much global warming has affected the fire rate or how much it has not. The general map of Australia with its precipitation data and temperature data will be compared to the fire map and any correlation between these data will be analysed and presented.

Methods

Data Collection

Data has been collected from multiple sources. The main fire data is originated from NASA's earth database [1]. There are two different types of data provided by NASA, which are NASA FIRMS MODIS and VIIRS Fire/Hotspot. The difference between these two are the sensors, where MODIS is Moderate resolution Imaging Spectroradiometer and VIIRS is Visible Infrared Imaging Radiometer Suite. VIIRS is more sensitive sensor to detect fire as it has 375 meters resolution per pixel compared to MODIS's 1000 meters resolution per pixel. Thus, in this report data from VIIRS has been used. Since it was difficult to obtain the database during the certain times, the fire data has been obtained from Kaggle's Fires from Space: Australia [3]. This data contains VIIRS's fire data of Australia from 1st of October 2019 to 11th of January 2020. Climate data of temperature, rainfall and solar exposure has been collected from Australian Bureau of Meteorology (BOM) [2] for 2019 and 2020 in 5 areas including Brisbane, Sydney, Melbourne, Perth and Adelaide)

Data Explanation

The data that have been collected has some labels that are not easy to be understood. Most data have usual labels such as temperature, latitude, longitude, year, month, and day which are general data that are generally used. However, there are some data with labels that are specific to this set of data. These data are explained to increase the understanding.

Fire Data

Latitude and longitude are GPS values of the centre location the satellite has picked up of the fire with nominal 375-meter fire pixel.

Brightness is brightness temperature measured of the fire pixel monitored in Kelvin. There are two different types of brightness which are ti4 and ti5 which are just 2 different channels of the VIIRS satellite of being Temperature I-4 and I-5.

Scan and track are the pixel size at the nadir which reflects the actual scanned and tracked pixel size of the fire.

Date and time are in YYYY-MM-DD HHSS format which is the recorded date and time the satellite overpassed the fire location. This time is in UTC.

Confidence is the confidence level of the data. Data that has high confidence level is recorded n and data that has low confidence level is recorded with h.

Frp is fire radiation power which depicts the fire radiative power recorded by satellite in MW.

Climate Data

Climate data has been collected from main weather stations that are in the major cities around the coast that has been affected by the fire. Thus, all the data contains station numbers. In example station number 9225 is the weather station Perth Metro located in Perth.

Latitude and longitude are GPS values of weather stations.

Dates are in separate columns of year month and day. In YYYY MM DD format.

Temperatures are in two types, which are maximum and minimum temperature recorded. These temperatures are in degrees Celsius.

Rainfall amount is the precipitation amount recorded in millimetres.

Solar exposure is the record of daily solar exposure in MJ/m².

Data Process and clean ups

Data has been processed and cleaned up to be seen clearer and in need to analysis.

In general

Firstly, there were number of unnecessary data such as type of satellite, station code, scan, and track. These data are characters or Boolean values only exist to represent which type or instruments were used which is unnecessary in actual data analysis and visualisation stage.

Secondly, all the null values and NA values were removed. There were some missing data that may have been caused with mechanical faults or human errors. These data will make visualisation and analysis difficult.

Climate

Firstly, as the date format of climate and fire data are in different format, it has been changed to same date format of 'year-month-day'. This is important as the main key of all data is the date as this is a time series data.

Secondly, as all the climate data has been provided in different files, all of them were merged in to one file based on the date and its station number. After merged station number were replaced with its city name in order to recognise the location better with labels.

Thirdly, where needed some missing data were filled with mean values, such as temperature being filled with mean values of 3 days before and after that day. Also, data on some locations that were outside the research range has been also removed. As this research mainly focuses on the major cities around the coast.

Fourthly, weather station number has been changed to its city name.

Fire

Firstly, in fire data there were 2 different types of brightness which were ti4 and ti5. The difference between these two are just the channels. After research, ti4 is more frequently used data, so ti5 data were removed.

Secondly, all the location data are just represented in latitude and longitude which are difficult to understand and difficult to analyse with climate data. From google map [4], latitude and longitude range has been acquired and grouped the data by city according to the data.

Merge

All data has been merged into a single file in order to join the data together in to a single key. This makes the data more related and easier to analyse. The keys that were used to join were city name and the date. the After merging, there were around 23000 rows of data that were missing a data, which has been caused due to fire data containing data of whole area of Australia, where only records of few cities have been obtained for climate data. These were removed to clean up the data.

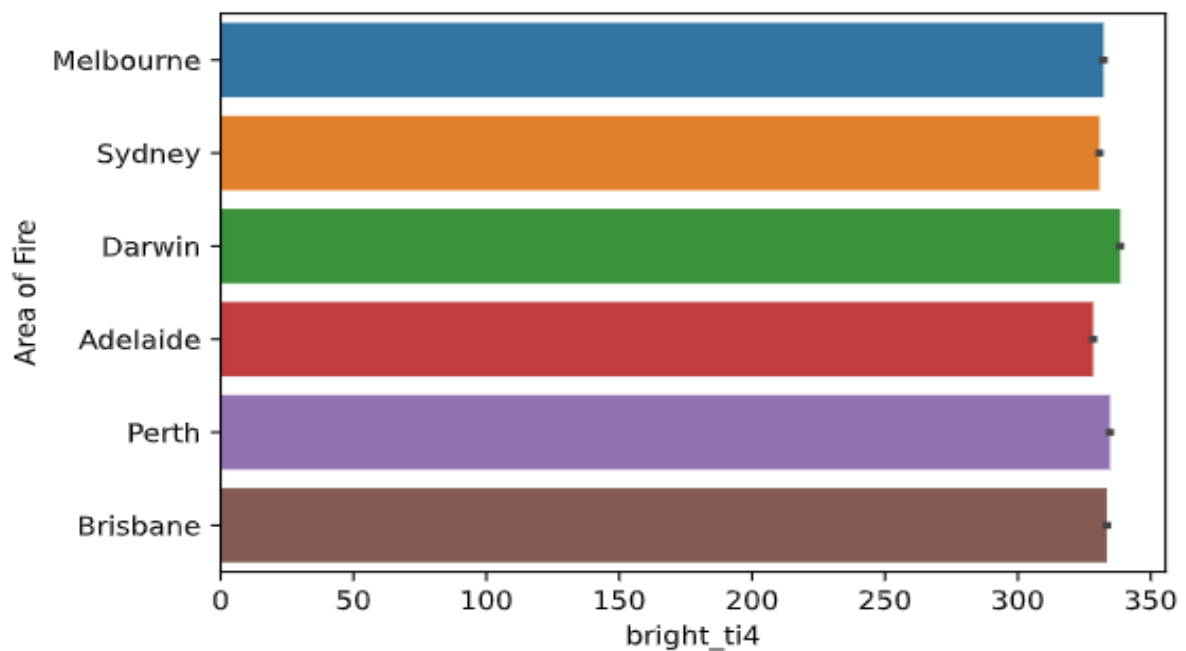
Result

General EDA

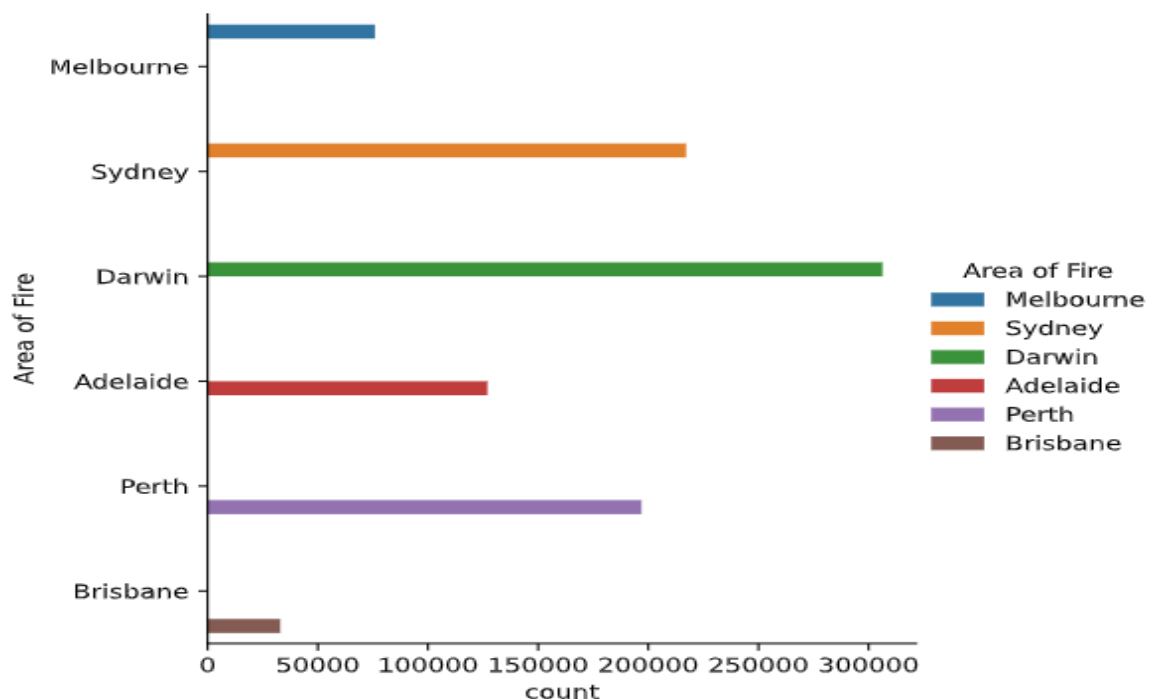
vars	n	mean	sd	median	trimmed	mad	min	max	range	skew	kurtosis	se
Latitude.x	630083	-31.91158512	3.946556185	-32.00854	-32.17293117	3.816153096	-43.21232	-17.01117	26.20115	0.554207761	0.495109735	0.004971866
Longitude.x	630083	146.319818	9.877920704	150.23787	148.7048029	2.835754194	113.44701	153.45218	40.00517	-1.936676613	2.251702085	0.012444191
bright_ti4	630083	331.6624289	22.29545817	332.5	331.2954554	28.9107	208	367	159	0.014757089	-0.743360609	0.028087787
scan	630083	0.458774749	0.088324904	0.43	0.448524641	0.059304	0.32	0.8	0.48	1.112195191	1.13259548	0.000111272
track	630083	0.472473341	0.116504708	0.42	0.456158923	0.088956	0.36	0.78	0.42	0.924774025	-0.313870981	0.000146772
frp	630083	16.2244398	51.41024916	4.5	7.412679862	4.74432	0	10717.2	10717.2	31.34538911	3814.079941	0.06476656
Latitude.y	630083	-33.67049832	2.289808117	-33.86	-33.65551823	1.571556	-37.83	-27.48	10.35	0.392405907	1.196972992	0.002884697
Longitude.y	630083	137.8430485	14.80422311	144.98	138.8098772	9.458988	115.79	153.04	37.25	-0.631696327	-1.29122801	0.018650339
Maximum.temperature	630083	28.8876448	6.49710797	28.3	28.68064226	6.07866	14.2	45.3	31.1	0.306417871	-0.518777229	0.008185047
Minimum.temperature	630083	16.82353944	3.882706433	17.3	16.8980088	4.00302	4.2	33.6	29.4	0.077400676	0.737611662	0.004891428
Solar.exposure	630083	26.44843378	4.936302305	27.5	27.08351985	5.1891	2.2	32.2	30	-1.252279826	1.90561343	0.006218747
Rainfall	630083	0.402055285	3.435985477	0	0.00644081	0	0	130.4	130.4	30.41547056	1115.534478	0.00432865

First general information about cleaned up merged data has been described. There are total of 63003 data.

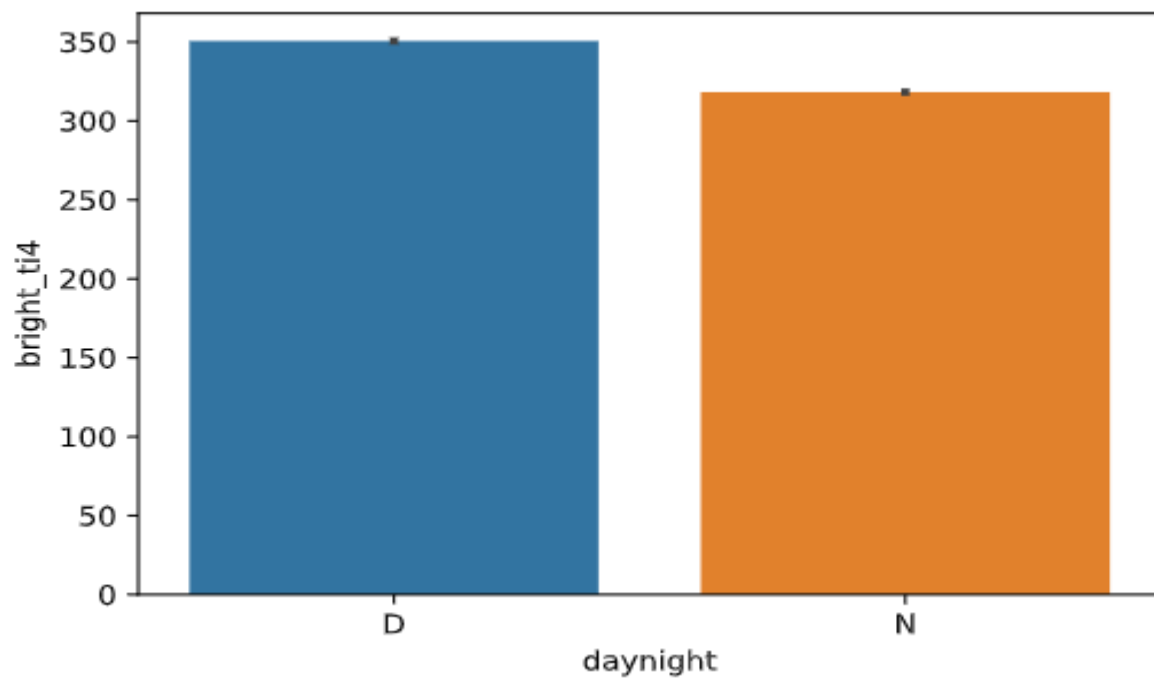
Fire



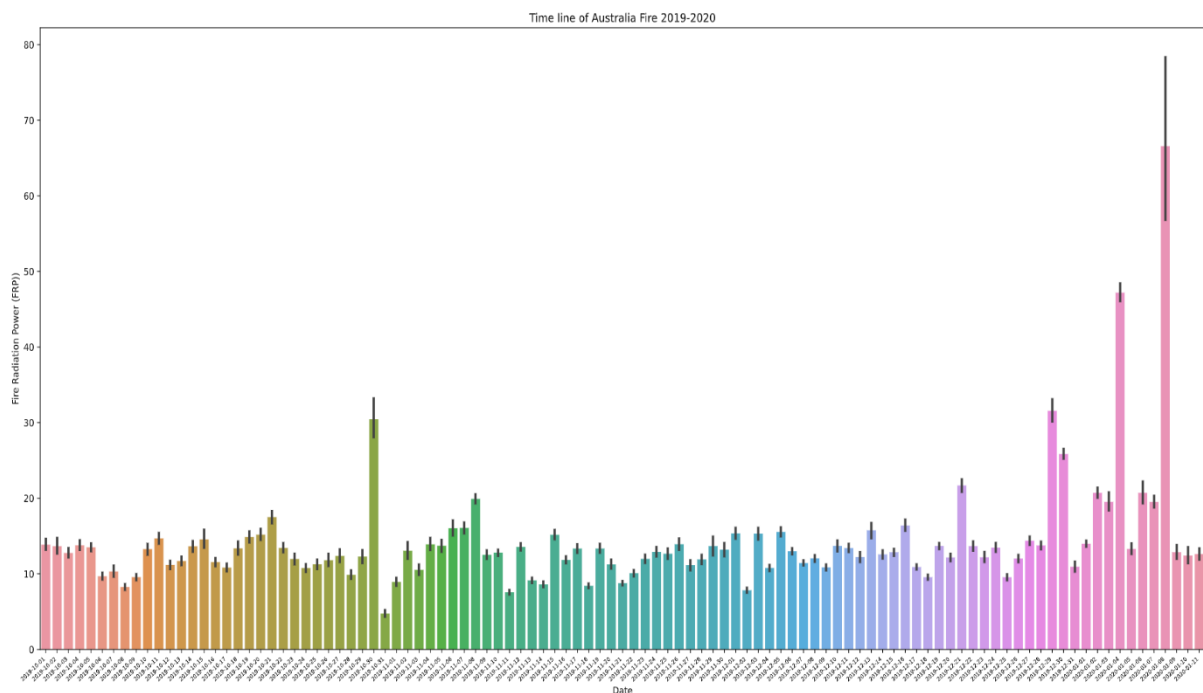
A bar graph of areas that had fires and brightness were drawn. It shows Darwin had most strong brightness and Adelaide the least. This would be due to Darwin being up in the north close to the equator.



Number of fires in the are also have been drawn with bar graph, with Darwin with the greatest number of fires recorded and Brisbane with least. This is different to the graph above with the brightness.

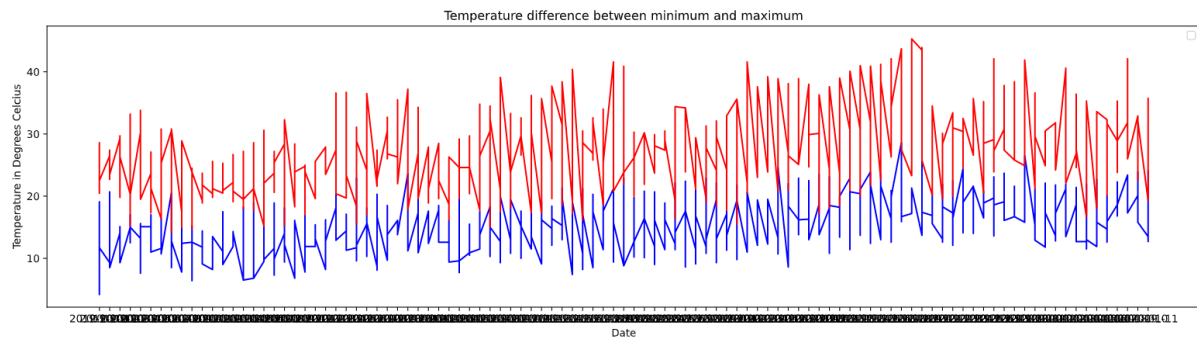


Histogram of brightness by day and night has been shown. This shows that during day time where the sun is up in the sky fires were stronger and when the sun sets the fires reduced.

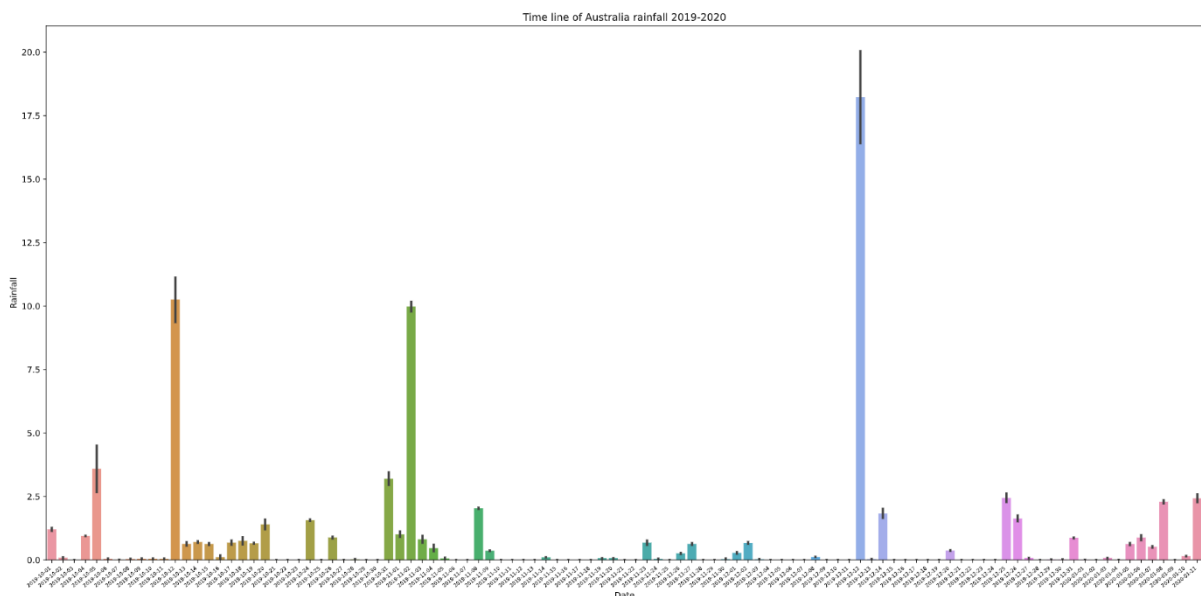


Timeline of the fire has been drawn from the 10th of October 2019 to 11th of January 2020. It shows there were one peak fire 30th of October 2019 and more fires starting to occur after 29th of December 2019. In 4th and 8th of January 2020, there were 2 peaks and 8th of January recorded one of the highest FRP record in history with 68.

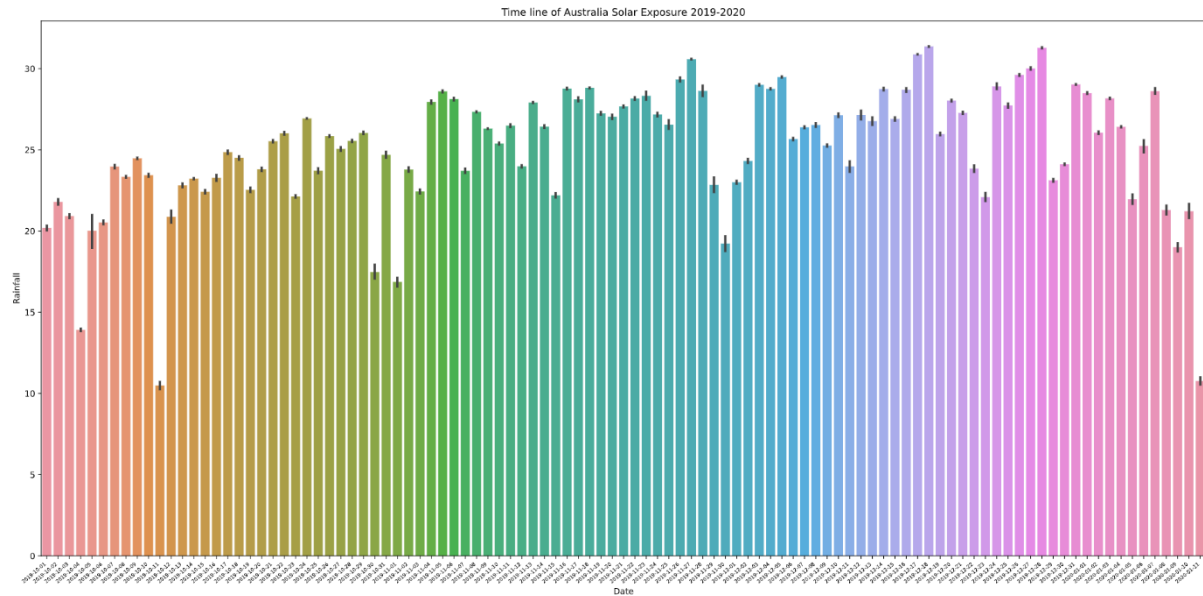
Climate



This is a line graph of maximum and minimum temperature recorded during the period of the record. There were some unusual differences between the maximum and minimum temperatures in some dates. Also, it shows that temperature gradually increased where in Late December to early January temperature peaking over 40 degrees and going down a bit after.

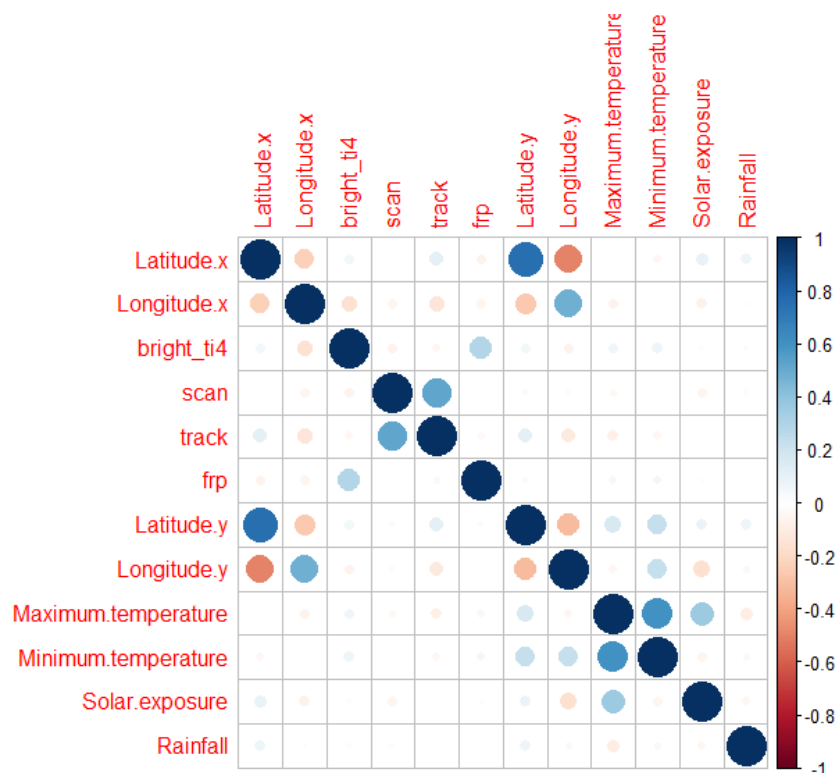


Timeline of rainfall has been drawn, this shows that there were not many rains during these periods especially in November and December and huge rain in 12th of December 2019, but not much after. This shows how rains were important to catch the fire and cool down.

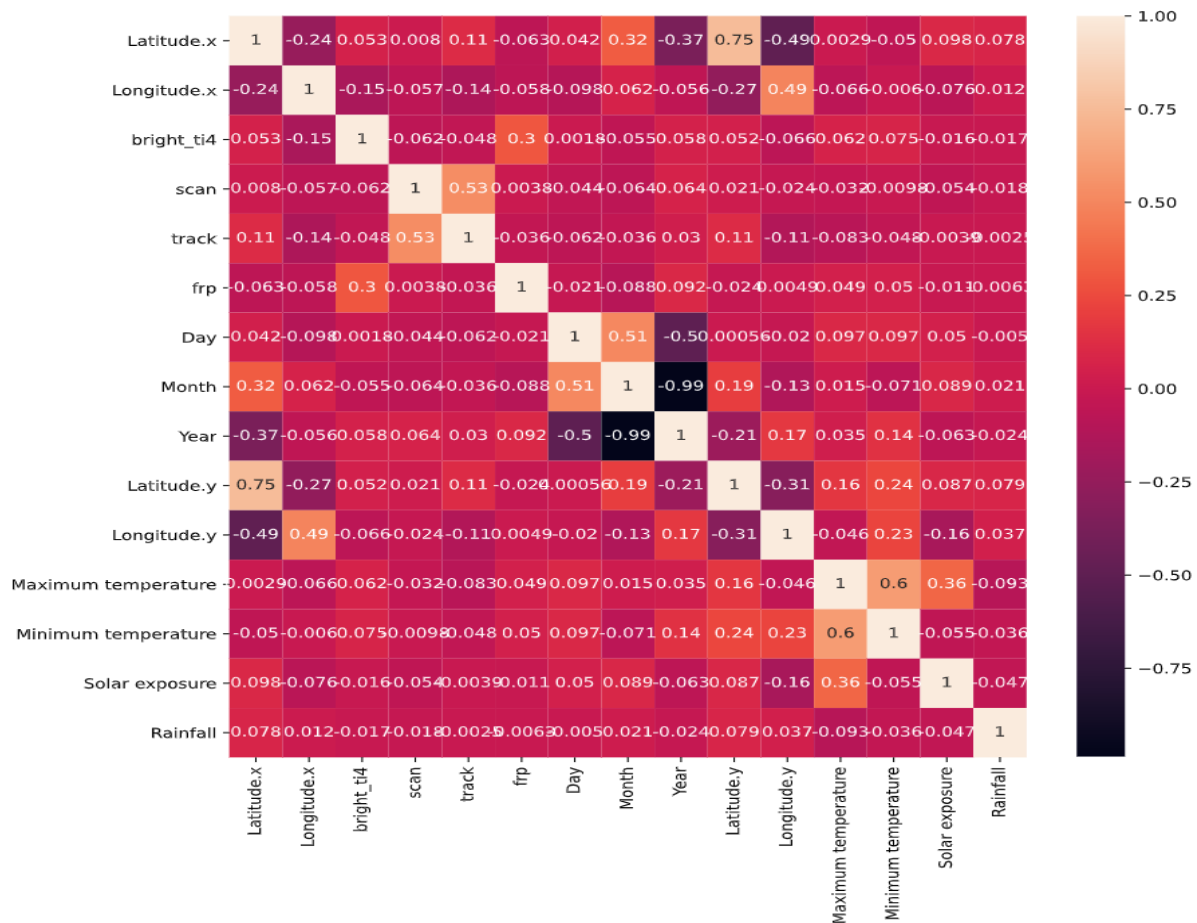


Timeline of solar exposure has also been drawn and the solar exposure also generally increased from October to January.

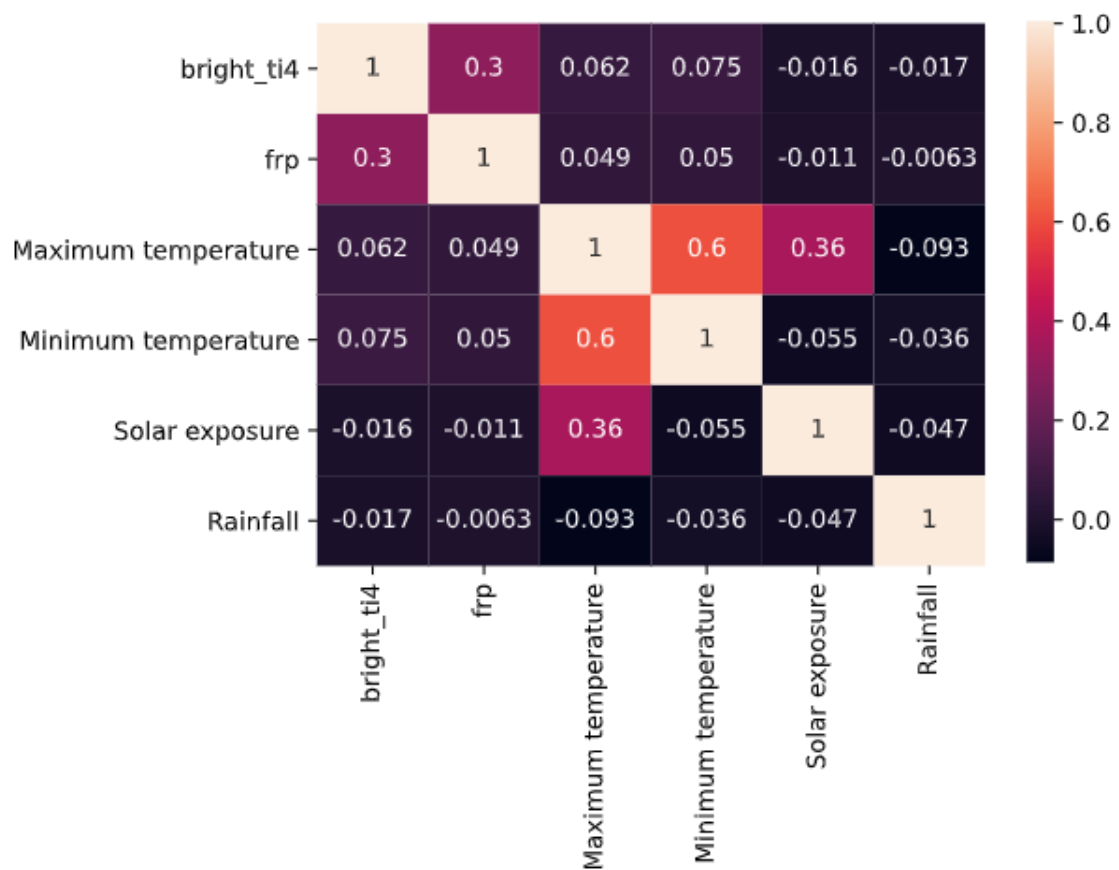
Relation



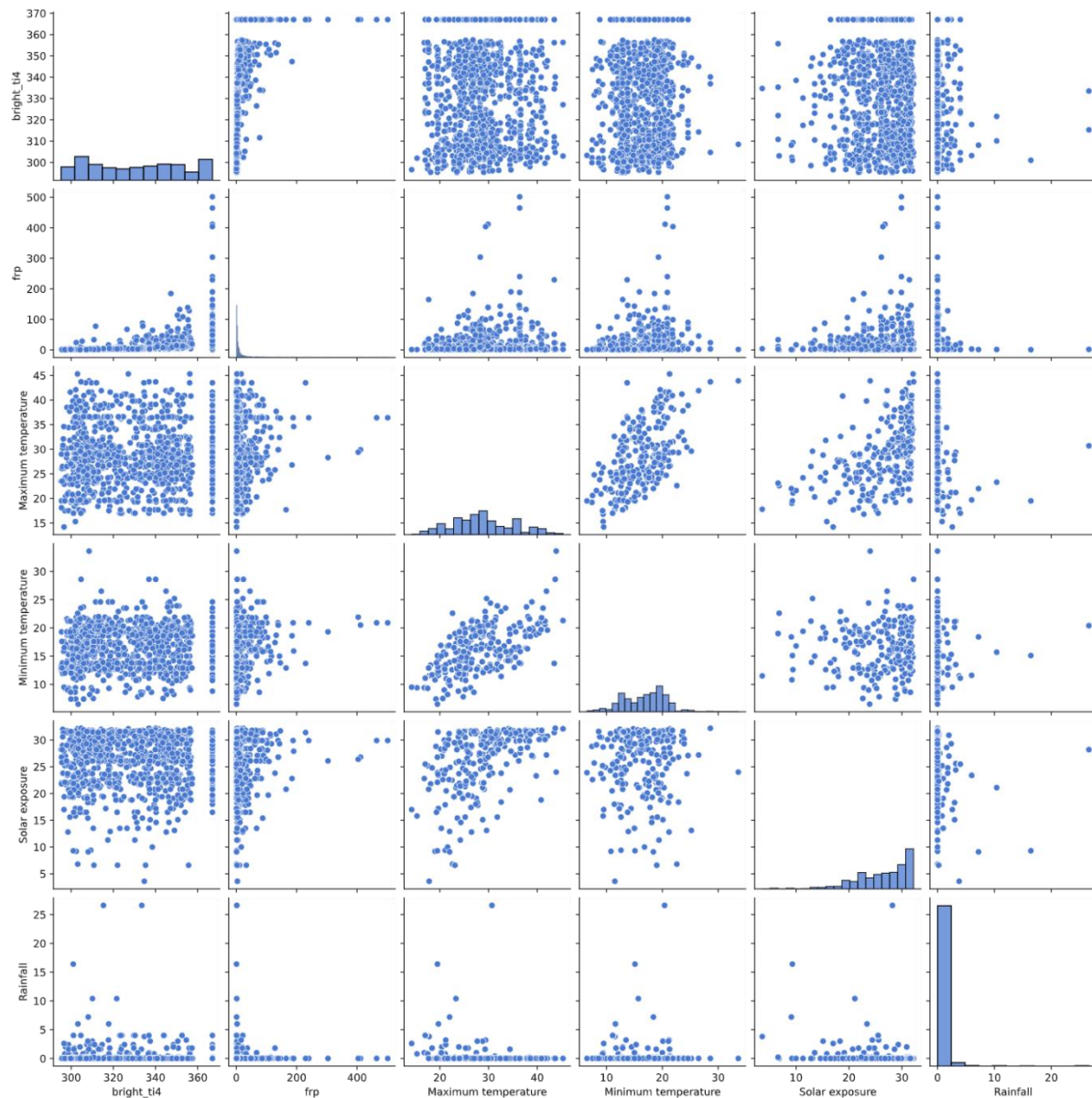
Correlation plot has been done in order to show the correlation between each variable. This shows there is mediate relation between solar exposure and maximum temperature, but not much relationship of fire related to any climate data.



To see the correlation clearer it has been presented in numbers. Some values are in negative, which shows there is not much correlation between climate and fire.

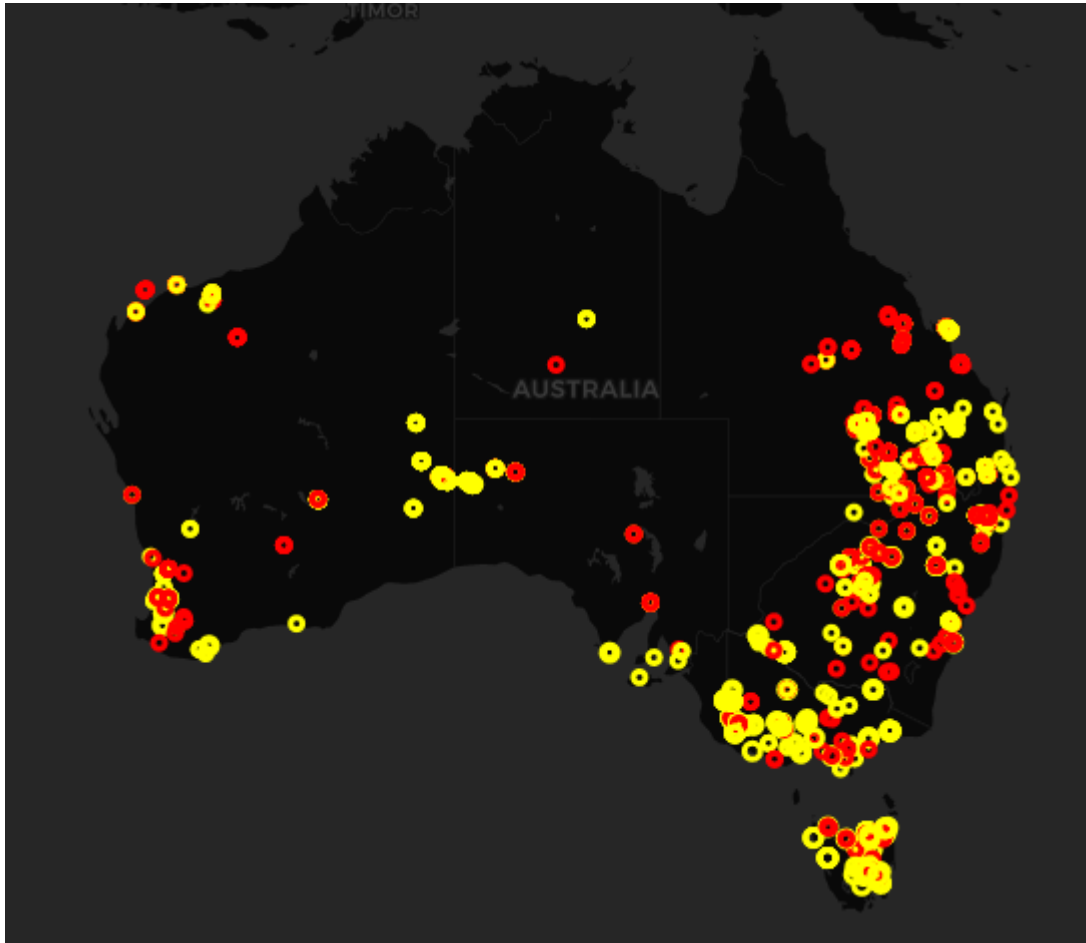


Due to too much unnecessary data more reduced correlation plots has been done. Correlation between solar exposure and maximum temperature is inevitable, also with frp and brightness. Other than that there is not much correlation between each data.

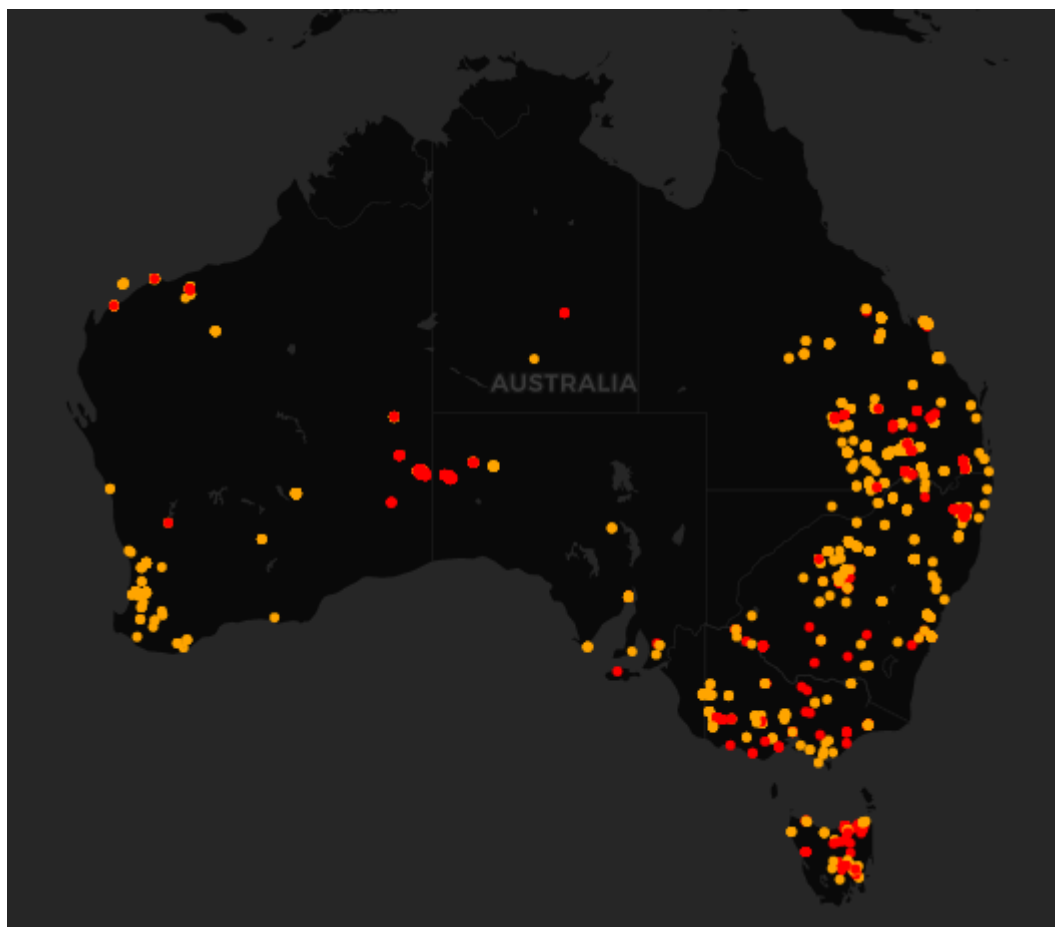


This pair plot shows the plots of each data. This shows some relationship between brightness and temperature and solar exposure.

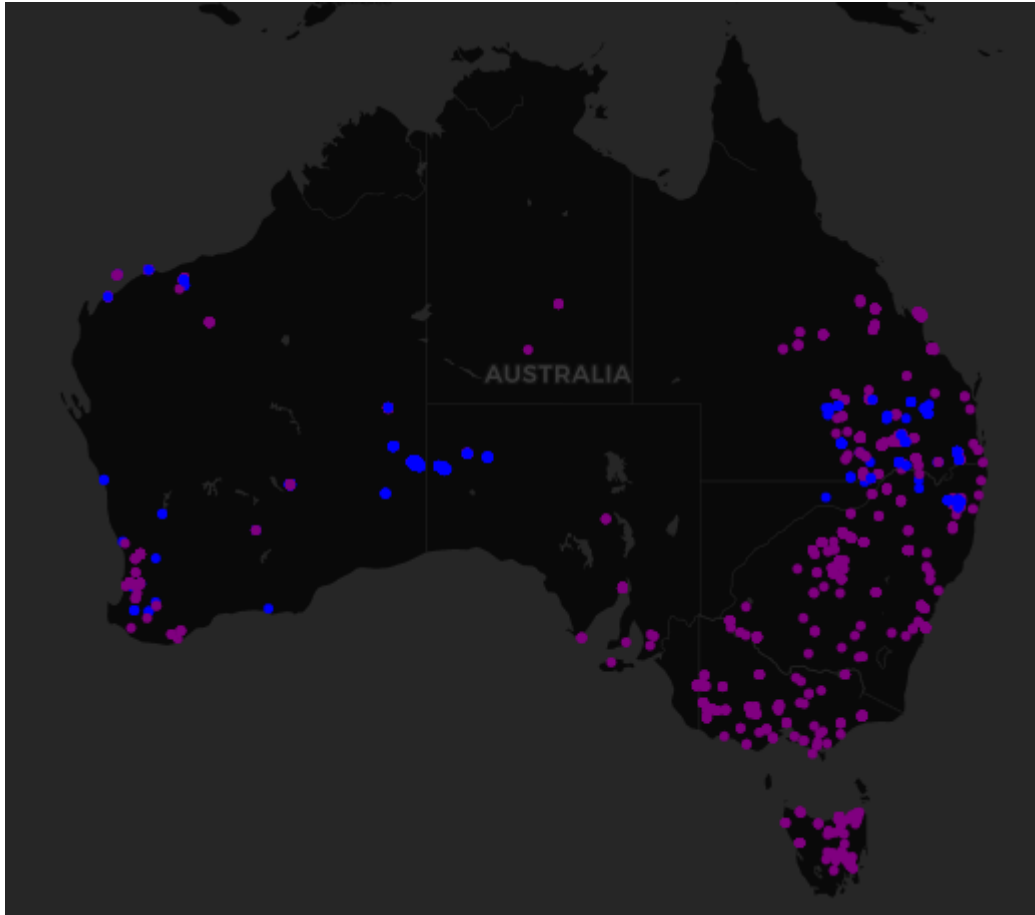
Map



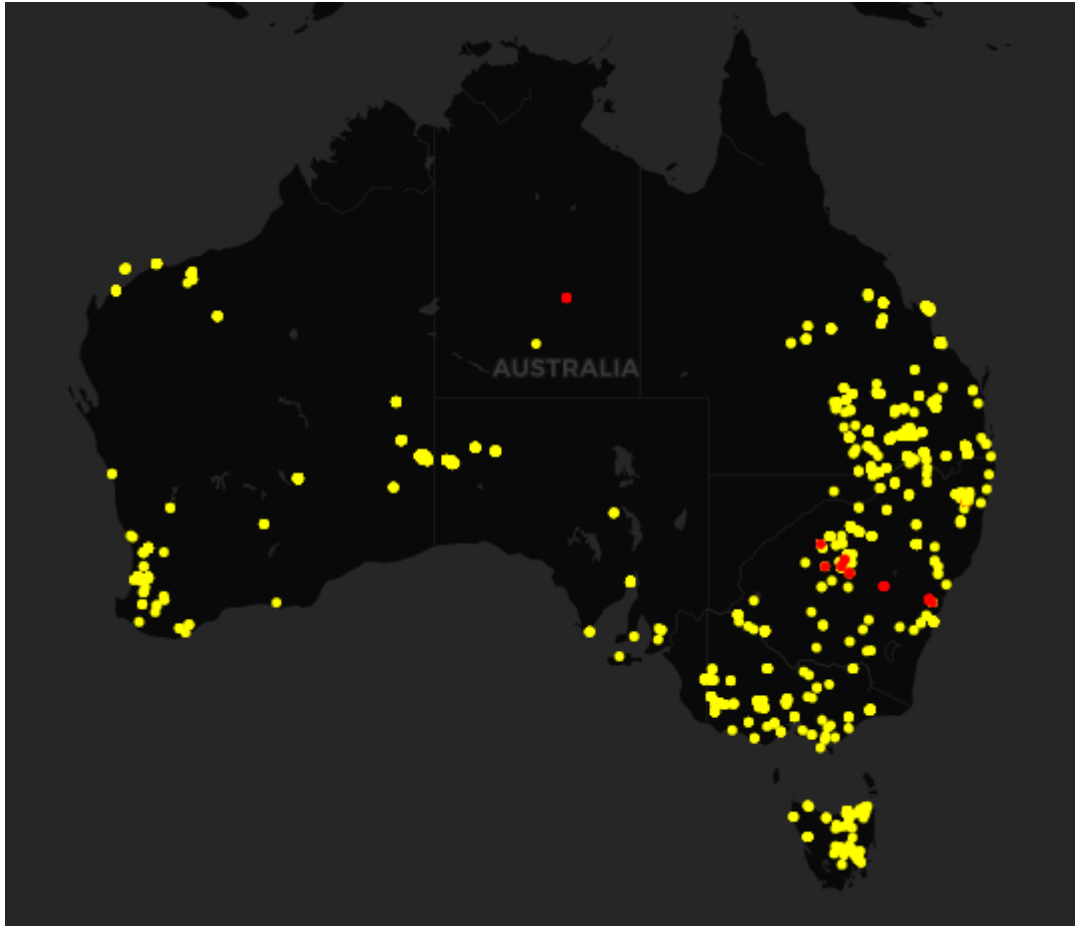
Brightness stronger than 325 has been recorded with red and lower with yellow. This shows there were strong fires near Brisbane, Sydney, Canberra and Perth.



Solar exposure higher than 20 has been recorded with red and lower with orange. The major areas on the eastern coast near Brisbane and Melbourne shows high solar exposures.



Precipitations higher than 1 is represented with blue and lower with purple. This shows only few locations in Queensland near Brisbane had much rainfall and others did not. Considering Brisbane area had the least number of fires, this shows that rainfall did catch fires.



Maximum temperatures higher than 35 degrees Celsius has been presented in red and lower with yellow. Showing there were high temperatures peaking over 35 in Canberra, Sydney area.

Summary

After all the visualisations done, more understanding of the data has been acquired. From the correlation plots, there were not much correlation found between the climate and fire data. However, the map data gave more understanding of the fire. Brisbane where there was least fire, there were more rains in that area, meaning it was much cooler and rain could catch the fire. Also, the solar exposure shows that areas with high solar exposure were the areas that has strong fires.

Discussion

Limitations

Some limitations were found in this report. As the fire data are only obtained through NASA's satellite, it may not be fully accurate on the size or the heat. Also, some data acquired were not complete and were missing either due to human error or mechanical fault.

After completing the visualisation and analysis, if more data from previous years were able to be acquired, better data analysis and in-depth visualisation of comparison could have been done. Also, some other data from multiple different sources may be acquired to compare if they are available.

By using only 4 sets of data, not much information could be achieved. If more data set and more techniques could be used, better data analysis and visualisation may be done.

Also, many numbers of visualizations that has been done per cities or locations were not included in this report, since they were too many duplicates of others and could not find meaningful result. If more data were to be used these results may become useful.

Conclusion

In conclusion, after visualisation more understanding of the data that has been acquired on the fire and climate during the period of 1st of October 2019 to 11th of January 2020. The results showed that there is relationship between high temperature and solar exposure and that solar exposure creates huge fires. Also, areas with more rainfall had less number of fires.

References

- [1] Active Fire Data. Available From: <https://earthdata.nasa.gov/earth-observation-data/near-real-time/firms/active-fire-data> . Accessed 10th April 2020..
- [2] Climate Data. Available From: <http://www.bom.gov.au/?ref=logo> . Accessed 10th April 2020.
- [3] Fires From Space. Kaggle. Available From: https://www.kaggle.com/carlosparadis/fires-from-space-australia-and-new-zealand?select=fire_nrt_M6_96619.csv . Accessed 14th April 2020.
- [4] Google Map. Available From: map.google.com. Accessed on 25th April 2020.
- [5] Australia fire story. Available From: <https://storymaps.arcgis.com/stories/9ebbe1b54dc847f2a7dd01917c9f3071> . Accessed 28th April 2020.
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