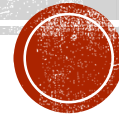


# ARE SUMMERS IN JAPAN AND FAIRBANKS GETTING WARMER EVERY YEAR?



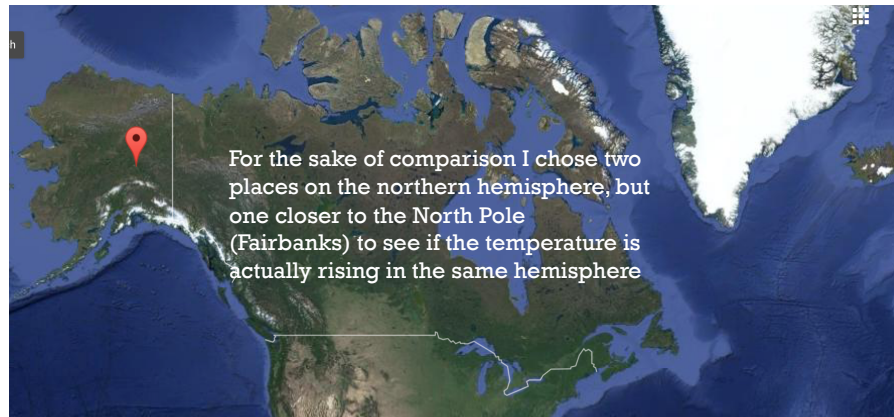
By Yujiro Fujiwara

## INTRODUCTION

- I thought about doing data mining on this topic because every summer it seems that the temperature in Japan just keeps going up. News everywhere talk about climate change and how it affects the temperatures around the world. Hotter and hotter summers in Tokyo, seem to be the norm but I have never taken the time to check if there is actual evidence for this. Why Fairbanks? I decided to get the data from a city that's close to the North Pole to see if it is also getting warmer in historically cold places
- Since the historical data on temperature is vast, I decided to take only 48 years worth of data. I collected the average minimum temperatures and average maximum temperatures of the month of August for Tokyo, Japan and Fairbanks, Alaska, USA to see if the tendency has been actually on the rise



## FAIRBANKS' LOCATION



## TOKYO'S LOCATION



## SOURCES

- I got the data for Fairbanks from [Weather Warehouse](#)
- For Japan, I chose Tokyo and the data I retrieved the data from [Japan Meteorological Agency](#)
- I am using Celsius as my temperature unit because it is what I used in my daily life. The data that I found for Fairbanks was in Fahrenheit so I converted using the formula  $C = (F - 32) * (9/5)$



## PROCESS

- I found the information on historical temperatures for August in Japan and Fairbanks. For each place, I put on a spreadsheet only the average minimums and the average maximums for August of each year from 1969-2016
- Then I graphed all the points for minimum and maximum individually then using the scatter plot and liner regression I graphed the line over the points. With this I found the information I needed to see if there was a positive or a negative rate of change.



## CAVEATS

- By no means I am trying to prove global warming. The data used here is just a tool to answer the theme question. To even address the question of global warming I would have to draw data from gas emissions and other sources. Consequently, find statistical correlation (I think is doable but still, it will be inconclusive). I cannot make conclusions about climate change based on these two cities, and only temperature
- However, the question can be modified to give it different perspectives



## CAVEATS

- I chose August as my sample month because that is the warmest of all the months in the year in Japan. I could have chosen to show all the data per month to have a better perspective of the overall change, but I have focused on the summer season because the perception of a hotter summer and the reality of it may differ completely. I wanted to find data for evidence for this ever popular and relevant topic
- I chose Fairbanks for being a city that's close to the North Pole (not to be confused with the town North Pole in Fairbanks). No special reason in particular



# CAVEATS

- I left R square out because I don't think is relevant for my question and it is not appropriate for the amount of data, given that I only take into account the average minimums and average maximums. Day to day data could be better for predictions which in contrast could yield a higher R square
- The equations are just estimates of the behavior of the data over the mean
- Now to the data. Is it actually getting hotter in Tokyo and Fairbanks during summer?



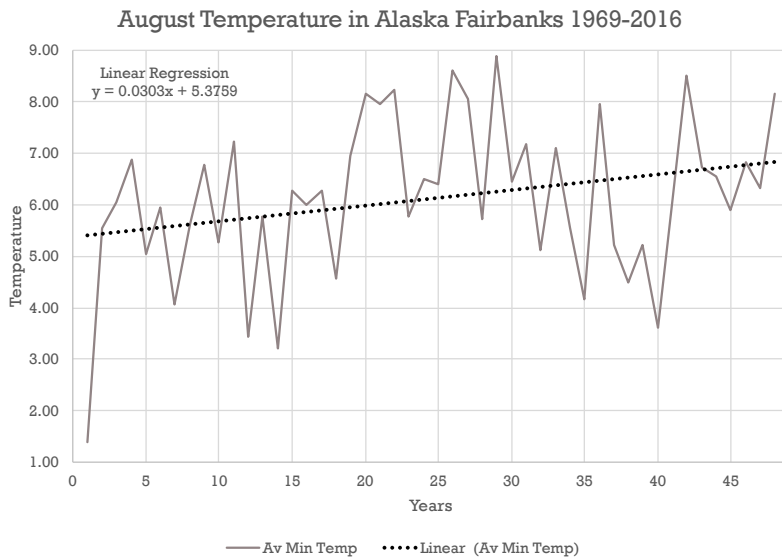
## EXCEL TABLE DATA FROM FAIRBANKS

Fairbanks, Alaska, USA			Fairbanks, Alaska, USA		
Year	Av Min	Av. Max	Year	Av Min	Av. Max
1969	1.4	15.7	1993	6.4	18.3
1970	5.6	18.2	1994	8.6	21.3
1971	6.1	18.6	1995	8.1	18.7
1972	6.9	21.1	1996	5.7	17.0
1973	5.1	17.2	1997	8.9	19.8
1974	5.9	19.1	1998	6.4	16.7
1975	4.1	17.4	1999	7.2	20.7
1976	5.6	21.2	2000	5.1	15.8
1977	6.8	22.8	2001	7.1	19.8
1978	5.3	20.9	2002	5.6	17.7
1979	7.2	21.7	2003	4.2	19.4
1980	3.4	18.8	2004	7.9	23.8
1981	5.8	18.8	2005	5.2	19.4
1982	3.2	18.5	2006	4.5	16.3
1983	6.3	16.7	2007	5.2	20.4
1984	6.0	16.8	2008	3.6	16.3
1985	6.3	17.6	2009	6.1	17.1
1986	4.6	17.2	2010	8.5	21.2
1987	6.9	19.7	2011	6.7	18.7
1988	8.2	18.9	2012	6.6	19.3
1989	7.9	20.9	2013	5.9	21.7
1990	8.2	20.0	2014	6.8	20.0
1991	5.8	17.3	2015	6.3	16.3
1992	6.5	19.4	2016	8.2	21.2

FROM THIS DATA WE CAN SEE THAT THESE DISCRETE POINTS ARE GOING UP AND DOWN FROM YEAR TO YEAR BUT IT IS HARD TO CONFIRM IF THE TREND IS ON THE RISE OR NOT. COINCIDENTALLY, IT HAPPENS THAT THE MINIMUM EXTREMA WAS ON 1969 WHICH IS THE FIRST YEAR OF DATA. THIS COULD SKEW THE LINEAR REGRESSION



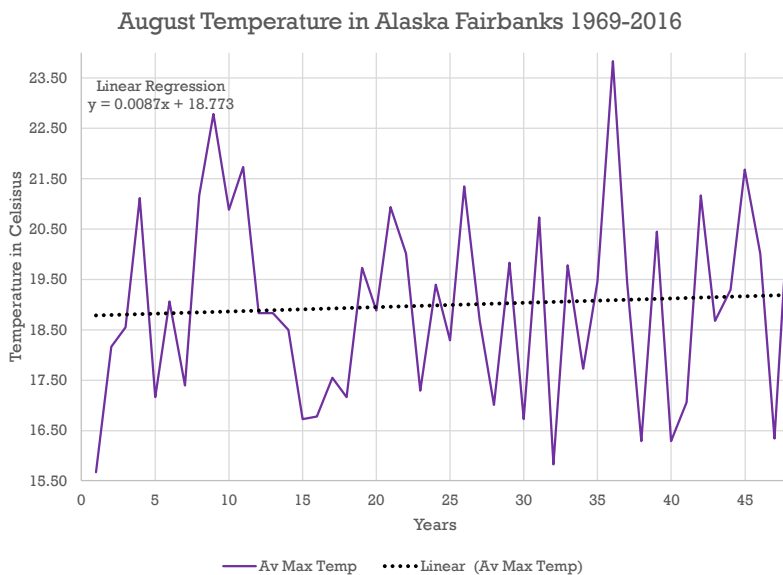
# AVERAGE MINIMUM TEMPERATURE FAIRBANKS, ALASKA



I USED THE LINEAR REGRESSION OPTION ON EXCEL TO COME UP WITH AN EQUATION. HOWEVER IMPERFECT IT MAY BE, THIS SHOWS THAT THE RATE OF CHANGE OVER TIME ON THE AVERAGE MINIMUM TEMPERATURES IS POSITIVE. R SQUARE WAS LOW BUT I DON'T SEE HOW THAT WOULD AFFECT THE POSITIVE RATE OF CHANGE. A BETTER OR WORSE ESTIMATION WOULD LIKELY YIELD A POSITIVE RATE.



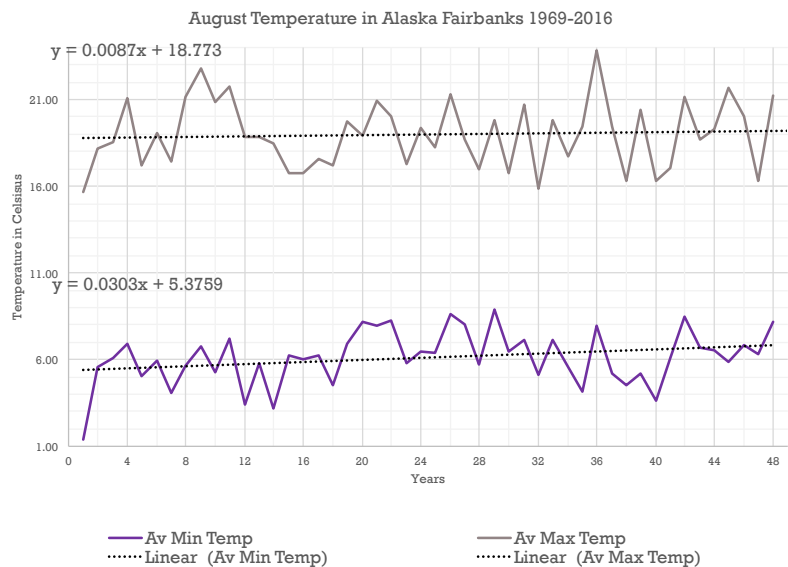
# AVERAGE MAXIMUM TEMPERATURE OF FAIRBANKS, ALASKA



ON THE MAXIMUM AVERAGES IT SEEMS THAT THE SLOPE IS NOT AS INCLINED AS IN THE MINIMUM AVERAGES. NEVERTHELESS, THE SLOPE IS POSITIVE, MEANING THAT THERE HAS BEEN AN INCREASE. R SQUARE WAS STILL LOW BUT HIGHER THAN THE PREVIOUS LINE (PLEASE READ MY CAVEAT FOR THIS)



# COMBINED TEMPERATURES OF FAIRBANKS, ALASKA



HAVING BOTH GRAPHS ON THE SAME CHART SHOWS THAT THE CHANGE OF RATE IS POSITIVE, EVEN THOUGH IT MAY NOT BE AS SIGNIFICANT AS OTHER PARTS OF THE GLOBE. USING THE AVERAGE RATE OF CHANGE OF BOTH LINES OVER 48 YEARS THE INCREASE HAS BEEN OF 0.936 DEGREES



# TABLE DATA FROM TOKYO

Ueno,Tokyo, Japan		
Av Min	Av Max	Year
21.2	31.6	1969
21.7	30.7	1970
21.2	29.9	1971
20.6	31.3	1972
22	32	1973
21.2	30.9	1974
20.6	30.1	1975
20	29.9	1976
20.9	30	1977
21	33.1	1978
21.3	32.4	1979
21.2	28.4	1980
19.6	30	1981
21.1	29.7	1982
22.1	32.1	1983
21.8	32.8	1984
22.2	32.1	1985
21.5	31.3	1986
21.7	32.3	1987
21.8	30.3	1988
21.6	30.8	1989
22.1	32.9	1990
21.6	30	1991
21.9	30.8	1992

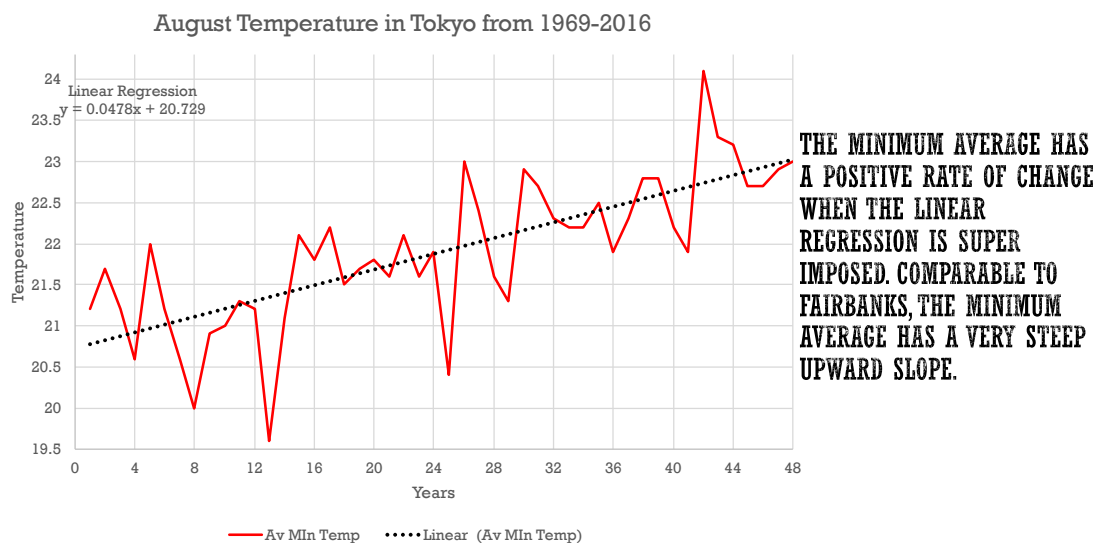
Ueno,Tokyo, Japan		
Av Min	Av Max	Year
20.4	28.7	1993
23	33.7	1994
22.4	34.9	1995
21.6	31.8	1996
21.3	32.4	1997
22.9	32.8	1998
22.7	31.4	1999
22.3	34.2	2000
22.2	32.1	2001
22.2	32.2	2002
22.5	31.5	2003
21.9	31	2004
22.3	31.6	2005
22.8	33.3	2006
22.8	33.2	2007
22.2	31.8	2008
21.9	31.3	2009
24.1	34	2010
23.3	32.7	2011
23.2	32.9	2012
22.7	34	2013
22.7	31.3	2014
22.9	32.2	2015
23	33.8	2016

THE DATA FOR JAPAN WAS VAST SO I HAD TO START FROM THE LOWEST RECORD IN THE U.S. DATA THAT I COULD FIND TO MATCH MY TIME FRAME. THAT WAS 1969. THE INCREASE OVER TIME SEEMS TO BE MORE SIGNIFICANT IN JAPAN BUT THE TEMPERATURES ARE NATURALLY HIGHER SINCE JAPAN IS CLOSER TO THE EQUATOR COMPARED TO FAIRBANKS.

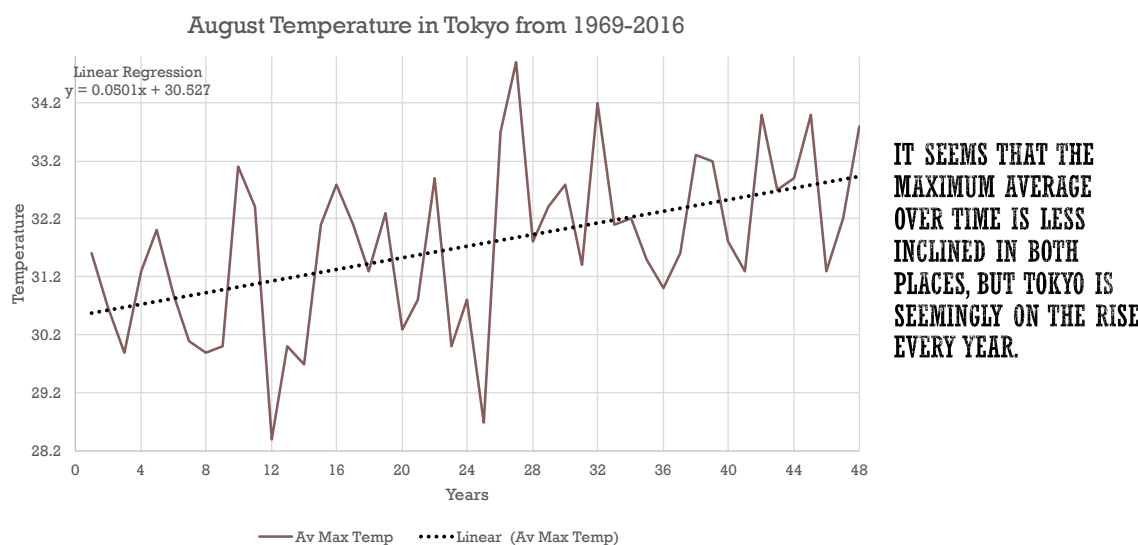




# AVERAGE MINIMUM TEMPERATURE OF TOKYO, JAPAN

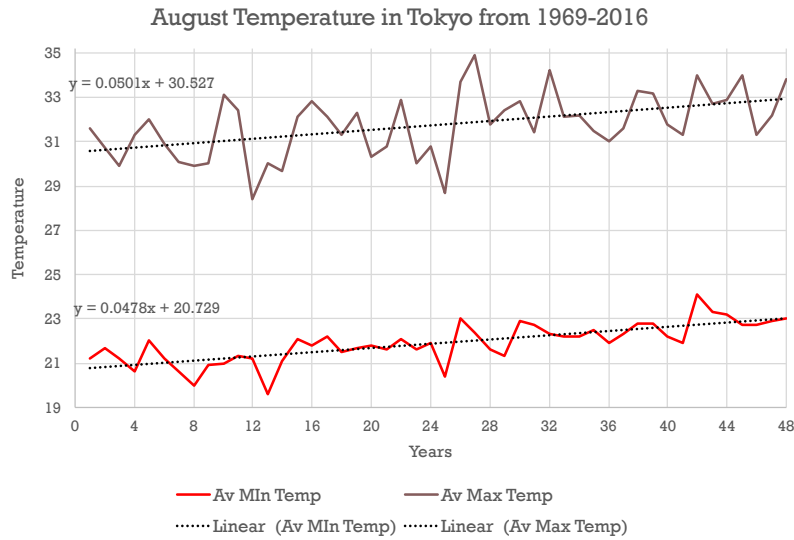


# AVERAGE MAXIMUM TEMPERATURE OF TOKYO, JAPAN





# COMBINED TEMPERATURES OF TOKYO, JAPAN



WHEN BOTH GRAPHS ARE COMPARED AND THE AVERAGE RATE OF CHANGE OF BOTH SLOPES IS CALCULATED OVER 48 YEARS, THERE HAS BEEN AN INCREASE OF 2.3 DEGREES. AS EXPECTED THE R SQUARE FOR BOTH SETS OF DATA WERE HIGHER THAN IN FAIRBANKS

## COMBINED DATA TABLES

Fairbanks, Alaska, USA					Ueno, Tokyo, Japan				
Year	Av Min	Av. Max	Av Min	Av Max	Year	Av Min	Av. Max	Av Min	Av Max
1969	1.4	15.7	21.2	31.6	1993	6.4	18.3	20.4	28.7
1970	5.6	18.2	21.7	30.7	1994	8.6	21.3	23	33.7
1971	6.1	18.6	21.2	29.9	1995	8.1	18.7	22.4	34.9
1972	6.9	21.1	20.6	31.3	1996	5.7	17.0	21.6	31.8
1973	5.1	17.2	22	32	1997	8.9	19.8	21.3	32.4
1974	5.9	19.1	21.2	30.9	1998	6.4	16.7	22.9	32.8
1975	4.1	17.4	20.6	30.1	1999	7.2	20.7	22.7	31.4
1976	5.6	21.2	20	29.9	2000	5.1	15.8	22.3	34.2
1977	6.8	22.8	20.9	30	2001	7.1	19.8	22.2	32.1
1978	5.3	20.9	21	33.1	2002	5.6	17.7	22.2	32.2
1979	7.2	21.7	21.3	32.4	2003	4.2	19.4	22.5	31.5
1980	3.4	18.8	21.2	28.4	2004	7.9	23.8	21.9	31
1981	5.8	18.8	19.6	30	2005	5.2	19.4	22.3	31.6
1982	3.2	18.5	21.1	29.7	2006	4.5	16.3	22.8	33.3
1983	6.3	16.7	22.1	32.1	2007	5.2	20.4	22.8	33.2
1984	6.0	16.8	21.8	32.8	2008	3.6	16.3	22.2	31.8
1985	6.3	17.6	22.2	32.1	2009	6.1	17.1	21.9	31.3
1986	4.6	17.2	21.5	31.3	2010	8.5	21.2	24.1	34
1987	6.9	19.7	21.7	32.3	2011	6.7	18.7	23.3	32.7
1988	8.2	18.9	21.8	30.3	2012	6.6	19.3	23.2	32.9
1989	7.9	20.9	21.6	30.8	2013	5.9	21.7	22.7	34
1990	8.2	20.0	22.1	32.9	2014	6.8	20.0	22.7	31.3
1991	5.8	17.3	21.6	30	2015	6.3	16.3	22.9	32.2
1992	6.5	19.4	21.9	30.8	2016	8.2	21.2	23	33.8

WHEN WE COMPARE THE DATA IT IS OBVIOUS THAT THE DIFFERENCE BETWEEN THESE TWO CITIES IS SIGNIFICANT. THAT DOES NOT MEAN ANYTHING OF COURSE, BUT WHEN YOU TAKE A LOOK TO THE OVER IMPOSED LINEAR REGRESSION TOKYO HAS BEEN GETTING SIGNIFICANTLY HOTTER EVERY YEAR COMPARED TO FAIRBANKS BY ABOUT +1.4 DEGREES DIFFERENCE

# INTERNET DATA SOURCE FOR FAIRBANKS

Weather Warehouse												
Your Resource for Weather Information												
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If you are using Internet Explorer, this page requires at least version 8 or higher to properly display the information												
Click for More Historical Weather Data												
Past Monthly Weather Data for Fairbanks, AK [Alaska] ("Fairbanks Intl Arpt") : AUGUST, 1949 - 2016												
All months for this station: January February March April May June July August September October November December [Other Locations] Help												
Year	Lowest Temperature (F)	Highest Temperature (F)	Warmest Minimum Temperature (F)	Cooldest Maximum Temperature (F)	Average Minimum Temperature (F)	Average Maximum Temperature (F)	Mean Temperature (F)	Total Precipitation (in)	Total Snowfall (in)	Max 24hr Precipitation (in)	Max 24hr Snowfall (in)	
2016	42	79	58	58	52.1	70.2	61.1	1.56	0.00	0.45	0.00	
2015	33	80	59	47	47.1	62.0	54.6	2.98	0.00	0.75	0.00	
2014	33	80	58	52	49.3	68.9	59.1	2.29	0.00	0.89	0.00	
2013	34	85	58	51	49.1	69.6	59.4	2.02	0.00	0.68	0.00	
2012	37	78	53	54	46.0	66.5	56.3	1.45	0.00	0.82	0.00	
2011	40	76	56	56	47.9	66.5	57.2	1.60	0.00	0.49	0.00	
2010	40	91	63	57	50.0	69.8	59.9	1.46	0.00	0.69	0.00	
2009	33	84	57	52	45.7	63.2	54.5	2.72	0.00	0.58	0.00	
2008	37	76	55	55	45.5	64.5	55.0	2.66	0.00	0.38	0.00	
2007	40	82	59	57	50.3	70.7	60.5	1.52	0.00	0.63	0.00	
2006	36	73	55	54	45.2	63.6	54.4	2.16	0.00	0.63	0.00	
2005	37	84	57	51	47.5	67.1	57.3	0.24	0.00	0.11	0.00	
2004	39	83	59	57	51.5	72.9	62.2	0.37	0.00	0.34	0.00	
2003	41	79	57	51	47.0	65.4	56.2	1.89	0.00	0.50	0.00	
2002	37	83	54	51	46.4	62.8	54.6	3.02	0.00	0.82	0.00	
2001	42	76	55	55	48.6	65.9	57.3	2.01	0.00	0.46	0.00	
2000	35	78	54	47	44.0	59.3	51.6	3.04	0.00	0.52	0.00	
1999	37	86	57	54	48.6	67.3	57.9	1.85	0.00	0.54	0.00	
1998	33	80	54	50	45.7	60.2	53.0	3.18	0.00	0.69	0.00	
1997	34	82	62	55	49.8	67.5	58.7	1.70	0.00	0.50	0.00	

THIS IS THE SITE THAT CONTAINED MANY PLACES IN THE U.S. BUT THE NUMBER OF YEARS WAS NOT AS VAST AS THE JAPANESE SITE. THE ORIGINAL DATA WAS IN FAHRENHEIT SO I CONVERTED TO CELSIUS TO BE CONSISTENT IN MY COMPARISON.



# INTERNET DATA SOURCE FOR TOKYO

気象庁

Japan Meteorological Agency

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> Tables of Monthly Climate Statistics

> Monthly mean daily minimum temperature

Monthly mean daily minimum temperature (°C)

UENO WMO Station ID:47649

Monthly mean daily minimum temperature

Refresh

UENO WMO Station ID:47649 Lat 34°45.7'N Lon 136°08.5'E

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1937				4.9	9.9	14.5	21.6	21.8	17.0	10.4	5.5	-0.9	11.6
1938	-3.1	-2.9	1.4	4.3	11.8	16.3	20.7	21.6	16.1	12.1	2.1	-0.6	8.3
1939	-3.0	-1.8	0.7	5.5	9.4	15.2	21.6	21.1	17.0	11.0	5.3	-2.7	8.3
1940	-2.9	-3.1	-0.6	4.2	8.2	14.2	21.7	20.0	16.9	10.5	4.7	0.1	7.8
1941	-1.5	-2.6	0.6	3.2	9.5	16.6	20.9	21.4	16.5	8.9	4.8	0.5	8.2
1942	-2.4	-1.9	2.6	3.0	9.0	16.2	22.2	21.6	18.3	8.6	1.5	-2.0	8.1
1943	-4.2	-3.6	-1.2	2.3	10.0	16.7	21.4	21.4	18.9	9.9	2.3	-0.9	7.8
1944	-2.2	-3.1	-0.8	4.0	12.1	15.3	20.8	21.5	16.1	10.3	4.4	-1.1	8.1
1945	-2.5	-3.3	-1.0	3.8	10.5	16.1	19.3	23.2	18.3	11.8	3.1	-0.7	8.2
1946	-2.1	-2.7	0.4	6.0	11.1	17.4	21.6	21.1	16.4	10.6	6.9	-0.1	8.9
1947	-1.2	-4.6	-1.7	2.4	9.1	15.0	21.2	21.0	17.1	8.6	0.8	-1.8	7.2
1948	-2.6	-2.6	0.1	6.0	10.5	16.0	21.8	21.1	17.1	10.2	4.5	2.1	8.7
1949	-2.4	0.3	-1.5	2.8	10.5	16.0	20.7	21.2	17.5	8.9	4.1	0.6	8.2
1950	-0.3	-0.6	0.1	5.9	12.1	16.5	21.4	21.4	17.7	9.9	4.7	-1.0	9.0
1951	-2.6	-1.5	0.5	5.4	9.5	13.8	20.0	22.0	14.5	11.4	3.8	0.0	8.1
1952	-1.3	-2.1	0.8	5.4	9.4	15.8	20.2	21.3	17.3	9.4	5.1	-0.7	8.4
1953	-2.5	-1.9	2.3	2.7	10.2	17.6	20.8	21.7	17.4	10.1	4.5	0.1	8.6
1954	-0.2	-2.0	-0.2	6.8	11.0	15.2	19.1	21.3	19.0	10.0	3.5	1.0	8.7
1955	-2.7	-1.7	2.6	6.7	10.8	17.6	21.9	20.3	16.8	11.7	1.1	-0.4	8.7

THIS IS THE SITE THAT I USED FOR THE TEMPERATURES IN JAPAN. A VAST SOURCE OF HISTORICAL TEMPERATURES FOR JAPAN. THE ORIGINAL DATA WAS IN CELSIUS



# CONCLUSION

- From the retrieved data I cannot say for sure if there is a uniform yearly increase. Nevertheless, from the linear regression of the mean max and min averages the rate of change is positive.
- In Tokyo there has been an approximate **increase of 2.3 degrees Celsius** over 48 years
- In Fairbanks there has been an approximate **increase of 0.936 degrees Celsius** over 48 years
- We may say that the temperatures in Tokyo and Fairbanks have increased over the 48 years span of the data



# REFERENCES

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- Google.(n.d.). Retrieved September 30, 2016, from <https://www.google.co.jp/maps/place/Tokyo/@37.9166169,133.2045516,2101453m/data=!3m1!1e3!4m5!3m4!1s0x605d1b87f02e57e7:0x2e01618b22571b89!8m2!3d35.6894875!4d139.6917064>

