

macroclimate

ibdj

2026-01-14 22:50

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1 Macroclimate data sources

Background macroclimate of Kangerluarsunnguaq (Kobbefjord, Nuuk 64.13334, -51.34368). Data produced by [Asiaq - Greenland Survey](#) for [Greenland Ecosystem Monitoring \(GEM 2020c, 2020a, 2020b\)](#) and DMI ([Cappelen 2021; Jensen 2024](#)).

2 Temperature data

The imported data has entries between 2007 and 2022.

Temperatures between -30.2°C (2008-02-11) and 23.2°C (2016-06-10) have been recorded.

2.1 Mean annual temperature

The mean temperature across all entries is -0.1003°C.

The warmest months are July (10.49°C), August (9.49°C) and June (7.25°C).

The coldest months are February (-8.97°C), March (-7.97°C), and January (-7.34°C).

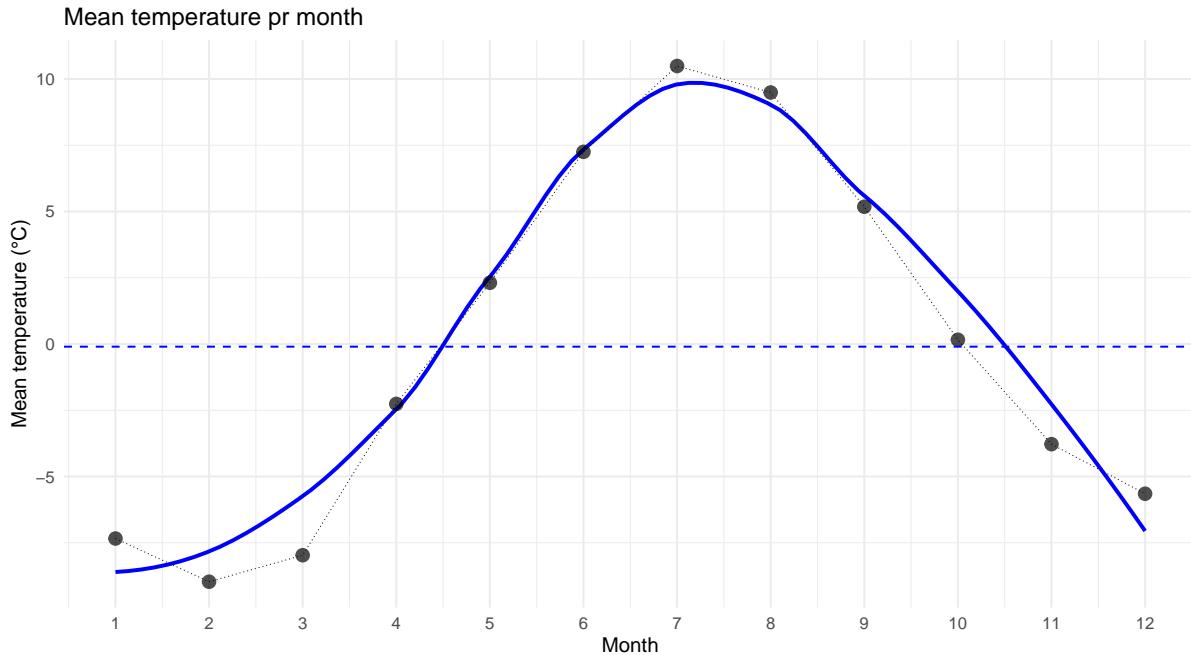


Figure 1: Mean air temperature (°C) pr month, based on data from 2007 to 2022. The dashed line represent yearly mean of -0.1°C.

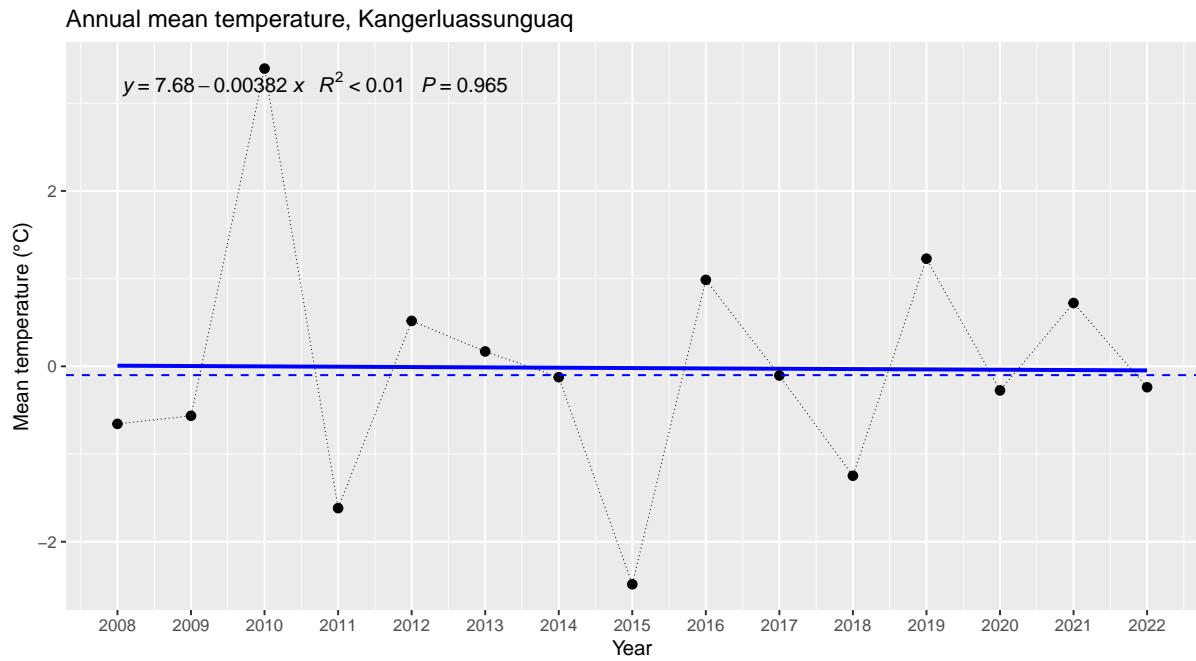


Figure 2: Mean air temperature pr year ($^{\circ}\text{C}$) from 2008 to 2022. Data from 2007 is excluded because data is only from October, November and December. Blue dashed line indicate over all mean of -0.1003°C . Solid blue is trend line.

Mean temperature of warmest months

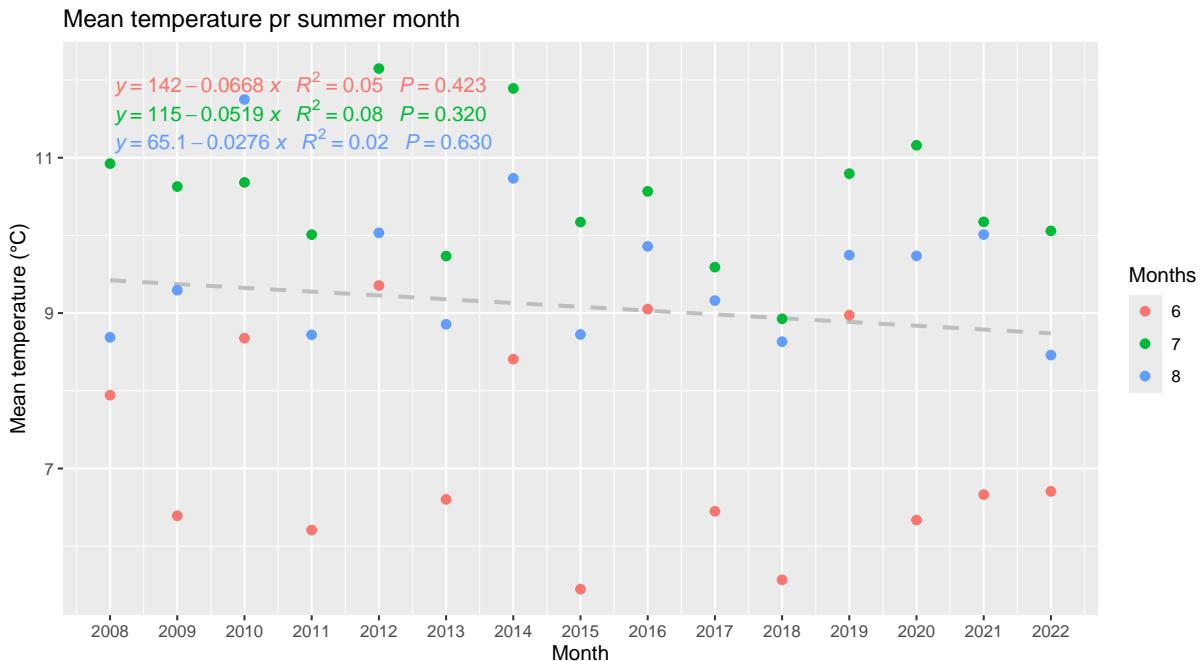


Figure 3: Mean air temperature (°C) pr for July, August, and June based on data from 2007 to 2022. P-value for the regression is 0.416. The mean of the warmest months across all years are 9.081°C.

Call:

```
lm(formula = mean ~ year, data = data_temp_monthly_mean_summer)
```

Residuals:

Min	1Q	Median	3Q	Max
-3.6340	-0.7226	0.1279	1.2551	2.9202

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	107.34623	119.65318	0.897	0.375
year	-0.04877	0.05938	-0.821	0.416

Residual standard error: 1.721 on 43 degrees of freedom

Multiple R-squared: 0.01544, Adjusted R-squared: -0.007454

F-statistic: 0.6745 on 1 and 43 DF, p-value: 0.416

2.2 Temperature anomalies

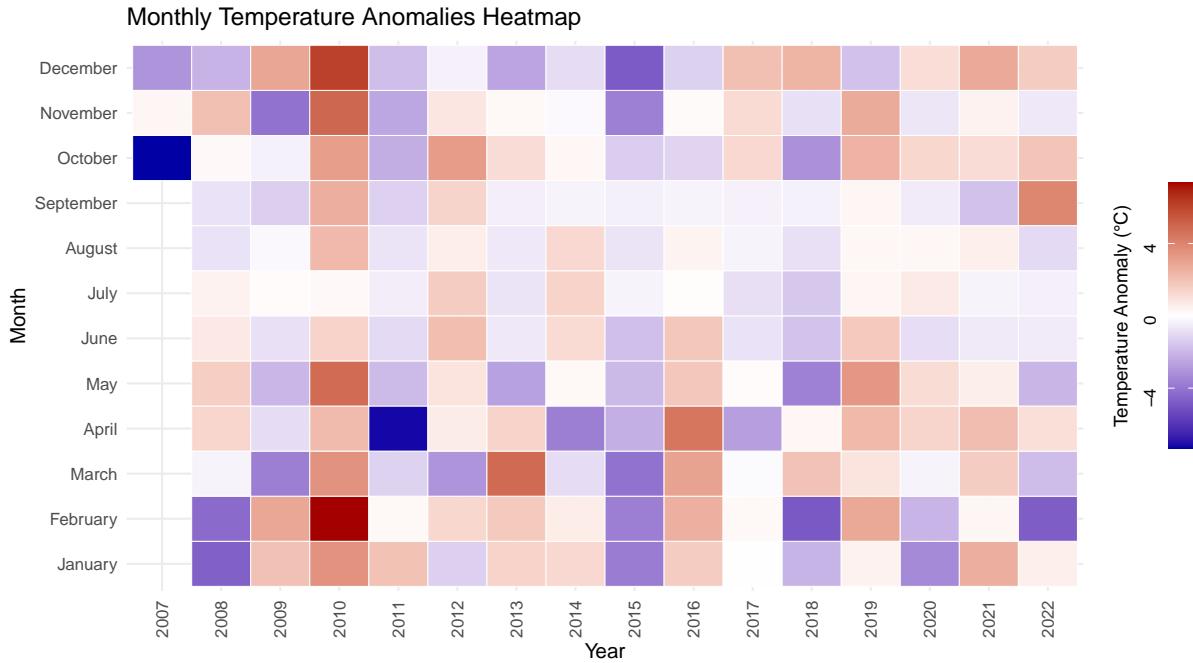


Figure 4: Monthly Temperature Anomalies Heatmap. The stronger the color the bigger the difference from mean temperature of the respective month across all monitored years ($^{\circ}\text{C}$).

2.3 Absolute values of anomalies

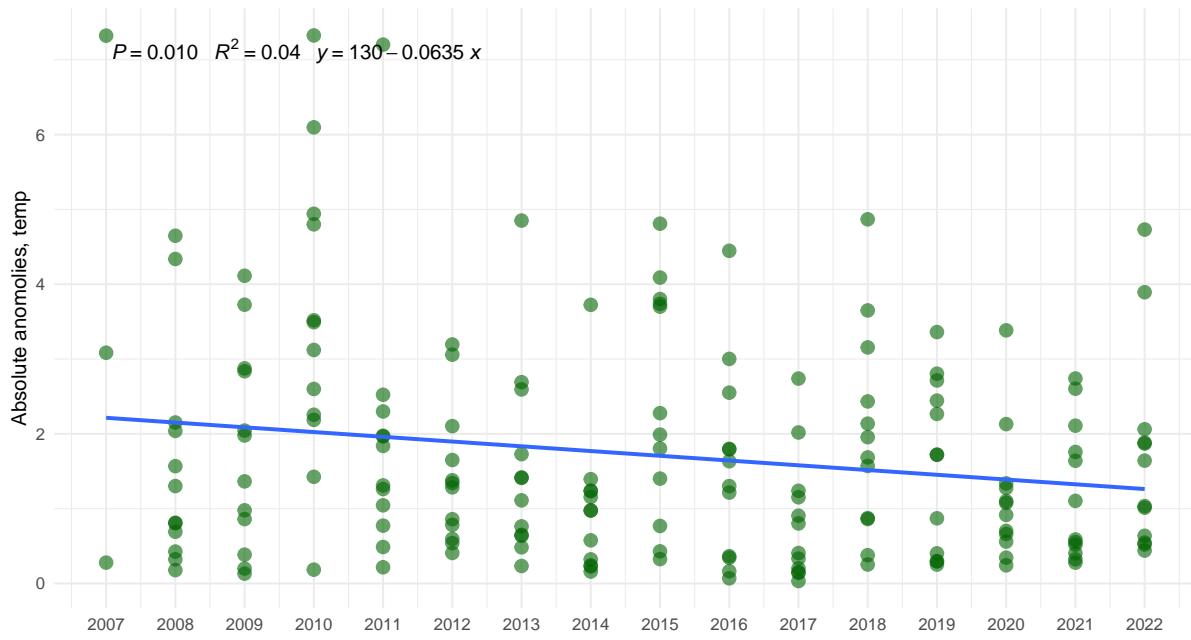


Figure 5: Absolut values of anomalies (difference from mean) of respective month.

3 Precipitation data

3.1 Yearly precipitation

The mean annual precipitation is 886.15 mm. 874.0611111

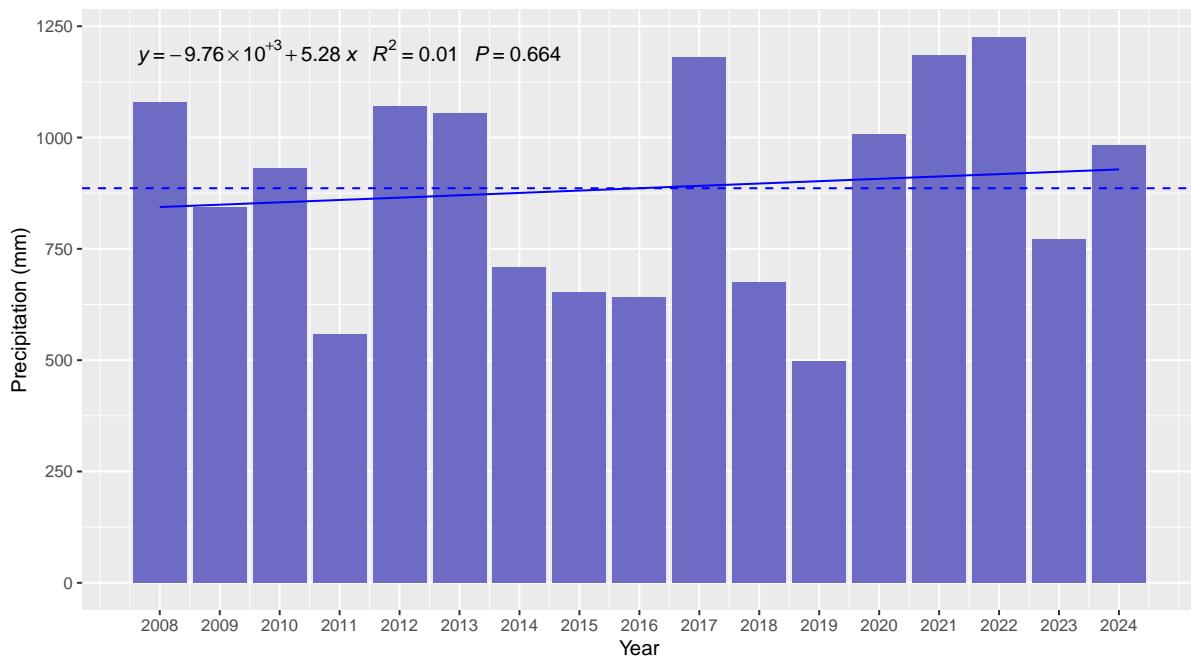


Figure 6: Mean yearly precipitation (mm) from 2008 to 2024. Data from 2007 is excluded because it was only from May - December. Blue dashed line indicate over all mean of 886.15 mm.

3.2 Monthly precipitation

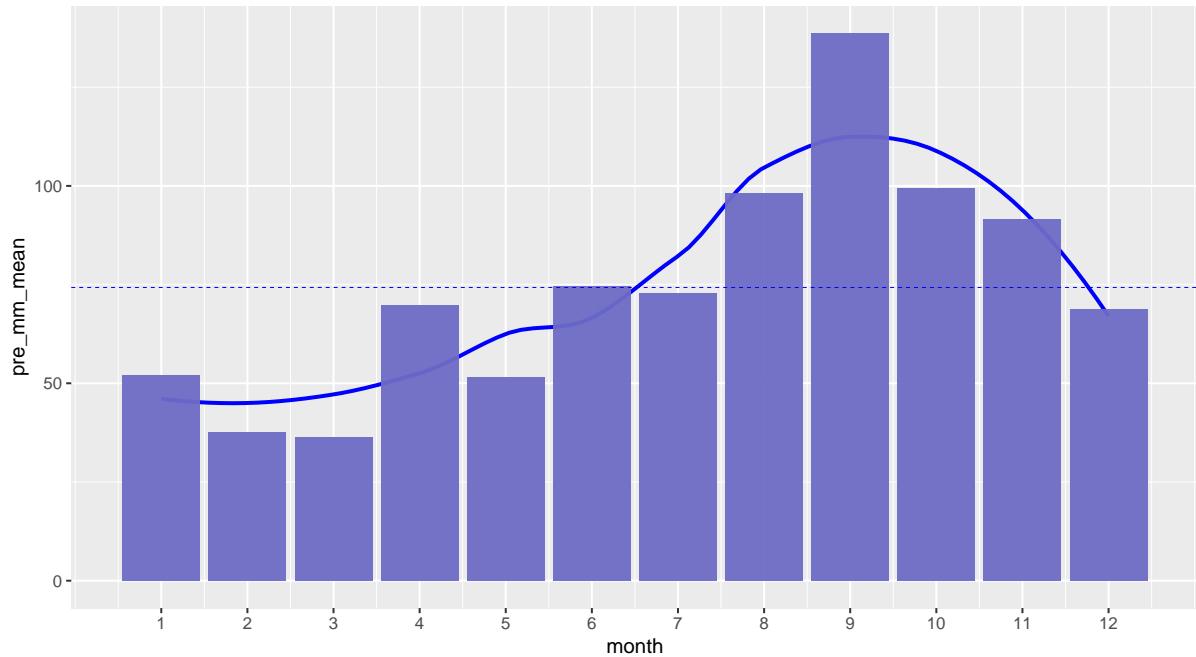


Figure 7: Mean monthly precipitation (mm) including data from 2007 to 2024. Blue dashed line represent monthly mean of 74.27 mm. ADD SF BARS!

The months with the most precipitation are September (138.64 mm), October (99.38 mm), August (98.28 mm), which account for 336.3 mm or 37.95 % of the yearly precipitation.

The months with the least precipitation are May (51.51 mm), February (37.62 mm), March (36.44 mm).

3.3 Precipitation type

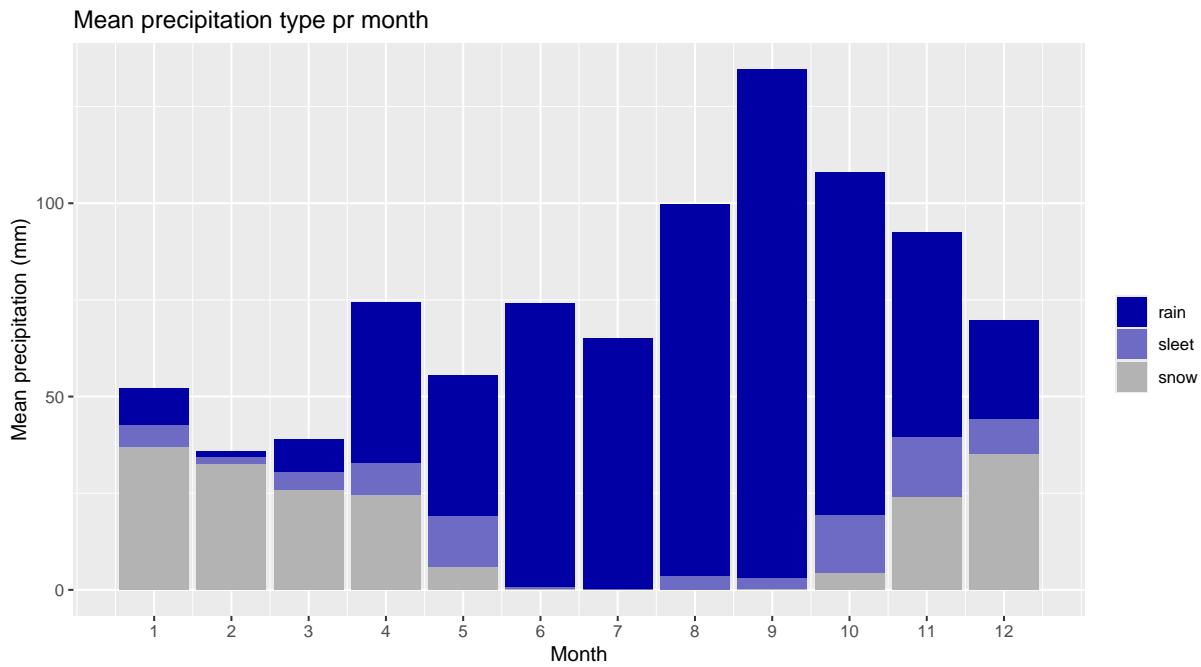


Figure 8: Mean monthly distribution of types of precipitation (mm). Based on data from 2008 to 2022. Sleet is defined as precipitation that fell when temperatures were between -1°C and 1°C.

Out of 886.15 (900.8) mm mean annual precipitation, rain accounts for 631.55 mm (70.1 %), snow accounts for 188.71 mm ((20.9 %)), and sleet for the remaining 80.54 mm (8.9 %).

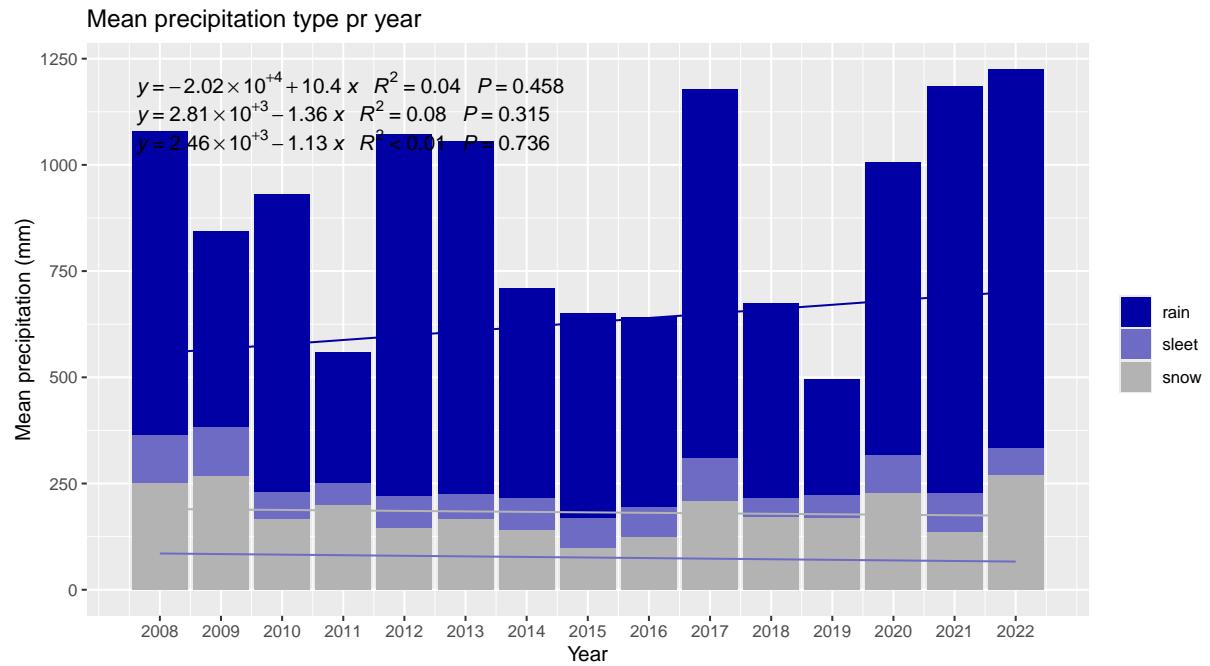


Figure 9: Mean precipitation pr. month over the monitoring period (2008 - 2022). Sleet is defined as precipitation that fell when temperatures were between -1°C and 1°C . (Data only to 2022 because the temperature data is only till 2022.)

3.4 Precipitation anomalies

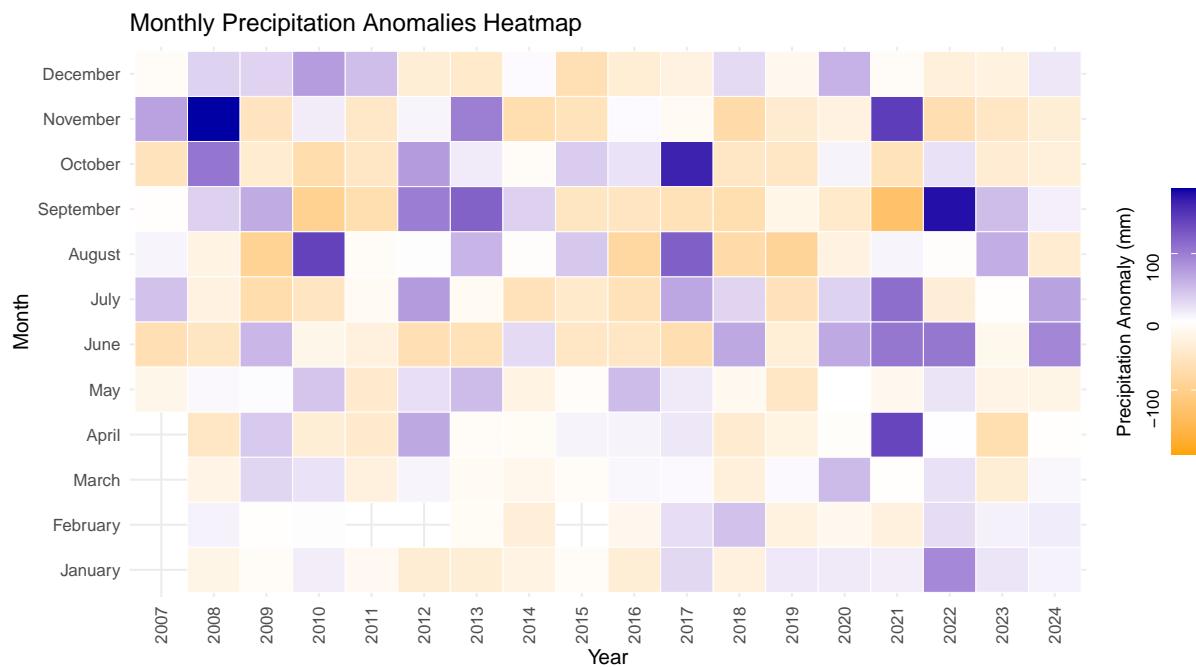


Figure 10: Monthly precipitation anomaly ($^{\circ}\text{C}$). Stronger colors indicate large derivation from the month mean.

3.5 Absolute values of anomalies

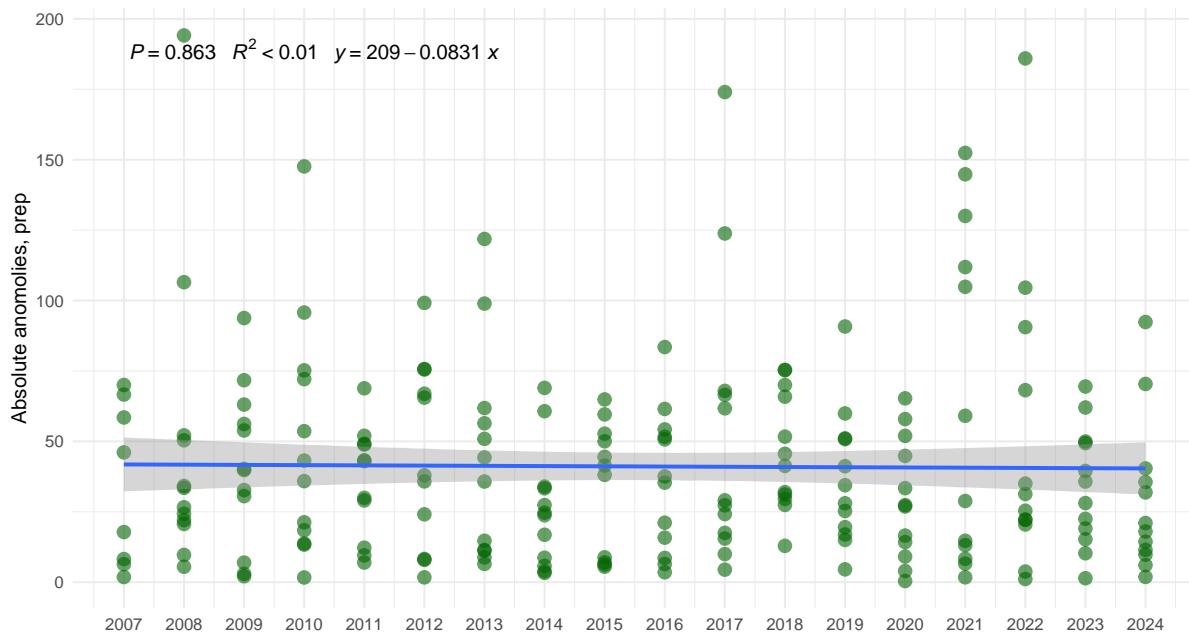


Figure 11: Absolut values of anomalies (difference from mean) of respective month.

4 PAR data

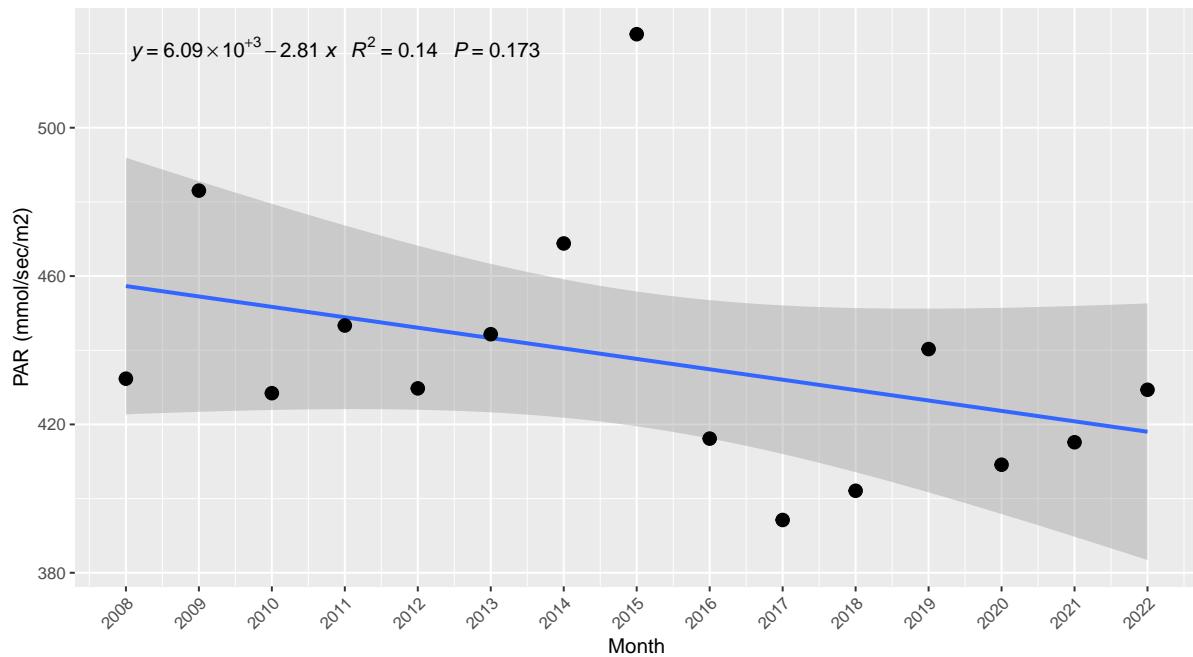


Figure 12: Monthly mean PAR from 2008 to 2022. Calculations based on PAR values only when the sun is up (solar elevation > 0).

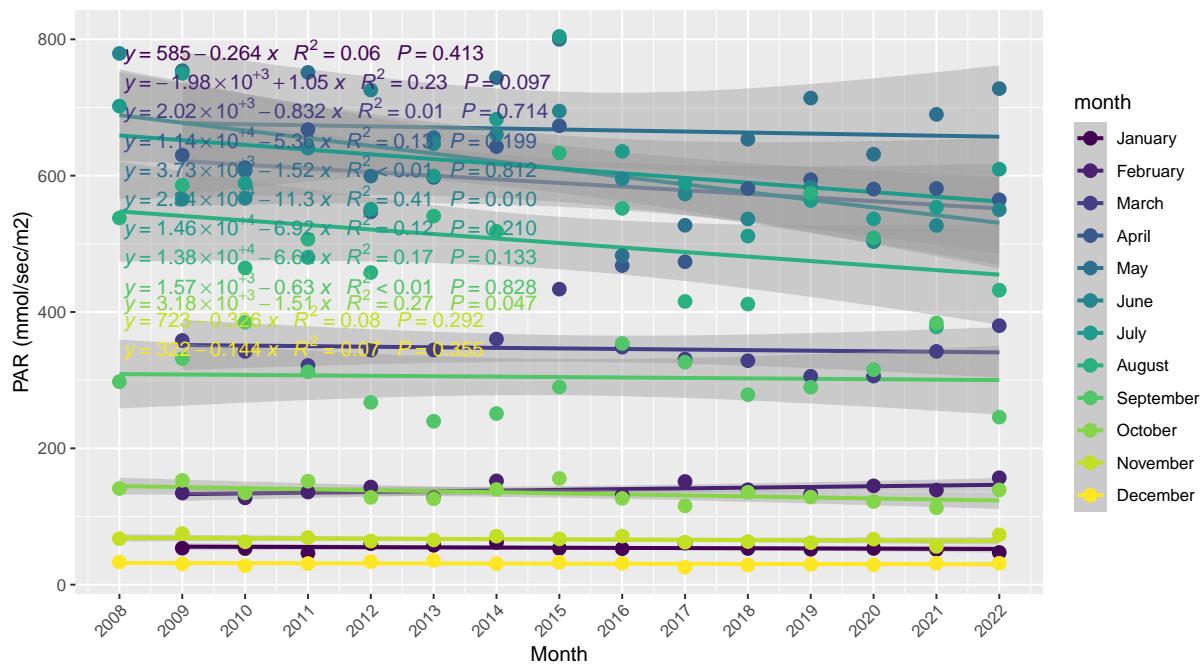


Figure 13: Monthly mean PAR from 2008 to 2022. Calculations based on PAR values only when the sun is up (solar elevation > 0).

4.1 Monthly means

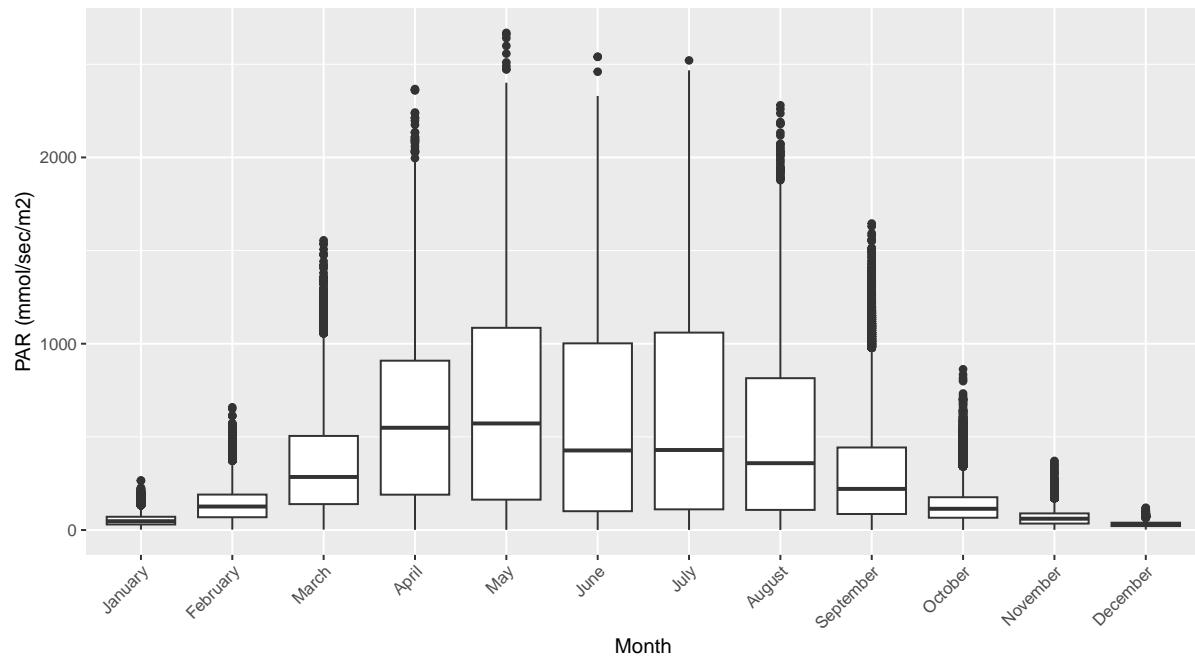


Figure 14: Monthly mean PAR from 2008 to 2022. Calculations based on PAR values only when the sun is up (solar elevation > 0).

4.2 Highest monthly means

The months with the highest mean levels of PAR (when the sun is up, solar elevation > 0) are May (663.1), July (610.3), June (597).

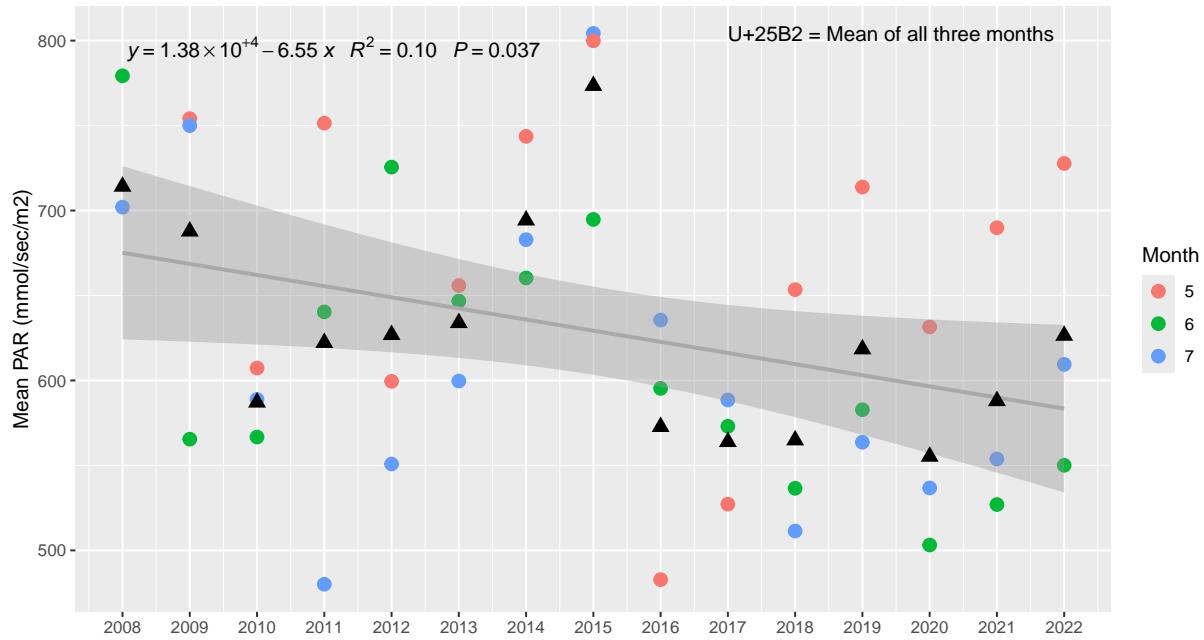


Figure 15: Mean of months with highest PAR.

Data indicate that high-radiation months have gotten less radiant during the monitoring period (see Figure 15).

Call:

```
lm(formula = par_mean ~ year, data = par_highest_mean)
```

Residuals:

Min	1Q	Median	3Q	Max
-175.44	-60.59	-17.74	68.27	174.95

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	13835.416	6118.291	2.261	0.0290 *
year	-6.554	3.036	-2.159	0.0366 *

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 85.33 on 42 degrees of freedom

Multiple R-squared: 0.09987, Adjusted R-squared: 0.07843

F-statistic: 4.66 on 1 and 42 DF, p-value: 0.03664

4.3 Mean pr month

4.4 Observations above 2000

Call:

```
lm(formula = above_2000 ~ year, data = above_2000)
```

Residuals:

Min	1Q	Median	3Q	Max
-8.299	-6.156	-3.513	4.737	27.486

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	152.8806	646.6144	0.236	0.814
year	-0.0714	0.3210	-0.222	0.825

Residual standard error: 8.88 on 41 degrees of freedom

Multiple R-squared: 0.001205, Adjusted R-squared: -0.02316

F-statistic: 0.04946 on 1 and 41 DF, p-value: 0.8251

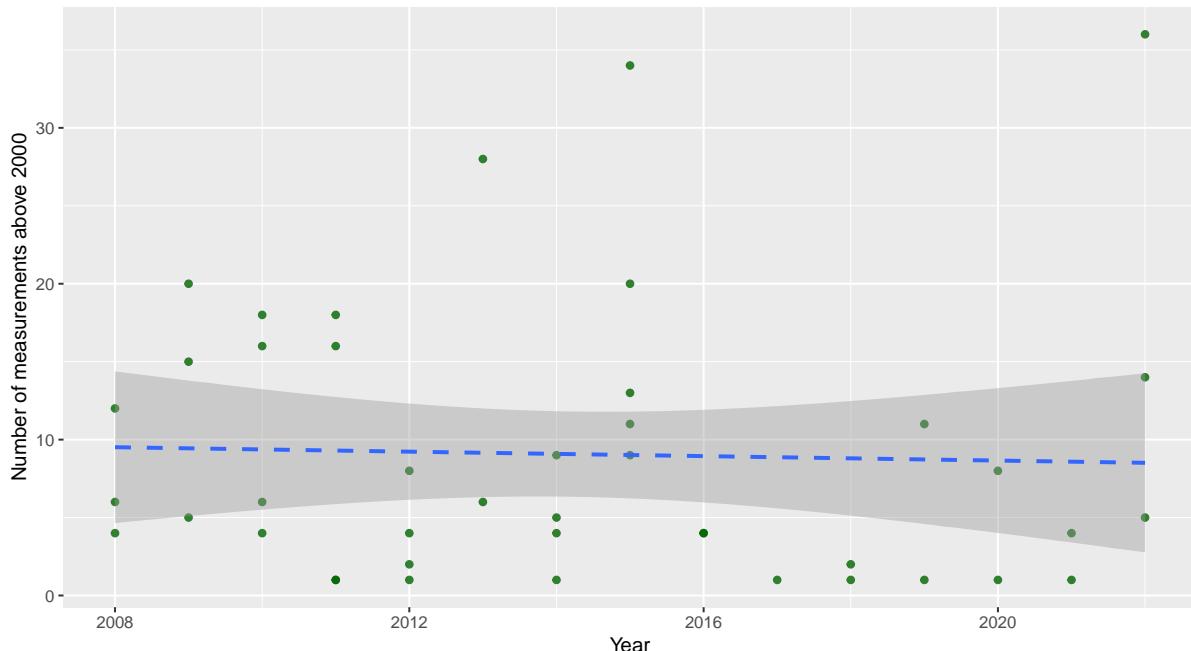


Figure 16: Number of measurements of PAR above 2000.

4.5 PAR anomalies

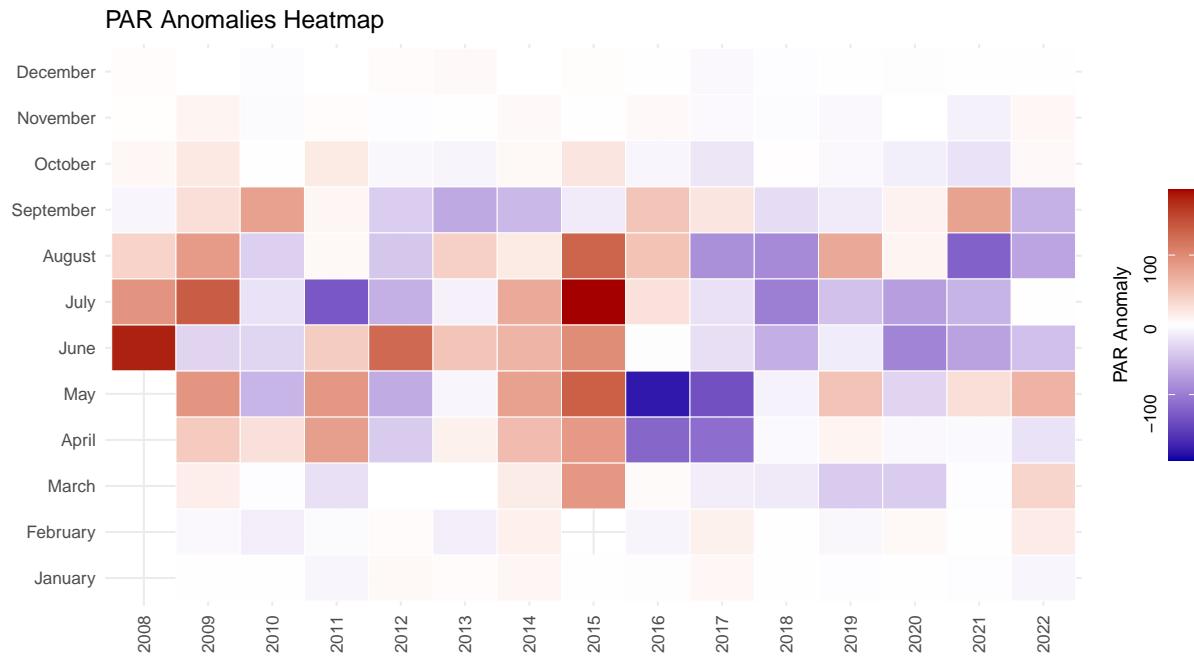


Figure 17: Anomalies (difference from mean) of respective month. Stronger color indication bigger difference from monthly mean across entire period.

4.6 Absolute values of anomalies

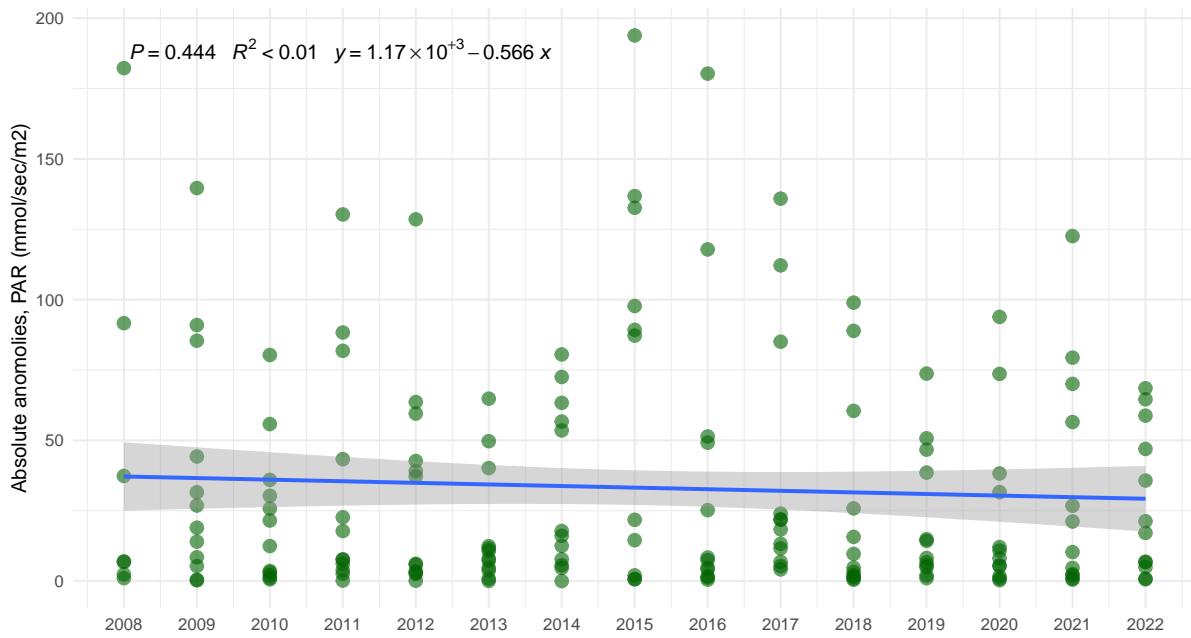


Figure 18: Absolut values of anomalies (difference from mean) of respective month.

5 Degree days

The number of degree days (days with a mean temperature $> 0^\circ\text{C}$) has not changed significantly during the monitoring period.

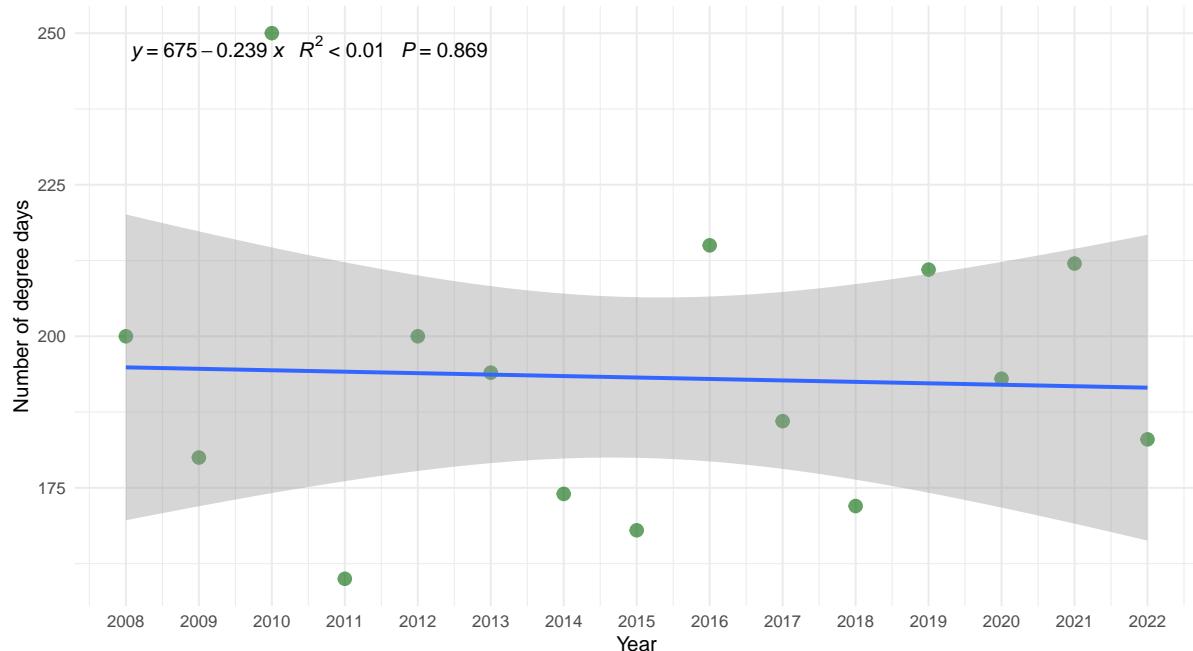


Figure 19: Degree days, days with mean temperature above 0°C

##Degree days anomalies (in number of days)

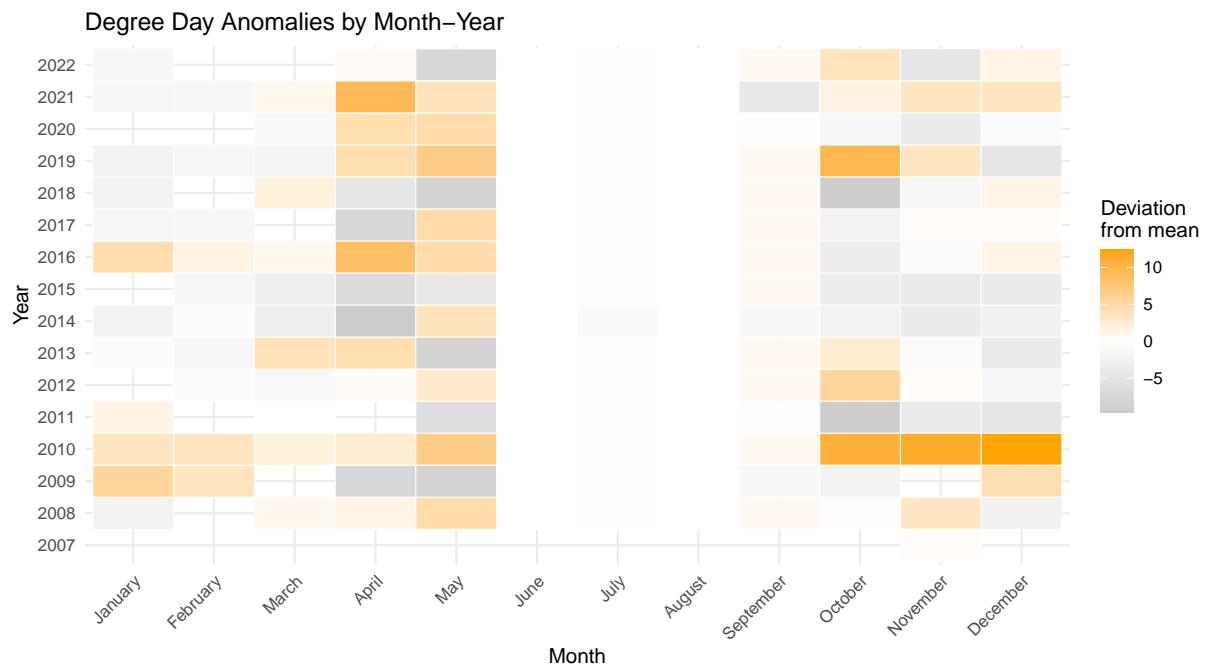


Figure 20: Degree days, days with mean temperature above 0°C

##Absolute numbers of variation in degree days

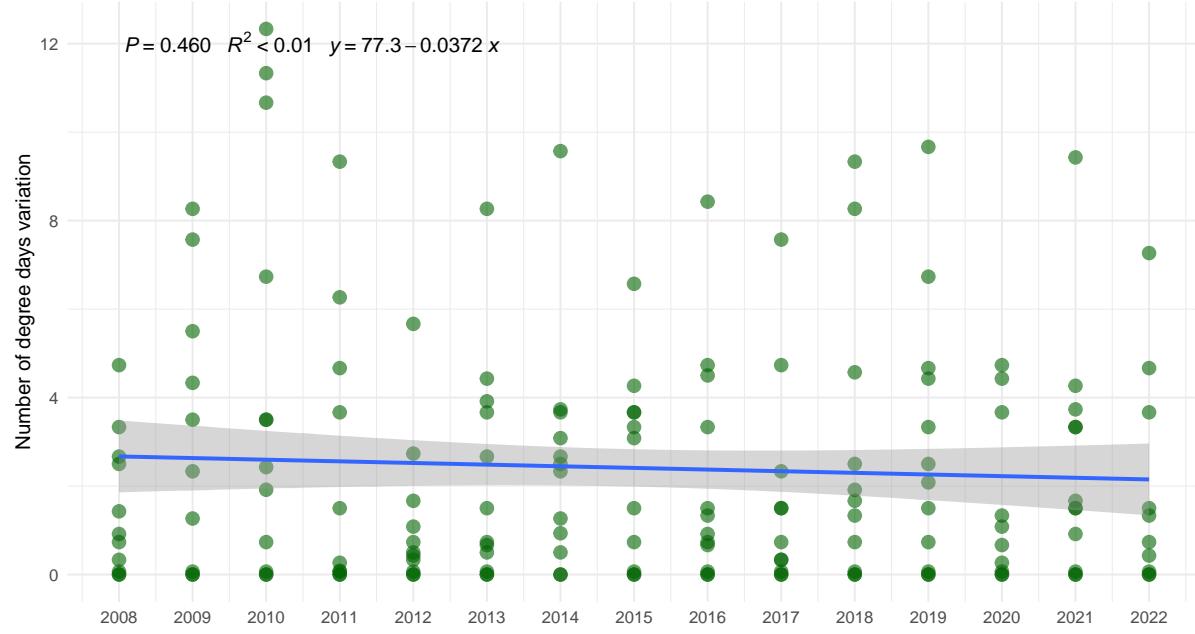


Figure 21: Absolute numbers of deviation from mean number of degree days

6 Historic climate context

6.1 CHELSA

Lookings to see if CHELSA data shoc the same pattern of minimal change as the local data. Using this guide to optain data: <https://gitlabext.wsl.ch/karger/rchelsa>

6.2 DMI

Looking at the historic weather data from DMI from Nuuk. I.e. not the exact location of Kangerluarsunnguaq, but Nuuk. Hoping to illustrate over all trends.

- How does the data look, when compared during the monitoring period > 2007 for Nuuk?
- What are the trends during the historic period?
- For rain
- For temp
- Only for year or monthly trends too?

- Station Nuuk is (3)4250
- 601 is accumulated precipitation
- for 25-08: 101 is Mean air temperature ($^{\circ}\text{C}$; 2 meters above ground).

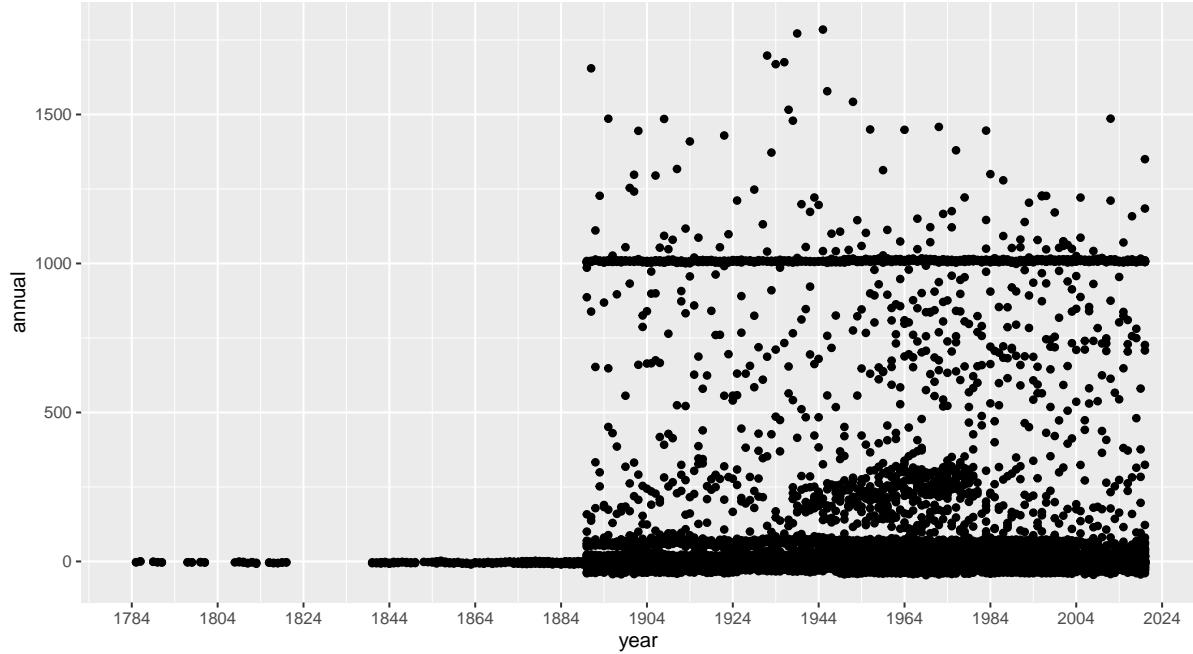


Figure 22: Mean air temperature ($^{\circ}\text{C}$) pr year, from 1784 to 2020. Yearly mean of 173.6°C .
Yearly mean ranges from -46.1°C to 1785°C .

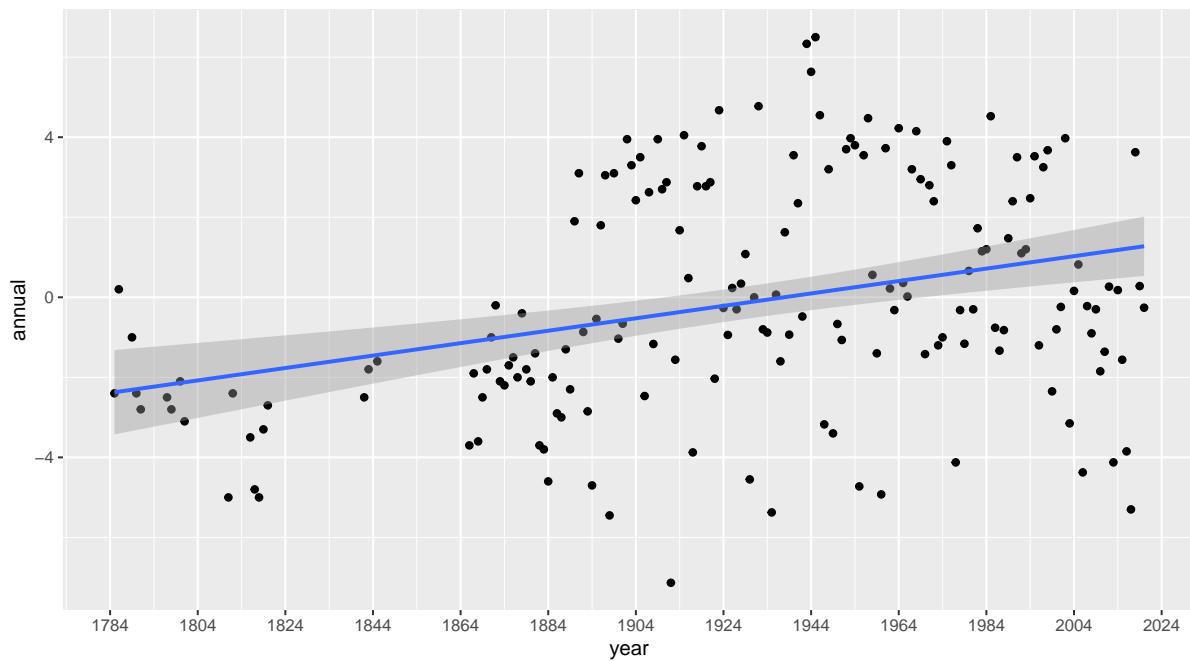


Figure 23: Mean air temperature ($^{\circ}\text{C}$) pr year, from 1785 to 2020. Yearly mean of -0.1°C .
 Yearly mean ranges from -7.13°C to 6.5°C . Mean temperature has increase from -2.448°C in 1784 to 1.272°C in 2024

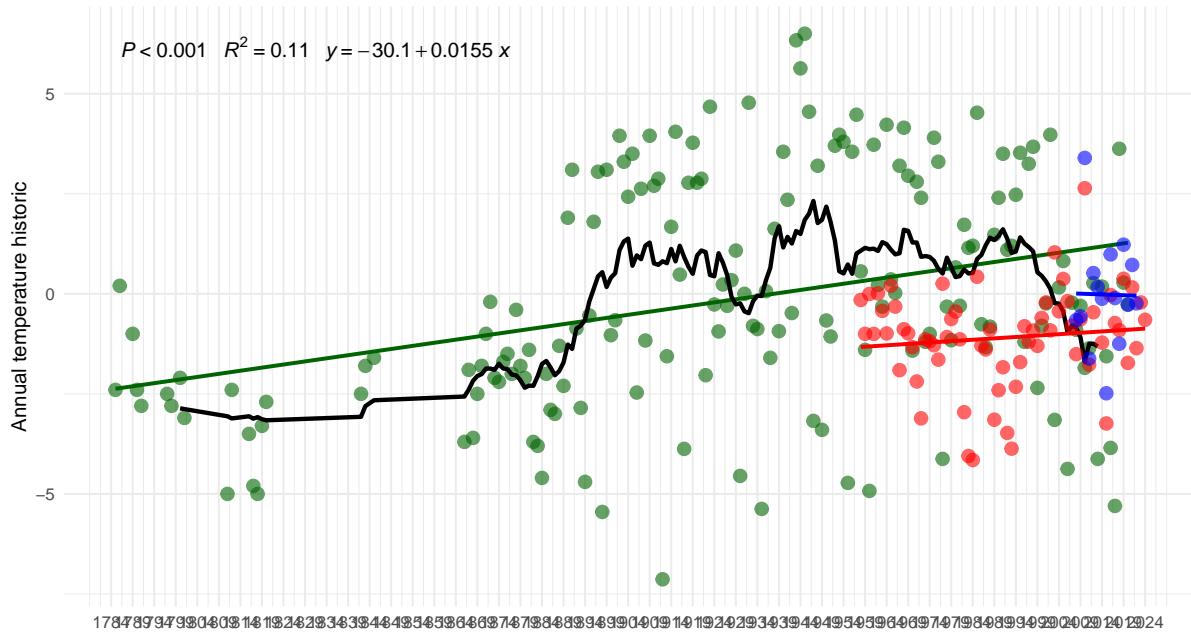


Figure 24: Annual historic temperature in $^{\circ}\text{C}$.

```
tibble [16 x 2] (S3: tbl_df/tbl/data.frame)
$ Year      : num [1:16] 2008 2009 2010 2011 2012 ...
$ mean_temp: num [1:16] -1.508 -0.639 2.638 -1.771 -0.461 ...

tibble [15 x 3] (S3: tbl_df/tbl/data.frame)
$ year: num [1:15] 2008 2009 2010 2011 2012 ...
$ mean: num [1:15] -0.656 -0.564 3.395 -1.617 0.518 ...
$ sd   : num [1:15] 9.29 7.99 6.67 8.01 8.96 ...
```

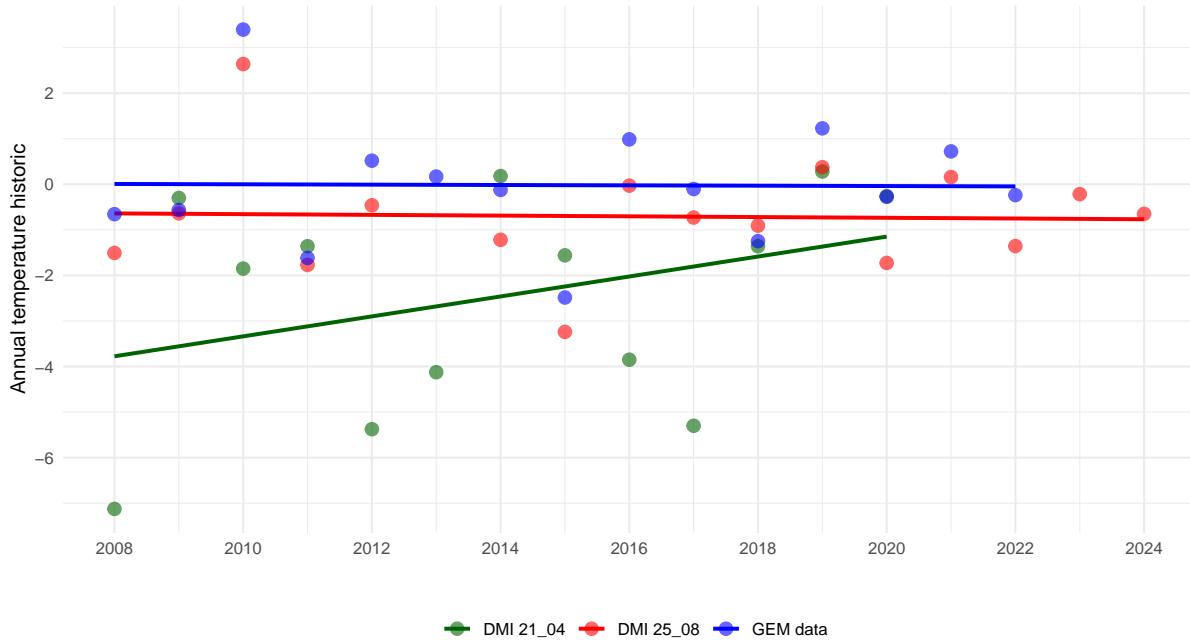


Figure 25: Annual historic temperature in °C only from 2008 to current. DMI 25-08 (Nuuk) and GEM data (Kangerluarsungguaq) corresponds very well.

7 TO DOS

- [] make all plots similar. Ref. mnd plots from NERO analysi.

References

Cappelen, John. 2021. “Greenland – DMI Historical Climate Data Collection 1784-2020.” 21-04. Danish Meteorological Institute. <https://www.dmi.dk/fileadmin/Rapporter/2021/DMIRep21-04.pdf>.

- GEM. 2020a. "ClimateBasis Nuuk - Precipitation - Precipitation Accumulated (Mm)." Greenland Ecosystem Monitoring. <https://doi.org/10.17897/SXJ8-WA79>.
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- Jensen, Caroline Drost. 2024. "Weather Observations from Greenland 1958-2023." 24–08. Danish Meteorological Institute.