macroclimate

ibdj

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Table of contents

List of Figures

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).

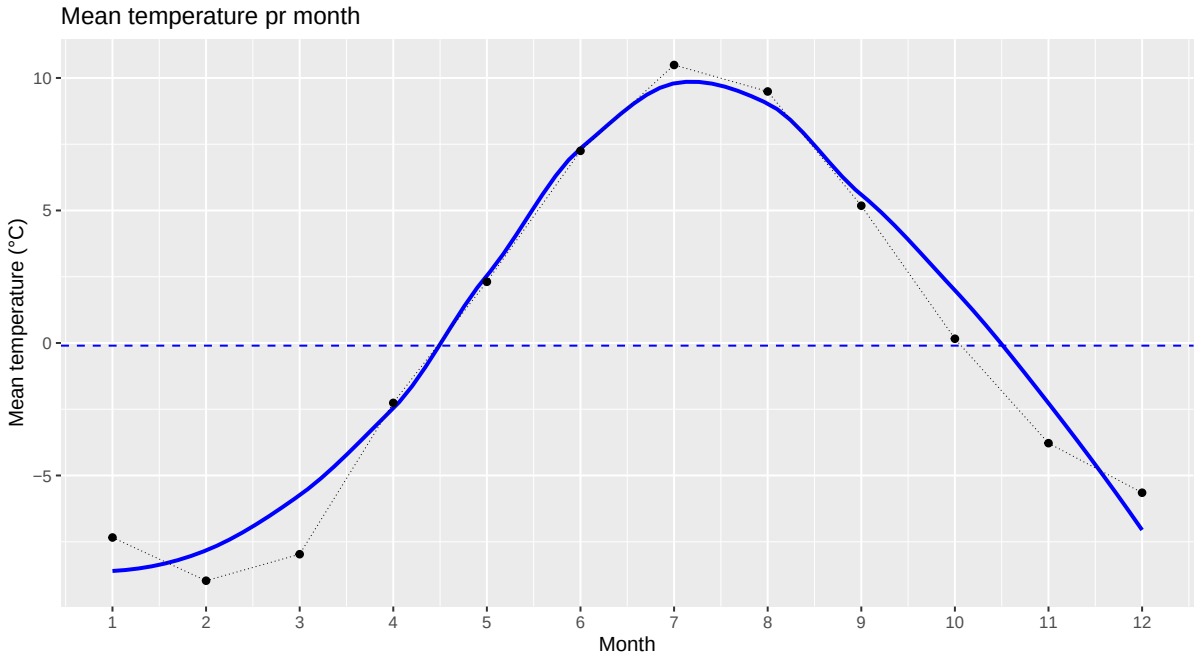

Figure 1: Mean air temperature (°C) pr month, based on data from 2007 to 2022. The dashed line represent yearly mean of -0.1°C.

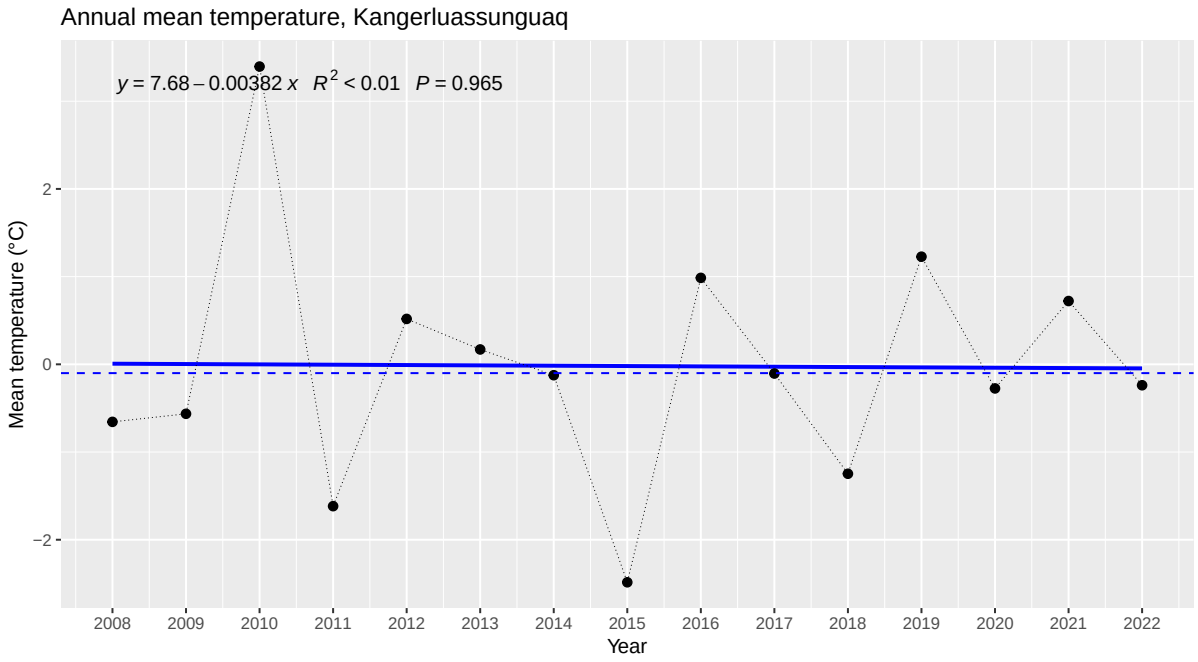

Figure 2: Mean air temperature pr year (°C) from 2008 to 2022. Data from 2007 is excluded because data is only from October, November and December. Blue dashed line indicate over all mean of -0.1003°C. Solid blue is trend line.

Mean temperature of warmest months

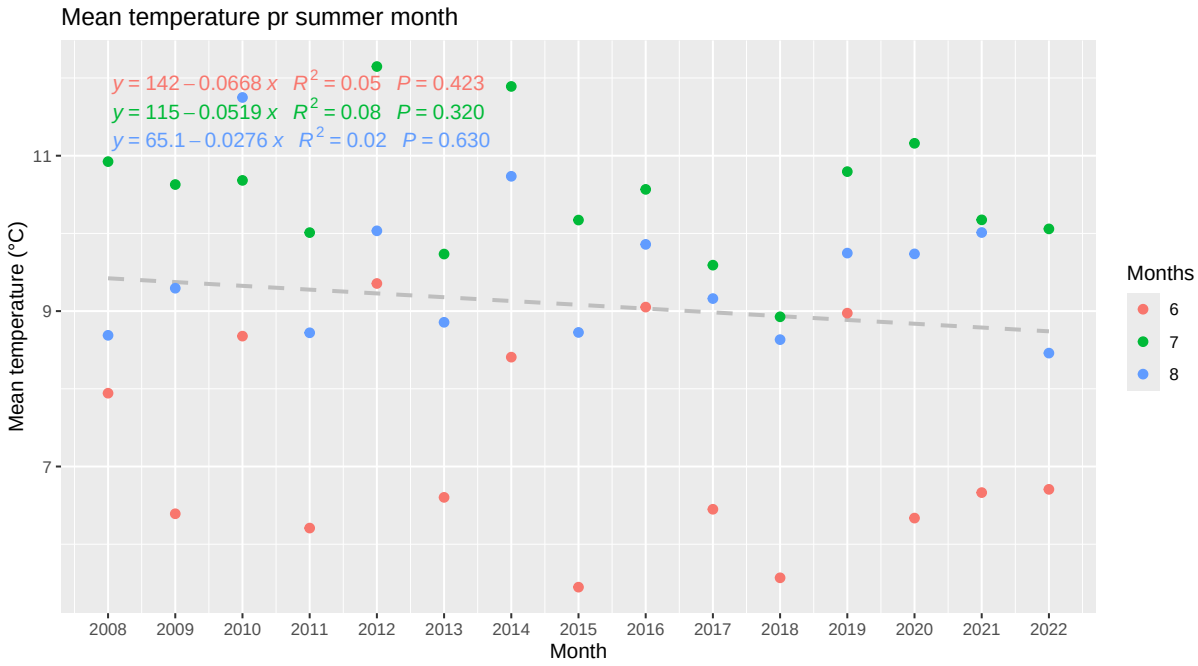

Figure 3: Mean air temperature (°C) pr for July, August, and June based on data from 2007 to 2022. P-value for the regression i 0.416. The mean of the warmests months across all years are 9.081°C.

```
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

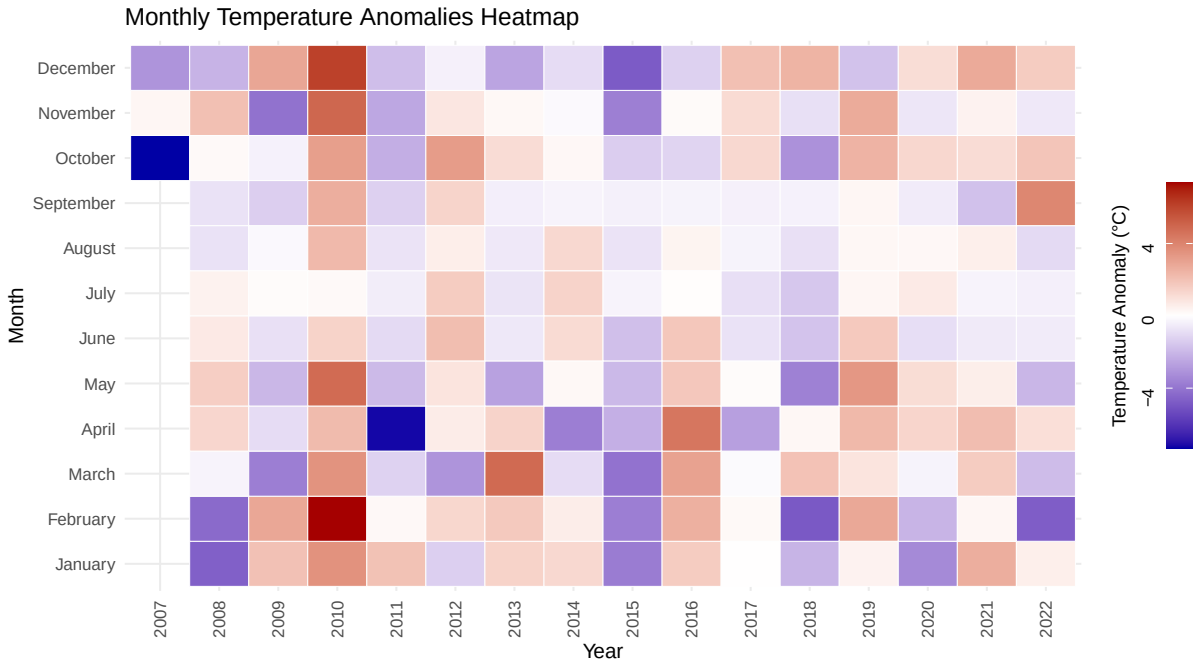

Figure 4: Monthly Temperature Anomalies Heatmap. The stronger the color the bigger the difference from mean temperature of the respective month across all monitored years (°C).

2.3 Absolute values of anomolies

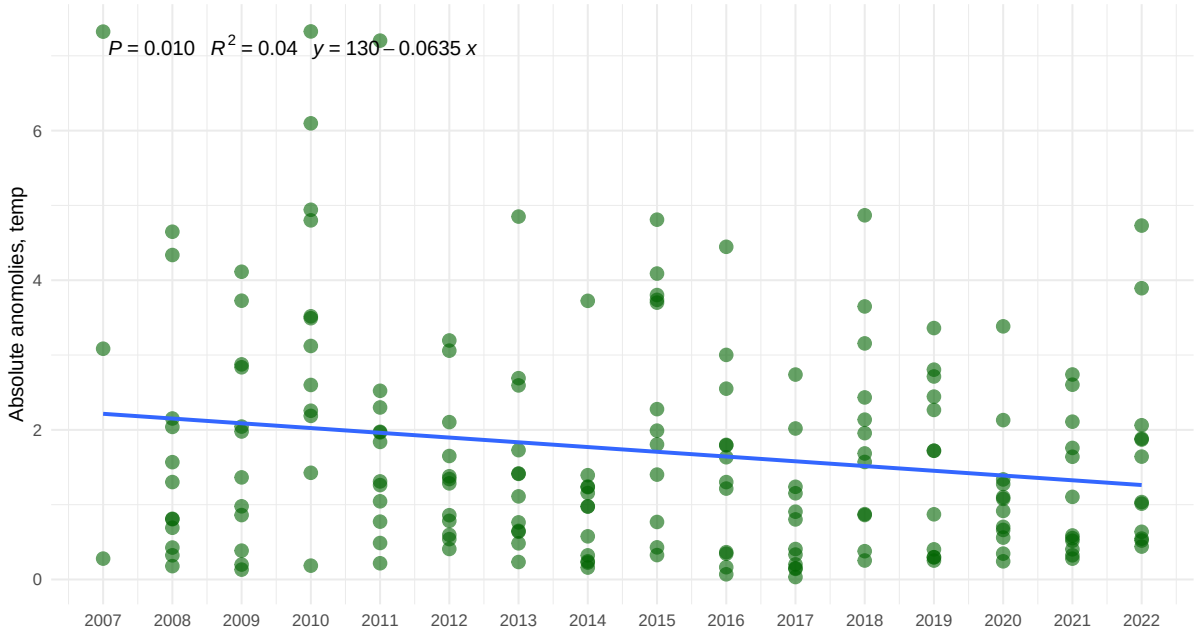

Figure 5: Absolut values of anomolies (difference from mean) of respective month.

3 Precipitation data

3.1 Yearly precipitation

The mean annual precipitation is 886.15 mm. 874.0611111

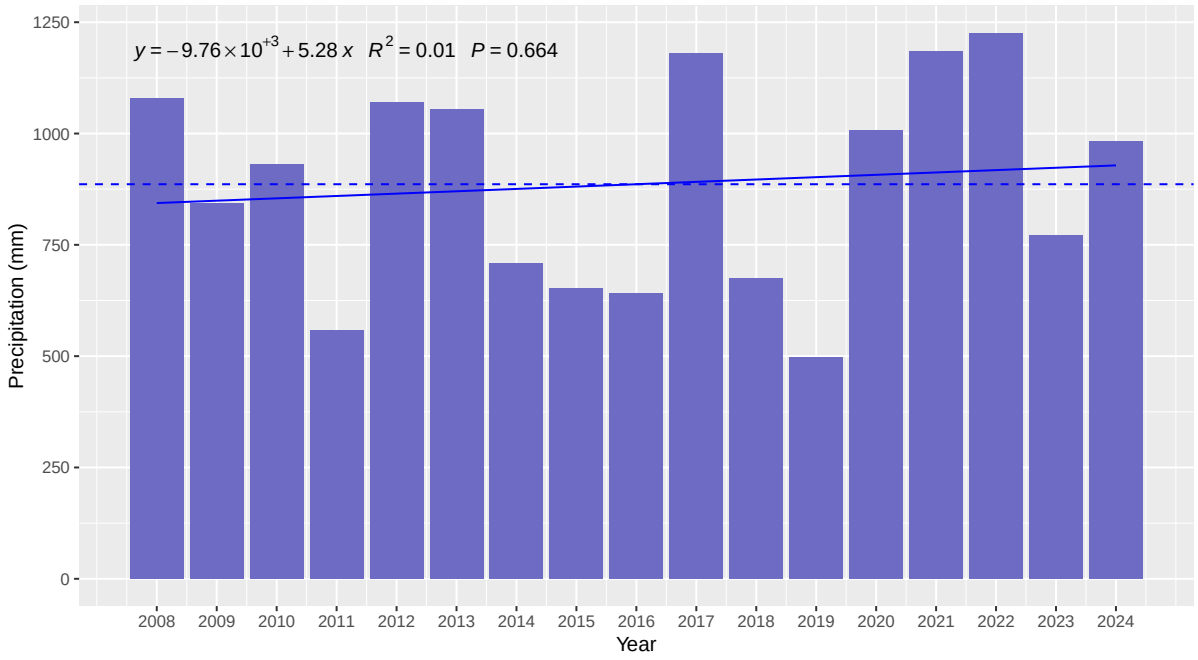

Figure 6: Mean yearly precipitation (mm) from 2008 to 2024. Data from 2007 is excluded because it was only from May - December. Blue dashed line indicate over all mean of 886.15 mm.

3.2 Monthly precipitation

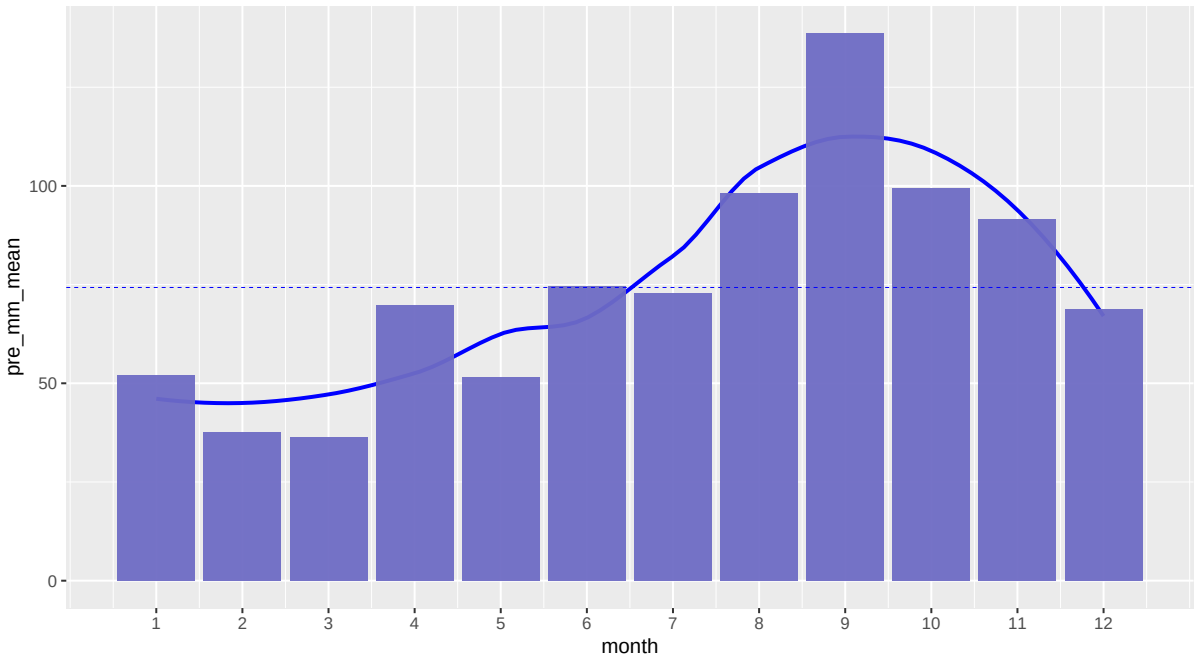

Figure 7: Mean monthly precipitation (mm) including data from 2007 to 2024. Blue dashed line represent monthly mean of 74.27 mm. ADD SF BARS!

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

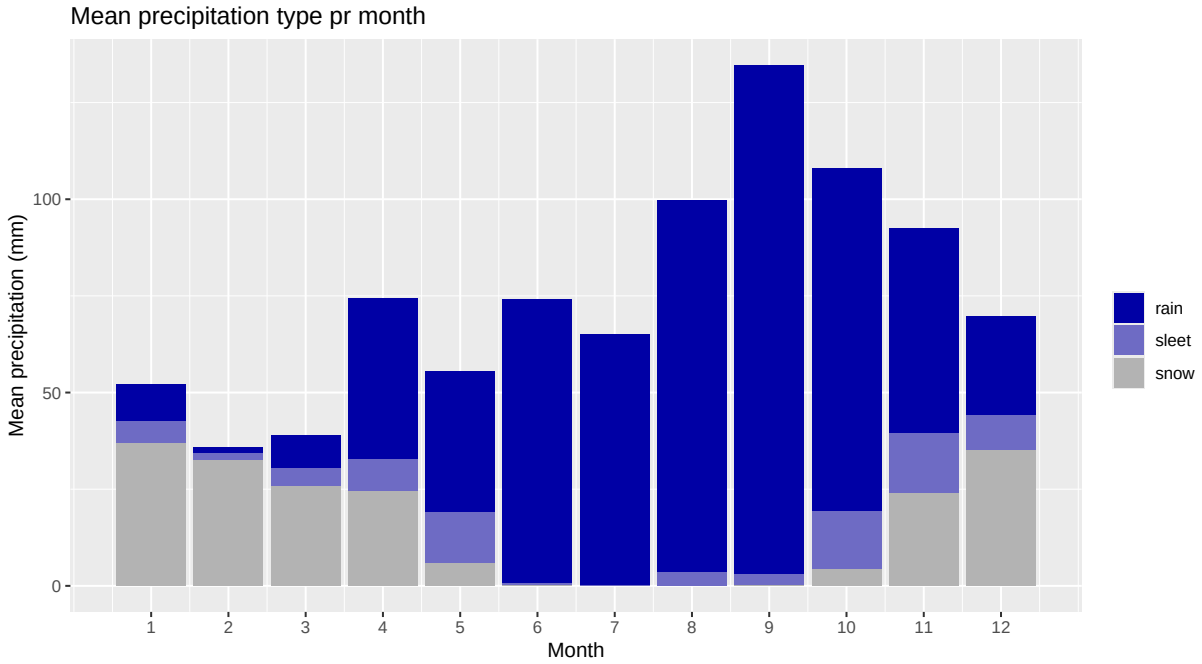

Figure 8: Mean monthly distribution of types of precipitation (mm). Based on data from 2008 to 2022. Sleet is defined as precipitation that fell when temperatures were between -1°C and 1°C.

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 %).

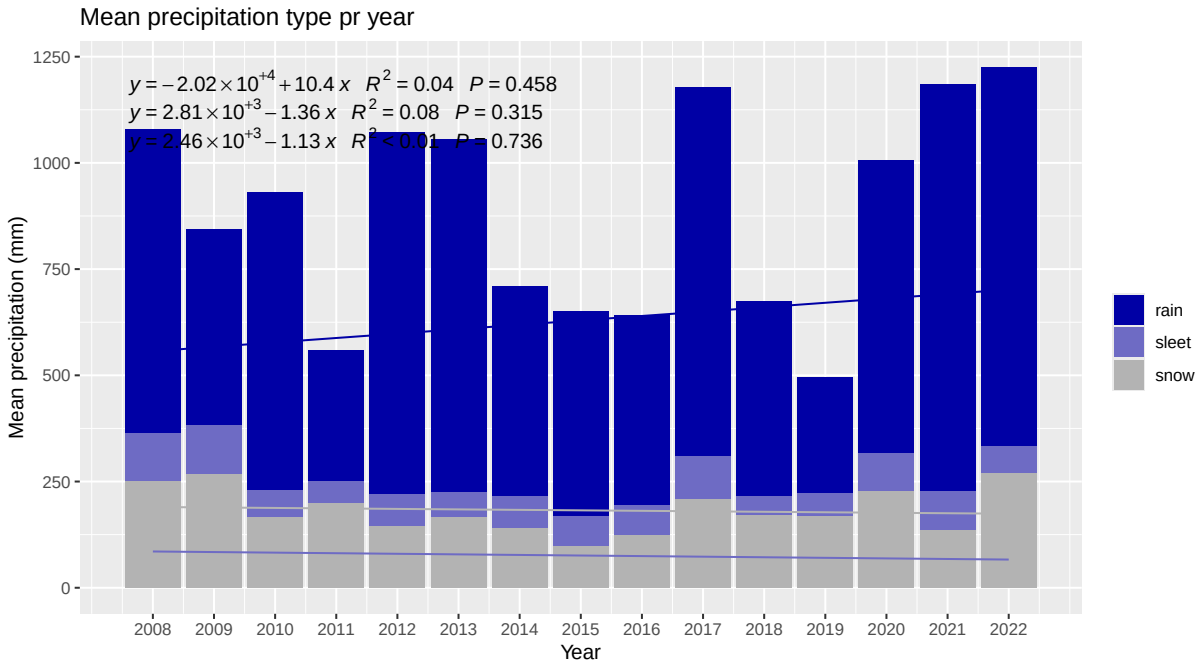

Figure 9: Mean percipitation pr. month over the monitoring period (2008 - 2022). Sleet is defined as precipitation that fell when temperatures were between -1°C and 1°C. (Data only to 2022 because the temperature data is only till 2022.)

3.4 Precipitation anomalies

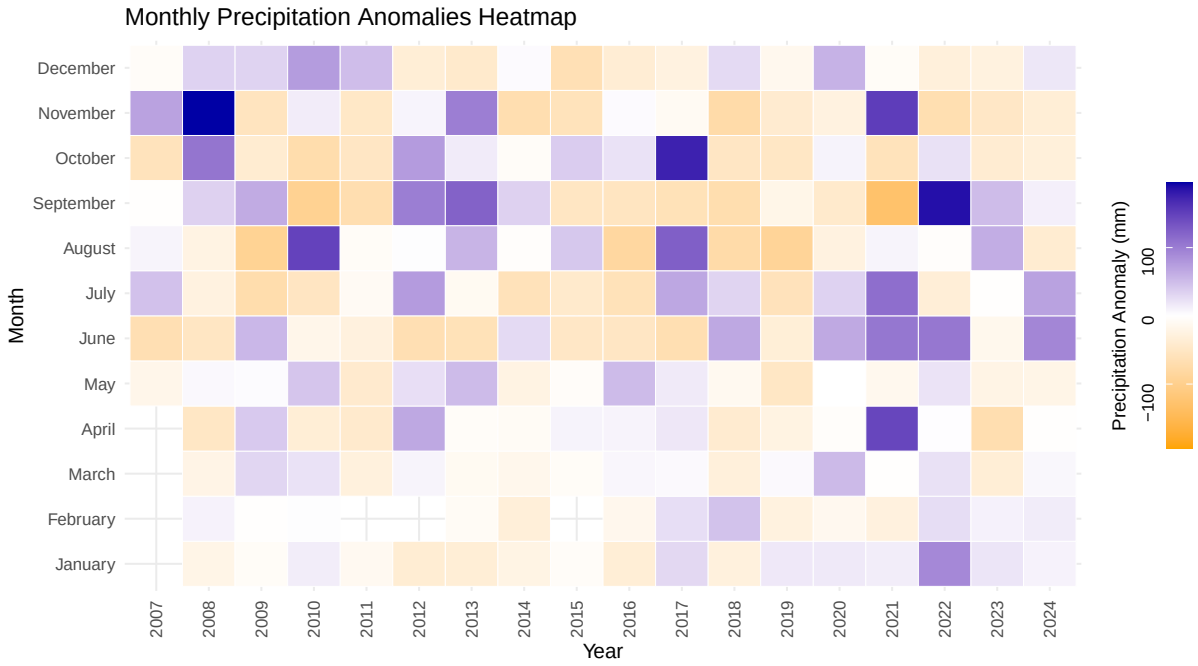

Figure 10: Monthly precipitation anomaly (°C). Stronger colors indicate large derivation from the month mean.

3.5 Absolute values of anomolies

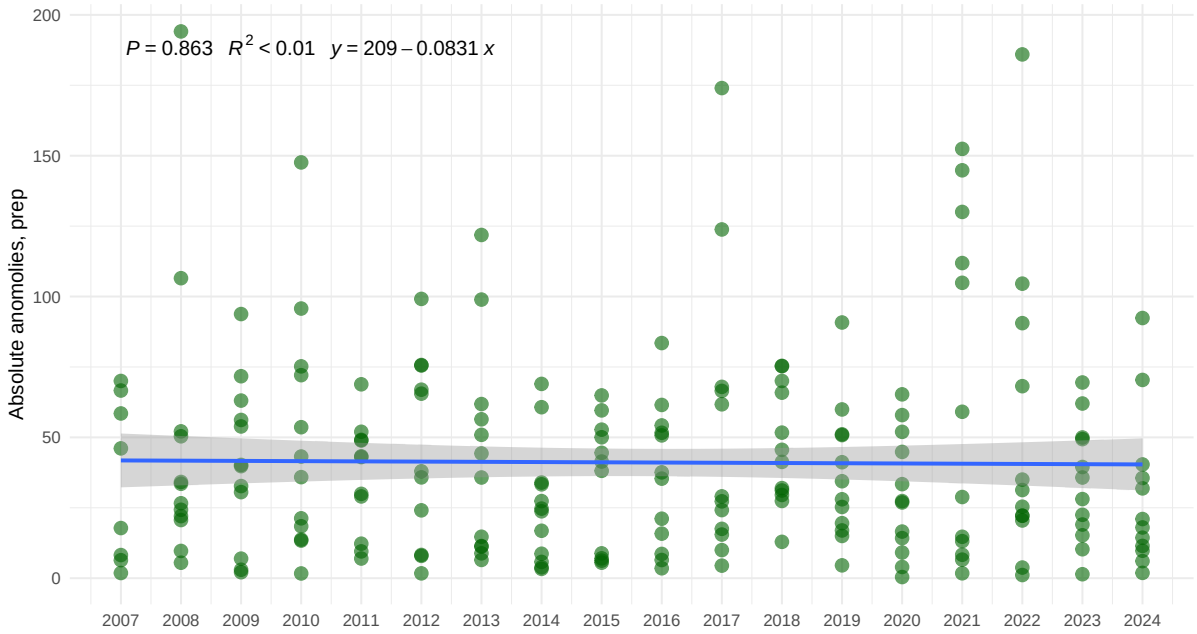

Figure 11: Absolut values of anomolies (difference from mean) of respective month.

4 PAR data

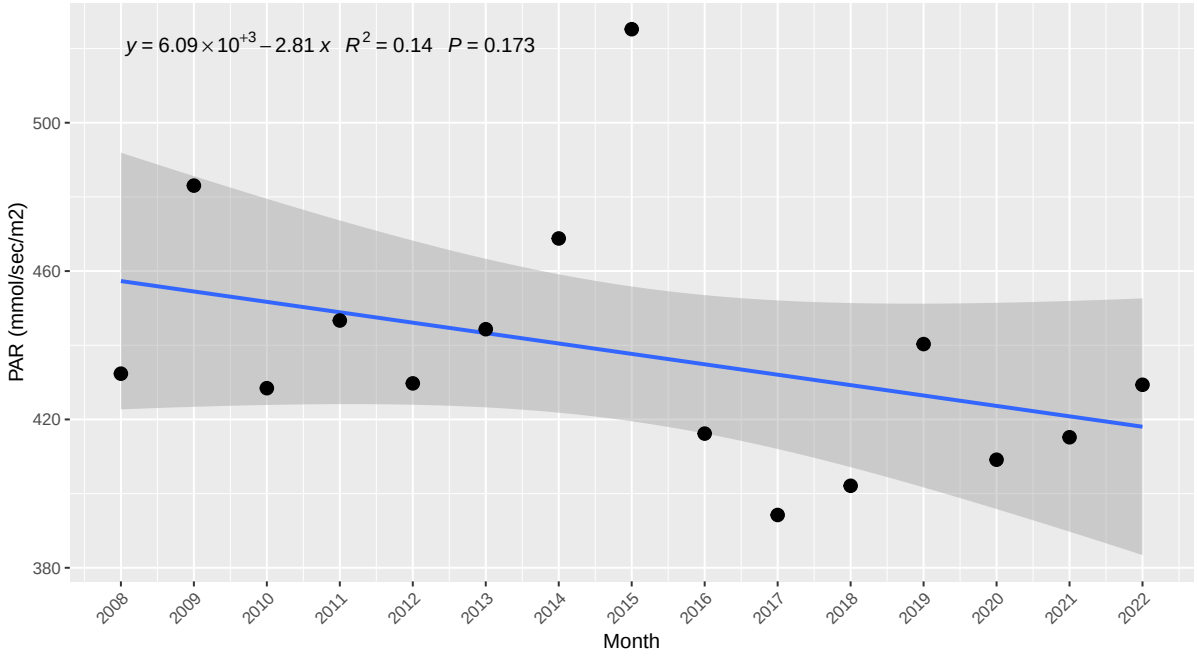

Figure 12: Monthly mean PAR from 2008 to 2022. Calculations based on PAR values only when the sun is up (solar elevation > 0).

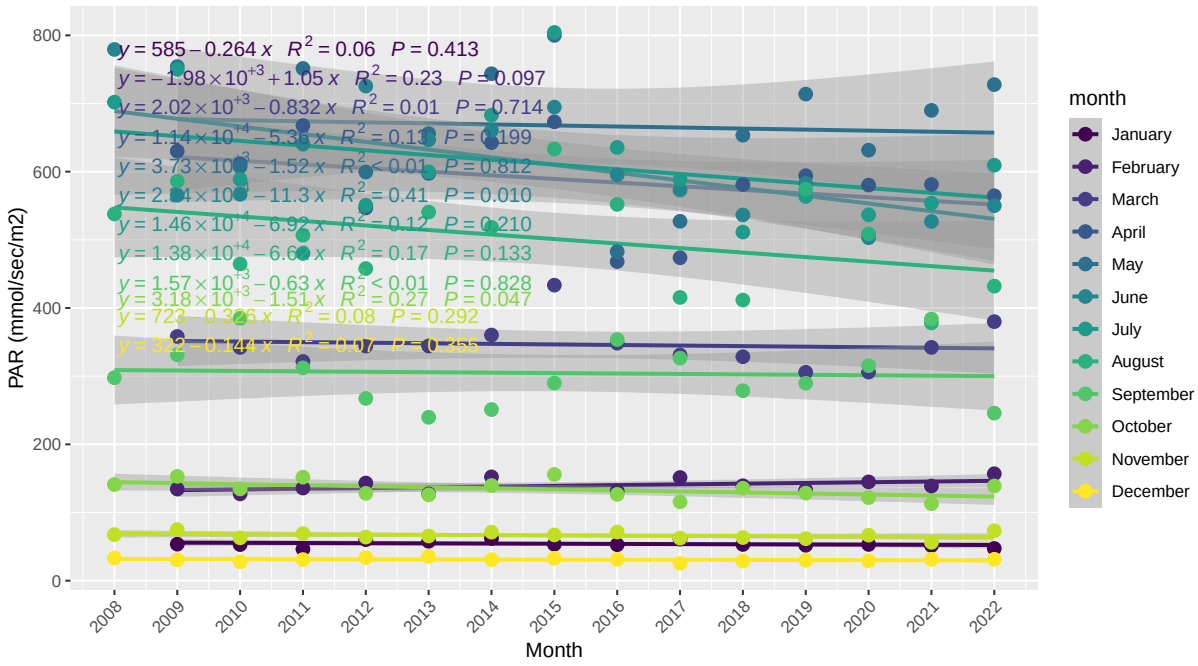

Figure 13: Monthly mean PAR from 2008 to 2022. Calculations based on PAR values only when the sun is up (solar elevation > 0).

4.1 Monthly means

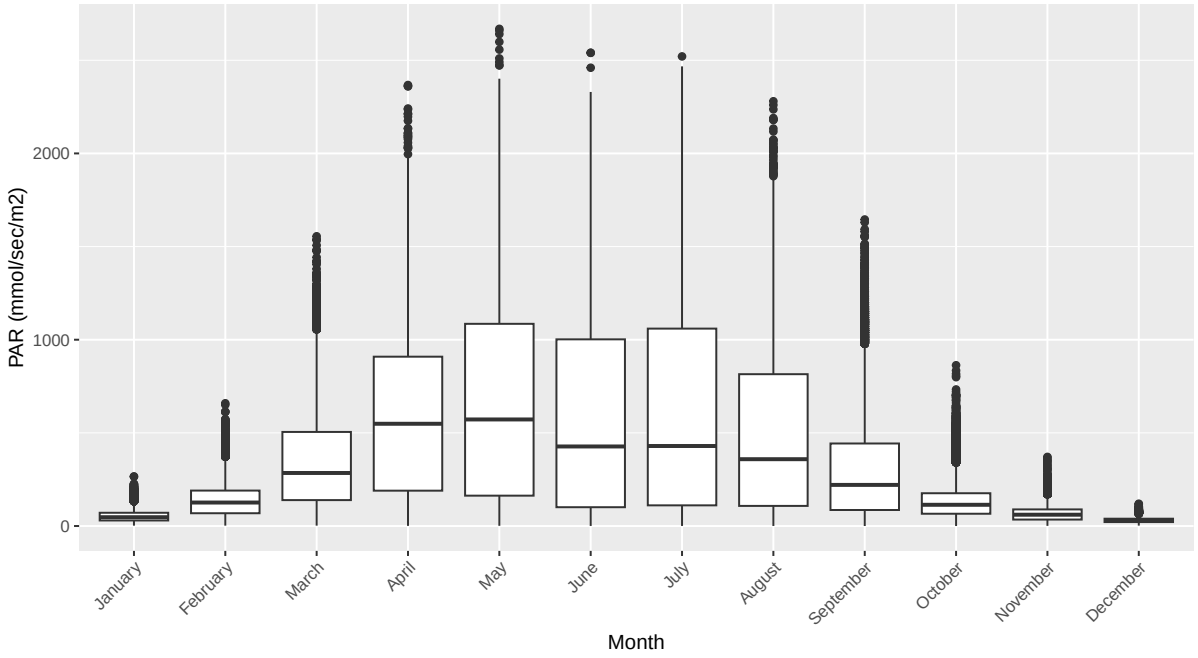

Figure 14: Monthly mean PAR from 2008 to 2022. Calculations based on PAR values only when the sun is up (solar elevation > 0).

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).

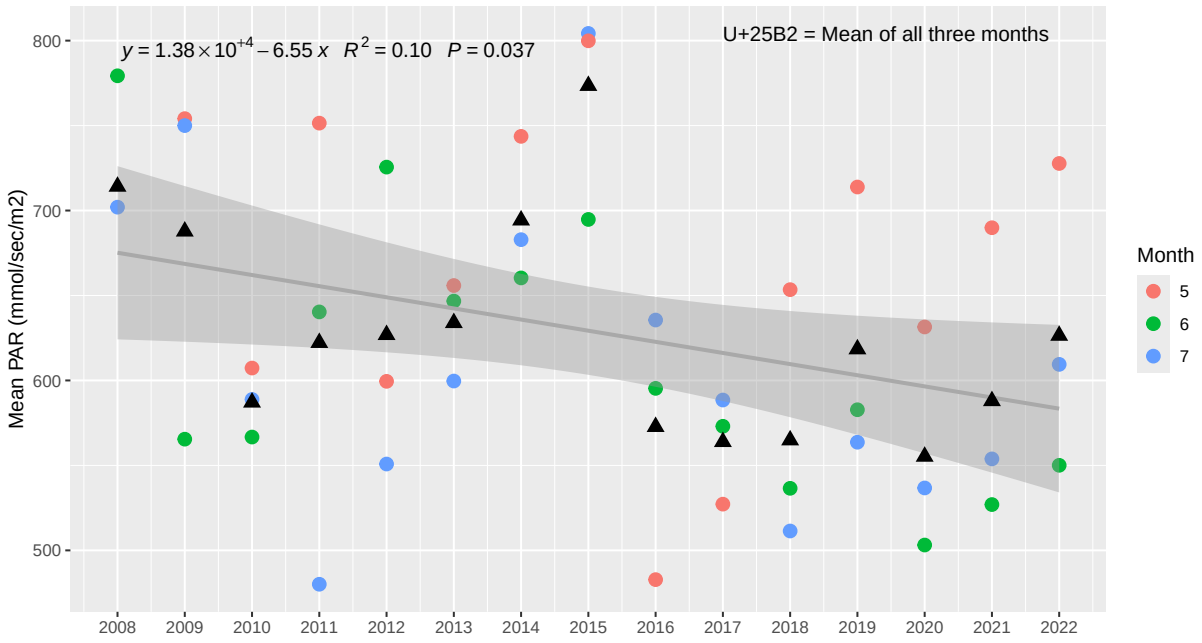

Figure 15: Mean of months with highest PAR.

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
```

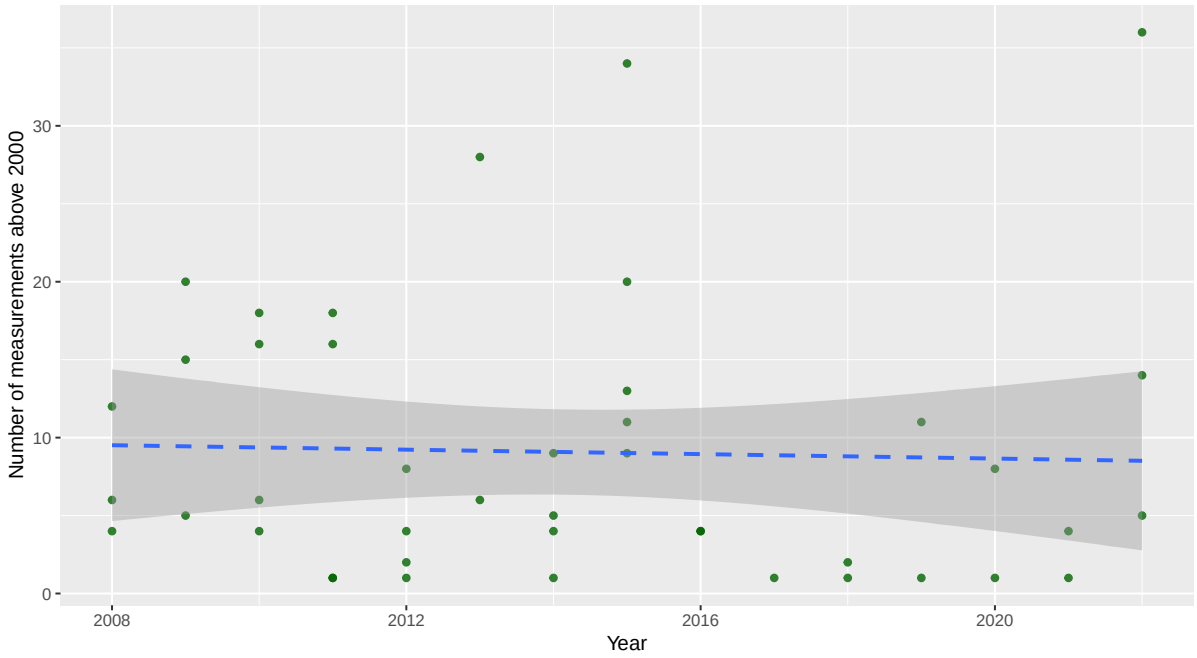

Figure 16: Number of measurements of PAR above 2000.

4.5 PAR anomalies

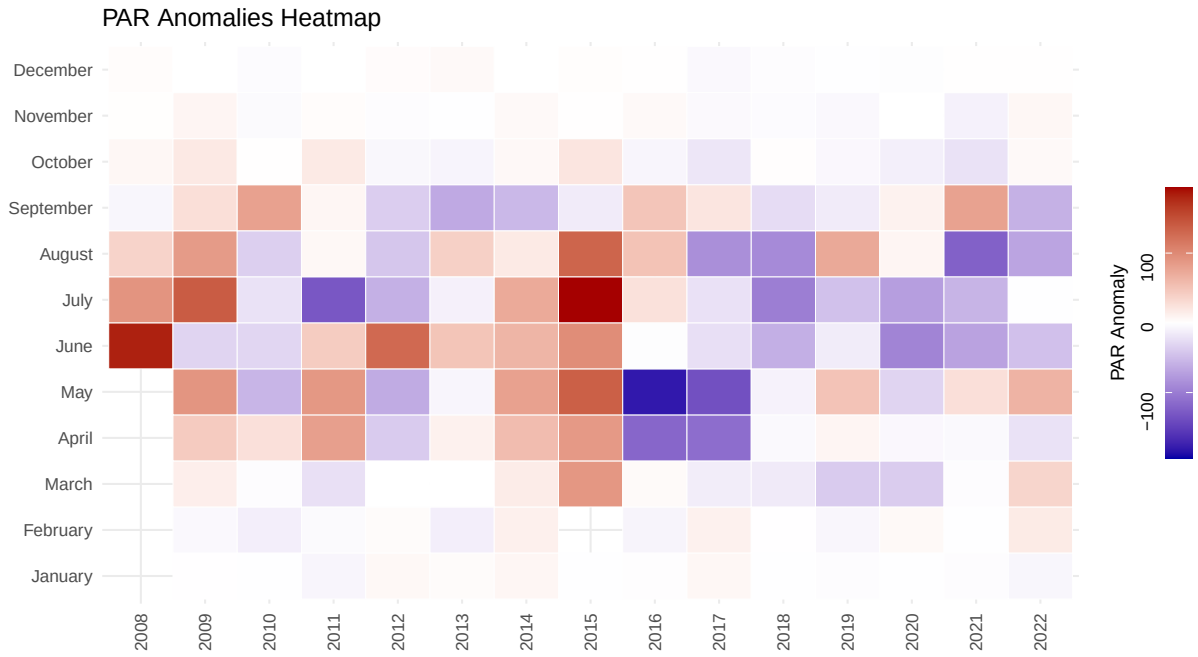

Figure 17: Anomolies (difference from mean) of respective month. Stronger color indication bigger difference from monthly mean across entire period.

4.6 Absolute values of anomolies

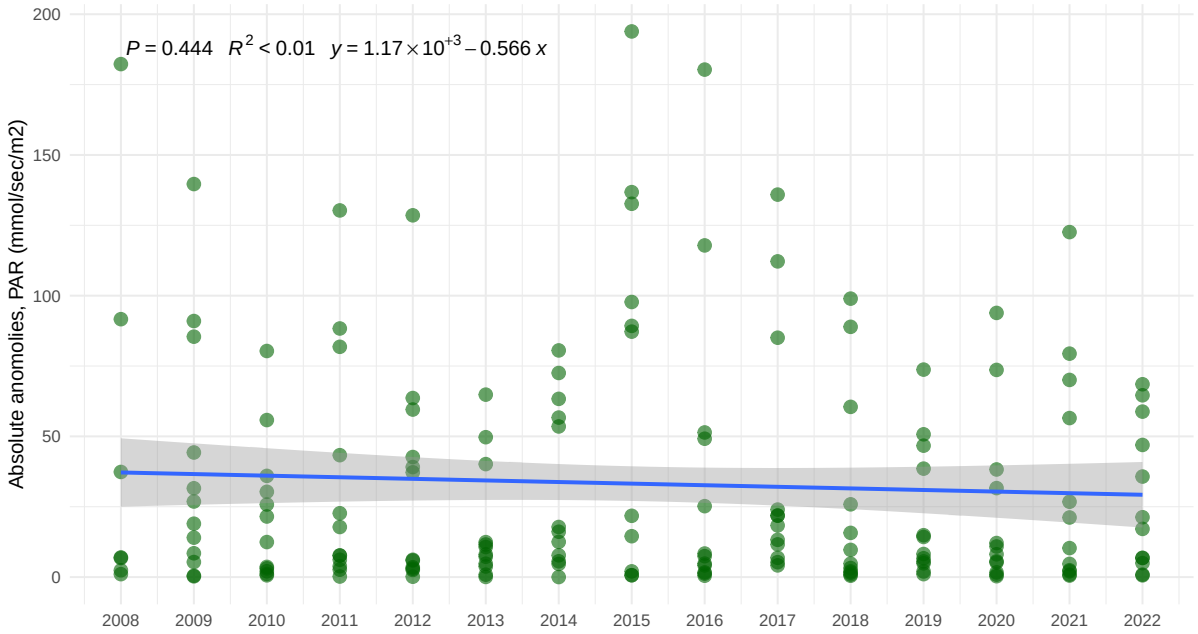

Figure 18: Absolut values of anomolies (difference from mean) of respective month.

5 Degree days

The number of degree days (days with a mean temperature $> 0°C$) has not changed significantly during th emonitoring period.

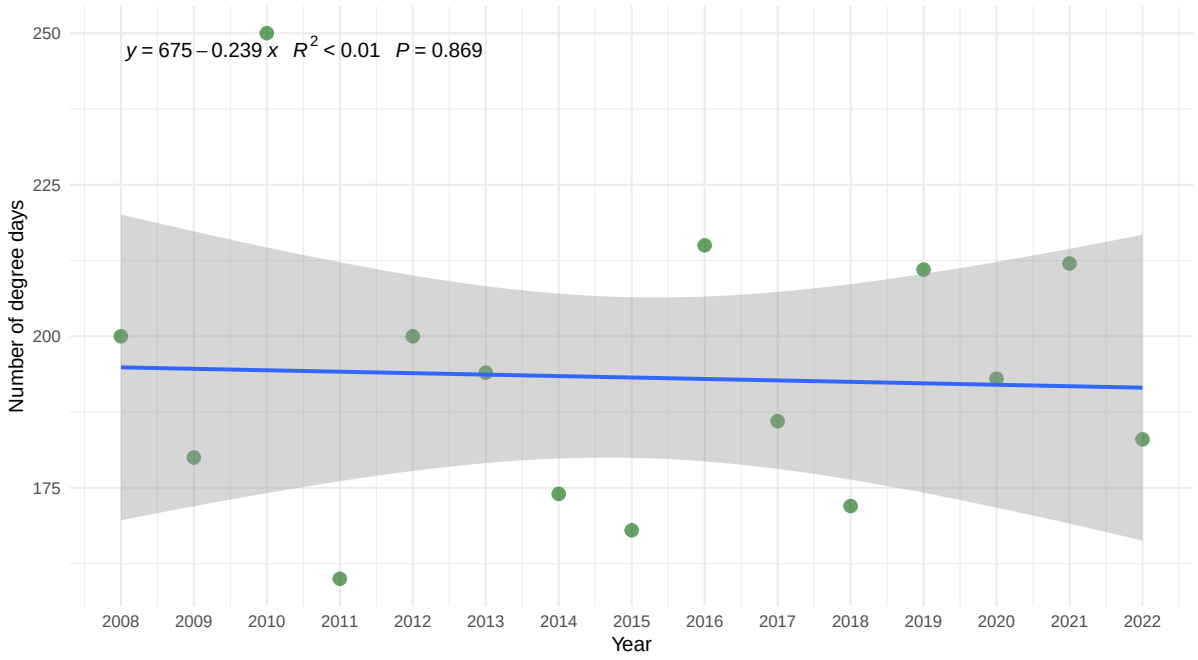

Figure 19: Degree days, days with mean temperature above 0°C

##Degree days anomilies (in number of days)

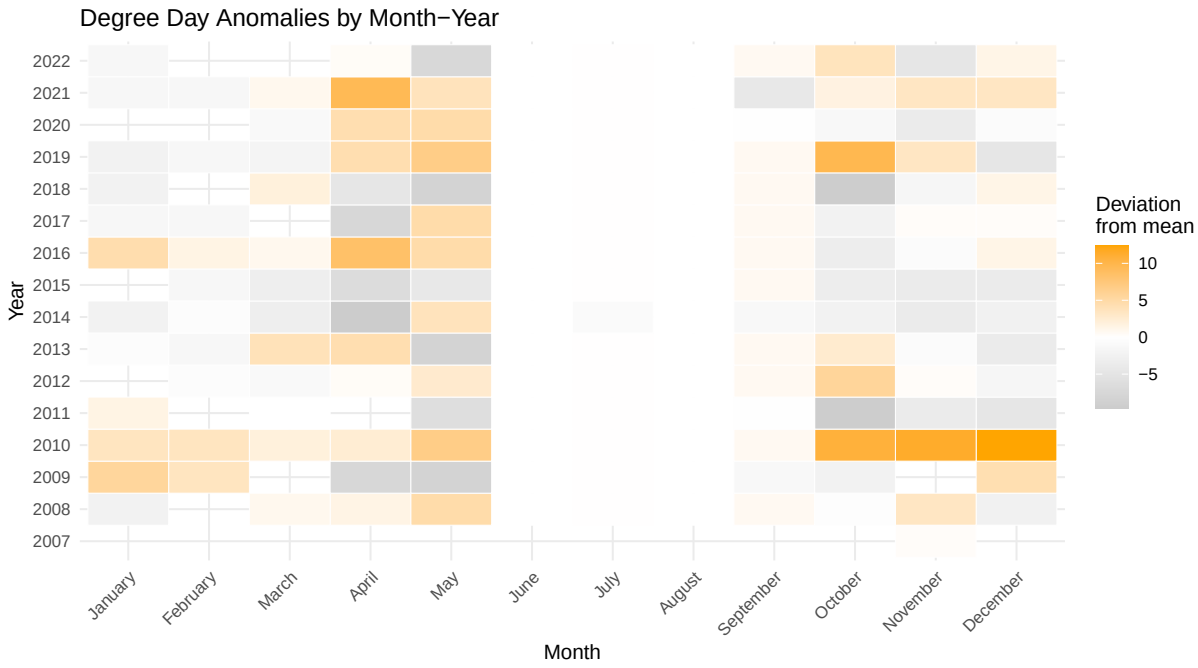

Figure 20: Degree days, days with mean temperature above 0°C

##Absolute numbers of variation in degree days

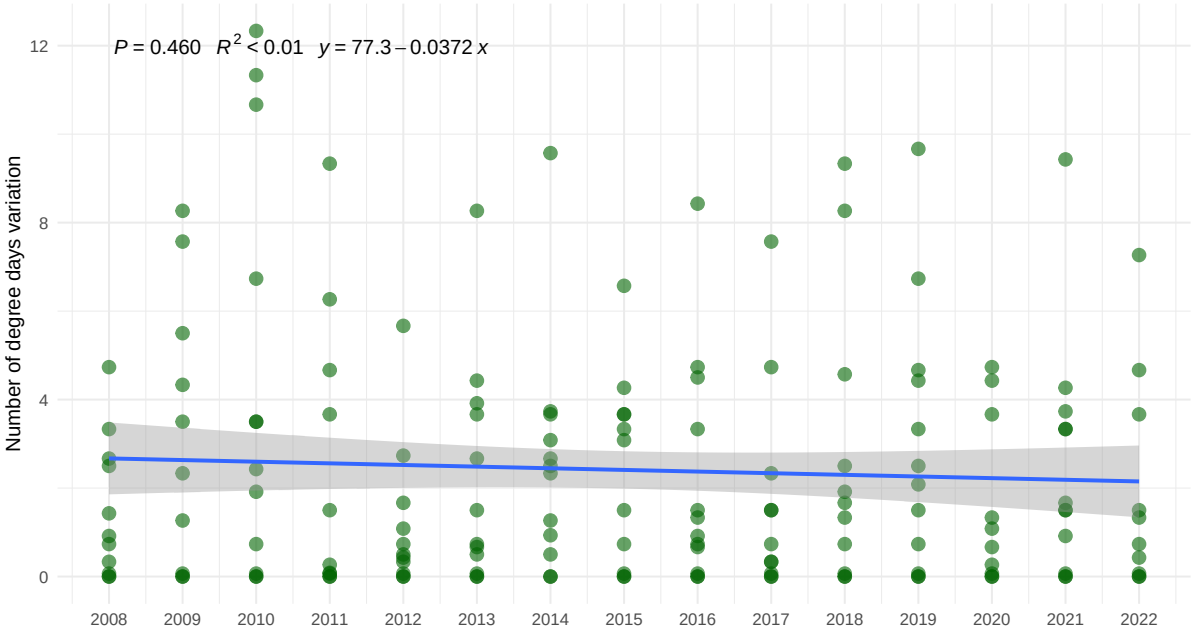

Figure 21: Absolute numers of deviation from mean number of degree days

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 (°C; 2 meters above ground).

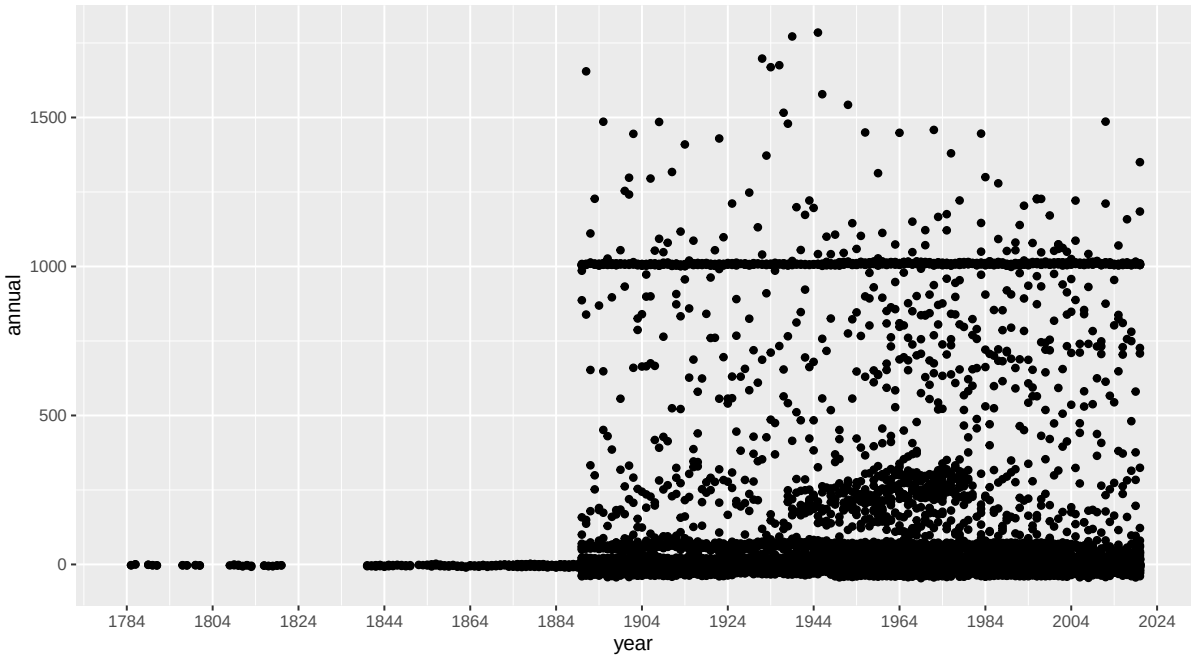

Figure 22: Mean air temperature (°C) pr year, from 1784 to 2020. Yearly mean of 173.6°C. Yearly mean ranges from -46.1°C to 1785°C.

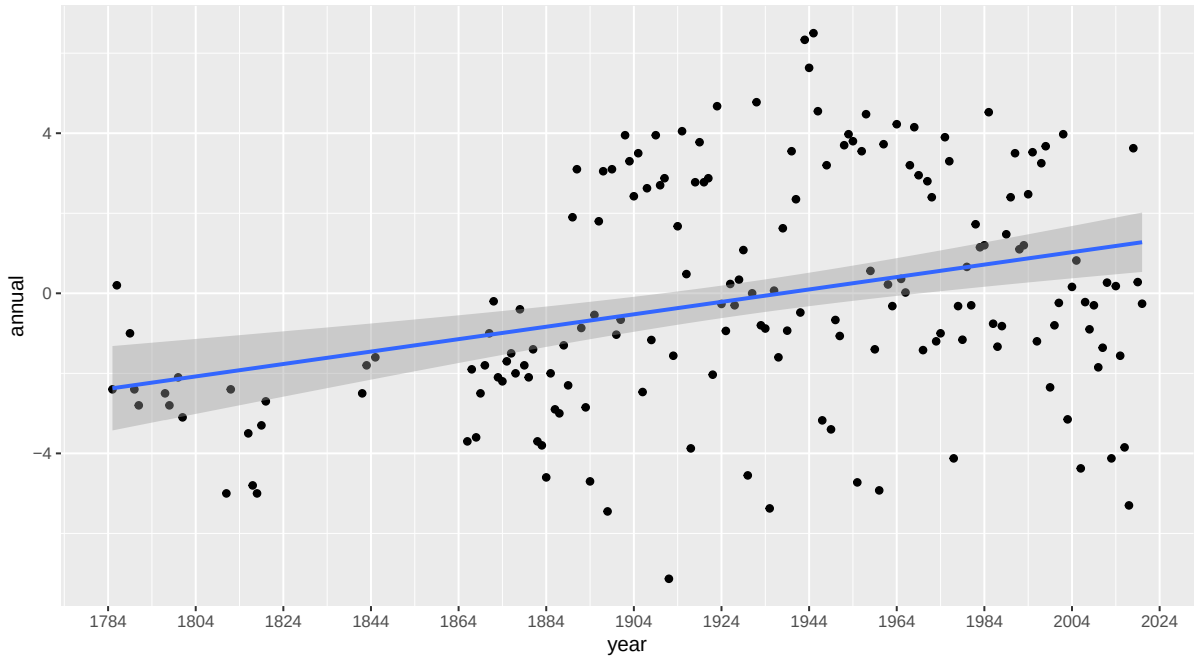

Figure 23: Mean air temperature (°C) pr year, from 1785 to 2020. Yearly mean of -0.1°C. Yearly mean ranges from -7.13°C to 6.5°C. Mean temperature has increase from -2.448°C in 1784 to 1.272°C in 2024

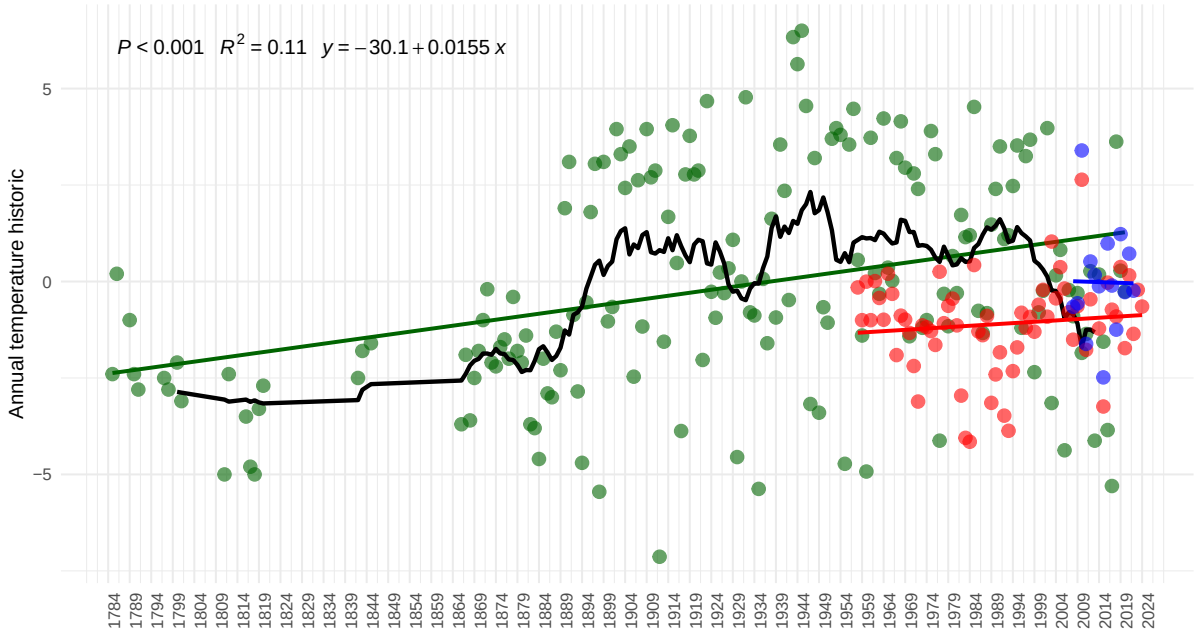

Figure 24: Annual historic temperature in °C.

```
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 ...
```

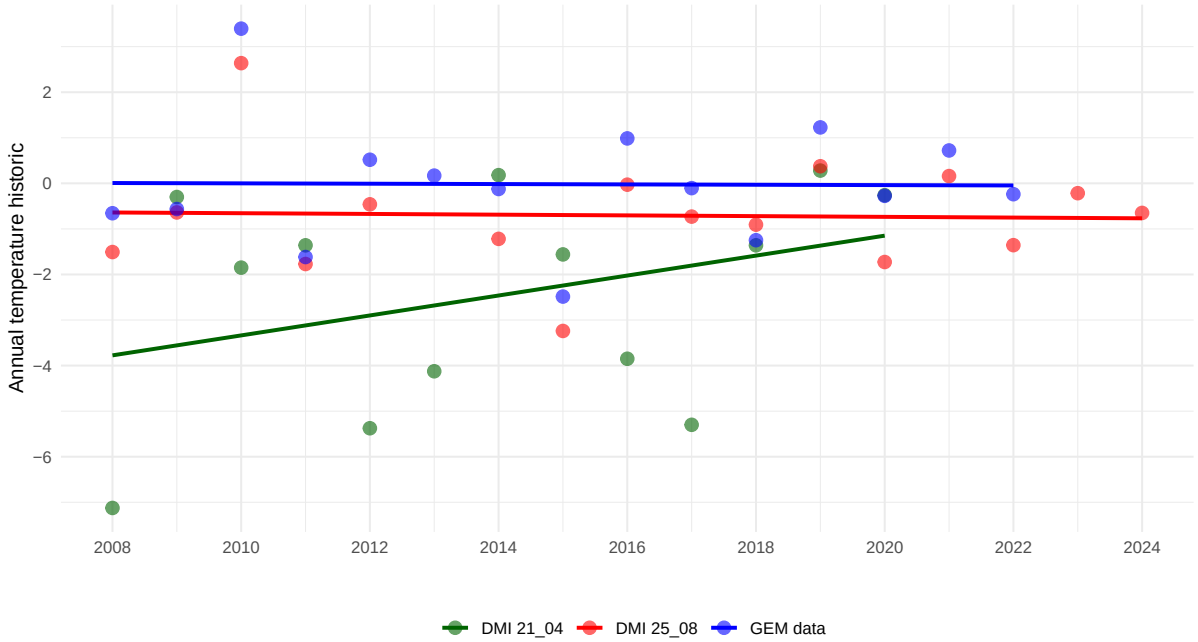

Figure 25: Annual historic temperature in °C.

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.

———. 2020b. "ClimateBasis Nuuk - Radiation - Photosyntetic Active Radiation @ 200 Cm - 5min Average (Mmol/M2/Sec)." Greenland Ecosystem Monitoring. https://doi.org/10.17897/8Z2W-D993.

———. 2020c. “ClimateBasis Nuuk - Temperature - Air Temperature @ 200 Cm - 30min Average (°C).” Greenland Ecosystem Monitoring. https://doi.org/10.17897/PGN3-7597.
Jensen, Caroline Drost. 2024. “Weather Observations from Greenland 1958-2023.” 24–08. Danish Meteorological Institute.