ISAT 300

Spring Semester 2025, Section 1

Lab Instructor: Dr. Chris Bachman

Semester Project: Temperature Trends in Harrisonburg and Evidence of Global Warming

Date: May 9th, 2025

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Honor Pledge: On our honor, we (Joseph Gros, Alex Chizmadia, Sebastian Erb, Jaylon Taylor) have neither given nor received unauthorized help on this assignment

Abstract:

Understanding the regional and global manifestations of climate change requires both short-term observational studies and long-term historical data analysis. This investigation was designed to explore the presence of climate change through the examination of air temperature trends in Harrisonburg, Virginia and several international locations with over a century of weather records. The project employed two primary strategies: localized data collection using HOBO MX2201 temperature probes over a 30-day period in Harrisonburg, and a comparative analysis of historical temperature datasets spanning over 100 years from weather stations in Tasiilaq (Greenland), Stornoway (Scotland), and Alexandrovsk-Sakhalinsky (Russia). To verify local measurements, data from the Dale Enterprise Weather Station were used as a benchmark, and a t-test between HOBO 1 and Dale Enterprise returned a t-value of 5.064, suggesting significant variation likely due to location and environmental conditions rather than instrumentation error. However, long-term temperature comparisons at Dale Enterprise between 1900–1924 and 2000–2024 for March ($t = 0.974$), July ($t = 1.520$), and December ($t = 1.334$) revealed no statistically significant differences, suggesting local climate stability or variability masked by regional factors. In contrast, the global datasets showed a consistent and statistically significant warming trend. Tasiilaq presented some of the most conclusive results, with t-values of 5.45 (March), 11.27 (August), and 9.47 (January), each indicating p-values < 0.001. Stornoway showed a warming of average March highs from 44.6°F to 47.7°F, with a $p\text{-value} < 0.001$. Aleksandrovsk-Sakhalinsky revealed a temperature increase of 1.48°F in March between its historical and modern datasets, supported by a t-value of 4.86 and a $p\text{-value} < 0.0001$. These findings demonstrate a clear and statistically supported warming trend globally, even when local data such as that from Harrisonburg appears less conclusive. The results validate the project's hypothesis that climate change is both detectable and statistically significant in long-term temperature data, with global patterns supporting the broader scientific consensus on global climate change.

Introduction:

Climate change has emerged as one of the most pressing global challenges of the 21st century, with far-reaching consequences for ecosystems, economies, and communities. A key indicator of climate change is the long-term rise in global temperatures, often attributed to increasing concentrations of greenhouse gases due to human activity. To understand these trends at both local and global scales, it is essential to collect and analyze accurate temperature data over extended periods. This lab aimed to investigate patterns of temperature change by combining short-term, local temperature monitoring with long-term, global climate data analysis. [1]

Using a HOBO temperature probe, temperature data were recorded in Harrisonburg, Virginia over a 30-day period to observe local temperature fluctuations. In parallel, historical temperature records spanning 100 years from various global weather stations were analyzed to assess the presence of long-term warming trends and determine whether the data supports the scientific consensus on climate change.

By comparing localized temperature data with broader global trends, this experiment seeks to contextualize individual observations within the larger narrative of climate change. The specific focus of this investigation is to determine whether the century-long global temperature data provides statistically significant evidence of global warming. It is hypothesized that the global dataset will exhibit a clear upward trend in average temperatures over the past century, reinforcing concerns about anthropogenic climate change and emphasizing the importance of ongoing environmental monitoring.

Methods and Materials:

To examine temperature trends at both local and global scales, this lab employed a combination of short-term data collection and long-term climate data analysis. For the local study, two HOBO temperature probes were used to record hourly air temperature readings over a 30-day period in Harrisonburg, Virginia. Two sub teams within the lab group were responsible for choosing the location of the devices. One device was installed on the balcony of an apartment complex, while the other was placed under some foliage behind an apartment complex and next to the road.

**Image 1 :** *Photo of HOBO 1's probing location*

**Image 2 :** *Photo of an alternate angle of HOBO 1's probing location*

**Image 3 :** *Photo of HOBO 2's probing location*

To validate the data collected by the HOBO probe, historical weather records from the Dale Enterprise weather station, also located in Harrisonburg, were obtained from a NOAA database. Average temperature values for the month of March were extracted from both the HOBO and Dale Enterprise datasets. A two-sample t-test was performed to determine whether there was a statistically significant difference between the two sources. This statistical comparison allowed for an evaluation of the accuracy and consistency of the HOBO device when compared to an official weather monitoring station.

Equation 1*: two-sample t-test formula:* $t = \frac{|x_1 - x_2|}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$

Additionally, temperature data from Dale Enterprise spanning 100 years was analyzed through 24-year segments to produce data that serves as tangible evidence regarding climate change. These 24 year intervals were chosen to ensure that the data analyzed was digestible while still outlining temperature differences over a 100 year timeframe. Data was taken within these 24-year chunks from 3 different months: March, July and December. The purpose of this was to find if there were any significant differences between average temperatures based on season and overall climate circumstance within the context of global warming. For each month, the average temperature of the whole month was analyzed across 24 years from 1900-1924 and then from 2000-2024 to gain a better understanding if there was a difference with average temperatures after 100 years.

As part of the global analysis portion of the project, individual members of the team were responsible for selecting and analyzing temperature data from different international locations with at least 100 years of data to work with.. Joseph Gros focused on Tasiilaq, Greenland. This team member examined data across two 20-year time intervals, similar to that of the Dale Enterprise investigation: 1900–1920 and 2000–2020. Daily high temperatures were used to calculate monthly averages and standard deviations for each time period, so that meaningful comparisons could be made in regards to global warming. To capture seasonal variation, three representative months, January, March, and August were selected, differing slightly from the months analyzed in the local investigation. Finally, two-sample t-tests were performed for each of the selected months to determine whether the observed changes in average temperatures between the two time periods were statistically significant.

Stornoway, Scotland | March Temperature Analysis (1874-1885), (2010-2021)

For the global analysis, Jaylon Taylor focused on Stornoway Scotland. We gathered information from the daily highs of March of 1874-1885 and 2010-2021 Scotland. From 1874-1885, the average March daily high was averaged to be 44.6. The average from 2010-2021 was averaged to be 47.7. The standard deviation for the March 1874-1885 daily high was 4.8. The standard deviation for the March 2010-2021 was 3.8. Both of these standard deviations can be considered high dealing with degrees of temperature which has to be taken into account. We were able to gather enough information for a T-test giving P to be < 0.001,which indicated that the average March daily highs were statistically significant.

Aleksandrovsk-Sakhalinsky, Russia | March Temperature Analysis (1894–2025)

To explore regional manifestations of global climate change, this section investigates long-term temperature trends in Aleksandrovsk-Sakhalinsky, a town located in the Sakhalin Oblast of Russia. Located in the Russian Far East near the Sea of Okhotsk, Sakhalin Island experiences a subarctic climate characterized by long, cold winters and short, mild summers. This makes March a transitional month between seasons, a key indicator of early warming patterns. Using historical records from over 100 years of temperature data, this analysis evaluates whether statistically observable warming has occurred in this northern climate zone, thereby contributing to the broader investigation of global climate patterns.

The data used for this analysis was drawn from a comprehensive dataset ranging from 1894 to 2025. The average March temperatures were extracted from a NOAA-linked database and cross-referenced with site-specific Excel records provided by the instructor, **Figure 11**. The dataset was separated into two intervals: 1894–1994 (early period) and 1995–2025 (recent period), allowing for temporal comparison of mean temperatures and standard deviations across a century-long span.

Results:

This investigation evaluated evidence of climate change by analyzing both short-term and long-term temperature data. Locally, data was collected in Harrisonburg, Virginia, using a HOBO temperature probe and compared with historical records from the Dale Enterprise weather station. Globally, long-term temperature trends were examined using datasets from multiple international weather stations. This section summarizes the statistical analyses performed to determine whether observed temperature differences over time and between sources were significant, contributing to the broader understanding of global climate patterns.

March HOBO and Dale Enterprise Results:

This section examines the temperature data collected by Team 1 and Team 2 using the HOBO MX2201 Temperature Data Logger. Images 2 and 3 in the "Methodology" section show where the data loggers were placed and their corresponding geographic locations. To enable meaningful comparison, the HOBO logger data were compared with temperature readings from the Dale Enterprise Weather Station, as all devices were operating simultaneously in Harrisonburg, Virginia. Figure 1 below displays a line graph of the maximum high temperatures recorded by the two HOBO loggers alongside those from the Dale Enterprise Weather Station.

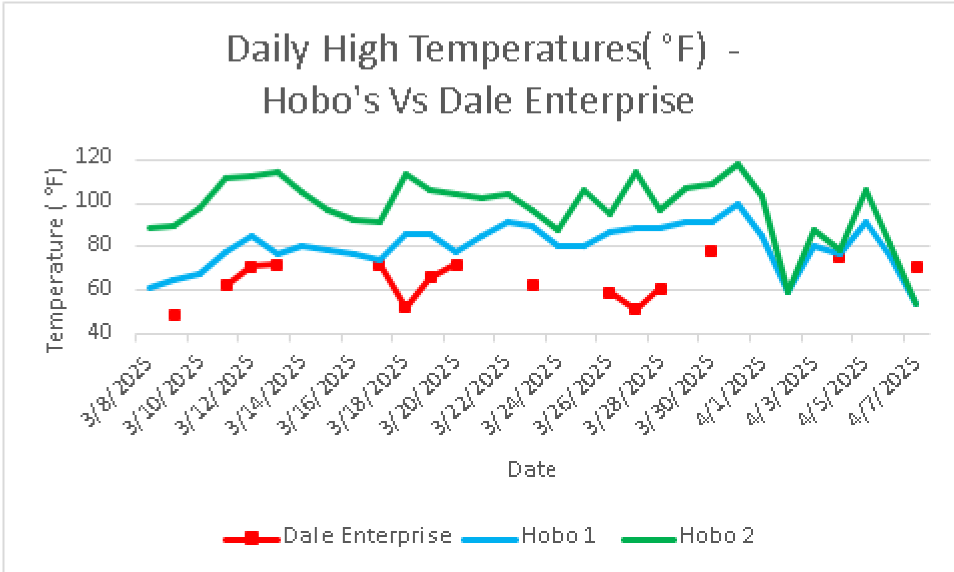

Figure 1: *Graph showing temperature data from both HOBO probes as well as the Dale Enterprise data within the same period. Gaps in the Dale Enterprise data simply represent gaps in the available data gathered from NOAA.*

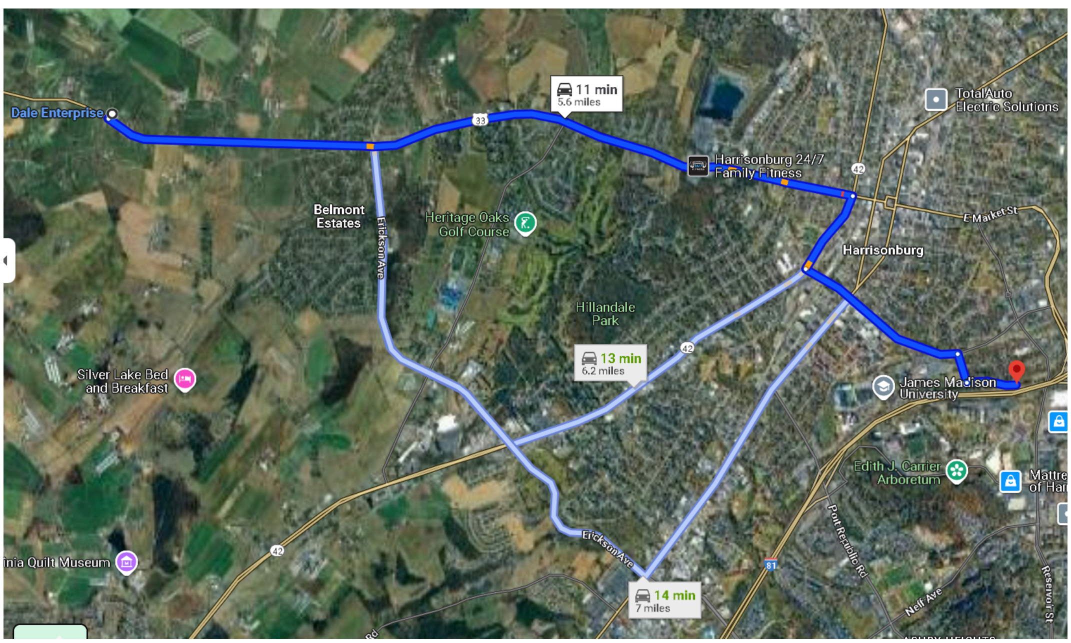

Image 4: Geographical location of Dale Enterprise Weather Station and the Location of Hobo 1

Image 4 represents the geological difference between the two locations of Hobo 1 (bottom left) and Dale Enterprise (top right) and its location slightly outside of the town.

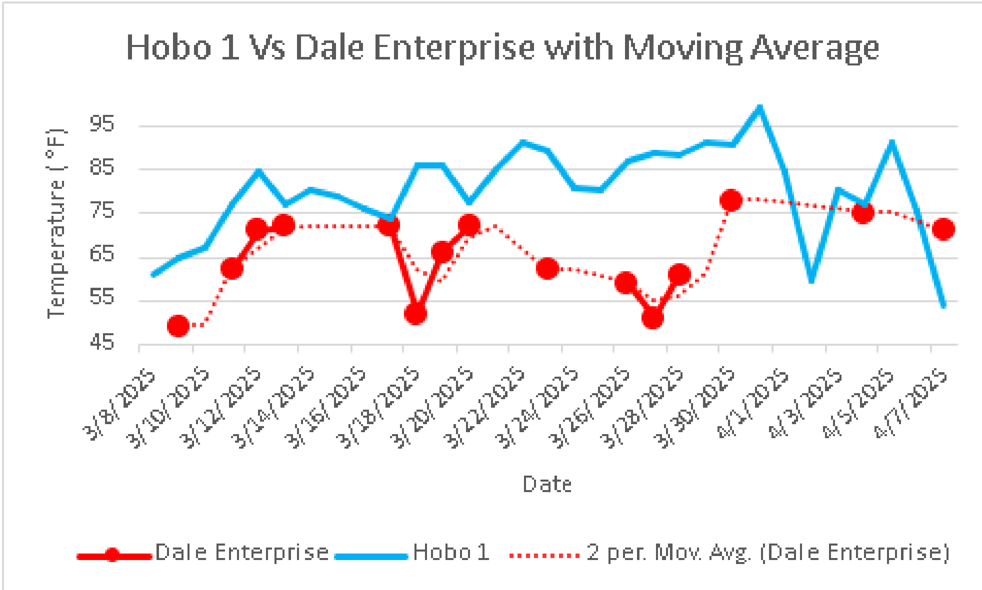

Figure 2: *Graph comparing HOBO 1 data to the moving average of Dale enterprises data.*

Finally, after gathering the temperature data from Team 1's and Team 2's HOBO loggers, as well as from the Dale Enterprise Weather Station, the teams performed a t-test to evaluate the similarity between the data from Team 1's HOBO logger and the Dale Enterprise station, although it is a slight similarity as seen in **Figure 1 & 2** above. The equations below show the t-test formula used and the resulting statistical outcome.

Equation 1*: two-sample t-test formula:* $t = \frac{|x_1 - x_2|}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$

$$t = 5.064$$

This t value results in a very high p value that shows the data is statistically significant and has major differences!

Dale Enterprise Data Analysis:

Dale Enterprise, the third oldest weather station in the United States, has been recording weather data continuously since January 1, 1893, according to NOAA [2]. While this section focuses specifically on the average daily maximum temperatures in March from 1900 to 2024, later sections expand the analysis to include March, July, and December, comparing two time periods—1900–1924 and 2000–2024. This broader seasonal and temporal comparison offers deeper insight into how temperature patterns in Harrisonburg, Virginia, have shifted over more than a century.

March 1900 - 2025

This section focuses solely on the average March temperatures from Dale Enterprise from 1900, which was 7 years after the inception of its beginning, till today, March 2025. ***Figure 3*** below presents a line graph of the average March temperatures from 1900 - 2025. ***Table 2*** presents the data table used to construct ***Figure 3***.

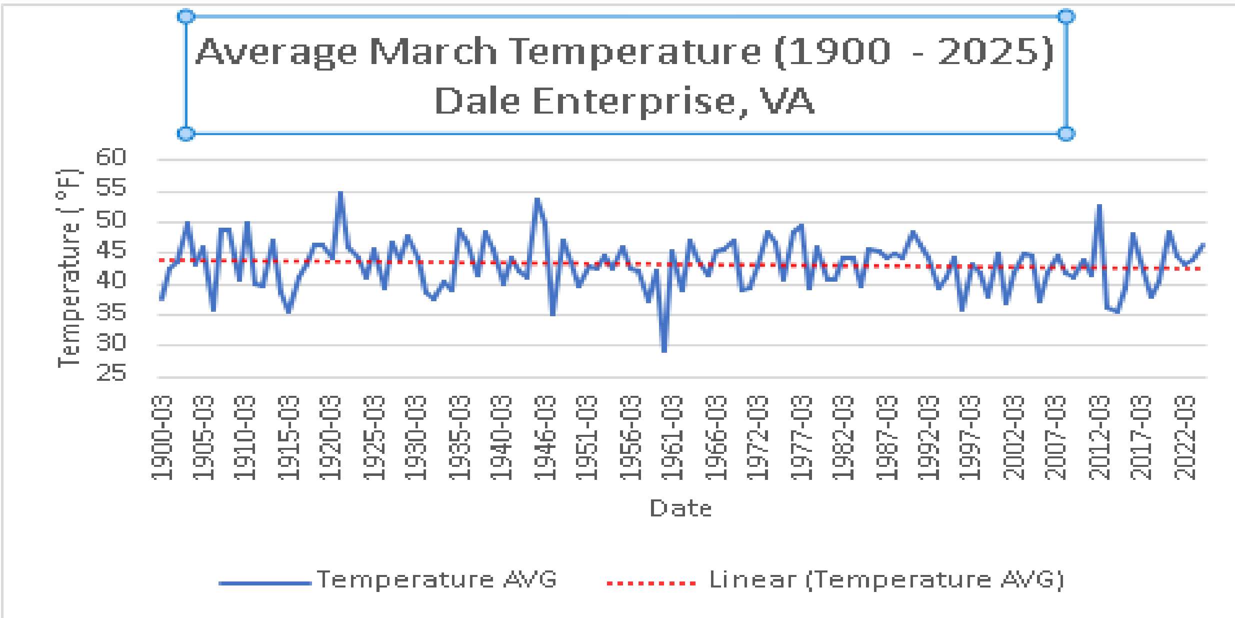

Figure 3: *Graph showing temperature fluctuations of Dale Enterprise data from 1900-2025 in the month of March, with a linear trendline.*

Dale Enterprise Monthly Average of March, July, and December 1900 - 1924 & 2000 - 2024

This section focuses on the monthly average for 3 different months and compares them 100 years apart from each other comparing 24 years across 100 years from 1900 - 1924 & from 2000-2024. ***Figure 4*** below shows the difference between the two 24 year periods and the linear trendlines for each for the Monthly Average temperatures in March. ***Table 1*** presents the data table used to create ***Figure 4**, **Figure 5, & Figure 6***

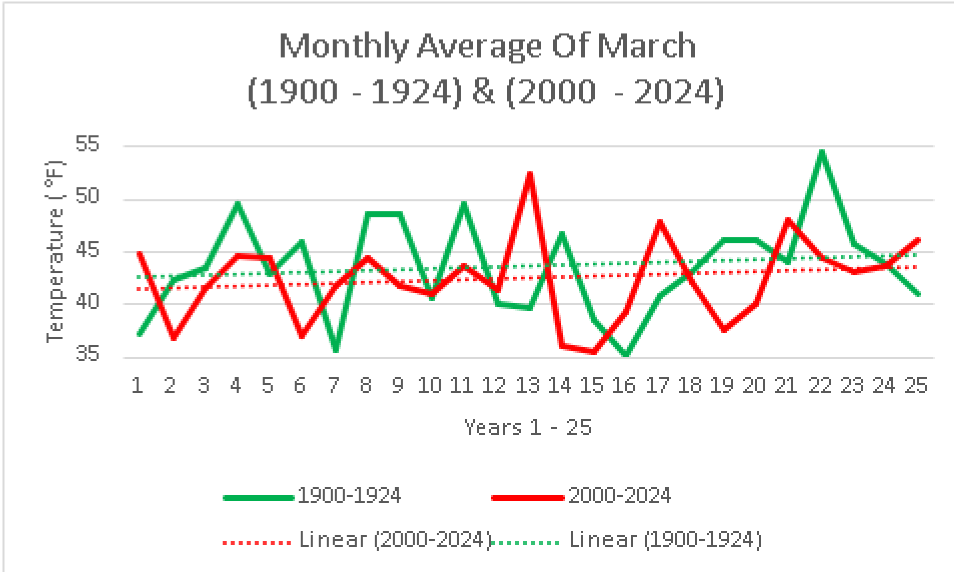

Figure 4: *Graph comparing temperature fluctuations of March between 1900 and 2024, within a span of 20 years. The linear trendlines on the graph are moving upwards, slightly.*

t = 0.974

Figure 5 below shows the difference between the 24 year period of 1900 - 1924 and 2000 - 2024 and their respective linear trendlines for the Monthly Average Temperature in July.

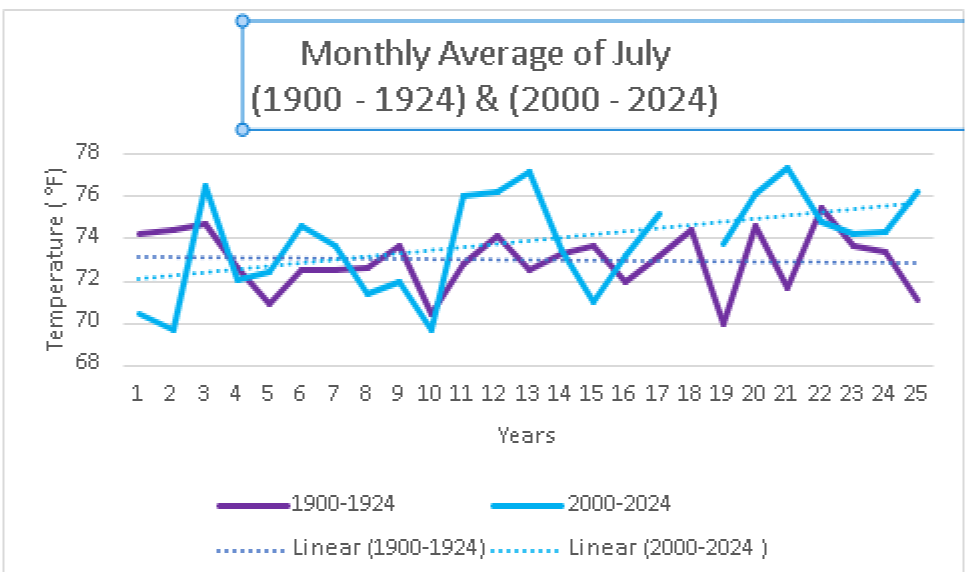

Figure 5: *Graph comparing temperature fluctuations of July between 1900 and 2024, within a span of 20 years. The linear trendlines on the graph are moving upwards, slightly.*

t = 1.520

Figure 6 below shows the difference between the 24 year period of 1900 - 1924 and 2000 - 2024 and their respective linear trendlines for the Monthly Average Temperature in December.

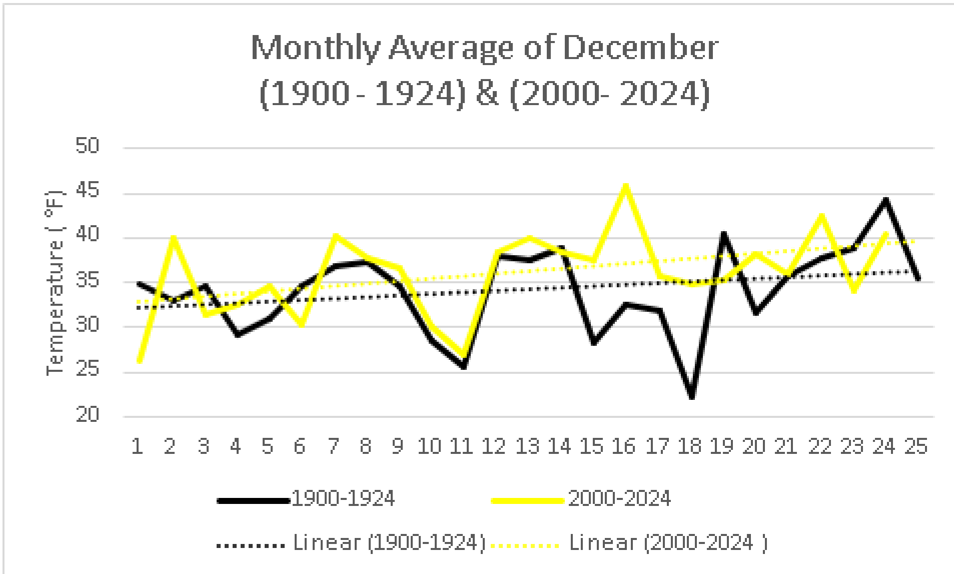

Figure 6: *Graph comparing temperature fluctuations of December between 1900 and 2024, within a span of 20 years. The linear trendlines on the graph are moving upwards, slightly.*

$t = 1.334$

Tasiilaq, Greenland Results:

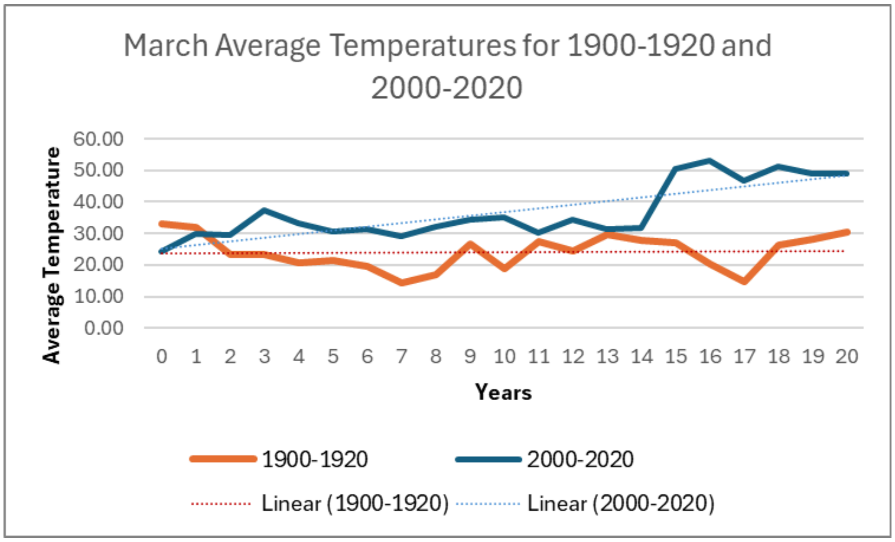

Figure 7: *Graph comparing temperature fluctuations of March in Tasiilaq, Greenland between 1900 and 2024, within a span of 20 years. The linear trendline for the 2000-2020 dataset is moving upward noticeably, while the 1900-1920 dataset's trendline is more or less level.*

Month	1900-1920 SDs	2000-2020 SDs	1900-1920 Means	2000-2020 Means
March	5.46	8.94	24.07	36.81
August	5.27	3.82	49.59	33.18
January	5.46	5.54	28.23	44.69

Table 3: *Means and standard deviations collected from March, August and January in Tasiilaq, Greenland used for t-tests.*

Putting the data from **Table 3** through a t-test resulted in a t-value of 5.45, which, when compared to a t-table results in a t-value of less than 0.001, suggesting the difference within the data is very highly statistically significant.

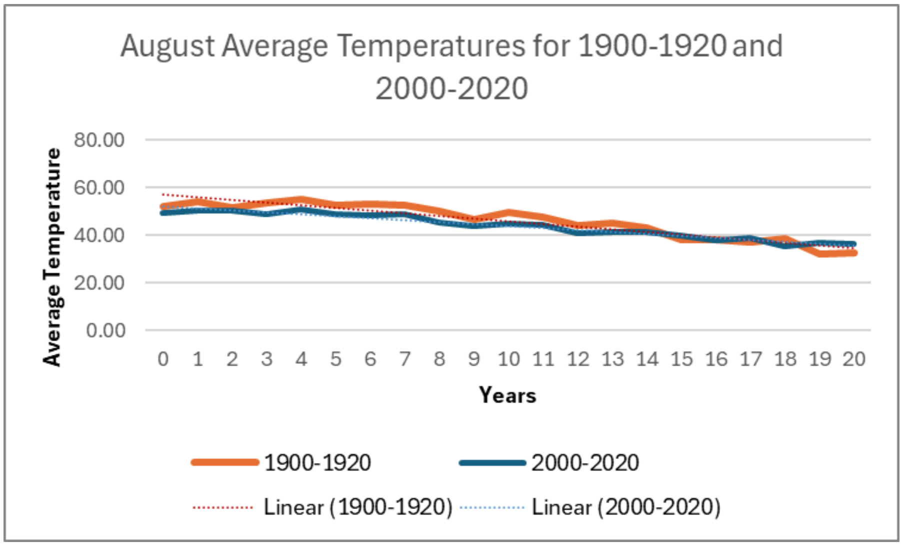

Figure 8: *Graph comparing temperature fluctuations of August in Tasiilaq, Greenland between 1900 and 2024, within a span of 20 years. The linear trendlines on the graph are moving downward, slightly. Notice that both sets of data look very similar.*

Putting the data from **Table 3** through a t-test resulted in a t-value of 11.27, which, when compared to a t-table results in a t-value of less than 0.001, suggesting the difference within the data is very highly statistically significant.

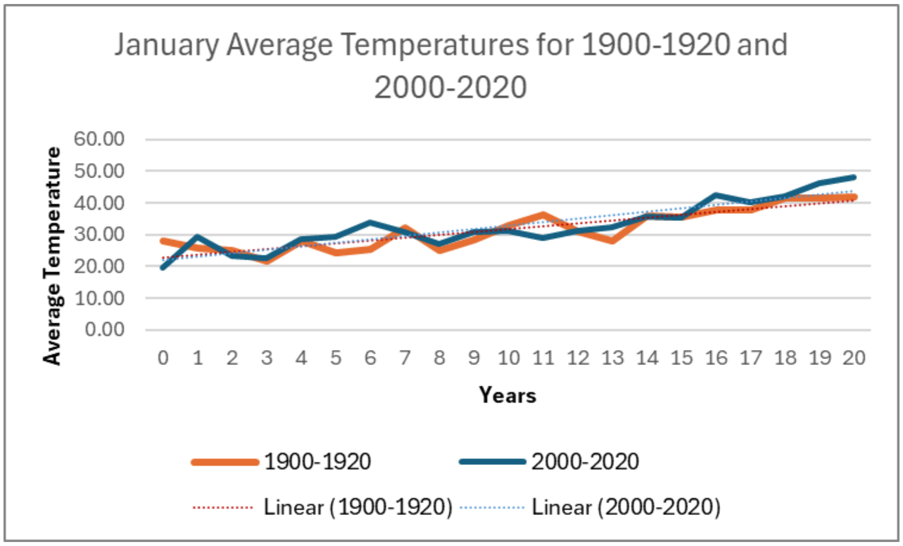

Figure 9: *Graph comparing temperature fluctuations of January in Tasiilaq, Greenland between 1900 and 2024, within a span of 20 years. The linear trendlines on the graph are moving upward, slightly. Again, both datasets have a very similar shape.*

Putting the data from **Table 3** through a t-test resulted in a t-value of 9.47, which, when compared to a t-table results in a t-value of less than 0.001, suggesting the difference within the data is very highly statistically significant.

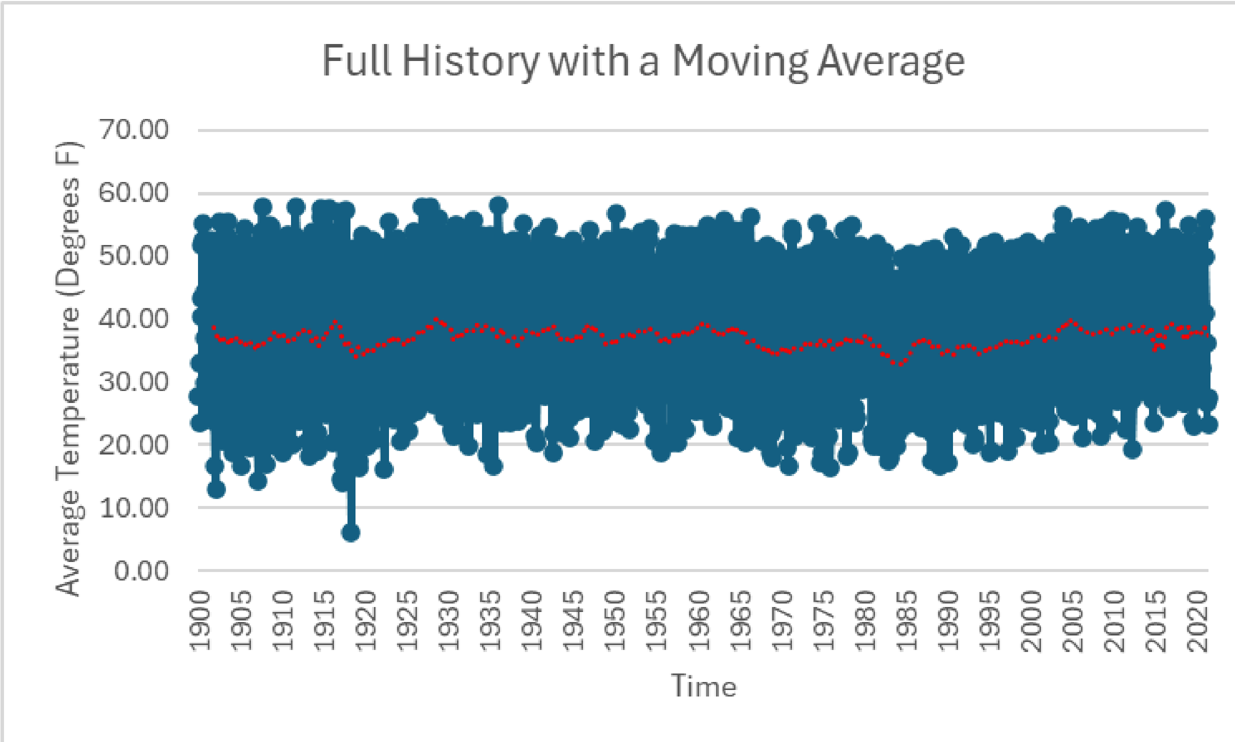

Figure 10: *Graph of Tasiilaq, Greenland's full temperature history from 1900-2020 with a moving average trendline. Notice various sporadic behaviour patterns as time goes on, as well as the low temperature's minimums decreasing over time.*

Alexandrovsk-Sakhalinsky, Russia Results:

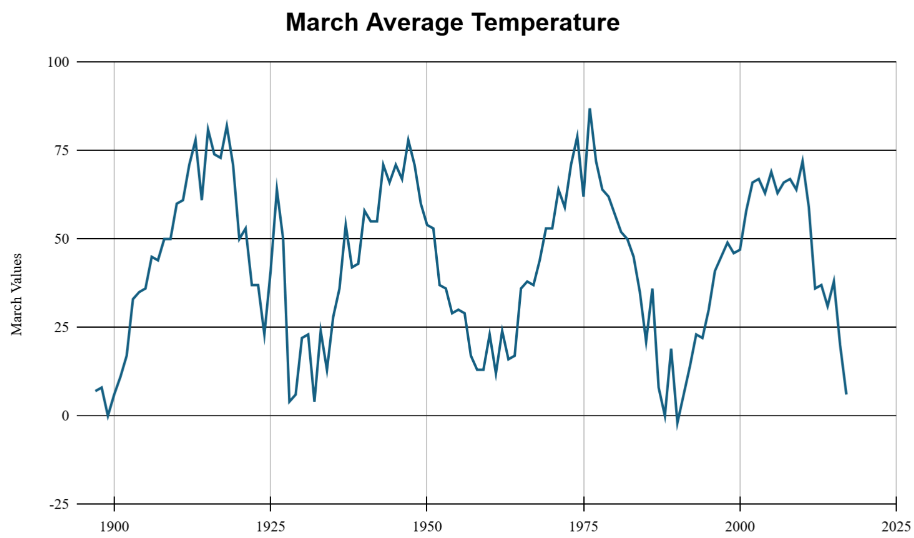

Figure 11: *March Average Temperature of Alexandrovsk-Sakhalinsky, Russia*

After performing a t-test using the data from Alexandrovsk-Sakhalinsky, the resulting t-value was 4.86, with a corresponding p-value less than 0.0001, proving it to be extremely statistically significant.

Stornoway, Scotland Data Analysis/Results:

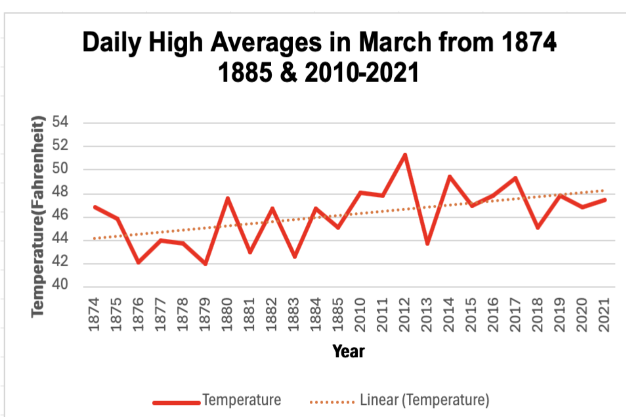

Figure 12: *March Average Daily High from 1874-1885 and 2010-2021* **Figure 13:** *T-test results*

T-Test Values:

T Value = 9.761

P-Value = <0.0001

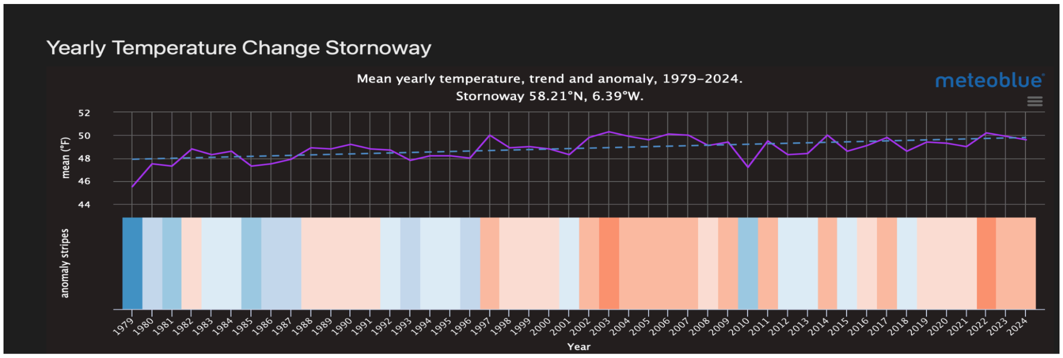

Figure 14: *Yearly Temperature Change in Scotland*

Based on the data and information gathered and other research done to help determine whether global warming is happening in Scotland, we were able to conclude that it is happening in Stornoway Scotland. An example to help support this is the coastal erosion which is a sign of natural geological impact, but is due to coastal structures interfering with littoral transport(movement of sediments along a shoreline). An increase is possible by human impact from construction. Another supporting evidence is the Increased flooding occurred due to the rising sea levels which can also cause erosion. Stornoway ten warmest years all occurred since 1997, with the warmest being in 2022. This is crucial as the coldest yearly temperatures happened in the first ten years and increased tremendously over the expected line of best fit. [3] [4]

Discussion:

This section will focus on analyzing and discussing the information presented in the "Results" section in the same chronological order.

March HOBO and Dale Enterprise Data Analysis:

When comparing the HOBO data to that of Dale Enterprise, a notable difference was observed between both HOBOs and that of Dale Enterprise. HOBO 2 had significantly larger values than that of HOBO 1 with wide fluctuations and unrealistic daily high temperatures, this could be due to the relative location next to a parking lot inside the apartment complex and possibly the materials it was on being wood, along with the sun exposure. HOBO 1 also exhibited higher temperatures than the readings from Dale Enterprise, although not to the scale of HOBO 2, but these differences were seen in **Figure 1.** The slight difference in HOBO 1 could be the location as it was covered by some leaves and foliage to begin with and it looked similar to that of Dale Enterprise but then natural elements could have shifted it resulting in more solar exposure and thermal radiation, consequently, yielding higher temperature readings. A small part of this could have been due to urban heat island effect and that both HOBO were right in Harrisonburg while the Dale Enterprise station was a little outside of town, as seen in **Image 4**. Another factor was the lack of data from Dale Enterprise, as the data was downloaded from NOAA it was missing daily high days which made it difficult to get a full understanding and definitely could have shifted the t-test values.

A t-test was conducted of HOBO 1 and Dale Enterprise, as they showed the most similarities. The final result showed that the data was very statistically significant, showing great difference between the HOBOs and Dale Enterprise. This could be due to a number of things, such as the technological difference or the substantial amount of errors in the data collection of the HOBOs, but cannot attribute to climatic differences and it is from similar areas of Harrisonburg, Virginia.

While this data shows stark differences in a very close area, it does not definitely validate or invalidate climate change and can represent the complexities and challenges involved in data collection and the accuracy of various datasets used across disiplines. The many factors that can influence temperature data—such as sun exposure, geographic location, urban development, and other environmental conditions—warrant a critical and cautious approach when interpreting and using this information.

Dale Enterprise Data Analysis:

Over the past 125 years, average March temperatures show a general downward trend, though this trend is marked by significant year-to-year fluctuations, as illustrated in **Figure 3**. When comparing average temperatures for March, July, and December at the Dale Enterprise Weather Station in Harrisonburg, Virginia, the trendlines and t-tests reveal conflicting patterns over time.

Figure 4 presents the trendline and t-test results for average March temperatures between 1900–1924 and 2000–2024. While both periods exhibit similar highs and lows with notable fluctuations, the trendline suggests that March temperatures were slightly warmer in the early 1900s than in the past 25 years. However, the t-test indicates that this difference is not statistically significant, meaning the variation is likely due to random fluctuations rather than a meaningful shift.

Figure 5 focuses on July, showing a different pattern. In the early 1900s, temperatures began relatively high but ended lower, with limited variation throughout the period. In contrast, the 2000s show a gradual increase in daily high temperatures over the 25-year span. Despite these apparent trends, the t-test again revealed no statistically significant difference between the two periods, suggesting that the averages and fluctuations are still relatively similar over the century.

Figure 6 presents data for December, where the trend reverses from March. Here, the 2000s show slightly higher average temperatures than the early 1900s, and both periods display a gradual increase in average temperatures. Yet, as with the other months, the t-test for December found no statistically significant difference.

Taken together, these findings highlight the complexity of interpreting climate data. While trend lines can suggest changes over time, statistical tests like the t-test help determine whether those changes are meaningful. Relying on a single month or method could lead to misleading or contradictory conclusions. Therefore, it's essential to consider multiple analytical approaches, as well as the temporal and spatial context of the data, to draw more reliable insights.

Tasiilaq , Greenland Data Analysis:

The analysis of long-term temperature data from Tasiilaq, Greenland, reveals strong evidence of climate change in the region. Although the temperature graphs for the early 20th and early 21st centuries appear visually similar, the results of the two-sample t-tests indicate that the observed differences in average air temperatures are very highly statistically significant. This suggests that the changes in temperature patterns over the past century are unlikely to be the result of random variation or short-term weather fluctuations. While the magnitude of change in average temperatures may appear relatively modest, the statistical findings confirm that the warming trend is consistent and measurable. This highlights an important distinction: statistical significance does not necessarily imply a dramatic shift, but rather a reliable, persistent difference that supports broader climate change trends.

In regions like Tasiilaq, where temperatures are already low, even small increases can have significant environmental and ecological impacts, such as glacial melt. The results from Tasiilaq align with global scientific consensus that the Earth's climate is warming, particularly in polar and subpolar regions. These findings contribute to the broader investigation by confirming that long-term climate change is detectable not only in global averages but also in localized datasets, reinforcing the importance of continuous temperature monitoring and historical climate data analysis. **Figure 10**, while appearing to show relatively insignificant data, it is again important to note the small, yet unusual fluctuations in the data. Near the end of the timeline, there is some sporadic behaviour, another indicator of climate change, as opposed to exclusively warming the planet in a steady fashion. In addition to this, the figure also displays a steady upward trend in the maximum low temperatures, which is a well documented effect of human's impact on the climate. [5] [6]

Alexandrovsk-Sakhalinsky, Russia Data Analysis:

Statistical analysis revealed a clear warming trend in the more recent period. The mean March temperature from 1894 to 1994 was 24.82°F, while the corresponding mean from 1995 to 2025 rose to 26.30°F, indicating an increase of 1.48°F. The standard deviation increased slightly from 8.01 to 8.04, suggesting that while the region has warmed, the interannual variability in March temperatures has remained relatively stable. Like other high-latitude regions, Sakhalin is especially sensitive to climate change due to snow and ice feedback loops, which can amplify warming through reduced albedo.

To assess whether this observed increase is statistically significant, a two-sample t-test was conducted using temperature data from both periods. The resulting t-value was 4.86, with a corresponding p-value less than 0.0001.

This result indicates a very highly significant difference in March temperatures before and after 1995, providing strong statistical evidence of long-term warming in the region. These findings are visually represented in **Figure 11**, which plots March temperatures from 1894 to 2025. A vertical red line marks the 1995 division, highlighting the post-1995 upward trend in temperature averages.

The Aleksandrovsk-Sakhalinsky dataset strongly supports the hypothesis of local climate warming. While this analysis focused specifically on March, future studies could examine full seasonal or annual trends to confirm whether similar patterns persist year-round. Additionally, data on instrumentation history and siting conditions would further strengthen interpretations over such a long timeframe. Nevertheless, the significant rise in March temperatures aligns with global climate trends documented by institutions like NOAA and the IPCC. Continued warming in Sakhalin could have implications for regional biodiversity, permafrost stability, and marine ecosystems dependent on seasonal ice cover. This case study demonstrates how localized data collection can reinforce and contextualize broader patterns of anthropogenic climate change.

Conclusion:

The results of this investigation strongly support the conclusion that climate change is occurring, as evidenced by long-term temperature trends and statistical analyses across multiple global and local datasets. While the absolute temperature differences over time may appear modest, the consistency and statistical significance of the changes are clear indicators of a broader warming trend. Every international location analyzed (Tasiilaq, Greenland; Stornoway, Scotland; and Alexandrovsk-Sakhalinsky, Russia) demonstrated extremely statistically significant increases in temperature over time, with p-values well below 0.001. These results provide robust support for the global scientific consensus on climate change. Such findings are especially meaningful in regions like Greenland and Sakhalinsky, where even small increases in temperature can lead to profound environmental changes such as glacial melt. [5]

In contrast, the data from Harrisonburg, Virginia, particularly from the Dale Enterprise station, showed less dramatic or statistically significant changes. This suggests that Harrisonburg may be an outlier in our dataset due to its unique geographic and environmental conditions, such as elevation and local microclimate effects. Furthermore, discrepancies between local HOBO sensor readings and the Dale Enterprise station highlight the challenges and limitations of localized short-term temperature monitoring, which can be influenced by urban heat effects and sensor placement. Despite these local anomalies, the overwhelming global evidence backed by rigorous statistical testing points to a clear and measurable warming trend. Therefore, this project concludes that climate change is indeed occurring and that statistical analysis of long-term temperature data is a powerful tool in detecting and understanding these patterns, lining up with the experiment's initial hypothesis. Continued monitoring and broader data collection will remain essential in tracking the progression and impacts of global climate change.

Appendix:
[1] Table 1: Hobo and Dale Enterprise Monthly Data Tables
[2] Tabe 2: 1900 - 2025 Dale Enterprise March Data
References:
[1] "Causes - NASA Science." NASA, NASA, 23 Oct. 2024, science.nasa.gov/climate-change/causes/. Accessed 7 May 2025

[2]Daily Summaries Station Details: DALE ENTERPRISE, VA US, GHCND:USC00442208 | Climate Data Online (CDO) | National Climatic Data Center (NCDC). https://www.ncdc.noaa.gov/cdo-web/datasets/GHCND/stations/GHCND:USC00442208/detail. Accessed 21 Marr. 2025

[3]HIAL completes Stornoway's coastal protection. Regional Gateway. (2023, October 19). https://www.regionalgateway.net/hial-completes-stornoways-coastal-protection-project/

[4] Climate change trends and projections. Adaptation Scotland. (2024, October 9). https://adaptation.scot/scotland-and-climate-change/climate-change-trends-and-projections/#:~:text=Scotland's%20changing%20climate&text=Our%20coastline%20is%20also%20changing,as%20more%20intense%20storm%20events.

[5] *Nakamura, Tracey. "Greenland Ice Sheet." NOAA Arctic, 10 Dec. 2024, arctic.noaa.gov/report-card/report-card-2024/greenland-ice-sheet-2024/. Accessed 9 May 2025*

[6] *EPA, Environmental Protection Agency, 25 Mar. 2025, www.epa.gov/climate-indicators/weather-climate.*