My title*

My subtitle if needed

Lexun Yu

November 20, 2024

First sentence. Second sentence. Third sentence. Fourth sentence.

1 Introduction

Climate change is a global challenges today. Patterns such as rising temperatures, shifting weather systems, and increased frequency of severe weather events. In 2021, floods swept through streets in Japanese cities, displacing millions, while extreme heat fueled wildfires in Siberia (Greenpeace East Asia 2021). Climate change impacts human health, ecosystems, food security, water supplies, and economic stability. Understanding the factors driving temperature changes is necessary for designing effective mitigation strategies. This requires examining the various contributors to temperature variations.

Some scholars have examined the changing climate. Xu et al. (2009) analyze the effects of rising temperatures in the Himalayas, highlighting increased frequency and duration of extreme events and shifts in ecosystems. These changes pose challenges to water supply, agriculture, and human populations. Visser et al. (2021) investigates the relationship between precipitation and temperature using data from the Australian Bureau of Meteorology. Visser's regression model indicates that average precipitation intensities increase with temperature, suggesting more intense rainfall in a warmer climate. The role of sea level pressure is also significant. Wills et al. (2022) note that observed trends in sea level pressure have intensified warming in the Indo-Pacific Warm Pool and caused slight cooling in the eastern equatorial Pacific. However, as Zhang, Zhang, and Chen (2017) argue, much of the research has focused on temperature and precipitation. Zhang, Zhang, and Chen (2017) expands on this by incorporating additional predictors—relative humidity and wind speed—and concludes, using data from the Ministry of Agriculture of China, that these variables are important in understanding climate dynamics.

*Code and data are available at: https://github.com/yulexun/ClimateChangeYVR.

With the data obtained from Canadian Centre for Climate Services (2022) and Meteorological Service of Canada (2023), this research paper aims to identify the factors influencing temperature at Vancouver International Airport. Located on the west coast of Richmond, the airport sits on Sea Island, surrounded by water. As a transportation hub for passengers and freight, it is important to assess the location's safety in a warming climate.

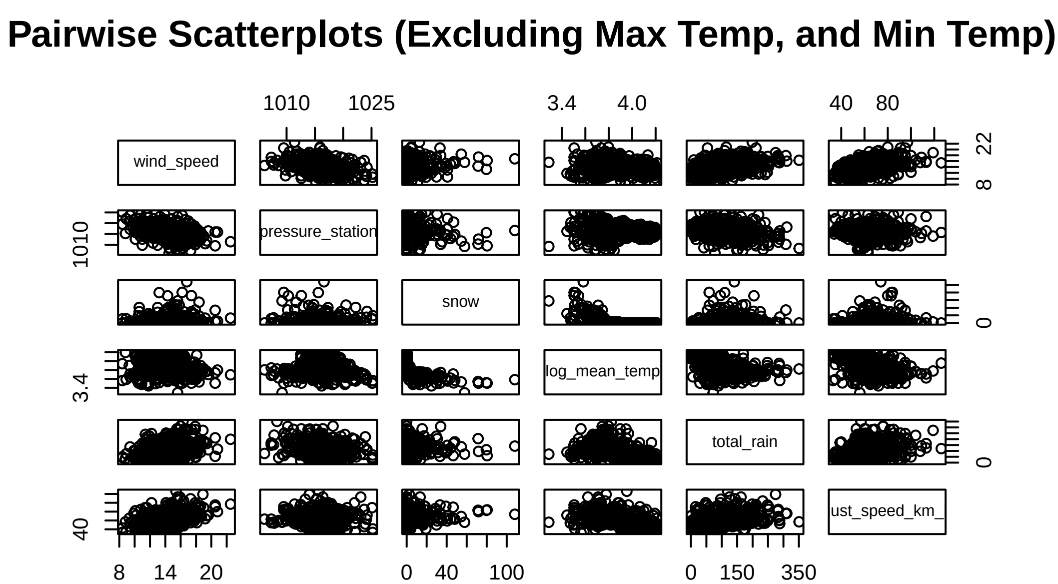
Estimand paragraph

Results paragraph

Telegraphing paragraph: The remainder of this paper is structured as follows. Section 2....

2 Data

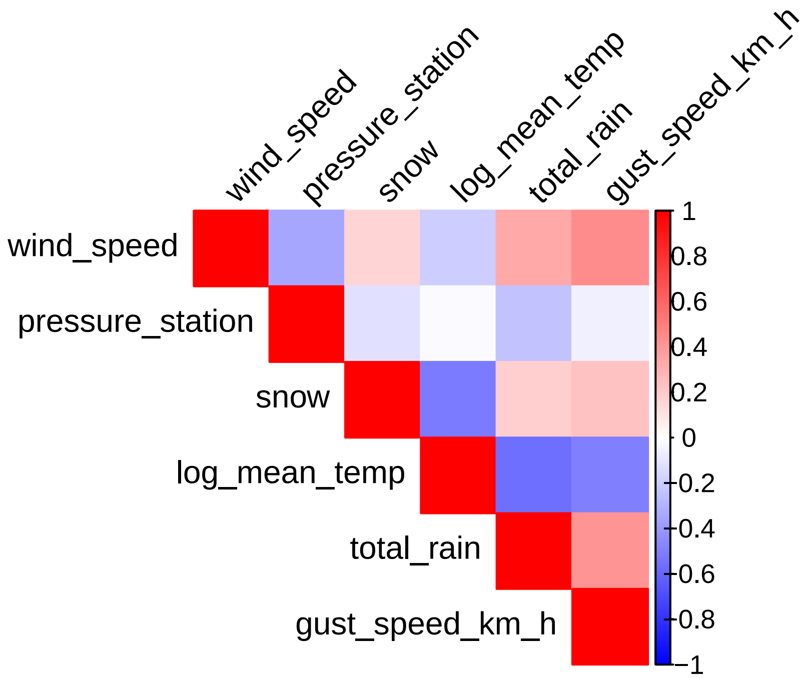
```
selected_data_1 <- analysis_data[, c("wind_speed", "pressure_station", "snow", "log_mean_temp
pairs(as.data.frame(selected_data_1), main = "Pairwise Scatterplots (Excluding Max Temp, and
```



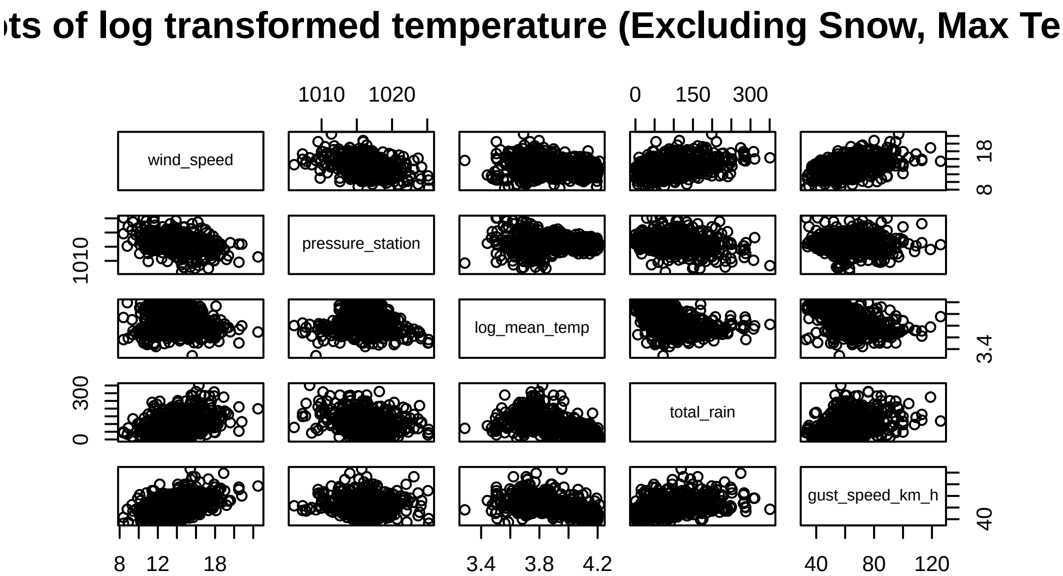

```
cor_matrix <- cor(selected_data_1)
print(cor_matrix)
```

```
                 wind_speed pressure_station       snow log_mean_temp
wind_speed        1.0000000      -0.34760462  0.1648222   -0.19023484
pressure_station -0.3476046       1.00000000 -0.1173164   -0.01396792
snow              0.1648222      -0.11731635  1.0000000   -0.51554945
log_mean_temp    -0.1902348      -0.01396792 -0.5155495    1.00000000
total_rain        0.3333823      -0.23418715  0.1843201   -0.56140560
gust_speed_km_h   0.4414225      -0.05910226  0.2300011   -0.49986221
                 total_rain gust_speed_km_h
wind_speed        0.3333823      0.44142245
pressure_station -0.2341872     -0.05910226
snow              0.1843201      0.23000113
log_mean_temp    -0.5614056     -0.49986221
total_rain        1.0000000      0.41892153
gust_speed_km_h   0.4189215      1.00000000
```

```r
corrplot(cor_matrix, method = "color", type = "upper",
         tl.col = "black", tl.srt = 45,
         col = colorRampPalette(c("blue", "white", "red"))(200))
```



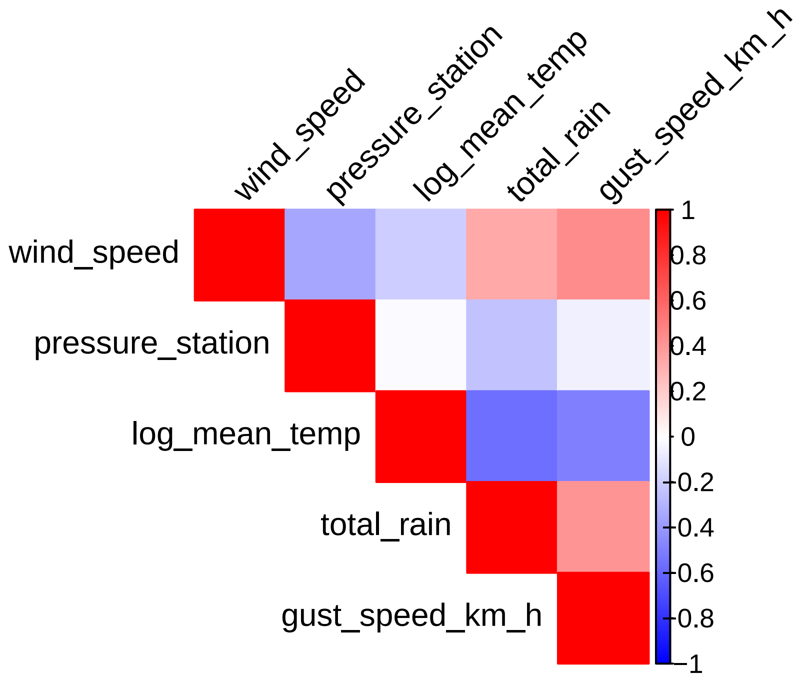

```r
selected_data_3 <- analysis_data[, c("wind_speed", "pressure_station", "log_mean_temp", "tota
pairs(as.data.frame(selected_data_3), main = "Pairwise Scatterplots of log transformed tempe
```




```r
cor_matrix <- cor(selected_data_3)
print(cor_matrix)
```

```
                 wind_speed pressure_station log_mean_temp total_rain
wind_speed        1.0000000      -0.34760462   -0.19023484  0.3333823
pressure_station -0.3476046       1.00000000   -0.01396792 -0.2341872
log_mean_temp    -0.1902348      -0.01396792    1.00000000 -0.5614056
total_rain        0.3333823      -0.23418715   -0.56140560  1.0000000
gust_speed_km_h   0.4414225      -0.05910226   -0.49986221  0.4189215
                 gust_speed_km_h
wind_speed            0.44142245
pressure_station     -0.05910226
log_mean_temp        -0.49986221
total_rain            0.41892153
gust_speed_km_h       1.00000000
```

```r
corrplot(cor_matrix, method = "color", type = "upper",
         tl.col = "black", tl.srt = 45,
         col = colorRampPalette(c("blue", "white", "red"))(200))
```



2.1 Overview

We use the statistical programming language R (R Core Team 2023)…. Our data (**shelter?**)…. Following (**tellingstories?**), we consider…

Overview text

2.2 Measurement

Some paragraphs about how we go from a phenomena in the world to an entry in the dataset.

2.3 Outcome variables

Add graphs, tables and text. Use sub-sub-headings for each outcome variable or update the subheading to be singular.

Some of our data is of penguins (**?@fig-bills**), from (**palmerpenguins?**).

Talk more about it.

And also planes (**?@fig-planes**). (You can change the height and width, but don't worry about doing that until you have finished every other aspect of the paper - Quarto will try to make it look nice and the defaults usually work well once you have enough text.)

Talk way more about it.

2.4 Predictor variables

Add graphs, tables and text.

Use sub-sub-headings for each outcome variable and feel free to combine a few into one if they go together naturally.

3 Model

The goal of our modelling strategy is twofold. Firstly,…

Here we briefly describe the Bayesian analysis model used to investigate… Background details and diagnostics are included in **?@sec-model-details**.

3.1 Model set-up

Define y_i as the number of seconds that the plane remained aloft. Then β_i is the wing width and γ_i is the wing length, both measured in millimeters.

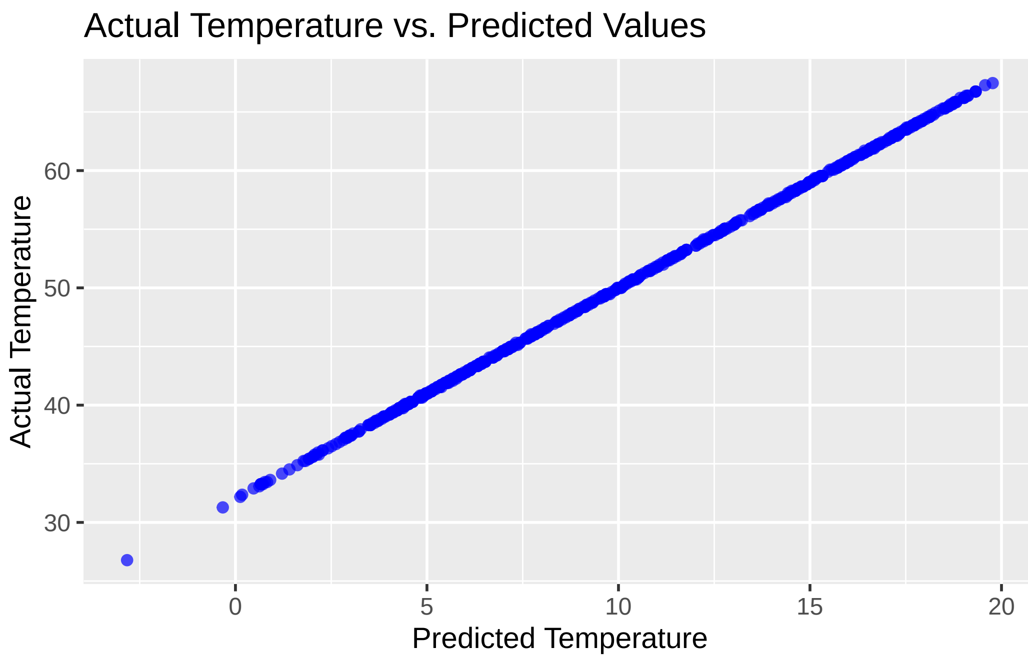
$$
\begin{aligned}
y_i|\mu_i, \sigma &\sim \text{Normal}(\mu_i, \sigma) && (1)\\
\mu_i &= \alpha + \beta_i + \gamma_i && (2)\\
\alpha &\sim \text{Normal}(0, 2.5) && (3)\\
\beta &\sim \text{Normal}(0, 2.5) && (4)\\
\gamma &\sim \text{Normal}(0, 2.5) && (5)\\
\sigma &\sim \text{Exponential}(1) && (6)
\end{aligned}
$$

We run the model in R (R Core Team 2023) using the `rstanarm` package of (**rstanarm?**). We use the default priors from `rstanarm`.

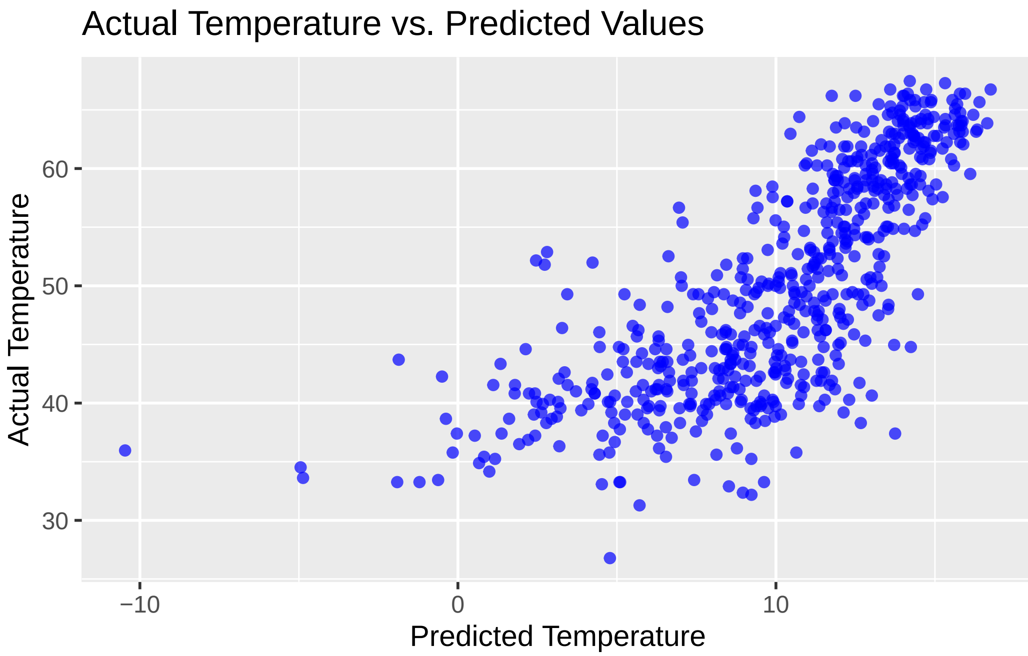
3.2 MLR Model

```r
fitted_values <- fitted(m1)
ggplot(data = analysis_data, aes(x = fitted_values, y = mean_temp_F)) +
  geom_point(color = "blue", alpha = 0.7) +
  geom_abline(intercept = 0, slope = 1, color = "red", linetype = "dashed", size = 1) +
  labs(x = "Predicted Temperature", y = "Actual Temperature", title = "Actual Temperature vs
```

```
Warning: Using `size` aesthetic for lines was deprecated in ggplot2 3.4.0.
i Please use `linewidth` instead.
```




```r
fitted_values <- fitted(m2)
ggplot(data = analysis_data, aes(x = fitted_values, y = mean_temp_F)) +
  geom_point(color = "blue", alpha = 0.7) +
  geom_abline(intercept = 0, slope = 1, color = "red", linetype = "dashed", size = 1) +
  labs(x = "Predicted Temperature", y = "Actual Temperature", title = "Actual Temperature vs
```



3.2.1 Model justification

We expect a positive relationship between the size of the wings and time spent aloft. In particular…

We can use maths by including latex between dollar signs, for instance θ.

4 Results

Our results are summarized in **?@tbl-modelresults**.

5 Discussion

5.1 First discussion point

If my paper were 10 pages, then should be be at least 2.5 pages. The discussion is a chance to show off what you know and what you learnt from all this.

5.2 Second discussion point

Please don't use these as sub-heading labels - change them to be what your point actually is.

5.3 Third discussion point

5.4 Weaknesses and next steps

Weaknesses and next steps should also be included.

A Appendix

B License

C Methodology of ECCC

The Adjusted and Homogenized Canadian Climate Data (AHCCD) is a collection of climate datasets developed by Environment and Climate Change Canada (2021a). These datasets provide long-term, quality-controlled data that have been adjusted to correct for non-climatic influences.

C.1 Population, Frame, and Sample

The population of interest in the AHCCD is the entirety of Canada's climate data, representing diverse geographical regions and climate conditions. The frame of the dataset are the climatological stations maintained by the ECCC that span across the countries in important locations such as airports, and banks of lakes or rivers. These stations record data on climate elements such as temperature, precipitation, surface pressure, and wind speed over extended periods. The sample is the selected stations across Canada, with adjustments applied to address inconsistencies. The datasets cover periods extending back to 1895 for precipitation, while other variables like wind speed and surface pressure start from 1953 or later. The recorded sample consists of monthly, seasonal, and annual data about surface air temperature, precipitation, pressure, and wind speed, according to Environment and Climate Change Canada (2021a).

C.2 Sample Corrections and Adjustments

The original data for AHCCD are extracted from the National Climate Data Archive of Environment Canada. These data include daily observations, such as maximum and minimum temperatures, precipitation, surface pressure, and wind speed. Observations are quality-controlled and adjusted to correct for biases due to changes in instruments, observation procedures, and other factors.

Precipitation data adjustments account for wind undercatch, evaporation, and gauge-specific losses. According to Environment and Climate Change Canada (2021b), corrections to account for wind undercatch, evaporation, and gauge specific wetting losses were implemented, especially in snowy conditions where snowfall is not fully captured by standard gauges. Corrections are made with the study by Devine and Mekis.

Surface air temperature adjustments apply Quantile-Matching techniques to remove inhomogeneities. According to Environment and Climate Change Canada (2021c), With Vincent and Wang's third generation homogenized temperature, Quantile-Matching ensures that the temperature data remain consistent across different periods, even when observation practices change.

Surface pressure and wind speed data undergo adjustments based on metadata and statistical tests for systematic shifts. According to Environment and Climate Change Canada (2021e), wind speed is first adjusted with a logarithmic wind profile, then tested for homogeneity using a technique based on regression models. It involves the identification of variation due to changes in anemometer and location change. The pressure data is corrected due to systematic shifts of non-updated station elevation and relocation, as stated by Environment and Climate Change Canada (2021d).

C.3 Sampling Approach and Trade-offs

According to the published methodology and the webpage by Dunbar (2020), they employ a systematic sampling approach by selecting specific climatological stations with long-term, consistent data records. In some cases, observations from neighboring or overlapping stations are merged to extend time series. The AHCCD dataset may also contain missing values, which can vary depending on the variable, station, and time. Additionally, the AHCCD dataset is site-specific, meaning it provides data specific to individual observation stations.

C.4 Missing Data Handling

Non-response, such as gaps in the data due to missing records, is managed by employing statistical and physical methods to homogenize the data. For instance, the AHCCD adjusts for shifts detected through historical evidence and metadata analysis. For large amount of missing data, ECCC mark the data as NA in the dataset (Canadian Centre for Climate Services 2022).

C.5 Strengths and Weaknesses

The AHCCD by Dunbar (2020) provides long-term, high-quality climate records adjusted for non-climatic factors such as changes in instrumentation, observation procedures, and station relocations, ensuring consistency and reliability for trend analysis in climate change.

The documentation acknowledges the possibility of missing values, which naturally arise in long-term observational datasets due to factors such as station interruptions, relocation, or equipment malfunctions (Environment and Climate Change Canada 2021a). Moreover, the dataset's coverage in Arctic regions is limited to the restricted to the mid-1940s to present, as this limitation reflects the historical absence of earlier systematic observations in these remote regions. # Posterior predictive check

In **?@fig-ppcheckandposteriorvsprior-1** we implement a posterior predictive check. This shows…

In **?@fig-ppcheckandposteriorvsprior-2** we compare the posterior with the prior. This shows…

References

Canadian Centre for Climate Services. 2022. "Adjusted and Homogenized Canadian Climate Data." https://climate-change.canada.ca/climate-data/#/adjusted-station-data.

Dunbar, Alyssa. 2020. "Adjusted and Homogenized Canadian Climate Data (AHCCD) - Data Collection Methodology." https://open.canada.ca/data/en/dataset/9c4ebc00-3ea4-4fe0-8bf2-66cfe1cddd1d/resource/26545adf-e689-4d83-8f2d-9aad3dfa6f57.

Environment and Climate Change Canada. 2021a. "Adjusted and Homogenized Canadian Climate Data." Datasets. https://www.canada.ca/en/environment-climate-change/services/climate-change/science-research-data/climate-trends-variability/adjusted-homogenized-canadian-data.html.

———. 2021b. "Climate Data: Adjusted Precipitation Data." Research;program results. https://www.canada.ca/en/environment-climate-change/services/climate-change/science-research-data/climate-trends-variability/adjusted-homogenized-canadian-data/precipitation.html.

———. 2021c. "Climate Data: Homogenized Surface Air Temperature Data." Program descriptions;program results. https://www.canada.ca/en/environment-climate-change/services/climate-change/science-research-data/climate-trends-variability/adjusted-homogenized-canadian-data/surface-air-temperature.html.

———. 2021d. "Climate Data: Homogenized Surface Pressure Data." Research. https://www.canada.ca/en/environment-climate-change/services/climate-change/science-research-data/climate-trends-variability/adjusted-homogenized-canadian-data/surface-pressure.html.

———. 2021e. "Climate Data: Homogenized Surface Wind Speed Data." Research;datasets. https://www.canada.ca/en/environment-climate-change/services/climate-change/science-research-data/climate-trends-variability/adjusted-homogenized-canadian-data/surface-wind-speed.html.

Greenpeace East Asia. 2021. "5 Ways the Climate Crisis Will Change Asia." *Greenpeace East Asia*. https://www.greenpeace.org/eastasia/blog/6802/5-ways-the-climate-crisis-will-change-asia/.

Meteorological Service of Canada. 2023. "Past Weather and Climate." https://www.canada.ca/en/services/environment/weather.html.

R Core Team. 2023. *R: A Language and Environment for Statistical Computing*. Vienna, Austria: R Foundation for Statistical Computing. https://www.R-project.org/.

Visser, Johan B., Conrad Wasko, Ashish Sharma, and Rory Nathan. 2021. "Eliminating the 'Hook' in Precipitation-Temperature Scaling." *Journal of Climate*, September, 1–42. https://doi.org/10.1175/JCLI-D-21-0292.1.

Wills, Robert C. J., Yue Dong, Cristian Proistosecu, Kyle C. Armour, and David S. Battisti. 2022. "Systematic Climate Model Biases in the Large-Scale Patterns of Recent Sea-Surface Temperature and Sea-Level Pressure Change." *Geophysical Research Letters* 49 (17): e2022GL100011. https://doi.org/10.1029/2022GL100011.

Xu, Jianchu, R. Edward Grumbine, Arun Shrestha, Mats Eriksson, Xuefei Yang, Yun Wang, and Andreas Wilkes. 2009. "The Melting Himalayas: Cascading Effects of Climate Change on Water, Biodiversity, and Livelihoods." *Conservation Biology* 23 (3): 520–30. https://doi.org/10.1111/j.1523-1739.2009.01237.x.

Zhang, Peng, Junjie Zhang, and Minpeng Chen. 2017. "Economic Impacts of Climate Change on Agriculture: The Importance of Additional Climatic Variables Other Than Temperature and Precipitation." *Journal of Environmental Economics and Management* 83 (May): 8–31. https://doi.org/10.1016/j.jeem.2016.12.001.