What Defines A Season

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I've treated & plotted weather data of 35 years and inferred why Japan doesn't define its seasons according to daylight like other nations with four seasons do and why temperature aligns with its seasons well, while for others not so much.

1 Introduction

Historically, places with steady daylight cycles use the astronomical system which defines seasons not via temperature, but via daylight as over the course of a year, the amount of daylight one experiences on a given day oscillates in what's basically a sine wave, compared to temperature—which can vary wildly from year to year. This is how the amount of daylight roughly changes across the course of a year in Western Europe (*ref. to the following image).*

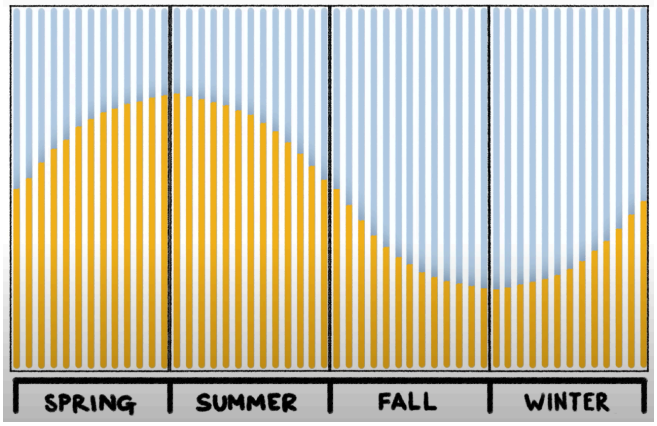


Fig. 1

But not in Japan. Due to the unfortunate geographical location of Japan along the western edge of the *Ring of Fire*, its daylight cycle is hardly ever consistent, unlike other nations with four-seasons.

However, contrary to discouraged *using-temperature-to-mark-the-season* stereotypes, Japan's average daily temperatures are highly consistent—according to our data spanning over 35 years—and follow a distinct seasonal pattern as the amount of daylight does in the northern hemisphere.

2 Japanese Weather

Fig. 2 & Fig. 3 accurately represents the average daily temperatures and average number of daily daylight hours observed during a period of 35 years (1984-2018), stacked in months to better study their correlation with seasons.

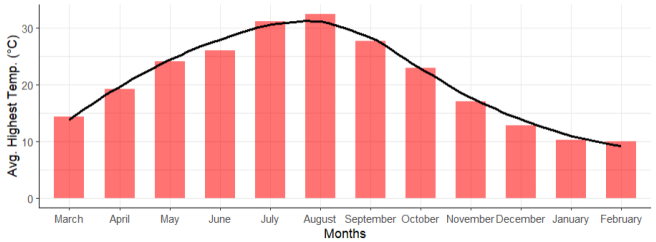


*Fig.2**

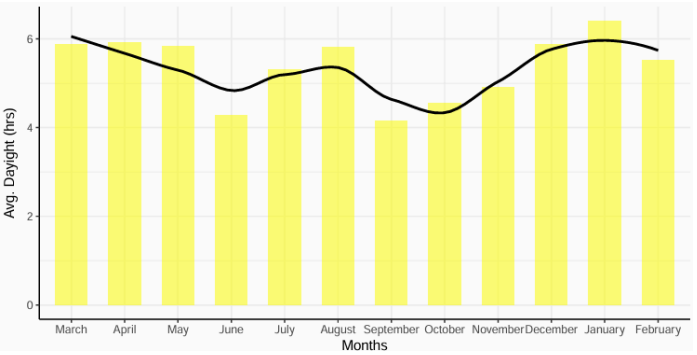


*Fig. 3**

2.1 Critical Observations

There are many critical observations to be made from the data as represented by the graphs, because if not then what was the point of plotting them. The daylight graph (fig. 3) makes some very insightful remarks and the temperature graph (fig. 2) unusually complements the seasons.

2.1.1 The Daylight Graph

Unlike other four-season nations, Japan's geography is too wet, literally. The weather is rainy—or snowy, depending on where you are and what month it is—in all parts of the country throughout the year, meaning inconsistent daylight hours thanks to the clouds blocking out the sun.

→ Daylight is especially scarce during June as it's the peak month of *Tsuyu* or rainy season.

→ Whilst temperatures remain high in September, days can be punctuated with intense periods of rainfall driven by the typhoons that hit during the month, resulting in unusually fewer hours of daylight.

→ Surprisingly, January observes the highest number of daylight hours while being the coldest.

→ Contrastingly, average daylight decreases as the Spring progresses and increases briefly during the Summer until the typhoons hit.

2.1.2 The Temperature Graph

Although the ancient Japanese didn't have thermometers to measure local temperatures, they defined seasons that align with it; by keeping track of natural processes like blossoming of flowers in Spring, changing of leaves in Fall, intense heat in Summer and snowfall in Winters, which are largely temperature-dependent or correlate with it.

→ We observe a curve perfectly representing how seasons are felt in Japan, unlike daylight-defined-seasons which feel very different.

**Please note the unconventional ordering of months which is done according to their mapping with seasons.*
Spring: March-May *Summer: June-August*
Fall: September-November *Winter: December-February*

2.2 Conclusion

As daylight hours are inconsistent and don't correspond to any such essential 'defining' phenomena, they are not used in japan to keep track of seasons.

3 Data-treatment & Plotting

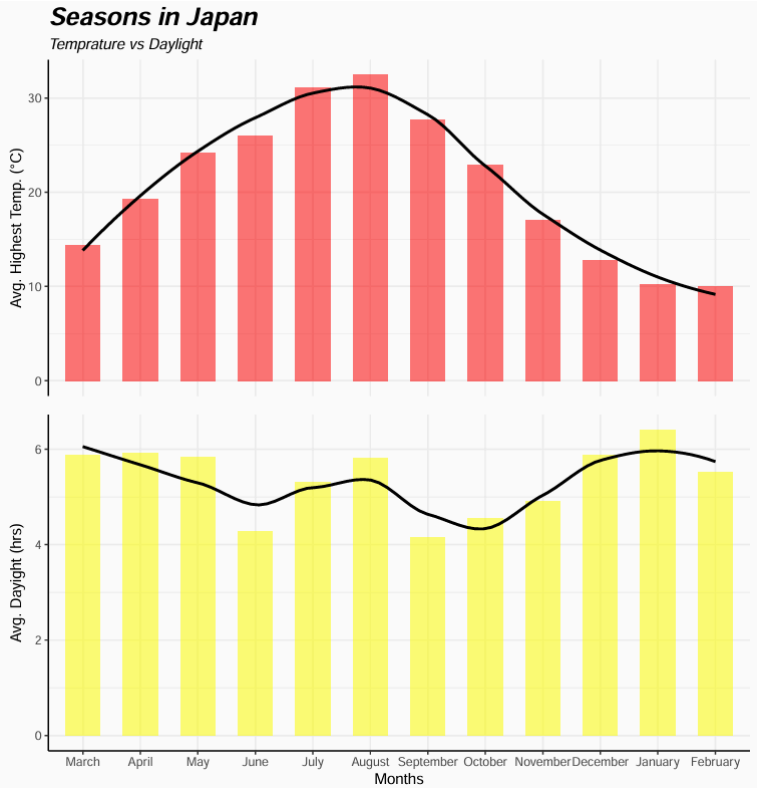
The data is carefully selected to accurately represent the facts whilst being manageable in size and stored in simple files (*.csv, *.xlsx). Then the data is somewhat treated (as it was not too complex) and plotted.

3.1 DataSet

The dataset used, "tokyo_data.csv" is downloaded from kaggle:
https://www.kaggle.com/datasets/loovmj/tokyo-weather-data/data?select=tokyo_data.csv
And is then converted to *.xlsx format to preserve all its features.

→ *Please refer to the R-script (finalProj_rahul.r) to follow the code and read the side-by-side explanation in the comments.*

3.2 Defending the Plots



1. Perceptual task: Only the position common scale perceptual task is required to be performed by the user which has the highest ranking.
2. Principles of Graphical Excellence:-
   - 2.1. It shows only the data and all of it.
   - 2.2. It induces the viewer to think only about the substance.
   - 2.3. It accurately represents the data without any distortion.
   - 2.4. It uses minimal space and only a strictly required amount of ink.
   - 2.5. The extra color dimension added helps the user to easily identify which graph is temperature's and which is daylight's, while making multiple quick comparisons.
   - 2.6. The scales are different but that is made fairly clear and reinforced by color, although that doesn't matter much to this specific case study, as only overall pattern matters.
3. Choice of Plot: Technically, each month in the graph contains a single point value, i.e the average daily temperature of the month or average daily daylight received but it makes sense to plot a height rather than a single point as it feels more tangible because we're psychologically conditioned to think that temperature is a height, we do it all the time while measuring temperature with a mercury thermometer.
4. More Justification: The additional ink used entices the user to engage more with the plot as it makes it easier to draw insights/patterns than a simple curve whether or not connected by points.
5. Lie Factor: Needless to say, the lie factor is 1 but just to show some numbers the following is the calculation calculating the lie factor of the first 2 bars of the temperature plot.

$$\frac{\frac{183-137}{137}}{\frac{19.20-14.31}{14.31}} = \frac{0.34}{0.34} \approx 1$$

6. Additional Curves: Finally, I believe the geom_smooth() curves are necessary for this study as it's with the help of these that we could conclude why Japan doesn't track its seasons according to daylight and rather chooses a more temperature inclined approach.