Growing Degree Days and Chills as Predictors of Cherry Blossom Bloom Days

The first blooming days of Cherry Blossom trees have long been observed in Japan for over a millennia. This tradition has spread over to many other nations that have cultivated species from this genus. In the modern day predictive methods can be applied to find an estimate of bloom dates using a multitude of techniques. Time-series, rainfall, and soil moisture are among some of the indicators used to find blooming days.

Our approach is composed of two indicators: firstly, we use a heuristic dubbed Growing Degree Days (GDD). It stems from the idea that plants do not experience time as we do, but that an accumulation of heat enables the blooming of plants. A sufficient accumulation of the heat at each day serves as a sufficient estimate for many species' development, for example common lilacs begin flowering at 80-110 GDDs. In our investigations, we found that another potential aid in estimating bloom days would be the total chill hours. More specifically, the amount of hours a day spent under 45 degrees Fahrenheit. Cherry trees (and many other plants) need a certain amount of chill hours during the winter, especially crucial are the months of December and January, to break their dormancy and resume growth in the Spring.

Three approaches were made, utilizing growing degree days, chill hours, or a naive linear model of the temperatures and locations. Some were combined and some weren't, but we found GDD to be the most parsimonious and effective predictor, followed by chill hours, then the naive model.

Utilizing historical data from the National Oceanic and Atmospheric Administration at four locations, we estimated an average temperature for each day and computed the cumulative GDD for each year up until the bloom day, the square, and cube of both quantities, the location of the cherry trees (Washington, Kyoto, Liestal), and amount of chill hours. A multiple linear regression model with interaction effects was run on this set of variables and was found to result in an adjusted R^2 of ~0.29 and an overall Mean Absolute Error of 5.3 days for all locations

We predict that for this year (2023), the first bloom day for Washington DC will be March 28th with an Mean Absolute Error (MAE) of 5 days, April 3rd for Kyoto with an MAE of 3.1 days, and March 31st for Liestal with an 7.75 day MAE. Vancouver has an estimated bloom day of March 31st, but due to lack of data we cannot give an approximation for the error.

Limitations of our work include the lack of data for Vancouver, which led us to model our predictions based on the values of the other locations. That is to say, Vancouver was predicted agnostic of the actual location. Another drawback was station data from NOAA being incomplete during many years. This left many gaps in data collected for chill hours. Additionally, total chill hours were found to be negatively correlated with accumulated temperature sums. This multicollinearity meant that the GDD model and Chill hours model did not play well when combined together.

To conclude, we found growing degree days to be the best predictor of the blooming dates of cherry trees at Washington DC, Kyoto, and Liestal, with decently small intervals for two

out of three locations. In the future we would like to investigate using data from this current year, and experiment with more complex models like random-forests or ARIMAs.