At first look at the data, we thought the cherry blossom date may have some dependence on time, but after plotting the autocovariance function of the data, we find that only for Kyoto, the cherry blossom date shows some seasonality and trend. The plot of the autocovariance function of blossom date for Liestal and Washington DC suggests that the data is stationary,

We then try to use the max temperature in spring as a predictor to predict the blossom date. For Washington DC, the average max temperature in spring explains a very little amount of variability in data, but the residual of the model shows some dependency on time. We then use a time-series model ARIMA to fit the residuals. Auto. arima suggests ARIMA(1,1,1) model.

Since the average max temperature in spring is not available after 2022, to use this variable to do prediction for the next 10 years, we used Holt's linear trend method to predict the temperature. Due to the chance of having the El Niño phenomenon in the future, the global warming effect, and the record high temperature in Washington in February(28 Celsius), we think it may be helpful to use 80% upper bound of the temperature prediction as the predictor for future blossom date. Adding together the predictions from the linear model with temperature as the predictor and the predictions of the residual from the ARIMA model, we got the blossom date for Washington in 2023 as around the 84th day of the year and goes up to 85 in the future.

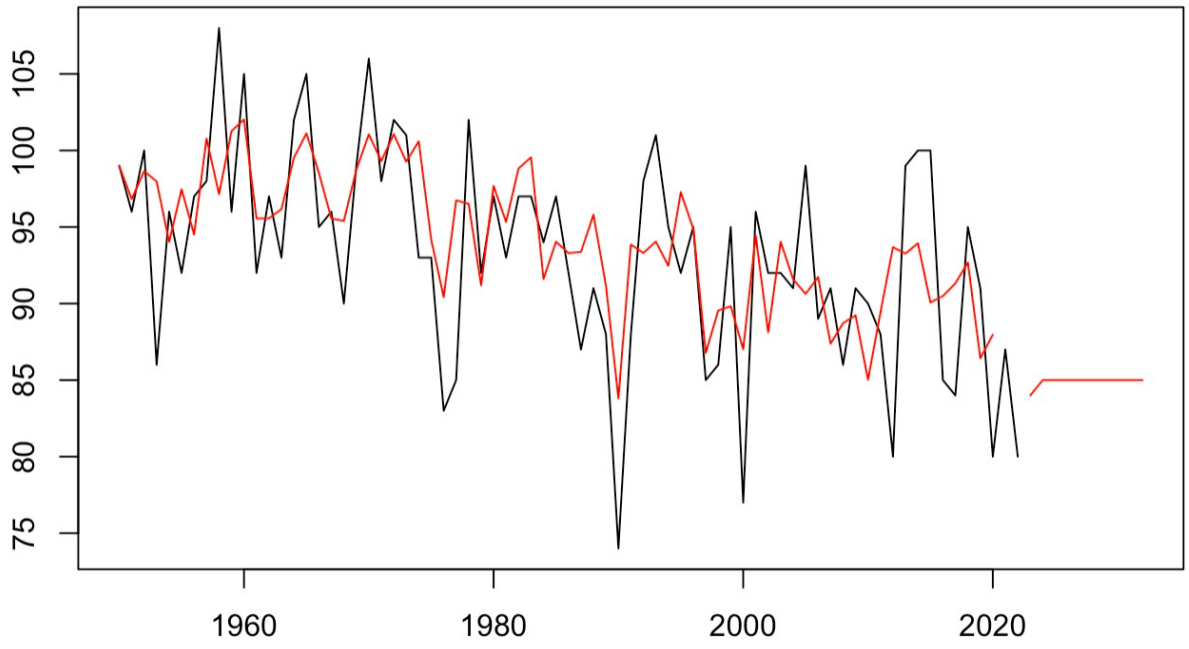

Figure 1. Prediction for Washington DC

We tried to use similar method to predict the blossom date and the average max temperature in spring for Kyoto and Liestal-Weideli.

For the average max temperature in spring for Kyoto, the Holts method predicts there's an upper trend, we choose the fitted value of the forecast. The residual of the linear model is stationary(auto. arima suggests ARIMA(0,0,0)), we choose the mean of the residual as the prediction for the linear model's residual. Thus the model for predicting Kyoto's cherry blossom date is a linear model with average max temperature in spring as the predictor, and the predictor of this linear model is predicted using Holt's method. The prediction for Kyoto in 2023 is at around the 93rd of the year and decreases to 90 in the future. We also tried several other smoothing methods on the blossom date series, but these models seem hard to catch the trend for the recent

year as the blossom date become earlier rapidly in recent years. The prediction we submitted is the earliest almond all our other predictions for Kyoto

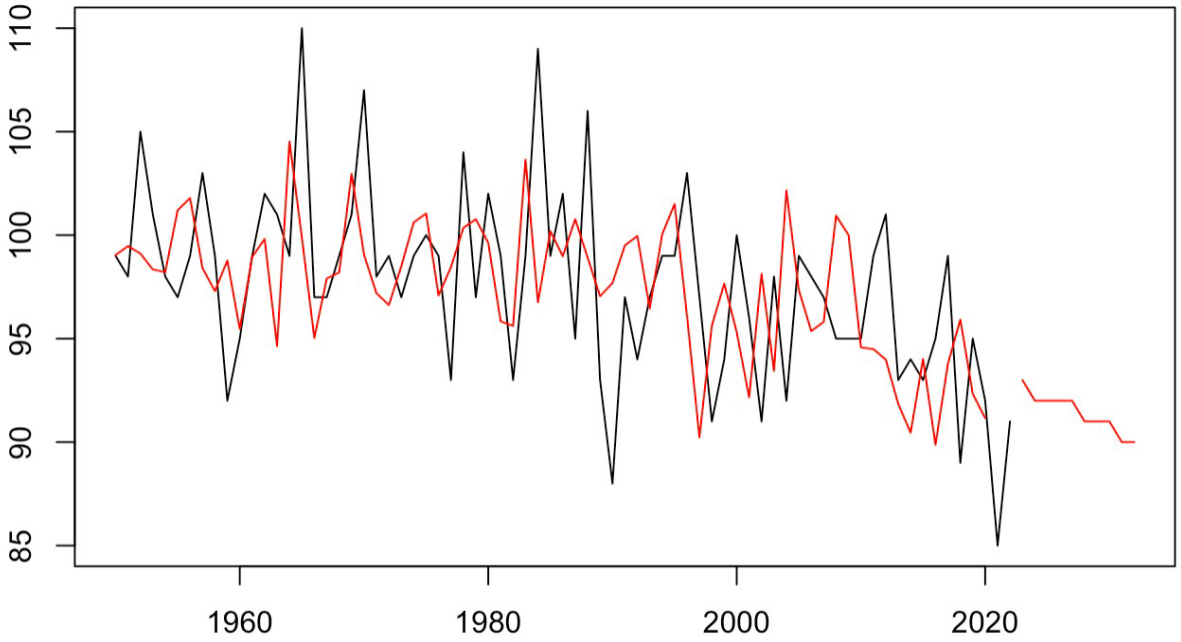

Figure 2. Prediction for Kyoto

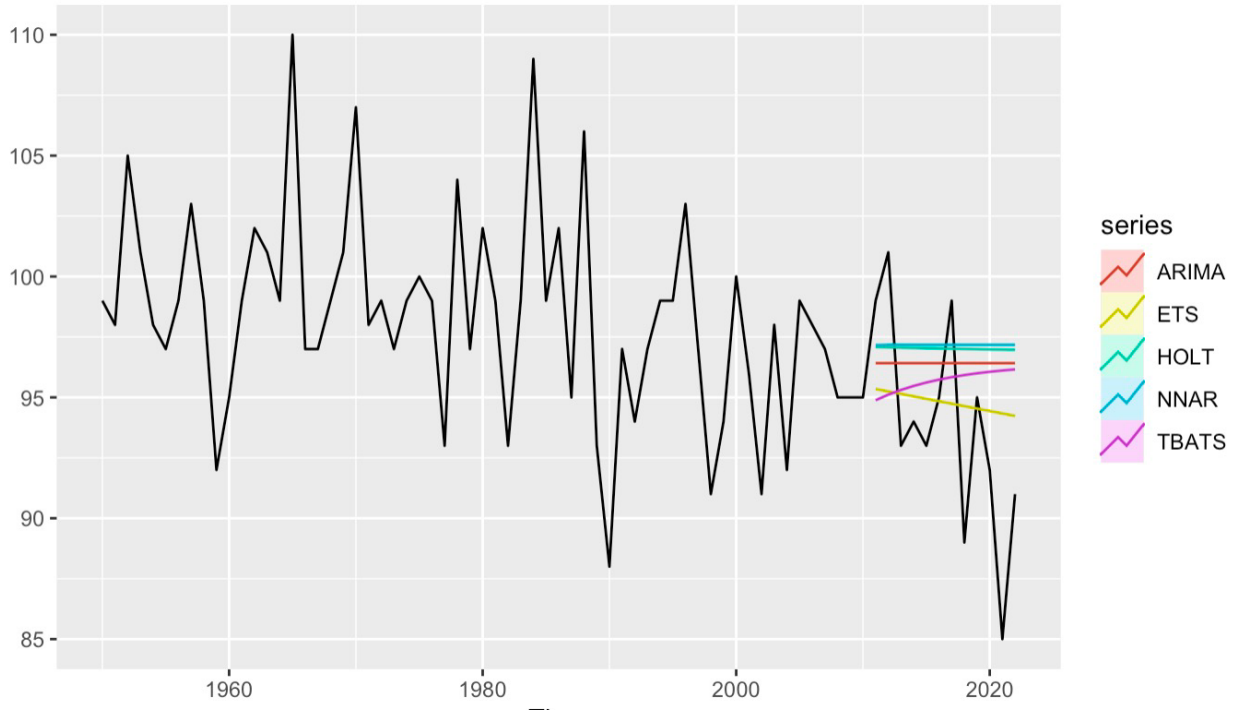

Figure 3. Other methods used for Kyoto

As for Liestal-Weideli, the residual for the linear model is also stationary, we choose a mean of residual as the prediction for future residuals, and the fitted value in Holt's method prediction. We predict the cherry blossom date for Liestal-Weideli in 2023 is around the 91th of the year, and 92 for future years.

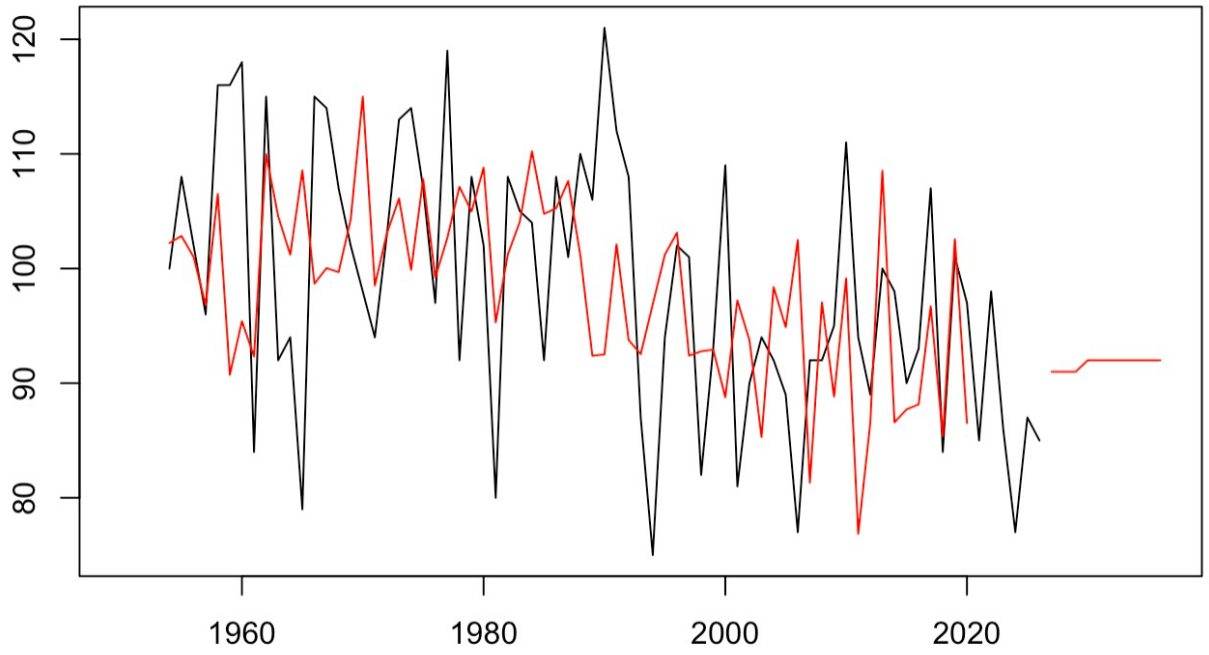

Figure 4. Prediction for Liestal-Weideli

The prediction for Vancouver is 102nd of the year 2023, it is far away from the observation in 2022. This is because we use the linear model that was used to predict blossom day for Washington DC, and the average max spring temperature has a very little dependency on time. Due to time concerns, we couldn't produce other methods to improve the results.