TEMP temperature comparison

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Introduction

This .Rmd file is to show the results of water temperature comparison between the global model prediction and the tributary field observation for 14 Great Lake locations.

Global water temperature model:

Bosmans, J., Wanders, N., Bierkens, M.F.P. et al. FutureStreams, a global dataset of future streamflow and water temperature. Sci Data 9, 307 (2022). https://doi.org/10.1038/s41597-022-01410-6

Modeled temperature: For all the graphs below, the black line is the mean weekly average temperature, the grey lines are the 95% confidence interval, the blue lines are the max and min temperature.

Field temperature: Each year's field observation is represented by one thin color line. When we have complete data for a year, we calculate the Root Mean Square Error (RMSE) for that year.

```
library(ggplot2)
library(dplyr)
library(knitr)
```

```
WT <- read.csv("water temperature clean/water_temperature_final_clean.csv",
               stringsAsFactors = TRUE)
WT$year <- as.factor(WT$year)

## Plot the modeled data and field observations
plot_temp <- function(water.pred, water.field) {

  ggplot(water.pred, aes(x = weeks, y = temperature.avg))+
    geom_line(size = 1.5)+
    geom_line(aes(x = weeks, y = lower.CI), size = 1, alpha = 0.5)+
    geom_line(aes(x = weeks, y = upper.CI), size = 1, alpha = 0.5)+
    geom_line(aes(x = weeks, y = max), size = 1, alpha = 0.4, color = "blue")+
    geom_line(aes(x = weeks, y = min), size = 1, alpha = 0.4, color = "blue")+
    geom_line(water.field, mapping = aes(x = weeks, y = temp, color = year))+
    scale_colour_hue()+
    theme_bw()
}

## Calculate the RMSE
calculate_rmse <- function(water.pred, water.field) {

  # Remove the observations from non-complete years
  water.field.c <- water.field[water.field$complete == 1,]

  # Get the unique levels of the "year" variable
```

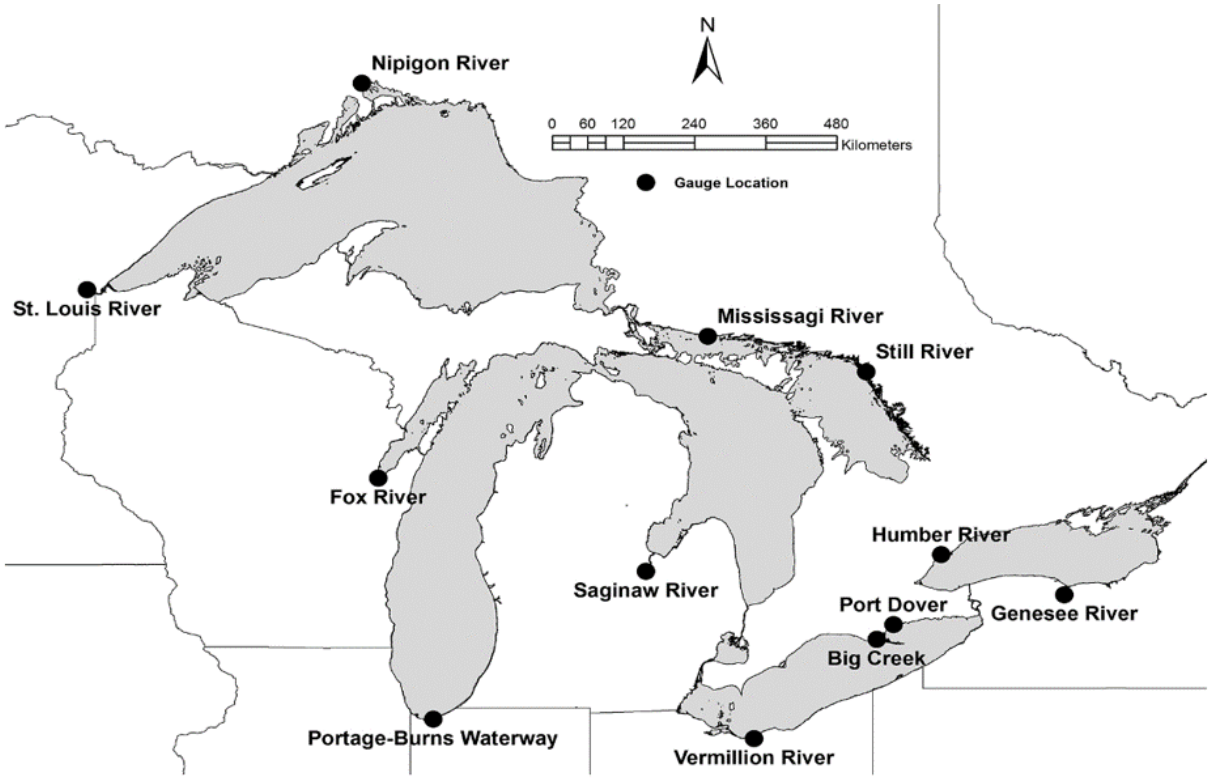
```
  unique_year <- unique(water.field.c$year)

  # Create a vector list to store the results
  rmse_list <- vector("numeric", 0)

  # Loop through each level and calculate the RMSE
  for (year.number in unique_year) {
    sub <- subset(water.field.c, year == year.number) # create subsets
    value <- sqrt(mean((sub$temp - water.pred$temperature.avg)^2))
    rmse_list[year.number] <- value
  }

  return(rmse_list)
}
```

Show the map of 12 tributary locations

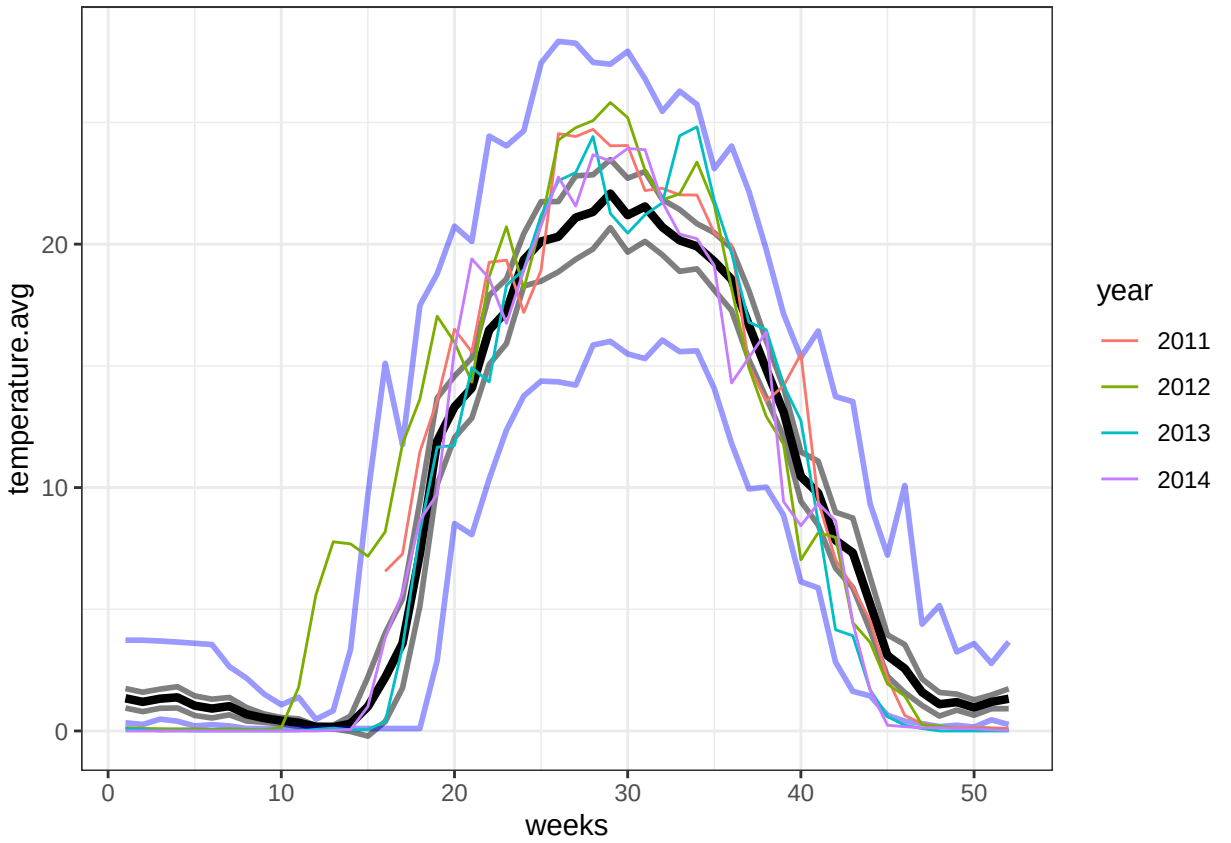


St. Louis River

```
# observed values
st.louis.field <- WT %>% filter(river == "stlouis")

# predicted values
st.louis.pred <- read.csv("water temperature clean/st_louis_model.csv")

# Plotting
plot_temp(st.louis.pred, st.louis.field)
```




```
# Calculate the Root Mean Square Error (RMSE)
calculate_rmse(st.louis.pred, st.louis.field)
```

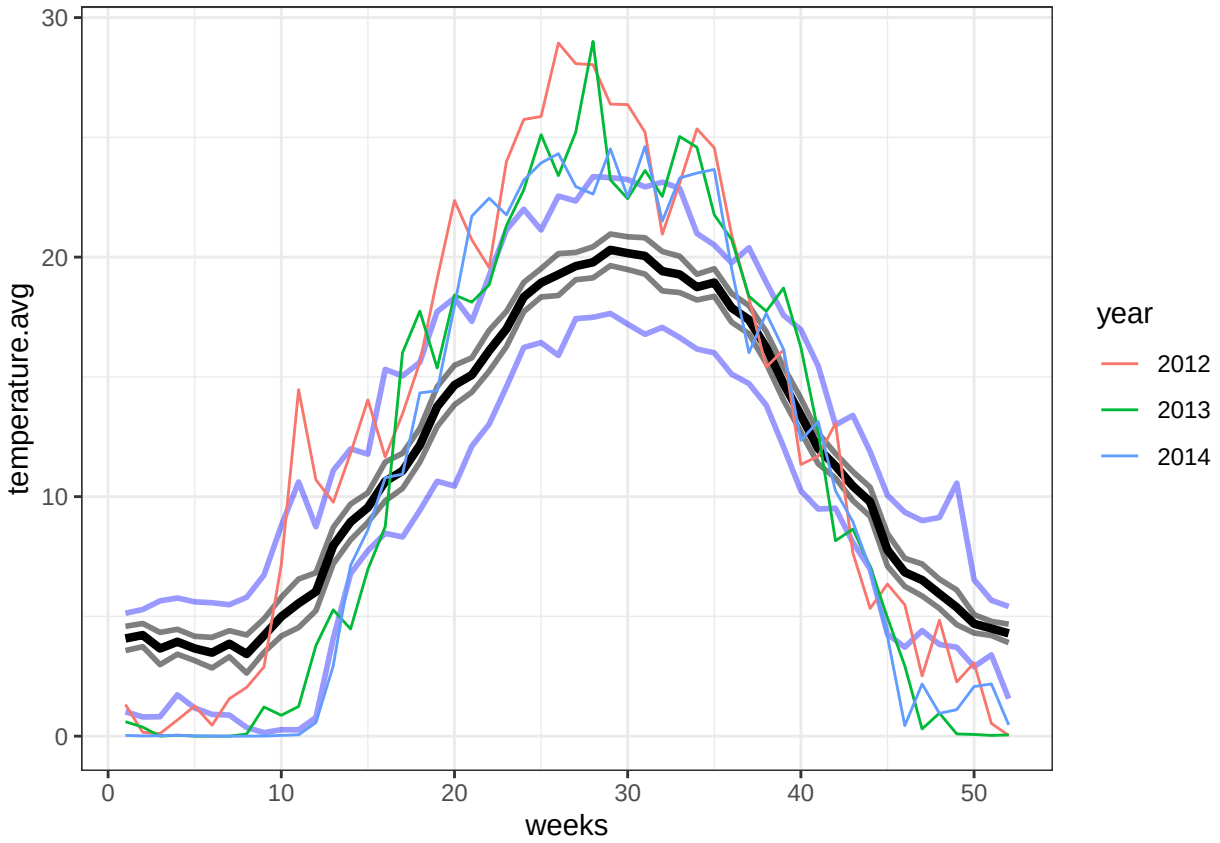
```
##     2012     2013     2014
## 3.188881 1.783592 1.833498
```

Saginaw

```
# observed values
saginaw.field <- WT %>% filter(river == "saginaw")

# predicted values
saginaw.pred <- read.csv("water temperature clean/saginaw_model.csv")

# Plotting
plot_temp(saginaw.pred, saginaw.field)
```




```
# Calculate the Root Mean Square Error (RMSE)
calculate_rmse(saginaw.pred, saginaw.field)
```

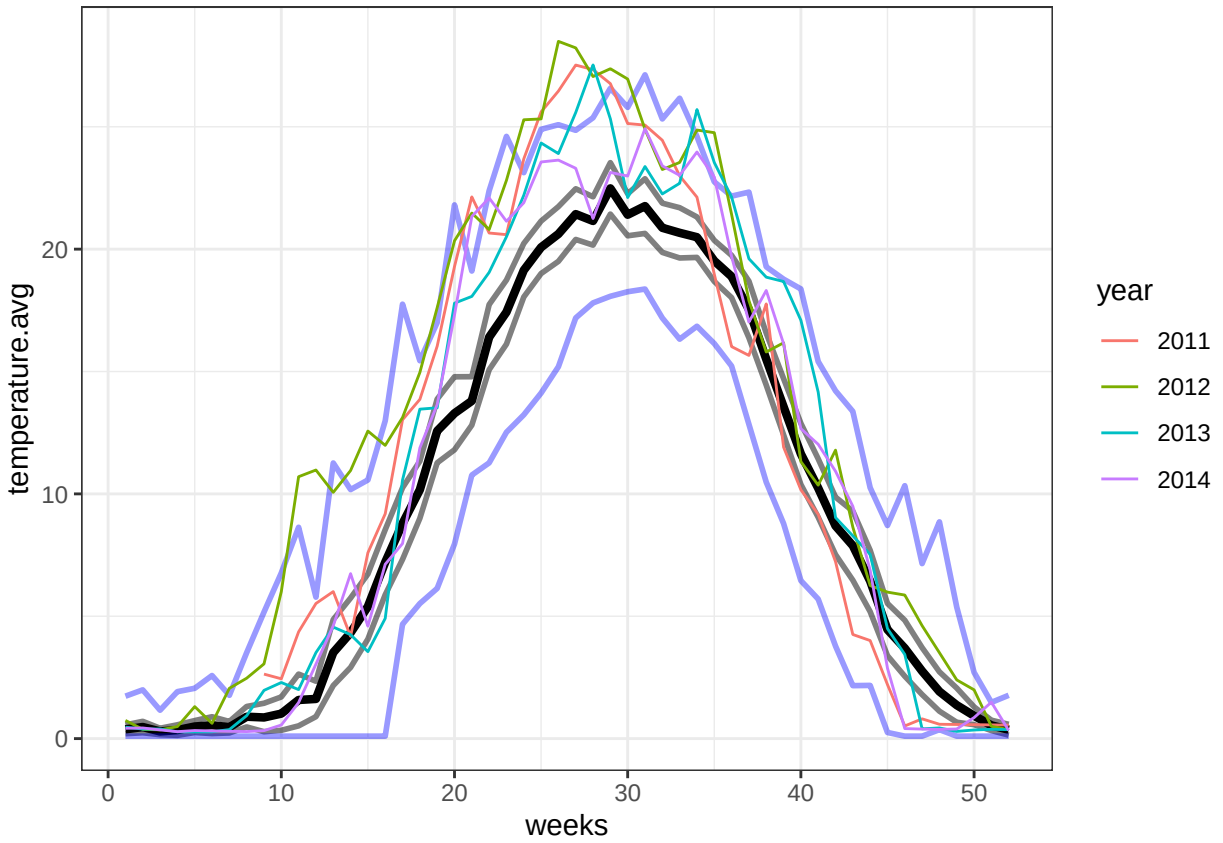
```
##     2012     2013     2014
## 4.502035 4.006986 3.766787
```

Fox River

```
# observed values
fox.field <- WT %>% filter(river == "fox")

# predicted values
fox.pred <- read.csv("water temperature clean/fox_model.csv")

# Plotting
plot_temp(fox.pred, fox.field)
```




```
# Calculate the Root Mean Square Error (RMSE)
calculate_rmse(fox.pred, fox.field)
```

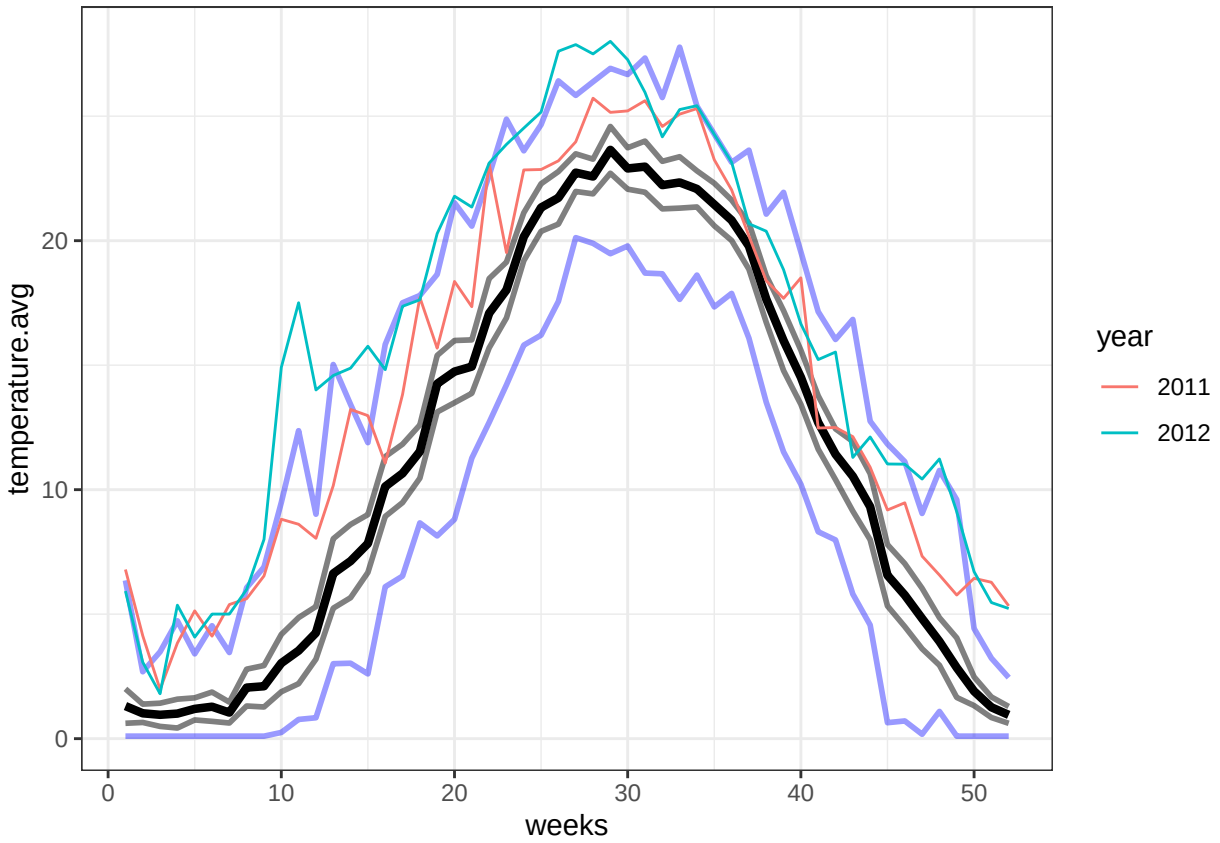
```
##     2012     2013     2014
## 4.304314 2.599478 2.262282
```

Portage-Burns Waterways

```
# observed values
pb.field <- WT %>% filter(river == "portage")

# predicted values
pb.pred <- read.csv("water temperature clean/pb_model.csv")

# Plotting
plot_temp(pb.pred, pb.field)
```




```
# Calculate the Root Mean Square Error (RMSE)
calculate_rmse(pb.pred, pb.field)
```

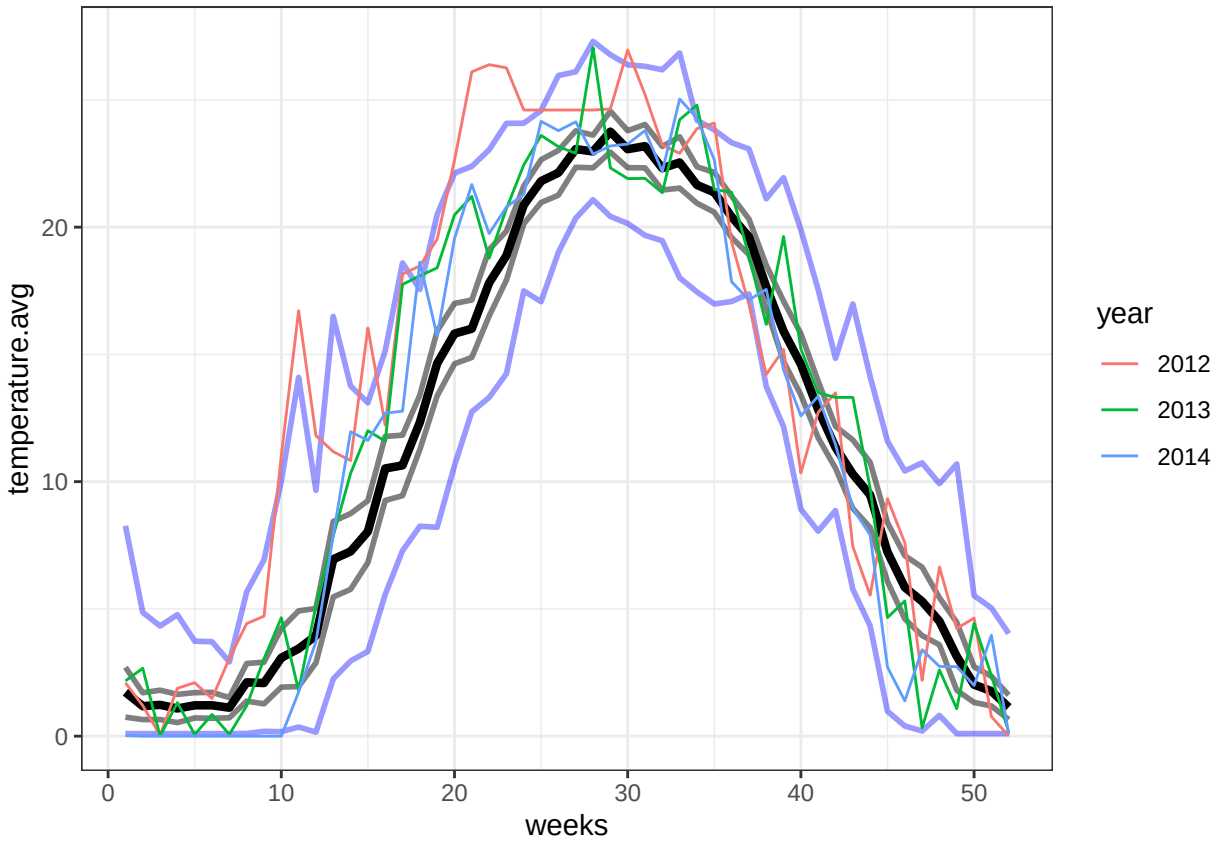
```
##     2011     2012
## 3.342312 5.440663
```

Vermilion River

```
# observed values
vermilion.field <- WT %>% filter(river == "vermilion")

# predicted values
vermilion.pred <- read.csv("water temperature clean/vermilion_model.csv")

# Plotting
plot_temp(vermilion.pred, vermilion.field)
```




```
# Calculate the Root Mean Square Error (RMSE)
calculate_rmse(vermilion.pred, vermilion.field)
```

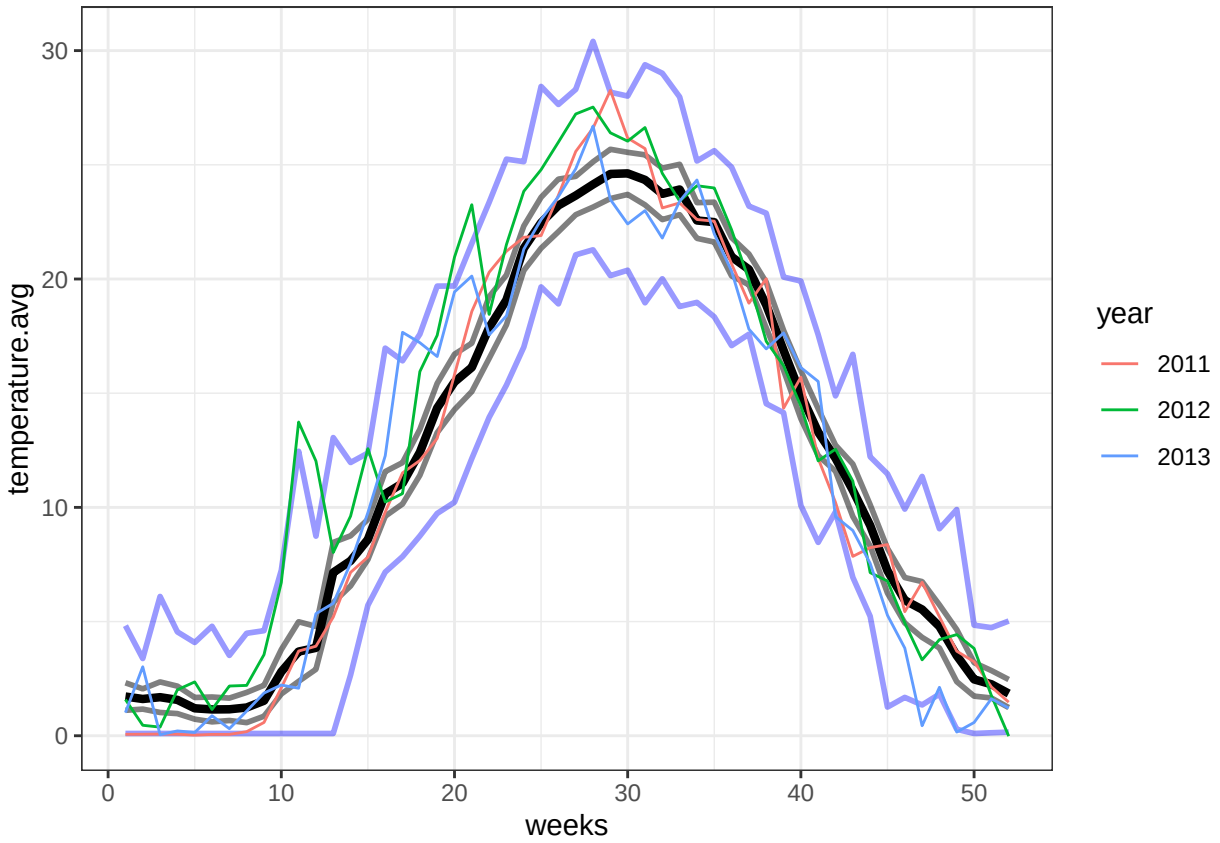
```
##     2012     2013     2014
## 4.334364 2.452943 2.294527
```

Genesee River

```
# observed values
genesee.field <- WT %>% filter(river == "genesee")

# predicted values
genesee.pred <- read.csv("water temperature clean/genesee_model.csv")

# Plotting
plot_temp(genesee.pred, genesee.field)
```




```
# Calculate the Root Mean Square Error (RMSE)
calculate_rmse(genesee.pred, genesee.field)
```

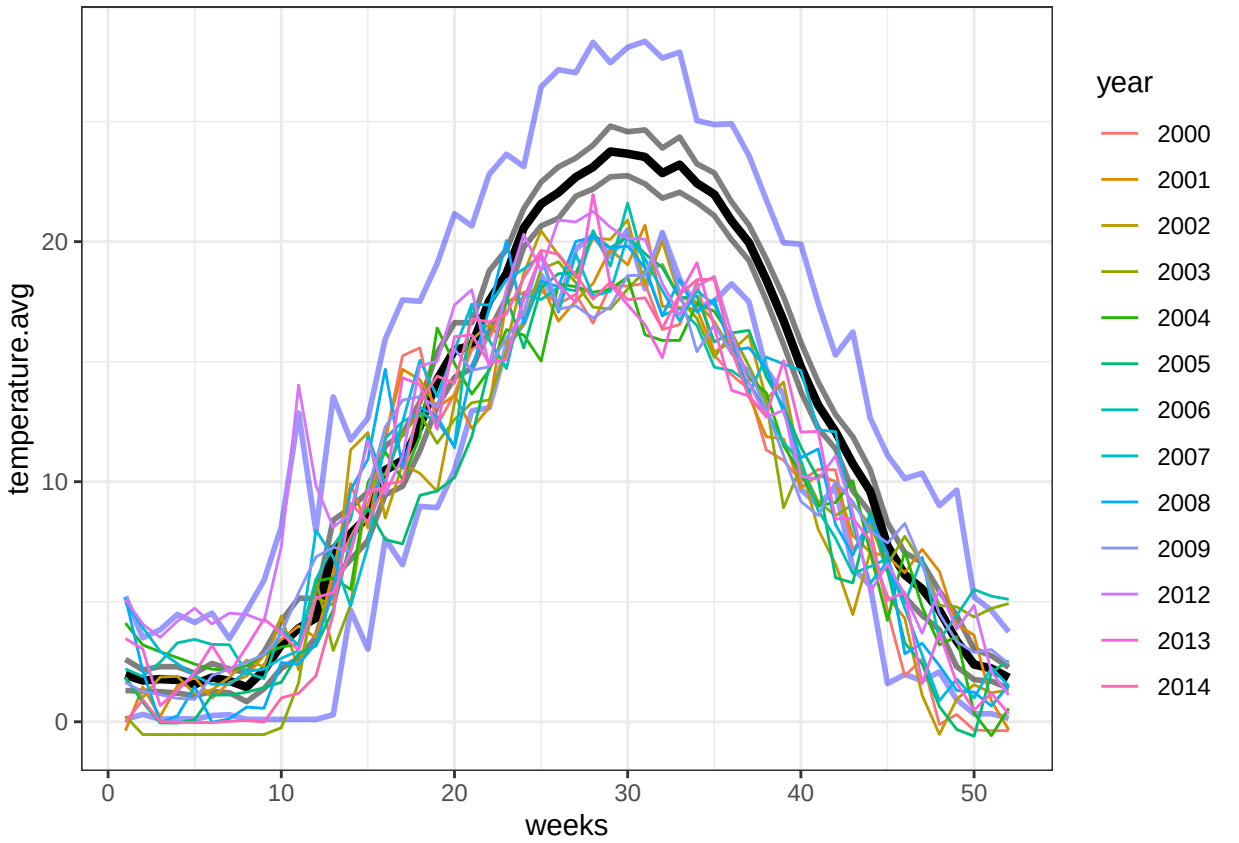
```
##     2011     2012     2013
## 1.373830 2.799377 2.124465
```

Big Creek River

```
# observed values
big.creek.field <- WT %>% filter(river == "big creek")

# predicted values
big.creek.pred <- read.csv("water temperature clean/bigcreek_model.csv")

# Plotting
plot_temp(big.creek.pred, big.creek.field)
```




```
# Calculate the Root Mean Square Error (RMSE)
calculate_rmse(big.creek.pred, big.creek.field)
```

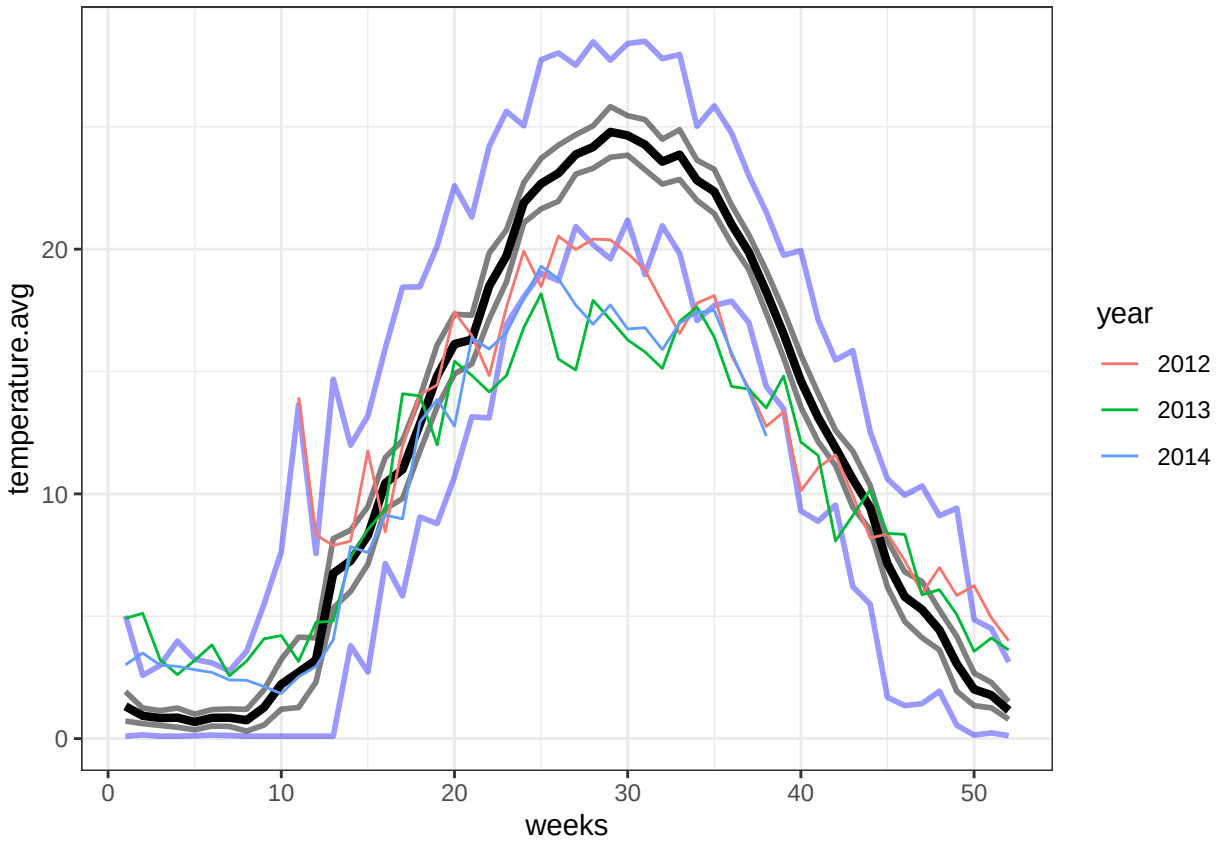
```
##     2001     2002     2003     2004     2005     2006     2007     2008
## 3.269360 3.153105 3.559391 3.458986 3.259173 3.377480 2.869060 2.946294
##     2009     2012     2013
## 3.233086 3.268681 3.268633
```

Big Otter River

```
# observed values
big.otter.field <- WT %>% filter(river == "big otter")

# predicted values
big.otter.pred <- read.csv("water temperature clean/bigotter_model.csv")

# Plotting
plot_temp(big.otter.pred, big.otter.field)
```




```
# Calculate the Root Mean Square Error (RMSE)
calculate_rmse(big.otter.pred, big.otter.field)
```

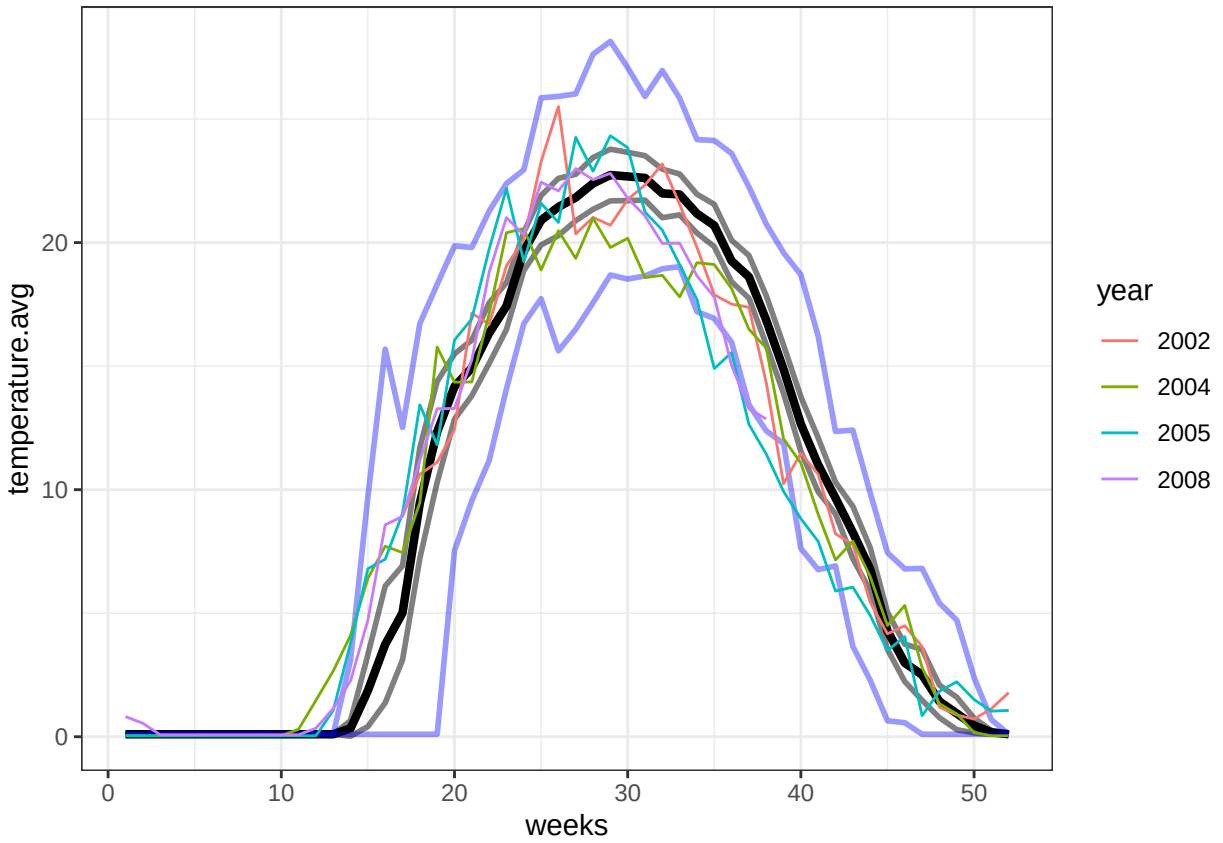
```
##     2013
## 4.168162
```

Still River

```
# observed values
still.field <- WT %>% filter(river == "still")

# predicted values
still.pred <- read.csv("water temperature clean/still_model.csv")

# Plotting
plot_temp(still.pred, still.field)
```




```
# Calculate the Root Mean Square Error (RMSE)
calculate_rmse(still.pred, still.field)
```

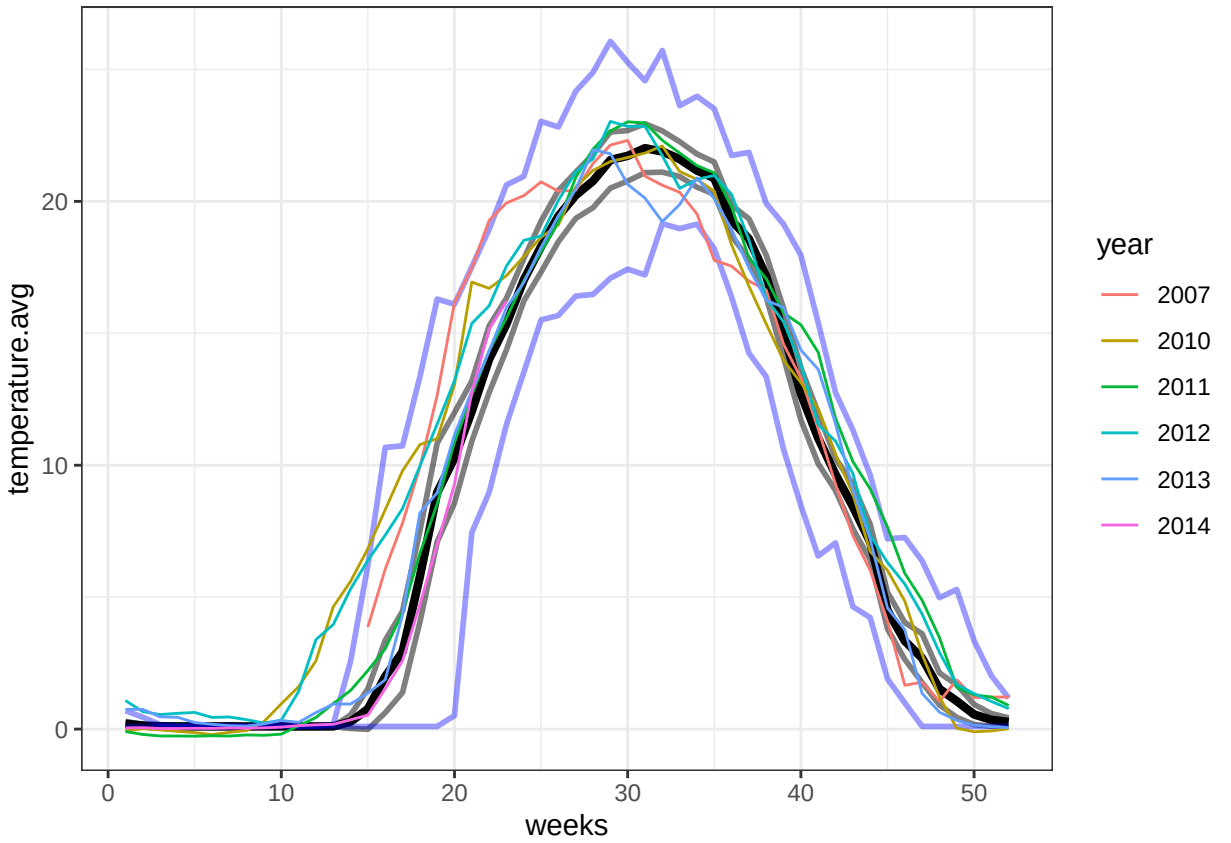
```
##     2004     2005
## 1.960587 2.597866
```

Mississagi River

```
# observed values
mississagi.field <- WT %>% filter(river == "mississagi")

# predicted values
mississagi.pred <- read.csv("water temperature clean/mississagi_model.csv")

# Plotting
plot_temp(mississagi.pred, mississagi.field)
```




```
# Calculate the Root Mean Square Error (RMSE)
calculate_rmse(mississagi.pred, mississagi.field)
```

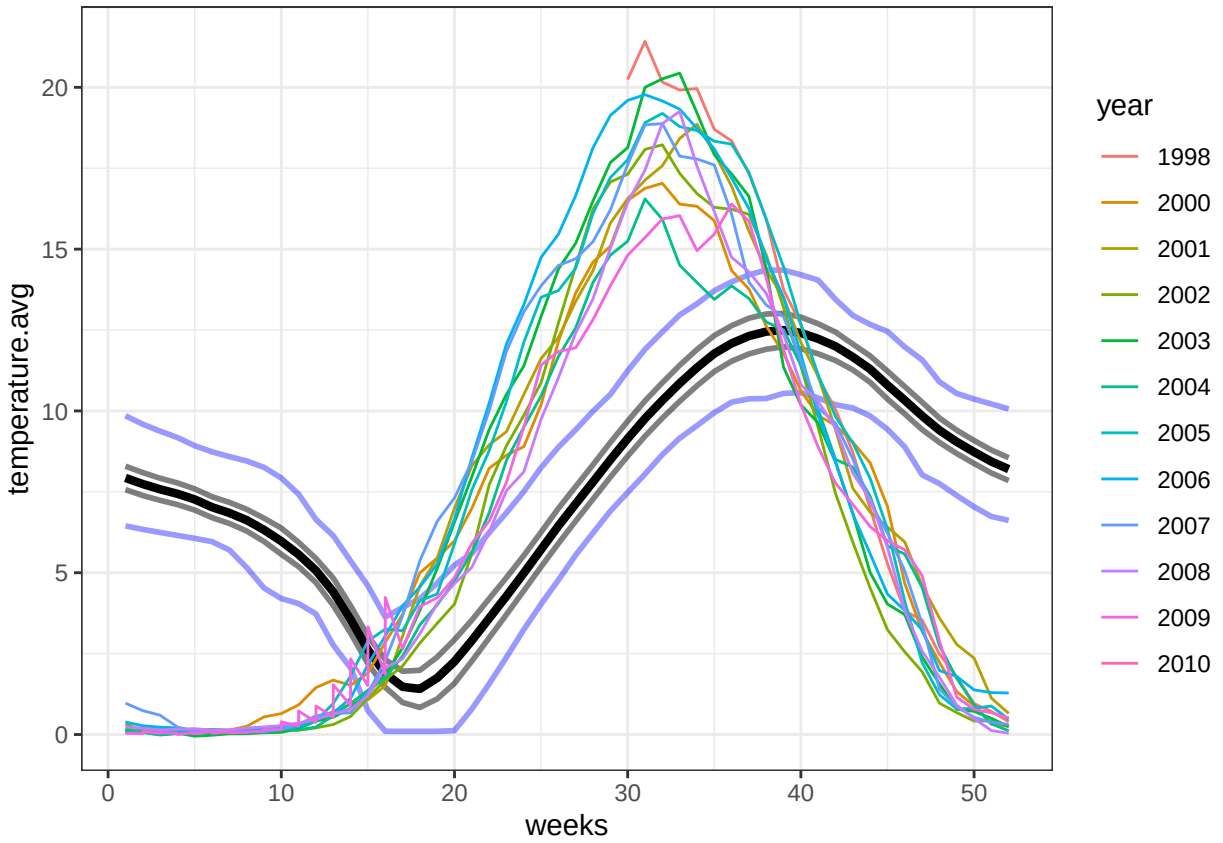
```
##      2010      2011      2012      2013
## 2.2910218 1.1949942 2.0958644 0.9778655
```

Nipigon River

```
# observed values
nipigon.field <- WT %>% filter(river == "nipigon")

# predicted values
nipigon.pred <- read.csv("water temperature clean/nipigon_model.csv")

# Plotting
plot_temp(nipigon.pred, nipigon.field)
```




```
# Calculate the Root Mean Square Error (RMSE)
calculate_rmse(nipigon.pred, nipigon.field)
```

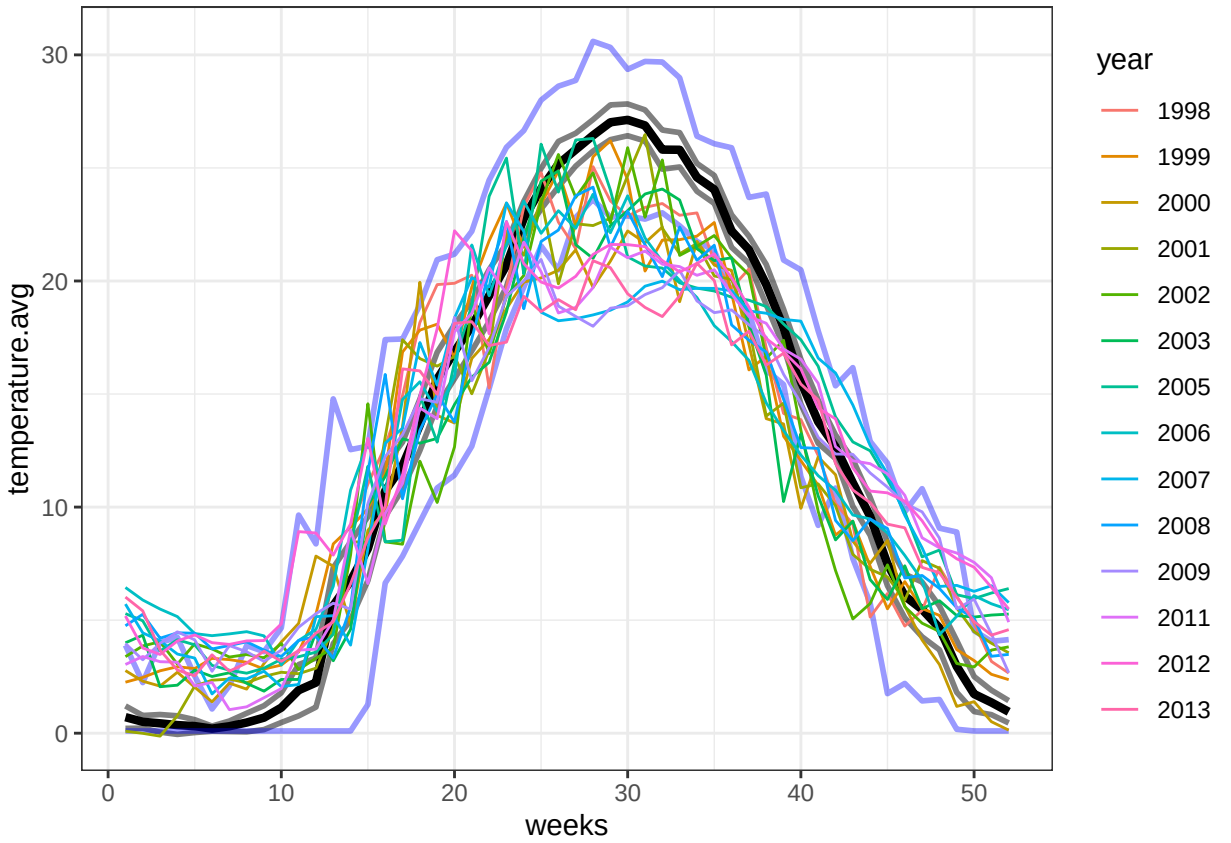
```
##     2000     2001     2002     2003     2004     2005     2006     2007
## 5.327893 5.556922 5.988086 6.460656 5.094236 6.144329 6.573985 6.081163
##     2008     2009
## 5.466469 5.179874
```

Humber River

```
# observed values
humber.field <- WT %>% filter(river == "humber")

# predicted values
humber.pred <- read.csv("water temperature clean/humber_model.csv")

# Plotting
plot_temp(humber.pred, humber.field)
```




```
# Calculate the Root Mean Square Error (RMSE)
calculate_rmse(humber.pred, humber.field)
```

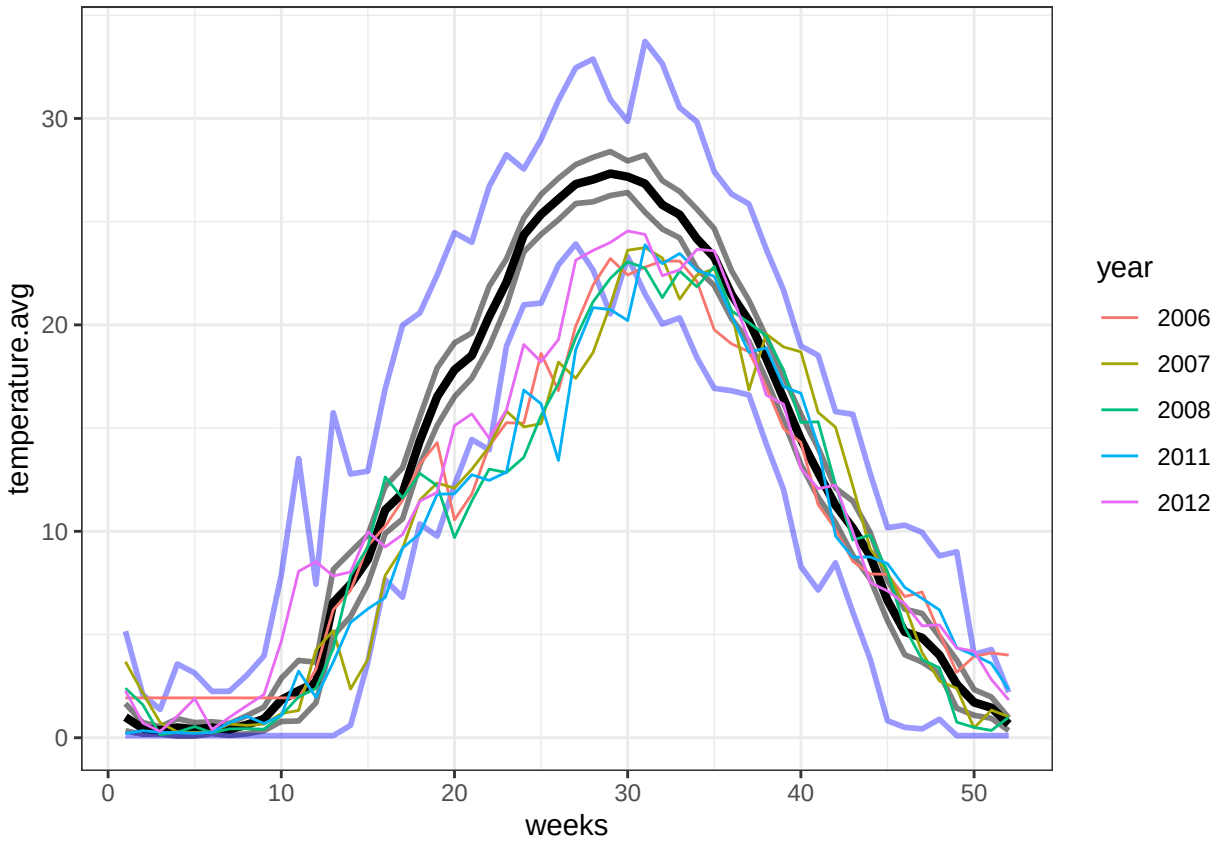
```
##     1999     2000     2001     2002     2003     2005     2006     2007
## 2.702475 3.278972 2.708040 2.910331 2.829245 3.286195 3.589397 3.979819
##     2008     2009     2011     2012     2013
## 3.109536 3.887906 3.367572 3.852328 3.746177
```

Port Dover

```
# observed values
portdover.field <- WT %>% filter(river == "portdover")

# predicted values
portdover.pred <- read.csv("water temperature clean/portdover_model.csv")

# Plotting
plot_temp(portdover.pred, portdover.field)
```




```
# Calculate the Root Mean Square Error (RMSE)
calculate_rmse(portdover.pred, portdover.field)
```

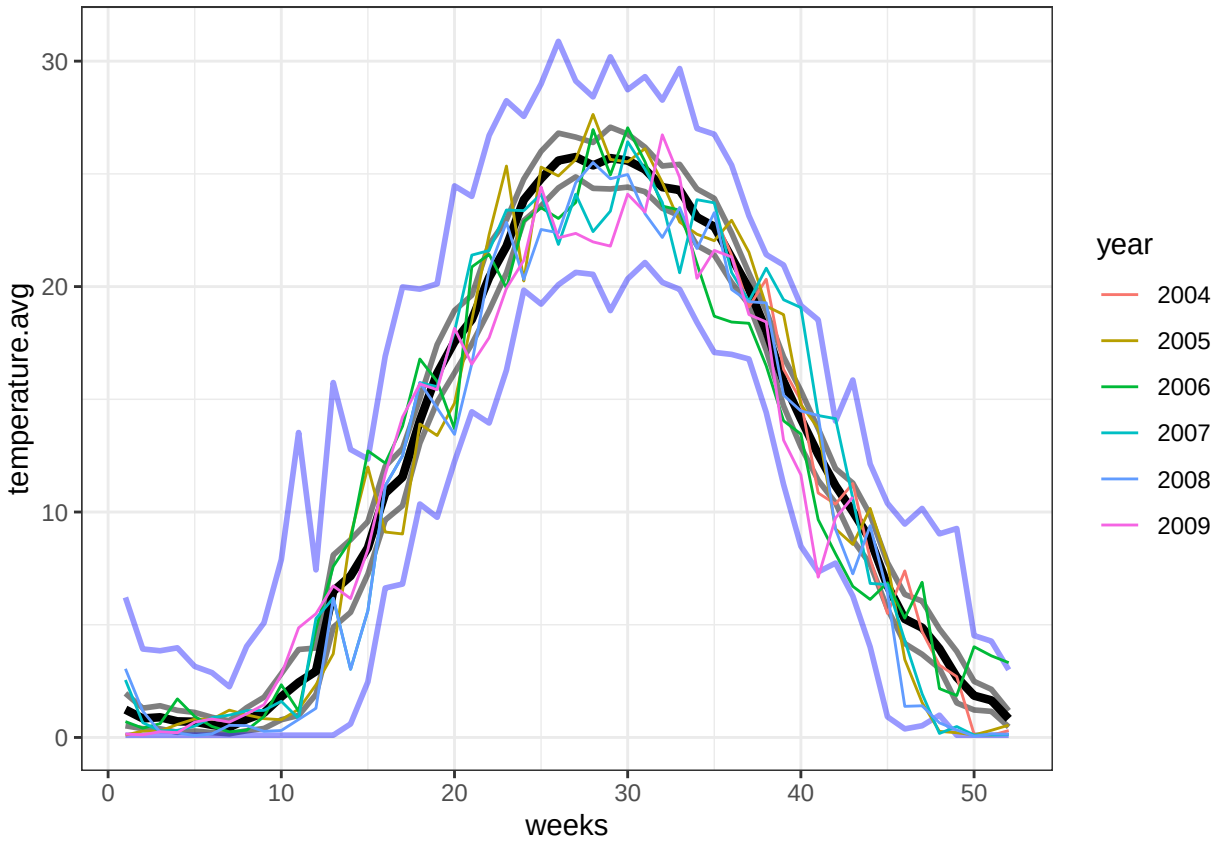
```
##     2006     2007     2008     2011     2012
## 3.494553 3.975524 3.886233 4.093340 2.883770
```

Long Point (Inner Bay)

```
# observed values
lp.field <- WT %>% filter(river == "longpoint")

# predicted values
lp.pred <- read.csv("water temperature clean/lp_model.csv")

# Plotting
plot_temp(lp.pred, lp.field)
```




```
# Calculate the Root Mean Square Error (RMSE)
calculate_rmse(lp.pred, lp.field)
```

```
##     2005     2006     2007     2008
## 1.739366 1.879522 1.944289 1.843360
```