Maladaptive plastic responses of flowering time to geothermal heating (Cerastium 2)

Analyses meteorological data

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Read data

Data preparation

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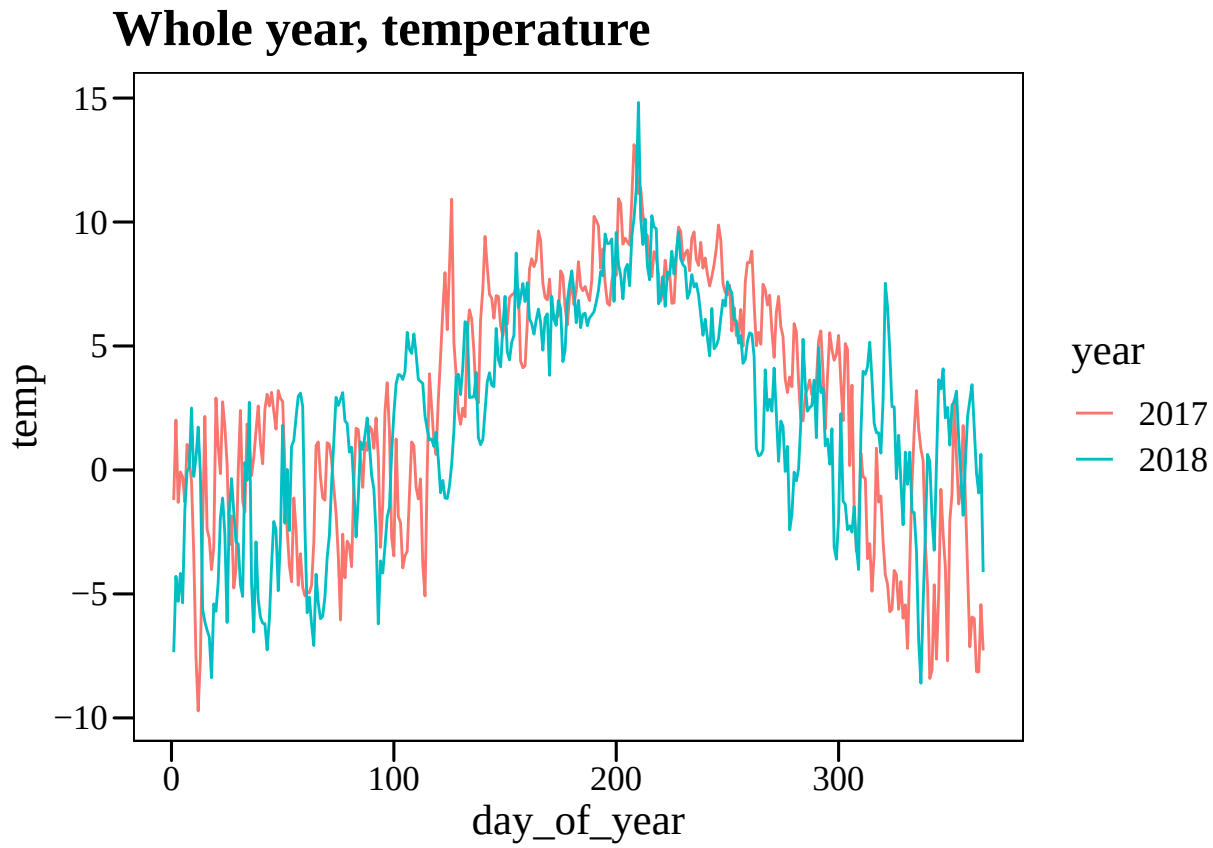
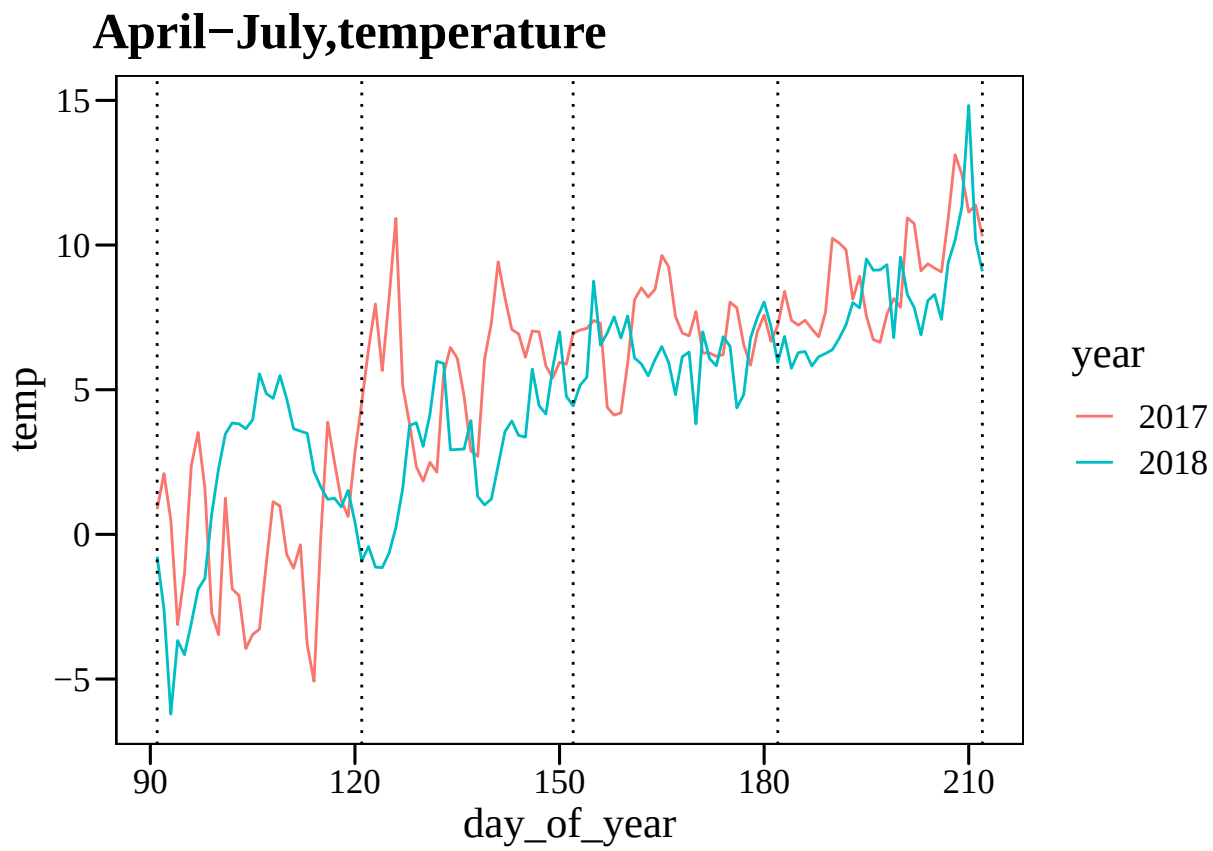
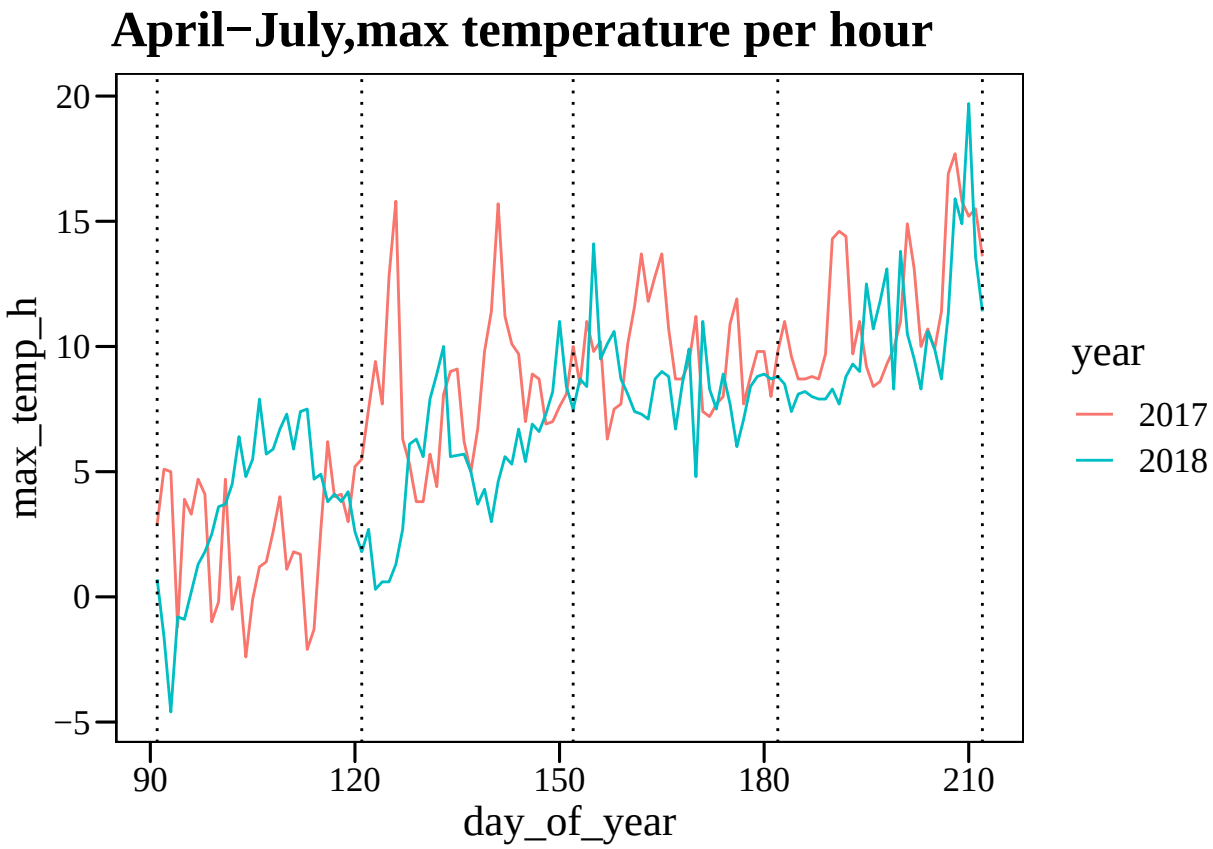
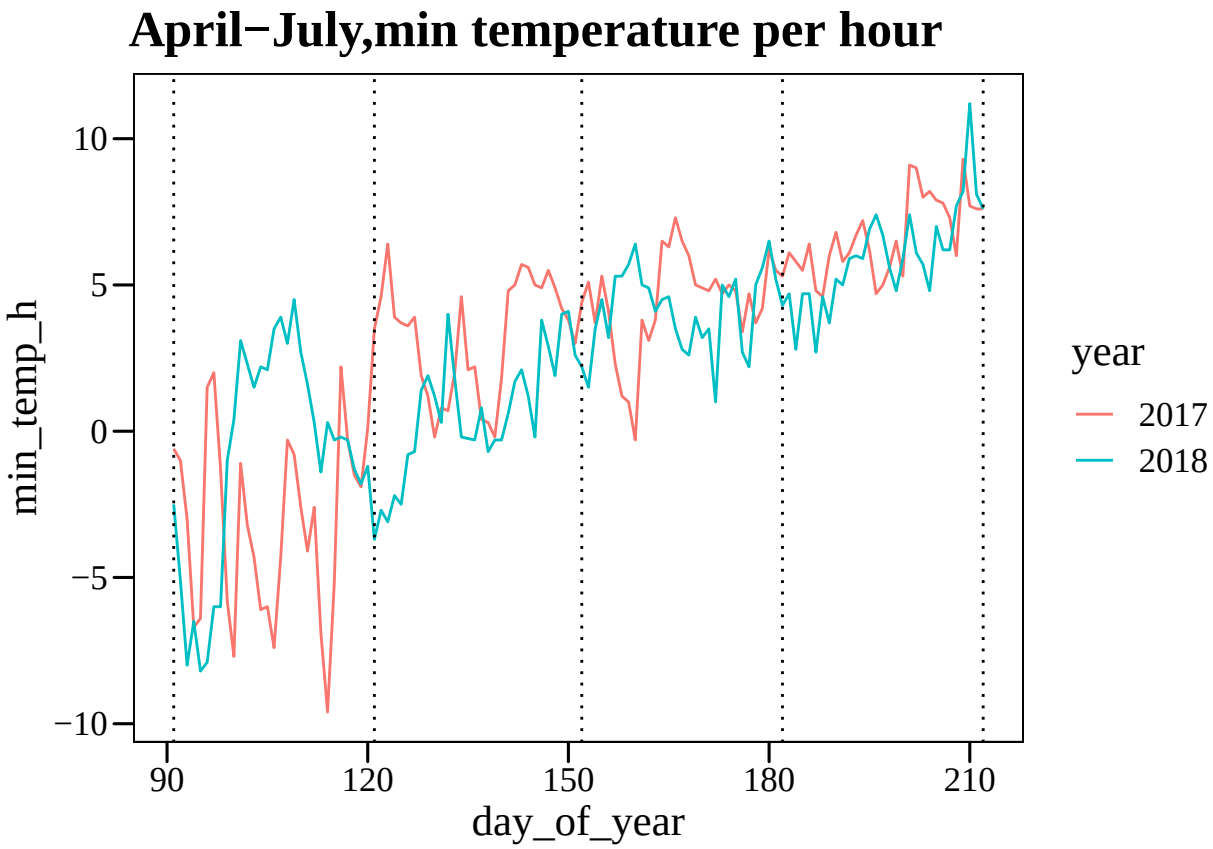



April−July,temperature
15
10
5
0
−5
temp
90
120
150
180
210
day_of_year
year
2017
2018


April−July,max temperature per hour
max_temp_h
20
15
10
5
0
−5
90
120
150
180
210
day_of_year
year
2017
2018



Compare montly temperatures

Observations	60
Dependent variable	temp
Type	OLS linear regression

F(1,58)	6.355
R^2	0.099
Adj. R^2	0.083

	Est.	S.E.	t val.	p
(Intercept)	-0.408	0.516	-0.791	0.432
year2018	1.841	0.730	2.521	0.014

Standard errors: OLS

Observations	61
Dependent variable	temp
Type	OLS linear regression

```
## $year
```

F(1,59)	25.165
R^2	0.299
Adj. R^2	0.287

	Est.	S.E.	t val.	p
(Intercept)	5.744	0.402	14.291	0.000
year2018	-2.875	0.573	-5.017	0.000

Standard errors: OLS

Observations	60
Dependent variable	temp
Type	OLS linear regression

F(1,58)	5.860
R^2	0.092
Adj. R^2	0.076

	Est.	S.E.	t val.	p
(Intercept)	7.004	0.224	31.233	0.000
year2018	-0.768	0.317	-2.421	0.019

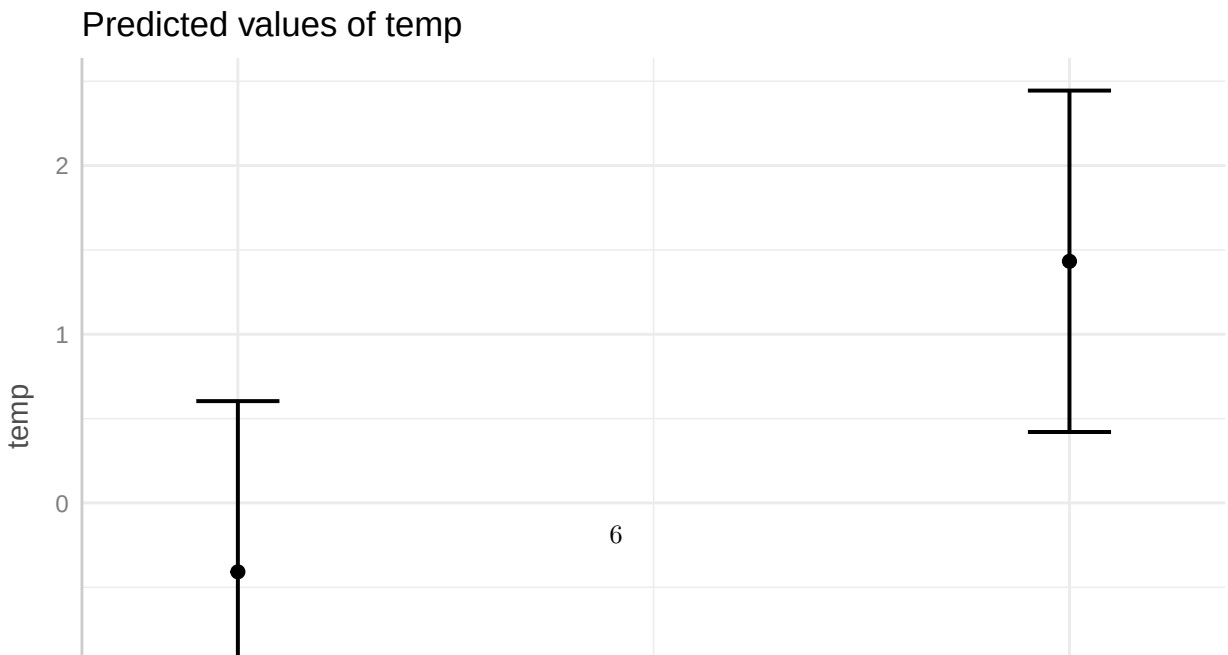
Standard errors: OLS

Observations	62
Dependent variable	temp
Type	OLS linear regression

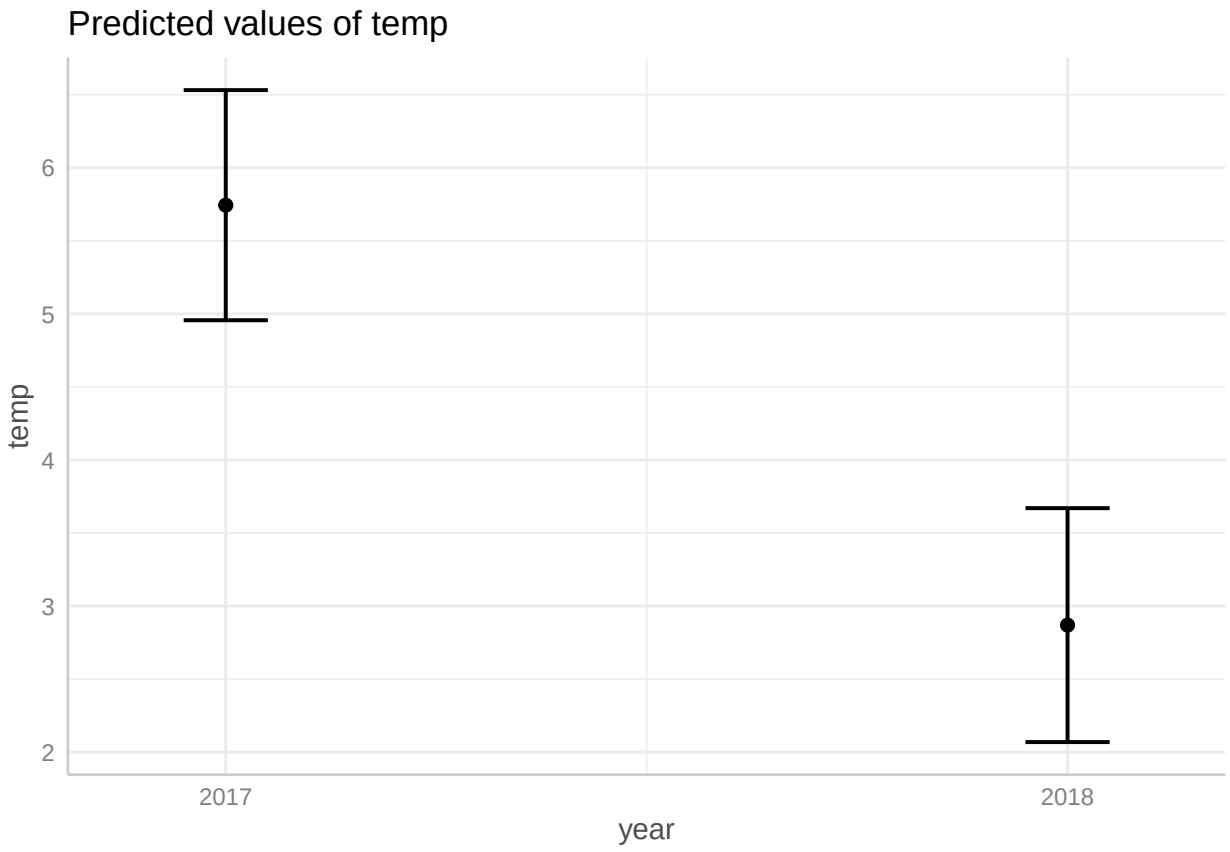
F(1,60)	3.584
R^2	0.056
Adj. R^2	0.041

	Est.	S.E.	t val.	p
(Intercept)	8.990	0.335	26.821	0.000
year2018	-0.897	0.474	-1.893	0.063

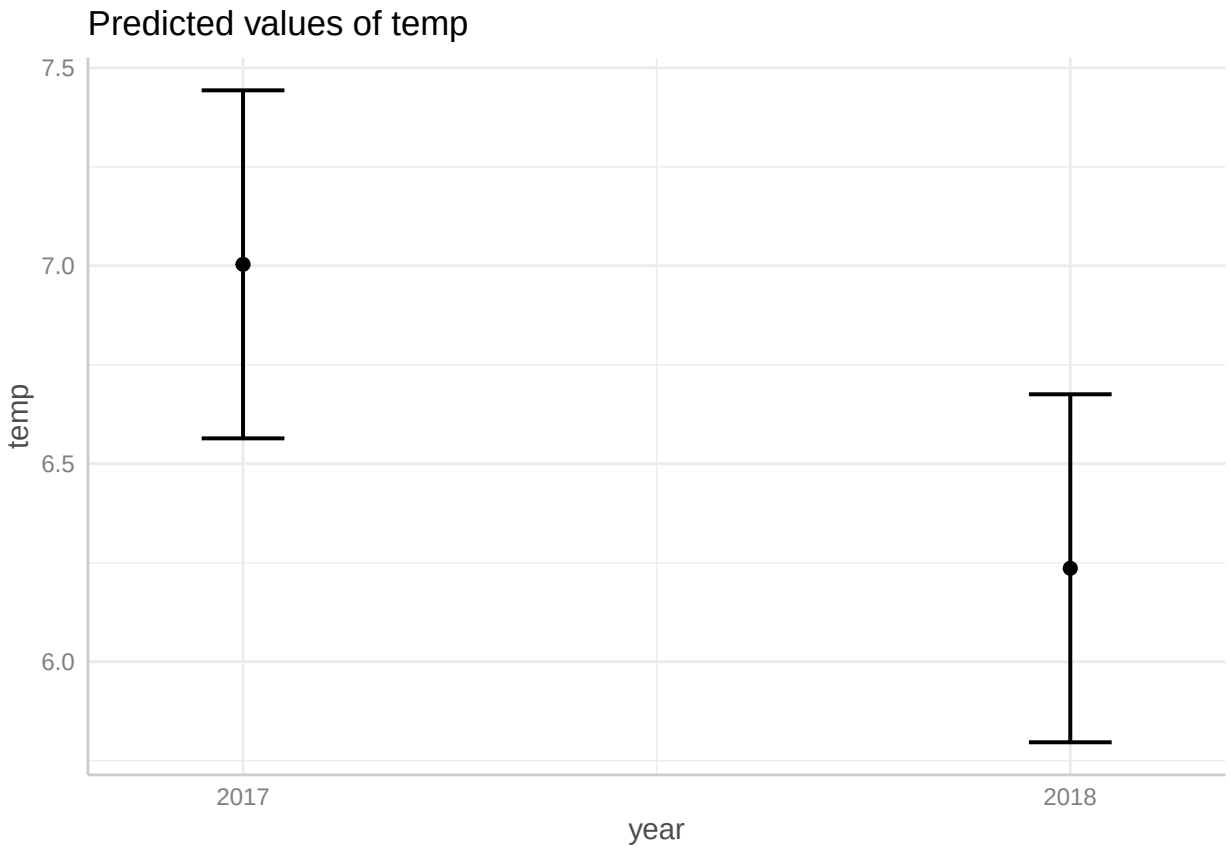
Standard errors: OLS



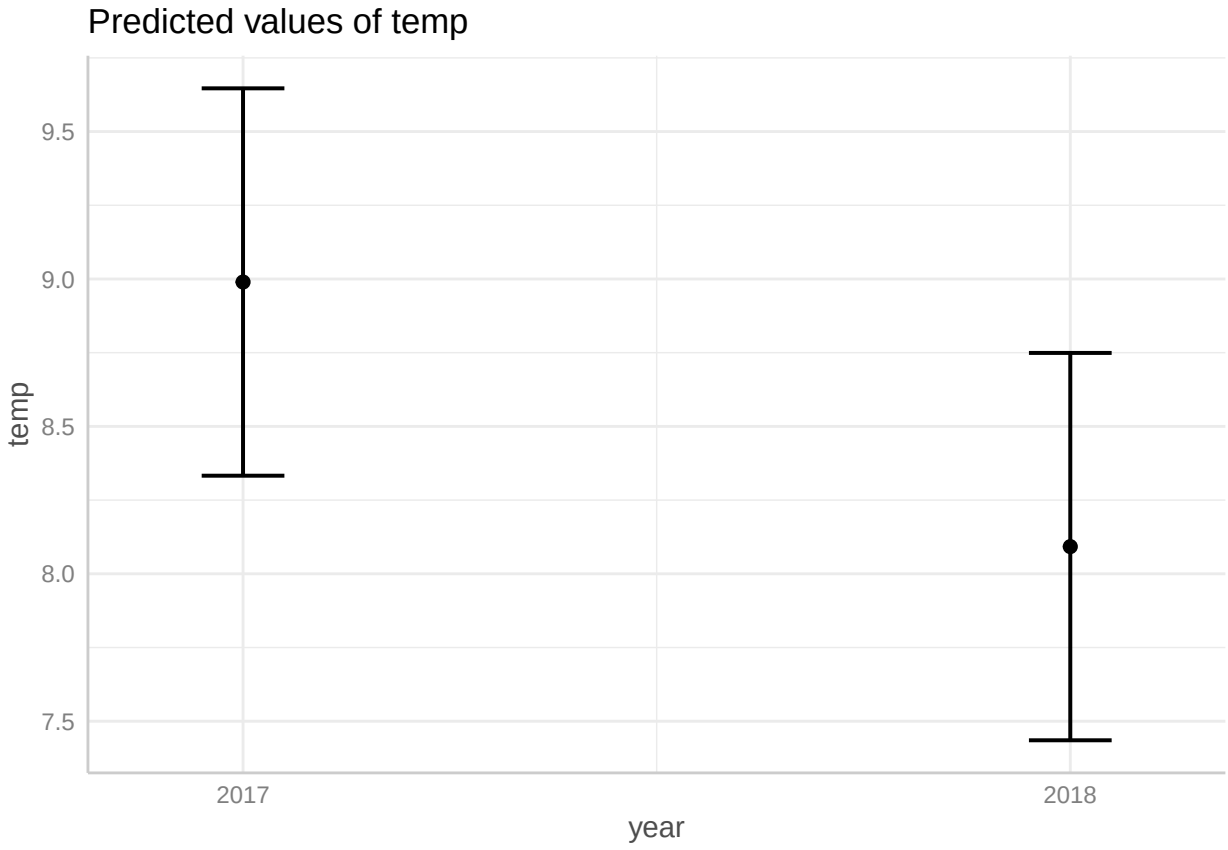
```
## $year
```




```
## $year
```




```
## $year
```



Observations	60
Dependent variable	max_temp_h
Type	OLS linear regression

F(1,58)	4.424
R^2	0.071
Adj. R^2	0.055

	Est.	S.E.	t val.	p
(Intercept)	2.157	0.502	4.296	0.000
year2018	1.493	0.710	2.103	0.040

Standard errors: OLS

Observations	61
Dependent variable	max_temp_h
Type	OLS linear regression

F(1,59)	15.685
R^2	0.210
Adj. R^2	0.197

	Est.	S.E.	t val.	p
(Intercept)	8.200	0.519	15.805	0.000
year2018	-2.930	0.740	-3.960	0.000

Standard errors: OLS

Observations	60
Dependent variable	max_temp_h
Type	OLS linear regression

F(1,58)	6.293
R^2	0.098
Adj. R^2	0.082

	Est.	S.E.	t val.	p
(Intercept)	9.687	0.333	29.123	0.000
year2018	-1.180	0.470	-2.509	0.015

Standard errors: OLS

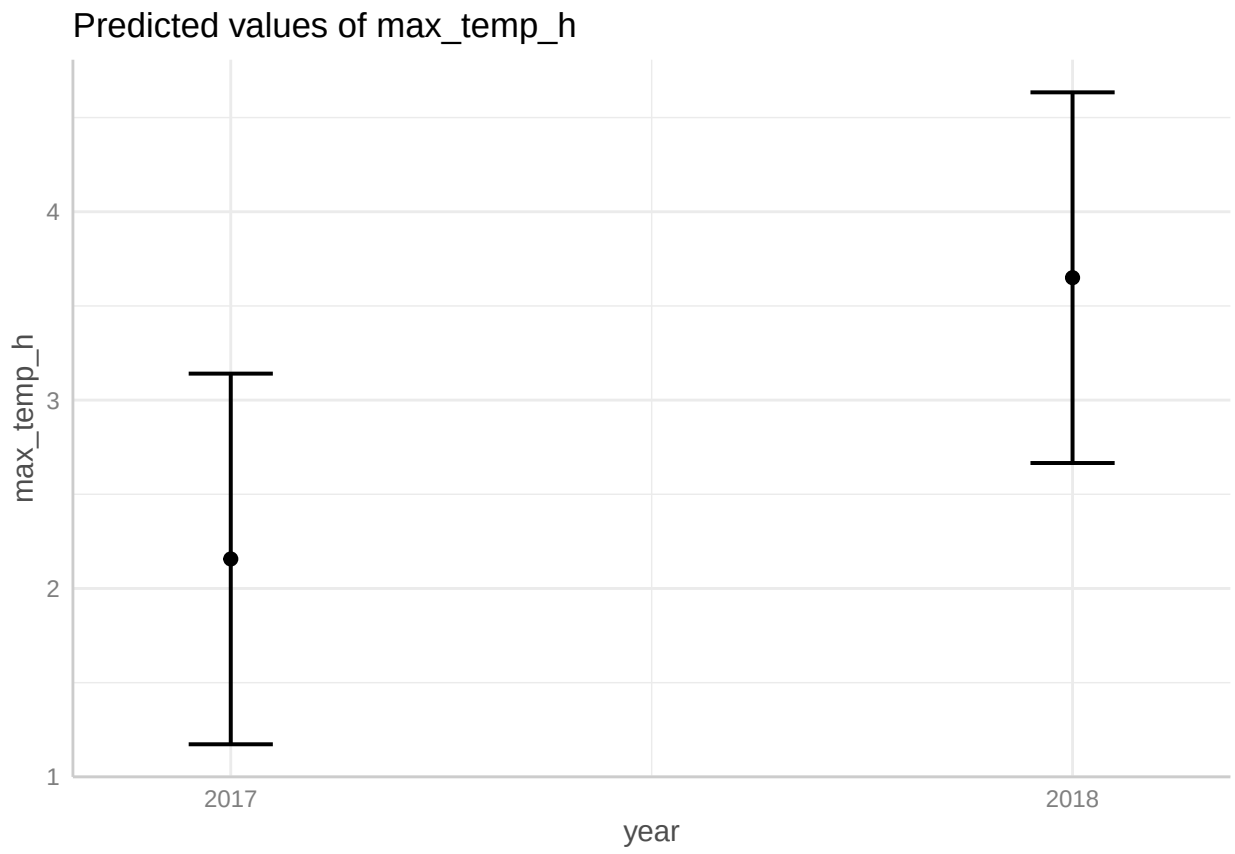
Observations	62
Dependent variable	max_temp_h
Type	OLS linear regression

F(1,60)	2.815
R^2	0.045
Adj. R^2	0.029

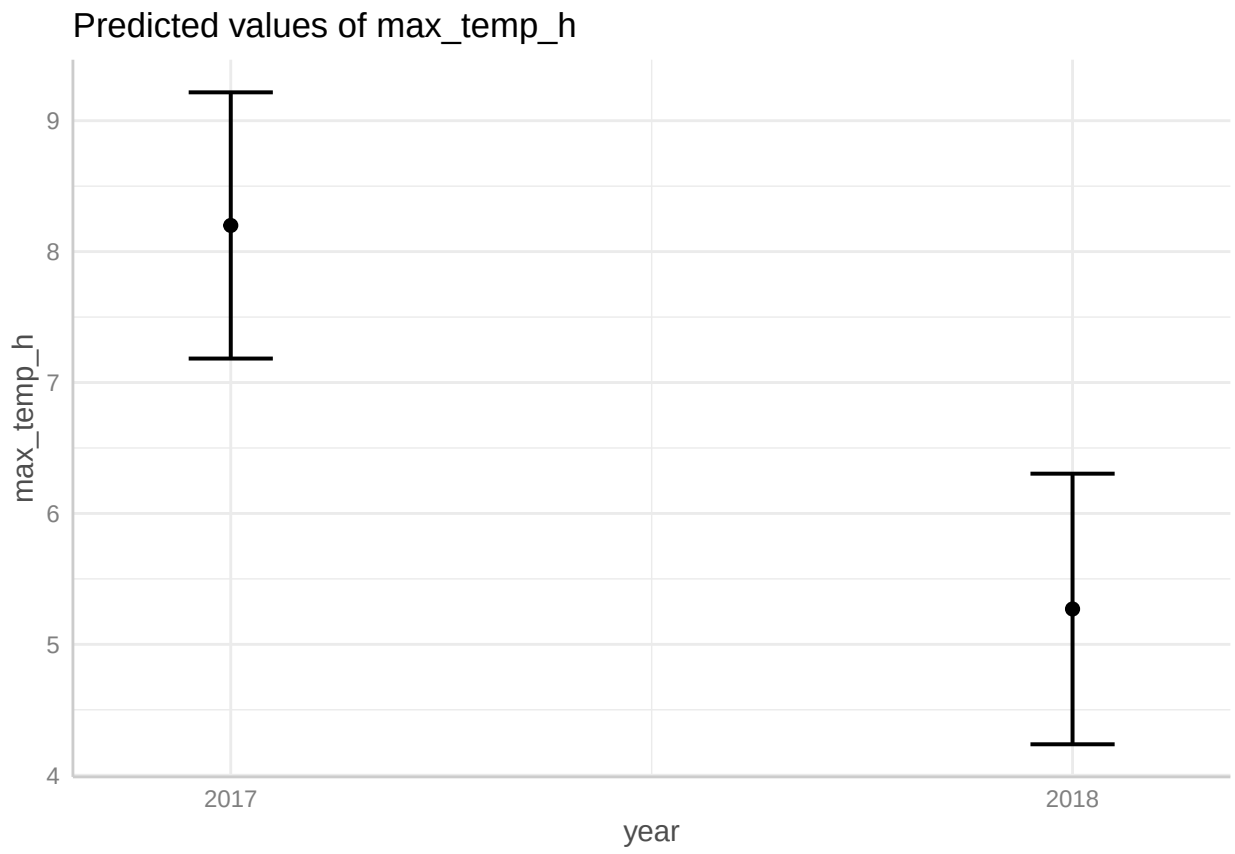
	Est.	S.E.	t val.	p
(Intercept)	11.616	0.513	22.664	0.000
year2018	-1.216	0.725	-1.678	0.099

Standard errors: OLS

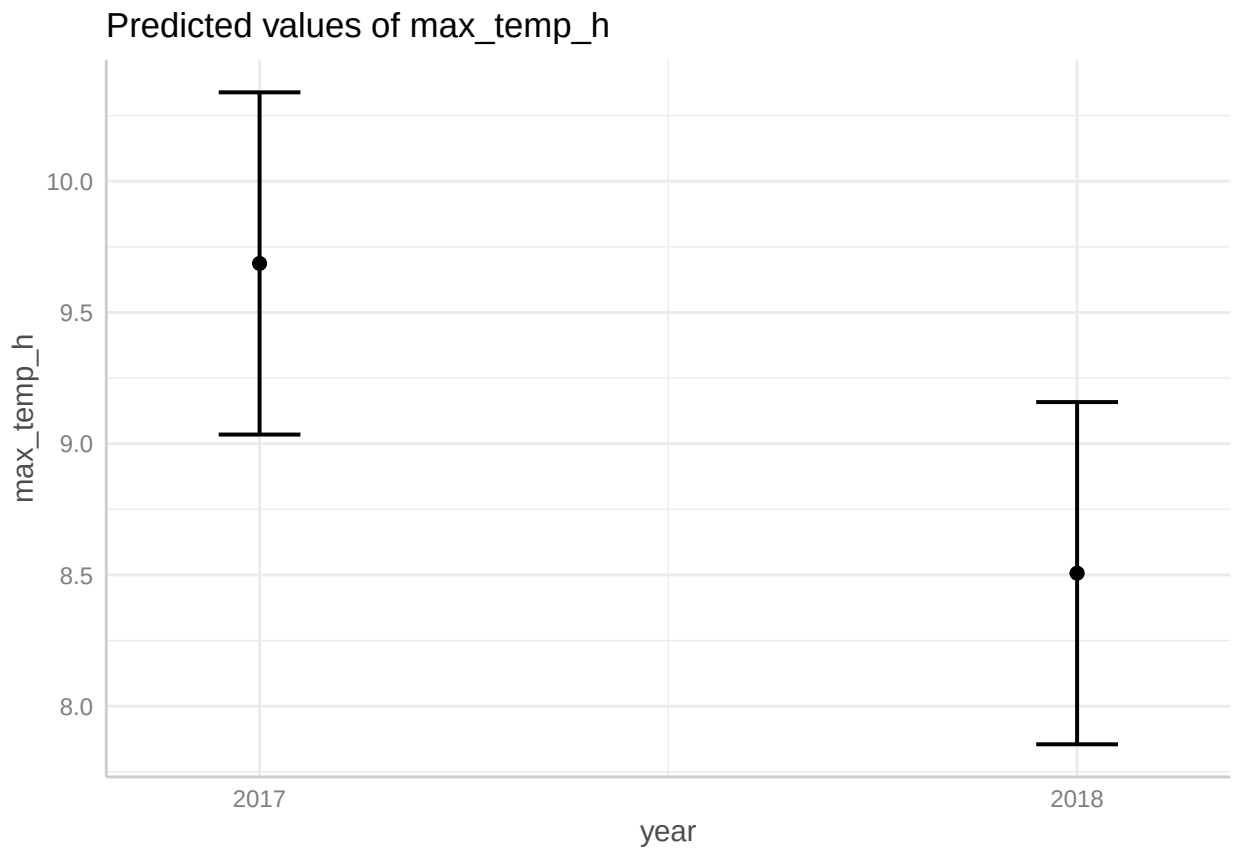
```
## $year
```




```
## $year
```


Predicted values of max_temp_h
max_temp_h
9
8
7
6
5
4
2017
2018
year

```
## $year
```


Predicted values of max_temp_h
10.0
9.5
9.0
8.5
8.0
max_temp_h
2017
2018
year

```
## $year
```

Observations	60
Dependent variable	min_temp_h
Type	OLS linear regression

F(1,58)	6.481
R^2	0.101
Adj. R^2	0.085

	Est.	S.E.	t val.	p
(Intercept)	-3.163	0.635	-4.981	0.000
year2018	2.287	0.898	2.546	0.014

Standard errors: OLS

Observations	61
Dependent variable	min_temp_h
Type	OLS linear regression

F(1,59)	24.577
R^2	0.294
Adj. R^2	0.282

	Est.	S.E.	t val.	p
(Intercept)	3.213	0.367	8.760	0.000
year2018	-2.593	0.523	-4.958	0.000

Standard errors: OLS

Observations	60
Dependent variable	min_temp_h
Type	OLS linear regression

F(1,58)	0.554
R^2	0.009
Adj. R^2	-0.008

	Est.	S.E.	t val.	p
(Intercept)	4.407	0.285	15.461	0.000
year2018	-0.300	0.403	-0.744	0.460

Standard errors: OLS

Observations	62
Dependent variable	min_temp_h
Type	OLS linear regression

F(1,60)	3.365
R^2	0.053
Adj. R^2	0.037

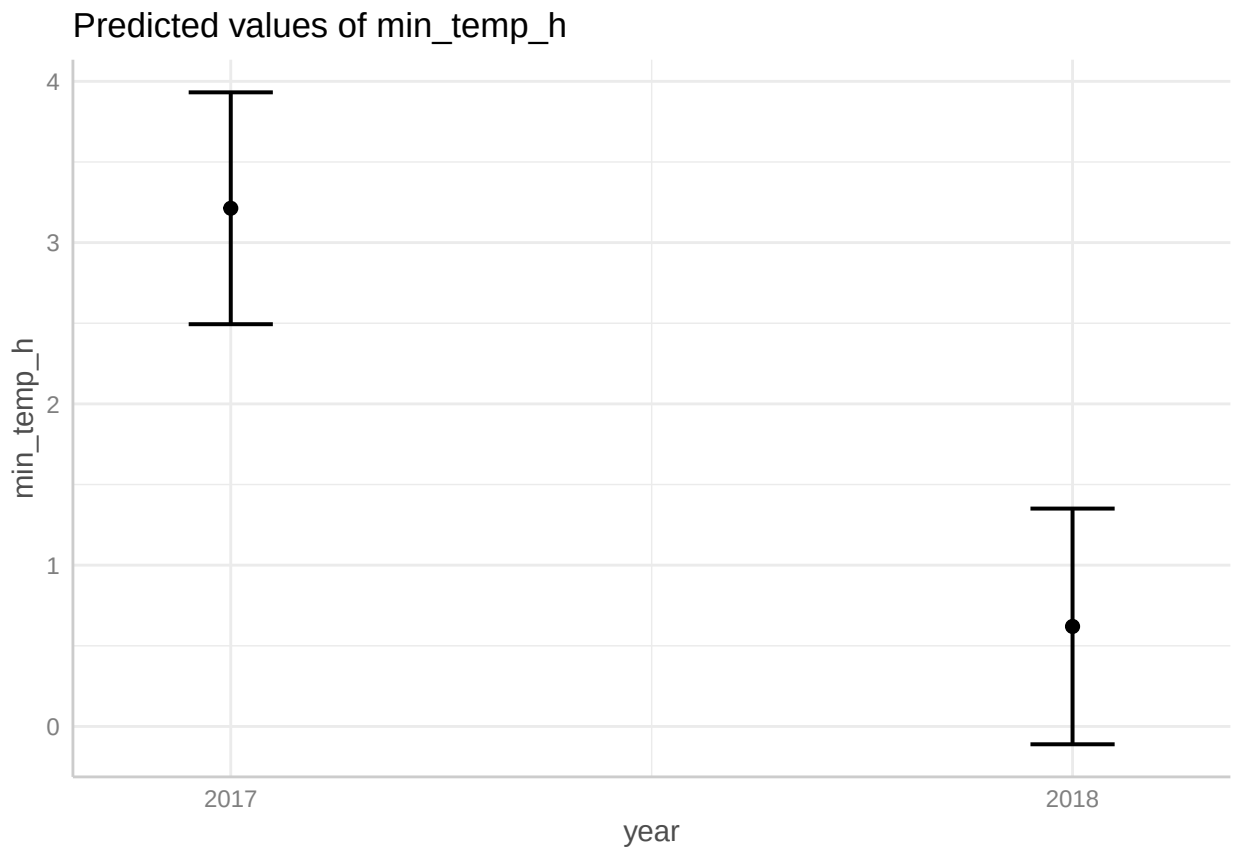
	Est.	S.E.	t val.	p
(Intercept)	6.642	0.276	24.061	0.000
year2018	-0.716	0.390	-1.834	0.072

Standard errors: OLS

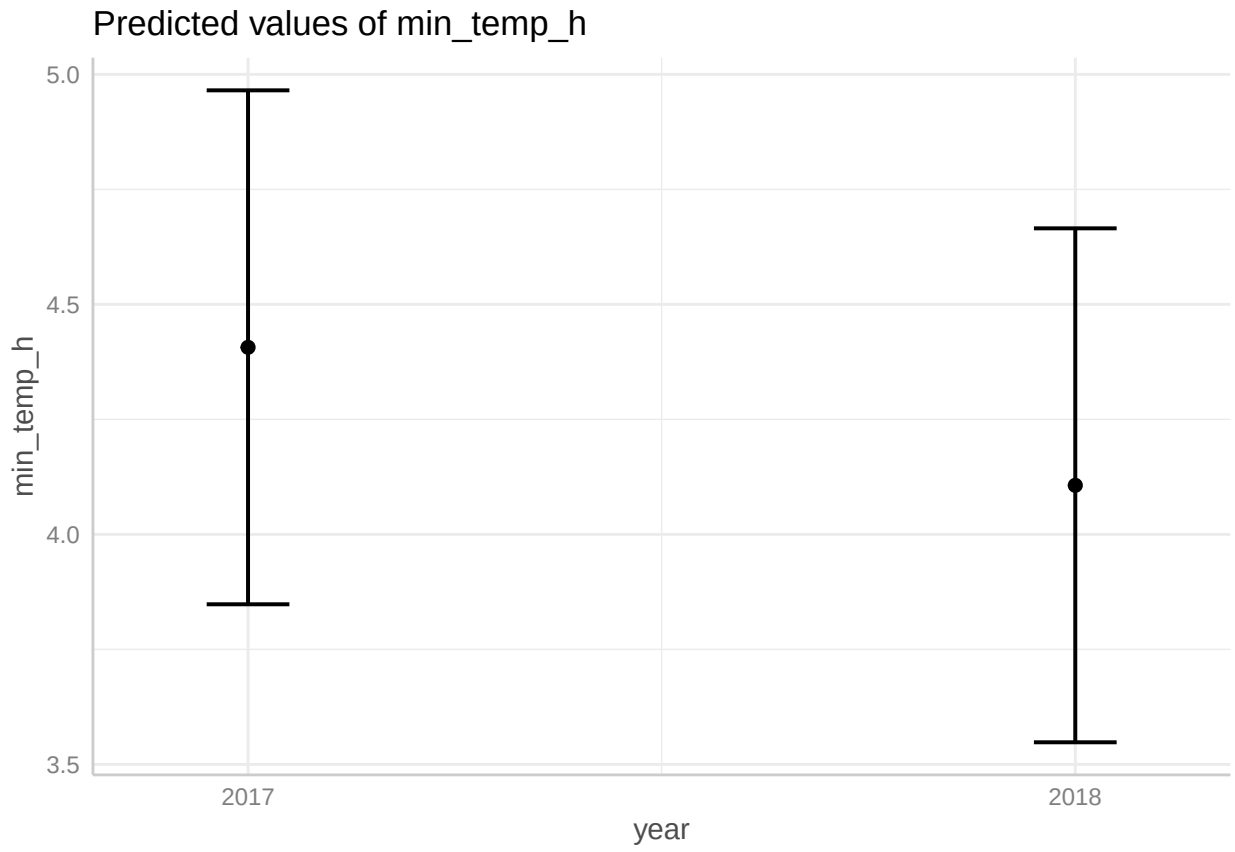
```
## $year
```


Predicted values of min_temp_h
0
−1
−2
−3
−4
min_temp_h
2017
2018
year

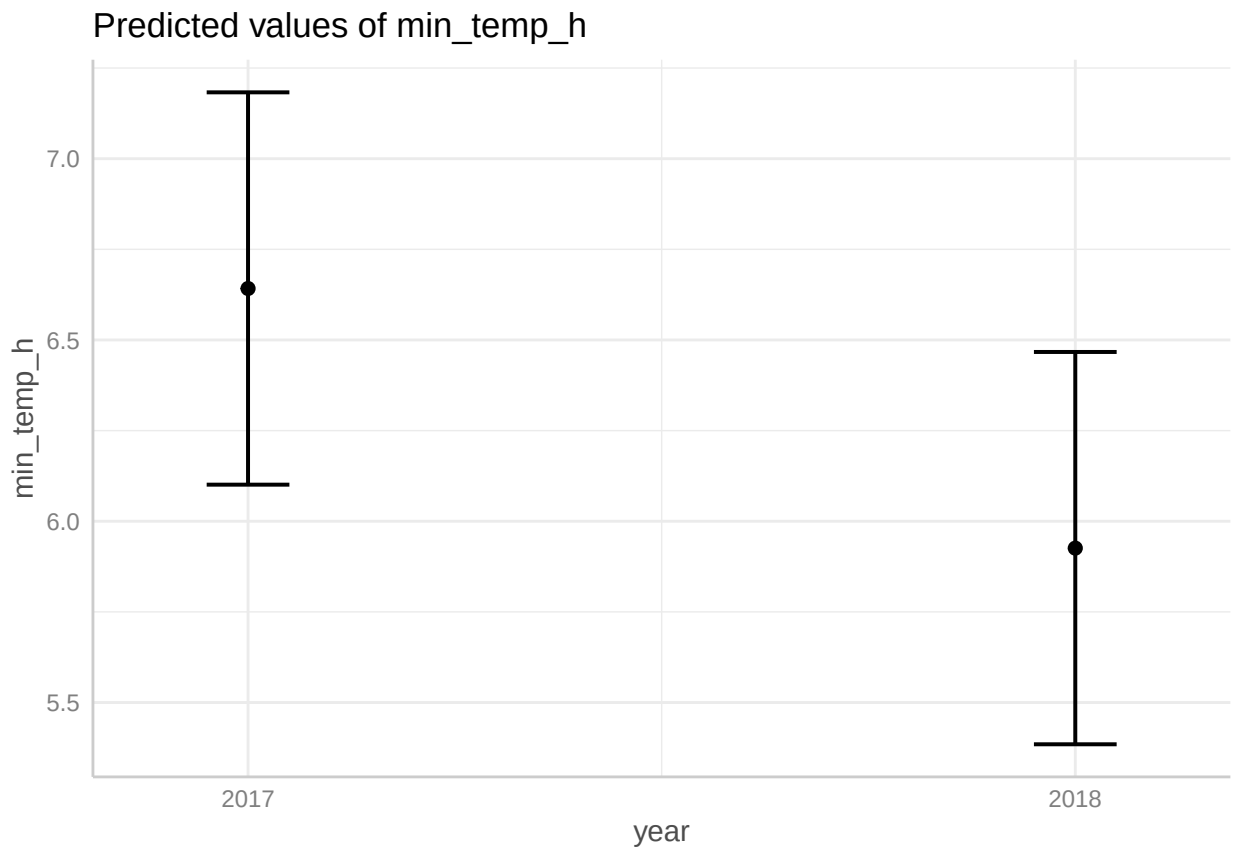
```
## $year
```


Predicted values of min_temp_h
min_temp_h
4
3
2
1
0
2017
2018
year

```
## $year
```


Predicted values of min_temp_h
5.0
4.5
4.0
3.5
min_temp_h
2017
2018
year

```
## $year
```



Start, end and length of the growing season

Start of the GS

Start date of the first 5-day period with mean daily temperatures over 5°C.

```
## [1] "2018-05-15"
```

```
## # A tibble: 2 x 15
## # Groups:   year [2]
##   station date        temp max_temp_h min_temp_h humidity windspeed
##     <dbl> <date>     <dbl>      <dbl>      <dbl>    <dbl>     <dbl>
## 1   31392 2017-05-02  6.42        7.5        4.6       96     10.5
## 2   31392 2018-06-02  5.15        8.7        1.5       98      4.19
##   hi_windspeed_h hi_3sec_windspeed windir year  day_of_year month temp_over_5
##            <dbl>             <dbl>  <dbl> <fct>       <dbl> <dbl>       <dbl>
## 1           15.6              21.5     98 2017          122     5           1
## 2            6.8               9      232 2018          153     6           1
##   rolling_sum_5
##           <dbl>
## 1             5
## 2             5
```

2017: May 2 (agrees with Bryndis calculation) 2018: June 2 (does not agree with Bryndis calculation)

End of the GS

When the 10-day running mean falls below 5°C.

```
## # A tibble: 2 x 14
## # Groups:   year [2]
##   station date        temp max_temp_h min_temp_h humidity windspeed
##     <dbl> <date>     <dbl>      <dbl>      <dbl>    <dbl>     <dbl>
## 1   31392 2017-10-06  3.36        5.2        0.6      100      6.86
## 2   31392 2018-09-20  0.86        2.9       -0.5       87     11.2
##   hi_windspeed_h hi_3sec_windspeed windir year  day_of_year month
##            <dbl>             <dbl>  <dbl> <fct>       <dbl> <dbl>
## 1           12.2              16.3     59 2017          279    10
## 2           13.5              18.7    351 2018          263     9
##   rolling_mean_10
##             <dbl>
## 1            4.86
## 2            4.69
```

2017: October 6 2018: September 20

Length of the GS

```
## Time differences in days
## [1] 157 110
```

2017: 157 days 2018: 110 days (difference of 157-110=47 days longer in 2017)

Number of days with freezing temperatures

Number of days with minimum temperatures (min_temp_h) lower than 0.

After GS start

```
## # A tibble: 5 x 3
## # Groups:   year [2]
##   year  date       min_temp_h
##   <fct> <date>          <dbl>
## 1 2017  2017-05-10       -0.2
## 2 2017  2017-05-19       -0.2
## 3 2017  2017-06-09       -0.3
## 4 2018  2018-09-14       -0.3
## 5 2018  2018-09-20       -0.5
```

3 days with freezing temperatures in spring 2017 after GS start. No days with freezing temperatures in spring 2018 after GS start (2 days with freezing temperatures in autumn before GS end).

In May

```
## # A tibble: 2 x 2
##   year  count
##   <fct> <int>
## 1 2017      2
## 2 2018     13
```

In June

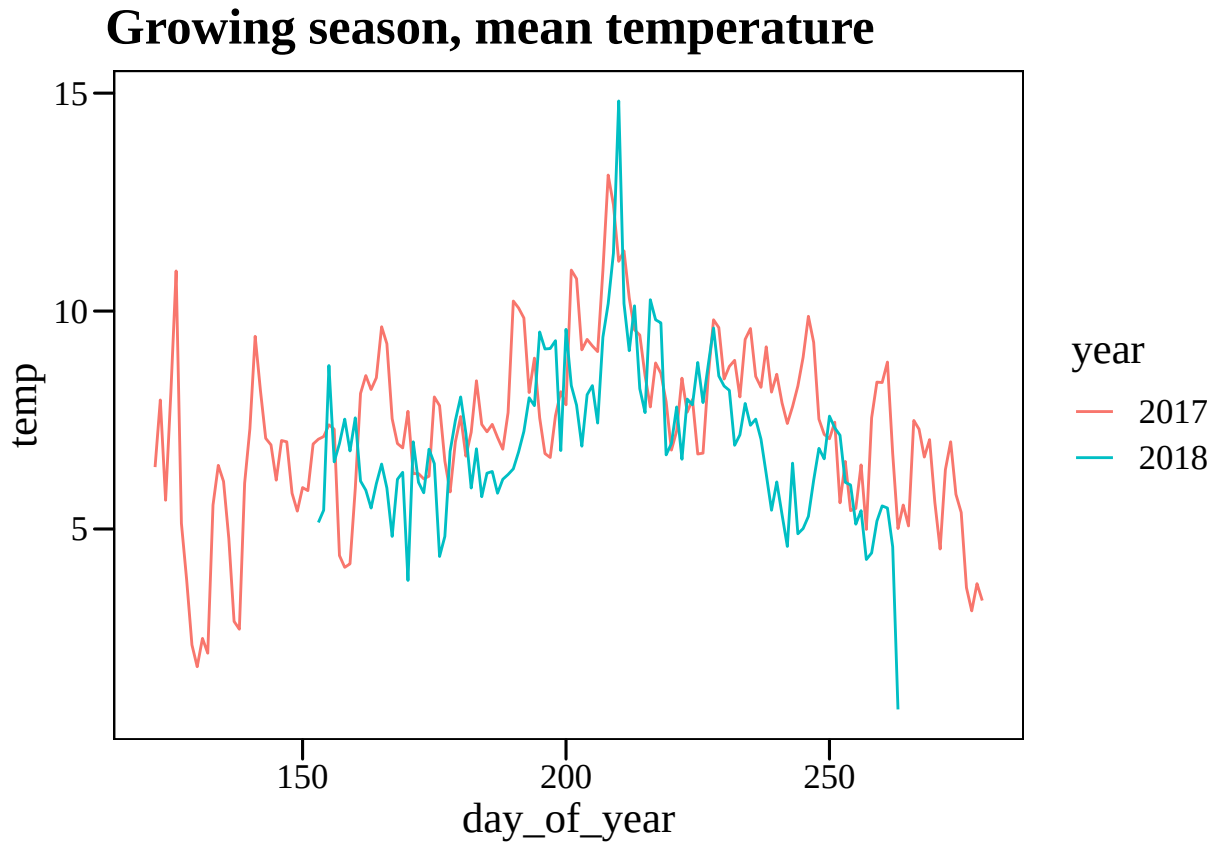
```
## # A tibble: 1 x 2
##   year  count
##   <fct> <int>
## 1 2017      1
```

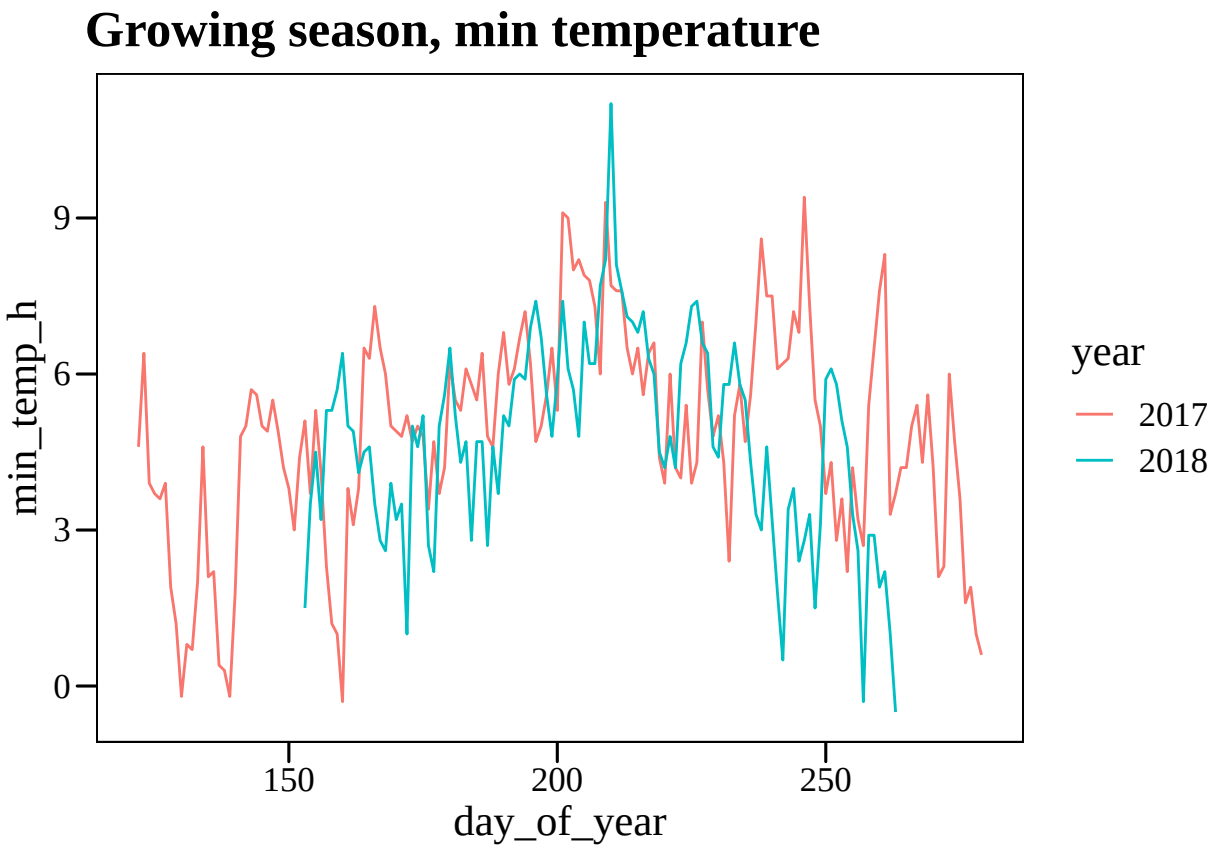
Compare GS temperatures

```
##
## Call:
## lm(formula = temp ~ year, data = .)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -6.178 -1.093 -0.073  1.137  7.782
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)   7.3030     0.1529  47.776   <2e-16 ***
## year2018     -0.2650     0.2380  -1.114    0.266
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.921 on 267 degrees of freedom
## Multiple R-squared:  0.004623,   Adjusted R-squared:  0.0008947
## F-statistic:  1.24 on 1 and 267 DF,  p-value: 0.2665
```

```
##
## Call:
## lm(formula = min_temp_h ~ year, data = .)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -5.2414 -1.1557  0.1443  1.3443  6.4586
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)   4.8557     0.1597   30.40   <2e-16 ***
## year2018     -0.1143     0.2486   -0.46    0.646
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
```

```
## Residual standard error: 2.008 on 267 degrees of freedom
## Multiple R-squared:  0.0007903,  Adjusted R-squared:  -0.002952
## F-statistic: 0.2112 on 1 and 267 DF,  p-value: 0.6462
```





No differences in GS temperatures.

Session info