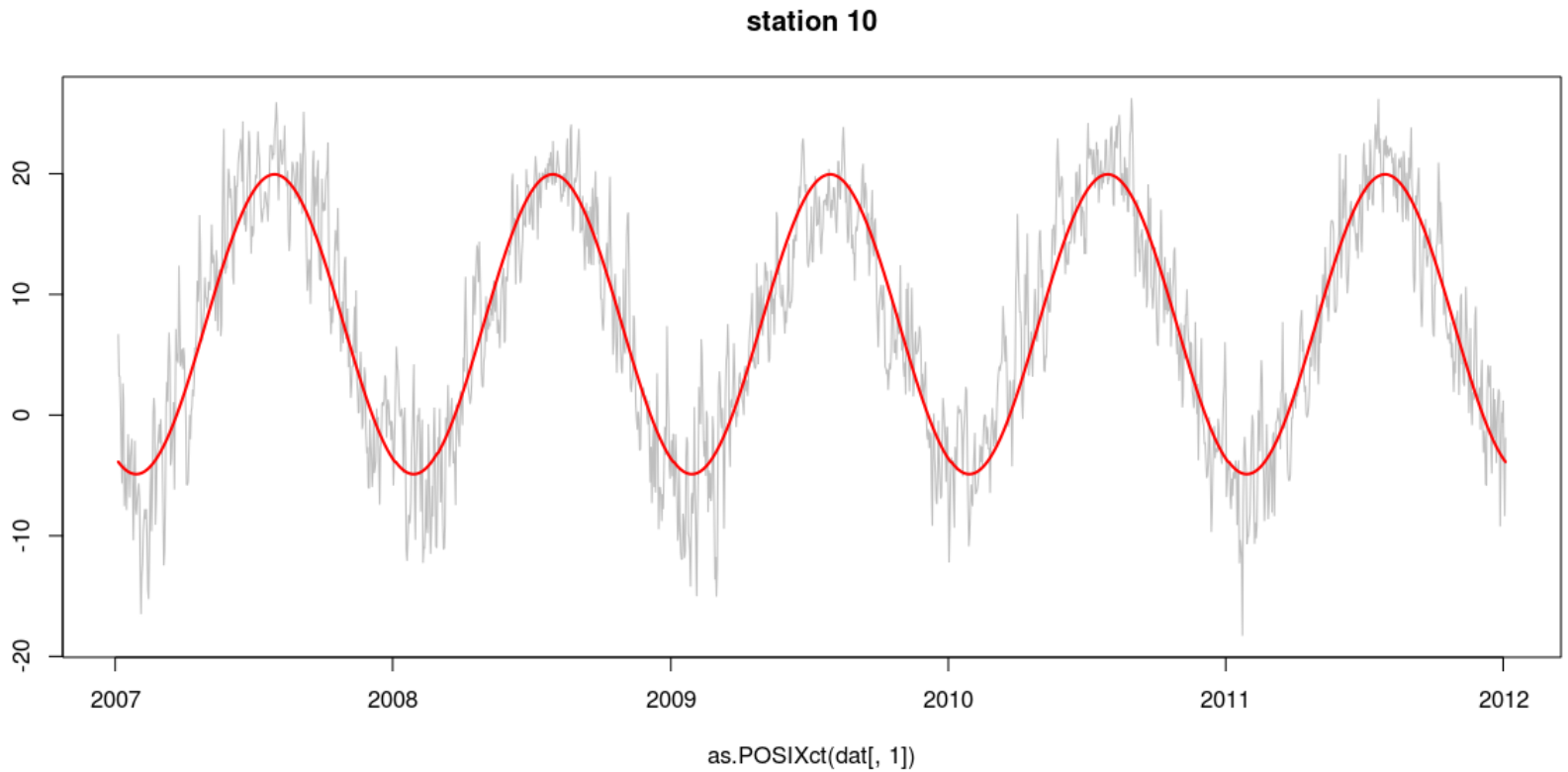
data

1. Obtained from the National Climatic Data Center (NCDC)
2. 82 weather stations
3. 2007 through 2012
4. daily mean temperature
5. held out 10 stations
6. held out 2012

preliminary models

Thought cosine function would be useful

$$Y = \beta_0 + \beta_1 x_1 + e$$



preliminary models

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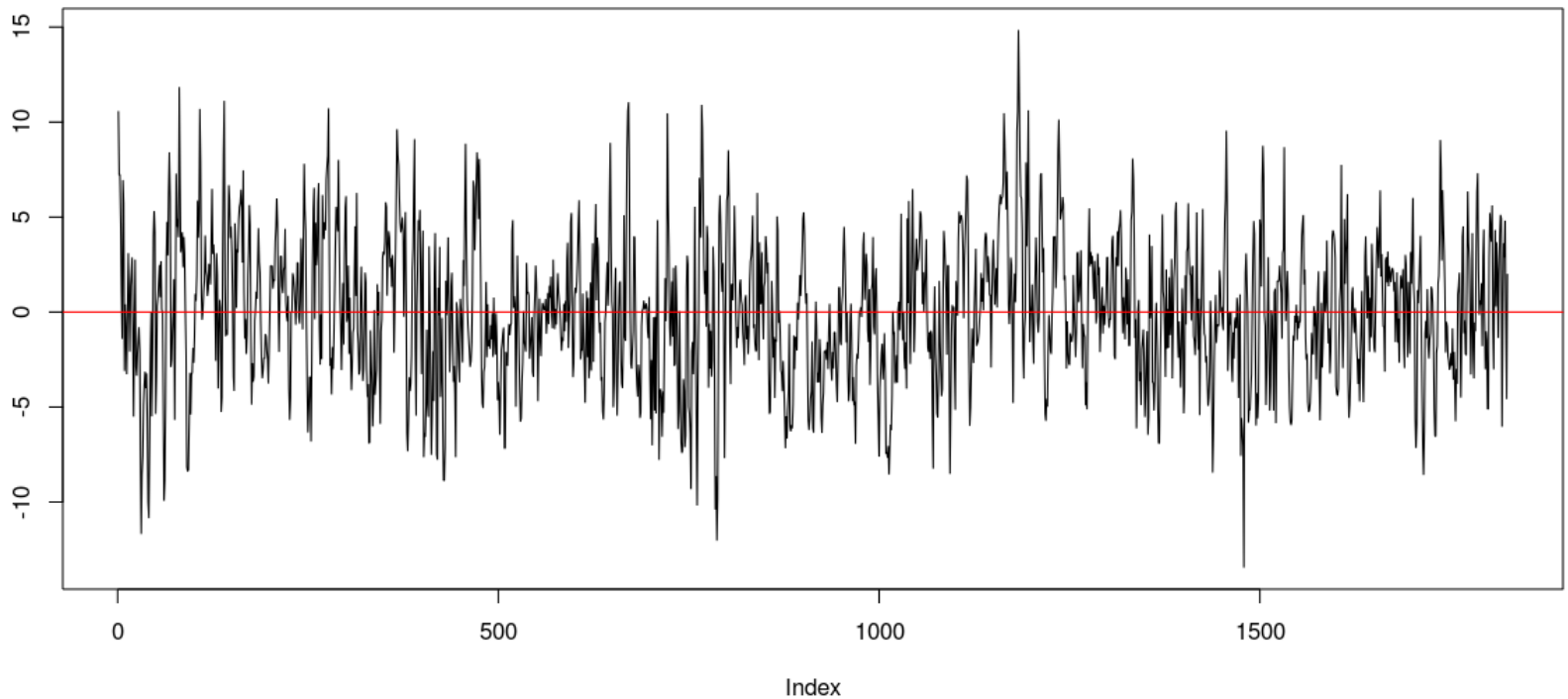
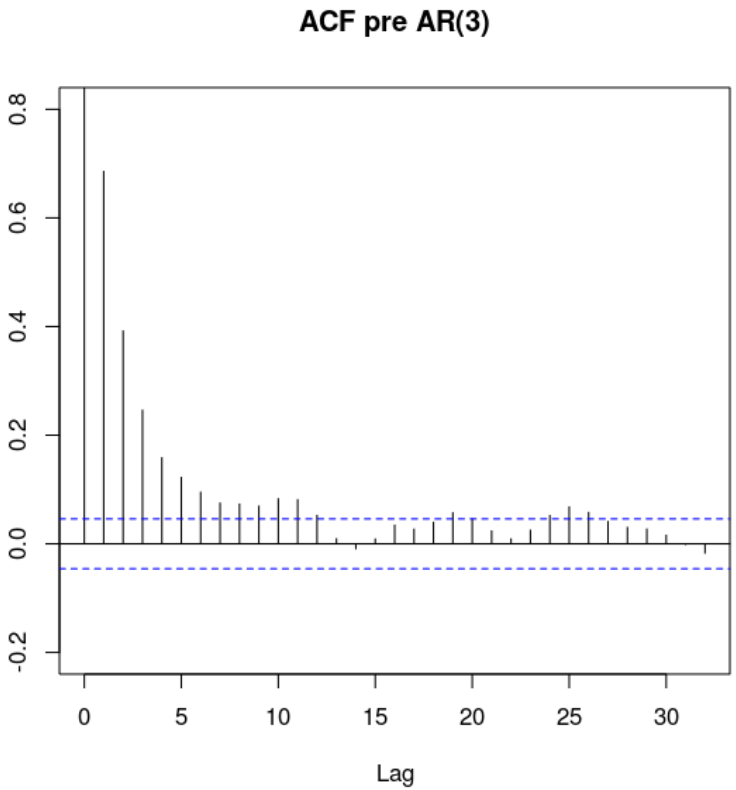
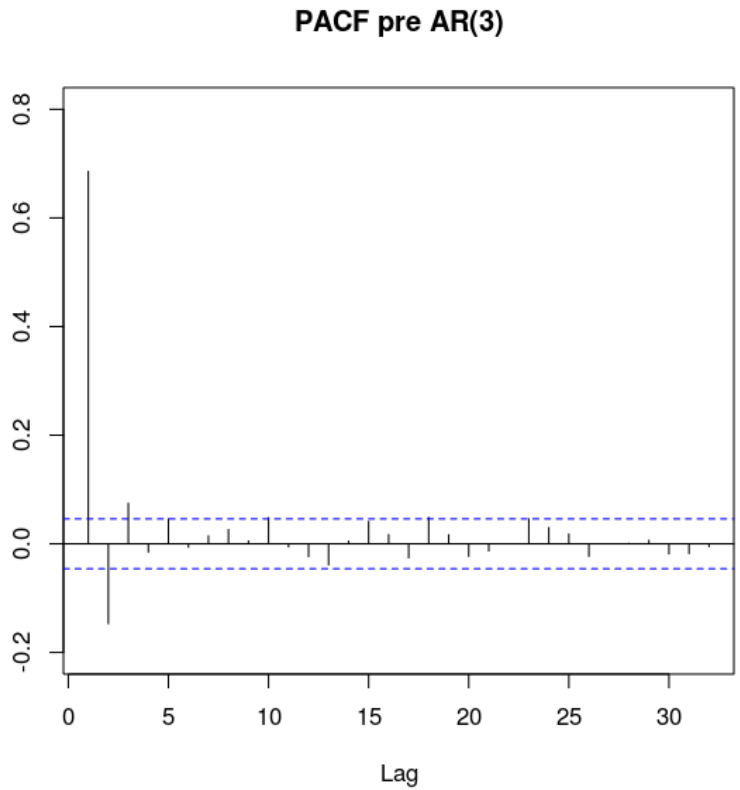
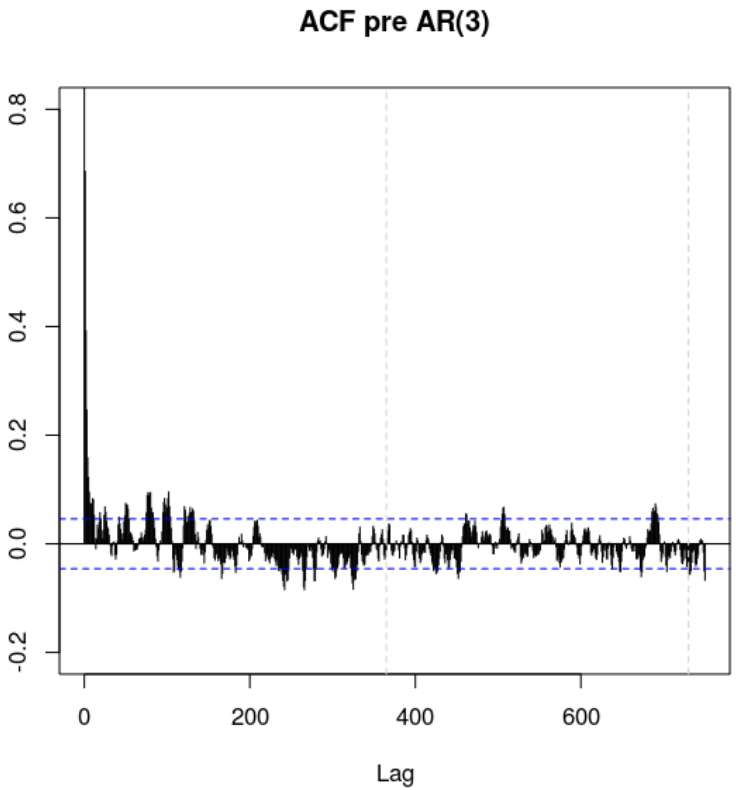


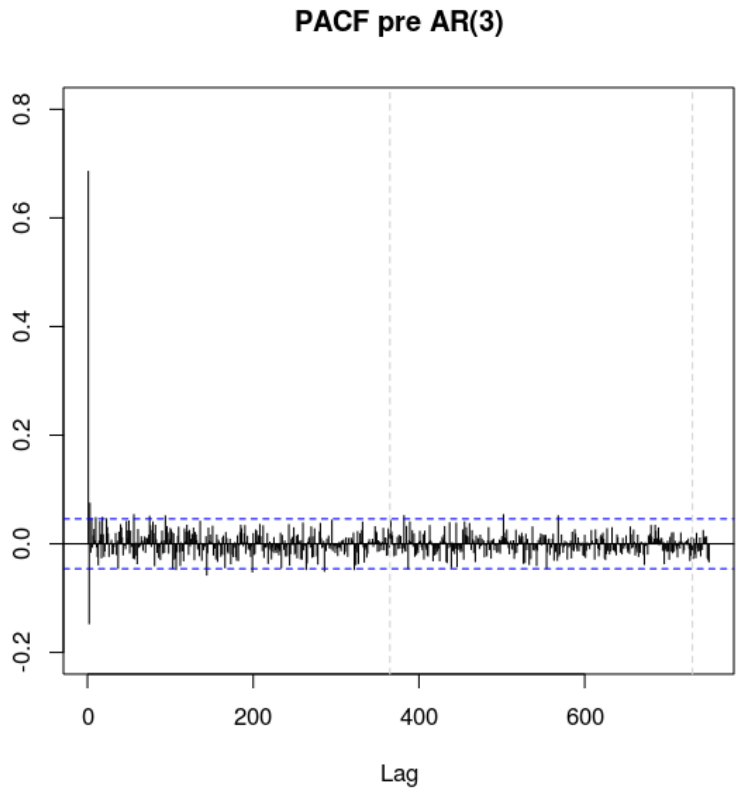
preliminary models



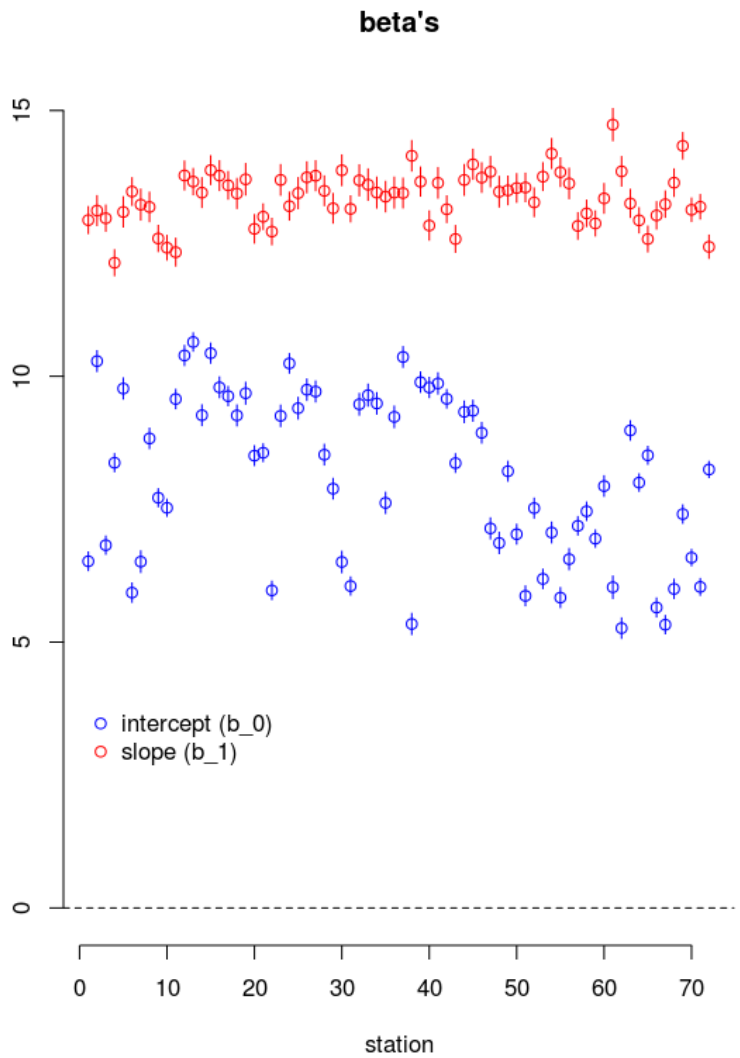


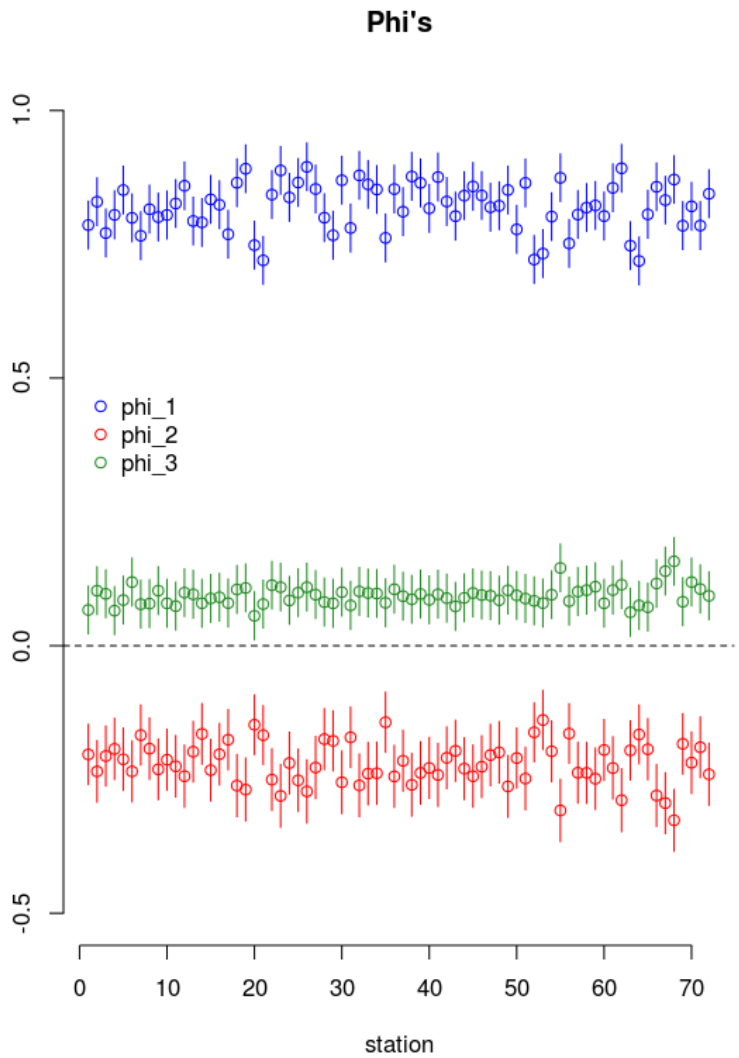
preliminary models



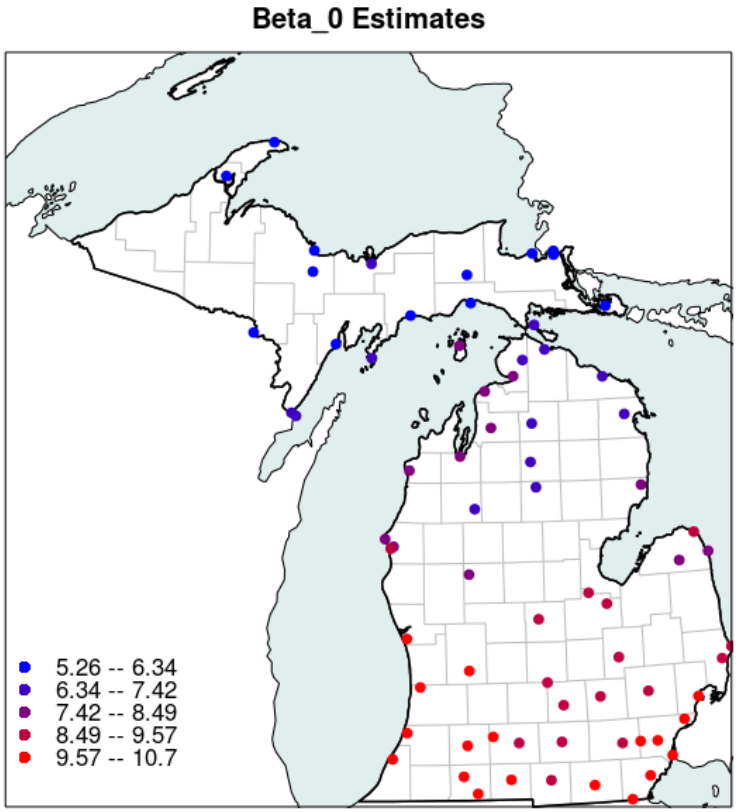


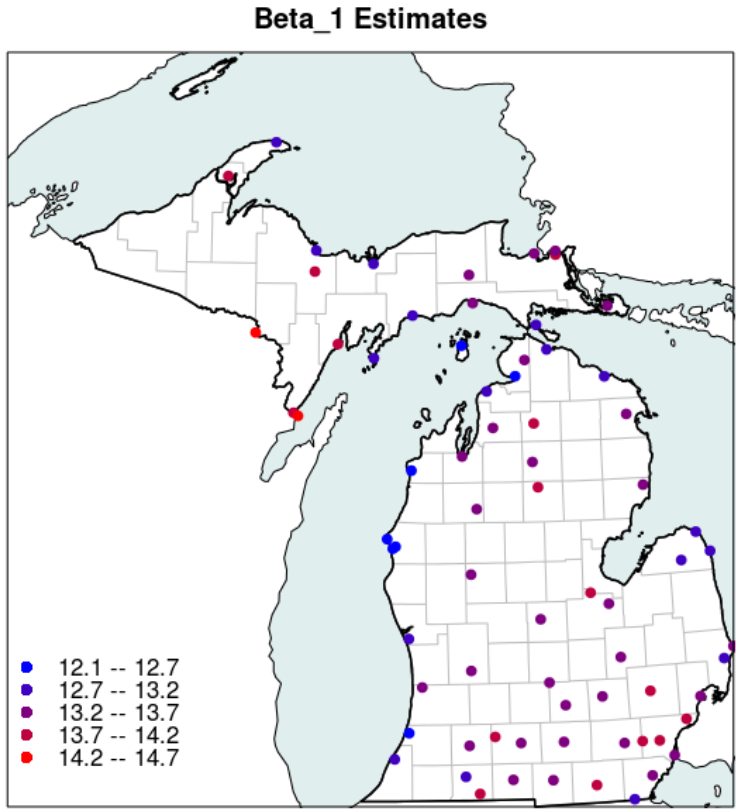
preliminary models



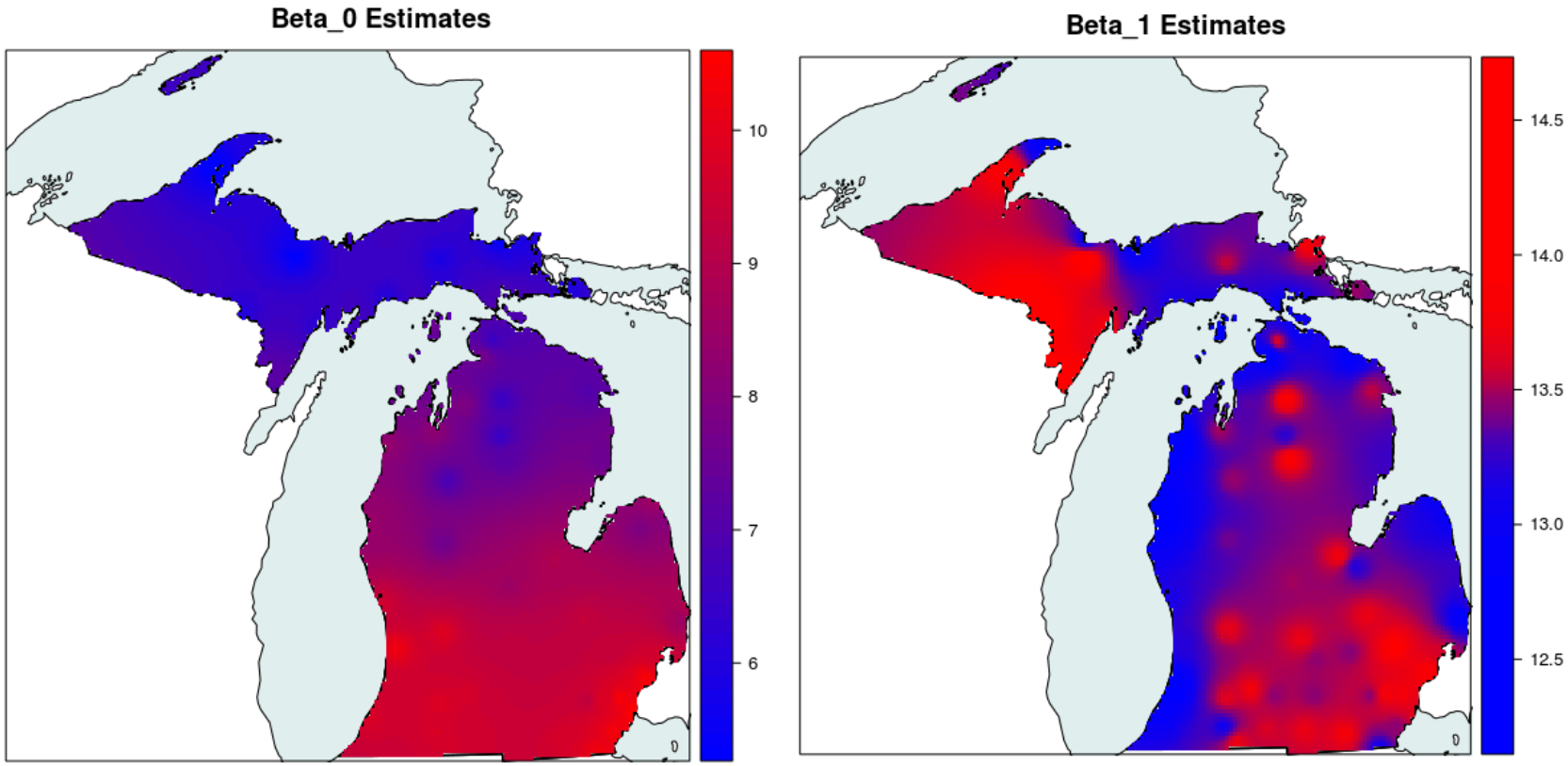


preliminary models





preliminary models



Model Proposal (Generalized Least Squares)

1. Seems clear the latitude is an important factor (X_2)
2. Seems that distance to the Great Lakes is important (X_3)
3. seasonal component (X_1)

$$
\begin{aligned}
Y_s &= \beta_0 + (\beta_1 + \beta_4 X_{s,3})X_1 + \beta_2 X_{s,2} + \beta_3 X_{s,3} + W_s \\
Y_s &= \beta_0 + \beta_1 X_1 + \beta_2 X_{s,2} + \beta_3 X_{s,3} + \beta_4 X_{s,3} X_1 + W_s \\
Y_s &= \boldsymbol{\beta} X_s + W_s \\
W_{s,t} &= \phi_1 W_{s,t-1} + \phi_2 W_{s,t-2} + \phi_3 W_{s,t-3} + e_{s,t}
\end{aligned}
$$

Model Proposal (Generalized Least Squares)

To get initial $\hat{\beta}_{ols}$, we are just going to stack up our Y_s's and X_s's

$$Y = \beta X + W$$

$$X = \begin{bmatrix} X_1 \\ X_2 \\ \vdots \\ X_{72} \end{bmatrix} \quad Y = \begin{bmatrix} Y_1 \\ Y_2 \\ \vdots \\ Y_{72} \end{bmatrix} \quad W = \begin{bmatrix} W_1 \\ W_2 \\ \vdots \\ W_{72} \end{bmatrix}$$

$$\hat{\beta}_{ols} = (X'X)^{-1}X'Y$$

$$W = Y - \hat{\beta}_{ols}X$$

Model Proposal (Generalized Least Squares)

Find $\phi_{s,1}, \phi_{s,2}, \phi_{s,3}$ by fitting ar(3) models to each W_s.

Like in the preliminary models, $\phi_{s,1}, \phi_{s,2}, \phi_{s,3}$ were very similar across s

Took mean of $\phi_{s,1}, \phi_{s,2}$, and $\phi_{s,3}$ to obtain ϕ_1, ϕ_2, ϕ_3

Model Proposal (Generalized Least Squares)

Now that we have ϕ_1, ϕ_2, ϕ_3,

$$\hat{\beta}_{gls} = (X'\Gamma^{-1}X)^{-1}X'\Gamma^{-1}Y$$
$$Cov(\hat{\beta}_{gls}) = (X'\Gamma^{-1}X)^{-1}$$

Prediction Equation

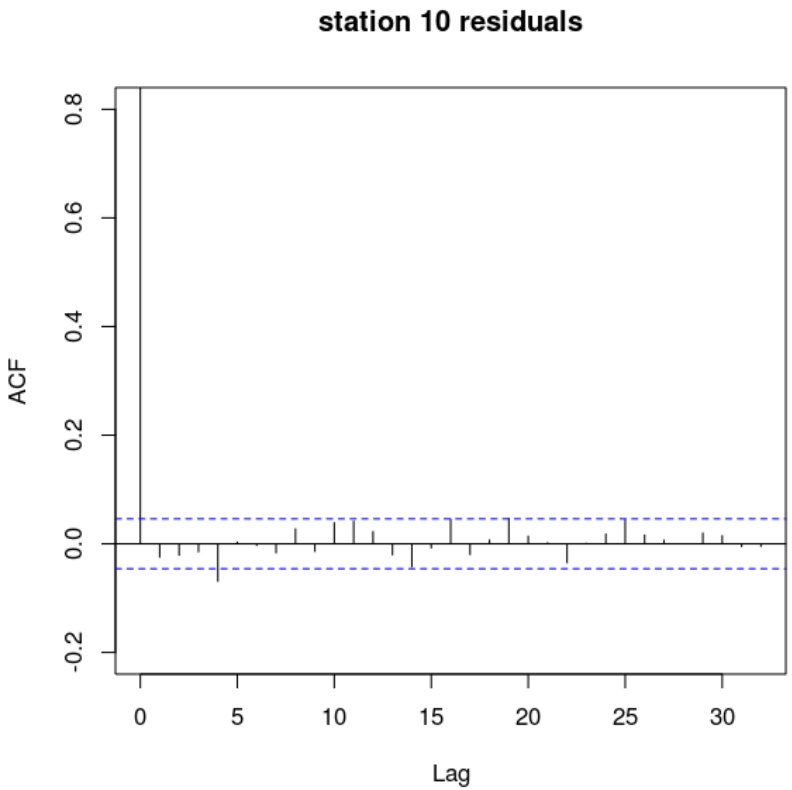
$$\hat{y}_{s,t} = \hat{\beta}_{gls} X_{s,t} + \phi_1 W_{s,t-1} + \phi_2 W_{s,t-2} + \phi_2 W_{s,t-3}$$

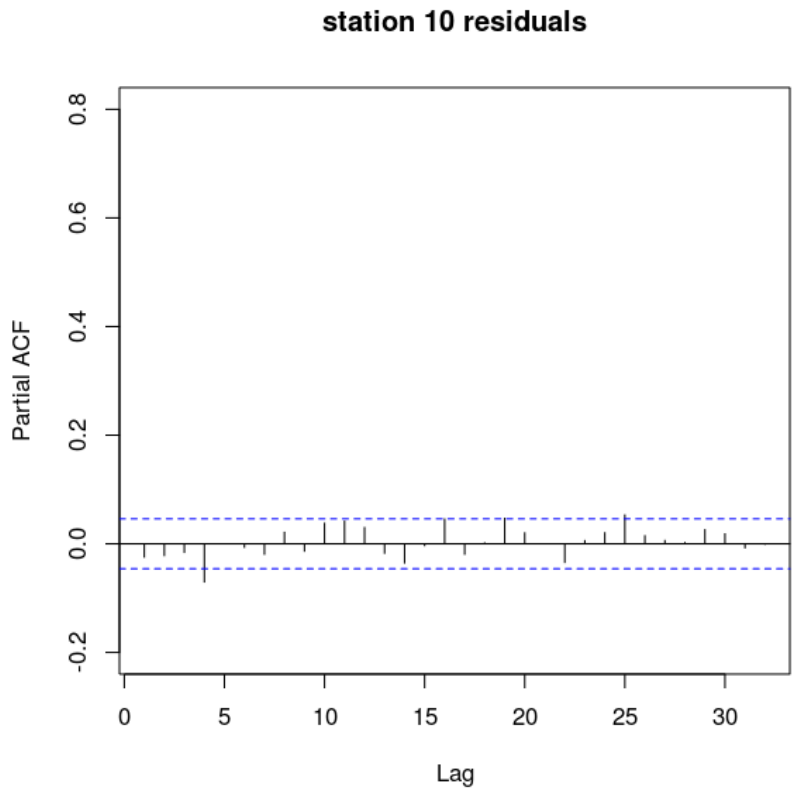
Fitted Model

$$Y_{s,t} = 4.244 + 13.17X_1 + 5.184e^{-6}X_{s,2} + 0.015X_{s,3} + .0055X_{s,3}X_1 + 0.84W_{s,t-1} - 0.22W_{s,t-2} + 0.11W_{s,t-3} + e_{s,t}$$

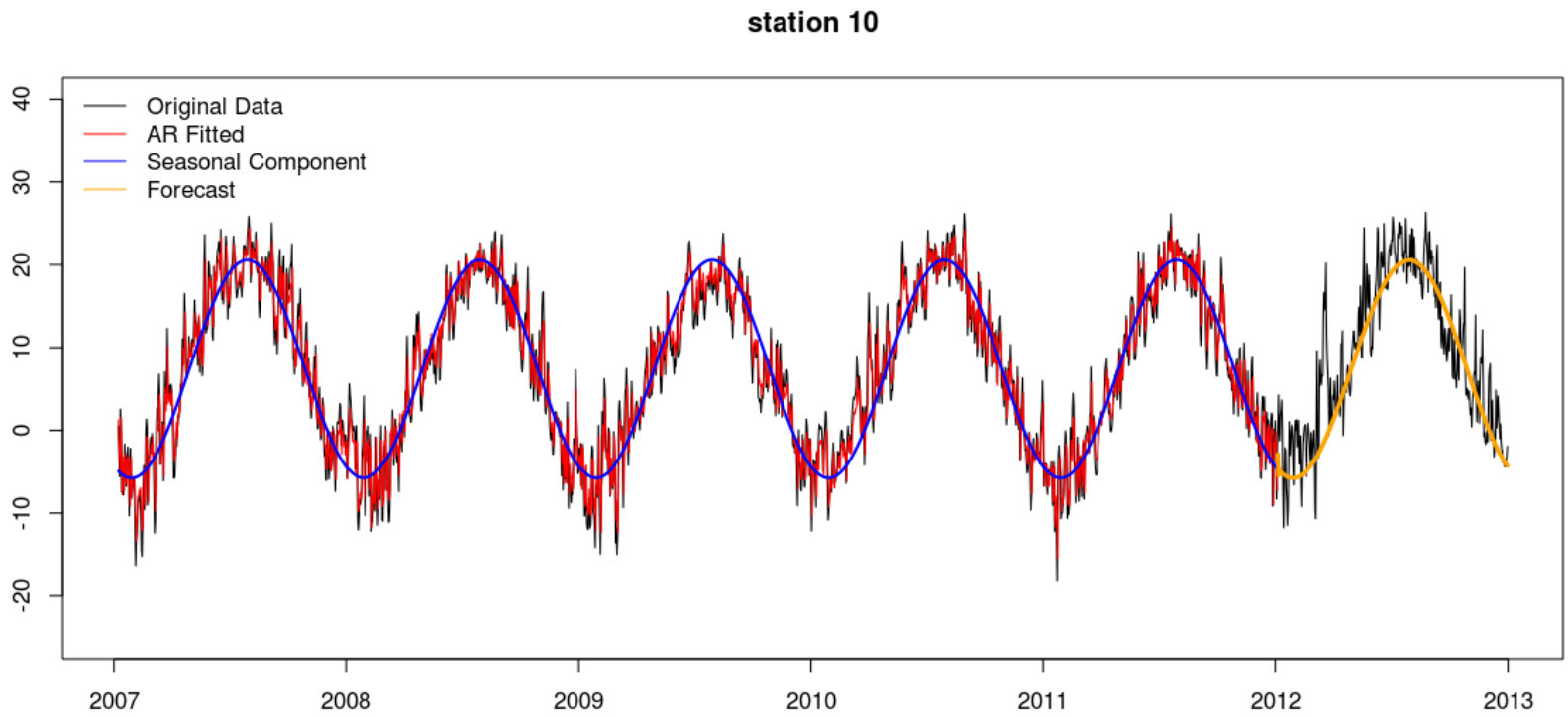
Coef	lower CI(95%)	Upper CI(95%)
Intercept	3.901	4.585
Season	13.06	13.27
Latitude	$4.670e^{-6}$	$5.699e^{-6}$
distance to lake	.012	.0162
interaction	.0032	.0079

residual pacf and acf

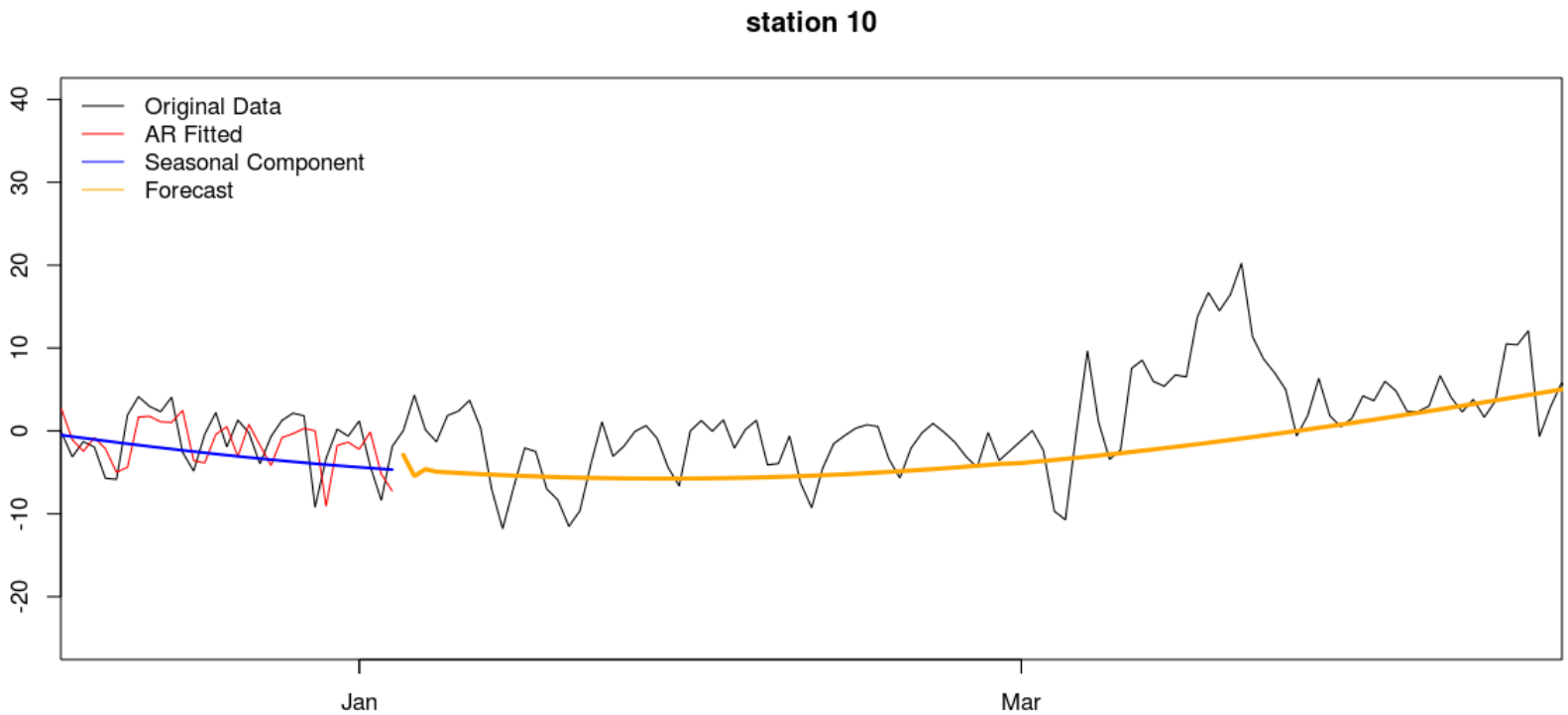




Forecast


station 10
Original Data
AR Fitted
Seasonal Component
Forecast
40
30
20
10
0
-10
-20
2007
2008
2009
2010
2011
2012
2013

Forecast


station 10
Original Data
AR Fitted
Seasonal Component
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10
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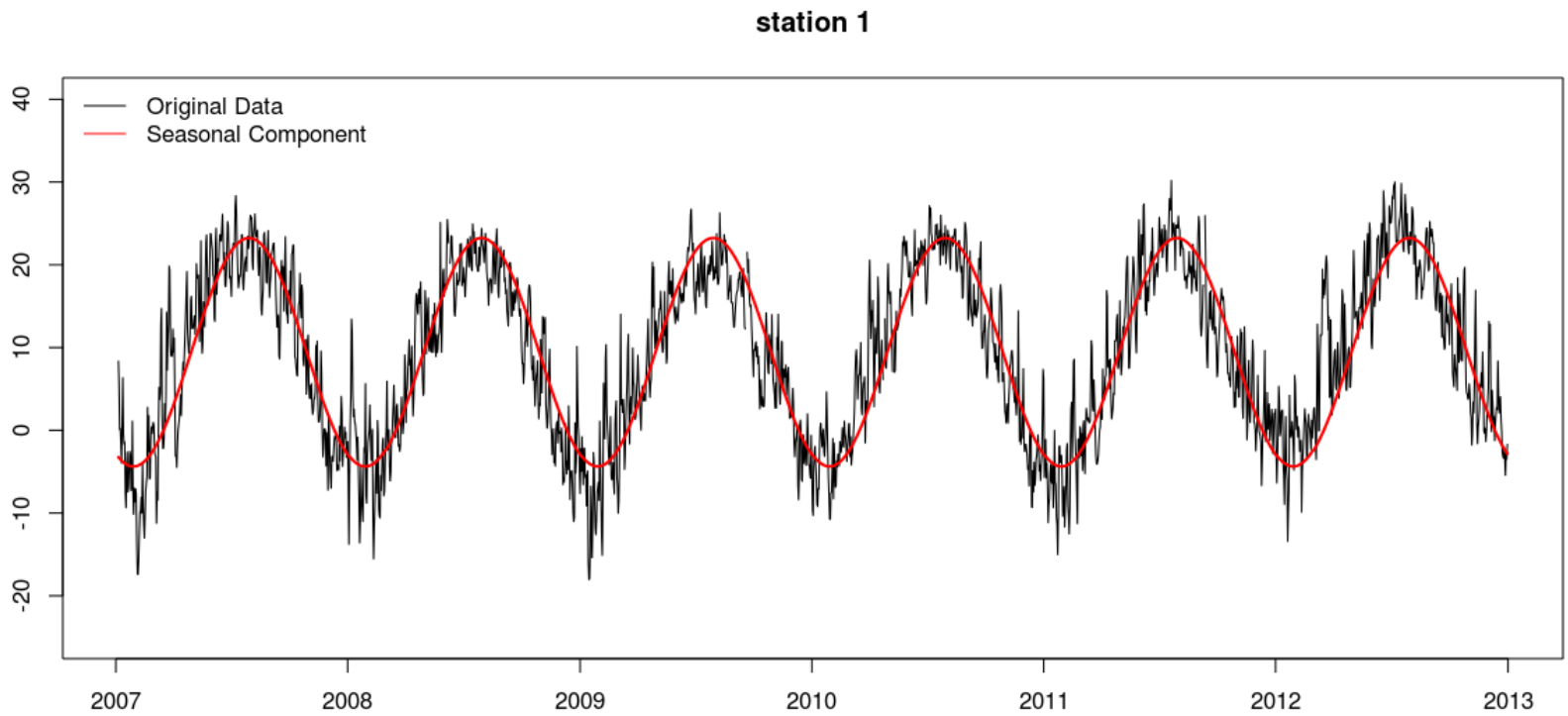
Jan
Mar

Spatial Prediction



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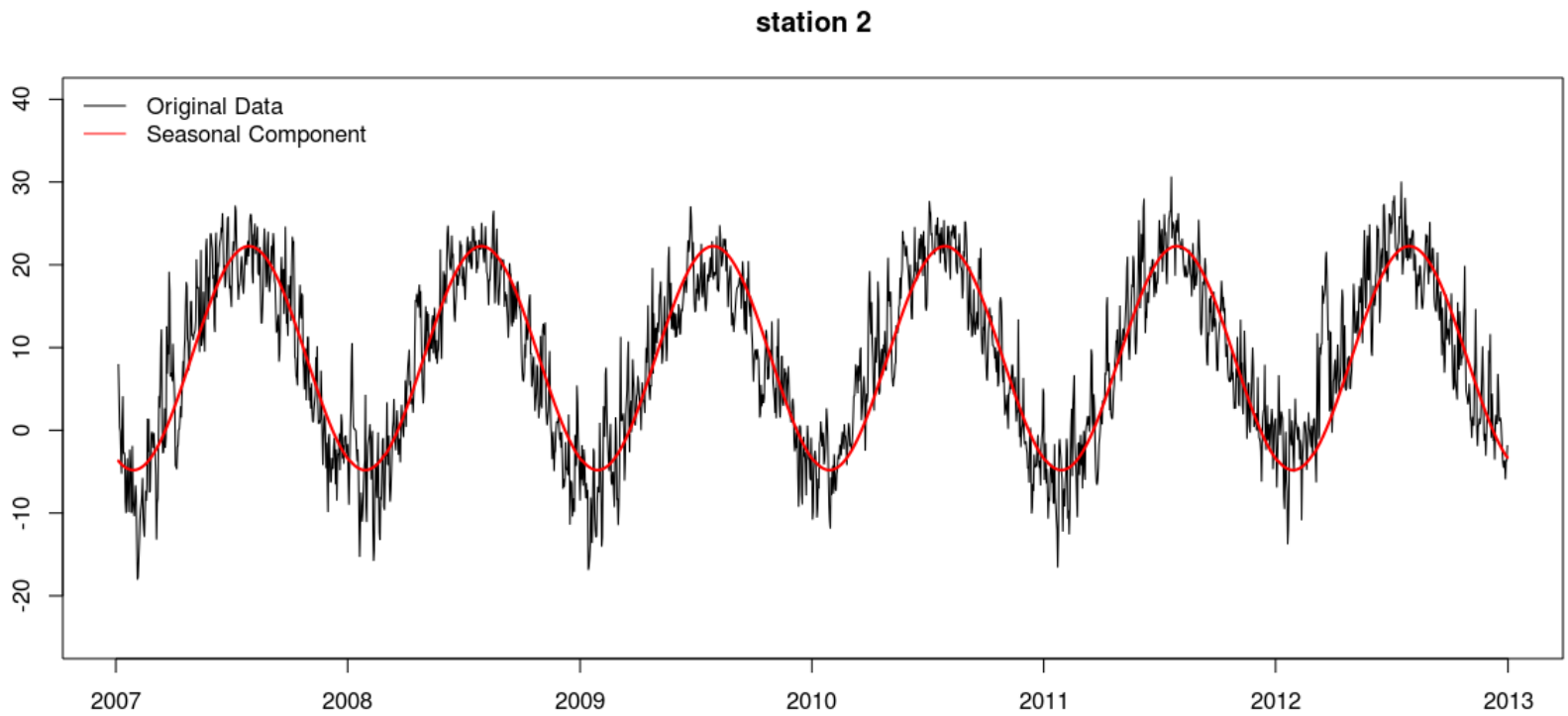

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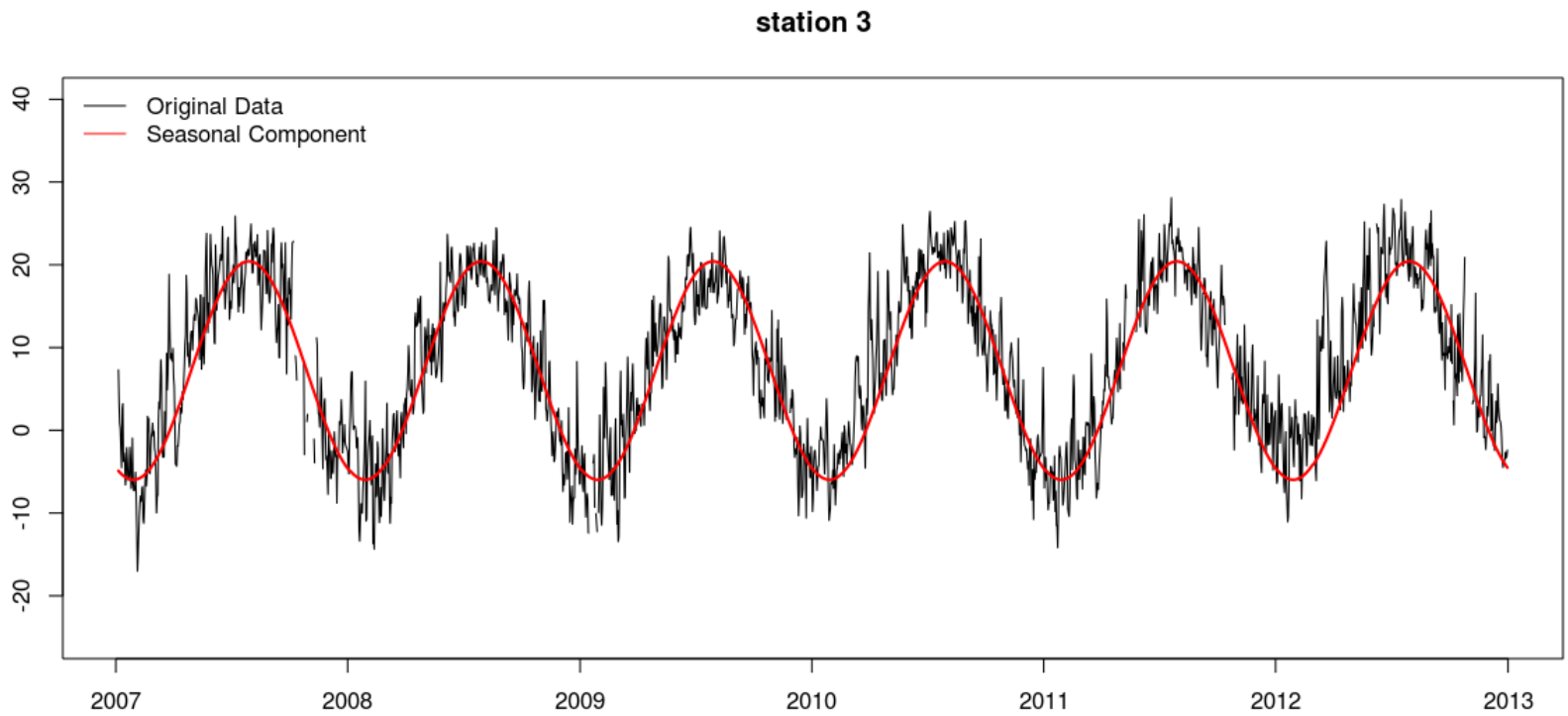

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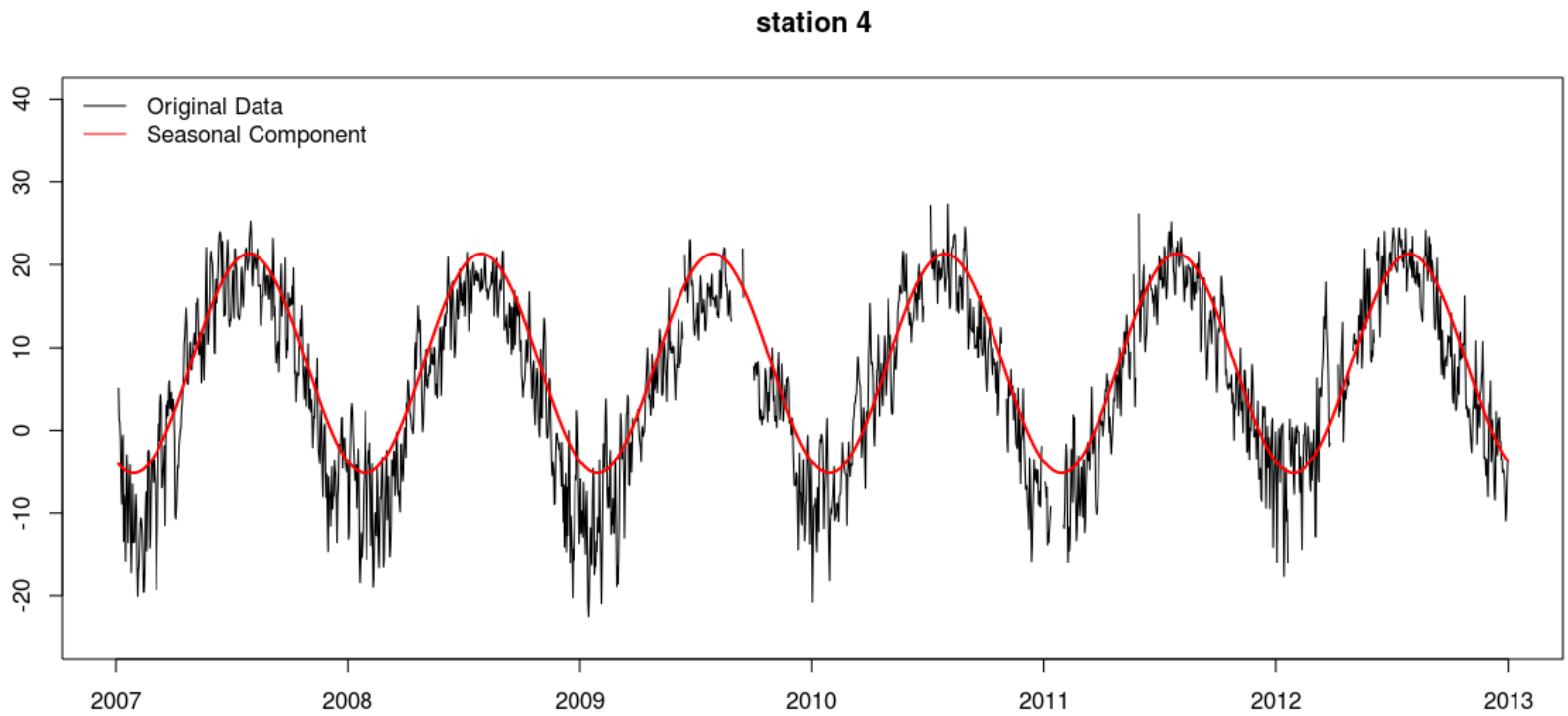

Spatial Prediction