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Adventures in Bayesian Structural Time Series

Part 5: Analyzing SST Data With Regression

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Outline

- SST data with covariates
- Use `bsts` to
  - Fit structural model with regression
  - Regression posterior
  - Forecast
  - Custom regresson prior

SST Data

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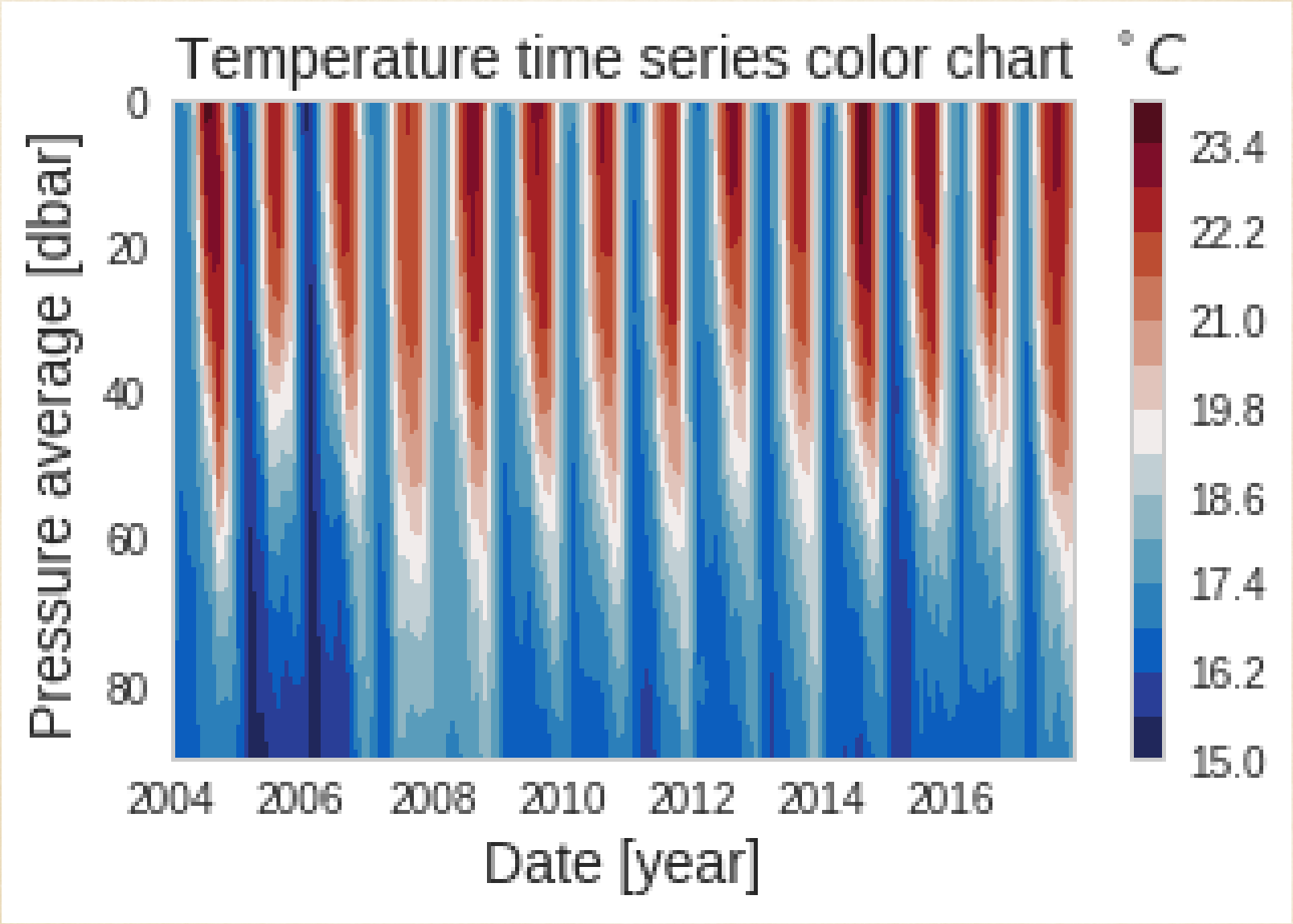
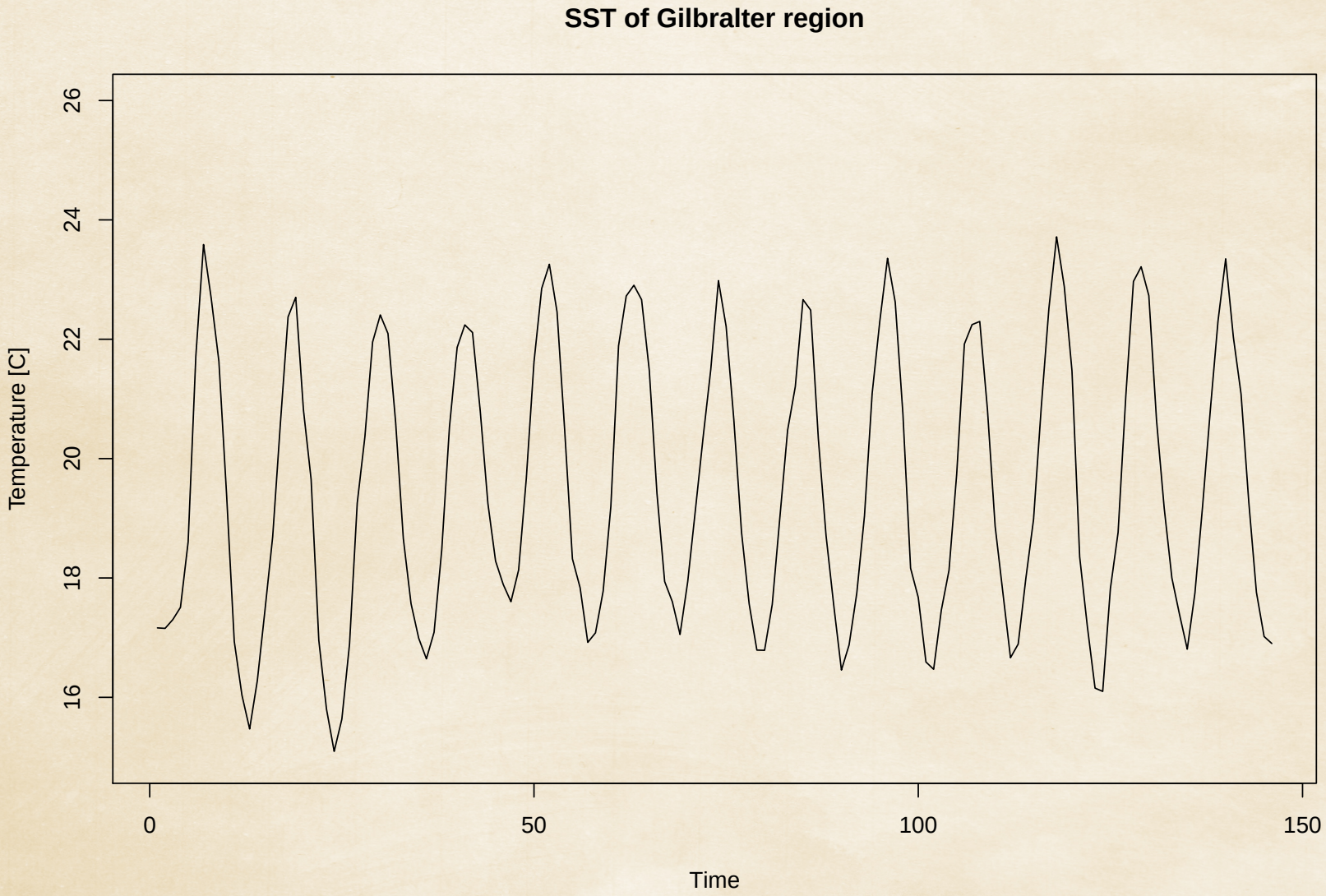
- Sea Surface Temperature near Gibraltar
- Aggregated monthly
- January 2004 to April 2018
- Covariates: depth at 10, 20, . . . , 90 meters

SST Data


Temperature time series color chart
°C
Pressure average [dbar]
0
20
40
60
80
2004
2006
2008
2010
2012
2014
2016
Date [year]
23.4
22.2
21.0
19.8
18.6
17.4
16.2
15.0

SST Data


SST of Gilbralter region
Temperature [C]
16
18
20
22
24
26
0
50
100
150
Time

Setup


```
library(readr)
library(bsts)

gib <- read_csv("data/gilbralter_time_series_r_2.csv",
                col_types = cols(startDate = col_skip(),
                                 timeIdx = col_skip()))
names(gib) <- c('SST', '10m', '20m', '30m', '40m',
                '50m', '60m', '70m', '80m', '90m')
gib_train <- gib[1:146, ]
gib_test <- gib[147:158, ]
```

SST Data

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```
head(gib_test[, 1:8])
```

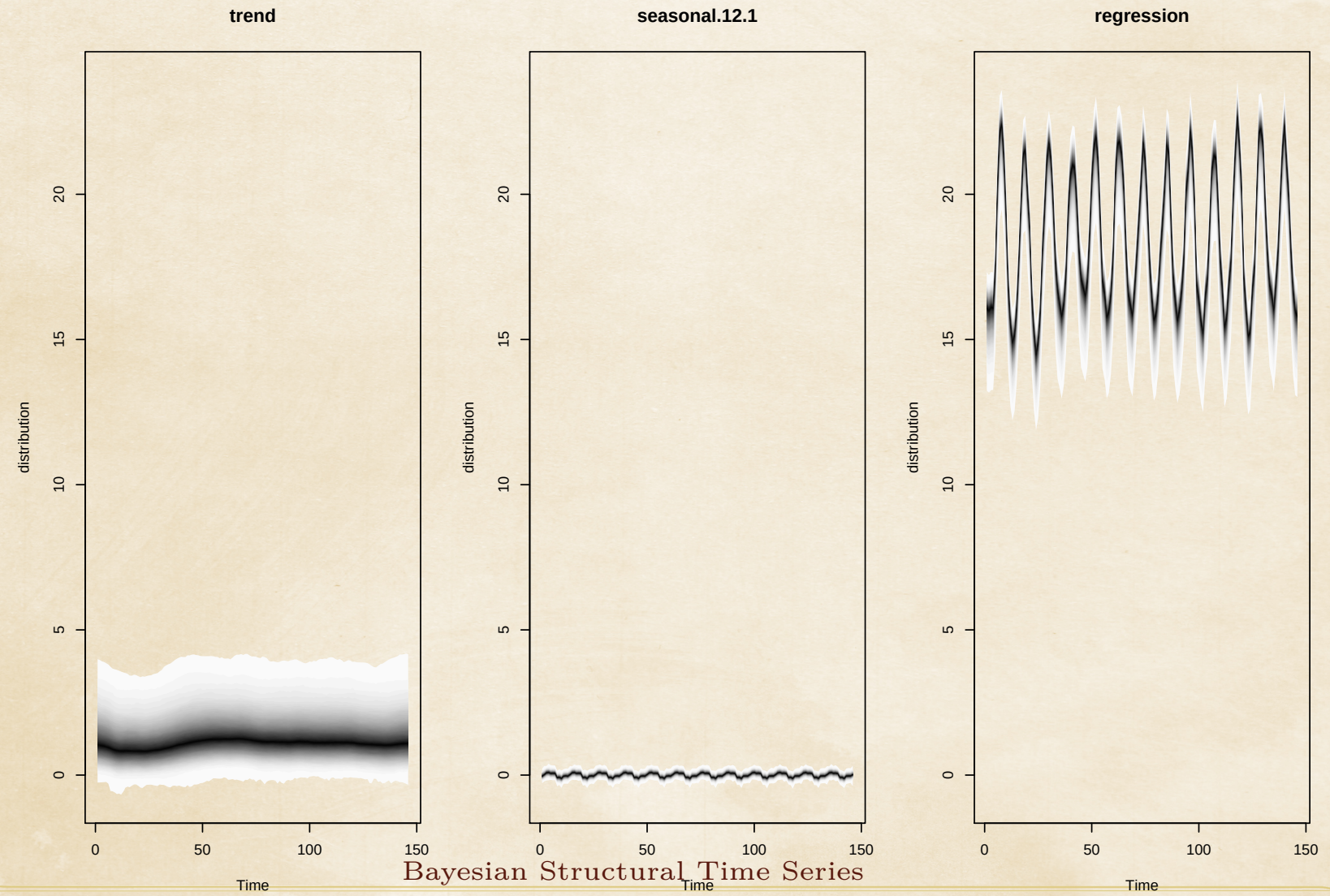
```
## # A tibble: 6 x 8
##     SST `10m` `20m` `30m` `40m` `50m` `60m` `70m`
##   <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl>
## 1  18.6  18.3  18.0  17.7  17.0  16.7  16.7  16.5
## 2  19.9  19.8  19.5  19.3  18.4  17.7  17.1  17.0
## 3  21.7  21.7  21.2  20.9  20.0  19.0  18.1  17.6
## 4  22.4  22.6  22.3  21.8  21.1  19.9  18.9  18.2
## 5  22.9  22.9  22.4  22.2  21.8  20.9  19.1  17.9
## 6  22.5  22.7  22.2  22.1  22.0  21.0  19.4  18.1
```

Model Fitting


```
ss <- AddLocalLinearTrend(list(), gib$SST)
ss <- AddSeasonal(ss, gib$SST, nseasons = 12)
model1 <- bsts(SST ~., state.specification = ss,
               data = gib_train, niter = 1000, ping = 0)
```

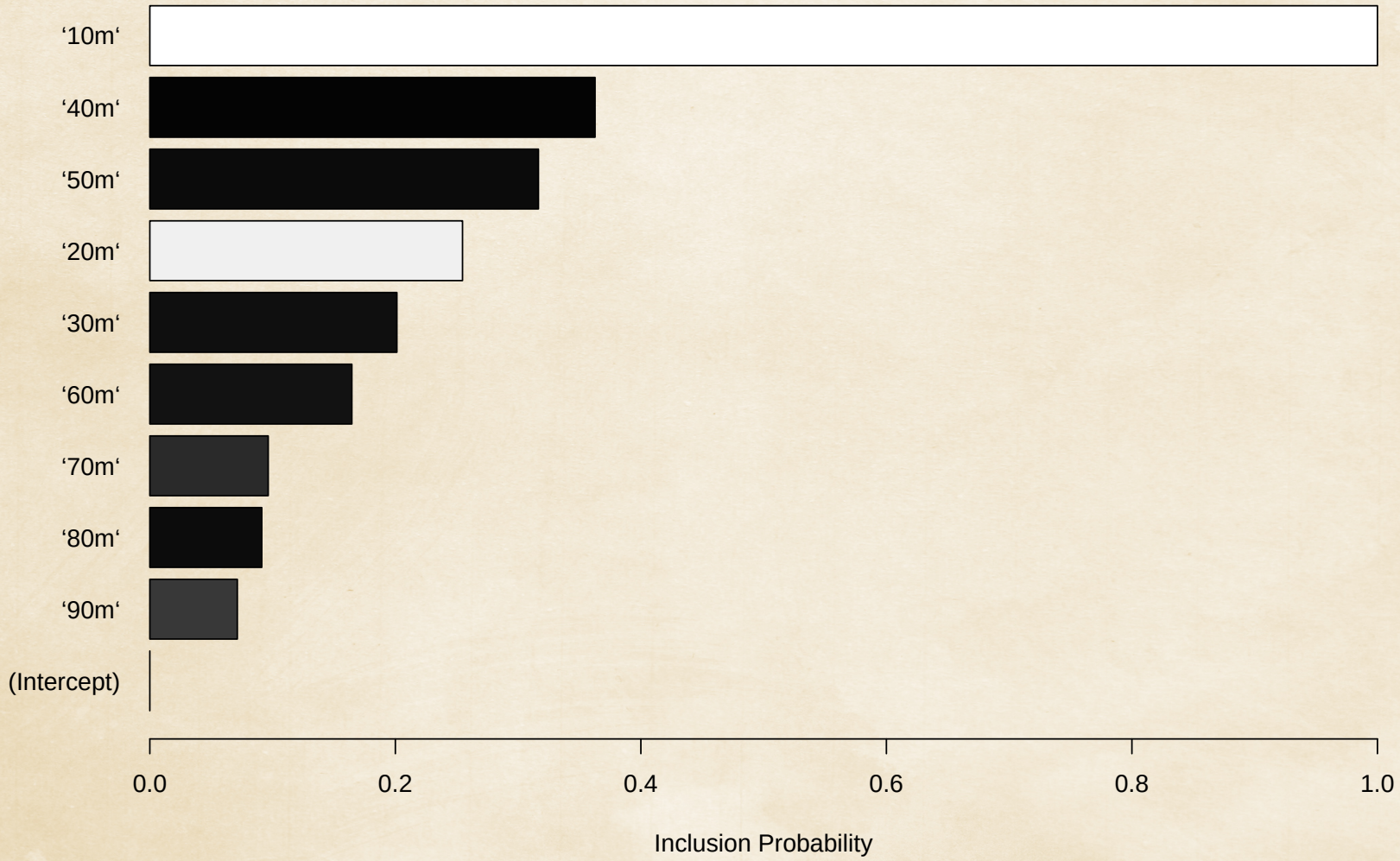
Model Plotting


```
plot(model1, 'components')
```



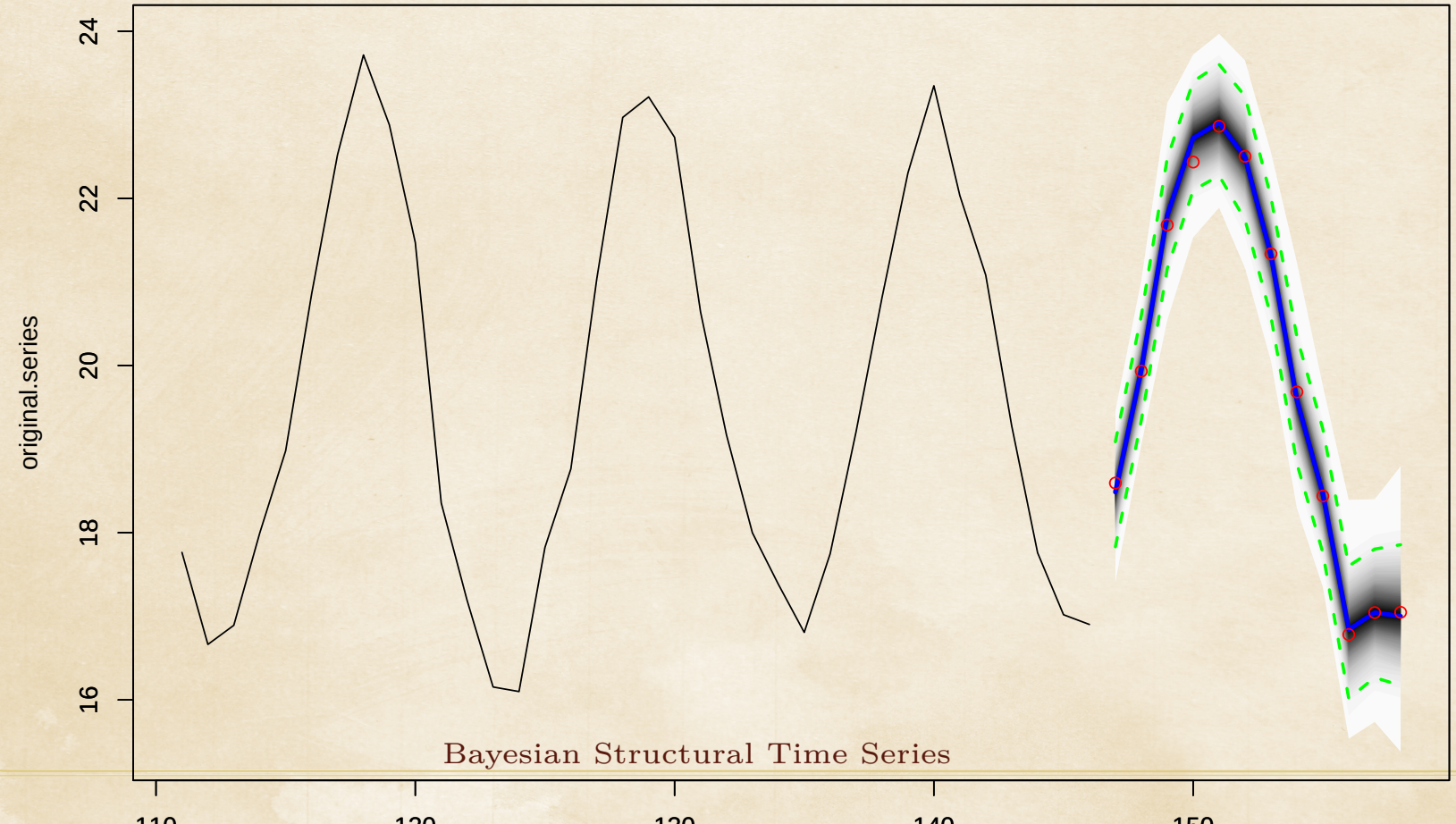
Model Plotting


```
plot(model1, 'coefficients')
```



Forecasting


```
model1_pred <- predict(model1, newdata = gib_test[, -1],
                       horizon = 12)
plot(model1_pred, plot.original = 36)
points(147:158, gib_test$SST, col = 'red')
```



Custom Regression Prior

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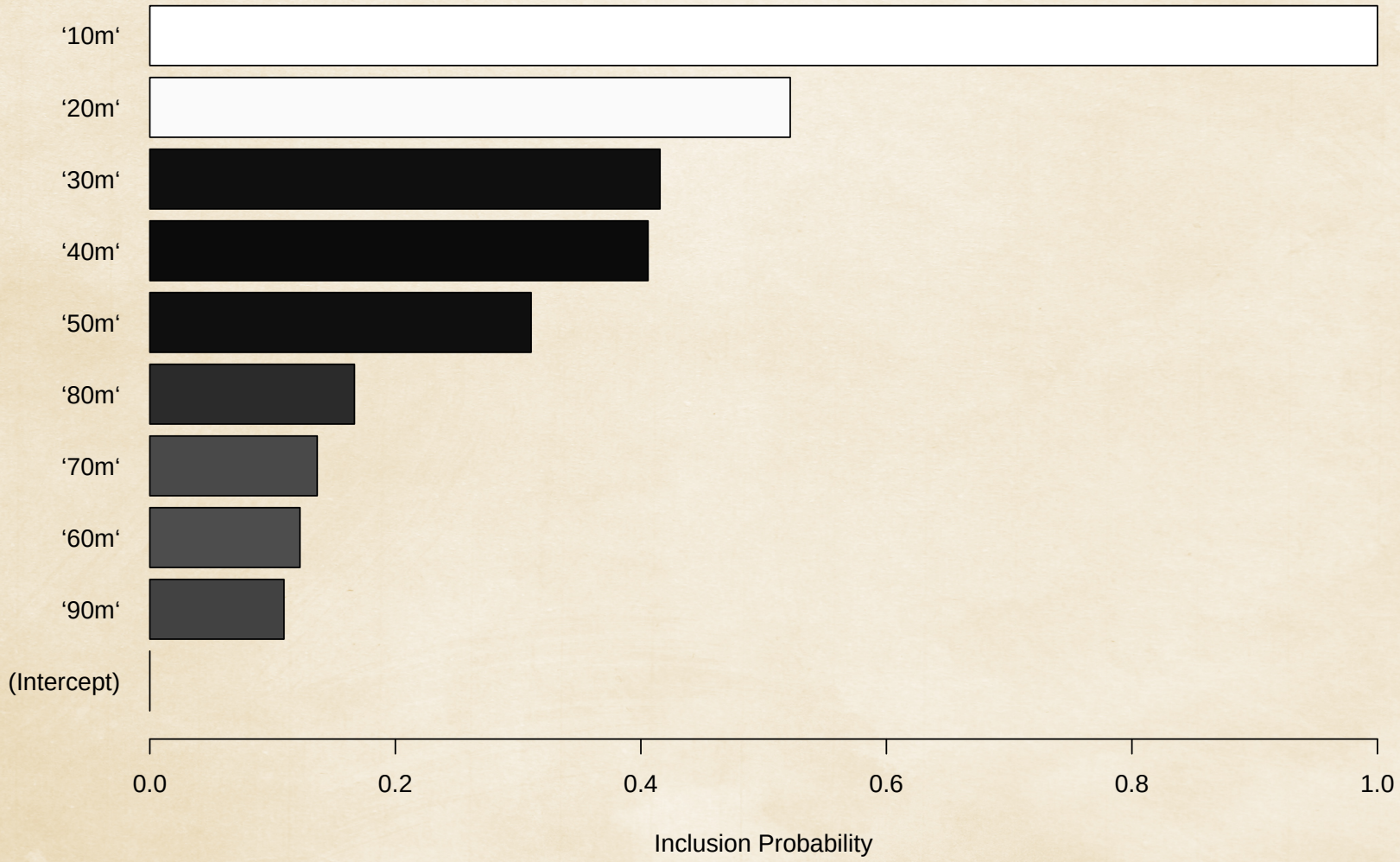
```
model2 <- bsts(SST ~., state.specification = ss,
               data = gib_train, niter = 1000, ping = 0,
               expected.model.size = 2)
```

Custom Regression Prior


```
plot(model2, 'coefficients')
```



Custom Regression Prior

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```
bp = c(.01,.5,.3,.3,.1,.1,.1,.1,.1,.1)
model3 <- bsts(SST ~., state.specification = ss,
               data = gib_train, niter = 1000, ping = 0,
               prior.inclusion.probabilities = bp)
```

Custom Regression Prior

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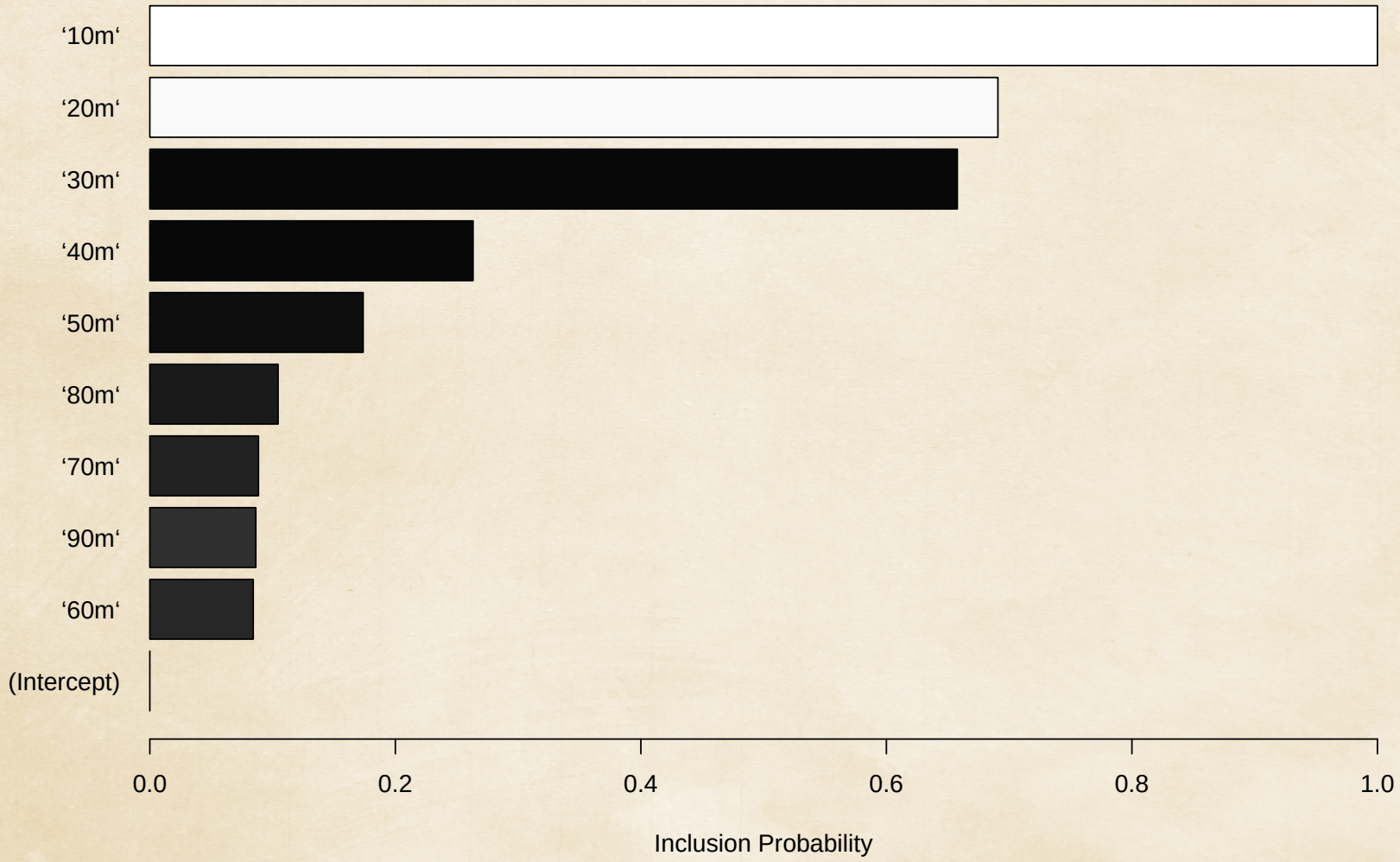
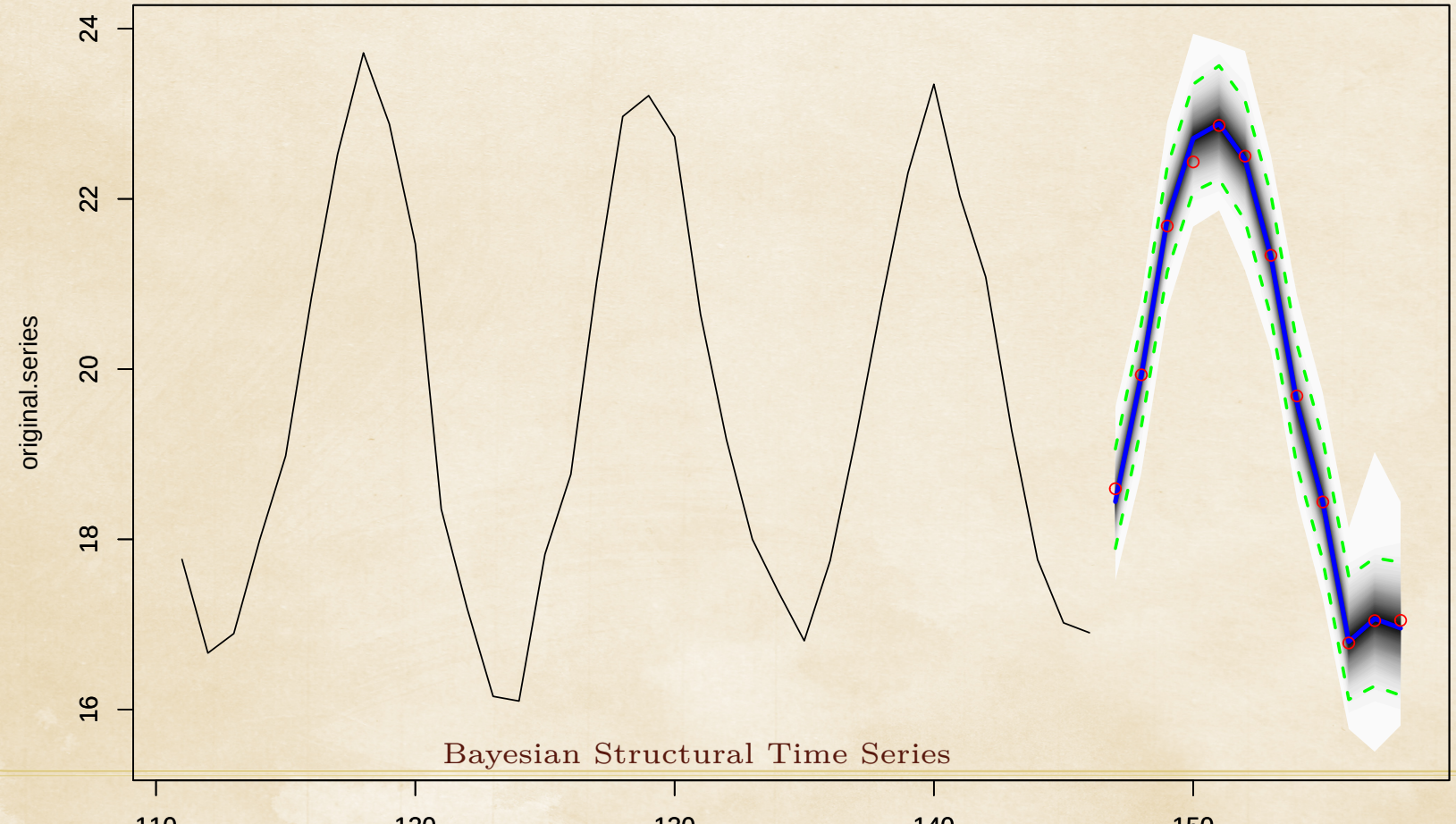
```
plot(model3, 'coefficients')
```



Forecasting


```
model3_pred <- predict(model3, newdata = gib_test[,-1],
                       horizon = 12)
plot(model3_pred, plot.original = 36)
points(147:158, gib_test$SST, col = 'red')
```