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# Adventures in Bayesian Structural Time Series

*Part 4: 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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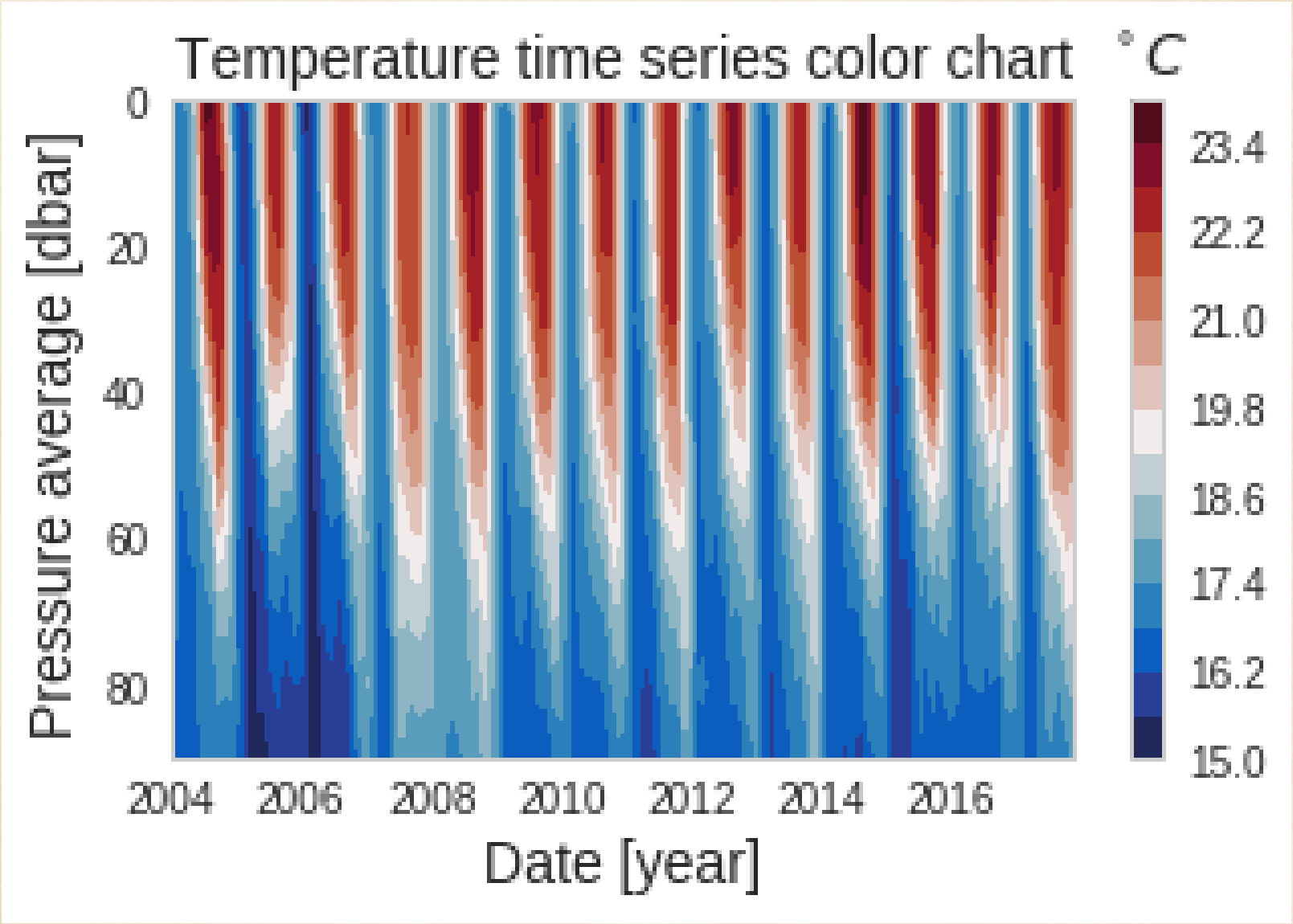
- Sea Surface Temperature near Gibraltar
- Aggregated monthly
- January 2004 to April 2018
- Covariates: depth at 10, 20, . . . , 90 meters

# 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, ]
```

# Model Fitting

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```
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

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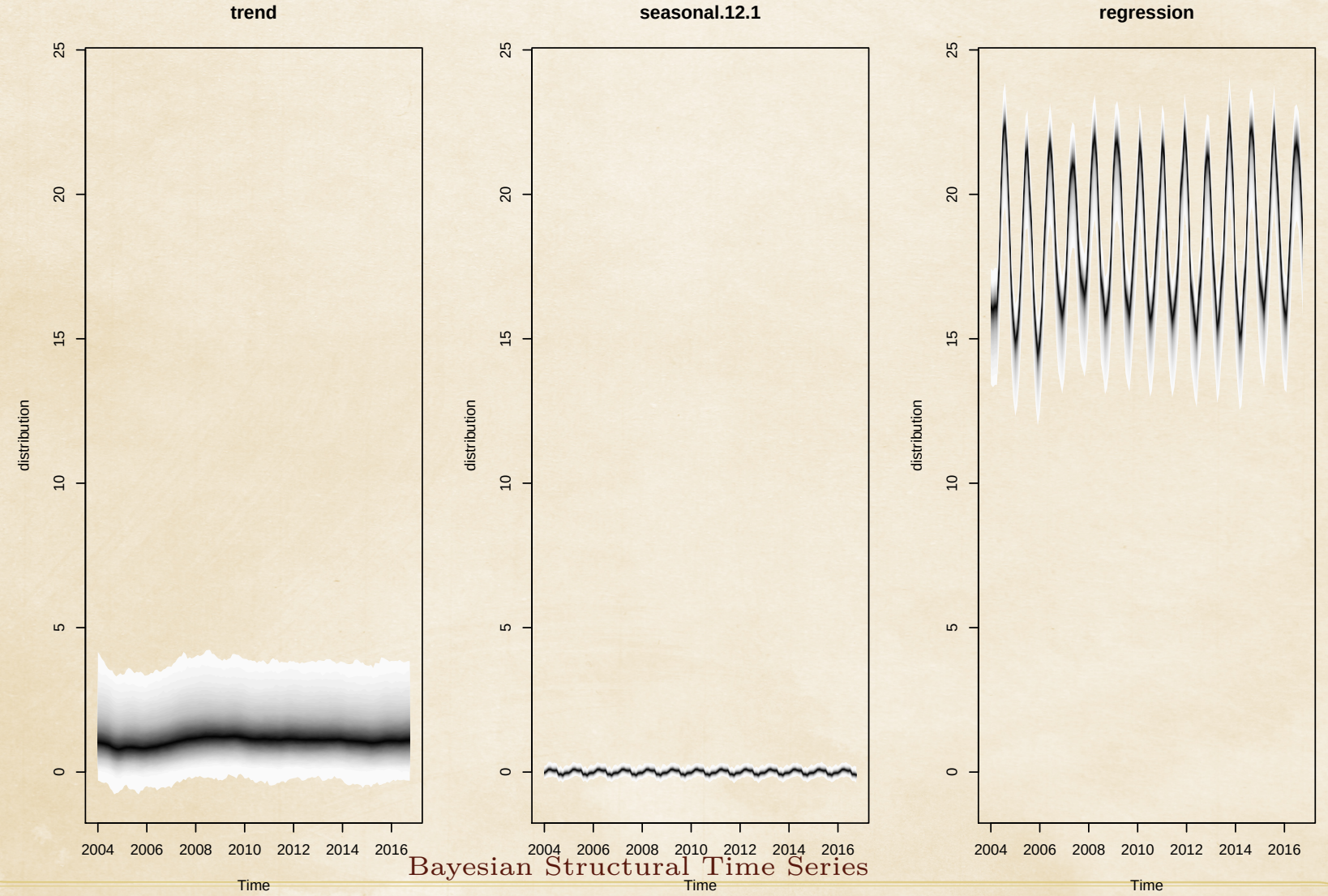
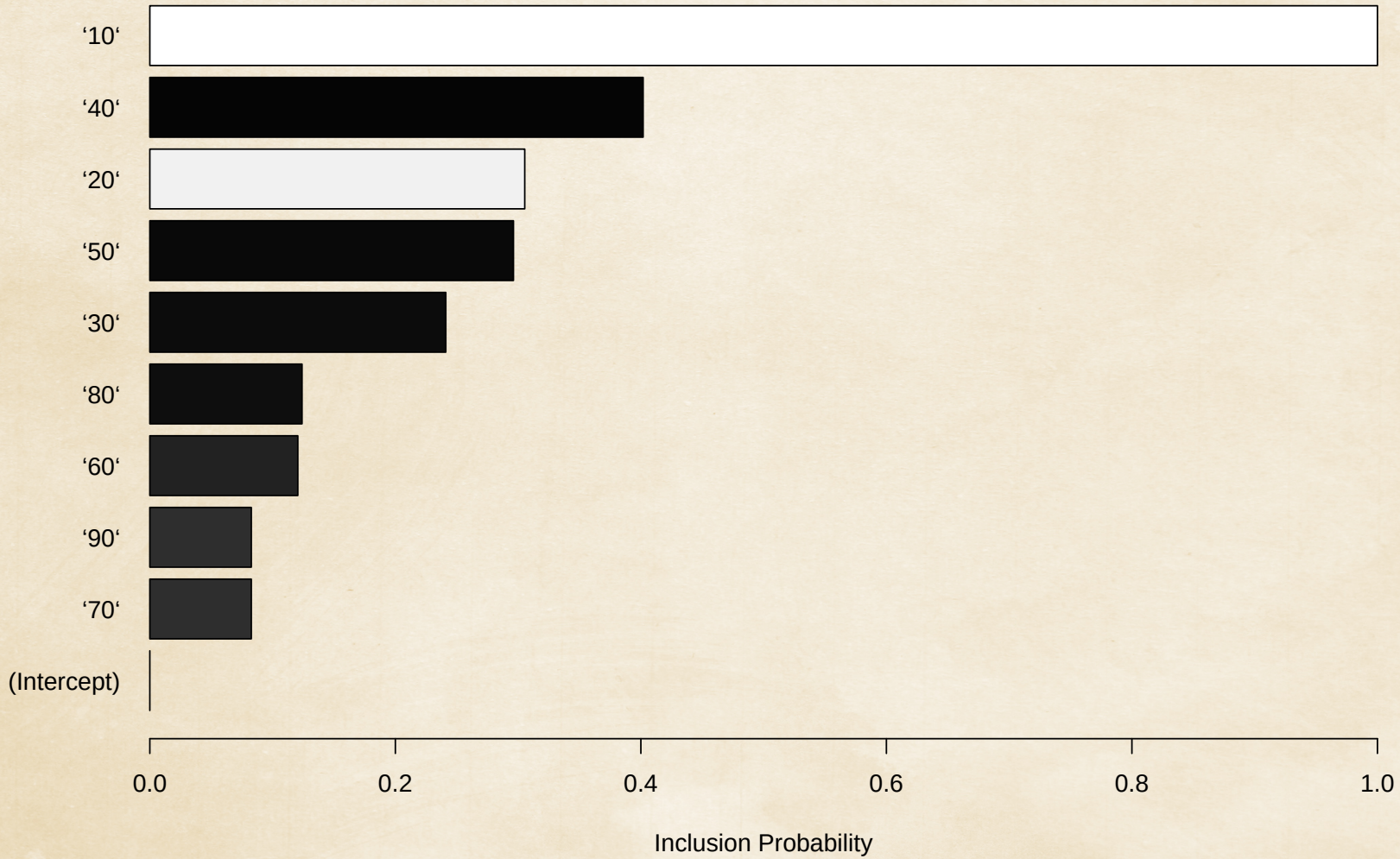
```
plot(model1, 'components')
```



# Model Plotting



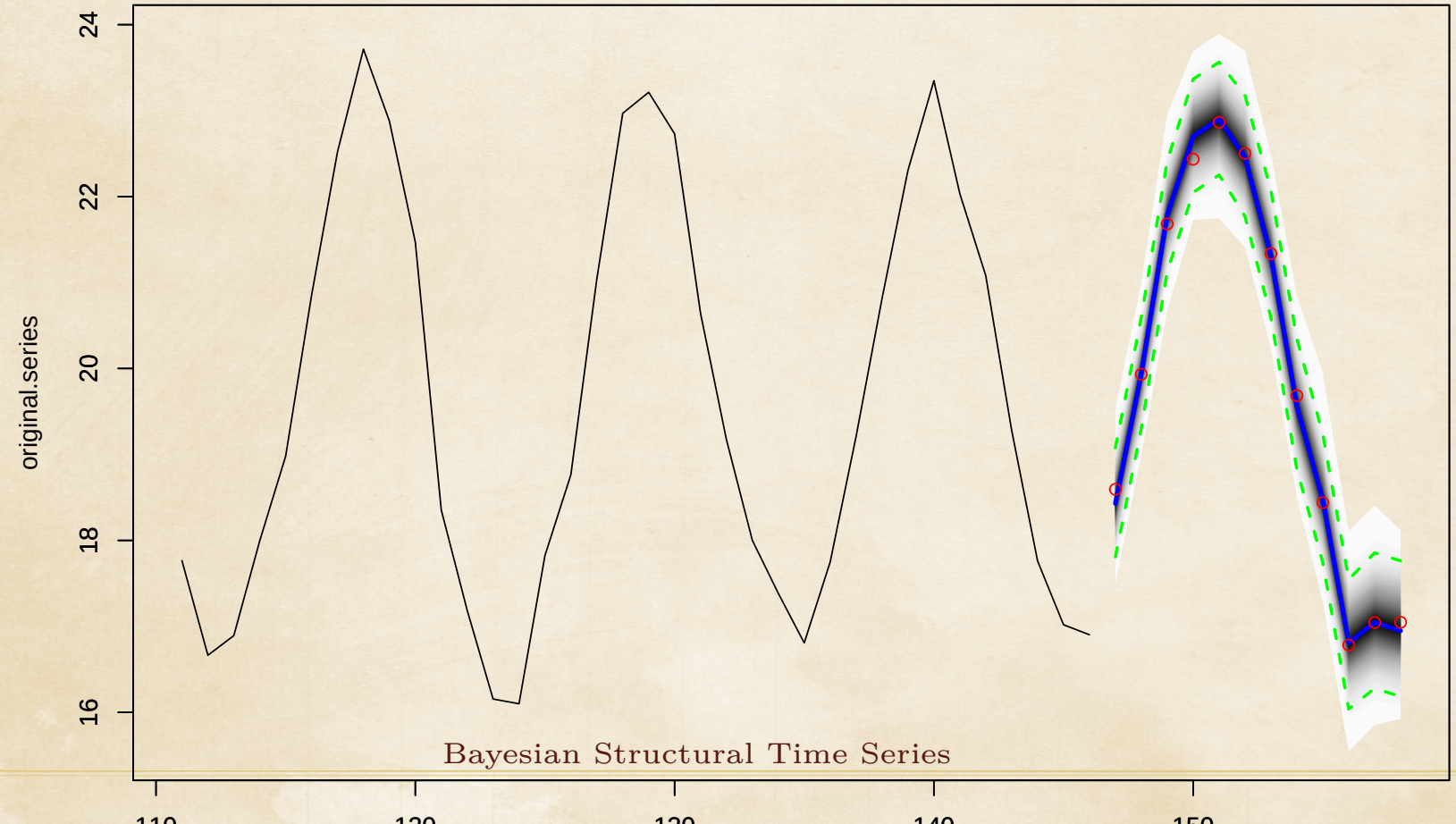
```
plot(model1, 'coefficients')
```



# 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



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

# Custom Regression Prior

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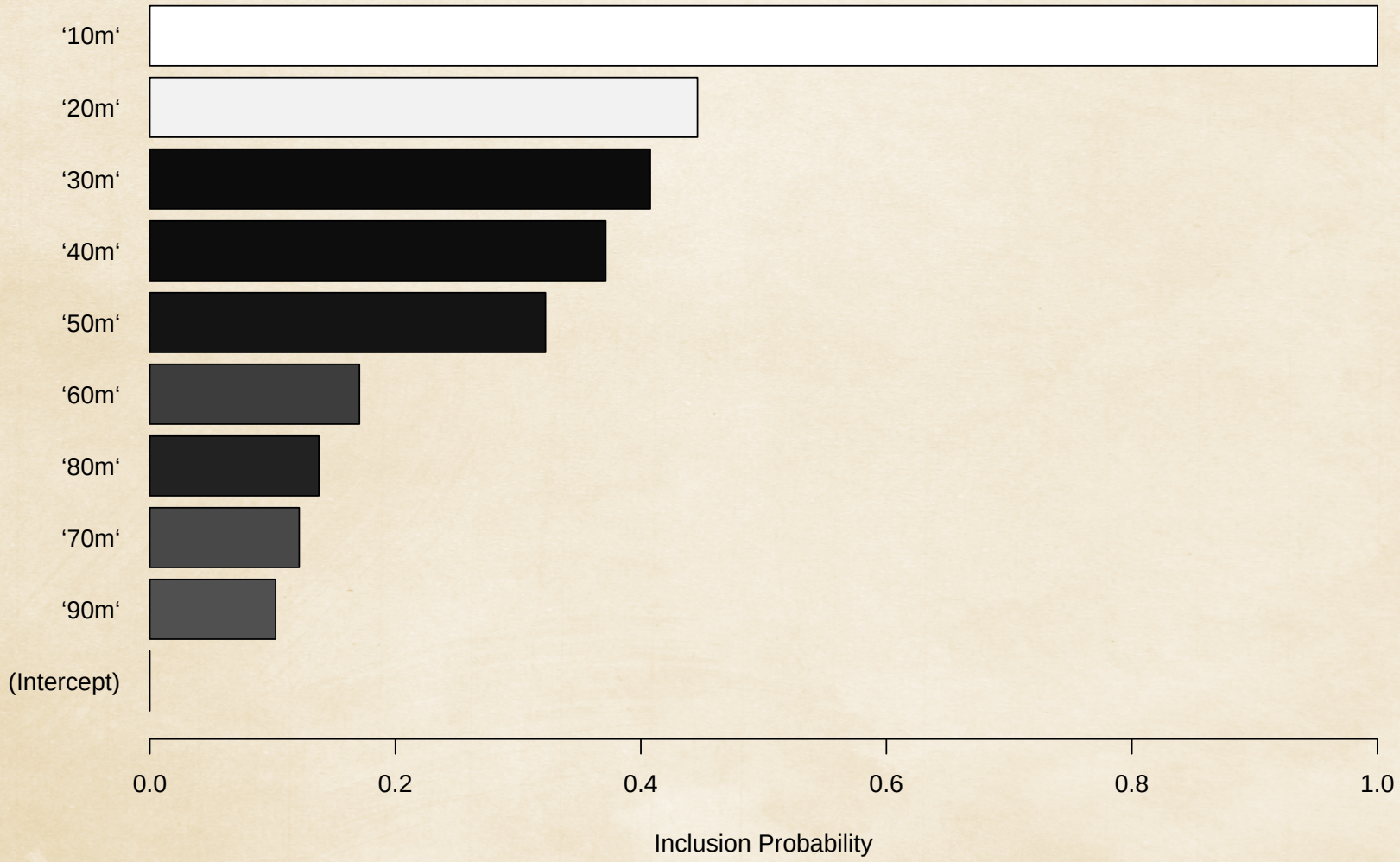
```
plot(model2, 'coefficients')
```



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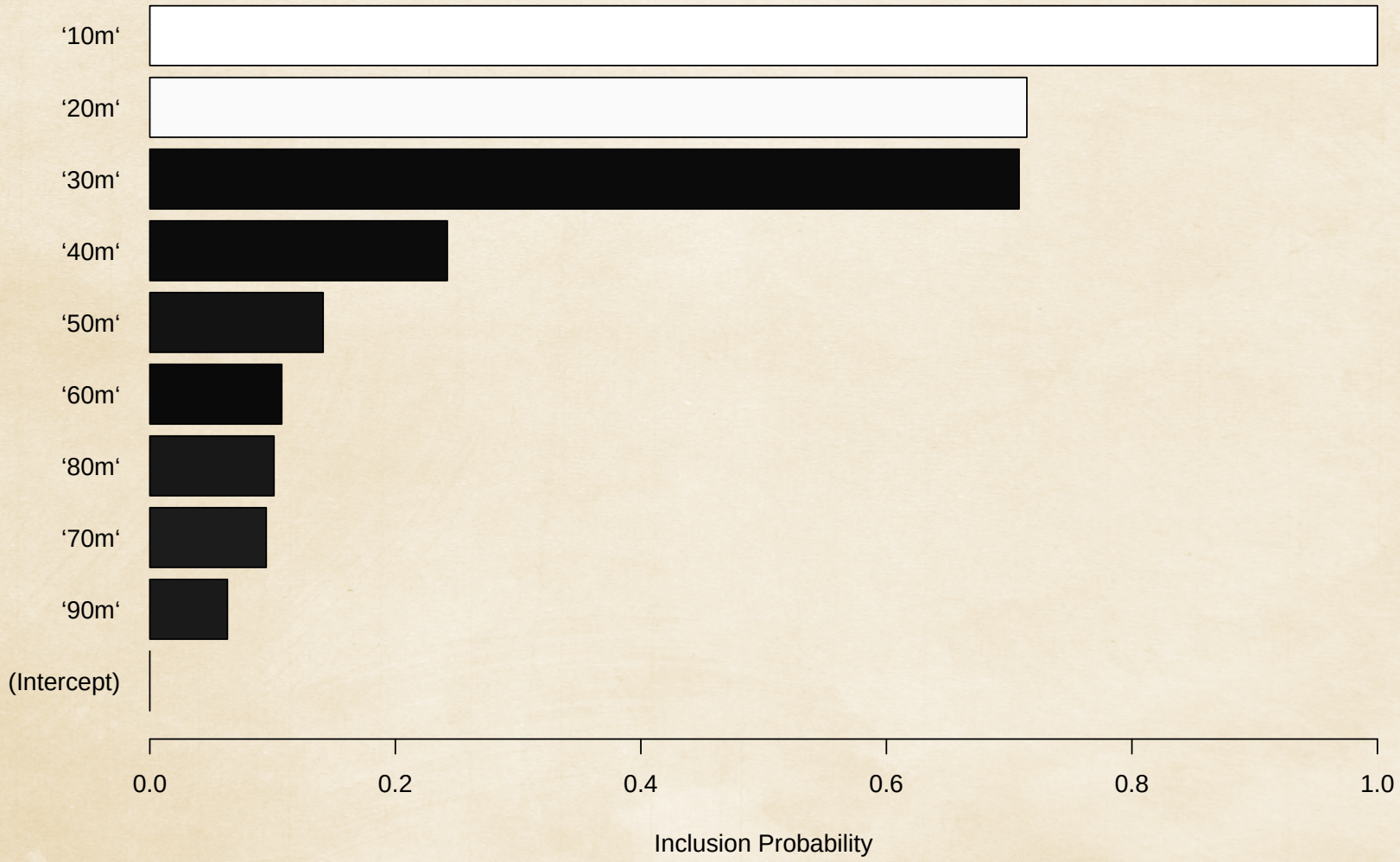
```
plot(model3, 'coefficients')
```



# 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')
```