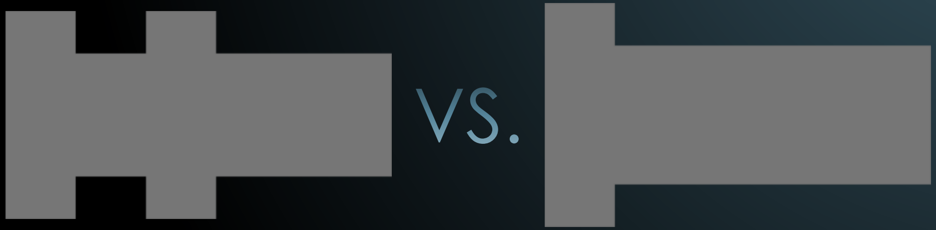
Somefin Fishy: Hydrodynamics of median fins

Dave Matthews

Project Goals

Use a robotic foil model to explore the roles of the dorsal fin in fish swimming

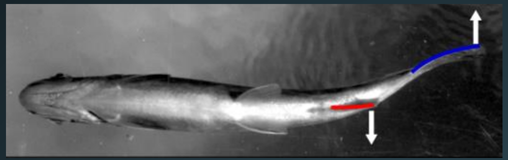
- Presence/absence



- Position

Predictors

- Phase angle (°)



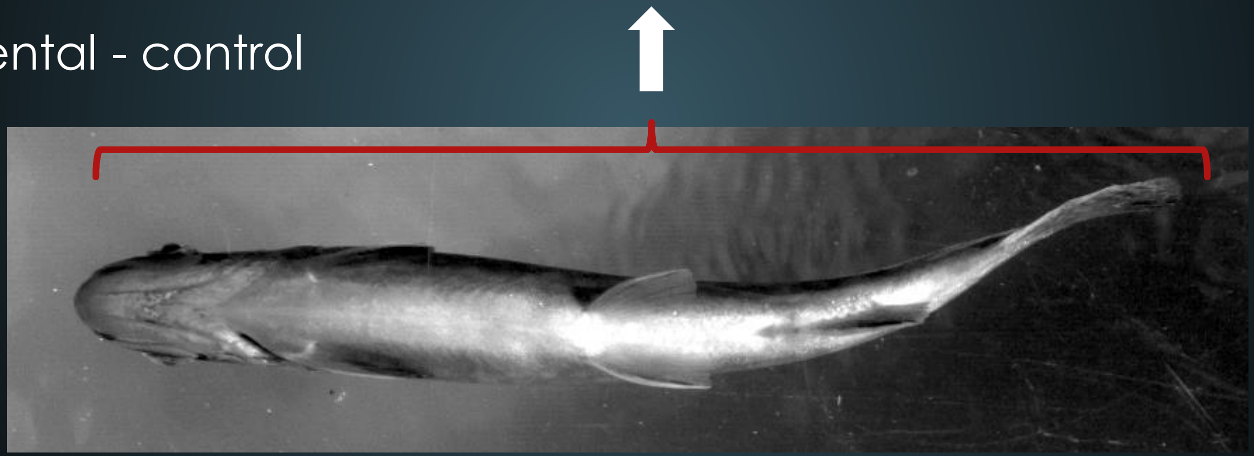
- Flapping amplitude ratio

- SPS (self propelled speed)

- Grouped by flapping frequency (HZ)

Response

- Lateral force
  - aka F_y
  - = Experimental - control



Fake Data

- Real data
  - Limited collection
  - Measured errors
- Created fake data with normal distributions around real data

"Grad school is stumbling from failure to failure with no loss of enthusiasm

-Winston Churchill"

-Lizzie Wolkovich

The Equation

- Fy ~ position + SPS + phase angle + Amplitude Ratio + (1 | frequency)
  - No interactions thanks to loo

Test Data

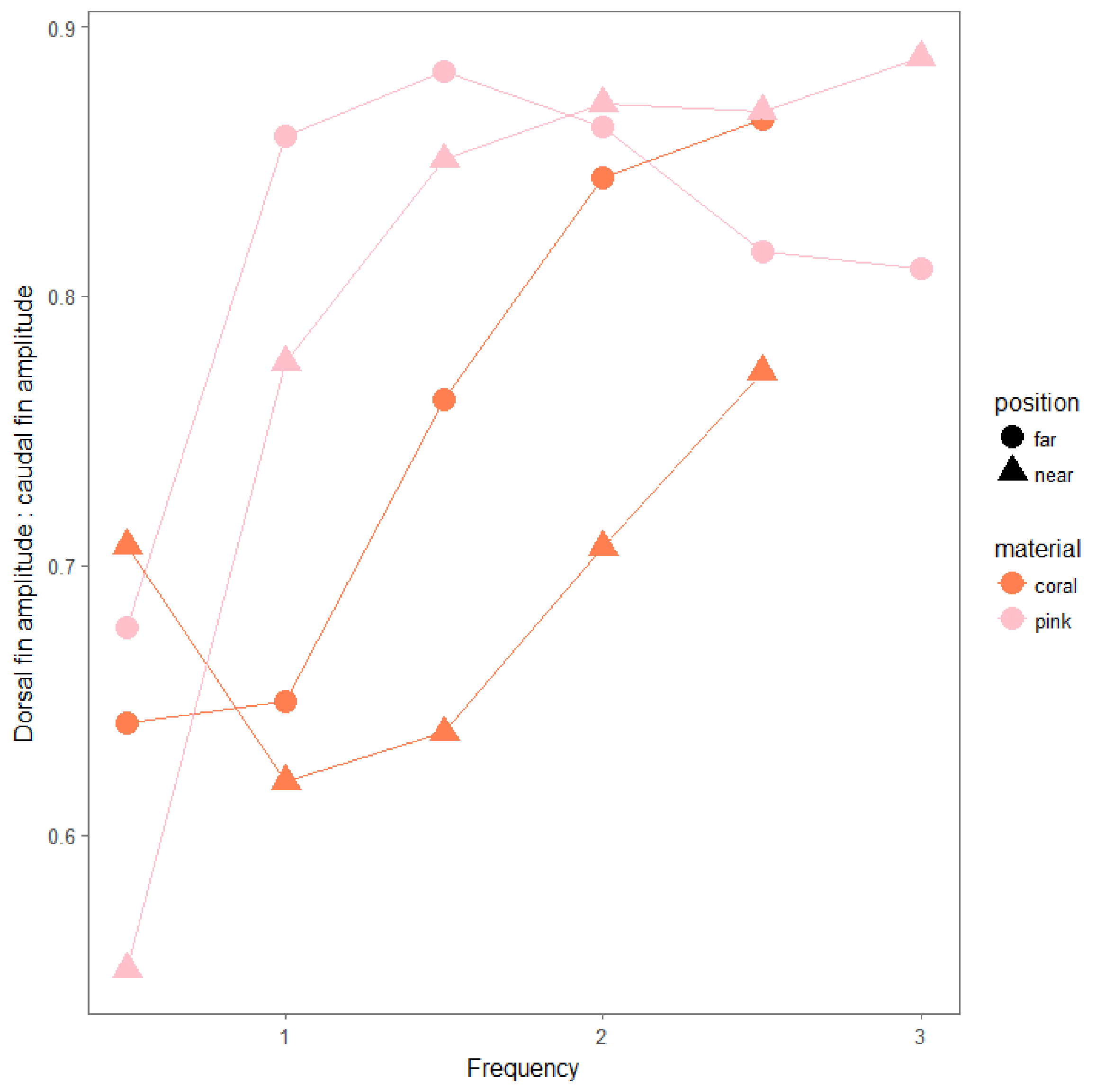
- Fy ~ position + SPS + phase angle + Amplitude Ratio + (1 | frequency)

Fake coefficients

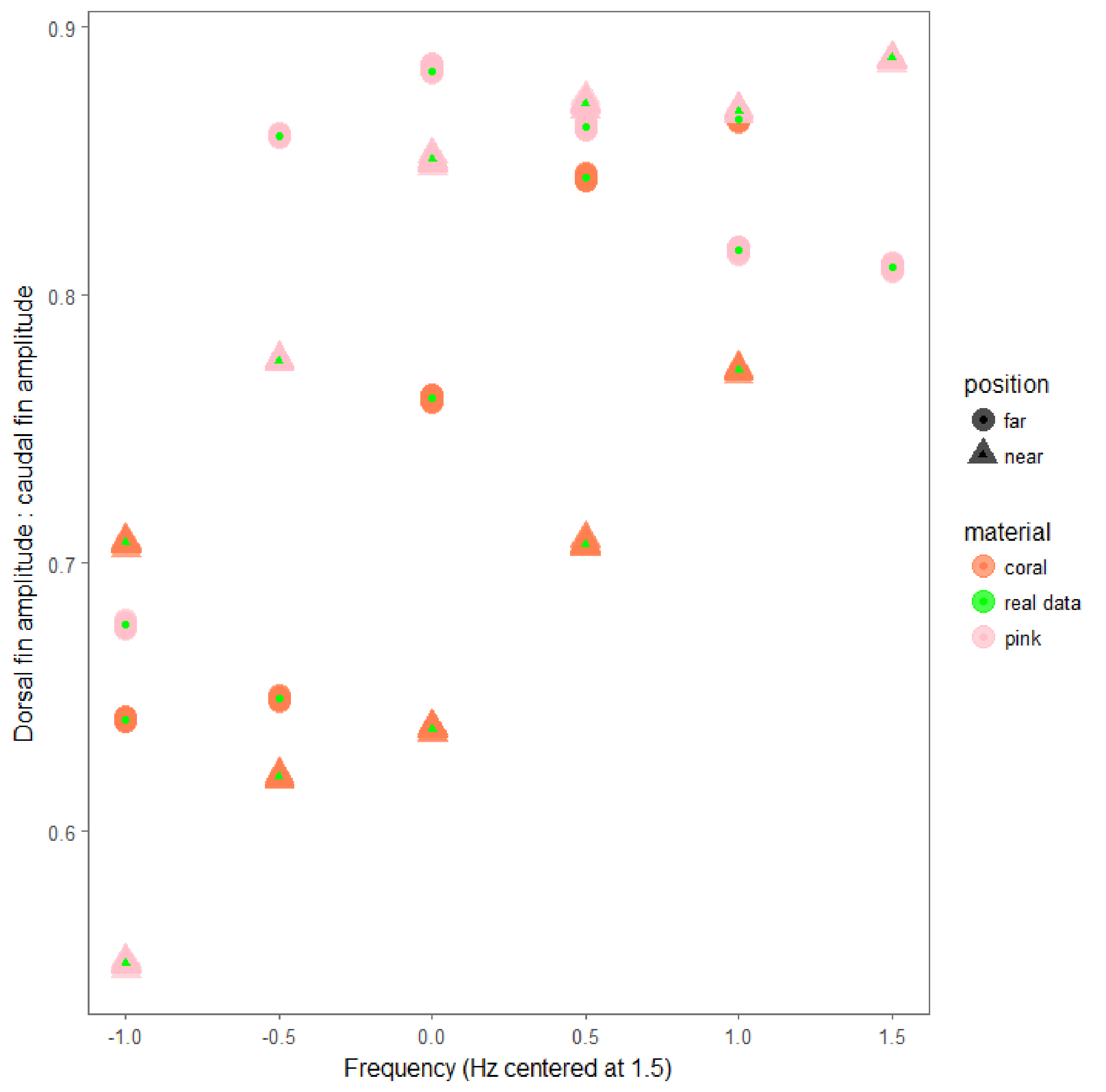
```
coefPos <- 50
range(fakeData$SPS) #-37 to 42
coefSPS <- 1
range(fakeData$phaseAng) #-51 to 49
coefAng <- -1
range(fakeData$flapAmpRatio) #-.22 to .12
coefAmpl <- -100
```

Fake data vectors

```
posVect <- c(rep(0,nTot/2), rep(1,nTot/2))
fakePosition <- sample(posVect, replace=FALSE)
fakeSPS <- rnorm(nTot, 35, 10)
fakeAng <- rnorm(nTot, 50, 15)
fakeAmpl <- rnorm(nTot, .15, .05)
freqGroup <- c(rep(1,10),rep(2,10),rep(3,10),rep(4,10),...
```



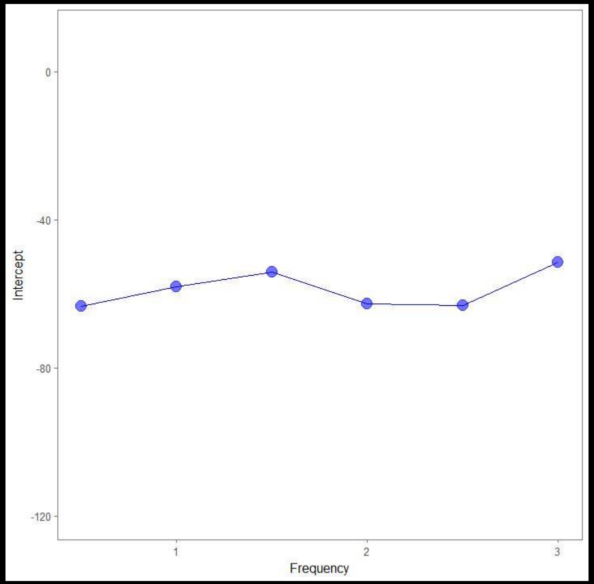
Dorsal fin amplitude : caudal fin amplitude
0.9
0.8
0.7
0.6
1
2
3
Frequency
position
far
near
material
coral
pink



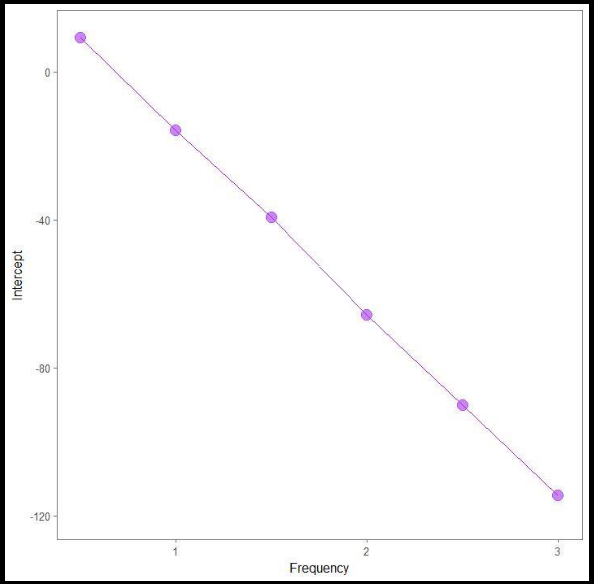
Dorsal fin amplitude : caudal fin amplitude
0.9
0.8
0.7
0.6
-1.0
-0.5
0.0
0.5
1.0
1.5
Frequency (Hz centered at 1.5)
position
far
near
material
coral
real data
pink

The Problem

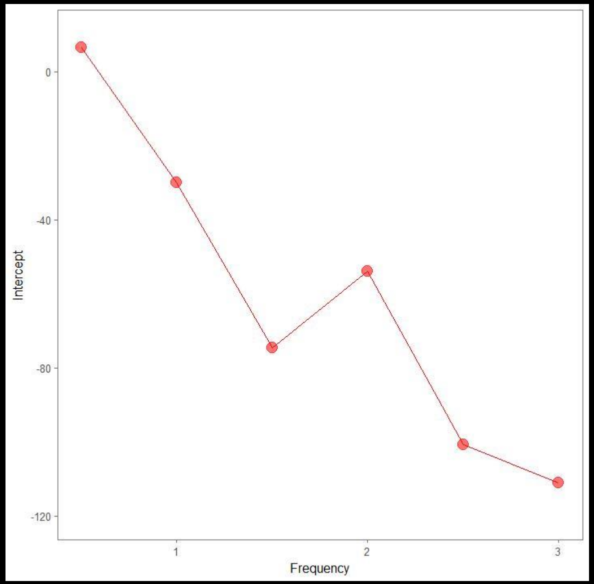
Data Analysis



What my model thinks my data does



What I think my data does

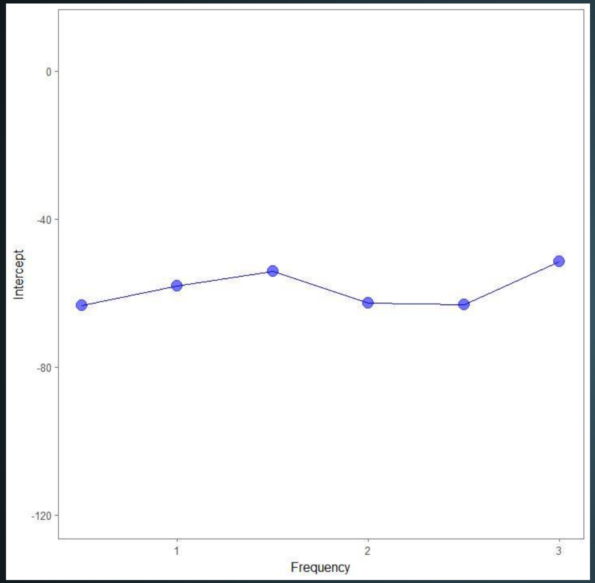


What my data actually does

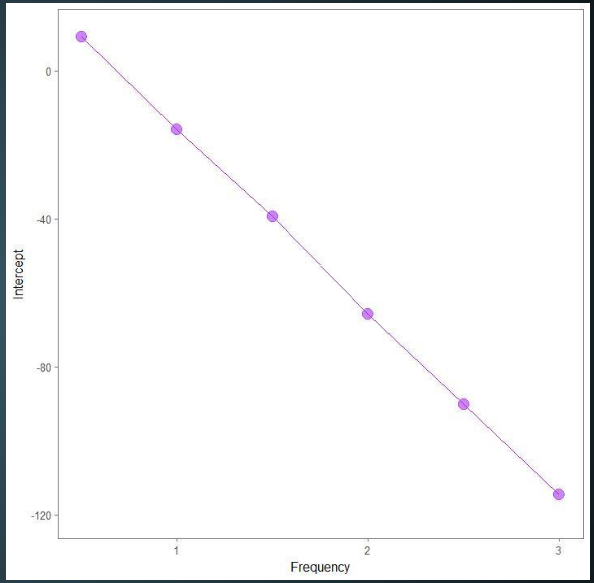
Fy ~ position + SPS + phase angle + Amplitude Ratio + (1 | frequency)

Fit both models!

“good” test data

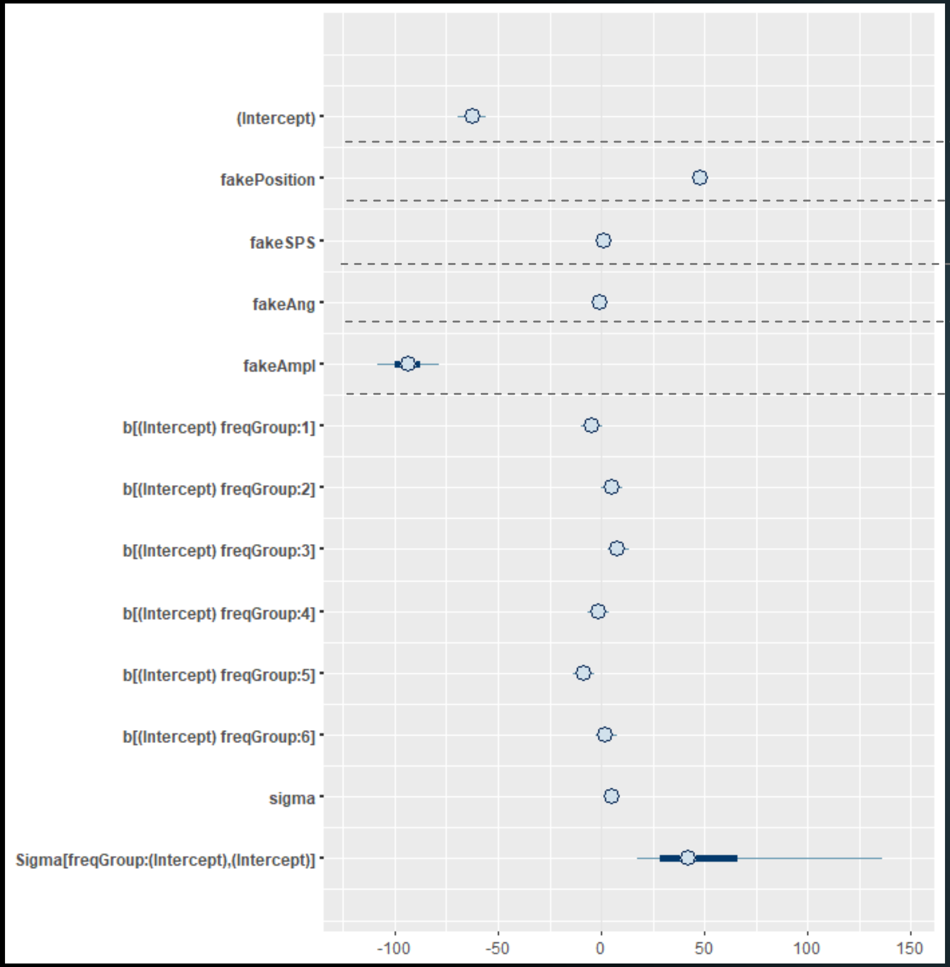


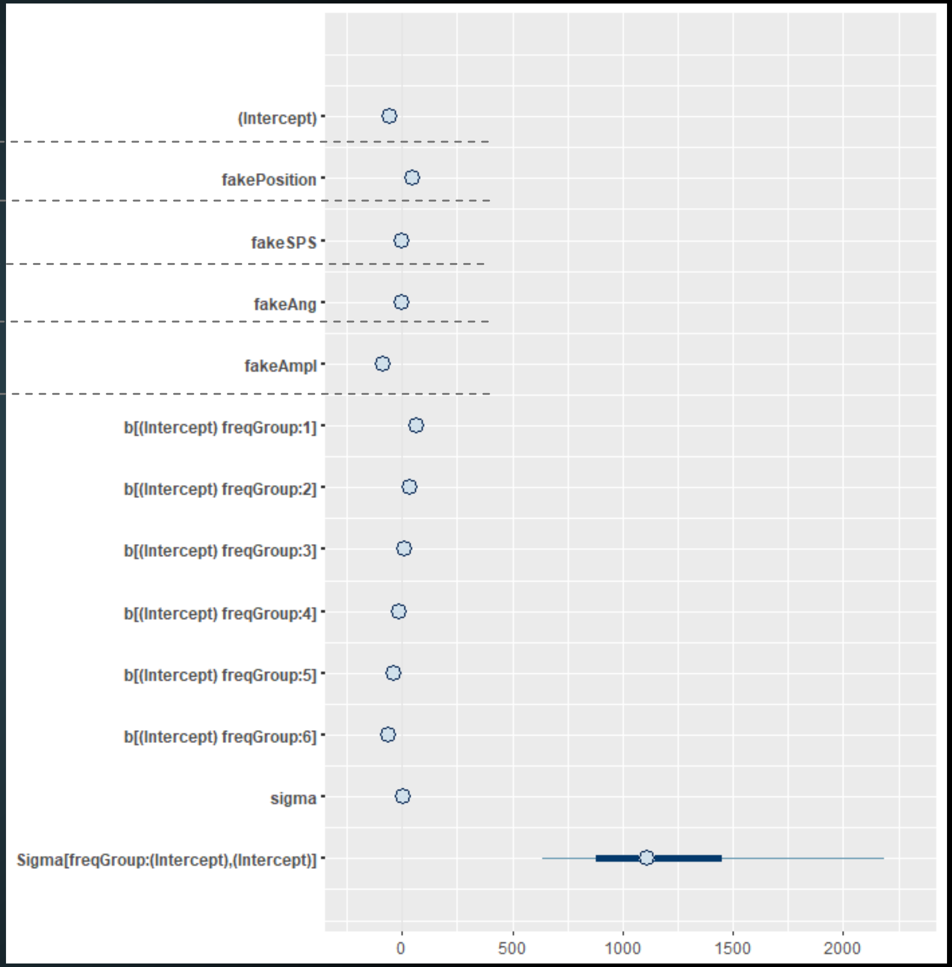
“bad” test data




```
#The Model (complex)
FyTestComp <- rep("NA", length(fakeSPS))
for(i in 1:length(fakeSPS)) {
  FyTestComp[i] <-  intComplex[freqGroup[i]]+coefPos*fakePosition[i]+coefSPS*fakeSPS[i]+coefAng*fakeAng[i]+coefAmpl*fakeAmpl[i]+rnorm(1,0,5)
}
```

“good” test data	“True” coefficients	“bad” test data
-62.4	-60	-54.8
48	50	49.2
1.1	1	1
-1	-1	-1
-93.2	-100	-89.5
60		1100

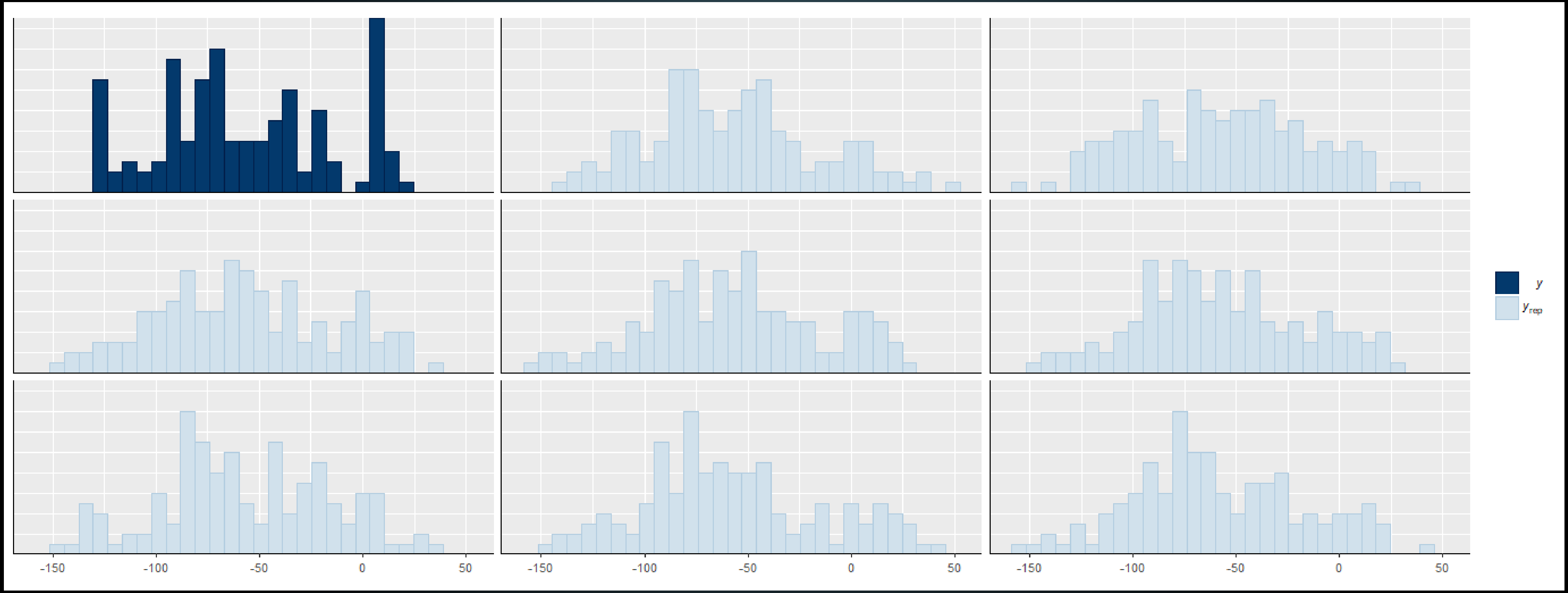




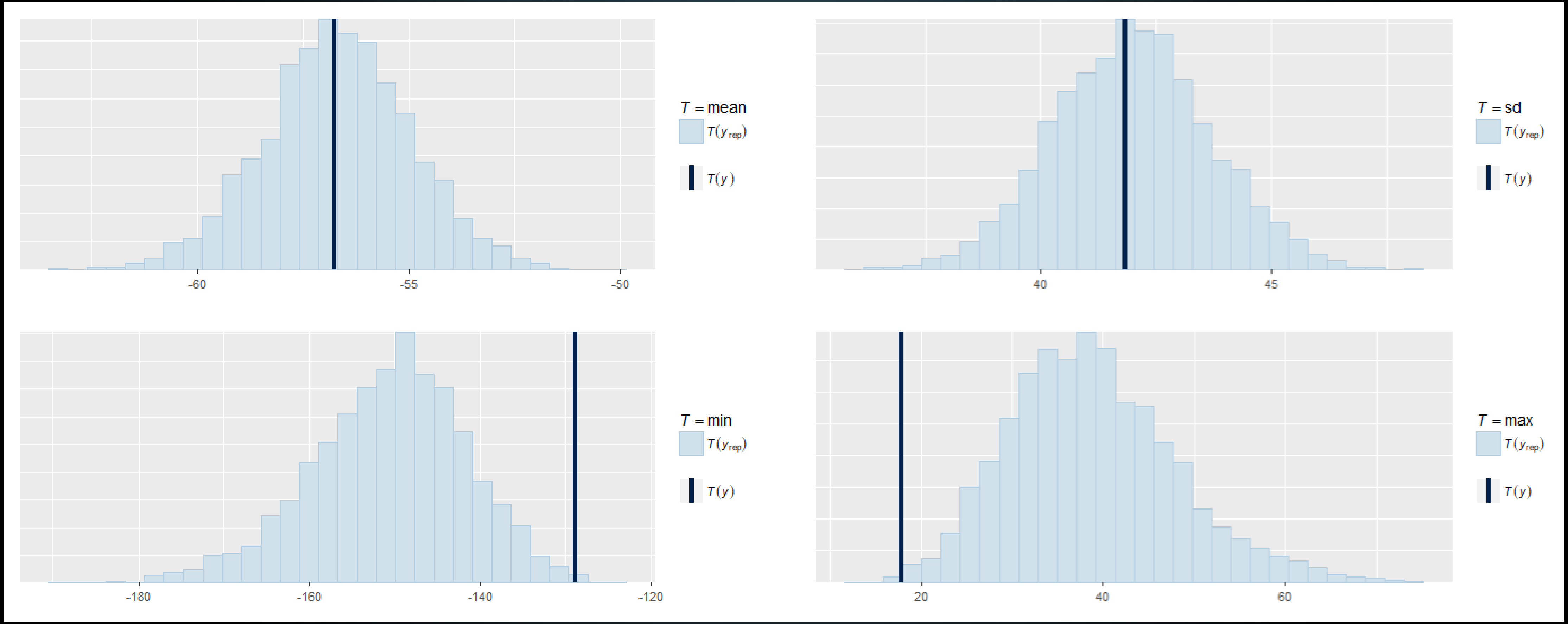
Good Enough!

ON TO THE REAL (FAKE) DATA

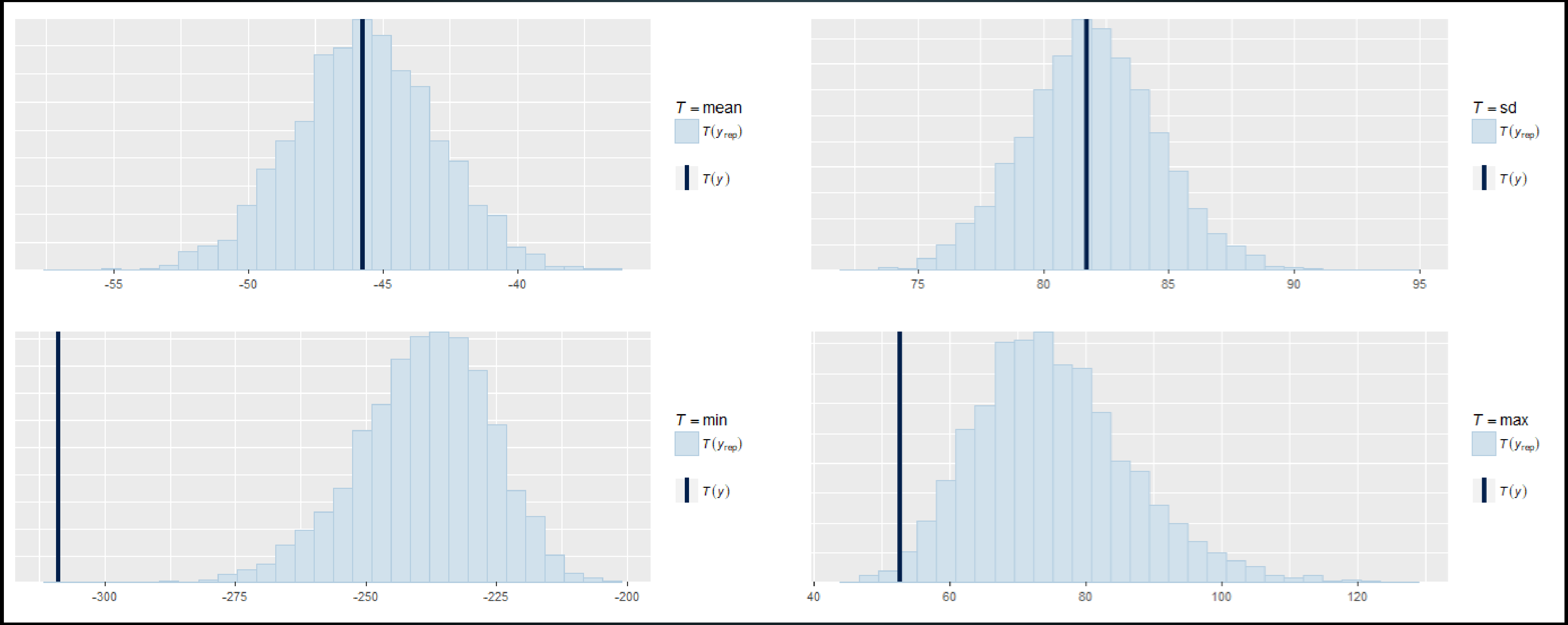
Posterior Predictive Checks (Pink)



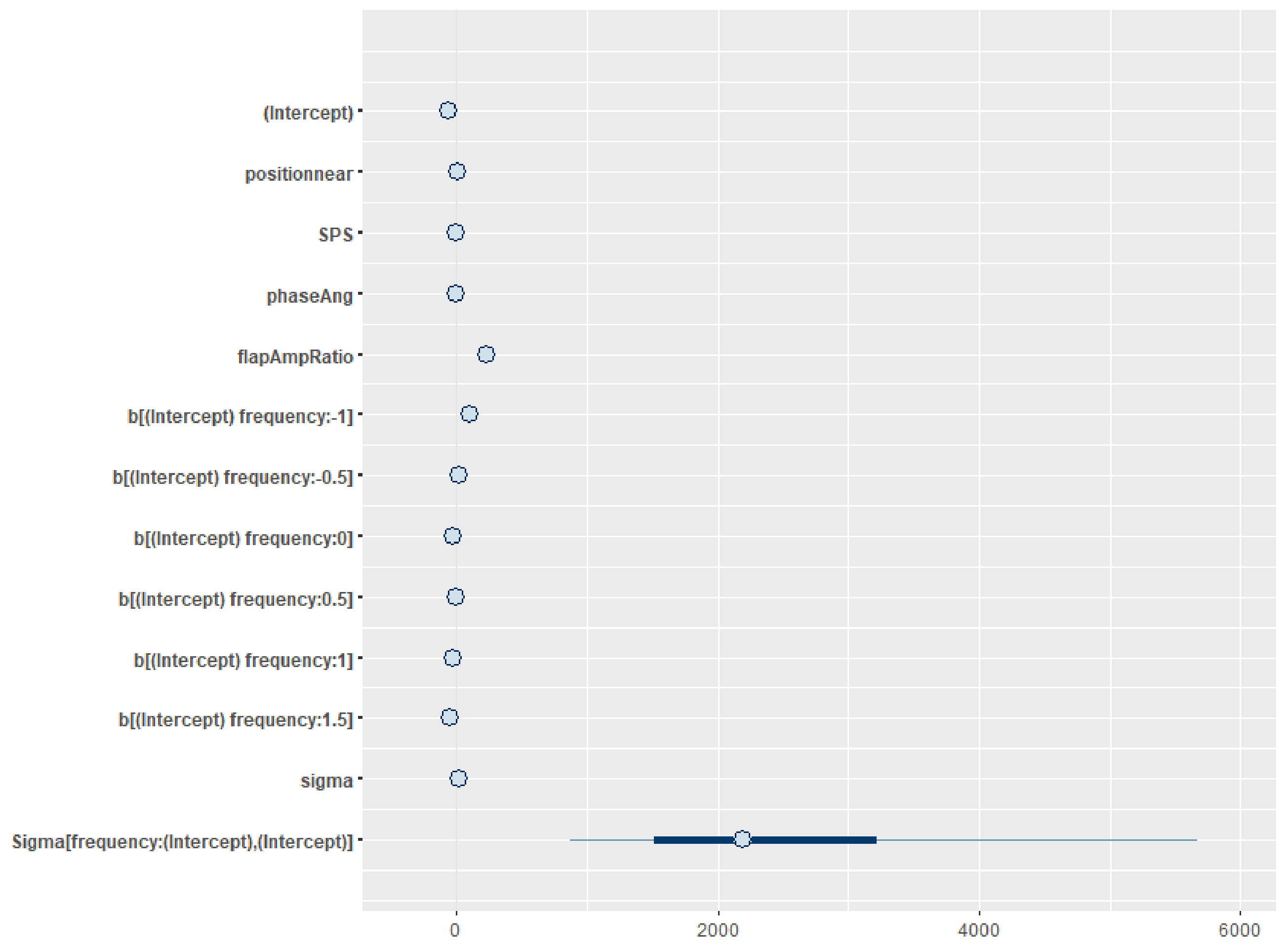
Posterior Predictive Checks (Pink)



Posterior Predictive Checks (Coral)

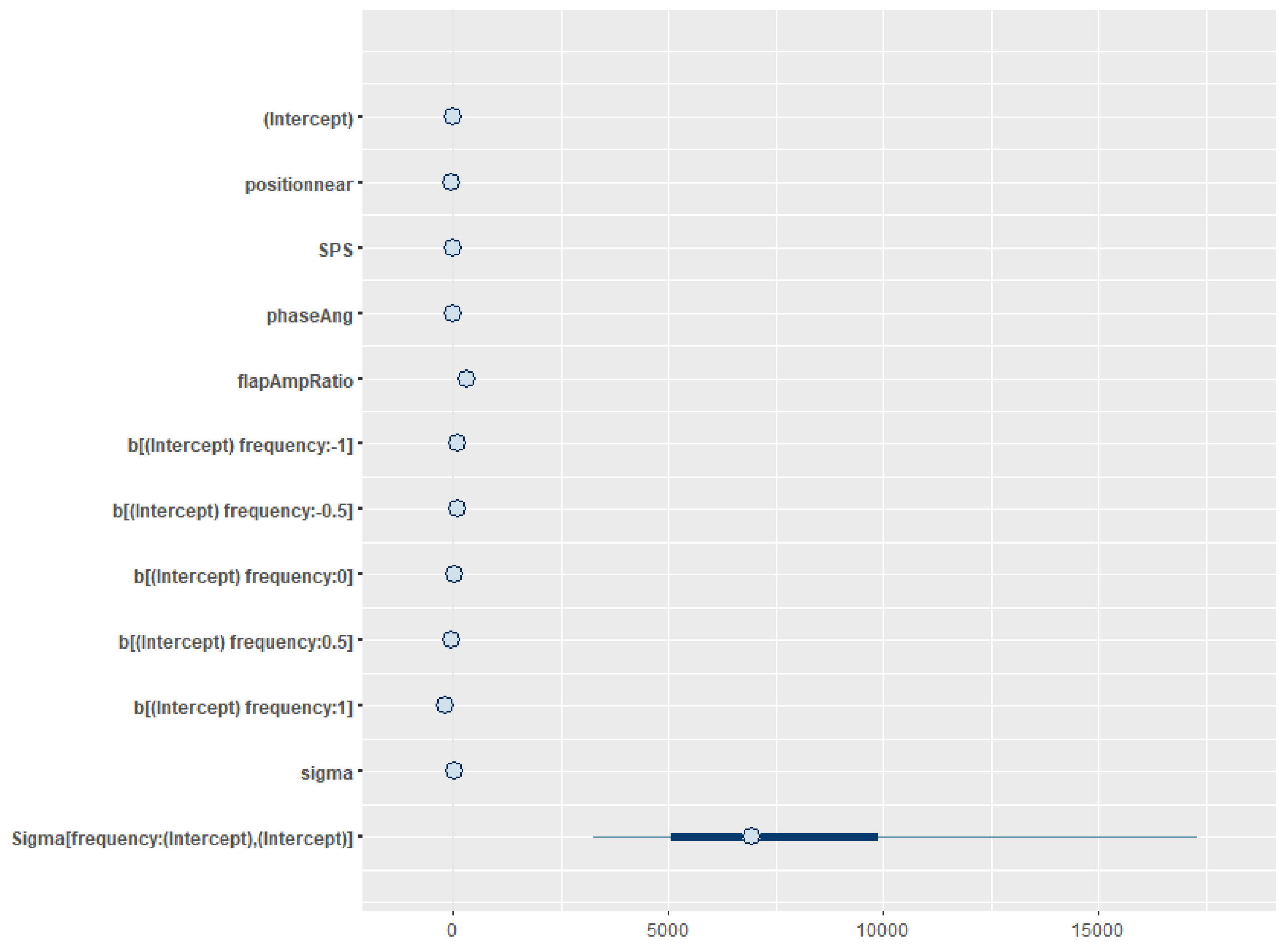


Model on Real (fake) Data (Pink)



- Intercept
  - -77.2, SD = 21.4
- Intercept (frequency=.5 Hz)
  - 110.8, SD = 23.3
- Intercept (frequency=2.5Hz)
  - -46.4, SD=21.8
- Intercept (frequency=3 Hz)
  - -53.4 SD = 22.8
- Position (near)
  - 20, SD = 6.9
- Amplitude ratio
  - 286.5, SD = 36.4

Model on Real (fake) Data (Coral)



- Intercept (frequency=1 Hz)
  - 83.6, SD = 42.7
- Intercept (frequency=2.5 Hz)
  - -153.1, SD = 49
- Amplitude ratio
  - 247.2, SD = 63.4

Main Results

- 2 models behave differently
  - Shape difference only mattered in pink
  - Effect of amplitude ratio consistent
- Next
  - Direct comparisons at each frequency

Now with real (real) data…