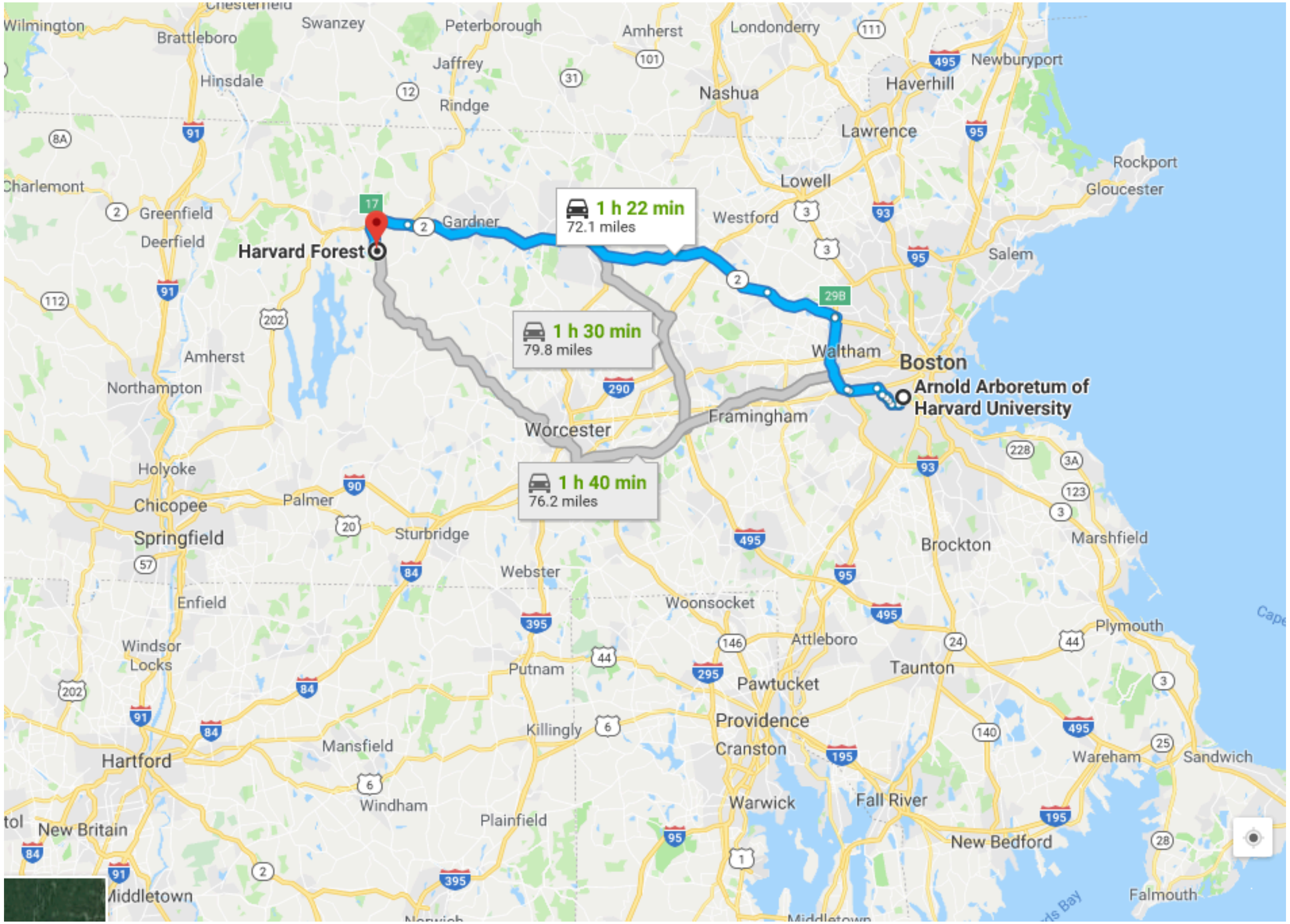
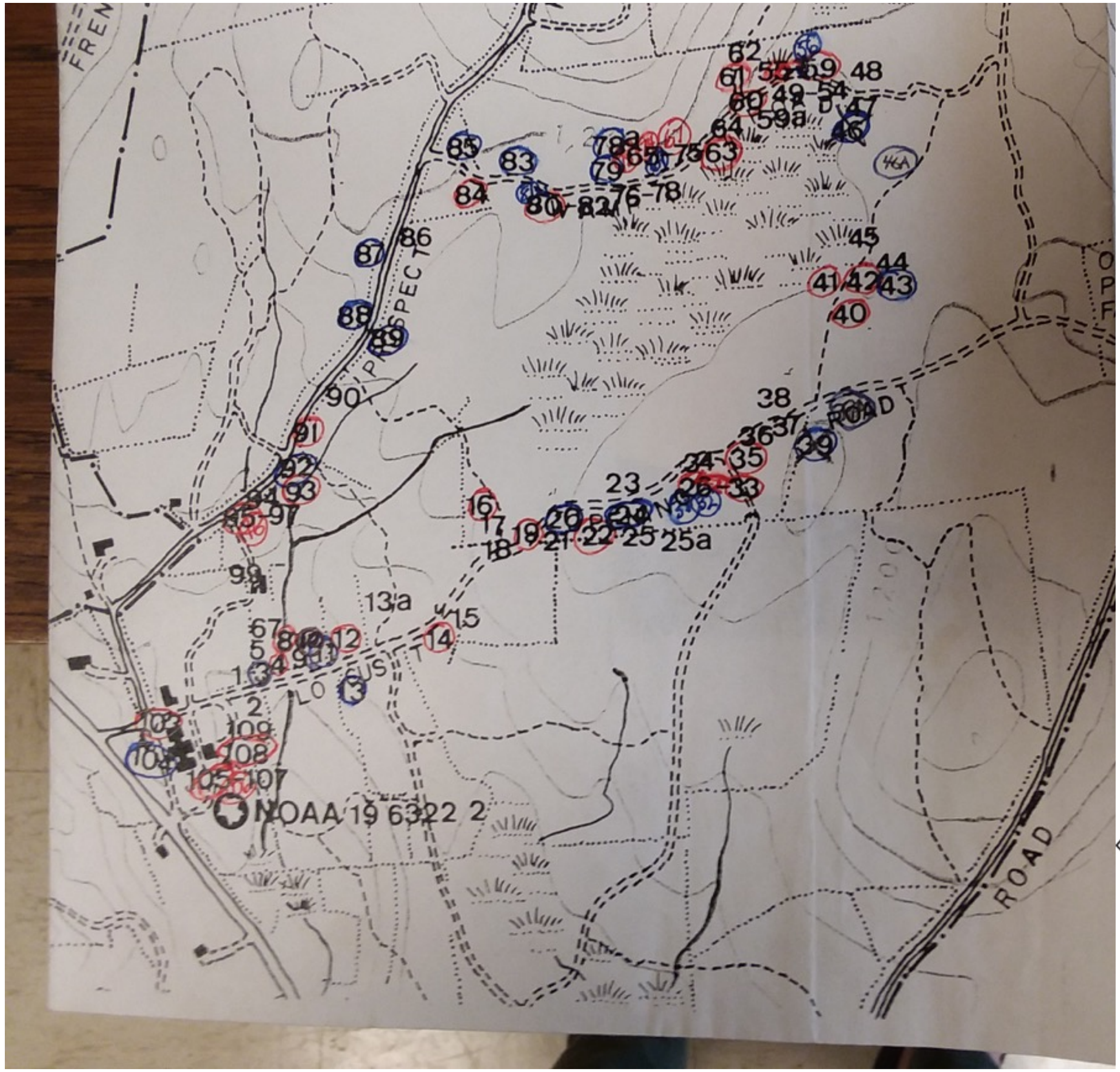
Study Question:



HARVARD FOREST

ARNOLD ARBORETUM


NOAA 19 6322 2
ROAD


The ARNOLD ARBORETUM of HARVARD UNIVERSITY
The Arnold Arboretum Tree Spotters
Beech Route
2 Trees
Birch Route
10 Trees
Hickory Route
10 Trees
Linden & North Woods Route
7 Trees
Maple Route
9 Trees
Oak Route
9 Trees
Peters Hill Route
10 Trees, 1 Shrub
Shrub Route
14 Shrubs
Hunnewell Visitor Center
Arborway Gate
Larz Anderson Bonsai Collection
Dana Greenhouses (No Public Access)
Centre Street Gate
Forest Hills Gate
Bradley Rosaceous Collection
Bussey Hill
Explorers Garden
South Street Gate
Hemlock Hill
Washington Street Gate
Walter Street Gate
Bussey Street Gate
Peters Hill Gate
Weld Hill
Peters Hill
Poplar Gate
Mendum Street Gate
Bussey Brook Meadow
N

APPROACH 1:

How do GDDs to leafout compare between hobo logger data and weather station data?

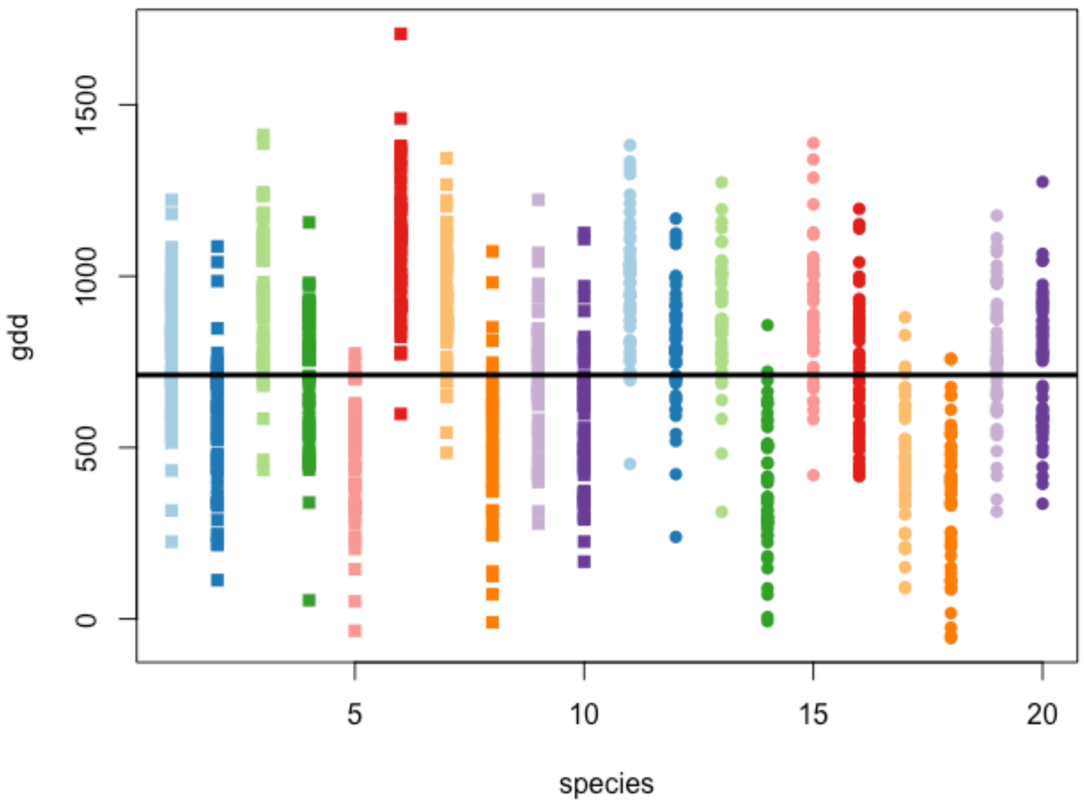
And how do these compare across sites?

GDDs ~ 1 + (1|species)

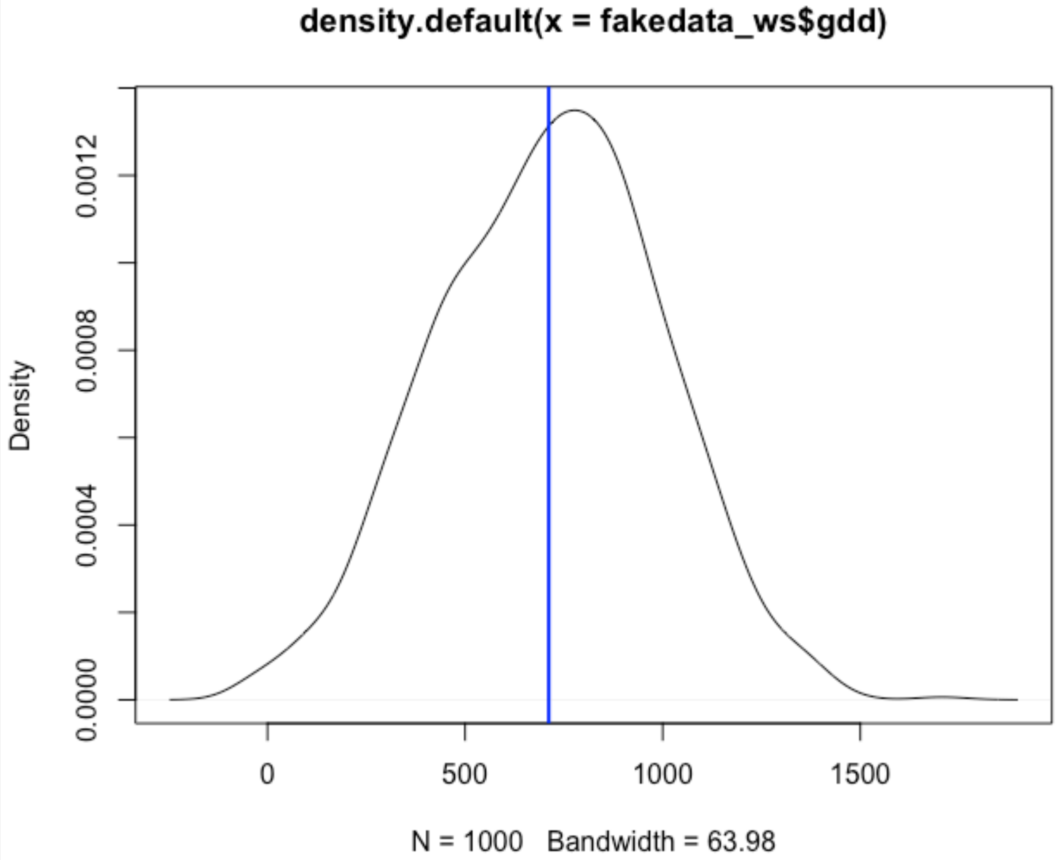
$$y_i \sim N(\boldsymbol{\mu}_i, \sigma)$$
$$y_i = \alpha_l + \sigma$$

```r
### WEATHER STATION DATA MODEL SIMULATION
### Okay, now let's make some fake data using help Rethinking, Gelman, OSPREE and Geoff
#  1) Let's make the observations much higher than the actual data to build a good model.
nsp = 20 # number of species
ntot = 50 # numbers of obs per species.

sample_a <- list(int.env = rnorm(1000, 700, 200))

#  2) Now, we will make varying intercepts
int.samples <- sapply(sample_a, FUN = function(x){
  sample(x, size = nsp * ntot, replace = TRUE)})

#  4) We need to make a random intercept model for each species
baseinter <- list(intercept = mean(int.samples))
baseinter.mat <- matrix(unlist(baseinter), ncol = length(baseinter), nrow = nsp * ntot, byrow = TRUE)
  ## From Geoff's simulate-linear.R code in OSPREE: Which parameters are random?
random.inter <- grep(pattern = paste("intercept", collapse = "|"), x = names(baseinter))
# Generate random intercepts (by species)
for(i in 1:length(random.inter)){
  baseinter.mat[, i] <- sapply(1:nsp, FUN = function(X){
    rep(rnorm(n = 1, mean = baseinter[[random.inter[i]]], sd = 200), ntot)})}

#  5) Calculate response
response <- sapply(1:nrow(int.samples), FUN = function(x){
    rnorm(n = 1, mean = baseinter.mat[x, ], sd = 200)})
```

```r
#  6) Make a dataframe of fake data
fakedata_ws <- cbind(data.frame(species = as.vector(sapply(1:nsp, FUN = function(x) rep(x, ntot))),
                 gdd = response))
```



gdd
1500
1000
500
0
5
10
15
20
species

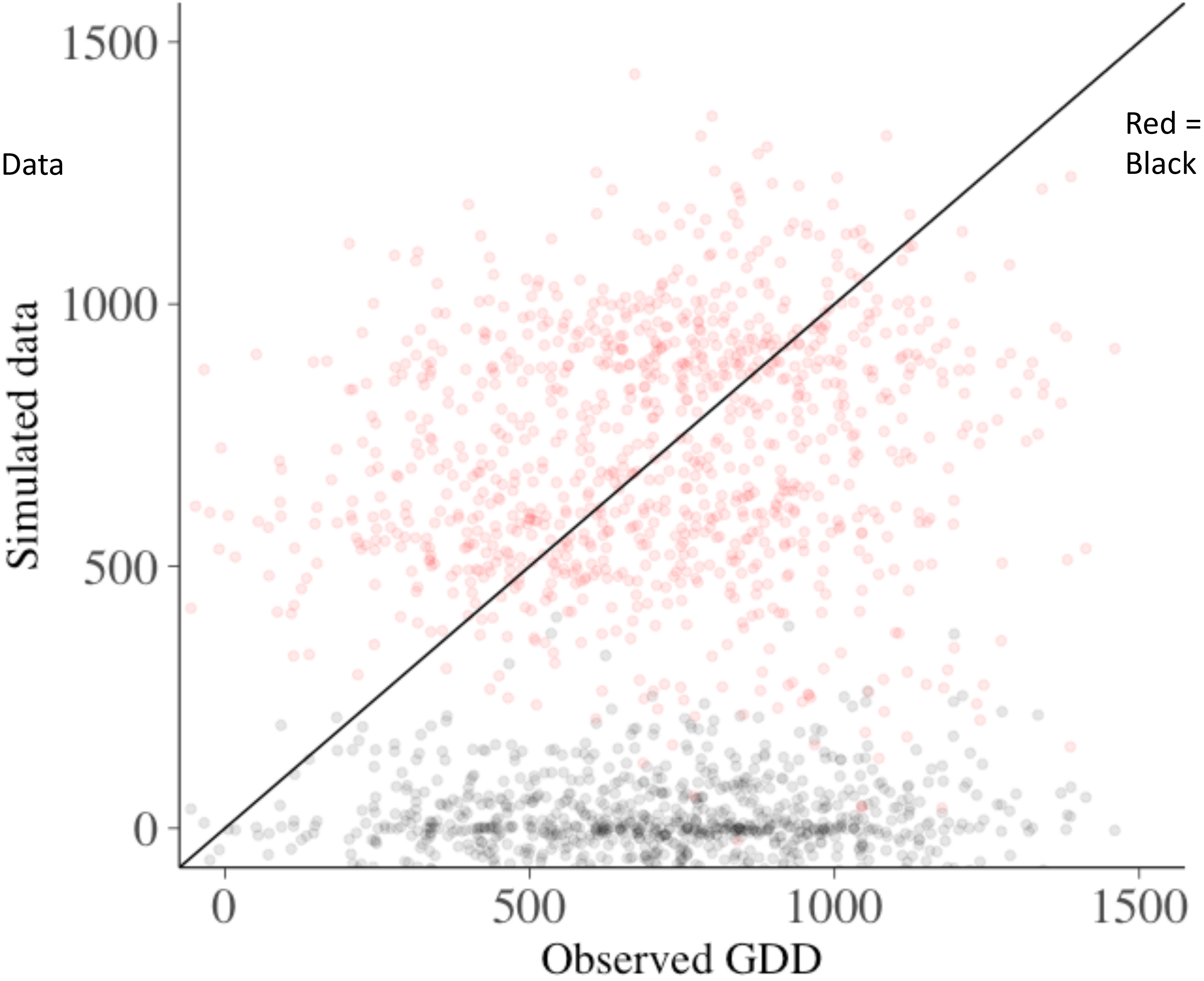


density.default(x = fakedata_ws$gdd)
Density
0.0000
0.0004
0.0008
0.0012
0
500
1000
1500
N = 1000 Bandwidth = 63.98

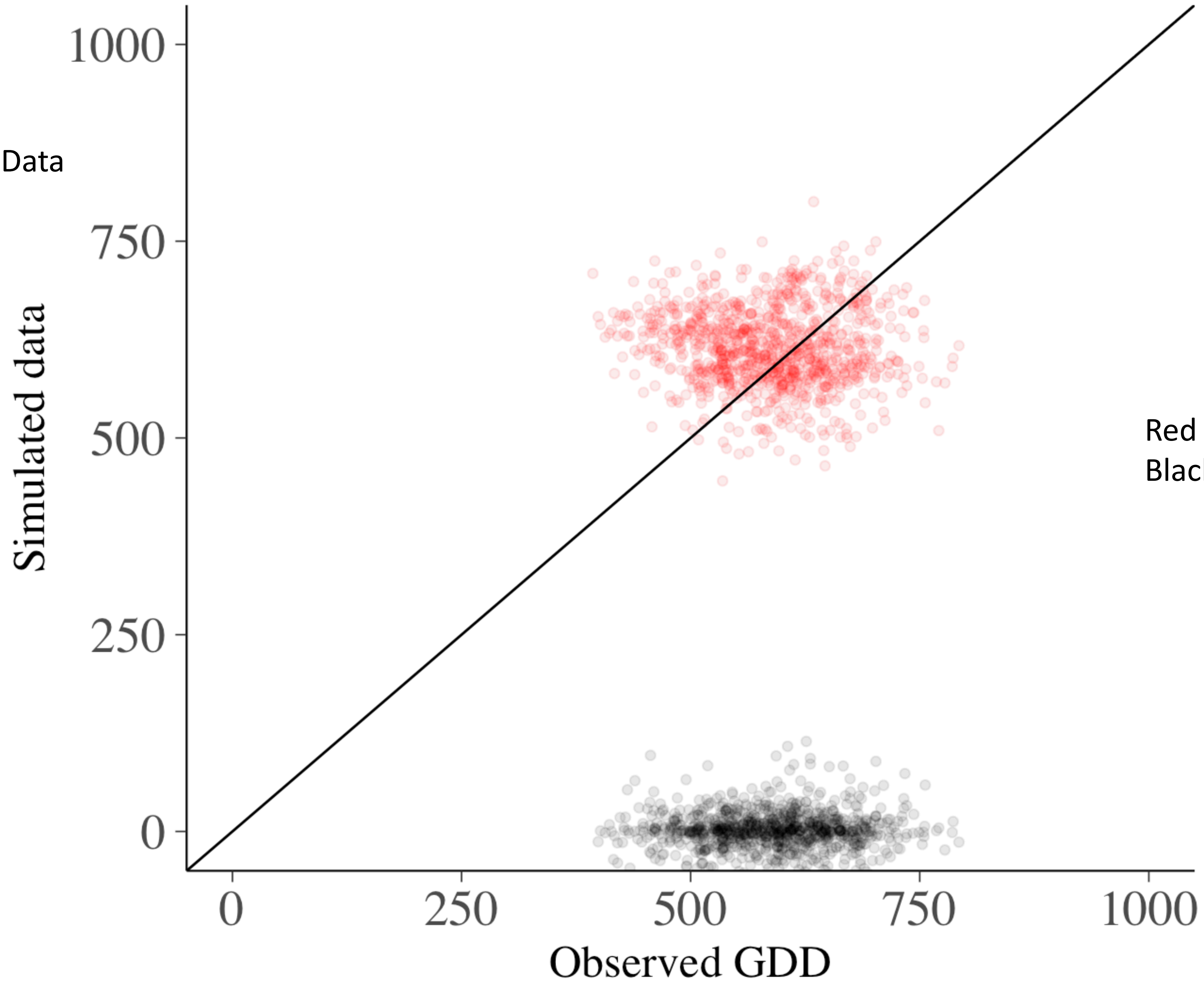
```r

## PRIOR PREDICTIVE CHECK time!!
# Now I will follow the workflow from the Gabry et al., 2019 paper
## Using vague priors
nsims <- length(fakedata_ws$species)
alpha <- rnorm(20, 700, 200)
sigma <- runif(20, 0, 200)

data1 <- data.frame(
  gdd = fakedata_ws$gdd,
  sim = alpha[fakedata_ws$species] +
    rnorm(nsims, mean = 0, sd = sigma)
)

xysim_labs <- labs(
  x = "Observed GDD",
  y = "Simulated data"
)

theme_set(bayesplot::theme_default(base_size = 18))
theme_update(axis.text = element_text(size = 20))

ggplot(data1, aes(x = gdd, y = sim)) +
  geom_point(alpha = 0.1, color = "red") +
  xysim_labs + coord_cartesian(xlim=c(0, 1500), ylim=c(0,1500)) + geom_abline(intercept=0, slope=1)

```

```r
## Using weakly informative priors
alpha2 <- rnorm(20, 0, 1)
sigma2 <- runif(20, 0, 1)

```

Weather Station Data



Hobo Logger Data



Red = vague priors
Black = weakly informative

APPROACH 2:

Let’s try and see if there’s an `urban’ effect by combining sites into one model.

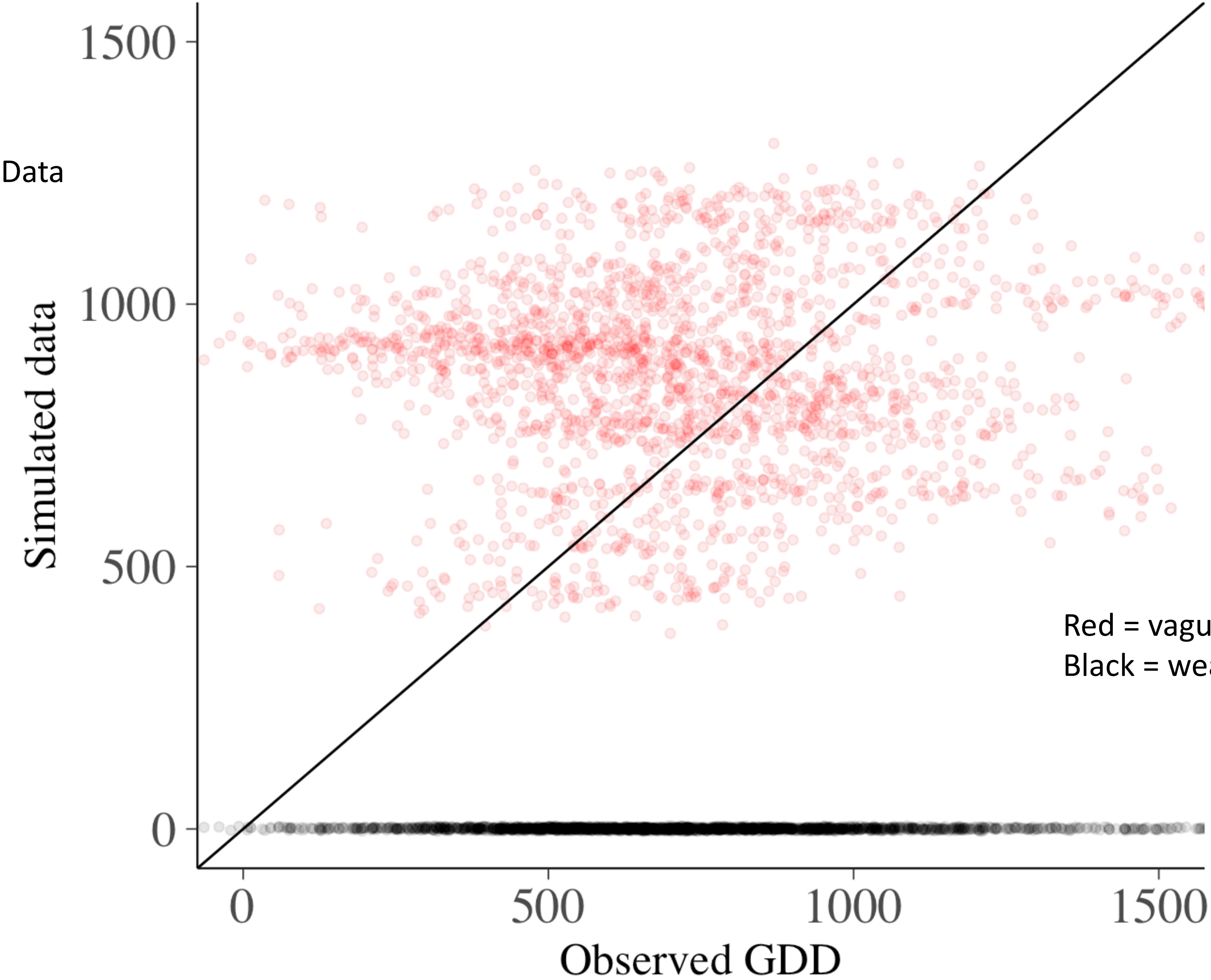
Again compare weather station data to hobo logger data in separate models

GDDlo ~ urban + (urban|species)

$$y_i \sim N(\boldsymbol{\mu}_i, \sigma)$$

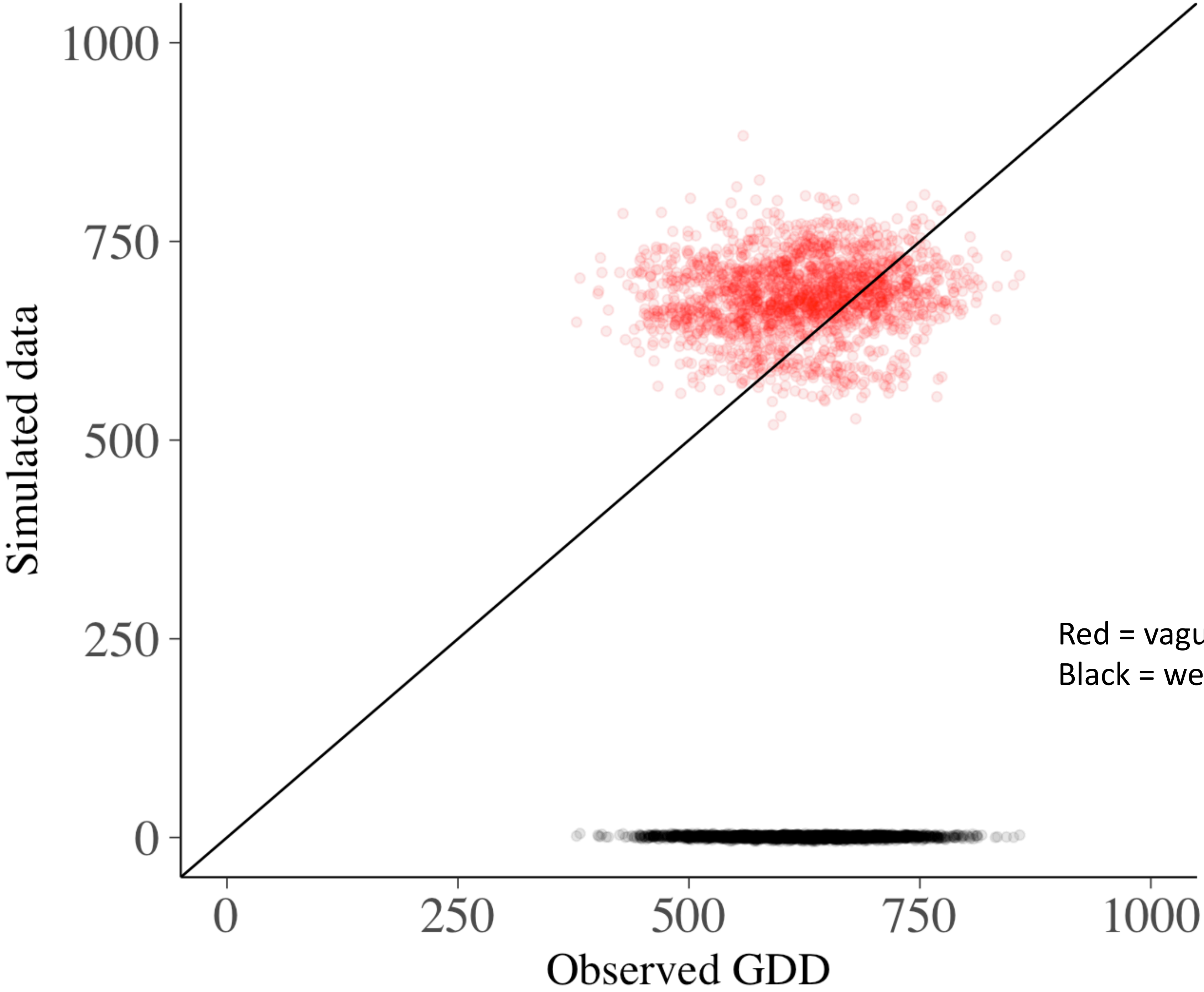
$$y_i = \alpha_l + \beta x_l + \sigma$$

Weather Station Data

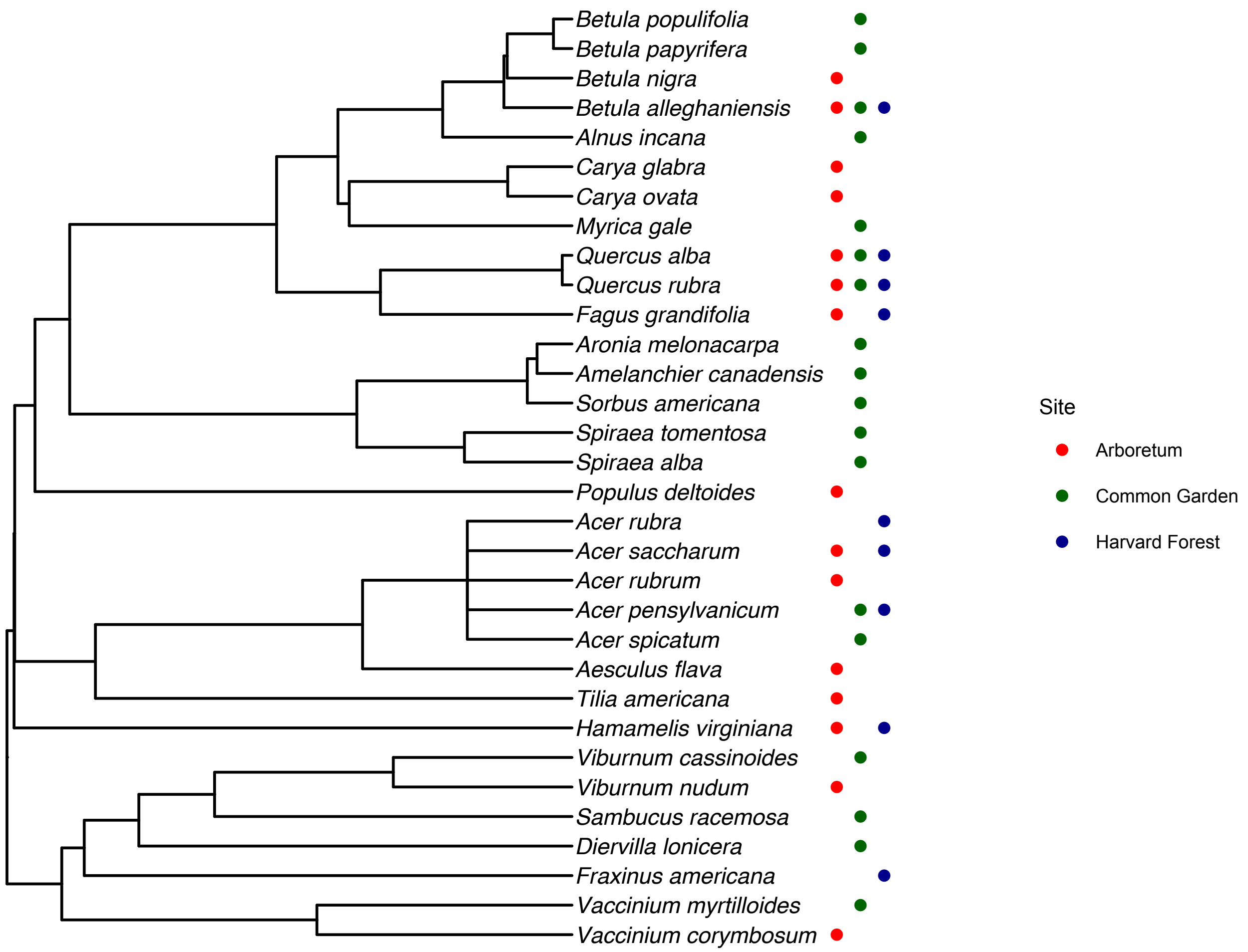


Red = vague priors
Black = weakly informative

Hobo Logger Data



Red = vague priors
Black = weakly informative



Betula populifolia
Betula papyrifera
Betula nigra
Betula alleghaniensis
Alnus incana
Carya glabra
Carya ovata
Myrica gale
Quercus alba
Quercus rubra
Fagus grandifolia
Aronia melonacarpa
Amelanchier canadensis
Sorbus americana
Spiraea tomentosa
Spiraea alba
Populus deltoides
Acer rubra
Acer saccharum
Acer rubrum
Acer pensylvanicum
Acer spicatum
Aesculus flava
Tilia americana
Hamamelis virginiana
Viburnum cassinoides
Viburnum nudum
Sambucus racemosa
Diervilla lonicera
Fraxinus americana
Vaccinium myrtilloides
Vaccinium corymbosum
Site
Arboretum
Common Garden
Harvard Forest