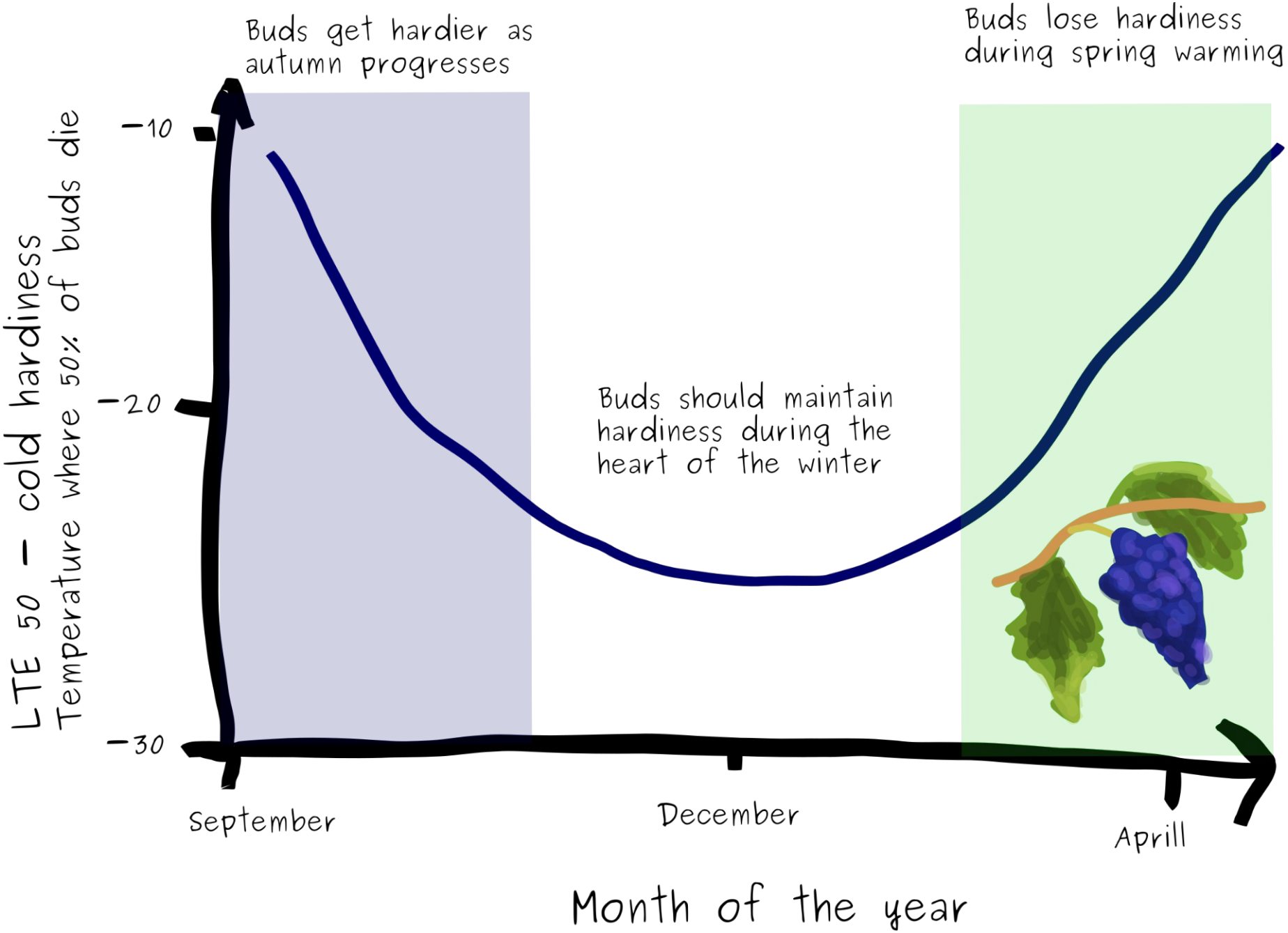
Cold hardiness model

Mixed model with three grouping factors on the intercept


Buds get hardier as autumn progresses
Buds lose hardiness during spring warming
LTE 50 – cold hardiness
Temperature where 50% of buds die
-10
-20
-30
Buds should maintain hardiness during the heart of the winter
September
December
Aprill
Month of the year

Background

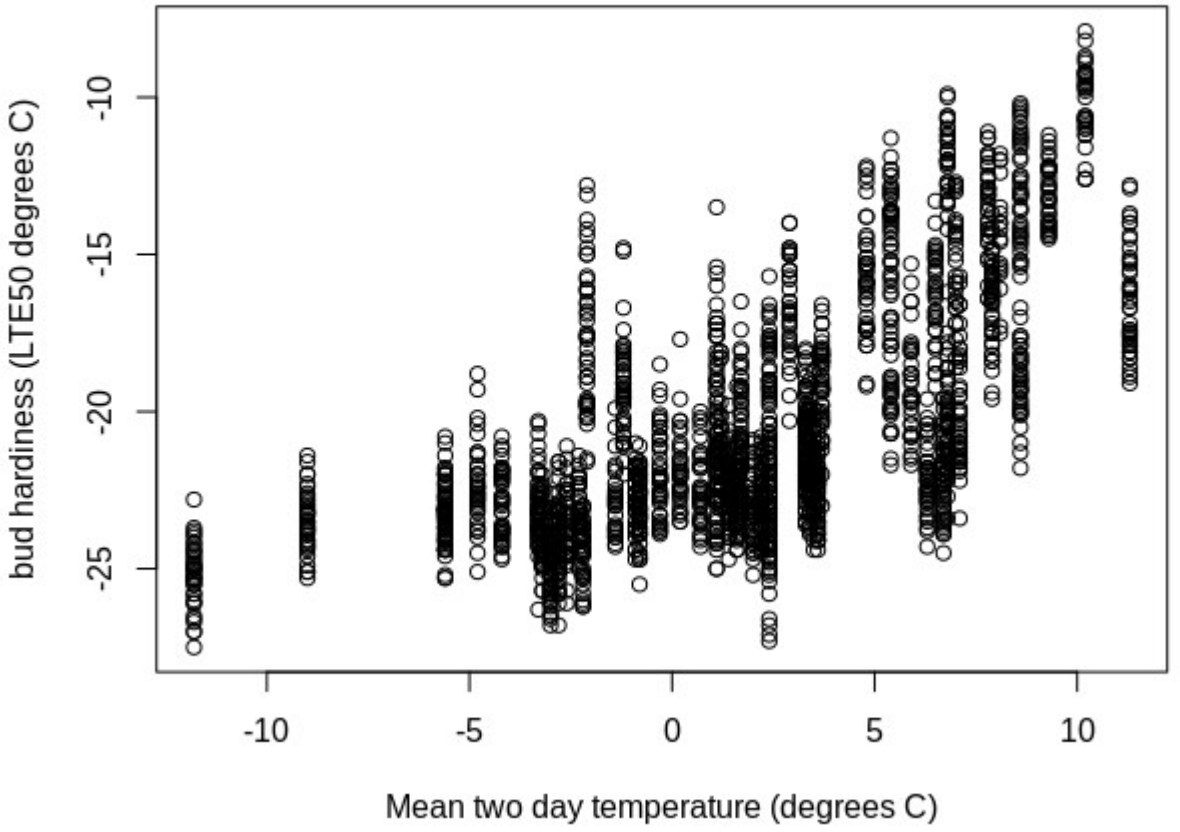
Aim: Partition the variation on winter hardiness (LTE50) into variation by variety, year and site location

Background

Question: Is variety more influential than site in determining wine grape bud hardiness?

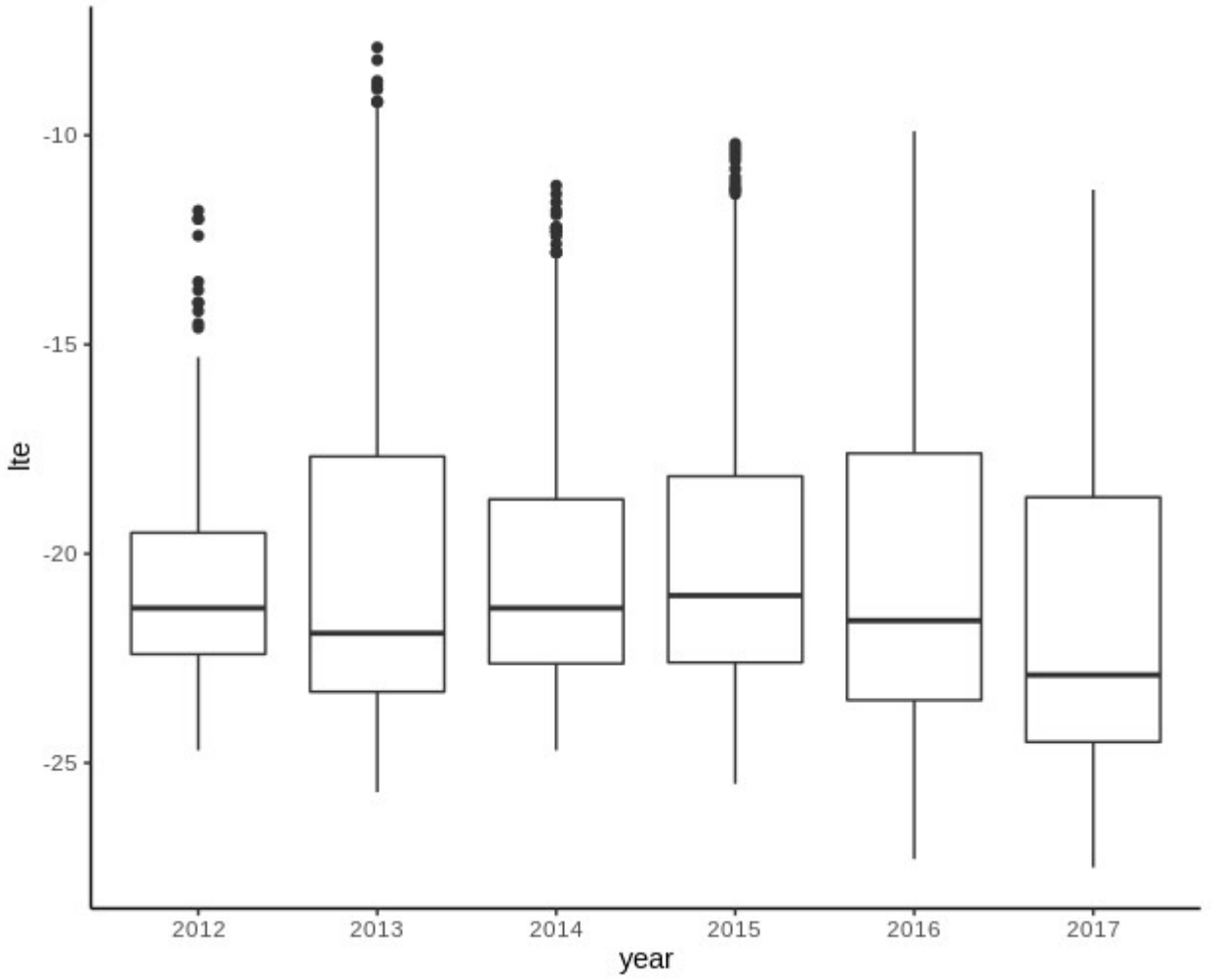
- Expect much less variation attributed to site if hardiness is controlled strongly by variety's physiology
- If lots of variation by site, this variation could be evidence of phenotypic plasticity, between clone variation or the effect of rootstock

Data

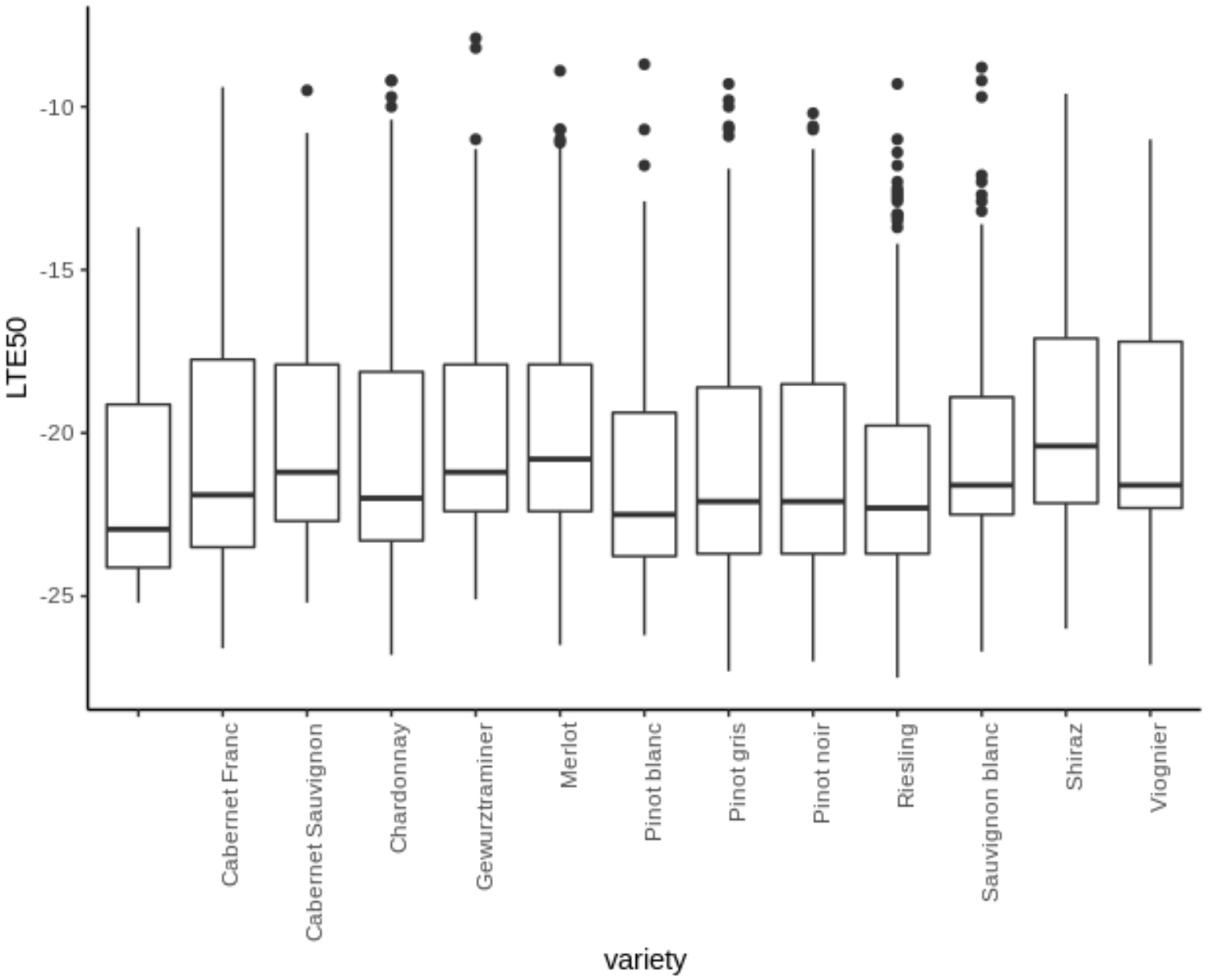


	Cabernet Franc	Cabernet Sauvignon	Chardonnay	Gewurztraminer	Merlot	Pinot blanc	Pinot gris	Pinot noir	Riesling	Sauvignon blanc	Shiraz	Viognier
Black Sage	59	59	59	0	59	59	59	59	94	24	59	0
Kelowna	0	0	0	35	0	0	0	59	59	0	0	0
Naramata Bench	0	0	59	0	0	0	59	35	35	0	0	0
OK Falls	0	0	59	59	0	0	59	0	0	0	0	0
Oliver	59	0	59	59	59	59	118	0	59	118	0	0
Osoyoos	35	177	59	0	94	0	0	59	0	0	247	35

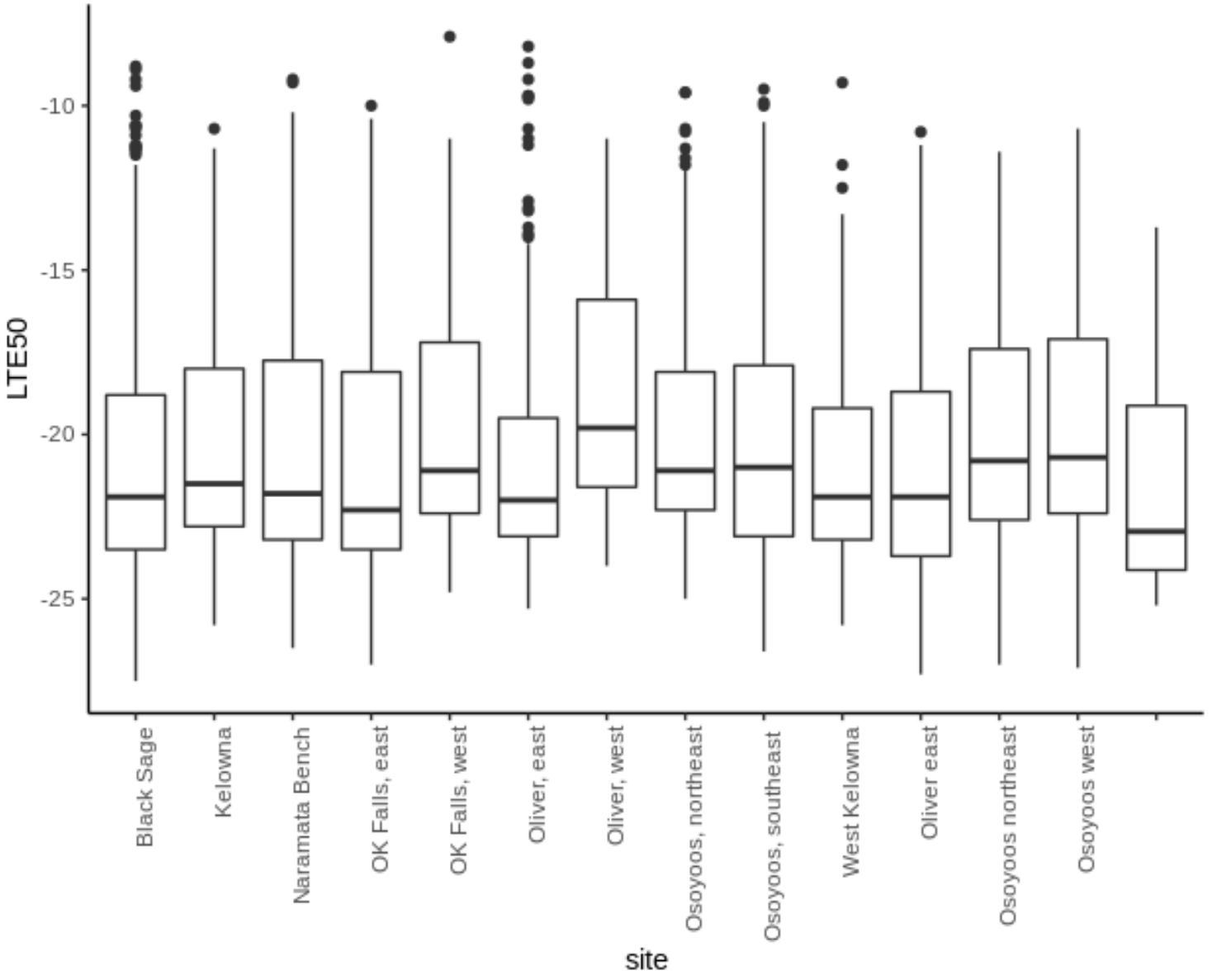
Data



Data


LTE50
-10
-15
-20
-25
Cabernet Franc
Cabernet Sauvignon
Chardonnay
Gewurztraminer
Merlot
Pinot blanc
Pinot gris
Pinot noir
Riesling
Sauvignon blanc
Shiraz
Viognier
variety

Data


LTE50
-10
-15
-20
-25
Black Sage
Kelowna
Naramata Bench
OK Falls, east
OK Falls, west
Oliver, east
Oliver, west
Osoyoos, northeast
Osoyoos, southeast
West Kelowna
Oliver east
Osoyoos northeast
Osoyoos west
site

$$y_i \sim \text{normal}(mu_i, \alpha)$$

$$mu_i = \alpha_g + \alpha_{var,i} + \alpha_{site,i} + \alpha_{year,i} + \beta * x_i$$

$$\alpha_g \sim \text{normal}(-15, 12)$$
$$\beta \sim \text{lognormal}(0, 1)$$
$$\sigma \sim \text{truncated normal}(0, 5)$$

$$\alpha_{var} \sim \text{normal}(0, \sigma_{var})$$
$$\sigma_{var} \sim \text{truncated normal}(0, 5)$$

$$\alpha_{site} \sim \text{normal}(0, \sigma_{site})$$
$$\sigma_{site} \sim \text{truncated normal}(0, 5)$$

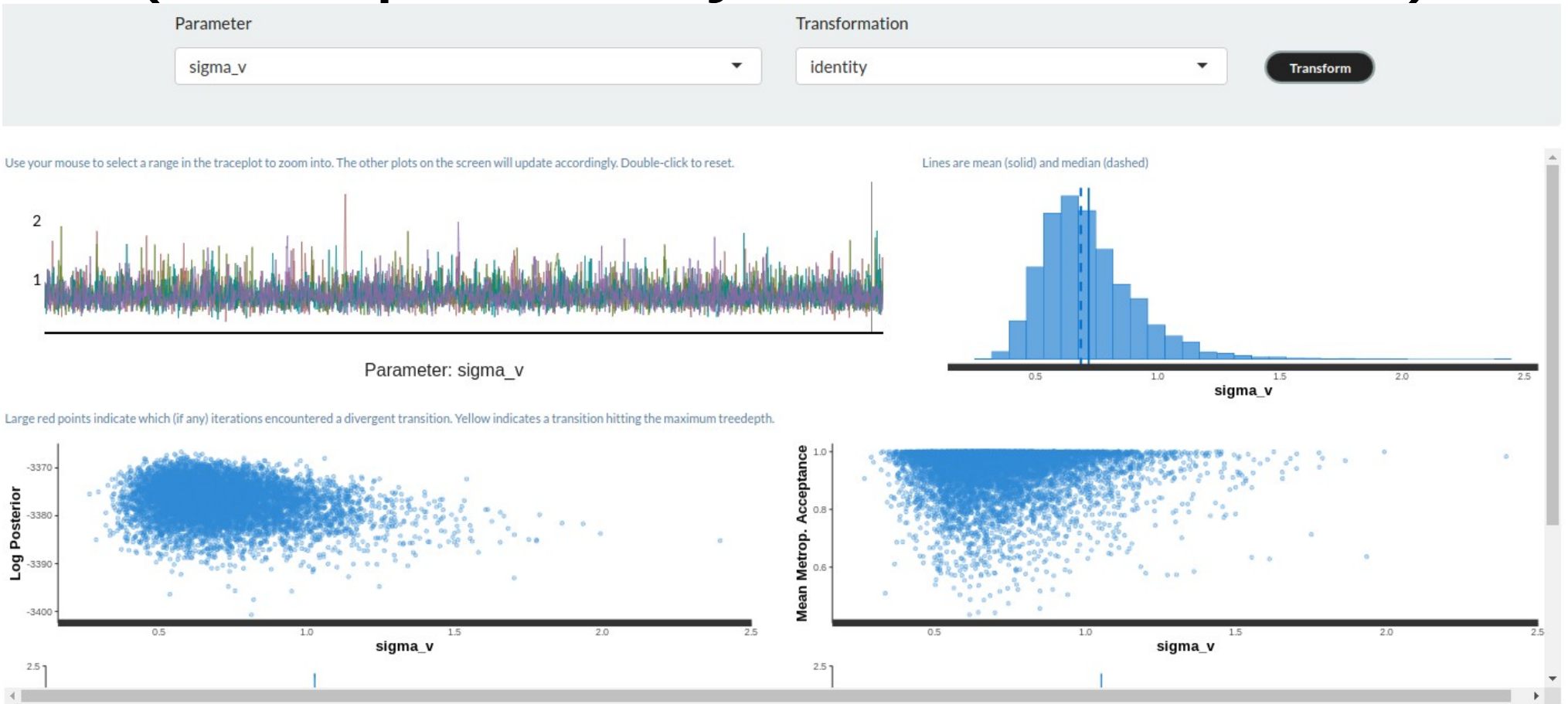
$$\alpha_{year} \sim \text{normal}(0, \sigma_{year})$$
$$\sigma_{year} \sim \text{truncated normal}(0, 5)$$

Stan Model

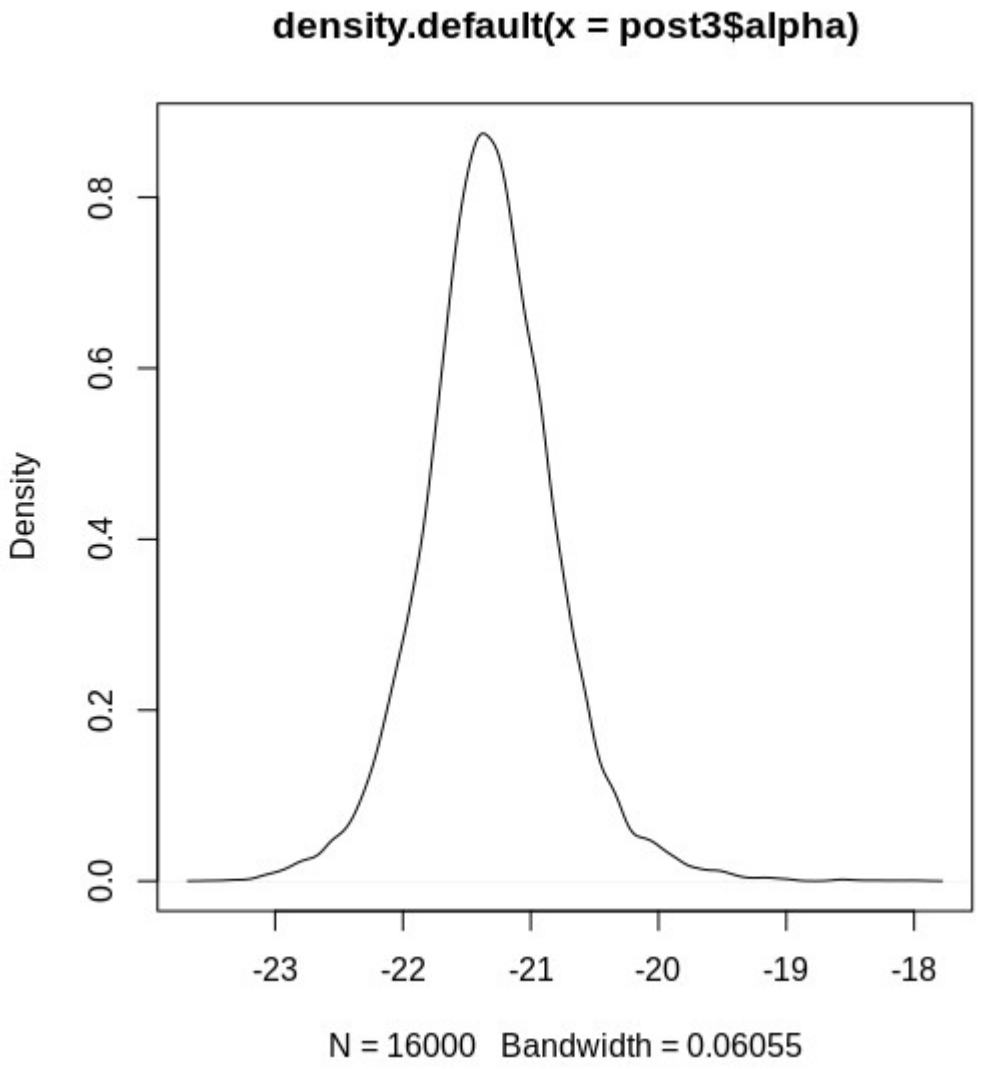
Please see the R file LinearModelHardiness3Randoms.R

Model fit

- (can open shiny stan from r code)



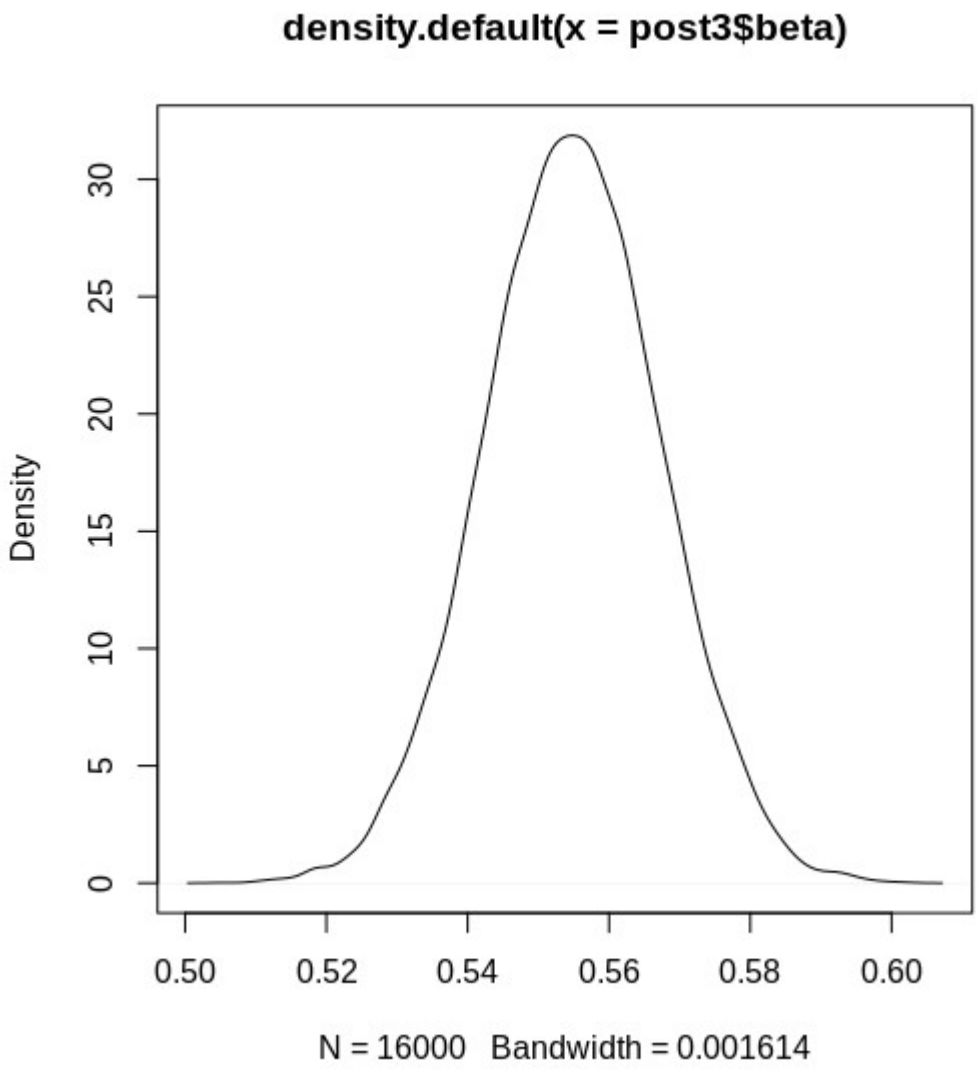
Results



Mean = -21.3 degrees C

HPDI (0.89) = -22.1 : -20.52

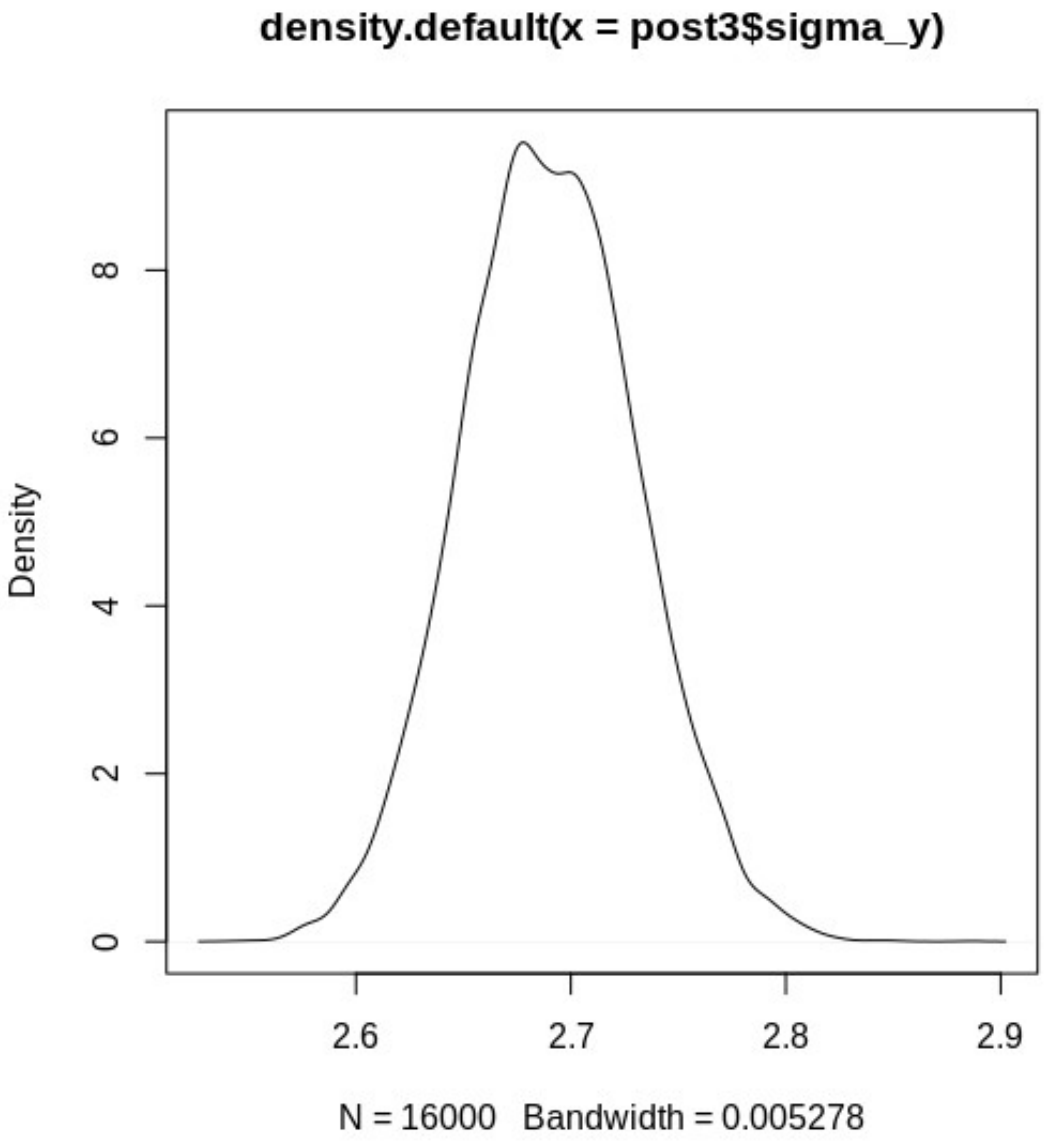
Results



Mean = 0.55

HPDI (0.89) = 0.53 : 0.57

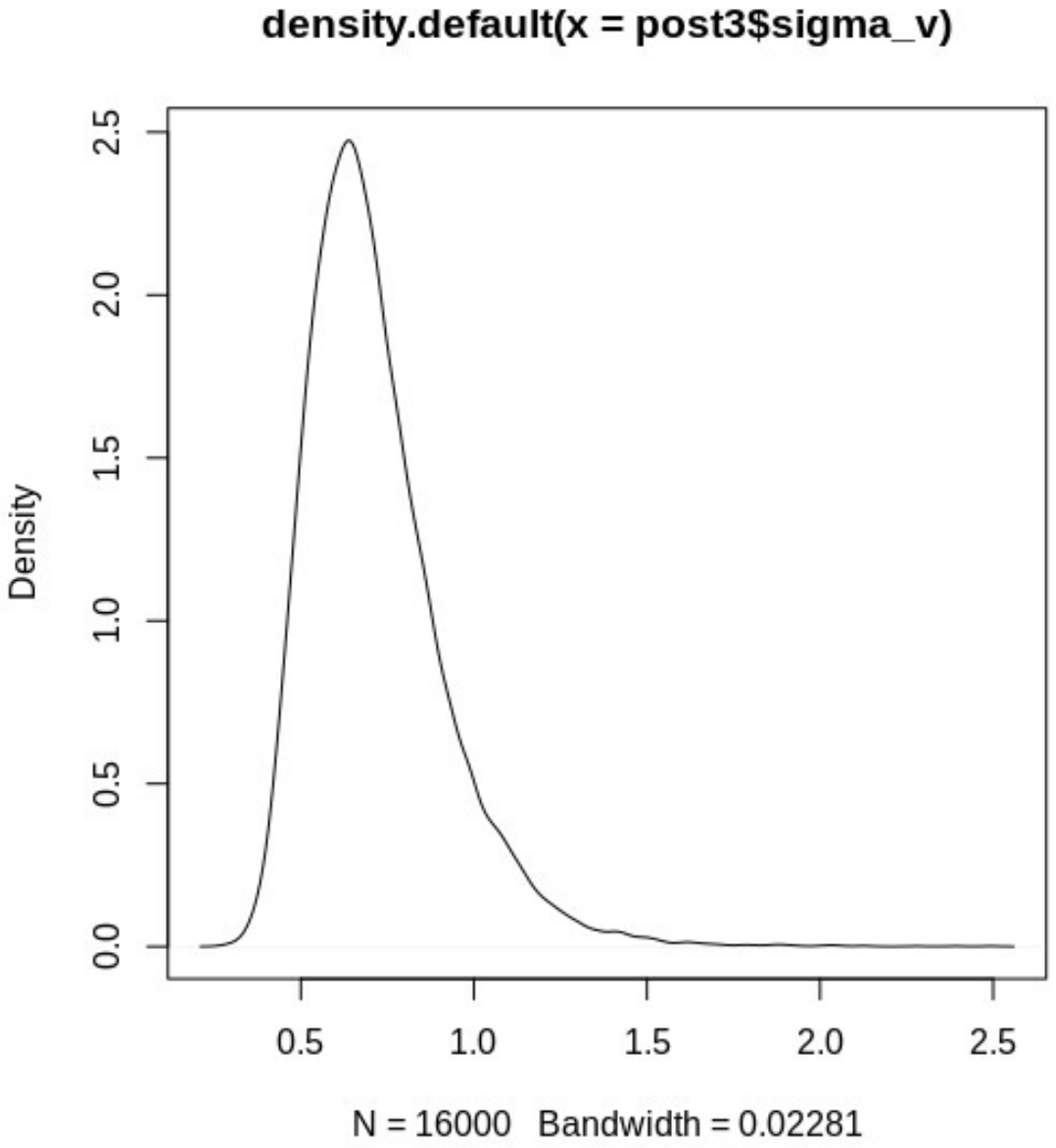
Results



Mean = 2.69

HPDI (0.89) = 2.62 : 2.75

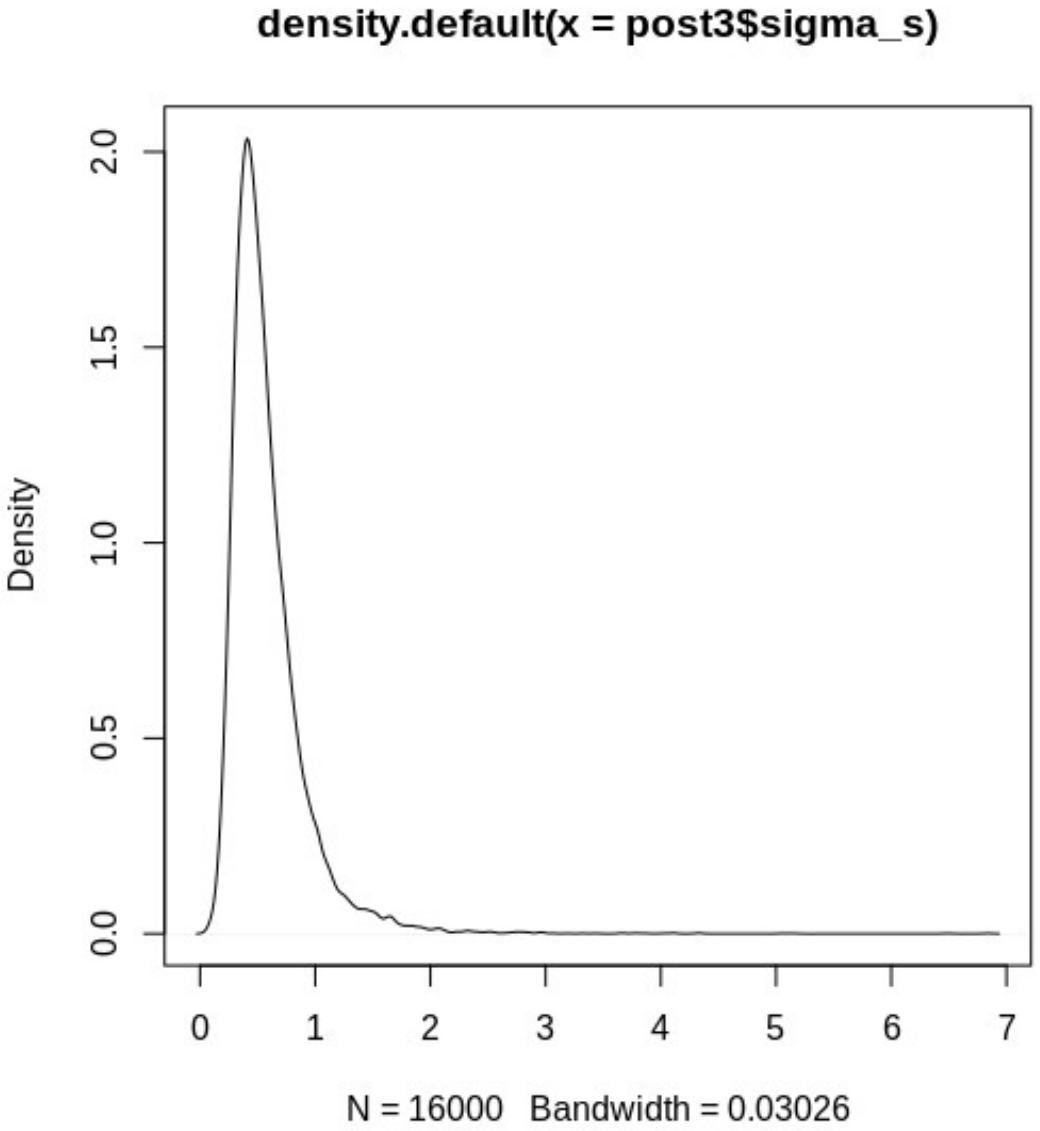
Results



Mean = 0.71

HPDI (0.89) = 0.43 : 0.98

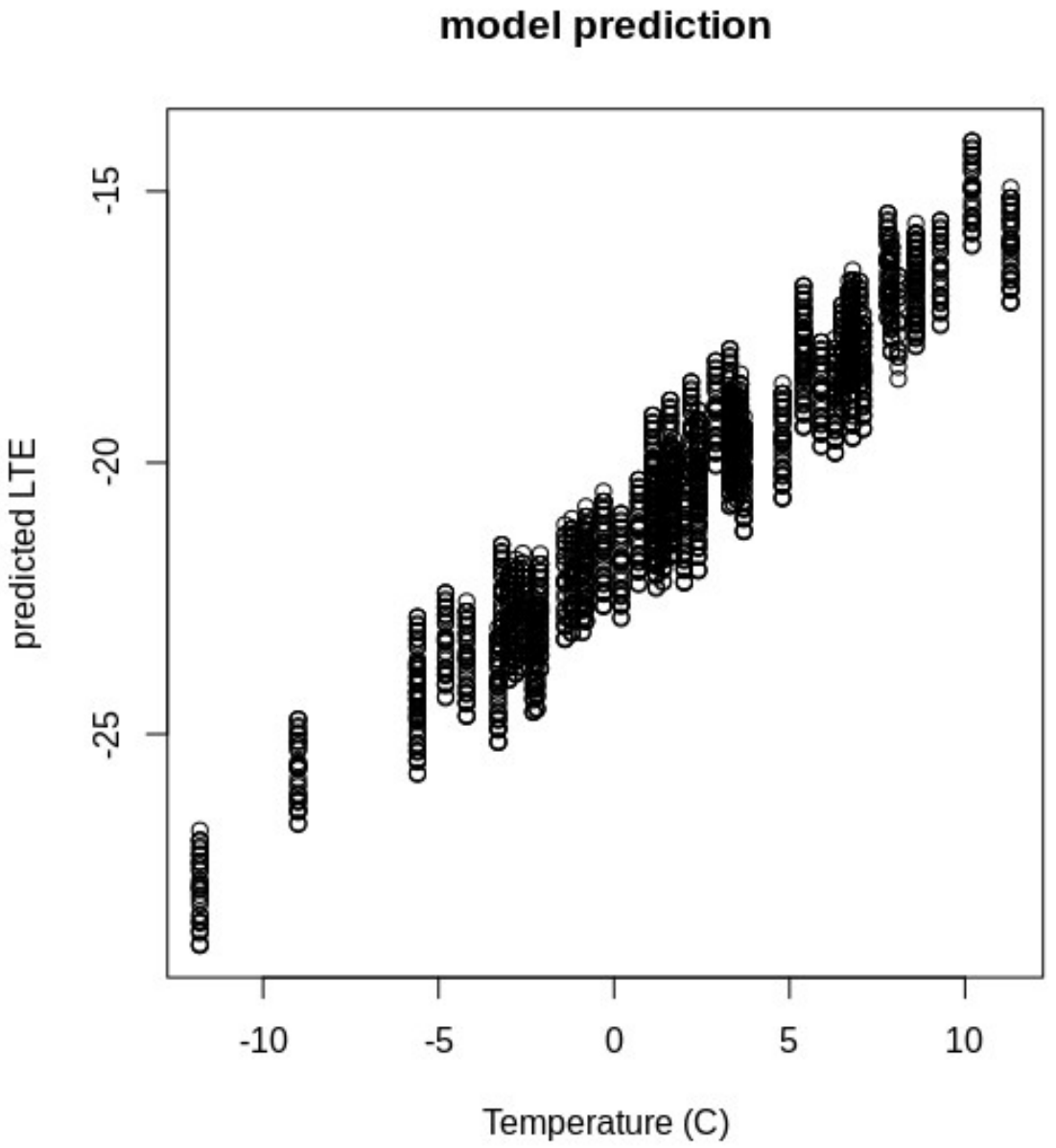
Results



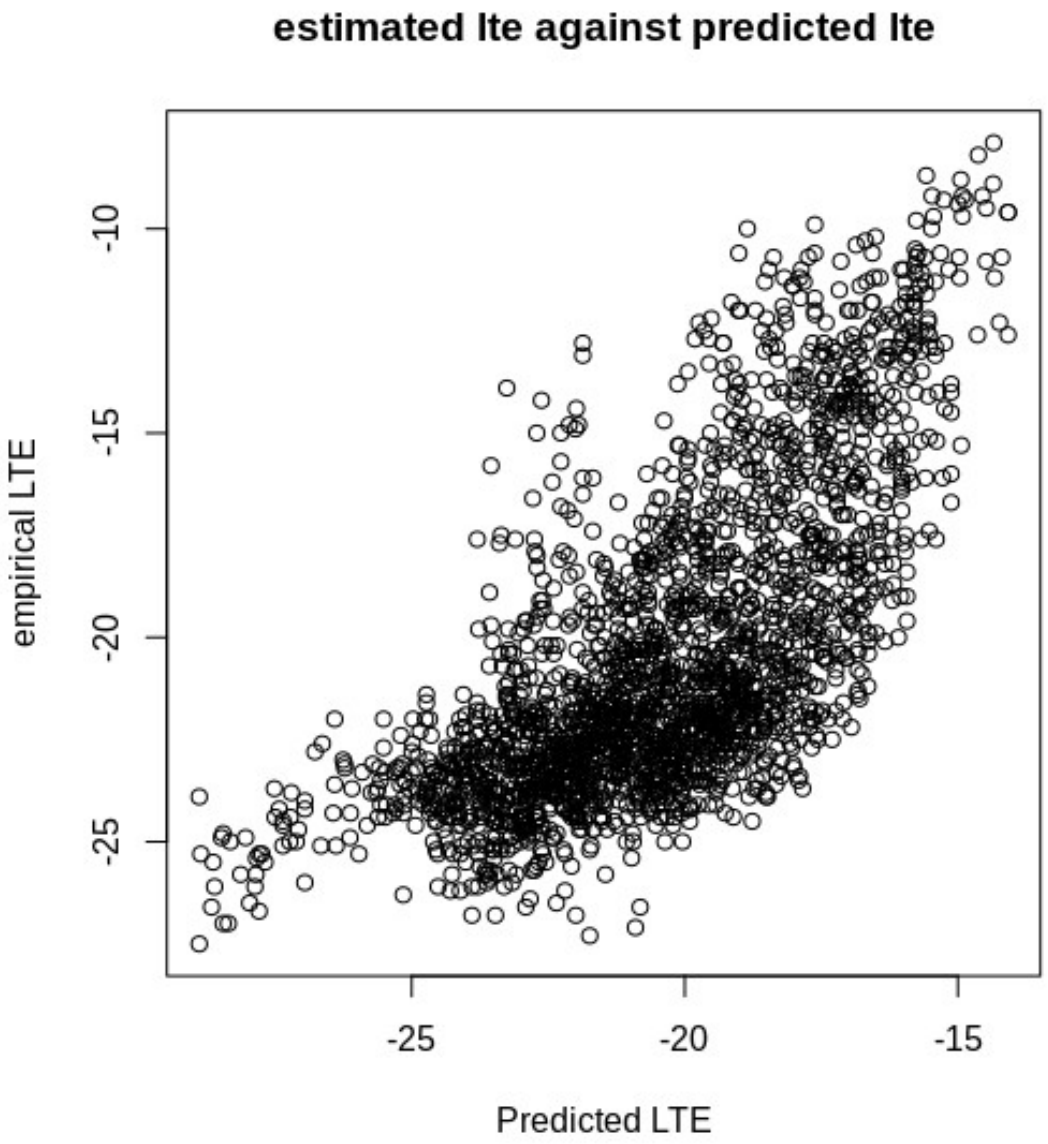
Mean = 0.58

HPDI (0.89) = 0.19 : 0.94

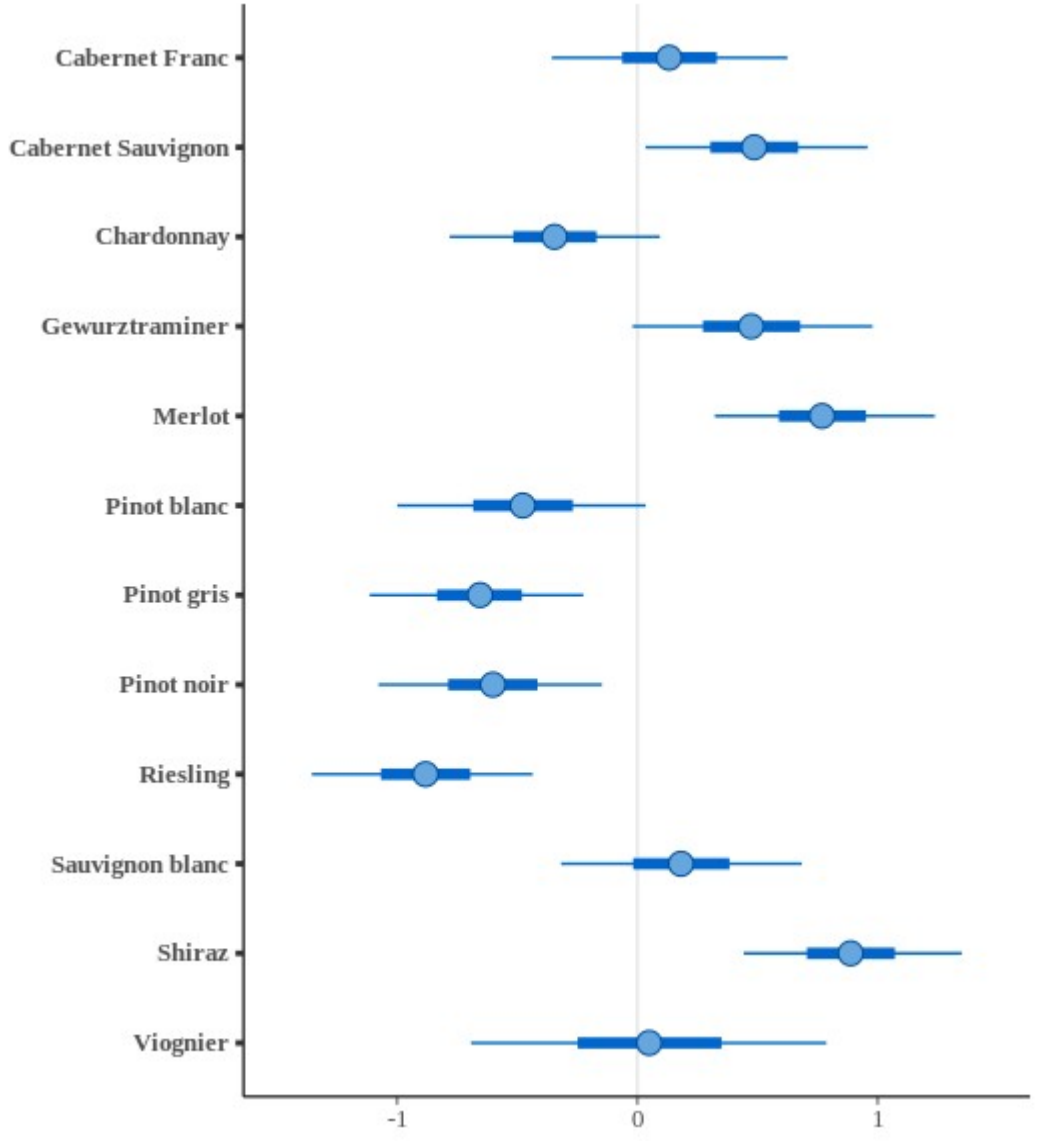
Results


model prediction
predicted LTE
-15
-20
-25
-10
-5
0
5
10
Temperature (C)

Results

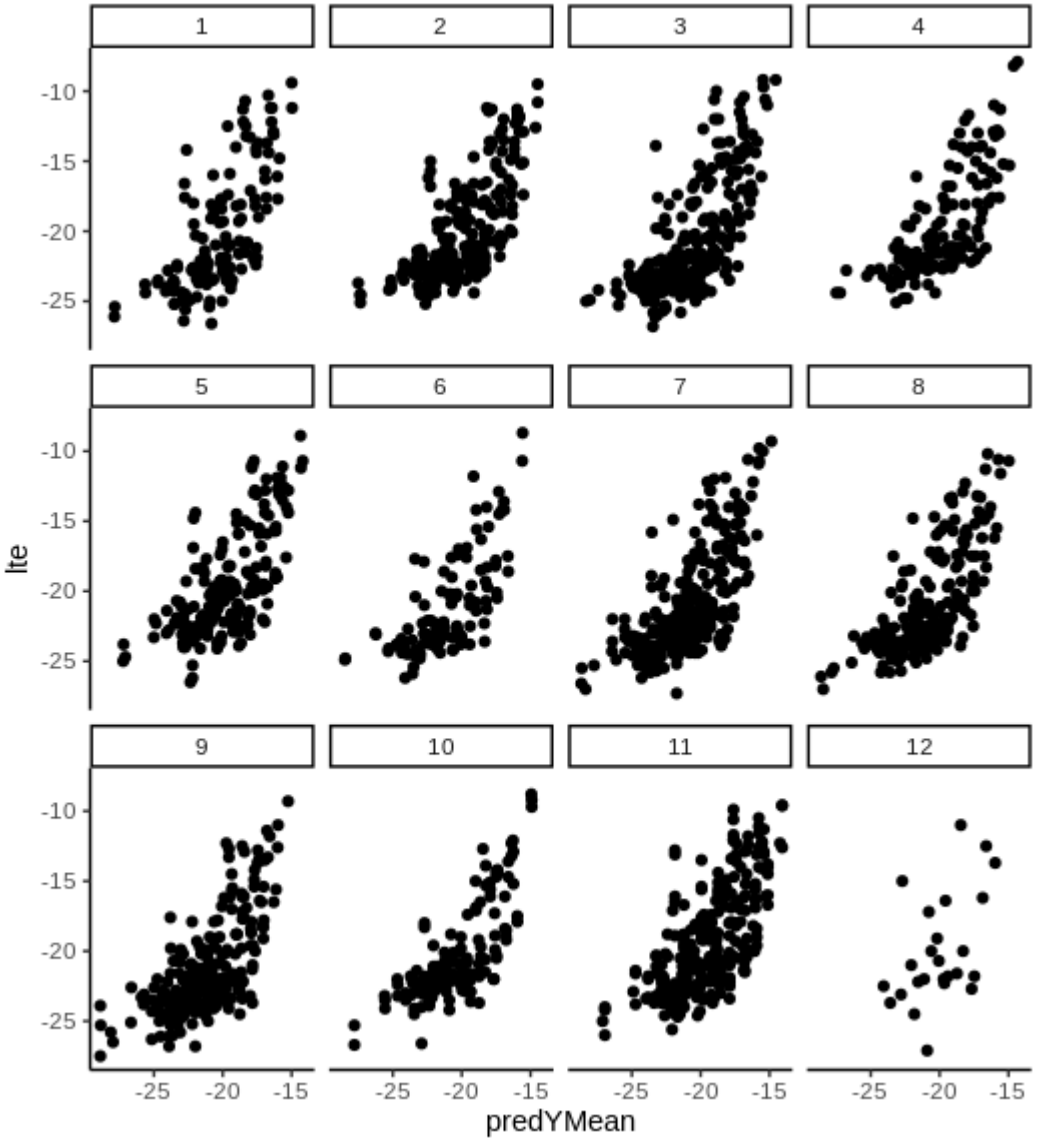

estimated lte against predicted lte
empirical LTE
-10
-15
-20
-25
-25
-20
-15
Predicted LTE

Results



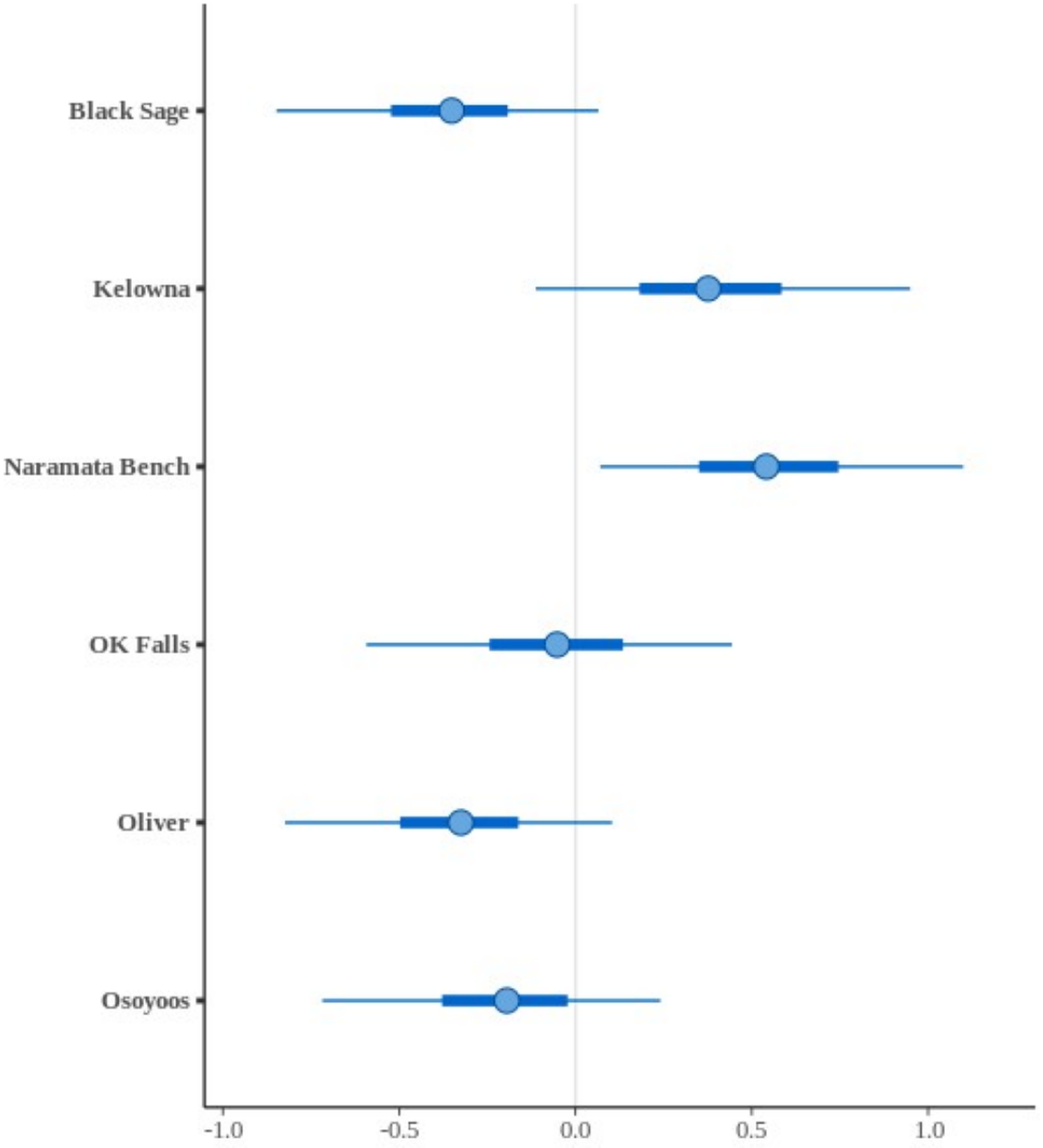
Variation by variety

Results



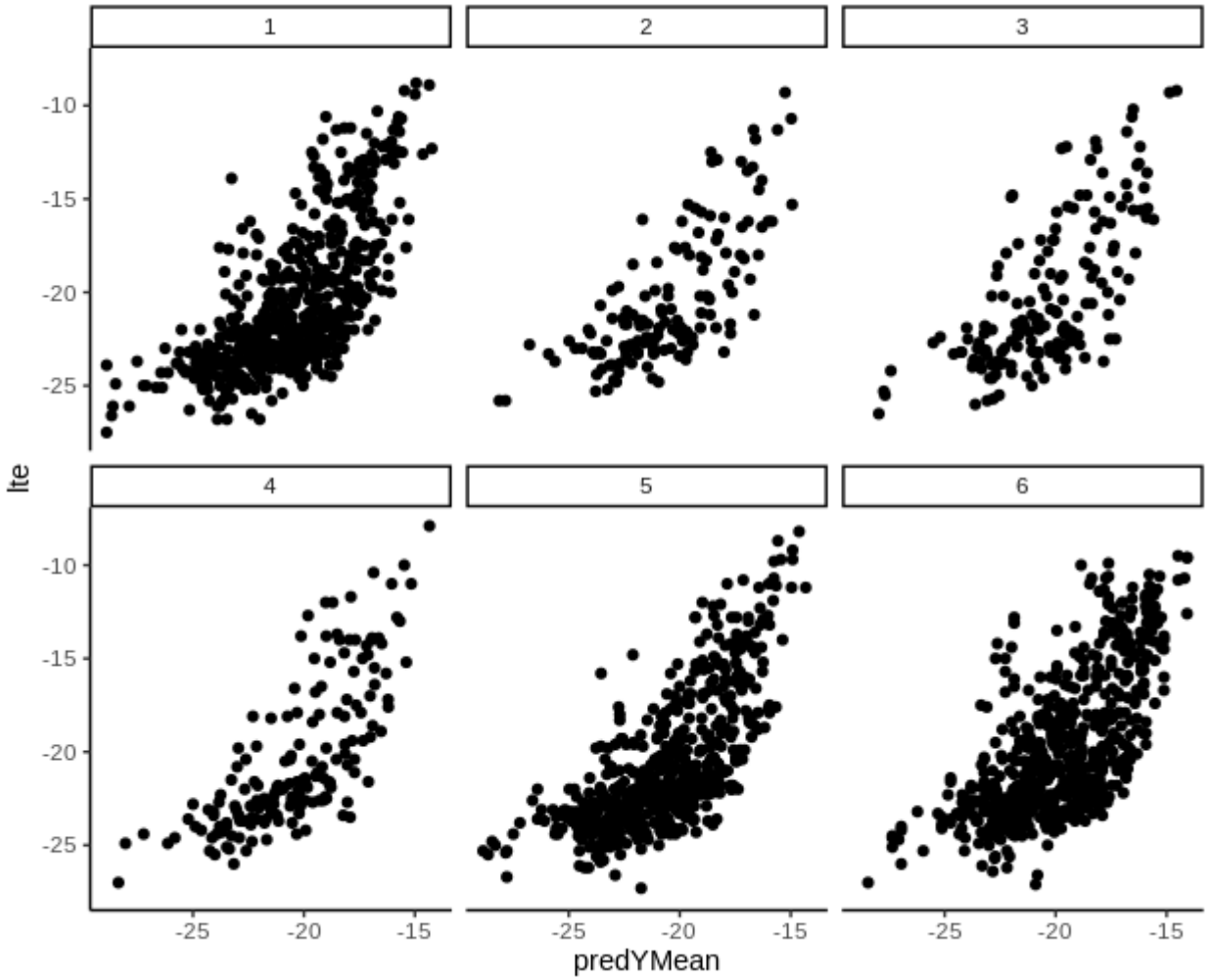
Variation by variety

Results



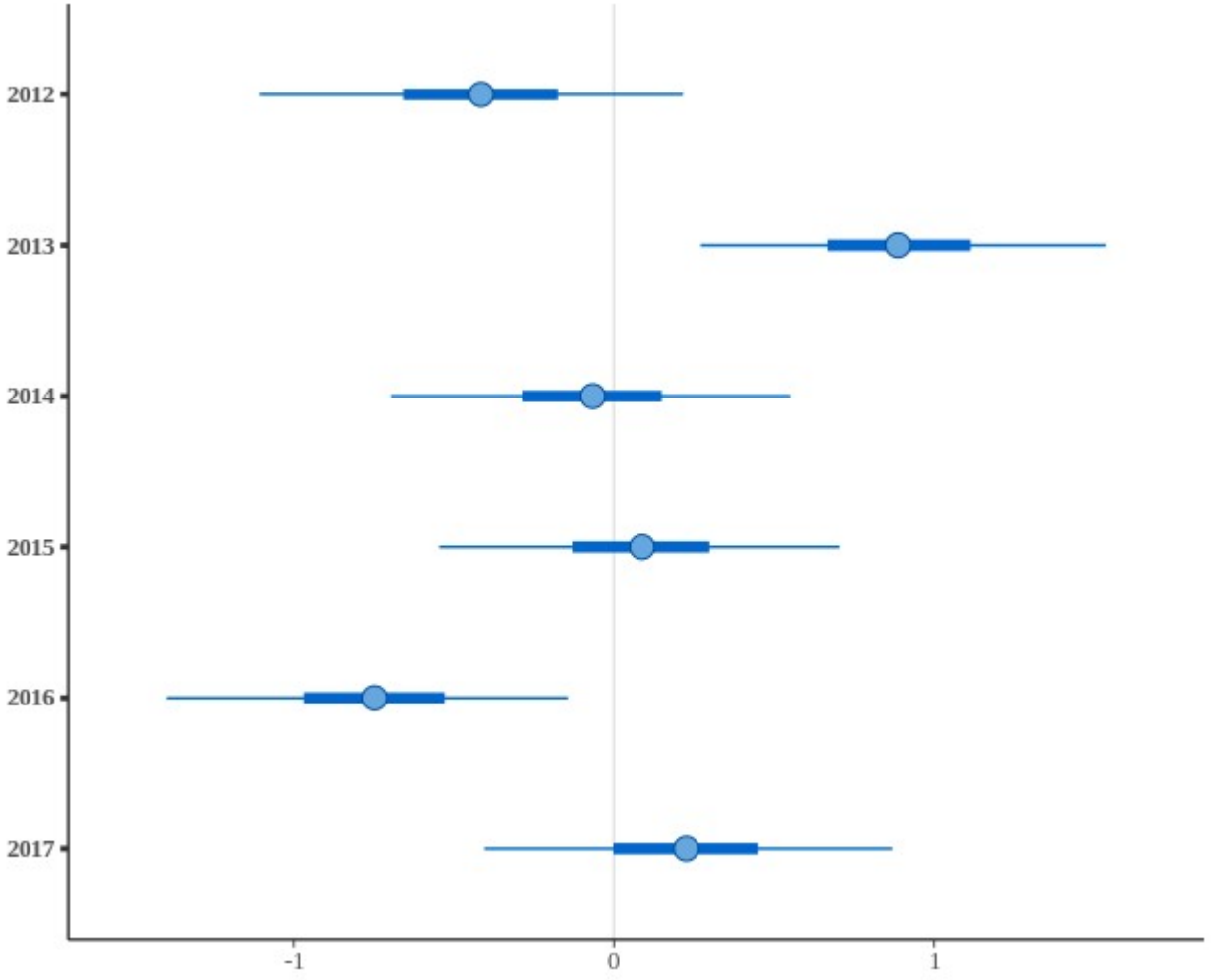
Variation by site location

Results



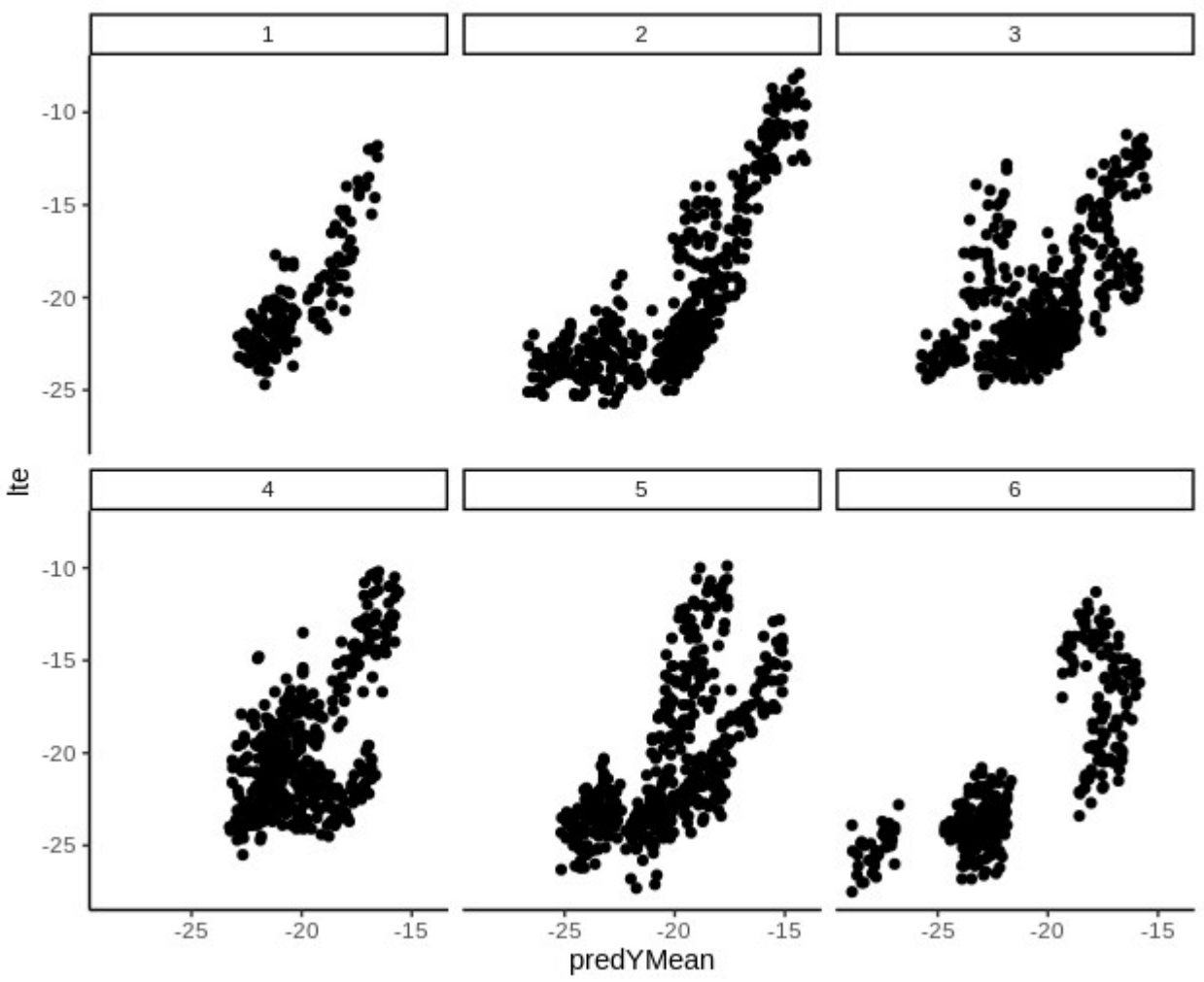
Variation by site location

Results



Variation by year

Results



Variation by year

Plan for next model

- Include random slopes for variety
- Assume that varieties that an be more cold tolerant should also have steeper slopes so they can get in and out of cold tolerance quicker
- Not including site at the moment

$$LTE_i \sim Normal(\mu_i, \sigma)$$

$$\mu_i = \alpha_{y_i} + \alpha_{v_i} + \beta_{y_i} * temp_i$$

$$\begin{bmatrix} \alpha_v \\ \beta_v \end{bmatrix} \sim MVNormal\left(\begin{bmatrix} \alpha \\ \beta \end{bmatrix}, S\right)$$

$$S = \begin{pmatrix} \sigma_\alpha & 0 \\ 0 & \sigma_\beta \end{pmatrix} R \begin{pmatrix} \sigma_\alpha & 0 \\ 0 & \sigma_\beta \end{pmatrix}$$

$$\alpha \sim Normal(-15, 12)$$
$$\beta \sim log Normal(0, 1)$$
$$\sigma \sim Normal(0, 5)$$
$$\sigma_y \sim Normal(0, 5)$$
$$\sigma_\alpha \sim Normal(0, 5)$$
$$\sigma_\beta \sim Normal(0, 1)$$
$$R \sim LKJcorr(2)$$

STAN code

- See stan_model_slope.stan

Not working - warning

Left-hand side of sampling statement (~) may contain a non-linear transform of a parameter or local variable.

If it does, you need to include a target += statement with the log absolute determinant of the Jacobian of the transform.

Left-hand-side of sampling statement:

```
a_b_variety ~ multi_normal_lpdf(...)
```

Parameter

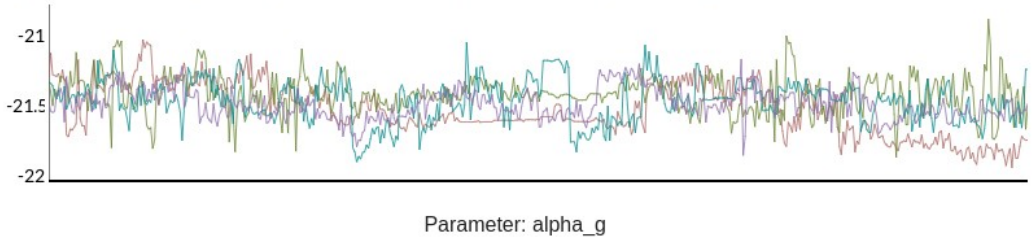
alpha_g

Transformation

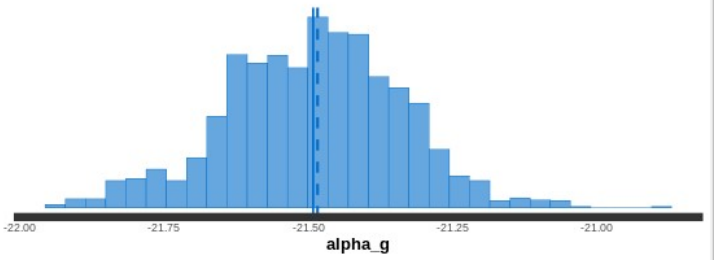
identity

Transform

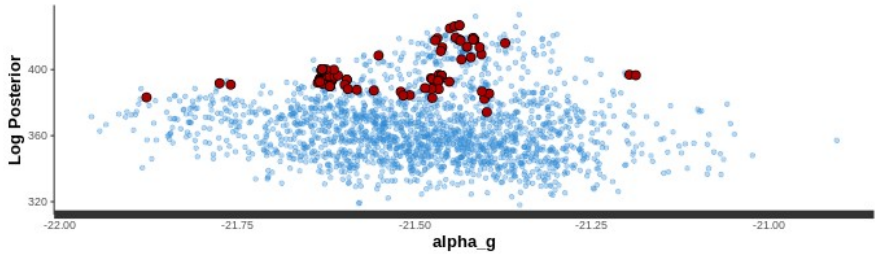
Use your mouse to select a range in the traceplot to zoom into. The other plots on the screen will update accordingly. Double-click to reset.

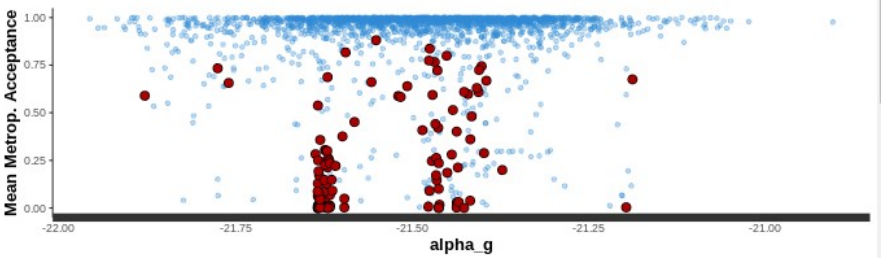


Lines are mean (solid) and median (dashed)



Large red points indicate which (if any) iterations encountered a divergent transition. Yellow indicates a transition hitting the maximum treedepth.



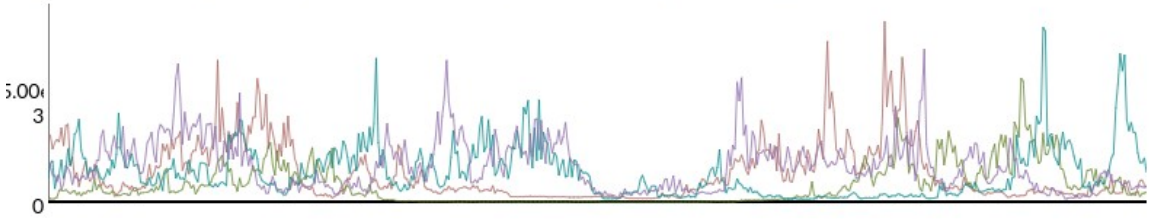


var_sigma[2]

identity

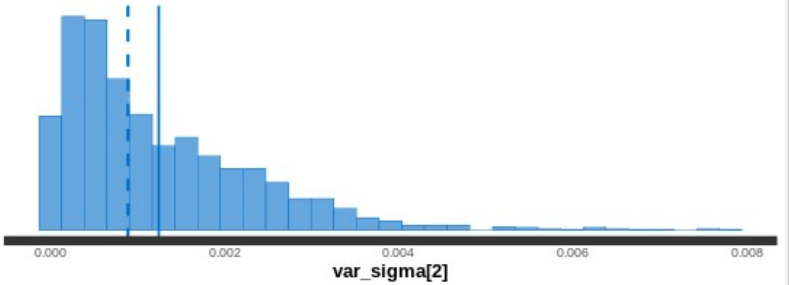
Transform

lse your mouse to select a range in the traceplot to zoom into. The other plots on the screen will update accordingly. Double-click to reset.



Parameter: var_sigma[2]

Lines are mean (solid) and median (dashed)



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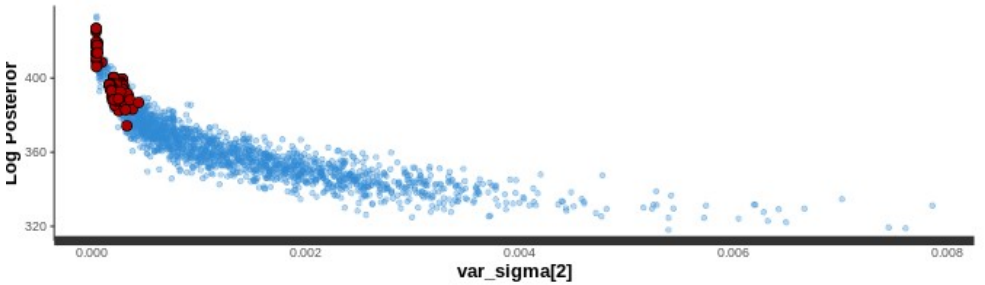
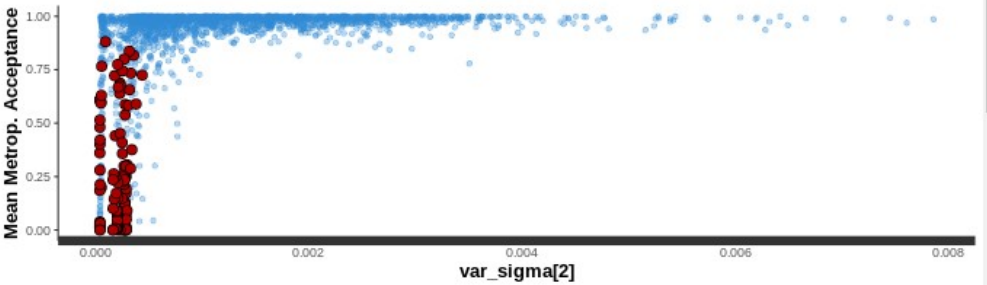




Parameter

Rho[1,1]

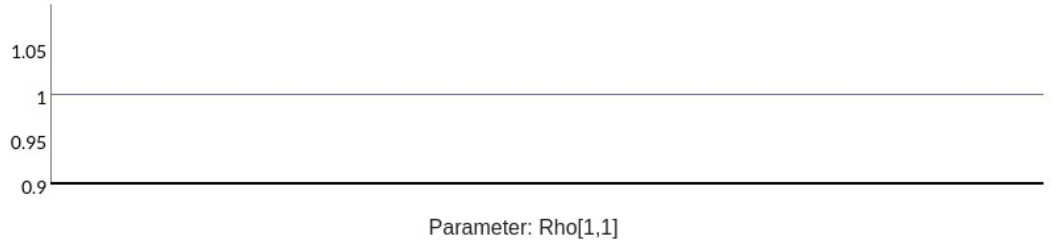
Transformation

identity

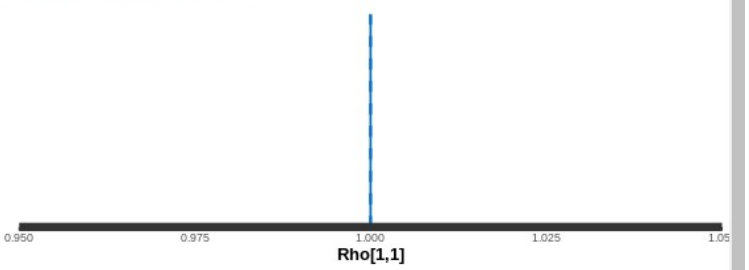
Transform

tions.

Use your mouse to select a range in the traceplot to zoom into. The other plots on the screen will update accordingly. Double-click to reset.



Lines are mean (solid) and median (dashed)



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