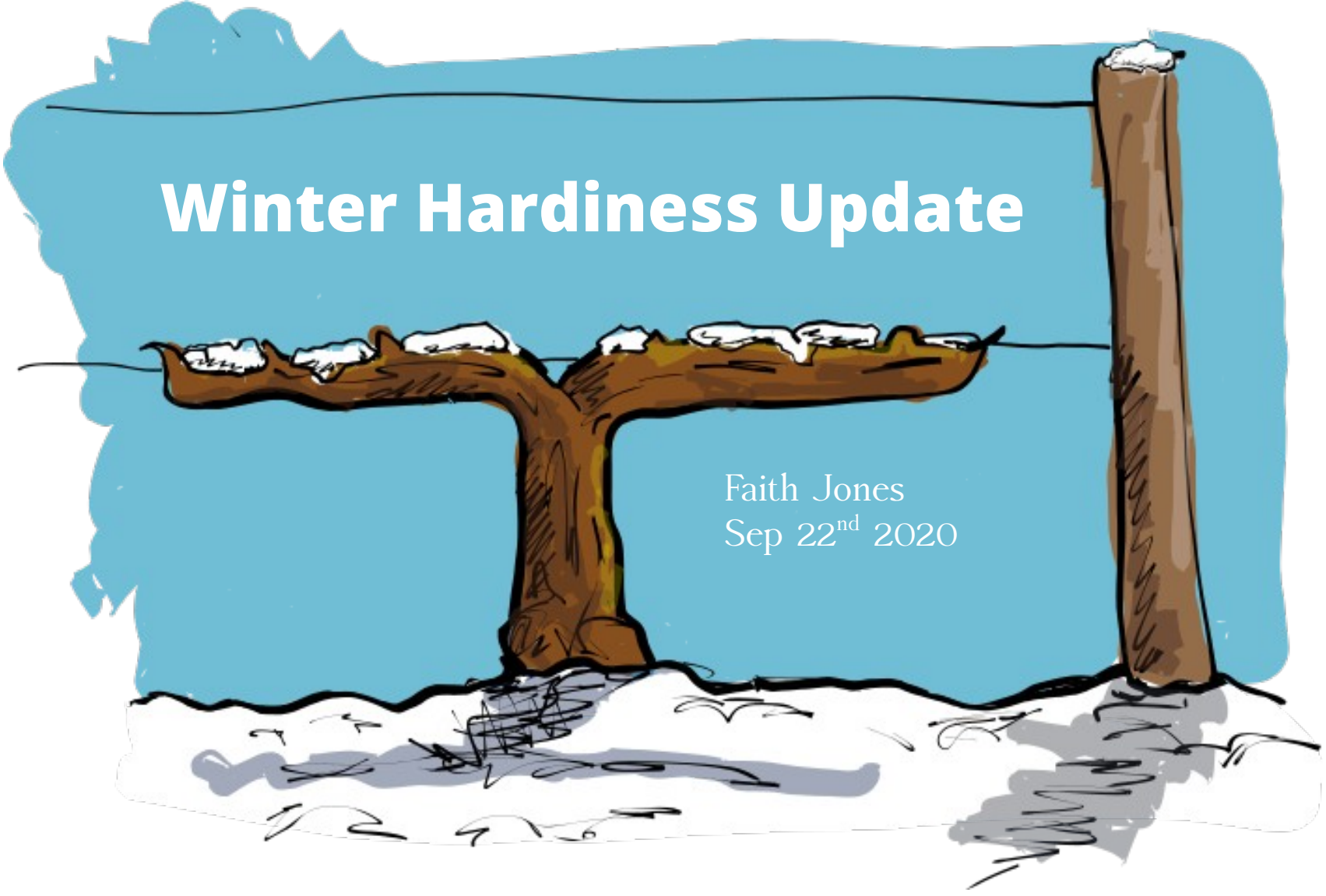
Winter Hardiness Update

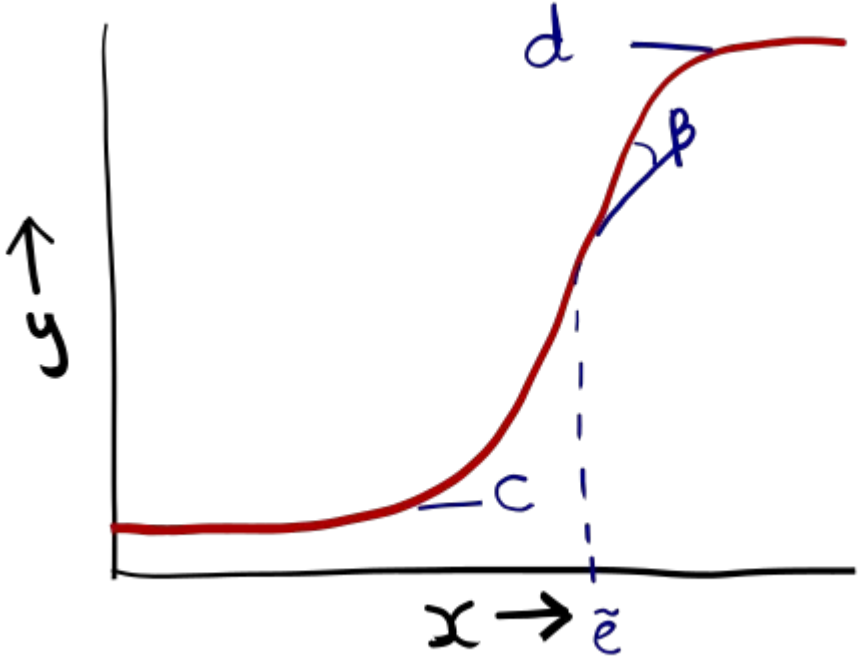


Faith Jones
Sep 22nd 2020

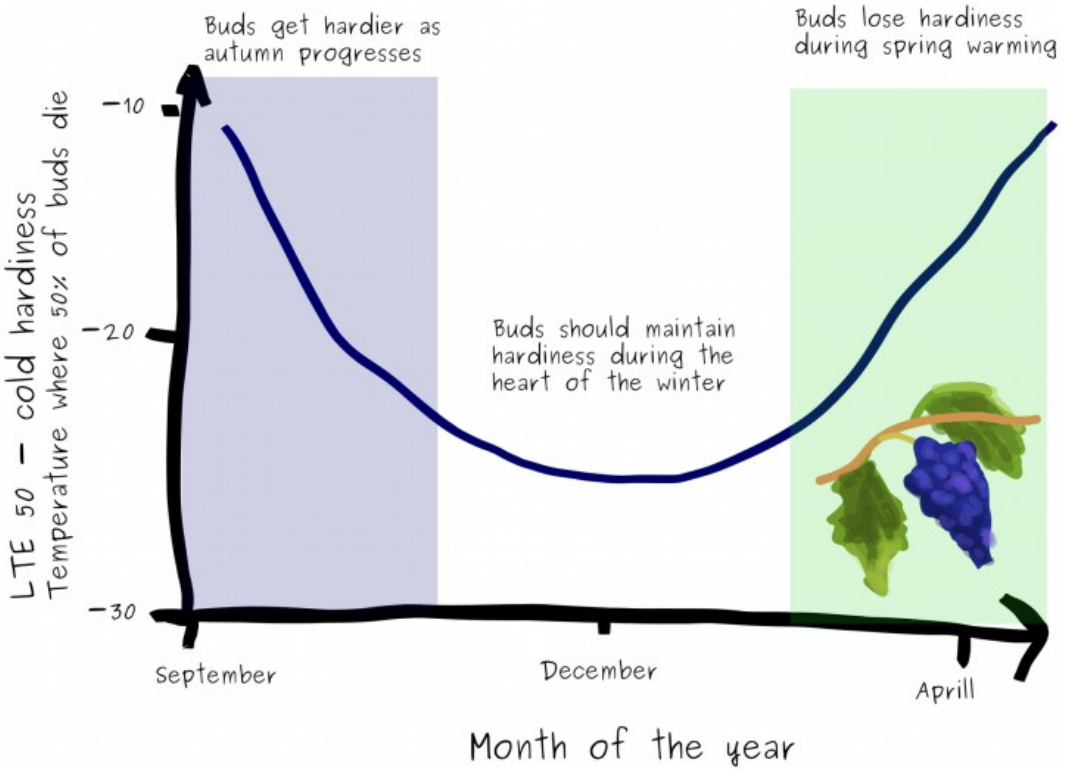
Reminder

Last time we walked through my workflow of a Sigmoidal model

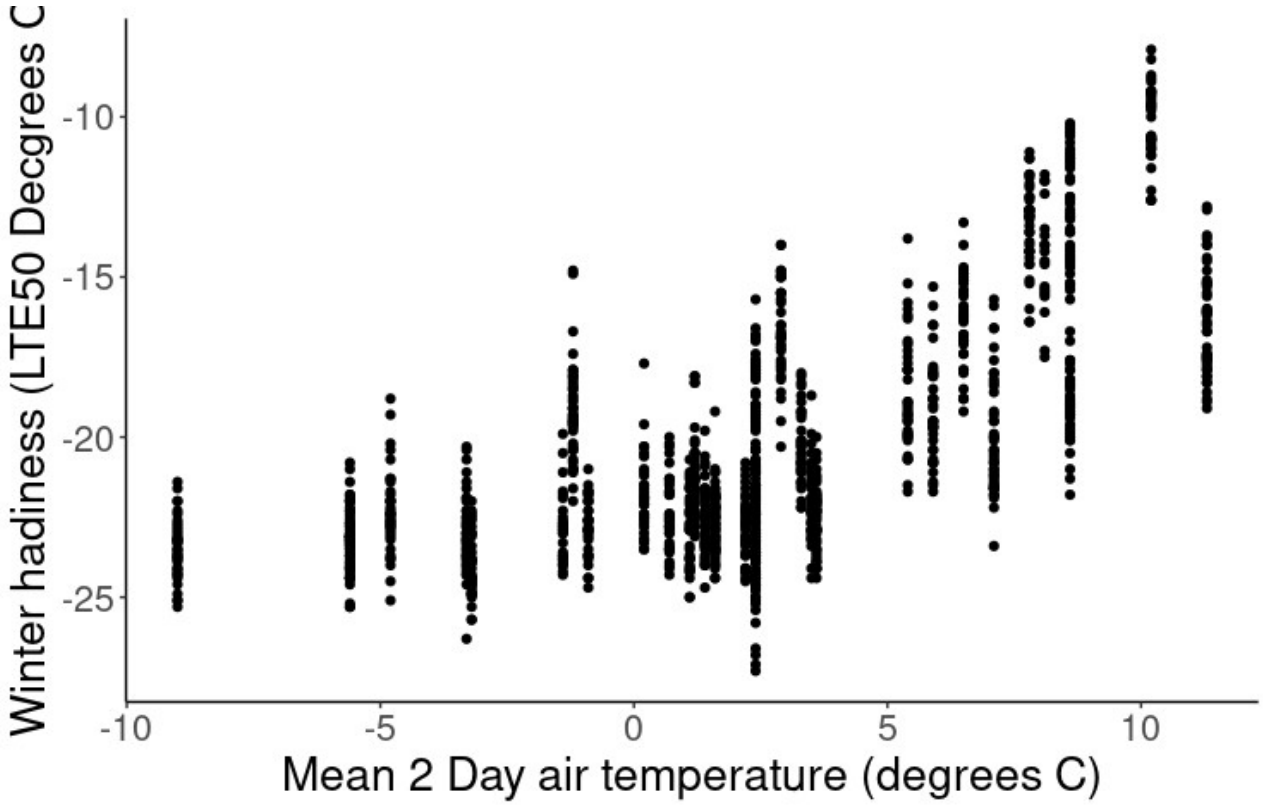
- Dose Responce Curve
- No hierarchical elements yet
- Was not quite fitting



The data


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

The data


Winter hadiness (LTE50 Decgrees C
-10
-15
-20
-25
-10
-5
0
5
10
Mean 2 Day air temperature (degrees C)

Model structure

$$\mu = f(x, (b, c, d, e)) = c + \frac{d - c}{1 + exp^{b(log(x) - \tilde{e})}} \tag{1}$$

$$\tilde{y}_i \sim normal(\mu_i, \sigma) \tag{2}$$

Where:

x is the concentration of the dose (amount of winter cold)
b is the response rate (slope)
d is the upper asymptote of the response (maximum hardiness)
c is the lower asymptote of the response (minimum hardiness)
e is the effective dose ED50 (winter temperature where cold hardiness is half way between min and max)
$\tilde{e}$ is the log of the effective dose ED50

Model structure – hierarchical!

Variety effects rate of change (b) and maximum hardiness (d)

Site effects only maximum hardiness (d)

$$\mu = f(x_i, (b, c, d, e)) = c + \frac{(d + d_{var,i} + d_{site,i}) - c}{1 + exp^{b_{var}(log(x_i) - \tilde{e})}} \tag{3}$$

$$d_{var} = dr_{var} * \sigma_{dvar} \tag{4}$$

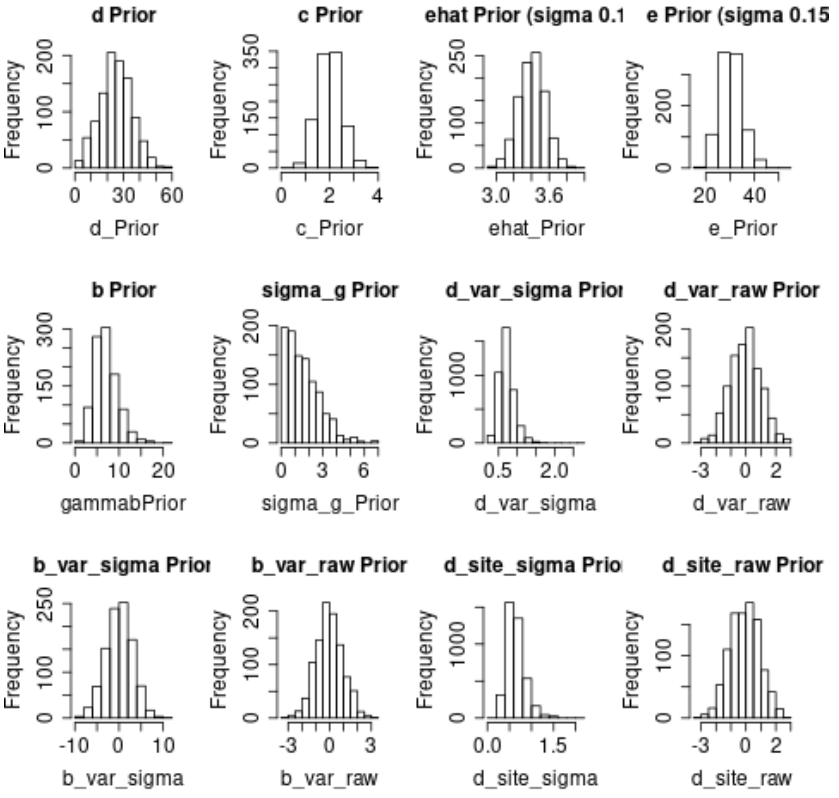
$$d_{site} = dr_{site} * \sigma_{dsite} \tag{5}$$

$$b_{var} = br_{var} * \sigma_{bvar} \tag{6}$$

$$\tilde{y}_i \sim normal(\mu_i, \sigma) \tag{7}$$

Model structure – priors

$$b \sim gamma(7, 1)$$
$$\sigma_{bvar} \sim normal(0, 3)$$
$$br_{var} \sim normal(0, 1)$$
$$d \sim Normal(25, 10)$$
$$\sigma_{dvar} \sim gamma(2.5, 1.75)$$
$$dr_{var} \sim normal(0, 1)$$
$$\sigma_{dsite} \sim gamma(2.5, 1.75)$$
$$dr_{site} \sim normal(0, 1)$$
$$c \sim normal(2, 0.5)$$
$$\tilde{e} \sim normal(log(30), 0.15)$$
$$\sigma \sim normal(0, 5)$$



C Prior

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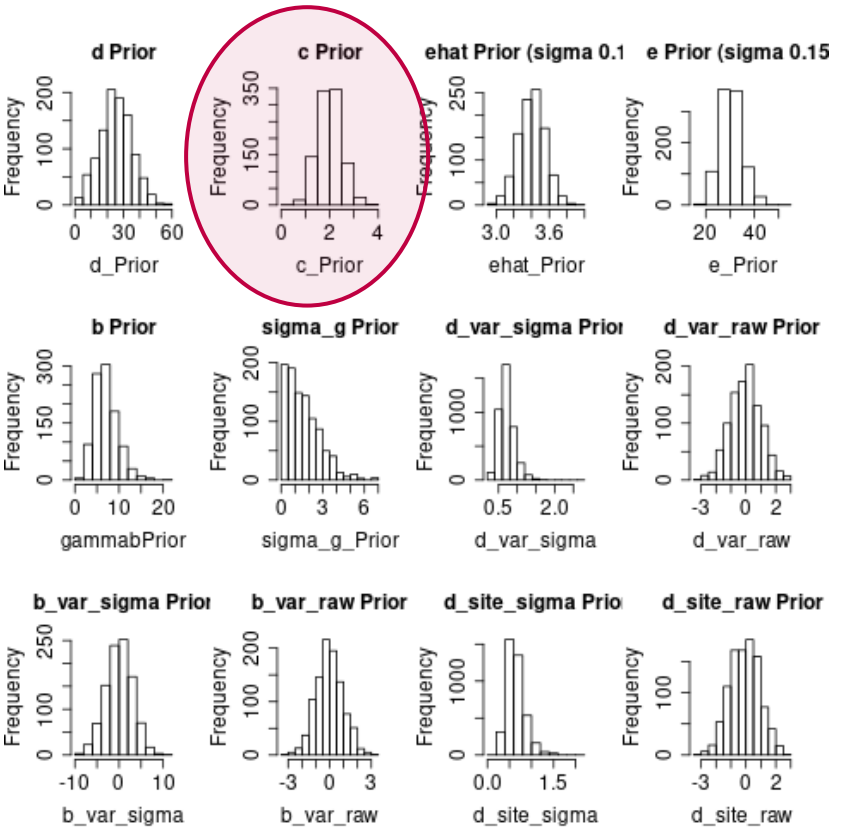
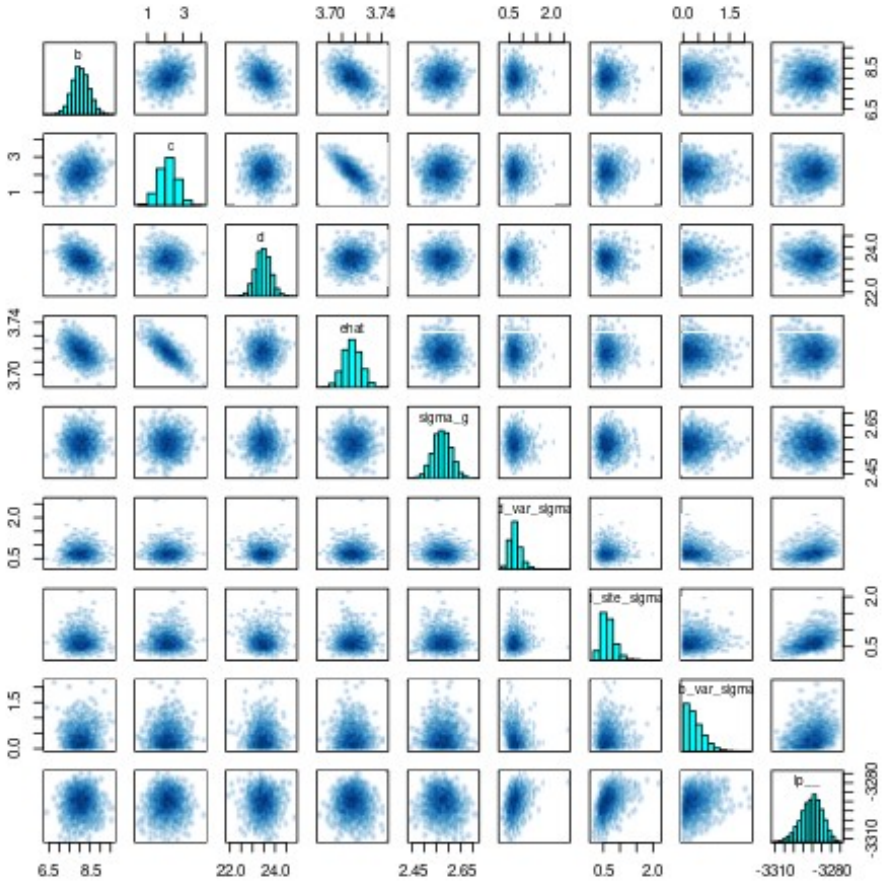


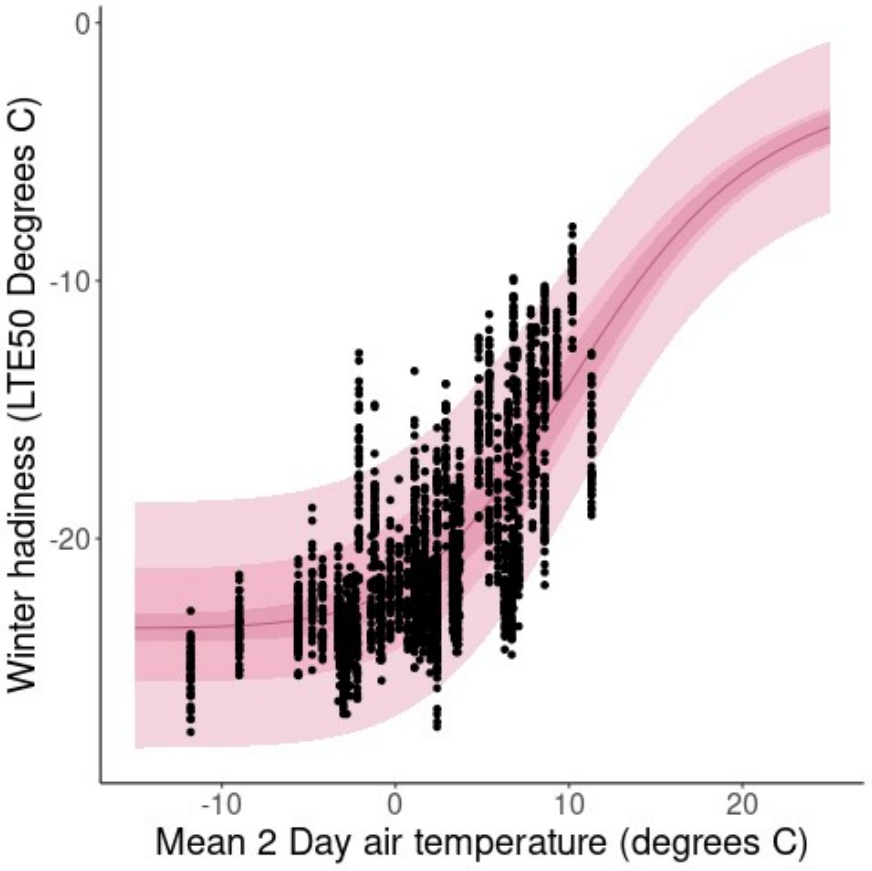
Model fit – pairs

No obvious fundamental problems

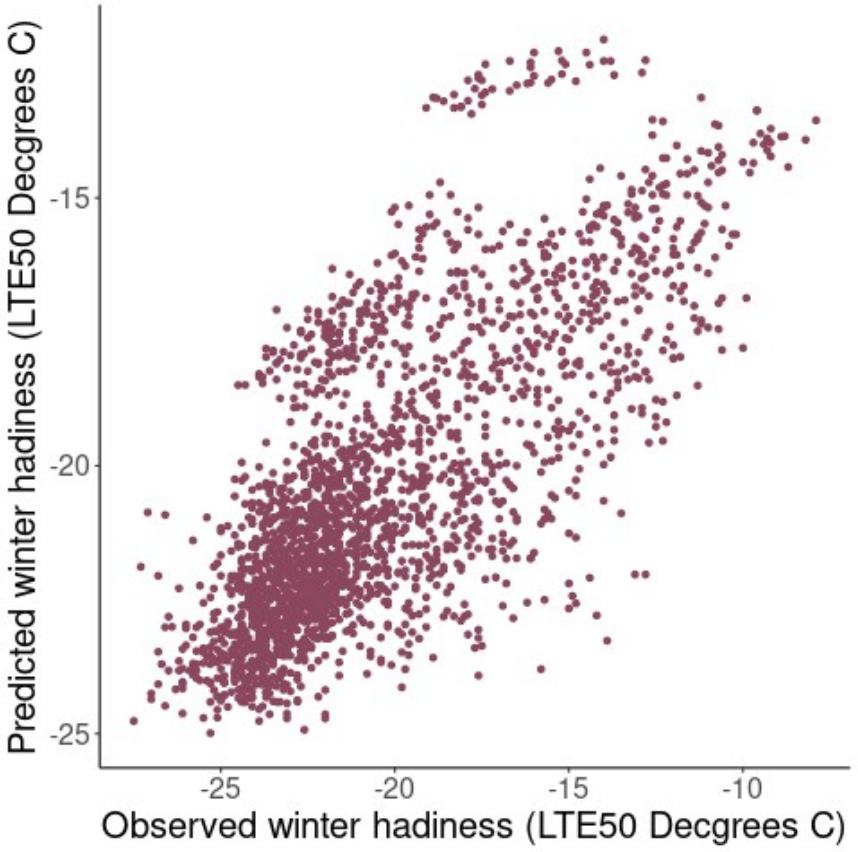
There is coliniarity bewteen parameters c and ehat, but that's why we constrained c so much.



Model fit

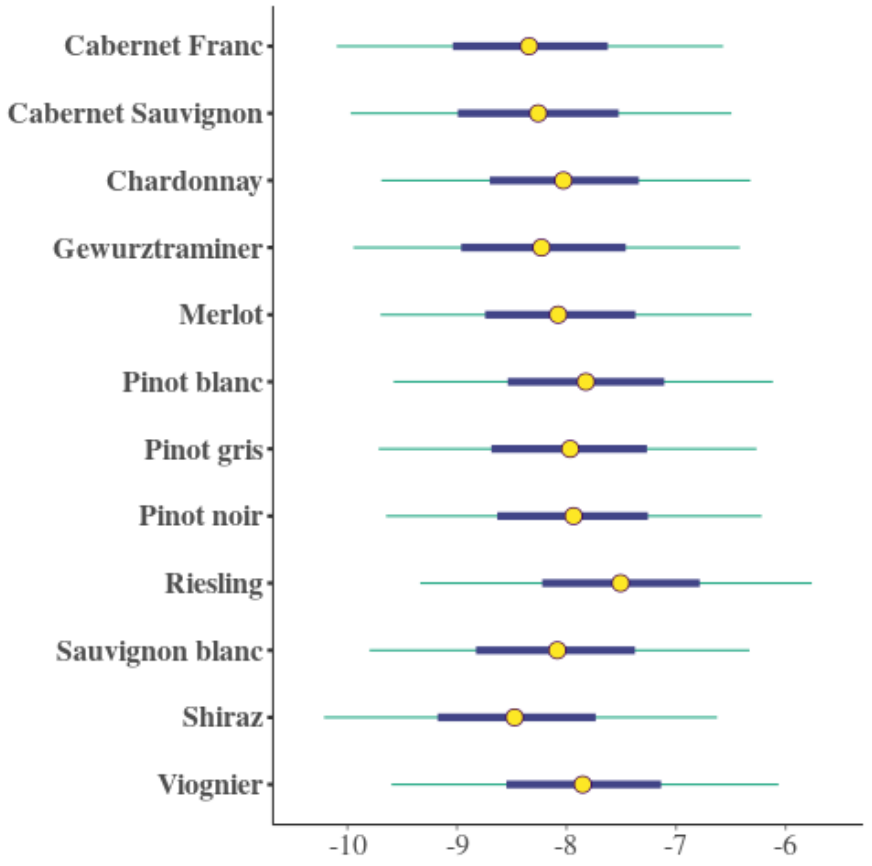

0
-10
-20
Winter hadiness (LTE50 Decgrees C)
-10
0
10
20
Mean 2 Day air temperature (degrees C)

Model fit


Predicted winter hadiness (LTE50 Decgrees C)
-15
-20
-25
-25
-20
-15
-10
Observed winter hadiness (LTE50 Decgrees C)

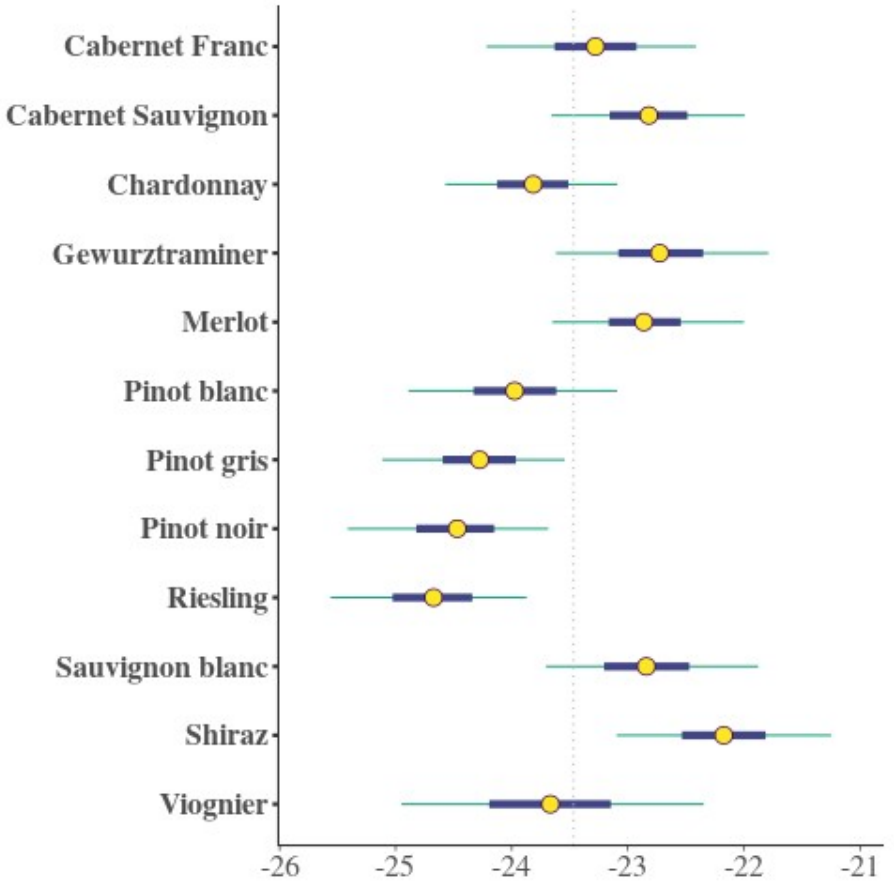
Model fit - variety effects

No obvious difference in rates of change of different varieties



Model fit - variety effects

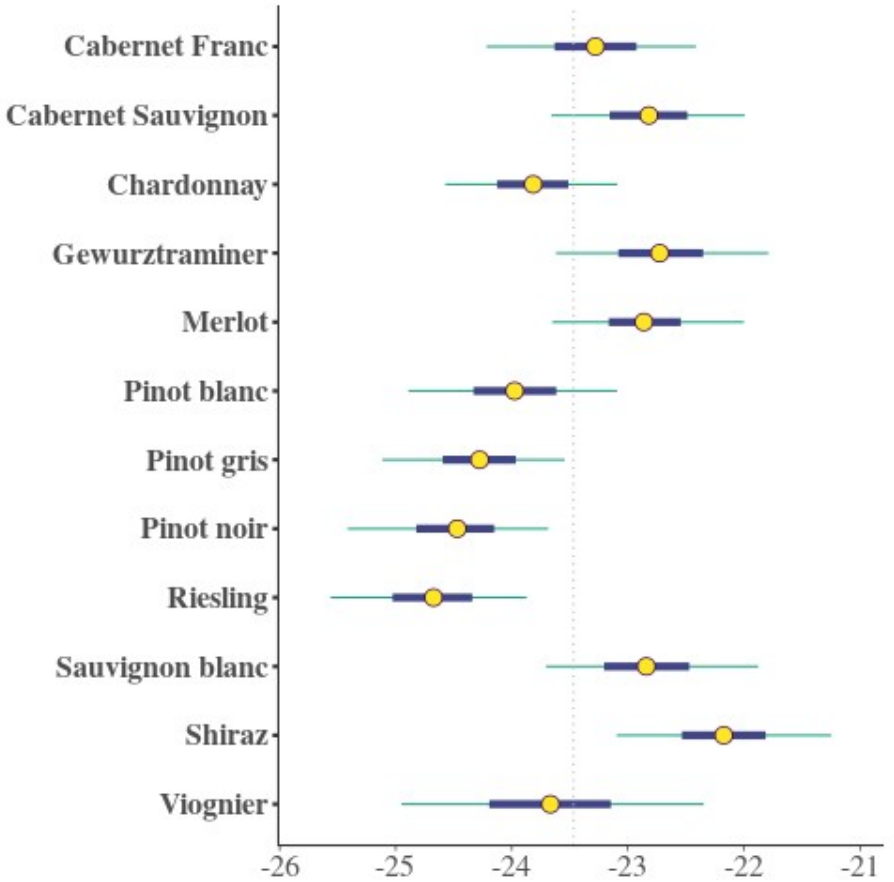
Difference in maximum hardiness of different varieties



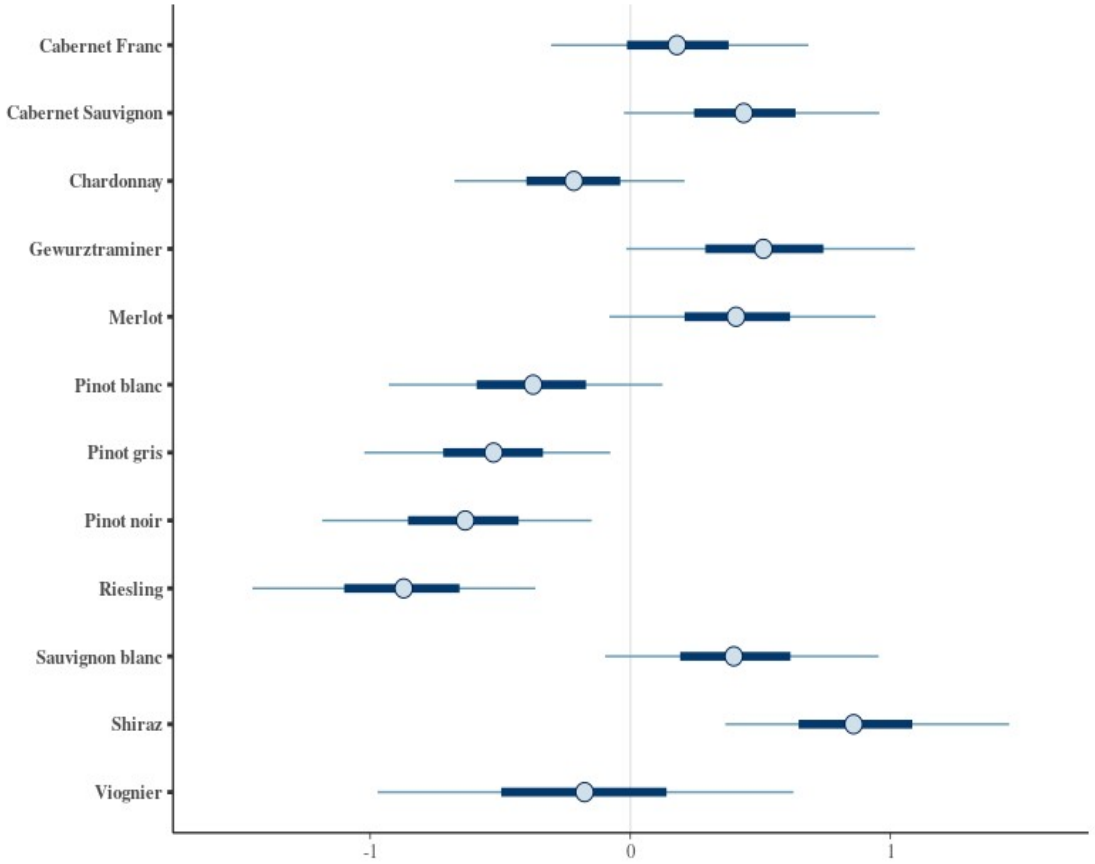
Model fit - variety effects

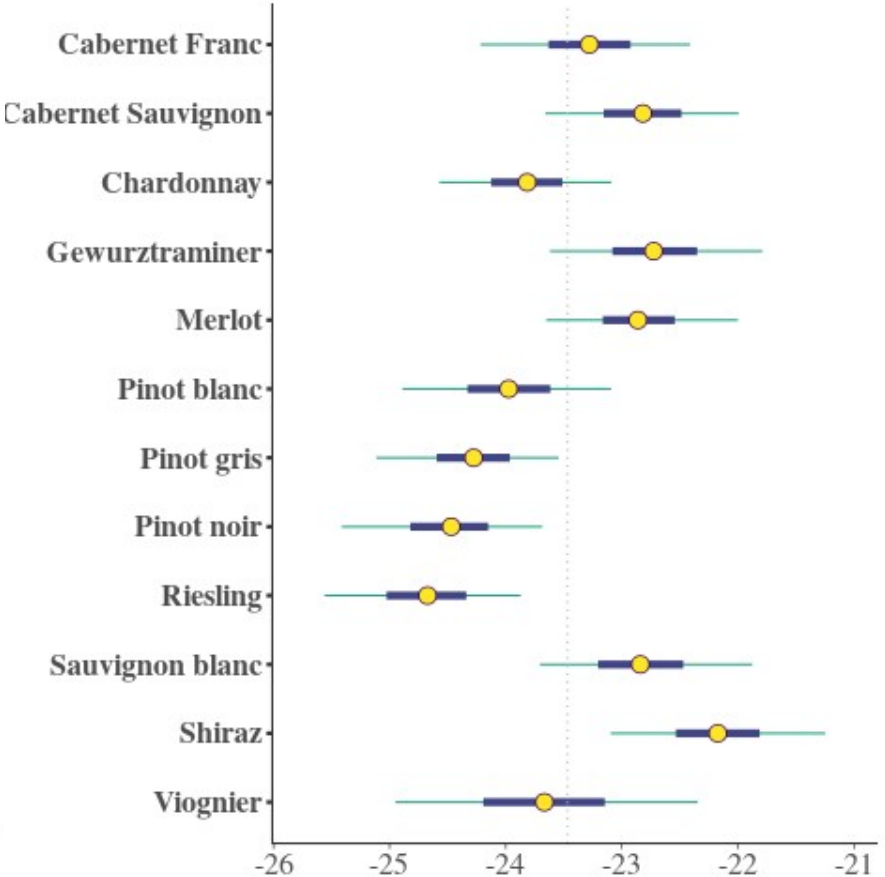
Difference in maximum hardiness of different varieties

Very similar to effect of variety on intercept of linear model I tried



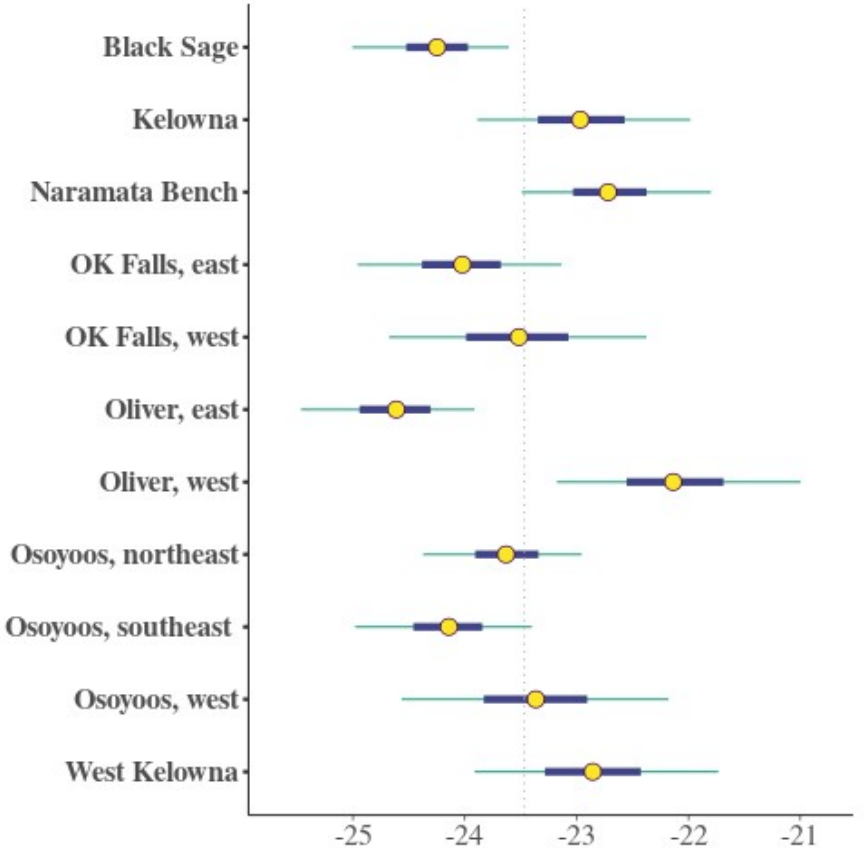
Model fit - variety effects





Model fit - site effects

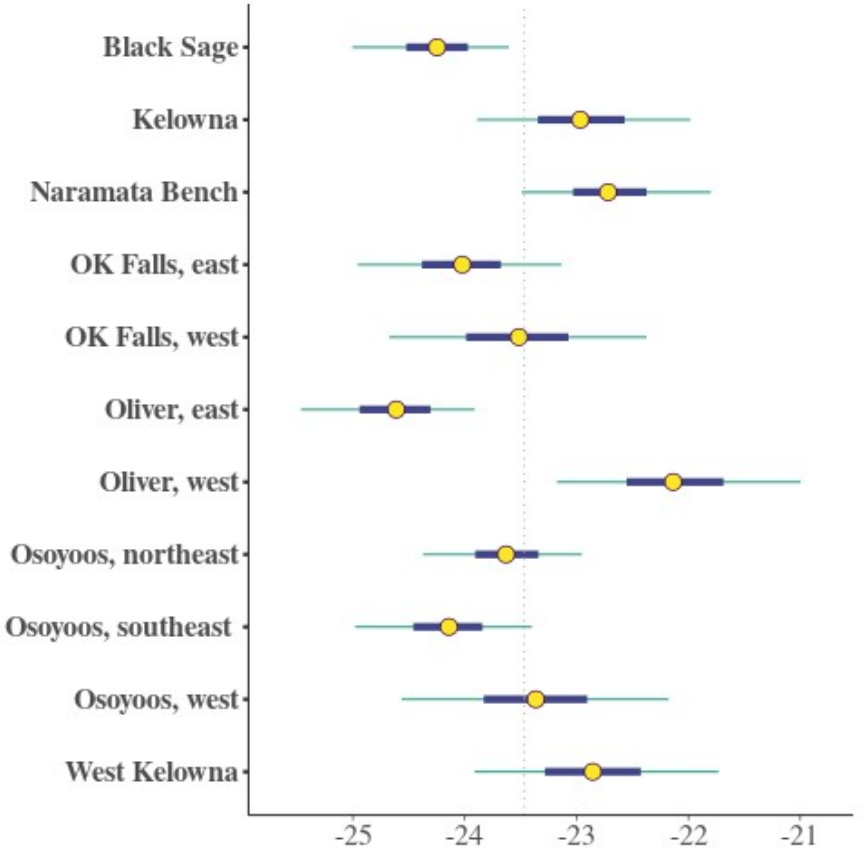
Difference in maximum hardiness of different sites



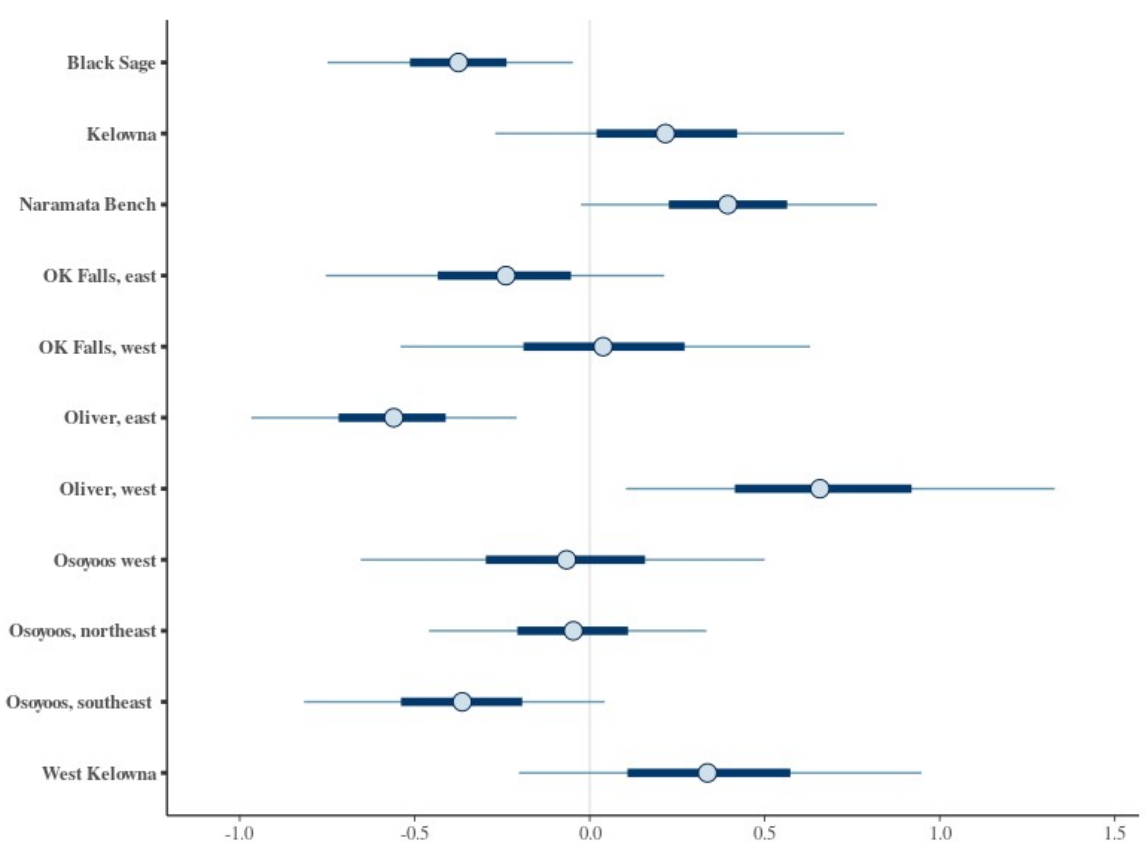
Model fit - site effects

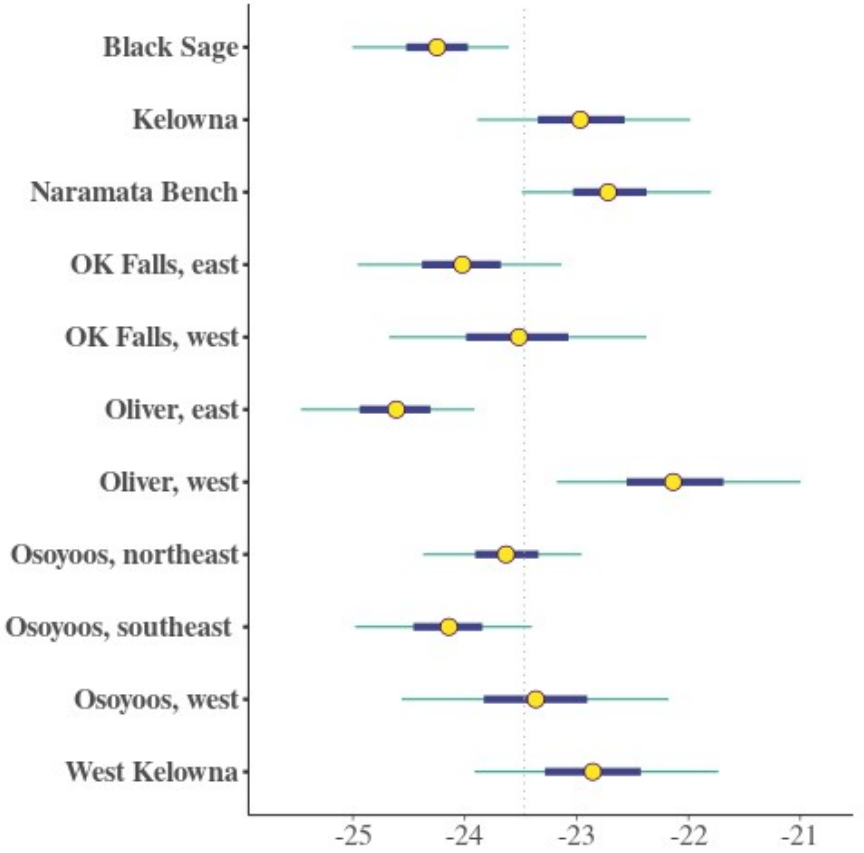
Difference in maximum hardiness of different sites

Again similar to results of effect of site on intercept in my old linear model

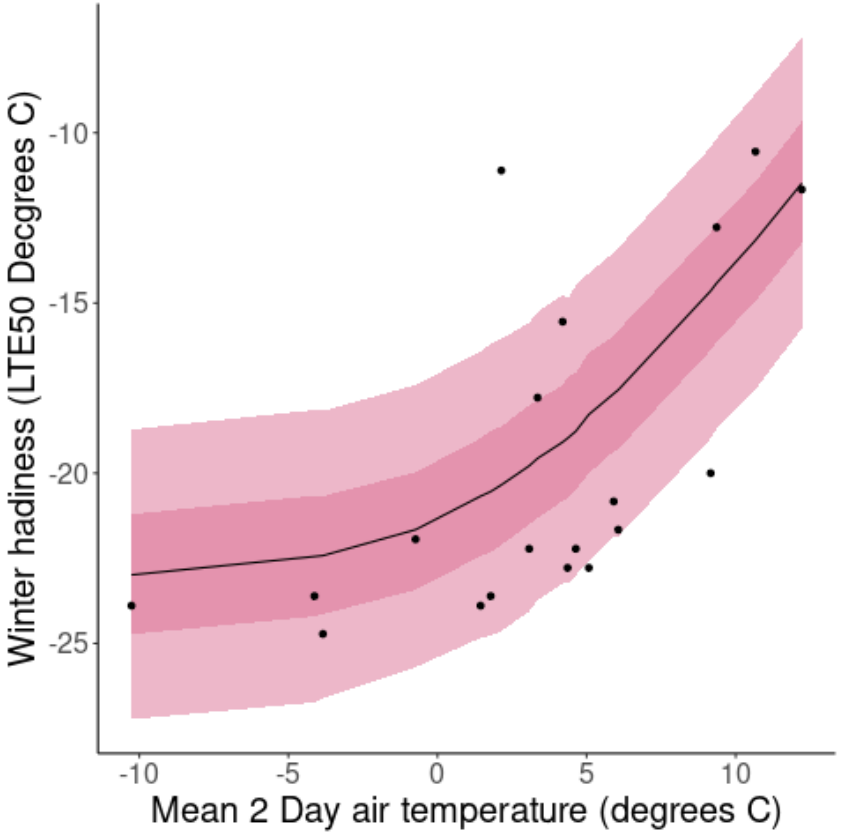


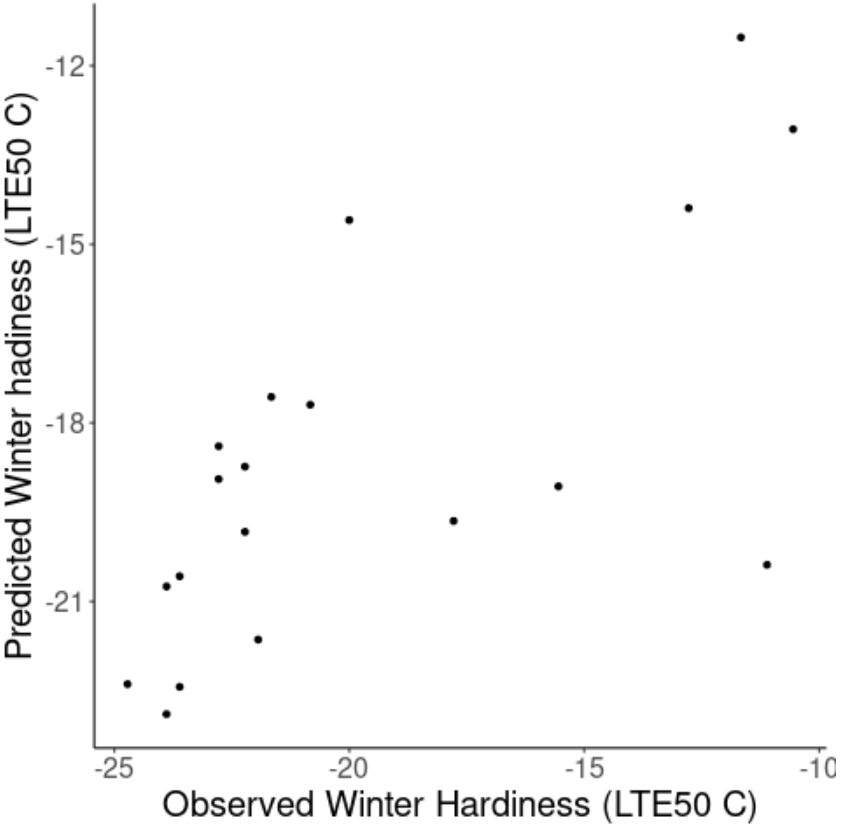
Model fit - site effects





Try with new data





Data from Washington State vines

Next steps

Generally happy with the model now, so need to actually use it for something useful!

Feed in Okanagan historical temperatures to see how the number of days where air temp falls below vine cold tollerance has changed

Extend analysis and model to include additional regions?
- maybe switch site effect to be region effect

Maybe include an effect for spring/autumn?

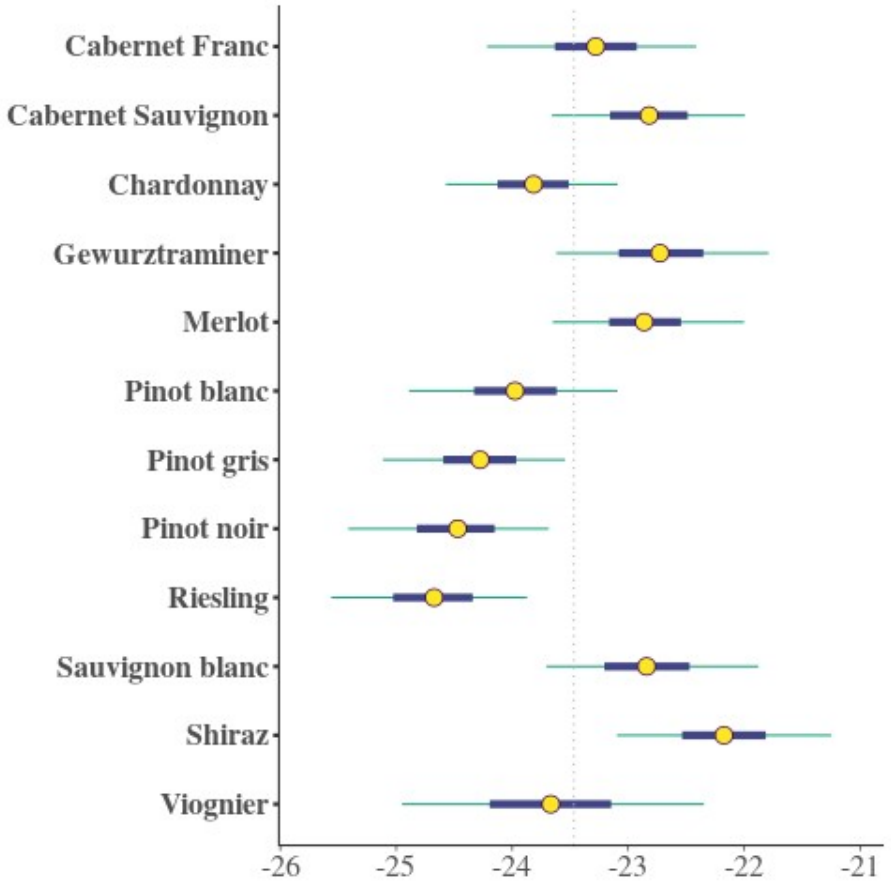
Next steps

Also talk to Carl!

and November - period of acclimation), remains fairly constant at

November 1 Mean Varietal Bud Hardiness (°C)		Variety	Maximum Bud Hardiness (°C)	Date of Maximum Bud Hardiness	March 1 Mean Varietal Bud Hardiness (°C)	
Shiraz	-14.3	Shiraz	-22.8	17-Jan	Gewurz	-20.1
Cab Sauv	-14.4	Merlot	-23.0	12-Jan	Merlot	-20.7
Merlot	-14.9	Gewurz	-23.1	2-Jan	Shiraz	-20.8
Cab Franc	-15.0	Cab Sauv	-23.1	12-Jan	Chardonnay	-21.0
Sauv blanc	-15.8	Sauv blanc	-23.1	1-Jan	Cab Sauv	-21.2
Gewurz	-16.0	Pinot blanc	-23.7	3-Jan	Cab Franc	-21.2
Pinot noir	-16.8	Riesling	-23.9	8-Jan	Sauv blanc	-21.2
Chardonnay	-16.9	Cab Franc	-24.0	9-Jan	Pinot noir	-21.3
Riesling	-16.9	Pinot noir	-24.1	6-Jan	Pinot gris	-21.7
Pinot gris	-17.0	Chardonnay	-24.1	3-Jan	Pinot blanc	-21.9
Pinot blanc	-17.1	Pinot gris	-24.2	6-Jan	Riesling	-22.2

Table 1. Date and mean of maximum varietal bud hardiness and mean bud hardiness for November 1 and March 1, 2012 – 2019.



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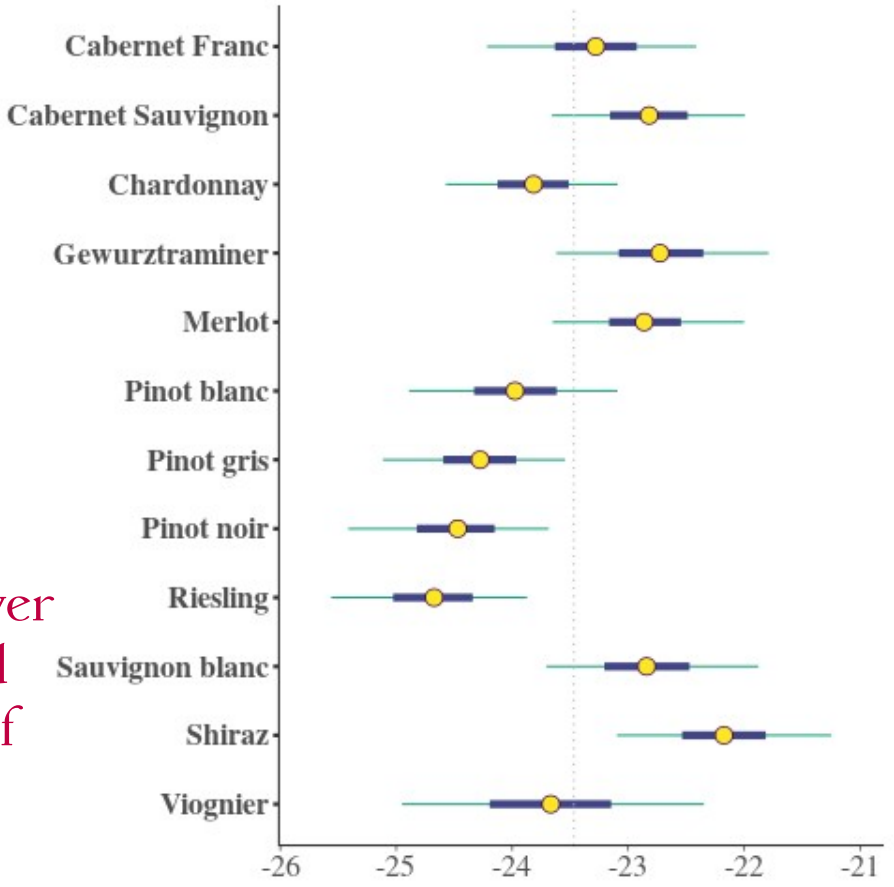

"The relative ranking among varieties however does vary through out the winter season and seems to be highlyinfluenced by the timing of grapevine phenological events such as fruit ripening and bud break."