Traitors modeling - phenology and mean trait values

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October 15, 2021

1 Overview

In this example I am trying to get the Traits phenology model working with mean trait values. We wanted to do this so:

1. We have had problems getting the trait section of the model working. This model is a backup if we can't get the full model working

2. Assuming we get this model working, we can use it to sanity check the full model results.

We have a single phenology model where we use mean trait values instead of the $\alpha_{trait,sp}$ values.

2 Model details

I chose priors using a combination by first looking at the Ospree priors, then tightening them until the model ran without divergences.

$$y_{phenp,i} \sim N(\mu_{pheno,i}, \sigma^2_{trait,y}) \tag{1}$$

$$\mu_{pheno,i} = \alpha_{pheno,sp[i]} + \beta_{forcing,sp[i]} * F_i + \beta_{chill,sp[i]} * Ch_i + \beta_{photo,sp[i]} * Ph_i \tag{2}$$

$$\alpha_{pheno,sp} \sim N(\mu_{\alpha,pheno}, \sigma_{\alpha,pheno}) \tag{3}$$

$$\beta_{forcing,sp} = \alpha_{force,sp} + \beta_{traitxforce} * \alpha_{trait,sp} \tag{4}$$

$$\beta_{chill,sp} = \alpha_{chill,sp} + \beta_{traitxchill} * \alpha_{trait,sp} \tag{5}$$

$$\beta_{photo,sp} = \alpha_{photo,sp} + \beta_{traitxphoto} * \alpha_{trait,sp} \tag{6}$$

$$\alpha_{pheno,sp} \sim N(\mu_{pheno}, \sigma^2_{pheno}) \tag{7}$$

$$\alpha_{force,sp} \sim N(\mu_{force}, \sigma^2_{force}) \tag{8}$$

$$\alpha_{chill,sp} \sim N(\mu_{chill}, \sigma^2_{chill}) \tag{9}$$

$$\alpha_{photo,sp} \sim N(\mu_{photo}, \sigma^2_{photo}) \tag{10}$$

$$\sigma^2_{trait,y} \sim N(20, 5) \tag{11}$$

$$\mu_{force} \sim N(0, 1) \tag{12}$$

$$\sigma^2_{force} \sim N(4, 3) \tag{13}$$

$$\mu_{chill} \sim N(0, 1) \tag{14}$$

$$\sigma^2_{chill} \sim N(4, 3) \tag{15}$$

$$\mu_{photo} \sim N(0, 1) \tag{16}$$

$$\sigma^2_{photo} \sim N(4, 3) \tag{17}$$

$$\mu_{pheno} \sim N(100, 20) \tag{18}$$

$$\sigma^2_{pheno} \sim N(0, 10) \tag{19}$$

$$\beta_{traitxforce} \sim N(0, 0.5) \tag{20}$$

$$\beta_{traitxchill} \sim N(0, 0.5) \tag{21}$$

$$\beta_{traitxphoto} \sim N(0, 0.5) \tag{22}$$

3 Prior Predictive Check

Most predicted dates are between 0 and about 220 (Figure 1) The predicted phenological dates plotted against forcing , chilling and photoperiod are in Figures 2, 3 and 4 respectively. I thought these values are probably OK - plants are unlikely to budburst in the autumn. Ideally I was hoping for a wider spread into the 300s though.

4 Running the model on Simulated data.

I then simulated data using the same structure as the Stan model, and with values similar to the real values we got when we used the real data. I know this is a bit backwards because I should not have run real data through the model without doing these checks first.

My simulated data included 150 species and 15 repetitions. Any more repetitions that this actually lead to divergences in the model fitting.

I ran the model with 4000 warmup and 6000 iterations. Unfortunately, although the model runs without divergent transitions or obvious posterior degeneracies that I could see (Figures 5), it isn't doing a great job of estimating values (Figure 6). I think model is struggling to differentiate between trait and trait related effect on phenology, and I'm not sure what to do about it.

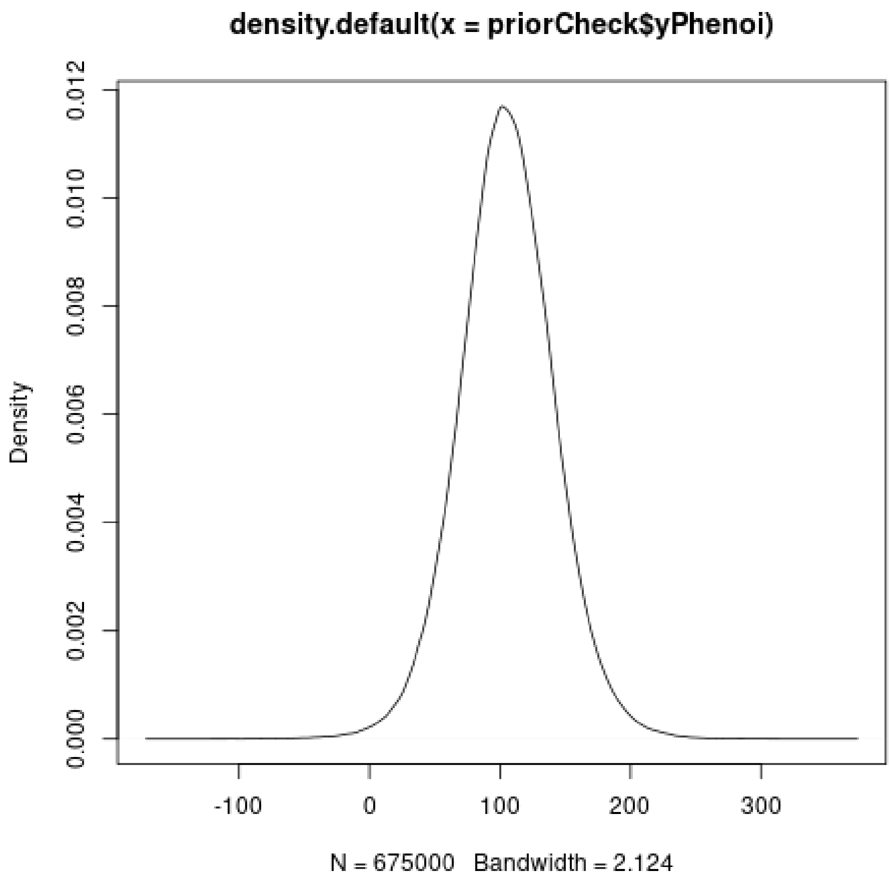

Figure 1: The prior predictive check distribution of phenological date values.

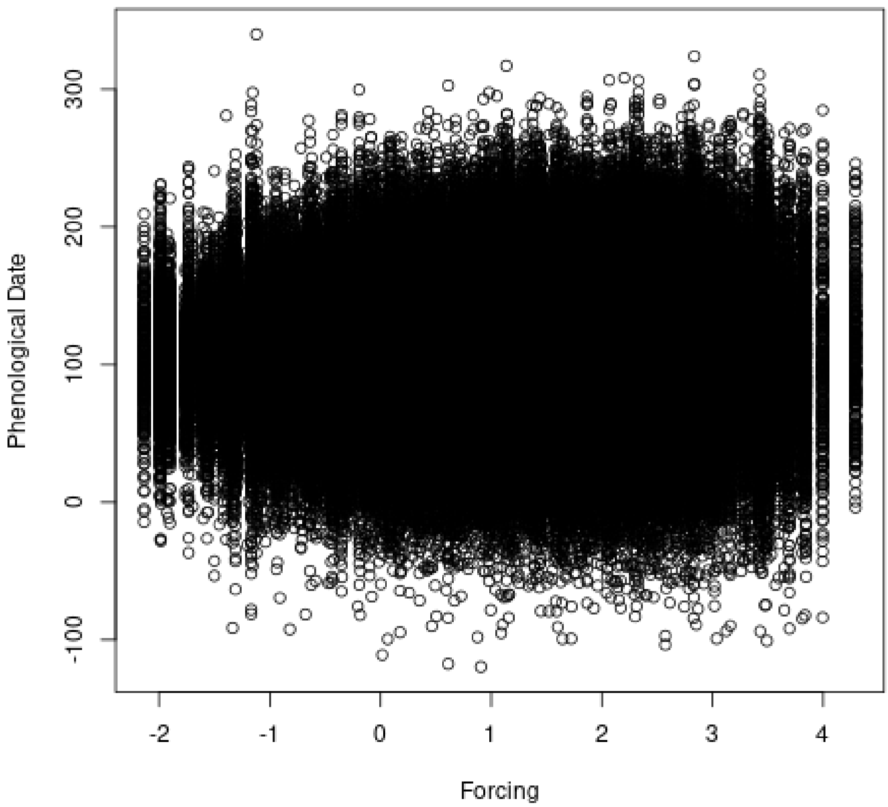

Figure 2: The prior predictive check distribution of phenological date against forcing values.

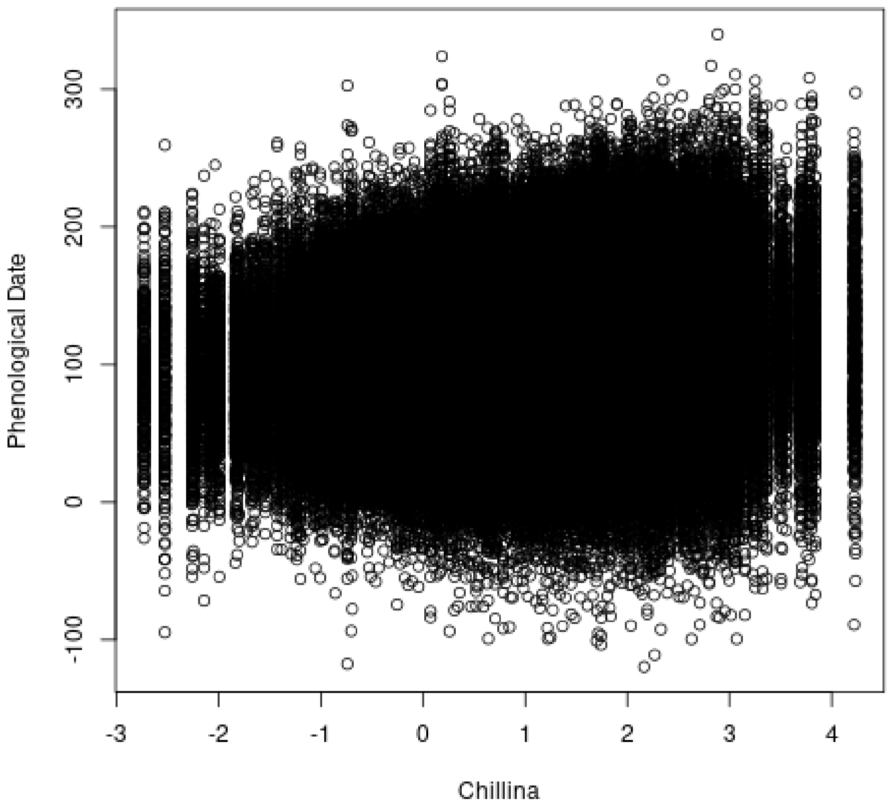

Figure 3: The prior predictive check distribution of phenological date against chilling values.

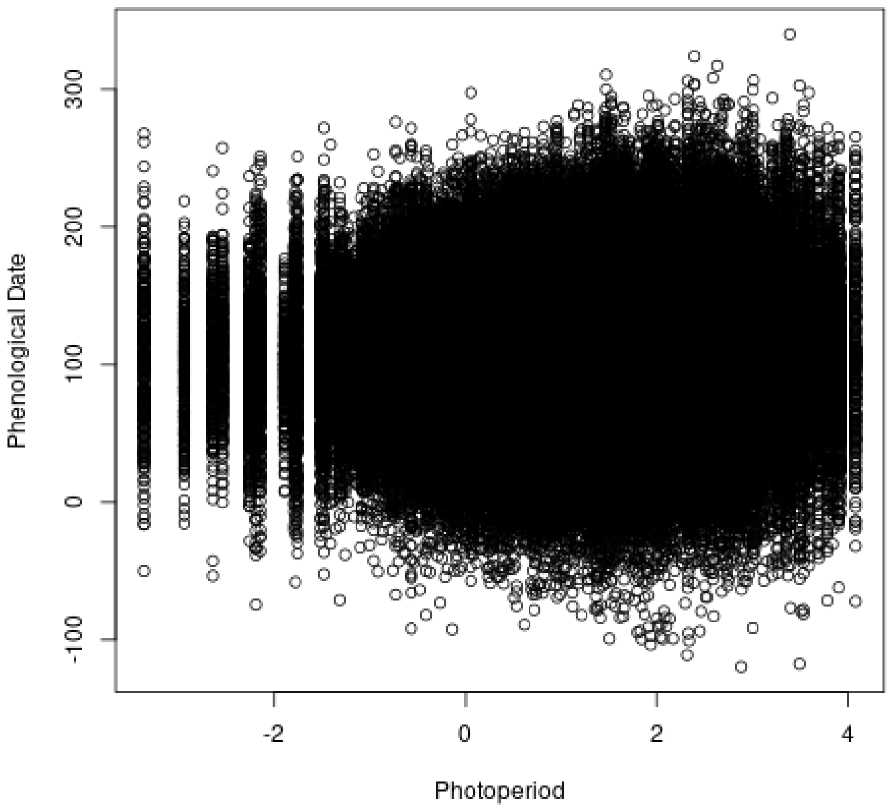

Figure 4: The prior predictive check distribution of phenological date against photoperiod values.

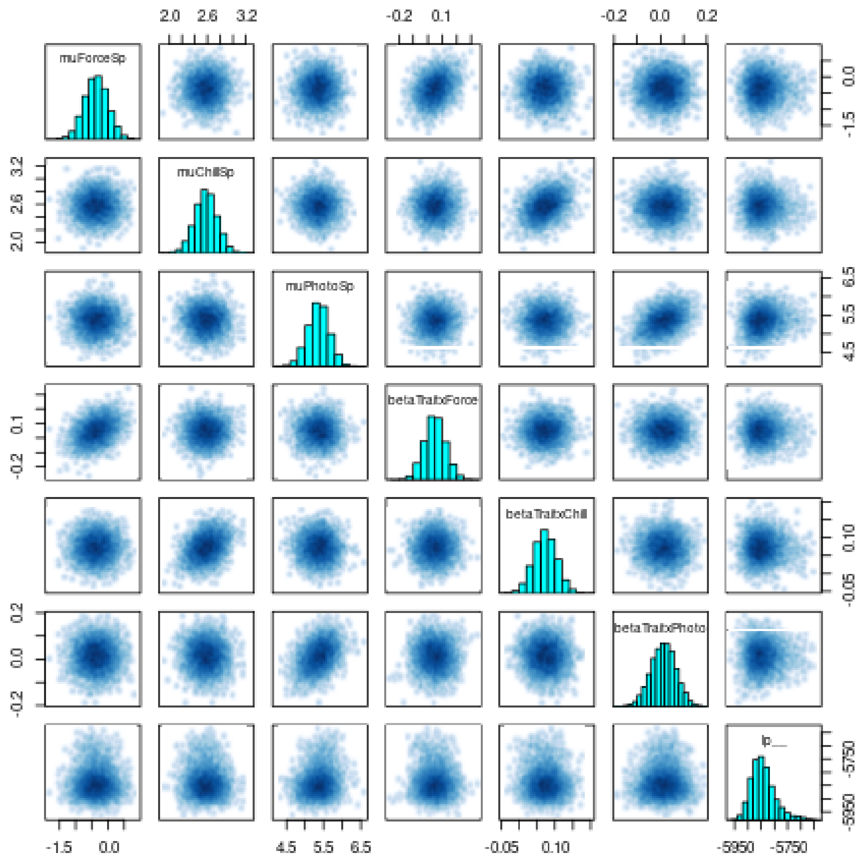

Figure 5: Posterior pairs plot for the main parameters of the Stan model using simulated data.

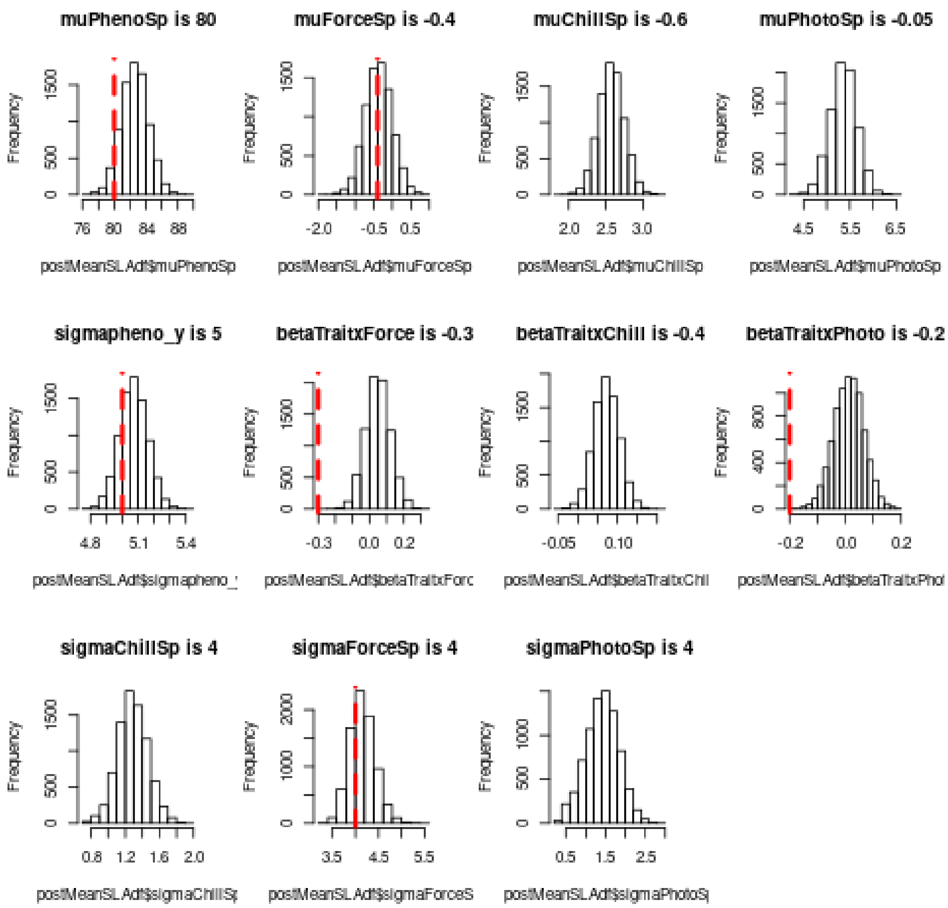

Figure 6: Posterior parameter estimations for each parameter. The red line represents the simulation value, and this value is repeated in the title of each panel. No red line overlaying the histogram means the simulated value was very different from the predicted value.