

data wrangling and plots

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4/2/21

Plots

Question: How does response vary with study covariates?

Hypothesis: SMD between constant and fluctuating environments is most affected by temperature parameters (range and mean) but is also likely affected by demographic parameters (age, size, organization level)

Initial conclusions: Flux_range and mean temperature appear to be the most important contributors to variation in yi, though organization also contributes.

```
#with interaction term
full_rf_model<-rma.mv(yi, vi, data=dat_MA_ES, mods = ~flux_range * mean_temp_constant +
                    exp_age + size + org_level,
                    random = ~1 | experiment_id/ study_id/ response_id,
                    method="REML")
full_rf_model
```

```
##
## Multivariate Meta-Analysis Model (k = 140; method: REML)
##
## Variance Components:
##
##      estim      sqrt  nlvls  fixed      factor
## sigma^2.1  0.0000  0.0002     2    no      experiment_id
## sigma^2.2  0.4801  0.6929    19    no      experiment_id/study_id
## sigma^2.3  0.3679  0.6065    54    no      experiment_id/study_id/response_id
##
## Test for Residual Heterogeneity:
## QE(df = 133) = 4966.2128, p-val < .0001
##
## Test of Moderators (coefficients 2:7):
## QM(df = 6) = 188.5784, p-val < .0001
##
## Model Results:
##
##      estimate      se      zval      pval      ci.lb
## intrcpt      1.4408  0.8785   1.6400  0.1010  -0.2811
## flux_range    0.2718  0.0488   5.5653 <.0001   0.1761
## mean_temp_constant 0.0170  0.0184   0.9255  0.3547 -0.0190
## exp_age     -0.5708  0.3985  -1.4323  0.1520 -1.3519
## size        -0.3056  0.2850  -1.0725  0.2835 -0.8641
```

```
## org_level -0.6683 0.3383 -1.9756 0.0482 -1.3314
## flux_range:mean_temp_constant -0.0136 0.0020 -6.7104 <.0001 -0.0176
## ci.ub
## intrcpt 3.1626
## flux_range 0.3675 ***
## mean_temp_constant 0.0530
## exp_age 0.2103
## size 0.2529
## org_level -0.0053 *
## flux_range:mean_temp_constant -0.0096 ***
##
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
#without interaction term
full_rf_model2<-rma.mv(yi, vi, data=dat_MA_ES, mods = ~flux_range + mean_temp_constant +
                      exp_age + size + org_level,
                      random = ~1 | experiment_id/ study_id/ response_id,
                      method="REML")
full_rf_model2
```

```
##
## Multivariate Meta-Analysis Model (k = 140; method: REML)
##
## Variance Components:
##
##      estim      sqrt nlvls fixed factor
## sigma^2.1 0.0000 0.0002     2   no      experiment_id
## sigma^2.2 0.5921 0.7694    19   no      experiment_id/study_id
## sigma^2.3 0.3692 0.6076    54   no      experiment_id/study_id/response_id
##
## Test for Residual Heterogeneity:
## QE(df = 134) = 5082.0033, p-val < .0001
##
## Test of Moderators (coefficients 2:6):
## QM(df = 5) = 143.6740, p-val < .0001
##
## Model Results:
##
##      estimate      se      zval      pval      ci.lb      ci.ub
## intrcpt      3.9455 0.8486   4.6492 <.0001   2.2822   5.6088 ***
## flux_range  -0.0468 0.0115  -4.0635 <.0001  -0.0694  -0.0242 ***
## mean_temp_constant -0.0931 0.0083 -11.2776 <.0001  -0.1093  -0.0769 ***
## exp_age     -0.5211 0.4305  -1.2104 0.2261  -1.3649   0.3227
## size        -0.2607 0.3052  -0.8542 0.3930  -0.8589   0.3375
## org_level    -0.5649 0.3434  -1.6453 0.0999  -1.2379   0.1080 .
##
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
#full model split out by stocks/rates
full_rf_stocks<-rma.mv(yi, vi, data=dat_MA_ES, mods = ~flux_range + mean_temp_constant +
                      exp_age + size + org_level + resp_type,
```

```

        random = ~1 | experiment_id/ study_id/ response_id,
        method="REML")
full_rf_stocks

```

```

##
## Multivariate Meta-Analysis Model (k = 140; method: REML)
##
## Variance Components:
##
##      estim      sqrt  nlvls  fixed      factor
## sigma^2.1  0.0000  0.0002     2    no      experiment_id
## sigma^2.2  0.6413  0.8008    19    no      experiment_id/study_id
## sigma^2.3  0.3492  0.5910    54    no      experiment_id/study_id/response_id
##
## Test for Residual Heterogeneity:
## QE(df = 133) = 5044.3409, p-val < .0001
##
## Test of Moderators (coefficients 2:7):
## QM(df = 6) = 145.7976, p-val < .0001
##
## Model Results:
##
##      estimate      se      zval      pval      ci.lb      ci.ub
## intrcpt          3.5009  0.9275   3.7746  0.0002   1.6831   5.3188 ***
## flux_range       -0.0463  0.0115  -4.0198 <.0001  -0.0689  -0.0237 ***
## mean_temp_constant -0.0934  0.0083 -11.3076 <.0001  -0.1096  -0.0772 ***
## exp_age          -0.5082  0.4413  -1.1516  0.2495  -1.3730   0.3567
## size            -0.2895  0.3117  -0.9287  0.3530  -0.9004   0.3214
## org_level        -0.5581  0.3381  -1.6505  0.0988  -1.2209   0.1046 .
## resp_typedtrait   0.5324  0.3899   1.3654  0.1721  -0.2318   1.2965
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```

#full model split out by life history outcomes
full_rf_thermal<-rma.mv(yi, vi, data=dat_MA_ES, mods = ~flux_range + mean_temp_constant +
                        exp_age + size + org_level + stressful ,
                        random = ~1 | experiment_id/ study_id/ response_id,
                        method="REML")

```

```

## Warning in rma.mv(yi, vi, data = dat_MA_ES, mods = ~flux_range +
## mean_temp_constant + : Rows with NAs omitted from model fitting.

```

```

full_rf_thermal

```

```

##
## Multivariate Meta-Analysis Model (k = 132; method: REML)
##
## Variance Components:
##
##      estim      sqrt  nlvls  fixed      factor
## sigma^2.1  0.0000  0.0002     2    no      experiment_id

```

```
## sigma^2.2  0.6271  0.7919    18    no                experiment_id/study_id
## sigma^2.3  0.3784  0.6151    53    no  experiment_id/study_id/response_id
##
## Test for Residual Heterogeneity:
## QE(df = 125) = 2792.3174, p-val < .0001
##
## Test of Moderators (coefficients 2:7):
## QM(df = 6) = 12.8046, p-val = 0.0462
##
## Model Results:
##
##              estimate      se      zval      pval      ci.lb      ci.ub
## intrcpt          -0.1022  1.1577  -0.0883  0.9297  -2.3711   2.1668
## flux_range        -0.0132  0.0168  -0.7831  0.4336  -0.0461   0.0198
## mean_temp_constant  0.0843  0.0330   2.5559  0.0106   0.0196   0.1489  *
## exp_age          -0.1052  0.4536  -0.2319  0.8166  -0.9941   0.7838
## size            -0.8962  0.3367  -2.6615  0.0078  -1.5562  -0.2362  **
## org_level        -0.5430  0.3507  -1.5483  0.1216  -1.2304   0.1444
## stressfully      -0.0232  0.0851  -0.2729  0.7849  -0.1901   0.1437
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Relevant plots

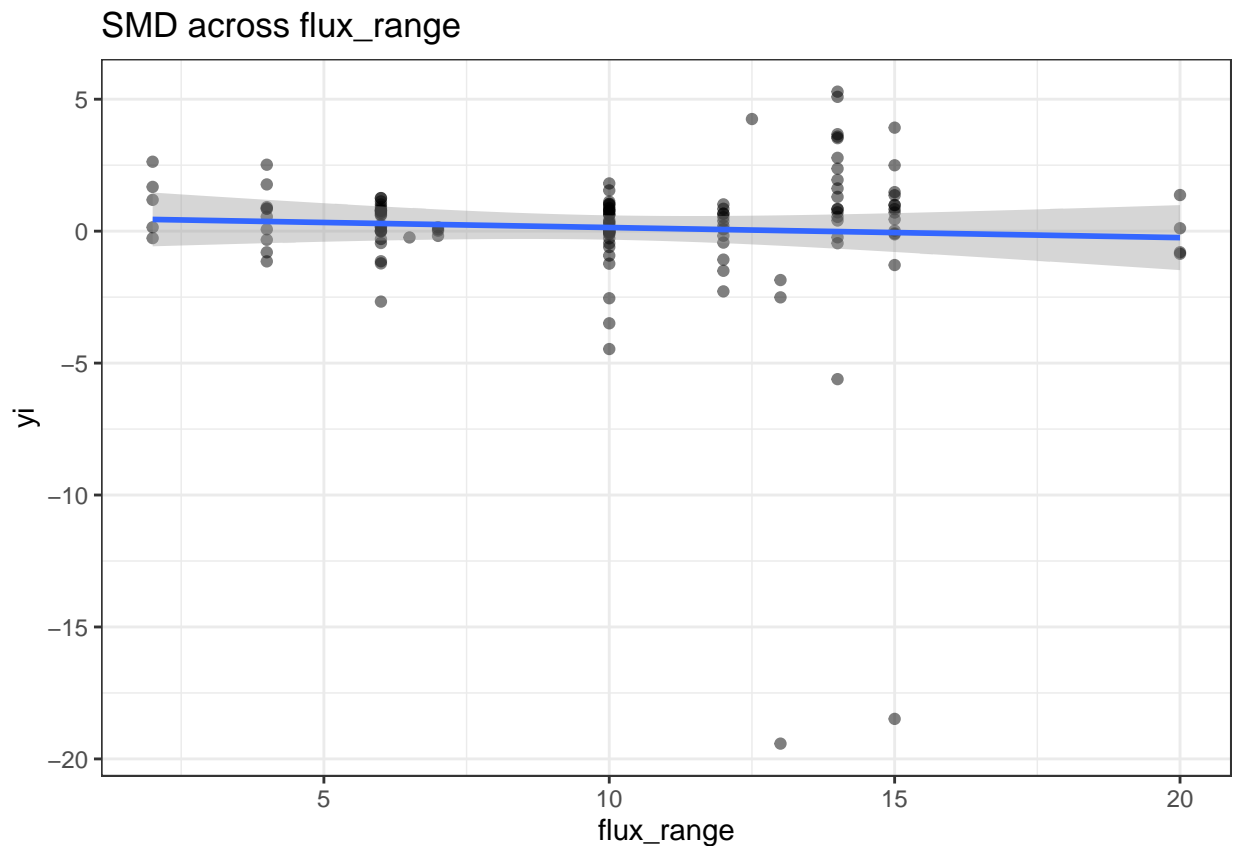


Figure 1. Data visualization supports model findings that there is a difference between shorter fluctuation

ranges and longer fluctuation ranges.

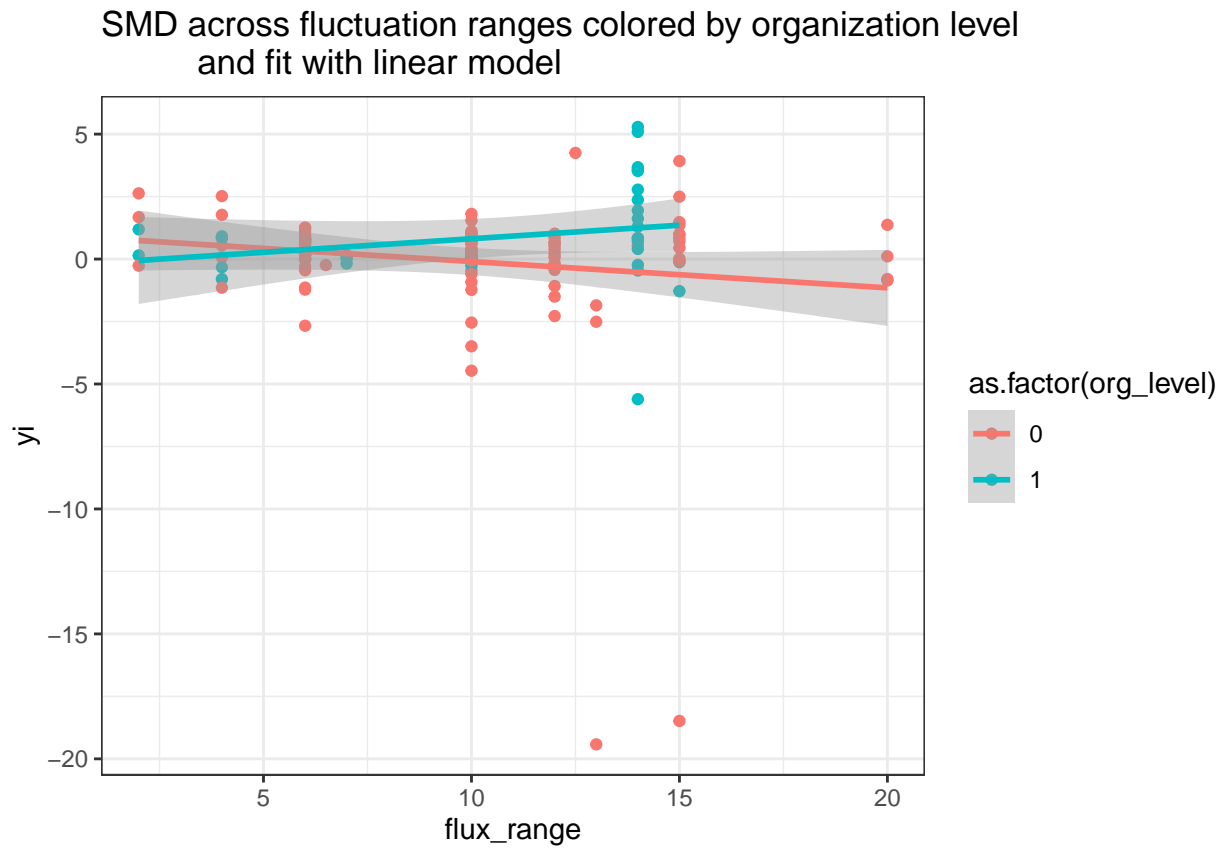


Figure 2. We can also see that there a difference in effect size in organization level responses across fluctuation range. Population level reponses trended positively across fluctuation ranges, while organism level responses trended negatively across fluctuation ranges.

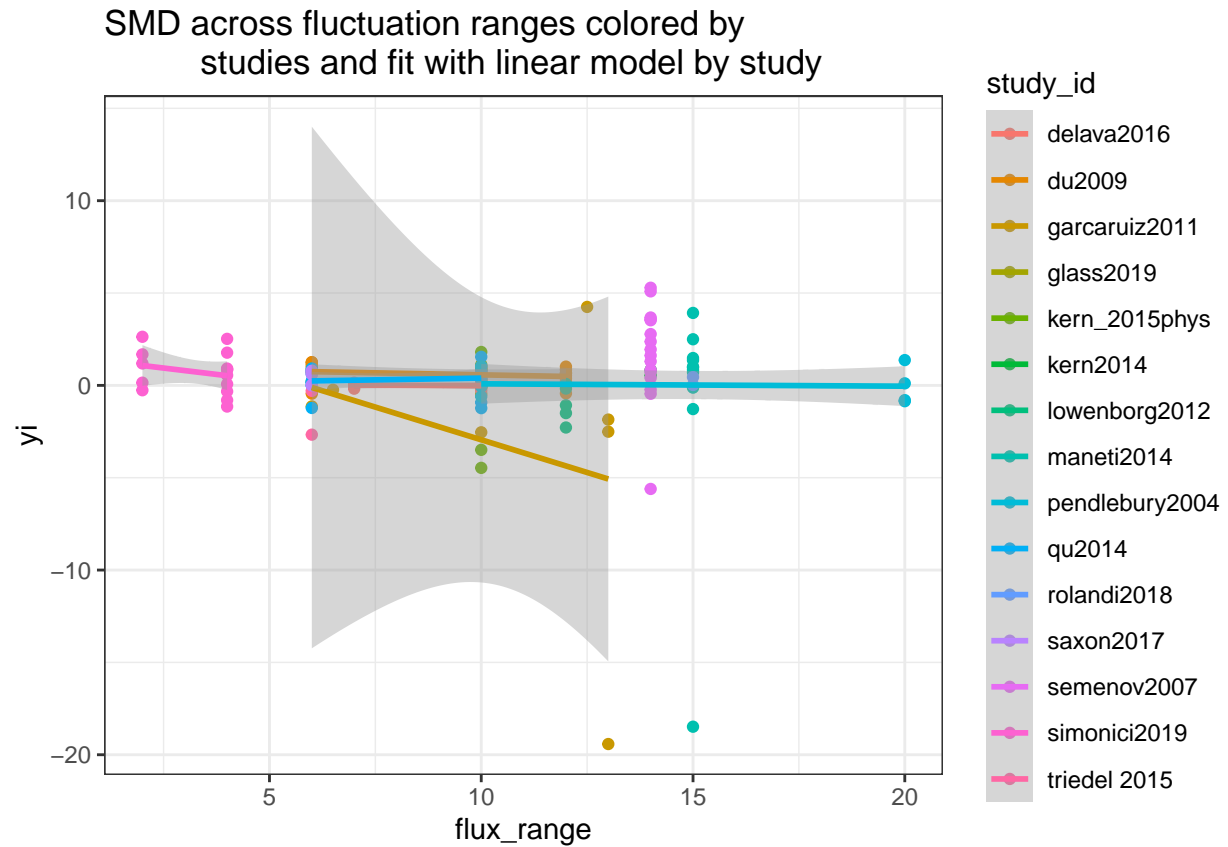


Figure 3. When broken out by study, we can see that there is disagreement in the effect of fluctuation range on effect size.

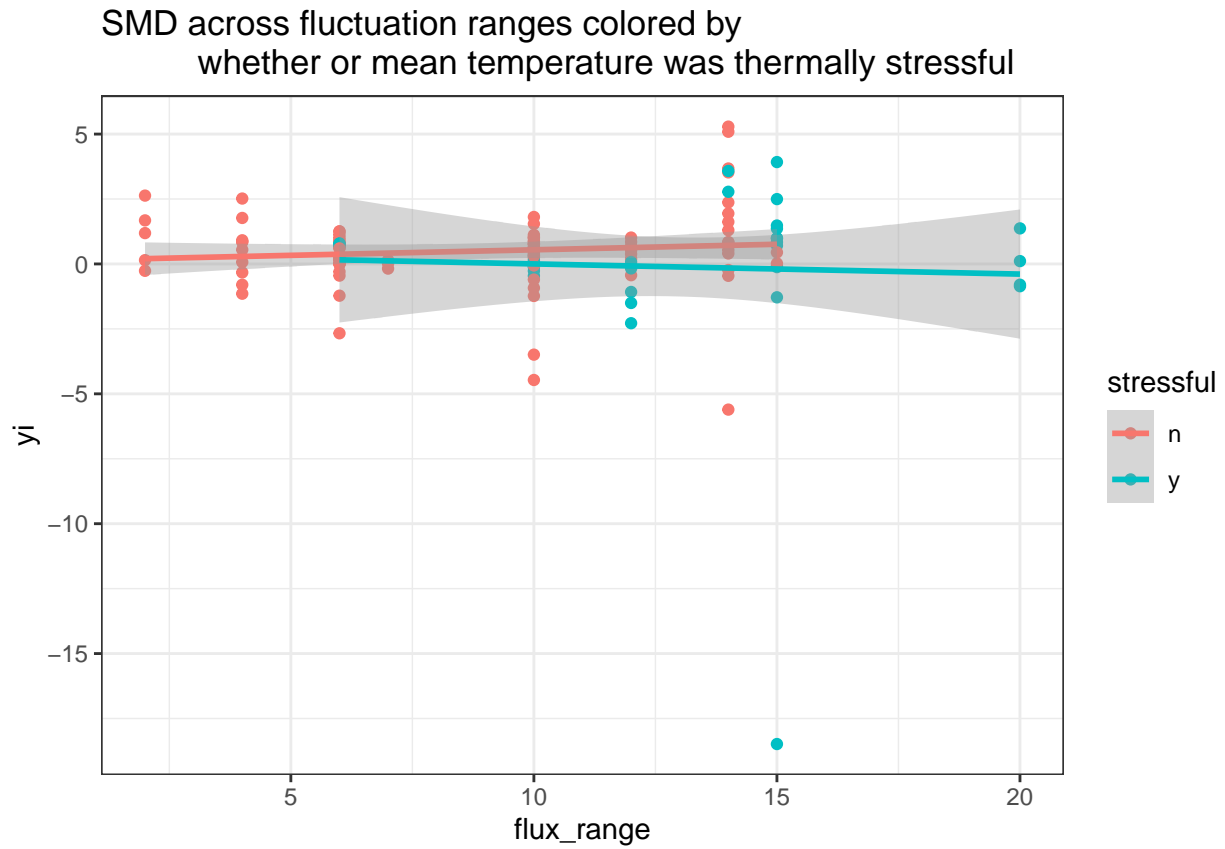


Figure 4. When we consider where the temperatures in the fluctuation range reach thermally stressful levels, there is a small difference between responses to stressful temperatures (negative) and non-stressful temperatures (positive).

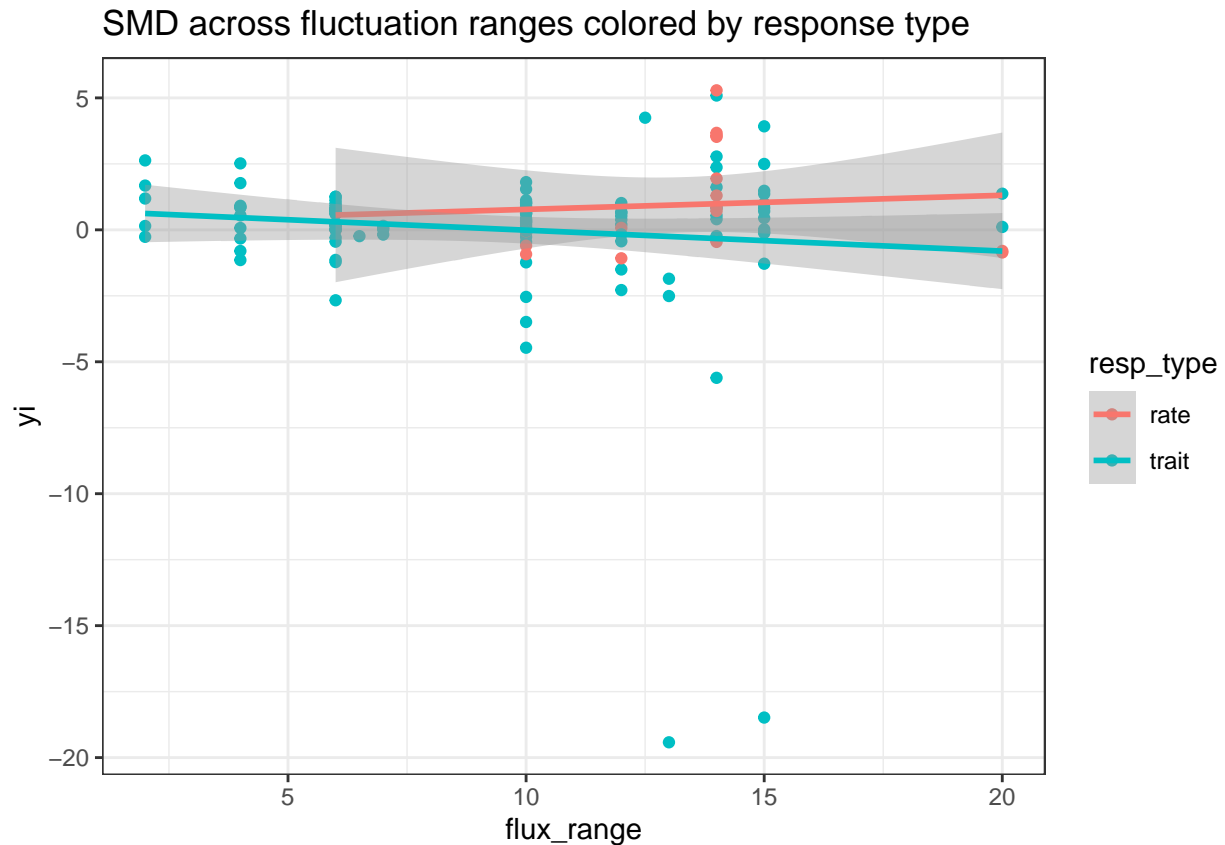


Figure 5.

Question: How does response compare across studies and experiments?

Hypothesis: There should be differences across studies because of differences in experimental designs and study organism that would mean different magnitudes of response.

Initial conclusions: The studies overall are different in their responses but not owing to study_id or experiment. However, the mixed effects model does suggest some differences when you include study _id as a mod.

```
##
## Multivariate Meta-Analysis Model (k = 140; method: REML)
##
## Variance Components:
##
##      estim      sqrt  nlvls  fixed      factor
## sigma^2.1  0.0000  0.0002     2    no      experiment_id
## sigma^2.2  0.5980  0.7733    19    no  experiment_id/study_id
##
## Test for Heterogeneity:
## Q(df = 139) = 5373.4640, p-val < .0001
##
## Model Results:
##
## estimate      se      zval      pval      ci.lb      ci.ub
```



```
## 0.1261 0.1808 0.6976 0.4854 -0.2282 0.4804
##
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Relevant Plots

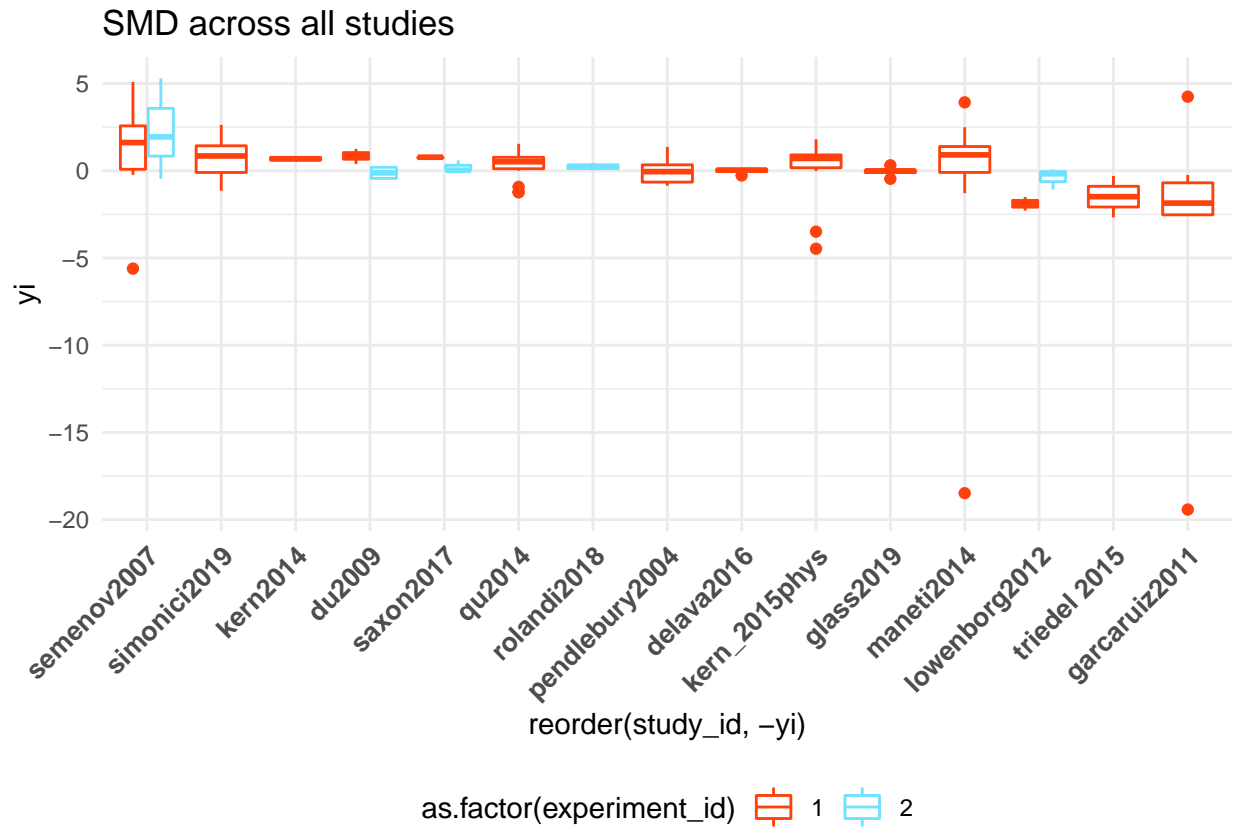


Figure 6. When we look at experiment and study, we can see across the 15 studies included in this meta-analysis there are differences across and within experiments.

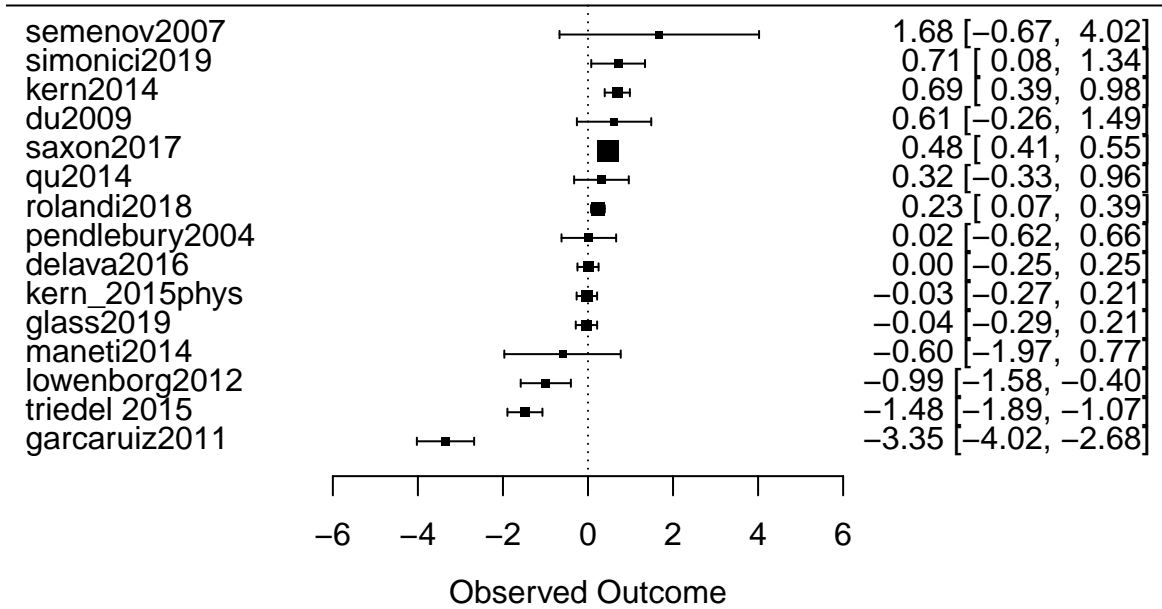


Figure 7. I kind of like this figure better than the boxplot in Figure 5 as an overall figure?

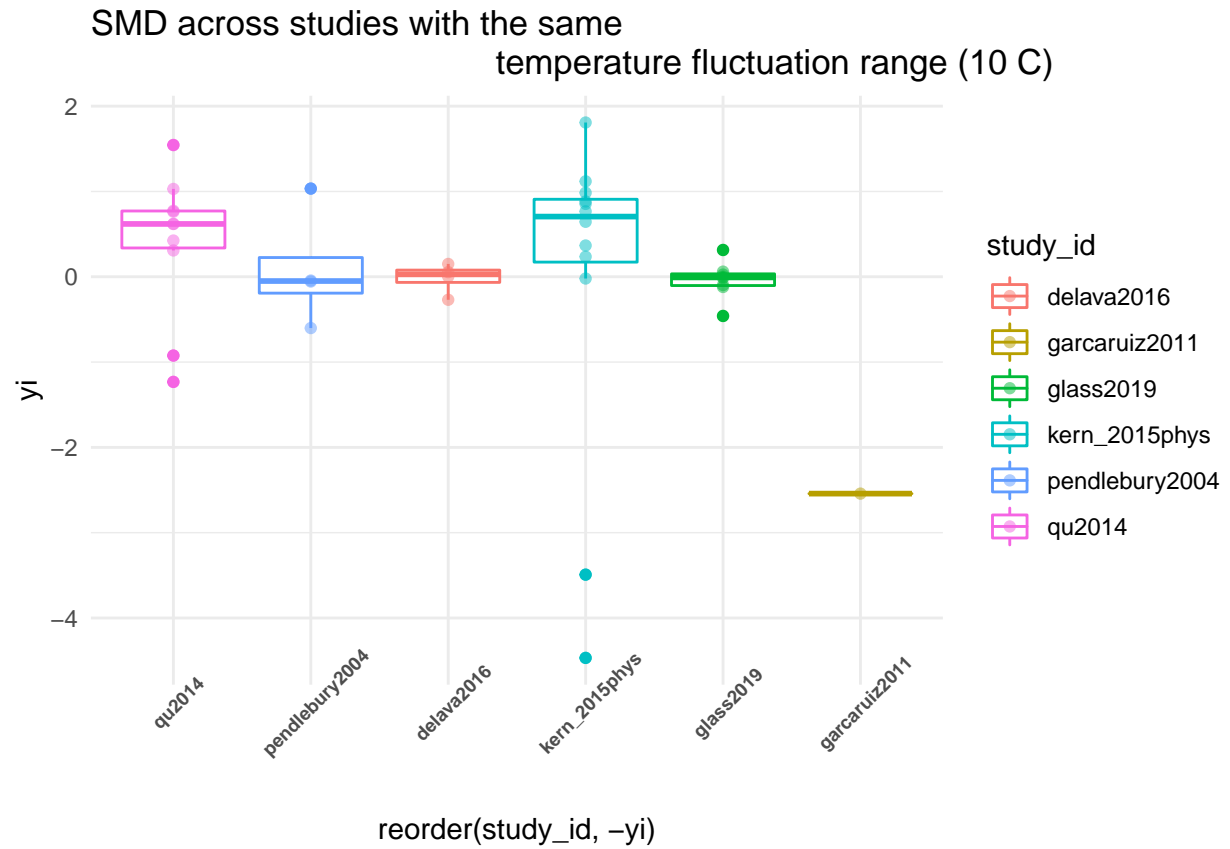


Figure 8.

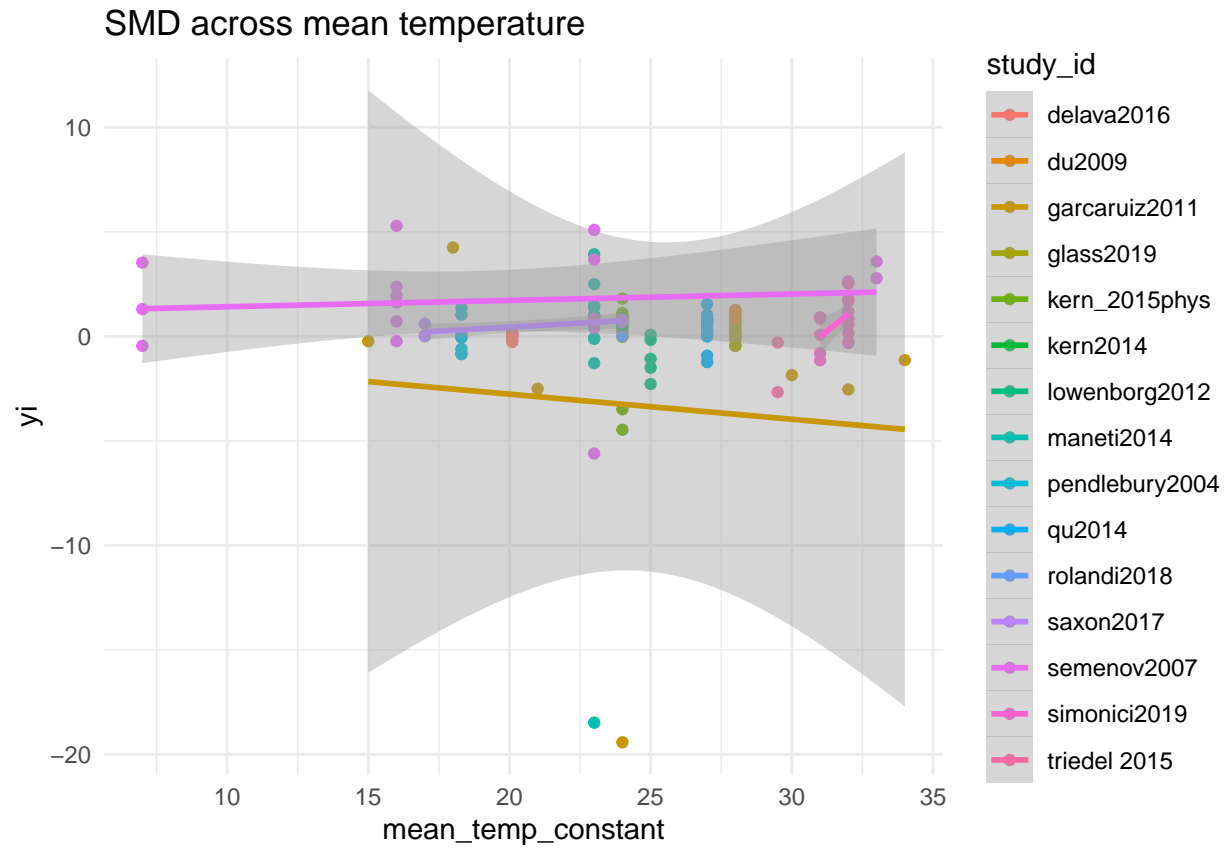


Figure 9.

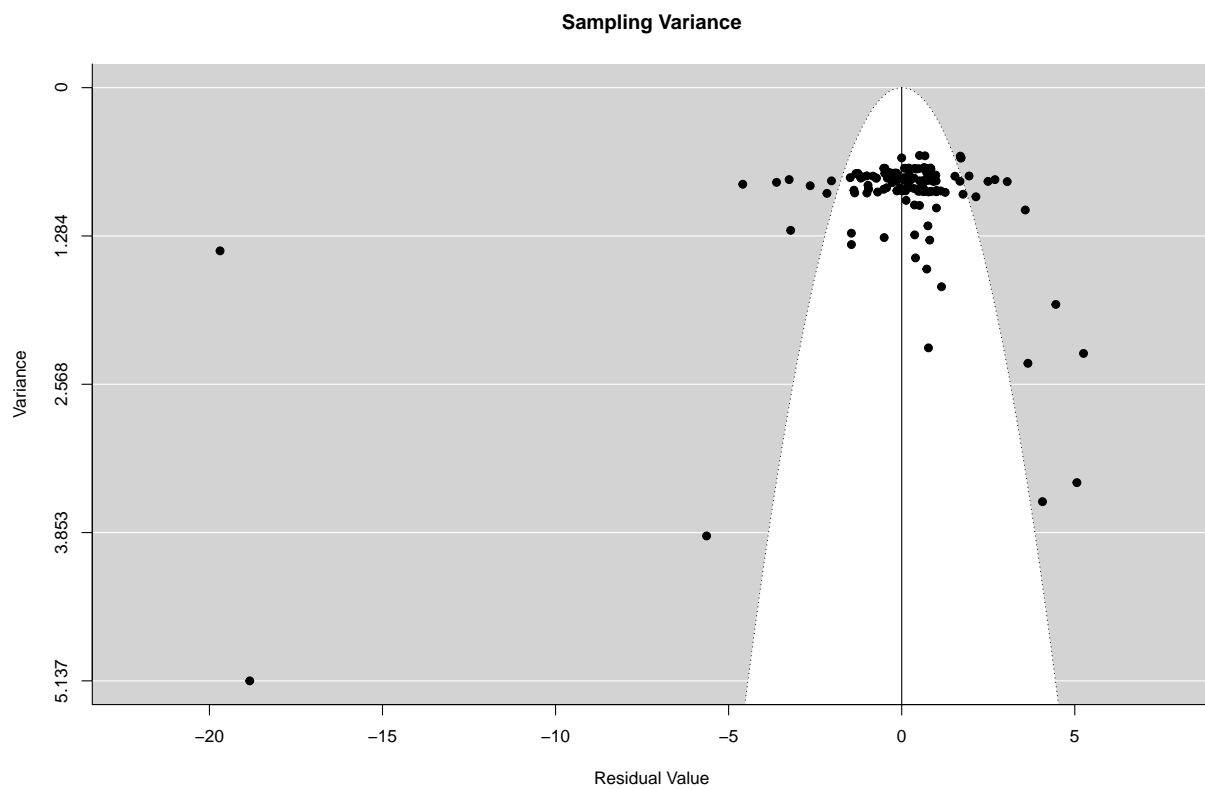
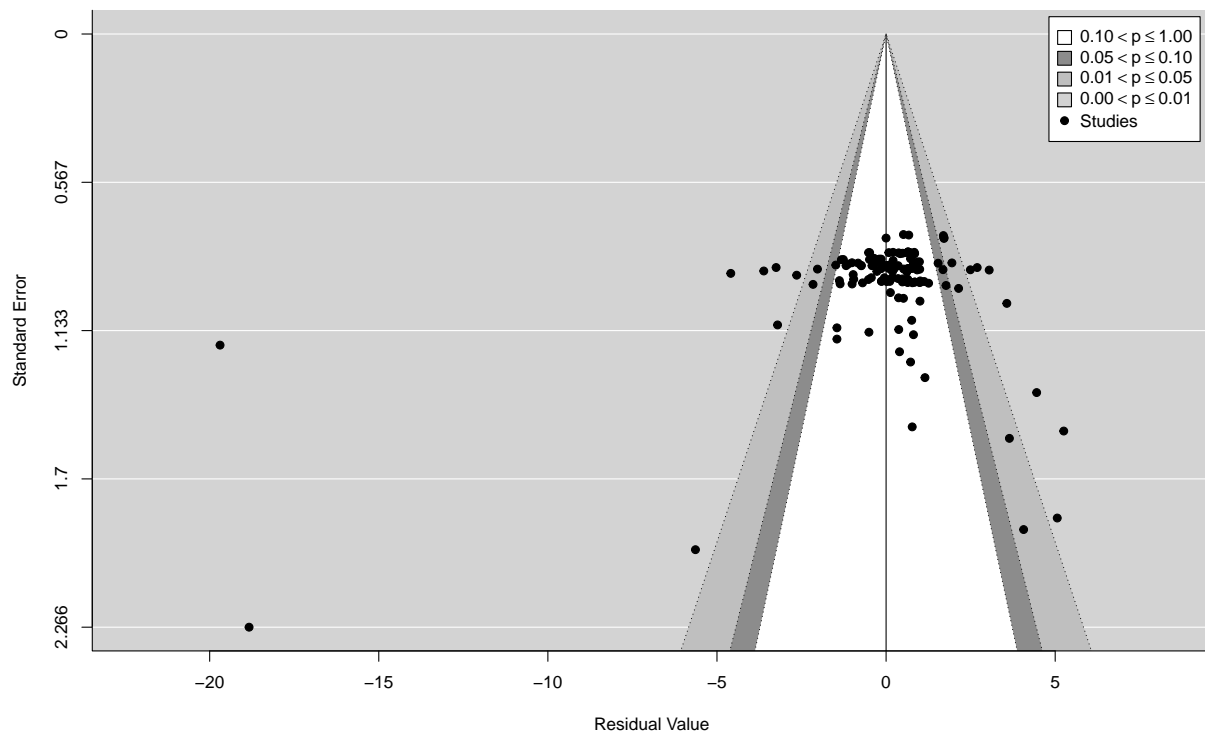


Figure 10. Well, from what I can gather, a majority of the effect sizes from our meta-analysis have a

non-significant effect size value. However, there is a population of a couple influential effect sizes that are significantly important.

Supplementary Plots/Code

```
## Warning in rma.mv(yi, vi, data = common_range, random = ~1 | experiment_id/  
## study_id, : Single-level factor(s) found in 'random' argument. Corresponding  
## 'sigma2' value(s) fixed to 0.
```