Cable Bateria 2024 Initial Analysis

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Contents

Necessary libraries

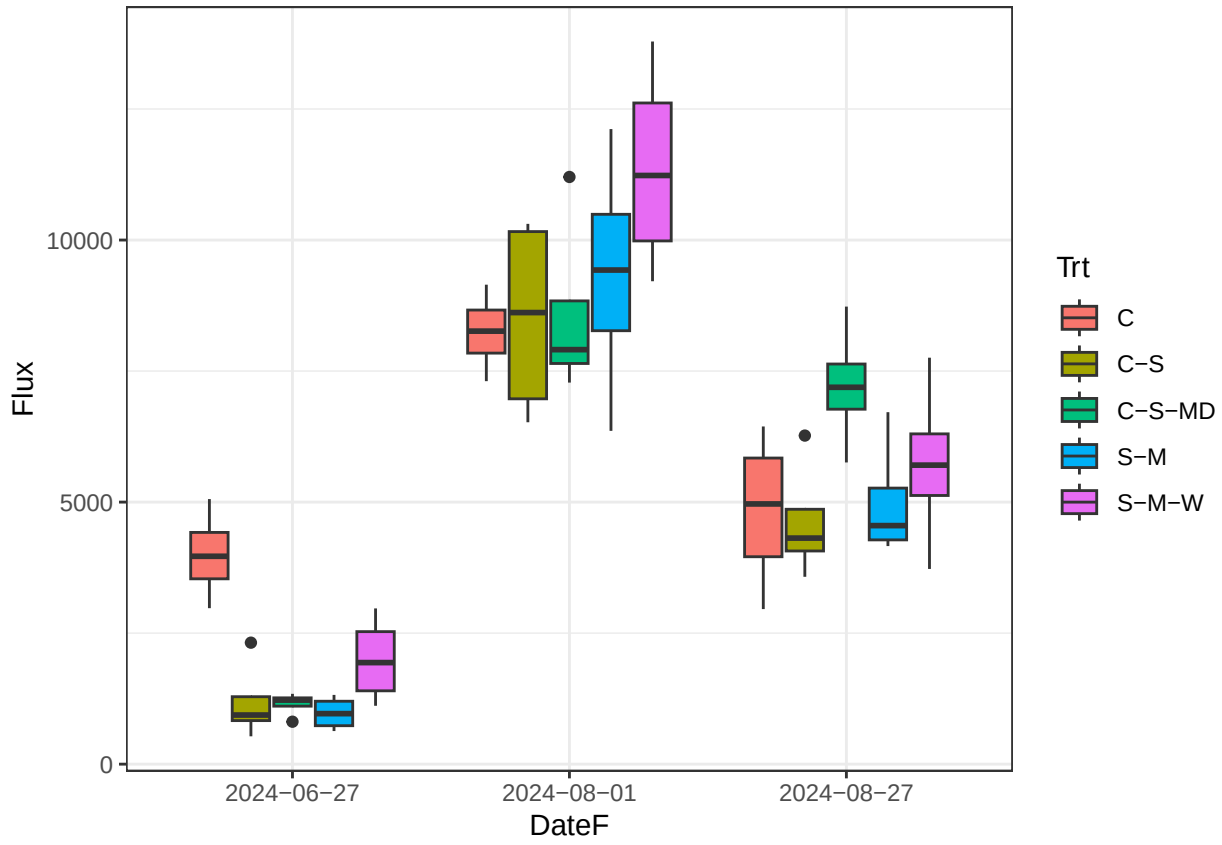
Read data into excel

```
gas_flux <- read_excel("Cable_Bateria_2024_GHG_Data.xlsx", sheet = 1)

gas_flux$Trt <- gas_flux$Plot
gas_flux$Flux <- gas_flux$`CH4_Flux(gha-1d-1)`

gas_flux$DateF <- as.factor(gas_flux$Date)

#this code is to remove the rep at the end of the plot, which gives the treatment
gas_flux <- gas_flux %>%
mutate(Trt = substr(Trt, 1, nchar(Trt) - 2))
table(gas_flux$Trt)
```

```
##
##      C    C-S C-S-MD    S-M  S-M-W
##     12     12     12     12     12
```

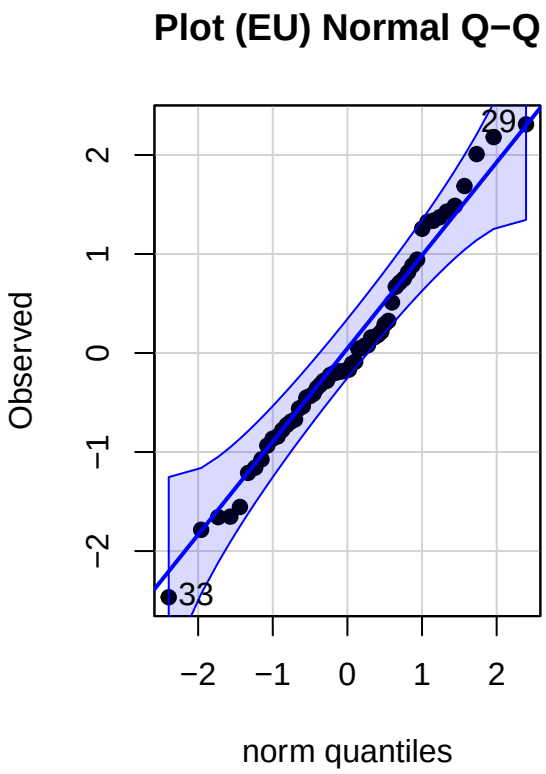
Get some feeling

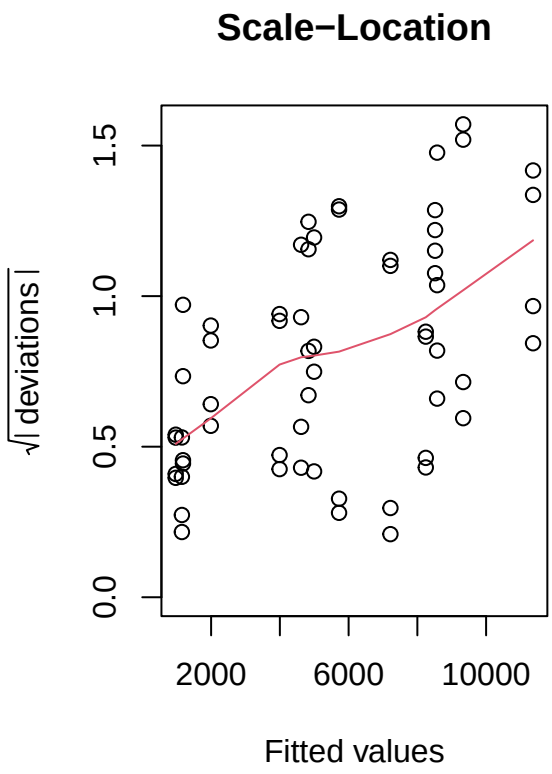
```
ggplot(gas_flux, aes(y=Flux, x=DateF, fill=Trt)) + geom_boxplot()
```



Linear model:lm

```
gas_model <- lm(Flux ~ Trt*DateF, data = gas_flux)
#gas_model <- lmer(Flux ~ Trt*DateF+(1|DateF:Trt), data = gas_flux)
pls205_diagnostics(gas_model)
```






```
anova(gas_model)
```

```
## Analysis of Variance Table
##
## Response: Flux
##           Df    Sum Sq   Mean Sq  F value    Pr(>F)
## Trt        4  17845083   4461271   2.3022  0.073104 .
## DateF      2 540391855 270195927 139.4342 < 2.2e-16 ***
## Trt:DateF  8  51248810   6406101   3.3059  0.004711 **
## Residuals 45  87201139   1937803
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
gas_means <- emmeans(gas_model, spec ='Trt', by='DateF')
gas_effects <- contrast(gas_means, method = 'pairwise', adjust = "tukey")
summary(gas_effects)
```

```
## DateF = 2024-06-27:
##  contrast           estimate  SE df t.ratio p.value
##  C - (C-S)            2810.7 984 45   2.855  0.0483
##  C - (C-S-MD)         2842.5 984 45   2.888  0.0447
##  C - (S-M)            3021.4 984 45   3.069  0.0284
##  C - (S-M-W)          2001.5 984 45   2.033  0.2672
##  (C-S) - (C-S-MD)       31.8 984 45   0.032  1.0000
```

```
##  (C-S) - (S-M)         210.7 984 45   0.214  0.9995
##  (C-S) - (S-M-W)      -809.3 984 45  -0.822  0.9224
##  (C-S-MD) - (S-M)      178.9 984 45   0.182  0.9997
##  (C-S-MD) - (S-M-W)   -841.1 984 45  -0.854  0.9118
##  (S-M) - (S-M-W)     -1019.9 984 45  -1.036  0.8372
##
## DateF = 2024-08-01:
##  contrast           estimate  SE df t.ratio p.value
##  C - (C-S)            -271.1 984 45  -0.275  0.9987
##  C - (C-S-MD)         -330.3 984 45  -0.336  0.9972
##  C - (S-M)           -1088.1 984 45  -1.105  0.8028
##  C - (S-M-W)         -3121.5 984 45  -3.171  0.0218
##  (C-S) - (C-S-MD)      -59.2 984 45  -0.060  1.0000
##  (C-S) - (S-M)        -817.0 984 45  -0.830  0.9199
##  (C-S) - (S-M-W)     -2850.4 984 45  -2.896  0.0438
##  (C-S-MD) - (S-M)     -757.8 984 45  -0.770  0.9379
##  (C-S-MD) - (S-M-W)  -2791.2 984 45  -2.836  0.0507
##  (S-M) - (S-M-W)     -2033.4 984 45  -2.066  0.2527
##
## DateF = 2024-08-27:
##  contrast           estimate  SE df t.ratio p.value
##  C - (C-S)             215.4 984 45   0.219  0.9995
##  C - (C-S-MD)        -2384.0 984 45  -2.422  0.1281
##  C - (S-M)            -162.0 984 45  -0.165  0.9998
##  C - (S-M-W)          -889.6 984 45  -0.904  0.8940
##  (C-S) - (C-S-MD)    -2599.4 984 45  -2.641  0.0798
##  (C-S) - (S-M)        -377.4 984 45  -0.383  0.9953
##  (C-S) - (S-M-W)     -1105.0 984 45  -1.123  0.7938
##  (C-S-MD) - (S-M)     2222.0 984 45   2.257  0.1779
##  (C-S-MD) - (S-M-W)   1494.3 984 45   1.518  0.5564
##  (S-M) - (S-M-W)      -727.7 984 45  -0.739  0.9461
##
## P value adjustment: tukey method for comparing a family of 5 estimates
```

```
cld(gas_means,
    Letters = letters,
    alpha = 0.05)
```

```
## DateF = 2024-06-27:
##  Trt    emmean  SE df lower.CL upper.CL .group
##  S-M       970 696 45     -432     2372  a
##  C-S-MD   1149 696 45     -253     2551  a
##  C-S      1181 696 45     -221     2583  a
##  S-M-W    1990 696 45      588     3392  ab
##  C        3992 696 45     2590     5393   b
##
## DateF = 2024-08-01:
##  Trt    emmean  SE df lower.CL upper.CL .group
##  C        8245 696 45     6843     9647  a
##  C-S      8516 696 45     7114     9918  a
##  C-S-MD   8575 696 45     7173     9977  ab
##  S-M      9333 696 45     7931    10735  ab
##  S-M-W   11366 696 45     9965    12768   b
##
```

```
## DateF = 2024-08-27:
##  Trt    emmean  SE df lower.CL upper.CL .group
##  C-S      4617 696 45     3216     6019  a
##  C        4833 696 45     3431     6235  a
##  S-M      4995 696 45     3593     6397  a
##  S-M-W    5723 696 45     4321     7124  a
##  C-S-MD   7217 696 45     5815     8619  a
##
## Confidence level used: 0.95
## P value adjustment: tukey method for comparing a family of 5 estimates
## significance level used: alpha = 0.05
## NOTE: If two or more means share the same grouping symbol,
##       then we cannot show them to be different.
##       But we also did not show them to be the same.
```

```
cld <- as.data.frame(cld(gas_means,
    Letters = letters,
    alpha = 0.05))
```

```
gas_graphing <- gas_flux %>% group_by(Trt, DateF) %>%
   mutate(Flux_sd = sd(Flux)) %>%
  summarise(Flux = mean(Flux),
            Flux_sd = mean(Flux_sd)) %>%
  left_join(cld %>% select(DateF, Trt, .group), by = c("DateF", "Trt"))
```

```
## `summarise()` has grouped output by 'Trt'. You can override using the `.groups`
## argument.
```

```
gas_graphing$group <- gas_graphing$.group
```

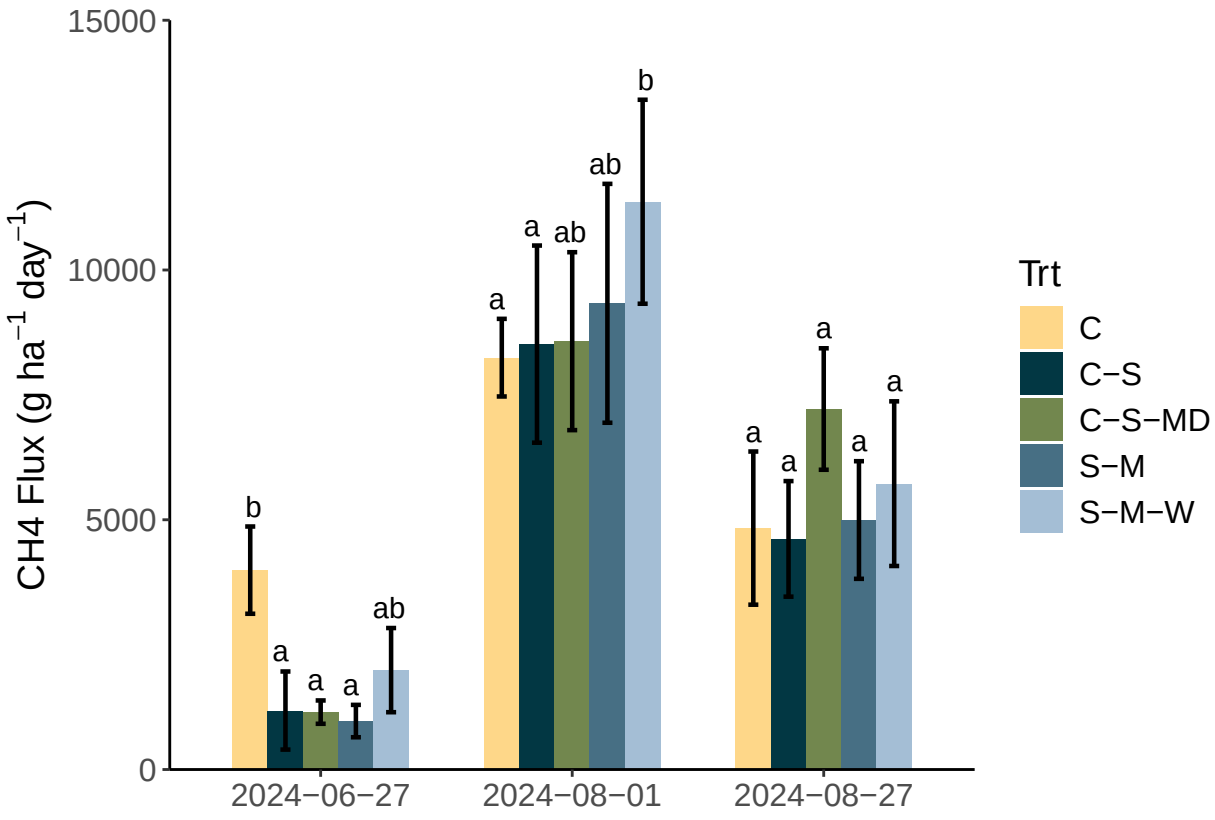
Graph

```
second <-
  ggplot(gas_graphing, aes(x = DateF, y = Flux, fill = Trt))+
    geom_bar(stat = "identity", position = "dodge", width = 0.7)+
    scale_fill_paletteer_d("nationalparkcolors::Acadia")+
    geom_errorbar(aes(ymin=Flux-Flux_sd, ymax=Flux+Flux_sd), width=.2, size=0.8 ,position=position_dodg
    scale_y_continuous(name=expression("CH4 Flux (g ha"^{-1}*" day"^{-1}*")"), expand = c(0, 0), limits
    scale_x_discrete(name="")+
    theme_classic()+
    theme(axis.text = element_text(size = 12), axis.title = element_text(size=14))+
    theme(legend.text = element_text(size = 12),legend.title = element_text(size = 14))+
    geom_text(aes(label = group, y = Flux + Flux_sd + 200), position = position_dodge(0.7), vjust = 0,
```

```
## Warning: Using `size` aesthetic for lines was deprecated in ggplot2 3.4.0.
## i Please use `linewidth` instead.
## This warning is displayed once every 8 hours.
## Call `lifecycle::last_lifecycle_warnings()` to see where this warning was
## generated.
```

```
    #geom_vline(xintercept = c(1.5,2.5), linetype = "dashed", color = "black", size =0.7)
```

```
second
```



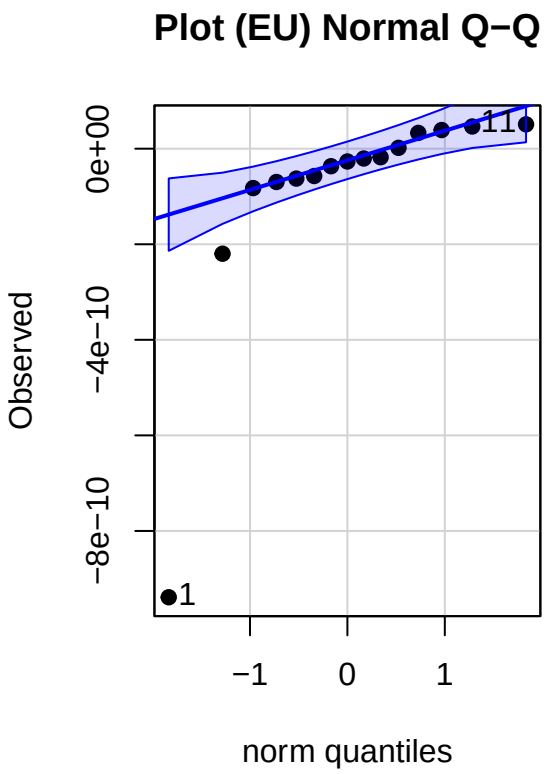

```
ggsave(second, filename = "27Aug.png", height = 15, width = 20, units = "cm", dpi=100)
```

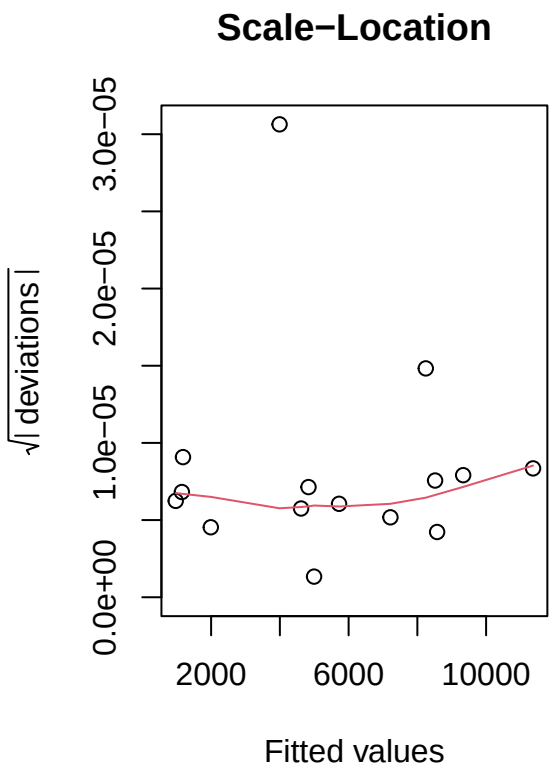
linear model:lmer

```
gas_model_lmer <- lmer(Flux ~ Trt*DateF+(1|Trt:Date), data = gas_flux)
```

```
## Warning in as_lmerModLT(model, devfun): Model may not have converged with 1
## eigenvalue close to zero: 3.0e-10
```

```
pls205_diagnostics(gas_model_lmer, EU ="Trt:Date" )
```






```
anova(gas_model_lmer)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##             Sum Sq Mean Sq NumDF DenDF F value  Pr(>F)
## Trt         618073  154518     4    45  0.0797 0.98816
## DateF     18716740 9358370     2    45  4.8294 0.01259 *
## Trt:DateF  1775028  221878     8    45  0.1145 0.99845
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
gas_means_lmer <- emmeans(gas_model_lmer, spec ='Trt', by='DateF')
gas_effects_lmer <- contrast(gas_means_lmer, method = 'pairwise', adjust = "tukey")
summary(gas_effects_lmer)
```

```
## DateF = 2024-06-27:
##  contrast           estimate   SE    df t.ratio p.value
##  C - (C-S)            2810.7 5289 37512   0.531  0.9841
##  C - (C-S-MD)         2842.5 5289 37512   0.537  0.9835
##  C - (S-M)            3021.4 5289 37512   0.571  0.9792
##  C - (S-M-W)          2001.5 5289 37512   0.378  0.9957
##  (C-S) - (C-S-MD)       31.8 5289 37512   0.006  1.0000
##  (C-S) - (S-M)         210.7 5289 37512   0.040  1.0000
##  (C-S) - (S-M-W)      -809.3 5289 37512  -0.153  0.9999
##  (C-S-MD) - (S-M)      178.9 5289 37512   0.034  1.0000
```

```
##  (C-S-MD) - (S-M-W)   -841.1 5289 37512  -0.159  0.9999
##  (S-M) - (S-M-W)     -1019.9 5289 37512  -0.193  0.9997
##
## DateF = 2024-08-01:
##  contrast           estimate   SE    df t.ratio p.value
##  C - (C-S)            -271.1 5289 37512  -0.051  1.0000
##  C - (C-S-MD)         -330.3 5289 37512  -0.062  1.0000
##  C - (S-M)           -1088.1 5289 37512  -0.206  0.9996
##  C - (S-M-W)         -3121.5 5289 37512  -0.590  0.9766
##  (C-S) - (C-S-MD)      -59.2 5289 37512  -0.011  1.0000
##  (C-S) - (S-M)        -817.0 5289 37512  -0.154  0.9999
##  (C-S) - (S-M-W)     -2850.4 5289 37512  -0.539  0.9833
##  (C-S-MD) - (S-M)     -757.8 5289 37512  -0.143  0.9999
##  (C-S-MD) - (S-M-W)  -2791.2 5289 37512  -0.528  0.9845
##  (S-M) - (S-M-W)     -2033.4 5289 37512  -0.384  0.9954
##
## DateF = 2024-08-27:
##  contrast           estimate   SE    df t.ratio p.value
##  C - (C-S)             215.4 5289 37512   0.041  1.0000
##  C - (C-S-MD)        -2384.0 5289 37512  -0.451  0.9915
##  C - (S-M)            -162.0 5289 37512  -0.031  1.0000
##  C - (S-M-W)          -889.6 5289 37512  -0.168  0.9998
##  (C-S) - (C-S-MD)    -2599.4 5289 37512  -0.491  0.9882
##  (C-S) - (S-M)        -377.4 5289 37512  -0.071  1.0000
##  (C-S) - (S-M-W)     -1105.0 5289 37512  -0.209  0.9996
##  (C-S-MD) - (S-M)     2222.0 5289 37512   0.420  0.9935
##  (C-S-MD) - (S-M-W)   1494.3 5289 37512   0.283  0.9986
##  (S-M) - (S-M-W)      -727.7 5289 37512  -0.138  0.9999
##
## Degrees-of-freedom method: kenward-roger
## P value adjustment: tukey method for comparing a family of 5 estimates
```

```
cld(gas_means_lmer)
```

```
## DateF = 2024-06-27:
##  Trt    emmean   SE    df lower.CL upper.CL .group
##  S-M       970 3740 37512    -6360     8301  1
##  C-S-MD   1149 3740 37512    -6181     8479  1
##  C-S      1181 3740 37512    -6150     8511  1
##  S-M-W    1990 3740 37512    -5340     9320  1
##  C        3992 3740 37512    -3339    11322  1
##
## DateF = 2024-08-01:
##  Trt    emmean   SE    df lower.CL upper.CL .group
##  C        8245 3740 37512      915    15575  1
##  C-S      8516 3740 37512     1186    15846  1
##  C-S-MD   8575 3740 37512     1245    15906  1
##  S-M      9333 3740 37512     2003    16663  1
##  S-M-W   11366 3740 37512     4036    18697  1
##
## DateF = 2024-08-27:
##  Trt    emmean   SE    df lower.CL upper.CL .group
##  C-S      4617 3740 37512    -2713    11948  1
##  C        4833 3740 37512    -2497    12163  1
```

```
##  S-M      4995 3740 37512    -2336    12325  1
##  S-M-W    5723 3740 37512    -1608    13053  1
##  C-S-MD   7217 3740 37512     -114    14547  1
##
## Degrees-of-freedom method: kenward-roger
## Confidence level used: 0.95
## P value adjustment: tukey method for comparing a family of 5 estimates
## significance level used: alpha = 0.05
## NOTE: If two or more means share the same grouping symbol,
##       then we cannot show them to be different.
##       But we also did not show them to be the same.
```