

PNAS Figures

PAZ

22 novembre 2016

Required R-packages:

```
# Data wrangling
library("plyr")
library("dplyr")

# Melting data sets & changin axes
library("reshape2")
library("ggrepel")

# Plotting:
library("ggplot2")
library("cowplot")
library("gridExtra")
library("Cairo")
library("GGally")
library("scales")
```

Working directory

```
# setwd("D:/Documents/these_pablo/Alteckendorf2016/R")
# setwd("/Users/DayTightChunks/Documents/PhD/Routput/Alteck/R")
# setwd("D:/Documents/these_pablo/Alteckendorf2016/00_TransparencyFolder")
getwd()
```

```
## [1] "D:/Documents/these_pablo/Alteckendorf2016/HydrologicalMonitoring"
```

Soils

```
weeklySoil = read.csv2("Data/WeeklySoils_Rng.csv", na.strings=c('#DIV/0!', '', 'NA'), header = TRUE)
weeklySoil$Date.ti <- as.POSIXct(strptime(weeklySoil$Date.ti, "%Y-%m-%d %H:%M", tz="EST")) # csv typos,
#weeklySoil$Date.ti <- as.POSIXct(strptime(weeklySoil$Date.ti, "%d/%m/%Y %H:%M", tz="EST"))
sum(is.na(weeklySoil$Date.ti))
```

```
## [1] 0
```

```
#weeklySoil$Conc.ComSoil.SD <-
# ifelse(weeklySoil$Conc.ComSoil.SD == as.character("#DIV/0!"), NA, as.numeric(as.character(weeklySoil$Conc.ComSoil.SD)))
str(weeklySoil)
```

```
## 'data.frame':   51 obs. of  26 variables:
## $ ID           : Factor w/ 51 levels "AW-N-0","AW-N-0x",...: 2 19 36 1 18 35 3 20 37 10 ...
## $ Transect     : Factor w/ 3 levels "N","S","T": 1 2 3 1 2 3 1 2 3 1 ...
## $ Wnum         : int  -1 -1 -1 0 0 0 1 1 1 2 ...
```

```
## $ Date.Soil      : Factor w/ 17 levels "03/05/2016 13:10",...: 13 13 13 16 16 16 3 3 3 7 ...
## $ Date.ti       : POSIXct, format: "2016-03-25 00:04:00" "2016-03-25 00:04:00" ...
## $ Conc.mug.g.dry.soil: num  0.0183 0.0285 0.0205 0.8893 3.204 ...
## $ Conc.ComSoil.SD  : num  NA NA NA 1.46 2.77 ...
## $ N_compsoil      : int   NA NA NA NA NA NA NA 2 NA 3 ...
## $ comp.d13C       : num  NA NA NA NA NA ...
## $ comp.d13C.SD    : num  NA NA NA NA NA ...
## $ comp.d13C.SE     : num  NA NA NA NA NA ...
## $ N_ngC           : int   NA NA NA NA NA NA NA 2 NA 3 ...
## $ ngC.mean        : num  NA NA NA NA NA ...
## $ ngC.SD          : num  NA NA NA NA NA ...
## $ ngC.SE          : num  NA NA NA NA NA ...
## $ DD13C.comp      : num  NA NA NA NA NA ...
## $ f.max.comp       : num  NA NA NA NA NA ...
## $ B.max.comp       : num  NA NA NA NA NA ...
## $ f.min.comp       : num  NA NA NA NA NA ...
## $ B.min.comp       : num  NA NA NA NA NA ...
## $ f.mean.comp      : num  NA NA NA NA NA ...
## $ B.mean.comp      : num  NA NA NA NA NA ...
## $ MassSoil.g       : num  12.61 18.8 4.44 613.08 2112.12 ...
## $ Area.N           : num  139266 139266 139266 139266 139266 ...
## $ Area.T           : num  43713 43713 43713 43713 43713 ...
## $ Area.S           : num  133175 133175 133175 133175 133175 ...
```

```
# weeklySoil = weeklySoil %>%
#   group_by(Transect) %>%
#   arrange(Transect, Wnum)
```

```
weeklySoil$Transect <- factor(weeklySoil$Transect, levels = c("N", "T", "S"))
```

Soil Concentrations

```
#####
# Concentrations
#####
#####
#####
```

```
#weeklySoil$ti[3] <- as.POSIXct("2016-04-14 08:25:00")
#weeklySoil$ti[14] <- as.POSIXct("2016-04-14 08:25:00")
#weeklySoil$ti[24] <- as.POSIXct("2016-04-14 08:25:00")
#lb1a2 <- paste("App.")
lbW012 <- paste("App.W0/1/2")
lbW9 <- paste("App.W9")
```

```
limits_conc_soil <- aes(ymin=Conc.mug.g.dry.soil-Conc.ComSoil.SD, ymax=Conc.mug.g.dry.soil+Conc.ComSoil.SD)
#limits_conc_soil <- aes(ymin=mean-0.5, ymax=mean+0.5)
```

```
pd <- position_dodge(0.5) # move them .05 to the left and right
```

```
co = ggplot(weeklySoil[4:48, ],
  aes(x=Date.ti, y=Conc.mug.g.dry.soil, colour=Transect, group = Transect)) +
  geom_point() +
```

```

geom_line() +

# Error bars
geom_errorbar(limits_conc_soil, width=.1, position=pd) +
# scale_y_continuous(limits=c(0,10), oob = rescale_none) +

# Themes and axes
theme_bw() +
theme(legend.position = "top",
      axis.text.x=element_text(angle = 45, hjust = 1)
      #axis.text.x=element_blank(),
      #axis.title.x=element_blank()
      ) +

scale_x_datetime(breaks = date_breaks("2 weeks"), labels = date_format("%b %d")) +
ylab(expression(paste("Conc. S-Meto. ", {({\mu}*g / g.soil.dry)}))) +
# facet_wrap(~Transect, nrow = 3) +
# xlab("Date") +
# theme() +
scale_x_datetime(breaks = date_breaks("2 weeks"), labels = date_format("%b %d")) +

# Smooth linear models
# stat_smooth(method = "lm", formula = y ~ poly(x, 2)) +
# stat_smooth(method = "lm") +

# Text
# W0 Application
# annotate("text", x = as.POSIXct('2016-03-25 08:04:00'), y = 4, label = lb1a2, parse = T, size = 3.0)
geom_segment(aes(x = as.POSIXct('2016-04-14 08:04:00'), y = 0.5, xend = as.POSIXct('2016-03-26 01:04:00'),
                 arrow = arrow(length = unit(0.2, "cm")))) +

# W1 Application
geom_segment(aes(x = as.POSIXct('2016-04-14 08:04:00'), y = 0.5,
                 xend = as.POSIXct('2016-04-05 08:04:00'), yend = 0), color = "black",
                 arrow = arrow(length = unit(0.2, "cm")))) +

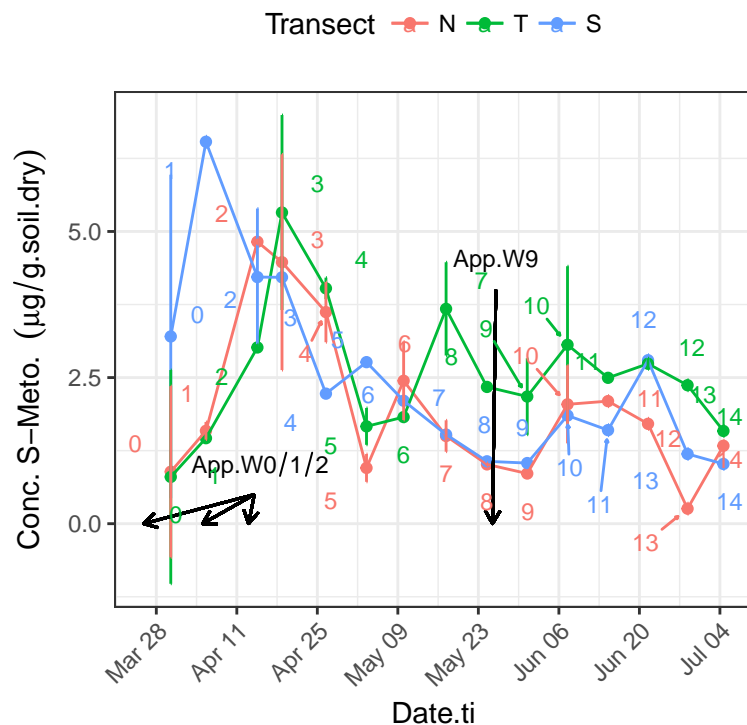
# W2 Application
annotate("text", x = as.POSIXct('2016-04-15 08:04:00'), y = 1, label = lbW012, parse = T, size = 3.0)
geom_segment(aes(x = as.POSIXct('2016-04-14 08:04:00'), y = 0.5,
                 xend = as.POSIXct('2016-04-13 08:04:00'), yend = 0), color = "black",
                 arrow = arrow(length = unit(0.2, "cm")))) +

# W9 Application
annotate("text", x = as.POSIXct('2016-05-26 08:04:00'), y = 4.5, label = lbW9, parse = T, size = 3.0)
geom_segment(aes(x = as.POSIXct('2016-05-26 08:04:00'), y = 4,
                 xend = as.POSIXct('2016-05-25 18:04:00'), yend = 0), color = "black",
                 arrow = arrow(length = unit(0.2, "cm")))) +

geom_text_repel(aes(label=as.factor(Wnum)),
                size = 3,
                arrow = arrow(length = unit(0.005, 'npc'), type = "closed"),
                force = 0.5,
                point.padding = unit(0.5, 'lines'),
                max.iter = 2e3,
                nudge_x = .05)

```

co



```
# Linear model
# ggsave(co, filename = "CompositeConcLM.png", width = 7, height = 5, units = "in", scale = 1)

ggsave(co, filename = "CompositeConcLM.tiff", height = 10, width = 8.7, units = 'cm')

# No linear model
# ggsave(co, filename = "CompositeConc.png", width = 7, height = 5, units = "in", scale = 1)
```

Soil isotope signatures

```
initialDelta = -31.21
weeklySoil$DD13C.comp <- (weeklySoil$comp.d13C - (initialDelta))
weeklySoil$ngC.Label <- ifelse(weeklySoil$ngC.mean<5, "< 5 ng",
                               ifelse(weeklySoil$ngC.mean<10, "< 10 ng",
                                       ifelse((weeklySoil$ngC.mean >= 10 & weeklySoil$ngC.mean < 15), "< 15 ng",
                                             ifelse((weeklySoil$ngC.mean >= 15 & weeklySoil$ngC.mean < 20), "< 20 ng",
                                                   ifelse(weeklySoil$ngC.mean >= 20 & weeklySoil$ngC.mean < 30, "< 30 ng C"
                                                         )
                                             )
                                       )
                               )

limits_dCsoil <- aes(ymin=comp.d13C-comp.d13C.SD, ymax=comp.d13C+comp.d13C.SD)
#limits_dCsoil <- aes(ymin=comp.d13C-0.5, ymax=comp.d13C+0.5)
lb1a <- paste("App.~S-meto.")
lb1ab <- paste("delta~{13}~C:-31.21")
lb1a2 <- paste("App. ")

lbW012 <- paste("App.W0/1/2")
```

```

lbW9 <- paste("App.W9")

isCo = ggplot(weeklySoil, aes(x=Date.ti, y=comp.d13C, colour=Transect, group = Transect)) +
  geom_errorbar(limits_dCsoil, width=.05) +
  geom_point() +
  theme_bw() +
  #stat_smooth(method = "lm", formula = y ~ poly(x, 2)) +
  stat_smooth(method = "lm") +
  facet_wrap(~Transect, nrow = 3) +
  xlab("Date") +
  theme(axis.text.x=element_text(angle = 45, hjust = 1)) +
  #ylab(expression(paste({delta}~"13", "C", ' \211')))) +
  ylab(expression(paste({delta}~"13", "C", ' (\u2030)')) +
  scale_y_continuous(breaks=seq(-34,-21,2)) +
  geom_hline(yintercept = -31.21, color = "dodgerblue4", linetype = "dotted") +
  geom_hline(yintercept = -30.71, color = "dodgerblue3", linetype = "dotted") +
  geom_hline(yintercept = -31.71, color = "dodgerblue3", linetype = "dotted") +
  annotate("text", x = as.POSIXct('2016-04-05 22:04:00'), y = -22.5, label = lb1a, parse = T, size = 3.0) +
  annotate("text", x = as.POSIXct('2016-04-05 22:04:00'), y = -23.5, label = lb1ab, parse = T, size = 3.0) +

  annotate("text", x = as.POSIXct('2016-03-25 08:04:00'), y = -29, label = lb1a2, parse = T, size = 3.0) +
  geom_segment(aes(x = as.POSIXct('2016-03-25 08:04:00'), y = -29.8,
    xend = as.POSIXct('2016-03-25 08:04:00'), yend = -31.0),
    arrow = arrow(length = unit(0.2, "cm"))) +
  annotate("text", x = as.POSIXct('2016-04-03 00:04:00'), y = -29, label = lb1a2, parse = T, size = 3.0) +
  geom_segment(aes(x = as.POSIXct('2016-04-03 00:04:00'), y = -29.8,
    xend = as.POSIXct('2016-04-05 08:04:00'), yend = -31.0),
    arrow = arrow(length = unit(0.2, "cm"))) +
  annotate("text", x = as.POSIXct('2016-04-13 08:04:00'), y = -25, label = lb1a2, parse = T, size = 3.0) +
  geom_segment(aes(x = as.POSIXct('2016-04-13 08:04:00'), y = -26,
    xend = as.POSIXct('2016-04-13 08:04:00'), yend = -31.0),
    arrow = arrow(length = unit(0.2, "cm"))) +
  annotate("text", x = as.POSIXct('2016-05-26 08:04:00'), y = -29, label = lb1a2, parse = T, size = 3.0) +
  geom_segment(aes(x = as.POSIXct('2016-05-26 08:04:00'), y = -29.8,
    xend = as.POSIXct('2016-05-25 08:04:00'), yend = -31.0),
    arrow = arrow(length = unit(0.2, "cm"))) +
  #scale_x_continuous(breaks=seq(0,11,1)) +
  scale_x_datetime(breaks = date_breaks("2 weeks"), labels = date_format("%b %d")) +

  #annotate("text", x = as.POSIXct('2016-05-30 20:04:00'), y = -30.5, label = lb1a, parse = T, size = 2) +
  theme(legend.position = "top")

# isCo

# Linear model (LM)
# ggsave(isCo, filename = "CompositeIsotopesLM.png", width = 7, height = 5, units = "in", scale = 1)
# No linear model
# ggsave(isCo, filename = "CompositeIsotopes.png", width = 7, height = 5, units = "in", scale = 1)

# View(weeklySoil)

# Ommitted, graph is tautological.

```

```

### Delta vs. f (Soils)
soilf = ggplot(weeklySoil, aes(x=f.comp, y=DD13C.comp, colour=Transect, group = Transect)) +
  #geom_errorbar(limits_dCsoil, width=.05) +
  geom_point() +
  theme_bw() +
  stat_smooth(method = "lm", formula = y ~ poly(x, 2)) +
  #stat_smooth(method = "lm") +
  facet_wrap(~Transect, nrow = 3) +
  scale_x_reverse() +
  xlab("Fraction remaining (f)") +
  theme(axis.text.x=element_text(angle = 45, hjust = 1)) +
  #ylab(expression(paste({delta}^{"13"}, "C", ' \211')))) +
  ylab(expression(paste({Delta~delta}^{"13"}, "C", ' (\u2030)')) +
  #scale_y_continuous(breaks=seq(-34,-21,2)) +
  theme(legend.position = "top") +
  #geom_text_repel(aes(label=WeekNo, color = factor(Transect)),
    #arrow = arrow(length = unit(0.005, 'npc'), type = "closed"),
    #force = 1,
    #point.padding = unit(1.0, 'lines'),
    #max.iter = 2e3,
    #nudge_x = .2) +

  geom_point()

# soilf

#####
#####
#####
### DeltaDelta vs time
#####
# View(weeklySoil)
# limits_DdCsoil <- aes(ymin=comp.d13C-comp.d13C.SD-initialDelta, ymax=comp.d13C+comp.d13C.SD-initialDelta)
limits_DdCsoil <- aes(ymin=comp.d13C-comp.d13C.SE-initialDelta, ymax=comp.d13C+comp.d13C.SE-initialDelta)

# pd <- position_dodge(0.5)
# A0df[1:27,]
deltaTime = ggplot(na.omit(weeklySoil), aes(Date.ti, DD13C.comp)) +
  geom_errorbar(limits_DdCsoil) +
  geom_point(aes(shape = Transect, colour = ngC.Label)) +
  labs(shape="Transect", colour = "Mass Carbon") +

  # geom_point(weeklySoil[1:48, ], aes(x=Date.ti, y=DD13C.comp, colour=Transect, group = Transect)) +

# Themes and axes
theme_bw() +
theme(# legend.position="none",
      # axis.title.x = element_blank(),
      axis.text.x=element_text(angle = 45, hjust = 1)
    ) +
xlab("Date") +
scale_x_datetime(breaks = date_breaks("2 weeks"), labels = date_format("%b %d")) +

```

```

ylab(expression(paste({Delta~delta}^"13","C", ' (\u2030)')) +
scale_y_continuous(breaks=seq(0, 8, 1)) +
# ylab(expression(paste({delta}^"13","C", ' \211')) +
# ylab(expression(paste({delta}^"13","C", ' (\u2030)')) +
# facet_wrap(~Transect, nrow = 3) +

# Smooth linear models
stat_smooth(data = weeklySoil, aes(group = Transect), method = "lm", se=FALSE) +
# stat_smooth(method = "lm", formula = y ~ poly(x, 2)) +
# stat_smooth(data=subset(weeklySoil[4:27, ]), method = "lm", formula = y~x, se=F) +
# stat_smooth(data=subset(weeklySoil[18:36, ]), method = "lm", formula = y~x, se=F) +

# Text
# Application W0
annotate("text",
  x = as.POSIXct('2016-04-04 01:04:00'), y = 6, label = lbW012, parse = T, size = 3.0) +
geom_segment(aes(x = as.POSIXct('2016-04-03 08:04:00'), y = 5.5,
  xend = as.POSIXct('2016-03-25 22:04:00'), yend = -0), color = "black",
  arrow = arrow(length = unit(0.2, "cm")))) +
#annotate("text",
#  x = as.POSIXct('2016-04-03 00:04:00'), y = 2, label = lb1a2, parse = T, size = 3.0) +

# Application W1
geom_segment(aes(x = as.POSIXct('2016-04-03 08:04:00'), y = 5.5,
  xend = as.POSIXct('2016-04-05 08:04:00'), yend = 0), color = "black",
  arrow = arrow(length = unit(0.2, "cm")))) +
# annotate("text", x = as.POSIXct('2016-04-15 08:04:00'), y = 1, label = lb1a2, parse = T, size = 3.0)

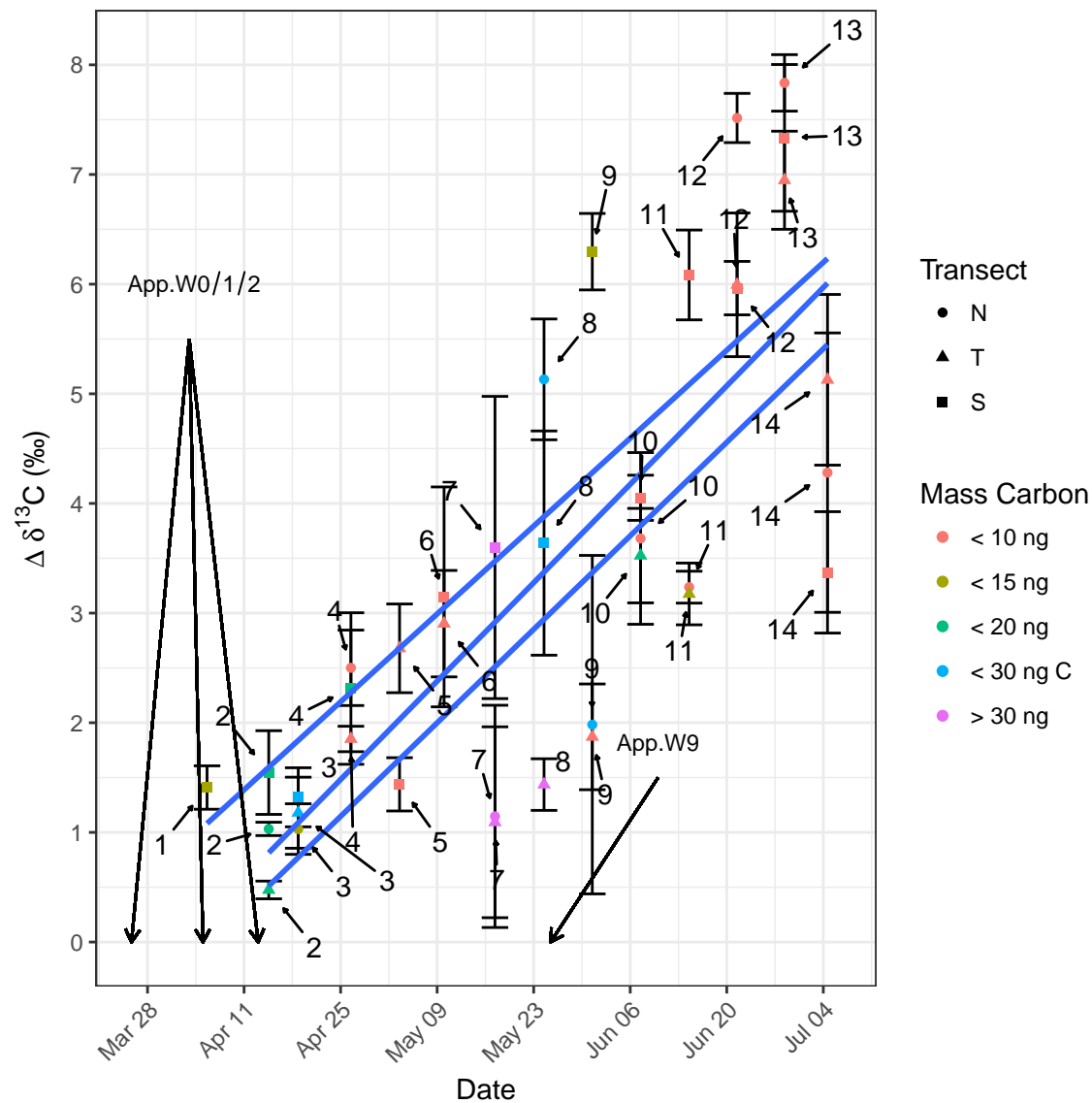
# Application W2
geom_segment(aes(x = as.POSIXct('2016-04-03 08:04:00'), y = 5.5,
  xend = as.POSIXct('2016-04-13 08:04:00'), yend = 0), color = "black",
  arrow = arrow(length = unit(0.2, "cm")))) +

# Application W9
annotate("text",
  x = as.POSIXct('2016-06-10 08:04:00'), y = 1.8, label = lbW9, parse = T, size = 3.0) +
geom_segment(aes(x = as.POSIXct('2016-06-10 08:04:00'), y = 1.5,
  xend = as.POSIXct('2016-05-25 18:04:00'), yend = 0), color = "black",
  arrow = arrow(length = unit(0.2, "cm")))) +

geom_text_repel(aes(label=Wnum),
  arrow = arrow(length = unit(0.005, 'npc'), type = "closed"),
  force = 1,
  point.padding = unit(1.0, 'lines'),
  max.iter = 2e3,
  nudge_x = .2)

deltaTime

```



```
#soils = plot_grid(co, deltaTime, ncol = 1, nrow = 2, align = "v")
#soils
```

Delta time final

```
limits_DdCsoil <- aes(ymin=comp.d13C-comp.d13C.SE-initialDelta, ymax=comp.d13C+comp.d13C.SE-initialDelta)

weeklySoil$ngC.Label <- ifelse(weeklySoil$ngC.mean < 10, "< 10 ng", "> 10 ng")

# ifelse( weeklySoil$ngC.mean >= 10 & weeklySoil$ngC.mean < 15, "< 15 ng"

wk <- weeklySoil
# wk <- na.omit(weeklySoil)
wk$Application <- ifelse(wk$Date.ti == as.POSIXct('2016-05-17 09:16:00', tz = "EST") & wk$Transect == "N",
  ifelse(wk$Date.ti == as.POSIXct('2016-03-30 12:18:00', tz = "EST") & wk$Transect == "T",
    ifelse(wk$Date.ti == as.POSIXct('2016-04-05 15:08:00', tz = "EST") & wk$Transect == "S",
      ifelse(wk$Date.ti == as.POSIXct('2016-04-14 13:52:00', tz = "EST") & wk$Transect == "N",
```



```

deltaTime = ggplot(wk, aes(Date.ti, DD13C.comp)) +
  geom_errorbar(limits_DdCsoil, width = 0.5) +
  geom_point(aes(colour = Transect, shape = ngC.Label, shape = "Application"), size = 2) +
  labs(colour="Transect", shape = "Mass Carbon") +
  geom_point(aes(Date.ti, Application, shape = "Application"),
    size = 2, data = wk, legend.title = element_blank()) +
  # geom_point(weeklySoil[1:48, ], aes(x=Date.ti, y=DD13C.comp, colour=Transect, group = Transect)) +

# Themes and axes
theme_bw() +
theme(legend.position="top",
  # axis.title.x = element_blank(),
  axis.text.x=element_text(angle = 45, hjust = 1)
) +
xlab("Date") +
scale_x_datetime(breaks = date_breaks("2 weeks"), labels = date_format("%b %d")) +
guides(col = guide_legend(nrow = 3), shape = guide_legend(nrow = 3)) +
ylab(expression(paste({Delta~delta}~"13", "C", ' (\u2030)')) +
scale_y_continuous(breaks=seq(0, 8, 1)) +
# ylab(expression(paste({delta}~"13", "C", ' \211')) +
# ylab(expression(paste({delta}~"13", "C", ' (\u2030)')) +
# facet_wrap(~Transect, nrow = 3) +

# Smooth linear models
#stat_smooth(data = weeklySoil, aes(group = Transect, colour = Transect), method = "lm", se=FALSE) +
stat_smooth(data = weeklySoil, method = "lm", se=T) +
# stat_smooth(data = subset(weeklySoil[1:34, ]), method = "lm", formula = y ~ poly(x, 2), se=FALSE) +
# stat_smooth(method = "lm", formula = y ~ poly(x, 2)) +
# stat_smooth(data=subset(weeklySoil[1:34, ]), method = "lm", formula = y~x, se=F) +
# stat_smooth(data=subset(weeklySoil[1:34, ]), aes(group = Transect, colour = Transect), method = "lm"
# stat_smooth(data=subset(weeklySoil[18:36, ]), method = "lm", formula = y~x, se=F) +

# Text
# Application W0
#annotate("text",
#  x = as.POSIXct('2016-04-04 01:04:00'), y = 6, label = lbW012, parse = T, size = 3.0) +
#geom_segment(aes(x = as.POSIXct('2016-04-03 08:04:00'), y = 5.5,
#  xend = as.POSIXct('2016-03-25 22:04:00'), yend = -0), color = "black",
#  arrow = arrow(length = unit(0.2, "cm")))) +
#annotate("text",
#  x = as.POSIXct('2016-04-03 00:04:00'), y = 2, label = lb1a2, parse = T, size = 3.0) +

# Application W1
#geom_segment(aes(x = as.POSIXct('2016-04-03 08:04:00'), y = 5.5,
#  xend = as.POSIXct('2016-04-05 08:04:00'), yend = 0), color = "black",
#  arrow = arrow(length = unit(0.2, "cm")))) +
# annotate("text", x = as.POSIXct('2016-04-15 08:04:00'), y = 1, label = lb1a2, parse = T, size = 3.0)

# Application W2
#geom_segment(aes(x = as.POSIXct('2016-04-03 08:04:00'), y = 5.5,
#  xend = as.POSIXct('2016-04-13 08:04:00'), yend = 0), color = "black",
#  arrow = arrow(length = unit(0.2, "cm")))) +

```

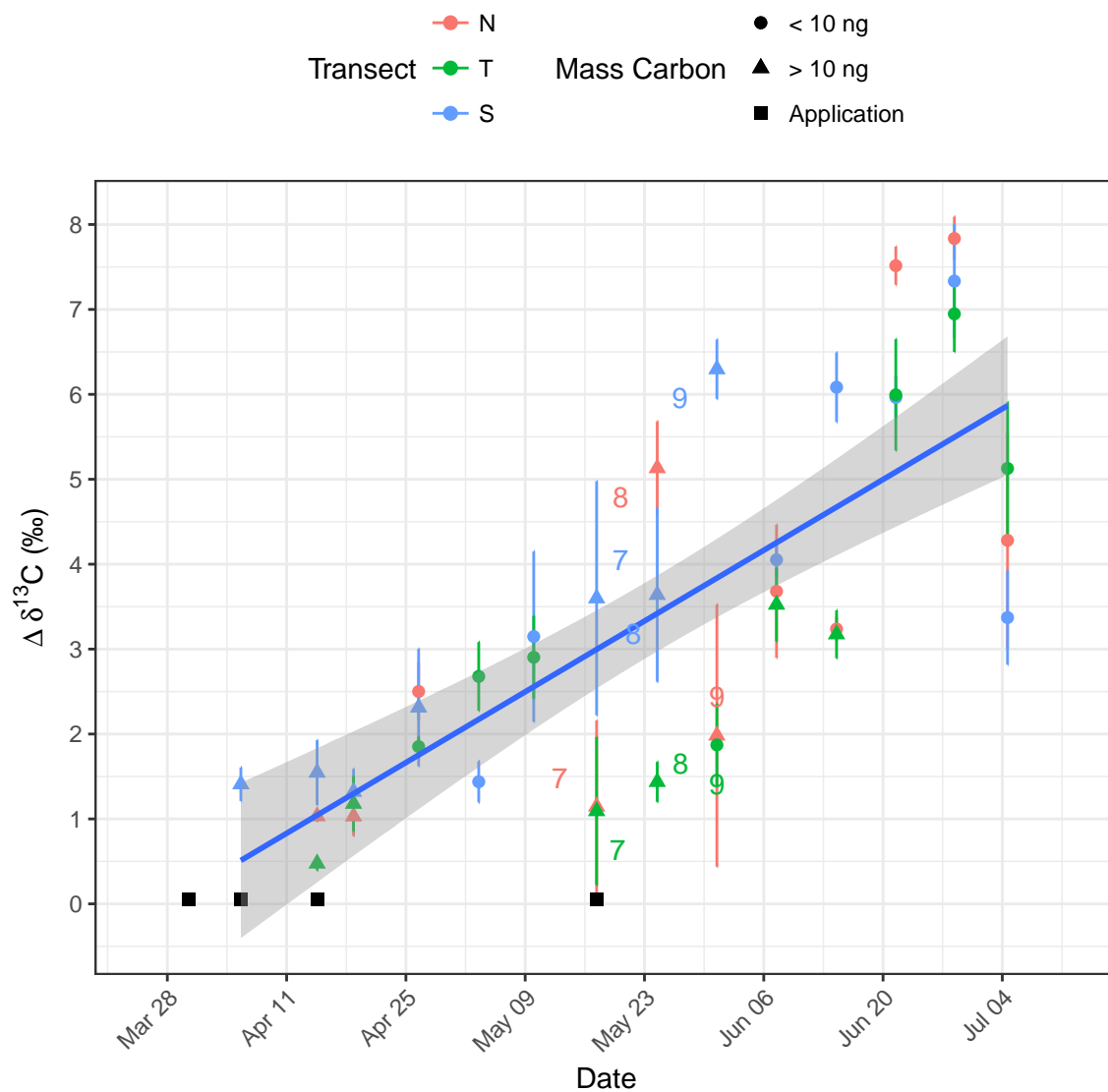
```

# Application W9
#annotate("text",
#      x = as.POSIXct('2016-06-10 08:04:00'), y = 1.8, label = lbW9, parse = T, size = 3.0) +
#geom_segment(aes(x = as.POSIXct('2016-06-10 08:04:00'), y = 1.5,
#      xend = as.POSIXct('2016-05-25 18:04:00'), yend = 0), color = "black",
#      arrow = arrow(length = unit(0.2, "cm")))) +

geom_text_repel(data = subset(weeklySoil, Wnum < 10 & Wnum > 6), aes(label=Wnum, colour = Transect),
      arrow = arrow(length = unit(0.01, 'npc'), type = "closed"),
      force = 1,
      point.padding = unit(0.5, 'lines'),
      max.iter = 2e3,
      nudge_x = .5, show.legend = F)

deltaTime

```



```
ggsave(deltaTime, filename = "Composite_DD.png", width = 8, height = 5, units = "in", scale = 1)
```

Degradation

```
lb1a2 <- paste("App.")

lb1b <- paste("(A)~epsilon:-1.5")
lb1b2 <- paste("(B)~epsilon:-2.0")

Bsoil =ggplot(weeklySoil)+
  #geom_errorbar(limits_dCsoil, width=.05) +
  #geom_point(aes(x=Date.ti, y=B.comp, colour=Transect, group = Transect)) +
  geom_point(aes(x=Date.ti, y=B.min.comp, colour=Transect, group = Transect)) + #, color = "dodgerblue4"
  theme_bw() +
  # stat_smooth(method = "lm", formula = y ~ poly(x, 2)) +
  #stat_smooth(aes(x=Date.ti, y=B.min.comp), method = "lm", se = F, color = "dodgerblue4") +
  #stat_smooth(aes(x=Date.ti, y=B.comp), method = "lm", se = F, color = "grey40") +

  # Individual / broken lines
  #geom_smooth(data=subset(weeklySoil[10:27, ]), aes(x=Date.ti, y=B.min.comp), method = "lm", se = F, c
  #geom_smooth(data=subset(weeklySoil[31:45, ]), aes(x=Date.ti, y=B.min.comp), method = "lm", se = F, c
  #geom_smooth(data=subset(weeklySoil[10:27, ]), aes(x=Date.ti, y=B.comp), method = "lm", se = F, color
  #geom_smooth(data=subset(weeklySoil[31:45, ]), aes(x=Date.ti, y=B.comp), method = "lm", se = F, color

  # Continous lines
  # geom_smooth(data=subset(weeklySoil[1:45, ]), aes(x=Date.ti, y=B.min.comp), method = "lm", formula =
  # geom_smooth(y=B.min.comp, method = "lm", formula = y ~ poly(x, 2)) +
  # facet_wrap(~Transect, nrow = 3) +
  xlab("Date") +
  theme(axis.text.x=element_text(angle = 45, hjust = 1)) +
  #ylab(expression(paste({delta}~"13", "C", ' \211')))) +
  ylab("Degradation (%)") +
  scale_y_continuous(breaks=seq(0, 100, 20)) +
  #geom_hline(yintercept = -31.47, color = "dodgerblue4", linetype = "dotted") +
  #geom_hline(yintercept = -30.97, color = "dodgerblue3", linetype = "dotted") +
  #geom_hline(yintercept = -31.97, color = "dodgerblue3", linetype = "dotted") +
  annotate("text", x = as.POSIXct('2016-04-11 20:04:00'), y = 100, label = lb1b, parse = T, size = 3.0,
  annotate("text", x = as.POSIXct('2016-04-11 20:04:00'), y = 85, label = lb1b2, parse = T, size = 3.0,

  annotate("text", x = as.POSIXct('2016-03-25 08:04:00'), y = 30, label = lb1a2, parse = T, size = 3.0)
  geom_segment(aes(x = as.POSIXct('2016-03-25 08:04:00'), y = 25,
    xend = as.POSIXct('2016-03-25 08:04:00'), yend = 20),
    arrow = arrow(length = unit(0.2, "cm"))) +
  annotate("text", x = as.POSIXct('2016-04-03 00:04:00'), y = 30, label = lb1a2, parse = T, size = 3.0)
  geom_segment(aes(x = as.POSIXct('2016-04-03 00:04:00'), y = 25,
    xend = as.POSIXct('2016-04-05 08:04:00'), yend = 20),
    arrow = arrow(length = unit(0.2, "cm"))) +
  annotate("text", x = as.POSIXct('2016-04-13 08:04:00'), y = 30, label = lb1a2, parse = T, size = 3.0)
  geom_segment(aes(x = as.POSIXct('2016-04-13 08:04:00'), y = 25,
    xend = as.POSIXct('2016-04-13 08:04:00'), yend = 20),
```

```

        arrow = arrow(length = unit(0.2, "cm")) +
        annotate("text", x = as.POSIXct('2016-05-26 08:04:00'), y = 30, label = lb1a2, parse = T, size = 3.0)
        geom_segment(aes(x = as.POSIXct('2016-05-26 08:04:00'), y = 25,
            xend = as.POSIXct('2016-05-25 08:04:00'), yend = 20),
            arrow = arrow(length = unit(0.2, "cm"))) +
        scale_x_datetime(breaks = date_breaks("2 weeks"), labels = date_format("%b %d")) +
        #scale_x_continuous(breaks=seq(0,11,1)) +
        theme(legend.position = "top")

# Bsoil

# Linear model
# ggsave(Bsoil, filename = "CompositeDegradationLM.png", width = 7, height = 5, units = "in", scale = 1)

#deltaCo = plot_grid(co, isCo, ncol = 2, nrow = 1, align = "h")
# deltaCoBio = plot_grid(co, isCo, Bsoil, ncol = 3, nrow = 1, align = "h")
# deltaCoBio

# Linear model
#ggsave(deltaCo, filename = "CompositeConcLM.png", width = 6, height = 7, units = "in", scale = 1)
# ggsave(deltaCoBio, filename = "SoilConcDeltBio_LM.png", width = 11.69, height = 8.27, units = "in", s

# No linear model
#ggsave(deltaCo, filename = "CompositeConc.png", width = 6, height = 7, units = "in", scale = 1)

# weeklySoil2 = weeklySoil[1:45, ]
# View(weeklySoil2)

Bsoil2 = ggplot(weeklySoil, aes(x=Date.ti, y=B.min.comp, colour=Transect, group = Transect)) +
  geom_point() +
  # geom_point(aes(x=Date.ti, y=B.comp, colour=Transect, group = Transect)) +
  theme_bw() +
  stat_smooth(method = "lm", formula = y ~ poly(x, 2), se=FALSE)

# Bsoil2

```

Water

```

A0df = read.csv2("Data/WeeklyHydroContam_R.csv")
str(A0df)

```

```

## 'data.frame':    51 obs. of  87 variables:
## $ ti              : Factor w/ 51 levels "2016-03-25 00:04:00",...: 1 2 3 4 5 6 7 8 9 10 ...
## $ WeekSubWeek     : Factor w/ 51 levels "W0-0x","W0-1",...: 1 2 3 4 5 6 26 27 28 29 ...
## $ tf              : Factor w/ 51 levels "2016-03-25 12:02:00",...: 1 2 3 4 5 6 7 8 9 10 ...
## $ iflux           : num  1.25 1.12 1.31 1.46 16.33 ...
## $ fflux           : num  1.13 1.31 1.46 16.45 15.18 ...
## $ changeflux      : num  -0.119 0.189 0.148 14.989 -1.15 ...
## $ maxQ            : num  1.25 1.38 1.64 38.4 18.67 ...

```

```

## $ minQ : num 1.118 1.082 0.929 1.449 13.201 ...
## $ Duration.Hrs : num 12 82.5 37.6 27.3 23.1 ...
## $ chExtreme : num -0.13 0.256 0.33 36.944 -3.133 ...
## $ Peak : int NA NA NA 1 NA NA 2 NA NA 3 ...
## $ Markers : num NA NA NA 16.9 NA ...
## $ TimeDiff : Factor w/ 18 levels "106","136","150",...: NA NA NA 10 NA NA 2 NA NA 11 ...
## $ AveDischarge.m3.h : num 1.2 1.21 1.28 14.32 15.53 ...
## $ Volume.m3 : num 14.4 100.2 48.3 390.4 359.2 ...
## $ Sampled.Hrs : num 12 82.5 37.6 27.3 23.1 ...
## $ Sampled : Factor w/ 2 levels "Not Sampled",...: 1 2 1 2 2 1 2 2 1 2 ...
## $ Conc.mug.L : num 0.246 0.246 3.517 6.788 6.561 ...
## $ Conc.SD : num 0.0193 0.0193 0.1544 0.2894 0.1906 ...
## $ OXA_mean : num 4.82 4.82 17.68 30.53 32.49 ...
## $ OXA_SD : num 1.141 1.141 5.663 10.185 0.243 ...
## $ ESA_mean : num 18.1 18.1 32 46 41.3 ...
## $ ESA_SD : num 3.497 3.497 3.267 3.037 0.853 ...
## $ N.x : int NA 3 NA 3 3 NA 3 3 NA 3 ...
## $ diss.d13C : num NA -26.7 NA -30.5 -30.6 ...
## $ SD.d13C : num NA 0.936 NA 0.106 0.151 ...
## $ se.d13C : num NA 0.5403 NA 0.0612 0.0874 ...
## $ MES.mg.L : num NA 53.4 NA 62.5 22.5 ...
## $ MES.sd : num NA NA NA NA NA NA NA NA NA NA ...
## $ MO.mg.L : num NA 0 NA 0.001 0.0001 NA 0.0001 0.0001 NA 0.0058 ...
## $ Conc.Solids.mug.gMES : num 0.645 0.645 0.385 0.126 0.436 ...
## $ Conc.Solids.ug.gMES.SD : num 0.0232 0.0232 0.0252 0.0271 0.1232 ...
## $ N.y : int NA NA NA NA NA NA 3 3 NA NA ...
## $ filt.d13C : num NA NA NA NA NA ...
## $ filt.SD.d13C : num NA NA NA NA NA ...
## $ filt.se.d13C : num NA NA NA NA NA ...
## $ DD13C.diss : num NA 4.545 NA 0.741 0.59 ...
## $ DD13C.filt : num NA NA NA NA NA ...
## $ f.diss : num NA 0.0689 NA 0.6459 0.706 ...
## $ f.filt : num NA NA NA NA NA ...
## $ B.diss : num NA 93.1 NA 35.4 29.4 ...
## $ B.filt : num NA NA NA NA NA ...
## $ NH4.mM : num NA NA NA 0.05 NA NA NA NA NA ...
## $ TIC.ppm.filt : num NA NA NA 51.8 44.8 NA 66.7 52.1 NA 69.4 ...
## $ Cl.mM : num NA NA NA 1.48 1574 ...
## $ NO3...mM : num NA NA NA 616 778 ...
## $ PO4..mM : int NA NA NA NA NA NA NA NA NA ...
## $ NPOC.ppm : num NA NA NA 4 4.4 NA 5.8 3.4 NA 9.1 ...
## $ TIC.ppm.unfilt : num NA NA NA 44.8 26.4 NA 39 32.3 NA 54.8 ...
## $ TOC.ppm.unfilt : num NA NA NA 4.7 5.4 NA 2.7 3.8 NA 3.9 ...
## $ ExpMES.Kg : num 5.35 5.35 14.88 24.4 8.08 ...
## $ Appl.Mass.g : num 6369 0 0 0 0 ...
## $ CumAppMass.g : num 6369 6369 6369 6369 6369 ...
## $ DissSmeto.mg : num 3.54 24.6 170.04 2649.91 2357 ...
## $ DissSmeto.mg.SD : num 0.278 1.934 7.463 112.98 68.486 ...
## $ DissSmeto.g : num 0.00354 0.0246 0.17004 2.64991 2.357 ...
## $ DissSmeto.g.SD : num 0.000278 0.001934 0.007463 0.11298 0.068486 ...
## $ DissOXA.mg : num 69.5 483.2 854.7 11918.4 11672.7 ...
## $ DissOXA.mg.SD : num 16.5 114.3 273.8 3976 87.3 ...
## $ DissOXA.g : num 0.0695 0.4832 0.8547 11.9184 11.6727 ...
## $ DissOXA.g.SD : num 0.0165 0.1143 0.2738 3.976 0.0873 ...

```

```
## $ DissESA.mg : num 260 1808 1548 17951 14830 ...
## $ DissESA.mg.SD : num 50.4 350.3 158 1185.5 306.6 ...
## $ DissESA.g : num 0.26 1.81 1.55 17.95 14.83 ...
## $ DissESA.g.SD : num 0.0504 0.3503 0.158 1.1855 0.3066 ...
## $ FiltSmeto.mg : num 3.45 3.45 5.73 3.07 3.52 ...
## $ FiltSmeto.mg.SD : num 0.124 0.124 0.374 0.66 0.996 ...
## $ FiltSmeto.g : num 0.00345 0.00345 0.00573 0.00307 0.00352 ...
## $ FiltSmeto.g.SD : num 0.000124 0.000124 0.000374 0.00066 0.000996 ...
## $ TotSMout.mg : num 6.99 28.06 175.77 2652.98 2360.52 ...
## $ TotSMout.mg.SD : num 0.216 1.37 5.284 79.89 48.432 ...
## $ TotSMout.g : num 0.00699 0.02806 0.17577 2.65298 2.36052 ...
## $ TotSMout.g.SD : num 0.000216 0.00137 0.005284 0.07989 0.048432 ...
## $ FracDiss : num 0.506 0.877 0.967 0.999 0.999 ...
## $ FracFilt : num 0.49352 0.12301 0.03261 0.00116 0.00149 ...
## $ MELsm.g : num 0.302 2.078 2.379 30.241 27.008 ...
## $ MELsm.g.SD : num 0.0269 0.1868 0.1789 2.4062 0.1634 ...
## $ CumOutDiss.g : num 0.00354 0.02815 0.19818 2.84809 5.2051 ...
## $ CumOutFilt.g : num 0.00345 0.0069 0.01263 0.01571 0.01923 ...
## $ CumOutSmeto.g : num 0.00699 0.03505 0.21082 2.8638 5.22432 ...
## $ CumOutMELsm.g : num 0.302 2.38 4.76 35.001 62.009 ...
## $ BalMassDisch.g : num 6369 6367 6365 6334 6307 ...
## $ prctMassOut : num 4.98e-05 2.00e-04 1.25e-03 1.89e-02 1.68e-02 ...
## $ FracDeltaOut : num 0 -0.00533 0 -0.57576 -0.51483 ...
## $ Events : Factor w/ 51 levels "0-1","0-2","0-3",...: 1 2 3 4 5 6 30 31 32 33 ...
## $ Weeks : Factor w/ 16 levels "W0","W1","W10",...: 1 1 1 2 2 2 9 9 9 10 ...
## $ Event : int 0 0 0 1 1 1 2 2 2 3 ...
```

```
A0df$ti <- as.POSIXct(strptime(A0df$ti, "%Y-%m-%d %H:%M", tz="EST"))
sum(is.na(A0df$ti)) == 0
```

```
## [1] TRUE
```

Outlet - Concentrations

```
# View(A0df)

# Subset the data
# newdata <- mydata[ which(mydata$gender=='F' & mydata$age > 65), ]

limits_conc <- aes(ymin=Conc.mug.L-Conc.SD, ymax=Conc.mug.L+Conc.SD, color = Event, group = Event)
dfSampled <- A0df[which(A0df$Sampled == 'Sampled'), ]
dfSampled$Row <- seq.int(nrow(dfSampled))

conc1 <- ggplot(dfSampled, aes(x=ti, y=Conc.mug.L)) +
  geom_point(aes(color = Event, group = Event)) +
  # geom_point(aes(color = Event)) +

  # Error bars
  geom_errorbar(limits_conc, width=1) +

  # Themes and axes
  theme_bw() +
  theme(axis.text.x=element_text(angle = 45, hjust = 1),
```

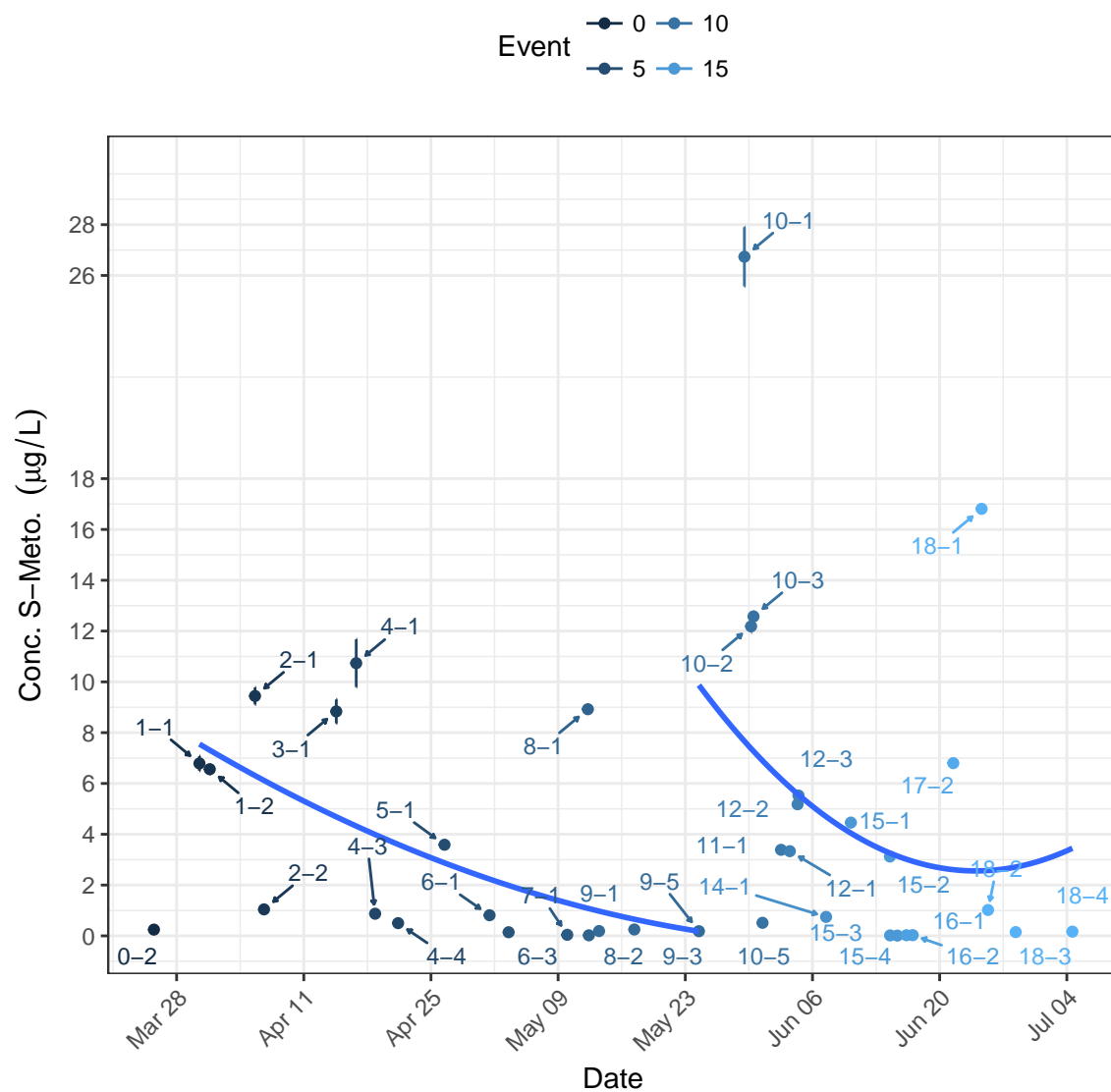
```

    #axis.text.x=element_blank(),
    #axis.title.x=element_blank(),
    legend.position="top"
  )+
  guides(col = guide_legend(nrow = 2)) + # Sets legend parameters
  xlab("Date") +
  scale_x_datetime(breaks = date_breaks("2 weeks"), labels = date_format("%b %d")) +
  ylab(expression(paste("Conc. S-Meto. ", {({\mu}*g / L)}))) +
  scale_y_continuous( breaks = c(28, 26, 18,16,14,12,10, 8, 6, 4, 2, 0), limits = c(0, 30) ) +

  # Smooth linear models
  geom_smooth(data=subset(AOdf[4:28, ]), method = "lm", formula = y ~ poly(x, 2), se = F) +
  geom_smooth(data=subset(AOdf[28:length(AOdf), ]), method = "lm", formula = y ~ poly(x, 2), se= F) +
  #stat_smooth(data=subset(dfSampled[19:30, ]), method = "lm", formula = y ~ x) +
  # Text
  # Application W9
  # annotate("text",
  #         x = as.POSIXct('2016-06-10 08:04:00'), y = -1, label = lbW9, parse = T, size = 3.0) +
  # geom_segment(aes(x = as.POSIXct('2016-06-05 08:04:00'), y = -1,
  #                 xend = as.POSIXct('2016-05-25 18:04:00'), yend = -0.9), color = "black",
  #             arrow = arrow(length = unit(0.2, "cm")) +
  geom_text_repel(aes(label=Events, color = Event), # WeekSubWeek or Weeks
                 size = 3,
                 arrow = arrow(length = unit(0.005, 'npc'), type = "closed"),
                 force = 0.5,
                 point.padding = unit(0.5, 'lines'),
                 max.iter = 2e3,
                 nudge_x = .05, show.legend = F)

```

concl



```
cor.p.SM <- cor.test(dfSampled$Conc.mug.L, dfSampled$diss.d13C, method = "pearson")
cor.p.SM
```

```
##
## Pearson's product-moment correlation
##
## data: dfSampled$Conc.mug.L and dfSampled$diss.d13C
## t = -1.0794, df = 23, p-value = 0.2916
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
## -0.5656317 0.1922336
## sample estimates:
## cor
## -0.2195757
```

```
cor.p.ESA <- cor.test(dfSampled$ESA_mean, dfSampled$diss.d13C)
cor.p.ESA
```



```
##
## Pearson's product-moment correlation
##
## data: dfSampled$ESA_mean and dfSampled$diss.d13C
## t = -0.77426, df = 23, p-value = 0.4467
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
## -0.5216589 0.2515954
## sample estimates:
## cor
## -0.15938

cor.p.SM.soils <- cor.test(wk$Conc.mug.g.dry.soil, wk$comp.d13C)
cor.p.SM.soils
```

```
##
## Pearson's product-moment correlation
##
## data: wk$Conc.mug.g.dry.soil and wk$comp.d13C
## t = -4.2655, df = 36, p-value = 0.0001379
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
## -0.7585899 -0.3187871
## sample estimates:
## cor
## -0.5794211
```

Outlet - Masses vs time

```
library("tidyr")

dfSampled1 <- dfSampled[ , c("ti", "Peak", "Event", "Events",
                             "TotSMout.g", "TotSMout.g.SD",
                             "DissOXA.g", "DissOXA.g.SD",
                             "DissESA.g", "DissESA.g.SD",
                             "MELsm.g", "MELsm.g.SD")]

limits_conc <- aes(ymin=Conc.mug.L-Conc.SD, ymax=Conc.mug.L+Conc.SD, color = Event, group = Event)

#mass1 <- ggplot(dfSampled) +
#  geom_point(aes(x=ti, y=SimOutSmeto.g)) +
#  geom_point(aes(x=ti, y=SimMELsm.g)) +
#  scale_colour_manual(values=c("blue", "cyan4"))
```

Outlet Isotope Shifts (DD)

In the same plot consider this secondary axis, where the secondary axis is a formulat of the first:

```
ggplot(mpg, aes(displ, hwy)) + geom_point() + scale_y_continuous("mpg (US)", sec.axis = sec_axis(~ . *
1.20, name = "mpg (UK)") )
```

Or this: <https://github.com/tidyverse/ggplot2/wiki/Align-two-plots-on-a-page>

```
# DeltaDelta Water
#limits_DdCwater <- aes(ymin=diss.d13C-SD.d13C-initialDelta, ymax=diss.d13C+SD.d13C-initialDelta, color = Event)
limits_DdCwater <- aes(ymin=diss.d13C-se.d13C-initialDelta, ymax=diss.d13C+se.d13C-initialDelta, color = Event)

iso2 <- ggplot(dfSampled, aes(x=ti, y=DD13C.diss)) +
  # Error bars
  # geom_errorbar(aes(ymin=mean.d13C-SD.d13C, ymax=mean.d13C+SD.d13C), width=.1) +
  geom_errorbar(limits_DdCwater, width=1) +

  # Themes and Axes
  # theme_gray() +
  # theme(axis.text.x = element_blank()) +
  # theme(plot.margin = unit(c(1,1,1,1), "lines")) +
  theme_bw() +
  theme(legend.position="none",
        # legend.title = element_blank(),
        axis.text.x=element_text(angle = 45, hjust = 1)) +
  guides(col = guide_legend(nrow = 2)) + # Sets legend parameters
  xlab("Date") +
  scale_x_datetime(breaks = date_breaks("2 weeks"), labels = date_format("%b %d")) +

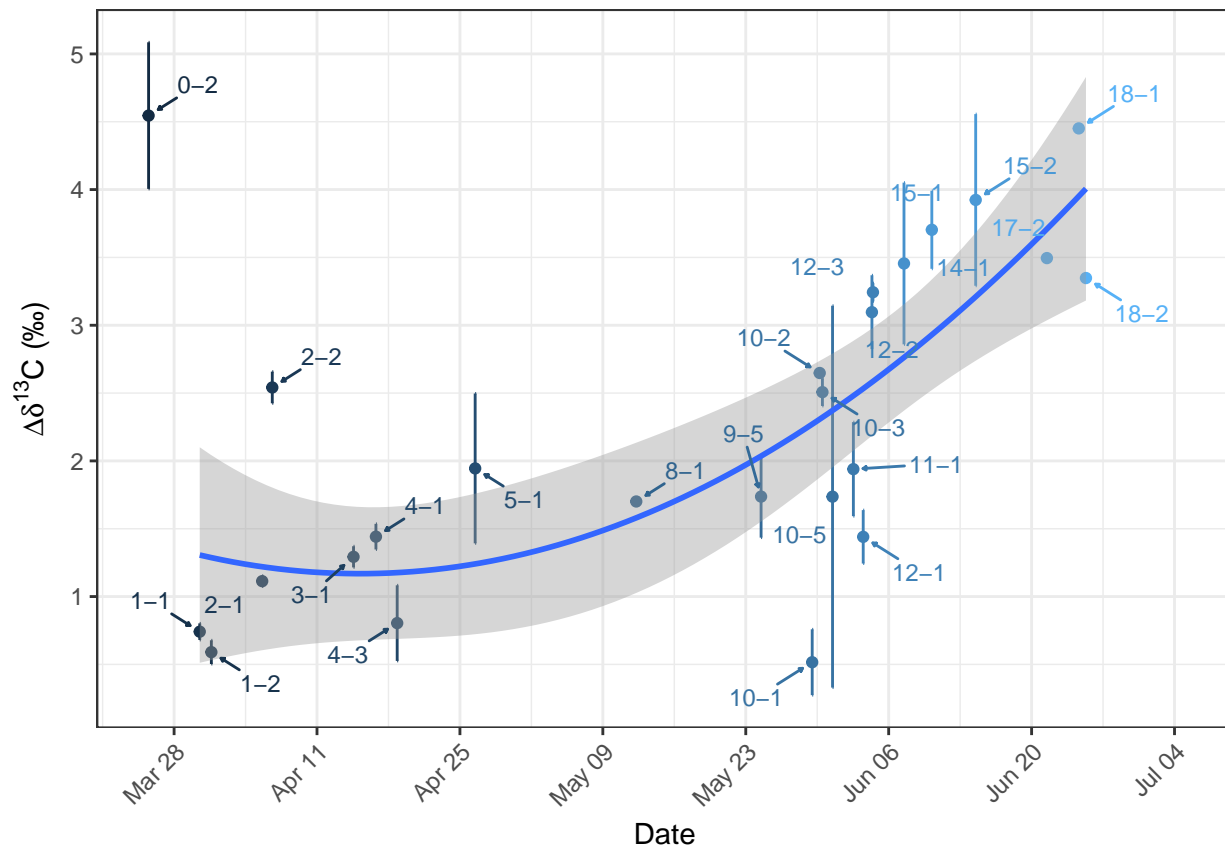
  # scale_y_continuous(breaks = c(-32,-31,-30,-29, -28, -27), limits = c(-32, -26.4) ) +
  # scale_y_continuous(breaks = c(6, 4, 2, 0), limits = c(-1, 6) ) +
  scale_y_continuous(breaks=seq(0, 6, 1)) +
  ylab(expression(paste({Delta}, {delta}^{"13"}, "C", ' (\u2030)'))) +

  #scale_x_datetime(breaks = date_breaks("week"), labels = date_format("%m/%d")) +
  geom_point( aes(color = Event, group = Event)) +

  # Smooth linear models
  # stat_smooth(method = "lm", formula = y ~ x) +
  # geom_smooth(data=subset(AOdf[4:length(AOdf), ]), method = "lm", formula = y ~ poly(x, 2)) +
  #geom_smooth(data=subset(AOdf[4:27, ]), method = "lm", formula = y~x) +
  #geom_smooth(data=subset(AOdf[28:length(AOdf), ]), method = "lm", formula = y ~ x) +
  geom_smooth(data=subset(AOdf[4:length(AOdf), ]), method = "lm", formula = y ~ poly(x, 2)) +

  # Text
  # annotate("text",
  #         x = as.POSIXct('2016-06-10 08:04:00'), y = 0.3, label = lbW9, parse = T, size = 3.0) +
  # geom_segment(aes(x = as.POSIXct('2016-06-05 08:04:00'), y = 0.2,
  #                 xend = as.POSIXct('2016-05-25 18:04:00'), yend = 0), color = "black",
  #             arrow = arrow(length = unit(0.2, "cm")))) +
  # annotate("text", x = as.POSIXct('2016-06-25 00:04:00'), y = -31.2, label = lb1, parse = T) +
  geom_text_repel(aes(label=Events, color = Event),
                  size = 3,
                  arrow = arrow(length = unit(0.005, 'npc'), type = "closed"),
                  force = 0.5,
                  point.padding = unit(0.5, 'lines'),
                  max.iter = 2e3,
                  nudge_x = .05)
  #ylab(expression(paste({delta}^{"13"}, "C", ' \u2113')))
  #ylab(expression(paste({delta}^{"13"}, "C")))
```

iso2



```
# plot_grid(co, deltaTime, ncol = 1, nrow = 2, align = "v")
```

```
conc2 <- ggplot(A0df[28:length(A0df),], aes(x=ti, y=Conc.mug.L)) +
  geom_point(aes(color = Weeks, group = Weeks)) +
  # Error bars
  # geom_errorbar(aes(ymin=mean.d13C-SD.d13C, ymax=mean.d13C+SD.d13C), width=.1) +
  geom_errorbar(limits_conc, width=1) +

  # Themes & axes
  # theme_gray() +
  theme_bw() +
  theme(legend.position = "none") +
  theme(axis.text.x=element_text(angle = 45, hjust = 1),
        axis.text.y = element_blank(),
        legend.title = element_blank(),
        plot.margin = unit(c(0,3.5,0,0), "lines")) +
  #scale_x_datetime(breaks = date_breaks("week"), labels = date_format("%m/%d")) +
  scale_y_continuous(breaks = c(20,15,10,5,0), limits = c(-5, 20) ) +
  xlab("Date") +
  ylab("") +

  # Smooth linear models
  stat_smooth(method = "lm", formula = y ~ poly(x, 2)) +
  #geom_hline(yintercept = -31.21, color = "dodgerblue4", linetype = "dotted") +
```

```

#geom_hline(yintercept = -30.71, color = "dodgerblue3", linetype = "dotted") +
#geom_hline(yintercept = -31.71, color = "dodgerblue3", linetype = "dotted") +

# Text
#annotate("text", x = as.POSIXct('2016-06-25 00:04:00'), y = -31.2, label = lb1, parse = T) +
annotate("text", x = as.POSIXct('2016-05-27 08:04:00'), y = -3, label = "App.4", parse = T) +
geom_segment(aes(x = as.POSIXct('2016-05-26 08:04:00'), y = -4,
                  xend = as.POSIXct('2016-05-26 08:04:00'), yend = -5.0),
              arrow = arrow(length = unit(0.2, "cm")) +
geom_text_repel(aes(label=Weeks, color = factor(Weeks)),
                size = 3,
                arrow = arrow(length = unit(0.005, 'npc'), type = "closed"),
                force = 0.5,
                point.padding = unit(0.5, 'lines'),
                max.iter = 2e3,
                nudge_x = .05)

#concs = plot_grid(conc1, conc2, ncol = 2, nrow = 1, align = "h")
#concs

```

Outlet Isotopes - Continuous (by Week)

```

A0df$SD.d13C.err <- ifelse(is.na(A0df$SD.d13C), 0.5, A0df$SD.d13C)
# limits_dC <- aes(ymin=diss.d13C-SD.d13C.err, ymax=diss.d13C+SD.d13C.err, color = Weeks, group = Weeks)
limits_dC <- aes(ymin=diss.d13C-SD.d13C, ymax=diss.d13C+SD.d13C, color = Weeks, group = Weeks)
# View(A0df)

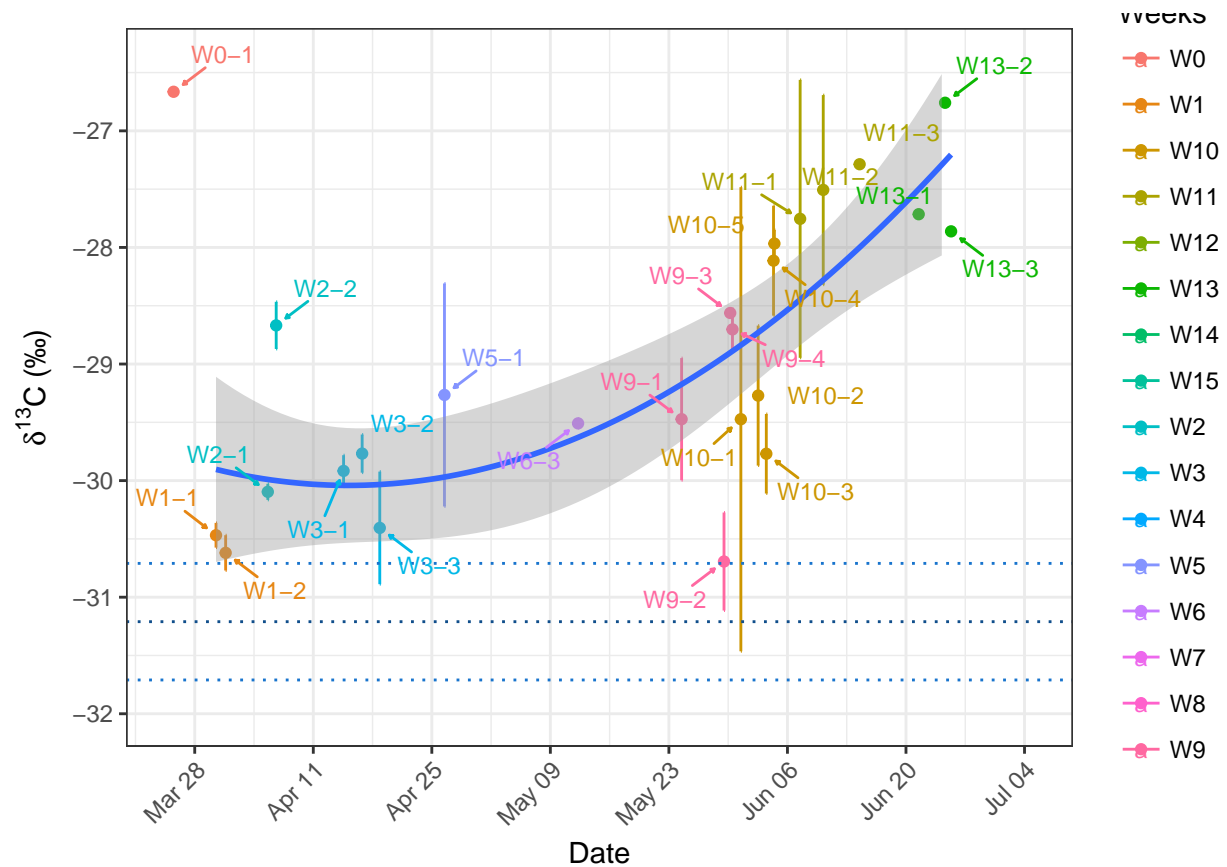
iso <- ggplot(A0df, aes(x=ti, y=diss.d13C)) +
  #geom_errorbar(aes(ymin=mean.d13C-SD.d13C, ymax=mean.d13C+SD.d13C), width=.1) +
  geom_errorbar(limits_dC, width=1) +
  #theme_gray() +
  theme_bw() +
  theme(axis.text.x=element_text(angle = 45, hjust = 1)) +
  #scale_x_datetime(breaks = date_breaks("week"), labels = date_format("%m/%d")) +
  scale_x_datetime(breaks = date_breaks("2 weeks"), labels = date_format("%b %d")) +
  geom_point(aes(color = Weeks, group = Weeks)) +
  #stat_smooth(method = "lm", formula = y ~ x) +
  geom_smooth(data=subset(A0df[4:length(A0df), ]), method = "lm", formula = y ~ poly(x, 2)) +
  #stat_smooth(method = "lm", formula = y ~ poly(x, 2)) +
  #theme(axis.text.x = element_blank()) +
  #theme(plot.margin = unit(c(1,1,1,1), "lines")) +
  geom_hline(yintercept = -31.21, color = "dodgerblue4", linetype = "dotted") +
  geom_hline(yintercept = -30.71, color = "dodgerblue3", linetype = "dotted") +
  geom_hline(yintercept = -31.71, color = "dodgerblue3", linetype = "dotted") +
  #annotate("text", x = as.POSIXct('2016-06-25 00:04:00'), y = -31.2, label = lb1, parse = T) +
  xlab("Date") +
  #theme(legend.position="top") +
  scale_y_continuous(breaks = c(-32,-31,-30,-29, -28, -27), limits = c(-32, -26.4) ) +
  ylab(expression(paste({delta}~"13", "C", ' (\u2030)')) +
  geom_text_repel(aes(label=WeekSubWeek, color = factor(Weeks)),
                  size = 3,

```

```

    arrow = arrow(length = unit(0.005, 'npc'), type = "closed"),
    force = 0.5,
    point.padding = unit(0.5, 'lines'),
    max.iter = 2e3,
    nudge_x = .05)
#ylab(expression(paste({delta}^{"13"}, "C", ' \211')))
#ylab(expression(paste({delta}^{"13"}, "C")))
iso

```



```

ggsave(iso, filename = "Outlet_Delta_ti_cont.png", width = 8, height = 5, units = "in", scale = 1)

```

All plots

```

concSoils <- co + theme(legend.position='none')
concWater <- conc1 + theme(legend.position='none')
isoSoils <- deltaTime + theme(legend.position='none')

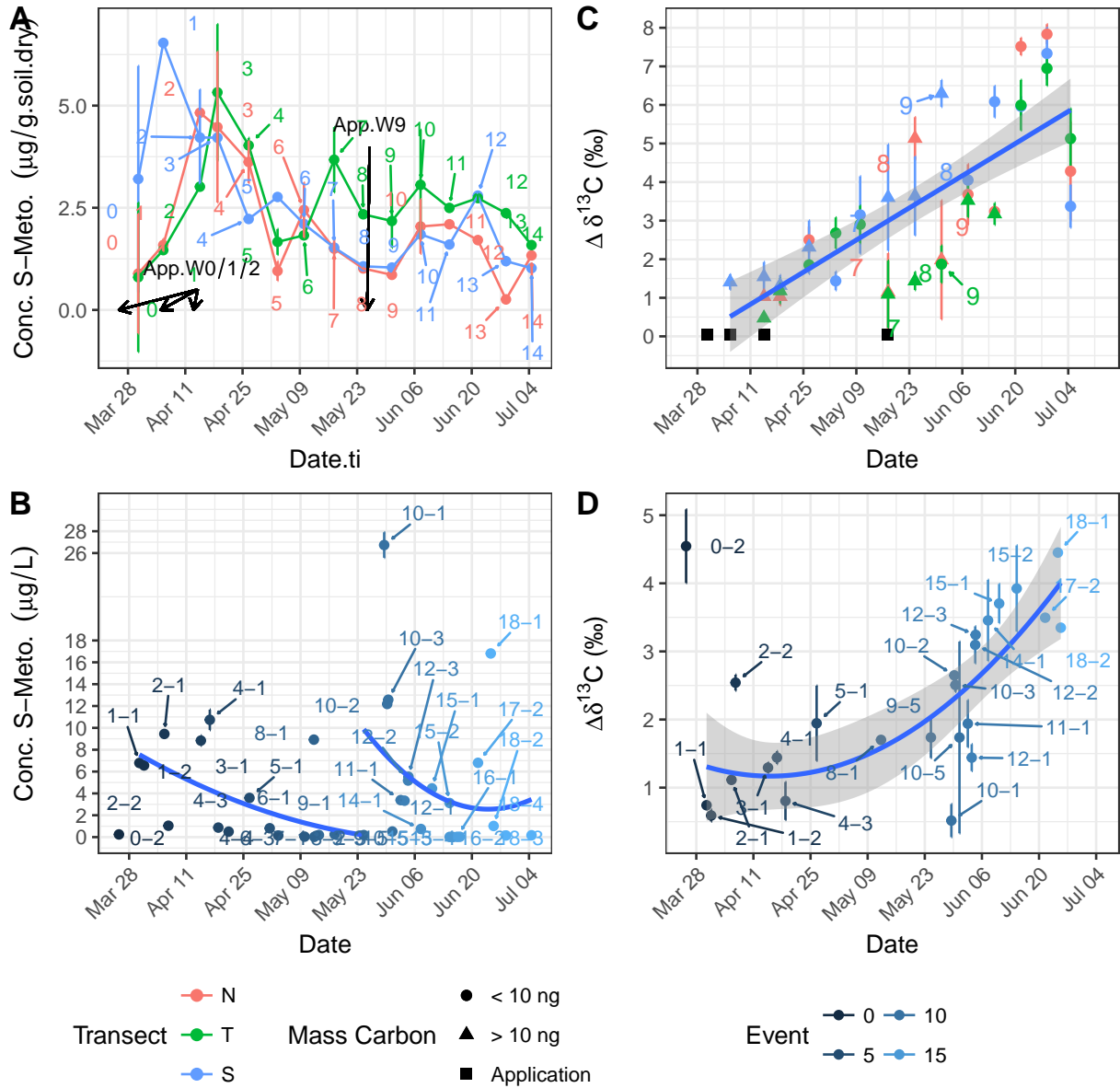
legend_soils = get_legend(deltaTime)
legend_water = get_legend(conc1)

grid4 <- plot_grid(concSoils, isoSoils, concWater, iso2,
  ncol =2, nrow = 2, align = "v",
  labels = c("A", "C", "B", "D"))

```

```
fig1 <- ggdraw() +
  draw_plot(grid4, x=0, y=.2, width = 1, height = .8) +
  draw_plot(legend_water, x=0.5, y = 0.05, width = 0.5, height = 0.2) +
  draw_plot(legend_soils, x=0, y=0.05, width = 0.6, height = 0.2)
```

fig1



```
ggsave(fig1, filename = "SoilsAndOutlet.tiff", height = 18, width = 17.8, units = 'cm')
```

Mass balance approach

```
library("ggplot2")
library("scales")
library("reshape2")
library("zoo")

soilsOut = read.csv2("Data/MassBalance_R.csv", header = T)
soilsOut$ti <- as.POSIXct(soilsOut$ti, "%Y-%m-%d %H:%M", tz = "EST")
sum(is.na(soilsOut$ti))

## [1] 0

print("Mass Balance Soils")

## [1] "Mass Balance Soils"

str(soilsOut)

## 'data.frame':    52 obs. of  39 variables:
##  $ ti                : POSIXct, format: "2016-03-25 00:04:00" "2016-03-25 12:04:00" ...
##  $ WeekSubWeek       : Factor w/ 51 levels "W0-0x","W0-1",...: 1 2 3 4 5 6 26 27 28 29 ...
##  $ Event             : int  0 0 0 1 1 1 2 2 2 3 ...
##  $ B.diss            : num  NA 93.1 NA 35.4 29.4 ...
##  $ B.filt            : num  NA NA NA NA NA ...
##  $ CumOutDiss.g       : num  0.00354 0.02815 0.19818 2.84809 5.2051 ...
##  $ CumOutFilt.g       : num  0.00345 0.0069 0.01263 0.01571 0.01923 ...
##  $ CumAppMass.g       : num  6369 6369 6369 6369 6369 ...
##  $ CumOutMELsm.g      : num  0.302 2.38 4.76 35.001 62.009 ...
##  $ B.mean.comp.North  : num  NA NA NA NA NA ...
##  $ B.max.comp.North   : num  NA NA NA NA NA ...
##  $ B.min.comp.North   : num  NA NA NA NA NA ...
##  $ MassSoil.g.North   : num  12.6 NA NA 613.1 NA ...
##  $ comp.d13C.North    : num  NA NA NA NA NA ...
##  $ comp.d13C.SD.North : num  NA NA NA NA NA ...
##  $ comp.d13C.SE.North : num  NA NA NA NA NA ...
##  $ ID.N              : Factor w/ 17 levels "AW-N-0","AW-N-0x",...: 2 NA NA 1 NA NA 3 NA NA 10 ...
##  $ Area.N            : num  139266 NA NA 139266 NA ...
##  $ Area.T            : num  43713 NA NA 43713 NA ...
##  $ Area.S            : num  133175 NA NA 133175 NA ...
##  $ B.mean.comp.Talweg : num  NA NA NA NA NA ...
##  $ B.max.comp.Talweg  : num  NA NA NA NA NA ...
##  $ B.min.comp.Talweg  : num  NA NA NA NA NA ...
##  $ MassSoil.g.Talweg  : num  4.44 NA NA 173.27 NA ...
##  $ comp.d13C.Talweg   : num  NA NA NA NA NA ...
##  $ comp.d13C.SD.Talweg : num  NA NA NA NA NA ...
##  $ comp.d13C.SE.Talweg : num  NA NA NA NA NA ...
##  $ ID.T              : Factor w/ 17 levels "AW-T-0","AW-T-0x",...: 2 NA NA 1 NA NA 3 NA NA 10 ...
##  $ B.mean.comp.South  : num  NA NA NA NA NA ...
##  $ B.max.comp.South   : num  NA NA NA NA NA ...
##  $ B.min.comp.South   : num  NA NA NA NA NA ...
##  $ MassSoil.g.South   : num  18.8 NA NA 2112.1 NA ...
##  $ comp.d13C.South    : num  NA NA NA NA NA ...
##  $ comp.d13C.SD.South : num  NA NA NA NA NA ...
##  $ comp.d13C.SE.South : num  NA NA NA NA NA ...
```

```

## $ ID.S : Factor w/ 17 levels "AW-S-0","AW-S-0x",...: 2 NA NA 1 NA NA 3 NA NA 10 ...
## $ CatchMassSoil.g : num 35.8 NA NA 2898.5 NA ...
## $ BulkMass.g : num 14.1 NA NA 1183.7 NA ...
## $ BulkCatch.d13 : num NA NA NA NA NA ...

# Melt data set
##Subset the necessary columns
soilsRemainMass <- soilsOut[, c("ti", "CumAppMass.g", "CumOutDiss.g", "CumOutFilt.g", "CumOutMELsm.g",

# Replace Catchment Mass's NA with the most recent non-NA prior to it (assumes no degradation).
# Purpose: To match continuous outlet time array
# soilsRemainMass$CatchMassSoil.g <- na.locf(soilsRemainMass$CatchMassSoil.g)

##Then rearrange your data frame
remainMassMolten <- soilsRemainMass[, c("ti", "CumAppMass.g", "CumOutDiss.g", "CumOutFilt.g", "CumOutMELsm.g",
remainMassMolten <- melt(remainMassMolten, id=c("ti"))

# View(remainMassMolten)

pg <- remainMassMolten
pg <- na.omit(pg)

# Change variable names:
levels(pg$variable)[levels(pg$variable)=="CumAppMass.g"] <- "Applied SM Cum. (Survey)"
levels(pg$variable)[levels(pg$variable)=="CumOutMELsm.g"] <- "MEL-SM Cum. (Outlet)"
levels(pg$variable)[levels(pg$variable)=="CatchMassSoil.g"] <- "Persistent SM (Top soil 1cm)"

levels(pg$variable)[levels(pg$variable)=="CumOutDiss.g"] <- "Dissolved SM Cum. (Outlet)"
levels(pg$variable)[levels(pg$variable)=="CumOutFilt.g"] <- "Sediment SM Cum. (Outlet)"

# Change the order:
levels(pg$variable)

## [1] "Applied SM Cum. (Survey)" "Dissolved SM Cum. (Outlet)"
## [3] "Sediment SM Cum. (Outlet)" "MEL-SM Cum. (Outlet)"
## [5] "Persistent SM (Top soil 1cm)"

pg$variable <- factor(pg$variable, levels = c("Applied SM Cum. (Survey)", "Persistent SM (Top soil 1cm)",
pgSimple <- pg[which(pg$variable != ("Dissolved SM Cum. (Outlet)") & pg$variable != ("Sediment SM Cum.
# names(pg)[names(pg)=="variable"] <- "Estimated Mass"

massBalTop <- ggplot(pg) +
  geom_line(aes(x=ti, y=value, group = variable, color=variable)) +
  geom_point(aes(x=ti, y=value, group = variable, shape=variable, color=variable)) +

# Themes and axes
theme_bw() +
theme(axis.text.x=element_text(angle = 45, hjust = 1),
  # axis.text.x=element_blank(),
  # axis.title.x=element_blank(),
  legend.position="top"
)+

```



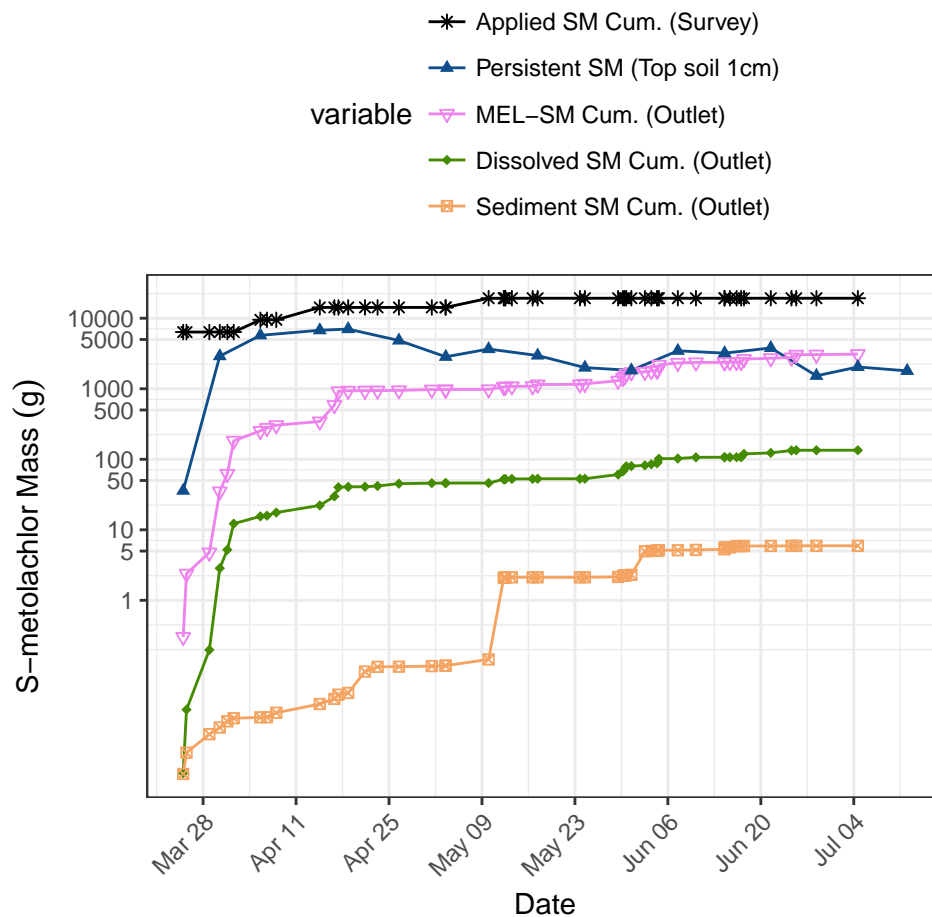
```

# labs(group = "Estimated Mass") +
guides(col = guide_legend(ncol = 1)) + # Sets legend parameters
scale_colour_manual(values=c("black" , "dodgerblue4", "violet", "chartreuse4" , "sandybrown")) +
scale_shape_manual(values = c(8, 17, 25, 18, 7)) +

#scale_colour_manual(values=c("black" , "chartreuse4", "orangered2", "#F8766D", "dodgerblue4", "#61
#scale_shape_manual(values = c(15, 18, 16, 23, 17, 13, 6)) +

xlab("Date") +
scale_x_datetime(breaks = date_breaks("2 weeks"), labels = date_format("%b %d")) +
ylab(expression(paste("S-metolachlor Mass ", {(g)}))) +
# scale_y_continuous(breaks = c(100, 5000, 10000, 20000), limits = c(100, 20000) )
scale_y_continuous(trans=log_trans(), breaks=c(1,5,10,50,100,500,1000,5000, 10000))
massBalTop

```



```

massBalBottom <- ggplot(pg) +
  geom_line(aes(x=ti, y=value, color=variable)) +

# Themes and axes
theme_bw() +
theme(axis.text.x=element_text(angle = 45, hjust = 1),
      #axis.text.x=element_blank(),
      #axis.title.x=element_blank(),

```

```

    legend.position="none"
  )+
  # guides(col = guide_legend(nrows = 2)) + # Sets legend parameters
  xlab("Date") +
  scale_x_datetime(breaks = date_breaks("2 weeks"), labels = date_format("%b %d")) +
  ylab(expression(paste("Mass. S-Meto. ", {(g)}))) +
  scale_y_continuous(breaks = c(1, 25, 50, 100), limits = c(0, 100) )

# massBal = plot_grid(massBalTop, massBalBottom, ncol = 1, nrow = 2, align = "v")

massBal_MEL <- ggplot(pgSimple) +
  geom_line(aes(x=ti, y=value, group = variable, color=variable)) +

  # Themes and axes
  theme_bw() +
  theme(# axis.text.x=element_text(angle = 45, hjust = 1),
        axis.text.x=element_blank(),
        axis.title.x=element_blank(),
        legend.position="top"

  )+
  labs(color = "Estimated Mass") +
  guides(col = guide_legend(ncol = 3)) + # Sets legend parameters

  # xlab("Date") +
  scale_x_datetime(breaks = date_breaks("2 weeks"), labels = date_format("%b %d")) +
  ylab(expression(paste("S-metolachlor ", {(g)})))

# massBal_MEL

massBalLegend <- get_legend(massBalTop)

```

Catchment degradation based on bulk signatures

```

# Pure and cuve isotope average
d13Co = -31.2144

# Lab enrichment:
# Alteck
# More degr. under saturation because anaerobic is best according to Fatima
epsilon_max = -1.5 # +/- 0.3 (@ 20C, 20% vwc)
epsilon_min = -2.0 # +/- 0.2 (@ 20C, 40% vwc)

epsilon_mean = -1.75

# Vine
# (@ 20C, 20% vwc) -0.8 +/- 0.1
# (@ 30C, 20% vwc) -1.4 +/- 0.2
# (@ 20C, 40% vwc) -1.7 +/- 0.2

```

```

# Average

# Remaining fraction
soilsOut$DD13C.bulk <- (soilsOut$BulkCatch.d13 - (d13Co))

# Max epsilon (30C, 20%)
soilsOut$f.max.bulk <-
  ((10^(-3)*soilsOut$BulkCatch.d13 + 1)/(10^(-3)*d13Co + 1))^(1000/(epsilon_max))

soilsOut$B.max.bulk <-
  (1 - soilsOut$f.max.bulk)*100

# Min epsilon (20C, 40%)
soilsOut$f.min.bulk <-
  ((10^(-3)*soilsOut$BulkCatch.d13 + 1)/(10^(-3)*d13Co + 1))^(1000/(epsilon_min))

soilsOut$B.min.bulk <-
  (1 - soilsOut$f.min.bulk)*100

# Mean epsilon (# Alteck)
soilsOut$f.mean.bulk <-
  ((10^(-3)*soilsOut$BulkCatch.d13 + 1)/(10^(-3)*d13Co + 1))^(1000/(epsilon_mean))

soilsOut$B.mean.bulk <-
  (1 - soilsOut$f.mean.bulk)*100

bulkB <- ggplot(soilsOut, aes(x=ti, y=B.mean.bulk)) +
  geom_point() +
  # geom_point(aes(x=Date.ti, y=B.comp, colour=Transect, group = Transect)) +

# Theme and axes
theme_bw() +
ylab("Degr. %") +
theme(legend.position = "top",
      #axis.title = element_blank(),
      #axis.title.x = element_blank(),
      #axis.text.x = element_blank()
      axis.text.x=element_text(angle = 45, hjust = 1)
    ) +
xlab("Date") +
scale_x_datetime(breaks = date_breaks("2 weeks"), labels = date_format("%b %d")) +

# scale_y_continuous(breaks = c(25, 50, 75, 100), limits = c(0, 100) ) +
# stat_smooth(method = "lm", formula = y ~ poly(x, 2), se=FALSE)
# geom_smooth(data=subset(weeklySoil[14:28, ]), method = "lm", formula = y ~ poly(x, 2), se = F) +
geom_smooth(aes(group = 1), method = "lm", formula = y ~ poly(x, 2))
# stat_smooth(data=subset(weeklySoil[4:39, ]), method = "lm", formula = y ~ poly(x, 2), se = F)
# stat_smooth(method = "lm", formula = y ~ x, se=FALSE)
#geom_text_repel(aes(label=Wnum, color = factor(Transect)),

```

```

#           size = 3,
#           arrow = arrow(length = unit(0.005, 'npc'), type = "closed"),
#           force = 0.5,
#           point.padding = unit(0.5, 'lines'),
#           max.iter = 2e3,
#           nudge_x = .05)

# bulkB

```

Degradation based on transect signatures

```

# Merge Bulk Degradation into weekly soil dataframe (only one (e.g. South) transect as root)
soilsOut$PersistPrct <- (soilsOut$CatchMassSoil.g/soilsOut$CumAppMass.g)*100
soilsOut$DischPrct <- ((soilsOut$CumOutDiss.g+soilsOut$CumOutFilt.g)/soilsOut$CumAppMass.g)*100
bulkDegDF <- soilsOut[, c("ti", "WeekSubWeek", "ID.S", "BulkCatch.d13", "B.mean.bulk", "B.max.bulk", "B.min.bulk", "B.persist.bulk", "B.disch.bulk", "B.leach.bulk", "B.leach.bulk.corr")]

bulkDegDF$TotBL <- bulkDegDF$B.min.bulk + bulkDegDF$PersistPrct + bulkDegDF$DischPrct
bulkDegDF$LeachPrct <- 100-bulkDegDF$TotBL
bulkDegDF$LeachPrctCorr <- ifelse(bulkDegDF$LeachPrct > 0, bulkDegDF$LeachPrct, NA)

# Delete rows from specified Columns
completeFun <- function(data, desiredCols) {
  completeVec <- complete.cases(data[, desiredCols])
  return(data[completeVec, ])
}

bulkDegDF <- completeFun(bulkDegDF, "TotBL")

bulkDegDF$Transect <- "Degraded (Bulk)"

# names(bulkDegDF)[names(bulkDegDF) == "B.mean.bulk"] <- "B.mean.com"
names(bulkDegDF)[names(bulkDegDF) == "ti"] <- "Date.ti"

# Splitting the identifier name into Type, Week No., tc..
bulkDegDF$ID.S <- as.character(bulkDegDF$ID.S)
split <- strsplit(bulkDegDF$ID.S, "AW-S-", fixed = T)
bulkDegDF$Wnum <- sapply(split, "[", 2) # Creates new column without "Split0"

bulkDegDF$Week = paste("W", bulkDegDF$Wnum, sep = "")

bulkDegDF <- bulkDegDF[, c("Date.ti", "Transect",
                          "B.mean.bulk", "B.max.bulk", "B.min.bulk",
                          "PersistPrct", "DischPrct", "TotBL", "LeachPrct", "LeachPrctCorr",
                          "Week")]
bulkDegDF$RemainLabel <- "Persistent frac. (Top Soil 1cm)"
bulkDegDF$DischLabel <- "Discharge (Outlet)"
bulkDegDF$LeachLabel <- "Leached (Inferred)"

```

```

levels(bulkDegDF$Transect)[levels(bulkDegDF$Transect)=="Bulk"] <- "Degraded (Bulk)"

wSoil <- weeklySoil[, c("Date.ti", "Transect", "B.mean.comp", "B.max.comp", "B.min.comp")]
levels(wSoil$Transect)[levels(wSoil$Transect)=="N"] <- "North"
levels(wSoil$Transect)[levels(wSoil$Transect)=="T"] <- "Talweg"
levels(wSoil$Transect)[levels(wSoil$Transect)=="S"] <- "South"

# colnames(wSoil) <- c("Date.ti", "Transect", "B.mean.bulk", "B.max.bulk", "B.min.bulk")

# wSoil$Week <- NA
# wSoilBulkDeg <- rbind(wSoil, bulkDegDF)

#names(bulkDegDF)[names(bulkDegDF) == "ID.S"] <- "ID"
#wSoilBulkDeg <- merge(weeklySoil, bulkDegDF, by="ID", all = T)
#wSoilBulkDeg$BulkLabel[!is.na(wSoilBulkDeg$WeekSubWeek)] <- "Bulk"

levels(wSoil$Transect)

## [1] "North" "Talweg" "South"

#wSoil$Transect <- factor(wSoil$Transect, levels = c("Bulk Fraction", "North", "Talweg", "South" ))
wSoil$Transect <- factor(wSoil$Transect, levels = c("North", "Talweg", "South" ))

#wSoilBulkDeg$B.max.bulk[wSoilBulkDeg$Transect == "North"] <- NA
#wSoilBulkDeg$B.max.bulk[wSoilBulkDeg$Transect == "Talweg"] <- NA
#wSoilBulkDeg$B.max.bulk[wSoilBulkDeg$Transect == "South"] <- NA

#wSoilBulkDeg$B.min.bulk[wSoilBulkDeg$Transect == "North"] <- NA
#wSoilBulkDeg$B.min.bulk[wSoilBulkDeg$Transect == "Talweg"] <- NA
#wSoilBulkDeg$B.min.bulk[wSoilBulkDeg$Transect == "South"] <- NA

limits_bulkdeg <- aes(ymin=B.min.bulk, ymax=B.max.bulk, x = Date.ti, colour = Transect, group = Transect)

Bsoil1 <-
  ggplot() +
    # geom_point(size = 2) +
    # ggplot(data = wSoilBulkDeg, aes(Date.ti, B.mean.bulk, colour = Transect, shape=Transect, group = Transect)) +
    geom_point(data = wSoil,
               aes(Date.ti, B.mean.comp, colour = Transect, shape=Transect, group = Transect), size = 2) +
    geom_point(data = bulkDegDF,
               aes(Date.ti, B.mean.bulk, colour = Transect, shape=Transect, group = Transect), size = 2) +
    geom_point(data = bulkDegDF,
               aes(Date.ti, PersistPrct, colour = RemainLabel, shape=RemainLabel, group = RemainLabel), size = 2) +
    geom_point(data = bulkDegDF,
               aes(Date.ti, DischPrct, colour = DischLabel, shape=DischLabel, group = DischLabel), size = 2) +
    geom_point(data = bulkDegDF,
               aes(Date.ti, LeachPrctCorr, colour = LeachLabel, shape=LeachLabel, group = LeachLabel), size = 2) +
    geom_errorbar(data = bulkDegDF, limits_bulkdeg) + # With 2 data frames
    stat_smooth(data=subset(bulkDegDF, Transect == "Degraded (Bulk)"),
               mapping = aes(y = B.mean.bulk, x = Date.ti), # With 2 data frames
               colour = "black",

```

```

        method = "lm", formula = y ~ poly(x, 2), se=F) +

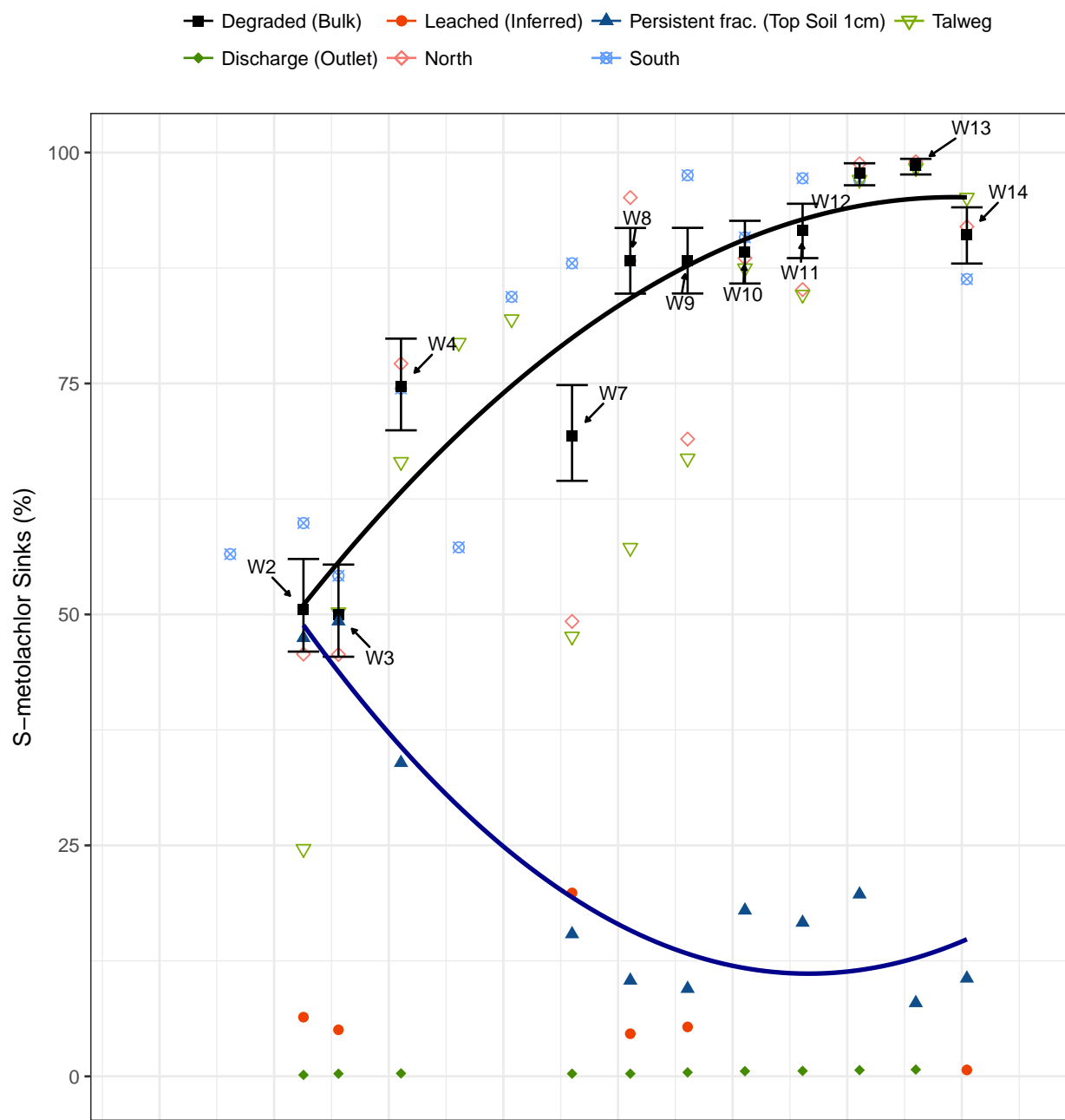
stat_smooth(data=subset(bulkDegDF, RemainLabel == "Persistent frac. (Top Soil 1cm)",
        mapping = aes(y = PersistPrct, x = Date.ti), # With 2 data frames
        colour = "darkblue",
        method = "lm", formula = y ~ poly(x, 2), se=F) +
scale_colour_manual(values=c("black" , "chartreuse4", "orangered2", "#F8766D", "dodgerblue4", "#619
scale_shape_manual(values = c(15, 18, 16, 23, 17, 13, 6)) +
theme_bw() +
ylab("S-metolachlor Sinks (%)") +
theme(legend.position = "top",
        legend.title = element_blank(),
        #axis.title = element_blank(),
        axis.title.x = element_blank(),
        axis.text.x = element_blank()
        #axis.text.x=element_text(angle = 45, hjust = 1)
        ) +
# xlab("Date") +
scale_x_datetime(breaks = date_breaks("2 weeks"), labels = date_format("%b %d")) +
# ylab(expression(paste("Degradation %")))) +

# scale_y_continuous(breaks = c(25, 50, 75, 100), limits = c(0, 100) ) +

# geom_smooth(data=subset(weeklySoil[14:28, ]), method = "lm", formula = y ~ poly(x, 2), se = F) +
# geom_smooth(aes(group = 1), method = "lm", formula = y ~ poly(x, 2)) +
# stat_smooth(data=subset(weeklySoil[4:39, ]), method = "lm", formula = y ~ poly(x, 2), se = F)
# stat_smooth(method = "lm", formula = y ~ x, se=FALSE)
geom_text_repel(data=subset(bulkDegDF, Transect == "Degraded (Bulk)"),
        mapping = aes(y=B.mean.bulk, x= Date.ti, label=Week),
        size = 3,
        arrow = arrow(length = unit(0.005, 'npc'), type = "closed"),
        force = 0.9,
        point.padding = unit(0.9, 'lines'),
        max.iter = 2e3,
        nudge_x = .05, show.legend = F)

```

Bsoil1



```
colnames(bulkDegDF)[which(names(bulkDegDF) == "Transect")] <- "Catchment"
limits_bulkdegCAT <- aes(ymin=B.min.bulk, ymax=B.max.bulk, x = Date.ti, colour = Catchment, group = Cat
solidpts <- ggplot() +
  # geom_point(size = 2) +
  # ggplot(data = wSoilBulkDeg, aes(Date.ti, B.mean.bulk, colour = Transect, shape=Transect, group = Tr
  geom_point(data = bulkDegDF,
    aes(Date.ti, B.mean.bulk, colour = Catchment, shape=Catchment, group = Catchment), size = 1
  geom_point(data = bulkDegDF,
    aes(Date.ti, PersistPrct, colour = RemainLabel, shape=RemainLabel, group = RemainLabel), s
  geom_point(data = bulkDegDF,
    aes(Date.ti, DischPrct, colour = DischLabel, shape=DischLabel, group = DischLabel), size =
```

```

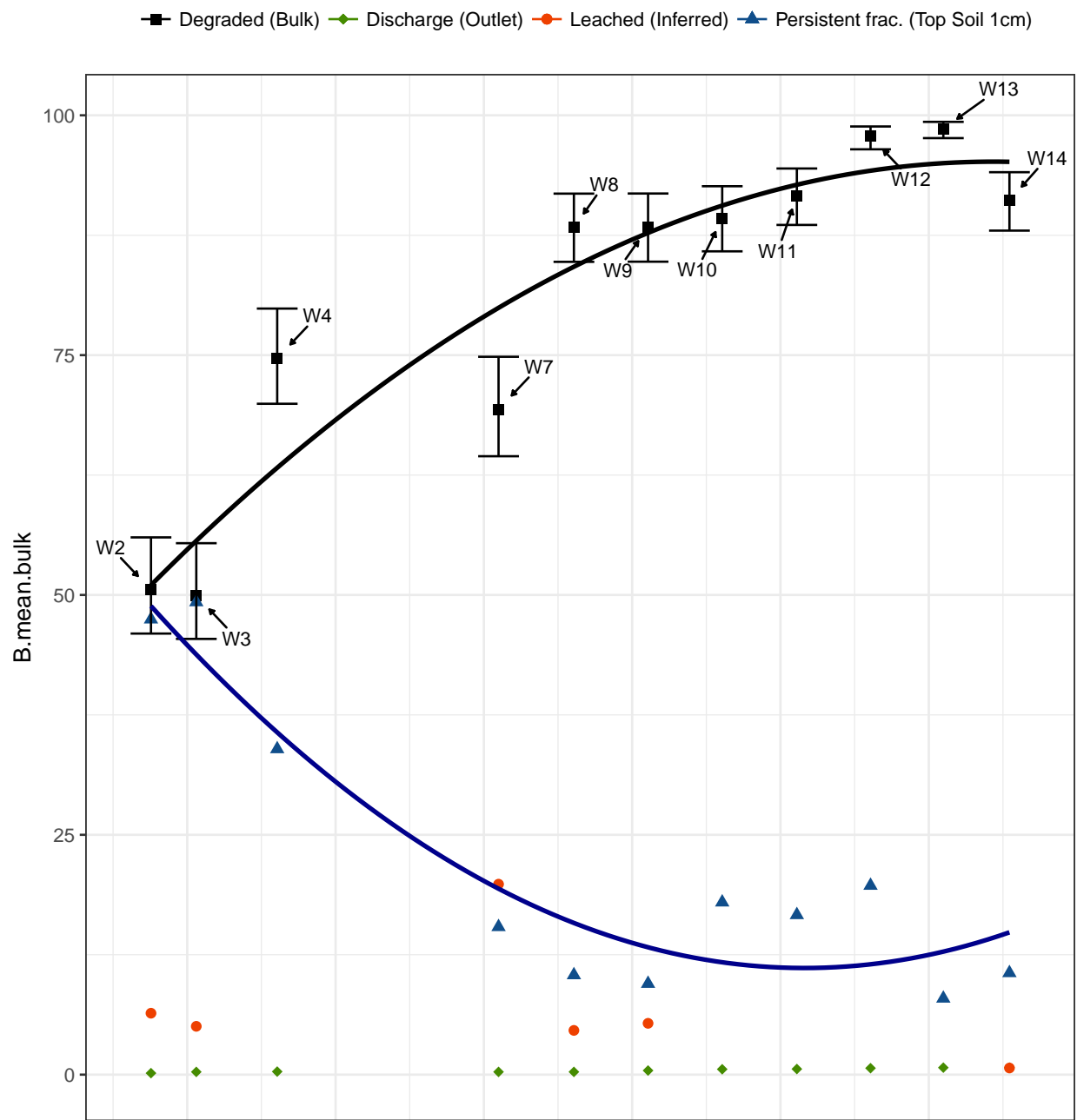
geom_point(data = bulkDegDF,
           aes(Date.ti, LeachPrctCorr, colour = LeachLabel, shape=LeachLabel, group = LeachLabel), si

geom_errorbar(data = bulkDegDF, limits_bulkdegCAT) + # With 2 data frames
stat_smooth(data=subset(bulkDegDF, Catchment == "Degraded (Bulk)",
                        mapping = aes(y = B.mean.bulk, x = Date.ti), # With 2 data frames
                        colour = "black",
                        method = "lm", formula = y ~ poly(x, 2), se=F) +

stat_smooth(data=subset(bulkDegDF, RemainLabel == "Persistent frac. (Top Soil 1cm)",
                        mapping = aes(y = PersistPrct, x = Date.ti), # With 2 data frames
                        colour = "darkblue",
                        method = "lm", formula = y ~ poly(x, 2), se=F) +
#scale_colour_manual(values=c("black", "#F8766D", "#7CAE00", "#619CFF")) +
scale_colour_manual(values=c("black", "chartreuse4", "orangered2", "dodgerblue4")) +
scale_shape_manual(values = c(15, 18, 16, 17)) +
theme_bw() +
theme(legend.position = "top",
      legend.title = element_blank(),
      #axis.title = element_blank(),
      axis.title.x = element_blank(),
      axis.text.x = element_blank()
      #axis.text.x=element_text(angle = 45, hjust = 1)
      ) +
# xlab("Date") +
scale_x_datetime(breaks = date_breaks("2 weeks"), labels = date_format("%b %d")) +
geom_text_repel(data=subset(bulkDegDF, Catchment == "Degraded (Bulk)",
                           mapping = aes(y=B.mean.bulk, x= Date.ti, label=Week),
                           size = 3,
                           arrow = arrow(length = unit(0.005, 'npc'), type = "closed"),
                           force = 0.9,
                           point.padding = unit(0.9, 'lines'),
                           max.iter = 2e3,
                           nudge_x = .05, show.legend = F)

solidpts

```

```

#colnames(wSoil)[which(names(wSoil) == "Transect")] <- "Transect-Deg."
emptypts <-
  ggplot() +
    # geom_point(size = 2) +
    # ggplot(data = wSoilBulkDeg, aes(Date.ti, B.mean.bulk, colour = Transect, shape=Transect, group = Transect)) +
    geom_point(data = wSoil,
               aes(Date.ti, B.mean.comp, colour = Transect, shape=Transect, group = Transect), size = 2)

#scale_colour_manual(values=c("black", "#F8766D", "#7CAE00", "#619CFF")) +
scale_colour_manual(values=c("#F8766D", "#7CAE00", "#619CFF")) +

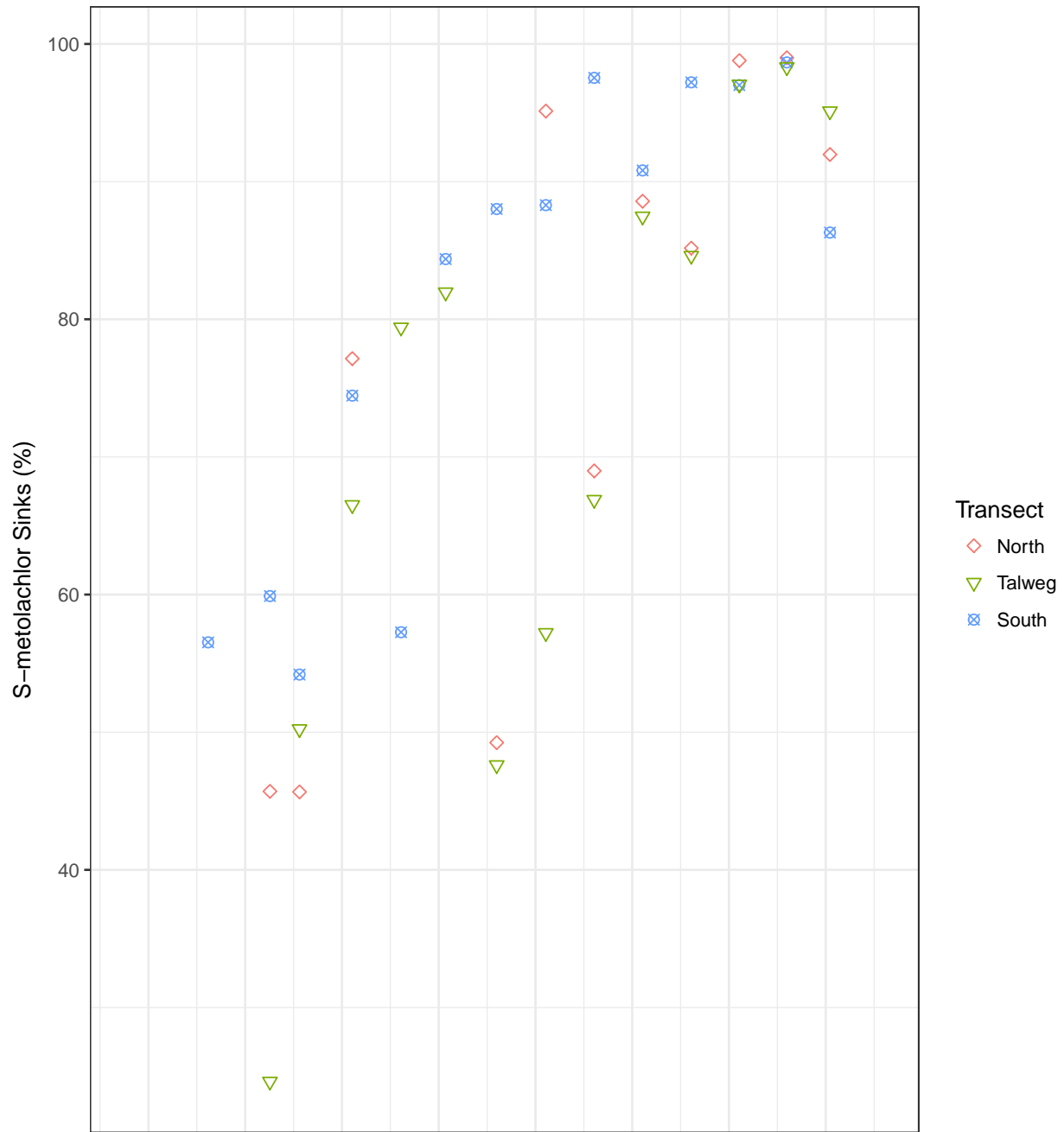
```

```

scale_shape_manual(values = c(23, 6, 13)) +
# guides(guide_legend(title = waiver()))+
# labs(color = "Number of gears") +
#scale_colour_manual(values=c("black", "chartreuse4", "orangered2", "#F8766D", "dodgerblue4", "#61
#scale_shape_manual(values = c(15, 18, 16, 23, 17, 13, 6)) +
theme_bw() +
ylab("S-metolachlor Sinks (%)") +
theme(#legend.position = "top",
      # legend.title = element_blank(),
      #axis.title = element_blank(),
      axis.title.x = element_blank(),
      axis.text.x = element_blank()
      #axis.text.x=element_text(angle = 45, hjust = 1)
    ) +
# xlab("Date") +
scale_x_datetime(breaks = date_breaks("2 weeks"), labels = date_format("%b %d"))

```

emptypts



```
#colnames(wSoil)[which(names(wSoil) == "Transect-Deg.")] <- "Transect"

## Merging both figures

# massBalNoL <- massBal + theme(legend.position='none')
BsoilNoL <- Bsoil1 + theme(legend.position='none')
MBalNoL <- massBalTop + theme(legend.position = 'none')

legend_deg_solid = get_legend(solidpts +
  theme(legend.title = element_text(face = "bold"),
    legend.text = element_text(size = 9),
```

```

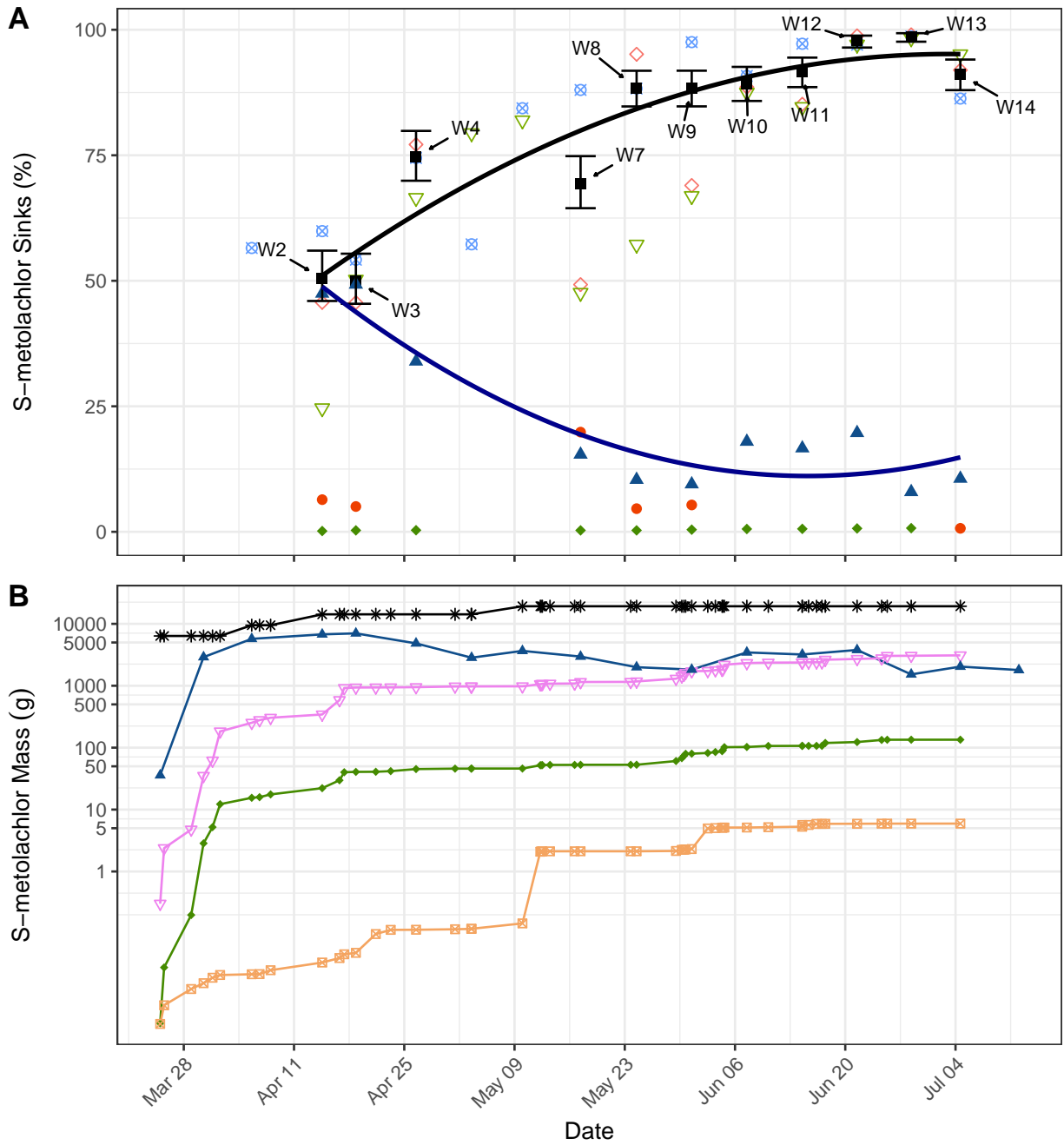
        legend.key.height = unit(x = 0.35, units = 'cm'),
        legend.background = element_rect(colour = "black")) +
        guides(colour = guide_legend(title.position = "top", ncol = 1, byrow = T)))

legend_deg_empty = get_legend(emptypts +
    theme(legend.title = element_text(face = "bold"),
          legend.text = element_text(size = 9),
          legend.key.height = unit(x = 0.35, units = 'cm'),
          legend.background = element_rect(colour = "black")) +
    guides(colour = guide_legend(title.position = "top", ncol = 1, byrow = T)))

legend_mass = get_legend(massBalTop +
    theme(legend.text = element_text(size = 9),
          legend.key.height = unit(x = 0.4, units = 'cm'),
          legend.background = element_rect(colour = "black"),
          legend.title = element_blank()))
    #+ guides(colour = guide_legend(title = "Mass Distribution", title.position

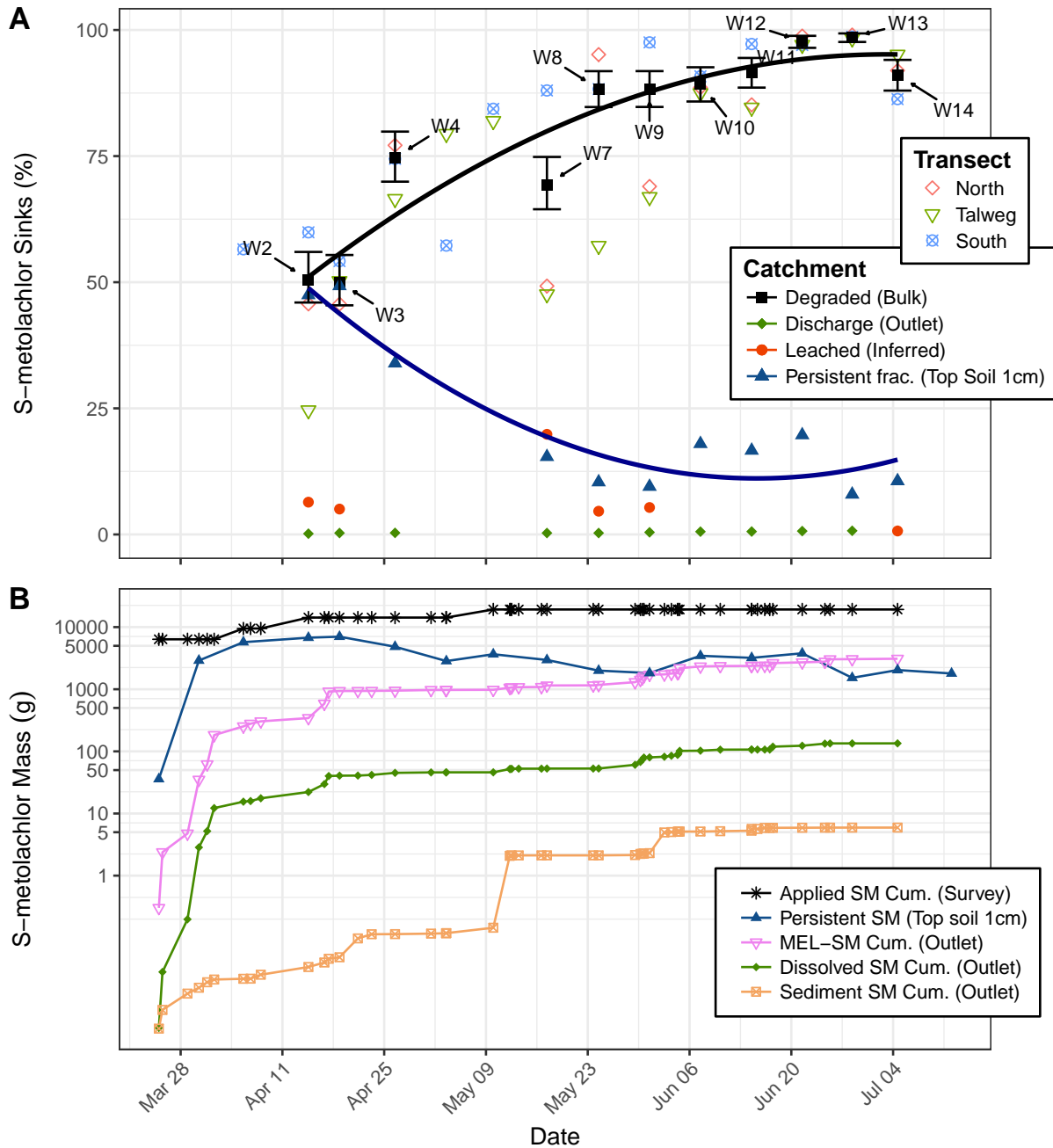
gridPartB <- plot_grid(BsoilNoL, MBalNoL,
    ncol = 1, nrow = 2, align = "v",
    labels = c("A", "B"))
gridPartB

```



```
fig2 <- ggdraw() +
  draw_plot(gridPartB, x=0, y=0, width = 0.93, height = 1) +
  draw_plot(legend_deg_solid, x=0.48, y =0.62, width = 0.70, height = 0.20) +
  draw_plot(legend_deg_empty, x=0.52, y =0.65, width = 0.75, height = 0.35) +
  draw_plot(legend_mass, x=0.5, y=0.05, width = 0.63, height = 0.28)
```

fig2



```
ggsave(fig2, filename = "BvsMassBal.tiff", height = 17, width = 17.8, units = 'cm')
```

Degradation per transect (no bulk)

```
Bsoil2 = ggplot(wSoil, aes(x=Date.ti, y=B.mean.comp, colour=Transect, shape=Transect, group = Transect)) +
  # Bsoil2 = ggplot(wSoilBulkDeg, aes(x=Date.ti)) +
  #
  # stat_smooth(aes(y=B.mean.bulk), method = "lm", formula = y ~ poly(x, 2), se=T) +
  # geom_point(aes(y=B.mean.com, colour=Transect, group = Transect)) +
  # geom_point(aes(y=B.mean.bulk, group=BulkLabel, colour="Bulk Isotopes")) +
```

```

geom_point(size = 2) +

stat_smooth( method = "lm", formula = y ~ poly(x, 2), se=F) +

scale_colour_manual(values=c("#F8766D", "#7CAE00", "#619CFF")) +
scale_shape_manual(values = c(15, 16, 17)) +
# scale_shape_manual(values = c(23, 15, 16, 17)) +
# geom_point(aes(x=Date.ti, y=B.comp, colour=Transect, group = Transect)) +
# Theme and axes
theme_bw() +
ylab("Degr. %") +
theme(legend.position = "top",
      #axis.title = element_blank(),
      axis.title.x = element_blank(),
      axis.text.x = element_blank()
      #axis.text.x=element_text(angle = 45, hjust = 1)
      ) +
# xlab("Date") +
scale_x_datetime(breaks = date_breaks("2 weeks"), labels = date_format("%b %d"))
# ylab(expression(paste("Degradation %")))) +

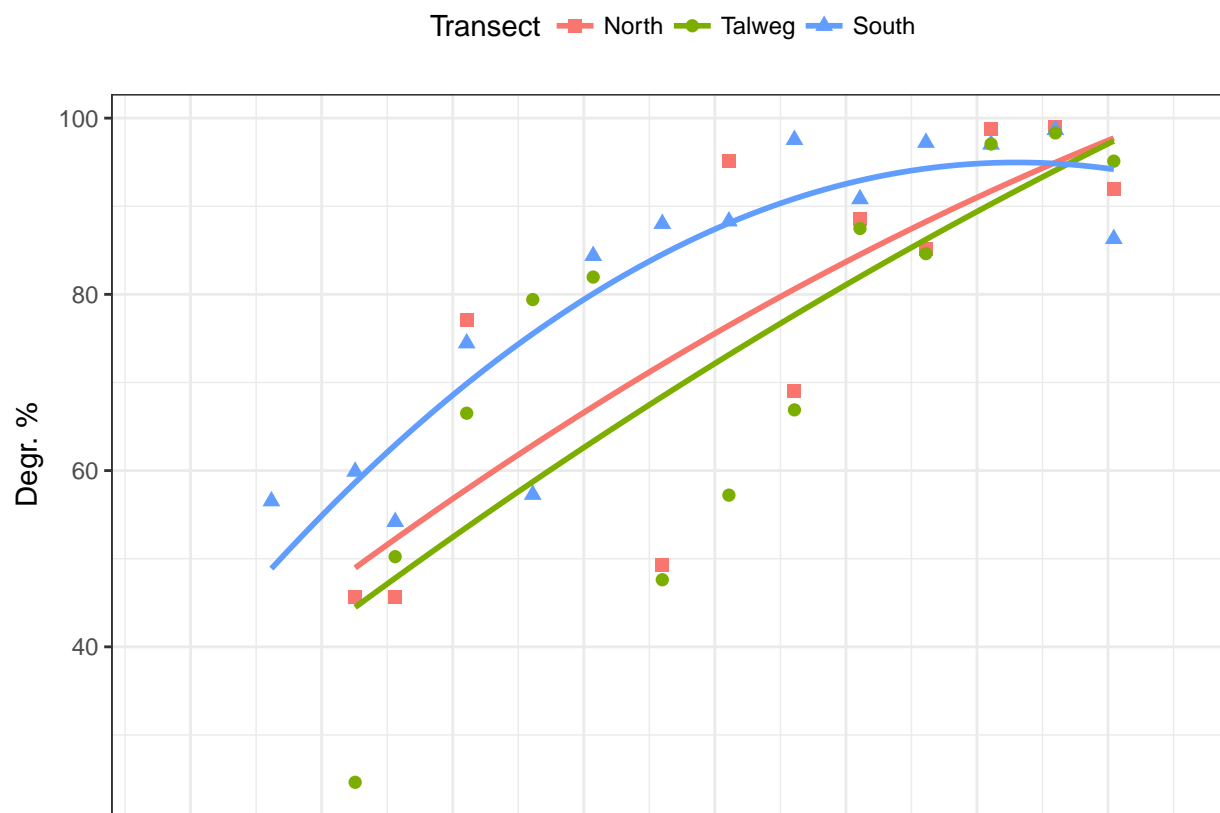
# scale_y_continuous(breaks = c(25, 50, 75, 100), limits = c(0, 100) ) +

# geom_smooth(data=subset(weeklySoil[14:28, ]), method = "lm", formula = y ~ poly(x, 2), se = F) +
# geom_smooth(aes(group = 1), method = "lm", formula = y ~ poly(x, 2)) +
# stat_smooth(data=subset(weeklySoil[4:39, ]), method = "lm", formula = y ~ poly(x, 2), se = F)
# stat_smooth(method = "lm", formula = y ~ x, se=FALSE)

#geom_text_repel(aes(y=B.mean.bulk, label=Wnum, color = factor(Transect)),
#               size = 3,
#               arrow = arrow(length = unit(0.005, 'npc'), type = "closed"),
#               force = 0.5,
#               point.padding = unit(0.5, 'lines'),
#               max.iter = 2e3,
#               nudge_x = .05)

```

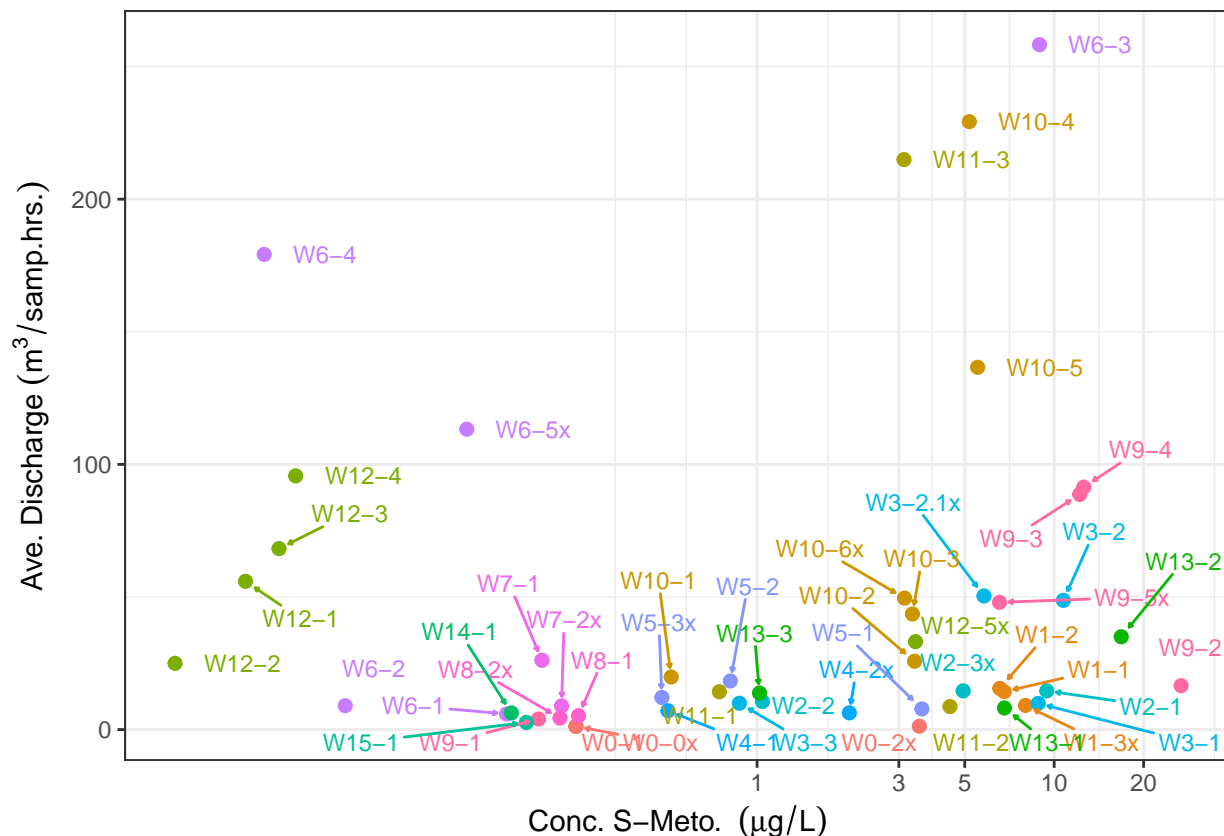
Bsoil2

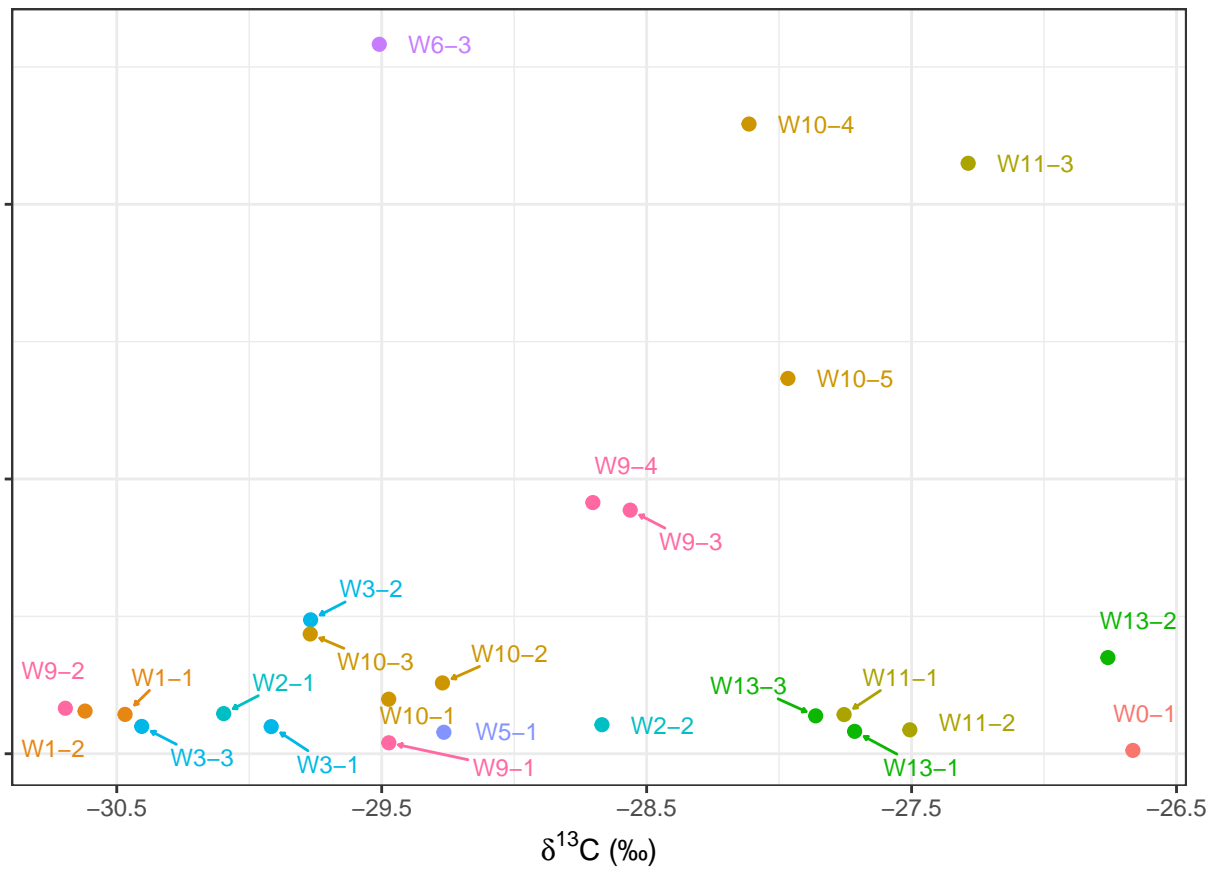


XY-Plots

```
QC <- ggplot(A0df, aes(y=AveDischarge.m3.h, x=Conc.mug.L, group = WeekSubWeek, color = Weeks)) +
  geom_point(size = 2) +
  theme_bw() +
  theme(axis.text.y = element_blank()) +
  theme(legend.title=element_blank()) +
  theme(plot.margin = unit(c(0,0.5,0,0), "lines")) +
  #stat_smooth(method = "lm", formula = y ~ poly(x, 2)) +
  theme_bw() +
  theme(legend.position="none") +
  #scale_y_continuous(trans=log_trans(), breaks=c(1, 5, 10, 50, 100, 200)) +
  scale_x_continuous(trans=log_trans(), breaks=c(1, 3, 5, 10, 20)) +
  ylab(expression(paste("Ave. Discharge ", {(m^3} / samp.hrs. )}))) +
  xlab(expression(paste("Conc. S-Meto. ", {(mu}*g / L)}))) +
  geom_text_repel(aes(label=WeekSubWeek, color = factor(Weeks)),
    size = 3,
    arrow = arrow(length = unit(0.005, 'npc'), type = "closed"),
    force = 0.5,
    point.padding = unit(0.5, 'lines'),
    max.iter = 2e3,
    nudge_x = .05)
```

QC





```
acd = plot_grid(QC, QD, ncol = 2, nrow = 1, align = "h")
acd
```

