

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/Alteckendorf2016/00_TransparencyFolder"
```

Soils

```
weeklySoil = read.csv2("Data/WeeklySoils_R.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.

str(weeklySoil)
```

```
## 'data.frame':   51 obs. of  17 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   0.018 0.029 0.02 1.398 2.881 ...
## $ Conc.ComSoil.SD : Factor w/ 27 levels "#DIV/0!","0,015792484",...: NA NA NA NA NA NA 19 17 9 12
## $ N_compsoil     : int    NA NA NA NA NA NA 3 2 3 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 ...
## $ DD13C.comp     : num    NA NA NA NA NA ...
## $ f.comp         : num    NA NA NA NA NA ...
## $ B.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 ...
## $ MassSoil.g     : num   24.8 31.7 13 1927.5 3152.7 ...
```

```
# 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.")
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)

co =ggplot(weeklySoil,
           aes(x=Date.ti, y=Conc.mug.g.dry.soil, colour=Transect, group = Transect)) +
  #geom_errorbar(limits_conc_soil, width=.05) +
  geom_point() +
  geom_line() +
  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("Conc. S-Meto. ", {({\mu}*g / g.soil.dry)}))) +

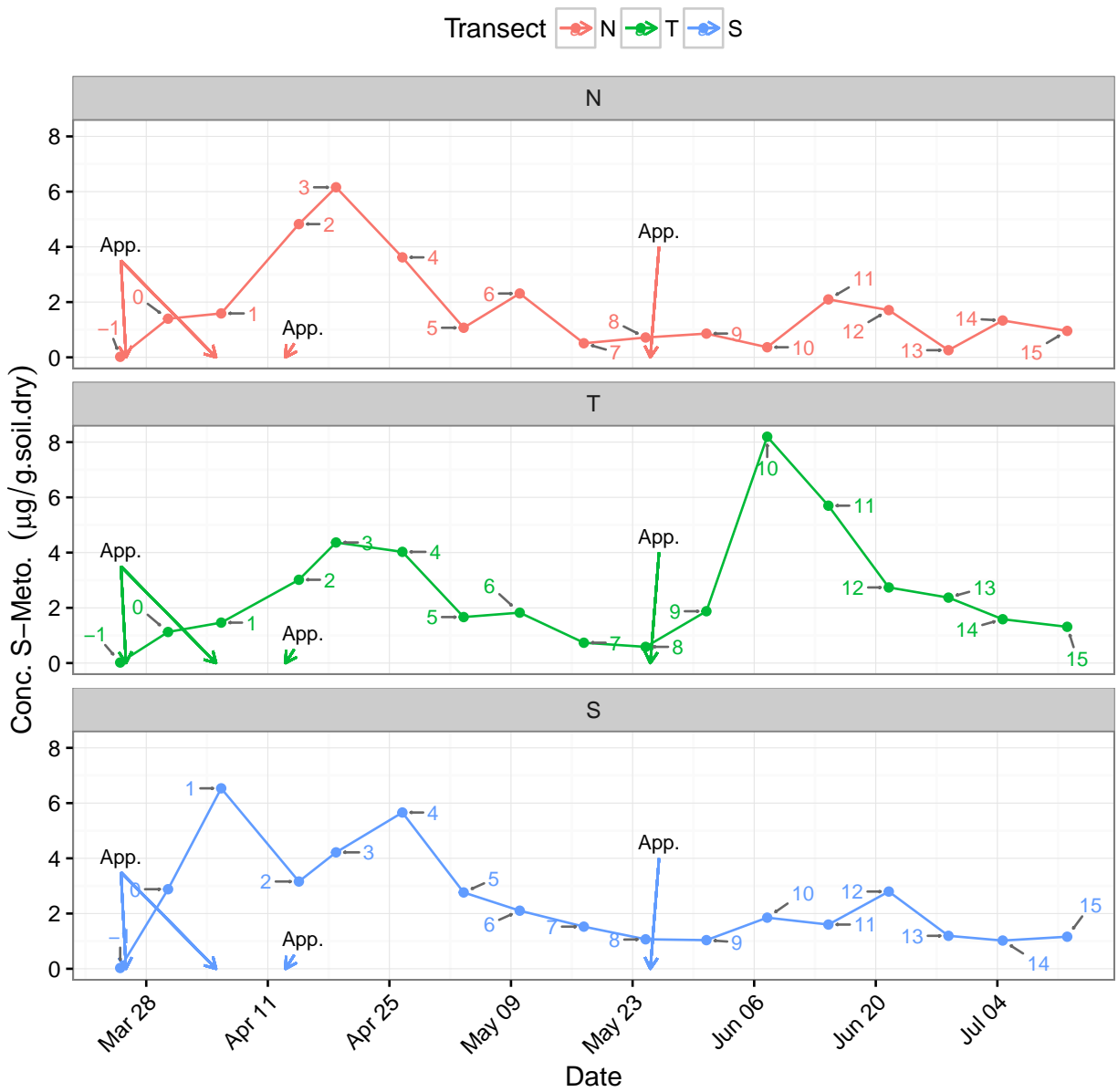
  annotate("text",
          x = as.POSIXct('2016-03-25 08:04:00'), y = 4, label = lb1a2, parse = T, size = 3.0) +
```

```

geom_segment(aes(x = as.POSIXct('2016-03-25 08:04:00'), y = 3.5,
                    xend = as.POSIXct('2016-03-25 22:04:00'), yend = -0),
              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) +
geom_segment(aes(x = as.POSIXct('2016-03-25 08:04:00'), y = 3.5,
                    xend = as.POSIXct('2016-04-05 08:04:00'), yend = 0),
              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) +
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),
              arrow = arrow(length = unit(0.2, "cm")))) +
annotate("text",
         x = as.POSIXct('2016-05-26 08:04:00'), y = 4.5, label = lb1a2, 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 08:04:00'), yend = 0),
              arrow = arrow(length = unit(0.2, "cm")))) +
scale_x_datetime(breaks = date_breaks("2 weeks"), labels = date_format("%b %d")) +
theme(legend.position = "top") +
geom_text_repel(aes(label=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)

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

Soil isotope signatures

```
weeklySoil$DD13C.comp <- (weeklySoil$comp.d13C - (-31.21))

limits_dCsoil <- aes(ymin=comp.d13C-comp.d13C.SD, ymax=comp.d13C+comp.d13C.SD)
```

```

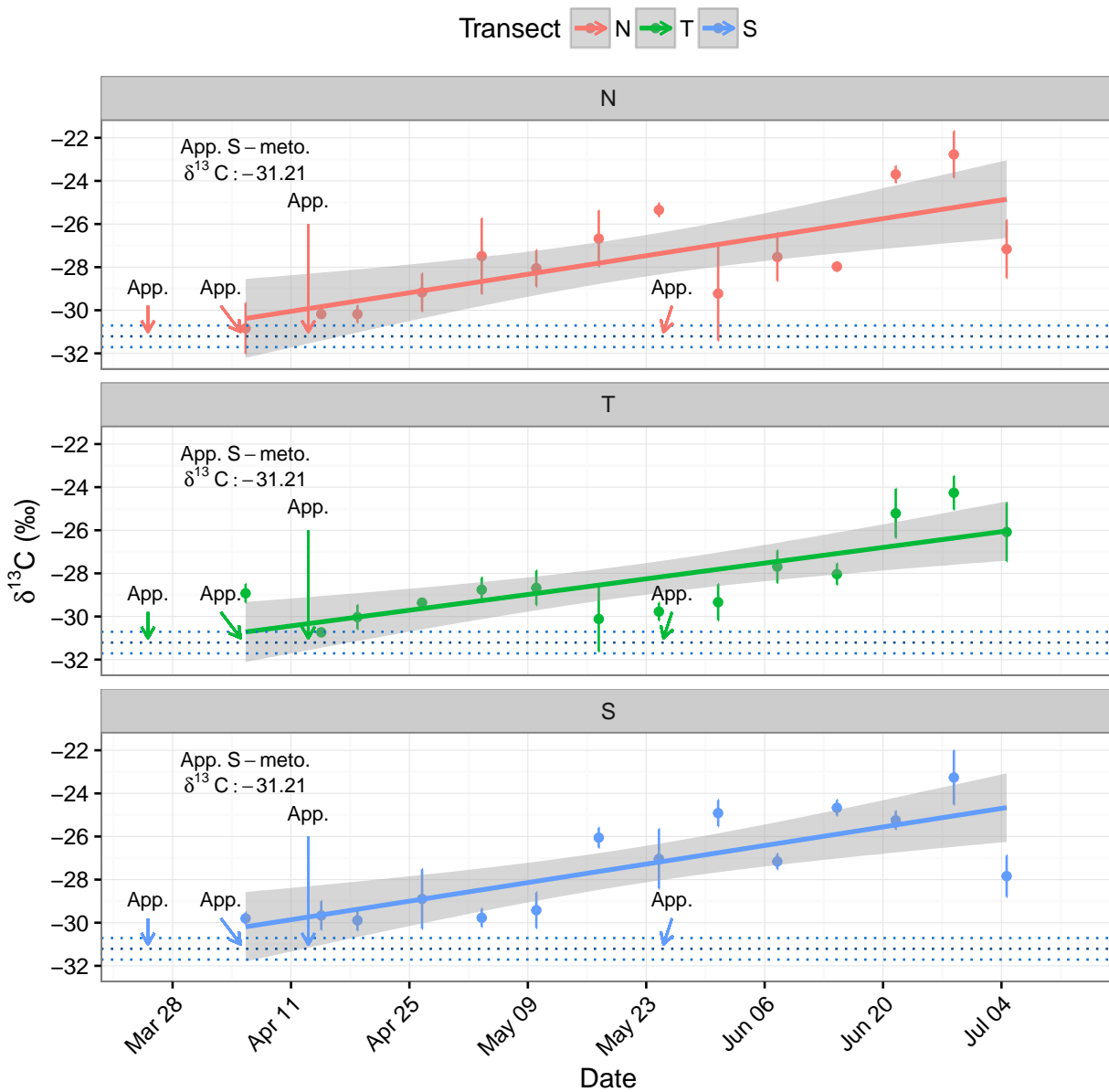
#limits_dCsoil <- aes(ymin=comp.d13C-0.5, ymax=comp.d13C+0.5)
lb1a <- paste("App.~S-meto.")
lb1ab <- paste("delta^{13}~C:-31.21")
lb1a2 <- paste("App.")

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

```



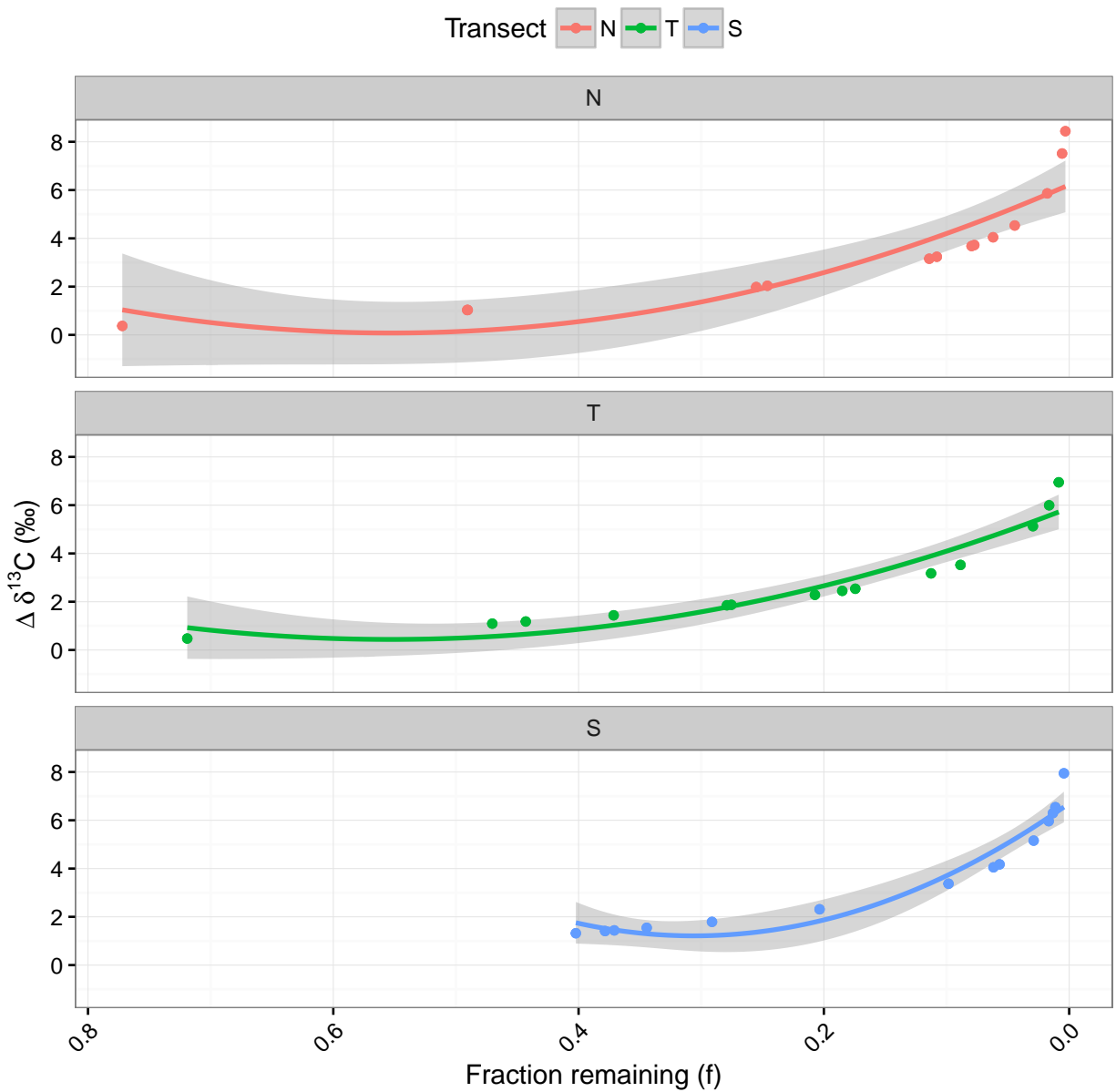
```
# Linear model (LM)
ggsave(isCo, filename = "CompositeIsotopesLM.png", width = 7, height = 5, units = "in", scale = 1)
# No linear model
# ggsave(isCo, filename = "CompositeIsotopes.png", width = 7, height = 5, units = "in", scale = 1)

### 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

```



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"
```



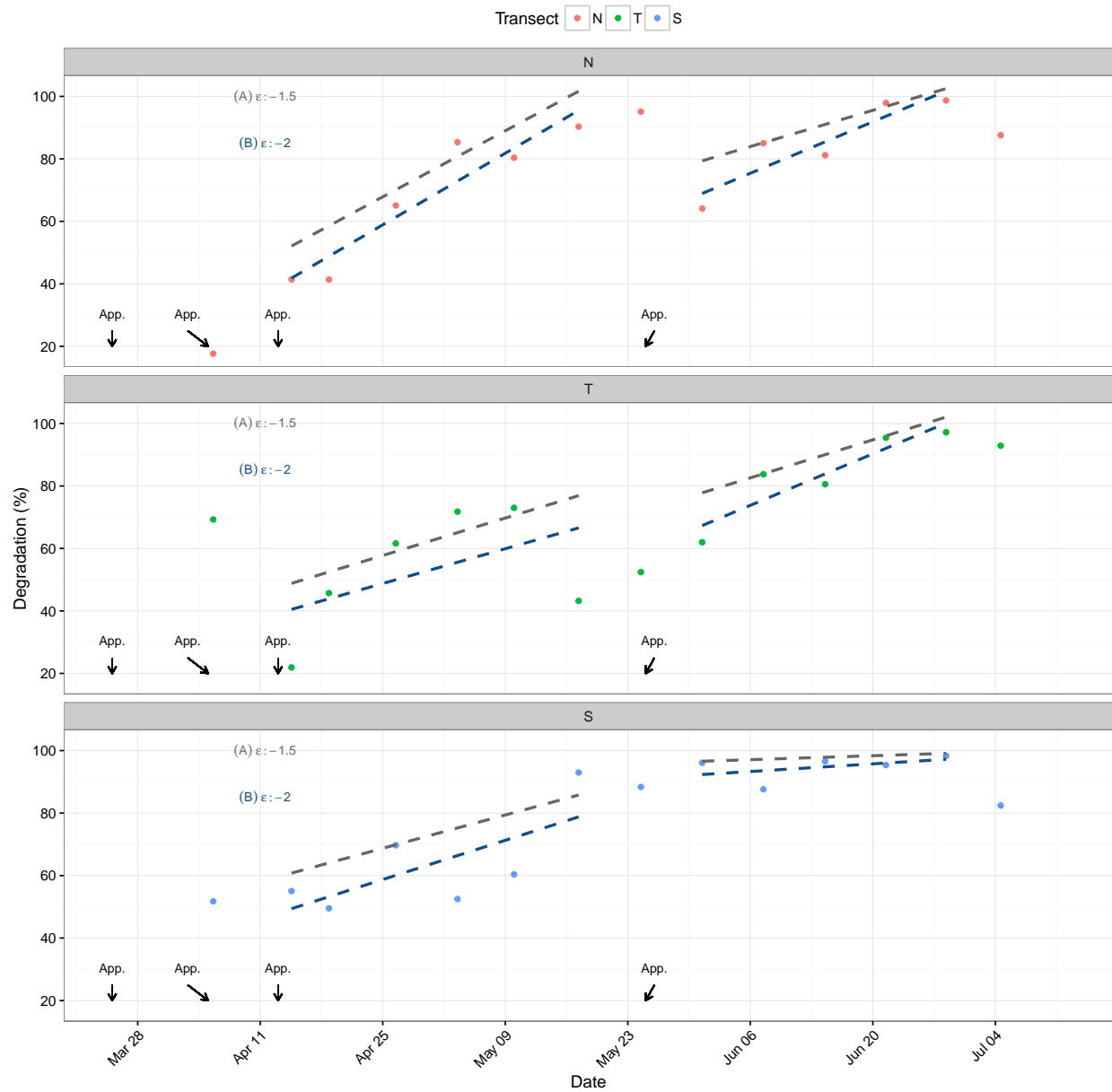
```

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") +
geom_smooth(data=subset(weeklySoil[10:27, ]), aes(x=Date.ti, y=B.min.comp), method = "lm", se = F, color = "dodgerblue4") +
geom_smooth(data=subset(weeklySoil[31:45, ]), aes(x=Date.ti, y=B.min.comp), method = "lm", se = F, color = "dodgerblue4") +
geom_smooth(data=subset(weeklySoil[10:27, ]), aes(x=Date.ti, y=B.comp), method = "lm", se = F, color = "grey40") +
geom_smooth(data=subset(weeklySoil[31:45, ]), aes(x=Date.ti, y=B.comp), method = "lm", se = F, color = "grey40") +
#geom_smooth(y=B.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,
          align = "center", dx = 0, dy = -10) +
annotate("text", x = as.POSIXct('2016-04-11 20:04:00'), y = 85, label = lb1b2, parse = T, size = 3.0,
          align = "center", dx = 0, dy = -10) +

annotate("text", x = as.POSIXct('2016-03-25 08:04:00'), y = 30, label = lb1a2, parse = T, size = 3.0,
          align = "center", dx = 0, dy = 10) +
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,
          align = "center", dx = 0, dy = 10) +
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,
          align = "center", dx = 0, dy = 10) +
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,
          align = "center", dx = 0, dy = 10) +
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", scale = 1)
```

```
# No linear model
```

```
#ggsave(deltaCo, filename = "CompositeConc.png", width = 6, height = 7, units = "in", scale = 1)
```

Water

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

```

## 'data.frame':    51 obs. of  59 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 ...
## $ peak            : num  1.25 1.38 1.64 38.4 18.67 ...
## $ valley          : num  1.118 1.082 0.929 1.449 13.201 ...
## $ tdiff           : num  12 82.5 37.6 27.3 23.1 ...
## $ chExtreme       : num  -0.13 0.256 0.33 36.944 -3.133 ...
## $ 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  NA 0.246 NA 6.788 6.561 ...
## $ Conc.SD         : num  NA 0.0193 NA 0.2894 0.1906 ...
## $ 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  NA 0.645 NA 0.126 0.436 ...
## $ N.y             : int  NA 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 0.0546 NA 0.6218 0.685 ...
## $ f.filt          : num  NA NA NA NA NA ...
## $ B.diss          : num  NA 94.5 NA 37.8 31.5 ...
## $ B.filt          : num  NA NA NA NA NA ...
## $ NH4.mM          : num  NA NA NA 0.05 NA 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 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  NA 5.35 NA 24.4 8.08 ...
## $ DissSmeto.mg    : num  NA 24.6 NA 2649.9 2357 ...
## $ FiltSmeto.mg    : num  NA 3.45 NA 3.07 3.52 ...
## $ TotMassOut.mg   : num  NA 28.1 NA 2653 2360.5 ...
## $ FracDiss        : num  NA 0.877 NA 0.999 0.999 ...
## $ FracFilt        : num  NA 0.12301 NA 0.00116 0.00149 ...
## $ Appl.Mass.g     : num  6369 0 0 0 0 ...
## $ CumAppMass.g    : num  6369 6369 6369 6369 6369 ...
## $ SimOutDiss.g    : num  0 0.0246 0 2.6499 2.357 ...
## $ SimOutFilt.g    : num  0 0.00345 0 0.00307 0.00352 ...
## $ SimOutSmeto.g   : num  0 0.0281 0 2.653 2.3605 ...

```

```
## $ CumOutDiss.g      : num  0 0.0246 0.0246 2.6745 5.0315 ...
## $ CumOutFilt.g      : num  0 0.00345 0.00345 0.00652 0.01004 ...
## $ CumOutSmeto.g     : num  0 0.0281 0.0281 2.681 5.0416 ...
## $ BalMassDisch.g    : num  6369 6369 6369 6367 6364 ...
## $ FracMassOut       : num  0 0.000308 0 0.029119 0.025909 ...
## $ FracDeltaOut      : num  0 -0.00821 0 -0.88723 -0.79334 ...

# Adding a Weeks column for labelling
A0df$WeekSubWeek <- as.character(A0df$WeekSubWeek)
Split <- strsplit(A0df$WeekSubWeek, "-", fixed = TRUE)
A0df$Weeks <- sapply(Split, "[", 1)

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

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

Outlet - Concentrations

```
pos <- position_dodge(0.5)
conc_lb1 <- paste("App.1")

limits_conc <- aes(ymin=Conc.mug.L-Conc.SD, ymax=Conc.mug.L+Conc.SD, color = Weeks, group = Weeks)
conc1 <- ggplot(A0df[1:27,], aes(x=ti, y=Conc.mug.L)) +
  #geom_errorbar(aes(ymin=mean.d13C-SD.d13C, ymax=mean.d13C+SD.d13C), width=.1) +
  geom_errorbar(limits_conc, 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")) +
  geom_point(aes(color = Weeks, group = Weeks)) +
  geom_smooth(data=subset(A0df[4:27, ]), 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(0,0.5,0,0), "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('2016-03-26 23:34:00'), y = -3, label = conc_lb1, parse = T) +
  annotate("text", x = as.POSIXct('2016-04-06 20:04:00'), y = -3, label = "App.2", parse = T) +
  annotate("text", x = as.POSIXct('2016-04-17 05:04:00'), y = -3, label = "App.3", parse = T) +
  xlab("Date") +
  ylab(expression(paste("Conc. S-Meto. ", {({mu}*g / L)}))) +
  theme(legend.position = "top") +
  theme(legend.title = element_blank()) +
  scale_y_continuous(breaks = c(20,15,10,5, 0), limits = c(-5, 20) ) +
  geom_segment(aes(x = as.POSIXct('2016-03-25 08:04:00'), y = -4,
    xend = as.POSIXct('2016-03-25 08:04:00'), yend = -5.0),
    arrow = arrow(length = unit(0.2, "cm")) +
```

```

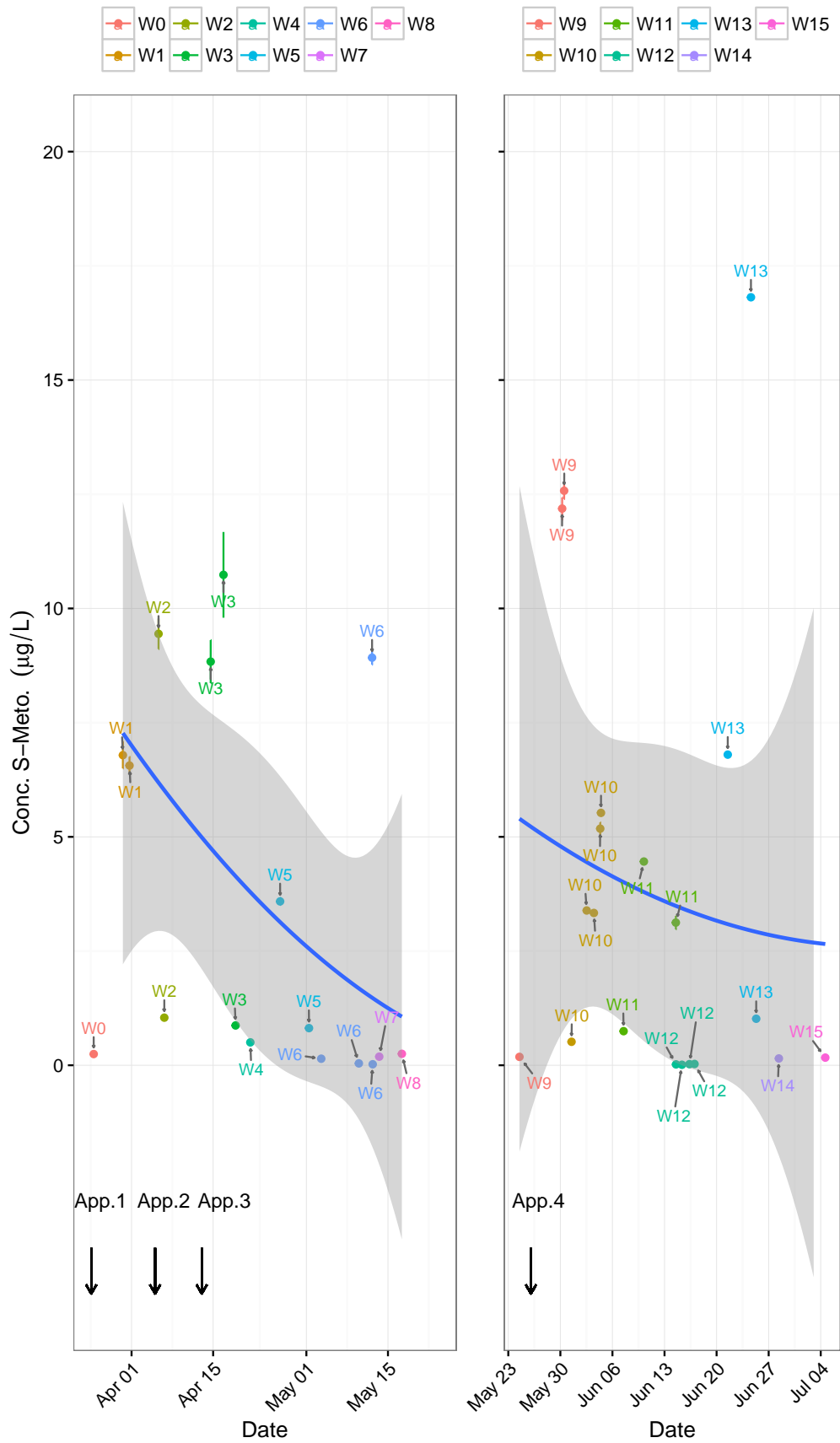
geom_segment(aes(x = as.POSIXct('2016-04-05 08:04:00'), y = -4,
  xend = as.POSIXct('2016-04-05 08:04:00'), yend = -5.0),
  arrow = arrow(length = unit(0.2, "cm")))) +
geom_segment(aes(x = as.POSIXct('2016-04-13 08:04:00'), y = -4,
  xend = as.POSIXct('2016-04-13 08:04:00'), yend = -5.0),
  arrow = arrow(length = unit(0.2, "cm")))) +
#ylab(expression(paste({delta}~"13", "C", ' (\u2030)')) +
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)
#ylab(expression(paste({delta}~"13", "C", ' \211'))))
#ylab(expression(paste({delta}~"13", "C")))
#conc1

conc2 <- ggplot(AOdf[28:length(AOdf),], aes(x=ti, y=Conc.mug.L)) +
  #geom_errorbar(aes(ymin=mean.d13C-SD.d13C, ymax=mean.d13C+SD.d13C), width=.1) +
  geom_errorbar(limits_conc, 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")) +
  geom_point(aes(color = Weeks, group = Weeks)) +
  stat_smooth(method = "lm", formula = y ~ poly(x, 2)) +
  theme(axis.text.y = element_blank()) +
  theme(plot.margin = unit(c(0,3.5,0,0), "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") +
  ylab("") +
  theme(legend.position = "top") +
  theme(legend.title = element_blank()) +
  scale_y_continuous(breaks = c(20,15,10,5,0), limits = c(-5, 20) ) +
  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)
  #ylab(expression(paste({delta}~"13", "C", ' \211'))))
  #ylab(expression(paste({delta}~"13", "C")))

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

```

concs

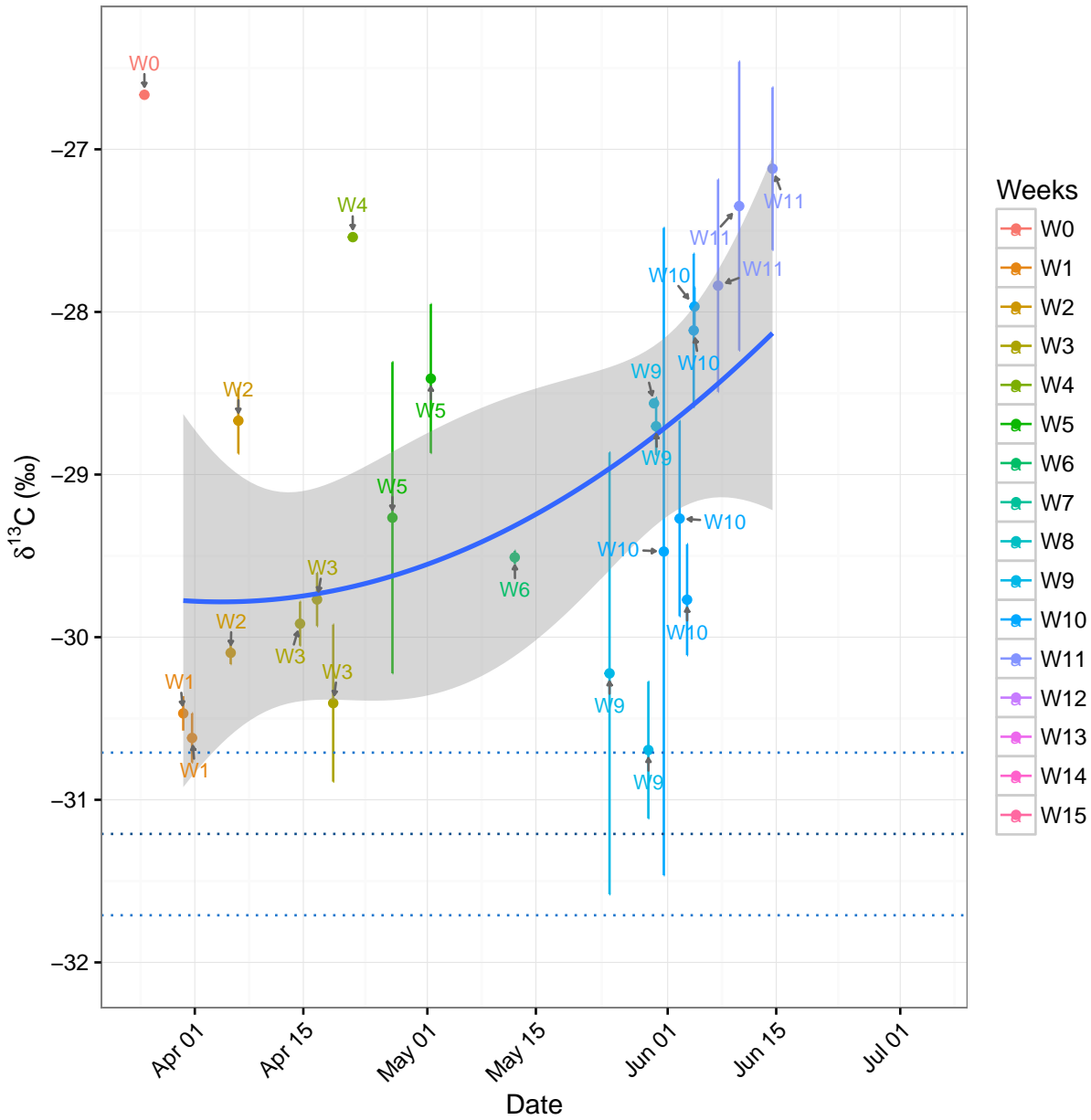


Outlet Isotopes - Continous

```
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)

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")) +
  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=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)
  #ylab(expression(paste({delta}^"13", "C", ' \u2111'))))
  #ylab(expression(paste({delta}^"13", "C"))))

iso
```



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

Outlet Isotopes - broken by application

```
#limits_dC <- aes(ymin=diss.d13C-0.5, ymax=diss.d13C+0.5, color = Weeks, group = Weeks)
#limits_dC <- aes(ymin=diss.d13C-SD.d13C, ymax=diss.d13C+SD.d13C, color = Weeks, group = Weeks)
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)

iso1 <- ggplot(A0df[3:27,], 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")) +
geom_point(aes(color = Weeks, group = Weeks)) +
stat_smooth(method = "lm", formula = y ~ x) +
#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")) +
theme(plot.margin = unit(c(0,0.5,0,0), "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=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)
#ylab(expression(paste({delta}~"13", "C", ' \u211')) +
#ylab(expression(paste({delta}~"13", "C")))

iso2 <- ggplot(AOdf[28:42,], 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")) +
geom_point(aes(color = Weeks, group = Weeks)) +
stat_smooth(method = "lm", formula = y ~ poly(x, 2)) +
theme(axis.text.y = element_blank()) +
theme(plot.margin = unit(c(0,3.5,0,0), "lines")) +
#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") +
ylab(" ") +
theme(legend.position="top") +
theme(legend.title = element_blank()) +
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=Weeks, color = factor(Weeks)),
  size = 3,

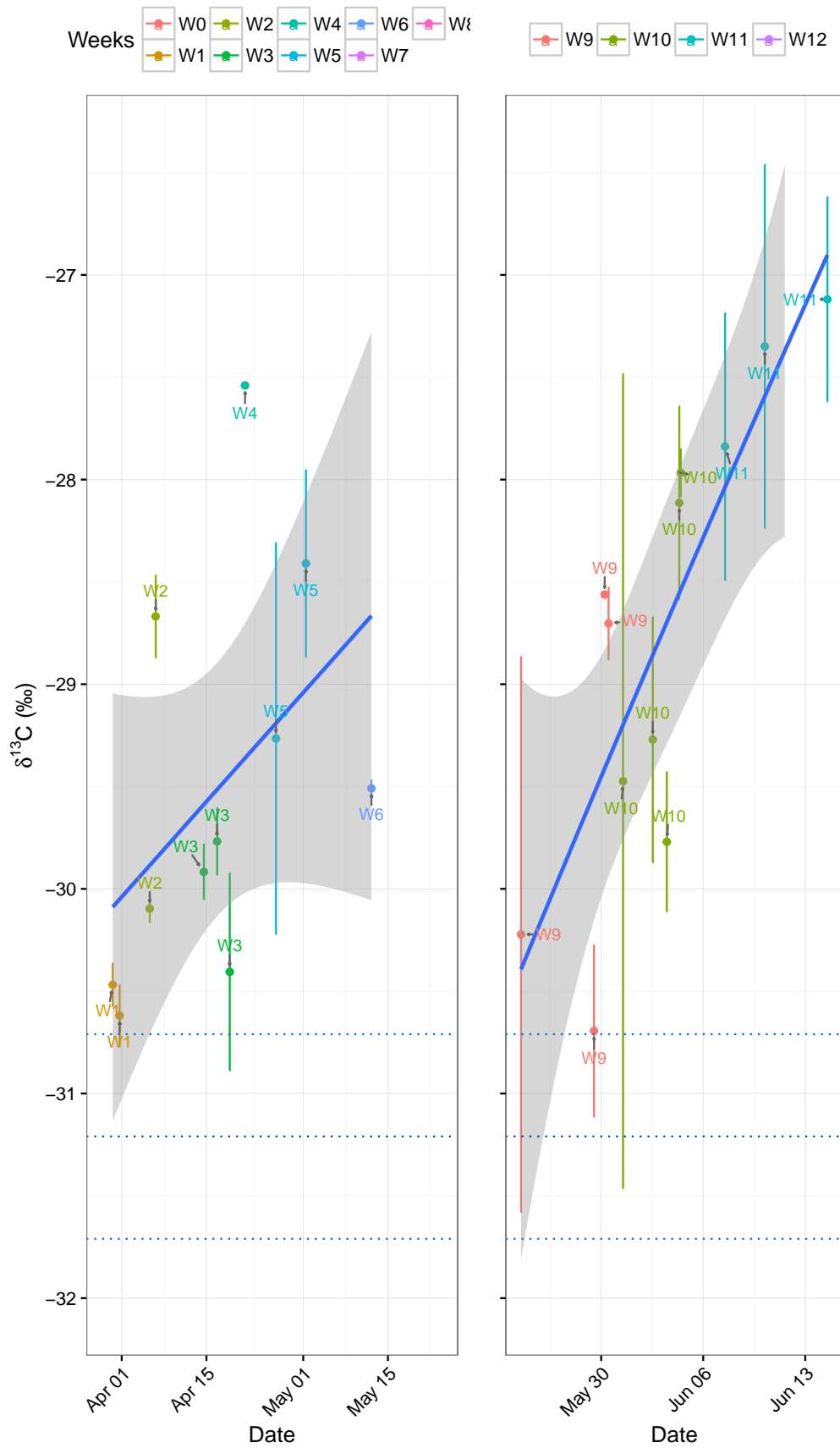
```

```

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

isos = plot_grid(iso1, iso2, ncol = 2, nrow = 1, align = "h")
isos

```

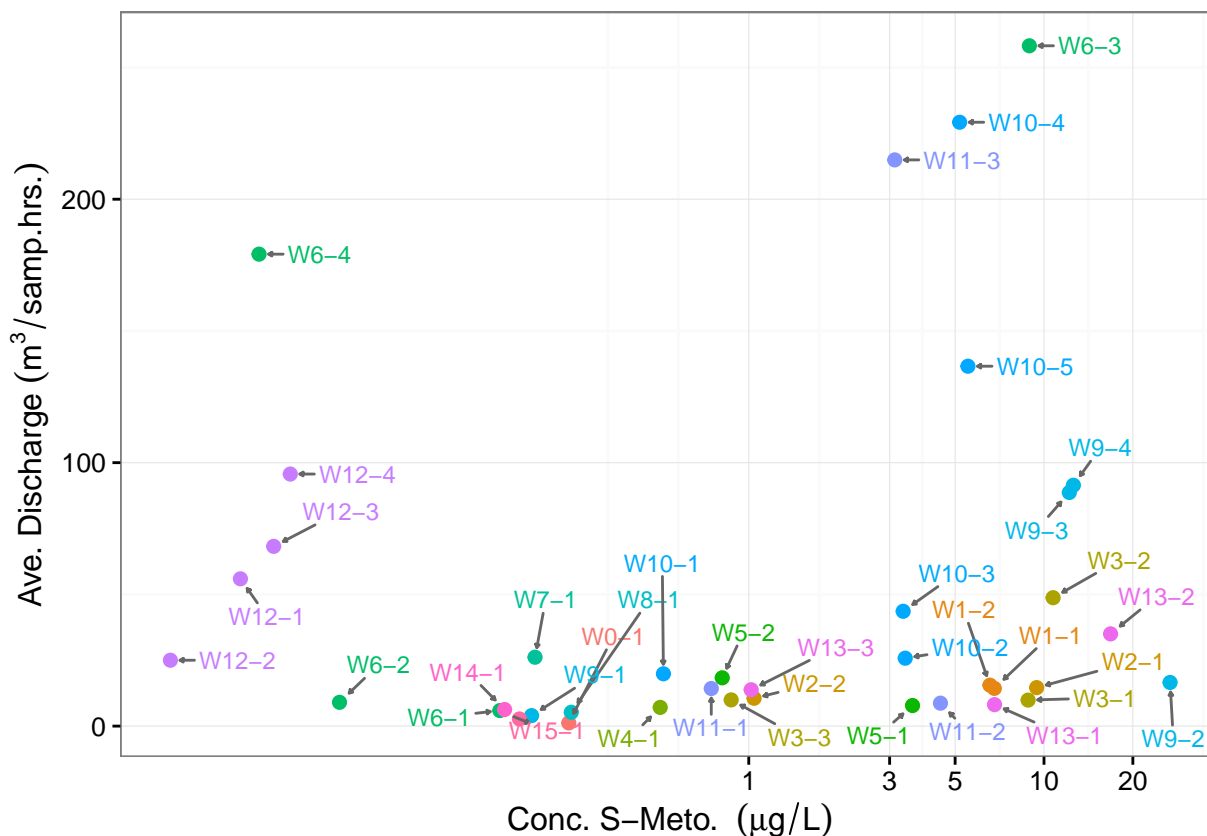


```
ggsave(isos, filename = "Outlet_Delta_ti.png", width = 8, height = 4.6, units = "in", scale = 1)
```

XY-Plots

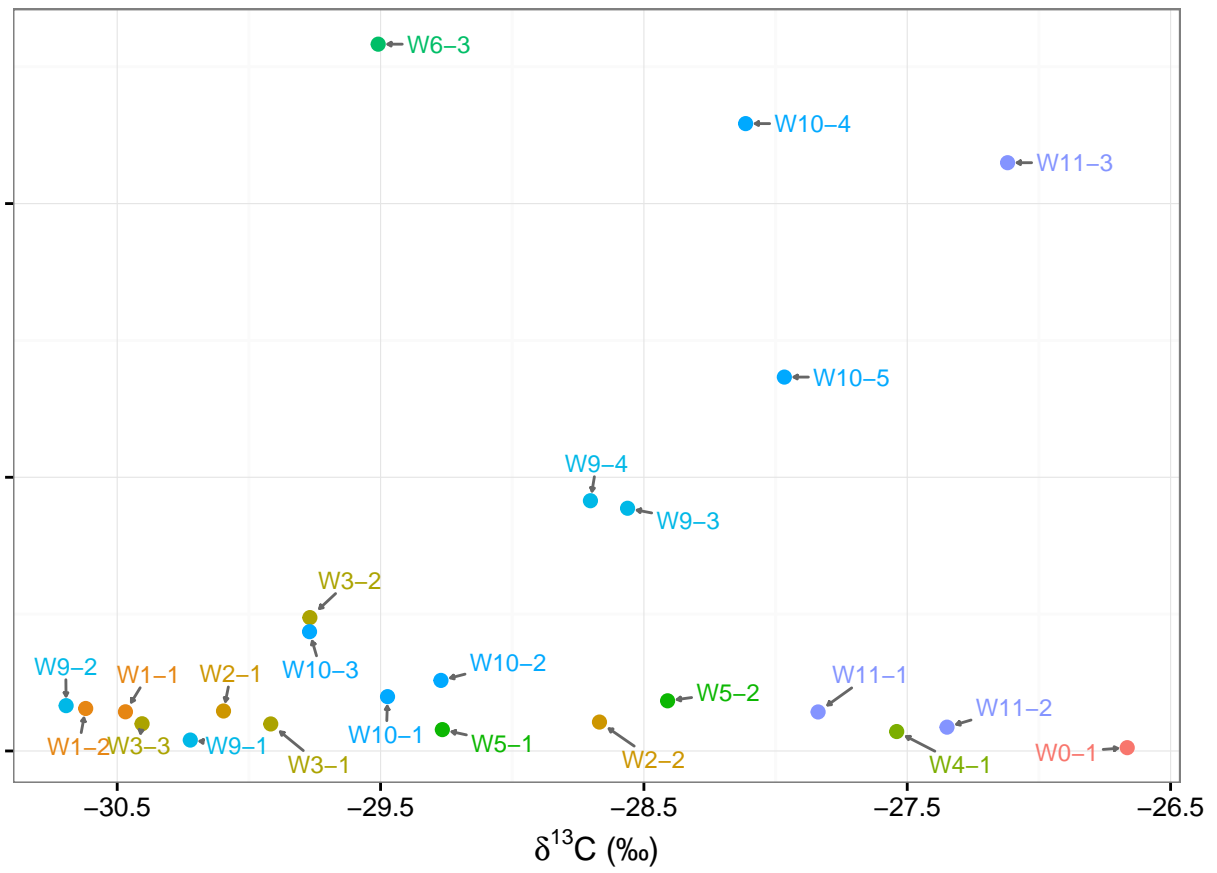
```
QC <- ggplot(A0df, aes(y=AveDischarge.m3.h, x=Conc.mug.L, group = WeekSubWeek, color = Weeks)) +
  geom_point(size = 2) +
  theme_bw() +
  theme(axis.text.y = element_blank()) +
  theme(legend.title=element_blank()) +
  theme(plot.margin = unit(c(0,0.5,0,0), "lines")) +
  #stat_smooth(method = "lm", 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



```
QD <- ggplot(A0df, aes(y=AveDischarge.m3.h, x=diss.d13C, group = WeekSubWeek, color = Weeks)) +
  geom_point(size = 2) +
  theme_bw() +
  theme(axis.text.y = element_blank()) +
  theme(plot.margin = unit(c(0,0.8,0,0), "lines")) +
  #theme(legend.title=element_blank()) +
  #theme(legend.text = element_text(size = 10)) +
  theme(legend.position="none") +
  #stat_smooth(method = "lm", formula = y ~ poly(x, 2)) +
  #scale_y_continuous(trans=log_trans(), breaks=c(1, 3, 5, 8, 10, 30, 50, 80, 100, 300)) +
  ylab(expression(paste("Ave. Discharge ", {(m^{3} / sample)}))) +
  ylab("") +
  scale_x_continuous(breaks=seq(-31.5, -26.5, 1)) +
  xlab(expression(paste({\delta}^{13}, "C", ' (‰)'))) +
  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)
```

QD



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