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Supplementary material

High-temporal resolution optical in-situ sensors capture dissolved organic carbon dynamics after prescribed fire in blackwater forest ecosystems

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Text S1 – LOESS input explanation and example and R code, Sensor DOC_{LOESS} with WS77

1. Load WS77 data log directly from sensor

```
library(ggplot2)
head(WS77[,1:4])

## # A tibble: 6 x 4
##                  date turbidity   TOC  temp
##                <dttm>     <dbl> <dbl> <dbl>
## 1 2016-12-23 10:47:00      8.89 29.47  8.97
## 2 2016-12-23 10:42:00      8.17 29.44  9.05
## 3 2016-12-23 10:37:00      8.64 29.13  8.90
## 4 2016-12-23 10:32:00      8.51 29.57  9.05
## 5 2016-12-23 10:27:00      9.64 29.58  9.05
## 6 2016-12-23 10:22:00      9.05 29.73  9.05
```

2. Input data file with pre-calculated error from DOC,grab - DOC,raw sensor

```
print(err77)

## # A tibble: 26 x 2
##                   date      err
##                 <dttm>    <dbl>
##  1 2016-03-29 12:00:00 41.29281
##  2 2016-04-11 10:50:00 29.98865
##  3 2016-04-21 15:46:00 32.29426
##  4 2016-04-22 12:00:00 31.57618
##  5 2016-04-23 16:23:00 29.76182
##  6 2016-04-17 15:47:00 30.88931
##  7 2016-06-09 14:00:00  1.17622
##  8 2016-06-10 14:00:00  4.85213
##  9 2016-06-11 14:00:00  4.55006
## 10 2016-06-14 14:00:00  5.28279
## # ... with 16 more rows
```

3. Calculate loess smooth model with DOC error (sensor-lab) in WS77, then correct all sensor values

```
y.loess <-loess(as.numeric(err)~as.numeric(date), span=0.3, data=err77)
WS77$err<-predict(y.loess, WS77$date)
WS77$corr.TOC <-WS77$TOC-predict(y.loess, WS77$date)
WS77$corr.TOC <-with(WS77, ifelse(corr.TOC<0,0, corr.TOC))
write.csv(WS77,"WS77_corrTOC.csv")

head(subset(WS77[,1:5], is.na(corr.TOC) == FALSE))

## # A tibble: 6 x 5
##                  date turbidity   TOC  temp corr.TOC
```

```
##              <dttm>     <dbl> <dbl> <dbl>    <dbl>
## 1 2016-11-16 13:59:00    16.87 59.41 11.98 26.27176
## 2 2016-11-16 13:54:00    20.89 60.72 11.98 27.57982
## 3 2016-11-16 13:49:00    18.77 59.94 11.98 26.79788
## 4 2016-11-16 13:43:00    18.51 59.78 12.06 26.63556
## 5 2016-11-16 13:38:00    19.72 60.23 11.98 27.08362
## 6 2016-11-16 13:33:00    17.94 59.49 11.90 26.34168
```

4. Plot corrected DOC and error

```
library(ggplot2)
ggplot(subset(WS77, err>0 & TOC<80 &TOC>0))+
  guides(shape = guide_legend(override.aes = list(size = 20)))+
  geom_point(aes(x=date, y=err, color="error"), alpha=0.1, size=0.1)+
  geom_point(aes(x=date,y=corr.TOC, color="DOC.LOESS"), size=0.1)+
  theme_bw()+
  theme(panel.grid=element_blank(),
        axis.title.x=element_blank(),
        axis.title.y = element_text(size=12, face="bold"),
        legend.position="bottom")+
  scale_color_manual(name=element_blank(),
                     values= c(error="black", DOC.LOESS="red"))+
  labs(y=expression(paste("DOC"[LOESS]," or DOC Error (mg/L)")))+
  ylim(0,80)
```

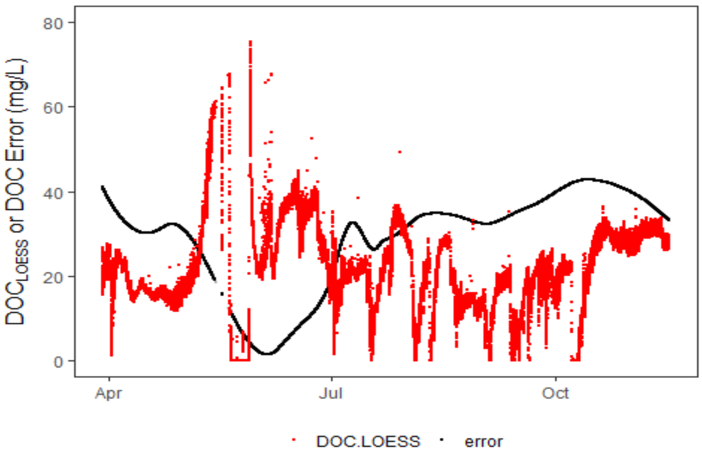

Figure S1. Print-out of the R-code after DOC is corrected. Estimated DOC error (black dots) for 5-minute interval DOC sensor readings based on corrections with grab samples and locally weighted regression (LOESS fit, span = 0.3). Corrected DOC values (red dots) after subtracting estimated error from raw sensor DOC data.

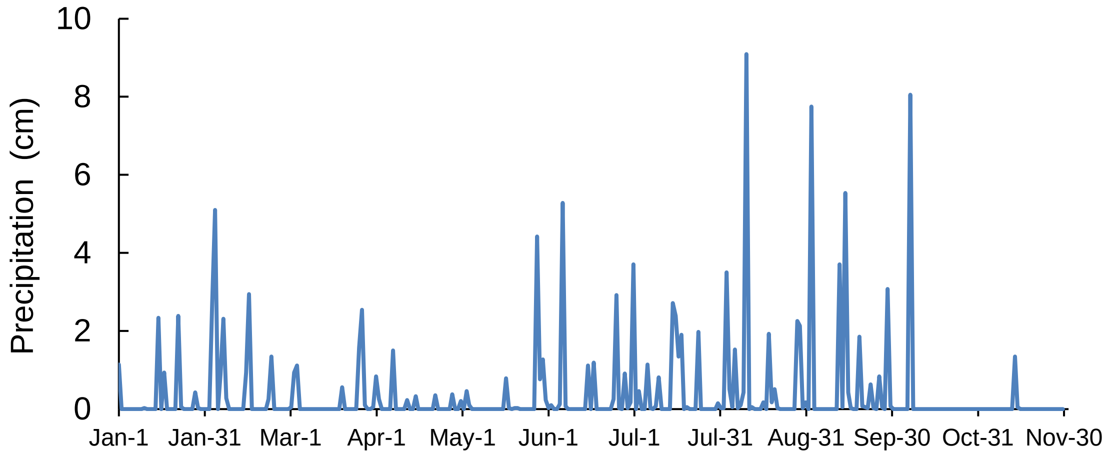

Figure S2. Recorded precipitation for 2016 at the Turkey Creek USGS meteorological station at the Santee Experimental Forest.
https://waterdata.usgs.gov/sc/nwis/uv?site_no=02172035

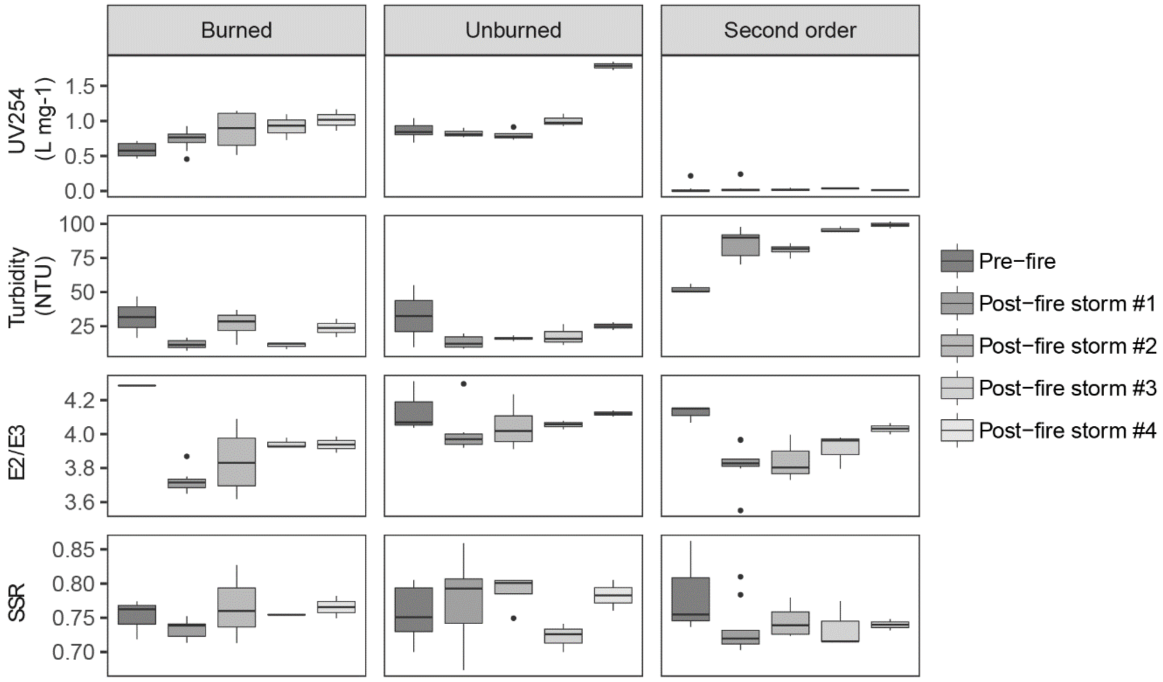

Figure S3 Boxplots of UV absorbance at 254 nm (UV254), turbidity, absorbance at 254 nm/ 360 nm (E2/E3), and spectral slope ratios (SSR) in all watersheds for pre-fire baseline and post-fire storms.

Text S2 – Chloride as tracer for mass balance mixing model of the burned and unburned first-order watersheds converging into the second-order watershed.

Watershed Mixing model

Chloride was chosen as a hydrologic tracer based on available water quality parameters collected by the US Forest Service. We used chloride mass balances as the mixing model for first-order watersheds (WS77, WS80) contributing to the second-order watershed (WS79). The error of the model was determined by equation 1, where Q is flowrate ($m^3\ d^{-1}$), C is the chloride concentration ($g\ m^{-3}$), and the subscripts denote each of the watersheds. A lower error percentage means that the first-order watershed contributions can account for the majority of the second-order watershed chloride. The positive error values indicate the introduction of additional chloride while the negative error values indicate an incomplete export of all chloride from the first-order watersheds to the second-order watershed.

$$Error\ (\%) = \left[1 - \frac{Q_{WS77}C_{WS77} + Q_{WS80}C_{WS80}}{Q_{WS79}C_{WS79}}\right] \times 100 \qquad (1)$$

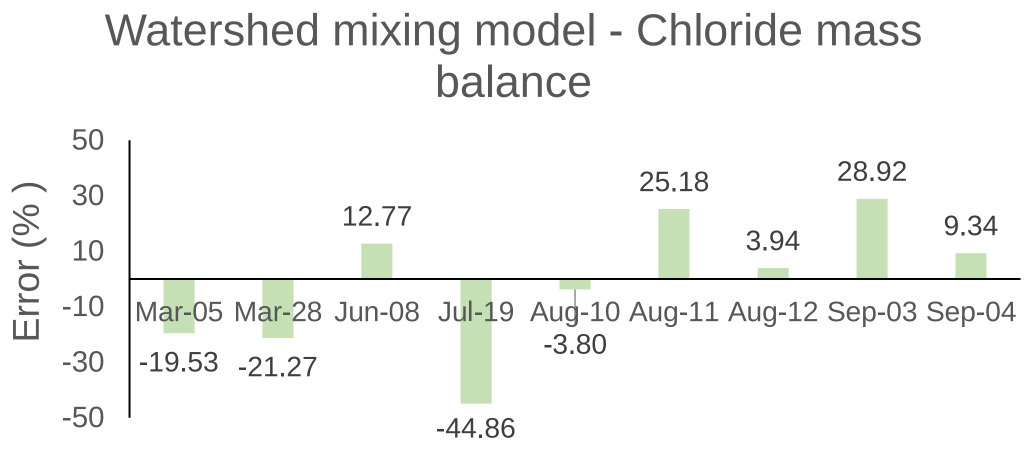

Figure S4. Error percentage of mixing model of first-order watersheds (WS77,80) feeding into second-order watershed (WS79) based on chloride mass balance. Positive values indicate first-order watershed contributions not account for all the chloride in WS79.

Table S1. Shapiro-Wilk test for normality for all watersheds and pre-fire and post-fire storm periods. p values with an asterisk were not normally distributed (α=0.05)

Watershed	Period	p value
Burned	Pre-fire	0.562
	Post-fire storm #1	**0.012***
	Post-fire storm #2	0.121
	Post-fire storm #3	0.126
	Post-fire storm #4	0.43
Unburned	Pre-fire	**0.018***
	Post-fire storm #1	**0.004***
	Post-fire storm #2	0.908
	Post-fire storm #3	**0.024***
	Post-fire storm #4	0.115
Second order	Pre-fire	0.109
	Post-fire storm #1	**0.045***
	Post-fire storm #2	**0.045***
	Post-fire storm #3	**0.031***
	Post-fire storm #4	0.772

Table S2. Wilcoxon rank sum test between the burned and unburned first-order watershed DOC concentrations. p values with an asterisk indicate significant differences in DOC distributions (α=0.05)

Period	p value
Pre-fire	**0.004***
Post-fire 1st storm	0.242
Post-fire 2nd storm	**0.003***
Post-fire 3rd storm	**0.001***
Post-fire 4th storm	0.572