NMF

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```
# load the packages
library(NMF)
library(tidyverse)
library(gridExtra)
library(readxl)
```

Procedure

1. Remove hourly observation with missing observation for any chemical
2. Remove background noise level using min values (except for chemicals with minimum value < 2*LOD and maximum value > 100*LOD)
3. Zero values are converted to a random value between 0 and 0.5*LOD
4. Normalize using min and max
5. Compute weight matrix according to Guha's paper, without LOQ

Reading the data

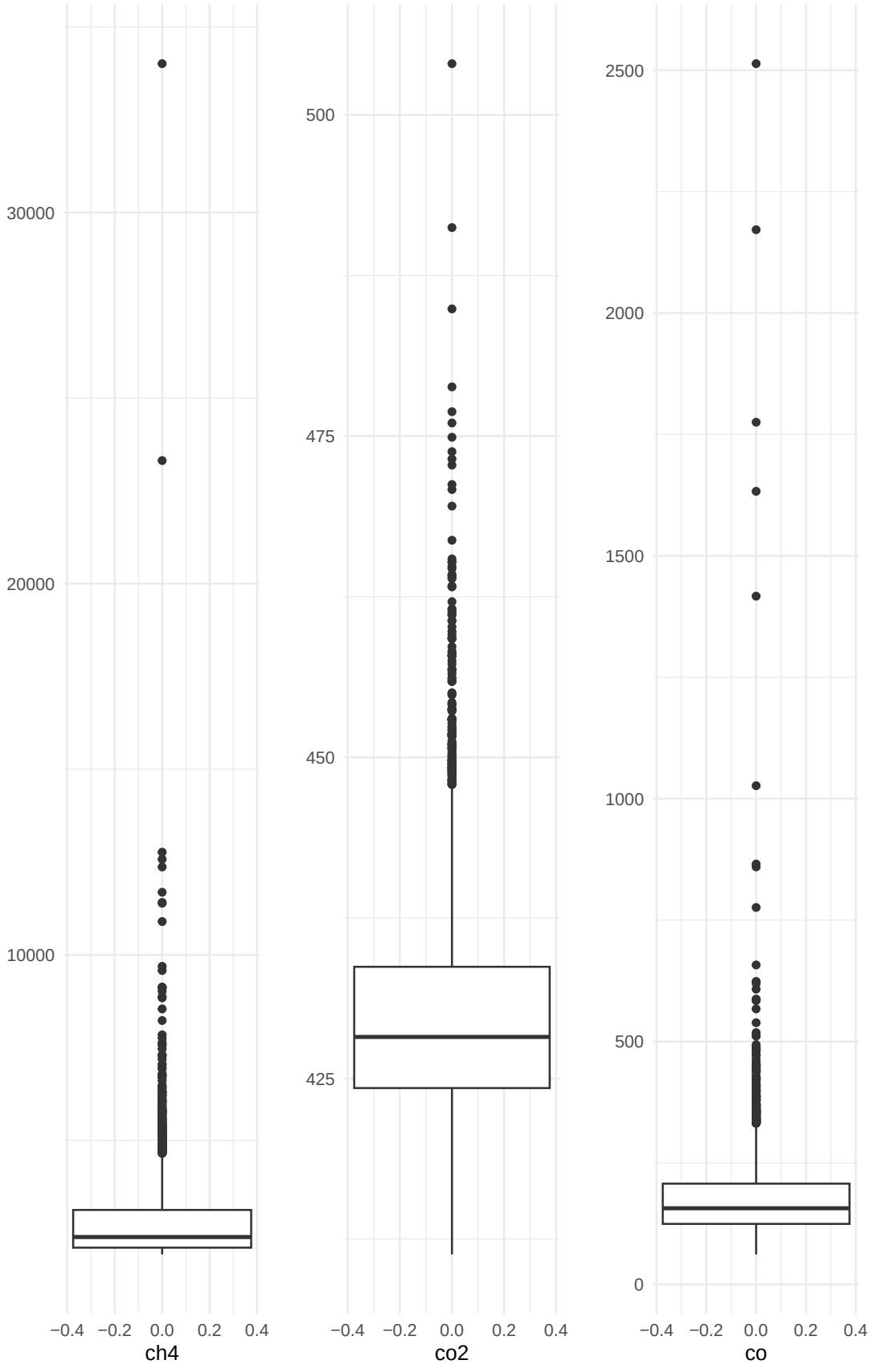
```
# read the radon data
# Old:
# hourly_radon <- readRDS("hourly_radon.rds")
# New:
hourly_data <- readRDS("../DataProcessing/Trailer_hourly_merge_20240905.rds")
```

```
# PROCEDURE STEP 1:
# remove NAs
hourly_nona <- hourly_data %>% select(-c(temp_bb,rhi, esf_bb, distToLovi,inv_dist,
                                         distToLovi_wells, monthly_oil, monthly_gas)) %>% na.omit()

vocs <- c("ethane", "ethene", "propane", "propene",
                                        "1_3-butadiene", "i-butane", "n-butane",
                                        "acetylene", "cyclopentane", "i-pentane",
                                        "n-pentane", "n-hexane", "isoprene", "n-heptane",
                                        "benzene", "n-octane", "toluene", "ethyl-benzene",
                                        "m&p-xylene", "o-xylene")
# retrieving the vocs, removing everything else except the vocs
hourly_vocs <- hourly_nona %>% select(any_of(vocs))

# retrieving the non-vocs: co2_ppm, nox, ch4, h2s, so2, o3
# double check this
non_vocs <- c('ch4', 'co2_ppm', 'co', 'h2s', 'so2', 'nox', 'o3')
hourly_non_vocs <- hourly_nona %>% select(all_of(non_vocs)) %>% rename('co2' = 'co2_ppm')
```

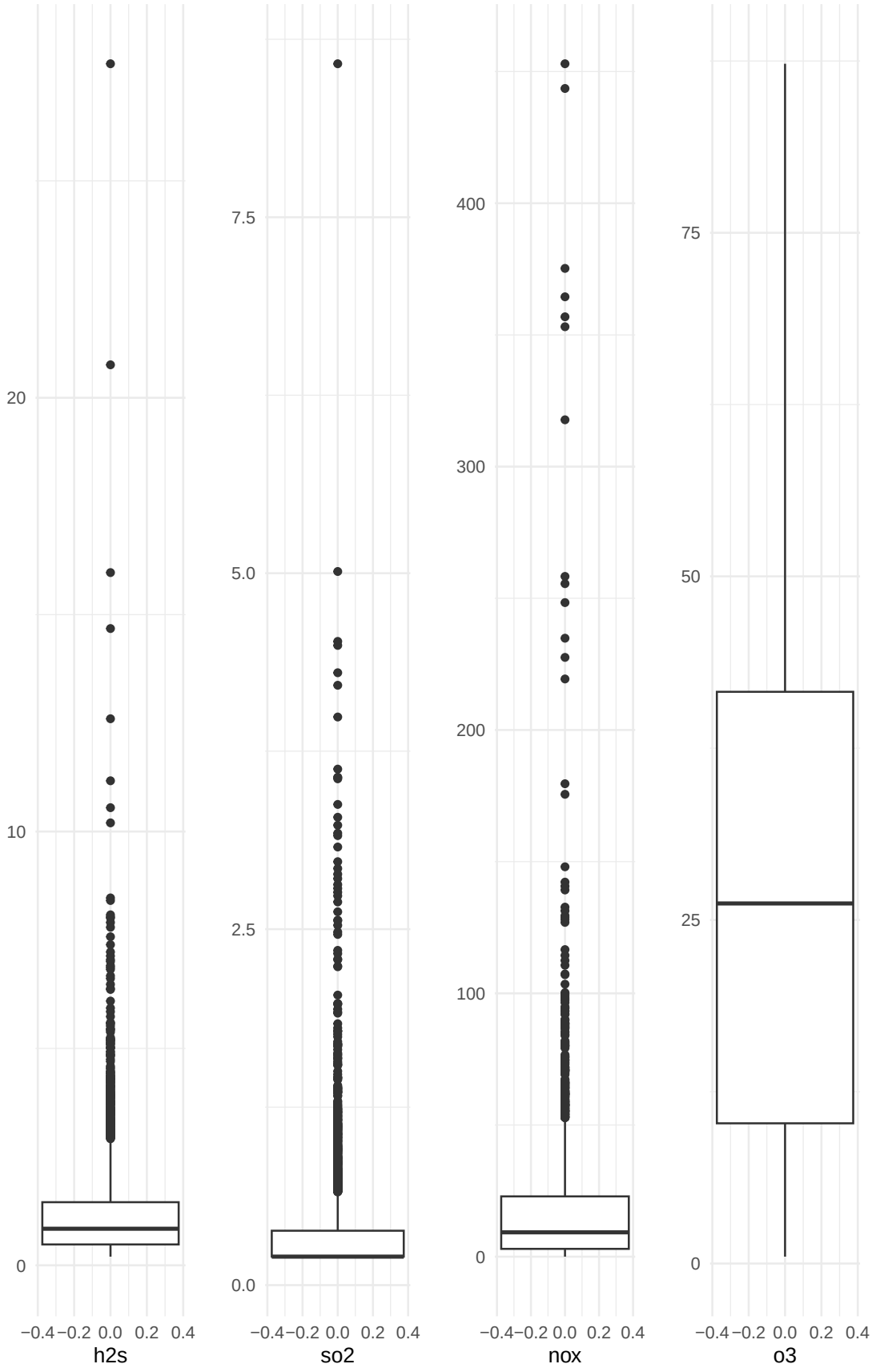
```r
hourly_full_nona <- cbind(hourly_non_vocs, hourly_vocs)

# retrive a vector of yearmonth
hourly_dates <- hourly_nona %>%
  mutate(yearmonth = substring(day, 0, 7)) %>%
  pull(yearmonth)
```

Data visualisation

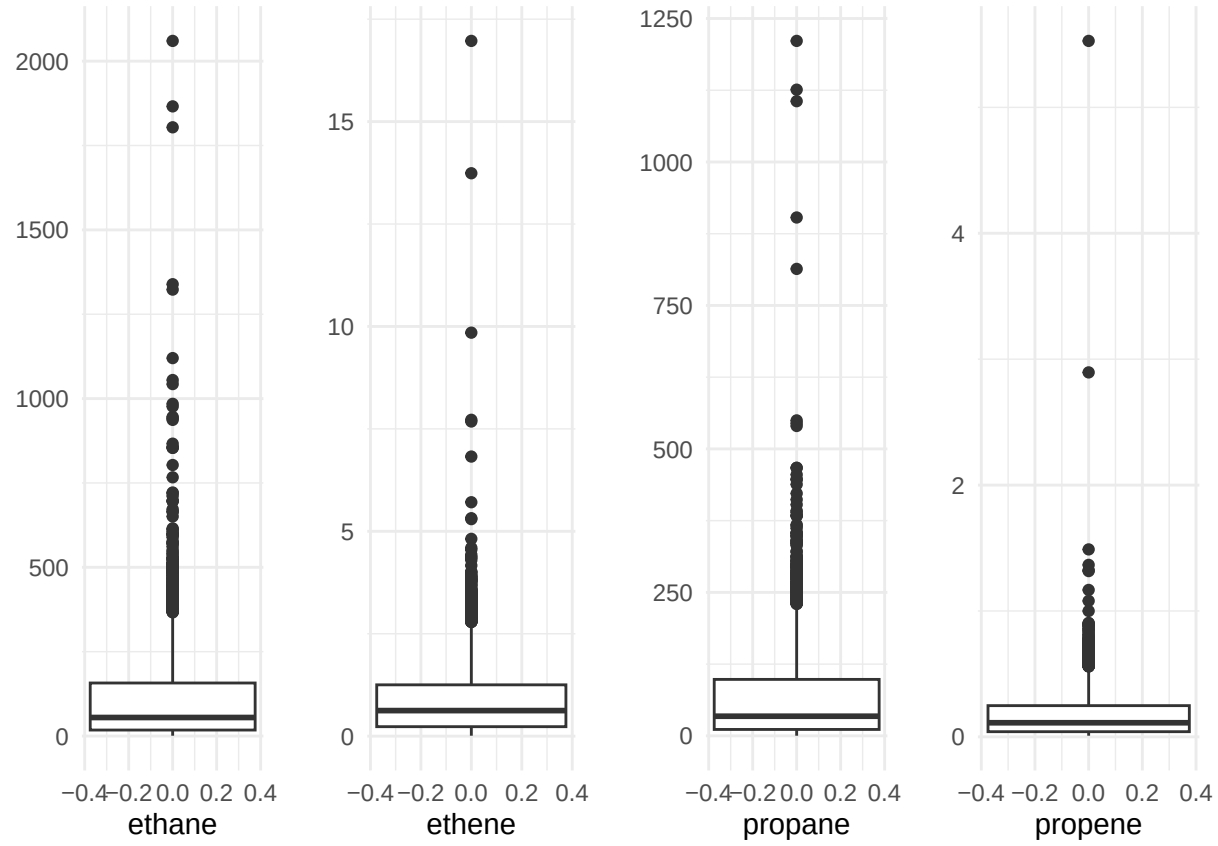
```r
non_vocs <- c('ch4', 'co2', 'co', 'h2s', 'so2', 'nox', 'o3')
for (compound in non_vocs) {
  assign(paste0(compound, '_boxplot'),
         ggplot(hourly_non_vocs) +
           geom_boxplot(aes(y = .data[[compound]])) +
           labs(x = compound, y = '') +
           theme_minimal())
}

grid.arrange(ch4_boxplot, co2_boxplot, co_boxplot, nrow = 1)
```


30000
20000
10000
−0.4 −0.2 0.0 0.2 0.4
ch4
500
475
450
425
−0.4 −0.2 0.0 0.2 0.4
co2
2500
2000
1500
1000
500
0
−0.4 −0.2 0.0 0.2 0.4
co

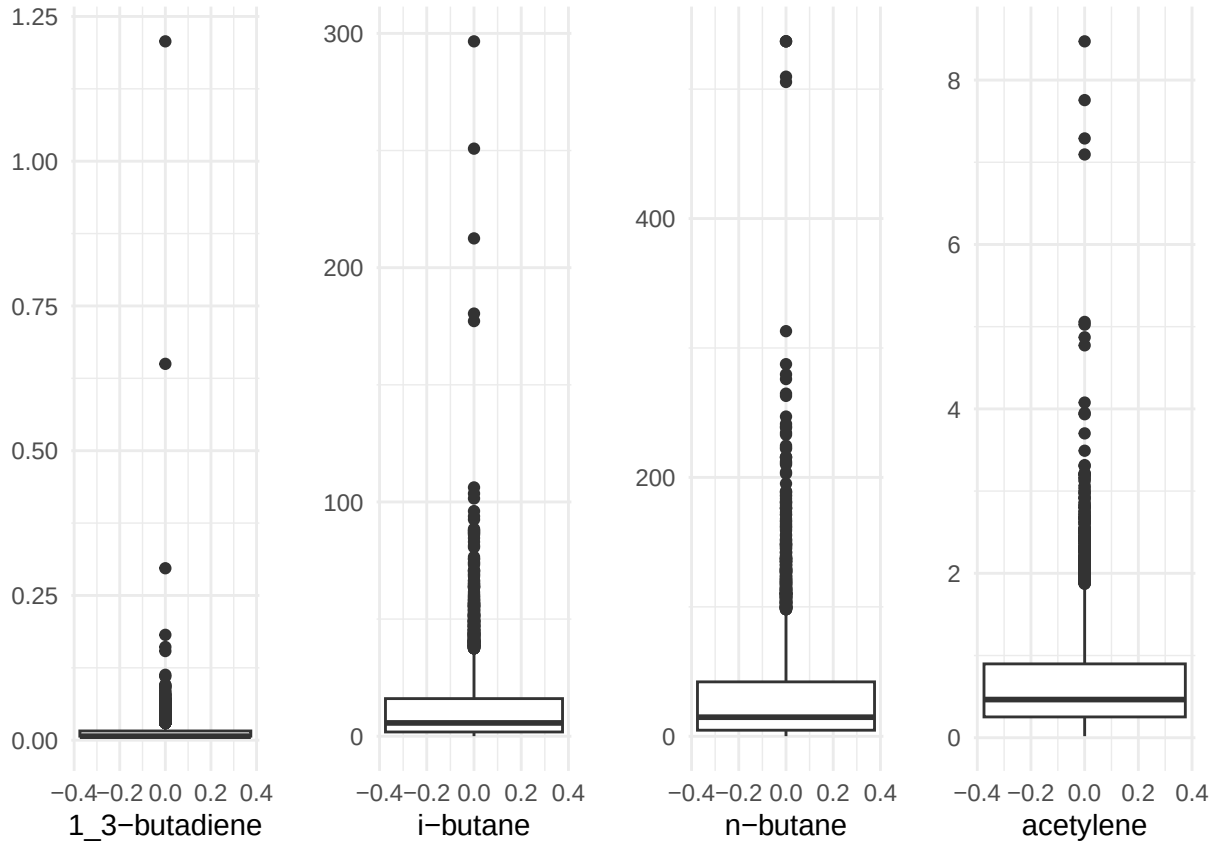
```r
grid.arrange(h2s_boxplot, so2_boxplot, nox_boxplot, o3_boxplot, nrow = 1)
```


20
10
0
−0.4 −0.2 0.0 0.2 0.4
h2s
7.5
5.0
2.5
0.0
−0.4 −0.2 0.0 0.2 0.4
so2
400
300
200
100
0
−0.4 −0.2 0.0 0.2 0.4
nox
75
50
25
0
−0.4 −0.2 0.0 0.2 0.4
o3

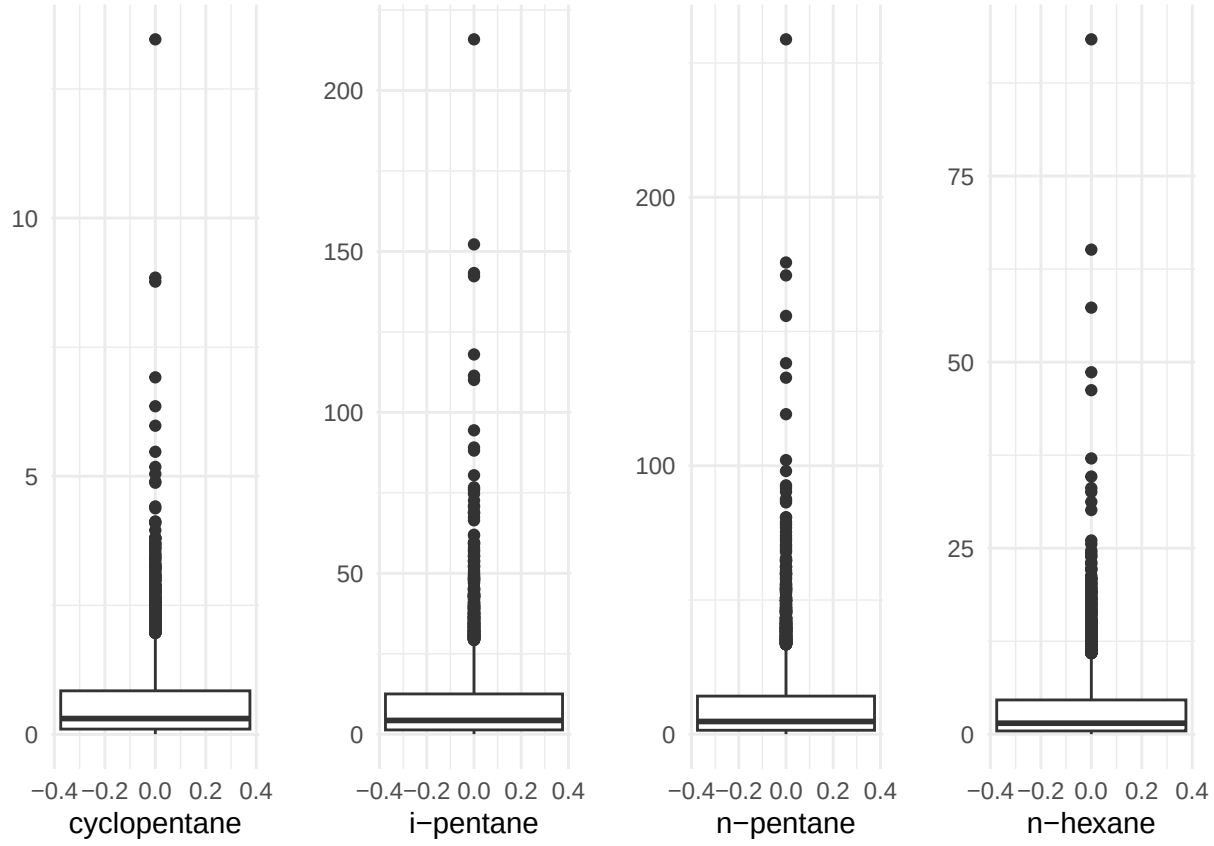
```
for (compound in vocs) {
  assign(paste0(compound, '_boxplot'),
         ggplot(hourly_vocs) +
           geom_boxplot(aes(y = .data[[compound]])) +
           labs(x = compound, y = '') +
           theme_minimal())
}
grid.arrange(get(paste0(vocs[1], '_boxplot')), get(paste0(vocs[2], '_boxplot')),
             get(paste0(vocs[3], '_boxplot')), get(paste0(vocs[4], '_boxplot')), nrow = 1)
```



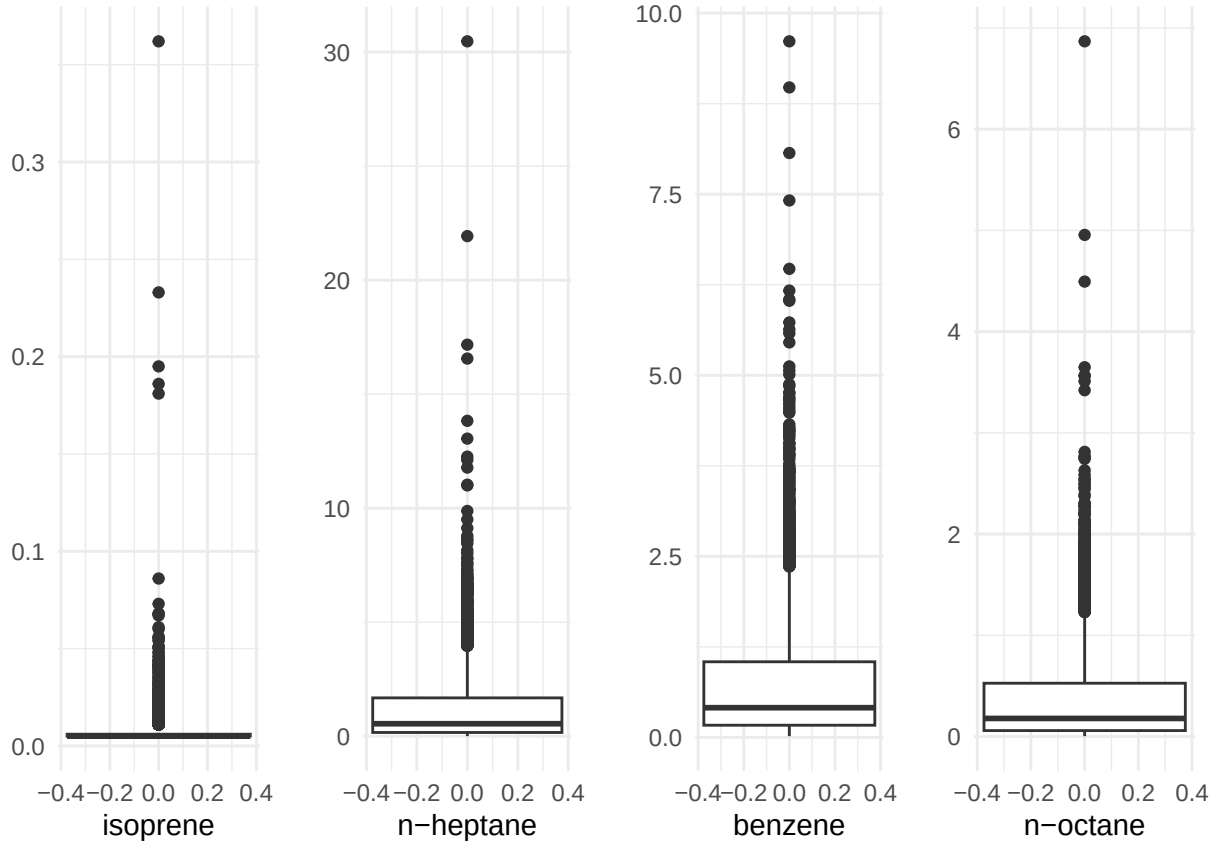

```
grid.arrange(get(paste0(vocs[5], '_boxplot')), get(paste0(vocs[6], '_boxplot')),
             get(paste0(vocs[7], '_boxplot')), get(paste0(vocs[8], '_boxplot')), nrow = 1)
```



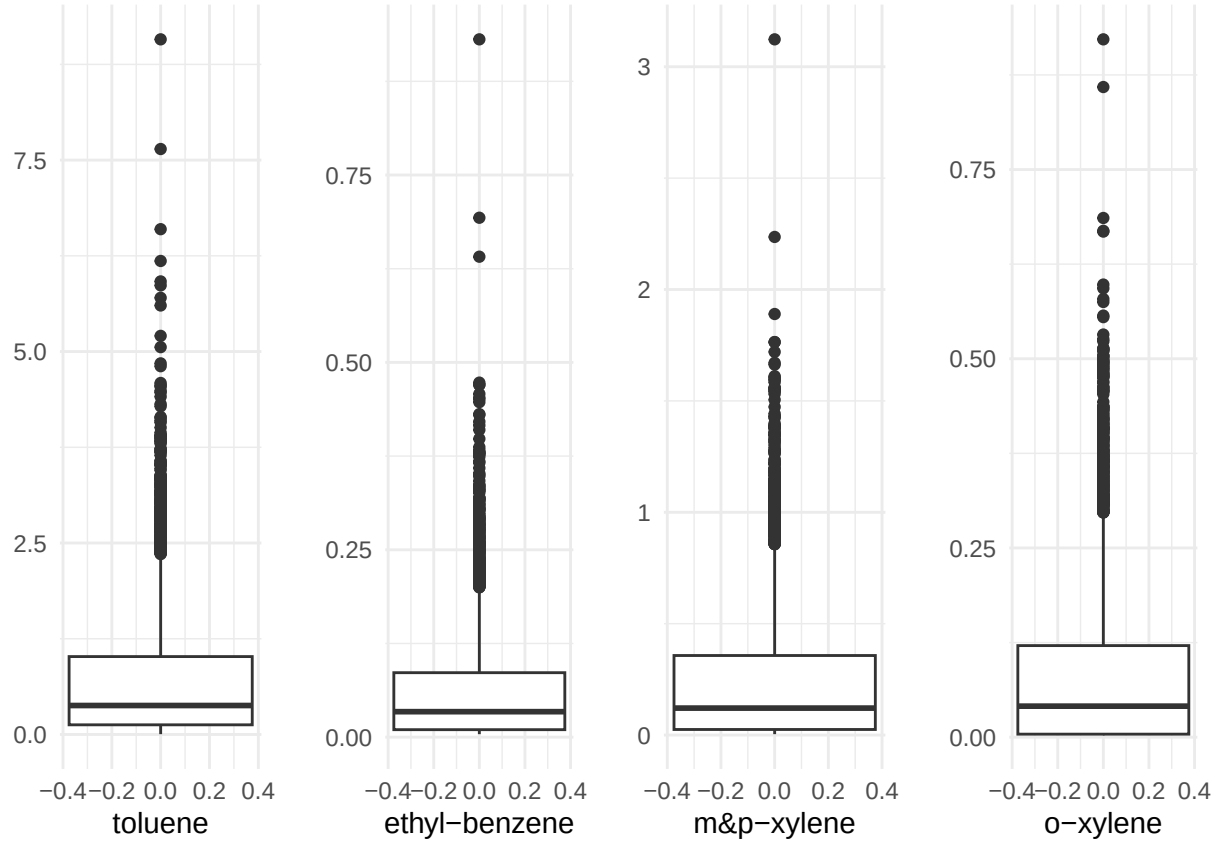

```
grid.arrange(get(paste0(vocs[9], '_boxplot')), get(paste0(vocs[10], '_boxplot')),
             get(paste0(vocs[11], '_boxplot')), get(paste0(vocs[12], '_boxplot')), nrow = 1)
```




```
grid.arrange(get(paste0(vocs[13], '_boxplot')), get(paste0(vocs[14], '_boxplot')),
             get(paste0(vocs[15], '_boxplot')), get(paste0(vocs[16], '_boxplot')), nrow = 1)
```




```
grid.arrange(get(paste0(vocs[17], '_boxplot')), get(paste0(vocs[18], '_boxplot')),
             get(paste0(vocs[19], '_boxplot')), get(paste0(vocs[20], '_boxplot')), nrow = 1)
```



Data preprocessing

```r
# Define LOD for each chemical
LOD_non_voc <- c('ch4' = 0.9,
                 'co2' = 0.0433,
                 'co' = 40,
                 'h2s' = 0.4,
                 'so2' = 0.4,
                 'nox' = 0.05,
                 'o3' = 1)

LOD_voc_monthly <- read_csv('../data/LNM_VOC_LOD_Rounded.csv') %>% select(-1)
# extract the yearmonth from date variables
LOD_voc_monthly <- LOD_voc_monthly %>%
  mutate(yearmonth = strftime(as.POSIXct(start_date, format = '%Y-%m-%d %H:%M:%S', tz = 'UTC'), '%Y-%m'

LOD_voc_monthly <- LOD_voc_monthly %>%
  select(-c(start_date, end_date)) %>%
  select(!any_of(ends_with('half_ldl')))

colnames(LOD_voc_monthly) <- str_replace_all(names(LOD_voc_monthly), '_ldl', '')

LOD_voc_avg <- read_xlsx('../data/LNM_VOC_Uncertainties.xlsx', skip = 1)
LOD_voc_avg <- LOD_voc_avg %>%
  select(1, 4) %>%
```

```
  rename('LOD' = 2, 'chemical' = 1) %>%
  head(20)
```

```
# find the min for background-levels
background_levels <- sapply(hourly_full_nona, min)
background_levels
```

```
##           ch4           co2            co           h2s           so2
##      1928.000       411.300        61.630         0.200         0.200
##           nox            o3        ethane        ethene       propane
##         0.025         0.500         0.916         0.011         0.224
##       propene 1_3-butadiene      i-butane      n-butane     acetylene
##         0.009         0.007         0.035         0.090         0.019
##  cyclopentane     i-pentane     n-pentane      n-hexane      isoprene
##         0.005         0.038         0.042         0.021         0.005
##     n-heptane       benzene      n-octane       toluene ethyl-benzene
##         0.004         0.017         0.004         0.004         0.004
##    m&p-xylene      o-xylene
##         0.004         0.004
```

```
get_info <- function(column) {
  N <- length(column)
  background <- quantile(column, 0)
  quantile1 <- quantile(column, 0.01)
  quantile99 <- quantile(column, 0.99)
  n_background <- sum(column == background)
  max <- max(column)
  return(c(N, quantile1, quantile99, max, background, n_background))
}

info_table <- hourly_full_nona %>%
  reframe(across(everything(), ~ get_info(.x)))

info_table <- info_table %>%
  mutate(rownames = c('N', '1st percentile', '99th percentile', 'Max', 'Background', '# Background')) %
  pivot_longer(-rownames) %>%
  pivot_wider(names_from = rownames, values_from = value)

knitr::kable(info_table)
```

name	N	1st percentile	99th percentile	Max	Background	# Background
ch4	4497	1963.40000	6318.81200	34010.900	1928.000	1
co2	4497	417.09000	457.87120	503.990	411.300	1
co	4497	84.90720	444.04320	2513.440	61.630	1
h2s	4497	0.20000	5.18084	27.700	0.200	777
so2	4497	0.20000	1.83896	8.578	0.200	3065
nox	4497	0.22700	92.01080	452.959	0.025	2
o3	4497	0.50000	72.11200	87.300	0.500	255
ethane	4497	1.80852	536.67200	2060.000	0.916	1
ethene	4497	0.01100	3.52212	16.970	0.011	163
propane	4497	0.81700	305.54000	1211.000	0.224	1
propene	4497	0.00900	0.70228	5.528	0.009	401
1_3-butadiene	4497	0.00700	0.05904	1.207	0.007	3126

name	N	1st percentile	99th percentile	Max	Background	# Background
i-butane	4497	0.14496	63.53760	296.600	0.035	1
n-butane	4497	0.34792	171.37600	536.900	0.090	1
acetylene	4497	0.04900	2.66204	8.471	0.019	1
cyclopentane	4497	0.00500	3.12356	13.460	0.005	96
i-pentane	4497	0.10396	51.02080	215.900	0.038	1
n-pentane	4497	0.10300	58.10280	258.800	0.042	1
n-hexane	4497	0.04196	18.32640	93.360	0.021	2
isoprene	4497	0.00500	0.03204	0.362	0.005	2815
n-heptane	4497	0.01500	6.58924	30.470	0.004	5
benzene	4497	0.02700	3.87512	9.610	0.017	3
n-octane	4497	0.00400	2.01452	6.867	0.004	100
toluene	4497	0.01296	3.53640	9.077	0.004	11
ethyl-benzene	4497	0.00400	0.31604	0.931	0.004	898
m&p-xylene	4497	0.00400	1.31824	3.123	0.004	814
o-xylene	4497	0.00400	0.45912	0.922	0.004	1266

```
# PROCEDURE STEP 2:
#adjustments that were made according to paper
#William: I'm guessing this refers to Gunnar's paper section 2.2 and Guha 3.3

# Check whether chemical has background noise level that needs to be removed
# i.e, NO ADJUSTMENT if minimum value < 2*LOD and maximum value > 100*LOD
adjusting_neg_bg_from_lod <- function(chemical, LOD, background, hourly_data){
    # get min and max
    min_value <- min(hourly_data[chemical], na.rm = TRUE)
    max_value <- max(hourly_data[chemical], na.rm = TRUE)
    # if min less than double LOD or max > 100 times LOD
    # adjust to -100 (for entire column???)
    if (min_value < 2 * LOD & max_value > 100 * LOD ){
      return (0)
    }
  return (background)
}
```

```
# Check if background is negligible for non voc
# merge background and LOD
background_lod_non_voc <- tibble(chemical = non_vocs,
                                 LOD = LOD_non_voc,
                                 background = unname(background_levels[non_vocs]))
adjusted_background_non_voc <- background_lod_non_voc %>%
  rowwise() %>%
  mutate(min = min(hourly_full_nona[chemical], na.rm = TRUE),
         LODx2 = 2 * LOD,
         criterion1 = min(hourly_full_nona[chemical], na.rm = TRUE) < 2 * LOD,
         max = max(hourly_full_nona[chemical], na.rm = TRUE),
         LODx100 = 100 * LOD,
         criterion2 = max(hourly_full_nona[chemical], na.rm = TRUE) > 100 * LOD,
         adjusted_background = adjusting_neg_bg_from_lod(chemical, LOD, background, hourly_full_nona))
```

```
# Check if background is negligible for voc
# merge background and LOD
```

```
background_lod_voc <- LOD_voc_avg %>%
  left_join(tibble(chemical = setdiff(names(background_levels), non_vocs),
                   background = background_levels[setdiff(names(background_levels), non_vocs)]))
```

```
## Joining with `by = join_by(chemical)`
```

```
adjusted_background_voc <- background_lod_voc %>%
  rowwise() %>%
  mutate(min = min(hourly_full_nona[chemical], na.rm = TRUE),
         LODx2 = 2 * LOD,
         criterion1 = min(hourly_full_nona[chemical], na.rm = TRUE) < 2 * LOD,
         max = max(hourly_full_nona[chemical], na.rm = TRUE),
         LODx100 = 100 * LOD,
         criterion2 = max(hourly_full_nona[chemical], na.rm = TRUE) > 100 * LOD,
         adjusted_background = adjusting_neg_bg_from_lod(chemical, LOD, background, hourly_full_nona))
```

```
# So now we have the adjusted background concentrations
hourly_nona_bgrm <- hourly_full_nona %>%
  mutate(across(adjusted_background_non_voc$chemical, ~  .x - adjusted_background_non_voc$adjusted_backg
hourly_nona_bgrm <- hourly_nona_bgrm %>%
  mutate(across(adjusted_background_voc$chemical, ~  .x - adjusted_background_voc$adjusted_background[ac
```

```
# look at zero values
colSums(hourly_nona_bgrm == 0)
```

```
##           ch4           co2            co           h2s           so2
##             1             1             1           777          3065
##           nox            o3       ethane       ethene       propane
##             0           255             1             0             1
##       propene 1_3-butadiene      i-butane      n-butane     acetylene
##             0          3126             1             1             0
##  cyclopentane     i-pentane     n-pentane      n-hexane      isoprene
##             0             1             1             2          2815
##     n-heptane       benzene      n-octane       toluene ethyl-benzene
##             0             0             0             0             0
##    m&p-xylene      o-xylene
##             0             0
```

```
# PROCEDURE STEP 3
# replace zero values with random values between 0 and 0.5*LOD
set.seed(123)
replace_zero_with_random <- function(column, name, LOD_df){
  LOD <- LOD_df$LOD[LOD_df$chemical == name]
  column <- if_else(column == 0, round(runif(length(column), 0, 0.5 * LOD), 3), column)
  return (column)
}

hourly_nona_bgrm_zerorepl <- hourly_nona_bgrm %>%
  mutate(across(adjusted_background_non_voc$chemical, ~ replace_zero_with_random(.x, cur_column(), adjus

hourly_nona_bgrm_zerorepl <- hourly_nona_bgrm_zerorepl %>%
  mutate(across(adjusted_background_voc$chemical, ~ replace_zero_with_random(.x, cur_column(), adjusted_
```

Normalize the non-vocs

```
#normalizing function
normalize_column <- function(column){
  background <- quantile(column, 0)
  max <- quantile(column, 1) # this could be adjusted
  return ((column - background)/(max - background))
}
```

```
# normalize all
hourly_nona_bgrm_zerorepl_norm <- as_tibble(sapply(as.list(hourly_nona_bgrm_zerorepl), normalize_column
summary(hourly_nona_bgrm_zerorepl_norm)
```

```
##       ch4                co2               co                h2s
##  Min.   :0.000000   Min.   :0.0000   Min.   :0.00000   Min.   :0.00000
##  1st Qu.:0.005697   1st Qu.:0.1397   1st Qu.:0.02347   1st Qu.:0.01022
##  Median :0.014615   Median :0.1826   Median :0.03663   Median :0.02338
##  Mean   :0.027164   Mean   :0.1998   Mean   :0.04550   Mean   :0.03517
##  3rd Qu.:0.037362   3rd Qu.:0.2415   3rd Qu.:0.05734   3rd Qu.:0.04564
##  Max.   :1.000000   Max.   :1.0000   Max.   :1.00000   Max.   :1.00000
##       so2                nox                o3             ethane
##  Min.   :0.000000   Min.   :0.000000   Min.   :0.0000   Min.   :0.000000
##  1st Qu.:0.007997   1st Qu.:0.006515   1st Qu.:0.1117   1st Qu.:0.008171
##  Median :0.015756   Median :0.020376   Median :0.2960   Median :0.026203
##  Mean   :0.026295   Mean   :0.036923   Mean   :0.3080   Mean   :0.051422
##  3rd Qu.:0.023633   3rd Qu.:0.050500   3rd Qu.:0.4735   3rd Qu.:0.075895
##  Max.   :1.000000   Max.   :1.000000   Max.   :1.0000   Max.   :1.000000
##      ethene            propane            propene          1_3-butadiene
##  Min.   :0.00000   Min.   :0.000000   Min.   :0.000000   Min.   :0.000000
##  1st Qu.:0.01303   1st Qu.:0.009005   1st Qu.:0.005798   1st Qu.:0.001667
##  Median :0.03615   Median :0.028067   Median :0.018663   Median :0.004167
##  Mean   :0.05116   Mean   :0.054283   Mean   :0.028932   Mean   :0.007500
##  3rd Qu.:0.07324   3rd Qu.:0.081075   3rd Qu.:0.043305   3rd Qu.:0.007500
##  Max.   :1.00000   Max.   :1.000000   Max.   :1.000000   Max.   :1.000000
##     i-butane           n-butane           acetylene         cyclopentane
##  Min.   :0.000000   Min.   :0.000000   Min.   :0.00000   Min.   :0.000000
##  1st Qu.:0.005999   1st Qu.:0.008556   1st Qu.:0.02769   1st Qu.:0.007284
##  Median :0.019042   Median :0.027302   Median :0.05265   Median :0.022445
##  Mean   :0.038815   Mean   :0.055538   Mean   :0.07600   Mean   :0.043917
##  3rd Qu.:0.054019   3rd Qu.:0.078140   3rd Qu.:0.10400   3rd Qu.:0.062356
##  Max.   :1.000000   Max.   :1.000000   Max.   :1.00000   Max.   :1.000000
##    i-pentane          n-pentane          n-hexane          isoprene
##  Min.   :0.000000   Min.   :0.000000   Min.   :0.00000   Min.   :0.000000
##  1st Qu.:0.006092   1st Qu.:0.005596   1st Qu.:0.00465   1st Qu.:0.002801
##  Median :0.019717   Median :0.018229   Median :0.01578   Median :0.005602
##  Mean   :0.041448   Mean   :0.039184   Mean   :0.03511   Mean   :0.010377
##  3rd Qu.:0.057853   3rd Qu.:0.054789   3rd Qu.:0.04925   3rd Qu.:0.011204
##  Max.   :1.000000   Max.   :1.000000   Max.   :1.00000   Max.   :1.000000
##    n-heptane          benzene            n-octane          toluene
##  Min.   :0.000000   Min.   :0.00000   Min.   :0.000000   Min.   :0.00000
##  1st Qu.:0.005317   1st Qu.:0.01574   1st Qu.:0.008014   1st Qu.:0.01345
##  Median :0.017889   Median :0.04097   Median :0.025499   Median :0.04122
##  Mean   :0.039271   Mean   :0.07624   Mean   :0.054094   Mean   :0.07760
##  3rd Qu.:0.055078   3rd Qu.:0.10706   3rd Qu.:0.076206   3rd Qu.:0.11165
##  Max.   :1.000000   Max.   :1.00000   Max.   :1.000000   Max.   :1.00000
```

```
##  ethyl-benzene        m&p-xylene          o-xylene
##  Min.   :0.000000   Min.   :0.000000   Min.   :0.00000
##  1st Qu.:0.006472   1st Qu.:0.006733   1st Qu.:0.00000
##  Median :0.032363   Median :0.037512   Median :0.04031
##  Mean   :0.061284   Mean   :0.076834   Mean   :0.08577
##  3rd Qu.:0.088457   3rd Qu.:0.113177   3rd Qu.:0.12745
##  Max.   :1.000000   Max.   :1.000000   Max.   :1.00000
```

Combine and Transpose

```
normalized_matrix <- as.matrix(hourly_nona_bgrm_zerorepl_norm) #important: using the normalized VOCs fo

# Transpose <- cbind(Normalized_Data, Merged_VOCs)
# rownames(Transpose) <- as.character(Transpose[,1]) # I'm not able to run this line, but it shouldn't
# transpose_normalized_matrix <- t(as.matrix(normalized_matrix))

number_row<- dim(normalized_matrix)[1] #store number of rows (used for checking)
number_column<- dim(normalized_matrix)[2] #store number of columns
```

NMF section

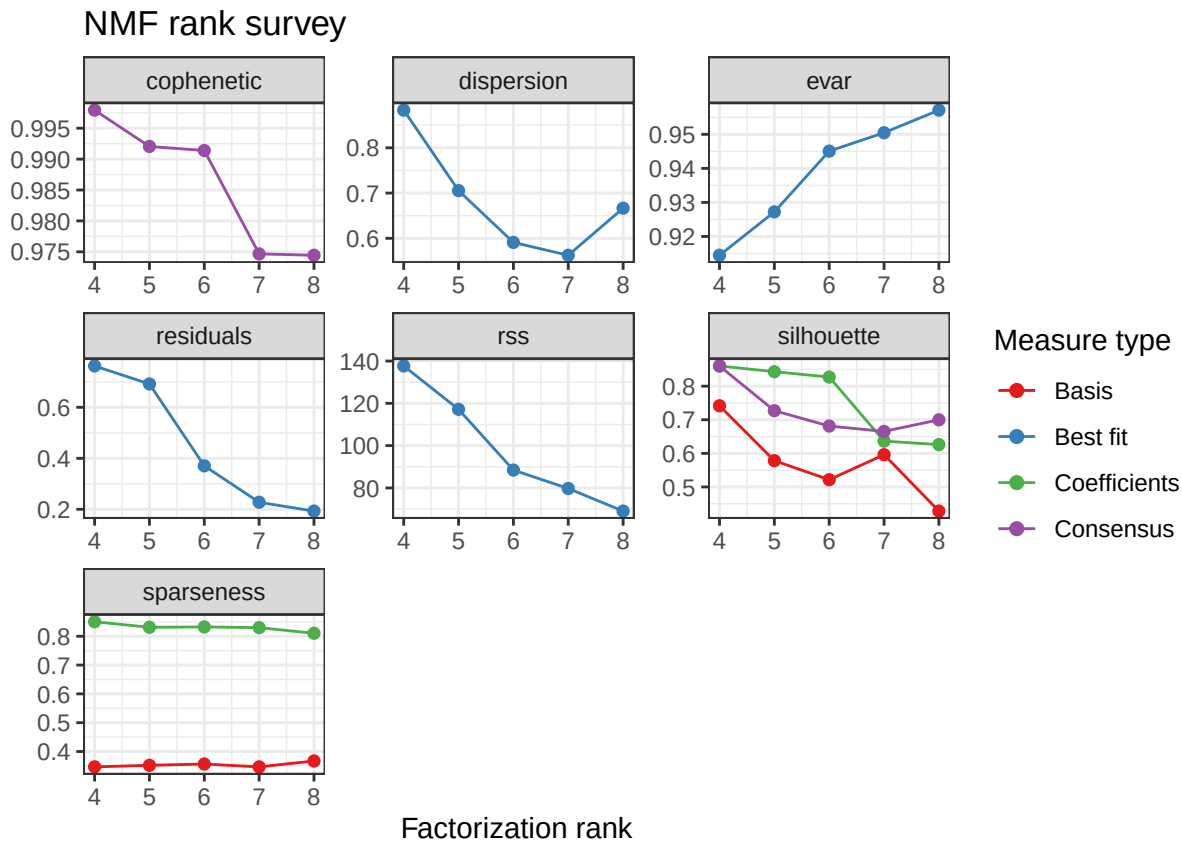
```
# compute weight matrix (uncertainties)
# Based on the Guha paper
# next comment is from the other nmf R file
weight_matrix <- matrix(0, nrow = nrow(normalized_matrix), ncol = ncol(normalized_matrix))
LOD_merged <- tibble(chemical = c(adjusted_background_non_voc$chemical, adjusted_background_voc$chemical
                     LOD = c(adjusted_background_non_voc$LOD, adjusted_background_voc$LOD))

LOD_merged <- tibble(chemical = names(hourly_nona_bgrm_zerorepl_norm)) %>%
  left_join(LOD_merged)
```

```
## Joining with `by = join_by(chemical)`
```

```
# creating uncertainty Matrix
for (i in 1:number_row) {
  for (j in 1:number_column) {
    xij <- normalized_matrix[i, j]
    LOD <- LOD_merged$LOD[[j]]
    # Get LOD value for this row
    if (j == 1) {
      # based on equation 6, we sqrt ch4 (at column = 1) and times by 1
      weight_matrix[i, j] <- sqrt(xij)
    } else if (j == 2) {
      # 0.25 for co2
      weight_matrix[i, j] <- 0.25 * sqrt(xij)
    } else if (j == 3) {
      # 0.5 for CO
      weight_matrix[i, j] <- 0.5 * sqrt(xij)
    } else if (xij <= LOD) {
      weight_matrix[i, j] <- 2 * LOD # equation 5a) in reference paper
    } else {
      weight_matrix[i, j] <- sqrt(((0.1 * xij)**2 + LOD**2))  #equation 5c) in reference paper
    }
  }
```

```
}
```

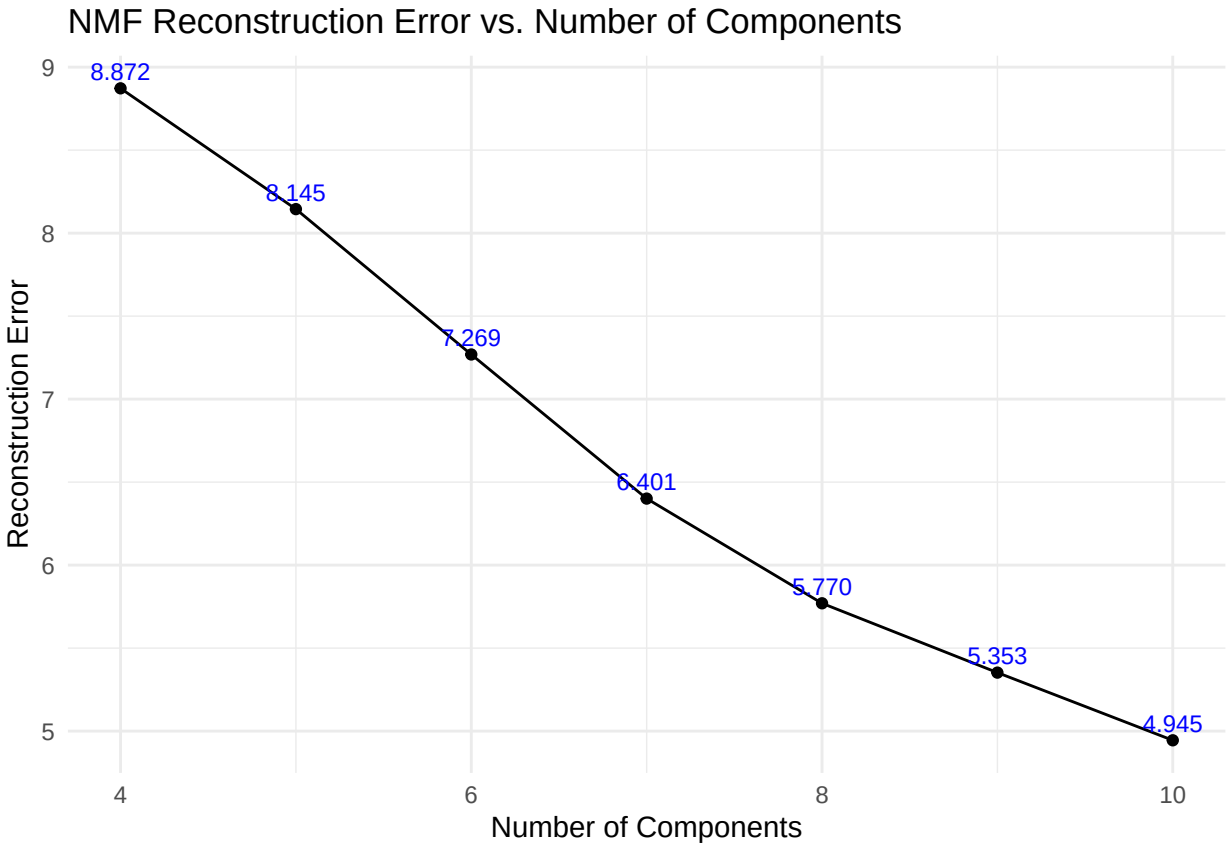
```
# plots the NMF rank survey
plot(estimate_rank)
```



Source contributions

NMF - SVD seed

```
# Try Eva's approach
components <- 4:10
errors <- numeric(length(components) - 4)

# Loop over the number of components
# for (n in components) {
#   nmf_result <- nmf(normalized_matrix, rank = n, method = "KL", seed='nndsvd')
#   reconstruction <- basis(nmf_result) %*% coef(nmf_result)
#   error <- norm(normalized_matrix - reconstruction, type = "F")
#   errors[n-3] <- error
#   print(paste0('Completed ', n - 3, ' out of 7'))
# }
#
# saveRDS(errors, 'errors_norm.rds')

errors <- readRDS('errors_norm.rds')
```


NMF Reconstruction Error vs. Number of Components
Reconstruction Error
Number of Components
9
8
7
6
5
4
6
8
10
8.872
8.145
7.269
6.401
5.770
5.353
4.945

Method comparisons

Remove Ozone

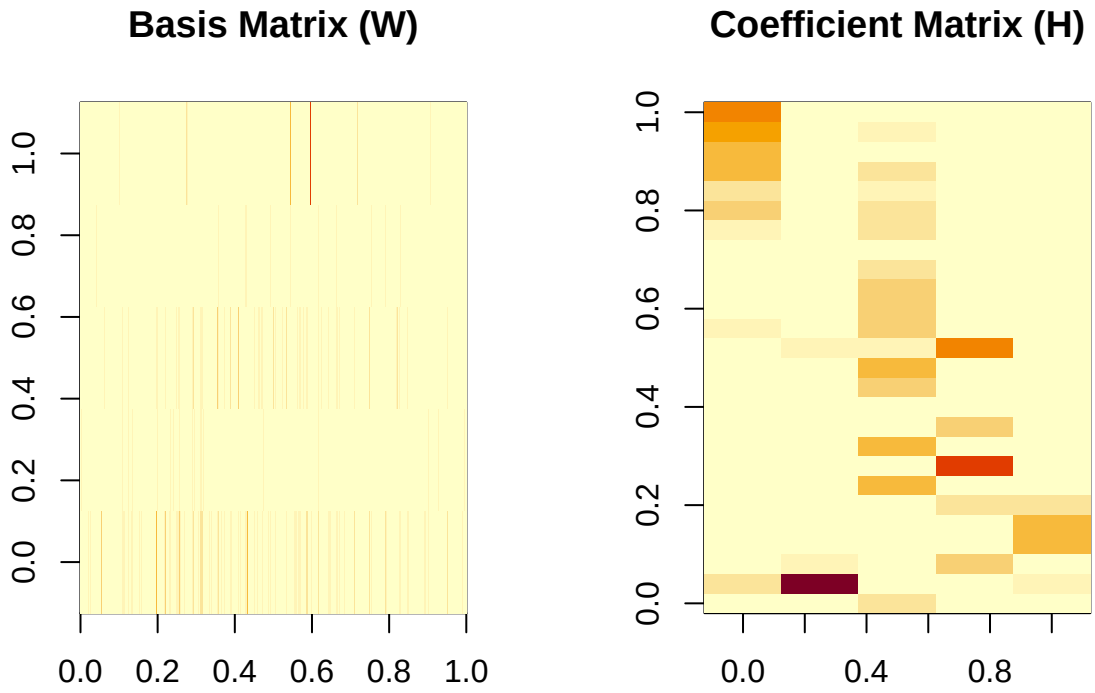
4 Components

5 Components

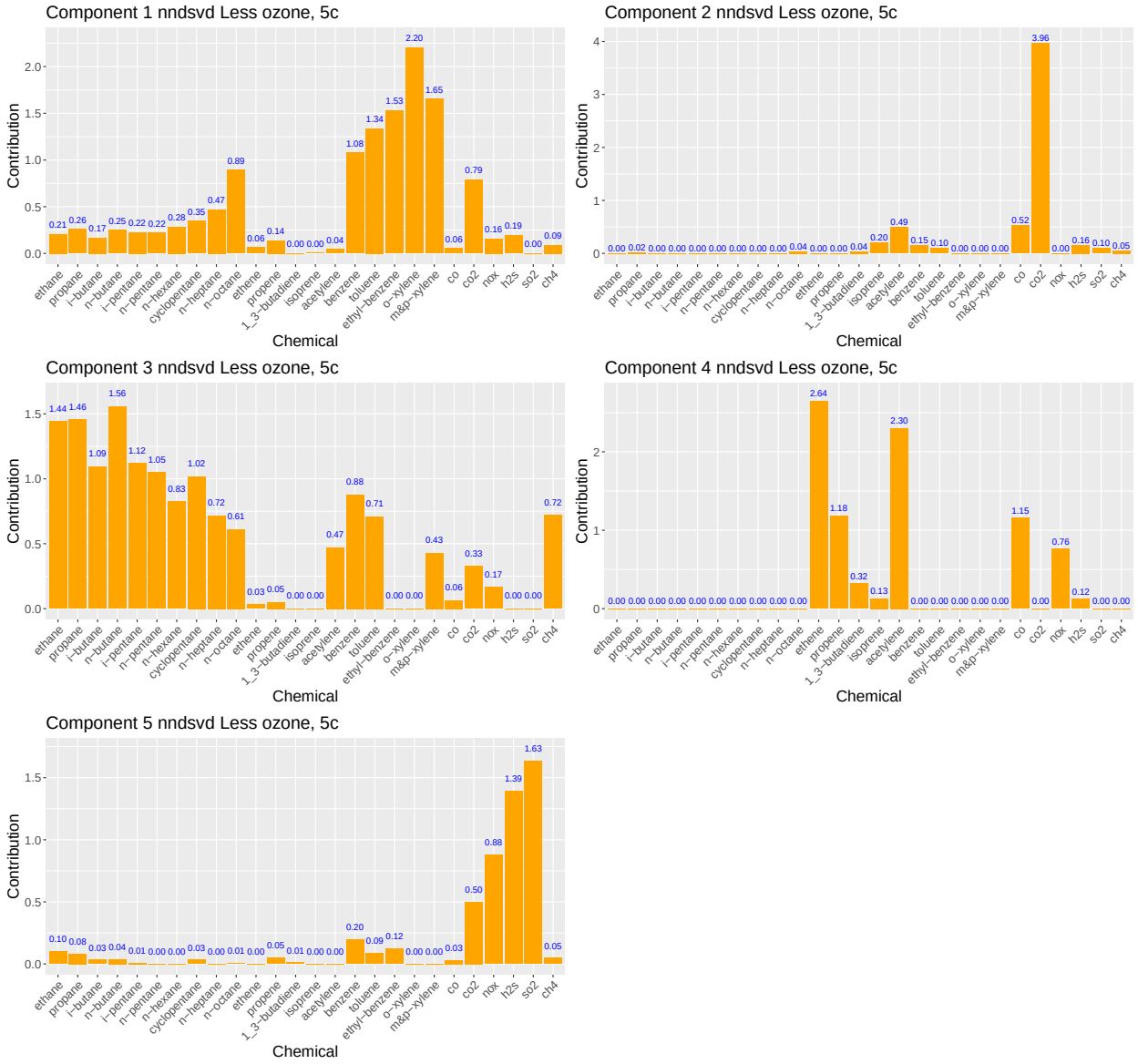
```
nmf_result_5c_less_o3 <- nmf(normalized_matrix_less_o3, rank = 5, method = "KL", seed='nndsvd')
```

```
## Warning in sqrt(S[i] * termn) * uun: Recycling array of length 1 in array-vector arithmetic is depre
##   Use c() or as.vector() instead.

## Warning in sqrt(S[i] * termn) * vvn: Recycling array of length 1 in array-vector arithmetic is depre
##   Use c() or as.vector() instead.

## Warning in sqrt(S[i] * termn) * uun: Recycling array of length 1 in array-vector arithmetic is depre
##   Use c() or as.vector() instead.

## Warning in sqrt(S[i] * termn) * vvn: Recycling array of length 1 in array-vector arithmetic is depre
##   Use c() or as.vector() instead.

## Warning in sqrt(S[i] * termn) * uun: Recycling array of length 1 in array-vector arithmetic is depre
##   Use c() or as.vector() instead.

## Warning in sqrt(S[i] * termn) * vvn: Recycling array of length 1 in array-vector arithmetic is depre
##   Use c() or as.vector() instead.

## Warning in sqrt(S[i] * termp) * uup: Recycling array of length 1 in array-vector arithmetic is depre
##   Use c() or as.vector() instead.

## Warning in sqrt(S[i] * termp) * vvp: Recycling array of length 1 in array-vector arithmetic is depre
##   Use c() or as.vector() instead.
```

```
basis_matrix_5c_less_o3 <- basis(nmf_result_5c_less_o3)
coef_matrix_5c_less_o3 <- coef(nmf_result_5c_less_o3)

par(mfrow = c(1, 2))
image(basis_matrix_5c_less_o3, main = "Basis Matrix (W)")
image(coef_matrix_5c_less_o3, main = "Coefficient Matrix (H)")
```



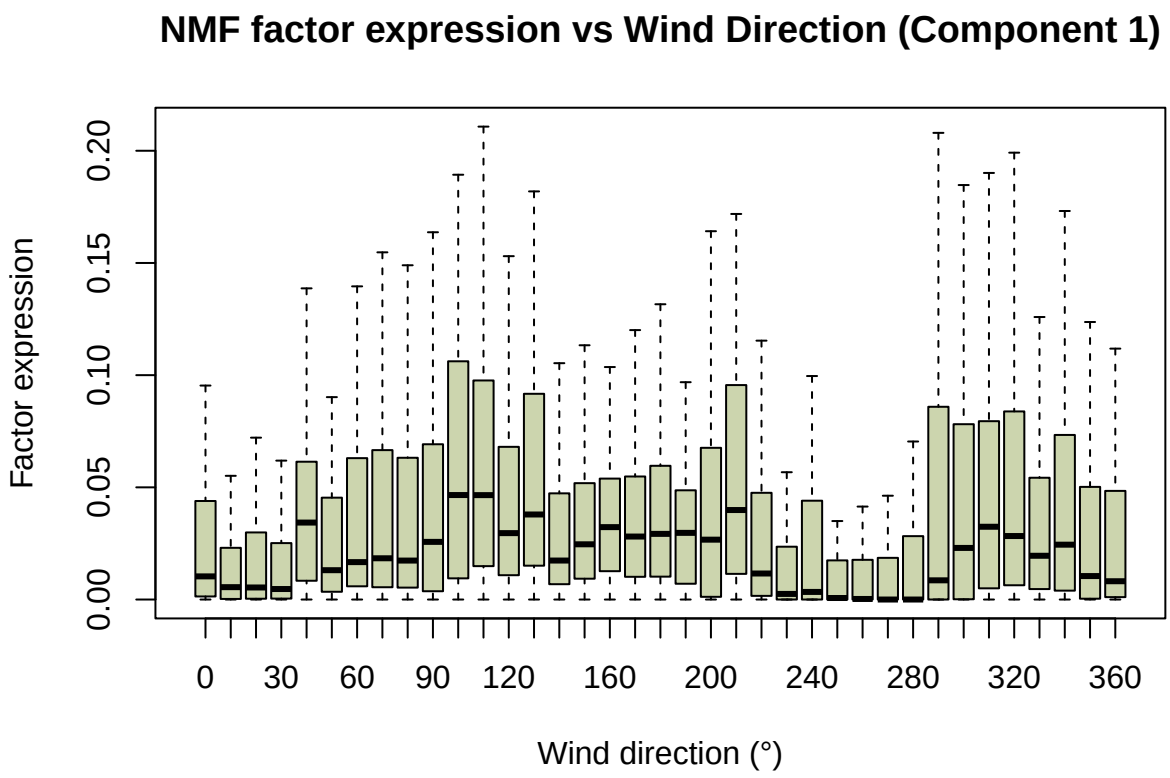

```
# Convert H to a data frame for ggplot
H_df_5c_less_o3 <- as.data.frame(coef_matrix_5c_less_o3)
# Add a column for chemicals
H_df_5c_less_o3$Component <- rownames(H_df_5c_less_o3)

# Reshape data to long format
H_long_5c_less_o3 <- pivot_longer(H_df_5c_less_o3, cols = -Component, names_to = "Chemical", values_to =

# Plot
nmfplt_1_svd_5c_less_o3 <- get_component_plot(H_long_5c_less_o3,
                                              '1', 'Component 1 nndsvd Less ozone, 5c')
nmfplt_2_svd_5c_less_o3 <- get_component_plot(H_long_5c_less_o3,
                                              '2', 'Component 2 nndsvd Less ozone, 5c')
nmfplt_3_svd_5c_less_o3 <- get_component_plot(H_long_5c_less_o3,
                                              '3', 'Component 3 nndsvd Less ozone, 5c')
nmfplt_4_svd_5c_less_o3 <- get_component_plot(H_long_5c_less_o3,
                                              '4', 'Component 4 nndsvd Less ozone, 5c')
nmfplt_5_svd_5c_less_o3 <- get_component_plot(H_long_5c_less_o3,
                                              '5', 'Component 5 nndsvd Less ozone, 5c')
```

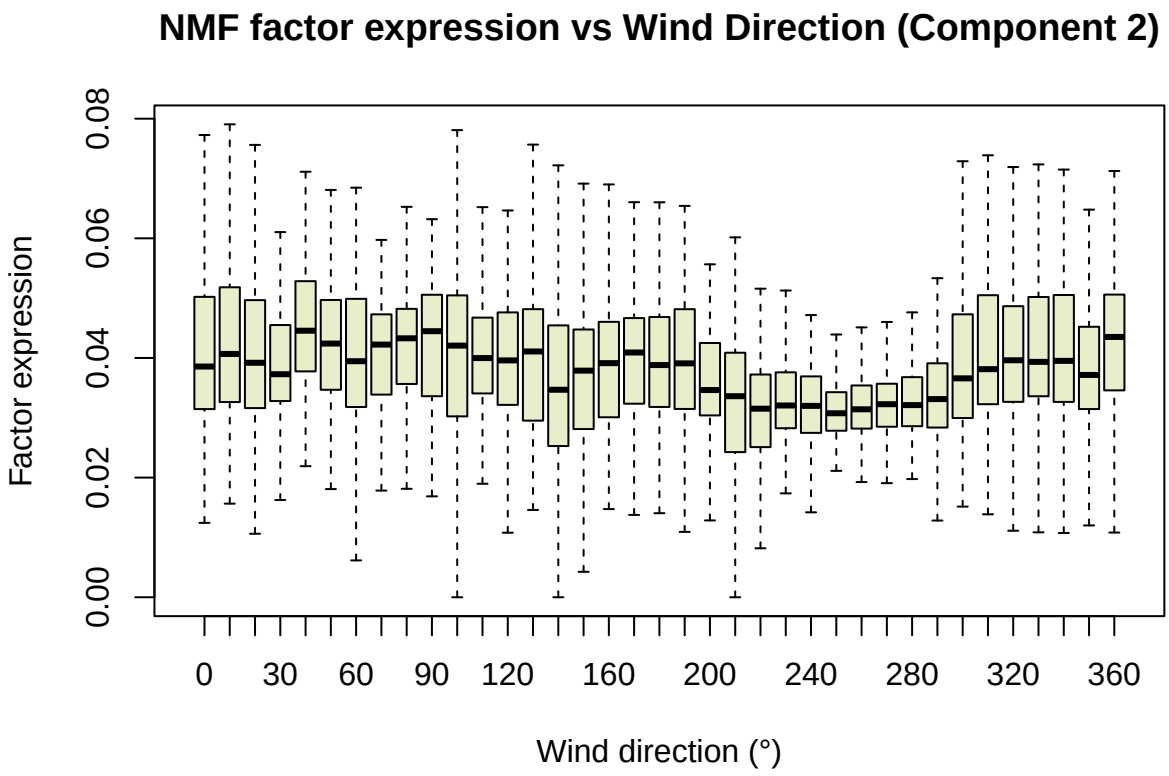


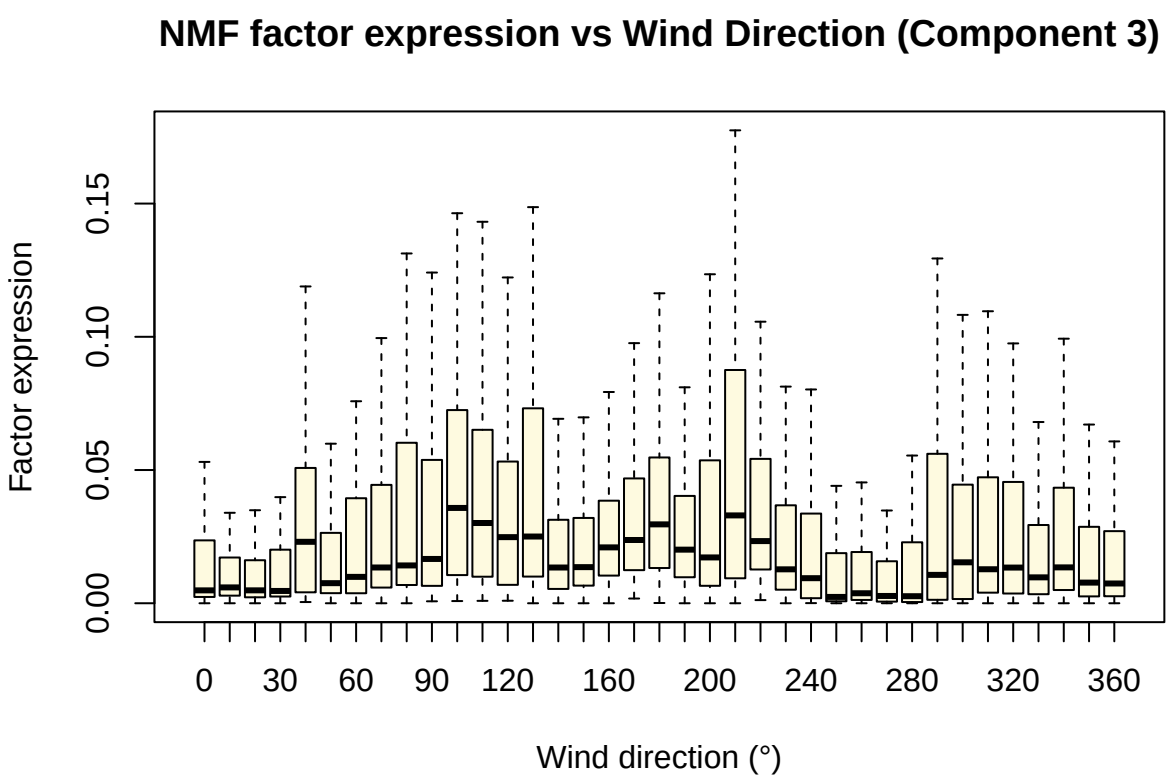
Wind plots

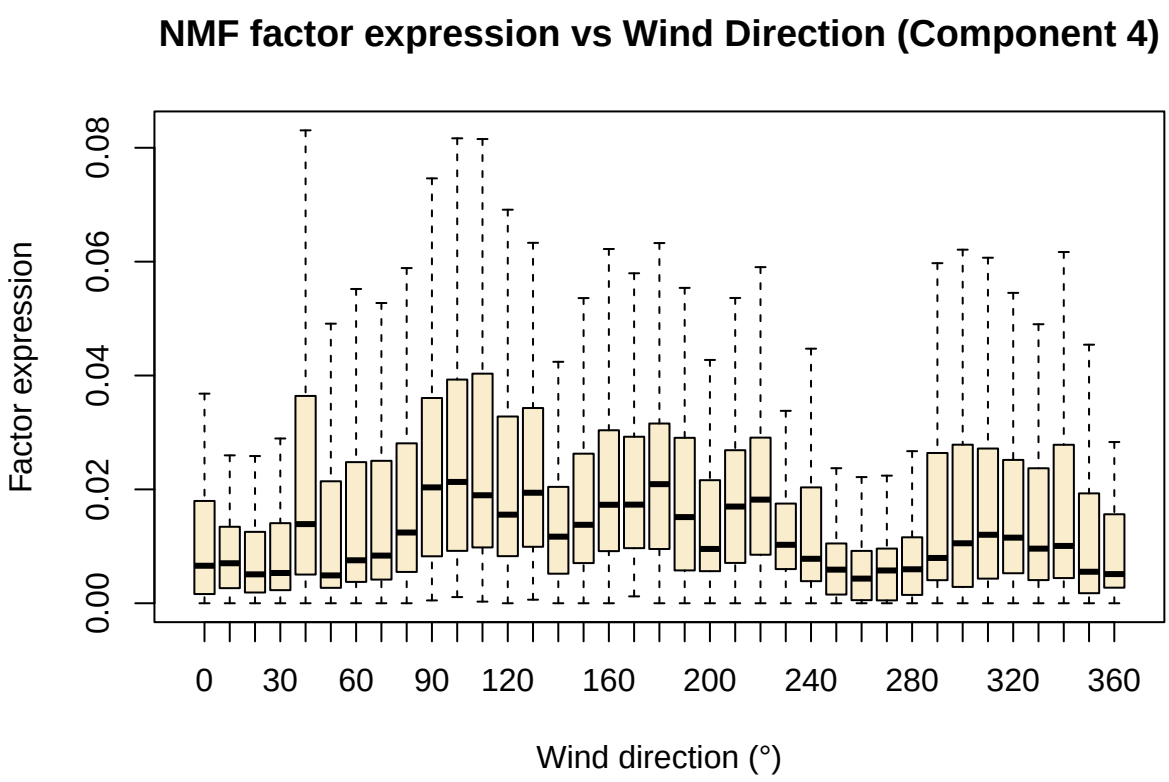
```
hourly_wind_nona <- hourly_nona %>%
  select(wdr_deg, wsp_ms)

data_to_plot <- tibble(
  component1 = basis(nmf_result_5c_less_o3)[,1],
  component2 = basis(nmf_result_5c_less_o3)[,2],
  component3 = basis(nmf_result_5c_less_o3)[,3],
  component4 = basis(nmf_result_5c_less_o3)[,4],
  component5 = basis(nmf_result_5c_less_o3)[,5],
  wd = round(hourly_wind_nona$wdr_deg, -1)
)
# ) %>%
#   pivot_longer(cols = c(1:5), names_to = 'component', values_to = 'component_wind')
# data_to_plot %>%
```

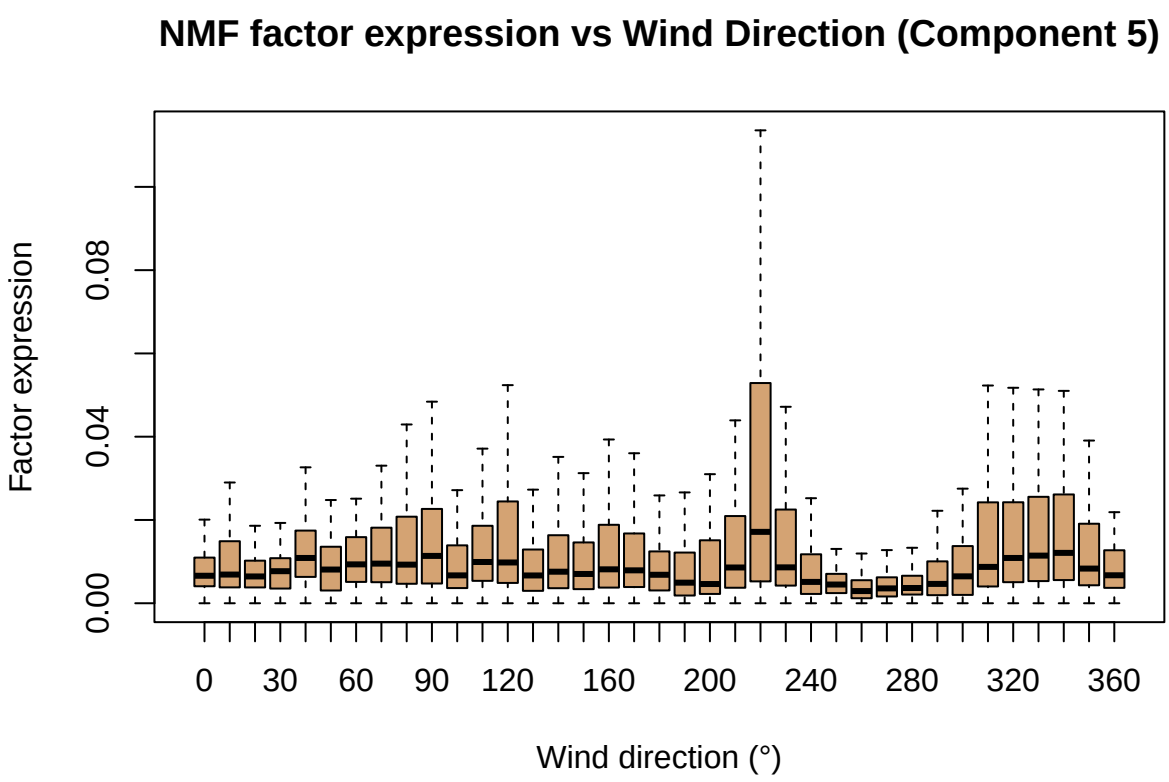
```
#   ggplot(aes(x = wd, y = component_wind, group = wd, fill = component)) +
#   geom_boxplot() +
#   facet_wrap(~component)
```




NMF factor expression vs Wind Direction (Component 2)
Factor expression
0.00
0.02
0.04
0.06
0.08
0
30
60
90
120
160
200
240
280
320
360
Wind direction (°)


NMF factor expression vs Wind Direction (Component 3)
Factor expression
0.00
0.05
0.10
0.15
0
30
60
90
120
160
200
240
280
320
360
Wind direction (°)


NMF factor expression vs Wind Direction (Component 4)
Factor expression
0.00
0.02
0.04
0.06
0.08
0
30
60
90
120
160
200
240
280
320
360
Wind direction (°)



6 Components

Wind plots

Remove Ozone + chemicals with more than 500+ background values

4 Components

5 Components

Compare to 4 components