R Notebook

```
rm(list=ls())
setwd("~/WORKSHOP/QAANAAQ/")
library(sp)
library(nleqslv)
library(lubridate)
```

```
##
## Attaching package: 'lubridate'
```

```
## The following objects are masked from 'package:base':
##
##     date, intersect, setdiff, union
```

```
library(oce)
```

```
## Loading required package: gsw
```

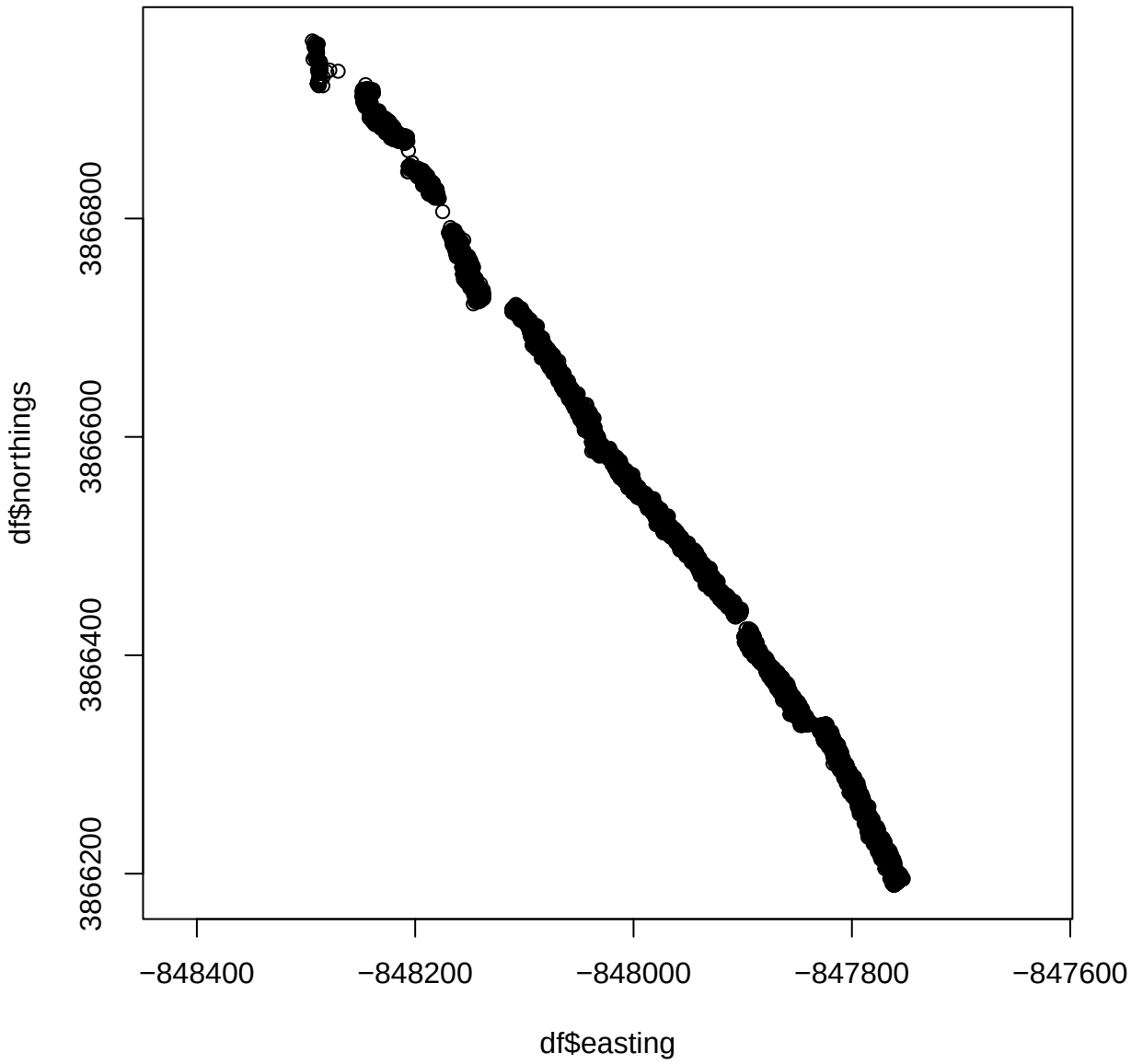
```
library(nloptr)
library(maps)
library(ggplot2)
library(ggmap)
```

```
## i Google's Terms of Service: <https://mapsplatform.google.com>
##   Stadia Maps' Terms of Service: <https://stadiamaps.com/terms-of-service/>
##   OpenStreetMap's Tile Usage Policy: <https://operations.osmfoundation.org/policies/tiles/>
## i Please cite ggmap if you use it! Use `citation("ggmap")` for details.
```

```
library(parallel)

#
df <- read.csv("DATA/EXB_csv.csv",sep=",",header=T)
parsed_date <- strptime(df$DateTime.UTC..YYMMDDHHmmss., format="%Y-%m-%dT%H:%M:%S")
# Convert to POSIXct
df$POSIX <- as.POSIXct(parsed_date)
df <- df[,-3]
```

lat/lon to northings/eastings

```r
# Create a SpatialPoints object
points <- SpatialPoints(cbind(df$Long, df$Lat), proj4string = CRS("+proj=longlat +ellps=WGS84"))

# Define the target projection
target_projection <- "+proj=tmerc +lat_0=49 +lon_0=-2 +k=0.9996012717 +x_0=400000 +y_0=-100000 +ellps=a

# Transform the coordinates to the target projection
transformed_points <- spTransform(points, CRS(target_projection))

# Extract the eastings and northings
eastings <- transformed_points@coords[,1]
northings <- transformed_points@coords[,2]



# Create a data frame with the eastings and northings
df$easting <- eastings
df$northings <- northings
#
plot(df$easting,df$northings,asp=1)
```



calculate speeds between points observed

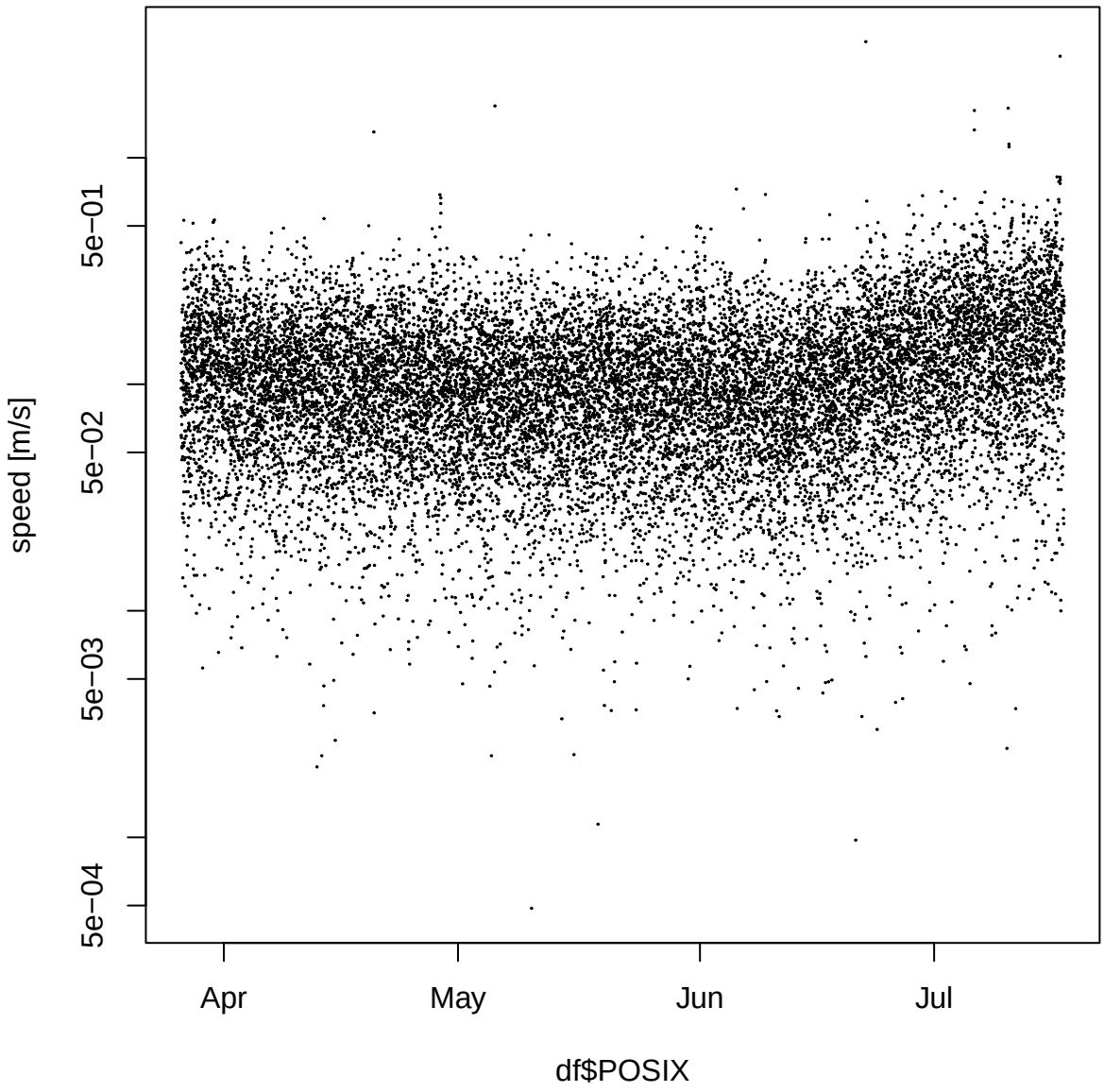
```
speed <- NULL
u <- NULL
v <- NULL
for (i in 1:(nrow(df)-1))
{
  d_easting <- df$easting[i+1]-df$easting[i]
  d_northing <- df$northings[i+1]-df$northings[i]
  dr <- sqrt((d_easting)^2+(d_northing)^2)
  dt <- as.numeric(df$POSIX[i+1]-df$POSIX[i])
  speed <- c(speed,dr/dt)
  u <- c(u,d_easting/dt)
  v <- c(v,d_northing/dt)
```

```
}
speed <- c(speed,NA)
u <- c(u,NA)
v <- c(v,NA)
df$speed <- speed
df$u <- u
df$v <- v
```

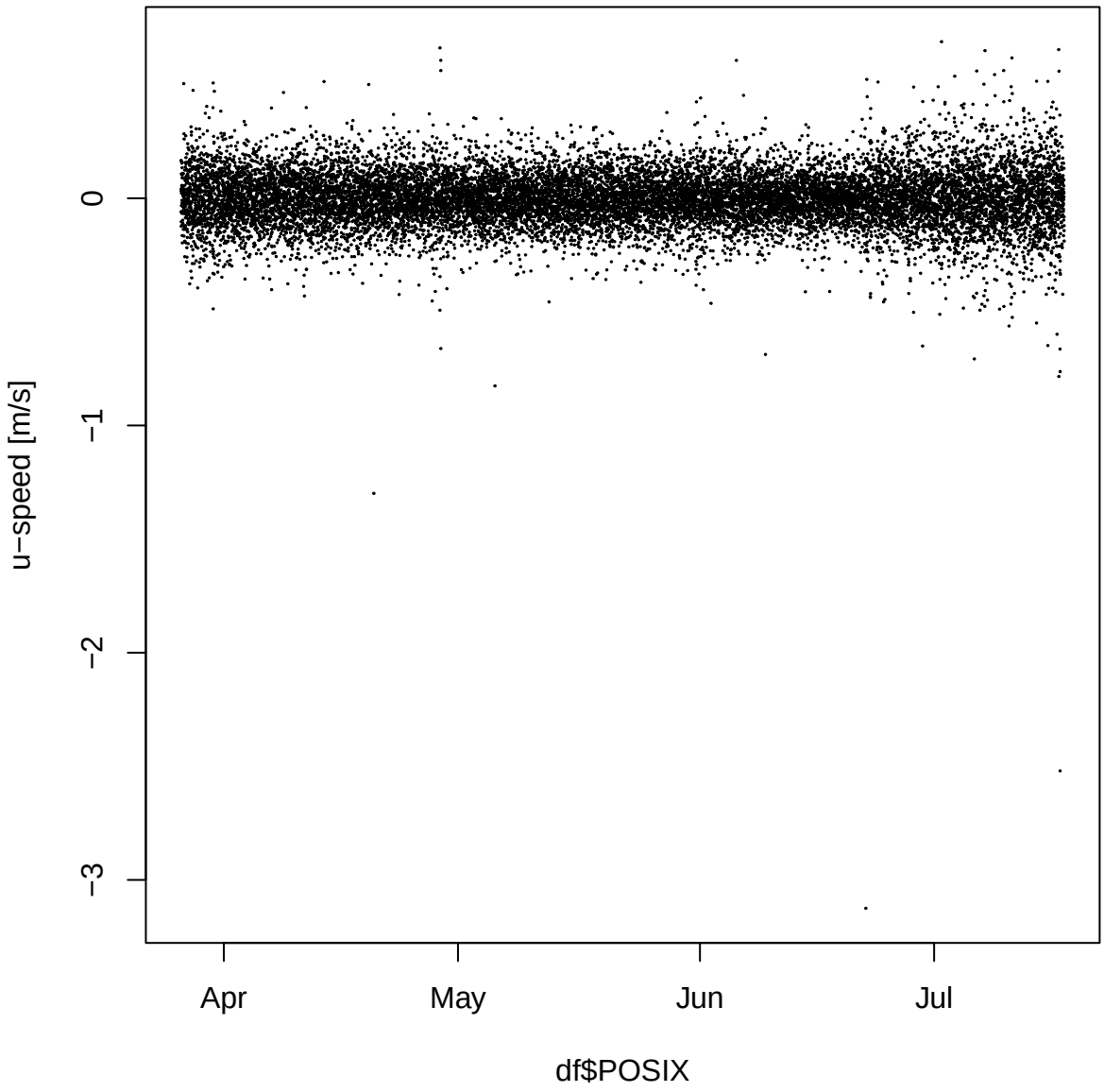
plots

```
plot(df$POSIX,df$speed,pch=19,cex=0.1,main="EXB bouy at Qaanaaq 2024",ylab="speed [m/s]",log="y")
```

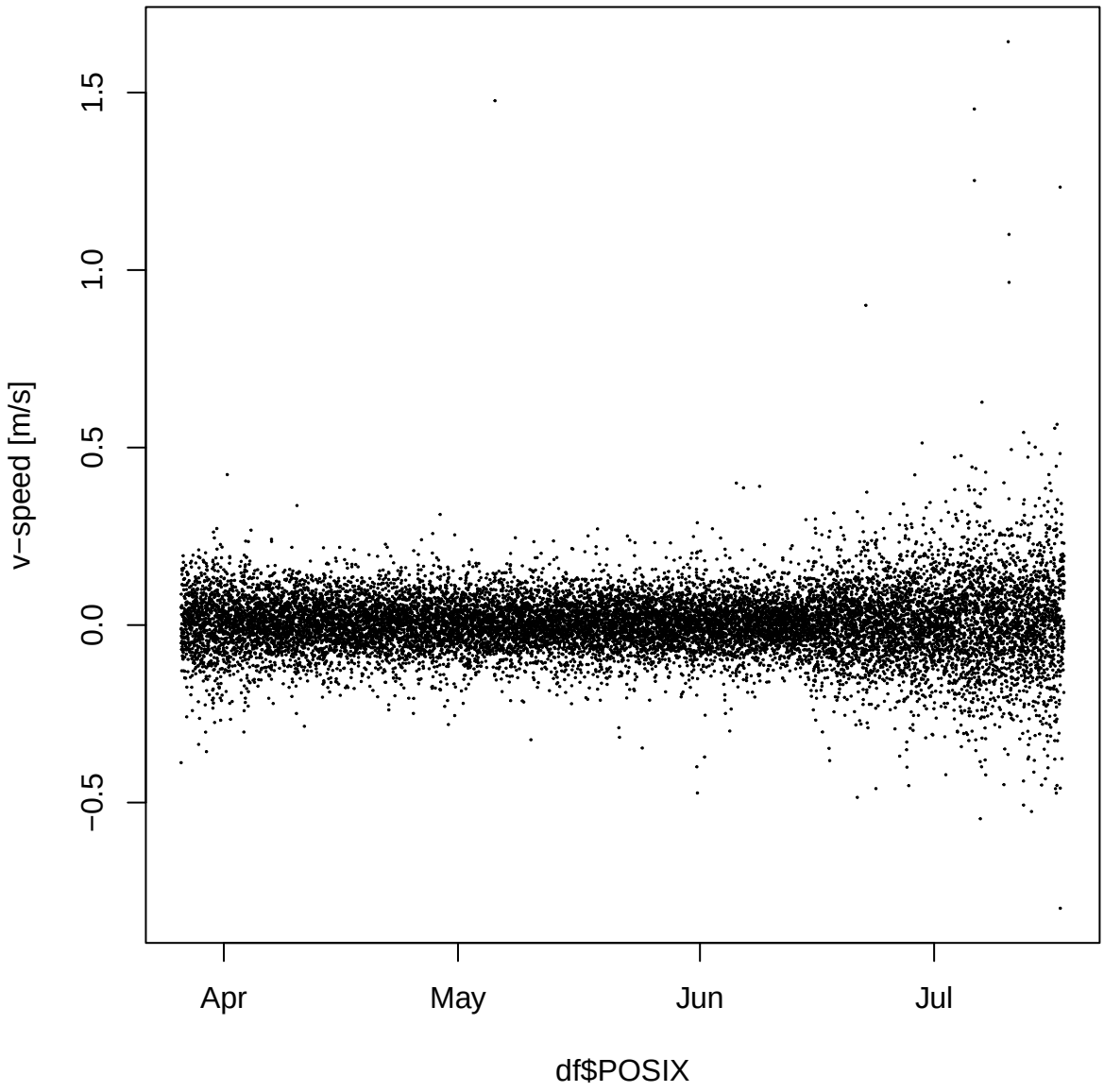
```
## Warning in xy.coords(x, y, xlabel, ylabel, log): 1 y value <= 0 omitted from
## logarithmic plot
```




```
plot(df$POSIX,df$u,pch=19,cex=0.1,main="EXB bouy at Qaanaaq 2024",ylab="u-speed [m/s]")
```

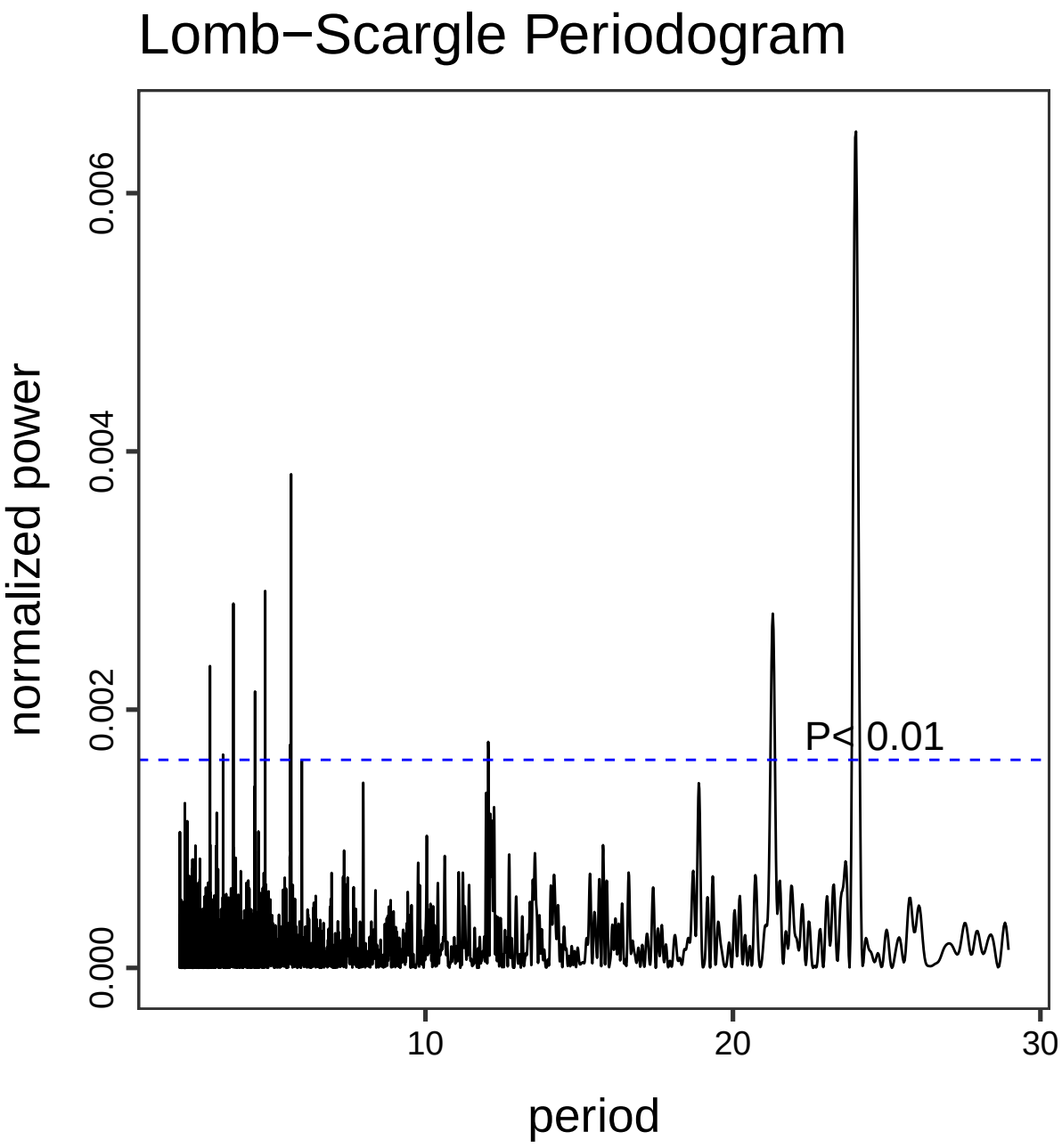



```
plot(df$POSIX,df$v,pch=19,cex=0.1,main="EXB bouy at Qaanaaq 2024",ylab="v-speed [m/s]")
```

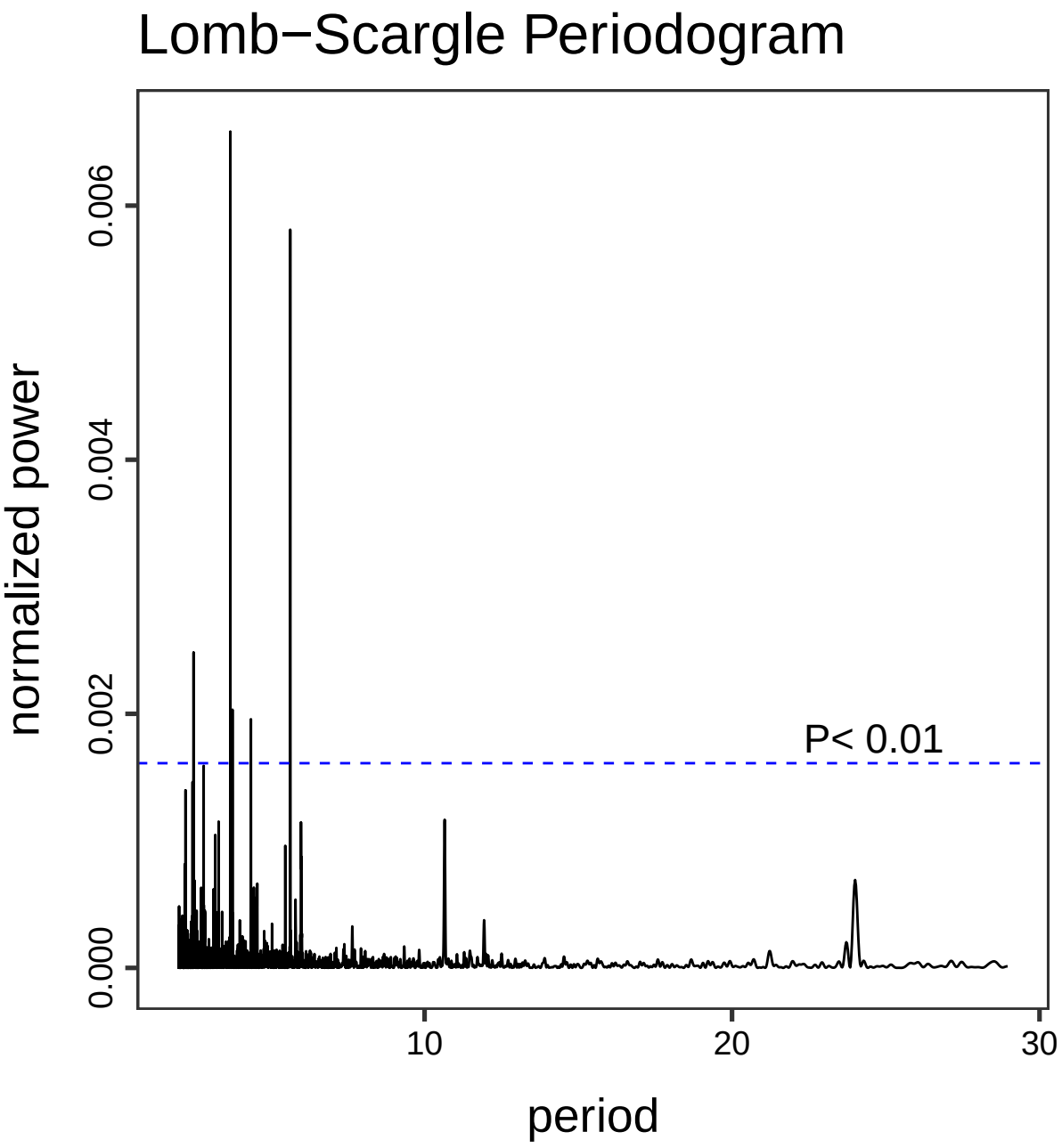


Scargle periodogram

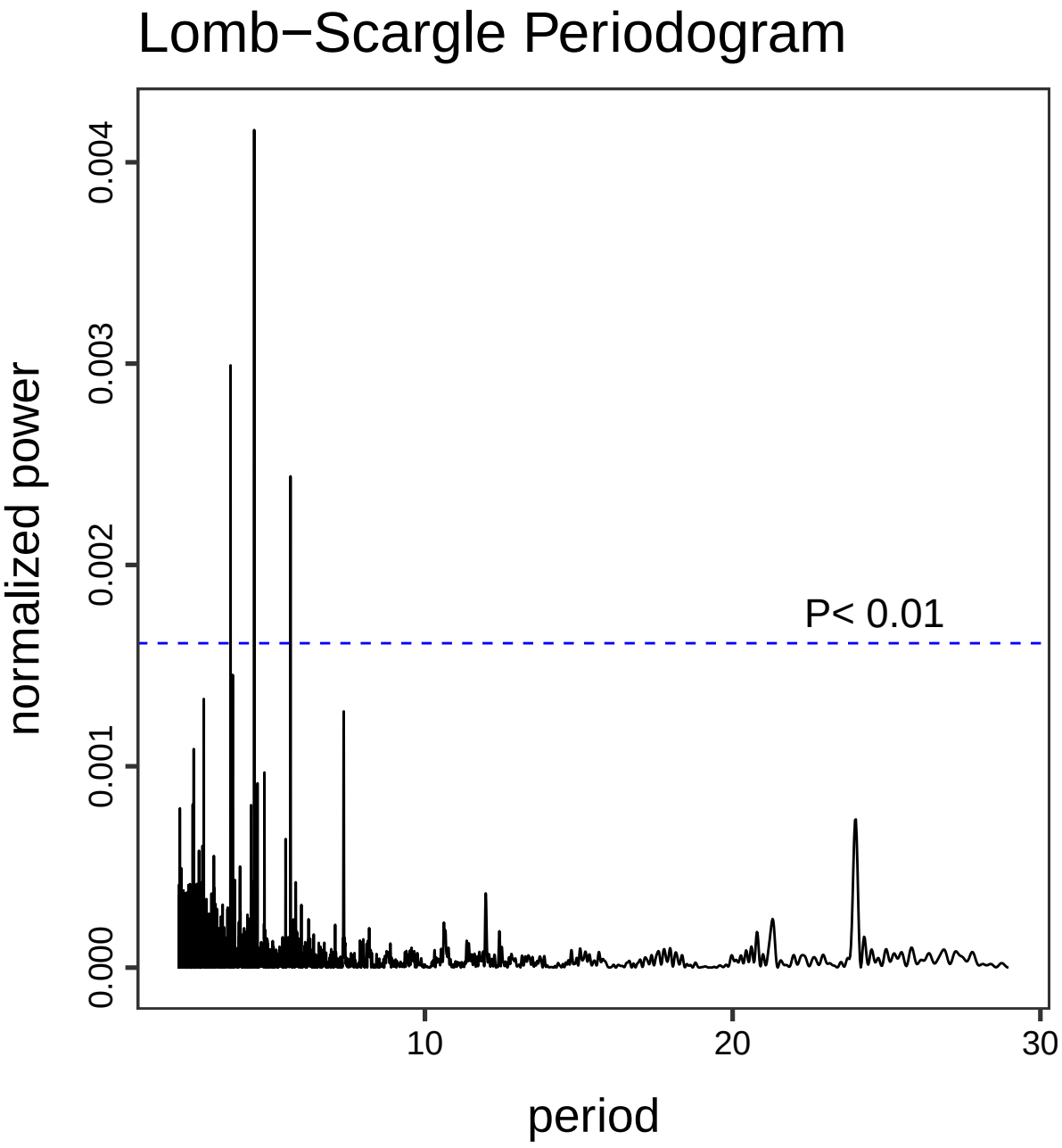
```
library(lomb)
df <- na.omit(df)
df$hours <- as.numeric(difftime(df$POSIX, min(df$POSIX), units = "hours"))
# speed
test_period_in_hours <- 15
test_signal <- sin(2*pi/test_period_in_hours*df$hours)*0.0 #0.005
# Compute Lomb-Scargle periodogram
ls_periodogram <- lsp(cbind(df$hours, df$speed-mean(df$speed)+test_signal), fit.sin = TRUE, type="perio
```



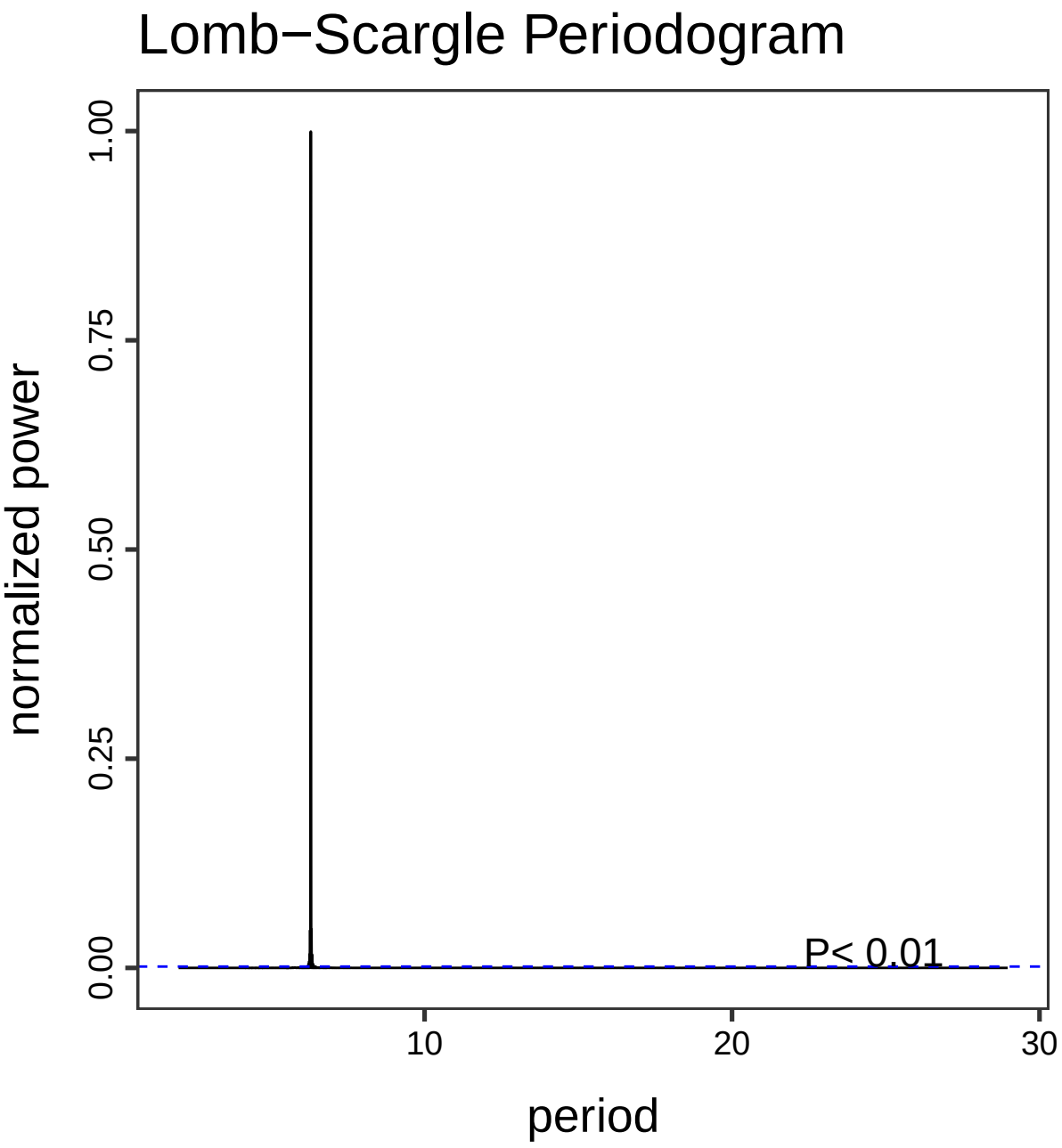

```
# u
# Compute Lomb-Scargle periodogram
ls_periodogram_u <- lsp(cbind(df$hours, df$u-mean(df$u)), fit.sin = TRUE, type="period",   from=2, to =
```




```
# v
# Compute Lomb-Scargle periodogram
ls_periodogram_v <- lsp(cbind(df$hours, df$v-mean(df$v)), fit.sin = TRUE, type="period",   from=2, to =
```



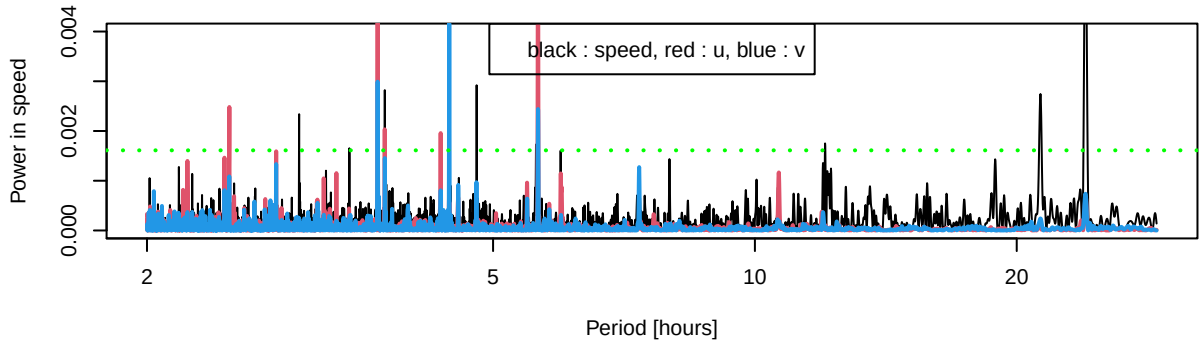

```
# test signal
test_period_in_hours <- 6.3
test_signal <- sin(2*pi/test_period_in_hours*df$hours)
ls_periodogram_test <- lsp(cbind(df$hours, test_signal), fit.sin = TRUE, type="period",   from=2, to = 1
```

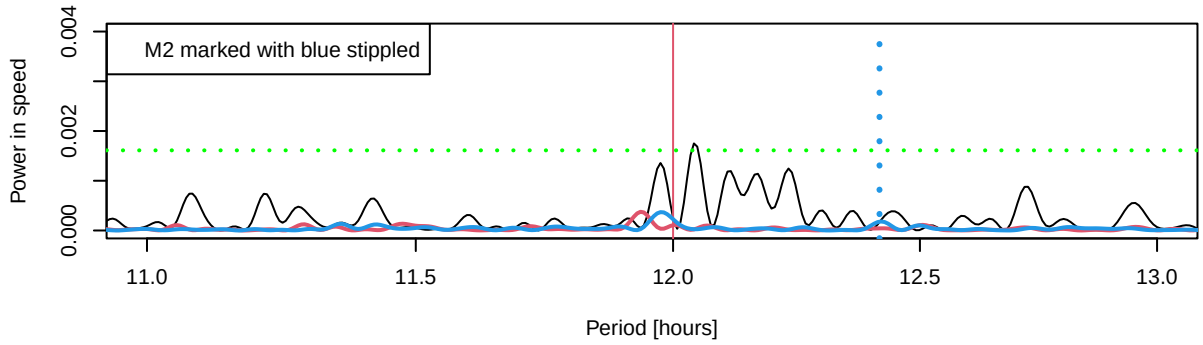


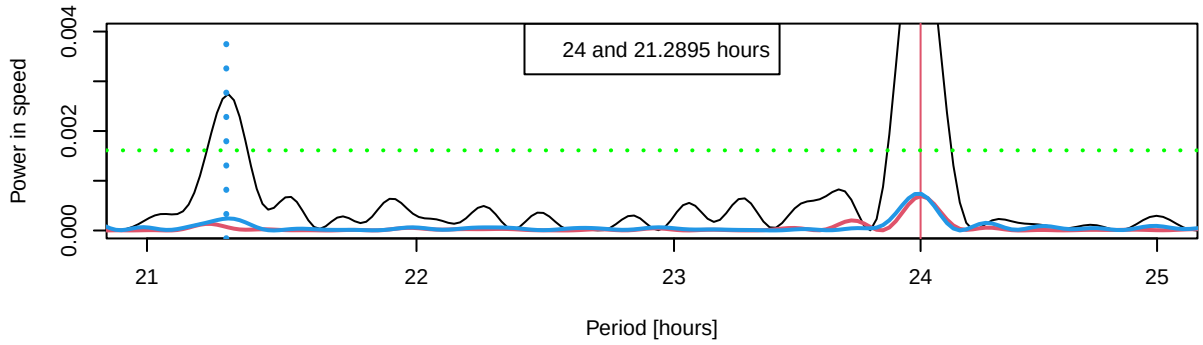
plots

```
par(mfrow=c(3,1))
plot(ls_periodogram$scanned, ls_periodogram$power, type = 'l', xlab = 'Period [hours]', ylab = 'Power i
#abline(v=test_period_in_hours,col=2,lwd=1)
#abline(v=24,col=2,lwd=1)
#abline(v=12,col=2,lwd=1)
#abline(v=12.41666,col=4,lty=3,lwd=3)
#abline(v=24/3,col=2,lwd=1)
#abline(v=24/4,col=2,lwd=1)
```

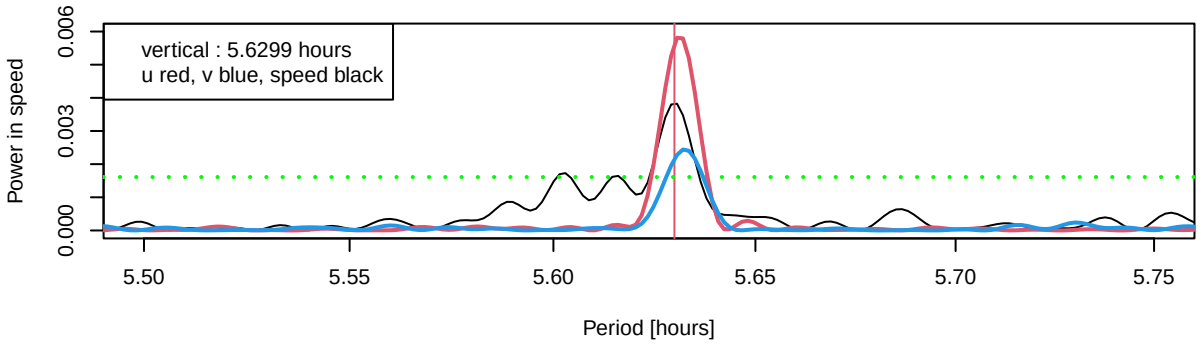
```r
#abline(v=24/5,col=2,lwd=1)
lines(ls_periodogram_u$scanned, ls_periodogram_u$power,col=2,lwd=2)
lines(ls_periodogram_v$scanned, ls_periodogram_v$power,col=4,lwd=2)
abline(h=ls_periodogram$sig.level,col="green",lty=3,lwd=2)
legend("top",legend="black : speed, red : u, blue : v")


plot(ls_periodogram$scanned, ls_periodogram$power, type = 'l', xlab = 'Period [hours]', ylab = 'Power i
abline(v=test_period_in_hours,col=2,lwd=1)
abline(v=24,col=2,lwd=1)
abline(v=12,col=2,lwd=1)
abline(v=12.41666,col=4,lty=3,lwd=3)
abline(h=ls_periodogram$sig.level,col="green",lty=3,lwd=2)
legend("topleft",legend="M2 marked with blue stippled")
lines(ls_periodogram_u$scanned, ls_periodogram_u$power,col=2,lwd=2)
lines(ls_periodogram_v$scanned, ls_periodogram_v$power,col=4,lwd=2)

plot(ls_periodogram$scanned, ls_periodogram$power, type = 'l', xlab = 'Period [hours]', ylab = 'Power i
abline(v=test_period_in_hours,col=2,lwd=1)
abline(v=24,col=2,lwd=1)
abline(v=12,col=2,lwd=1)
abline(v=12.41666,col=4,lty=3,lwd=3)
abline(v=21.2895,col=4,lty=3,lwd=3)
abline(h=ls_periodogram$sig.level,col="green",lty=3,lwd=2)
legend("top",legend="24 and 21.2895 hours")
lines(ls_periodogram_u$scanned, ls_periodogram_u$power,col=2,lwd=2)
lines(ls_periodogram_v$scanned, ls_periodogram_v$power,col=4,lwd=2)
```

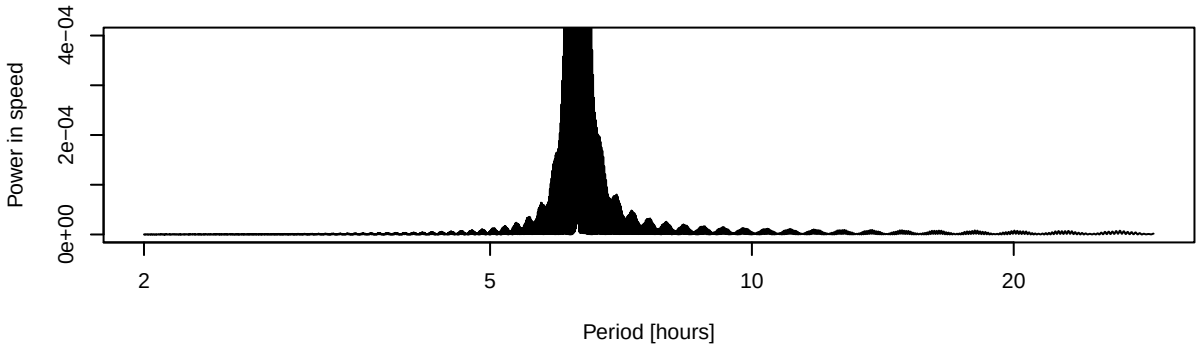







```
plot(ls_periodogram$scanned, ls_periodogram$power, type = 'l', xlab = 'Period [hours]', ylab = 'Power i
abline(v=test_period_in_hours,col=2,lwd=1)
abline(v=5.6299,col=2,lwd=1)
abline(h=ls_periodogram$sig.level,col="green",lty=3,lwd=2)
lines(ls_periodogram_u$scanned, ls_periodogram_u$power,col=2,lwd=2)
lines(ls_periodogram_v$scanned, ls_periodogram_v$power,col=4,lwd=2)
legend("topleft",legend=c("vertical : 5.6299 hours","u red, v blue, speed black"))

# spectrum of test signal
plot(ls_periodogram_test$scanned, ls_periodogram_test$power, type = 'l', xlab = 'Period [hours]', ylab =
```


vertical : 5.6299 hours
u red, v blue, speed black
Power in speed
0.000
0.003
0.006
5.50
5.55
5.60
5.65
5.70
5.75
Period [hours]


Power in speed
0e+00
2e−04
4e−04
2
5
10
20
Period [hours]