¶ Statistical analysis ¶

¶ Agalychnis lemur ¶

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Contents

```
source("~/Dropbox/R_package_testing/brmsish/R/extended_summary.R")
source("~/Dropbox/R_package_testing/brmsish/R/helpers.R")

label_spectro_temp <- function(wave, reference = NULL, detection = NULL, envelope = FALS
    threshold = NULL, smooth = 5, collevels = seq(-100, 0, 5), palette = viridis::viridi
    template.correlation = NULL, line.x.position = 2, hop.size = NULL, col.line = NULL,
    ...) {
    # adjust wl based on hope.size
    if (!is.null(hop.size))
        wl <- round(wave@samp.rate * hop.size/1000, 0)

    # reset graphic device on exit
    oldpar <- par(no.readonly = TRUE)
    on.exit(par(oldpar))

    if (envelope | !is.null(template.correlation))
        par(mfrow = c(2, 1), mar = c(0, 4, 1, 1)) else par(mar = c(4, 4, 1, 1))

    # plot spectrogram
    seewave::spectro(wave = wave, grid = FALSE, scale = FALSE, palette = palette,
        collevels = collevels, axisX = if (envelope | !is.null(template.correlation))
            FALSE else TRUE, ...)
```

```
    # plot detection
    if (!is.null(reference))
        for (i in seq_len(nrow(reference))) lines(x = (reference[i, c("start", "end")]),
            y = rep(line.x.position, 2), col = col.line[1], lwd = 7, lend = 2)

    # plot detection
    if (!is.null(detection))
        for (i in seq_len(nrow(detection))) lines(x = (detection[i, c("start", "end")]),
            y = rep(line.x.position - 0.3, 2), col = col.line[2], lwd = 7, lend = 2)

    usr <- par("usr")

    # add legend
    if (!is.null(detection) & !is.null(reference))
        legend(x = usr[2] * 0.98, y = usr[4] * 0.98, col = col.line[1:2], legend = c("Re
            "Detección"), text.width = 0.3, lwd = 4, bg = "#FFFFFFE6", xjust = 1,
            yjust = 1)

    if (is.null(detection) & !is.null(reference))
        legend(x = usr[2] * 0.98, y = usr[4] * 0.98, col = col.line[1], text.width = 0.3
            legend = c("Referencia"), lwd = 4, bg = "#FFFFFFE6", xjust = 1, yjust = 1)

    if (is.null(reference) & !is.null(detection))
        legend(x = usr[2] * 0.98, y = usr[4] * 0.98, col = col.line[2], legend = c("Dete
            lwd = 4, text.width = 0.3, bg = "#FFFFFFE6", xjust = 1, yjust = 1)

    if (envelope) {
        # set graphic device for envelope
        par(mar = c(4, 4, 0.3, 1))

        if (!is.null(smooth))
            smooth <- round(wave@samp.rate * smooth/1000, 0)

        # plot envelope
        seewave::env(wave, colwave = "#07889B", ssmooth = smooth)

        # add threshold line
        if (!is.null(threshold))
            abline(h = par("usr")[4] * threshold/100, col = col.line[3], lwd = 3)
    } else if (!is.null(template.correlation)) {
        # set graphic device for correlations
        par(mar = c(4, 4, 0.3, 1))

        plot(x = seq(template.correlation$template.duration/2, duration(wave) - template
```

```
            length.out = length(template.correlation$correlation.scores)), y = template.
            type = "l", xlab = "Tiempo (s)", ylab = "Correlación", col = "#07889B",
            lwd = 1.6, xaxs = "i", xlim = c(0, duration(wave)))

        # add threshold line
        if (!is.null(threshold))
            abline(h = threshold, col = col.line[3], lwd = 3)

    }
}
```

```
clim_dat_2020 <- read_excel("./data/datos_metereologicos/Estacion_met/Dat_met_estacion_2
    sheet = "2020")

clim_dat_2019 <- read_excel("./data/datos_metereologicos/Estacion_met/Dat_met_estacion_2
    sheet = "2019")

clim_dat <- rbind(clim_dat_2019, clim_dat_2020)

clim_dat <- clim_dat[, c("filename", "Año", "Mes", "Día", "Hora", "Temp (°C)",
    "Humedad Relat.", "Precipitación")]

names(clim_dat) <- c("filename", "year", "month", "day", "hour", "temp", "HR", "rain")

clim_dat <- aggregate(cbind(rain, temp, HR) ~ filename + year + month + day + hour,
    clim_dat, mean)

clim_dat$year <- clim_dat$year + 2000

clim_dat$date <- as.Date(paste(clim_dat$year, clim_dat$month, clim_dat$day, sep = "-"))


clim_dat$date_hour <- paste(gsub("-", "", clim_dat$date), clim_dat$hour, sep = "-")

call_dat <- read.csv("./data/processed/call_rate_per_date_time_and_site.csv")

# remove 5 pm data and keep only form Sukia
call_dat <- call_dat[call_dat$hour != 17, ]
call_dat <- call_dat[call_dat$site != "LAGCHIMU", ]


call_dat$date_hour <- paste(sapply(as.character(call_dat$site_date_hour), function(x) st
    "_")[[1]][2]), call_dat$hour, sep = "-")
```

```r
call_dat$temp <- sapply(1:nrow(call_dat), function(x) {
    y <- clim_dat$temp[clim_dat$date_hour == call_dat$date_hour[x]]

    if (length(y) < 1)
        y <- NA

    return(y)
})


call_dat$HR <- sapply(1:nrow(call_dat), function(x) {
    y <- clim_dat$HR[clim_dat$date_hour == call_dat$date_hour[x]]

    if (length(y) < 1)
        y <- NA

    return(y)
})


call_dat$rain <- sapply(1:nrow(call_dat), function(x) {
    y <- clim_dat$rain[clim_dat$date_hour == call_dat$date_hour[x]]

    if (length(y) < 1)
        y <- NA

    return(y)
})

# proportion of acoustic data with climatic data
sum(call_dat$date_hour %in% clim_dat$date_hour)/nrow(call_dat)
sum(!is.na(call_dat$temp))/nrow(call_dat)


call_dat <- call_dat[!is.na(call_dat$temp), ]

call_dat$day <- as.numeric(substr(sapply(as.character(call_dat$site_date_hour), function
    "_")[[1]][2]), 7, 8))

call_dat$date <- as.Date(paste(call_dat$year, call_dat$month, call_dat$day, sep = "-"))

call_dat$moon.date <- ifelse(call_dat$hour < 12, as.Date(call_dat$date - 1), as.Date(cal

call_dat$moon.date <- as.Date(call_dat$moon.date, origin = "1970-01-02")
```

```r
## add moon
call_dat$moonlight <- lunar.illumination(call_dat$moon.date, shift = -6)


call_dat$date_hour_min <- strptime(paste(paste(call_dat$year, call_dat$month, call_dat$d
    sep = "-"), paste(call_dat$hour, "00", sep = ":")), format = "%Y-%m-%d  %H:%M")

call_dat$hour_diff <- as.numeric(call_dat$date_hour_min - min(call_dat$date_hour_min))/3


call_dat$rain_24 <- sapply(1:nrow(call_dat), function(x) sum(clim_dat$rain[strptime(clim
    format = "%Y-%m-%d") == (strptime(call_dat$date[x], format = "%Y-%m-%d") - 60 *
    60 * 24)]))

call_dat$rain_48 <- sapply(1:nrow(call_dat), function(x) sum(clim_dat$rain[strptime(clim
    format = "%Y-%m-%d") == (strptime(call_dat$date[x], format = "%Y-%m-%d") - 60 *
    60 * 48)]))

clim_dat$date_hour_min <- strptime(paste(paste(clim_dat$year, clim_dat$month, clim_dat$d
    sep = "-"), paste(clim_dat$hour, "00", sep = ":")), format = "%Y-%m-%d %H:%M")

clim_dat$hour_diff <- as.numeric(clim_dat$date_hour_min - min(call_dat$date_hour_min))/3

call_dat$prev_temp <- sapply(1:nrow(call_dat), function(x) {

    # if(call_dat$hour_diff[x] < 48) pt <- NA else
    pt <- mean(clim_dat$temp[clim_dat$hour_diff %in% (call_dat$hour_diff[x] - 48):(call_
        24)])

    return(pt)
})

write.csv(call_dat, "./data/processed/acoustic_and_climatic_data_by_hour.csv")
```

Purpose

- Evaluate effect of enviromental factors on vocal activity of *A. lemur*

Prepare data

Descriptive stats

```
call_dat_site <- read.csv("./data/processed/call_rate_per_date_time_and_site.csv")
```

- Total number of recordings: 9681
- Total recordings per site:

```
agg_recs <- aggregate(rec_time ~ site, data = call_dat_site, length)
names(agg_recs)[1:2] <- c("site", "rec_count")

# print table as kable
kb <- kable(agg_recs, row.names = TRUE, digits = 3)

kb <- kable_styling(kb, bootstrap_options = c("striped", "hover", "condensed", "responsi

print(kb)
```

site

rec_count

1

LAGCHIMU

5127

2

SUKIA

4554

- Total recording time: 3224
- Total recording time per site:

```
agg_recs <- aggregate(rec_time ~ site, data = call_dat_site, sum)
names(agg_recs)[1:2] <- c("site", "recording_time")

agg_recs$recording_time <- round((agg_recs$recording_time)/60)

# print table as kable
kb <- kable(agg_recs, row.names = TRUE, digits = 3)
```

```
kb <- kable_styling(kb, bootstrap_options = c("striped", "hover", "condensed", "responsi

print(kb)
```

site

recording_time

1

LAGCHIMU

1707

2

SUKIA

1517

- Total detections: 540203
- Total detections per site:

```
agg_recs <- aggregate(n_call ~ site, data = call_dat_site, sum)
names(agg_recs)[1:2] <- c("calls", "count")

# print table as kable
kb <- kable(agg_recs, row.names = TRUE, digits = 3)

kb <- kable_styling(kb, bootstrap_options = c("striped", "hover", "condensed", "responsi

print(kb)
```

calls

count

1

LAGCHIMU

169485

2

SUKIA

370718

- Call rate: 18.598587

- Call rate per site:

```
agg_recs <- aggregate(call_rate ~ site, data = call_dat_site, mean)
agg_recs$sd <- aggregate(call_rate ~ site, data = call_dat_site, sd)[, 2]

names(agg_recs)[1:3] <- c("site", "call_rate", "sd")

# print table as kable
kb <- kable(agg_recs, row.names = TRUE, digits = 3)

kb <- kable_styling(kb, bootstrap_options = c("striped", "hover", "condensed", "responsi

print(kb)
```

site

call_rate

sd

1

LAGCHIMU

11.018

18.039

2

SUKIA

27.133

87.778

```
call_rate_hour <- read.csv("./data/processed/acoustic_and_climatic_data_by_hour.csv")


agg <- aggregate(cbind(temp, prev_temp, HR, rain, rain_24, rain_48, moonlight) ~
    1, call_rate_hour, function(x) round(c(mean(x), sd(x), min(x), max(x)), 3))

agg <- as.data.frame(matrix(unlist(agg), ncol = 4, byrow = TRUE, dimnames = list(c("Temp
    "Previous temperature", "Relative humidity", "Night rain", "Rain 24 hours", "Rain 48
    "Moonlight"), c("mean", "sd", "min", "max"))))
# print table as kable
kb <- kable(agg, row.names = TRUE, digits = 3)

kb <- kable_styling(kb, bootstrap_options = c("striped", "hover", "condensed", "responsi

print(kb)
```

mean

sd

min

max

Temperature

24.229

2.126

19.472

31.763

Previous temperature

24.097

0.988

20.005

27.111

Relative humidity

90.056

8.464

55.158

99.940

Night rain

0.079

0.457

0.000

10.417

Rain 24 hours

1.441

3.161

0.000

25.620

Rain 48 hours

1.453

3.170

0.000

25.620

Moonlight

0.495

0.355

0.000

1.000

Mean and sd temperature: 24.229179

Mean previous temperature: 24.097073

Mean temperature: 24.229179

Mean cumulative rain per hour: 0.079232

Mean cumulative rain per hour previous 24 hours: 1.44064

Mean daily cumulative rain per hour previous 48 hours: 1.45317

Bayesian regression models

Scale variables and set model parameters

```
call_rate_hour <- read.csv("./data/processed/acoustic_and_climatic_data_by_hour.csv")

# make hour a factor
call_rate_hour$hour <- factor(call_rate_hour$hour)

# scale and mean-center
call_rate_hour$sc_temp <- scale(call_rate_hour$temp)
call_rate_hour$sc_HR <- scale(call_rate_hour$HR)
call_rate_hour$sc_rain <- scale(call_rate_hour$rain)
call_rate_hour$sc_rain_24 <- scale(call_rate_hour$rain_24)
call_rate_hour$sc_rain_48 <- scale(call_rate_hour$rain_48)
call_rate_hour$sc_moonlight <- scale(call_rate_hour$moonlight)
call_rate_hour$sc_prev_temp <- scale(call_rate_hour$prev_temp)

priors <- c(prior(normal(0, 4), class = "b"))
chains <- 4
iter <- 10000
```

Global models

The increase in relative humidity, decrease in temperature, increase in the previous accumulated rain, decrease in the night rain, decrease in the percentage of the moon illuminated cause the activity of A. lemur to increase?

```
fit_glob1 <- brm(n_call | resp_rate(rec_time) ~ sc_temp + sc_HR + sc_moonlight +
    sc_rain + sc_rain_24 + sc_prev_temp + ar(p = 2, time = hour_diff, gr = hour),
    data = call_rate_hour, iter = iter, chains = chains, cores = chains, family = negbin
    prior = priors, file = "./data/processed/regression_models/global_rain_24", file_ref


fit_glob2 <- brm(n_call | resp_rate(rec_time) ~ sc_temp + sc_HR + sc_moonlight +
    sc_rain + sc_rain_48 + sc_prev_temp + ar(p = 2, time = hour_diff, gr = hour),
    data = call_rate_hour, iter = iter, chains = chains, cores = chains, family = negbin
    prior = priors, file = "./data/processed/regression_models/global_rain_48", file_ref
```

```
extended_summary(read.file = "./data/processed/regression_models/global_rain_24.rds",
    n.posterior = 1000)
```

global_rain_24

priors

formula

iterations

chains

thinning

warmup

diverg_transitions

rhats > 1.05

min_bulk_ESS

min_tail_ESS

seed

1

b-normal(0, 4) Intercept-student_t(3, 3.6, 2.5) sderr-student_t(3, 0, 2.5) shape-gamma(0.01, 0.01)

n_call | resp_rate(rec_time) ~ sc_temp + sc_HR + sc_moonlight + sc_rain + sc_rain_24 + sc_prev_temp + ar(p = 2, time = hour_diff, gr = hour)

10000

4

1

5000

0

0

9377.5

12503.8

536473866

Estimate

l-95% CI

u-95% CI

Rhat

Bulk_ESS

Tail_ESS

b_Intercept

0.698

0.636

0.760

1

9377.5

12503.8

b_sc_temp

0.573

0.493

0.654

1

10930.3

12951.7

b_sc_HR

0.307

0.233

0.381

1

14333.7

14034.8

b_sc_moonlight

-0.090

-0.149

-0.031

1

12403.9

13102.6

b_sc_rain

0.038

0.002

0.075

1

18321.1

15080.0

b_sc_rain_24

0.091

0.053

0.130

1

18798.2

14951.0

b_sc_prev_temp

-0.024

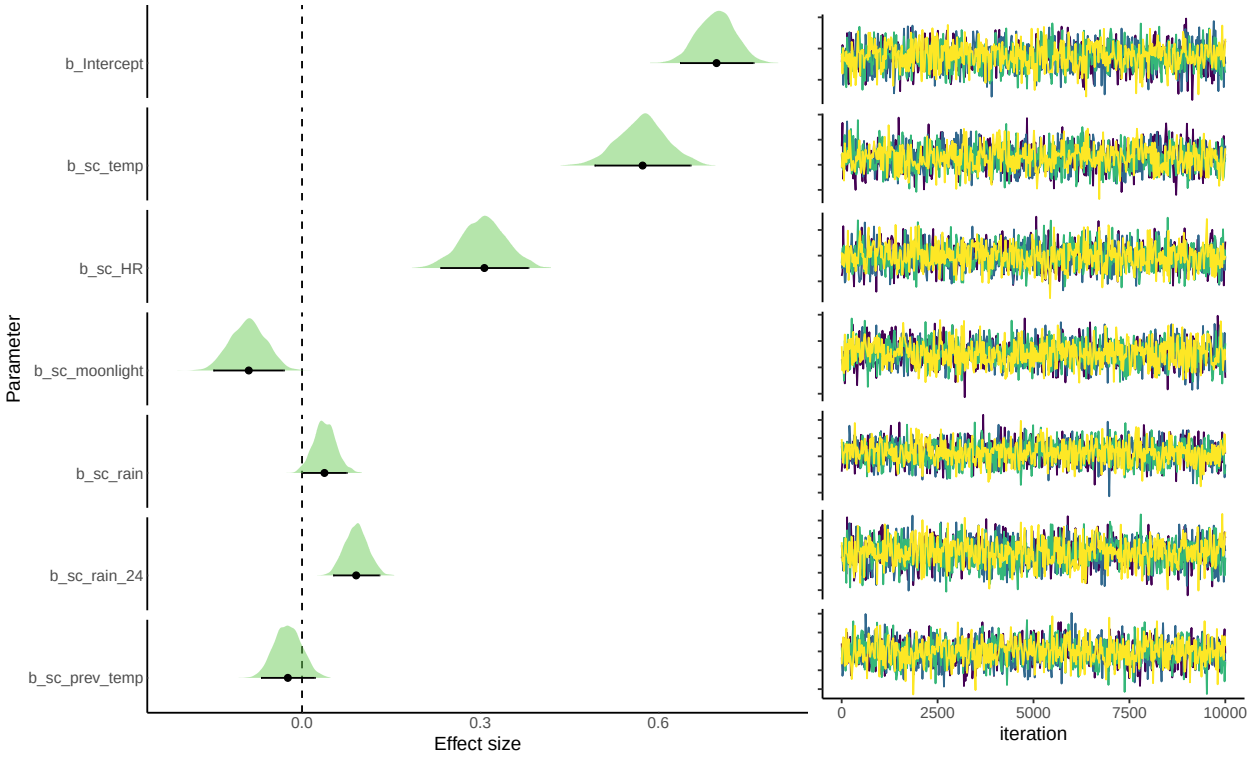
-0.069

0.022

1

14546.5

13679.8




```
extended_summary(read.file = "./data/processed/regression_models/global_rain_48.rds",
    n.posterior = 1000)
```

global_rain_48

priors

formula

iterations

chains

thinning

warmup

diverg_transitions

rhats > 1.05

min_bulk_ESS

min_tail_ESS

seed

1

b-normal(0, 4) Intercept-student_t(3, 3.6, 2.5) sderr-student_t(3, 0, 2.5) shape-gamma(0.01, 0.01)

n_call | resp_rate(rec_time) ~ sc_temp + sc_HR + sc_moonlight + sc_rain + sc_rain_48 + sc_prev_temp + ar(p = 2, time = hour_diff, gr = hour)

10000

4

1

5000

0

0

12375.1

13473.4

58053599

Estimate

l-95% CI

u-95% CI

Rhat

Bulk_ESS

Tail_ESS

b_Intercept

0.703

0.640

0.766

1

12375.1

13699.9

b_sc_temp

0.566

0.485

0.649

1

13593.6

13473.4

b_sc_HR

0.303

0.228

0.379

1

17757.9

15101.0

b_sc_moonlight

-0.098

-0.158

-0.039

1

18857.2

14680.5

b_sc_rain

0.031

-0.006

0.068

1

22865.9

15592.2

b_sc_rain_48

-0.006

-0.044

0.033

1

24427.4

16403.0

b_sc_prev_temp

-0.037

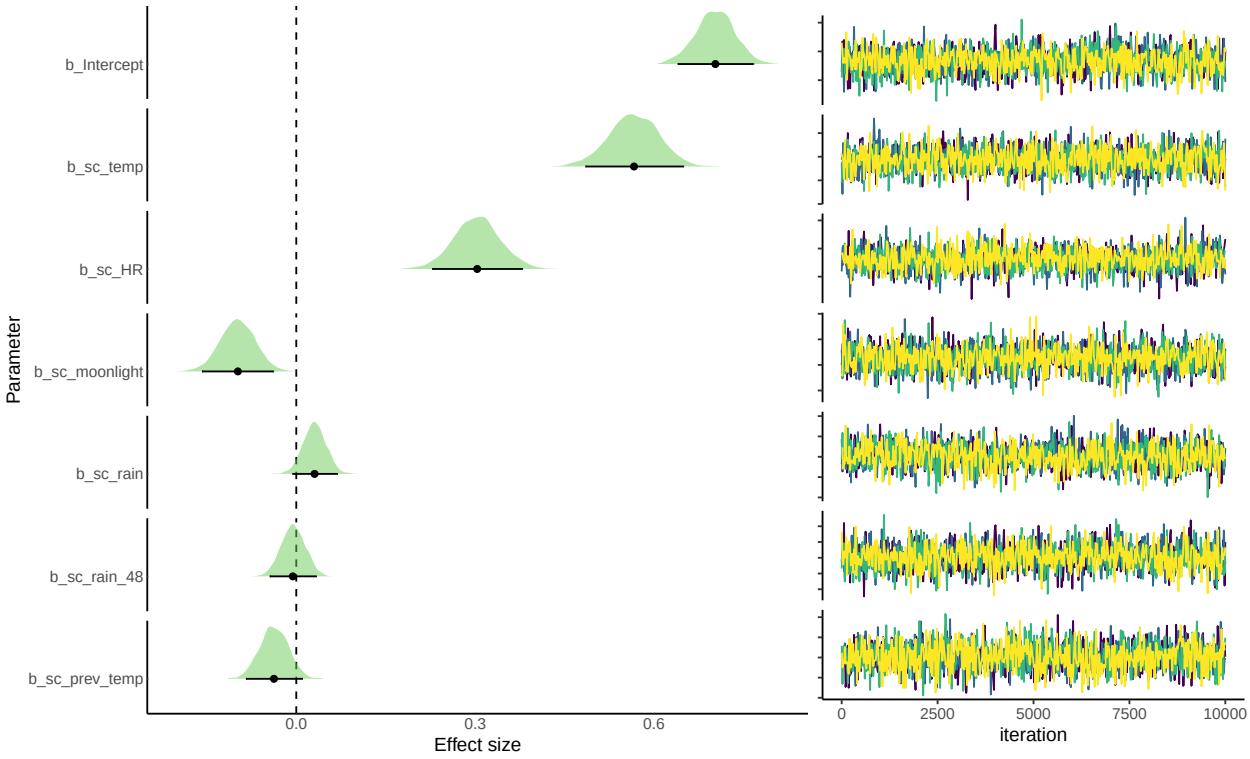
-0.084

0.010

1

20592.6

15806.9



Temperature

The increase in temperature at night causes that activity of A. lemur to decrease?

```
fit2.1 <- brm(n_call | resp_rate(rec_time) ~ sc_temp + sc_rain + sc_rain_24 + ar(p = 2,
    time = hour_diff, gr = hour), data = call_rate_hour, iter = iter, chains = chains,
    cores = chains, family = negbinomial(), prior = priors, file = "./data/processed/reg
    file_refit = "always")

fit2.2 <- brm(n_call | resp_rate(rec_time) ~ sc_temp + sc_rain + sc_rain_48 + ar(p = 2,
    time = hour_diff, gr = hour), data = call_rate_hour, iter = iter, chains = chains,
    cores = chains, family = negbinomial(), prior = priors, file = "./data/processed/reg
    file_refit = "always")

fit2.3 <- brm(n_call | resp_rate(rec_time) ~ sc_prev_temp + ar(p = 2, time = hour_diff,
    gr = hour), data = call_rate_hour, iter = iter, chains = chains, cores = chains,
    family = negbinomial(), prior = priors, file = "./data/processed/regression_models/t
    file_refit = "always")
```

```
extended_summary(read.file = "./data/processed/regression_models/temp2.1.rds", n.posteri
```

temp2.1

priors

formula

iterations

chains

thinning

warmup

diverg_transitions

rhats > 1.05

min_bulk_ESS

min_tail_ESS

seed

1

b-normal(0, 4) Intercept-student_t(3, 3.6, 2.5) sderr-student_t(3, 0, 2.5) shape-gamma(0.01, 0.01)

n_call | resp_rate(rec_time) ~ sc_temp + sc_rain + sc_rain_24 + ar(p = 2, time = hour_diff, gr = hour)

10000

4

1

5000

1

0

10328.4

12111.8

1846130948

Estimate

l-95% CI

u-95% CI

Rhat

Bulk_ESS

Tail_ESS

b_Intercept

0.698

0.634

0.762

1

10328.4

12111.8

b_sc_temp

0.312

0.261

0.361

1

12331.5

14350.8

b_sc_rain

0.044

0.008

0.083

1

20658.2

15981.9

b_sc_rain_24

0.090

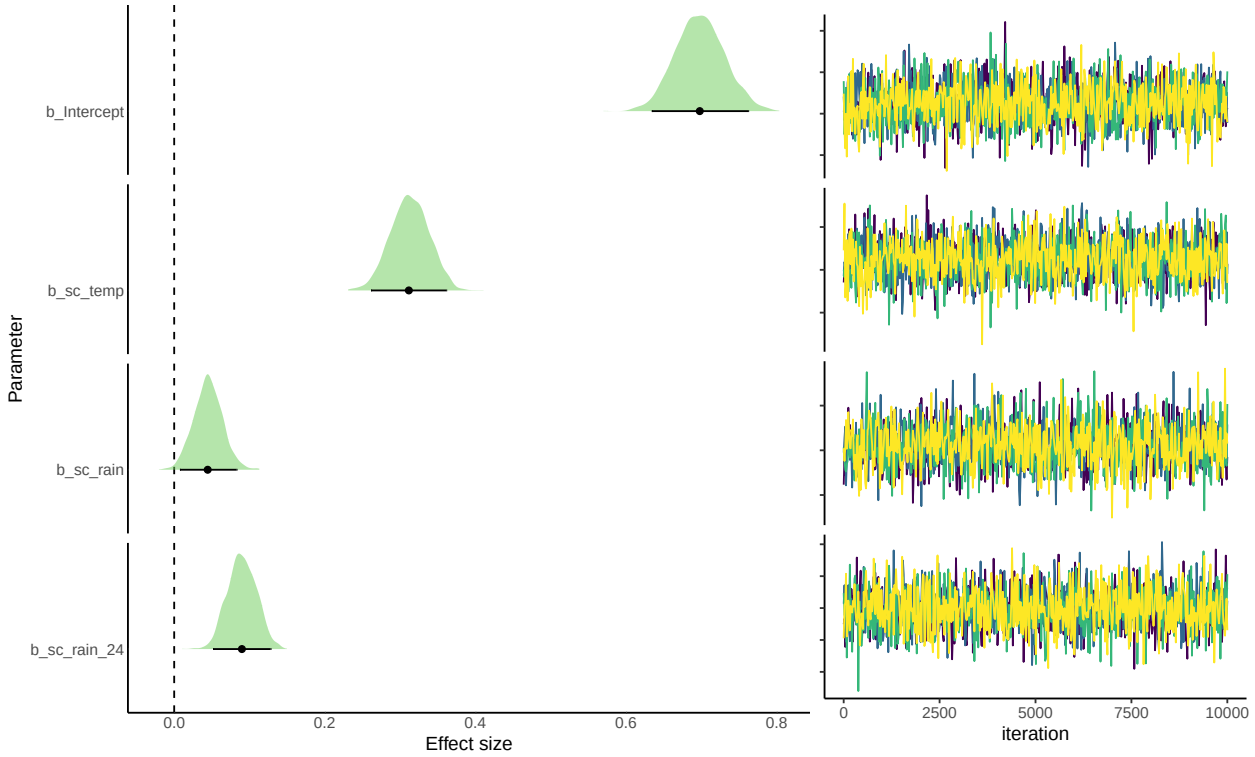
0.052

0.128

1

20542.9

16470.9




```
extended_summary(read.file = "./data/processed/regression_models/temp2.2.rds", n.posteri
```

temp2.2

priors

formula

iterations

chains

thinning

warmup

diverg_transitions

rhats > 1.05

min_bulk_ESS

min_tail_ESS

seed

1

b-normal(0, 4) Intercept-student_t(3, 3.6, 2.5) sderr-student_t(3, 0, 2.5) shape-gamma(0.01, 0.01)

n_call | resp_rate(rec_time) ~ sc_temp + sc_rain + sc_rain_48 + ar(p = 2, time = hour_diff, gr = hour)

10000

4

1

5000

0

0

8873.8

11982.2

2046380001

Estimate

l-95% CI

u-95% CI

Rhat

Bulk_ESS

Tail_ESS

b_Intercept

0.701

0.635

0.766

1

8873.8

11982.2

b_sc_temp

0.305

0.255

0.355

1

10391.0

13564.9

b_sc_rain

0.036

0.000

0.073

1

17117.4

15242.3

b_sc_rain_48

0.006

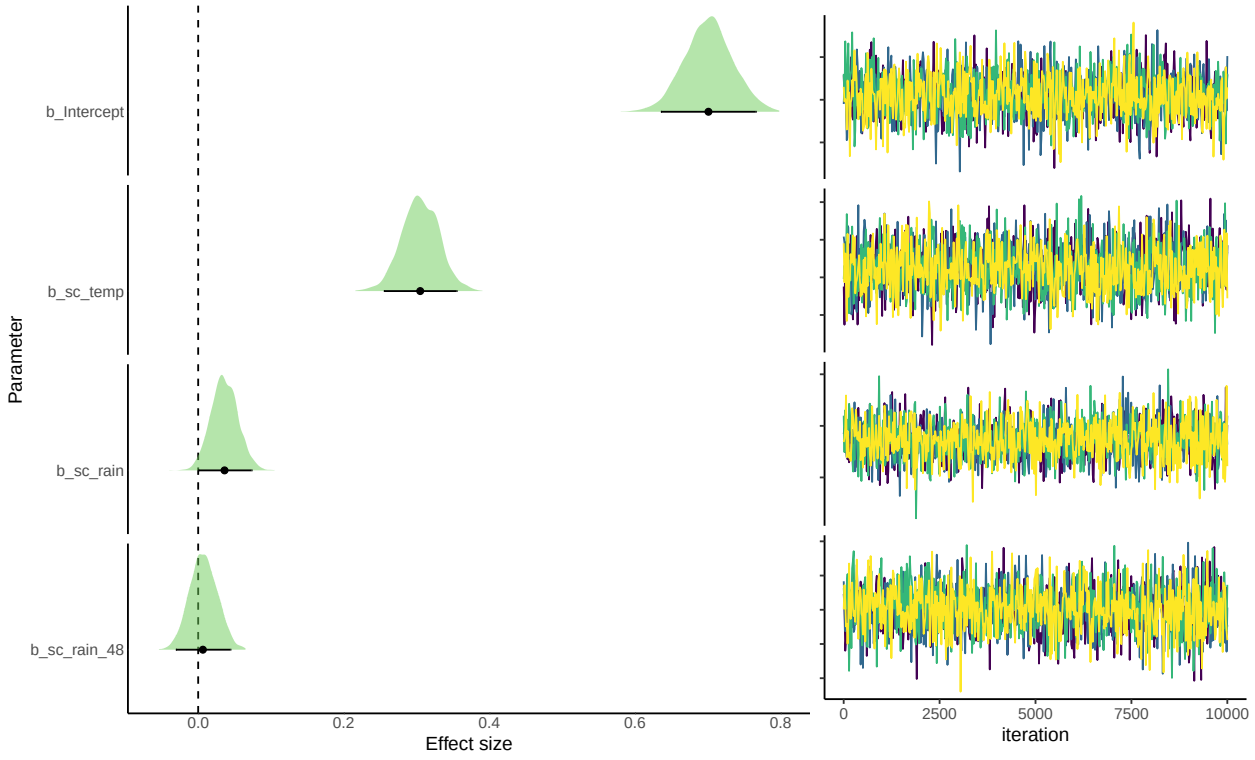
-0.031

0.044

1

17732.8

15884.1




```
extended_summary(read.file = "./data/processed/regression_models/temp2.3.rds", n.posteri
```

temp2.3

priors

formula

iterations

chains

thinning

warmup

diverg_transitions

rhats > 1.05

min_bulk_ESS

min_tail_ESS

seed

1

b-normal(0, 4) Intercept-student_t(3, 3.6, 2.5) sderr-student_t(3, 0, 2.5) shape-gamma(0.01, 0.01)

n_call | resp_rate(rec_time) ~ sc_prev_temp + ar(p = 2, time = hour_diff, gr = hour)

10000

4

1

5000

0

0

20200

15620.2

1962664000

Estimate

l-95% CI

u-95% CI

Rhat

Bulk_ESS

Tail_ESS

b_Intercept

0.675

0.605

0.745

1

20200.0

15620.2

b_sc_prev_temp

-0.002

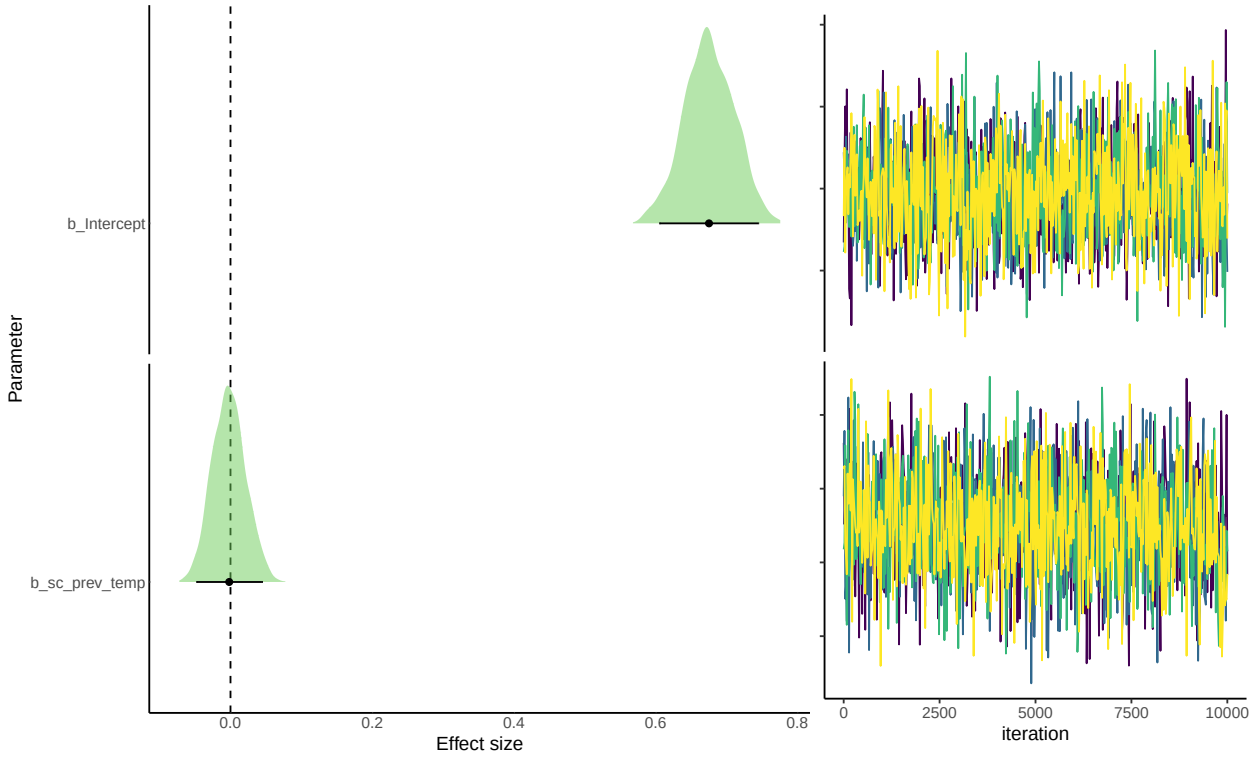
-0.048

0.044

1

36045.7

16766.2



Relative humidity

Does an increase in relative humidity cause the activity of A. lemur to increase?

```
fit.3.1 <- brm(n_call | resp_rate(rec_time) ~ sc_temp + sc_HR + sc_rain + sc_rain_24 +
    ar(p = 2, time = hour_diff, gr = hour), data = call_rate_hour, iter = iter, chains =
    cores = chains, family = negbinomial(), prior = priors, file = "./data/processed/reg
    file_refit = "always")
```

```
fit.3.2 <- brm(n_call | resp_rate(rec_time) ~ sc_temp + sc_HR + sc_rain + sc_rain_48 +
    ar(p = 2, time = hour_diff, gr = hour), data = call_rate_hour, iter = iter, chains =
    cores = chains, family = negbinomial(), prior = priors, file = "./data/processed/reg
    file_refit = "always")  # Este tengo que doblemente confirmarlo
```

```
extended_summary(read.file = "./data/processed/regression_models/RH3.1.rds", n.posterior
```

RH3.1

priors

formula

iterations

chains

thinning

warmup

diverg_transitions

rhats > 1.05

min_bulk_ESS

min_tail_ESS

seed

1

b-normal(0, 4) Intercept-student_t(3, 3.6, 2.5) sderr-student_t(3, 0, 2.5) shape-gamma(0.01, 0.01)

n_call | resp_rate(rec_time) ~ sc_temp + sc_HR + sc_rain + sc_rain_24 + ar(p = 2, time = hour_diff, gr = hour)

10000

4

1

5000

0

0

10000

12606.5

1854758574

Estimate

l-95% CI

u-95% CI

Rhat

Bulk_ESS

Tail_ESS

b_Intercept

0.699

0.637

0.760

1

10000.0

12606.5

b_sc_temp

0.578

0.499

0.656

1

13756.3

13884.5

b_sc_HR

0.314

0.242

0.385

1

17498.1

14651.1

b_sc_rain

0.037

0.002

0.075

1

24287.1

16414.2

b_sc_rain_24

0.096

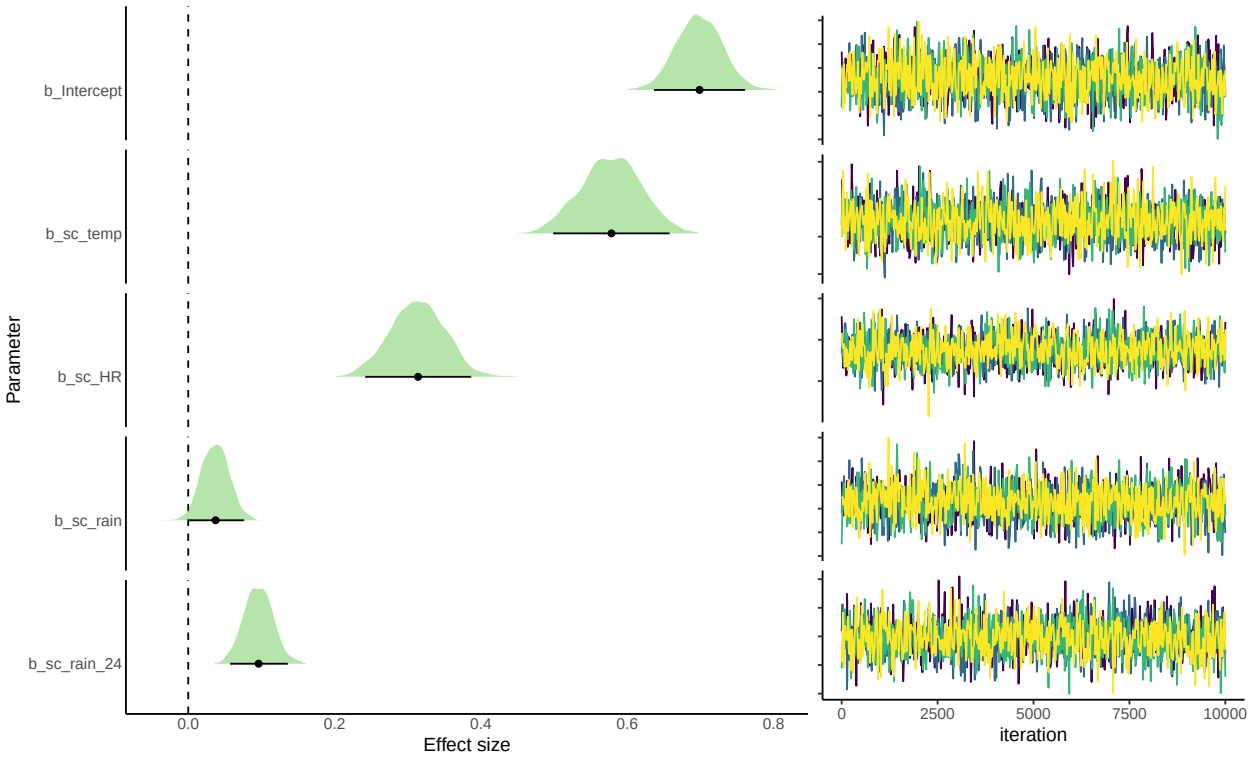
0.058

0.135

1

22809.6

15579.0




```
extended_summary(read.file = "./data/processed/regression_models/RH3.2.rds", n.posterior
```

RH3.2

priors

formula

iterations

chains

thinning

warmup

diverg_transitions

rhats > 1.05

min_bulk_ESS

min_tail_ESS

seed

1

b-normal(0, 4) Intercept-student_t(3, 3.6, 2.5) sderr-student_t(3, 0, 2.5) shape-gamma(0.01, 0.01)

n_call | resp_rate(rec_time) ~ sc_temp + sc_HR + sc_rain + sc_rain_48 + ar(p = 2, time = hour_diff, gr = hour)

10000

4

1

5000

0

0

8492.95

12550.7

1444793977

Estimate

l-95% CI

u-95% CI

Rhat

Bulk_ESS

Tail_ESS

b_Intercept

0.703

0.641

0.765

1

8492.95

12697.7

b_sc_temp

0.567

0.488

0.648

1

9626.63

12550.7

b_sc_HR

0.308

0.235

0.382

1

12079.96

13794.6

b_sc_rain

0.029

-0.007

0.066

1

18138.82

15107.9

b_sc_rain_48

0.005

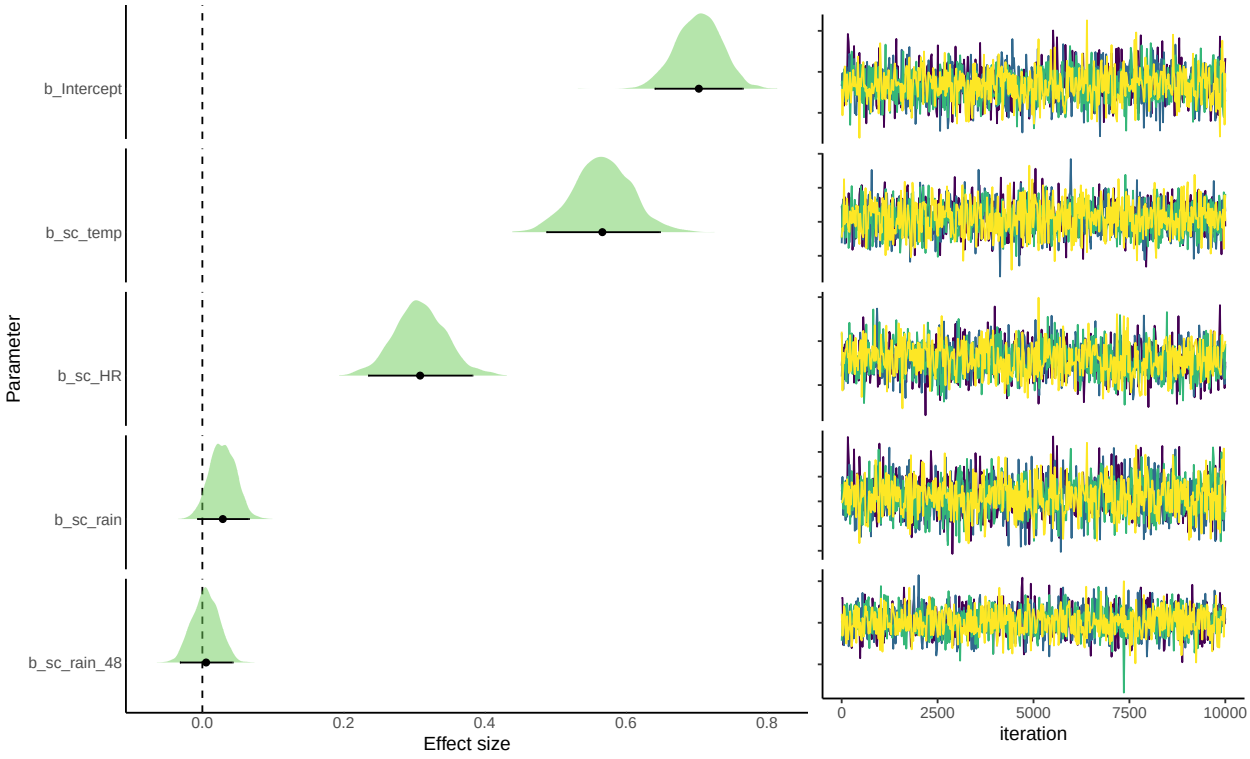
-0.032

0.043

1

16926.99

14915.2



Moon

Decreasing the percentage of the moon illuminated causes an increase in A. lemur activity?

```
fit.4 <- brm(n_call | resp_rate(rec_time) ~ sc_moonlight + ar(p = 2, time = hour_diff,
    gr = hour), data = call_rate_hour, iter = iter, chains = chains, cores = chains,
    family = negbinomial(), prior = priors, file = "./data/processed/regression_models/m
    file_refit = "always")
```

```
extended_summary(read.file = "./data/processed/regression_models/moon4.rds", n.posterior
```

moon4

priors

formula

iterations

chains

thinning

warmup

diverg_transitions

rhats > 1.05

min_bulk_ESS

min_tail_ESS

seed

1

b-normal(0, 4) Intercept-student_t(3, 3.6, 2.5) sderr-student_t(3, 0, 2.5) shape-gamma(0.01, 0.01)

n_call | resp_rate(rec_time) ~ sc_moonlight + ar(p = 2, time = hour_diff, gr = hour)

10000

4

1

5000

0

0

19357

14632

1734290538

Estimate

l-95% CI

u-95% CI

Rhat

Bulk_ESS

Tail_ESS

b_Intercept

0.674

0.606

0.743

1

19357.0

14632.0

b_sc_moonlight

-0.128

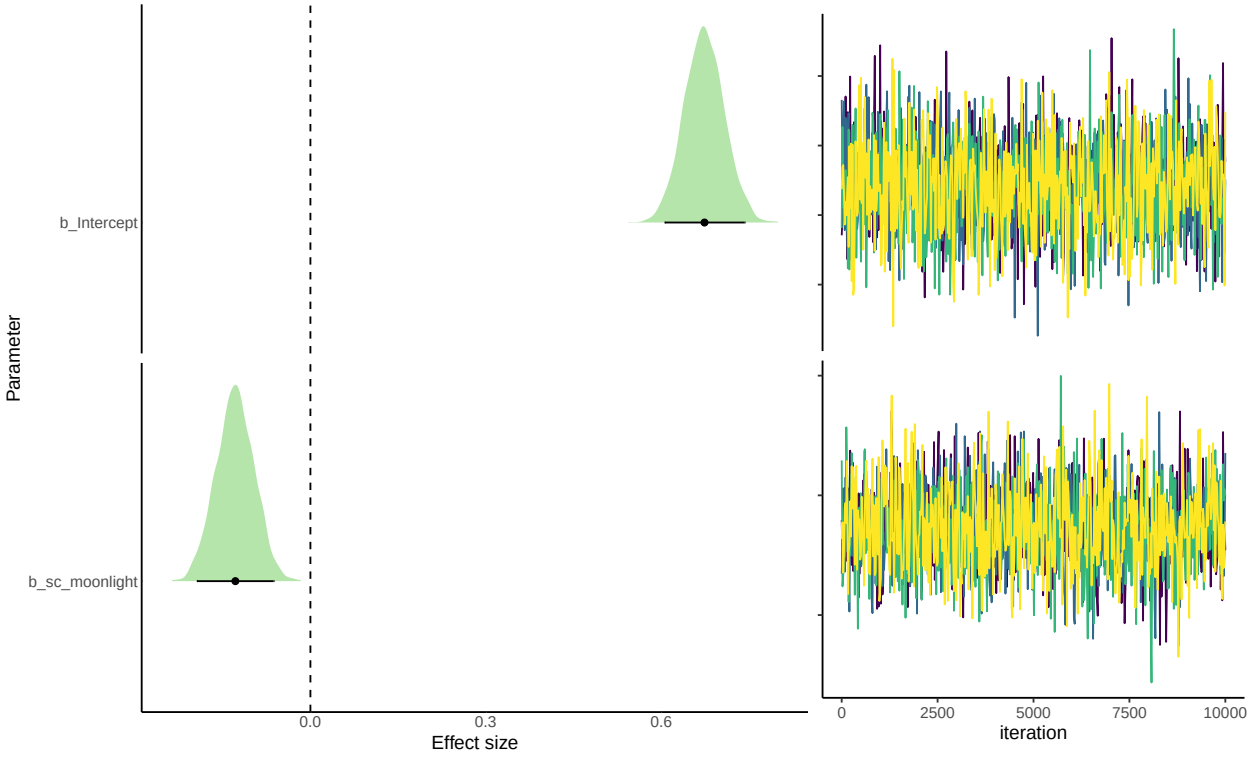
-0.194

-0.063

1

31443.5

15209.9



Night rain

If the night rain decreases can affect the A. lemur activity to increase?

```
fit.5.1 <- brm(n_call | resp_rate(rec_time) ~ sc_prev_temp + sc_rain + sc_rain_48 +
    ar(p = 2, time = hour_diff, gr = hour), data = call_rate_hour, iter = iter, chains =
    cores = chains, family = negbinomial(), prior = priors, file = "./data/processed/reg
    file_refit = "always")

fit.5.2 <- brm(n_call | resp_rate(rec_time) ~ sc_prev_temp + sc_rain + sc_rain_24 +
    ar(p = 2, time = hour_diff, gr = hour), data = call_rate_hour, iter = iter, chains =
    cores = chains, family = negbinomial(), prior = priors, file = "./data/processed/reg
    file_refit = "always")
```

```
extended_summary(read.file = "./data/processed/regression_models/night_rain5.1.rds",
    n.posterior = 1000)
```

night_rain5.1

priors

formula

iterations

chains

thinning

warmup

diverg_transitions

rhats > 1.05

min_bulk_ESS

min_tail_ESS

seed

1

b-normal(0, 4) Intercept-student_t(3, 3.6, 2.5) sderr-student_t(3, 0, 2.5) shape-gamma(0.01, 0.01)

n_call | resp_rate(rec_time) ~ sc_prev_temp + sc_rain + sc_rain_48 + ar(p = 2, time = hour_diff, gr = hour)

10000

4

1

5000

0

0

15449.5

13446.5

1903747053

Estimate

l-95% CI

u-95% CI

Rhat

Bulk_ESS

Tail_ESS

b_Intercept

0.676

0.607

0.745

1.001

15449.5

13446.5

b_sc_prev_temp

0.003

-0.046

0.052

1

27583.8

14753.3

b_sc_rain

-0.006

-0.042

0.030

1

29045.4

16584.0

b_sc_rain_48

0.014

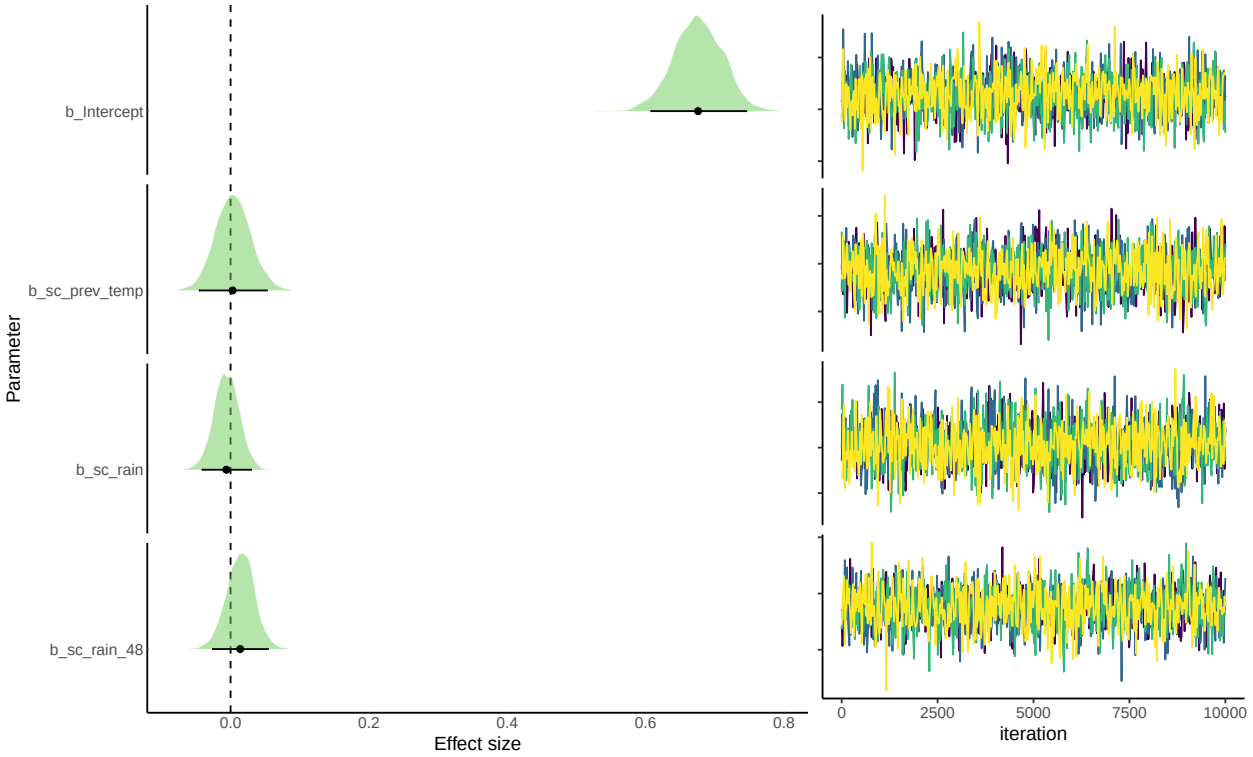
-0.027

0.054

1

27750.2

15632.5




```
extended_summary(read.file = "./data/processed/regression_models/night_rain5.2.rds",
    n.posterior = 1000)
```

night_rain5.2

priors

formula

iterations

chains

thinning

warmup

diverg_transitions

rhats > 1.05

min_bulk_ESS

min_tail_ESS

seed

1

b-normal(0, 4) Intercept-student_t(3, 3.6, 2.5) sderr-student_t(3, 0, 2.5) shape-gamma(0.01, 0.01)

n_call | resp_rate(rec_time) ~ sc_prev_temp + sc_rain + sc_rain_24 + ar(p = 2, time = hour_diff, gr = hour)

10000

4

1

5000

0

0

21570

14952.6

1800703315

Estimate

l-95% CI

u-95% CI

Rhat

Bulk_ESS

Tail_ESS

b_Intercept

0.673

0.604

0.742

1

21570.0

14952.6

b_sc_prev_temp

0.007

-0.039

0.054

1

39064.3

16543.7

b_sc_rain

0.001

-0.035

0.038

1

36294.6

16198.6

b_sc_rain_24

0.077

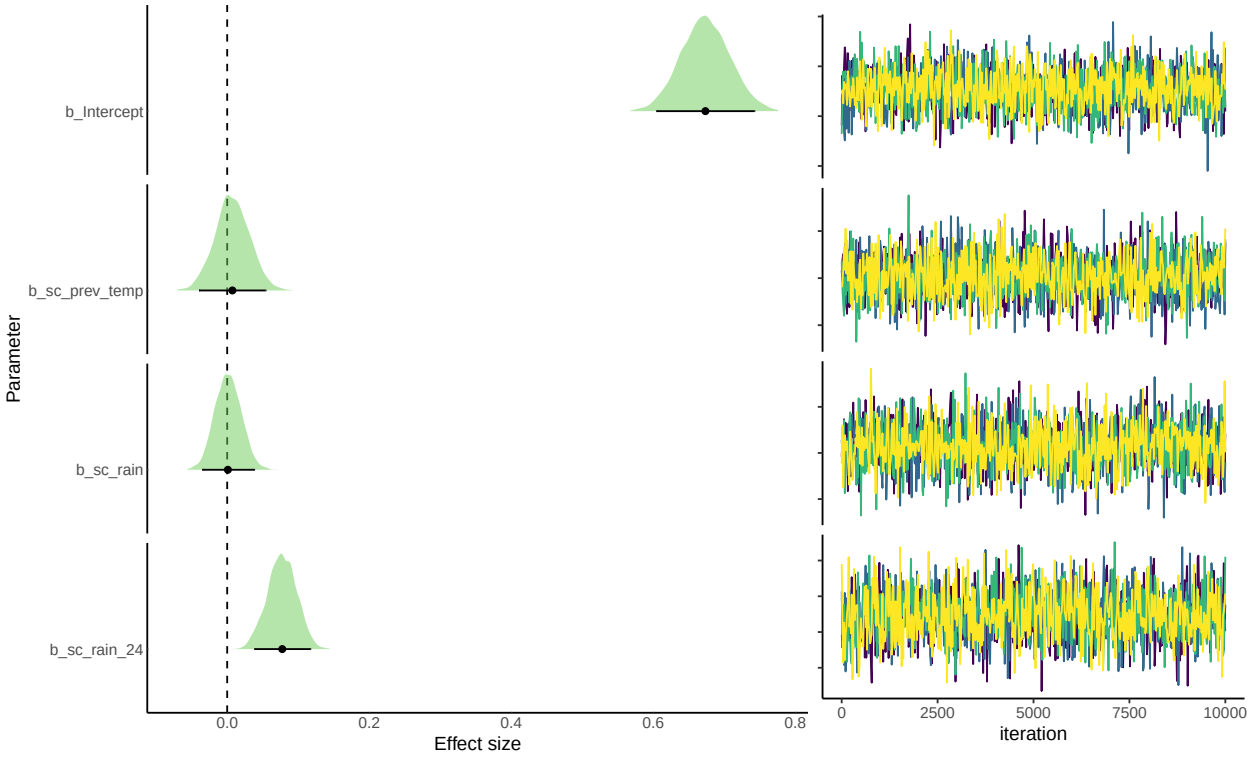
0.038

0.117

1

34404.5

17412.9



Previous Rain

Does an increase in the accumulated previous rain causes that A. lemur activity to increase?

```
fit.6.1 <- brm(n_call | resp_rate(rec_time) ~ sc_temp + sc_rain + sc_rain_48 + ar(p = 2,
    time = hour_diff, gr = hour), data = call_rate_hour, iter = iter, chains = chains,
    cores = chains, family = negbinomial(), prior = priors, file = "./data/processed/reg
    file_refit = "always")

fit.6.2 <- brm(n_call | resp_rate(rec_time) ~ sc_temp + sc_rain + sc_rain_24 + ar(p = 2,
    time = hour_diff, gr = hour), data = call_rate_hour, iter = iter, chains = chains,
    cores = chains, family = negbinomial(), prior = priors, file = "./data/processed/reg
    file_refit = "always")

fit.6.3 <- brm(n_call | resp_rate(rec_time) ~ sc_temp + sc_HR + sc_rain_24 + ar(p = 2,
    time = hour_diff, gr = hour), data = call_rate_hour, iter = iter, chains = chains,
    cores = chains, family = negbinomial(), prior = priors, file = "./data/processed/reg
    file_refit = "always")
```

```
extended_summary(read.file = "./data/processed/regression_models/previous_rain6.1.rds",
    n.posterior = 1000)
```

previous_rain6.1

priors

formula

iterations

chains

thinning

warmup

diverg_transitions

rhats > 1.05

min_bulk_ESS

min_tail_ESS

seed

1

b-normal(0, 4) Intercept-student_t(3, 3.6, 2.5) sderr-student_t(3, 0, 2.5) shape-gamma(0.01, 0.01)

n_call | resp_rate(rec_time) ~ sc_temp + sc_rain + sc_rain_48 + ar(p = 2, time = hour_diff, gr = hour)

10000

4

1

5000

0

0

8446.05

11423.8

20512253

Estimate

l-95% CI

u-95% CI

Rhat

Bulk_ESS

Tail_ESS

b_Intercept

0.701

0.636

0.764

1

8446.05

11423.8

b_sc_temp

0.304

0.254

0.355

1

10470.72

13123.6

b_sc_rain

0.036

0.000

0.074

1

16919.56

15417.1

b_sc_rain_48

0.007

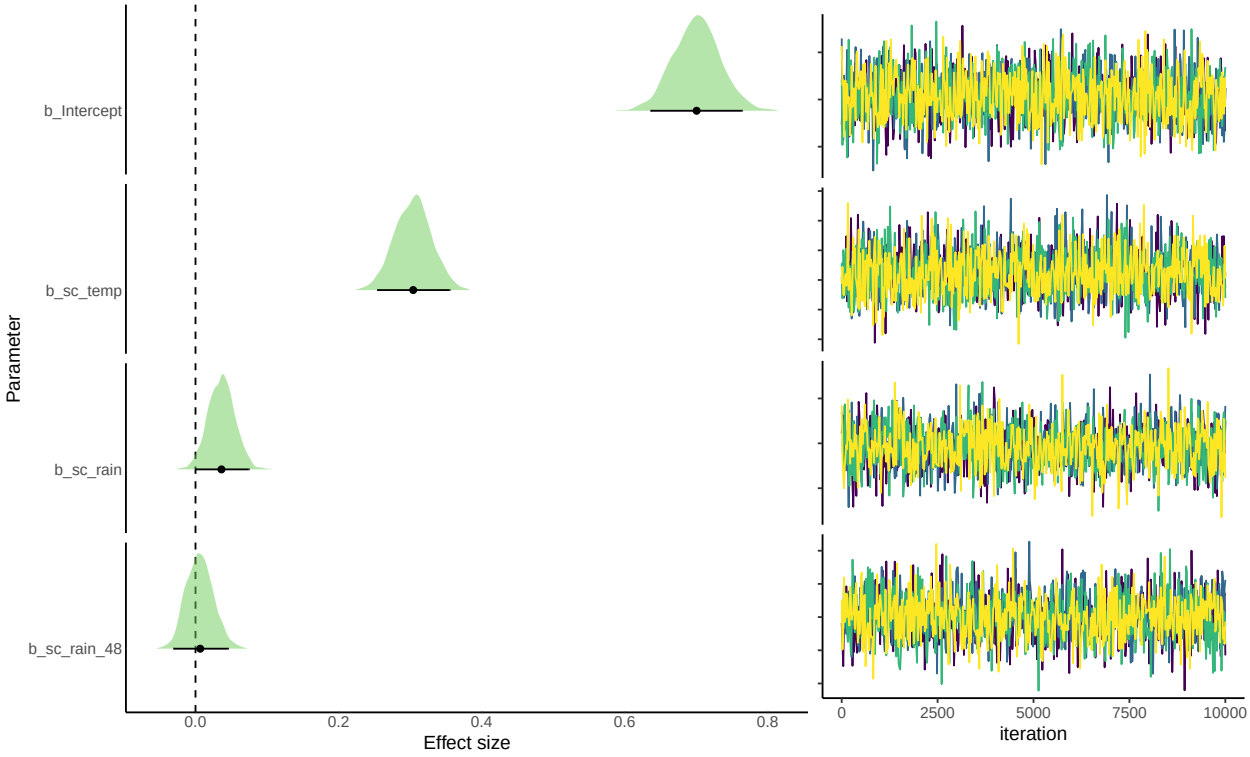
-0.031

0.045

1

17069.15

15935.4




```
extended_summary(read.file = "./data/processed/regression_models/previous_rain6.2.rds",
    n.posterior = 1000)
```

previous_rain6.2

priors

formula

iterations

chains

thinning

warmup

diverg_transitions

rhats > 1.05

min_bulk_ESS

min_tail_ESS

seed

1

b-normal(0, 4) Intercept-student_t(3, 3.6, 2.5) sderr-student_t(3, 0, 2.5) shape-gamma(0.01, 0.01)

n_call | resp_rate(rec_time) ~ sc_temp + sc_rain + sc_rain_24 + ar(p = 2, time = hour_diff, gr = hour)

10000

4

1

5000

0

0

11468.2

13337.9

1714781937

Estimate

l-95% CI

u-95% CI

Rhat

Bulk_ESS

Tail_ESS

b_Intercept

0.698

0.633

0.762

1

11468.2

13337.9

b_sc_temp

0.312

0.262

0.362

1

13834.2

13973.2

b_sc_rain

0.045

0.008

0.083

1

23413.4

15796.1

b_sc_rain_24

0.090

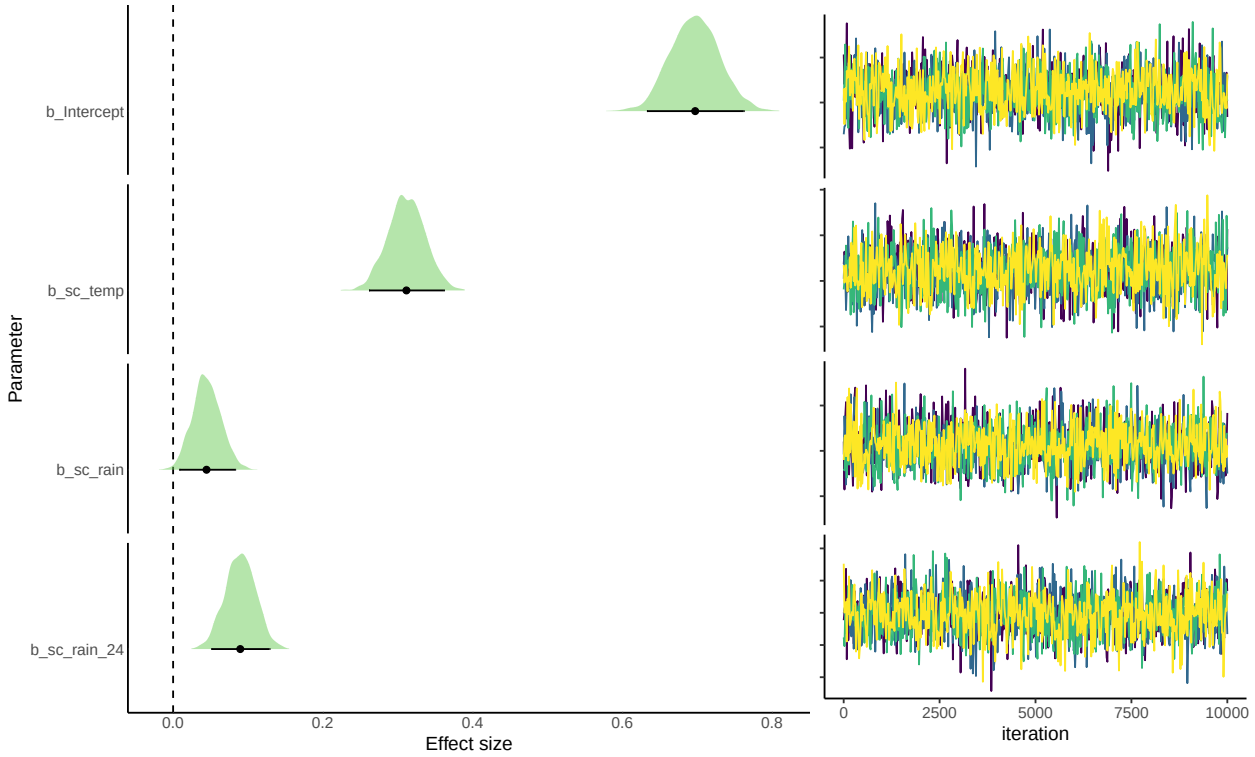
0.051

0.129

1

22867.5

15487.7




```
extended_summary(read.file = "./data/processed/regression_models/night_rain6.3.rds",
    n.posterior = 1000)
```

night_rain6.3

priors

formula

iterations

chains

thinning

warmup

diverg_transitions

rhats > 1.05

min_bulk_ESS

min_tail_ESS

seed

1

b-normal(0, 4) Intercept-student_t(3, 3.6, 2.5) sderr-student_t(3, 0, 2.5) shape-gamma(0.01, 0.01)

n_call | resp_rate(rec_time) ~ sc_temp + sc_HR + sc_rain_24 + ar(p = 2, time = hour_diff, gr = hour)

10000

4

1

5000

2

0

7697.31

11401.3

2086406674

Estimate

l-95% CI

u-95% CI

Rhat

Bulk_ESS

Tail_ESS

b_Intercept

0.699

0.636

0.760

1

7697.31

11401.3

b_sc_temp

0.572

0.493

0.650

1

8657.91

12183.9

b_sc_HR

0.318

0.244

0.391

1

10071.18

12501.7

b_sc_rain_24

0.093

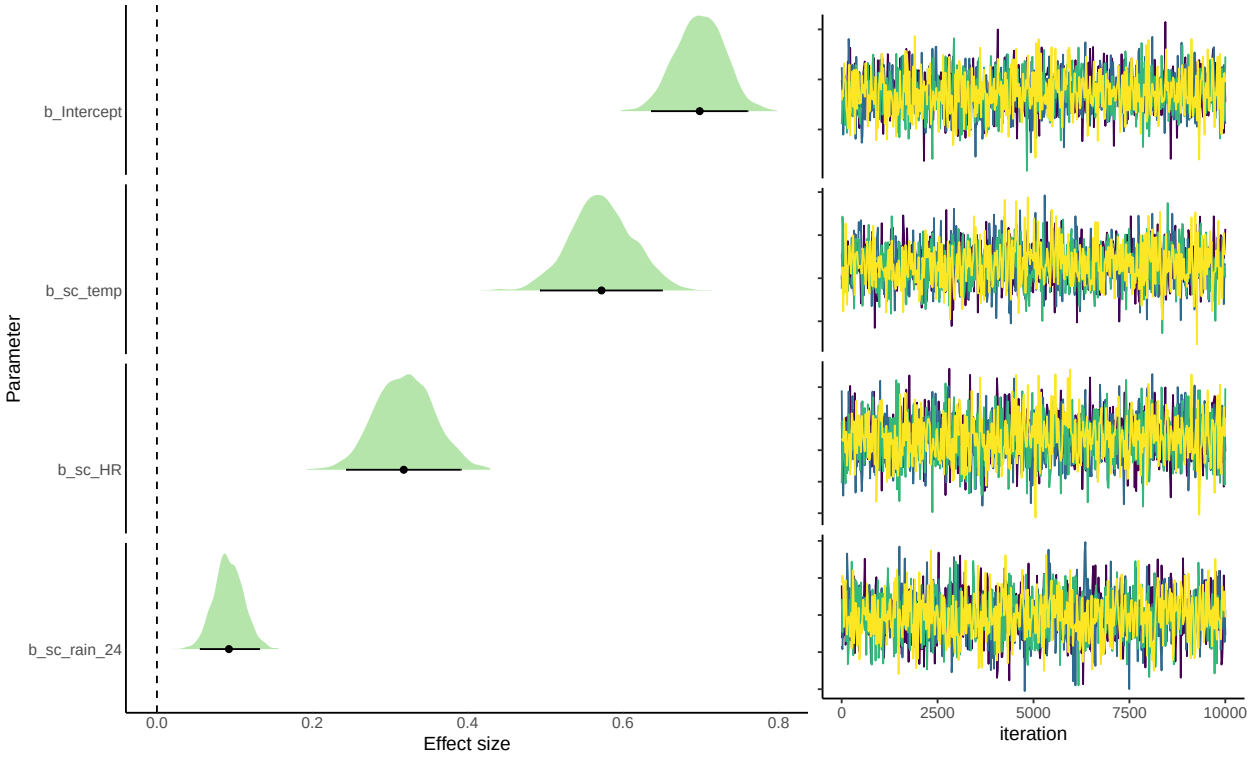
0.055

0.131

1

14992.10

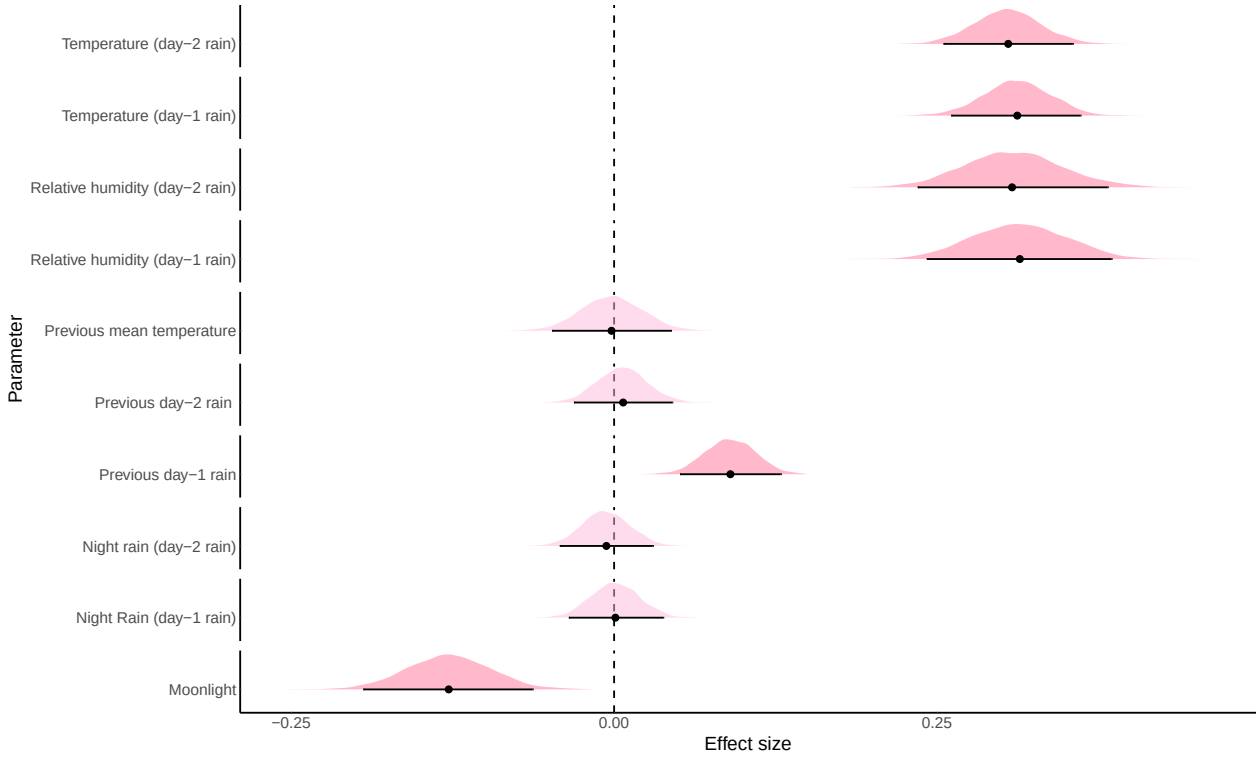
14450.6



Causal model combined effect size plot

Takes the effect sizes (and posteriors) from the right causal models

```r
coef_table <- read.csv("./data/processed/summary_causal_model_table_13-01-23.csv",
    sep = "\t")

coef_table$variable <- coef_table$Label
coef_table$value <- coef_table$Estimate
coef_table$significance <- ifelse(coef_table$CI_low * coef_table$CI_high > 0, "sig",
    "no.sig")

posteriors_l <- lapply(1:nrow(coef_table), function(x) {

    # print(x)
    X <- readRDS(coef_table$Model[x])
    xdrws <- brms::as_draws(X)
    post <- xdrws$`1`[[paste0("b_", coef_table$Variable[x])]]
    out <- data.frame(variable = coef_table$Label[x], value = post, significance = coef_
    return(out)
})

posteriors <- do.call(rbind, posteriors_l)

coef_table$variable <- factor(coef_table$Label, levels = sort(unique(coef_table$Label),
    FALSE))
posteriors$variable <- factor(posteriors$variable, levels = sort(unique(posteriors$varia
    TRUE))


fill_values <- c("#FFB9DF", "#FF7598")
fill_values <- adjustcolor(fill_values, alpha.f = 0.5)

# creat plots gg_dists <-
ggplot2::ggplot(data = posteriors, ggplot2::aes(y = variable, x = value, fill = signific
    ggplot2::geom_vline(xintercept = 0, col = "black", lty = 2) + ggdist::stat_halfeye(g
    .width = c(0.95), normalize = "panels", color = "transparent") + ggplot2::scale_fill
    guide = "none") + ggplot2::geom_point(data = coef_table) + ggplot2::geom_errorbar(da
    ggplot2::aes(xmin = CI_low, xmax = CI_high), width = 0) + ggplot2::scale_color_manua
    ggplot2::facet_wrap(~variable, scales = "free_y", ncol = 1) + ggplot2::theme_classic
    ggplot2::theme(axis.ticks.length = ggplot2::unit(0, "pt"), plot.margin = ggplot2::ma
        0, 0, 0, "pt"), legend.position = "none", strip.background = ggplot2::element_bl
        strip.text = ggplot2::element_blank()) + ggplot2::labs(x = "Effect size",
    y = "Parameter")  #+
```




```
# ggplot2::xlim(range(c(posteriors_by_chain$value, 0)) * plot.area.prop)

ggsave(filename = "./figures/summary_effect_sizes_pooled_from_multiple_causal_models.jpe
```

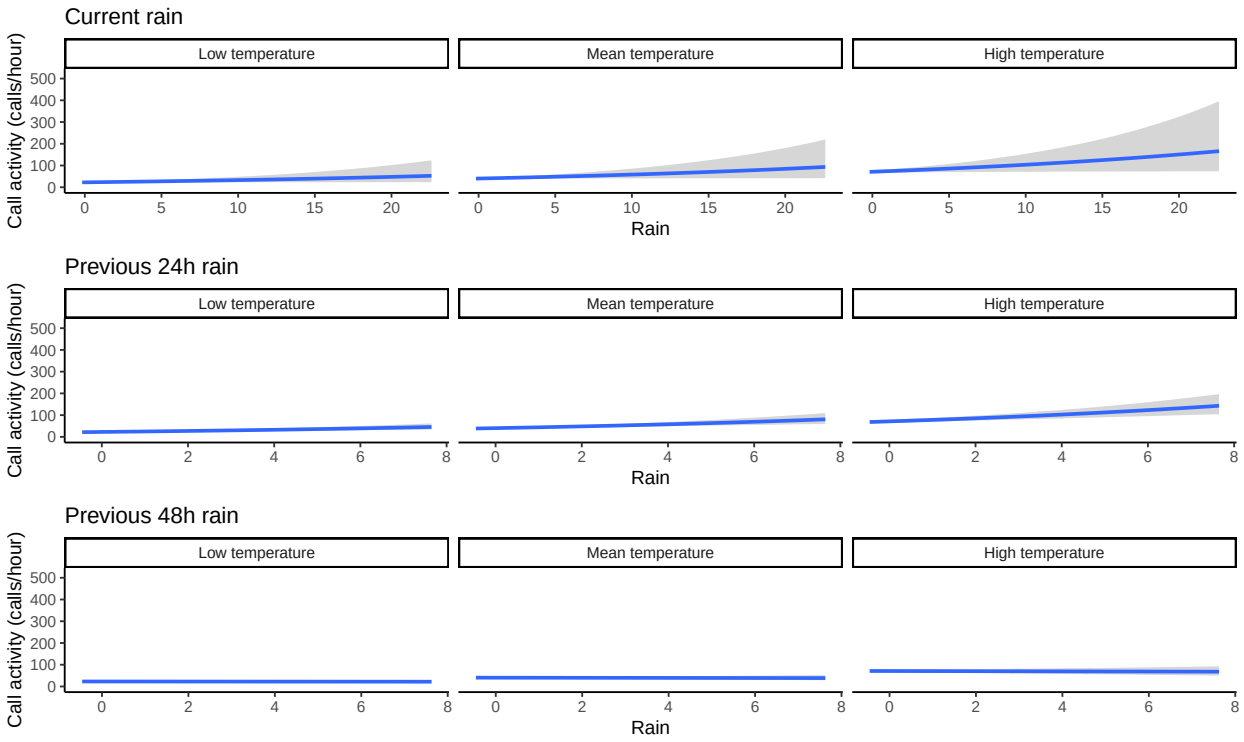
Conditional plots

Measured based on the global model

Rain and temperature

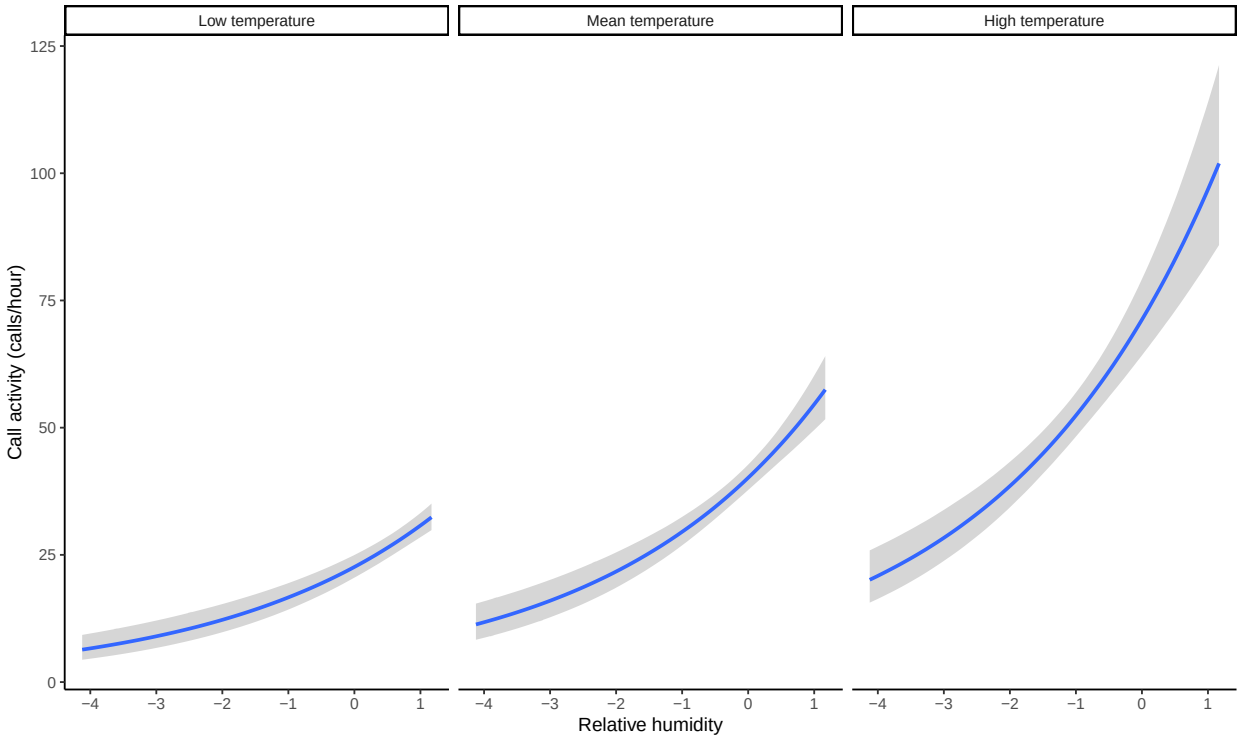
```
glob_mod_24 <- readRDS("./data/processed/regression_models/global_rain_24.rds")

conditions <- data.frame(sc_temp = c(`Low temperature` = -1, `Mean temperature` = 0,
    `High temperature` = 1))

rain_gg <- plot(conditional_effects(glob_mod_24, effects = "sc_rain", conditions = condi
    plot = FALSE)[[1]] + scale_color_viridis_d() + theme_classic() + ylim(c(0, 520)) +
    ggtitle("Current rain") + labs(x = "Rain", y = "Call activity (calls/hour)")

rain24_gg <- plot(conditional_effects(glob_mod_24, effects = "sc_rain_24", conditions =
```

```
    plot = FALSE)[[1]] + scale_color_viridis_d() + theme_classic() + ylim(c(0, 520)) +
    ggtitle("Previous 24h rain") + labs(x = "Rain", y = "Call activity (calls/hour)")

glob_mod_48 <- readRDS("./data/processed/regression_models/global_rain_48.rds")

rain48_gg <- plot(conditional_effects(glob_mod_48, effects = "sc_rain_48", conditions =
    plot = FALSE)[[1]] + scale_color_viridis_d() + theme_classic() + ylim(c(0, 520)) +
    ggtitle("Previous 48h rain") + labs(x = "Rain", y = "Call activity (calls/hour)")


cowplot::plot_grid(rain_gg, rain24_gg, rain48_gg, nrow = 3)
```

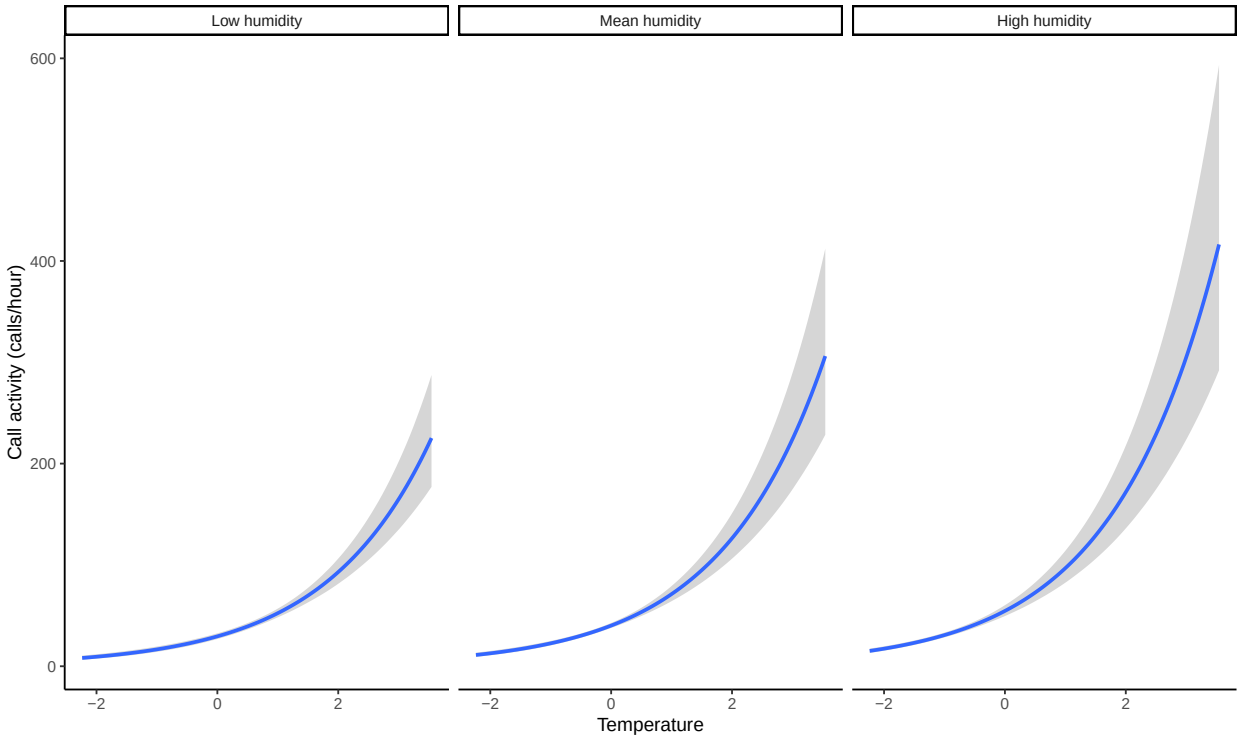


Relative humidity and temperature

```
conditions <- data.frame(sc_temp = c(`Low temperature` = -1, `Mean temperature` = 0,
    `High temperature` = 1))

hr_temp_gg <- plot(conditional_effects(glob_mod_24, effects = "sc_HR", conditions = cond
    plot = FALSE)[[1]] + scale_color_viridis_d() + theme_classic() + labs(x = "Relative
    y = "Call activity (calls/hour)")

hr_temp_gg
```

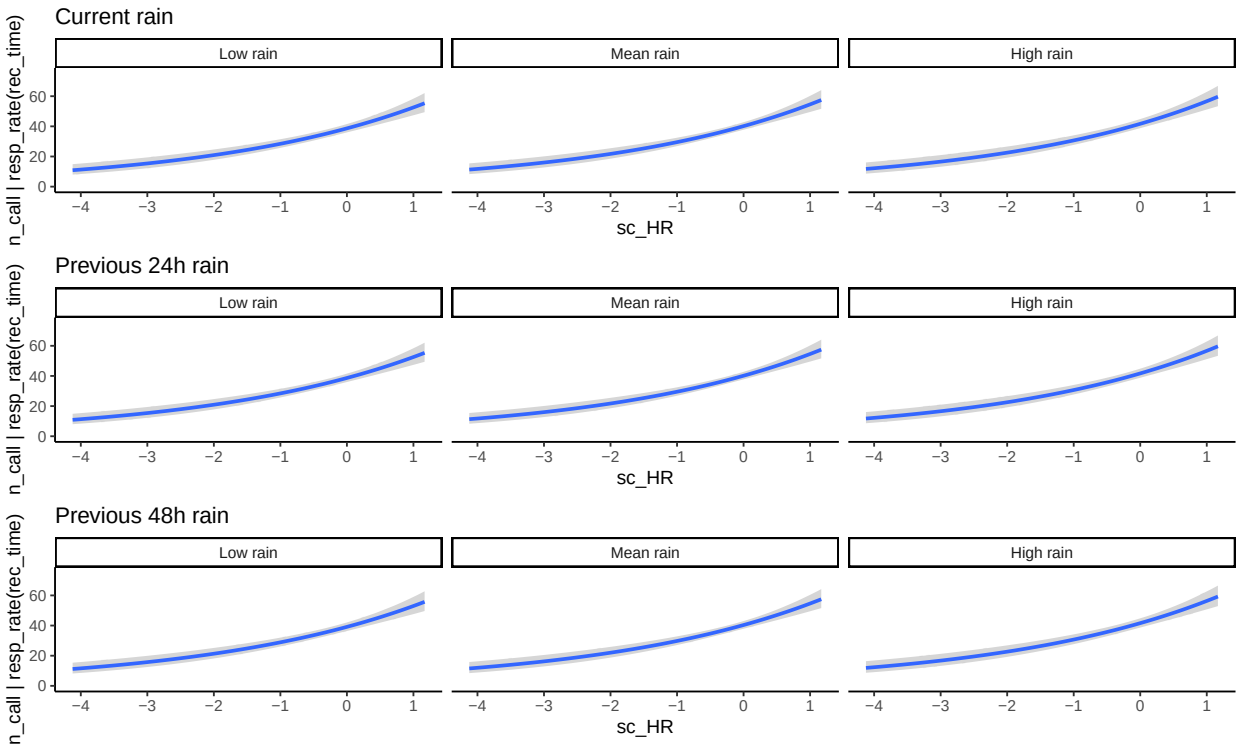



```
conditions <- data.frame(sc_HR = c(`Low humidity` = -1, `Mean humidity` = 0, `High humid

temp_hr_gg <- plot(conditional_effects(glob_mod_24, effects = "sc_temp", conditions = co
    plot = FALSE)[[1]] + scale_color_viridis_d() + theme_classic() + labs(x = "Temperatu
    y = "Call activity (calls/hour)")

temp_hr_gg
```

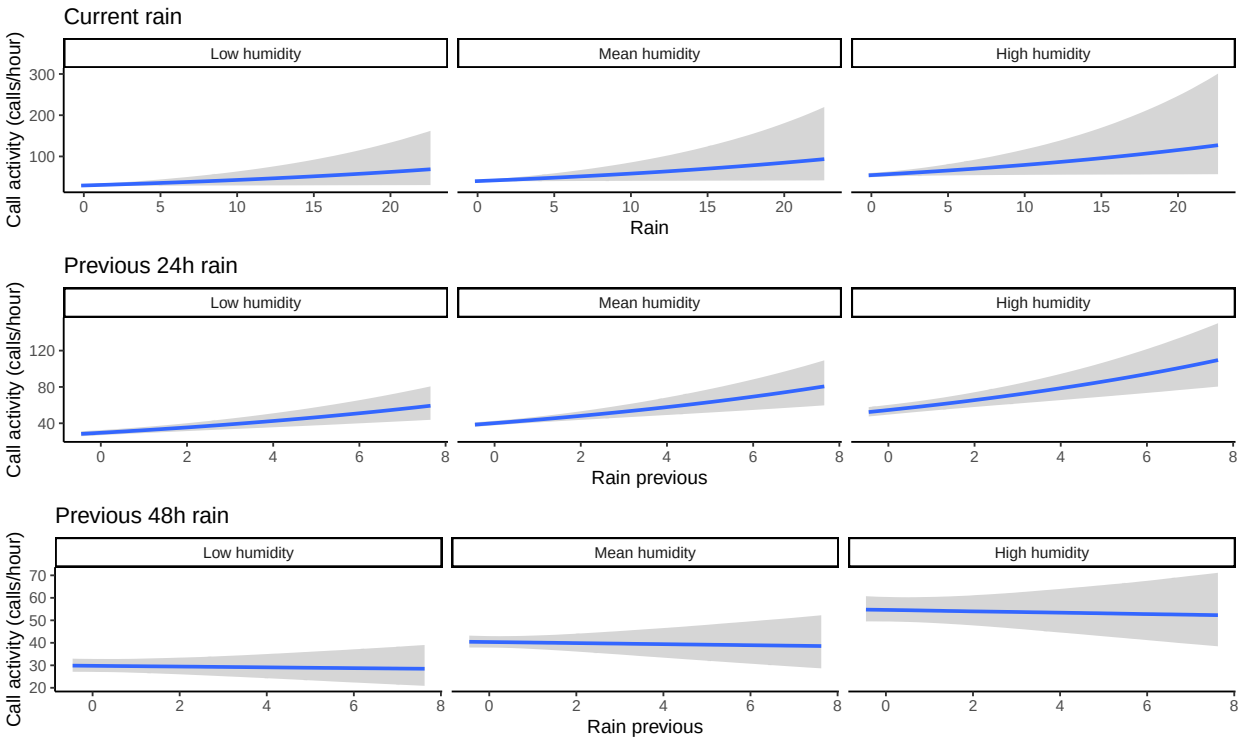


Relative humidity and rain

```
conditions <- data.frame(sc_rain = c(`Low rain` = -1, `Mean rain` = 0, `High rain` = 1))


rain_gg <- plot(conditional_effects(glob_mod_24, effects = "sc_HR", conditions = conditi
    plot = FALSE)[[1]] + scale_color_viridis_d() + theme_classic() + ylim(c(0, 75)) +
    ggtitle("Current rain")

rain24_gg <- plot(conditional_effects(glob_mod_24, effects = "sc_HR", conditions = condi
    plot = FALSE)[[1]] + scale_color_viridis_d() + theme_classic() + ylim(c(0, 75)) +
    ggtitle("Previous 24h rain")

rain48_gg <- plot(conditional_effects(glob_mod_48, effects = "sc_HR", conditions = condi
    plot = FALSE)[[1]] + scale_color_viridis_d() + theme_classic() + ylim(c(0, 75)) +
    ggtitle("Previous 48h rain")

cowplot::plot_grid(rain_gg, rain24_gg, rain48_gg, nrow = 3)
```

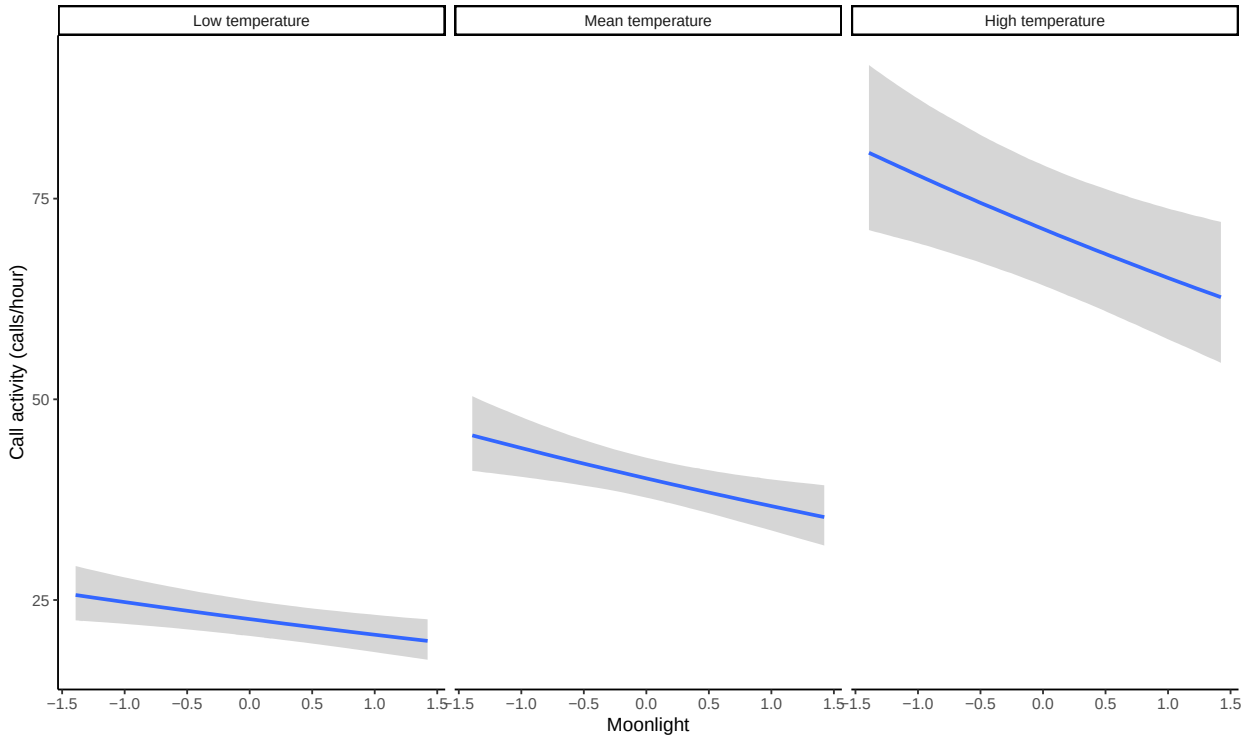



```
conditions <- data.frame(sc_HR = c(`Low humidity` = -1, `Mean humidity` = 0, `High humid

rain_hr_gg <- plot(conditional_effects(glob_mod_24, effects = "sc_rain", conditions = co
    plot = FALSE)[[1]] + scale_color_viridis_d() + theme_classic() + ggtitle("Current ra
    labs(x = "Rain", y = "Call activity (calls/hour)")

rain24_hr_gg <- plot(conditional_effects(glob_mod_24, effects = "sc_rain_24", conditions
    plot = FALSE)[[1]] + scale_color_viridis_d() + theme_classic() + ggtitle("Previous 2
    labs(x = "Rain previous", y = "Call activity (calls/hour)")

rain48_hr_gg <- plot(conditional_effects(glob_mod_48, effects = "sc_rain_48", conditions
    plot = FALSE)[[1]] + scale_color_viridis_d() + theme_classic() + ggtitle("Previous 4
    labs(x = "Rain previous", y = "Call activity (calls/hour)")

cowplot::plot_grid(rain_hr_gg, rain24_hr_gg, rain48_hr_gg, nrow = 3)
```

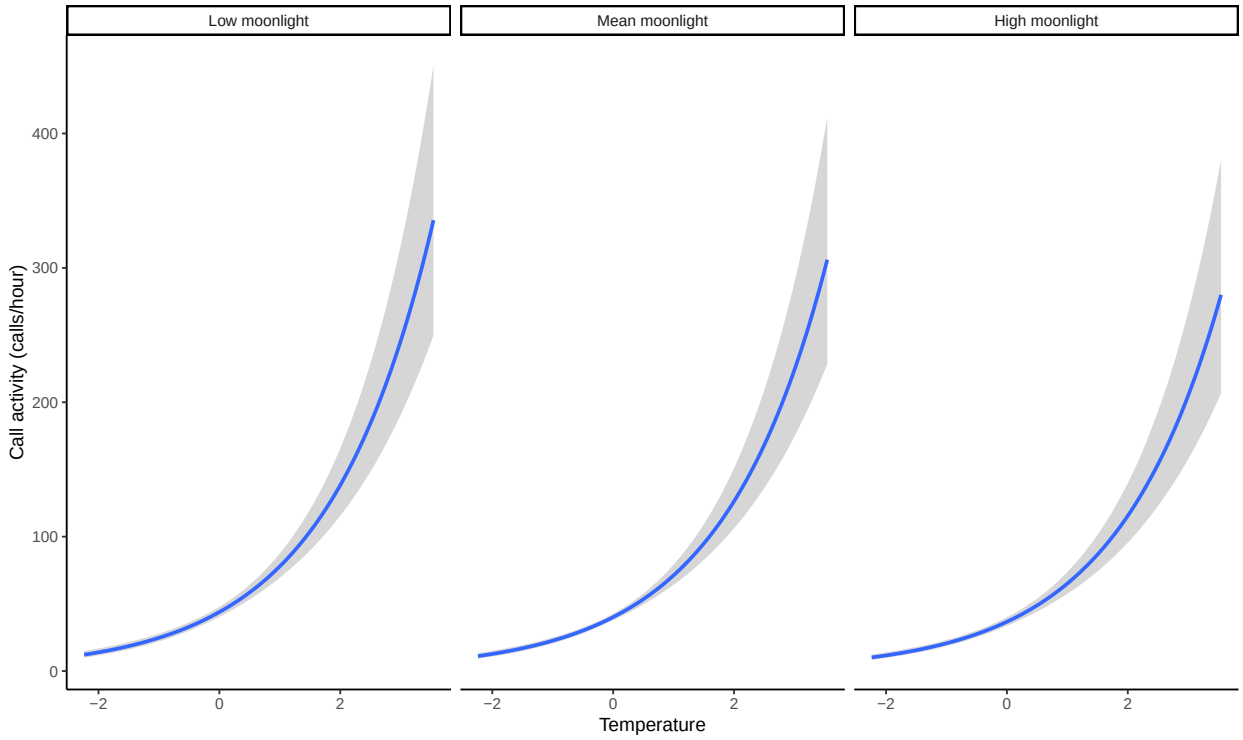


Moonlight and temperature

```
conditions <- data.frame(sc_temp = c(`Low temperature` = -1, `Mean temperature` = 0,
    `High temperature` = 1))

moon_temp_gg <- plot(conditional_effects(glob_mod_24, effects = "sc_moonlight", conditio
    plot = FALSE)[[1]] + scale_color_viridis_d() + theme_classic() + labs(x = "Moonlight
    y = "Call activity (calls/hour)")

moon_temp_gg
```




```
conditions <- data.frame(sc_moonlight = c(`Low moonlight` = -1, `Mean moonlight` = 0,
    `High moonlight` = 1))

temp_moon_gg <- plot(conditional_effects(glob_mod_24, effects = "sc_temp", conditions =
    plot = FALSE)[[1]] + scale_color_viridis_d() + theme_classic() + labs(x = "Temperatu
    y = "Call activity (calls/hour)")

temp_moon_gg
```




```
# st <- data.frame(sound.files = 'FIGURA_LEMUR.wav', selec = 1, start = 0.1,
# end = 0.4)

# tweak_spectro(st, length.out = 20, ovlp = 99, wl = c(100, 1000), pal =
# c('reverse.gray.colors.2', 'viridis', 'reverse.terrain.colors'), path =
# './figures/Figura_canto_lemur', flim = c(1, 4), ncol = 10, nrow = 6, width =
# 15, collev.min = c(-110))

wav <- readWave("./figures/Figura_canto_lemur/FIGURA_LEMUR.wav")

graphics.off()
par(mfrow = c(2, 1), mar = c(0, 4, 4, 1))

warbleR:::spectro_wrblr_int2(wav, flim = c(1, 4), wl = 700, grid = F, collevels = seq(-1
    0, 1), ovlp = 0, palette = viridis, axisX = FALSE)

peaks <- c(0.320165, 0.9, 1.7, 2.6, 3.5, 4.2, 4.5)  # + seq(-0.1, 0.2, length.out = 7)
valleys <- seq(0, duration(wav) + 0.3, length.out = 100)

cor_dat <- data.frame(time = c(peaks, valleys), cor = c(rep(0.7, length(peaks)),
    rep(0.1, length(valleys))))

cor_dat$cor <- cor_dat$cor + rnorm(nrow(cor_dat), sd = 0.03)
cor_dat$cor <- smoothw(cor_dat$cor, wl = 2, f = 10)
```

```r
cor_dat <- cor_dat[order(cor_dat$time), ]

par(mar = c(2, 4, 0, 1))

plot(cor_dat$time, cor_dat$cor, type = "l", xaxs = "i")



spectro(wav, flim = c(1, 4), wl = 700, grid = F, collevels = seq(-125, 0, 1), ovlp = 99,
    palette = viridis, axisX = FALSE, tlim = c(1.53, 1.63), scale = FALSE, flab = "Frecu
    tlab = "Tiempo (s)")

template <- data.frame(sound.files = "FIGURA_LEMUR.wav", selec = 1, start = 1.55,
    end = 1.61, bottom.freq = 2, top.freq = 3)


# get correlations
correlations <- template_correlator(templates = template, files = "FIGURA_LEMUR.wav",
    path = "./figures/Figura_canto_lemur/")


thresh <- 0.7
# run detection
detection <- template_detector(template.correlations = correlations, threshold = thresh)

reference <- template_detector(template.correlations = correlations, threshold = 0.55)
detection


# plot spectrogram
label_spectro_temp(wave = wav, reference = reference, detection = detection, template.co
    flim = c(1, 4), threshold = thresh, hop.size = 10, ovlp = 50, collevels = seq(-125,
        0, 1), col.line = c("#AFBF35", "#F20505", "#F2622E"), flab = "Frecuencia (kHz)",
    tlab = "Tiempo (s)")

# 012623 034941 AFBF35 F2622E F20505
```

Takeaways

-

Sum up results

-

Next steps

-

Session information

```
## R version 4.1.0 (2021-05-18)
## Platform: x86_64-pc-linux-gnu (64-bit)
## Running under: Ubuntu 20.04.2 LTS
##
## Matrix products: default
## BLAS:   /usr/lib/x86_64-linux-gnu/atlas/libblas.so.3.10.3
## LAPACK: /usr/lib/x86_64-linux-gnu/atlas/liblapack.so.3.10.3
##
## locale:
##  [1] LC_CTYPE=pt_BR.UTF-8       LC_NUMERIC=C
##  [3] LC_TIME=es_CR.UTF-8        LC_COLLATE=pt_BR.UTF-8
##  [5] LC_MONETARY=es_CR.UTF-8    LC_MESSAGES=pt_BR.UTF-8
##  [7] LC_PAPER=es_CR.UTF-8       LC_NAME=C
##  [9] LC_ADDRESS=C               LC_TELEPHONE=C
## [11] LC_MEASUREMENT=es_CR.UTF-8 LC_IDENTIFICATION=C
##
## attached base packages:
## [1] stats     graphics  grDevices utils     datasets  methods   base
##
## other attached packages:
##  [1] ohun_0.1.0         warbleR_1.1.28     NatureSounds_1.0.4 seewave_2.2.0
```

```
##  [5] tuneR_1.4.1        brmsish_1.0.0      lunar_0.2-1        ggplot2_3.4.0
##  [9] knitr_1.42         kableExtra_1.3.4   HDInterval_0.2.2   readxl_1.3.1
## [13] posterior_1.3.1    cowplot_1.1.1      ggdist_3.2.0       brms_2.18.0
## [17] Rcpp_1.0.9         viridis_0.6.2      viridisLite_0.4.1  remotes_2.4.2
##
## loaded via a namespace (and not attached):
##   [1] backports_1.4.1      systemfonts_1.0.4    plyr_1.8.7
##   [4] igraph_1.3.5         splines_4.1.0        crosstalk_1.2.0
##   [7] TH.data_1.1-0        rstantools_2.2.0     inline_0.3.19
##  [10] digest_0.6.31        htmltools_0.5.4      fansi_1.0.3
##  [13] magrittr_2.0.3       checkmate_2.1.0      RcppParallel_5.1.5
##  [16] matrixStats_0.62.0   xts_0.12.2           sandwich_3.0-1
##  [19] svglite_2.1.0        prettyunits_1.1.1    colorspace_2.0-3
##  [22] signal_0.7-7         rvest_1.0.3          textshaping_0.3.5
##  [25] xfun_0.36            dplyr_1.0.10         callr_3.7.3
##  [28] crayon_1.5.2         RCurl_1.98-1.9       lme4_1.1-27.1
##  [31] survival_3.2-11      zoo_1.8-11           ape_5.6-2
##  [34] glue_1.6.2           gtable_0.3.1         emmeans_1.8.1-1
##  [37] webshot_0.5.4        distributional_0.3.1 pkgbuild_1.4.0
##  [40] rstan_2.21.7         abind_1.4-5          scales_1.2.1
##  [43] mvtnorm_1.1-3        DBI_1.1.1            miniUI_0.1.1.1
##  [46] dtw_1.23-1           xtable_1.8-4         diffobj_0.3.4
##  [49] proxy_0.4-27         stats4_4.1.0         StanHeaders_2.21.0-7
##  [52] DT_0.26              htmlwidgets_1.5.4    httr_1.4.4
##  [55] threejs_0.3.3        ellipsis_0.3.2       pkgconfig_2.0.3
##  [58] loo_2.4.1.9000       farver_2.1.1         utf8_1.2.2
##  [61] labeling_0.4.2       tidyselect_1.2.0     rlang_1.0.6
##  [64] reshape2_1.4.4       later_1.3.0          munsell_0.5.0
##  [67] cellranger_1.1.0     tools_4.1.0          cli_3.6.0
##  [70] generics_0.1.3       ggridges_0.5.4       evaluate_0.20
##  [73] stringr_1.5.0        fastmap_1.1.0        ragg_1.1.3
##  [76] oce_1.7-8            yaml_2.3.7           processx_3.8.0
##  [79] pbapply_1.6-0        nlme_3.1-152         mime_0.12
##  [82] projpred_2.0.2       formatR_1.11         rstanarm_2.21.3
##  [85] xml2_1.3.3           compiler_4.1.0       bayesplot_1.9.0
##  [88] shinythemes_1.2.0    rstudioapi_0.14      gamm4_0.2-6
##  [91] tibble_3.1.8         stringi_1.7.12       highr_0.10
##  [94] ps_1.7.2             Brobdingnag_1.2-9    lattice_0.20-44
##  [97] Matrix_1.5-1         nloptr_1.2.2.2       markdown_1.3
## [100] fftw_1.0-7           shinyjs_2.1.0        tensorA_0.36.2
## [103] vctrs_0.5.2          pillar_1.8.1         lifecycle_1.0.3
## [106] gsw_1.0-6            bridgesampling_1.1-2 estimability_1.4.1
## [109] bitops_1.0-7         Sim.DiffProc_4.8     httpuv_1.6.6
## [112] R6_2.5.1             promises_1.2.0.1     gridExtra_2.3
## [115] codetools_0.2-18     boot_1.3-28          colourpicker_1.2.0
```

```
## [118] MASS_7.3-54          gtools_3.9.3         assertthat_0.2.1
## [121] rjson_0.2.21         withr_2.5.0          Deriv_4.1.3
## [124] shinystan_2.6.0      multcomp_1.4-17      mgcv_1.8-36
## [127] parallel_4.1.0       grid_4.1.0           coda_0.19-4
## [130] minqa_1.2.4          rmarkdown_2.20       shiny_1.7.3
## [133] base64enc_0.1-3      dygraphs_1.1.1.6
```