SEIR model simulation

## Load packages

library(deSolve)  
library(tidyverse)

## Set initial values

I\_init <- 1e-07  
E\_init <- 3 \* I\_init  
R\_init <- 0  
S\_init <- 1 - I\_init - E\_init - R\_init  
  
R0\_1\_init <- 10  
R0\_2\_init <- -4  
R0\_init <- 0.5 \* (R0\_1\_init + R0\_2\_init)  
  
init <- c(  
 S = S\_init,  
 E = E\_init,  
 I = I\_init,  
 R = R\_init,  
 R0\_1 = R0\_1\_init,  
 R0\_2 = R0\_2\_init,  
 R0 = R0\_init  
)

## Set parameters

pi\_r <- 1 / 18  
pi\_e <- 1 / 5.2  
R0\_1bar <- -4  
R0\_2bar <- 10  
eta1 <- 1 / 35  
eta2 <- 1 / 100  
  
parameters <- c(  
 pi\_r = pi\_r,  
 pi\_e = pi\_e,  
 R0\_1bar = R0\_1bar,  
 R0\_2bar = R0\_2bar,  
 eta1 = eta1,  
 eta2 = eta2  
)

## Set time frame

times <- seq(0, 548, by = 1)

## Formulate the SIR model

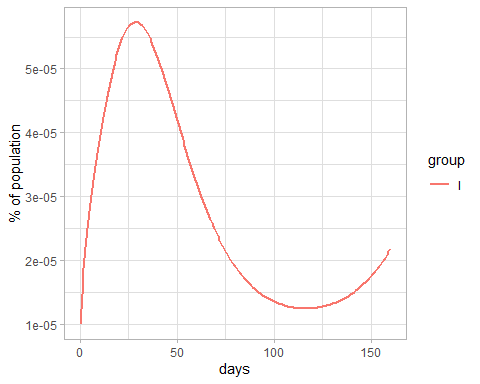
sir <- function(time, state, parameters) {  
  
 with(as.list(c(state, parameters)), {  
  
 dS = -0.5 \* (R0\_1 + R0\_2) \* pi\_r \* S \* I  
 dE = 0.5 \* (R0\_1 + R0\_2) \* pi\_r \* S \* I - pi\_e \* E  
 dI = pi\_e \* E - pi\_r \* I  
 dR = pi\_r \* I  
   
 dR0\_1 = -eta1 \* (R0\_1 - R0\_1bar)  
 dR0\_2 = -eta2 \* (R0\_2 - R0\_2bar)  
 dR0 = -0.5 \* eta1 \* (R0\_1 - R0\_1bar) -0.5 \* eta2 \* (R0\_2 - R0\_2bar)  
   
 results = c (dS, dE, dI, dR, dR0\_1, dR0\_2, dR0)  
 list (results)  
 })  
}

## Solve ODE

out <- ode(  
 y = init,  
 times = times,  
 func = sir,  
 parms = parameters  
)

## Plot pandemic progress

out\_long <- out %>%   
 as.data.frame() %>%  
 select(time, S, E, I, R) %>%   
 pivot\_longer(-time, names\_to = "group", values\_to = "prop")  
  
out\_long %>%   
 filter(group == "I", time <= 160) %>%   
 ggplot(aes(x = time, y = prop \* 100, color = group)) +  
 geom\_line(size = 1) +   
 theme\_light() +   
 labs(  
 x = "days",  
 y = "% of population"  
 )



# Plot R\_t

R0\_long <- out %>%   
 as.data.frame() %>%  
 select(time, R0, R0\_1, R0\_2) %>%   
 pivot\_longer(-time, names\_to = "type", values\_to = "value")  
  
R0\_long %>%   
 filter(type == "R0", time <=160) %>%   
 ggplot(aes(x = time, y = value, color = type)) +  
 geom\_line(size = 1) +   
 theme\_light() +   
 labs(  
 x = "days",  
 y = "basic reproduction number"  
 )

