Representative dmo for HYPUD

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Overview

This demo compares regular and high-frequency slurry removal from pig barns, plus storage emission.

Prep

```
devtools::load_all()
```

```
## i Loading ABM
```

```
library(data.table)
library(ggplot2)
```

Inputs

Say, 450 pigs, constant slurry production at 5 kg/pig-d, over 11 week batch.

```
mng_pars1 <- list(slurry_prod_rate = 2200,
                  slurry_mass = 20000,
                  storage_depth = 2,
                  resid_depth = 0.1,
                  area = 200,
                  empty_int = 73,
                  temp_C = 18,
                  wash_water = 0,
                  wash_int = NA,
                  rest_d = 0,
                  resid_enrich = 0.5)
```

```
sub_pars <- list(subs = c('VSd'),
                 T_opt_hyd = c(VSd = 40),
                 T_min_hyd = c(VSd = 0),
                 T_max_hyd = c(VSd = 90),
                 hydrol_opt = c(VSd = 0.01),
                 sub_fresh = c(VSd = 50),
                 sub_init = c(VSd = 50))
```

```
grp_pars <- list(grps = c('m0', 'm1', 'm2','sr1'),
                 yield = c(default = 0.05, sr1 = 0.065),
                 xa_fresh = c(all = 0.05),
                 xa_init = c(all = 0.05),
                 dd_rate = c(all = 0.02),
```

```
                ks = c(default = 1, sr1 = 0.5),
                qhat_opt = c(m0 = 0.8, m1 = 0.9, m2 = 1.5, sr1 = 9),
                T_opt = c(m0 = 18, m1 = 18, m2 = 28, sr1 = 44),
                T_min = c(m0 = 0, m1 = 6.41, m2 = 6.41, sr1 = 0),
                T_max = c(m0 = 25, m1 = 25, m2 = 38, sr1 = 51))
```

```
mic_pars <- list(dd_rate_xa = 0.02)
```

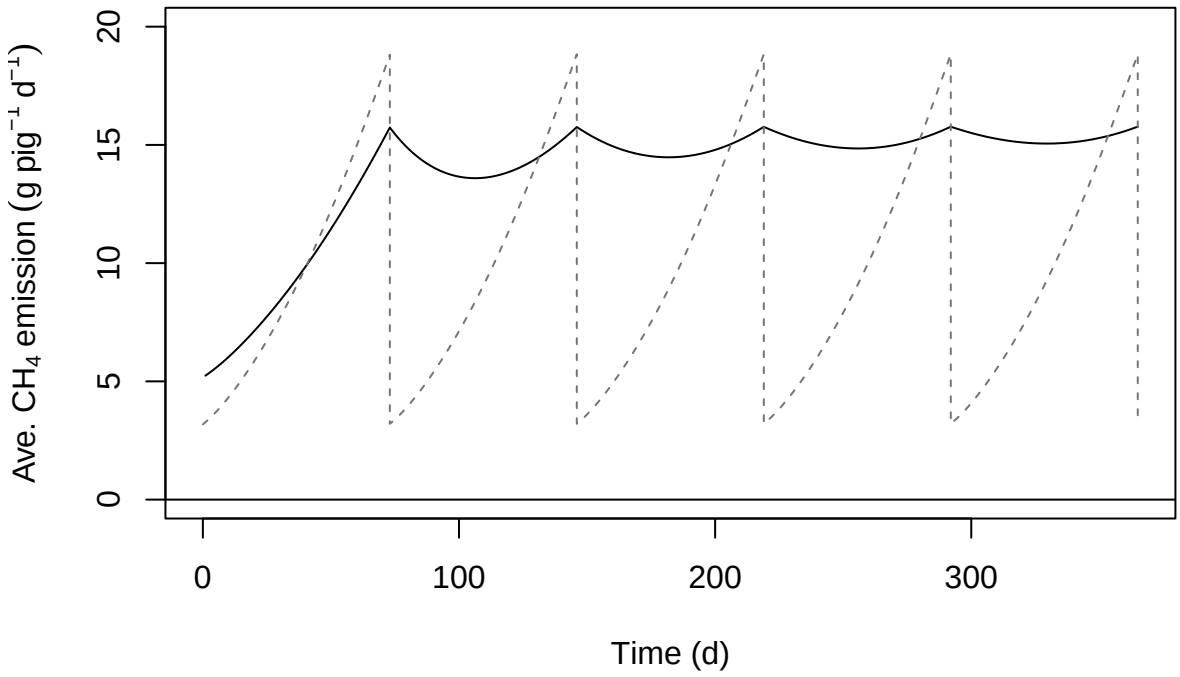
```
man_pars <- list(VFA_fresh = c(VFA = 2), pH = 7, dens = 1000)

chem_pars <- list(COD_conv = c(CH4 = 1/0.2507, xa = 1/0.7069561,
                               VFA = 1/0.9383125, S = 1/0.5015, VS = 1/0.69,
                               CO2_aer = 1/0.436, CO2_sr = 1/1.2,
                               C_xa = 1/0.3753125))
```

```
out1b <- abm(365.1,
             mng_pars = mng_pars1,
             man_pars = man_pars,
             grp_pars = grp_pars,
             mic_pars = mic_pars,
             sub_pars = sub_pars,
             chem_pars = chem_pars,
             startup = 1)
```

```
##
## Startup run 1x -> and final run
```

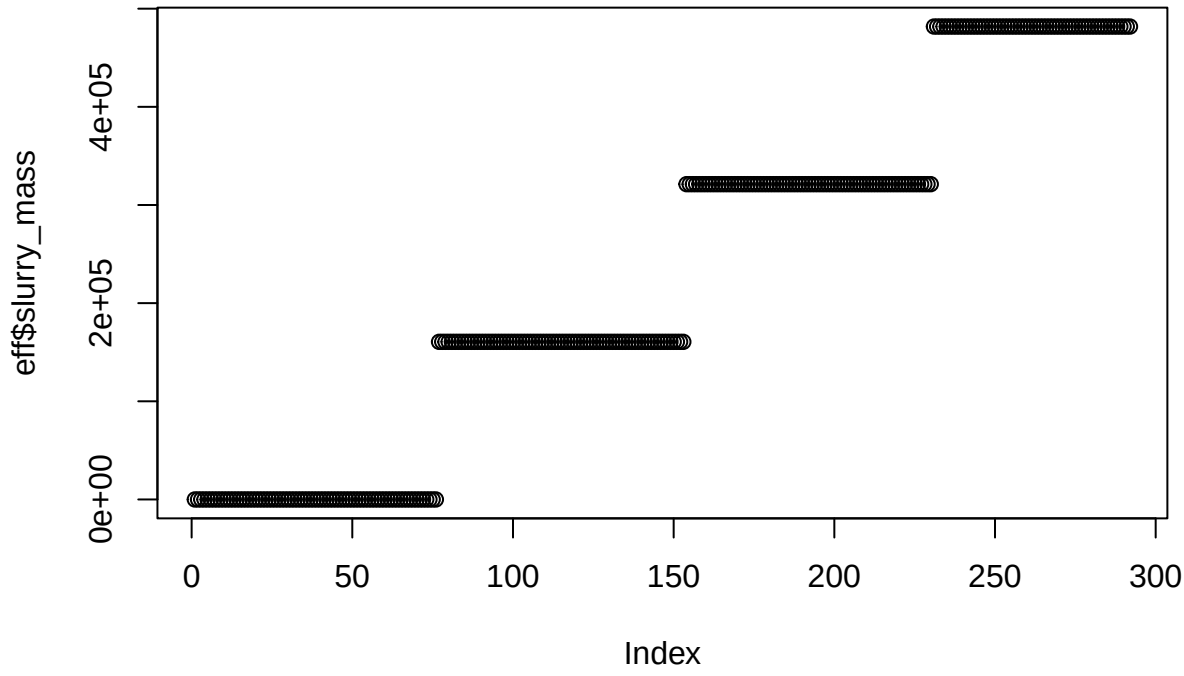
```
## Using starting conditions from `starting` argument
```

```
setDT(out1b)
plot(CH4_emis_cum / 400 / time ~ time, data = out1b,
     type = 'l', ylim = c(0, 20),
     xlab = 'Time (d)', ylab = expression('Ave. CH'[4]~'emission'~(g~'pig'^'-1'~d^'-1')))
abline(h = 0, lty = 1)
par(new = TRUE)
plot(CH4_emis_rate ~ time, data = out1b, type = 'l', lty = 2, col = 'gray46',
     ylim = c(0, 13000), axes = F, xlab = '', ylab = '')
```



Now storage of effluent.

```
sm <- as.numeric(out1b[c(FALSE, diff(slurry_mass_eff) > 0), .(slurry_mass_eff)][1])
concs <- out1b[c(FALSE, diff(slurry_mass_eff) > 0), .(VSd_conc, VFA_conc)]
eff <- data.table(time = 1:(4*mng_pars1$empty_int))
eff[, slurry_mass := sm * cumsum((time %% 77 == 0))]
plot(eff$slurry_mass)
```



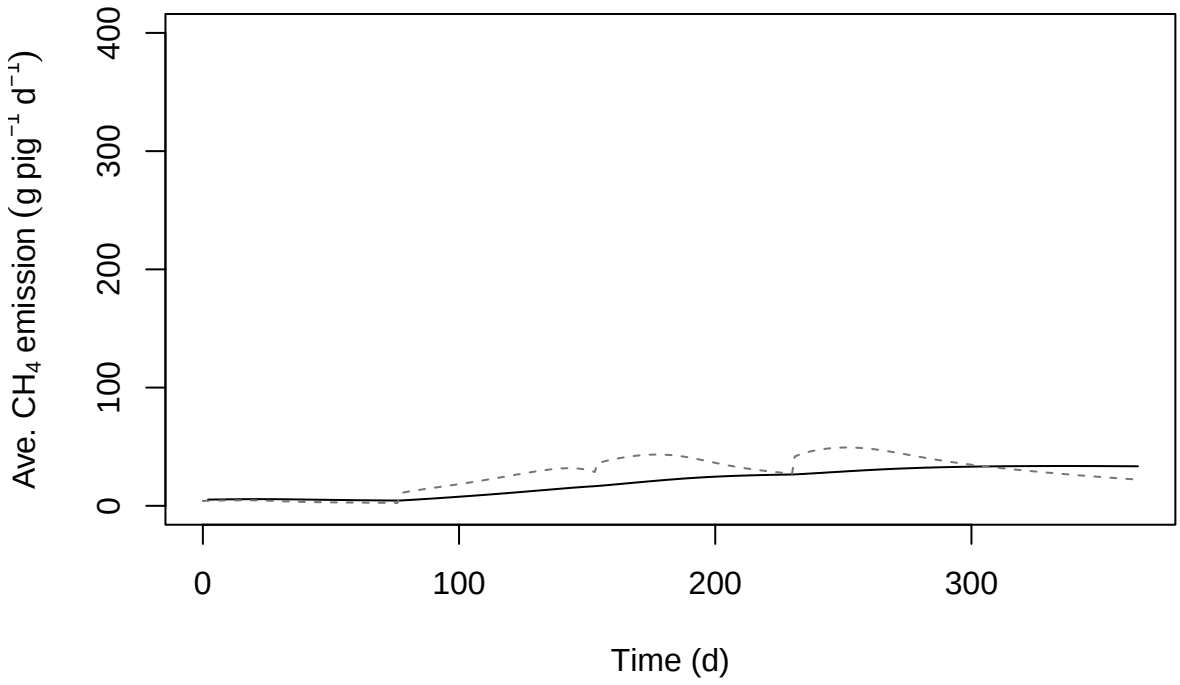

```
devtools::load_all()
```

```
## i Loading ABM
```

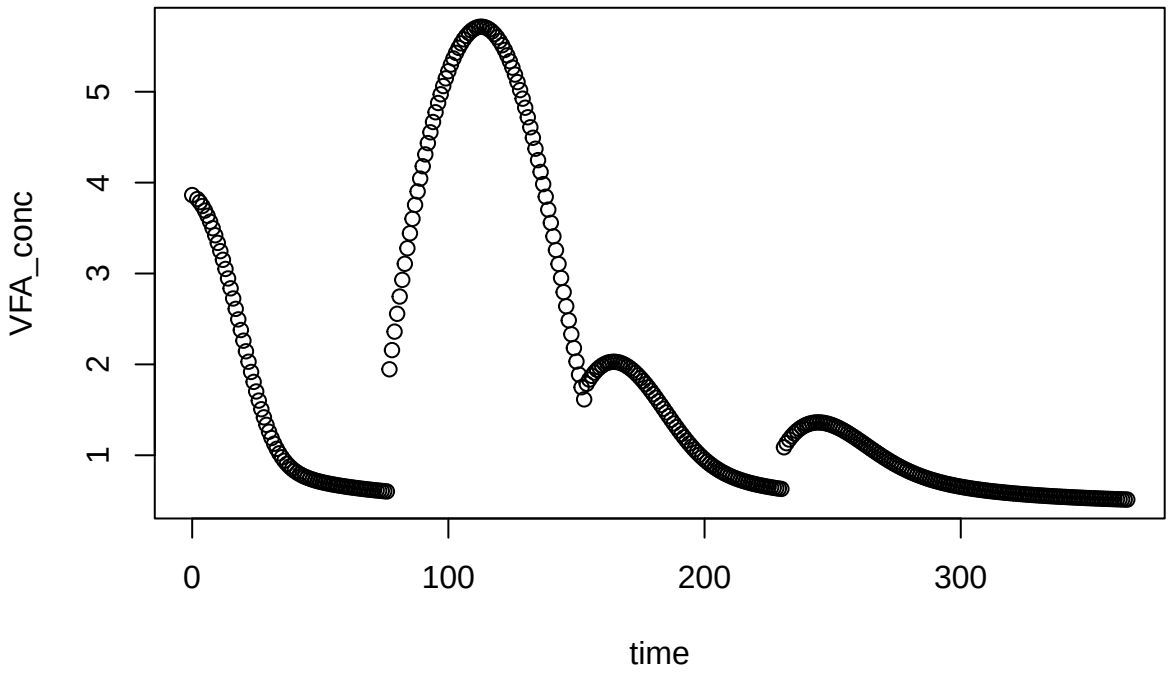
```
out1e <- abm(365,
             mng_pars = mng_pars1,
             man_pars = man_pars,
             grp_pars = grp_pars,
             mic_pars = mic_pars,
             sub_pars = sub_pars,
             chem_pars = chem_pars,
             var_pars = list(var = eff),
             starting = out1)
```

```
## Using starting conditions from `starting` argument
```

```
setDT(out1e)
plot(CH4_emis_cum / 400 / time ~ time, data = out1e,
     type = 'l', ylim = c(0, 400),
     xlab = 'Time (d)', ylab = expression('Ave. CH'[4]~'emission'~(g~'pig'^'-1'~d^'-1')))
par(new = TRUE)
plot(CH4_emis_rate ~ time, data = out1e, type = 'l', lty = 2, col = 'gray46',
     ylim = c(0, 200000), axes = F, xlab = '', ylab = '')
```




```
plot(VFA_conc ~ time, data = out1e)
```



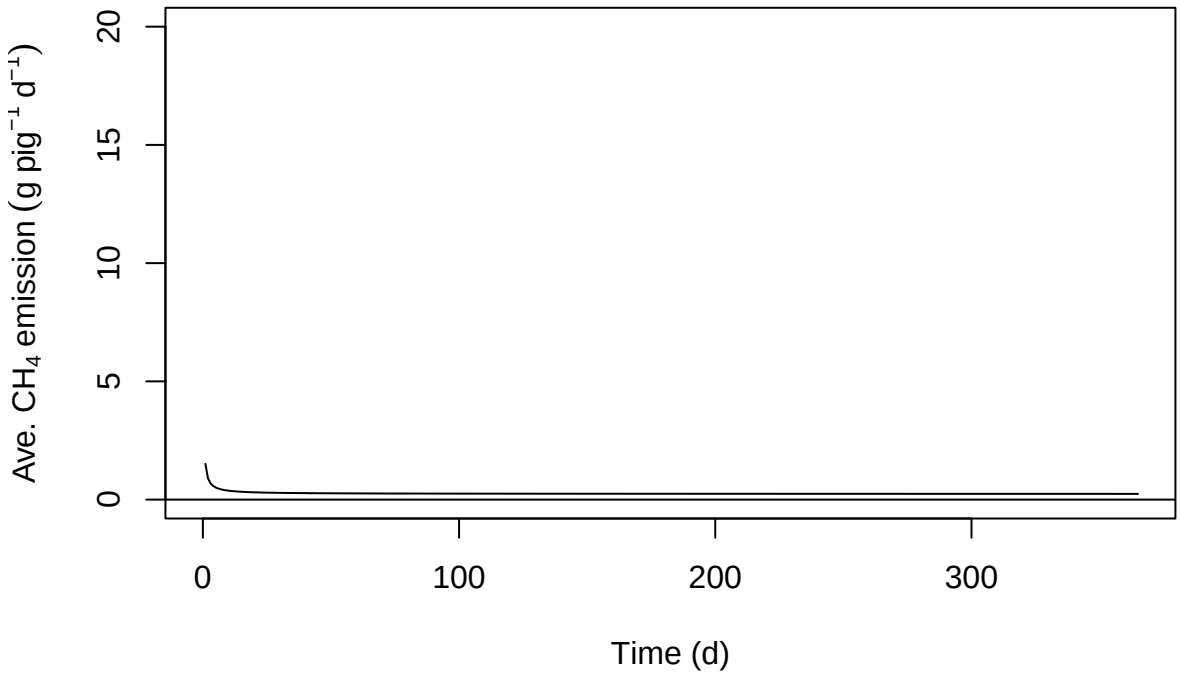
Scenario 2 is with frequent emptying.

```
mng_pars2 <- list(slurry_prod_rate = 2200,
                  slurry_mass = 20000,
                  storage_depth = 2,
                  resid_depth = 0.01,
                  area = 200,
                  empty_int = 1,
                  temp_C = 18,
                  wash_water = 0,
                  wash_int = NA,
                  rest_d = 0,
                  resid_enrich = 0.5)
```

```
out2b <- abm(365,
             mng_pars = mng_pars2,
             man_pars = man_pars,
             grp_pars = grp_pars,
             mic_pars = mic_pars,
             sub_pars = sub_pars,
             chem_pars = chem_pars,
             startup = 1)
```

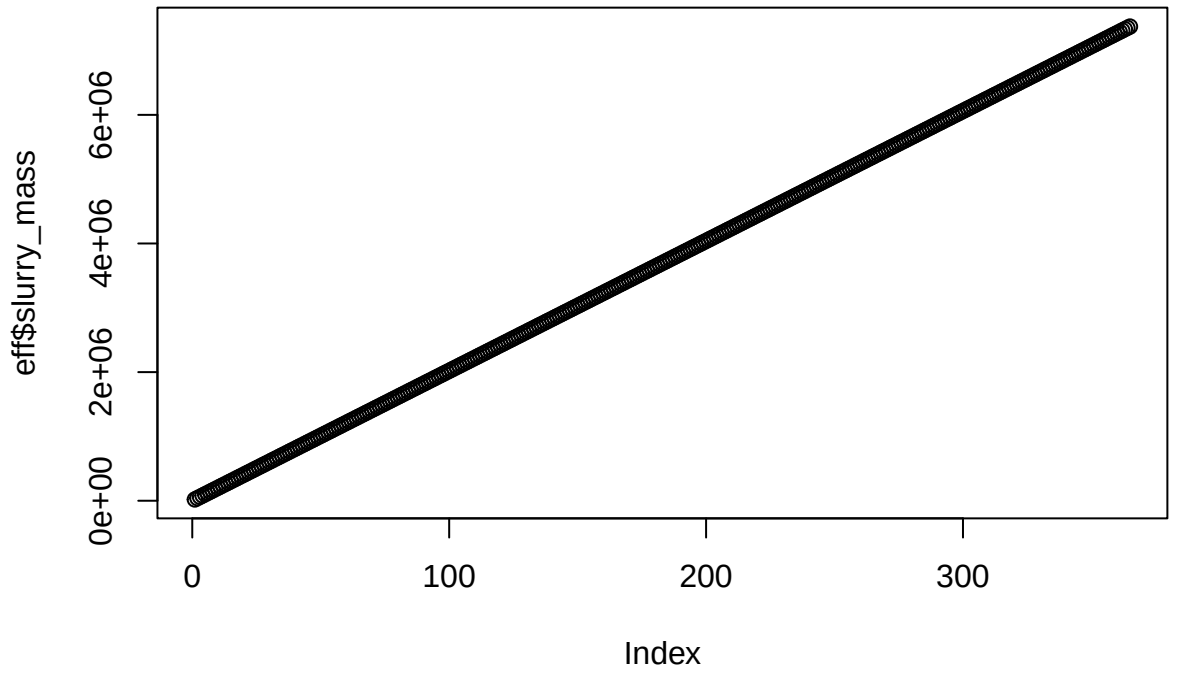
```
##
## Startup run 1x -> and final run

## Using starting conditions from `starting` argument
```

```
setDT(out2b)
plot(CH4_emis_cum / 400 / time ~ time, data = out2b,
     type = 'l', ylim = c(0, 20),
     xlab = 'Time (d)', ylab = expression('Ave. CH'[4]~'emission'~(g~'pig'^'-1'~d^'-1')))
abline(h = 0, lty = 1)
```



Now storage of slurry removed from the barn.

```
sm <- as.numeric(out2b[c(FALSE, diff(slurry_mass_eff) > 0), .(slurry_mass_eff)][1])
concs <- out2b[c(FALSE, diff(slurry_mass_eff) > 0), .(VSd_conc, VFA_conc)]
eff <- data.table(time = 1:365)
eff[, slurry_mass := sm * cumsum((time %% mng_pars2$empty_int == 0))]
plot(eff$slurry_mass)
```




```
devtools::load_all()
```

```
## i Loading ABM
```

```
out2e <- abm(365,
             mng_pars = mng_pars2,
             man_pars = man_pars,
             grp_pars = grp_pars,
             mic_pars = mic_pars,
             sub_pars = sub_pars,
             chem_pars = chem_pars,
             var_pars = list(var = eff),
             starting = out1)
```

```
## Using starting conditions from `starting` argument
```

```
setDT(out2e)
plot(CH4_emis_cum / 400 / time ~ time, data = out2e,
     type = 'l', ylim = c(0, 400),
     xlab = 'Time (d)', ylab = expression('Ave. CH'[4]~'emission'~(g~'pig'^'-1'~d^'-1')))
par(new = TRUE)
plot(CH4_emis_rate ~ time, data = out2e, type = 'l', lty = 2, col = 'gray46',
     ylim = c(0, 300000), axes = F, xlab = '', ylab = '')
```