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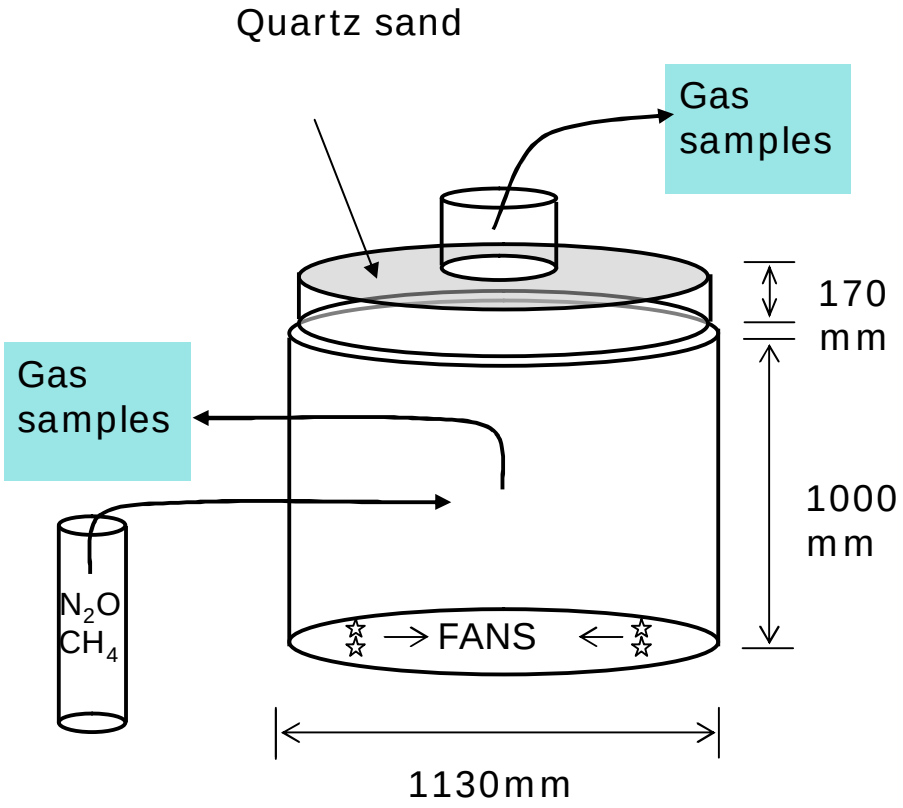
Comparison of static chambers to measure N_2O and CH_4 fluxes from soils: results

Mari Pihlatie, Jesper Riis Christiansen, Hermanni Aaltonen, Janne Korhonen, Jukka Pumpanen, Terhi Rasilo, Ana Paula Rosa, Giuseppe Benanti, Jatta Hirvensalo, Michael Giebels, Mohamed Helmy, Peter Schreiber, Radoslaw Juszczak, Roland Klefoth, Sara Vicca, Serça Dominique, Stephanie Jones, Raquel Lobo do Vale, Benjamin Wolf

Content

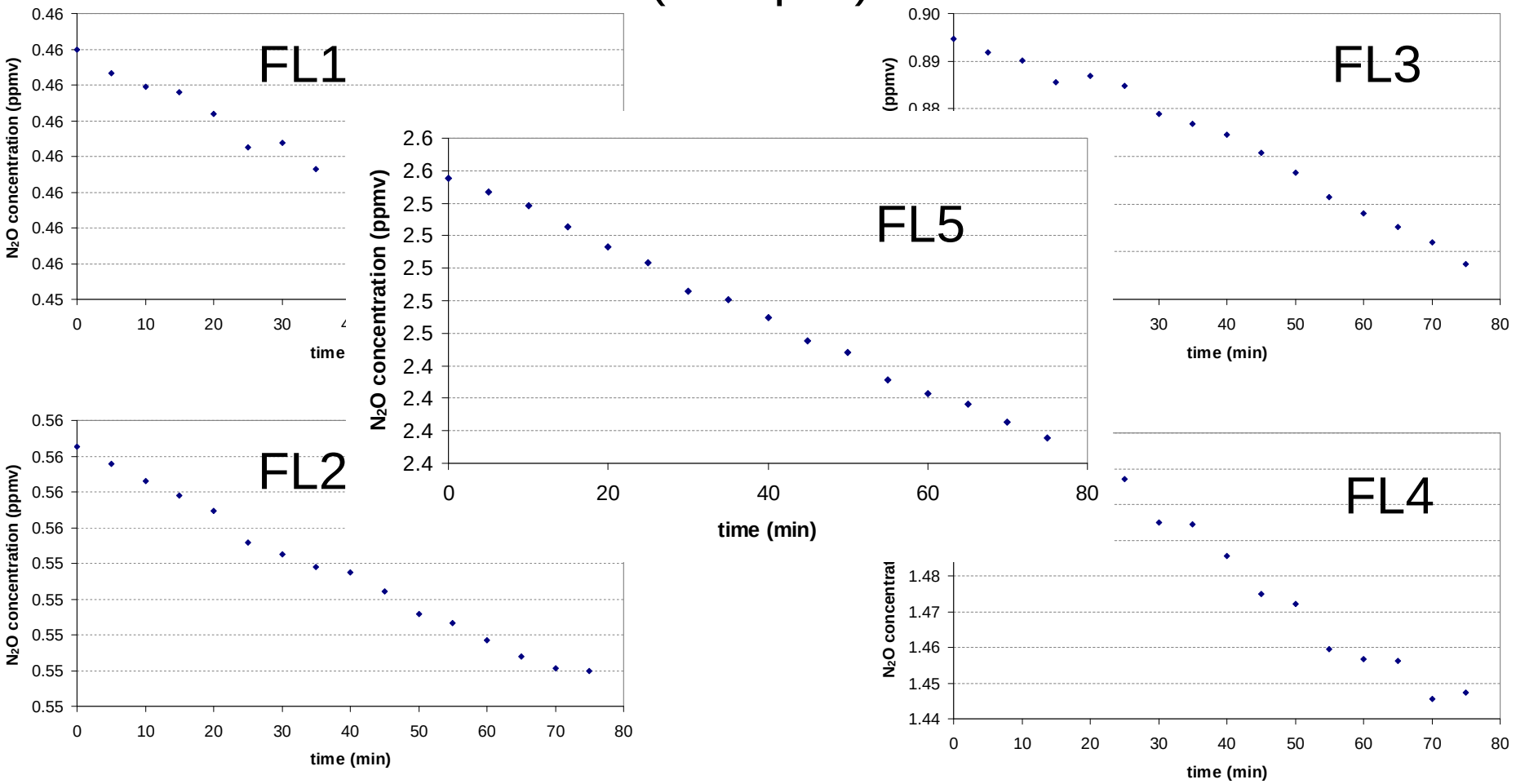
- What does the data look like?
- How do we calculate the fluxes from the reference chamber (Pumpeli)?
- Performance of the calibration system
- Chamber fluxes versus reference fluxes
- Future work

The calibration system (Pumpeli)



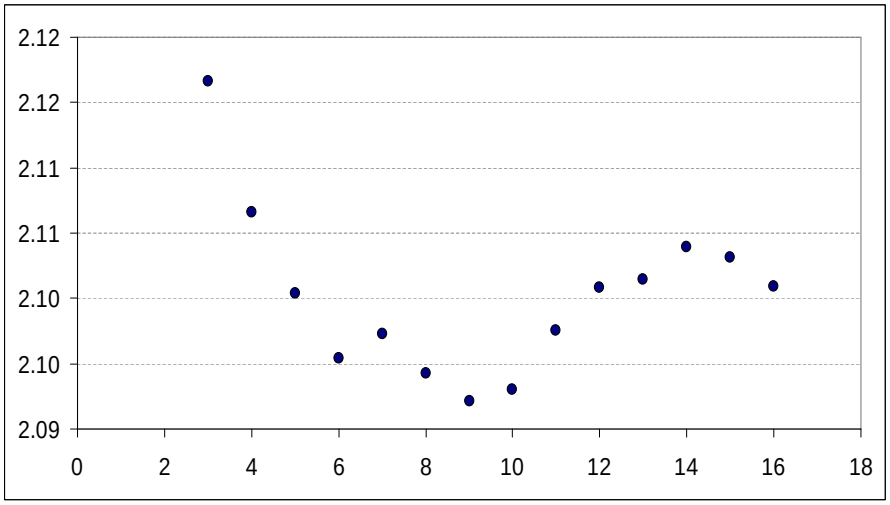
What does the data look like?

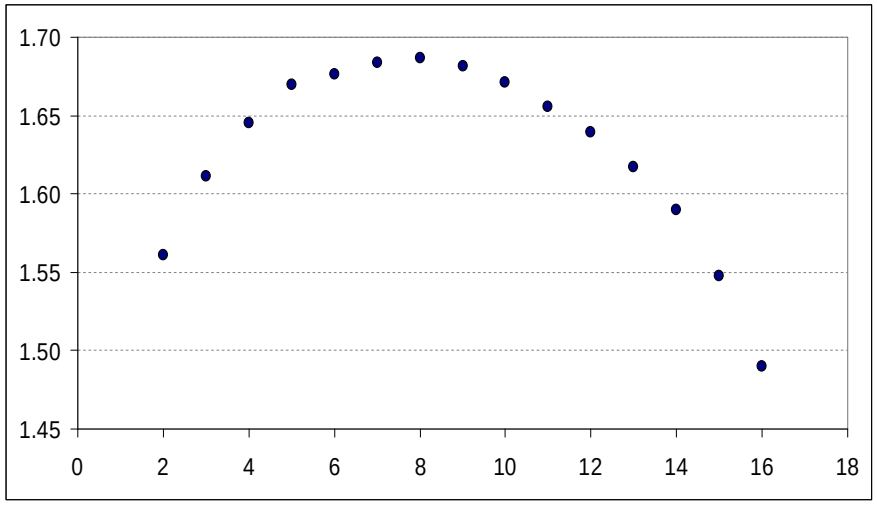
Calibration tank (Pumpeli) concentrations



Some problems during the campaign

- Autosampler problem: gas vials not pressurized (week 35)
- GC problem: Much of the N_2O data useless
  - Non-linearity of the ECD (can be possibly corrected?)
  - Unstability of the GC





How the reference fluxes are calculated?

- Flux from the tank (Pumpeli) according to Pumpanen et al. (2004):

$$F = \frac{V(C_f(t_1) - (C_f(t_2)) + V_s((C_f(t_1) + C_{amb}(t_1))/2 - (C_f(t_2) + C_{amb}(t_2))/2)}{(t_2 - t_1)A}$$

Where

$C_f(t_i)$ = fitted gas concentration inside the tank at time t_i

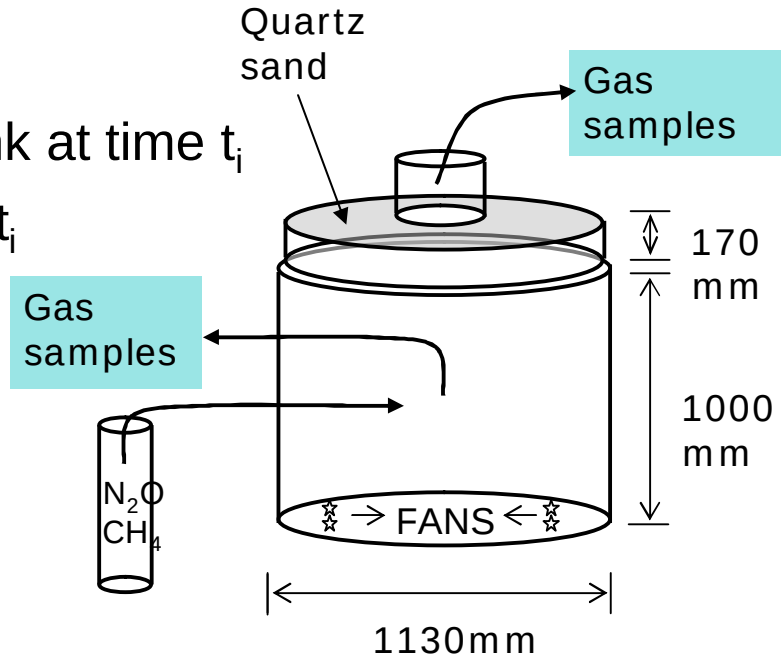
$C_{amb}(t_i)$ = ambient gas concentration at time t_i

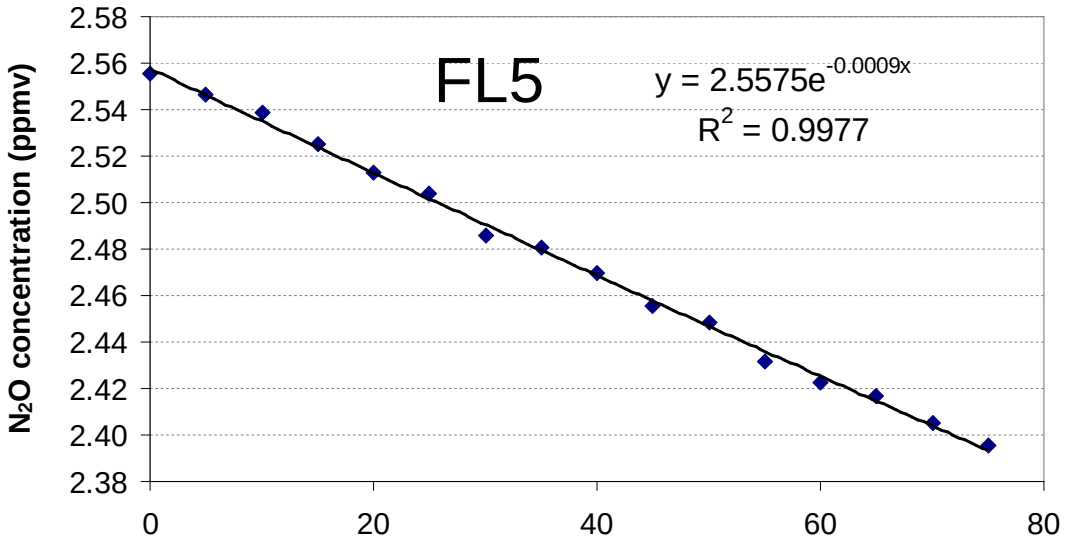
V = volume of the tank (1 m^3)

V_s = volume of air-filled porosity in the sand

A = surface area of the sand layer

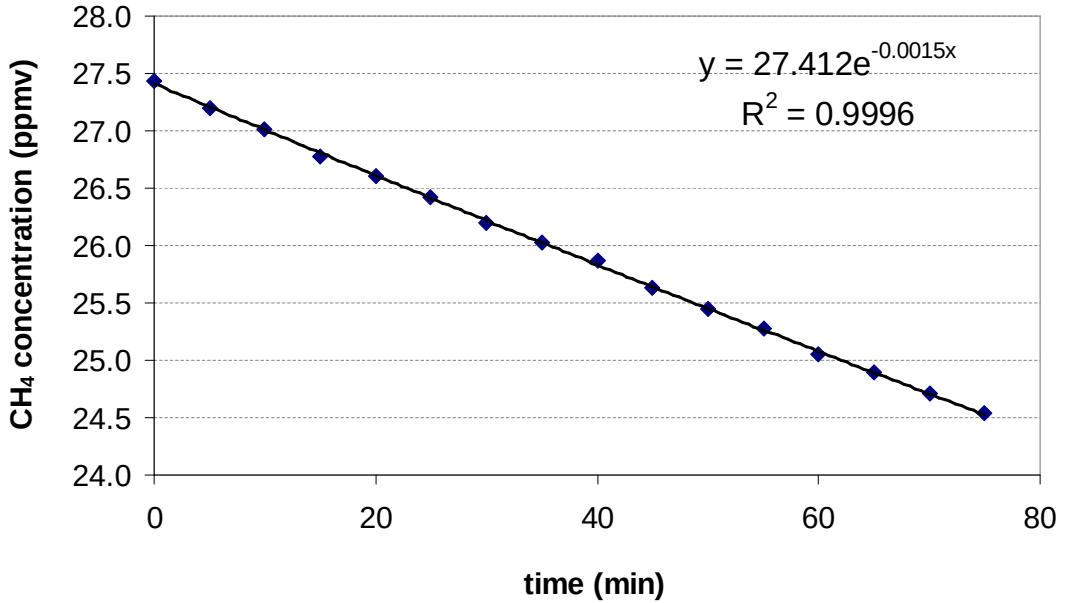
Time steps 5 min





208 μg N_2O m^{-2} h^{-1}

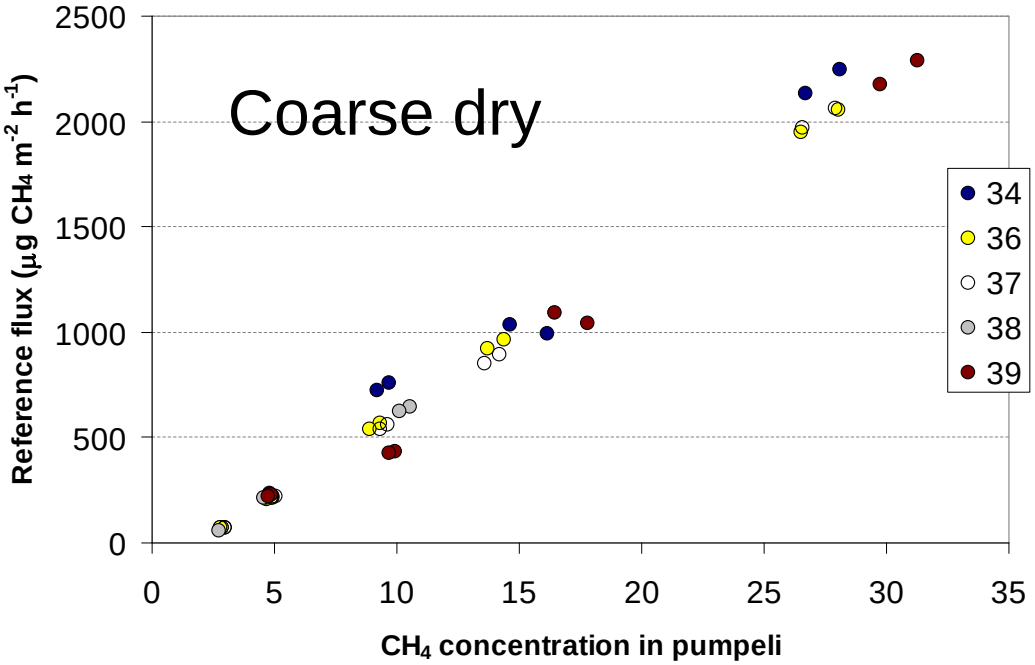
201 μg N_2O m^{-2} h^{-1}

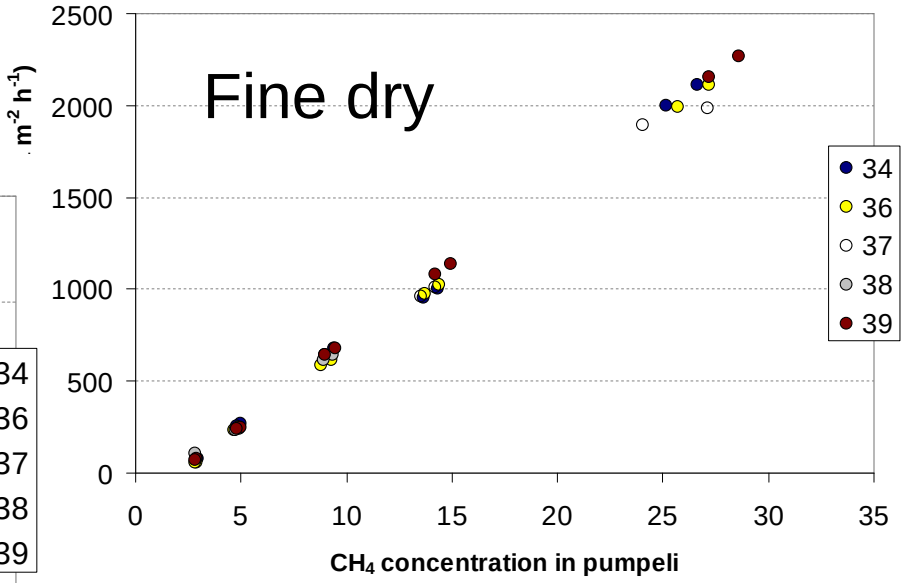


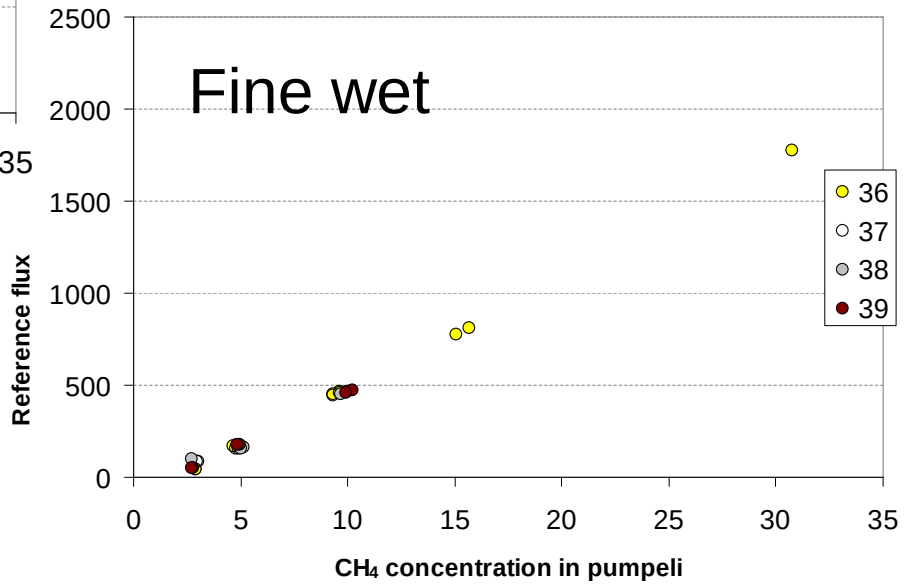
2113 μg CH_4 m^{-2} h^{-1}

1998 μg CH_4 m^{-2} h^{-1}

Performance of the calibration system







Comparable to the CO_2 campaign

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Comparison of different chamber techniques for measuring soil CO_2 efflux

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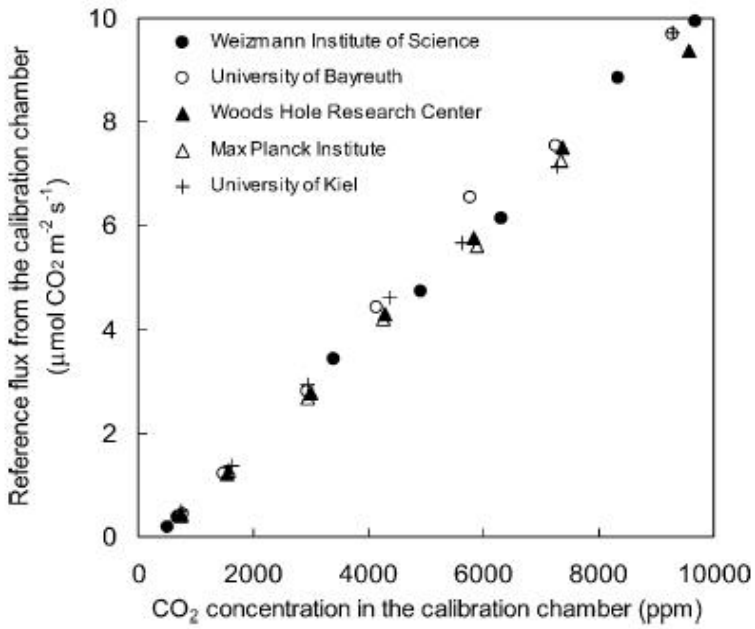
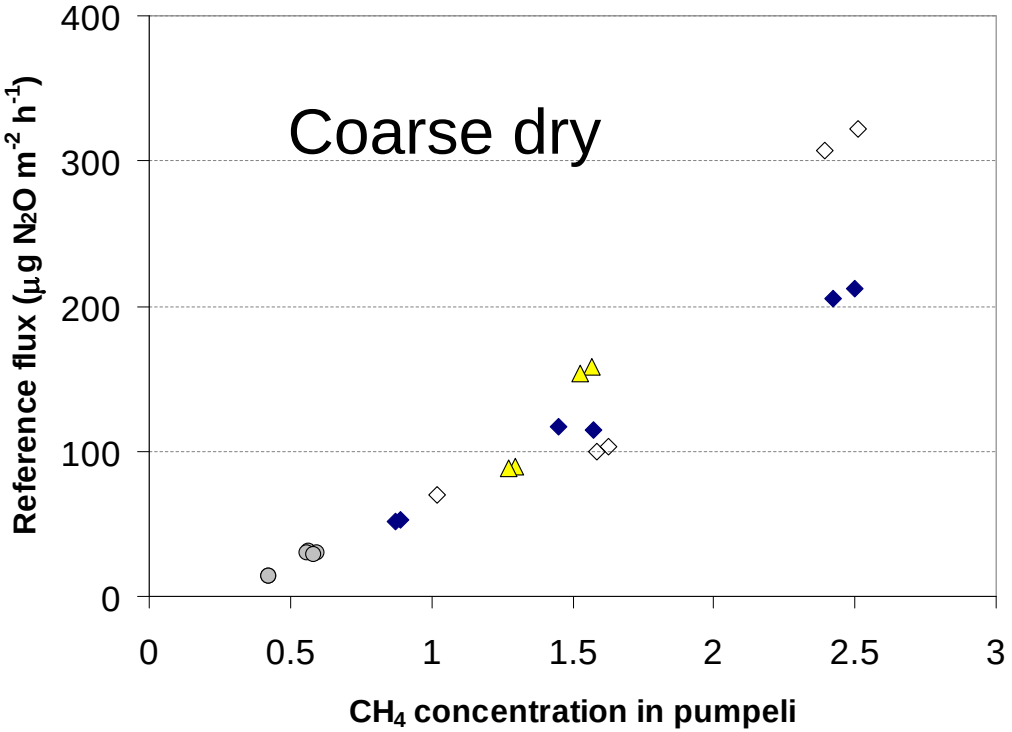
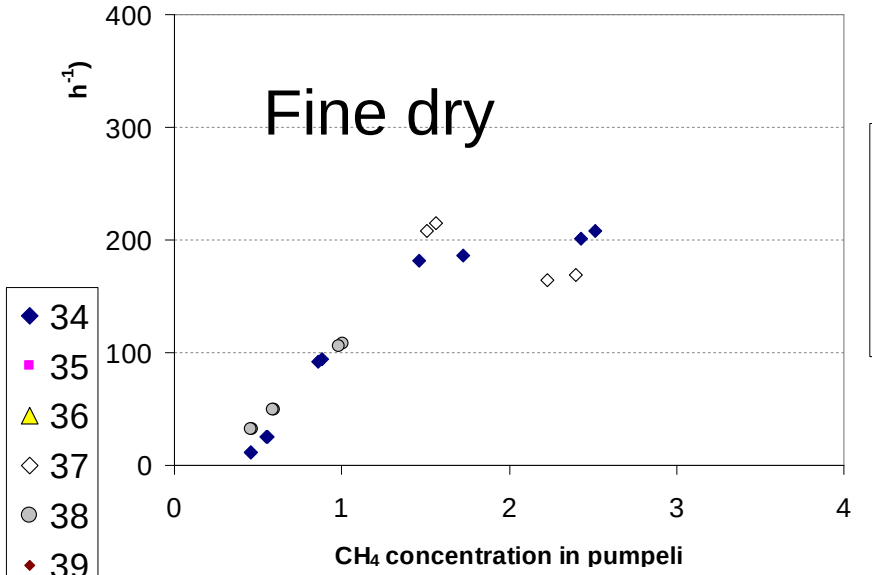
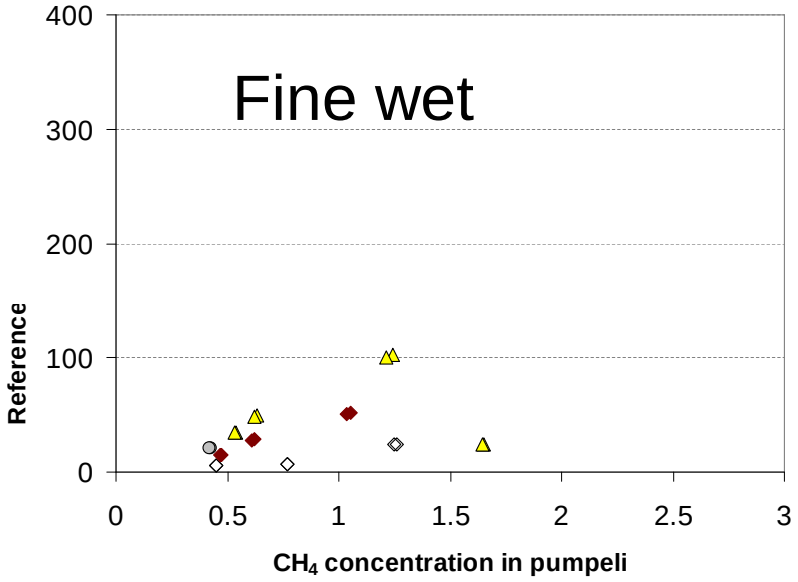
Timo Vesala[b], Sini Niinistö[c], Annalea Lohila[d], Tuula Larmola[e], Mi
Mari Pihlatie[b], Ivan Janssens[f], Jorge Curiel Yuste[f], José M. Gri
Sascha Reth[h], Jens-Arne Subke[i], Kathleen Savage[j], Werner Kutsch[k],
Waldemar Ziegler[m], Peter Anthoni[m], Anders Lindroth[n], Pert



Not so good with N_2O…







How the chamber fluxes are calculated?

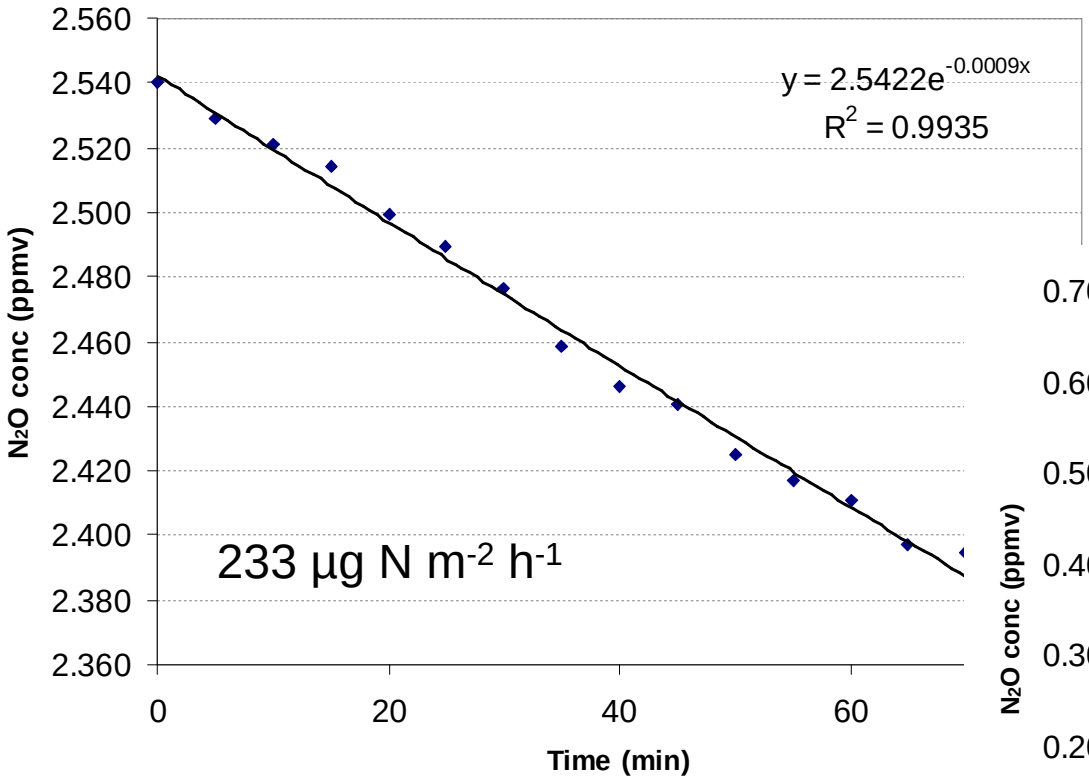
- Linear regression
- Exponential fit (not yet)
- Other calculation methods (not yet)

Data examples

linear regression

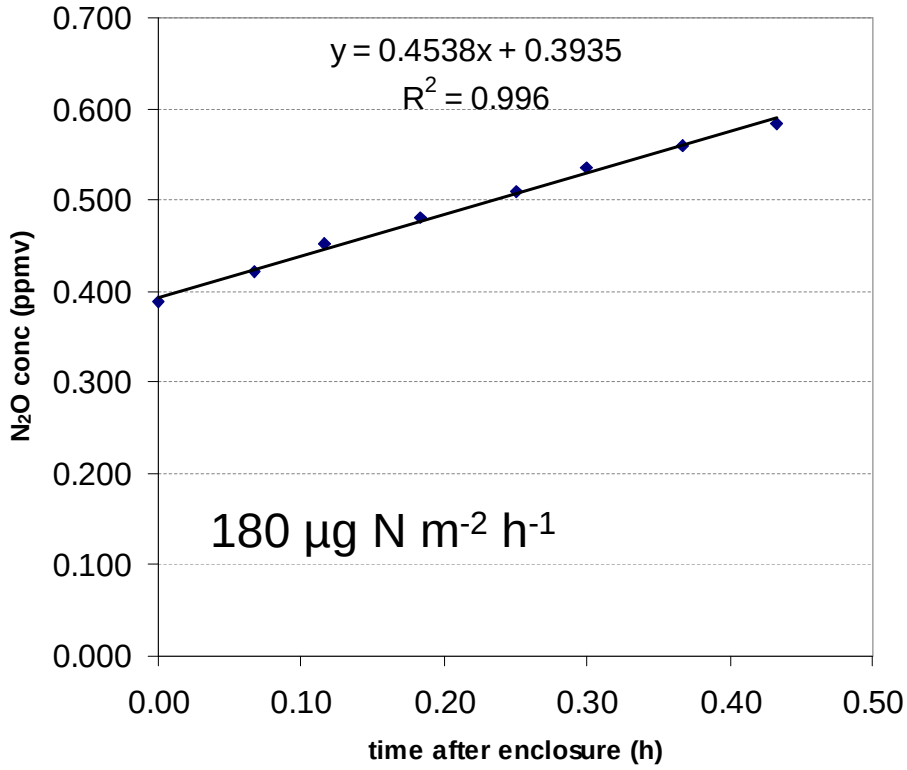
Flux level 5

Coarse sand



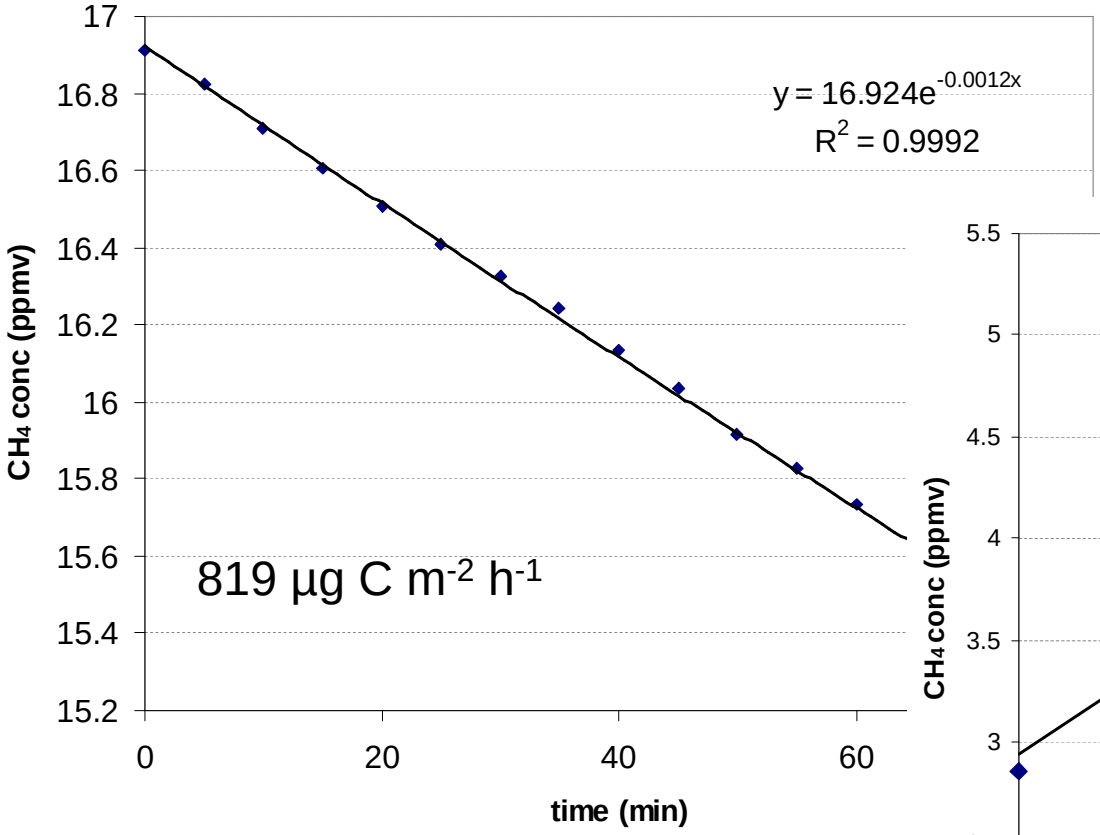
Pumpeli N_2O concentration

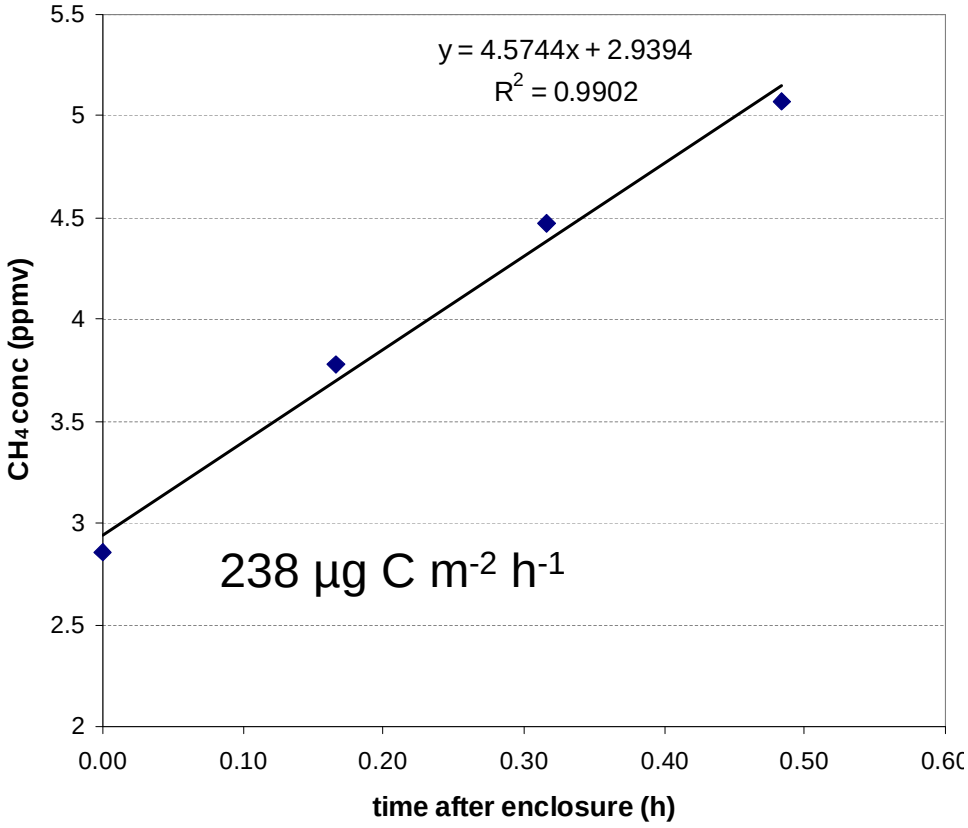
Chamber N_2O concentration



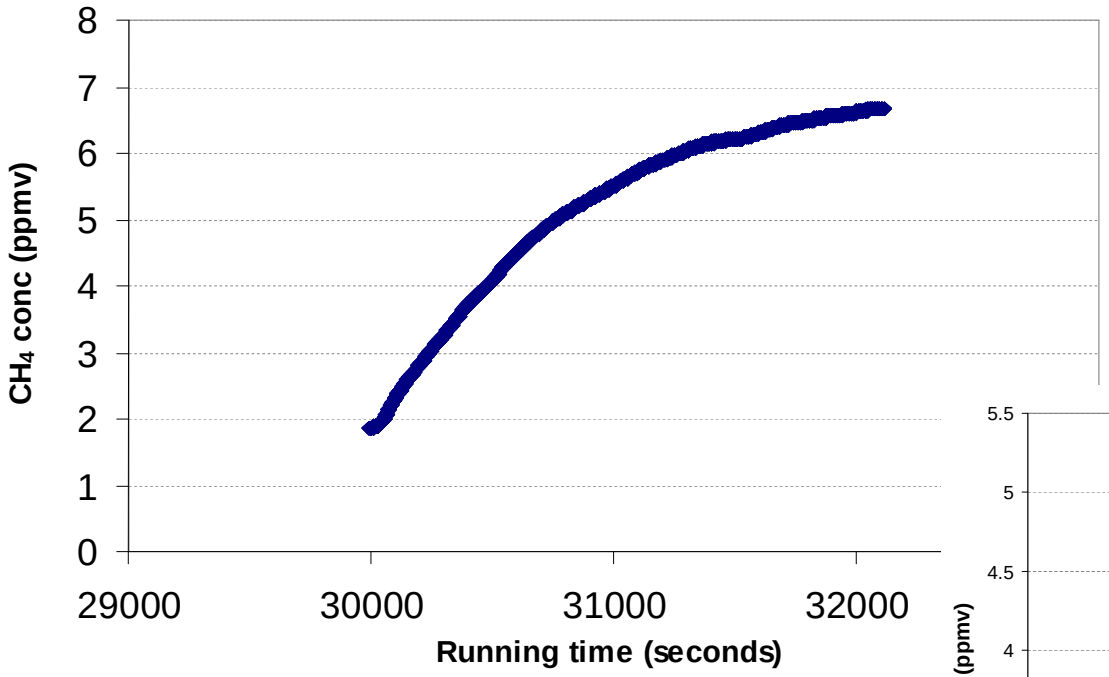
Flux level 4

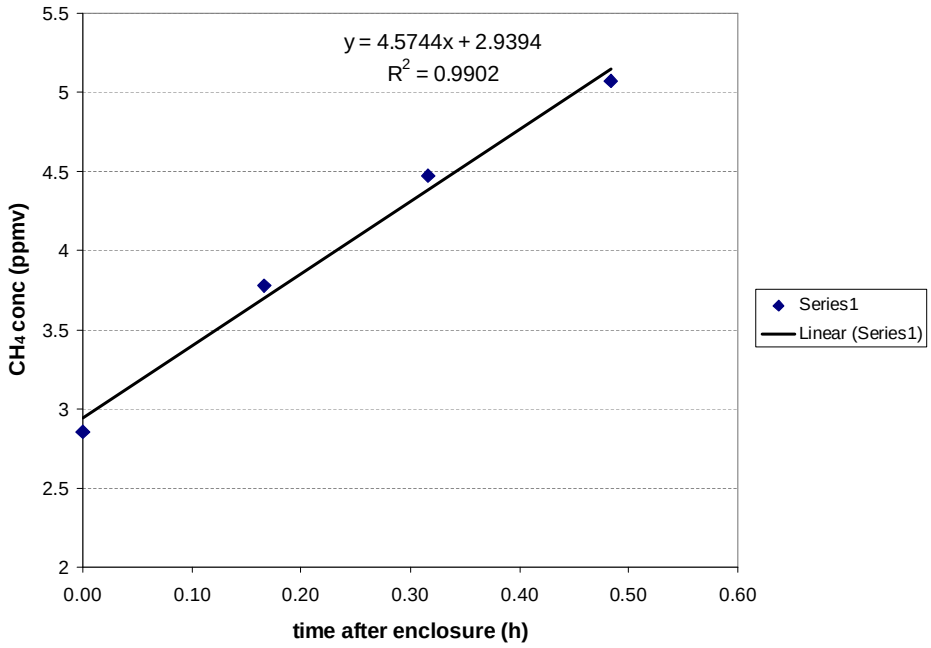
Coarse sand



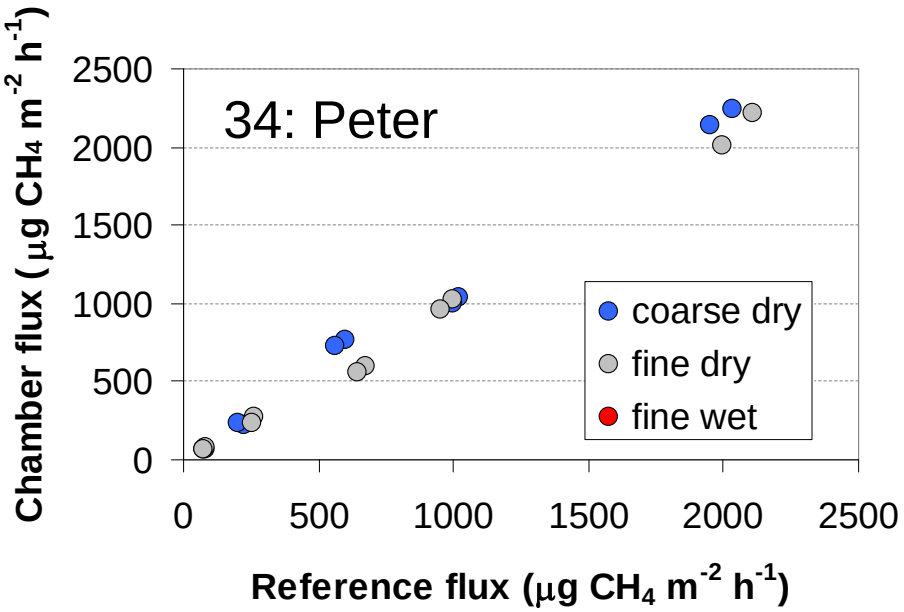


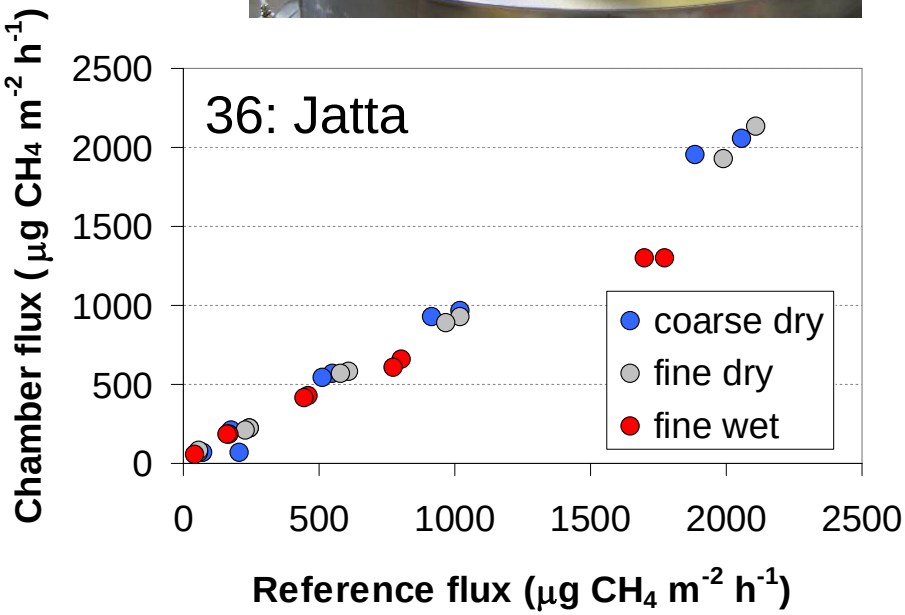
Exponential behaviour

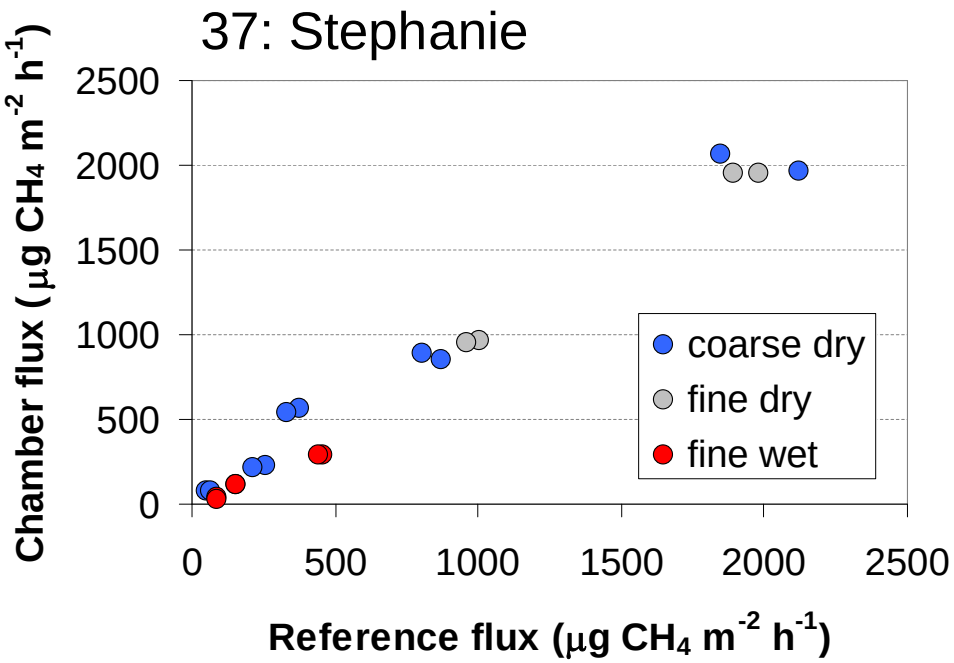


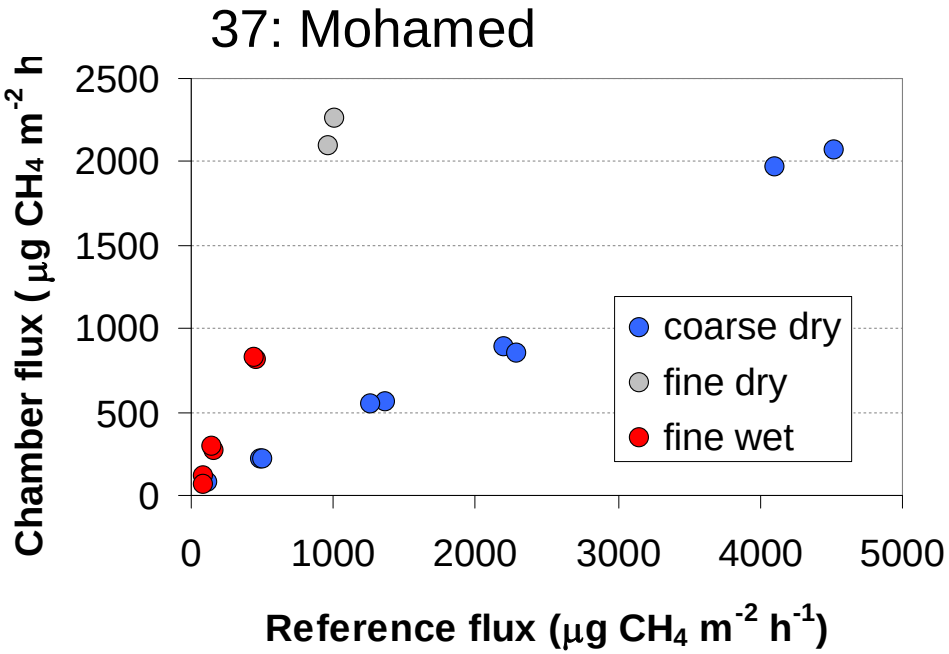


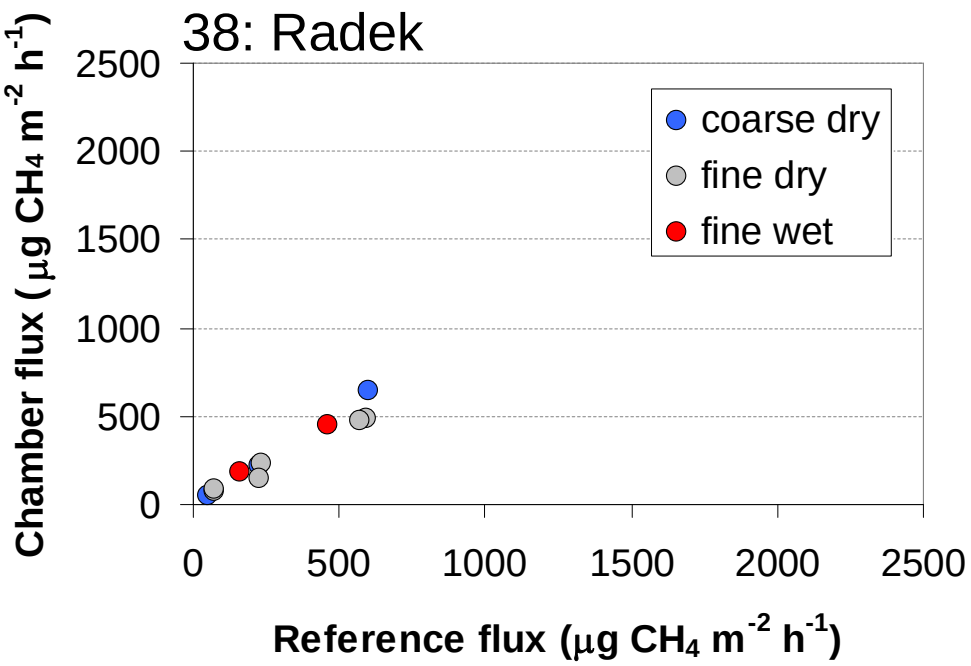
Chamber fluxes vs. reference fluxes

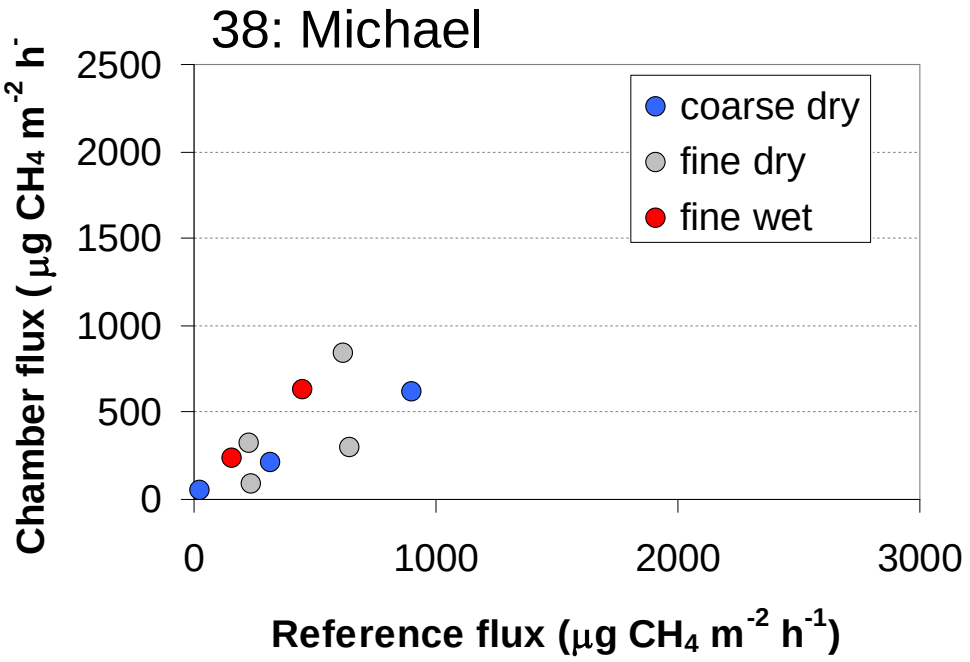


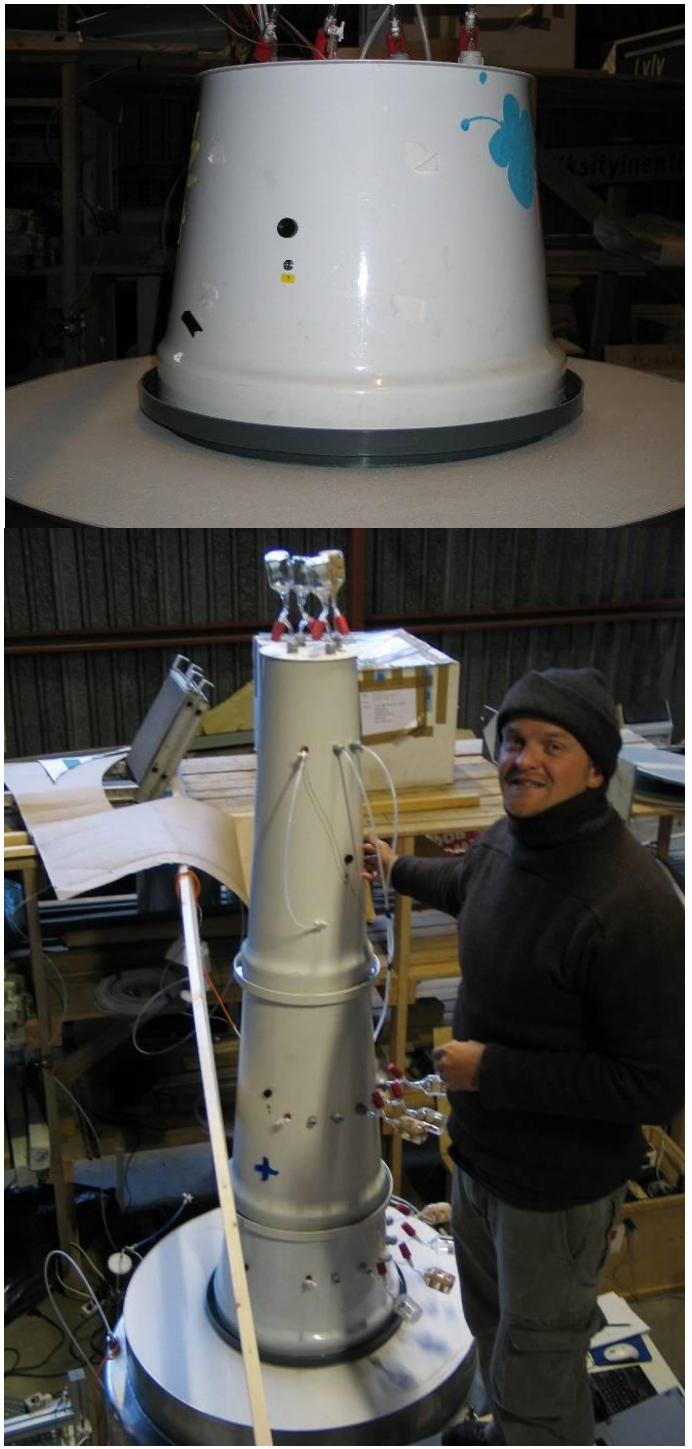


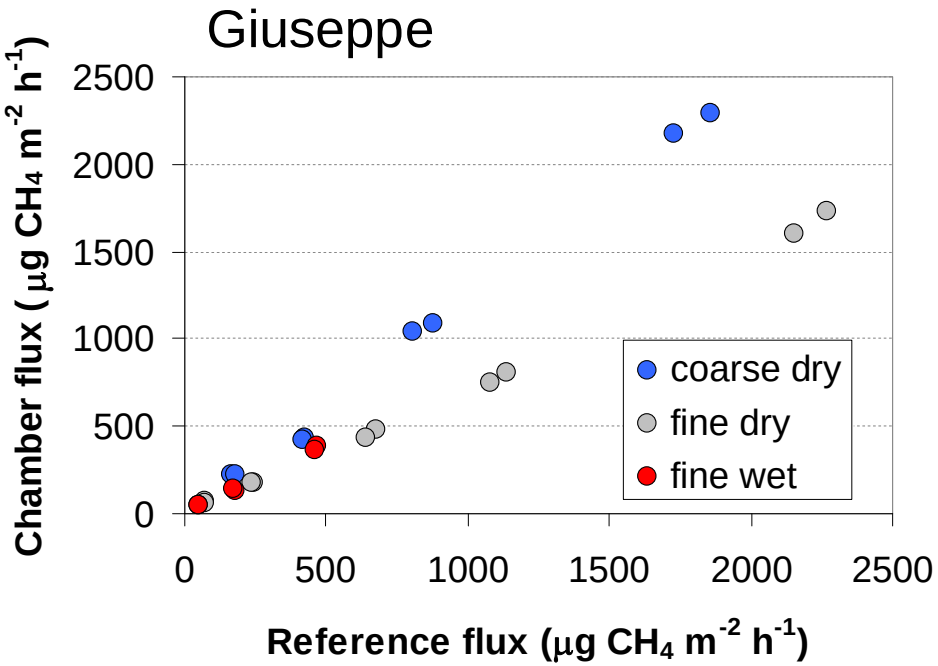

37: Stephanie
Chamber flux (μg CH4 m-2 h-1)
2500
2000
1500
1000
500
0
0
500
1000
1500
2000
2500
Reference flux (μg CH4 m-2 h-1)
coarse dry
fine dry
fine wet

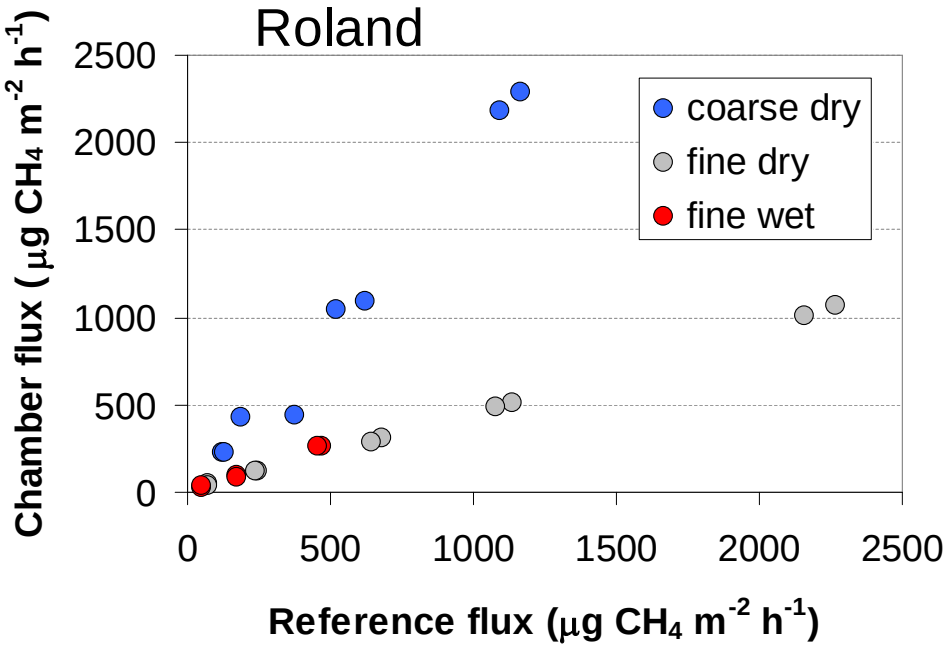

37: Mohamed
Chamber flux (μg CH4 m-2 h
2500
2000
1500
1000
500
0
0
1000
2000
3000
4000
5000
Reference flux (μg CH4 m-2 h-1)
coarse dry
fine dry
fine wet

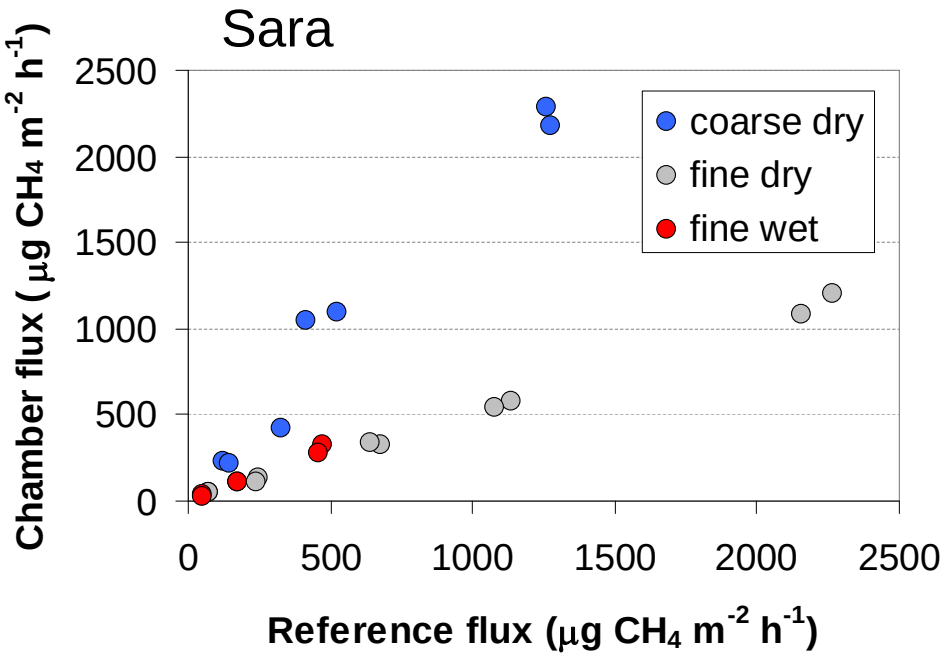

38: Radek
Chamber flux (µg CH4 m-2 h-1)
2500
2000
1500
1000
500
0
0
500
1000
1500
2000
2500
Reference flux (µg CH4 m-2 h-1)
coarse dry
fine dry
fine wet


38: Michael
Chamber flux (µg CH4 m-2 h-
2500
2000
1500
1000
500
0
0
1000
2000
3000
Reference flux (µg CH4 m-2 h-1)
coarse dry
fine dry
fine wet



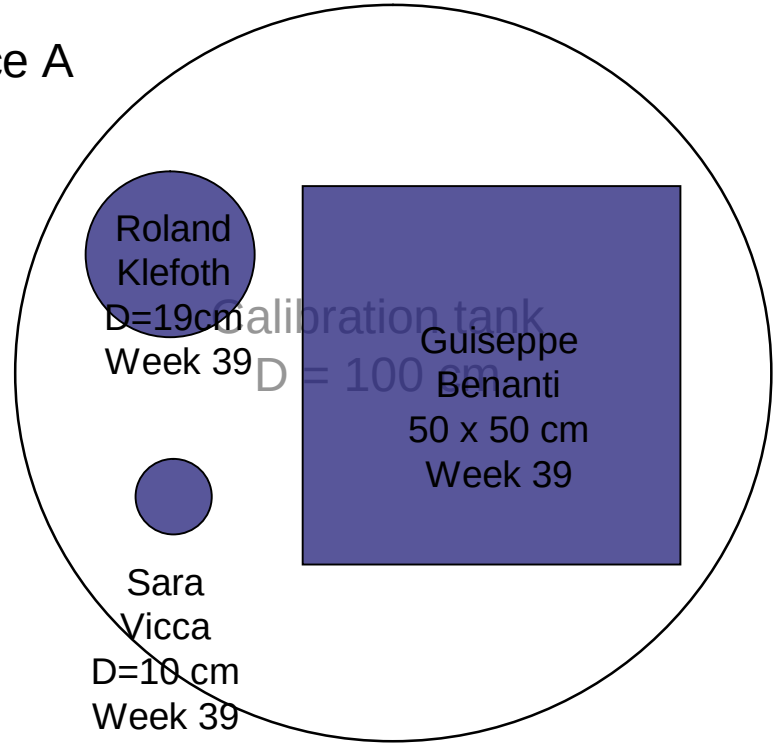

Giuseppe
Chamber flux (µg CH4 m-2 h-1)
Reference flux (µg CH4 m-2 h-1)
0
500
1000
1500
2000
2500
coarse dry
fine dry
fine wet

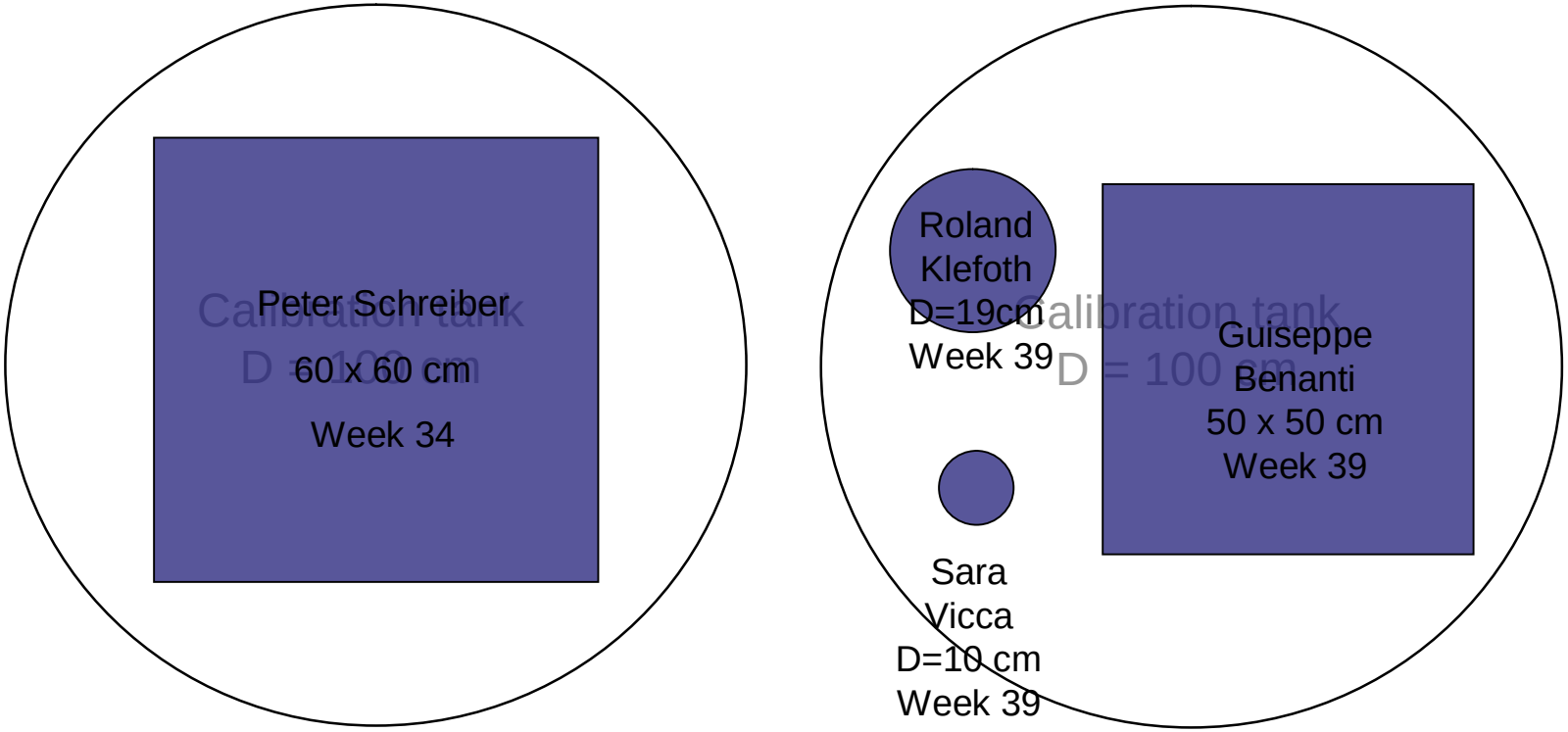

Roland
Chamber flux (µg CH4 m-2 h-1)
Reference flux (µg CH4 m-2 h-1)
0
500
1000
1500
2000
2500
coarse dry
fine dry
fine wet


Sara
Chamber flux (µg CH4 m-2 h-1)
Reference flux (µg CH4 m-2 h-1)
0
500
1000
1500
2000
2500
coarse dry
fine dry
fine wet

Future work

- Process the missing data
- Use different flux calculation methods for chambers
- Compare chamber fluxes to the ”MEGA” chamber
- Estimate a ”leak” rate using
  - Chamber A / Pumpeli surface A
  - Collar insertion depth
  - Other?




Peter Schreiber
60 x 60 cm
Week 34
Calibration tank
D = 100 cm
Roland
Klefoth
D=19cm
Week 39
Guiseppe
Benanti
50 x 50 cm
Week 39
Sara
Vicca
D=10 cm
Week 39
Calibration tank
D = 100 cm

Flux calculation

- Linear regression

$$F = \frac{dC}{dt} H$$

- Exponential fit

$$\frac{dC(t)}{dt} = \frac{Ag}{V}(C_s - C_0) = \frac{g}{H}(C_s - C_0)$$

Where

A = chamber basal area (m^2)

g = transport coefficient ($m\ s^{-1}$)

V = chamber volume (m^3)

C_s = gas concentration in the soil

C_0= gas concentration at time 0 (ambient)

H = chamber height (m)

$$C(t) = -\frac{B'}{A'} + (C_0 + \frac{B'}{A'})e^{A't}$$

$$A' = -\frac{Ag}{V} \qquad B' = \frac{AgC_s}{V}$$