Methane emission from dairy farm located North of Heidelberg

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Introduction

Weinheim is a city located 20 km North of Heidelberg. The region between Heidelberg an Weinheim is a typical farmland with dairy farms and biogas plants. Target place this studies was dairy farm situated on north-east of Weinheim. The farm has a livestock of about 320 - 340 dairy cows with an average milk production of 29 l per cow and day. A biogas plant (yellow bracket) is located next to the cowshed (green point).
Two CRDS analysers (G2201-I or LI-7810) were used for methane measurements. Moreover different 2D and 3D weather station were used. Initially, the measurements campaigns were focused on isotopes studies, but including always mobile plume crossings in order to apply Gaussian plume models at a later stage.

J.Kammerer, *A Study of Controlled Methane Release Experiments For Emissions Quantification with an Application to a Dairy Farm,* Master thesis, 2019

Measurements & method

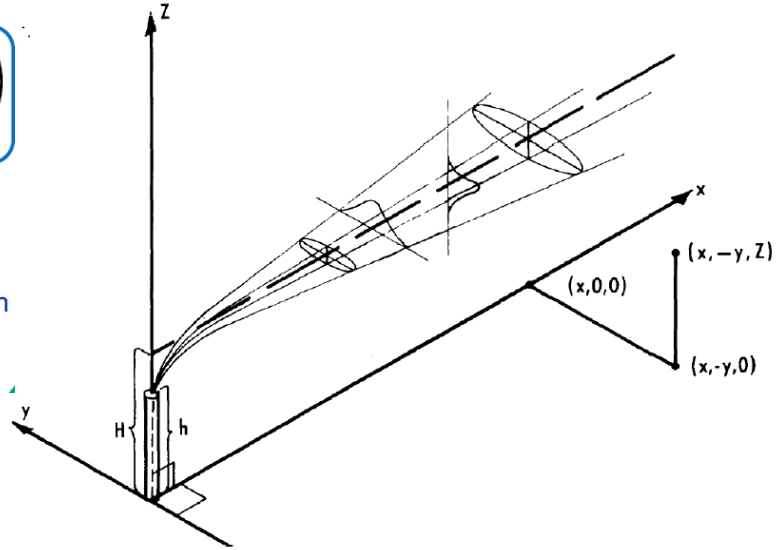
To determine the temporal and spatial variability of emissions, collected data are analysed with Gaussian plume model (equation below) to obtain emissions from dairy cows and biogas plant. For each mobile measurements campaign, we analysed 10 - 30 transects (driving the car forward and backward on the nearby parallel roads). Using metrological data, from 2D weather station on the roof of the car. The stability class was chosen from Pasquill table (classes from A to F) (1961).

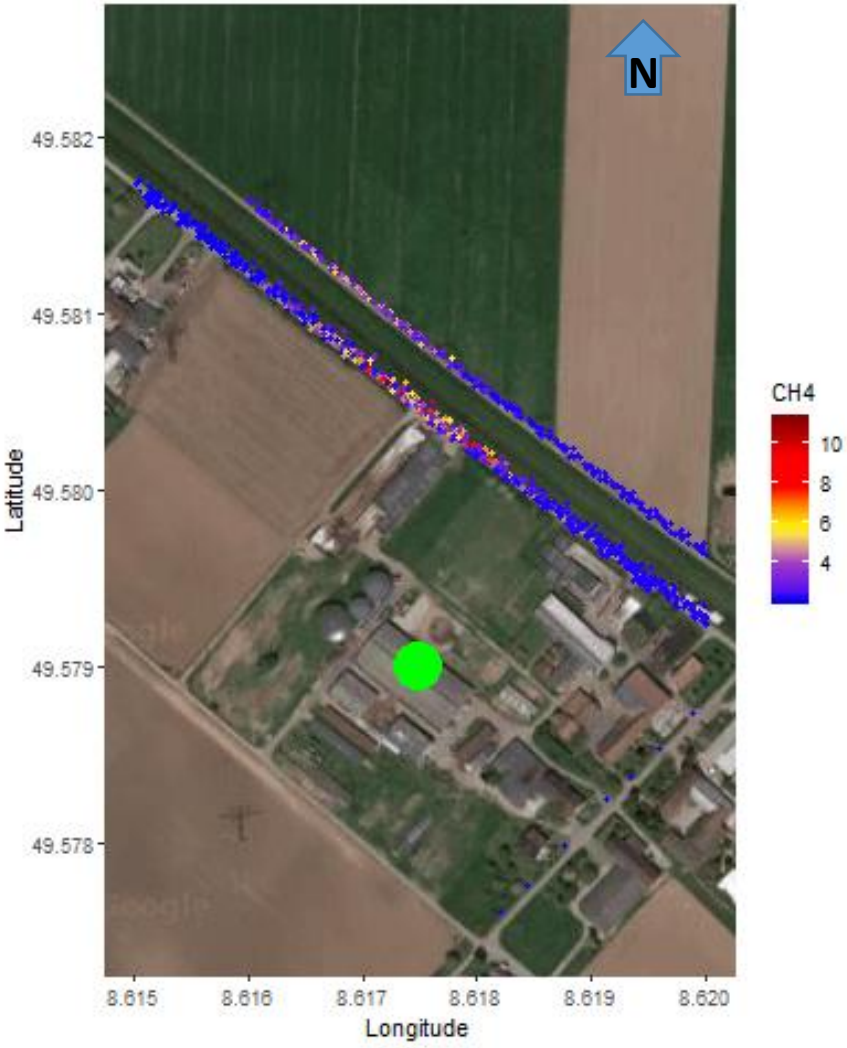
$$C(x,y,z) = \frac{Q}{2\pi U \sigma_y \sigma_z} \exp\left(-\frac{y^2}{2\sigma_y^2}\right) \exp\left(-\frac{(z-h)^2}{2\sigma_z^2}\right)$$

Concentration at center-line

Concentration in The crosswind direction

Concentration in The vertical direction



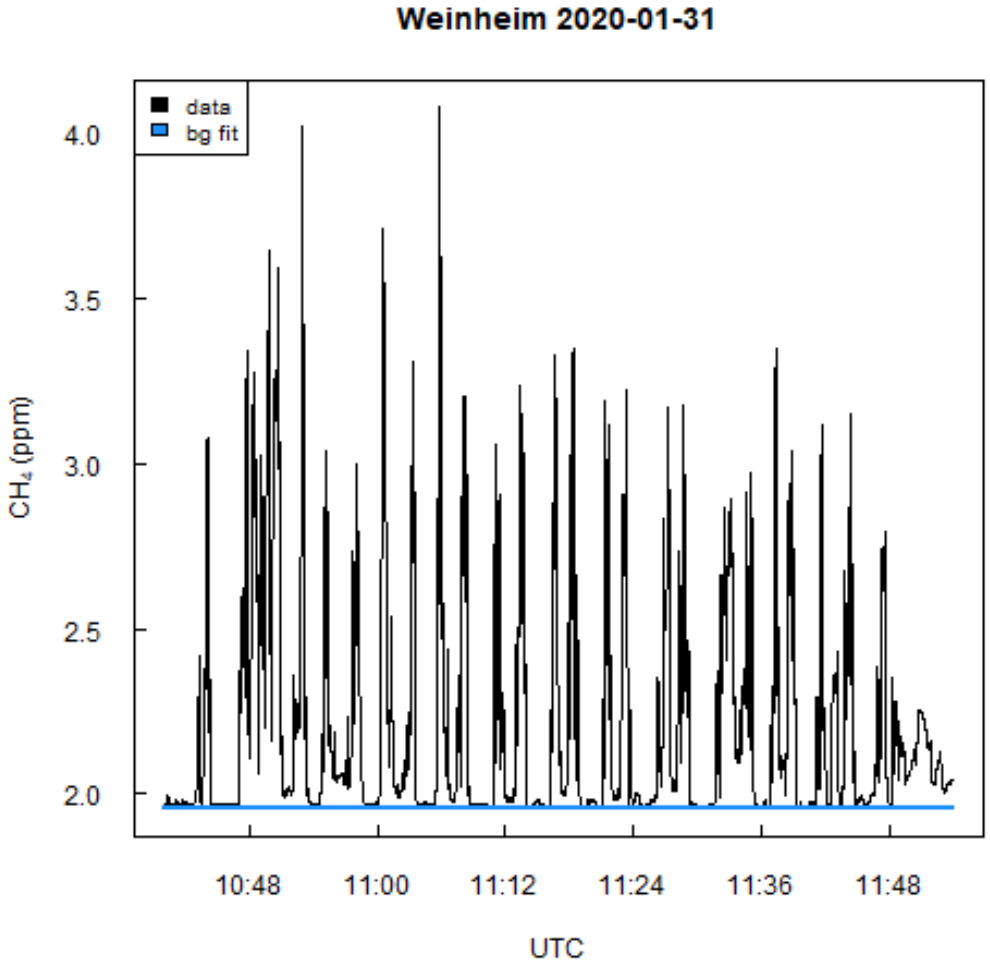


M. Omara, *Methane emissions measurements and quantification using EPA's Other Test Method (OTM) 33A, EDF*

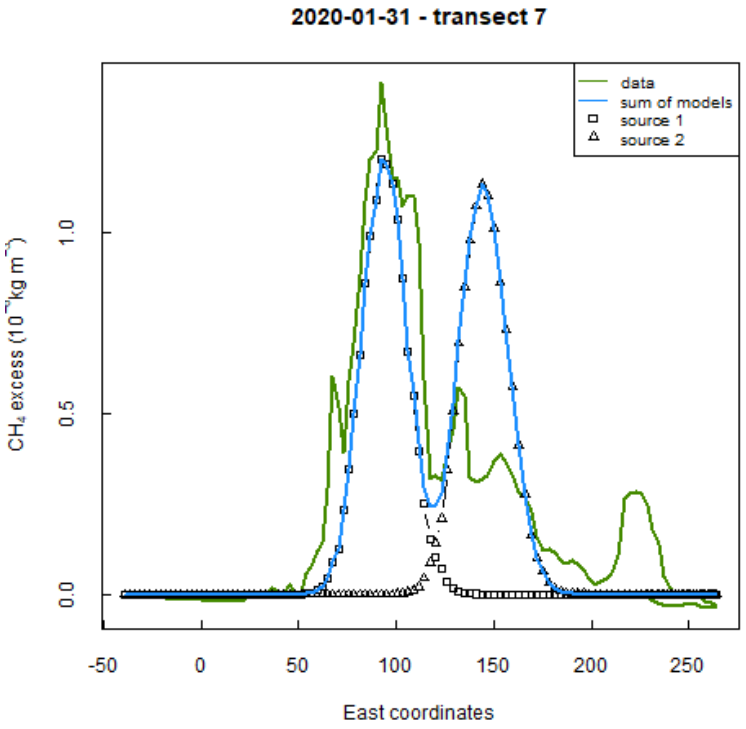
Results 01.2020

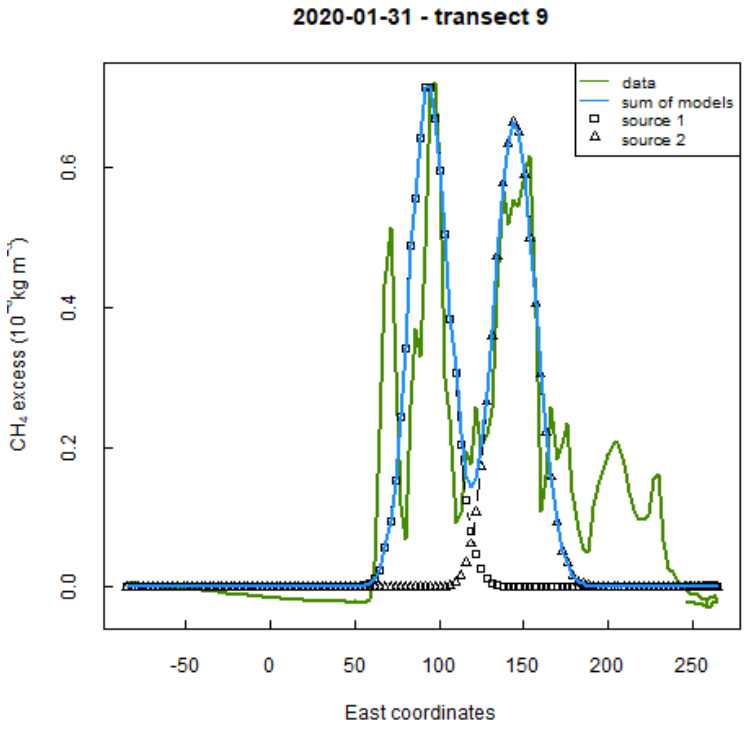
Example of methane measurements during plume crossing close to a farm in Weinheim in January 2020. As it is visible on plot the methane peaks vary between 2.8 and 4.0 ppm.

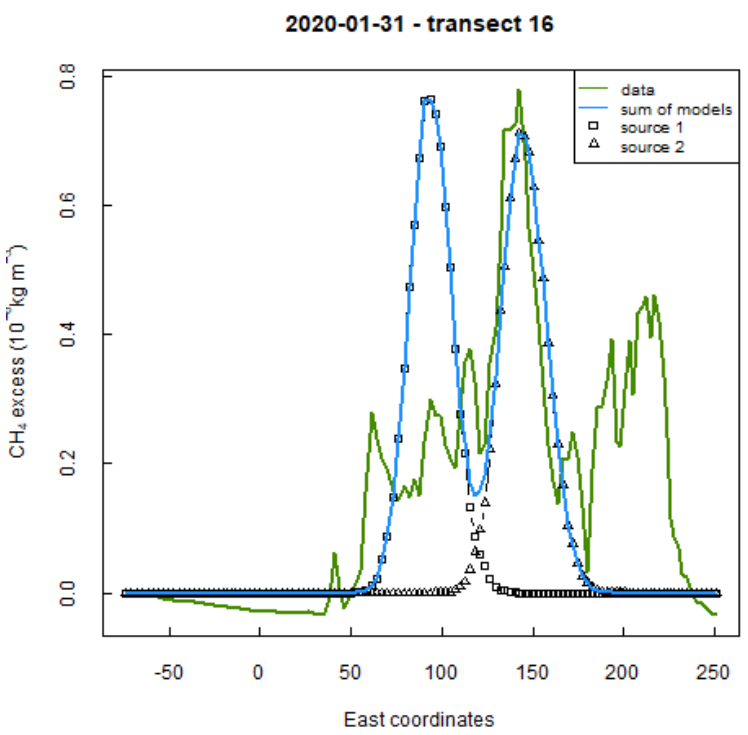
In April 2019 it we found a situation with larger CH4 variabilities on a time scale of hours (shown later). To derive the methane emissions of the farm, measured peaks were modelled with Gaussian formula and then integrals for both peaks (measured and modelled) were calculated and compared.



Results 01.2020





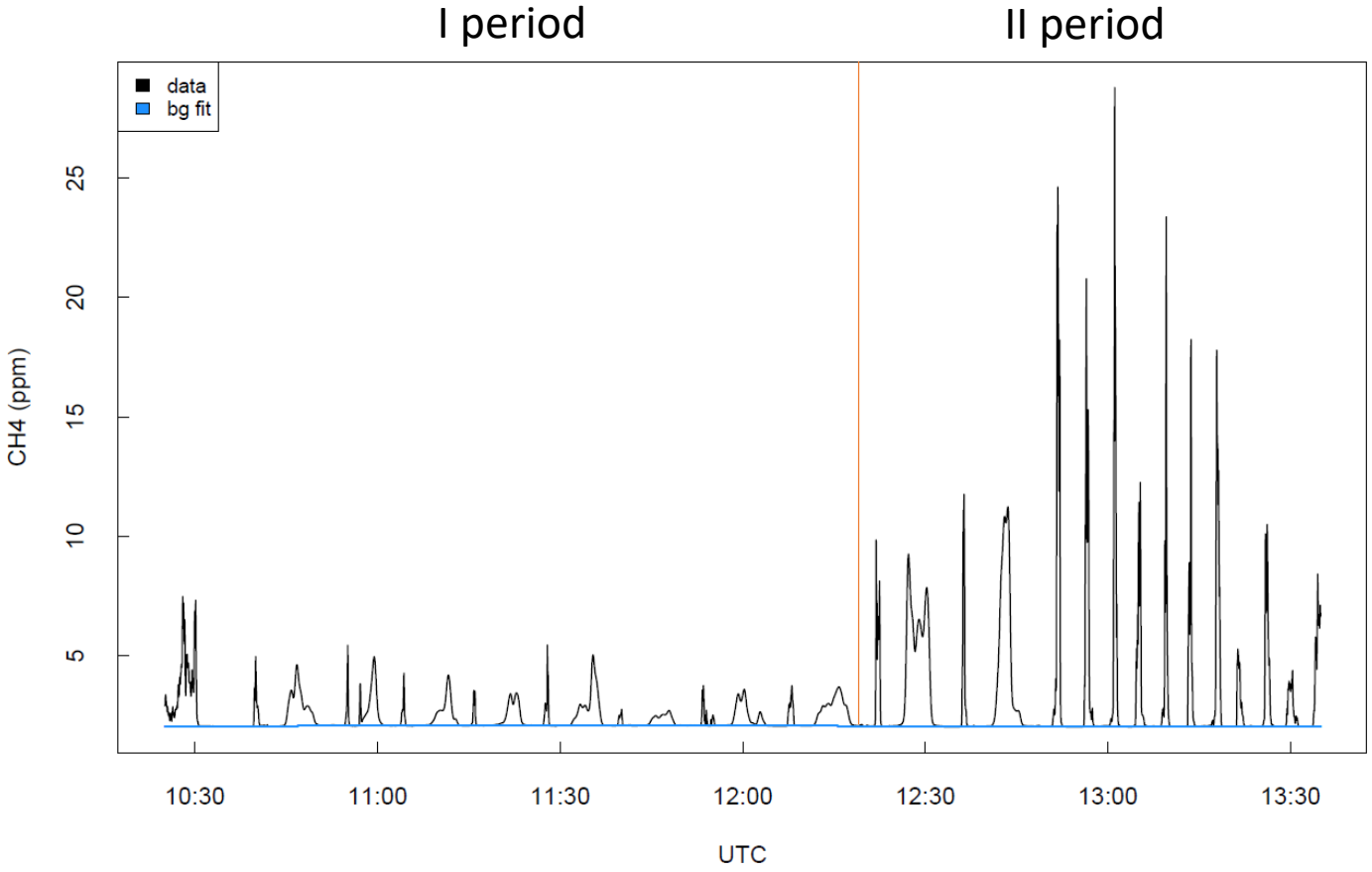


Collected data were analysed with R codes written by J. Kammerer. Typical for this farm is a double peak, which is due to two sources, namely the farm and the close by biogas plant. Emission estimated for this farm (320 cows) equals 2.6 ± 0.7 g CH_4/s.

Report from 2018 of The German Environment Agency (Umweltbundesamt - UBA) presents emission factors among others for cows since 1990. For 2016 (last reported value) it was 136.4 kg/cow/a. Taking only the mean emission factor per cow, not including manure and biogas plants, we expect with 320 cows 1.4 g CH_4/s.

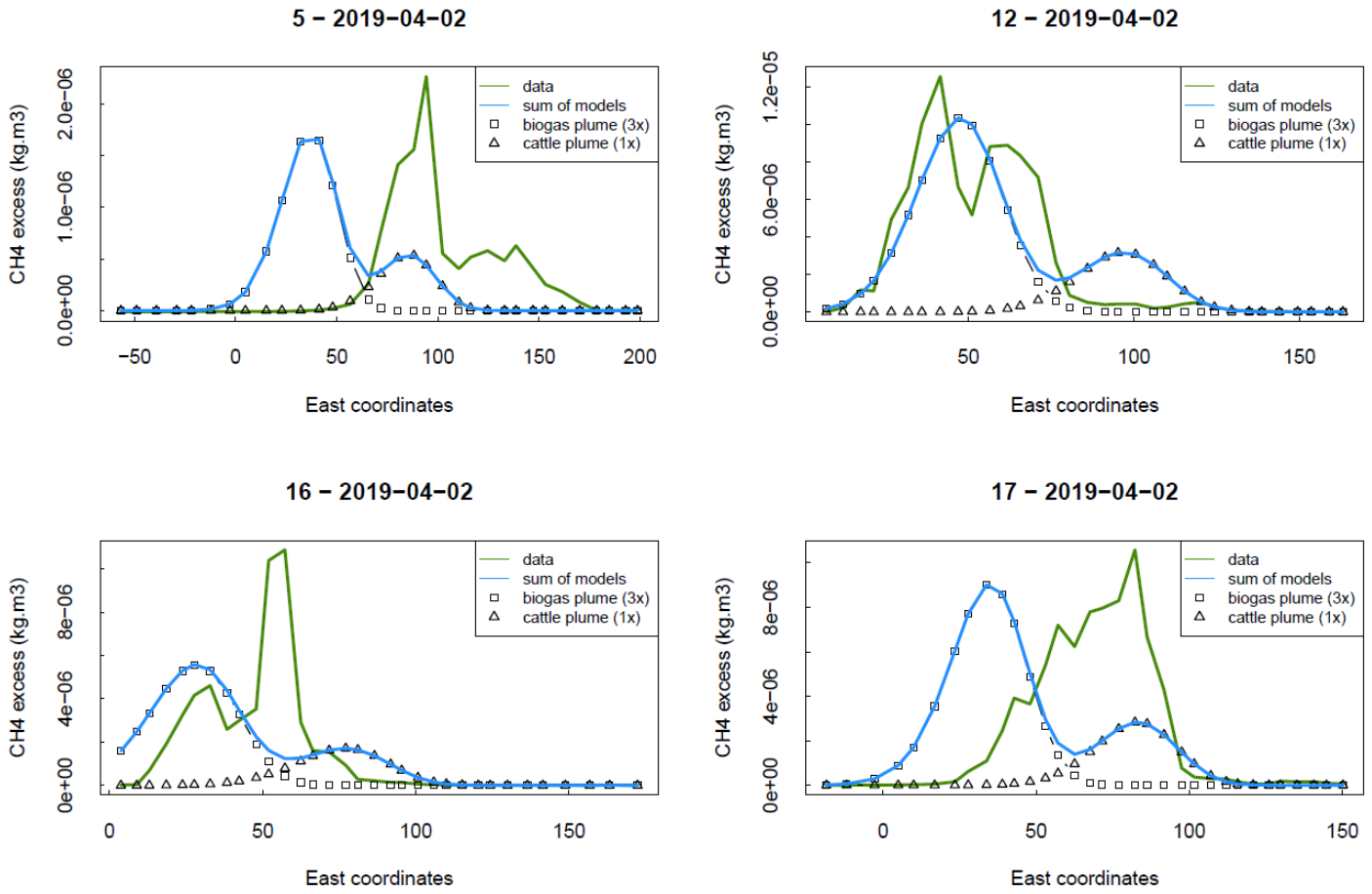
Results for April 2019

Measurements from April 2019 show two different periods with lower peak heights and larger ones up to 26 ppm CH4. We divided this time series in two parts. First part includes 8 peaks (to the left of the line) and second 12 peaks (to the right of the line). During first part of measurements the wind speed was lower (in the range 2.5 to 4.5 m/s) than for the second part of peaks (4.5 to 5.5 m/s). Higher methane concentration is here correlated with higher wind speed.



J.Kammerer, *A Study of Controlled Methane Release Experiments For Emissions Quantification with an Application to a Dairy Farm,* Master thesis, 2019

Results for 04.2019



Estimated emission for the first 8 peaks equals 4.1 ± 1.3 g/s. For the next 12 peaks (with higher wind speed) emissions equals 24.5 ± 10.9 g/s. In the second case the estimated emission is much higher than from January 2020. It is more complicated case, because wind speed has increased.

Compare to UBA emission factors multiplied by 320 cows, the measured emission is 3 to 17 times higher.

This special event in April 2020, is example with very high peaks and emissions, which were most probably due to a leakage or opening of the pressure release valve of the biogas plant.

J.Kammerer, *A Study of Controlled Methane Release Experiments For Emissions Quantification with an Application to a Dairy Farm*, Master thesis, 2019

Umweltbundesamt. *Berichterstattung unter der Klimarahmenkonvention der Vereinten Nationen und dem Kyoto-Protokoll 2018 - Nationaler Inventarbericht zum Deutschen Treibhausgasinventar 1990–2016*, 2018

Conclusions

- The first estimations of the emissions (cows and biogas included) shows strong variabilities and up to 10 times higher values, than expected when comparing to UBA reported emission values for dairy cows
- Analysis of other examples are needed and will be provided in the next few weeks
- Bag samples with isotopic signature will be collected during next campaign to evaluate the possibility to separate between stable and biogas plant

THANK YOU FOR YOUR PARTICIPATION

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