Slurry methane emissions: Farm to national predictions

Daniel Fletcher, Vera Eory

SRUC, West Mains Road, Edinburgh, EH9 3JG, Scotland

dfletcher@sruc.ac.uk

Introduction

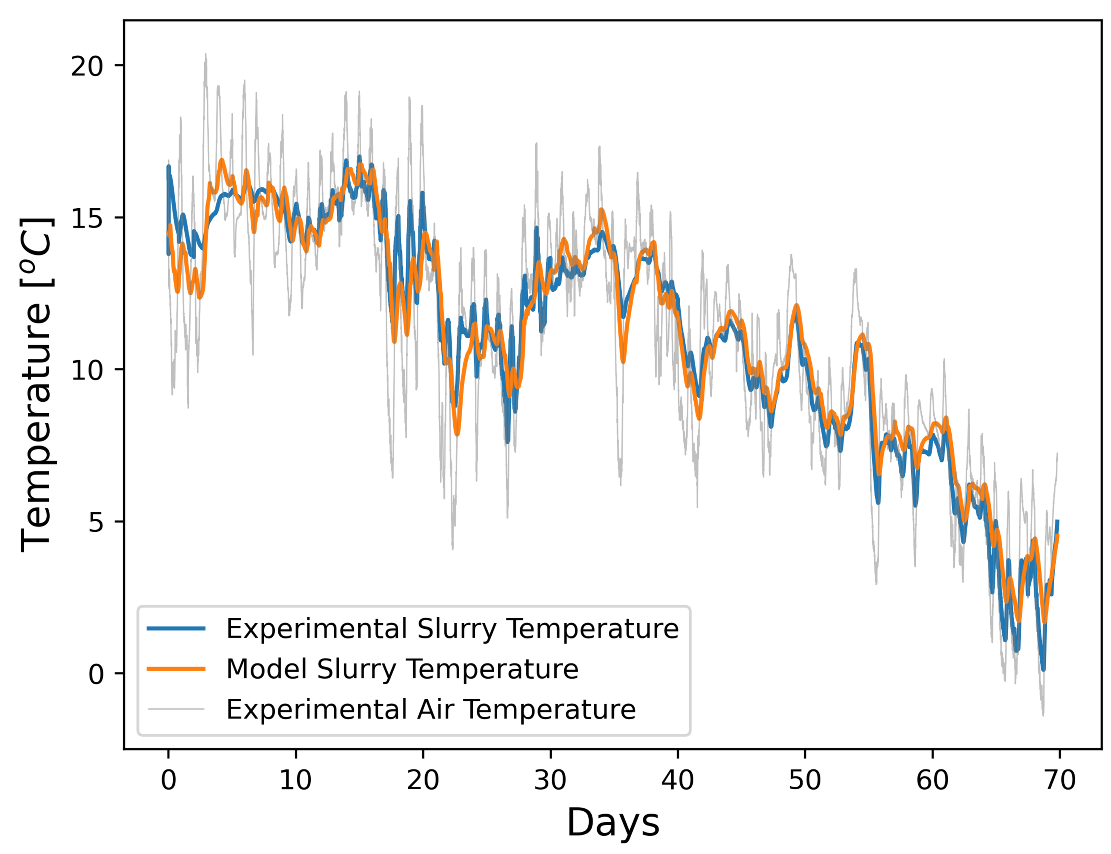
- 16% of agricultural greenhouse gas emissions in the UK are from manure.
- Temperature is a major driver for slurry methane emissions (Figure 1b).
- Differences in climate cause variations in these emission, and global warming may accelerate emissions.
- The UK Greenhouse Gas Inventory (GHGInv) uses a constant emissions multiplier for slurry methane, regardless of the climate, housing patterns of cattle and slurry emptying dates

We developed a model which can estimate slurry methane emissions across the UK using spatially resolved climate and cattle spatial distribution. A web interface for the model is also developed to guide manure-management decisions by farmers and fill data gaps on slurry emptying dates and animal housing periods.

Methods

- The model uses air temperatures to determine slurry temperatures (Fig 1a) which in turn defines the rate of methane production (Fig 1b). The model accounts for the rate slurry storage is filled and when slurry storage is emptied.
- Inputs WebApp: Open-meteo weather API and user input on management decisions on housing and slurry emptying.
- Inputs Spatial map: Daily air temperature map (Met Office) and June agricultural census on cattle distribution 2019 for spatial maps. We assume slurry is emptied twice per year on April 14th and October 15th and either:
  - i) Slurry is generated at a constant rate throughout the year according to GHGInv
  - ii) The cattle are housed for the housing proportion used by the GHGInv centred around the winter solstice, resulting in most slurry being generated in winter.

1a



1b

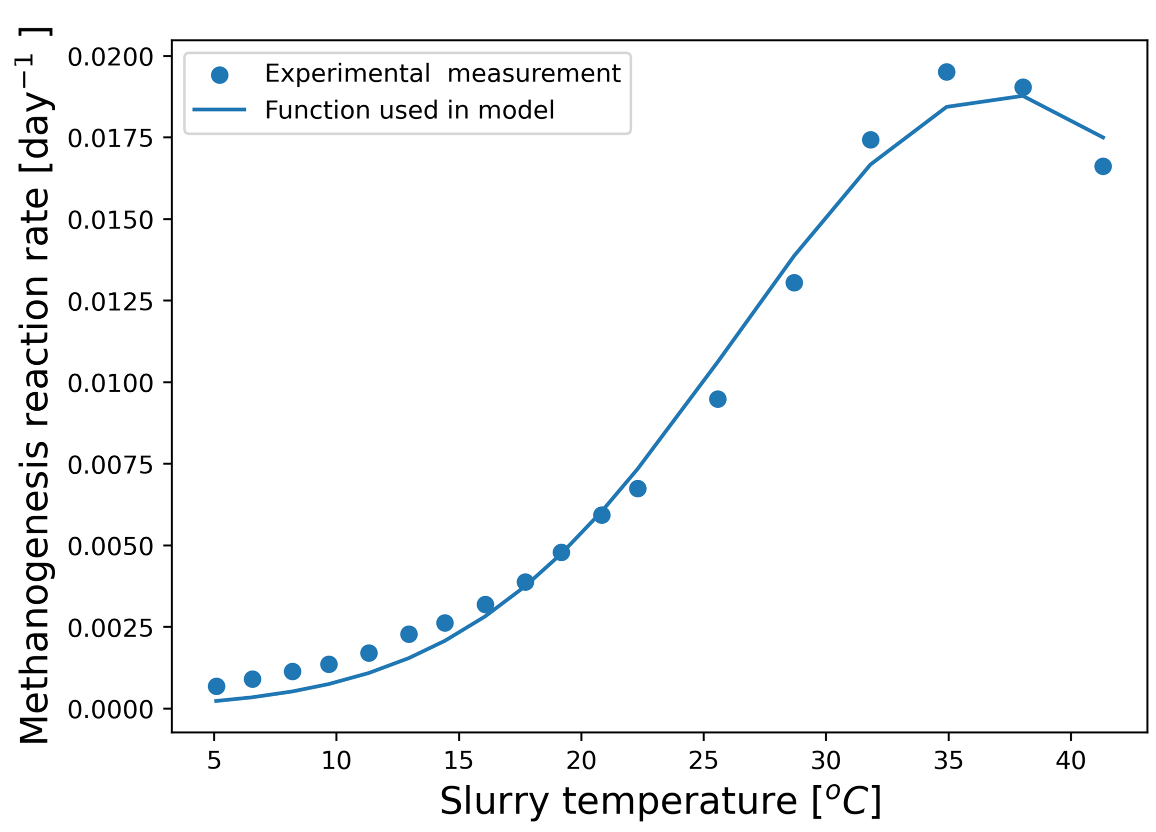
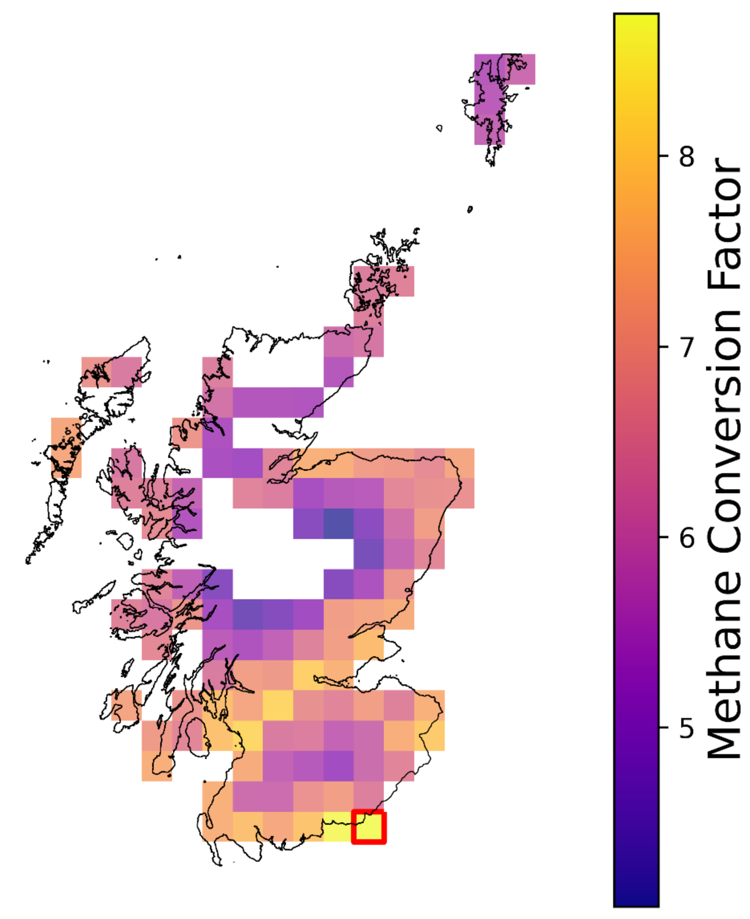
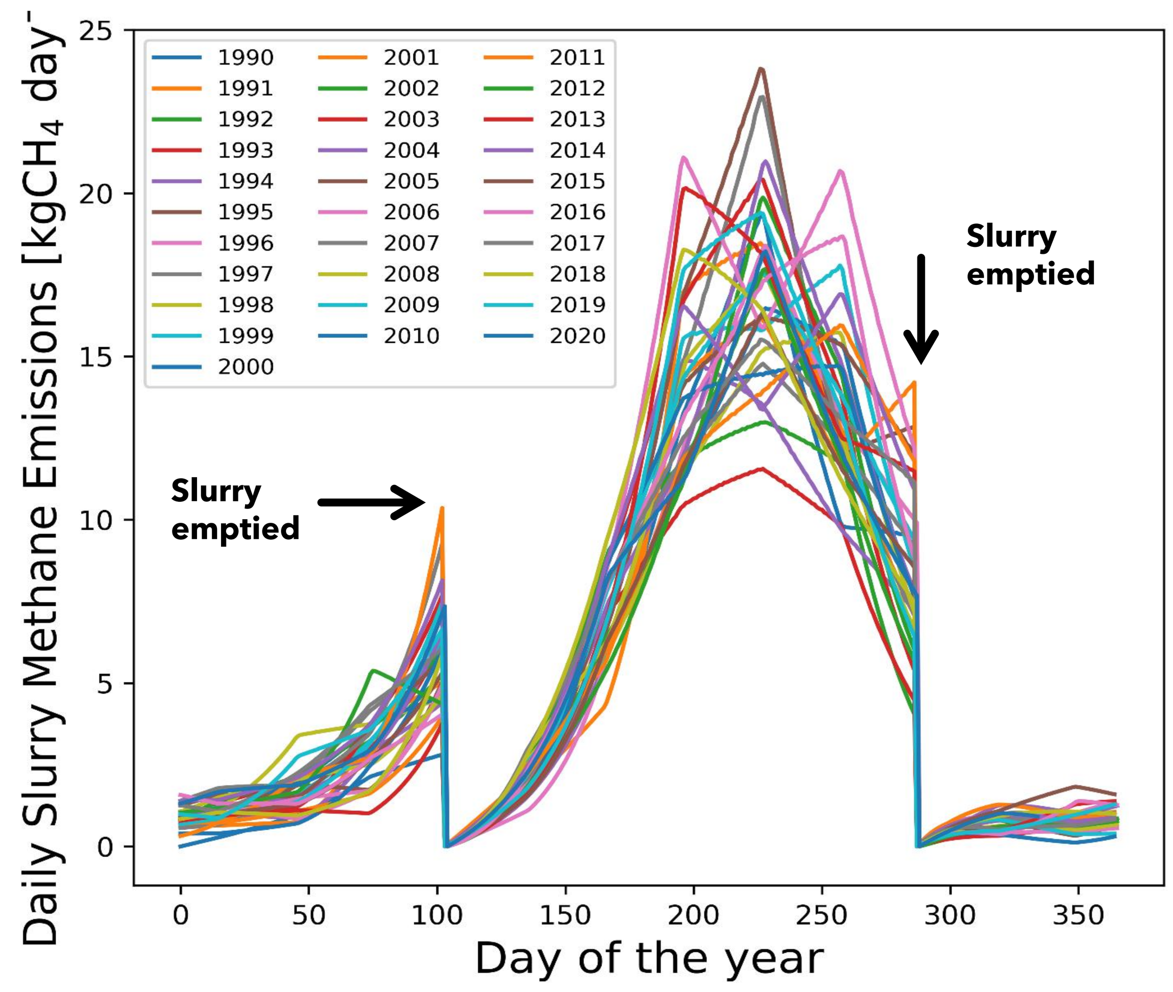


Figure 1:
Ingredients in the model used for estimating spatial slurry methane emissions a) Calculating slurry temperature based on local air temperatures (experimental data from Misselbrook (2016)); b) Calculating the rate of methane production as a function of slurry temperature (experimental data from Elsgaard (2016)).

Results

Figure 2:
Top: Average Slurry Methane Conversion Factor (Emissions factor) from 1990 to 2020 accounting for cattle distribution and temperature.
Bottom: Daily slurry emissions in the red box highlighted on the map. Constant slurry production (i) is assumed for these results.





Link to Web App for personalized slurry emission
https://axial-trail-391808.web.app/

- The Methane Conversion Factor (MCF) is the emissions factor which controls slurry methane emissions in GHG inventory calculations. For constant rate slurry generation (case i), the Scottish MCF is 7.5% while for winter weighted slurry generation (case ii) the MCF is 2.2%.
- Local MCF (Fig 2) is highest where the temperature is highest. This coincides with the main dairying region of Scotland.
- **By interacting with the Web app** readers can see that methane emissions are highly dependent on local temperatures, slurry emptying time and housing patterns of cattle.

Conclusions

- Spatial emissions approximations improve upon GHG calculations by accounting for cattle housing period, distribution and slurry emptying dates.
- Lack of available data on slurry emptying dates and cattle housing makes it difficult to accurately predict slurry methane emissions.
- Web App can help individual farmers forecast and predict their slurry methane emissions and help fill data gaps.
- Accounting for the fact that most cattle are housed in winter so most slurry storage happens over the coldest periods results in 350% lower estimated slurry methane emissions in this case study.

Acknowledgements

This project is funded by the UKRI Agri-food for Net Zero Network+ www.agrifood4netzero.net and was supported by the Rural and Environment Science and Analytical Services Division (SRUC-C5-1).

References: Misselbrook (2016): doi.org/10.2134/jeq2015.12.0618;
Elsgaard (2016): doi.org/10.1016/j.scitotenv.2015.07.145
Open-meteo Zippenfenig, P. (2023). Open-Meteo.com Weather API [Computer software]. Zenodo. https://doi.org/10.5281/ZENODO.7970649