

Supplementary Material

S1: Mobile campaign data

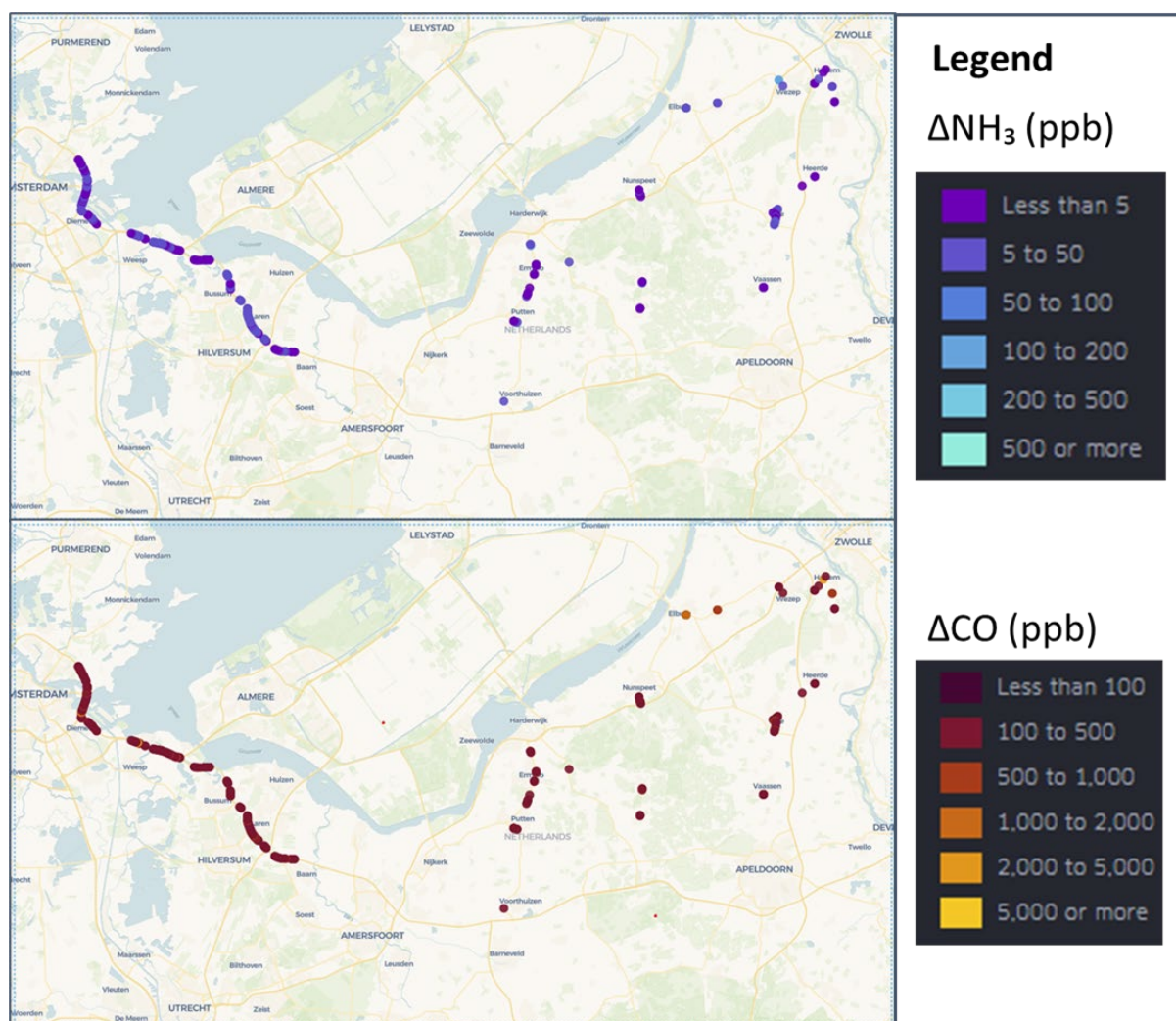


Figure S1: Spatial visualization generated using *kepler.gl* of background-corrected gas concentration enhancements measured during the mobile campaign on 21 February 2023. Data points recorded between 09:00 and 15:45 with enhancements exceeding 3 ppb for NH₃, 100 ppb for CO, and 15 ppm for CO₂ were retained. Panels show (a) ΔNH₃ and (b) ΔCO. Colors represent different enhancement magnitude classes observed during specific driving periods. The basemap is provided by *MapLibre*.

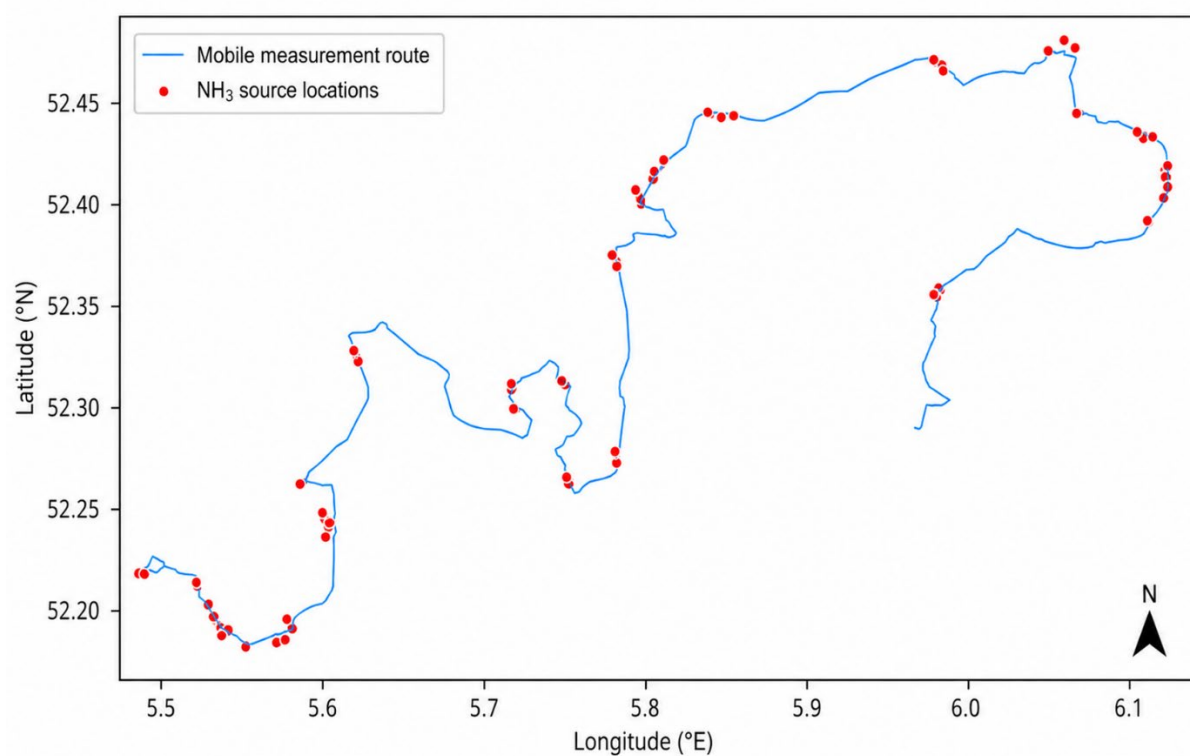


Figure S2: Spatial distribution of NH_3 source locations (red circles) relative to the mobile measurement route (blue) across the Veluwe region, the Netherlands. Exact source coordinates are omitted for privacy reasons.

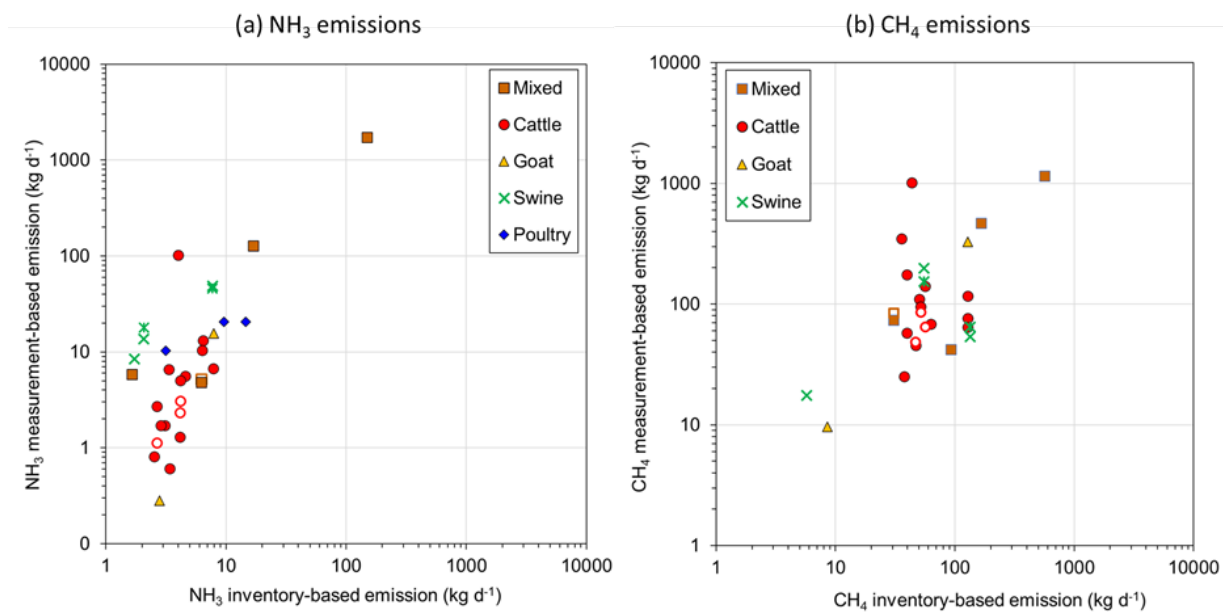


Figure S3: Double-logarithmic comparison of emission estimates from inventories and measurements for NH₃ (a) and CH₄ (b). Some livestock farms were measured twice; second measurements are shown as open brown squares, red circles, or green stars for mixed-species, cattle, and swine farms, respectively.

Table S1: Summary of 49 NH₃ and CH₄ emission sources, measured enhancement ratios, inverse-modelled emissions, and inventory data.

(This table is provided as a separate Excel file (Table_S1.xlsx)).

S2: HT calibration and validation

Field calibration of the HT-8700E NH₃ analyzer was conducted during the 2023 Veenkampen campaign in Wageningen, the Netherlands (28 March–29 May), using co-located miniDOAS (2.2D) measurements from RIVM as a reference. The HT inlet and the path-averaged miniDOAS system MD16 were installed at comparable heights (~2.8 m above ground) and within approximately 50 m of each other, ensuring comparable sampling conditions. In contrast, a second miniDOAS instrument (MD14) was installed at a much lower height (~0.6 m), and was therefore not used for calibration due to differences in sampling height and representativeness.

The miniDOAS instruments (MD16 and MD14) were well calibrated and provided reliable preliminary half-hourly NH₃ concentrations over a range of approximately 1–100 µg m⁻³, representative of ambient conditions during the campaign. However, the HT instrument exhibited a systematic bias relative to MD16, revealing limitations in the factory calibration procedure based on a permeation tube.

To address this, an in situ calibration approach was applied using concurrent field observations. Half-hourly HT data were first filtered based on optical signal strength (OSS > 20%) to ensure data quality, followed by removal of clear outliers. The filtered dataset was then compared with MD16 observations over the full campaign period.

The comparison revealed a non-linear relationship between the HT and miniDOAS measurements, particularly at lower concentration levels. A polynomial regression provided the best agreement between the two datasets across the full concentration range (Fig. S4a). This behavior is consistent with the influence of environmental factors (e.g. temperature) and limitations of the initial factory indoor calibration, which only covered higher concentration ranges (100–800 µg m⁻³).

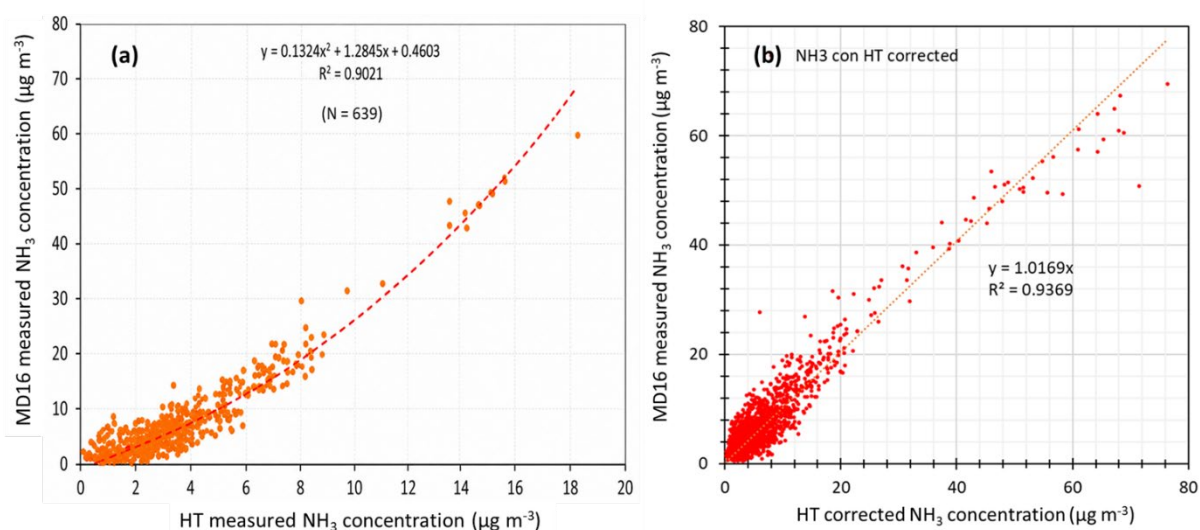


Figure S4: Comparison of HT and MD16 concentrations under field conditions. (a) Raw HT measurements when HT OSS > 20%. (b) Comparison with MD16 after correction of the full HT dataset when HT OSS > 10%.

The derived polynomial calibration function was subsequently applied to the full HT dataset (including data with OSS > 10%) prior to further analysis. After correction, the HT measurements showed improved agreement with the miniDOAS observations throughout the campaign (Fig. S4b and Fig. S5).

In total, 1353 half-hourly data points were used for calibration and validation, representing approximately 52% of the dataset with intermediate OSS values (10–20%) and 48% with higher signal quality (OSS > 20%). Reduced signal quality during part of the campaign was associated with precipitation events and mirror degradation.

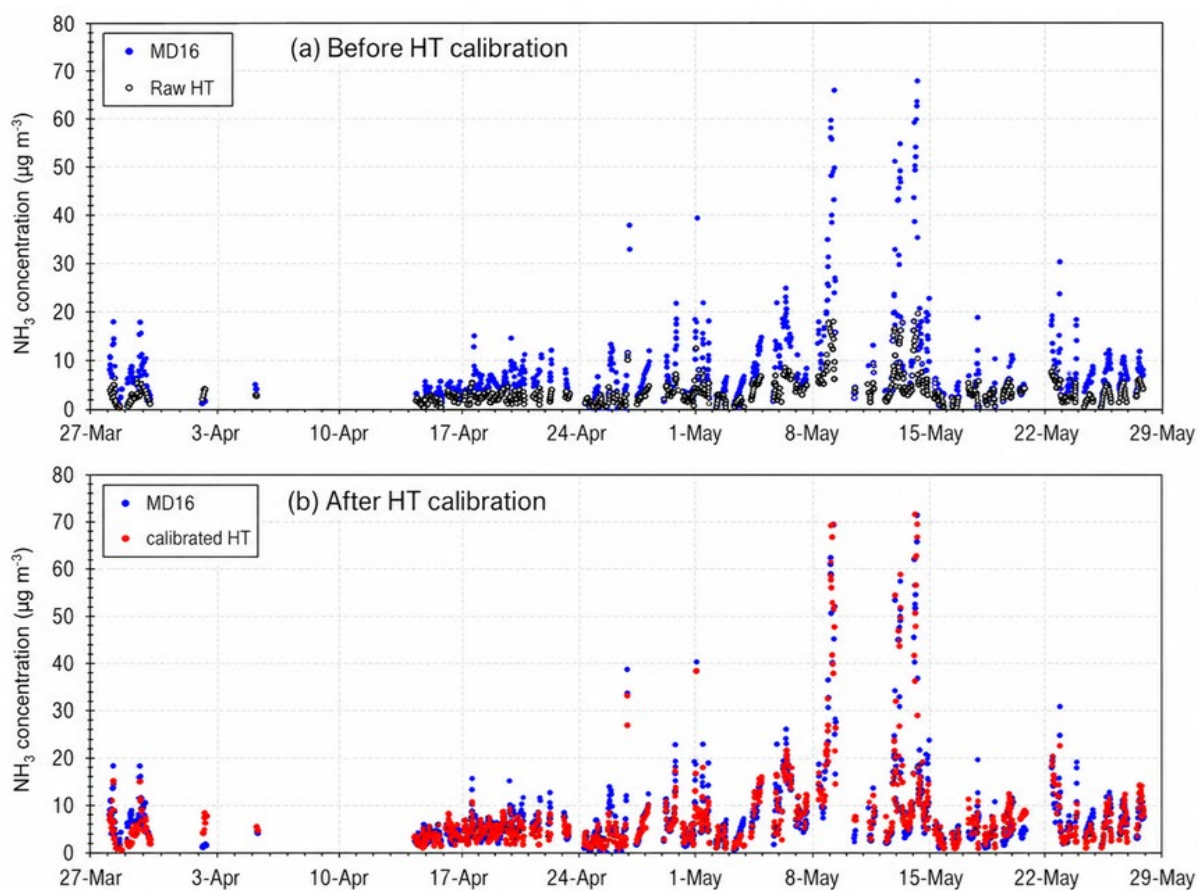


Figure S5: Time series of raw and calibrated NH₃ concentrations measured by HT compared with concurrent NH₃ measurements from miniDOAS (MD16) during the Veenkampen field campaign in 2023.