National Institute for Public Health
and the Environment
Ministry of Health, Welfare and Sport 1

Field comparison of two novel open-path instruments to measure ammonia fluxes during the RITA'21 campaign.

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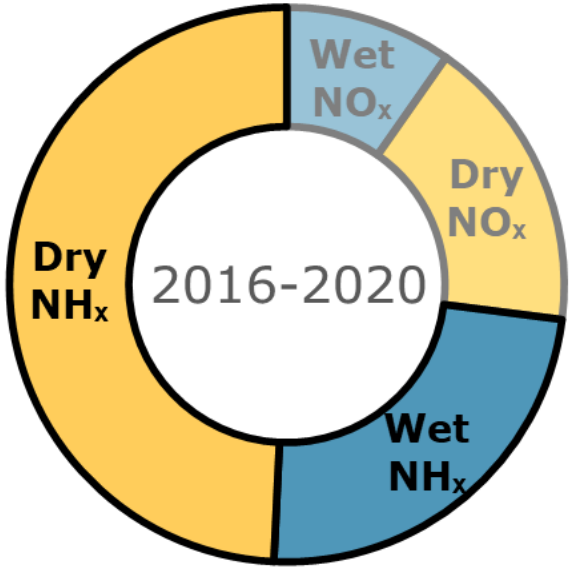
Motivation and aim of the campaign

- NH_3 dry deposition is the largest fraction of nitrogen deposition
- Very difficult to measure
- Only monthly averaged measurements



➡ Ruisdael campaign aim:
half-hourly flux measurements to see the deposition and emission processes.

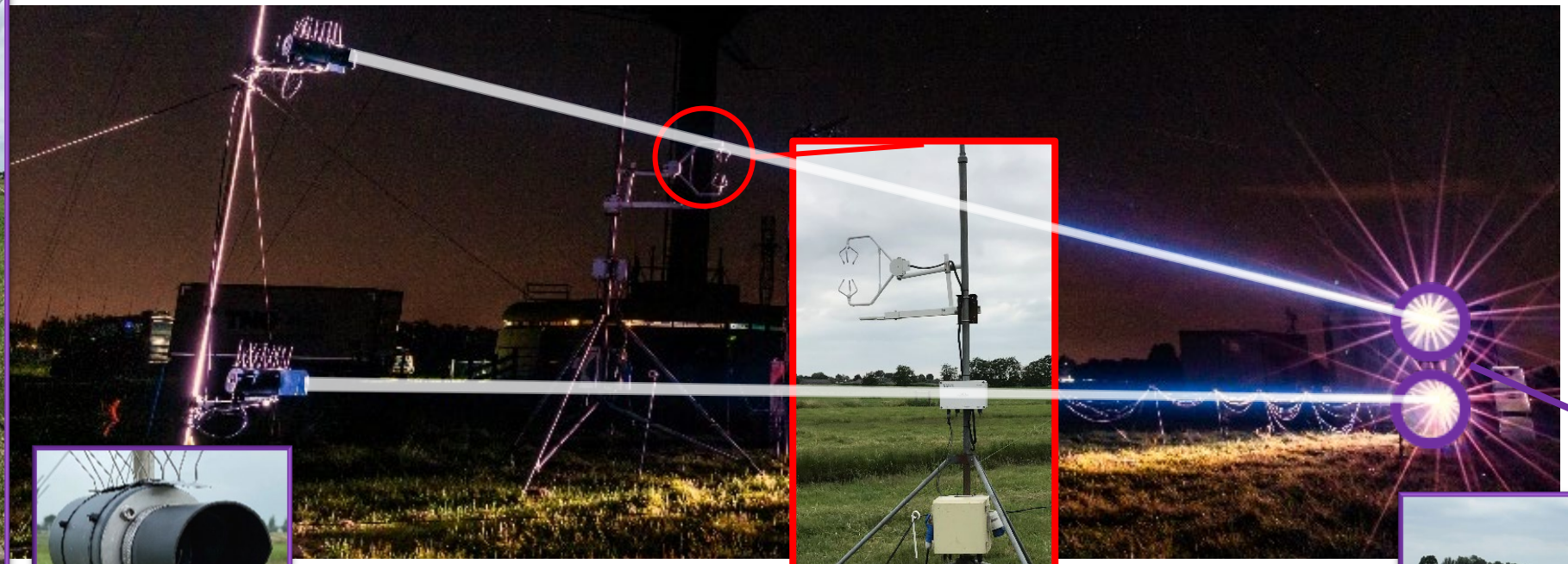
Two methods using open path instruments

- Aerodynamic flux gradient method (AGM) using broadband UV-based miniDOAS 2.2D (RIVM)

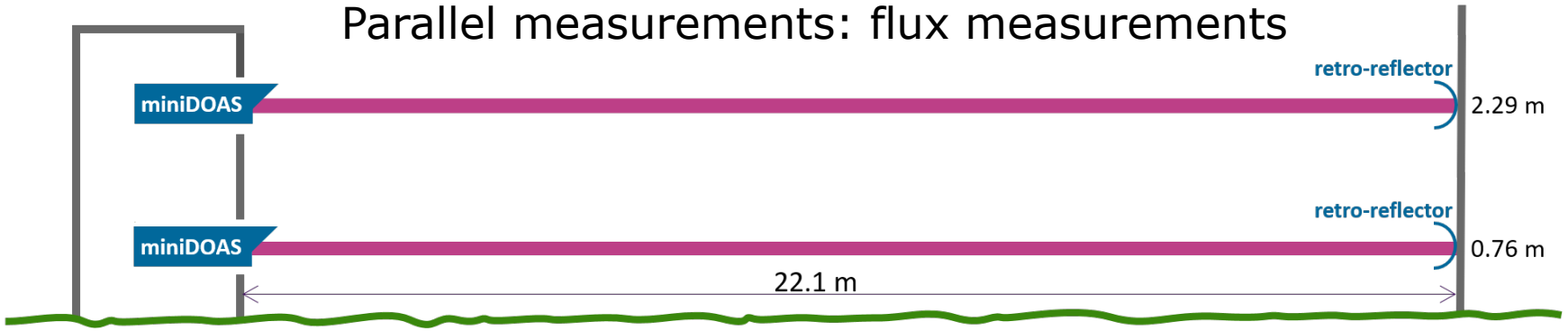
- Eddy covariance (EC) using QCL infrared-based HT8700 (Healthy Photon Ltd, Cn)

miniDOAS gradient

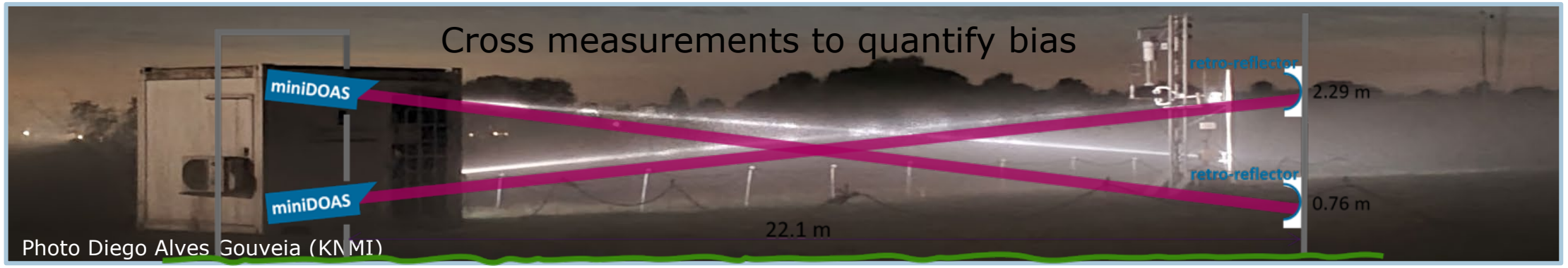
$$F_{NH_3} = F_* \cdot dNH_3$$



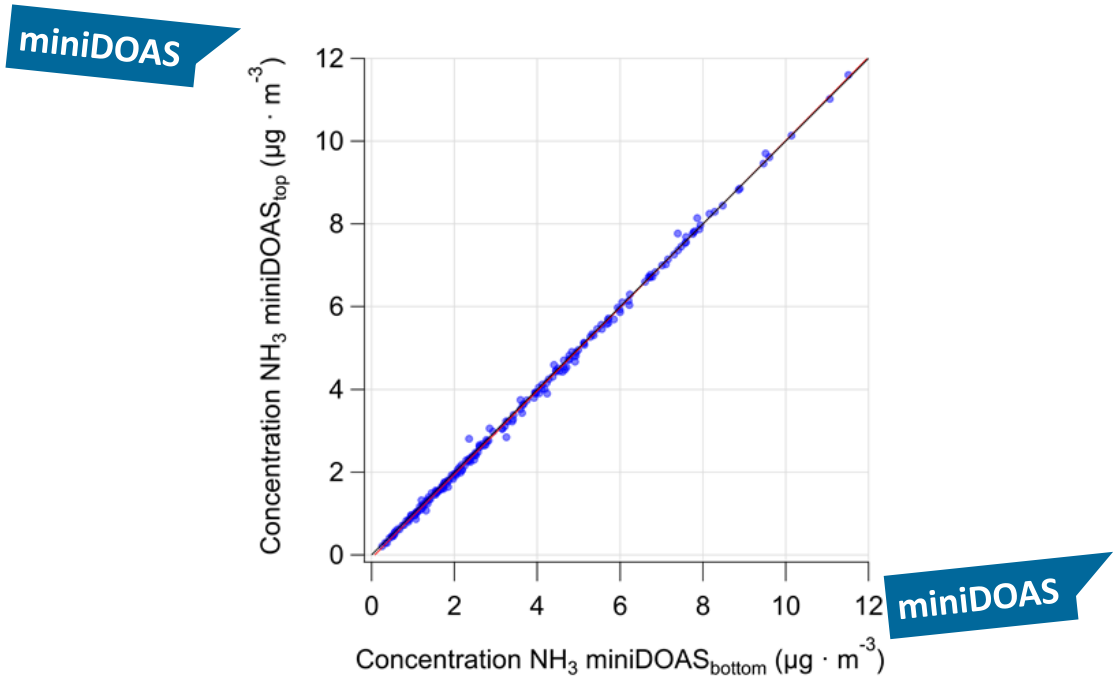
miniDOAS gradient



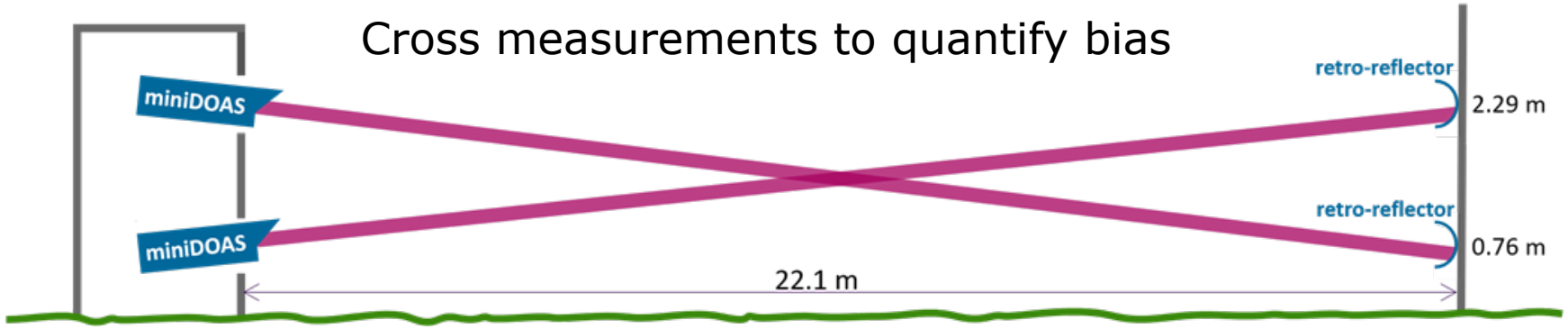
Gradient method requires zero bias



miniDOAS intercalibration



Cross measurements to quantify bias



Eddy covariance setup

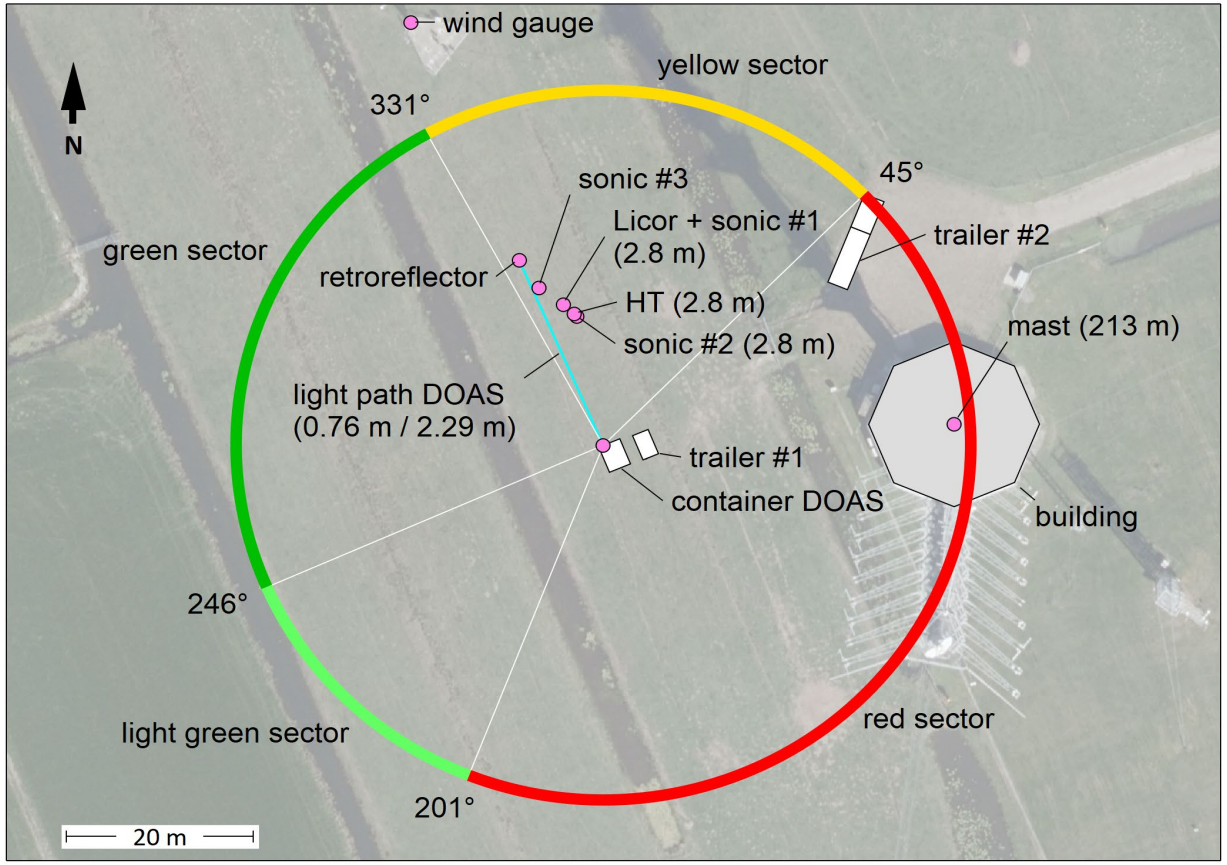
- HT8700 from China

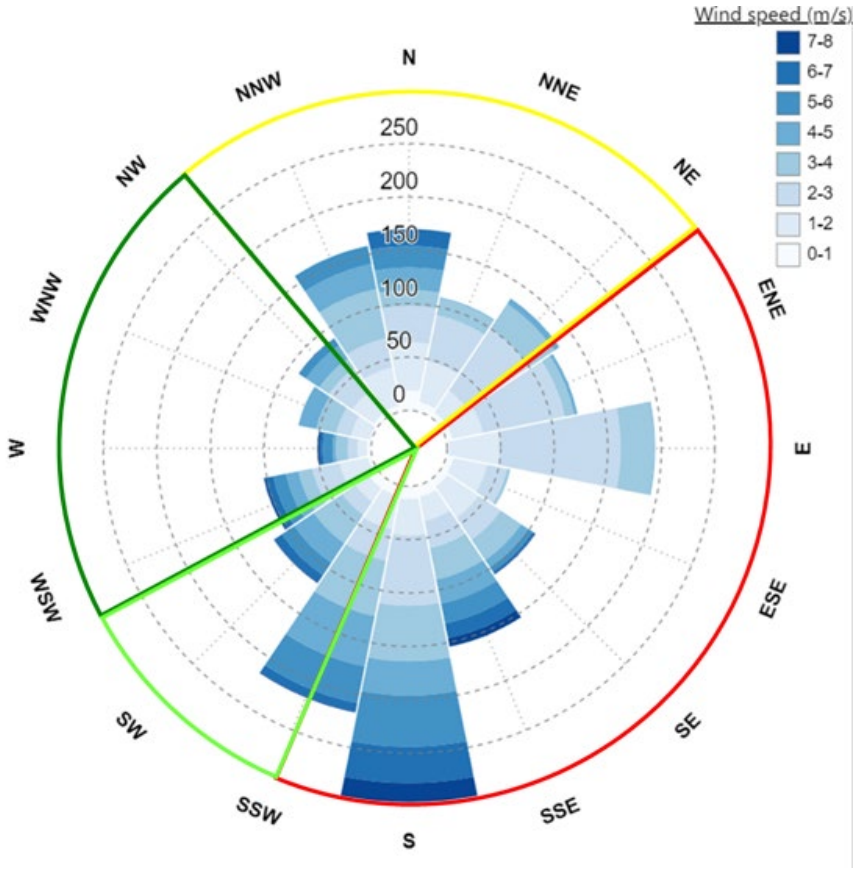
$$F_{\mathrm{NH_3}} = -\overline{w'\mathrm{NH_3'}}$$

- Correction for density impact H_2O etc.
- Correction for spectral loss due to size instrument and spatial separation HT and sonic

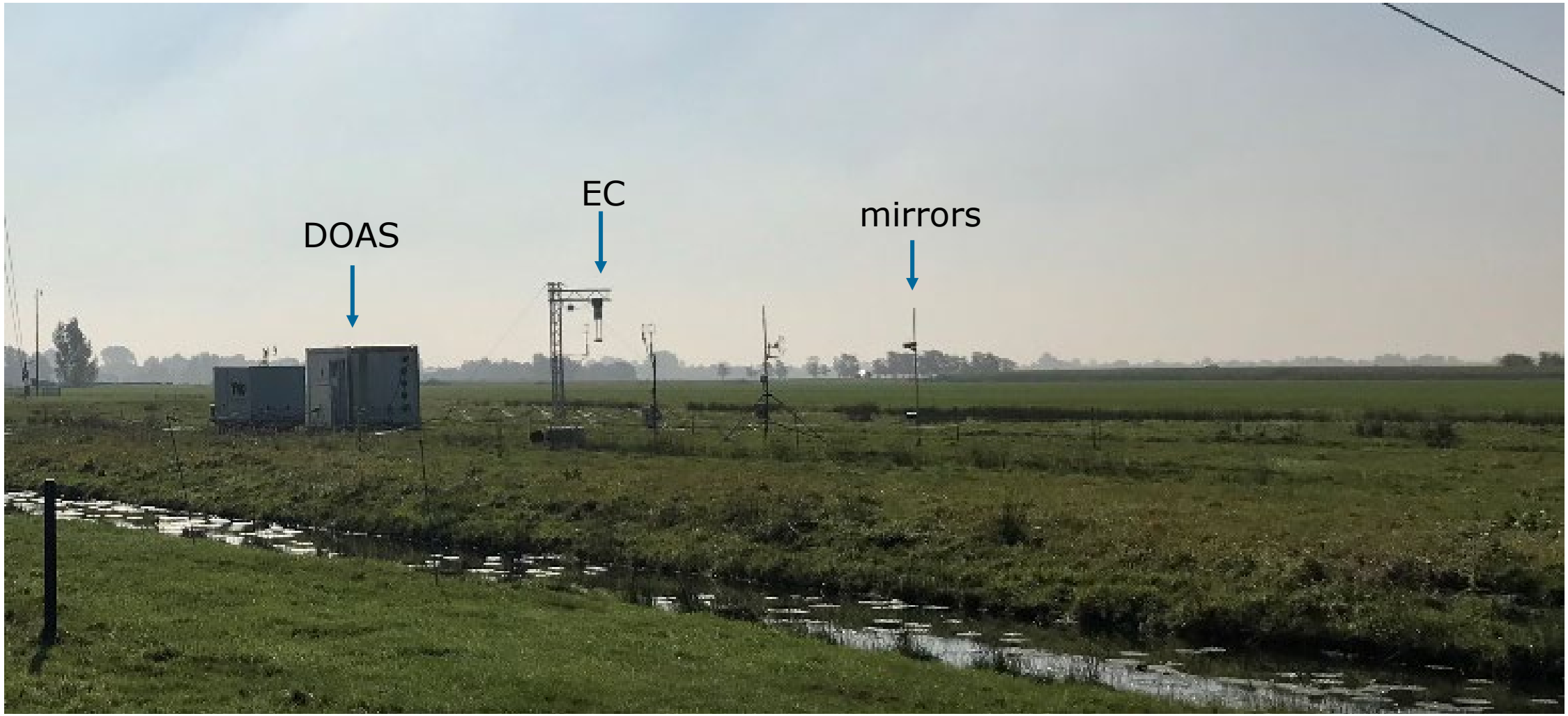
Cabauw campaign

27 August to 1 October 2021

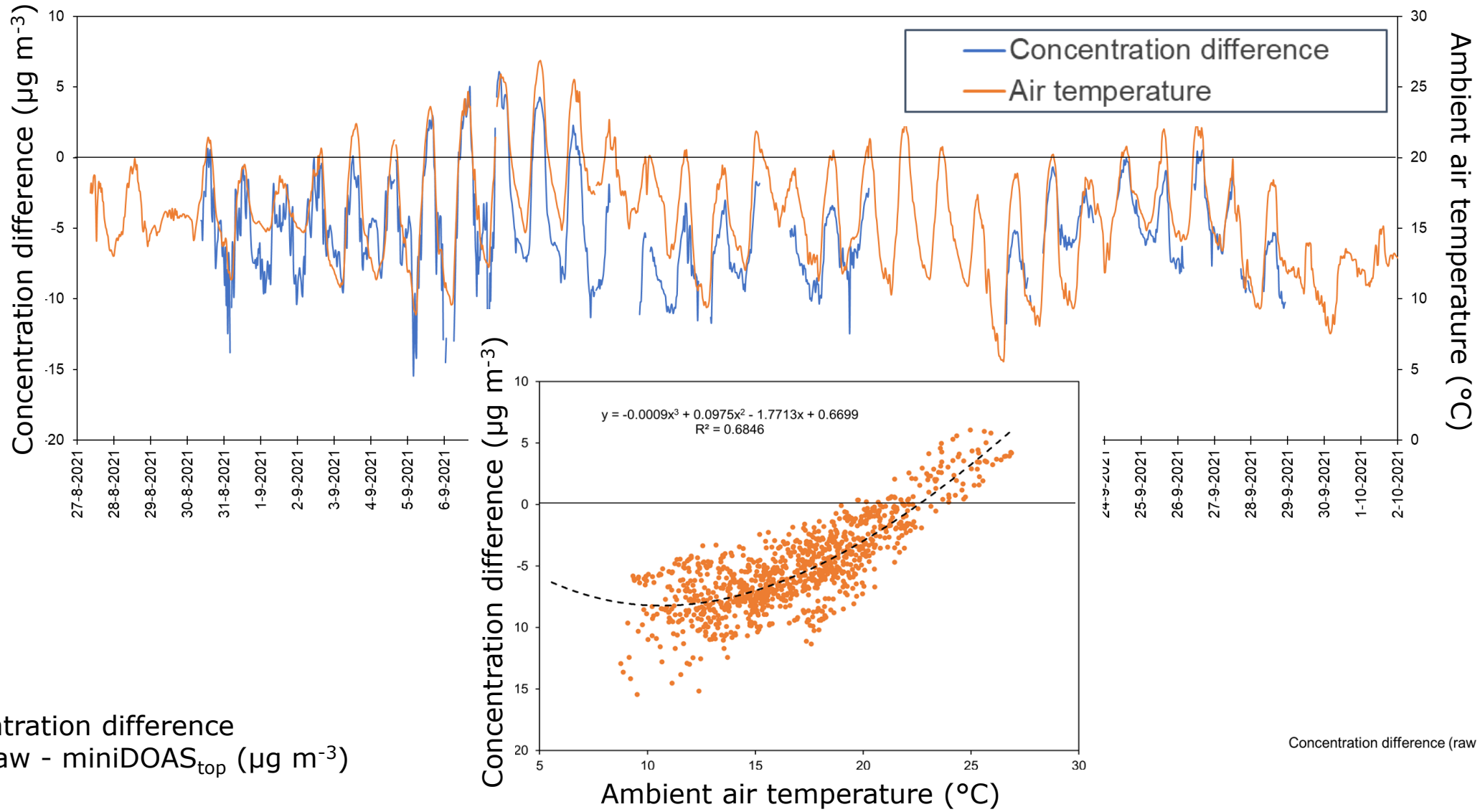




Cabauw campaign - instrument setup

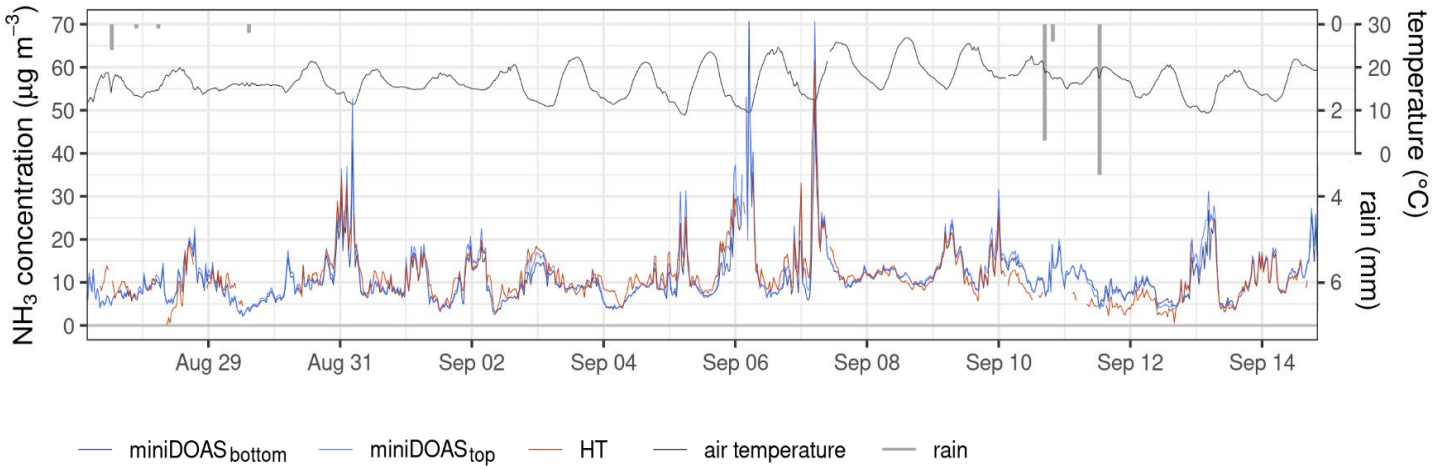


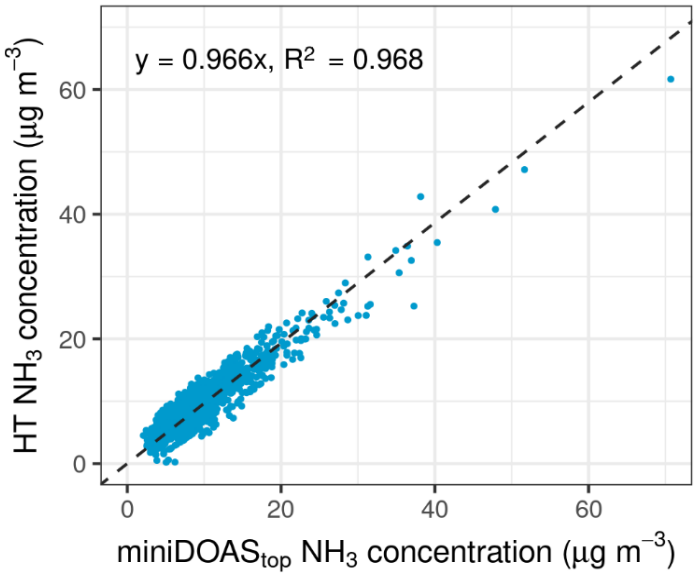
HT concentration changed with air temperature



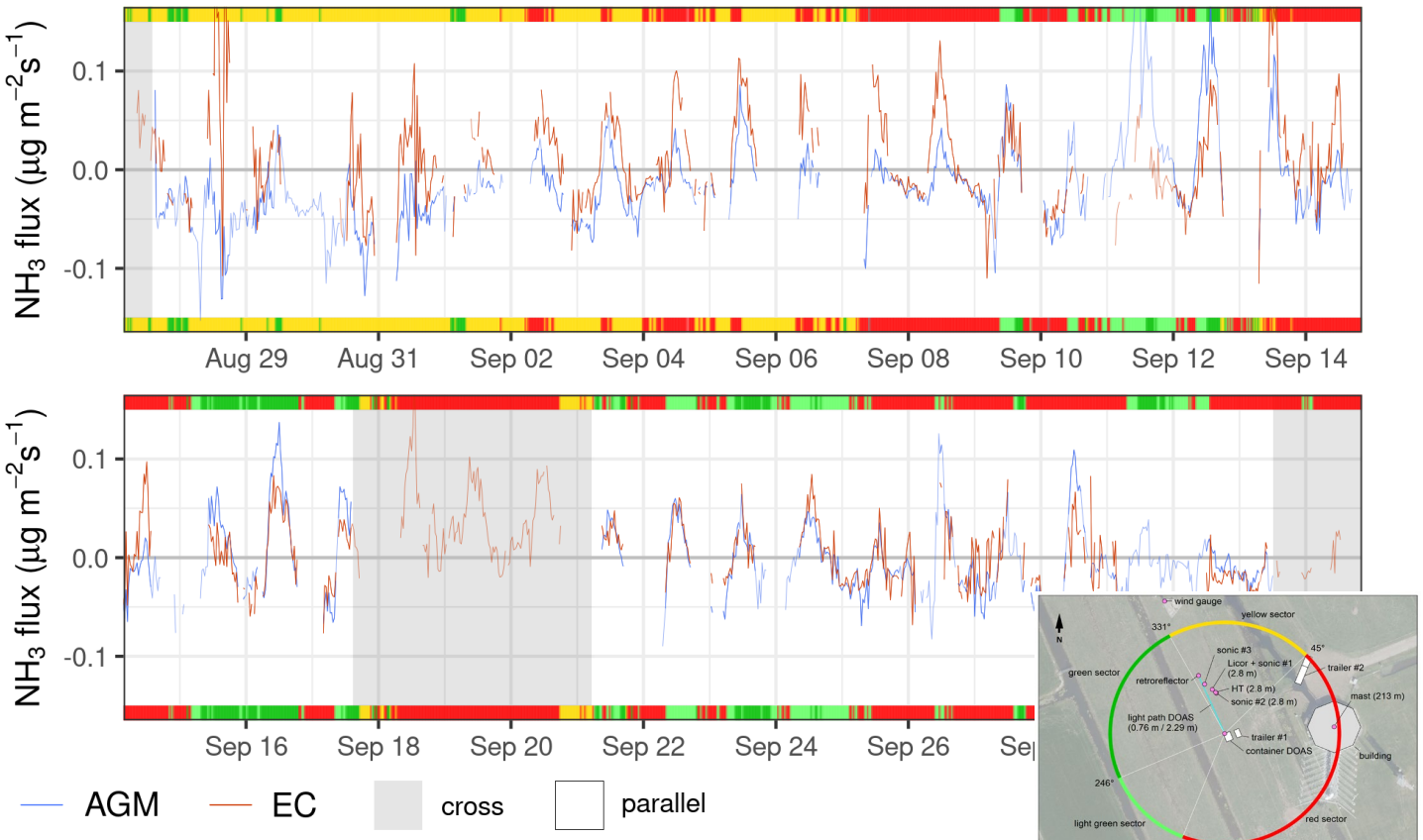
Concentration difference
= HT raw - miniDOAS$_{top}$ (µg m^{-3})

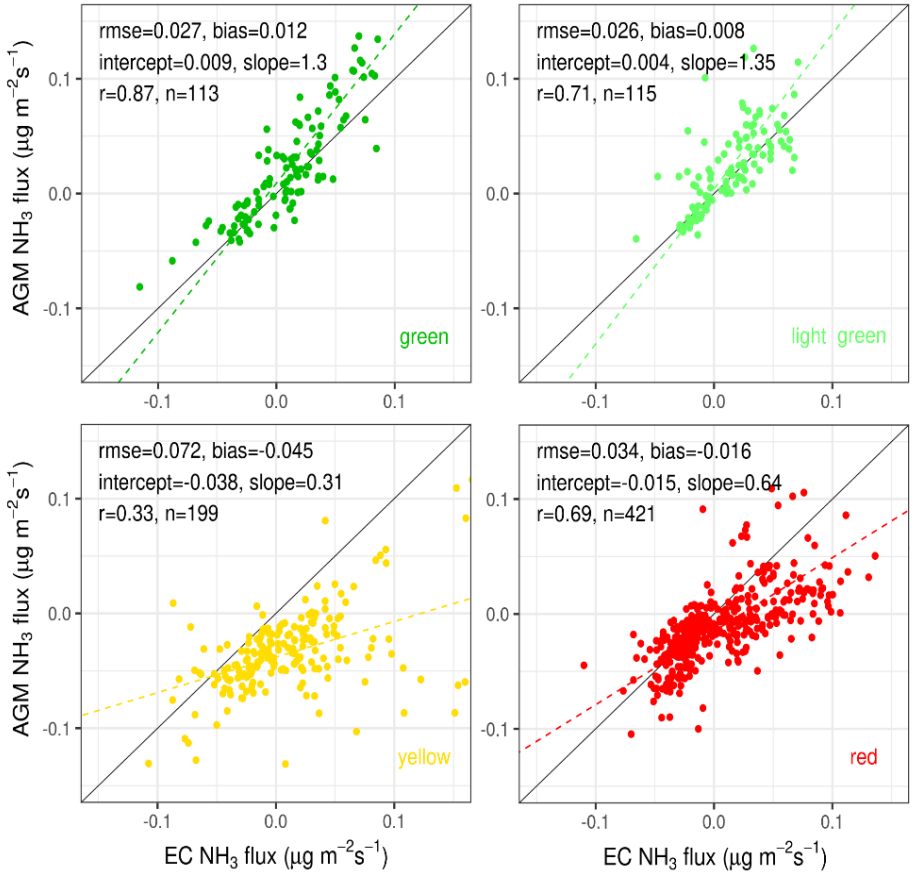
HT concentration after temperature correction





Flux comparison



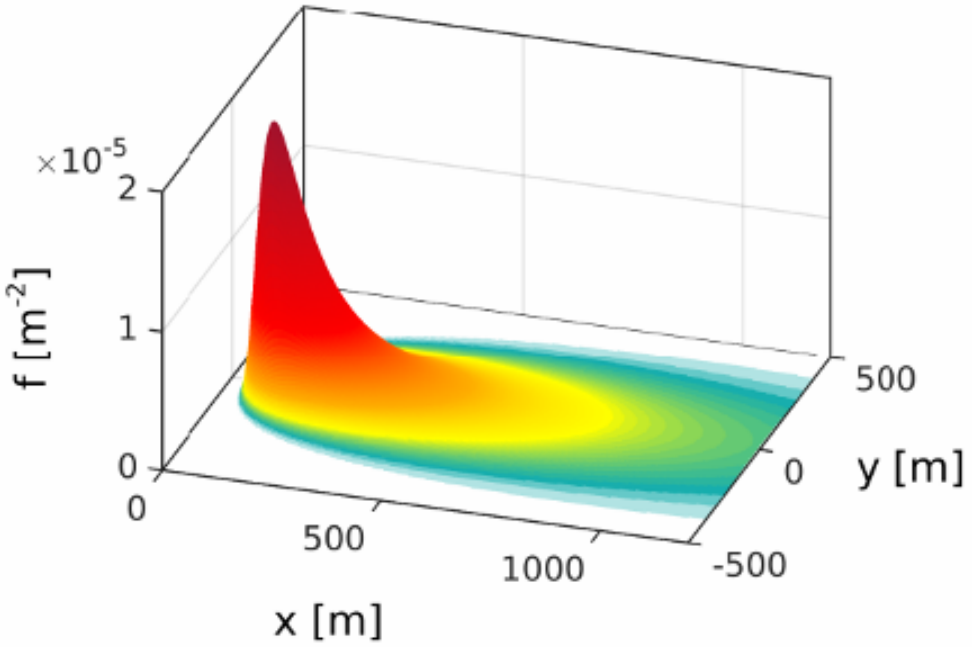


Obstacle-free area: highly comparable fluxes

Potential causes of difference in flux: footprint

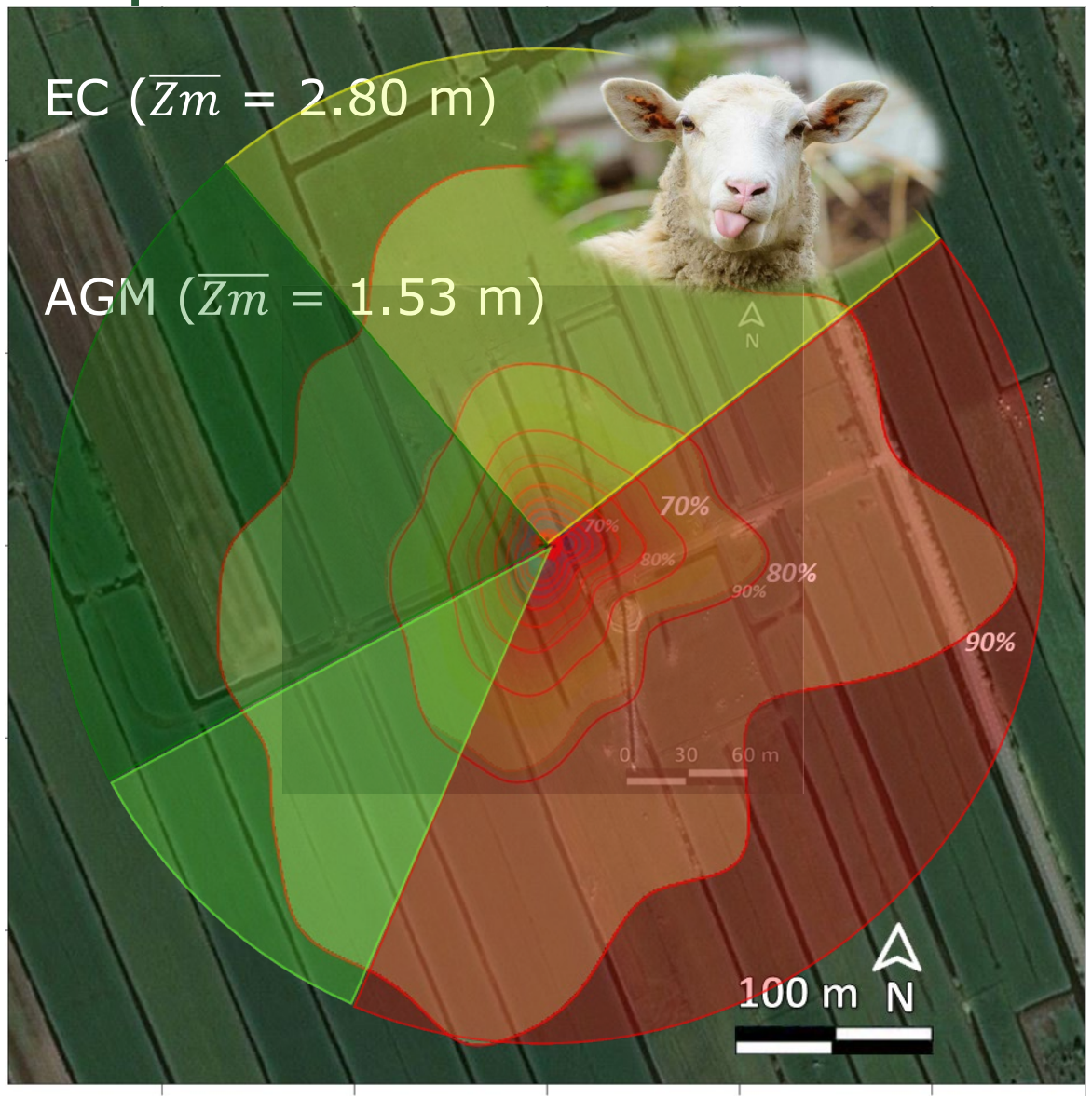
- Flux footprint:
  - the upwind area where the atmospheric flux measured by an instrument is generated.
  - an upwind area "seen" by the instruments measuring vertical turbulent fluxes.

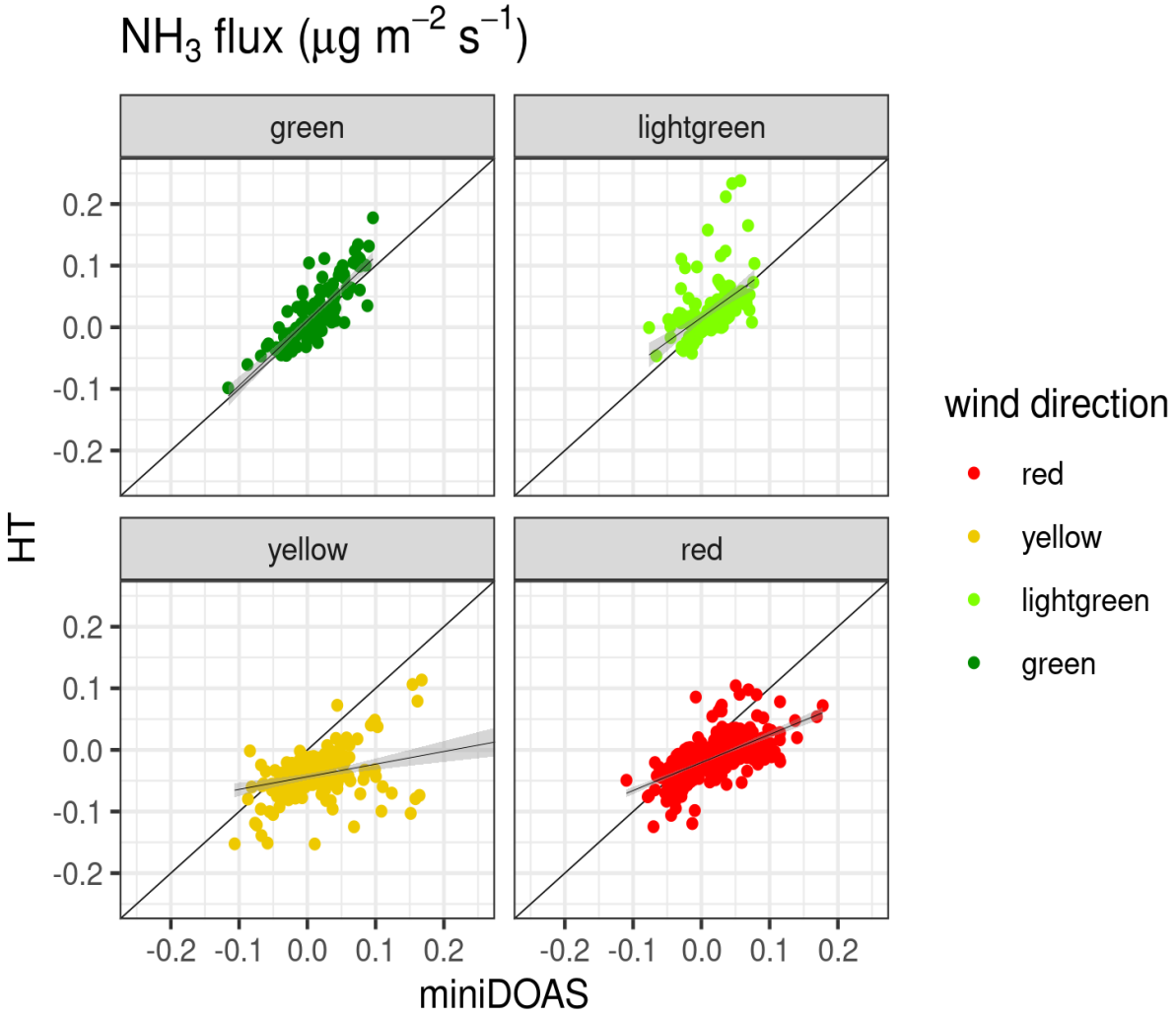
- Main factors affecting size and shape:
  - measurement height
  - surface roughness
  - atmospheric thermal stability



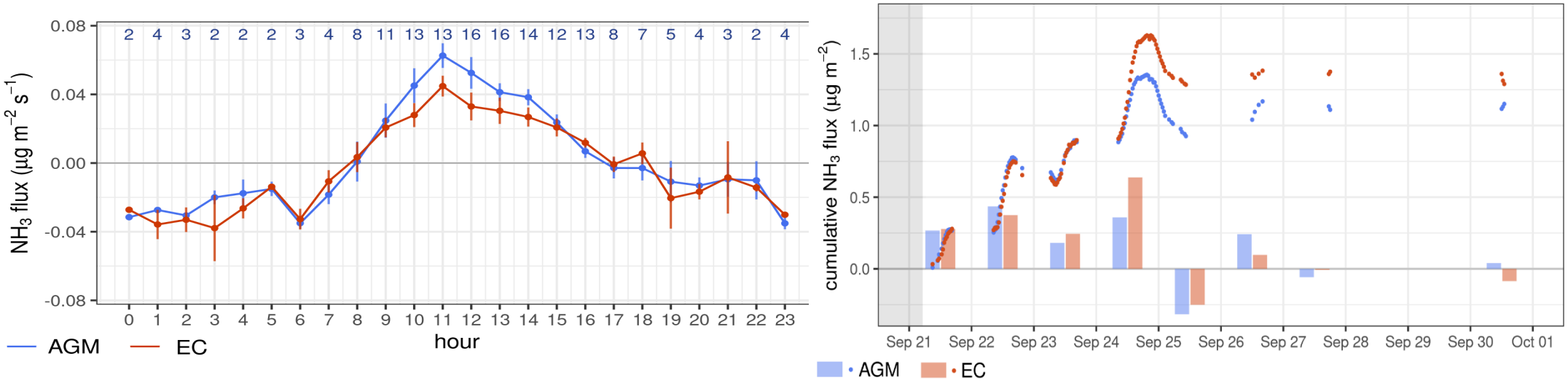
(Figure from https://footprint.kljun.net/)

Footprint and homogeneity: key factors influencing flux comparison





Diurnal cycle of AGM and EC flux



Only after 15 September: farm manuring stopped

Conclusions

- Half-hourly flux measurements feasible
- Under optimal conditions, both systems show:
  - Comparable deposition values
  - Similar structures of timeseries and diurnal cycles
- MiniDOAS ~100% uptime outside calibration periods (~35% of total period)
- HT data loss during rain (~21% of total period), and mirror deterioration
- Although HT concentration is sensitive to air T, it almost had no impact on HT fluxes.

Preprint paper: https://amt.copernicus.org/preprints/amt-2022-171/

To be continued @ Veenkampen

- more homogeneous footprint
- No sheep

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+ NO_x and ozon flux

50 m

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- Dr. Daniëlle van Dinther (TNO) for merging various EC data streams
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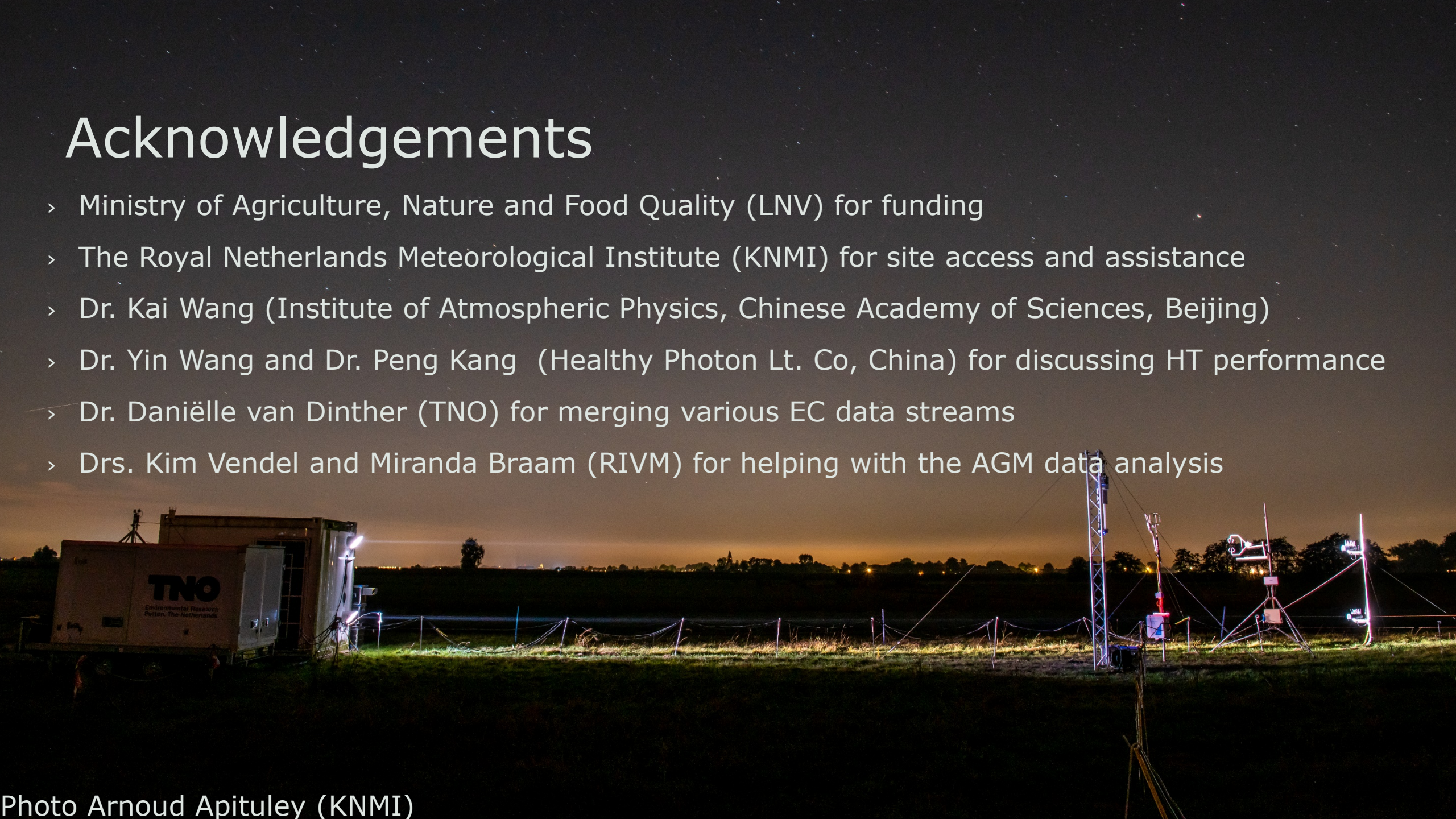

Photo Arnoud Apituley (KNMI)

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Thank you for your attention

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