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

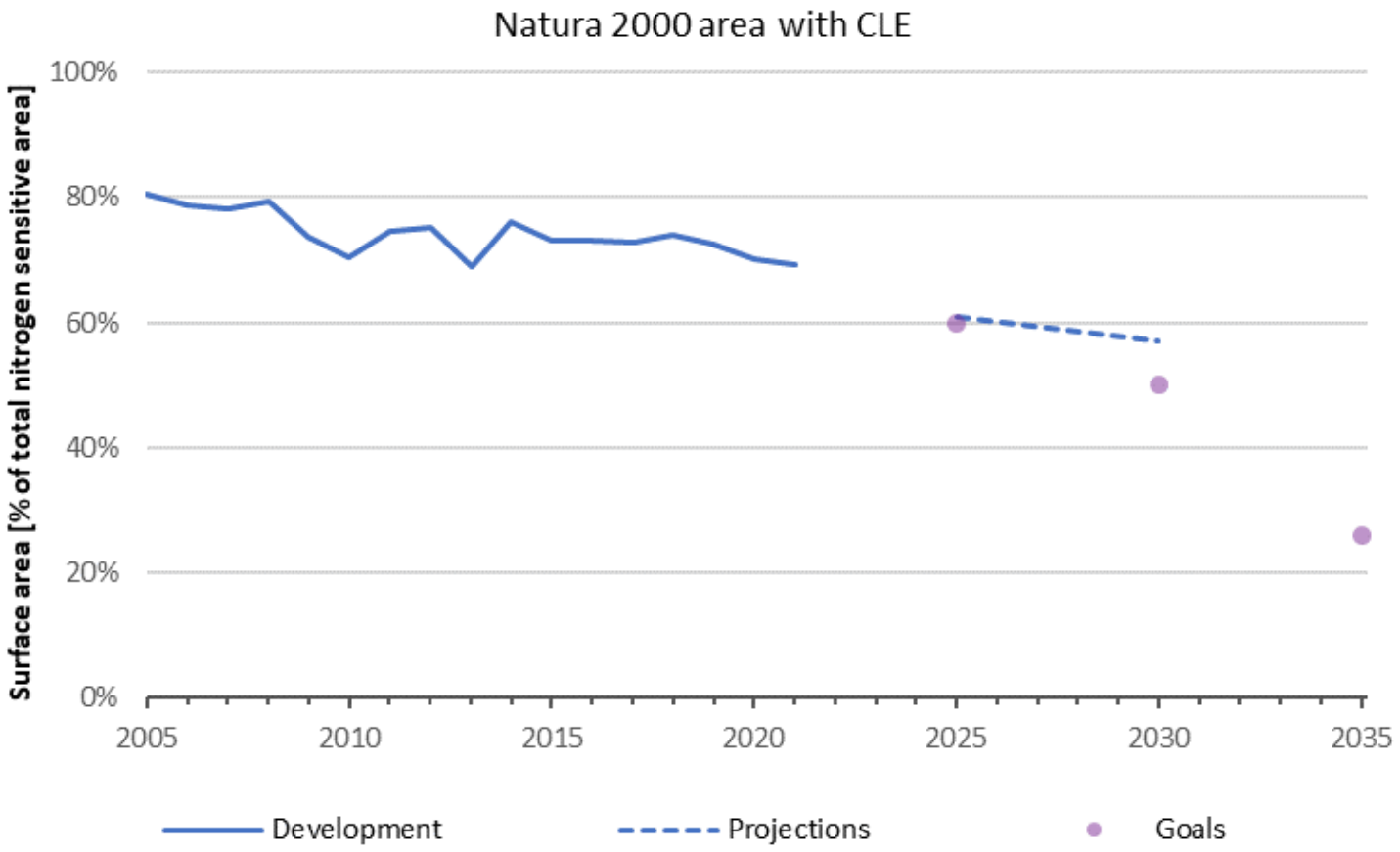
Measurement-model fusion techniques to quantify nitrogen deposition in the Netherlands

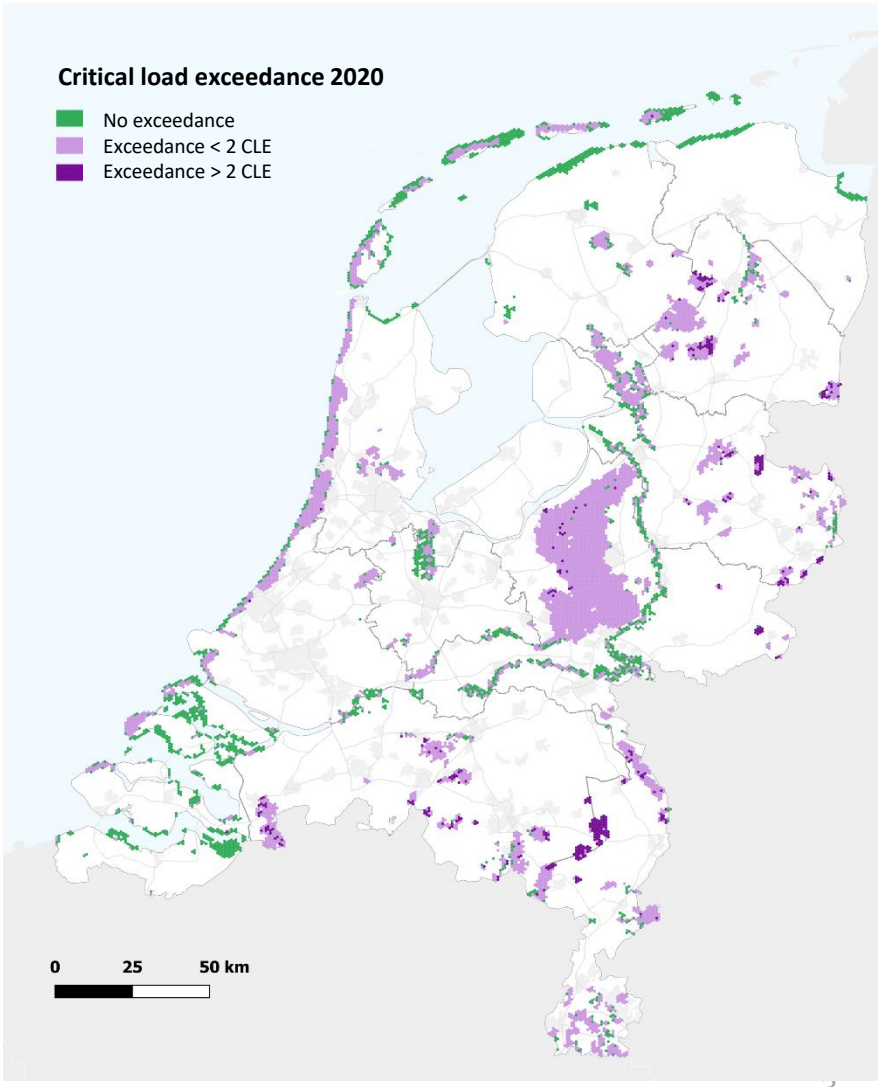
Roy Wichink Kruit

With thanks to many colleagues

Nitrogen crisis

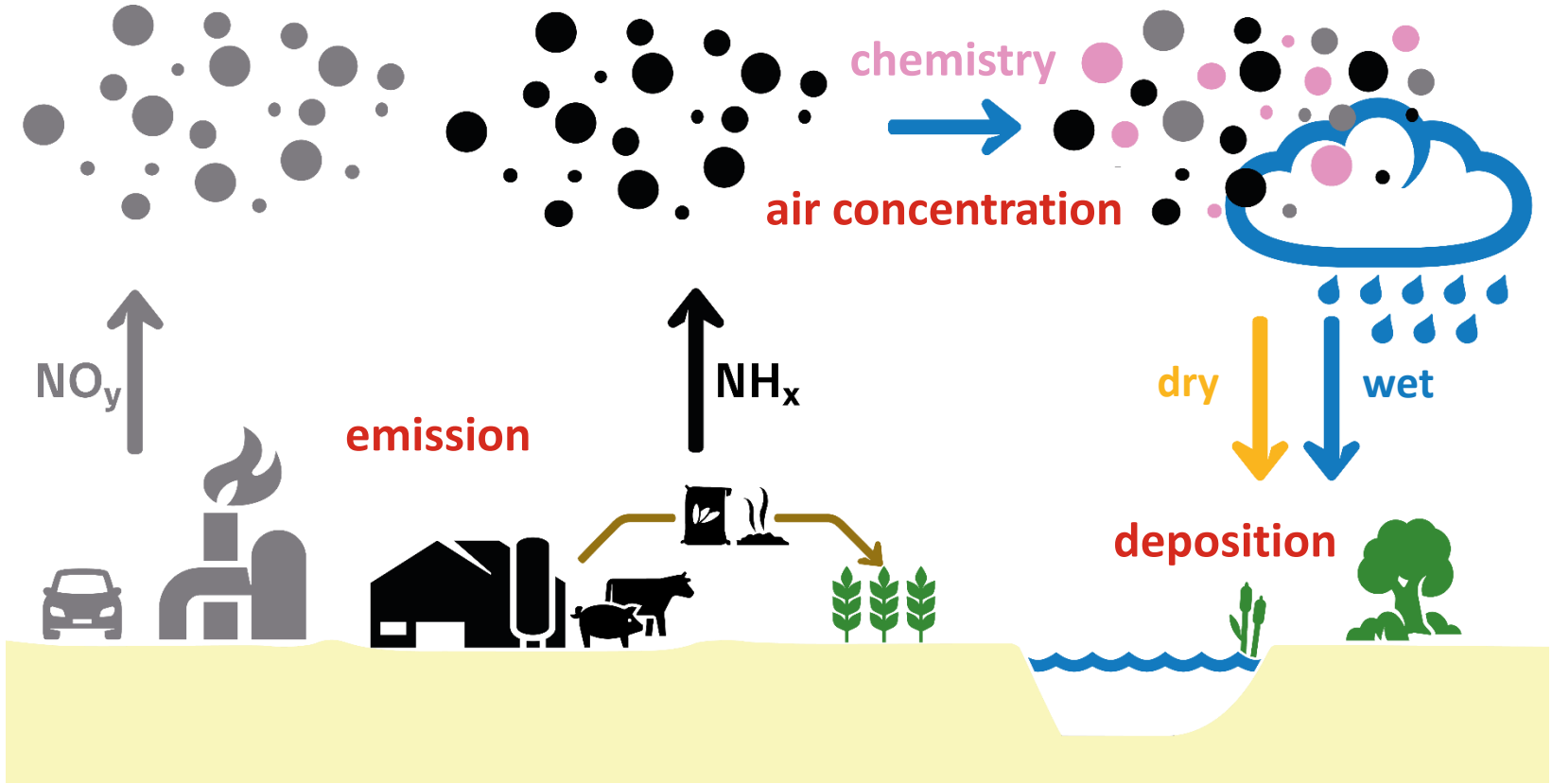
Critical load exceedance





N-Deposition

- Oxidized: $\mathbf{NO_y} = NO_2 + NO + HNO_3 + HNO_2 + NO_3^- + PAN$
- Reduced: $\mathbf{NH_x} = NH_3 + NH_4^+$

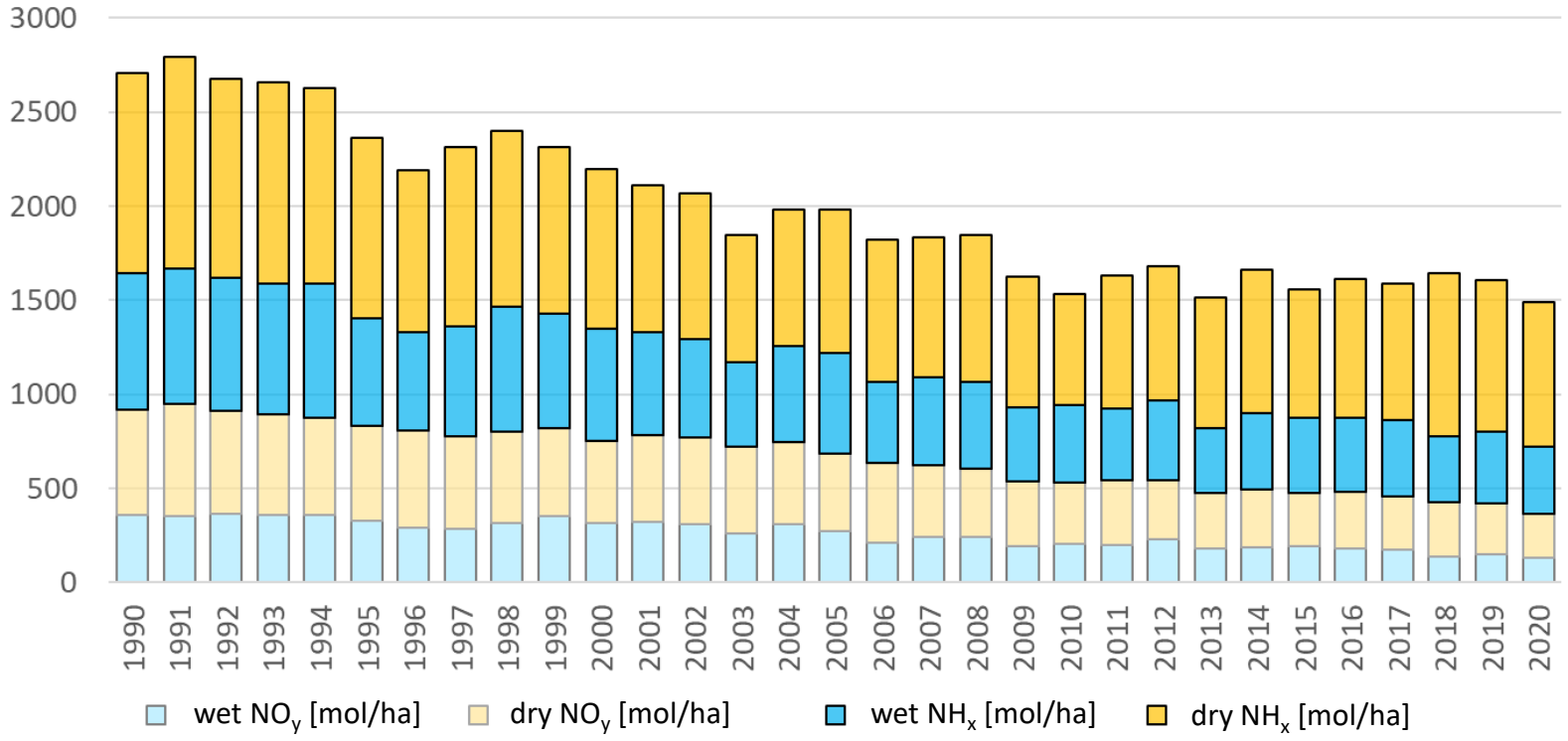


N-Deposition

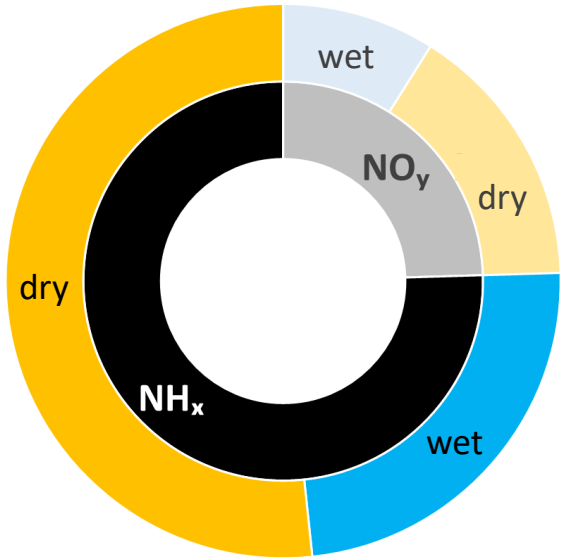
Netherlands:

± 17 million inhabitants
± 4 million cows
± 12 million pigs
>100 million chickens
Roughly 300 x 200 km

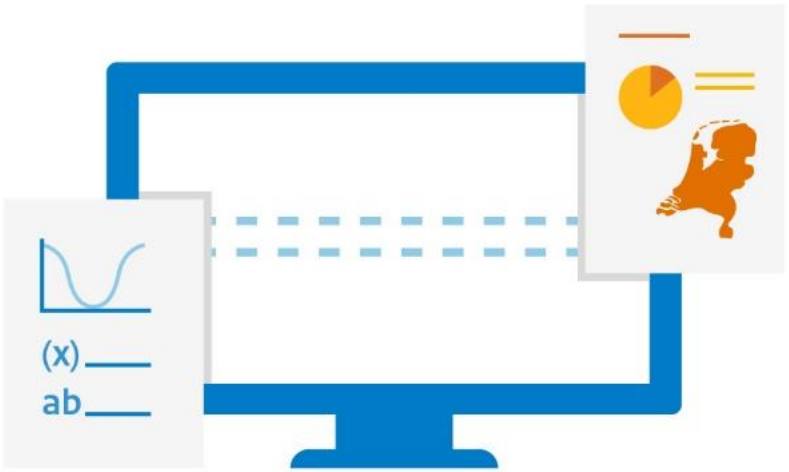
Nitrogen deposition [mol/ha]

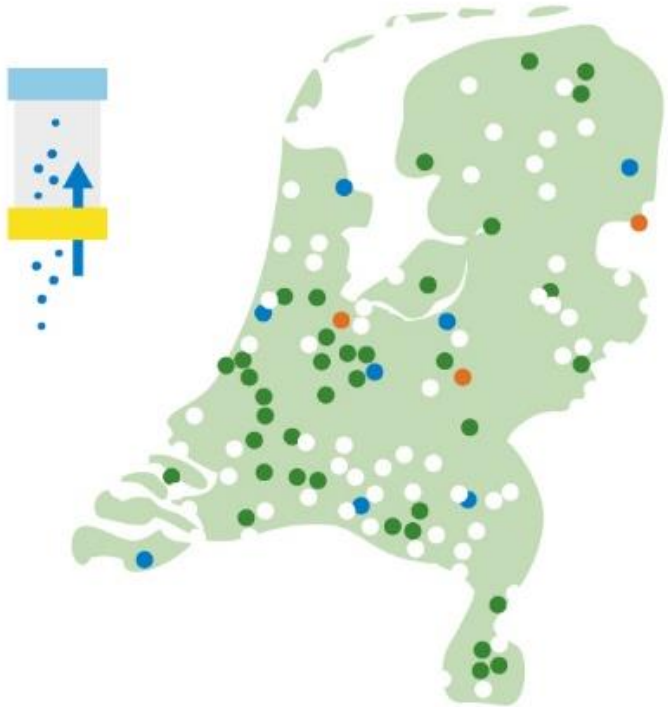


Apportionment N-deposition 2020



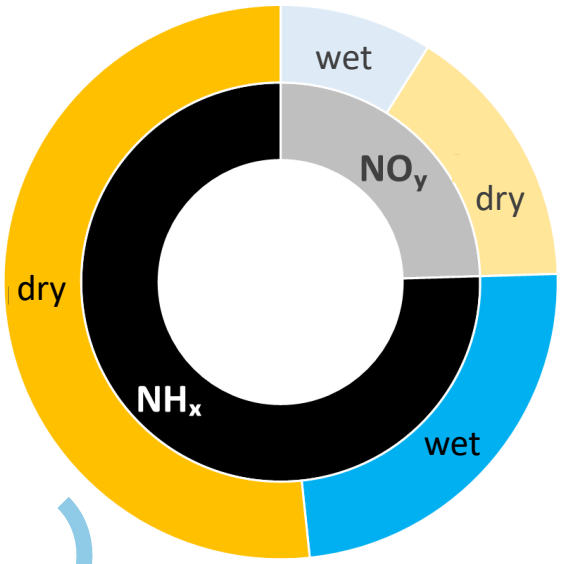
Assessment of the nitrogen deposition



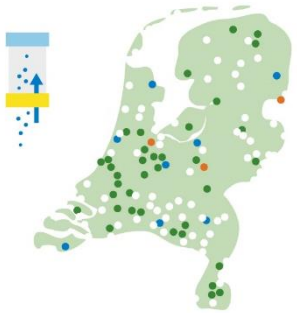


Modelling

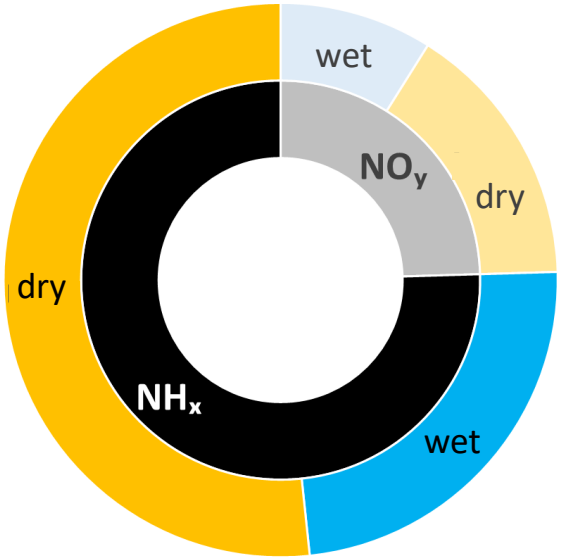
- Pollutant Release and Transfer Register (RIVM, CBS, PBL, WUR, TNO)
- Meteorology (KNMI)
- Landuse (WUR)



Observations

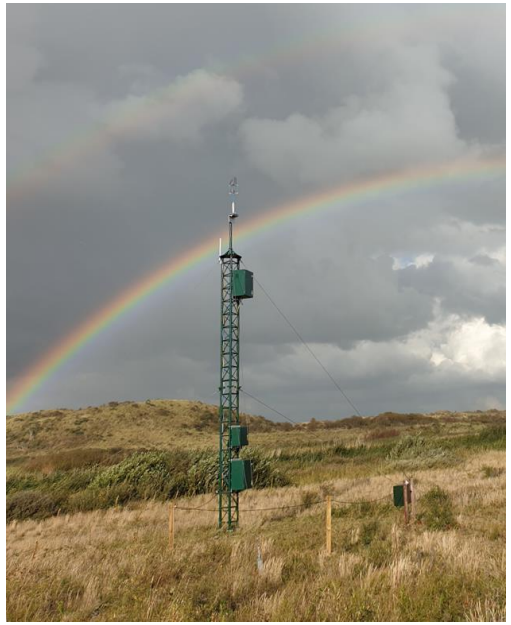


Apportionment N-deposition 2020



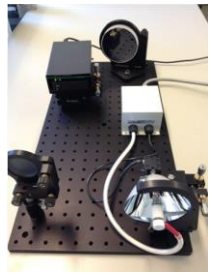
wet NH_x wet NO_y

dry NH_x

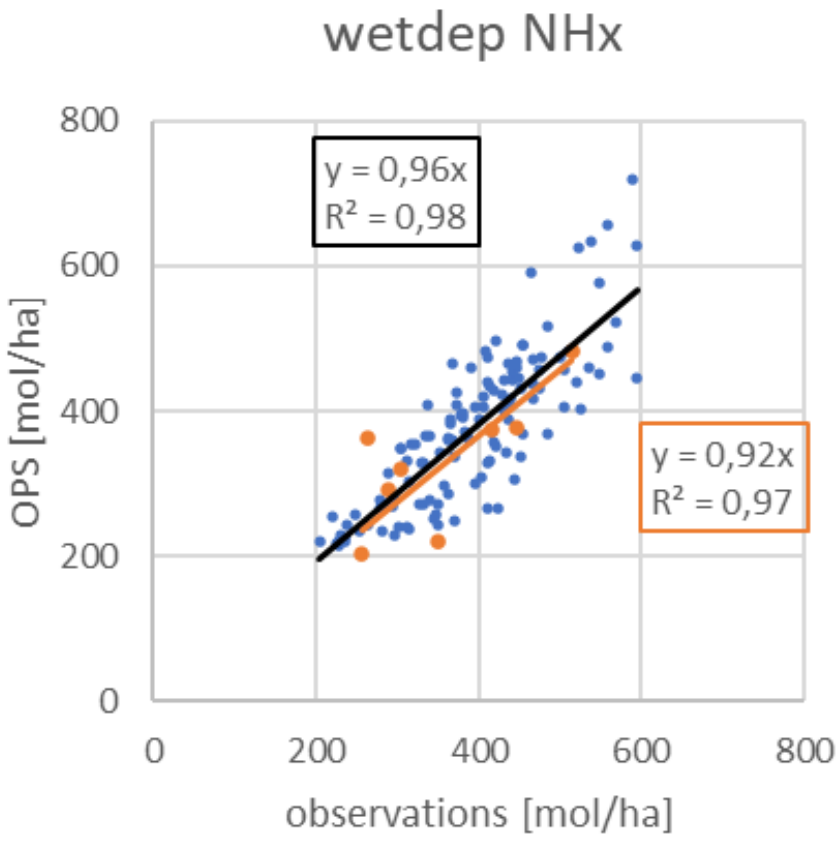


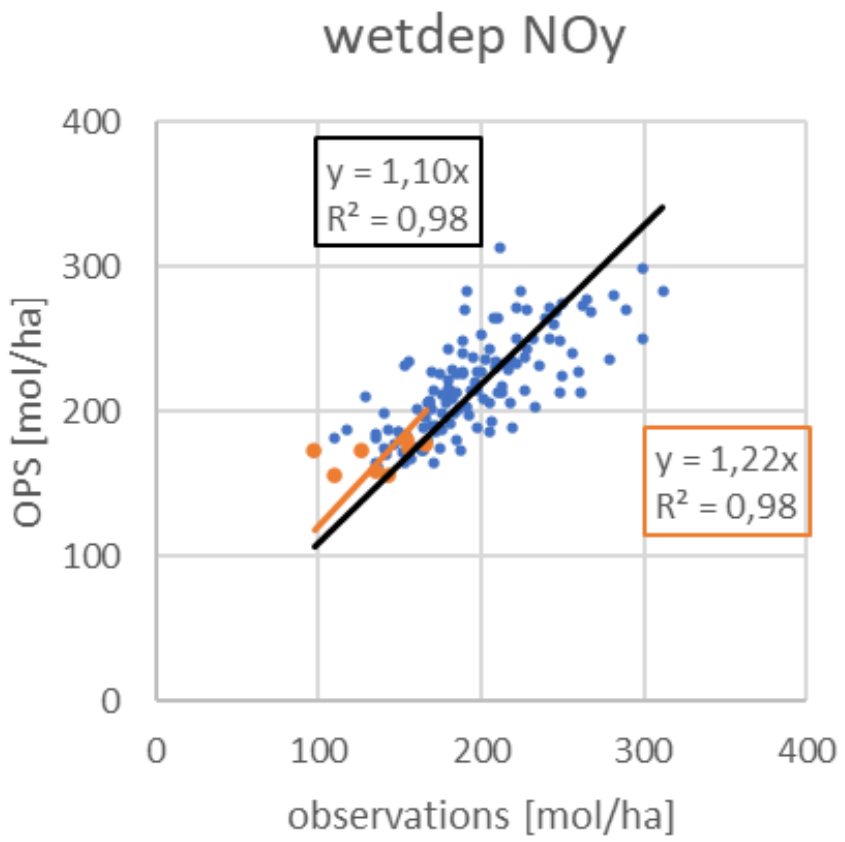
concentrations NO_x

concentrations NH_3

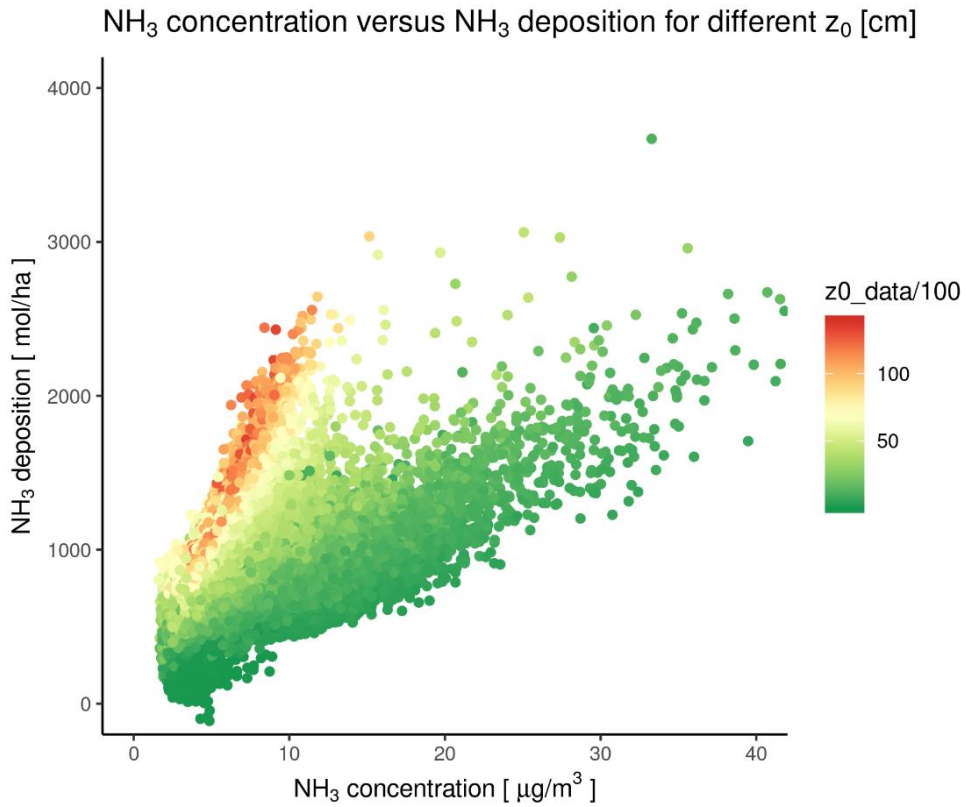


Datafusion – wet deposition

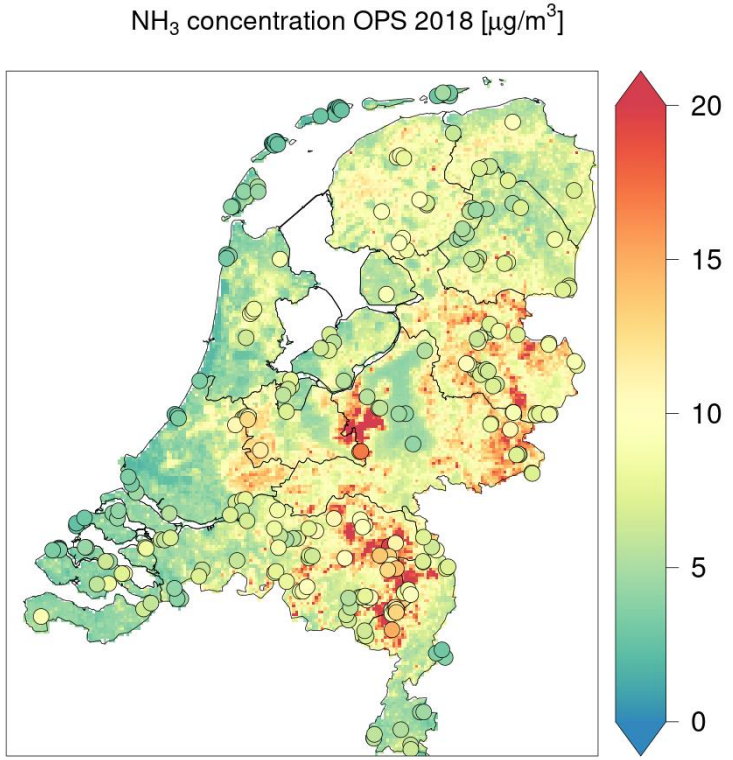


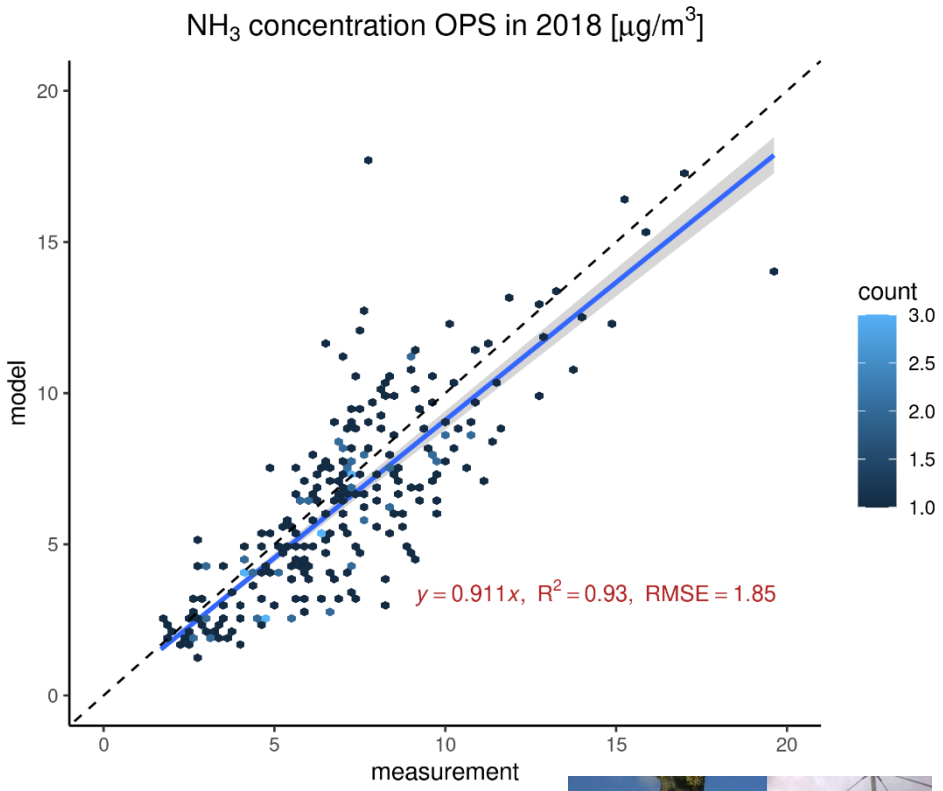


Datafusion – dry deposition

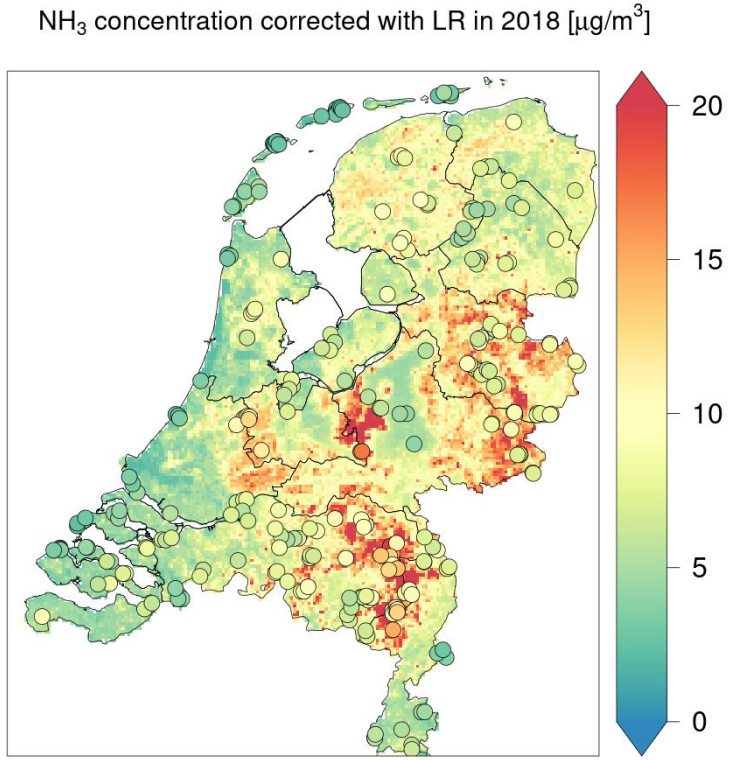
- Too little dry deposition observations to use for datafusion
- Dry deposition ~ deposition velocity x concentration
- 

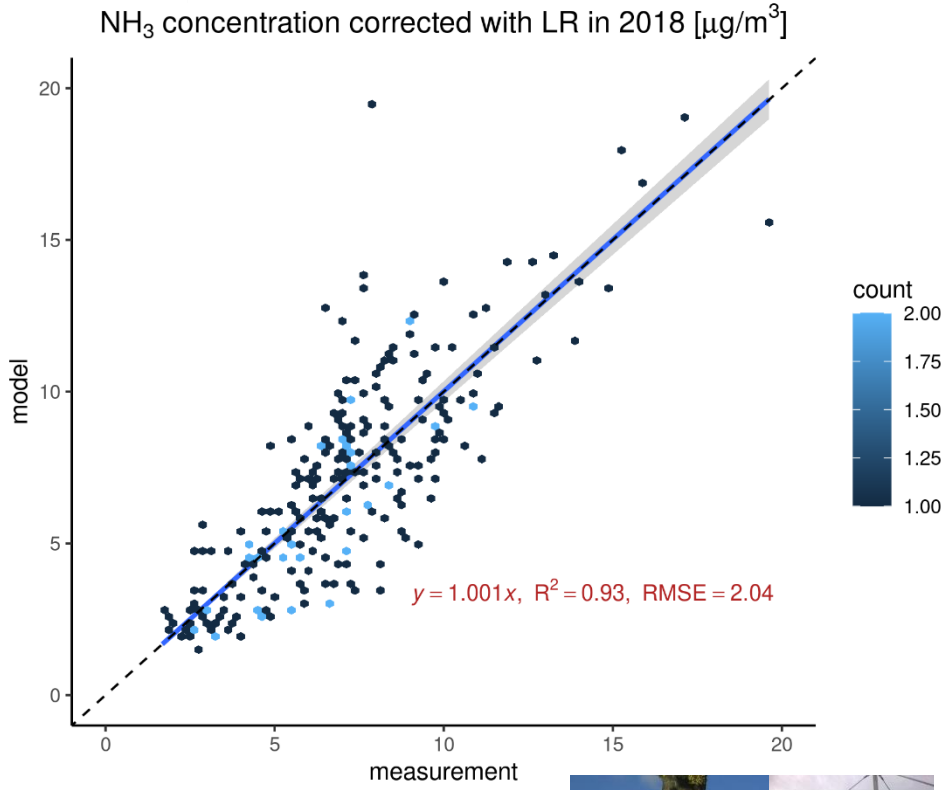
NH_3-concentration



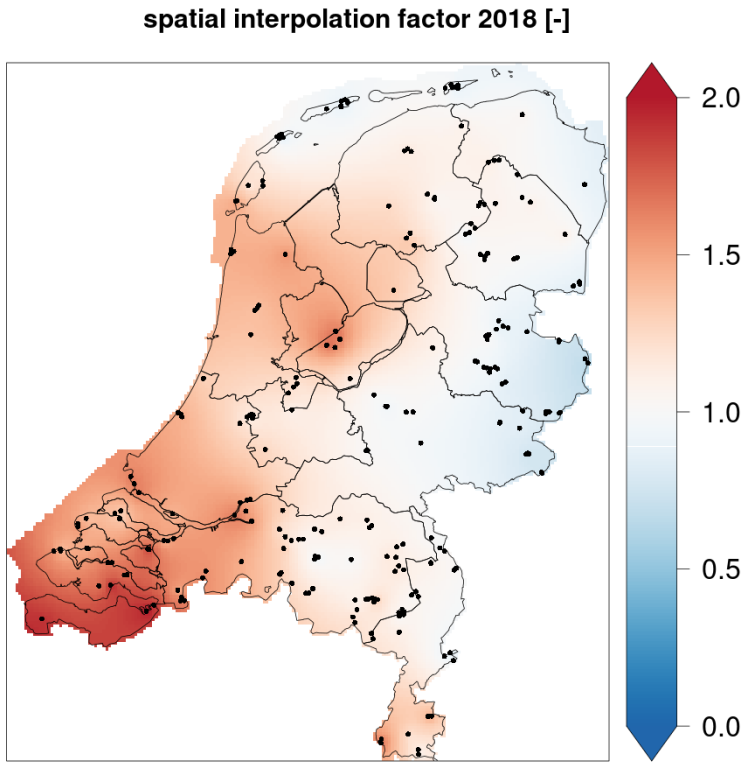


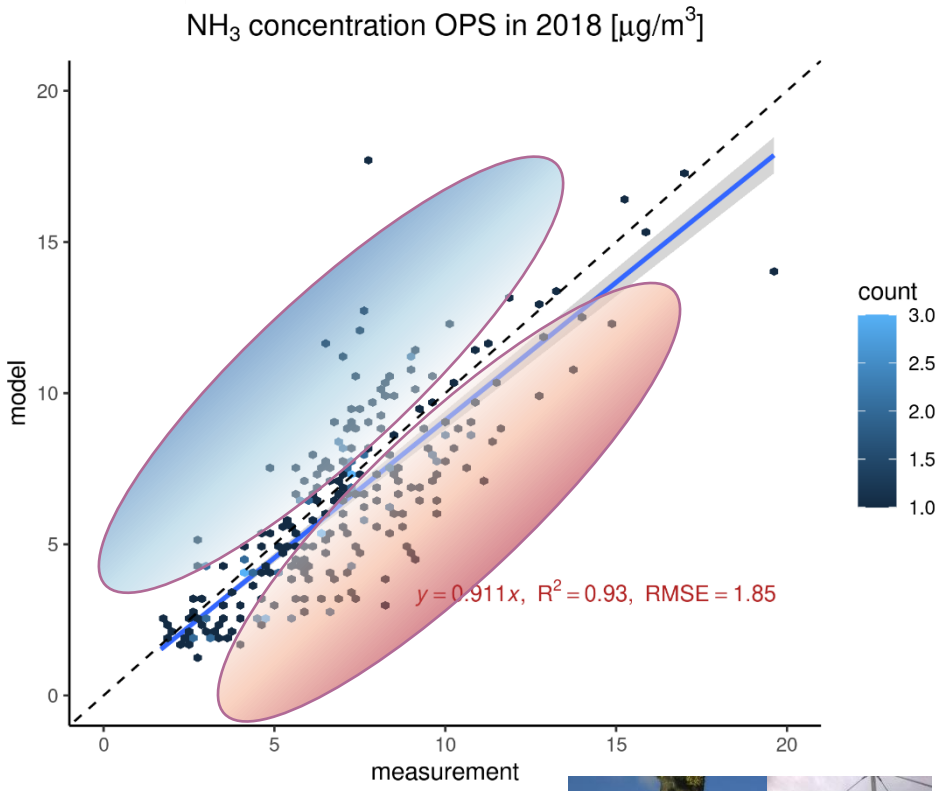
NH_3-concentration





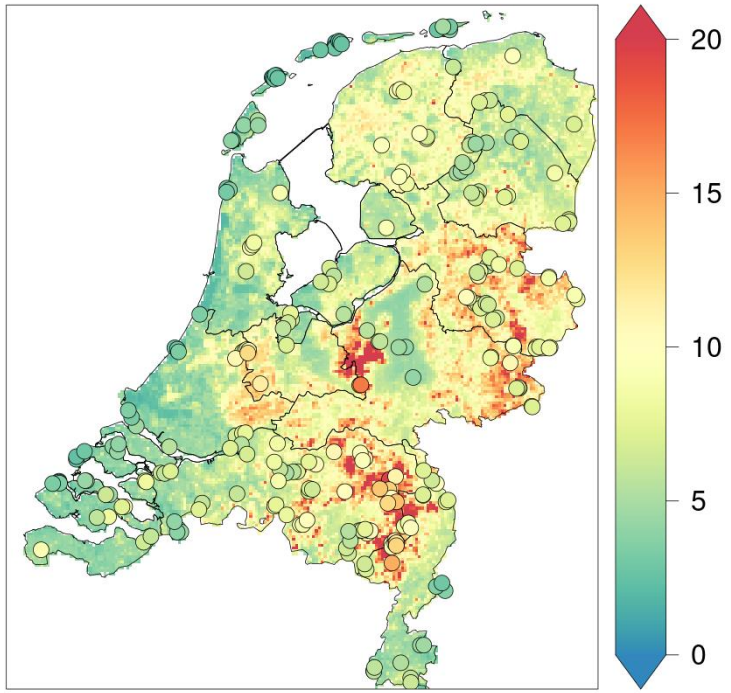
NH_3-concentration



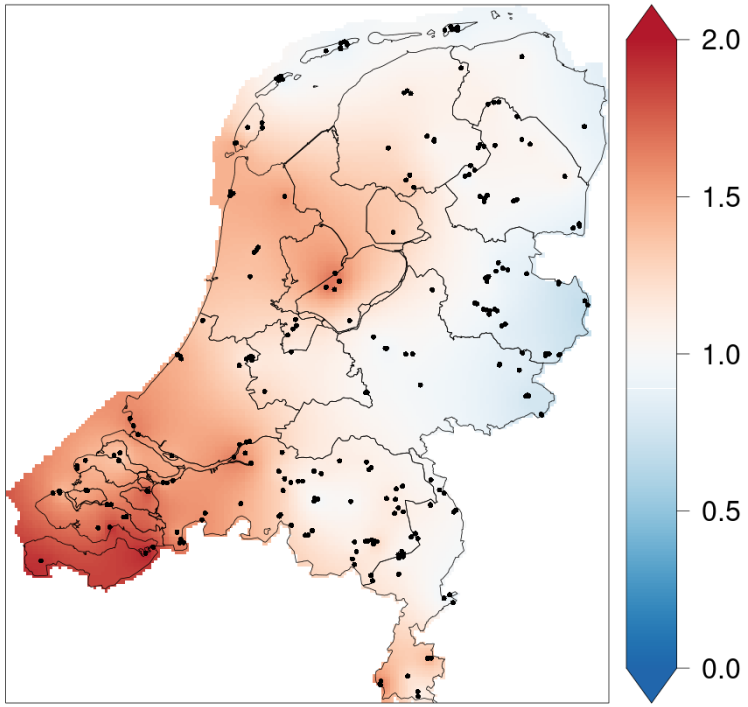


NH_3-concentration

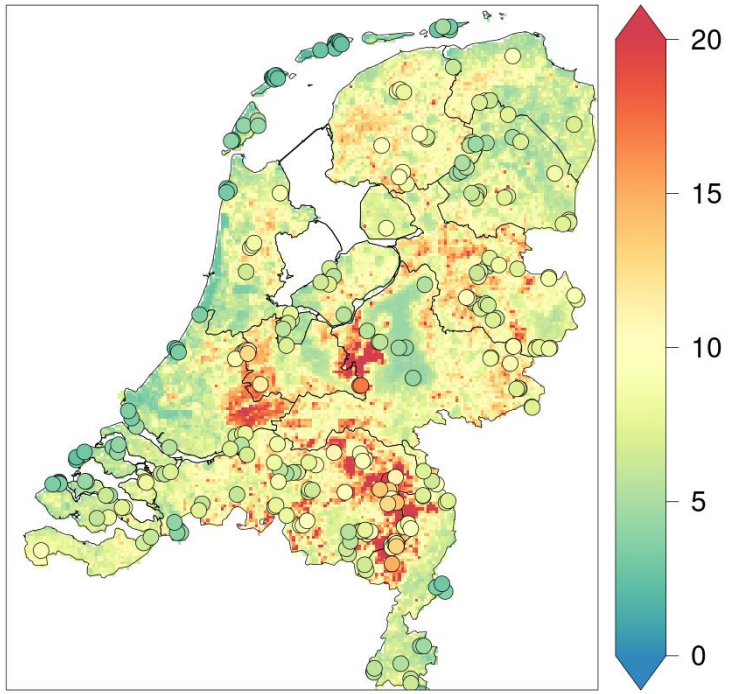
NH_3 concentration OPS 2018 [µg/m^3]



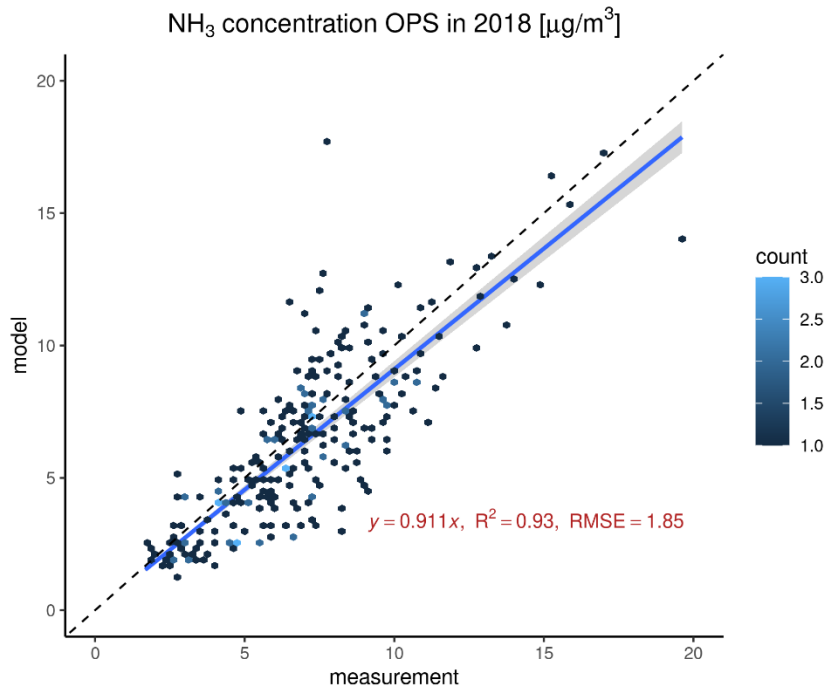
spatial interpolation factor 2018 [-]

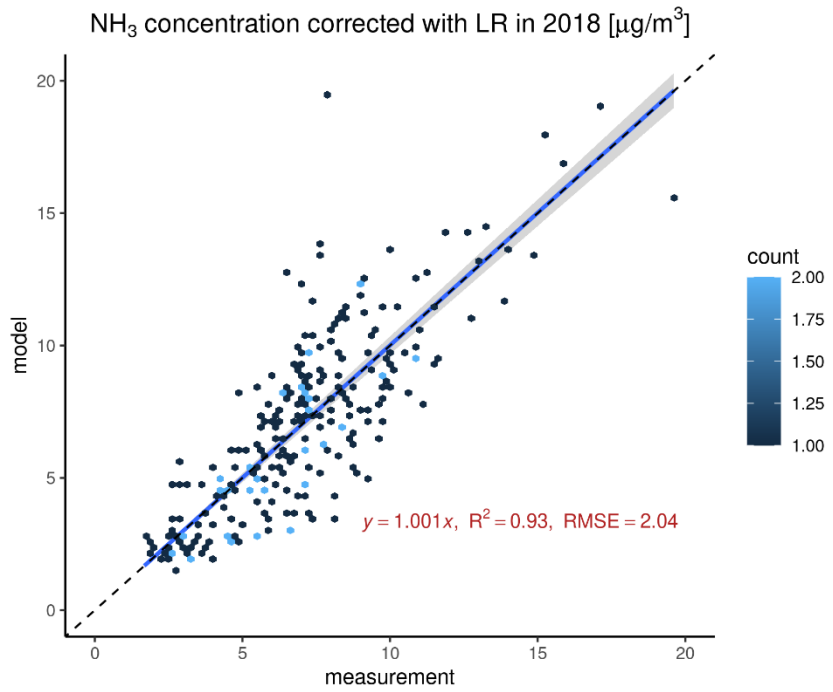


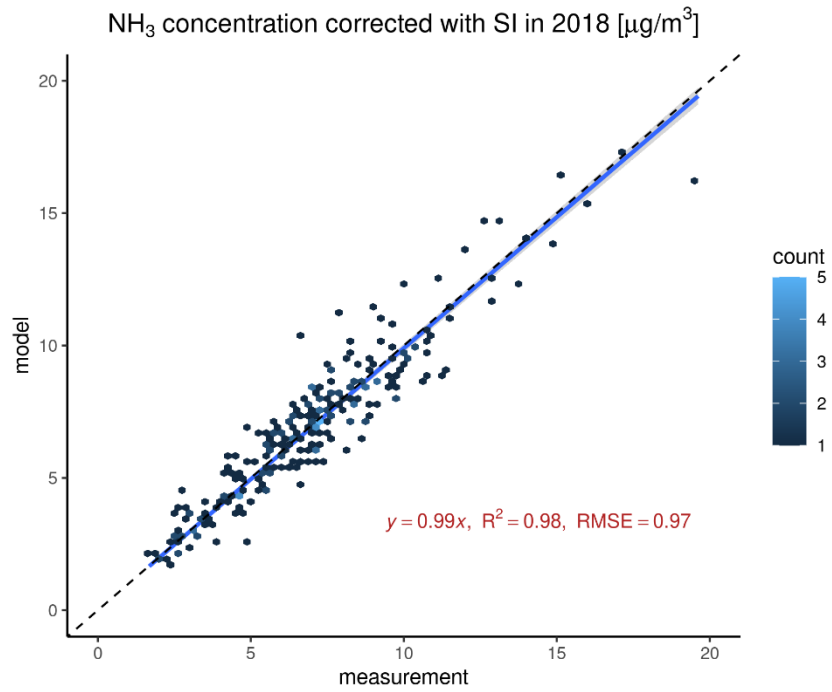
NH_3 concentration corrected with SI in 2018 [µg/m^3]



NH_3-concentration







Conclusions

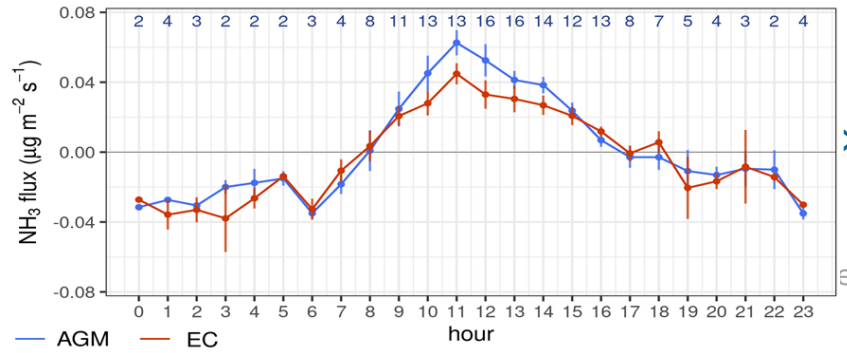
- To assess the total nitrogen deposition model calculations and measurement can be combined
- Wet deposition measurements can be used to correct model calculations for possible biases
- Dry deposition measurements are too expensive and likely also too variable in space and cannot (yet) be used for model correction
- To correct dry deposition of NH_x, concentration measurements of NH_3 can be used
- Depending on the amount of measurement locations spatial interpolation can be used
- It remains important to find explanations for the (spatial) differences!

Extra slides:

Measurement techniques used in the Netherlands for ‘dry deposition’ and emission measurements

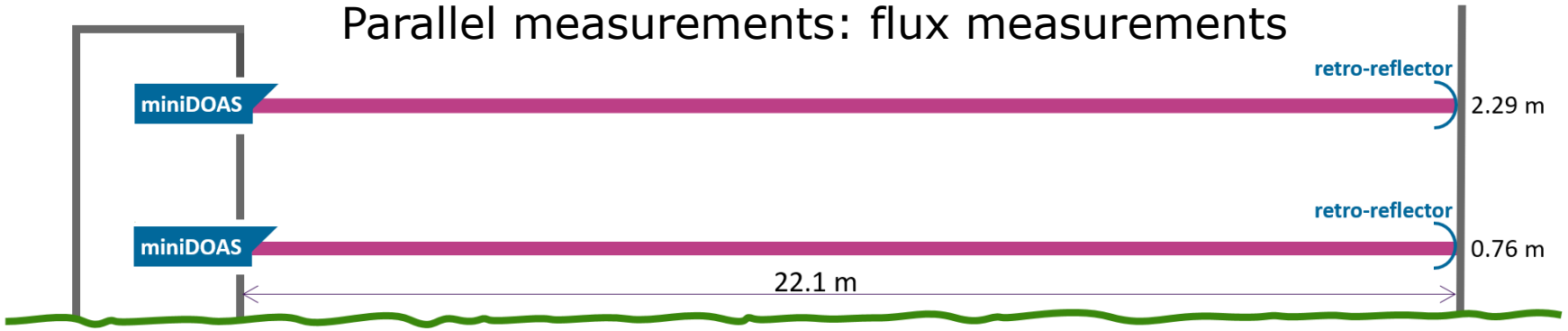
Dry deposition measurements for process studies

- 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)

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



Gradient method requires zero bias

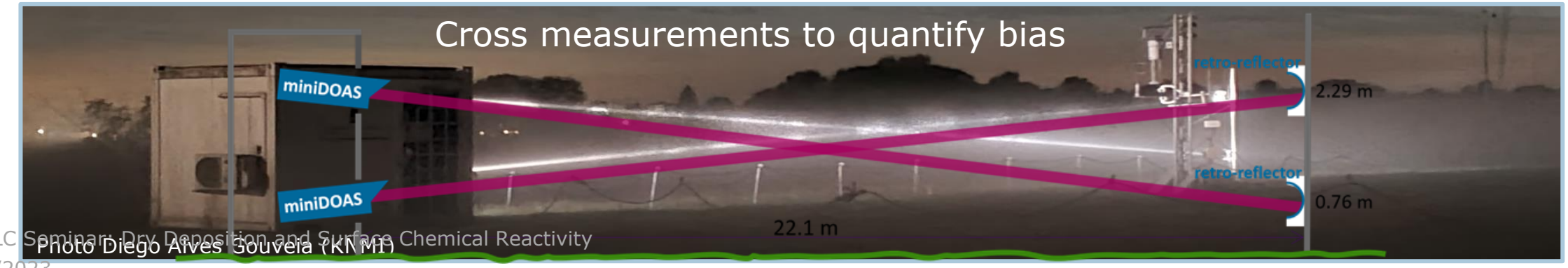
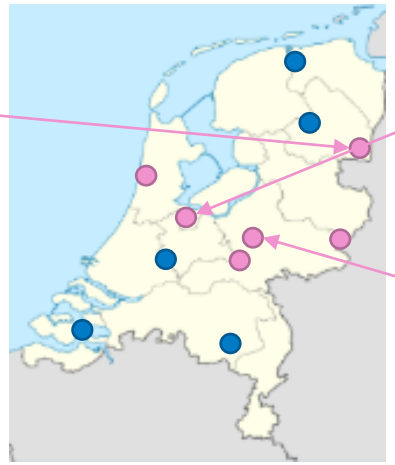


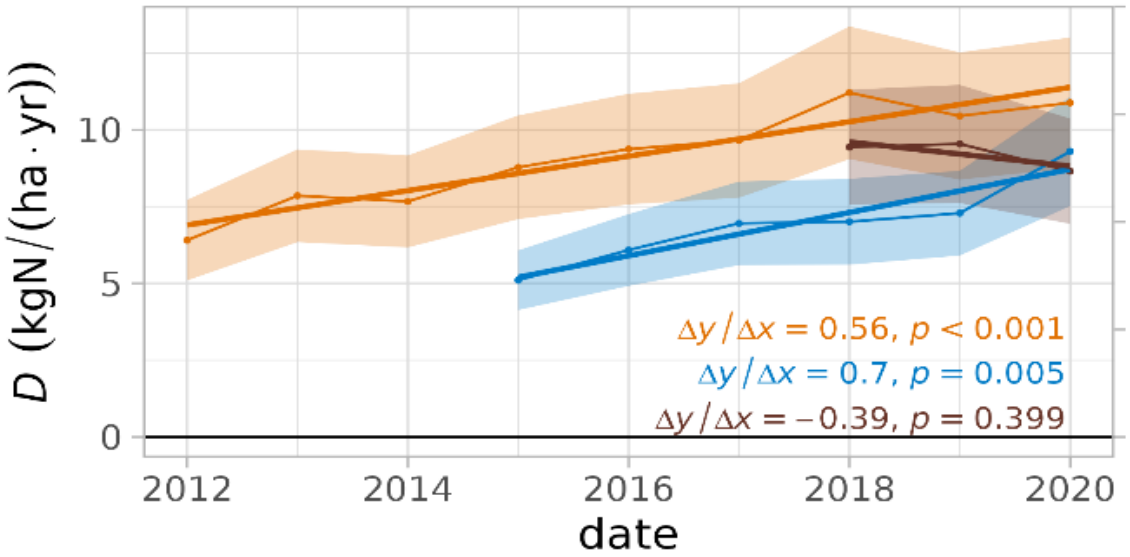
Photo Diego Alves Souveia (KNMI)

Rutledge et al., 2023:
https://doi.org/10.21945/RIVM-2022-0202

Dry deposition measurements for monitoring



- COTAG operational
- COTAG in preparation



Berkhout et al., 2008:
https://rivm.openrepository.com/handle/10029/259718

Emission measurements with LIDAR