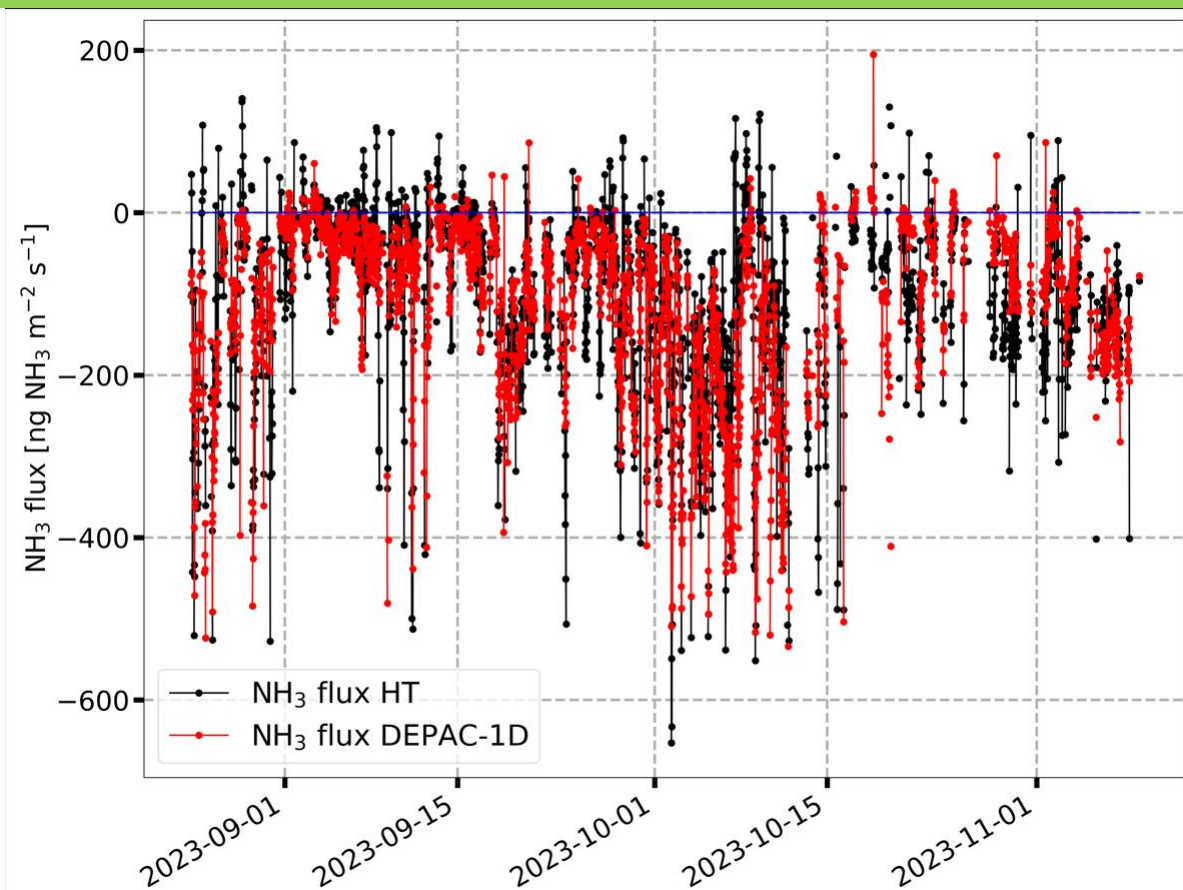


And finally... one more ammonia story

Arjan Hensen, Pascal Wintjen, Jun Zhang
Harmen van Mamson, Pim van den Bulk, Ilona Velzeboer, Danielle van Dinther
RIVM & WUR-Loobos Crew



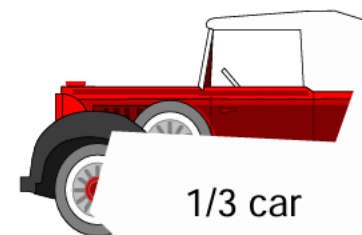
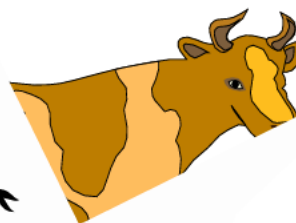
NETHERLANDS



NETHERLANDS

Per person in NL

1/4 cow



1/3 car

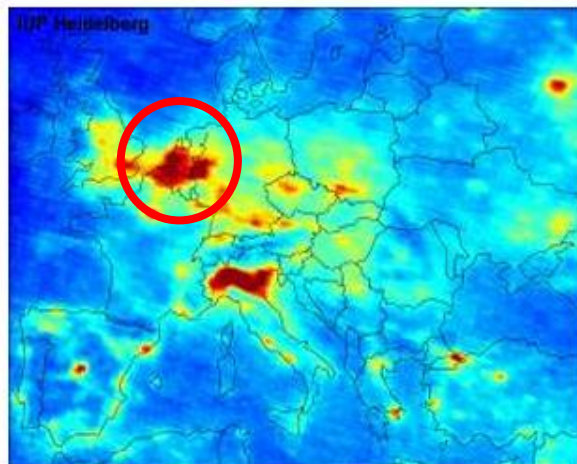


8 chicken

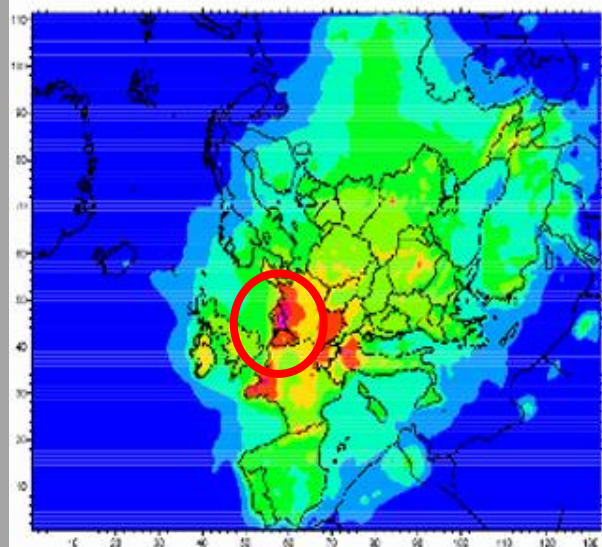


1 pig

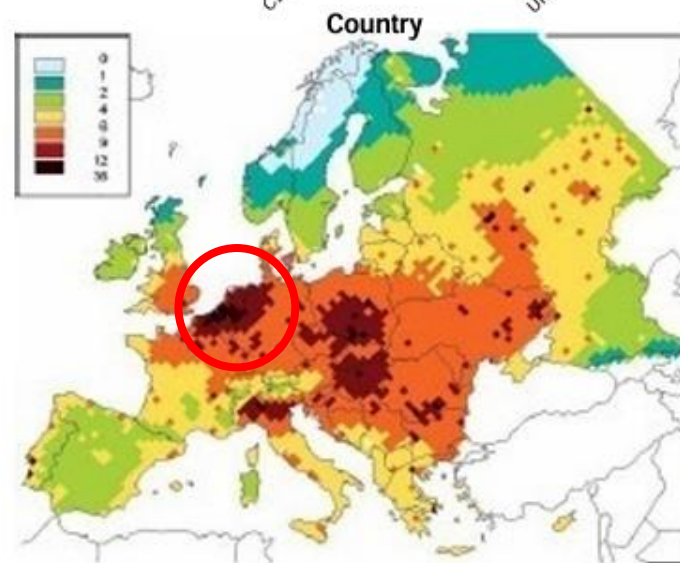
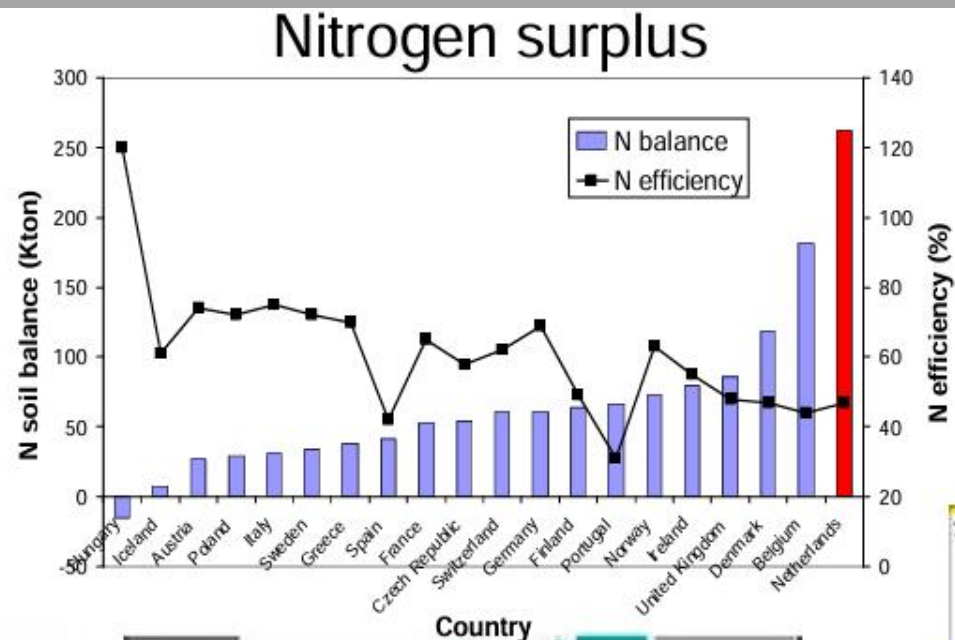




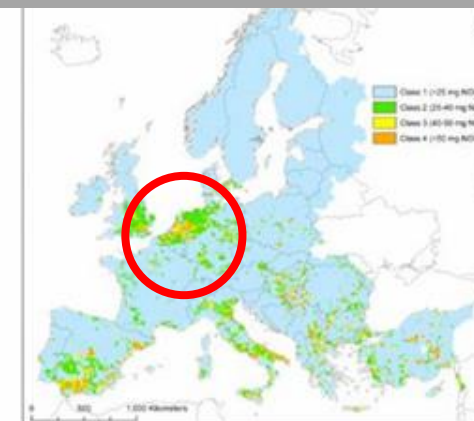
NO₂ concentrations



N deposition



PM concentrations

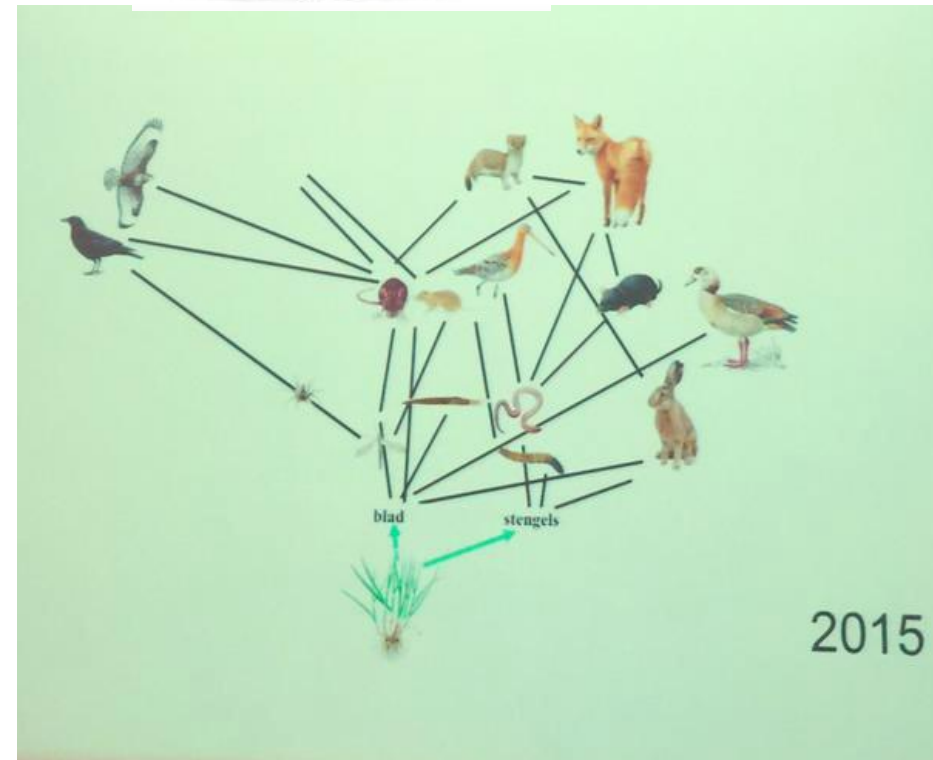


N in groundwater

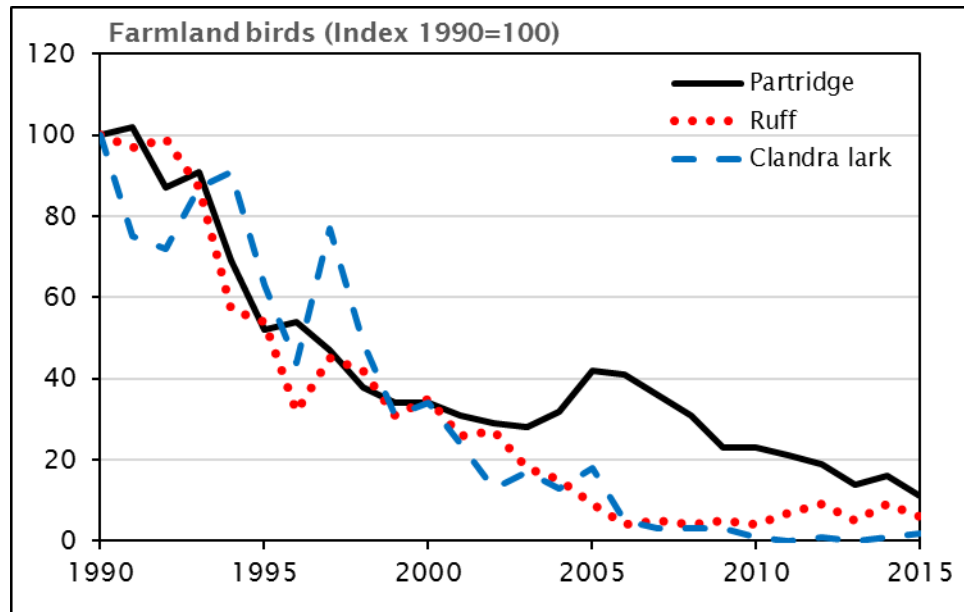
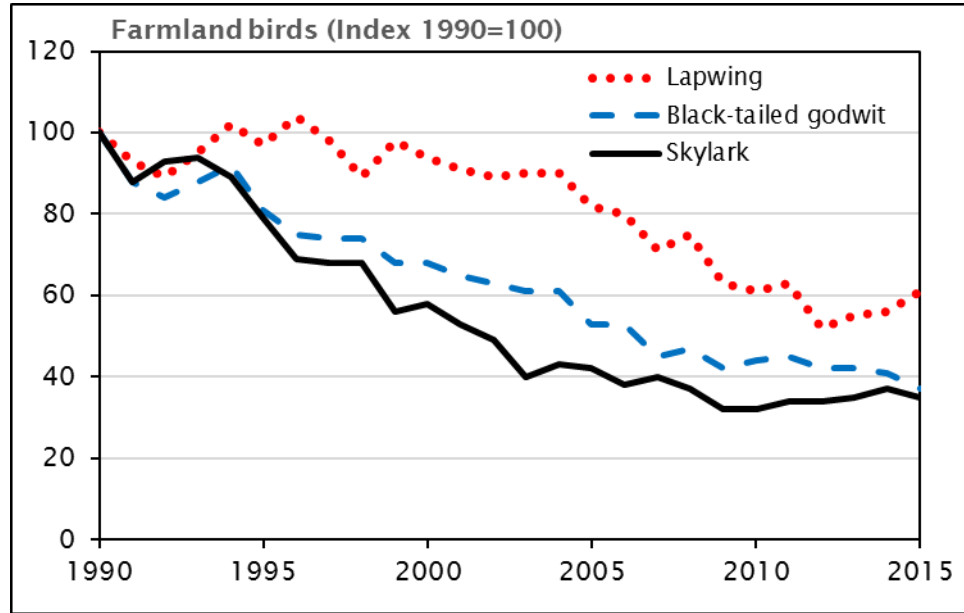


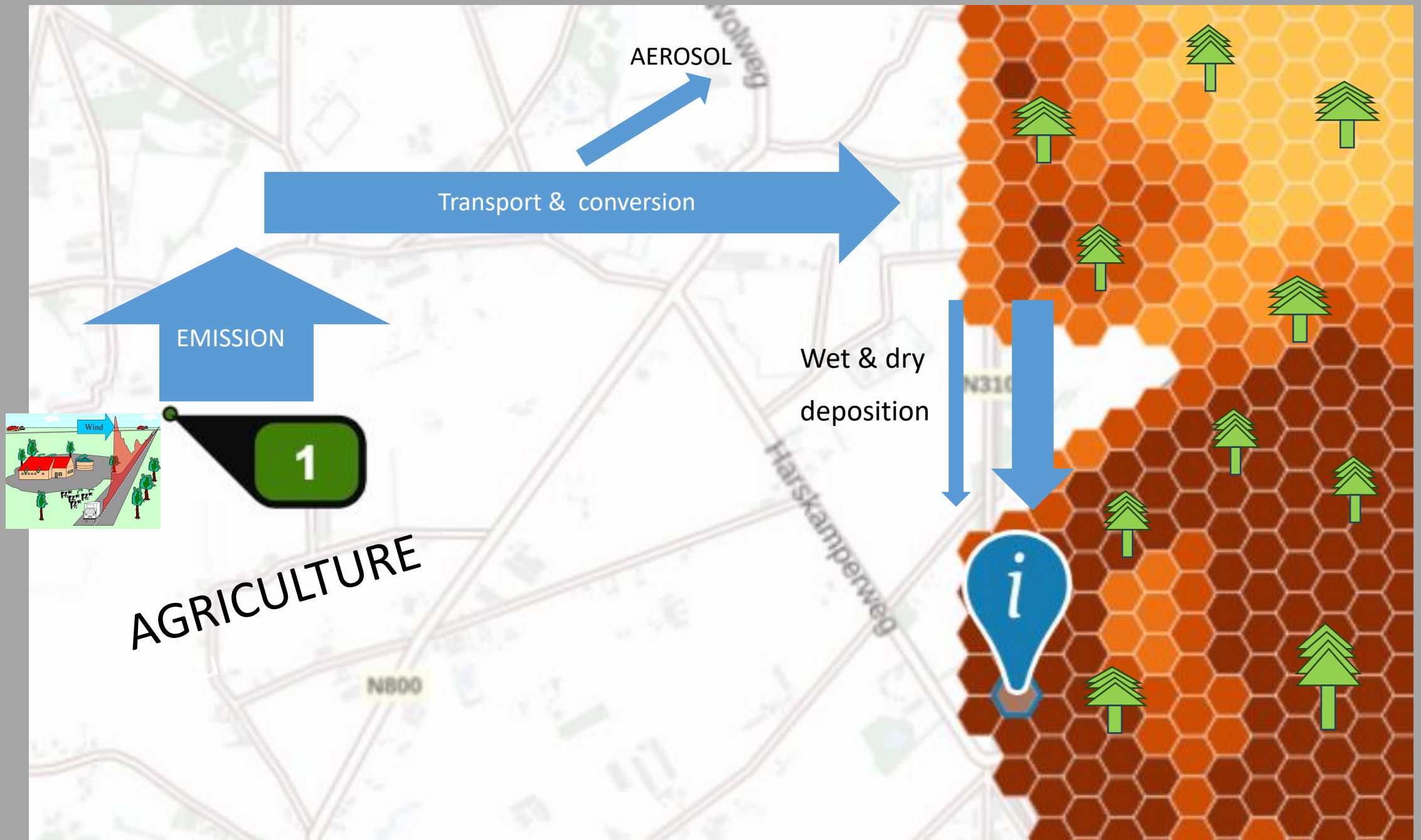
N in rivers

NL: INSECTS DECREASED BY 75%



Source: Jeroen Onrust/Theunis Piersma





Input

Assessment points

Calculation jobs

Results

Export

Scenario input

big testfarm - Project

Name

big testfarm

Delete

Scenario

Project

Year

2024

Emission sources

1

Source 1

Delete all sources

NO_x

0.0 kg/y

NH₃

5,200.0 kg/y

Buildings

400 cow farm

Nature

AGRICULTURE

176215, 467054

500 m

Information

Receptor id

4768354

Coordinate

x:176883 y:464325

Result

Background

Deposition NO_x + NH₃

2,452.92 mol/ha/y

big testfarm

Pollutant

Deposition NO_x + NH₃

5.15 mol/ha/y

Extra

Result

Total

2,458.07 mol/ha/y

Habitat type on selected hectares

Habitatcode / type

CL

Mapped

Lg13 - Bos van arme zandgronden

1,071.00

0.1 ha

L4030 - Droge heiden

714.00

0.3 ha

ZGL4030 - Droge heiden

714.00

0.6 ha

Nature areas at this location

Input

Assessment points

Calculation jobs

Results

Export

Scenario input

big testfarm - Project

Namebig testfarm

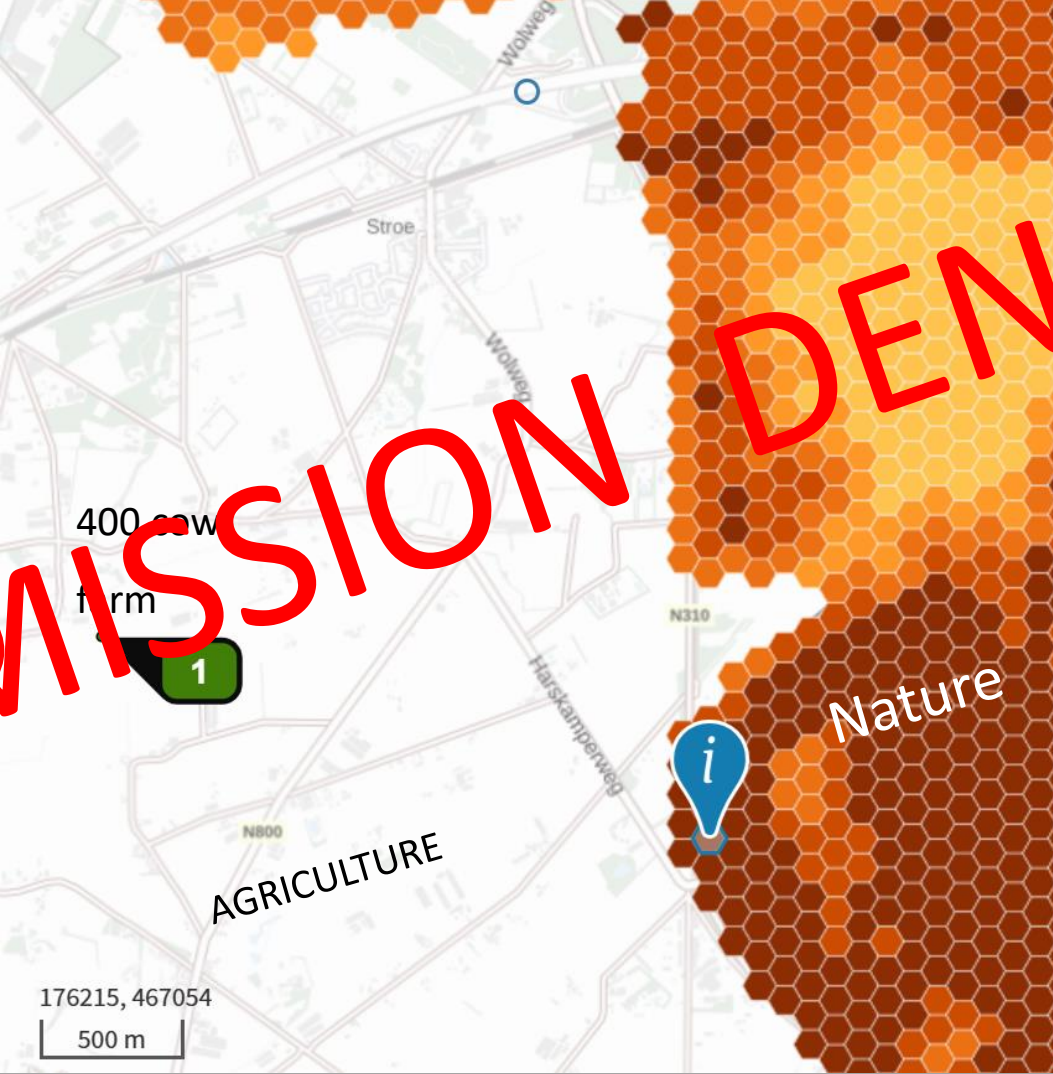
ScenarioProjectYear2024

Emission sources

Source 1

Delete all sources

NO_x0 kg/y5,200 kg/y



Information

Receptor id4768354

Coordinatex:176883 y:464325

Result

Background

Deposition NO_x + NH₃2,452.92 mol/ha/y

big testfarm

Pollutant

Deposition NO_x + NH₃

Extra Result

5.15 mol/ha/y

Total

2,458.07 mol/ha/y

Habitat type on selected hectares

Habitatcode / typeCLMapped

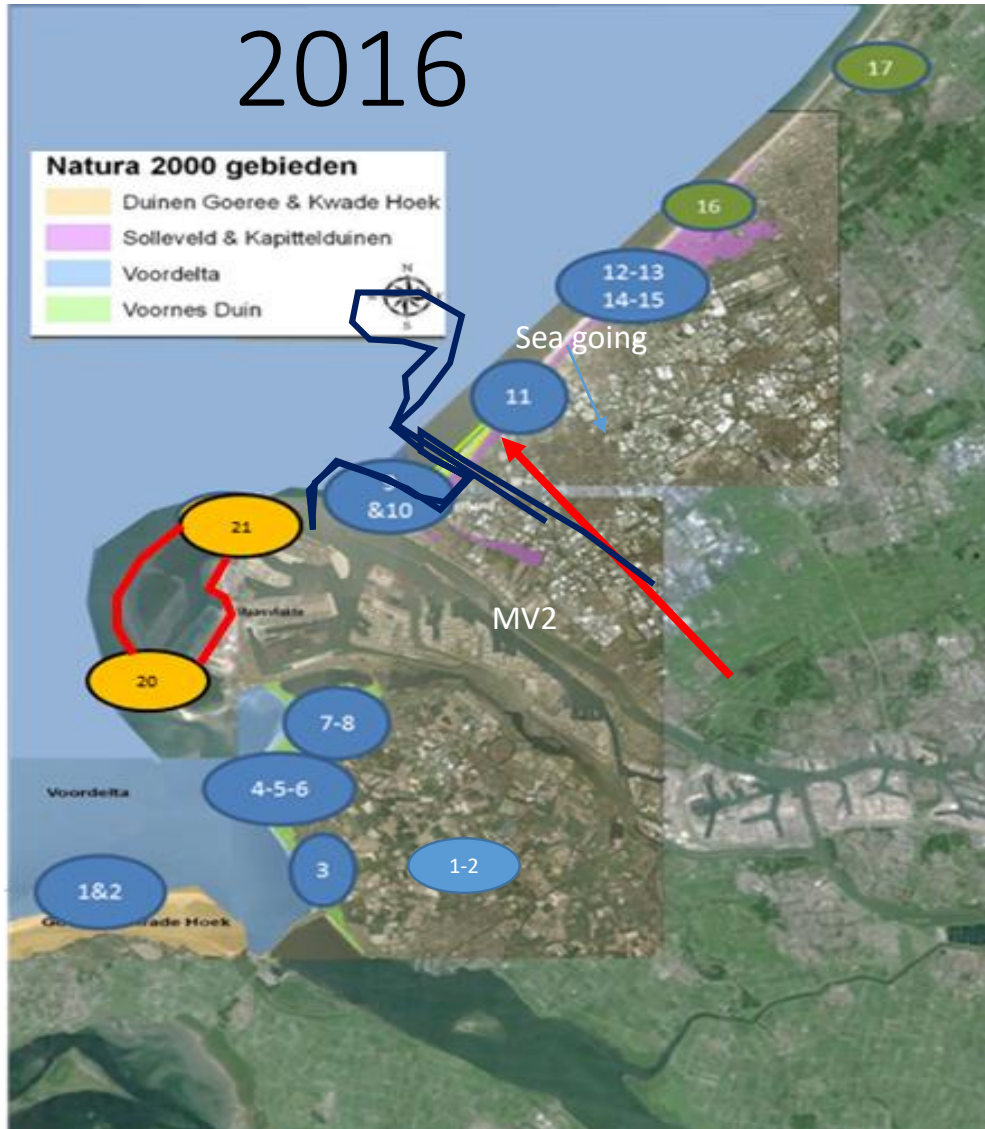
Lg13 - Bos van arme zandgronden1,071.000.1 ha

L4030 - Droge heiden714.000.3 ha

ZGL4030 - Droge heiden714.000.6 ha

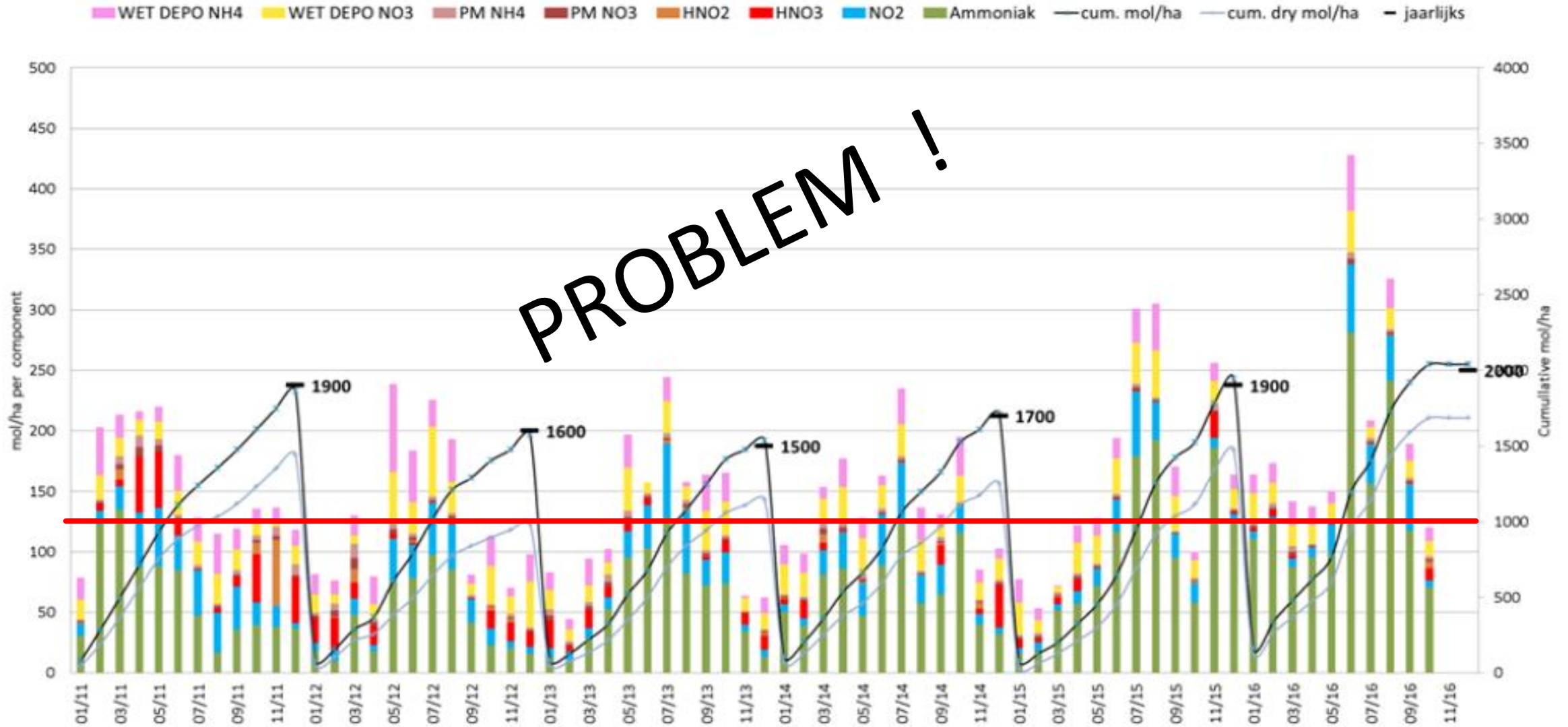
Nature areas at this location

Maasvlakte 19 sand dune stations 2011-2016



Wet deposition 30 % Dry deposition 70%

Total Deposition: Oostvoorne Zuid 2



NITROGEN STORY IS BULLSHIT

PROTEST



'Impact stikstof op bos overdreven'

Afname kalk in Nederlandse bossen

Wetenschappelijk onderzoek heeft uitgewezen dat de afname van kalk in Nederlandse bossen overdreven is. De afname van kalk is vooral veroorzaakt door de afname van kalk in de bodem, die door de afname van kalk in de bodem wordt veroorzaakt.



BOERDERIJ

[Home](#) [Markt](#) [Grond](#) [Opinie](#) [Boerenleven](#)

[Rundvee](#) [Varkens](#) [Akkerbouw](#) [Mechanisatie](#) [Pluimvee](#)

cool blue Best verkochte laptops van januari.

10.

Expertblog
20 okt 2019 | 24 reacties

‘Stikstofcrisis: laat u zich niets wijsmaken, leer van onze Europese burenen!’

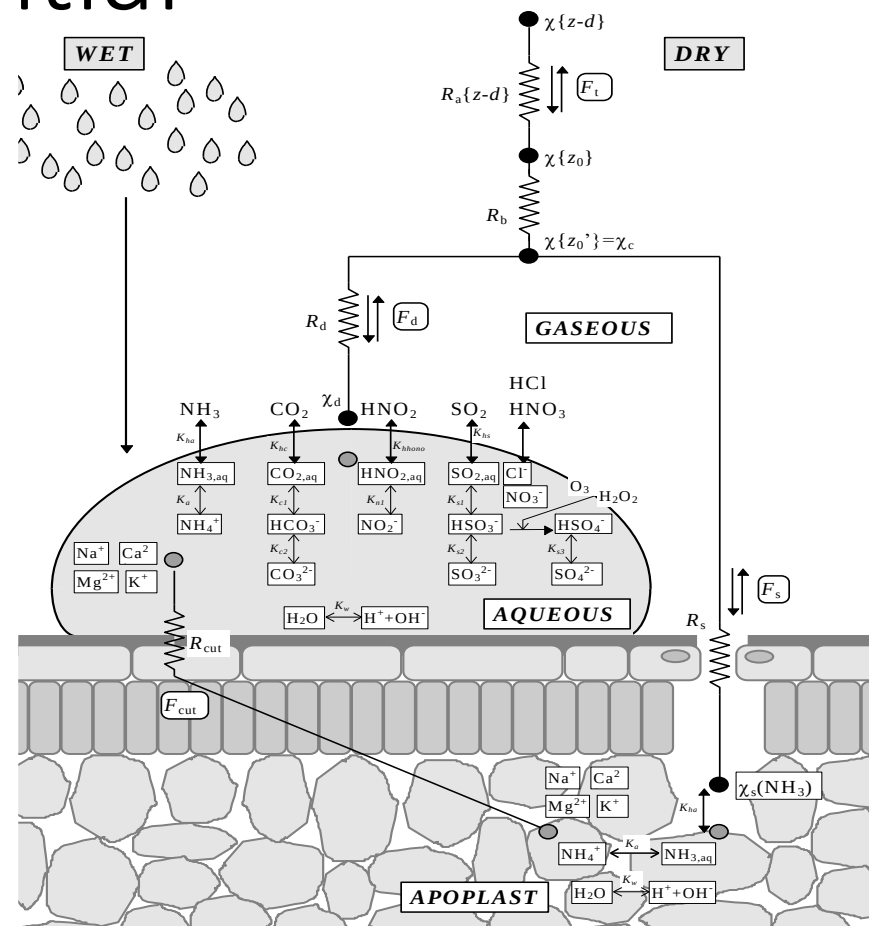
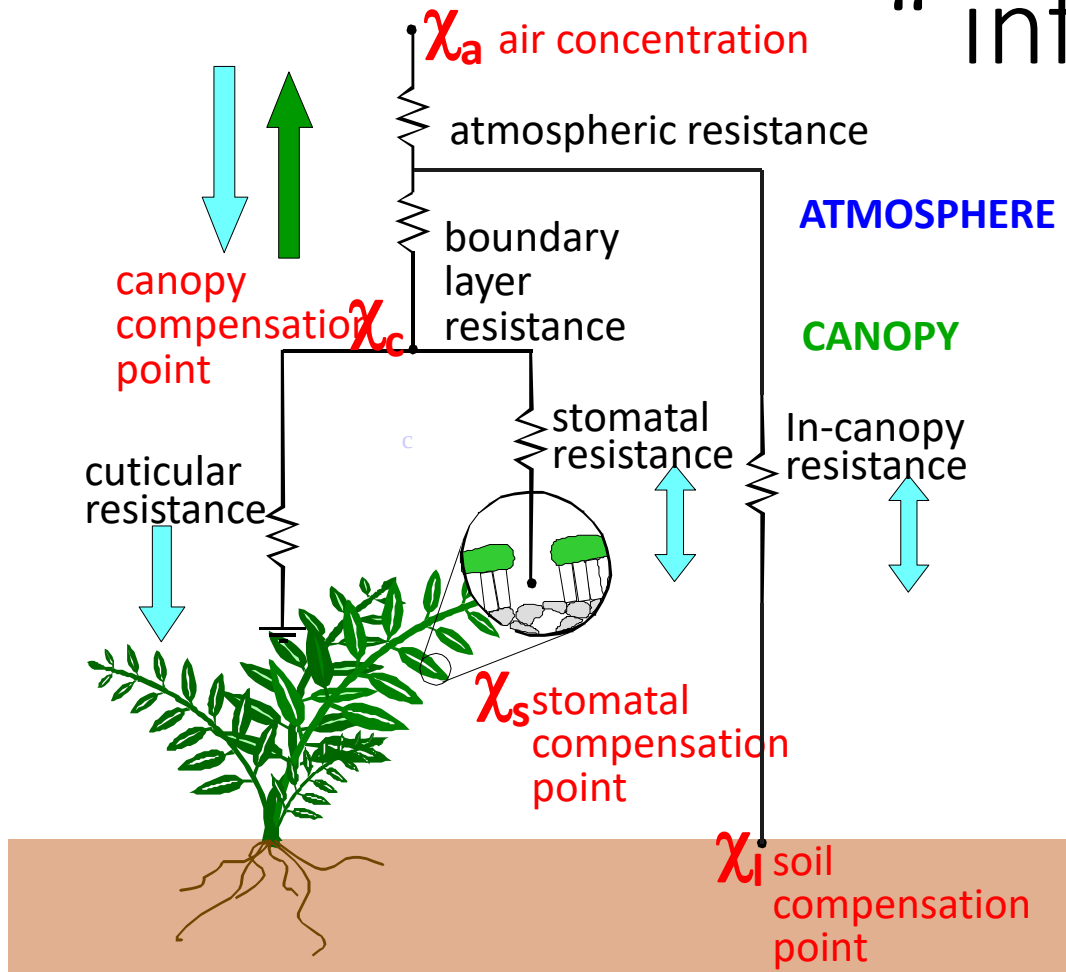
Annie Schreijer-Pierik
Europarlementariër

Het is helemaal niet zo zeker dat koeienscheten de achteruitgang van soorten in een Natura 2000-gebied veroorzaken.

Na de **uitspraak van de Raad van State** over het stikstofbeleid en **advies van het Col** juridisch en voor zorg en

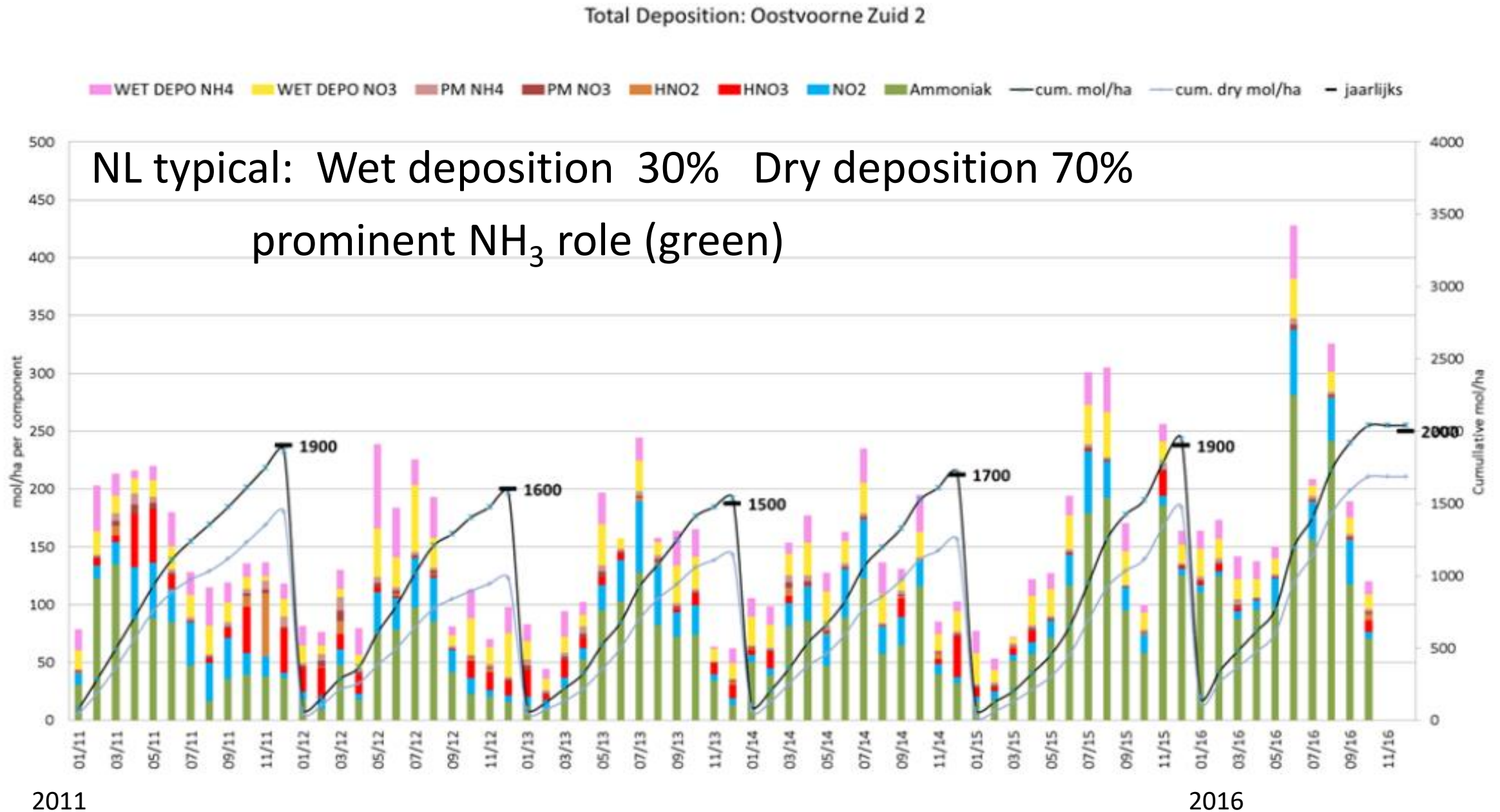
Measure concentration → calculate deposition

“ inferential”

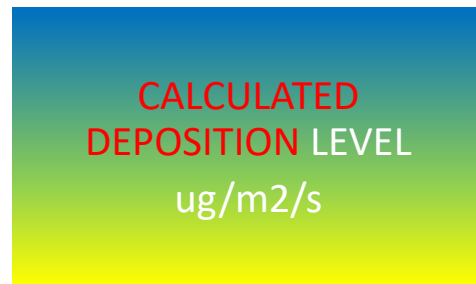
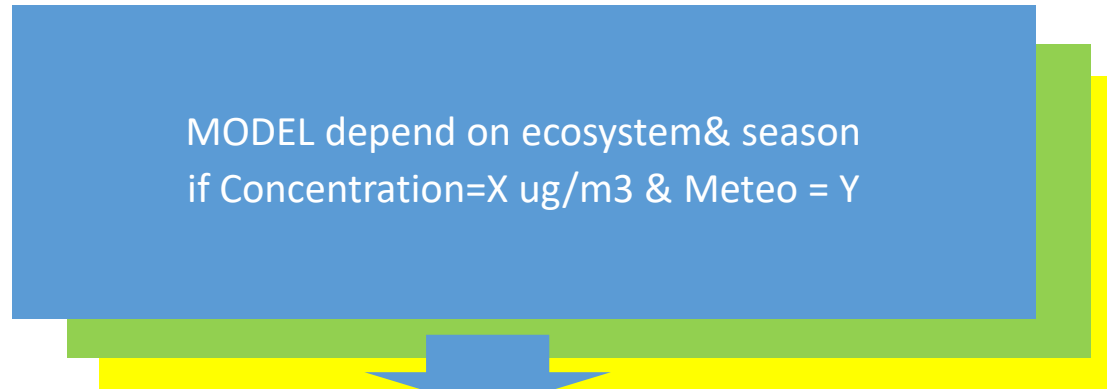
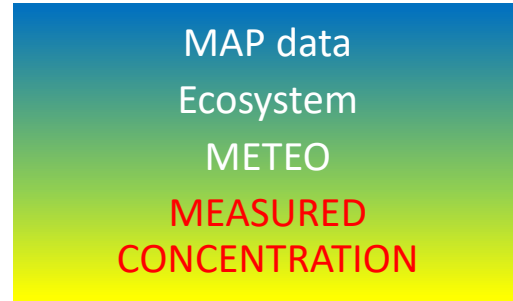


Nemitz et al., 2001

RESULT EXAMPLE



INFERRENTIAL CALCULATION



Model parametrisation need for :

- Needle forest
- Deciduous forest
- Water
- Grassland
- Arable land
- Semi natural And more

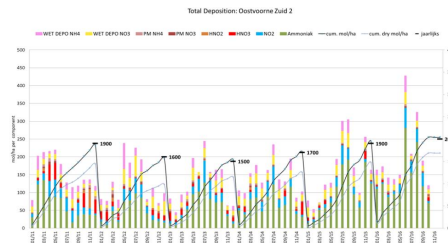


MODEL depend on ecosystem & season
if Concentration = $X \text{ ug/m}^3$ & Meteo = Y

CALCULATED
DEPOSITION LEVEL
ug/m²/s

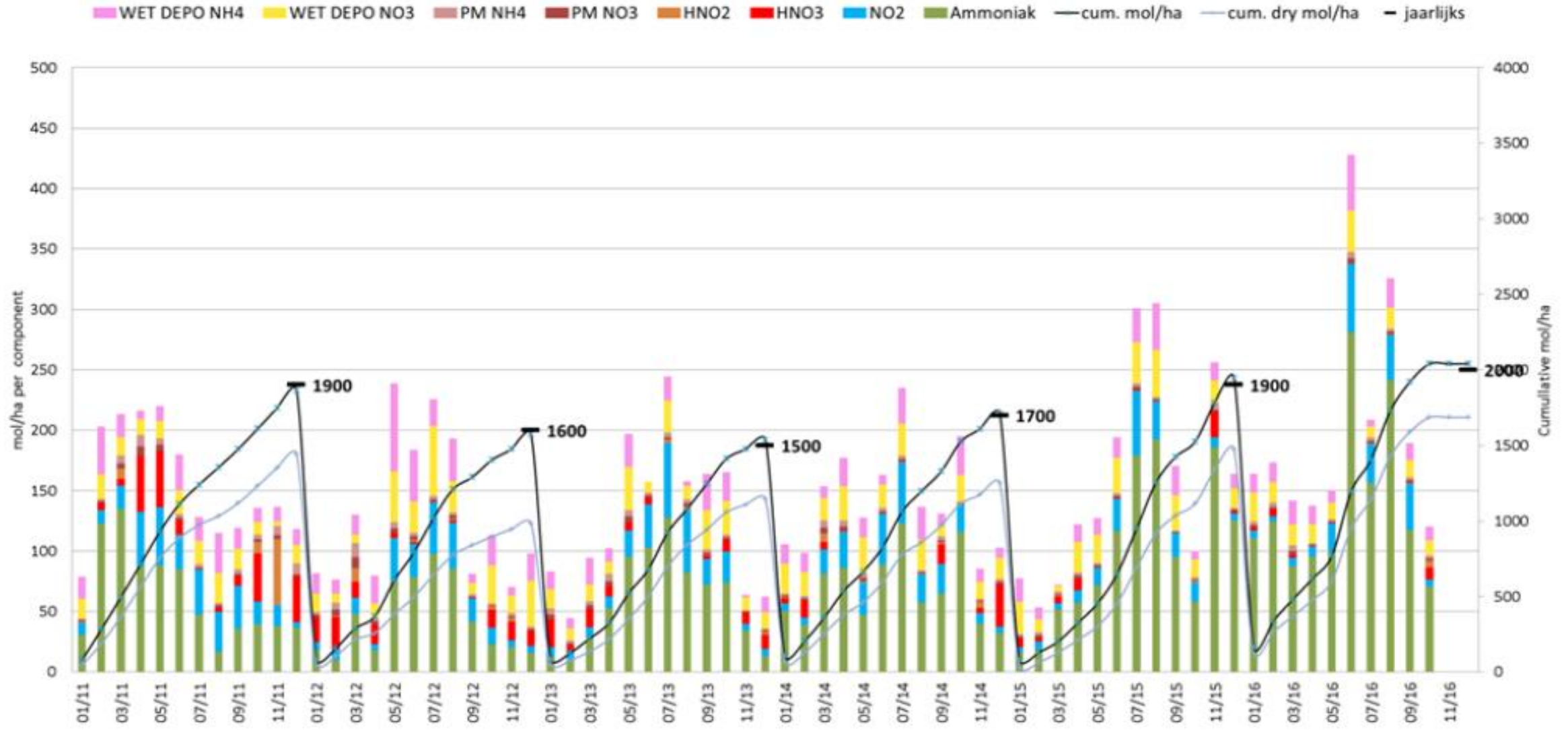


Ecosystem: LAI, height, z_0
METEO (Q,T, RH, Rain

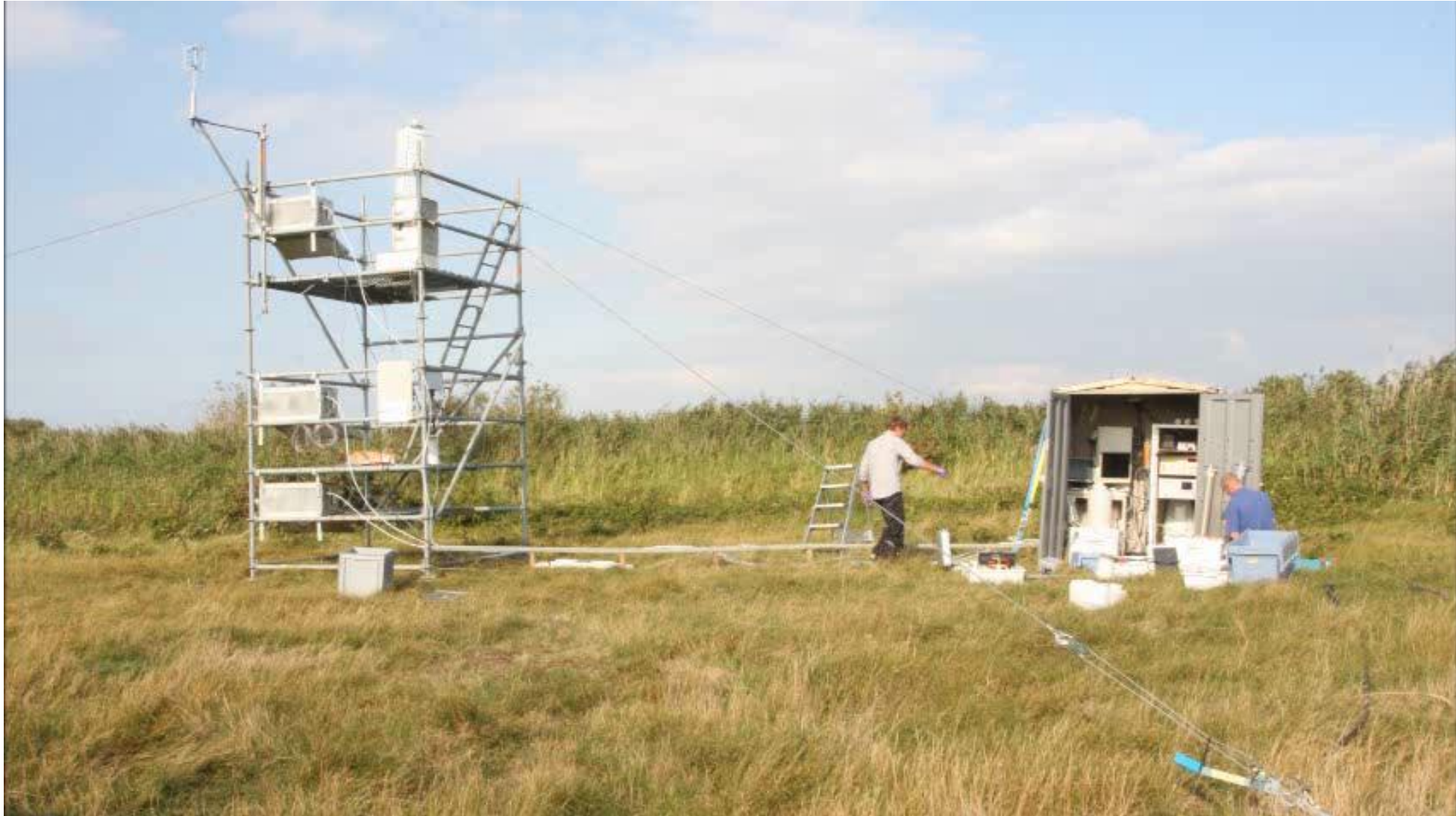


Wet deposition 30 % Dry deposition 70%

Total Deposition: Oostvoorne Zuid 2



2015 DISAPPOINTMENT IN THE DUNES



Disappointment in the dunes



K.J.A. Vendel *et al.*

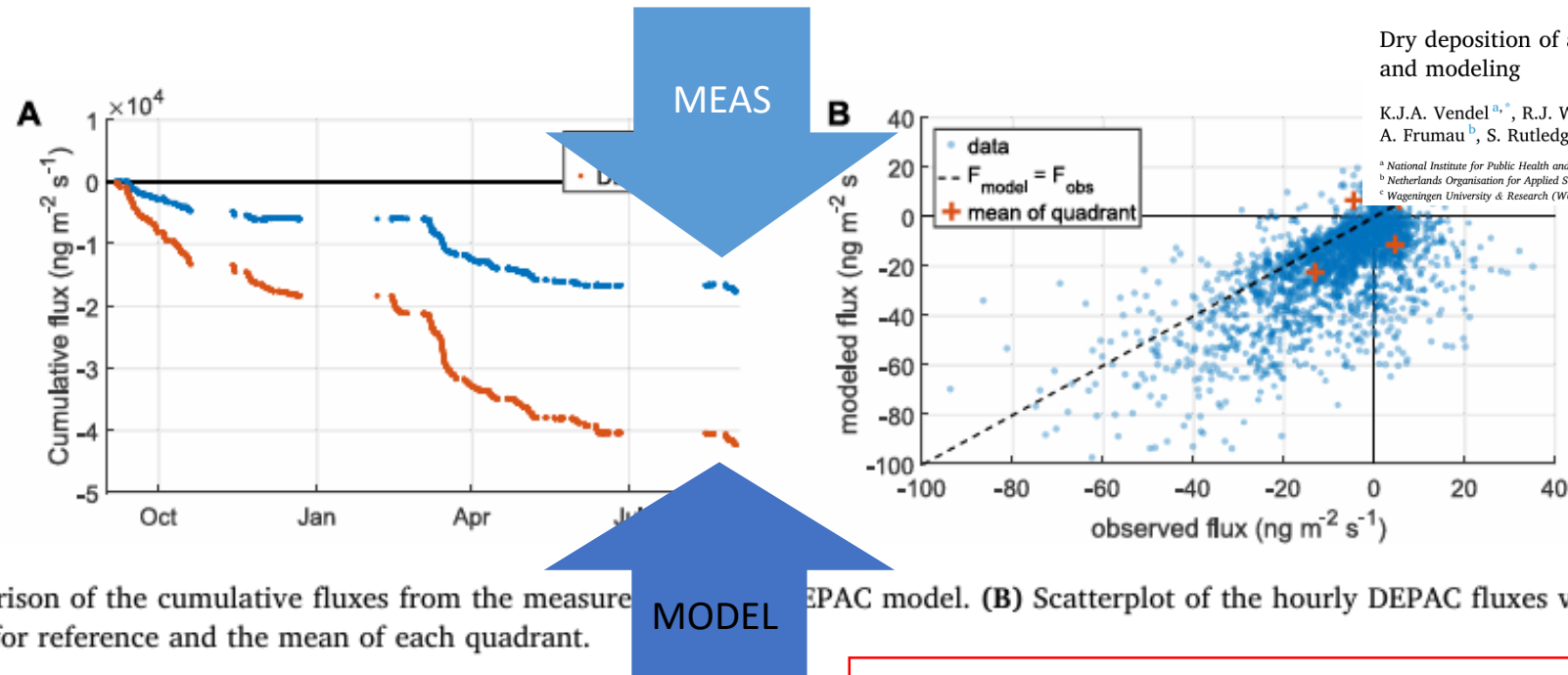


Fig. 7. (A) Comparison of the cumulative fluxes from the measurements and the DEPAC model. (B) Scatterplot of the hourly DEPAC fluxes versus observed fluxes, a dashed $y = x$ line for reference and the mean of each quadrant.

Table 3

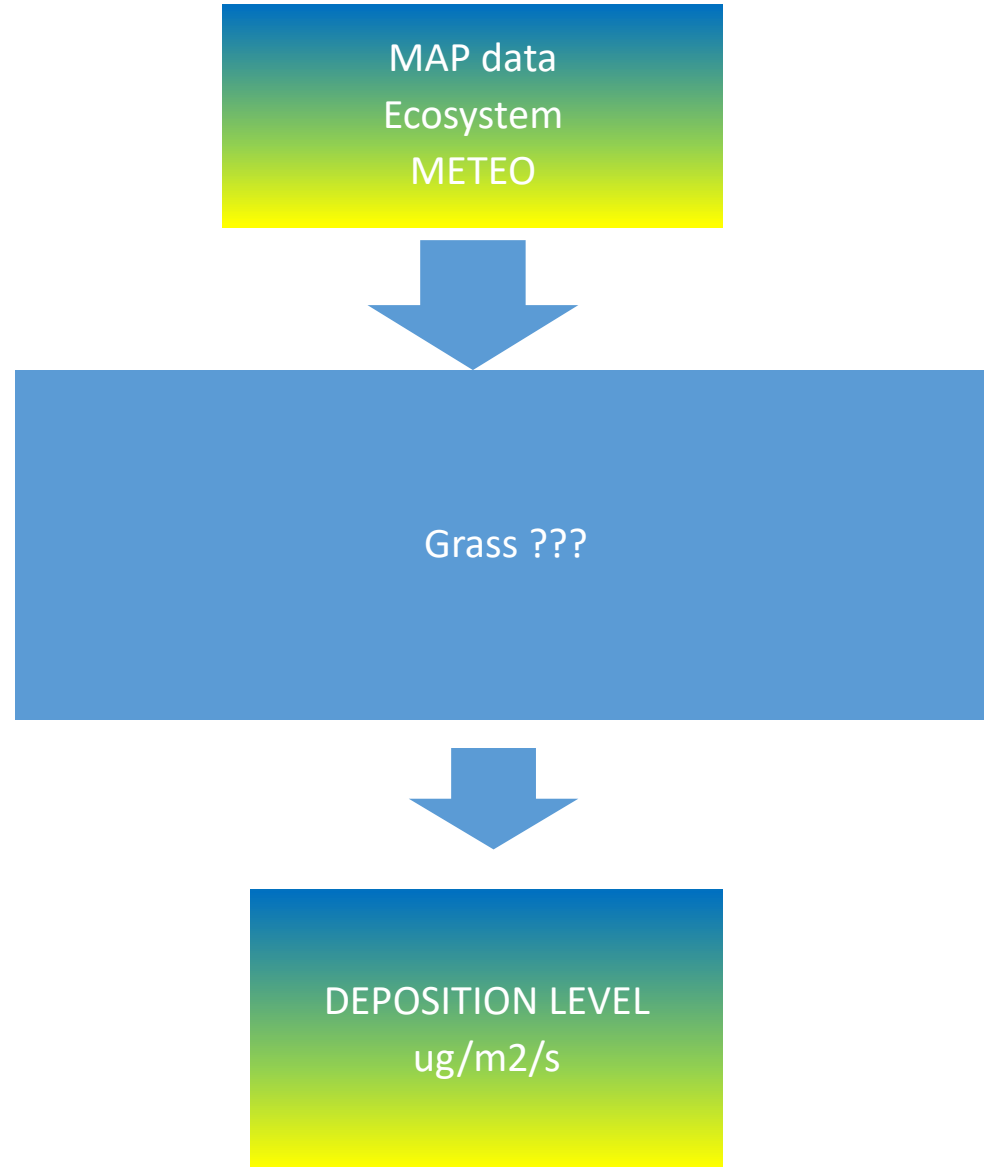
Summary of the mean and median fluxes and the number of hours with deposition or emission fluxes from observations and DEPAC modeling.

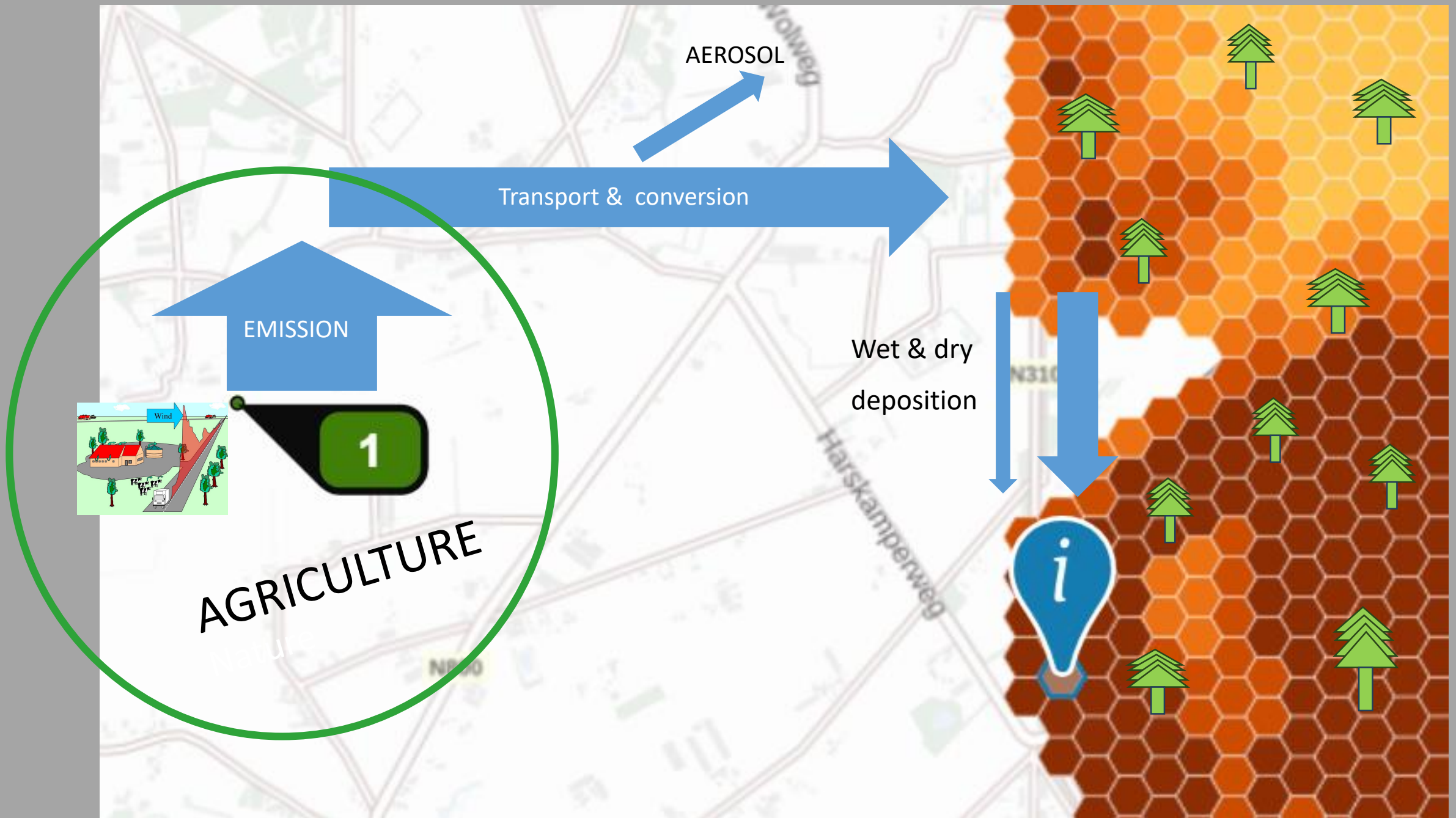
	Observations	DEPAC
Mean flux	$-7.1 \pm 1.7 \text{ ng m}^{-2} \text{ s}^{-1}$	$-17.0 \text{ ng m}^{-2} \text{ s}^{-1}$
Number of hours with deposition flux	1671	2308
Number of hours with emission flux	811	174

Measured & gapfilled $132 \pm 32 \text{ mol ha}^{-1} \text{ yr}^{-1}$
(= 1.8 kgN/ha/y)

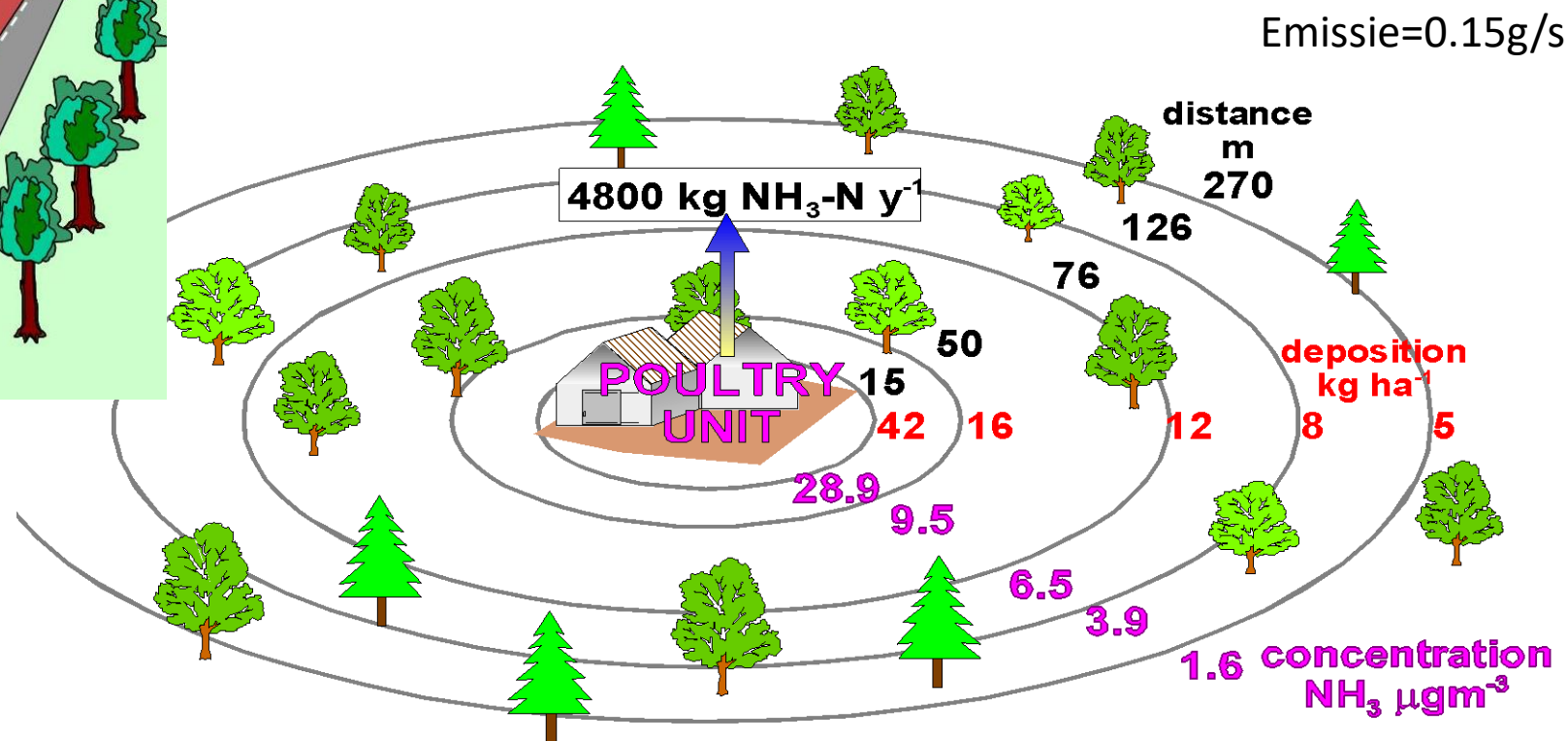
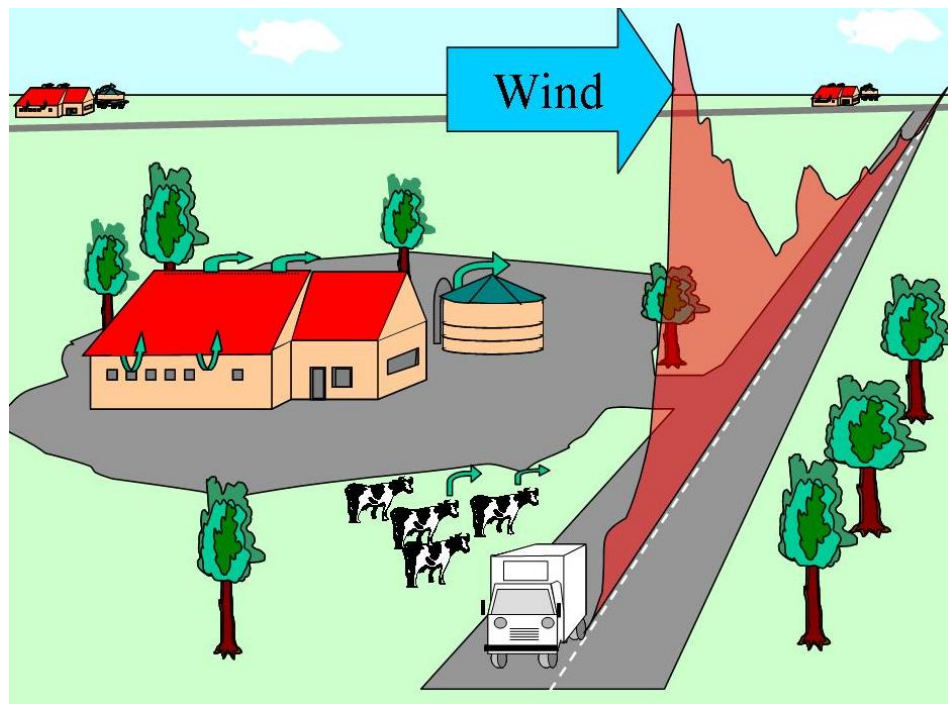
Factor 2 difference between model and measurement

DUNES....



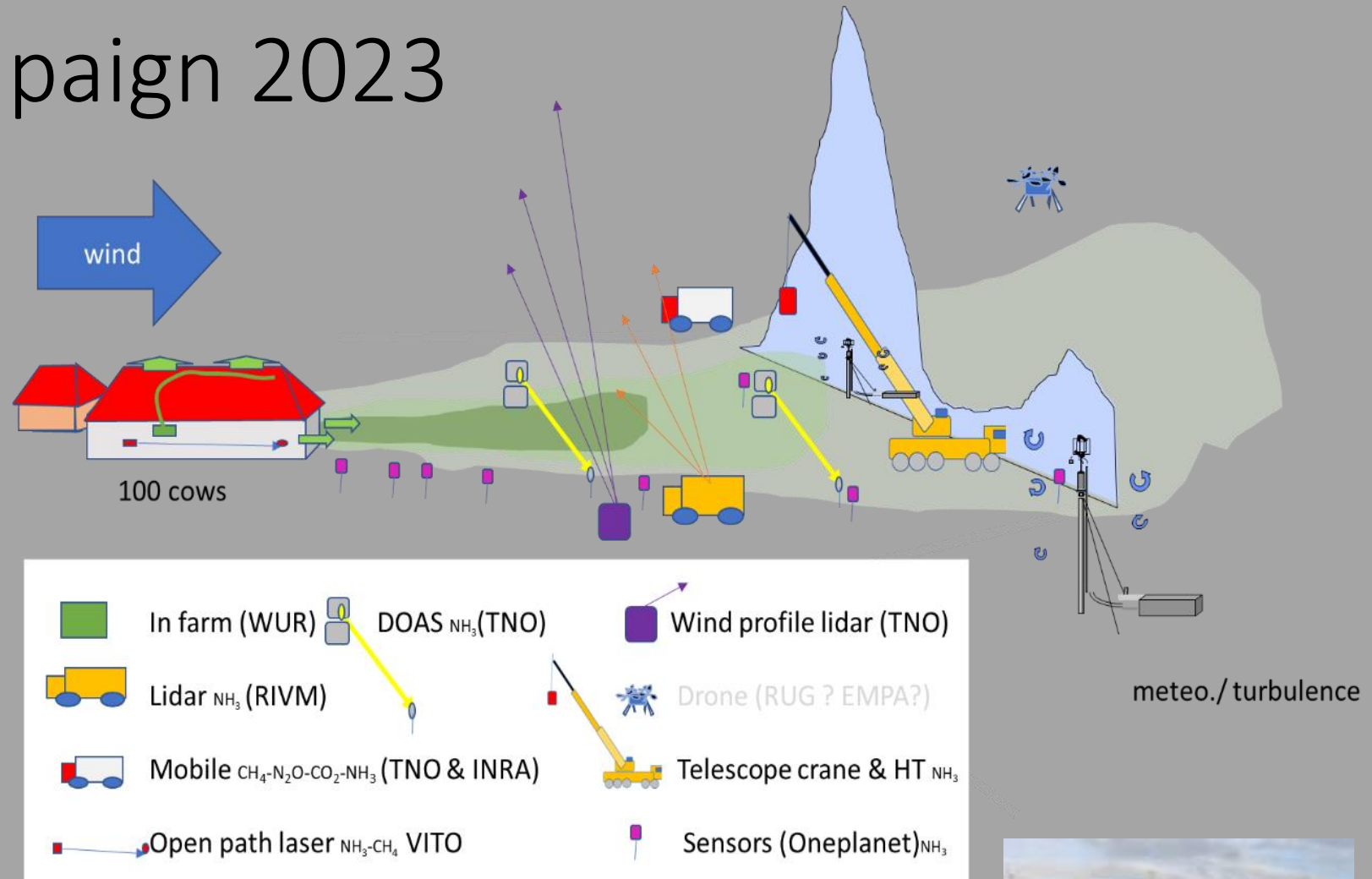


Emission



Fowler et al., 2001

Farm plume campaign 2023



ILVO

Evaluation of the 3D dispersion of ammonia and methane downwind of a farm

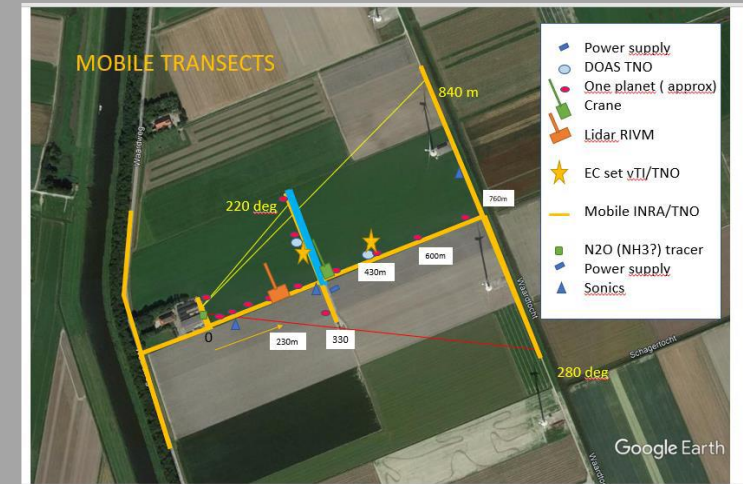
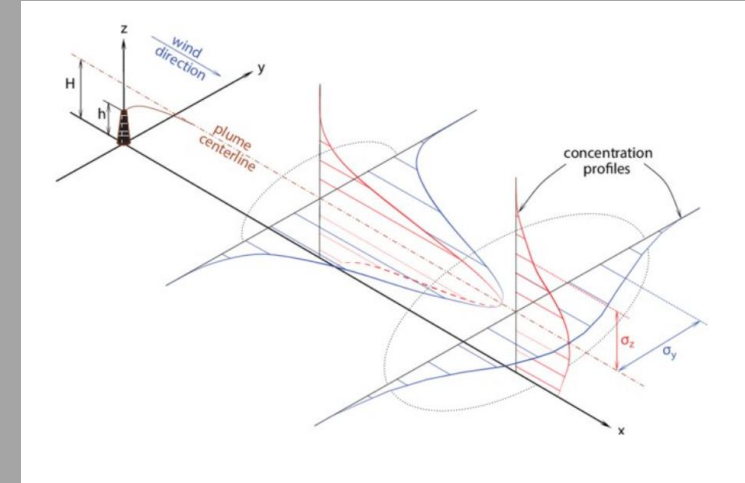
A.Hensen¹, P. Bronsveld, J. Zhang¹, I. Velzeboer¹, W.C.M van den Bulk¹, H. van Mansom¹, G.Bergman¹, C.Flechar², P. Buysse², S. Berkhout³, R van der Hoff³, M. Haalima³, K. Felter³, S. Zhuang⁴, B.Celikol⁴, J. Fabius⁴, R. Suer⁴, S.M.A.C. van Heuven⁵, H.J. van Dooren⁶, J. Mosquera⁶, J. Vonk^{6,4}, A. Declerck⁷, W. Grauls⁷, K.Mahieu⁷

Paper in prep

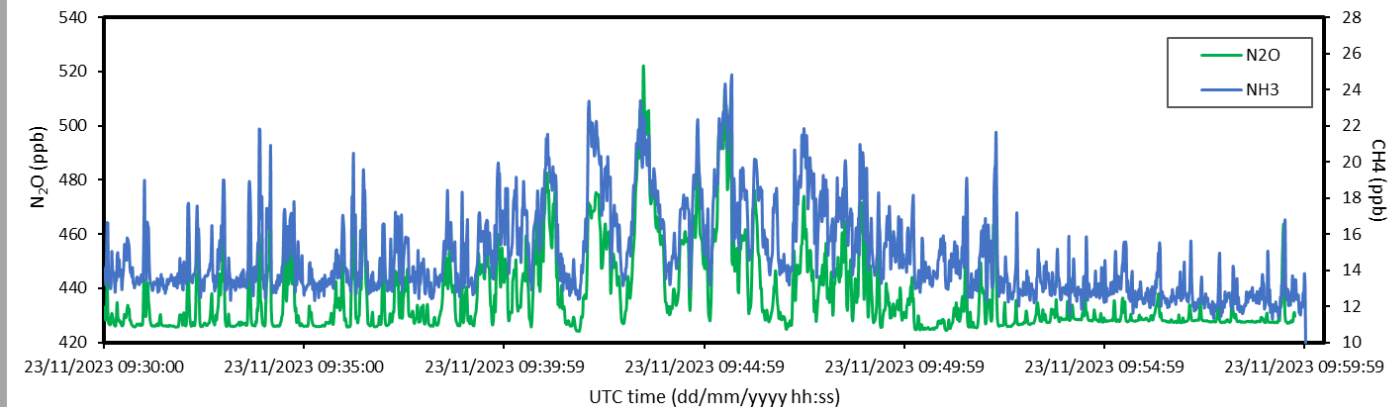
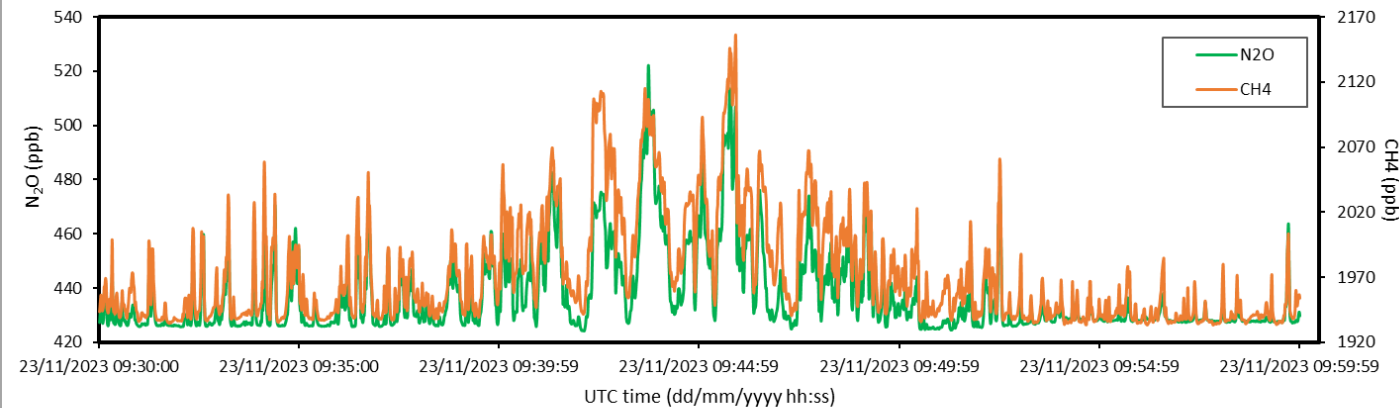
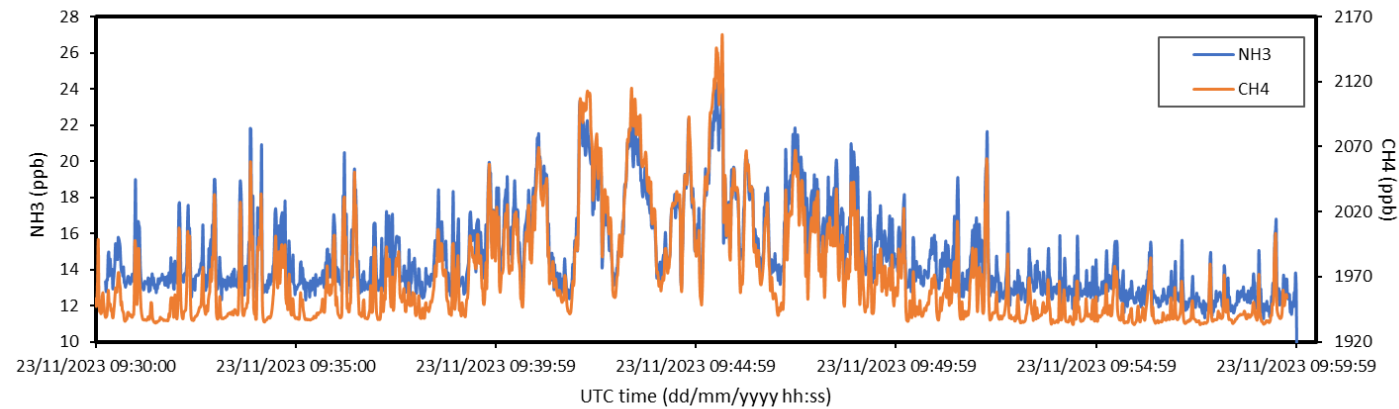
INRAE
la science pour le territoire, l'humain, la terre



Vertical plume measurements on the crane



Test MIRO instrument NH_3 & MIRO GHG data

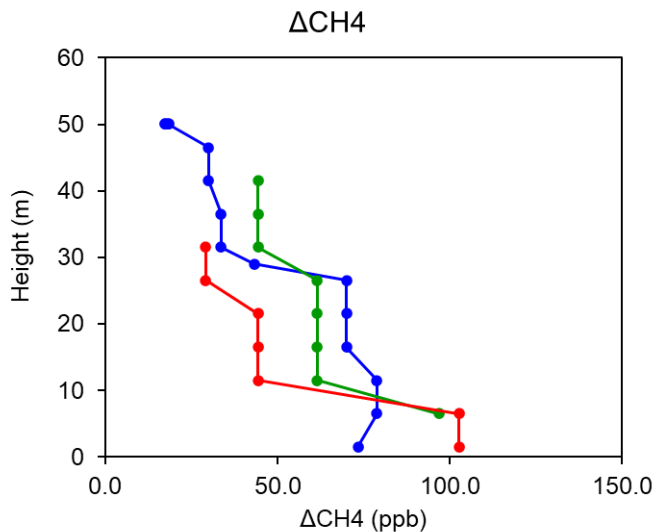
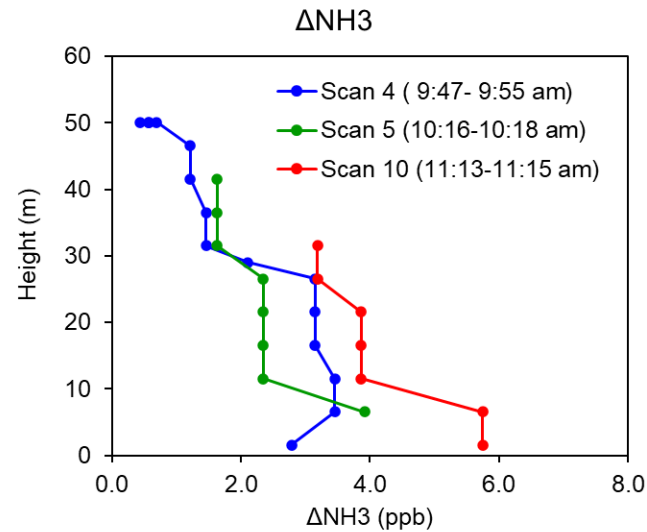
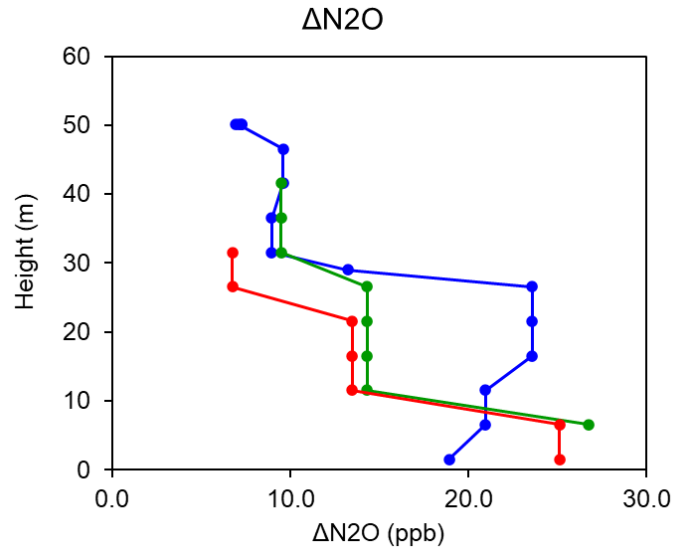


- NH_3 at 300m distance
- On this day 20 ug/m^3 – isch
- Wonderful correlation with closed path



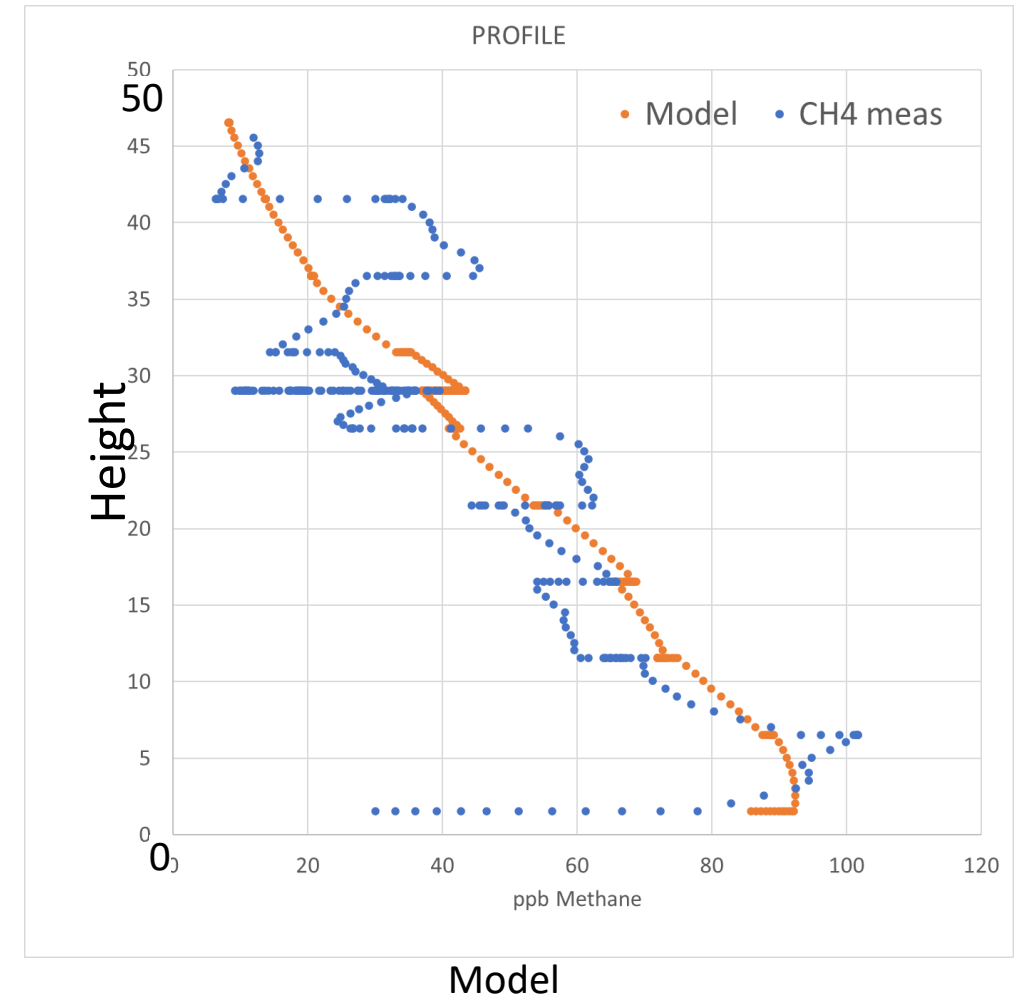
& N_2O (

Vertical profile reproduced by plume model

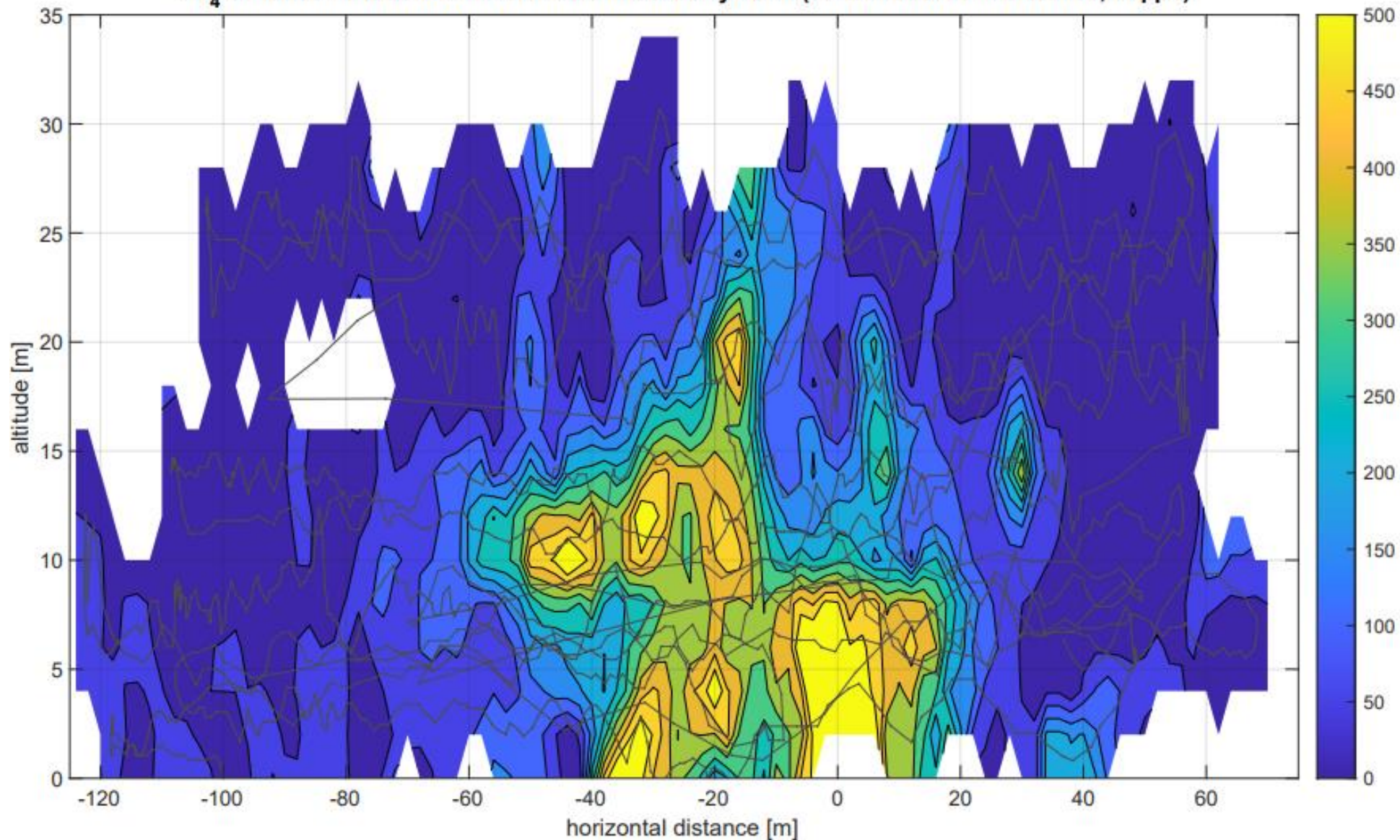


Concentration NH_3 , CH_4 and N_2O tracer is reduced at larger heights.

Tracermethod and model also applicable on vertical plume measurements



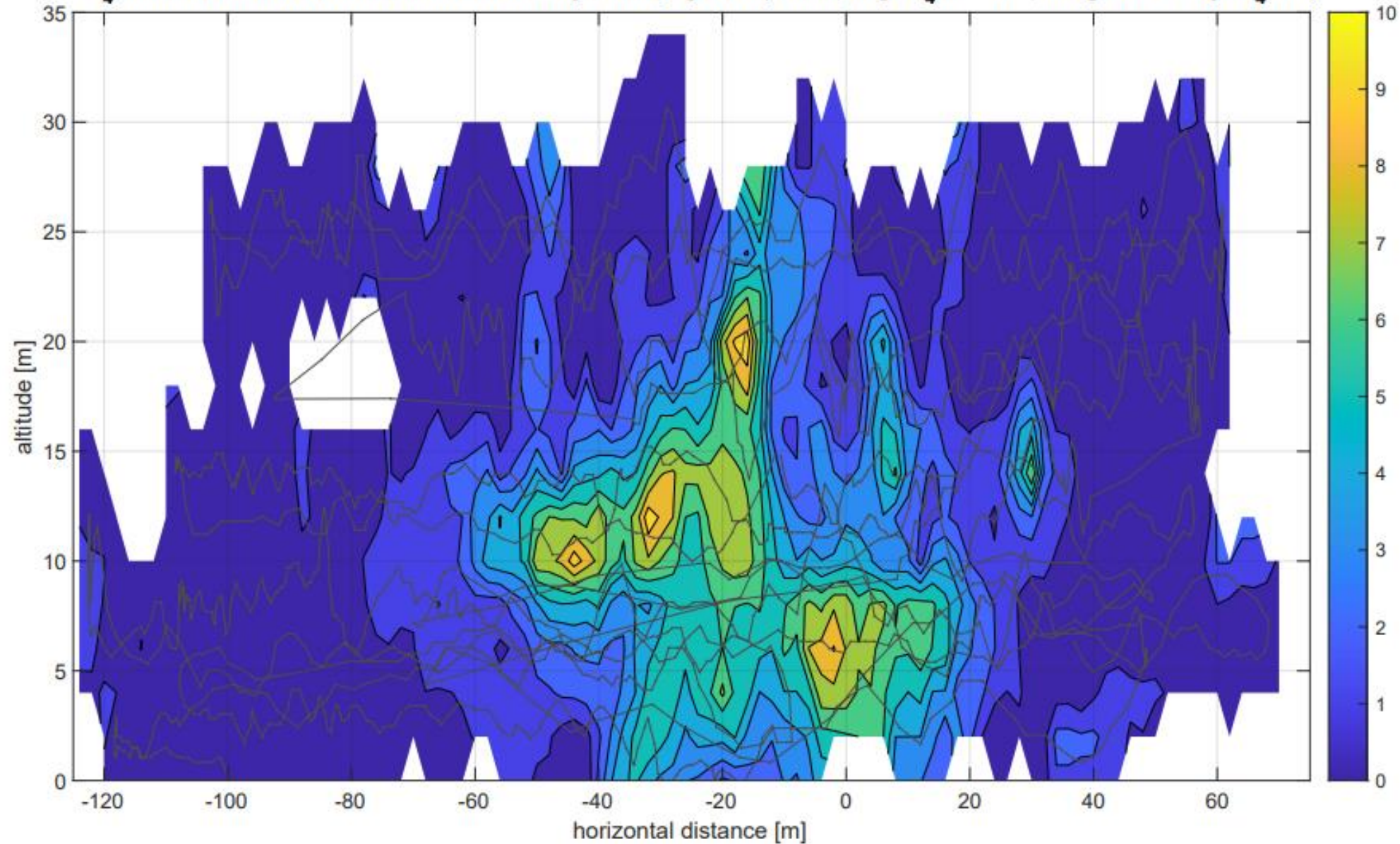
CH₄ enhancement downwind of Middenmeer dairy Farm (curtain at 37±6 m distance; in ppb)



university of
 groningen

Noni, Huilin & Steven RUG

CH₄ mass flux downwind of Middenmeer dairy Farm (log wind profile; in gCH₄ m⁻² h⁻¹; integral = 9.8 kgCH₄ h⁻¹)



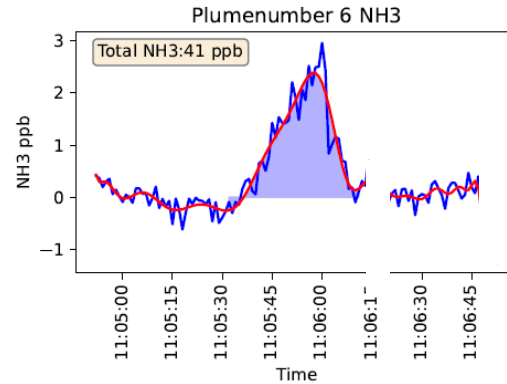
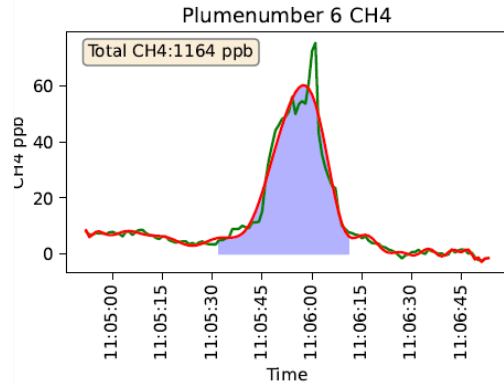
university of
 groningen

Noni, Huilin & Steven RUG

Application of tracer metho

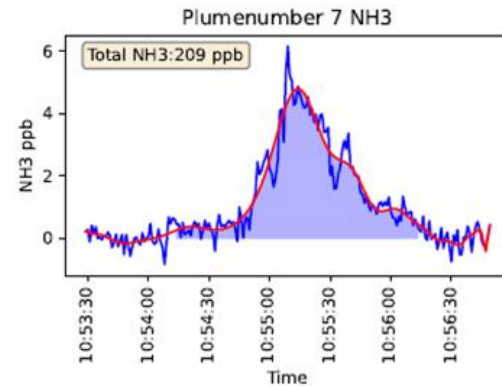
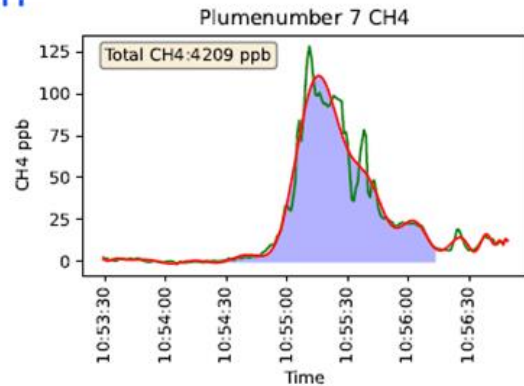
750 m

Monday



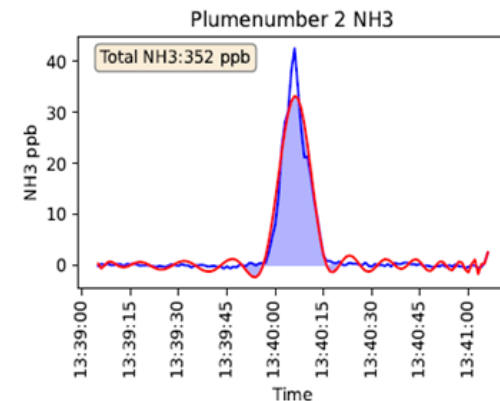
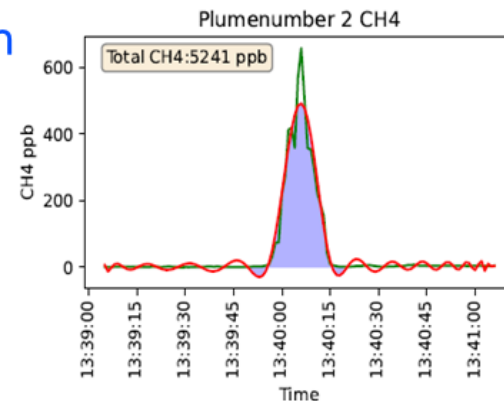
300 m

Thursday



175 m

Tuesday



Inside

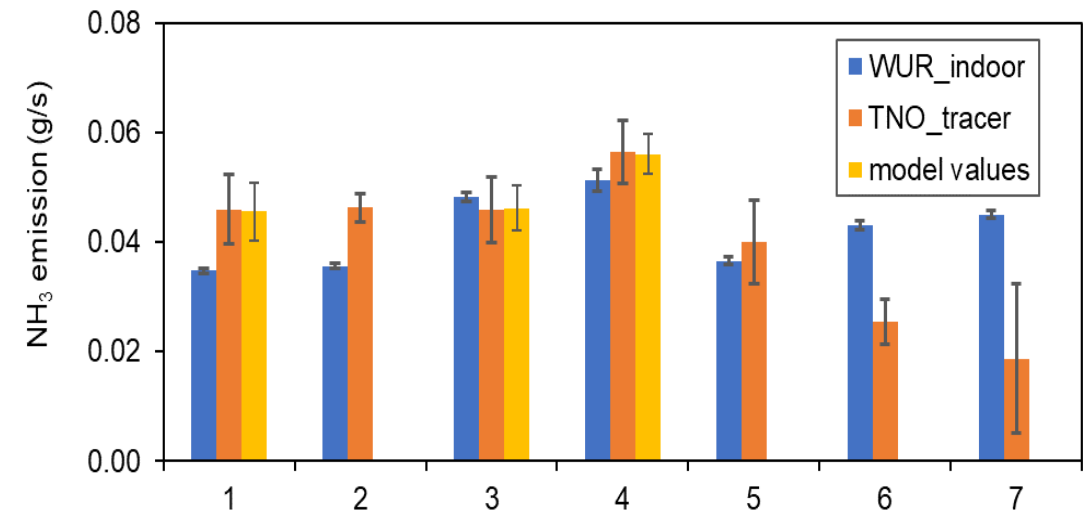
AERODYNE: CH₄ N₂O CO₂

Outside:

HT: NH₃



NH₃ emission during 3-day tracer release period



2024 campaign



VSL
TNO
VTI (Germany)
CEH (Scotland)
WLR

Special guests :
Oneplanet
RIVM

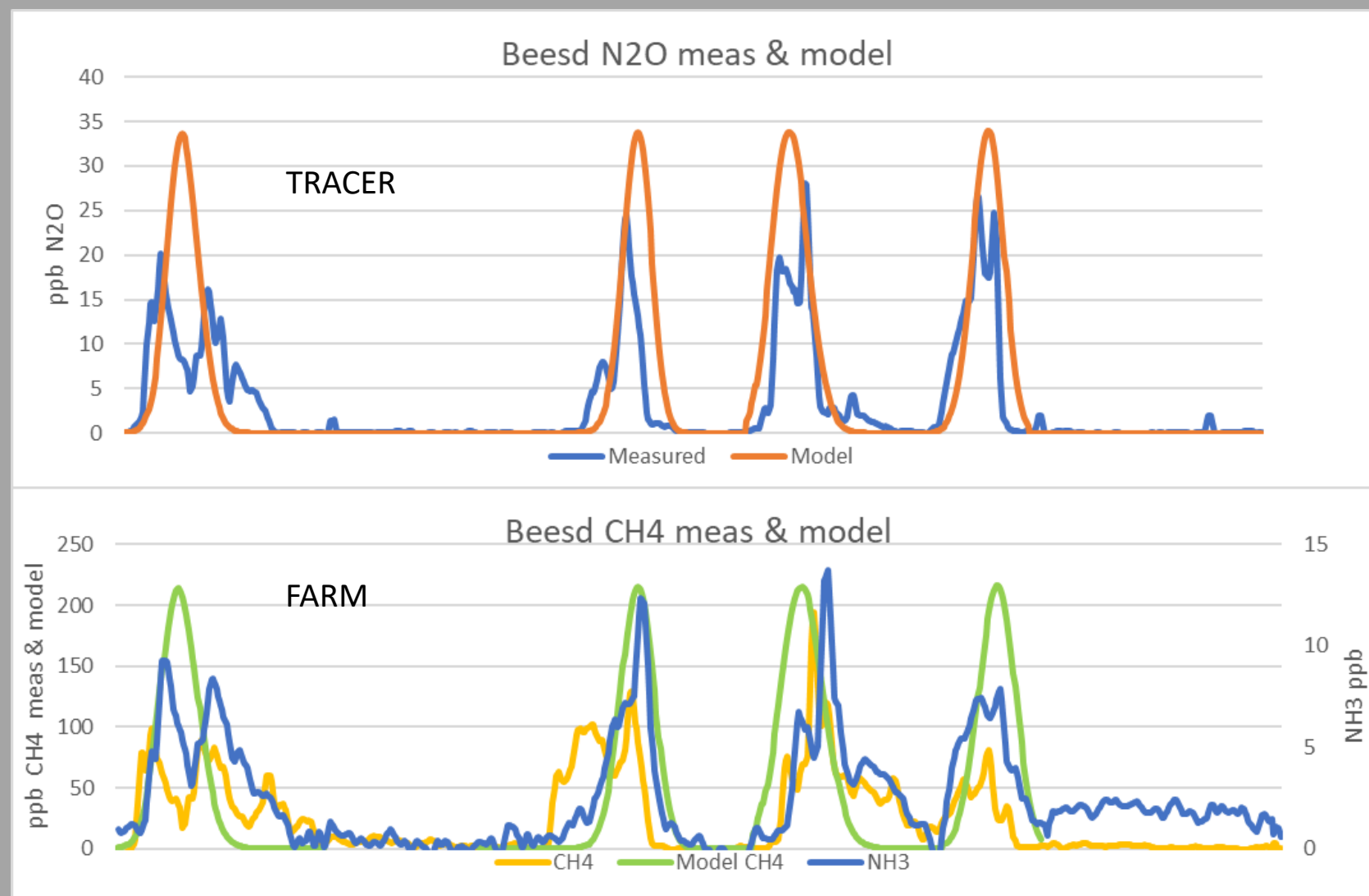


Gauss model

Farm 350 m away

CH₄ plumes 100ppb

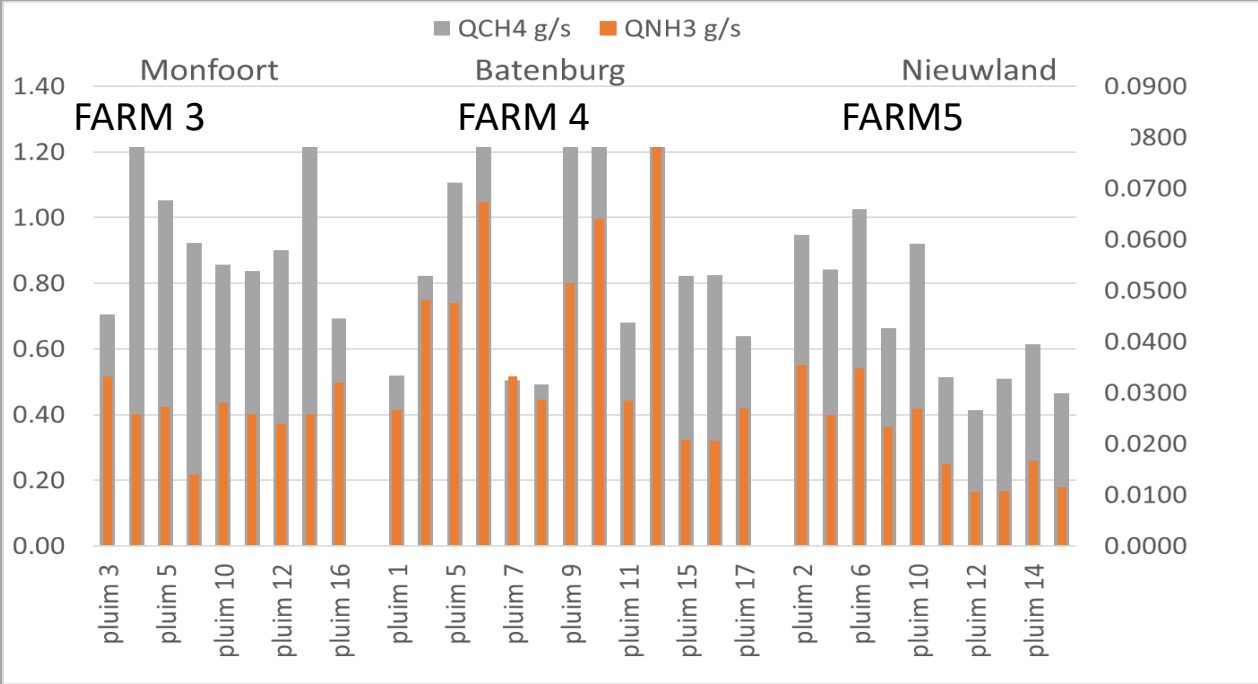
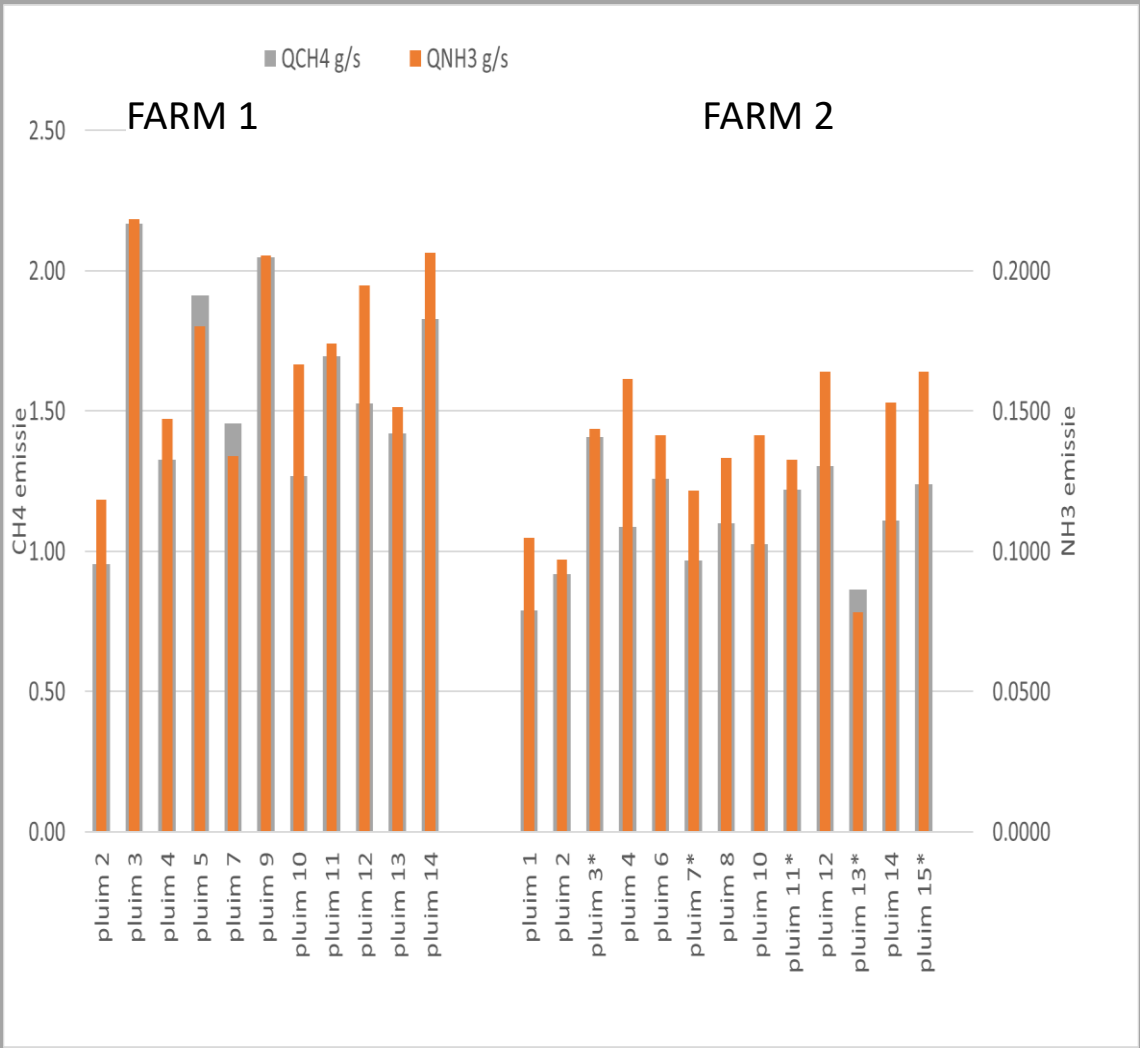
NH₃ plumes 10 ppb

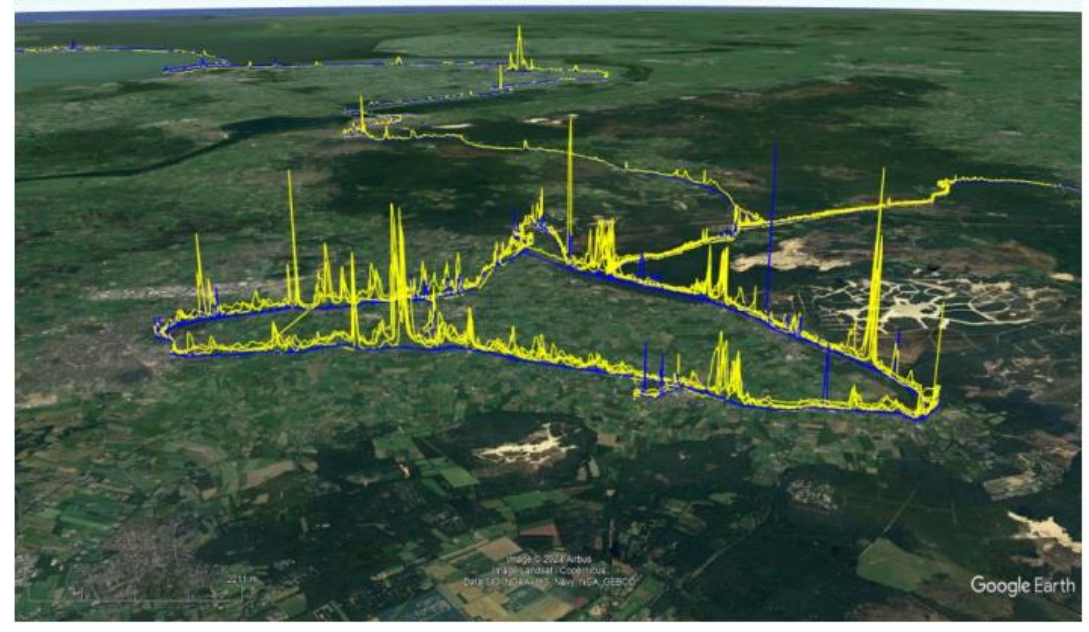
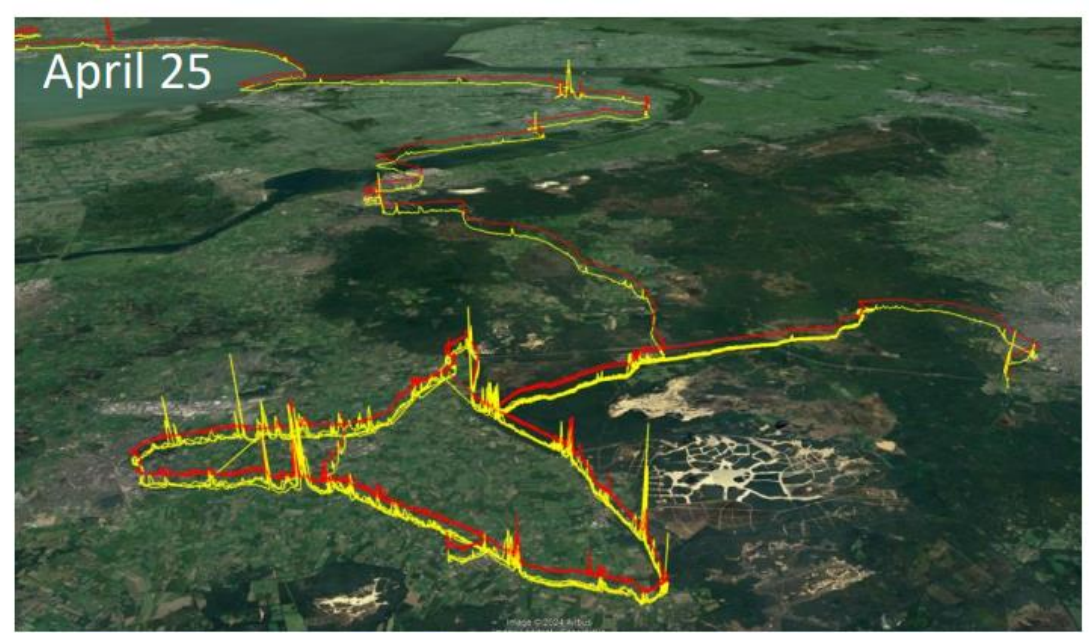
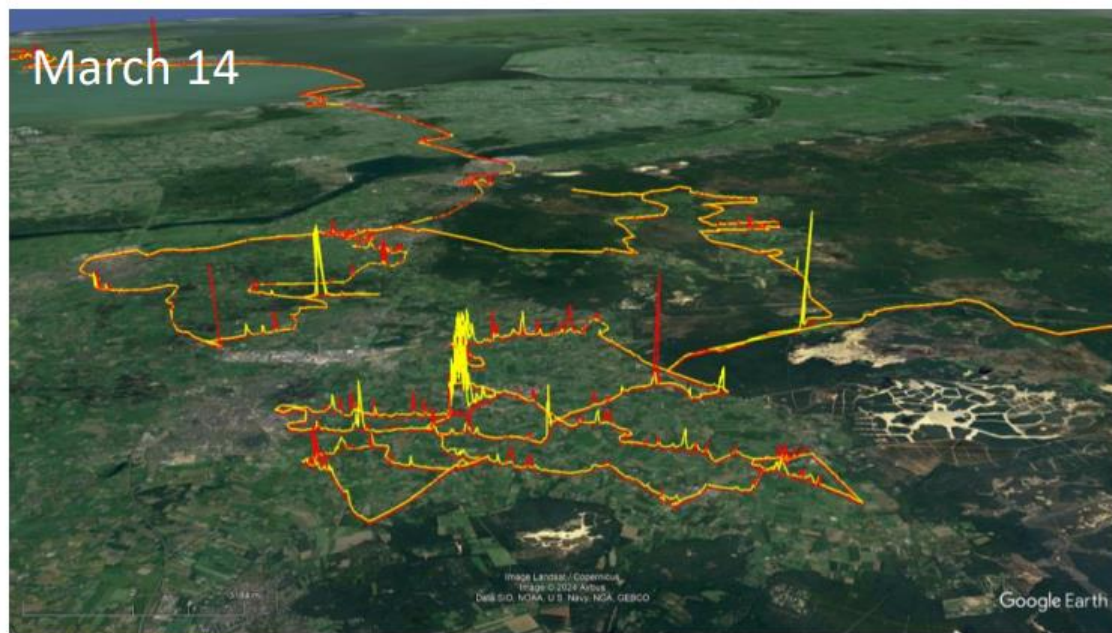


- $$C(x, y, z) = \frac{Q}{2\pi u \sigma_y \sigma_z} e^{\frac{-y^2}{(2\sigma_y)^2}} \left(e^{\frac{-(z-h_s)^2}{(2\sigma_z)^2}} + e^{\frac{-(z+h_s)^2}{(2\sigma_z)^2}} \right)$$

When you have more time at one farm

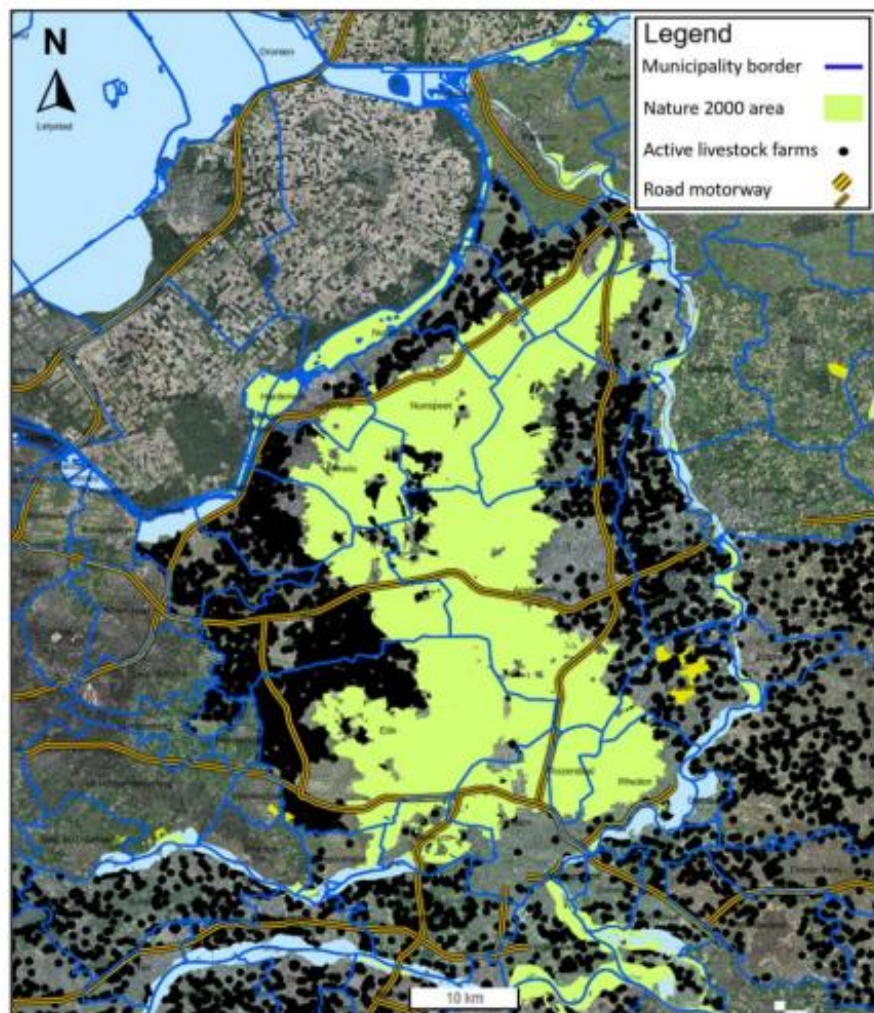
TAN project (RVO)
DMS,
Louis Bolk,
Leiden University,
Peter



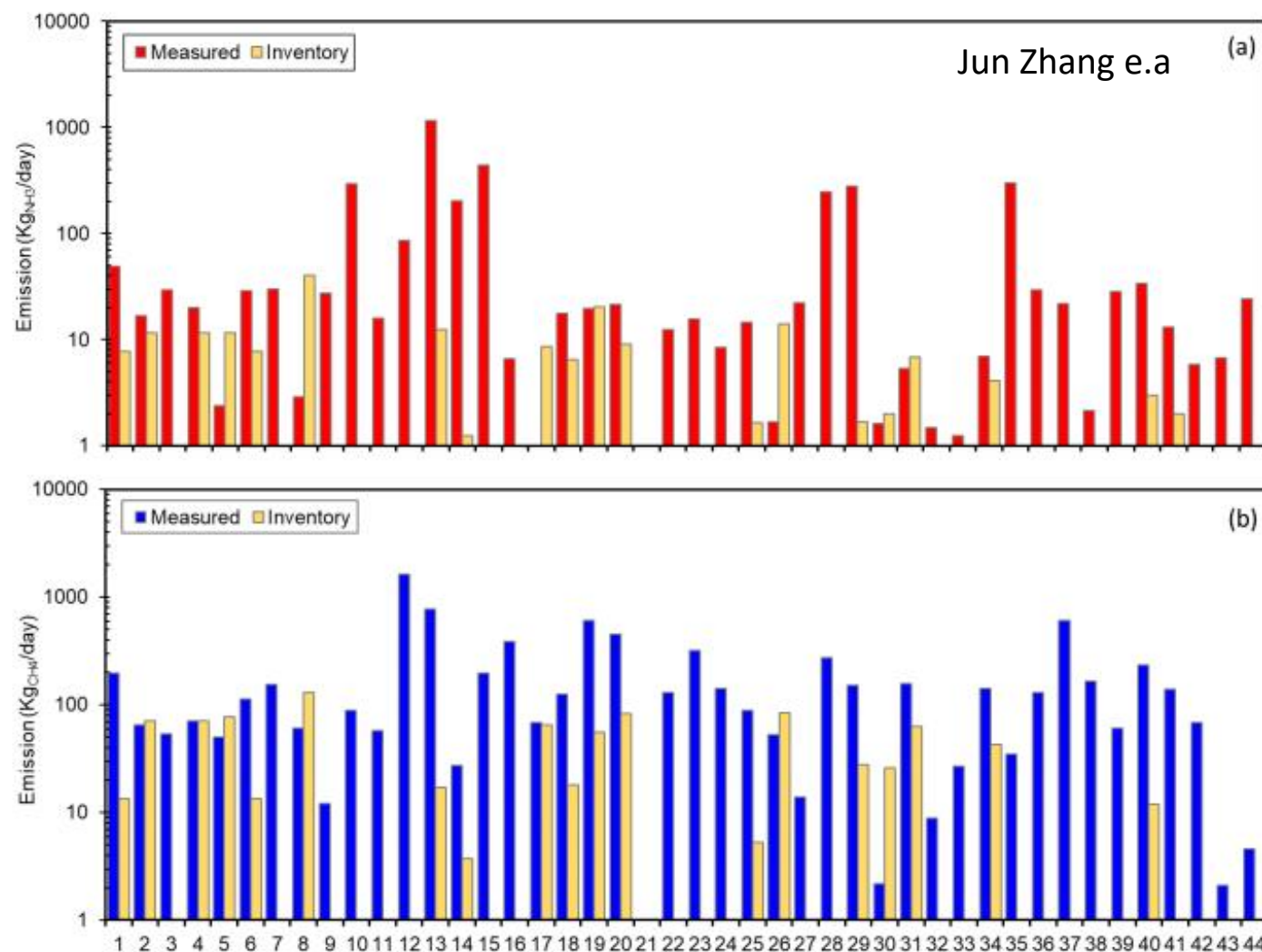


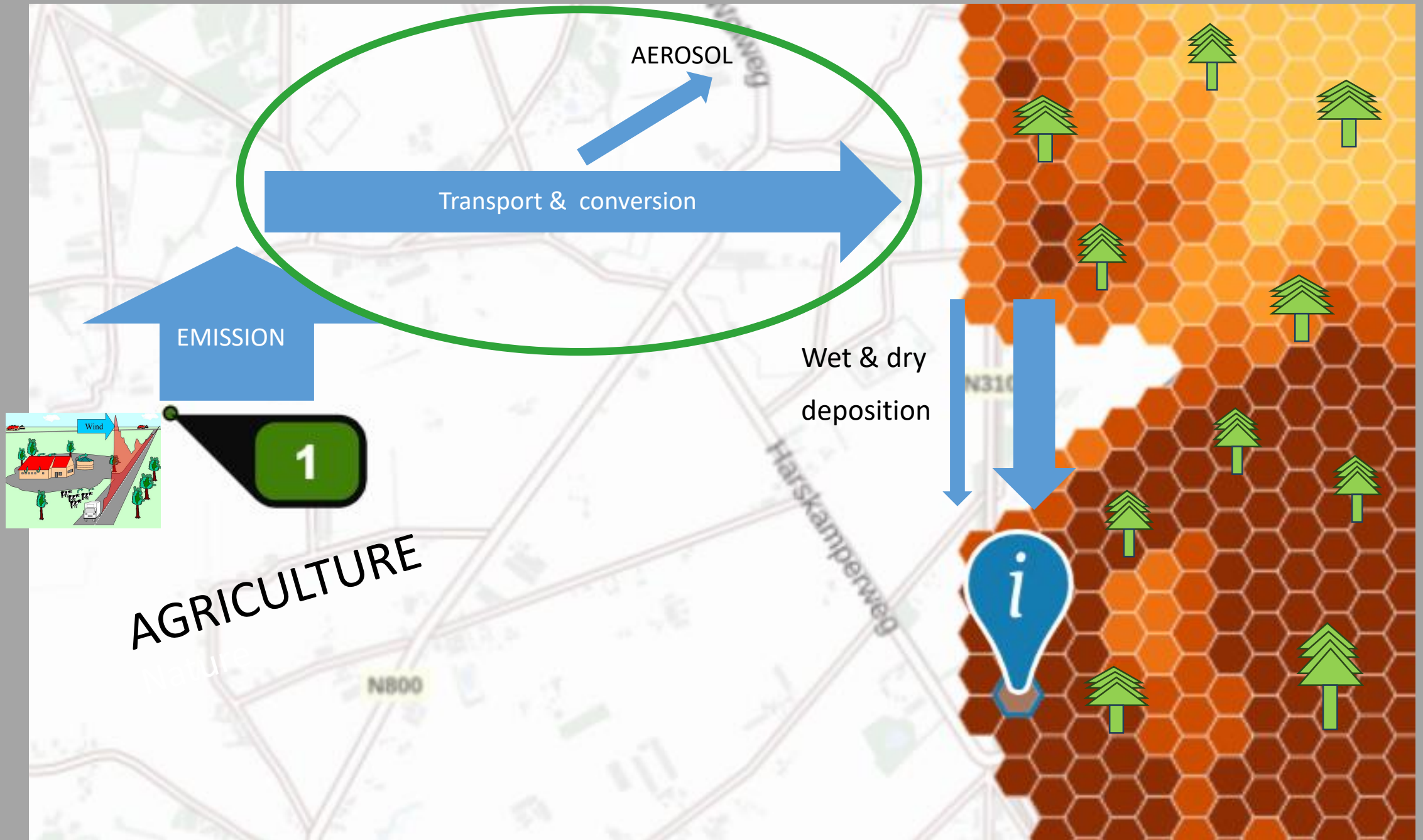
2023 emission inventory for Gelderland province

challenge is to distinguish individual sources on-road



KaartViewer - KRD (igoview.nl)

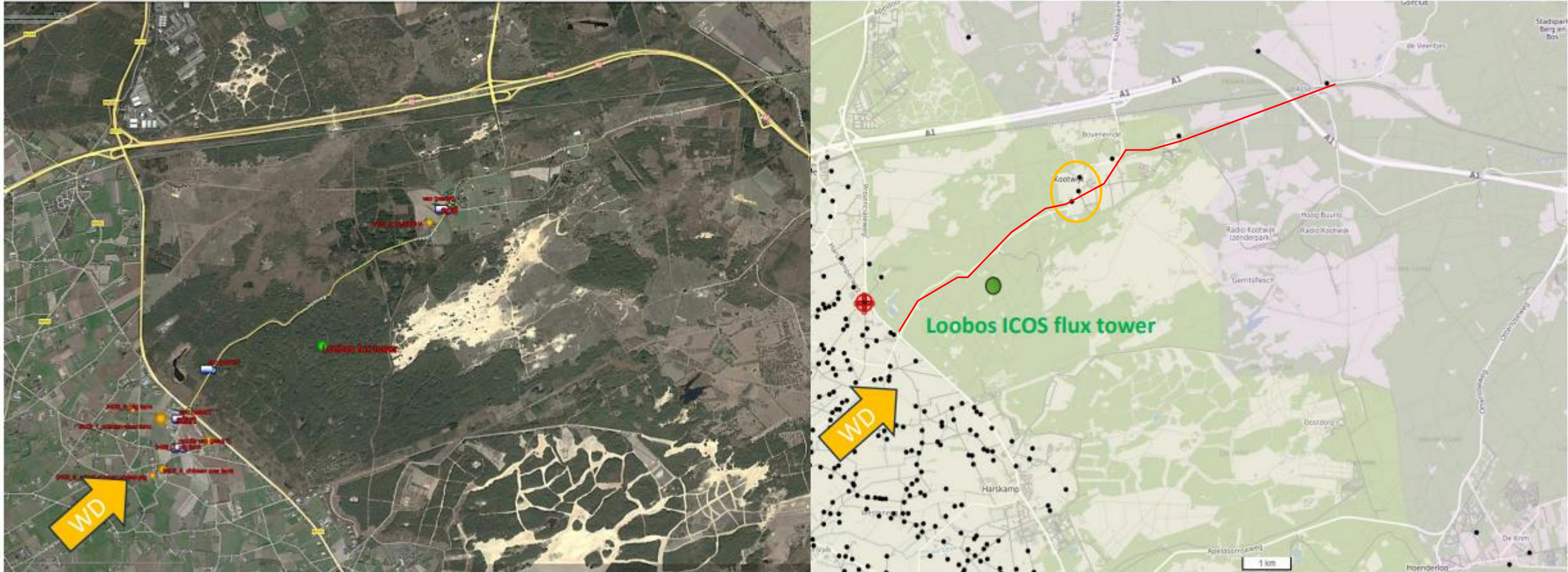




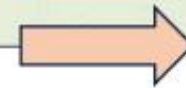
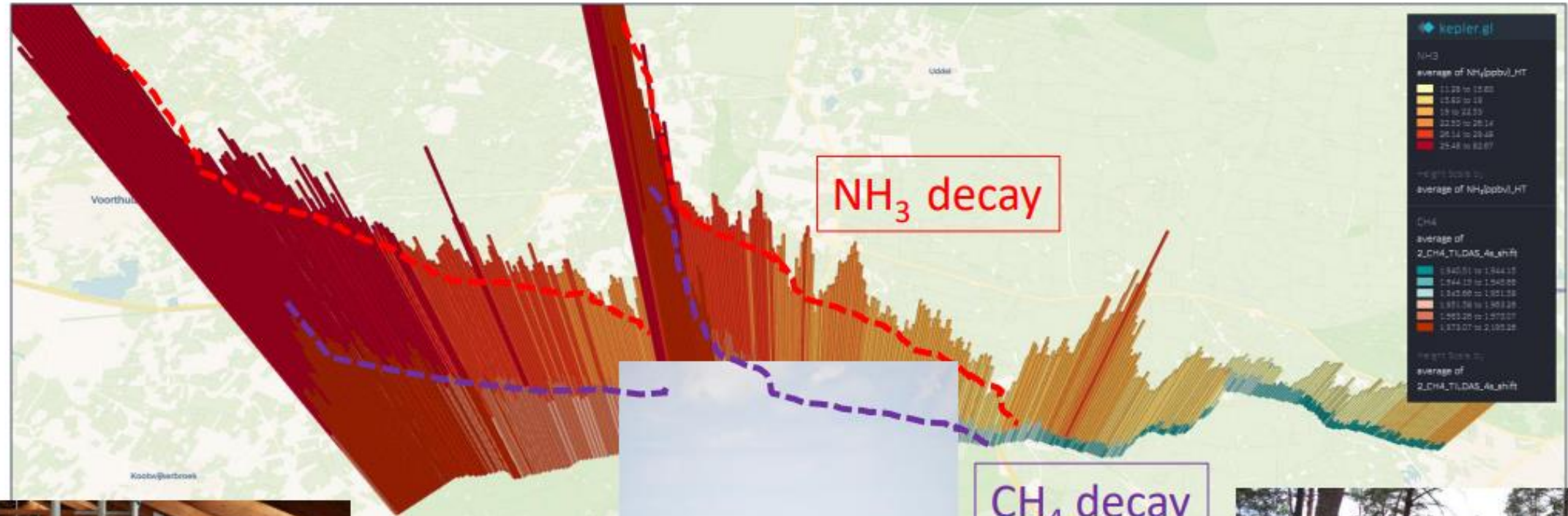




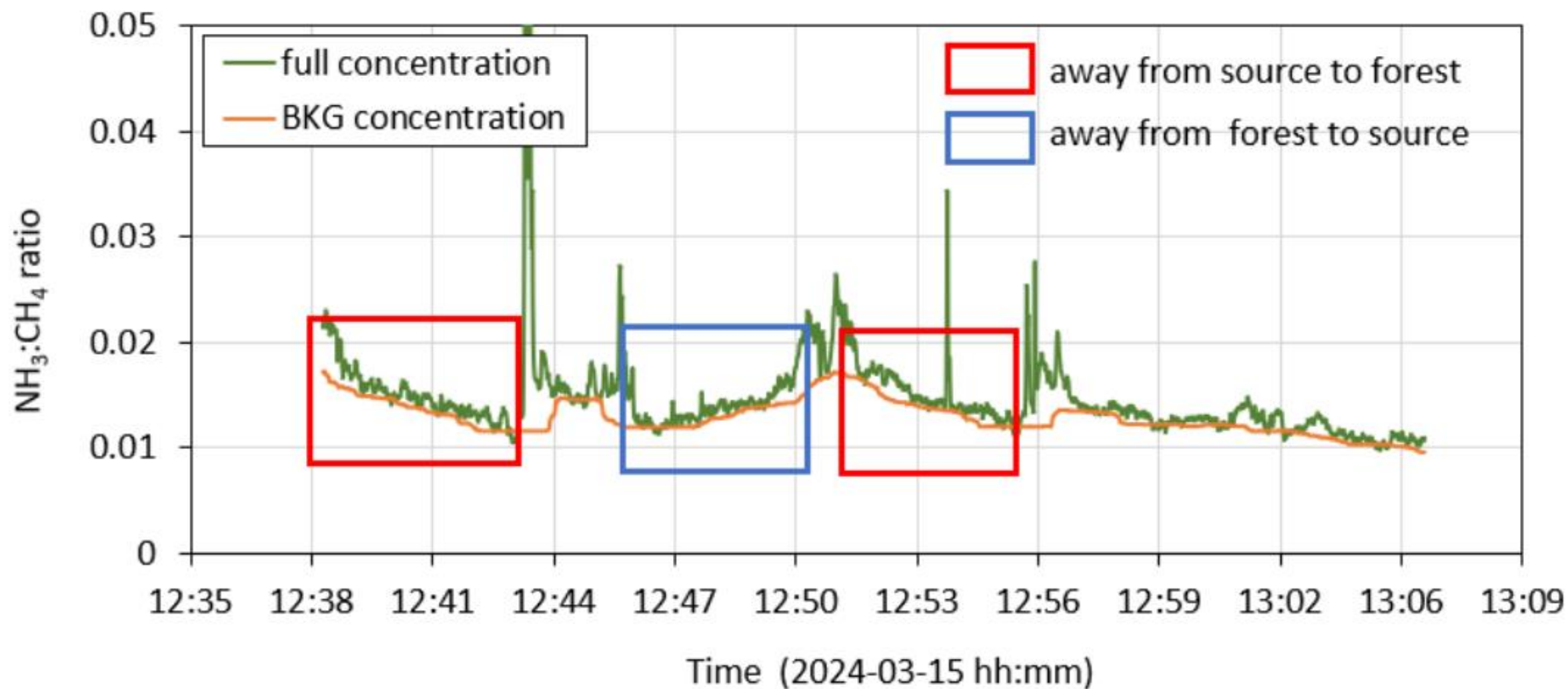
From emission to deposition:
when nature area is surrounded by livestock and traffic sources...

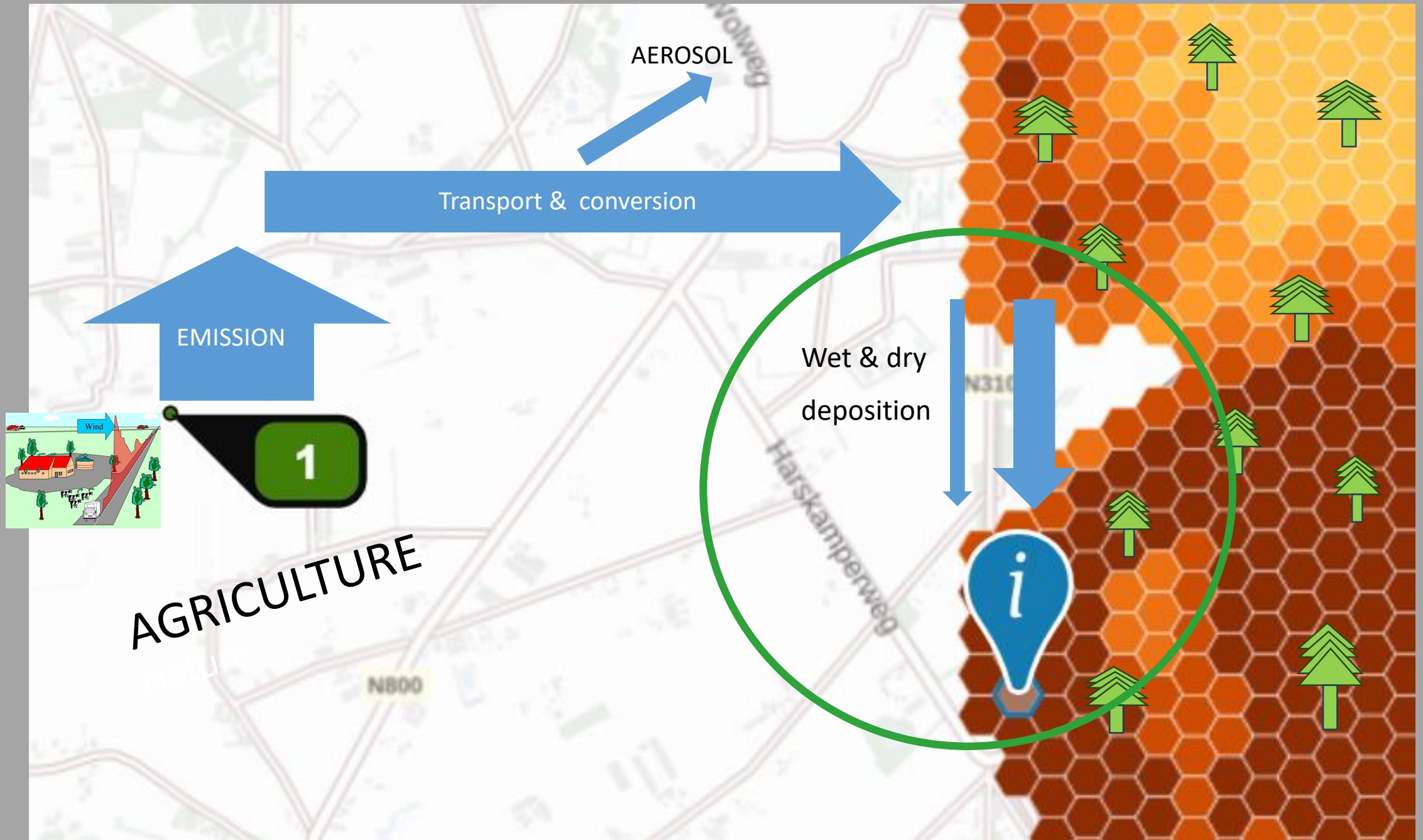


From source to forest -- $\text{NH}_3:\text{CH}_4$ ratio changes

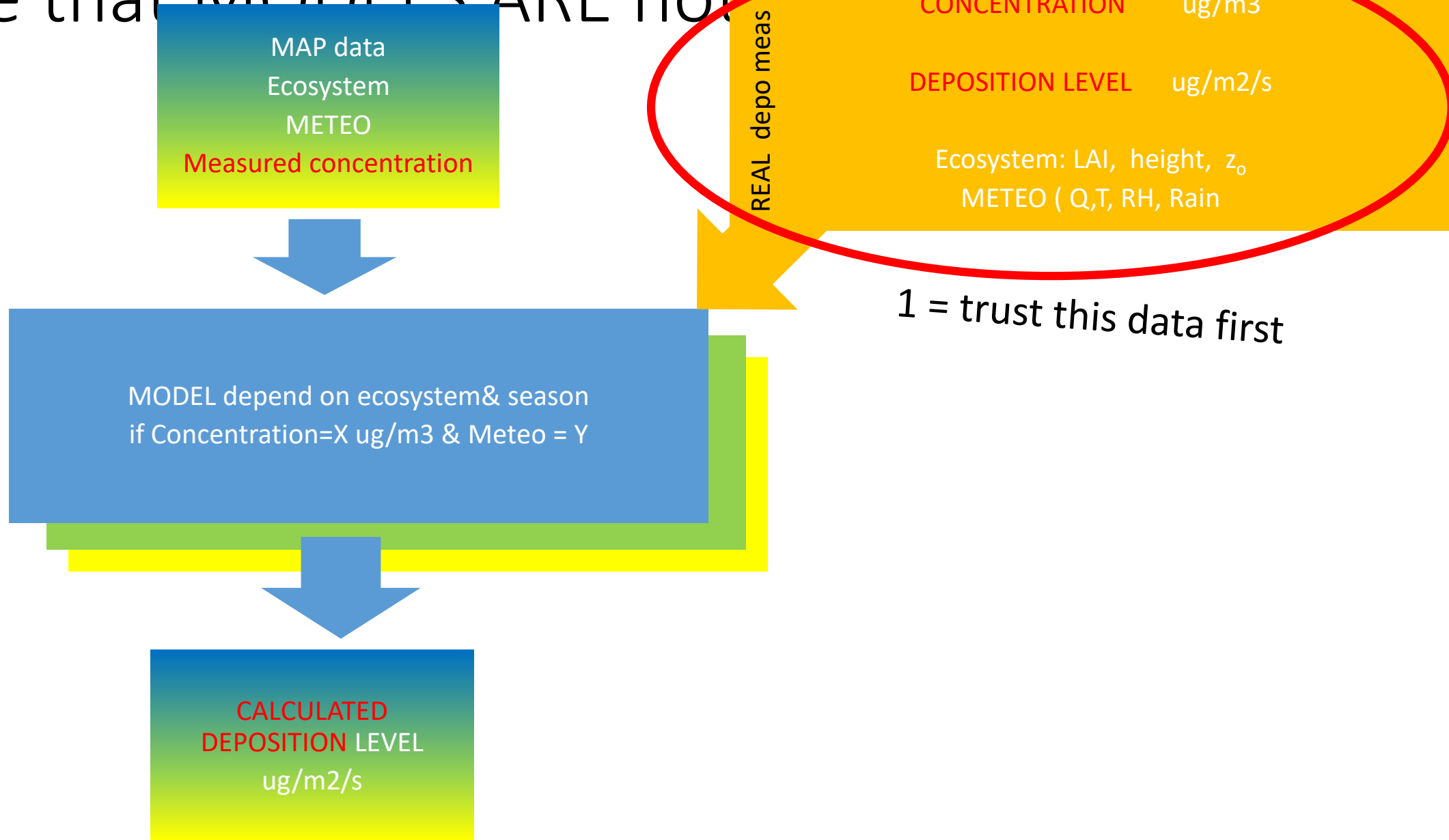


$\text{NH}_3:\text{CH}_4$ ratio changes in and out of forest area

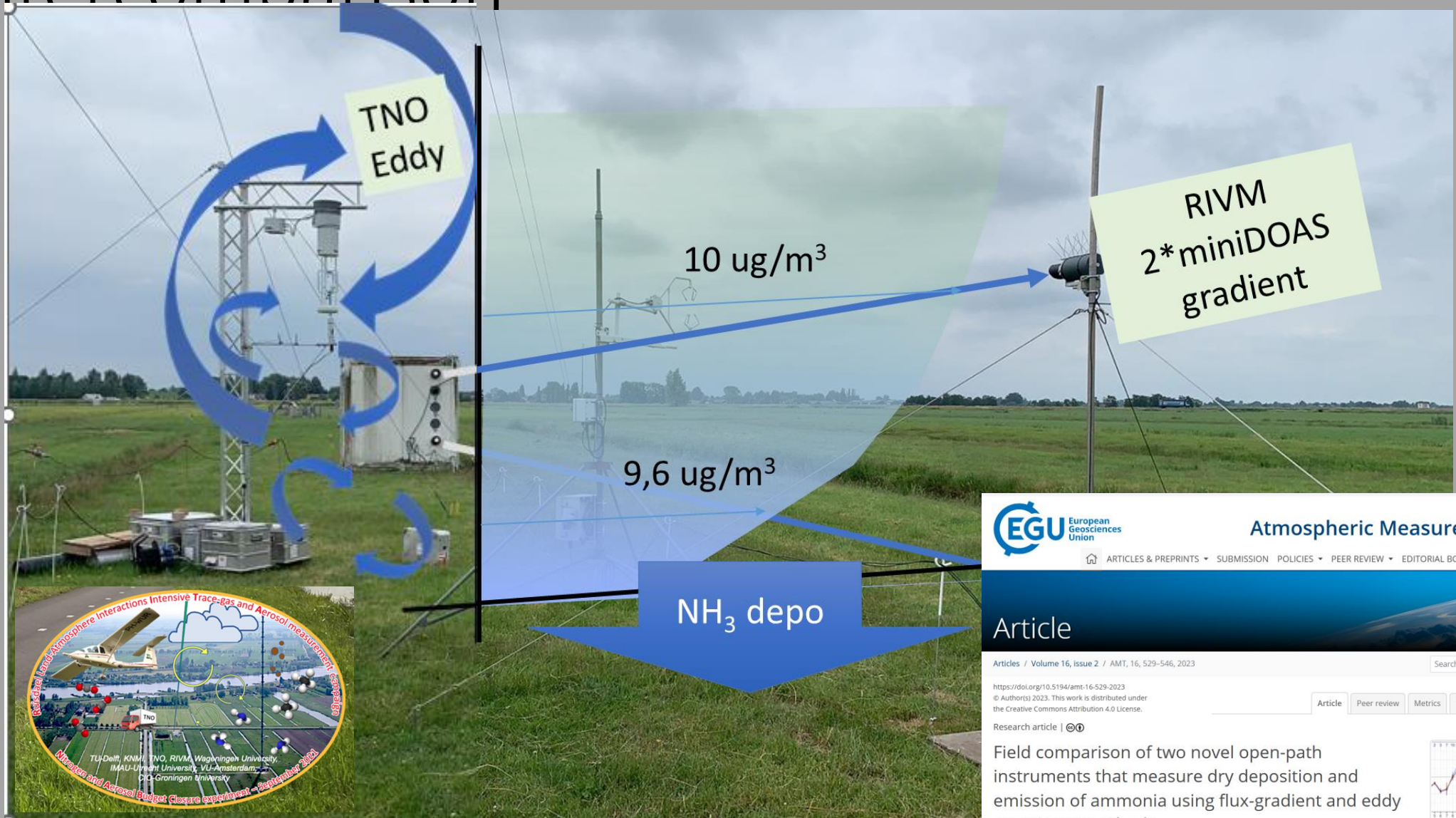




Prove that MODELS ARE not



STEP 1. (RIMA) HT –DOAS Cabauw intercomparison



CAN WE TRUST THE RULES ? 1 = CAN WE TRUST MEASUREMENT =OK

EGU European Geosciences Union

Atmospheric Measurement Techniques

ARTICLES & PREPRINTS SUBMISSION POLICIES PEER REVIEW EDITORIAL BOARD ABOUT EGU PUBLICATIONS

Article

Articles / Volume 16, Issue 2 / AMT, 16, 529–546, 2023

<https://doi.org/10.5194/amt-16-529-2023>
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Research article | ©

27 Jan 2023

Field comparison of two novel open-path instruments that measure dry deposition and emission of ammonia using flux-gradient and eddy covariance methods

Daan Swart, Jun Zhang, Shelley van der Graaf, Susanna Rutledge-Jonker, Arjan Hensen, Stijn Berkhout, Pascal Wintjen, René van der Hoff, Marty Haalima, Arnoud Frumau, Pim van den Bulk, Ruben Schulte, Margreet van Zanten, and Thomas van Goethem

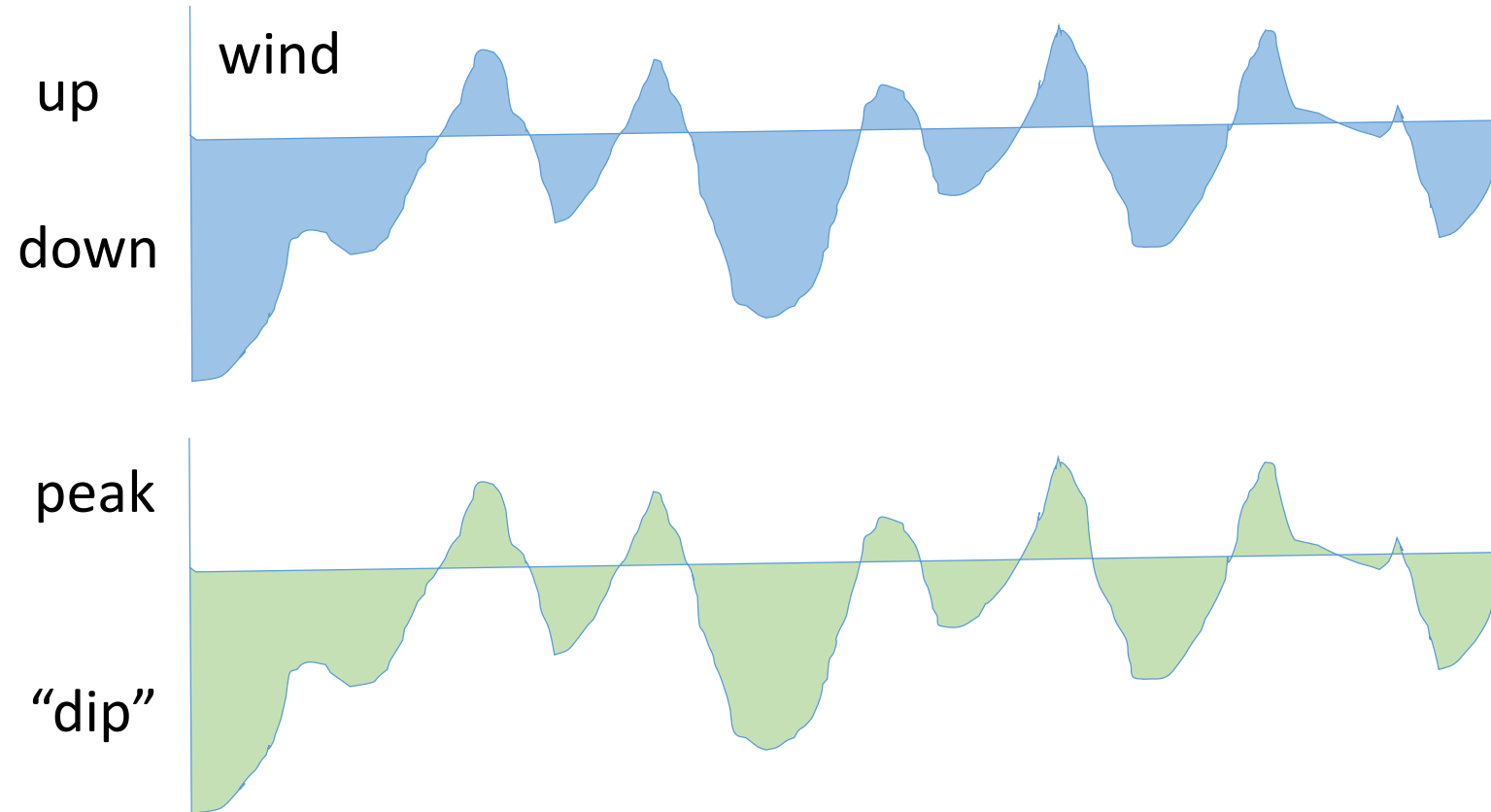
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EndNote

Short summary
During a 5-week comparison campaign, we tested two set-ups to measure half hourly ammonia...

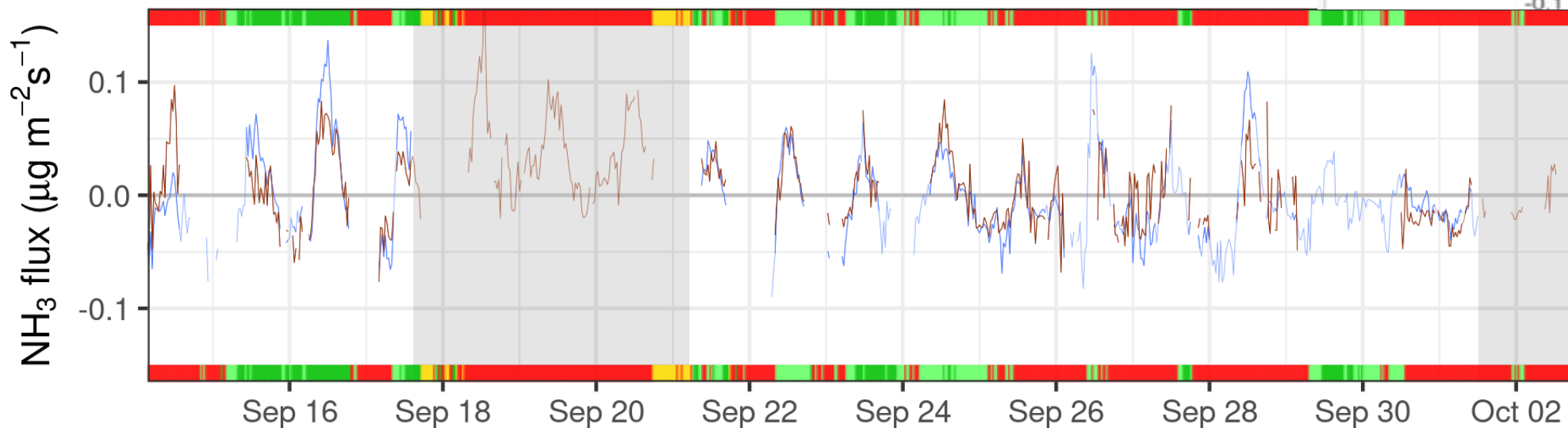
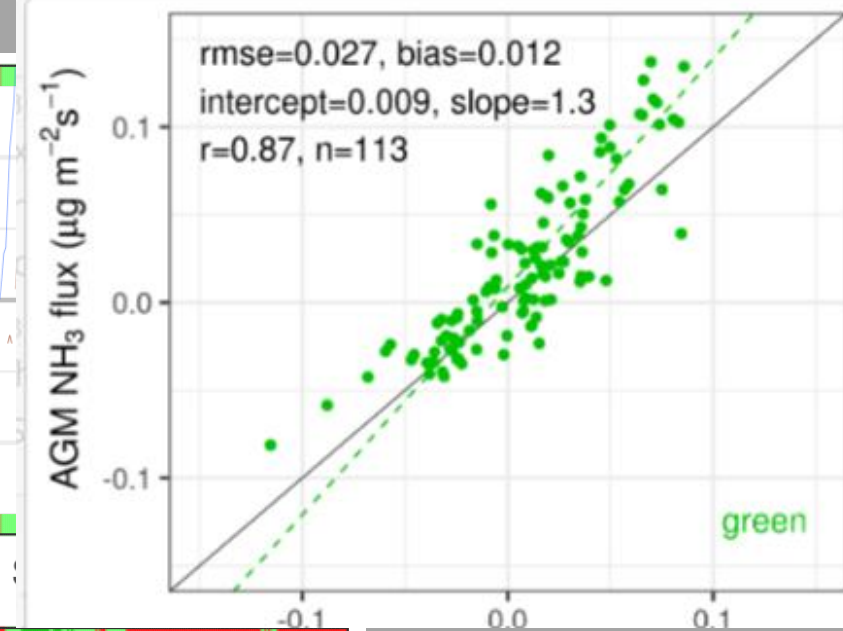
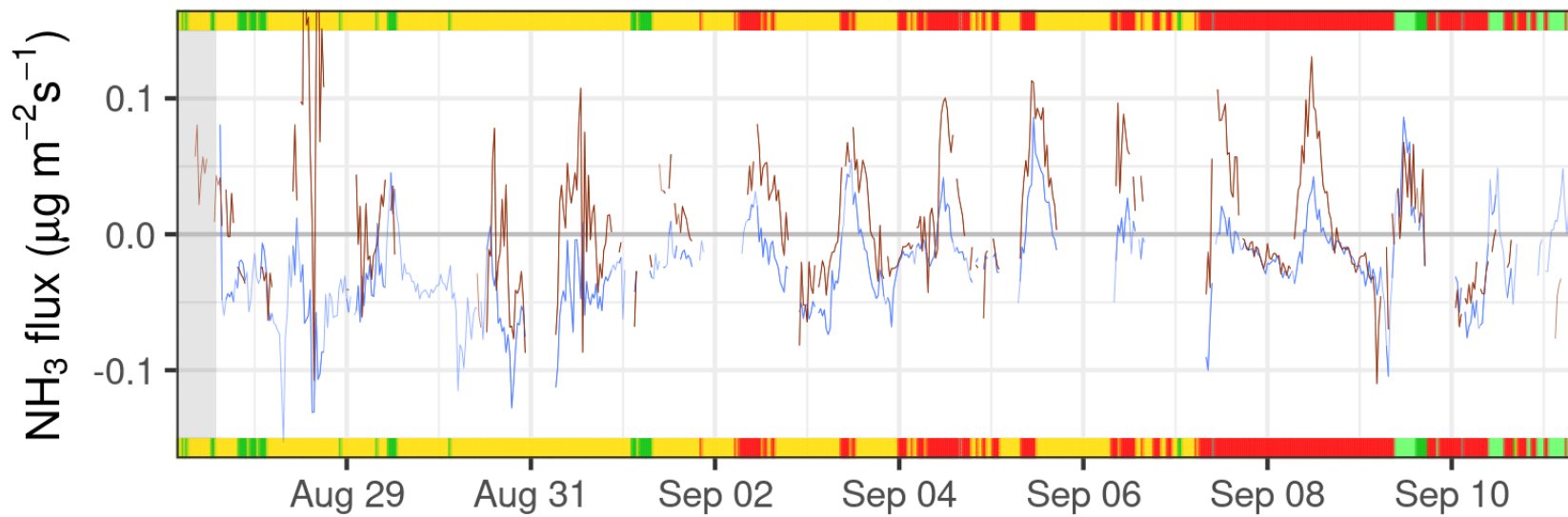
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Eddy Correlation (EC)



Correlate = emission



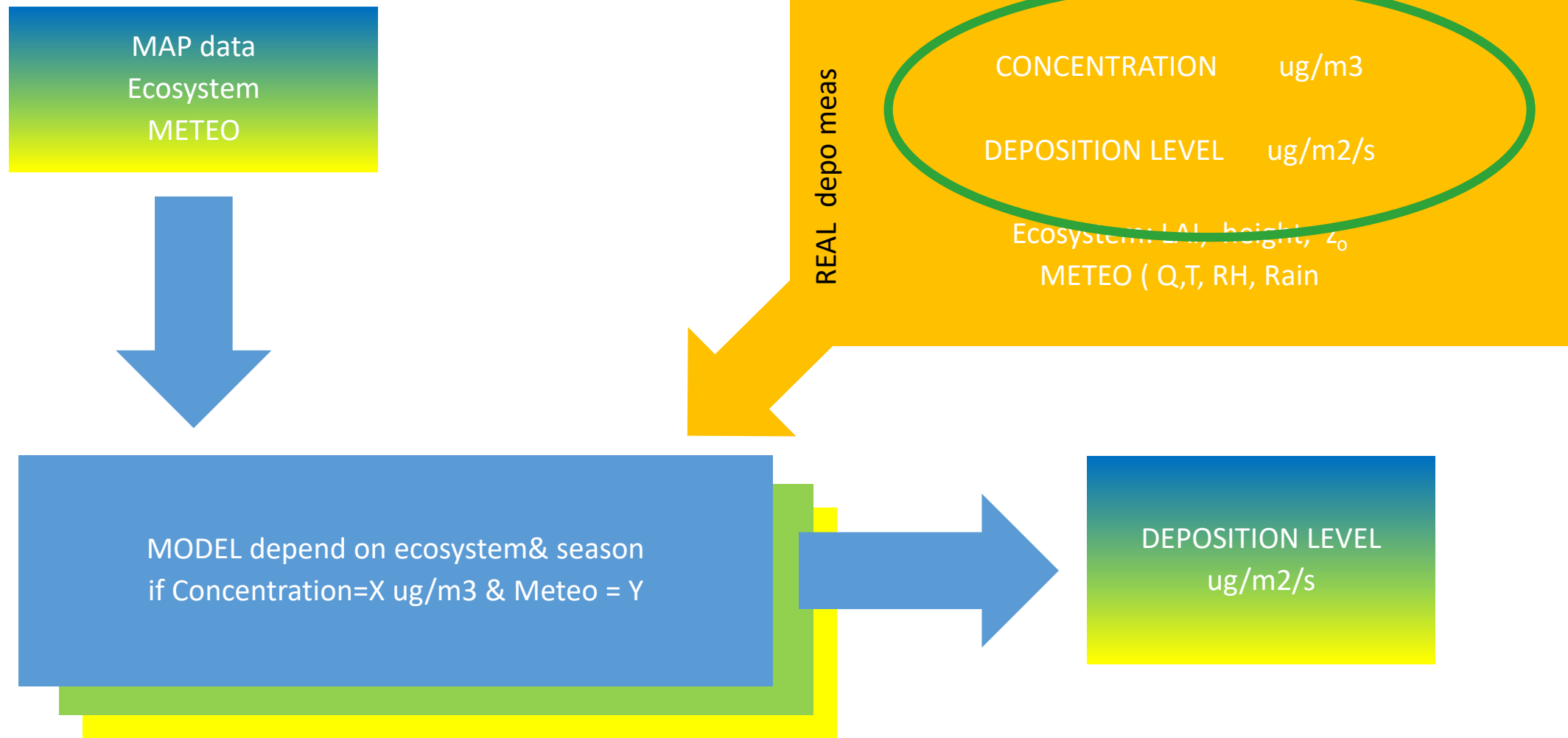
— AGM — EC cross parallel

HT	MiniDoas
EC	Gradient
IR	UV
POINT	20m path

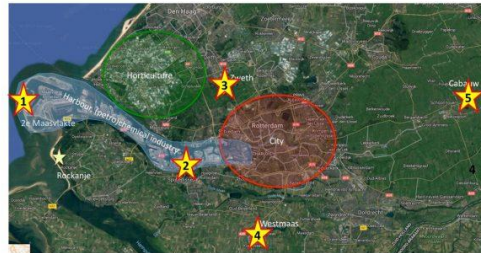
OK

But too short for parametrisation

Prove that MODELS ARE not LOUZY



NL RUISDAEL program



Ruisdael Rotterdam
Observational stations

1. Slufter, 2e Maasvlakte (RUG, TNO, DCMR)
2. Geulhaven (KNMI, DCMR)
3. De Zweth (TNO)
4. Westmaas (TNO, RIVM)
5. Cabauw ICOS station

Image: Google Earth



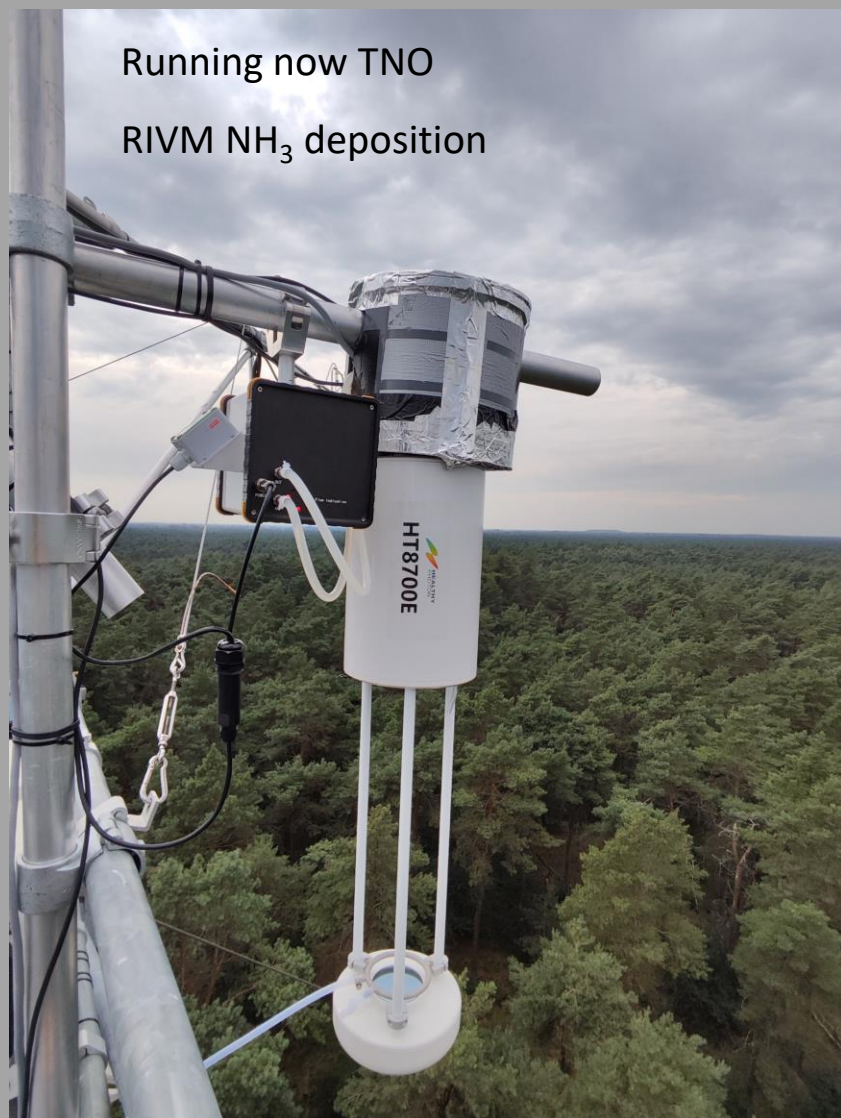
Ruisdael Urban-Atmosphere Interactions Intensive Trace-gas and Aerosol Measurement Campaign

Rotterdam 2022



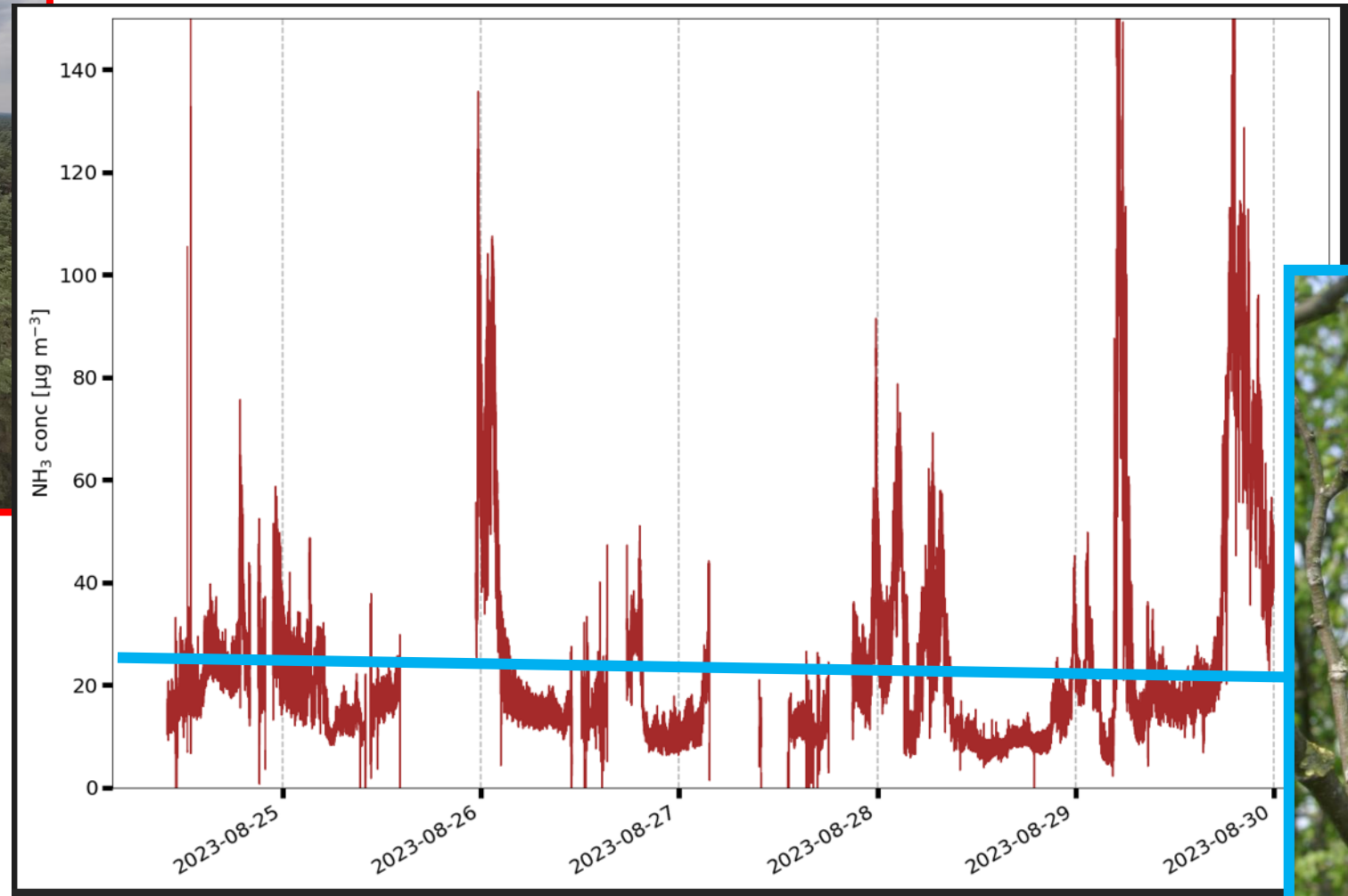
Loobos site

ICOS FLUX LEVEL 2 site



>25 years of CO₂ flux data !!!

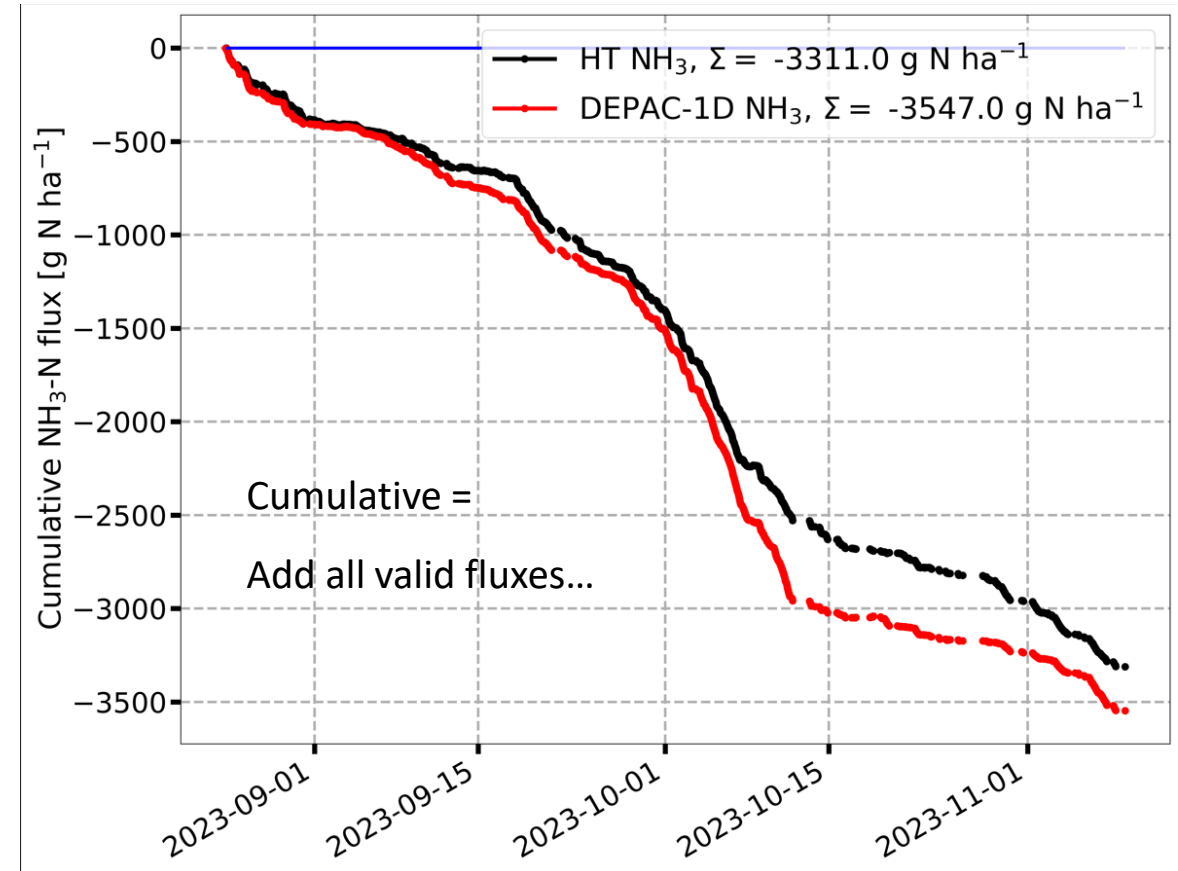
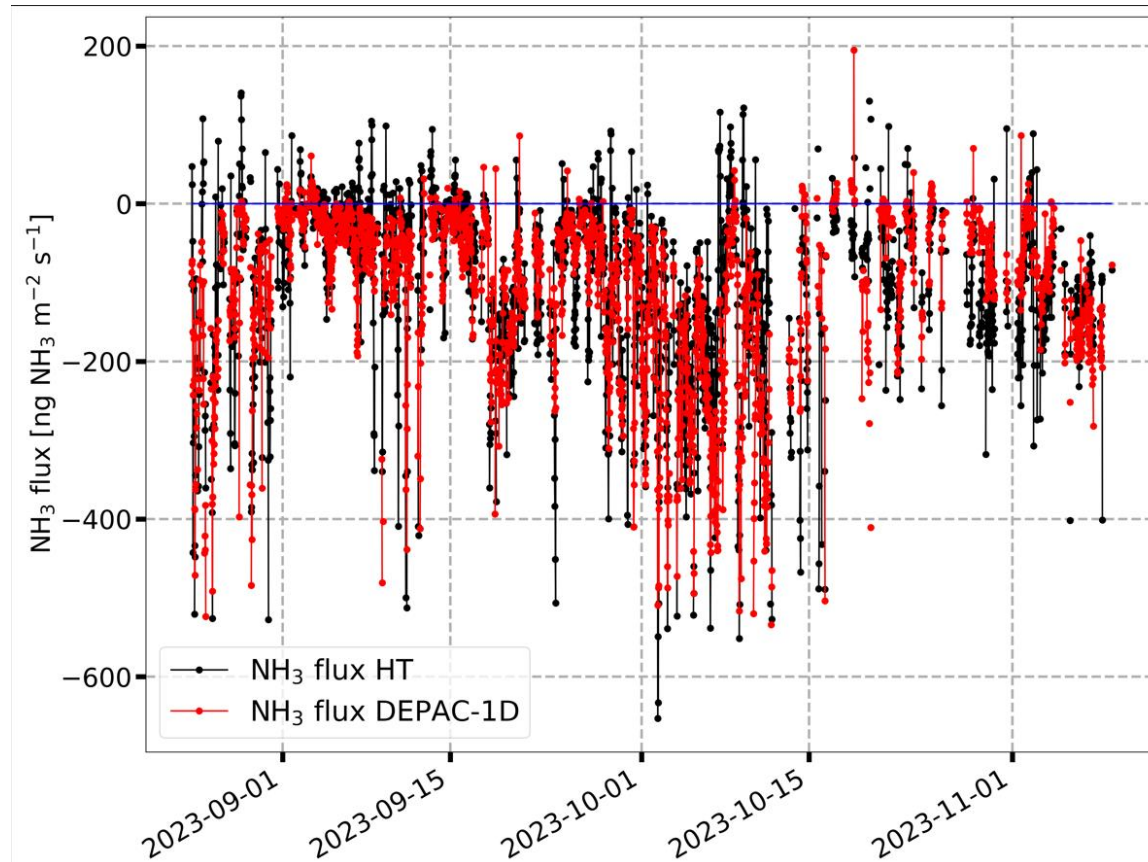
CONCENTRATION PATTERN



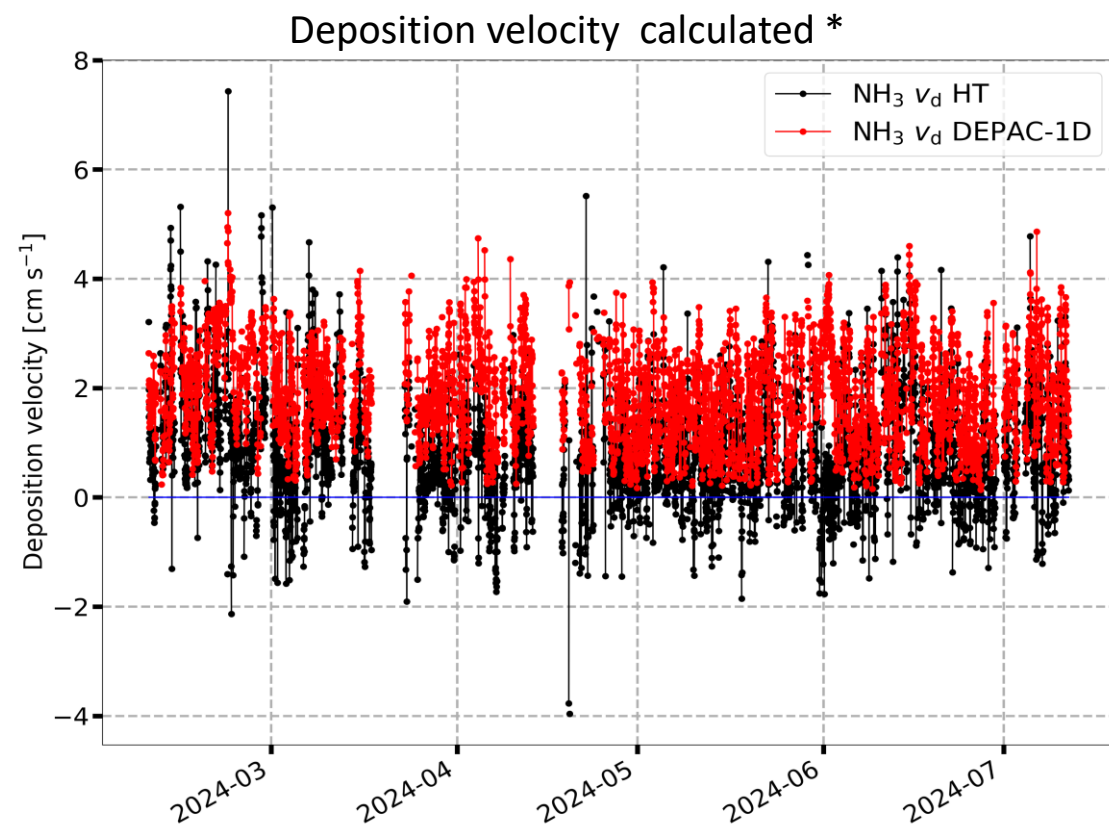
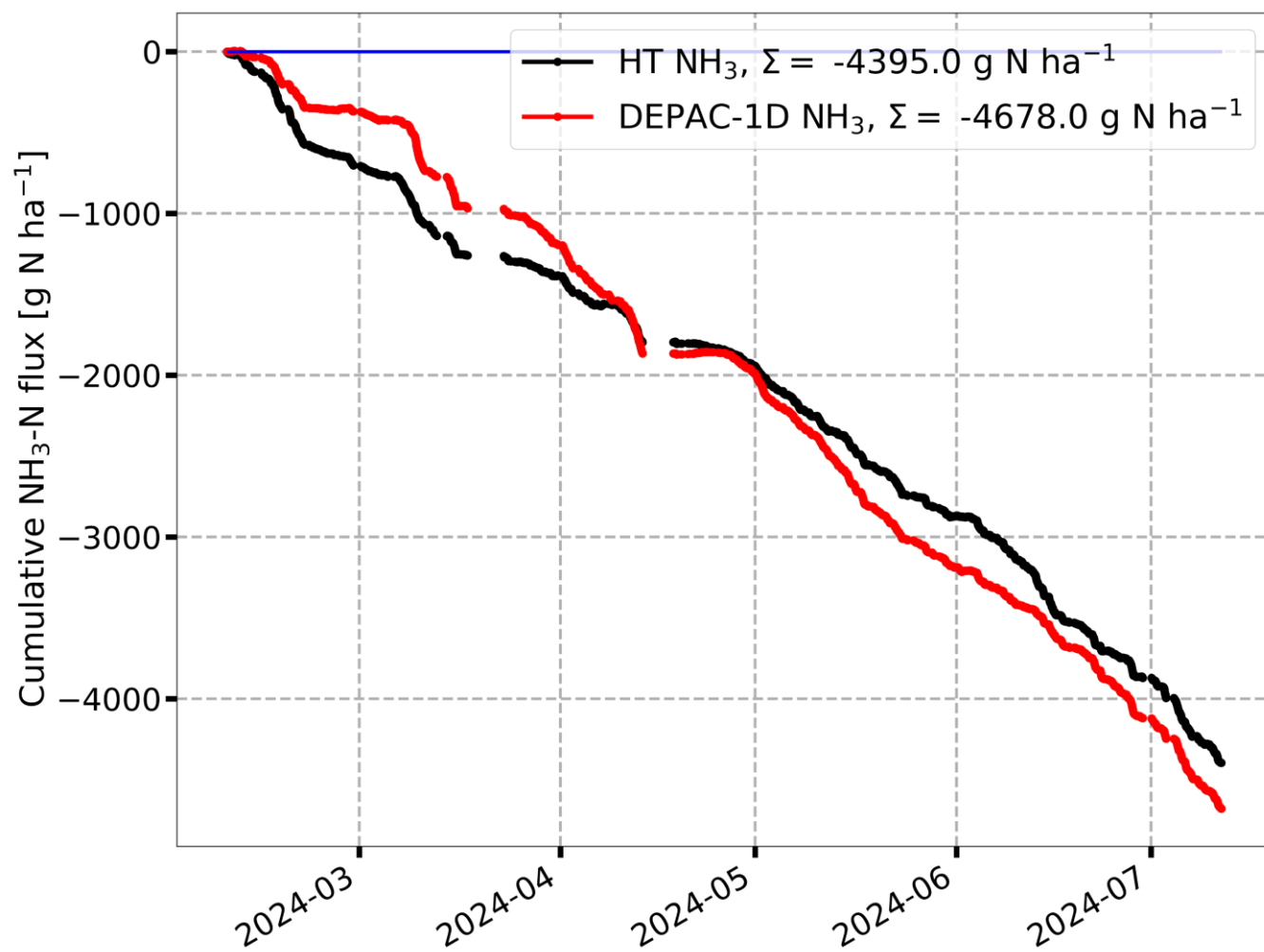
Add in 2023

HT-NH₃ open path instrument

RESULT LOOBOS 2023

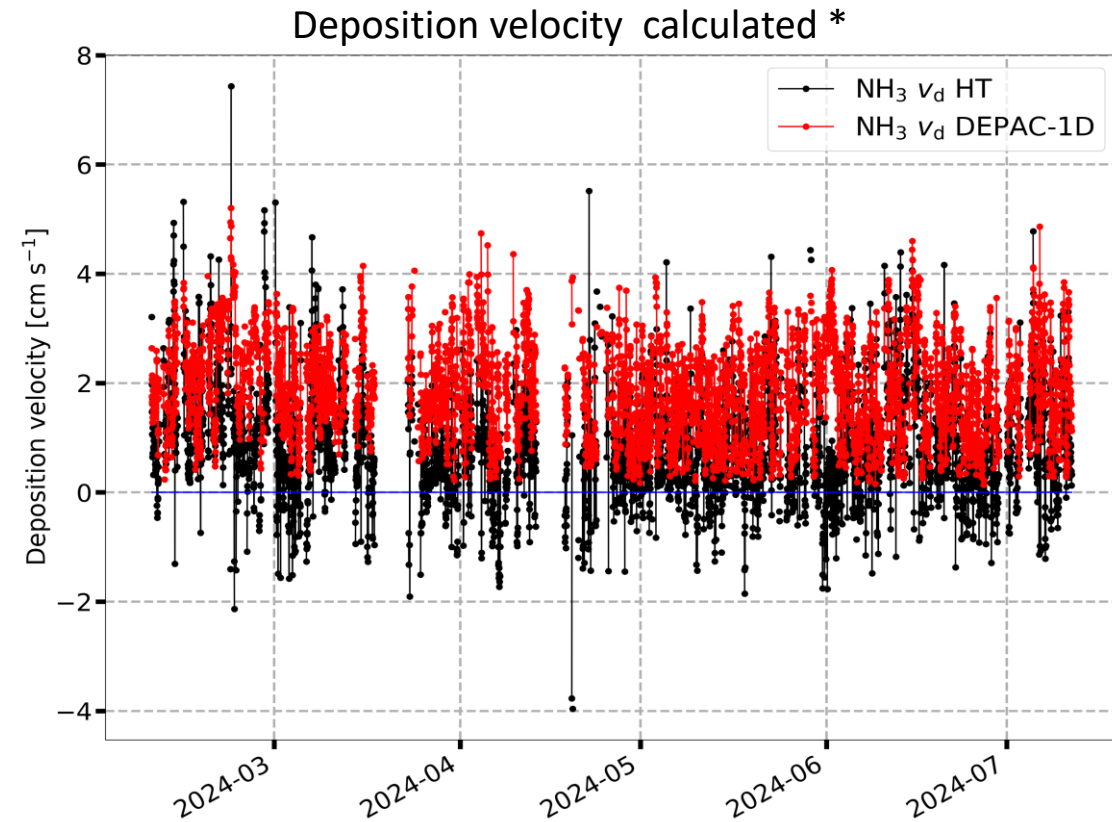
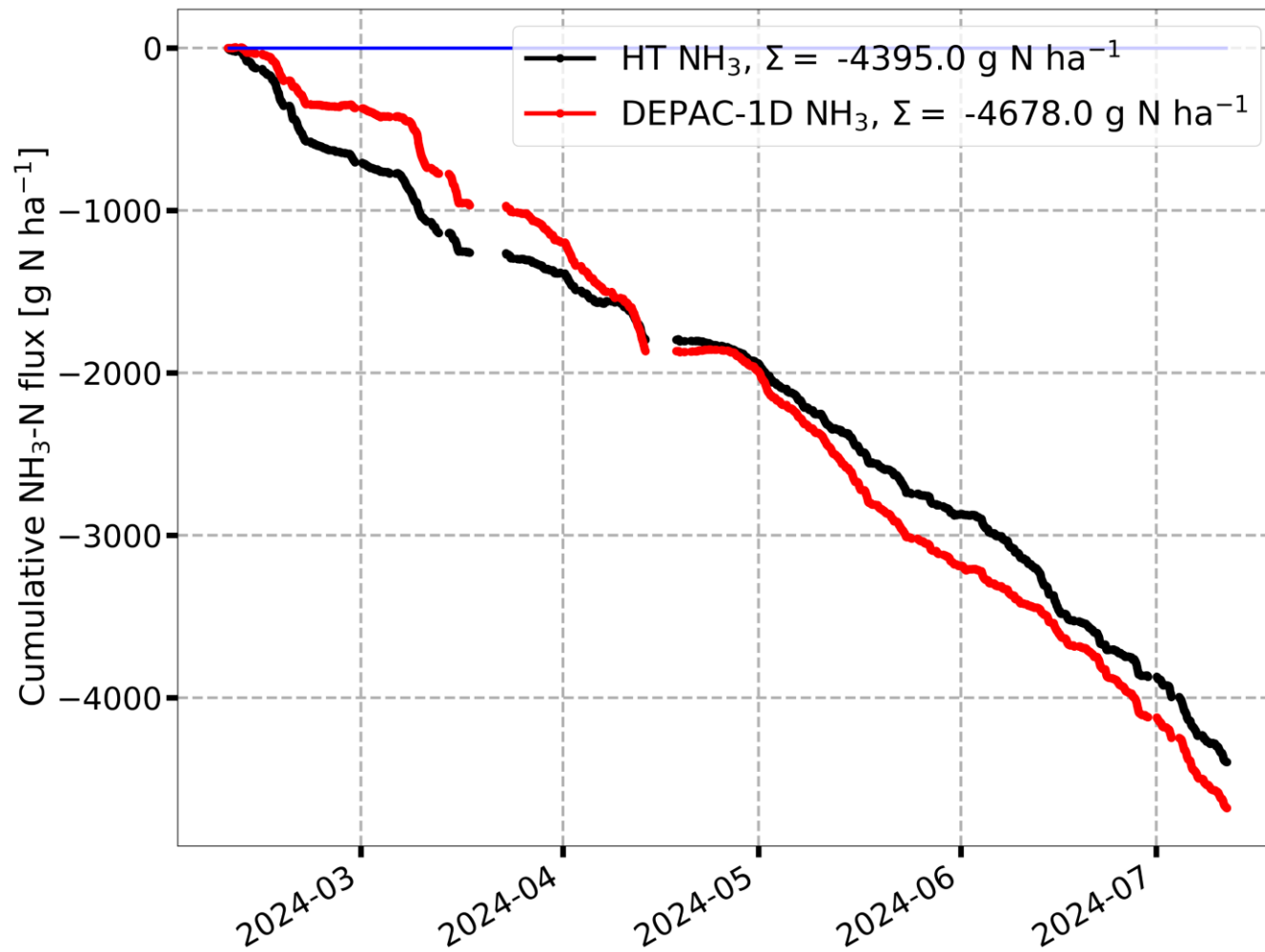


2024



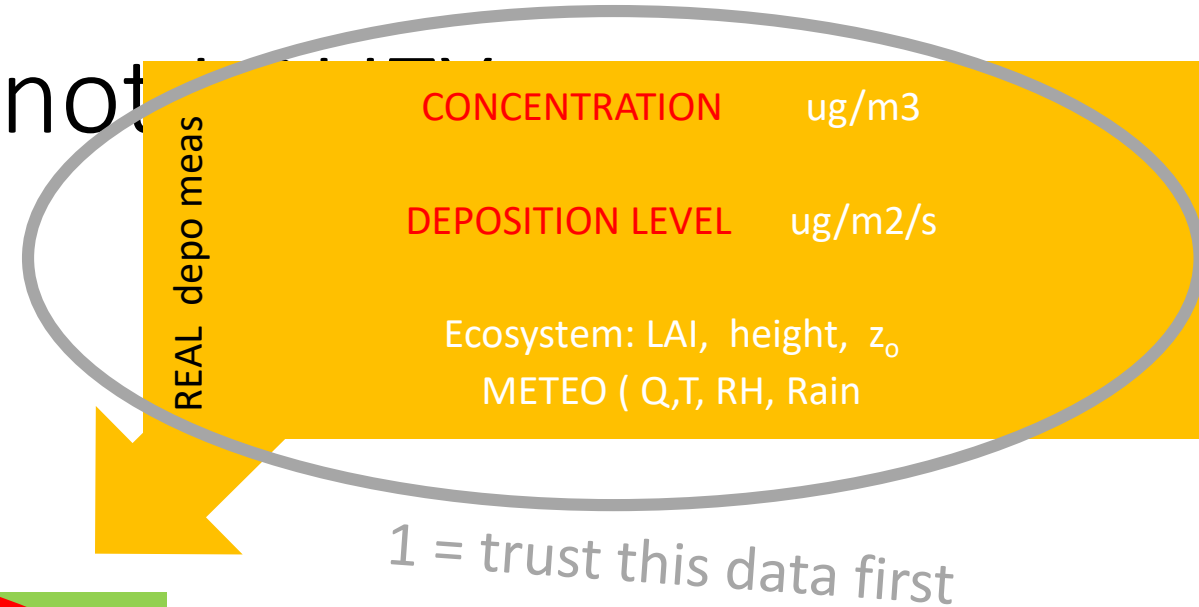
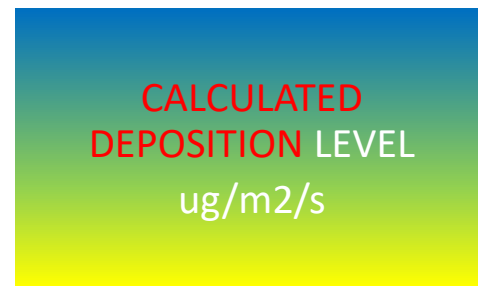
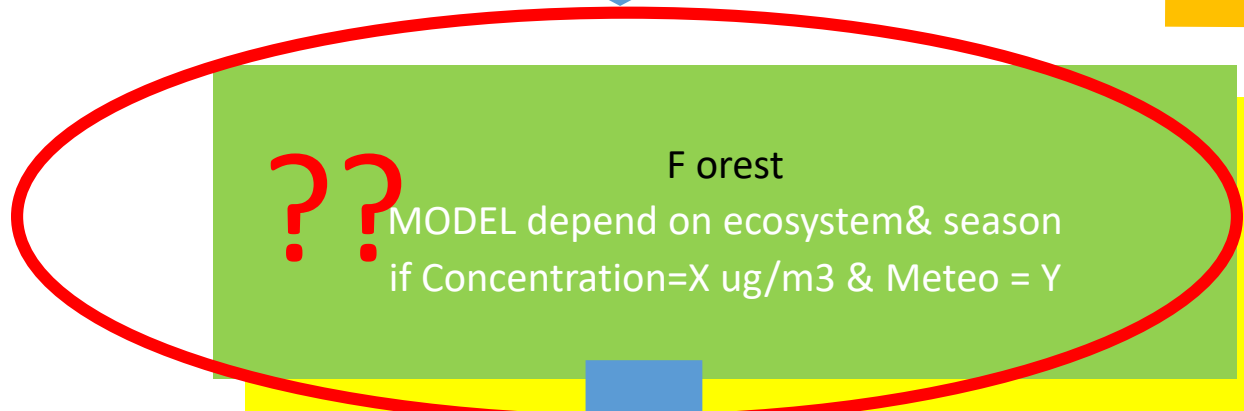
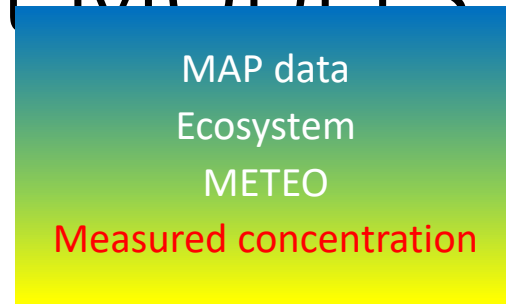
* HT calibrated versus DOAS

2024 Right for the wrong reason? → working on that



* HT calibrated versus DOAS

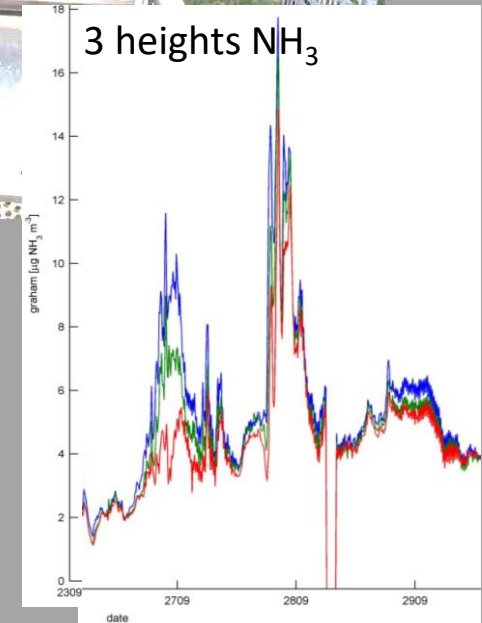
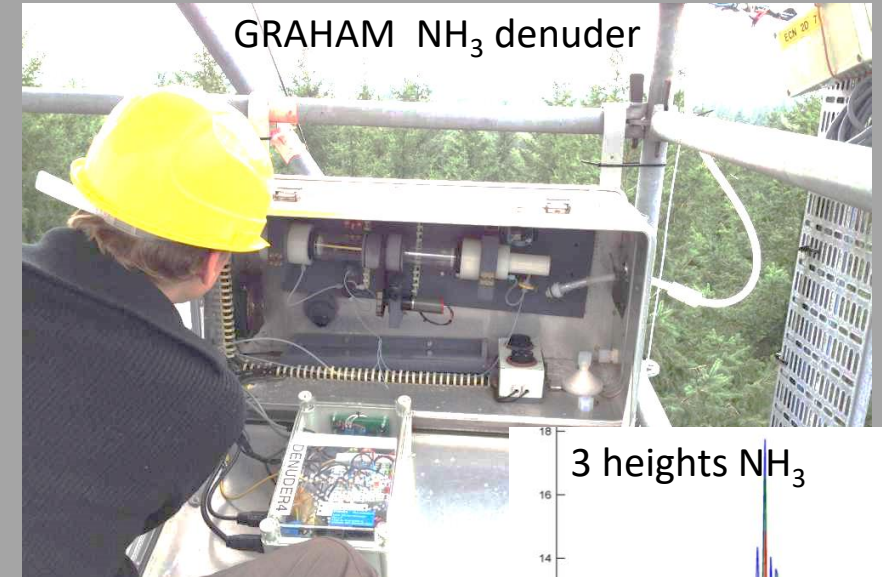
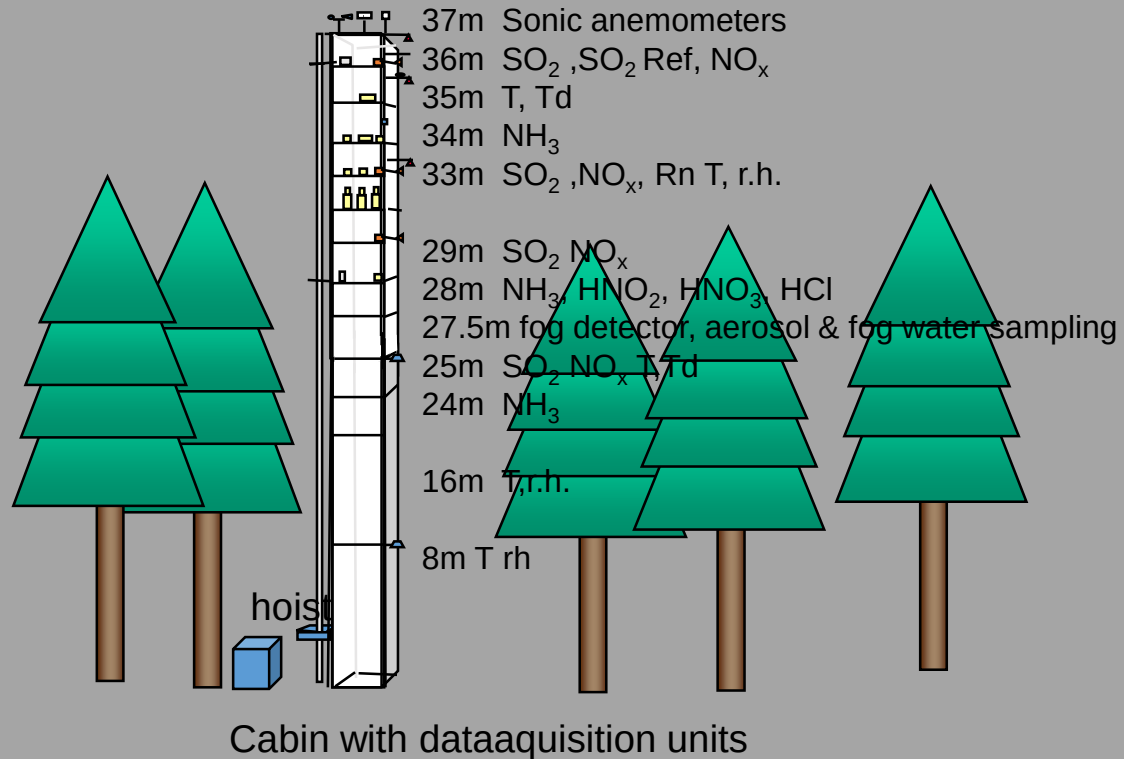
Prove that MODELS ARE not



2: Show that the model works

FOREST MODEL ?

Speuld tower like data 80-90's



SPEULD data = FOREST SPECIFIC RELATION BETWEEN NH_3 CONCENTRATION LEVELS AND DEPOSITION

Conclusion & Wrap up

- With the new HT instrument we can now do
- Emission measurements → Farm experiment (remember the RUG drone too !!!)
- Transport check → in / out forest & large area check
- NH_3 eddy covariance measurements
 - agree with (completely different) RIVM – atmospheric gradient measurements !
 - have a high data coverage
 - The “FOREST” parametrisations in DEPAC works quite well for Loobos site.

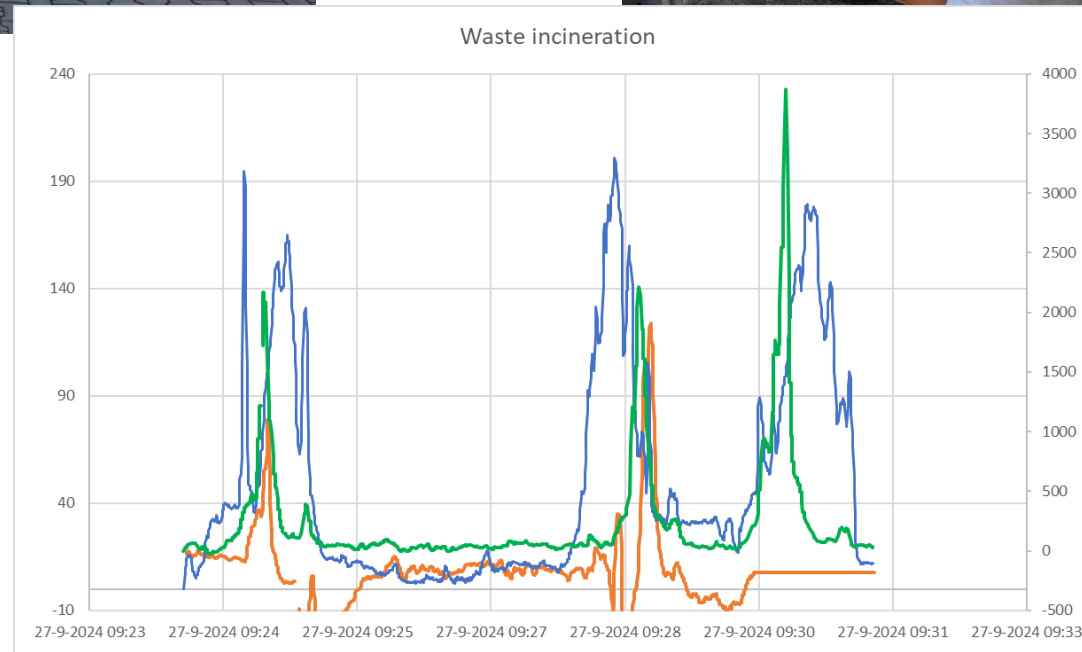
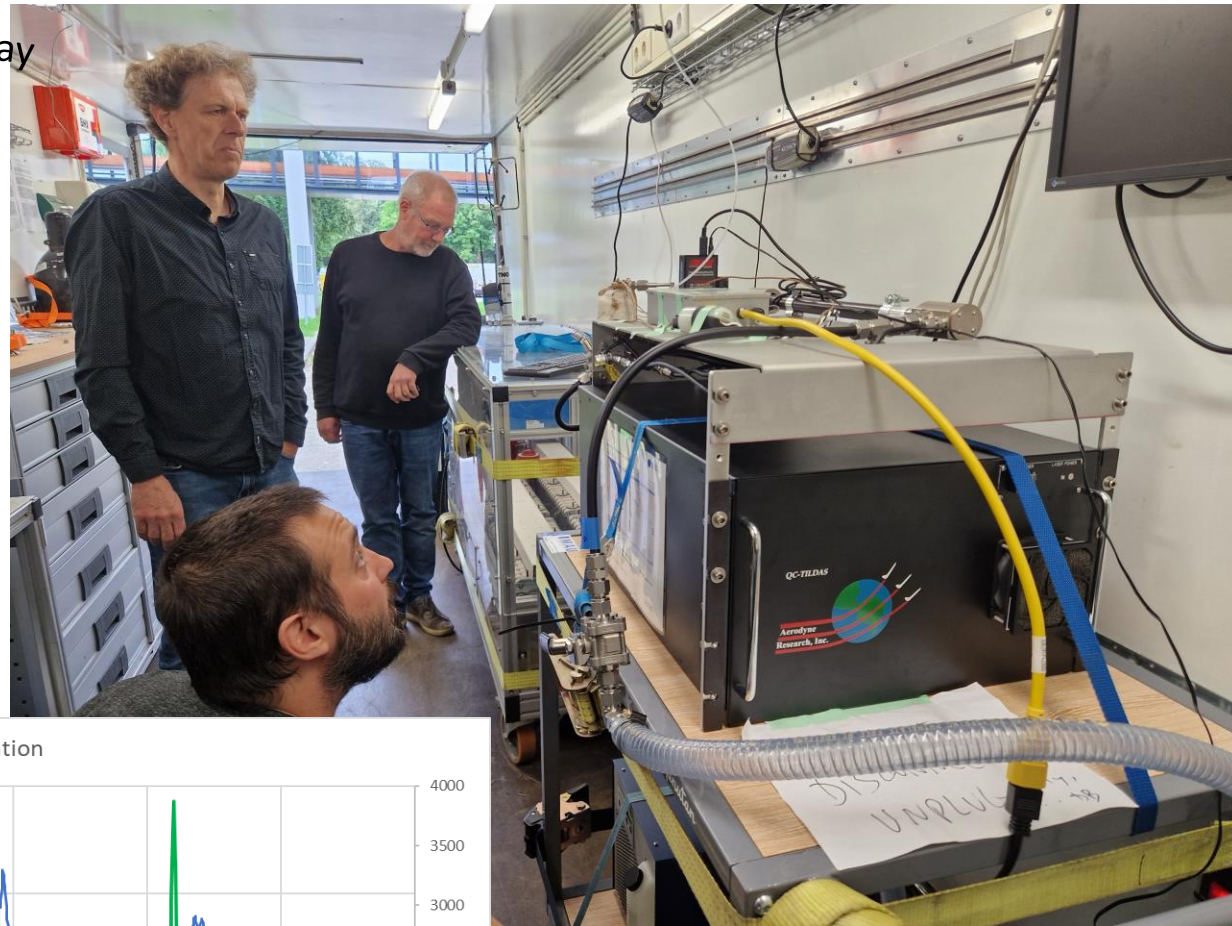
Conclusion & Wrap up

- With the new HT instrument we can now do
- Emission measurements → Farm experiment (remember the RUG drone too !!!)
- Transport check → in / out forest & large area check
- NH_3 eddy covariance measurements
 - NOW: Redo the dunes
 - And wetlands
 - And broadleaf forest
 - And ...
- ALSO: use it for industrial NH_3 emissions in relation with Hydrogen infrastructure.



Last Thursday
& Friday

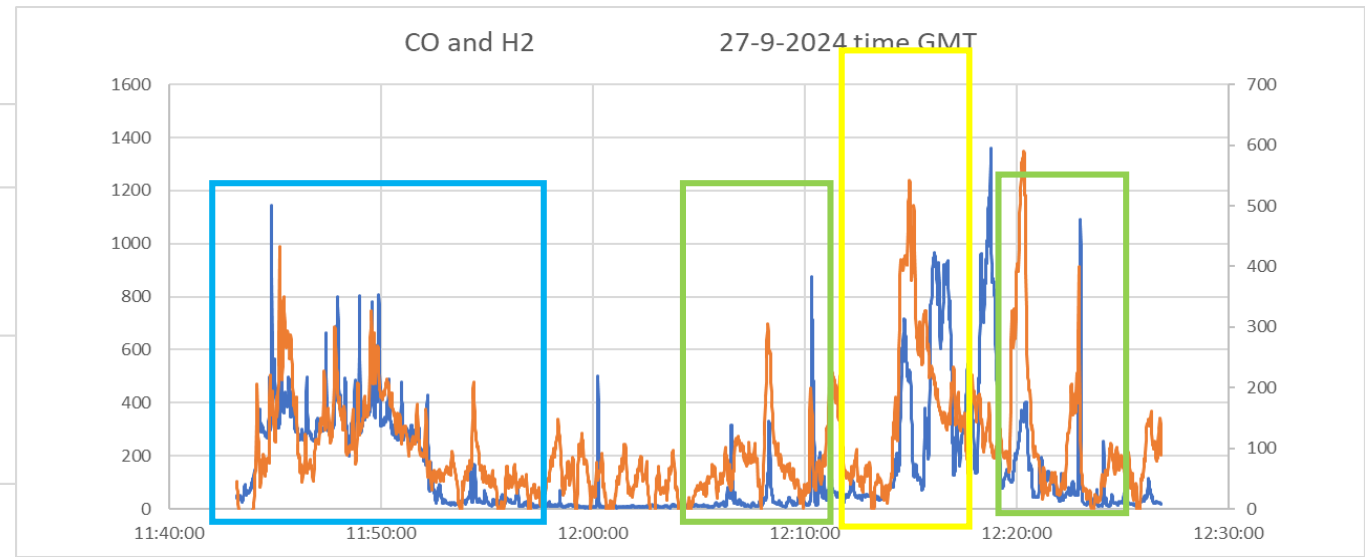
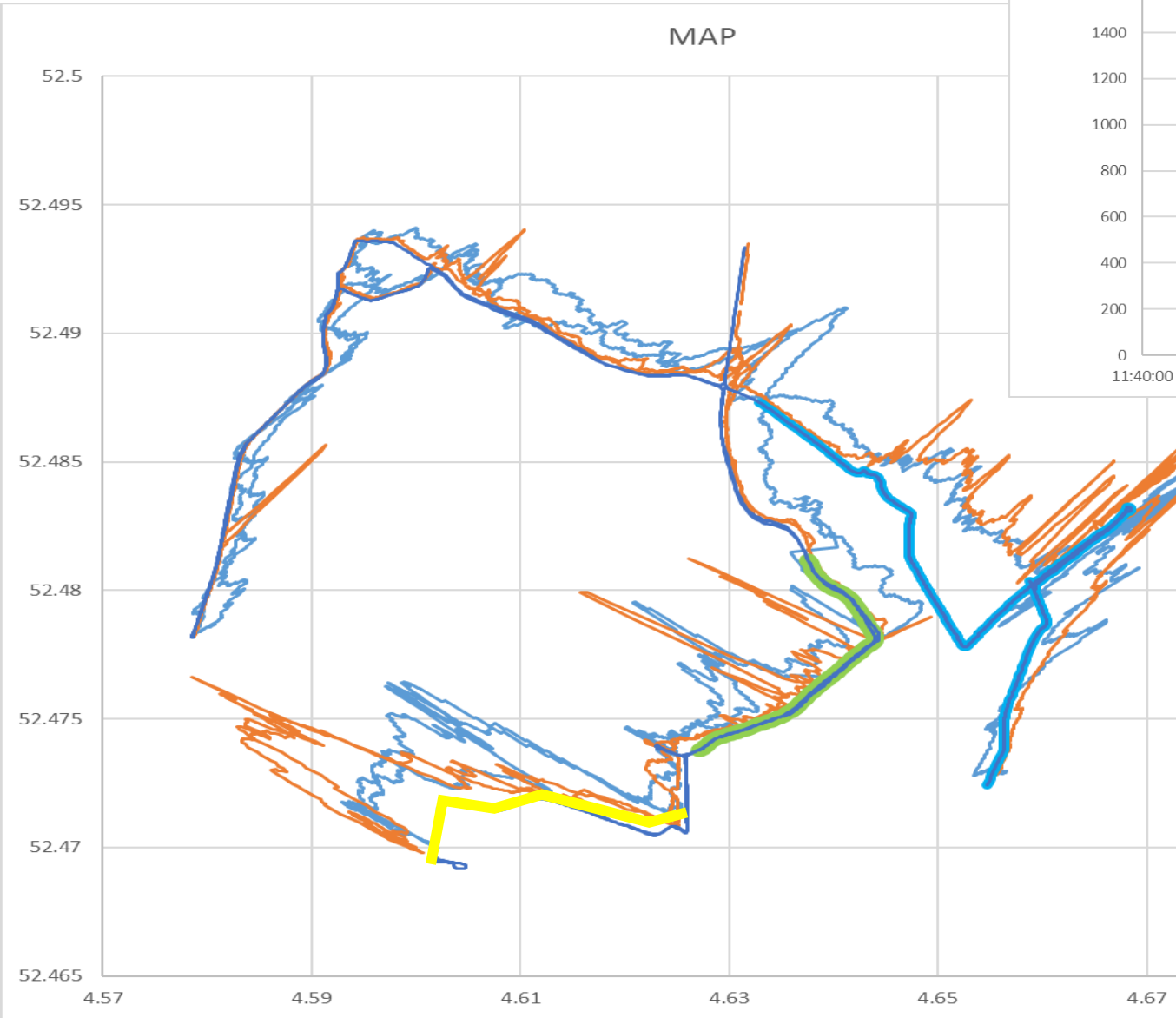
Ilona
Harmen
& UU IMAU
Ceres
Thomas
David, Maisch



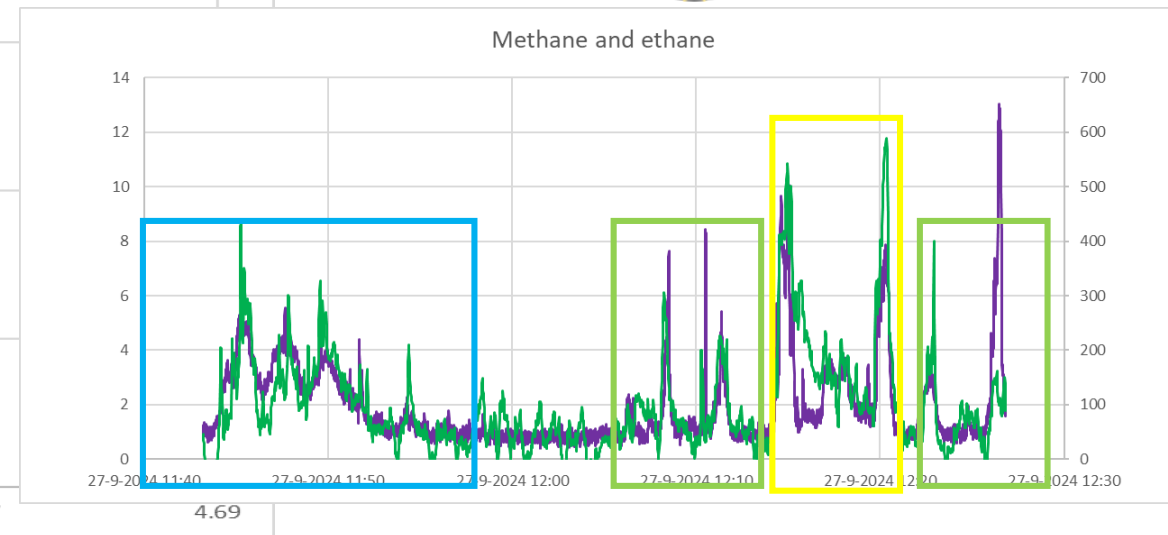
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TATARATIEEE !!!! : Hydrogen !



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Thank you for your attention

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