



Rijksinstituut voor Volksgezondheid
en Milieu

*Ministerie van Volksgezondheid,
Welzijn en Sport*



Nitrogen

From source to effect

Albert Bleeker



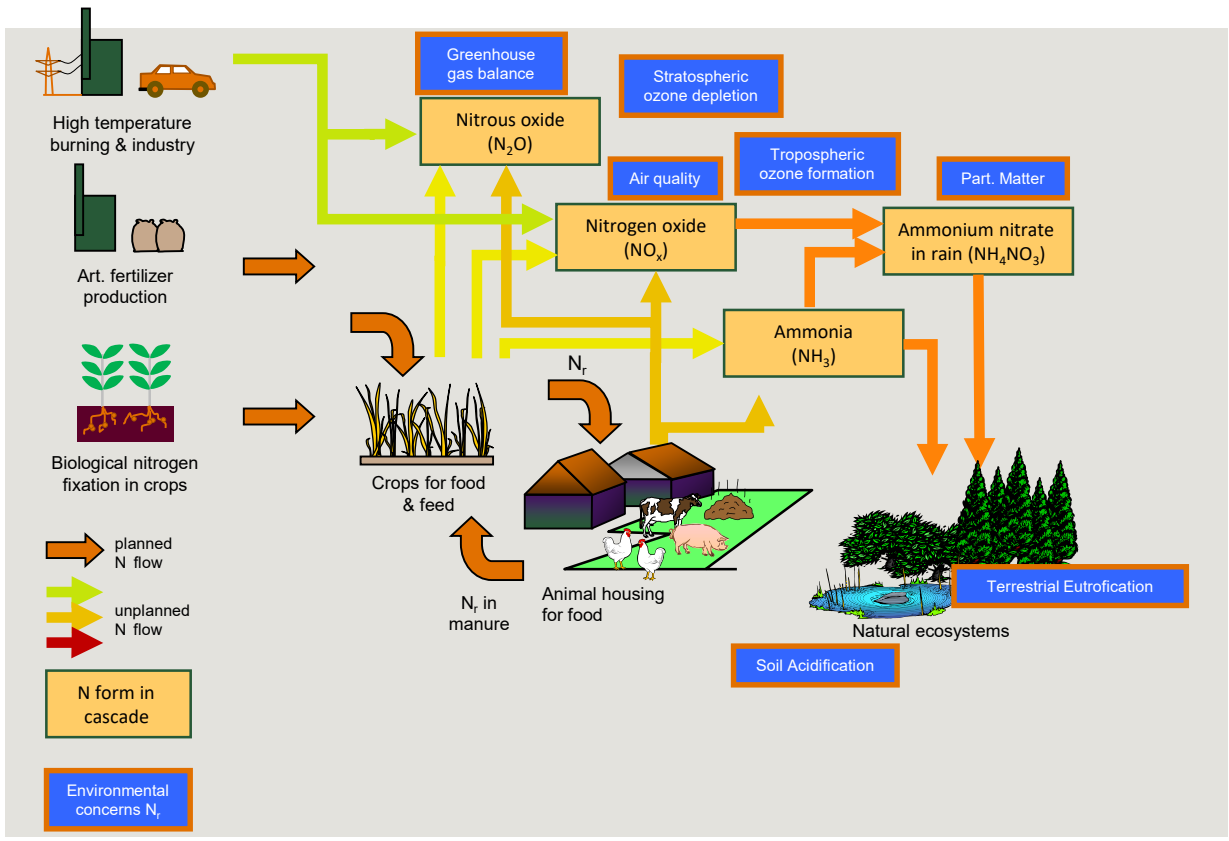


Nitrogen in the air

- The atmosphere consists of 78% non reactive N_2
- Reactive nitrogen, N_r , :
 - By-product during burning of (fossil) fuels for transport and energy production (traffic and industry), nitrogen oxides, NO_x
 - For production of art. fertilizer N_2 is converted to ammonia, NH_3 : for food production (agriculture)



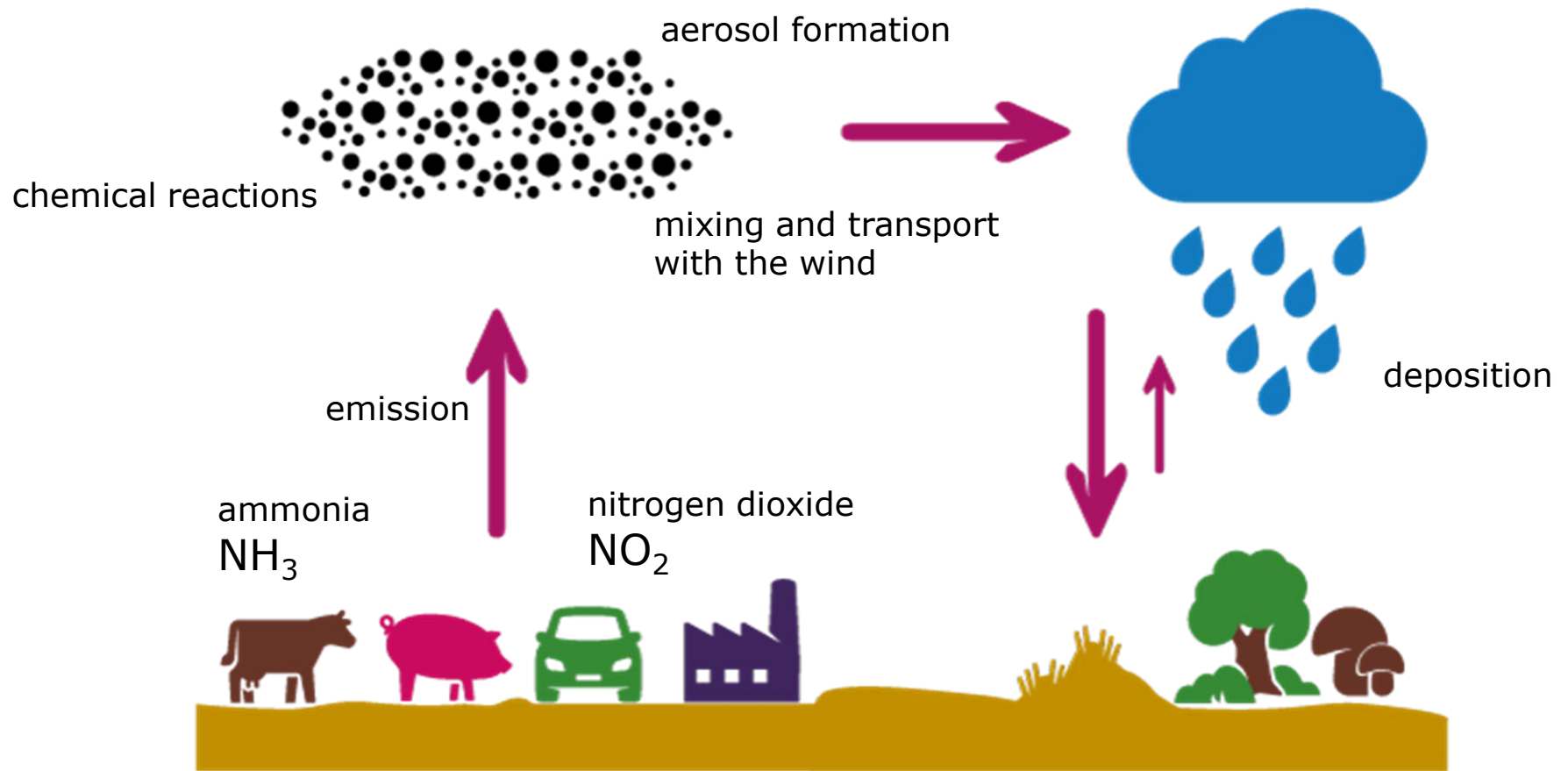
Nitrogen: from source to effect



Sutton et al. (2011)

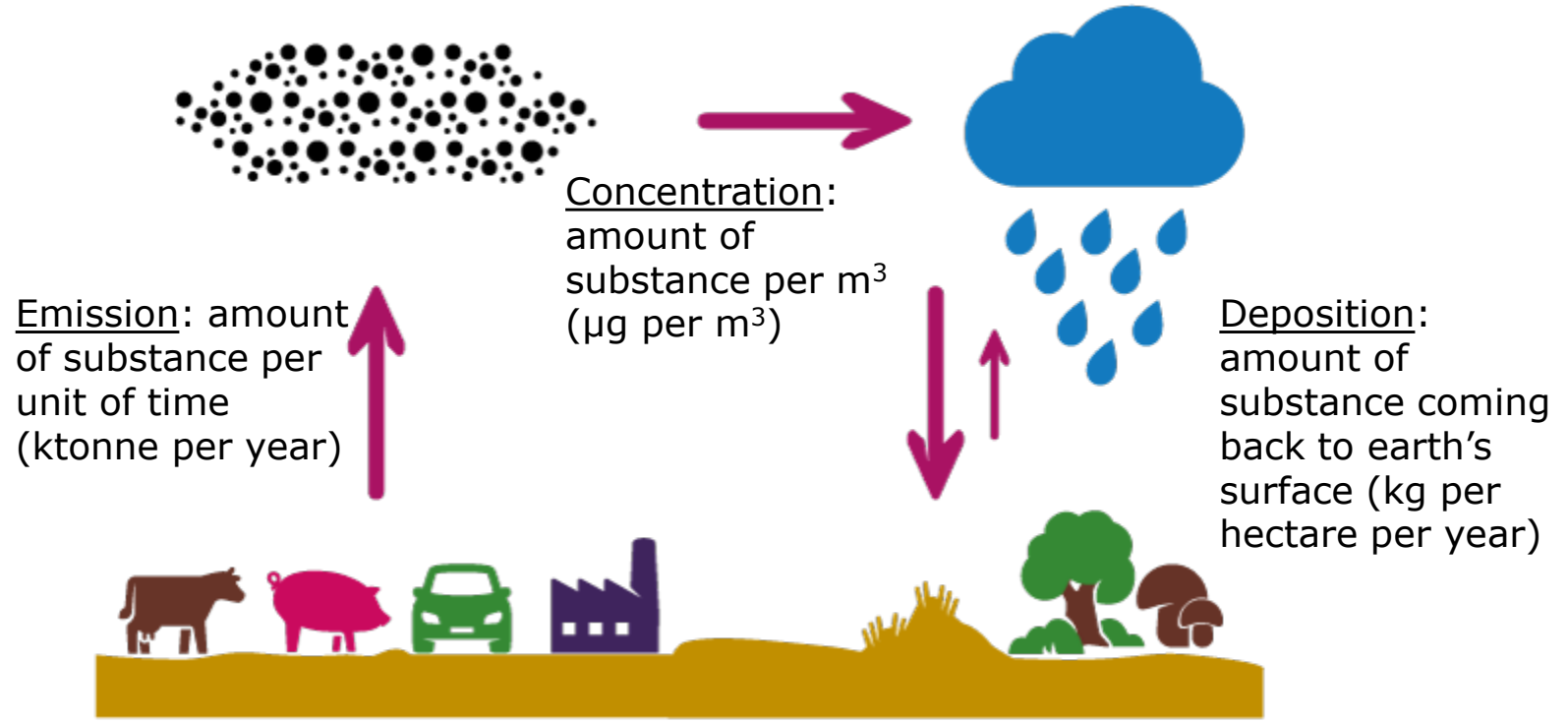


What happens in the air?



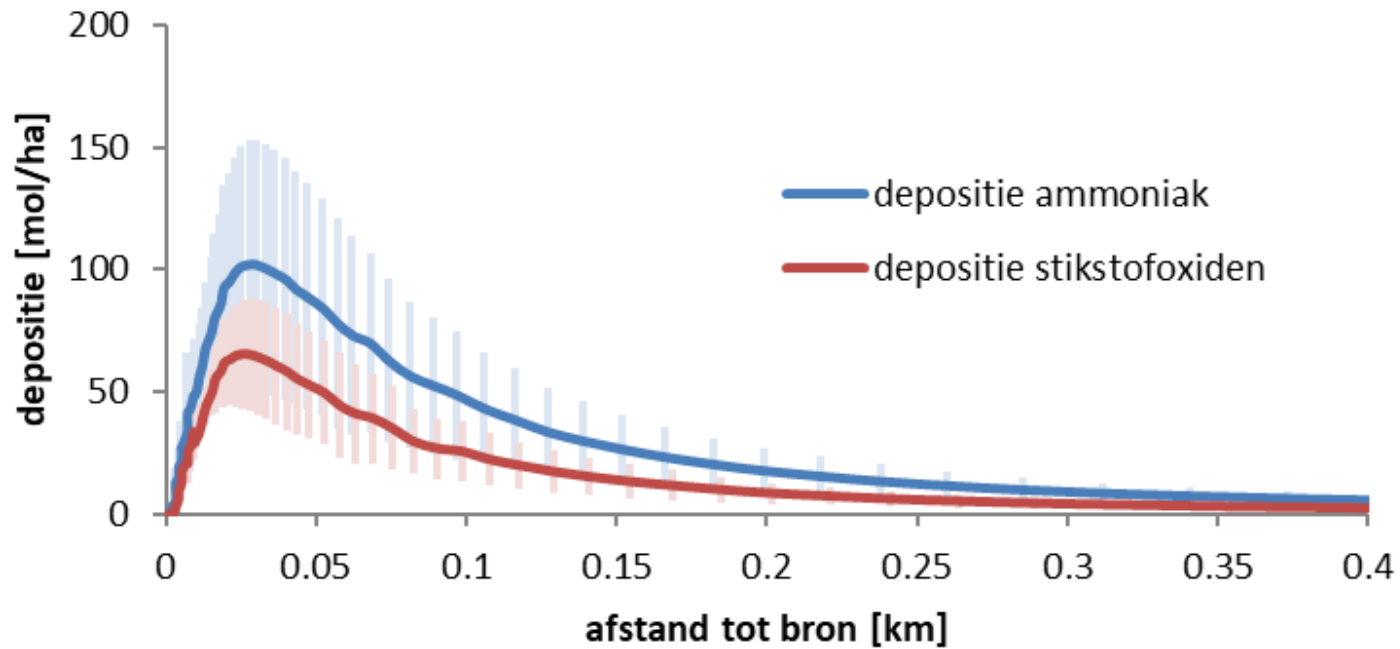


From *emission* via *dispersion/transport* to *concentration* and *deposition*



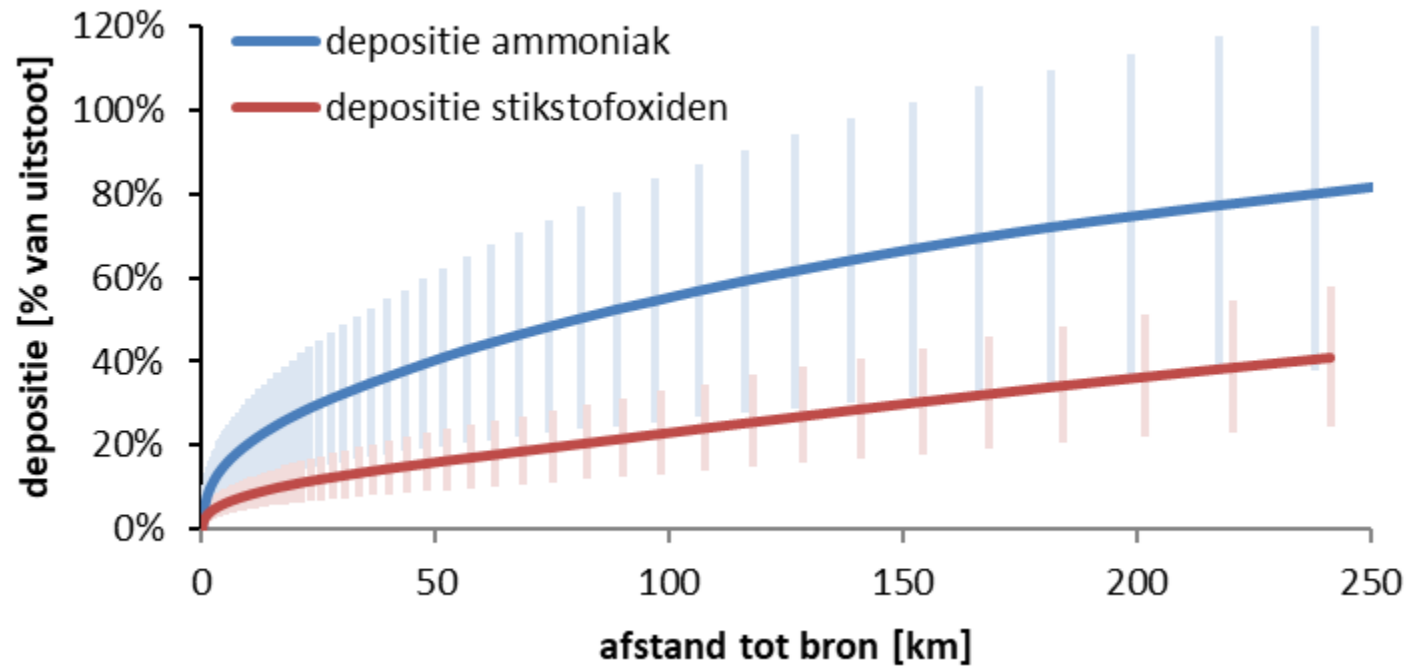


Transport distance





Transport distance



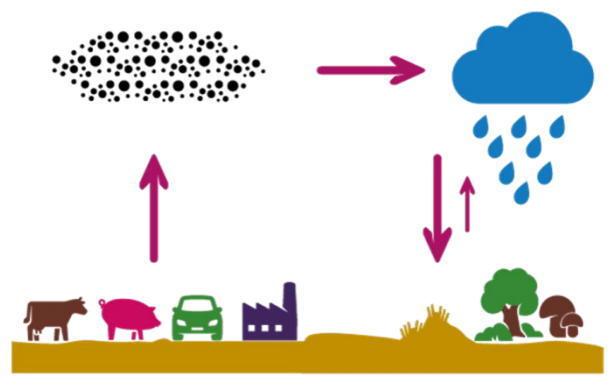


How do we monitor nitrogen?

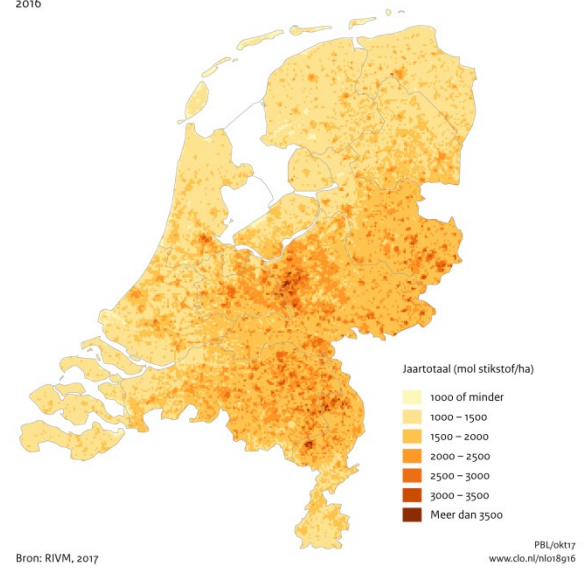
- Emissions
- Measurements
- Model calculations



- Measurements:
Determining levels,
Validation/calibration of model calculations
- Model:
National 'pictures'
Contribution sources
Look into the future



Vermestende depositie
2016

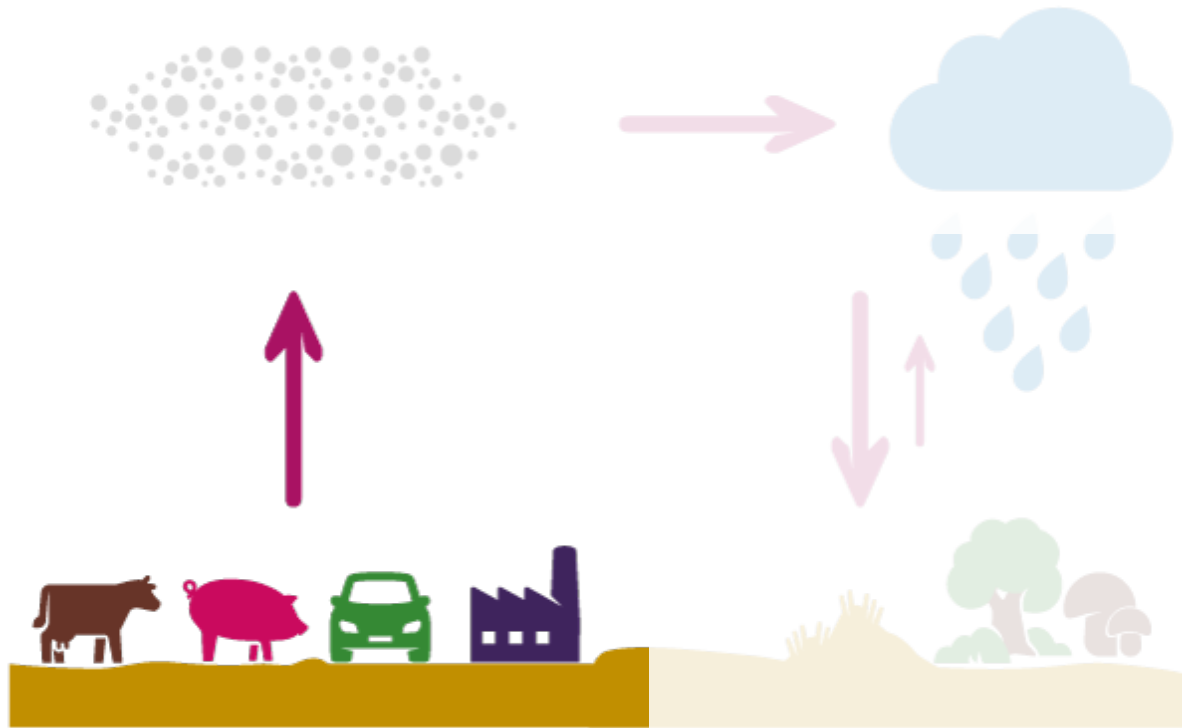


Bron: RIVM, 2017

PBL/okt17
www.clo.nl/nlo18916



Emission registration





Emission registration

- Since 1974 about 350 substances
- RIVM coordinates
(cooperation with CBS, PBL, Deltares, RWS, WenR, WecR, Livestock Research (WUR), TNO, Fugro et cetera)
- Official source for international reporting
- All data can be found on www.emissieregistratie.nl



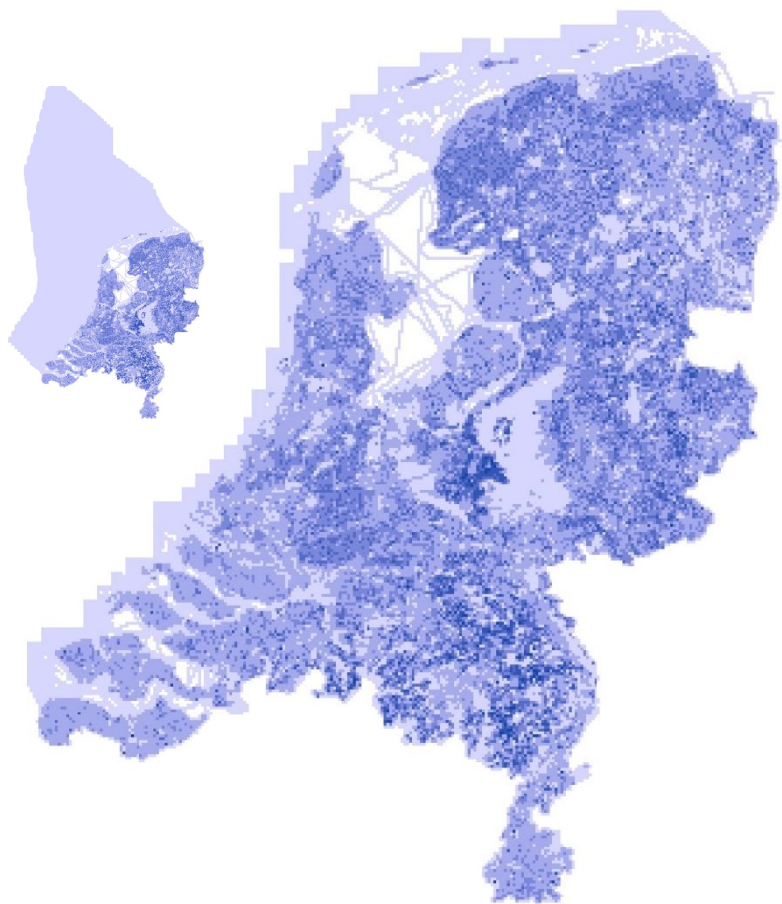
Determining emissions

- Emissions are determined following guidelines laid down in *international guidebooks*
- Diffuse sources: $\text{emission} = \text{emission factor} * \text{activity data}$
 - Emission factor based on measurements
 - Activity data mostly statistical data
- Point sources: registered
 - Emissions for about 3000 companies
 - Registered by companies
 - Checked and approved by authorities
 - www.e-mjv.nl

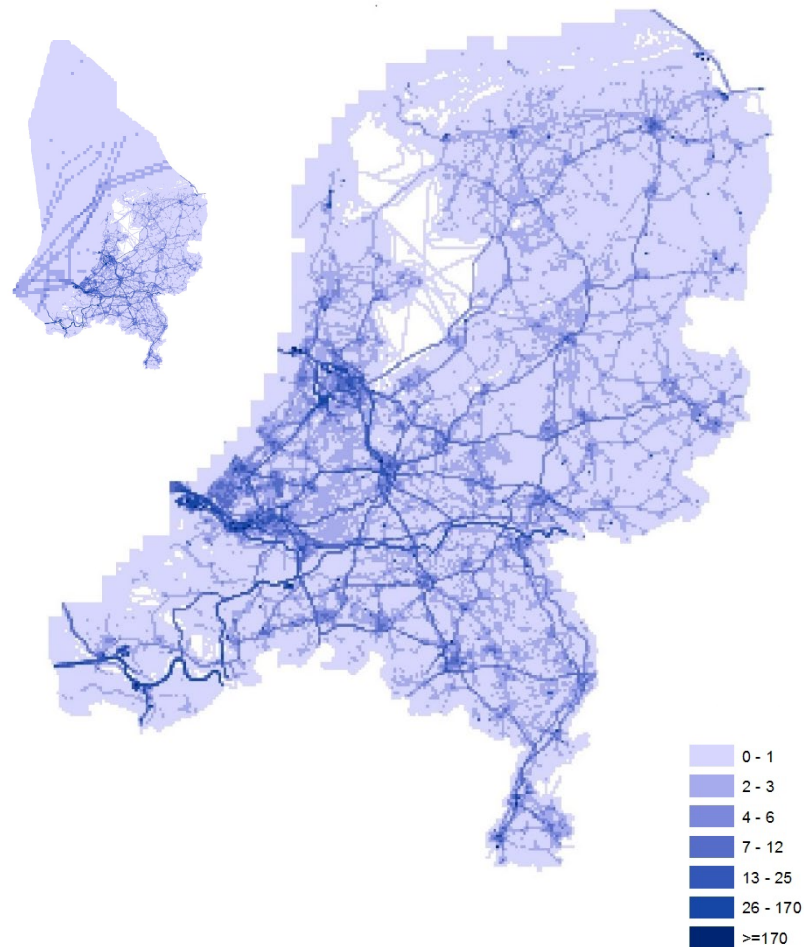
Nitrogen emissions



Ammonia emission

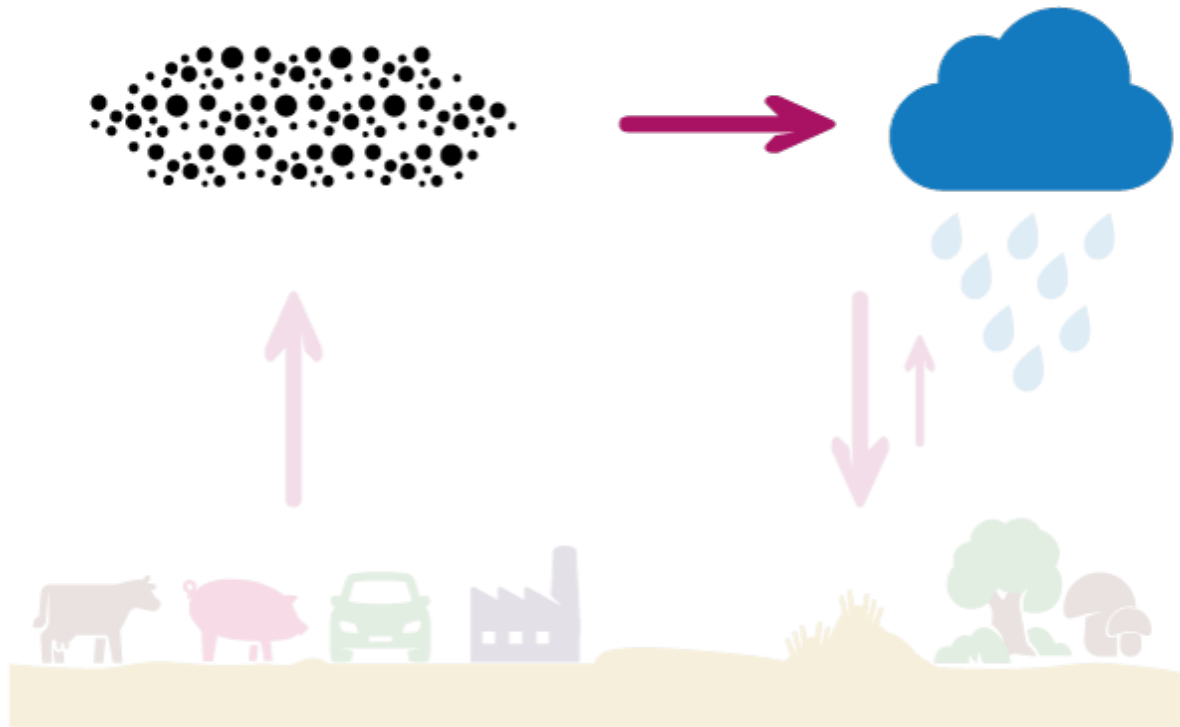


Nitrogen oxides emission



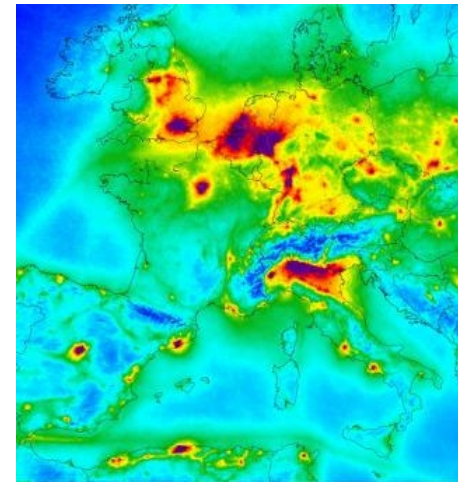


Measuring concentration and deposition



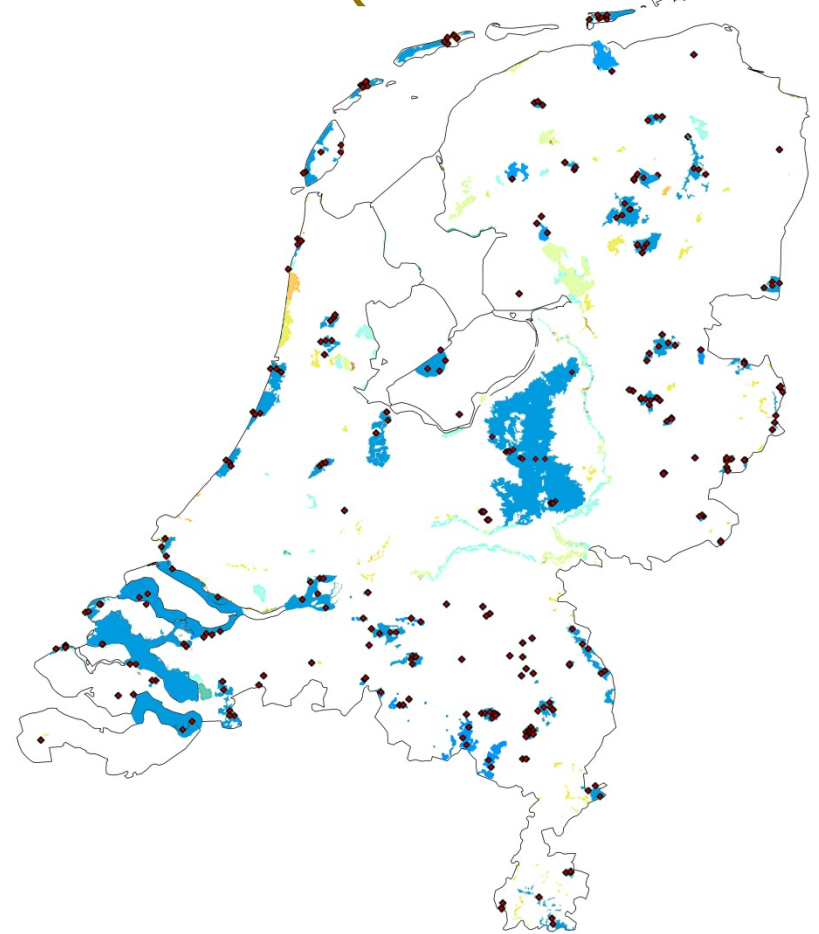
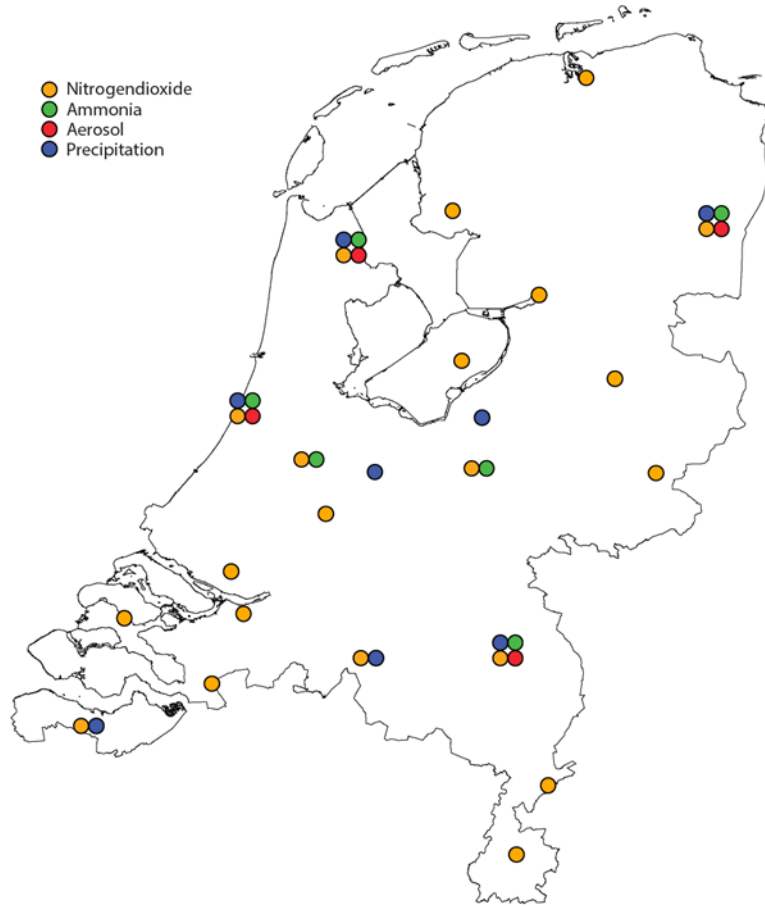


Measuring concentrations: how?





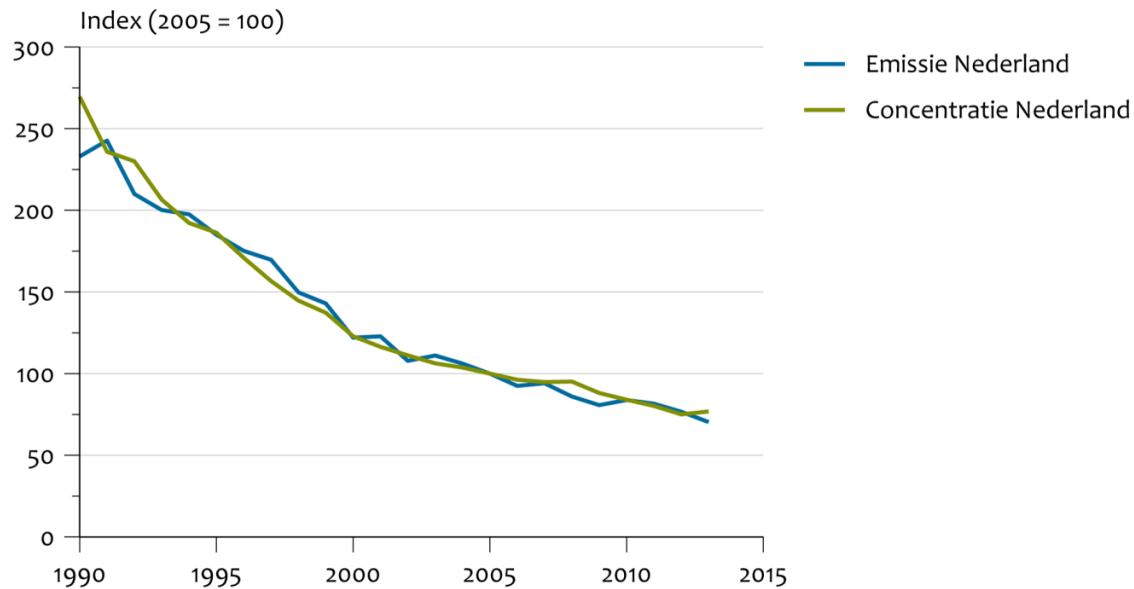
Measuring concentrations: where? (LML and MAN)





Evaluating trends emission-concentrations: NO_x

Stikstofoxiden (NO_x), stedelijk verkeer



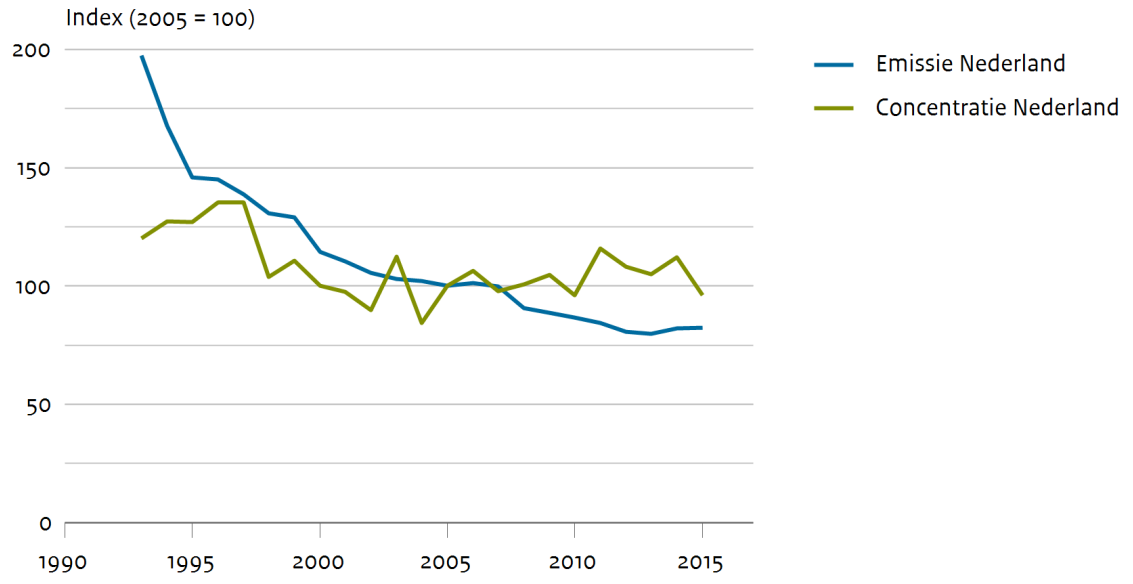
Bron: RIVM, 2014.

RIVM/jul14
www.clo.nl/nl008111



Evaluating trends emissions-concentrations: NH₃

Ammoniak (NH₃)

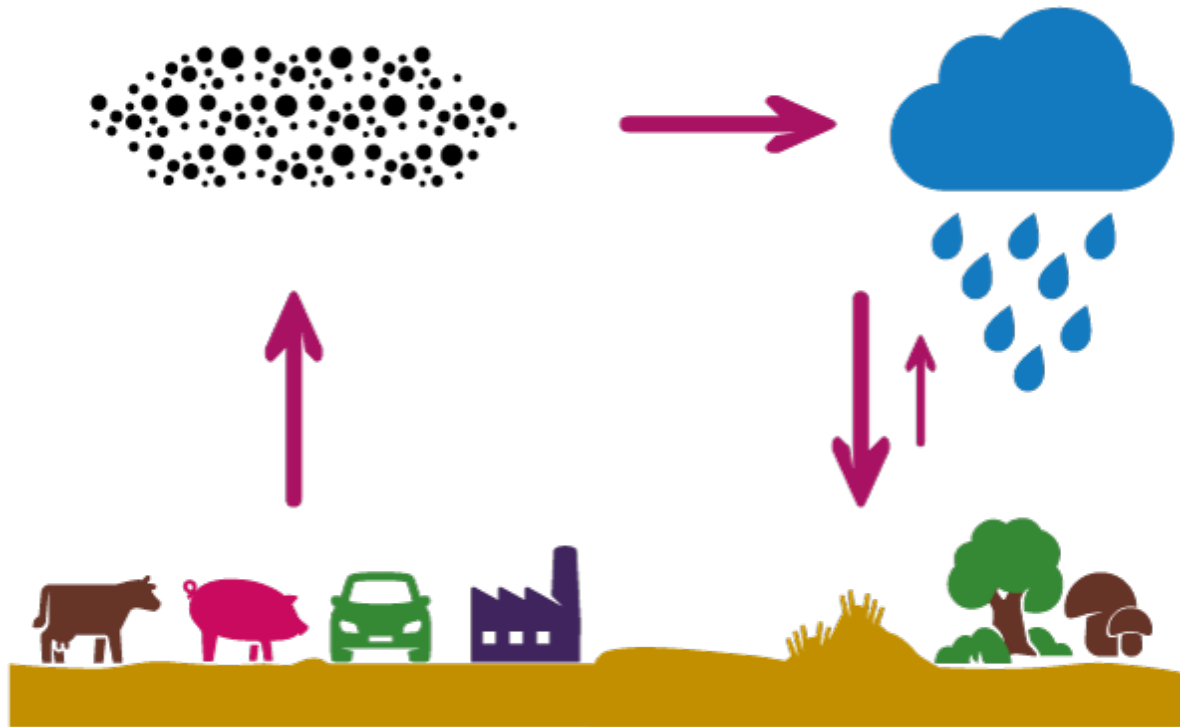


Bron: RIVM, 2017.

RIVM/okt17
www.clo.nl/nl0081

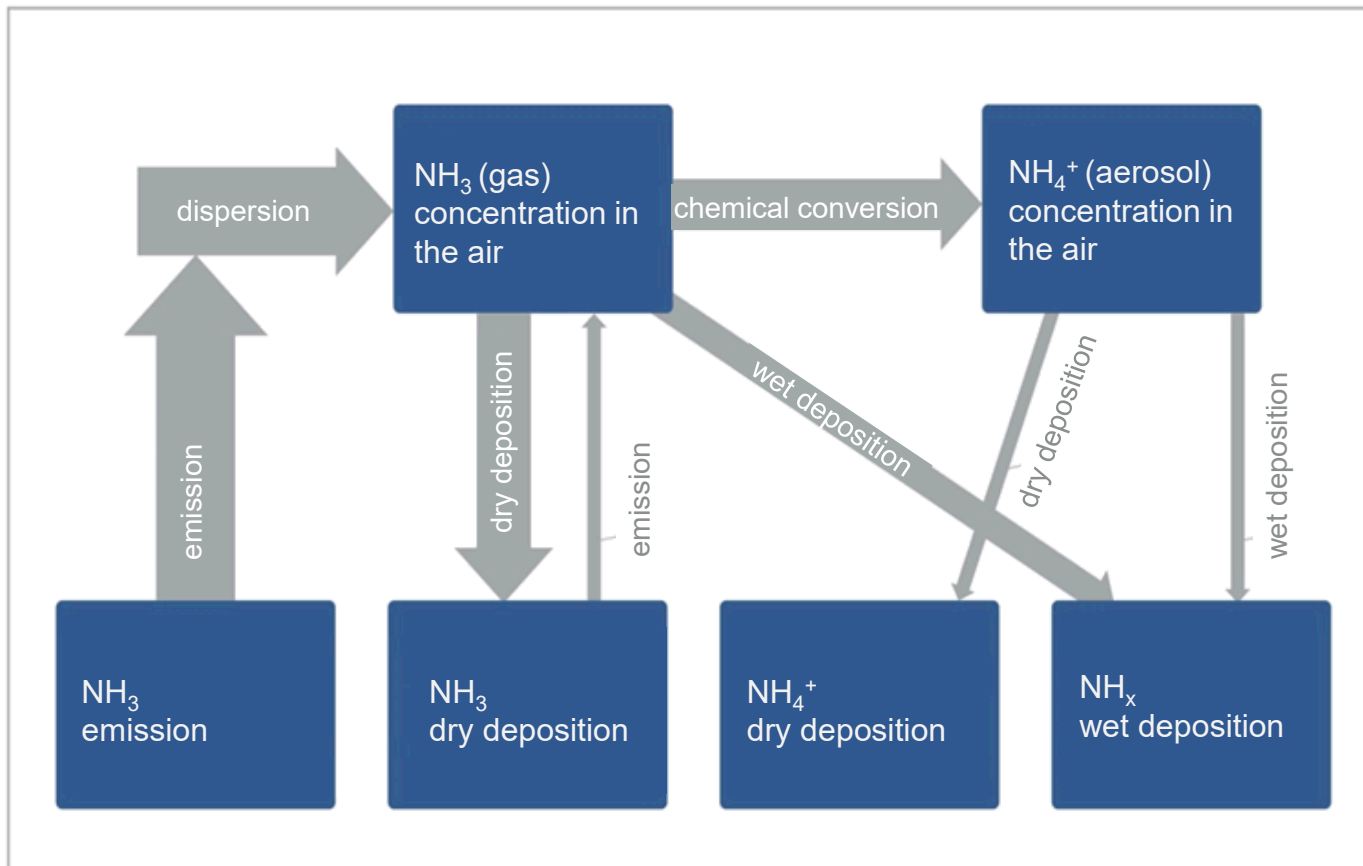


Modeling processes: concentration and deposition





OPS: model based on atmospheric processes

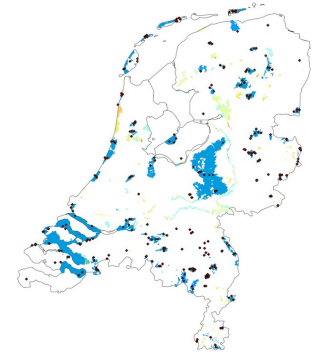
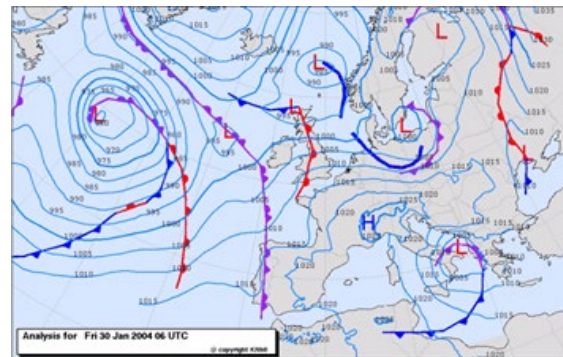
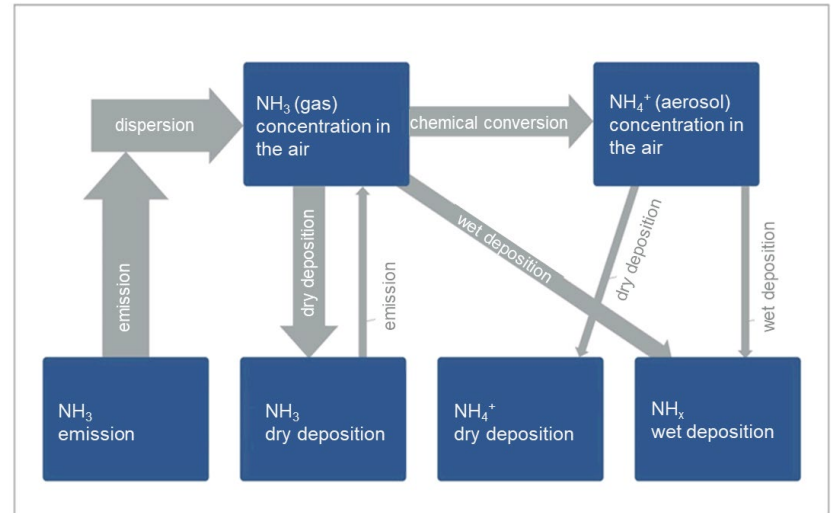
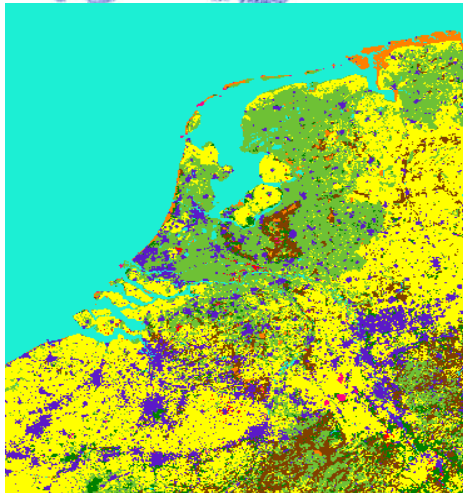
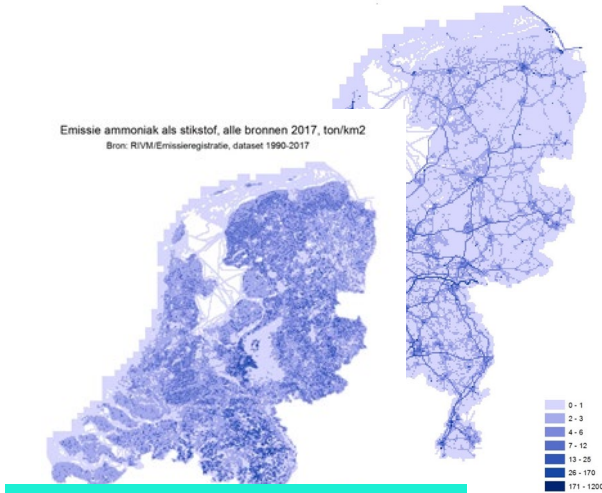




Emissie stikstofoxiden als stikstof, alle bronnen 2017, ton/km²
Bron: RIVM/Emissieregistratie, dataset 1990-2017

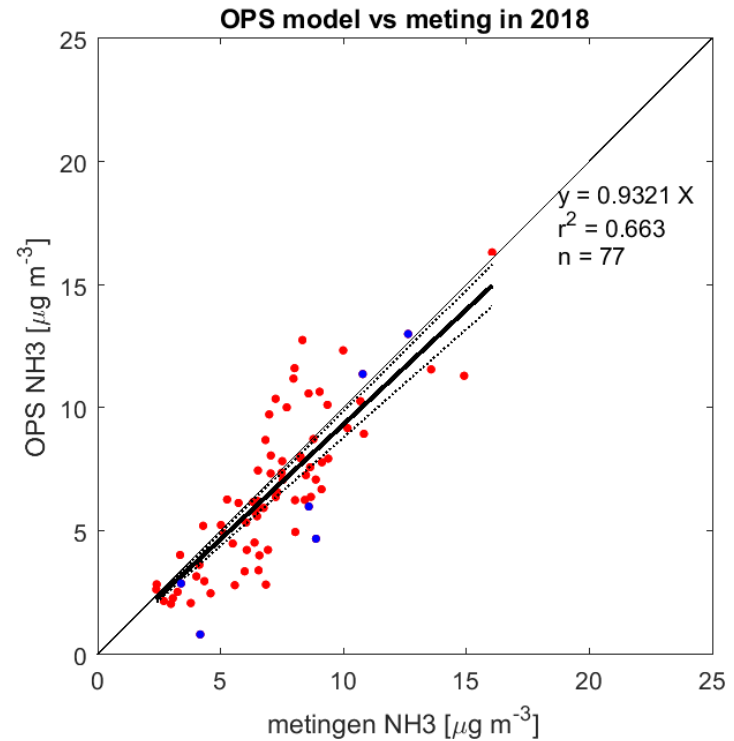
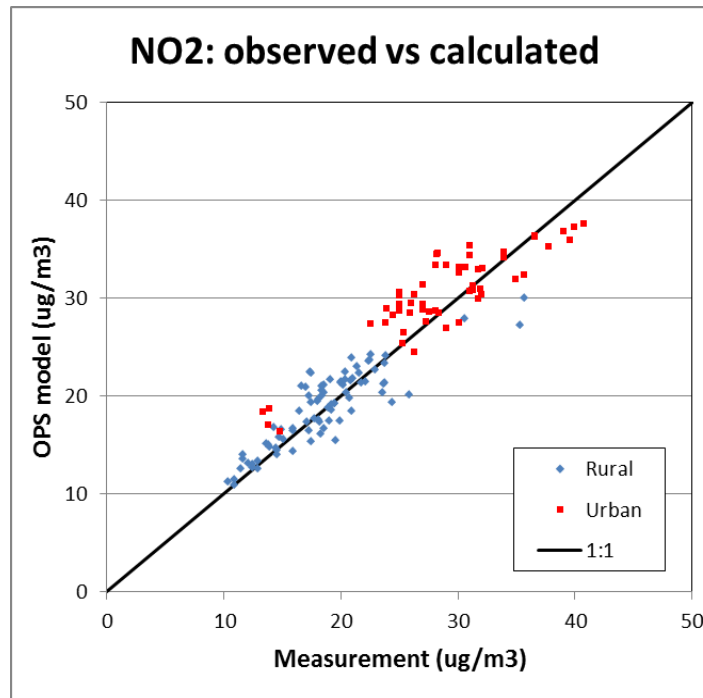
Input for calculations

Emissie ammoniak als stikstof, alle bronnen 2017, ton/km²
Bron: RIVM/Emissieregistratie, dataset 1990-2017





Model validation and calibration



Model validation: comparison with measurements

Model calibration: correction for systematic deviations (based on validation)



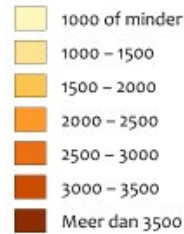
Deposition on a 1x1 km or ha resolution

Vermestende depositie

2014

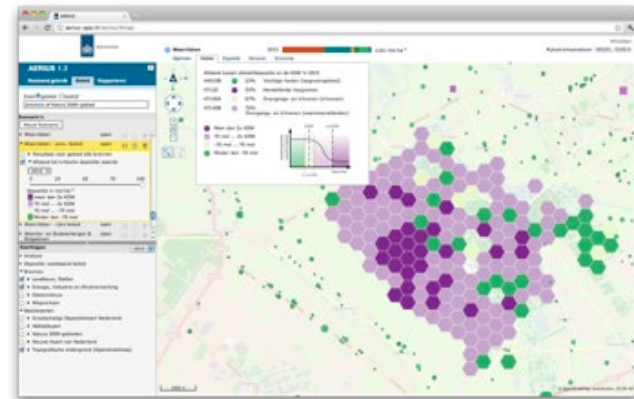
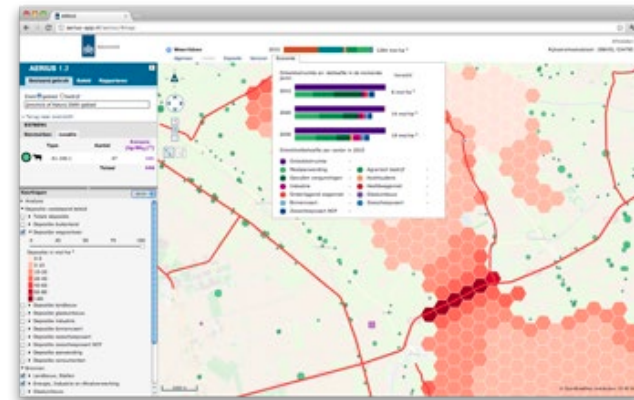


Jaartotaal (mol stikstof/ha)



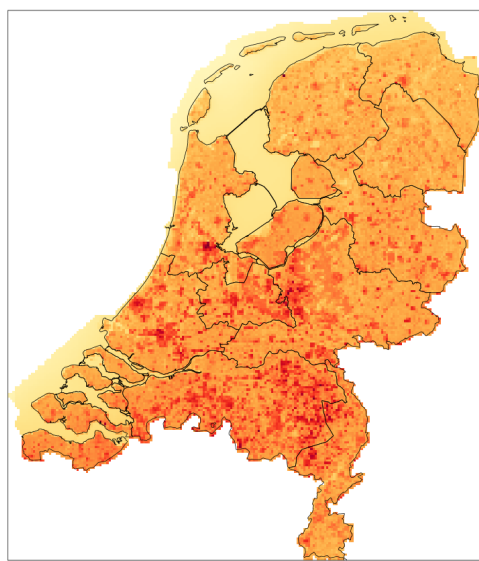
Bron: RIVM, 2015.

PBL/apr15
www.clo.nl/nl018914

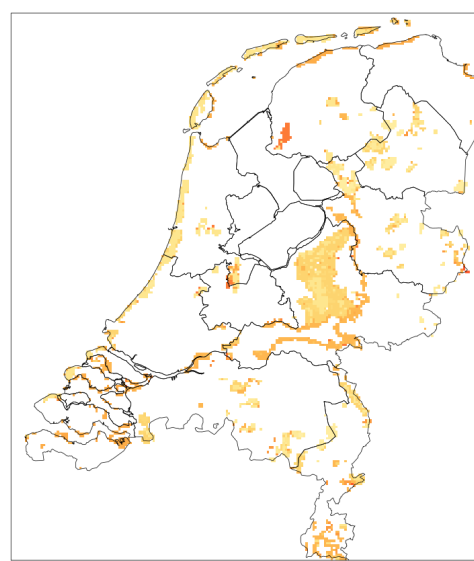




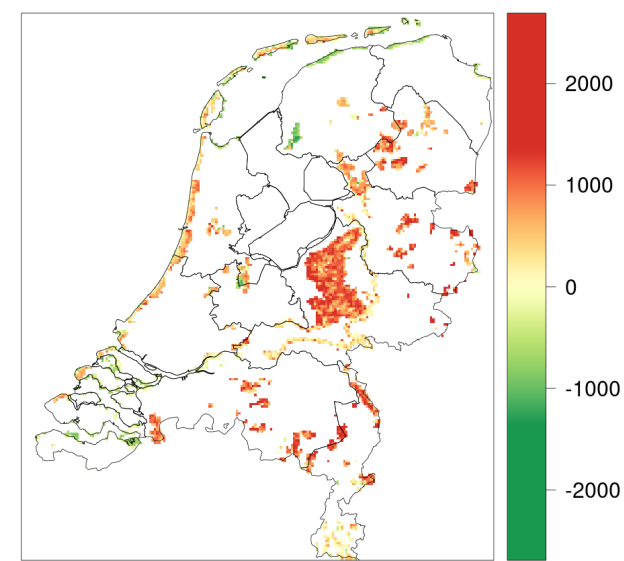
Exceedance of critical loads



Deposition



CLoad



Exceedance
(= Deposition - CLoad)



Final remarks

- The whole chain from source to effect is currently monitored
 - Emission
 - Concentration
 - Deposition
- However, uncertainties are present in monitoring (over the whole chain) and, in some cases, can be very large (e.g. dry deposition)
- Therefore, monitoring should be further improved (a.o. dry deposition measurements, emission inventories, satellite images, etc.)
- Furthermore, it should be better indicated in what way uncertainties play a role in policy support



- More information on
 - www.emissieregistratie.nl
 - man.rivm.nl
 - www.luchtmeetnet.nl
 - www.aerius.nl
 - www.rivm.nl/stikstof

THANK YOU