Royal Netherlands Meteorological Institute
Ministry of Infrastructure and the Environment

OMI observations during CINDI-2

15 March 2018
CINDI-2 Data Workshop
Mutters, Austria

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Henk Eskes
KNMI

Outline & Motivation

Update of Presentation given at CINDI-2 workshop (April 2017)

- OMI QA4ECV data included
- Updated MAX-DOAS dataset from BIRA for on-ground comparison

OMI data overview

- Data filtering and differences in retrievals

Summary of the "Best" OMI days

Conclusions & Future work

- TROPOMI Campaign Early Summer 2019

Model information available

Motivation: Validation

- OMI is external check for CINDI-2 datasets and give regional context
- CINDI-2 datasets are external check for OMI retrievals
- Instrument calibration & retrieval techniques for CINDI-2 instrumentation will be used for TROPOMI validation, FRM_4DOAS

OMI data overview

Orbit-based Level 2 Data

- Contains the most metadata, quality & error flagging information

Level 3 Gridded Data

- More easily comparable to model fields, etc.

Overpass files – Level 2 Data calculated for Cabauw and other sites

ESA/KNMI Temis www.temis.nl

NASA Goddard-DISC https://disc.gsfc.nasa.gov/

NASA Giovanni https://giovanni.gsfc.nasa.gov/giovanni/

Aura Validation Data Center (AVDC) https://avdc.gsfc.nasa.gov/

QA4ECV project site http://www.qa4ecv.eu

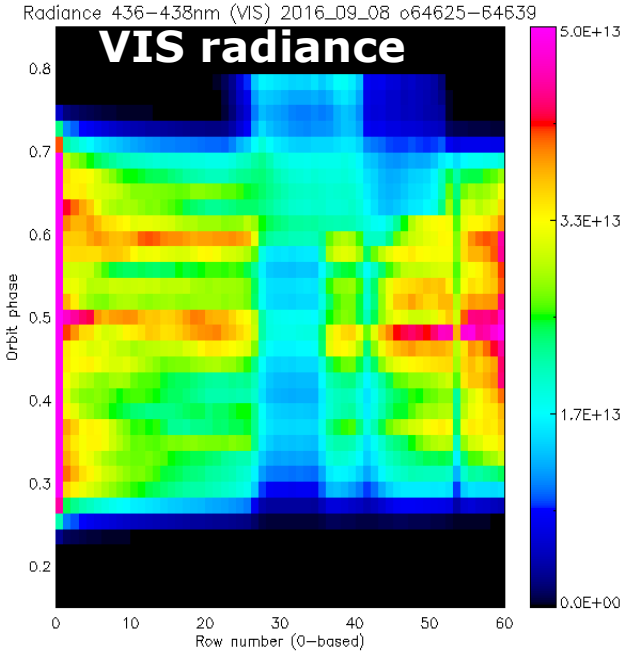
Data filtering

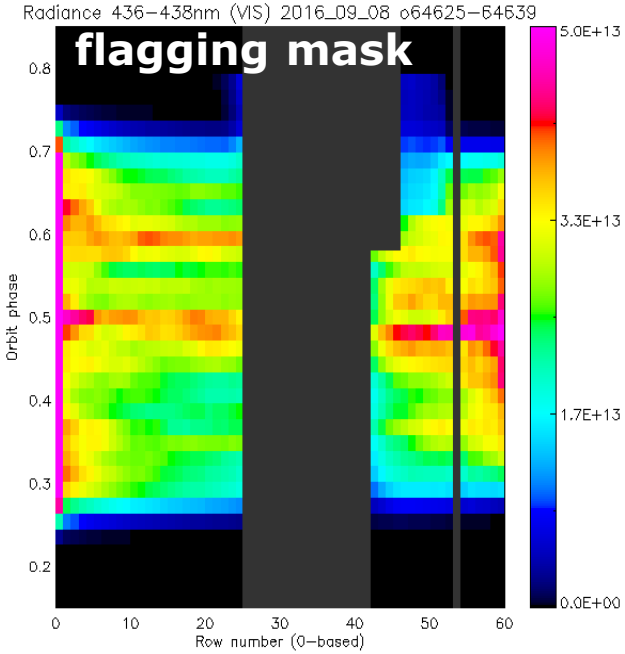
Cloud screening

- 30% radiative cloud fraction

Row Anomaly

- Remove data from rows 24-45, 53 (0-based)
- http://projects.knmi.nl/omi/research/calibration/instrument_status_v3/rowanomaly/rowanomaly.php





OMI NO_2 retrievals

Second Cabauw Intercomparison of Nitrogen Dioxide Measuring Instruments

OMI data products

Near-daily global coverage,
13 x 24 km^2, at nadir

Equatorial crossing ~13:30 LT,
Typically 2 orbits over NL per day

Different approach:
Slant columns, AMF, stratospheric correction, a priori (TM4 v GMI)

OMNO2 (v3.0) NASA product

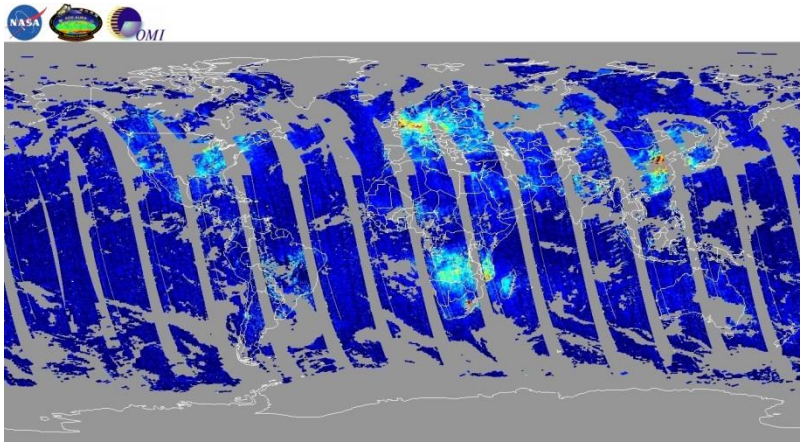
Total and Tropospheric VCDs

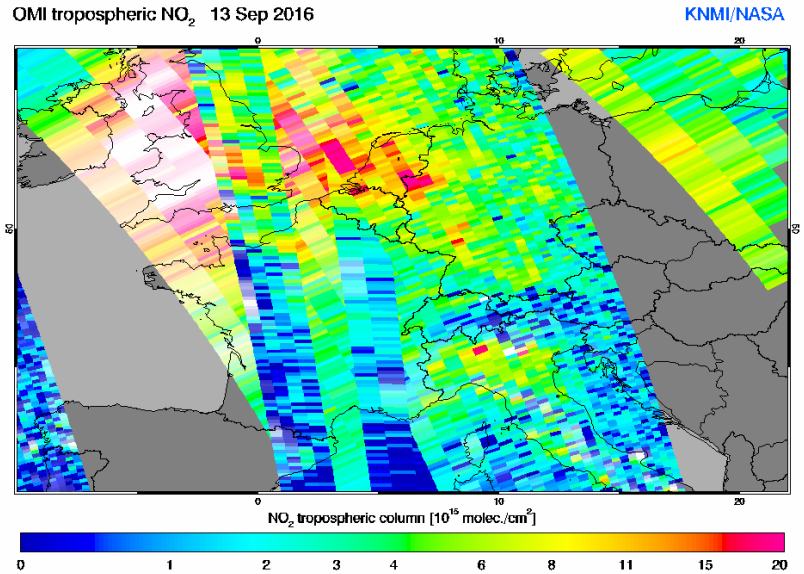
Krotkov et al., AMTD, 2017

DOMINO (v2.0) KNMI product

Stratospheric and Tropospheric VCDs

Boersma et al., AMT, 2011





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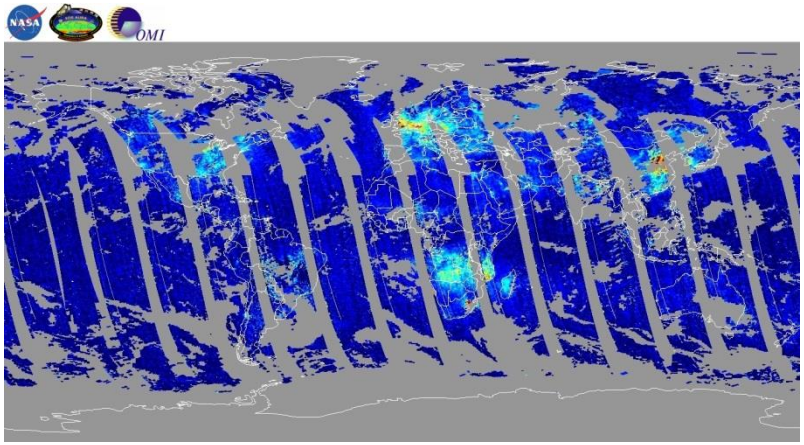
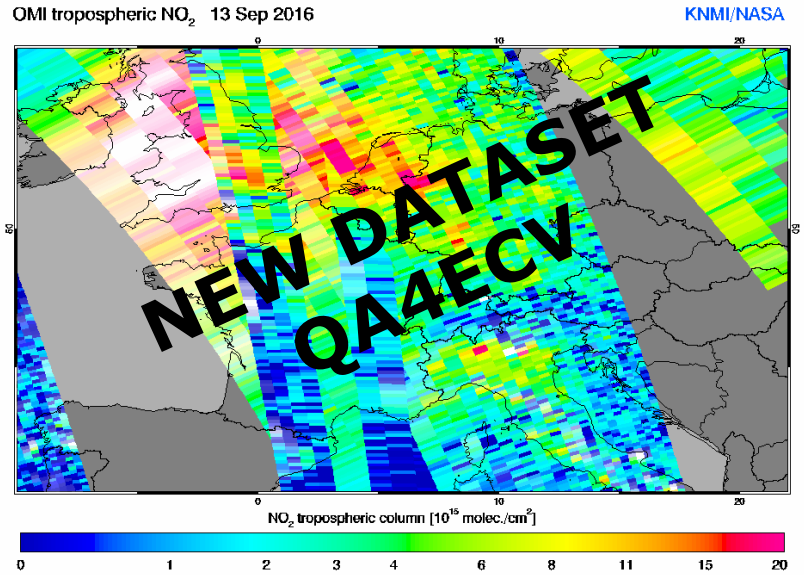


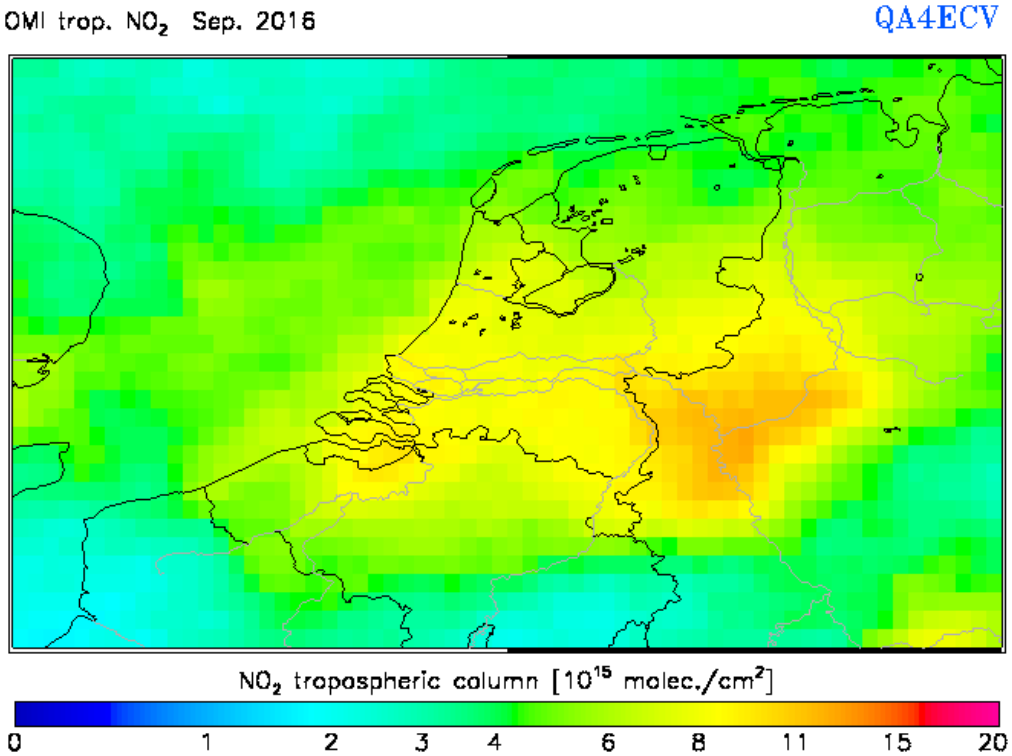


QA4ECV algorithm settings for OMI NO_2

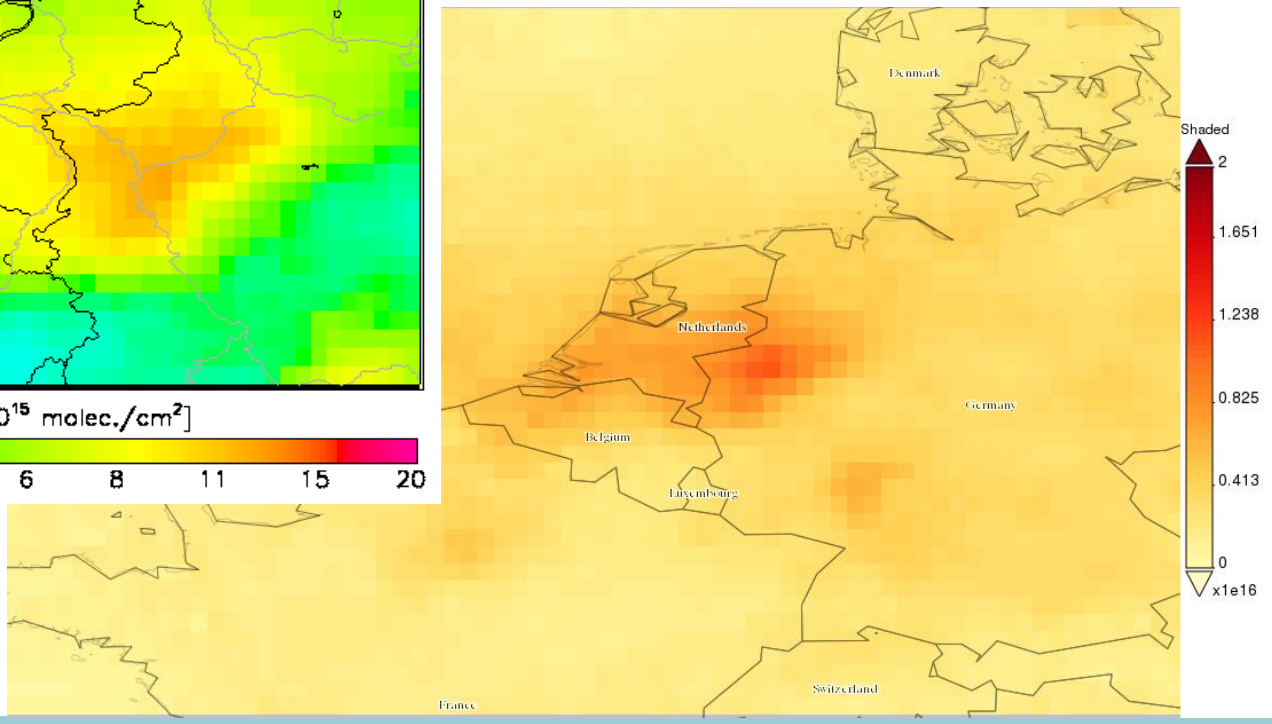
	QA4ECV	DOMINO v2
Spectral fitting	QDOAS/NLIN 405-465 nm	OMNO2A v1 405-465 nm
	Intensity offset correction, liquid water, O_2-O_2, NO_2, O_3, H_2O, Ring, poly	Only NO_2, O_3, H_2O, Ring, polynomial
	Optimized wavelength calibration	
Stratospheric correction	TM5 1° x 1°, nudging to HNO_3:O_3 climatologies from ODIN, major speed-up, versatile code	TM4 3° x 2°, nudging to HNO_3:O_3 ratios from UARS + O3MSR climatologies
	STREAM	
Stripe correction	Online	A posteriori
AMF LUT, more vertical layers	More reference points (437.5 nm) 173 x 14 x 26 x 10 x 11 x 16	Fewer reference points (439 nm) 24 x 10 x 10 x 10 x 13 x 16
	Sphericity-corrected	Pseudo-spherical
Surface albedo	OMI LER 5-year	OMI LER 3-year
Clouds	Improved O_2-O_2 [Veefkind et al., 2016]	O_2-O_2 [Acarreta et al., 2004]
A priori profile	TM5-mp 1° x 1°	TM4 3° x 2°
Terrain height	Pixel average GMTED2010	Center of DEM_3KM

OMI Monthly NO_2

September 2016, OMNO2d Tropospheric Column L3 (bottom)

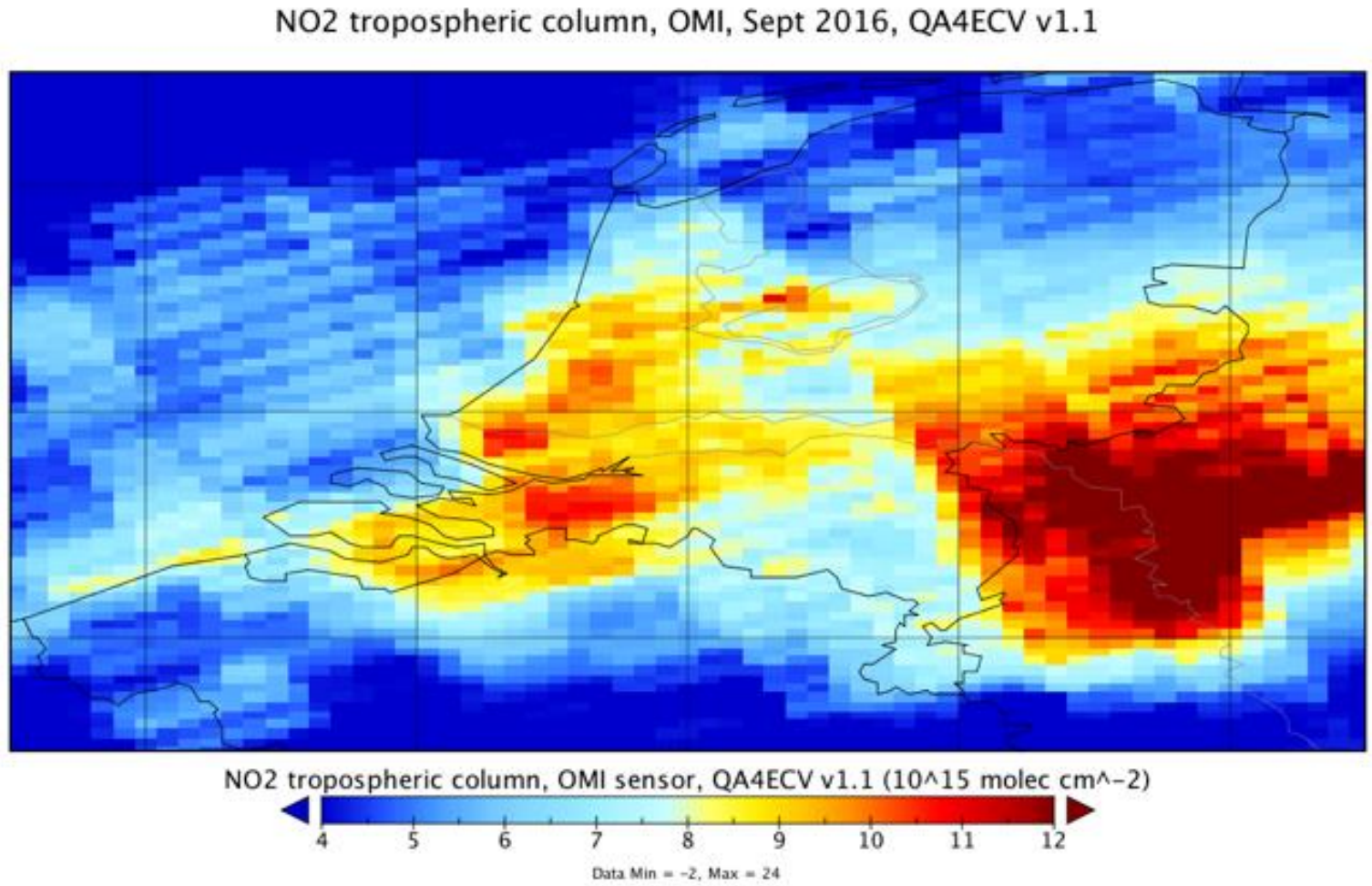


QA4ECV **QA4ECV September 2016**



OMI Monthly NO_2

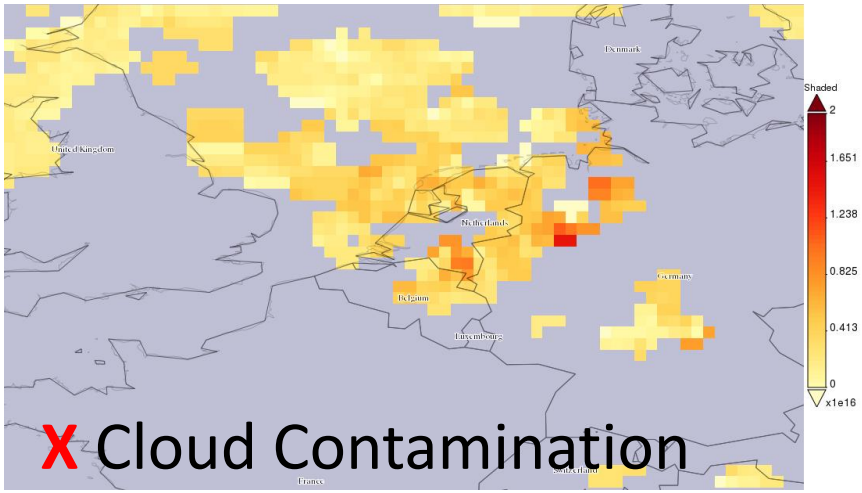
QA4ECV September 2016, higher resolution (0.08 x 0.04)

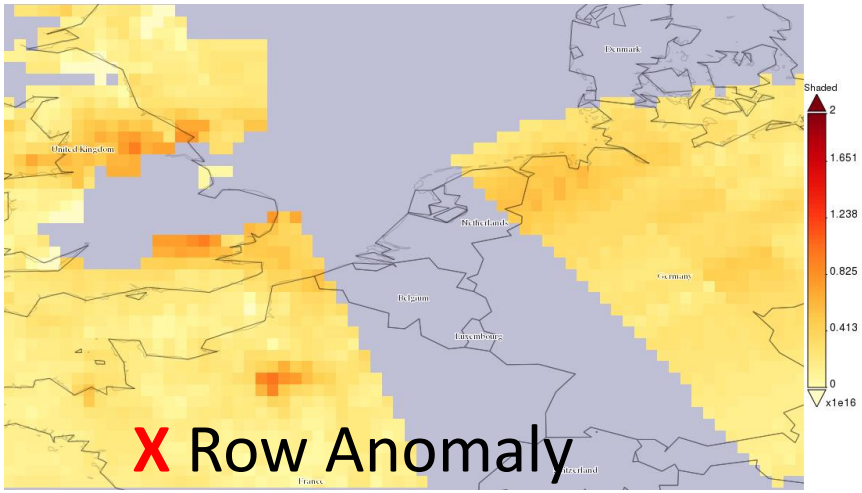


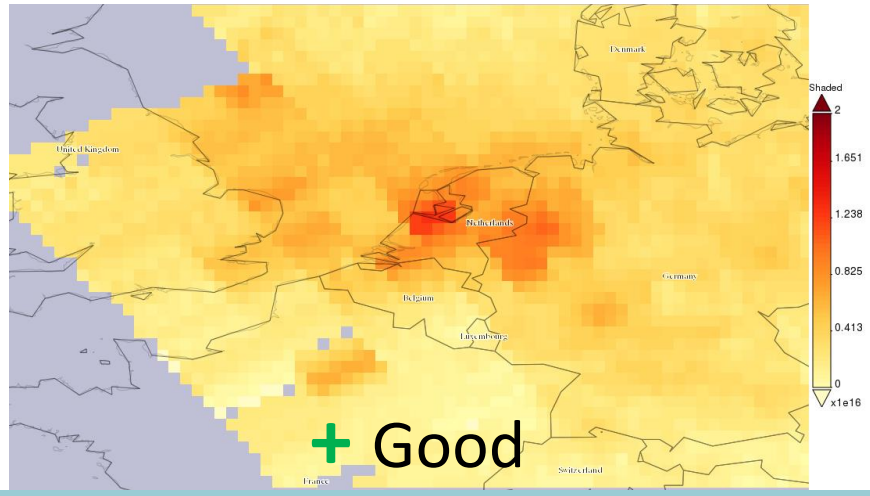
Determining the 'Best' Days for OMI

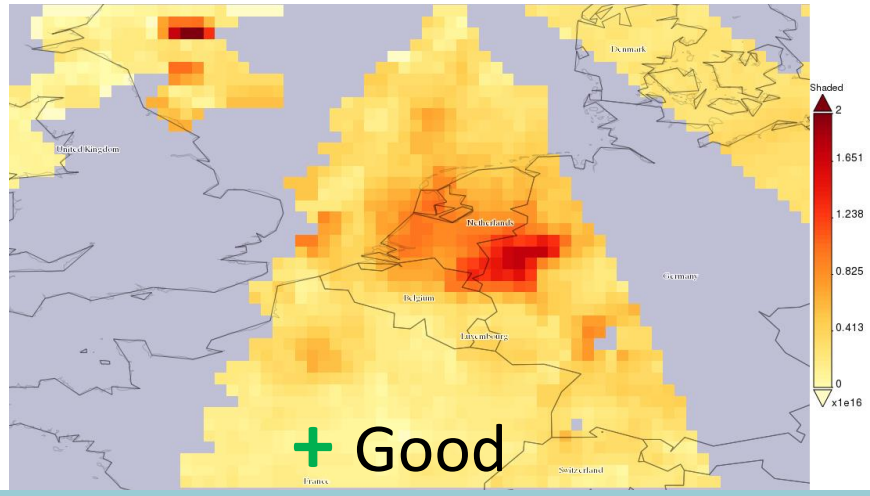
Second Cabauw Intercomparison of Nitrogen Dioxide Measuring Instruments

2016_0904, 0907, 0908, 0927, OMNO2d Tropospheric Column L3





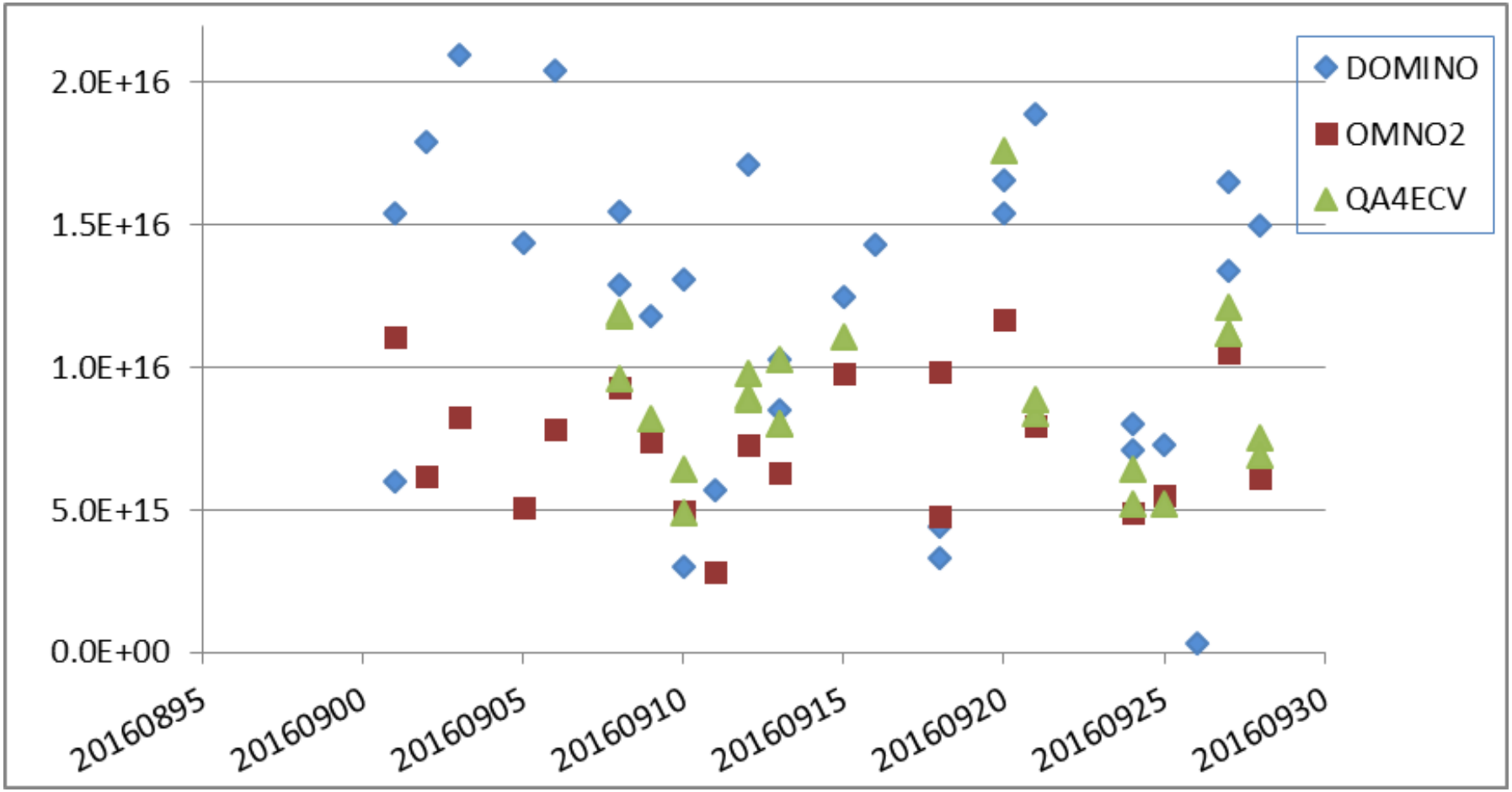




Overpass files for 3 OMI Retrievals

Second Cabauw Intercomparison of Nitrogen Dioxide Measuring Instruments

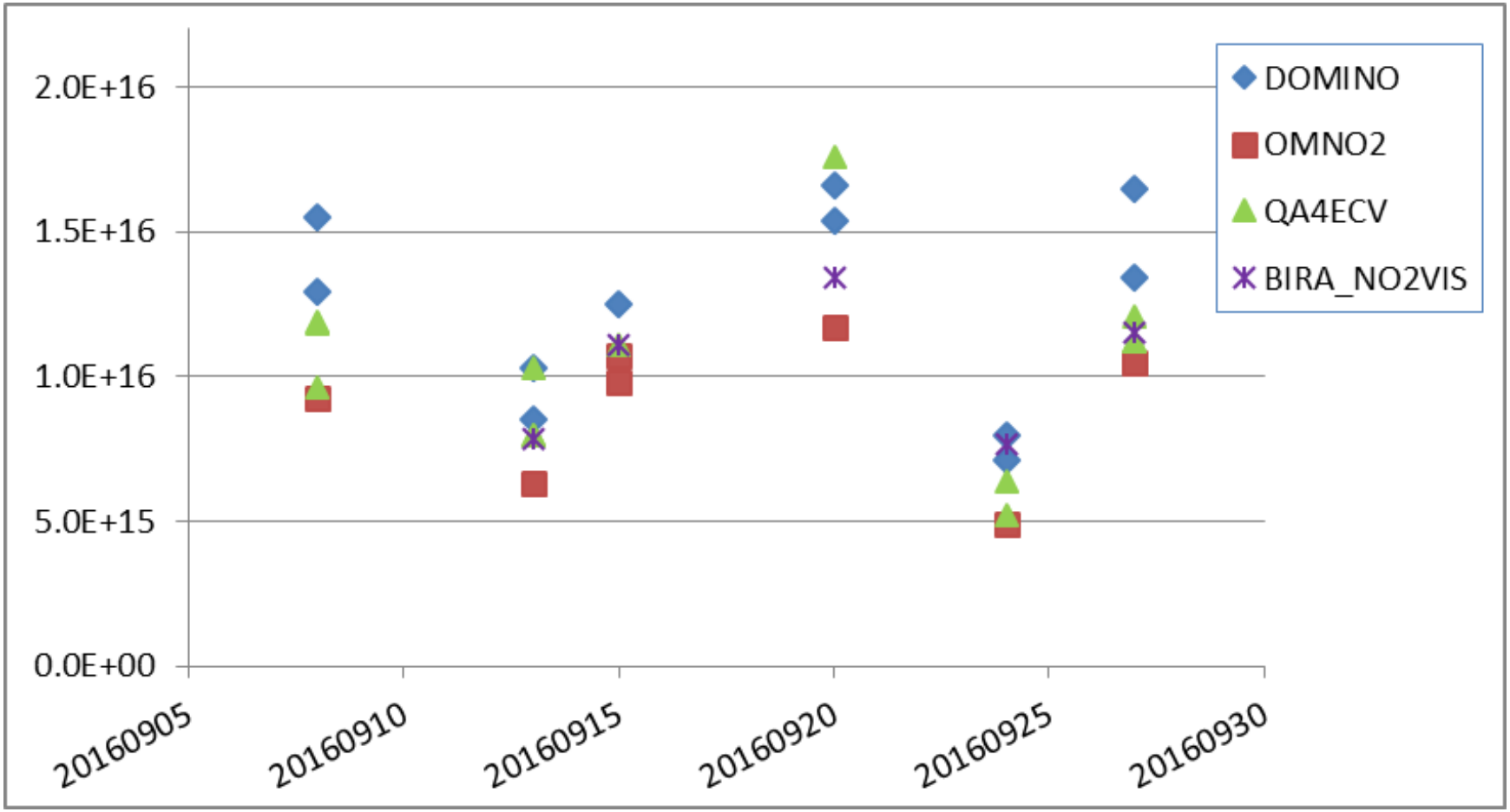
NO_2 Tropospheric Vertical Column Density for September @ Cabauw



OMI + MAX-DOAS on 'Best' Days

Second Cabauw Intercomparison of Nitrogen Dioxide Measuring Instruments

NO_2 Tropospheric Vertical Column Density for "Best" days @ Cabauw



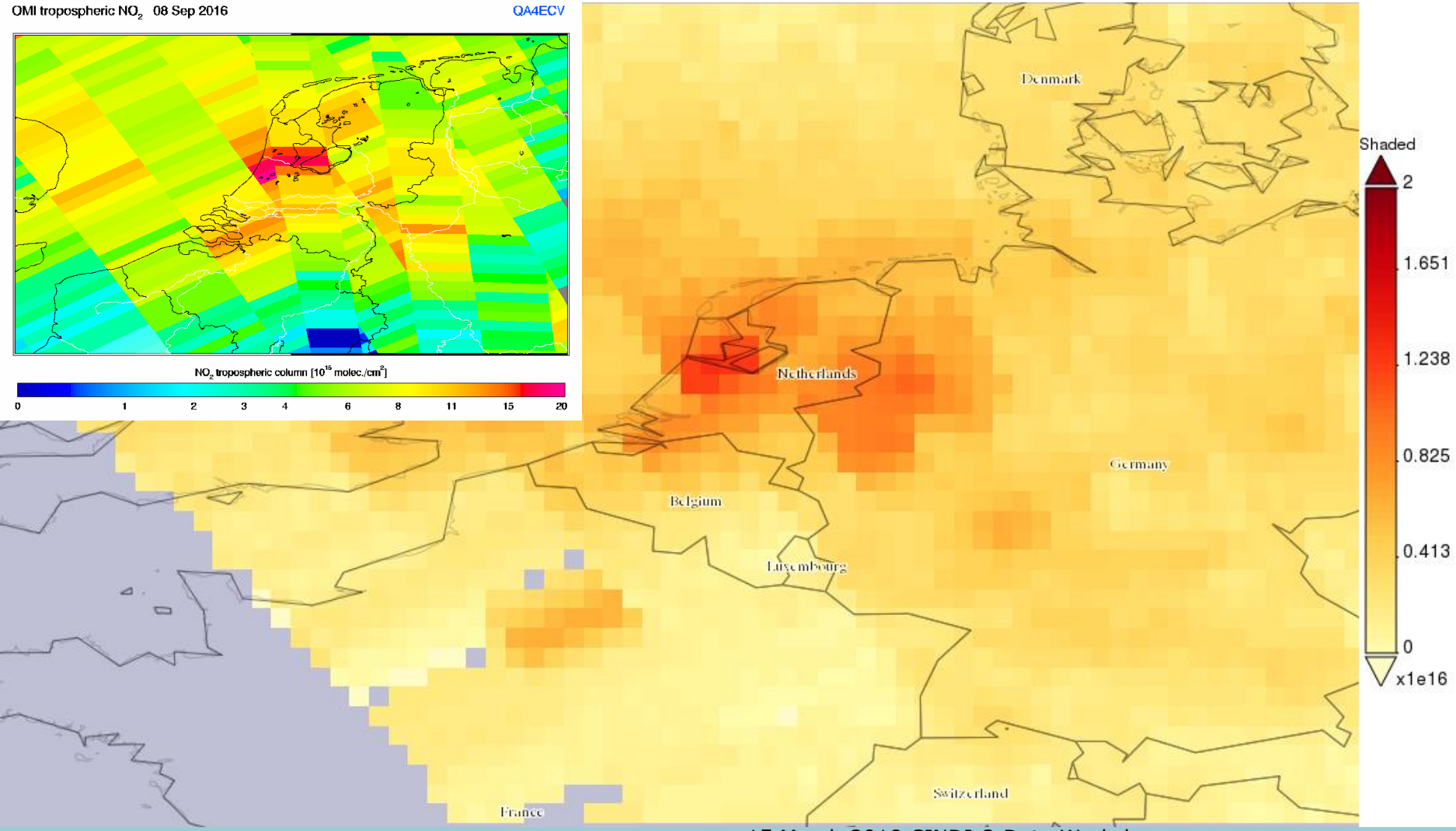
BIRA MAX-DOAS data courtesy of Francois Hendrick

Summary

Date	Coverage	Ground [molec/cm2]	QA4ECV [molec/cm²]	OMNO2 [molec/cm²]	DOMINO [molec/cm²]
30-Aug	very good		**8.5** (2) (2.7)	**6.9** (2) (2.01)	**12.5** (1) (10.6)
08-Sep	very good		**11.1** (3) (2.8)	**9.3** (1) (2.49)	**14.2** (2) (5.30)
13-Sep	very good	**7.8** (6) (1.41)	**8.8** (3) (2.3)	**6.3** (1) (2.35)	**9.4** (2) (3.00)
15-Sep	good	**11.1** (6) (1.99)	**11.1** (1) (3.0)	**10.3** (2) (2.69)	**12.5** (1) (12.3)
20-Sep	more clouds	**13.4** (6) (2.41)	~~**17.6** (1) (4.6)~~	**11.7** (1) (5.55)	**16.0** (2) (11.1)
24-Sep	very good	**7.7** (6) (1.39)	**5.8** (2) (1.8)	**4.9** (1) (2.04)	**7.6** (2) (6.50)
27-Sep	good	**11.5** (6) (2.07)	**11.5** (3) (3.1)	**10.5** (1) (2.89)	**15.0** (2) (14.8)

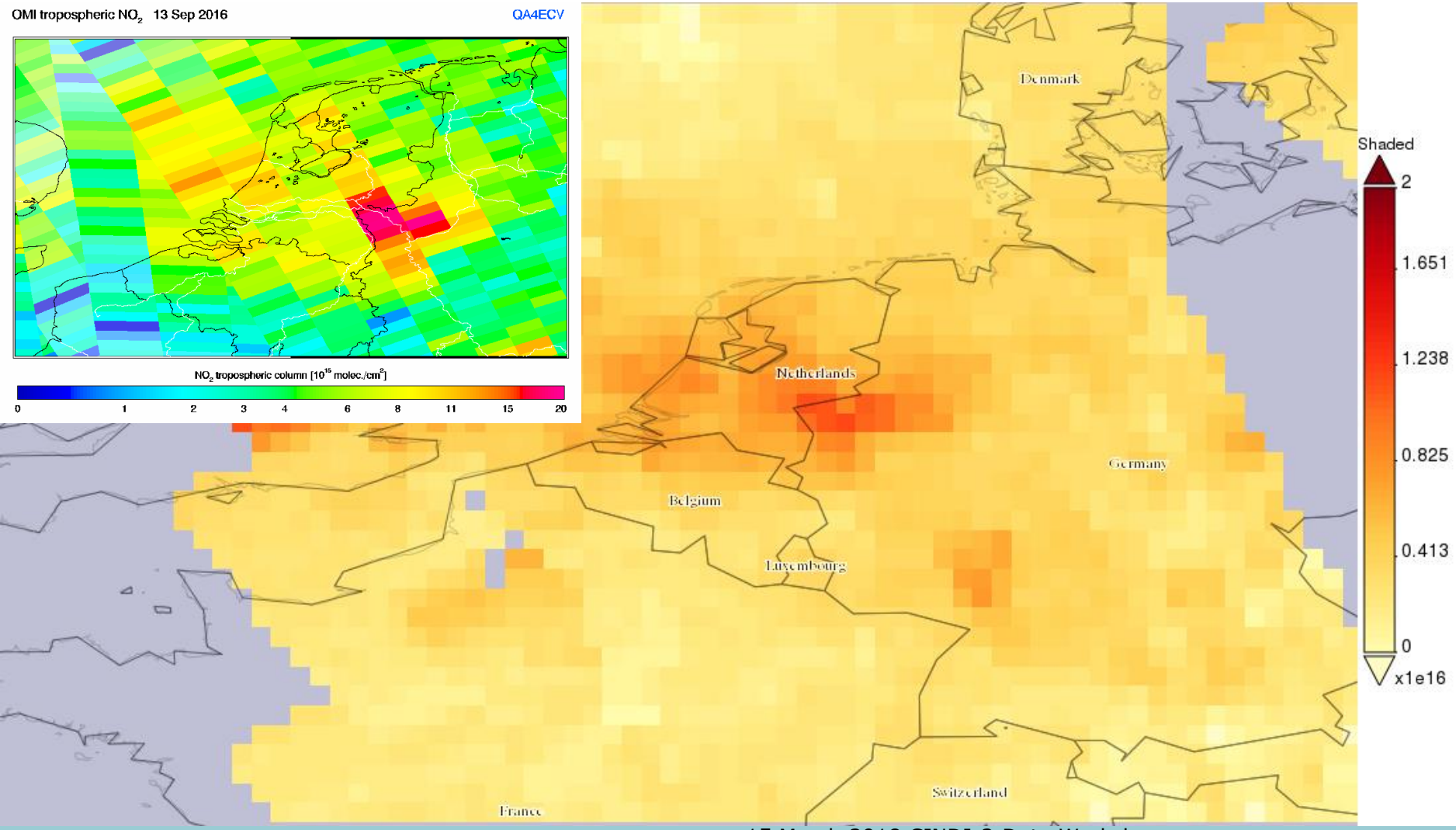
OMI NO_2

2016_0908, OMNO2d Tropospheric Column L3



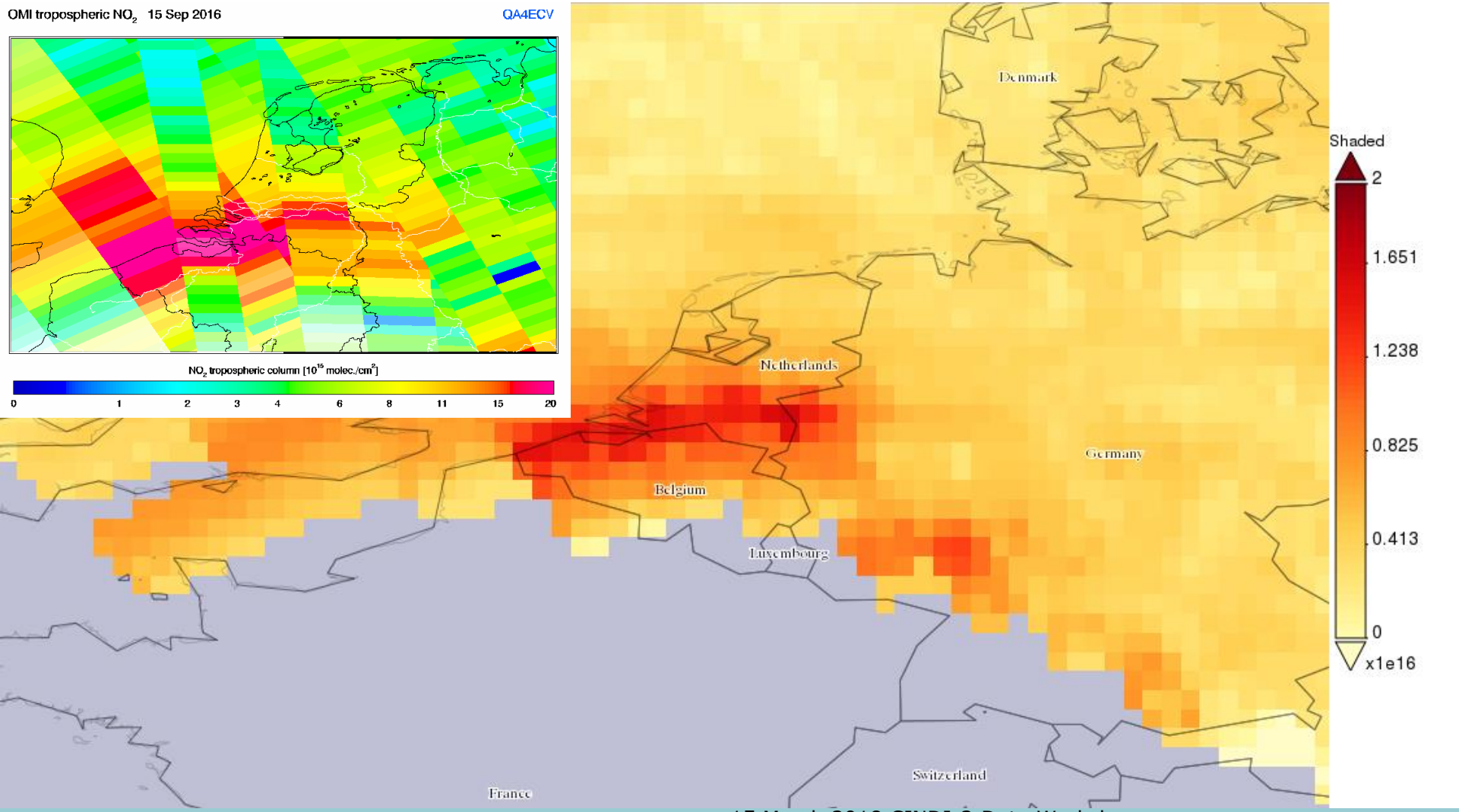
OMI NO_2

2016_0913, OMNO2d Tropospheric Column L3



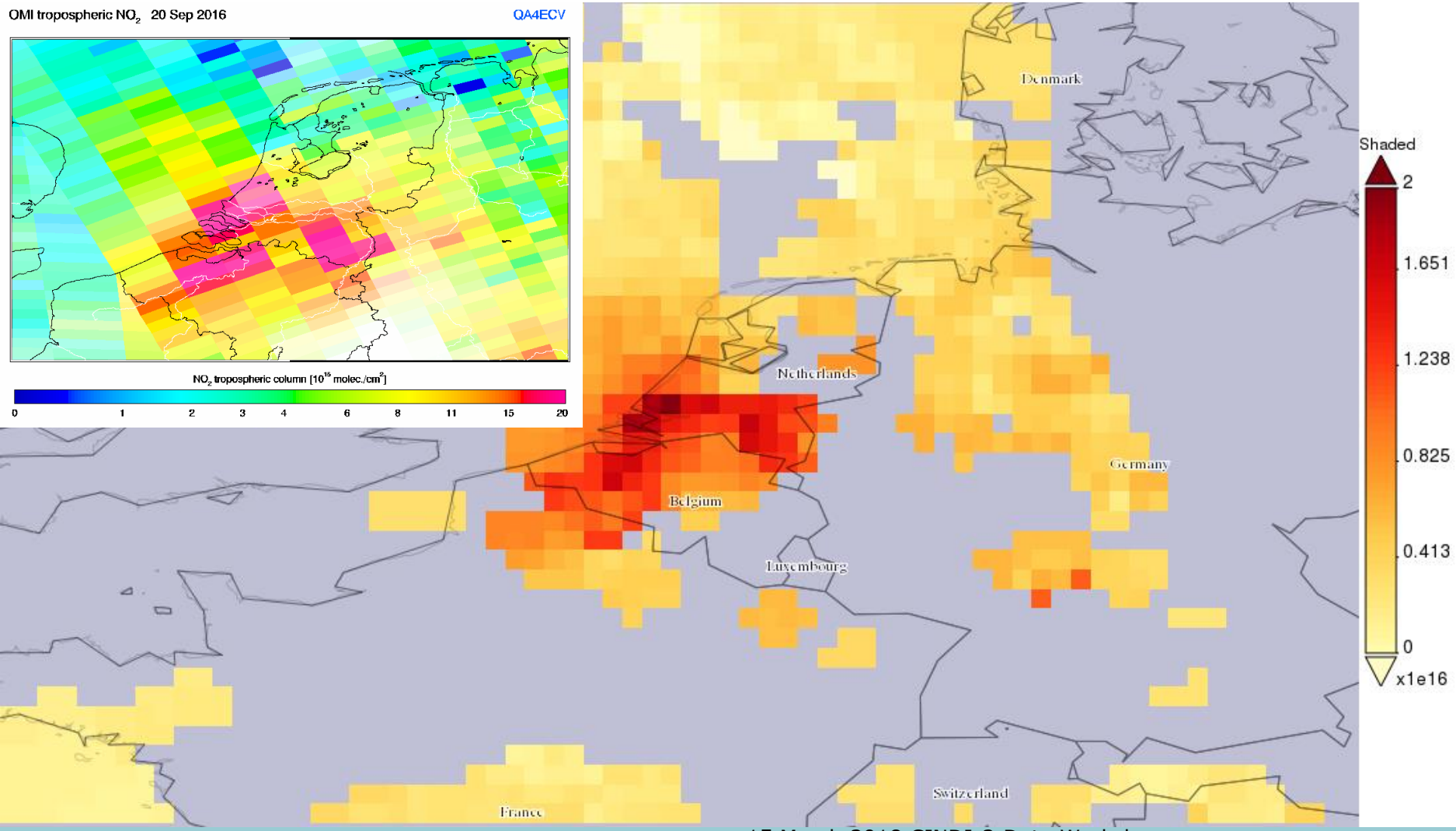
OMI NO_2

2016_0915, OMNO2d Tropospheric Column L3



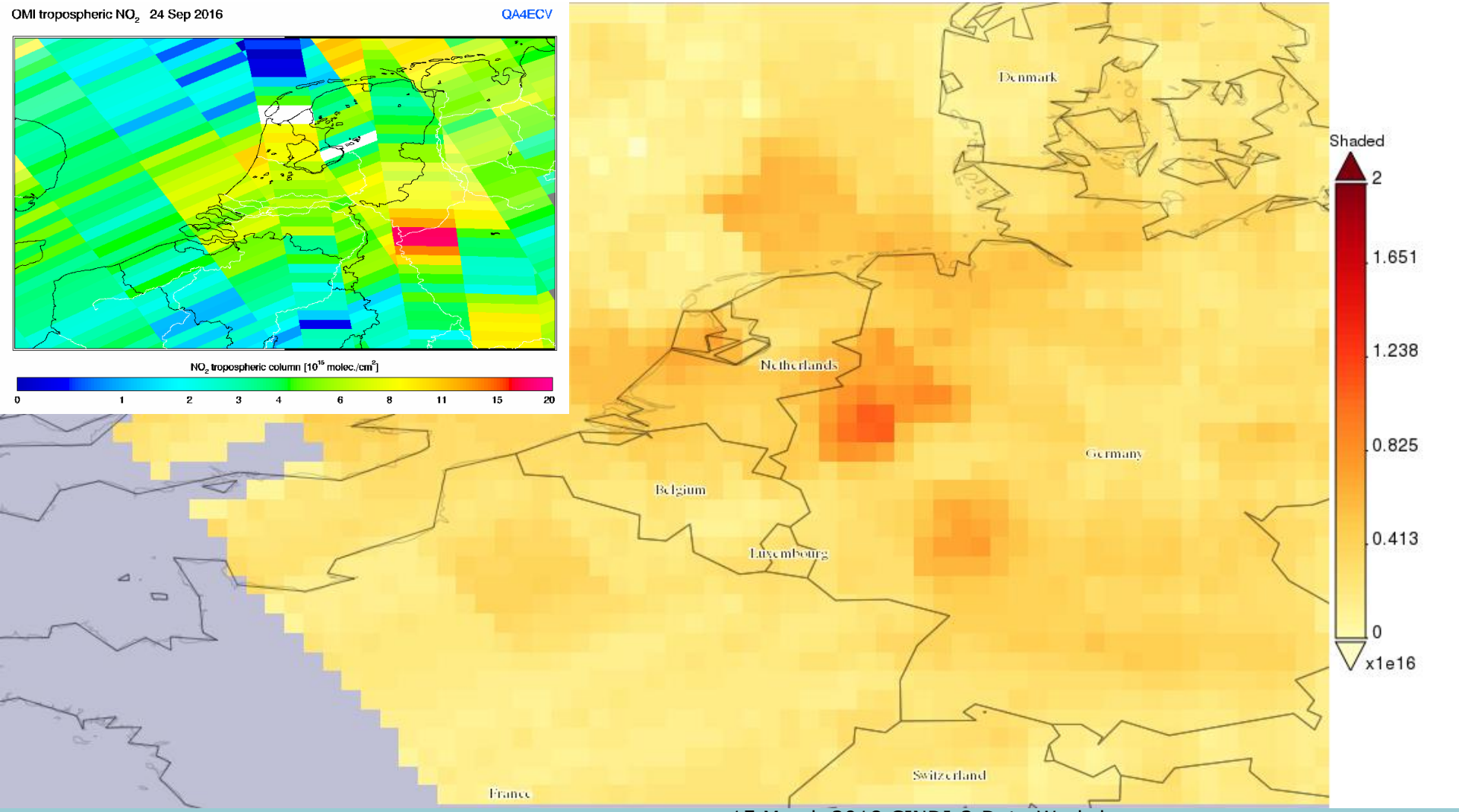
OMI NO_2

2016_0920, OMNO2d Tropospheric Column L3



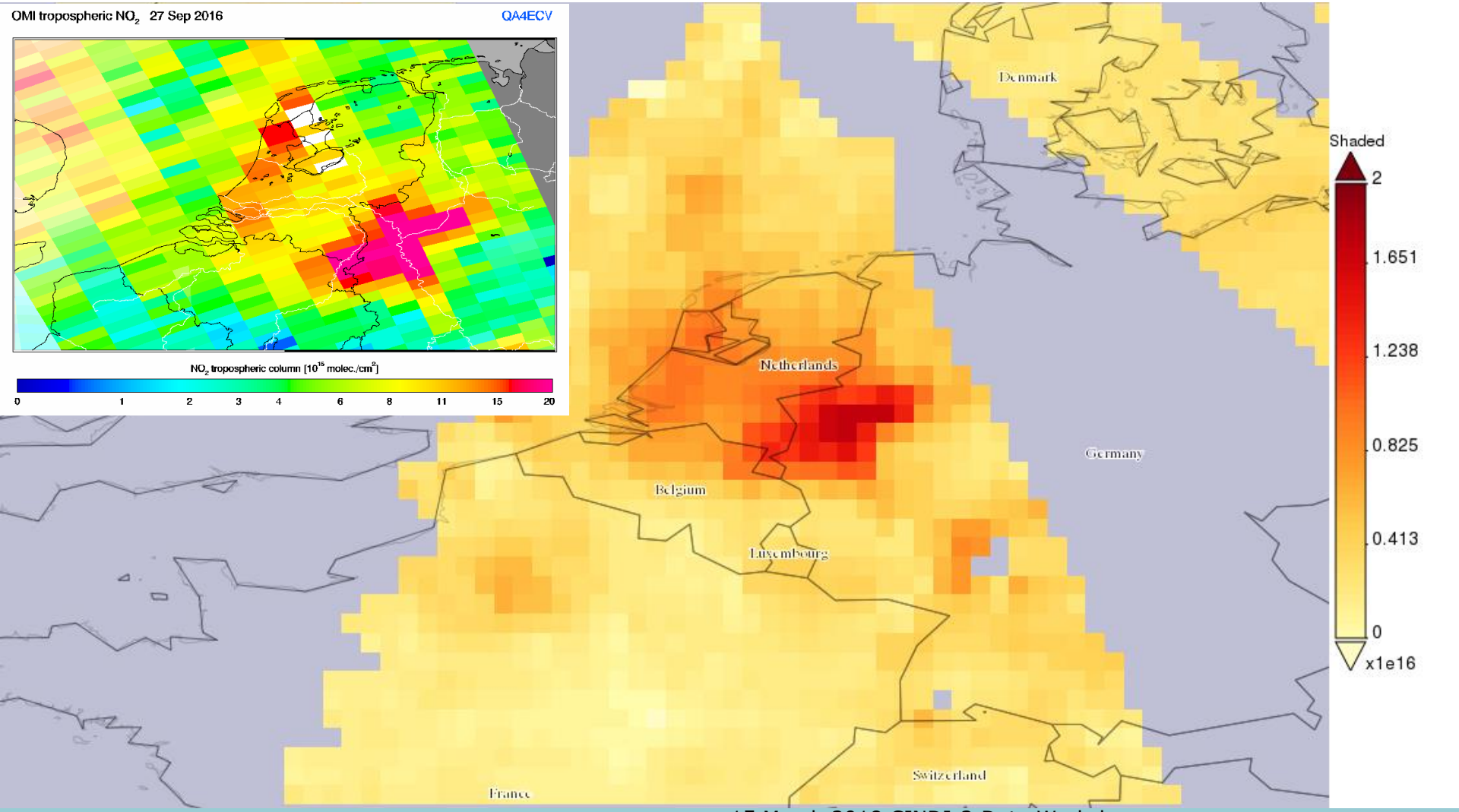
OMI NO_2

2016_0924, OMNO2d Tropospheric Column L3



OMI NO_2

2016_0927, OMNO2d Tropospheric Column L3



Conclusions & future

Second Cabauw Intercomparison of Nitrogen Dioxide Measuring Instruments

OMI's "Best" Days provide good basis for CINDI-2 validation/verification

- these days cover a range of NO2 column amounts, also one "less-than-golden" day with more clouds
- The improved QA4ECV dataset agree the best with ground-based MAX-DOAS

FUTURE:

Slant column comparisons

Further analysis of *a priori* profiles, averaging kernel (DOMINO) and NO_2-sonde profiles

Analysis of OMI zoom-mode data from 16 September over Cabauw

Comparison OMI to GOME-2 for more diurnal information

S5P/TROPOMI Campaign at Cabauw

Timing:

- Late Spring/Early Summer 2019

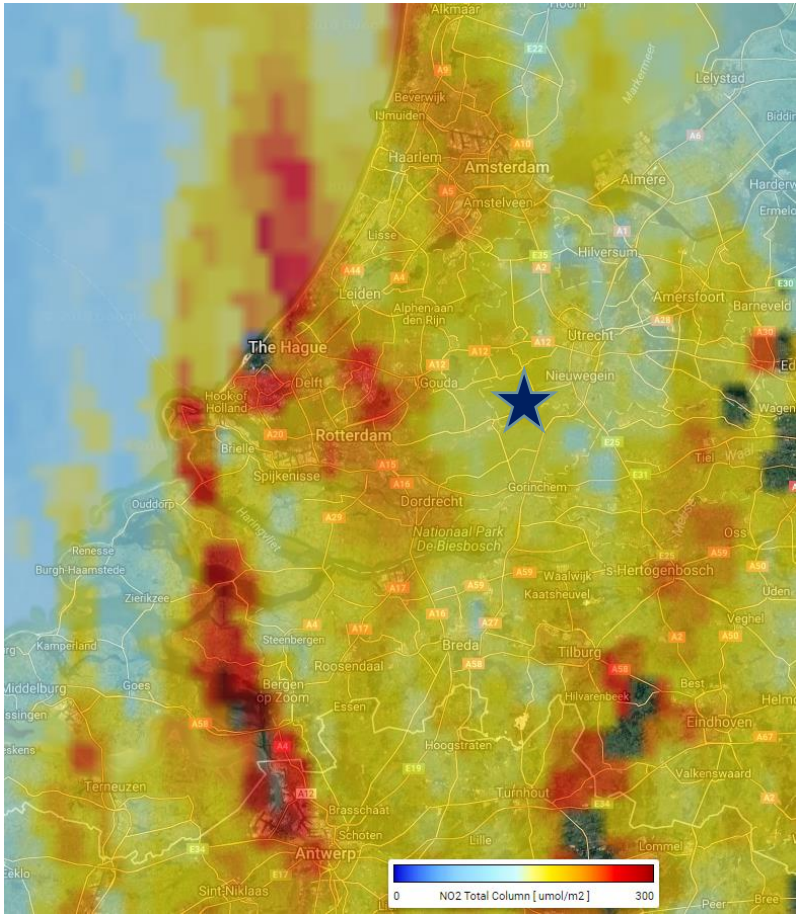
Objectives:

- Spatial variability within a TROPOMI pixel for more than NO_2
- Mobile & Aircraft platforms welcome!

- Effect of clouds and aerosols on trace gas retrievals
- Quantifying mixed cloudy days

- Evaluate spectral albedo effects in more detail
  - Looking for instrumentation

- **Work with stations with instruments calibrated during CINDI-2,** for faster data delivery



Model information available

Second Cabauw Intercomparison of Nitrogen Dioxide Measuring Instruments

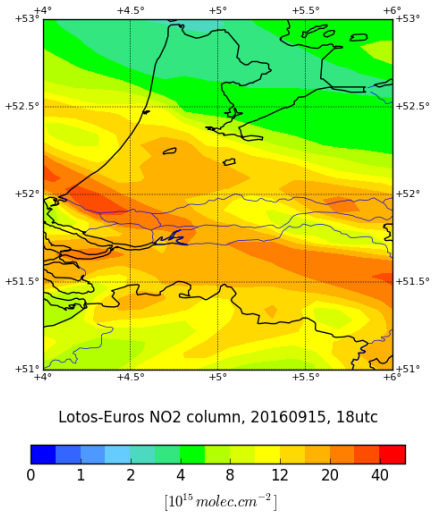
Specifications:

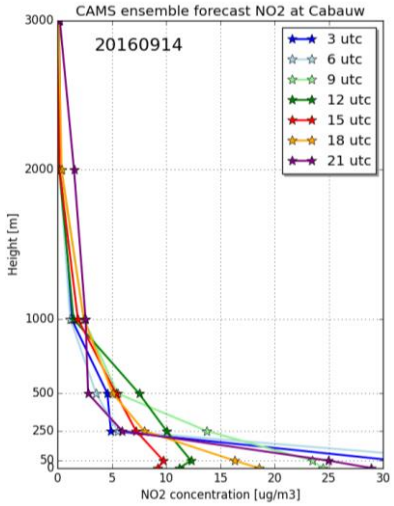
CAMS-regional

- Models: Ensemble,
- (Chimère, Emep, Eurad, Lotos-Euros, Match, Mocage, Silam)
- 0.1 x 0.1 degree resolution

Dutch air quality forecasts

- LOTOS-EUROS model,
- 7km resolution, hourly output



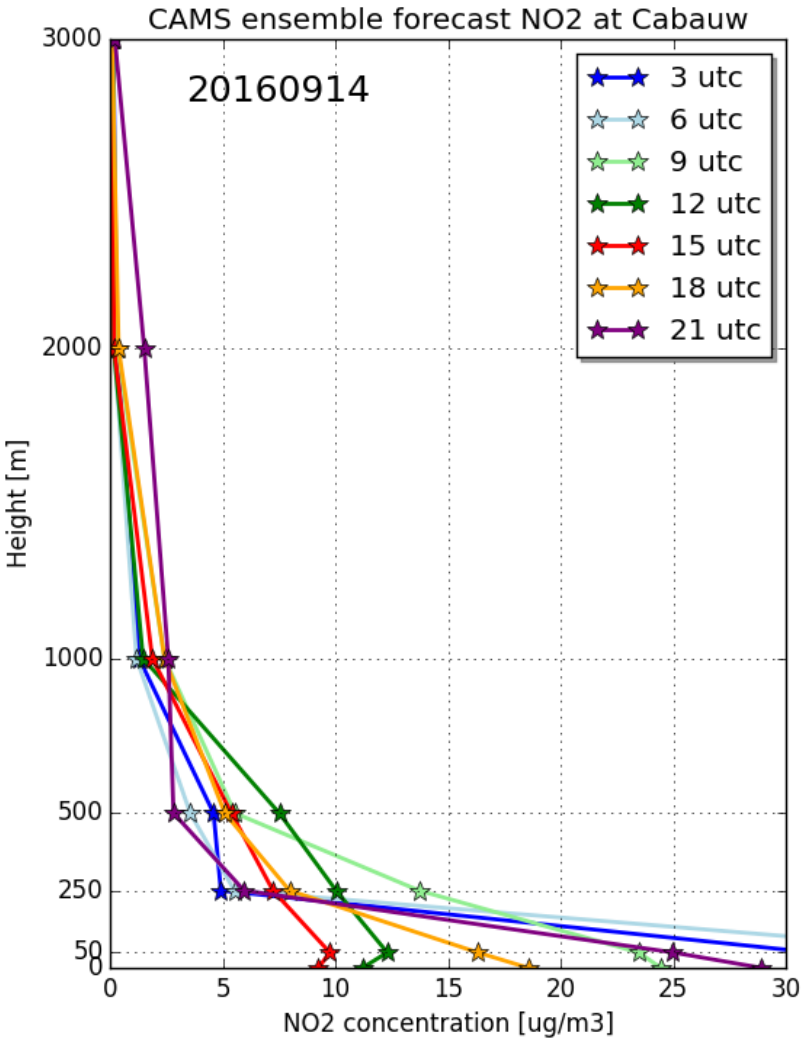


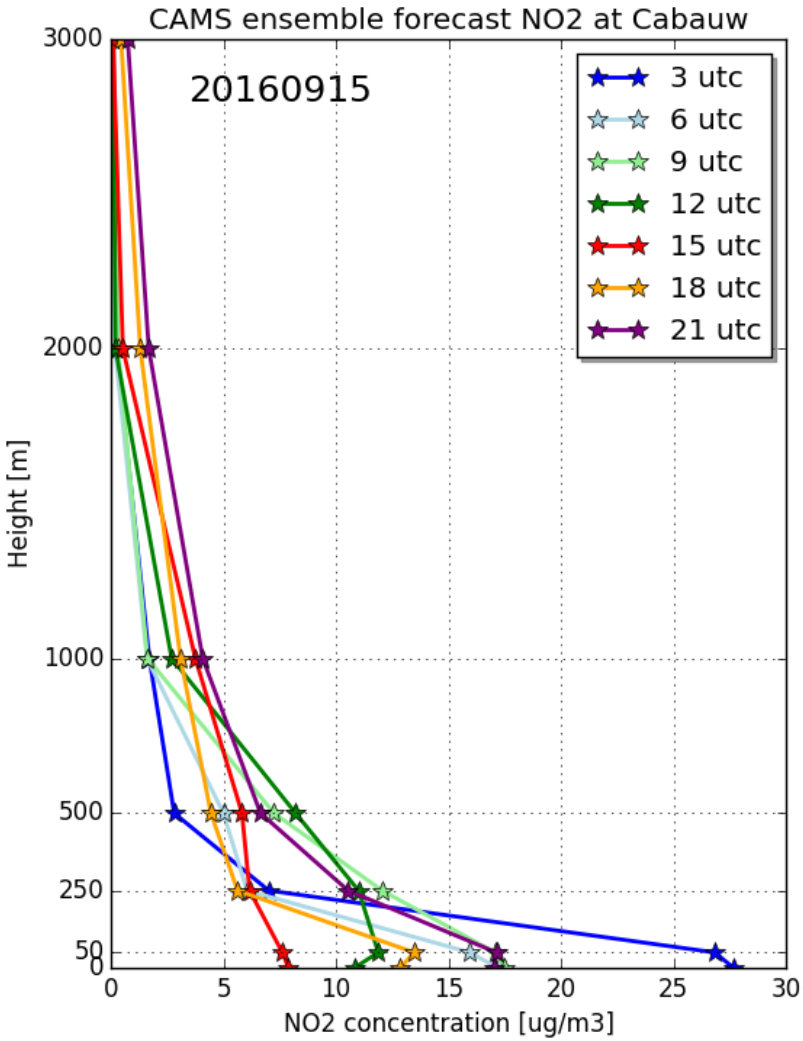
Please contact Henk Eskes – KNMI for any data, image requests:

eskes@knmi.nl

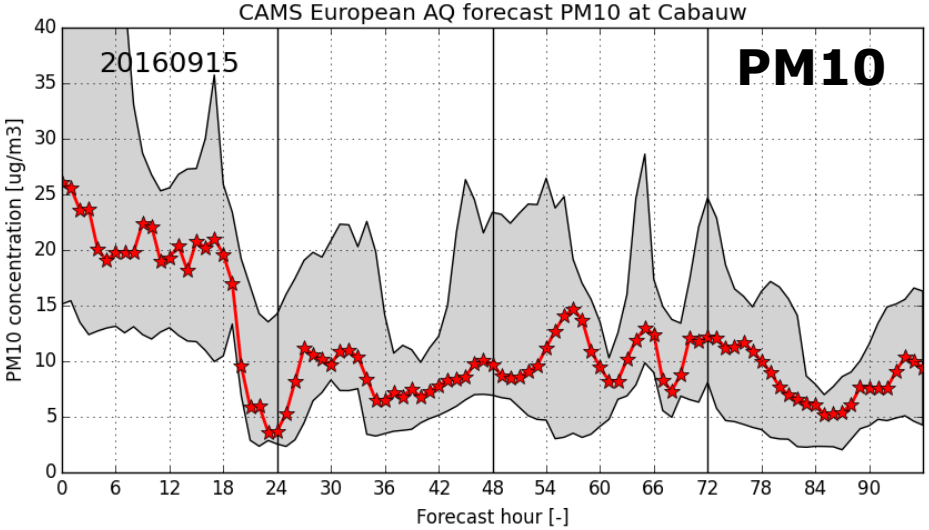
Extra slides

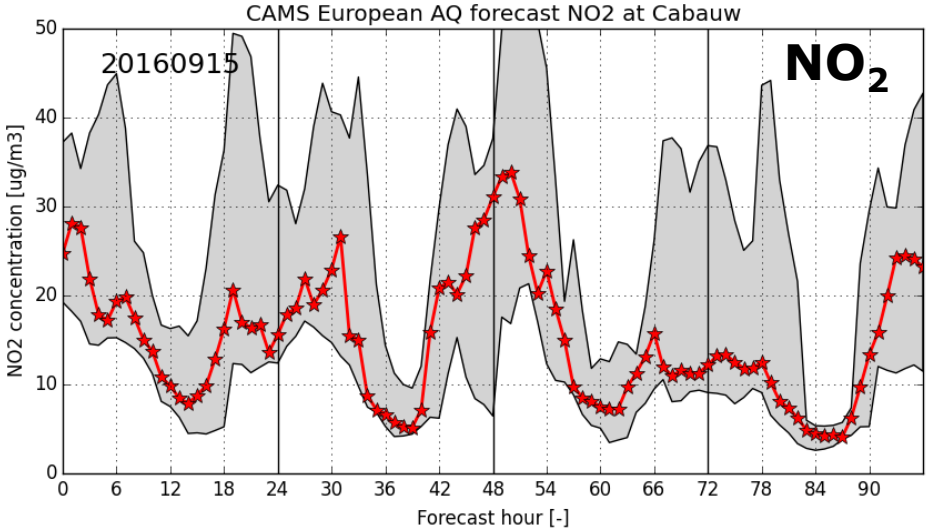
CAMS NO_2 profiles



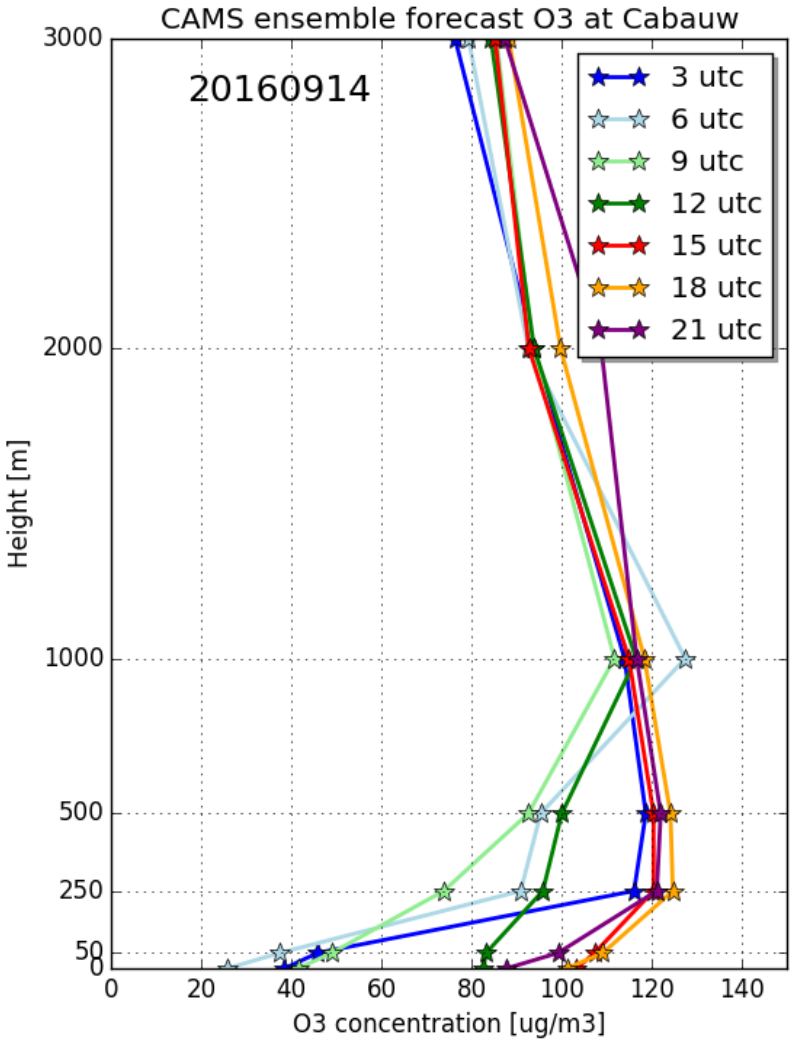


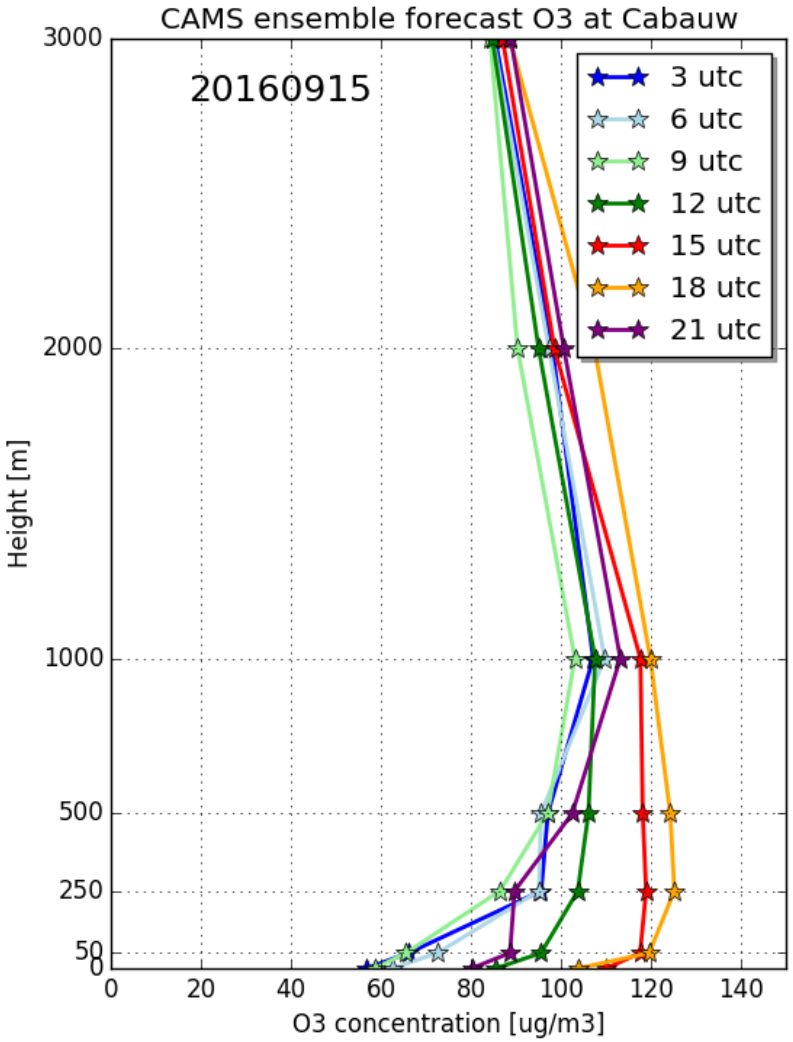
CAMS time series



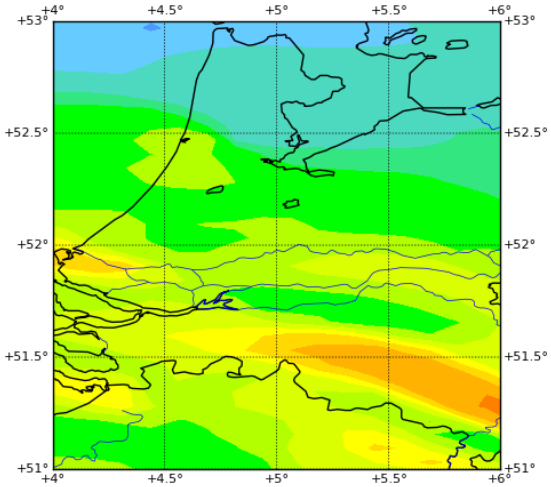


CAMS O_3 profiles



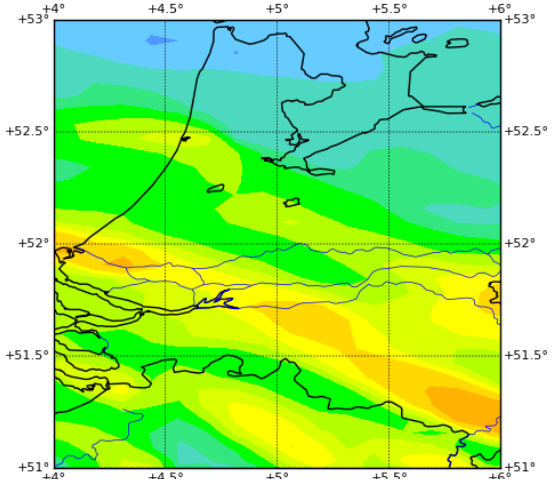


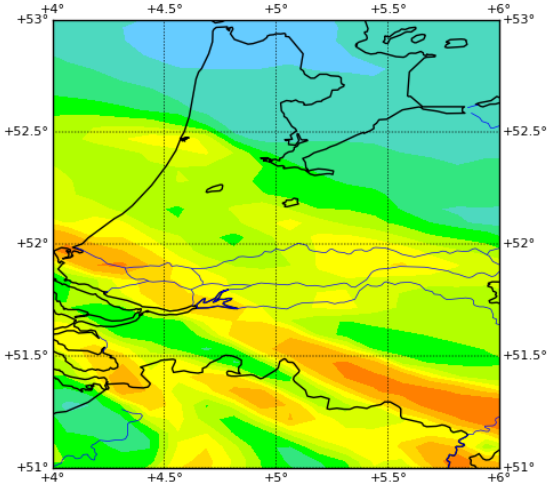
Forecast NO_2 column, LOTOS-EUROS 15 Sep



9 UTC

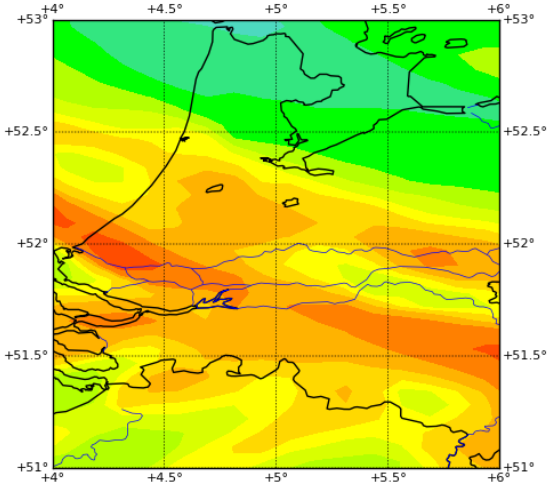
12 UTC



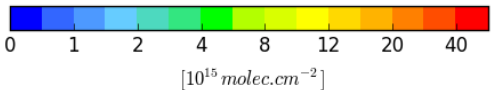


15 UTC

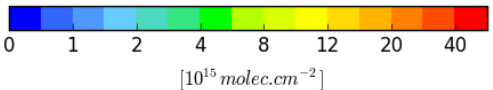
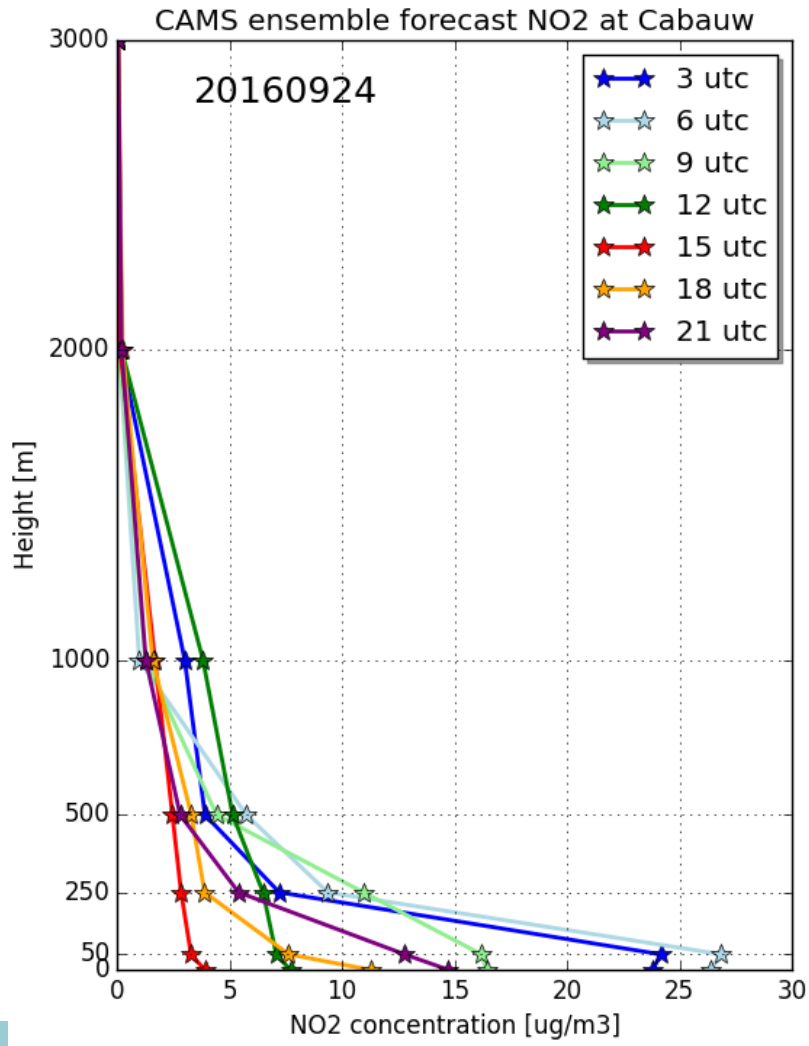
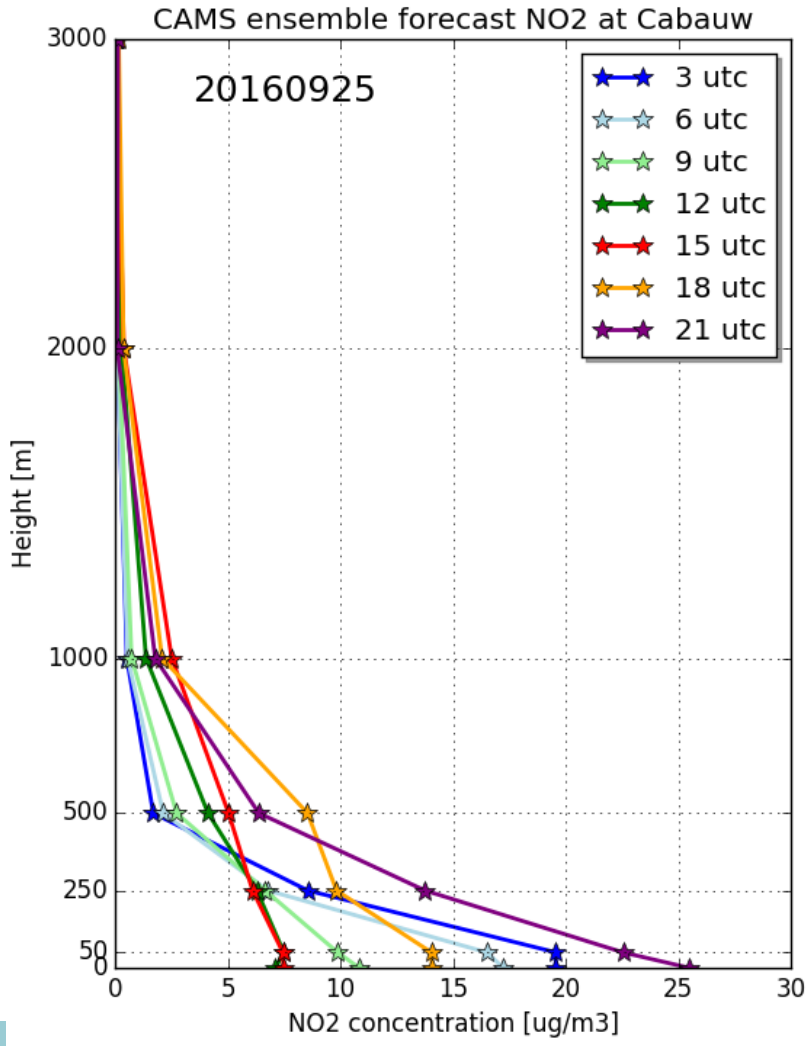
18 UTC



Lotos-Euros NO2 column, 20160915, 15utc



Lotos-Euros NO2 column, 20160915, 18utc



CAMS NO_2 profiles