EVALUATION OF DISCREPANCIES IN THE ANTHROPOGENIC NOX EMISSION TRENDS ACROSS EUROPE

SYNERGISTIC USE OF LOTOS-EUROS AND REMOTE SENSING NO2 TROPOSPHERIC COLUMNS |

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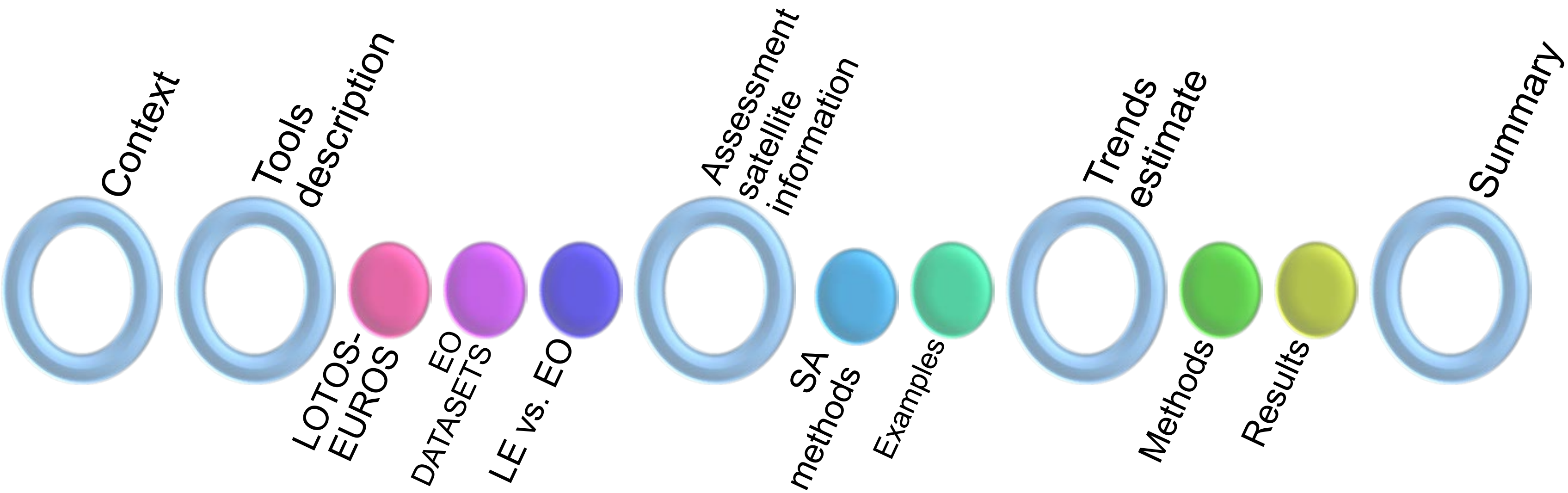
TNO innovation for life

CONTENT



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CONTEXT

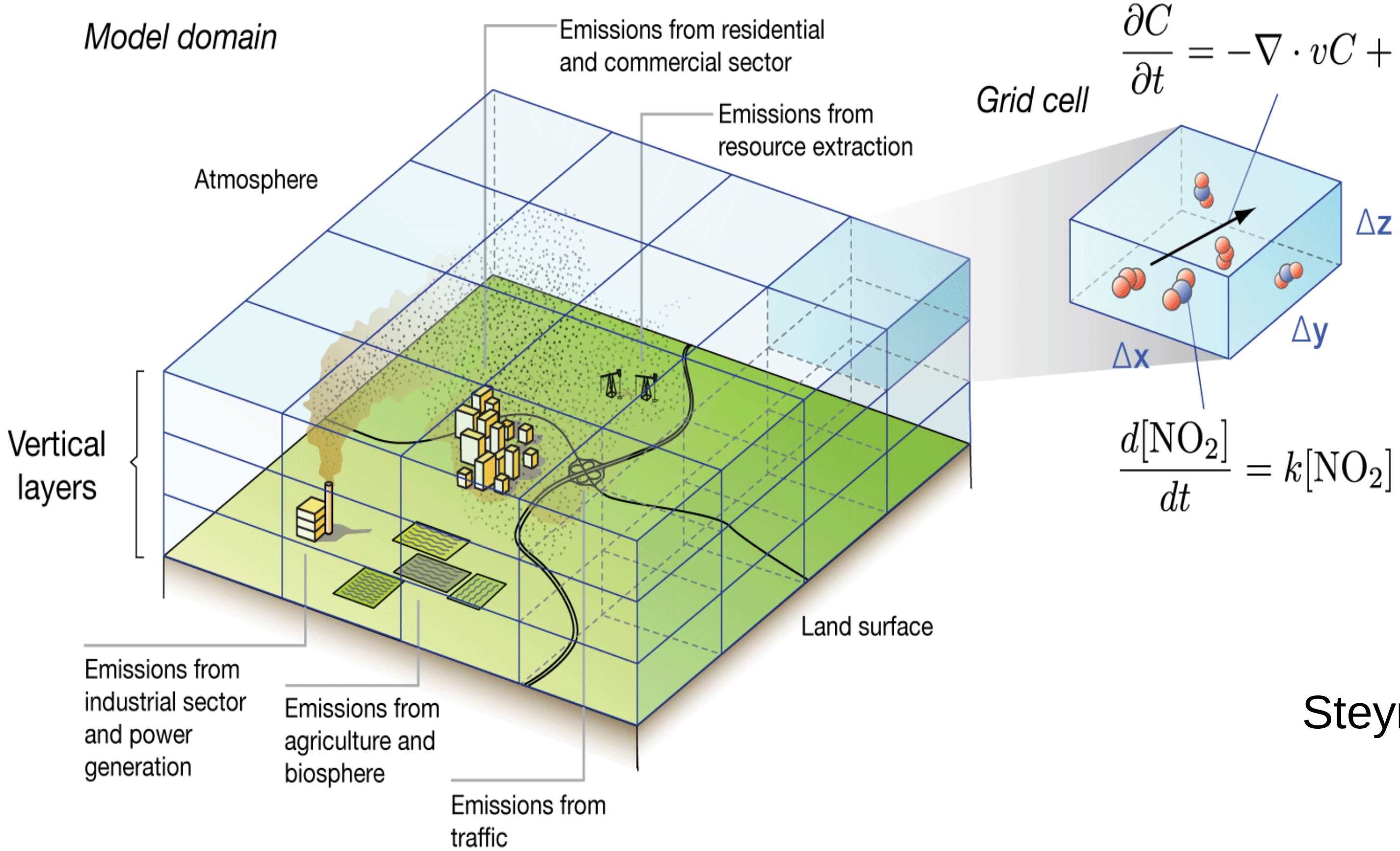
We evaluate the discrepancies in the anthropogenic NOx emission trends across Europe derived from OMI and GOME-2 datasets and the LOTOS-EUROS chemistry transport model

Goal:

contribute to the verification and improvement of the UNECE/EMEP emission inventory over Europe by synergistic use of satellite data and chemistry transport model

LOTOS-EUROS

chemistry transport model



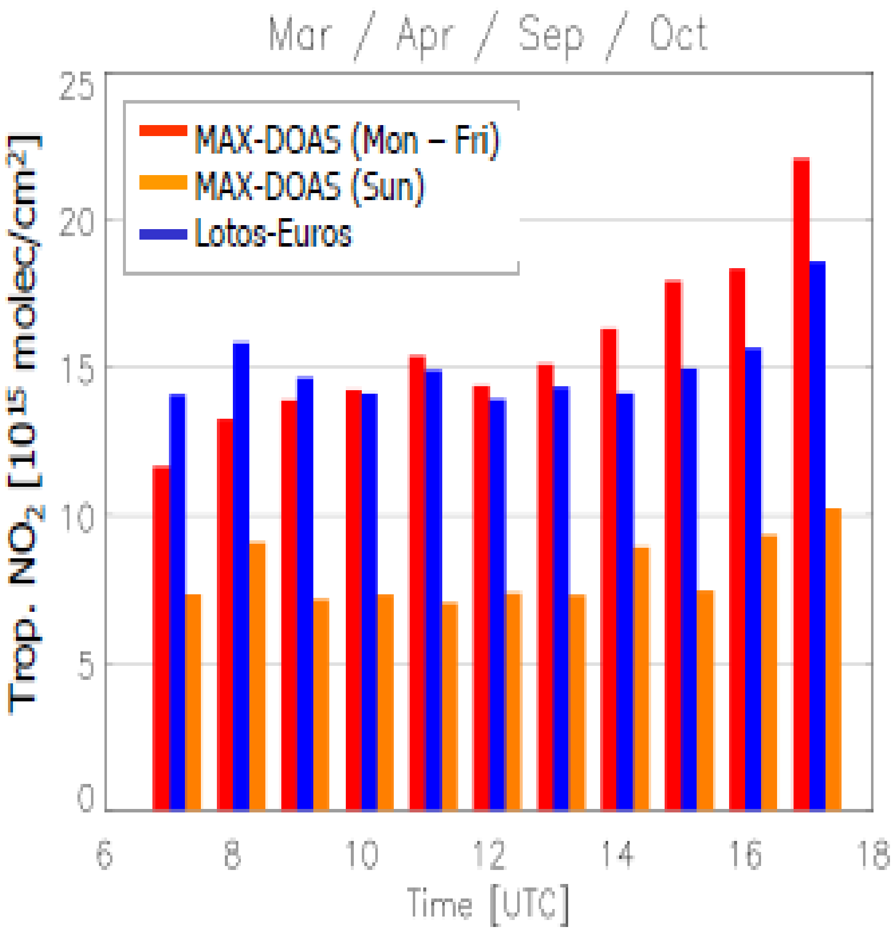
$$\frac{\partial C}{\partial t} = -\nabla \cdot vC + \nabla \cdot KC$$

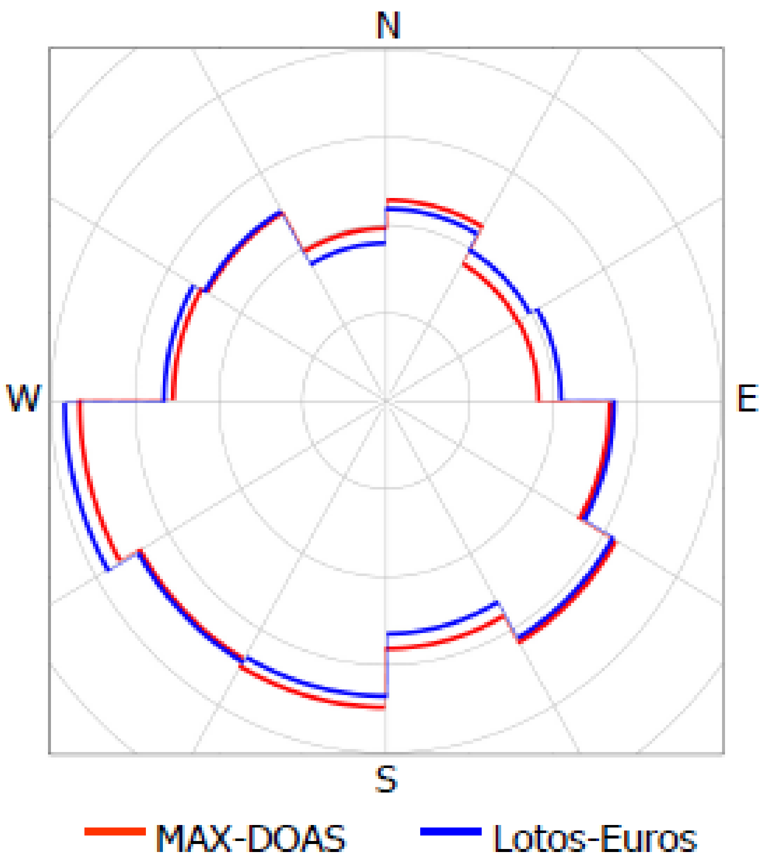
$$\frac{d[\mathrm{NO_2}]}{dt} = k[\mathrm{NO_2}] - J[\mathrm{O_3}]$$

Steyn et al. (2012)

Air quality modelling is the 3-D mathematical prediction of the ambient concentration of pollutant based on available measured inputs.

CABAUW: MAX-DOAS VS. LOTOS-EUROS





Vlemmix et al, 2015, ACP

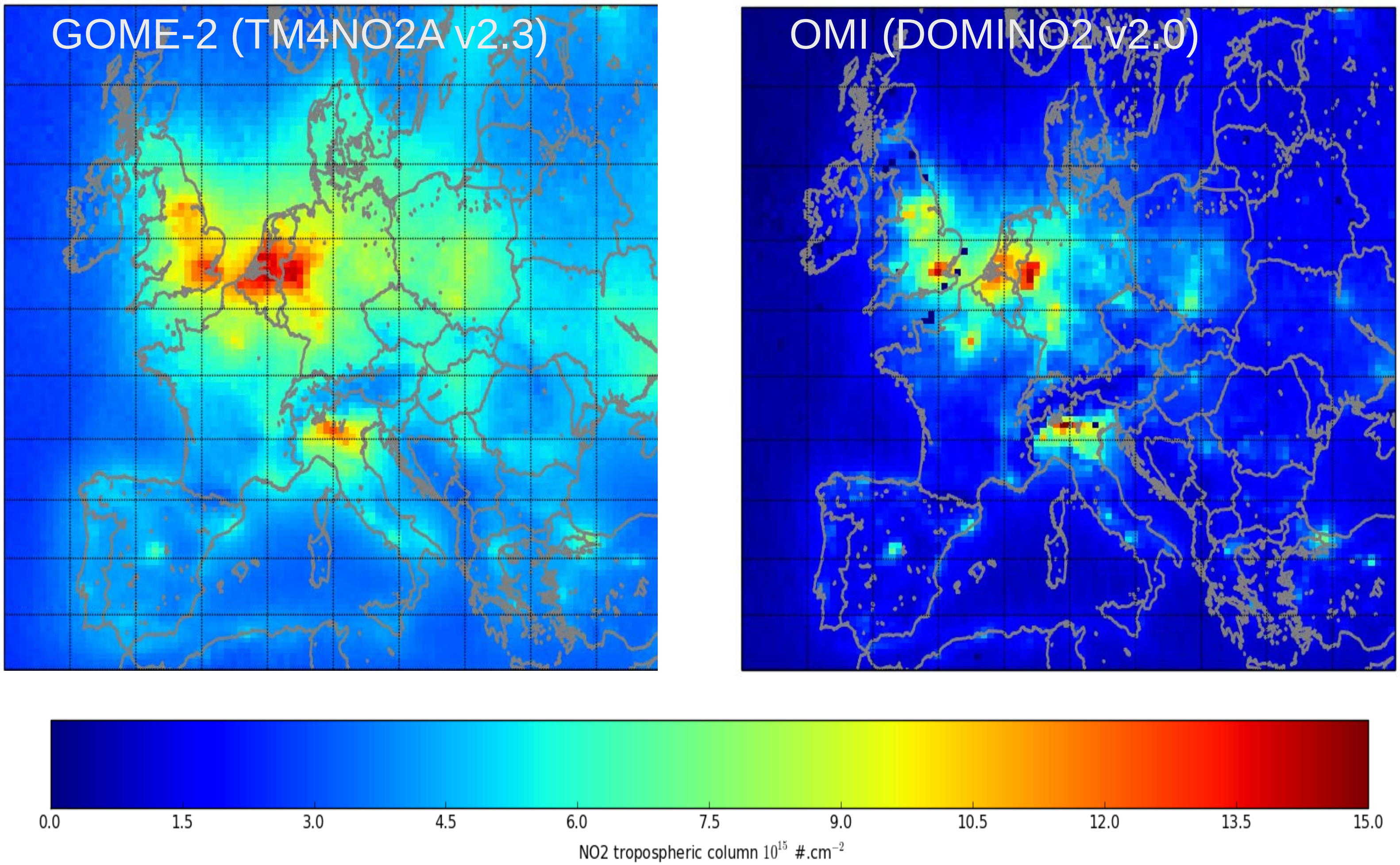
GOME-2 and OMI

- GOME-2 and OMI instrument have a similar temporal sampling frequency
- GOME-2 and OMI instruments are nadir-viewing spectrometers
- OMI (Aura satellite) in July 2004 : spatial resolution of 24×13km
- GOME-2 (METOP-A satellite) in October 2006 spatial resolution of 80×40km
- The local over pass is around 9:30 for GOME-2 and around 13:30 for OMI
- We use the Royal Netherlands Meteorological Institute (KNMI) OMI (DOMINO2 v2.0) and GOME-2 (TM4NO2A v2.3) tropospheric NO2 vertical column density (VCD)
- Data are rejected if cloud frac >0.5 surface albedo >0.3

EARTH OBSERVATION DATASETS

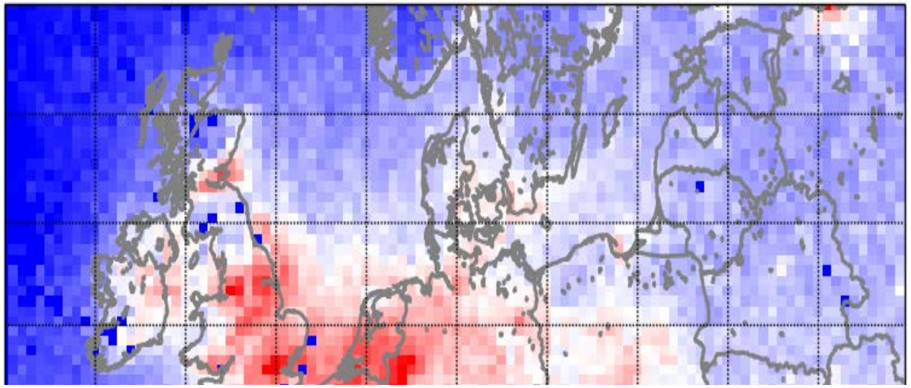
MULTI YEAR AVERAGE OF NO2 VCD ACROSS EUROPE

2007-2013

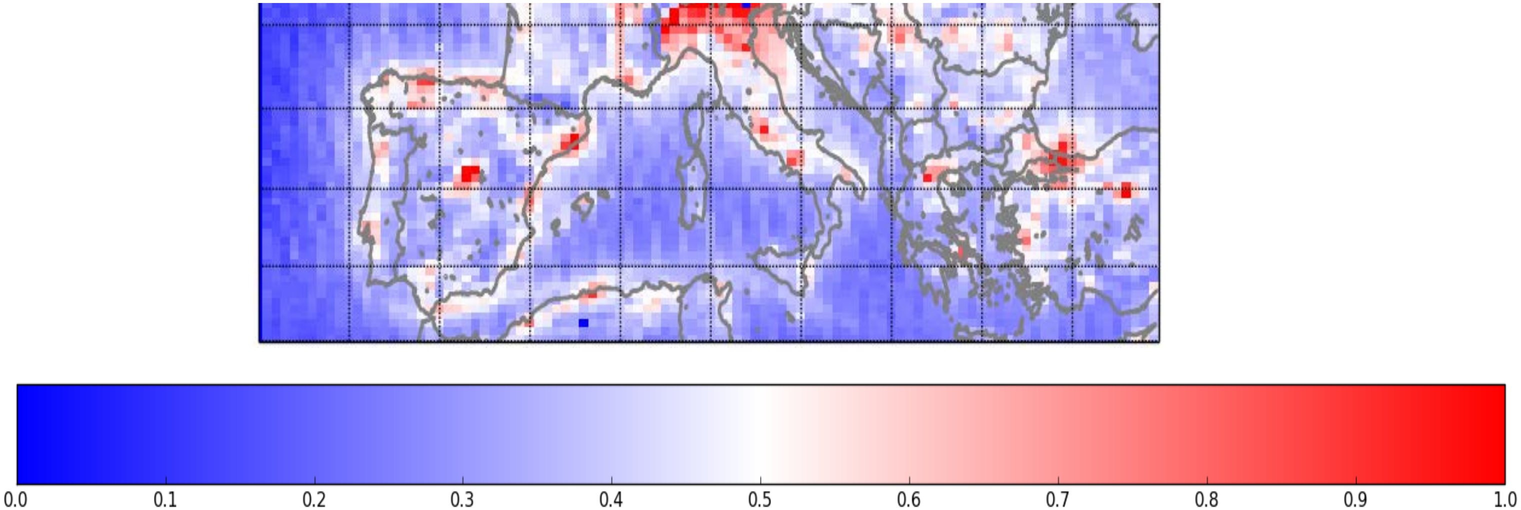


MULTI YEAR AVERAGE RATIO OF NO2

$$\frac{\text{OMI NO2}}{\text{GOME NO2}}$$

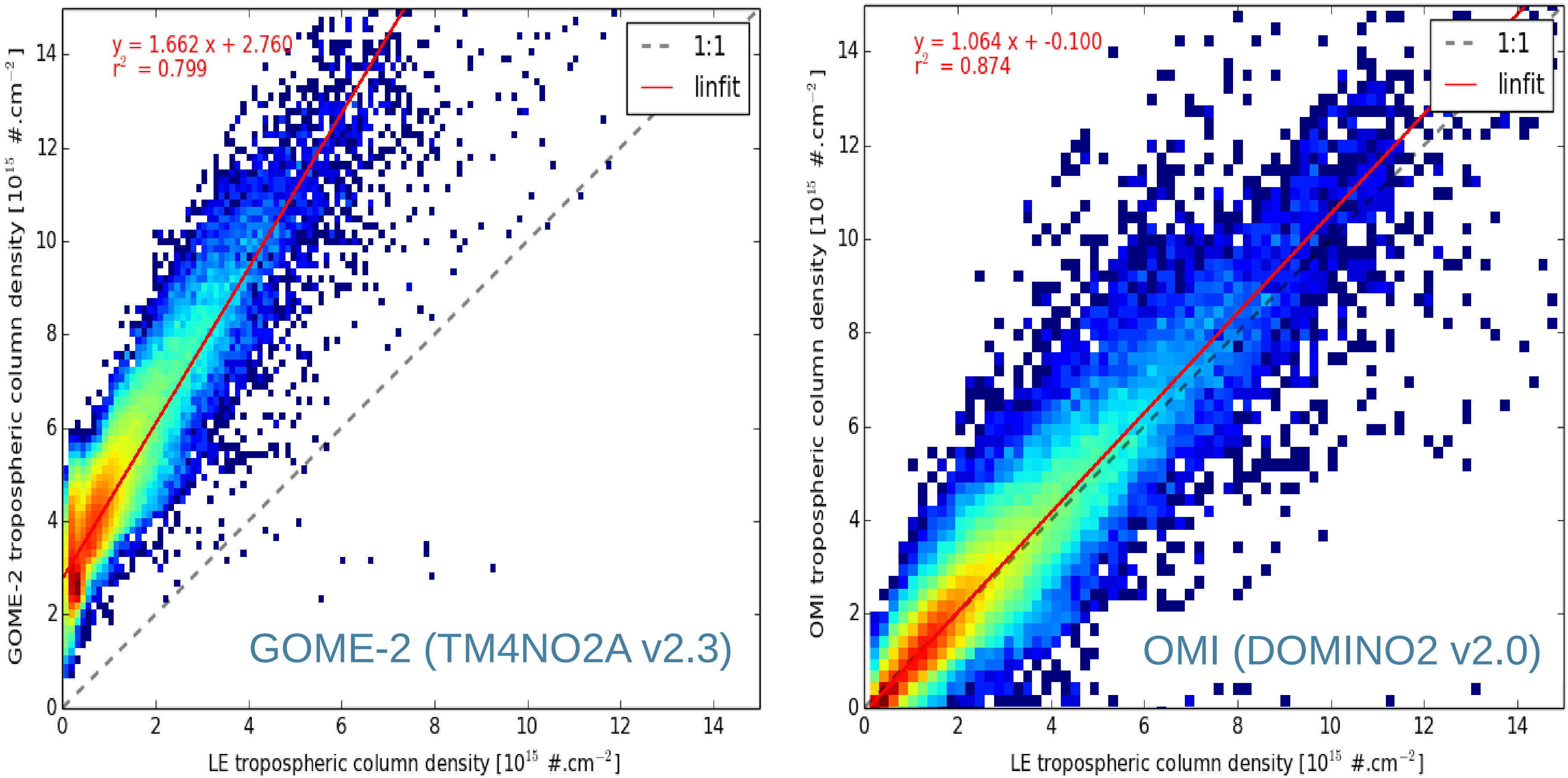


The substantial difference between the two datasets raises an obvious question of consistency in potential science applications to estimate emission strengths. Though trends might be similar.



SIMULATION VS EO DATA

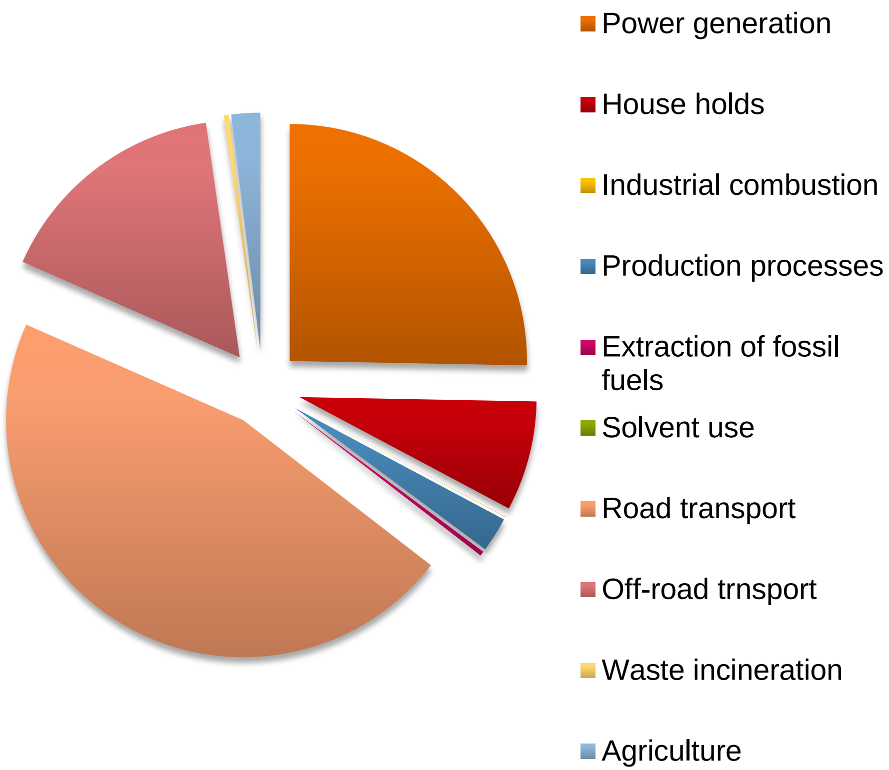
MONTHLY AVERAGE 2007-2013



SOURCE APPORTIONMENT: METHODOLOGY

Source apportionment module makes use of a labelling approach i.e. the contribution of each source for a set of sources is tracked through the model system.

Anthropogenic emission



The emissions are categorized per source sector and time of emission

LOTOS-EUROS run for 2009 over Europe using TNO MACC emission for 2009

Kranenburg et al. (2012)

SOURCE APPORTIONMENT: R-RHUR

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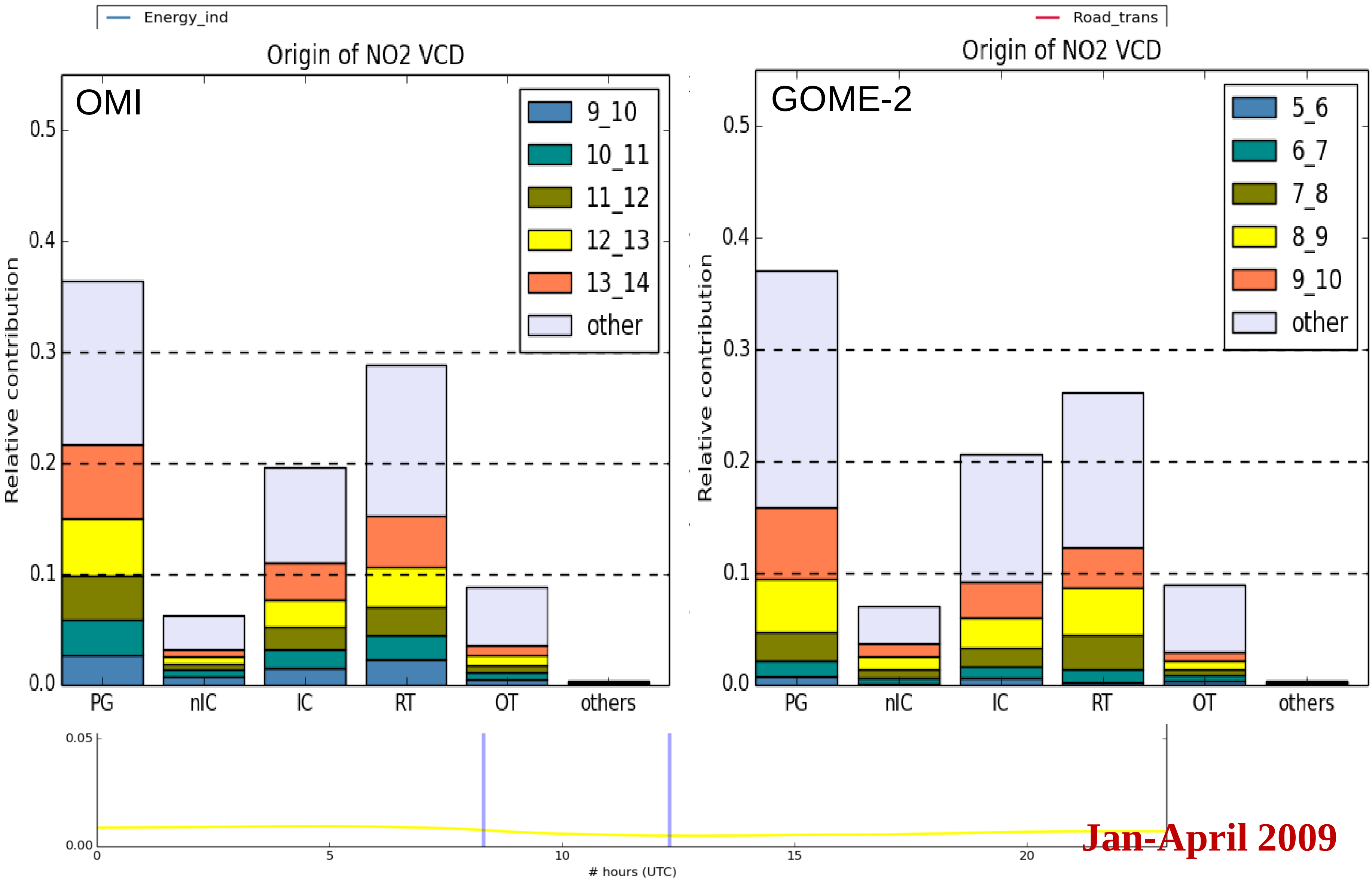
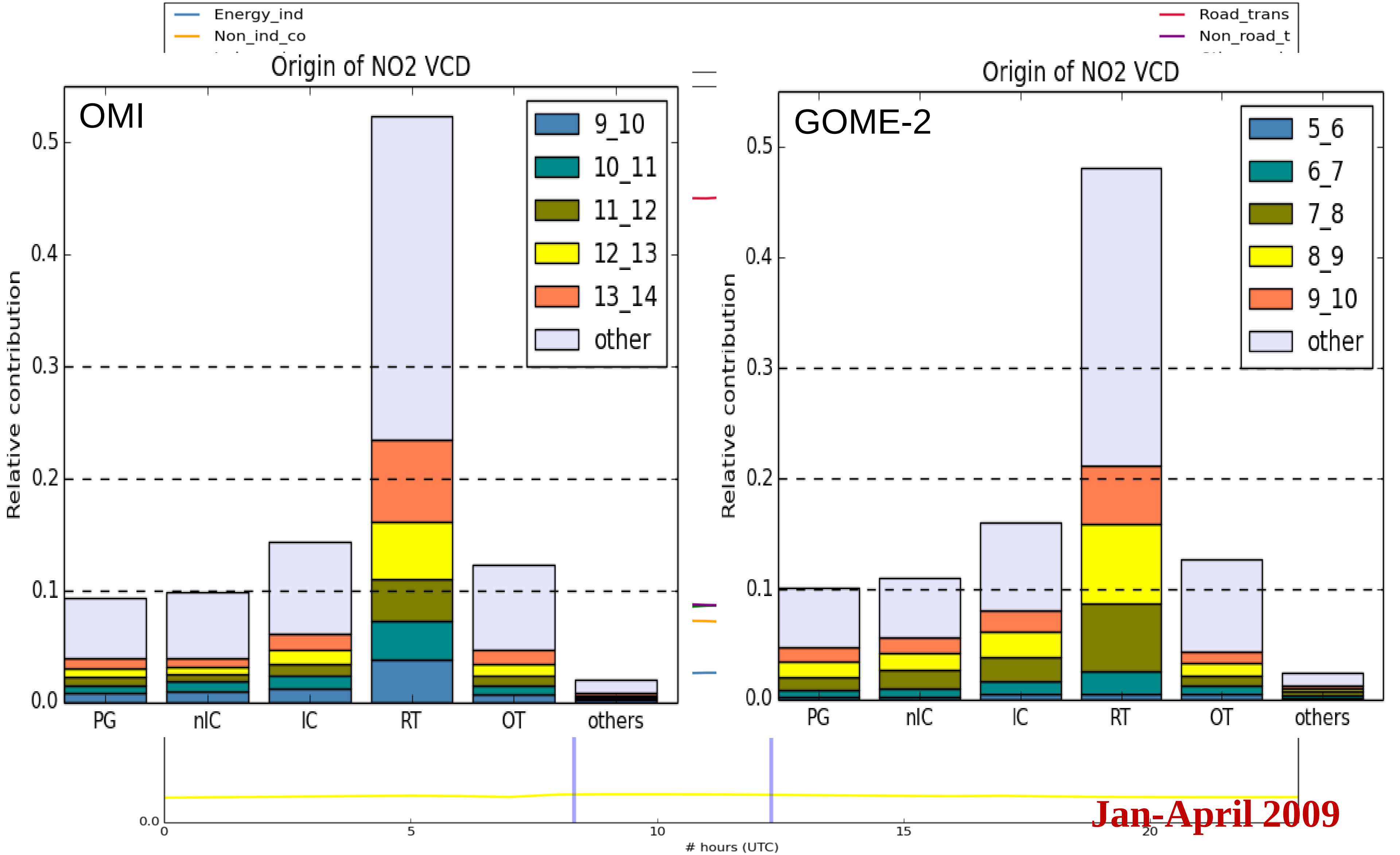


Jan-April 2009

SOURCE APPORTIONMENT: PO-VALLEY



EV

TRENDS IN NO2 COLUMNS: A-PRIORI

We assume that NO2 tropospheric VCD is a summation of various contribution

$$NO_{2instrumentl} = NO_{2emis} + NO_{2transport} + \ldots. + NO_{2meteo}$$

Can be modelled using a RAQ using a fix emission database

LOTOS-EUROS run for 2007-2013 period over Europe using TNO MACC emission for 2005

NO2 tropospheric VCD modelled were constructed using the instrument averaging kernel and output at their respective location and time overpasses.

The data are then meshed into an 0.5x0.25 lon x lat grid and a monthly remnant between instrument and model was computed.

TRENDS IN NO2 COLUMNS: METHODOLOGY

Remnant between Instrument and model

$$Y_t = C + \frac{1}{12} B X_t + A \sin\left(\frac{\pi}{6} + \alpha\right) + N_t$$

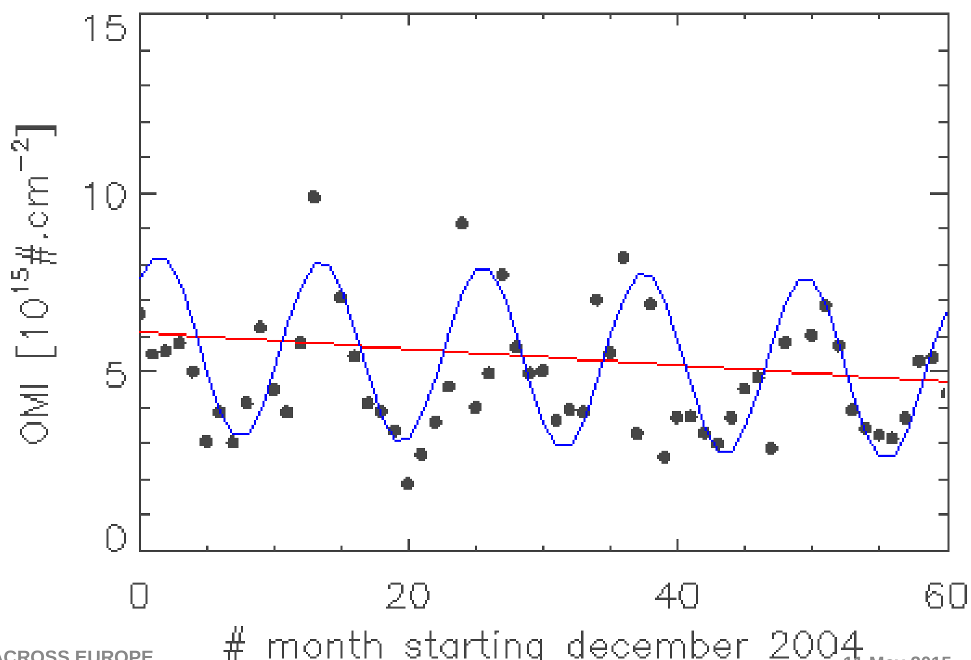
[Weatherhead et al 1998]

Seasonal component

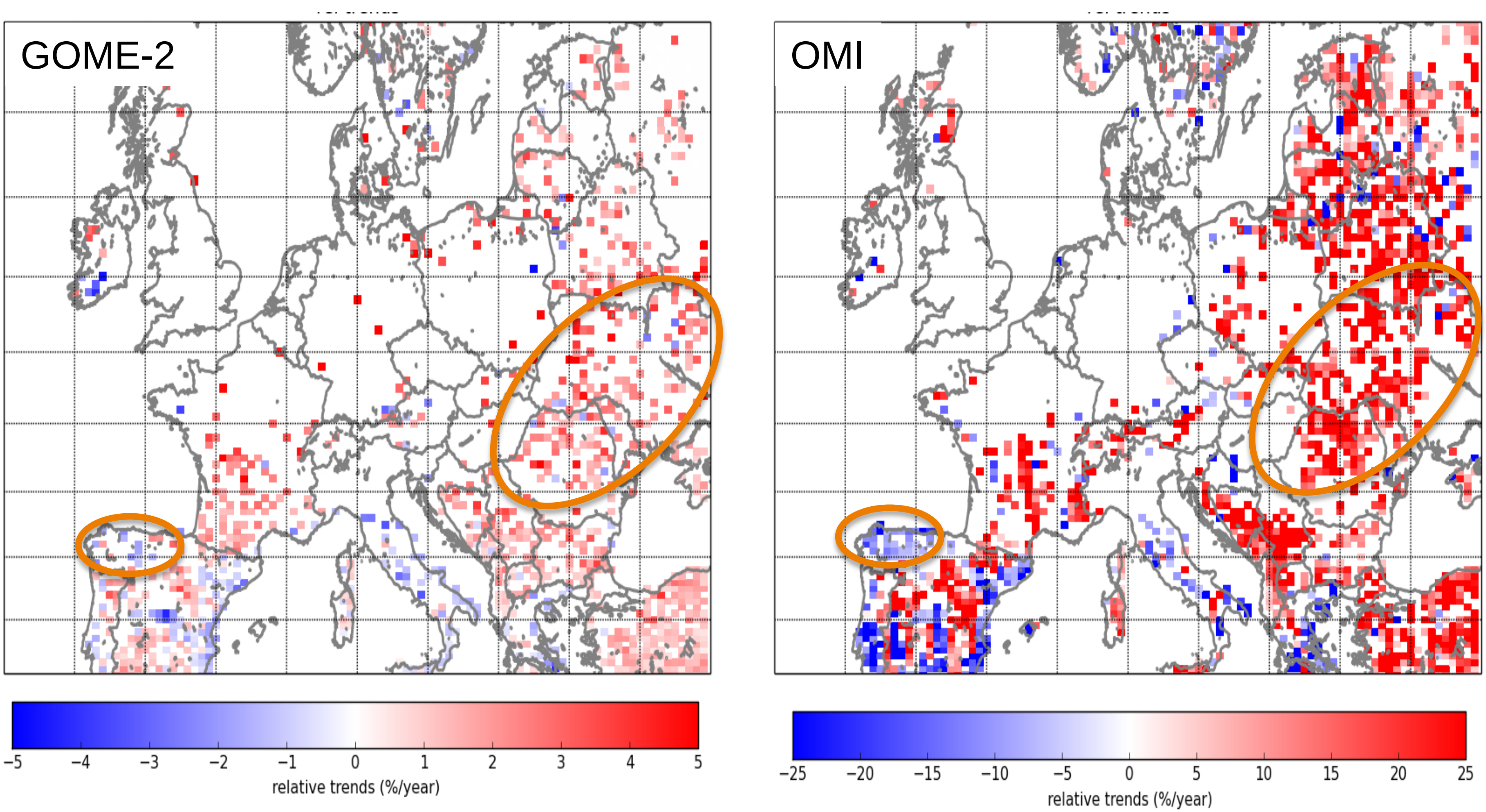
Annual trends

Significance analysis:

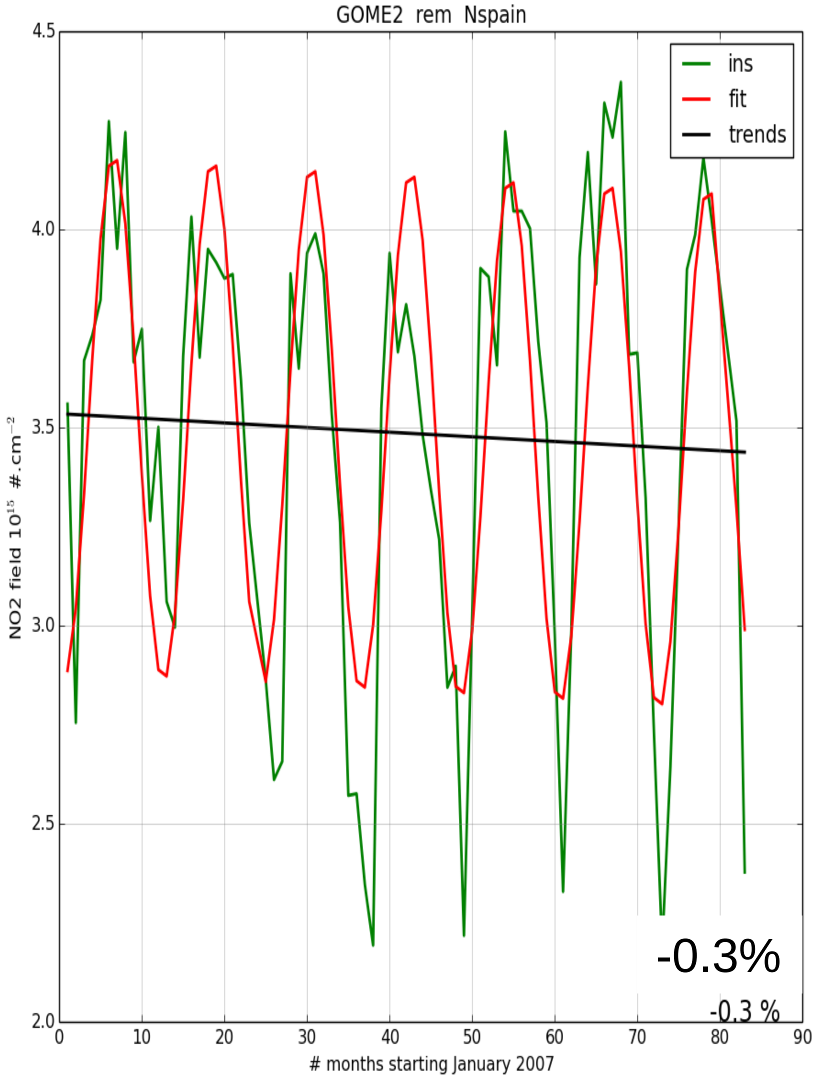
|B/σ| > 2 then trends is significant. (95% confidence)

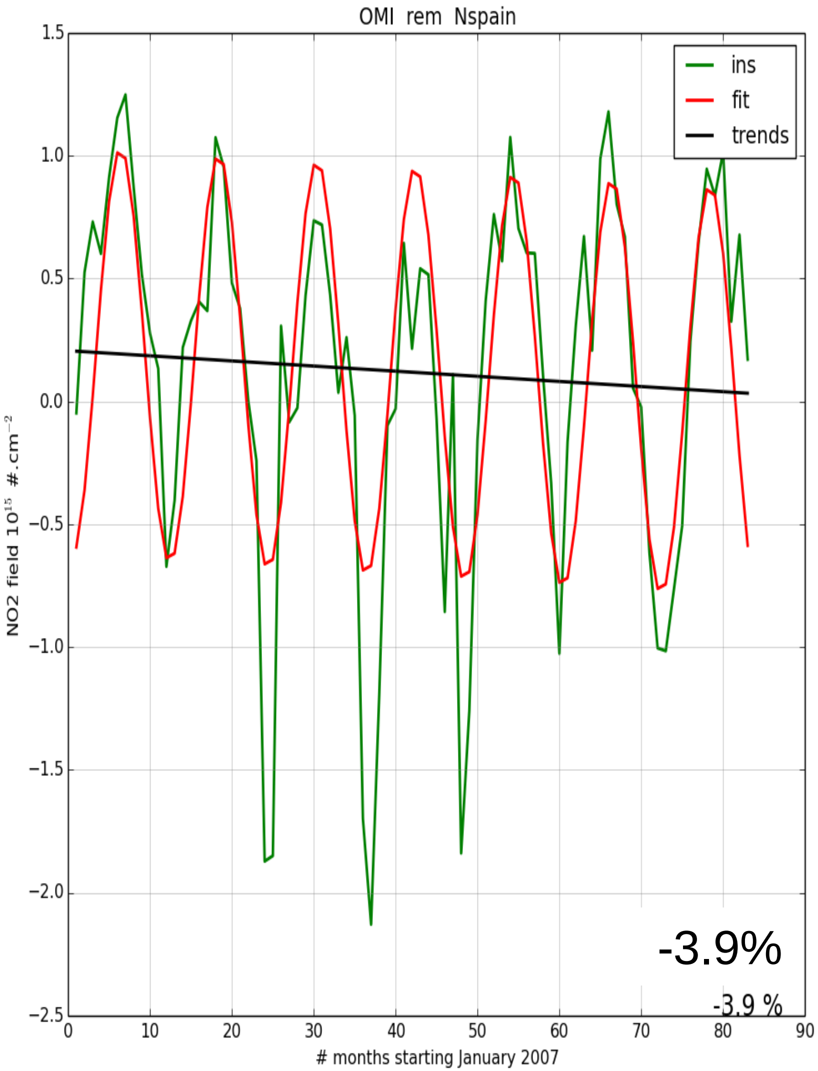


TRENDS IN REMNANT

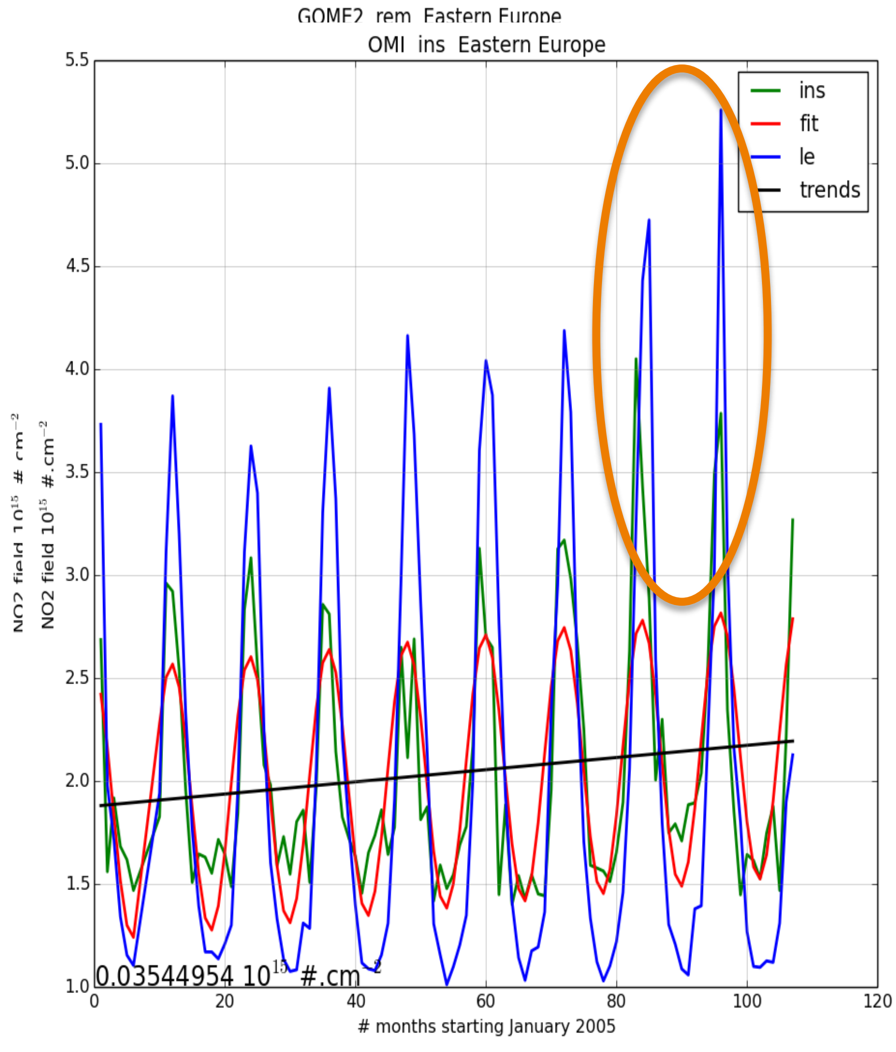


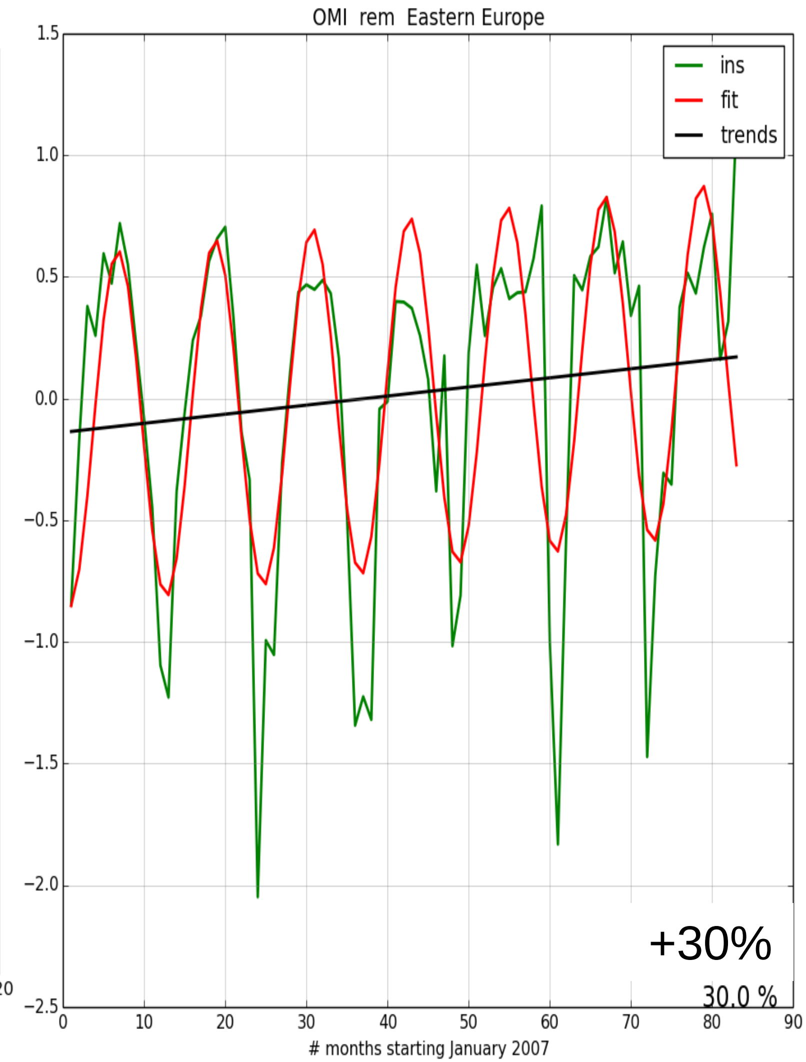
ZOOM OVER N-SPAIN





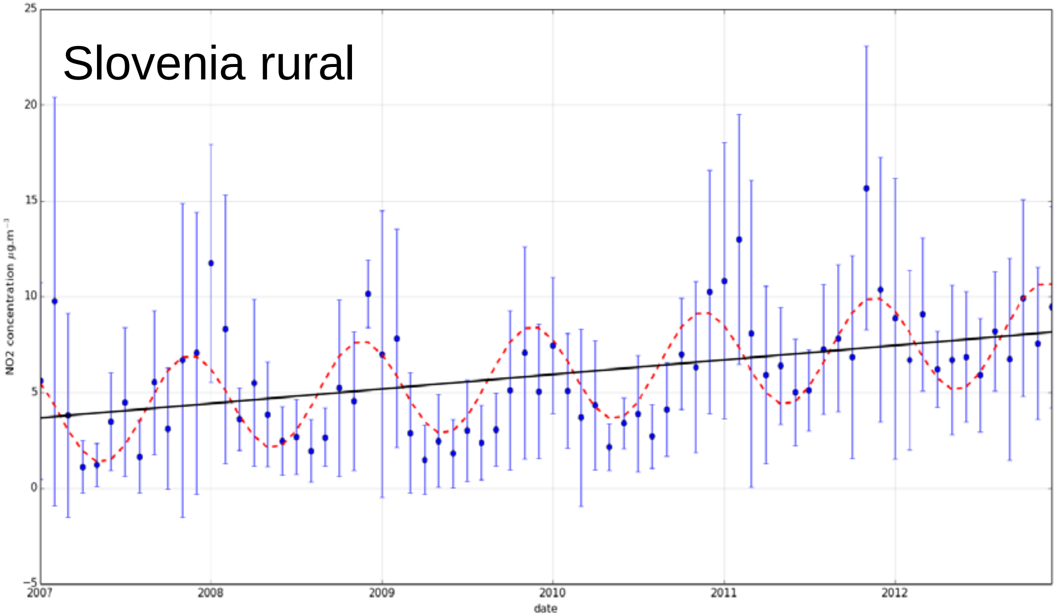
ZOOM OVER EASTERN EUROPE

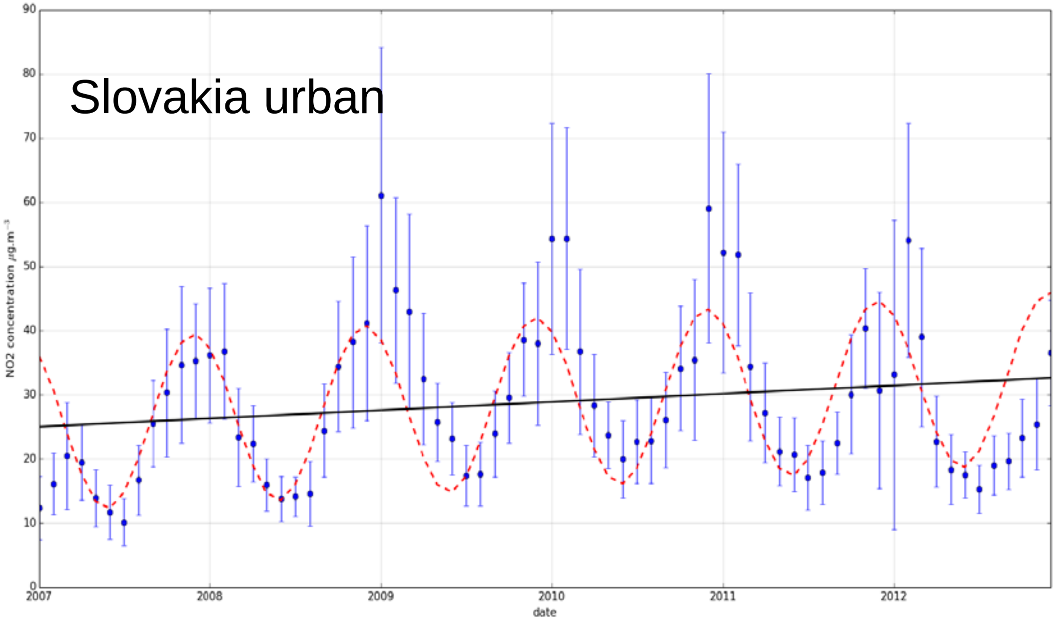




ZOOM OVER EASTERN EUROPE

preliminary

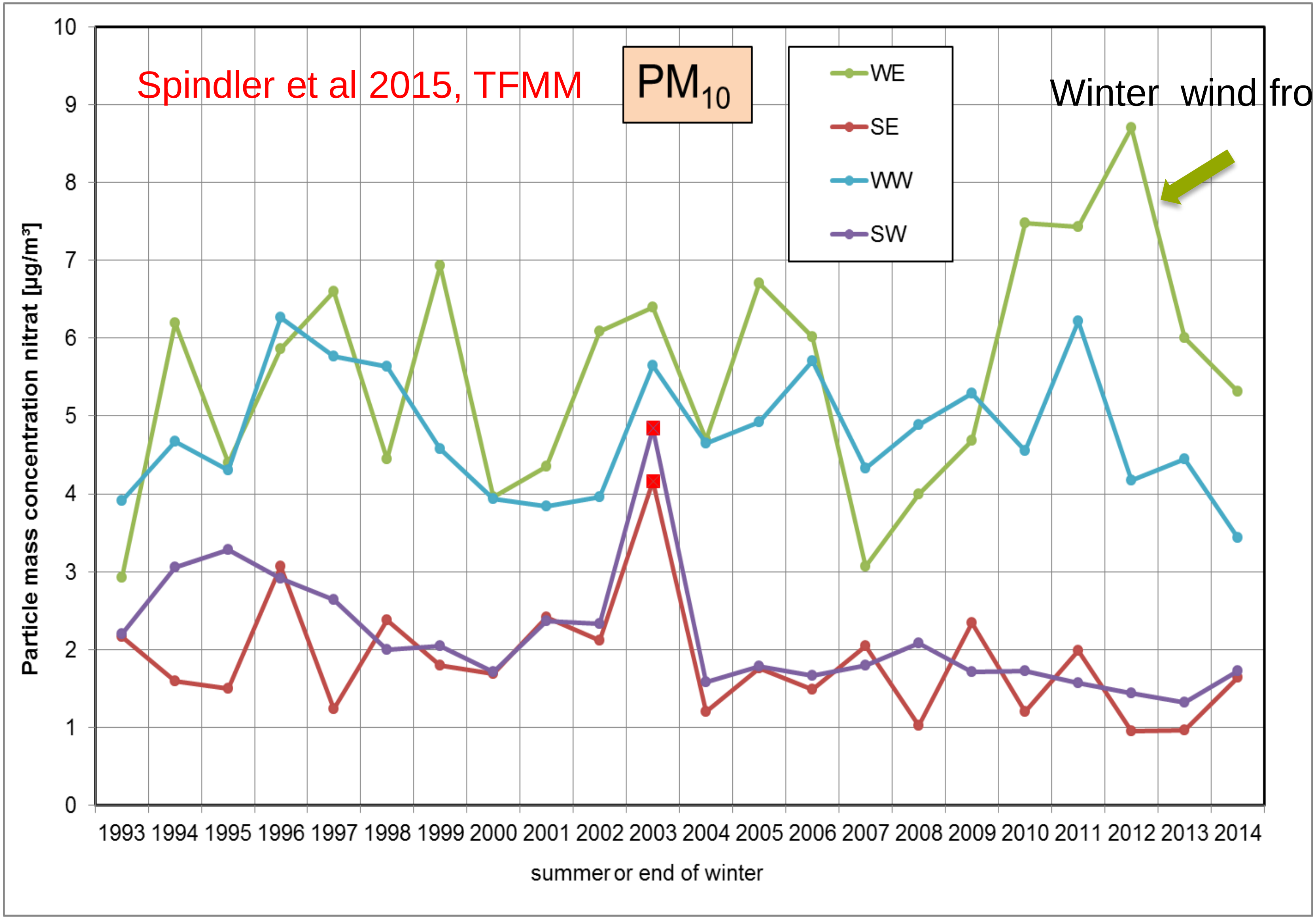




Trends in the concentration at AIRBASE station is under investigation.

Some station present a positive trends. The amplitude remains to be confirmed.

ZOOM OVER EASTERN EUROPE



SUMMARY

- **Source Apportionment**
  - GOME-2 and OMI should provide with the same information for NOx emission inversion study. The combined information could not be used to discriminate between source sector emission trends. However, they could be used conjointly in an inversion scheme to further constraint your model for inverse NOx emission.
- **Trends**
  - The detection of a significant trends across Europe is scarce
  - Between 2007 and 2013 the trends derived from GOME-2 and OMI have a similar distribution across Europe.
  - Over North Western Europe: GOME-2 and OMI dataset agree => No significant trends
  - Over Western Europe : OMI trends are in average 10 times higher than the trends derived from GOME-2 data
  - Over Eastern Europe a positive trends up to 30% is observed in the OMI trends dataset.

THANK YOU FOR YOUR ATTENTION

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PRESCRIBED DIURNAL PROFILE