Modelled vs Measured NOx Trends

Do we have a problem?

12th May 2022

Dr Chris Dore

Image c/o Time Out

Modelled vs Measured NOx Trends

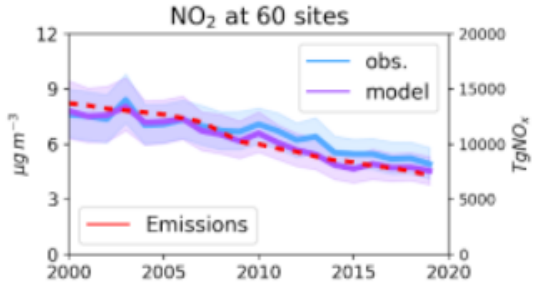
Contents

1. NOx trend discrepancies

Trends in air pollution 2000-2019

- How has the trend study been done:
  - Model calculations in 0.1x0.1 with **revised emissions** (total and gridding)
  - EMEP observations
  - Sulphur (SO_2, SO_4^{2-}, wet dep), oxidized nitrogen (NO_2, HNO_3, NO_3^-, wet dep), reduced nitrogen (NH_3, NH_4^+, wet dep), $PM_{2.5}$ and PM_{10} (chemical species, **including EC/OC from 2010-2019**), ozone
- Issues: trends for EECCA (and western Balkan) countries are not presented as reported emissions to a large extent is missing and observations are lacking - large uncertainties
- For PM: 'condensables' are included *as they are in reported EMEP emissions*, thus they are not consistently included (historical data set including condensables did not yet exist)
- Documented in EMEP Status Report 1/2021

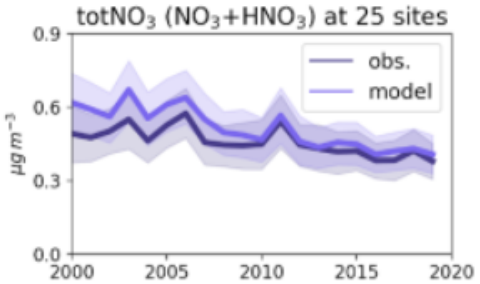
1. NOx trend discrepancies



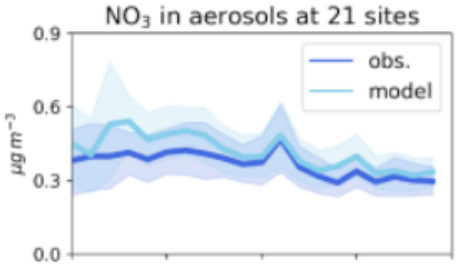
Change in NOx emissions (west EMEP): -48%

NO_2:
Obs: -24%
Mod: -42%

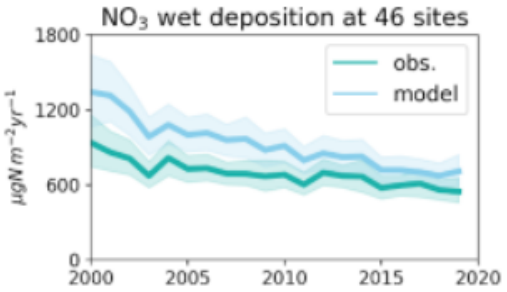
Depend on inclusion/ exclusion of observations



HNO_3+NO_3^-:
Obs: -30%
Mod: -40%



NO_3^- aerosol:
Obs: -38%
Mod: -48%



Wet deposition of oxidized nitrogen:
Obs: -26%
Mod: -45%

Trends in oxidized nitrogen

Substantial reductions in NOx emissions have lead to large reductions in observed oxidized nitrogen - but the changes in observations are not as large as the reported emission reductions

LRTAP Long-range Transboundary Air Pollution

Norwegian Meteorological Institute

NILU

1. NOx trend discrepancies

JGR Atmospheres

RESEARCH ARTICLE
10.1029/2021JD035872

Decadal Variabilities in Tropospheric Nitrogen Oxides Over United States, Europe, and China

Zhe Jiang and Rui Zhu contributed equally to this work.

Zhe Jiang[1], Rui Zhu[1], Kazuyuki Miyazaki[2], Brian C. McDonald[3], Zbigniew Klimont[4], Bo Zheng[5], K. Folkert Boersma[6,7], Qiang Zhang[8], Helen Worden[9], John R. Worden[2], Daven K. Henze[10], Dylan B. A. Jones[11], Hugo A. C. Denier van der Gon[12], and Henk Eskes[7]

Europe		Reduction rates (2005–2018)	Trends/yr(2005–2010)	Trends/yr(2010–2018)
Bottom-up	ECLIPSE NO_x	−46.1%	−4.7%	−2.9%
	CAO NO_x (temp. adj.)	−28.9% (2005–2015)	−4.1%	−2.3% (2010–2015)
Top-down	Continental average	−15.3%	−3.0%	−0.9%
	Urban grids (top 10% OMI NO_2)	−22.4%	−2.9%	−2.3%
OMI NO_2	Continental average	−22.8%	−4.2%	−1.2%
	Sampled at Airbase	−31.5%	−4.2%	−2.3%
Surface NO_2	Airbase	−27.2%	−2.4%	−2.6%

2. Speculative explanation

NOx emission inventories in Europe may be:

- Overestimating the effectiveness of SCR systems on heavy-duty trucks under lower engine temperatures
- Underestimating light-duty diesel vehicle NOx emission factors during colder ambient temperatures
- **More work/assessment needed.**

Thoughts from the TFEIP??

- We think EFs are well characterised… and constantly under review
- Could it be an issue with activity data?