emep

Co–operative programme for monitoring and evaluation of the long–range transmissions of air pollutants in Europe

LRTAP Long-range Transboundary Air Pollution

emep msc-w: Progress in 2023/2024

Hilde Fagerli, Willem van Caspel, Peter Wind & rest of the EMEP/MSC-W team

TFMM, Warsaw 6-7th May 2024

Meteorologisk institutt

MSC-W activities 2023/2024 presented at this TFMM

1. Ozone - Importance of European, non-European and CH_4 mitigation, update
2. Source-receptor methodologies: brute force vs sensibilities (local fractions)

3. **Evaluation of modelled versus observed NMVOC compounds at EMEP sites in Europe** Yao Ge (Today at 14:30)
4. **Primary Biological Aerosol Particle (PBAP) modelling in EMEP.** Gunnar Lange. (Tuesday 11:30)

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Ozone - Importance of European, non-European and CH_4 mitigation

- What is it possible to achieve for ozone by 2050 by
  - reducing CH_4 emissions
  - reducing European emissions
  - reducing emissions outside of Europe (ROW)
- What can be achieved compared to 'no further policy' (CLE)?
- What is new compared to TFHTAP/TFMM work:
  - Gothenburg Protocol Review emission scenarios (CLE, MFR, LOW)
  - Including new indicators for ozone such as Peak Season MDA8
  - **Including other indicators such as POD_3crop and SOMO35**
  - **Meteorological variability**

Why CH4?

CH_4 is considered to be included in a revised Gothenburg protocol

How?

- Global EMEP MSC-W model runs for 2015, 2050 (CLE, MFR, LOW) and in addition with CH_4 concentrations changed -> **Boundary and initial conditions**
- European EMEP MSC-W model runs for 2015, 2050 (CLE, MFR, LOW) and CH_4 concentrations

2050 LOW scenario - *Ambitious global action on air pollution and methane, including non-technical measures*

Simulated ozone concentrations in the future and the impact of European NOx/VOC, Rest of World (ROW) NOx/VOC and CH4 emission mitigation

Meteorological variability and model performance

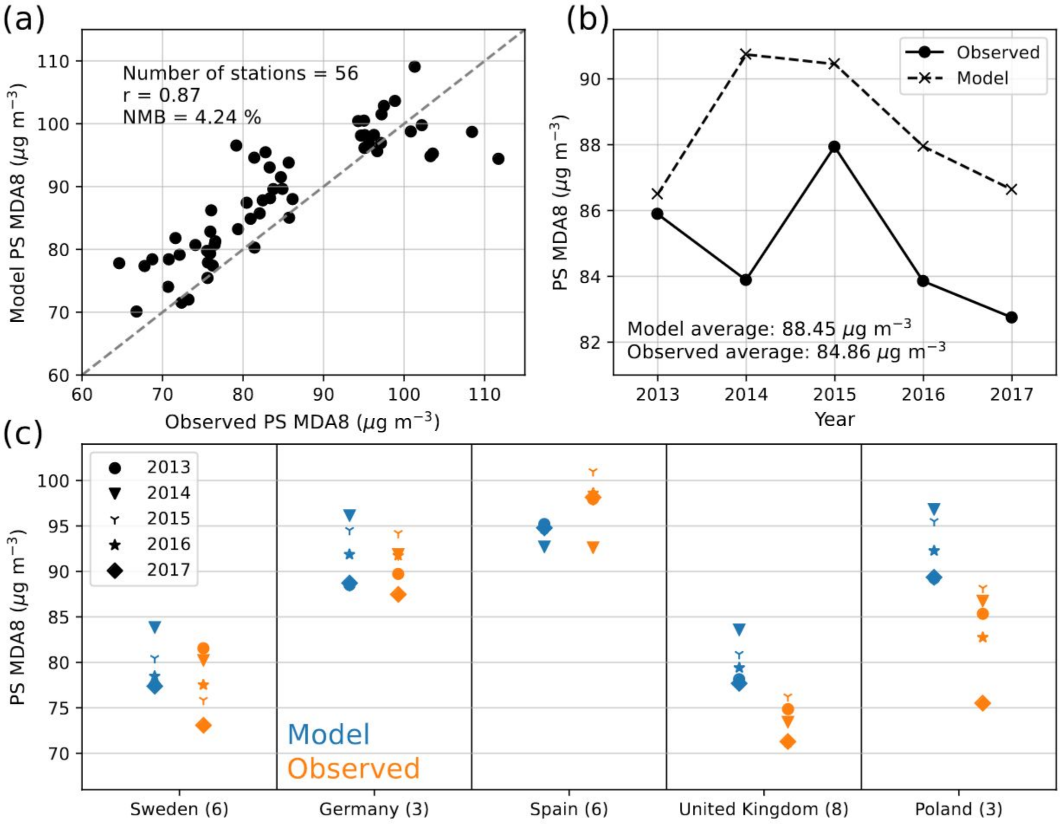
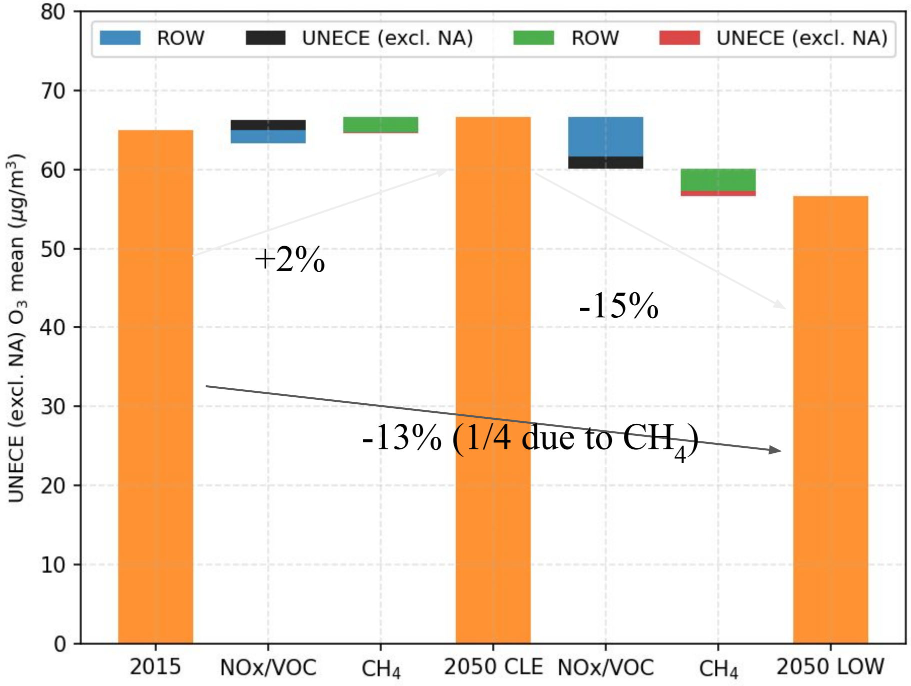


Figure 2. Modelled versus observed peak season MDA8 across Europe. Panel (a) shows five-year averaged values at each of the 56 stations, with panel (b) showing the annual values averaged over all stations. Panel (c) shows the yearly averages for Sweden, Germany, Spain, the United Kingdom, and Poland, with the number in brackets indicating the number of stations in each of the countries.

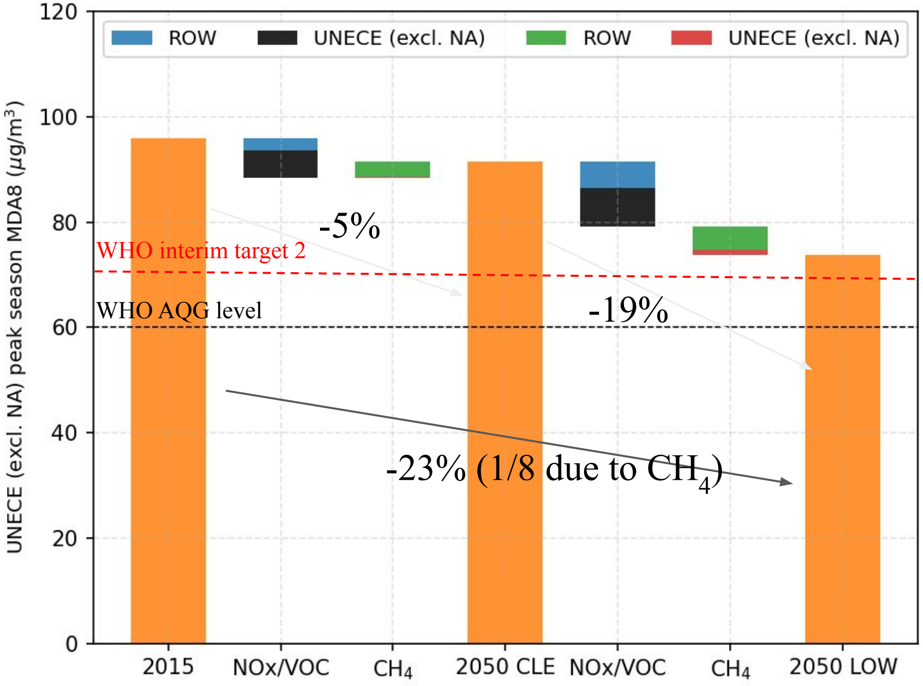
The EMEP MSC-W model is:

- reproducing MDA8 well for the 5-year average
- able to model and span the meteorological variability (compare well to observations for ‘high’ and ‘low’ MDA8 years)

- Substantial reductions can be achieved, but WHO AQG levels not attained even in LOW
- CH_4 becomes more important because of its projected increase in CLE.
- Action on methane would only be part of the solution; (UNECE) NOx/VOC emission reductions would still be very important to reduce surface O_3



Ozone mean, population weighted



Peak season MDA8, population weighted

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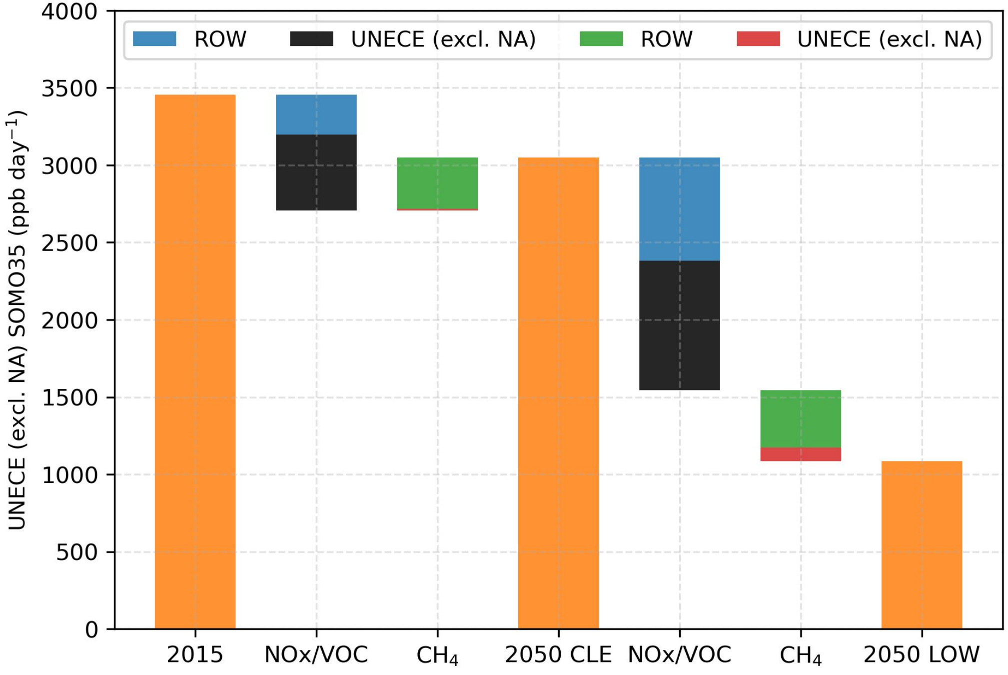
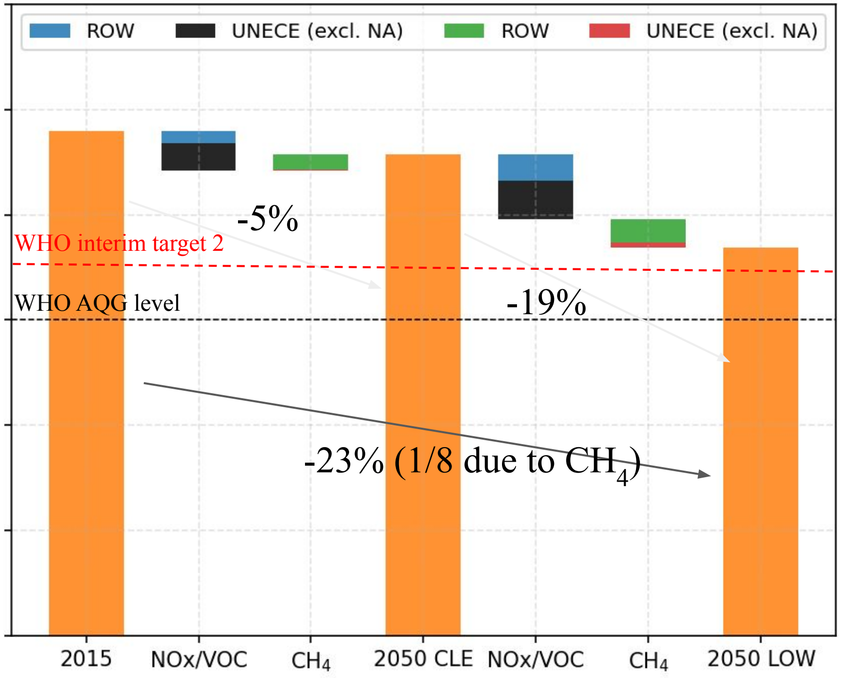
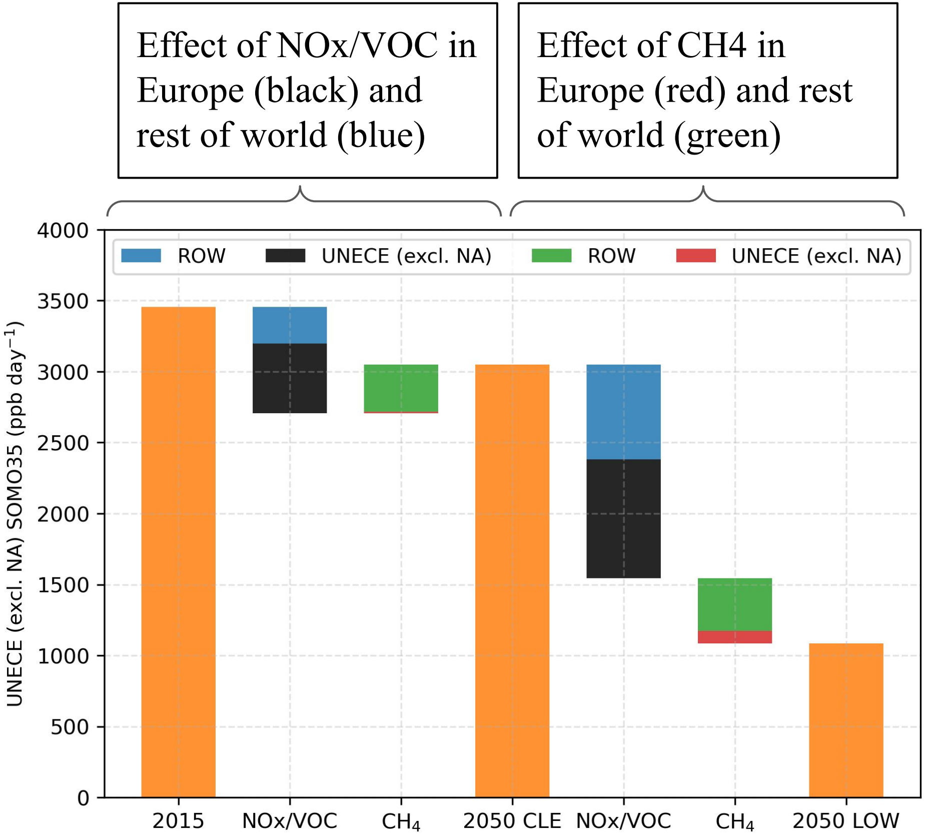


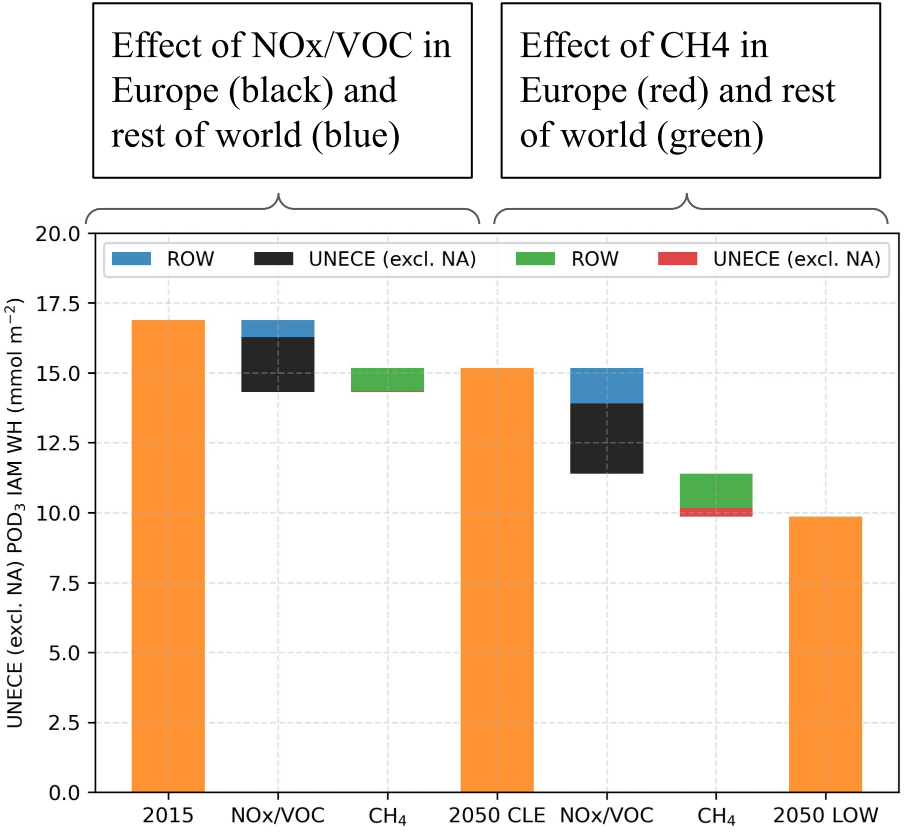
SOMO35, population weighted



Peak season MDA8, population weighted



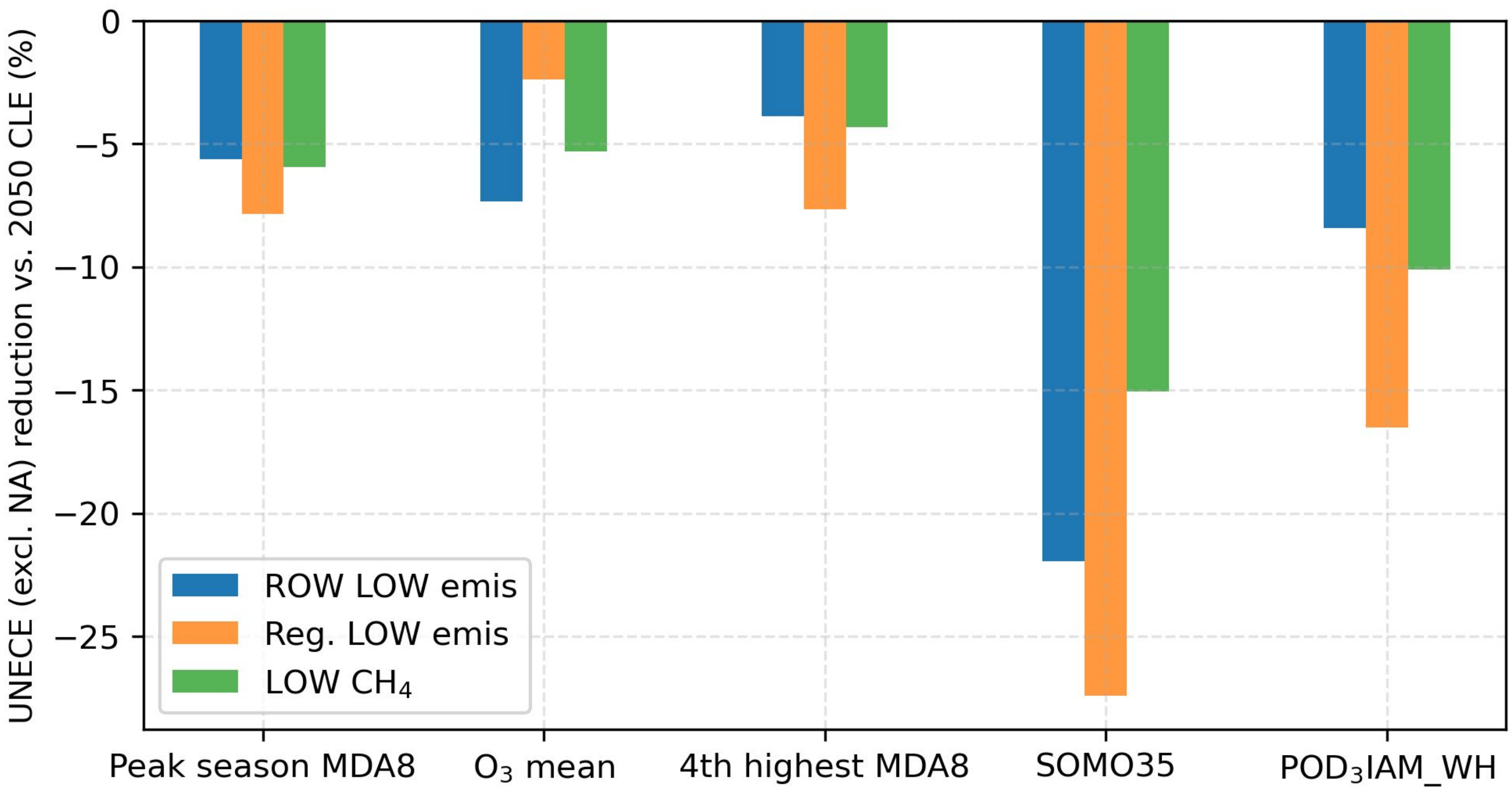
Population weighted SOMO35



POD3 (crop area)

Results are qualitatively the same, but the effect of LOW versus CLE for 2050 is much larger (because of the cut off)

2050 LOW versus 2050 CLE



Results are qualitatively the same (except ozone mean for which European actions are less important), but the effect of LOW versus CLE for 2050 is much larger (because of the cut off)

Next steps

- Partcipate in the upcoming TFHTAP exercise - EMEP MSC-W model as one of the ‘ensemble members’
- Submit paper:-)

Van Caspel, W, Klimont, Z, Heyes, C. and Fagerli, H. Role and potential of methane mitigation to reduce surface ozone in Europe: Scenario analysis using the EMEP MSC-W model. Submitted (?) to ACP

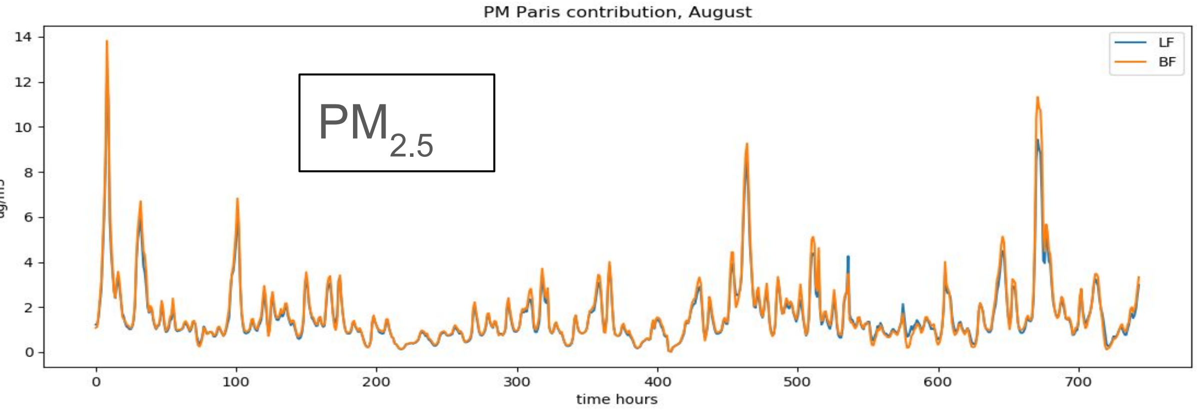
Source-receptor methodologies: brute force and sensibilities (local fractions) and their applicability

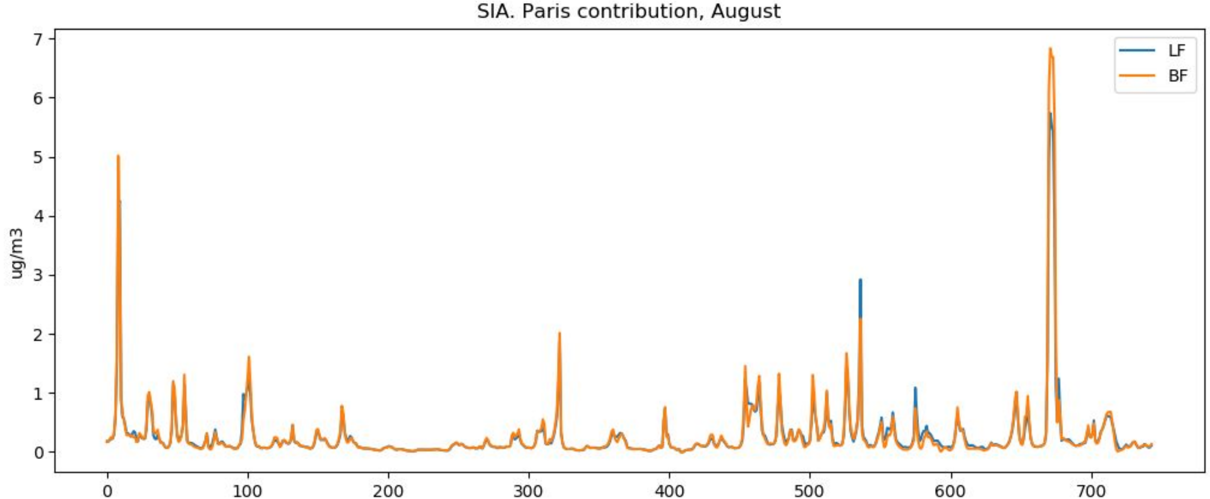
What is Local Fraction?

- Originally developed to give the fractions of pollutants from local sources. Used for downscaling (uEMEP)
- A technical method to track a large number (10 000 s) of pollutant sources (efficiently)
- New: can track pollutants through chemical reactions (non linear species can be tracked)
- Gives the ***sensibility*** to (small) changes in emissions
- For example $\partial O_3/\partial E_{k\_NOx}$, how much Ozone changes for changes in NOx emissions in region k.
- For linear species Brute Force (BF, 15% reductions) and LF are in principle identical

P. Wind et al, 2020. Local fractions – a method for the calculation of local source contributions to air pollution, illustrated by examples using the EMEP MSC-W model (rv4_33).https://doi.org/10.5194/gmd-13-1623-2020

Source-receptor methodologies: brute force and sensibilities (local fractions) and their applicability





The LF method has been implemented & tested for:

- PPM
- deposition of S and N
- O_3
- NO_2
- MDA8

NEW (partly tested):

- SOMO35
- SIA (Secondary inorganic aerosols)
- *SOA (Secondary organic aerosols)*
- *BVOC (Biogenic Volatile Organic Compounds)*
- $PM_{2.5}$ including water
- POD is being implemented

Comparison of LF and BF

- Source receptor calculations for 2021 with EMEP MSC-W model and LF method was set up identically to the Brute Force (BF) calculations done this year

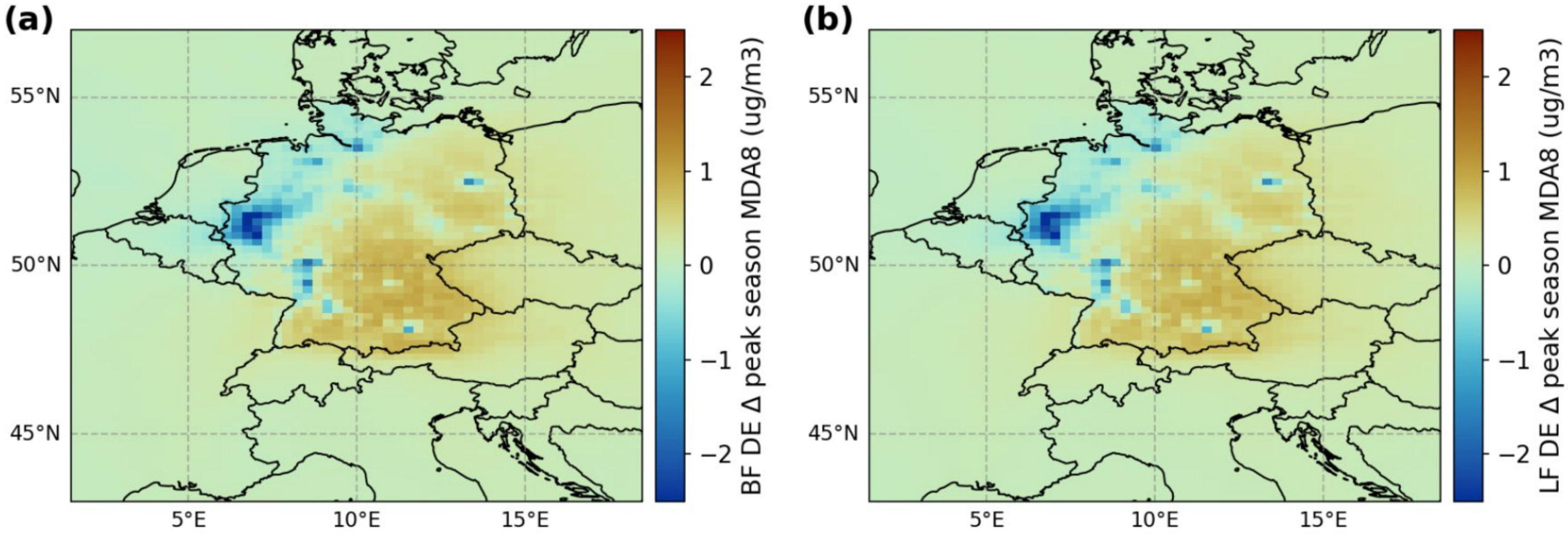
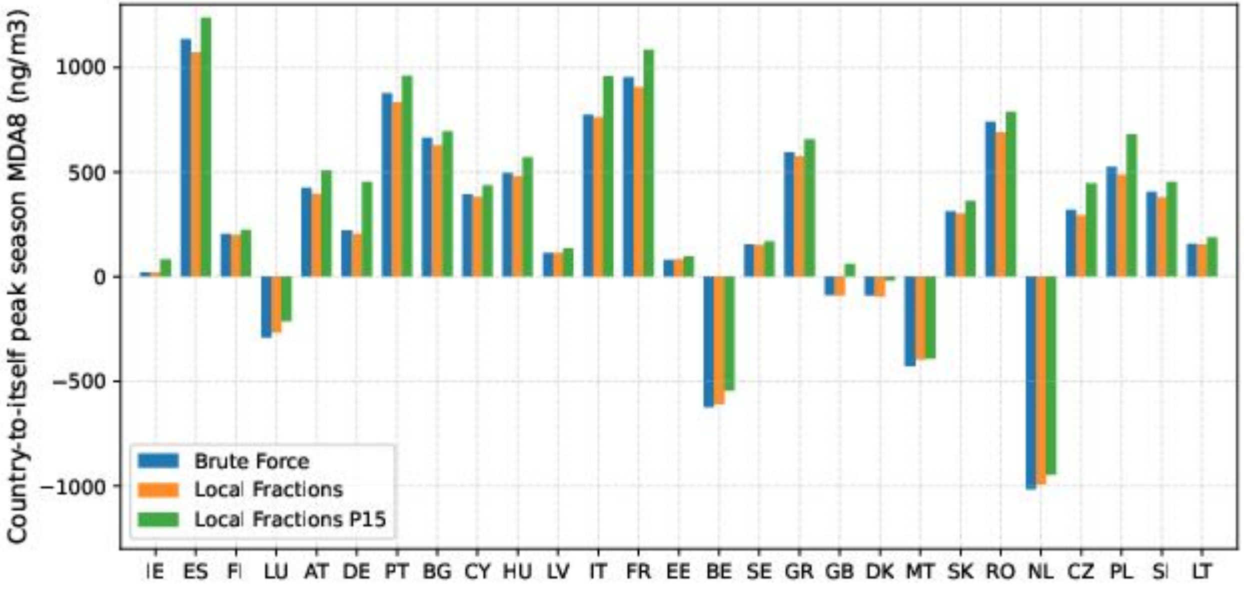


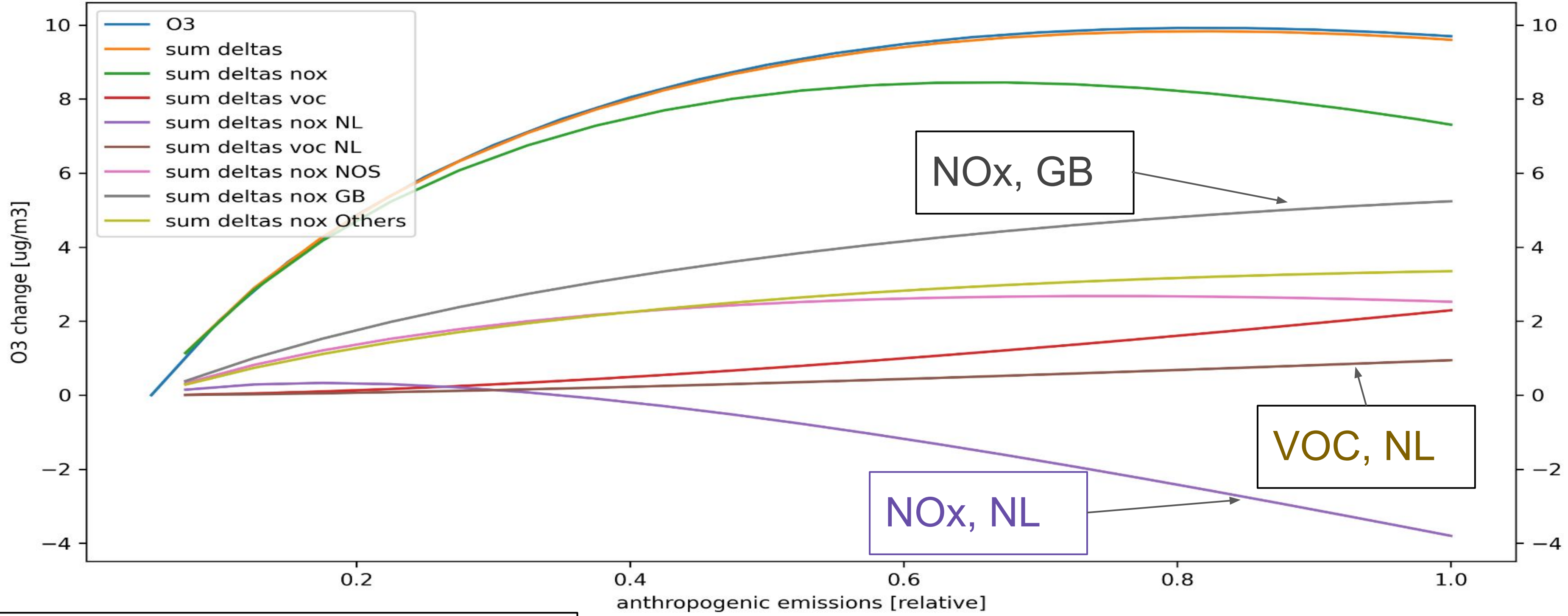
Figure 5.1: Comparison of the impact of a 15% NOx emission reduction from Germany (DE) on peak season MDA8 calculated using the BF **(a)** and LF **(b)** methods.

Country-to-itself contributions to Peak season MDA8 in 2021 (with 15% NOx emis reductions)



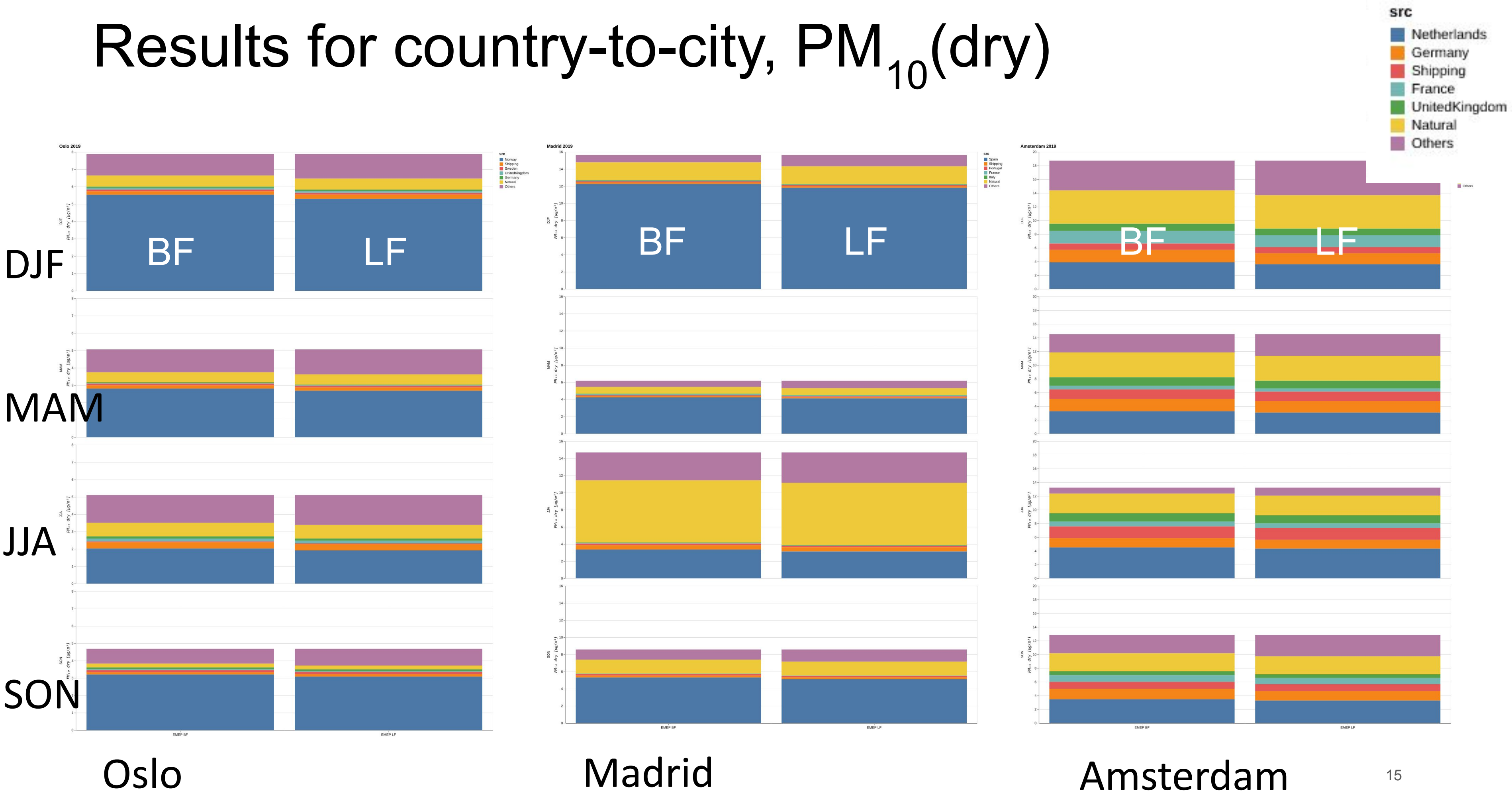
- Local Fractions: results (derivatives) calculated at 100% emissions
- Local Fractions P15: results (derivatives) calculated at 85% emissions
- BF and LF gives similar results (difference usually smaller than non-linearity

O_3 concentrations, July, due to NOx/VOC reductions, NL

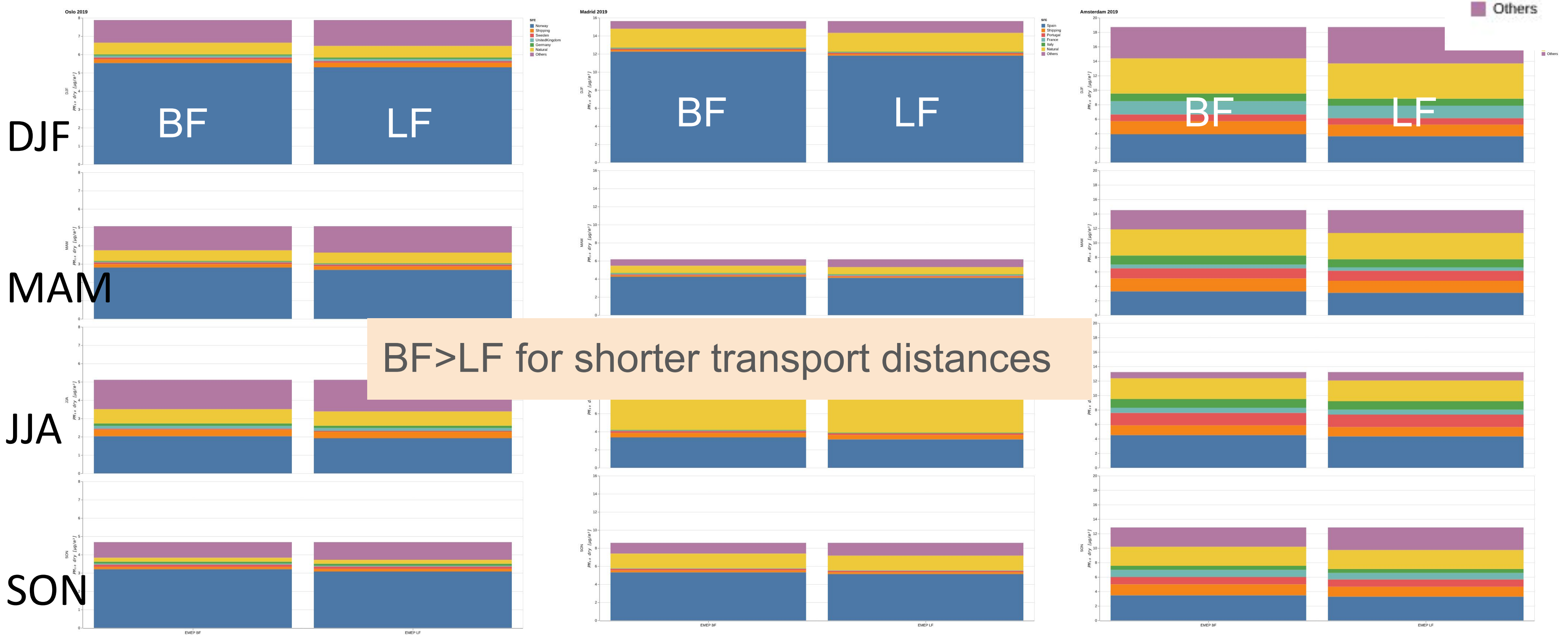


Could potentially be parametrized and implemented in GAINS

Results for country-to-city, PM_{10}(dry)

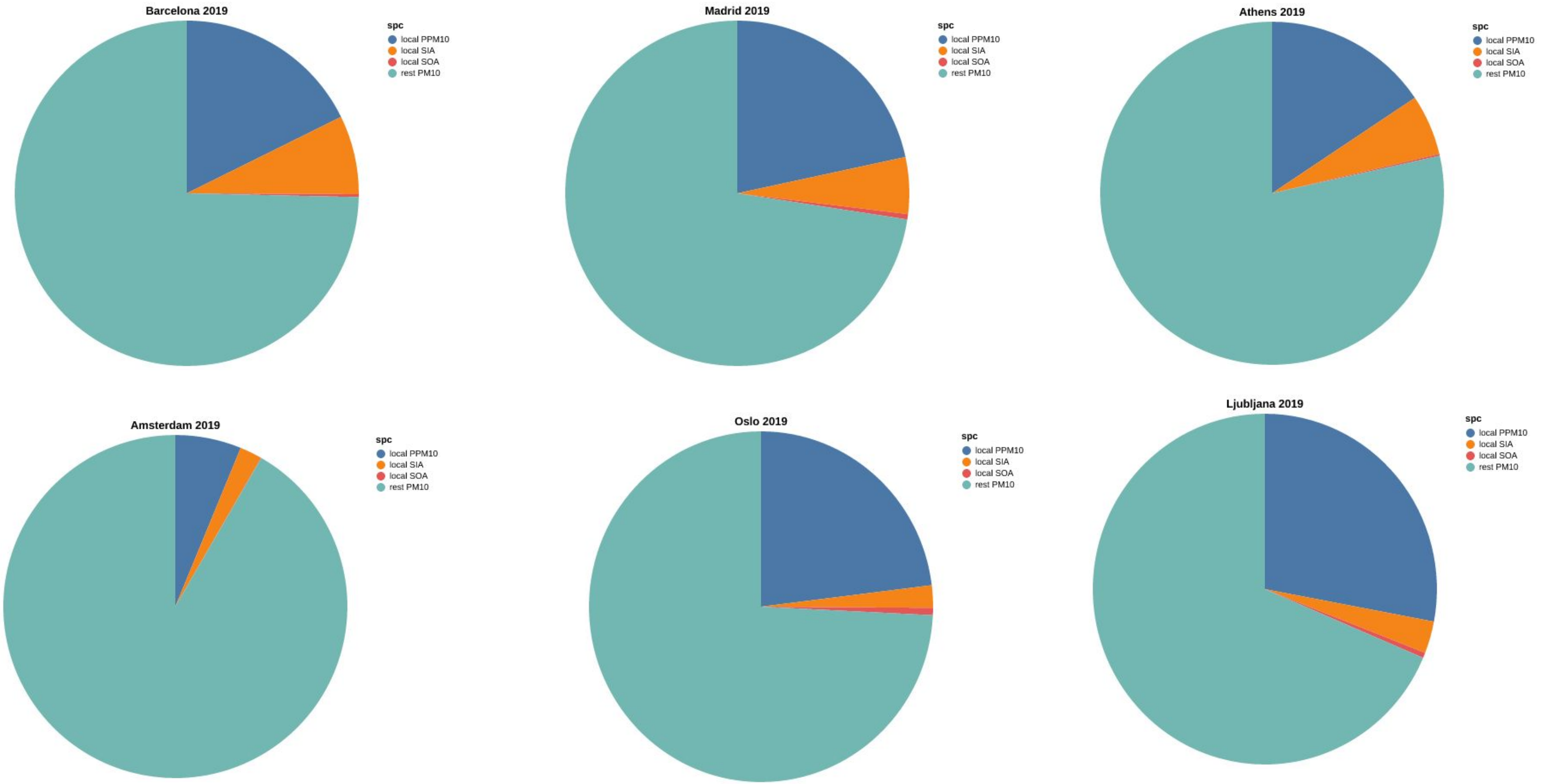


Results for country-to-city, PM_{10}(dry)



Oslo Madrid Amsterdam

Is the ‘local=PPM’ approximation valid on a yearly basis?



Summary

- Local Fractions allow to compute the concentration/emissions relationship over a large emission range **very efficiently**
- **Differences due to advection larger than non-linearities**
- Work now and further:
  - Include more relevant indicators (e.g. O_3max, POD, SOMO35, MDA8)
  - Investigate non-linearities, e.g. vary levels of emissions
  - Work with CIAM about O_3 inclusion in GAINS - optimization for GP revision
  - Compare methodologies, e.g. TFHTAP

- Working on how to use and present all this information

Aerosol and Air Quality Research

Special Issue:
Carbonaceous Aerosols in the Atmosphere

Trends in Air Pollution in Europe

Wenche Aas[1*], Hilde Fagerli[2], Andres Alastuey[3]
Anna Degorska[5], Stefan Feigenspan[6], Hans Brenn
Daniel Heinesen[2], Christoph Hueglin[7], Adéla Holu
Augustin Mortier[2], Marijana Murovec[10], Jean-Phi
David Simpson[2,11], Sverre Solberg[1], Svetlana Tsyr
Karl Espen Yttri[1]

[1] NILU, EMEP/CCC Kjeller, Norway
[2] Norwegian Meteorological Institute, EMEP/MSC-W, Oslo, I
[3] Institute of Environmental Assessment and Water Researc
Research Centre, Ispra (VA), I
otection, National Research I
), Dessau-Roßlau, Germany
ories for Materials Science and

accepted

Geosci. Model Dev., 16, 7433–7459, 2023
https://doi.org/10.5194/gmd-16-7433-2023

Geoscientifi
Model Developmen

Implementation and evaluation of updated photolysis rate EMEP MSC-W chemistry-transport model using Cloud-J

Willem E. van Caspel[1], David Simpson[1,2], Jan Eiof Jonson[1], Anna M. K. Benedictow[1], Yao Ge[1], Alc
Giandomenico Pace[3], Massimo Vieno[4], Hannah L. Walker[4,5,a], and Mathew R. Heal[5]

[1]Norwegian Meteorological Institute, Oslo, Norway
[2]Department of Space, Earth and Environment, Chalmers University of Technology, Gothenburg, Sweden
[3]ENEA Laboratory of Observations And Measurements for the Environment and Climate, Rome, Italy
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[5]School of Chemistry, University of Edinburgh, Joseph Black Building, David Brewster Road, Edinburgh,
[a]now at: Ricardo Energy & Environment, Blythswood Square, Glasgow, UK

Correspondence: Willem E. van Caspel (willemvc@met.no)

Received: 4 July 2023 – Discussion started: 29 August 2023
Revised: 8 November 2023 – Accepted: 15 November 2023 – Published: 21 December 2023

Preprint

https://doi.org/10.5194/egusphere-2023-3102

Abstract Discussion Metrics

19 Jan 2024

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EndNote

Status: this preprint is open for discussion and under review for Atmospheric Chemistry and Physics (ACP).

Evaluation of modelled versus observed NMVOC compounds at EMEP sites in Europe

Yao Ge, Sverre Solberg, Mathew Heal, Stefan Reimann, Willem van Caspel, Bryan Hellack, Thérèse Salameh, and David Simpson

Abstract. Atmospheric volatile organic compounds (VOC) constitute a wide range of species, acting as precursors to ozone and aerosol formation. Atmospheric chemistry and transport models (CTMs) are crucial to understanding the emissions, distribution, and impacts of VOCs. Given the uncertainties in VOC emissions, lack of evaluation studies, and recent changes in emissions, this work adapts the European Monitoring and Evaluation Programme Meteorological Synthesizing Centre – West (EMEP MSC-W) CTM to evaluate emission inventories in Europe. Here we undertake the first intensive model-measurement comparison of VOCs in two decades. The modelled surface concentrations are evaluated both spatially and temporally, using measurements from the regular EMEP monitoring network in 2018 and 2019, and a 2022 campaign. To achieve this, we utilised the UK National Atmospheric Emission Inventory to derive explicit emission profiles for individual species and employed a `tracer' method to produce pure concentra ... mpare the use of two European inventorie ... c; those for 2019 and 2022 use CAMS and CRIv2

Short summa
Atmospheric vo
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In discussion

Future scenarios for air quality in Europe, the Western Balkans and EECCA countries: an assessment for the Gothenburg protocol review

Bruce R. Denby[a,*], Zbigniew Klimont[b], Agnes Nyiri[a], Gregor Kiesewetter[b], Chris Heyes[b] and Hilde Fagerli[a]

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[b] International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria

ARTICLE INFO

Keywords:
air quality modelling
Gothenburg protocol review
population exposure
Future scenarios
EMEP MSC-V
uEMEP
GAINS

ABSTRACT

The Gothenburg Protocol (Protocol to Abate Acidification, Eutrophication and Ground-level Ozone) was first established in 1999 to support the enactment of the 1979 Convention on Long-range Transboundary Air Pollution. The Executive Body launched a review in December 2019 which was concluded in December 2022. In order to support the review and contribute to the assessment of the remaining risks for health, ecosystems and crops, model calculations have ... n scenarios which include both baseline and ... rios. The uEMEP/EMEP MSC-W modelling ... MEP is a downscaling module for the EMEP ... ons, at 250 m for exposure, to be made. In this ... p and present the calculated concentrations, exposure and source contributions based on emission scenario input from CIAM (Center for

Submitted to Atm. Env.

Sub-grid variability and its impact on exposure in regional scale air quality and integrated assessment models: application of the uEMEP downscaling model.

Bruce R. Denby[a,*], Gregor Kiesewetter[b], Agnes Nyiri[a], Zbigniew Klimont[b], Hilde Fagerli[a], Eivind G. Wærsted[a] and Peter Wind[a]

[a]Norwegian Meteorological Institute, Henrik Mohn
[b]International Institute for Applied Systems Analysi

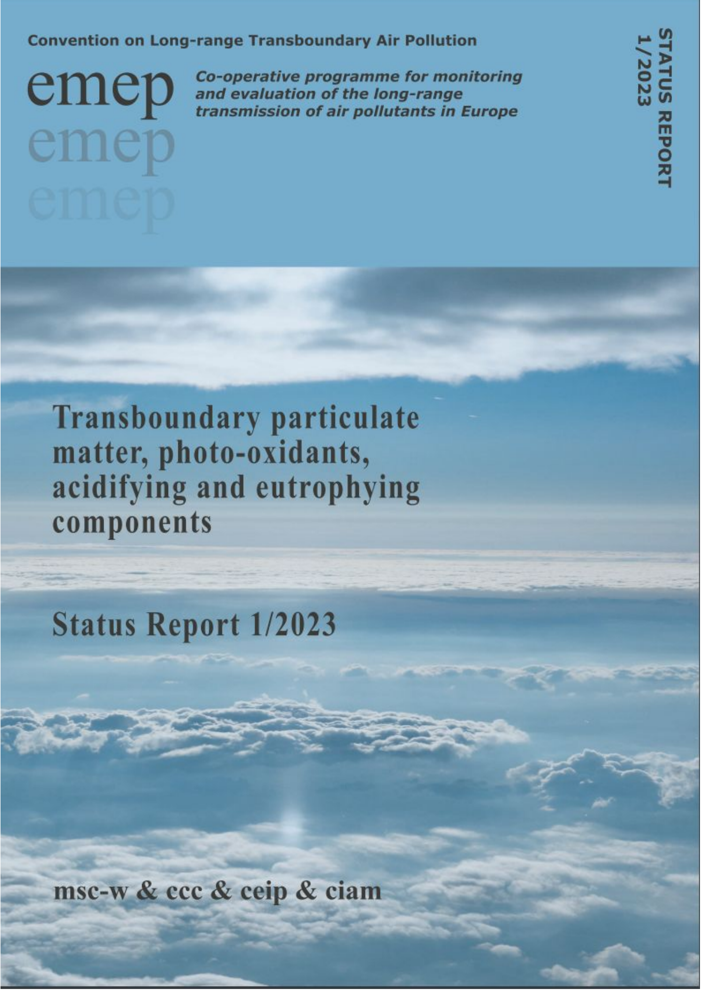
ARTICLE INFO

Keywords:
air quality modelling
sub-grid variability
population exposure
source receptor modelling
GAINS
EMEP MSC-W
uEMEP

Regional scale air quality and integrated assessment models are necessarily limited in their spatial resolution, particularly when applied to larger regions such as Europe or for global applications. The EMEP MSC-W chemical transport model and the GAINS integrated assessment model, which makes use of source receptor information precalculated by the EMEP MSC-W model, use a highest resolution of $0.1^o \times 0.1^o$. The most recent set of source receptor matrices for GAINS has been provided at still coarser resolution, $0.3^o \times 0.2^o$. These resolutions cannot account for variability at finer scales. Variability within grids, both concentration and population distributions, can be significant. To improve exposure calculations that take into account the sub-grid variability, the uEMEP model has been applied to provide suitable parameterisations

Submitted to Atm. Env.

EXTRA SLIDES



MSC-W Data Note 1/2023
Date: August 2023

METEOROLOGISK INSTITUTT
Norwegian Meteorological Institute

Transboundary air pollution by sulphur, nitrogen, ozone and particulate matter in 2021

Germany

H. Klein, M. Gauss, S. Tsyro, and Á. Nyíri

Data Note 2023

ISSN 1890-0003

МСЦ-З Записка о данных 1/2023
Дата: август 2023

METEOROLOGISK INSTITUTT
Норвежский Метеорологический Институт

Трансграничное загрязнение воздуха серой, азотом, озоном и твёрдыми частицами в 2021 году

Казахстан

Х. Кляйн, М. Гаусс, С. Цыро и А. Нийри

Перевод с английского: С. Цыро

Записка о данных 2023

ISSN 1890-0003

Assessment of air pollution in 2021 (2022), source receptor matrixes, country reports done with emissions ‘including condensables’
Overview of assessment, research & technical activities

https://emep.int/publ/reports/2023/EMEP_Status_Report_1_2023.pdf

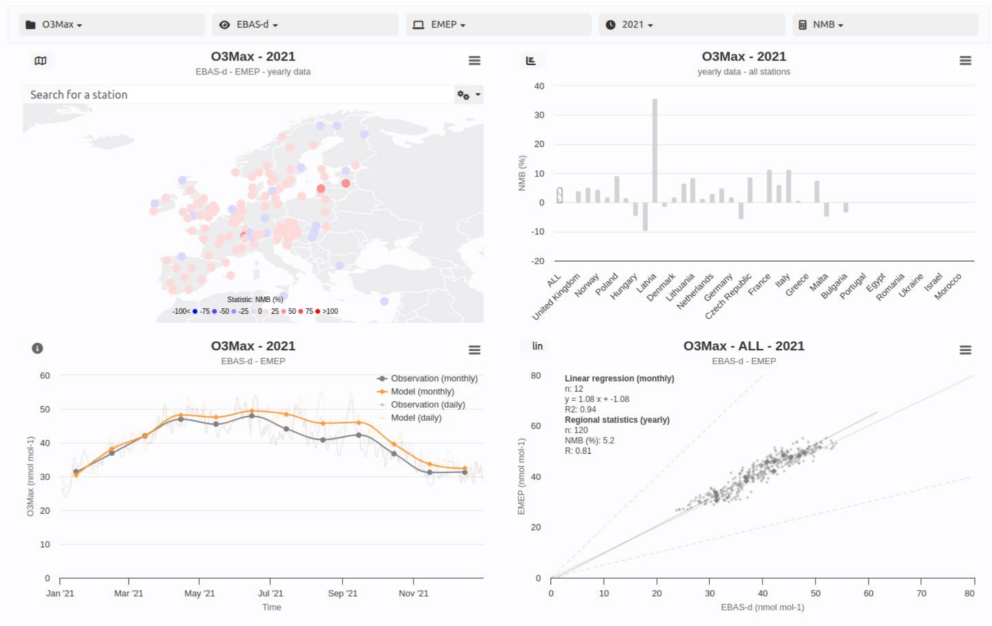
LRTAP
Long-range Transboundary Air Pollution

Additional products from reporting 2023 (2024)

EMEP MSC-W model runs for 1990-2022 available (33 years!) with updated emissions (by CEIP) and a consistent model version. Available from https://emep.int/mscw/mscw_moddata.html

Will redo 1990-2023 with updated emissions from CEIP this summer

NB: ‘Condensables’ consistent from 2005



Online model evaluation (and observation assessment) on AeroVal:

https://aeroval.met.no/evaluation.php?project=emep&exp_name=2023-reporting&station=ALL

Scenarios for the Gothenburg Protocol review

- Available on web from https://emep.int/mscw/2022GP_review_scenarios.html

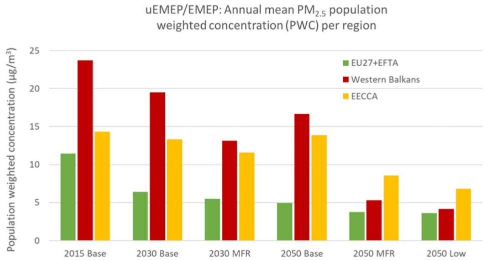


Figure 4.44: Calculated population weighted concentrations (PWC) for the 3 regions and for all scenarios using uEMEP for $PM_{2.5}$.

EMEP (2022). Denby, B.R., Nyíri, A., Fagerli, H., Klimont, Z., 2022. Chapter 4: uEMEP/EMEP modelling for the Gothenburg protocol review, in: EMEP Report 1/2022, Transboundary particulate matter, photo-oxidants, acidifying and eutrophying components. The Norwegian Meteorological Institute, Oslo, Norway, pp. 65–100. URL:

Future scenarios for air quality in Europe, the Western Balkans and EECCA countries: an assessment for the Gothenburg protocol review

Bruce R. Denby[a,*], Zbigniew Klimont[b], Agnes Nyiri[a], Gregor Kiesewetter[b], Chris Heyes[b] and Hilde Fagerli[a]

[a] *Norwegian Meteorological Institute, Henrik Mohns plass 1, 0313 Oslo, Norway*
[b] *International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria*

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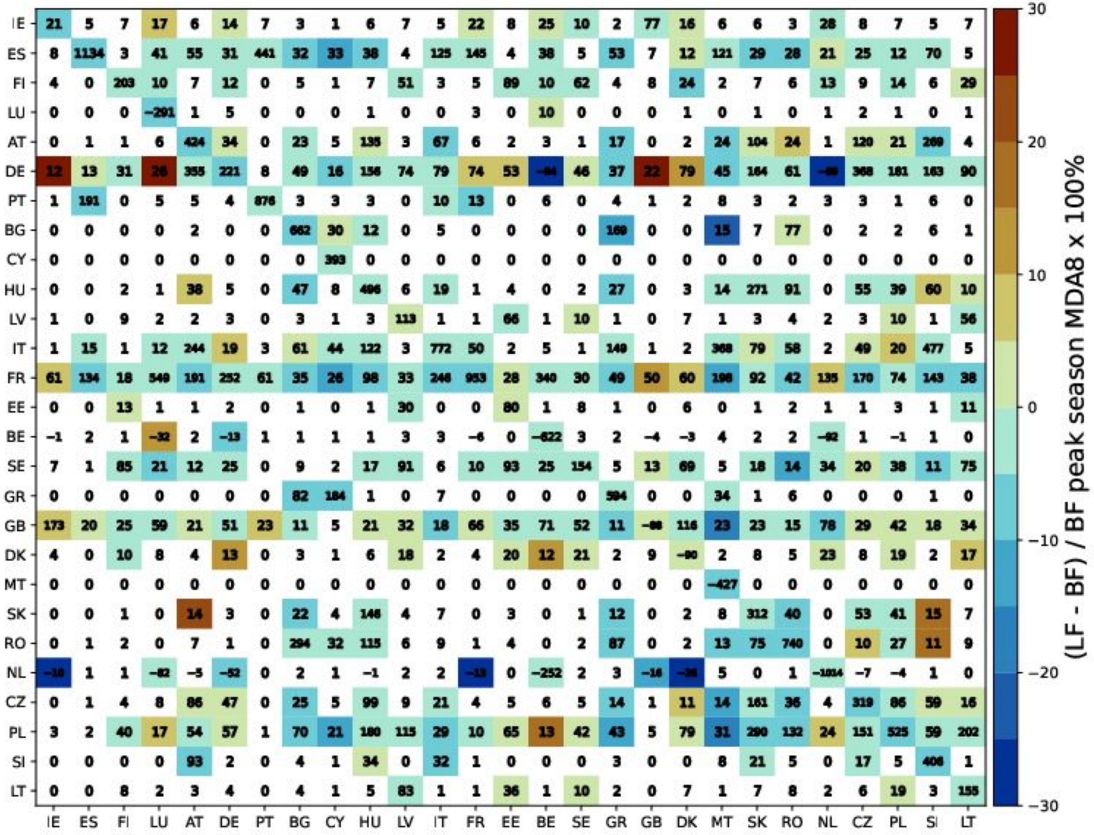
Blame matrix for peak season MDA8

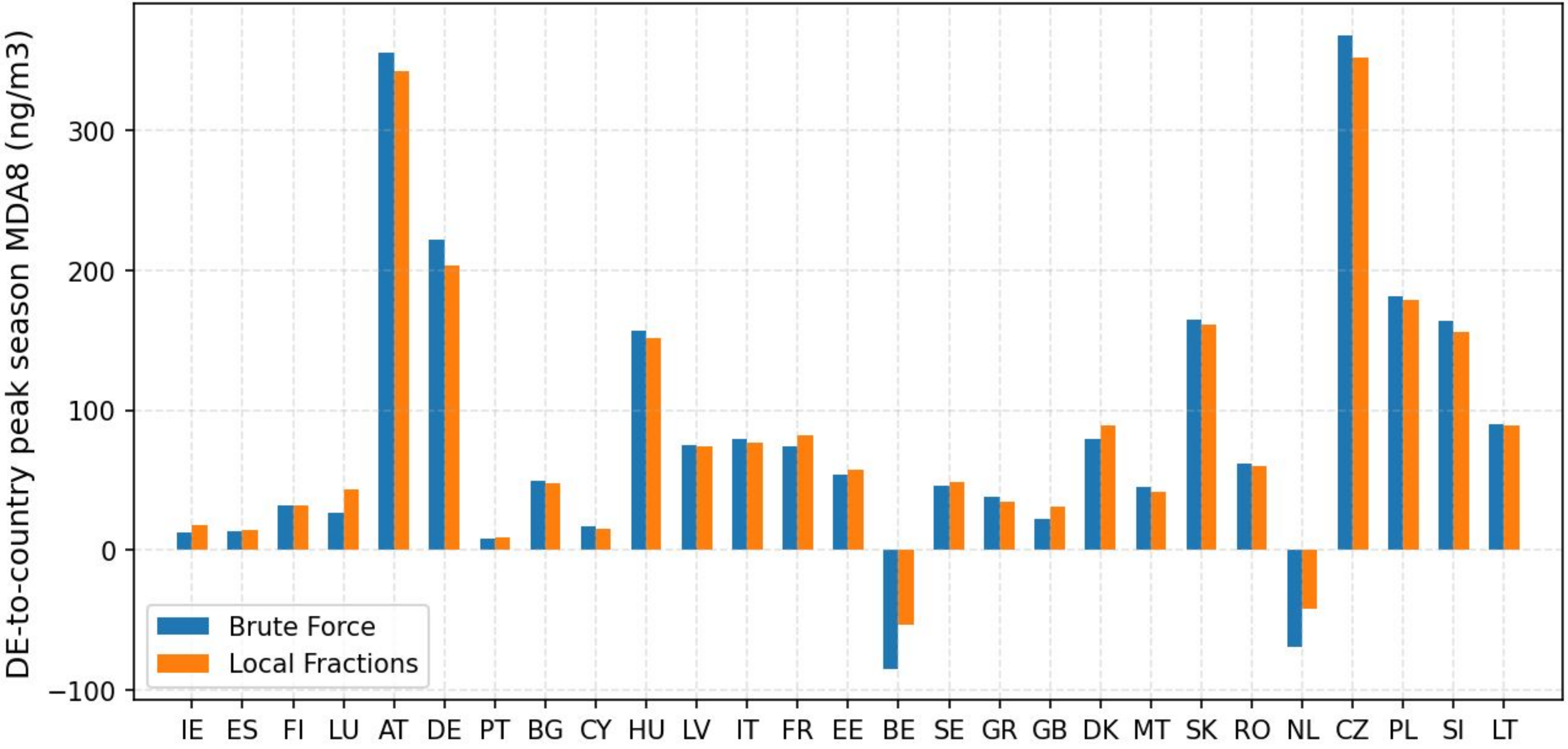
Emitters



Receptor

Numbers: Contributions for a 15% NOx reduction (BF)
Colours: Percentage difference

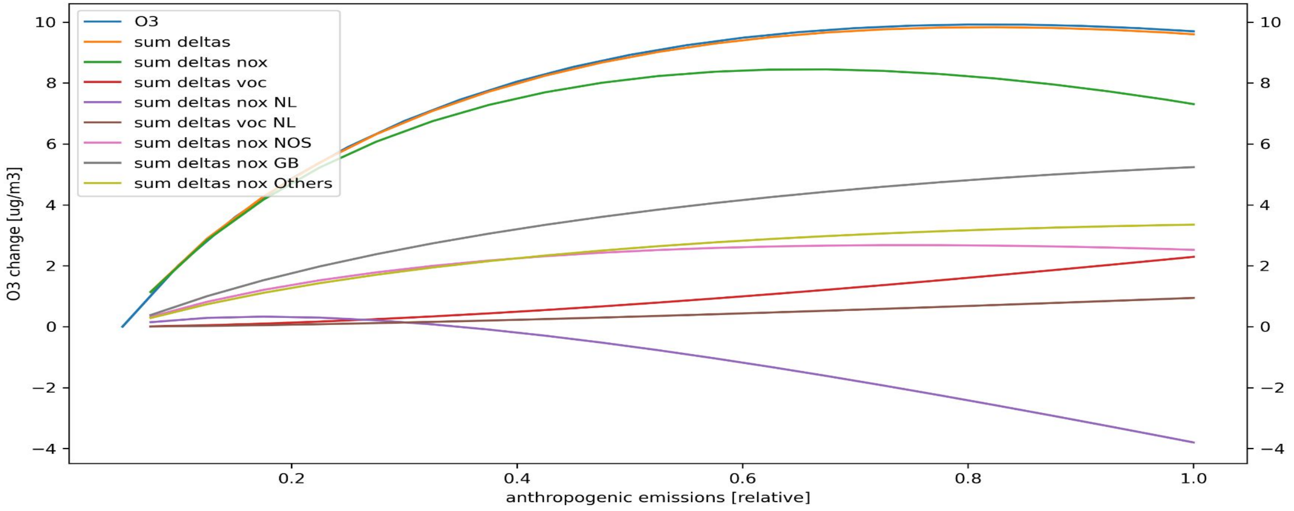
DE to countries



Very small absolute differences that can be explained

1.1.1.6 Update GAINS for simulating O_3 response to reduction of precursor emissions

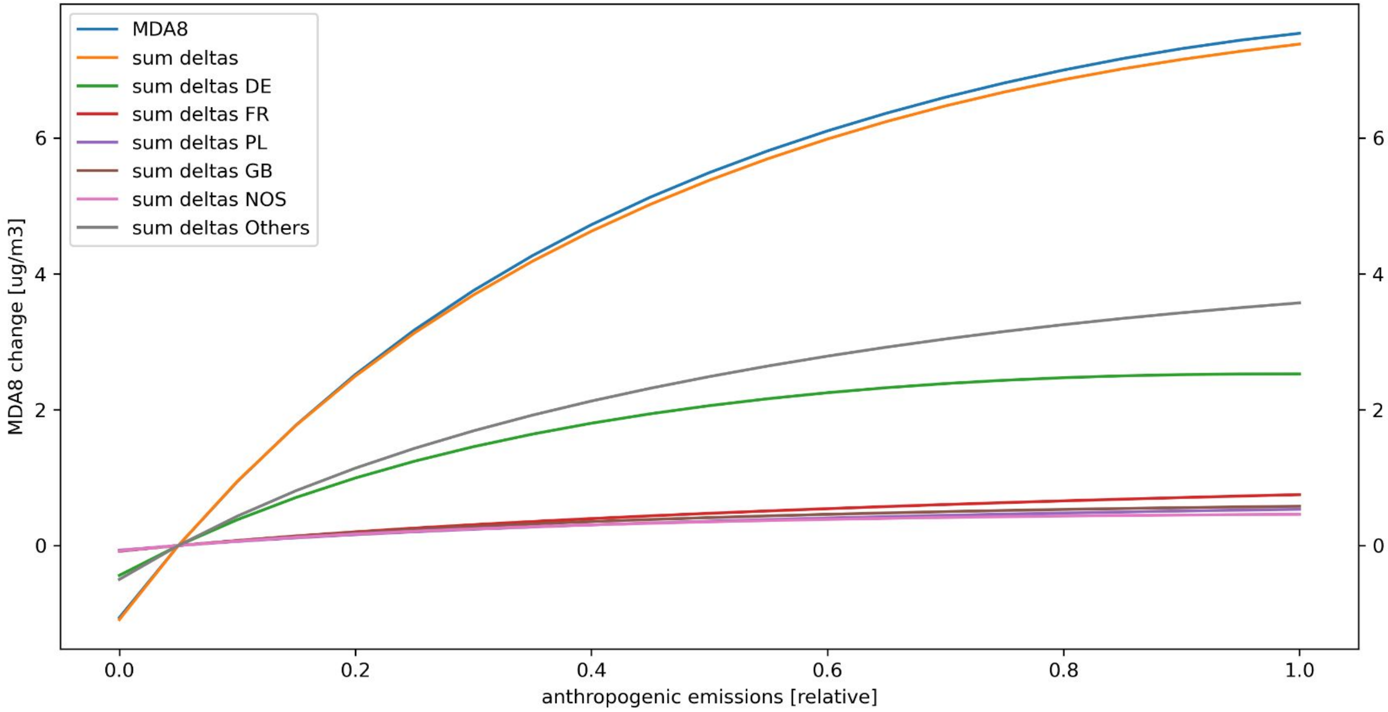
O_3 concentrations, July, due to NOx/VOC reductions, NL



Could potentially be parametrized and implemented in GAINS, but do you want to parametrize this?

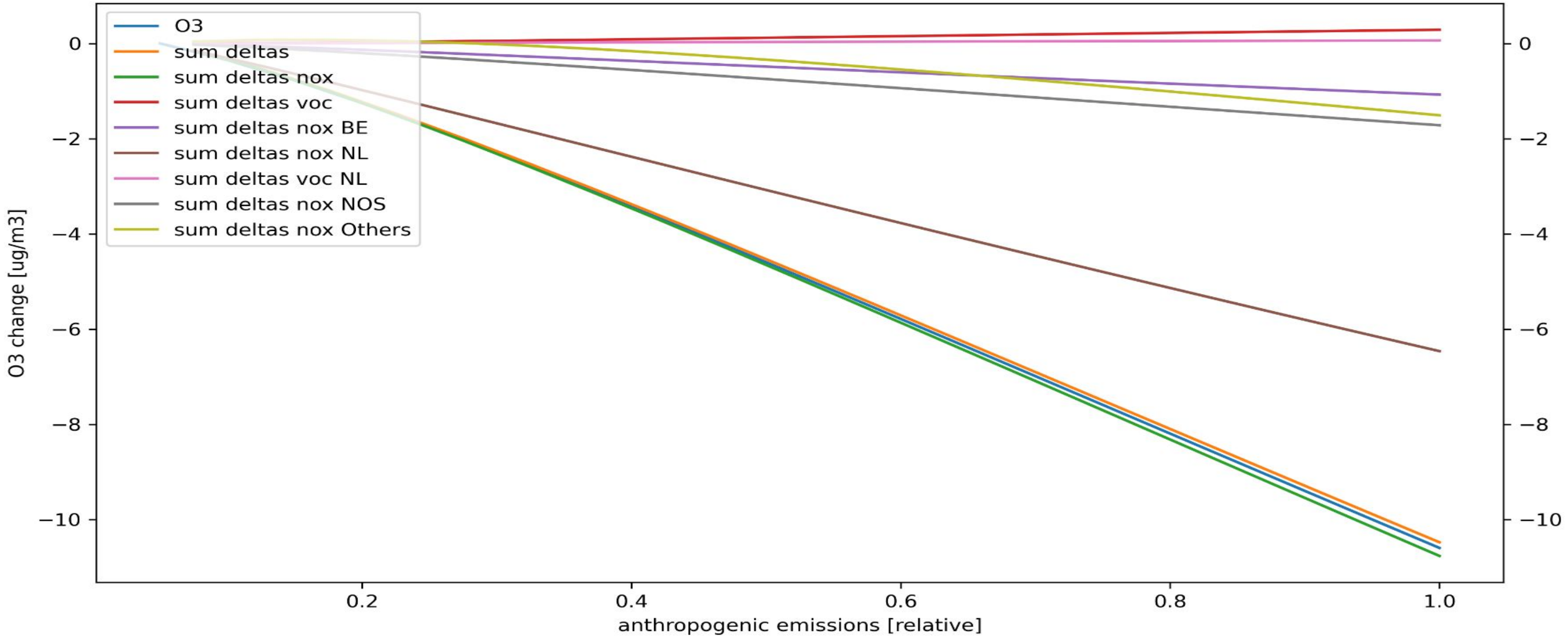
- The local fraction method has been tested and compared to BF
- When and how far can we assume linearity?
  - (How large reductions - which regimes, NOx vs VOC etc)
- Which indicators should we focus on for GAINS?
  - Peak season MDA8?
  - SOMO35?
  - POD3_crop?
  - other?

Peak season MDA8 due to NOx reductions, DE

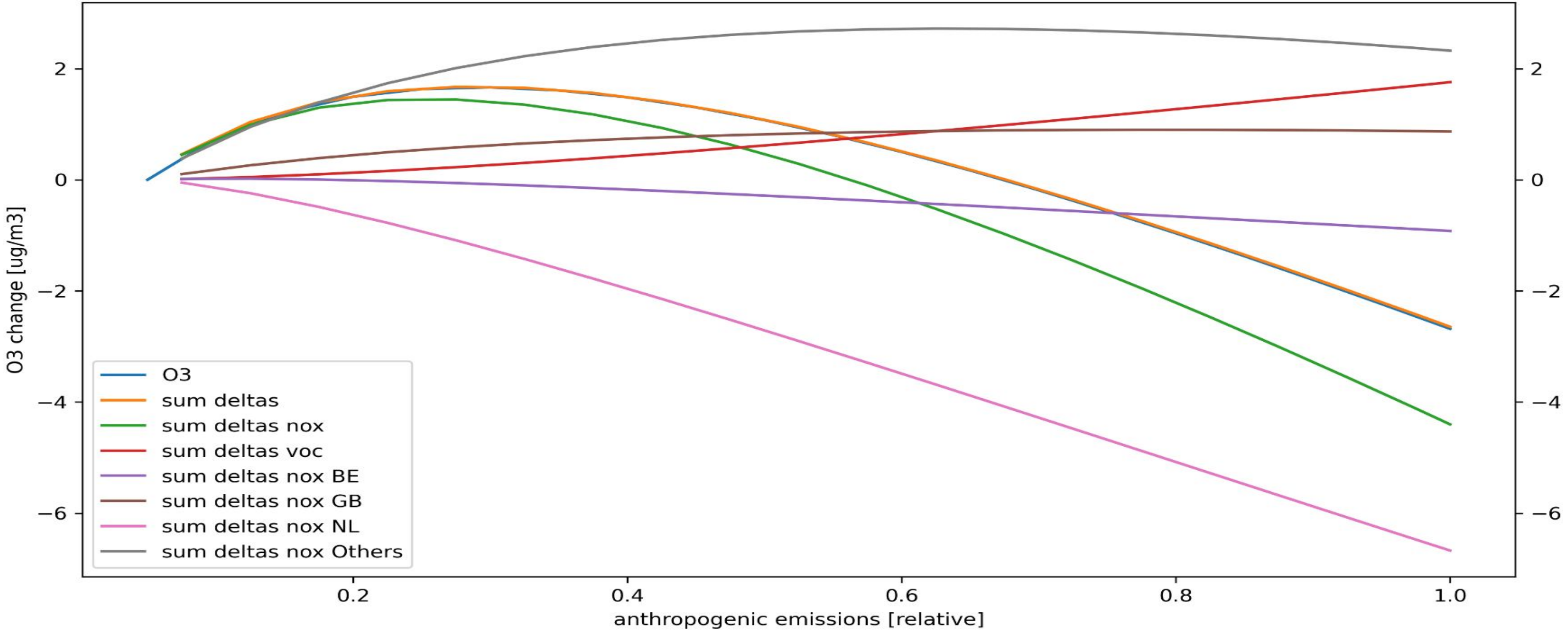


Could potentially be parametrized and implemented in GAINS

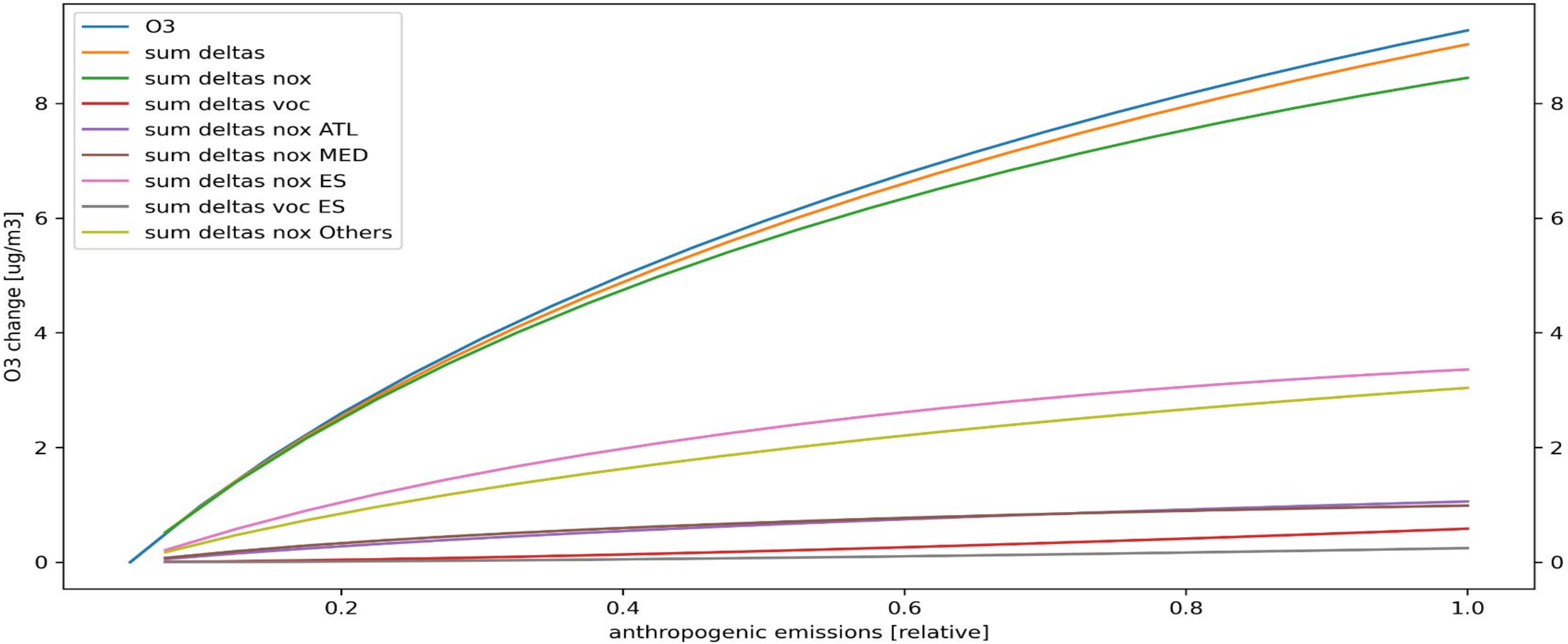
NL O_3 concentrations, Feb
All anthropogenic VOC NOx emis 0->full



NL O_3 concentrations, one year
All anthropogenic VOC NOx emis 0->full

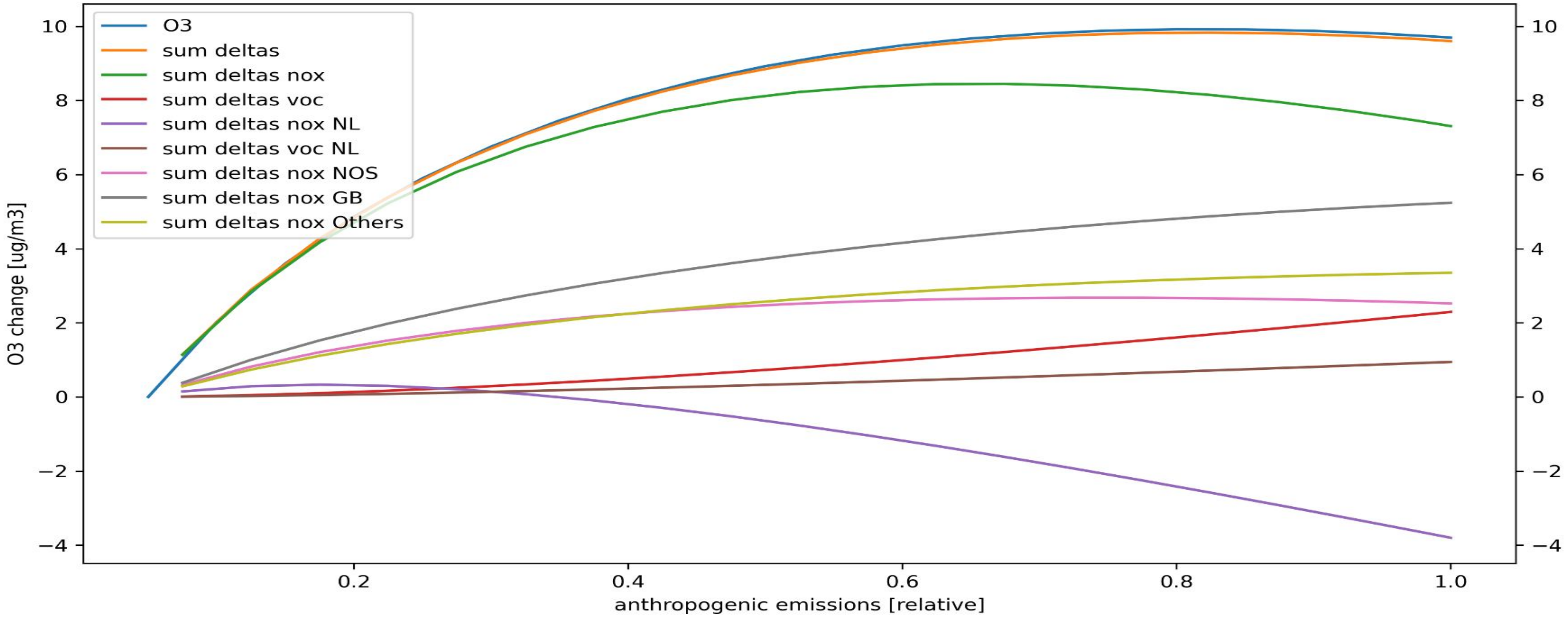


Spain O_3 concentrations, one year
All anthropogenic VOC NOx emis 0->full



NL O_3 concentrations, July
All anthropogenic VOC NOx antropogenic emis 0->full

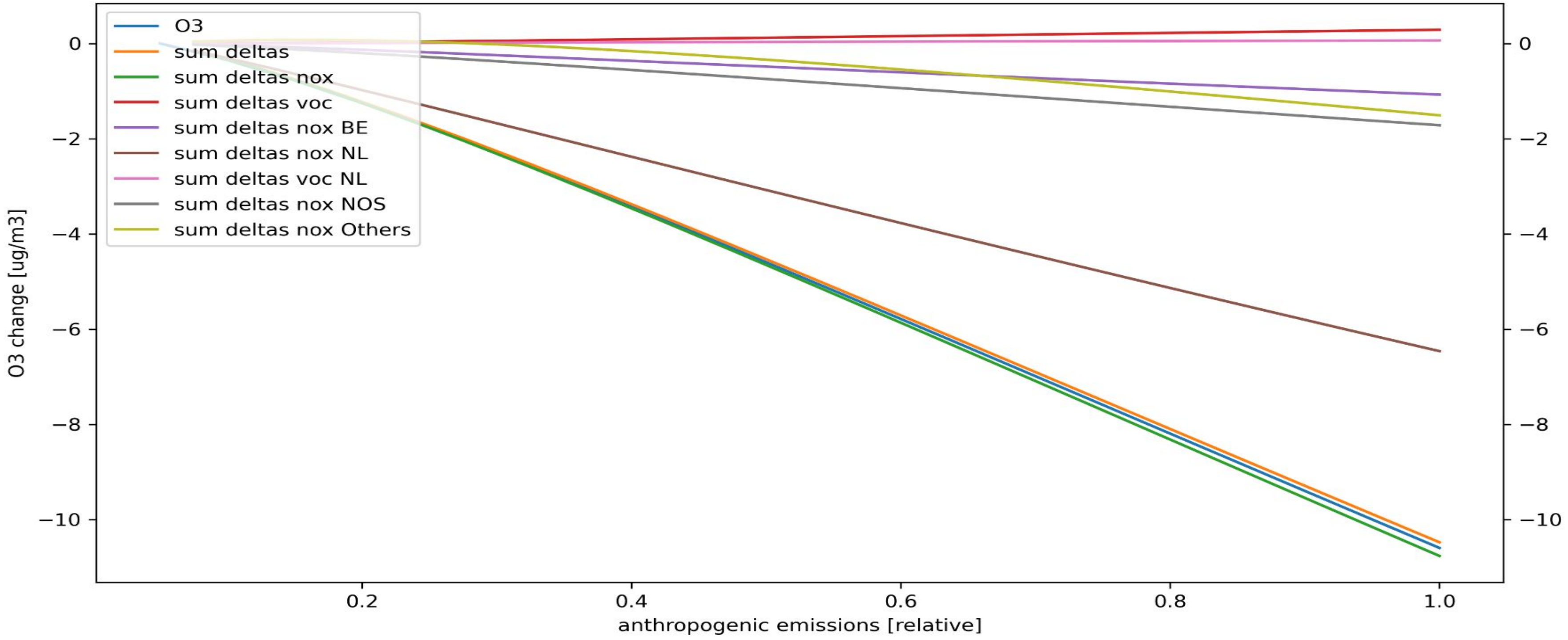
Norwegian Meteorological Institute



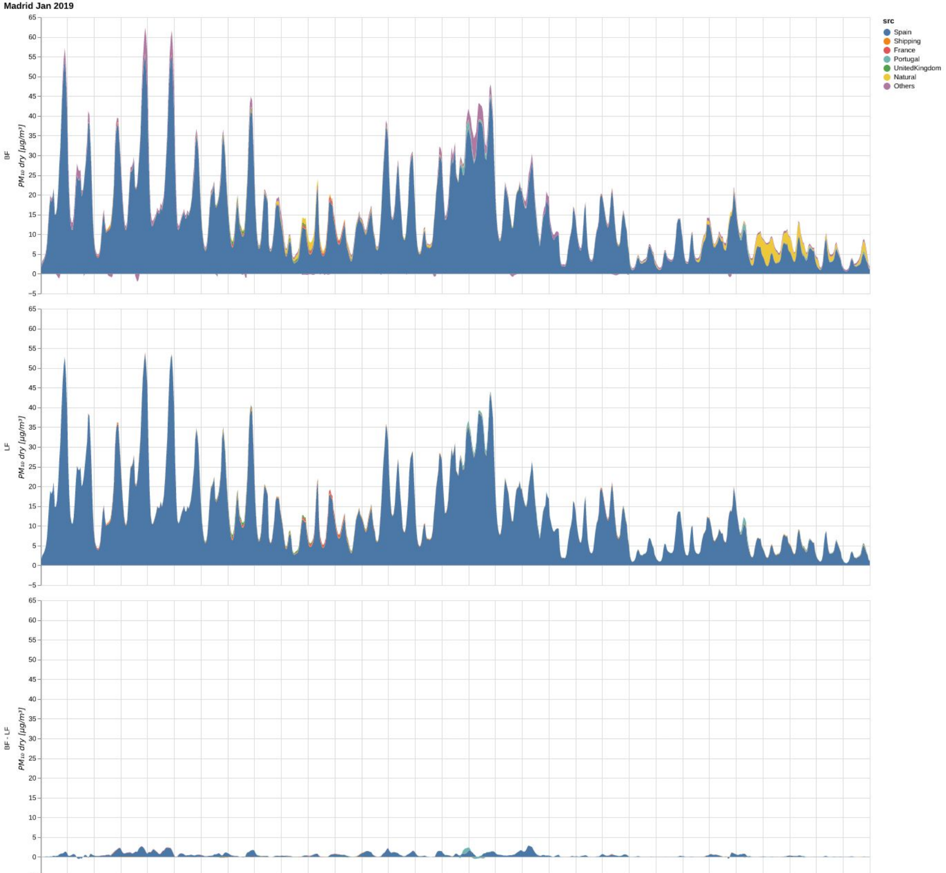
Norwegian Meteorological Institute, EMEP/MSC-W

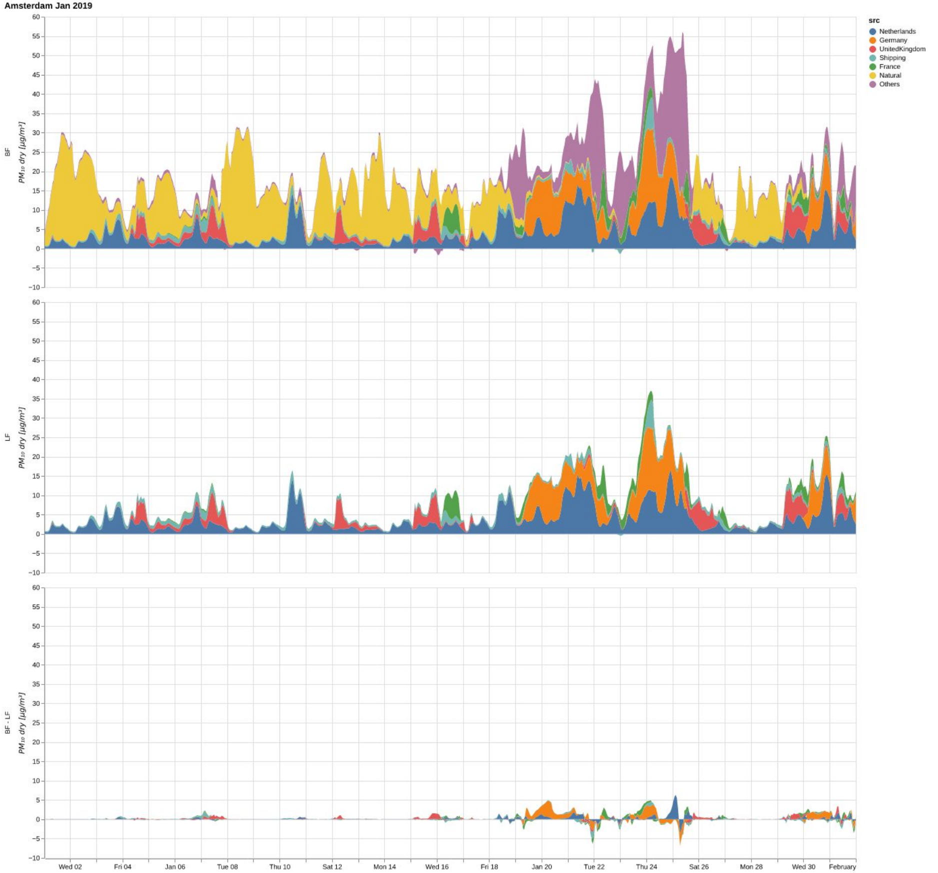
NL O_3 concentrations, Feb
All anthropogenic VOC NOx emis 0->full

Norwegian Meteorological Institute

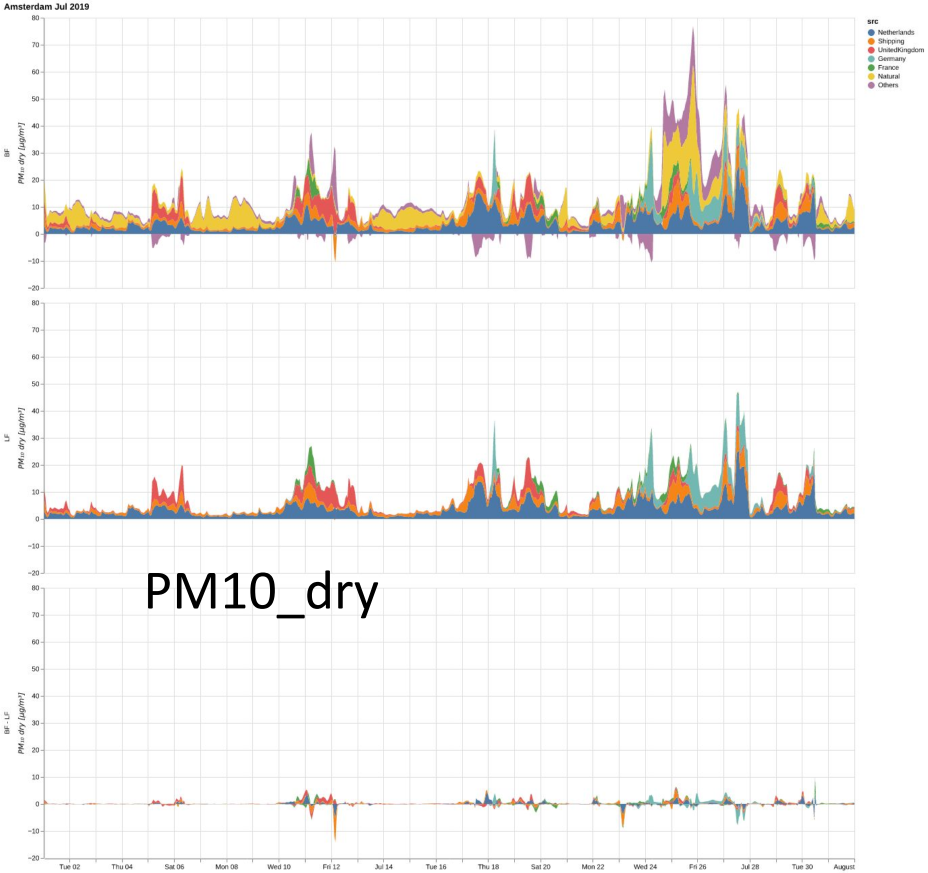


Country-to-city PM10dry, timeseries

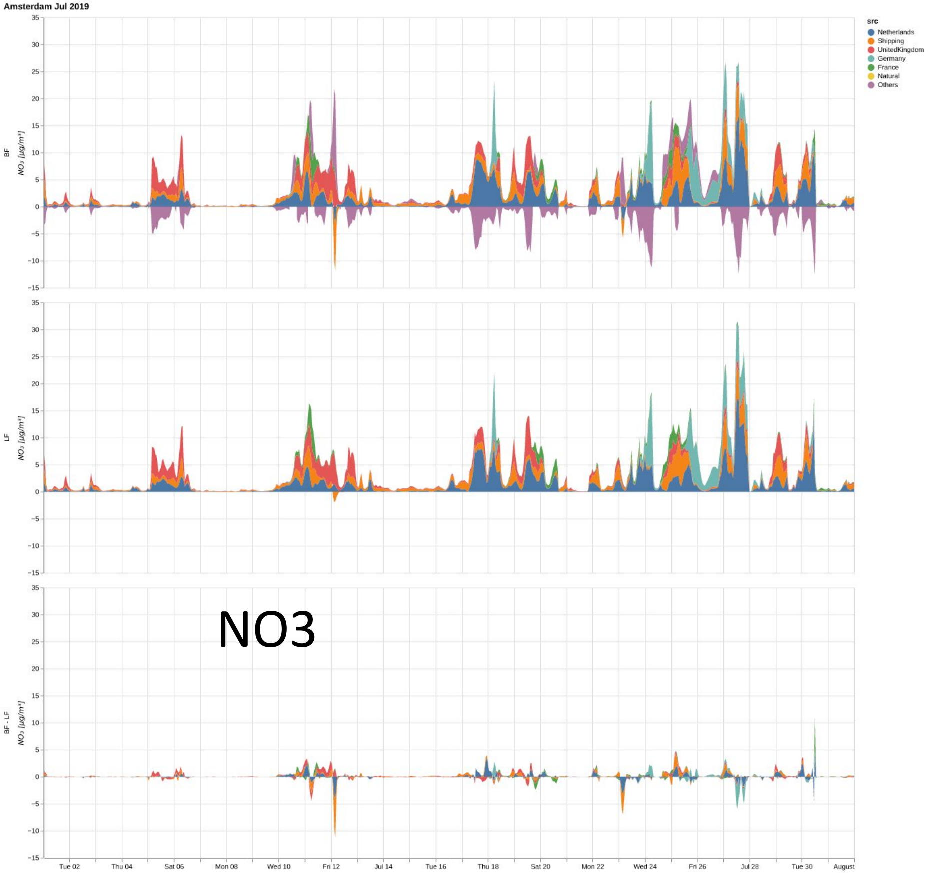




Amsterdam, July



PM10_dry



NO3

WP elements for MSC-W 2024/2025

- **Scenario assessment relevant for a potential GP revision using multiscale GAINS and EMEP/uEMEP**
- **Focus on EECCA and West Balkan countries** (trends, spatial distribution, projections, assessments including use of satellite data). (MSC-W, CIAM, CEIP)
- **Assess the importance of global LOW scenario** (including CH_4 pledge) for European O_3 2030-2050 and other relevant (CH4) scenarios (also in co-operation with TFHTAP)
- Review of methodologies: **brute force & sensibilities** (local fractions) and their applicability (including IAM)
- Work on the **inclusion of ozone** in IAM (GAINS), importance of agricultural NMVOC
- Evaluation EMEP/MSC-W model against **in-situ VOC measurements** from IMP 2022 and EMEP network (and HCHO from satellites)
- **Condensable organics/OC** (make better use of the EMEP/ACTRIS/COLOSSAL campaign and other data to understand sources), (MSC-W, CCC, TFMM)
- Contribute to TFHTAP exercise on CH_4 (?), Fires (TFHTAP, MSC-W)
- Increased cooperation with WGE (use of observational data from ICP Forest, use of uEMEP for effects related work)