emep

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

UNECE

Convention on Long-range Transboundary Air Pollution

MSC-W: Progress of activities 2024/2025

Hilde Fagerli, Gunnar Lange, Agnes Nyiri, Svetlana Tsyro, Willem van Caspel, Peter Wind, David Simpson & rest of the EMEP/MSC-W team

TFMM Potsdam, 5th-7th May 2025

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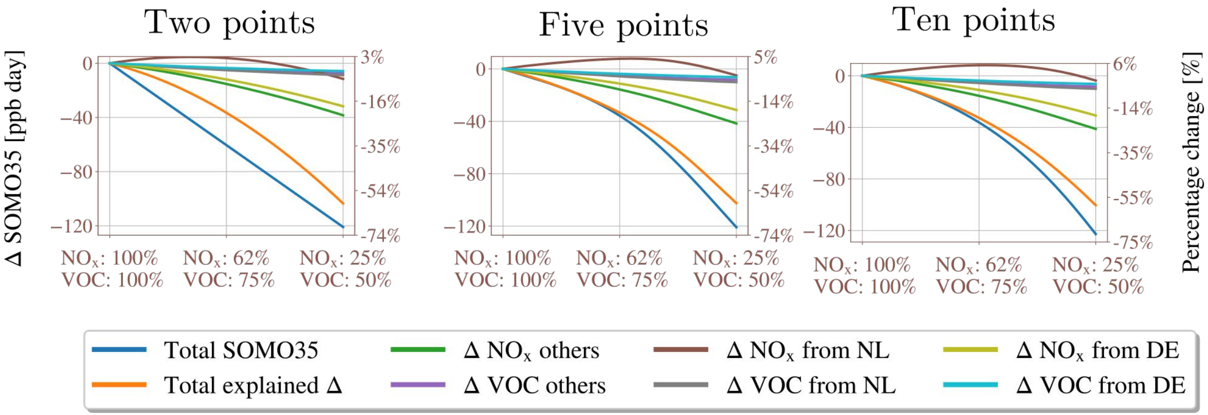
Overview

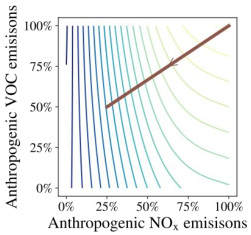
- Ozone response to changes in emissions - in the perspective of including this into the integrated assessment model GAINS
- What is the quality of our model simulations for EECCA & West Balkan ?
- *Assessment of the reported EC/BC emissions using modelling - S. Tsyro, Monday 17:15*
- *EMEP MSC-W modelling for the GP review & revision - H. Fagerli, Wednesday at 11*

How to parametrize in GAINS?

- A ‘realistic path’ has been chosen for the calculation of derivatives (2015 to 2050 MFR)

SOMO35 NL





2 points is probably enough for a quadratic fit

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

- GAINS: integrated assessment model that includes
  - Parametrized deposition/concentration response to emission changes
  - Health effects, ecosystem impacts (exceedances of CLs, biodiversity)
  - Cost of emission mitigation measures

=> Used for e.g. optimizing scenarioes for a certain endpoint, or for giving results for specific scenarios

=> Very important for Gothenburg Protocol Revision, e.g. the 50% health effect reduction target

- Ozone:
  - ‘Old’, linear response

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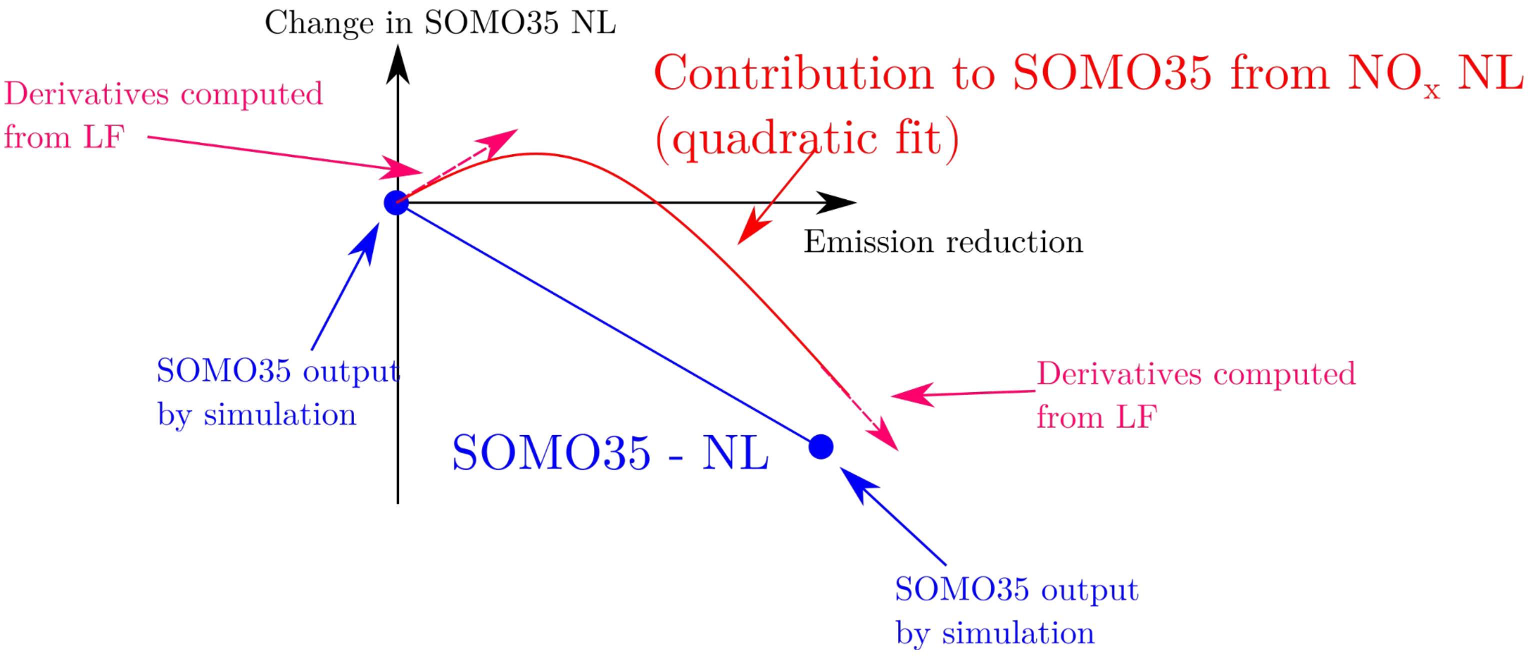
How should we parametrize O_3 response in GAINS to NOx & VOC emission changes?



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

In GAINS we want to implement the response in ozone indicators to different emission precursors. But is this **response** (Delta indicator/Delta emission for country/component/sector to grid) also sensitive to:

- The **hemispheric inflow of ozone** (boundary conditions) - or can IIASA 'add' BCs independently?
- **Resolution**: does it matter if we do modelling in 0.1x0.1 or 0.3x0.2 degree?
- Emission changes being **low** level (e.g. traffic) or **high** level (e.g. power plants)?
- The **soil NOx** scheme applied?
- CO 'background' concentrations?

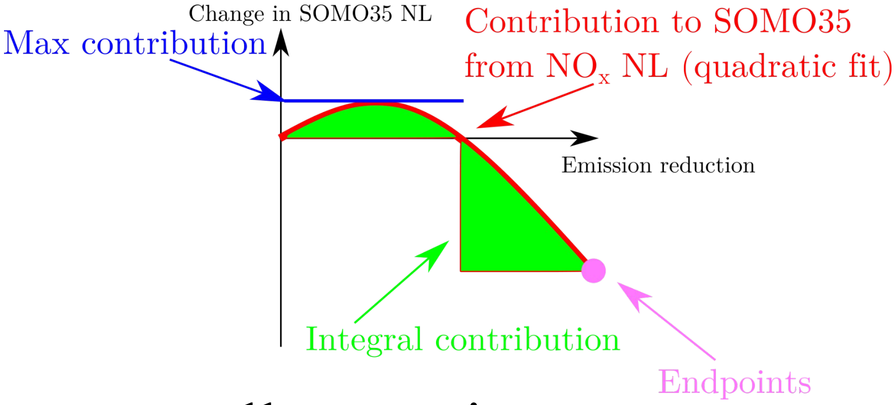
Wind & van Caspel, 2025 Generalized local fractions – a method for the calculation of sensitivities to emissions from multiple sources for chemically active species, illustrated using the EMEP MSC-W model (rv5.5) https://doi.org/10.5194/egusphere-2024-3571, 2025.

Full presentations:
https://docs.google.com/presentation/d/1nBqQqMU4LQR1FuMLIEarM8UDnRWskzxPPfPG40UCzqM/edit?usp=sharing

Wind & van Caspel, 2025
Generalized local fractions – a method for the calculation of sensitivities to emissions from multiple sources for chemically active species, illustrated using the EMEP MSC-W model (rv5.5)
https://doi.org/10.5194/egusphere-2024-3571, 2025.

Explanation of plots

All plots shown consider the scenarios going from 2015 CLE to 2050 MFR



Scatter plots: Compare two scenarios across all countries

- Show both the local fractions (derivatives) and total indicator
- The closer to the 1:1 line, the better
- All plots are on the same axis
- Show the ***max***, the ***integral*** and the ***endpoint*** (see figure) for each country/pollutant
- Show total indicator change and the indicator at the endpoint

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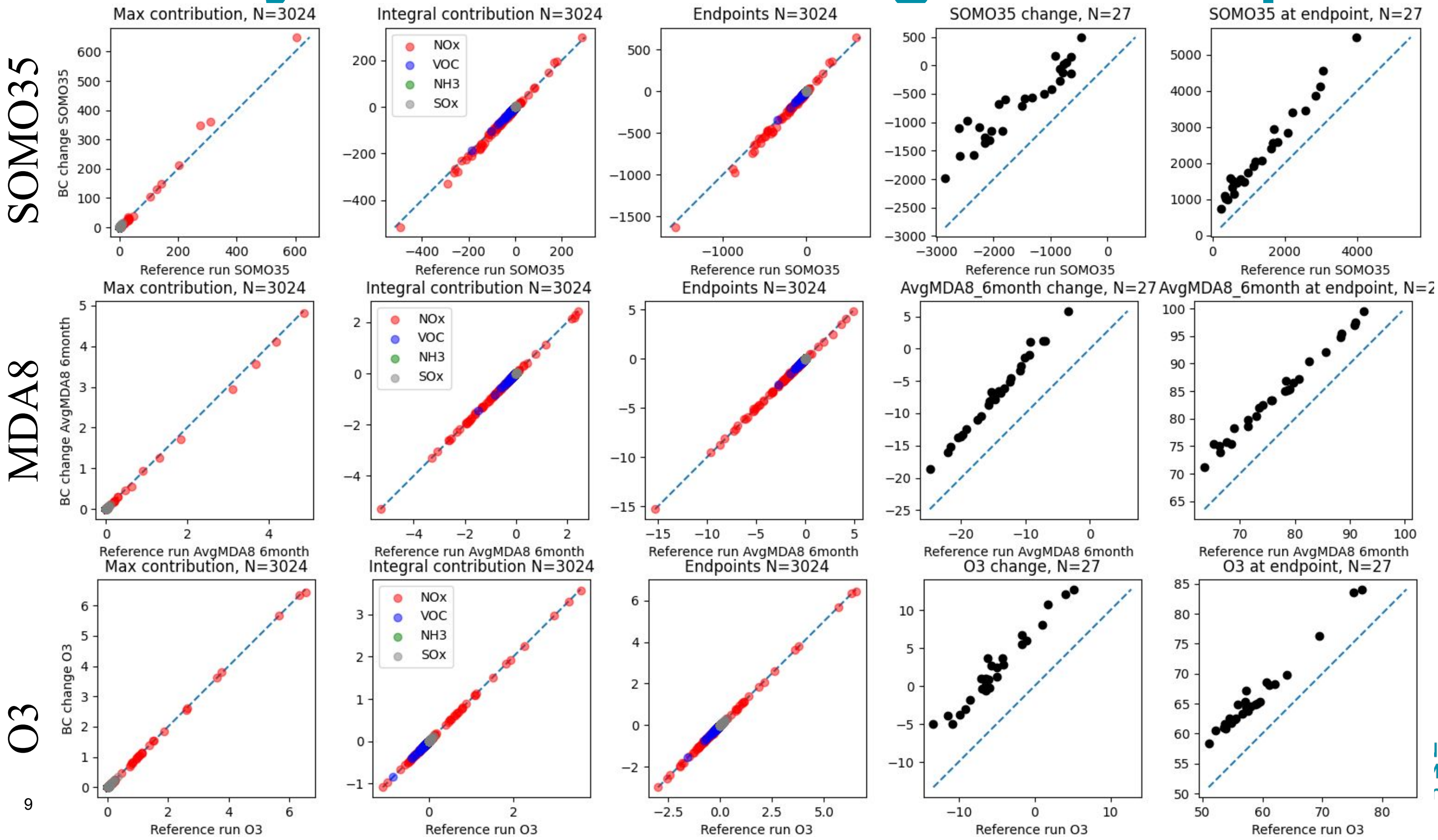
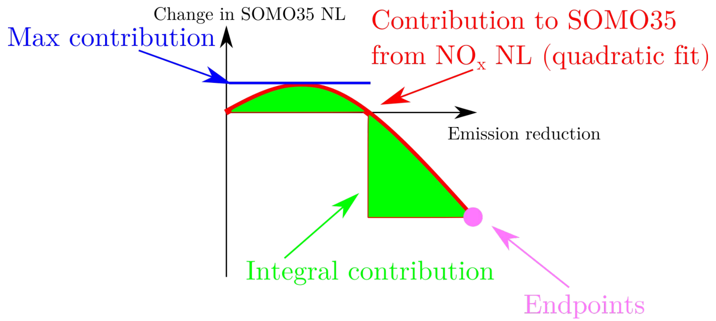
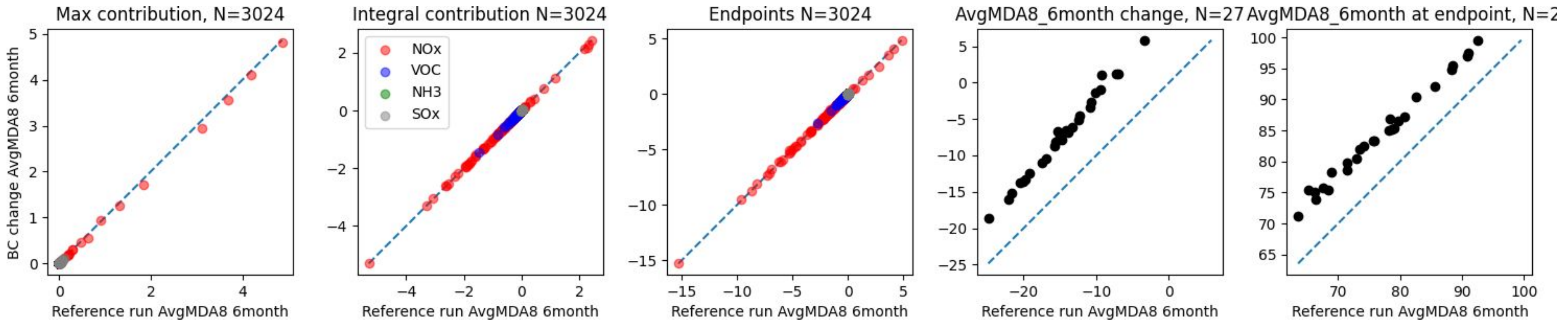
Boundary conditions change scatter plot



Are the derivatives sensitive to boundary conditions changes? 2015 CLE versus 2050 MFR BIC



MDA8



Max.contribution integral endpoint change(N=27) endpoint(N=27)

N= 3024 (4 components, from 28 countries, to 27 countries)

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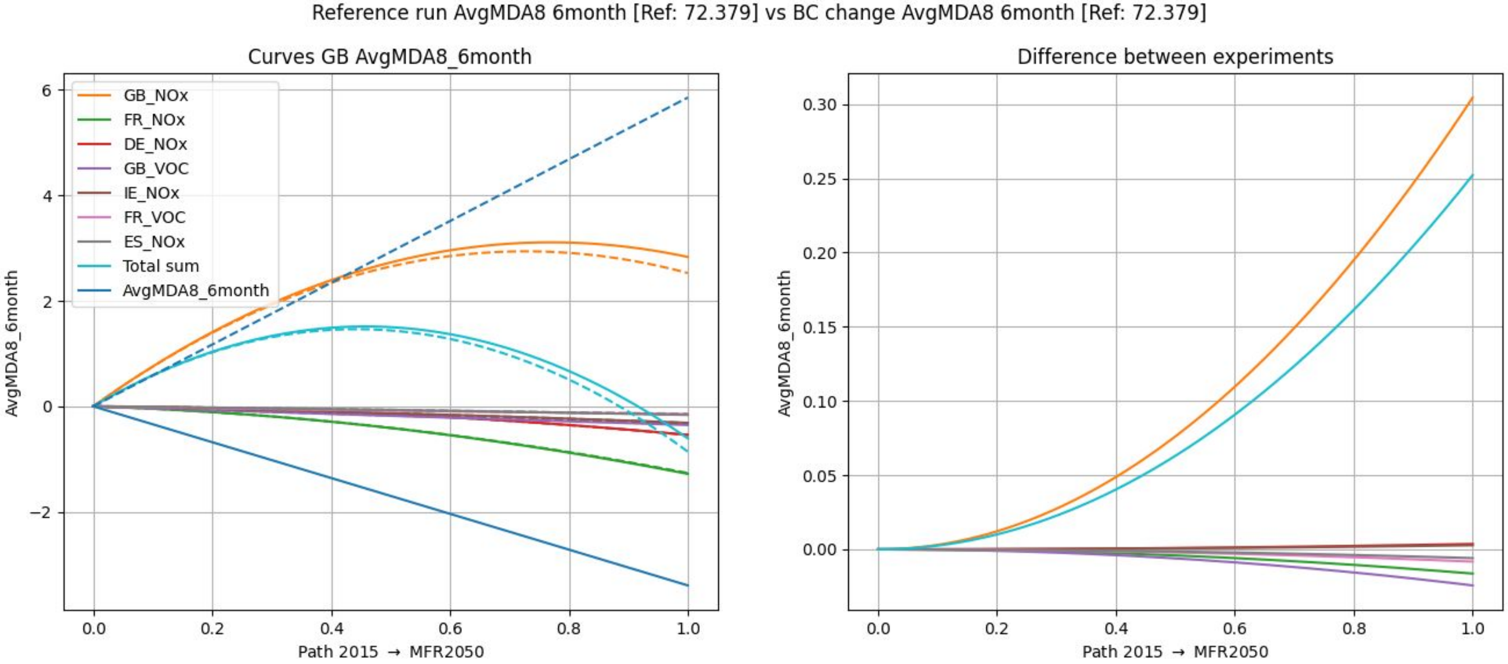
Boundary conditions change curves GB MDA8



Compare two scenarios for specific country

- Left-hand panel: Full vs dotted line are the two different scenarios
- Right-hand panel: Difference between scenarios
- Absolute value of the indicator at CLE condition is at the top
- We show the most extreme country in each case

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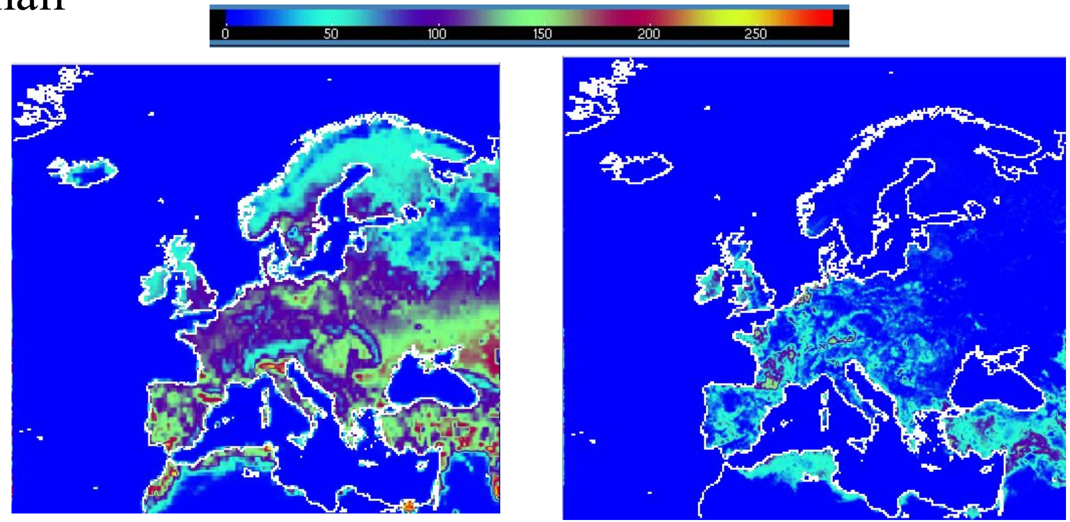
Analysis: SoilNOx scheme change

- SoilNOx scheme has smaller impact on indicator but larger impact on derivative compared to changing boundary conditions

- Overall effect is still quite small

Emission BioNatNo (mgm2)



Reference SoilNOx scheme

Changed (old) SoilNOx scheme

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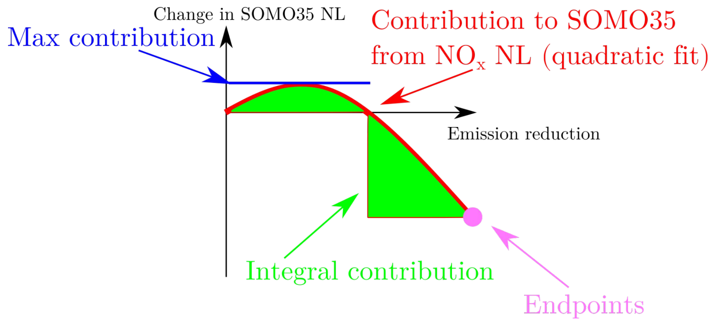
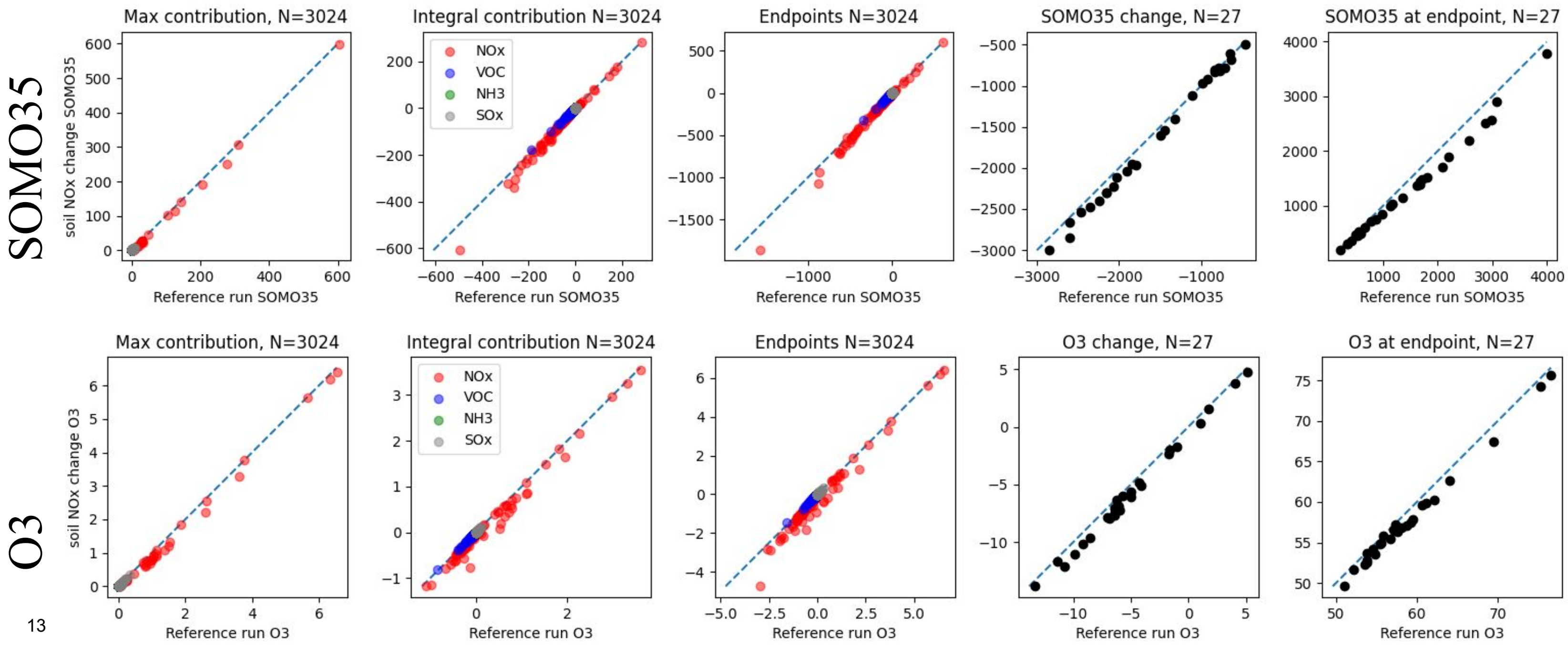
SoilNox change





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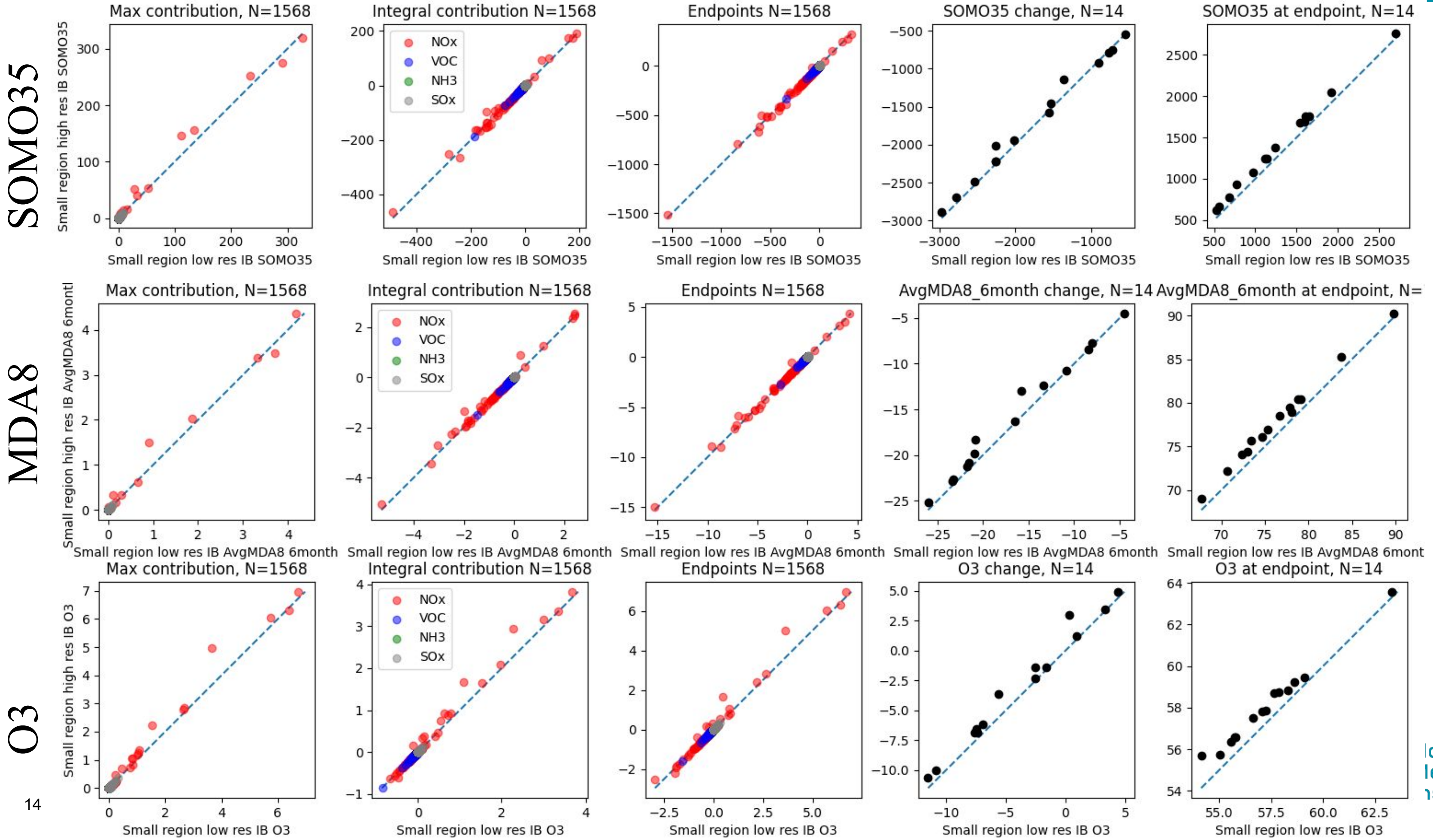
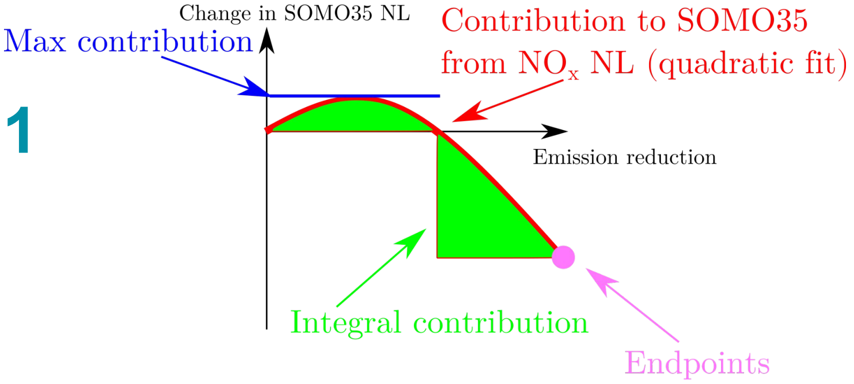
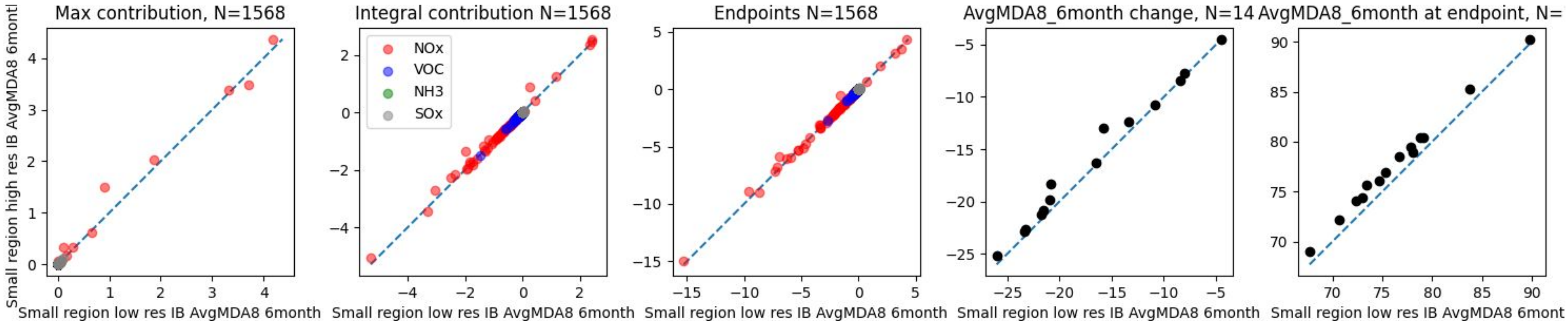
Resolution change ignoring boundary countries scatter plot



Is resolution important for the derivatives? 0.3x0.2 versus 0.1x0.1 degree



MDA8



Max.contribution integral endpoint change(N=27) endpoint(N=27)

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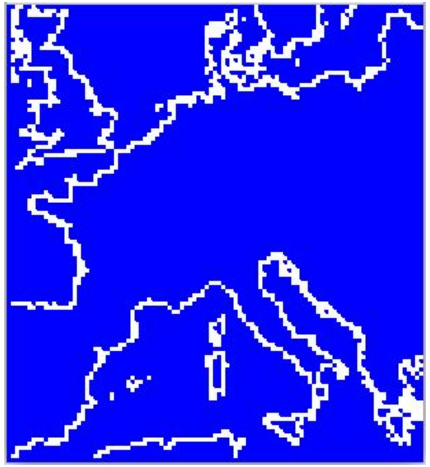
Is it important to parametrize low and high level sources separately?

This does exactly the same as the reduced EMEP0302 resolution experiment, but now also split into 13 GNFR sectors. We also split into low/high sources.



EMEP code	SNAP	GNFR_CAMS code	Source
1	1	A	Public Power
2	3	B	Industry
3	2	C	Other Stationary Combustion
4	5	D	Fugitive
5	6	E	Solvents
6	7	F	Road Transport
7	8	G	Shipping
8	8	H	Aviation
9	8	I	Offroad
10	9	J	Waste
11	10	K	Agri - Livestock
12	10	L	Agri - Other
13	3	M	Other

NOx Agricultural: 11, 12
NOx Point sources: 1,2,4,10
NOx Low-level sources: 3,5,6,7,8,9
NOx Rest: 13

VOC Agricultural: 11,12
VOC Rest: 1,2,3,4,5,6,7,8,9,10,13

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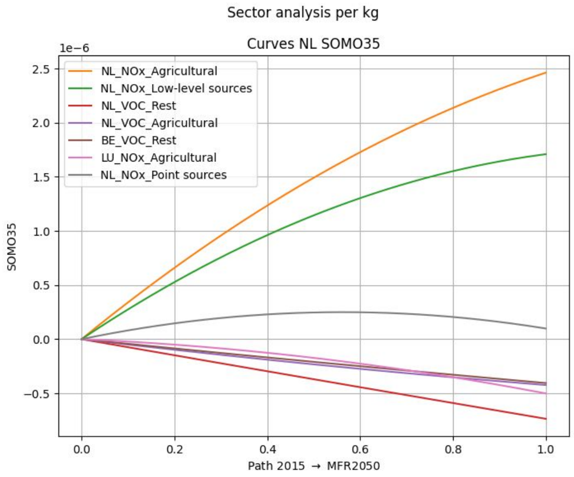
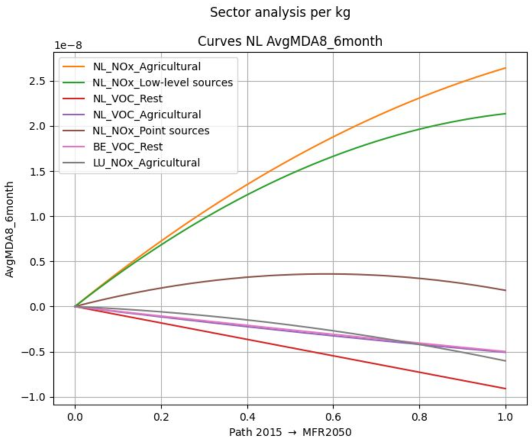
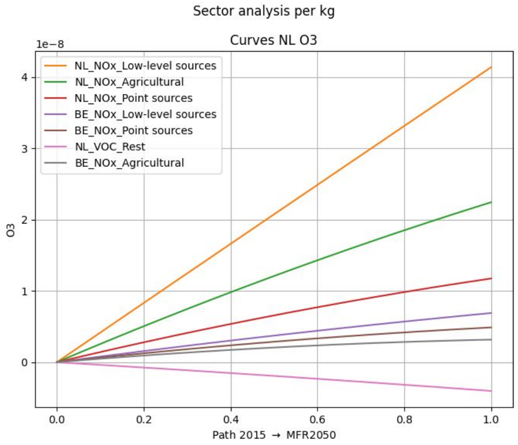
Sector split aggregate per kg NL

N.B! Colors are not consistent







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13	3	M	Other

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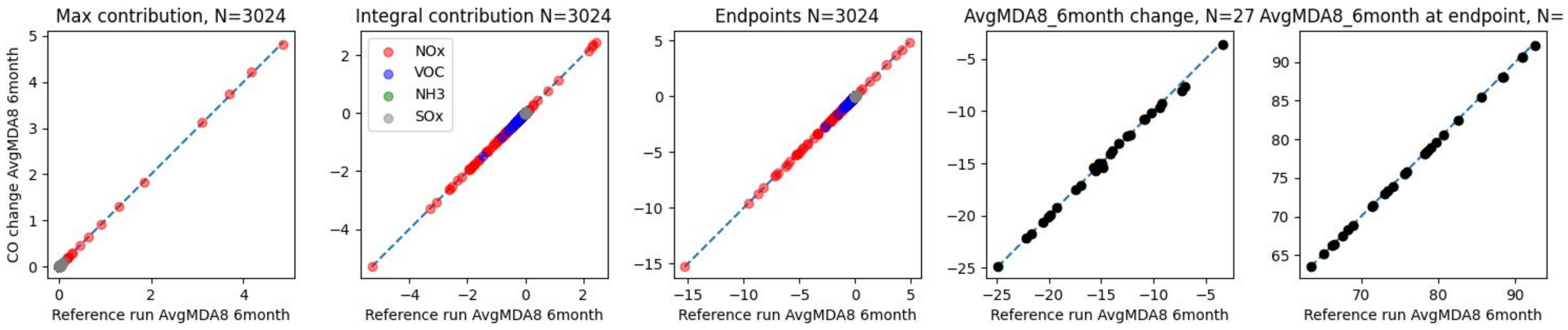
Does the response depend on CO concentrations (50% reduction of CO)?

MDA8



Max.contribution integral endpoint change(N=27) endpoint(N=27)

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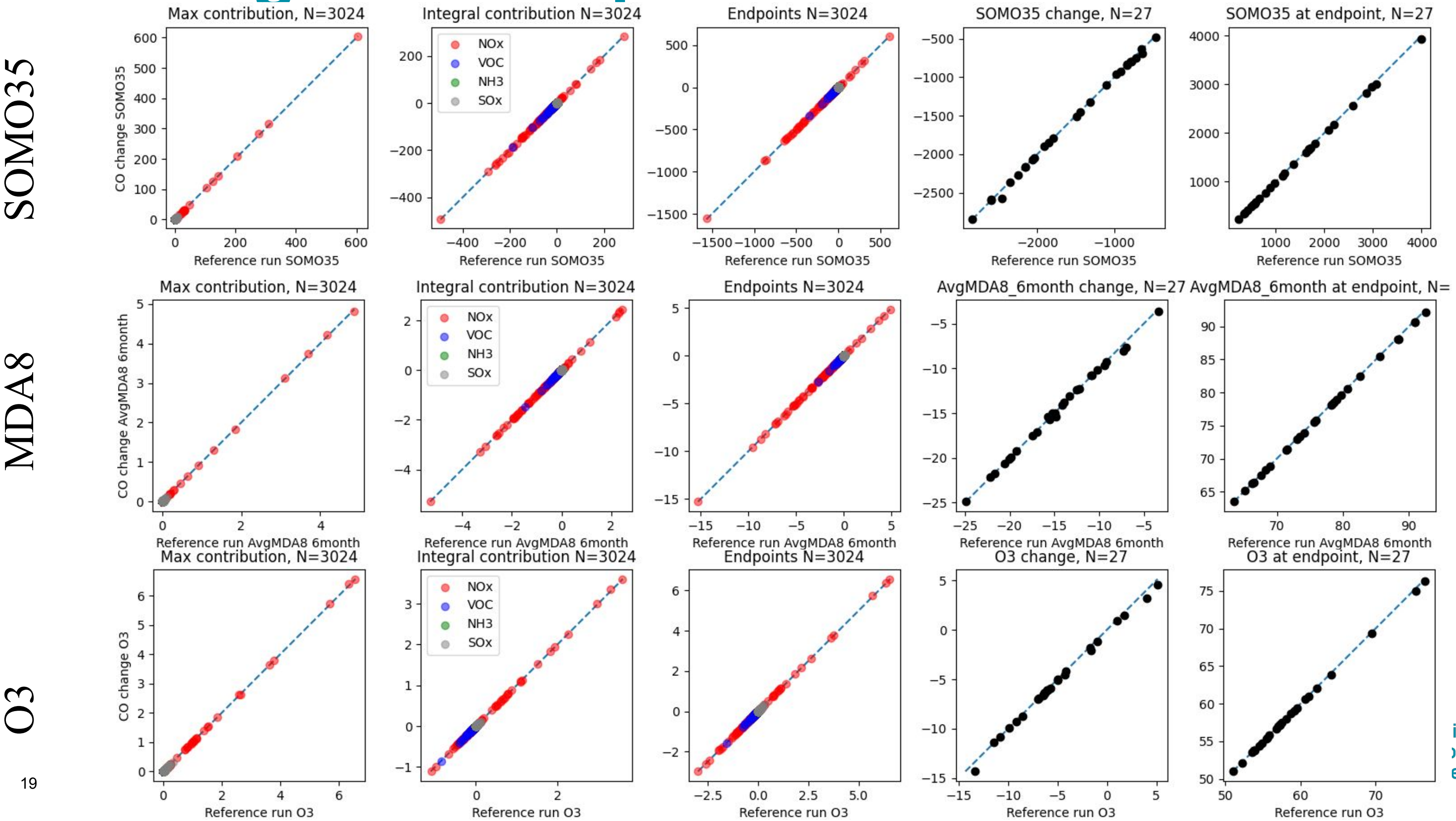
CO change scatter plot



Conclusions

- BC:
  - The absolute value of the indicator depends on BC, but the derivatives/sensitivities are largely unaffected.
  - In general, with CLE boundary conditions, the final indicator is larger, so that the change in the indicator is smaller (less negative).
- SoilNOx scheme:
  - smaller impact on indicator but larger impact on derivative compared to changing boundary conditions
- Resolution:
  - Higher resolution does seem to induce a small bias in the total indicator, but as there is no bias in the difference of indicators, this is approximately evenly distributed between CLE and MFR
  - No clear systematic pattern in derivatives
- High versus low-level sources:
  - Important (!) Will be taken into account
- CO:
  - Smallest impact of all of the tested ones

All tests finalized - final model runs about to start and will be parametrized and implemented in GAINS

Assessment of the (u)EMEP model results for the Western Balkans and EECCA regions using surface observations and satellite derived data.

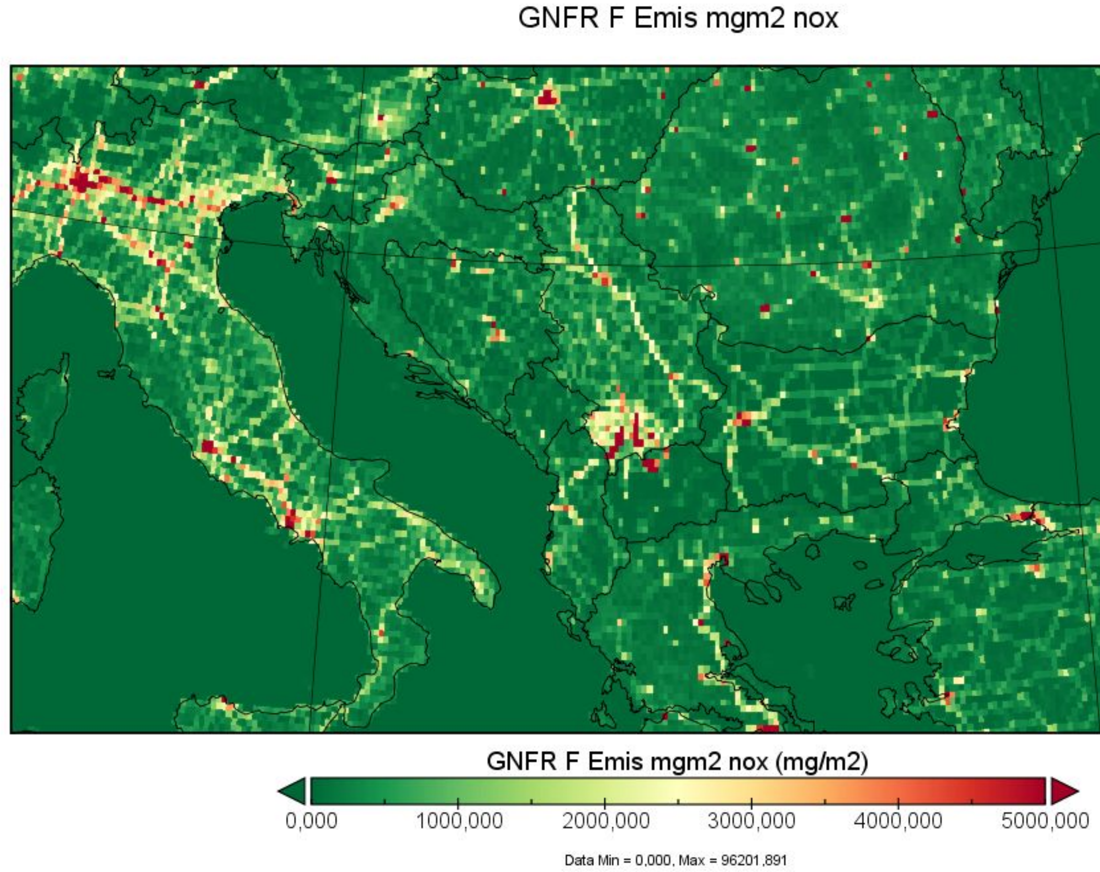
Why?

- Quality & availability of EMEP observations and emissions - how good is our modelling for these areas?
- Areas with high air pollution
- Evaluation of the 2022 EMEP model results

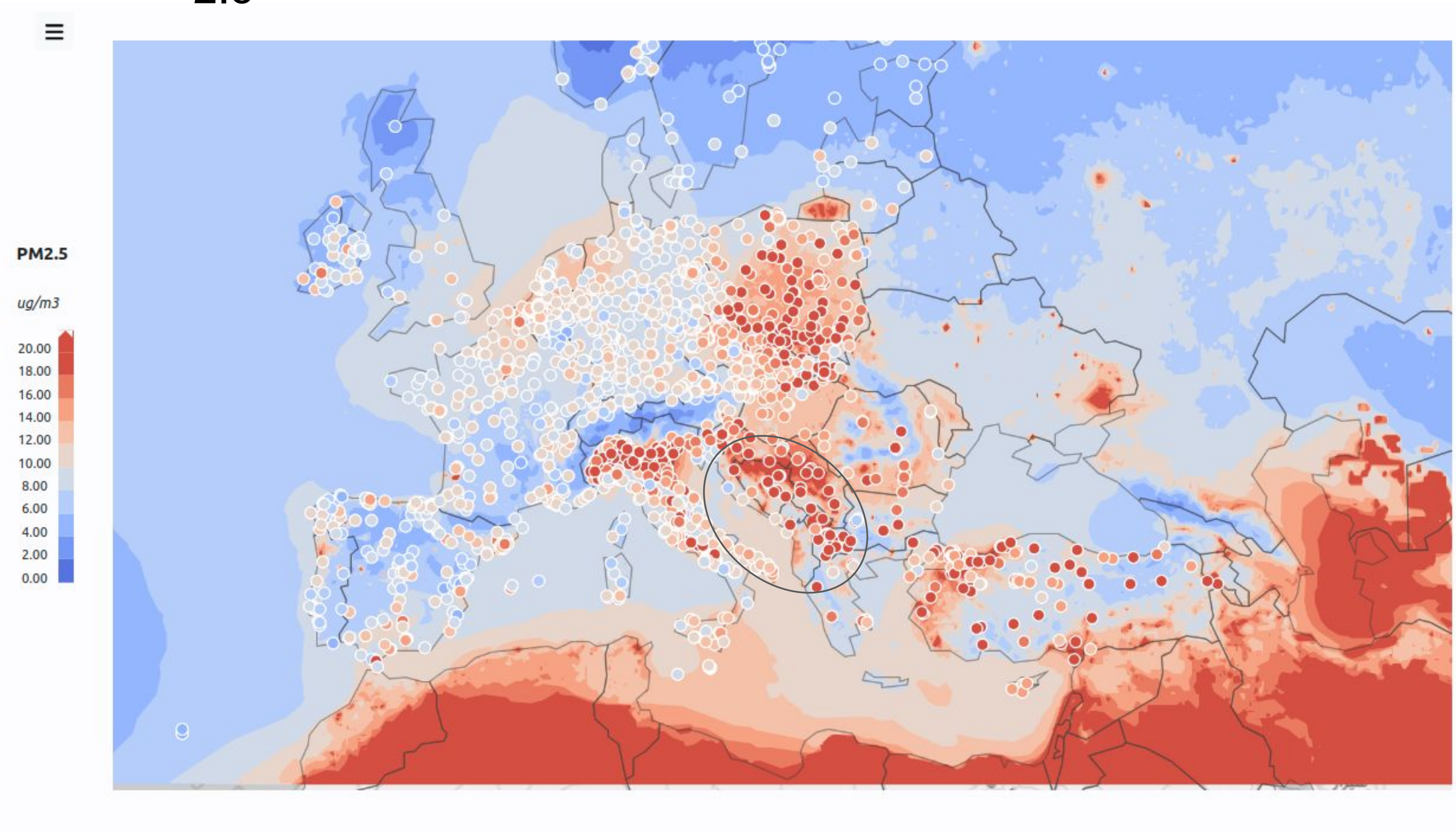
Country	Data source	Gridding
Albania	Replaced (GAINS)	CAMS proxies
Bosnia and Herzegovina	Replaced (GAINS)	CAMS proxies
Montenegro	Replaced (GAINS)	CAMS proxies
North Macedonia	Reported	Reported
Serbia	Reported	CAMS proxies
Armenia	Replaced (GAINS)	CAMS proxies
Azerbaijan	Replaced (GAINS)	CAMS proxies
Georgia	Partly replaced (GAINS)	Reported
Kazakhstan	Replaced (GAINS)	EDGAR proxies
Kyrgyzstan	Partly replaced (GAINS)	EDGAR proxies
Moldova	Extrapolated	CAMS proxies
Tajikistan	GAINS	EDGAR proxies
Turkmenistan	GAINS	EDGAR proxies
Uzbekistan	GAINS	EDGAR proxies

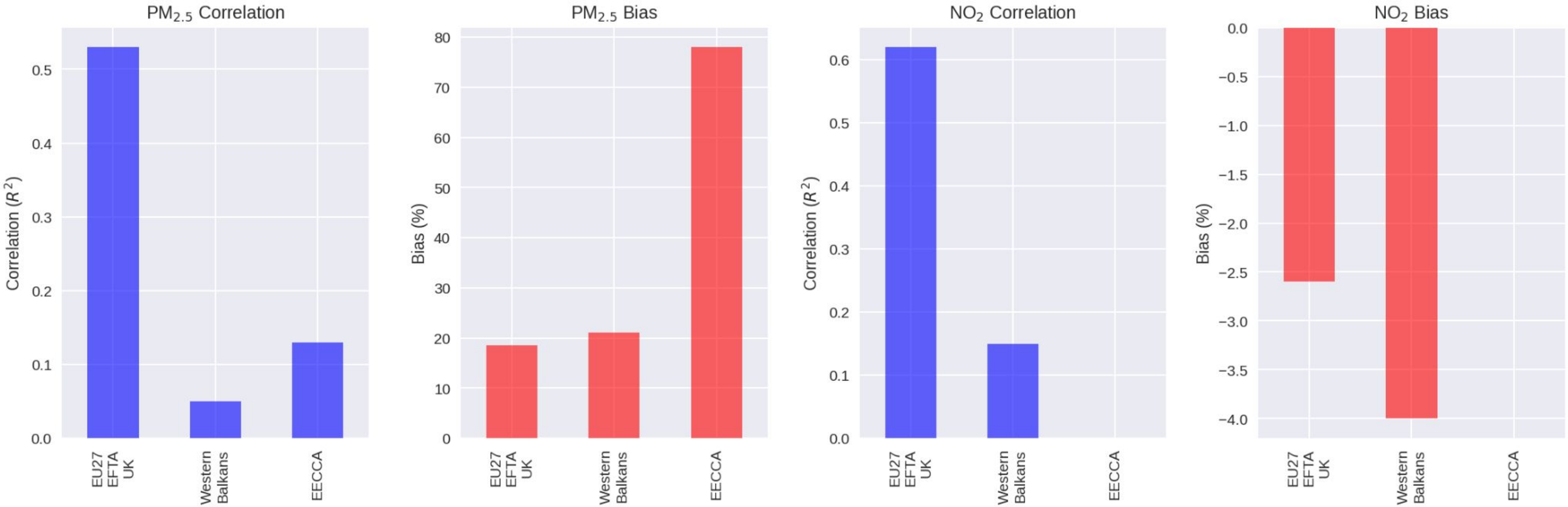
Table 4.2: Emission data sources for the EECCA and Western Balkans regions in 2022. Only countries where measurements are available are listed.

NOx emissions, traffic - data set for modellers



PM$_{2.5}$ model with observations on top

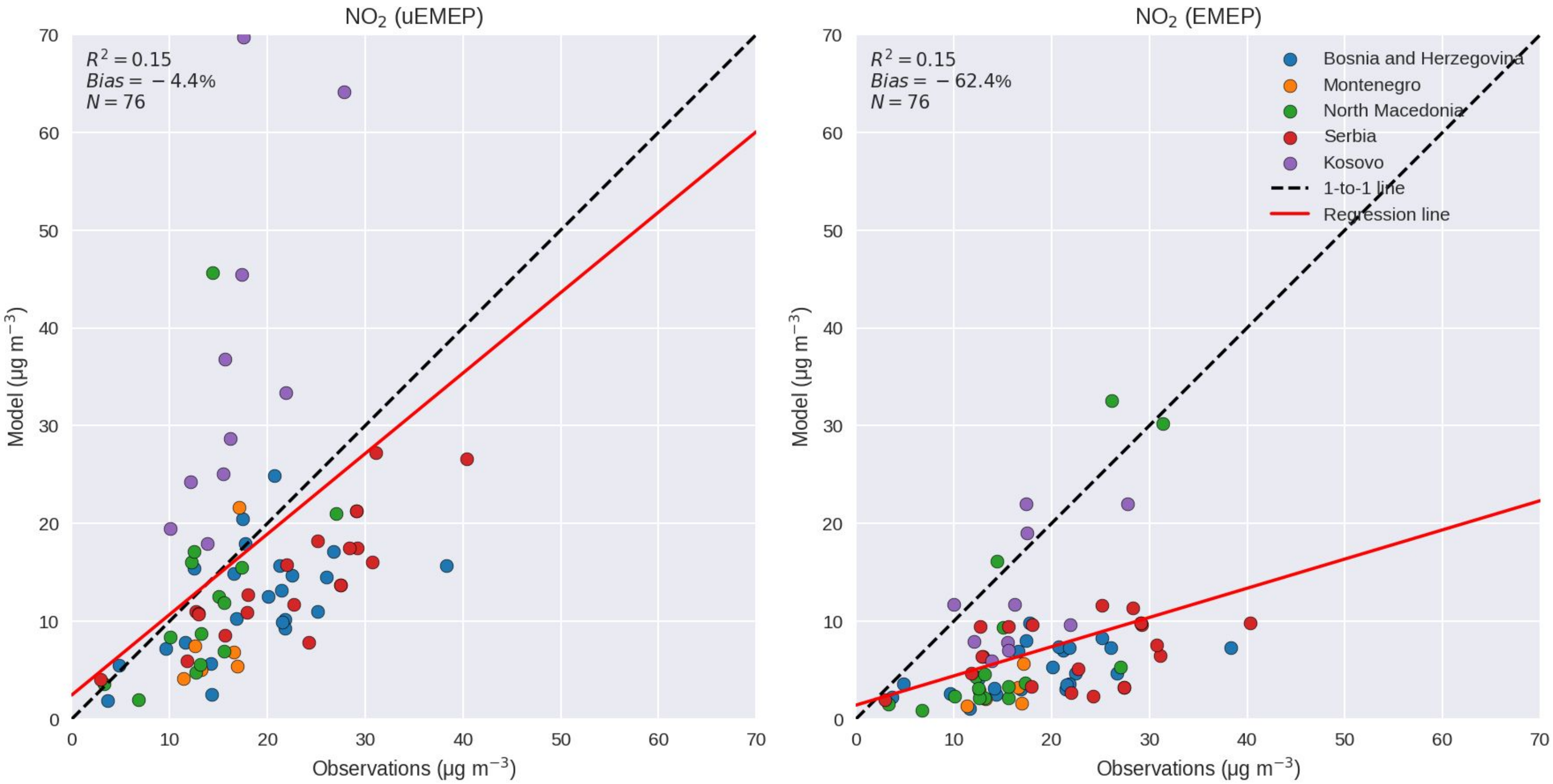




- $PM_{2.5}$ and NO_2 show reduced spatial correlation in the Western Balkans and EECCA regions compared to the EU region when taking the regions as a whole, but for WB correlation within a country is similar
- Significantly higher bias for EECCA countries ($PM_{2.5}$)

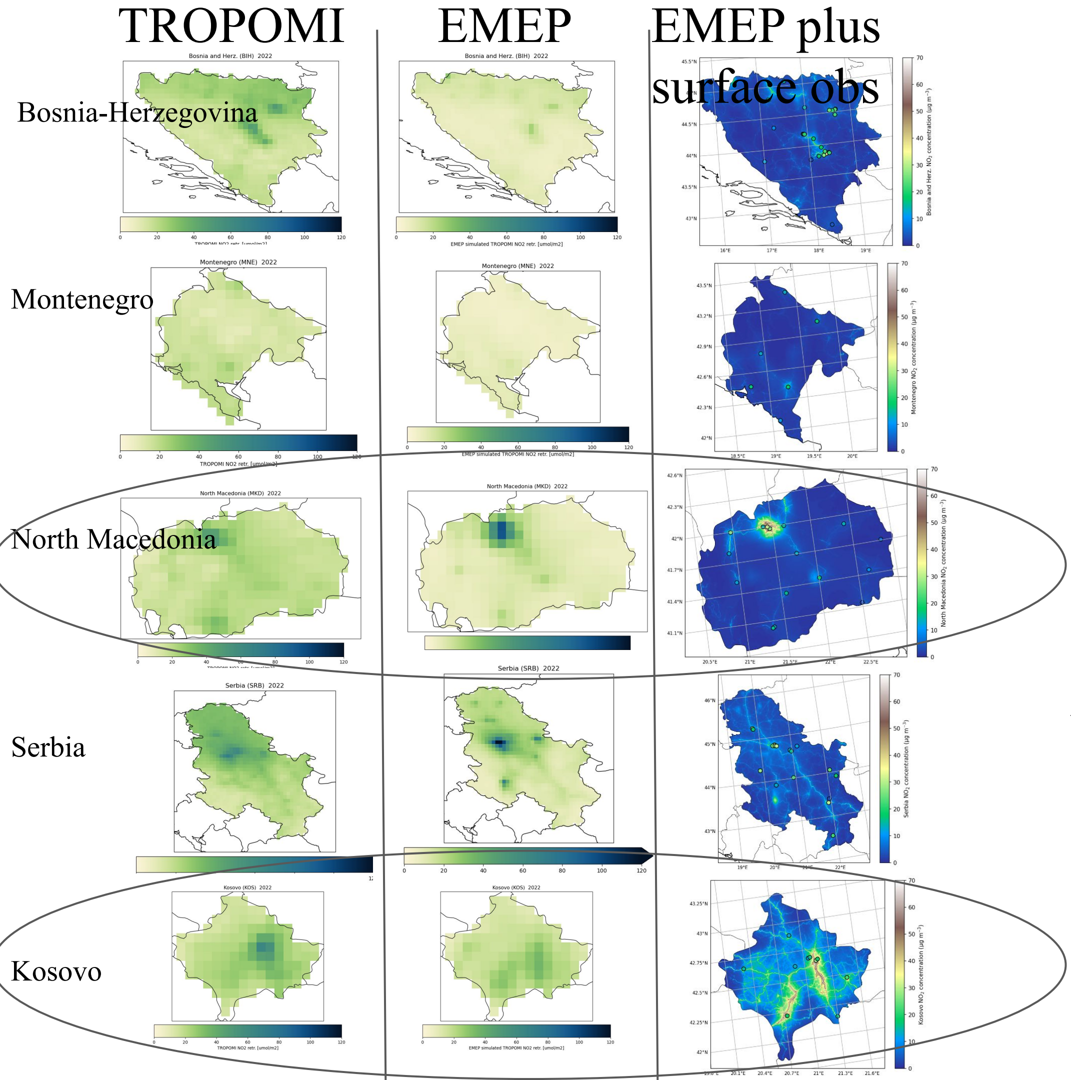
Country/Area	$PM_{2.5}$			NO_2			Region
	R^2	Bias (%)	N	R^2	Bias (%)	N	
Austria	0.27	23.9	71	0.65	-3.6	145	EU27
Belgium	0.59	31.7	143	0.73	7.3	200	EU27
Bulgaria	-	-	-	0.45	-3.5	23	EU27
Czechia	0.60	16.9	93	0.69	-4.4	97	EU27
Germany	0.07	18.9	297	0.65	-12.4	641	EU27
Denmark	-	-	-	0.72	-20.5	14	EU27
Spain	0.12	22.0	269	0.67	2.6	495	EU27
Greece	0.0	0.8	14	0.62	52.3	26	EU27
France	0.25	6.75	215	0.70	8.0	366	EU27
Finland	0.65	6.75	20	0.50	-36.1	38	EU27
Croatia	0.76	18.1	14	0.69	-30.8	16	EU27
Hungary	0.20	9.1	16	0.74	-7.7	24	EU27
Ireland	0.01	-13.5	48	0.52	-17.8	31	EU27
Italy	0.43	29.0	327	0.55	-1.4	642	EU27
Lithuania	-	-	-	0.24	-6.1	17	EU27
Netherlands	0.10	36.7	38	0.75	18.9	60	EU27
Romania	0.02	19.9	27	0.47	3.5	121	EU27
Poland	0.46	6.6	140	0.81	-28.3	147	EU27
Portugal	0.16	69.6	20	0.59	-18.8	60	EU27
Sweden	0.07	11.0	44	0.52	-14.57	116	EU27
Slovenia	0.13	24.4	18	0.60	26.0	11	EU27
Slovakia	0.09	-20.9	48	0.45	-16.3	41	EU27
Luxembourg	-	-	-	0.15	-8.3	116	EFTA
Switzerland	-	-	-	0.72	8.4	32	EFTA
Norway	0.24	41.9	60	0.52	12.7	52	EFTA
United Kingdom	0.51	11.1	15	0.58	6.8	136	UK
Bosnia and Herzegovina	0.13	24.1	14	0.29	-34.7	23	Western Balkans
Montenegro	-	-	-	0.27	-42.5	6	Western Balkans
North Macedonia	0.14	-5.42	14	0.61	38.9	16	Western Balkans
Serbia	0.03	2.8	18	0.72	-35.8	21	Western Balkans
Kosovo	0.31	96.3	13	0.47	117.3	10	Western Balkans

Table 4.3: Performance statistics of the uEMEP model for each country/area in the EU27, EFTA, UK and Western Balkans regions. With the exception of Montenegro, only countries with at least 10 stations are included.



uEMEP NO_2 concentrations are generally **overestimated** for sites in **Kosovo (and North Macedonia)** but underestimated for sites in Serbia, Montenegro and Bosnia-Herzegovina.

Spatial correlations for individual countries are significantly higher than the overall regional correlation.



Systematic underestimation of NO_2 tropospheric column concentrations in background, overestimated in source areas

Did not find the systematic differences between the WB countries for satellite;

Compare at exactly same location, day time etc (take into account representativeness). ONGOING

Test new emission data from GAINS

Need for improved observational systems and more accurate emission data, both total and spatially distributed.

Thank you for your attention

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Institute

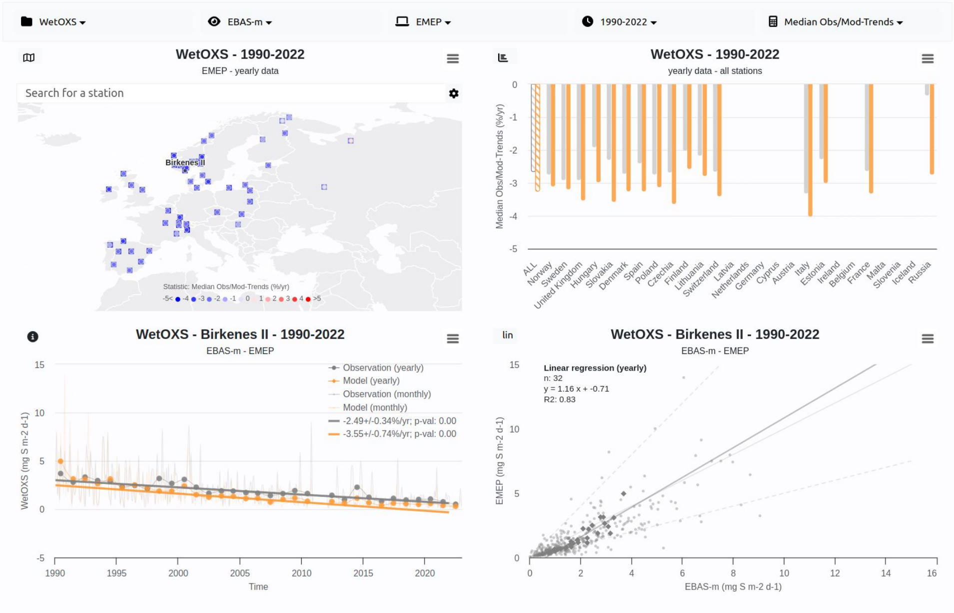
Trend interface & 1990-2023 model results

EMEP MSC-W model runs for 1990-2023 available (34 years!) with updated emissions (by CEIP) and a consistent model version. Available from *https://emep.int/mscw/mscw_moddata.html*

NB: 'Condensables' consistent from 2005

Trend interface extended back to 1990 (with 'raw observations') https://aeroval.met.no/pages/evaluation/?project=emep_trends&experiment=2024-trends_1990-2022
Online model evaluation (and observation assessment) for a range of years on AeroVal:

https://aeroval.met.no/evaluation.php?project=emep&exp_name=2024-reporting&station=ALL



Everything can be accessed from emep.int/mscw

CEIP provided updated emission data and CCC provided an extract of observational EBAS data base