Norwegian Meteorological Institute

Preliminary evaluation of air pollution in the Western Balkans and EECCA regions

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EPCAC Workshop September 2024

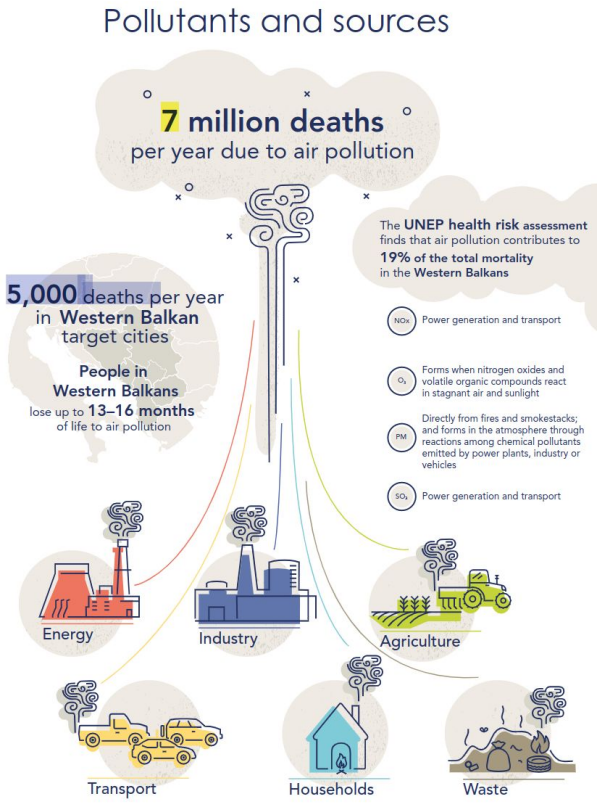
Air pollution in Western Balkan and EECCA regions

Background

- Significant air quality issues from old heating systems, coal-fired power plants, and traffic
- Negative impacts on the environment and public health
- Provide context for current efforts to improve air quality in these regions (UNECE, UNEP, WHO)
- Models (EMEP and uEMEP) are crucial, but knowledge about the performance is limited

Challenges

- Limited availability and quality of emission and observational data
- Limited knowledge about the performance of regional and local air quality modeling

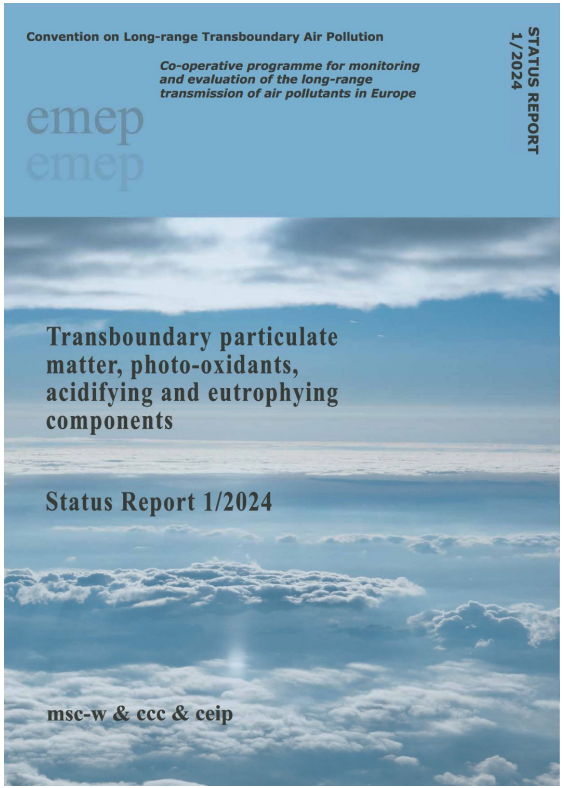


UNEP, 2021

Objectives

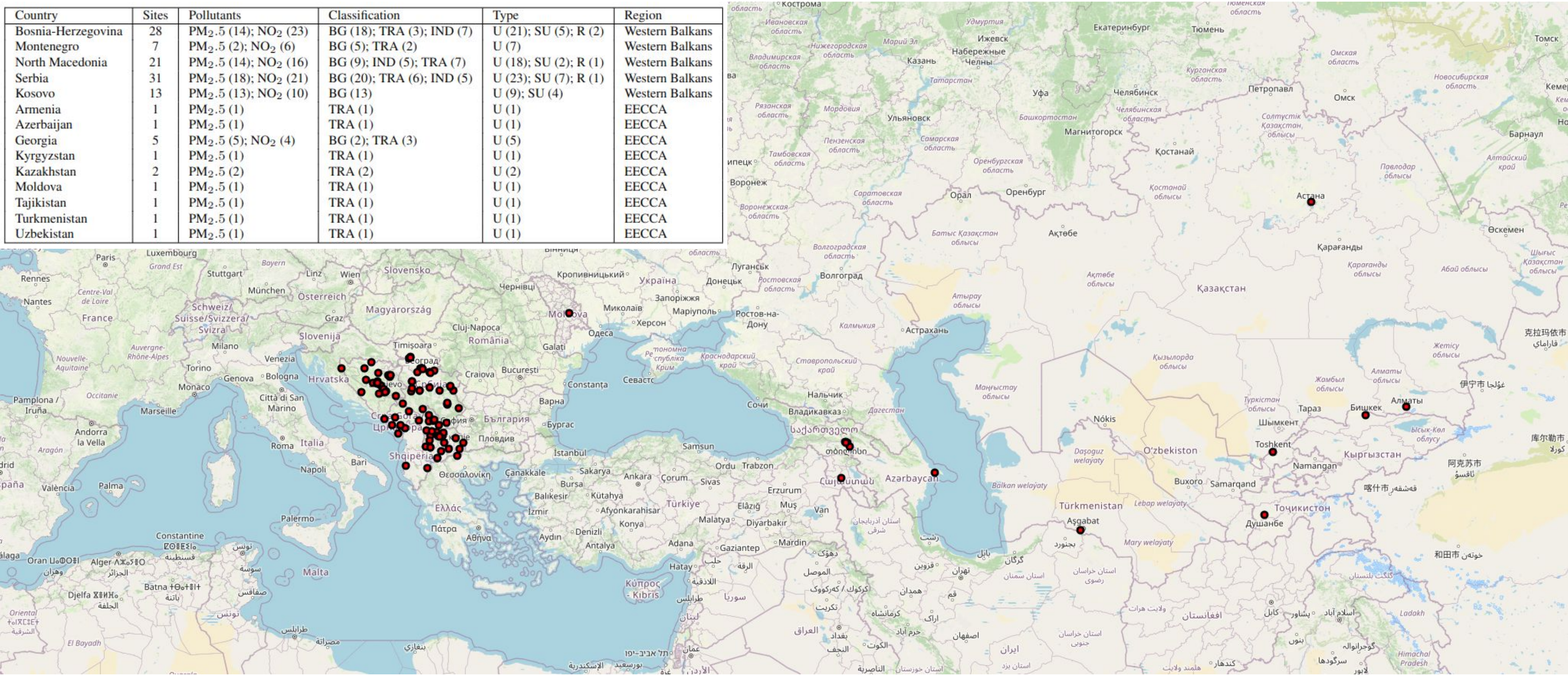
- Assess air quality in the Western Balkans and EECCA regions using uEMEP
- Evaluate model performance against surface observations for $PM_{2.5}$ and NO_2
- Compare performance of uEMEP in the Western Balkans with EU, and explore areas for improvement

See Chapter 4 in EMEP Status Report 1/2024

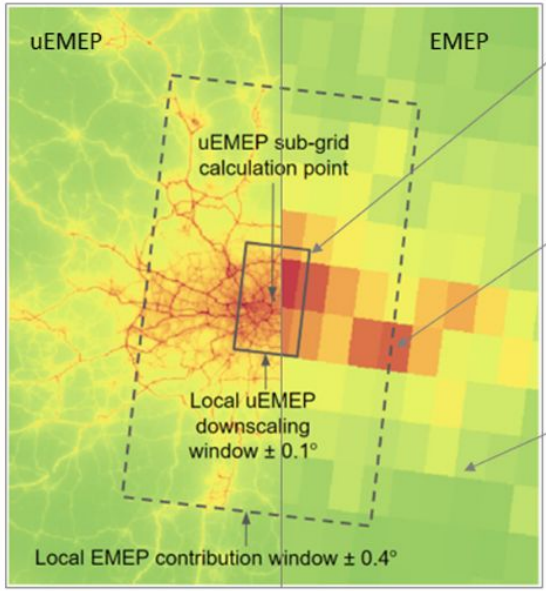


Surface measurements

Country	Sites	Pollutants	Classification	Type	Region
Bosnia-Herzegovina	28	$PM_{2.5}$ (14); NO_2 (23)	BG (18); TRA (3); IND (7)	U (21); SU (5); R (2)	Western Balkans
Montenegro	7	$PM_{2.5}$ (2); NO_2 (6)	BG (5); TRA (2)	U (7)	Western Balkans
North Macedonia	21	$PM_{2.5}$ (14); NO_2 (16)	BG (9); IND (5); TRA (7)	U (18); SU (2); R (1)	Western Balkans
Serbia	31	$PM_{2.5}$ (18); NO_2 (21)	BG (20); TRA (6); IND (5)	U (23); SU (7); R (1)	Western Balkans
Kosovo	13	$PM_{2.5}$ (13); NO_2 (10)	BG (13)	U (9); SU (4)	Western Balkans
Armenia	1	$PM_{2.5}$ (1)	TRA (1)	U (1)	EECCA
Azerbaijan	1	$PM_{2.5}$ (1)	TRA (1)	U (1)	EECCA
Georgia	5	$PM_{2.5}$ (5); NO_2 (4)	BG (2); TRA (3)	U (5)	EECCA
Kyrgyzstan	1	$PM_{2.5}$ (1)	TRA (1)	U (1)	EECCA
Kazakhstan	2	$PM_{2.5}$ (2)	TRA (2)	U (2)	EECCA
Moldova	1	$PM_{2.5}$ (1)	TRA (1)	U (1)	EECCA
Tajikistan	1	$PM_{2.5}$ (1)	TRA (1)	U (1)	EECCA
Turkmenistan	1	$PM_{2.5}$ (1)	TRA (1)	U (1)	EECCA
Uzbekistan	1	$PM_{2.5}$ (1)	TRA (1)	U (1)	EECCA



EMEP and uEMEP

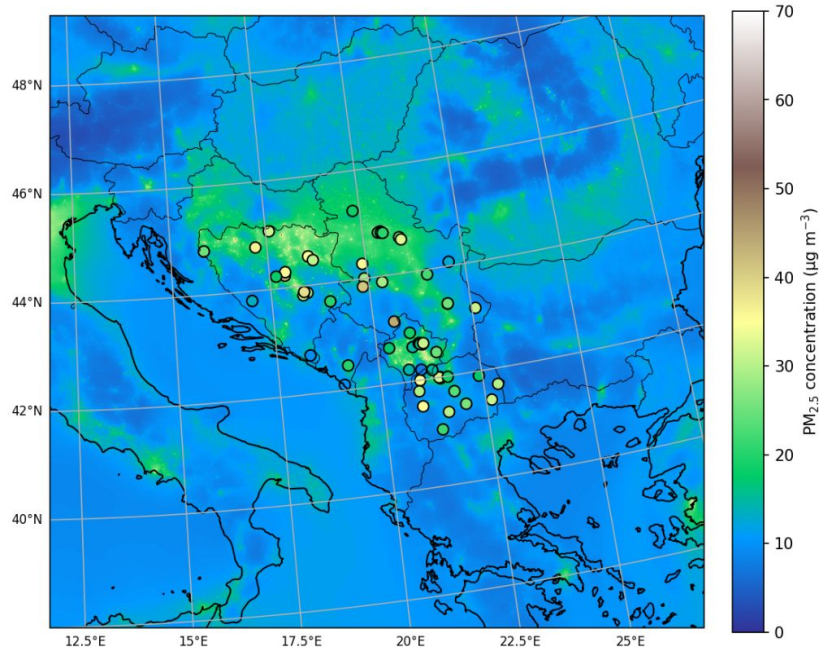


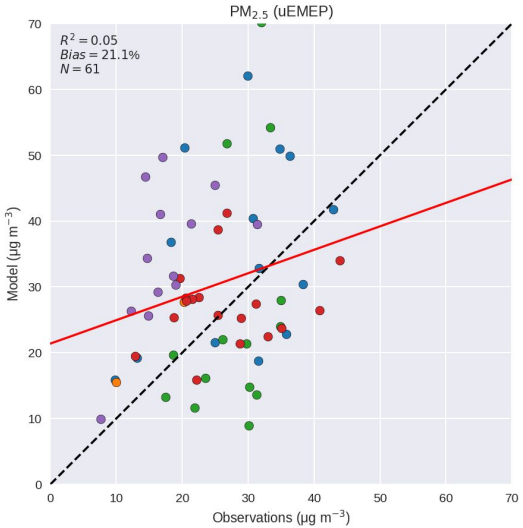
Denby et al., 2024

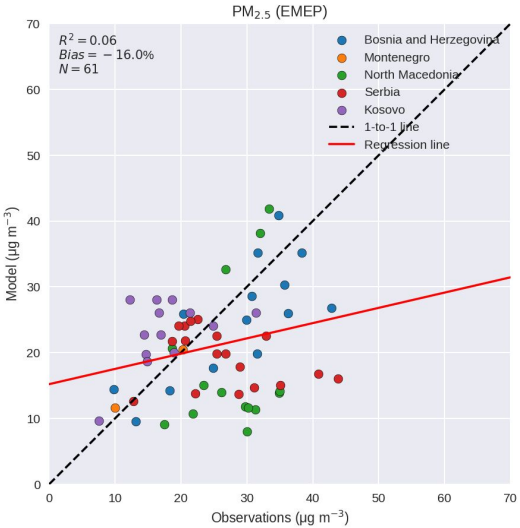
- $PM_{2.5}$ and NO_2 modelled for 2022
- Reported emissions are used when available. Otherwise gap-filled or replaced.
- Estimates are annual mean concentrations
- Estimates are performed for all observational sites as well as for the regions

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

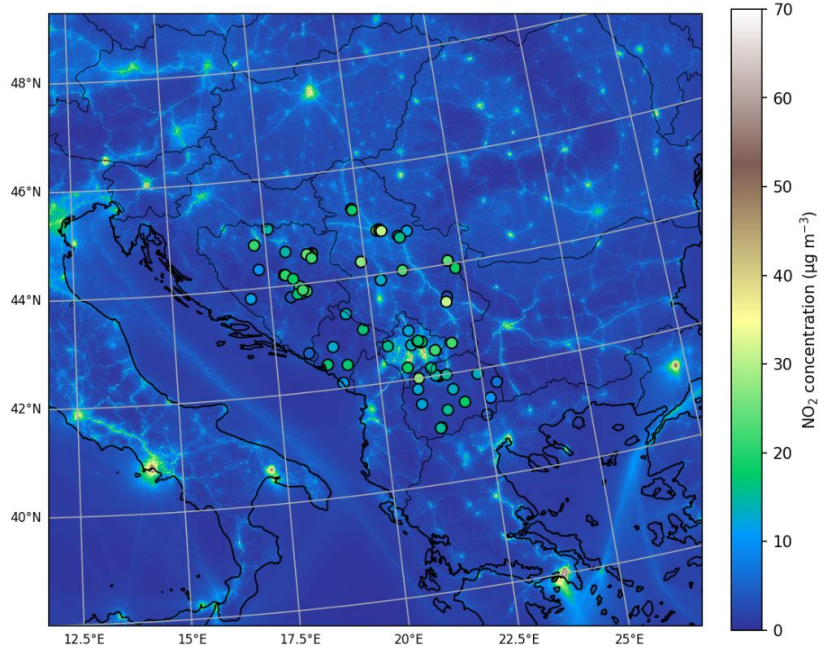
$PM_{2.5}$ in the Western Balkans

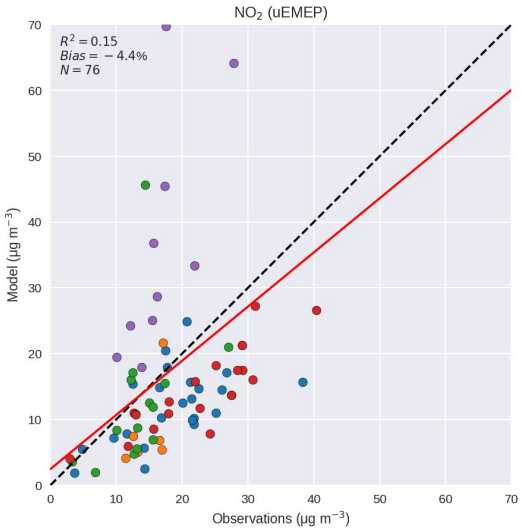


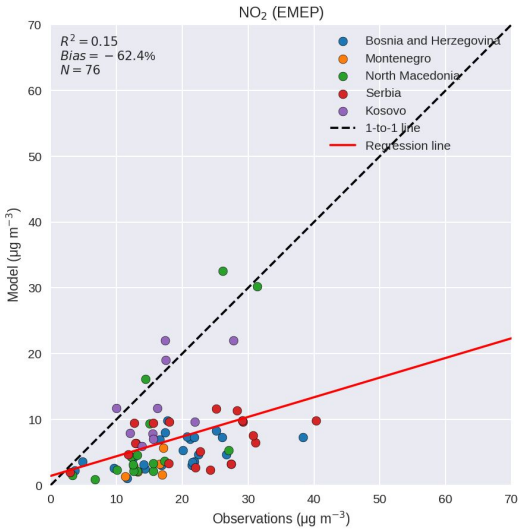




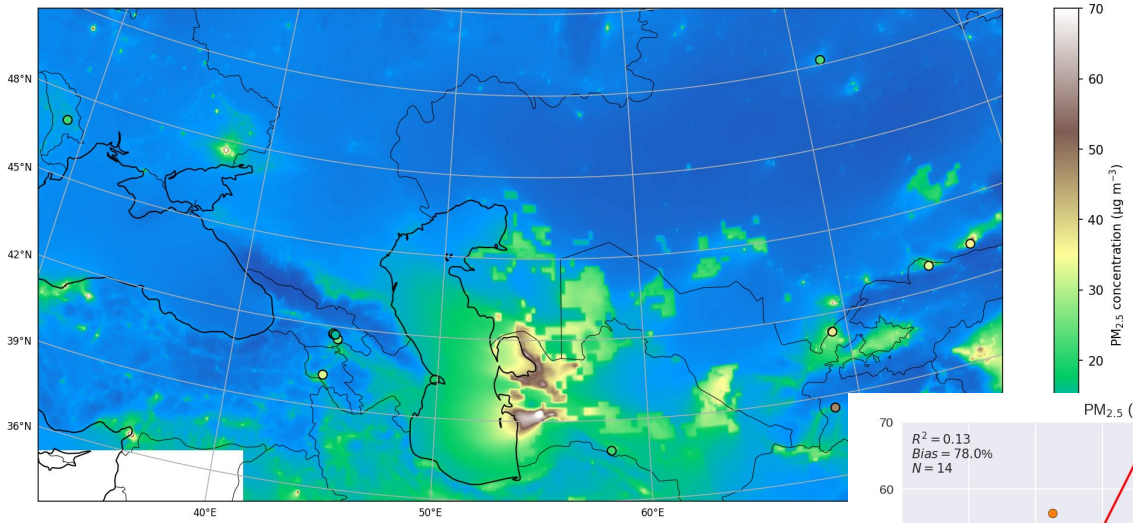
NO_2 in the Western Balkans

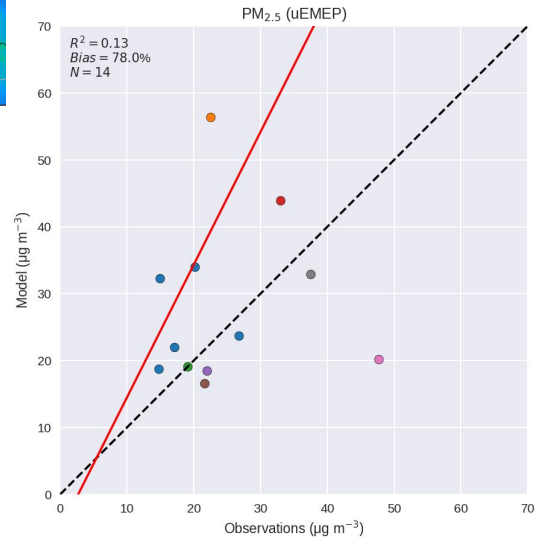


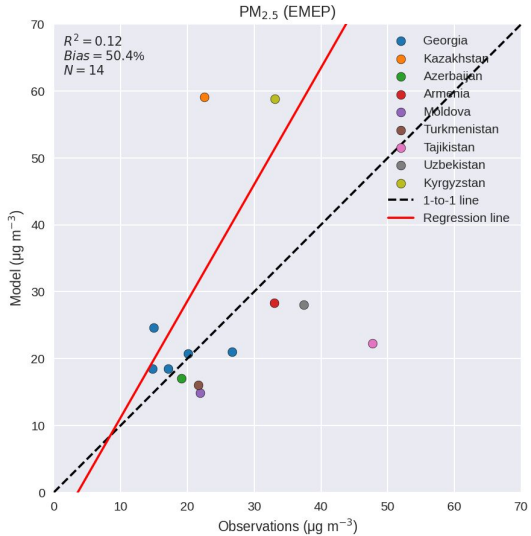




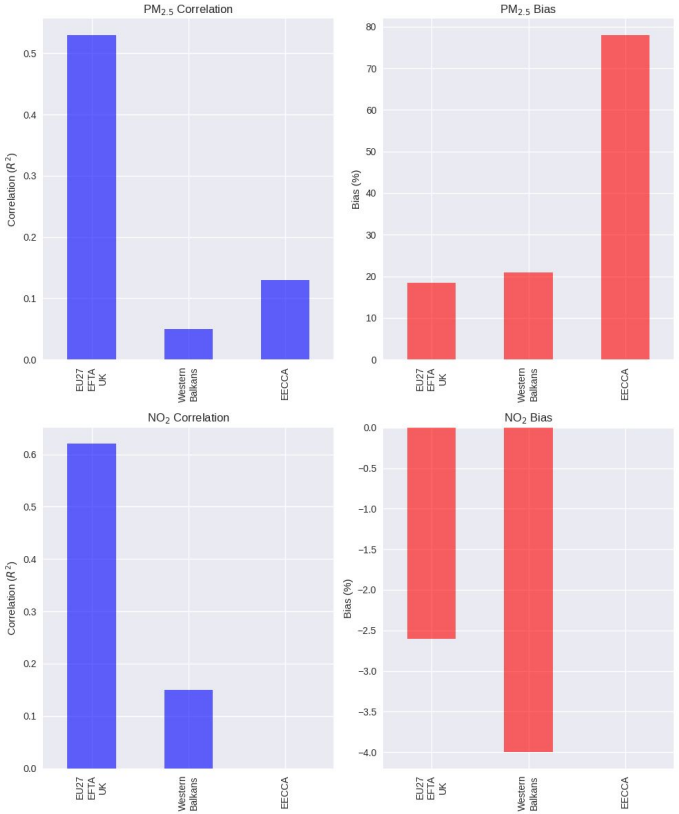
$PM_{2.5}$ in the EECCA Region





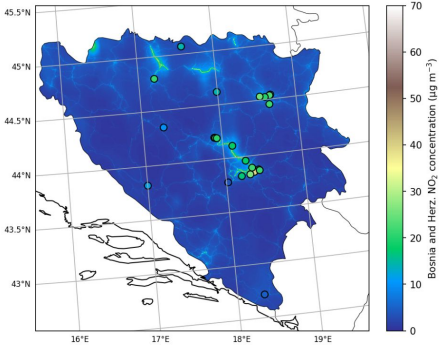


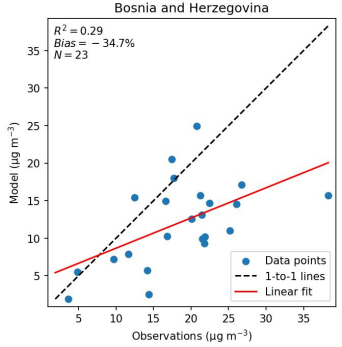
Regional comparison

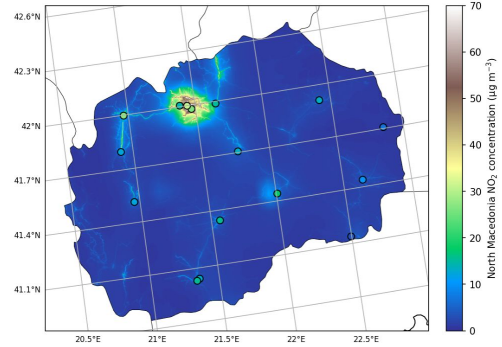


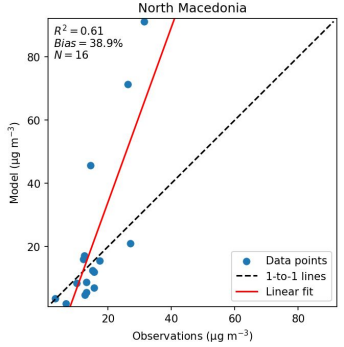
Country/Area	$PM_{2.5}$			NO_2			Region
	R^2	Bias (%)	N	R^2	Bias (%)	N	
Austria	0.27	23.9	71	0.65	-3.6	145	EU27
Belgium	0.59	31.7	143	0.73	7.3	200	EU27
Bulgaria	-	-	-	0.45	-3.5	23	EU27
Czechia	0.60	16.9	93	0.69	-4.4	97	EU27
Germany	0.07	18.9	297	0.65	-12.4	641	EU27
Denmark	-	-	-	0.72	-20.5	14	EU27
Spain	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

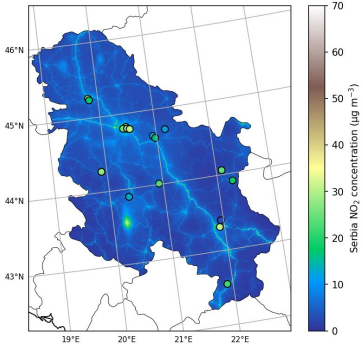
NO_2 patterns for individual countries/regions

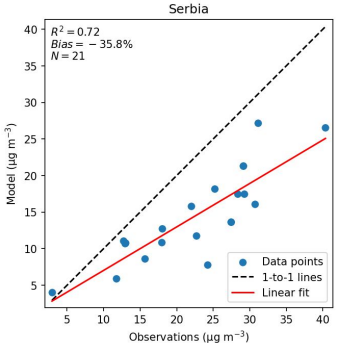


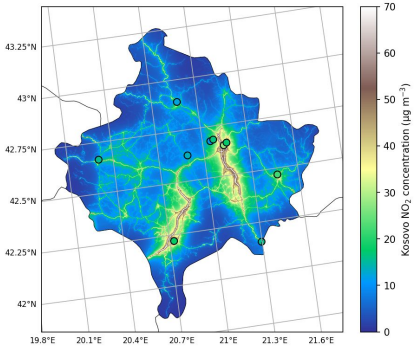


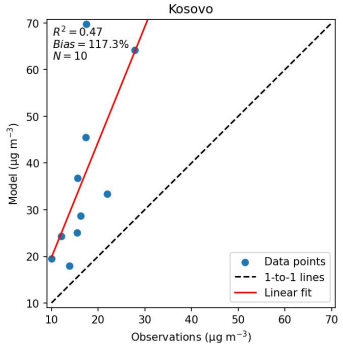












Concluding remarks

Conclusions

- uEMEP provide valuable insights into air pollution in the Western Balkans and EECCA regions
- For PM2.5, both EMEP and uEMEP have limited accuracy
- For NO2, uEMEP provides a significant improvement compared with EMEP
- In the Western Balkans, the spatial correlation for NO2 is generally on par with other European countries, however, the bias differs significantly

Future steps and recommendations

- Increase the number of monitoring stations, especially in the EECCA region
- Improve quality of emission estimates and expand availability of gridded emissions

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Thank you for your attention!

EMEP report: https://emep.int/publ/reports/2024/EMEP_Status_Report_1_2024.pdf
EMEP model: https://github.com/metno/emep-ctm
uEMEP model: https://github.com/metno/uEMEP

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