Supplementary Information

SI1: Comparison of historic simulations to EEA stations for certain species

Since we are using historic simulations and not hindcast simulations as the reference for our future scenarios, they are not directly comparable to measurements, since they are prepared with climatological meteorological inputs and not reanalyzed meteorological inputs. Also, the emissions in our simulations don't change and are always ECLIPSE CLE 2010 emissions, which could also produce discrepancies. Therefore, a yearlong profile was prepared from an average of historic simulations between the years 1996 and 2005. Another annual profile was prepared with all available EEA e-reporting stations for key species for the period of 2005-2015. These two profiles were compared in annual and monthly comparisons, the results for which are provided in figures SI1 fig.1 and SI1 fig.2 for O_3, NO_2, PM_{10} and $PM_{2.5}$. The results shown below were filtered to only include rural and remute stations. Table SI1 shows statistic information for these comparisons.

	Mean_S	Mean_M	% Bias	Sd_S	Sd_M	R
O3	65.4	61.9	5.9	20.6	12.2	0.69
NO2	6.9	11.3	-38.9	7.8	4.3	0.55
PM2.5	9.5	11.9	-20.7	8.2	3.9	0.49
PM10	12.5	18.9	-33.5	7.2	4.6	0.34

Table SI1 1. Statistical parameters for the comparisons performed using EEA stations and our historic simulations. A monthly profile of EEA data covering the period of 2006 to 2015 is compared to a monthly profile of historic simulations covering the period of 1996 to 2005. Mean_S and Mean_M show simulation and measurement averages respectively, Sd_S and SD_M show the standard deviation of simulations and measurements respectively.

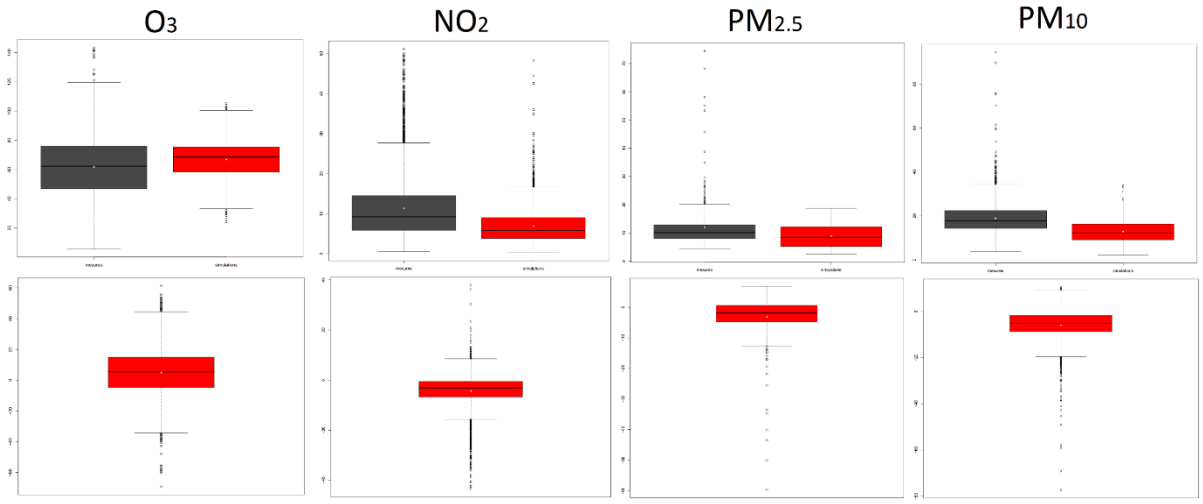


Figure SI1 1. Comparison of the same data introduced in table 1 to historic simulations. First row shows the average of the comparisons in black for measurements and in red for historic simulations. Second row shows the boxplot for the biases between the two.

SI 2: 2D temperature images for different seasons

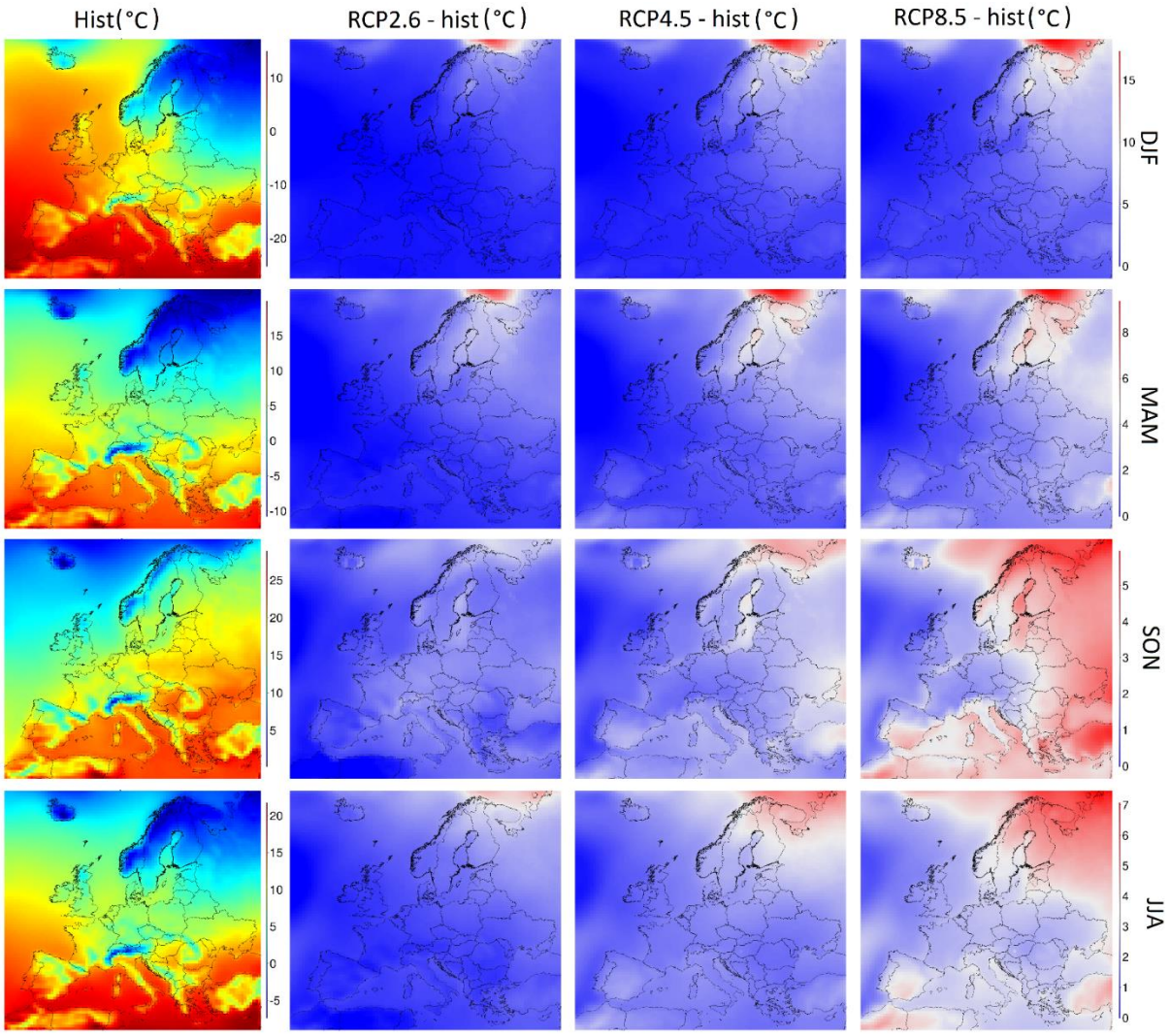


Figure SI2 1. Seasonal temperature maps for historic simulations (in °C, first column from the left), and the difference between RCP2.6, RCP4.5 and RCP8.5 (in °C, second to fourth columns from the left). Each row shows one season, from the top DJF, MAM, SON and JJA respectively.

SI 3: Meteorological parameters for different scenarios for MEDW and MEDE sub-domains

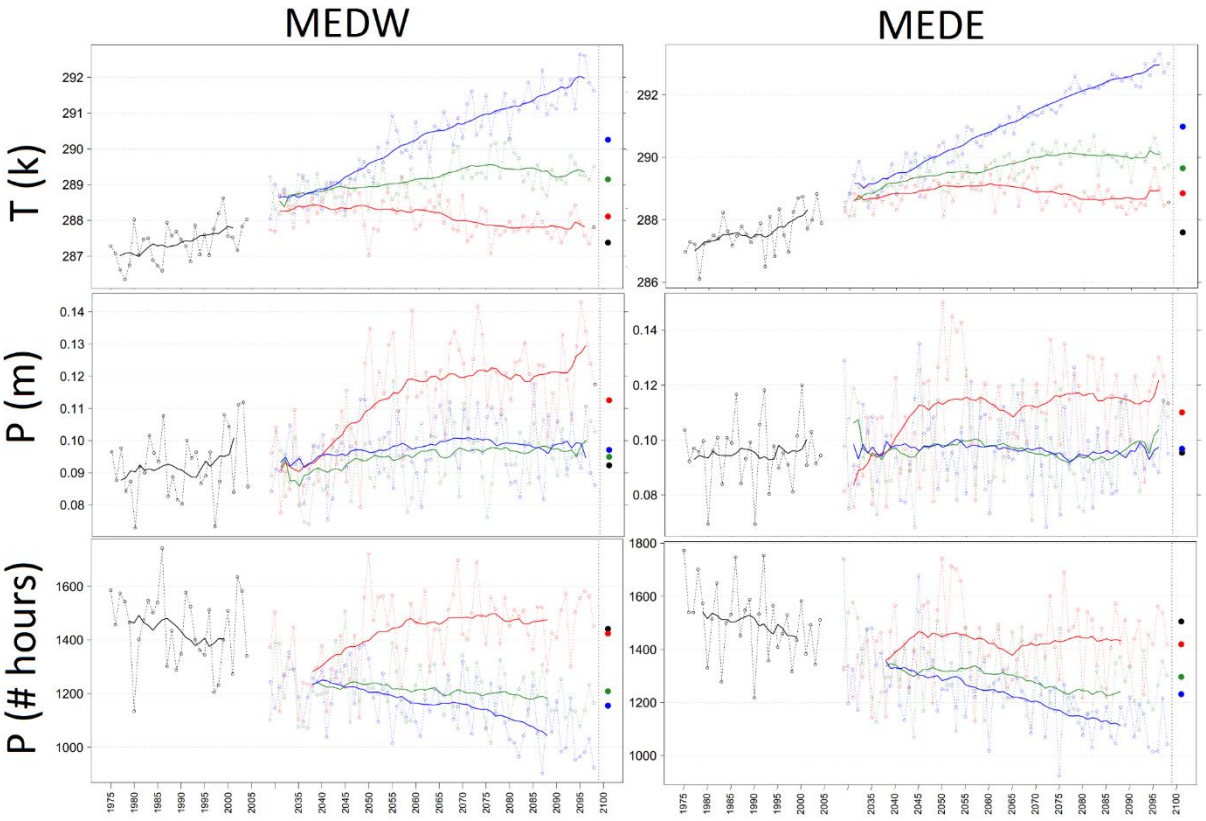


Figure SI3 1. Same as figure 2, but for MEDE and MEDW.

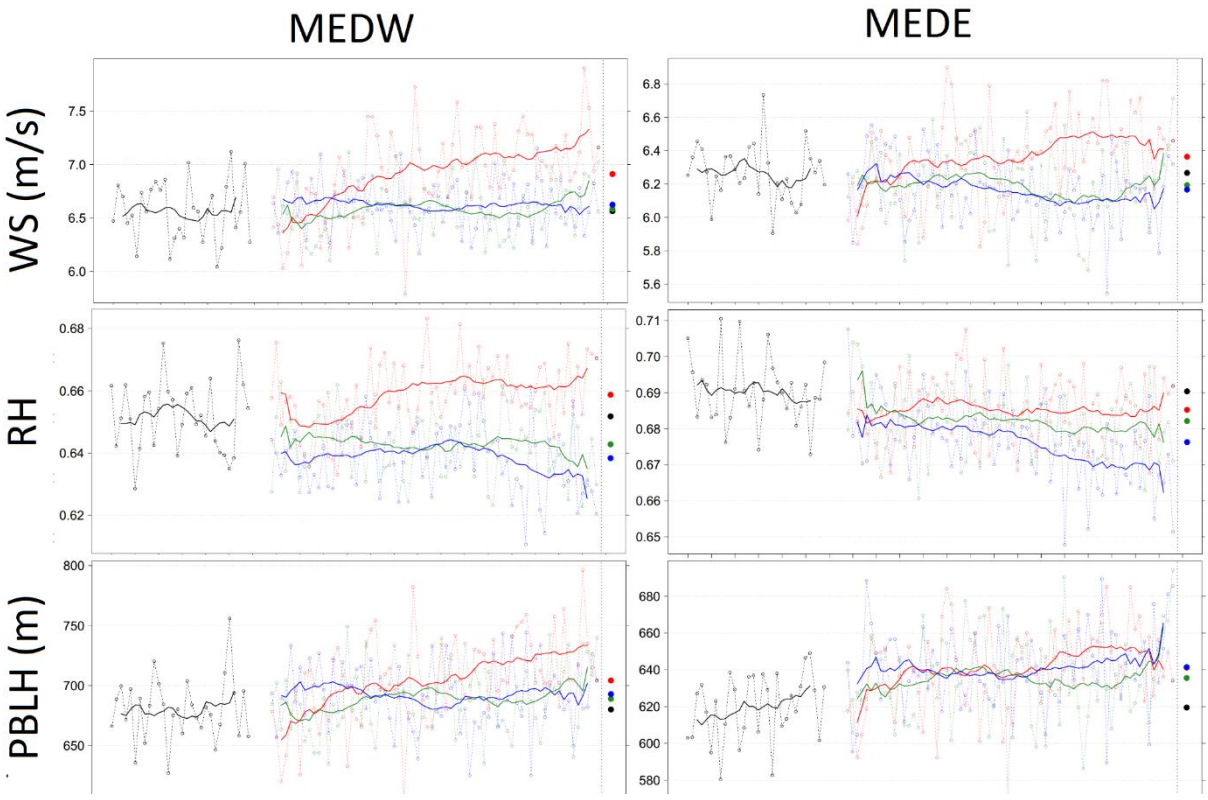


Figure SI3 2. Same as figure 2, but for MEDE and MEDW.

SI4: Correlations of meteorological parameters to each other

EUR

	T	P	RH	WS	PBLH	SWRD
T	1	0.05	-0.03	0.09	0.37	-0.72
P	-0.28	1	-0.26	0.76	0.72	0.26
RH	-0.40	0.60	1	-0.60	-0.60	-0.21
WS	-0.55	0.72	0.30	1	0.94	0.01
PBLH	-0.33	0.33	-0.38	0.64	1	-0.18
SWRD	0.50	-0.75	-0.80	-0.62	-0.05	1

MED

	T	P	RH	WS	PBLH	SWRD
T	1	-0.55	0.53	-0.28	-0.66	-0.01
P	0.36	1	-0.70	0.62	0.80	-0.19
RH	0.01	0.38	1	-0.80	-0.95	-0.34
WS	-0.01	0.76	-0.61	1	0.77	0.30
PBLH	-0.01	0.53	-0.95	0.70	1	0.14
SWRD	-0.43	-0.60	-0.38	-0.18	0.17	1

Table SI4. Correlations of meteorological parameters to each other, red values show the correlation for winter and green values for summer, on the left for EUR and on the right for MED.

SI 5: Information regarding to $PM_{2.5}$

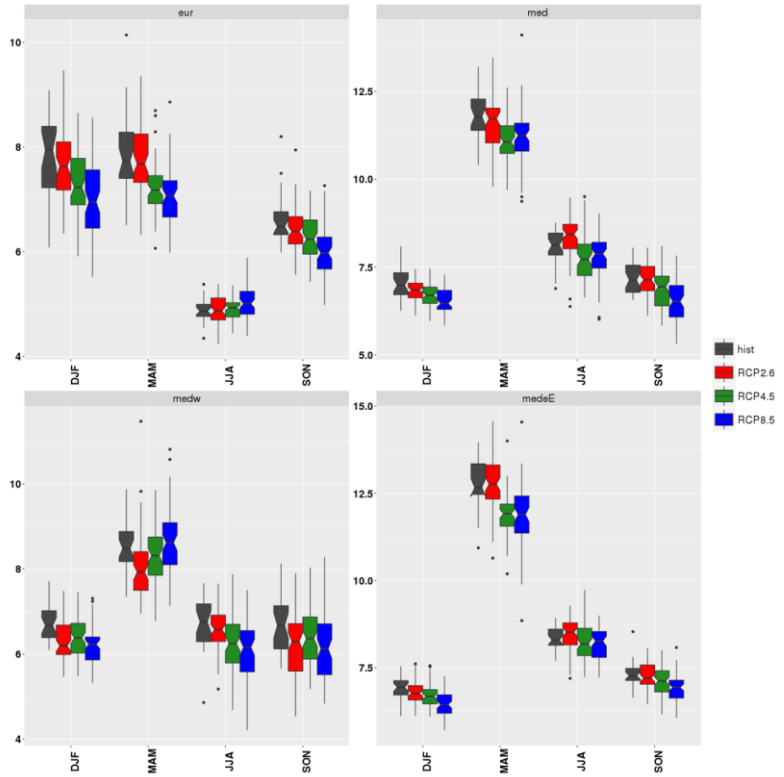
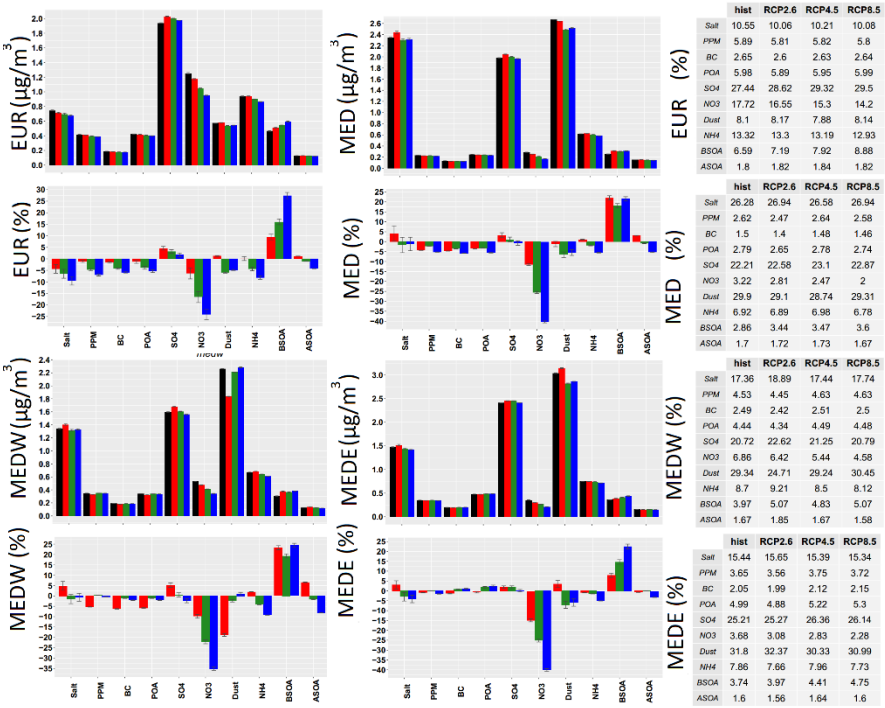


Figure SI5 1. Seasonal concentrations of $PM_{2.5}$ for all subdomains.



	hist	RCP2.6	RCP4.5	RCP8.5
Salt	10.55	10.06	10.21	10.08
PPM	5.89	5.81	5.82	5.8
BC	2.65	2.6	2.63	2.64
POA	5.98	5.89	5.95	5.99
SO4	27.44	28.62	29.32	29.5
NO3	17.72	16.55	15.3	14.2
Dust	8.1	8.17	7.88	8.14
NH4	13.32	13.3	13.19	12.93
BSOA	6.59	7.19	7.92	8.88
ASOA	1.8	1.82	1.84	1.82

EUR (%)

	hist	RCP2.6	RCP4.5	RCP8.5
Salt	26.28	26.94	26.58	26.94
PPM	2.62	2.47	2.64	2.58
BC	1.5	1.4	1.48	1.46
POA	2.79	2.65	2.78	2.74
SO4	22.21	22.58	23.1	22.87
NO3	3.22	2.81	2.47	2
Dust	29.9	29.1	28.74	29.31
NH4	6.92	6.89	6.98	6.78
BSOA	2.86	3.44	3.47	3.6
ASOA	1.7	1.72	1.73	1.67

MED (%)

	hist	RCP2.6	RCP4.5	RCP8.5
Salt	17.36	18.89	17.44	17.74
PPM	4.53	4.45	4.63	4.63
BC	2.49	2.42	2.51	2.5
POA	4.44	4.34	4.49	4.48
SO4	20.72	22.62	21.25	20.79
NO3	6.86	6.42	5.44	4.58
Dust	29.34	24.71	29.24	30.45
NH4	8.7	9.21	8.5	8.12
BSOA	3.97	5.07	4.83	5.07
ASOA	1.67	1.85	1.67	1.58

MEDW (%)

	hist	RCP2.6	RCP4.5	RCP8.5
Salt	15.44	15.65	15.39	15.34
PPM	3.65	3.56	3.75	3.72
BC	2.05	1.99	2.12	2.15
POA	4.99	4.88	5.22	5.3
SO4	25.21	25.27	26.36	26.14
NO3	3.68	3.08	2.83	2.28
Dust	31.8	32.37	30.33	30.99
NH4	7.86	7.66	7.96	7.73
BSOA	3.74	3.97	4.41	4.75
ASOA	1.6	1.56	1.64	1.6

MEDE (%)

Figure SI5 2. Same as figure 7, but for $PM_{2.5}$

SI 6: Regressions for different seaosns and different components

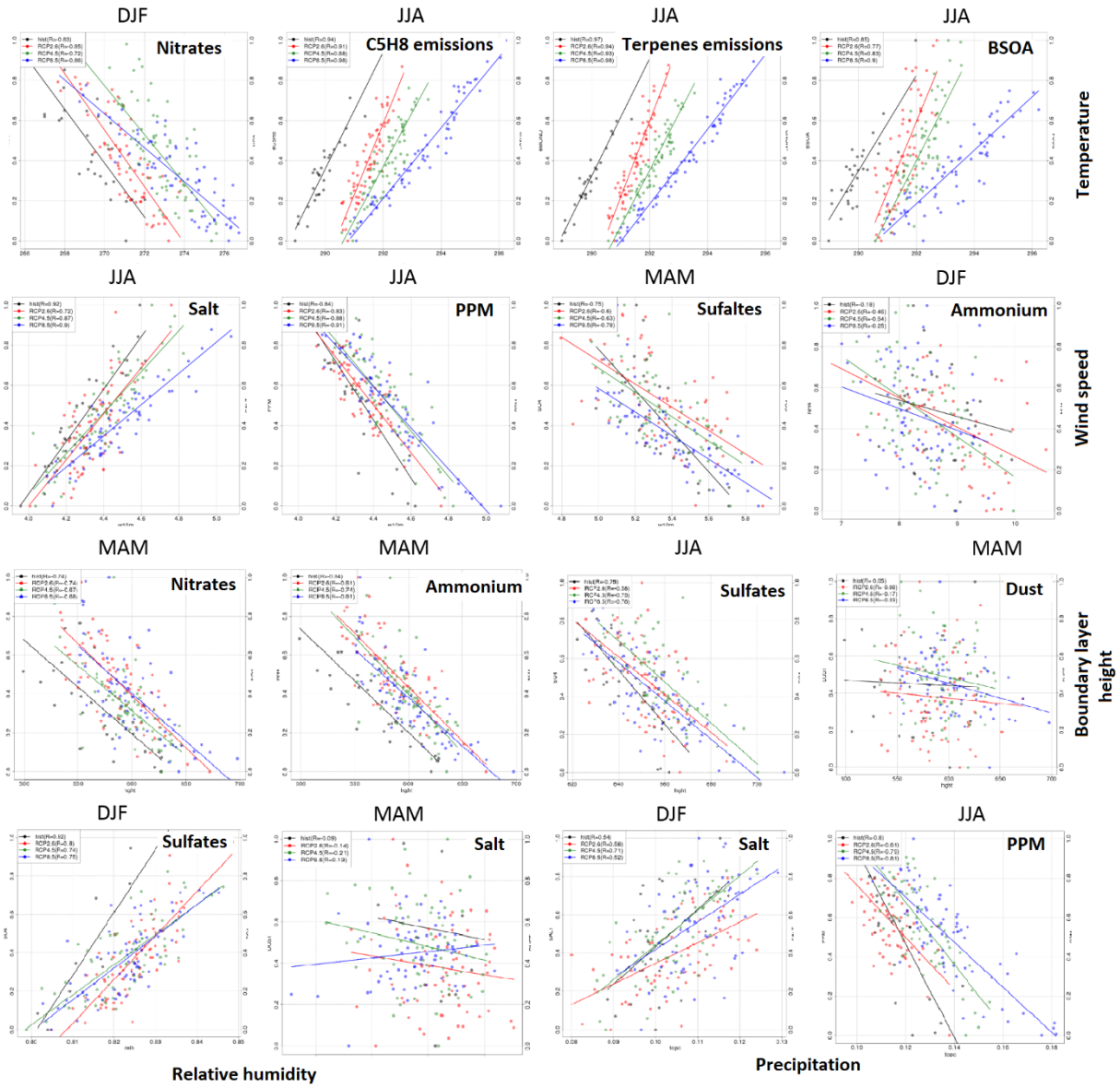


Figure SI6 1. Individual correlations for all scenarios with different components for EUR sub-domain: the name of the component, season and the meteorological parameter is written on each figure.

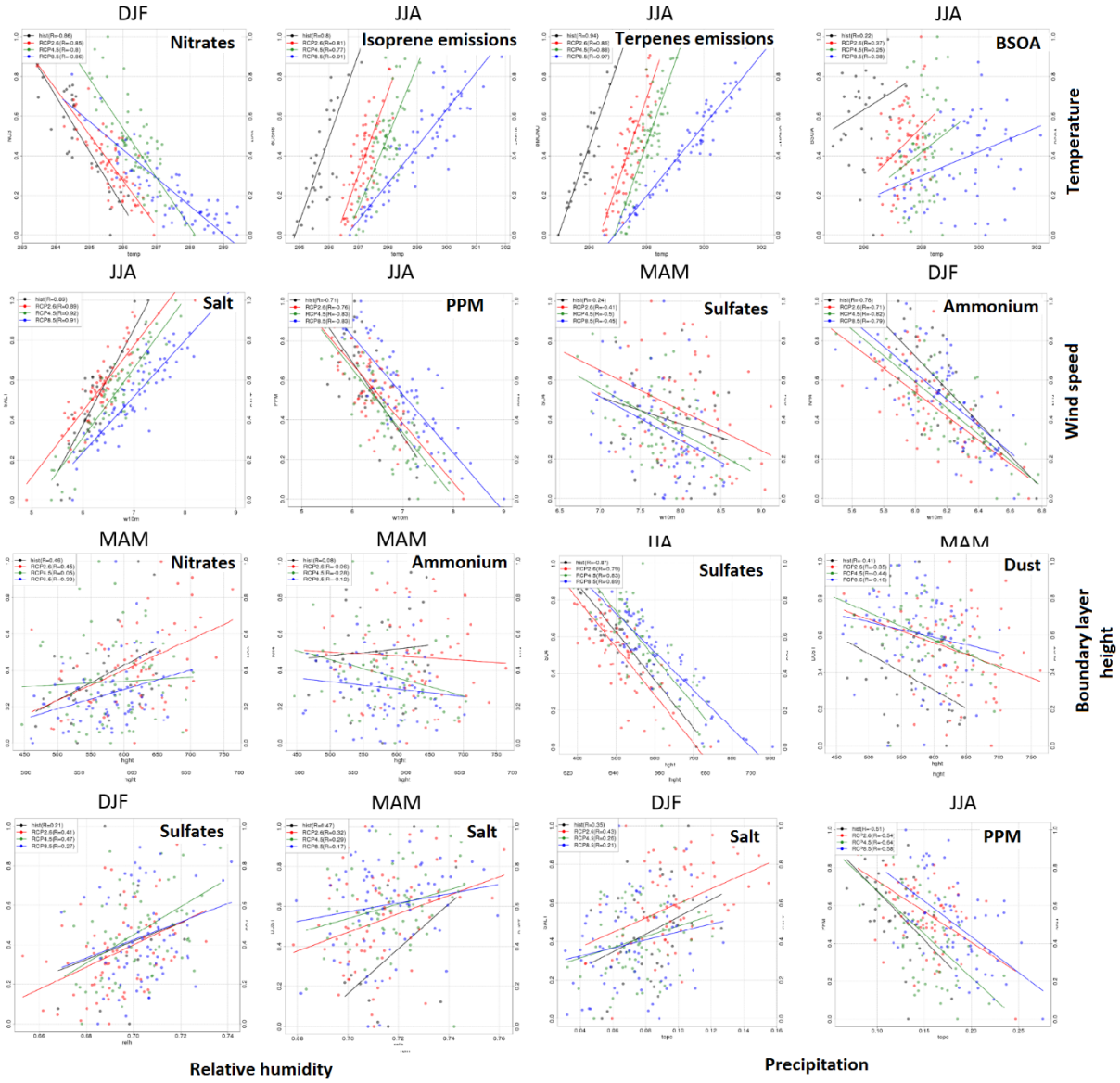


Figure SI6 2. Individual correlations for all scenarios with different components for EUR sub-domain: the name of the component, season and the meteorological parameter is written on each figure.

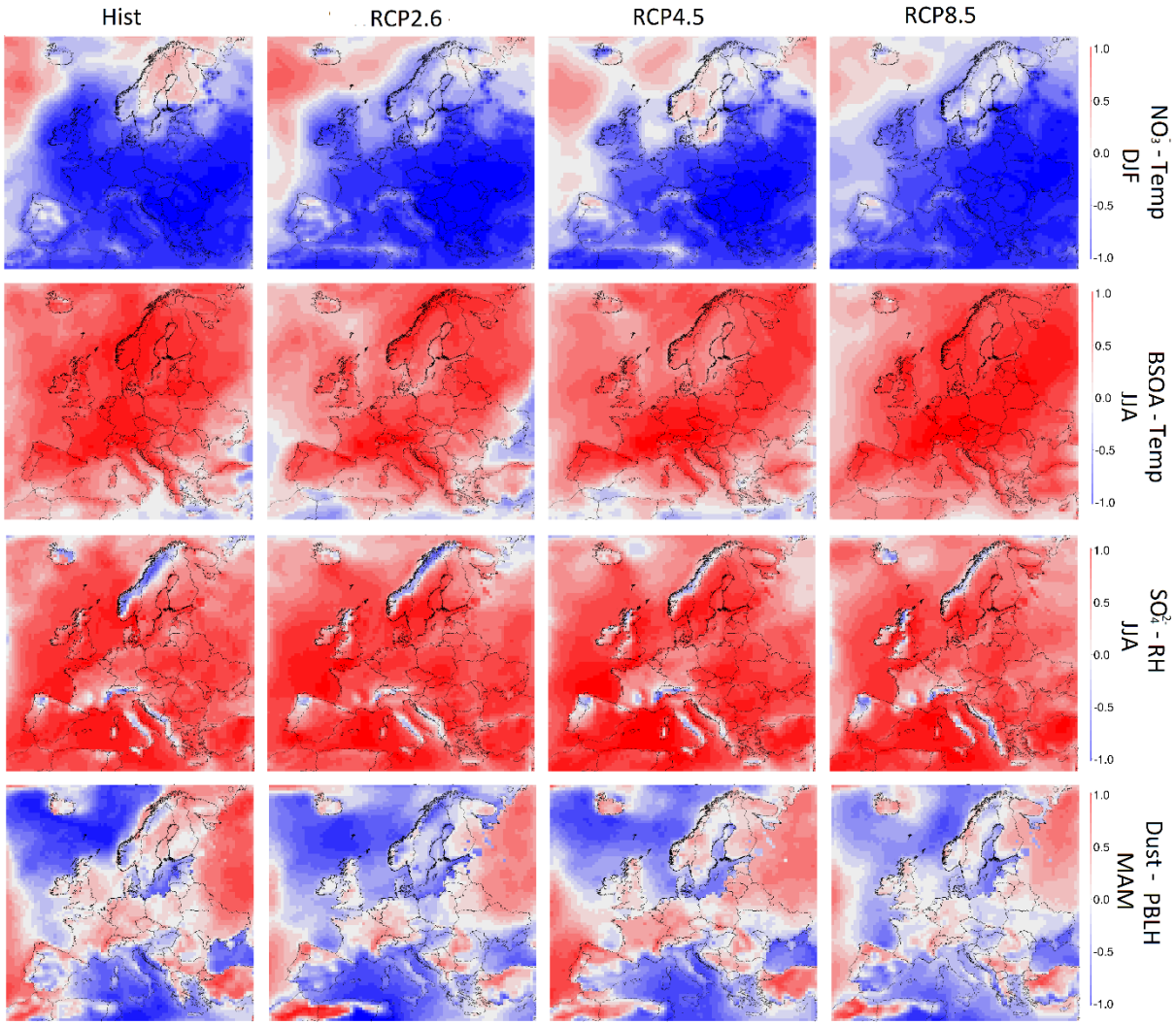


Figure SI6 3. Correlations of historic and future scenarios for BSOA, nitrate, sulfate and dust with temperature, temperature, relative humidity and PBL height respectively for the season in which the concentration of the pollutant is highest. Each column corresponds to one scenario (name above column). Each row shows the correlation of one pollutant with one meteorological parameter on a scale of -1 to 1.

SI7: Seasonal absolute and relative

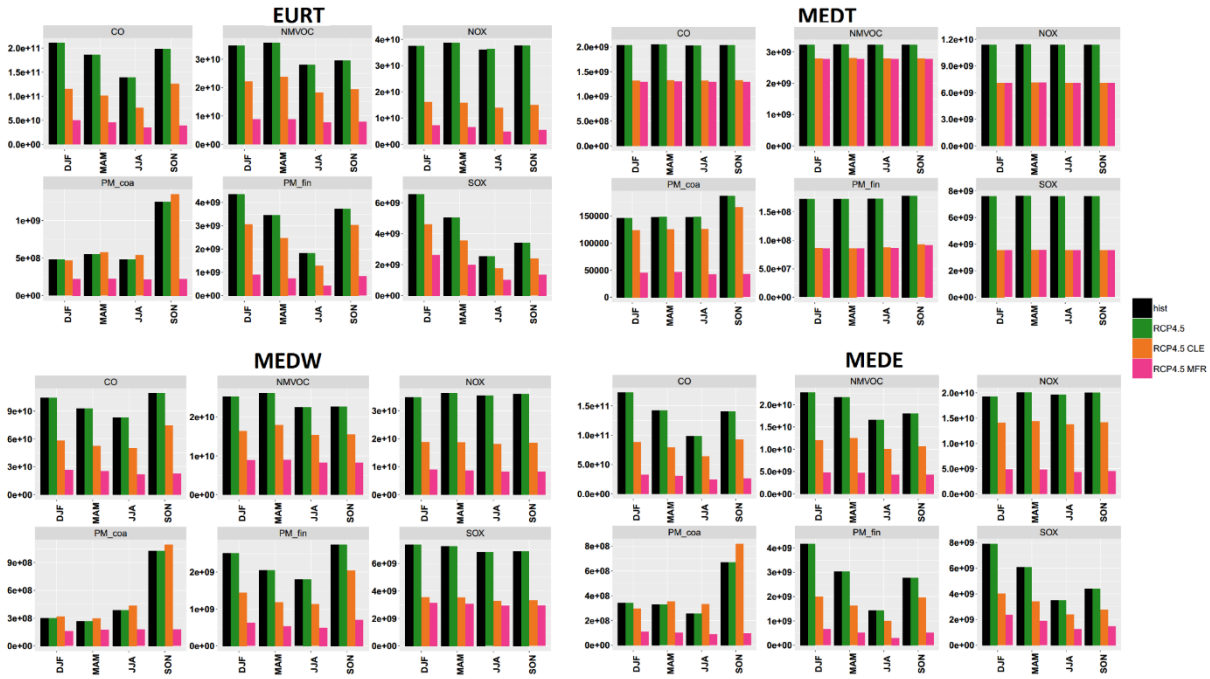


Figure SI7 1. Anthropogenic emissions for CLE-2010, CLE 2050 and MFR 2050 emissions

SI8: Seasonal comparison for the impact of each driver on PM_{10} components

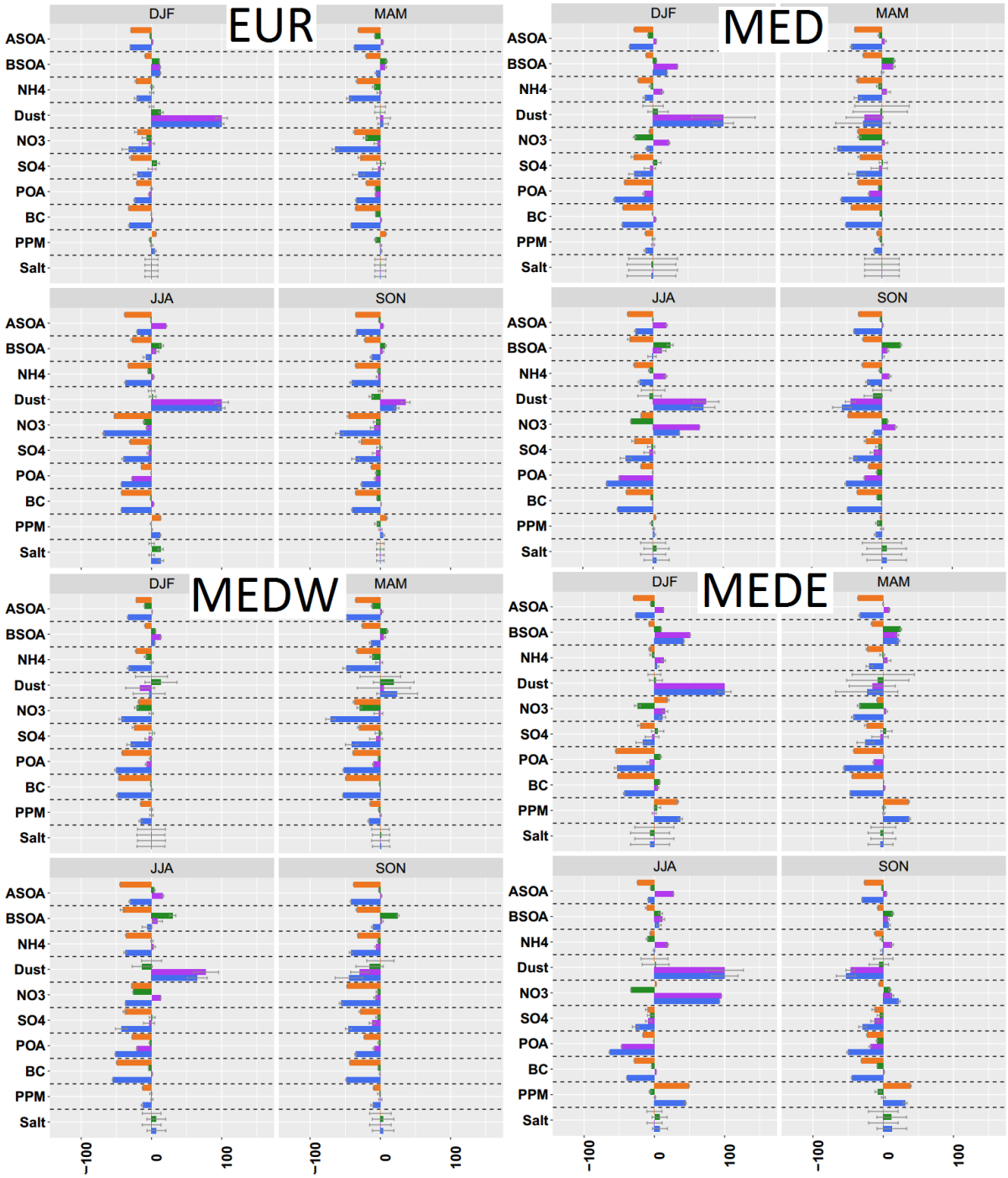


Figure SI8 1. Seasonal relative impact of climate, BC and emission drivers on PM_{10} components for different sub-domains, the name of the sub-domains is written on each panel. Each sub-panel shows one season. Error bars show the confidence interval calculated by annual averages.