Supplement of "Impact of methane and other precursor emission reductions on surface ozone in Europe: Scenario analysis using the EMEP MSC-W model"

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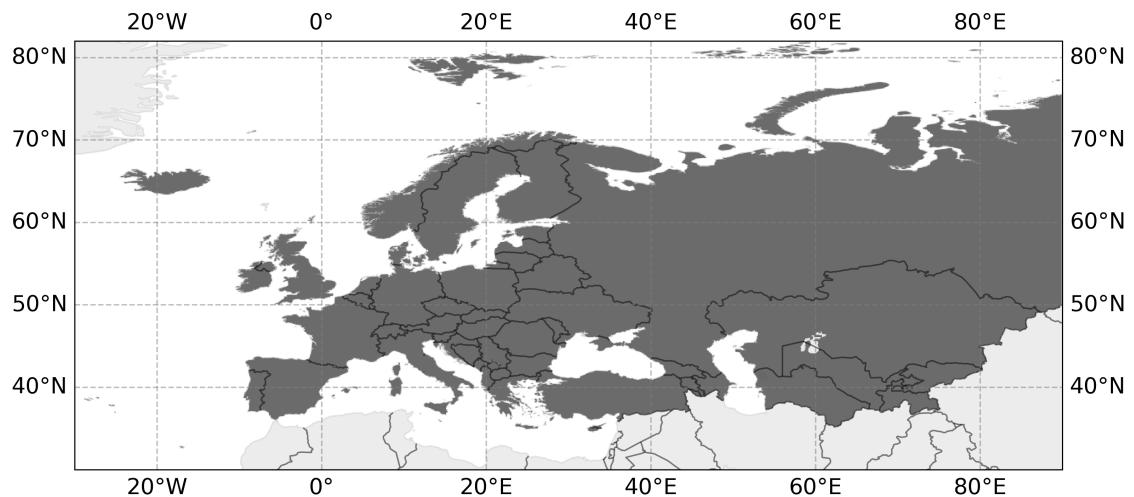
Figure S1. Dark-grey shaded region marks the EMEP region within the $0.1° \times 0.1°$ regional EMEP modelling domain.

Table S1. 600-ensemble mean global mean CH_4 concentrations calculated using the MAGICC7 model for the emission scenarios described in Sect. 3 of the main text.

| Year	2015	2020	2025	2030	2035	2040	2045	2050
CLE CH_4 (ppb)	1842	1897	1956	2016	2073	2129	2185	2236
MFR CH_4 (ppb)	1842	1897	1956	1936	1824	1750	1700	1651
LOW CH_4 (ppb)	1842	1897	1955	1928	1801	1709	1642	1574
LOW-CH4 CH_4 (ppb)	1842	1897	1956	1917	1761	1635	1536	1440
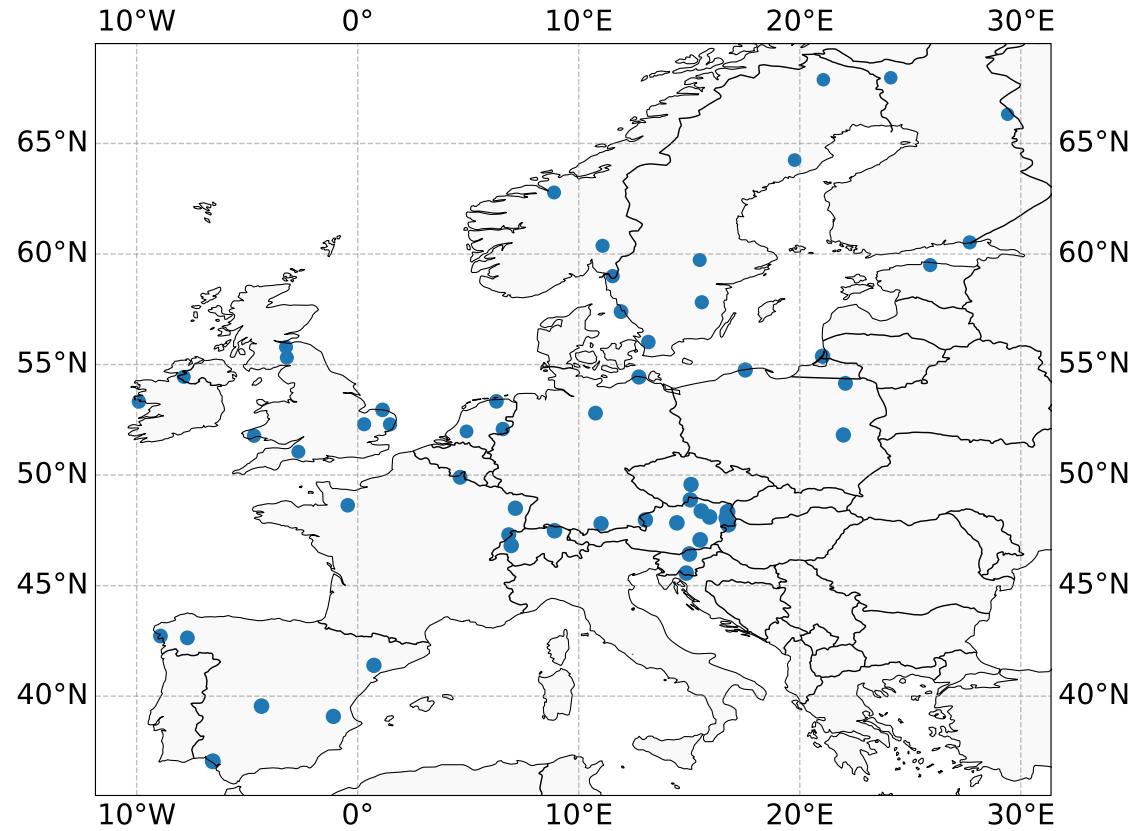
Figure S2. Geographical locations of the 56 EBAS stations with peak season MDA8 measurements available for each of the years between 2013-2017, as referred to in Sect. 4.3 of the main text.

(a)
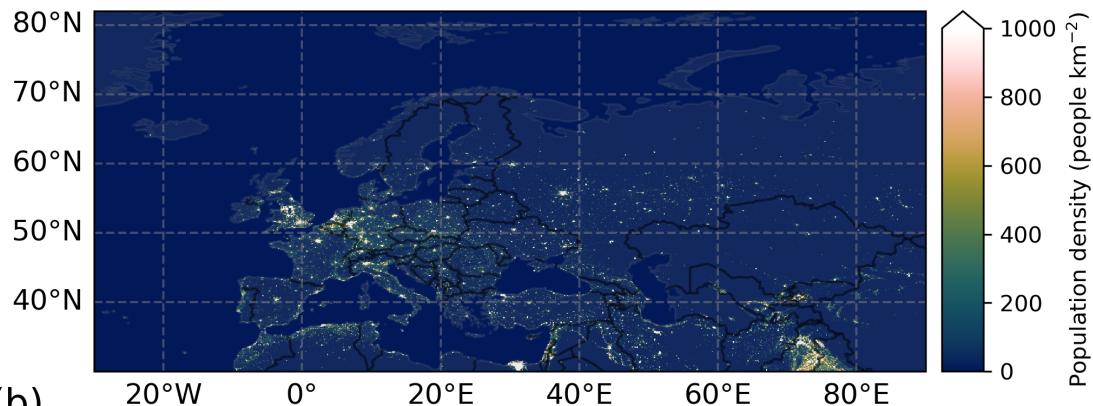
(b)
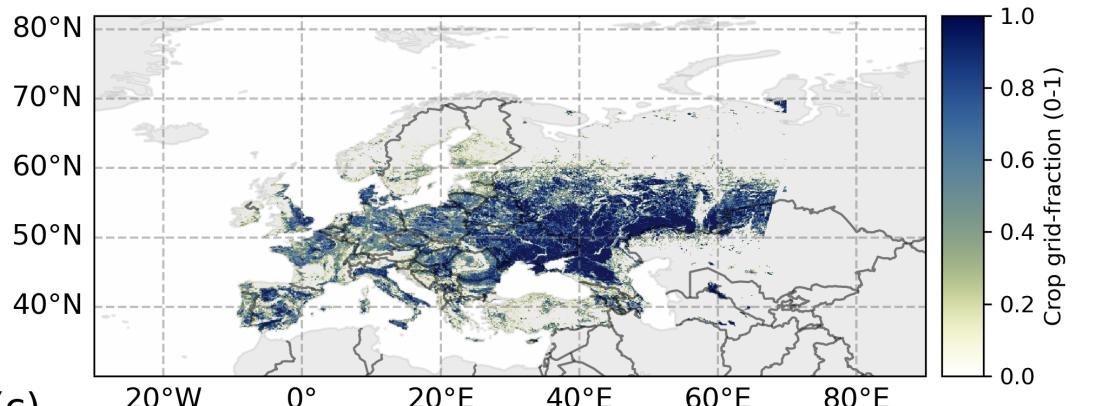
(c)
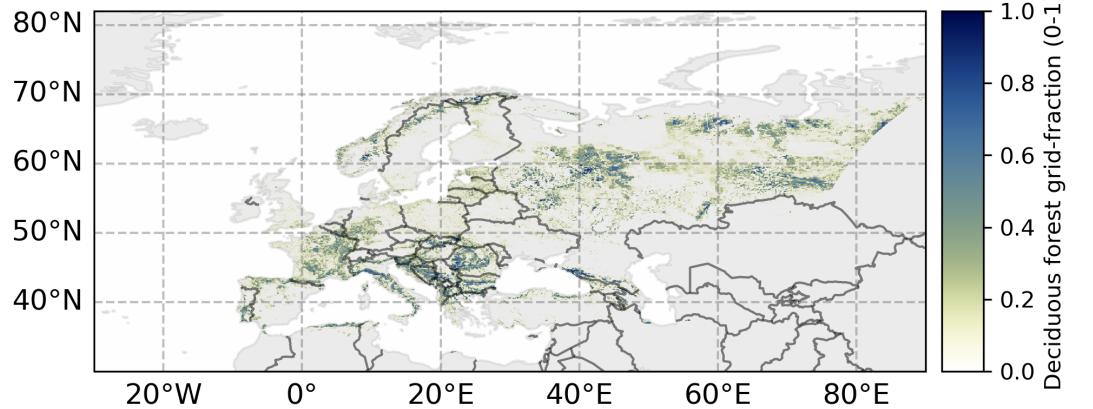
Figure S3. Panels (a), (b), and (c) show the population density (people km^{-2}), crop grid-fraction, and deciduous forest grid-fraction, respectively, across the $0.1° \times 0.1°$ EMEP regional modelling domain. Note the difference in color-scheme for the population density map.
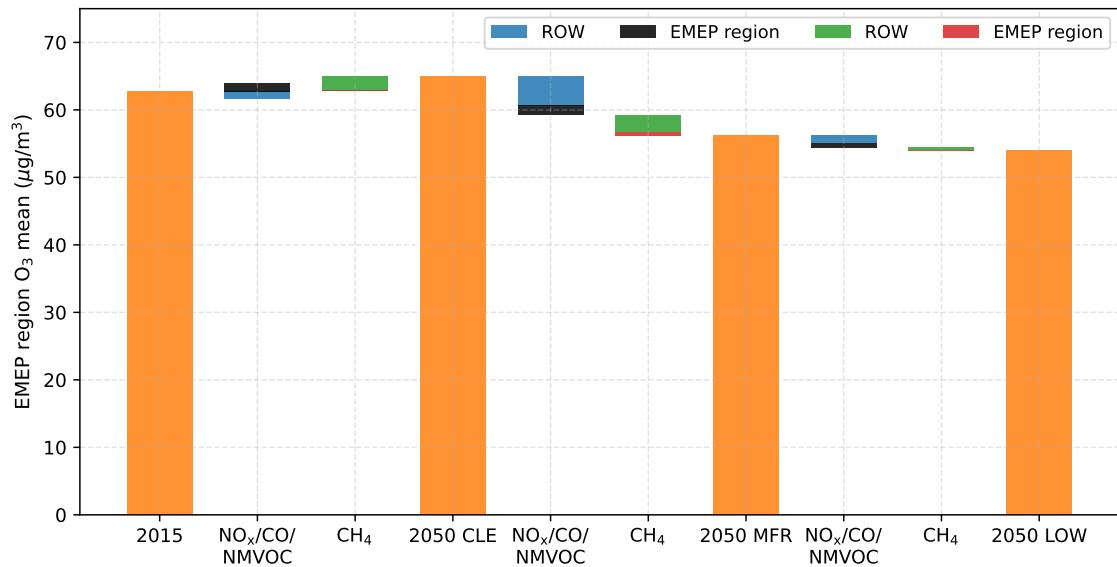
Figure S4. Cascade plot of population weighted EMEP region annual mean O_3 concentration changes arising from NO_x, VOC, and CO emission ('Emis') changes within the EMEP region (black) and ROW (blue), and from background CH_4 changes arising from CH_4 emission changes in the EMEP region (red) and ROW (green), for the 2050 CLE, MFR, and LOW scenarios.
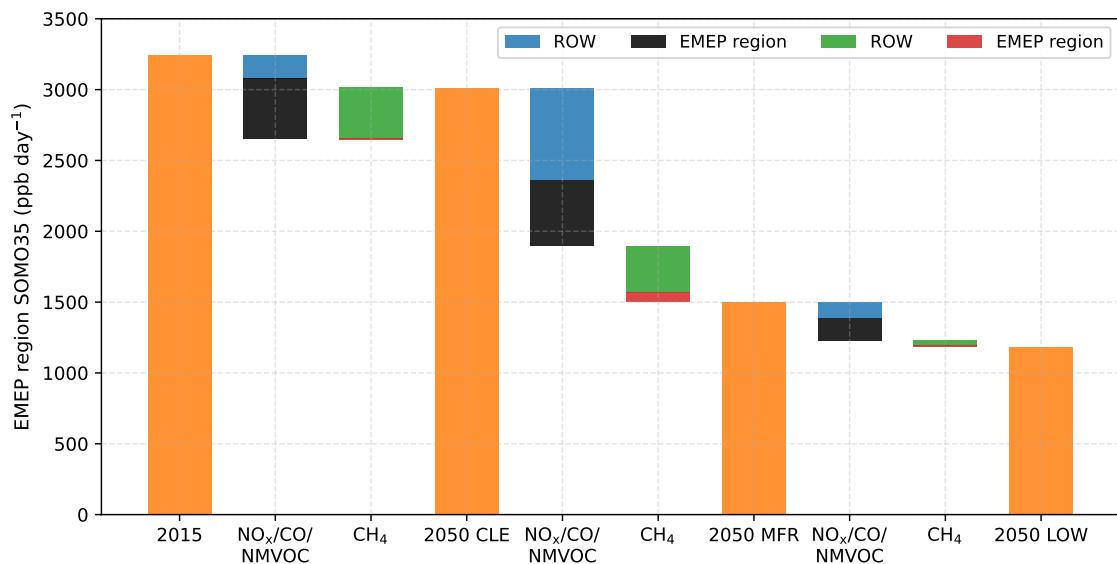

Figure S5. Cascade plot of population weighted EMEP region SOMO35 changes arising from NO_x, VOC, and CO emission ('Emis') changes within the EMEP region (black) and ROW (blue), and from background CH_4 changes arising from CH_4 emission changes in the EMEP region (red) and ROW (green), for the 2050 CLE, MFR, and LOW scenarios.
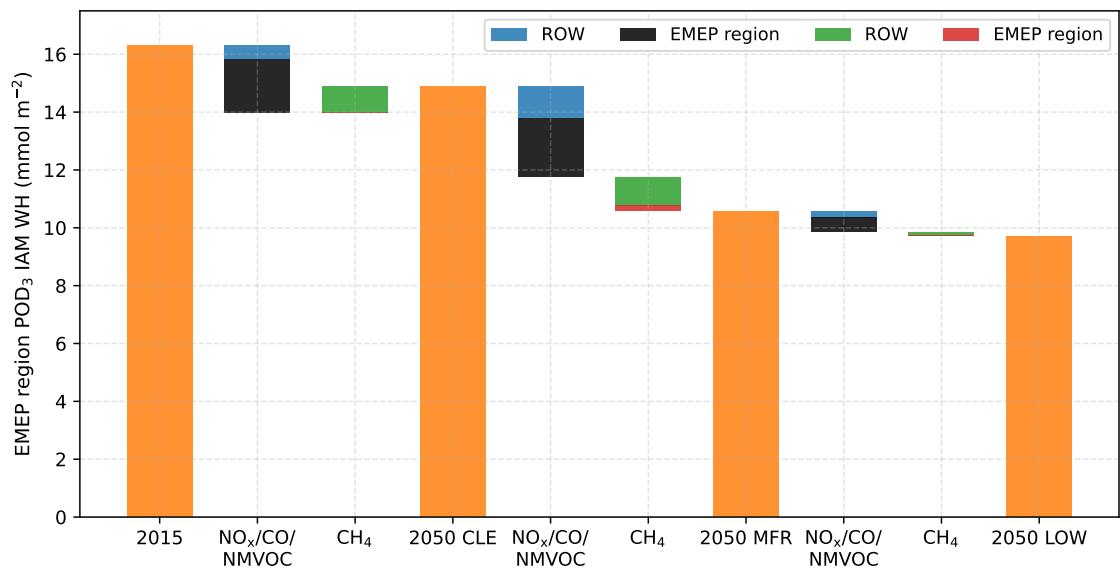
Figure S6. Cascade plot of crop-area weighted EMEP region POD_3IAM_{WH} changes arising from NO_x, VOC, and CO emission ('Emis') changes within the EMEP region (black) and ROW (blue), and from background CH_4 changes arising from CH_4 emission changes in the EMEP region (red) and ROW (green), for the 2050 CLE, MFR, and LOW scenarios.
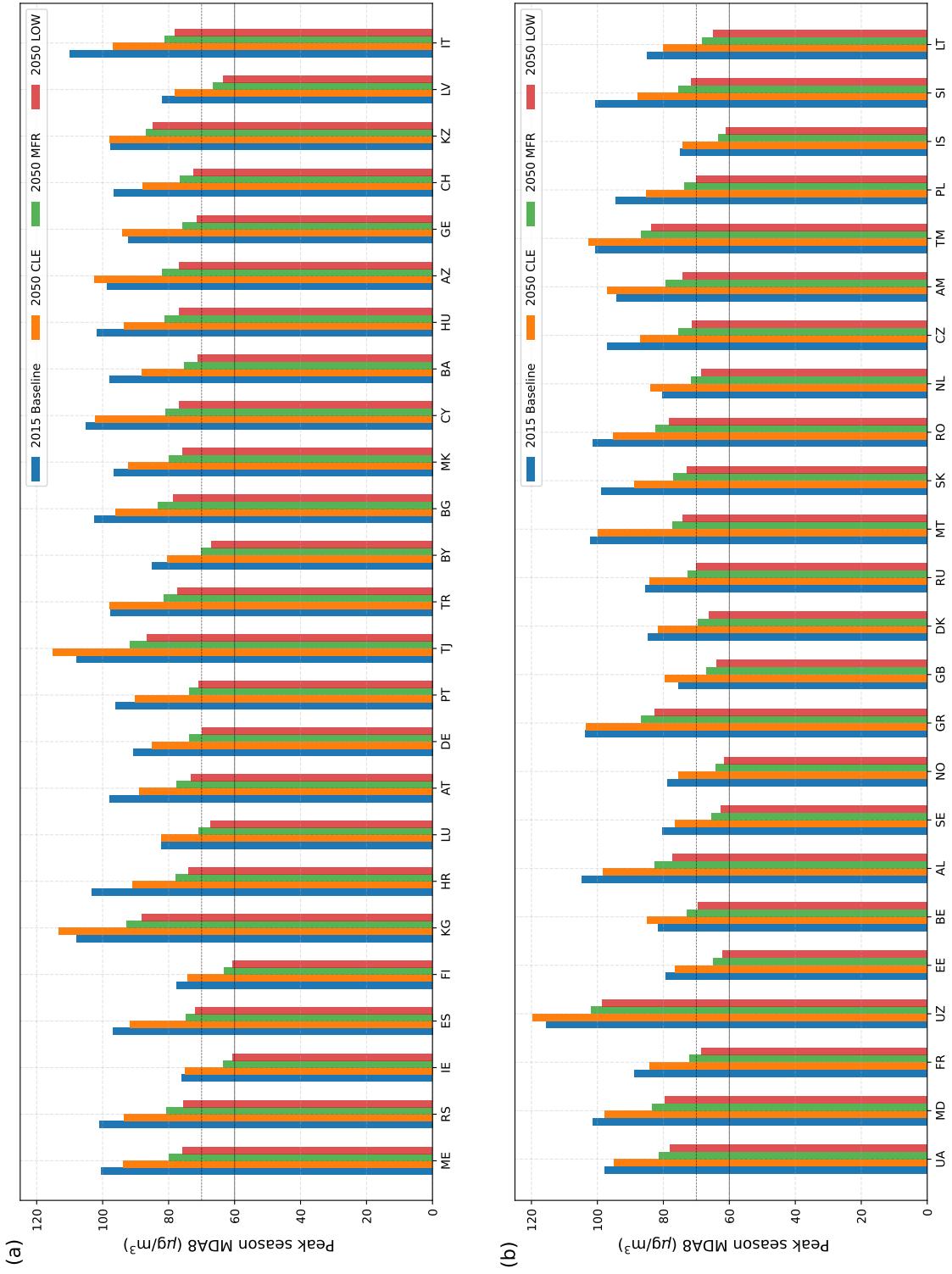
Figure S7. Population weighted country average peak season MDA8 concentrations for the 2015 baseline and 2050 CLE, MFR, and LOW scenarios for each of the 49 countries within the EMEP region. Country names are listed using their ISO 3166-1 alpha-2 codes, with the list of countries split between panels (a) and (b) for readability. The horizontal solid black and dashed grey lines indicate the WHO guideline and interim peak season MDA8 limits, respectively.
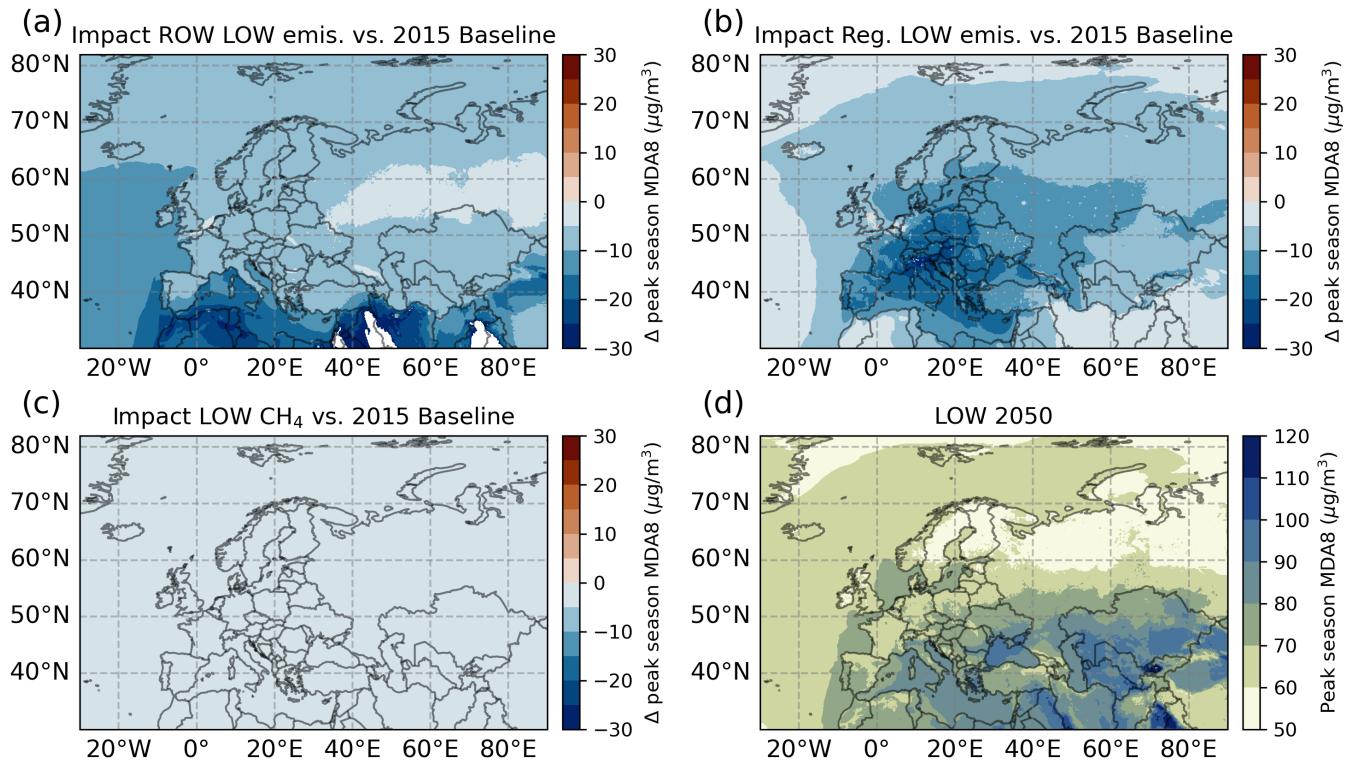
Figure S8. Panel (a) shows the reductions in peak season MDA8 achieved by 2050 ROW LOW emissions relative to the 2015 baseline scenario, while panel (b) shows the reductions achieved by EMEP region LOW emissions. Panel (c) shows the reductions achieved by the difference in background CH_4 concentrations between 2050 LOW and 2015 baseline (1574 versus 1834 ppb). Panel (d) shows the peak season MDA8 concentrations simulated for the full 2050 LOW scenario. Note the difference in color-scale for panel (d).

Table S2. Absolute and percentage (brackets) changes in health and vegetation O3 indicators resulting from precursor emission changes in the EMEP (reg.) and ROW regions, and from background CH_4 changes. End values represent the average values at the scenario end-points.

Scenario		2015 Base to 2050 CLE	2015 Base to 2050 MFR[a]	2015 Base to 2050 LOW[a]	2050 CLE to 2050 MFR	2050 CLE to 2050 LOW[a]	2050 MFR to 2050 LOW
PS MDA8[a]	Reg. emis	-3.9 (-4.4 %)	-9.3 (-10.4 %)	-10.7 (-12.0 %)	-5.4 (-6.2 %)	-6.8 (-7.9 %)	-1.5 (-2.0 %)
	ROW emis	-1.6 (-1.8 %)	-5.5 (-6.2 %)	-6.5 (-7.3 %)	-4.0 (-4.6 %)	-4.9 (-5.7 %)	-1.0 (-1.3 %)
	CH_4	2.8 (3.2 %)	-1.1 (-1.2 %)	-1.6 (-1.8 %)	-3.9 (-4.5 %)	-4.4 (-5.1 %)	-0.5 (-0.7 %)
	End value	86.6	73.4	70.5	73.4	70.5	70.5
O3 mean[a]	Reg. emis	-1.5 (-2.2 %)	-4.5 (-6.7 %)	-5.4 (-8.1 %)	-3.0 (-4.5 %)	-3.9 (-5.9 %)	-0.9 (-1.6 %)
	ROW emis	-1.3 (-2.0 %)	-5.4 (-8.0 %)	-6.5 (-9.7 %)	-4.1 (-6.1 %)	-5.2 (-7.8 %)	-1.1 (-2.0 %)
	CH_4	2.1 (3.1 %)	-0.8 (-1.2 %)	-1.2 (-1.7 %)	-2.8 (-4.3 %)	-3.2 (-4.8 %)	-0.4 (-0.7 %)
	End value	66.6	56.7	54.2	56.7	54.2	54.2
4th MDA8[a]	Reg. emis	-4.4 (-3.0 %)	-9.6 (-6.7 %)	-11.4 (-7.9 %)	-5.3 (-3.8 %)	-7.0 (-5.0 %)	-1.7 (-1.3 %)
	ROW emis	-1.4 (-1.0 %)	-5.4 (-3.7 %)	-6.4 (-4.5 %)	-4.0 (-2.8 %)	-5.0 (-3.5 %)	-1.0 (-0.8 %)
	CH_4	2.6 (1.8 %)	-0.9 (-0.6 %)	-1.4 (-1.0 %)	-3.5 (-2.5 %)	-4.0 (-2.8 %)	-0.5 (-0.4 %)
	End value	140.6	127.8	124.6	127.8	124.6	124.6
JJA O3 max[c]	Reg. emis	-4.7 (-4.8 %)	-11.0 (-11.3 %)	-12.6 (-12.9 %)	-6.3 (-6.7 %)	-7.9 (-8.3 %)	-1.6 (-2.0 %)
	ROW emis	-1.4 (-1.5 %)	-4.7 (-4.8 %)	-5.3 (-5.5 %)	-3.2 (-3.4 %)	-3.9 (-4.1 %)	-0.7 (-0.8 %)
	CH_4	3.4 (3.5 %)	-1.2 (-1.3 %)	-1.9 (-1.9 %)	-4.6 (-4.9 %)	-5.3 (-5.6 %)	-0.6 (-0.8 %)
	End value	94.8	80.6	77.6	80.6	77.6	77.6
JJA O3 mean[a]	Reg. emis	-3.3 (-4.5 %)	-7.8 (-10.6 %)	-8.9 (-12.2 %)	-4.5 (-6.3 %)	-5.6 (-7.8 %)	-1.1 (-1.8 %)
	ROW emis	-1.2 (-1.6 %)	-3.9 (-5.3 %)	-4.5 (-6.1 %)	-2.7 (-3.8 %)	-3.3 (-4.6 %)	-0.6 (-0.9 %)
	CH_4	2.7 (3.7 %)	-1.0 (-1.4 %)	-1.5 (-2.1 %)	-3.7 (-5.2 %)	-4.2 (-5.9 %)	-0.5 (-0.8 %)
	End value	71.7	60.7	58.5	60.7	58.5	58.5
SOMO35[b]	Reg. emis	-373 (-12.3 %)	-860 (-28.3 %)	-981 (-32.3 %)	-486 (-17.4 %)	-608 (-21.7 %)	-121 (-8.6 %)
	ROW emis	-179 (-5.9 %)	-733 (-24.1 %)	-838 (-27.6 %)	-553 (-19.8 %)	-658 (-23.6 %)	-104 (-7.4 %)
	CH_4	307 (10.1 %)	-33 (-1.1 %)	-74 (-2.4 %)	-341 (-12.2 %)	-381 (-13.7 %)	-40 (-2.9 %)
	End value	2795	1413	1147	1413	1147	1147

[a] Area weighted EMEP region average in µg m^{-3}. [b] Area weighted EMEP region average in ppb day^{-1}. [c] Area weighted average converted from ppb to using the standard-atmosphere O$_3$ conversion factor of 1.96.