Supplement to 'Attributing land transport emissions to ozone and ozone precursors in Europe and Germany'

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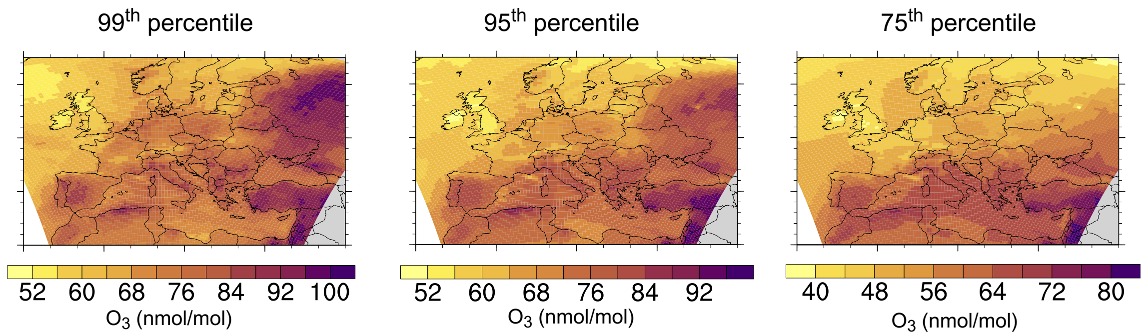

Figure S1: 99th, 95th and 75th percentile of ozone (in nmol mol^{-1}) for the period JJA 2008–2010 based on 3-hourly model output. Results of the *REF* simulation.

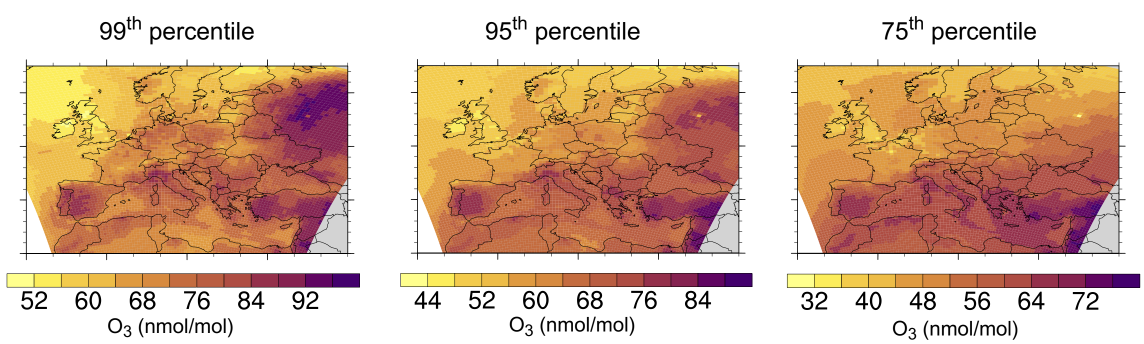

Figure S2: 99th, 95th and 75th percentile of ozone (in nmol mol^{-1}) for the period JJA 2008–2010 based on 3-hourly model output. Results of the *EVEU* simulation.

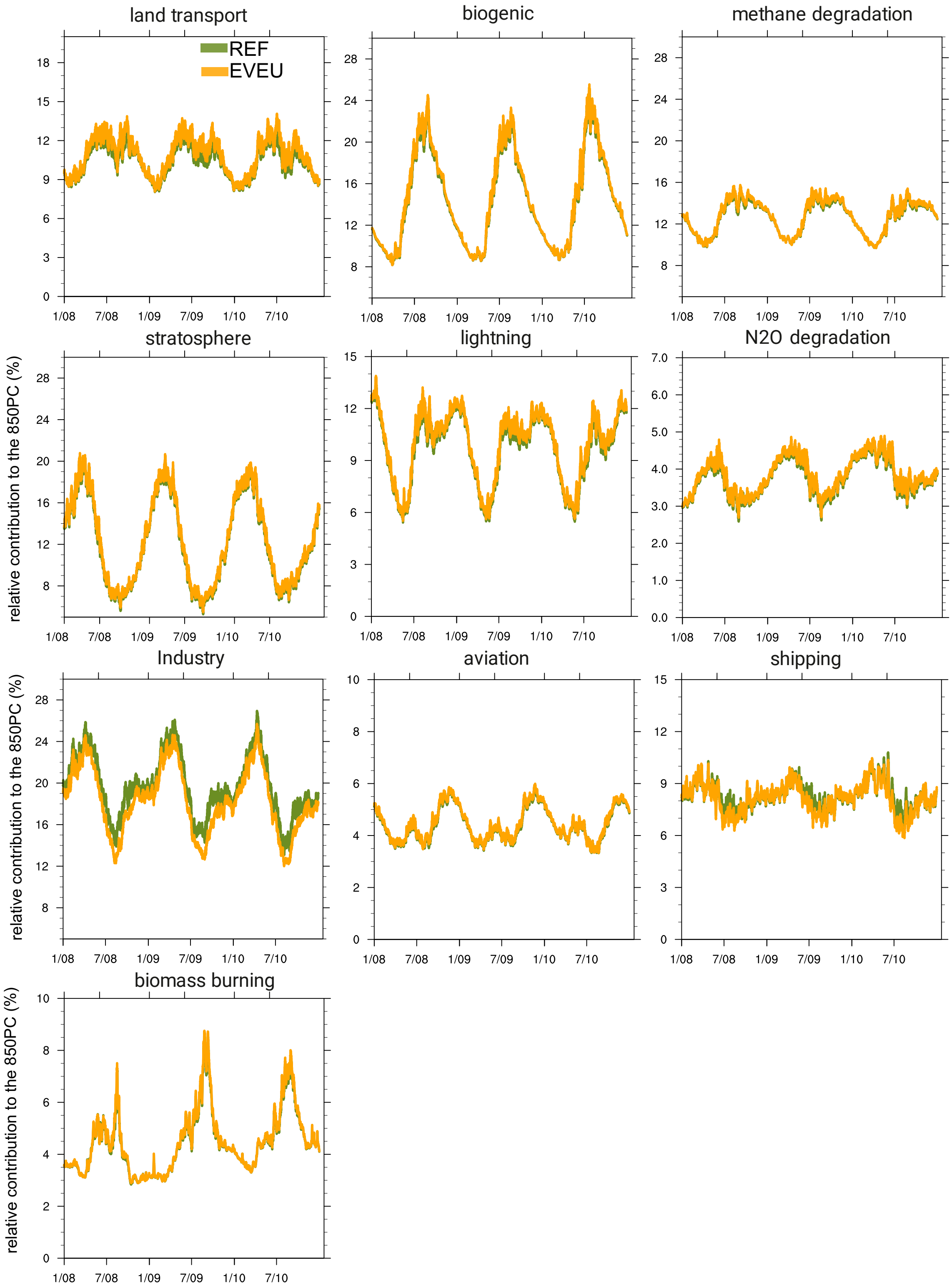

Figure S3: Relative contribution (area average over CM50 domain) of different emission sources to the ozone column up to 850 hPa (called 850PC).

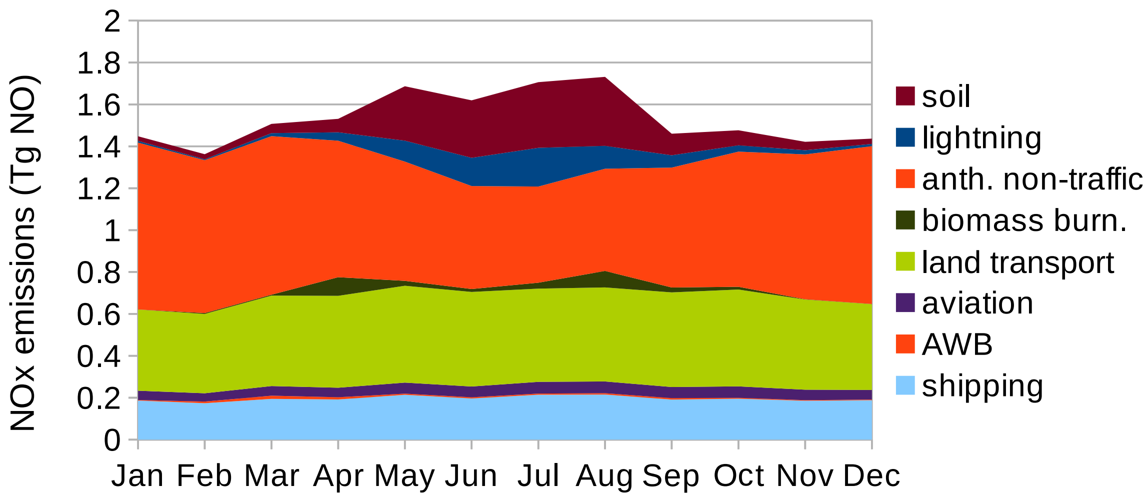

Figure S4: Monthly total emissions of NO (in Tg) within the CM50 domain for different emission sources. For the anthropogenic emissions the MAC inventory is used. Shown is the cycle for the year 2008. In different years or with the *VEU* emission inventory a similar cycle is observed. Figure reproduced from Mertens (2017).

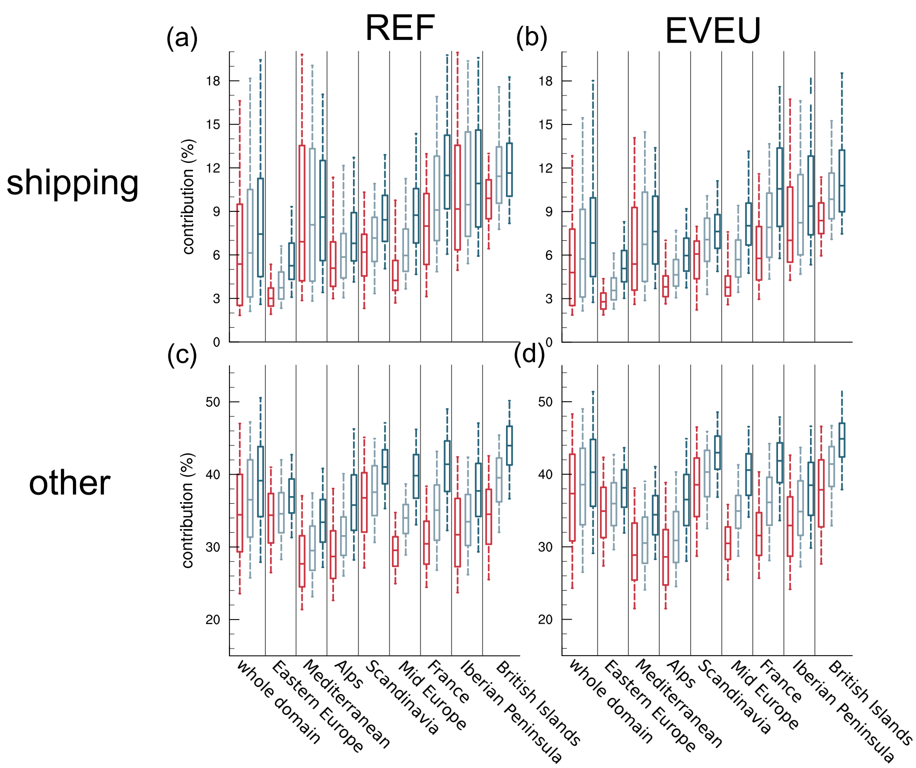

Figure S5: Box-whisker plot showing the contribution of the shipping and all other ozone sources to ground-level ozone (in %) (a) and (b) show the relative contributions of O_3^{shp} at the 99th,95th and 75th percentile of ozone; (c) and (d) the relative contribution of all other sources (lightning, CH4, stratosphere, biomass burning, and N2O) to ozone. The lower and upper end of the box indicates the 25th and 75th percentile, the bar the median, and the whiskers the 5th and 95th percentile of the contributions of all gridboxes within the indicated regions. All values are calculated for JJA of the period 2008 to 2010 and are based on 3-hourly model output. The data were transformed on a regular grid with a resolution of 0.5° x 0.5° to allow for the analyses on the defined regions.

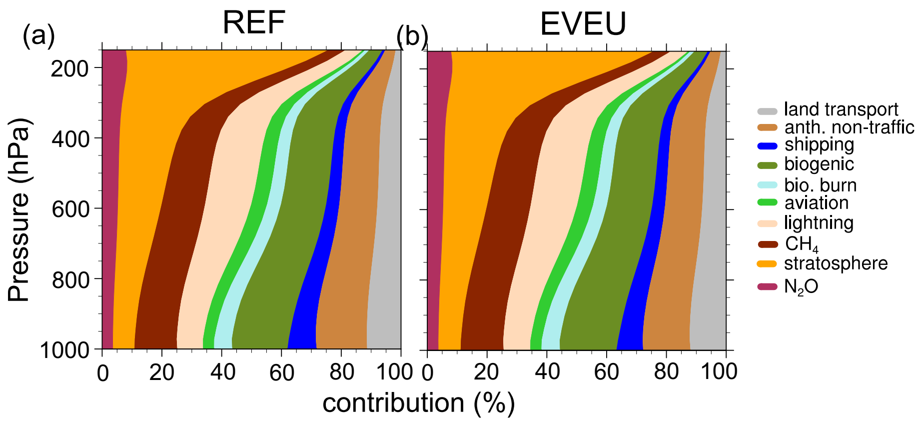

Figure S6: Vertical distribution of the area averaged (box defined as 10° W-38° E and 30° N-70° E) relative contributions of all tagged categories as simulated by textbf(a) *REF* and **(b)** *EVEU*. All data are averaged for JJA 2008–2010.

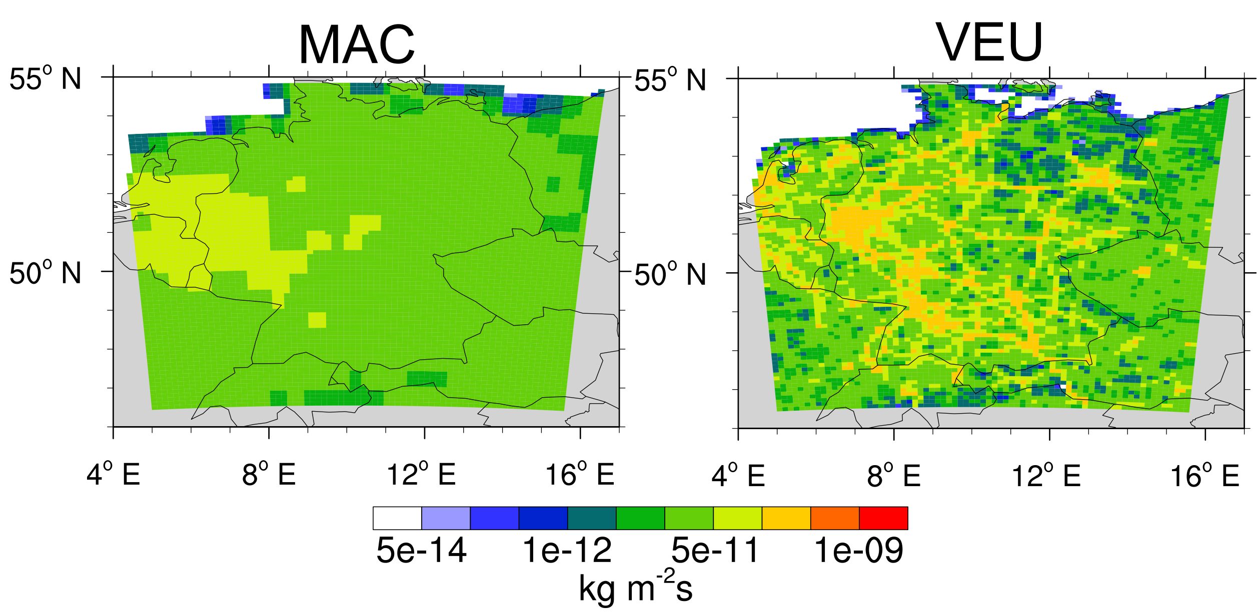

Figure S7: Comparison of emission fluxes for NO_x from the land transport sector (in kg (NO) m^{-2} s^{-1}) between the MAC (left), and VEU inventories. Values are averaged for May to August 2008.

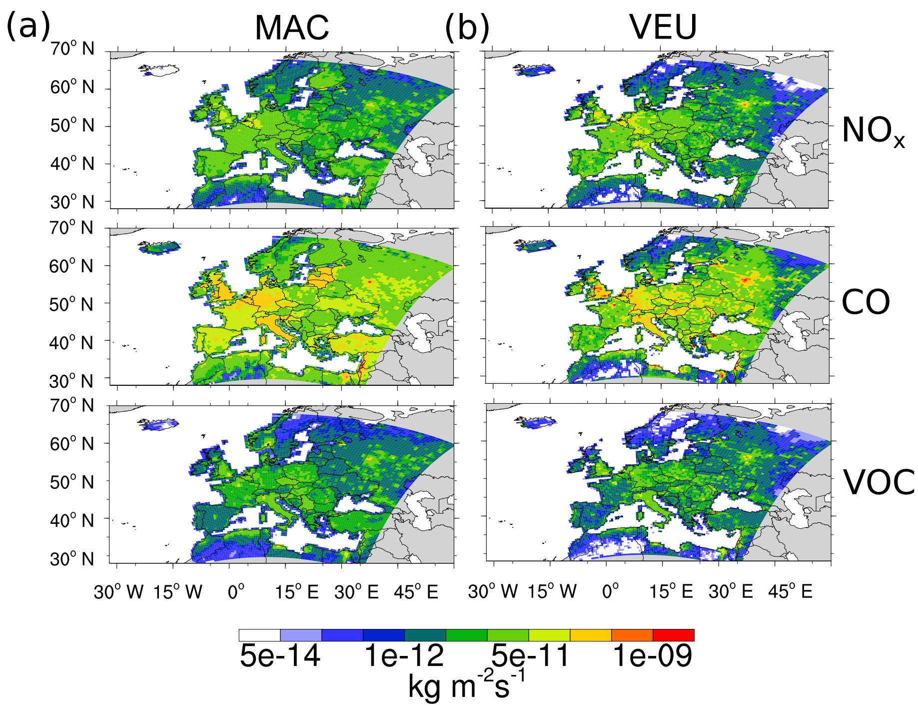

Figure S8: Annually averaged emission fluxes from the land transport sector (in kg m^{-2} s^{-1}) **(a)** MACCity and **(b)** VEU emission inventories. Shown are the emissions of NO_x (in kg NO), CO (in kg CO); and VOC (in kg C).

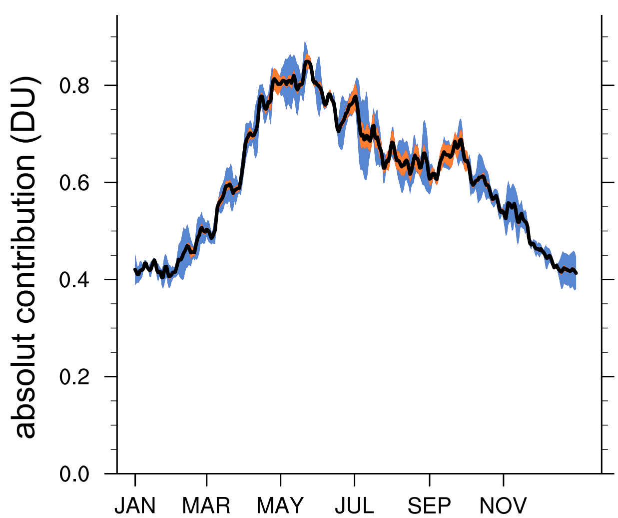

Figure S9: Annual cycle of the absolute contribution of land transport emissions to the ozone column up to 850 hPa (in %).The black line indicates the mean contribution as simulated by CM50, averaged over the years 2008–2010 and the two simulations (*REF*, *EVEU*). The blue shading indicates the standard deviation with respect to time for the years 2008 to 2010 for the *EVEU* simulation. The orange shading indicates the standard deviation with respect to time between the 2008–2010 averaged annual cycles between the *REF* and the *EVEU* simulation.

S1 Definition of the PRUDENCE subdomains

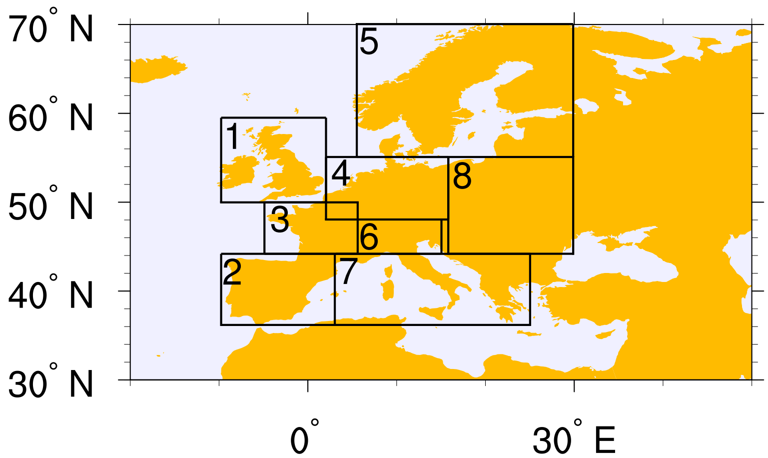

Figure S10: Geographical definition of the eight subdomains (black, 1–8) as defined in the PRUDENCE project (Christensen et al., 2007). Figure is reproduced from Mertens (2017).

S2 Emission totals

The following Tables summaries the emissions of NO_x, CO and VOCs from all anthropogenic and natural sources applied in the different simulations. Please note, that for every specie only these emission sectors are given where emissions occur. These sector are:

- **road t.**: land transport emissions
- **anth. nt**: Anthropogenic non-traffic emissions
- **shipping**: Shipping emissions
- **aviation**: Aviation emissions
- **Soil-**NO_x: NO_x emissions from soils calculated by the model
- **LNOX**: Lightning NO_x emissions
- **AWB**: Agricultural waste burning emissions
- **BB** : Biomass burning emissions
- **biog.**: Further biogenic emissions, not calculated by the model but prescribed as annual climatology
- **biog.** C_5H_8: Biogenic isoprene emissions, calculated by the model

Tables S1–S3 give the total emissions of EMAC of NO_x, CO and VOC, respectively. Please note, that the given total emissions for C_5H_8 from biogenic origin are scaled with 0.6 for EMAC (Jöckel et al., 2006) and 0.45 for COSMO/MESSy (Mertens et al., 2016).

Table S1: Total emissions of NO_x (in Tg a^{-1} in amount of NO) for EMAC. Given are the annual totals averaged the years 2008 to 2010.

Simulation	road t.	anth. nt	shipping	aviation	Soil NO_x	LNOX	AWB	BB	Sum
REF	20.4	37.0	12.8	2.2	12.7	12.4	0.418	10.7	109
EVEU	20.4	37.0	12.8	2.2	12.7	12.4	0.418	10.7	109

Table S2: Total emissions of CO (in (in Tg a^{-1}) for EMAC. Given are the annual totals averaged the years 2008 to 2010.

Simulation	road t.	anth. nt	shipping	AWB	biog.	BB	Sum
REF	149	415	1.34	20.3	113	406	1100
EVEU	149	415	1.34	20.3	113	406	1100

Table S3: Total emissions of VOC (in Tg a^{-1} in amount of C) for EMAC. Given are the annual totals averaged the years 2008 to 2010.

Simulation	road t.	anth. nt	shipping	biog. C_5H_8	AWB	biog.	BB	Sum
REF	17.4	73.4	2.30	282	0.943	108	14.5	498
EVEU	17.4	73.4	2.30	282	0.943	108	14.5	498

Table S4: Total emissions of NO_x (in Tg in amount of NO) for CM12. Given are the annual totals for the May to August 2008.

Simulation	road t.	anth. nt	shipping	aviation	Soil NO_x	LNOX	AWB	BB	Sum
REF	0.342	0.335	0.0333	0.0642	0.167	0.0456	0.000761	0.00361	0.988
EVEU	0.441	0.277	0.0263	0.0555	0.167	0.0456	0.000761	0.00361	1.01

Table S5: Total emissions of CO (in Tg) for CM12. Given are the annual totals for the May to August 2008.

Simulation	road t.	anth. nt	shipping	AWB	biog.	BB	Sum
REF	1.27	1.41	0.00348	0.0333	4.81	0.12	7.65
EVEU	1.18	0.842	0.000719	0.0333	4.81	0.12	6.98

Table S6: Total emissions of VOC (in Tg in amount of C) for CM12. Given are the annual totals for the May to August 2008.

Simulation	road t.	anth. nt	shipping	biog. C_5H_8	AWB	biog.	BB	Sum
REF	0.141	0.538	0.00413	0.423	0.0111	0.372	0.00516	1.49
EVEU	0.143	0.383	0.00175	0.423	0.0111	0.372	0.00516	1.34

S3 References

References

Christensen, J. H., Carter, T. R., Rummukainen, M., and Amanatidis, G.: Evaluating the performance and utility of regional climate models: the PRUDENCE project, Climatic Change, 81, 1–6, doi:10.1007/s10584-006-9211-6, URL `http://dx.doi.org/10.1007/s10584-006-9211-6`, 2007.

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