



*Supplement of*

## **Modeling the drivers of fine PM pollution over Central Europe: impacts and contributions of emissions from different sources**

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# S1 Statistical indicators used in the validation of the model experiments

Pearson correlation coefficient ( $r$ ), normalized mean bias (NMB), and normalized mean square error (NMSE) are defined as:

$$r = \frac{\sum_{i=1}^N (m_i - \bar{m})(o_i - \bar{o})}{\sqrt{\sum_{i=1}^N (m_i - \bar{m})^2} \sqrt{\sum_{i=1}^N (o_i - \bar{o})^2}}, \quad (\text{S1})$$

$$\text{NMB} = \frac{\sum_{i=1}^N (m_i - o_i)}{\sum_{i=1}^N o_i}, \quad (\text{S2})$$

$$\text{NMSE} = \frac{\frac{1}{N} \sum_{i=1}^N (m_i - o_i)^2}{\bar{m} \bar{o}}, \quad (\text{S3})$$

where  $m_i$  and  $o_i$  denote the corresponding modeled and observed concentrations in the compared sample, respectively,  $N$  is the total number of pairs  $m_i$  vs.  $o_i$  in the sample, and  $\bar{m}$  and  $\bar{o}$  stand for the arithmetic average of modeled and observed concentrations in the sample, respectively.

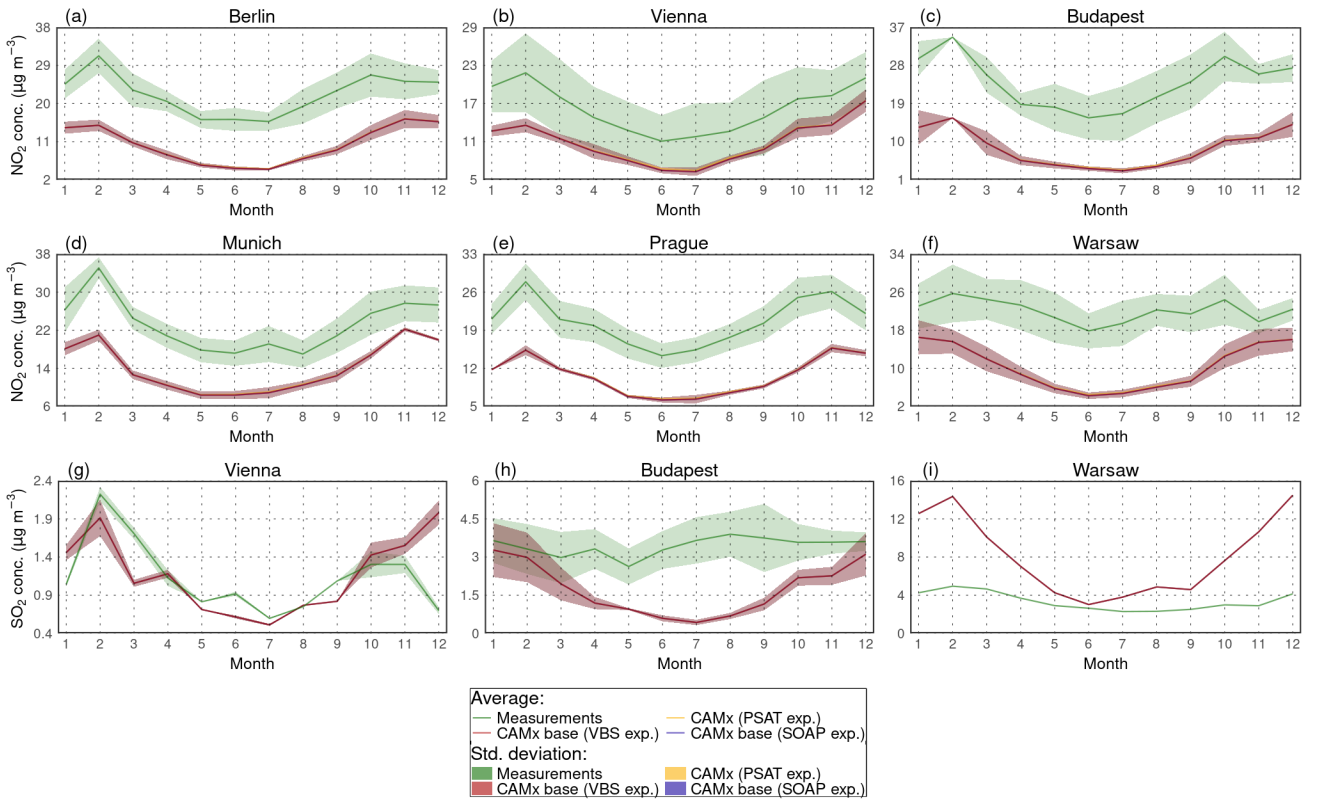
The standard deviation ( $\sigma$ ) from a finite data set  $\{x_1, x_2, \dots, x_N\}$  containing  $N$  numbers is defined as:

$$\sigma = \sqrt{\frac{1}{N} \sum_{i=1}^N (x_i - \bar{x})^2}, \quad (\text{S4})$$

where  $\bar{x}$  represents the arithmetic average of all  $x_i$  in the set.

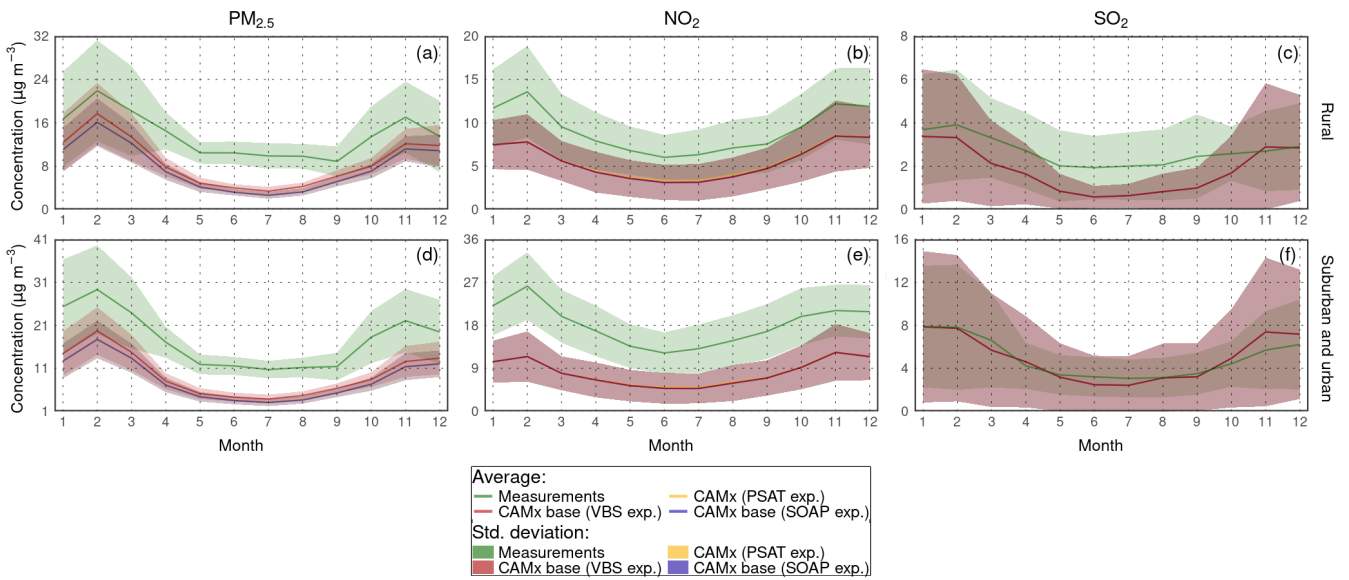
# S2 Figures and tables

Annual cycles of average monthly concentrations of NO<sub>2</sub> and SO<sub>2</sub> averaged over all suburban and urban background stations in individual cities during 2018-2019



**Figure S1.** Comparison of modeled (the base simulation of the SOAP/VBS experiment – blue/red lines, the simulation of the PSAT experiment – orange lines) and measured (AirBase data – green lines) annual cycles of average monthly NO<sub>2</sub> and SO<sub>2</sub> concentrations (in  $\mu\text{g m}^{-3}$ ) averaged over all suburban and urban background stations in individual cities (listed in Table S1) during 2018–2019. Panels (a–f) show the average annual cycles of NO<sub>2</sub> in Berlin, Vienna, Budapest, Munich, Prague, and Warsaw, respectively. Panels (g–i) show the average annual cycles of SO<sub>2</sub> in Vienna, Budapest, and Warsaw, respectively. The colored areas indicate the standard deviations of the averages, calculated using Eq. (S4). Their color scale corresponds to the scale used for the averages.

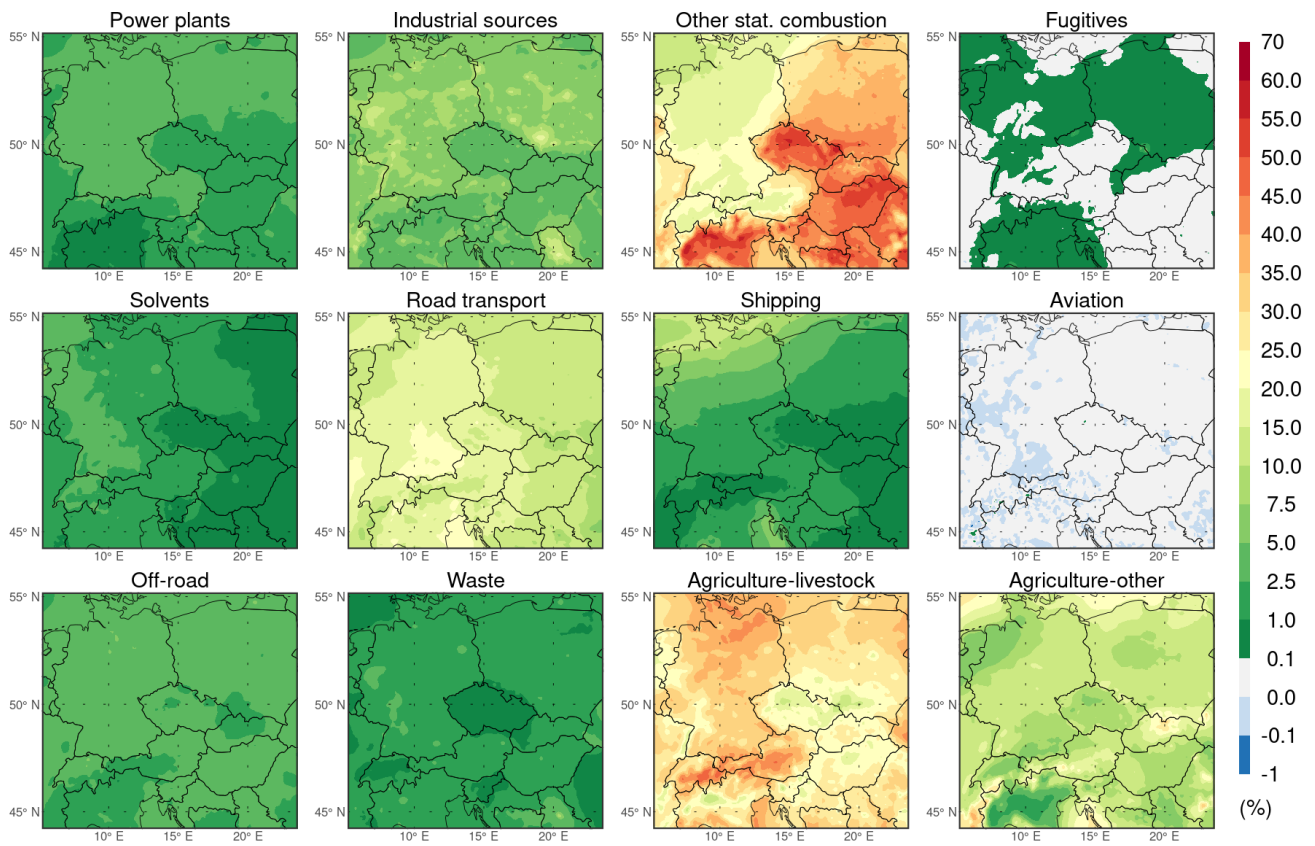
Annual cycles of average monthly concentrations of selected pollutants averaged over all background stations in selected areas during 2018-2019



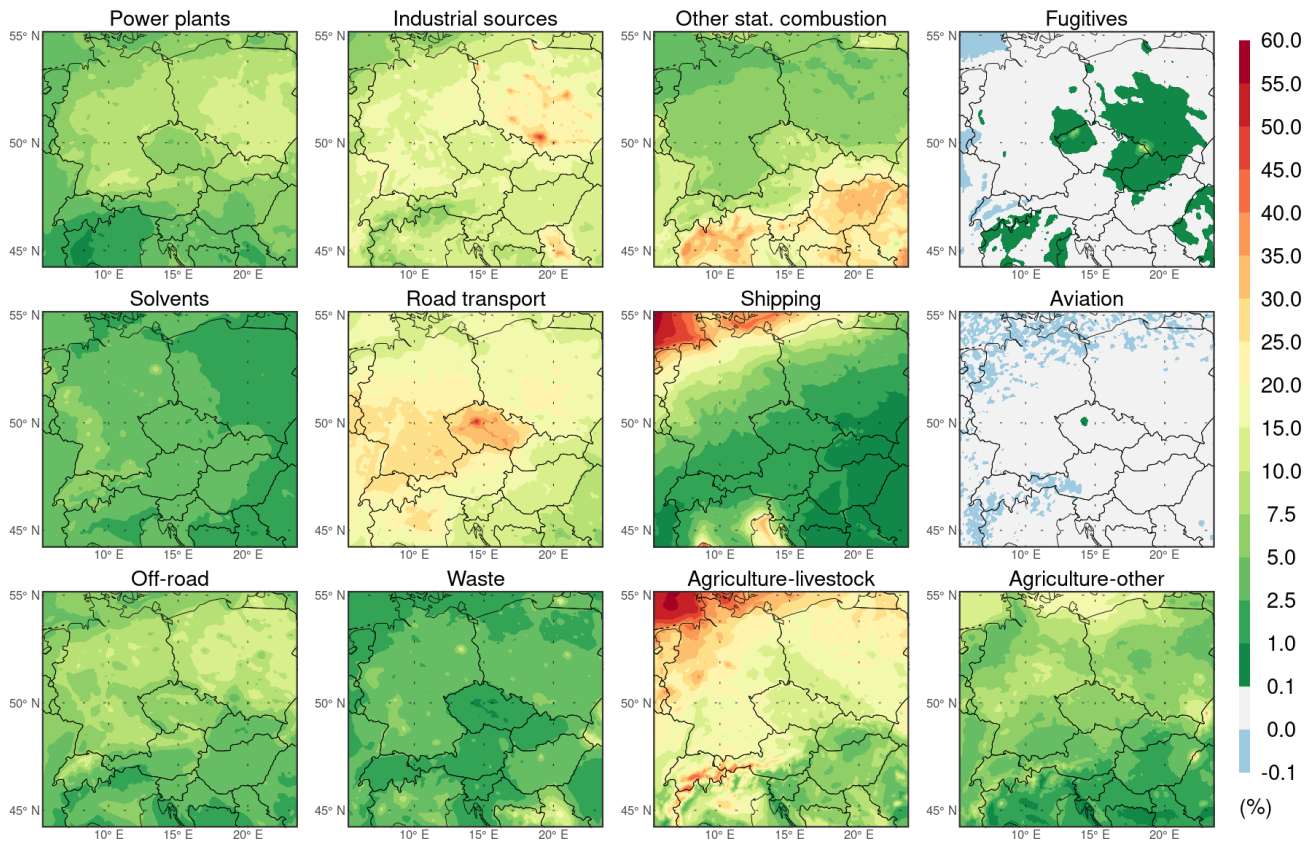
**Figure S2.** Comparison of modeled (the base simulation of the SOAP/VBS experiment – blue/red lines, the simulation of the PSAT experiment – orange lines) and measured (AirBase data – green lines) annual cycles of average monthly concentrations of PM<sub>2.5</sub> (a, d), NO<sub>2</sub> (b, e), and SO<sub>2</sub> (c, f) averaged over all rural (a–c), suburban and urban (d–f) background stations (listed in Table S3) during 2018–2019. All concentrations are shown in  $\mu\text{g m}^{-3}$ . The colored areas indicate the standard deviations of the averages, calculated using Eq. (S4). Their color scale corresponds to the scale used for the averages.

Average seasonal relative impact on PM<sub>2.5</sub> concentration in the SOAP experiment

(a) DJF 2018-2019



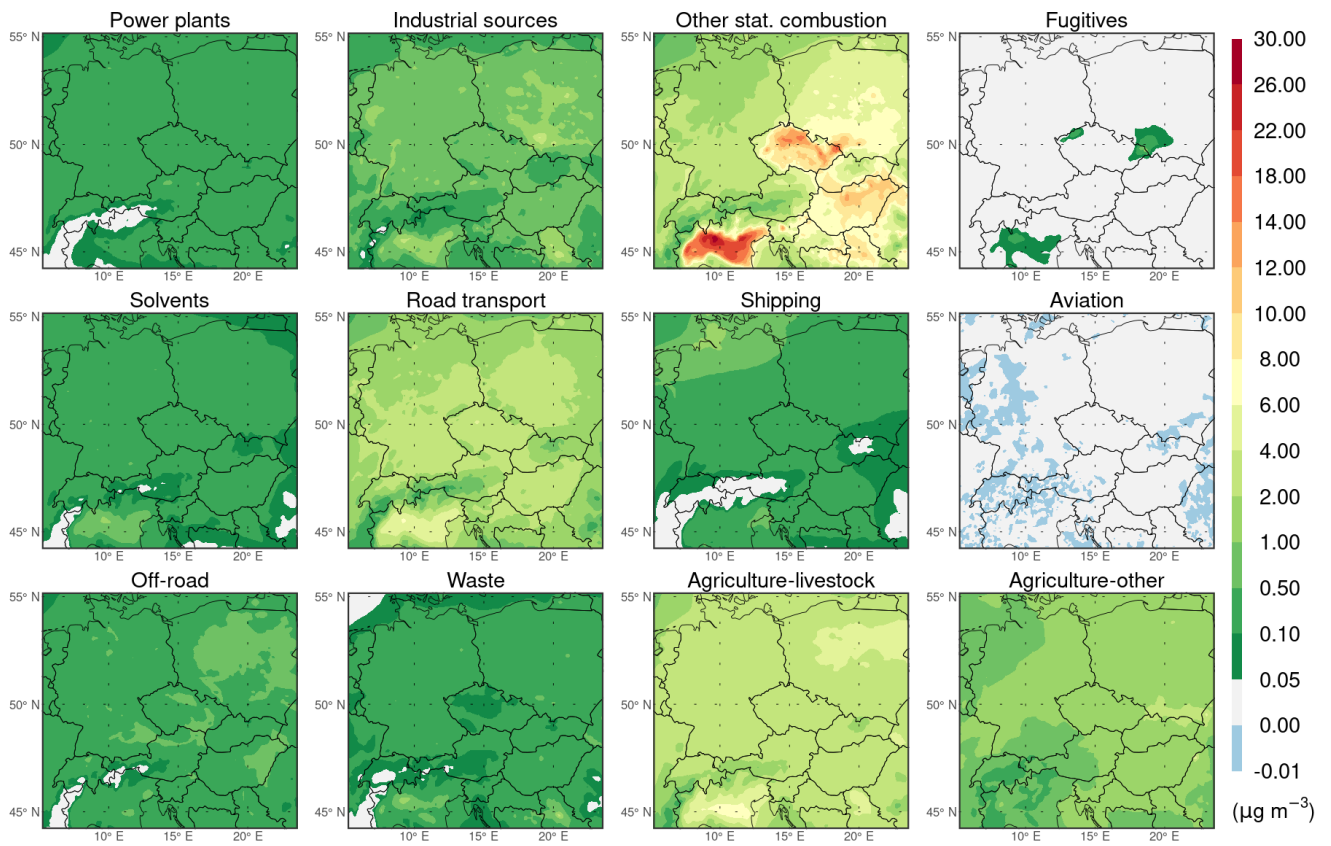
(b) JJA 2018-2019



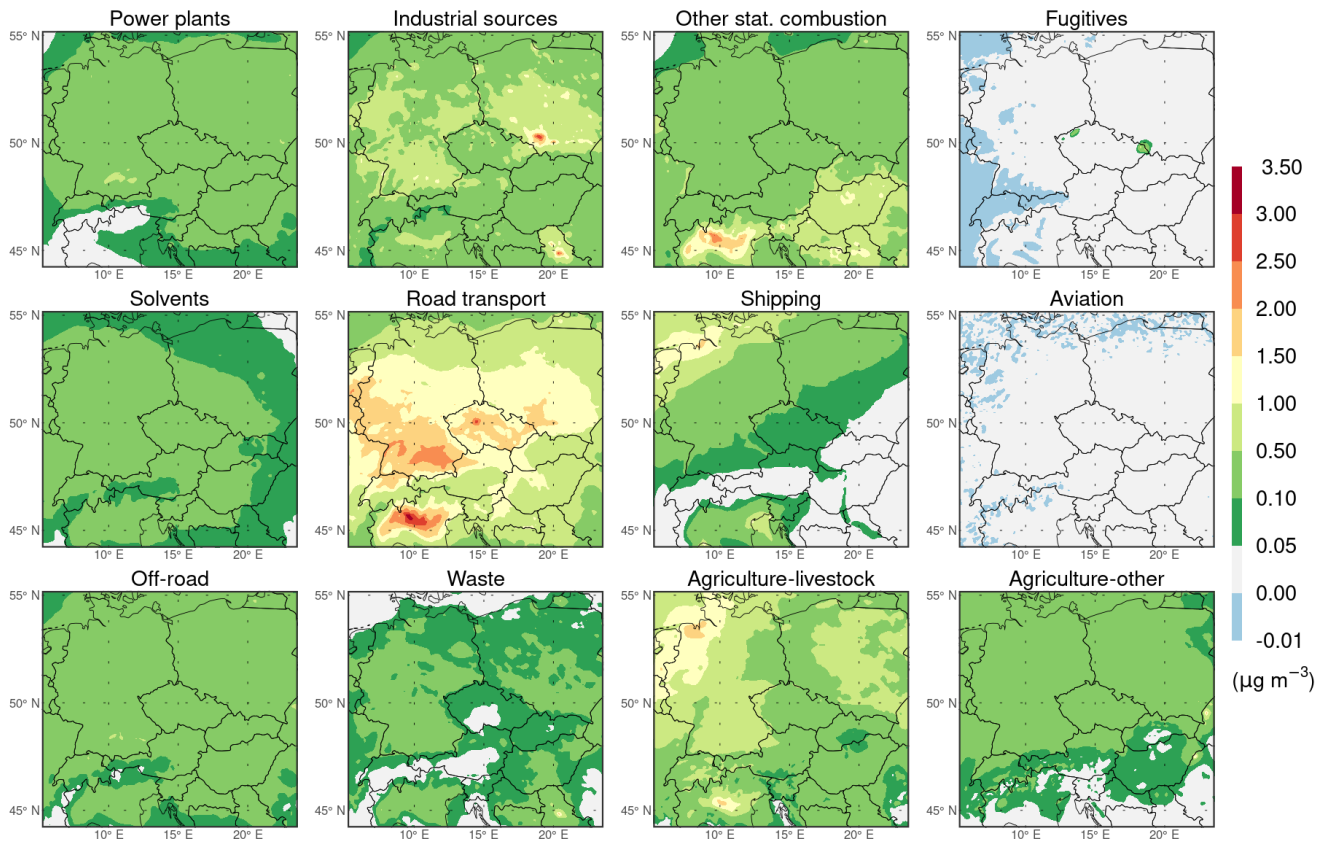
**Figure S3.** Spatial distributions of the average seasonal relative impact of emissions from individual GNFR sectors A–L (indicated by the sector names in the titles of the subpanels) on PM<sub>2.5</sub> concentration (in %) during the winter (a) and summer (b) seasons of 2018–2019 in the SOAP experiment.

Average seasonal absolute impact on PM<sub>2.5</sub> concentration in the VBS experiment

(a) DJF 2018-2019



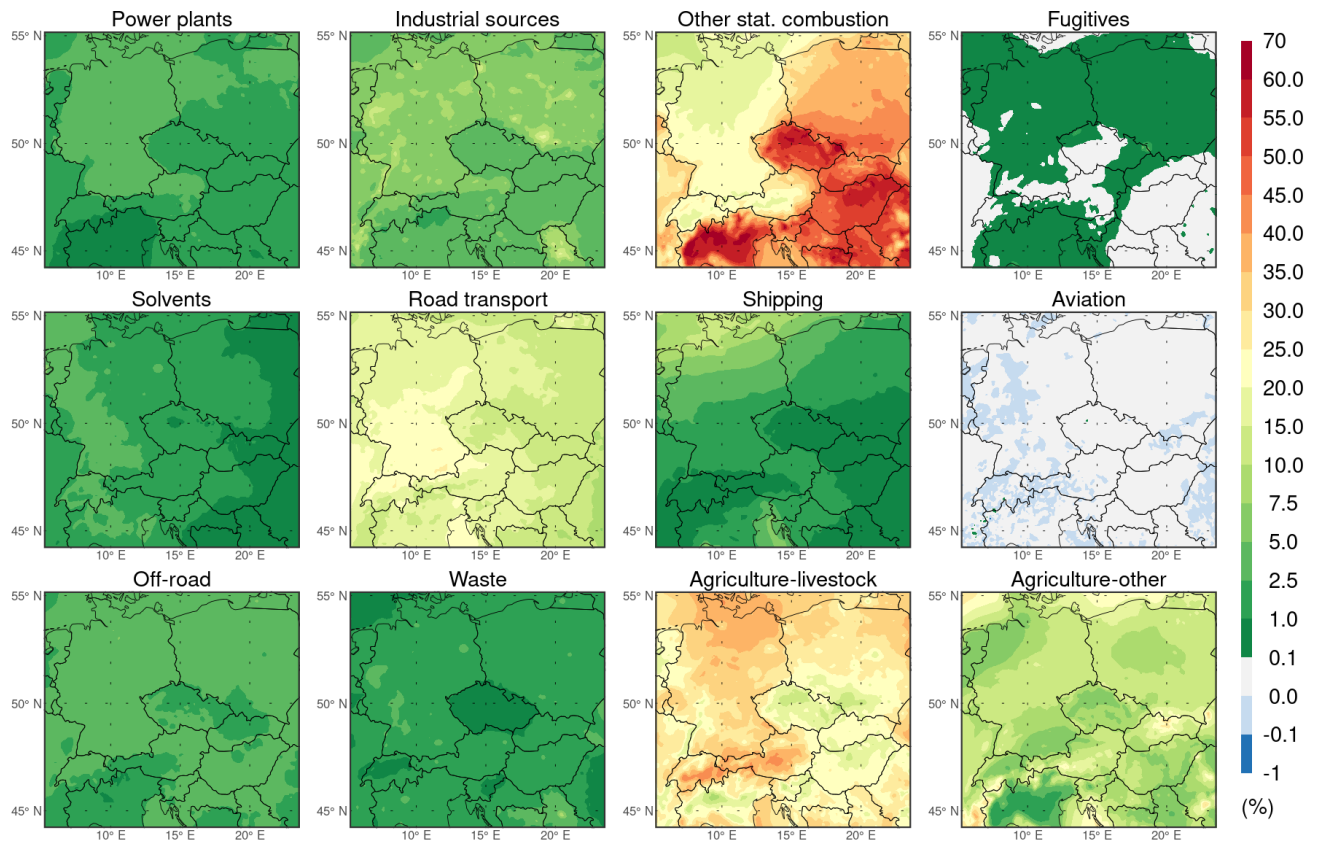
(b) JJA 2018-2019



**Figure S4.** Spatial distributions of the average seasonal absolute impact of emissions from individual GNFR sectors A–L (indicated by the sector names in the titles of the subpanels) on PM<sub>2.5</sub> concentration (in  $\mu\text{g m}^{-3}$ ) during the winter (a) and summer (b) seasons of 2018–2019 in the VBS experiment.

Average seasonal relative impact on PM<sub>2.5</sub> concentration in the VBS experiment

(a) DJF 2018-2019



(b) JJA 2018-2019

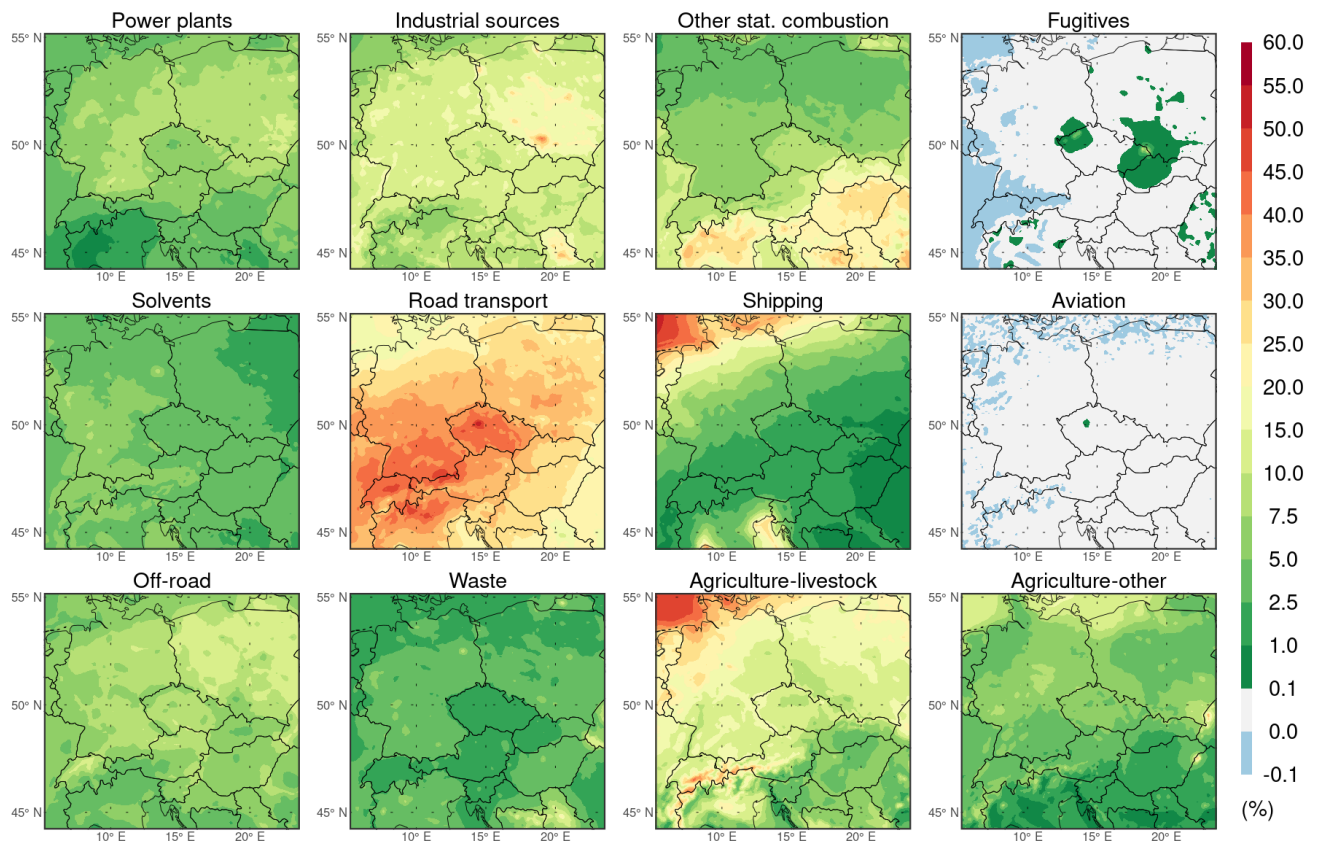
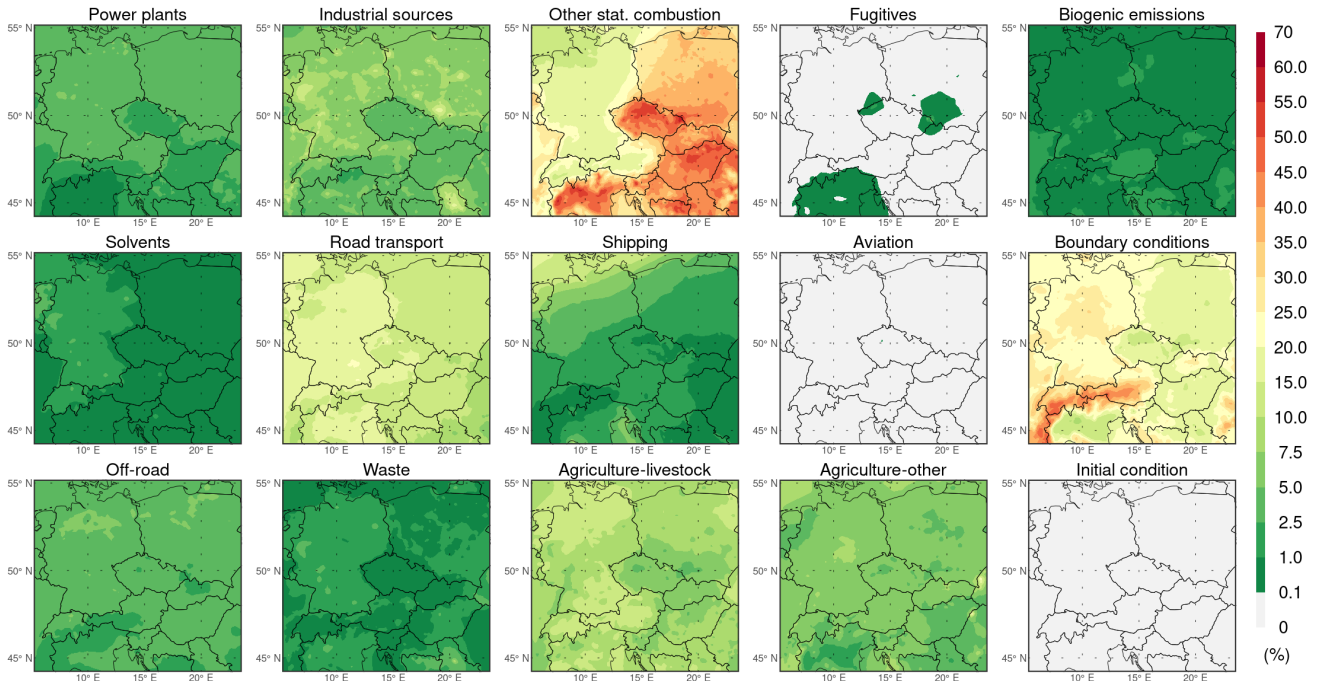


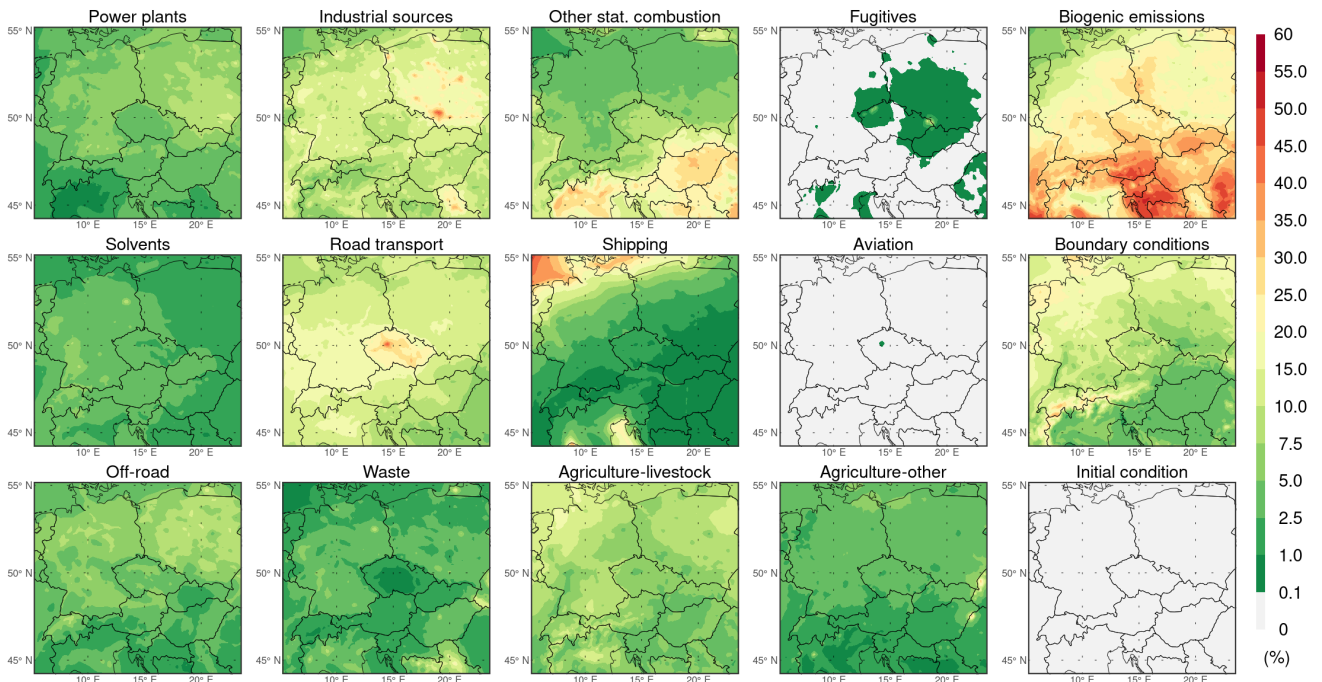
Figure S5. Same as Fig. S3 but for the VBS experiment.

Average seasonal relative contribution to PM<sub>2.5</sub> concentration in the PSAT experiment

(a) DJF 2018-2019



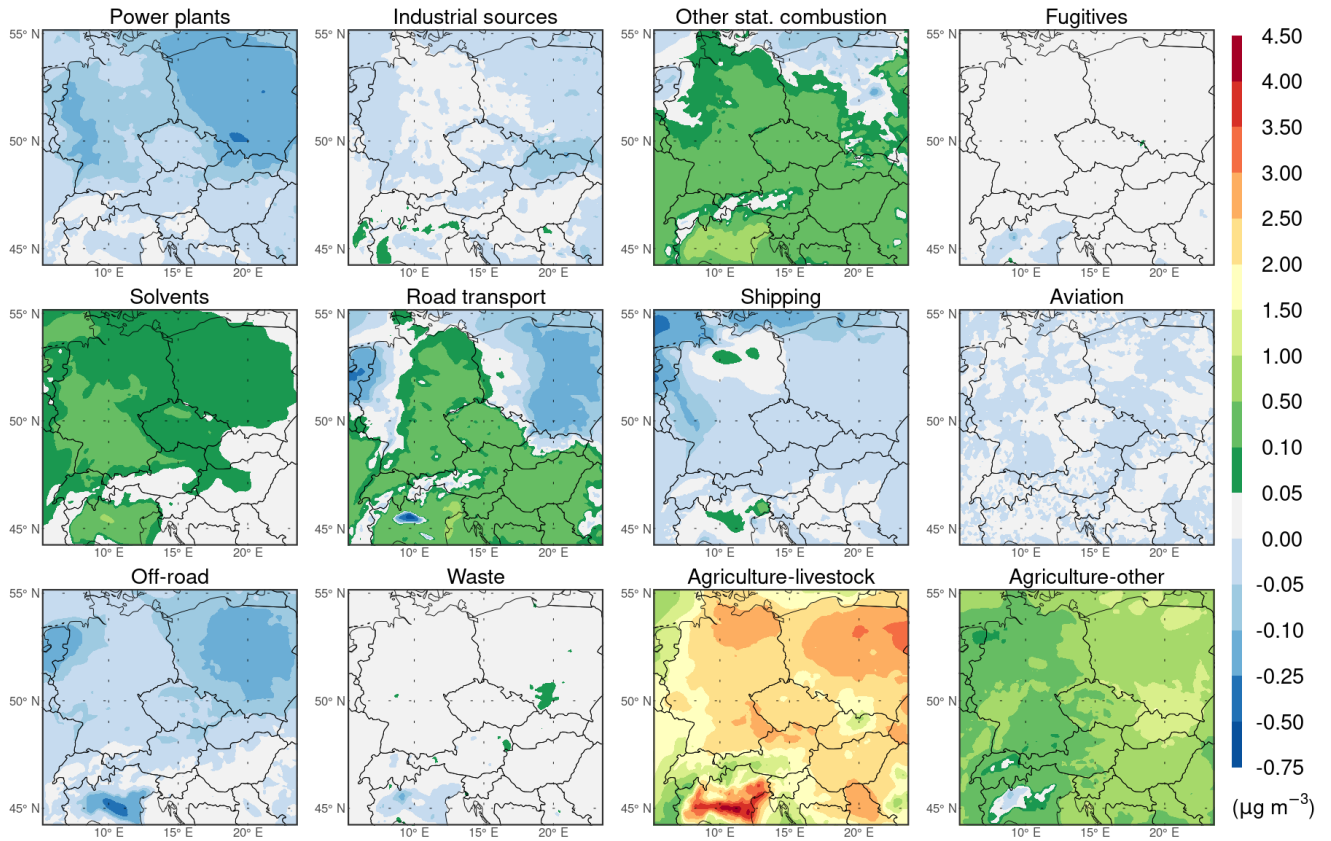
(b) JJA 2018-2019



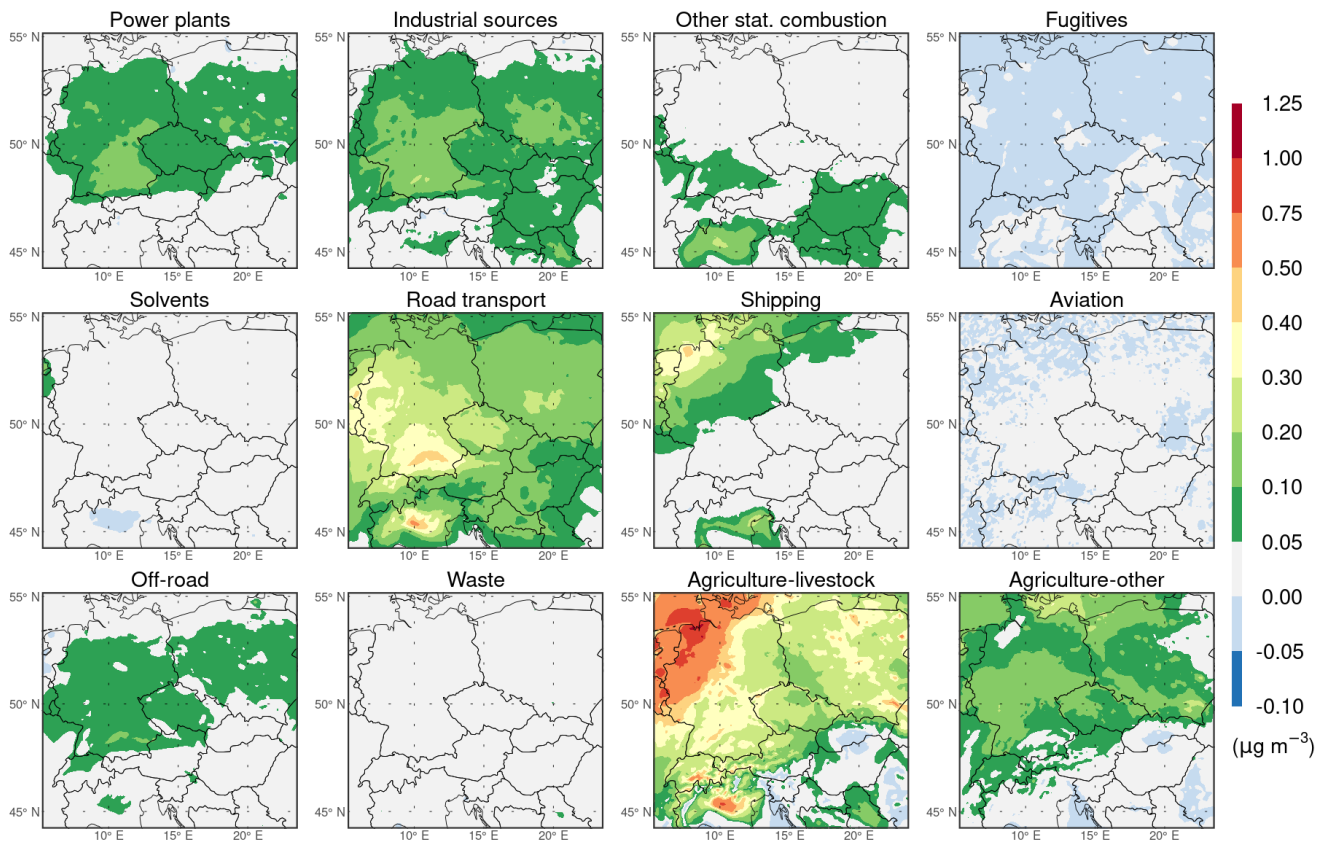
**Figure S6.** Spatial distributions of the average seasonal relative contribution of emissions from individual categories (indicated in the titles of the subpanels) to PM<sub>2.5</sub> concentration (in %) during the winter (a) and summer (b) seasons of 2018–2019 in the PSAT experiment. Categories used: GNFR sectors A–L (labeled by the sector names), biogenic emissions, boundary conditions, and initial condition.

Difference between the average seasonal absolute impact on  $PM_{2.5}$  concentration in the SOAP experiment and the average seasonal absolute contribution to  $PM_{2.5}$  concentration in the PSAT experiment

(a) DJF 2018-2019



(b) JJA 2018-2019

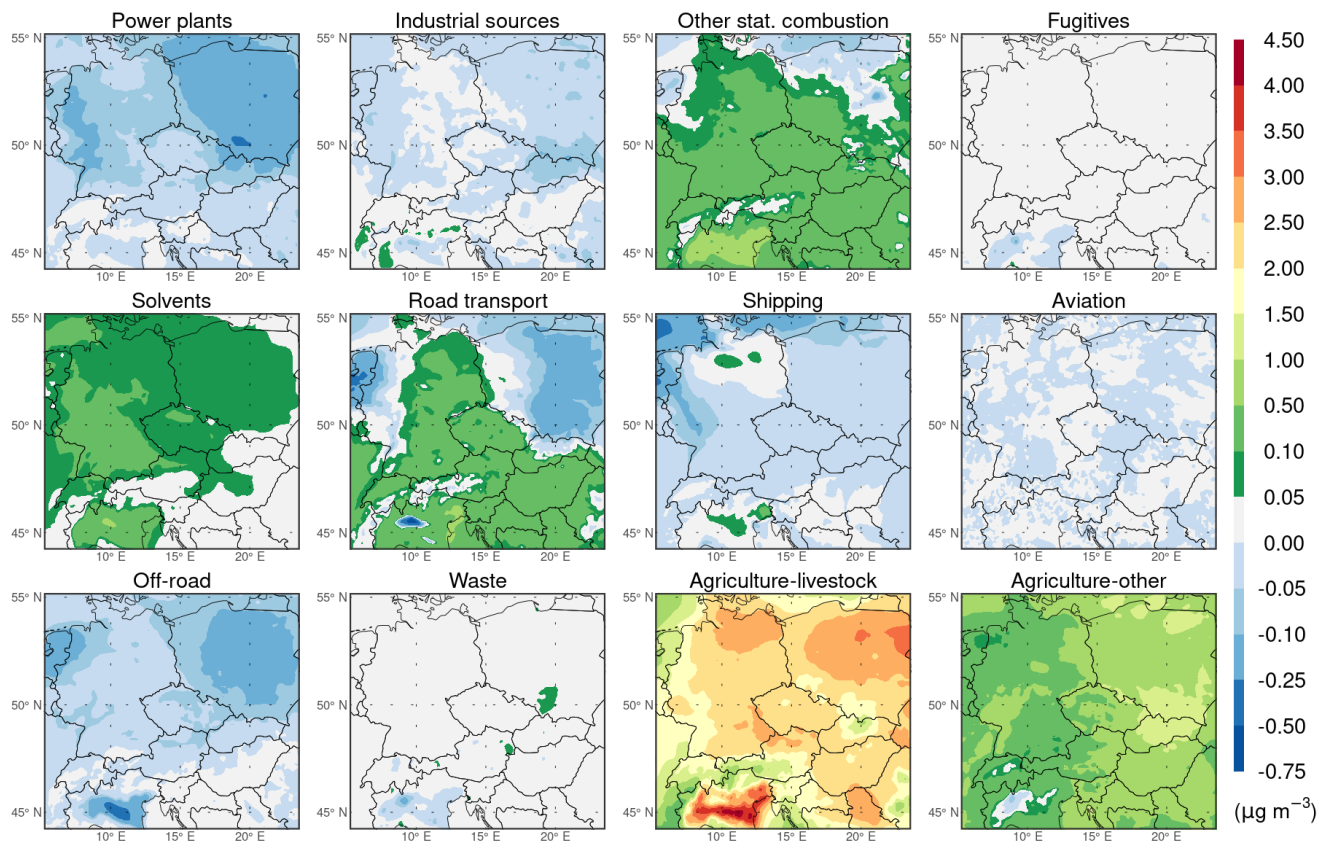


**Figure S7.** Spatial distributions of the difference between the average seasonal absolute impacts of emissions from individual GNFR sectors A-L (indicated by the sector names in the titles of the subpanels) on  $PM_{2.5}$  concentration in the SOAP experiment and their corresponding average seasonal absolute contributions to  $PM_{2.5}$  concentration in the PSAT experiment (in  $\mu g m^{-3}$ ) during the winter (a) and summer (b) seasons of 2018–2019.

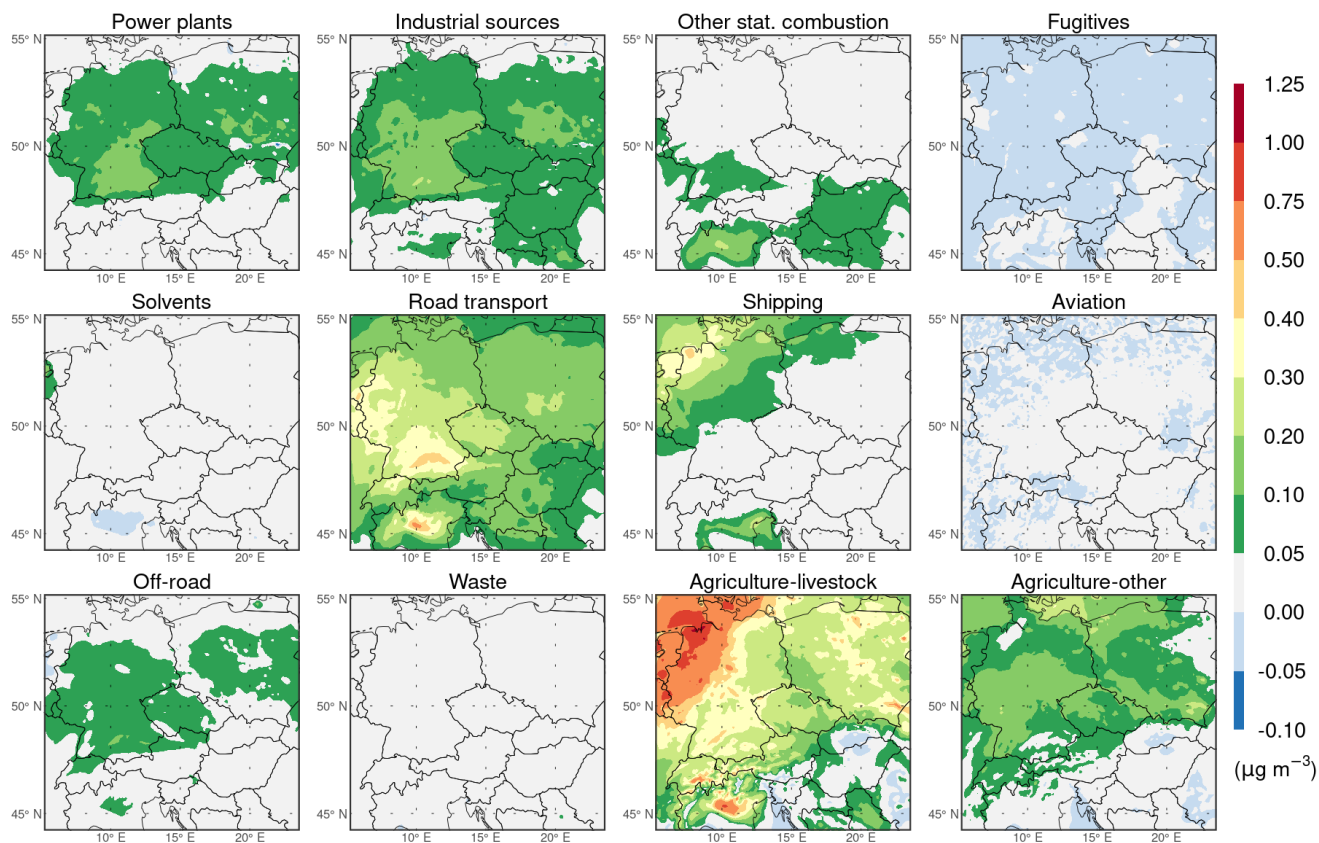


Difference between the average seasonal absolute impact on SA concentration in the SOAP experiment and the average seasonal absolute contribution to SA concentration in the PSAT experiment

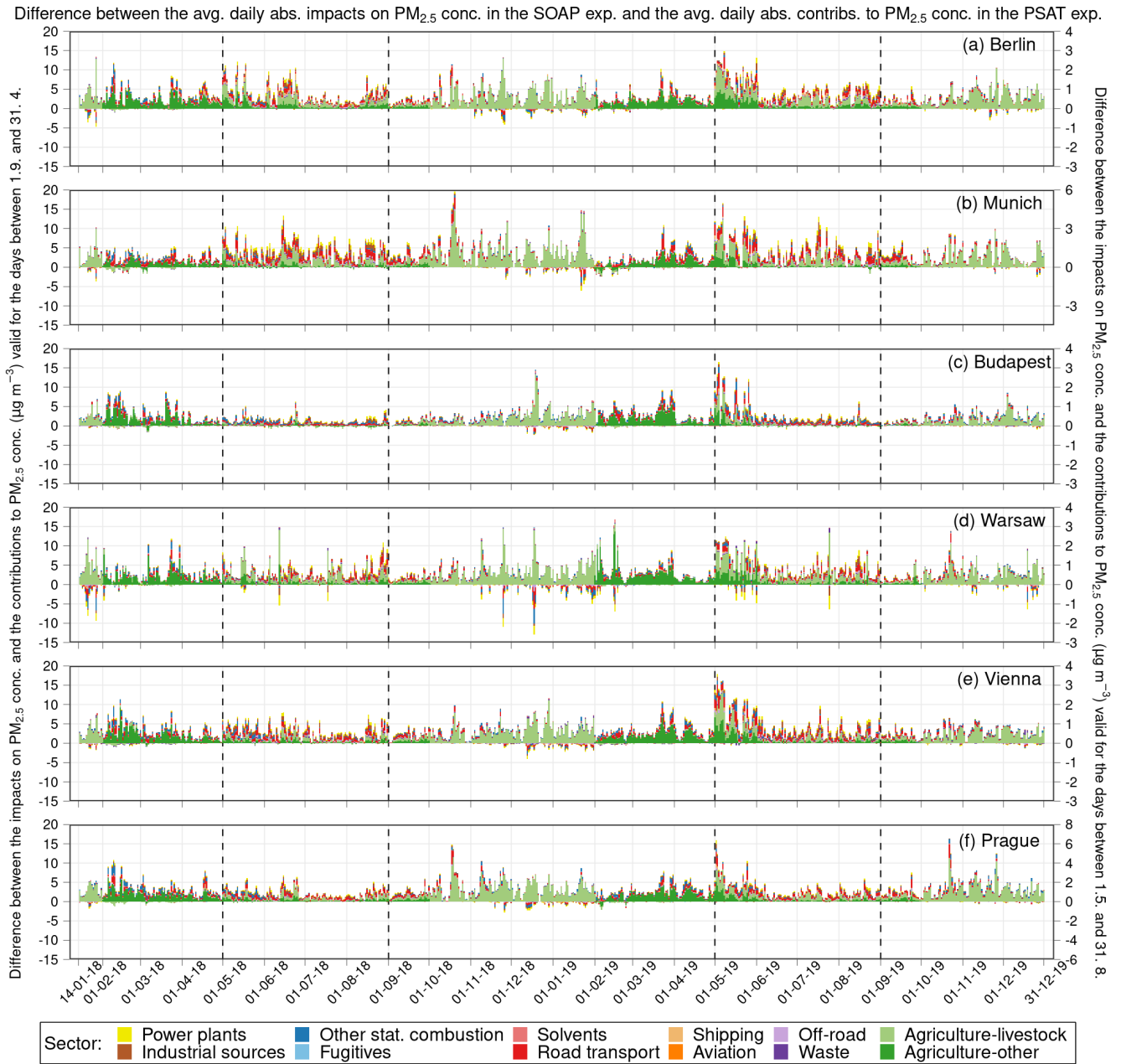
(a) DJF 2018-2019



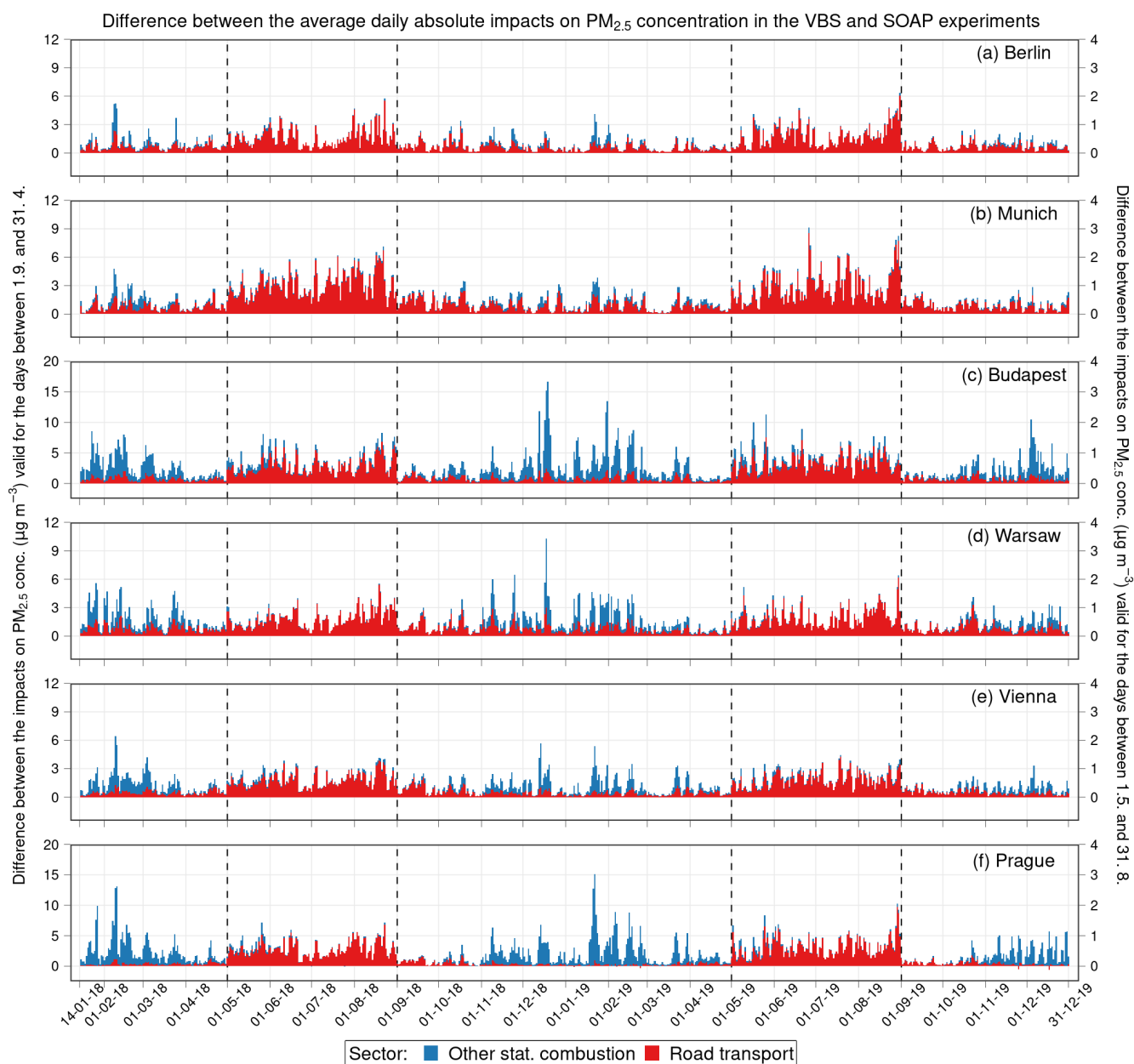
(b) JJA 2018-2019



**Figure S8.** Spatial distributions of the difference between the average seasonal absolute impacts of emissions from individual GNFR sectors A-L (indicated by the sector names in the titles of the subpanels) on the concentration of secondary aerosol (SA) in the SOAP experiment and their corresponding average seasonal absolute contributions to SA concentration in the PSAT experiment (in  $\mu\text{g m}^{-3}$ ) during the winter (a) and summer (b) seasons of 2018–2019. SA is represented here by the sum of  $\text{PNH}_4$ ,  $\text{PNO}_3$ ,  $\text{PSO}_4$ , and  $\text{SOA}$ .

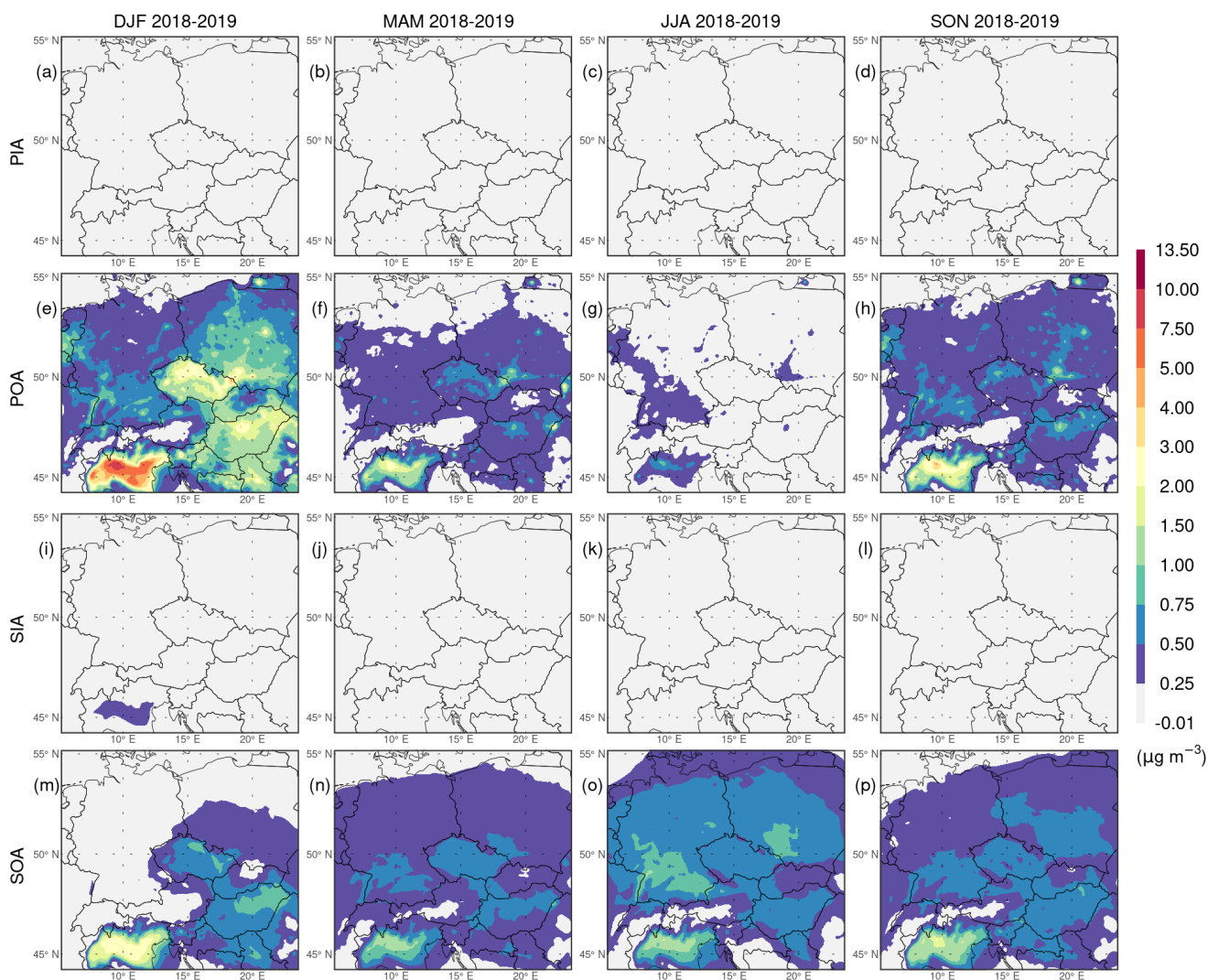


**Figure S9.** Temporal evolution of the differences between the average daily absolute impacts of emissions from individual GNFR sectors A–L (indicated by the sector names in the legend) on  $PM_{2.5}$  concentration in the SOAP experiment and their corresponding average daily absolute contributions to  $PM_{2.5}$  concentration in the PSAT experiment (in  $\mu g m^{-3}$ ) above Berlin (a), Munich (b), Budapest (c), Warsaw (d), Vienna (e), and Prague (f). The scale on the left (right) side is valid for the days between 1.9. and 31.4. (1.5. and 31.8.).



**Figure S10.** Temporal evolution of the differences between the average daily absolute impacts of emissions from other stationary combustion and road transport on PM<sub>2.5</sub> concentration (in  $\mu\text{g m}^{-3}$ ) above Berlin (a), Munich (b), Budapest (c), Warsaw (d), Vienna (e), and Prague (f) in the VBS and SOAP experiments. The scale on the left (right) side is valid for the days between 1.9. and 31.4. (1.5. and 31.8.).

Difference between the seasonal concentrations of individual aerosol aggregates in the VBS and SOAP experiments



**Figure S11.** Spatial distributions of the difference between the average seasonal concentrations of individual aerosol aggregates (in  $\mu\text{g m}^{-3}$ ) in the base simulations of the VBS and SOAP experiments during the winter (first column), spring (second column), summer (third column), and autumn (fourth column) seasons of 2018–2019. Aerosol aggregates used: PIA – primary inorganic aerosol (a–d), POA – primary organic aerosol (e–h), SIA – secondary inorganic aerosol (i–l), SOA – secondary organic aerosol (m–p).

**Table S1.** Rural, urban and suburban background stations used to validate the concentrations of PM<sub>2.5</sub>, NO<sub>2</sub>, and SO<sub>2</sub>.

Pollutant	Station area	European codes of stations <sup>1</sup>
PM <sub>2.5</sub>	Rural	AT30407, AT31902, AT0ENK1, AT0ILL1, CZ0ZTNV, CZ0PKUJ, CZ0UTUS, CZ0ULOM, CZ0TVER, CZ0JKOS, CZ0TSTD, CZ0BMIS, CZ0MBEL, DEBY004, DEBY049, DENW068, DEBY072, DEBB053, DEBB065, DEBY013, DEMV012, DEMV024, DESH056, DEBY109, DEMV004, DETH061, DENI060, DEHE066, DEHE046, DERP028, DERP017, DEST104, DEBY124, DEST098, DENI031, DEUB005, DESH008, HU0040A, PL0243A, PL0505A, PL0077A, PL0243A, PL0005R, SK0007R, SK0406A
	Urban and suburban	AT32701, AT4S156, AT4S404, AT10001, AT4S125, AT4S416, AT60197, AT9STAD, AT32301, AT4S407, AT4S409, AT60178, AT2KA71, AT60107, AT4S184, AT4S406, AT9LOB, CZ0LILL, CZ0TOVK, CZ0MPRR, CZ0BBDN, CZ0TFMI, CZ0ZVMZ, CZ0EMTP, CZ0THAR, CZ0TKAR, CZ0BBNI, CZ0TCTN, CZ0PPLV, CZ0SMBO, CZ0UDCM, CZ0ZJHJ, CZ0BBNY, CZ0EPAU, CZ0SKLM, CZ0TTRR, CZ0CCBD, CZ0TOZR, CZ0ZLLN, CZ0ALIB, CZ0UTPM, CZ0KSOM, CZ0UULK, CZ0UOMOM, CZ0ARIE, CZ0ASTO, CZ0MOLL, CZ0PPLL, CZ0TRYC, CZ0TRK, DEBY187, DEBY058, DEST002, DEBY067, DEBB083, DEBY002, DEHH059, DEBB089, DENW024, DEBY039, DEMV021, DEBY012, DEST044, DENW179, DESH023, DEBY075, DESL012, DENW030, DEBY077, DERP053, DEBB067, DEBB092, DEBY118, DEBY099, DERP019, DENI054, DEHB002, DEBY052, DEBY088, DESH058, DEHE018, DEBB048, DEBB075, DEHH033, DEHE135, DENI016, DETH093, DEBB063, DENW114, DEHE022, DEMV028, DEST050, DEBB086, DENW008, DESH015, DEBY005, DEBY007, DENI041, DEBY031, DENW010, DETH036, DERP022, DENW247, DEBB007, DEST077, DEBY009, DEBB021, DEHH008, DERP009, DENW002, DENI042, DENI049, DENI038, DEHB005, DETH020, DENW022, DENW021, DENI043, DEBB064, HU0057A, HU0039A, HU0056A, HU0023A, HU0022A, HU0026A, HU0029A, HU0034A, PL0148A, PL0565A, PL0594A, PL0218A, PL0538A, PL0052A, PL0115A, PL0138A, PL0213A, PL0096A, PL0129A, PL0143A, PL0071A, PL0194A, PL0501A, PL0141A, PL0585A, PL0507A, PL0144A, PL0136A, PL0008A, PL0134A, PL0248A, PL0175A, PL0539A, PL0543A, PL0673A, PL0677A, PL0678A, PL0308A, PL0079A, PL0085A, PL0248A, PL0502A, PL0492A, PL0071A, PL0549A, PL0550A, PL0295A, PL0517A, PL0498A, PL0494A, PL0198A, PL0535A, PL0238A, PL0091A, PL0091A, PL0008A, PL0496A, PL0495A, PL0143A, PL0276A, PL0413A, PL0503A, PL0534A, PL0501A, PL0096A, PL0100A, PL0552A, PL0499A, PL0491A, PL0527A, PL0175A, PL0523A, PL0566A, PL0500A, PL0490A, PL0497A, PL0398A, PL0151A, PL0192A, PL0493A, PL0213A, PL0141A, PL0624A, PL0591A, PL0518A, PL0542A, PL0530A, PL0171A, PL0509A, PL0653A, PL0682A, PL0684A, PL0690A, PL0245A, PL0704A, SK0008A, SK0263A, SK0050A, SK0020A, SK0264A, SK0031A, SK0030A, SK0268A, SK0037A, SK0027A, SK0025A, SK0134A, SK0013A, SK0262A, SK0022A, SK0001A, SK0004A, SK0048A
NO <sub>2</sub>	Rural	AT2WO35, AT72538, AT30302, AT30403, AT53055, AT10002, AT31904, AT30202, AT30502, AT32604, AT31701, AT31703, AT2SP10, AT31902, AT0ILL1, AT0PILL1, AT60151, AT31204, AT0ENK1, AT0KLLH, AT30407, CZ0JKOS, CZ0BMIS, CZ0MJES, CZ0TSTD, CZ0TVER, CZ0UTUS, CZ0TCER, CZ0ZTNV, CZ0UDOK, CZ0HPLO, CZ0PKUJ, CZ0USNZ, CZ0ULOM, DENI031, DEHE046, DEBB053, DEHE039, DEUB028, DENI063, DEBY196, DENW064, DERP013, DEHE024, DEHE050, DEBE032, DERP014, DEBE051, DEBE056, DEST089, DESN093, DESN051, DESN074, DESN076, DESH008, DEMV004, DEHE060, DEHE026, DEHE043, DEHE028, DEMV026, DEMV012, DERP028, DEBY013, DEBY049, DEBY004, DEUB005, DEUB030, DEMV017, DETH061, DENW081, DETH042, DENW068, DESL019, DEBY109, DESN079, DERP016, DENI077, DEBB066, DETH026, DEMV024, DENW065, DEBE062, DENW066, DEBB065, DEUB001, DEBE027, DEHE042, DERP017, DENI059, DENI060, DEBY124, DEBW087, DEST098, DEBY072, DEST104, DERP015, DEBW004, HU0040A, HU0040A, PL0128A, PL0182A, PL0094A, PL0243A, PL0068A, PL0121A, PL0247A, PL0105A, PL0014A, PL0150A, PL0077A, PL0505A, PL0622A, PL0211A, PL0005R, PL0691A, SK0007R, SK0006R, SK0041A
	Urban and suburban	AT10003, AT32301, AT32501, AT30601, AT60170, AT80807, AT30401, AT900ZA, AT30201, AT30301, AT32701, AT4S125, AT60177, AT56072, AT60178, AT4S406, AT4S409, AT9STEF, AT4S416, AT30065, AT30101, AT60172, AT60179, AT72113, AT31901, AT9SCHA, AT4S184, AT9STAD, AT2SP18, AT60119, AT4S407, AT9LOB, AT60145, AT31401, AT60118, AT51200, AT60138, AT60139, AT60141, AT60106, AT60107, AT9JAE, AT60114, AT60180, AT60198, AT60197, AT60194, AT60195, AT4S156, AT10001, AT2KA71, AT4S404, AT32401, AT72912, CZ0CPRA, CZ0TOVK, CZ0PPLV, CZ0CCBD, CZ0TKAR, CZ0TFMI, CZ0TCTN, CZ0TOFF, CZ0ZLLN, CZ0AKOB, CZ0ALIB, CZ0ARIE, CZ0KSOM, CZ0UDCM, CZ0UULK, CZ0UOMOM, CZ0MOLL, CZ0ZLLN, CZ0LILL, CZ0TOPO, CZ0EMTP, CZ0ABRE, CZ0BBDN, CZ0TRK, CZ0BBNY, CZ0UULM, CZ0SKLS, CZ0SMBO, CZ0EPAO, CZ0PPLV, CZ0TRYC, CZ0ARIE, CZ0SPBR, DENW247, DEBW023, DESL013, DEBW033, DEBY052, DEBB021, DEHB001, DERP021, DENI054, DEHE045, DEBB092, DESH023, DEBW039, DENI038, DENW010, DEBB067, DEBB063, DENW114, DEHH047, DEHH050, DEBE018, DEHH079, DEHH081, DERP009, DENW022, DEBY032, DEBW019, DEHE001, DEBW076, DENI020, DEST011, DENI042, DEBY058, DEBY089, DESN092, DEBW029, DEBY113, DEMV021, DENW095, DESN004, DENW030, DENW029, DENW038, DEBW098, DENW009, DEBW010, DENW006, DEBY068, DENW067, DEBW073, DESH035, DEBE034, DETH020, DEHE134, DEHE005, DESN104, DETH117, DEBW052, DEBB064, DESL010, DEMV007, DEBY088, DEBY039, DEBE066, DESL011, DEHE020, DEBW107, DESH057, DETH041, DENI028, DEHE028, DETH095, DENW381, DERP025, DEBW059, DETH013, DEBY075, DENI029, DENW382, DENW002, DEHE044, DESH058, DENW079, DENW080, DEBB048, DEMV019, DENW096, DEBY030, DEHH008, DEHE135, DEHB002, DEBW013, DEBY189, DEHE018, DEHE013, DEBB007, DENI016, DEBY007, DENI041, DEST002, DENW094, DERP053, DENI062, DEST105, DEBB075, DEBY005, DEBE010, DENW024, DEBW024, DEBB055, DEHE030, DEBE051, DEST029, DENW062, DEBW046, DENW011, DEST066, DEBY012, DESN001, DESL012, DENW078, DEHH059, DESN059, DENW179, DENW071, DEHE032, DEST044, DESL017, DEBW042, DEHE022, DEBY099, DEBW027, DEHB005, DEBW015, DESN019, DERP001, DETH009, DEBY079, DEBW112, DEBW081, DEBY009, DETH018, DERP007, DEST077, DERP022, DENW059, DEHH033, DEBW038, DENI011, DETH036, DEBY020, DENI024, DENI052, DEBW084, DETH005, DEST050, DENW008, DERP060, DEBE068, DESN045, DENI043, DEBY031, DEHB004, DEBY118, DEHE011, DEBB086, DERP019, DEBY187, DEHB012, DETH093, DEBB083, DENW053, DEBY067, DETH011, DEBY188, HU0037A, HU0029A, HU0032A, HU0035A, HU0025A, HU0036A, HU0042A, HU0039A, HU0026A, HU0022A, HU0057A, HU0034A, HU0038A, HU0023A, PL0209A, PL0552A, PL0568A, PL0190A, PL0594A, PL0520A, PL0468A, PL0520A, PL0187A, PL0171A, PL0213A, PL0518A, PL0317A, PL0138A, PL0129A, PL0031A, PL0504A, PL0273A, PL0509A, PL0096A, PL0502A, PL0558A, PL0237A, PL0050A, PL0049A, PL0239A, PL0240A, PL0573A, PL0507A, PL0244A, PL0245A, PL0238A, PL0398A, PL0241A, PL0148A, PL0295A, PL0321A, PL0052A, PL0529A, PL0543A, PL0066A, PL0143A, PL0312A, PL0134A, PL0136A, PL0582A, PL0503A, PL0194A, PL0141A, PL0048A, PL0008A, PL0550A, PL0591A, PL0184A, PL0501A, PL0091A, PL0495A, PL0115A, PL0559A, PL0560A, PL0192A, PL0581A, PL0047A, PL0175A, PL0045A, PL0046A, PL0236A, PL0242A, PL0151A, PL0222A, PL0618A, PL0212A, PL0198A, PL0544A, PL0193A, PL0585A, PL0575A, PL0294A, PL0276A, PL0248A, PL0218A, PL0563A, PL0079A, PL0494A, PL0539A, PL0640A, PL0657A, PL0673A, PL0675A, PL0677A, PL0681A, PL0682A, PL0310A, PL0698A, PL0700A, SK0263A, SK0048A, SK0134A, SK0001A, SK0020A, SK0008A, SK0025A, SK0037A, SK0050A
SO <sub>2</sub>	Rural	AT30801, AT2WO35, AT30302, AT30103, AT30202, AT60190, AT0PILL1, AT60185, AT60151, AT0ENK1, AT0ILL1, AT30407, AT31701, AT31902, AT31904, AT31703, AT30502, CZ0PKUJ, CZ0ZTNV, CZ0LFRF, CZ0USNZ, CZ0ULOM, CZ0JKOS, CZ0BMIS, CZ0MJES, CZ0TSTD, CZ0TVER, CZ0UKRU, CZ0UTUS, CZ0UDOK, DEST089, DETH042, DERP015, DERP016, DESL001, DEMV026, DEHE060, DEBB066, DESN074, DEMV012, DEMV004, DEUB030, DEUB028, DENI058, DETH061, DERP013, DEUB005, DEBW004, DEUB001, DERP014, DEST098, DESL019, DERP017, DEHE042, HU0040A, PL0077A, PL0211A, PL0505A, PL0247A, PL0014A, PL0121A, PL0182A, PL0443A, PL0128A, PL0068A, PL0094A, PL0243A, PL0105A, PL0150A, PL0622A, PL0005R, PL0649A, PL0691A, SK0007R
	Urban and suburban	AT32301, AT32501, AT30601, AT60170, AT900ZA, AT30301, AT30201, AT60177, AT4S406, AT4S409, AT4S416, AT30401, AT31401, AT2KA71, AT60179, AT31901, AT9SCHA, AT9STAD, AT9STEF, AT60119, AT51200, AT31301, AT60138, AT60106, AT60180, AT32401, AT4S156, AT10001, AT10003, CZ0LILL, CZ0ULTT, CZ0TOPO, CZ0CCBD, CZ0UULM, CZ0ZJHJ, CZ0EPAU, CZ0SKLS, CZ0EPAO, CZ0PPLV, CZ0BBNY, CZ0PPLV, CZ0MPRR, CZ0TKAR, CZ0TCTN, CZ0TOFF, CZ0ZLLN, CZ0ALIB, CZ0ARIE, CZ0UTPM, CZ0KSOM, CZ0UULK, CZ0TRYC, DEBW029, DESL017, DERP025, DENW002, DERP022, DENI020, DEHH081, DESN092, DEHB004, DEMV007, DEHB012, DENW040, DEHB002, DESN045, DESH035, DERP009, DENW024, DEHH079, DEBE066, DEHE005, DESL002, DERP021, DERP019, DEST028, DEST077, DETH009, DEHE020, DENI043, DENI042, DEHE135, DEHB001, DEHE011, DEHE013, DEMV019, DERP007, DEHH008, DEST011, DEMV021, DEHE018, DENI038, DESL012, DERP001, DEHE022, DESN001, DEHE001, DEHH059, DETH020, DESN024, DEHB005, DEBB064, DEBB021, DESL006, HU0023A, HU0057A, HU0026A, HU0038A, HU0029A, HU0036A, HU0025A, HU0042A, HU0037A, HU0022A, HU0039A, HU0035A, HU0034A, HU0032A, PL0468A, PL0143A, PL0236A, PL0503A, PL0242A, PL0031A, PL0049A, PL0050A, PL0048A, PL0398A, PL0245A, PL0582A, PL0273A, PL0504A, PL0321A, PL0218A, PL0520A, PL0194A, PL0495A, PL0008A, PL0507A, PL0136A, PL0501A, PL0552A, PL0509A, PL0565A, PL0312A, PL0591A, PL0568A, PL0237A, PL0581A, PL0317A, PL0045A, PL0129A, PL0563A, PL0594A, PL0184A, PL0550A, PL0192A, PL0295A, PL0518A, PL0190A, PL0115A, PL0138A, PL0175A, PL0096A, PL0091A, PL0238A, PL0209A, PL0047A, PL0573A, PL0276A, PL0241A, PL0234A, PL0529A, PL0151A, PL0046A, PL0558A, PL0187A, PL0502A, PL0171A, PL0244A, PL0212A, PL0543A, PL0239A, PL0240A, PL0052A, PL0213A, PL0079A, PL0585A, PL0198A, PL0148A, PL0222A, PL0544A, PL0294A, PL0494A, PL0539A, PL0671A, PL0673A, PL0675A, PL0677A, PL0681A, PL0682A, PL0684A, PL0698A, PL0700A, SK0013A, SK0030A, SK0013A, SK0008A, SK0001A, SK0050A, SK0027A

<sup>1</sup> Detailed information about individual stations can be found in the AirBase database based on these codes.

**Table S2.** Rural background stations used to validate the concentrations of individual PM<sub>2.5</sub> components. Symbols ✓ indicate which components were measured at the individual stations.

Database	Station code	EMEP's member	Station name	Country	Longitude	Latitude	PNH <sub>4</sub>	PNO <sub>3</sub>	PSO <sub>4</sub>	EC	OC
AirBase	AT0002R	Yes	Illmitz	Austria	47.77	16.7664	✓	✓	✓		
EBAS	CZ0003R	Yes	Košetice	Czechia	49.5734	15.0803	✓	✓	✓	✓	✓
EBAS	DE0004R	Yes	Melpitz	Germany	51.5255	12.9277	✓	✓	✓	✓	✓
EBAS	HU0002R	Yes	K-puszt	Hungary	46.9667	19.5833	✓	✓	✓		
EBAS	PL0002R	Yes	Jarczew	Poland	51.8144	21.9724	✓	✓	✓		
EBAS	PL0004R	Yes	Leba	Poland	54.7539	17.5343	✓	✓	✓		
EBAS	PL0005R	Yes	Diabla Gora	Poland	54.15	22.0667	✓	✓	✓	✓	✓
EBAS	PL0009R	Yes	Zielonka	Poland	53.6621	17.934	✓	✓	✓	✓	✓
AirBase	PL0505A	No	Osiecznica	Poland	51.3176	15.4317	✓	✓	✓	✓	✓
EBAS	SK0006R	Yes	Starina	Slovakia	49.05	22.2667	✓	✓	✓		

**Table S3.** Urban and suburban background stations used to validate the concentrations of PM<sub>2.5</sub>, NO<sub>2</sub>, and SO<sub>2</sub> in individual cities.

Pollutant	City	European codes of stations <sup>1</sup>
PM <sub>2.5</sub>	Berlin	DEBE010, DEBE034, DEBE068
	Munich	DEBY039, DEBY089
	Vienna	AT9STAD, AT90LOB
	Budapest	HU0022A
	Warsaw	PL0143A, PL0141A
	Prague	CZ0ALIB, CZ0ARIE, CZ0ASTO
NO <sub>2</sub>	Berlin	DEBE018, DEBE034, DEBE066, DEBE010, DEBE051, DEBE068
	Munich	DEBY089, DEBY039, DEBY189
	Vienna	AT900ZA, AT9STEF, AT9SCHA, AT9STAD, AT90LOB, AT9JAEG
	Budapest	HU0036A, HU0042A, HU0022A
	Warsaw	PL0143A, PL0141A, PL0673A
	Prague	CZ0AKOB, CZ0ALIB, CZ0ARIE, CZ0ABRE, CZ0ACHO
SO <sub>2</sub>	Vienna	AT900ZA, AT9SCHA, AT9STAD, AT9STEF
	Budapest	HU0036A, HU0042A, HU0022A
	Warsaw	PL0673A

<sup>1</sup> Detailed information about the individual stations can be found in the AirBase database based on these codes.

**Table S4.** Prague synoptic stations used to validate temperature and wind speed.

Station name	Longitude	Latitude
Praha–Karlovy	14.4276	50.0691
Praha–Kbely	14.538	50.1232
Praha–Libuš	14.4467	50.0077
Praha–Ruzyně	14.2555	50.1003

**Table S5.** Comparison of the seasonal averages of the average daily absolute (relative) impacts/contributions<sup>1</sup> of individual categories<sup>2</sup> on/to PM<sub>2.5</sub> concentration in  $\mu\text{g m}^{-3}$  (in %) calculated from the SOAP and VBS/PSAT experiments for Berlin. While the highest averages within each season are shown in red for each experiment, the second and third highest averages are shown in blue. The seasonal relative averages greater than or equal to 5 % are shown in bold. The last row shows the sum of the seasonal averages.

Berlin Category	Seasonal avrg. of the avrg. daily abs. imp./contrib. <sup>1</sup> of the given cat. <sup>2</sup> on/to PM <sub>2.5</sub> ( $\mu\text{g m}^{-3}$ )						Seasonal avrg. of the avrg. daily relat. imp./contrib. <sup>1</sup> of the given cat. <sup>2</sup> on/to PM <sub>2.5</sub> (%)					
	Winter (DJF)			Summer (JJA)			Winter (DJF)			Summer (JJA)		
	SOAP	VBS	PSAT	SOAP	VBS	PSAT	SOAP	VBS	PSAT	SOAP	VBS	PSAT
GNFR A	0.44	0.43	0.52	0.21	0.26	0.16	3.7	3.3	4.3	<b>7.1</b>	<b>6.5</b>	<b>5.3</b>
GNFR B	1.04	1.05	1.03	<b>0.55</b>	<b>0.59</b>	<b>0.47</b>	<b>10.3</b>	<b>9.6</b>	<b>9.8</b>	<b>19.9</b>	<b>16.0</b>	<b>17.1</b>
GNFR C	<b>2.06</b>	<b>2.38</b>	<b>1.96</b>	0.14	0.16	0.12	<b>17.0</b>	<b>17.7</b>	<b>16.1</b>	4.9	4.2	4.1
GNFR D	0.01	0.02	0.01	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1
GNFR E	0.36	0.37	0.27	0.21	0.25	0.20	3.6	3.4	2.9	<b>7.7</b>	<b>6.8</b>	<b>7.2</b>
GNFR F	<b>1.81</b>	<b>2.39</b>	<b>1.71</b>	<b>0.44</b>	<b>1.06</b>	<b>0.32</b>	<b>15.3</b>	<b>19.4</b>	<b>14.3</b>	<b>15.7</b>	<b>28.1</b>	<b>11.4</b>
GNFR G	0.41	0.41	0.4	0.13	0.17	0.08	4.1	3.9	4.0	<b>5.0</b>	<b>5.5</b>	3.0
GNFR H	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR I	0.46	0.47	0.49	0.20	0.28	0.16	4.1	3.9	4.4	<b>7.6</b>	<b>7.7</b>	<b>6.2</b>
GNFR J	0.35	0.39	0.32	0.21	0.23	0.19	4.0	4.0	3.5	<b>8.1</b>	<b>6.5</b>	<b>7.3</b>
GNFR K	<b>3.05</b>	<b>3.06</b>	0.84	<b>0.36</b>	<b>0.37</b>	0.14	<b>34.1</b>	<b>31.8</b>	<b>8.7</b>	<b>13.9</b>	<b>11.3</b>	<b>5.2</b>
GNFR L	1.33	1.34	0.66	0.17	0.18	0.07	<b>10.3</b>	<b>9.7</b>	4.7	<b>6.4</b>	<b>5.0</b>	2.5
BIO	-	-	0.09	-	-	<b>0.56</b>	-	-	0.9	-	-	<b>20.3</b>
IC	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
BC	-	-	<b>2.35</b>	-	-	0.24	-	-	<b>26.2</b>	-	-	<b>10.1</b>
$\Sigma$	11.32	12.31	10.65	2.62	3.55	2.71	106.6	106.8	99.9	96.4	97.7	99.8

<sup>1</sup> While the impacts (imp.) are connected with the SOAP and VBS experiments, the contributions (contrib.) are connected with the PSAT experiment.

<sup>2</sup> The categories (cat.) considered in the SOAP and VBS experiments are GNFR sectors A–L; the categories considered in the PSAT experiment are GNFR sectors A–L, BIO – biogenic emissions, IC – initial condition, and BC – boundary conditions.

**Table S6.** Same as Table S5 but for Munich.

Munich Category	Seasonal avrg. of the avrg. daily abs. imp./contrib. <sup>1</sup> of the given cat. <sup>2</sup> on/to PM <sub>2.5</sub> (µg m <sup>-3</sup> )						Seasonal avrg. of the avrg. daily relat. imp./contrib. <sup>1</sup> of the given cat. <sup>2</sup> on/to PM <sub>2.5</sub> (%)					
	Winter (DJF)			Summer (JJA)			Winter (DJF)			Summer (JJA)		
	SOAP	VBS	PSAT	SOAP	VBS	PSAT	SOAP	VBS	PSAT	SOAP	VBS	PSAT
	GNFR A	0.45	0.44	0.52	0.44	0.48	0.31	3.2	2.8	3.7	<b>8.6</b>	<b>7.7</b>
GNFR B	0.98	0.98	1.00	<b>0.87</b>	<b>0.92</b>	<b>0.70</b>	<b>8.8</b>	<b>8.0</b>	<b>8.8</b>	<b>18.8</b>	<b>15.7</b>	<b>15.4</b>
GNFR C	<b>2.13</b>	<b>2.55</b>	<b>2.02</b>	0.26	0.31	0.21	<b>18.7</b>	<b>19.6</b>	<b>17.5</b>	<b>6.2</b>	<b>5.7</b>	<b>5.1</b>
GNFR D	0.01	0.01	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.0	0.1
GNFR E	0.45	0.47	0.31	0.30	0.38	0.28	4.1	3.8	3.1	<b>7.3</b>	<b>6.8</b>	<b>6.9</b>
GNFR F	<b>2.21</b>	<b>2.99</b>	<b>2.11</b>	<b>1.06</b>	<b>2.13</b>	<b>0.74</b>	<b>17.7</b>	<b>22.6</b>	<b>16.7</b>	<b>23.6</b>	<b>38.5</b>	<b>16.5</b>
GNFR G	0.13	0.13	0.14	0.05	0.06	0.03	1.1	1.0	1.2	1.0	1.1	0.6
GNFR H	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR I	0.43	0.46	0.45	0.32	0.41	0.25	3.7	3.5	3.9	<b>7.5</b>	<b>7.5</b>	<b>5.9</b>
GNFR J	0.34	0.40	0.32	0.29	0.31	0.26	3.7	3.8	3.4	<b>7.3</b>	<b>6.1</b>	<b>6.6</b>
GNFR K	<b>3.10</b>	<b>3.12</b>	1.00	<b>0.70</b>	<b>0.72</b>	0.34	<b>33.4</b>	<b>30.8</b>	<b>9.6</b>	<b>15.2</b>	<b>12.3</b>	<b>7.0</b>
GNFR L	0.87	0.87	0.68	0.17	0.18	0.11	<b>5.8</b>	<b>5.3</b>	4.3	3.9	3.1	2.2
BIO	-	-	0.09	-	-	<b>0.88</b>	-	-	1.1	-	-	<b>20.8</b>
IC	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
BC	-	-	<b>2.50</b>	-	-	0.28	-	-	<b>26.5</b>	-	-	<b>6.6</b>
∑	11.10	12.42	11.14	4.46	5.90	4.39	100.3	101.3	99.8	99.5	104.5	99.7

<sup>1</sup> While the impacts (imp.) are connected with the SOAP and VBS experiments, the contributions (contrib.) are connected with the PSAT experiment.

<sup>2</sup> The categories (cat.) considered in the SOAP and VBS experiments are GNFR sectors A–L; the categories considered in the PSAT experiment are GNFR sectors A–L, BIO – biogenic emissions, IC – initial condition, and BC – boundary conditions.

**Table S7.** Same as Table S5 but for Budapest.

Budapest Category	Seasonal avrg. of the avrg. daily abs. imp./contrib. <sup>1</sup> of the given cat. <sup>2</sup> on/to PM <sub>2.5</sub> (µg m <sup>-3</sup> )						Seasonal avrg. of the avrg. daily relat. imp./contrib. <sup>1</sup> of the given cat. <sup>2</sup> on/to PM <sub>2.5</sub> (%)					
	Winter (DJF)			Summer (JJA)			Winter (DJF)			Summer (JJA)		
	SOAP	VBS	PSAT	SOAP	VBS	PSAT	SOAP	VBS	PSAT	SOAP	VBS	PSAT
	GNFR A	0.28	0.27	0.31	0.12	0.14	0.09	1.4	1.2	1.7	4.2	3.6
GNFR B	0.91	0.92	0.91	<b>0.42</b>	<b>0.45</b>	<b>0.37</b>	<b>5.1</b>	4.4	<b>5.1</b>	<b>14.5</b>	<b>11.8</b>	<b>12.6</b>
GNFR C	<b>9.18</b>	<b>12.12</b>	<b>8.89</b>	<b>0.93</b>	<b>1.03</b>	<b>0.87</b>	<b>52.7</b>	<b>56.9</b>	<b>50.8</b>	<b>30.8</b>	<b>26.7</b>	<b>28.6</b>
GNFR D	0.01	0.01	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.1	0.1
GNFR E	0.19	0.25	0.13	0.10	0.15	0.10	1.1	1.1	0.7	3.5	3.7	3.3
GNFR F	<b>2.17</b>	<b>2.95</b>	<b>1.94</b>	<b>0.39</b>	<b>1.04</b>	0.31	<b>11.2</b>	<b>13.1</b>	<b>10.1</b>	<b>13.3</b>	<b>27.1</b>	<b>10.6</b>
GNFR G	0.15	0.15	0.17	0.03	0.04	0.03	0.9	0.8	1.0	1.0	1.2	0.9
GNFR H	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR I	0.47	0.48	0.47	0.09	0.18	0.07	2.4	2.0	2.4	3.0	4.7	2.4
GNFR J	0.39	0.51	0.38	0.20	0.22	0.19	2.4	2.5	2.3	<b>6.8</b>	<b>5.8</b>	<b>6.4</b>
GNFR K	<b>2.85</b>	<b>2.88</b>	0.92	0.10	0.11	0.10	<b>17.4</b>	<b>15.0</b>	<b>5.3</b>	3.3	2.7	3.2
GNFR L	1.38	1.39	0.62	0.04	0.05	0.04	<b>7.7</b>	<b>6.8</b>	3.2	1.4	1.2	1.3
BIO	-	-	0.10	-	-	<b>0.73</b>	-	-	0.6	-	-	<b>24.4</b>
IC	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
BC	-	-	<b>2.52</b>	-	-	0.08	-	-	<b>16.6</b>	-	-	2.9
∑	17.98	21.93	17.36	2.42	3.41	2.98	102.4	103.9	99.8	81.9	88.6	99.8

<sup>1</sup> While the impacts (imp.) are connected with the SOAP and VBS experiments, the contributions (contrib.) are connected with the PSAT experiment.

<sup>2</sup> The categories (cat.) considered in the SOAP and VBS experiments are GNFR sectors A–L; the categories considered in the PSAT experiment are GNFR sectors A–L, BIO – biogenic emissions, IC – initial condition, and BC – boundary conditions.

**Table S8.** Same as Table S5 but for Warsaw.

Warsaw Category	Seasonal avrg. of the avrg. daily abs. imp./contrib. <sup>1</sup> of the given cat. <sup>2</sup> on/to PM <sub>2.5</sub> (µg m <sup>-3</sup> )						Seasonal avrg. of the avrg. daily relat. imp./contrib. <sup>1</sup> of the given cat. <sup>2</sup> on/to PM <sub>2.5</sub> (%)					
	Winter (DJF)			Summer (JJA)			Winter (DJF)			Summer (JJA)		
	SOAP	VBS	PSAT	SOAP	VBS	PSAT	SOAP	VBS	PSAT	SOAP	VBS	PSAT
GNFR A	0.41	0.40	0.64	0.30	0.31	0.26	2.2	1.9	3.2	<b>8.1</b>	<b>6.8</b>	<b>6.9</b>
GNFR B	1.78	1.82	1.84	<b>1.08</b>	<b>1.09</b>	<b>1.00</b>	<b>10.7</b>	<b>9.9</b>	<b>10.7</b>	<b>32.4</b>	<b>26.0</b>	<b>29.7</b>
GNFR C	<b>6.62</b>	<b>7.83</b>	<b>6.74</b>	0.16	0.18	0.15	<b>39.1</b>	<b>41.2</b>	<b>39.0</b>	5.1	4.4	4.6
GNFR D	0.03	0.04	0.01	0.01	0.01	0.01	0.2	0.2	0.1	0.2	0.2	0.2
GNFR E	0.16	0.18	0.08	0.07	0.10	0.07	0.8	0.8	0.5	2.2	2.3	2.1
GNFR F	<b>1.83</b>	<b>2.58</b>	<b>2.00</b>	<b>0.55</b>	<b>1.21</b>	<b>0.43</b>	<b>10.5</b>	<b>13.6</b>	<b>11.0</b>	<b>16.0</b>	<b>28.1</b>	<b>12.4</b>
GNFR G	0.19	0.19	0.23	0.04	0.07	0.03	1.3	1.2	1.5	1.4	1.7	0.9
GNFR H	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR I	0.46	0.49	0.58	0.22	0.30	0.18	2.8	2.6	3.3	<b>6.8</b>	<b>7.2</b>	<b>5.5</b>
GNFR J	0.35	0.43	0.31	0.21	0.22	0.19	2.2	2.3	1.9	<b>6.6</b>	<b>5.5</b>	<b>6.0</b>
GNFR K	<b>3.53</b>	<b>3.55</b>	1.03	<b>0.48</b>	<b>0.49</b>	0.20	<b>23.1</b>	<b>21.1</b>	<b>6.5</b>	<b>13.7</b>	<b>11.3</b>	<b>5.7</b>
GNFR L	1.63	1.64	0.72	0.17	0.17	0.08	<b>7.9</b>	<b>7.3</b>	3.6	4.7	3.9	2.1
BIO	-	-	0.09	-	-	<b>0.52</b>	-	-	0.5	-	-	<b>15.9</b>
IC	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
BC	-	-	<b>2.45</b>	-	-	0.22	-	-	<b>18.1</b>	-	-	<b>7.5</b>
∑	16.99	19.15	16.72	3.29	4.15	3.34	100.8	102.1	99.9	97.2	97.4	99.5

<sup>1</sup> While the impacts (imp.) are connected with the SOAP and VBS experiments, the contributions (contrib.) are connected with the PSAT experiment.

<sup>2</sup> The categories (cat.) considered in the SOAP and VBS experiments are GNFR sectors A–L; the categories considered in the PSAT experiment are GNFR sectors A–L, BIO – biogenic emissions, IC – initial condition, and BC – boundary conditions.

**Table S9.** Same as Table S5 but for Vienna.

Vienna Category	Seasonal avrg. of the avrg. daily abs. imp./contrib. <sup>1</sup> of the given cat. <sup>2</sup> on/to PM <sub>2.5</sub> (µg m <sup>-3</sup> )						Seasonal avrg. of the avrg. daily relat. imp./contrib. <sup>1</sup> of the given cat. <sup>2</sup> on/to PM <sub>2.5</sub> (%)					
	Winter (DJF)			Summer (JJA)			Winter (DJF)			Summer (JJA)		
	SOAP	VBS	PSAT	SOAP	VBS	PSAT	SOAP	VBS	PSAT	SOAP	VBS	PSAT
GNFR A	0.48	0.48	0.54	0.26	0.29	0.20	3.7	3.4	4.2	<b>8.4</b>	<b>7.2</b>	<b>6.4</b>
GNFR B	0.97	0.97	1.00	<b>0.59</b>	<b>0.63</b>	<b>0.49</b>	<b>7.8</b>	<b>7.2</b>	<b>7.9</b>	<b>19.0</b>	<b>15.7</b>	<b>16.0</b>
GNFR C	<b>4.20</b>	<b>5.14</b>	<b>3.97</b>	<b>0.38</b>	<b>0.43</b>	0.34	<b>31.8</b>	<b>34.6</b>	<b>30.1</b>	<b>12.1</b>	<b>10.7</b>	<b>10.6</b>
GNFR D	0.01	0.02	0.01	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.1	0.1
GNFR E	0.22	0.26	0.14	0.14	0.21	0.13	1.8	1.8	1.2	4.8	<b>5.1</b>	4.3
GNFR F	<b>2.07</b>	<b>2.45</b>	<b>1.91</b>	<b>0.58</b>	<b>1.23</b>	<b>0.43</b>	<b>15.0</b>	<b>16.5</b>	<b>13.9</b>	<b>19.2</b>	<b>31.4</b>	<b>14.3</b>
GNFR G	0.15	0.15	0.17	0.05	0.07	0.04	1.2	1.2	1.5	1.7	1.8	1.2
GNFR H	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR I	0.47	0.49	0.52	0.21	0.31	0.16	3.4	3.2	3.8	<b>6.8</b>	<b>8.0</b>	<b>5.3</b>
GNFR J	0.32	0.35	0.28	0.12	0.14	0.10	2.8	2.9	2.4	3.8	3.5	3.3
GNFR K	<b>3.03</b>	<b>3.05</b>	0.84	0.21	0.23	0.11	<b>28.5</b>	<b>26.5</b>	<b>7.3</b>	<b>7.2</b>	<b>5.9</b>	3.6
GNFR L	1.51	1.51	0.78	0.13	0.14	0.07	<b>8.9</b>	<b>8.2</b>	4.5	4.1	3.4	2.0
BIO	-	-	0.10	-	-	<b>0.85</b>	-	-	0.9	-	-	<b>27.7</b>
IC	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
BC	-	-	<b>2.56</b>	-	-	0.14	-	-	<b>22.1</b>	-	-	<b>5.0</b>
∑	13.43	14.87	12.82	2.67	3.68	3.06	105	105.6	99.8	87.2	92.8	99.8

<sup>1</sup> While the impacts (imp.) are connected with the SOAP and VBS experiments, the contributions (contrib.) are connected with the PSAT experiment.

<sup>2</sup> The categories (cat.) considered in the SOAP and VBS experiments are GNFR sectors A–L; the categories considered in the PSAT experiment are GNFR sectors A–L, BIO – biogenic emissions, IC – initial condition, and BC – boundary conditions.



**Table S10.** Same as Table S5 but for Prague.

Prague Category	Seasonal avrg. of the avrg. daily abs. imp./contrib. <sup>1</sup> of the given cat. <sup>2</sup> on/to PM <sub>2.5</sub> (µg m <sup>-3</sup> )						Seasonal avrg. of the avrg. daily relat. imp./contrib. <sup>1</sup> of the given cat. <sup>2</sup> on/to PM <sub>2.5</sub> (%)					
	Winter (DJF)			Summer (JJA)			Winter (DJF)			Summer (JJA)		
	SOAP	VBS	PSAT	SOAP	VBS	PSAT	SOAP	VBS	PSAT	SOAP	VBS	PSAT
GNFR A	0.32	0.30	0.34	0.18	0.21	0.11	1.6	1.4	1.8	4.5	4.2	2.8
GNFR B	0.62	0.62	0.60	<b>0.41</b>	<b>0.44</b>	<b>0.32</b>	3.4	3.1	3.3	<b>10.5</b>	<b>9.2</b>	<b>8.3</b>
GNFR C	<b>9.73</b>	<b>12.39</b>	<b>9.45</b>	0.33	0.36	0.29	<b>49.6</b>	<b>54.1</b>	<b>48.2</b>	<b>8.5</b>	<b>7.5</b>	<b>7.4</b>
GNFR D	0.01	0.02	0.01	0.01	0.01	0.01	0.1	0.1	0.0	0.2	0.1	0.2
GNFR E	0.15	0.20	0.06	0.10	0.17	0.09	0.7	0.8	0.3	2.6	3.4	2.3
GNFR F	<b>3.66</b>	<b>3.88</b>	<b>3.55</b>	<b>1.81</b>	<b>2.42</b>	<b>1.58</b>	<b>18.5</b>	<b>17.6</b>	<b>18.0</b>	<b>46.8</b>	<b>51.5</b>	<b>40.7</b>
GNFR G	0.16	0.16	0.17	0.06	0.09	0.04	0.9	0.8	1.1	1.7	2.0	1.0
GNFR H	0.01	0.01	0.01	0.01	0.01	0.01	0.0	0.1	0.0	0.2	0.2	0.2
GNFR I	0.43	0.44	0.46	0.21	0.32	0.15	2.0	1.8	2.2	<b>5.4</b>	<b>6.7</b>	3.9
GNFR J	0.08	0.10	0.05	0.03	0.05	0.03	0.5	0.5	0.3	0.9	1.2	0.8
GNFR K	<b>2.83</b>	<b>2.85</b>	0.85	<b>0.39</b>	<b>0.41</b>	0.16	<b>18.7</b>	<b>17.0</b>	<b>5.0</b>	<b>10.3</b>	<b>9.0</b>	4.1
GNFR L	1.35	1.33	0.81	0.20	0.22	0.09	<b>5.9</b>	<b>5.2</b>	3.3	<b>5.1</b>	4.6	2.2
BIO	-	-	0.11	-	-	<b>0.74</b>	-	-	0.6	-	-	<b>19.1</b>
IC	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
BC	-	-	<b>2.56</b>	-	-	0.25	-	-	<b>15.6</b>	-	-	6.8
Σ	19.35	22.30	19.03	3.74	4.71	3.87	101.9	102.5	99.7	96.7	99.6	99.8

<sup>1</sup> While the impacts (imp.) are connected with the SOAP and VBS experiments, the contributions (contrib.) are connected with the PSAT experiment.

<sup>2</sup> The categories (cat.) considered in the SOAP and VBS experiments are GNFR sectors A–L; the categories considered in the PSAT experiment are GNFR sectors A–L, BIO – biogenic emissions, IC – initial condition, and BC – boundary conditions.

**Table S11.** Comparison of the seasonal averages of the average daily absolute impacts/contributions of the individual categories on/to PEC concentration in  $\mu\text{g m}^{-3}$  calculated from the SOAP and VBS/PSAT experiments above Berlin, Munich, Budapest, Warsaw, Vienna, and Prague.

Category	Seasonal average of the average daily absolute impacts/contributions <sup>1</sup> of the given categories <sup>2</sup> on/to PEC ( $\mu\text{g m}^{-3}$ )											
	Winter (DJF)			Summer (JJA)			Winter (DJF)			Summer (JJA)		
	SOAP	VBS	PSAT	SOAP	VBS	PSAT	SOAP	VBS	PSAT	SOAP	VBS	PSAT
	<b>Berlin</b>						<b>Warsaw</b>					
GNFR A	0.01	0.01	0.01	0.0	0.0	0.0	0.01	0.01	0.01	0.0	0.0	0.0
GNFR B	0.02	0.02	0.02	0.01	0.01	0.01	0.06	0.06	0.06	0.03	0.03	0.03
GNFR C	0.39	0.39	0.39	0.03	0.03	0.03	2.51	2.5	2.51	0.06	0.06	0.06
GNFR D	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.01	0.01	0.0	0.0	0.0
GNFR E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR F	0.09	0.09	0.09	0.04	0.05	0.04	0.2	0.2	0.2	0.1	0.1	0.1
GNFR G	0.01	0.01	0.01	0.01	0.01	0.01	0.0	0.0	0.0	0.0	0.0	0.0
GNFR H	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR I	0.07	0.07	0.07	0.05	0.05	0.05	0.04	0.04	0.04	0.03	0.03	0.03
GNFR J	0.05	0.05	0.05	0.03	0.03	0.03	0.05	0.05	0.05	0.03	0.03	0.03
GNFR K	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR L	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BIO	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
IC	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
BC	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
$\Sigma$	0.64	0.64	0.64	0.17	0.18	0.17	2.88	2.87	2.88	0.25	0.25	0.25
	<b>Munich</b>						<b>Vienna</b>					
GNFR A	0.01	0.01	0.01	0.0	0.0	0.0	0.02	0.02	0.02	0.01	0.01	0.01
GNFR B	0.02	0.02	0.02	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.01	0.01
GNFR C	0.41	0.41	0.41	0.05	0.05	0.05	0.94	0.94	0.94	0.11	0.11	0.11
GNFR D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR F	0.11	0.11	0.11	0.07	0.07	0.07	0.10	0.10	0.10	0.07	0.07	0.07
GNFR G	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.01	0.01	0.01	0.01	0.01
GNFR H	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR I	0.07	0.07	0.07	0.06	0.06	0.06	0.05	0.05	0.05	0.04	0.04	0.04
GNFR J	0.05	0.05	0.05	0.04	0.04	0.04	0.02	0.02	0.02	0.01	0.01	0.01
GNFR K	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR L	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BIO	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
IC	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
BC	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
$\Sigma$	0.67	0.67	0.67	0.23	0.23	0.23	1.16	1.16	1.16	0.26	0.26	0.26
	<b>Budapest</b>						<b>Prague</b>					
GNFR A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR B	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
GNFR C	3.35	3.35	3.35	0.39	0.39	0.39	0.82	0.82	0.82	0.03	0.03	0.04
GNFR D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR F	0.17	0.17	0.17	0.08	0.08	0.08	0.26	0.26	0.25	0.17	0.17	0.17
GNFR G	0.01	0.01	0.01	0.01	0.01	0.01	0.0	0.0	0.0	0.0	0.0	0.0
GNFR H	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR I	0.03	0.03	0.03	0.02	0.02	0.02	0.04	0.04	0.04	0.03	0.03	0.03
GNFR J	0.06	0.06	0.06	0.03	0.03	0.03	0.01	0.01	0.01	0.0	0.0	0.0
GNFR K	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR L	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BIO	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
IC	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
BC	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
$\Sigma$	3.64	3.64	3.64	0.54	0.54	0.54	1.14	1.14	1.14	0.24	0.24	0.25

<sup>1</sup> While the impacts are connected with the SOAP and VBS experiments, the contributions are connected with the PSAT experiment.

<sup>2</sup> The categories considered in the SOAP and VBS experiments are GNFR sectors A–L; the categories considered in the PSAT experiment are GNFR sectors A–L, BIO – biogenic emissions, IC – initial condition, and BC – boundary conditions.

**Table S12.** Same as Table S11 but for FPRM.

Seasonal average of the average daily absolute impacts/contributions <sup>1</sup> of the given categories <sup>2</sup> on/to FPRM ( $\mu\text{g m}^{-3}$ )												
Category	Winter (DJF)			Summer (JJA)			Winter (DJF)			Summer (JJA)		
	SOAP	VBS	PSAT	SOAP	VBS	PSAT	SOAP	VBS	PSAT	SOAP	VBS	PSAT
<b>Berlin</b>						<b>Warsaw</b>						
GNFR A	0.05	0.05	0.05	0.02	0.02	0.02	0.08	0.08	0.08	0.06	0.06	0.06
GNFR B	0.47	0.47	0.47	0.26	0.27	0.27	1.17	1.17	1.17	0.68	0.68	0.68
GNFR C	0.22	0.22	0.22	0.01	0.01	0.01	0.75	0.75	0.76	0.01	0.01	0.01
GNFR D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR E	0.22	0.22	0.22	0.13	0.13	0.13	0.05	0.05	0.05	0.03	0.03	0.03
GNFR F	0.22	0.22	0.22	0.1	0.1	0.1	0.18	0.18	0.18	0.09	0.09	0.09
GNFR G	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR H	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR I	0.03	0.03	0.03	0.02	0.02	0.02	0.04	0.04	0.04	0.03	0.03	0.03
GNFR J	0.08	0.08	0.08	0.06	0.06	0.06	0.08	0.08	0.08	0.06	0.06	0.06
GNFR K	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
GNFR L	0.01	0.01	0.01	0.0	0.0	0.0	0.01	0.01	0.01	0.0	0.0	0.0
BIO	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
IC	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
BC	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
$\Sigma$	1.31	1.31	1.31	0.61	0.62	0.62	2.37	2.37	2.38	0.95	0.95	0.95
<b>Munich</b>						<b>Vienna</b>						
GNFR A	0.04	0.04	0.04	0.02	0.02	0.02	0.13	0.13	0.13	0.07	0.07	0.07
GNFR B	0.4	0.4	0.4	0.28	0.28	0.28	0.48	0.48	0.48	0.3	0.3	0.3
GNFR C	0.19	0.19	0.19	0.02	0.02	0.02	0.57	0.57	0.58	0.04	0.04	0.04
GNFR D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR E	0.26	0.26	0.25	0.17	0.17	0.17	0.10	0.10	0.10	0.06	0.06	0.06
GNFR F	0.25	0.25	0.25	0.16	0.17	0.17	0.21	0.21	0.22	0.17	0.17	0.17
GNFR G	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR H	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR I	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02
GNFR J	0.09	0.09	0.09	0.08	0.08	0.08	0.04	0.03	0.03	0.03	0.03	0.03
GNFR K	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.0	0.0	0.0
GNFR L	0.01	0.01	0.01	0.0	0.0	0.0	0.01	0.01	0.01	0.0	0.0	0.0
BIO	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
IC	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
BC	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
$\Sigma$	1.28	1.28	1.27	0.77	0.78	0.78	1.58	1.57	1.59	0.69	0.69	0.69
<b>Budapest</b>						<b>Prague</b>						
GNFR A	0.01	0.01	0.01	0.0	0.0	0.0	0.01	0.01	0.01	0.0	0.0	0.0
GNFR B	0.45	0.45	0.45	0.22	0.22	0.22	0.23	0.23	0.23	0.15	0.15	0.16
GNFR C	0.71	0.71	0.71	0.07	0.07	0.07	3.46	3.45	3.46	0.09	0.09	0.09
GNFR D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR E	0.08	0.08	0.08	0.04	0.04	0.04	0.02	0.02	0.02	0.02	0.02	0.02
GNFR F	0.19	0.19	0.19	0.09	0.10	0.10	1.58	1.58	1.58	1.03	1.03	1.03
GNFR G	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR H	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR I	0.02	0.02	0.02	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02
GNFR J	0.09	0.09	0.09	0.06	0.06	0.05	0.01	0.01	0.01	0.01	0.01	0.01
GNFR K	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.01
GNFR L	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.0	0.0	0.0
BIO	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
IC	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
BC	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
$\Sigma$	1.57	1.57	1.58	0.51	0.52	0.51	5.36	5.35	5.35	1.33	1.33	1.34

<sup>1</sup> While the impacts are connected with the SOAP and VBS experiments, the contributions are connected with the PSAT experiment.

<sup>2</sup> The categories considered in the SOAP and VBS experiments are GNFR sectors A–L; the categories considered in the PSAT experiment are GNFR sectors A–L, BIO – biogenic emissions, IC – initial condition, and BC – boundary conditions.

**Table S13.** Same as Table S11 but for POA.

Category	Seasonal average of the average daily absolute impacts/contributions <sup>1</sup> of the given categories <sup>2</sup> on/to POA ( $\mu\text{g m}^{-3}$ )											
	Winter (DJF)			Summer (JJA)			Winter (DJF)			Summer (JJA)		
	SOAP	VBS	PSAT	SOAP	VBS	PSAT	SOAP	VBS	PSAT	SOAP	VBS	PSAT
	<b>Berlin</b>						<b>Warsaw</b>					
GNFR A	0.01	0.0	0.01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR B	0.03	0.03	0.03	0.02	0.02	0.02	0.06	0.1	0.06	0.04	0.04	0.04
GNFR C	0.41	0.63	0.41	0.03	0.04	0.03	1.33	2.34	1.33	0.03	0.04	0.03
GNFR D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.0	0.0	0.0	0.0
GNFR E	0.0	0.01	0.0	0.0	0.0	0.0	0.0	0.02	0.0	0.0	0.0	0.0
GNFR F	0.05	0.57	0.05	0.03	0.27	0.03	0.1	0.8	0.1	0.05	0.33	0.05
GNFR G	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.0	0.0	0.0	0.01	0.0
GNFR H	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR I	0.09	0.1	0.08	0.06	0.06	0.06	0.11	0.13	0.11	0.08	0.08	0.08
GNFR J	0.13	0.16	0.13	0.09	0.09	0.09	0.12	0.19	0.12	0.09	0.09	0.09
GNFR K	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.04	0.03	0.02	0.02	0.02
GNFR L	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.0	0.0	0.0	0.0
BIO	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
IC	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
BC	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
$\Sigma$	0.75	1.53	0.74	0.26	0.52	0.26	1.76	3.64	1.75	0.31	0.61	0.31
	<b>Munich</b>						<b>Vienna</b>					
GNFR A	0.01	0.0	0.01	0.0	0.01	0.0	0.03	0.03	0.03	0.01	0.02	0.01
GNFR B	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.01	0.02	0.01
GNFR C	0.44	0.74	0.44	0.05	0.07	0.05	1.05	1.68	1.05	0.1	0.13	0.1
GNFR D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR E	0.0	0.02	0.0	0.0	0.01	0.0	0.0	0.02	0.0	0.0	0.0	0.0
GNFR F	0.07	0.73	0.07	0.04	0.44	0.04	0.05	0.36	0.05	0.03	0.22	0.03
GNFR G	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.01	0.01	0.01	0.01	0.01
GNFR H	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR I	0.08	0.1	0.08	0.07	0.08	0.07	0.07	0.09	0.07	0.06	0.07	0.06
GNFR J	0.13	0.18	0.13	0.12	0.13	0.12	0.05	0.08	0.05	0.04	0.05	0.04
GNFR K	0.03	0.04	0.03	0.03	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.01
GNFR L	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BIO	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
IC	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
BC	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
$\Sigma$	0.78	1.84	0.78	0.33	0.8	0.33	1.3	2.32	1.29	0.27	0.53	0.27
	<b>Budapest</b>						<b>Prague</b>					
GNFR A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.01	0.0	0.0	0.0	0.0
GNFR B	0.03	0.04	0.03	0.01	0.02	0.01	0.01	0.02	0.01	0.01	0.01	0.01
GNFR C	2.68	4.88	2.68	0.3	0.36	0.3	3.76	5.91	3.76	0.1	0.11	0.1
GNFR D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR E	0.0	0.02	0.0	0.0	0.0	0.0	0.0	0.03	0.0	0.0	0.0	0.0
GNFR F	0.07	0.76	0.07	0.03	0.28	0.04	0.19	0.4	0.19	0.12	0.25	0.12
GNFR G	0.01	0.01	0.01	0.01	0.01	0.01	0.0	0.0	0.0	0.0	0.01	0.0
GNFR H	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR I	0.04	0.05	0.04	0.02	0.04	0.02	0.05	0.07	0.06	0.05	0.06	0.05
GNFR J	0.14	0.24	0.14	0.09	0.09	0.08	0.02	0.03	0.02	0.01	0.02	0.01
GNFR K	0.02	0.04	0.02	0.01	0.02	0.02	0.02	0.03	0.01	0.01	0.02	0.01
GNFR L	0.01	0.01	0.01	0.0	0.0	0.0	0.01	0.0	0.01	0.0	0.0	0.0
BIO	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
IC	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
BC	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
$\Sigma$	3.0	6.05	3.0	0.47	0.82	0.48	4.06	6.48	4.06	0.3	0.48	0.3

<sup>1</sup> While the impacts are connected with the SOAP and VBS experiments, the contributions are connected with the PSAT experiment.

<sup>2</sup> The categories considered in the SOAP and VBS experiments are GNFR sectors A–L; the categories considered in the PSAT experiment are GNFR sectors A–L, BIO – biogenic emissions, IC – initial condition, and BC – boundary conditions.

**Table S14.** Same as Table S11 but for  $\text{PNH}_4$ .

Category	Seasonal average of the average daily absolute impacts/contributions <sup>1</sup> of the given categories <sup>2</sup> on/to $\text{PNH}_4$ ( $\mu\text{g m}^{-3}$ )											
	Winter (DJF)			Summer (JJA)			Winter (DJF)			Summer (JJA)		
	SOAP	VBS	PSAT	SOAP	VBS	PSAT	SOAP	VBS	PSAT	SOAP	VBS	PSAT
	<b>Berlin</b>						<b>Warsaw</b>					
GNFR A	0.1	0.1	0.01	0.05	0.05	0.0	0.08	0.08	0.0	0.07	0.07	0.0
GNFR B	0.12	0.12	0.09	0.06	0.06	0.01	0.1	0.1	0.08	0.07	0.07	0.01
GNFR C	0.23	0.23	0.05	0.01	0.01	0.0	0.46	0.46	0.28	0.01	0.01	0.0
GNFR D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR E	0.02	0.02	0.02	0.0	0.0	0.0	0.01	0.01	0.0	0.0	0.0	0.0
GNFR F	0.32	0.32	0.07	0.04	0.04	0.01	0.29	0.29	0.07	0.04	0.04	0.01
GNFR G	0.09	0.09	0.0	0.02	0.02	0.0	0.04	0.04	0.0	0.01	0.01	0.0
GNFR H	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR I	0.06	0.06	0.0	0.01	0.01	0.0	0.06	0.06	0.0	0.01	0.01	0.0
GNFR J	0.02	0.02	0.06	0.0	0.0	0.01	0.02	0.03	0.05	0.01	0.01	0.01
GNFR K	0.69	0.69	0.81	0.08	0.08	0.12	0.82	0.82	0.99	0.11	0.11	0.16
GNFR L	0.31	0.31	0.64	0.04	0.04	0.07	0.4	0.4	0.69	0.04	0.04	0.07
BIO	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
IC	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
BC	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
$\Sigma$	1.96	1.96	1.75	0.31	0.31	0.22	2.28	2.29	2.16	0.37	0.37	0.26
	<b>Munich</b>						<b>Vienna</b>					
GNFR A	0.1	0.1	0.01	0.1	0.11	0.0	0.07	0.07	0.02	0.04	0.04	0.0
GNFR B	0.13	0.13	0.07	0.14	0.14	0.02	0.1	0.1	0.04	0.06	0.06	0.0
GNFR C	0.24	0.24	0.04	0.03	0.03	0.0	0.34	0.34	0.12	0.02	0.02	0.0
GNFR D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR E	0.03	0.03	0.02	0.0	0.0	0.0	0.02	0.02	0.01	0.0	0.0	0.0
GNFR F	0.39	0.4	0.08	0.13	0.14	0.02	0.38	0.38	0.05	0.04	0.04	0.0
GNFR G	0.03	0.03	0.0	0.01	0.01	0.0	0.03	0.03	0.0	0.01	0.01	0.0
GNFR H	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR I	0.06	0.06	0.0	0.03	0.03	0.0	0.07	0.07	0.0	0.01	0.01	0.0
GNFR J	0.02	0.02	0.05	0.01	0.01	0.02	0.05	0.05	0.16	0.01	0.01	0.02
GNFR K	0.7	0.7	0.95	0.16	0.16	0.29	0.69	0.69	0.82	0.05	0.05	0.09
GNFR L	0.2	0.2	0.63	0.04	0.04	0.11	0.35	0.35	0.69	0.03	0.03	0.06
BIO	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
IC	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
BC	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
$\Sigma$	1.9	1.91	1.85	0.65	0.67	0.46	2.1	2.1	1.91	0.27	0.27	0.17
	<b>Budapest</b>						<b>Prague</b>					
GNFR A	0.07	0.07	0.0	0.03	0.03	0.0	0.08	0.08	0.0	0.05	0.05	0.0
GNFR B	0.09	0.09	0.02	0.04	0.04	0.0	0.09	0.09	0.01	0.06	0.06	0.0
GNFR C	0.5	0.51	0.38	0.02	0.02	0.0	0.33	0.34	0.21	0.02	0.02	0.0
GNFR D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR E	0.01	0.01	0.01	0.0	0.0	0.0	0.02	0.02	0.0	0.0	0.0	0.0
GNFR F	0.38	0.39	0.05	0.01	0.01	0.0	0.35	0.36	0.1	0.07	0.07	0.01
GNFR G	0.03	0.03	0.0	0.0	0.0	0.0	0.04	0.04	0.0	0.01	0.01	0.0
GNFR H	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR I	0.09	0.09	0.0	0.0	0.0	0.0	0.07	0.07	0.0	0.02	0.02	0.0
GNFR J	0.02	0.02	0.07	0.0	0.0	0.0	0.01	0.01	0.01	0.0	0.0	0.0
GNFR K	0.66	0.66	0.89	0.02	0.02	0.07	0.64	0.64	0.82	0.09	0.09	0.14
GNFR L	0.32	0.32	0.55	0.01	0.01	0.03	0.31	0.31	0.66	0.04	0.05	0.07
BIO	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
IC	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
BC	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
$\Sigma$	2.17	2.19	1.97	0.13	0.13	0.10	1.94	1.96	1.81	0.36	0.37	0.22

<sup>1</sup> While the impacts are connected with the SOAP and VBS experiments, the contributions are connected with the PSAT experiment.<sup>2</sup> The categories considered in the SOAP and VBS experiments are GNFR sectors A–L; the categories considered in the PSAT experiment are GNFR sectors A–L, BIO – biogenic emissions, IC – initial condition, and BC – boundary conditions.

**Table S15.** Same as Table S11 but for PNO<sub>3</sub>.

Category	Seasonal average of the average daily absolute impacts/contributions <sup>1</sup> of the given categories <sup>2</sup> on/to PNO <sub>3</sub> (µg m <sup>-3</sup> )											
	Winter (DJF)			Summer (JJA)			Winter (DJF)			Summer (JJA)		
	SOAP	VBS	PSAT	SOAP	VBS	PSAT	SOAP	VBS	PSAT	SOAP	VBS	PSAT
	<b>Berlin</b>						<b>Warsaw</b>					
GNFR A	0.15	0.15	0.27	0.04	0.04	0.02	0.08	0.08	0.21	0.03	0.03	0.02
GNFR B	0.21	0.21	0.2	0.05	0.05	0.02	0.15	0.15	0.14	0.06	0.06	0.01
GNFR C	0.49	0.49	0.53	0.02	0.02	0.01	0.72	0.73	0.77	0.01	0.01	0.0
GNFR D	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.01	0.0	0.0	0.0	0.0
GNFR E	0.07	0.07	0.0	0.01	0.01	0.0	0.05	0.05	0.0	0.0	0.0	0.0
GNFR F	1.17	1.18	1.25	0.13	0.14	0.09	1.21	1.22	1.42	0.15	0.16	0.12
GNFR G	0.31	0.31	0.36	0.07	0.07	0.05	0.16	0.16	0.21	0.03	0.03	0.02
GNFR H	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR I	0.22	0.22	0.3	0.04	0.04	0.03	0.26	0.26	0.38	0.06	0.06	0.04
GNFR J	0.06	0.06	0.0	0.01	0.01	0.0	0.06	0.06	0.01	0.01	0.01	0.0
GNFR K	2.21	2.21	0.0	0.21	0.22	0.0	2.28	2.29	0.0	0.2	0.21	0.0
GNFR L	0.88	0.88	0.01	0.11	0.11	0.0	0.7	0.7	0.02	0.08	0.08	0.0
BIO	-	-	0.01	-	-	0.01	-	-	0.01	-	-	0.02
IC	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
BC	-	-	2.32	-	-	0.19	-	-	2.41	-	-	0.17
Σ	5.77	5.78	5.25	0.69	0.71	0.42	5.68	5.71	5.58	0.63	0.65	0.4
	<b>Munich</b>						<b>Vienna</b>					
GNFR A	0.12	0.12	0.25	0.1	0.11	0.07	0.12	0.12	0.2	0.04	0.04	0.01
GNFR B	0.16	0.16	0.22	0.12	0.12	0.06	0.14	0.14	0.21	0.06	0.06	0.02
GNFR C	0.52	0.52	0.57	0.05	0.05	0.03	0.68	0.69	0.63	0.02	0.02	0.01
GNFR D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR E	0.1	0.1	0.0	0.0	0.0	0.0	0.05	0.05	0.0	0.0	0.0	0.0
GNFR F	1.44	1.46	1.55	0.47	0.49	0.35	1.39	1.41	1.45	0.14	0.14	0.1
GNFR G	0.1	0.1	0.13	0.03	0.03	0.02	0.1	0.1	0.14	0.02	0.02	0.01
GNFR H	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR I	0.2	0.2	0.27	0.11	0.11	0.08	0.27	0.27	0.37	0.05	0.05	0.03
GNFR J	0.04	0.04	0.0	0.02	0.02	0.0	0.13	0.14	0.01	0.02	0.02	0.0
GNFR K	2.21	2.22	0.0	0.38	0.39	0.0	2.18	2.19	0.0	0.14	0.14	0.0
GNFR L	0.52	0.52	0.04	0.11	0.12	0.0	0.96	0.96	0.07	0.09	0.09	0.0
BIO	-	-	0.01	-	-	0.03	-	-	0.01	-	-	0.01
IC	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
BC	-	-	2.46	-	-	0.24	-	-	2.51	-	-	0.10
Σ	5.41	5.44	5.50	1.39	1.44	0.88	6.02	6.07	5.6	0.58	0.58	0.29
	<b>Budapest</b>						<b>Prague</b>					
GNFR A	0.09	0.09	0.13	0.01	0.01	0.0	0.11	0.11	0.17	0.04	0.04	0.01
GNFR B	0.13	0.13	0.16	0.02	0.02	0.0	0.12	0.12	0.14	0.05	0.05	0.01
GNFR C	0.91	0.93	0.74	0.01	0.01	0.0	0.71	0.73	0.55	0.02	0.02	0.01
GNFR D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR E	0.03	0.03	0.0	0.0	0.0	0.0	0.05	0.05	0.0	0.0	0.0	0.0
GNFR F	1.42	1.43	1.42	0.04	0.04	0.03	1.35	1.36	1.40	0.26	0.27	0.18
GNFR G	0.1	0.1	0.13	0.0	0.0	0.0	0.12	0.12	0.16	0.03	0.03	0.02
GNFR H	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR I	0.32	0.32	0.37	0.01	0.01	0.01	0.26	0.26	0.33	0.07	0.07	0.04
GNFR J	0.06	0.06	0.01	0.01	0.01	0.0	0.03	0.03	0.0	0.0	0.0	0.0
GNFR K	1.9	1.9	0.0	0.05	0.05	0.0	2.03	2.04	0.0	0.26	0.27	0.0
GNFR L	0.86	0.86	0.04	0.02	0.02	0.0	0.84	0.84	0.12	0.14	0.14	0.01
BIO	-	-	0.01	-	-	0.01	-	-	0.01	-	-	0.02
IC	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
BC	-	-	2.47	-	-	0.04	-	-	2.51	-	-	0.21
Σ	5.82	5.85	5.48	0.17	0.17	0.09	5.62	5.66	5.39	0.87	0.89	0.51

<sup>1</sup> While the impacts are connected with the SOAP and VBS experiments, the contributions are connected with the PSAT experiment.

<sup>2</sup> The categories considered in the SOAP and VBS experiments are GNFR sectors A–L; the categories considered in the PSAT experiment are GNFR sectors A–L, BIO – biogenic emissions, IC – initial condition, and BC – boundary conditions.

**Table S16.** Same as Table S11 but for  $\text{PSO}_4$ .

Seasonal average of the average daily absolute impacts/contributions <sup>1</sup> of the given categories <sup>2</sup> on/to $\text{PSO}_4$ ( $\mu\text{g m}^{-3}$ )												
Category	Winter (DJF)			Summer (JJA)			Winter (DJF)			Summer (JJA)		
	SOAP	VBS	PSAT	SOAP	VBS	PSAT	SOAP	VBS	PSAT	SOAP	VBS	PSAT
<b>Berlin</b>						<b>Warsaw</b>						
GNFR A	0.14	0.14	0.18	0.1	0.1	0.11	0.17	0.17	0.33	0.16	0.16	0.2
GNFR B	0.19	0.19	0.21	0.14	0.14	0.15	0.22	0.22	0.32	0.19	0.19	0.22
GNFR C	0.25	0.25	0.29	0.02	0.02	0.02	0.71	0.71	0.97	0.03	0.03	0.03
GNFR D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR E	0.01	0.01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR F	-0.04	-0.04	0.0	0.01	0.01	0.0	-0.13	-0.13	0.01	0.0	0.0	0.0
GNFR G	0.0	0.0	0.01	0.01	0.01	0.01	-0.02	-0.02	0.01	0.0	0.0	0.01
GNFR H	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR I	-0.01	-0.01	0.01	0.0	0.0	0.0	-0.03	-0.03	0.01	0.0	0.0	0.0
GNFR J	0.01	0.01	0.0	0.0	0.0	0.0	0.02	0.02	0.0	0.01	0.01	0.0
GNFR K	0.12	0.12	0.0	0.04	0.04	0.0	0.38	0.38	0.0	0.13	0.13	0.0
GNFR L	0.13	0.13	0.0	0.02	0.02	0.0	0.50	0.50	0.0	0.05	0.05	0.0
BIO	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
IC	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
BC	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
$\Sigma$	0.8	0.8	0.7	0.34	0.34	0.29	1.82	1.82	1.65	0.57	0.57	0.46
<b>Munich</b>						<b>Vienna</b>						
GNFR A	0.18	0.18	0.21	0.2	0.2	0.21	0.12	0.12	0.15	0.09	0.09	0.09
GNFR B	0.24	0.24	0.26	0.3	0.3	0.31	0.2	0.2	0.23	0.14	0.14	0.14
GNFR C	0.24	0.24	0.27	0.03	0.03	0.04	0.41	0.4	0.46	0.03	0.03	0.03
GNFR D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR E	0.01	0.01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR F	-0.04	-0.04	0.01	0.01	0.01	0.01	-0.06	-0.06	0.01	0.01	0.01	0.0
GNFR G	0.0	0.0	0.01	0.0	0.0	0.0	0.0	0.0	0.01	0.01	0.01	0.01
GNFR H	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR I	0.0	0.0	0.01	0.0	0.0	0.01	-0.01	-0.01	0.0	0.0	0.0	0.0
GNFR J	0.01	0.01	0.0	0.0	0.0	0.0	0.02	0.02	0.0	0.0	0.0	0.0
GNFR K	0.14	0.14	0.0	0.12	0.12	0.0	0.13	0.13	0.0	0.02	0.02	0.0
GNFR L	0.13	0.13	0.0	0.02	0.02	0.0	0.18	0.18	0.0	0.01	0.01	0.0
BIO	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
IC	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
BC	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
$\Sigma$	0.91	0.91	0.77	0.68	0.68	0.58	0.99	0.98	0.86	0.31	0.31	0.27
<b>Budapest</b>						<b>Prague</b>						
GNFR A	0.12	0.12	0.16	0.08	0.08	0.08	0.13	0.13	0.15	0.09	0.09	0.09
GNFR B	0.18	0.18	0.22	0.11	0.11	0.12	0.16	0.16	0.18	0.13	0.13	0.13
GNFR C	0.65	0.65	0.7	0.03	0.03	0.03	0.44	0.44	0.47	0.03	0.03	0.03
GNFR D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR F	-0.06	-0.06	0.01	0.01	0.01	0.0	-0.04	-0.04	0.01	0.01	0.01	0.01
GNFR G	0.0	0.0	0.01	0.01	0.01	0.01	0.0	0.0	0.01	0.01	0.01	0.01
GNFR H	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR I	-0.01	-0.01	0.01	0.0	0.0	0.0	-0.01	-0.01	0.0	0.0	0.0	0.0
GNFR J	0.01	0.01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR K	0.26	0.26	0.0	0.01	0.01	0.0	0.12	0.12	0.0	0.02	0.02	0.0
GNFR L	0.18	0.18	0.0	0.01	0.01	0.0	0.18	0.18	0.0	0.01	0.01	0.0
BIO	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
IC	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
BC	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
$\Sigma$	1.33	1.33	1.11	0.26	0.26	0.24	0.98	0.98	0.82	0.3	0.3	0.27

<sup>1</sup> While the impacts are connected with the SOAP and VBS experiments, the contributions are connected with the PSAT experiment.

<sup>2</sup> The categories considered in the SOAP and VBS experiments are GNFR sectors A–L; the categories considered in the PSAT experiment are GNFR sectors A–L, BIO – biogenic emissions, IC – initial condition, and BC – boundary conditions.

**Table S17.** Same as Table S11 but for SOA.

Category	Seasonal average of the average daily absolute impacts/contributions <sup>1</sup> of the given categories <sup>2</sup> on/to SOA ( $\mu\text{g m}^{-3}$ )											
	Winter (DJF)			Summer (JJA)			Winter (DJF)			Summer (JJA)		
	SOAP	VBS	PSAT	SOAP	VBS	PSAT	SOAP	VBS	PSAT	SOAP	VBS	PSAT
	<b>Berlin</b>						<b>Warsaw</b>					
GNFR A	-0.01	-0.01	0.0	0.0	0.04	0.0	-0.01	-0.02	0.0	0.0	0.01	0.0
GNFR B	0.0	0.0	0.0	0.0	0.03	0.0	0.01	0.01	0.01	0.01	0.02	0.01
GNFR C	0.08	0.16	0.07	0.02	0.03	0.01	0.13	0.33	0.12	0.02	0.02	0.01
GNFR D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.0	0.0	0.0	0.0
GNFR E	0.03	0.03	0.02	0.07	0.12	0.07	0.04	0.05	0.02	0.05	0.07	0.04
GNFR F	-0.01	0.04	0.02	0.09	0.45	0.05	-0.02	0.02	0.03	0.11	0.48	0.06
GNFR G	0.0	0.0	0.0	0.01	0.04	0.0	0.0	0.0	0.0	0.0	0.02	0.0
GNFR H	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR I	0.0	0.0	0.0	0.02	0.08	0.01	-0.01	-0.01	0.0	0.02	0.09	0.01
GNFR J	0.0	0.01	0.0	0.01	0.02	0.0	0.0	0.01	0.0	0.01	0.02	0.01
GNFR K	0.0	0.0	0.0	0.0	0.01	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR L	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.0	0.0	0.0	0.0
BIO	-	-	0.08	-	-	0.55	-	-	0.08	-	-	0.5
IC	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
BC	-	-	0.03	-	-	0.05	-	-	0.03	-	-	0.05
$\Sigma$	0.09	0.23	0.22	0.22	0.82	0.74	0.14	0.41	0.29	0.22	0.73	0.69
	<b>Munich</b>						<b>Vienna</b>					
GNFR A	-0.01	-0.02	0.0	0.0	0.04	0.0	-0.01	-0.01	0.0	0.0	0.02	0.0
GNFR B	-0.01	-0.01	0.0	0.0	0.04	0.01	0.0	-0.01	0.0	0.0	0.04	0.01
GNFR C	0.10	0.21	0.09	0.03	0.06	0.02	0.22	0.52	0.19	0.06	0.09	0.04
GNFR D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.0	0.0	0.0	0.0
GNFR E	0.06	0.06	0.04	0.13	0.2	0.11	0.06	0.07	0.04	0.08	0.14	0.07
GNFR F	-0.02	0.07	0.03	0.17	0.81	0.09	-0.01	0.05	0.03	0.13	0.58	0.06
GNFR G	0.0	0.0	0.0	0.0	0.01	0.0	0.0	0.0	0.0	0.0	0.02	0.0
GNFR H	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR I	0.0	0.0	0.0	0.02	0.09	0.01	-0.01	-0.01	0.0	0.02	0.11	0.01
GNFR J	0.0	0.01	0.0	0.02	0.03	0.01	0.0	0.01	0.0	0.01	0.02	0.0
GNFR K	0.0	0.01	0.0	0.0	0.0	0.0	0.0	0.01	0.0	0.0	0.0	0.0
GNFR L	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.0
BIO	-	-	0.09	-	-	0.85	-	-	0.09	-	-	0.84
IC	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
BC	-	-	0.04	-	-	0.04	-	-	0.05	-	-	0.04
$\Sigma$	0.12	0.33	0.29	0.37	1.28	1.14	0.25	0.64	0.4	0.3	1.03	1.07
	<b>Budapest</b>						<b>Prague</b>					
GNFR A	-0.01	-0.01	0.0	0.0	0.01	0.0	-0.01	-0.01	0.0	0.0	0.02	0.0
GNFR B	0.0	0.0	0.01	0.0	0.02	0.01	0.0	0.0	0.0	0.0	0.03	0.0
GNFR C	0.37	1.08	0.33	0.11	0.15	0.07	0.21	0.7	0.18	0.04	0.06	0.02
GNFR D	0.0	0.01	0.0	0.0	0.0	0.0	0.0	0.01	0.0	0.0	0.0	0.0
GNFR E	0.07	0.1	0.04	0.06	0.1	0.06	0.05	0.08	0.03	0.09	0.15	0.07
GNFR F	0.0	0.07	0.04	0.12	0.51	0.06	-0.03	-0.04	0.03	0.14	0.61	0.07
GNFR G	0.0	-0.01	0.0	0.0	0.01	0.0	0.0	0.0	0.0	0.0	0.02	0.0
GNFR H	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GNFR I	-0.01	-0.02	0.01	0.02	0.09	0.01	-0.01	-0.02	0.0	0.02	0.12	0.01
GNFR J	0.01	0.03	0.01	0.01	0.03	0.01	0.0	0.01	0.0	0.01	0.02	0.0
GNFR K	0.0	0.01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.0
GNFR L	0.01	0.01	0.01	0.0	0.0	0.0	-0.01	-0.02	0.0	0.0	0.02	0.0
BIO	-	-	0.09	-	-	0.72	-	-	0.1	-	-	0.73
IC	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0
BC	-	-	0.05	-	-	0.04	-	-	0.04	-	-	0.05
$\Sigma$	0.44	1.27	0.59	0.32	0.92	0.98	0.2	0.71	0.38	0.3	1.06	0.95

<sup>1</sup> While the impacts are connected with the SOAP and VBS experiments, the contributions are connected with the PSAT experiment.

<sup>2</sup> The categories considered in the SOAP and VBS experiments are GNFR sectors A–L; the categories considered in the PSAT experiment are GNFR sectors A–L, BIO – biogenic emissions, IC – initial condition, and BC – boundary conditions.