S1 Temporal profiles

Table S1. Emission temporal profiles for month in year as a function of the GNFR category.

GNFR Category		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
A	Public Power	1.2	1.15	1.05	1	0.9	0.85	0.8	0.875	0.95	1	1.075	1.15
B	Industry	1.1	1.075	1.05	1	0.95	0.9	0.93	0.95	0.97	1	1.025	1.05
C	Other Stationary Combustion	1.7	1.5	1.3	1	0.7	0.4	0.2	0.4	0.7	1.05	1.4	1.65
D	Fugitives	1.2	1.2	1.2	0.8	0.8	0.8	0.8	0.8	0.8	1.2	1.2	1.2
E	Solvents	0.95	0.96	1.02	1	1.01	1.03	1.03	1.01	1.04	1.03	1.01	0.91
F	Road Transport	0.88	0.92	0.98	1.03	1.05	1.06	1.01	1.02	1.06	1.05	1.01	0.93
G	Shipping	1	1	1	1	1	1	1	1	1	1	1	1
H	Aviation	1	1	1	1	1	1	1	1	1	1	1	1
I	Off Road	1	1	1	1	1	1	1	1	1	1	1	1
J	Waste	1	1	1	1	1	1	1	1	1	1	1	1
K	Agricultural Livestock	0.7	0.75	0.85	0.9	1	1.1	1.2	1.25	1.3	1.1	1	0.85
L	Agricultural Other	0	2	4.75	2.9	0.5	0.4	0.2	0.5	0.75	0	0	0

Table S2. Emission temporal profiles for day in week as a function of the GNFR category.

GNFR Category		Mon	Tue	Wed	Thu	Fri	Sat	Sun
A	Public Power	1.06	1.06	1.06	1.06	1.06	0.85	0.85
B	Industry	1.08	1.08	1.08	1.08	1.08	0.8	0.8
C	Other Stationary Combustion	1.08	1.08	1.08	1.08	1.08	0.8	0.8
D	Fugitives	1	1	1	1	1	1	1
E	Solvents	1.2	1.2	1.2	1.2	1.2	0.5	0.5
F	Road Transport	1.02	1.06	1.08	1.1	1.14	0.81	0.79
G	Shipping	1	1	1	1	1	1	1
H	Aviation	1	1	1	1	1	1	1
I	Off Road	1	1	1	1	1	1	1
J	Waste	1	1	1	1	1	1	1
K	Agricultural Livestock	1	1	1	1	1	1	1
L	Agricultural Other	1	1	1	1	1	1	1

Table S3. Emission temporal profiles for hour in day (first 12 hours) as a function of the GNFR category.

GNFR Category		1	2	3	4	5	6	7	8	9	10	11	12
A	Public Power	0.79	0.72	0.72	0.71	0.74	0.8	0.92	1.08	1.19	1.22	1.21	1.21
B	Industry	0.75	0.75	0.78	0.82	0.88	0.95	1.02	1.09	1.16	1.22	1.28	1.3
C	Other Stationary Combustion	0.38	0.36	0.36	0.36	0.37	0.5	1.19	1.53	1.57	1.56	1.35	1.16
D	Fugitives	1	1	1	1	1	1	1	1	1	1	1	1
E	Solvents	0.5	0.35	0.2	0.1	0.1	0.2	0.75	1.25	1.4	1.5	1.5	1.5
F	Road Transport	0.19	0.09	0.06	0.05	0.09	0.22	0.86	1.84	1.86	1.41	1.24	1.2
G	Shipping	1	1	1	1	1	1	1	1	1	1	1	1
H	Aviation	1	1	1	1	1	1	1	1	1	1	1	1
I	Off Road	1	1	1	1	1	1	1	1	1	1	1	1
J	Waste	1	1	1	1	1	1	1	1	1	1	1	1
K	Agricultural Livestock	1	1	1	1	1	1	1	1	1	1	1	1
L	Agricultural Other	1	1	1	1	1	1	1	1	1	1	1	1

Table S4. Emission temporal profiles for hour in day (last 12 hours) as a function of the GNFR category.

GNFR Category		13	14	15	16	17	18	19	20	21	22	23	24
A	Public Power	1.17	1.15	1.14	1.13	1.1	1.07	1.04	1.02	1.02	1.01	0.96	0.88
B	Industry	1.22	1.24	1.25	1.16	1.08	1.01	0.95	0.9	0.85	0.81	0.78	0.75
C	Other Stationary Combustion	1.07	1.06	1	0.98	0.99	1.12	1.41	1.52	1.39	1.35	1	0.42
D	Fugitives	1	1	1	1	1	1	1	1	1	1	1	1
E	Solvents	1.5	1.5	1.5	1.5	1.5	1.4	1.25	1.1	1	0.9	0.8	0.7
F	Road Transport	1.32	1.44	1.45	1.59	2.03	2.08	1.51	1.06	0.74	0.62	0.61	0.44
G	Shipping	1	1	1	1	1	1	1	1	1	1	1	1
H	Aviation	1	1	1	1	1	1	1	1	1	1	1	1
I	Off Road	1	1	1	1	1	1	1	1	1	1	1	1
J	Waste	1	1	1	1	1	1	1	1	1	1	1	1
K	Agricultural Livestock	1	1	1	1	1	1	1	1	1	1	1	1
L	Agricultural Other	1	1	1	1	1	1	1	1	1	1	1	1

Table S5. Vertical profile of the distribution of emissions as a function of the GNFR category.

GNFR Category		20m	92m	184m	324m	522m	781m	1106m
A	Public Power	0	0	0.0025	0.51	0.453	0.0325	0.002
B	Industry	0.06	0.16	0.75	0.03	0	0	0
C	Other Stationary Combustion	1	0	0	0	0	0	0
D	Fugitives	0.02	0.08	0.6	0.3	0	0	0
E	Solvents	1	0	0	0	0	0	0
F	Road Transport	1	0	0	0	0	0	0
G	Shipping	0.2	0.8	0	0	0	0	0
H	Aviation	0.25	0.25	0.1	0.1	0.1	0.1	0.1
I	Off Road	1	0	0	0	0	0	0
J	Waste	0	0	0.41	0.57	0.02	0	0
K	Agricultural Livestock	1	0	0	0	0	0	0
L	Agricultural Other	1	0	0	0	0	0	0

S2   COSMO-GHG example namelist `INPUT_GHG`

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&GHGCTL
  in_tracers = 1,
/
&TRACER
  yshort_name = "CO2_ALL",
  igribparam = 30,
  igribtable = 13,
  itype_emiss = 2,
  itype_flux = 0,
  yunits = "kg kg-1",
  ystandard_name = "CO2_mass_fraction_anthropogenic",
  ylong_name = "Mass fraction of CO2 by anthropogenic emissions",
  itype_adv = 1,
  itype_diff = 0,
  itype_turbmix = 1,
  itype_passconv = 1,
  itype_ini = 0,
  itype_lbc = 0,
  itype_bbc = 0,
  itype_relax = 1,
  itype_damp = 0,
  itype_clip = 0,
  ldecay = .FALSE.,
  lifetime = 0,
  itype_tscale = 1,
  ycatl = "CO2_A_TNO","CO2_B_TNO","CO2_C_TNO","CO2_F1_TNO","CO2_F2_TNO",
          "CO2_F3_TNO","CO2_D_TNO","CO2_E_TNO","CO2_G_TNO","CO2_H_TNO",
          "CO2_I_TNO","CO2_J_TNO","CO2_K_TNO","CO2_L_TNO", "CO2_B_Carbocount",
          "CO2_C_Carbocount","CO2_J_Carbocount","CO2_L_Carbocount",
          "CO2_F_Carbocount"
  ytpl =  "GNFR_A_TNO","GNFR_B_TNO","GNFR_C_TNO","GNFR_F_TNO","GNFR_F_TNO",
          "GNFR_F_TNO","GNFR_D_TNO","GNFR_E_TNO","GNFR_G_TNO","GNFR_H_TNO",
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  yvpl =  "GNFR_area_sources","GNFR_area_sources","GNFR_area_sources",
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          "GNFR_area_sources"
/
.
```

## S3 COSMO-ART comparison online vs. offline

Fig. S1 shows averaged relative differences between the online and offline simulation for several COSMO-ART output variables. The differences are calculated for the lowest model layer and the averaging is done in the following way:

$$DIFF = \left| \frac{2 \times (\bar{\phi}_{\text{online}} - \bar{\phi}_{\text{offline}})}{\bar{\phi}_{\text{online}} + \bar{\phi}_{\text{offline}}} \right|, \tag{1}$$

where the spatially averaged field $\bar{\phi}$ is

$$\bar{\phi} = \frac{1}{N_i N_j} \sum_{i=1}^{N_i} \sum_{j=1}^{N_j} \phi_{i,j}. \tag{2}$$

Here, i and j are the grid indices in zonal and meridional directions, respectively. N_i and N_j are the total number of grid points in both directions and $\phi_{i,j}$ is the grid-point value of the repspective variable.
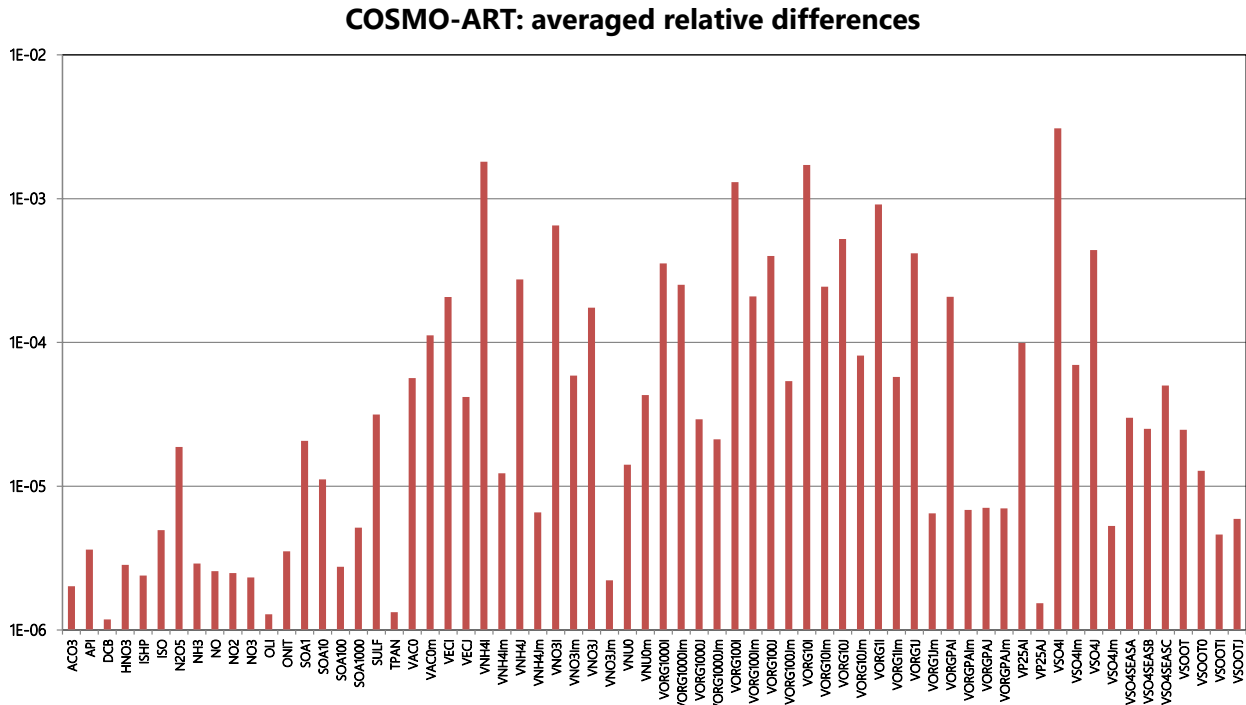
Figure S1. Averaged relative differences of COSMO-ART chemical species with values greater than 10^{-6}. Species starting with a "V" are aerosol compounds.