

BC ²																		
CO																		

¹ EF(TSP) also applied for PM₁₀ and PM_{2.5} (assumption: > 99% of TSP consists of PM_{2.5})

² estimated via a f-BC of 0.48 as provided in ⁵⁾, Chapter: 1.A.3.a, 1.A.5.b Aviation, page 49: "Conclusion".



For the country-specific emission factors applied for particulate matter, no clear indication is available, whether or not condensables are included.

Trend discussion for Key Sources

NFR 1.A.3.a ii (ii) - Domestic Civil Aviation - Cruise is **not included in the national emission totals** and hence **not included in the key category analysis**.

Recalculations

Activity data have been revised for all years within TREMOD AV to keep in line with information available from Eurocontrol's AEM model ⁶⁾.

Furthermore, for the first time, the use of aviation gasoline (avgas) for international flights has been estimated. These amounts have been re-allocated from NFR 1.A.3.a ii (i), where 100% of avgas consumption has been allocated so far.

Table 3: Revised annual fuel consumption in 1.A.3.a ii (ii), in terajoules

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
JET KEROSENE																	
Submission 2021	21.690	19.937	25.301	24.071	24.736	25.337	25.111	24.048	22.503	20.552	21.026	19.762	19.038	19.195	20.067	20.793	21.067
Submission 2020	20.024	20.875	22.967	21.565	22.122	22.904	23.145	21.771	21.579	21.776	20.673	18.717	19.614	19.730	19.746	19.074	19.178
absolute change	1.667	-938	2.334	2.505	2.615	2.433	1.966	2.277	923	-1.224	354	1.045	-576	-535	321	1.719	1.888
relative change	8,32%	-4,49%	10,16%	11,62%	11,82%	10,62%	8,49%	10,46%	4,28%	-5,62%	1,71%	5,58%	-2,94%	-2,71%	1,63%	9,01%	9,85%
AVGAS																	
Submission 2021	1.580	614	614	291	260	228	259	244	237	283	246	199	180	233	145	142	116
Submission 2020	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
absolute change	1.580	614	614	291	260	228	259	244	237	283	246	199	180	233	145	142	116

In parallel, the majority of **country-specific emission factors** has been revised within TREMOD AV based on information available from Eurocontrol's AEM model ⁷⁾.

Table 4: Revised emission-factor values, in [kg/TJ]

< NMVOC

~ Submission 2020	> 15.1	> 17.0	> 17.2	> 19.9	> 20.9	> 21.5	> 21.7	> 21.6	> 21.3	> 21.4	> 21.7	> 23.3	> 23.6	> 23.8	> 19.1	> 19.5		
~ Submission 2019	> 9.3	> 11.6	> 10.5	> 12.1	> 13.2	> 13.3	> 13.0	> 13.1	> 13.1	> 13.3	> 13.2	> 13.7	> 14.1	> 13.5	> 13.4	> 13.6		
~ absolute change	> 5.84	> 5.46	> 6.68	> 7.76	> 7.69	> 8.21	> 8.69	> 8.49	> 8.24	> 8.10	> 8.48	> 9.68	> 9.48	> 10.28	> 5.66	> 5.83		
~ relative change	> 63.0%	> 47.2%	> 63.8%	> 64.0%	> 58.1%	> 61.7%	> 66.7%	> 64.8%	> 63.1%	> 61.1%	> 64.0%	> 70.9%	> 67.1%	> 75.9%	> 42.2%	> 42.7%		
< Nitrogen oxides - NO _x																		
~ Submission 2020	> 330	> 367	> 332	> 319	> 317	> 320	> 333	> 346	> 354	> 356	> 360	> 359	> 366	> 365	> 379	> 380		
~ Submission 2019	> 342	> 381	> 351	> 338	> 339	> 346	> 358	> 366	> 372	> 375	> 380	> 385	> 384	> 388	> 396	> 402		
~ absolute change	> -12.51	> -14.42	> -18.74	> -19.36	> -21.48	> -26.16	> -25.15	> -20.71	> -18.06	> -19.21	> -20.09	> -26.37	> -17.21	> -22.82	> -17.11	> -21.59		
~ relative change	> -3.65%	> -3.79%	> -5.34%	> -5.72%	> -6.34%	> -7.55%	> -7.02%	> -5.65%	> -4.86%	> -5.13%	> -5.29%	> -6.85%	> -4.48%	> -5.88%	> -4.33%	> -5.38%		
< Sulphur oxides - SO _x																		
~ Submission 2020	> 19.7	> 19.5	> 19.5	> 19.6	> 19.6	> 19.6	> 19.6	> 19.6	> 19.6	> 19.6	> 19.6	> 19.6	> 19.6	> 19.6	> 19.6	> 19.6		
~ Submission 2019	> 25.1	> 15.2	> 8.5	> 6.3	> 5.9	> 5.5	> 5.1	> 4.7	> 4.7	> 4.7	> 4.7	> 4.7	> 4.7	> 4.7	> 4.7	> 4.7		
~ absolute change	> -5.45	> 4.30	> 11.08	> 13.28	> 13.71	> 14.13	> 14.55	> 14.98	> 14.98	> 14.98	> 14.98	> 14.98	> 14.98	> 14.98	> 14.98	> 14.98		
~ relative change	> -21.7%	> 28.2%	> 131%	> 209%	> 232%	> 257%	> 287%	> 322%	> 322%	> 322%	> 322%	> 322%	> 322%	> 322%	> 322%	> 322%		
< Black carbon - BC																		
~ Submission 2020	> 2.02	> 2.49	> 2.44	> 2.53	> 2.56	> 2.47	> 2.20	> 2.22	> 2.28	> 2.25	> 2.26	> 2.27	> 2.38	> 2.40	> 2.24	> 2.21		
~ Submission 2019	> 2.23	> 2.23	> 2.23	> 2.23	> 2.23	> 2.23	> 2.23	> 2.23	> 2.23	> 2.23	> 2.23	> 2.23	> 2.23	> 2.23	> 2.23	> 2.23		
~ absolute change	> -0.21	> 0.26	> 0.21	> 0.30	> 0.32	> 0.24	> -0.03	> -0.01	> 0.05	> 0.02	> 0.03	> 0.03	> 0.15	> 0.17	> 0.01	> -0.02		
~ relative change	> -9.52%	> 11.61%	> 9.50%	> 13.39%	> 14.49%	> 10.85%	> -1.42%	> -0.49%	> 2.32%	> 0.82%	> 1.34%	> 1.55%	> 6.53%	> 7.57%	> 0.29%	> -0.95%		
< Particulate matter - PM																		
~ Submission 2020	> 4.21	> 5.19	> 5.09	> 5.27	> 5.33	> 5.16	> 4.58	> 4.63	> 4.76	> 4.69	> 4.71	> 4.72	> 4.95	> 5.00	> 4.66	> 4.61		
~ Submission 2019	> 4.65	> 4.65	> 4.65	> 4.65	> 4.65	> 4.65	> 4.65	> 4.65	> 4.65	> 4.65	> 4.65	> 4.65	> 4.65	> 4.65	> 4.65	> 4.65		
~ absolute change	> -0.44	> 0.54	> 0.44	> 0.62	> 0.67	> 0.50	> -0.07	> -0.02	> 0.11	> 0.04	> 0.06	> 0.07	> 0.30	> 0.35	> 0.01	> -0.04		
~ relative change	> -9.52%	> 11.6%	> 9.50%	> 13.4%	> 14.5%	> 10.8%	> -1.42%	> -0.49%	> 2.32%	> 0.82%	> 1.34%	> 1.55%	> 6.53%	> 7.57%	> 0.29%	> -0.95%		
< Carbon monoxide - CO																		
~ Submission 2020	> 144.5	> 145.2	> 179.0	> 195.3	> 194.5	> 193.3	> 195.1	> 194.2	> 190.2	> 190.0	> 194.1	> 205.0	> 206.2	> 208.5	> 149.0	> 145.3		
~ Submission 2019	> 85.5	> 88.2	> 111.7	> 111.0	> 111.0	> 105.2	> 102.4	> 104.8	> 105.8	> 105.2	> 102.1	> 98.7	> 100.4	> 104.3	> 98.2	> 91.7		

~ absolute change	> 58.93	> 56.97	> 67.33	> 84.30	> 83.50	> 88.08	> 92.71	> 89.41	> 84.38	> 84.77	> 91.96	> 106.30	> 105.85	> 104.16	> 50.81	> 53.62		
~ relative change	> 68.9%	> 64.6%	> 60.3%	> 75.9%	> 75.2%	> 83.7%	> 90.5%	> 85.3%	> 79.7%	> 80.6%	> 90.1%	> 108%	> 105.4%	> 99.9%	> 51.7%	> 58.5%		



For more information on recalculated emission estimates for Base Year and 2018, please see the pollutant specific recalculation tables following chapter [8.1 - Recalculations](#)].

Uncertainties

For uncertainties information, please see the [main chapter](#) on civil aviation.

Planned improvements

For information on planned improvements, please see the [main chapter](#) on civil aviation.

FAQs

^{1), 4)} Knörr et al. (2020c): Knörr, W., Schacht, A., & Gores, S.: TREMOD Aviation (TREMOD AV) 2018 - Revision des Modells zur Berechnung des Flugverkehrs (TREMOD-AV). Heidelberg, Berlin: Ifeu Institut für Energie- und Umweltforschung Heidelberg GmbH & Öko-Institut e.V., Berlin & Heidelberg, 2020.

²⁾ Gores (2020): Inventartool zum deutschen Flugverkehrsinventar 1990-2018, im Rahmen der Aktualisierung des Moduls TREMOD-AV im Transportemissionsmodell TREMOD, Berlin, 2020.

³⁾ Knörr, W., Schacht, A., & Gores, S. (2010): Entwicklung eines eigenständigen Modells zur Berechnung des Flugverkehrs (TREMOD-AV) : Endbericht. Endbericht zum F+E-Vorhaben 360 16 029, URL: <https://www.umweltbundesamt.de/publikationen/entwicklung-eines-modells-zur-berechnung>; Berlin & Heidelberg, 2012.

⁵⁾ EMEP/EEA, 2019: EMEP/EEA air pollutant emission inventory guidebook 2019, <https://www.eea.europa.eu/publications/emep-eea-guidebook-2019/part-b-sectoral-guidance-chapters/1-energy/1-a-combustion/1-a-3-a-aviation/view>; Copenhagen, 2019.

^{6), 7)} Eurocontrol (2020): Advanced emission model (AEM); <https://www.eurocontrol.int/model/advanced-emission-model>; 2020.