

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
CO	21,184	21,581	21,324	21,543	21,850	21,864	21,979	21,921	22,002	22,097	21,979	22,459	21,962	21,040	20,928	20,957

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.



For information on the **emission factors for heavy-metal and POP exhaust emissions**, please refer to Appendix 2.3 - Heavy Metal (HM) exhaust emissions from mobile sources and Appendix 2.4 - Persistent Organic Pollutant (POP) exhaust emissions from mobile sources.

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 within TREMOD AV to keep in line with information the final 2019 NEB.

Furthermore, after the implementation of aviation gasoline (avgas) for international flights, the distribution onto LTO and Cruise stage have been revised widely for all years.

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

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
JET KEROSENE															
Submission 2022	20,263	20,927	23,058	21,646	21,682	21,885	20,757	18,799	19,050	19,826	19,831	19,163	19,300	20,451	9,441
Submission 2021	21,690	19,937	25,301	24,071	22,503	20,552	21,026	19,762	19,038	19,195	20,067	20,793	21,067	21,672	10,114
absolute change	-1,428	990	-2,243	-2,425	-821	1,333	-270	-963	11,4	630	-236	-1,630	-1,766	-1,221	-672
relative change	-6.58%	4.97%	-8.87%	-10.1%	-3.65%	6.49%	-1.28%	-4.87%	0.06%	3.28%	-1.17%	-7.84%	-8.38%	-5.63%	-6.65%
AVGAS															
Submission 2022	1,681	805	779	472	383	440	399	355	344	393	322	320	310	256	170
Submission 2021	1,681	805	779	472	382	440	398	354	343	393	322	320	310	256	170
absolute change	0.00	0.00	0.00	0.00	0.10	0.40	0.29	0.23	0.67	0.20	0.06	0.07	0.04	0.02	0.03
relative change	0.00%	0.00%	0.00%	0.00%	0.03%	0.09%	0.07%	0.06%	0.20%	0.05%	0.02%	0.02%	0.01%	0.01%	0.02%

In parallel, the majority of **country-specific emission factors** applied for 2019 has been revised within TREMOD AV.

Table 4: Revised country-specific emission-factors 2019, in [kg/TJ]

	NH ₃	NM VOC	NO _x	SO ₂	BC	PM	CO
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	NH ₃	NM VOC	NO _x	SO ₂	BC	PM	CO
KEROSENE							
Submission 2022	3,97	19,39	396	19,6	2,13	4,45	159,0
Submission 2021	3,97	19,18	390	19,6	2,26	4,71	155,3
absolute change	0,00	0,21	5,54	0,00	-0,13	-0,27	3,75
relative change	0,00%	1,11%	1,42%	0,00%	-5,64%	-5,64%	2,41%
AVGAS							
Submission 2022	NE	579	142,5	0,46	0,42	2,80	21040
Submission 2021	NE	579	142,6	0,46	0,42	2,80	21025
absolute change	0,00	-0,26	-0,14	0,00	0,00	0,00	15,2
relative change		-0,05%	-0,10%	0,00%	0,02%	0,02%	0,07%



For more information on recalculated emission estimates for Base Year and 2019, 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.

^{1), 4)} Knörr et al. (2021c): 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 (2021): 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.