

1.A.3.a i (ii) - International Civil Aviation: Cruise

Short description

Method	AD	EF	Key Category for
T1, T2, T3	NS, M	CS, D, M	not included in key category analysis

In NFR category 1.A.3.a i (ii) - International Civil Aviation: Cruise emissions from international flights from German airports during cruise stage (above 3,000 feet of altitude) are reported.

In the following, information on sub-category specific activity data, (implied) emission factors and emission estimates are provided.

Methodology

Activity Data

Specific jet kerosene consumption during LTO-stage is calculated within TREMOD AV as described in the [superordinate chapter](#) on civil aviation.

Table 1: annual jet kerosene consumption during cruise-stage, in terajoules

1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
150,852	187,855	243,544	288,819	305,632	291,248	314,638	320,599	307,487	306,766	331,644	365,499	376,210	

source: Knörr et al. (2019c) ¹⁾ & Gores (2019) ²⁾

gallery size="medium" : 1A3ai(ii)_AD.png [gallery](#)

Emission factors

All country specific emission factors used for emission reporting were basically ascertained within UBA project FKZ 360 16 029 ³⁾ and have since then been compiled, revised and maintained in TREMOD AV ⁴⁾.

For more information, please see [superordinate chapter](#) on civil aviation.

Table 2: Annual country-specific emission factors, in kg/TJ

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
NH ₃	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	
NMVO	13.4	9.47	5.93	5.44	5.35	5.20	5.07	4.95	4.91	4.81	4.70	4.70	4.64	4.65	4.46	4.52	4.64	
NO _x	308	313	319	330	331	334	335	339	346	349	354	354	354	354	359	361	362	
SO _x	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	19.6	
PM ¹	3.98	4.19	4.33	4.11	4.07	4.02	3.95	3.91	3.87	3.84	3.81	3.78	3.72	3.72	3.74	3.74	3.76	
BC ²	1.91	2.01	2.08	1.97	1.95	1.93	1.90	1.88	1.86	1.84	1.83	1.82	1.78	1.79	1.79	1.80	1.80	
CO	71.0	60.3	44.9	40.0	39.2	38.3	37.4	36.4	35.9	35.6	35.5	35.6	35.3	35.5	33.5	33.6	34.0	

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".

NOTE: 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

~ Submission 2020	> 1.91	> 2.01	> 2.08	> 1.97	> 1.95	> 1.93	> 1.90	> 1.88	> 1.86	> 1.84	> 1.83	> 1.82	> 1.78	> 1.79	> 1.79	> 1.80
~ 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	> -0.32	> -0.22	> -0.15	> -0.26	> -0.28	> -0.30	> -0.33	> -0.36	> -0.37	> -0.39	> -0.40	> -0.42	> -0.45	> -0.44	> -0.44	> -0.44
~ relative change	> -14.3%	> -9.8%	> -6.8%	> -11.6%	> -12.5%	> -13.5%	> -15.0%	> -16.0%	> -16.7%	> -17.5%	> -18.0%	> -18.7%	> -20.1%	> -19.9%	> -19.7%	> -19.5%
< Particulate matter - PM																
~ Submission 2020	> 3.98	> 4.19	> 4.33	> 4.11	> 4.07	> 4.02	> 3.95	> 3.91	> 3.87	> 3.84	> 3.81	> 3.78	> 3.72	> 3.72	> 3.74	> 3.74
~ 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	> -0.67	> -0.46	> -0.32	> -0.54	> -0.58	> -0.63	> -0.70	> -0.74	> -0.78	> -0.81	> -0.84	> -0.87	> -0.93	> -0.93	> -0.91	> -0.91
~ relative change	> -14.3%	> -9.8%	> -6.8%	> -11.6%	> -12.5%	> -13.5%	> -15.0%	> -16.0%	> -16.7%	> -17.5%	> -18.0%	> -18.7%	> -20.1%	> -19.9%	> -19.7%	> -19.5%
< Carbon monoxide - CO																
~ Submission 2020	> 71.0	> 60.3	> 44.9	> 40.0	> 39.2	> 38.3	> 37.4	> 36.4	> 35.9	> 35.6	> 35.5	> 35.6	> 35.3	> 35.5	> 33.5	> 33.6
~ Submission 2019	> 72.0	> 59.8	> 44.3	> 40.2	> 39.2	> 38.2	> 37.1	> 36.8	> 36.4	> 36.2	> 35.8	> 35.6	> 35.1	> 35.1	> 35.1	> 35.5
~ absolute change	> -0.97	> 0.48	> 0.55	> -0.21	> 0.00	> 0.17	> 0.32	> -0.41	> -0.47	> -0.59	> -0.28	> -0.05	> 0.19	> 0.40	> -1.55	> -1.90
~ relative change	> -1.35%	> 0.81%	> 1.24%	> -0.53%	> 0.01%	> 0.44%	> 0.87%	> -1.11%	> -1.29%	> -1.63%	> -0.78%	> -0.14%	> 0.54%	> 1.15%	> -4.42%	> -5.35%



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 more information, please see [superordinate chapter](#) on civil aviation.

Planned improvements

For more information, please see [superordinate chapter](#) on civil aviation.

[bibliography](#)

: 1 : Knörr, W., Schacht, A., & Gores, S. (2010): Entwicklung eines eigenständigen Modells zur Berechnung des Flugverkehrs (TREMOT-AV) : Endbericht. Endbericht zum F+E-Vorhaben 360 16 029, URL: <https://www.umweltbundesamt.de/publikationen/entwicklung-eines-modells-zur-berechnung>; Berlin & Heidelberg, 2012. : 2 : Knörr et al. (2019c): Knörr, W., Schacht, A., & Gores, S.: TREMOD Aviation (TREMOT AV) 2019 - Revision des Modells zur Berechnung des Flugverkehrs (TREMOT-AV). Heidelberg, Berlin: Ifeu Institut für Energie- und Umweltforschung Heidelberg GmbH & Öko-Institut e.V., Berlin & Heidelberg, 2019. : 3 : Gores (2019): Inventartool zum deutschen Flugverkehrsinventar

1990-2018, im Rahmen der Aktualisierung des Moduls TREMOD-AV im Transportemissionsmodell TREMOD, Berlin, 2019. : 4 : EMEP/EEA, 2019: EMEP/EEA air pollutant emission inventory guidebook 2019 - Copenhagen, 2019 : 5 : Eurocontrol (2019): Advanced emission model (AEM); <https://www.eurocontrol.int/model/advanced-emission-model>; 2019 [bibliography](#)

¹⁾ (bibcite 2)

²⁾ (bibcite 3)

³⁾ (bibcite 1)

⁴⁾ (bibcite 2)

⁵⁾ (bibcite 4)

⁶⁾ (bibcite 4)

⁷⁾ (bibcite 5)

⁸⁾ (bibcite 4)

⁹⁾ (bibcite 5)