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

Short description

Category Code	Method					AD					EF				
1.A.3.a ii (ii)	T1, T2, T3					NS, M					CS, D, M				
Key Category	**SO_2**	**NO_x**	**NH_3**	**NMVOC**	**CO**	**BC**	**Pb**	**Hg**	**Cd**	**Diox**	**PAH**	**HCB**	**TSP**	**PM_{10}**	**$PM_{2.5}$**
1.A.3.a ii (ii)	*not included in key category analysis*														

In NFR category *1.A.3.a ii (ii) - Domestic Civil Aviation: Cruise* emissions from domestic flights between 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

Actitvity Data

Specific fuel consumption during LTO-stage is calculated within TREMOD AV as described in the superordinate chapter.

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

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Kerosene	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	21.573
Avgas	1.580	614	614	291	260	228	259	244	237	283	246	199	180	233	145	142	116	72

source: Knörr et al. (2020c) [1)] & Gores (2020) [2)]

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 the 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
JET KEROSENE																		
NH_3	3,98	3,95	3,95	3,97	3,97	3,97	3,97	3,97	3,97	3,97	3,97	3,97	3,97	3,97	3,97	3,97	3,97	3,97
NMVOC	13,3	8,96	5,98	5,27	5,15	5,02	4,89	4,77	4,66	4,53	4,39	4,39	4,71	4,35	4,17	4,23	4,32	4,25
NO_x	313	317	329	338	338	342	343	346	352	354	360	362	362	366	370	372	373	375
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	19,6
BC	1,89	1,96	2,03	1,93	1,91	1,89	1,85	1,83	1,81	1,80	1,79	1,77	1,74	1,73	1,73	1,74	1,75	1,75
PM	3,94	4,08	4,23	4,02	3,98	3,93	3,86	3,81	3,77	3,74	3,72	3,69	3,62	3,59	3,61	3,62	3,64	3,65
CO	73,8	61,6	47,7	42,4	41,5	40,6	39,7	38,6	37,8	37,3	37,0	36,8	40,1	36,2	34,2	34,2	34,7	34,6
AVGAS																		
NH_3	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
NMVOC	468	498	477	462	452	451	461	470	460	523	519	518	506	515	430	437	449	467
NO_x	103	109	103	100	98	97	99	100	97	111	109	110	104	108	68,7	69,8	73,7	82,2
SO_x	0,46	0,46	0,46	0,46	0,46	0,46	0,46	0,46	0,46	0,46	0,46	0,46	0,46	0,46	0,46	0,46	0,46	0,46
BC	0,40	0,42	0,41	0,40	0,40	0,40	0,41	0,41	0,41	0,44	0,44	0,44	0,45	0,44	0,47	0,47	0,47	0,46
PM	2,69	2,80	2,74	2,68	2,65	2,67	2,70	2,76	2,74	2,96	2,96	2,93	2,97	2,95	3,11	3,14	3,13	3,08
TSP	17,9	18,0	17,9	17,9	17,8	17,8	17,9	17,9	17,9	18,1	18,1	18,1	18,1	18,1	18,3	18,3	18,3	18,2
CO	20.915	22.610	21.827	21.055	20.659	21.024	21.402	22.335	22.225	25.229	25.303	24.882	25.753	25.200	29.832	30.337	30.216	29.108

[1] EF(TSP) also applied for PM_{10} 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)].

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.