

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
PM¹	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
BC²	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																		
NH₃	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_{2,5}	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
PM₁₀	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 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 i (ii) - International 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 the 2019 EMEP/EEA Guidebook ⁶⁾ and Eurocontrol's AEM model ⁷⁾.

Table 3: Revised kerosene usage in 1.A.3.a i (ii), in terajoules

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Submission 2021																	
Submission 2020																	
absolute change																	
relative change																	

In parallel, the majority of **country-specific emission factors** has been revised within TREMOD AV based on information available from the 2019 EMEP/EEA Guidebook ⁸⁾ and Eurocontrol's AEM model ⁹⁾.

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

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
NON-METHANE VOLATILE ORGANIC COMPOUNDS - NMVOC																	
Submission 2021																	
Submission 2020																	
absolute change																	
relative change																	
NITROGEN OXIDES																	
Submission 2021																	
Submission 2020																	
absolute change																	
relative change																	
SULPHUR OXIDES																	
Submission 2021																	
Submission 2020																	
absolute change																	
relative change																	
BLACK CARBON - BC																	
Submission 2021																	
Submission 2020																	
absolute change																	
relative change																	
PARTICULATE MATTER - PM																	
Submission 2021																	
Submission 2020																	
absolute change																	
relative change																	
CARBON MONOXIDE - CO																	
Submission 2021																	
Submission 2020																	
absolute change																	
relative change																	



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 [main chapter](#) on civil aviation.

Planned improvements

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

FAQs

[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⁾ (bible 2)

²⁾ (bible 3)

³⁾ (bible 1)

⁴⁾ (bible 2)

⁵⁾ (bible 4)

⁶⁾ (bible 4)

⁷⁾ (bible 5)

⁸⁾ (bible 4)

⁹⁾ (bible 5)