1.A.3.a - Transport: Civil Aviation

Short description

NFR-Code	Name of Category	Method	AD	EF	Key Category
1.A.3.a	Civil Aviation	*see sub-category details*			
consisting of / including source categories					
LTO-range: Included in National Totals					
1.A.3.a i (i)	International Civil Aviation - LTO	*see sub-category details*			
1.A.3.a ii (i)	Domestic Civil Aviation - LTO	*see sub-category details*			
Cruise phase: Not included in National Totals					
1.A.3.a i (ii)	International Civil Aviation - Cruise	*see sub-category details*			
1.A.3.a ii (ii)	Domestic Civil Aviation - Cruise	*see sub-category details*			

Air transports differ significantly from land and water transports with respect to emissions production. In air transports, fuels are burned under atmospheric conditions that a) differ markedly from those prevailing at ground level and b) can vary widely. The main factors that influence the combustion process in this sector include atmospheric pressure, environmental temperature and humidity – all of which are factors that vary considerably with altitude.

In category 1.A.3.a - Civil Aviation the emissions from both national (domestic) and international civil aviation are reported with separate acquisition of flight phases LTO (Landing/Take-off: 0-3,000 feet) and Cruise (above 3,000 feet) where only emissions from LTO from both national and international flights have to be included in the national totals.

Emissions from military aircraft are not included in this category but are reported under Mobile Combustion.

Country specifics: The use of aviation gasoline is assumed to take place within the LTO-range of domestic flights only (below 3,000 feet). This assumption is a compromise due to a lack of further information and data.

Method

NOTE: Data available from Eurocontrol via the European Environment Agency (EEA) is not being used for inventory compilation. Nonetheless, depending on its timeliness, it is taken into account for verification purposes.

Estimation of aircraft emissions has been carried out using a tier 3a approach, i.e. under consideration of the annual distances flown by different types of aircraft, deviated into domestic and international flights, also considering the different flight stages LTO cycle (Landing/Take-off cycle, i.e. aircraft movements below 3,000 feet or about 915 meters of altitude) and cruise.

Essential for emissions reporting is the separation of domestic and international air traffic. This happens using a so-called split factor representing the ratio of fuel consumption for national flights and the over-all consumption.

For determination of this ratio, results from TREMOD AV (TRansport Emissions MODel AViation) have been used, based on the great circle distances flown by the different types of aircraft (Knörr et al. (2019c) & Gores (2019)) [1], [2]. Here, the ratio is calculated on the basis of statistics on numbers of national and international flights departing from German airports provided by the Federal Statistical Office (Statistisches Bundesamt).

For further dividing kerosene consumption onto flight stages LTO and cruise, again results calculated within the TREMOD AV data base based on data provided by the Federal Statistical Office have been used.

Emissions are being estimated by multiplying the kerosene consumption of the flight stage with specific emission factors (EF). Here, emissions of SO_2 and H_2O are independent from the method used, depending only on the quantity and qualities of the fuel used. In contrast, emissions of NO_x, NMVOC, and CO strongly depend on the types of engines, flight elevations, flight stage, etc. and can be estimated more precisely with higher tiers. The emission factors for NO_x, CO, and NMVOC are therefore computed within TREMOD AV.

The aviation gasoline (avgas) used is not added to the annual kerosene consumptions but reported separately. As proposed in (IPCC, 2006a), emissions caused by the incineration of avgas are calculated using adapted EF and calorific values following a tier1 approach. Here, a split into national and international shares is not necessary as avgas is supposed to only being used in smaller aircraft operating on domestic routes and within the LTO range. - This conservative assumption leads to a slight overestimation of national emissions.1

For further information on AD (entire time series), EF, key sources, and recalculations see sub-chapters linked above.

Activity Data

Kerosene

Emissions estimation is mainly based on consumption data for jet kerosene and aviation gasoline as provided in the national Energy Balances (AGEB, 2019) [3]. For very recent years with no AGEB data available (Normally the last year of the period reported.) data provided by the Federal Office of Economics and Export Control (BAFA) is being used.

Table 1: Sources for 1.A.3.a activity data

through 1994	**AGEB** - National Energy Balance, line 76: 'Luftverkehr'
from 1995	**AGEB** - National Energy Balance, line 63: 'Luftverkehr'
recent years / comparison	**BAFA** - Official oil data, table 7j: 'An die Luftfahrt' + 'An Sonstige'*

* to achieve consistency with AGEB data, amounts given for deliveries 'to Aviation' ('An die Luftfahrt') and 'to Others' ('An Sonstige') have to be added (see FAQs for more information)

Table 2: Total inland fuel deliveries to civil aviation 1990-2019, in terajoules source: Working Group on Energy Balances (AGEB): National Energy Balances (AGEB, 2019) [3]

For the present purposes, kerosene-consumption figures from NEB and BAFA statistics have to be broken down by national (= domestic) and international flights: Here, the split has been calculated on the basis of statistics on numbers of national and international flights departing from German airports

provided by the Federal Statistical Office (Statistisches Bundesamt) within TREMOD AV [1].

Table 3: Ratios for calculating the shares of fuels used in 1.A.3.a ii - Domestic and 1.A.3.a i - International Civil Aviation, in %

Table 4: Resulting annual shares of jet kerosene used in 1.A.3.a ii - Domestic and 1.A.3.a i - International Civil Aviation, in terajoules

The deviation of the kerosene consumed onto the two flight stages LTO and cruise again has been carried based on TREMOD AV estimations allowing the export of kerosene consumption during LTO for both domestic and international flights.

Table 5: Annual shares of LTO phase in domestic and international civil aviation, in %

source: number of domestic and international flights as provided by the Federal Statistical Office (Destatis, 2019), compiled and computed within [1] and [2] a assumption: all aircraft using aviation gasoline are operated within the LTO-range below 3,000 feet and only for domestic flights

Cruise consumption is then calculated as the difference between Total Consumption minus LTO Consumption.

Aviation Gasoline - AvGas

Consumption data have been taken from the national Energy Balance (Working Group on Energy Balances (AGEB), 2019 [3]) and the official mineral oil data provided by the Federal Office of Economics and Export Control (BAFA, 2019) [4]).

Planned improvements

Besides the routine revision of the underlying model, no specific improvements are planned.