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Basel-Mulhouse Airport and Air Quality - Part I: Emissions

An analysis of the available data on recent pollution at the Basel-Mulhouse airport by

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Introduction

The binational airport Basel Mulhouse is located 3.5 km northwest of the border to the city of Basel and 20 km southeast of Mulhouse. As it is fully located on French territory French aviation regulations apply, among which are the publication of emission inventories and immission measurements to control whether the airports pollution remains within legal limits. The main provider of pollution data is the organization ATMO GrandEst (see list of publications in the reference list of this publication).

While the number of passengers and the number of flights are ever increasing since 2002 it was surprising to see that in the publications pollution values went down rather than up. This prompted us to have a closer look into the practice of pollution measurement and pollution data interpretation.

Our 2018 airport-pollution-analyses is published as a series of three independent reports covering the emissions (this part I), the immissions (part II); and our own measurements of ultrafine particles (part III).

Our main conclusion indicates a likely underestimation of pollution at the airport. In comparison to other international airports (e.g. Zürich and Geneva) Basel-Mulhouse falls far behind their standards of pollution data handling. We therefore suggest improvements for future measurements, data evaluation and publications. Reliable emission inventories and immission measurements are essential for decision making to minimize health hazards of the exposed population. We also suggest measures to reduce pollution, like the immediate installation of electricity at the gates to allow jets to stop their auxiliary power units, as it is standard already at most large airports.

Finally we point on ignored pollutants using the example of ultrafine particles, which are measured on other airports, but until now ignored in Basel-Mulhouse. In our third report we thus provide data from sporadic measurements of our own, compare them to those from other airports and suggest to include those in future official analyses.

Problems Found in the Emissions Report, [ATMO_E2017] *

The inventory of the emissions [ATMO_E2017] collected the data for the year 2015 both for ground based pollution sources as well as the pollution produced by the aircrafts in the so called Landing and Take-Off (LTO) Cycle. The given figures for non aircraft based pollution sources are in line with data from other airports. The report however fails to indicate the pollution produced by the Auxiliary Power Units (APU) of the planes.
Most critical discrepancies however were found within the data reported for the LTO cycle. In table 1 the values provided in [ATMO_E2017], page 32, for carbon dioxide (CO_2) and nitrogen oxides (NOx) are compared with estimation from the DGAC [DGAC_E2017] for the Basel-Mulhouse airport and other French airports.
The carbon dioxide emission per passenger in 2015 is substantially lower compared to the DGAC data for the Basel-Mulhouse airport and also compared to the other airports.

* The currently available ATMO report version was published at the beginning of 2018 on the website of the Euroairport. In April the Airport was informed by ADRA that inconsistent data were found. ATMO GrandEst confirmed in May that some raw data received from the Airport were outside of the range, they consider typical, but that they were unable to check these data for correctness.
Finally, at the end of August, after multiple interventions of ADRA , BISF, and ATMO the Airport marked the ATMO report version 12/01/2018 on their website as „under revision“.

The ATMO report defines on page 5 as primary objective “Combien la zone aéroportuaire émet elle de gaz de serre et des polluants“. Later in the report it is mentioned that the CO_2 emitted by international flights is not included. This obviously means that for the LTO cycle just the CO_2 of planes to French destinations was counted.
Indeed the latest European guideline [EEA_2017] recommends that the CO_2 emissions should be split into a national and international part, in order to arrive at well defined national green house gas inventories. However there is absolute no indication that stipulates that the international part of the LTO cycle should be hidden from an official airport emission-report. In contrary all relevant guidelines, e.g. [ICAO_2011] emphasize that data should be presented in a comprehensive and transparent way. This is obviously not the case here where the mayor yearly source of emissions, which are the international flights, are not declared. This is particularly irritating, as other airports [TNO_E2017], [Walker_2017] do not use the same trick. They show a transparent overview for CO_2, kerosene consumption and pollutants.
Also the important reference value NO_x per passenger equivalent calculated from the data of ATMO is lower than for any other airport in the world where analogous data was available to us.

Table 1: Yearly emission data for carbon dioxide and nitrogen oxides in the LTO phase

Airport Year of Reference Published by	EuroAirport 2015 [ATMO_E2017]*	EuroAirport 2015 [DGAC]	Bordeaux 2015 [DGAC]	Toulouse 2015 [DGAC]	EuroAirport 2009 [ASPA_E2012]	EuroAirport 2010 [DGAC]
LTO: CO2 [tonnes/year]	7464	61100	44100	72900	67673	42200
LTO: CO2/PAXeq [kg]	1.0	8.1	8.1	8.7	14.8	9.3
LTO: NOx [tonnes/year]	180.4	248.1	191.3	305.5	273	169.2
LTO: NOx/PAXeq [g]	23.9	32.9	35.0	36.6	59.9	37.1
PAXeq* [Mio]	-	7.55	5.47	8.34	-	4.56
Passengers [Mio], (source web)	(7.06)	(7.06)	(5.29)	(7.67)	(3.85)	(4.13)
Movements*** [1000], (source web)	(94.4)	71.4	52.2	81.2	(75. 0)	55.2
PAXeq, part of long distance flights	-	1.2%	0.6%	0.6%	-	2.7%

*no clear source definition given in ATMO report, the figures might also include APU emissions
**PAXeq = number of physical passengers + airfreight in kg / 100 kg
***The DGAC indicates commercial movements only. The number of flights considered by ATMO is not mentioned in their report. The numbers underlined refer to the total number of movements during the year of reference.

We can use the DGAC 2015 data, and make a comparison for the emitted species found by ATMO, see table 2.

Table 2: Emissions from ATMO (no clear source definition) and DGAC (LTO values of commercial flights)

Species emitted Fuel consumption	ATMO for 2015 [tonnes/year]	DGAC (LTO) for 2015 [tonnes/year]	 [kg/day]	Difference ATMO/DGAC
Carbon dioxide	7`464	61`100	167`397	- 88%
Carbon monoxide	203.3	166.0	455	+22%
Volatile organics	19.3	16.5	45	+17%
Nitrogen oxides	180.4	248.1	680	- 27%
Sulfur dioxide	17.8	19.4	53	-8%
Kerosene consumption	-	19`300	52`877	-

A further example for the faultiness of the data published by the Basel-Mulhouse airport for the year 2015 can be illustrated by looking at the evolution of the mean nitrogen oxide emission over time per LTO cycles at the Mulhouse airport between 2000 and 2015 as published by the DGAC, figure 1 and comparing with the values in the ATMO reports, see figure 2.

Figure 1 indicates the lack of a steady increase in pollution per LTO cycle, which is a sign of changed aircraft fleet and engine improvements. After a steep raise before 2006 new engine technology led to a reduction of NO_x per flight. However to manage with the ever growing passenger numbers smaller planes were replaced by larger aircrafts after 2013 and heavier planes produce more NO_x per LTO cycle.

This increase together with the substantial growth in commercial movements from 55`000 to 71`000 between 2010 and 2015 led to a stunning NO_x increase of 47 % during this period, 169.2 t/y in 2010 to 248.1 t/y in 2015, according to the DGAC, see table 1.

Figure 2 shows the values for NO_x reported for the years 2009 [ASPA_E2012] and 2015 [ATMO_E2017]. The data want to suggest that a significant decrease in NO_x emission occurred from 2009 to 2015. The report [ATMO_E2017] also shows a NO_x value for the year 2010, which is not only inconsistent with the 2009 data, but the report also fails to comment on the discrepancy to the data published for the year 2009.

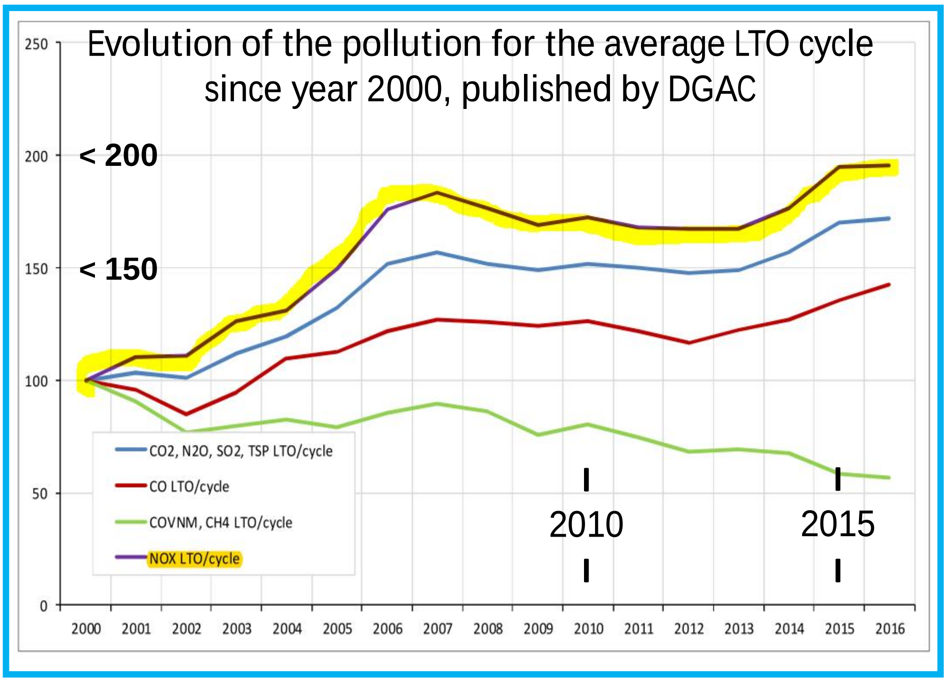

Figure 1: Evolution for polluting species per average LTO cycle at the EuroAirport, [DGAC_E2017]
The highlighted trace shows the evolution for NO_x, the blue trace the evolution for greenhouse gases, the red trace carbon monoxide and the green trace volatile organic compounds.

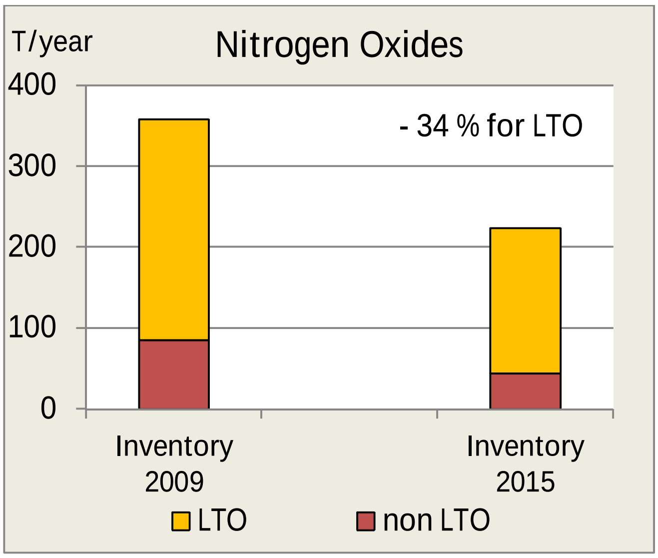

Figure 2: NO_x emitted by the EuroAirport according to reports[ASPA_E2012] and [ATMO_E2017]

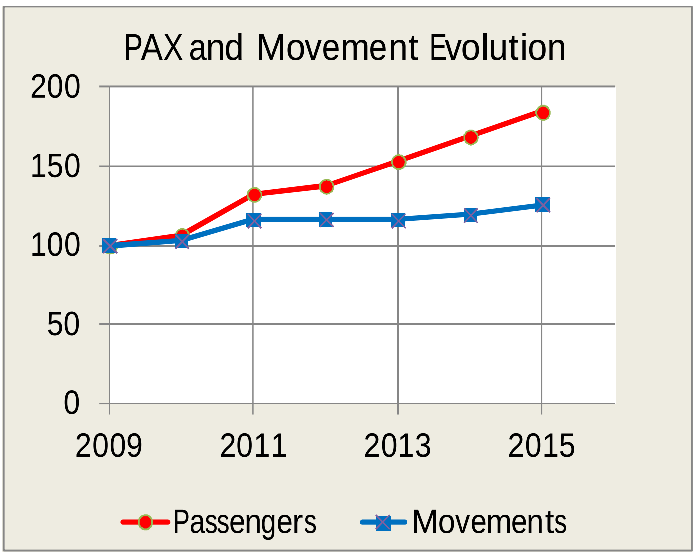

Figure 3: Key transport figures for the EuroAirport
Reference year 2009 with 3.85 Mio passengers, and total 74990 movements

Besides carbon dioxide these numbers indicate some further surprising differences. The ATMO report indicates higher carbon monoxide and volatile organics emissions. Again underestimated are the nitrogen oxides. This might have several reasons:

- The very short times used for the NO_x intensive flight phases, take-off and climb, see table 3
- The ATMO might have carried out their estimation with a different jet engine mix, rather old jet engines which typically have higher CO and volatile organic emissions.

The amount of sulfur dioxide almost agrees, however the sulfur values remain also questionable, because the DGAC [DGAC_2015] assumes a sulfur content of just 500 ppm. Kerosene supplied at many airports contains considerable more sulfur. The sulfur content used by ATMO is not declared in the report.

Our important finding is, that such major discrepancies cannot be explained by changes in the guidelines and models for emission inventories but must stem from incomplete or faulty input data or faulty application of the models.
The report [ATMO_E2017] also does not mention anywhere on which number of movements their calculation is based on. Probably the 20`000 non-commercial movements in 2015 were not included at all or were just considered without much detail.

One very probable reason for the substantial difference in emission values is the duration of some of the phases within the LTO cycle, see table 3. No justification is provided, for the very short times that were used for the 2015 estimation. It is very suspect that the times of the most kerosene consuming phases take-off (100% thrust) and climb (85% thrust) were reduced by up to 80%. These manipulations will result in a significant underestimation of the true pollution elicited by the flight operations at the Basel-Mulhouse airport.

Table 3: Duration of the phases in the LTO cycle, see page 10 [ASPA_E2012] and page 12 [ATMO_E2017]

	Approche, [sec]	Circulation au sol, [sec]	Décollage, [sec]	Montée, [sec]
Standard ICAO	240	1560	42	132
ASPA Rapport EAP pour 2009	240	861	50	180
AtMO Rapport EAP pour 2015	256	**798**	**32**	**30**

Pollution by the Use of the Auxiliary Power Units (APU)

At the Basel-Mulhouse airport planes waiting at the gates have no possibility to stop their kerosene driven APU. In contrast to many other Airports (e.g. Zürich, Geneva, and many French airports, see [ADEME_2018]) the Basel-Mulhouse airport fails to provide “clean” electrical energy and air conditioning to sustain the aircrafts functions on the ground. APU´s generate a substantial amount of pollution, as was documented by other airports [TNO_E2017], [Walker_2017], [Zurich_2005] and [Zurich_2018]. The calculation of reliable APU emissions is rather complex and depends not just on accurate duration of use but also very much on the type of APU installed. The ATMO report does not give any indication how this was done nor reveals the total yearly APU emissions.

Lead Emissions

The amount of lead emissions is a further element of questionable data provided by the airport. Airplanes with piston engines are still running on leaded petrol. More than 10`000 such flights are handled at the Basel-Mulhouse airport per year. Among these planes is also a historical airliner, the 50 tons heavy Lockheed Super Constellation, with a substantial consumption of not only leaded aviation gasoline but also lubrication oil by its four 18-cylinder piston engines during the start and climb phase.
To publish a lead pollution per year of only 20.3kg for 2015 for the LTO cycles at the EuroAirport appears to be a clear underestimation of the true value. A recent Dutch study [TNO_E2017] estimated a sum of 400 kg/year for the 6 largest airports in the Netherlands.

Concluding Remarks to the Basel-Mulhouse Emission Report 2015

Beyond the above mentioned deficits, the report does not explain the methodology used for the calculation of the respective pollutants with sufficient detail. The report just refers to guidelines, which only provide descriptions of various options how emissions can be estimated from aircraft data. A further surprising aspect of the report concerns its publication date, which was January 2018. At that time the data published by the DGAC concerning the identical aspects of pollution were already available. Nevertheless the authors of the ATMO report made no effort to mention the DGAC report nor commented on the discrepancies of the DGAC findings.

The report compares the emission values of the Basel-Mulhouse airport with the pollution emitted in the whole of Alsace and correctly states that the dominating source for most pollutants stems from road rather than air traffic. However it is not mentioned that already in 2015 the airport was among the 5 major single polluters for nitrogen oxides in the departments 67 and 68 as shown in figure 4.

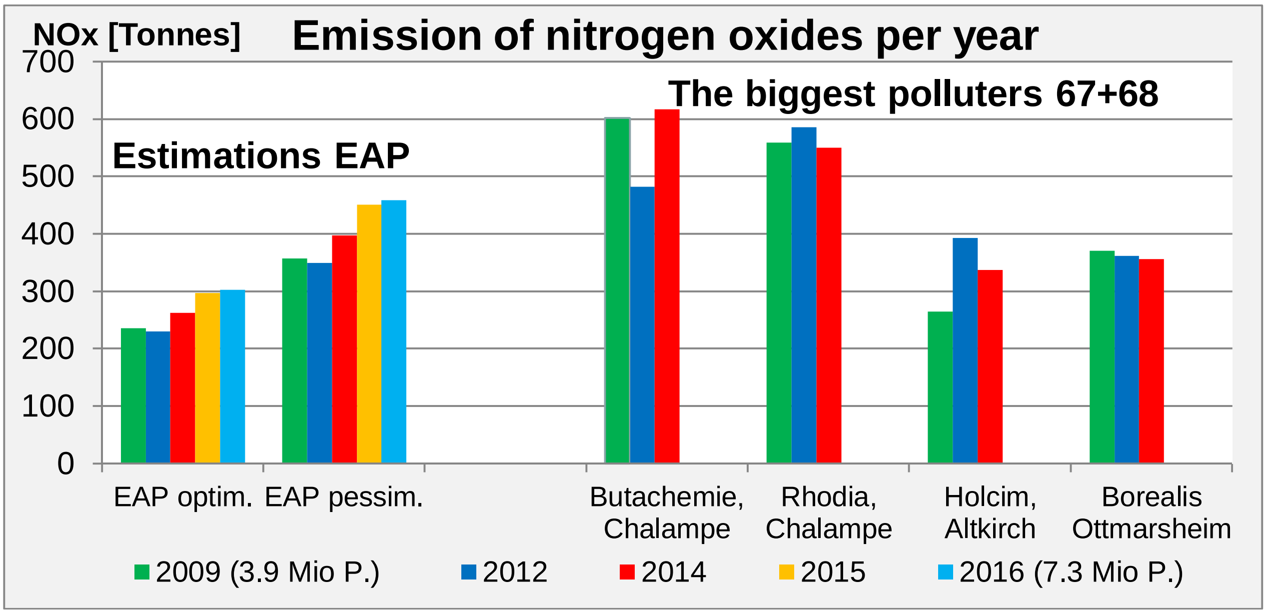

Figure 4: The biggest industrial polluters for nitrogen oxides in Bas-Rhin and Haut-Rhin, [DREAL_E2014]. For "EAP optimistic" the values from the DGAC + 20 % for non LTO NOx were used. The "EAP pessimistic" estimation is based on the NO_x (LTO+nonLTO) value of year 2009 in [ASPA_E2012] and then applied the same yearly growth as reported by the DGAC.

We thus urge the airport to change the current practice of forwarding data and instructions to their contractors. High quality reports are only possible with complete and transparent input data. We expect a statement of the airport on this matter in the very near future (before the next meeting of the tripartite meeting in autumn 2018). From the airport we not only expect clarification on its intention for future handling and publication of data. We expect the following:

- Transparent publication of emissions during the LTO cycle
- Transparent publication of emissions during APU use
- Comparability of data over time
- Comparability of pollution data quality with European airports like Zürich and Geneva
- Replacement of actual "polluter friendly" emission charge model by a methodology [ECAC_2011] that takes into account the real emissions during the LTO cycle. This is already in place at many environmentally conscious European airports [Yunos_2017].

We expect the airport to initiate the installation of electrical power to replace the use of APUs immediately and drive the project with maximal force while keeping transparency to the public. What was introduced e.g. at Geneva airport in 1999, first at selected gates, cannot be postponed at Basel-Mulhouse to the middle of the next decade. More than 20 years of delay is unacceptable for an international airport very close to human settlements that is proud of itself for the technical efficiency and the profitability.

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