Air Quality
Annual Report 2016

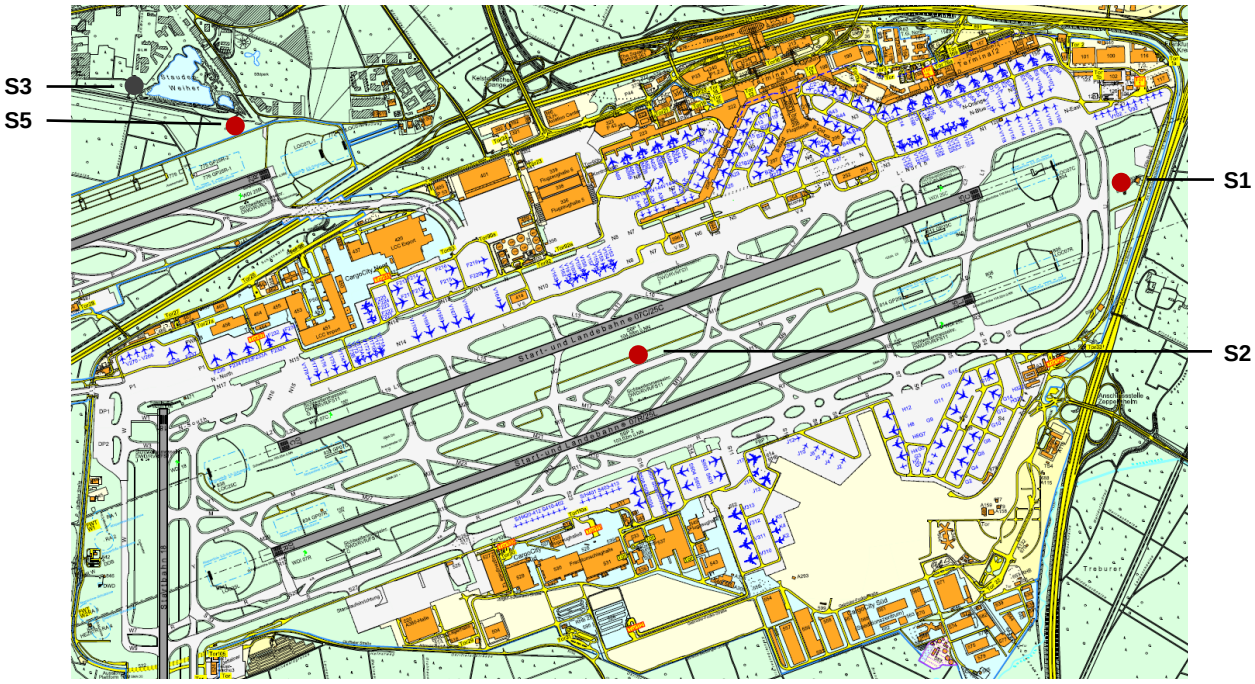
Report on Ambient Air Quality Monitoring at Frankfurt Airport

In 2016 we were able to look back on almost 15 years of air quality monitoring at Frankfurt Airport. Air quality had then moved into the center of attention during the approval procedure for the airport's capacity expansion. The subject of the approval was the construction of Runway Northwest and a new terminal on the south side of Frankfurt Airport. Measurements were supposed to improve the knowledge on various issues. First the status quo of air quality at the airport was to be determined as well as possible changes due to the expansion. Furthermore, they served to validate the simulation models in use and to survey particle pollution caused by construction activities. Meanwhile, these targets have been achieved. We now want to take this opportunity to present a brief review.

Originally, the measuring concept provided for a continuous series of records at a fixed location (S1), if at all possible. A second installation (S2), comparably equipped, was to be moved periodically in order to determine the spatial pollution structure. In practice the 'stationary' installation had to be moved temporarily for operational reasons and the 'mobile' one remained located at the same place for several years. In this edition we are presenting some multi-annual time series that have been derived beyond S1.

The ordinary annual monitoring figures are quite unremarkable in common with previous years, i.e. mostly at the urban background level.

Ambient Air Quality Monitoring Stations in 2016



S3: out of service since 2011, time series see p. 6 ff.

Annual Mean Values Compared to Air Quality Standards

		Measured Value	Air Quality Standard*
NO	S1	35	200 [1]
	S2	19	
	S5	13	
NO_2	S1	45	40 [2]
	S2	35	
	S5	31	
SO_2	S1	2	50 [3]
	S2	3	
CO	S1	0.3	- [4]
	S2	0.3	
O_3	S1	33	- [4]
	S2	39	
PM10	S1	17	40 [2]
	S2	17	
	S5	16	
PM2.5	S2	12	25 [2]
Benzene	S1	0.7	5 [2]
	S2	0.7	
Toluene	S1	1.1	30 [5]
	S2	1.1	
m/p-Xylene	S1	0.7	30 [5]
	S2	0.7	
Ethylbenzene	S1	0.2	20 [1]
	S2	0.2	
Benzopyrene	S1	0.2	1 [2]
	S2	0.2	
Arsenic	S1	0.3	6 [2]
Lead	S1	3.6	500 [2]
Cadmium	S1	0.1	5 [2]
Nickel	S1	1.4	20 [2]

Measuring unit: µg/m³, CO: mg/m³, benzopyrene, arsenic, lead, cadmium and nickel: ng/m³

PM10 = particles, passing a size selective airflow inlet with separation efficiency of 50% at aerodynamic diameter of 10 µm, PM2.5 definition corresponding

** Reference values used:*

[1] Reference value according to HLNUG (Hessisches Landesamt für Naturschutz, Umwelt und Geologie, Hessian State Agency for Nature Conservation, Environment and Geology)
[2] Limit value 39. BImSchV (German ordinance transposing Air Quality Directive 2008/50/EC into national law); arsenic, cadmium, nickel and benzopyrene: target value
[3] Limit value TA Luft 2002 (German Technical Instructions on Air Quality Control, for plants requiring licensing)
[4] No annual mean defined for assessment by respective regulations
[5] LAI recommendation (LAI = Länderausschuss für Immissionsschutz, Ambient Pollution Control Committee of German States)

In 2016, the monitoring equipment was available during more than 98% of the time.

Exceedance Frequency of Short-Term Standards

		Short-Term Standard	*Reference Interval*	*Recorded Exceedance Number per Year*	*Permissible* Exceedance Number per Year*
NO_2	*S1*	*200*	*1 Hour*	*2*	*18*
	S2			*0*	
	S5			*0*	
SO_2	*S1*	*350*	*1 Hour*	*0*	*24*
	S2			*0*	
CO	*S1*	*10 [1]*	*8 Hours*	*0*	*0*
	S2			*0*	
O_3	*S1*	*180 [2]*	*1 Hour*	*5*	*0*
	S2			*11*	
	S1	*240 [3]*	*1 Hour*	*0*	*0*
	S2			*0*	
	S1	*120 [1]*	*8 Hours*	*19 [4]*	*25 [4]*
	S2			*24 [4]*	
PM10	*S1*	*50*	*24 Hours*	*0*	*35*
	S2			*0*	
	S5			*0*	

Measuring Unit: µg/m³, CO: mg/m³
** Short-term standards according to 39. BImSchV (for explanation on 'permissible' refer to air quality report 'Lufthygienischer Jahresbericht 2004', available in German only):*

[1] Maximum permissible eight-hour floating mean of the day derived from hourly means (ozone: target value)
[2] Threshold for the information of the public by responsible authorities in case of exceedance within their network
[3] Threshold for triggering the alert in case of exceedance within the public network
[4] Three-year average (2014, 2015, 2016)

Corresponding short-term values for the assessment of PM2.5, particle constituents, NO, benzene, toluene, m/p-xylene, and ethylbenzene are not available.

In spite of less than average sunshine duration in 2016, the temperature of 11.1°C was above the long-term mean[1] again, as in the preceding years. The overall precipitation sum of 662 mm was slightly elevated and was distributed unevenly throughout the year. While the first half of the year was too wet, the second one was too dry.

Most concentration values were slightly below those of the preceding year. In particular, elevated ozone concentrations did not occur as frequently. The alert threshold was no longer exceeded and the information threshold was exceeded only in the course of five hours at S1 and eleven hours at S2.

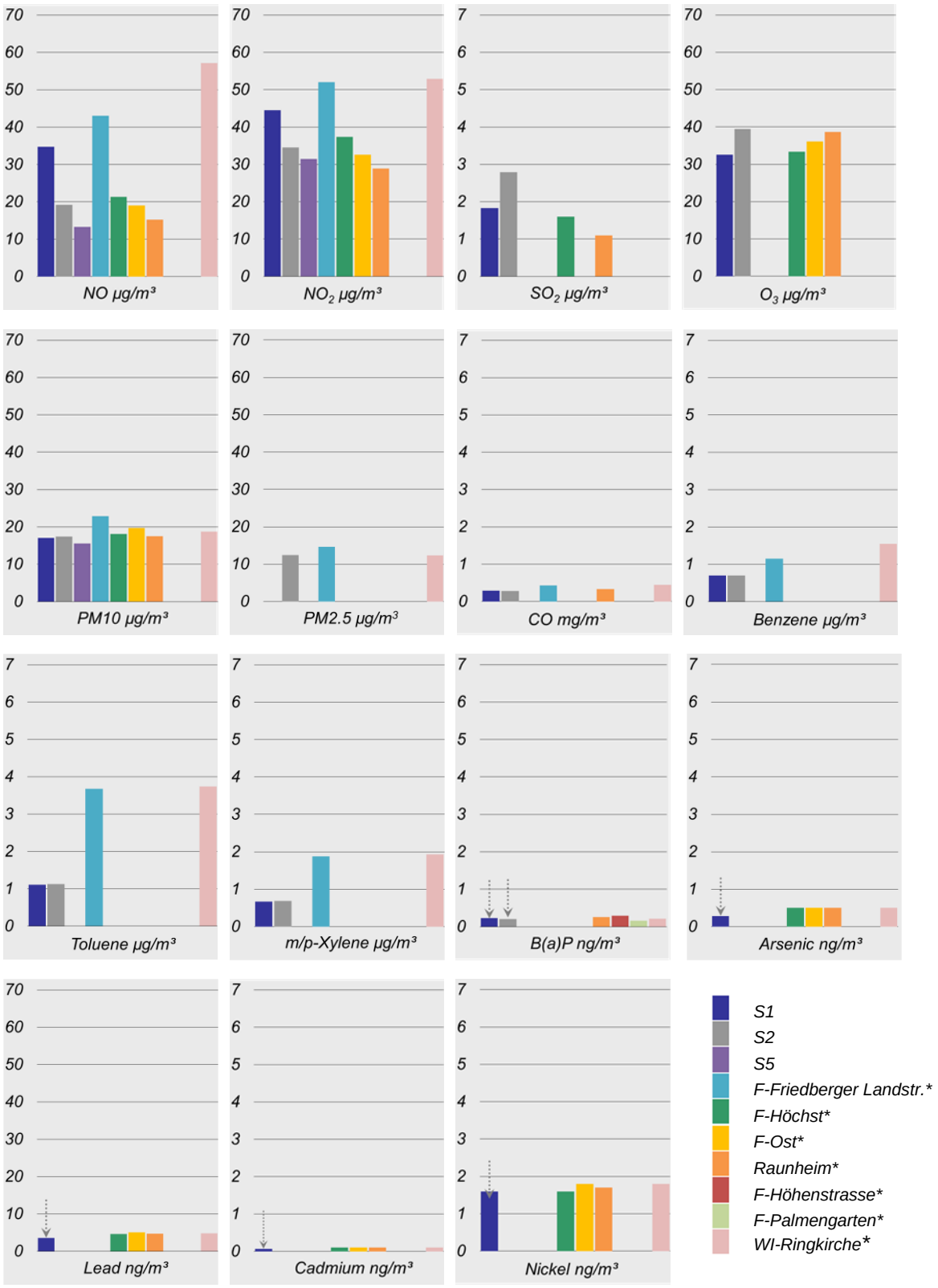
In the reporting period, the threshold for PM10 daily means was not exceeded at Fraport stations for the first time. Otherwise this threshold would have been permissible up to 35 days a year, even in the inhabited surroundings.

Only the annual mean of the NO_2 concentration at S1 remained above the reference value. Likewise, concentrations exceeding the short-term threshold were also only observed at S1. Two cases occurred on September 13 and 14, again confined to situations with northeasterly wind directions (from outside the airport) and calm wind conditions during the evening rush hours and soon afterwards.

Since the observed two instances of NO_2 short-term exceedance were within the permissible range, the key figures of the reporting period would again largely comply with human health protection standards, if they were applicable to airports. Once more, the only exception is the annual NO_2 mean at S1 being increased by vehicle emissions. It is similar to the concentration level at those urban sites that are also exposed to road traffic.

[1] 1981-2010 at the airport station of the German Meteorological Service (DWD)

Annual Means at Airport Sites Compared to Values from Near Sites of Public Network (HLNUG)*



No bar = species not available at site, F = Frankfurt/Main, WI = Wiesbaden, particle constituents: bars = preceding year's data, arrows = current FRA data

** Reference: Lufthygienischer Monatsbericht Dezember 2016 (floating annual means), HLNUG and Lufthygienischer Jahresbericht 2015 (Teil 2: Staub und Staubinhaltsstoffe), HLNUG.*
Part 2 ("Teil 2") for particles and particle constituents for 2016 not available by editorial deadline of this report.

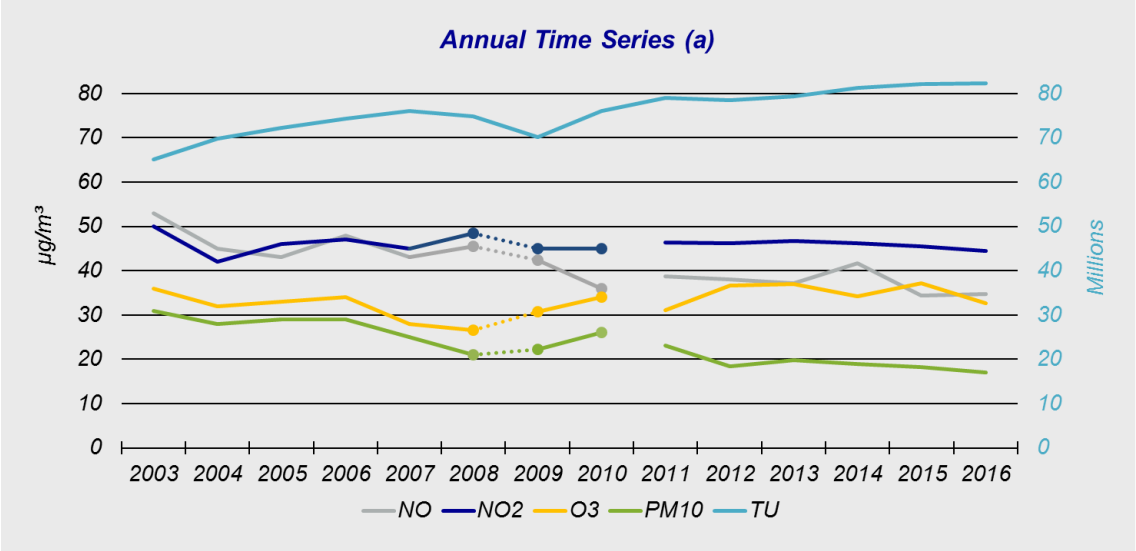
Comparison between Fraport Sites and Nearby HLNUG Sites

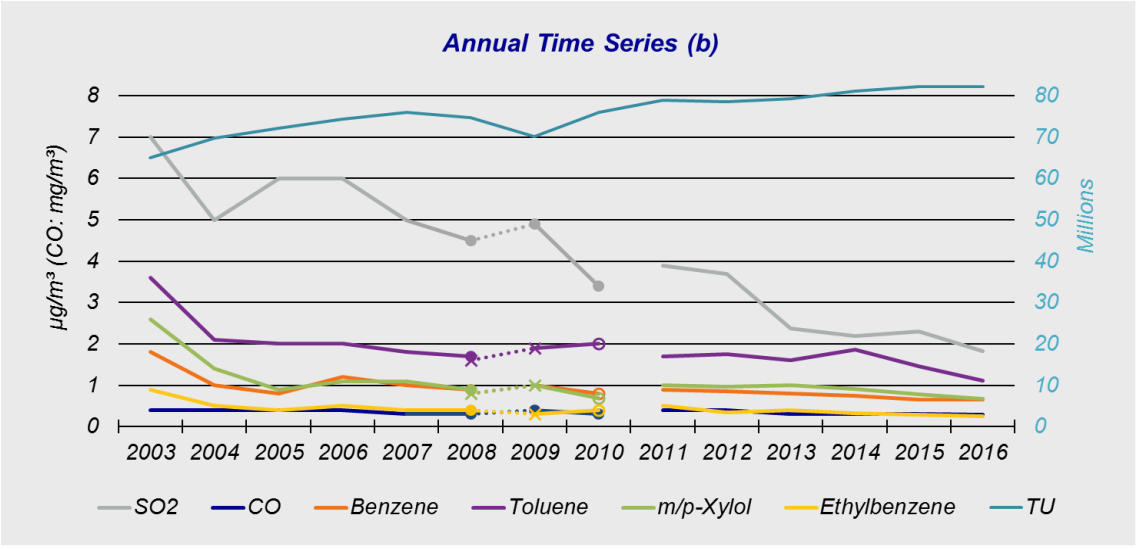
As in the preceding years 2016 concentrations at the airport sites were within the medium and lower range of those at the comparative HLNUG sites, except for SO_2. Because of the larger sulfur content of kerosene compared to other kinds of fuel an influence of aircraft emissions on SO_2 concentrations at the airport cannot be ruled out (see 2014 Air Quality Annual Report). Admittedly, the data are in the lower detectable range, thus small deviations or temporal fluctuations should not be over-emphasized, but the time series presented as this year's special topic indicate the airport's influence as well.

At all sites the concentrations of hydrocarbons and particle constituents, benzopyrene, arsenic, lead, cadmium and nickel, were very small in relation to the corresponding standards as they have been before.

Time Series of Annual Means (Station S1) and Traffic Units (TU)

With the traffic units showing only marginal changes, the concentration trend proves to be largely constant or slightly decreasing for particles, nitrogen oxides and hydrocarbons. After having stagnated for the last two years, also the SO_2 concentration has resumed to decline as in the years before.





1 TU = 1 passenger including luggage or 100 kg of air freight or airmail respectively
Solid lines: measurement results at site, dotted lines: minor change of site 2008 / 2009, 2010 relocation approx. 1000m to the north-northeast
Large dots: correction for gaps of data at site, crosses: low data volume at site without correction,
Circles: data derived from two sites

Review on Fraport Air Quality Monitoring

Air quality monitoring at Frankfurt Airport started in 2002 with two measuring containers in the western and eastern part of the airport area respectively (S1 and S2). There was neither a legal obligation to do so, nor are the results to be assessed by common benchmarks, which are oriented towards the protection of human health or sensitive ecosystems. Since people are staying at the airport only temporarily, they are not exposed to the extent assumed by the definitions of standards in the definite airport area.

However, the limit and target values are used as a guideline in order to integrate the results acquired at the airport into the frame of knowledge gained from the public air quality monitoring network. To this end, one prerequisite is that common technical standards be used widely.

Over the years, the range of monitored species was extended according to the development of limit values. As to certain issues, particular local measurements were performed. Thus from June 2004 on, the concentration of nitrogen oxides was recorded at the southern edge of Kelsterbach (S3) additionally, after model calculations within the scope of the approval procedure had indicated that the NO_2 limit value would possibly be exceeded due to the expansion. Measurements then revealed clearly lower concentrations than the necessarily conservative model calculation. From 2009 on, two more special measurements of nitrogen oxides and particles followed as decreed by the government authorities in order to survey the pollution caused by the large construction site of the Runway Northwest (S4 and S5).

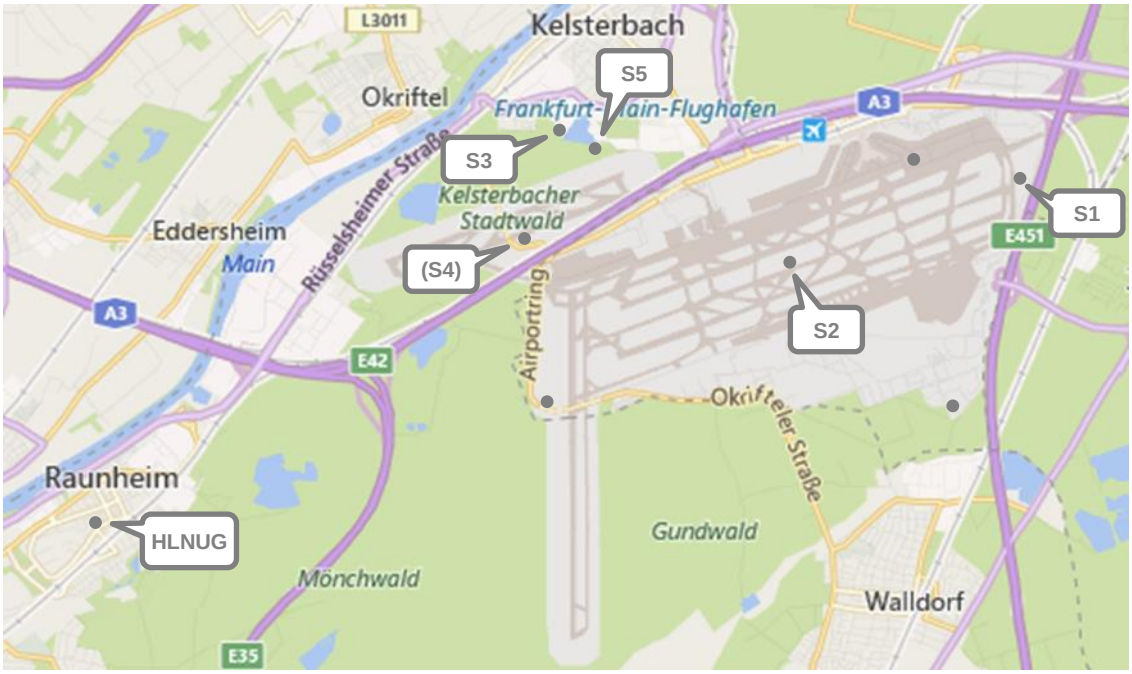
Thanks to preventing measures and short-term reactions taken when concentrations were recognizably approaching critical levels, limit exceedance in the inhabited vicinity caused by construction activities could be avoided.

Runway Northwest has been in use since November 2011 and infrastructure in the southern expansion area is taking shape.

Time Series at Various Sites in Comparison

Beyond the S1 site, records of several years are partly available also from the special measurements sites and from the S2 site originally designed as mobile. These results, having been reported only as annual figures before, are now presented as time series below. Additionally, the respective concentration courses from the nearest HLNUG station at Raunheim are included.

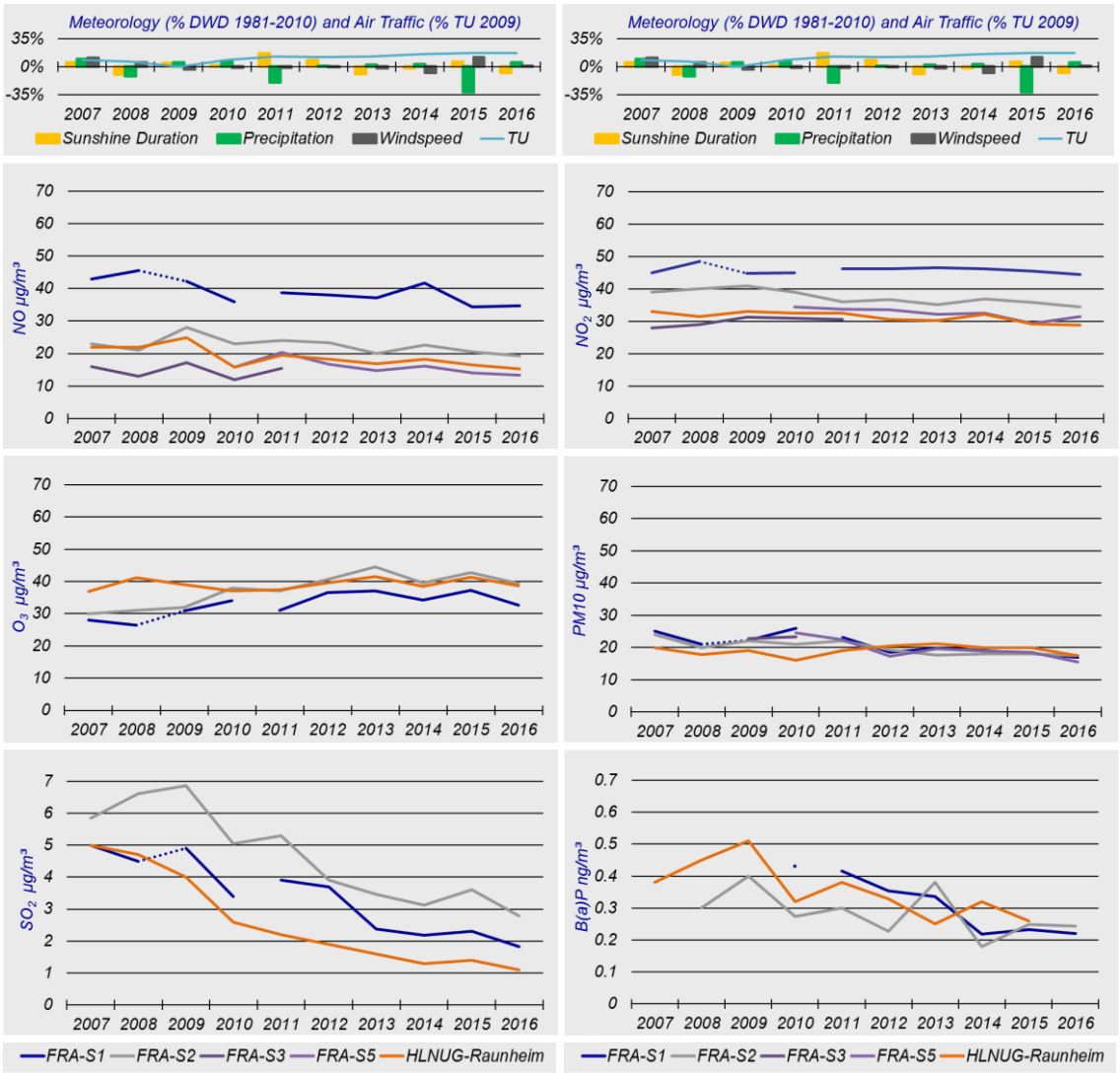
The site locations can be seen on the map section below. Dot markings without labels are sites where measurements were only temporary. The same applies to the S4 site.



Reference: google maps, adapted by Fraport

The selection of data is confined to time series of major availability. Nitrogen oxides, ozone, and particles represent the relevant components with respect to air quality. Sulfur dioxide and benzopyrene (B(a)P) were selected because they reveal interesting details.

To distinguish the sites, the color scheme of the bar graphs on p. 4 was adopted. On each side identically, the concentration diagrams below are preceded by diagrams of relative annual deviations regarding the following boundary conditions: sunshine duration, precipitation and wind speed as well as traffic units. Meteorological data were evaluated based on monthly values published via internet by the German Meteorological Service (DWD = Deutscher Wetterdienst). The annual means from the Raunheim HLNUG station were retrieved from the HLNUG annual reports.



Nitrogen Oxides (Top)

As to nitrogen oxides in the top part of the figure, a decrease is obvious over the last ten years, particularly with NO. In this regard, the S1 values are averaging considerably above those of the other stations, in particular for NO once again. The larger NO effect compared to NO_2 indicates emissions from close proximity, i.e. the motorway A5 to the East together with the interchange A3/A5 to the Northeast. During adverse air quality situations (northeasterly direction, calm wind) the site is located downwind of these traffic emissions sources. The course at S2 site is much more similar to the course at the other stations, although on a slightly higher level. Previous analyses had also indicated an influence of the motorway even there. At both sites impacts of aircraft emissions can be assumed as well, but they cannot be distinguished from the predominant influence of road traffic.

Ozone, PM10 (Center)

Ozone and PM10 concentrations are mostly characterized at larger scale and thus run in a significantly more regular way than the other components. In this respect, meteorology does play an important role, this is however, more the case with the short-term values. In the course of annual values such relation is not eye-catching with the reviewed stations. Since ozone is depleted in the presence of NO the concentrations of the components behave reversely. This can be recognized notably well at S1, where the ozone concentration level is lowest. The most regular course is to be found with PM10. In this regard, only the airport values between 2009 and 2011 are elevated, probably due to construction emissions. The decrease in the previous year 2016 is slightly larger than in the preceding years at all sites.

Sulfur Dioxide, Benzopyrene (Bottom)

While SO_2 and B(a)P concentrations are of minor importance in relation to the assessment values, conclusions can be drawn based on the above-mentioned courses regarding the difference in origin and thus the range of influence of the respective emission sources. Both components show a distinct decrease over time, however the ranking with respect to concentration levels is quite different. At the airport, the SO_2 concentration is clearly higher than at Raunheim. This is valid in particular with S2, indicating the effect of aircraft emissions, as already reported before. By contrast, B(a)P concentrations are lowest there. The higher level at Raunheim and maximum values at S1 correspond to the larger influence of road traffic supposed at those sites. Throughout the last years the concentration seems to have levelled off at a rather low background level.

Conclusions

The air quality monitoring results at Frankfurt Airport fit well into the frame of existing knowledge on the regional pollution situation. They reflect the strong local influence of road traffic. Although an influence of aircraft emissions can be assumed, this influence can hardly be identified by means of measurement. Even after the airport expansion, pollution concentrations have decreased, as was to be expected following the projections within the scope of the approval procedure.

Further Information:

Fraport AG
www.fraport.de

HLNUG Hessisches Landesamt für Naturschutz, Umwelt und Geologie
(Hessian State Agency for Nature Conservation, Environment and Geology)
http://www.hlnug.de

DIRECTIVE 2008/50/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
of 21 May 2008
on ambient air quality and cleaner air for Europe
http://ec.europa.eu/environment/air/quality/legislation/existing_leg.htm

DWD data WebWerdis
https://werdis.dwd.de

HLNUG Special Monitoring Campaign Frankfurt-Lerchesberg
http://www.hlnug.de/start/luft/sonstige-berichte.html
Erhebung der Luftqualität im Einzugsbereich der neuen NW-Landebahn des Flughafen Frankfurt Station Frankfurt-Lerchesberg

HLNUG Special Monitoring Campaign Flörsheim
http://www.hlnug.de/start/luft/sonstige-berichte.html
Erhebung der Luftqualität (Station Flörsheim) und des Staubniederschlags im Einzugsbereich der neuen NW-Landebahn des Flughafens Frankfurt

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