Operational platform for survey and forecast of local air quality of the Berre area: methods, results and perspectives

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Abstract

AIRFOBEP is the regional air quality agency in charge of the survey of the air pollution over the Berre pond region, which is one of the two main industrial areas in France. AIRFOBEP has developed an operational automated platform which routinely monitor and forecast air pollution over its territory. This paper discusses the operational tools associated with particle matter (PM10) and sulfur dioxide (SO_2). These tools are based on local air dispersion modelling to account for numerous local emission sources, considering a large simulation domain. A description of each tool will be given as well as an overall view of the performance of the system in terms of ground-level concentration.

Monitoring and forecasting pollutant dispersion at AIRFOBEP

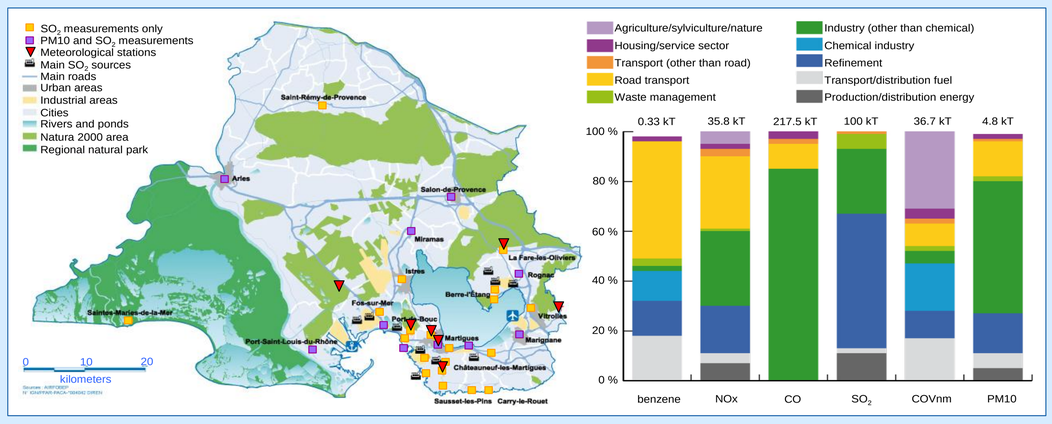
■ AIRFOBEP is the regional air quality agency in charge of the monitoring of air pollution over the Berre pond area, including the western part of the Bouches-du-Rhône department (south-east France).

■ **AIRFOBEP missions:** monitoring in real-time the majority of air pollutants that may impact human health and environment, forecasting air quality over the whole Berre pond region.

■ **Air quality forecasts (http://previsions.airfobep.org):**

■ They are designed both to inform populations about the air quality which is expected in the next few days and to take preventive measures of reduction of pollutant emissions associated with industries located on the border of the pond.

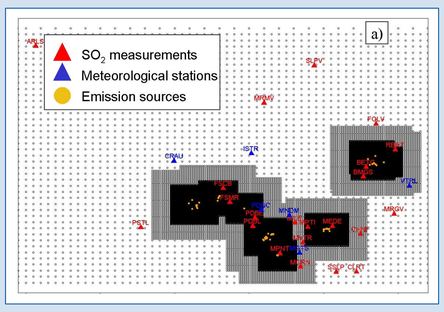
■ AIRFOBEP has developed an operational numerical platform to perform daily forecasts of air pollution at local scale over the whole Berre domain: automated predictions of concentrations of O_3, NO_2, SO_2 and PM10 which are based on local dispersion simulations which may be coupled to mesoscale photochemical simulation.



(Left) Geographical domain of the Berre pond region. Air quality monitoring and meteorological stations are reported as well. (Right) Sectorial distribution of pollutant release (adapted from AIRFOBEP©).

Monitoring and forecasting SO_2 pollution over the Berre pond region

Methodology



Simulation domains (ADMS4) used for each of the ten industrialists

■ **Main functionalities of the platform:** providing daily SO_2 forecasts for D, D+1 and D+2 and daily analysis for D-1.

■ **Methodology for D to D+2:** realization of 10 ADMS4 simulations (one for each industrialist of the Berre area).

■ 3D meteorology is derived from high resolution weather forecasts.

■ Emission rates are considered as constant.

■ Results are finally interpolated (merged) over a single grid.

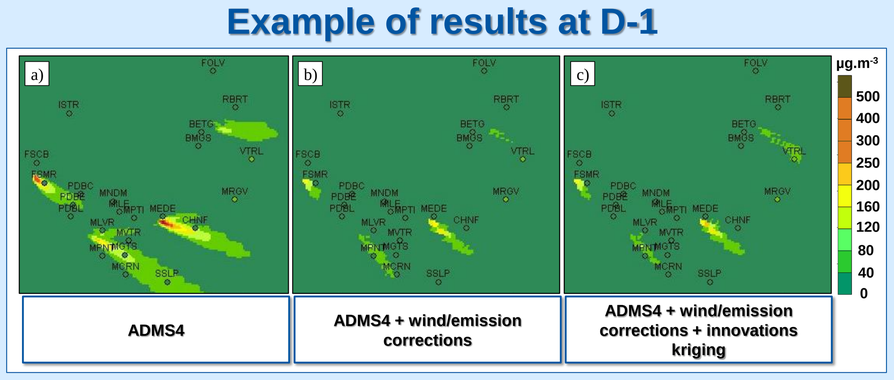
■ **Methodology for D-1:** as for D to D+2 but takes into account SO_2 measurements.

■ Meteorology is derived from observations.

■ Plumes directions and predicted concentration values are corrected considering that wind directions and emission rates are uncertain.

■ SO_2 measurements are kriged to predicted concentration fields.

Example of results at D-1

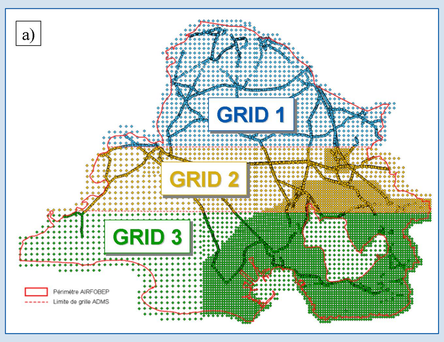


Hourly concentrations (µg.m-3) obtained at D-1 at different steps of the map generation

For this particular case-study, wind and emission rates corrections as well as innovation kriging led to improvements of the results in the vicinity of several sensors: FSMR, MEDE, VTRL, BETG and BMGS.

Monitoring and forecasting PM10 pollution over the Berre pond region

Methodology



Simulation domain (3 grids) used for ADMS-Urban

■ **Main functionalities of the platform:** providing daily PM10 forecasts for D and D+1 and daily analysis for D-1.

■ **Methodology for D to D+1:** realization of ADMS-Urban simulation.

■ Meteorology is derived from high resolution weather forecasts (Δx= Δy=1 km).

■ Emissions derived from an inventory of 2001 (contains each type of source).

■ Background pollution is derived from a statistical method based on measurements provided by the AIRFOBEP network.

■ Simulation results are then bias-corrected.

■ **Methodology for D-1:** as for D to D+1 but takes into account PM10 measurements.

■ Meteorology is derived from observations.

■ PM10 measurements are interpolated (innovations kriging) to predicted concentration fields.

Quantitative evaluation of the results

Variable	Station of measurement	Observed mean (µg.m^{-3})	Predicted mean (µg.m^{-3})	Bias (µg.m^{-3})	NMSE (%)	AQI good prediction (%)
Daily mean concentration	MILE (Best prediction)	27.91	27.95	-0.06	17.3	44
	PSLV (Worst prediction)	33.97	29.96	-4.07	37.3	36
	Mean over all stations	31.17	30.35	-0.66	20.69	41
Daily hourly maximum concentration	SLPV (Best prediction)	49.81	36.23	-14.3		
	PSLV (Worst prediction)	69.13	35.71	-35.21		
	Mean over all stations	56.14	36.26	-21.07		

Concentration classes (µg.m^{-3})		0-9	10-19	20-29	30-39	40-49	50-64	65-79	80-99	100-124	>124
Statistics for mean daily concentrations	Number of observed	1	56	124	109	53	22				
	Number of predicted		75	113	92	48	23				
	Mean bias (µg.m^{-3})	2.33	0.38	-1.1	-0.87	-1.37	-1.82				
Statistics for hourly concentrations	Number of observed	3481	18302	22800	18445	10391	6658	2063	874	293	234
	Number of predicted	1925	22055	27245	26822	12567	7412	818			
	Mean bias (µg.m^{-3})	7.86	4.42	3.04	0.65	-3.91	-10.49	-24.58	-41.62	-63.84	-113.9

Quantitative evaluation of simulations results at D-1 for the period ranging from the 1st January 2009 to the 31st December 2009

Conclusions

■ PM10 platform shows very good agreement with ground based measurements: real benefits from the bias and background pollution methods.

■ PM10 platform exhibits a strong negative bias in comparison with large PM10 concentrations.

■ SO_2 platform is operational but still under development for the generation of D-1 maps (correction of plume direction and emission rates / assimilation of SO_2 measurements).

■ The method of innovations kriging does not seem to be fully applicable to the SO_2 platform, in particular because SO_2 plume fields are discontinuous.

Future work for the SO_2 platform

■ Testing the application of individual plumes direction corrections that may differ between industrialists.

■ Taking into account the spatial direction when applying kriging of innovations. Such a methodology may bring valuable improvements for discontinuous concentrations fields that exhibit anisotropic structures.

■ Developing a statistical module that will provide quantitative assessments of SO_2 predictions. Such a quantitative evaluation module already exists for the platforms that have been developed for PM10, O_3 and NO_2 monitoring.