SYPROS
SIAAP odour forecasting system

The remapping process for odour management

New ! It is now possible to visualize odour plumes around a WWTP in real-time.

The major innovation is that the real-time adjustment of the source emission is based on on-site continuous measurements (meteorological data and TRS concentrations). In order to achieve it, the so-called remapping process has been developed (SYPROS : SYstème de PRévision des Odeurs du SIAAP = SIAAP odour forecasting system) is based on the 3D CFD dispersion tool Fluidyn-PANEIA using a Lagrangian puff model.

On site weather data

1) Identifying the source

The source definition is based on an iterative method of identification. Knowing beforehand the dilution factors establishing a unique relationship between emitter and receiver, the concentration of a source can be calculated from the measurement on one monitor point.

2) Estimating the concentration source

This value then makes it possible to estimate the concentration of another source by means of another monitoring point for which the measured concentration comes from the contributions of two sources, one identified and one unknown.

Total Reduced Sulfurs compounds (TRS) measurements

On site TRS measurments are done every 30 minutes
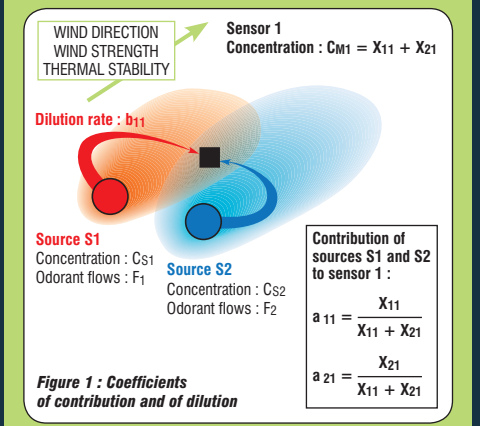
3) Checking out

In the case of the implementation of SYPROS on the Seine aval WWTP, the real-time calculation line contains a file which, for all meteorological conditions in the wind field database, summarises :
- The matching between the monitoring points impacted by the emissions in TRS from one or several facilities ;
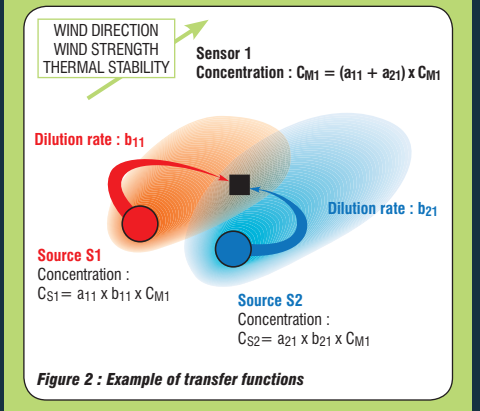- The corresponding transfer fonctions.
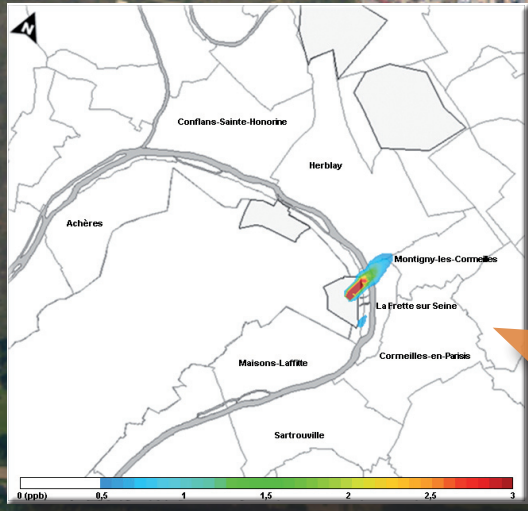
DETAILS OF CALCULATIONS

The concentration measured at sensor j is the result of the contribution of the emissions from sources i which impact that sensor. The contribution of these sources is designated a_{ij}. This contribution depends on the odorant flows emitted by these sources. The dilution rate between the concentration of TRS emitted by source S_i and sensor M_j is designated b_{ij}. This rate is independent of the odour flow emitted by source S_i. The theoretical calculations are illustrated on figure 1.

WIND DIRECTION / WIND STRENGTH / THERMAL STABILITY

Sensor 1 Concentration : $C_{M1} = X_{11} + X_{21}$

Dilution rate : b_{11}

Source S1 Concentration : C_{S1} Odorant flows : F_1

Source S2 Concentration : C_{S2} Odorant flows : F_2

Contribution of sources S1 and S2 to sensor 1 :

$$a_{11} = \frac{X_{11}}{X_{11} + X_{21}}$$

$$a_{21} = \frac{X_{21}}{X_{11} + X_{21}}$$

Figure 1 : Coefficients of contribution and of dilution

The transfer function makes it possible to estimate the concentration emitted by the source or the sources which emissions impact a given sensor, on the basis of the concentration measured by that sensor. For any given meteorological condition, the transfer function f_{ij} between any source i and any sensor j corresponds to the product of the coefficient of contribution of source i to sensor j and the coefficient of dilution between that source i and that sensor j (see also Figure 2).

WIND DIRECTION / WIND STRENGTH / THERMAL STABILITY

Sensor 1 Concentration : $C_{M1} = (a_{11} + a_{21}) \times C_{M1}$

Dilution rate : b_{11}

Dilution rate : b_{21}

Source S1 Concentration : $C_{S1} = a_{11} \times b_{11} \times C_{M1}$

Source S2 Concentration : $C_{S2} = a_{21} \times b_{21} \times C_{M1}$

Figure 2 : Example of transfer functions

Notation

For any given meteorological condition, the transfer functions are defined using the following notation :

i index of source S_i
j index of sensor j
C_{Si} concentration emitted by source S_i
C_{Mj} concentration measured by sensor j
X_{ij} concentration measured at sensor j proceeding from source i
a_{ij} contribution rate
b_{ij} dilution rate
f_{ij} transfer function = $a_{ij} \times b_{ij}$

Real-time management of odour nuisance

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Preventing the propagation of odorous compounds such as Total Reduced Sulphur compounds (TRS) is a real challenge for the SIAAP (Syndicat Interdépartemental pour l'Assainissement de l'Agglomération Parisienne = the public body that manages sanitation systems around Paris), trying to reduce nuisances for the nearby populations. Since the beginning of the 90s, an Environment Observatory has been established but until 2009, the monitoring was mainly supported by systematic actions. They do not allow a continuous follow-up in time and space of the odorous pollution of the plant.

The SYPROS numerical system was therefore developed in order to improve the odours monitoring on sites by a real-time and forecasting management of the odour nuisance.

The real-time management of odour nuisance on waste water treatment plant use a 3D simulation tool coupled to on-site sensors

SYPROS includes three functions :
- A «real time» function to produce uninterrupted and up-to-date odour concentrations maps on the surroundings of the sites.
- A «forecast» function to predict the episodes of bad smells according to weather forecast as well as events on site such as maintenance.
- A «diagnosis» function to model an odorous event knowing the circumstances (emission, weather conditions) leading to it for a better understanding of the mechanisms of transport and dilution in the ambient air.

With the conception of a model that couples CFD model, Lagrangian model to real-time adjustment (thanks to dynamic continuous entry data), it is now possible to forecast and to follow in real-time the odour dispersion around the Seine aval WWTP, which represent a major improvement regarding neighbourhood's relationships as well as the site management and planning.

SIAAP key figures

The S.I.A.A.P., central authority for water treatment in Paris region, treats every day 3 million m³ of water in 5 plants including the massive Waste Water Treatment Plant (WWTP) Seine aval located in Achères, which 1.8 M m³/day of flow rate treated makes it the largest in Europe.

SYNDICAT INTERDÉPARTEMENTAL POUR L'ASSAINISSEMENT

SIAAP
DE L'AGGLOMÉRATION PARISIENNE