EOLI

WP 7 : Supervision System development

Deliverable D 7.2 : Software platform able to dialog with the inputs and outputs of the diagnosis and control algorithms

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1. Introduction

This document presents the solution retained in terms of software platform to be used within the EOLI project. It presents the INRA-home-made software platform developed for being used within the EOLI project for the Decision Support System. As such, it can be considered as the "non-integrated version of the EOLI DSS software platform".

2. The software structure

The software described herebelow has been developed using the Guide User Interface of MATLAB 6.5. It uses the algorithms described in the EOLI deliverable D7.3 and follows the general structure of the supervision system described in the EOLI deliverable D7.1. Since this software is a non-integrated version only used at the LBE, it has been developed in French. Of course, the final version that is to be developed and delivered by SPES for EOLI will be in English.

This software allows the user to :

- Access all the on-line data saved in a database (via a secured network) and save locally these data on the actual computer in order to analyze them using the algorithms presented within the framework of the EOLI deliverable D7.3;
- Visualize the on-line data saved locally (DO, pH, Redox cycle per cycle);
- Reconfigure the classification parameters of each cycle;
- Change the drawing parameters of the data of all the available cycle to allow a better understanding of them;
- Simulate the system under different conditions with a model based on standard IWA activated sludge models (ASM1);
- Visualize the results of the classification realized with the software with a PCA;
- Visualize dynamically the evolution of each cycle with respect to a number of problems to be detected;
- Visualize and analyze the data available about the settling of the sludge (comparison of the final height of the sludge after a given time, initial velocity of the settling for each cycle, etc…);
- Optionally to change the duration of the different aerobic and anoxic phases of the SBR (available when the computer is connected to the SBR input/ouput devices).

The software in itself is made of 20 m-files, a number of data and dll-files using the exchange XML format defined by SPES to access the database (which uses the MySQL structure defined by SPES as well). The detailed description of the files as well as their interaction structure are given in the appendix.

3. Using the software

We restrict here our attention to the most important functions realized by the software and to the description of its main interface windows. Detailed description of its use will be delivered in the EOLI deliverable D7.5 under the form of a technical documentation and a user guide more specifically related to the final compiled version to be delivered by SPES.

Main window

When the program is launched (from the MATLAB prompt using the eoli.m function), the following main window appears :

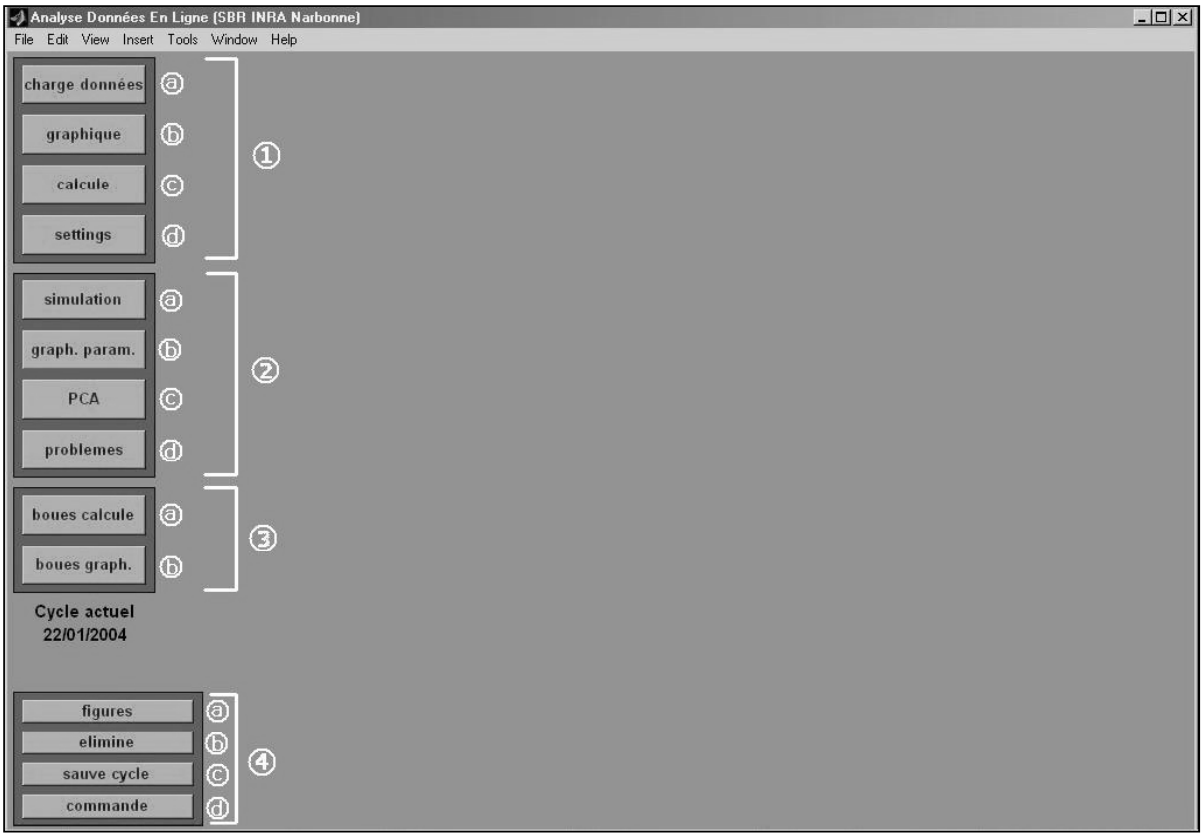


Figure 1 : *Main window of the DSS*

1) Is used to load data and to set a number of parameters to visualize them.
   a) Is used to load the data of interest (assuming they have been first loaded from the database using the button group (4)).
   b) Is used to plot the loaded data.
   c) Is used to compute the parameters Ti and Hi (cf. D7.3) of the loaded cycle.
   d) Is used to set visualization parameters : only useful if the loaded cycle is different from a standard cycle.
2) Is used to simulate and use the PCA abilities of the software for the classification of a set of cycles.
   a) Is used to specify different conditions from the standard ones and simulate the system.
   b) Is used to compare the parameters Ti and Hi of the specified cycles to be analyzed with respect to their standard values.
   c) Is used to apply the PCA using either the model or the data-based approach.
   d) Is used to visulalize the results of the classification of the set of pre-specified cycles.
3) Is used toi study the settling of the sludge.
   a) Is used to compute the classification parameters (related to the sludge) of each loaded cycle.
   b) Is used to compare the settling capabilities of the specified set of cycles and to detect potential problems.
4) Is used to access the process database (available when connected to the INRA-LBE internal network)
   a) Is used to pre-visualize the data of the loaded cycle.
   b) Is used to remove a loaded cycle.
   c) Is used to locally save a cycle (that will be further loaded for analysis using the button group (1))
   d) Is used to change the phase duration of the process when working in a constant sequential mode (available when the computer is directly connected to the process).

The loaded data can then be plotted cycle per cycle using a number of graphical settings and the classification parameters Ti and Hi are computed.

The selected are plotted as shown in figure 2.

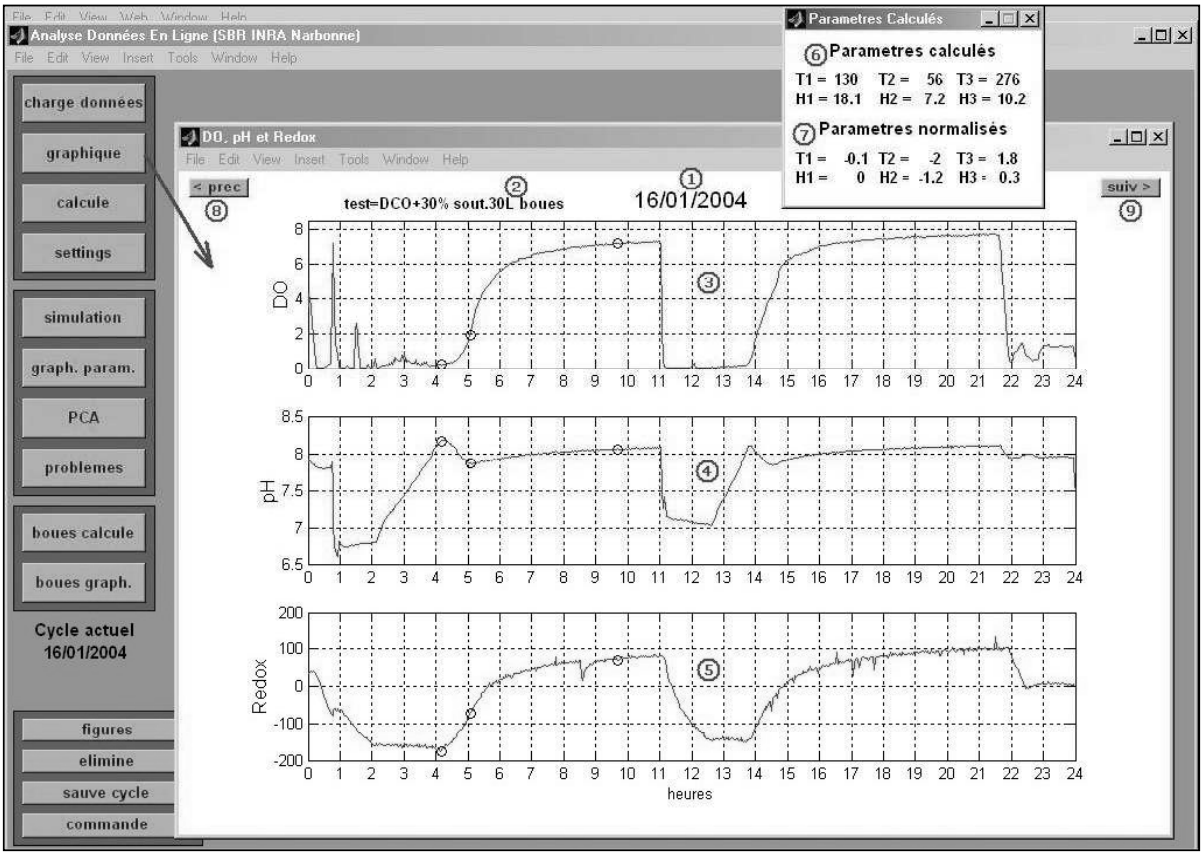


Figure 2 : *Plotting loaded data*

1) Date of the loaded cycle (day/month/year) [*nome*][1].
2) Comments attached to the loaded cycle (if any) [*mem_comments(x,:)*].
3) DO figure (circles indicate T1, T2 and T3) [*A2004_01_16(:,2)*].
4) pH figure [*A2004_01_16(:,4)*].
5) Redox potential figure [*A2004_01_16(:,1)*].
6) T1, T2, T3, H1, H2 and H3 parameters [*memoria(x,:)*].
7) T1, T2, T3, H1, H2 and H3 normalized with respect to simulation results [*memoria_norm(x,:)*].
8) and 9) previous and next loaded cycles.

In the second group of buttons, the user will find in particular all functions needed for the classification of the cycles with respect to standard cycles. Notice that it is possible to plot here the dynamical evolution of the different parameters Ti and Hi for a set of specified cycles. Now, let us go directly to the PCA analysis part. When clicking on the PCA button, the window represented in the figure 3 appears. Two options are possible : either the model or the data-based supervision approach is possible. In any case, a number of setting parameters are entered : for the model-based approach, all parameters can be changes or optimized using the simulation button while the cycles to be used for the PCA for the data-based approach are written by hand using the frame (7) in indicated figure 3. Once all parameters have been set, the user can click the button "OK" to run the PCA. An example of the results obtained using the model-based approach is pictured in figure 4. Both the cycles used for the PCA and the cycles to be analyzed projected into the new space are plotted. The distance of each projected cycle to the standard ones can be plotted using the "problemes" button where the related identified problem are specified for each cycle (cf. figure 5).

[1] Thoughout this document, the name of the corresponding variable in the workspace is indicated in italic between brackets.

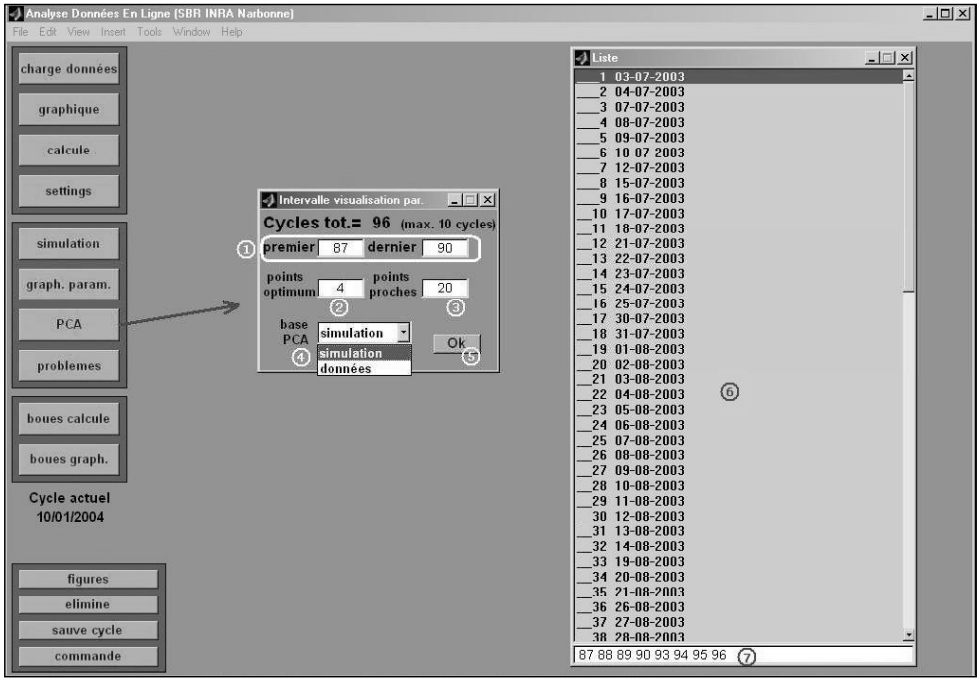


Figure 3 : *Plot data*

1) Is the real cycle to be classified [*proj_pr_ul(1,1:2)*].
2) During the analysis, a cycle is considered as "OK" (a cycle without any problem detected or, in other terms, a cycle which is close from a standard cycle) if one of the i closest cycles is known to be "OK" (in figure 3, i=4) [*point(1,1)*].
3) During the classification step, a cycle is compared to the i closest simulated (or extracted from the database) cycles (here i=20) [*point(1,2)*].
4) The user chooses if he uses the model or the data-based approach (in the case of the data-based, the minimum number of analyzed cycles should be 6) [*choix*].
5) Start the PCA.
6) List of available locally loaded cycles and corresponding comments.
7) Real cycles to be chosen in the case the data-based approach is used [*lista_cicli_reali*].

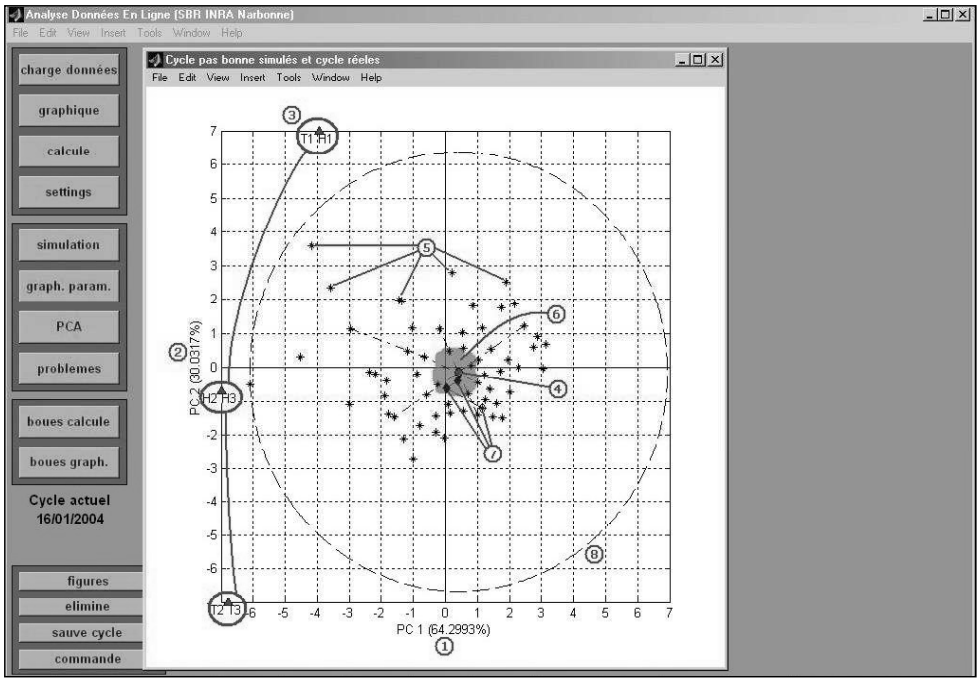


Figure 4 : *Plot the model-based PCA results*

1) First PC axis (and corresponding variance [*exp_ssq(1,3)*]).
2) Second PC axis (and corresponding variance [*exp_ssq(2,3)*]).
3) Direction of the classification parameters in the PCA space [*z_new(:,1:2)*].
4) The red circle indicates the simulated standard case [*exp_scores(dernier,1:2)*].
5) Black stars represent the simulations [*exp_scores(x,1:2)*].
6) The green zone is the zone where a point is considered as "OK" (normal or standard case).
7) Triangles or blue diamants are the projection of real cycles (if it is full, it means that the corresponding cycle has been classified as "OK") [*memoria_scores(x,1:2)*];
8) The black circle represents the distance between the standard cycle and the farest simulated point : since the most problematic cases are systematically simulated, all projections of real cycles should be at the interior of this circle. If it happens, it is expected that a very big problem occured. [*distanza*].

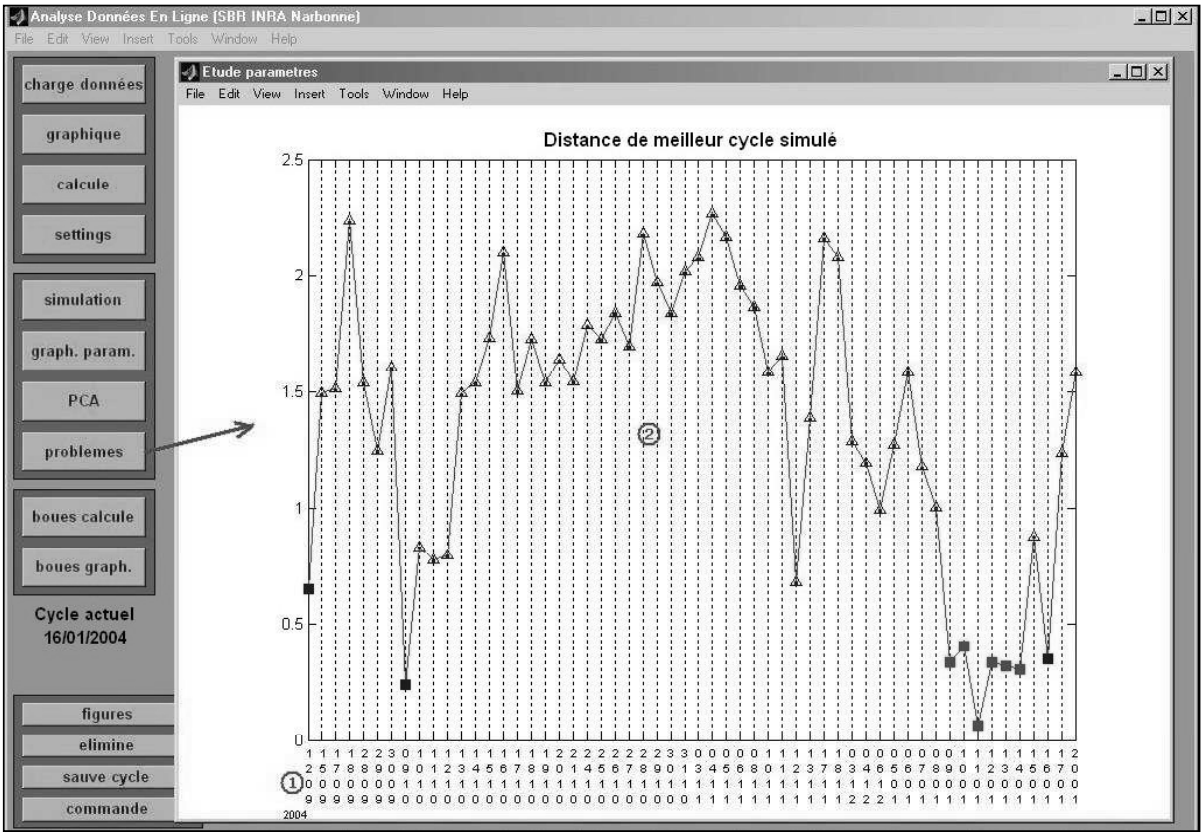


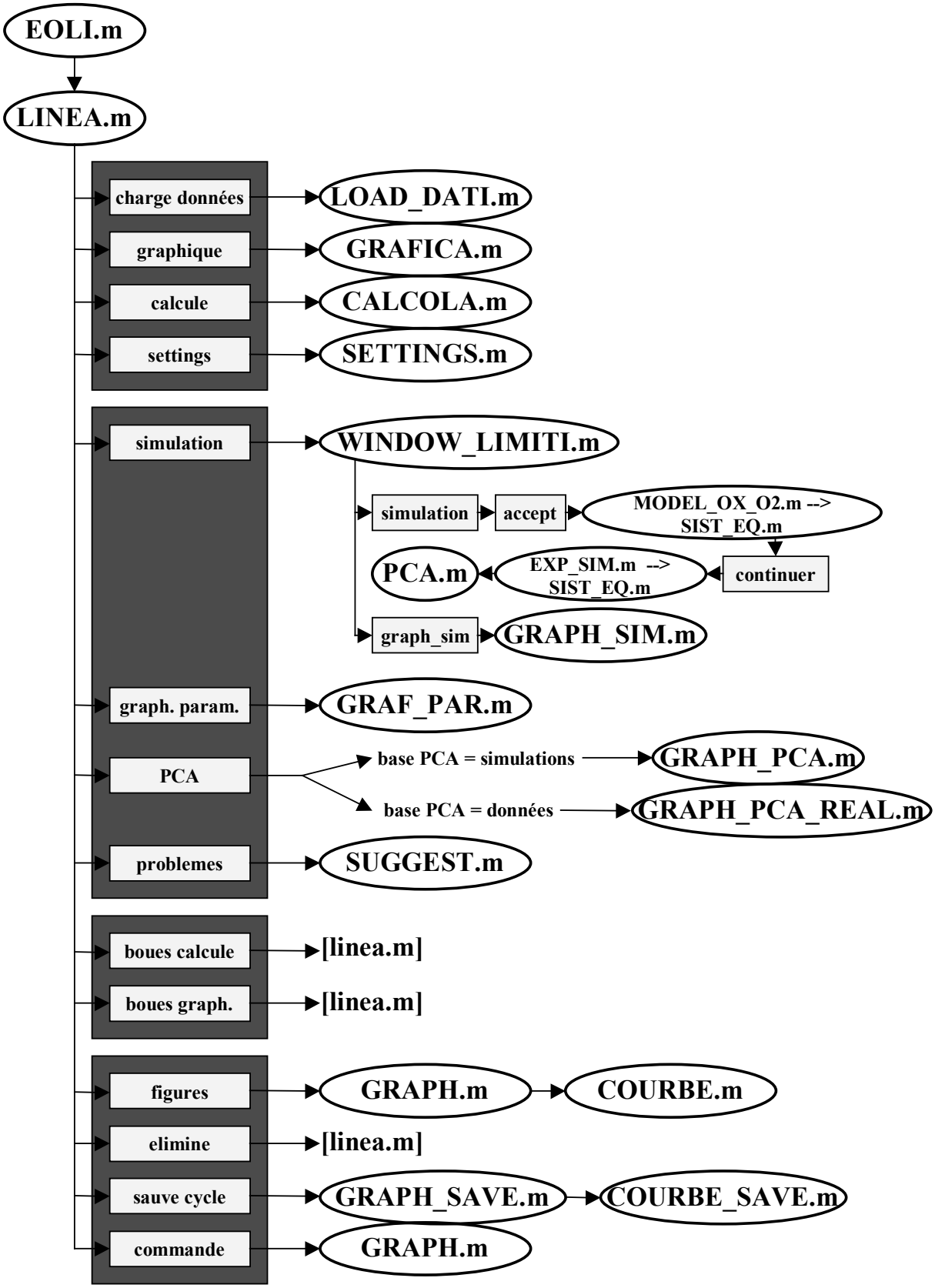
Figure 5 : *PCA results : potential problems identified for each analyzed cycle*

1) List (by date) of the cycles that have been analyzed (day and month) [*giorno(dist_pr_ul(1,1),dist_pr_ul(1,2))*].
2) Distance between the standard cycle and the corresponding analyzed cycle [*mem_dist(dist_pr_ul(1,1),dist_pr_ul(1,2))*]:
   - Triangles represent problematic cycles (the problem is identified by clicking on the date (on the x-axis)).
   - Blue squares are cycles classified as "OK".
   - Red cycles are cycles used as standard in the simulation.

The same abilities for the sludge characteristics are available using the button group (3) of the figure 1. Finally, the button group (4) can be used to access the database (only available if the actual computer is connected on the INRA-LBE network, to save or remove data on the actual computer or to change the duration of the different phases of the LBE SBR pilot plant (only available if the actual computer is connected to the input/output device of the pilot process.

Appendix : detailed description of files used in the software

Global structure of the program



Alphabetic list of matlab files

- CALCOLA.m
- COURBE.m
- COURBE_SAVE.m
- EOLI.m
- EXP_SIM.m
- GRAF_PAR.m
- GRAFICA.m
- GRAPH.m
- GRAPH_PCA.m
- GRAPH_PCA_REAL.m
- GRAPH_SAVE.m
- GRAPH_SIM.m
- LINEA.m
- LOAD_DATI.m
- MODEL_OX_O2.m
- PCA.m
- SETTINGS.m
- SIST_EQ.m
- SUGGEST.m
- WINDOW_LIMITI.m