PERSALYS, the graphical interface of OpenTURNS

M. Baudin [1] T. Delage [1] A. Dumas [2] A. Dutfoy [1]
G. Garcia [2] A. Geay [1] O. Mircescu [1] A. Ladier [2]
J. Schueller [2] T. Yalamas [2]

[1]EDF R&D. 6, quai Watier, 78401, Chatou Cedex - France, michael.baudin@edf.fr

[2]Phimeca Engineering. 18/20 boulevard de Reuilly, 75012 Paris - France, yalamas@phimeca.com

19 June 2020, OpenTURNS User's day

Contents

Bring Uncertainty Methodology to Engineers

- 5 years ago
  - EDF R&D wants to maximize the use of OpenTURNS® by its engineer/researcher (and improve an existing GUI) => develop a GUI to make more easy to use
  - Phimeca has already developed an "OpenTURNS GUI" (PhimecaSoft®) which satisfy some needs of EDF R&D but not all.
  - EDF R&D and Phimeca decide to start a specific partnership in order to develop a new GUI based on OpenTURNS® and "Salome Tools": Paraview, Yacs, ...
- Persalys is available, on Salome website, in EDF Specific Salome version and commercialized by Phimeca

Some expectations regarding the GUI

- As easy to use as possible and, when it is possible, a GUI which can guide the user
- Possibility to use it inside Salome Platform to
  - Use supercomputing resources (e.g. Gaïa, 3 052 Tflops peak, 41 000 cores)
  - Connect to EDF numerical code users (Code_Aster for example)
- Take benefit from the advanced visualization capability from Paraview
- Drive the GUI from a python script usable in an "expert" mode

PERSALYS, the graphical user interface of OpenTURNS

- Main goal : provide a graphical interface of OpenTURNS in the SALOME integration platform
- Features
  - Uncertainty quantification : definition of the probabilistic model (including dependence), distribution fitting (including copulas), physical model with vector input and vector output or 1D Fields, central tendency, sensitivity analysis, probability estimate, metamodeling (polynomial chaos, kriging), screening (Morris), optimization, design of experiments
  - Generic (not dedicated to a specific application)
  - GUI language : English, French
- Partners : EDF, Phiméca
- Licence : LGPL
- Schedule :
  - Since summer 2016, one EDF release per year
  - On the internet (free) : SALOME_EDF in the "CONTRIBUTIONS" section since 2018 on `https://www.salome-platform.org`

Calibration

Given a physical model H, observed inputs x, observed outputs y we can calibrate θ so that

$$y_i = H(x_i, \theta) + \epsilon$$

where ϵ is a random variable.
Calibration outputs:

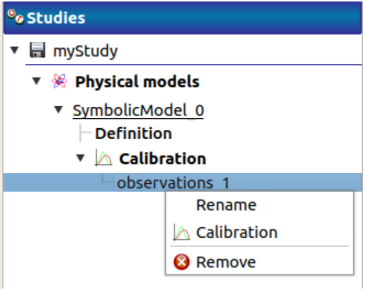
- the optimal value $\theta^\star$,
- the distribution of $\theta^\star$,
- the distribution of the residuals $r_i = y_i - H(x_i, \theta^\star)$.

This allows to get confidence intervals of $\theta^\star$.

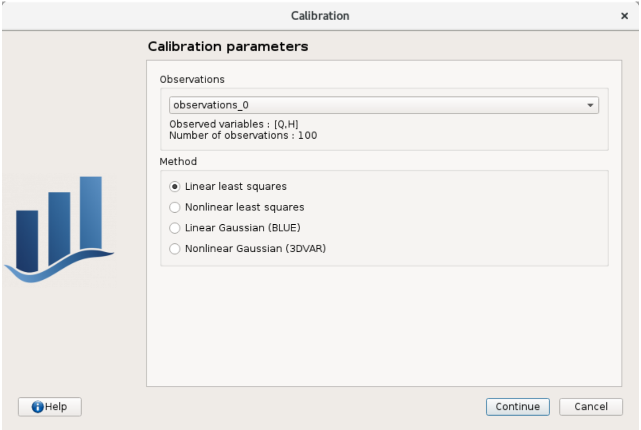
Calibration

In PERSALYS, this requires:

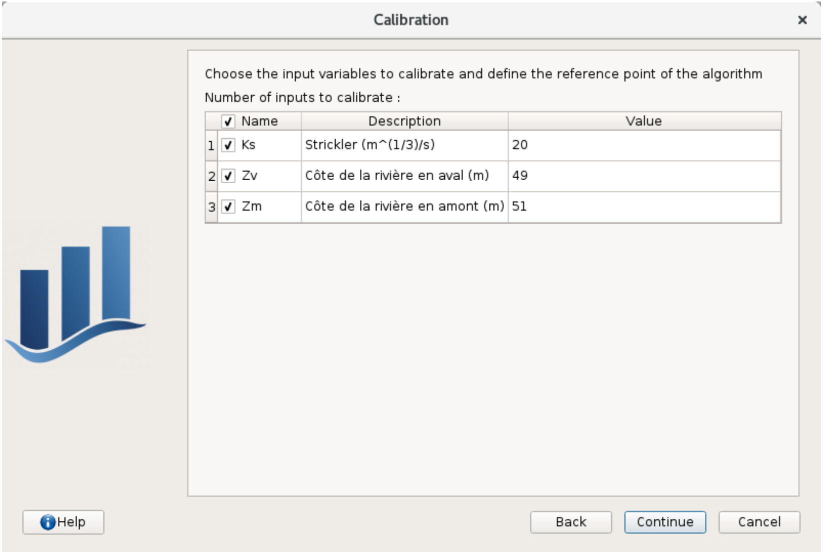
- a physical model H,
- a data file containing the observed inputs and outputs.



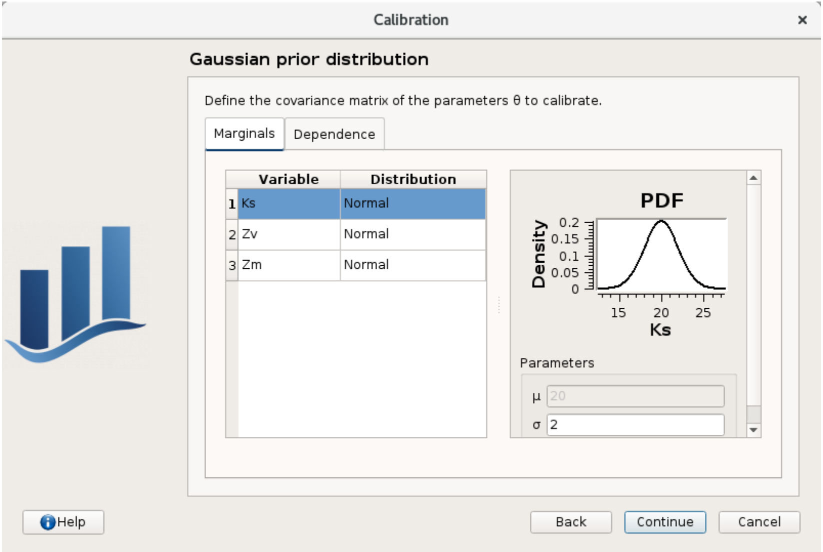
Calibration



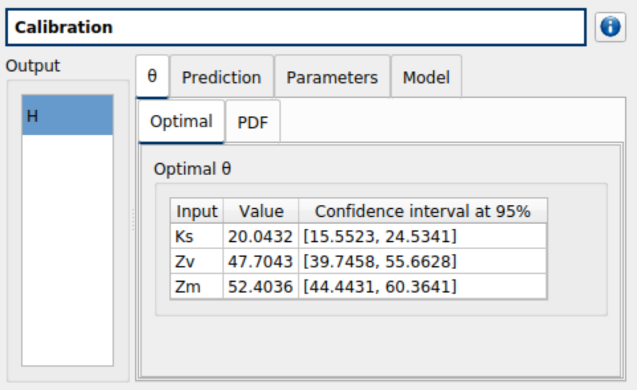
Calibration



Calibration

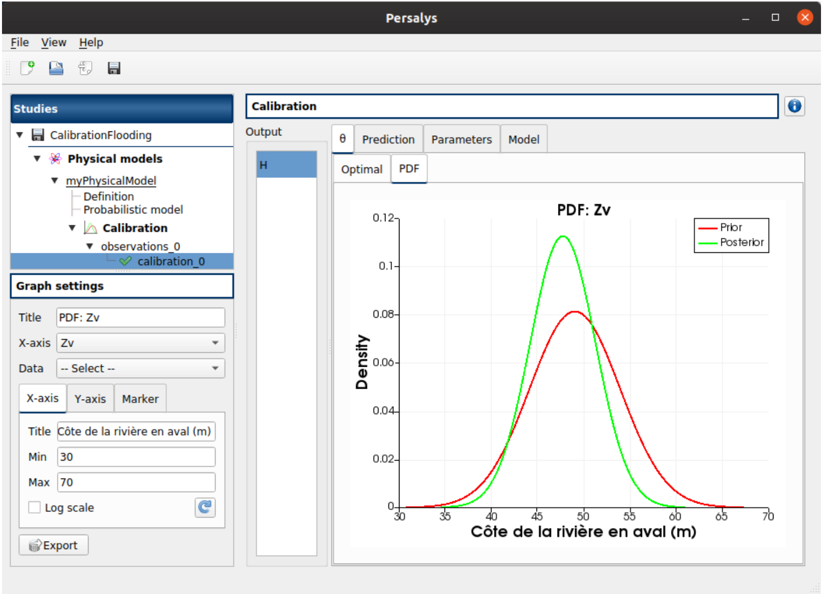


Calibration

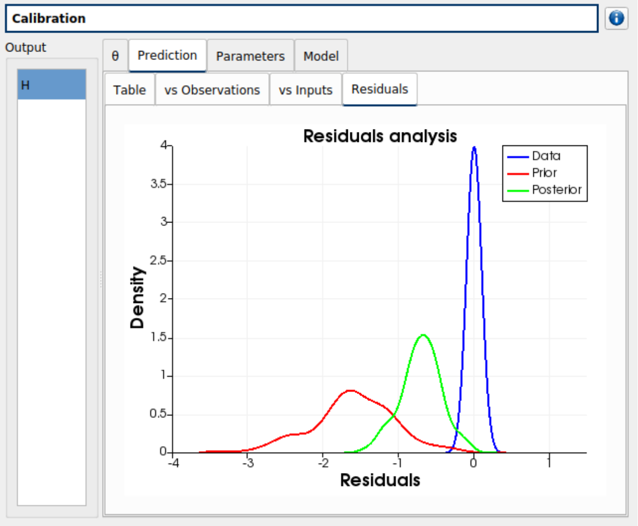


Input	Value	Confidence interval at 95%
Ks	20.0432	[15.5523, 24.5341]
Zv	47.7043	[39.7458, 55.6628]
Zm	52.4036	[44.4431, 60.3641]

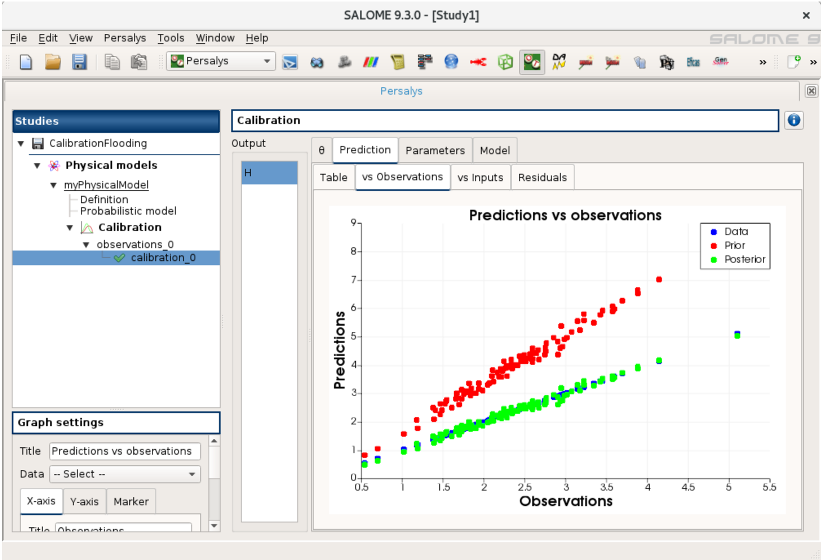
Calibration



Calibration



Calibration

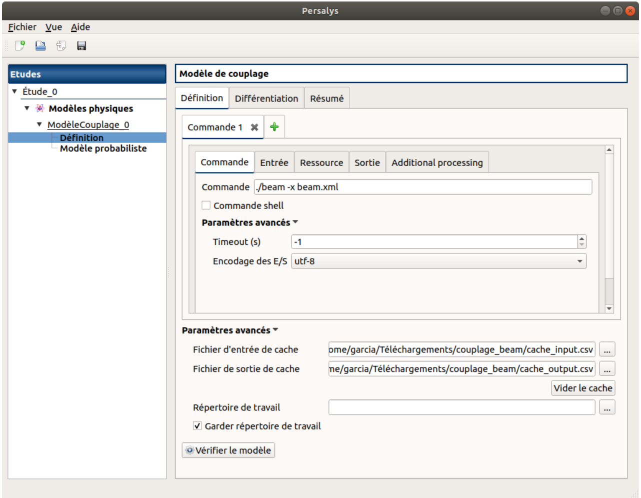


Coupling with external code

A new physical coupling dialog was created:

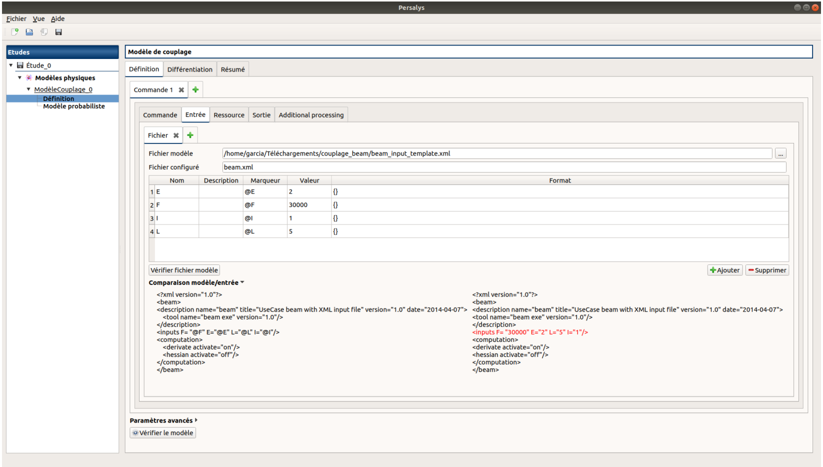
- Execute any computer code from system e.g. with command line statement
- Create a pipeline of commands
- Exchange data with input and output files
- Manage input and output cache to save simulations
- Can be parallel : multithread or distributed (in SALOME)
- Makes the tuning of input template file and the reading of output files easy

Coupling with external code



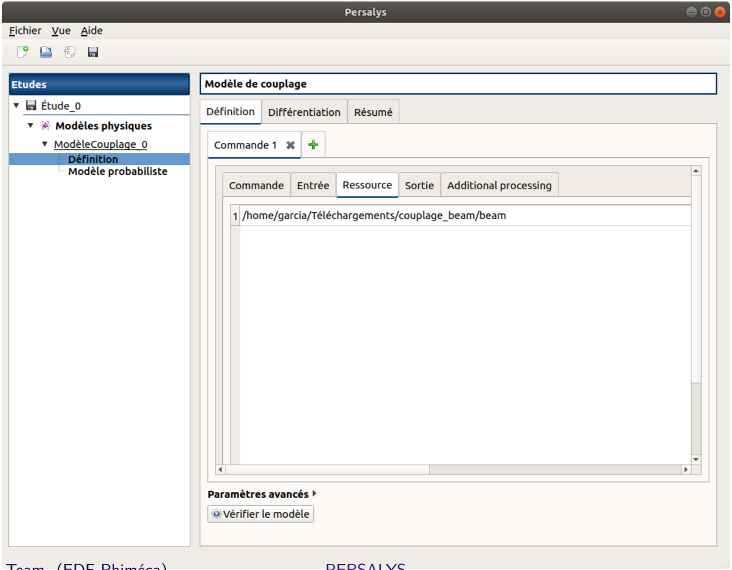
Coupling with external code

A diff can be generated between the input template and the actual input file.

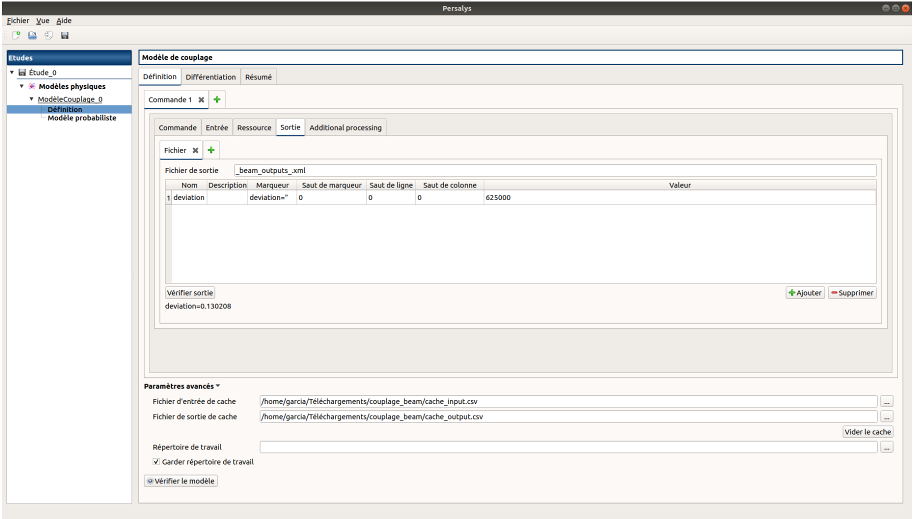


Coupling with external code

Resources are files to copy to run the simulation : mesh, parameters, etc...

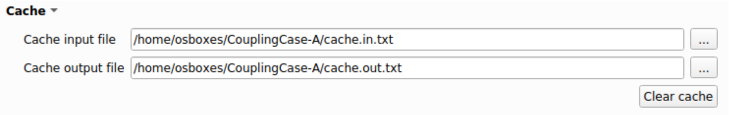


Coupling with external code



Coupling with external code

On-disk cache management: one input point X is only evaluated once.



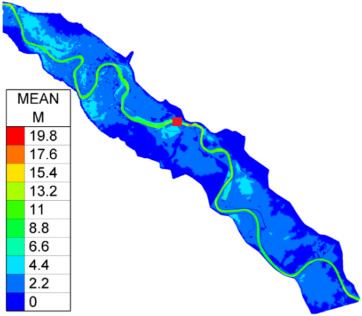
Website

`persalys.fr` : download (source, binaries), doc (videos tutorials), news

What's next ?

PERSALYS Roadmap :

- 2D Fields, 3D Fields
- In-Situ fields based on the MELISSA library (with INRIA): when we cannot store the whole sample in memory or on the hard drive, update the statistics (e.g. the mean, Sobol' indices) sequentially, with distributed computing.
- Linear regression.



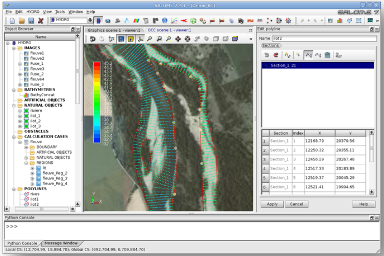
The end

Thanks !

Questions ?

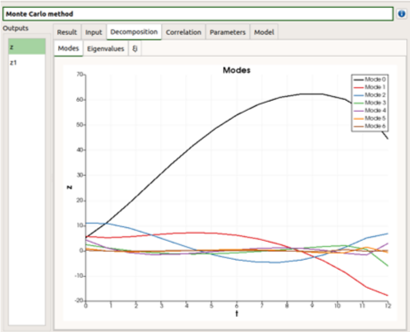
SALOME

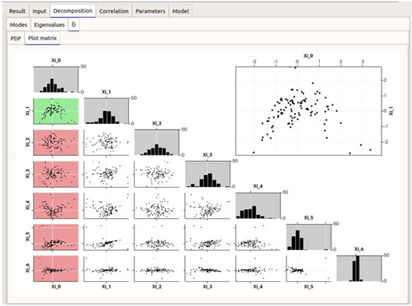
- Integration platform for pre and post processing, and 2D/3D numerical simulation
- Features : geometry, mesh, distributed computing
- Visualization, data assimilation, uncertainty treatment
- Partners : EDF, CEA, Open Cascade
- Licence : LGPL
- Linux, Windows
- `www.salome-platform.org`



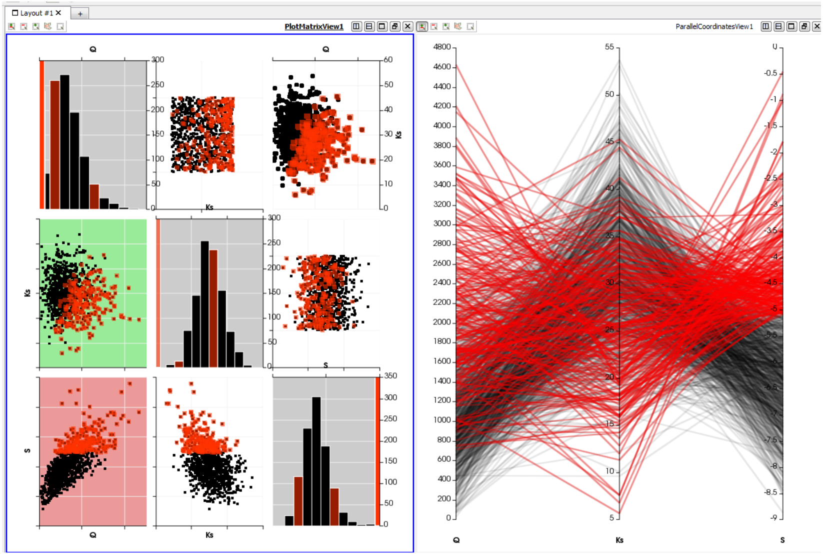
PERSALYS: 1D fields

- Karhunen Loeve decomposition
- Show modes, eigenvalues and projection coefficients



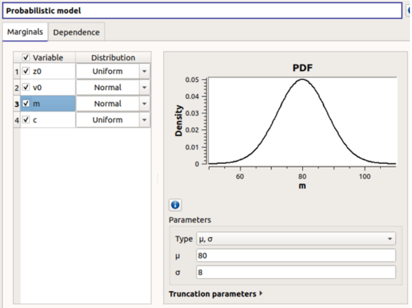


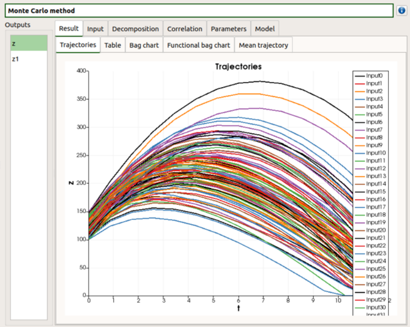
Interactive uncertainty visualization with Paraview



1D fields

- Probabilistic model
- Uncertainty propagation with simple Monte-Carlo sampling





1D fields

- BagChart and Functional Bagchart (from Paraview) based on High Density Regions (Hyndman, 1996).
- To do this, Paraview uses a principal component analysis decomposition.
- Linked and interactive selections in the views.