# Opus Terra™

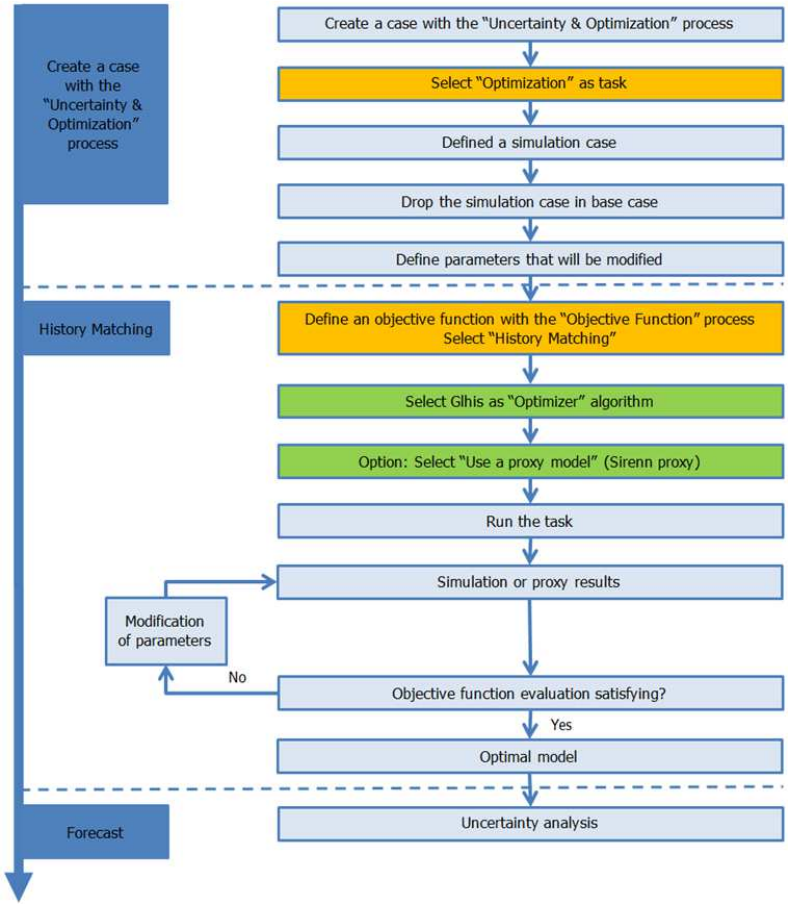
## Optimization & Uncertainty Solutions

Opus Terra™ (Optimization & Uncertainty Solutions) toolbox is a plug-in for Petrel* for optimization and uncertainties problems. Opus Terra™ is fully integrated in Petrel and can be used with all Petrel supported reservoir simulators. The Opus Terra™ toolbox aims to improve the workflows of reservoir engineering using various tools (proxy and optimizer).

Opus Terra™ allows **matching simulations with production data** via an optimizer. For example, Opus Terra™ can be used to describe the geological and/or geometrical properties of the reservoir by calibration of the production history (History Matching).

Opus Terra™ allows **optimizing field development** via a minimization or maximization of an objective function. For example, Opus Terra™ can be used to optimize wells placements, production rates ... The objective function can be defined with the "Objective function" process of Petrel, for example the maximization or minimization of the cumulative production, the net present value, the recovery fraction of either Oil volume, Gas volume or Hydrocarbon volume …

Opus Terra™ allows **analyzing uncertainties** using a proxy. Opus Terra™ allows bypassing time consuming reservoir simulations, while maintaining a good approximation of results. This can be very useful uncertainty analysis which requires huge amounts of reservoir simulations.




Opus Terra™ contains two plug-ins: Sirenn™ and Glhis™.

**Sirenn™ (Simulator Reservoir Neural Network)** is a very powerful and flexible tool to build proxy models of reservoir simulators. The proxy models are developed using artificial neural networks.

**Glhis™ (Global History Matching)** is a powerful and flexible tool to optimize many reservoir engineer problems. The optimizer is a global optimization method: CMA-ES (Covariance Matrix Adaptation – Evolution Strategy). The algorithm used is known as one of the most efficient for strongly nonlinear problems and as one of the best metaheuristics for continuous problems. The Covariance Matrix Adaptation - Evolution Strategy (CMA-ES) has been tested successfully on different reservoir engineer problems.

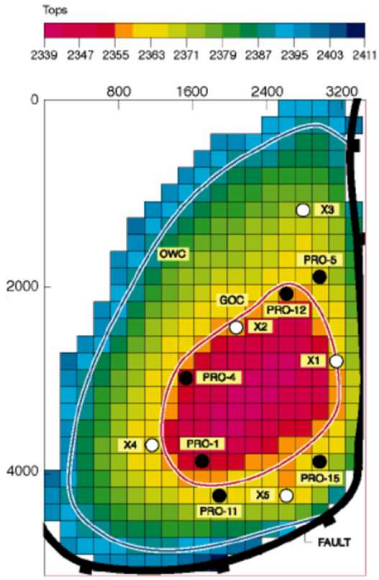
Example of a History Matching workflow - Opus Terra™ is **fully integrated in "Uncertainty & Optimization" process of Petrel**. You can improve your workflow by using the Opus Terra™ functionalities.

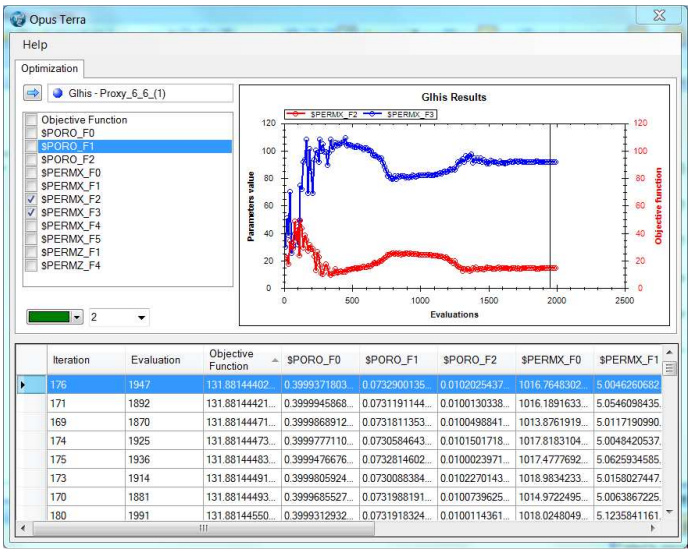
* mark of Schlumberger

# Application on the PUNQ-S3 model

The PUNQ-S3 case has been taken from a reservoir engineering study on a real field performed Elf Exploration Production. It was qualified as a small-size industrial reservoir engineering model.

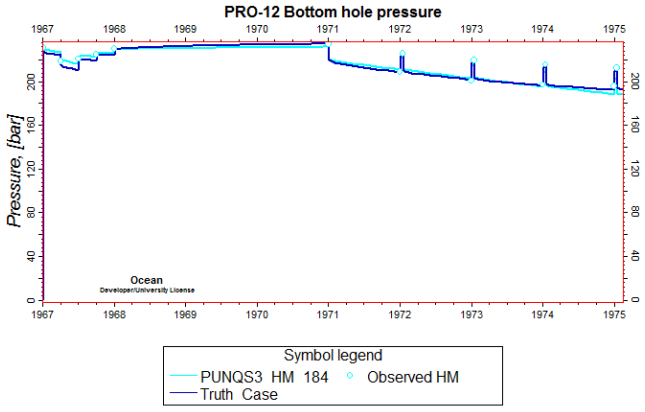
The geological parameters of PUNQ-S3 are the porosities, the vertical and horizontal permeabilities. The parameterization of PUNQ-S3 model is based on the geological description. We consider each facies, as describe in the geological description, and we estimates the constante properties for each facies: 18 porosities parameters.



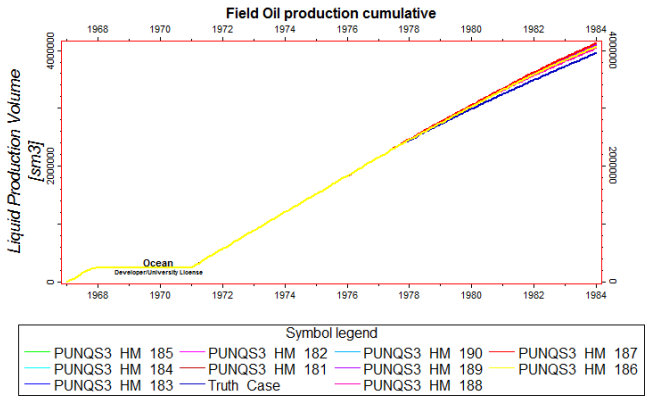




**Convergence of the optimization using Glhis™ on a Sirenn™ proxy of the objective function.**

All parameters and the objective function are displayed. All iterations are stored in a spreadsheet. Iterations can be sorted by clicking on head column, for example sort the iterations by the objective function value. By clicking on a row, the iteration is shown on the graph.




**Data Match.** Production data generated from model realizations based on an optimizer solution.




**Quantification of uncertainties in cumulative oil production for the total 16.5 year production period using Sirenn™.** Prediction obtains with 10 different solutions.

Acknowledgement
The PUNQ-S3 case is based on a real field example provided by Elf Exploration Production.