

# Demonstration of GLOBAL

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# Outline

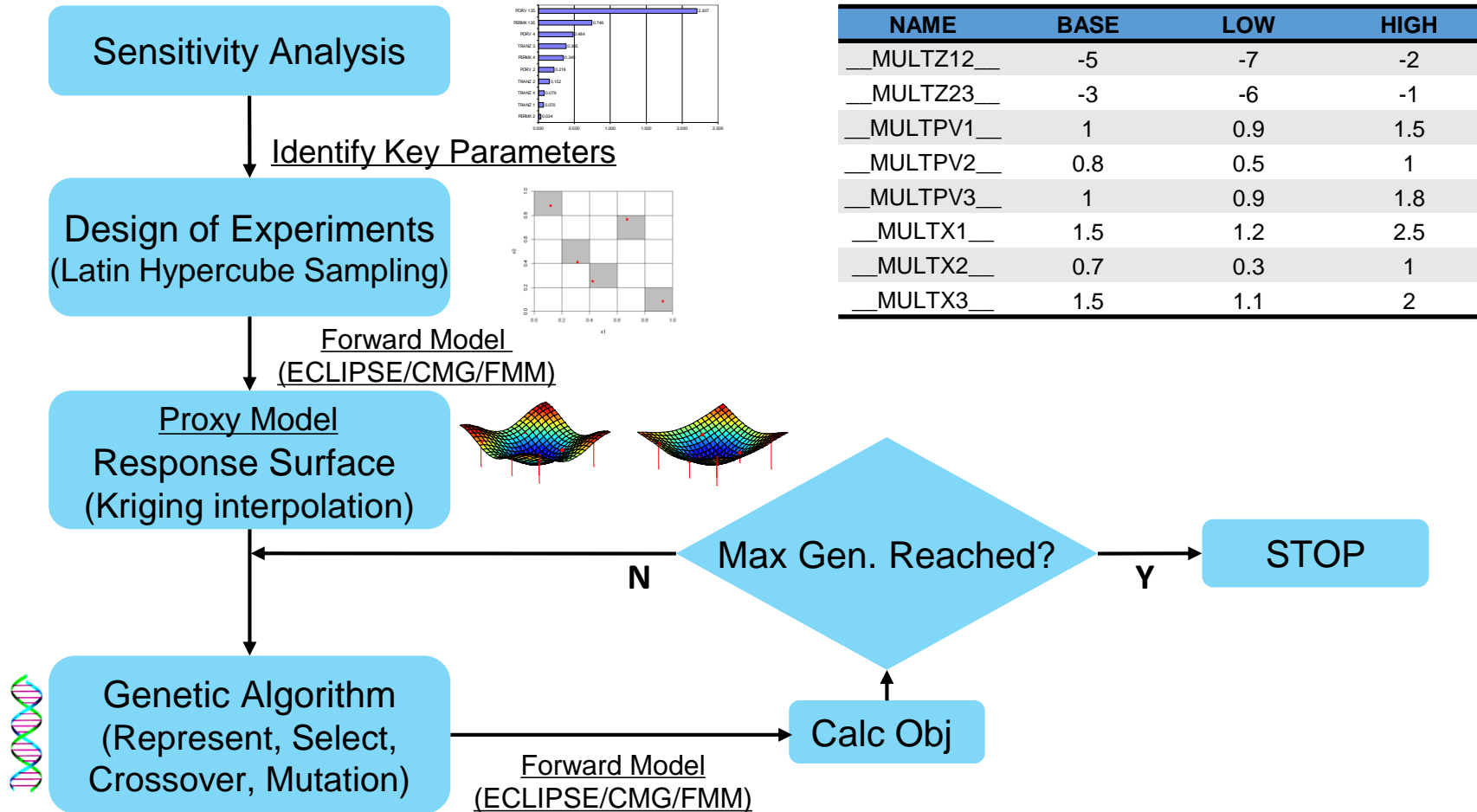
- Introduction
- Global Algorithm
- Eclipse Model Description
- Global Workflow
- View Global Results
- Global GUI

# Introduction

- GLOBAL is a History Matching software based on a derivative-free method
- Options for Forward Models – FMM, ECLIPSE and CMG
- It uses algorithms of Latin Hypercube Sampling, Genetic algorithm, Kriging, etc
- Developed in C++ and C# (for GUI)
- Can be implemented in both Windows and Linux

# Global Algorithm

✓ GA based Optimization Software

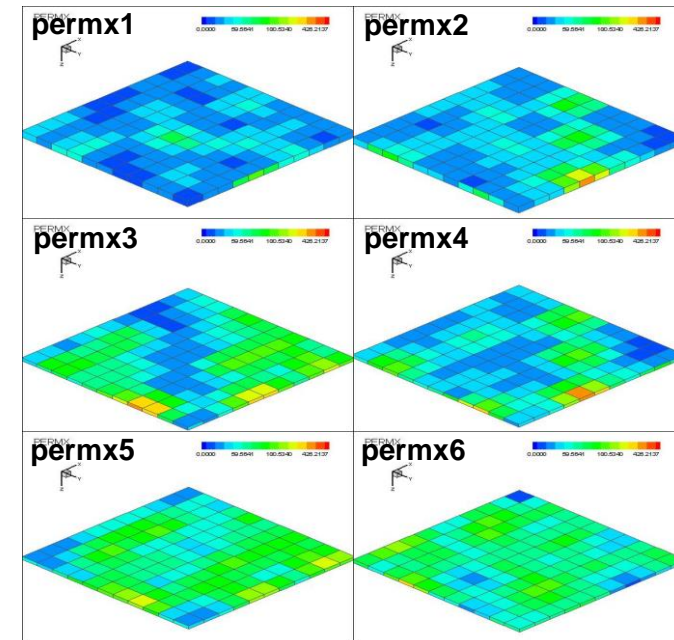
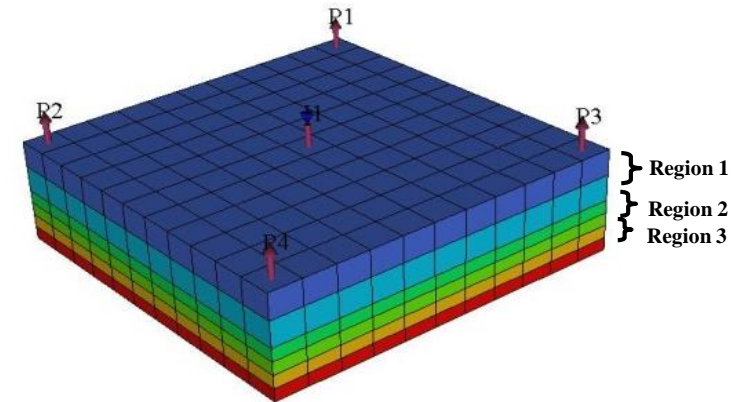


NAME	BASE	LOW	HIGH
__MULTZ12__	-5	-7	-2
__MULTZ23__	-3	-6	-1
__MULTPV1__	1	0.9	1.5
__MULTPV2__	0.8	0.5	1
__MULTPV3__	1	0.9	1.8
__MULTX1__	1.5	1.2	2.5
__MULTX2__	0.7	0.3	1
__MULTX3__	1.5	1.1	2

# ECLIPSE Synthetic Case

## Model for synthetic case

- 3D three-phase reservoir
- Grid blocks:  $11 \times 11 \times 6$
- One injector and four producers
- Three global regions defined by model layers (1-2, 3-4, 5-6)
- **Uncertain Parameters:**
  - pore volumes (regions 1-3)
  - horizontal permeability (regions 1-3)
  - vertical transmissibility (x2)



# Workflow Steps

- Identify global unknowns
- Construct Template Files (.TMPL)
- Construct Distribution File (.DISTR)
- Prepare GLOBAL Input file (.INP)
- Run GLOBAL in command prompt window
- View Objective file (\*.OBJ)

# STEP 1: Construct Template Files (.TMPL)

**.TMPL**

MULTIPLY								
	TRANZ	__MULTZ12__	1	11	1	11	2 /	
	TRANZ	__MULTZ23__	1	11	1	11	4 /	
	PORV	__MULTPV1__	1	11	1	11	1 /	
	PORV	__MULTPV2__	1	11	1	11	3 /	
	PORV	MULTPV3	1	11	1	11	5 /	
<b>Region 1</b>	←	TRANX	__MULTX1__	1	11	1	11	1 /
		TRANY	__MULTX1__	1	11	1	11	1 /
<b>Region 2</b>	←	TRANX	__MULTX2__	1	11	1	11	3 /
		TRANY	__MULTX2__	1	11	1	11	3 /
<b>Region 3</b>	←	TRANX	__MULTX3__	1	11	1	11	5 /
		TRANY	__MULTX3__	1	11	1	11	5 /

- Variables \_\_NAME\_\_ are tokens which are replaced by values to create a valid Eclipse include file
- Templates can be created for any simulator or for any text based application

# \*.TMPL to \*.INC file conversion by GLOBAL

## .TMPL

MULTIPLY							
TRANZ	__MULTZ12__	1	11	1	11	2	2/
TRANZ	__MULTZ23__	1	11	1	11	4	4/
PORV	__MULTPV1__	1	11	1	11	1	2/
PORV	__MULTPV2__	1	11	1	11	3	4/
PORV	__MULTPV3__	1	11	1	11	5	6/
TRANX	__MULTX1__	1	11	1	11	1	2/
TRANY	__MULTX1__	1	11	1	11	1	2/
TRANX	__MULTX2__	1	11	1	11	3	4/
TRANY	__MULTX2__	1	11	1	11	3	4/
TRANX	__MULTX3__	1	11	1	11	5	6/
TRANY	__MULTX3__	1	11	1	11	5	6/
/							



## .INC

MULTIPLY							
TRANZ	9.14E-05	1	11	1	11	2	2/
TRANZ	4.86E-05	1	11	1	11	4	4/
PORV	1.18706	1	11	1	11	1	2/
PORV	0.754902	1	11	1	11	3	4/
PORV	1.44706	1	11	1	11	5	6/
TRANX	1.86784	1	11	1	11	1	2/
TRANY	1.86784	1	11	1	11	1	2/
TRANX	0.516863	1	11	1	11	3	4/
TRANY	0.516863	1	11	1	11	3	4/
TRANX	1.69294	1	11	1	11	5	6/
TRANY	1.69294	1	11	1	11	5	6/
/							

- GLOBAL substitutes variable names GA evolved values
- If there are mathematical expressions, GLOBAL calculates resultant values
- GLOBAL saves resultant file as .INC file for inclusion to ECLIPSE \*.DATA



# STEP 2: Construct DISTRIBUTION File (.DISTR)

--NAME?	BASE	LOW	HIGH	NBIT	LOG10?	CONT?
__MULTZ12__	-5	-7	-2	4	1	1
__MULTZ23__	-3	-6	-1	4	1	1
__MULTPV1__	1	0.9	1.5	4	0	1
__MULTPV2__	0.8	0.5	1	4	0	1
__MULTPV3__	1	0.9	1.8	4	0	1
__MULTX1__	1.5	1.2	2.5	4	0	1
__MULTX2__	0.7	0.3	1	4	0	1
__MULTX3__	1.5	1.1	2	4	0	1

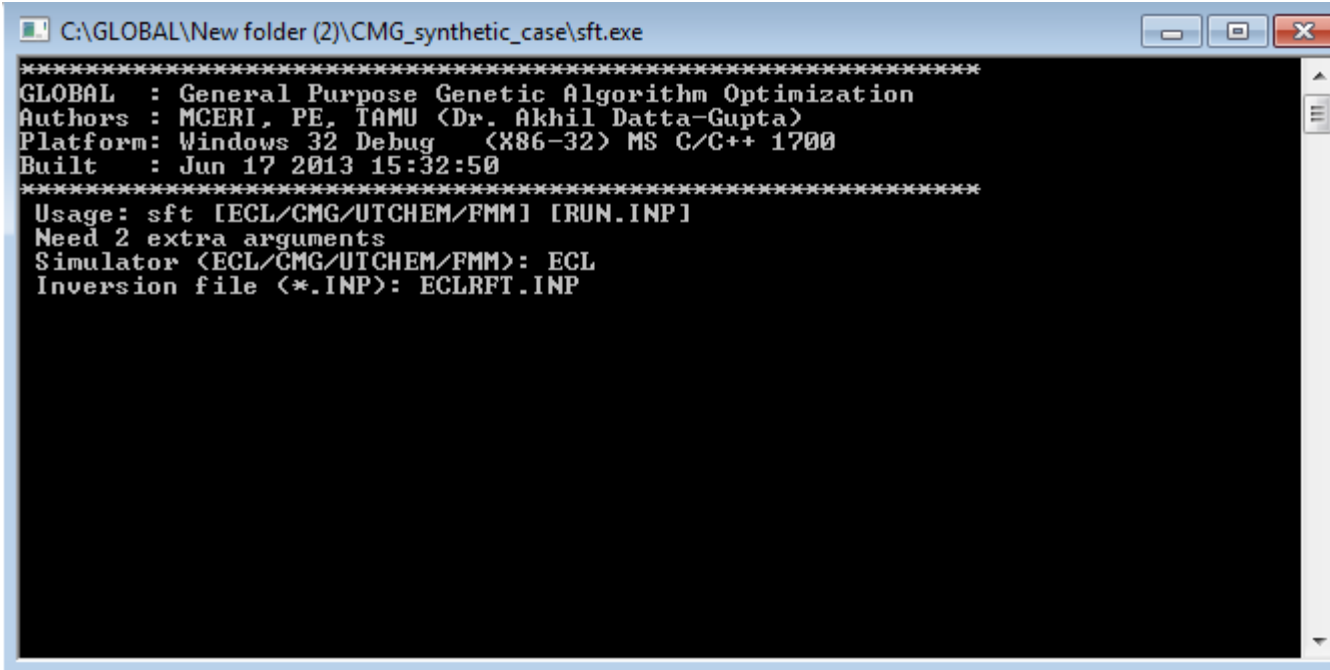
- **BASE** – sensitivity analysis as baseline in the Tornado diagram
- **LOW/HIGH** – lower and higher bounds of variables
- **NBIT** – number of bits used to represent current variable in a genome binary string
- **LOG10** – whether base/low/high values in current row are after log10
- **CONT** – whether this variable is continuous (1) or discrete (0)

# STEP 3: Prepare input file (.INP)

DIP_STUDYNAME ECLRFT	<b>Simulator settings</b> ECLIPSE
DIP_OBJECTIVE LPT MDT	<b>Objective settings</b>
DIP_SMRY_OBS1 SCHEDULE	Observed data from WCONHIST (Observed production data prepared in WCONHIST and WCONINJH; Observed MDT data prepared in ECL Office format)
DIP_MDT_OBS1 obs_mdt_office.txt	
-- use first 19 .S* file for HM, rest for prediction DIP_KEY_TSTEP 19 1-19	
DIP_INC_TMPL 1 MULTIPLY.TMPL	<b>Variable settings</b> Templates for variable substitution
DIP_INC_DISTR COARSE.DISTR	Distribution of variables
DIP_PROXY_NED 50 DIP_PROXY_TOL 0.5	<b>Proxy settings</b> NO. of experiment designs Tolerance for proxy check
DIP_GA_REPLACE 0.7 DIP_GA_POPSIZE 50 DIP_GA_NGEN 20	<b>GA settings</b> Elitism algorithm (Bottom 70% replaced) Population size (Even NO.) Max. NO. of generation

# STEP 4: Run global

- Add ECLIPSE into the system path  
`PATH=%PATH%;c:/ecl/macros`
- Double-click on the executable file
- Input "ECL" and "ECLRFT.INP" interactively



```
C:\GLOBAL\New folder (2)\CMG_synthetic_case\sft.exe
*****
GLOBAL : General Purpose Genetic Algorithm Optimization
Authors : MCERI, PE, TAMU (Dr. Akhil Datta-Gupta)
Platform: Windows 32 Debug (X86-32) MS C/C++ 1700
Built : Jun 17 2013 15:32:50
*****
Usage: sft [ECL/CMG/UTCHEM/FMM] [RUN.INP]
Need 2 extra arguments
Simulator <ECL/CMG/UTCHEM/FMM>: ECL
Inversion file (*.INP): ECLRFT.INP
```

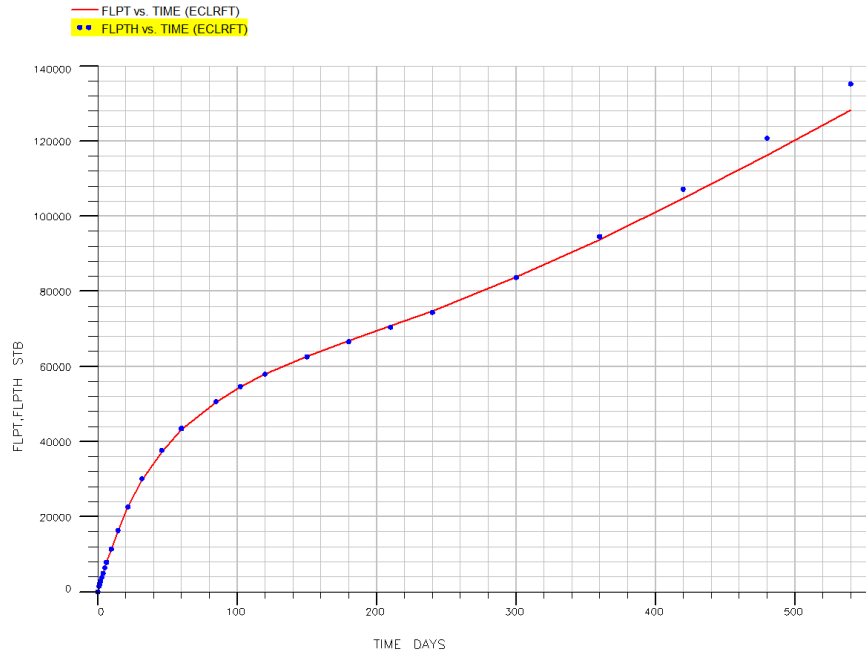
# VIEW OPTIMIZATION RESULTS

- Check results from .OBJ file
- Open .OBJ file by EXCEL and sort by objectives from smallest to largest
- Choose models with smaller objectives.
- Each chosen model is labeled by Run#. You can find the corresponding zip file backed up by the name \*\_####\_Run#.zip

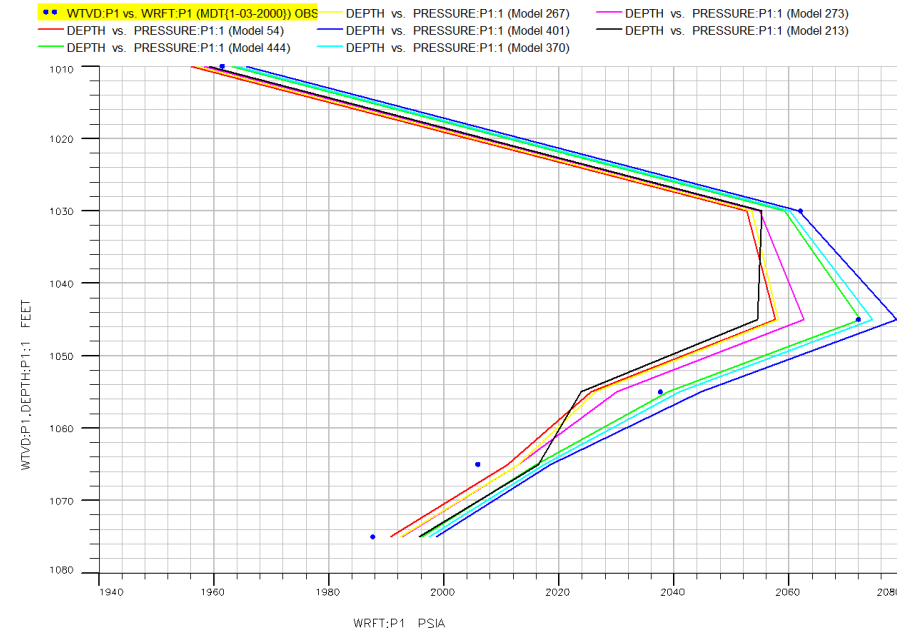
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	MULTZ12	MULTZ23	MULTPV1	MULTPV2	MULTPV3	MULTX1	MULTX2	MULTX3	ObjOver	ObjProx	ProxyErr	DataExact	objLP	objMC	Run#	Generation
2	-3.22E+00	-2.12E+00	1.19E+00	8.88E-01	1.45E+00	1.60E+00	5.66E-01	1.73E+00	3.77E+00	3.77E+00	0.00E+00	0.00E+00	9.23E+01	2.05E+01	444	20
3	-3.22E+00	-2.12E+00	1.19E+00	9.04E-01	1.45E+00	1.60E+00	5.88E-01	1.73E+00	3.81E+00	3.81E+00	0.00E+00	0.00E+00	9.79E+01	2.08E+01	401	18
4	-3.22E+00	-2.10E+00	1.19E+00	9.04E-01	1.45E+00	1.60E+00	5.88E-01	1.73E+00	3.82E+00	3.82E+00	0.00E+00	0.00E+00	9.86E+01	2.09E+01	388	18
5	-3.22E+00	-2.12E+00	1.19E+00	9.04E-01	1.45E+00	1.60E+00	5.88E-01	1.73E+00	3.82E+00	3.82E+00	0.00E+00	0.00E+00	9.84E+01	2.10E+01	413	19
6	-3.22E+00	-2.10E+00	1.19E+00	9.04E-01	1.45E+00	1.60E+00	5.88E-01	1.73E+00	3.82E+00	3.82E+00	0.00E+00	0.00E+00	9.88E+01	2.10E+01	389	18
7	-3.22E+00	-2.12E+00	1.19E+00	9.04E-01	1.45E+00	1.60E+00	5.66E-01	1.73E+00	3.82E+00	3.82E+00	0.00E+00	0.00E+00	1.01E+02	2.06E+01	323	14
8	-3.22E+00	-2.10E+00	1.19E+00	9.04E-01	1.45E+00	1.60E+00	5.66E-01	1.73E+00	3.82E+00	3.82E+00	0.00E+00	0.00E+00	1.01E+02	2.06E+01	370	17
9	-3.22E+00	-2.10E+00	1.19E+00	9.04E-01	1.45E+00	1.60E+00	5.66E-01	1.73E+00	3.82E+00	3.82E+00	0.00E+00	0.00E+00	1.01E+02	2.07E+01	397	18
10	-3.22E+00	-2.12E+00	1.19E+00	9.04E-01	1.45E+00	1.60E+00	5.66E-01	1.73E+00	3.83E+00	3.83E+00	0.00E+00	0.00E+00	1.02E+02	2.07E+01	315	13
11	-2.90E+00	-2.10E+00	1.19E+00	9.04E-01	1.45E+00	1.60E+00	5.66E-01	1.73E+00	3.83E+00	3.83E+00	0.00E+00	0.00E+00	1.03E+02	2.06E+01	432	20
12	-3.22E+00	-2.12E+00	1.19E+00	9.04E-01	1.45E+00	1.60E+00	5.88E-01	1.73E+00	3.83E+00	3.83E+00	0.00E+00	0.00E+00	1.01E+02	2.10E+01	422	19
13	-3.22E+00	-2.12E+00	1.19E+00	9.04E-01	1.46E+00	1.60E+00	5.66E-01	1.73E+00	3.83E+00	3.83E+00	0.00E+00	0.00E+00	1.03E+02	2.07E+01	349	15
14	-3.22E+00	-2.12E+00	1.19E+00	9.04E-01	1.46E+00	1.60E+00	5.88E-01	1.73E+00	3.83E+00	3.83E+00	0.00E+00	0.00E+00	1.00E+02	2.12E+01	404	18
15	-3.22E+00	-2.12E+00	1.19E+00	9.04E-01	1.45E+00	1.60E+00	5.66E-01	1.73E+00	3.83E+00	3.83E+00	0.00E+00	0.00E+00	1.04E+02	2.06E+01	415	19
16	-3.22E+00	-2.12E+00	1.19E+00	9.04E-01	1.45E+00	1.59E+00	5.88E-01	1.73E+00	3.83E+00	3.83E+00	0.00E+00	0.00E+00	9.91E+01	2.16E+01	403	18
17	-3.22E+00	-2.12E+00	1.19E+00	9.04E-01	1.46E+00	1.60E+00	5.66E-01	1.73E+00	3.84E+00	3.84E+00	0.00E+00	0.00E+00	1.03E+02	2.08E+01	427	19
18	-3.22E+00	-2.10E+00	1.19E+00	9.04E-01	1.46E+00	1.60E+00	5.66E-01	1.73E+00	3.84E+00	3.84E+00	0.00E+00	0.00E+00	1.04E+02	2.07E+01	406	18
19	-3.22E+00	-2.10E+00	1.19E+00	9.04E-01	1.46E+00	1.60E+00	5.88E-01	1.73E+00	3.84E+00	3.84E+00	0.00E+00	0.00E+00	1.02E+02	2.11E+01	433	20
20	-3.22E+00	-2.10E+00	1.19E+00	9.04E-01	1.46E+00	1.60E+00	5.66E-01	1.73E+00	3.84E+00	3.84E+00	0.00E+00	0.00E+00	1.04E+02	2.09E+01	390	18
21	-3.22E+00	-2.12E+00	1.19E+00	9.04E-01	1.45E+00	1.60E+00	5.66E-01	1.73E+00	3.84E+00	3.84E+00	0.00E+00	0.00E+00	1.05E+02	2.07E+01	393	18
22	-3.22E+00	-2.10E+00	1.19E+00	9.04E-01	1.46E+00	1.60E+00	5.88E-01	1.73E+00	3.84E+00	3.84E+00	0.00E+00	0.00E+00	1.02E+02	2.13E+01	398	18
23	-3.22E+00	-2.12E+00	1.19E+00	9.04E-01	1.46E+00	1.60E+00	5.88E-01	1.73E+00	3.84E+00	3.84E+00	0.00E+00	0.00E+00	1.02E+02	2.12E+01	375	17
24	-3.22E+00	-2.10E+00	1.19E+00	9.04E-01	1.46E+00	1.60E+00	5.88E-01	1.73E+00	3.85E+00	3.85E+00	0.00E+00	0.00E+00	1.03E+02	2.12E+01	435	20
25	-3.22E+00	-2.12E+00	1.19E+00	9.04E-01	1.46E+00	1.60E+00	5.66E-01	1.73E+00	3.85E+00	3.85E+00	0.00E+00	0.00E+00	1.06E+02	2.09E+01	428	19
26	-3.22E+00	-2.10E+00	1.19E+00	9.04E-01	1.46E+00	1.60E+00	5.66E-01	1.73E+00	3.85E+00	3.85E+00	0.00E+00	0.00E+00	1.06E+02	2.09E+01	425	19
27	-3.22E+00	-2.12E+00	1.19E+00	9.04E-01	1.46E+00	1.58E+00	5.88E-01	1.73E+00	3.87E+00	3.87E+00	0.00E+00	0.00E+00	1.02E+02	2.26E+01	442	20
28	-3.22E+00	-2.10E+00	1.20E+00	9.04E-01	1.45E+00	1.60E+00	5.88E-01	1.73E+00	3.88E+00	3.88E+00	0.00E+00	0.00E+00	1.10E+02	2.13E+01	436	20
29	-3.22E+00	-2.12E+00	1.20E+00	9.04E-01	1.45E+00	1.60E+00	5.66E-01	1.73E+00	3.89E+00	3.89E+00	0.00E+00	0.00E+00	1.15E+02	2.07E+01	429	20

# Global Results in ECLIPSE Office

# RESULTING MATCHES

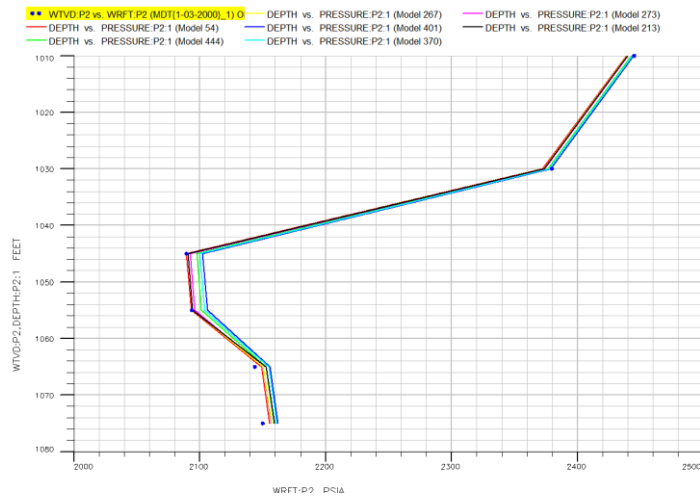


Liquid production from global updates

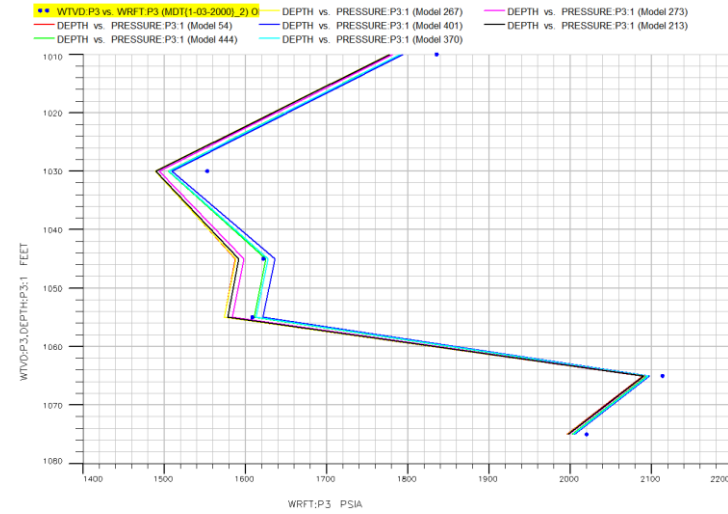


MDT pressure matches: P1

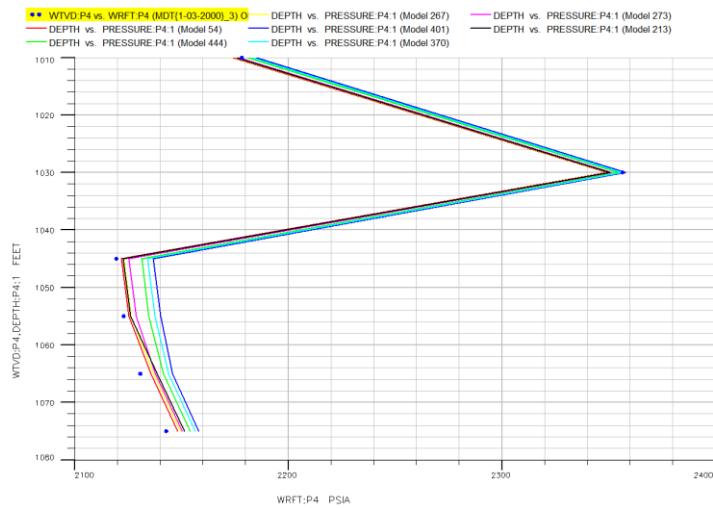
# RESULTING MATCHES (Cont.)



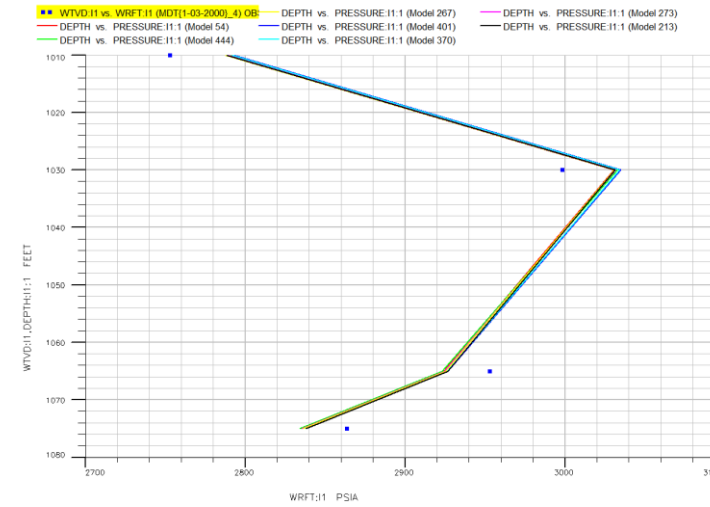
MDT pressure matches: P2



MDT pressure matches: P3



MDT pressure matches: P4

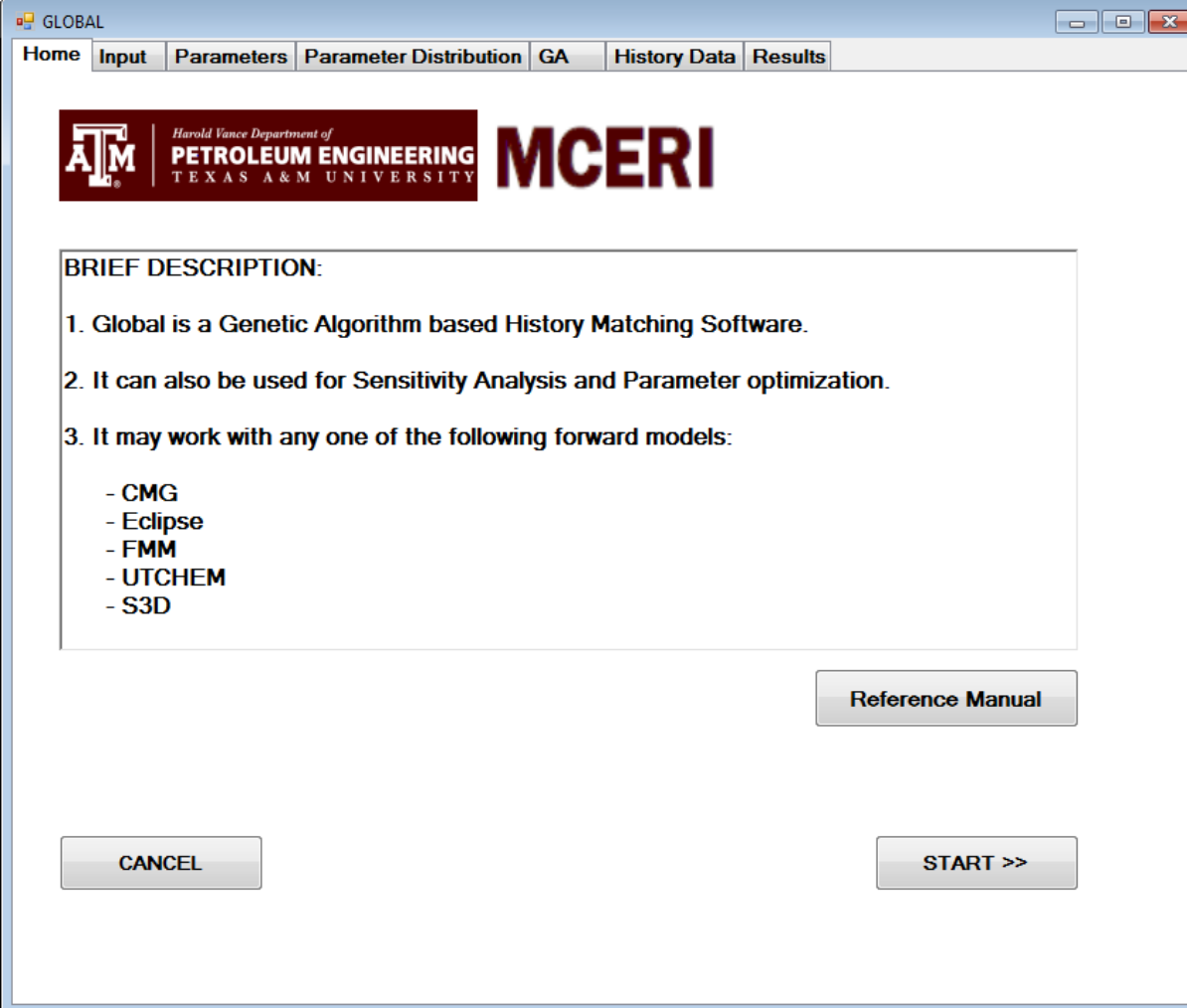


MDT pressure matches: I1

# Global GUI (Standalone Application in C#)



# Home Page



The screenshot shows a software window titled "GLOBAL" with a menu bar containing "Home", "Input", "Parameters", "Parameter Distribution", "GA", "History Data", and "Results". The main content area features the logo for the Harold Vance Department of Petroleum Engineering at Texas A&M University, along with the acronym "MCERI". Below the logo is a "BRIEF DESCRIPTION:" section containing a numbered list of three points. At the bottom of the window are three buttons: "CANCEL", "Reference Manual", and "START >>".

GLOBAL

Home Input Parameters Parameter Distribution GA History Data Results

**ATM** Harold Vance Department of  
**PETROLEUM ENGINEERING**  
TEXAS A & M UNIVERSITY **MCERI**

**BRIEF DESCRIPTION:**

1. Global is a Genetic Algorithm based History Matching Software.
2. It can also be used for Sensitivity Analysis and Parameter optimization.
3. It may work with any one of the following forward models:
  - CMG
  - Eclipse
  - FMM
  - UTCHEM
  - S3D

CANCEL Reference Manual START >>

# Global Inputs

The screenshot shows the 'GLOBAL' software interface with the 'Input' tab selected. The interface includes a navigation menu at the top with tabs for 'Home', 'Input', 'Parameters', 'Parameter Distribution', 'GA', 'History Data', and 'Results'. The main content area contains several configuration sections:

- Working Directory:** A text field containing 'C:\GLOBAL\Eclipse\_synthetic\_case\' and a 'Browse' button.
- Input File (\*.INP):** A section with two radio buttons: 'Create New' (unselected) and 'Existing File' (selected). The 'Existing File' option has a text field containing 'ECLRFT.INP' and a 'Browse' button. The 'Create New' option has an empty text field and a 'Create' button.
- Forward Simulator:** A dropdown menu currently set to 'ECLIPSE'.
- Path for Forward Simulator:** A text field containing '\$eclipse' and a 'Browse' button.
- Data File:** A text field containing 'ECLRFT' and a 'Browse' button.
- Sensitivity Analysis Only?:** A checkbox that is currently unchecked.

At the bottom of the window, there are two large buttons: '<< BACK' on the left and 'NEXT >>' on the right.

# Global Parameters

GLOBAL

Home Input Parameters Parameter Distribution GA History Data Results

Select the Template Files to be used :

Template Files (\*.TMPL)

MULTIPLY.TMPL

Distribution File (\*.DISTR)

Create New

Existing File

Create Browse

<< BACK

NEXT >>

# Parameter Distribution

GLOBAL

Home Input Parameters Parameter Distribution GA History Data Results

	NAME	BASE	MIN	MAX	NBIT	LOG10	CONTINU
	<u>MULTZ12</u>	-5	-7.0	-2.0	8	1	1
	<u>MULTZ23</u>	-3	-6.0	-1.0	8	1	1
▶	<u>MULTPV1</u>	1.0	0.9	1.5	8	0	1
	<u>MULTPV2</u>	0.8	0.5	1.0	8	0	1
	<u>MULTPV3</u>	1.0	0.9	1.8	8	0	1
	<u>MULTX1</u>	1.5	1.2	2.5	8	0	1
	<u>MULTX2</u>	0.7	0.3	1.0	8	0	1
	<u>MULTX3</u>	1.5	1.1	2.0	8	0	1
*							

Name

Base Value  Min. Value  Max. Value

No. of Bits  Log10?  Continuous?

Buttons: Add, Delete, Update, Save, << BACK, NEXT >>

# Global GA

GLOBAL

Home Input Parameters Parameter Distribution **GA** History Data Results

Objective Functions

- FBHP
- GPT
- LPT**
- MDT

NED for Proxy Model  Use existing Proxy .BIN file ?

Tolerance for Proxy Model

No. of Generations

Population per Generation

Elitism Replacement Probability

GA Crossover Probability

Mutation

<< BACK

NEXT >>

# History Data

GLOBAL

Home Input Parameters Parameter Distribution GA History Data Results

Summary file  Schedule  \*.txt/\*.fhf

MDT Obs. file

Drainage Vol. Obs. file

Time Interval/Time Steps  Time Interval  Time Steps

Wells for HM 

P1
P2
P3
P4
I1

 Select All

# Results

