

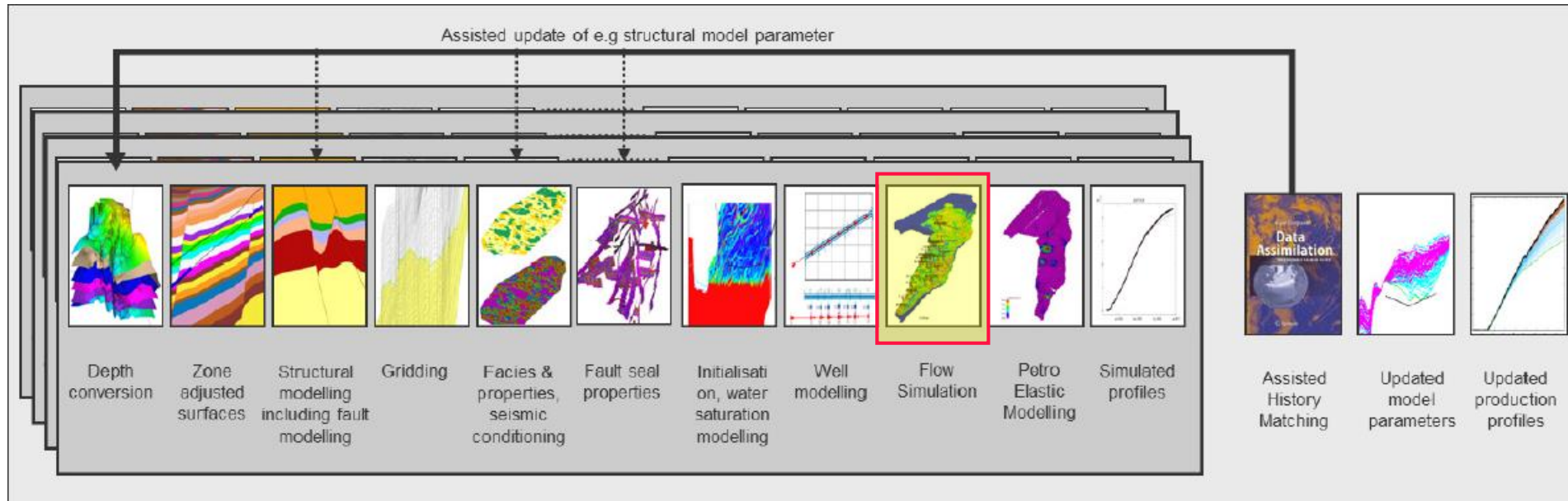


Experiences from Implementation of OPM Flow at Equinor

Introduction

- Successful OPM Flow pilot with asset #1
 - October 2017
- Flow RC3 delivered for Asset #1
 - October 2018
- Flow RC4 delivered for Asset #2
 - December 2018
- Will present experiences from asset #1
- Both assets are running the FMU workflow

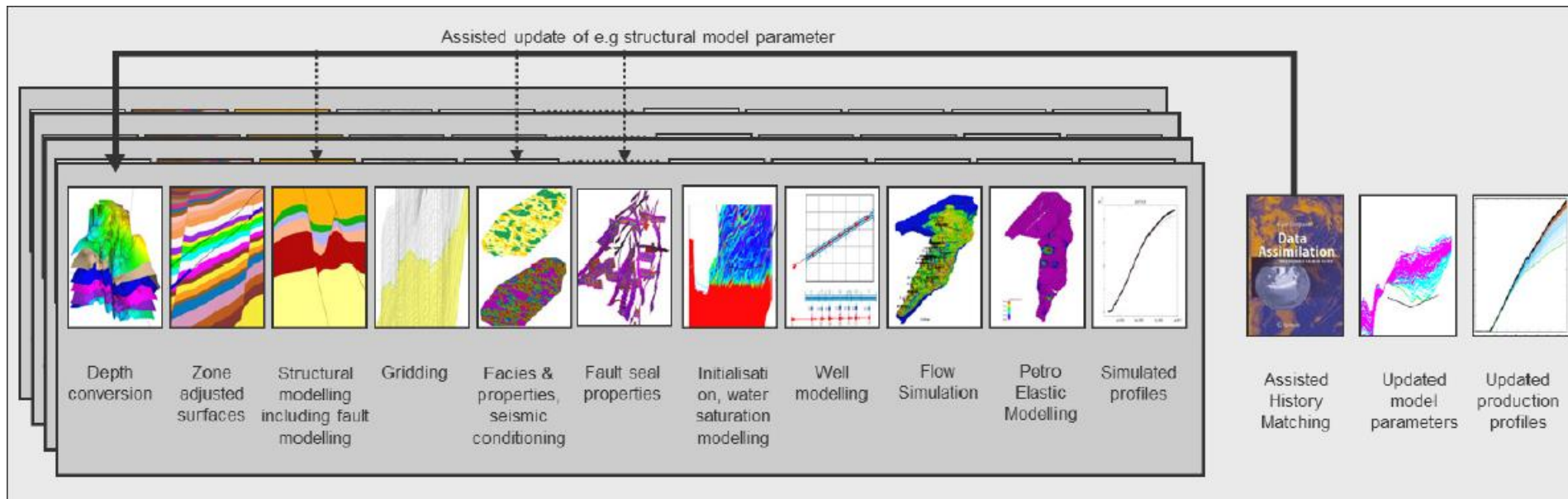
FMU – Fast Model Update



- **Figure 2** FMU concept:
- *i) Fast, updateable, and consistent, modelling workflow that supports an automatic model-building process.*
- *ii) Proper representation and propagation of uncertainties from static model to prediction.*
- *iii) Data assimilation - Conditioning the whole model chain on dynamic and seismic data.*

Eclipse input and output format

- Using Flow as a drop-in replacement for Eclipse
- Option to make Eclipse restart runs from flow simulations (interoperability)
 - E.g. cases where flow does not have sufficient prediction functionality



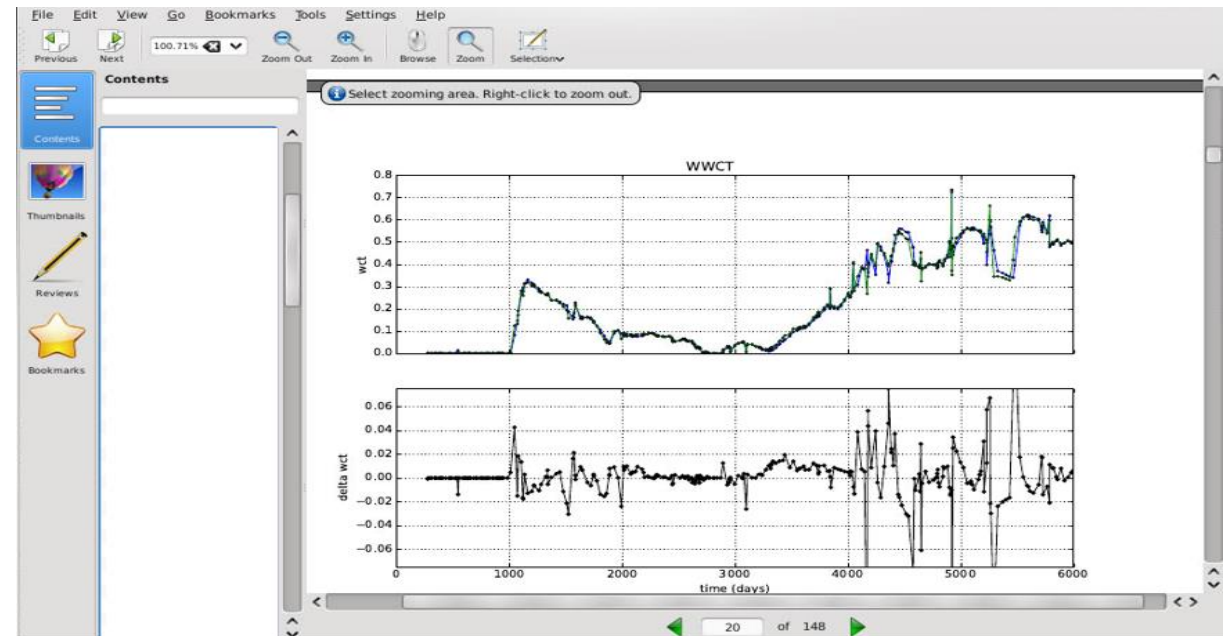
Experiences – QC process

- The QC process of a simulator is an extensive job
 - Replication of physics initial state
 - Replication of dynamics behaviour
 - Robustness over an ensemble of models.
- Eclipse simulations used as reference
- Simulation results with Flow shows good agreement with simulation results from Eclipse
- All QC and testing done upfront by OPM team in Equinor.

Evaluation results – Ensembles

- Tailor made python script which generated
 - Csv file holding statistics for mismatch
 - One pdf document for each pair of runs
- Runs and vectors that stood out from the statistics were checked using plots in the pdf

	run	type	well	vect	mean_diff	std_diff	max_diff
4							
5							
2633	69	prod		WWCT	0.016279	0.045201	0.49271
2649	7	prod		WWCT	0.017774	0.057669	0.49186
2743	6	prod		WWCT	0.02828	0.065717	0.4876
2812	89	prod		WWCT	0.0080106	0.040811	0.48489
2865	37	prod		WWCT	0.022239	0.058207	0.48388
2898	86	prod		WWCT	0.027541	0.067609	0.48143
2912	46	prod		WWCT	0.026558	0.066798	0.48039
2938	29	prod		WWCT	0.0074337	0.047842	0.47843
2965	52	prod		WWCT	0.0055878	0.03861	0.47774
3038	7	prod		WWCT	0.020607	0.054772	0.47617
3039	68	prod		WWCT	0.027658	0.075489	0.47611



Experiences – keyword not supported

- New functionality introduced during HM phase
 - New keyword, OPERATER

```

OPERATER
PORV 122 'MULTX' PORV 0.751291 /
PORV 123 'MULTX' PORV 0.761082 /
PORV 124 'MULTX' PORV 0.666224 /
PORV 125 'MULTX' PORV 0.910303 /
/

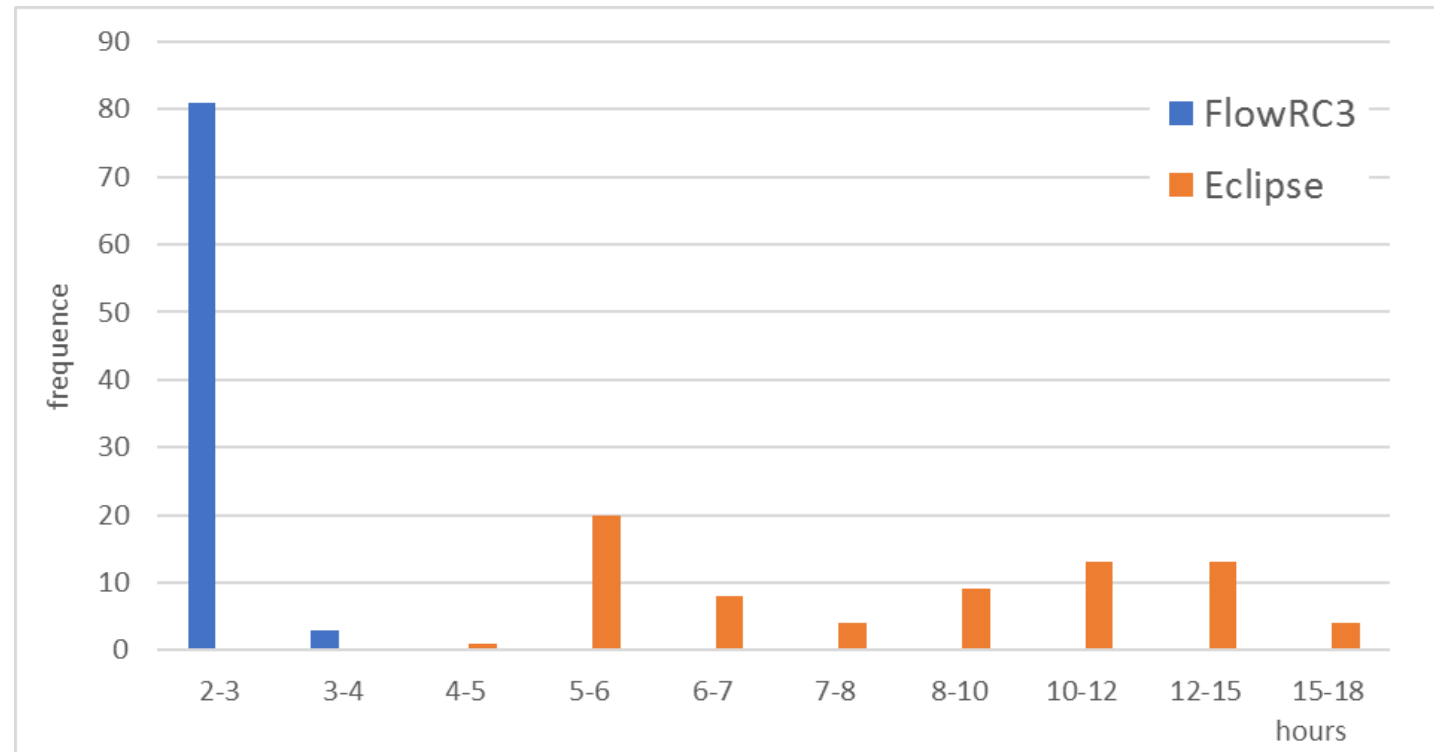
```

- Flow didn't support this keyword when this was introduced.
- Unfortunately, the keyword was ignored and the simulator carried on with the simulation.
- Engineer working in Asset #1 had no reason to believe that the keyword was ignored by the simulator.
 - No warnings or error messages
- Flow actually support other keywords that can do the exact same as OPERATER is set up to do here.

Experiences – simulation performance

FLOW RC3		
Number of completed runs	84/86	
Minimum	2.2	hrs
Maximum	3.1	hrs
Average	2.5	hrs

Eclipse 2017.2		
Number of completed runs	72/ 86	
Minimum	4.7	hrs
Maximum	16.4	hrs
Average	9.2	hrs



Experiences – simulation performance MPI

- MPI has been tested by OPM team on a full ensemble with 4 CPU pr run
 - All members showed reduced runtime compared with single cpu run.
 - MPI currently not used by the asset.

Experiences – conclusions

- Tremendous runtime performance for asset #1 model.
 - Enables more iterations and more completed runs
 - Large potential for improved quality of history matching
- Simulation results shows good agreement with simulation results from Eclipse
- Important that unsupported Keyword and unsupported options in keywords cause the simulation to stop.
 - OPERATER example
 - PINCH option all (asset #2 model)

Experiences from Implementation of OPM Flow at Equinor

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