Resource vs. Decision Models and Supervised Clustering

Simple workflows for handling uncertainty in mature fields

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Workflows for uncertainty-handling

more deterministic

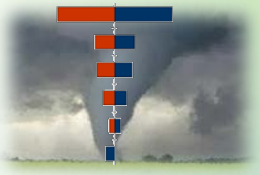
more stochastic

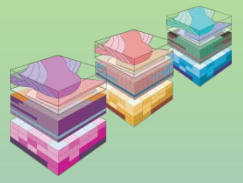
Best guess

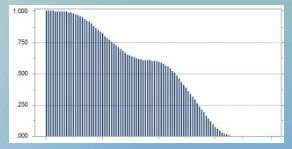
Sensitivities

Low-Mid-High cases

Deterministic model scenarios







Chance

Dice

Monte Carlo

Stochastic model realisations

easier options

more thought required

complexity

Choices for uncertainty handling

- Base case +/- (low-mid-high)
- Multiple stochastic – P90-P50-P10
- Multi-deterministic concept-based
- Multi-deterministic exhaustive
- Experimental Design
- Multi-deterministic clustering

25 years on …

it is quite clear …

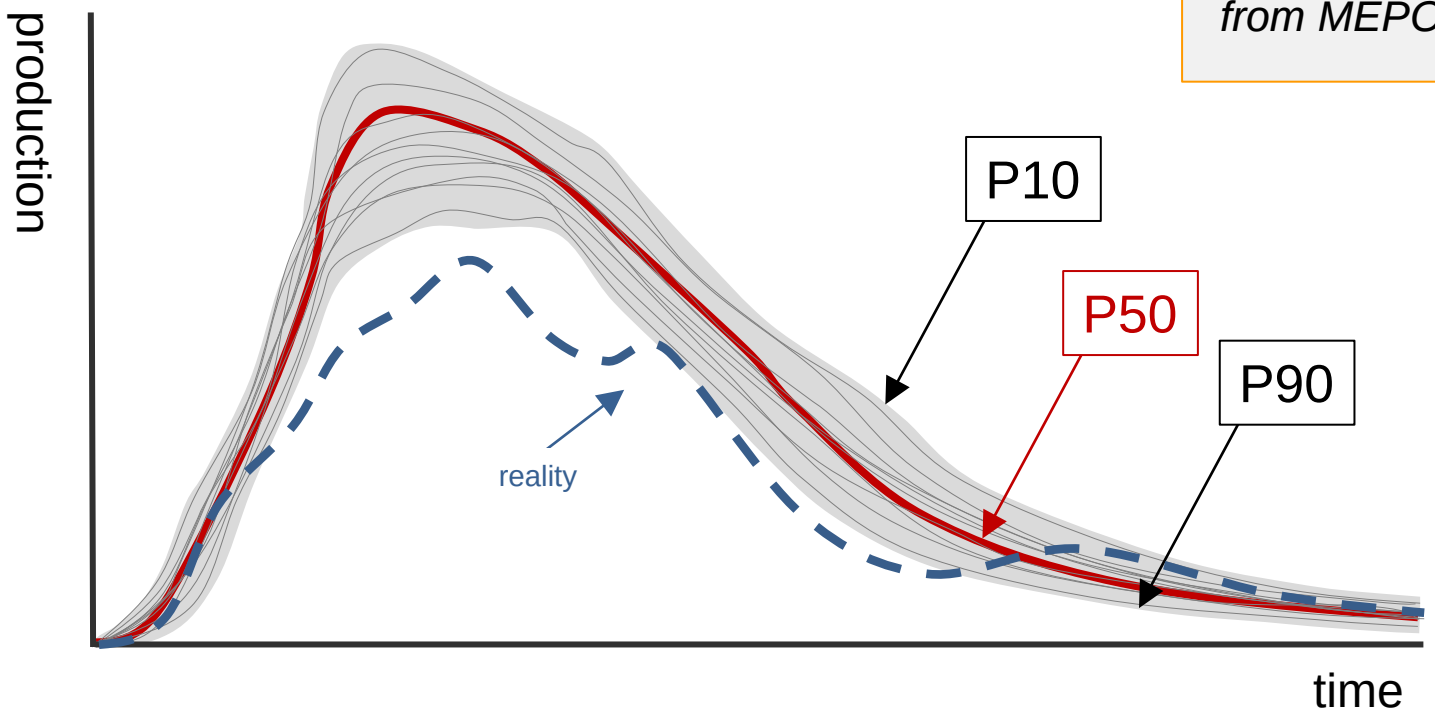
that all *can* be useful …

… and all have ‘issues’

Issue with stochastics?

Equiprobability

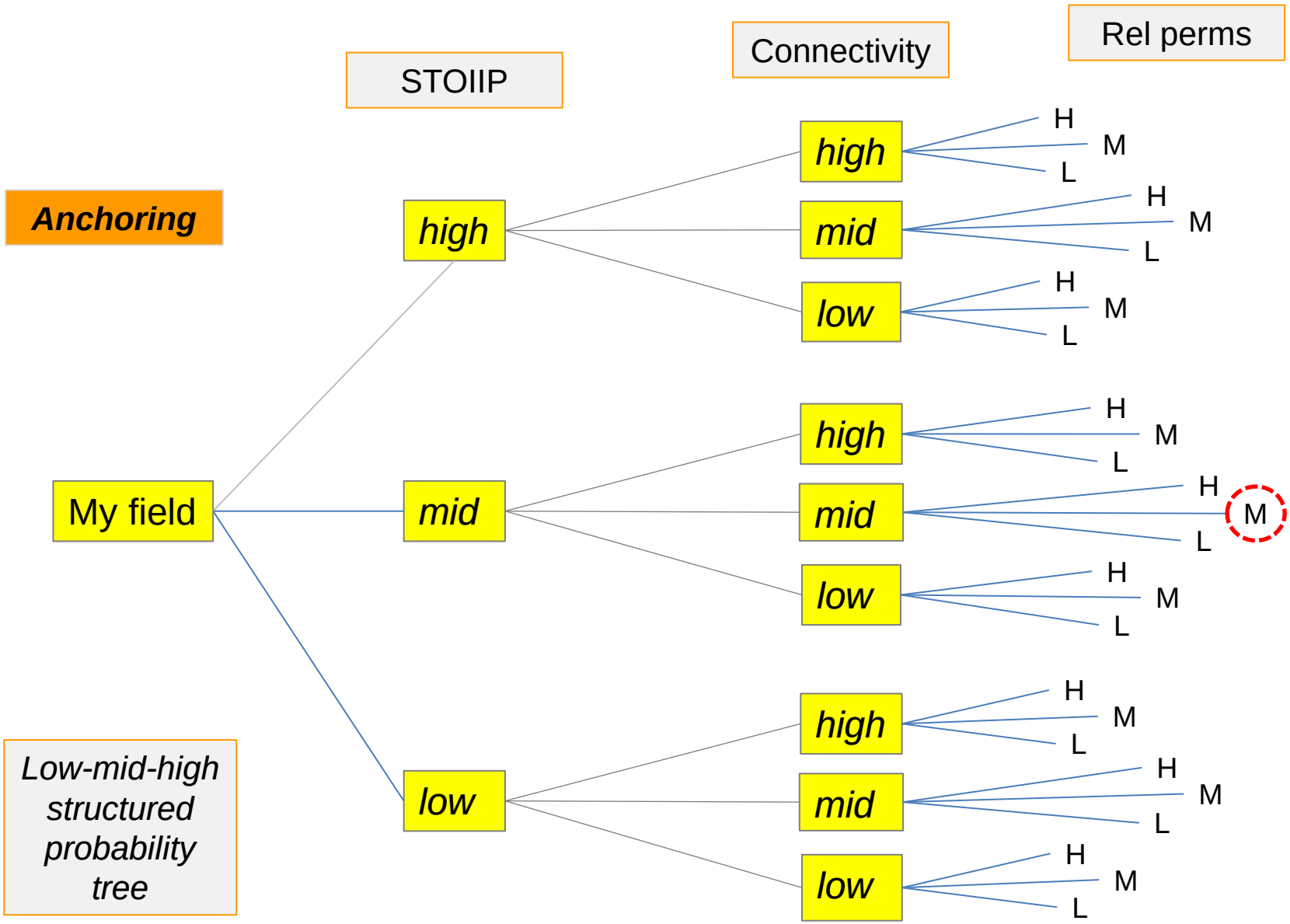
Multiple stochastic simulations from MEPO



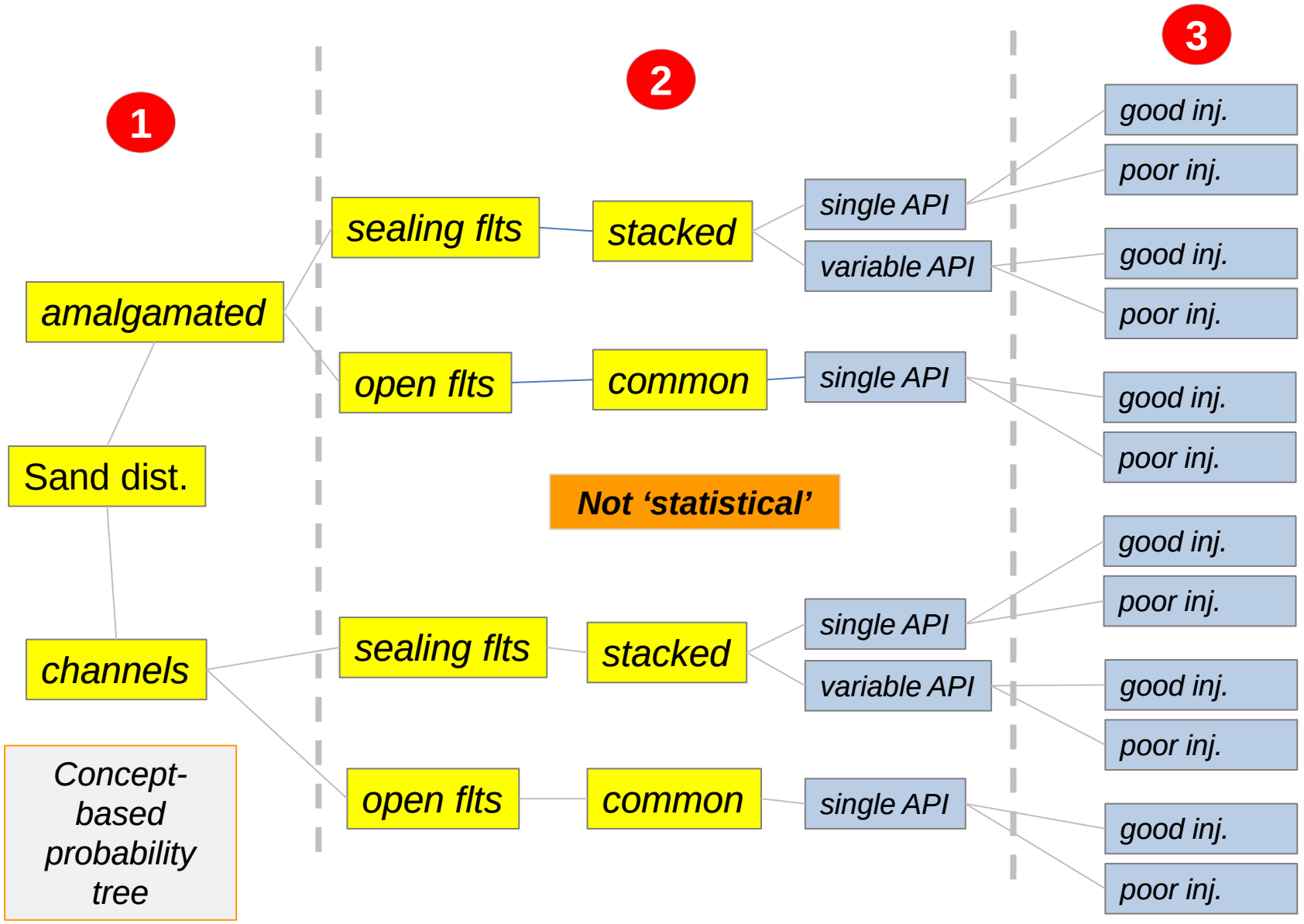
On a good day – provides an exhaustive exploration of uncertainty space

One a bad day - just a way of being wrong 5000 times

Issue with multi-determinism?

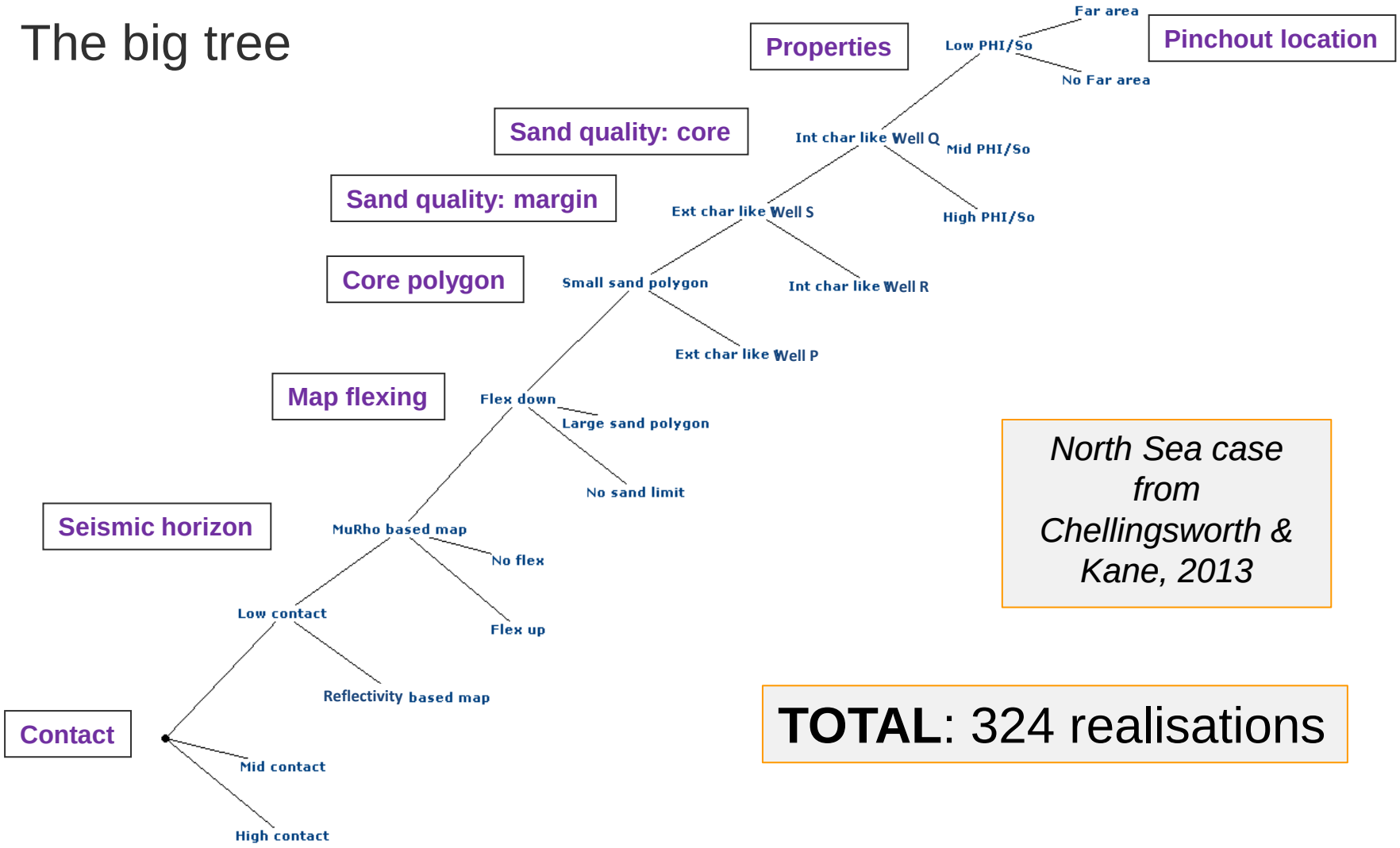


Issue with scenarios?



Issue with exhaustive multi-determinism?

The big tree



North Sea case from Chellingsworth & Kane, 2013

TOTAL: 324 realisations

Issue with exhaustive multi-determinism?

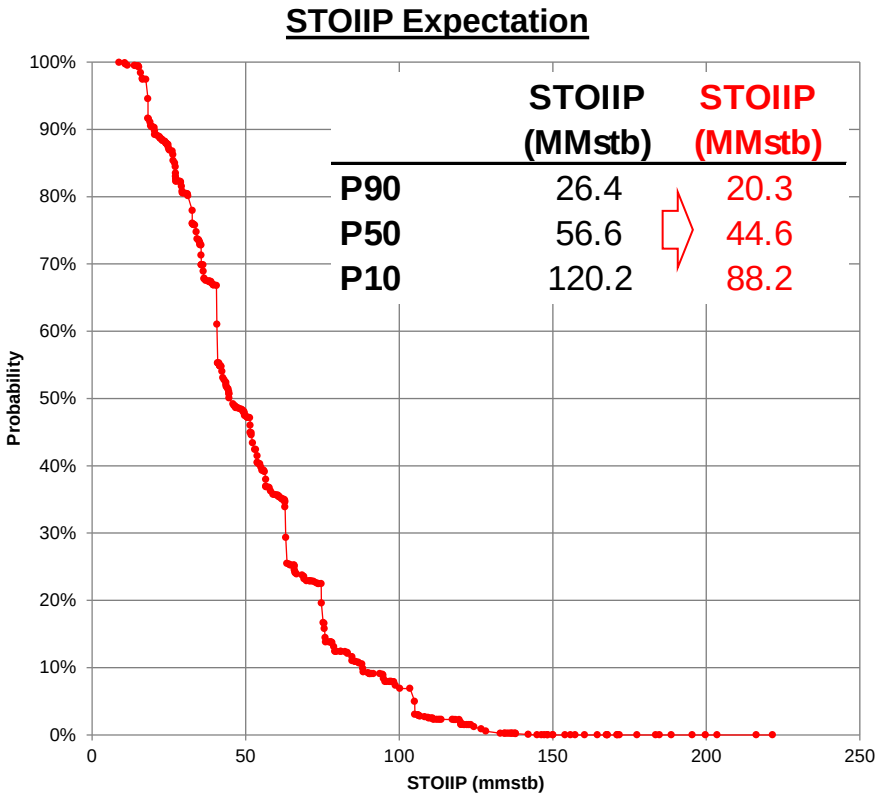
OWC	prob
OWC_v1	0.15
OWC_v2	0.05
OWC_v3	0.8
	1

Map type	prob
MuRho	0.2
Reflectivity	0.8
	1

Map flexing	prob
high	0.25
low	0.25
mid	0.5
	1

Sand	prob	
Large_poly_Like P_Like Q	0.05	0
Large_poly_Like P_Like R	0.05	0
Large_poly_Like S_Like Q	0.1	0
Large_poly_Like S_Like R	5	0
Interpolate	2	0.6
Small_poly_Like P_Like Q	5	0.1
Small_poly_Like P_Like R	0.0	0.1
Small_poly_Like S_Like Q	0.15	0.1
Small_poly_Like S_Like R	0.15	0.1
	1	***1***

Pinchout	prob
far	0.4
near	0.6
	1



Still governed by subjective choice

Issue with Experimental Design?

SimplePlacket-Burman ED matrix for 5 uncertainties

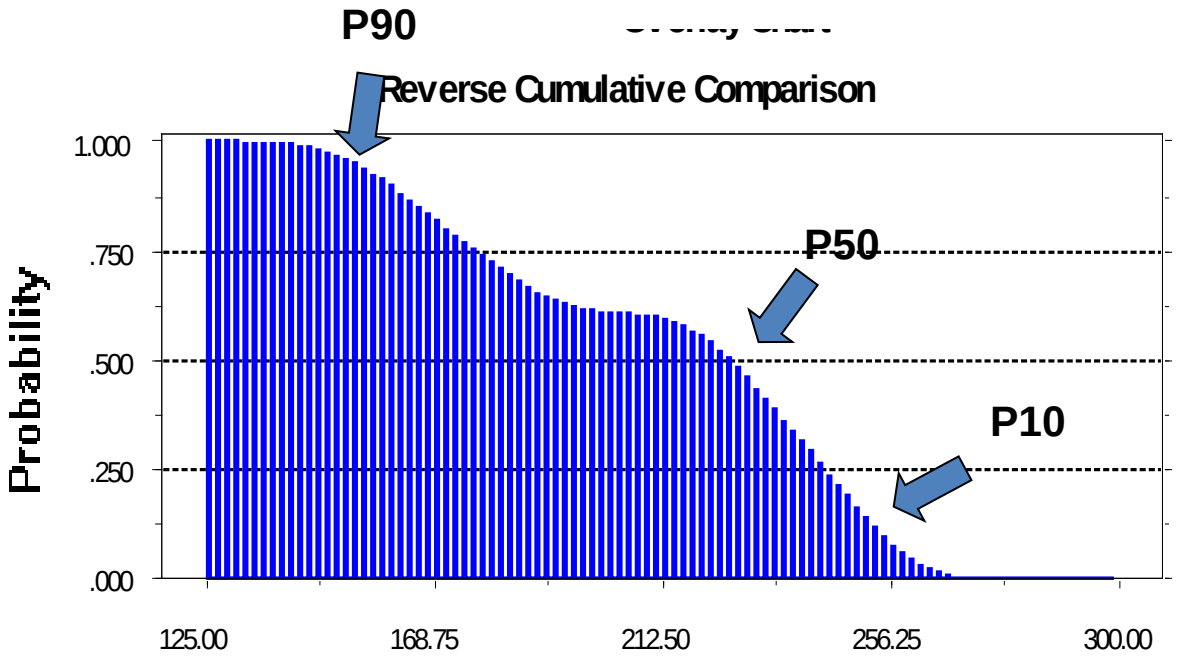
The ‘response’ values

	uncertainty					
run	A	B	C	D	E	**UR**
1	-1	1	1	1	-1	**60**
2	-1	-1	1	1	1	**90**
3	1	1	1	-1	1	**210**
4	1	-1	1	1	-1	**70**
5	1	1	-1	1	1	**170**
6	-1	-1	-1	-1	-1	**40**
7	1	-1	-1	-1	1	**65**
8	-1	1	1	-1	1	**190**
9	-1	1	-1	-1	-1	**80**
10	1	1	-1	1	-1	**110**
11	1	-1	1	-1	-1	**95**
12	-1	-1	-1	1	1	**180**

Issue with Experimental Design?

Result from Placket-Burman ED run for an 'Ultimate Recovery' response

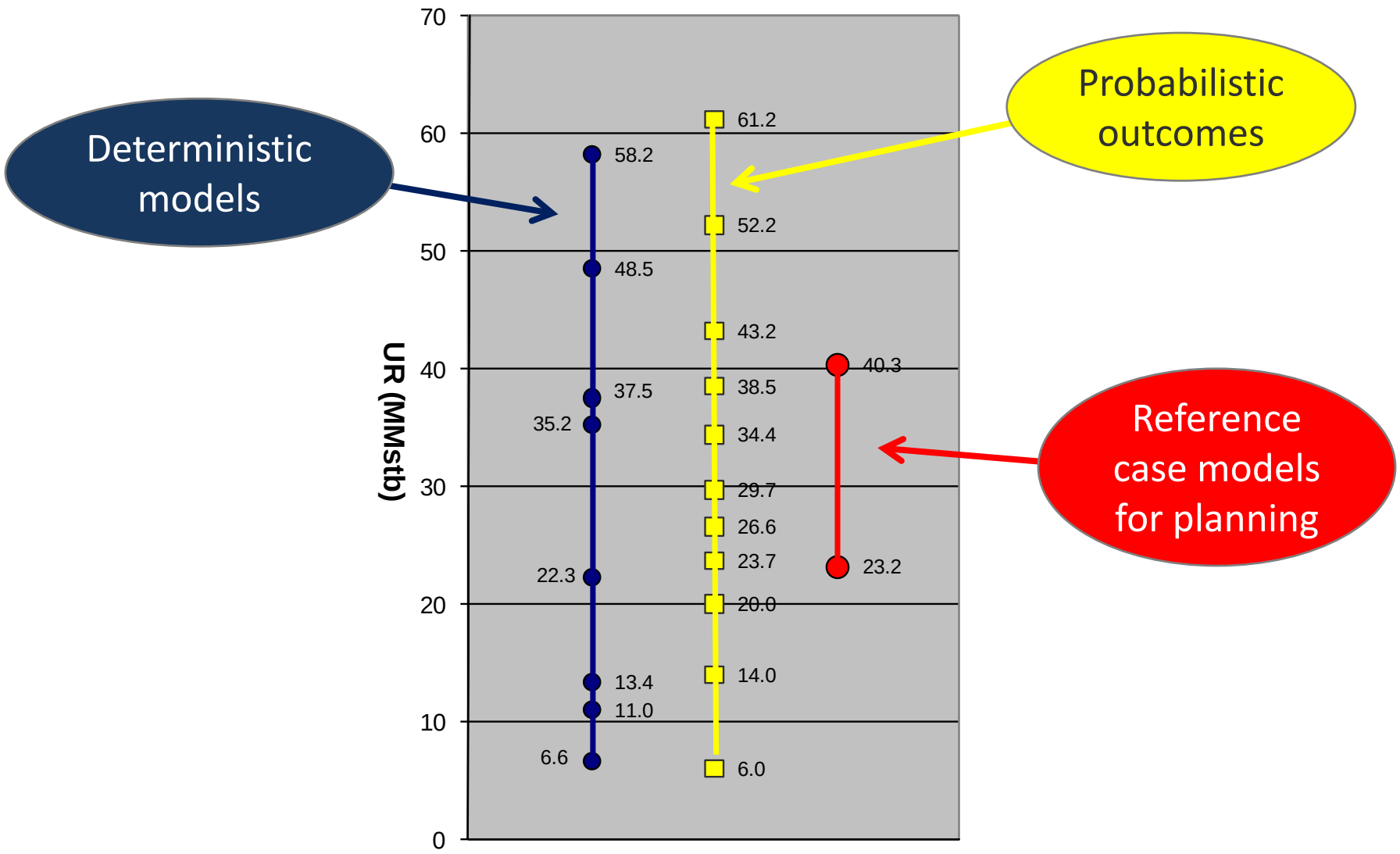
Percentile	ultimate recovery
100%	133.77
90%	159.34
75%	175.50
50%	224.04
25%	243.79
10%	254.96
0%	277.90



Capturing parameter relationships

See comments on ED from Jeff Caers ('Modelling Uncertainty, 2011')

Perhaps just do them all



Choices for uncertainty handling

	Issue
Base case +/- (low-mid-high)	Anchoring
Multiple stochastic – P90-P50-P10	Equiprobability
Multi-deterministic conceptual	Non-statistical
Multi-deterministic exhaustive	Non-statistical
Experimental Design	Non-linearity
Multi-deterministic clustering	…..

And add to that ..

The curse of the detailed full-field model

What have I learnt?

There is always an ‘issue’ of subjectivity somewhere in the workflow

No one preferred tool

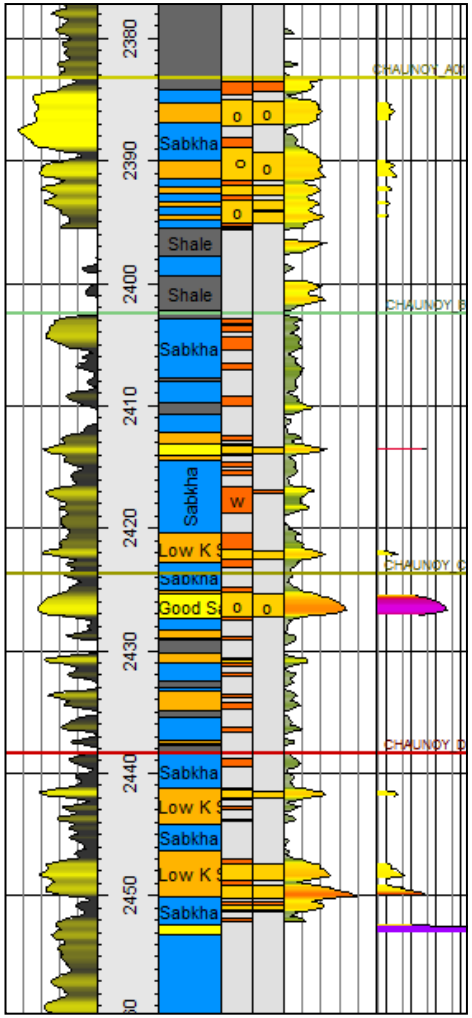
So what to do?

Define the model purpose, *specifically*

Find the **root cause** uncertainties

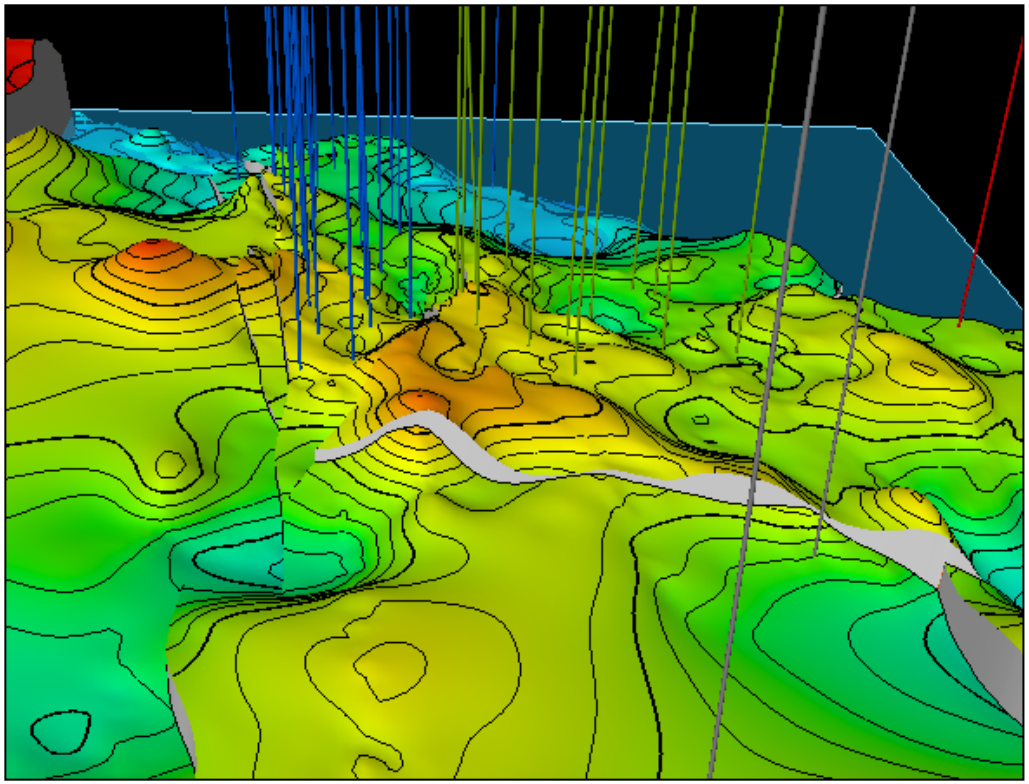
Choose a workflow which highlights the subjectivity and brings it to the front

The case of Champetron



Mature field under waterflood

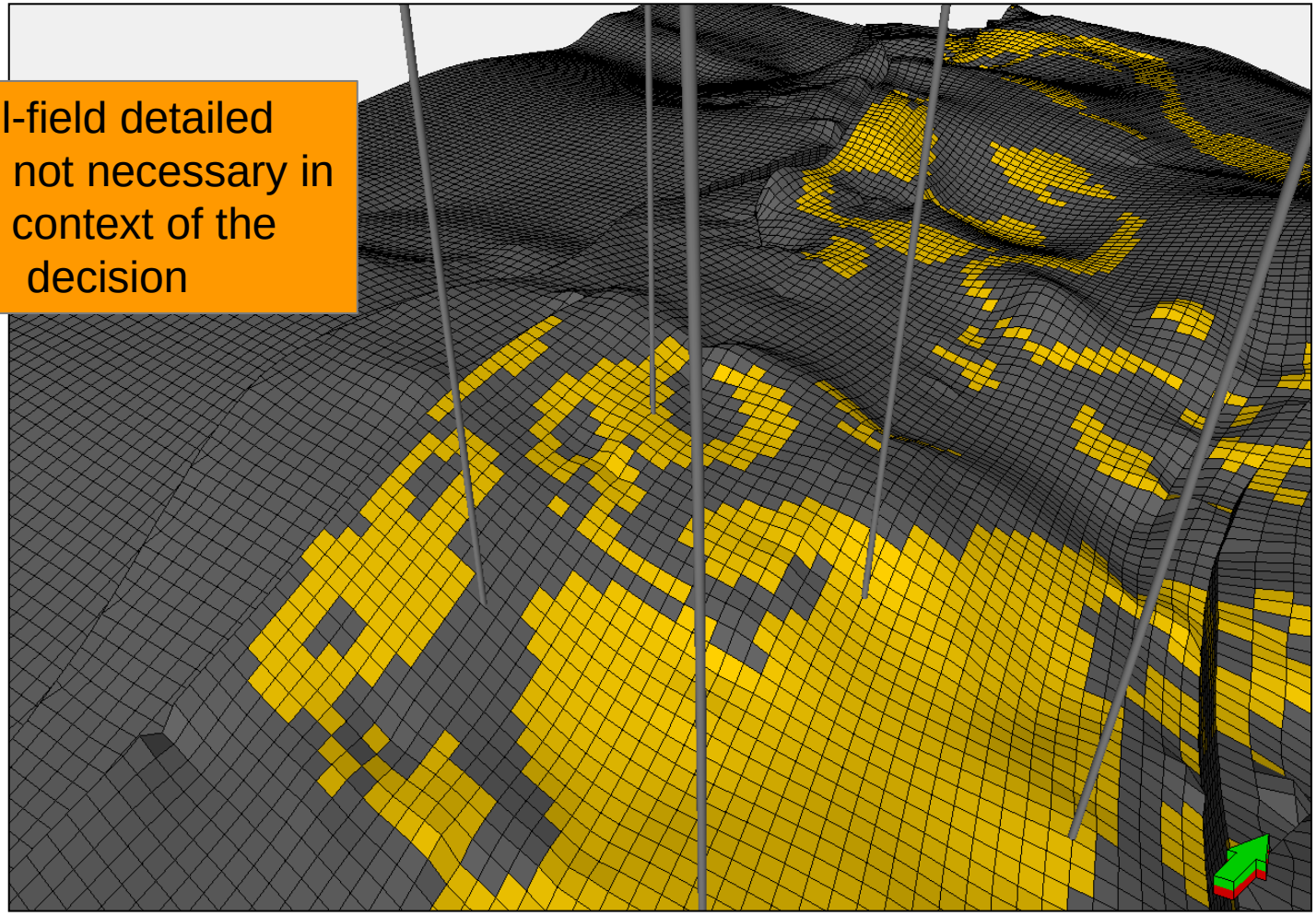
Decision: is it worth infilling?



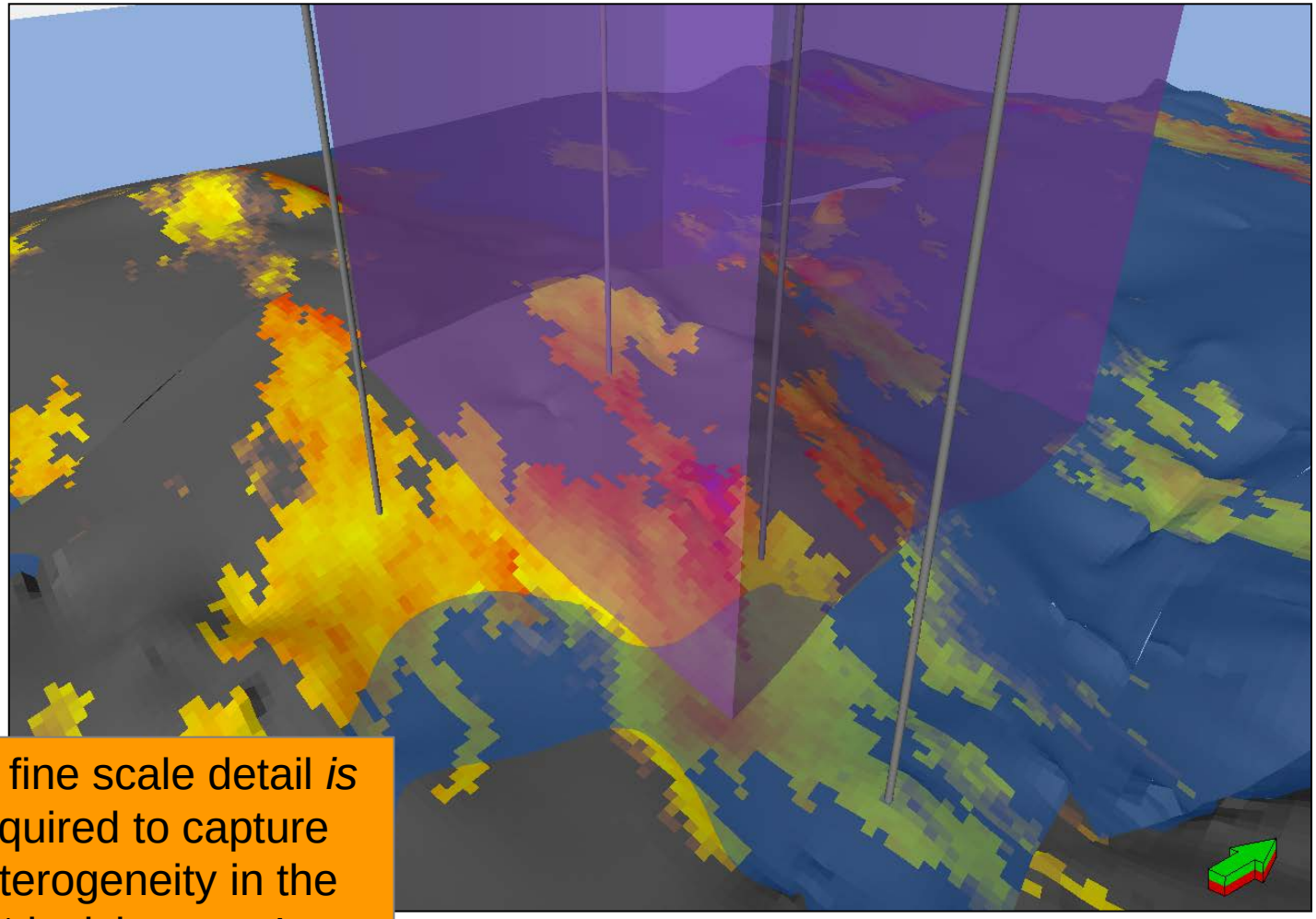
Oxlade & Bentley, Geol Soc 2015

Multi-scale solution

Full-field detailed match not necessary in the context of the decision

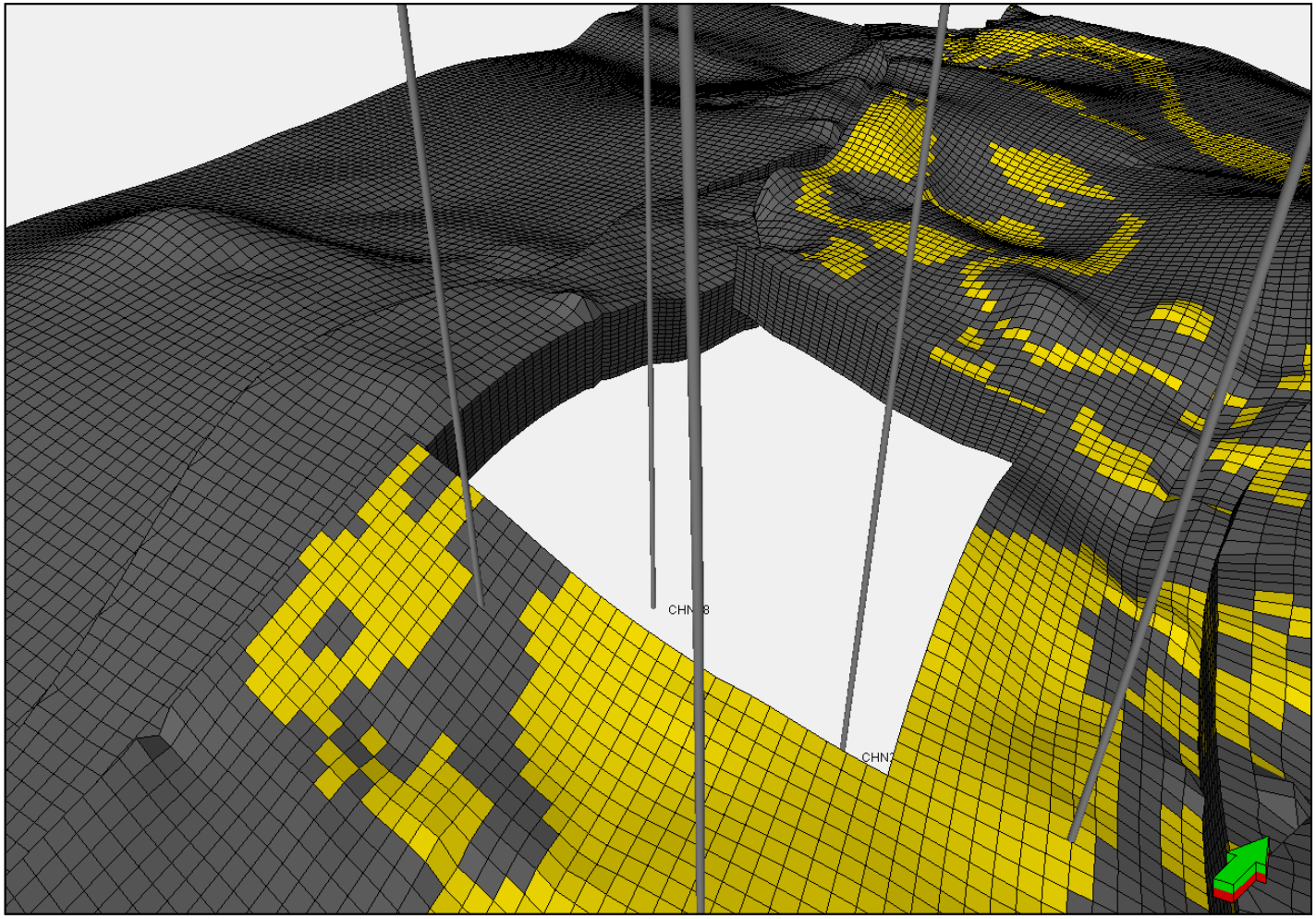


Extract detail

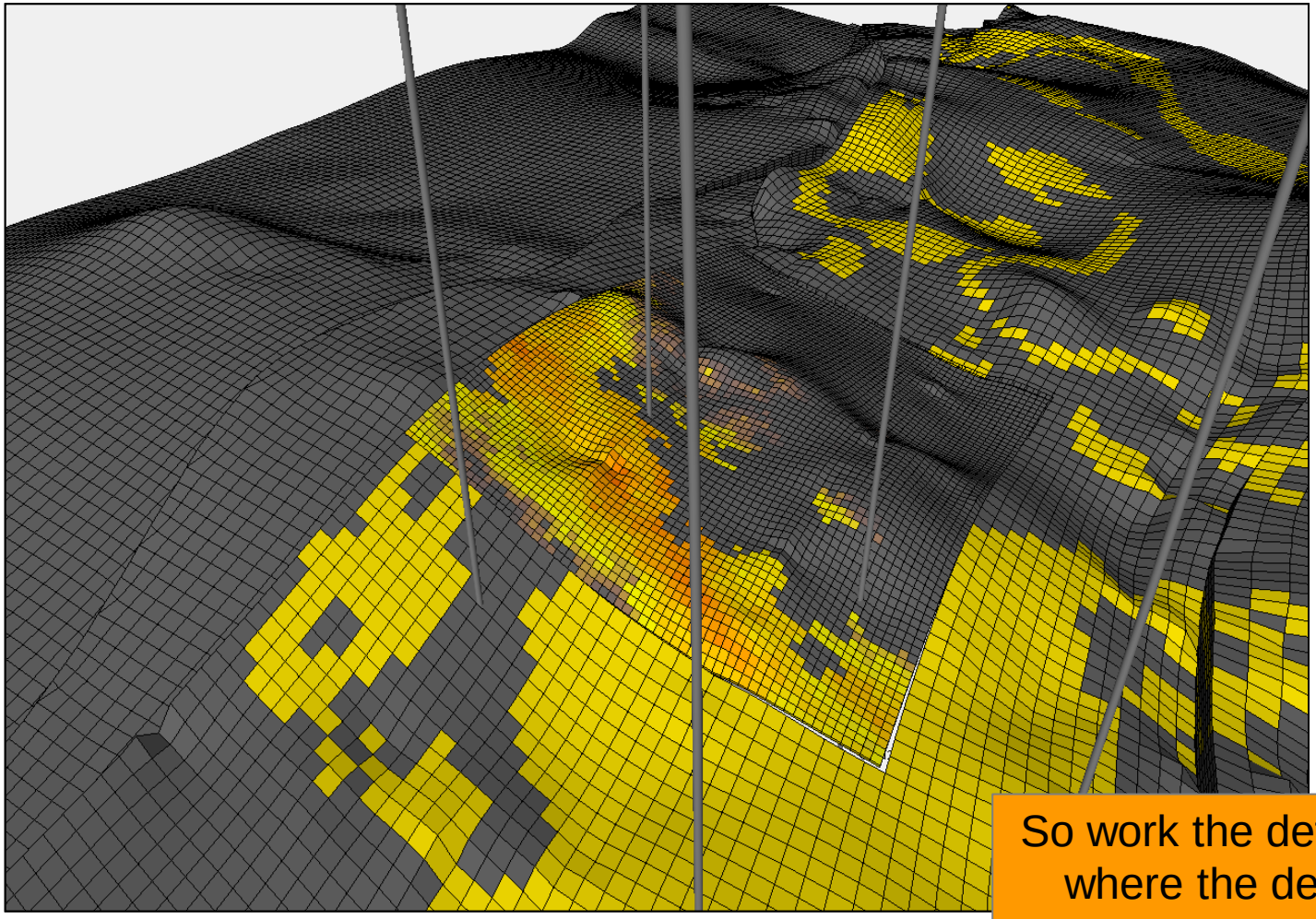


But fine scale detail *is* required to capture heterogeneity in the ‘decision area’

Multi-scale solution

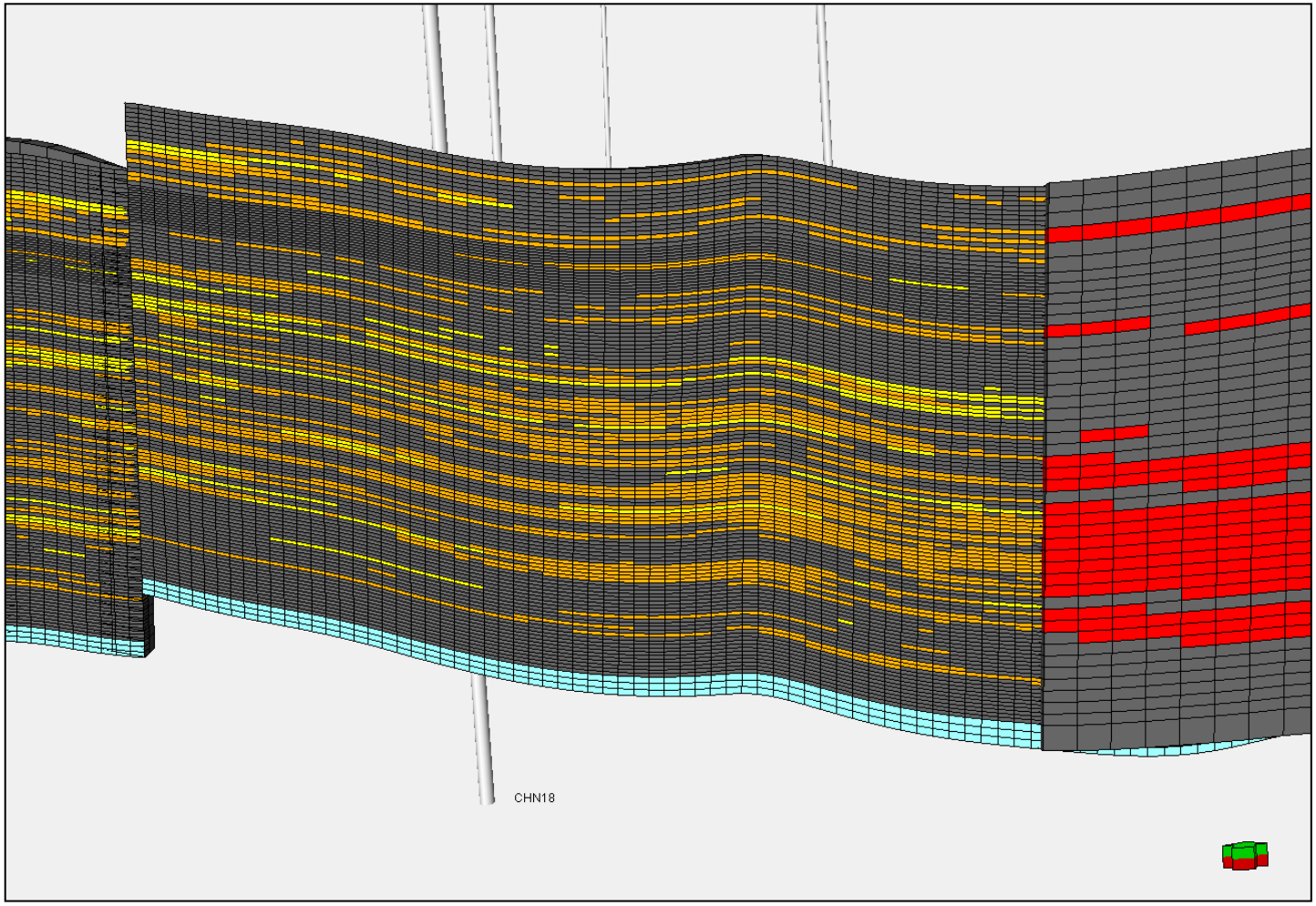


Multi-scale model

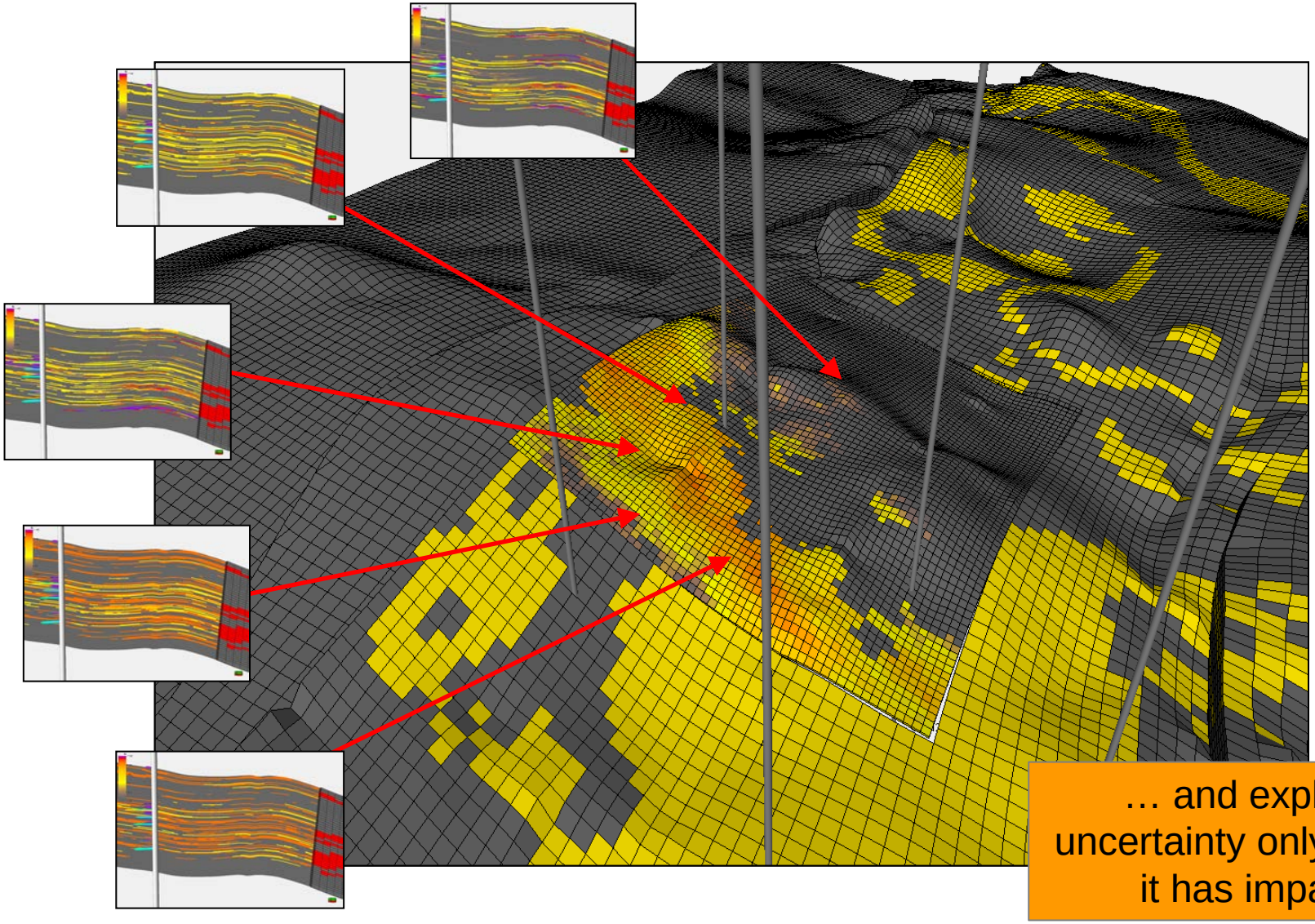


So work the detail only where the detail is needed

Check the join



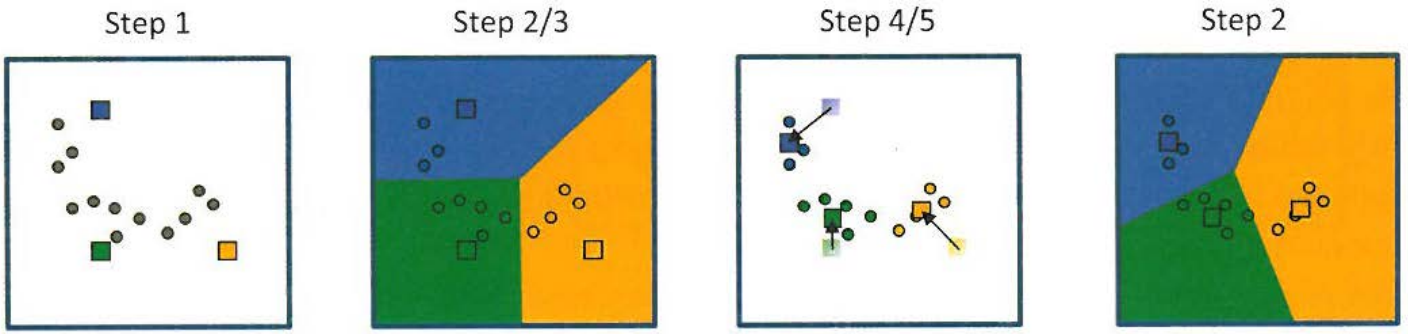
Vary the sector, constant background

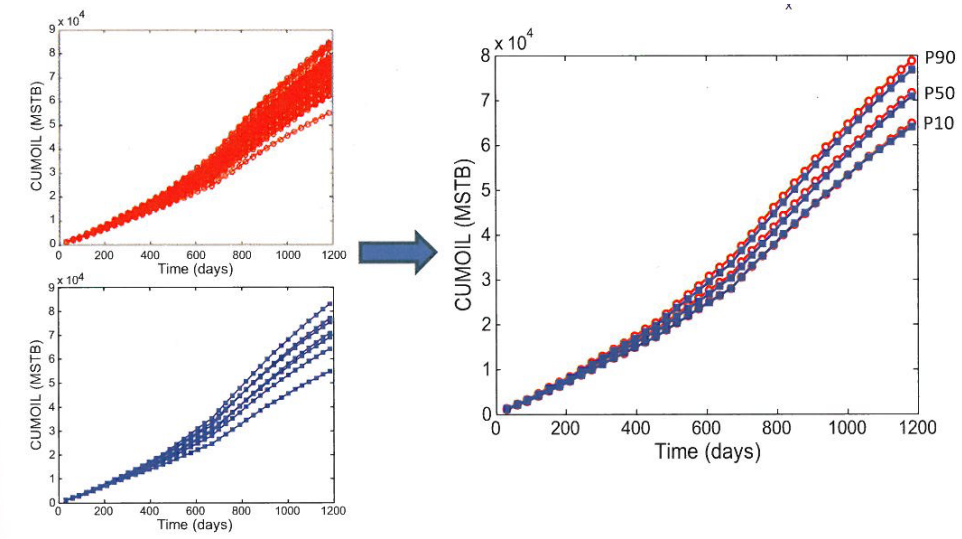


… and explore uncertainty only where it has impact

Distance methods and clustering

A means of selecting a representative sub-set of models from a large number of approximate models





'Unsupervised clustering'
Caers 2011

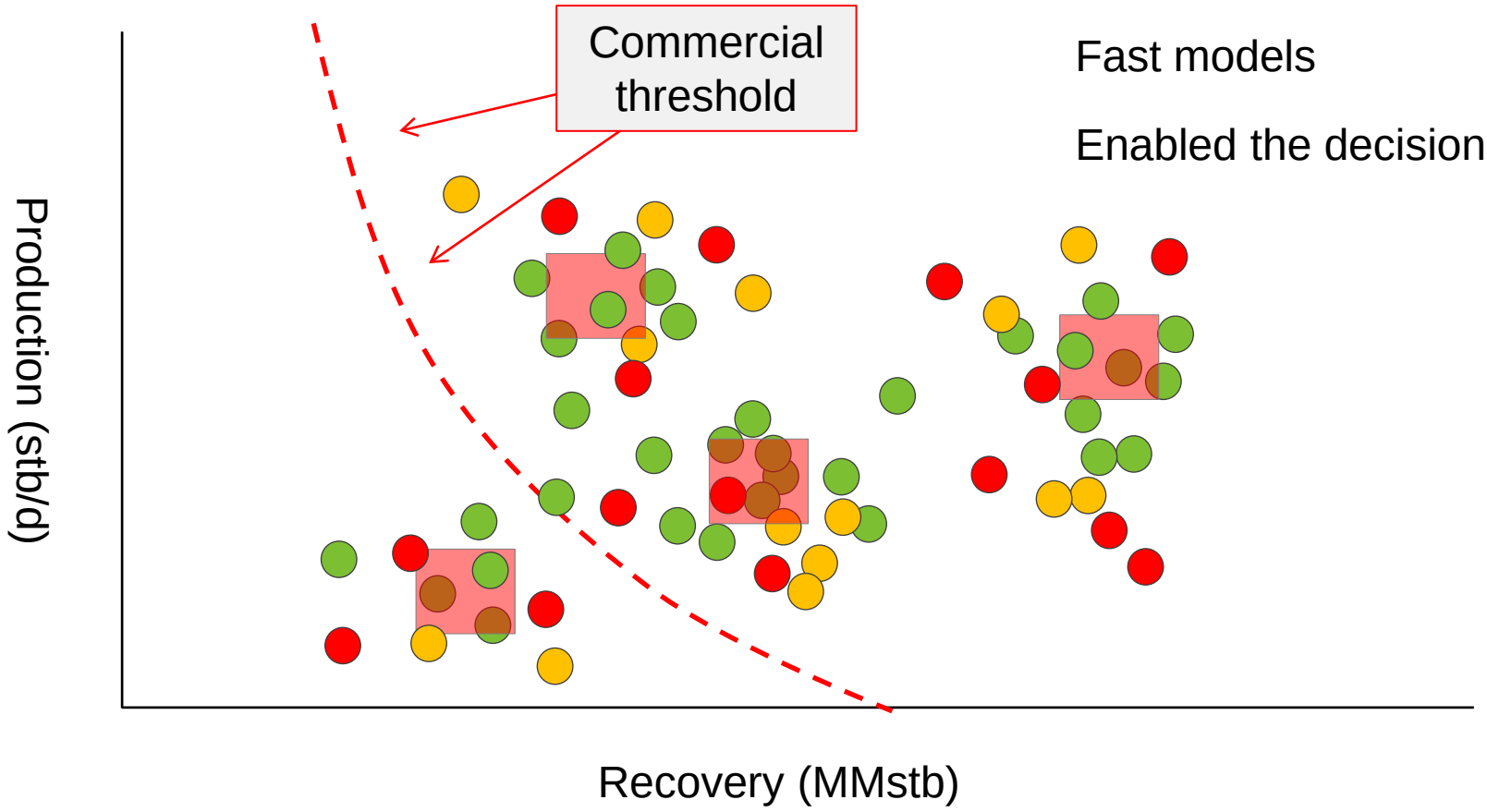
Supervised clustering for post-processing

No base case

Drivers are understood

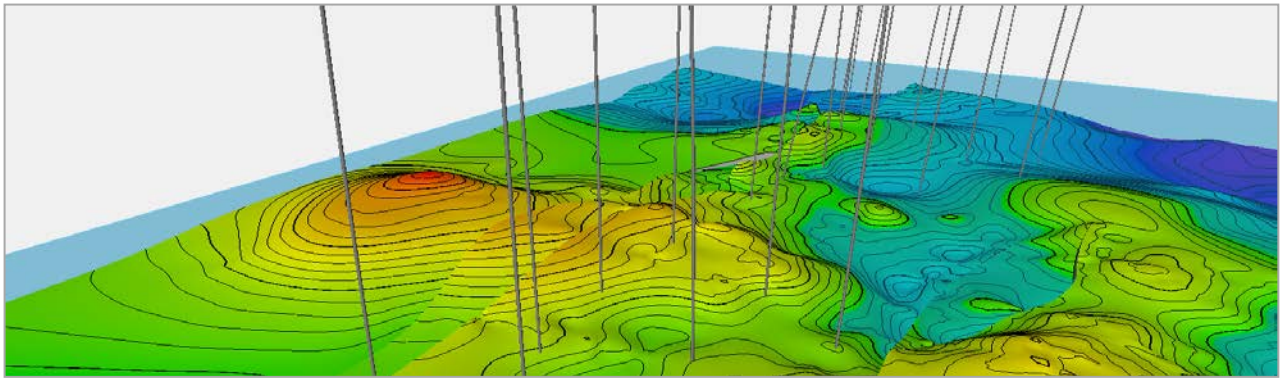
Fast models

Enabled the decision

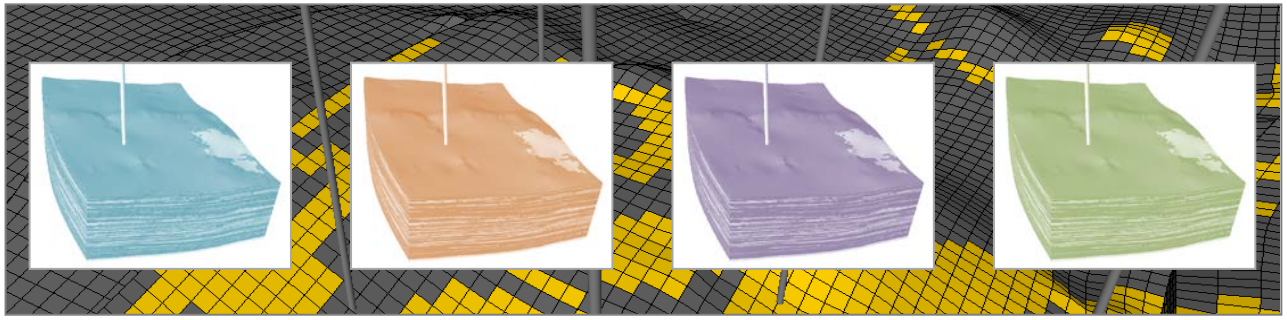


Resource vs. Decision models

The ‘Resource Model’



The ‘Decision Models’



Resource *vs.* Decision models & clustering

There is always a subjective step

Big models and complex workflows not necessarily the optimal choice

Simple solutions like clustering highlight the subjective ‘best judgements’ in a way that is easy to share

Resource *vs.* Decision model distinction separates the need for long-term life-cycle data bases and short-term decision