Cake & Discuss The Uncertainty Study

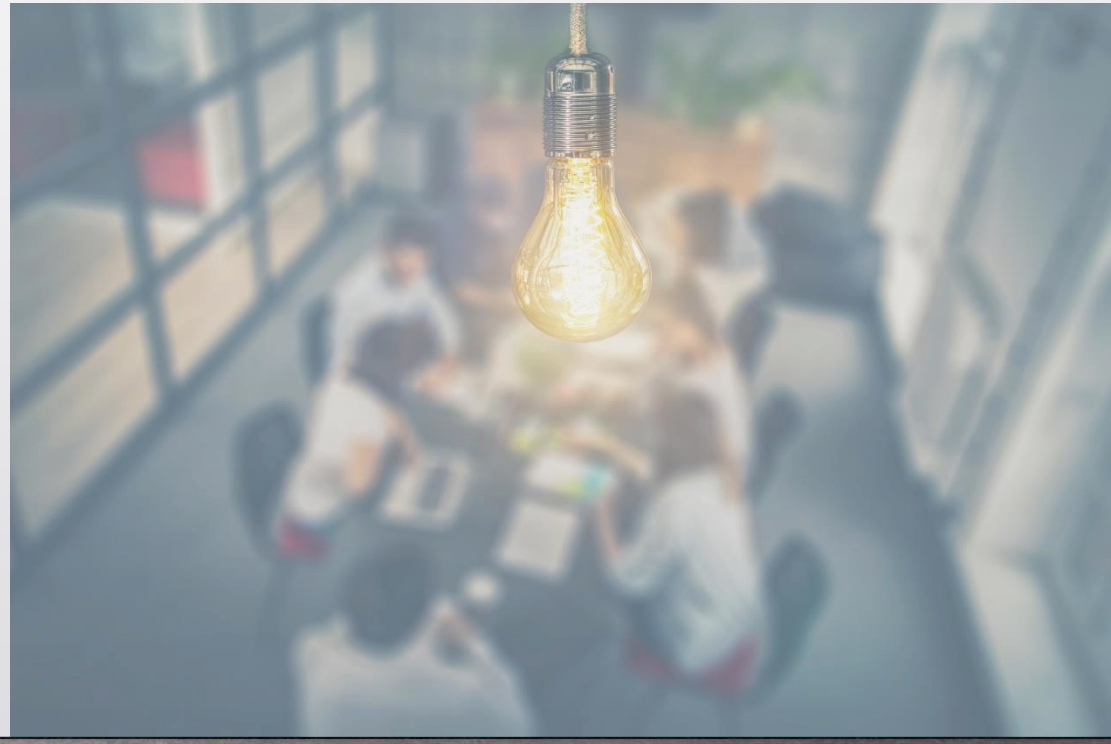
Organization Committee

Sonja Kuhlmann

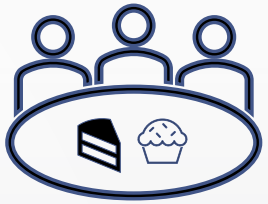
Marine Seignole

Oslo facilitator

Camilla Oftebro



HSE & Other Practicalities



Welcome to "Cake & Discuss"

TODAY:

7 November 24
The Uncertainty Study – Part2

Past sessions:

13 April 23
The Structural Framework

22 August 23
The Grid

7 November 23
The Property Model – Part1

23 April 24
The Property Model – Part2

27 August 24
The Uncertainty Study – Part1

Future sessions:

XXX
Data Sharing: Input and Output

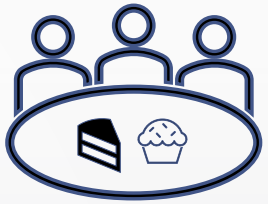
https://www.sodir.no/en/force/archive/

Impulse talk topics – Uncertainty session 1

- Uncertainty study design
- Implementing different concepts in a model
- QC of multiple realisations

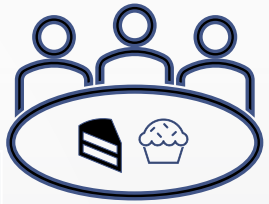
Welcome to "Cake & Discuss"

- Fundamental spirit of FORCE
  - Cooperative forum
  - Facilitate cooperation within the industry
- Group discussions
  - Discussion based on impulse talk
  - Small group: Mix of experience and expertise
  - Summary session
- This is not a place where we can solve all the issues but discuss and share experiences
  - If you want to bring up a topic: suggest an impulse talk

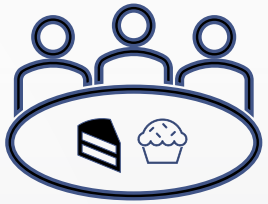


How this works

- Welcome and introduction
- Divide audience into groups
- Each group chooses a discussion keeper
- "Impulse" talks round today's topic
- Discussion time after talk
  - Have you seen this?/What's your best practice? ….
- Round the room: each group present findings
- In total 2 impulse talks and follow-up discussion in groups and presentation to other groups
- Closeout and feedback
- Mingle, talk & enjoy food and drinks throughout the afternoon

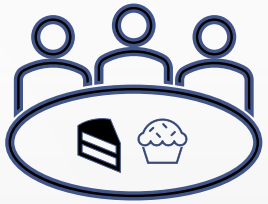


Time	Duration	Activity
12:30-12:55	25 min	Intro to concept Presentations “who is here today” Sort groups
12:55-13:10	15 min	1. “Impulse” talk
13:10-13:35	25 min	Group discussion
		Send picture of conclusion
13:35-13:45	10 min	Break (deliver talking points)
13:45-14:15	30 min	Presentations and overall discussion
14:15-14:30	15 min	2. “Impulse” talk
14:30-15:35	60 min (25+10+30)	Group discussion Send picture of conclusion Break (deliver talking points) Presentations and overall discussion
15:35-15:45	10 min	Closeout / feedback



The groups

Group 1	Group 2	Group 3	Group 4	Group 5	Group 6

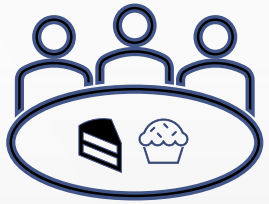


Choose a discussion keeper

- Role:
  - Keep the discussion going
  - Make sure everybody in the group gets talking time
  - Time keeping
  - Make sure the key ideas are on the flip chart
  - Find a presenter to other groups - 1 presenter per impulse talk
  - When problems are raised
    - -> probe for solutions
  - TAKE A PICTURE OF YOUR FLIP CHART / SHARE YOUR PPT
    - Send it to marine.seignole@akerbp.com
    - Mention your group number in the subject

Impulse talk topics

- Uncertainties vs. Scenarios: When & Why
- QC of multiple realisations



Impulse talk 1

ORLEN UPSTREAM NORWAY | Impulse Talk

Uncertainties vs. Scenarios: When & Why

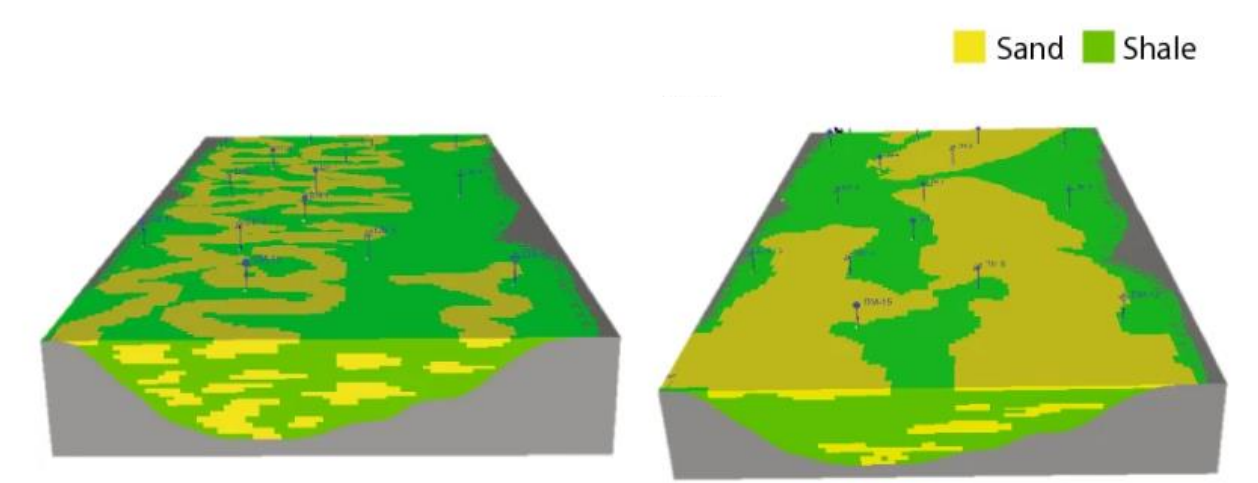
SODIR

07.11.2024

Definitions

Scenario

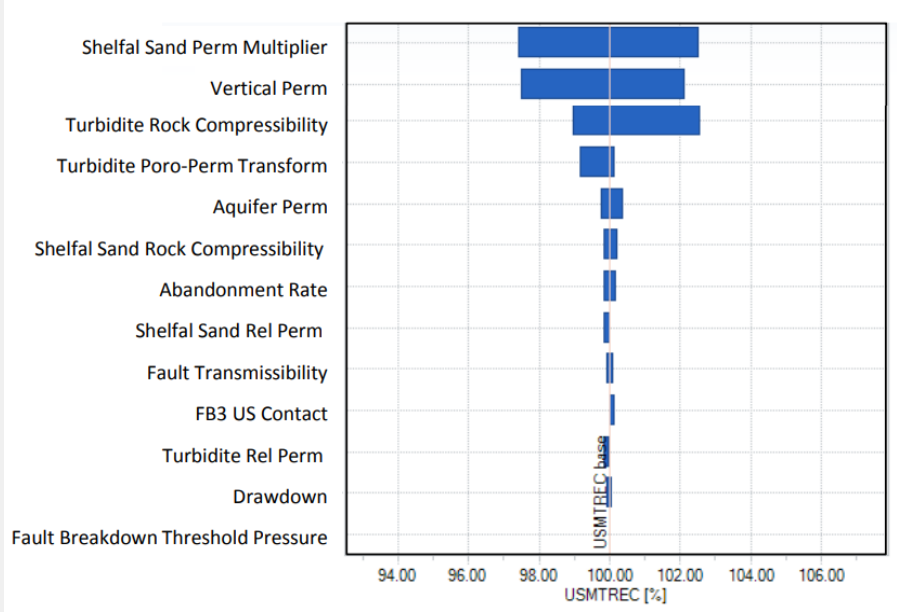
A specific set of input assumptions and/or constraints represented by a single ensemble member / group of members / a full ensemble. Different scenarios are used to represent deterministic values for parameters or sets of parameters **(FORCE, Guideline for Ensemble Data Sharing)**



Modified from Arnold, D. *et al* (2018)

Uncertainty:

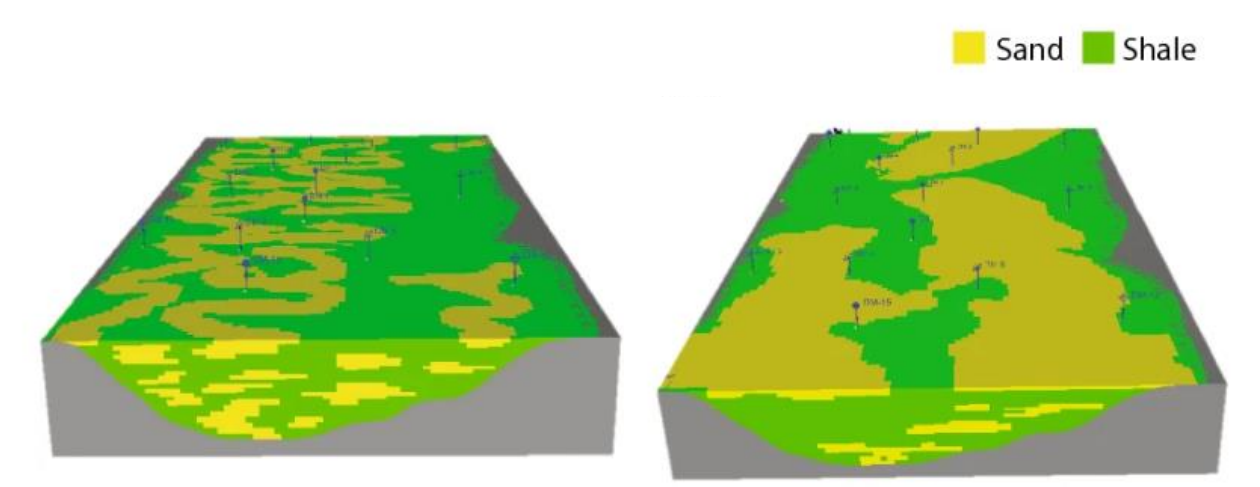
Range of values within which a practically unmeasurable or unknowable parameter is estimated to lie at some level of confidence **(Perez-Diaz, L. et al. 2020)**



Ryan, D. *et al* (2015)

Scenarios or just uncertainty?

- **Slightly different depositional environments can lead to different connectivity, properties and facies distributions**
- **Can all this differences be included in our uncertainty evaluation or do we need different scenarios / models?**
- **Different scenarios can be equally probable or not; risk to end up in the upper left circle**



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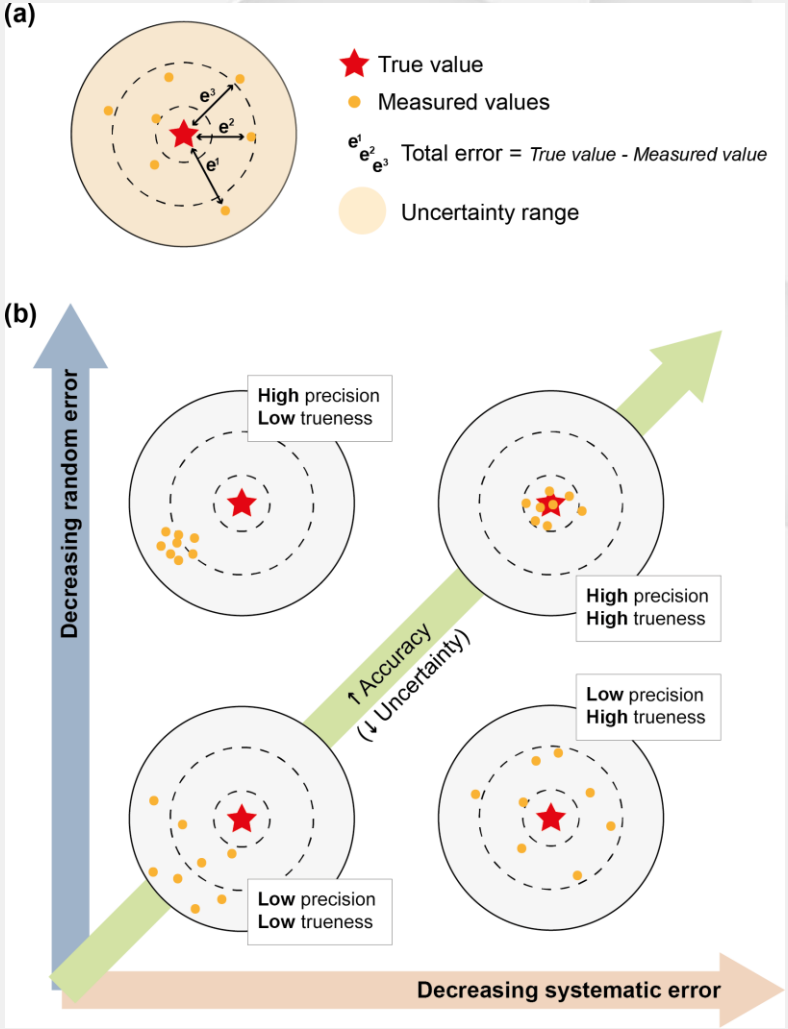
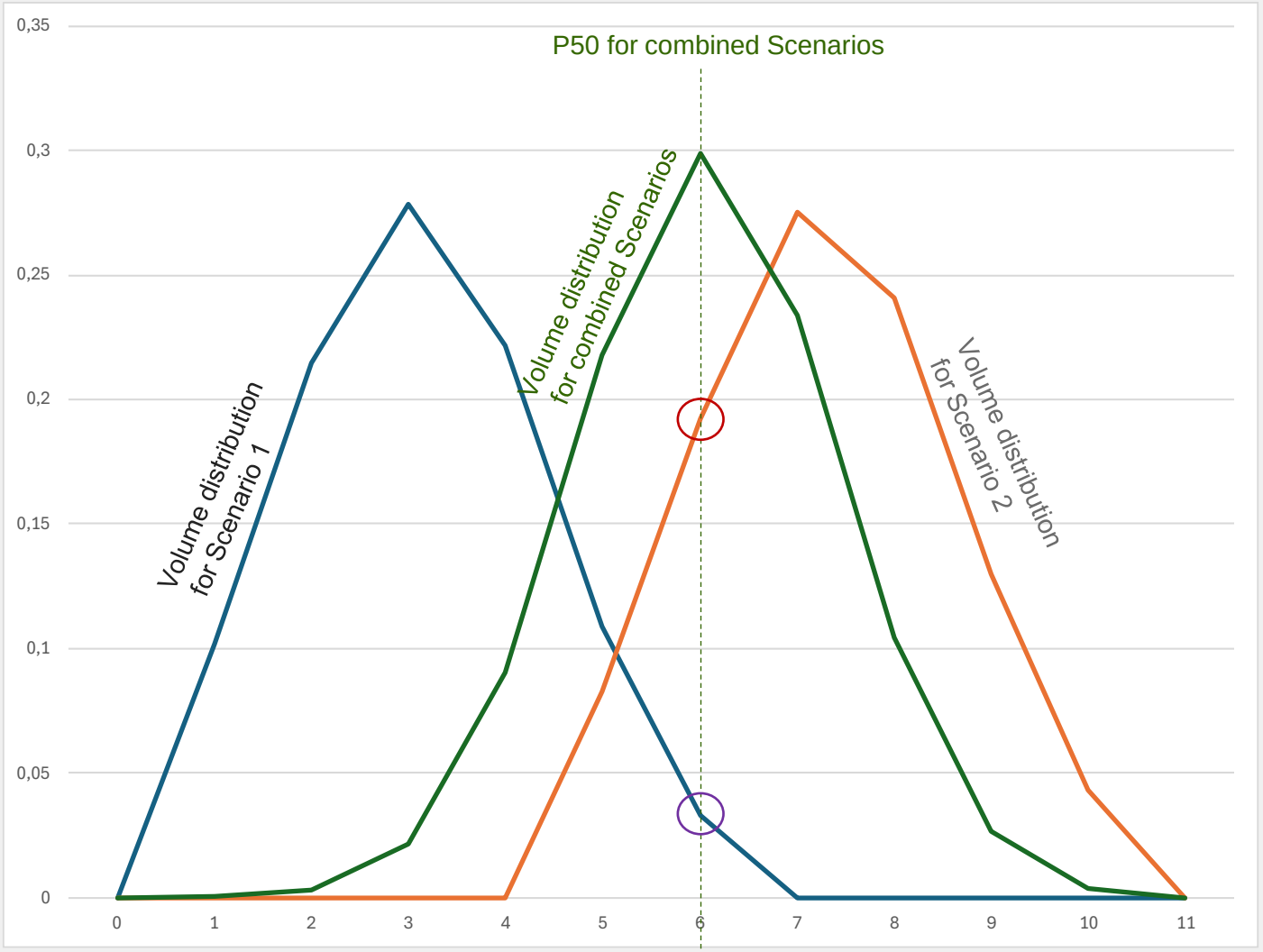


Perez-Diaz, L. *et al* (2020)

Combination of scenarios

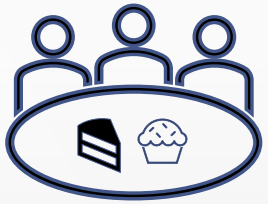


- **Combined volumetric distribution for different scenarios is not uncommon to see**
- **If a «close to P50» discrete case is picked, it could actually be a high case for Scenario 1 ◯ or a low case for Scenario 2 ◯**
- **Is this a right choice?**

ORLEN Upstream Norway

Questions to discuss

- **How different depositional / structural /… ideas need to be to require different scenarios instead of being part of the uncertainty work?**
- **Should different scenarios be combined into a single volumetric ensemble? Would P10-P50-P90 be representative? How to choose a proper discrete case?**



Group - Notes

- TAKE A PICTURE OF YOUR FLIP CHART
  - Send it to marine.seignole@akerbp.com
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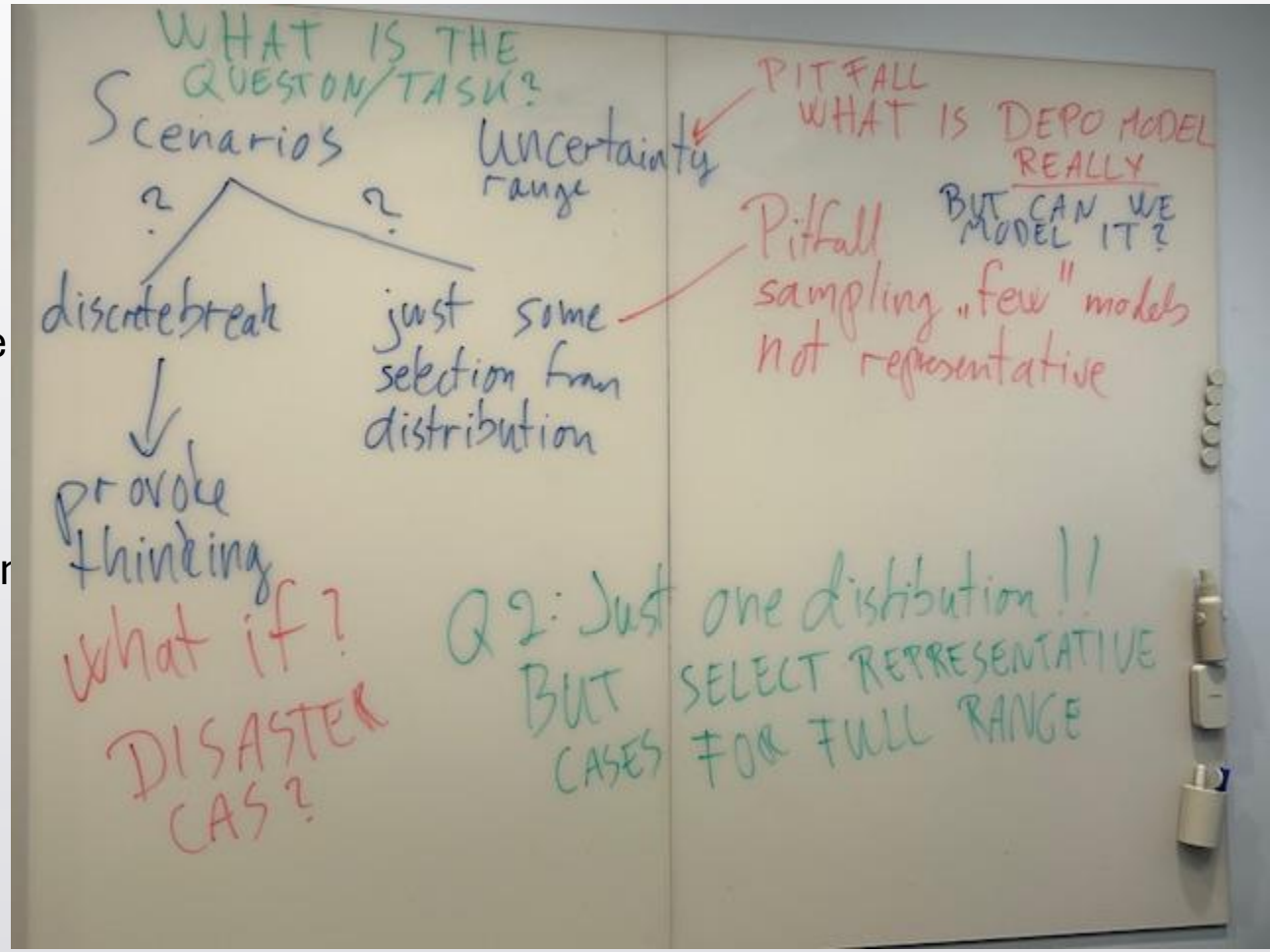
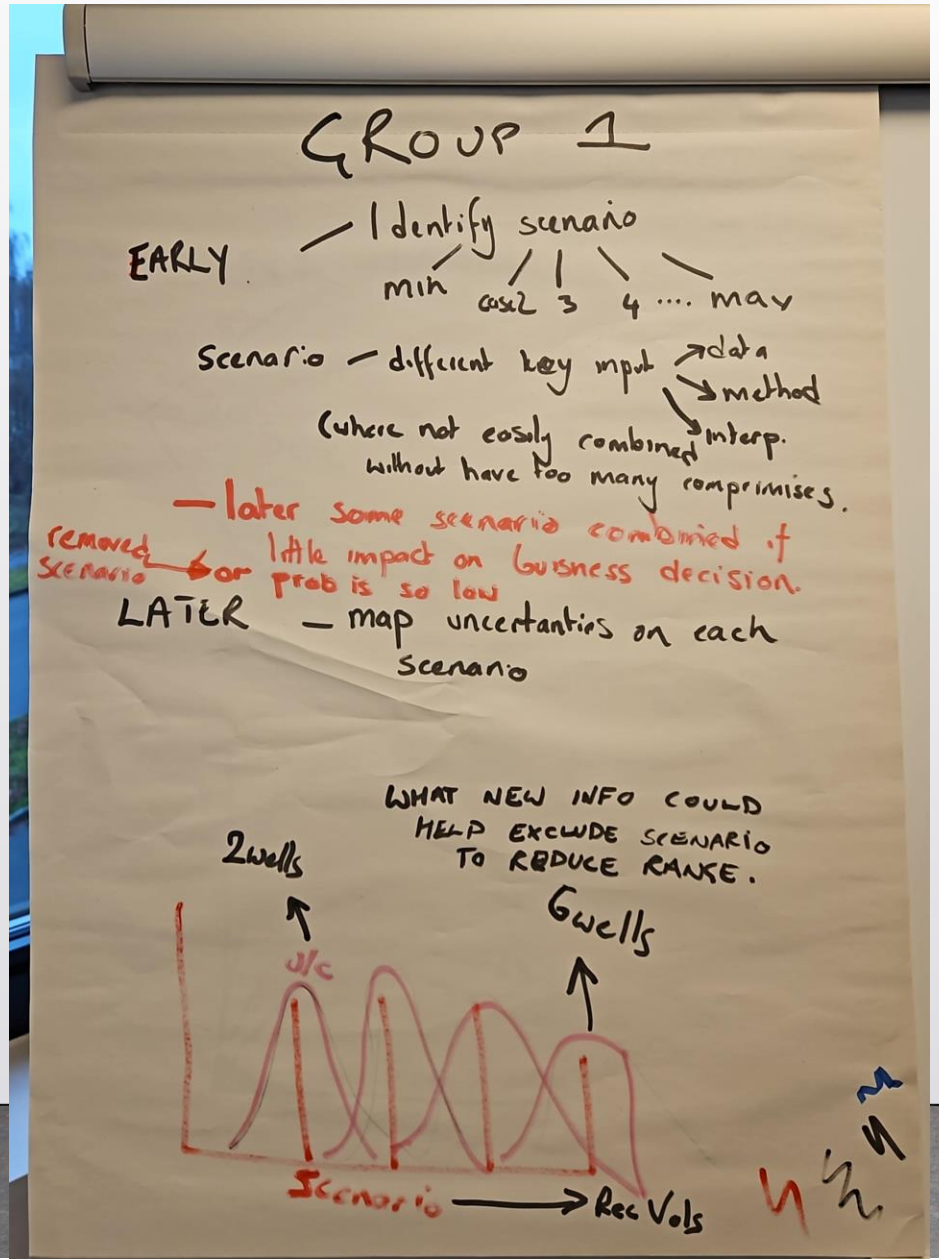
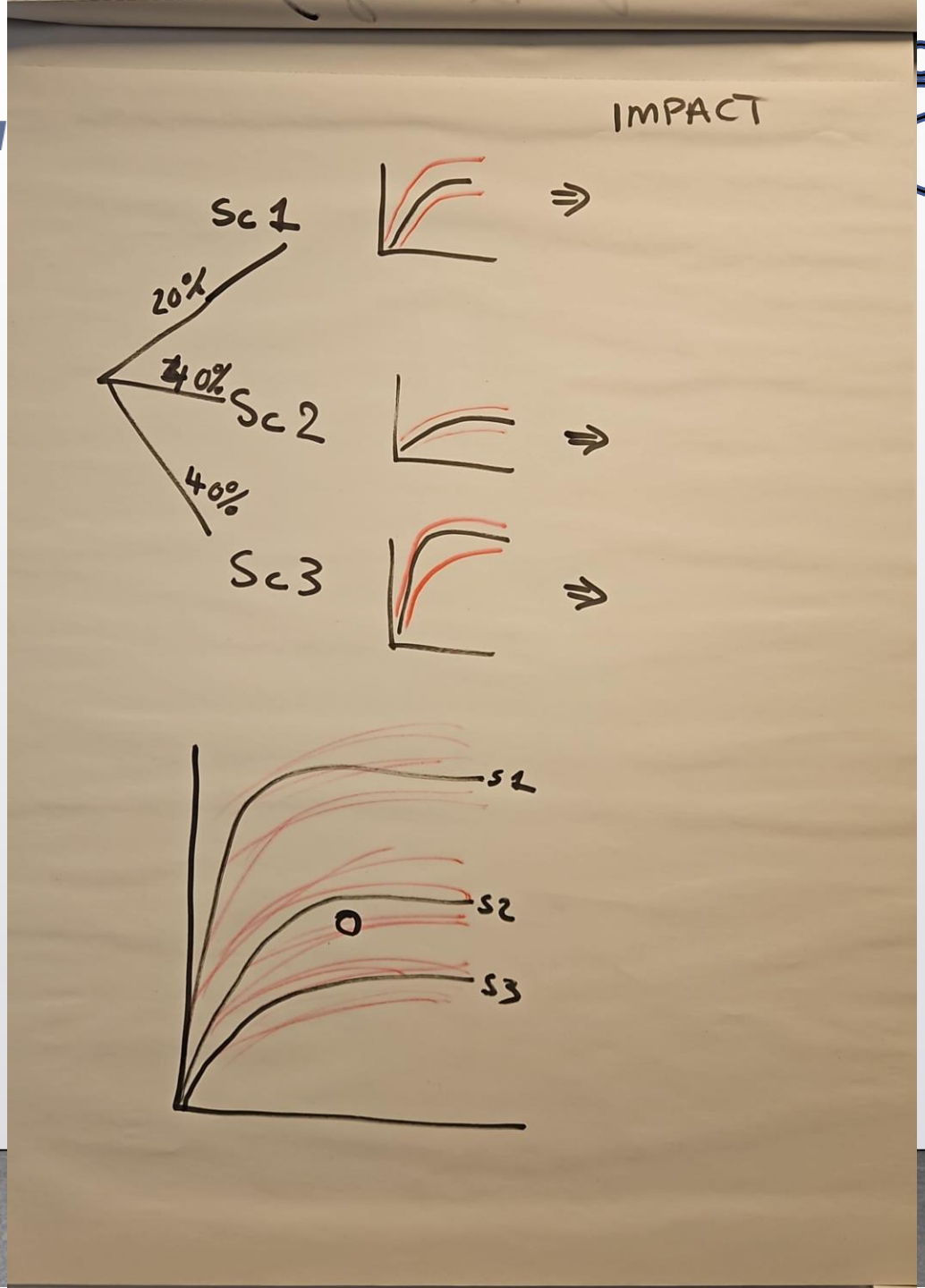
Oslo

- Scenarios gramatically discrete break
- Does is just mean a selection from the distribution.
- Every realization is a scenario.
- When we talk about scenarios we are challenged/provoked into thinking out of the box. Some fields probably can be captured by a steady range and others require discrete differences.
- Testing scenarios to see impact
- Even when we are confident we understand a depositior model are we correctly capturing it
- There is only one distribution so P50 is as was shown . Facilities could be constructed to best fir say P30 and P70.

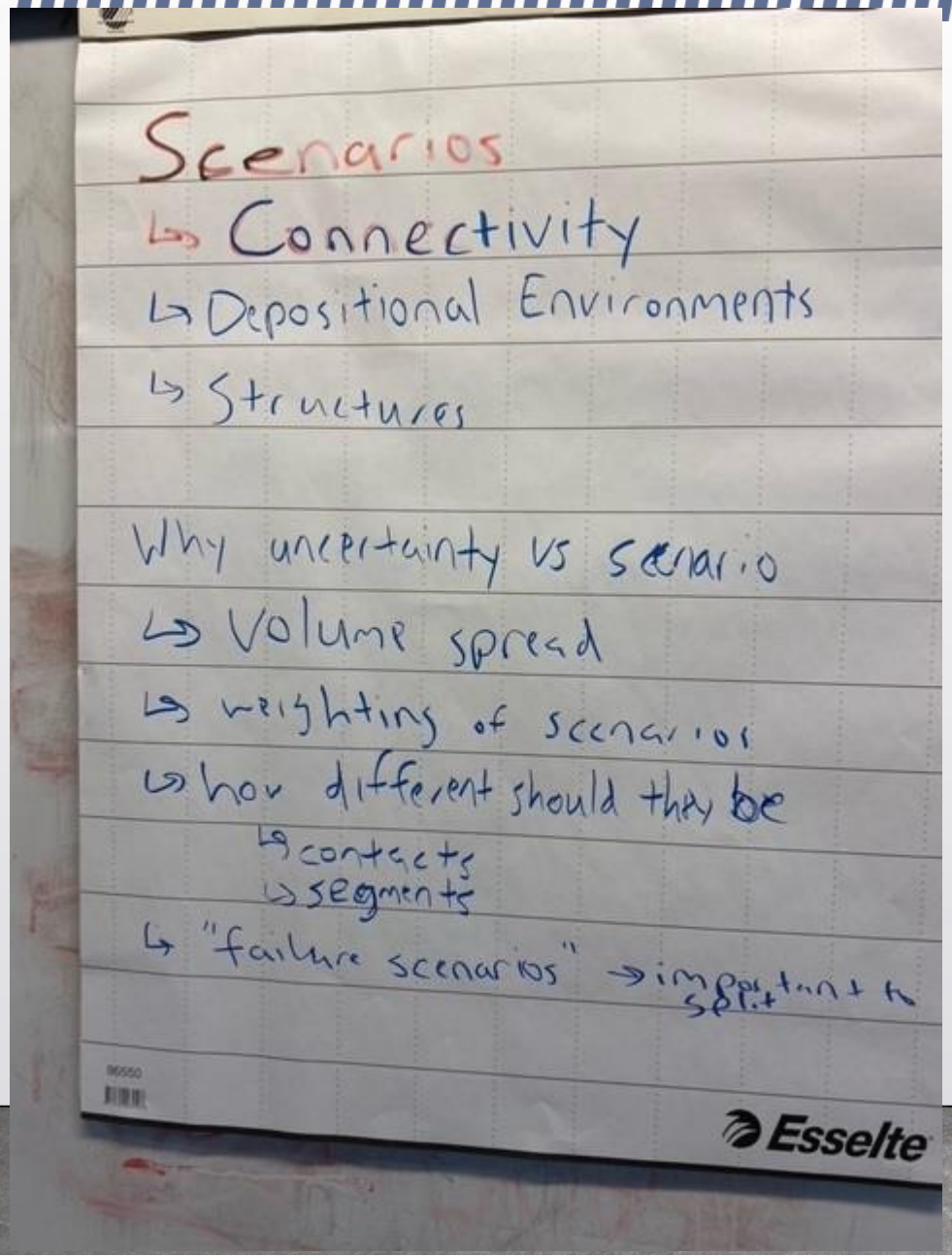


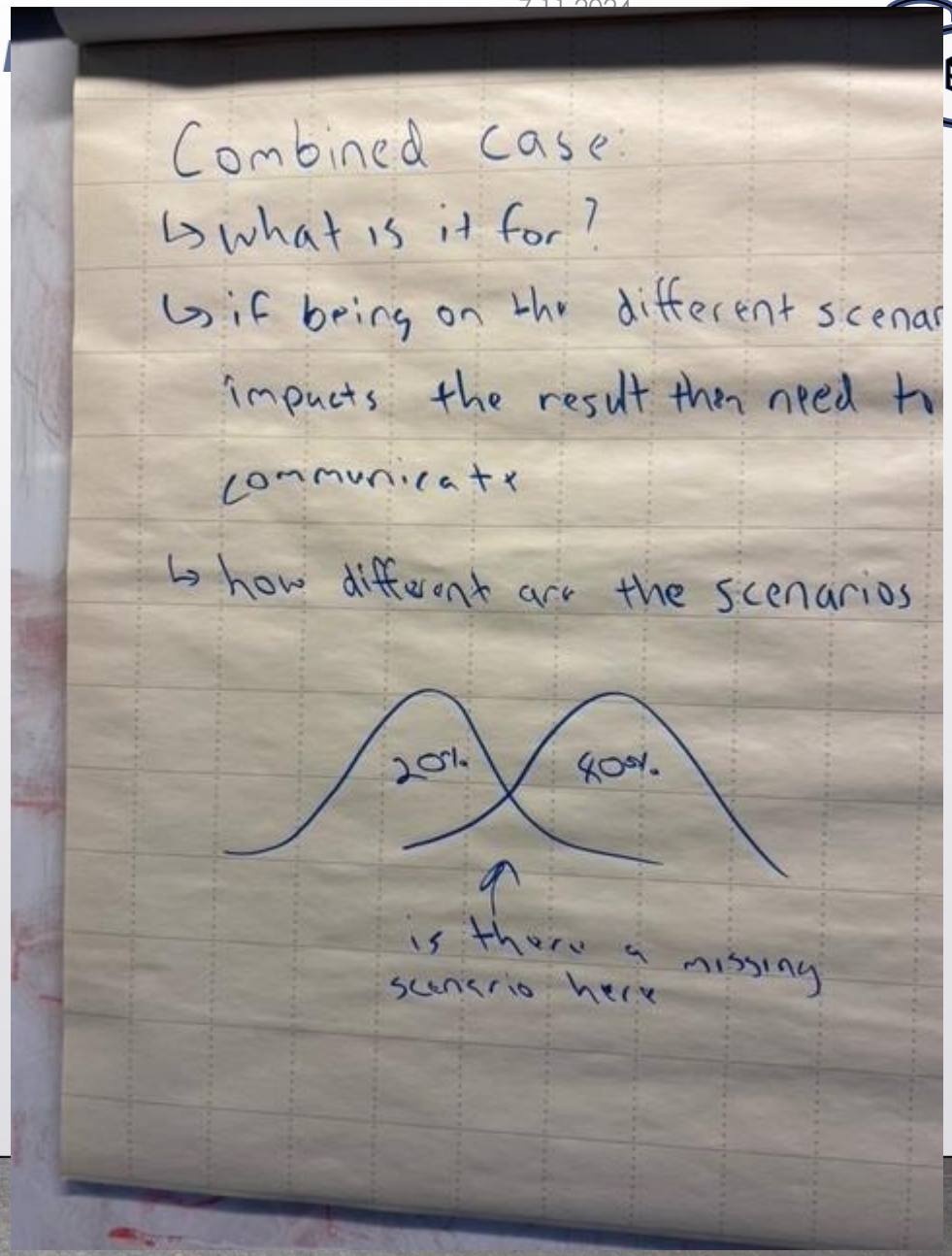
Group 1


GROUP 1
EARLY
Identify scenario
min
case2
3
4
.... max
Scenario – different key input → data → method
(where not easily combined) → interp.
without have too many compromises.
– later some scenario combined if
little impact on business decision.
removed scenario → or Prob is so low
LATER – map uncertainties on each scenario
WHAT NEW INFO COULD HELP EXCLUDE SCENARIO TO REDUCE RANGE.
2wells
6wells
u/c
Scenario
Rec Vols

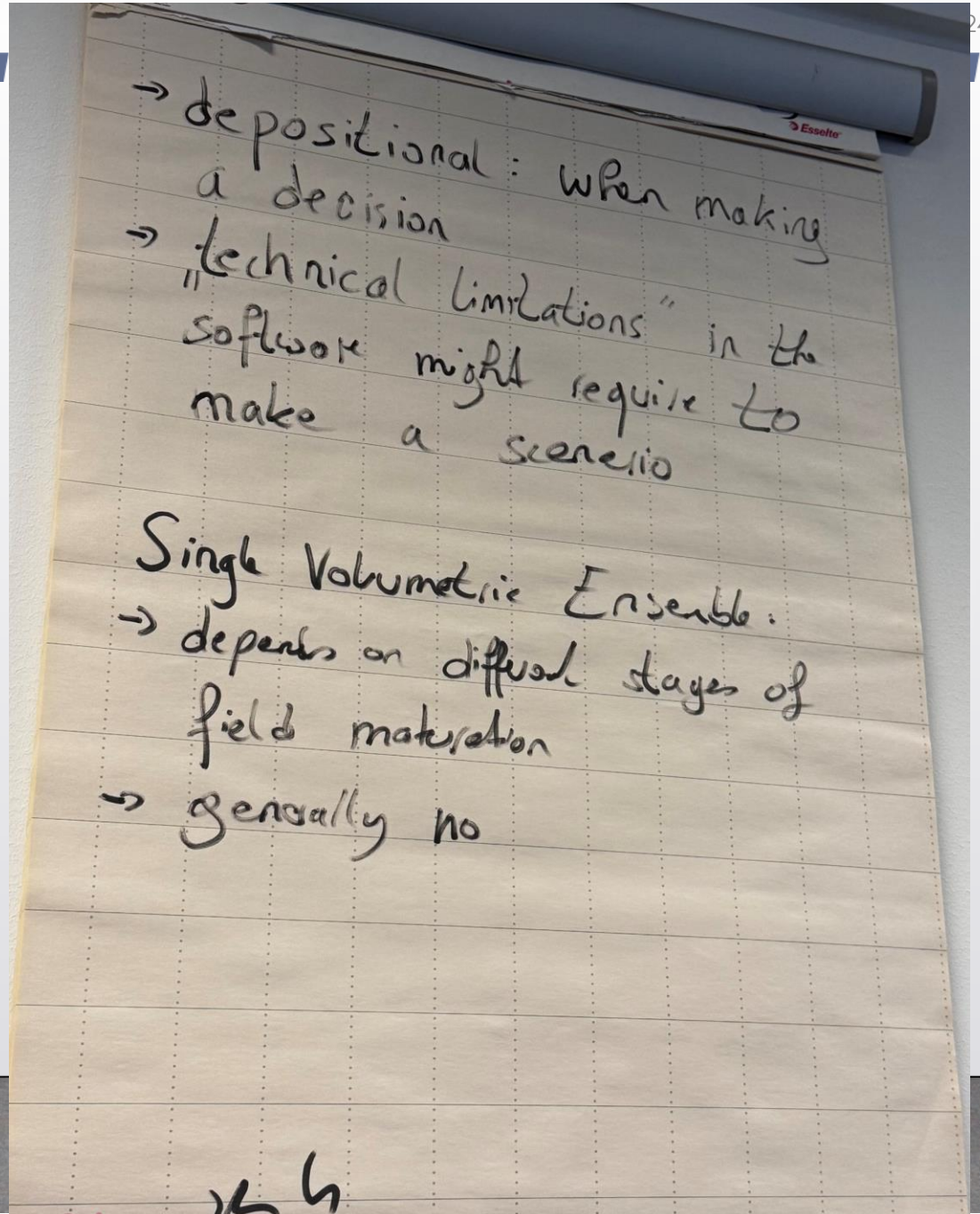

IMPACT
Sc 1
20%
40%
Sc 2
40%
Sc 3
S1
S2
S3
0

Group 2


Scenarios
↳ Connectivity
↳ Depositional Environments
↳ Structures
Why uncertainty vs scenario
↳ Volume spread
↳ weighting of scenarios
↳ how different should they be
↳ contacts
↳ segments
↳ "failure scenarios" → important to split
Esselte

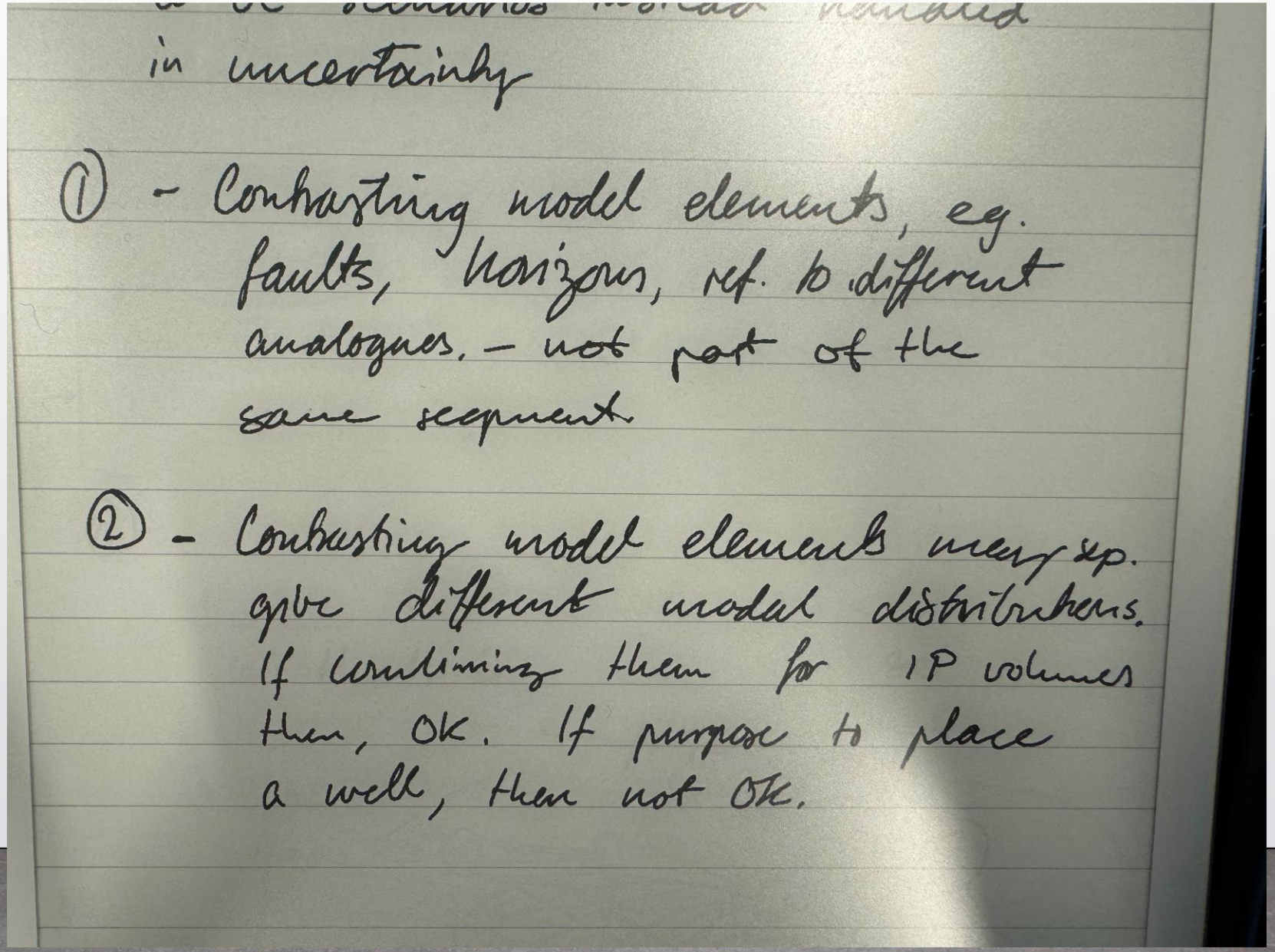

Combined case
↳ what is it for?
↳ if being on the different scenar
inputs the result then need to
communicate
↳ how different are the scenarios
20%
40%
is there a missing scenario here

Group 3


→ depositional: when making a decision
→ „technical limitations" in the software might require to make a scenario
Single Volumetric Ensemble:
→ depends on diffuse stages of field maturation
→ generally no

Group 4

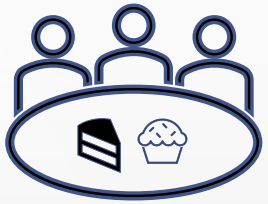
7.11.2024



in uncertainty

① - Contrasting model elements, eg. faults, horizons, ref. to different analogues. – not part of the same segment.

② - Contrasting model elements may sp. give different modal distributions. If combining them for IP volumes then, OK. If purpose to place a well, then not OK.



Impulse talk 2

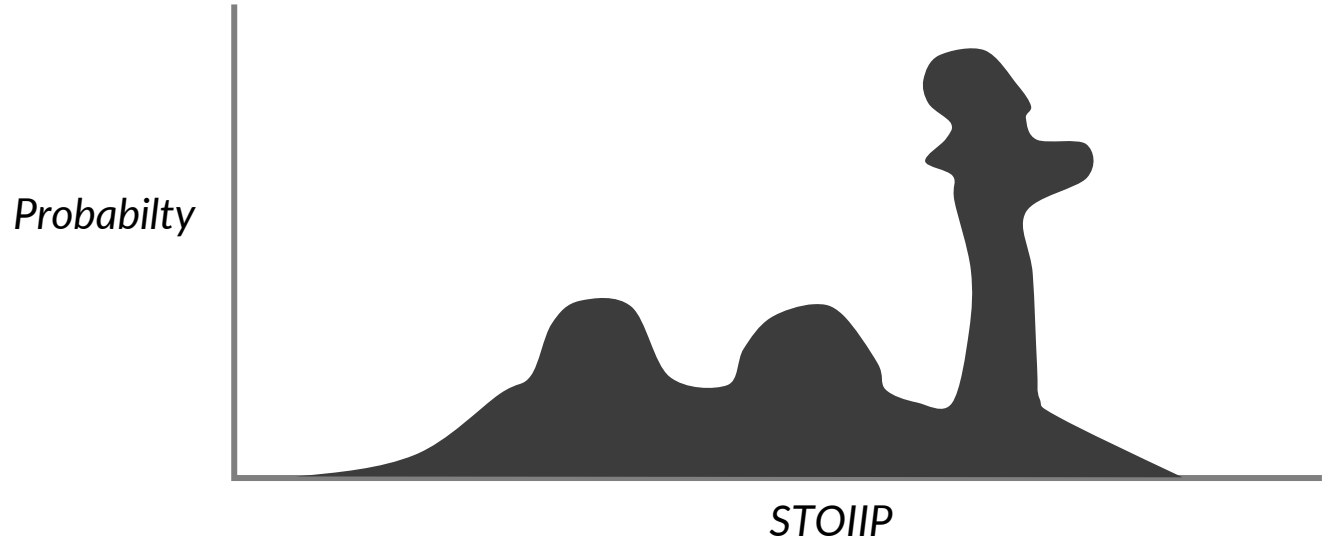
QC of ensemble geomodels

Jamie Quin

- QC of deterministic models
  - QC of input data
  - Show model surfaces and faults match seismic
  - Describe conceptual model and demonstrate that uncertainties are covered by scenarios.
  - Show facies proportions, ntg, porosity, permeability, saturation etc meet the distribution in the input log data or that they vary from these in expected ways (table format).
  - Report volumes at field and segment level (use this to back-calculate porosity etc – does it make sense?)
  - Scroll through models in I, J, and K to ensure geological consistency.
  - Low, mid and high case deterministic models to cover uncertainty span.
  - Present model and workflow coherently
  - Close liaison with RE

- In the worst case a QC presentation of an ensemble model can sound like this
  - Blah
  - Technology
  - Blah
  - 1 million realizations
  - Blah
  - Cloud
  - Blah
  - Uncertainty ranges

- Investment decision?



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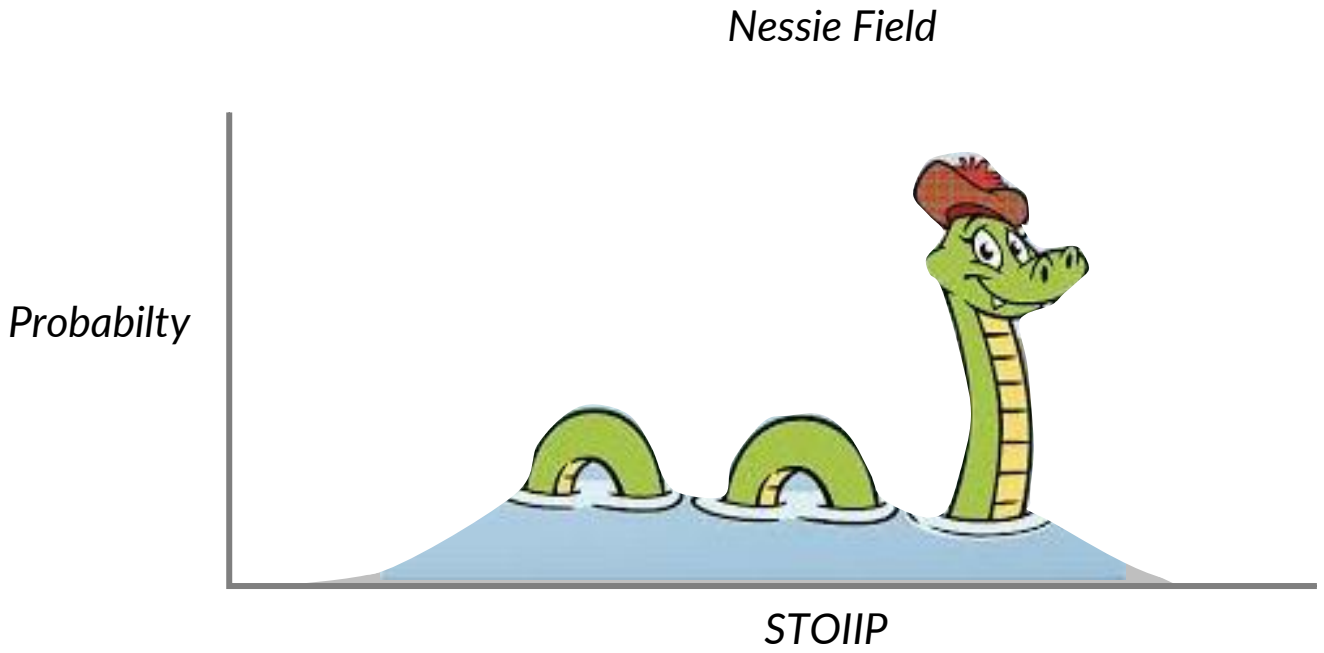
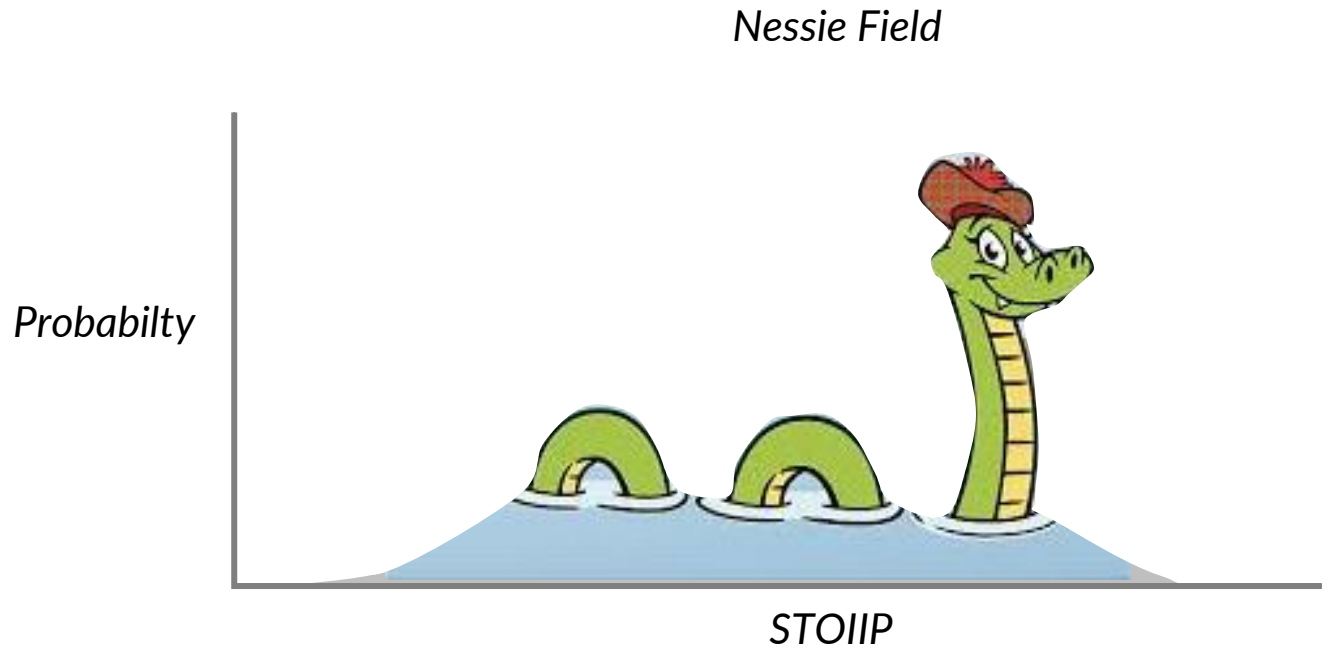
  - 1 million realizations
  - Blah
  - Cloud
  - Blah
  - Uncertainty ranges



- In the worst case a QC presentation of an ensemble model can sound like this
  - Blah
  - Technology
  - Blah
  - 1 million realizations
  - Blah
  - Cloud
  - Blah
  - Uncertainty ranges

As an investor of QC responsible: do you believe in Nessie?

What evidence have we seen that it exists as presented?



- In what ways does QC of an ensemble model differ from QC of a traditional deterministic model?
- The same things must be QC'd.

- QC of traditional models
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Conceptual Model

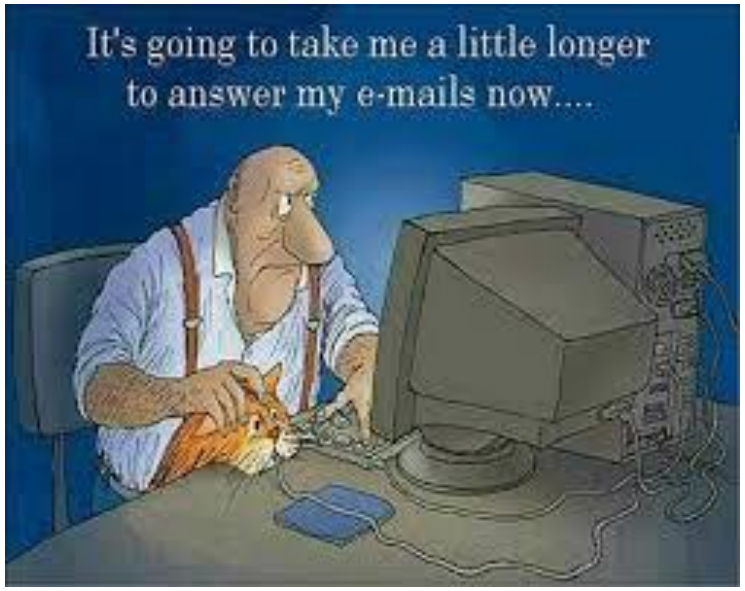
Technology

Paper maps

Challenging to capturing complexity

Deterministic 3D geomodels

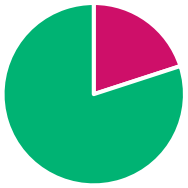
Ensemble geomodels



Mistakes, complication, software limitations, cat

Geology, geology, geology

Ref Case Correlation



80%

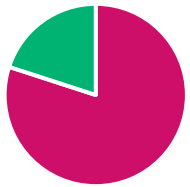
20%

10%

30%

20%

Alt Case Correlation



20%

7,5%

5%

7,5%

How should we present the conceptual model captured in an ensemble?

- QC of traditional models
  - QC of input data
  - Show model surfaces and faults match seismic
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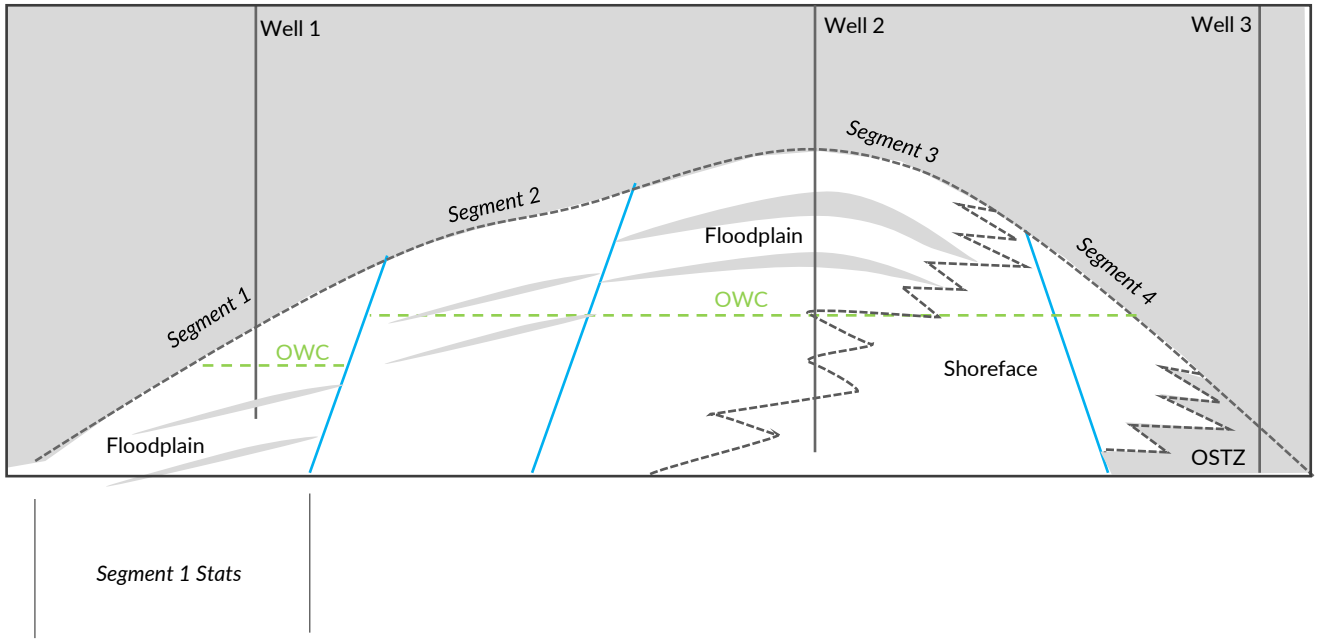
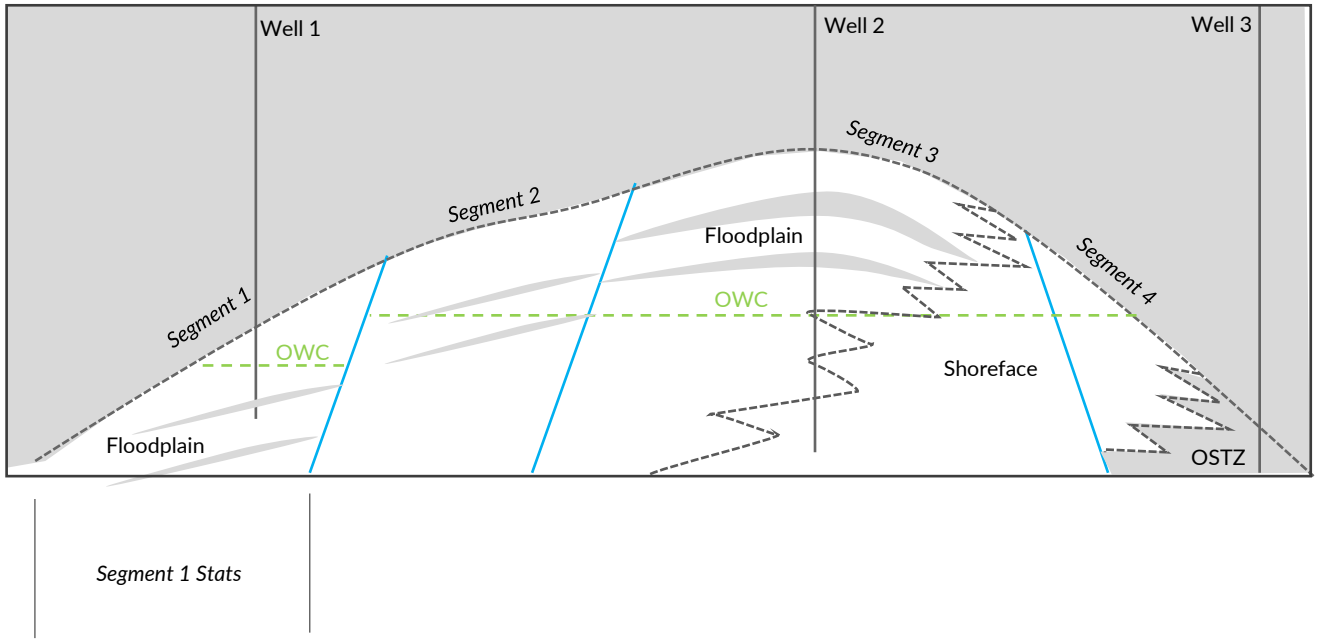
Nessie Field: Generic Oilfield – ref case



	Segment 1. FWL	Segment 1 Fl plain	Segment 1 Channel	Segment 1 Por	Segment 1 Por (fl plain)	Segment 1 Por (Channel)	Segment 1 Perm	Segment 1 Perm (fl plain)	Segment 1 Perm (Channel)	Segment 1 Sw	Segment 1 Sw (fl plain)	Segment 1 Sw (Channel)
Low Case	1972	50%	50%	0.20	0.12	0.25	1000	100	2000	0.40	0.95	0.30
Ref Case	2018	20%	80%	0.25	0.15	0.28	2000	200	3000	0.25	0.85	0.15
High Case	2025	5%	95%	0.30	0.18	0.32	3000	300	4000	0.10	0.60	0.10

Nessie Field: Generic Oilfield – ensemble case

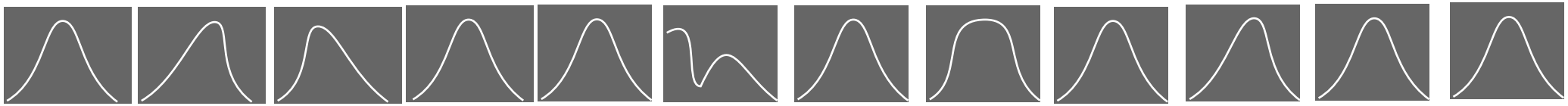


Export every possible statistic for each realisation

Target facies %
Actual facies %
Etc

Are there other ways to QC

	Segment 1. FWL	Segment 1 Fl plain	Segment 1 Channel	Segment 1 Por	Segment 1 Por (fl plain)	Segment 1 Por (Channel)	Segment 1 Perm	Segment 1 Perm (fl plain)	Segment 1 Perm (Channel)	Segment 1 Sw	Segment 1 Sw (fl plain)	Segment 1 Sw (Channel)
P90	1972	50%	50%	0.20	0.12	0.25	1000	100	2000	0.40	0.95	0.30
P50	2018	20%	80%	0.25	0.15	0.28	2000	200	3000	0.25	0.85	0.15
P10	2025	5%	95%	0.30	0.18	0.32	3000	300	4000	0.10	0.60	0.10



- QC of traditional models.
  - QC of input data
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  - Show facies proportions, ntg, porosity, permeability, saturation etc meet the distribution in the input log data or that they vary from these in expected ways (table format).
  - Report volumes at field and segment level.
  - Scroll through models in I, J, and K to ensure geological consistency
  - Low, mid and high case deterministic models to cover uncertainty span.
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Scroll through models in I, J, and K to ensure geological consistency

- Scroll through five different I sections and five J sections and scroll through? Create a video of this?
- Export maps for each realisation and scroll through these?
- Choose 10 realizations covering the uncertainty span and QC these?

- QC of traditional models
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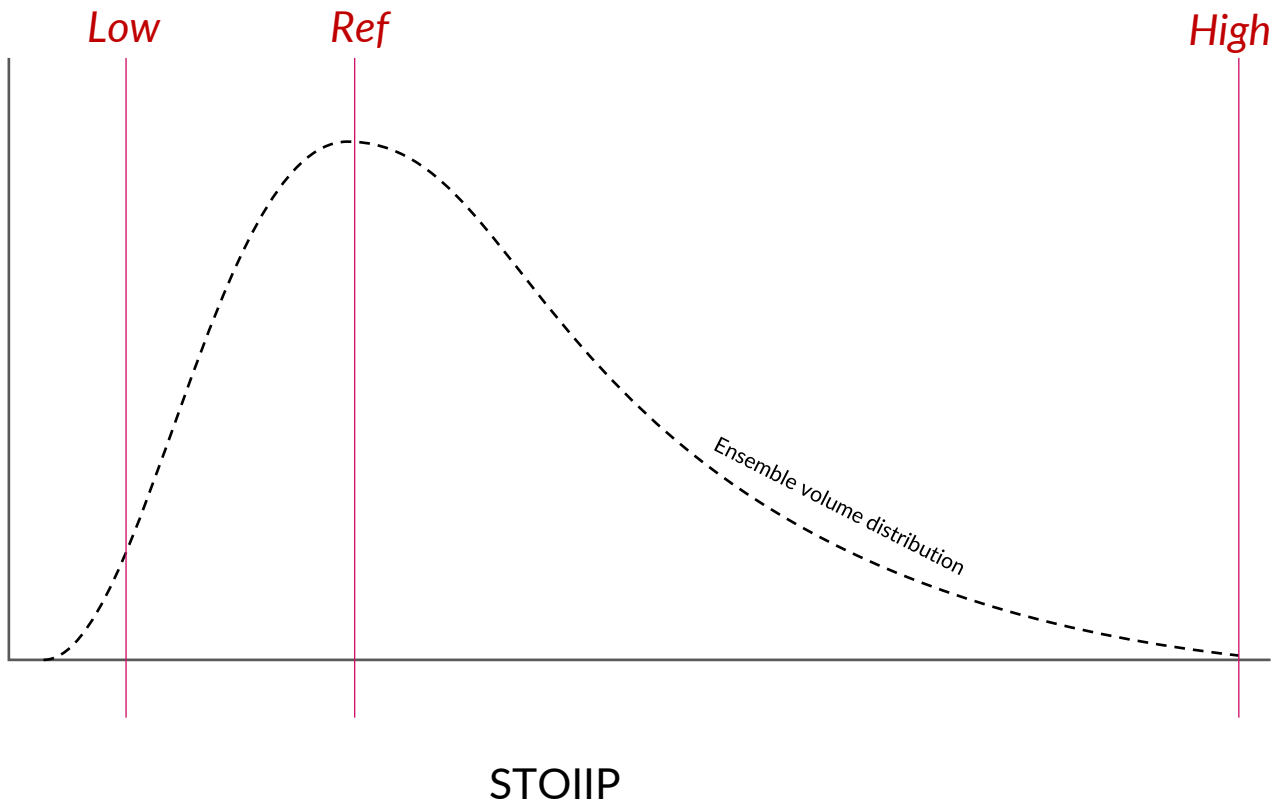
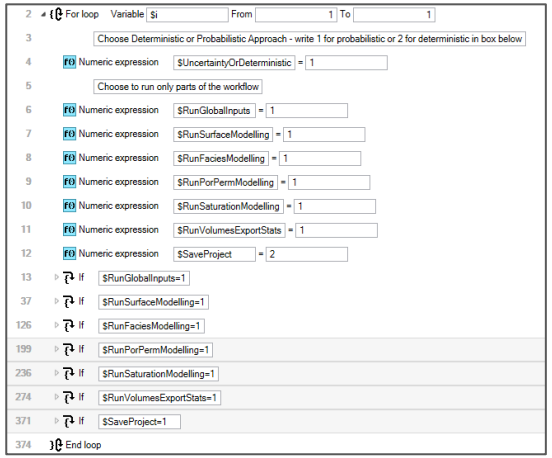
Ref case plus ensemble



The traditional reference case model has value.

- Detailed QC is possible (3D scrolling etc).
- Useful for visualisation (well planning etc).
- Useful to anchor ensemble volumes .
- Easy to modify the ref case to generate high and low cases and anchor the ensemble volume distribution.
- The same workflow can be used to generate deterministic reference cases and ensembles so it needn't involve more work.



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Facies

Parameter	Process	Variable	Comments
Facies			Hard/ soft facies are assigned from seismic and described earlier so this facies stage mainly concerns populating the different soft facies then including the dikes.
Facies	Pluri-guassian facies model 1. Construction of probability parameters for each Soft facies.	$ProbMaj=Ran(500, 3000) $VariogramRatio=$ProbMaj/$VariogramRatio $ProbMin=$ProbMaj/$VariogramRatio $ProbAzi=Triangular(0, 80,170) $MeanSoft1=Ran(0.1, 0.90) $MeanSoftSD=$MeanSoft1/4 $FractionSoft2and3	Distribution of the three soft facies. Modelling input requires probability maps for each facies. This is undertaken by firstly running pertophysical modelling on Soft1. Uncertainty variables include the mean probability and the variogram input. A second petrophysical modelling job is then run to define the split of facies Soft 2 and facies Soft 3 in the remaining probability space.
Facies	Pluri-guassian facies model 2. Construction of two Latent Gaussian fields	$LatentGaussianMaj=Ran(500,15000) $LatentGaussianMin=$LatentGaussianMaj/$VarRatio $LatentGaussianAzi=Triangular(0,80,180) $LatentGaussian2Maj=Ran(500,15000) $LatentGaussian2Min=$LatentGaussianMaj/$VarRatio $LatentGaussian2Azi=Triangular(0,80,180)	
Facies	Dikes are introduced in three steps. Firstly an object modelling step whereby one dike is introduced to the model in the EWT location. Then two steps of pluri-guassian facies modelling are applied.		
Facies	Dike in EWT		Firstly an object modelling step whereby one dike is introduced to the model in the EWT location
Facies	N-S Dikes	$Dikes_N_S_Prob_Maj=Round(Ran(3000,15000)) $Dikes_N_S_Prob_Min=$Dikes_N_S_Prob_Maj/30 $Prob_Maj=Round(Ran(3000,15000)) $Prob_Min=$Dikes_N_S_Prob_Maj/2 $Dikes_N_S_Mean=Ran(0.03,0.15) $Dikes_N_S_SD=$Dikes_N_S_Mean/3	Model N-S dikes. These can comprise up to 15% of the rock volume.
Facies	E-W Dikes	$Dikes_E_W_Prob_Maj=Round(Ran(3000,15000)) $Dikes_E_W_Prob_Min=$Dikes_N_S_Prob_Maj/30 $Prob_Maj=same as above $Prob_Min=same as above $Dikes_E_W_Mean=Ran(0.03,0.15) $Dikes_E_W_SD=$Dikes_E_W_Mean/3	Model E_W dikes. These can comprise up to 15% of the rock volume.

- QC of traditional models
  - QC of input data
  - Show model surfaces and faults match seismic
  - Describe conceptual model and demonstrate that uncertainties are covered by scenarios.
  - Show facies proportions, ntg, porosity, permeability, saturation etc meet the distribution in the input log data or that they vary from these in expected ways (table format).
  - Report volumes at field and segment level (use this to back-calculate porosity etc – does it make sense?)
  - Scroll through models in I, J, and K to ensure geological consistency.
  - Low, mid and high case deterministic models to cover uncertainty span.
  - Present model and workflow coherently
  - Close liaison with RE

For discussion

- What is the best way to communicate how different conceptual scenarios are included in the ensemble?
- What is the best method to output and QC statistics from the ensemble?
- How should we conduct the visual QC - how is this best achieved in an ensemble?
- Do high-mid-low deterministic cases have a role in the QC of ensembles?
- How should all the uncertainties in a model be presented in a coherent and understandable way?

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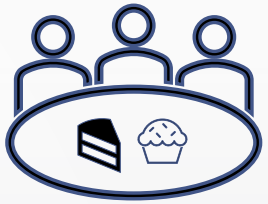
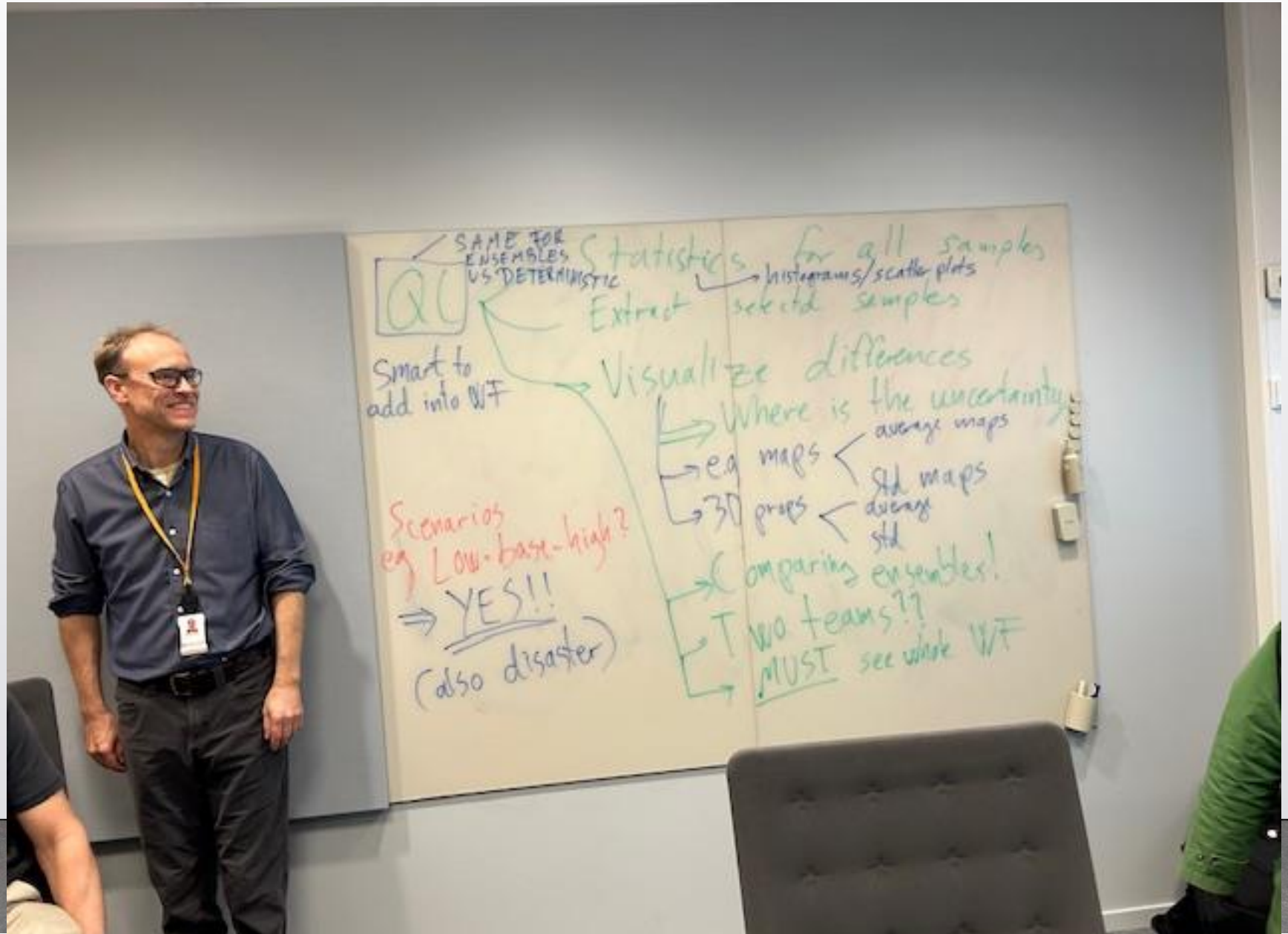


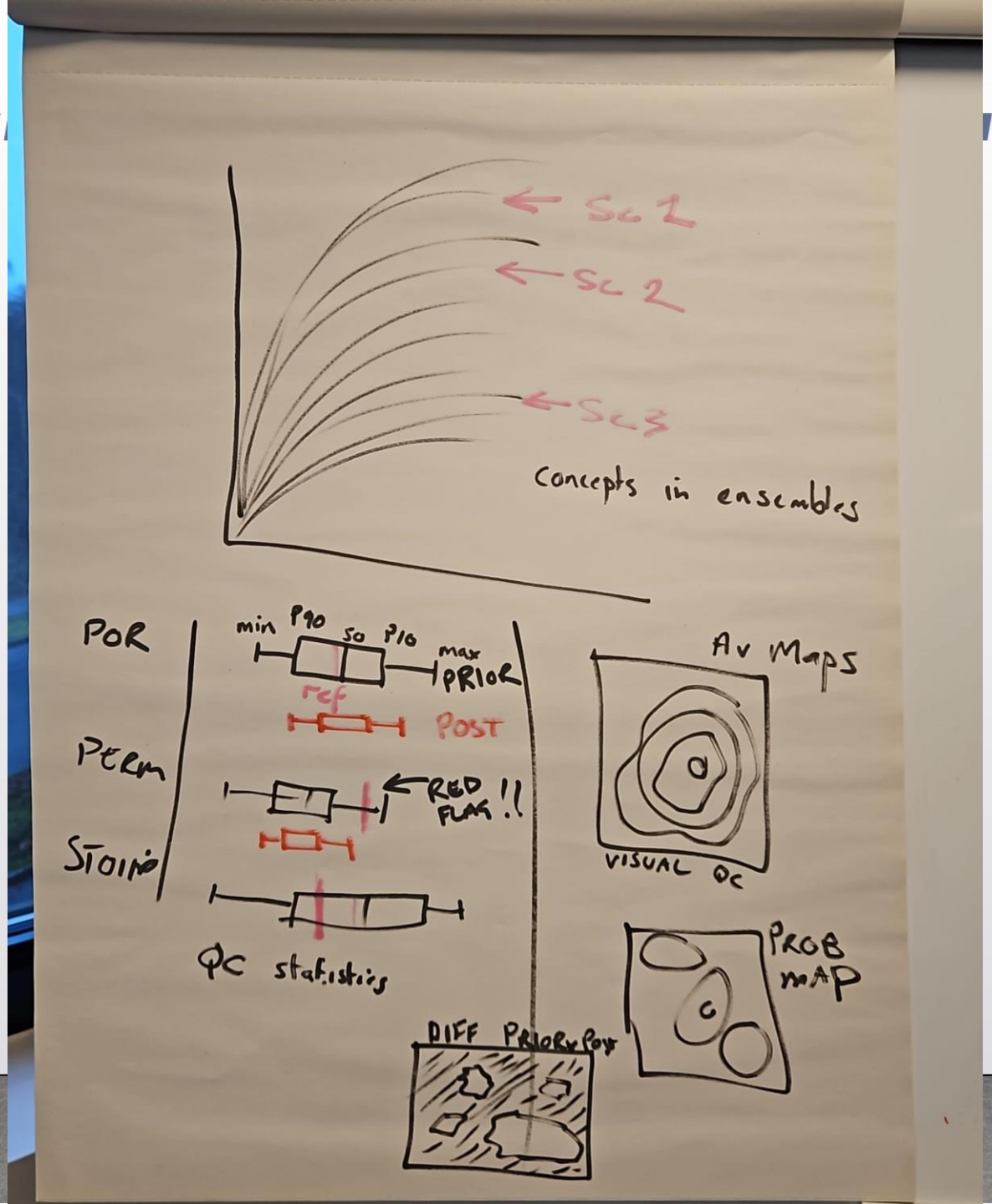
Group - Notes

- TAKE A PICTURE OF YOUR FLIP CHART
  - Send it to marine.seignole@akerbp.com
  - Mention your group number in the subject


QC
SAME FOR ENSEMBLES VS DETERMINISTIC
Statistics for all samples
histograms/scatter plots
Extract
selctd samples
Smart to add into WF
Visualize differences
Where is the uncertainty
eg maps
average maps
std maps
3D
props
average
std
Comparing ensembles!
Two teams??
MUST see whole WF
Scenarios
eg Low-base-high?
⇒ YES!!
(also disaster)

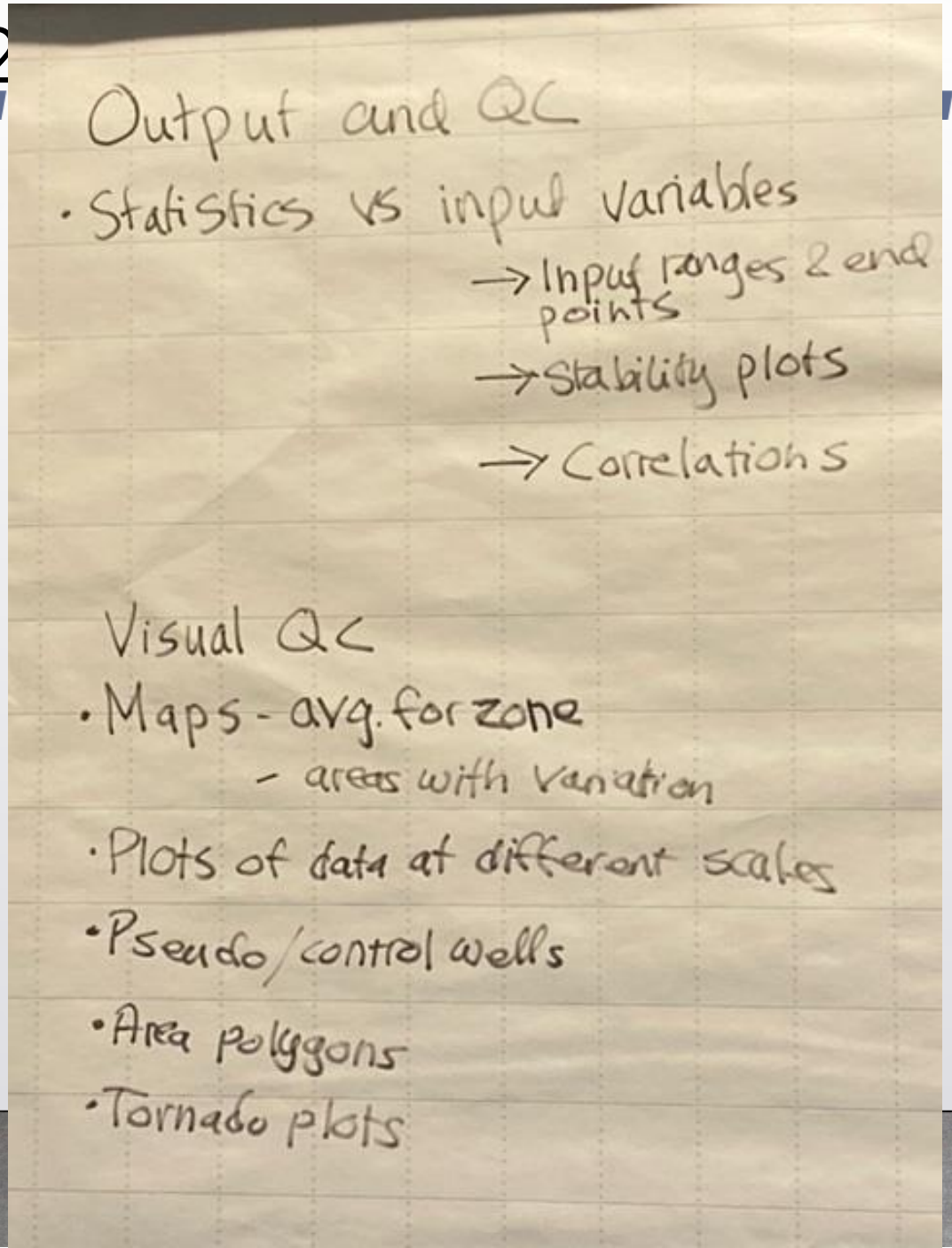
Group1

7.11.2024



Group2

7.11.2024



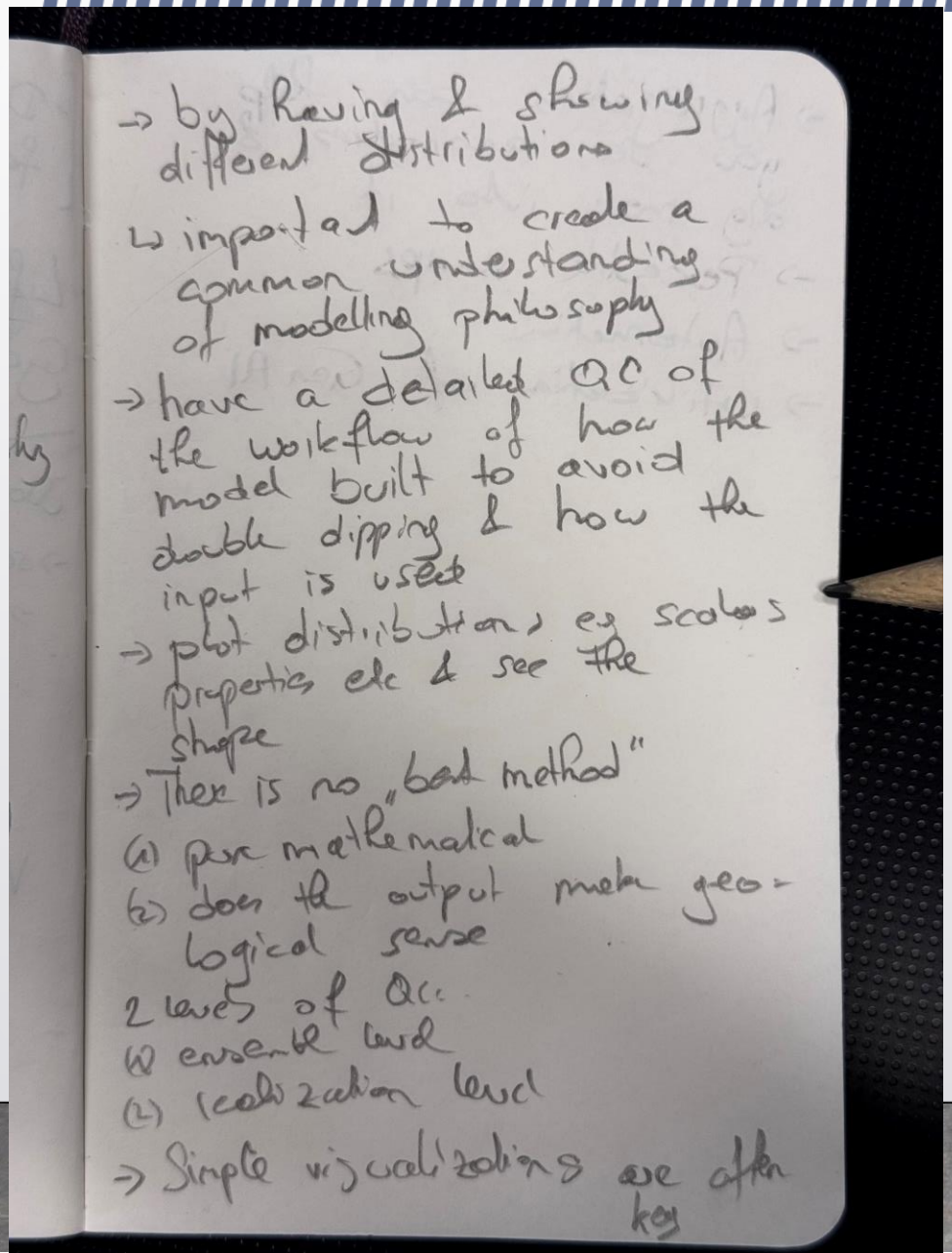
Output and QC

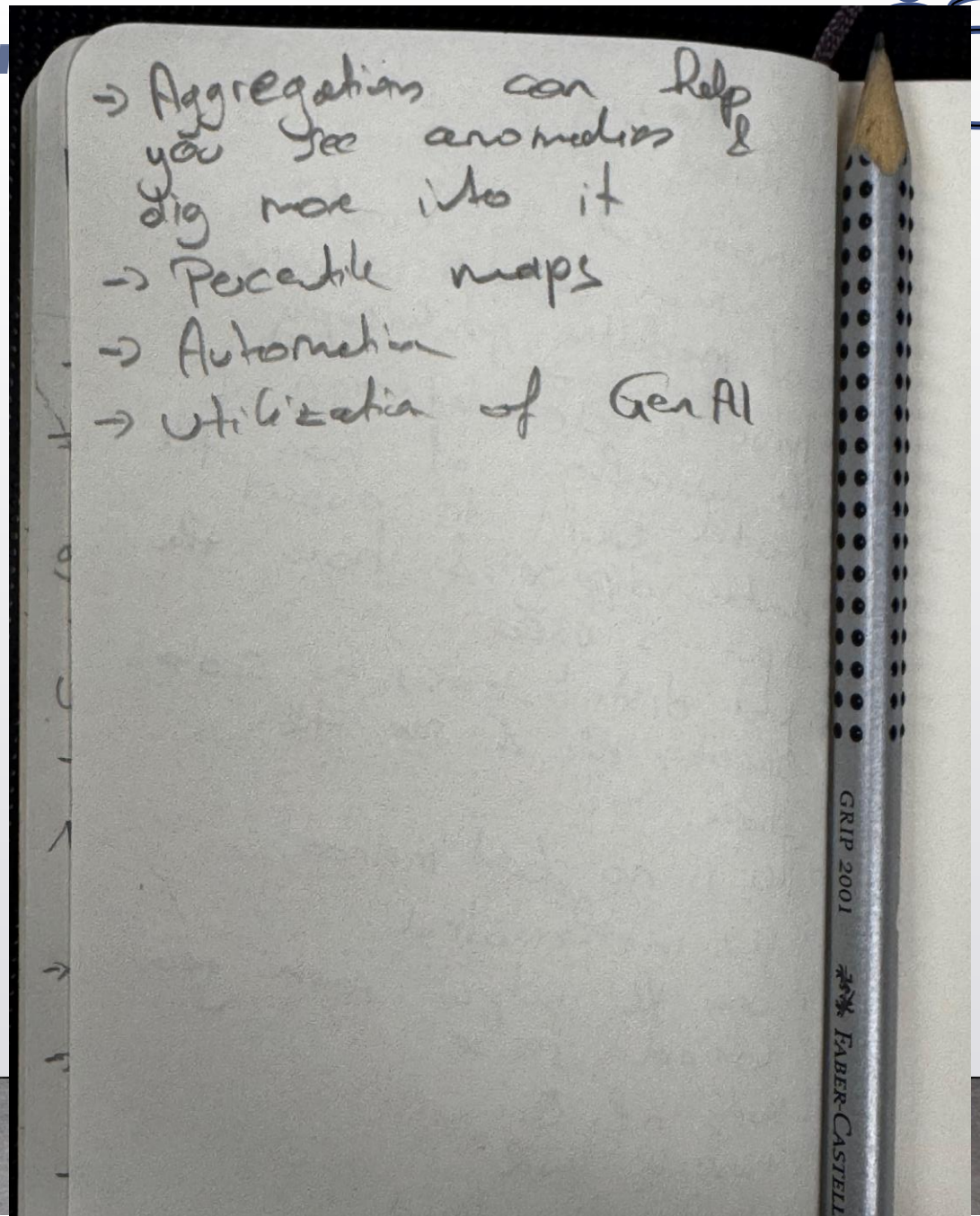
- Statistics vs input variables
  - → Input ranges & end points
  - → Stability plots
  - → Correlations

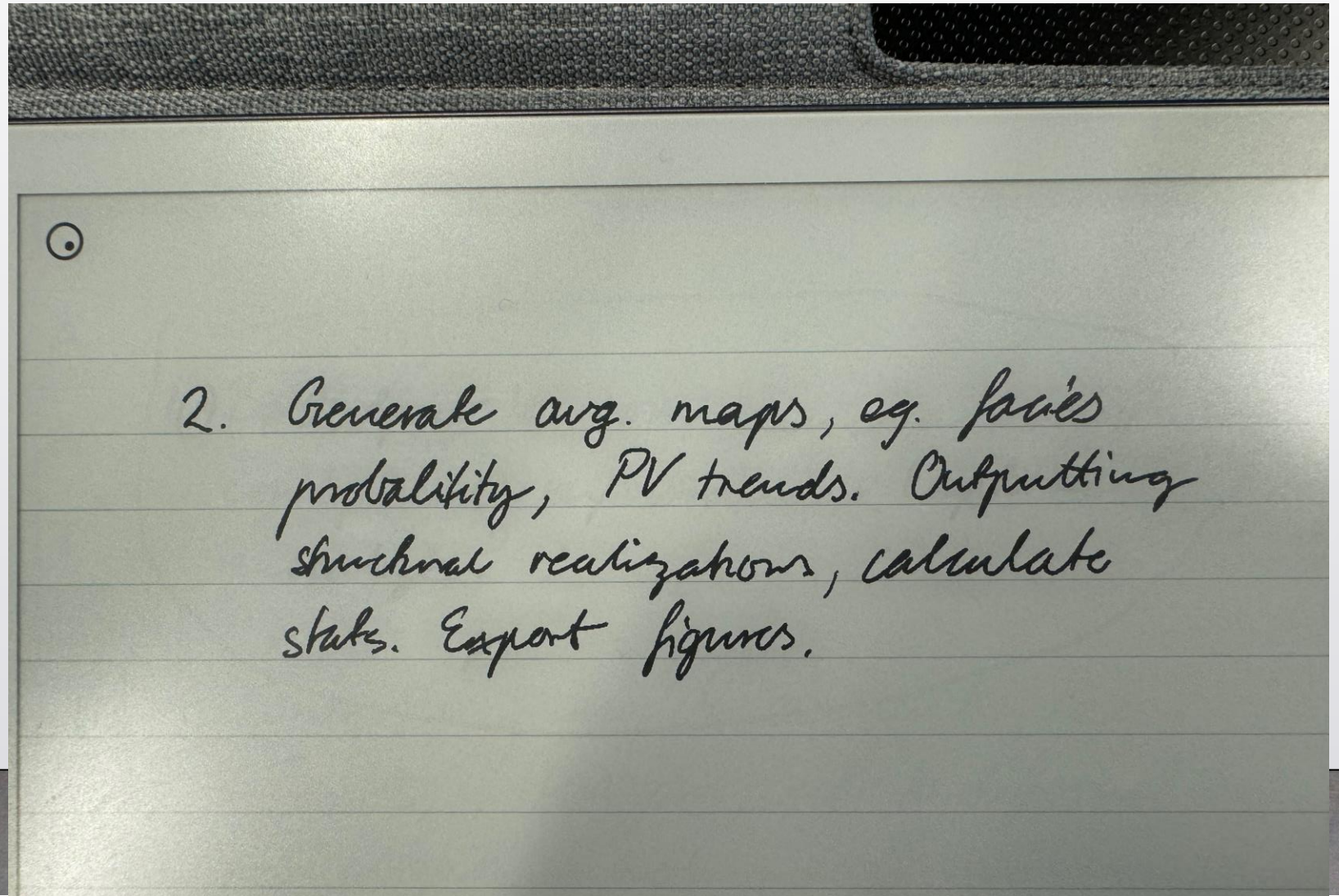
Visual QC

- Maps - avg. for zone
  - areas with variation
- Plots of data at different scales
- Pseudo/control wells
- Area polygons
- Tornado plots

Group3


→ by having & showing different distributions
↳ important to create a common understanding of modelling philosophy
→ have a detailed QC of the workflow of how the model built to avoid double dipping & how the input is used
→ plot distributions, eg scatters properties etc & see the shape
→ There is no "bad method"
(a) pure mathematical
(b) does the output make geological sense
2 levels of QC
(1) ensemble level
(2) realization level
→ Simple visualizations are often key

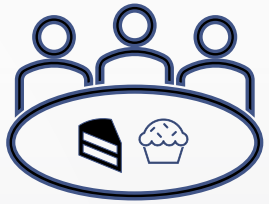

→ Aggregations can help you see anomalies & dig more into it
→ Percentile maps
→ Automation
→ utilization of GenAI
GRIP 2001
FABER-CASTELL


2. Generate avg. maps, eg. facies probability, PV trends. Outputting structural realizations, calculate stats. Export figures.

Feedback

- Format
- Session length
- Venue /Connection to other location
- Session topics
- Other feedback

Feedback: 25 returned questionnaires



- Participants:
  - 20 people in Stavanger :various company (ConocoPhillips-DNO-AkerBP- OMV Norge -OKEA- ORLEN Upstream Norway-Petoro-Harbour Energy- Vår Energy- Norske Shell- Halliburton)
  - 5 registered in Oslo but lot of extra people (~10) came and go during the talks- various company (AkerBP, INPEX idemitsu, Pandion Energy)
  - Been contacted with a lot of people to join after the registration deadline
  - ->More companies representation, good mix of recuring participants and newcomers
- Format and length:
  - exchange of experience seems to be appreciated by all as well as the social and relax setting .
  - 2 topics instead of 3 has allowed more time for discussions- Appreciated
  - Sweet spot of too short vs too long (time allocation in busy schedule)
  - The connection with Oslo has worked but hard to hear the discussions : cold spot in the room
  - More people means more noise during discussions- group in the coffee area ?
- Topics:
  - the mix of topics were well received and considered relevant
  - one commented that practical topics are easier to relate than the general session.
  - Fail case study: may be easier to present in this relax environment than formal 2 days seminar
  - Several asked for re-runs of some sessions
- Topics suggestions:
  - Uncertainty on Hard Data and its impact
  - Session about AI was asked by several -> Lunch&learn more suitable ? : how to use AI in data analysis, AI for modelling, AI for QC
  - How to link uncertainty and risk
  - History matching - communication between RE and G&G
  - Failure case discussion