ERM-3: Estimating Reserve Variability: Why Bother?

Introduction

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CAS Loss Reserving Seminar

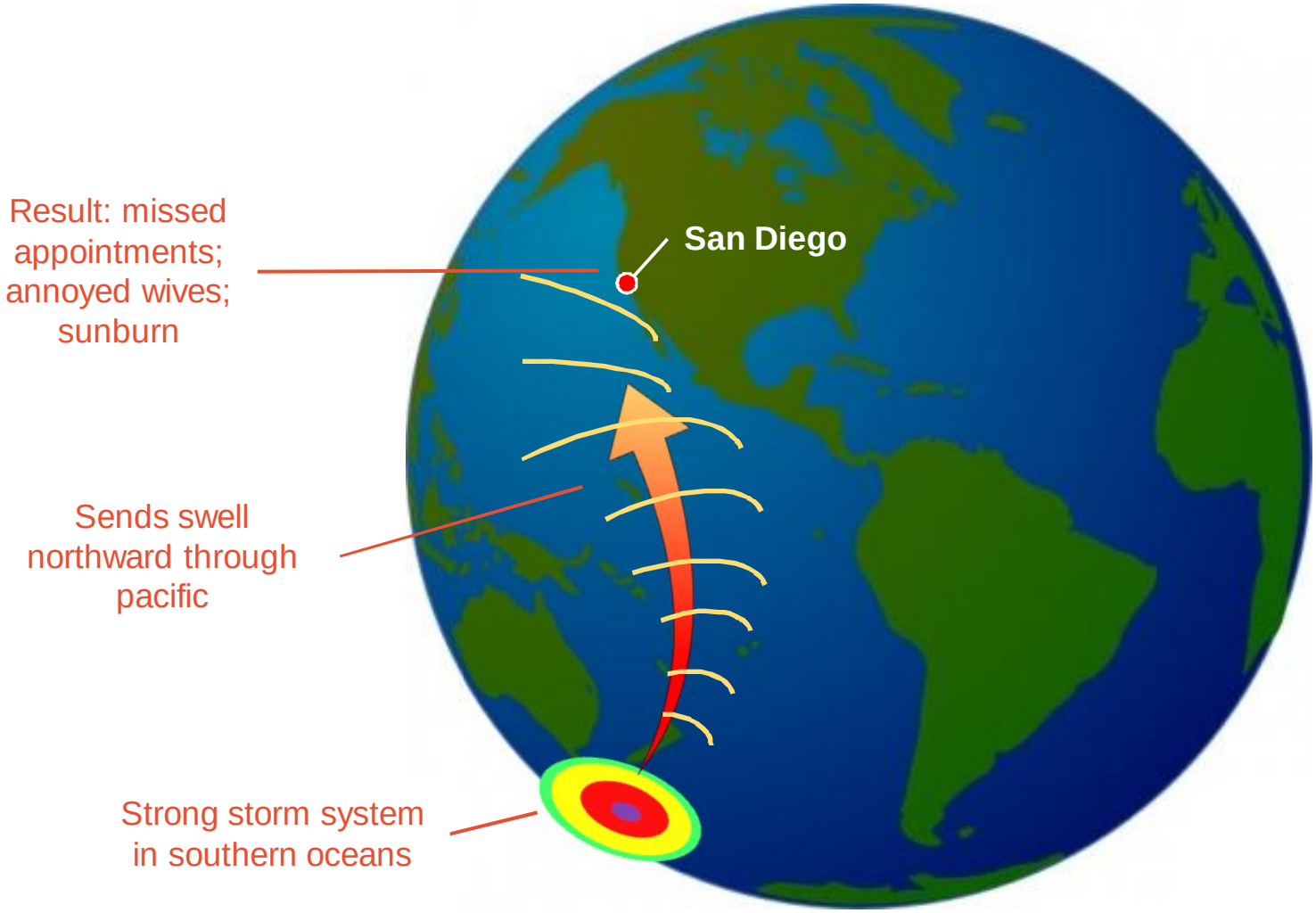
September 15-17 2014

TOWERS WATSON

Agenda

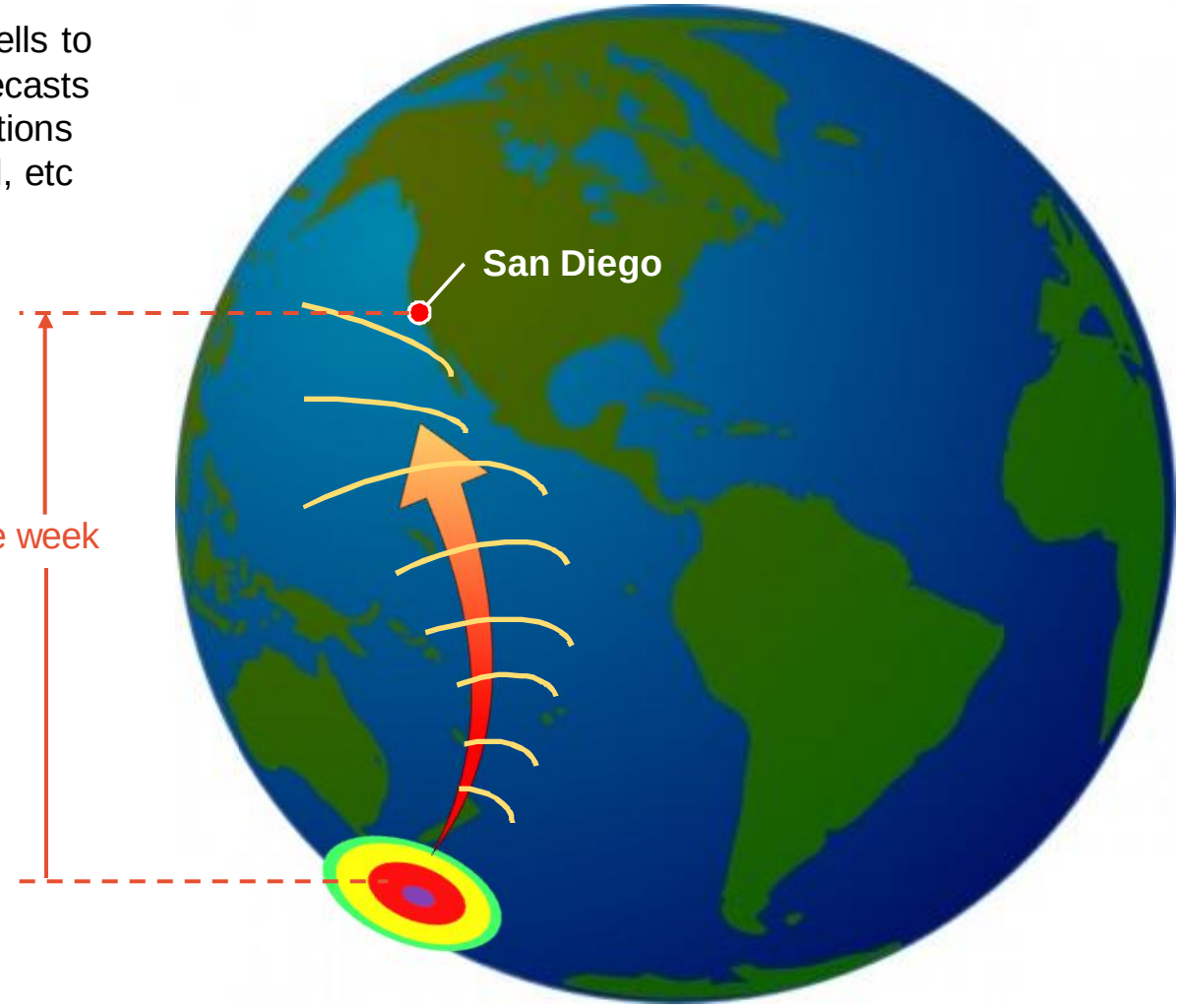
- What do we mean by ‘uncertainty’?
- What kind of approaches are available?
- How do they compare and which should I use?
- Why should I even bother?

Uncertainty A surfer's perspective



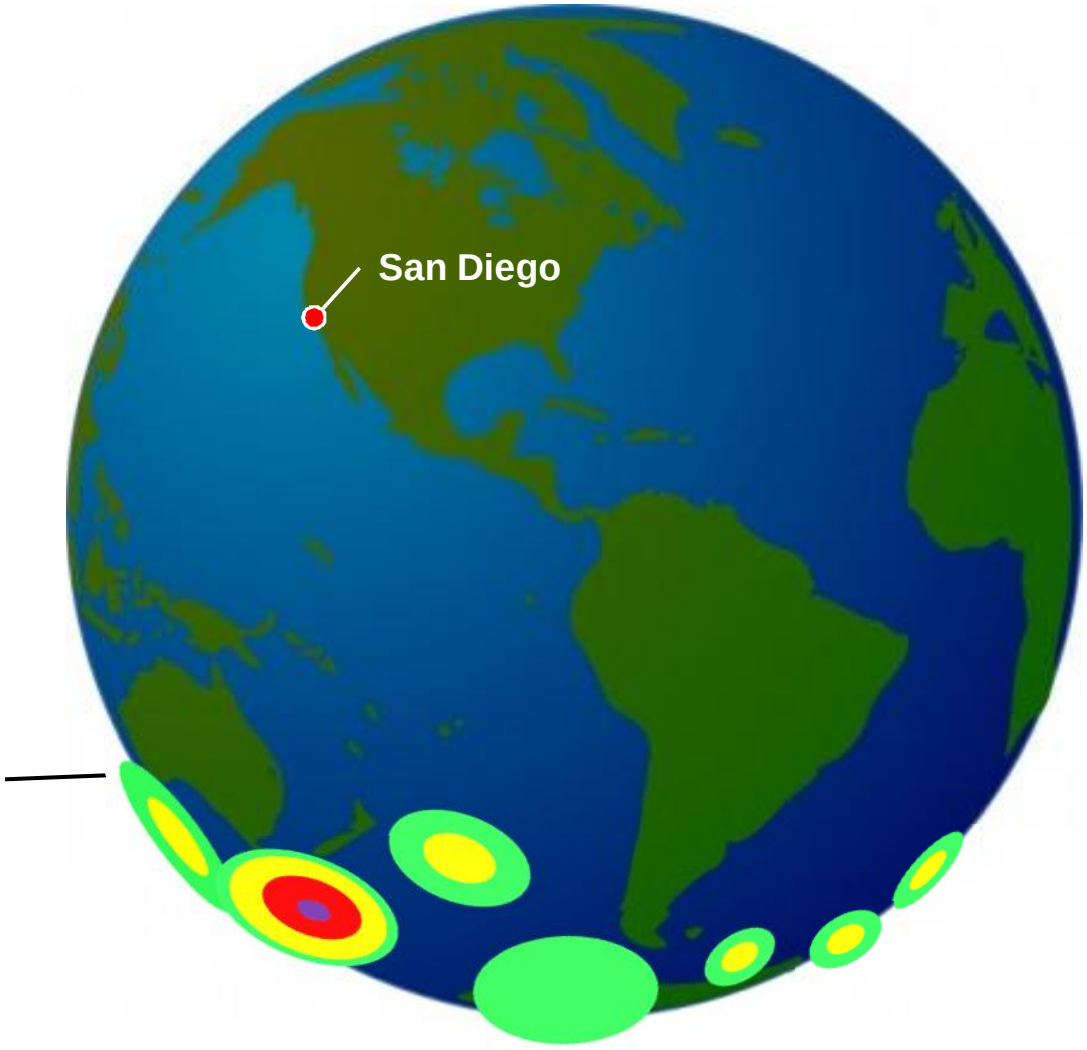
Uncertainty A surfer's perspective

- Given the time taken for swells to develop, surfers rely on forecasts in order to manage expectations with their wife / boss / friend, etc
- These forecasts are based on models developed by meteorologists
- However, the *actual* size and quality of waves are open to uncertainty:



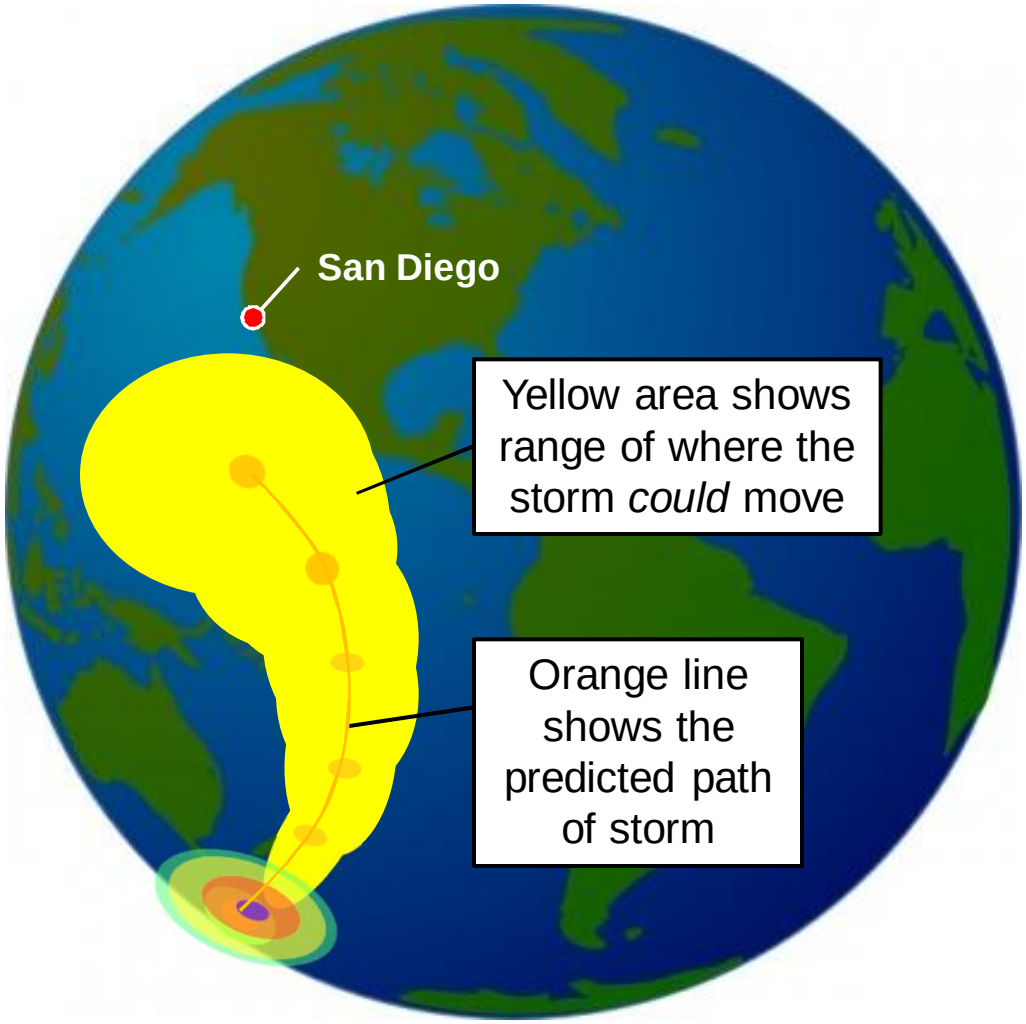
Uncertainty A surfer's perspective

- Weather and swell forecast models are generally based on observations made within weather systems
- The inherent variability of these observations means that, although we may be able to predict the expected track of a storm based on our model, we know that our model will be susceptible to a certain degree of ***parameter uncertainty***



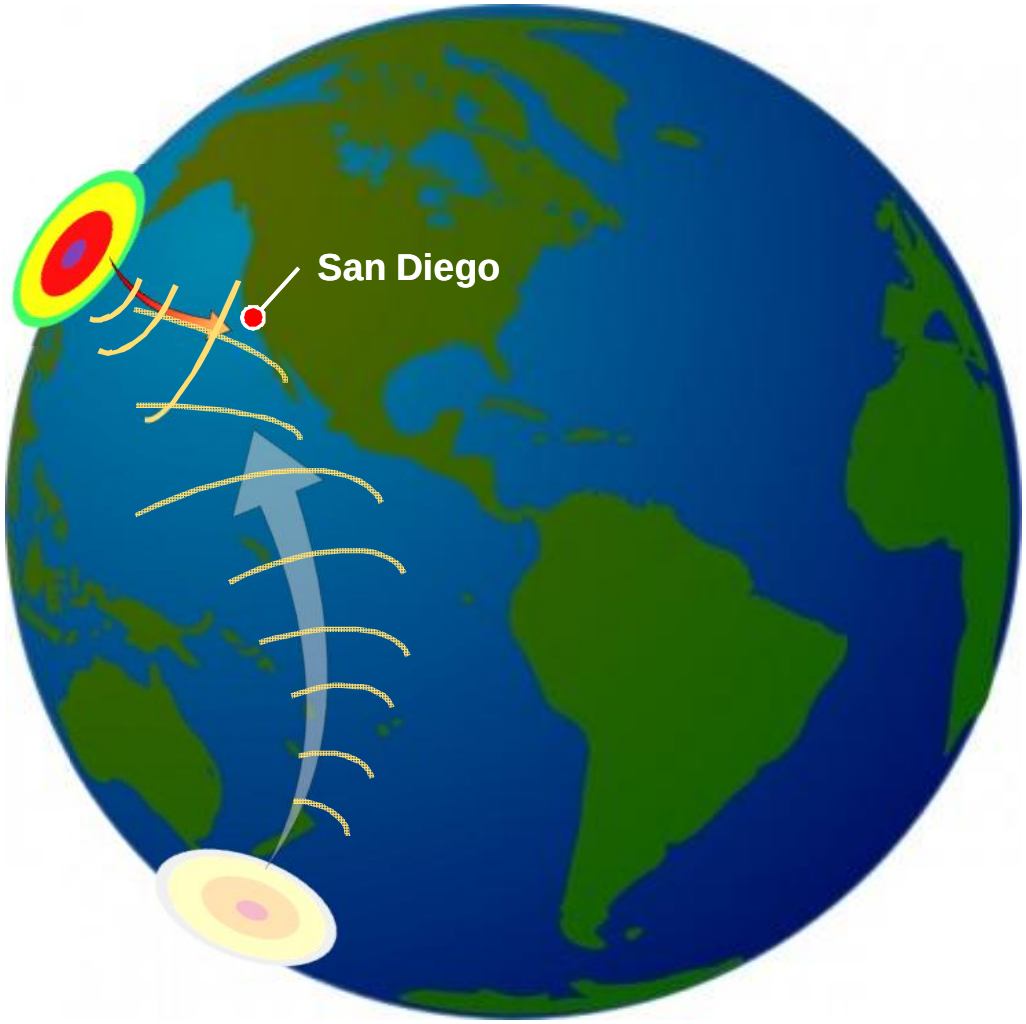
Uncertainty A surfer's perspective

- Even if a strong system does arise, and we are able to predict it's expected path…
- …there remains uncertainty around how it might *actually* develop and what may happen to the swell on it's long journey northward
- The uncertainty associated with the fact that we are forecasting a volatile process might be termed ***process uncertainty***



Uncertainty A surfer's perspective

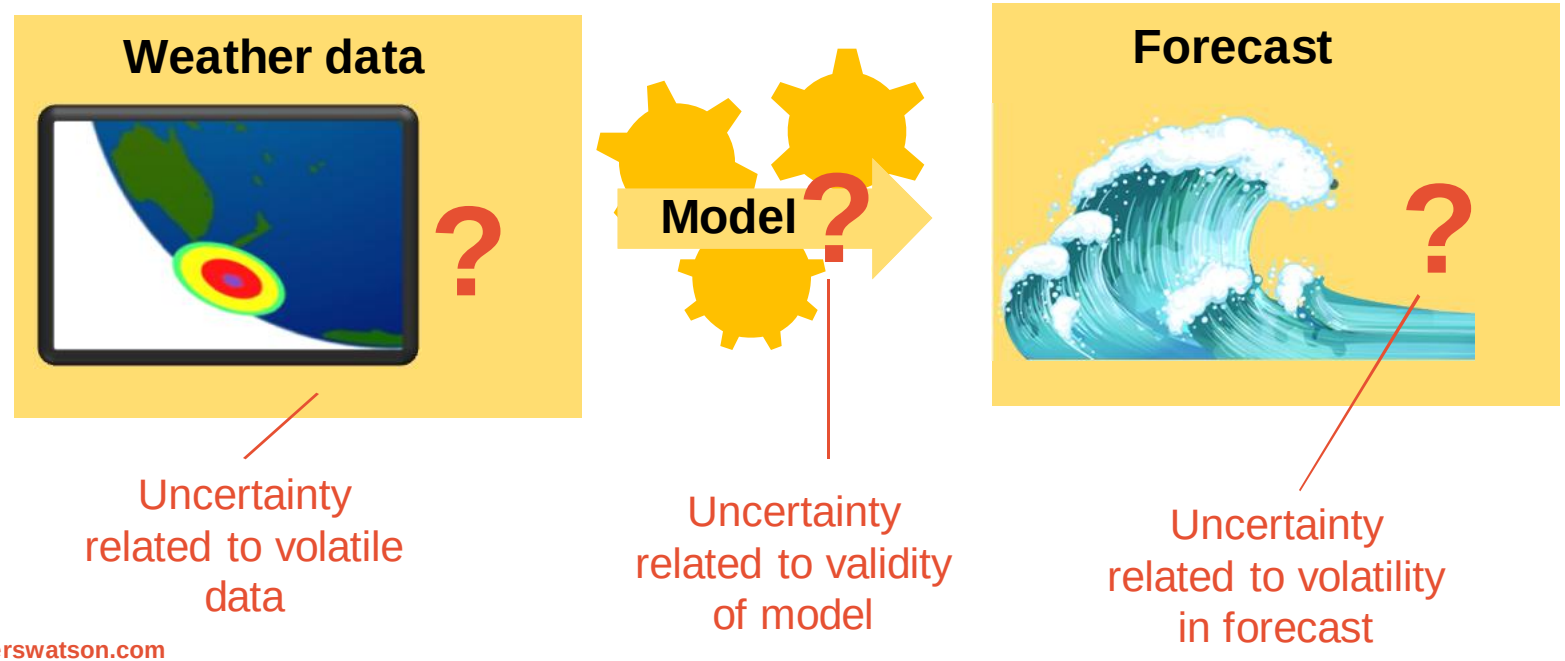
- We may even not have the single best model that is available
- Around this time of year, swells may also be originating from the northern hemisphere
- A single model in isolation may not tell the whole story when preparing to spend a weekend at the beach
- Uncertainty around which is the most appropriate model to use in forecasting might be termed ***model uncertainty***



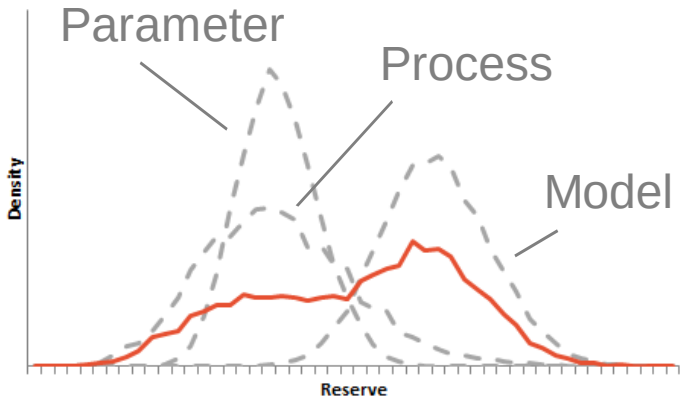
Uncertainty A surfer's perspective

- From this example, we might be able to surmise that the degree of stoke forecasted for San Diego-based surfers is susceptible to three main elements of uncertainty:
  - Parameter
  - Process
  - Model

Uncertainty A surfer's perspective



Uncertainty A actuary's perspective



Source Data

0.6	4.2	5.6	6.1	6.4	6.4	6.5	6.5	6.6
1.0	4.7	6.3	6.8	7.0	7.3	7.4	7.4	
1.1	4.6	6.3	6.8		7.1	7.2		
0.8	3.7	5.9	7.0	7.6	7.6			
0.7	4.1	6.4	9.8	9.8				
1.0	4.4	6.0	6.3					
0.9	4.9	6.7						
0.7	4.4							
1.1								

Uncertainty related to volatile data

Model

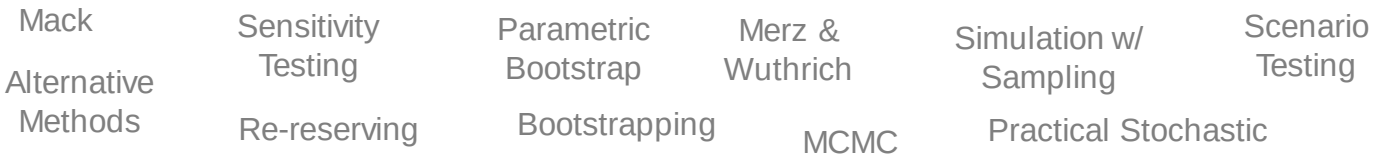
Uncertainty related to validity of model

Forecast

							7.4
						7.2	7.2
					7.8	7.8	7.8
				10.1	10.2	10.2	10.2
			6.7			6.8	6.8
		8.2	8.3	8.4		8.5	8.5
	7.3	7.6	7.7	7.8	7.9	7.9	7.9
7.8	9.1	9.5	9.7	9.8	9.8	9.9	9.9

Uncertainty related to volatility in forecast

A Range of Method



- There are a number of methods available to the actuary when analyzing reserve uncertainty
- Although we do not have time to cover each in depth, understanding the scope and the output available helps us understand which might add the most value given certain objectives…

Model Selection Primary purpose

Mack

Alternative Methods

Sensitivity Testing

Re-reserving

Parametric Bootstrap

Bootstrap

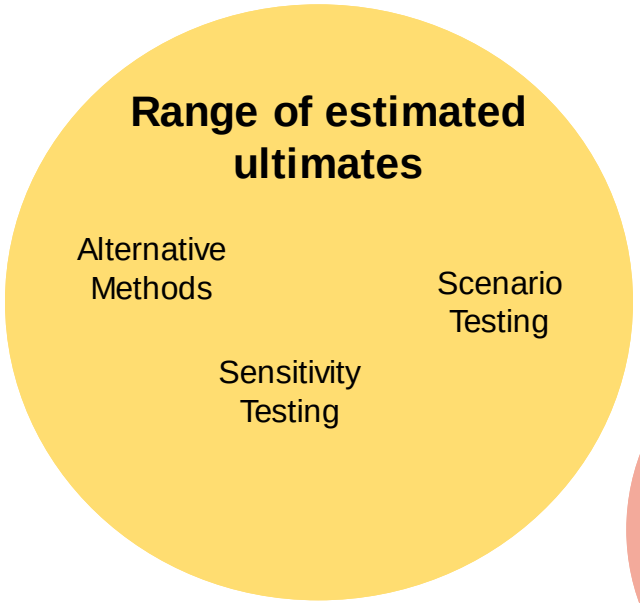
Merz & Wuthrich

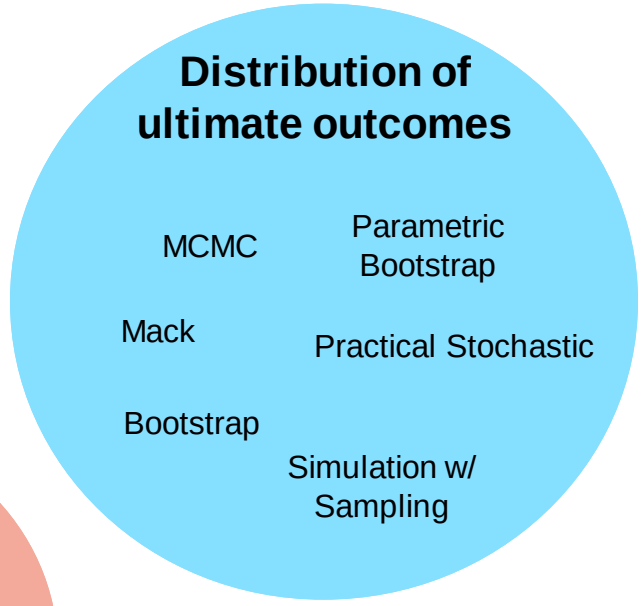
MCMC

Simulation w/ Sampling

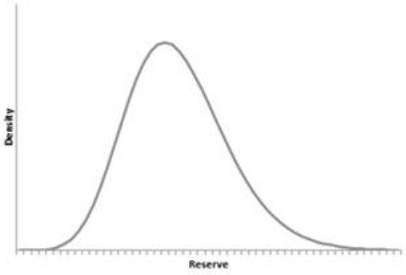
Practical Stochastic

Scenario Testing

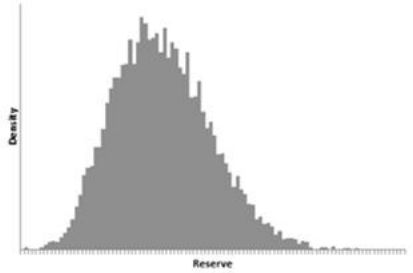




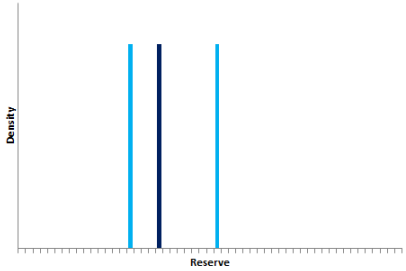
Model Selection Deterministic / Analytical / Simulation



Analytical



Simulation

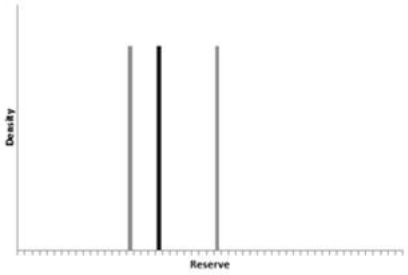


Deterministic

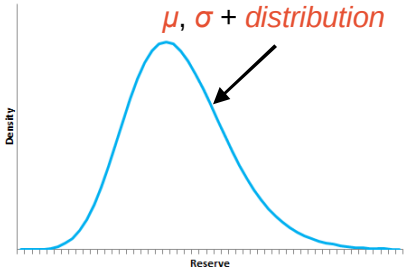
Deterministic methods typically allow the actuary to develop a range of *reasonable* outcomes.

However, each outcome is given equal weighting – i.e. there is no probability associated with the range – each is considered 'reasonable'

Model Selection Deterministic / Analytical / Simulation



Deterministic



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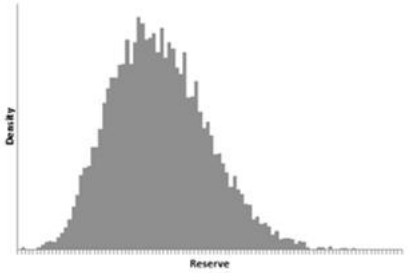
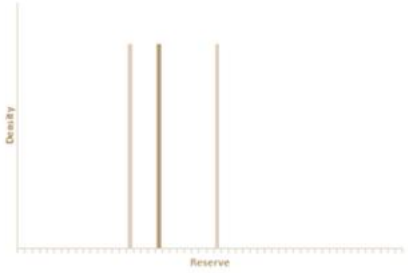


Simulation

Analytical methods are used to derive the statistical properties of a distribution of potential *outcomes* from a specific model

By assuming a distribution, percentiles and confidence intervals can be obtained

Model Selection Deterministic / Analytical / Simulation



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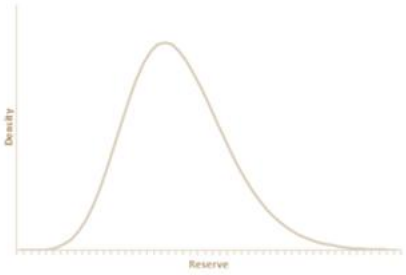
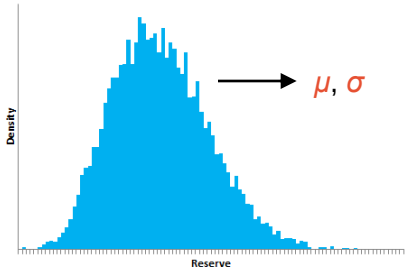


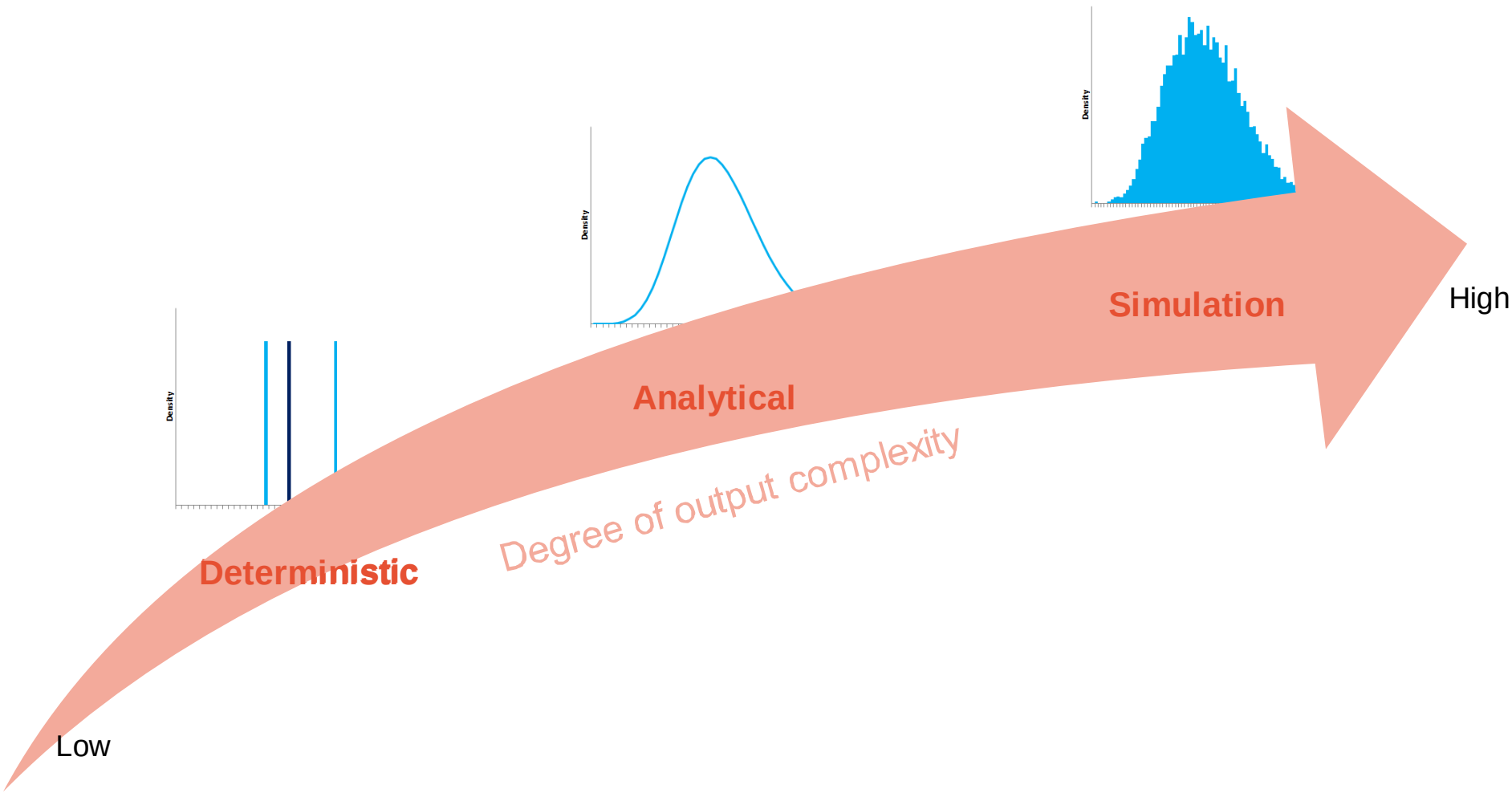
Analytical



Simulation

Simulation methods are used to obtain full predictive distributions from a given model, from which statistical properties may be derived.

Model Selection Deterministic / Analytical / Simulation



Model Selection Deterministic / Analytical / Simulation

Mack

Alternative Methods

Sensitivity Testing

Re-reserving

Parametric Bootstrap

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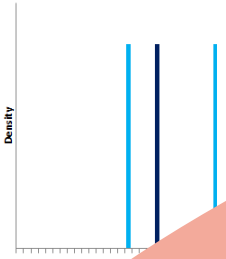

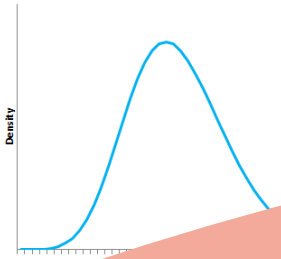

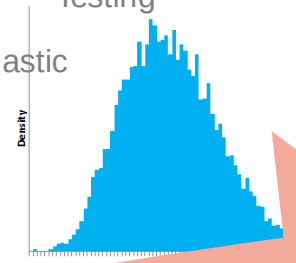

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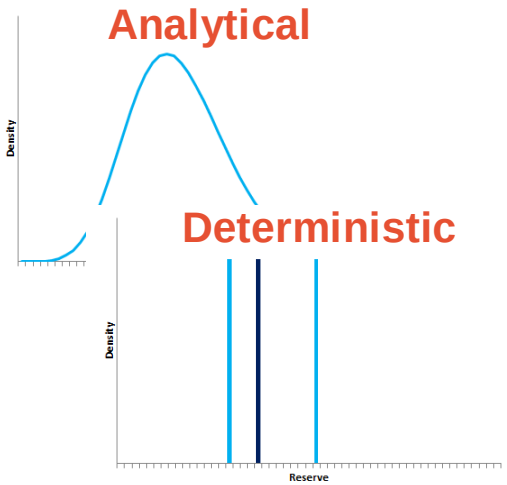
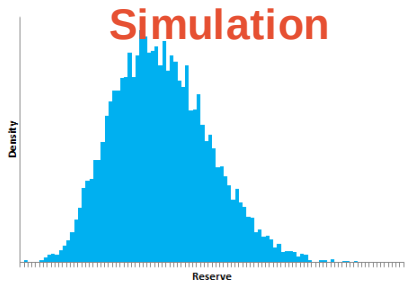
Model Selection Correlation

- Once correlation is accounted for, simulations are relatively easy to consolidate across lines of business
- Analytical and deterministic approaches are considerably more difficult to consolidate in a meaningful manner

Difficult ← Ease of consolidation across LoBs → **Easy**

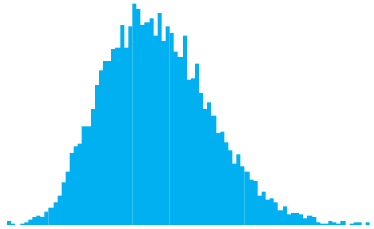


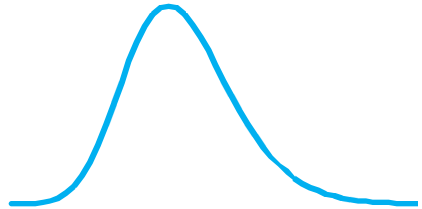


Model Selection Output

- Both analytical and simulation approaches can be used to develop a distribution around the final ultimate outcome or at any given point in the development

Simulation

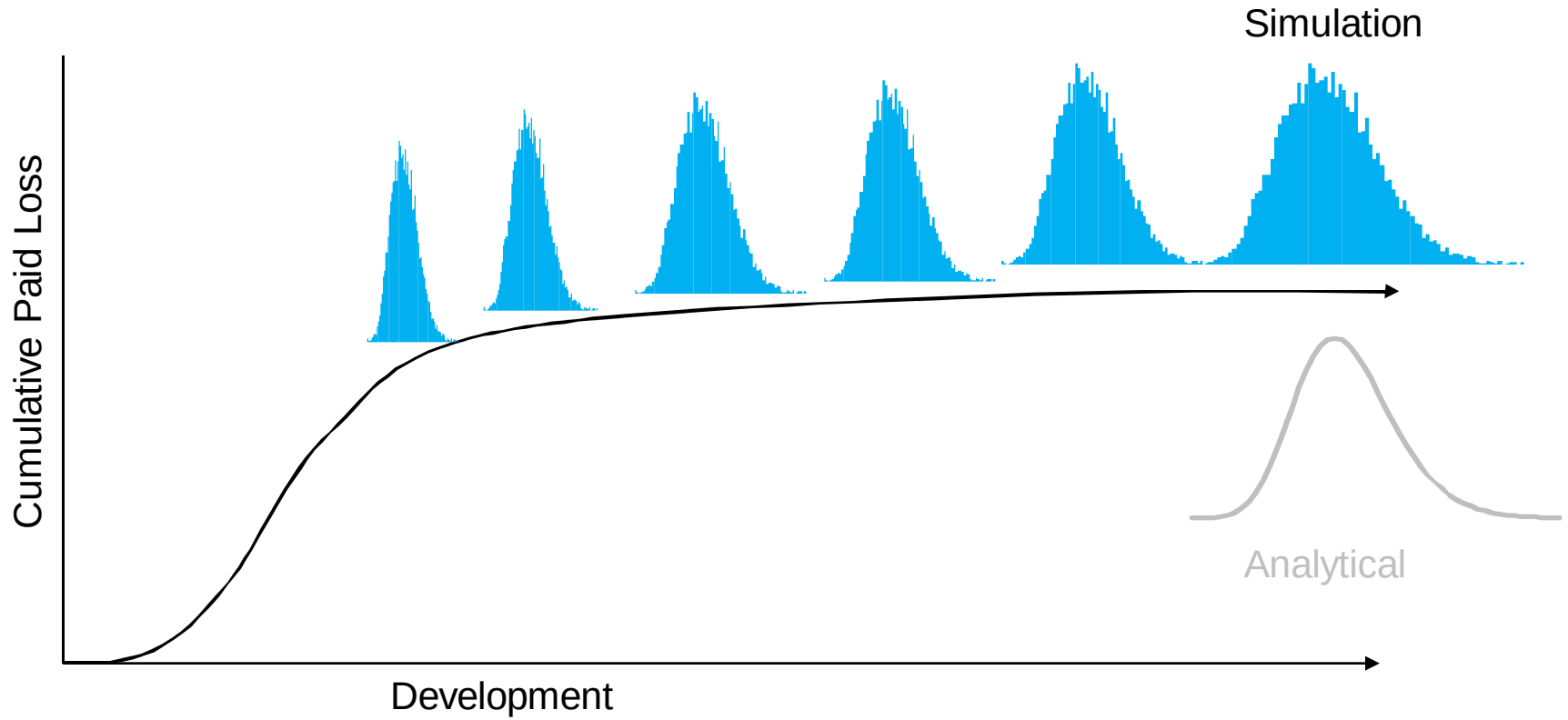




Analytical

Model Selection Deterministic / Analytical / Simulation

- Both analytical and simulation approaches can be used to develop a distribution around the final ultimate outcome or at any given point in the development
- However, simulation approaches such as Bootstrapping and MCMC also include volatility information related to the *complete* development of losses



Model Selection Deterministic / Analytical / Simulation

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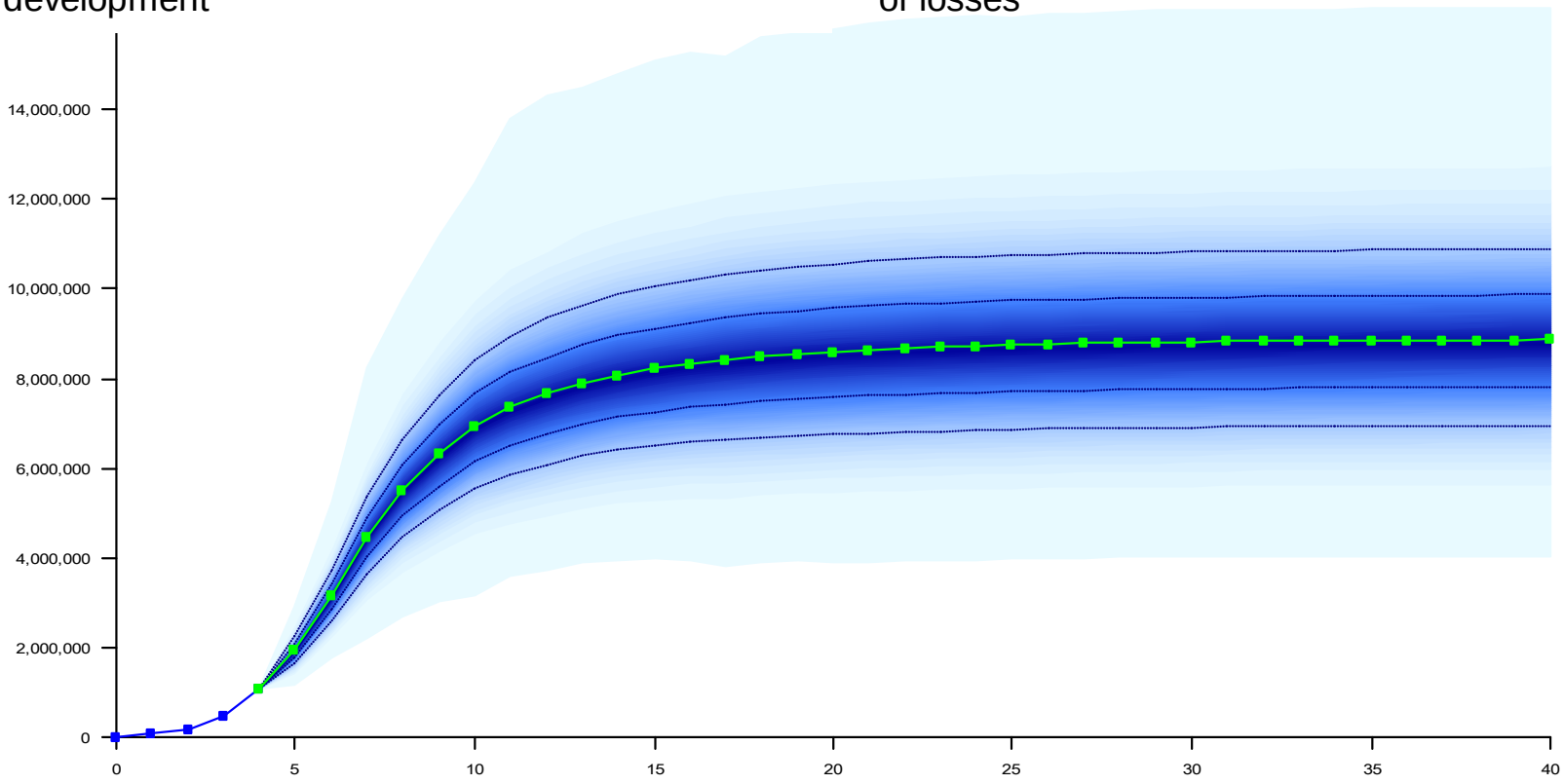
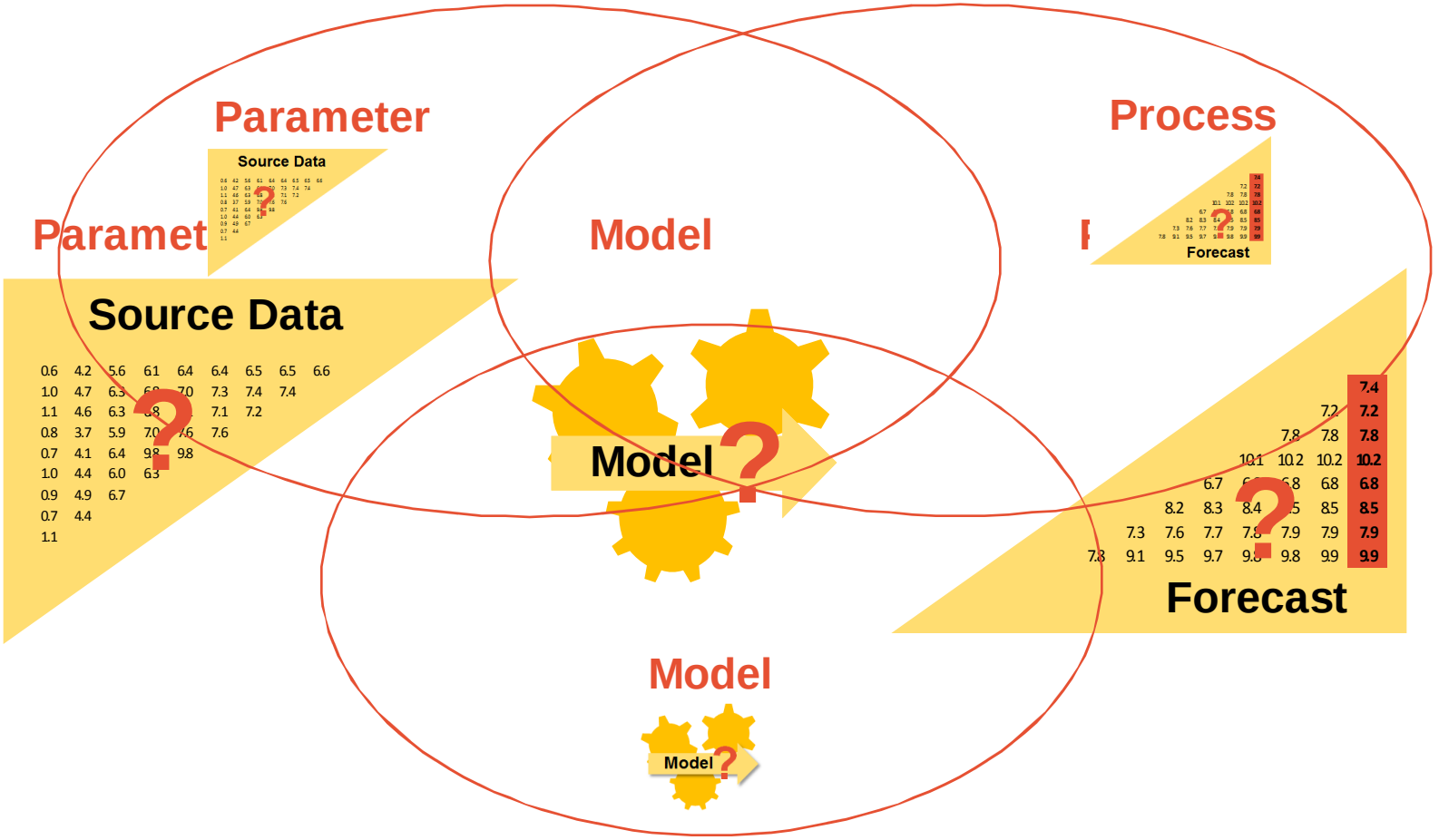


Model Selection Types of Uncertainty



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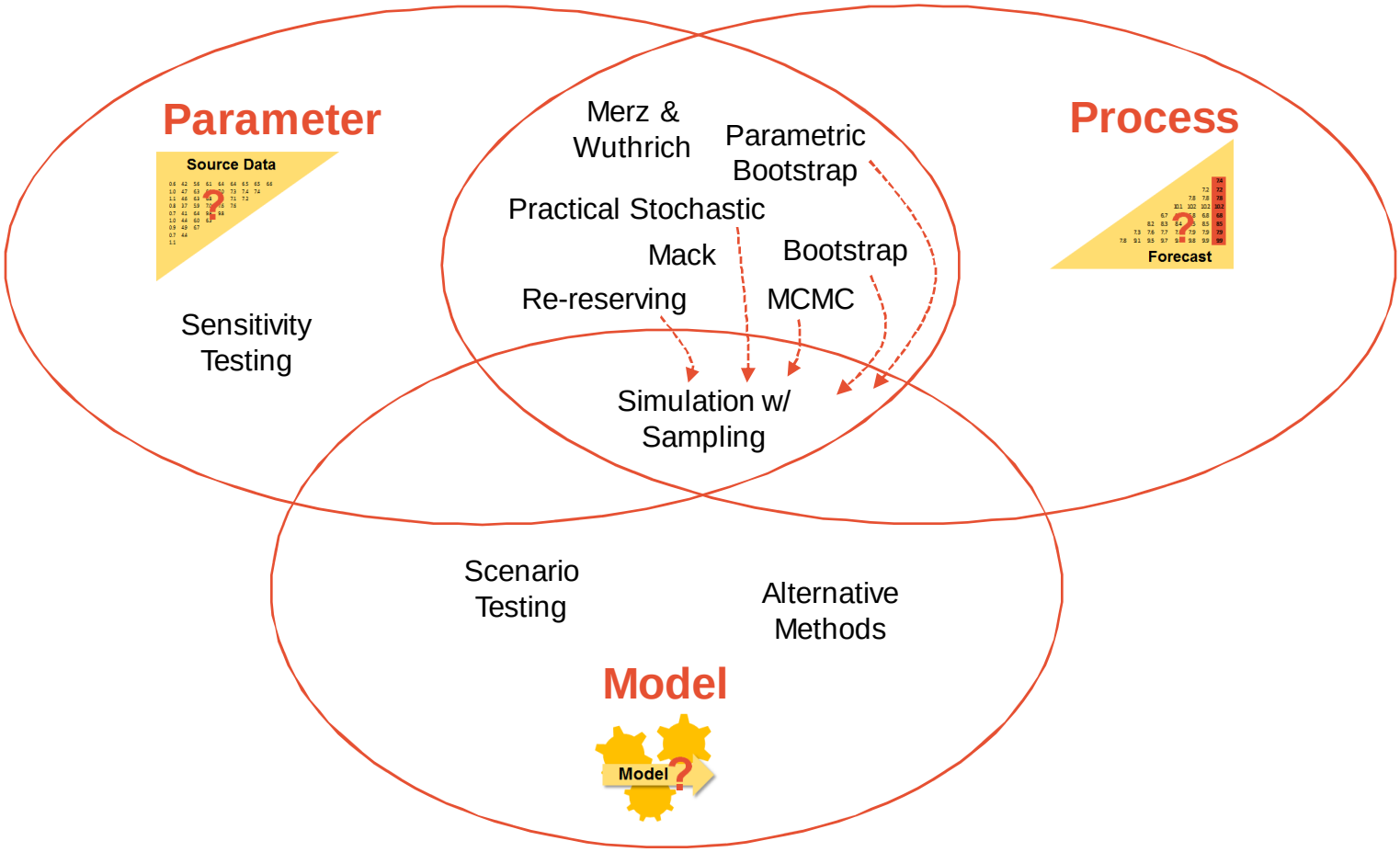
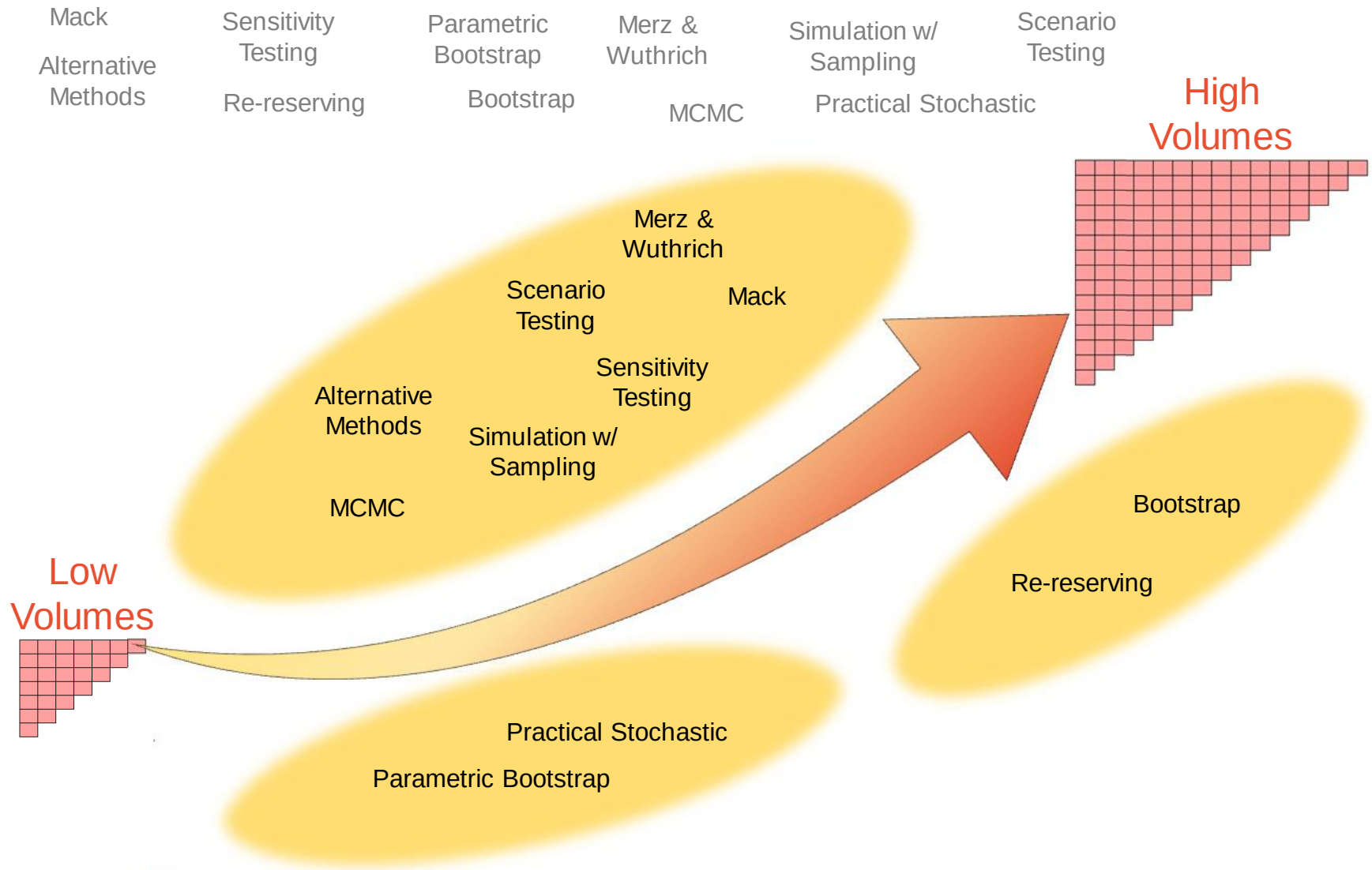
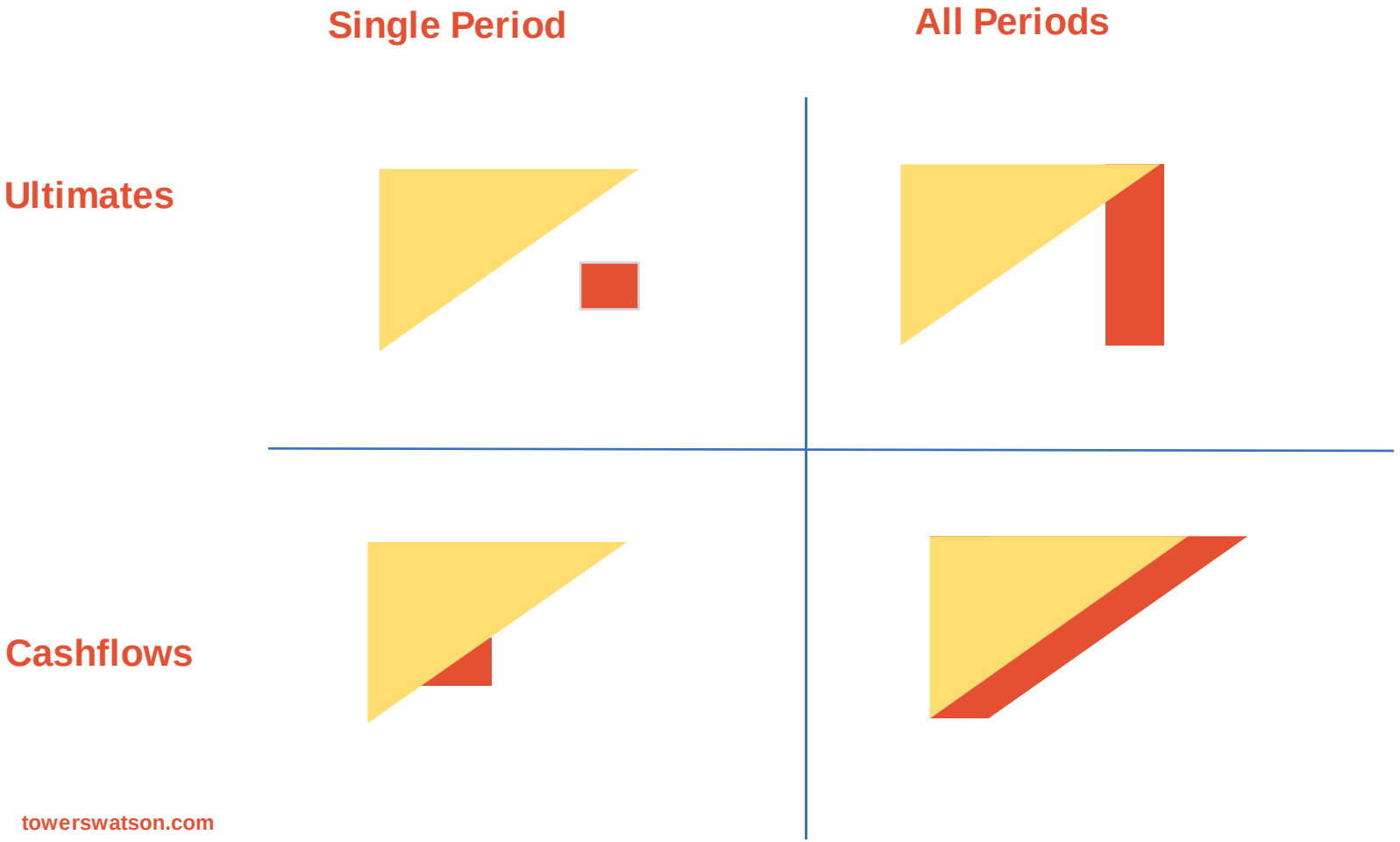


Model Selection Data Volume Available



Model Selection Uses

- Given the available outputs available from each of the various approaches, we can explore some potential uses



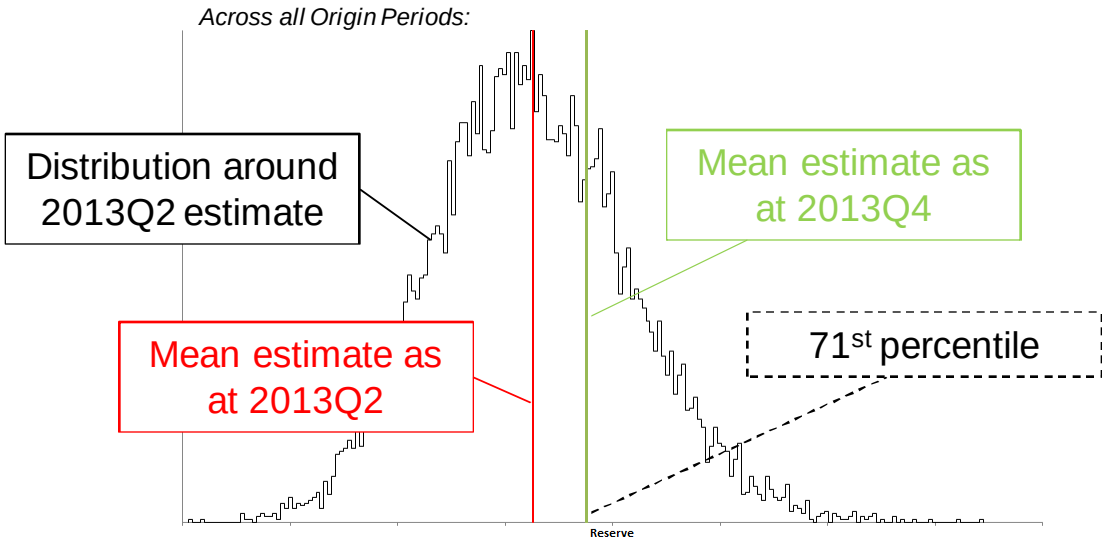
Model Selection Uses

- Given the available outputs available from each of the various approaches, we can explore some potential uses

	Single Period	All Periods
Ultimates	• Reserve evaluation: Comparison of Methods • Reinsurance • Reserve Evaluation: Changes in Ultimates	
Cashflows		

Model Selection Uses: Change in Ultimates

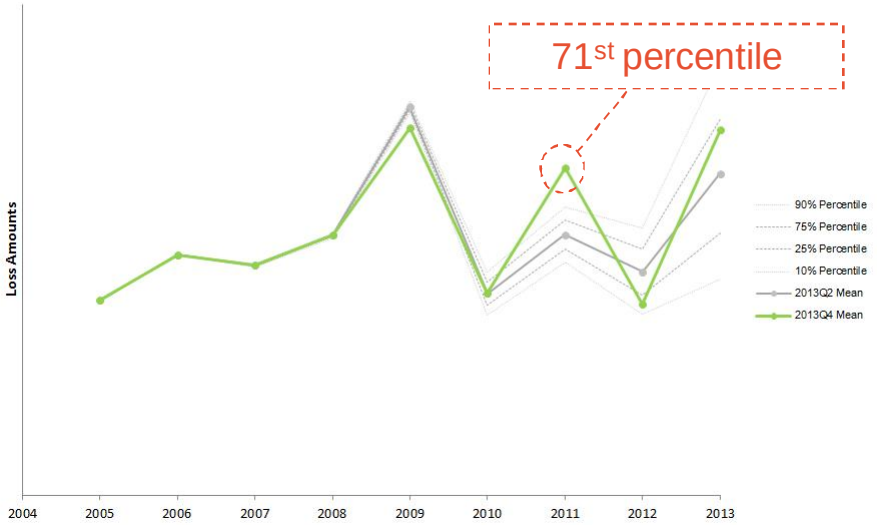
- The graph below shows the probability density cone around the total reserve based on a 2013Q2 analysis
- Once the year-end review is complete, we can imposed our new estimate on the graph



- Though this provides a general view of the materiality of the change total projected reserves, movement trends of individual years may be obscured

Model Selection Uses: Change in Ultimates

- The graph below shows the same results, but on a year-by-year basis with a distribution fan (showing the 10th, 25th, 75th and 90th percentiles) based on a 2013Q2 analysis
- Again, we can impose on our graphs our updated 2013Q4 estimates



- Period by period diagnostics such as these help identify trends while also providing insight into the materiality of the movement

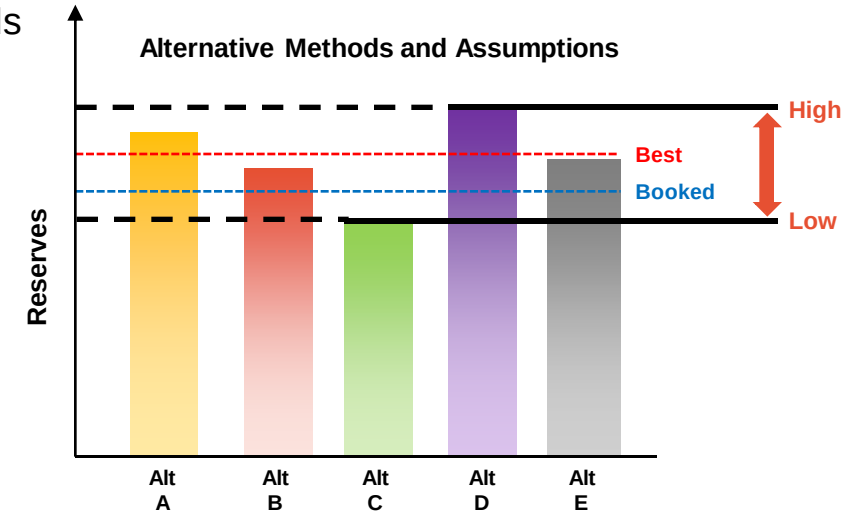
Model Selection Uses

- Given the available outputs available from each of the various approaches, we can explore some potential uses

	Single Period	All Periods
Ultimates	• Reserve evaluation: Comparison of Methods • Reinsurance • Reserve Evaluation: Changes in Ultimates	• Companywide Range • Financial Reporting • Reserve Opinion • Mergers & Acquisition
Cashflows		

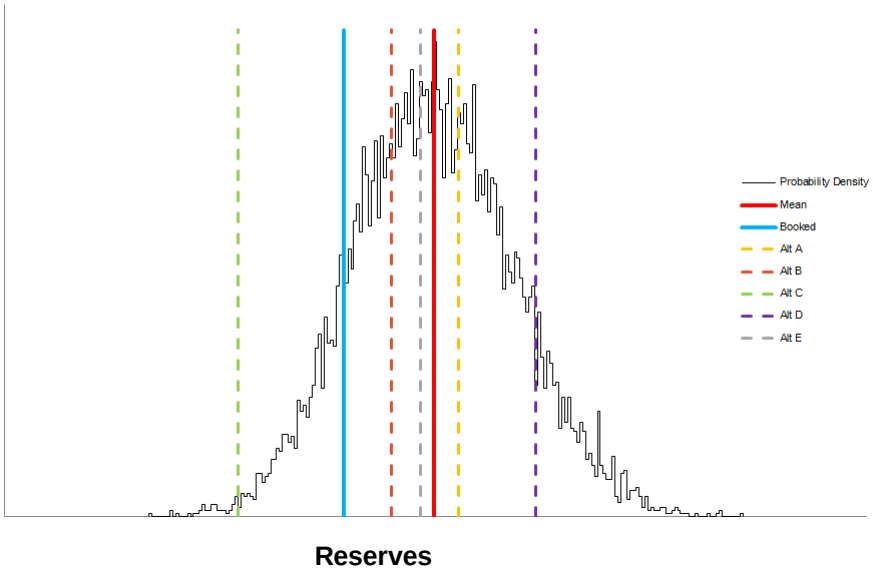
Model Selection Uses: Reasonableness

- Using a **Deterministic** approach:
  - Indications from different point estimate methods
  - More/less weight to the results of a particular point estimate
  - Slower or faster development patterns
  - Different trend assumptions
  - Consideration of reserving cycle…
- **Caution!** Notoriously hard to aggregate



Model Selection Uses: Reasonableness

- Using a Simulated approach:
  - Consider the range implied by parameter error only
  - Reconcile deterministic approaches to percentiles within the range to gain a feel for which percentiles make sense within each line of business

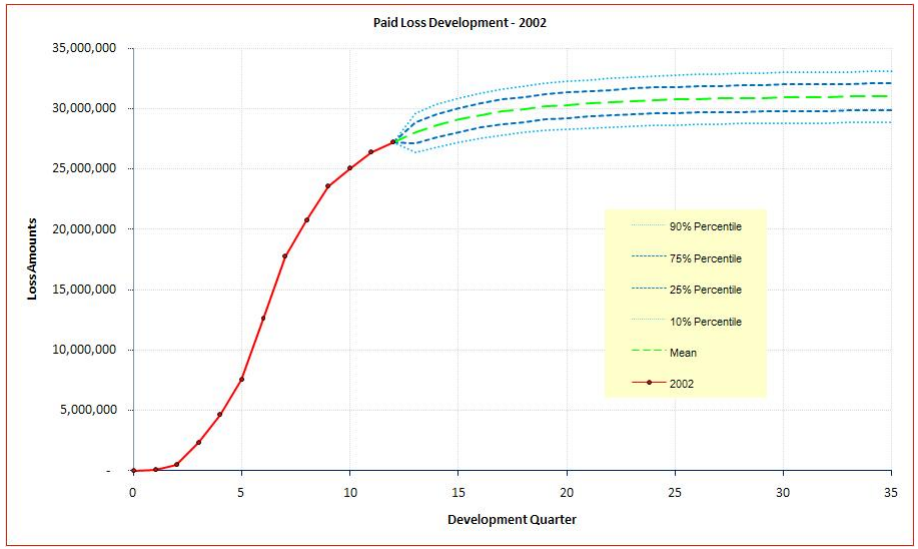


Model Selection Uses

- Given the available outputs available from each of the various approaches, we can explore some potential uses

	Single Period	All Periods
Ultimates	• Reserve evaluation: Comparison of Methods • Reinsurance • Reserve Evaluation: Changes in Ultimates	• Companywide Range • Financial Reporting • Reserve Opinion • Mergers & Acquisition
Cashflows	• Reserve Evaluation: Actual vs. Expected analysis	

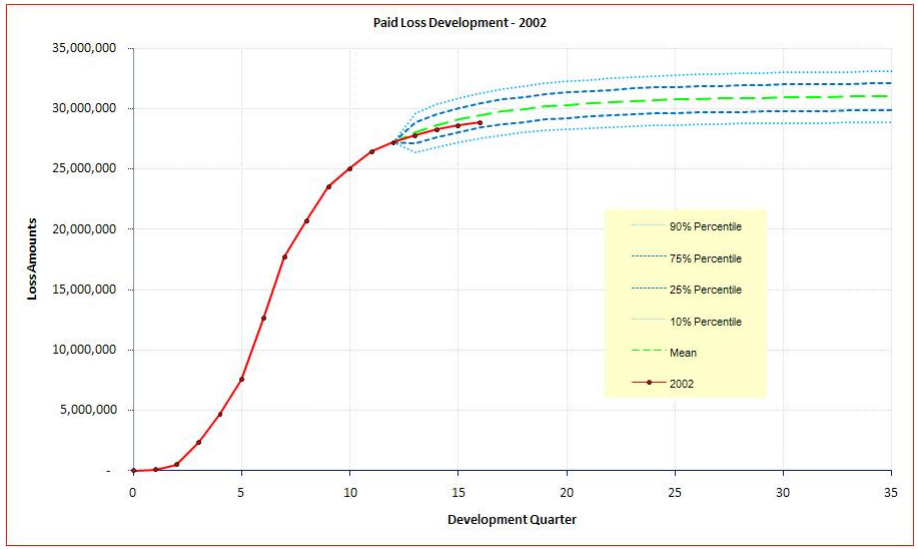
Model Selection Uses: Actual vs. Expected



- Simulation techniques allow the actuary to not only determine the uncertainty around the final estimate, but also in the cashflows that take the payments to ultimate

Origin Year	Paid Losses as at 2004	Estimated Ultimate Losses as at 2004	Expected Paid Losses 2004 to 2005
2001	30,378,231	32,047,216	936,357
2002	27,214,233	31,214,646	2,385,788
2003	16,758,431	25,785,079	5,677,598
2004	2,385,508	16,162,641	8,107,330

Model Selection Uses: Actual vs. Expected



- Simulation techniques allow the actuary to not only determine the uncertainty around the final estimate, but also in the cashflows that take the payments to ultimate
- Predicted cashflows, output from a variability analysis, will assist the actuary in determining the materiality of differences in actual cashflows over given periods when compared to the expected cashflows from a previous analysis

Origin Year	Paid Losses as at 2004	Estimated Ultimate Losses as at 2004	Expected Paid Losses 2004 to 2005	Actual Paid Losses 2004 to 2005	Actual - Expected 2004 to 2005	Cashflow Percentile
2001	30,378,231	32,047,216	936,357	608,703	(327,654)	4%
2002	27,214,233	31,214,646	2,385,788	1,640,305	(745,483)	27%
2003	16,758,431	25,785,079	5,677,598	5,757,792	80,194	53%
2004	2,385,508	16,162,641	8,107,330	9,004,136	896,806	69%
2005				3,241,443		

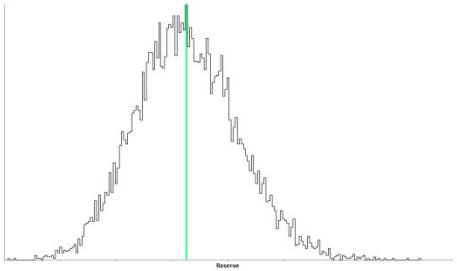
Model Selection Uses

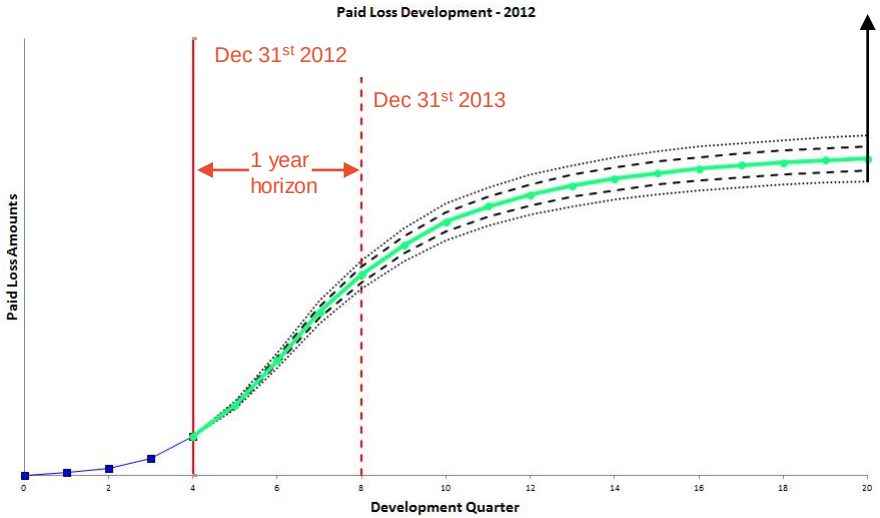
- Given the available outputs available from each of the various approaches, we can explore some potential uses

	Single Period	All Periods
Ultimates	• Reserve evaluation: Comparison of Methods • Reinsurance • Reserve Evaluation: Changes in Ultimates	• Companywide Range • Financial Reporting • Reserve Opinion • Mergers & Acquisition
Cashflows	• Reserve Evaluation: Actual vs. Expected analysis	• Inflation / Discounting scenario testing • Asset / liability matching • ERM • Re-reserving

Model Selection Uses: Re-reserving

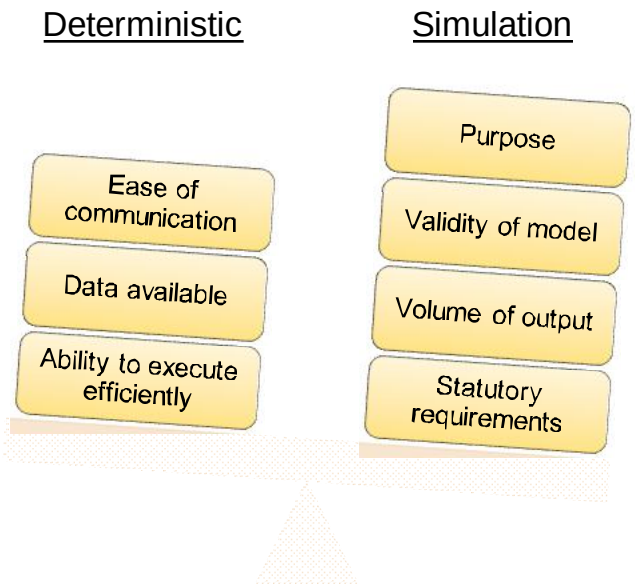
- What if our concern is how much our ultimate might be expected to move over a certain timeframe – e.g. a one-year time horizon
  - We can take just one year of simulated cashflows
  - And re-project to ultimate
- Projection of simulated cash-flows allow us to analyze and assess the expected development of our ultimates over time and set expectations





Model Selection Summary

- The approach selected should be fit for the purpose
  - Understand requirements before assessing which approach is suitable
  - Ensure sufficient resource is available to complete analysis in efficient manner
  - Be aware of the limitations of any model before embarking and ensure that these are communicated along with the results
- Should also consider how to communicate
  - With the data volumes available, we risk paralysis by analysis – focus on the diagnostics that are most informative for your needs
  - Ensure that communication is clear – there is no benefit in using an incredibly complex model if you are unable to educate others on your findings and build trust
  - Use graphs and diagnostics to distill complex information into a meaningful picture



So - why bother?

- As a surfer, you're often aware of when a significant swell is on the way, and as mentioned before, it's important to ensure schedules are re-arranged as necessary
- When assessing the potential, you have a few choices available to you:
  - The source data itself – weather charts and buoy data
  - Forecasting websites
  - The amiable, shouting lunatic in Ocean Beach who insists on yelling at me in a terrible British accent
- The point is that we are reliant on predictions as the basis for making critical planning decisions

From www.ndbc.noaa.gov

From surfline.com

From O.B.

- As such, we cannot simply blindly accept a single prediction from a single model – we have to understand the credibility of the information available and the reliability of the models (or opinions) before trying to explain to your other half why she'll be waking up alone again at the weekend