Met Office
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Simplifying marine decision-making (scientifically!)

An example of turning science into services

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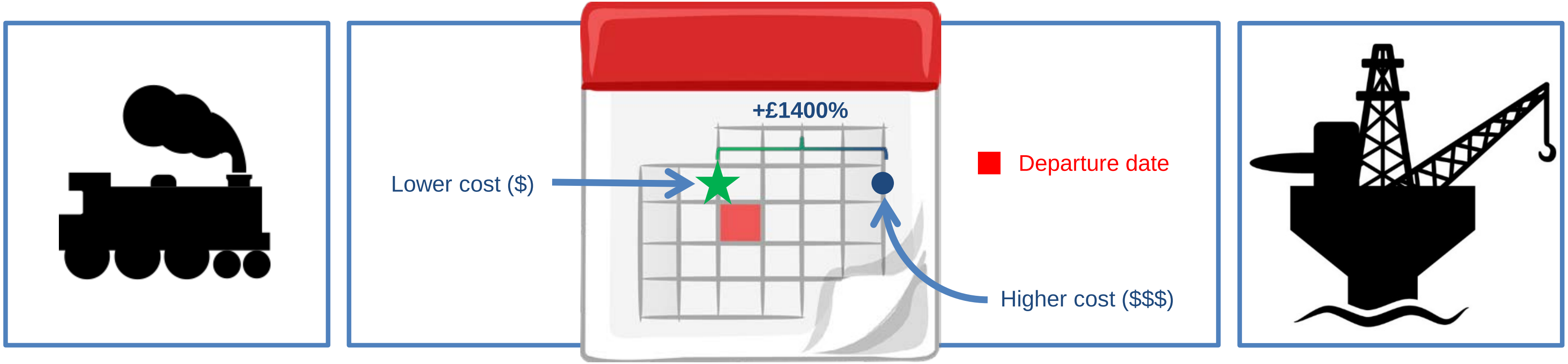
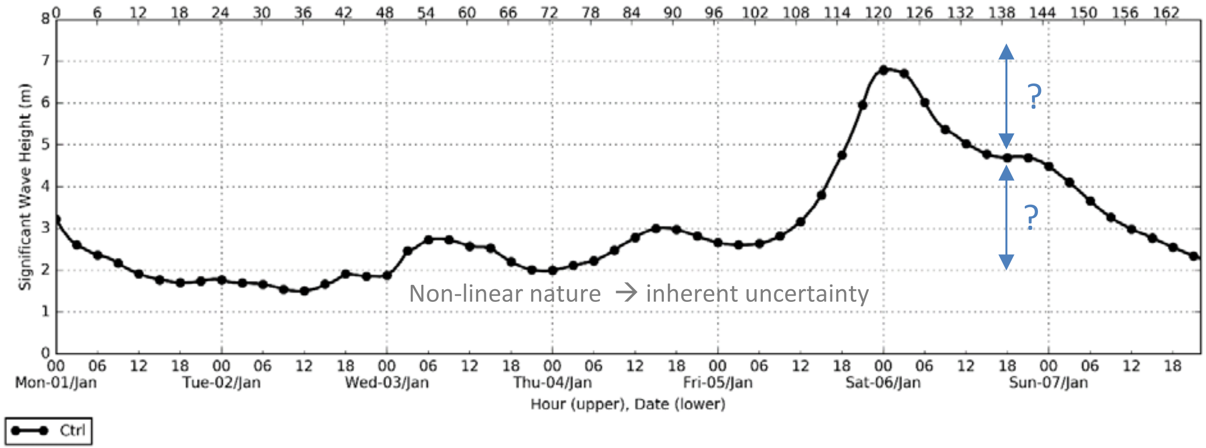
Background



Correct identification of calm weather windows can save many thousands of dollars per day in unplanned downtime, allowing large savings if decisions are made as early as possible – but only when the science is employed to best effect…

Deterministic forecasts

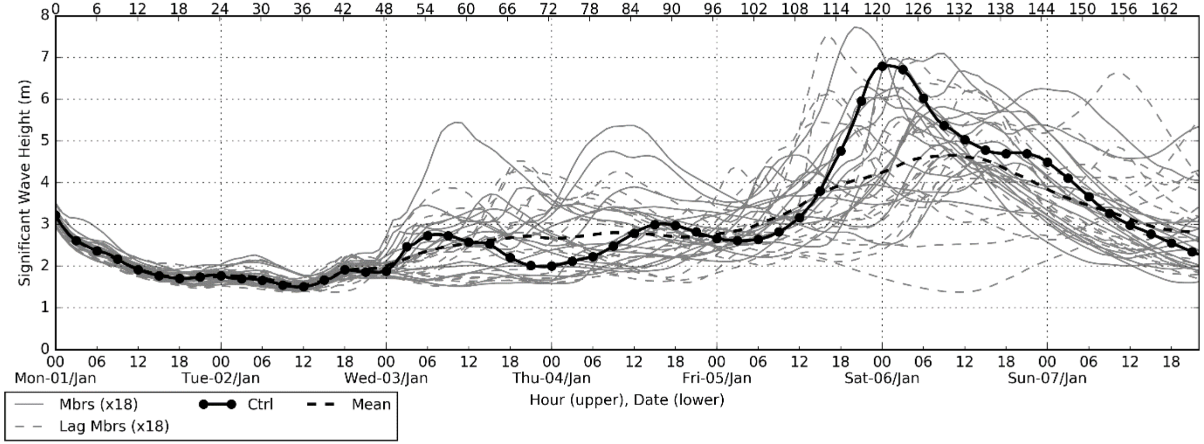
At present, most offshore industry decisions are based on deterministic (single) forecasts, but these fail to show the likelihood of an event occurring.



Typically, not an issue for obtaining final approval for whether to initiate a planned deployment, but often insufficient for maximizing efficient operational planning.

Probabilistic forecasts

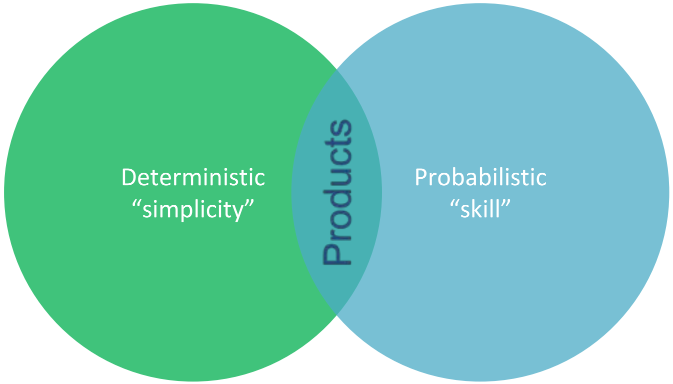
Aim to quantify the uncertainty dynamically, using multiple projections generated from a perturbed set of initial conditions / model parameterizations via the use of stochastically varying numerical schemes.

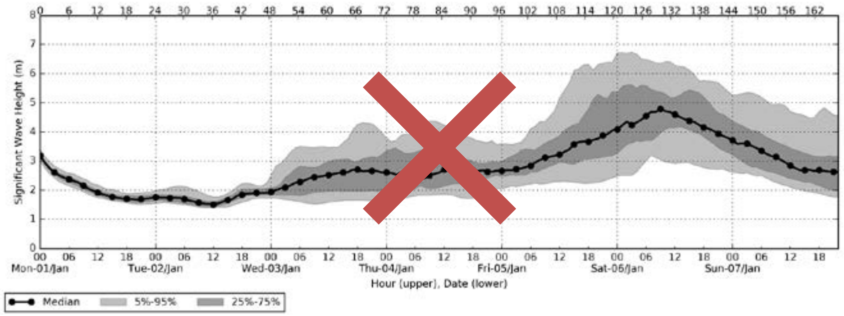


Ensemble forecast systems are constructed such that results from each member will be equally likely – therefore representative of the probability of an event occurring.

The scientific challenge

Aim to develop useful and usable products:





Relative economic value of probabilistic marine forecasts

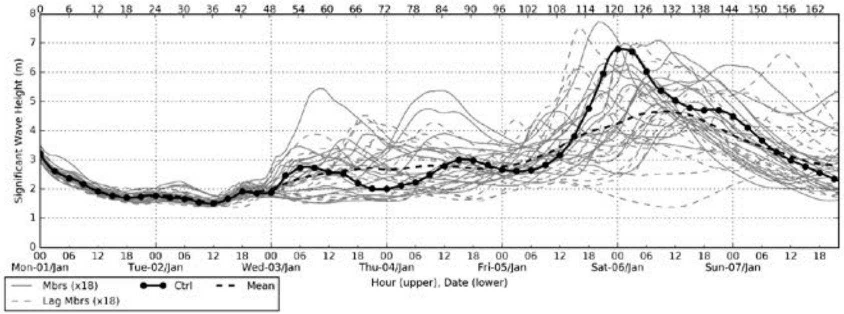
Continuous forecasts can be turned into binary forecasts by applying a user-relevant threshold.

With binary forecasts the action is clear:

Event forecast – take action

Event not forecast – take no action

With probabilistic forecasts, a decision must be made on which probability value to act on…



Relative economic value of probabilistic marine forecasts

Relative economic value allows financial impact of an adverse weather event to be estimated in industry-relevant terms.

Uses categorical verification stats, based on industry operating threshold:

- Monetary cost incurred whenever decision is made to protect (irrespective of occurrence);
- Monetary loss incurred whenever the event occurs and the decision made not to protect;

Value compared to climatological baseline (V=0) and expressed as a fraction of the maximum obtained from using a perfect forecast (V=1).

	Event observed	No event observed
Event forecast Action taken	Hit **COST +** **REDUCED LOSS**	False alarm **COST**
No event forecast No action taken	Miss **LOSS**	Correct rejection

$$V = \frac{E_c - Ef}{E_c - Ep} \approx \text{"skill score"}$$

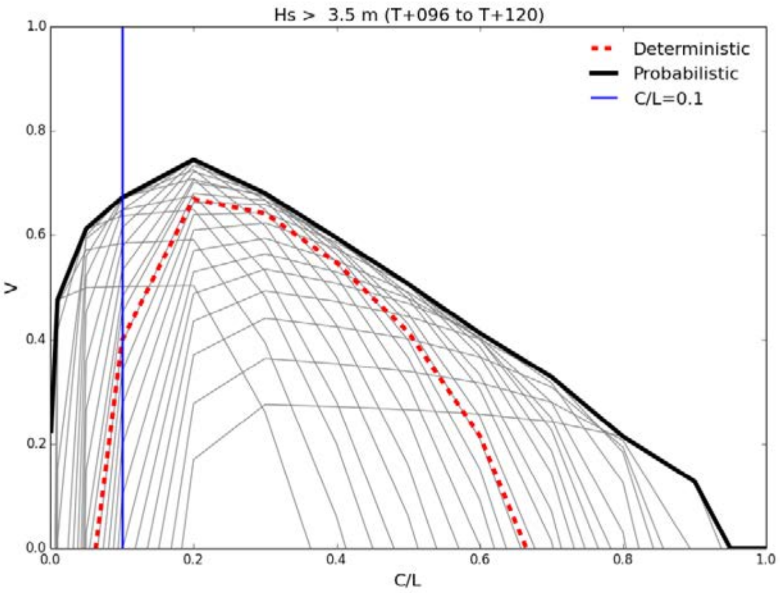
Ensemble: estimated for range of probability thresholds and presented in terms of C/L.

Relative economic value of probabilistic marine forecasts

→ Relative economic value as a function of C/L calculated from forecasts made 3 days ahead (10 locations, over 1 year):

- Adverse event: H_s >3.5m in 24 hours;
- Thin black lines = individual probability thresholds;
- Thick black line = optimum probability threshold that maximises V at each C/L;
- Dashed red line = result from deterministic forecast;

Highest value from ensemble: user gains some benefit over best-estimate forecasts/climatology.

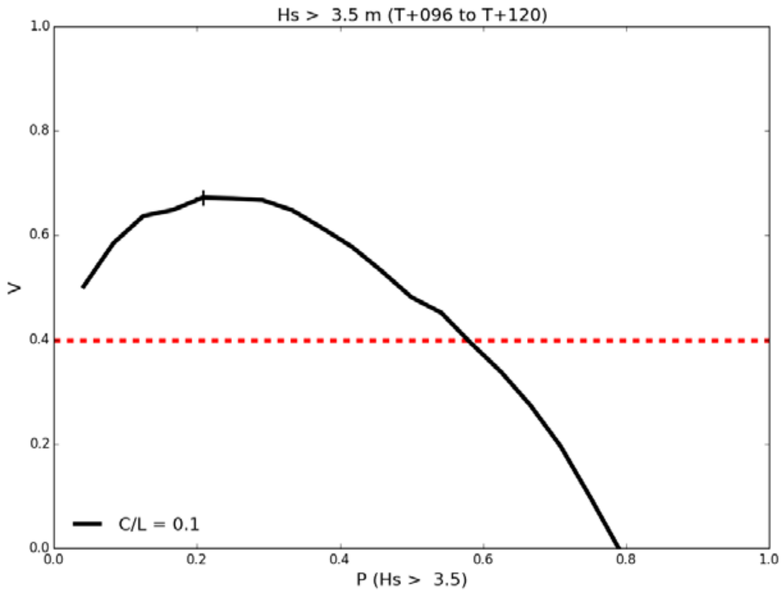


C/L determines the scale of the benefit, as well as the threshold to use for the basis of future decisions.

Relative economic value of probabilistic marine forecasts

→ Relative economic value of a subset of the same data, as a function of probability (fixed C/L=0.1)

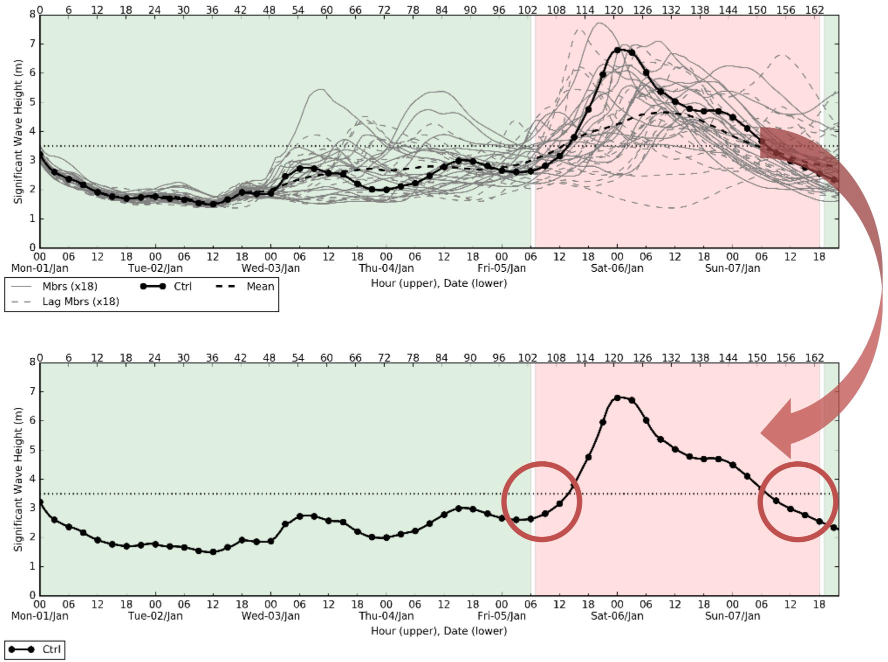
Value is maximum when P=0.2: user gains maximum benefit by postponing planned operations when more than 5 of 24 ensemble members forecast the adverse event (or vice versa).



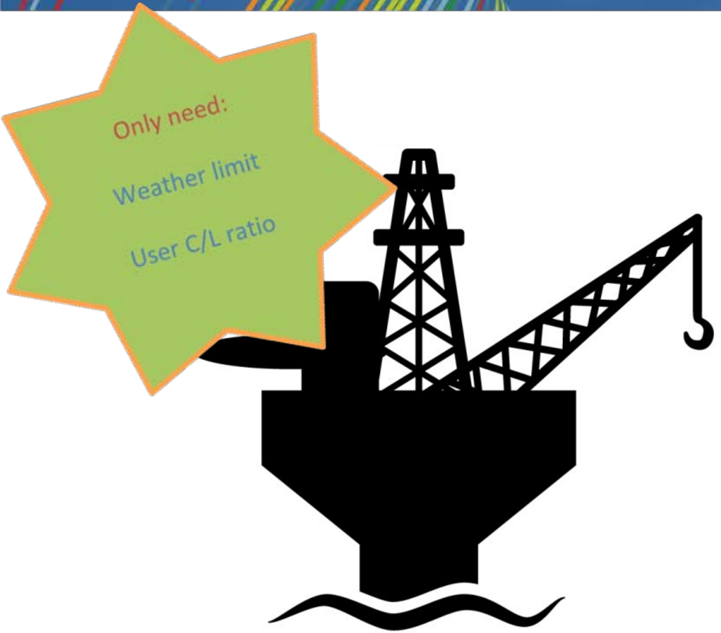
Relative economic value of probabilistic marine forecasts

→ Example visualisation of weather windows detection (P=0.2), simplified scientifically…

- Take action
- Take no action



Benefits to offshore asset managers



Actual decision-making often more complex than a simple yes/no, but the C/L framework offers a sensible basis for handling probabilities.

Greater reliability of probabilistic forecasts over deterministic forecasts days to weeks ahead offers the opportunity for more timely decision-making.

Useful in coordinating interrelated components of operations (e.g. vessels / supplies) or starting installation shut-down preparations (cancelling activities / removing non-essential personnel) early.

Thank you for listening!

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