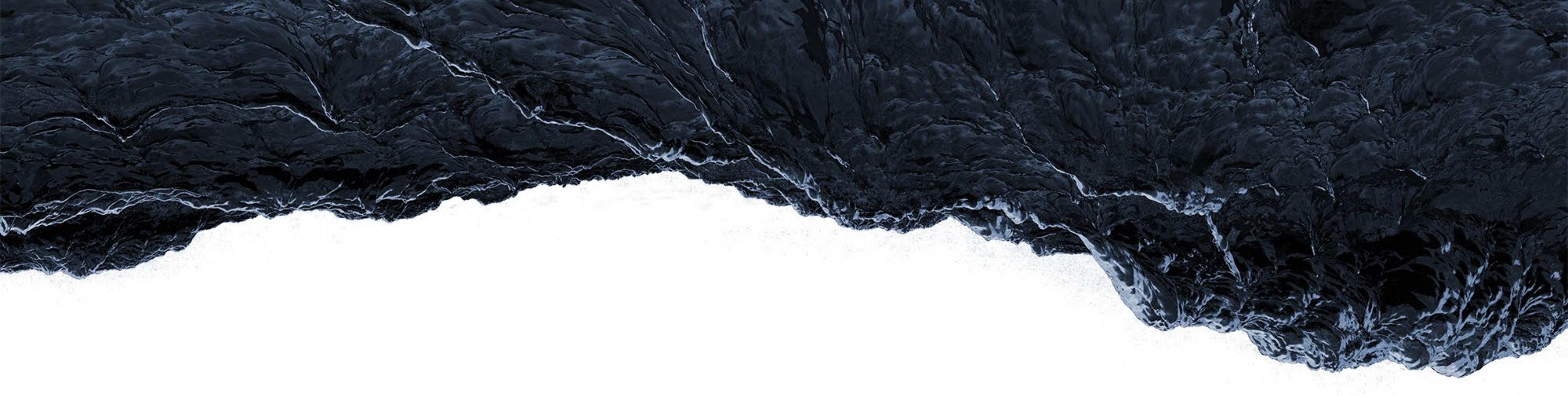


# Analysis of marine operations – theory meets real life



Entail


The analysis report says we cannot do the operation

# Why?

# The analysis is wrong

A lot of reasons why this is the case, which boils down to

# Conservatism & Uncertainty

# The good news is, this can be fixed!




Entail

# How to get theory closer to reality?

Remove uncertainty by using better analysis methods

| **Method** | **Documented workability** |
| --- | --- |
| Simplified physics | 30% (common approach) |
| Time domain one shot | 55% |
| Time domain optimize | 70% |
| No alpha factor | 80% |

# Example:

## Analysis of lowering through the splash zone of a suction anchor

# How to find the weather limits

For a set of sea states:

- Estimate tension in the lifting equipment
- Compare to the equipment breaking limits

**Must model the behavior of the lifted system**

# Behavior

## The anchor is pitching as it goes down

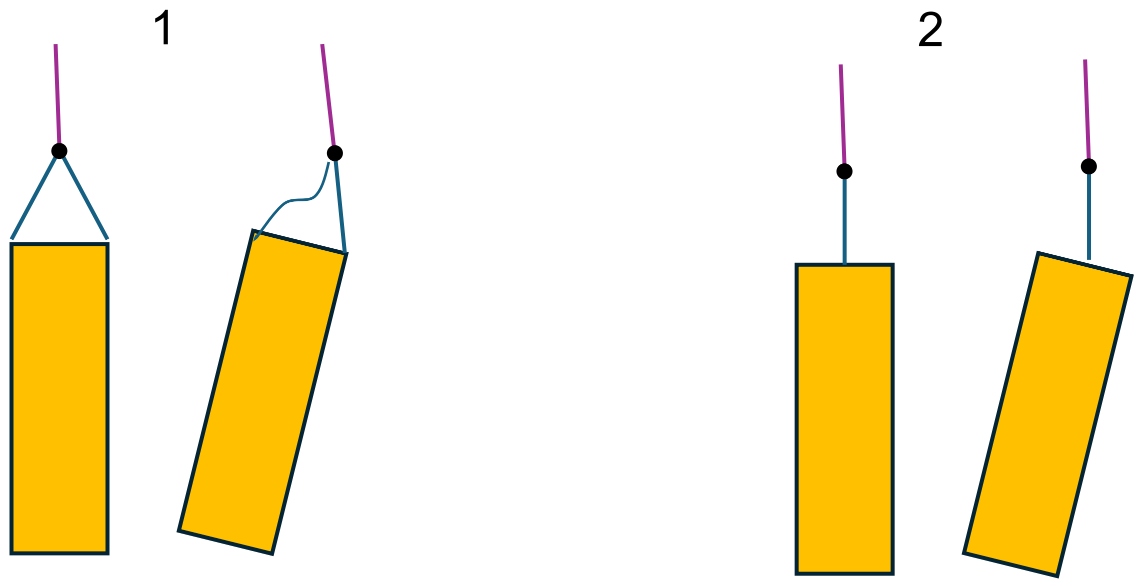
# How to rig and plan the lowering

We find two things:

- The crane tip should be high
- The orientation of the slings is important, to avoid them slacking

**But**

It is hard to document this behavior






Entail

# Documenting system behavior

2 main sources of uncertainty:

**Physics & Statistics**

**Physics**

What physical model appropriately captures the system behavior and thus the **response** to the incident waves?

**Statistics**

What is the probability of occurrence of the response that would satisfy my need for **conservatism**?

# Statistics

From DNV standard for lift

We need to be 90% certain that the real response is lower than the estimated response

## What does that mean?

It accounts for two random things:

1) The skill of the crane operator

and

2) The luck of the crane operator

in drawing a wave from the random wave train

But

Current state of the art analysis assumes a blind crane operator

## Reformulating initial statement:

We need to be 90% certain that the real response is lower than the estimated response, assuming that the crane operator is blind

# Physics

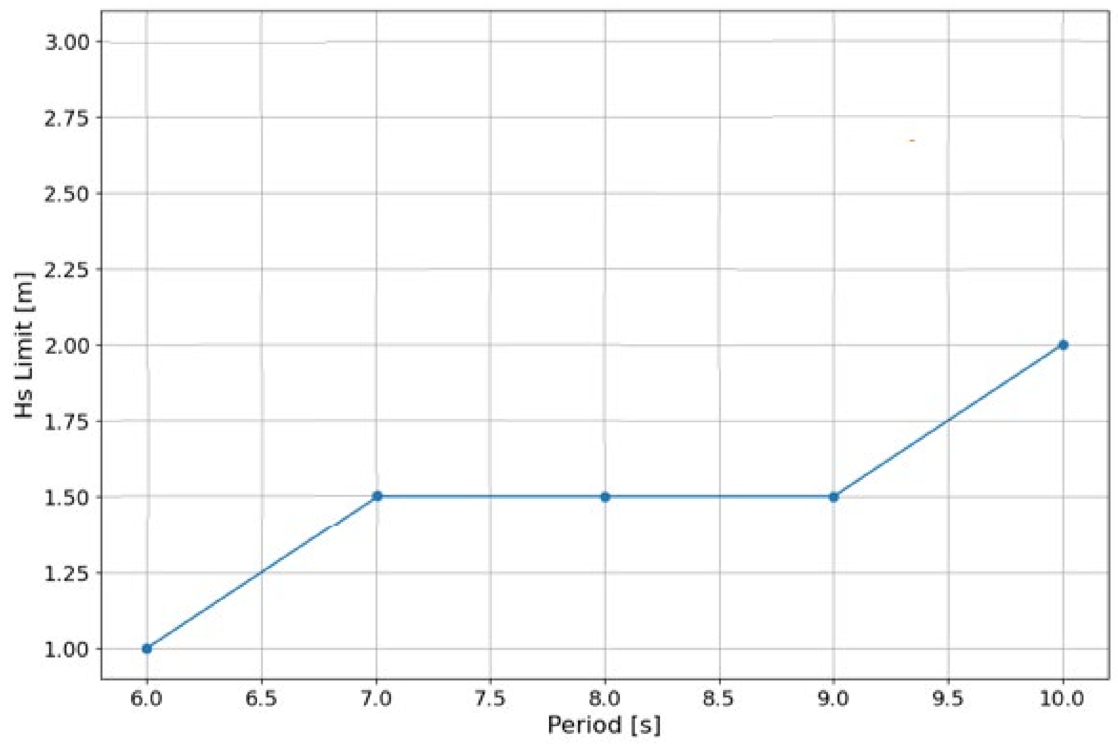
Here is where uncertainty can pile up

But

If you understand the system, there is room for both optimization and lowering the uncertainty!

# First approach to physics: Simplified analysis

- Easy. Can run in Excel, on a laptop
- Maybe good enough for summer

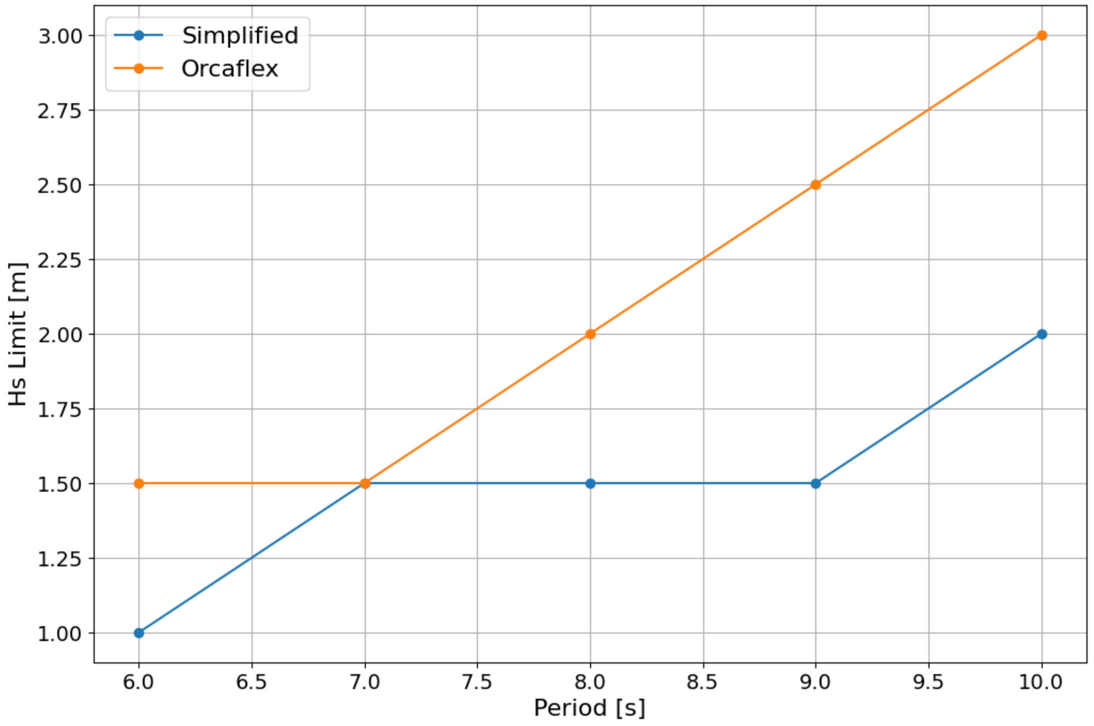



| Method | Documented workability |
|---|---|
| Simplified physics | 30% (common approach) |
| Time domain one shot | 55% |
| Time domain optimize | 70% |
| No alpha factor | 80% |

Entail

# Second approach: Time domain analysis, one shot

- Advanced software. Analysis costs more
- Maybe good enough for autumn

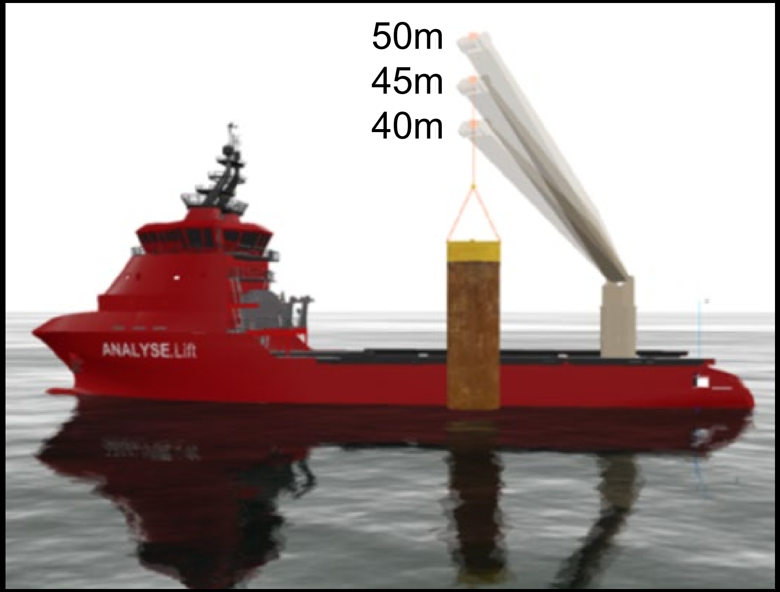


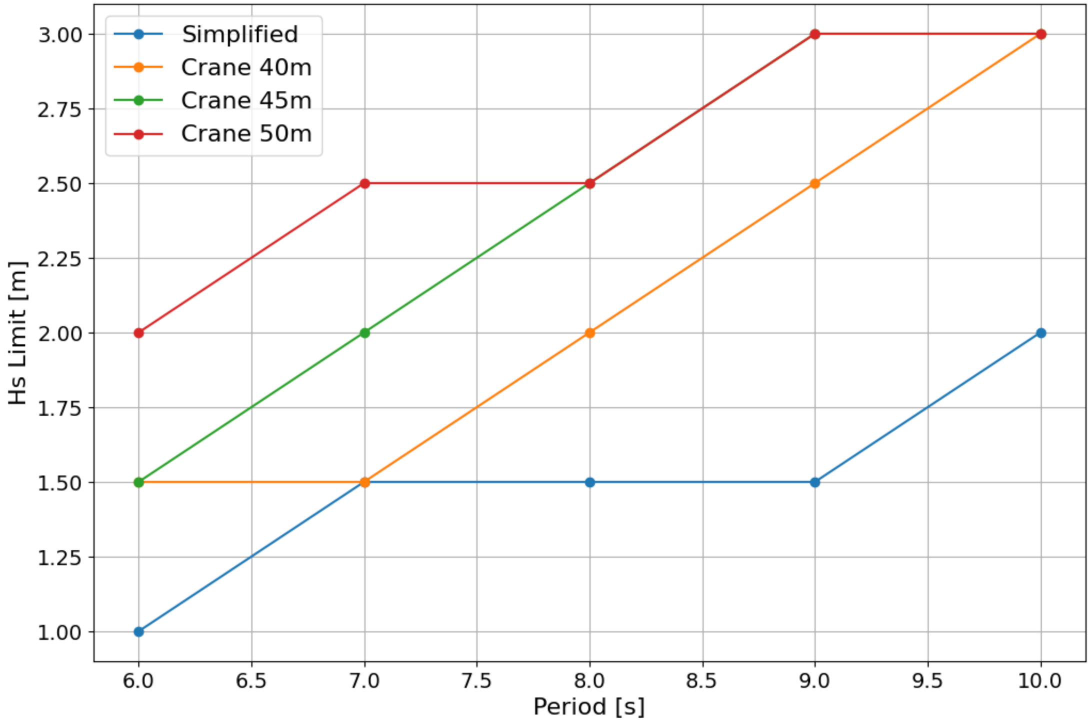

| Method | Documented workability |
| --- | --- |
| Simplified physics | 30% (common approach) |
| Time domain one shot | 55% |
| Time domain optimize | 70% |
| No alpha factor | 80% |

Entail

# Third approach: Time domain analysis, understand, optimize

- Advanced system. Analysis is expensive
- As good as it gets during planning

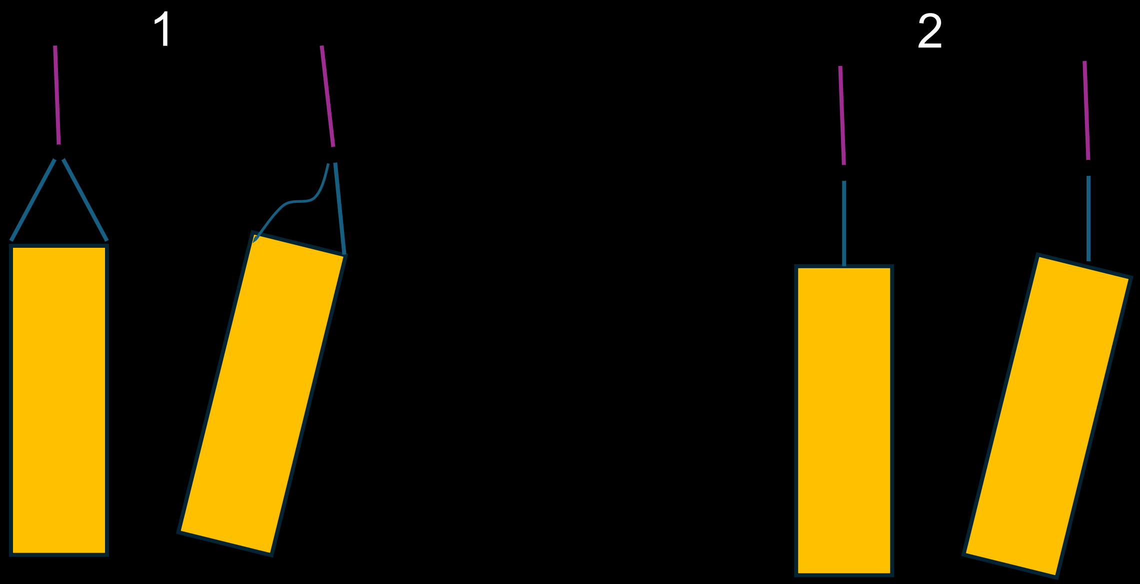


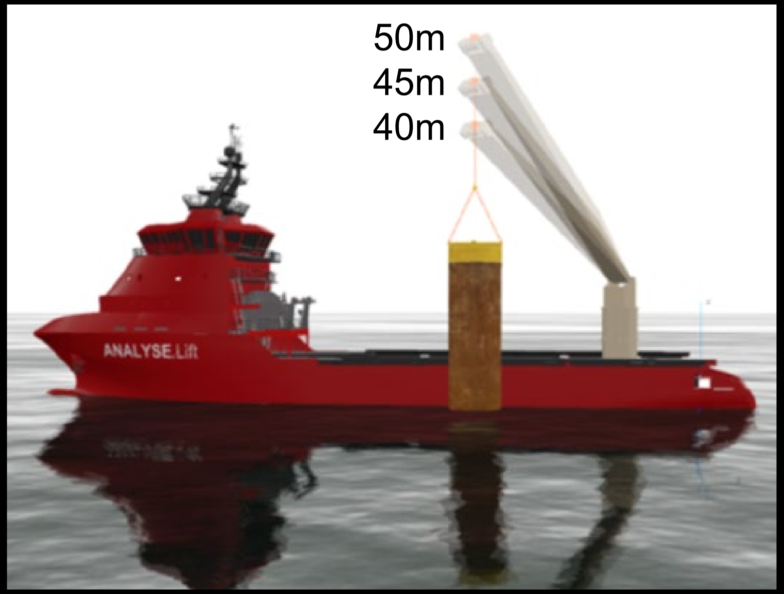




| Method | Documented workability |
|---|---|
| Simplified physics | 30% (common approach) |
| Time domain one shot | 55% |
| Time domain optimize | 70% |
| No alpha factor | 80% |

Entail

# Understanding system behavior leads to optimized method!




The analysis report says we cannot do the operation
Yes, I know.
To be conservative, I had to pile uncertainties on top of each other:
Simplified physics that doesn’t capture the behavior
90% response to account for a blind and unlucky crane operator


# With better methods during planning, we fixed this


# How good can it get?

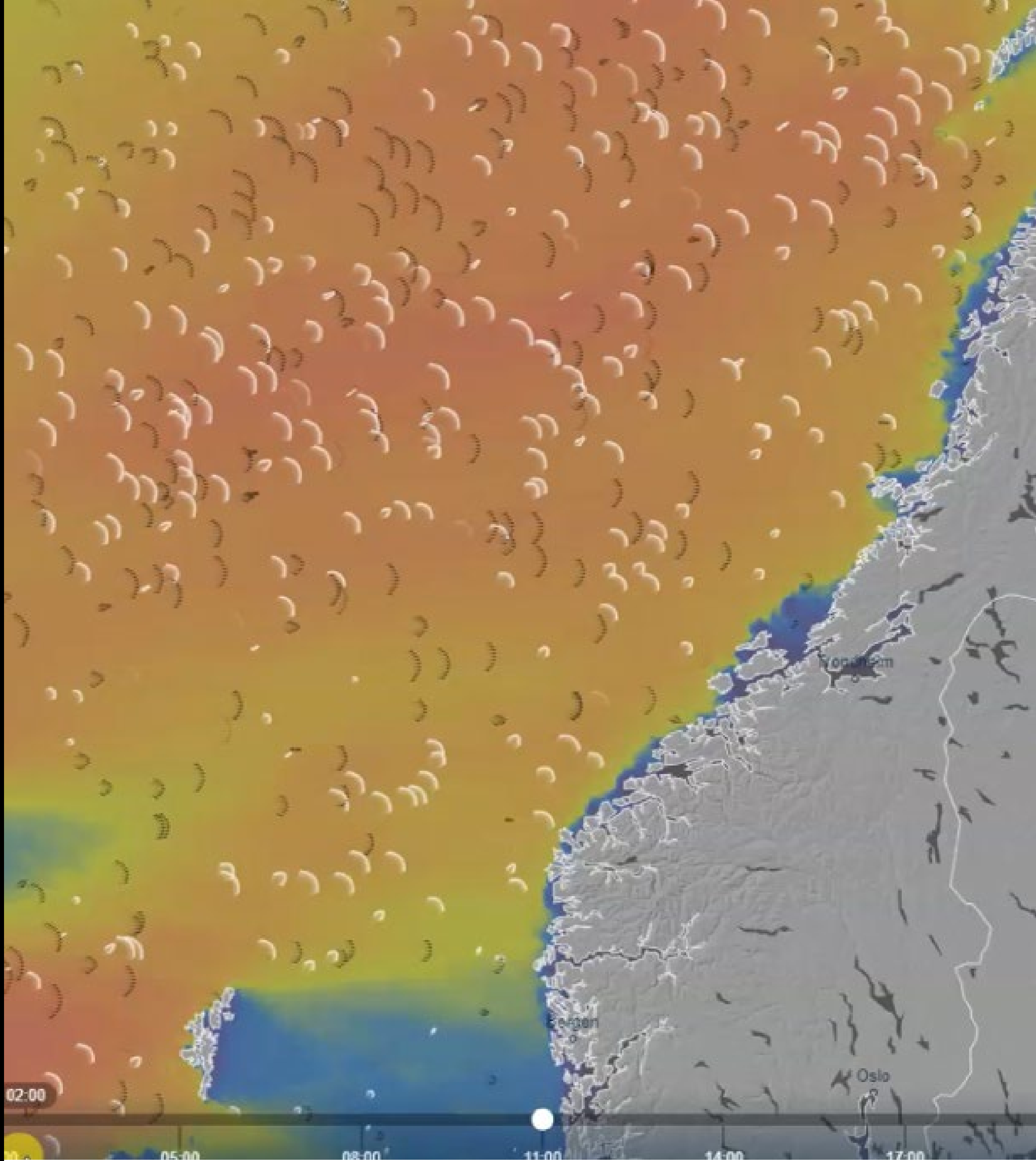

# Analysis during execution

# Response forecast

Reduce 2 sources of uncertainty:

1. More than one wave train (physics)
    1. From: All energy in worst direction and period
    2. To: Distribute energy correct in accordance with the forecast

2. Using the complete span of scenarios (the ensemble) can potentially remove the alpha factor (statistics)
    1. 50% estimate forecast: Hs=2m
    2. 90% from ensamble: Hs=1.9m
    3. With alpha-factor: Hs=1.5m



# Why is response forecasting hard?

Complex system of interacting software and hardware

QA, maintenance, uptime

Requires competence not already in most offshore companies

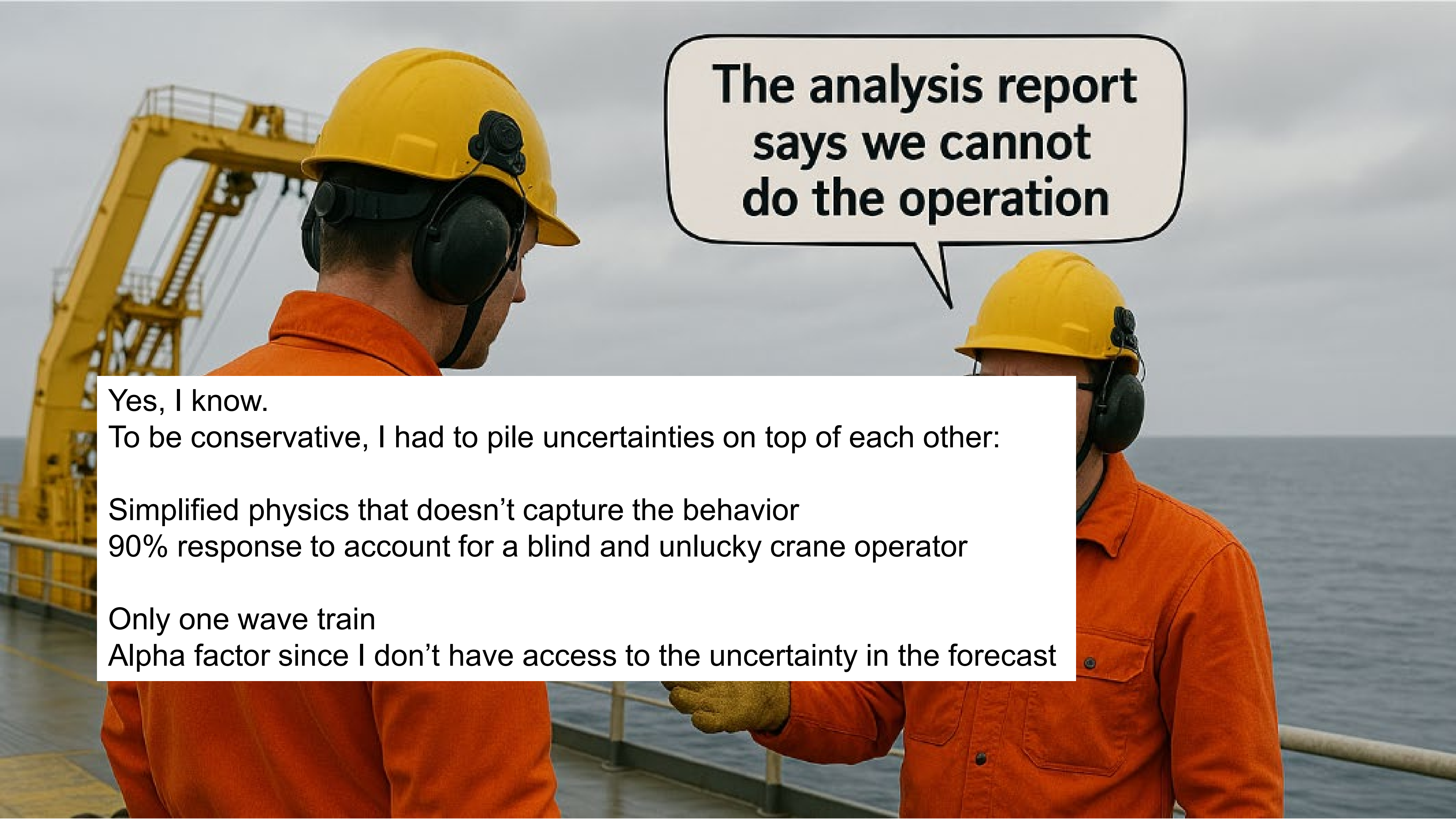
| Method | Documented workability |
| --- | --- |
| Simplified physics | 30% (common approach) |
| Time domain one shot | 55% |
| Time domain optimize | 70% |
| No alpha factor | 80% (HOW DO WE GET HERE?) |

Either

Implemented in a separate department in a large company

or

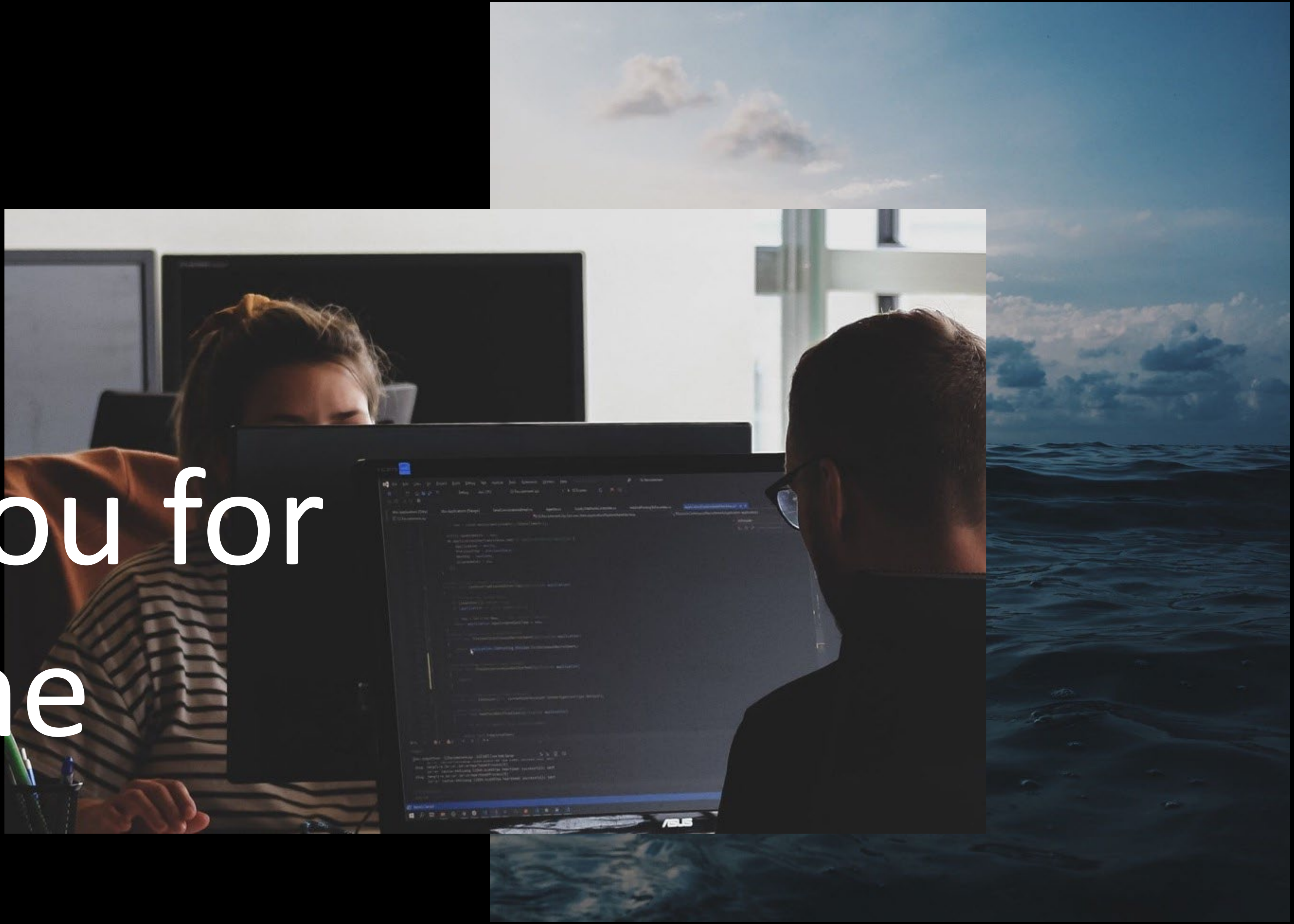
implemented in separate company and offered as a service




Yes, I know.
To be conservative, I had to pile uncertainties on top of each other:

Simplified physics that doesn’t capture the behavior
90% response to account for a blind and unlucky crane operator

Only one wave train
Alpha factor since I don’t have access to the uncertainty in the forecast



# Thank you for your time