APPLICATION OF STWAVE IN NORWEGIAN COASTAL WATERS

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By

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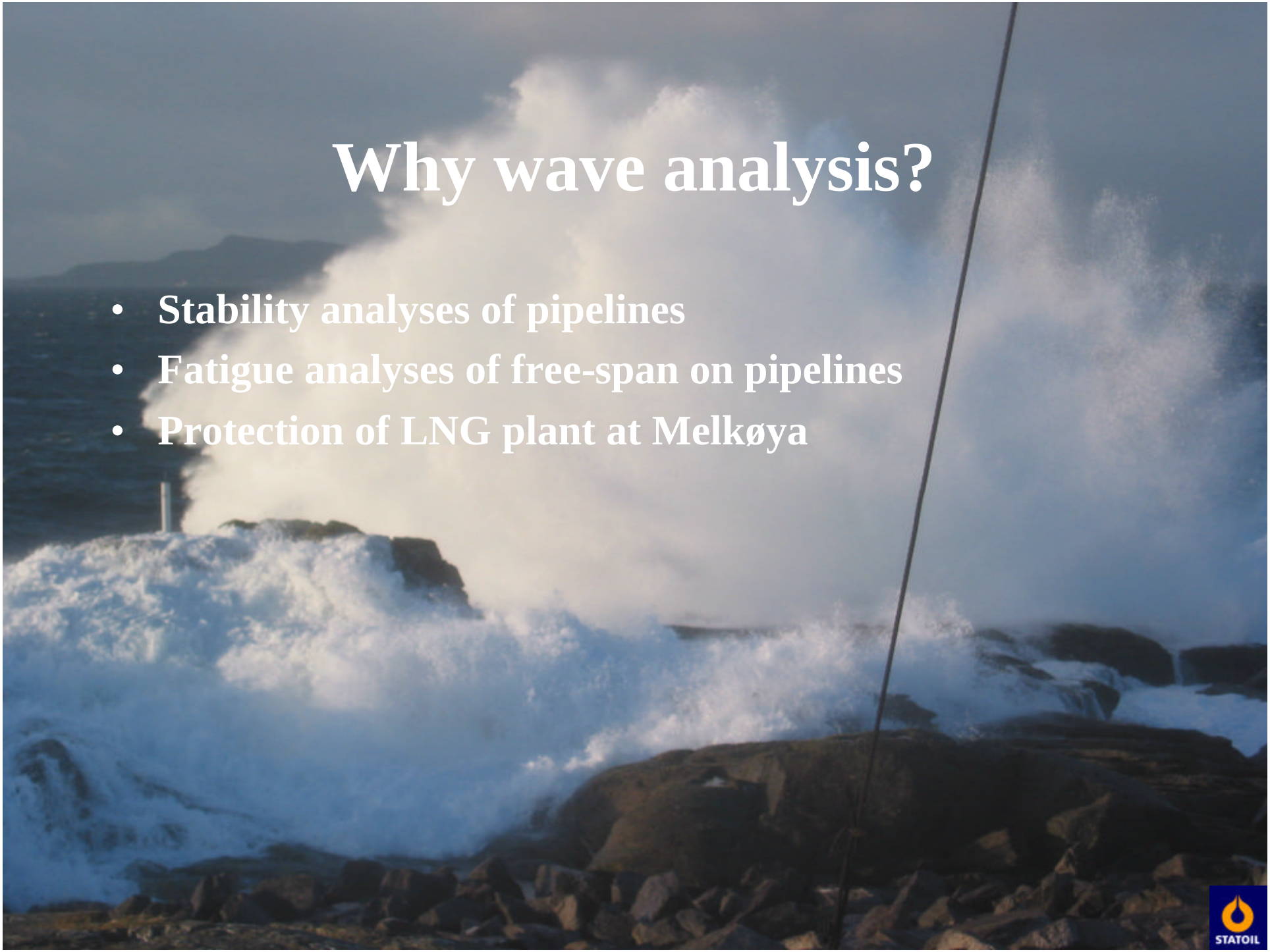
The Norwegian Government Oil Company (Statoil)

Use of STWAVE at Statoil!

- Statoil has been using STWAVE for 4 years
- STWAVE has been used for the shore approach for 4 pipelines in the North Sea
  - Langeled – Norway and UK
  - Statpipe – North Sea - Norway
  - Rogass – Pipline along the Norwegian Coast
  - Snøhvit – Pipeline from the Snøhvit field to Hammerfest

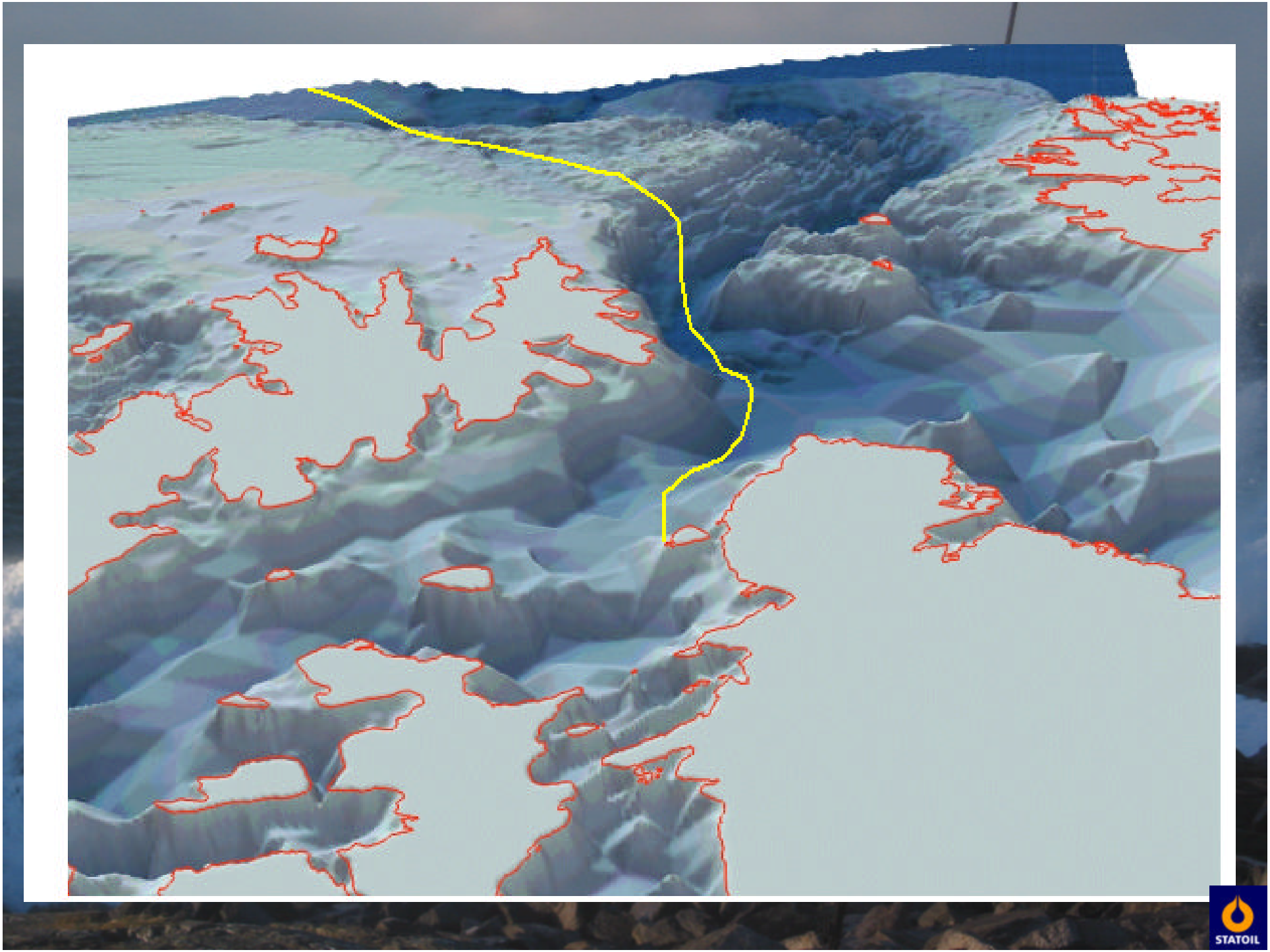
The Snøhvit Gas field!

- Snøhvit is a sub-sea development
- Approximate 140 km from the Norwegian Coast
- Pipeline from the Snøhvit field to Hammerfest
- LNG terminal at Hammerfest

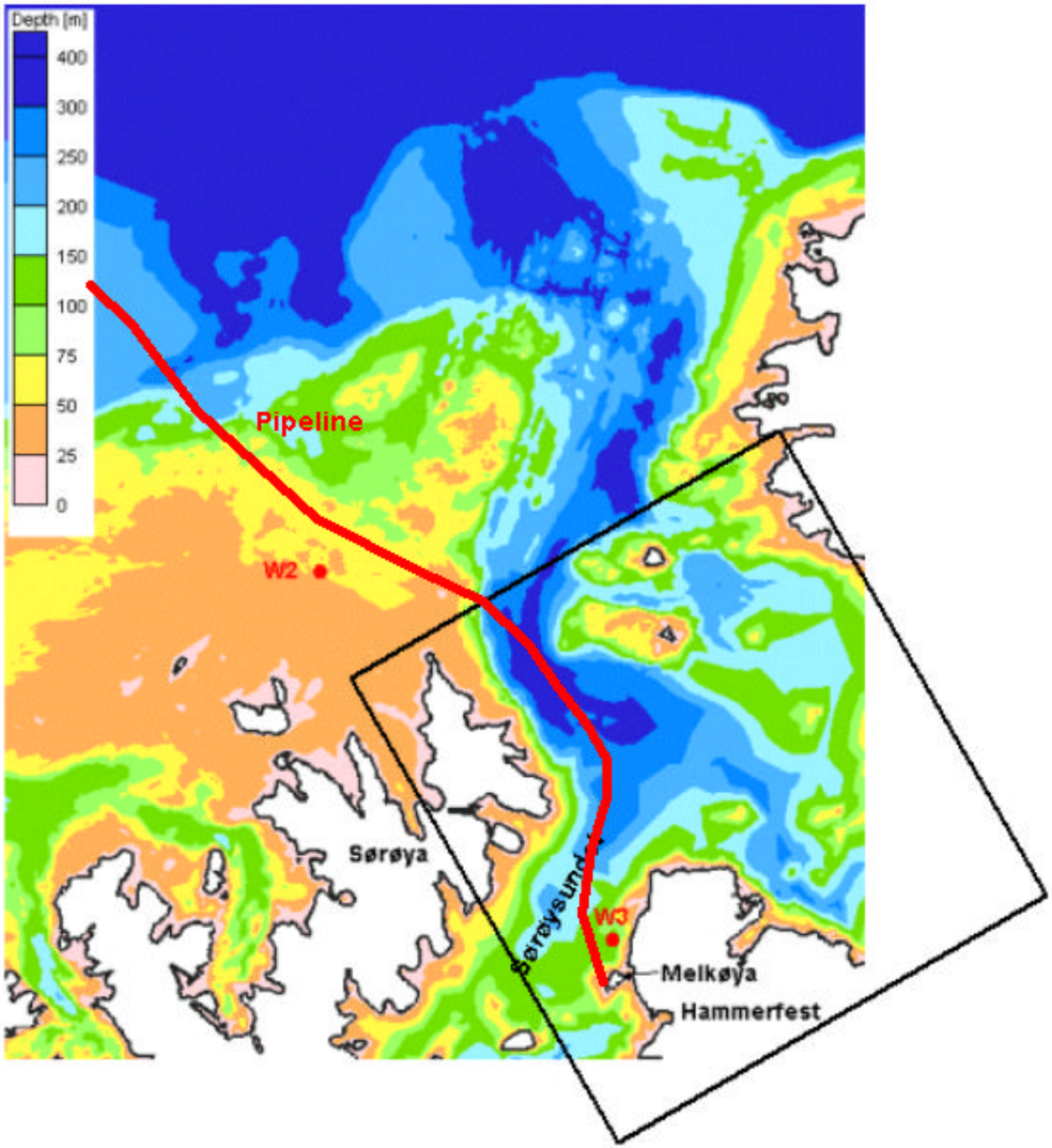


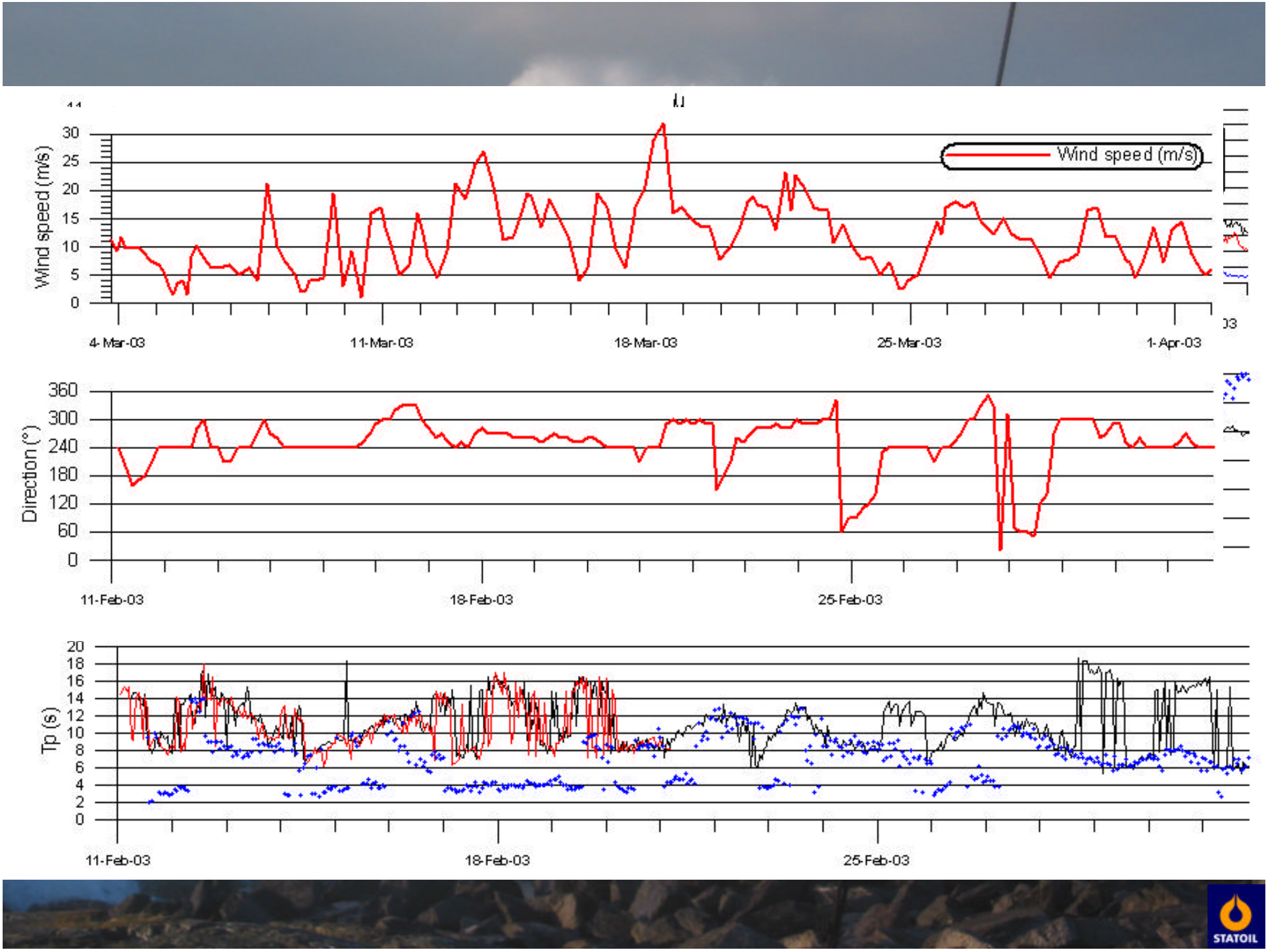
Why wave analysis?

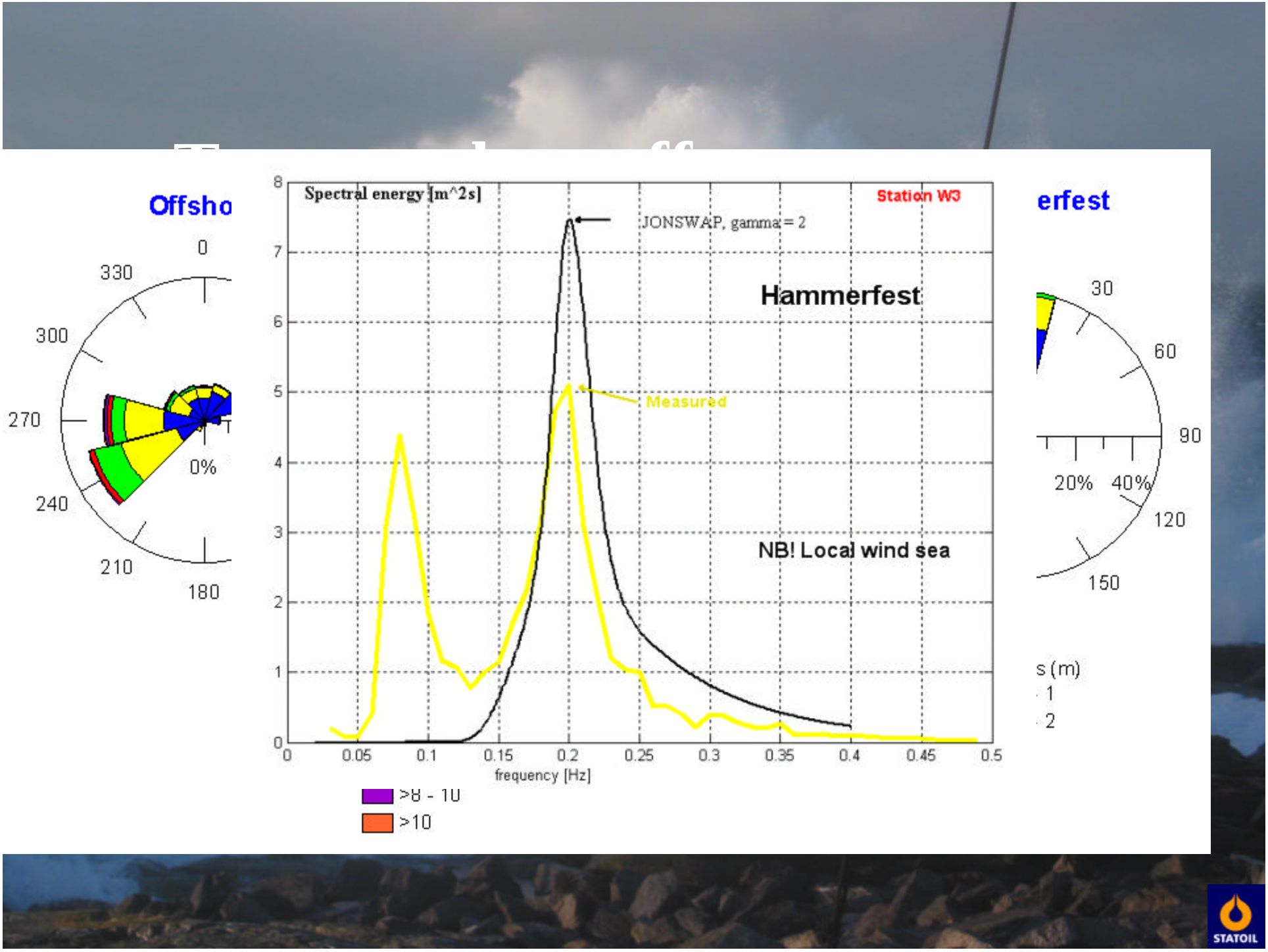
- Stability analyses of pipelines
- Fatigue analyses of free-span on pipelines
- Protection of LNG plant at Melkøya


STATOIL

- **100**
  - N
  - B

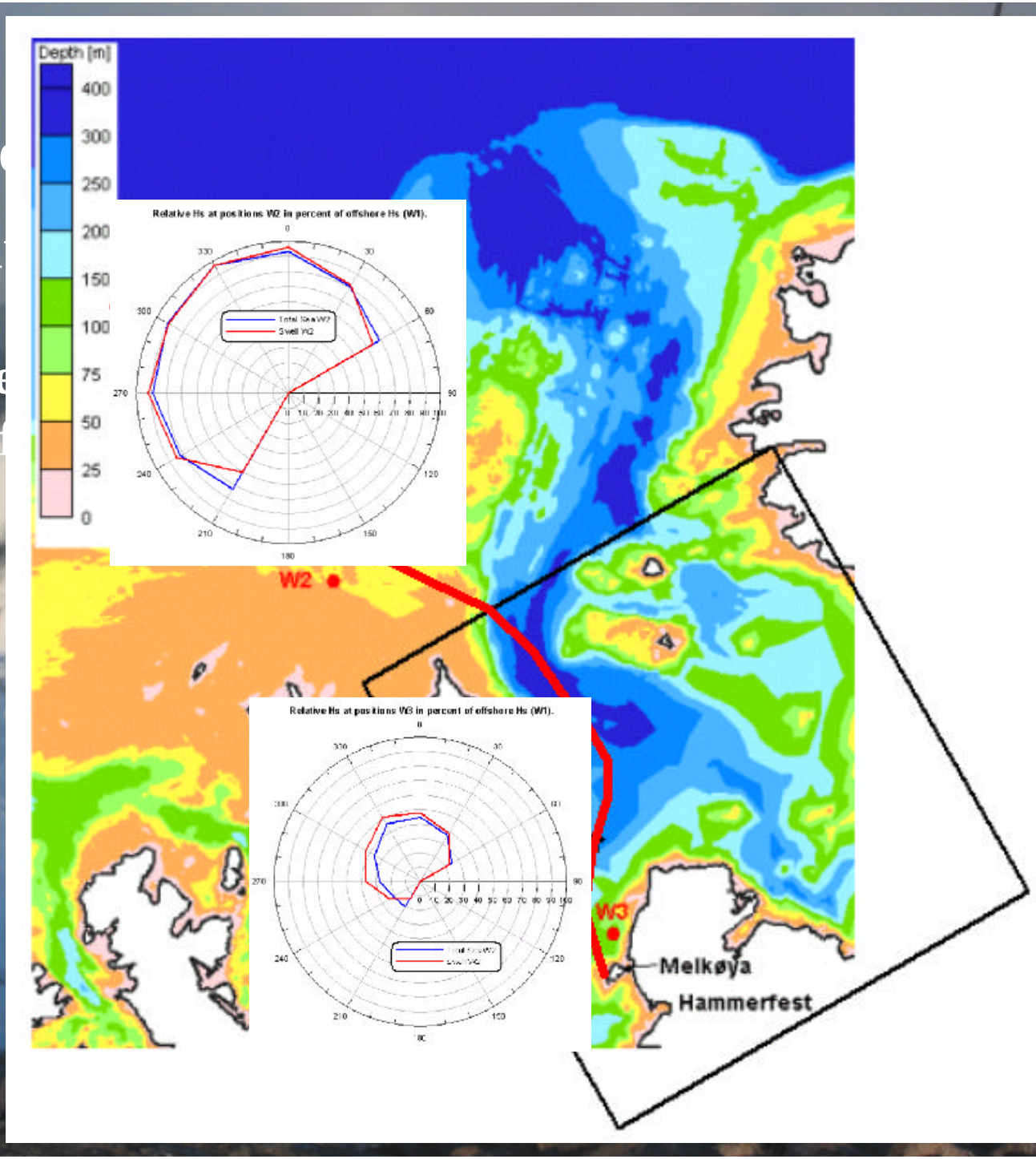

Depth [m]
400
300
250
200
150
100
75
50
25
0
Pipeline
W2
Sørøya
W3
Melkøya
Hammerfest

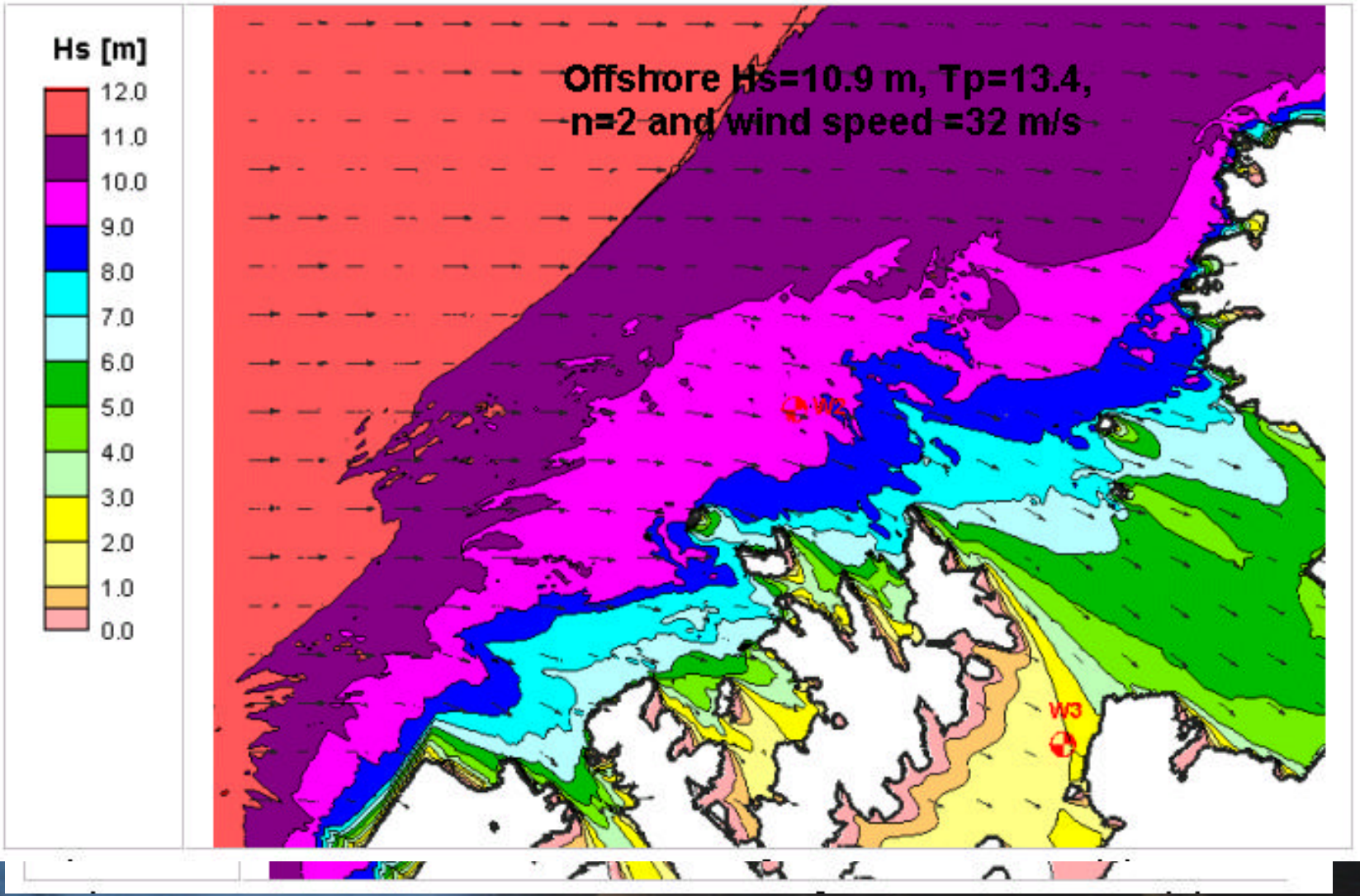

Wind speed (m/s)
30
25
20
15
10
5
0
Wind speed (m/s)
4-Mar-03
11-Mar-03
18-Mar-03
25-Mar-03
1-Apr-03
Direction (°)
360
300
240
180
120
60
0
11-Feb-03
18-Feb-03
25-Feb-03
Tp (s)
20
18
16
14
12
10
8
6
4
2
0
11-Feb-03
18-Feb-03
25-Feb-03


Offsho
0
330
300
270
240
210
180
0%
Spectral energy [m^2s]
Station W3
JONSWAP, gamma = 2
Hammerfest
Measured
NB! Local wind sea
frequency [Hz]
0
1
2
3
4
5
6
7
8
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
>8 - 10
>10
erfest
30
60
90
120
150
20%
40%
s (m)
1
2

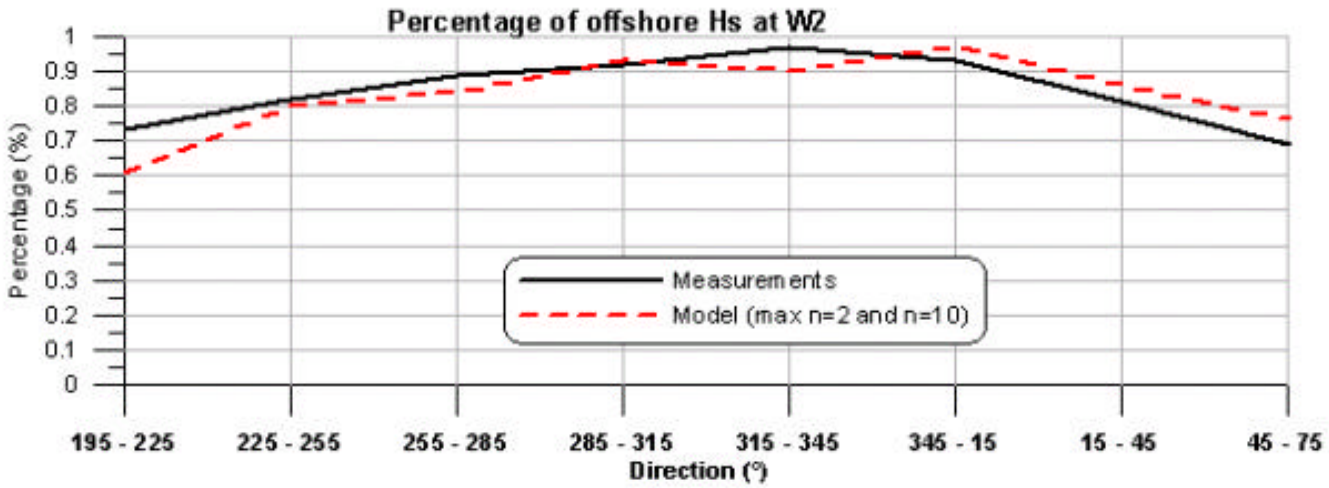
Reductio (W2) and a nts

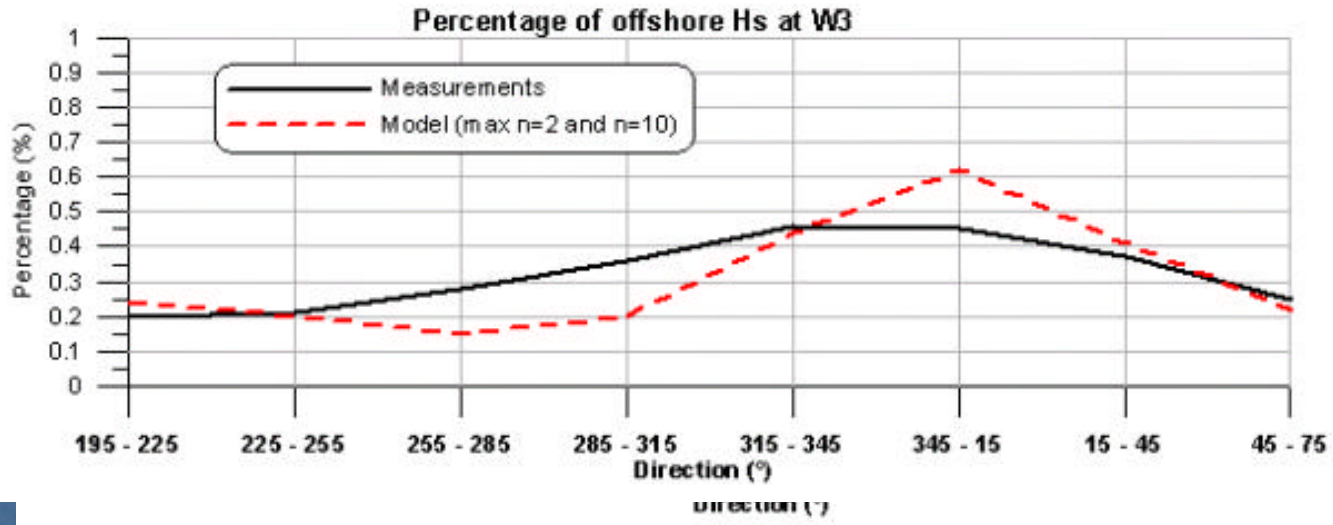
- Re nt of off




Hs [m]
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Offshore Hs=10.9 m, Tp=13.4,
n=2 and wind speed =32 m/s
W2
W3

- ST
- Fo
-


Percentage of offshore Hs at W2
Percentage (%)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Measurements
Model (max n=2 and n=10)
195 - 225
225 - 255
255 - 285
285 - 315
315 - 345
345 - 15
15 - 45
45 - 75
Direction (°)


Percentage of offshore Hs at W3
Percentage (%)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Measurements
Model (max n=2 and n=10)
195 - 225
225 - 255
255 - 285
285 - 315
315 - 345
345 - 15
15 - 45
45 - 75
Direction (°)

Conclusion

- Apply the most conservative spreading factor of n=2 and 10
- Apply associated wind
- Difficult to get enough energy around headlands even when a nested grid is used
- Even if the most conservative spreading factor, associated wind and nested grid are applied the results are not necessarily conservative!
- It is recommended to perform wave measurements at a few locations at the pipeline route
- If measurements not is performed a safety factor should be applied in order to take all uncertainties into account
- Be careful with results leeward of headlands