# Second order difference waves, directional spreading and the Draupner New Year Wave

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# Outline

Introduction

The Draupner Wave

Analysis of second order difference waves

Other evidence

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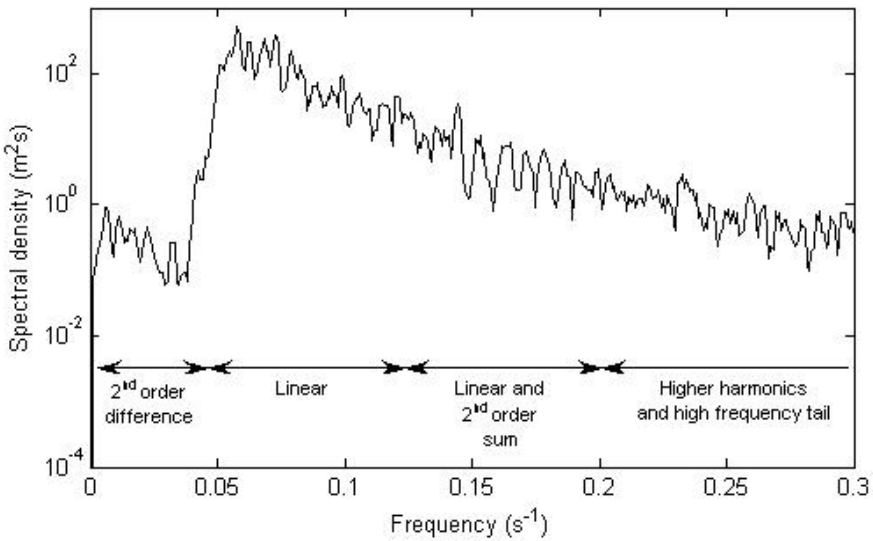
# The 2nd order sea-state

$$\eta_{linear} = \sum_{n=1}^{n=N} a_n \cos(\phi_n)$$

$$\eta_2^{\pm} = \sum_{n=1}^{n=N} \sum_{m=1}^{m=N} a_n a_m \kappa_{n,m}^{\pm} \cos(\phi_n \pm \phi_m)$$



# How to estimate directional spreading from a single point measurement

- Extract the free waves
- Calculate the ‘difference’ waves for a variety of spreading functions
- Compare the estimates to those measured
- For details: Adcock & Taylor (2009) Proc. Roy. Soc. 465(2110), 3083-3102

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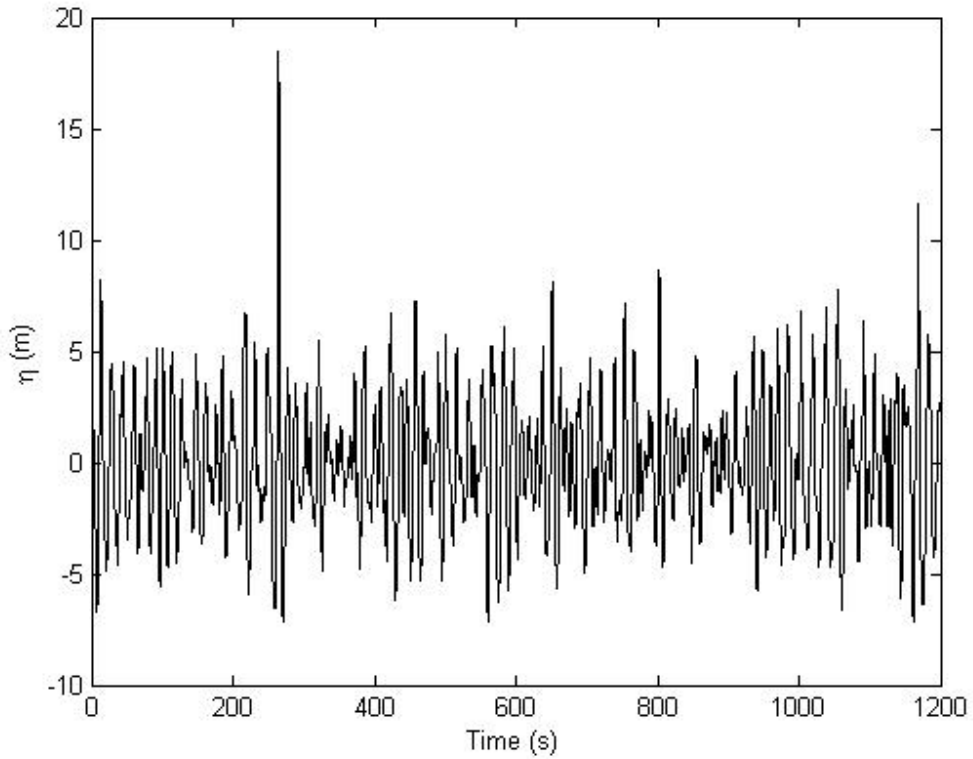
# The Draupner platform

- Draupner oil field in North Sea
- 70m water depth
- Sparse structure – minimal effect on the waves
- Waves recorded with downward pointing laser

# New Year Wave



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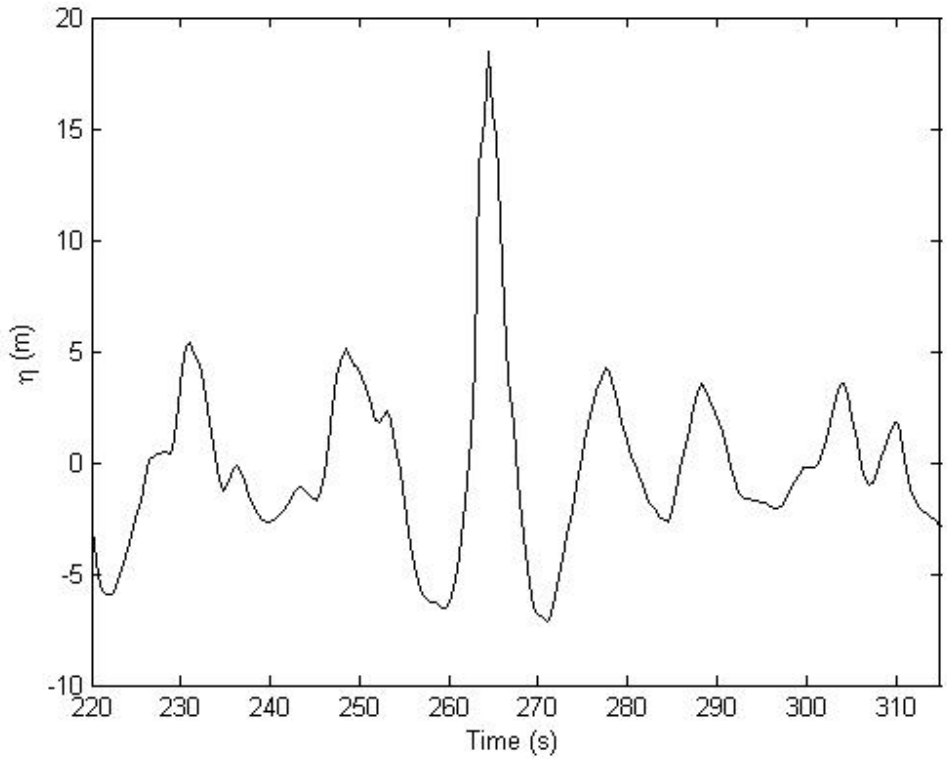

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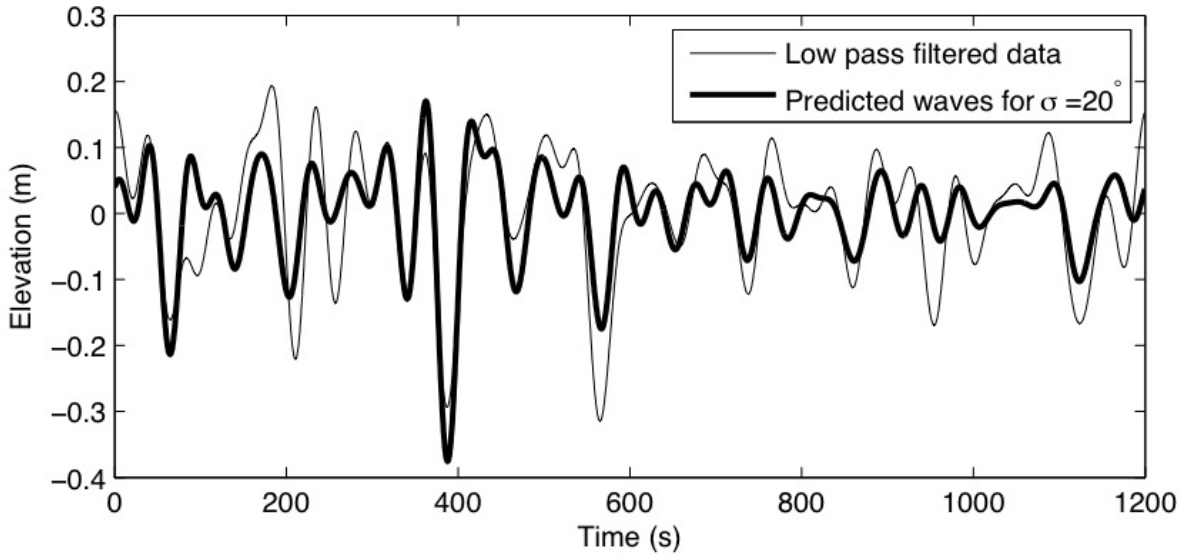
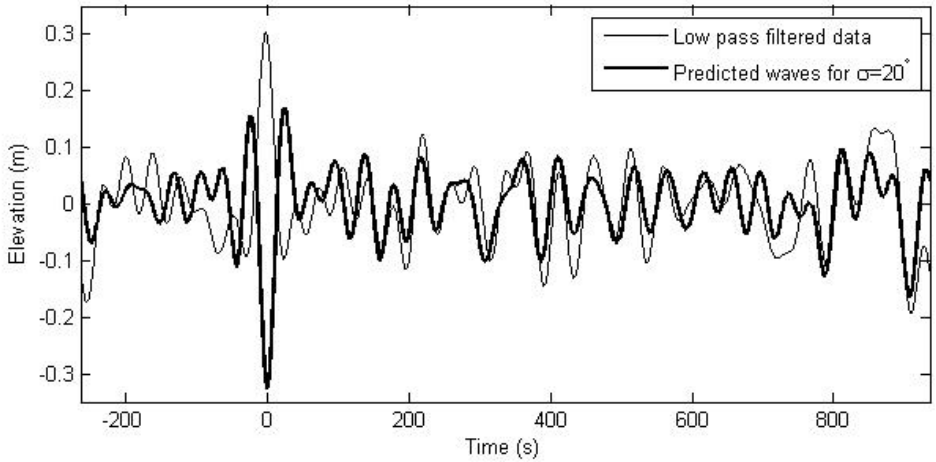



Estimate agrees with other evidence

- Direct measurement (240km away)
- Hindcast
- Second order sum analysis

# Low frequency waves around the giant wave




- Physics is wrong
- Our model of spreading is wrong

# Crossing waves

## Assumptions

- Both wave-groups add up to original record
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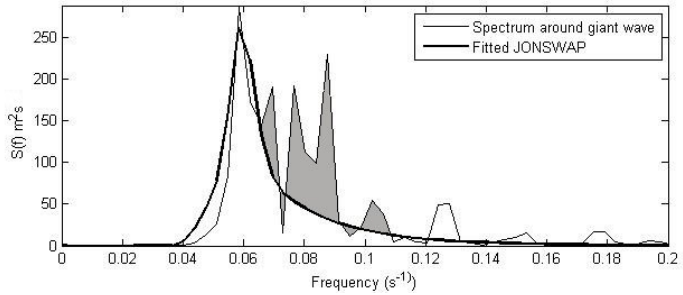

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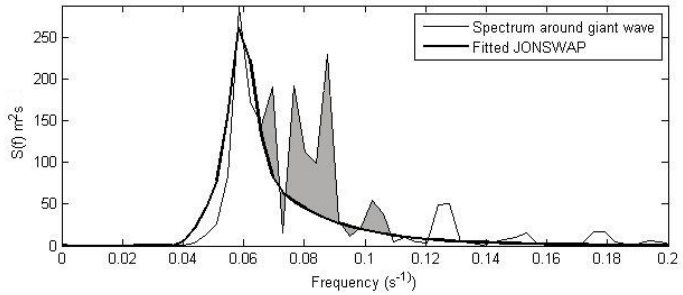


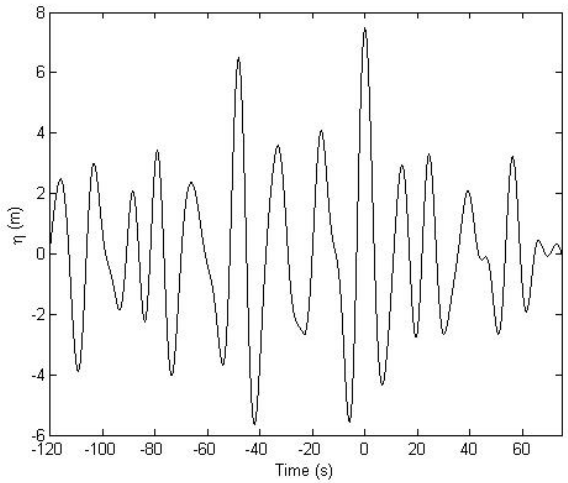


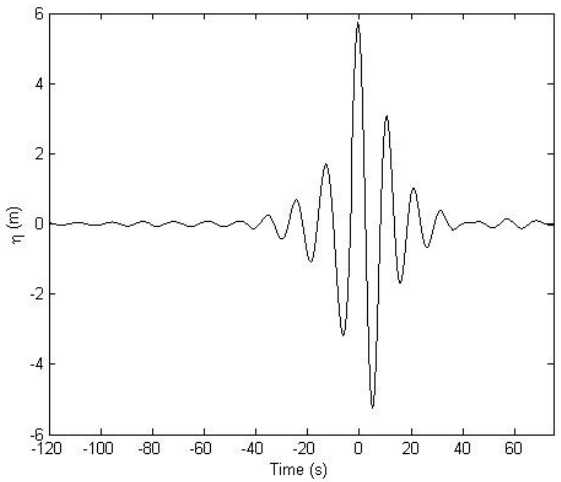

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- Assume each group has r.m.s. spreading about mean direction of 20°.
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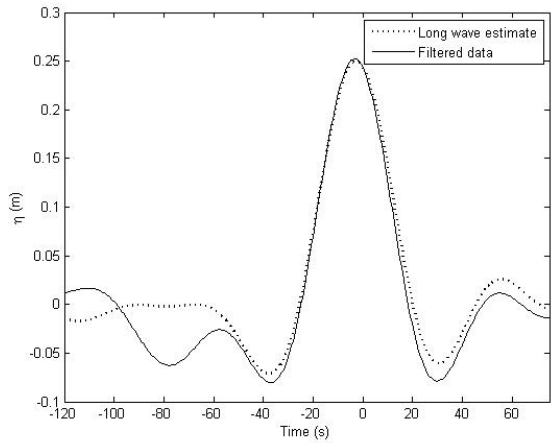


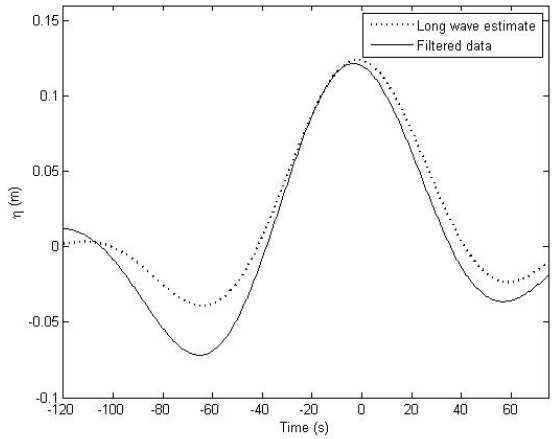

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# Other evidence that the Draupner wave was two packets crossing

- 2nd order sum term
- Forces on the platform
- Hindcast
- Wave breaking

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# Conclusions

- The low frequency part of the spectrum may be used to infer information about directional spreading
- Applying this to the Draupner wave shows this was caused by two wave-packets colliding at an angle greater than 90°
- This is consistent with other evidence

# Acknowledgements


- Numerical modeling – Shiqiang Yan and Qingwei Ma (City University, London)
- Sea-state hindcasts – Peter Janssen (ECMWF)