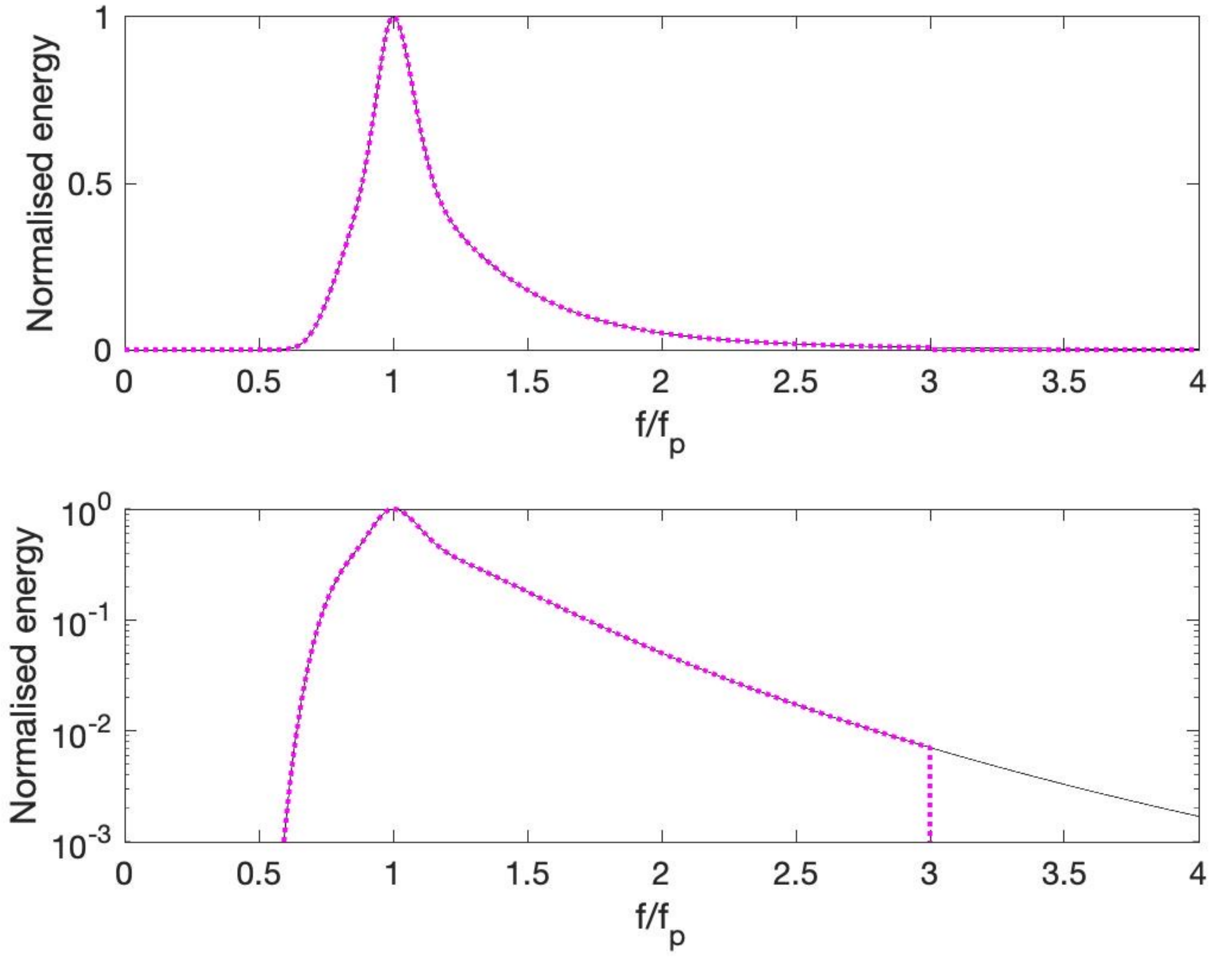
# IMPACT OF SPECTRAL CUTOFF ON ROGUE WAVES

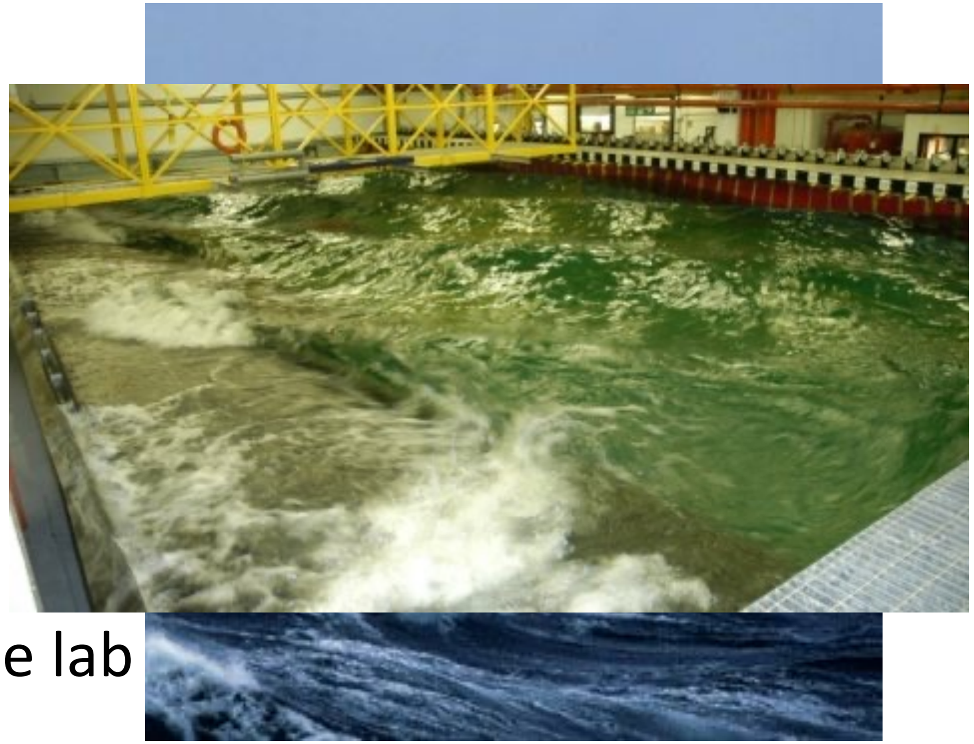
TIANNING TANG, DYLAN BARRATT, HARRY BINGHAM, TON VAN DEN BREMER, TOM ADCOCK

# What is a "spectral cutoff"

Same data plotted on different axes



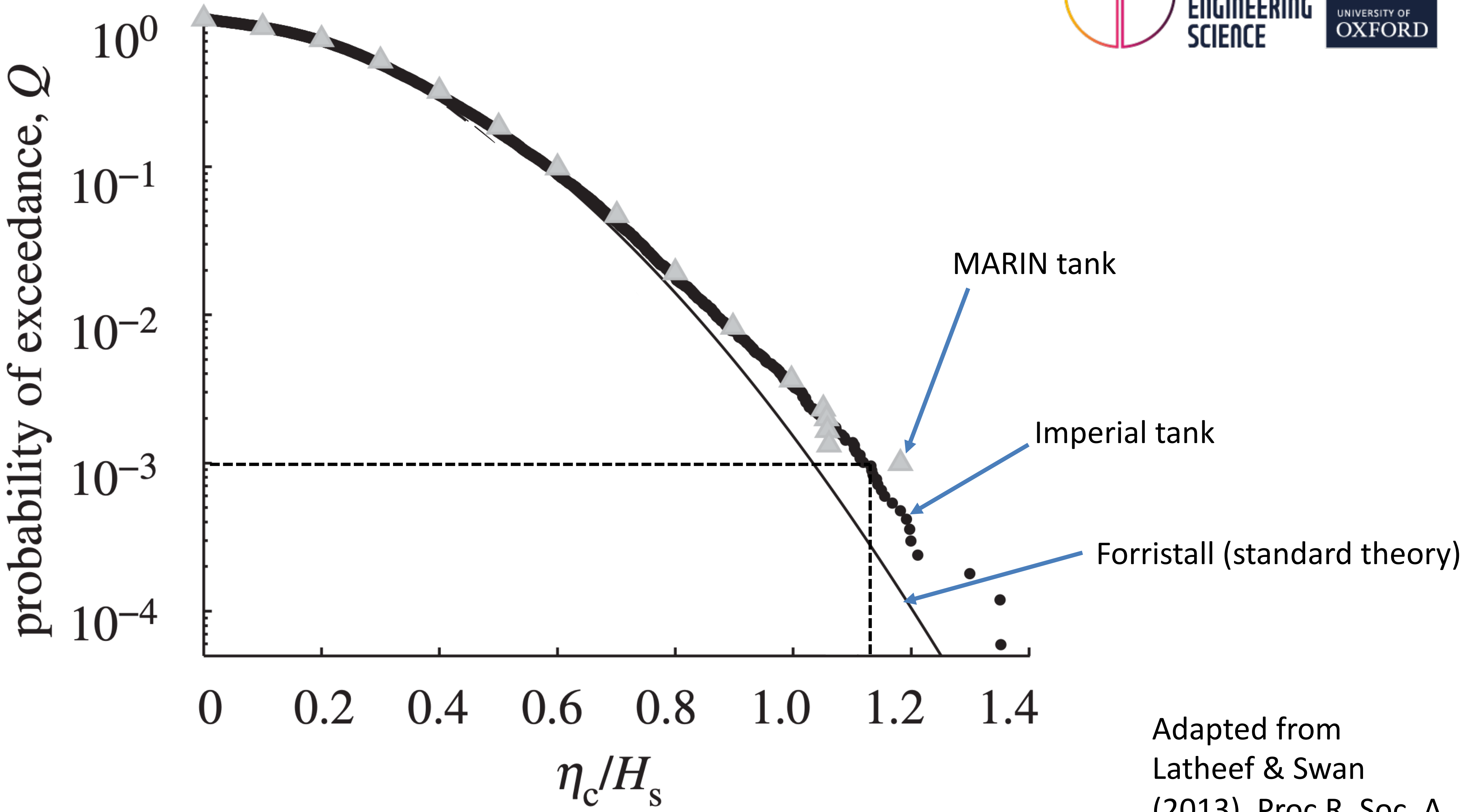
# Where do we see spectral cutoffs?



- Not very often in nature
- In the lab
- We want to recreate nature in the lab

# Latheef and Swan experiments

- Experiments run in the Imperial College wave basin
- We focus on a case with
  - kd=2
  - $kH_s/2=0.13$
  - 15 degree spreading



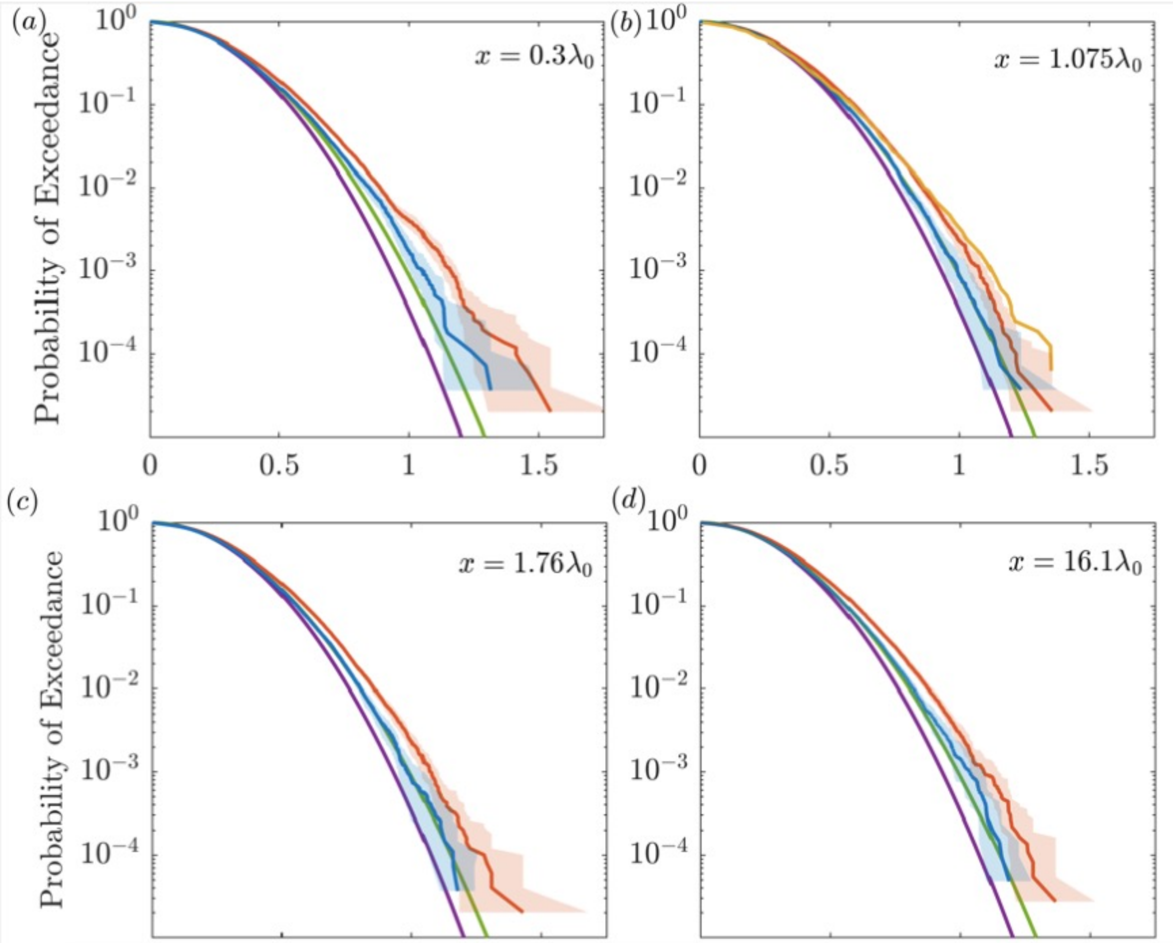

Adapted from
Latheef & Swan
(2013), Proc R. Soc. A

# How have we investigated this

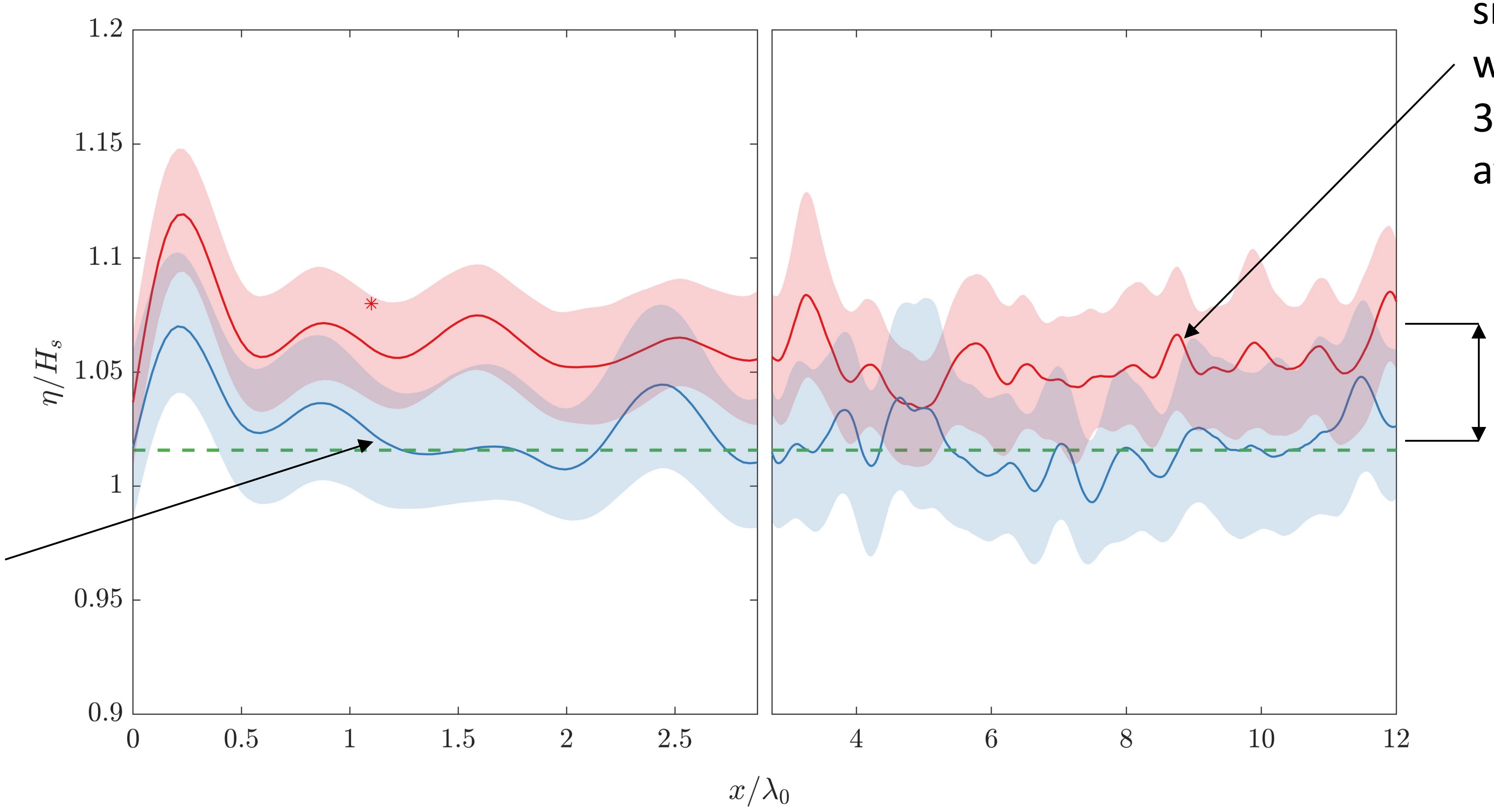
- We have run random wave simulations using OceanWave3D
- Waves are generated using a double relaxation zone
- Waves absorbed with pressure damping
- We run simulations with and without the high frequency tail

- Some important differences in generation and absorption compared with experiments

# Impact of spectral cutoff on crest statistics



# Impact of spectral cutoff on crest statistics




Fully non-linear simulation with waves above $3f_p$ suppressed at paddle

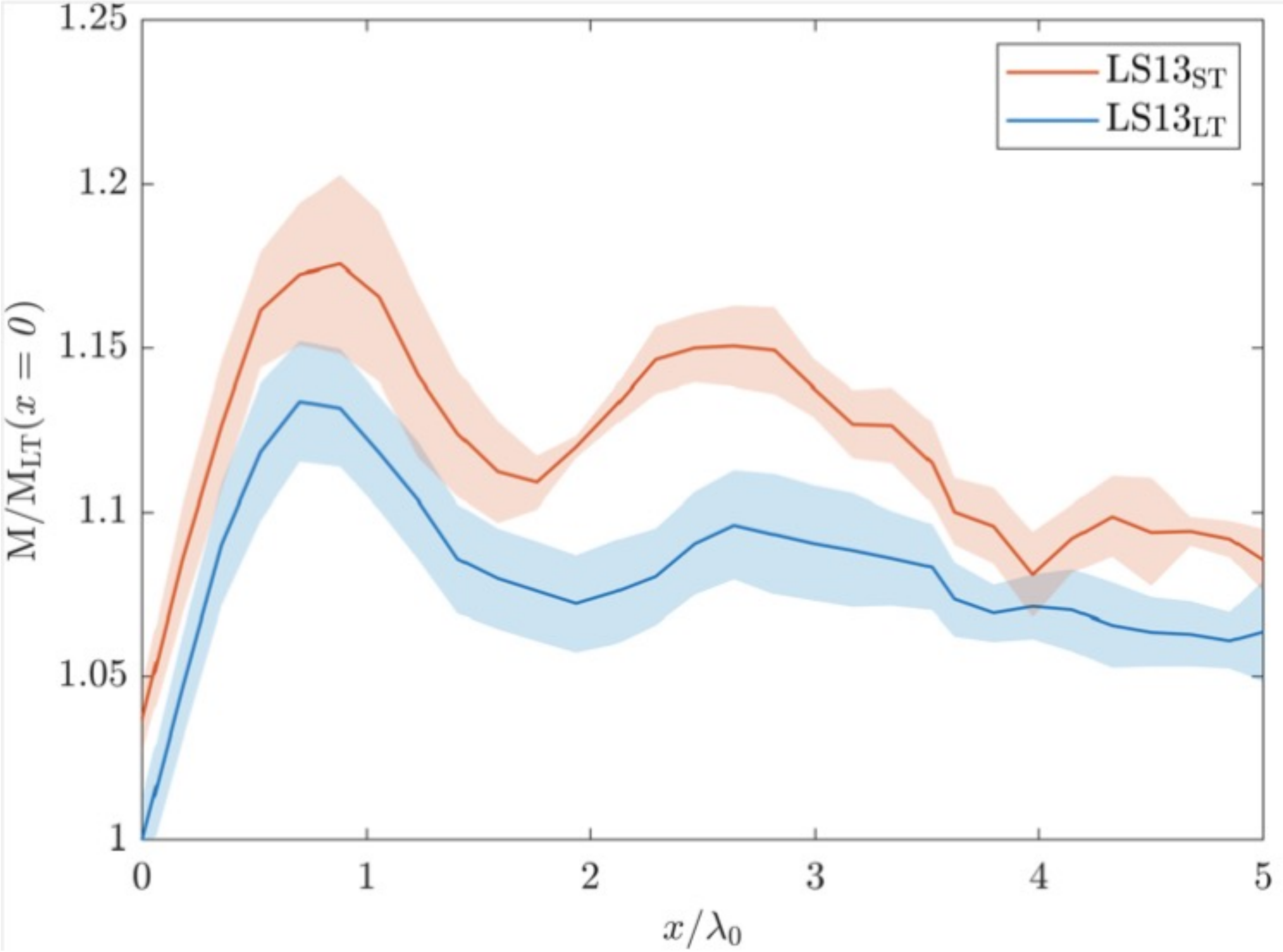
Fully non-linear simulation with full spectral tail at "paddle"

- 1% redistribution of energy can make a huge difference

# Kinematics

- Crest statistics are important but we also really want to know about kinematics as these are more directly related to loads
- Nobody has really found a good way of analysing kinematics
- We take an approach of using the inertia part of Morison's equation using the kinematics produced by the code
- We analyse the moment which is exceeded 1% of the time

# Impact of spectral cutoff on loads

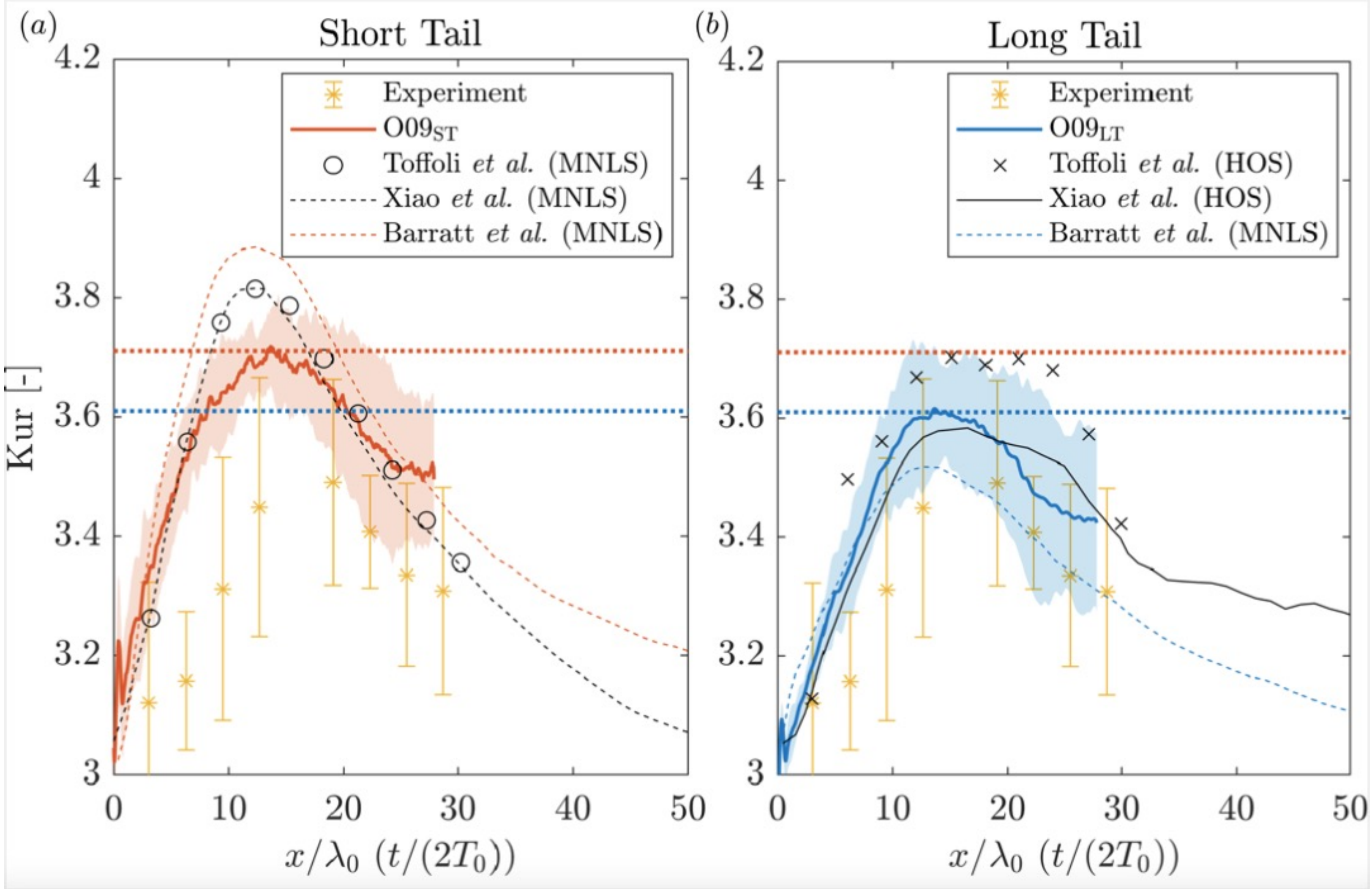


# Onorato et al case

DEPARTMENT OF ENGINEERING SCIENCE
UNIVERSITY OF OXFORD

- We have also considered the 2006 experiment carried out in MARINTEK
- More non-linear than the Latheef and Swan case (kd=4.9, $kH_s/2=0.16$ and about $12^o$ spreading)
- No information about spectral cutoff in the experiments
- Also simulated by other authors using both fully non-linear and MNLS models
- We consider two cutoffs at $2.4k_0$ and $6k_o$

# Kurtosis evolution



# Why?

- Very tiny changes in the initial setup produce quite significant changes
- Cutting off the high frequency tail seems to move things out of equilibrium
- Rebuilding the tail is a non-linear process. This process seems to lead to correlations between spectral components leading to more large waves

# Conclusions

- The high frequency tail matters to non-linear wave dynamics
  - It probably also matters for wave breaking and energy input from waves
- This problem is very hard to suppress in the laboratory
- It (probably) does not exist for unidirectional waves where the non-linear physics is different and the equilibrium spectrum is different