

Nonlinear effects and extreme wave statistics induced by an abrupt variation of water depth in coastal area

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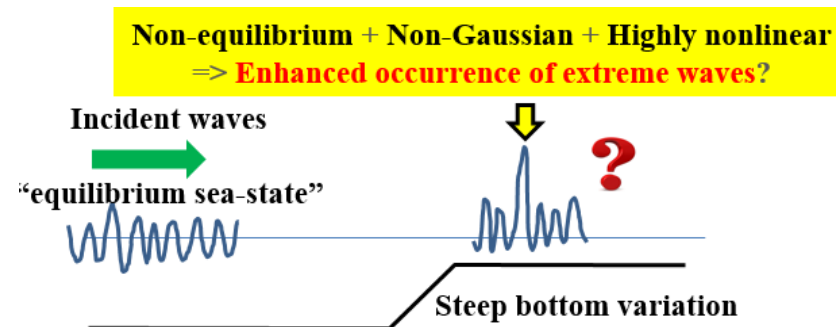
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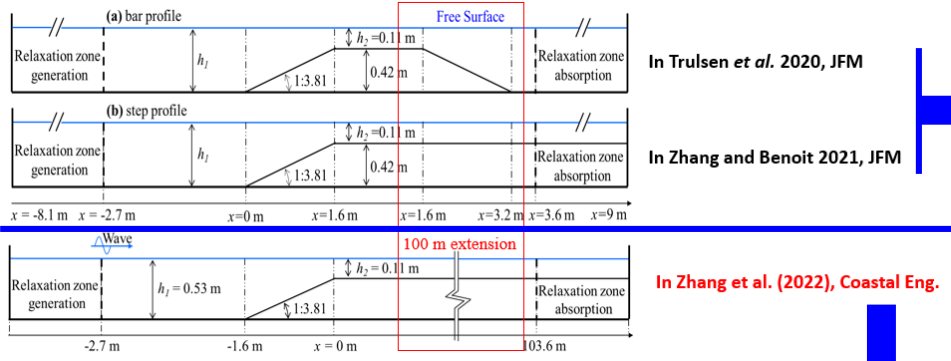


Nonlinear mechanisms for **freak wave** formation:

1. Modulational instability due to nonlinear 4-wave interactions.
2. **Wave-bottom interaction due to the enhancement of bound harmonics.**
3. Space-time focusing due to nonlinear dispersion in shallow water depth.



Effect of bottom shape at short- and long-scale after depth variation



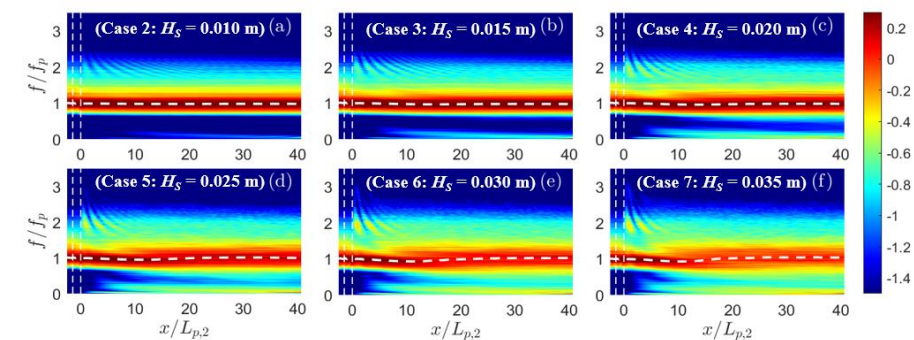
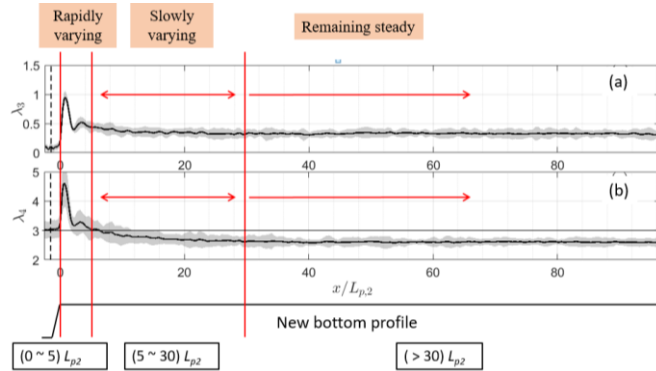
In Trulsen *et al.* 2020, JFM

In Zhang and Benoit 2021, JFM

In Zhang *et al.* (2022), Coastal Eng.

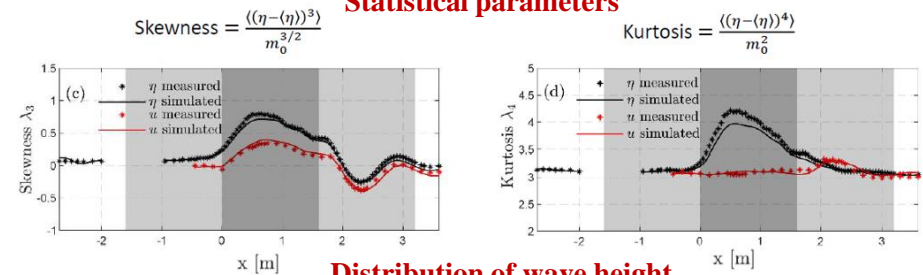
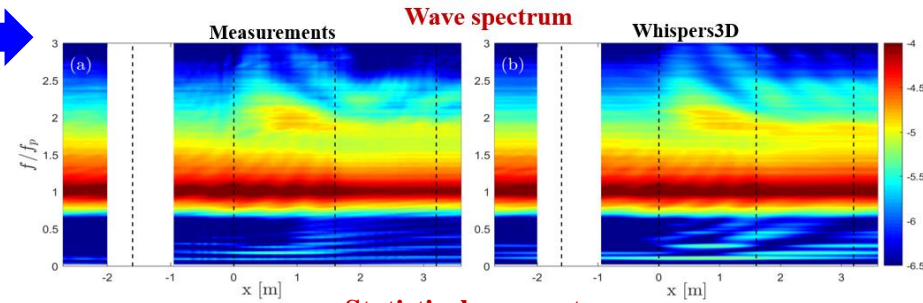
Num. simulation of the extended step profile with various levels of incident nonlinearity

Case 1 ($H_S = 3$ cm)

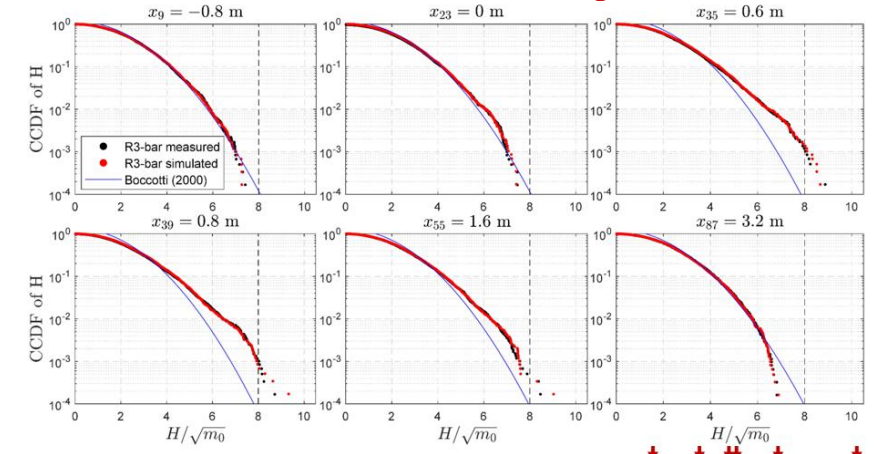


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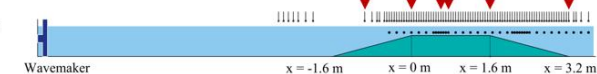
Num. simulation and comparison with experiments on the bar profile from Trulsen *et al.* (2020)



Distribution of wave height



Vertical dash line $H = 8\sqrt{m_0} = 2H_{m0}$
usual freak wave criterion



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