

Finite amplitude sand waves in shallow seas

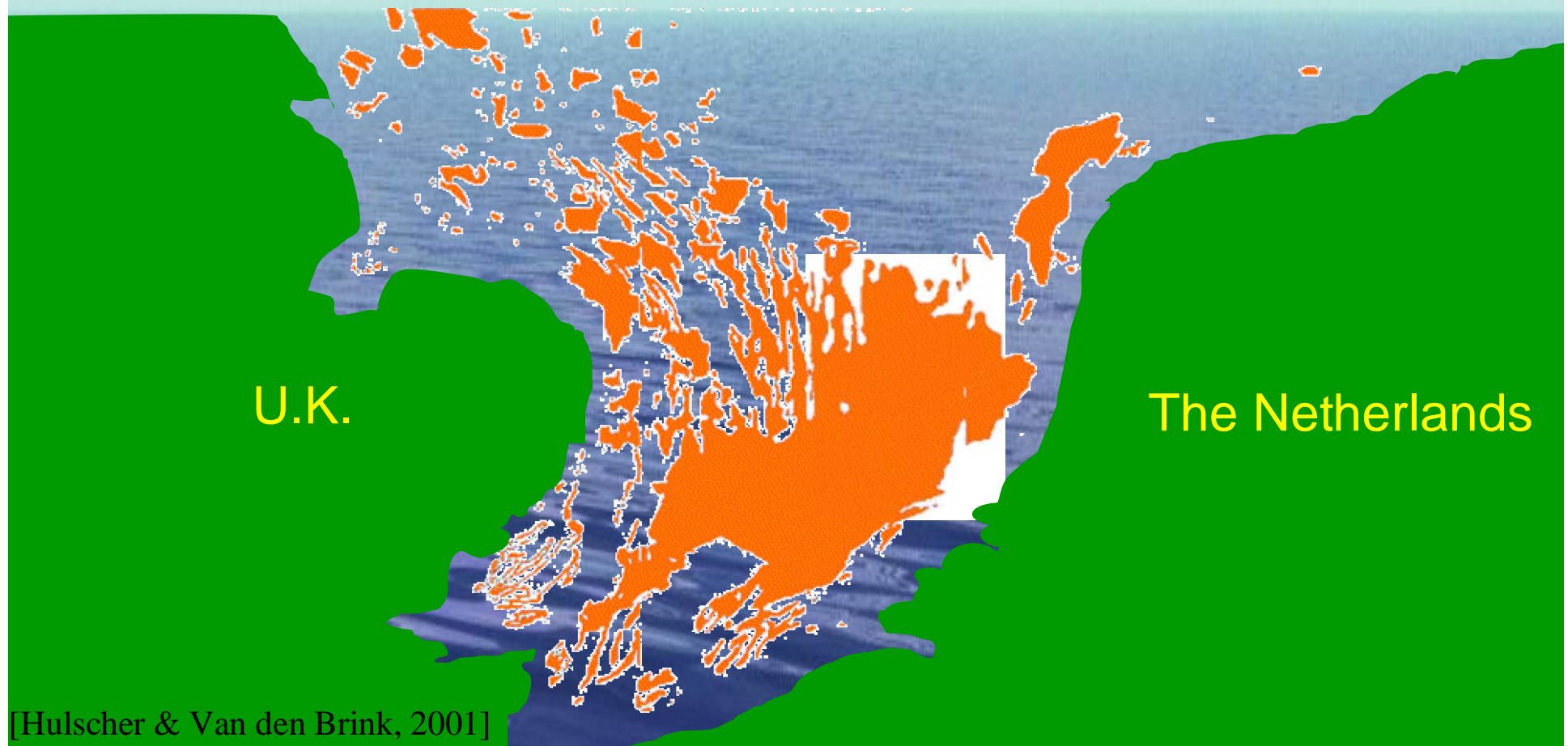
*Modelling of spatial and temporal variations in
offshore sandwaves*

Attila A. Németh

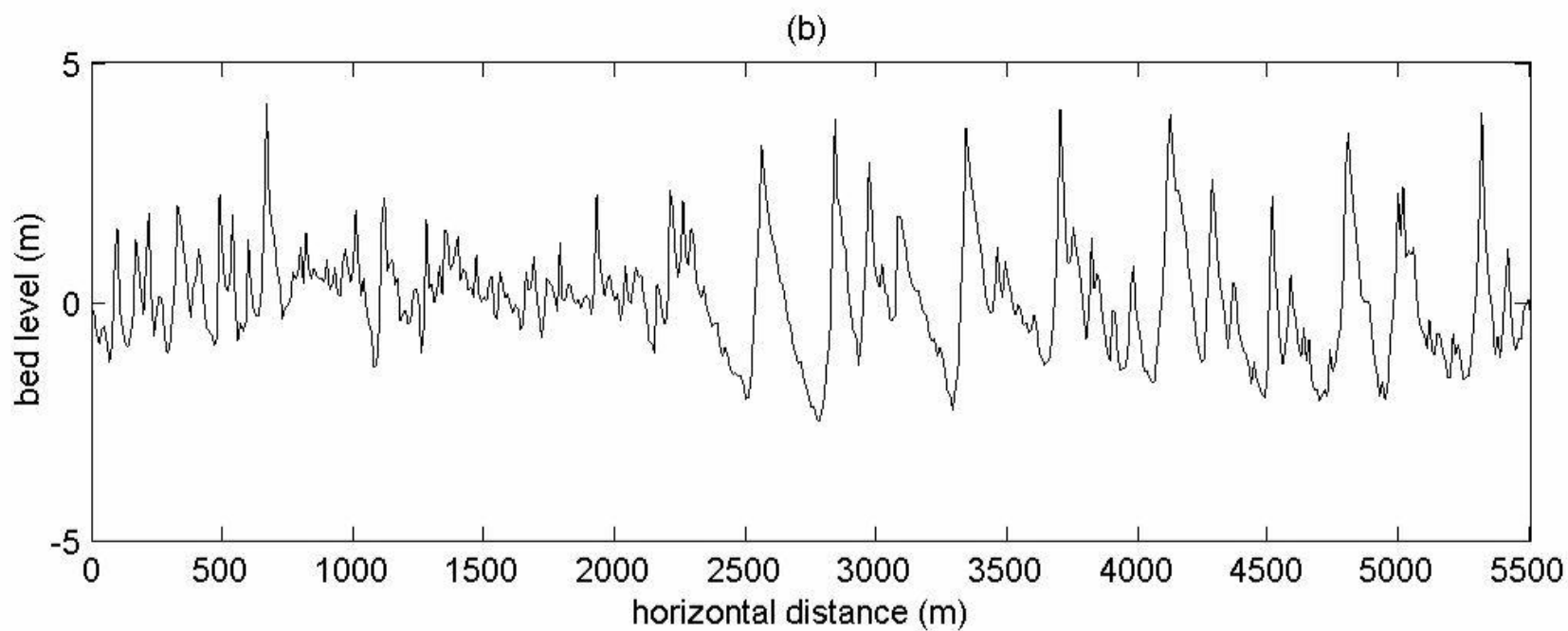
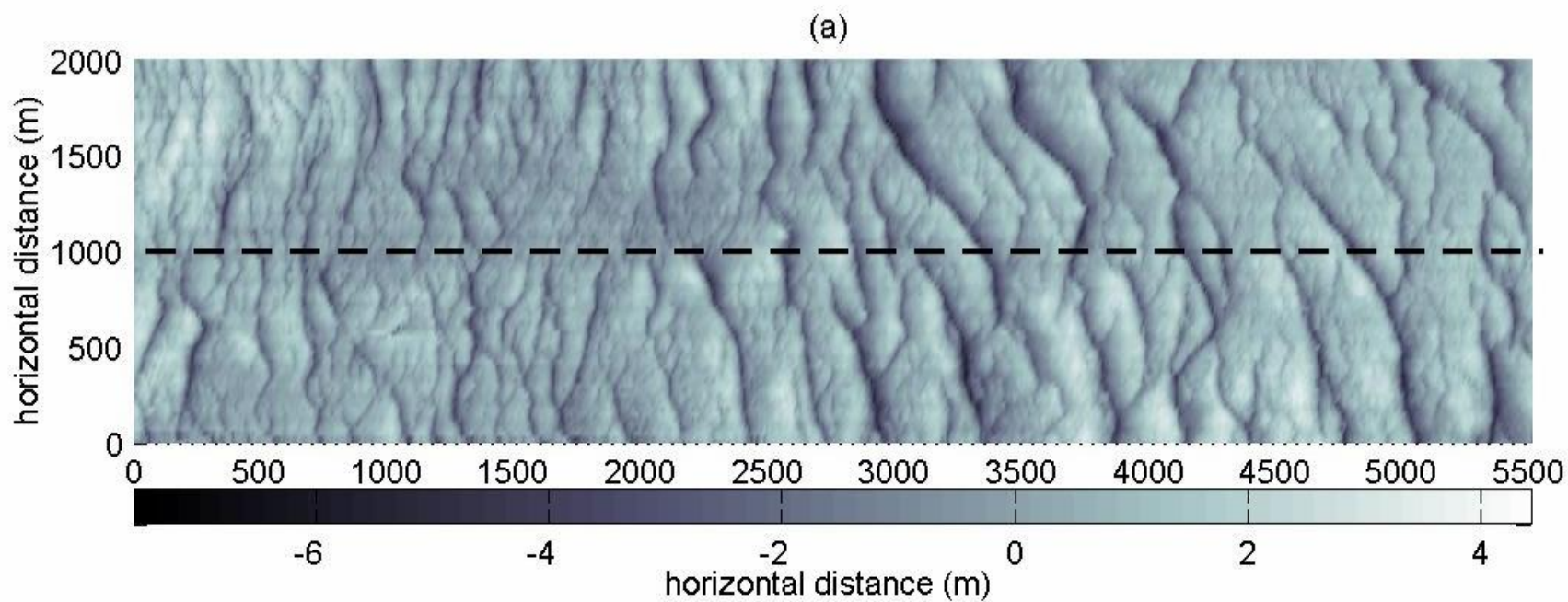


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Sand waves in the North Sea



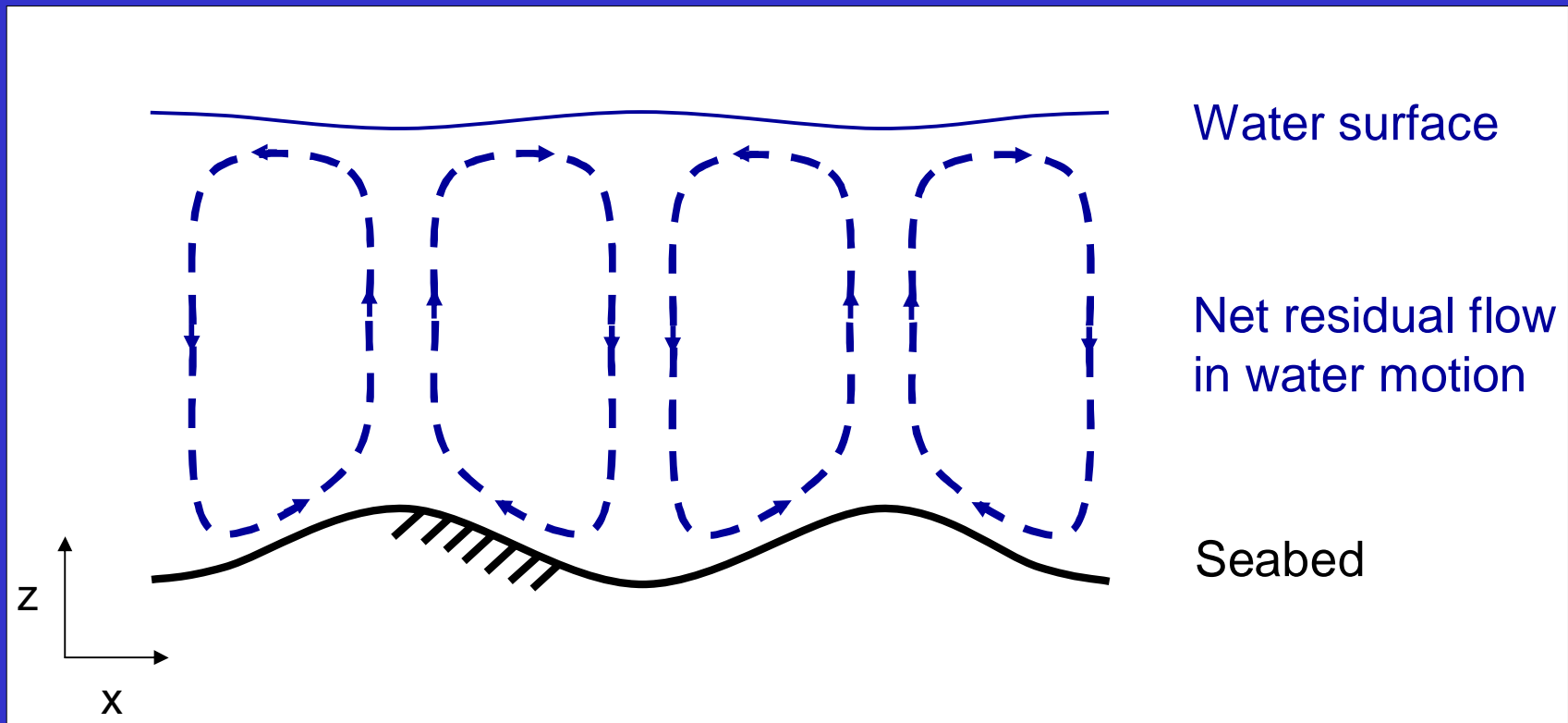
[Hulscher & Van den Brink, 2001]



Contents

- Introduction
- Simulation model
- Results sand wave evolution
- Future work
- Conclusions

Initial formation



Navigation & dredging



(North Sea Directorate)

Simulation model

$$\frac{\partial u}{\partial t} + u \frac{\partial u}{\partial x} + w \frac{\partial u}{\partial z} + g \frac{\partial \zeta}{\partial x} + v \frac{\partial^2 u}{\partial z^2}$$

- 2DV Shallow water equations
- Free surface

$$\frac{\partial u}{\partial x} + \frac{\partial u}{\partial z} = 0$$

- Bed load transport

$$S_b = \alpha |\tau_b|^3 \left[\tau_b - \lambda_1 \frac{\partial h}{\partial x} - \lambda_2 |\tau_b| \frac{\partial h}{\partial x} \right]$$

- Sediment balance

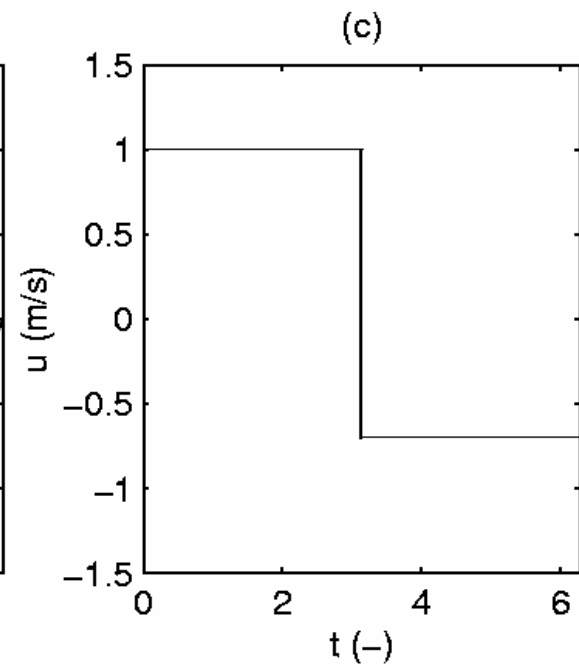
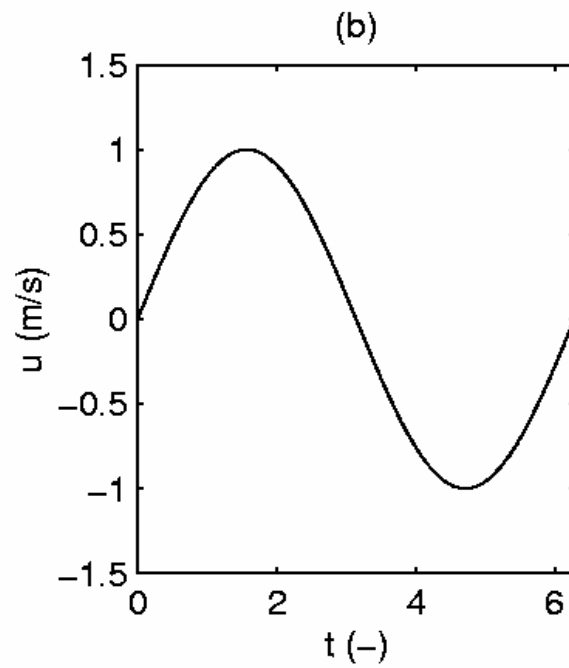
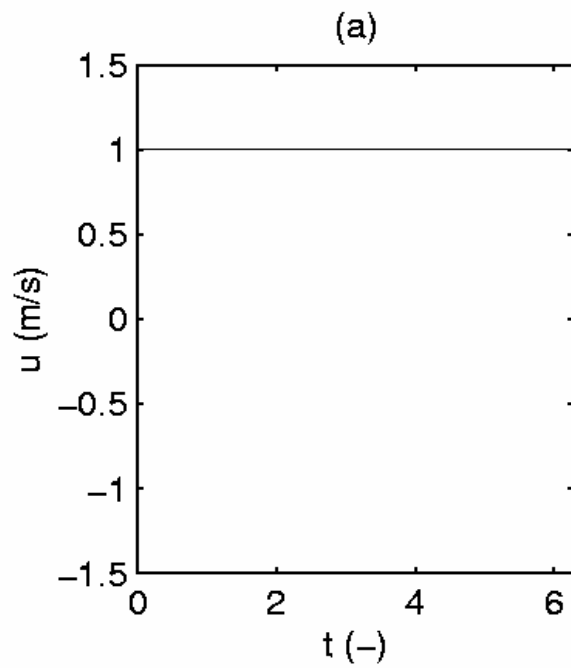
$$\frac{\partial h}{\partial t} + \frac{\partial S_b}{\partial x} = 0$$

Simulation model

- Chebyshev polynomials
- Implicit time-stepping
- (Non-)periodic

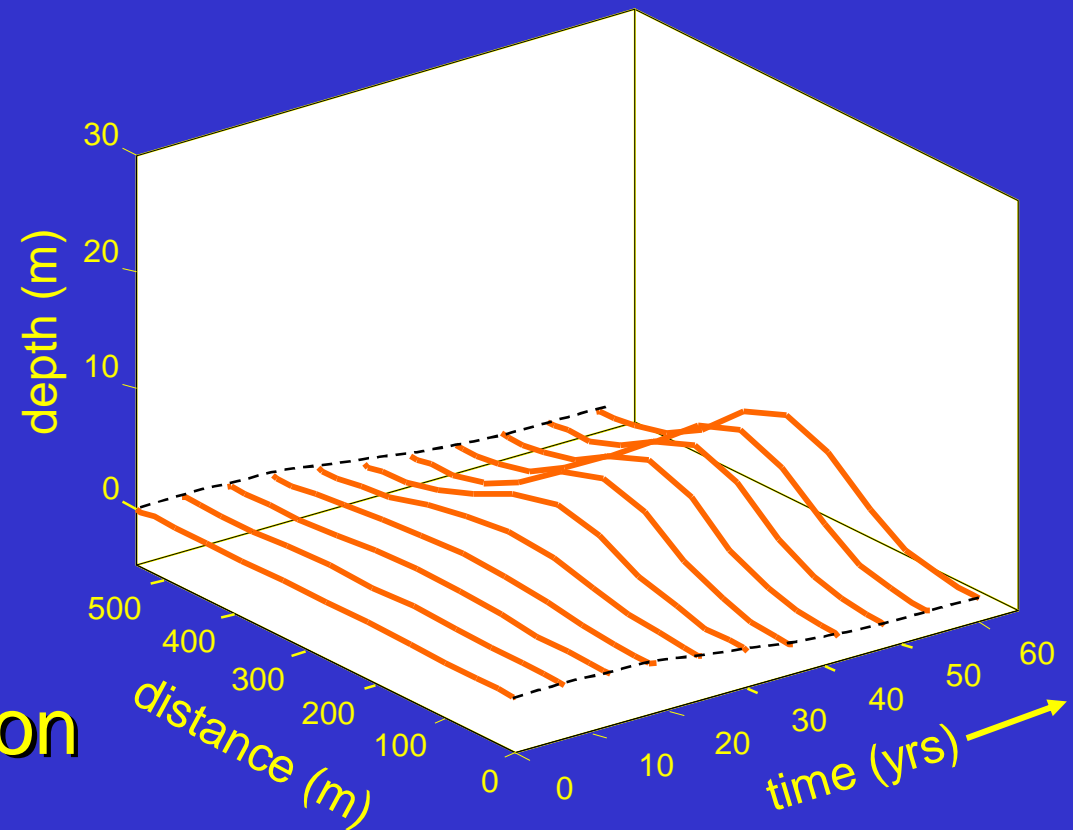
- Validated mathematically by comparing with linear stability analysis

Water motion



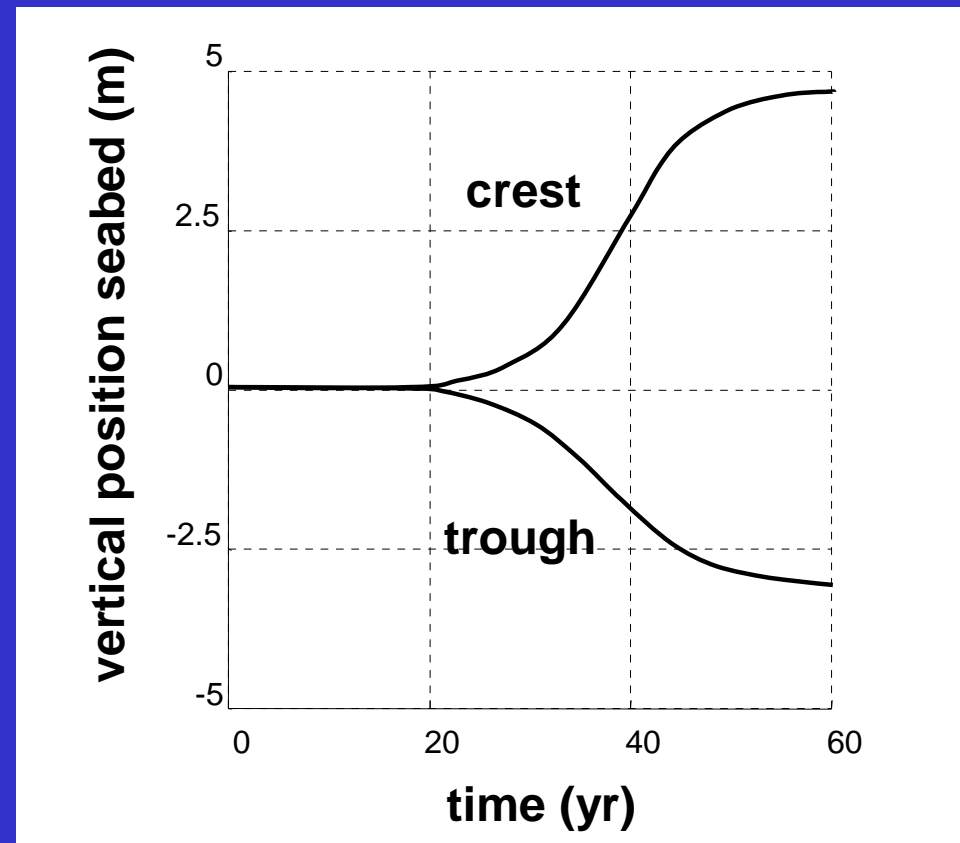
Results: Amplitude evolution

- Water depth
- Pattern
- Saturation in decades
- No flow separation

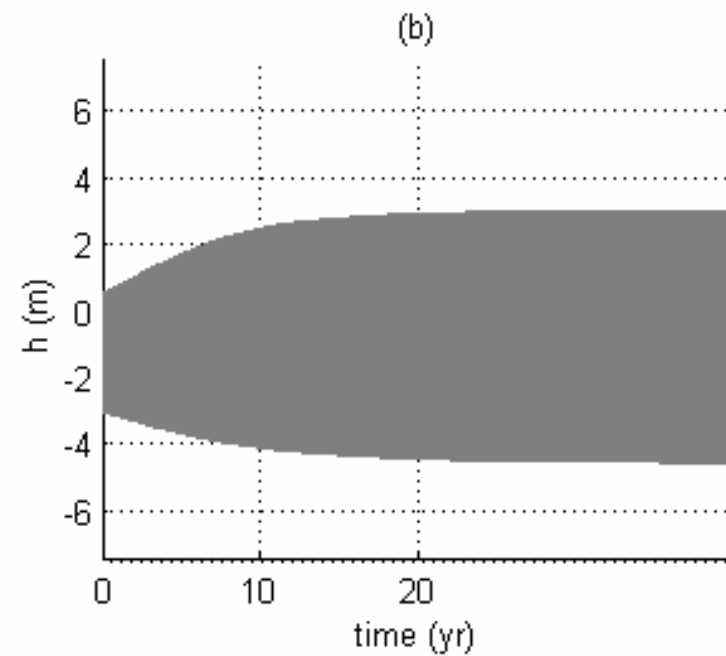
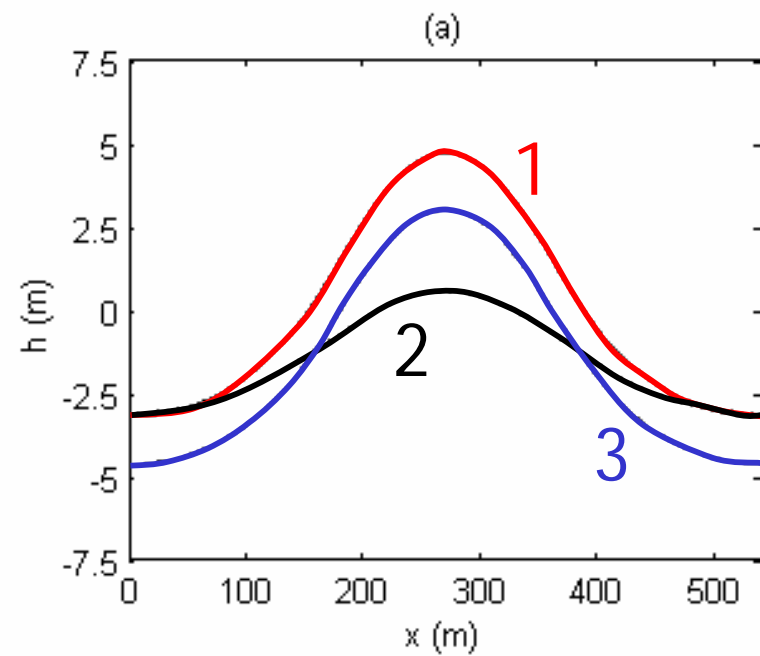


Results: Amplitude evolution

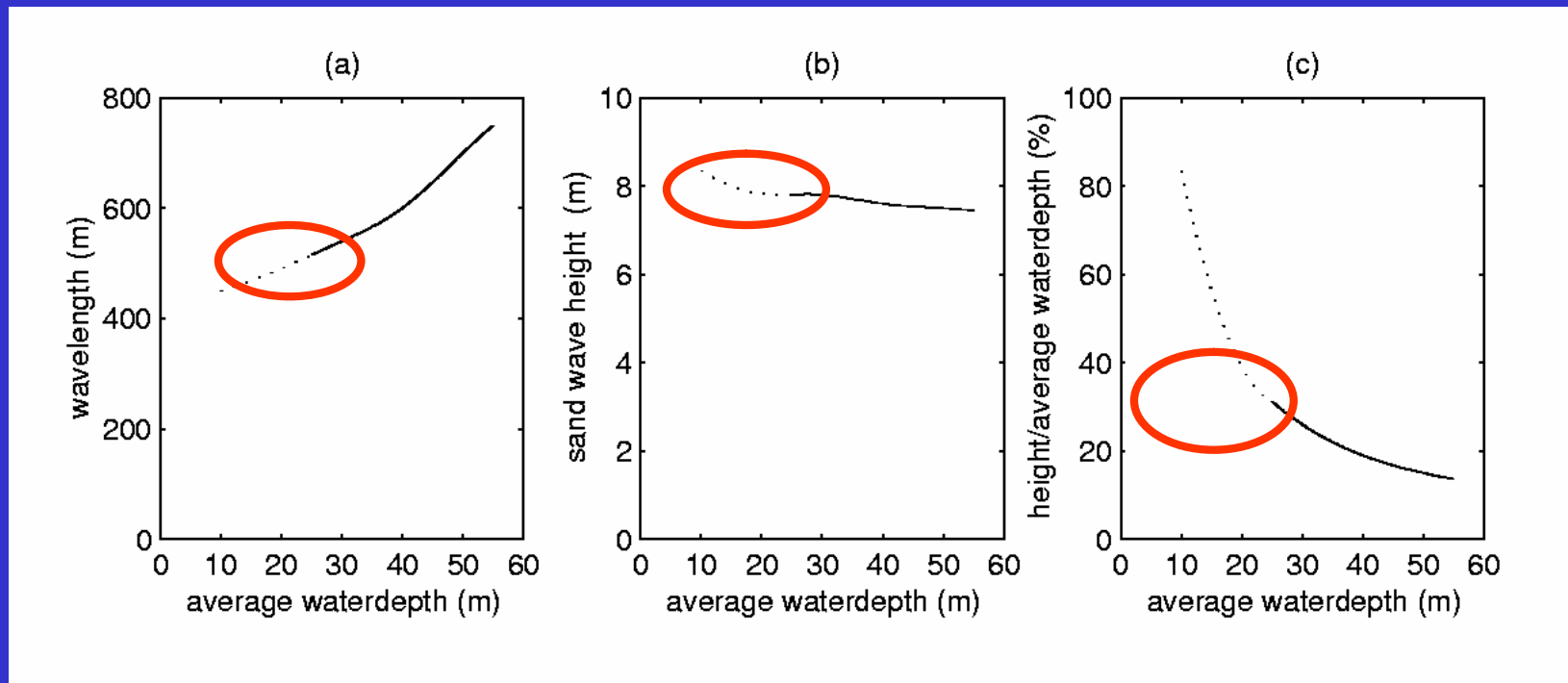
- Water depth
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Dredging



Water depth



Suspended transport

- Closer to shore
- Bed load transport
- Suspended sediment transport
- Storms



Conclusions

- Sand wave evolution
- Saturation at 20% of water depth for typical North Sea conditions
- Balance shear stress & slope effect

Questions?