

Modeling storm effects on sand wave dynamics

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Rijkswaterstaat

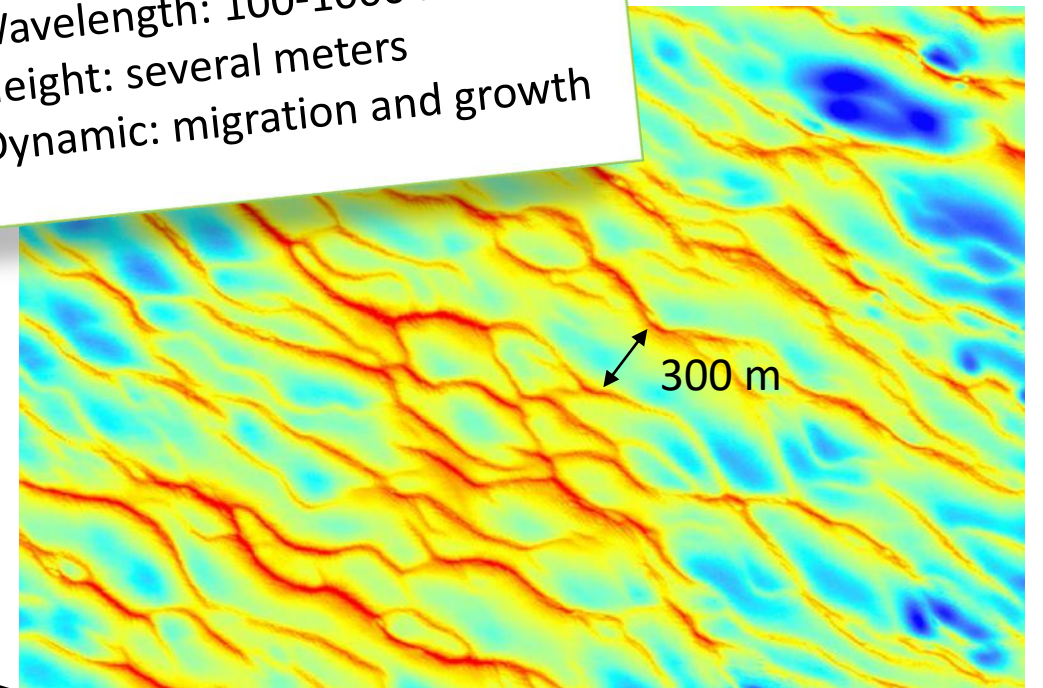
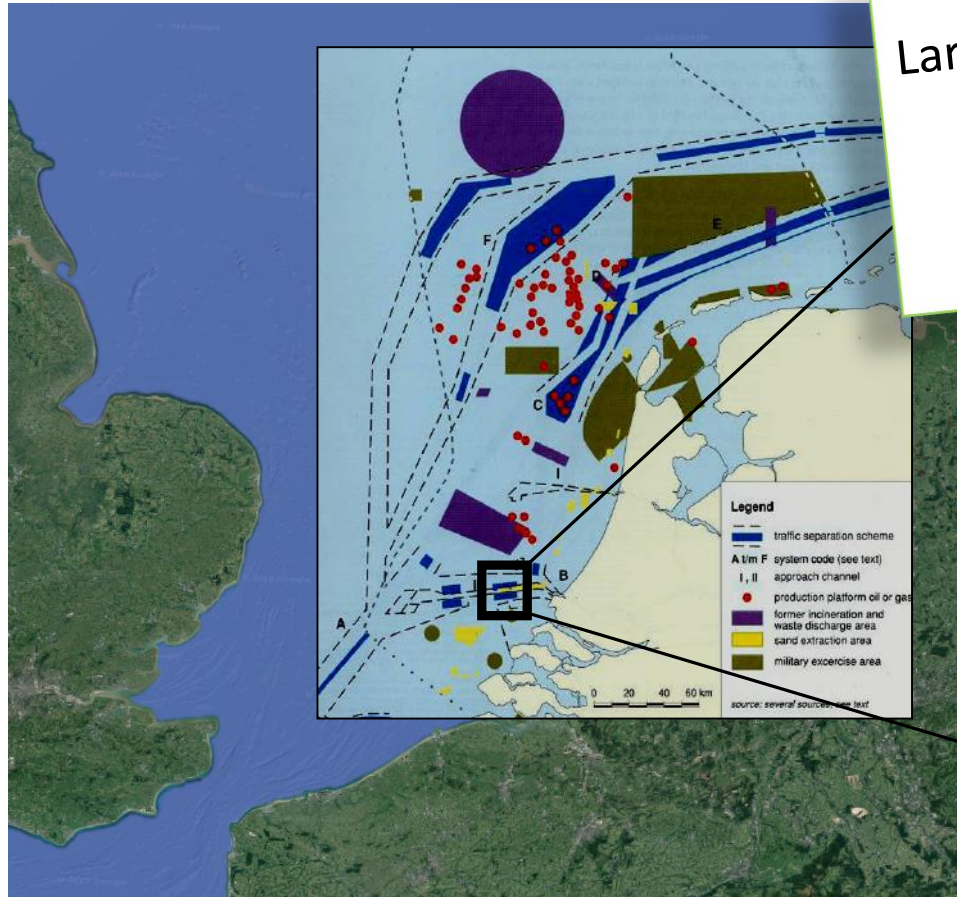


What are bed forms?



Why research their dynamics?

Large-scale rhythmic bedforms:
Wavelength: 100-1000 meters
Height: several meters
Dynamic: migration and growth

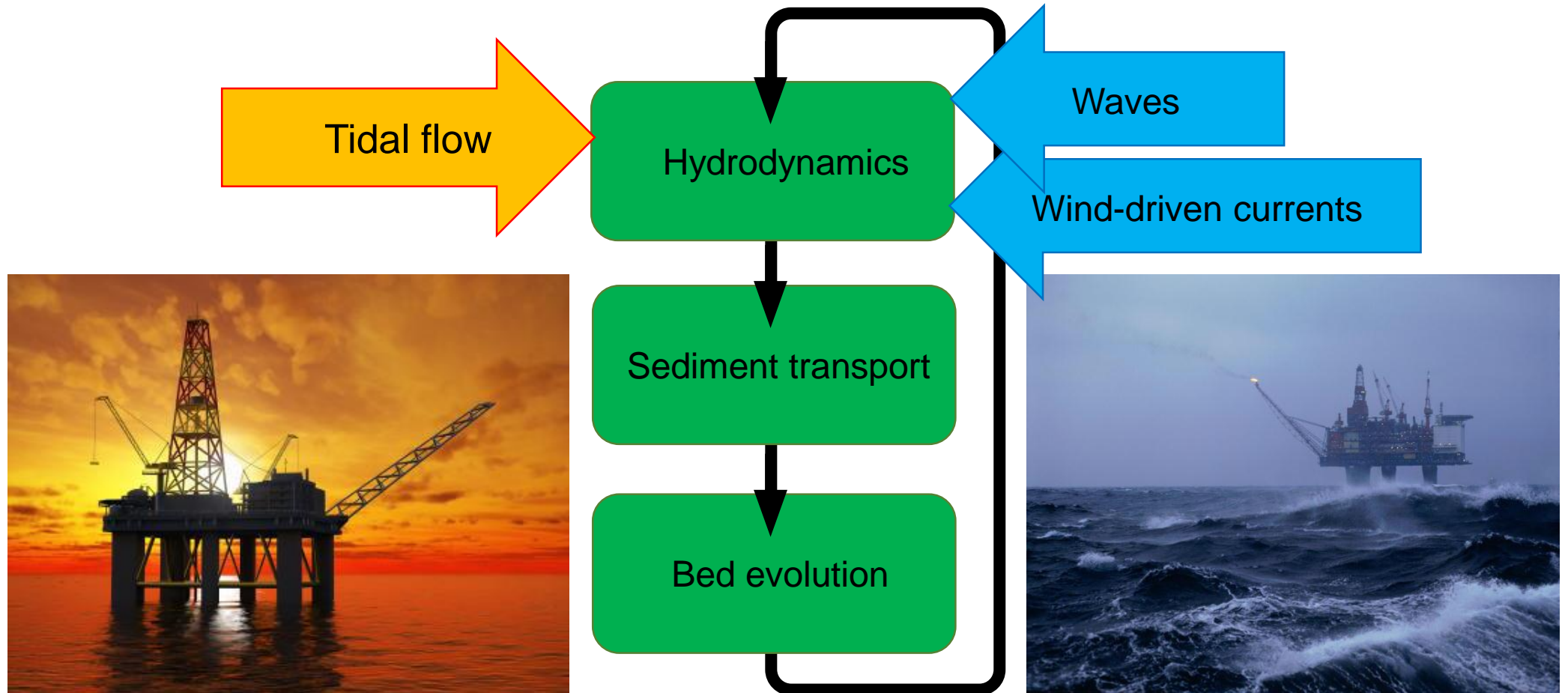


Sand waves in the Euro channel to Rotterdam
(Rijkswaterstaat)

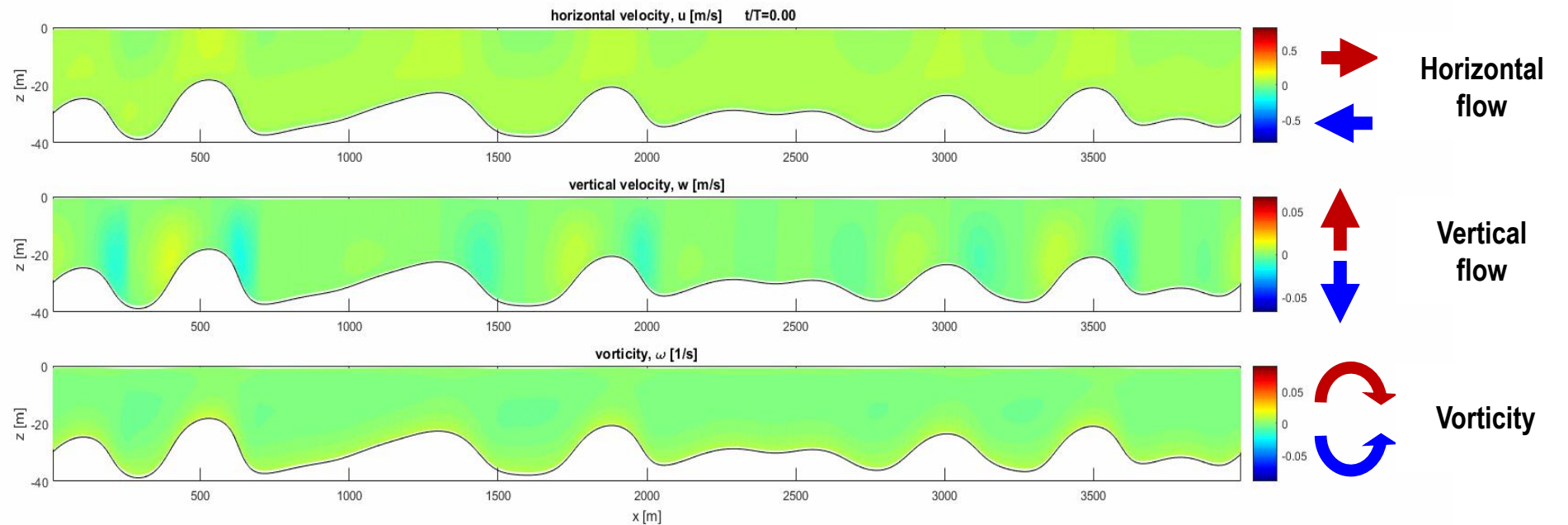
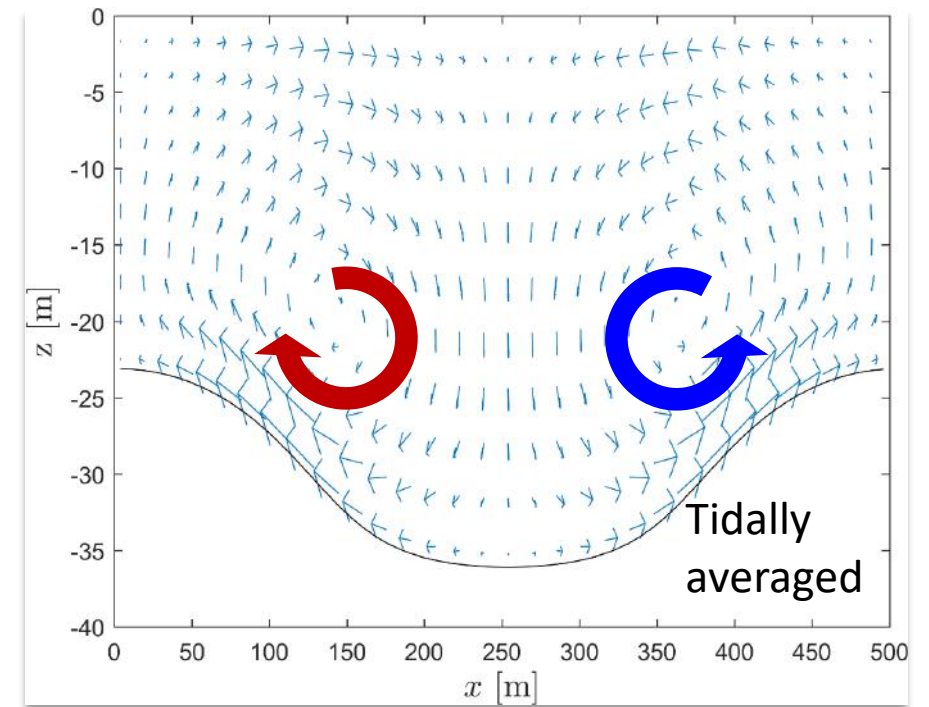
Nonlinear sand wave model development

- Before nonlinear models: **Linear stability analysis**
 - Small amplitude dynamics: GR, MR, FGM (Stage of Formation)
- Komarova & Newell (2000): **Weakly nonlinear analysis**
- Németh et al. (2006): **Nonlinear model** describing the evolution to **equilibrium height** of a single sand wave on a periodic domain
- Tonnon et al. (2007): **Delft3D** study on an artificial sand wave in the North Sea
- Van den Berg et al. (2012): Efficient nonlinear model for **larger domain** simulations
- Gerwen et al. (2018): Effect of **suspended load** and **tidal asymmetry** on finite amplitude sand wave dynamics using Delft3D
- Campmans et al. (2018): Effect of **storm effect** on finite amplitude sand wave dynamics
- Many aspects are still unknown!

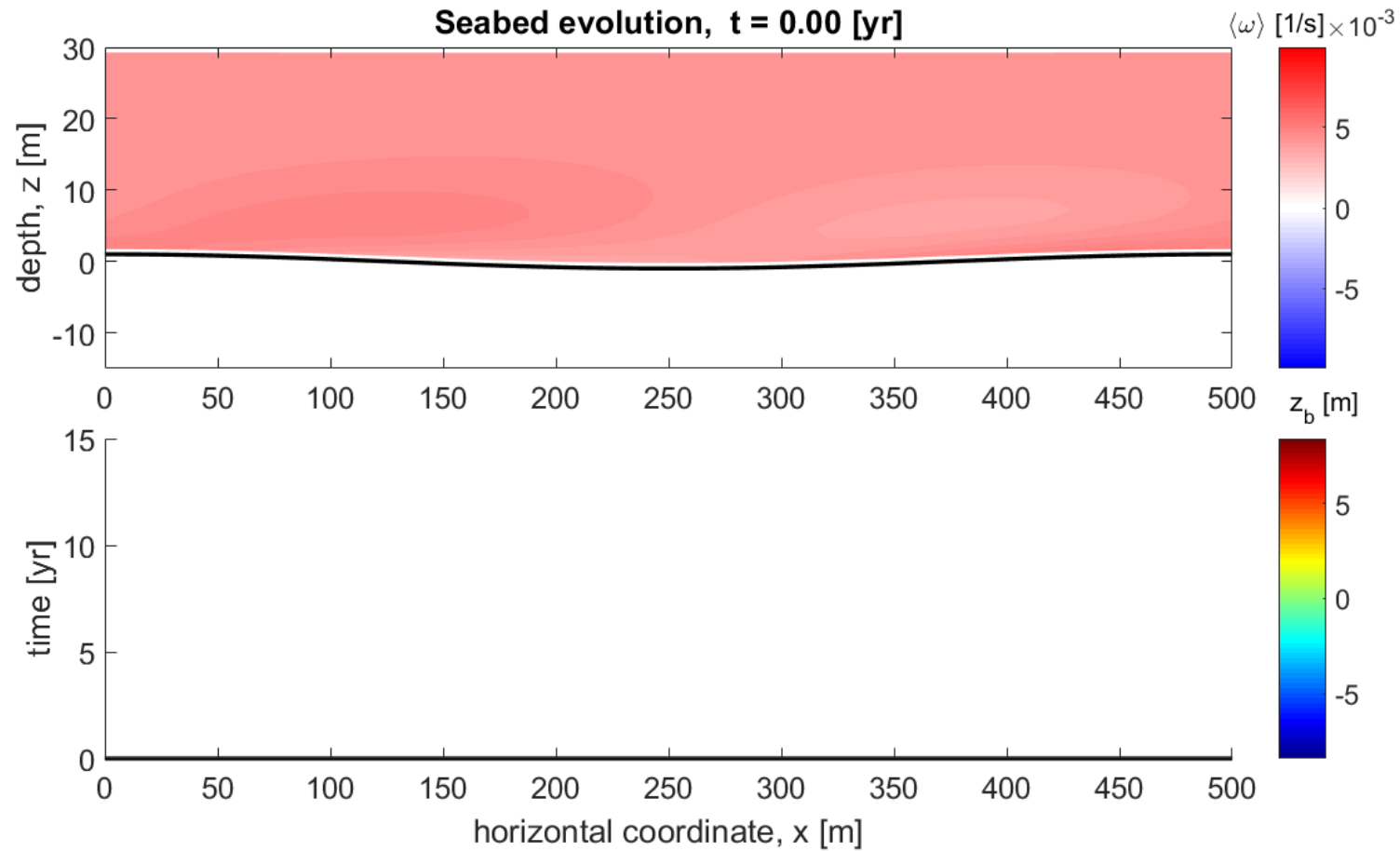
Why investigate the effects of storms?



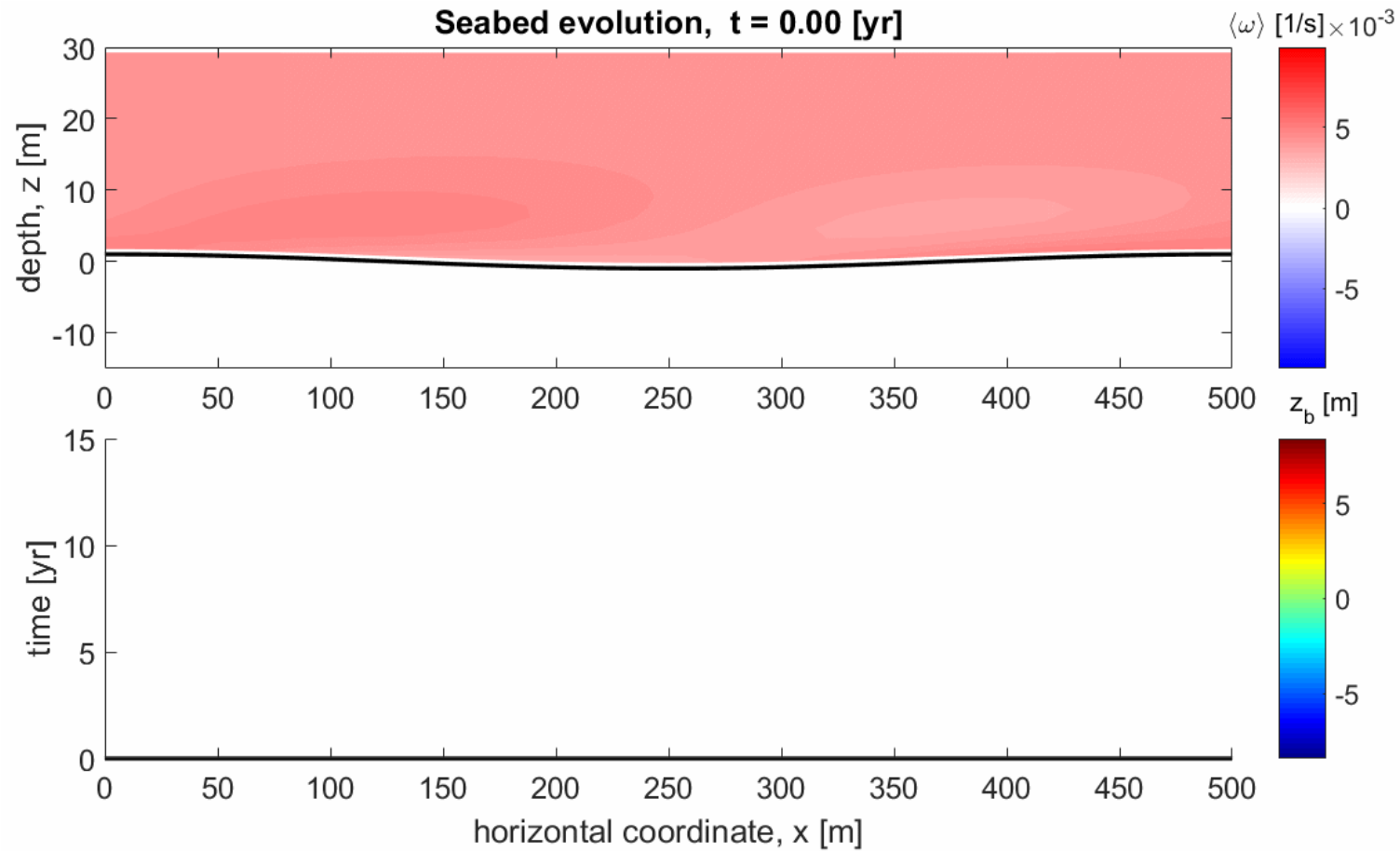
Hydrodynamic model



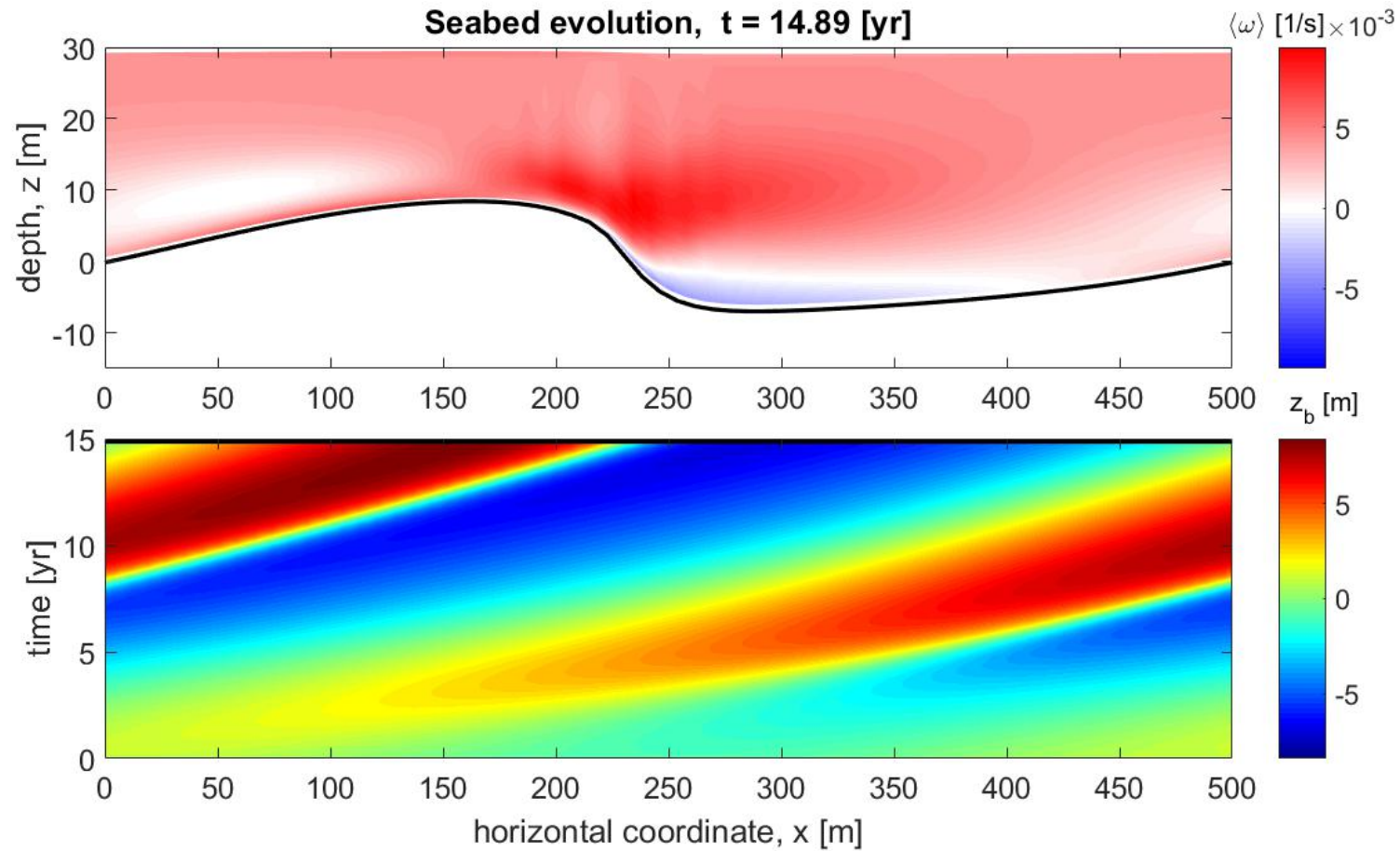
Evolution to equilibrium



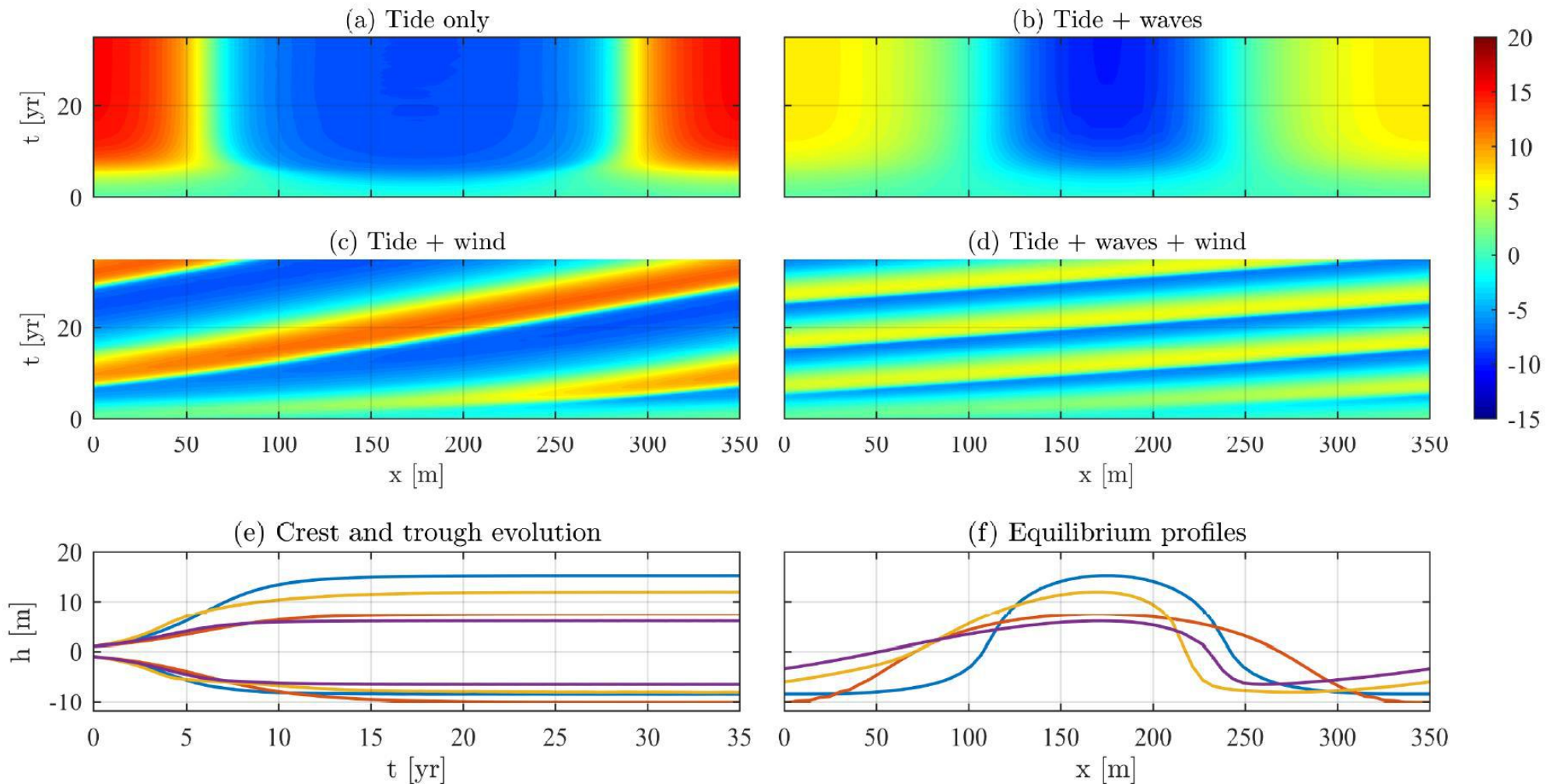
Evolution to equilibrium



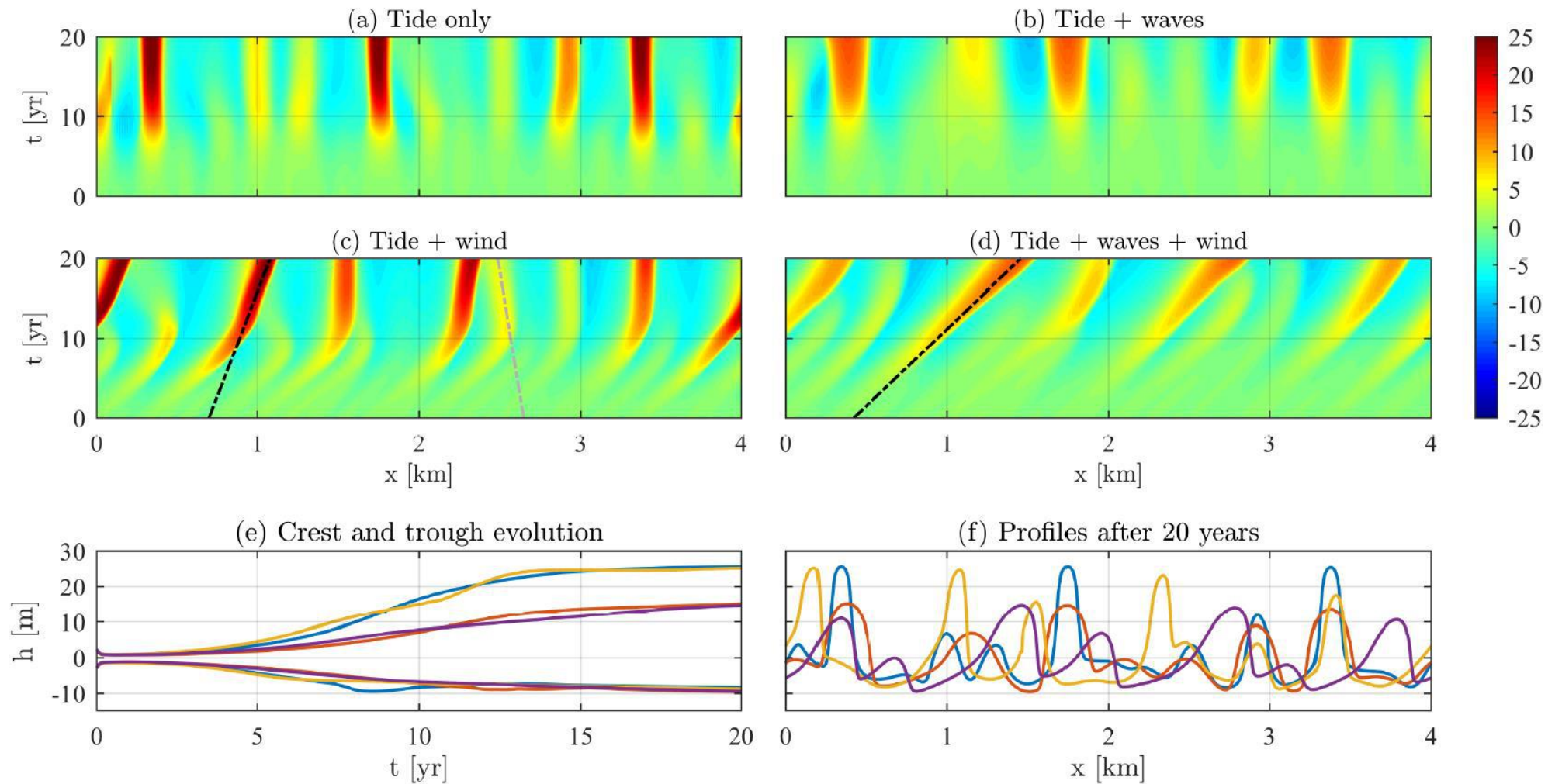
Evolution to equilibrium



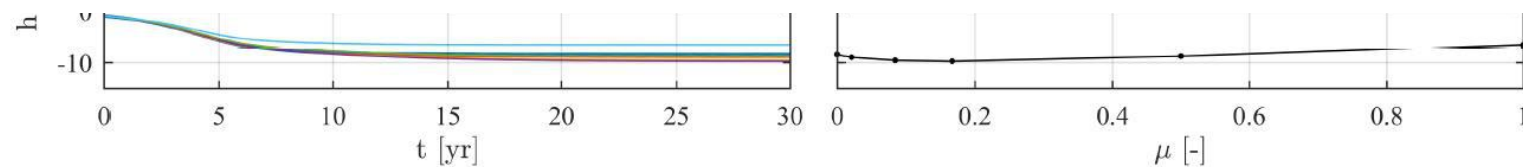
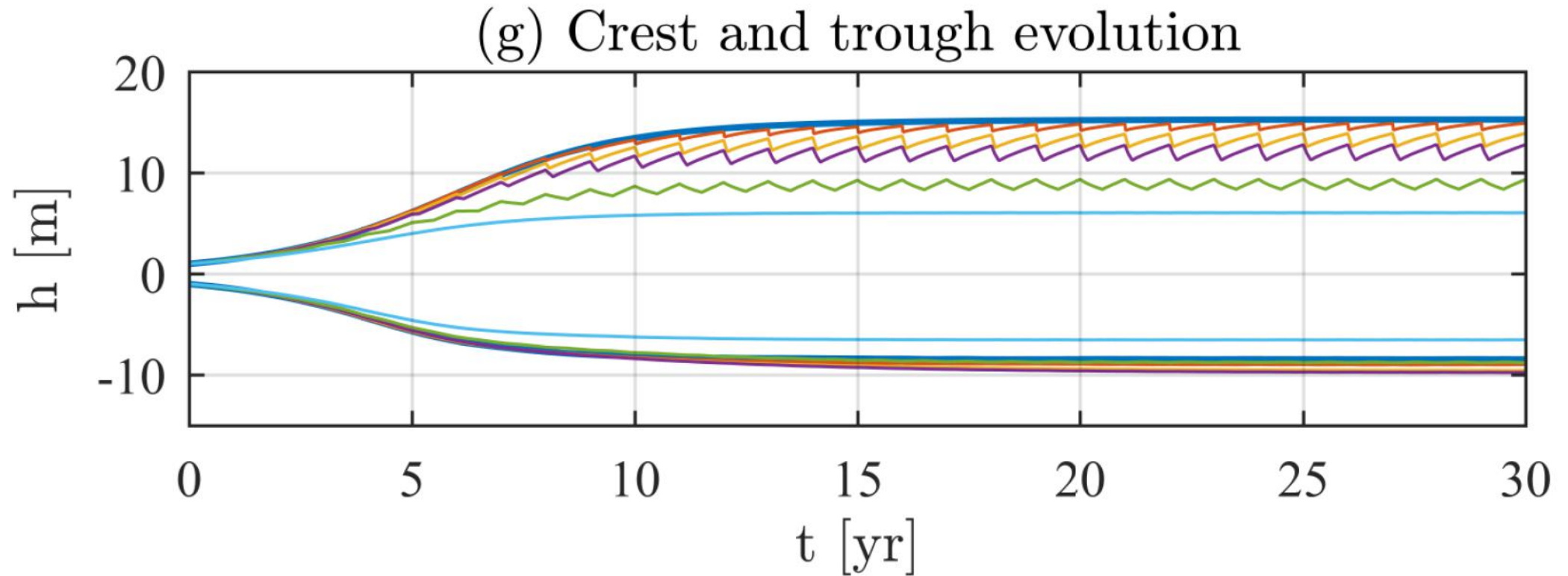
Storm effects: Waves and Wind



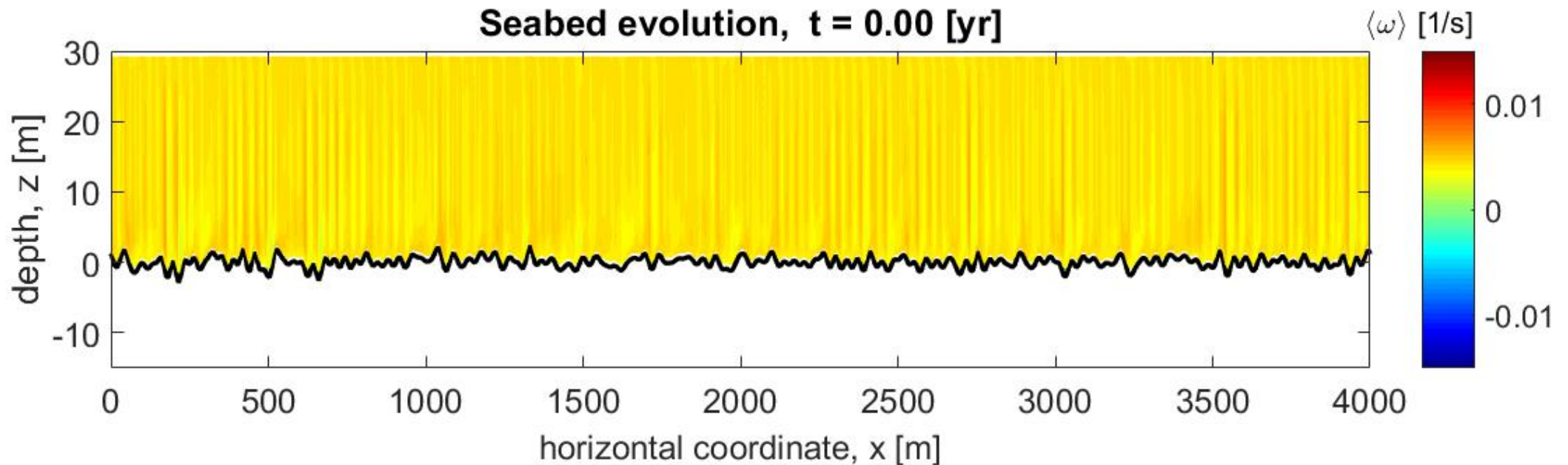
Storm effects: Waves and Wind



Intermittent storm effect

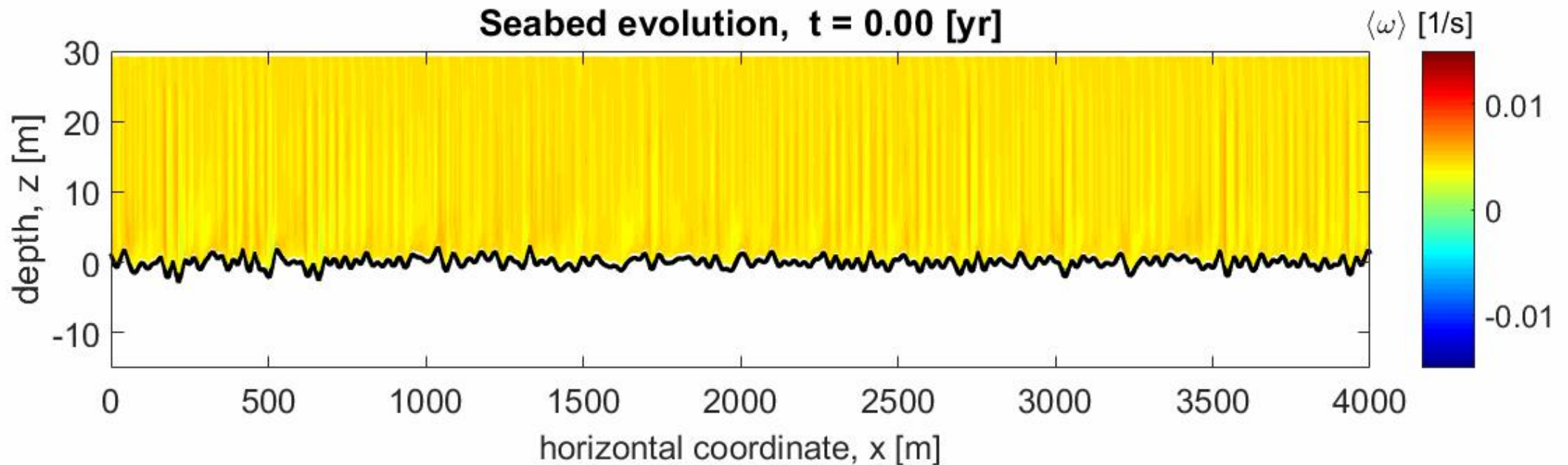


Simulation with waves and wind



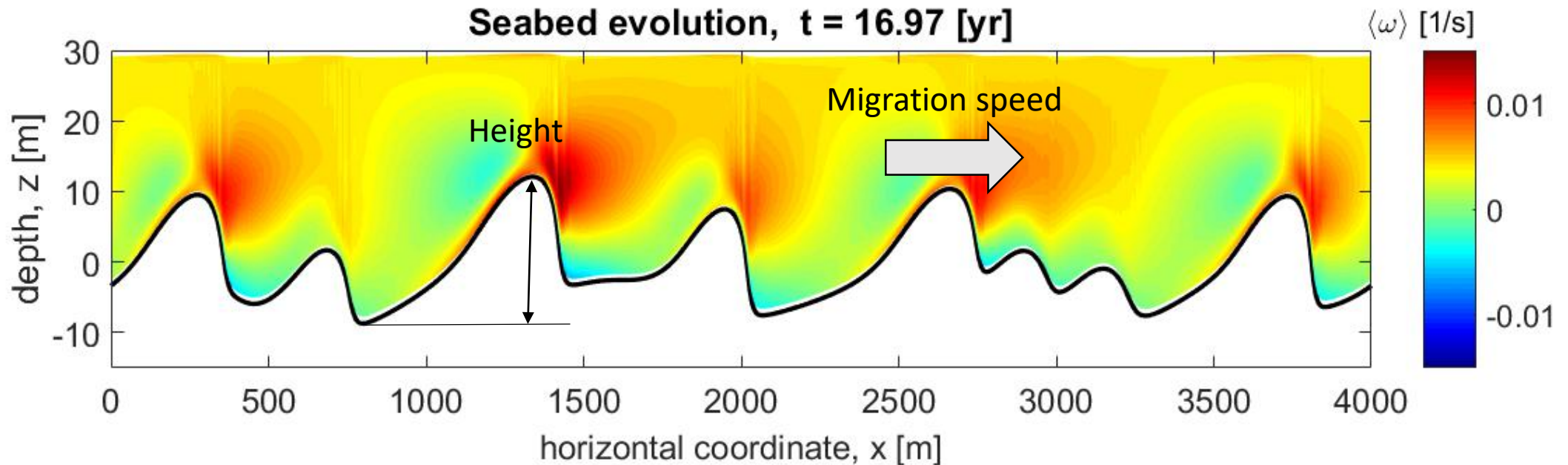
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Simulation with waves and wind



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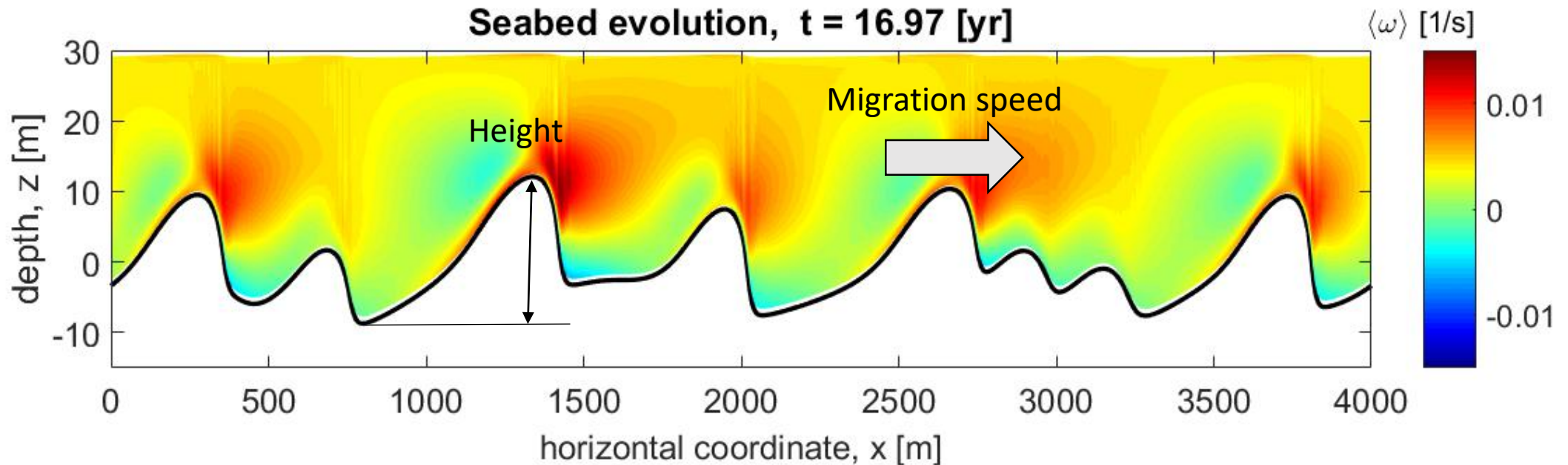
Simulation with waves and wind



- Waves: Sand wave height decreases
- Wind: Causes sand wave migration

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Well-known processes have to be included as easy as possible to understand the system



- Waves: Sand wave height decreases
- Wind: Causes sand wave migration

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