Modelling the finite amplitude dynamics of tidal sand waves with SWASH

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Sand waves ?

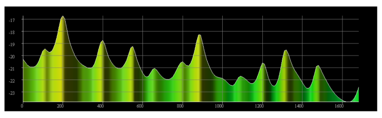
- These bed forms occur in shallow seas (30 m)

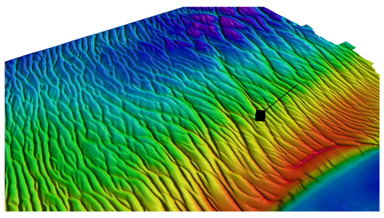
- Wavelength of $\mathcal{O}(100)$ m

- Amplitude of a few metres

- Able to migrate

- Perpendicular to the main tidal current direction





Approach

Hydrodynamics

SWASH [Zijlema *et. al*, 2011] :

- OPEN-source, finite difference

- Staggered, orthogonal curvilinear grid
- Non-hydrostatic, with pressure correction technique

- $k - \epsilon$ model

- Tidal wave imposed with additional force in momentum balance

Morphodynamics

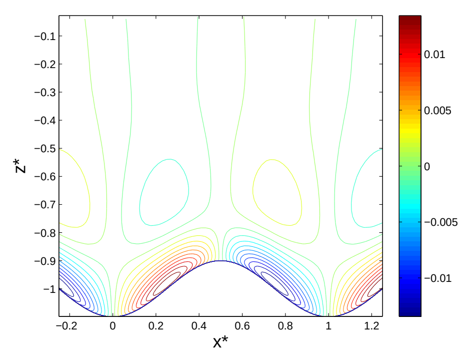
- Bottom roughness due to ripples

- Shear stress evaluated with constitutive law

- Bed load transport [Van Rijn, 1991]

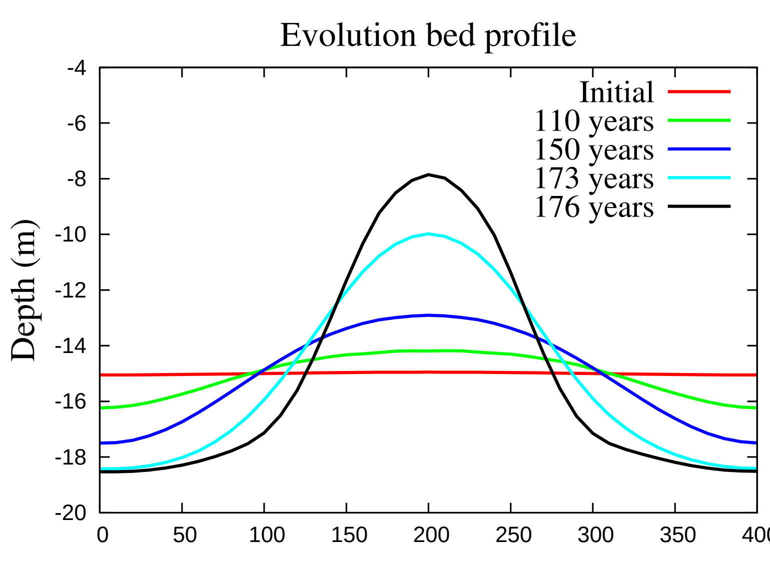
- Bed slope transpost following van den Berg *et. al* [2012]

Results: Flow field



Contourplot of the residual horizontal flow for a sand wave with amplitude of 4 m in a depth H of 20 m and a maximum depth averaged flow velocity of 0.5 ms^{-1}. The dimensionless distance in the horizontal direction x^* and the vertical direction z^* is plotted on the x and z-axes, respectively.

Results: Evolution profile of the bed forms



A flattening of the troughs and a sharpening of the wave crests is found similar to the results of van den Berg and van Damme [2007].

Motivation and aim

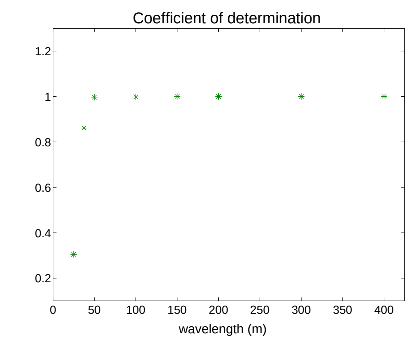
Motivation

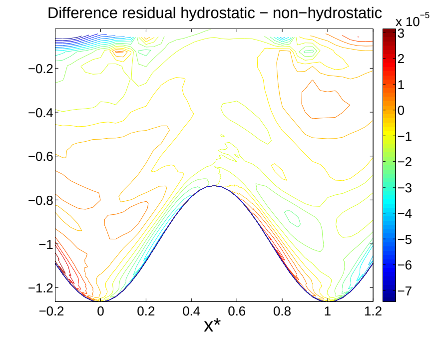
Employing a stability analysis, [Blondeaux and Vittori, 2011] illustrated the influence of the non-hydrostatic pressure component on the generation of sand waves.

Aim

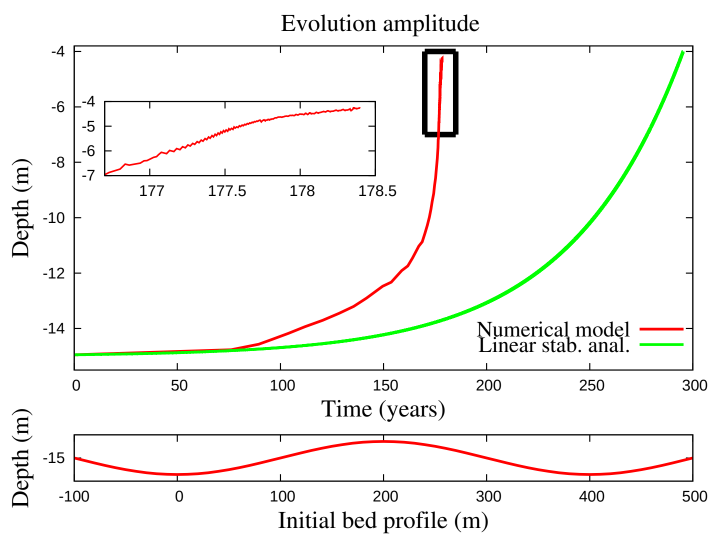
Analyse of the impact of non-hydrostatic part of the flow field on the finite amplitude dynamics of sand waves.

Results: Impact non-hydrostatic pressure





Results: Evolution amplitude



- Initial amplification resembles lin. stab. analyses
- Finite amplitude is characterised by oscillations however.

Discussion and conclusions

- Development of morphodynamic model for the finite-amplitude evolution of tidal sand waves based on SWASH is presented.
- Finite amplitude dynamics of the bed forms is not yet well resolved.
- Non-hydrostatic component of the flow field impacts particularly bed forms with small wavelengths, in accordance with results presented by Blondeaux and Vittori [2011].
- Impact of bottom boundary condition!

References

Blondeaux P. and Vittori G. 2011 The formation of tidal sand waves: Fully three-dimensional versus shallow water approaches. *Cont. Shelf Res.* **31**, 990 - 996

Zijlema M., Stelling G. and Smit P. 2011 SWASH: An operational public code for simulating wave fields and rapidly varied flows in coastal waters. *Coastal Engng.* **58**, 992-1012

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