Sand wave simulation on large domains

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RCEM 2005

Context

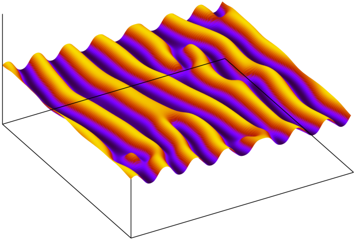
- Physical setting
- Practical relevance
- Other research

Approach

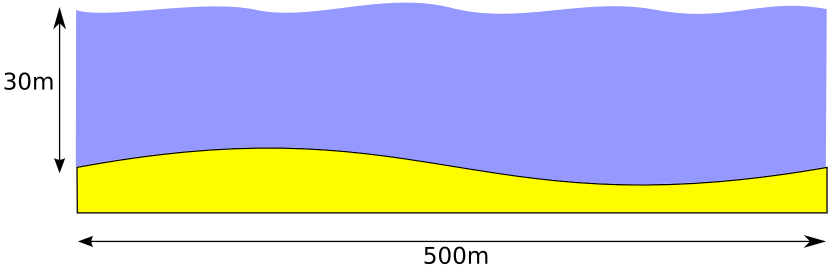
- Problem characteristics
- General applicability
- Benefit
- Technique

Results

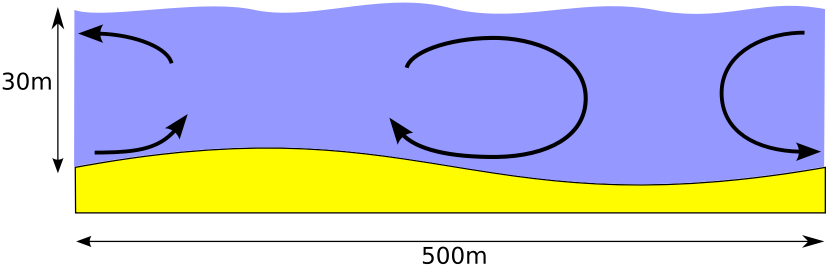
Future outlook



Physical setting



Physical setting



Practical relevance

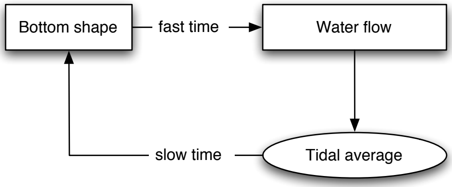
courtesy Google maps

- Shipping routes
- Oil pipes
- Telecommunication cables
- Construction of artificial islands
- Off shore wind turbines

Other research

- Linear stability analysis (Hulscher, Gerkema, Besio)
- Trend fitting (Wüst, Knaapen, probably numerous others)
- Numerical simulation (Németh)

Problem characteristics



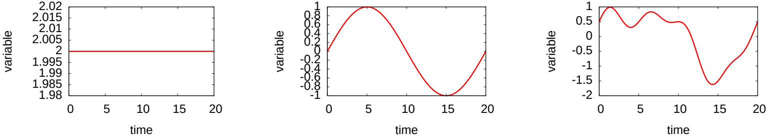
- Two time scales
- Most computation effort into flow
- Two consecutive flows are alike

Why you should stay awake

- Many calculations
- Slightly different settings
- Profit

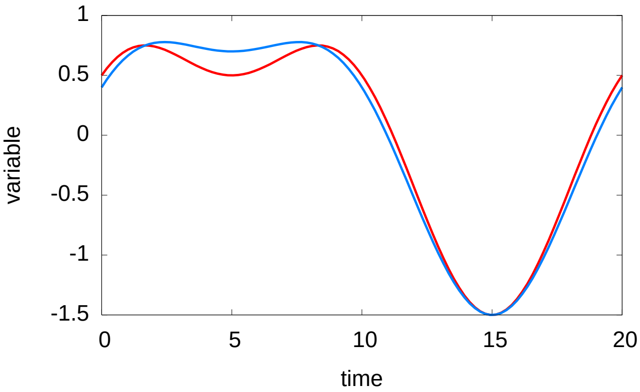
Applicability

Implicit solver, or time dependency harmonic



Benefit

Compute small changes instead of whole trajectory



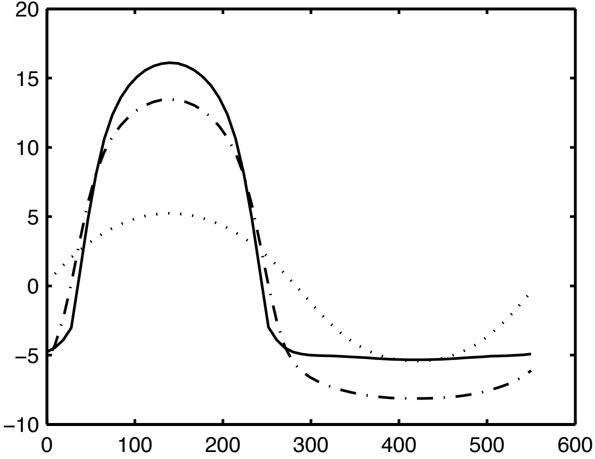
How do we do that?

- Newton iterator from previous solution
- Sparse LU / GMRES
- Use previous LU as preconditioner for GMRES

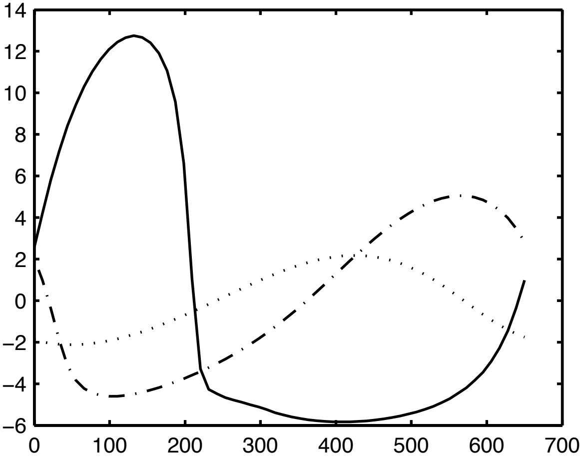
On sparse LU

- Local discretisation in space
- Tactical ordering of the discrete equations
- Band matrix with little fill in during LU
- $N_z < N_x$ gives small bandwidth

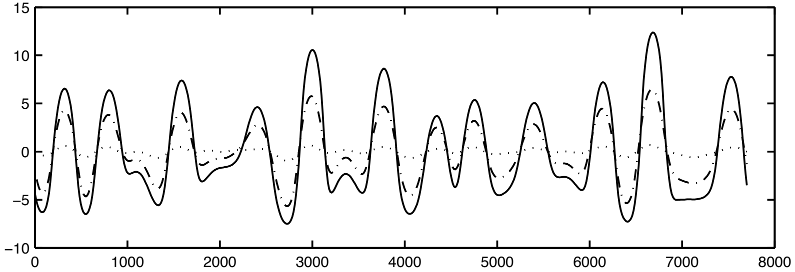
1 Wave



1 Wave with migration



Wave field



Future outlook

- How do the variations evolve in time?
- Extensions: turbulence modelling, sediment transport
- Simplifications: better understanding of mechanism behind residual flow

Acknowledgement

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If you ask for it

$$\partial_t u + u\partial_x u + w\partial_z u = A_v \partial_z^2 u - g\partial_x \zeta + F(t) \qquad (1)$$

$$\partial_x u + \partial_z w = 0 \qquad (2)$$

If you ask for it

$$A_v \partial_z u = Su|_{z=h(x)} \tag{3}$$

$$w - u\partial_x h = 0|_{z=h(x)} \tag{4}$$

$$\partial_z u = 0|_{z=H+\zeta(x,t)} \tag{5}$$

$$w = \partial_t \zeta + u\partial_x \zeta|_{z=H+\zeta(x,t)} \tag{6}$$

If you ask for it

$$B = \alpha\sqrt{|\tau_b|}\left[\tau_b - \lambda_1\partial_x h - \lambda_2|\tau_b|\partial_x h\right] \tag{7}$$

$$\tau_b = A_v \partial_z u\big|_{z=h(x)} \tag{8}$$

$$\partial_t h = -\partial_x B \tag{9}$$