

Coastal bathymetry from satellite and its use on coastal modelling

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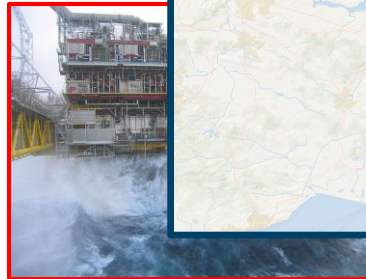


Agenda

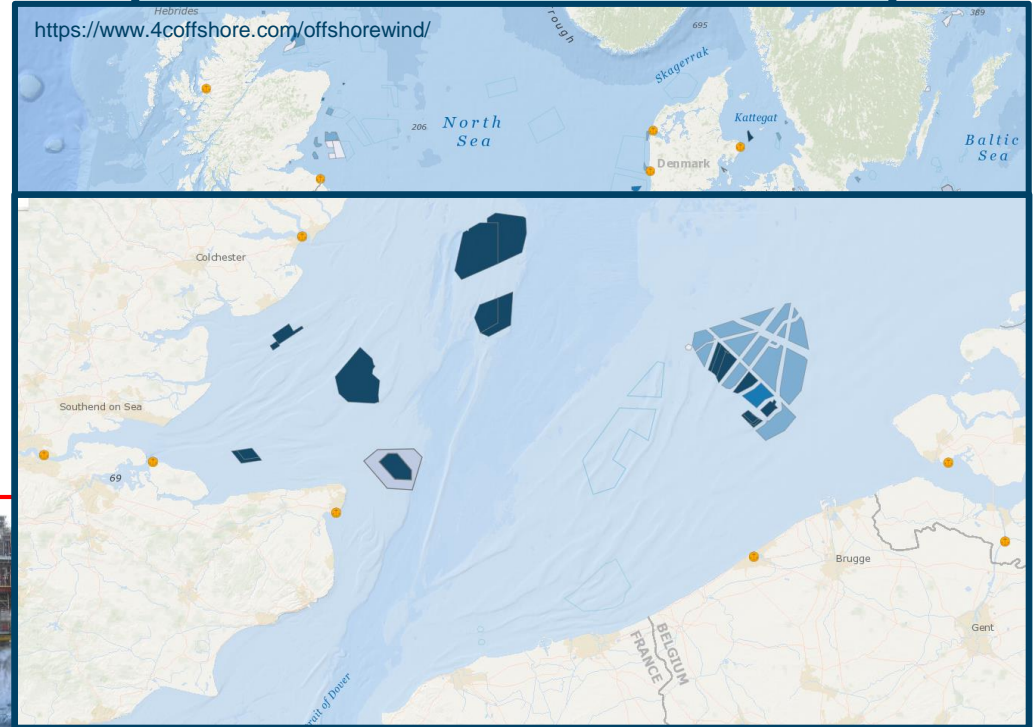
- Background
- Objective
- Tools and case study
 - SDB
 - Spectral wave model
 - MIKE3 wave FM
- Conclusions

Background

- Satellite developments
- Coastal developments
 - OWF
 - Harbours
 - Oil and gas
- Metocean studies (EVA, H_{m0} , H_{max} , ...)
 - Normal conditions
 - Extreme conditions



Copernicus Evolution and Applications with Sentinel Enhancements and Land Effluents for Shores and Seas



Objective

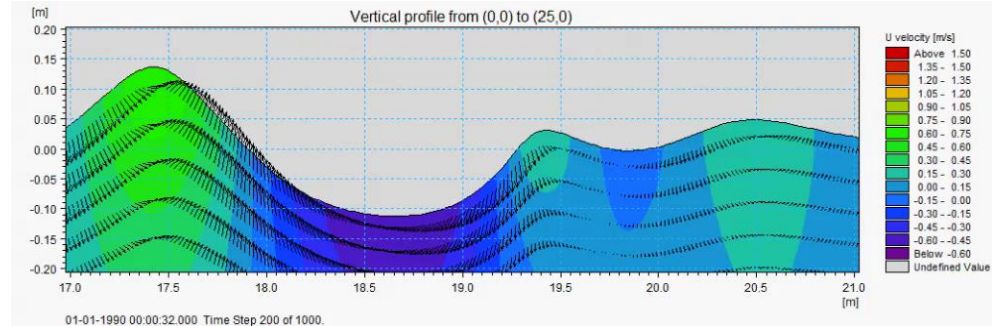
- High resolution bathymetry

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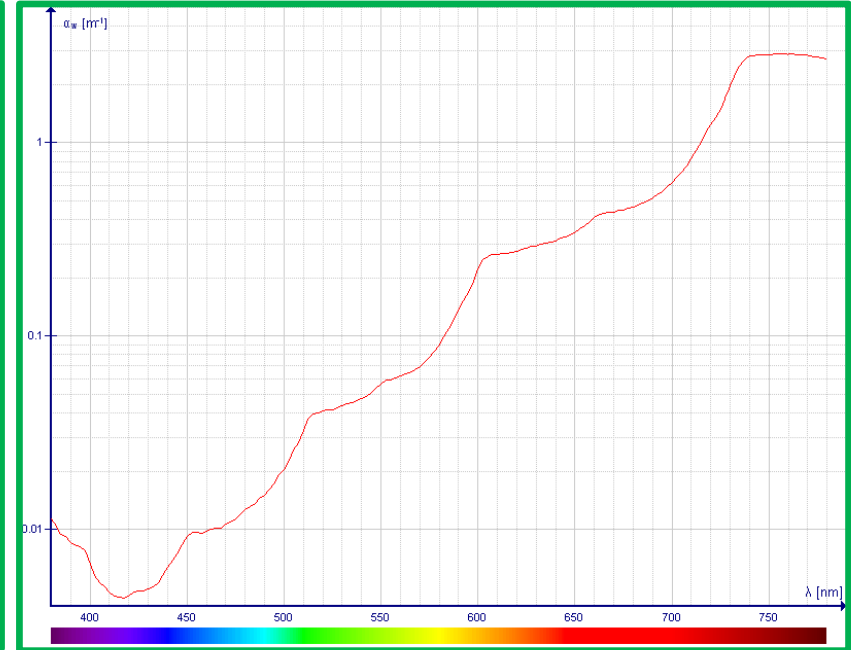
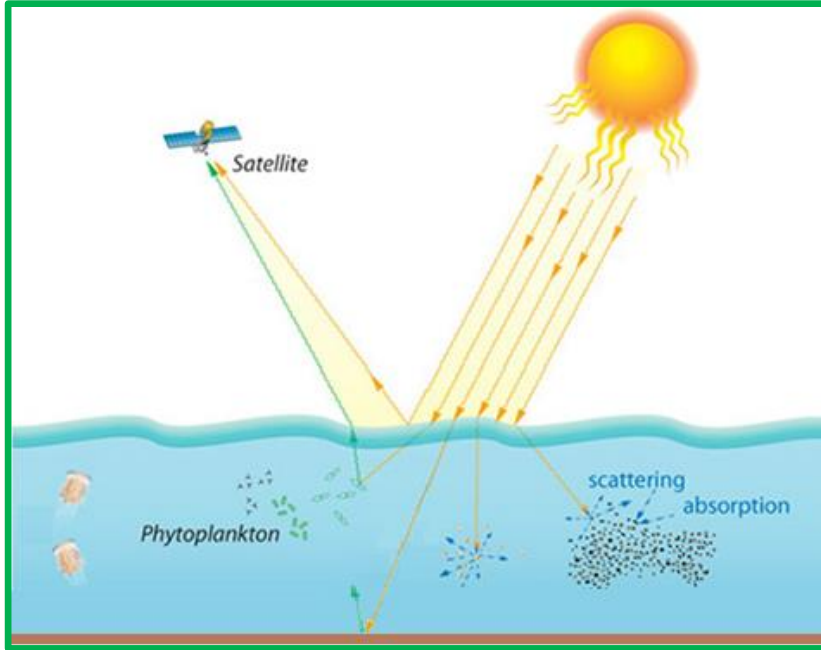
- Coastal wave modelling



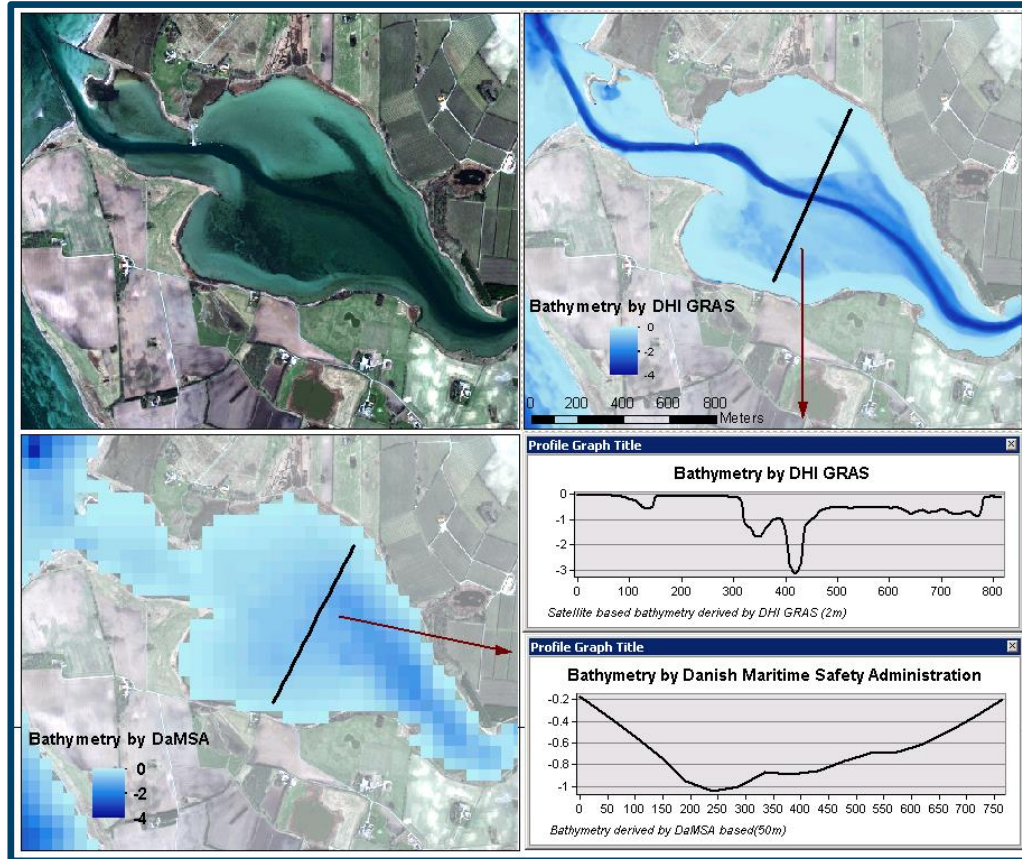
Better metocean conditions



What is SDB?



Example of Satellite Derived Bathymetry



Nipisat Sund (Grønland) and Palm Island (Dubai)

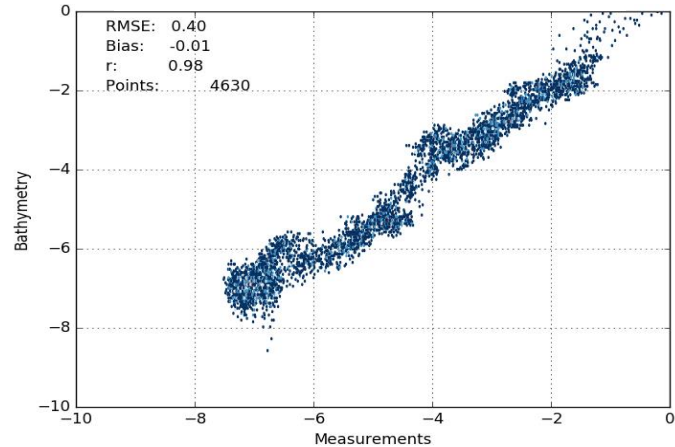
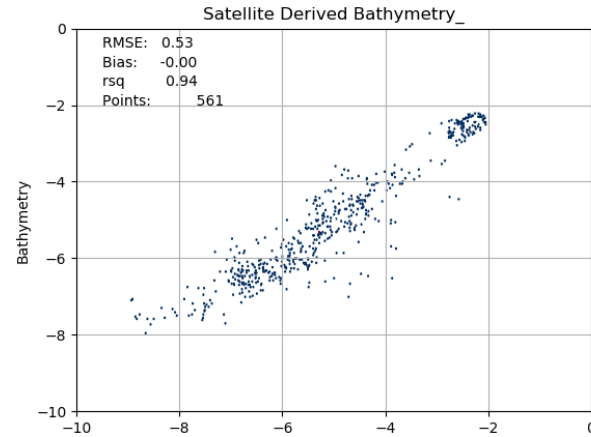
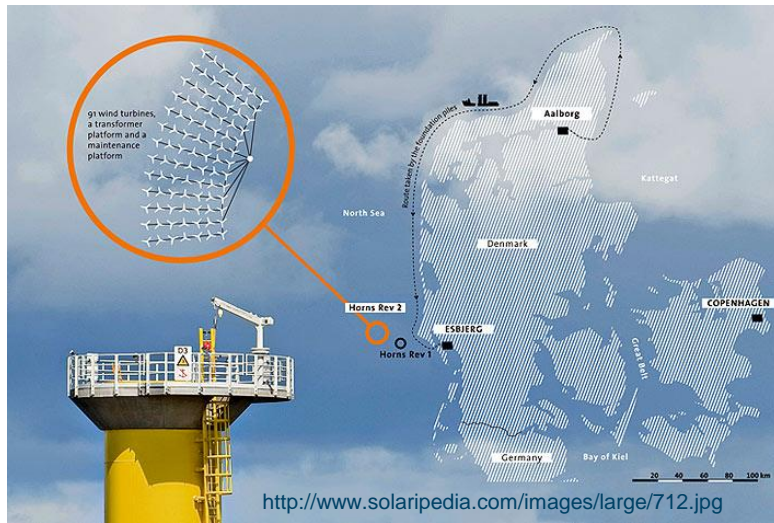


Image courtesy of Digital Globe

Case study: Horns Rev

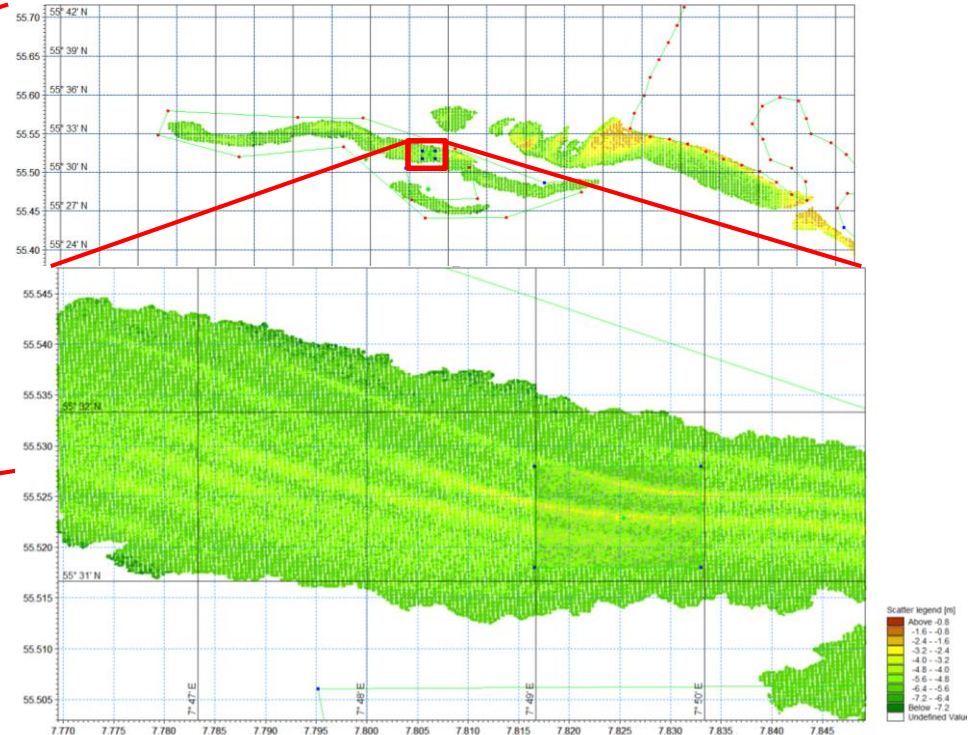
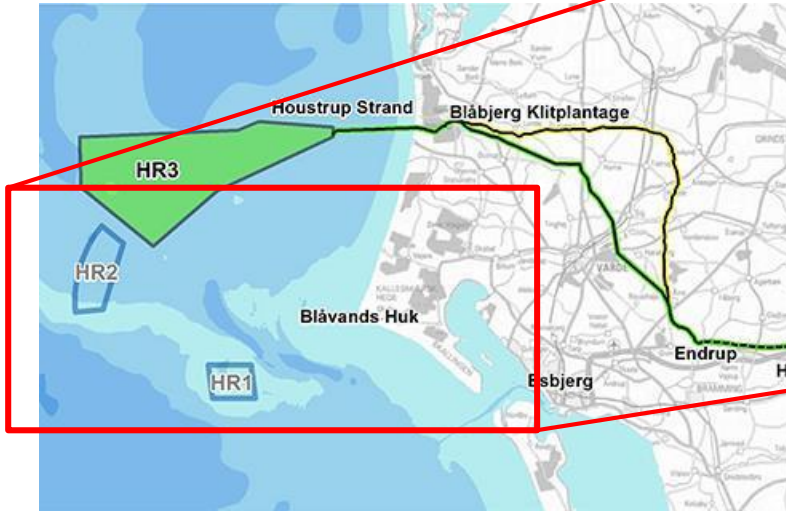
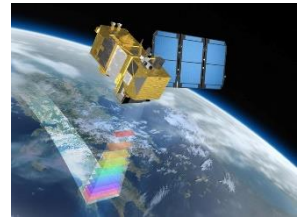
High resolution bathymetry for coastal wave modelling



<https://www2.deloitte.com/content/dam/Deloitte/dk/Documents/public-sector/megaprojects/Horns-Rev3-and-Kriegers-Flak-Peter-Sehestedt.pdf>

Case study

- Satellite Bathymetry

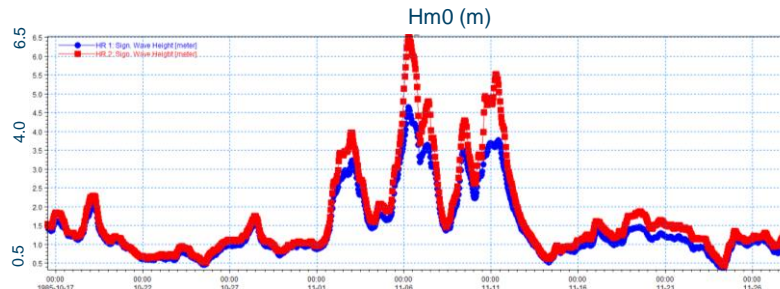
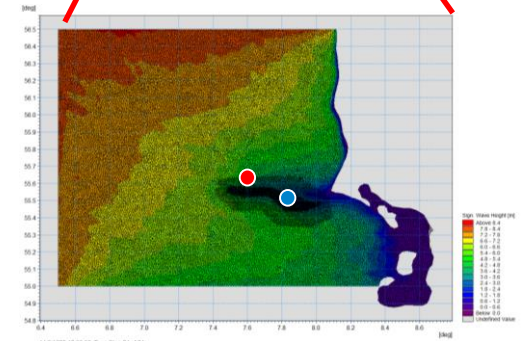
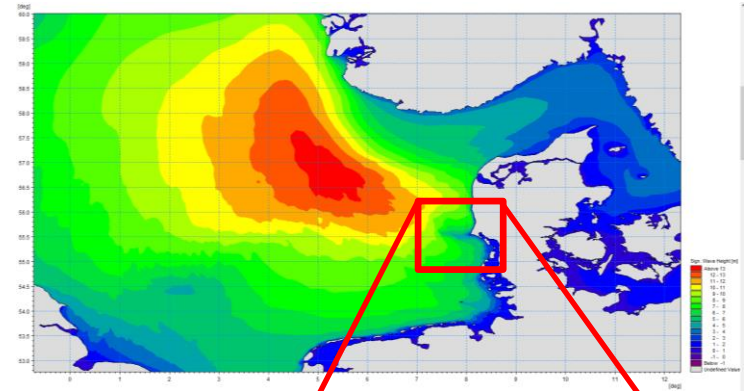


Spectral wave modelling. MIKE21 SW

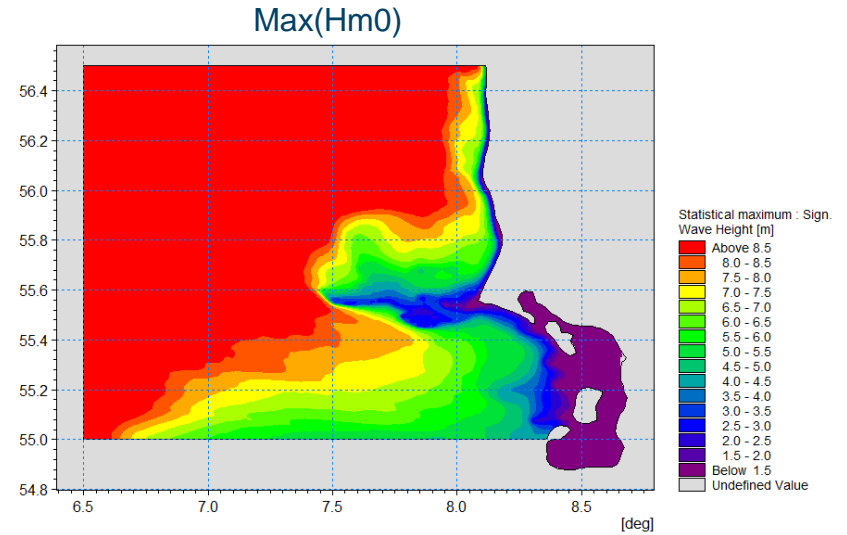
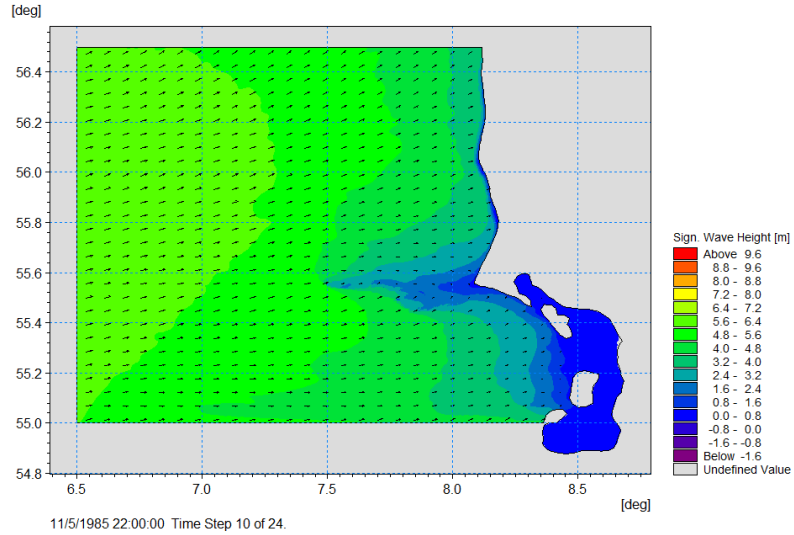
- 3rd generation spectral wave model
- Flexible mesh
- Janssen (1991)
- Spherical or Cartesian coordinates
- Wind stress from wind-wave coupling or wind C_D
- Stability corrected winds, air-water density ratio, surface current....

Downscaling

- CFSR
- Bathymetry: SDB + Emodnet
- 6/11/1985 (NW)
- Resolutions: 800-25 m

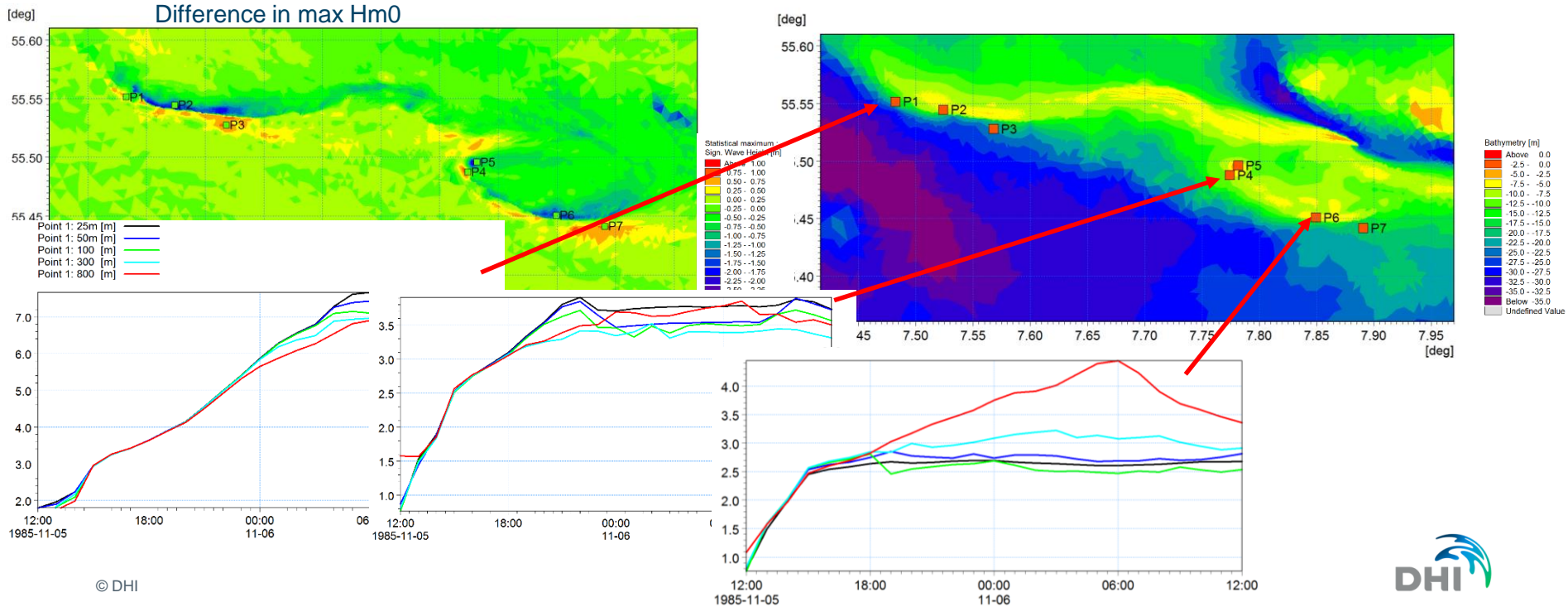
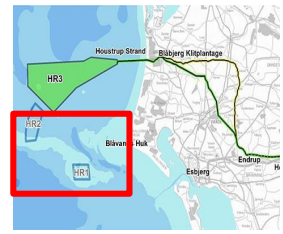


MIKE21 SW Results



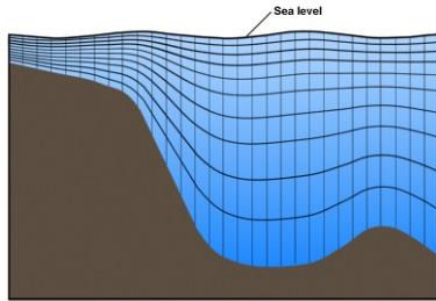
MIKE21 SW Results

Mesh resolution (25m vs 800m)

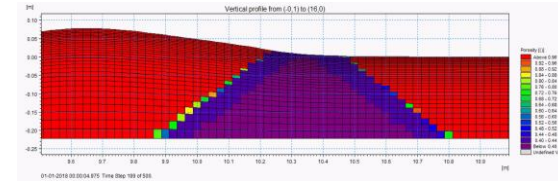


The new wave model MIKE 3 wave FM

Sigma Vertical Coordinate System



Navier-Stokes solver (in MIKE3FM framework)



A new 3D model - why?

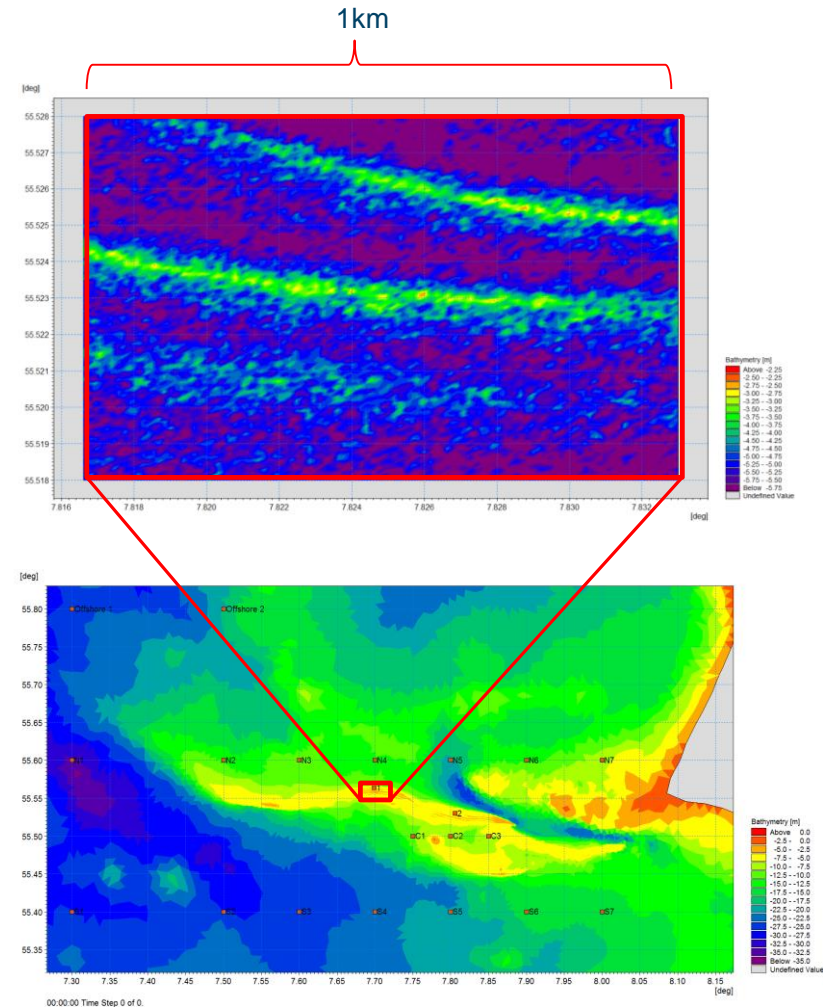
- We need a 3D **wave** for complicated jobs e.g.
 - Wave kinematics
 - Wave transformation for offshore wind farms at 30m depth
 - Navigation channels in exposed areas
 - Wave-current interaction
- We need a better 3D **flow** model for some difficult tasks
 - Mixing e.g. subsea outlets (e.g. cooling water)
 - Stratification
 - Internal waves

$$\frac{\partial h}{\partial t} + \nabla \cdot \mathbf{U} = 0 \quad \frac{\partial \mathbf{U}}{\partial t} + \nabla \cdot \mathbf{F}(\mathbf{U}) = \mathbf{S}_h + \mathbf{S}_q + \mathbf{S}_\rho$$

- Continuity equation
- Momentum equation
- Condition for the free surface
- ... and boundary conditions

MIKE3 wave FM

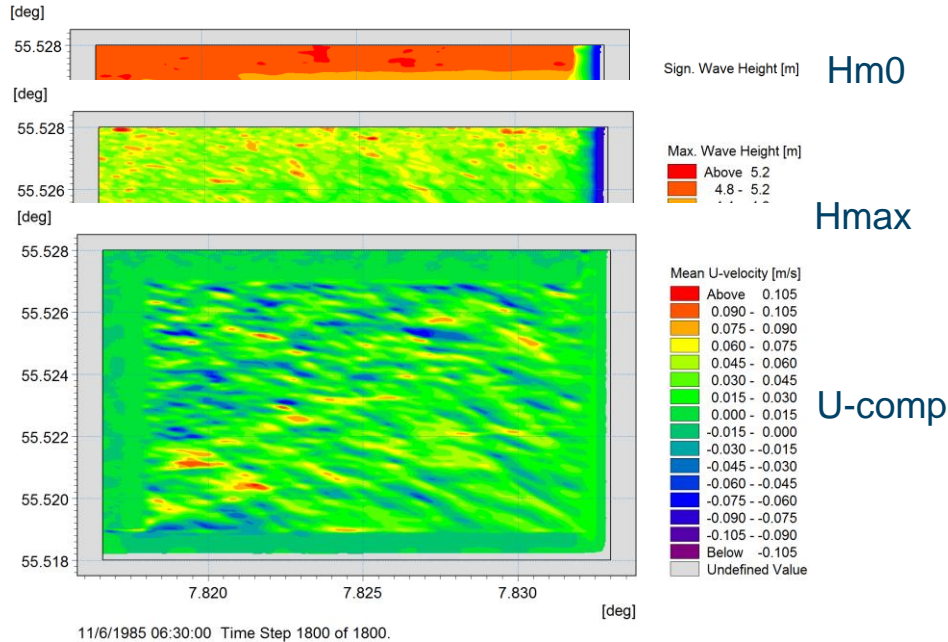
- Tests
 - Flat bottom /real bathymetry
 - Regular/irregular waves as BC
 - Rectangular mesh (2 m), 10 sig.
 - Generation zone / sponge zone
 - Bottom friction



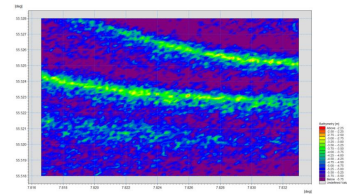
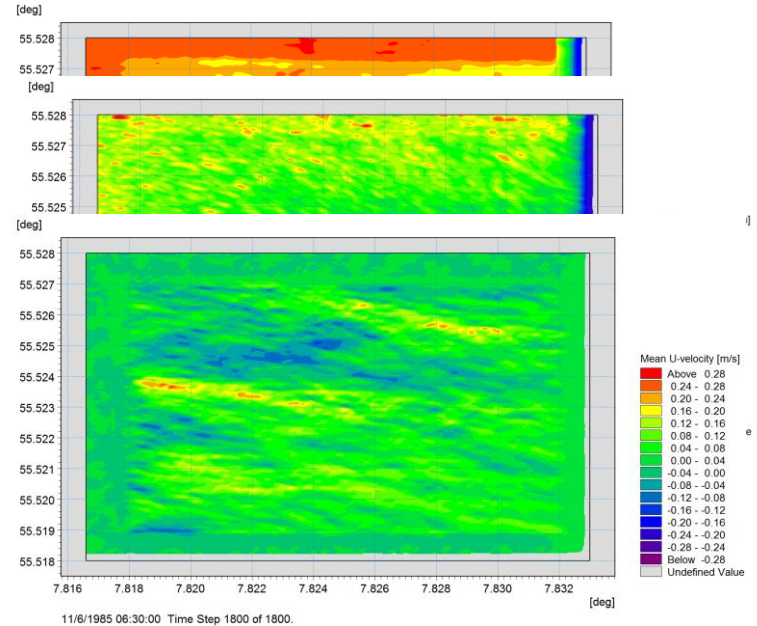
MIKE3 wave FM Results

- Irregular waves

Flat

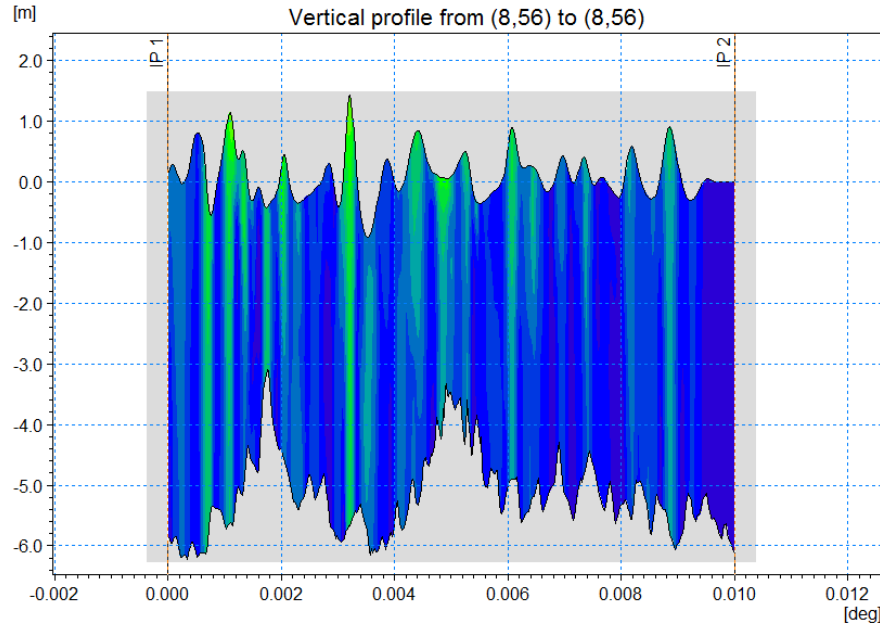
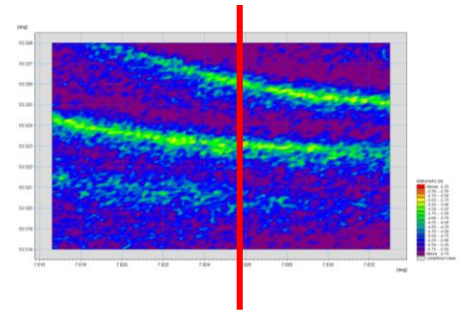


Real



MIKE3 wave FM Results

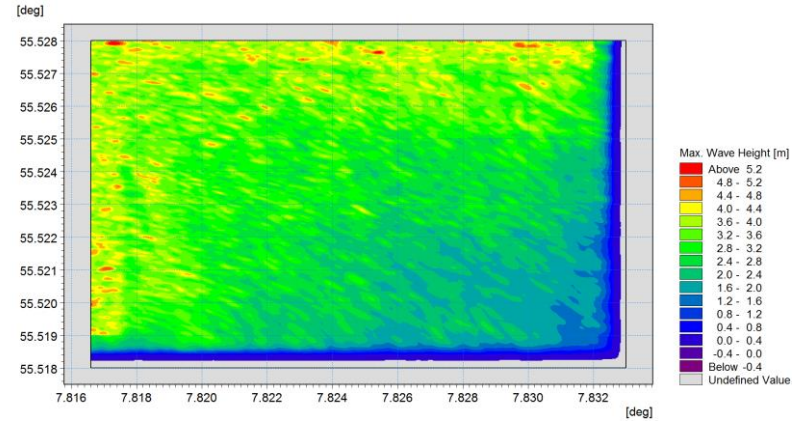
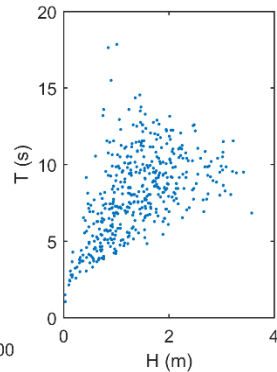
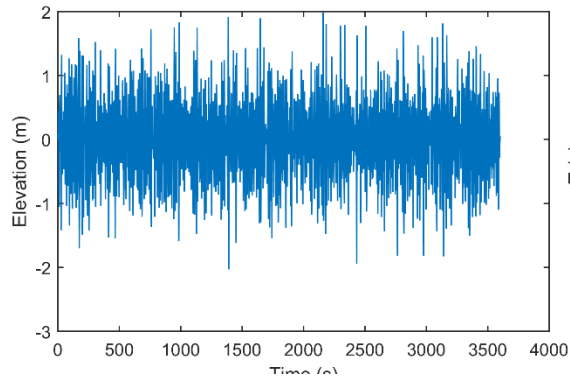
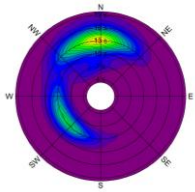
- Irregular waves



11/6/1985 06:16:40 Time Step 1000 of 1800.

MIKE3 wave FM Results. Hmax

- SW vs MIKE3



Max(Hmax) = 4.4 m
Mean(Hmax) = 2.7 m

Conclusions

- **SDB**
 - Successful high res bathymetry (< 7 m)
 - Limitations due to environmental conditions
- **MIKE21SW Vs MIKE3 wave FM**
 - SW sensitive to high res bathymetry (20% Hm0)
 - MIKE3 wave FM can provide detailed wave transformation/kinematics
 - Potential differences in parameters such as Hmax

NEXT

SDB: deeper areas? Validation with in-situ data

Wave models: Generation zone tests, validations,.....

Thank you

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- CEASELESS



MIKE3 wave FM Results. Hm0

- SW vs MIKE3

