

Modelling wave propagation and hydrodynamics in the East-Frisian Wadden Sea

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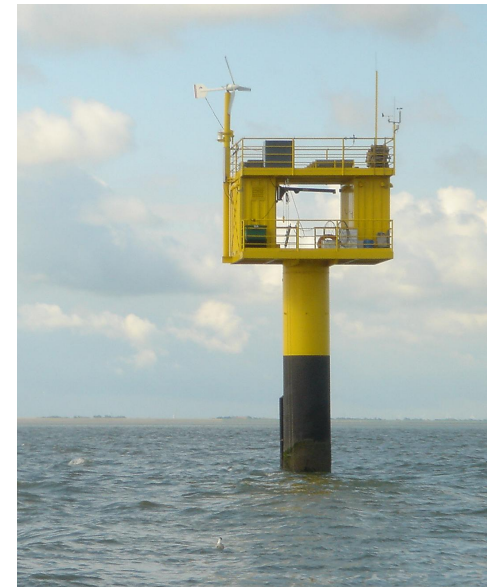


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Introduction



KLIFF – **Klima**folgenforschung in Niedersachsen



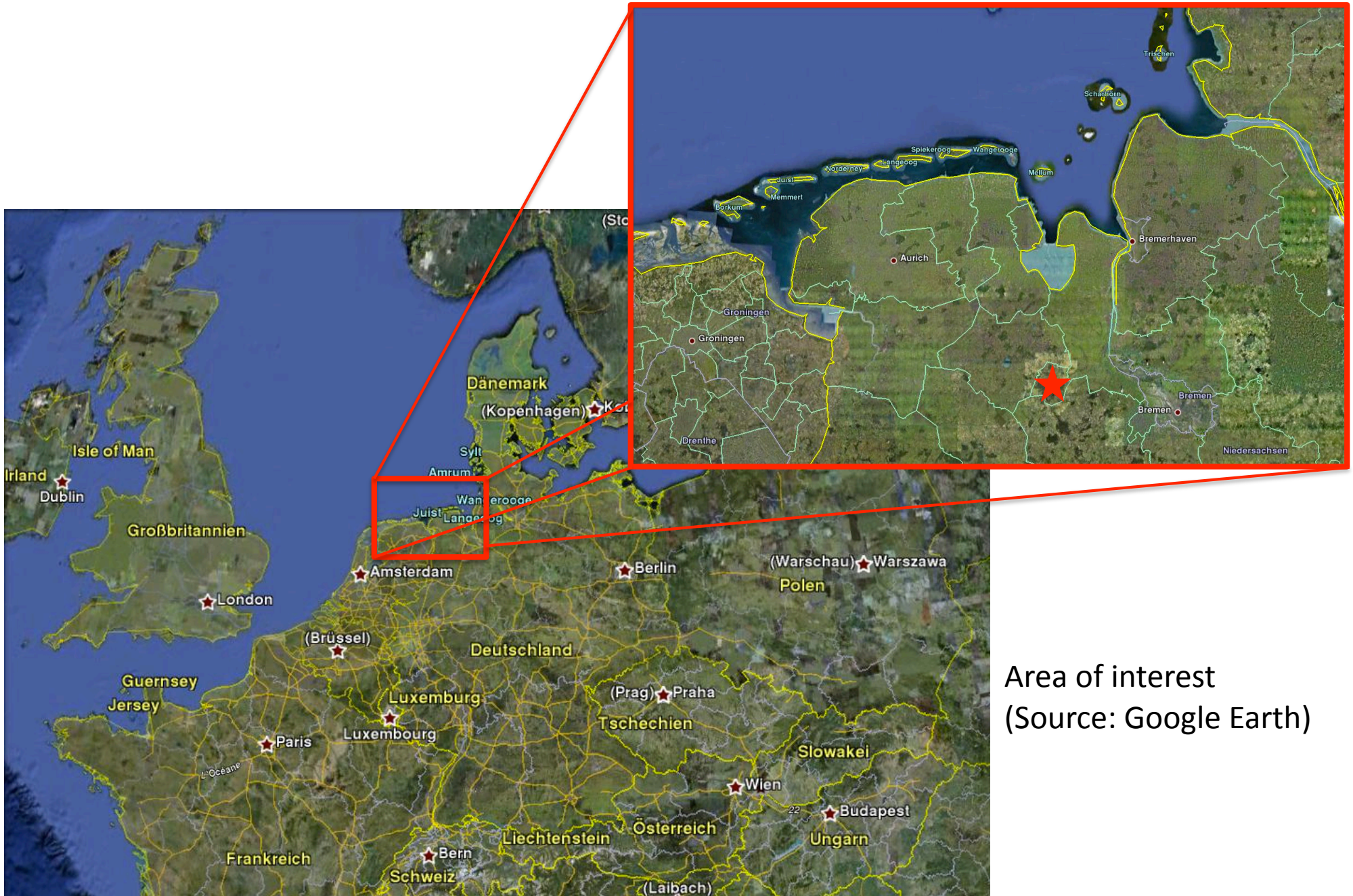
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Subproject 4

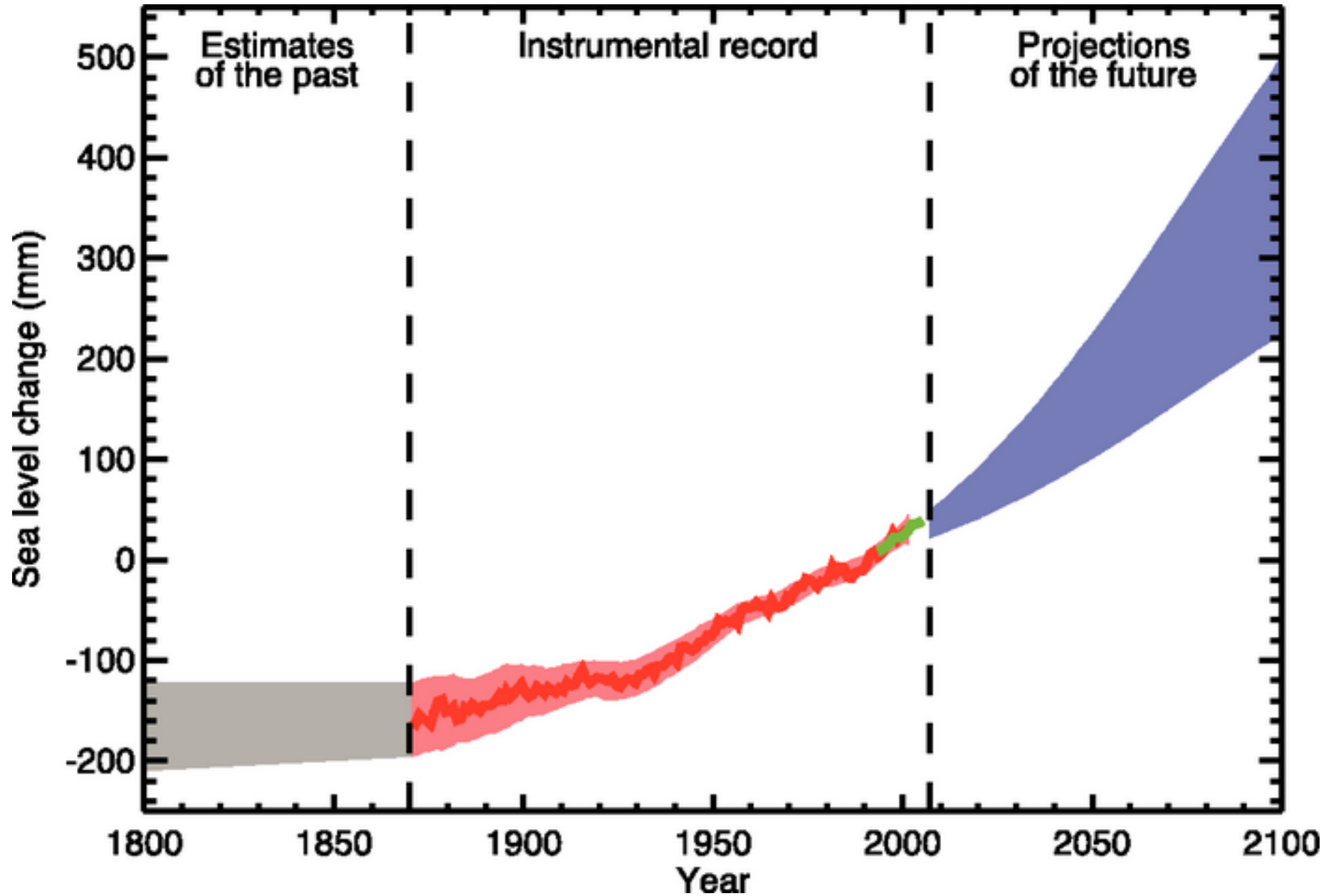


Evolution of Hydro- and Sedimentdynamics in the East Frisian Wadden Sea

- Changing Coastal Climate – Evaluating Adaptation Strategies For Coastal Protection Scheme (A-Küst)



Area of interest
(Source: Google Earth)



Projection of future sea level change (Source: IPCC Report 2007)



Potential flooding at a projected sea level rise of average high tide by 70 cm until 2050 (Source: Lochte et al. 2010)

Goals of the KLIFF-Project

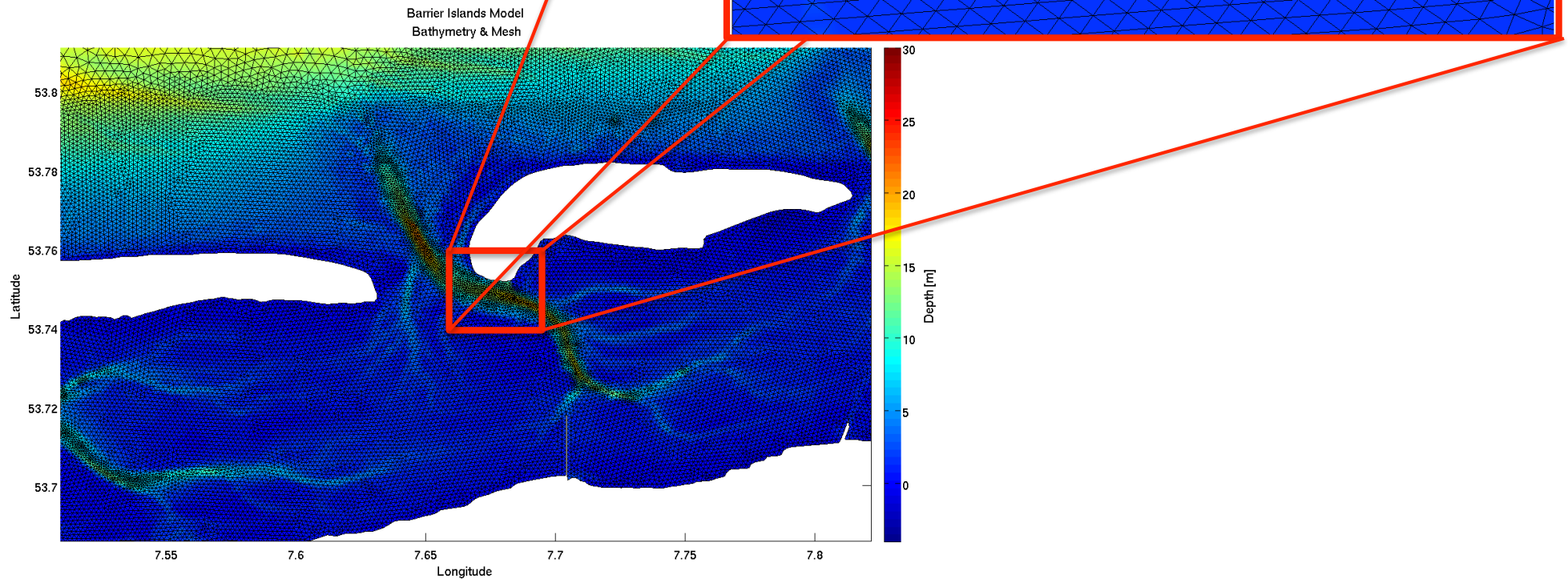
- High bandwidth of different climate scenarios
- Database of consequences of the climate change
- Identifying the consequences of different adaptation strategies
- Close communication with regional government authorities (e.g. NLWKN)

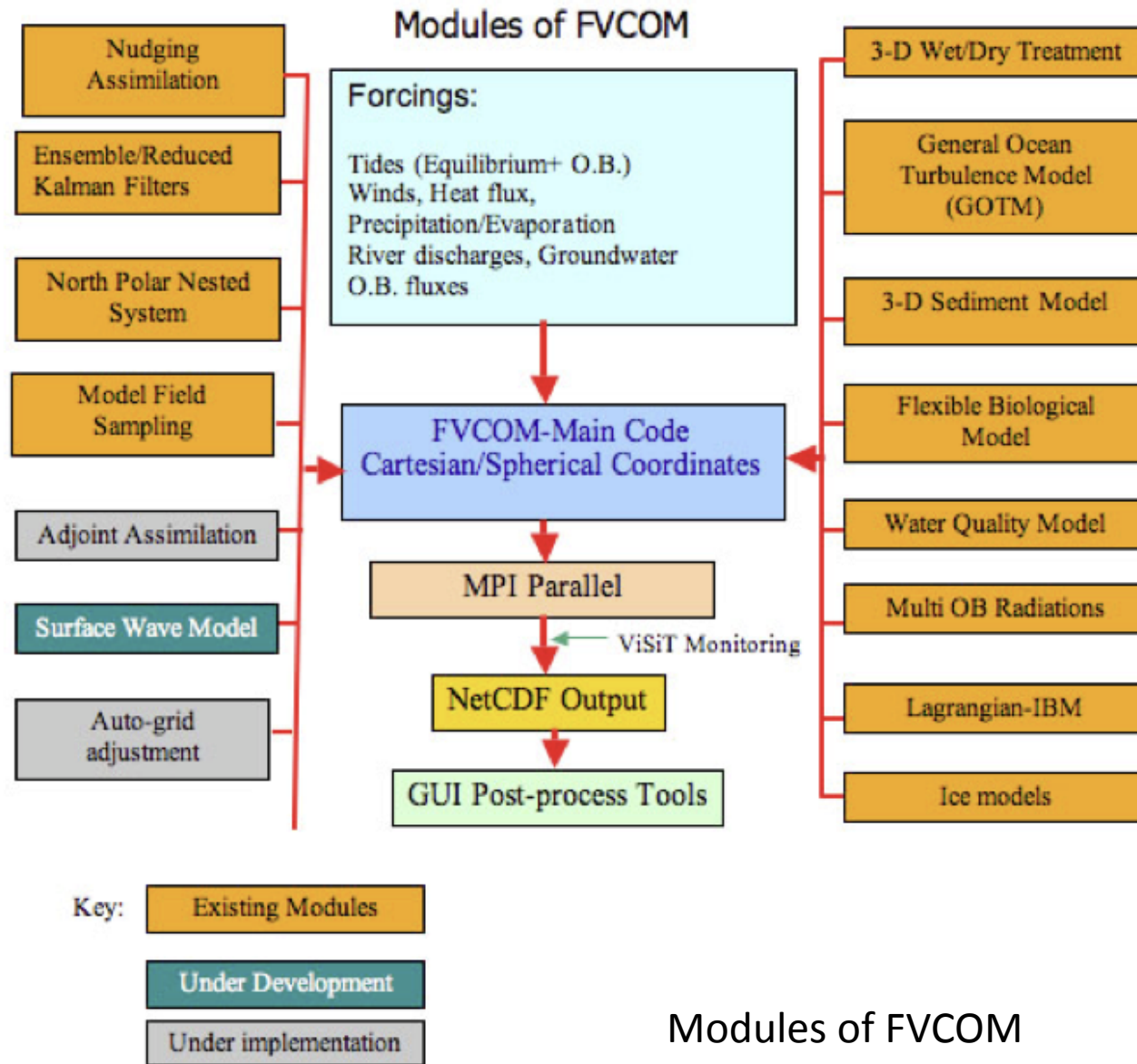
FVCOM-SWAVE

FVCOM-SWAVE

- Prognostic, unstructured-grid, finite-volume, free surface, 3-D primitive equations coastal ocean model (see e.g. Chen et al. 2006a and Qi et al. 2009)
- FVCOM computes the solution of the governing equations for momentum, continuity, temperature, salinity and density
- Third-generation wave model for obtaining realistic estimates of wave parameters in coastal areas
- SWAVE computes the solution of the wave action balance equation with sources and sinks

Gmsh
(Source: www.geuz.org/gmsh/)

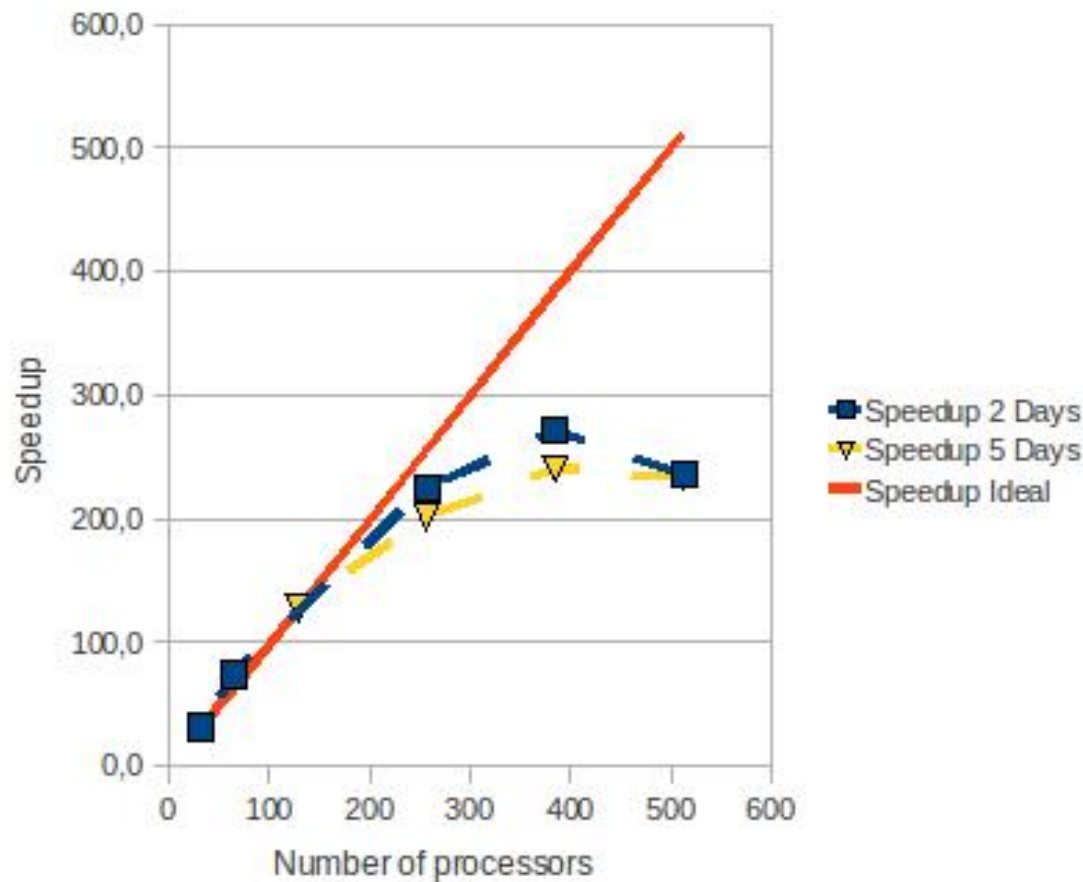




Modules of FVCOM

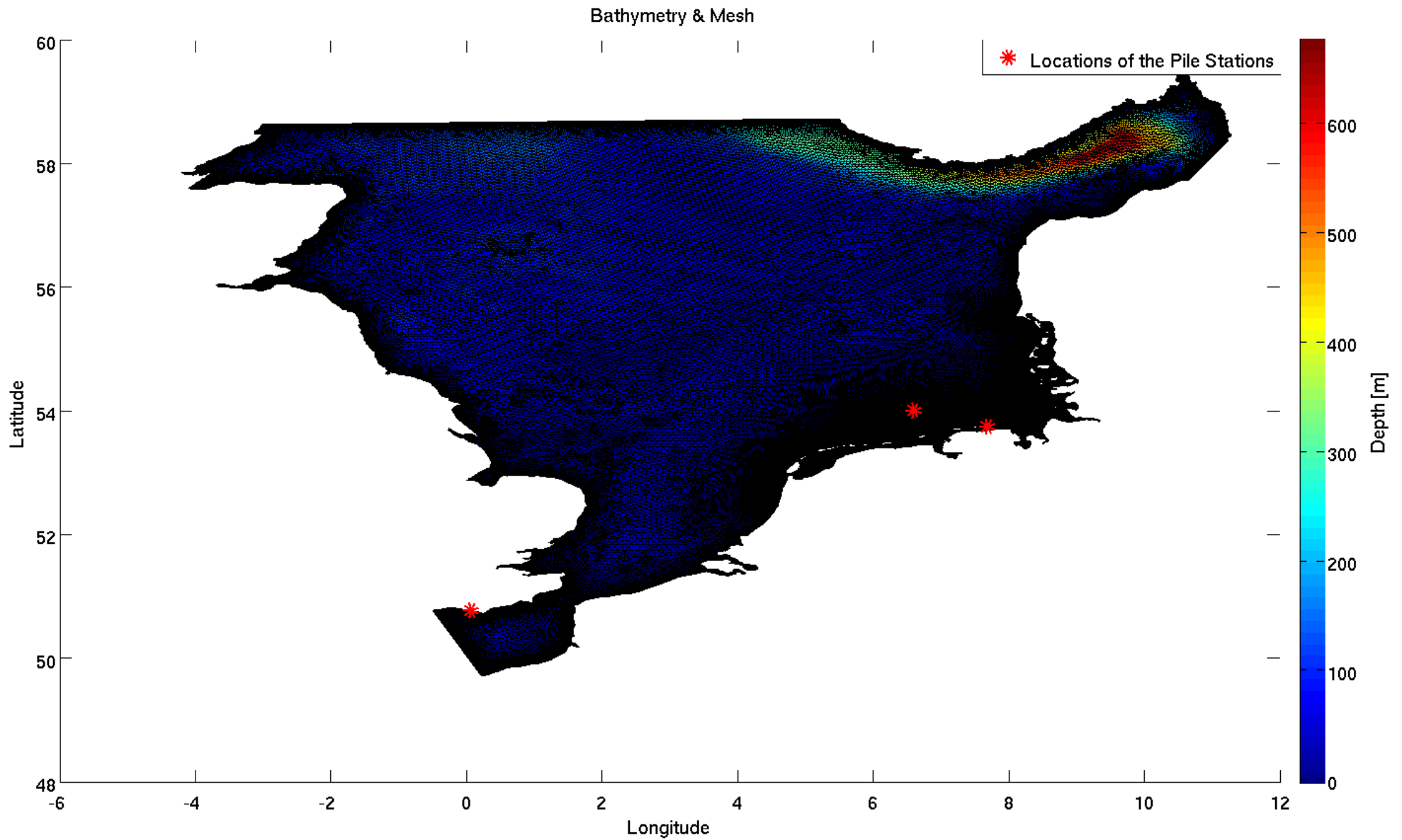
(Source: fvcom.smast.umassd.edu)

The North-German Supercomputing Alliance (HLRN) operates a massive parallel supercomputing system which is one of the most powerful computers in Germany and worldwide as well

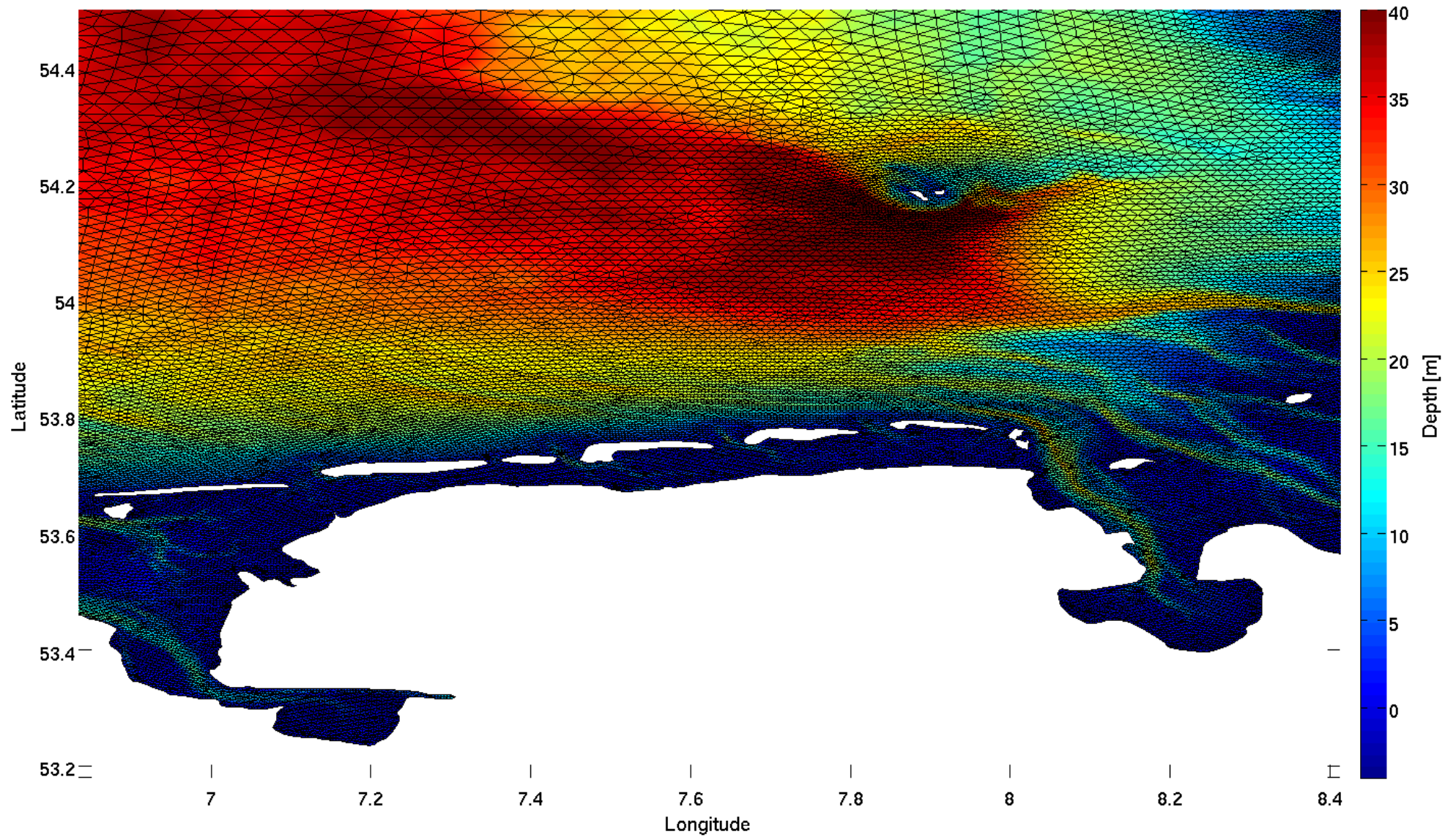


North Sea

- 3D-Mode
 - Version 3.1.4
 - Mesh: 220000 triangles, 113000 nodes
 - Horizontal resolution: 500m – 6km
 - Vertical resolution: 20 sigma-layers
 - Constant salinity and temperature: 35 PSU, 10°C
 - Boundary conditions: FES2004
 - Air pressure and wind conditions: German Weather Service (DWD) (2006: 1-hourly, 2007: 2-hourly)
 - Validation data: BSH, ICBM
 - Timestep FVCOM: 10s
 - Timestep SWAVE: 300s
 - Computation time: one timestep in ~1s, (128 prozessors)

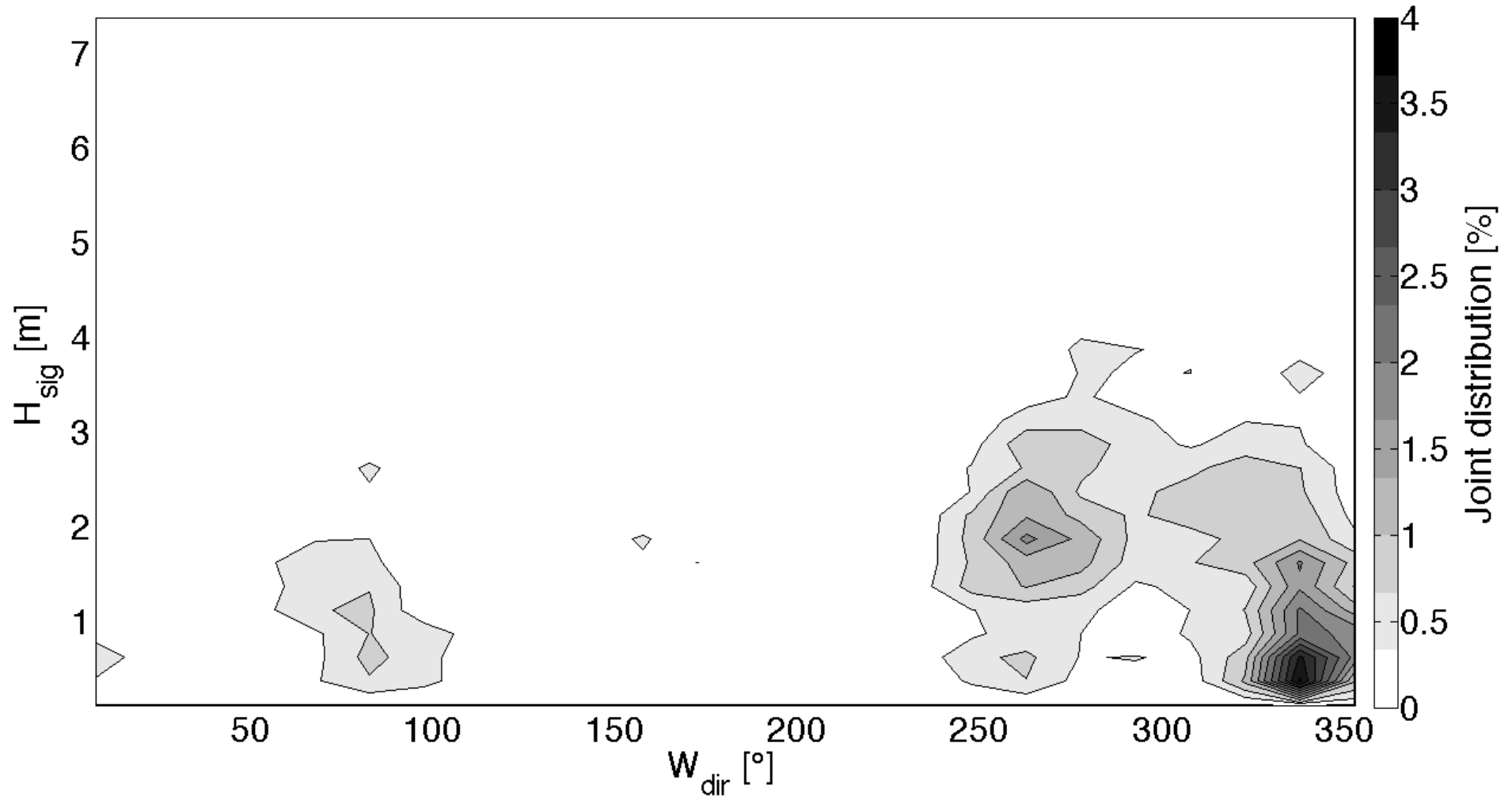


Bathymetry & Mesh

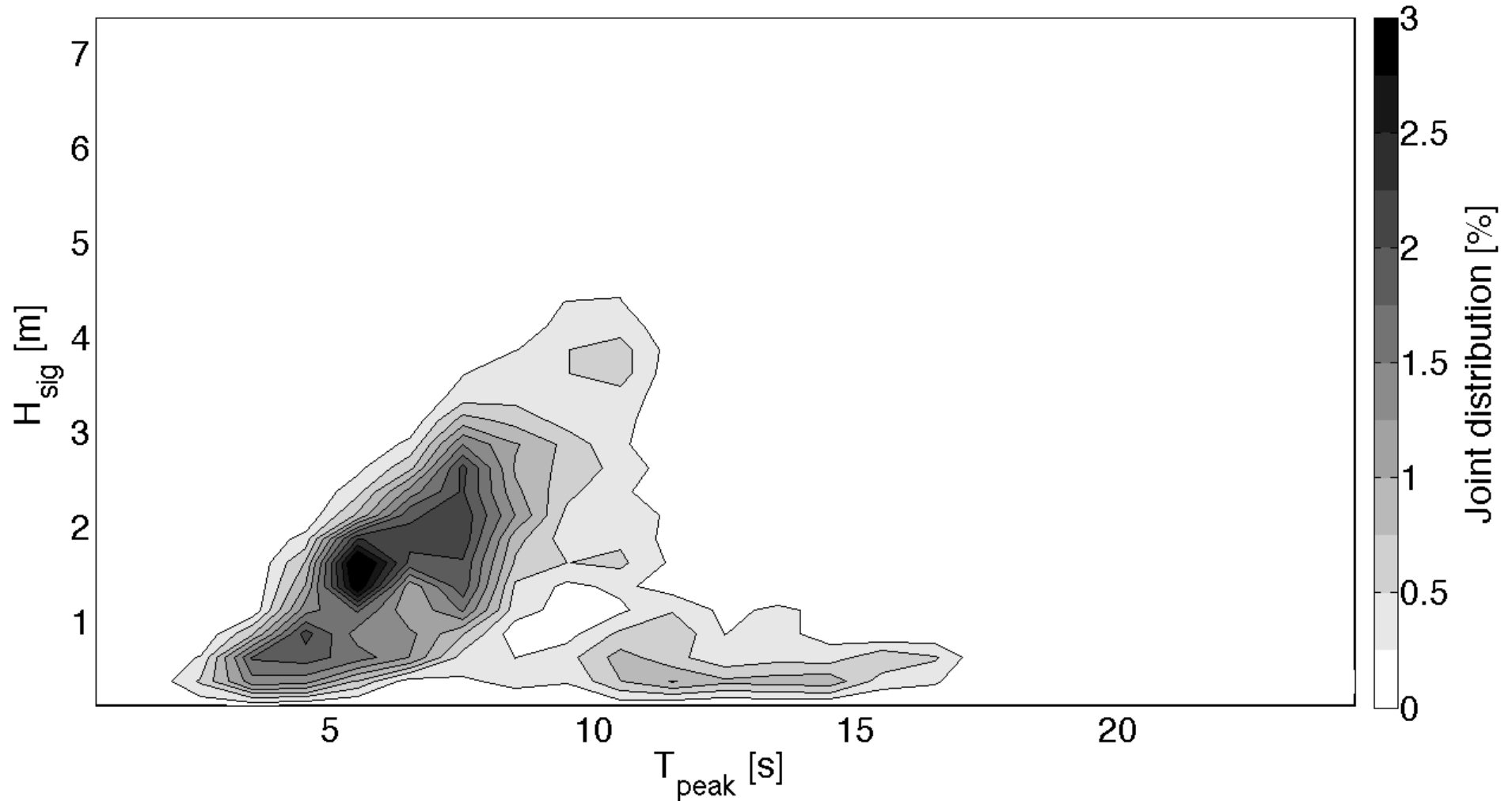


Test Case 1

Joint distribution of significant wave height and wave direction at FINO I station
Dec. 2007 - June 2008

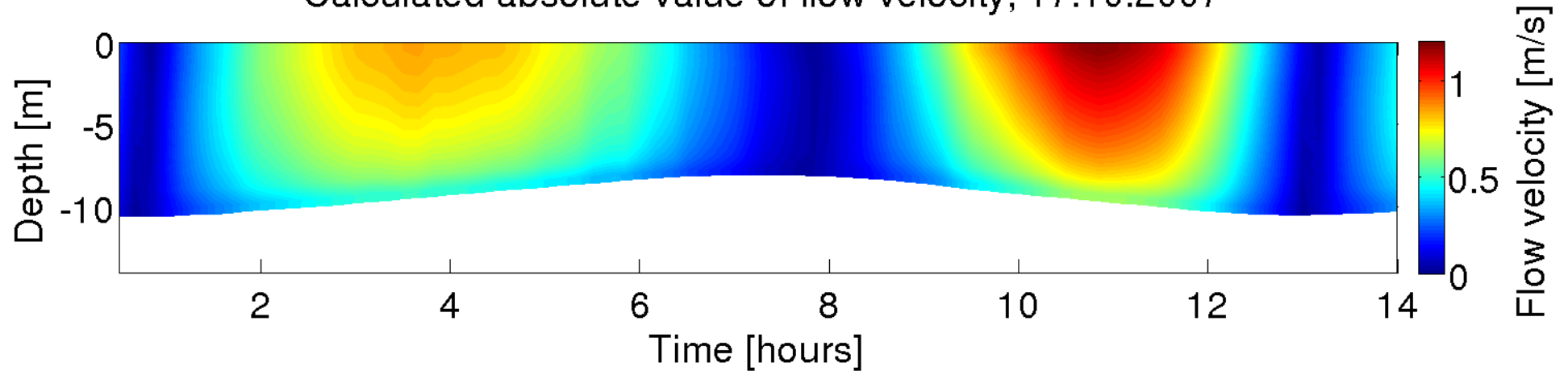


Joint distribution of significant wave height and peak period at FINO I station
Dec. 2007 - June 2008



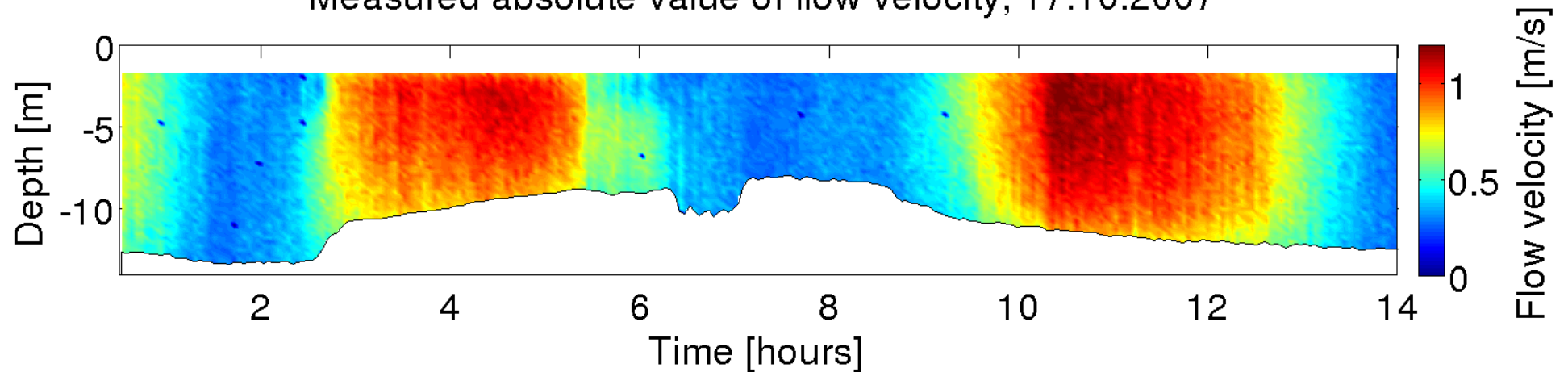
North Sea Model, FVCOM Data

Calculated absolute value of flow velocity, 17.10.2007

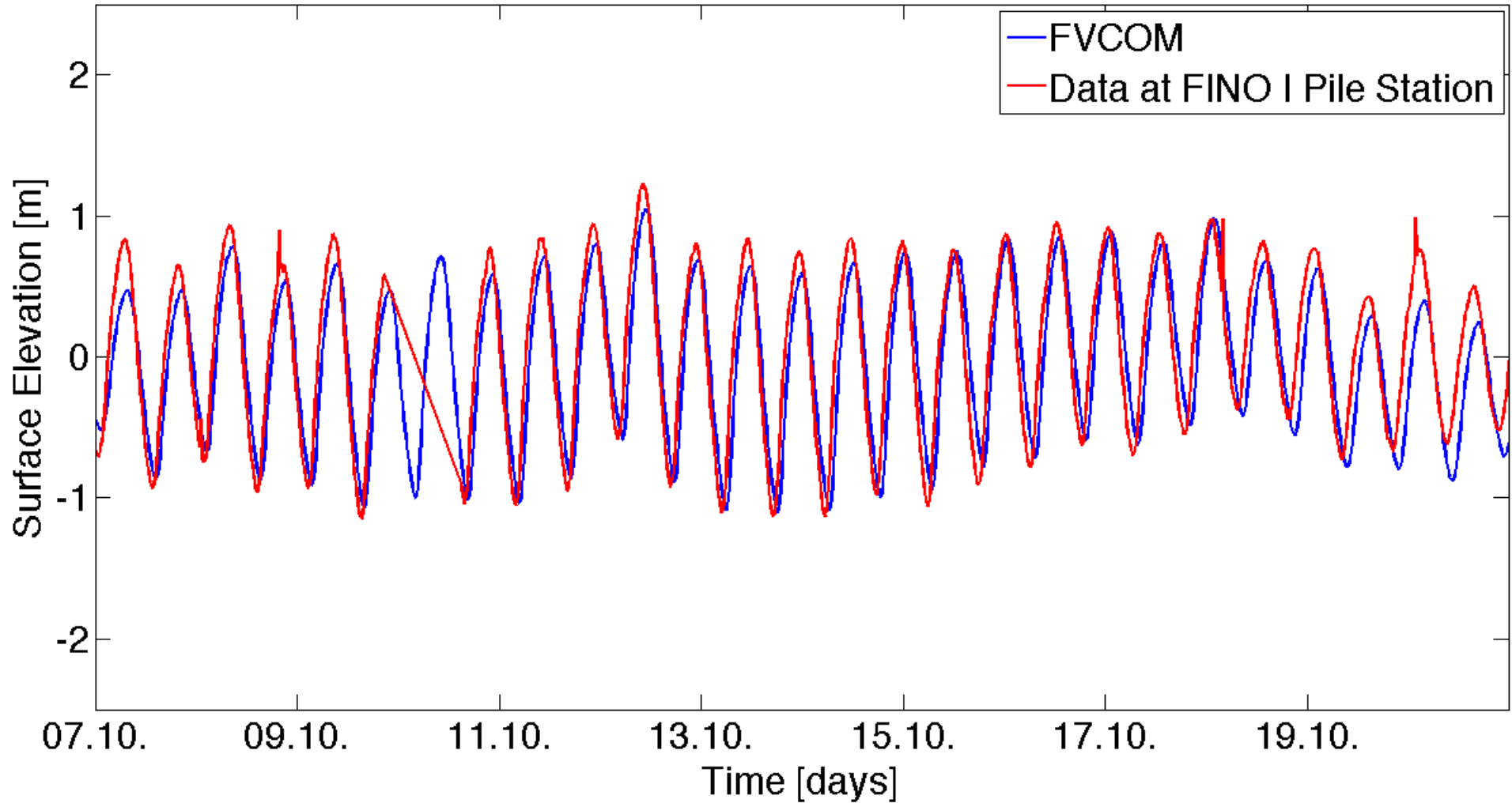


North Sea Model, ADCP Data

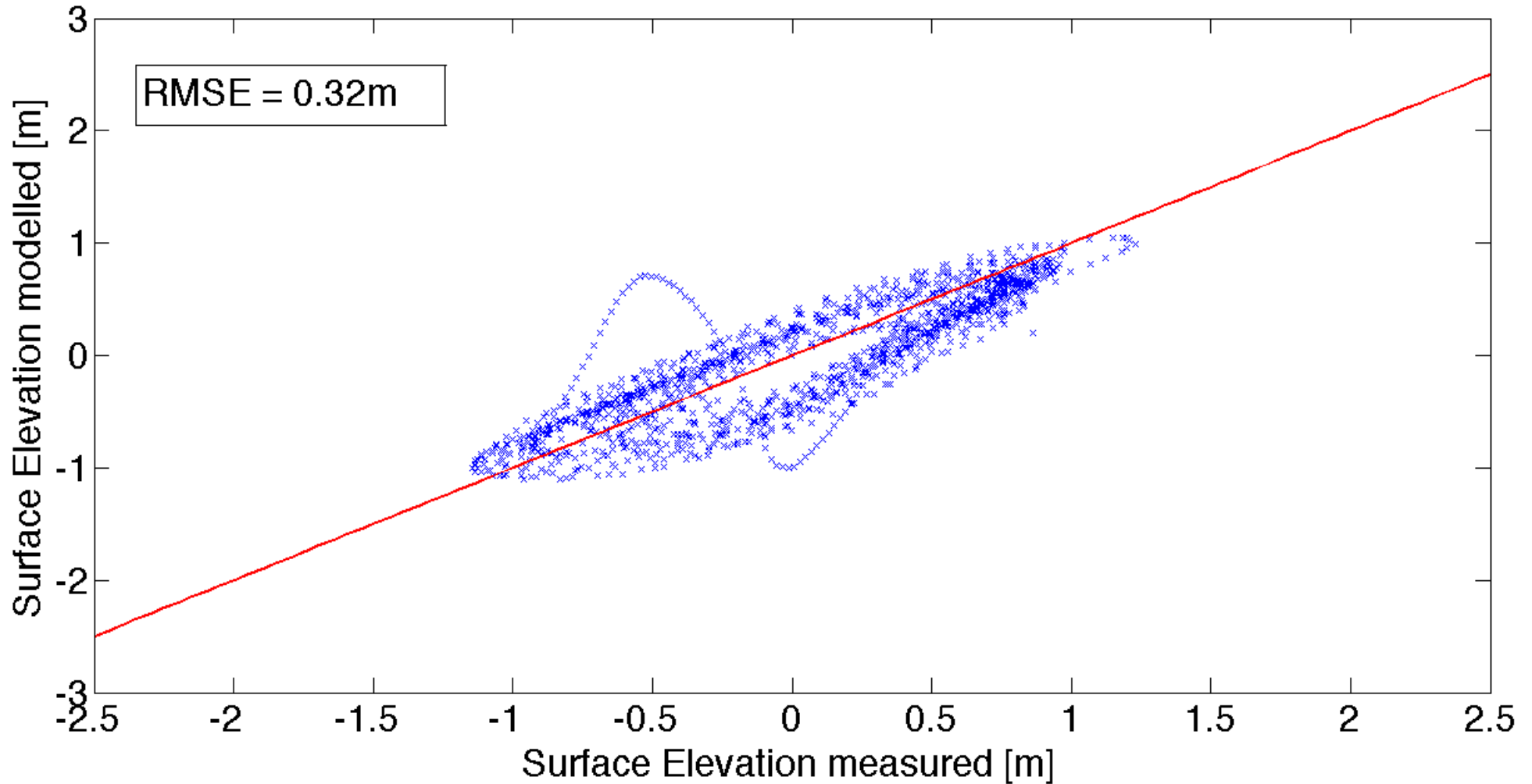
Measured absolute value of flow velocity, 17.10.2007



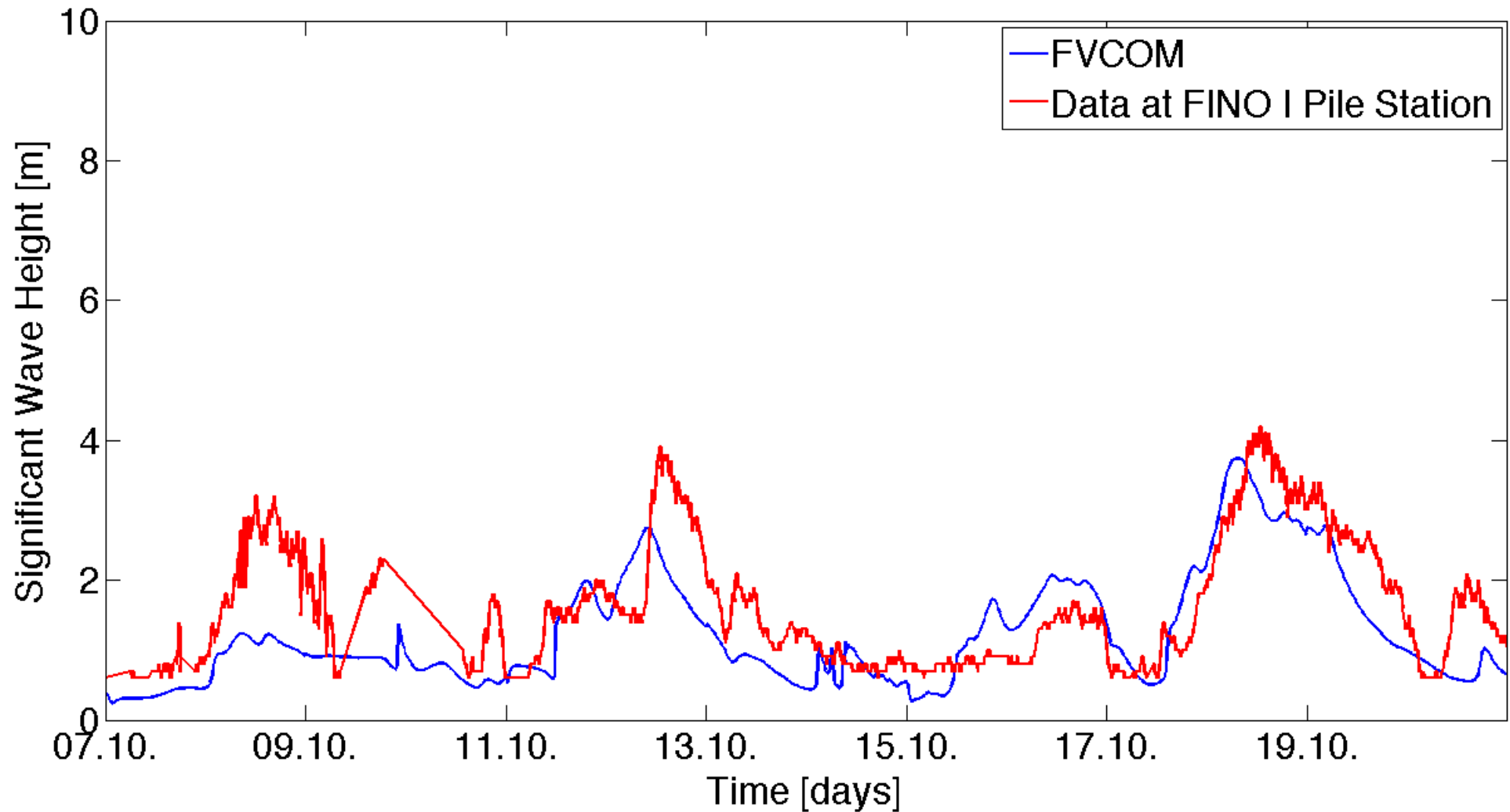
North Sea Model, October 2007, Surface Elevation, Fino I Pile Station
07.10.2007 - 21.10.2007



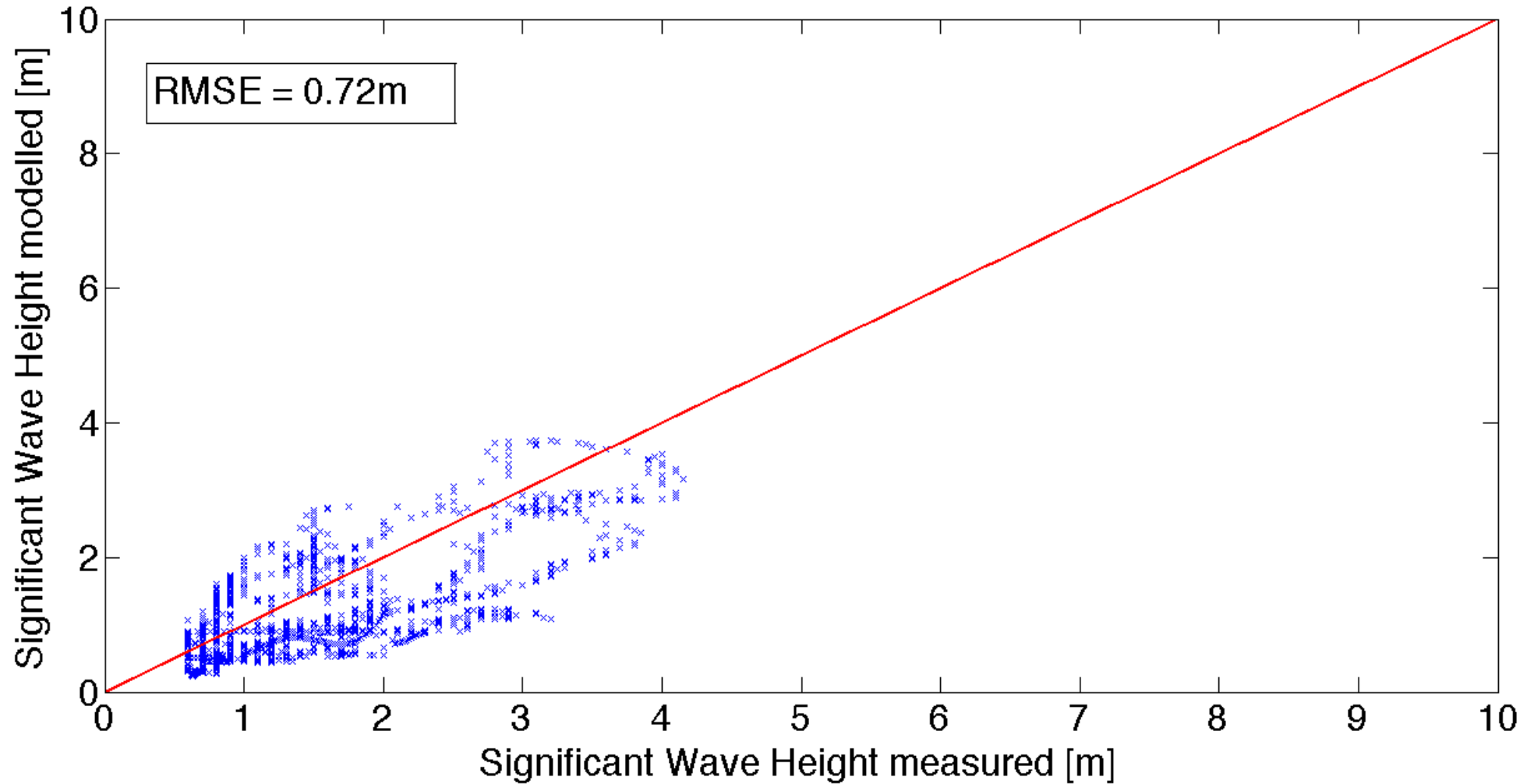
North Sea Model, October 2007, Surface Elevation, Fino I Pile Station
07.10.2007 - 21.10.2007



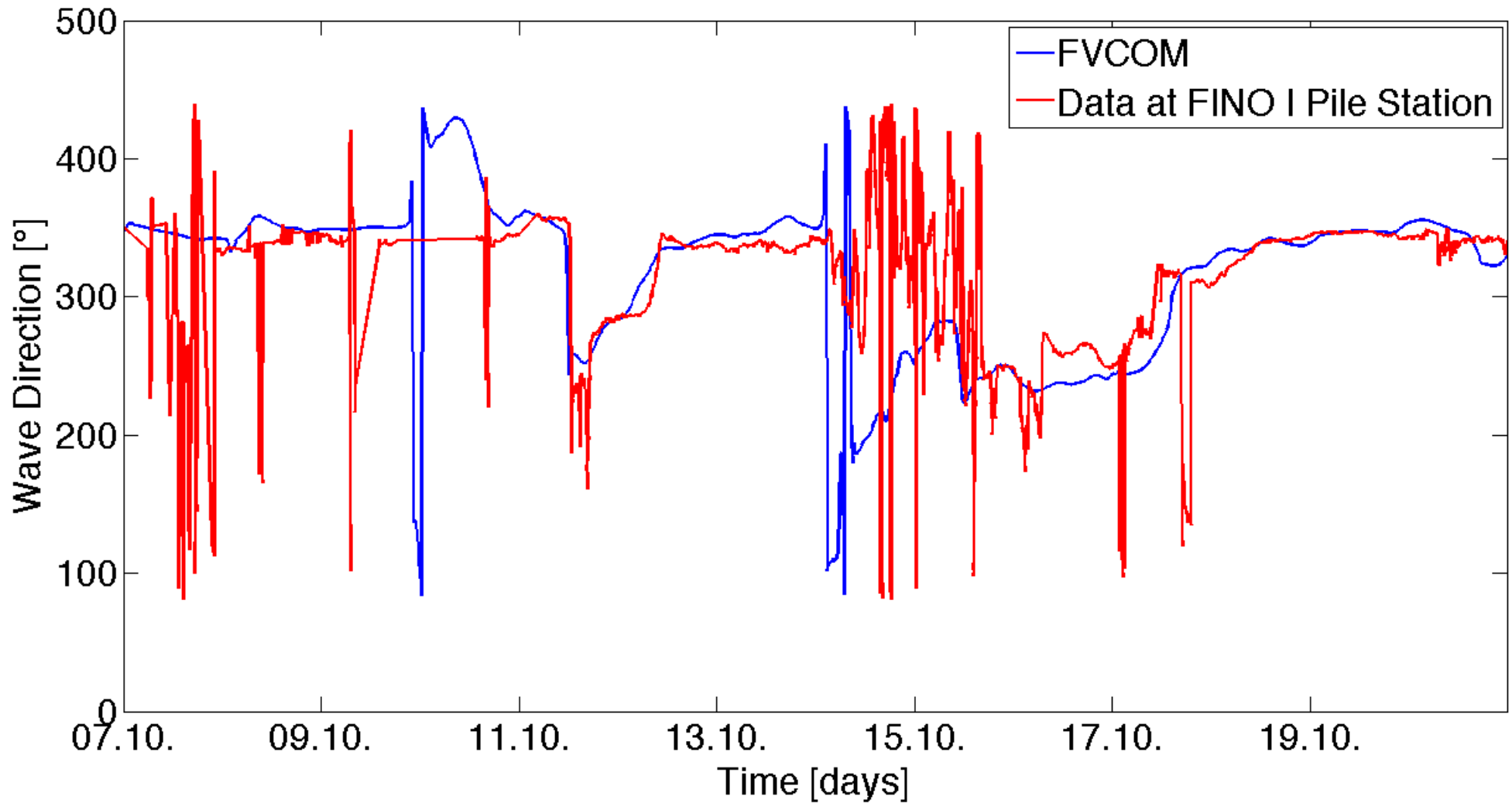
North Sea Model, October 2007, Significant Wave Height, Fino I Pile Station
07.10.2007 - 21.10.2007



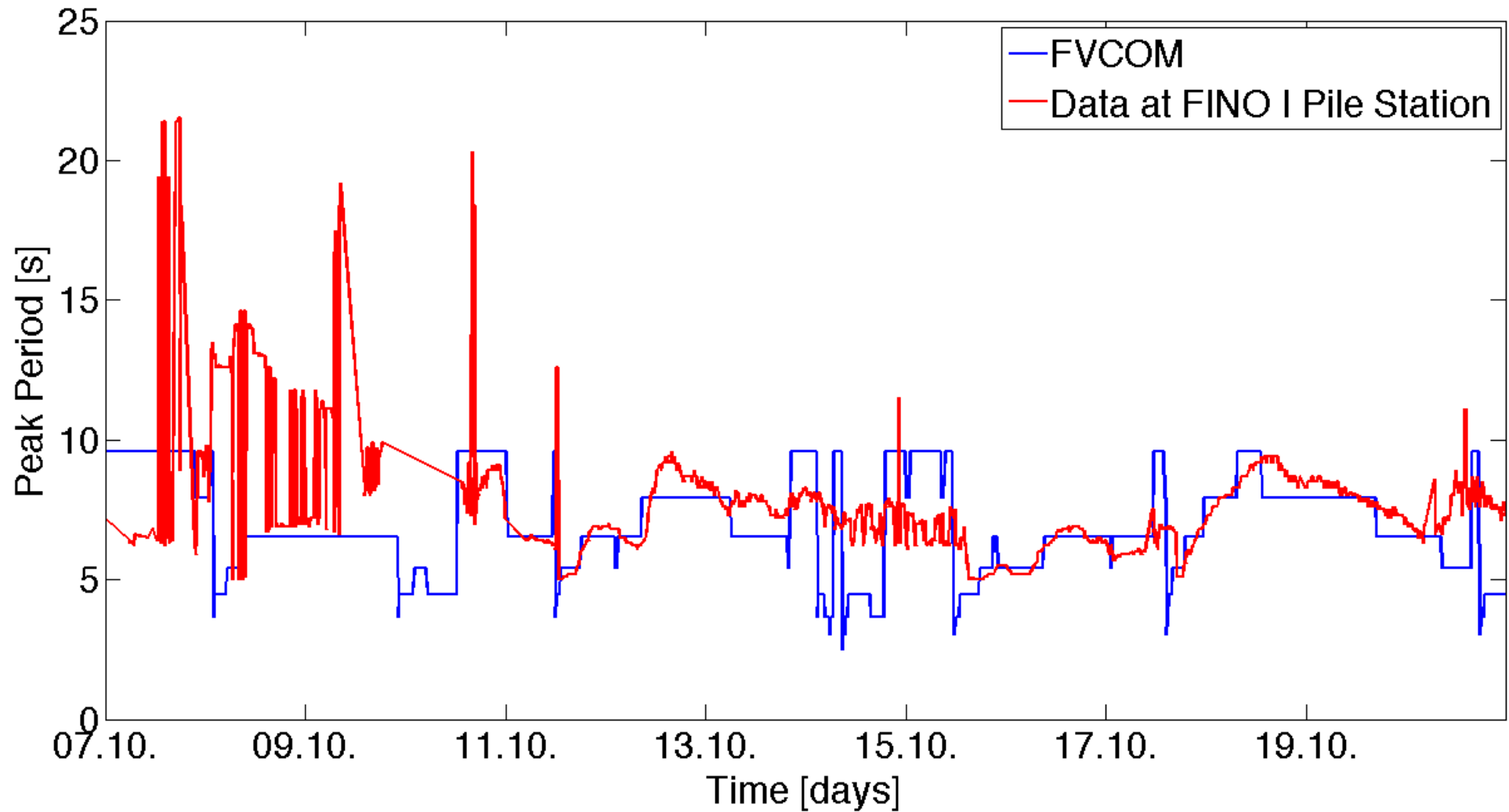
North Sea Model, October 2007, Significant Wave Height, Fino I Pile Station
07.10.2007 - 21.10.2007



North Sea Model, October 2007, Wave Direction (Nautical Convention), Fino I Pile Station
07.10.2007 - 21.10.2007

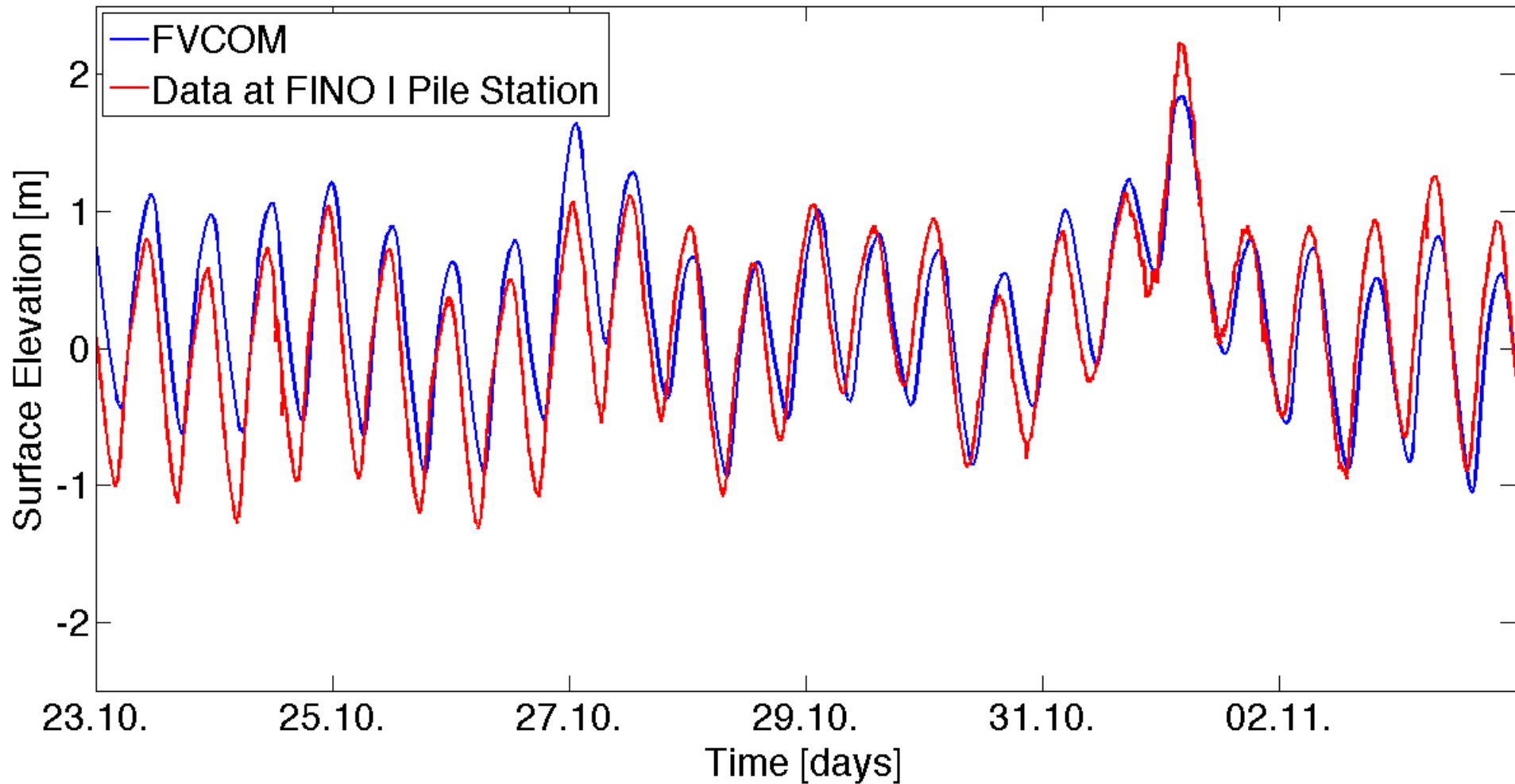


North Sea Model, October 2007, Peak Period, Fino I Pile Station
07.10.2007 - 21.10.2007

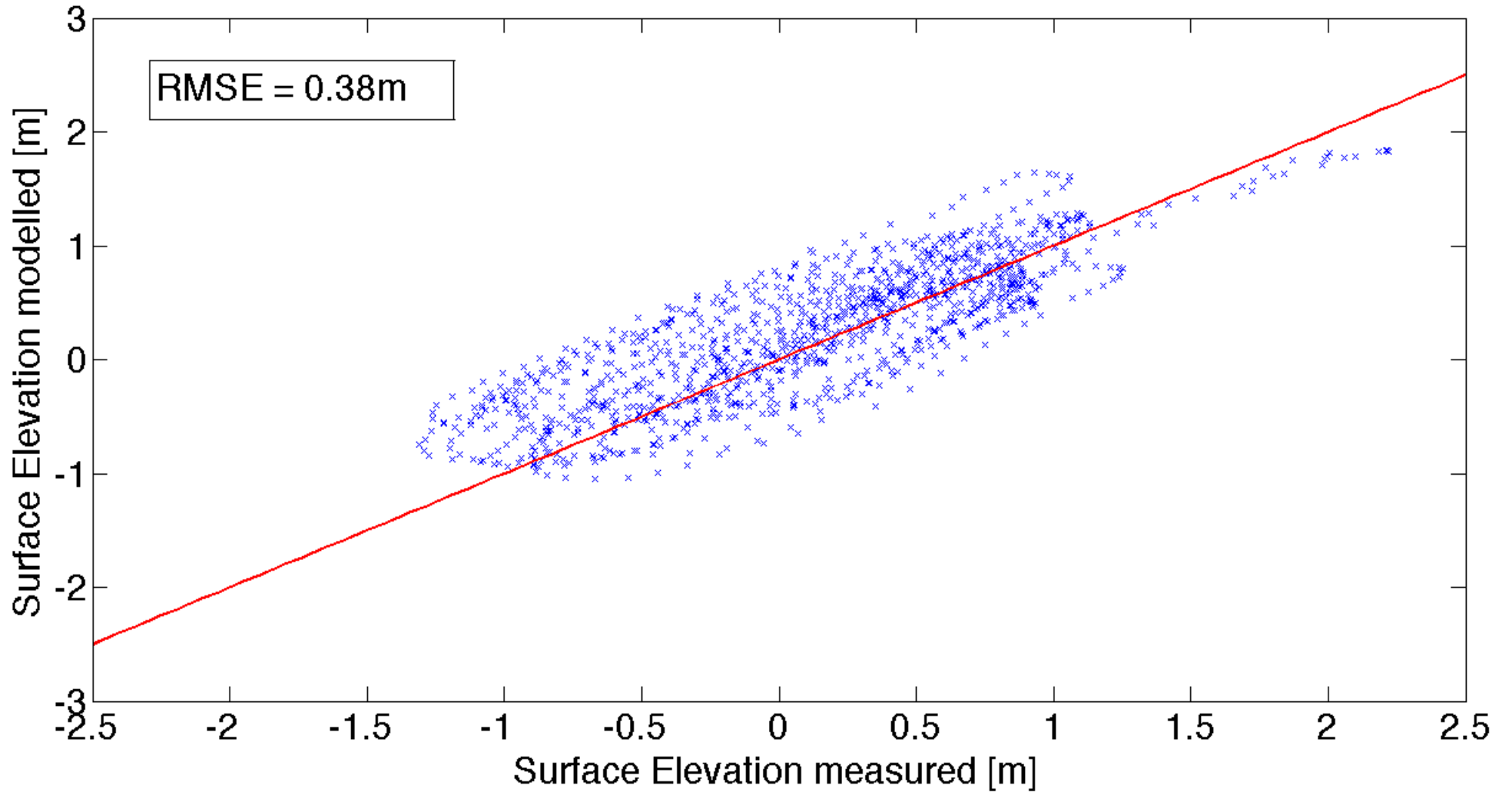


Test Case 2

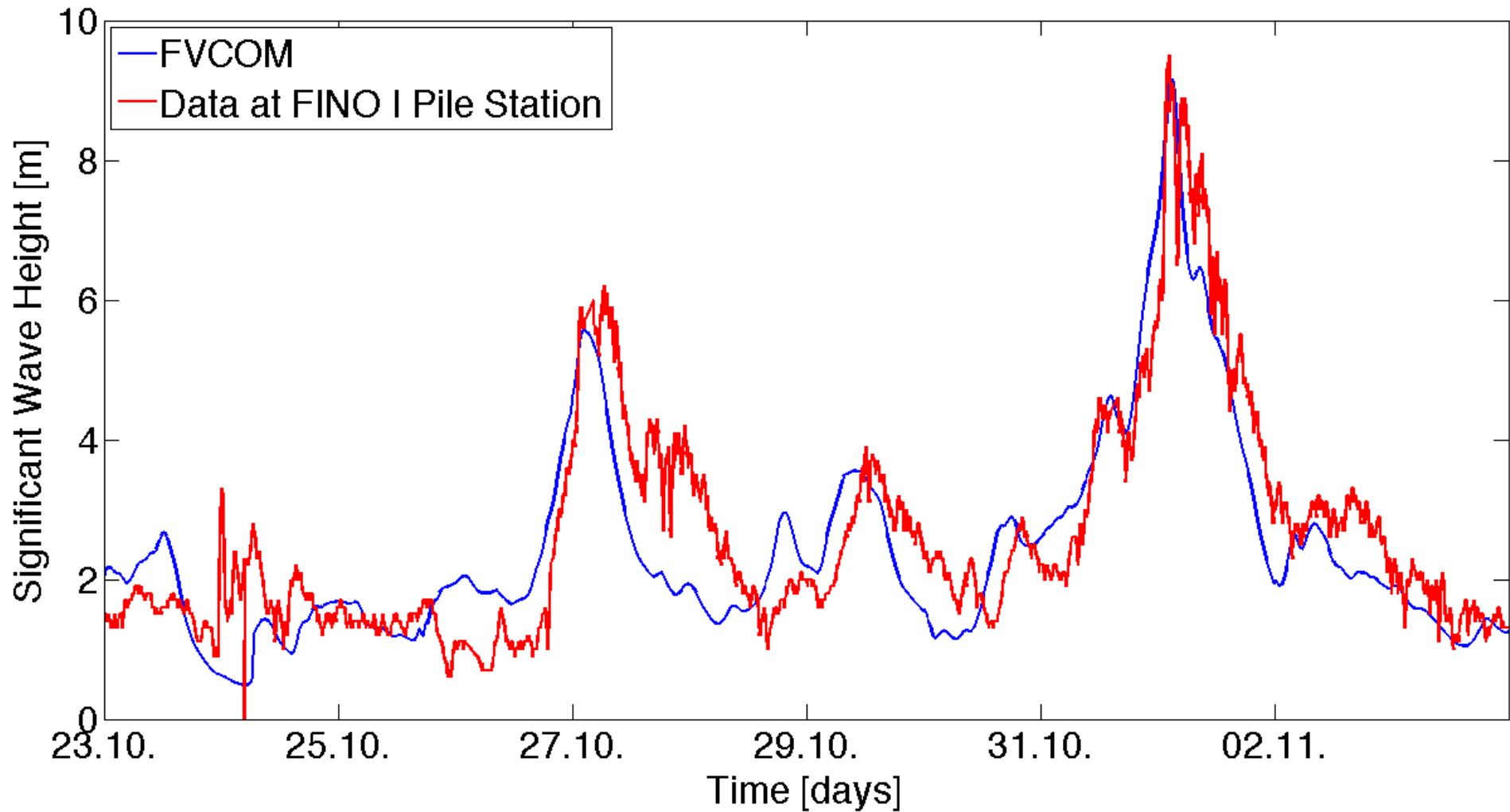
North Sea Model, Storm Britta 2006, Surface Elevation, Fino I Pile Station
23.10.2006 - 04.11.2006



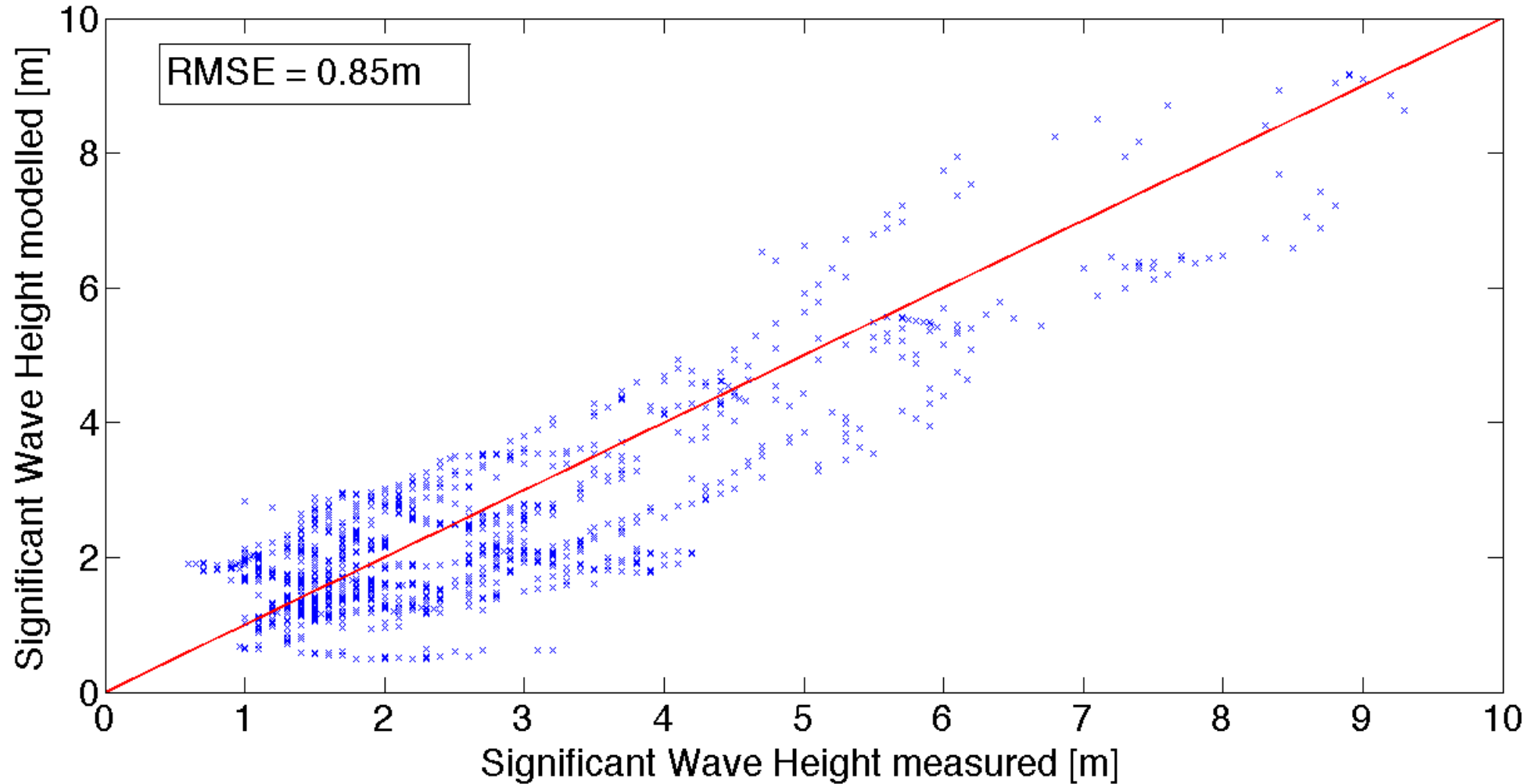
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23.10.2006 - 04.11.2006



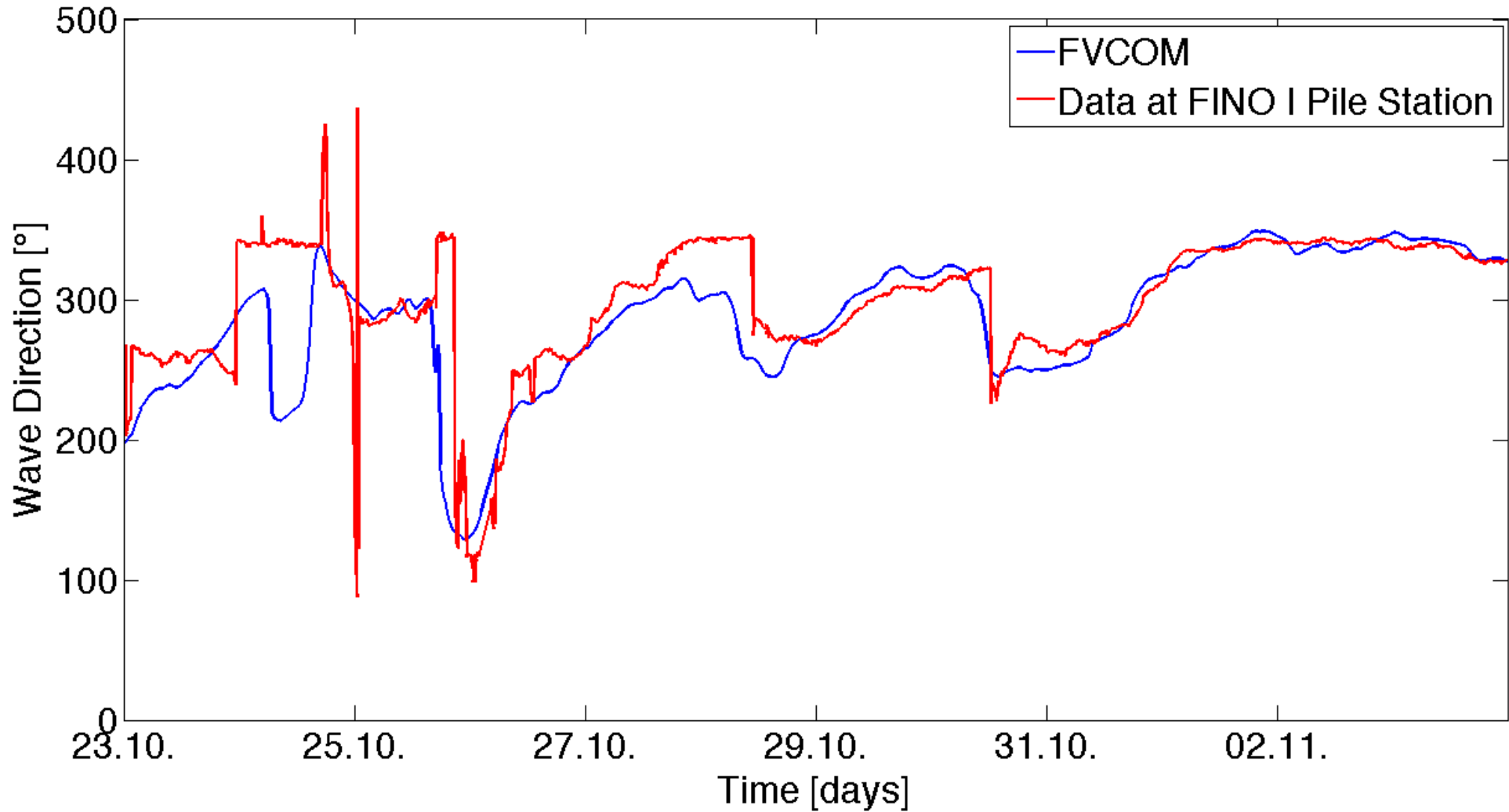
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23.10.2006 - 04.11.2006



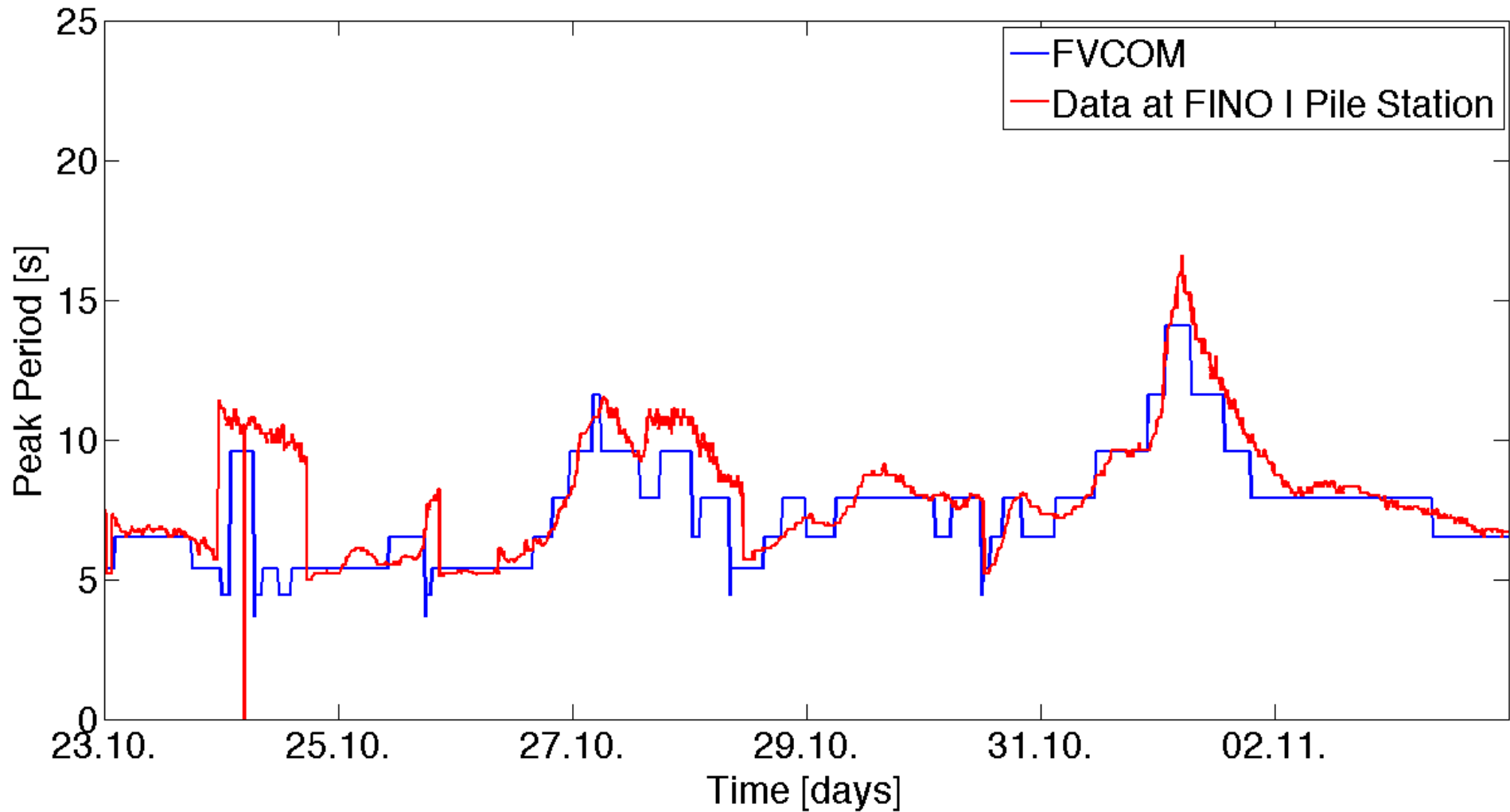
North Sea Model, Storm Britta 2006, Significant Wave Height, Fino I Pile Station
23.10.2006 - 04.11.2006



North Sea Model, Storm Britta 2006, Wave Direction (Nautical Convention), Fino I Pile Station
23.10.2006 - 04.11.2006



North Sea Model, Storm Britta 2006, Peak Period, Fino I Pile Station
23.10.2006 - 04.11.2006



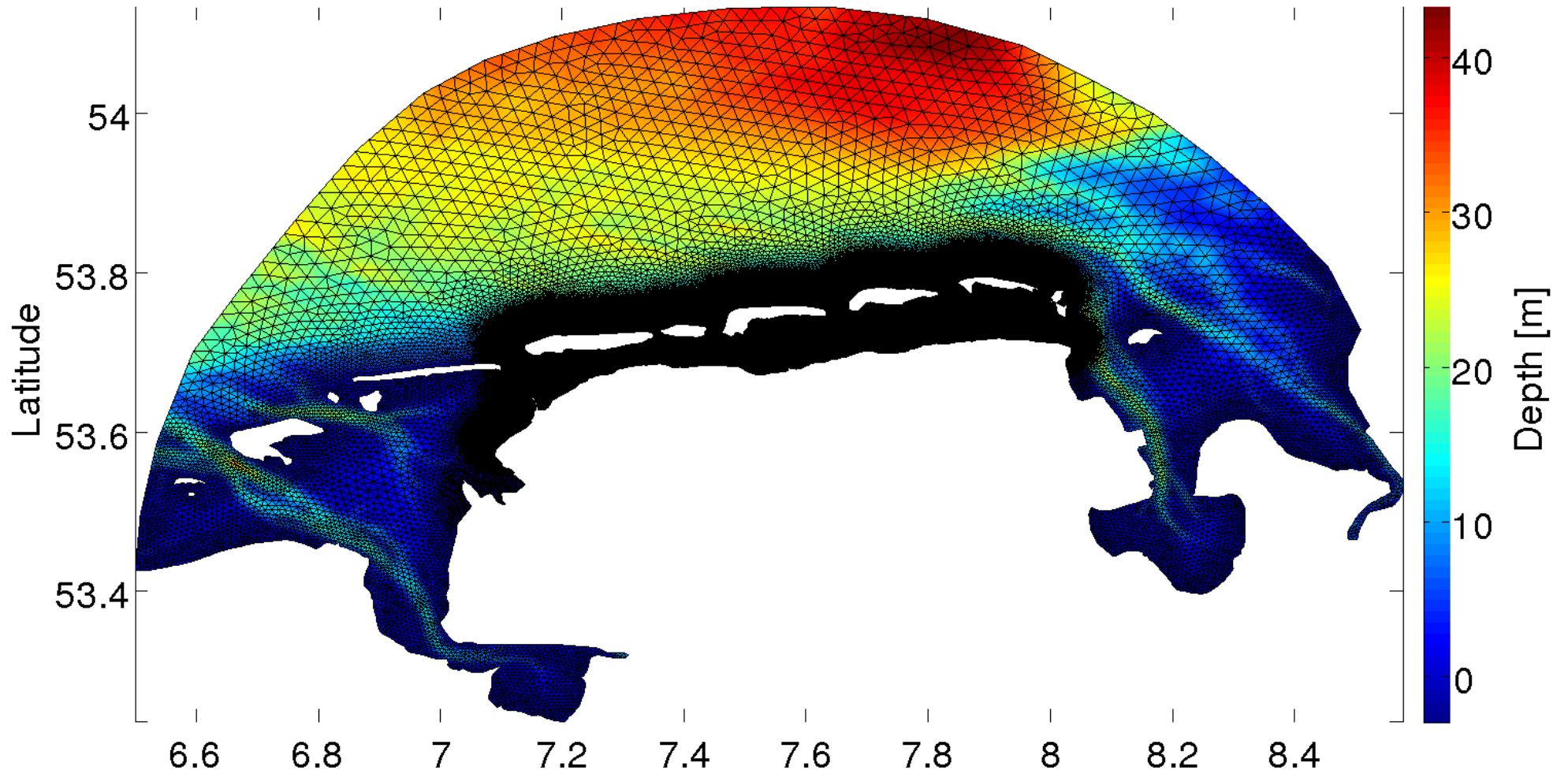
Conclusion

- Performance of FVCOM-SWAVE tested in the East Frisian Wadden Sea area
- Performance of model is acceptable
- Trends can be identified
- Spin-up time of 2 days too short
- Computational time problematic

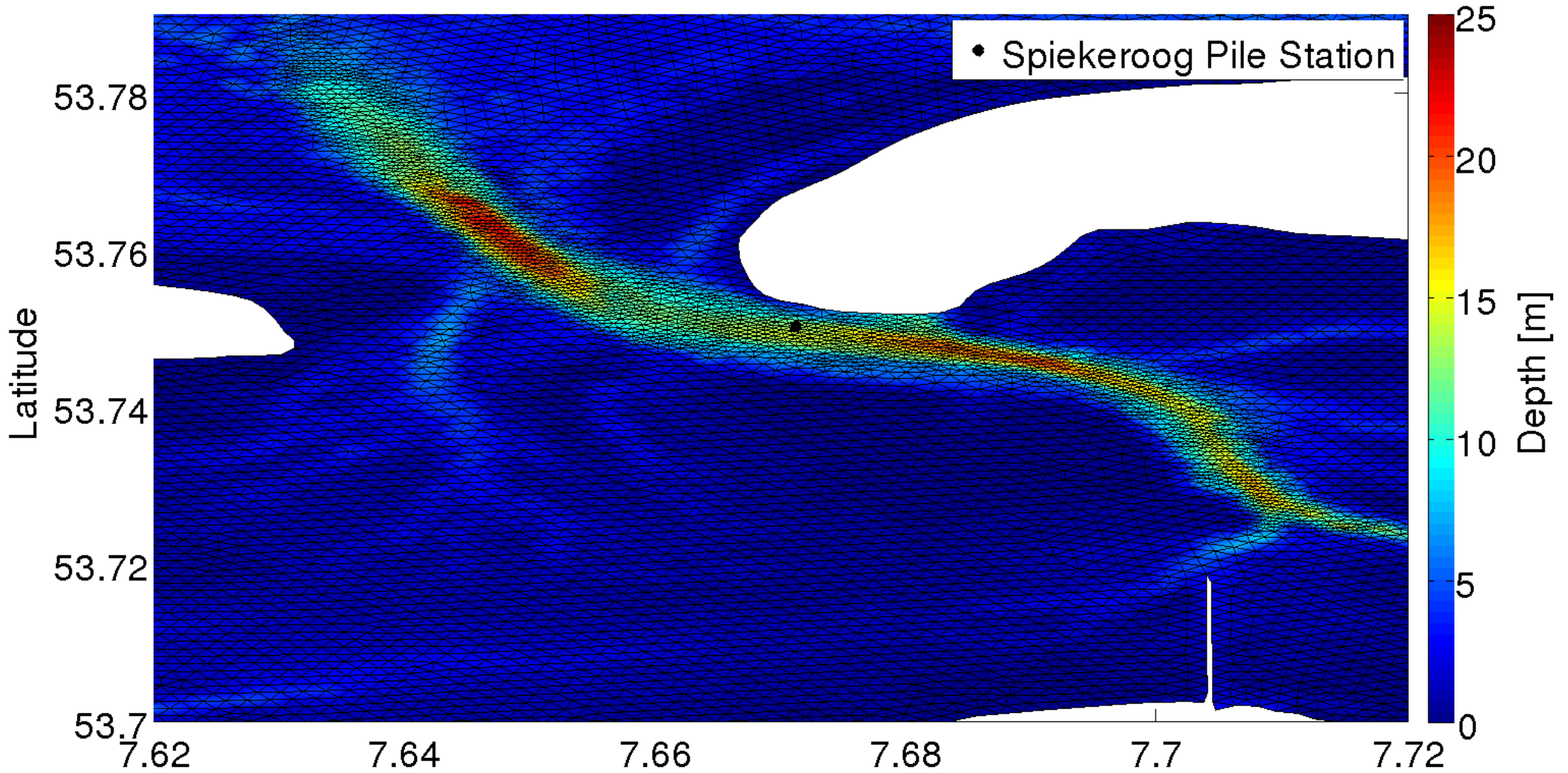
Outlook

- Using the FVCOM-Model including SWAVE in a Wadden Sea Model with a higher resolution
- Using the output of the North Sea Model as boundary conditions for the Wadden Sea model
- Calculating sediment distributions in the Wadden Sea
- Using variable temperature and salinity
- Studying the impacts of the climate change on the Wadden Sea

Barrier Islands Model Bathymetry & Unstructured Mesh



Barrier Islands Model Bathymetry & Unstructured Mesh



A wide-angle landscape photograph showing a coastal dune area. In the foreground, there are dense, dark, leafless bushes. A light-colored path winds through the dunes towards the ocean. The ocean is visible in the distance under a clear blue sky with a few wispy clouds. The text "Thank you for your attention!" is overlaid in the center of the image.

Thank you for your attention!