# Scour Development Around Offshore Wind Turbine Foundation: Field Measurement & Analysis

Figen H. Dixen, Jan Pedersen, Jesper Fris Dahl
*DONG Energy, Wind Power*

Martin Dixen
*DHI, Ports and Offshore Technology*

# Outline of Presentation

- Motivation
- Site location
- Monitoring set-up
- Environmental conditions
- Measurment results
- Mathematical model
- Comparison of the model with field data
- Conclusions

# MOTIVATION

- To investigate the spatial and temporal variability of scouring
- Site specific validation of how much variation in scour depth can be expected
- Compared with the results of mathematical model to see how well that model captured the variation.

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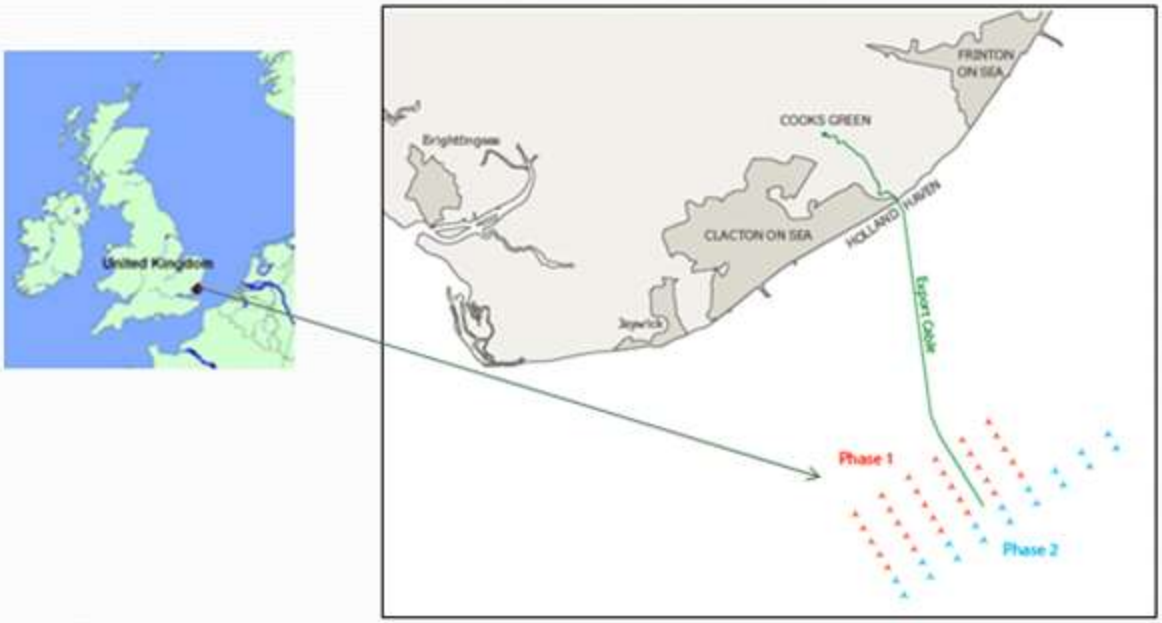
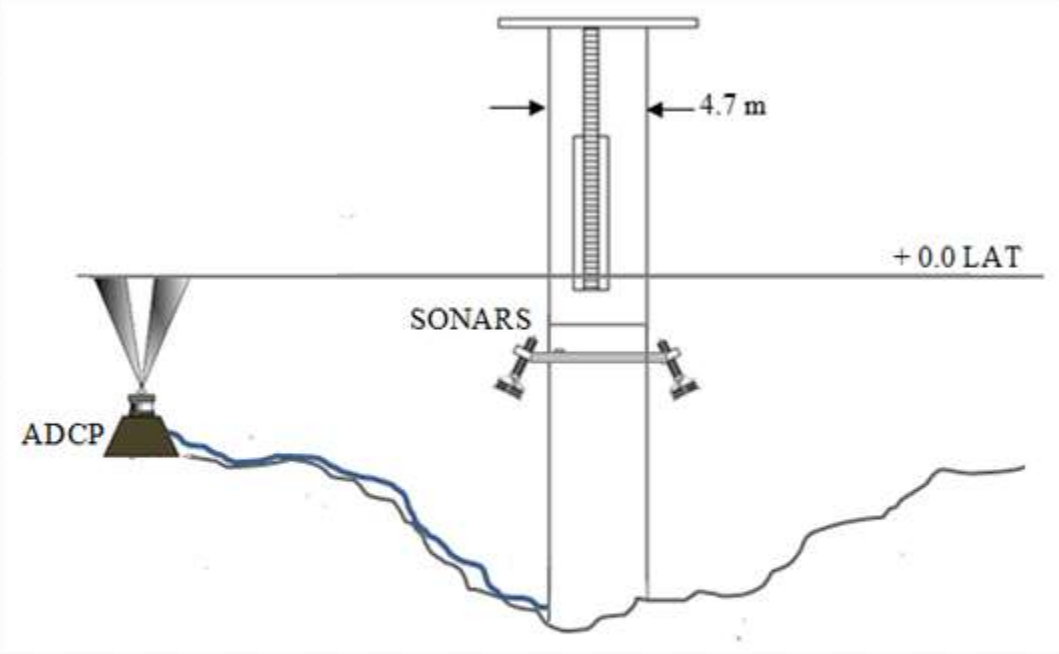
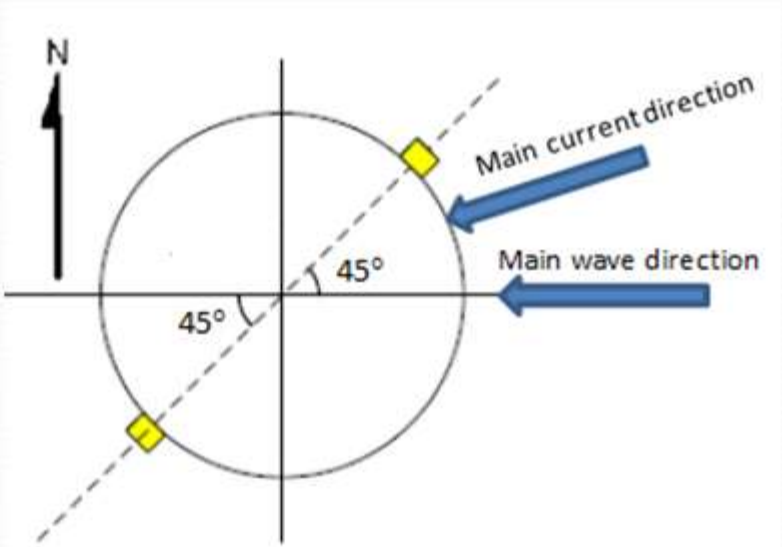
# GUNFLEET SANDS 1 & 2



# Measurement setup



# Environmental conditions



- **Wind Turbine Foundation**
  - Pile diameter : 4.7 m
- **Soil Properties**
  - Non-cohesive
  - Median grain diameter 0.2 mm
- **Environmental Condition**
  - For the observation period:
    - Water level =11.4 MSL
    - Wave conditions $Hs_{max}$=2.6 m Tp=8.3 s
    - $Uc_{max}$ = 1.1 m/s

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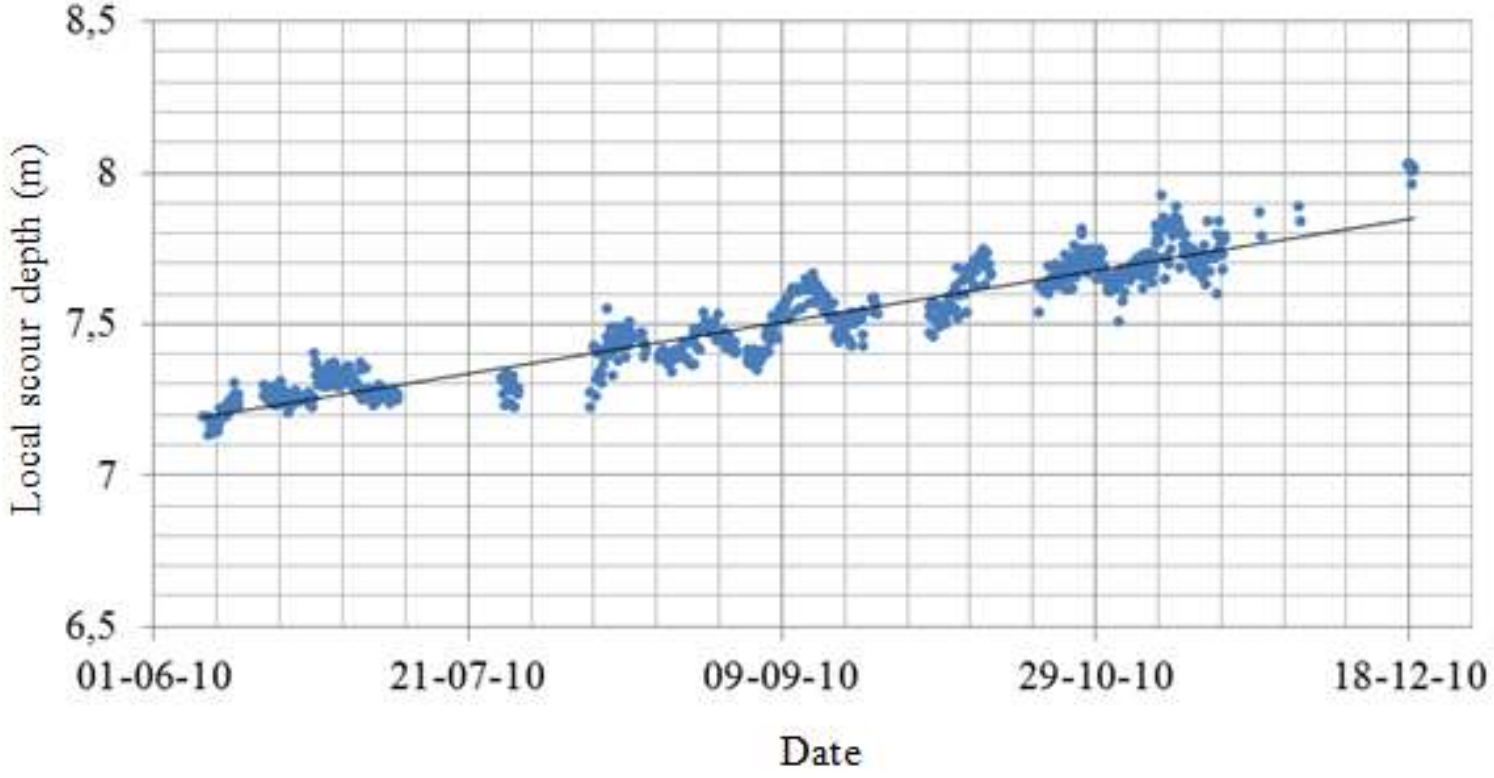
# Measured scour depths

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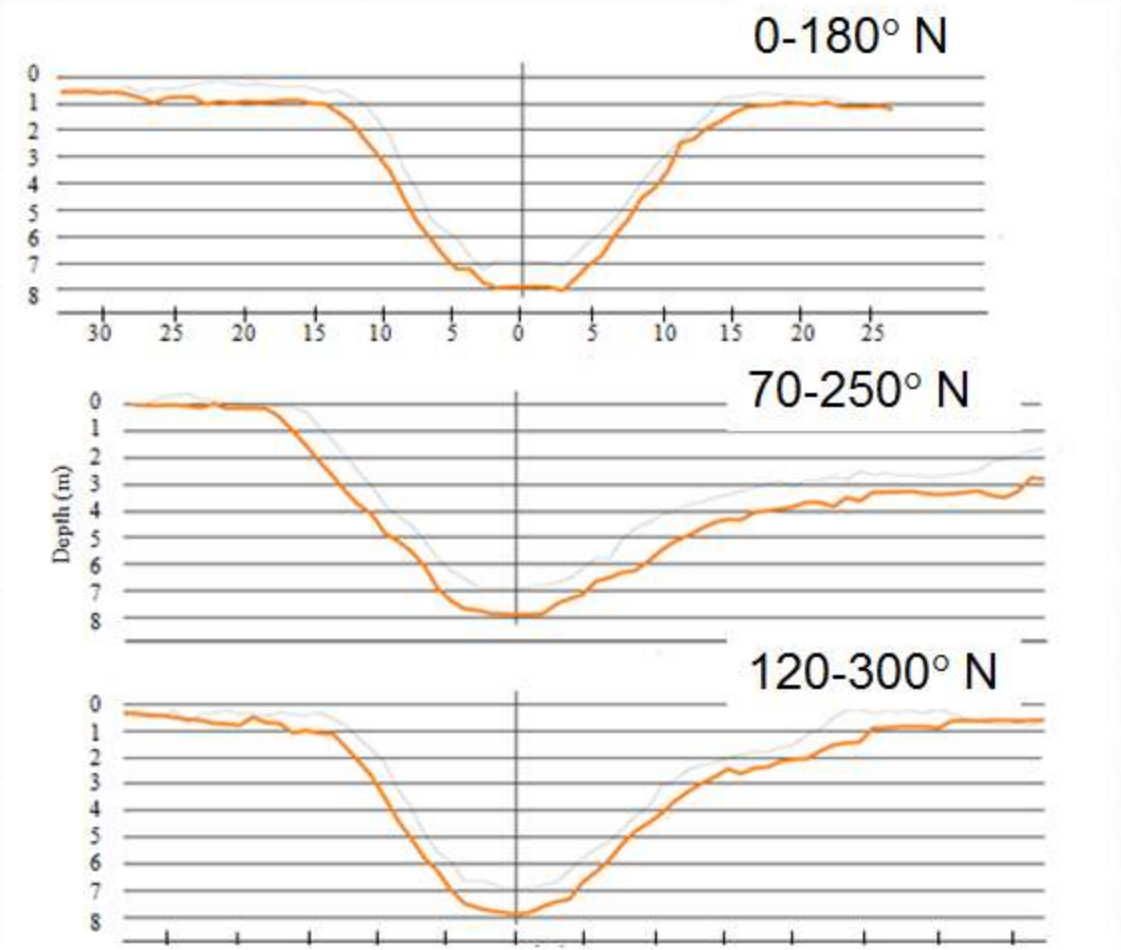


**Figure 4 : Spatial variation of scour depth.** — Start of measurements, — End of measuremen

## Mathematical model

Discretisation has been realized in the following way

$$S(t)=S_e\left(1-\exp\left(\frac{t}{T}\right)\right)$$ Whitehouse, 1998

$$S_i=S_{e,i}+\left(S_{i-1}-S_{e,i}\right)\exp\left(\frac{dt}{T}\right)$$

Where the equilibrium scour depth of each time step $S_{e,i}$, is taken as the $S_e$ corresponding to the environmental condition given in that particular time step.

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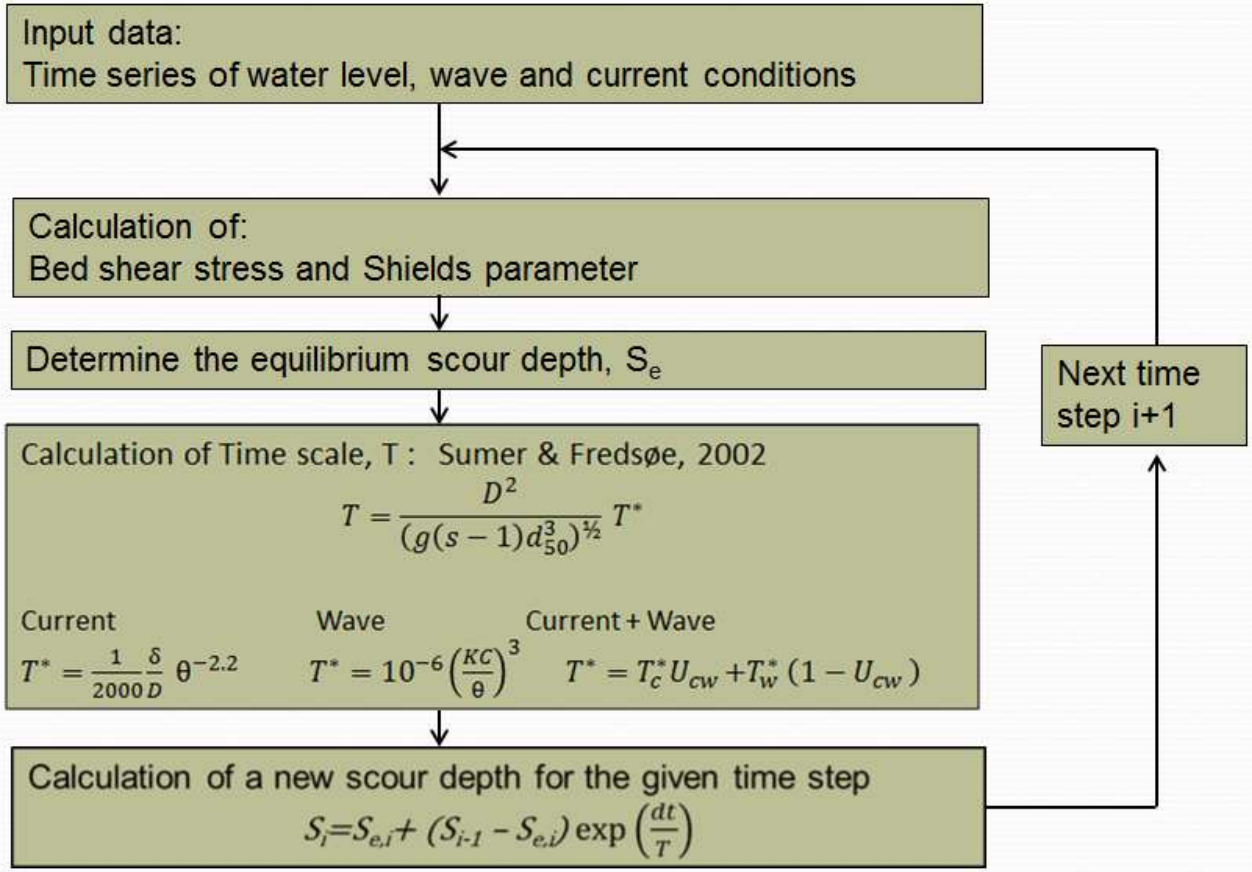
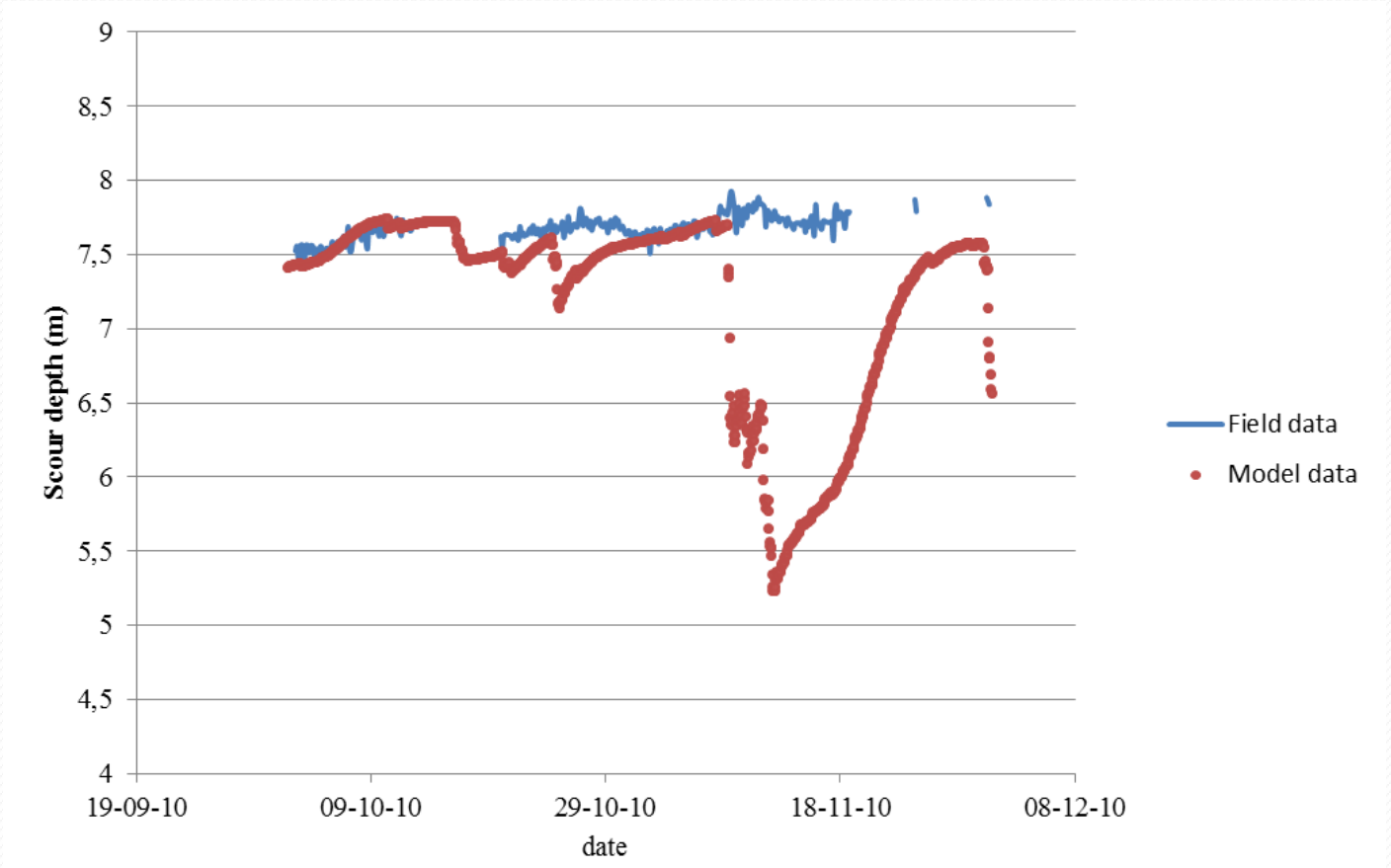
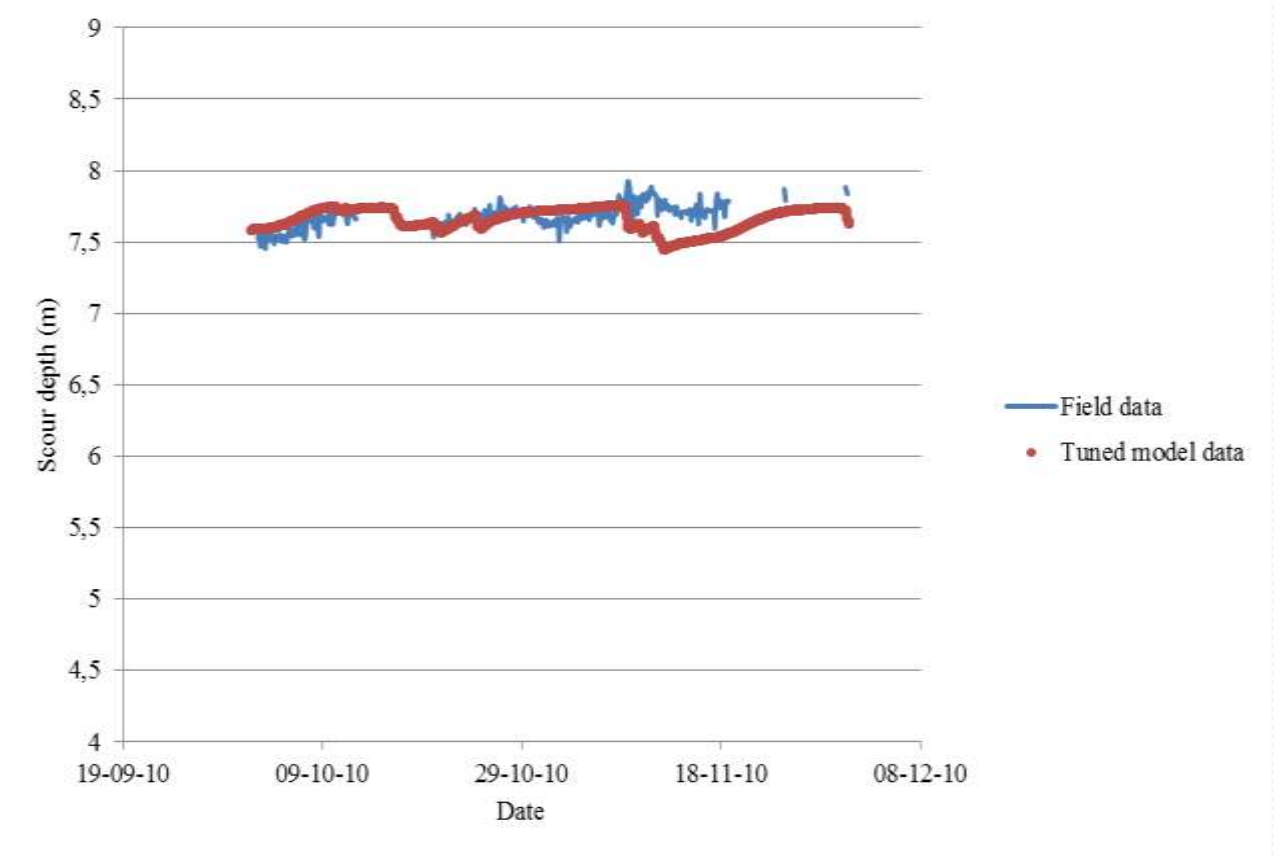

Input data:
Time series of water level, wave and current conditions
Calculation of:
Bed shear stress and Shields parameter
Determine the equilibrium scour depth, $S_e$
Calculation of Time scale, T : Sumer & Fredsøe, 2002
$T = \frac{D^2}{(g(s-1)d_{50}^3)^{1/2}} T^*$
Current
$T^* = \frac{1}{2000}\frac{\delta}{D}\theta^{-2.2}$
Wave
$T^* = 10^{-6}\left(\frac{KC}{\theta}\right)^3$
Current + Wave
$T^* = T_c^* U_{cw} + T_w^* (1 - U_{cw})$
Calculation of a new scour depth for the given time step
$S_i = S_{e,i} + (S_{i-1} - S_{e,i}) \exp\left(\frac{dt}{T}\right)$
Next time step i+1

# Comparison


9
8,5
8
7,5
7
6,5
6
5,5
5
4,5
4
Scour depth (m)
19-09-10
09-10-10
29-10-10
18-11-10
08-12-10
date
Field data
Model data

# Tuned model


9
8,5
8
7,5
7
6,5
6
5,5
5
4,5
4
Scour depth (m)
19-09-10
09-10-10
29-10-10
18-11-10
08-12-10
Date
Field data
Tuned model data

# Conclusions

- The maximum depth of scour observed during the measurement period is S/D=1.7.
- Scour depth increased despite of wave action and tidal reversal during the 6 months of measurement period.
- Assuming the backfilling rate as 10 times the scouring rate, the time development of scour has been predicted reasonably by using a relative simple mathematical model.

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# Thank you

Figen Dixen figdi@dongenergy.dk