Development of future expansion of San Vicente Harbour

Research on breakwater extension

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DUTCH PROCESS INNOVATORS

TU Delft

Deltas, Infrastructures & Mobility Initiative

ARCADIS

UCSC

Port research project (educational purpose)

- For Biobío-region:
  - Climate change analysis

- San Vicente Port:
  - Terminal operations
  - Nautical operations
  - Development plan

Paraguay
Chili
Uruguay
Argentinië

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Nautical operations

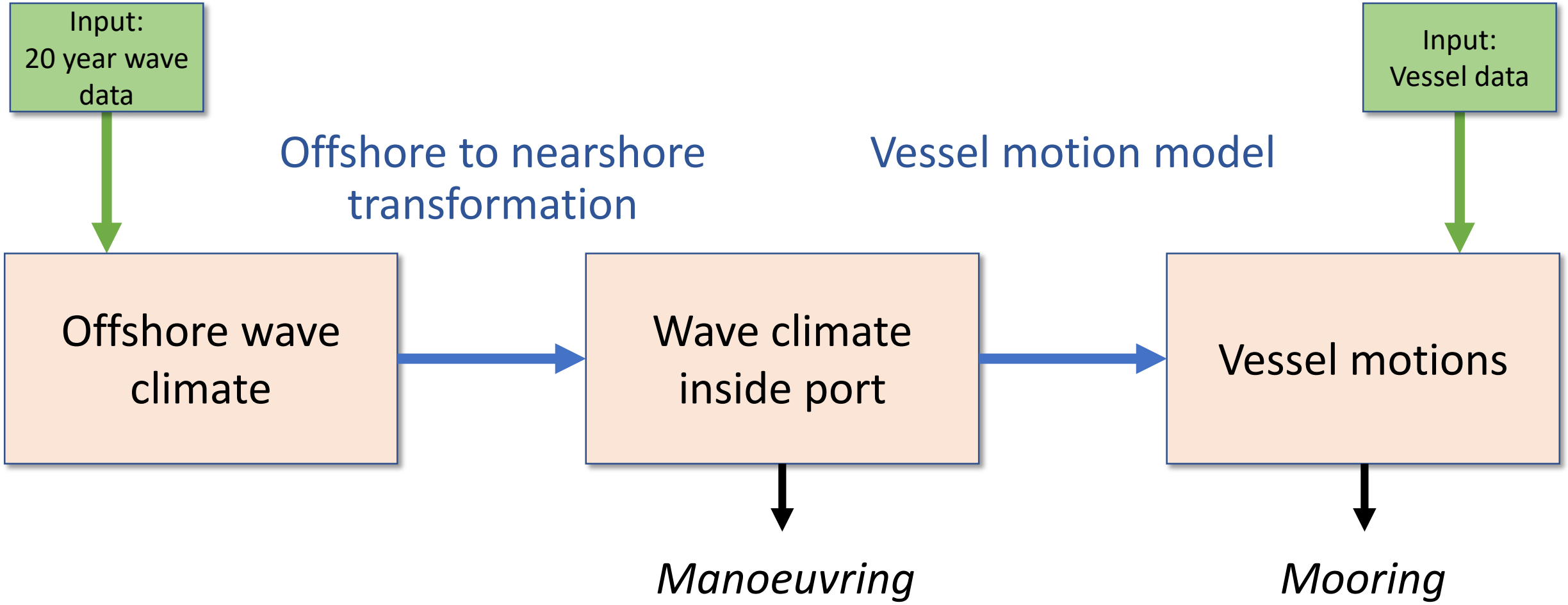
Manoeuvring

- Downtime
- Limit: H_s= 1.5 m

Mooring

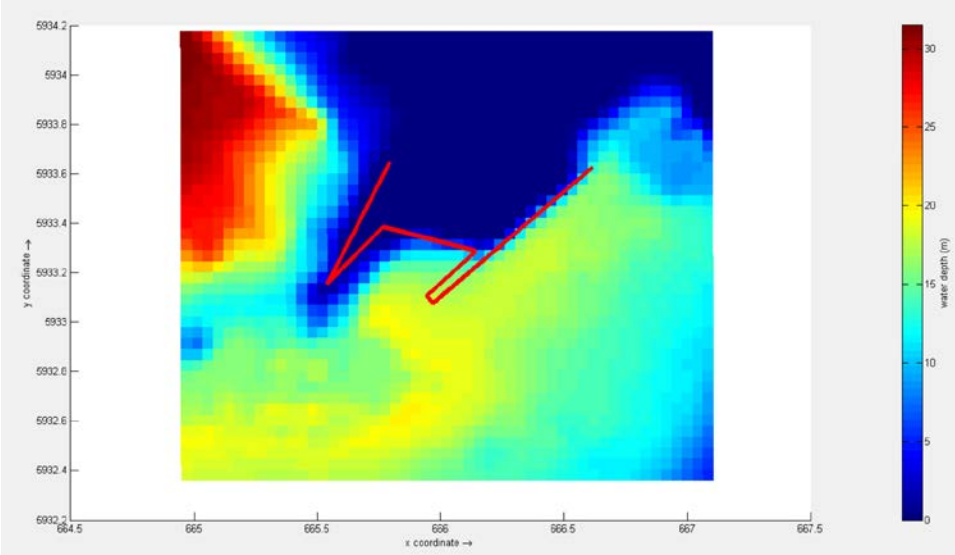
- (un)loading efficiency
- Limit: heave motion = 0.4 m

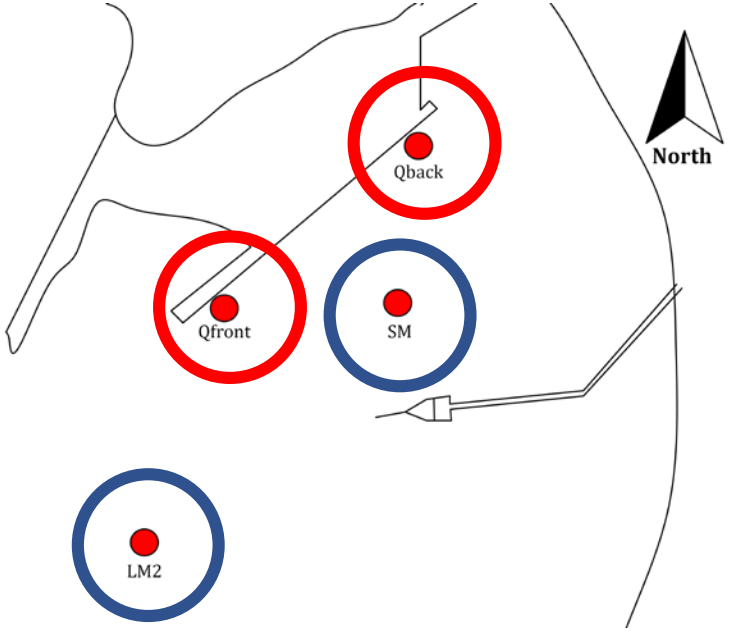
Methodology



Offshore to nearshore transformation

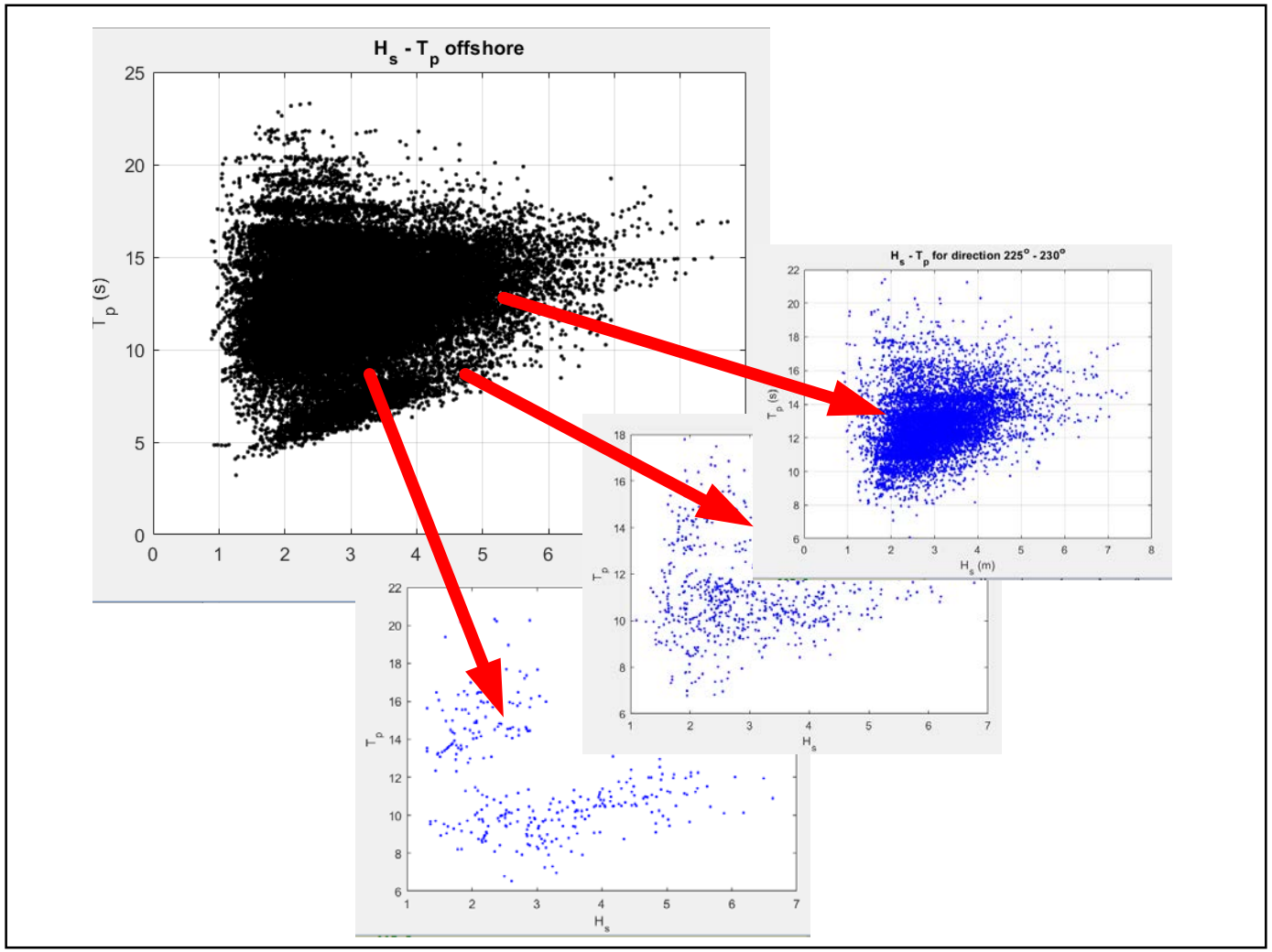
- Numerical model: Delft3D
  - Quay and breakwater elements
  - Offshore bathymetry and bathymetry of San Vicente Bay
  - ‘Observation’-points for nearshore locations





Offshore to nearshore transformation

1. **Wave grouping**
2. Delft3D simulations
3. Nearshore conditions
4. Interpolation
5. Nearshore wave climate



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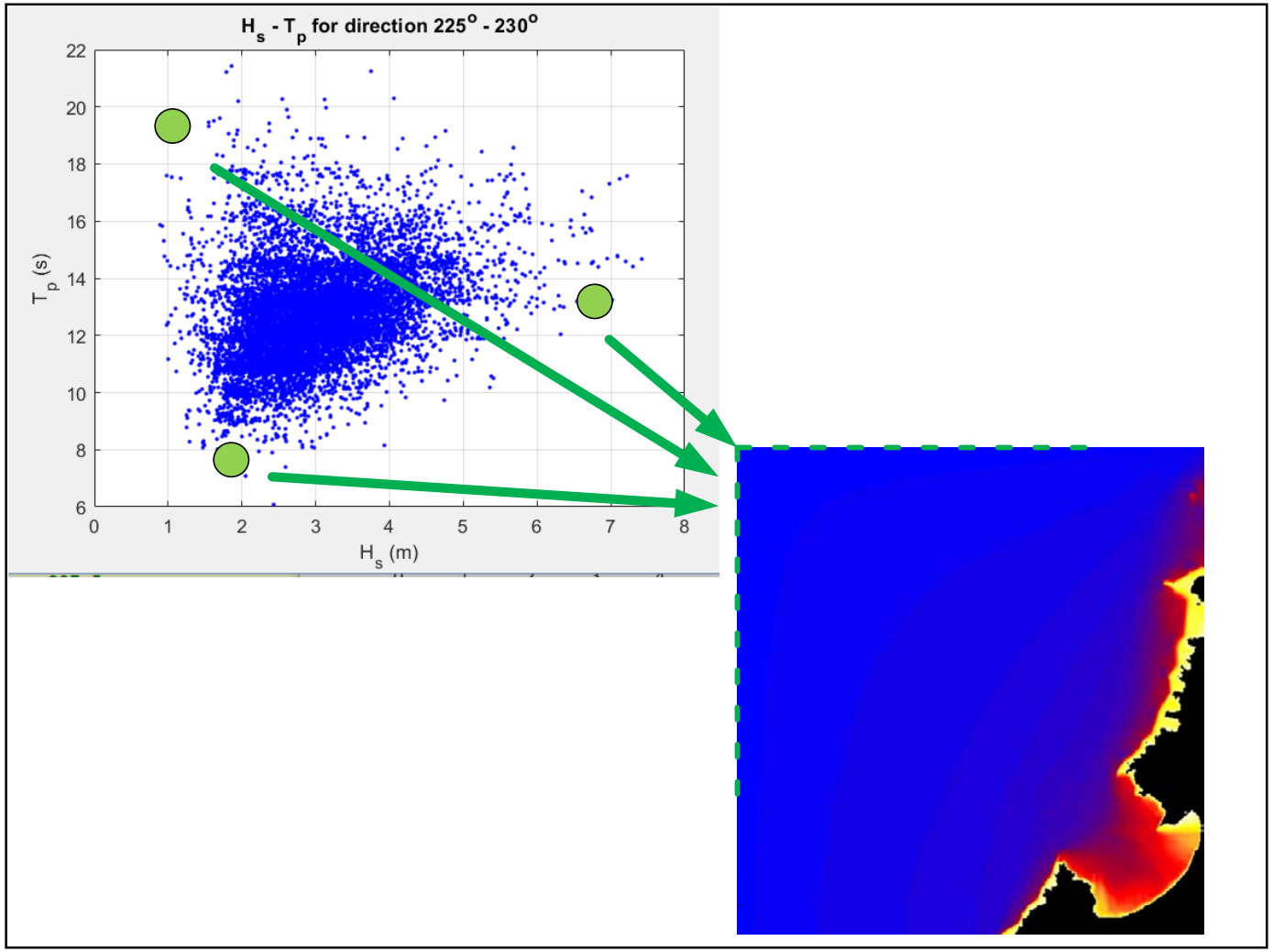

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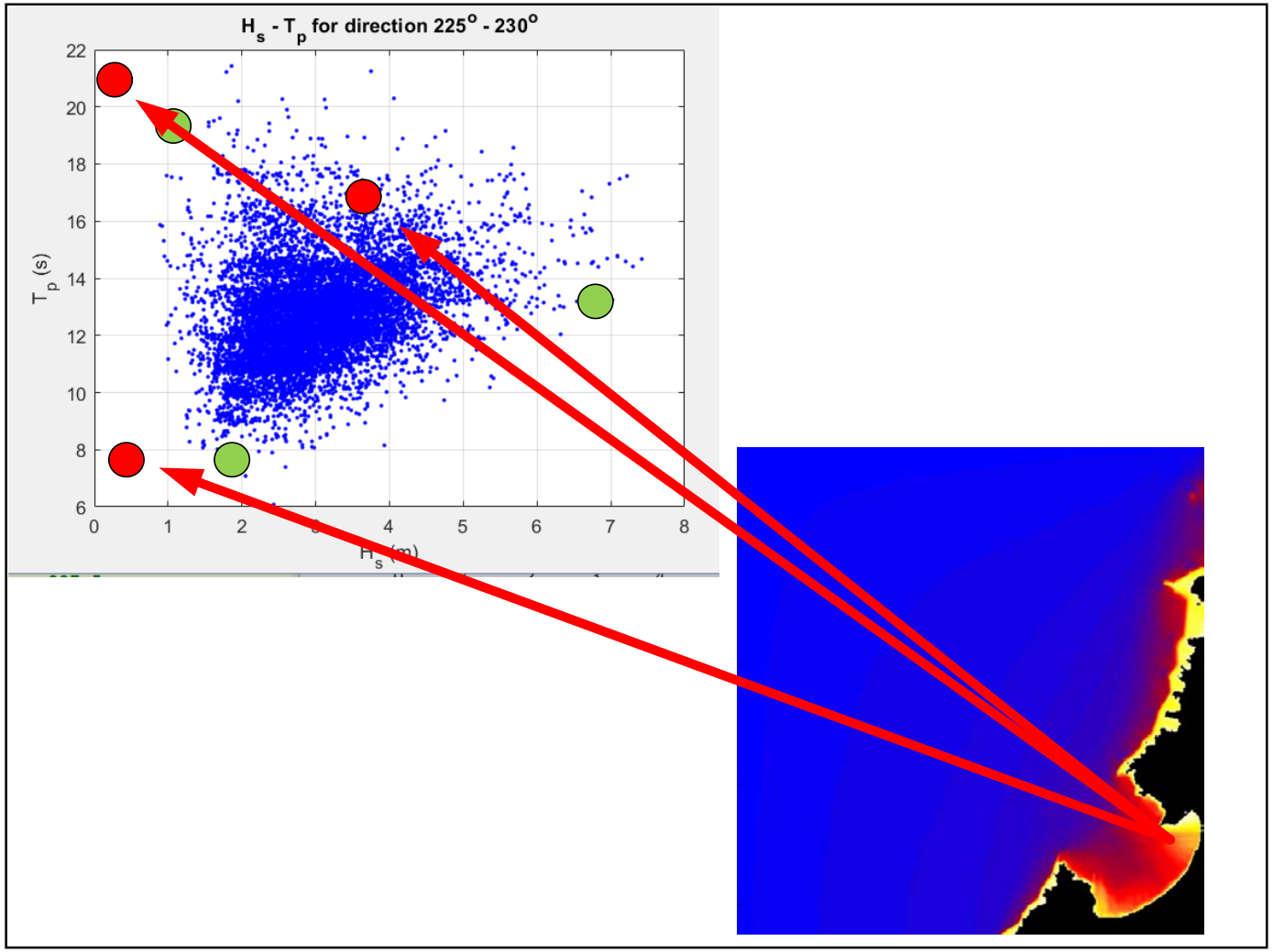

Offshore to nearshore transformation

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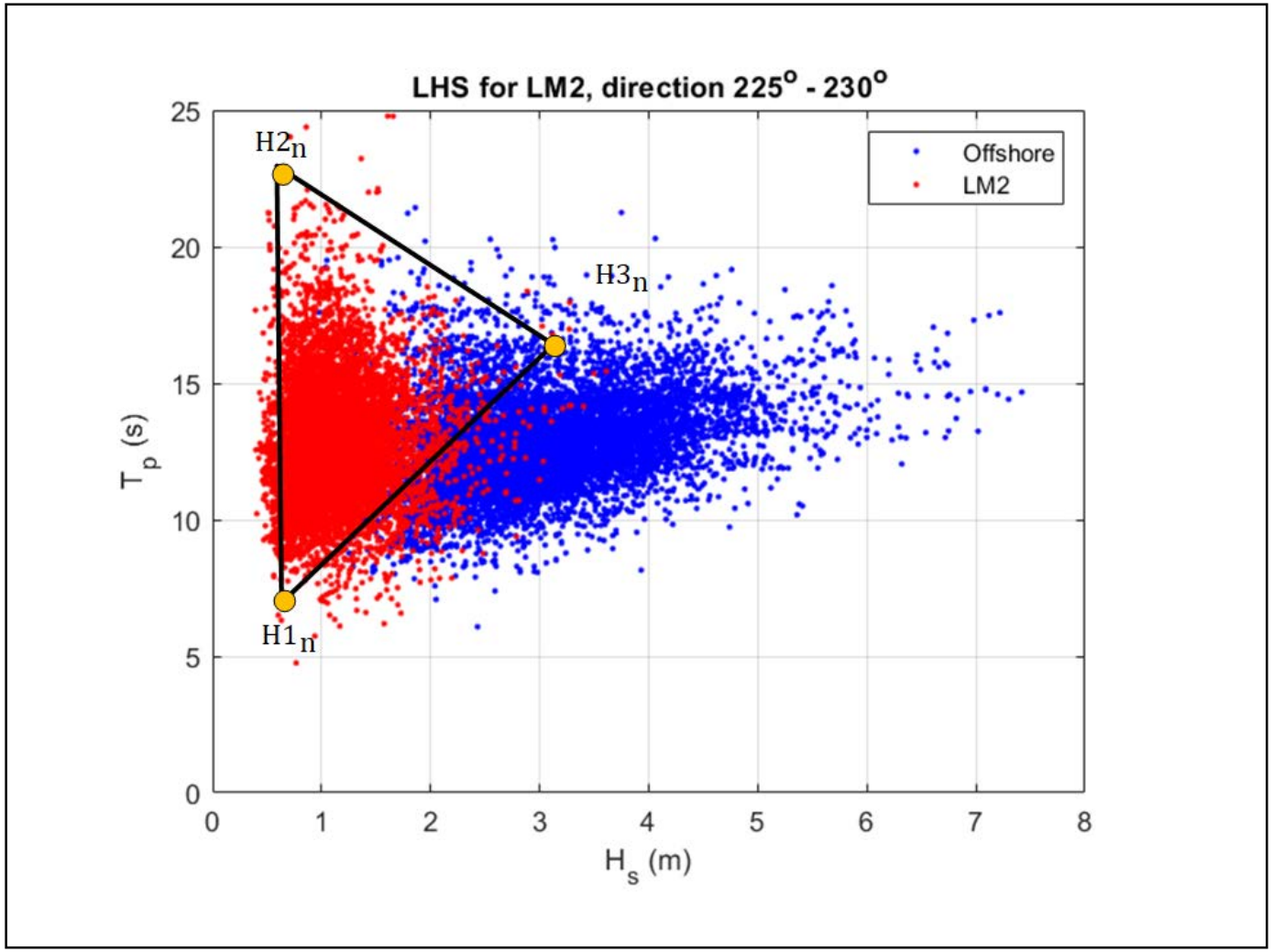

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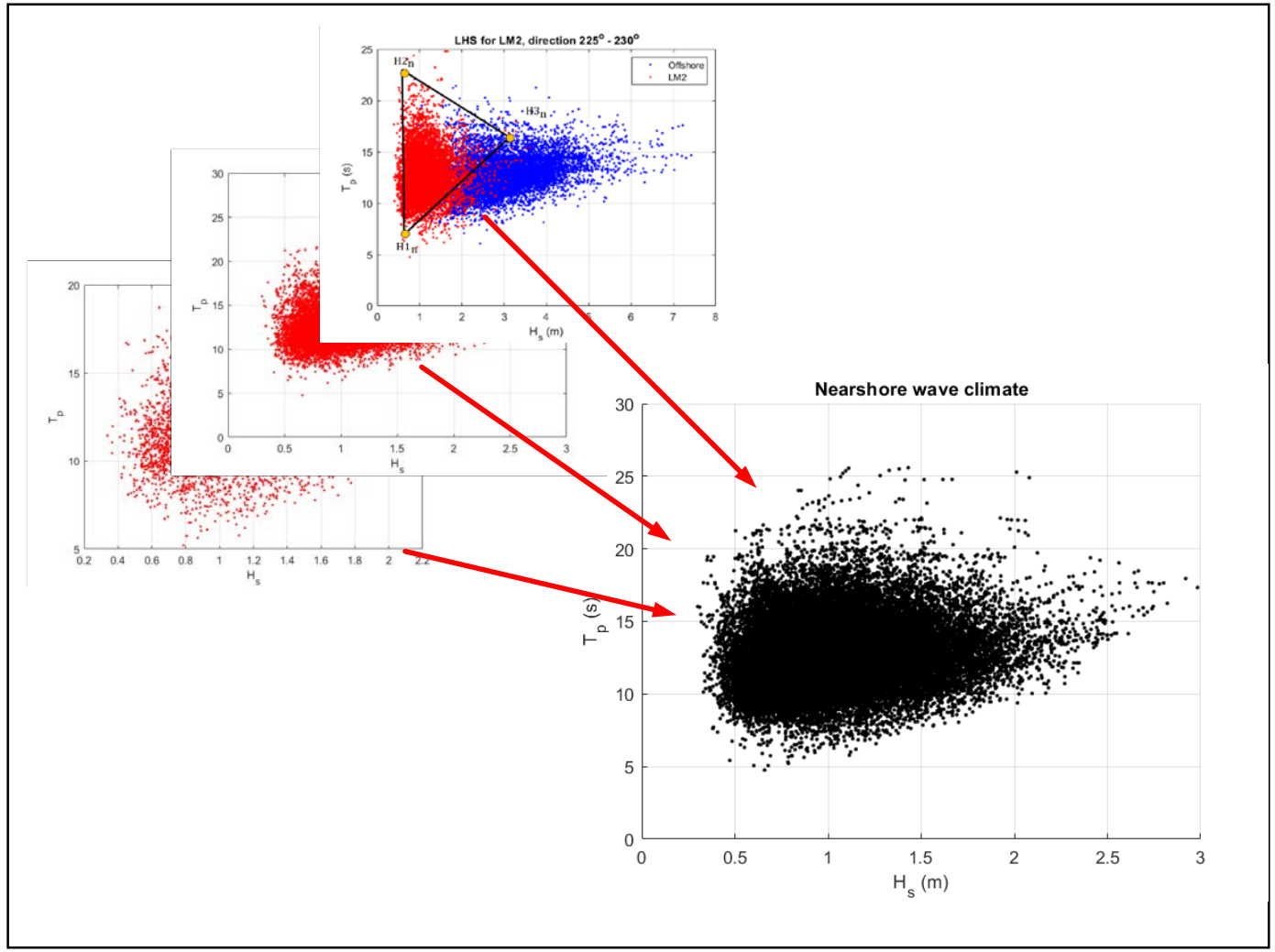
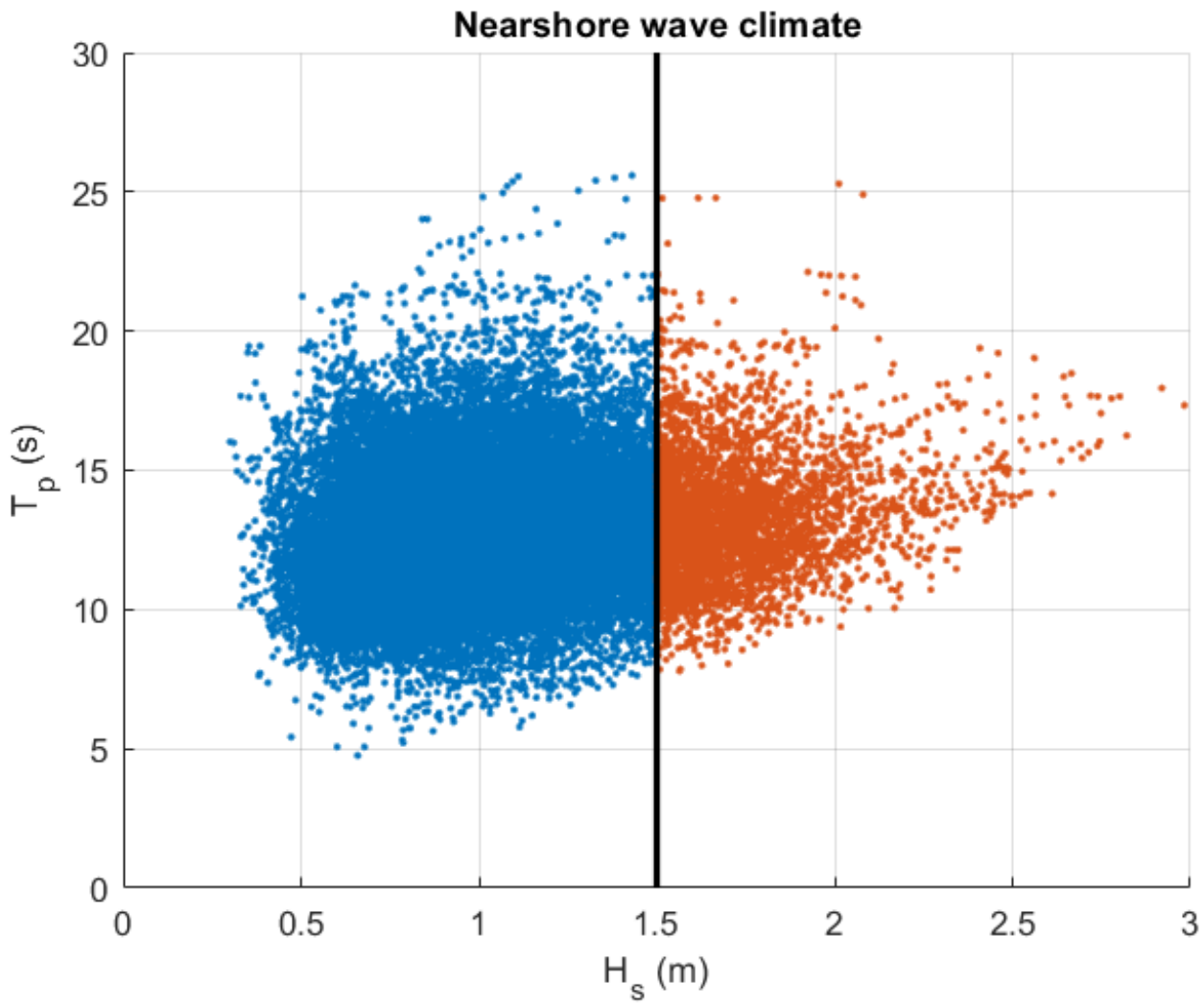


Offshore to nearshore transformation



Result:
87% of the time possible manoeuvring conditions

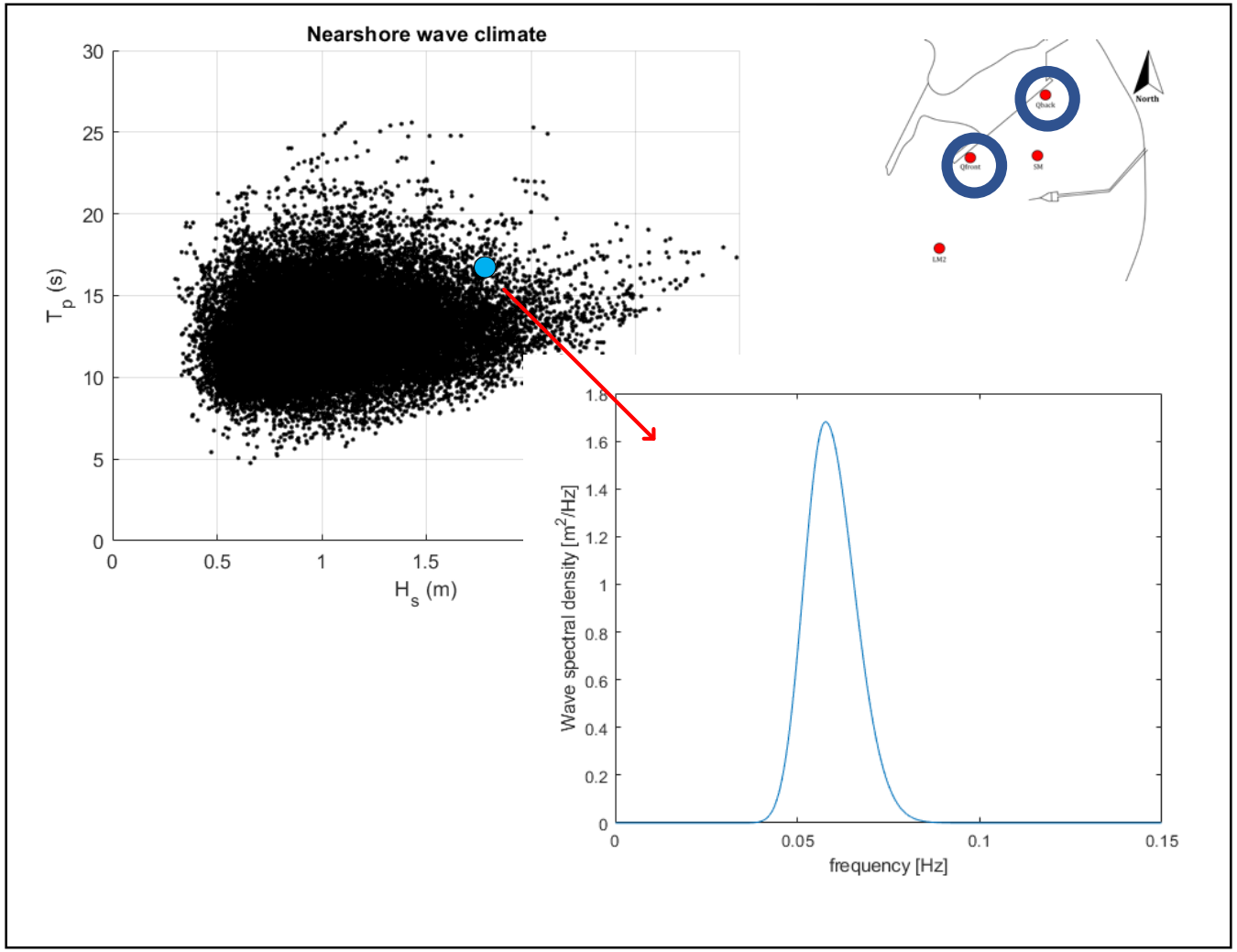
Vessel motion model

1. **Wave spectrum**

2. Response Amplitude Operator (RAO) and vessel grouping

3. Vessel motion spectrum

4. Heave oscilation



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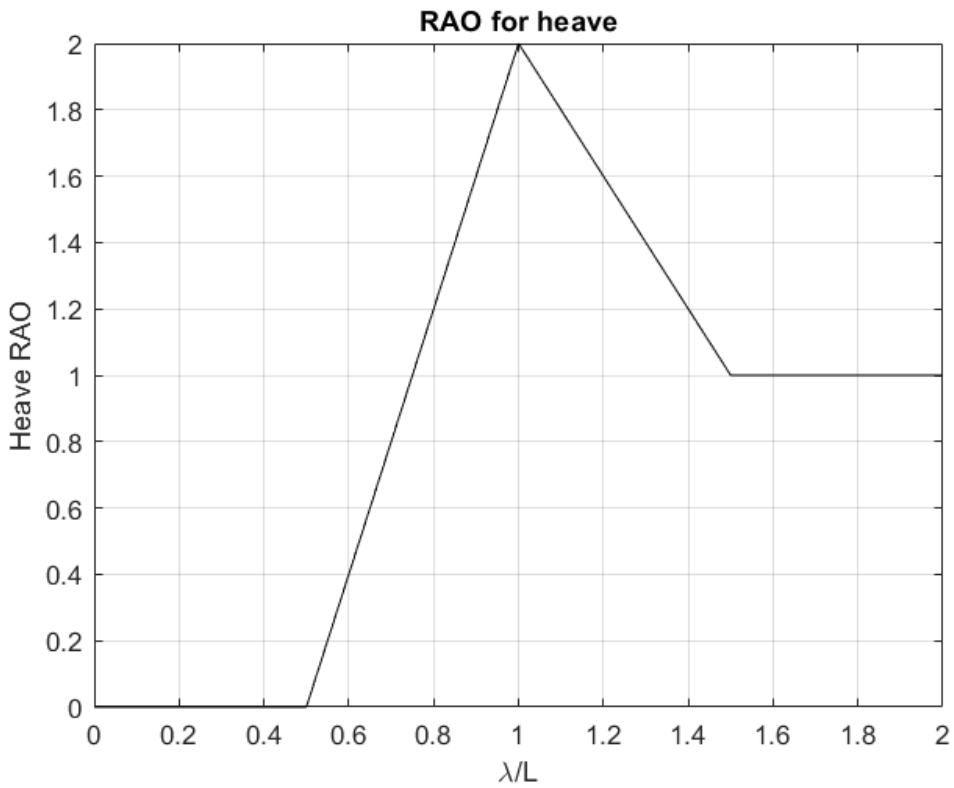


L= 347 m

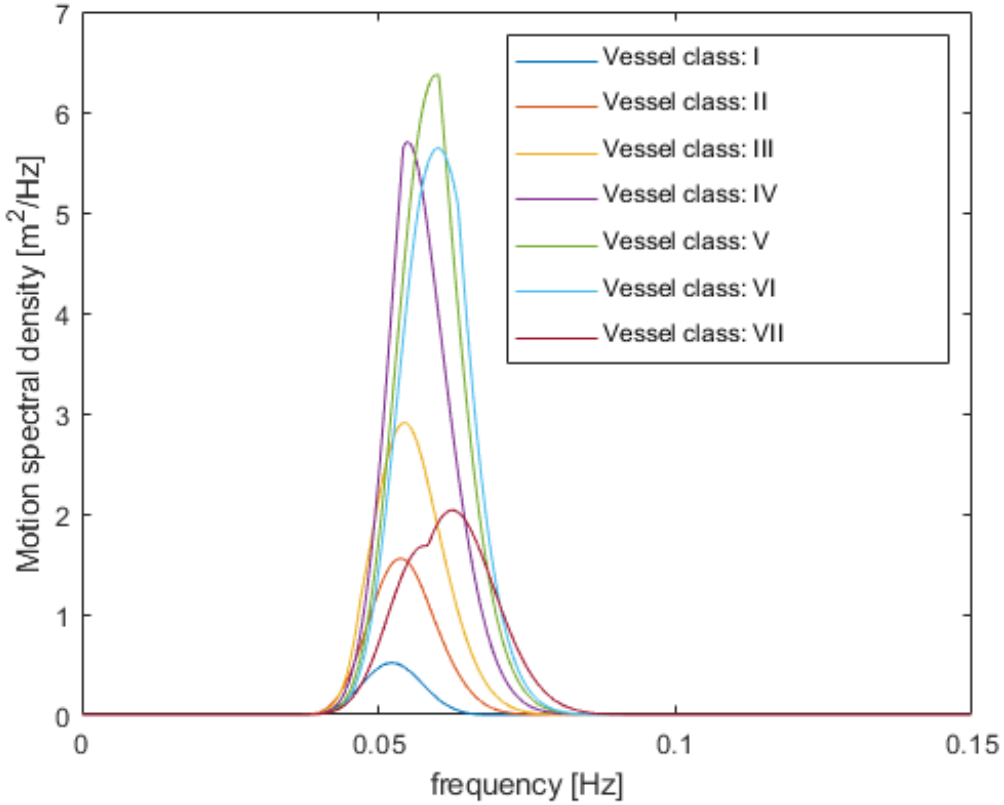
L = 138 m

L= 240 m

Vessel motion model

1. Wave spectrum
2. Response Amplitude Operator (RAO) and vessel grouping
3. **Vessel motion spectrum**
4. Heave oscilation

$$Wave\ spectrum\ \times RAO^2$$



Vessel motion model

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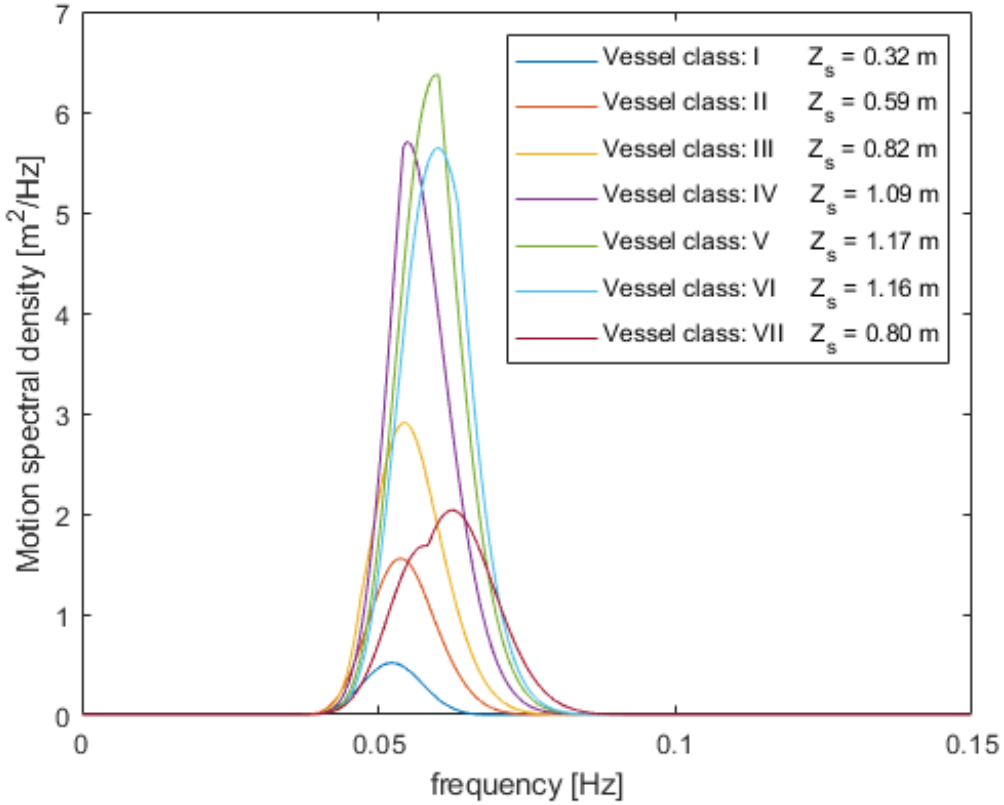
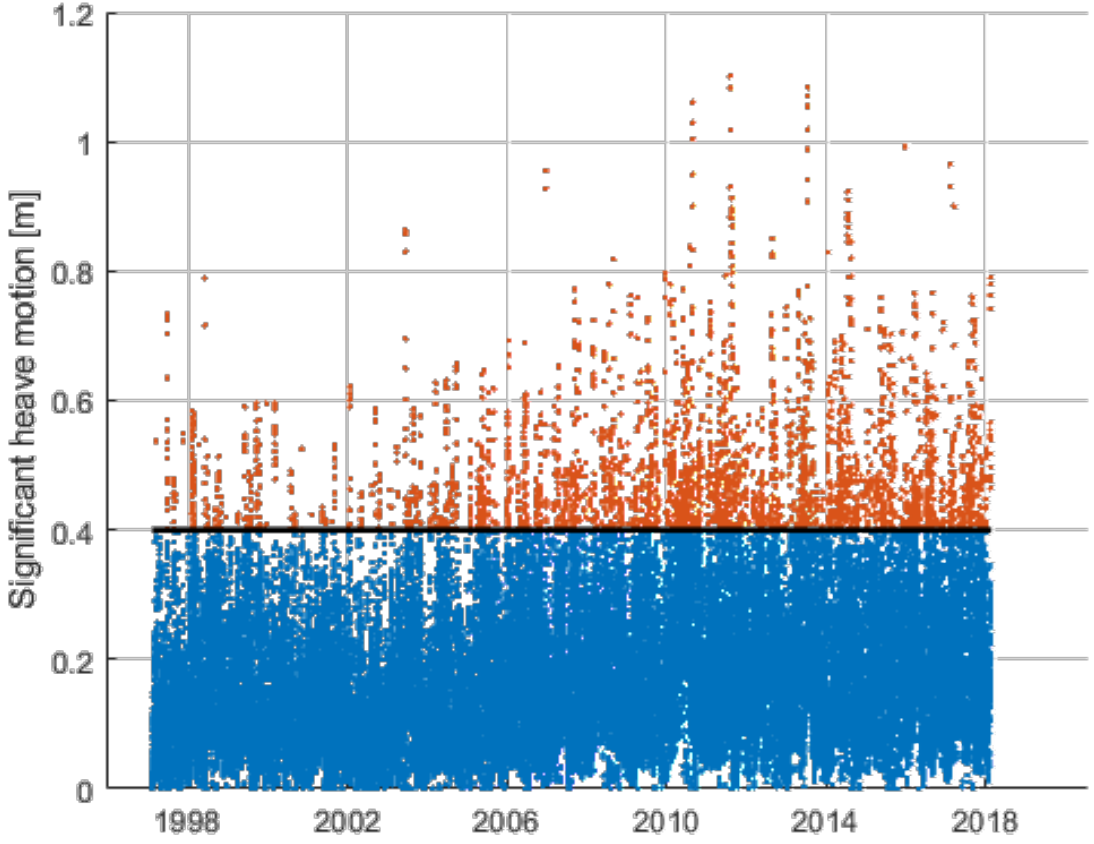
4. **Heave oscilation**

$$Heave = 4\sqrt{m_0}$$



Vessel motion model

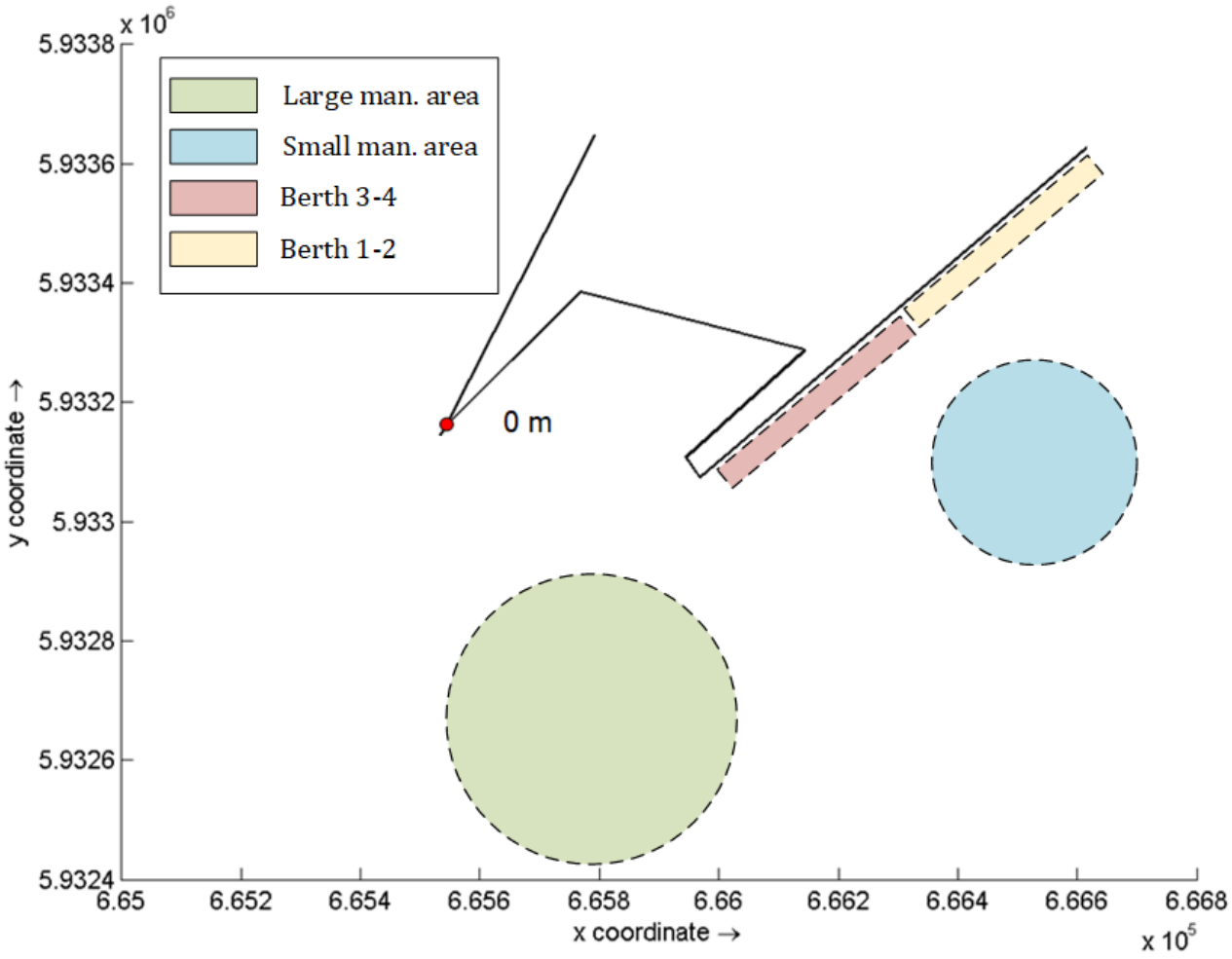
- Heave oscillation dataset per vessel (20 year)



Result:
95% of the time
optimal loading efficiency

Breakwater extension

- Increase sheltered zone
- Decrease tug downtime
- Decrease vessel motion



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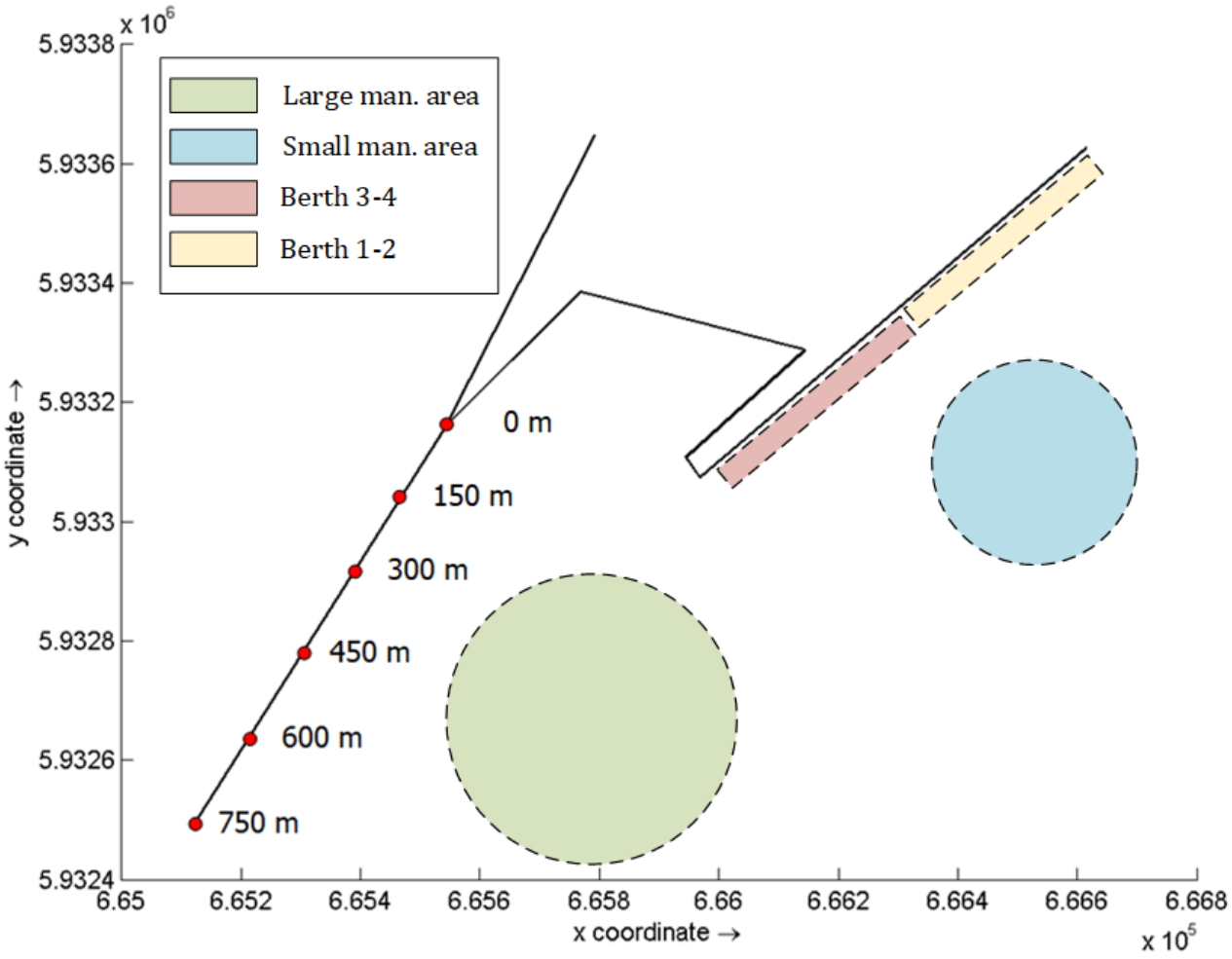
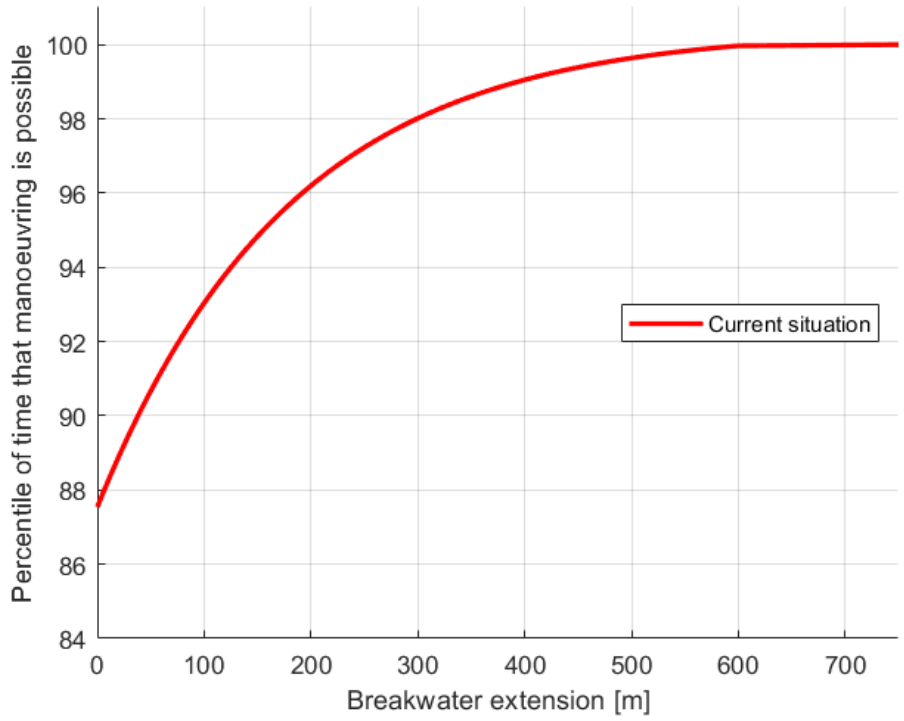
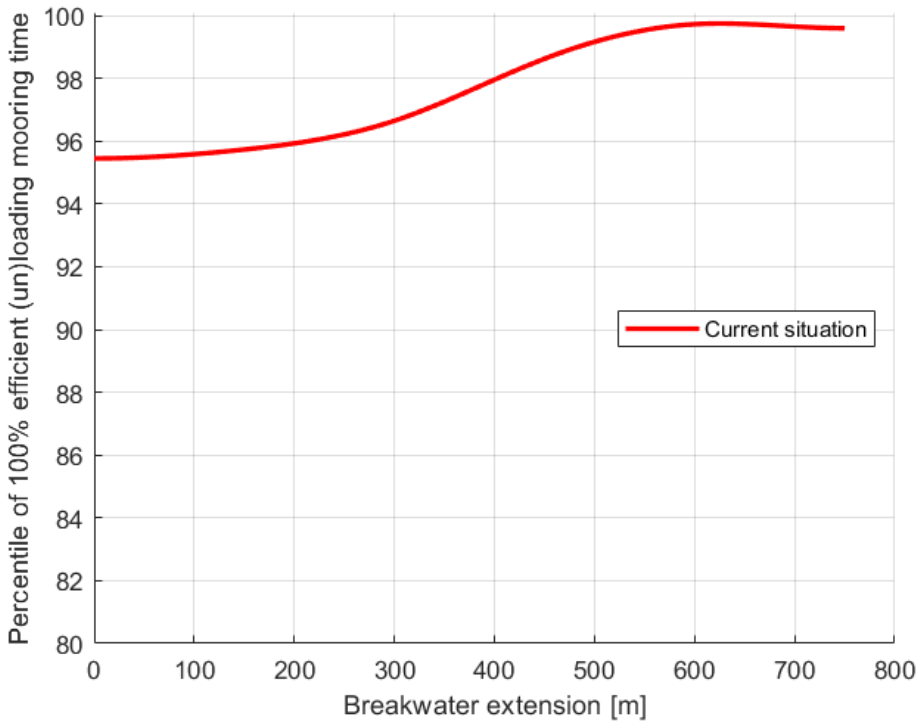


Influence of breakwater extension

Manoeuvring

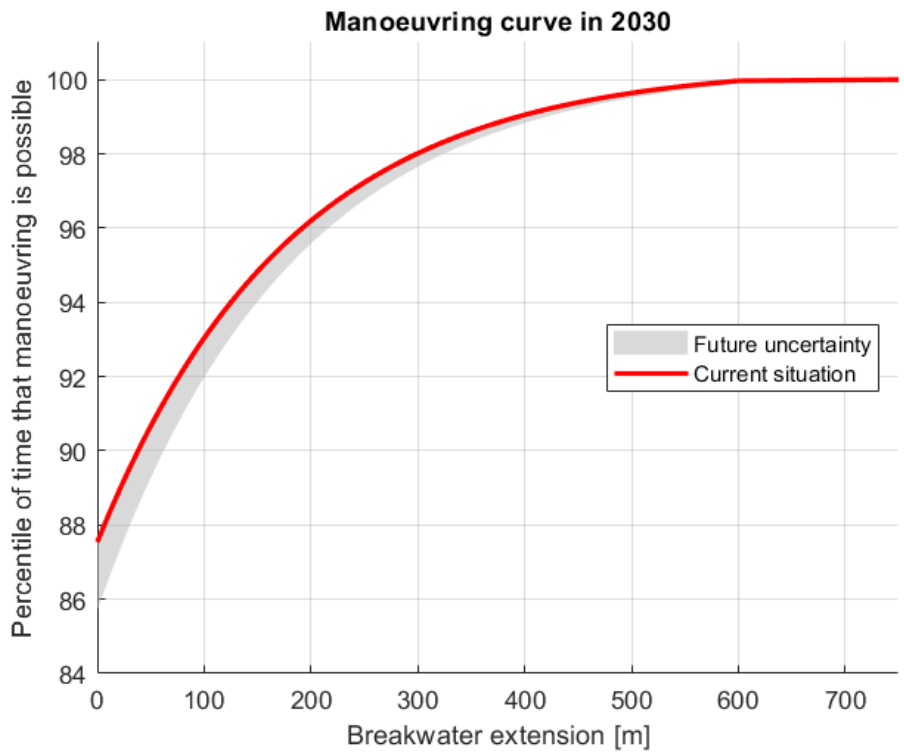


Mooring



Shift to larger container vessels

Manoeuvring



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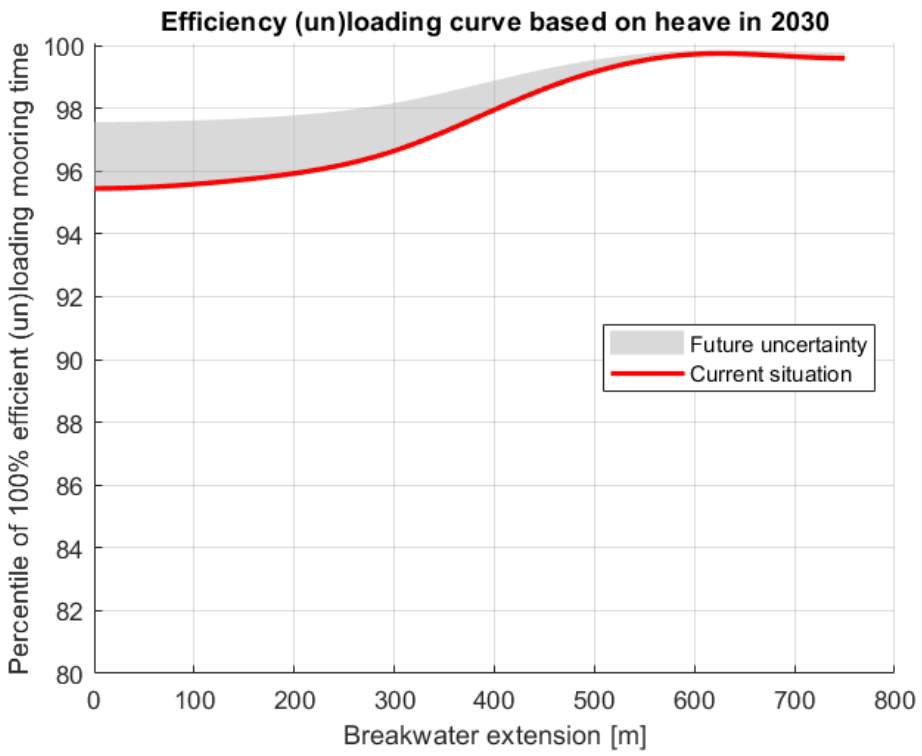

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