MARIN

BETTER SHIPS, BLUE OCEANS

SPOWTT

Improving Safety and Productivity of Offshore Wind Technician Transit

EERA DEEPWIND 2020

"Are seakeeping simulations useful for the planning of offshore wind O&M?"

Sebastien GUEYDON, 16 January 2020

Outline

- **Intro: SPOWTT**
- Objective & methodology
- Ship motion numerical assessment
- Onboard measurements
- Summary

About SPOWTT

improving **S**afety and **P**roductivity of **O**ffshore **W**ind **T**echnician **T**ransits

Sea State

Ship Motions

Motion Sickness,
Productivity,
Safety

CTV = crew transfer vessel

SPOWTT: Project consortium

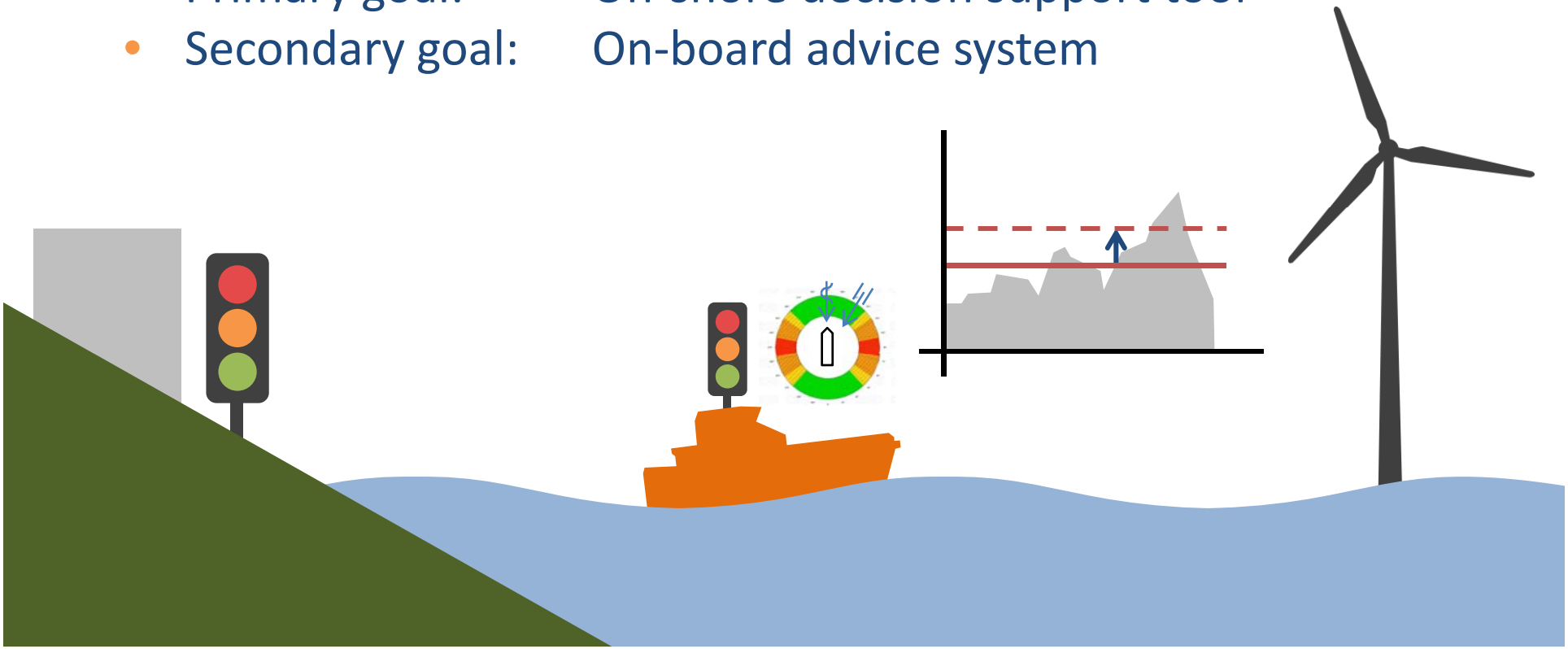
SIEMENS Gamesa
RENEWABLE ENERGY

CATAPULT
Offshore Renewable Energy

UNIVERSITY
OF HULL

Project goals

- Primary goal: On-shore decision support tool
- Secondary goal: On-board advice system



Examples CTV

Types:

Monohull

Catamaran

Swath

CATAMARANS POPULAR AMONG CTVs

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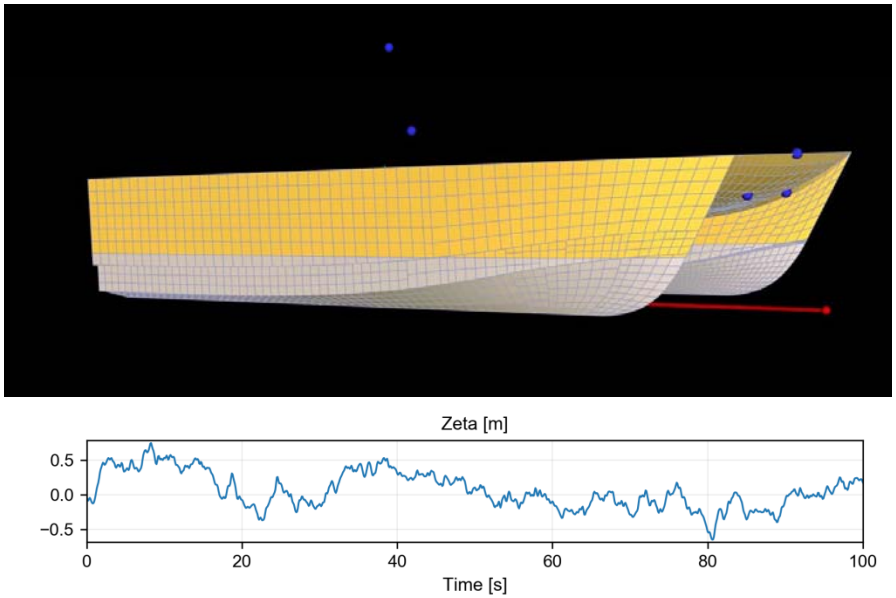
Are seakeeping simulations useful for the planning of O&M?

- Objective: “Validation” of calculated vessel motion data against full scale motion measurement data.

Ship motion simulation code

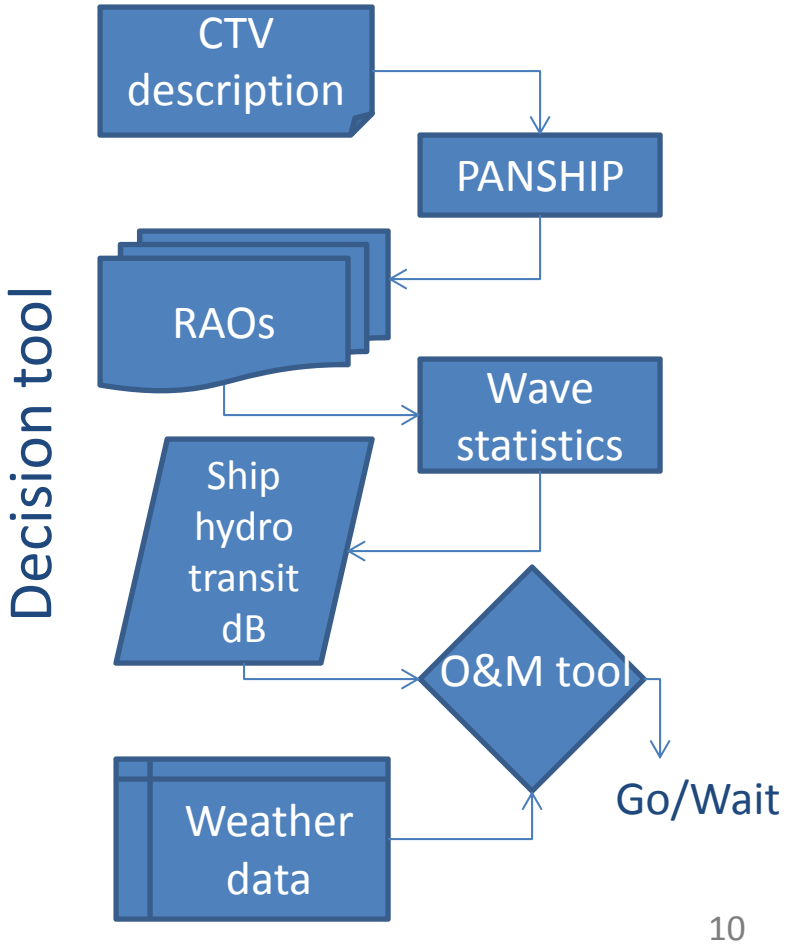


Real measurement on CTVs

How can seakeeping simulations be used for the planning of O&M?

- **Operability of transit journeys is determined using a dB of motion SDAs**

  SDA = Significant Double Amplitude
- SDA are calculated from motion RAOs
- RAOs are determined thanks to a ship motion simulation code: PANSHIP
- PANSHIP implements a semi-non-linear panel methods to predict hydrodynamic loads on fast ships
  - Accounting for lifting devices (foil/trim flap)



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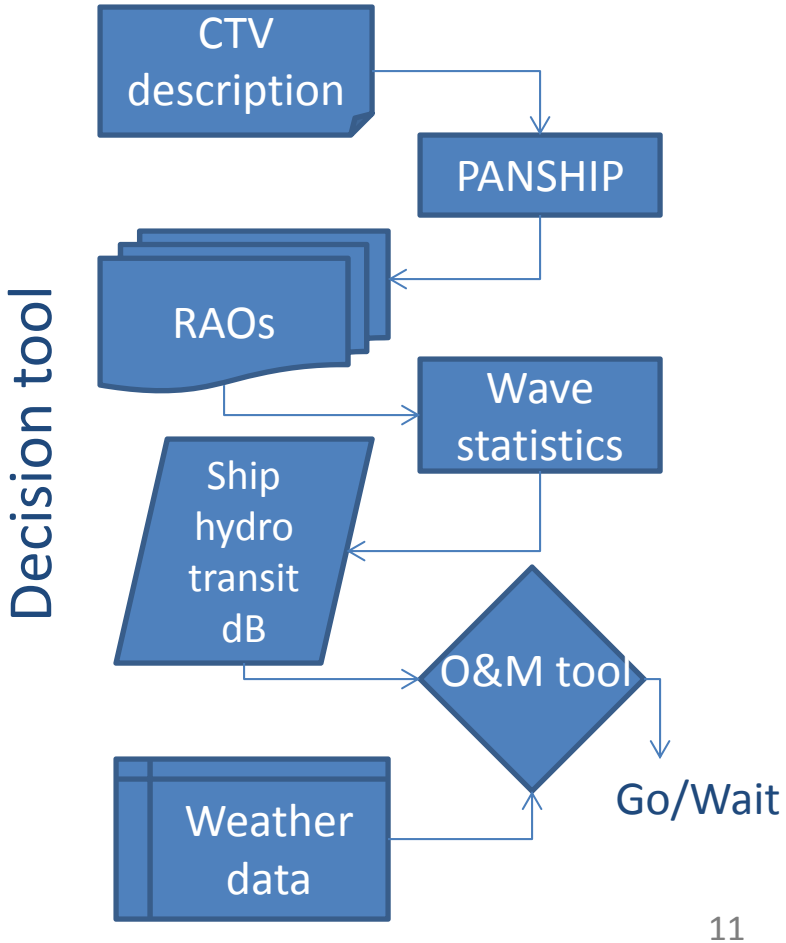

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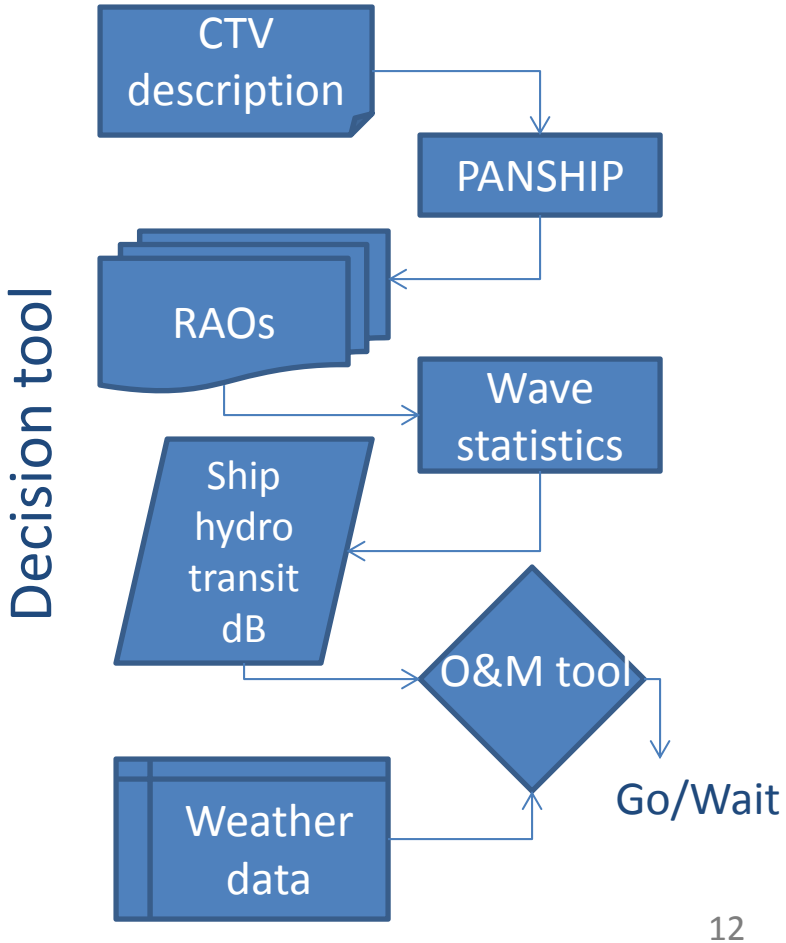

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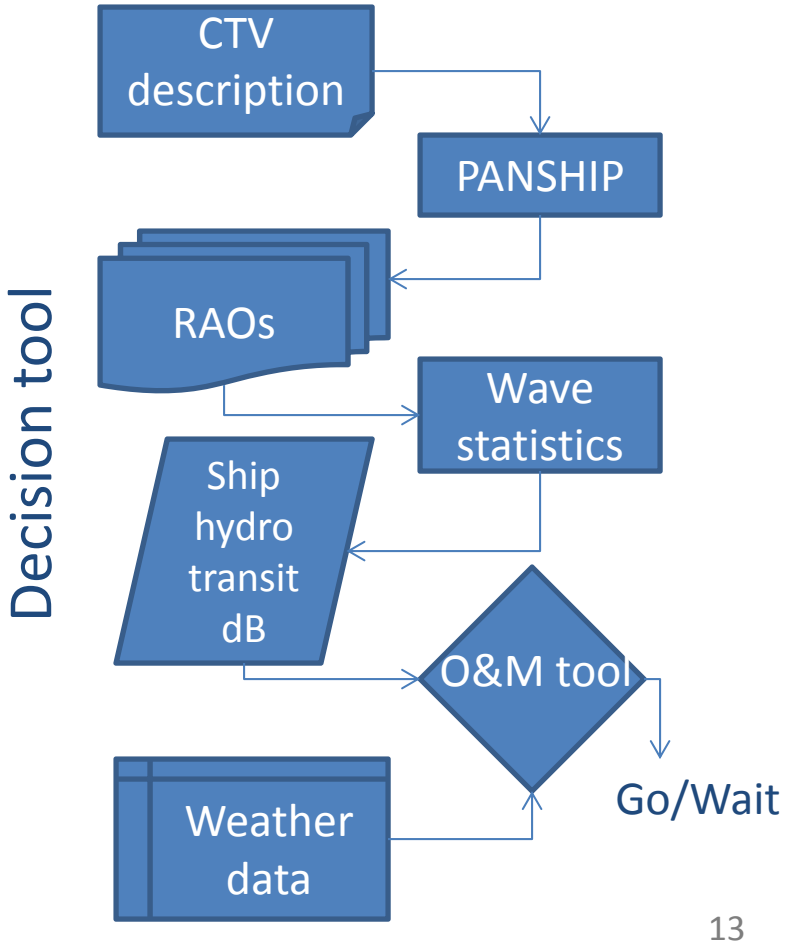
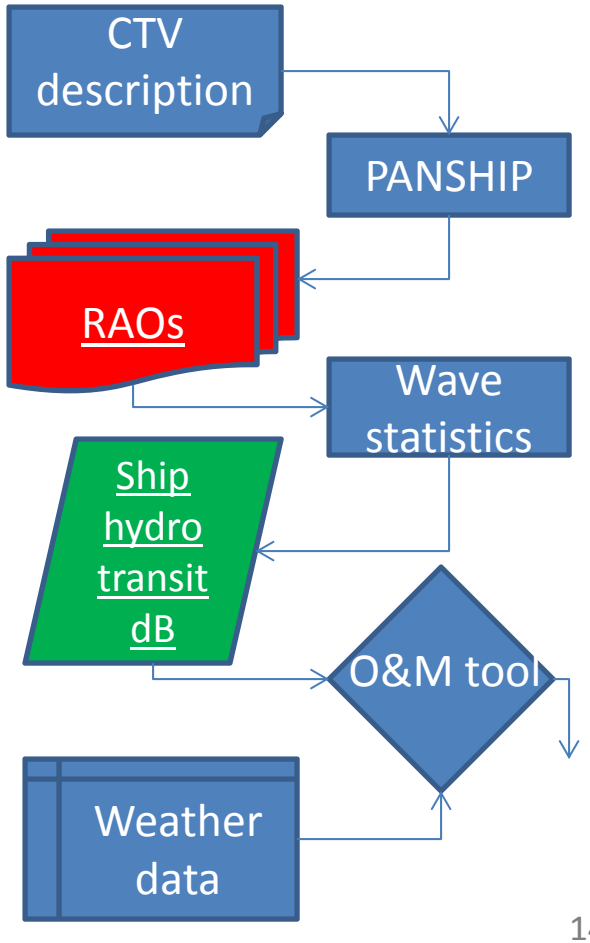


Most direct approaches

- Validation framework allowing for comparison at:

  A) Frequency level

  Spectral correlation of vessel motions and accelerations



Most direct approaches

- Validation framework allowing for comparison at:

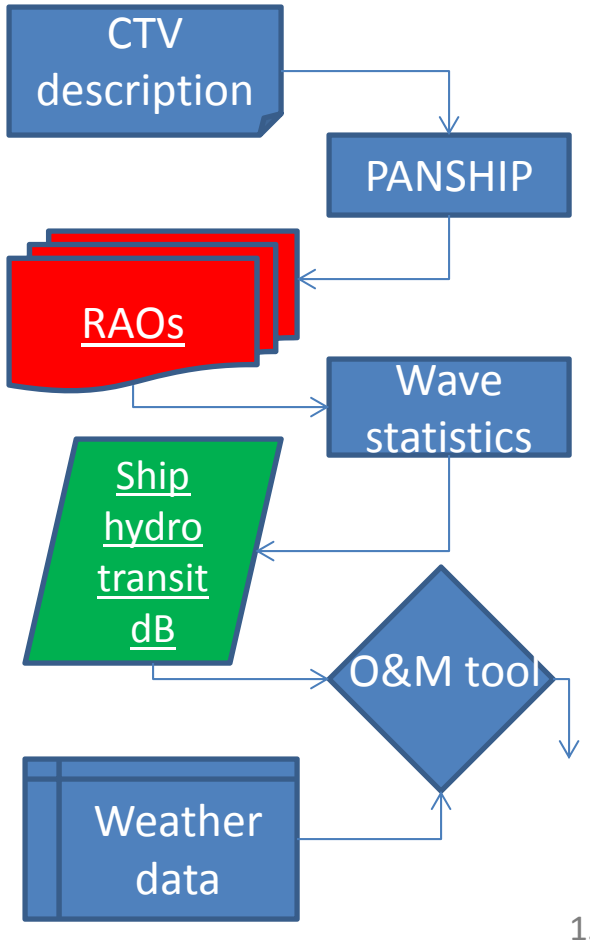
A) Frequency level

Spectral correlation of vessel motions and accelerations

B) Sea-state level

SDA of vessel motions and accelerations

$$SDA = 4\sigma = 4\sqrt{m_0}$$



Most direct approaches

- Validation framework allowing for comparison at:

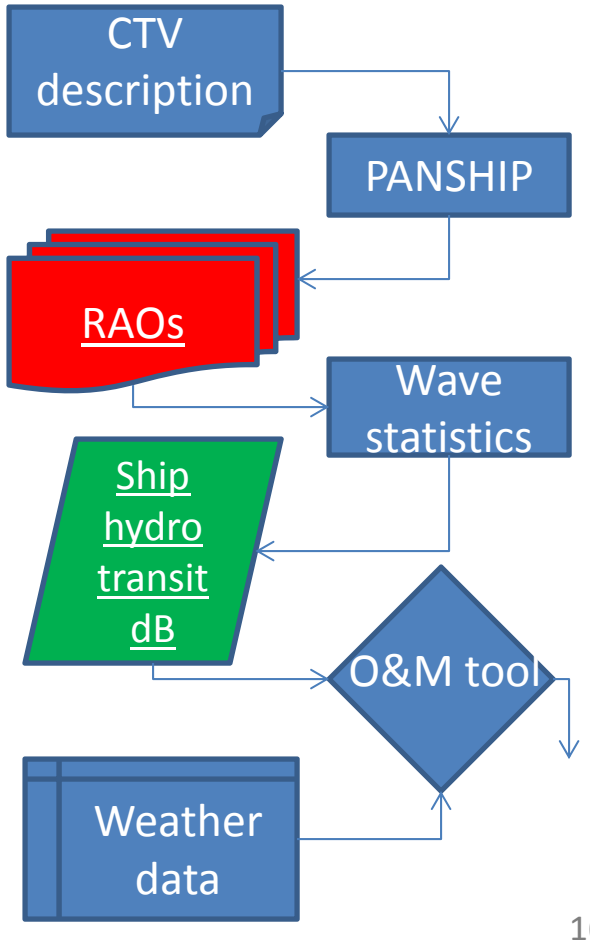
  A) Frequency level

  Spectral correlation of vessel motions and accelerations

  B) Sea-state level

  SDA of vessel motions and accelerations

- **Extract measurement data set for comparison:**
  - **~ steady heading**
  - **~ steady speed**
  - **~ steady wave condition (also wind and current)**



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- **Ship motion numerical assessment**
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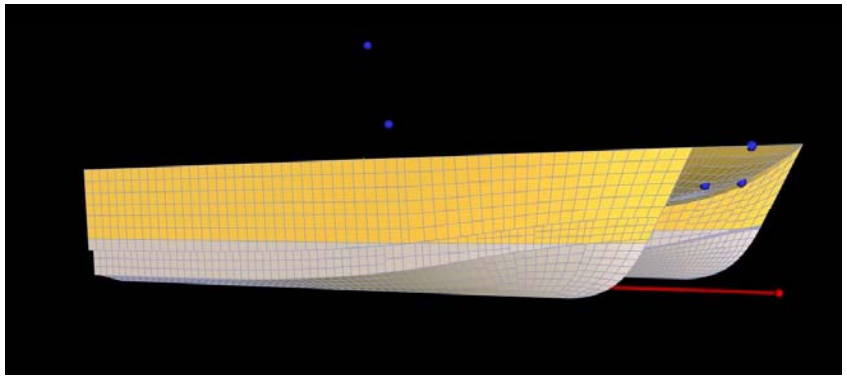
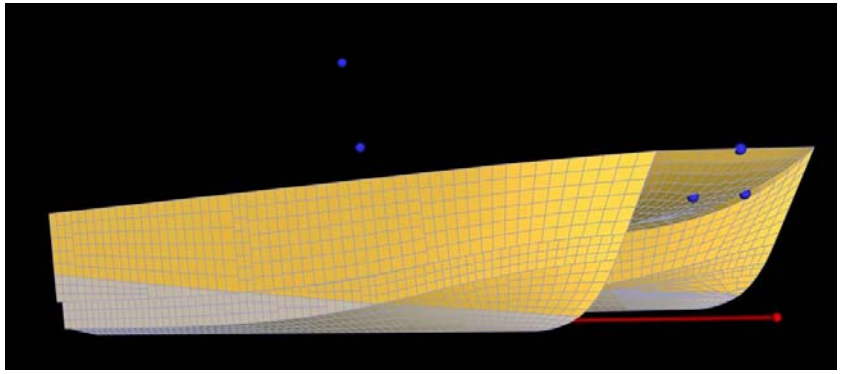
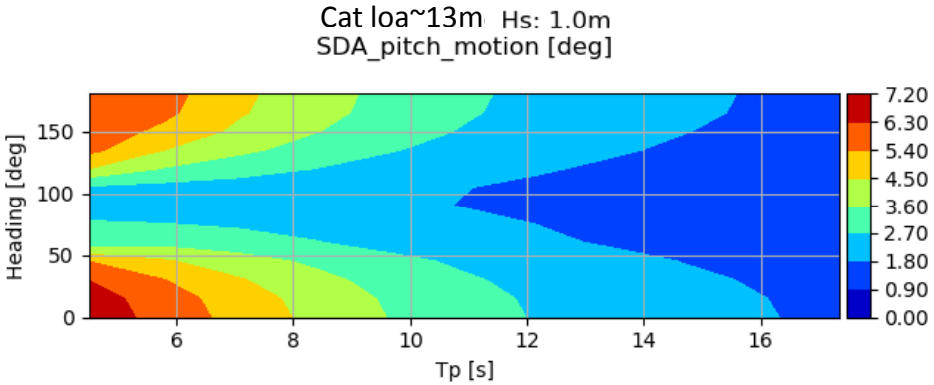
Ship motion numerical assessment

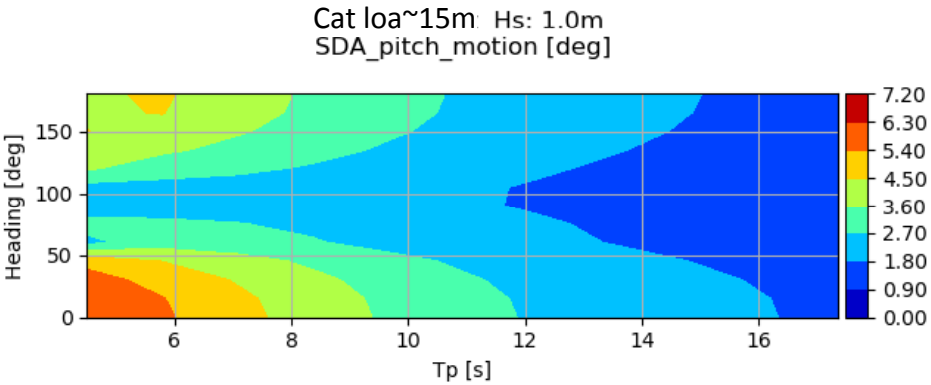
- RAO database calculated for 6 CTV with PANSHIP
- Assumptions:
  - Linear ship motions
  - Hull lines taken from general arrangement
  - GM, draft received from BMO
  - Radii of inertia estimated
  - No trim flap + trim flap with fixed angles

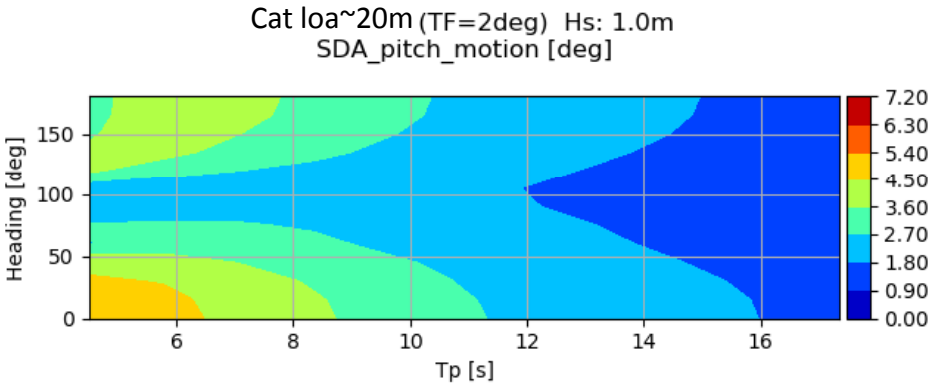




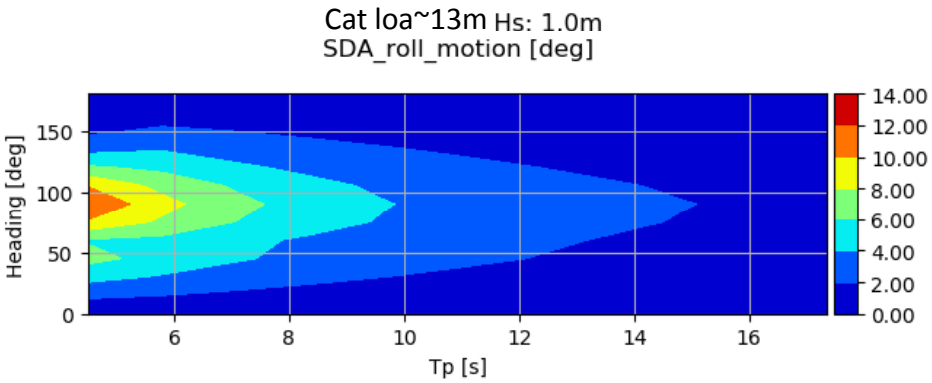
SDA pitch in Hs=1m @ Vs=25kn

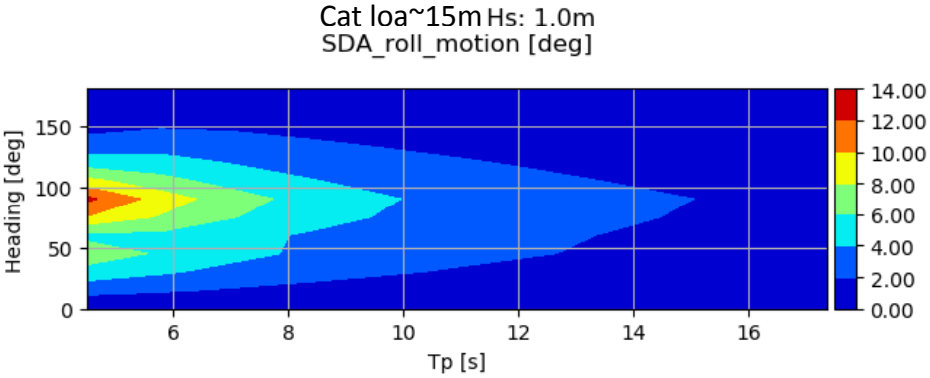


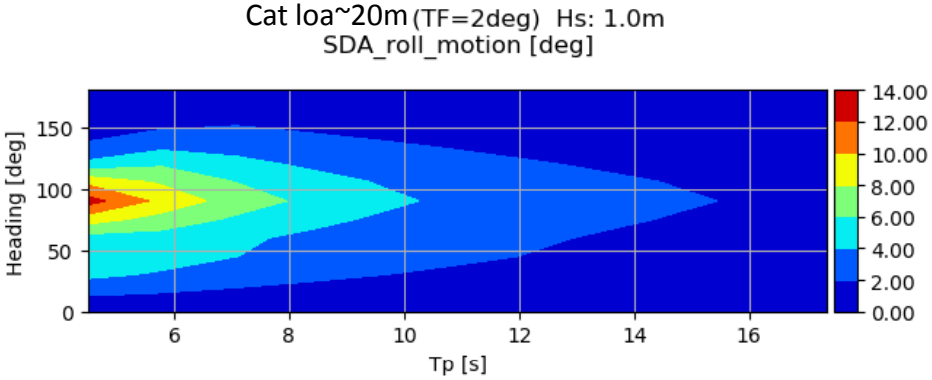




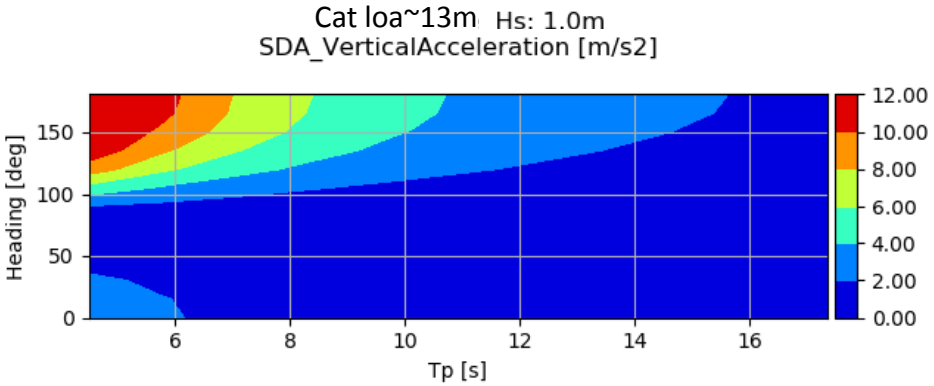
SDA roll in Hs=1m @ Vs=25kn

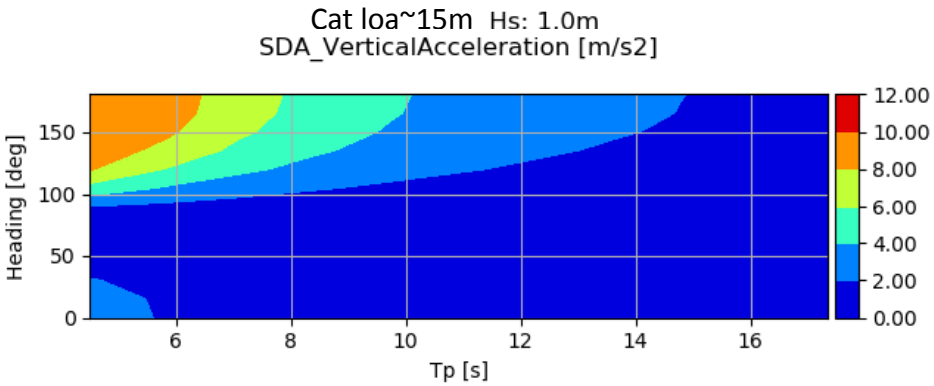


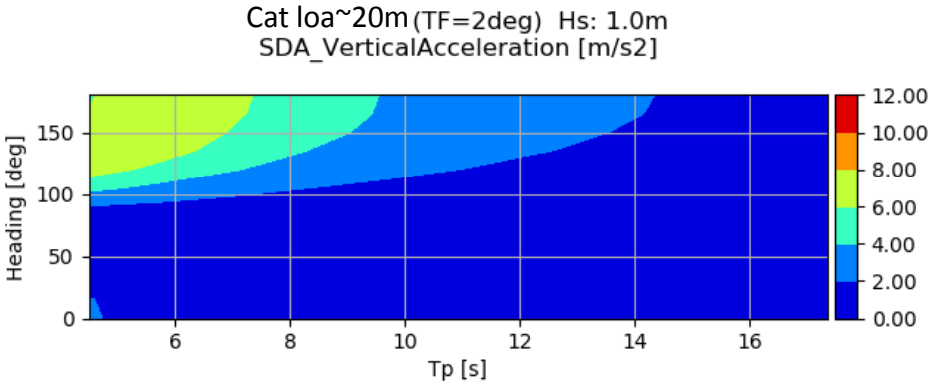




SDA vertical acceleration in Hs=1m @ Vs=25kn

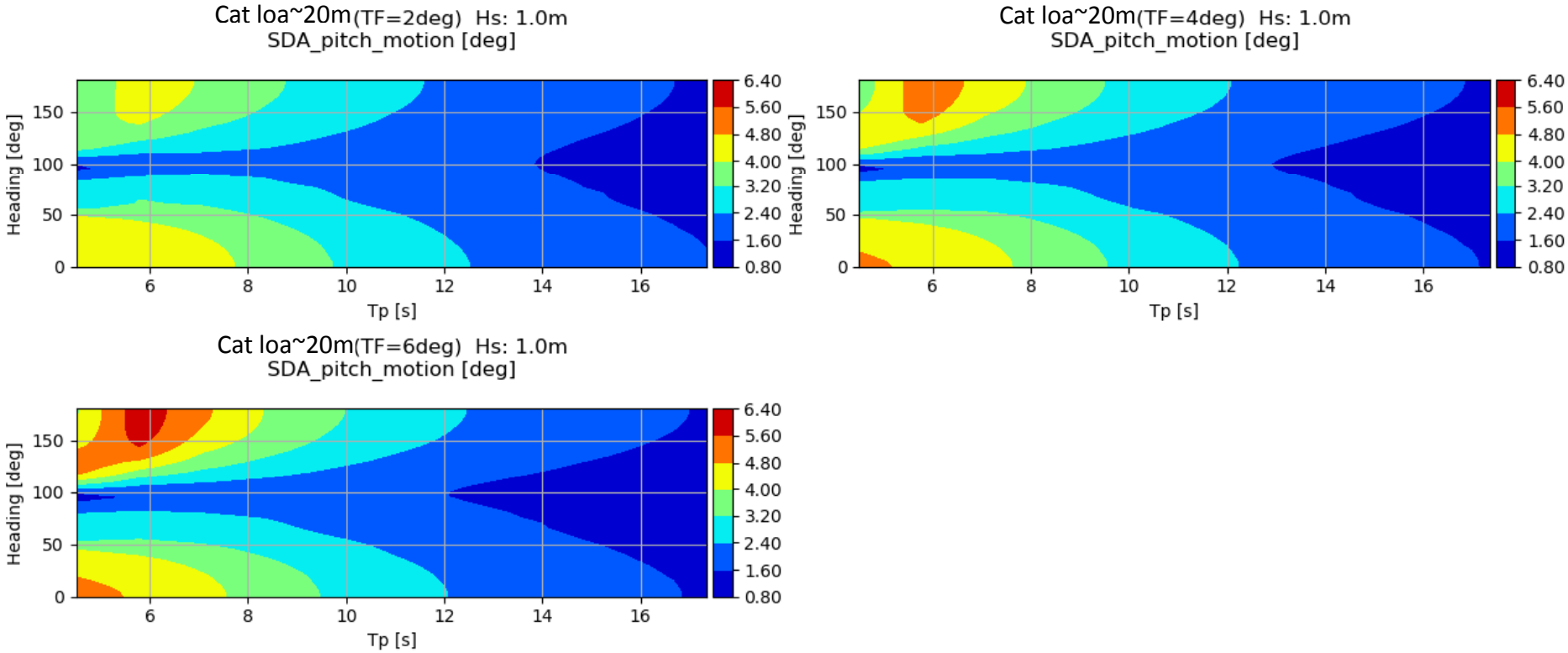






@Crew seats
Nordforsk: 11 m/s²

Effect of trim flap angle on pitch



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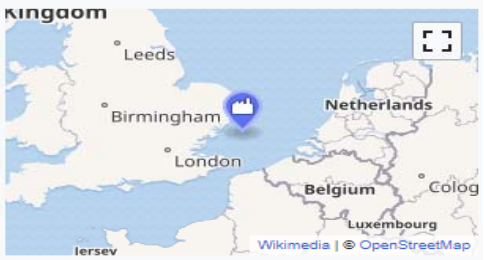
Explore and analyze measurements prior to validation

- Wave data
  - Wave buoy (not everywhere)
  - Satellite (+model(s)): Copernicus
- Vessel motion data
  - BMO data

Greater Gabbard



Location of Greater Gabbard wind farm in the North Sea

Country	England
Location	Inner Gabbard and The Galloper banks North Sea Suffolk Coast
Coordinates	51°52′48″N 1°56′24″E
Status	Operational
Commission date	2012
Owner(s)	Scottish and Southern RWE Npower Renewables
Wind farm	
Type	Offshore
Distance from shore	23 km (14 mi)
Power generation	
Units operational	140
Make and model	Siemens Wind Power: SWT3.6–107
Nameplate capacity	504 MW
Annual net output	1,800 GW·h (2013)[1]
External links	
Commons	Related media on Commons

[edit on Wikidata]

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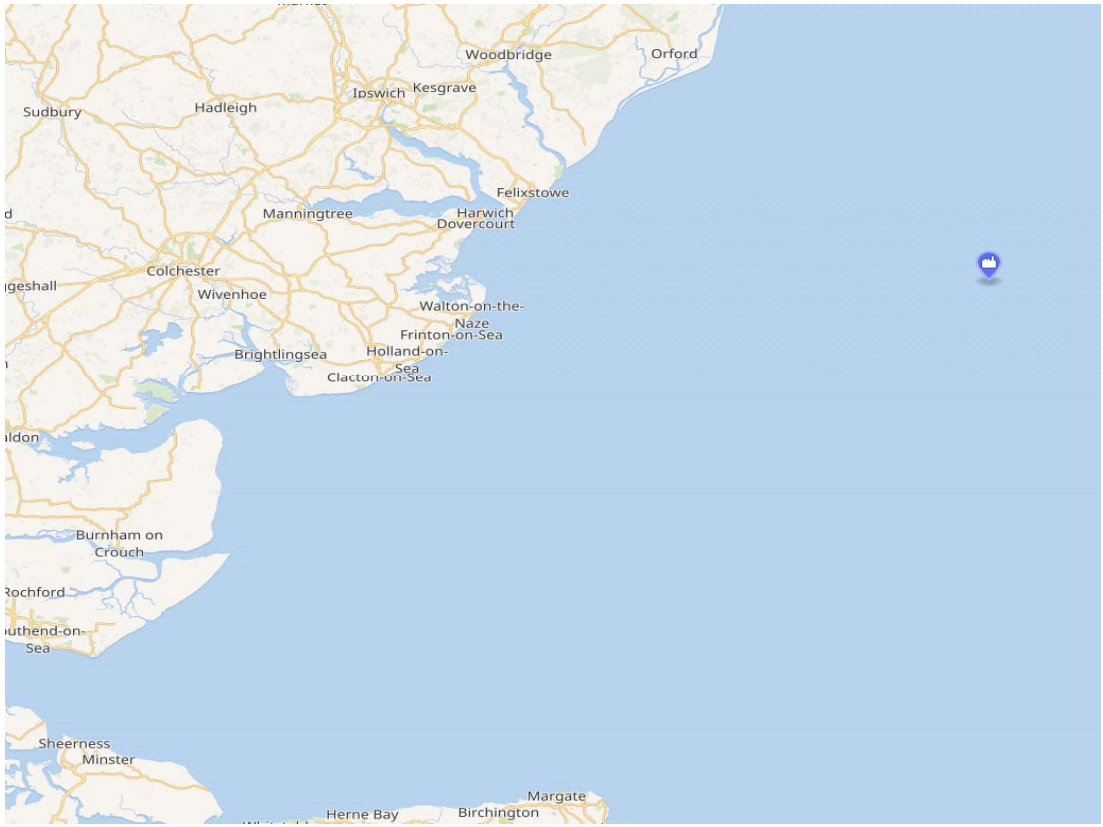
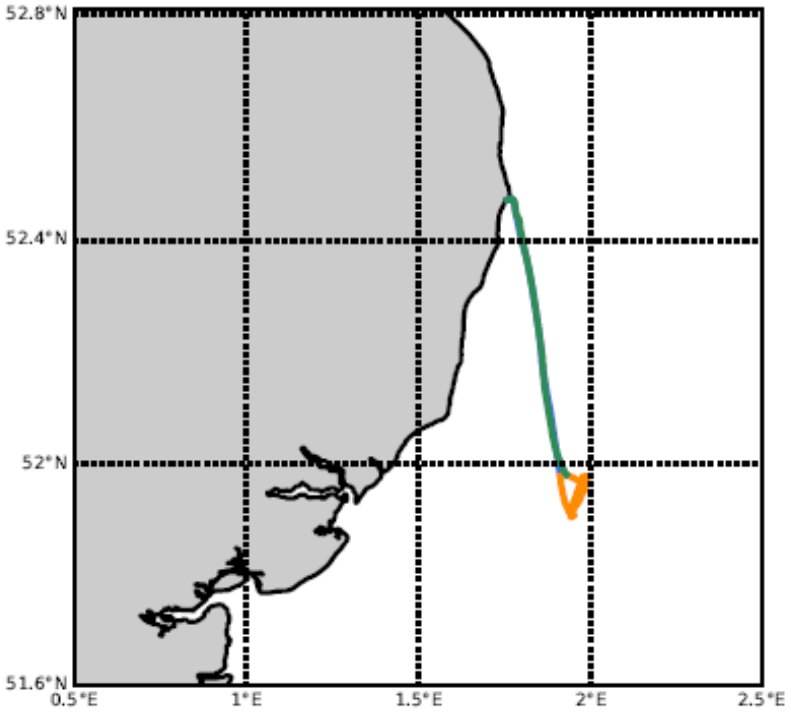
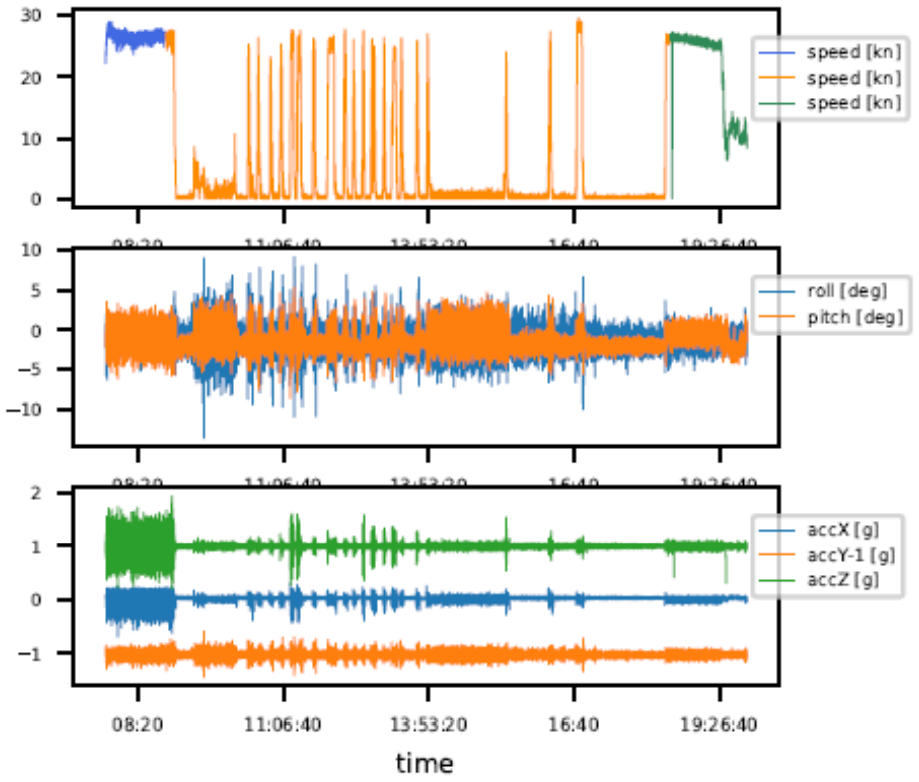
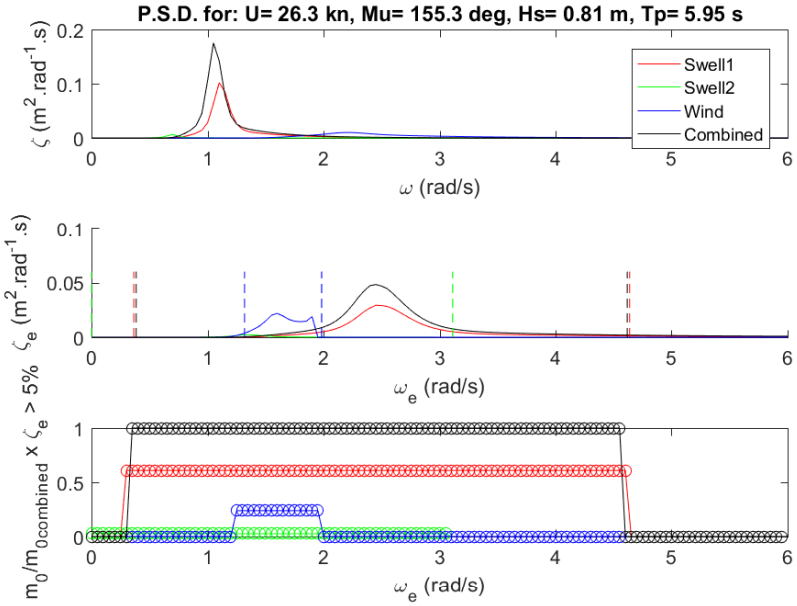


Example of vessel measurement data

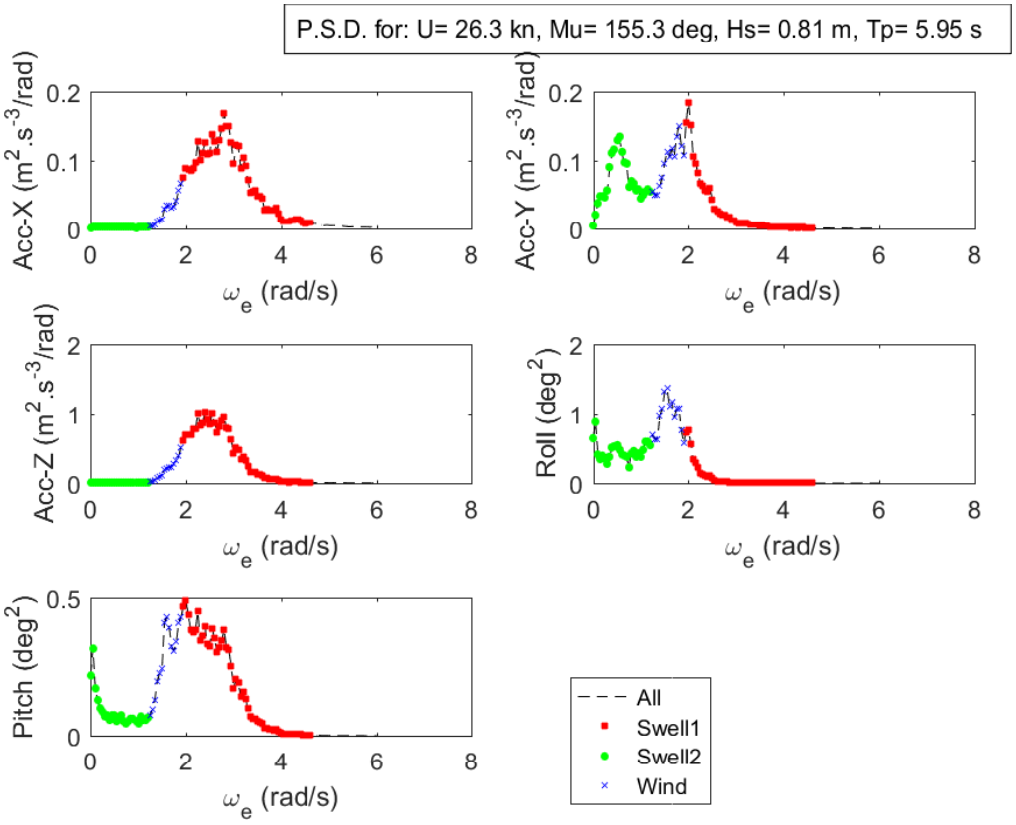




Example of PSDs during transit

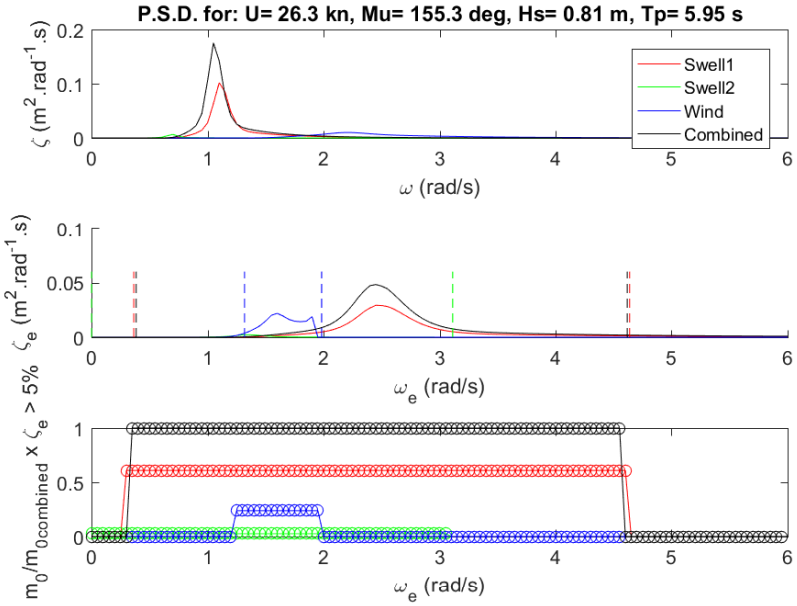


	mu_deg	Hs_m	Tp_s	m0_SI
Swell1	144.76	0.63252	5.6775	0.023753
Swell2	177.54	0.12757	9.1185	0.0010117
Wind	275.36	0.41259	2.8567	0.009289
Combined	155.28	0.81012	5.9503	0.038997



WAFO: http://www.maths.lth.se/matstat/wafo

Example of PSDs during transit with simulation results



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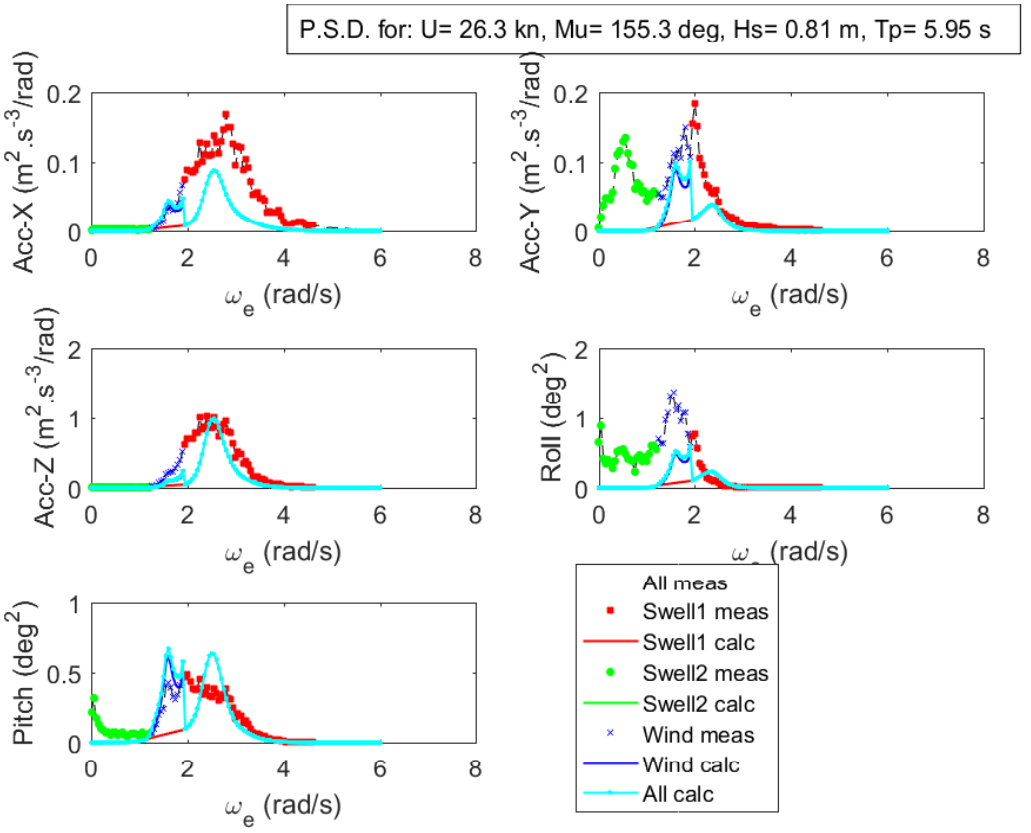

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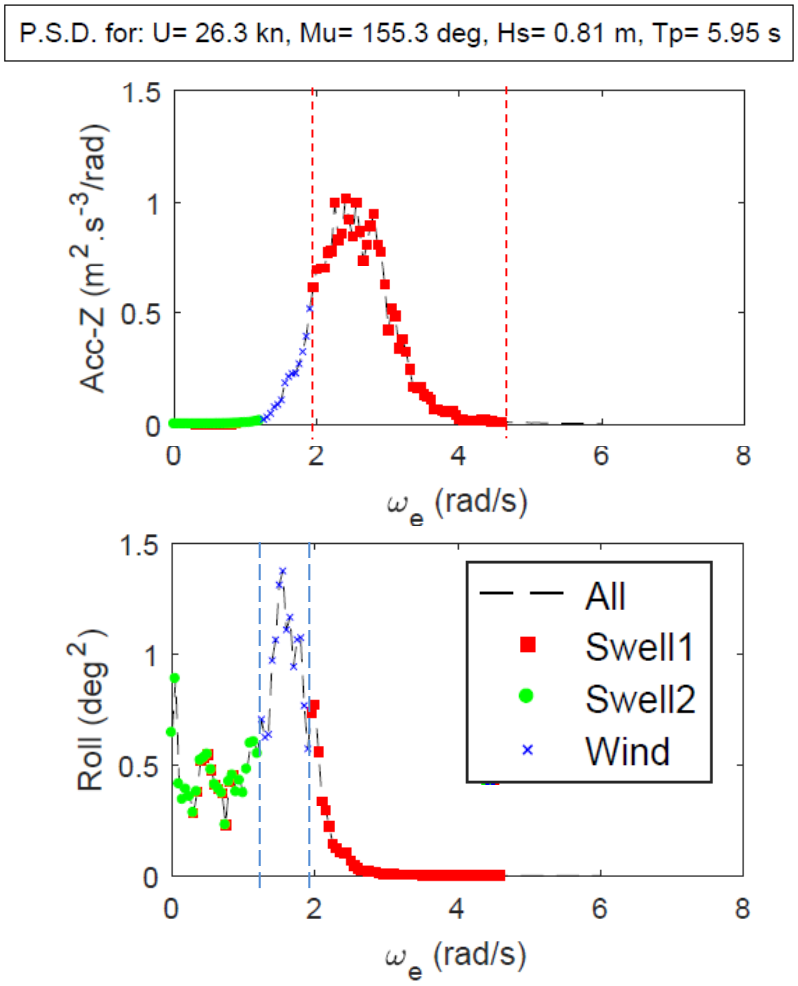
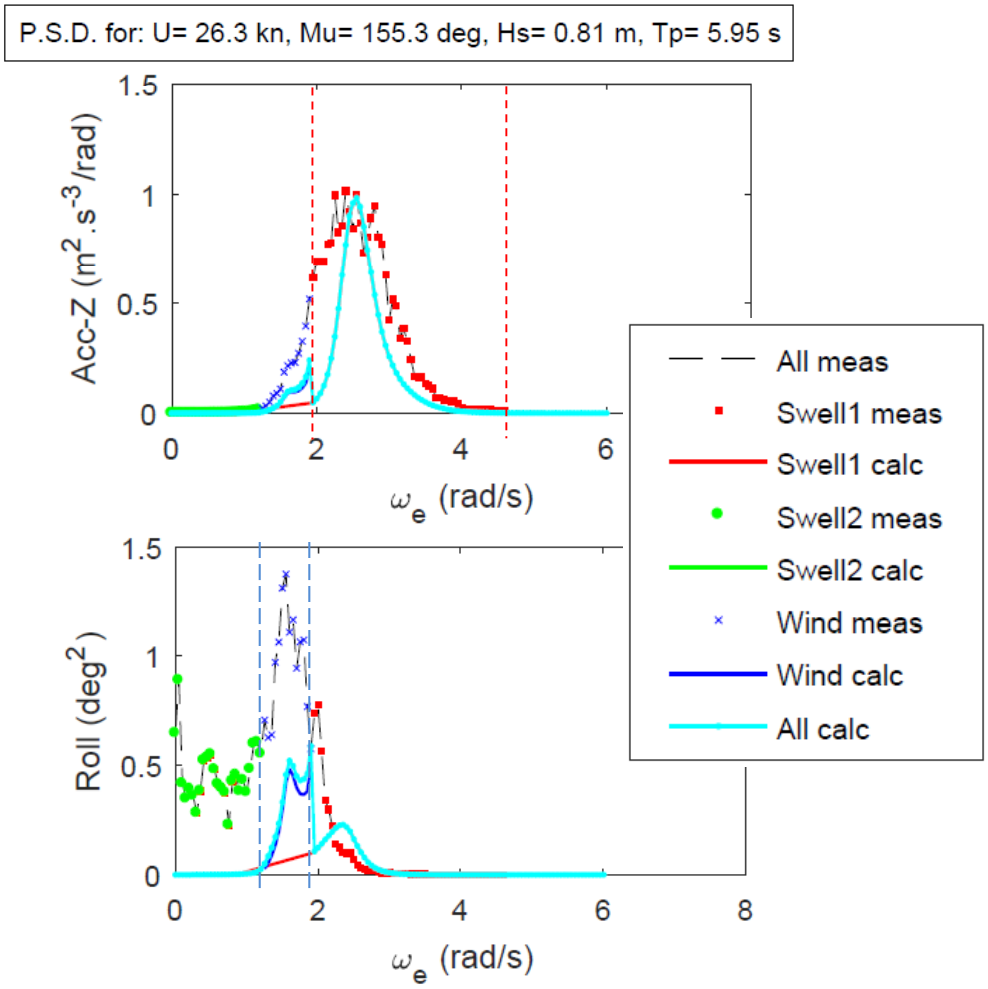
PSD of vertical acceleration and PSD of roll



Observations:

- Importance of distinct wave components
- Peaks are generally linked to a main WF component
- Lot's happening outside the main wave component:
  - LF response (roll)

PSD of vertical acceleration and PSD of roll



+:

- Distinct wave components
- Peaks are represented (global trend is there)

- :

- Amplitude are different (wind wave)
- Different m_0 (SDA)
- What's happening outside the main wave components is disregarded
  - No LF response (or swell 2)

First lessons, some hypotheses are questionable:

- JONSWAP for small waves
- Linear assumption
- Fidelity of CTV input data

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- **Conclusions**

Conclusions

- **A lot to learn from onboard measurements**
  - Most precise definition as possible is recommended
    - Copernicus is a good start (more wave components in distinct directions)
    - Quantification of directional spreading is currently missing
- PANSHIP validation based on onboard measurements not easy
  - Hull lines, loading condition and trim flap angle not known and all have large effect on linear ship motions
  - Local weather conditions not fully known (directional spreading, current, wind)
  - Uncertainty over heading, trim flap
- Driving factor for operability not precisely known but **seakeeping tools can help** with:
  - Seasickness/fatigue of maintenance crew
    - MSI within tool boundaries

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THANK YOU!

Contributors:

- BMO team
- Gerben Spaans
- Rob Grin
- Christian Lena
- Ka Wing Lam
- Erik-Jan de Ridder
- Jorrit-Jan Serraris

- EU with Copernicus
- Lund University with WAFO