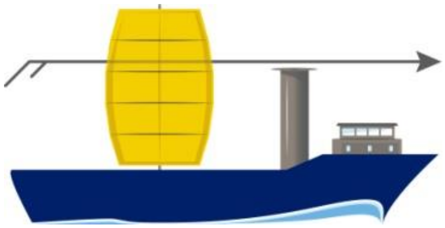
BETTER SHIPS, BLUE OCEANS



Towards standardised WASP performance predictions (updates from the WiSP project)

Rogier Eggers, MARIN

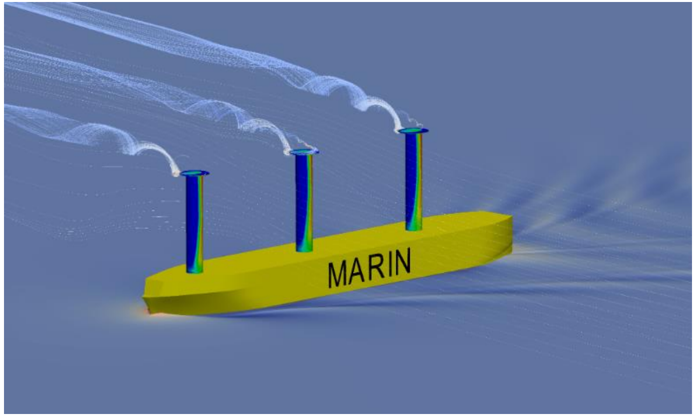
Natural Propulsion Seminar, Blue Week 2020

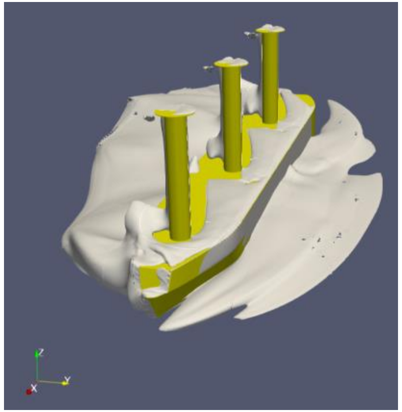
Outline

- General Wind Assistance developments at MARIN
- WiSP objectives
- Scope
- Preliminary results

Wind assist research @ MARIN

- **Aerodynamic forces, incl. interaction**
- Propeller performance (oblique inflow)
- Better hull forms and appendages
- Unsteady performance
- Steady performance (PPP)
- Voyage simulations





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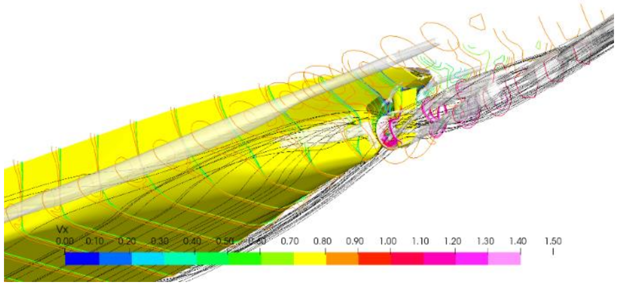

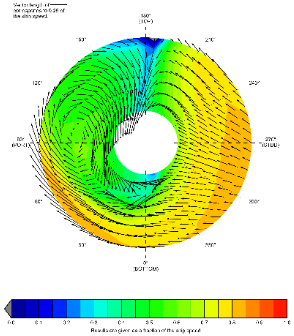

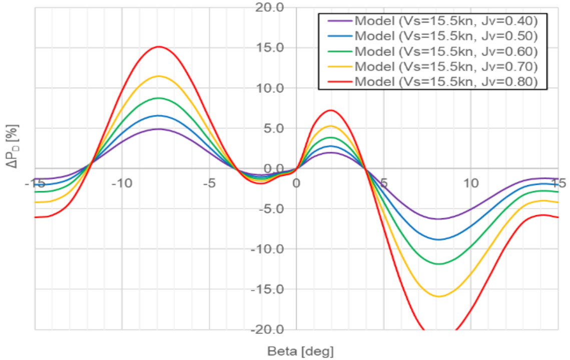

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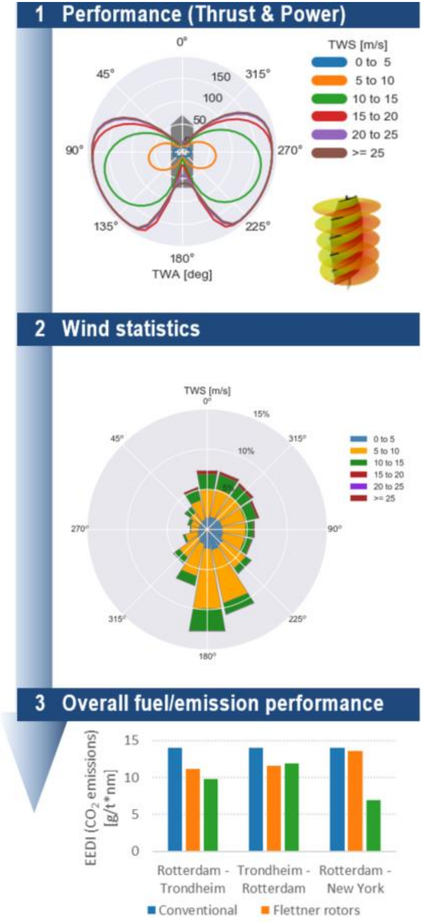

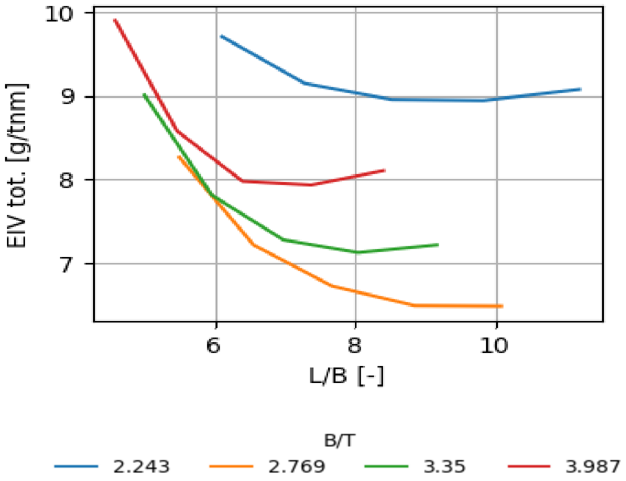

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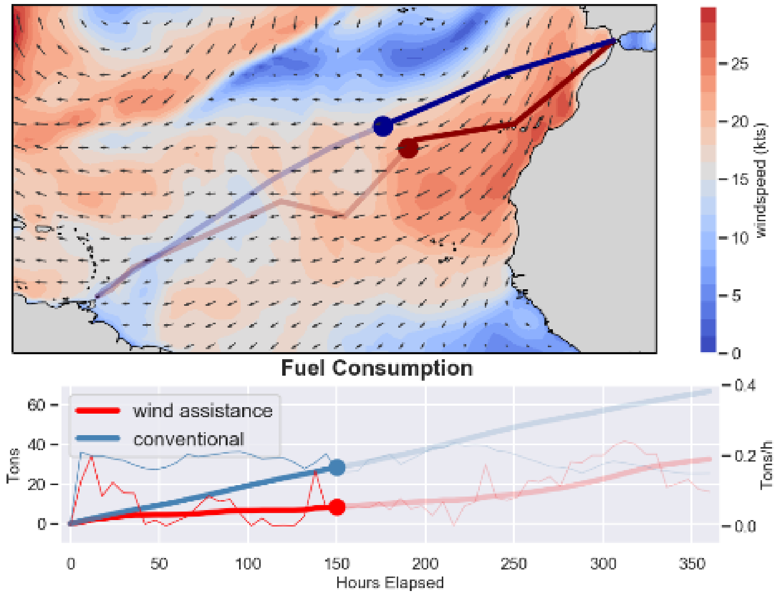


The WiSP project - Background

Dagmar Nelissen et al. "Study on the Analysis of Market Potentials and Market Barriers for Wind Propulsion Technologies for Ships", CE Delft, 2016

Identified as key barrier:

"Factors that contribute to the **uncertainty of the cost efficiency** … information on the **performance, operability, safety, durability, and economic implications** of wind propulsion is available yet and since the available information may only have a **limited value** and may not be **trusted or understood**."

The WiSP project - Objectives

Help overcome the barriers to implementation by:

- Improving transparency and methodology of performance predictions
- Providing reliable predictions to ship owners & operators
- Provide examples for compliance with existing rules and recommendations for rule improvements

The WiSP project - Scope

Task 1: Improved methods for transparent performance prediction

Task 2: Transparent performance predictions for ship owners/ operators

Task 3: Safety issues; compliance with class rules and statutory regulations; new rules

Task 1 & 2 Performance predictions

EEDI (MEPC.1/Circ.815) as baseline for prediction methodology:

$$\frac{\left(\prod_{j=1}^{M} f_j\right)\left(\sum_{i=1}^{nME} P_{ME(i)} \cdot C_{FME(i)} \cdot SFC_{ME(i)}\right) + \left(P_{AE} \cdot C_{FAE} \cdot SFC_{AE}*\right) + \left(\left(\prod_{j=1}^{M} f_j \cdot \sum_{i=1}^{nPTI} P_{PTI(i)} - \sum_{i=1}^{neff} f_{eff(i)} \cdot P_{AEeff(i)}\right) C_{FAE} \cdot SFC_{AE}\right) - \boxed{\left(\sum_{i=1}^{neff} f_{eff(i)} \cdot P_{eff(i)} \cdot C_{FME} \cdot SFC_{ME}**\right)}}{f_i \cdot f_c \cdot Capacity \cdot f_w \cdot V_{ref}}$$

CO_2 emissions savings calculated with

f_{eff} = Availability factor

P_{eff} = Effective (saved) power

C_{FME} = Carbon content in fuel (main engine)

SFC_{ME} = Specific fuel consumption (main engine)

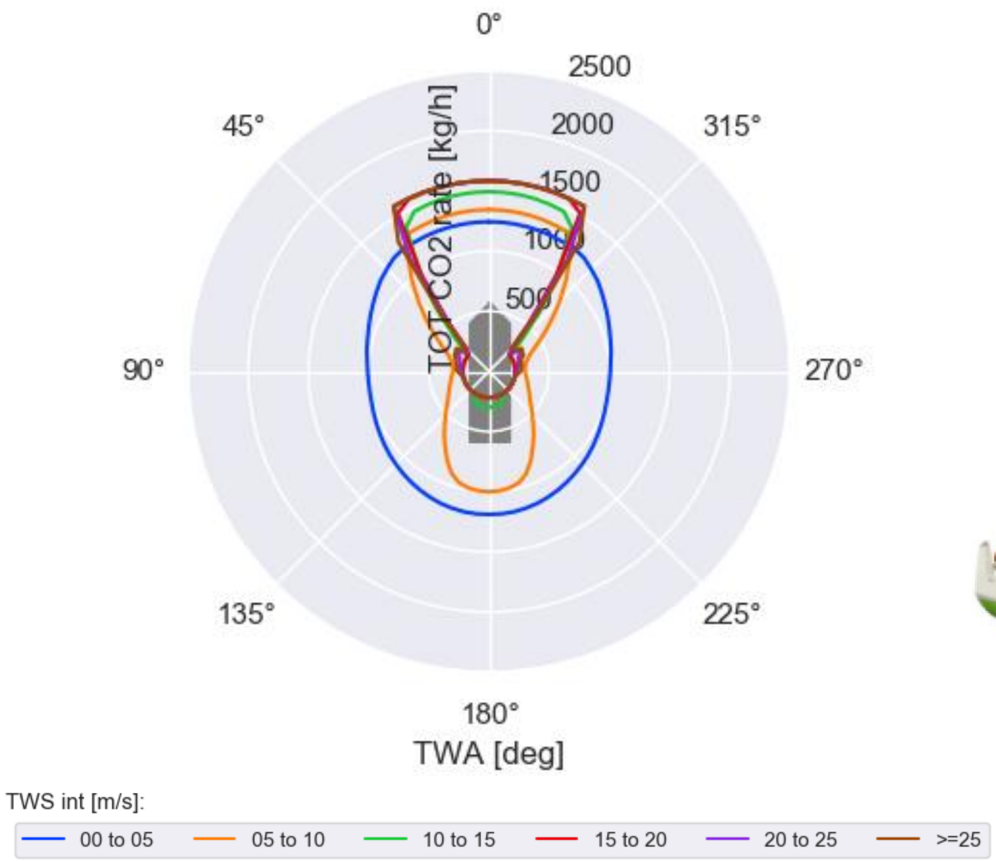
Starting point for WiSP: MEPC.1/Circ.815 is judged to be much too simple and open

The WiSP project - Deliverables

- Internal detail reports
  - Task 1&2: Sensitivity studies showing the impact of various modelling, applied to real data

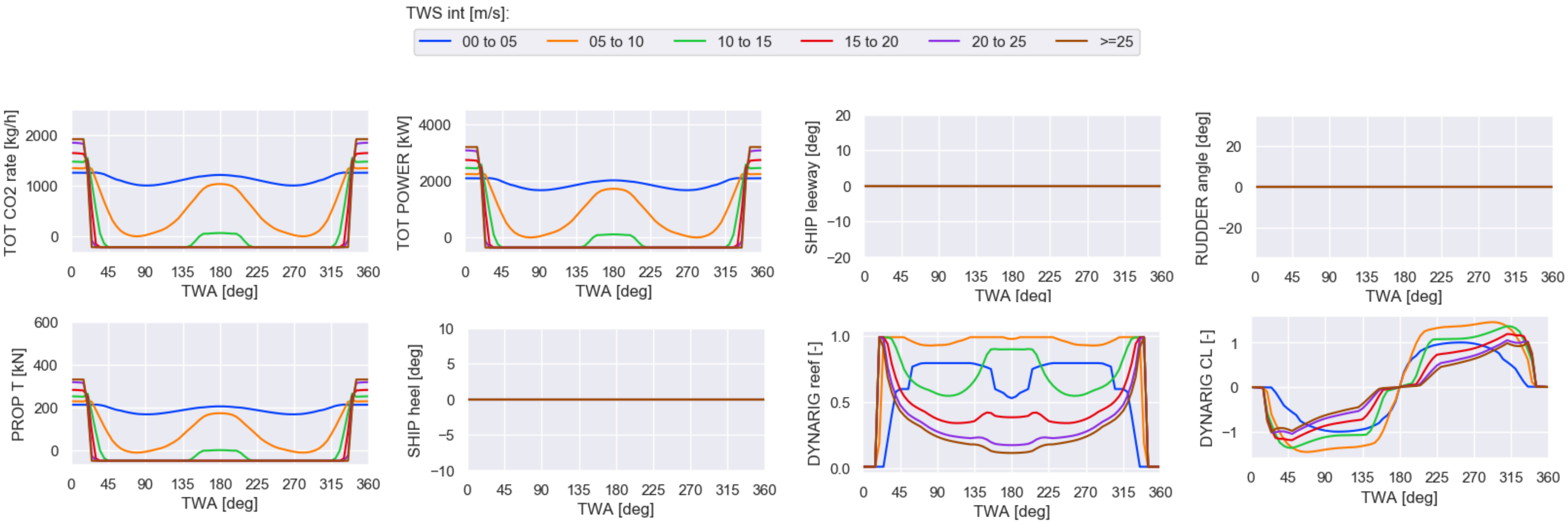
- Public reports, aimed to start an industry standard:
  - Task 1&2: Performance prediction methodology aimed at EEDI (two tiers)

Preliminary Results Case 1 – WASP (Ecoliner)



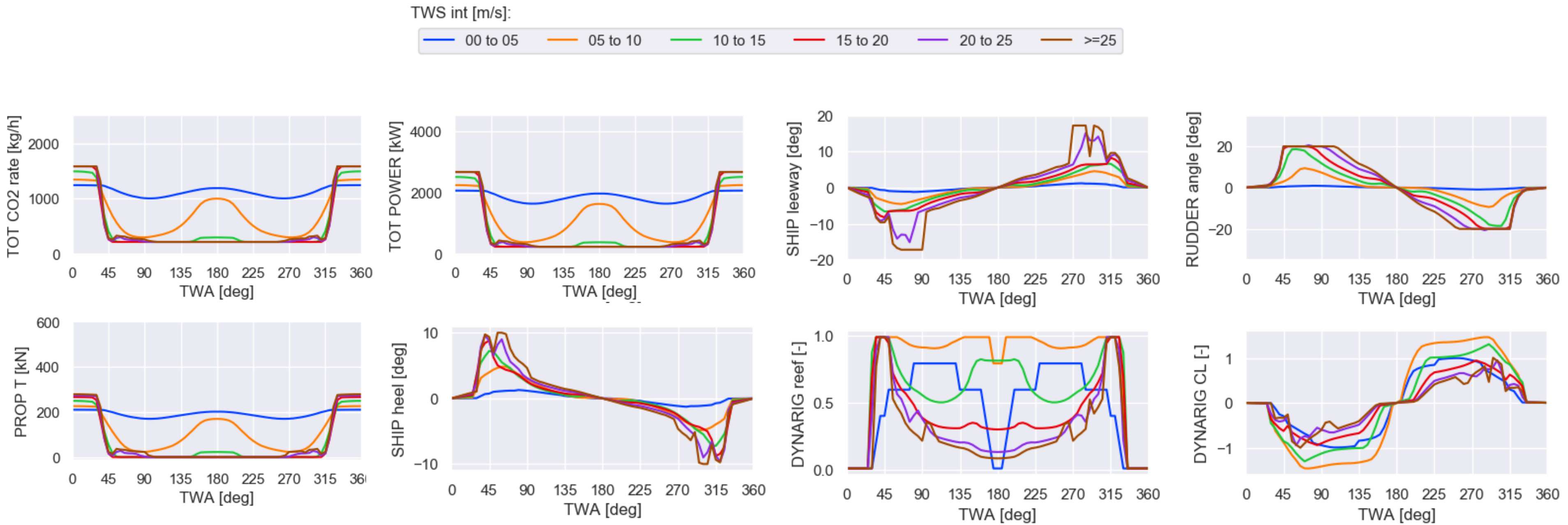
DYKSTRA
NAVAL ARCHITECTS

Preliminary Results - Baseline Circ.815



- Most simplified, but still conforming to Circ.815

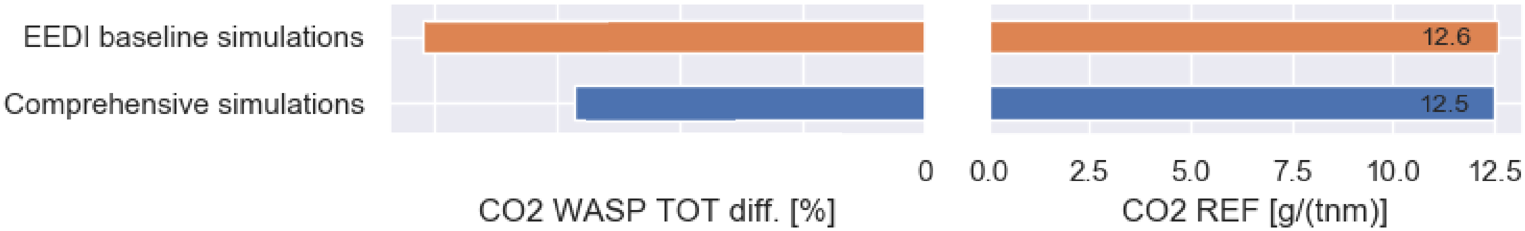
Preliminary Results - Comprehensive



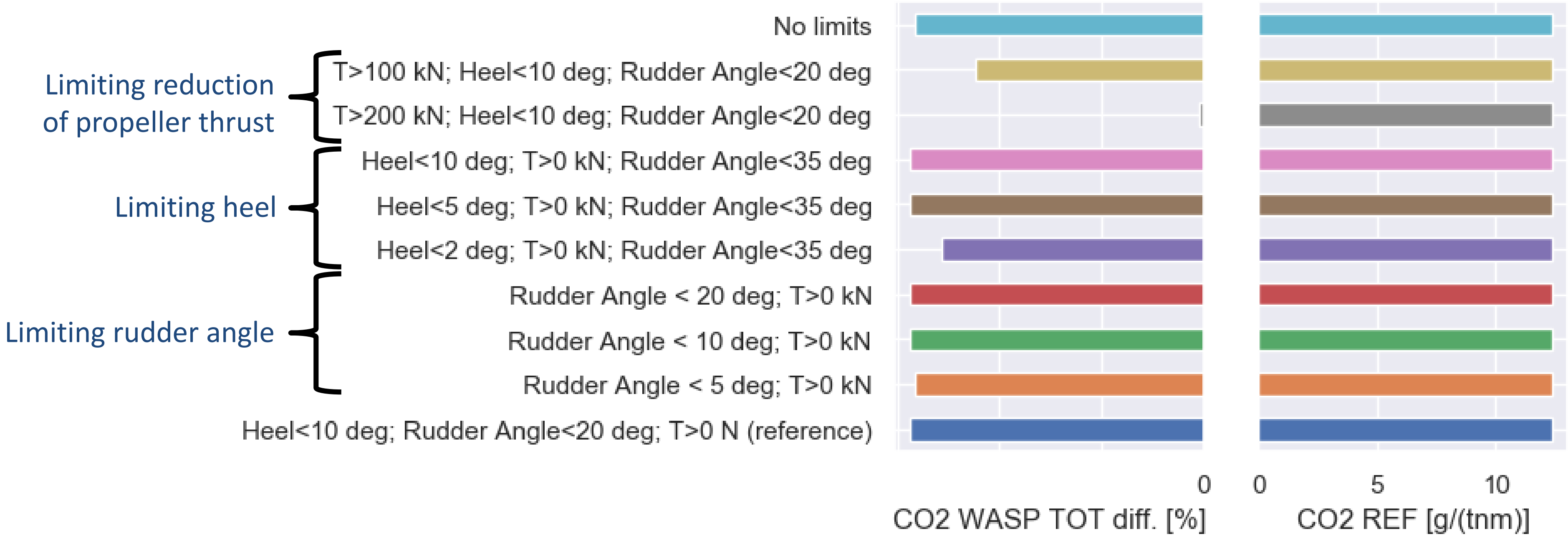
- Comprehensive modelling with more detailed physics and operational constraints

Baseline Circ.815 versus Comprehensive

- Savings are much more favourable for the baseline (Circ.815) modelling
- A bias in modelling that deserves more attention!

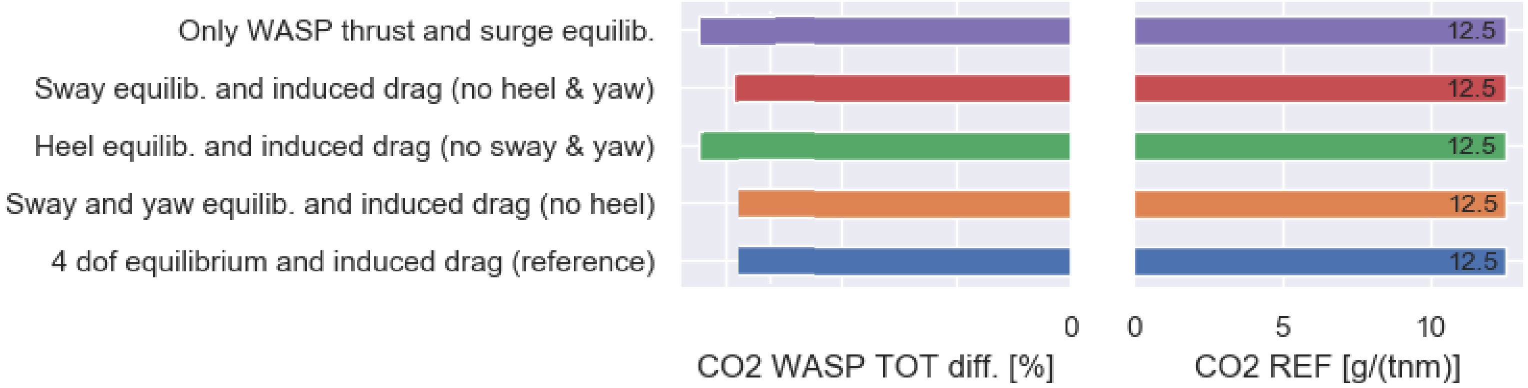


Sensitivity Heel, rudder and thrust limits



Force and moment balance

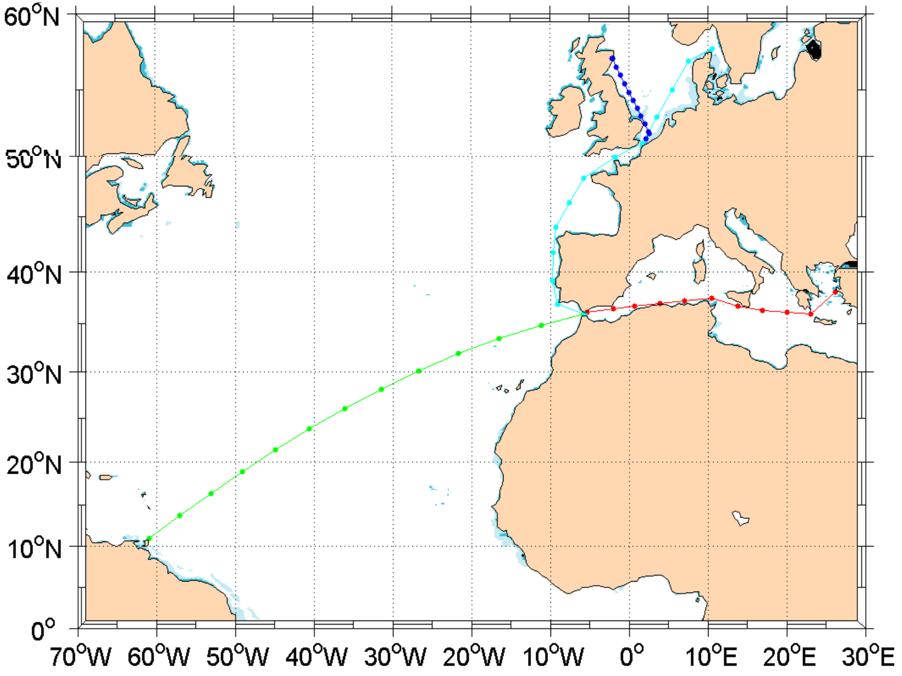
- It is mainly important to consider sway (leeway) balance; then leeway induced resistance is accounted for



Sensitivity wind statistics

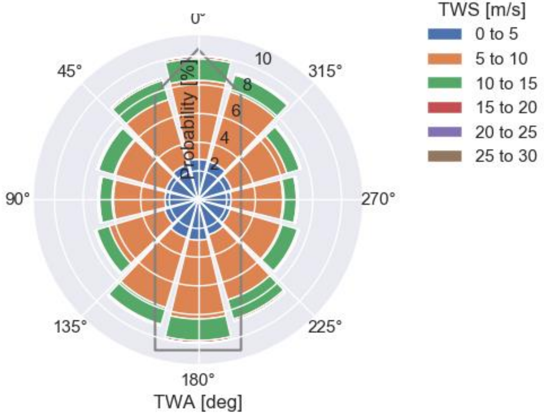
MEPC 62/INF.34

Additional routes

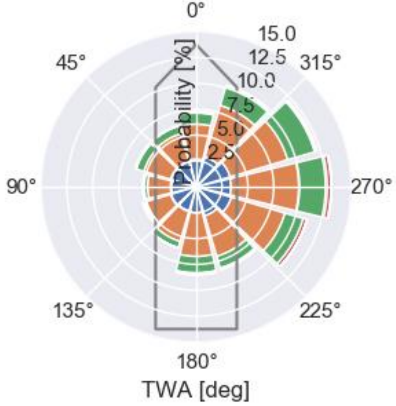


Sensitivity wind statistics

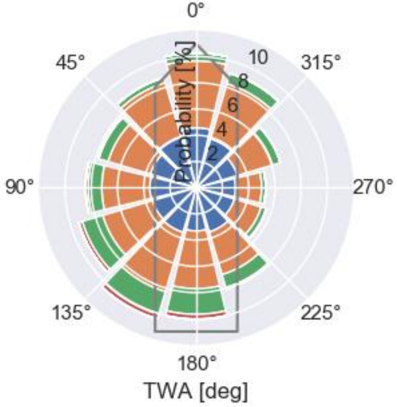
World Wide INF34



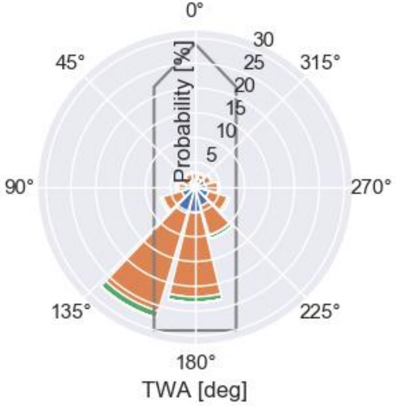
North Sea(NW -> SE)



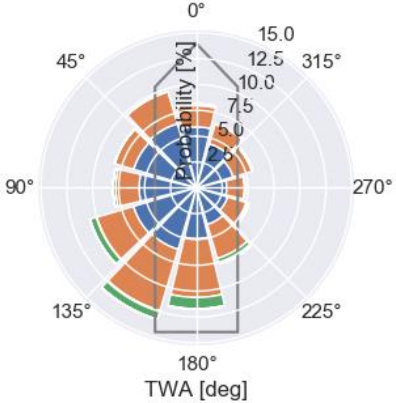
West Coast Europe (S –> N)



Europe –> Caribbean

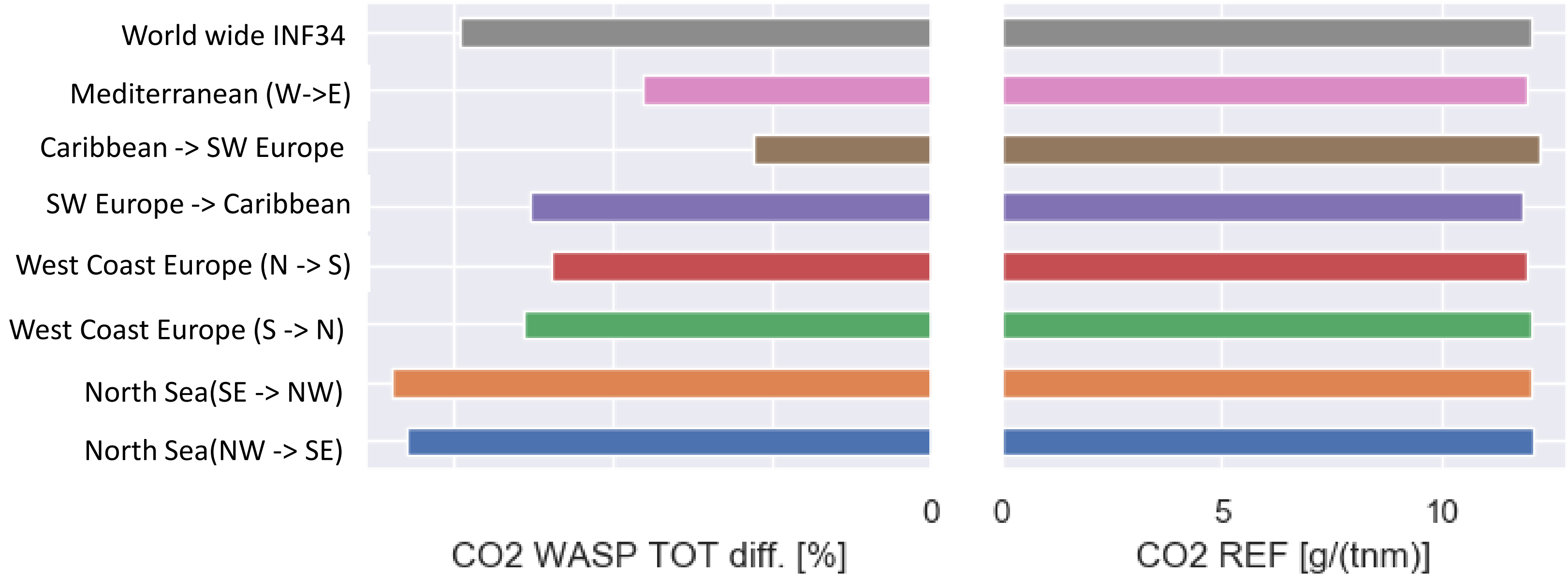


Mediterranean (W - > E)



Sensitivity wind statistics

- The IMO global wind statistics in INF.34 are not generally conservative



Preliminary observations Case 1

- Savings simple (Circ.815) calculations yield a much bigger saving than in more accurate calculations
- Particularly important (so far):
  - Wind statistics INF34 not always conservative
  - Resolving leeway induced heel resistance
  - Resolving wind at correct (centre of effort) height is important
  - Minimum propeller thrust and engine envelope, as well as maximum heel angle can limit savings

Further work in WiSP tasks 1&2

- Additional theoretical cases:
  - Hybrid Transition Coaster (MARIN)
  - Asphalt carrier (Blue Wasp Consultancy)
- Applied case(s)
- Publication of main results and recommended prediction methods

- Participants still welcome
- Completion of project by end of 2020

- Potential follow-up with onboard data (targeting EEOI)

Thank you for your attention

For any questions:

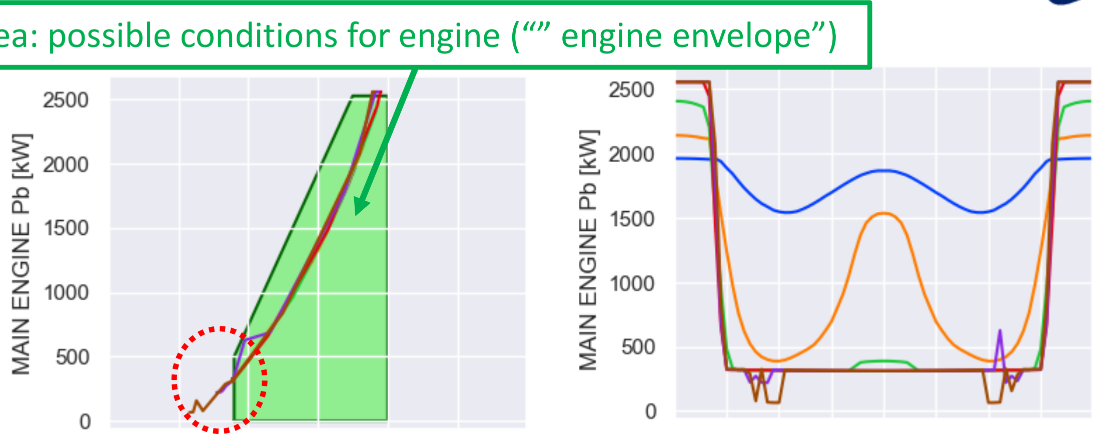
R.Eggers@marin.nl

P.M.Hooijmans@marin.nl

Propeller propulsion – CPP versus FPP

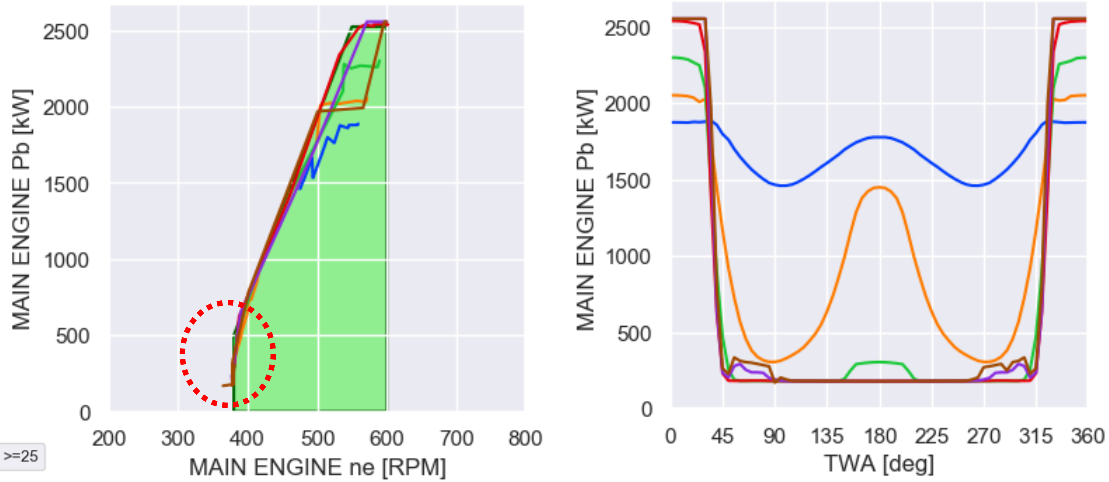
Fixed Pitch Propeller

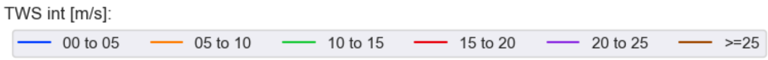
- Cannot depower when minimum engine RPM is hit
- Also results in convergence prolems



Controllable Pitch Propeller

- Can depower further, by reducing pitch



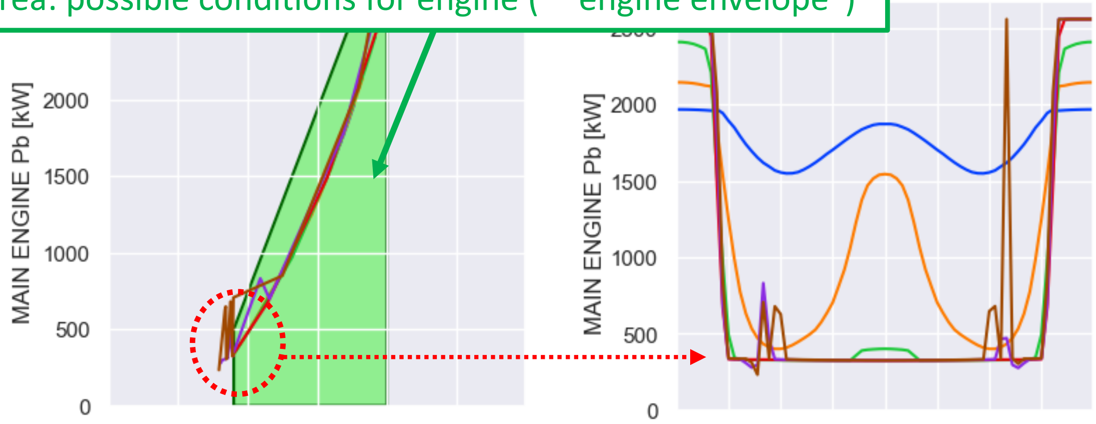


Propeller propulsion – Engine limits

Green area: possible conditions for engine ("" engine envelope")

With engine limits

- Power reduction limited by lowest rotation rate of engine



Without engine limits:

- Power can be reduced further