

The background of the top half of the slide is a photograph of a blue ocean with white-capped waves. A horizontal grid of thin white lines is visible at the top of the image. On the left side, there are four short, horizontal white dashes stacked vertically.

Challenging wind and waves

Linking hydrodynamic research to the maritime industry

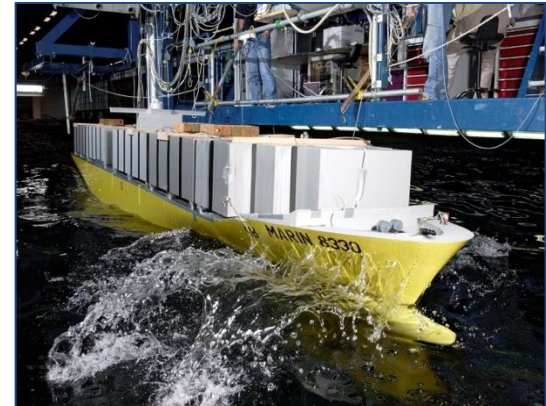
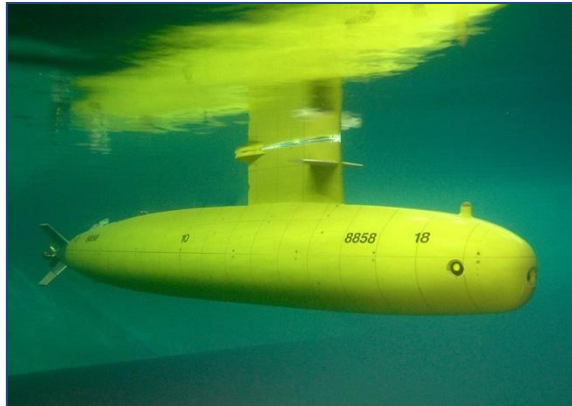
HYDRODYNAMIC ASPECTS OF WIND (ASSISTED) SHIP PROPULSION

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Sustainable Sea Transport Talanoa, 14-18 July 2014

MARIN DUAL MISSION

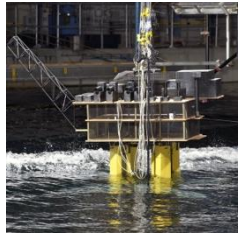
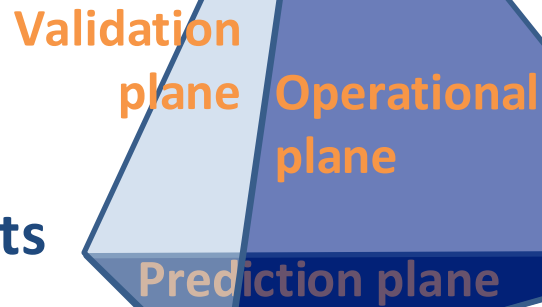
- To provide industry with innovative design solutions
- To carry out advanced research for the benefit of the maritime sector as a whole



MARIN ACTIVITIES



Monitoring

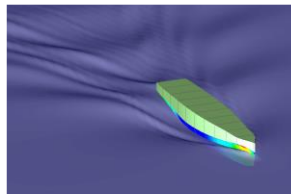


Model tests



Training

CFD&Simulation



MARIN INVOLVEMENT IN WIND PROPULSION PROJECTS

Amongst others:

- Wind Hybrid Coaster
- SAIL project
- Collaboration with Delft University of Technology with two PhD studies
- Others...



Wind Hybrid Coaster

Primarily looking into:

- Efficiency of underwater hull shape and appendages (calculations and model tests)
- Total operational efficiency in actual sea, wind current



SAIL project (picture: Ecoliner by Dykstra Naval Architects)

OLD VERSUS NEW

NEW:

- Specific arrival time
- High degree of reliability
- Safety standards
- Crew costs
- Possibilities of automation
- Different hull forms -> very efficient
- Cargo flows mainly based on economics

Ships nowadays are relatively advanced high-investment objects, strongly linked in a logistical system!



A Clipper



UT Wind Challenger

THE MAIN HYDRODYNAMIC ISSUES

The hull and its appendages are the platform for wind propulsion devices. The platform needs to deal with:

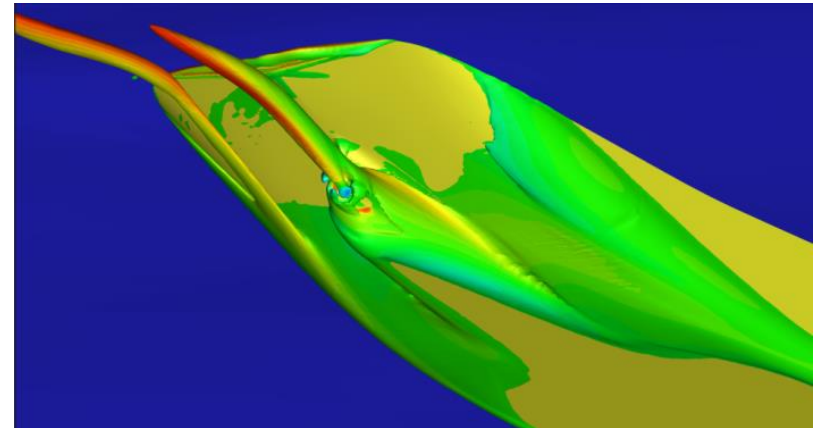
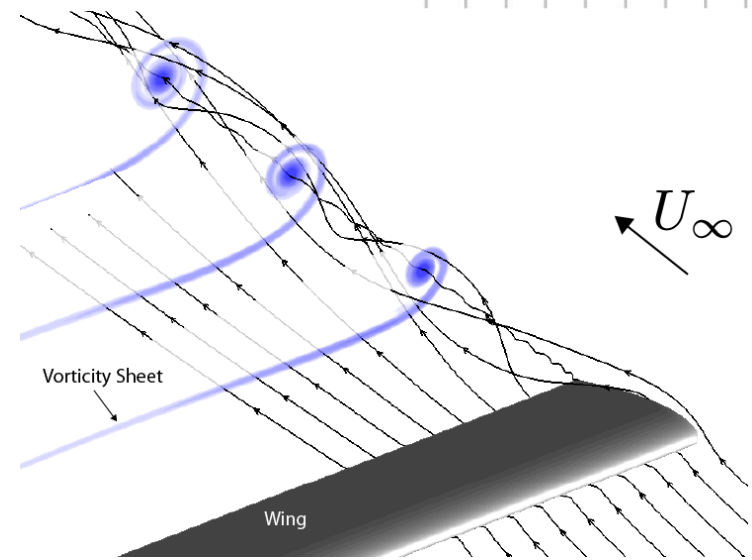
- Performance issues:
 - Non-zero mean heel, leeway and rudder angles, leading to additional resistance
 - Different and fluctuating ship speed and propeller load, leading to lower efficiency
- Operational issues:
 - Sail in good wind (selection of routes and use routing while sailing)
 - Maintain adequate seakeeping and manoeuvring capabilities

PERFORMANCE – 1. SPEED AND PROPELLER LOADING

- The speed of a ship with wind propulsion will fluctuate
 - Bulbous bow, shoulders and transom immersion will need attention
- Appropriate propeller for a large range of loadings:
 - Appropriate selection of pitch for a FPP or selection of a CPP (has a trade-off!)
- TOOLS:
 - Hull form and bulbous bow can be optimized using (simple) potential flow calculations
 - An appropriate design can be selected based on systematic series (e.g. Wageningen B- and C-series)

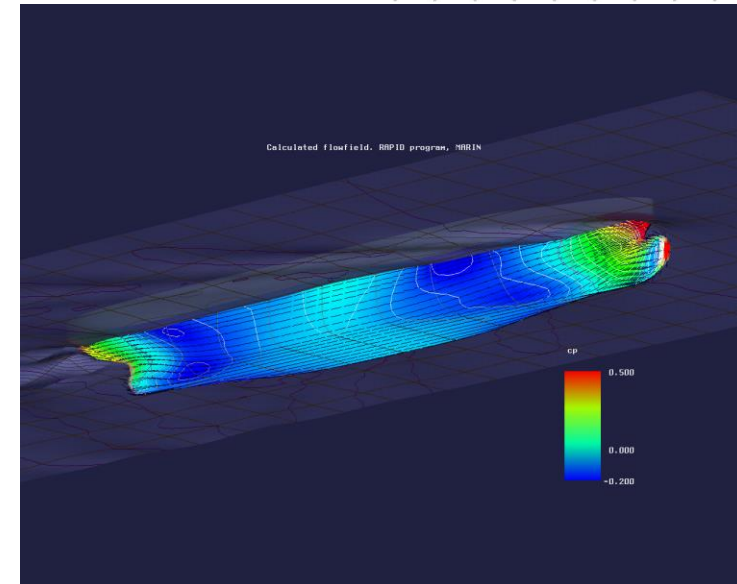
PERFORMANCE – 2. INDUCED RESISTANCE

- To resist sideways motion, the hull and rudder create lift.
- This comes with an increase in ship resistance through “lift induced drag” which can be considerable
- Some important aspects:
 - Aspect ratio of the hull and appendages (more draught is better!)
 - Section shape (more V-shape)
 - Appendages sizing and location -> are they more efficient than the hull?
 - The total lift of appendages + hull balances the wind forces! It is the distribution over various components of the ship that matters.



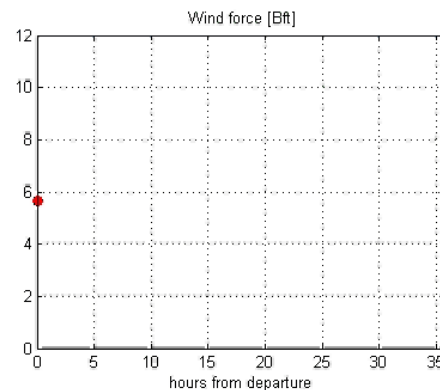
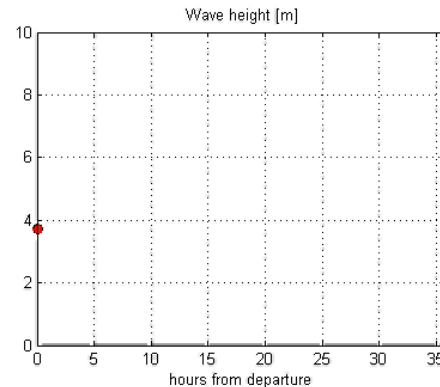
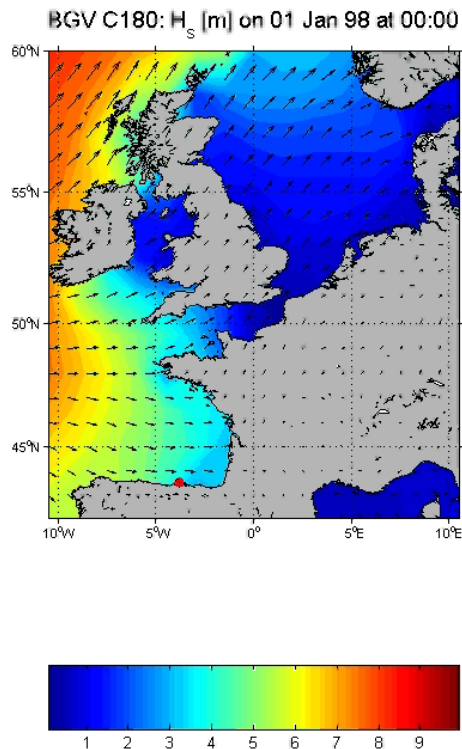
PERFORMANCE – 2. INDUCED RESISTANCE

- Induced resistance can be optimized using detailed CFD calculations and verified in model tests



OPERATIONAL – 1. EFFECT OF ENVIRONMENT AND ROUTING

- The power that can be harvested from the wind depends on the wind speed and direction!
- Voyage simulations allow to determine the operational performance using hindcast data for wind, waves and current and a re-routing algorithm



OPERATIONAL – 2. SEAKEEPING & MANOEUVRING

- Wind propulsion devices will experience dynamic loads due to ship motions and due to their own dynamic loading which need to be considered in their structural design
- When sailing in stern quartering wind and waves fully under wind power, ships may have difficulty to keep course as there is very little water flow velocity along the propeller
- Ships longer than 100m need to comply with the IMO manoeuvring criteria in resolution MSC. 137(76). This will need attention (the criteria currently do not define how to verify ships with wind propulsion).



THANK YOU!



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