

# Computational Modelling of Icebreaking Loads

Michael Huisman<sup>1</sup>, Sandro Erceg<sup>2</sup>, Thomas Rung<sup>1</sup>, Sören Ehlers<sup>2</sup>

<sup>1</sup>Institute for Fluid Dynamics and Ship Theory, <sup>2</sup>Institute for Structural Design and Analysis, Hamburg University of Technology, Germany

The last years have seen increasing activities in arctic sea areas with possible ice cover. This development has led to a stronger focus on the investigation of ship-ice interaction and manoeuvrability in ice-covered waters. Numerical simulation of ship-ice interaction offers the designer a valuable tool to assess ice loads on ship hulls in early design phases. We present a method to efficiently determine local and global loads on ships in ice at moderate computational expenses.

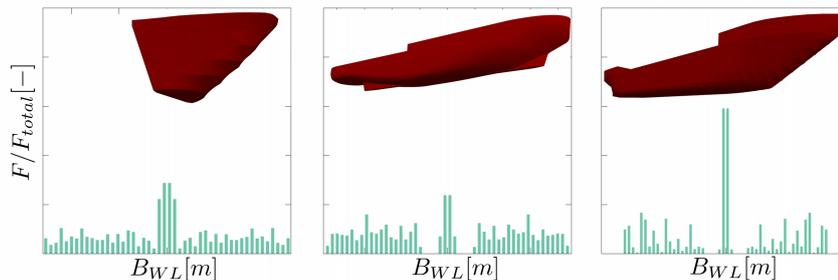
Recently, a number of publications focused on the simulation of the icebreaking process (e.g., [1]), while other studies put emphasis on a more detailed description of the transit through broken pack ice [2].

The objective of the present research is the holistic simulation of the icebreaking process along with the hydrodynamic interplay of the broken ice cups and the hull (Fig. 1). For this purpose, a free surface flow solver based upon the Lattice Boltzmann method is coupled to an icebreaking model and a contact-dynamic physics engine.

The direct simulation approach makes allows to determine local loads as well as global resistance. Applications included will examine various ships for different ice conditions. Emphasis is given to the load distribution on the hull as well as the total resistance. A closer look reveals large variations in load distributions for different ship types, which can be of great interest for the designer of ice-going vessels (Fig. 2).



**Fig. 1:** Icebreaking along the hull: Research vessel Kronprins Haakon in comparison with simulation results.



**Fig. 2:** Load distribution along the width of three different ship hulls: Coast Guard icebreaker Svalbard, tanker Uikku and arctic rescue vessel Typ189.

## Acknowledgement

This work has received funding from the German Federal Ministry for Economic Affairs and Energy under grant agreement No. **03SX412B** (PrICE-Project).

[1] Erceg, S., Ehlers, S., von Bock und Polach, R.U.F., Leira, B.J., 2014. A numerical model to initiate the icebreaking pattern in level ice. ASME 2014 33rd International Conference on Ocean, Offshore and Arctic Engineering, Vol. 10: Polar and Arctic Science and Technology, San Francisco, California, USA, June 8-13, 2014.

[2] Janßen, C.F., Mierke, D., Rung, T. (2017). On the development of an efficient numerical ice tank for the simulation of fluid-ship-rigid-ice interactions on graphics processing units. Computers & Fluids. 155 22-32.