Marin Ising (sjøsprøyt) på fartøyer, MARICE prosjektet

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Sea Spray Icing

Impact of icing on ships and offshore structures

- **Icing jeopardizing the stability and integrity of the vessel**
  - Heavy icing (>2 cm/h*) combined with heavy weather
  - typical weather threshold: air temperature <-9°C, wind speed >25 m/s

* *According to Overland algorithm*

Impact of icing on ships and offshore structures

- **Icing of essential components jeopardizing the safety and operability of the vessel**
  - Moderate icing: 0.7-2.0 cm/h
    - typical weather threshold: air temperature around -5°C, wind 15 m/s
  - Light icing: <0.7 cm/h
    - typical weather threshold: air temperature -4°C, wind 10 m/s

Anti Icing measures

- **Preventive Measures (anti-icing)**

Avoiding conditions where icing might occur	ships
Altering course/speed to avoid producing sea spray	ships
Designing the vessel to reduce the rate of ice accretion and ease of removal, protect (shielding) elements of high importance, insulation and heating traces	ships, offshore platforms
Increase the stability to better withstand the loads from the ice accretion	ships, offshore platforms

De-Icing measures

- **Mitigative Measures (de-icing)**

Wooden mallets	All types
Steam	All types
Heating	All types

Prediction versus observation

- **Preventive Measures (anti-icing)**

Avoiding conditions where icing might occur	ships
Altering course/speed to avoid producing sea spray	ships
Designing the vessel to reduce the rate of ice accretion and ease of removal, protect (shielding) elements of high importance, insulation and heating traces	ships, offshore platforms
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Prediction versus observation

- **Mitigative Measures (de-icing)**

Wooden mallets	All types
Steam	All types
Heating	All types

State – of – the - art

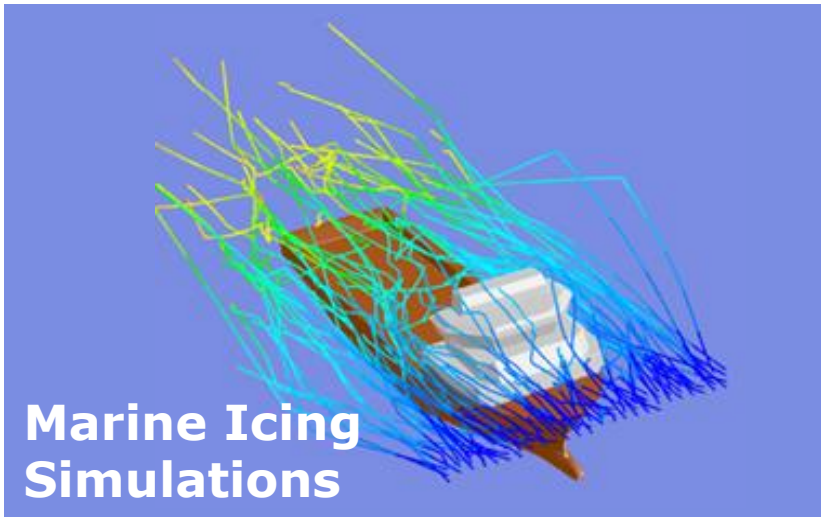
- **Weather agencies only apply empirically based models**
- **Two groups developed sea spray icing models in the 1980s**
  - Sintef (**ICEMOD**)
  - University of Alberta (**RIGICE**, **Spruance**)
- **Use simplified representations of the geometry and the air flow** around the structure, which leads to poor prediction of the heat transfer and, thus, ice accretion rate.
- **The models has only been verified against icing observations on small cylinders**
  - Run off is simplified, liquid water content vary (adds weight but do not require the phase change), added heat from surface are not taken into account
- **Main challenge has been the description of sea spray**
  - Droplet size distribution, amount of water, frequency

MARICE JIP

MarIce JIP: Marine Icing

- The overall objective was to provide predictive tools for and mitigation measures against sea spray icing for activities related to oil and gas production and transport
- Emphasis on offshore areas north of Norway and Russia.
- A Joint Industry Project, with funding from the Research Council of Norway and Statoil

MARICE Work Packages

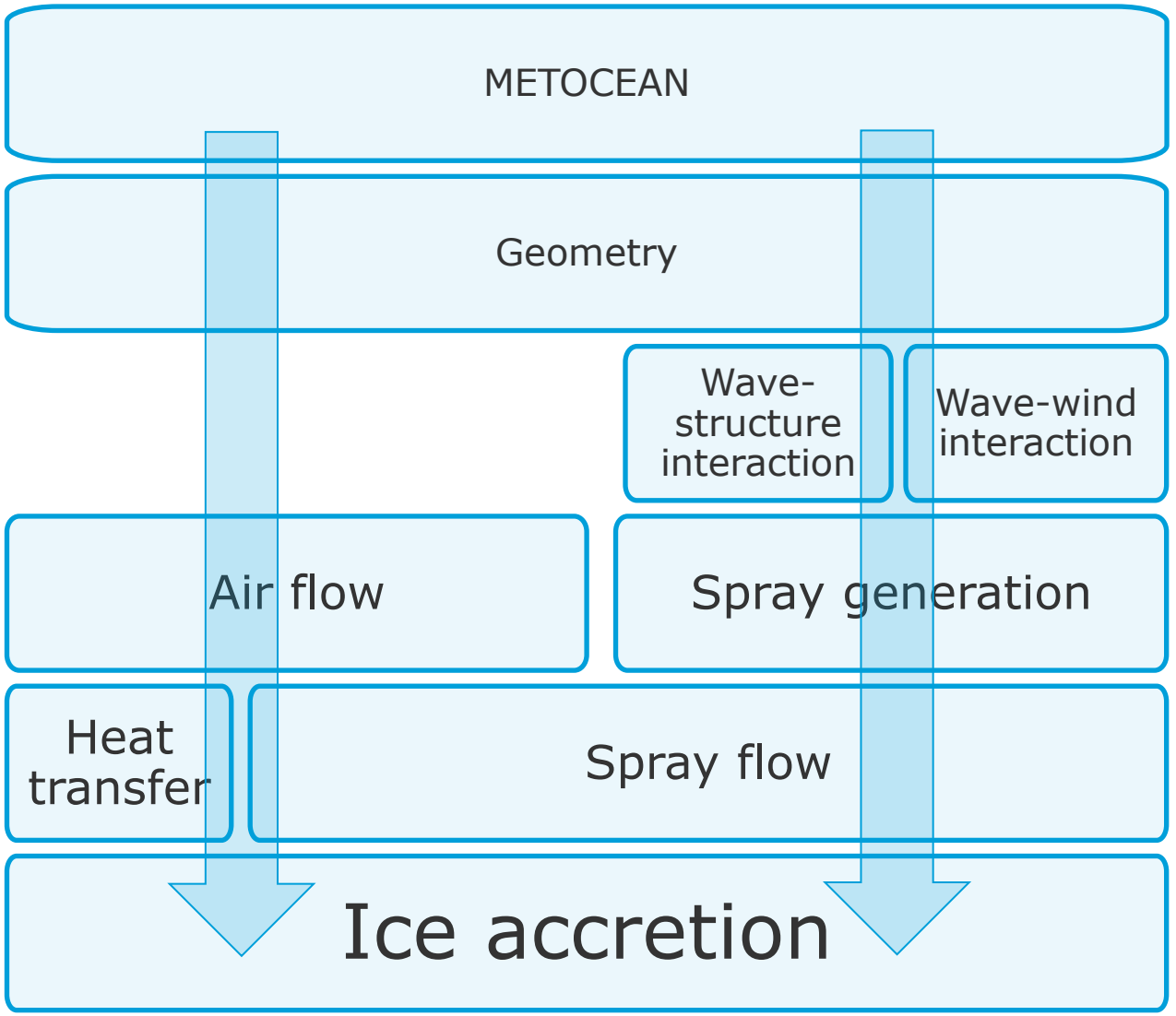


Marin Icing Simulations - Achievements

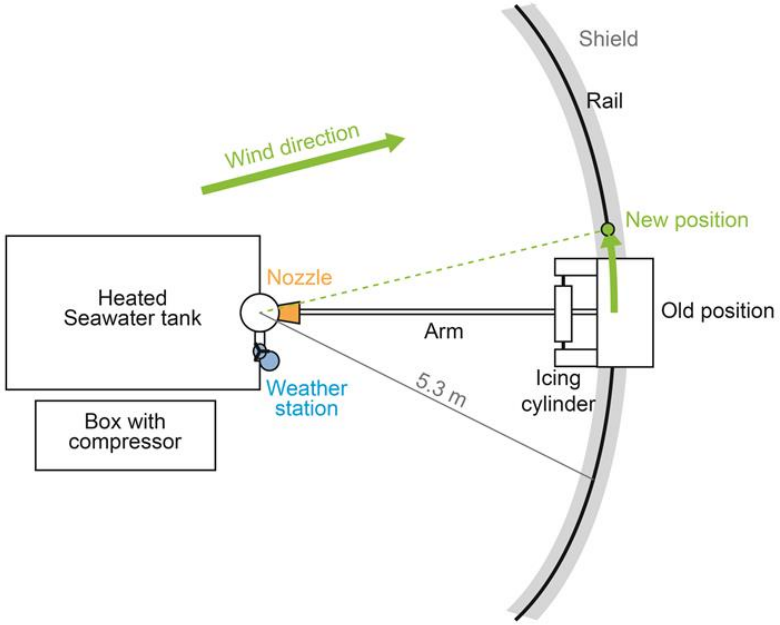
– ***ice cover formation*** *(i.e. ice accretion)* – impingement of seawater droplets with the vessel superstructure and subsequent freezing, melting and/or runoff of water.

– ***droplet flow*** – transport of seawater droplets by the air flow over the superstructure of the vessel;

– ***sea spray generation*** – generation of a cloud of droplets due to the interaction between waves and the structure.



Small-scale Measurements



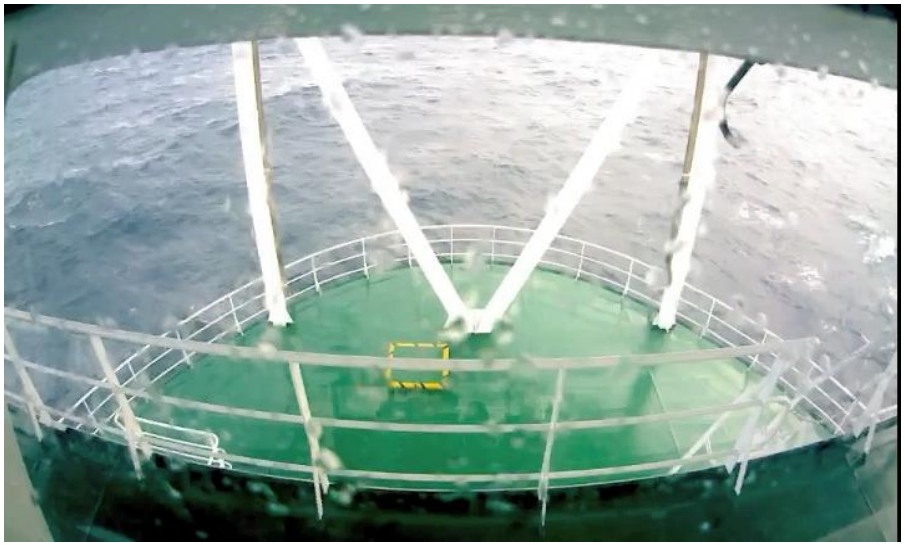
Achievements

- A new experimental equipment for measuring ice accumulation on a cylinder with respect to known weather and water spray conditions;
- Data for validation of time-dependent numerical icing model developed during the project;
- Testing of ice-resistant coatings.

Sea Spray Measurements

Achievements

- A new experimental equipment based on video cameras to register occurrence, duration and period of the sea spray;
- Extensive video material useful in studying sea spray characteristics with respect to vessel design and voyage parameters;

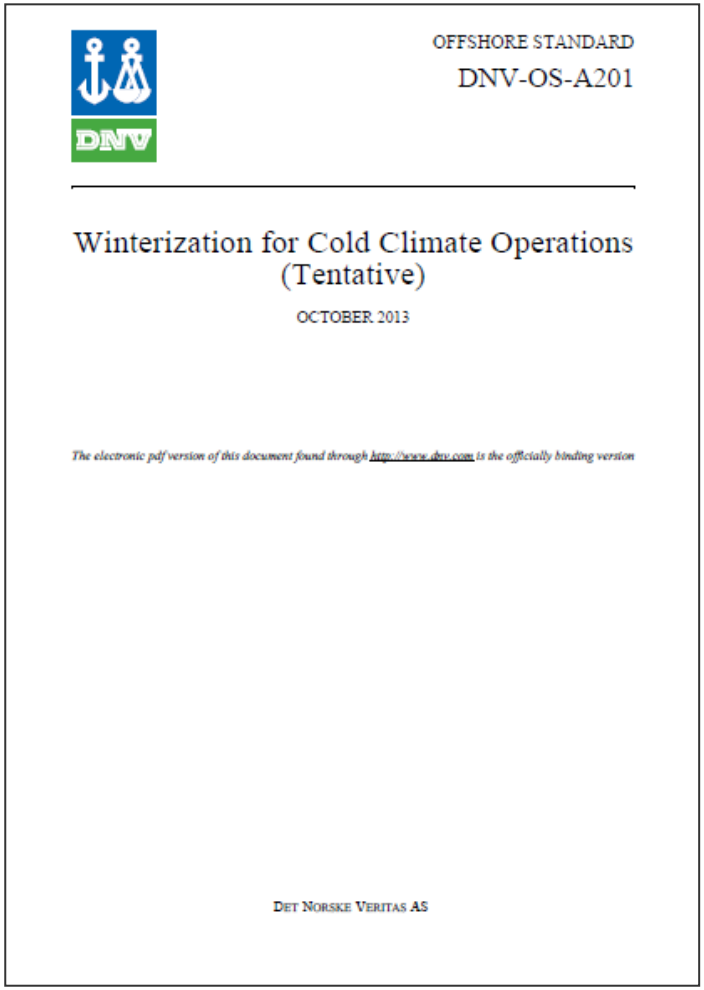


Further development

- Spray geometry, duration and period should be studied further. The collected data should be analyzed to identify and quantify governing parameters (sea state, vessel behavior) for sea spray generation.

Input to Rules and Regulations

- NORSOK N-003 is being updated
- A new ISO standard on data collection is being developed
- DNV-OS-A201 published Oct 2013



OFFSHORE STANDARD

DNV-OS-A201

Winterization for Cold Climate Operations (Tentative)

OCTOBER 2013

The electronic pdf version of this document found through http://www.dnv.com is the officially binding version

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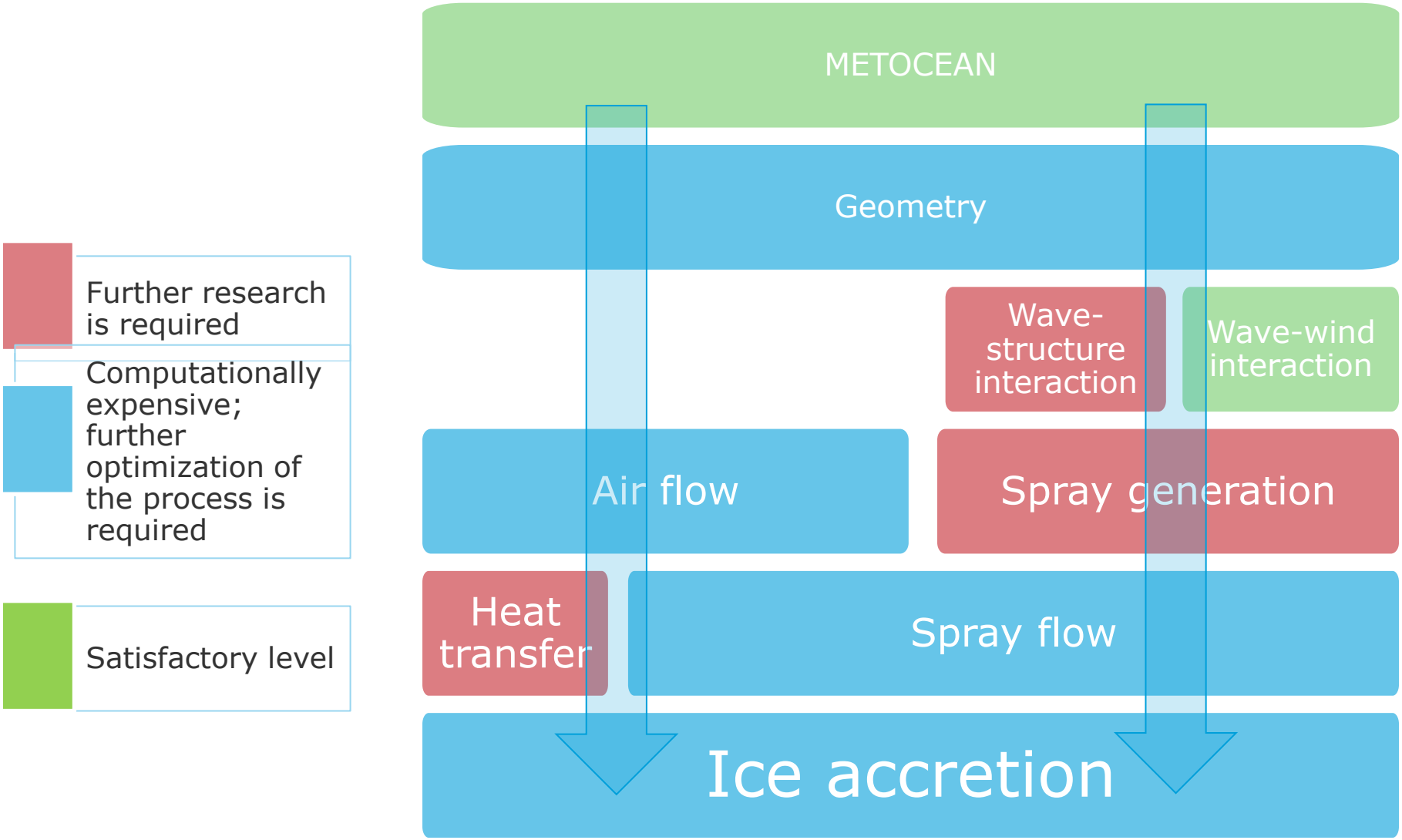
Marin Icing Simulations - Further development



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