Multidisciplinary approach for spray icing modelling and decision support in the Norwegian maritime sector (SPRICE)

An overview

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UiT The Arctic University of Norway · HERMES · KYSTVERKET NORWEGIAN COASTAL ADMINISTRATION · SINTEF · Gratanglaks · Norwegian Meteorological Institute · The Research Council of Norway

Background and Motivation


Icing of the Canadian Coast Guard Ship “Sir William Alexander” (Photo: Fishing Vessel Safety Division of the USCG)




Photo: Audun Mathiassen



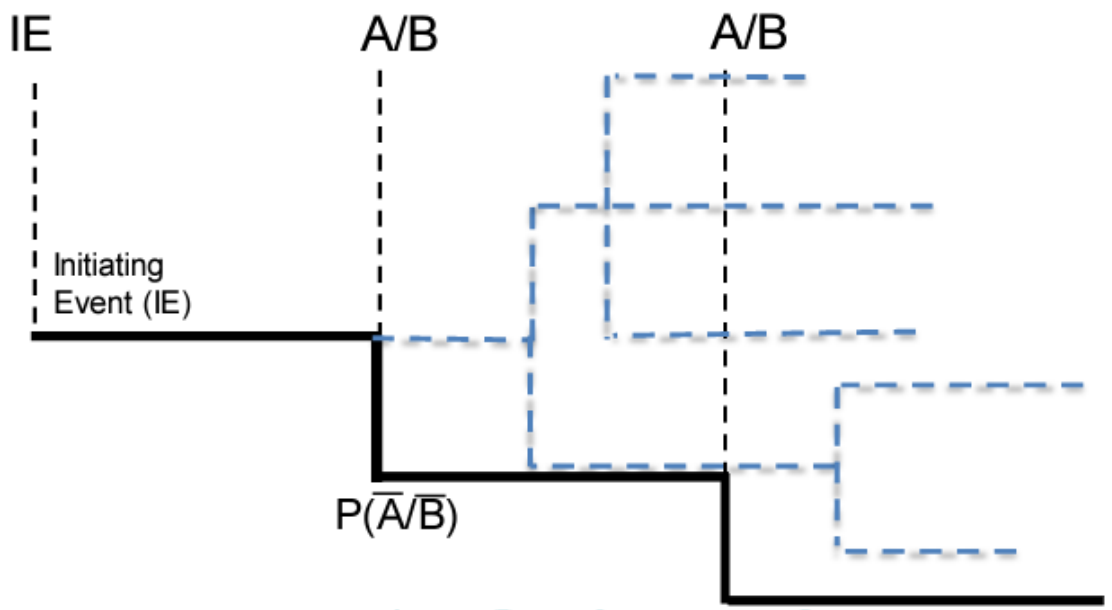


Motivation: Modelling spray icing, risks, making decisions under uncertainty



Active and ***passive*** safety barriers for reducing spray icing risks

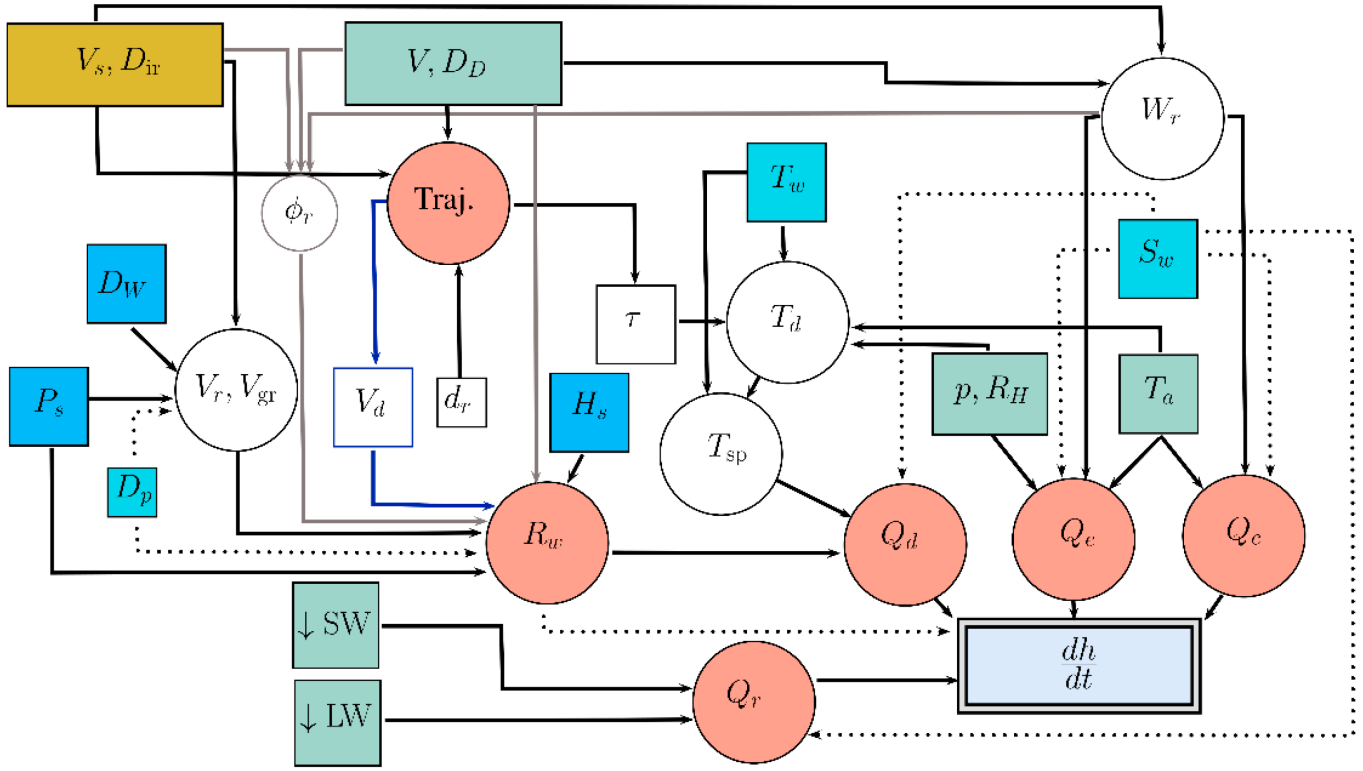
- **Technical**
- **Organisational**



Sequential decisions under uncertainties related to met-ocean parameters

Understanding spray icing

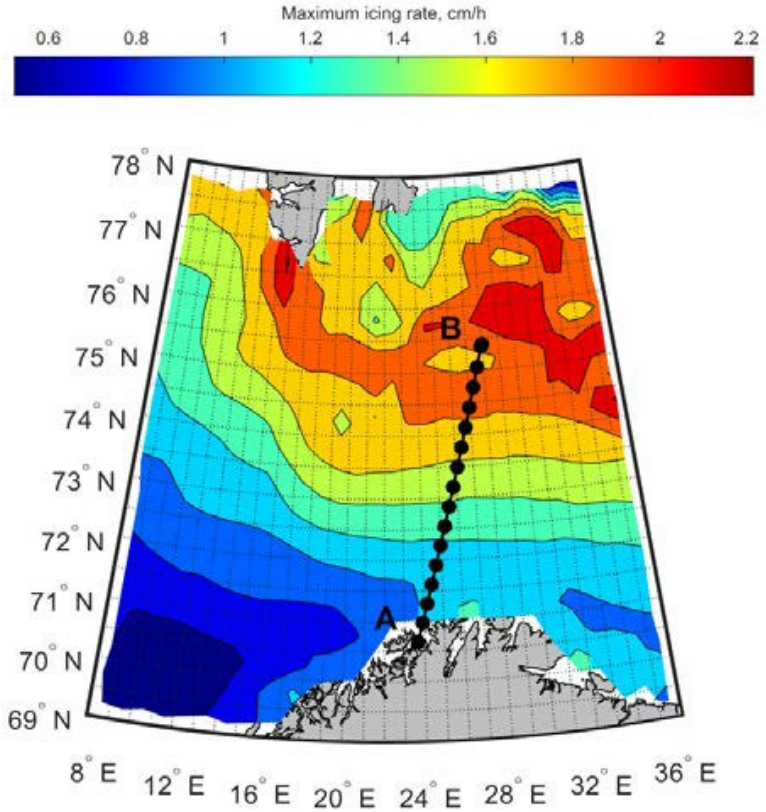
- ***Optimal design and operation of Winterisation measures & anti-icing / de-icing measures***
- Developing **spray icing models** (different applications)

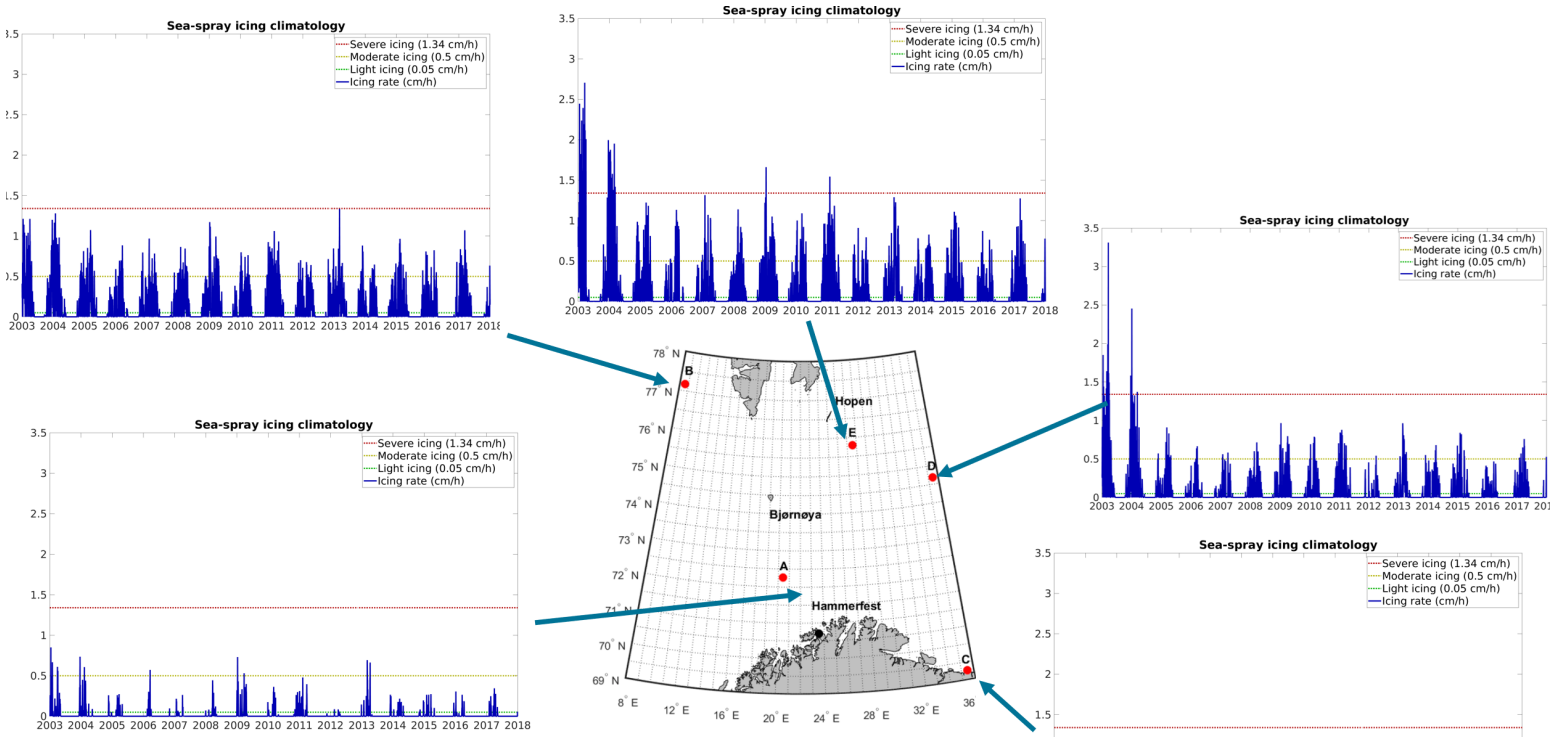


MINCOG (Samuelsen et al., 2017)

Understanding spray icing

- Spatial and temporal variations in the short- and long-term

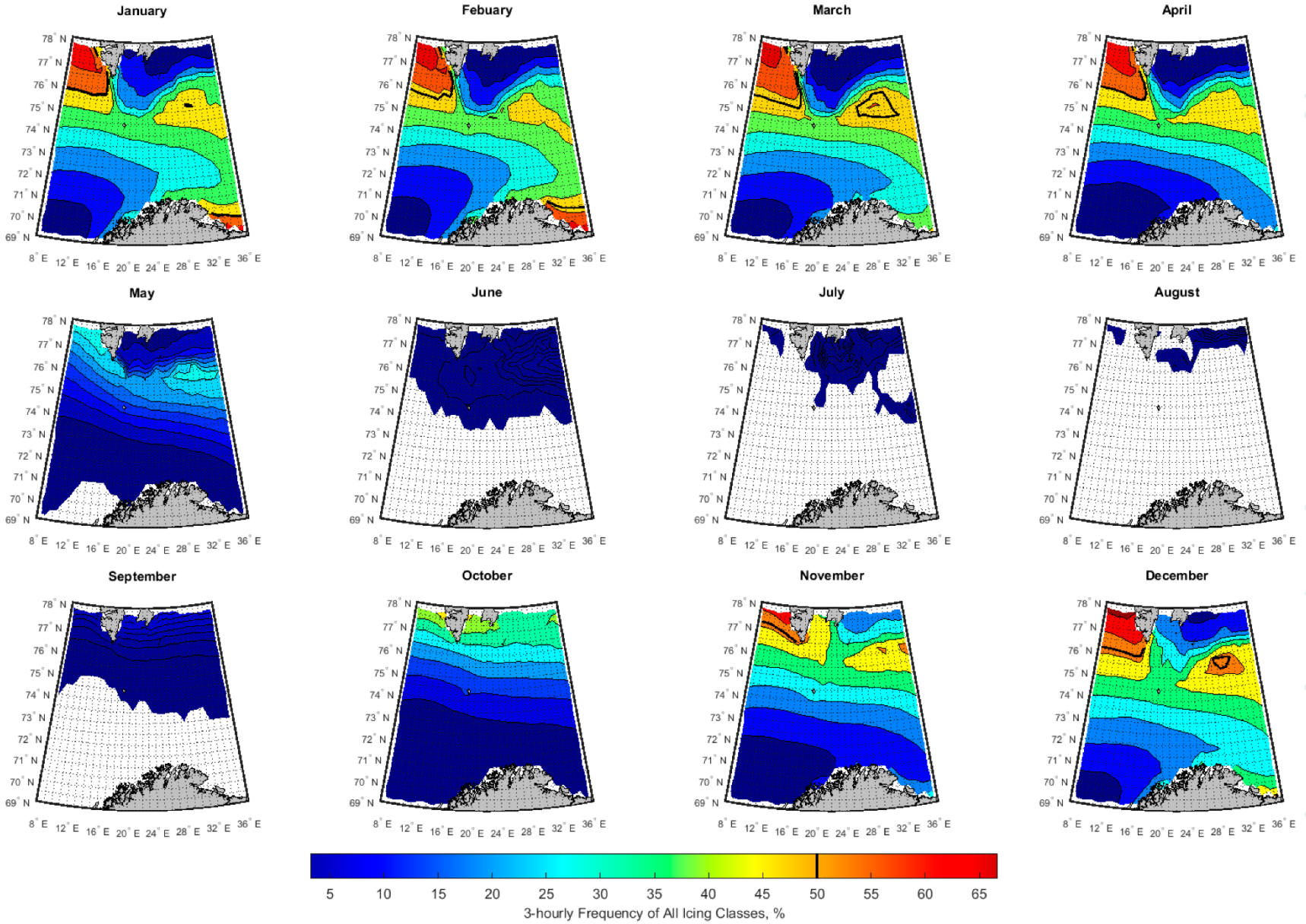




Data provided by the NORA3/WINDSURFER project, MET Norway (Eirik Samuelsen)

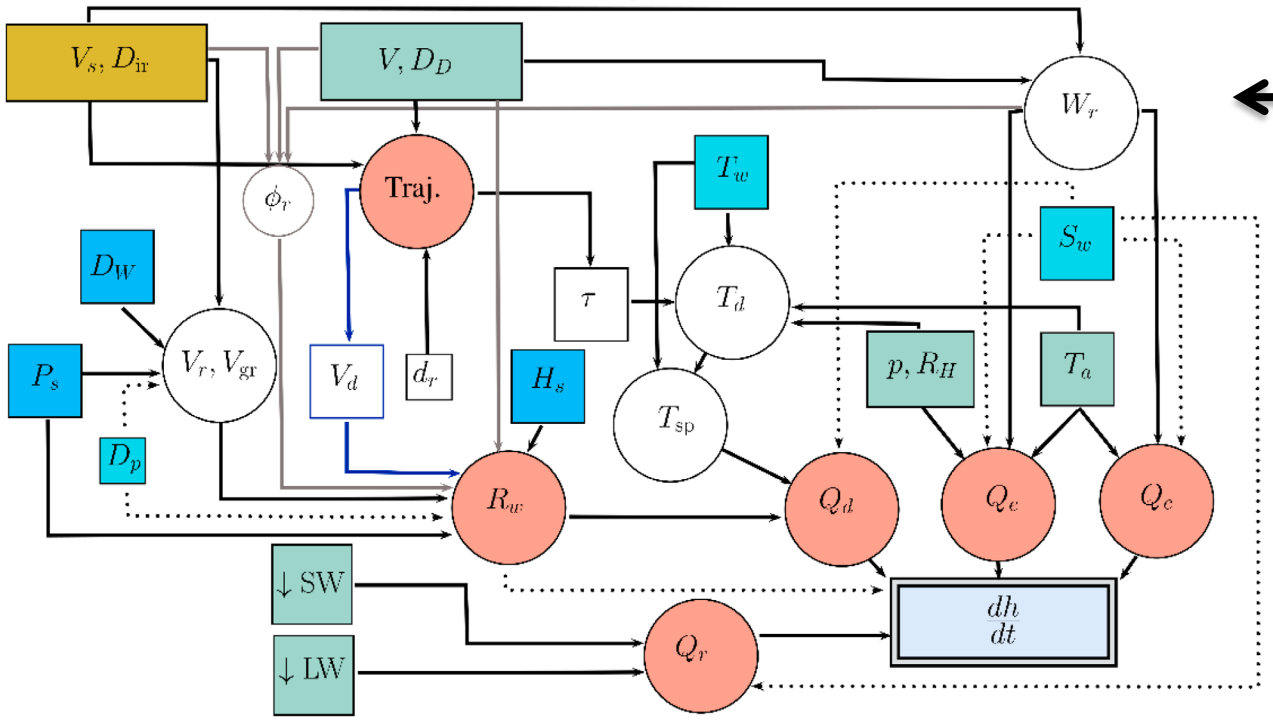
Understanding spray icing

- Probabilistic study of spray icing (frequencies, severity, long term trends, risk measures, etc.)
- Spatial and temporal variations



Understanding spray icing

Field measurements and empirical correlations…



MINCOG (Samuelsen et al., 2017)

$$w = w_o H_s^2 e^{-0.55h}$$
$$w = w_o' H_s^{2.5} e^{-0.55h}$$
$$w = 1.35 H_s^2 e^{-0.53z'}$$
$$w' = 1.7 \times 10^{-4} H_s$$
$$w' = 10^{-3} H_s$$
$$w = 0.1 H_s e^{(H_1 - 2z)}$$
$$w = 4.6e^{-\left(\frac{2z}{H_{m_0}}\right)^2}$$

Measuring Meteorological and atmospheric parameters

Understanding spray icing

- Vessel/facility/structure specifications and data

Where to focus?



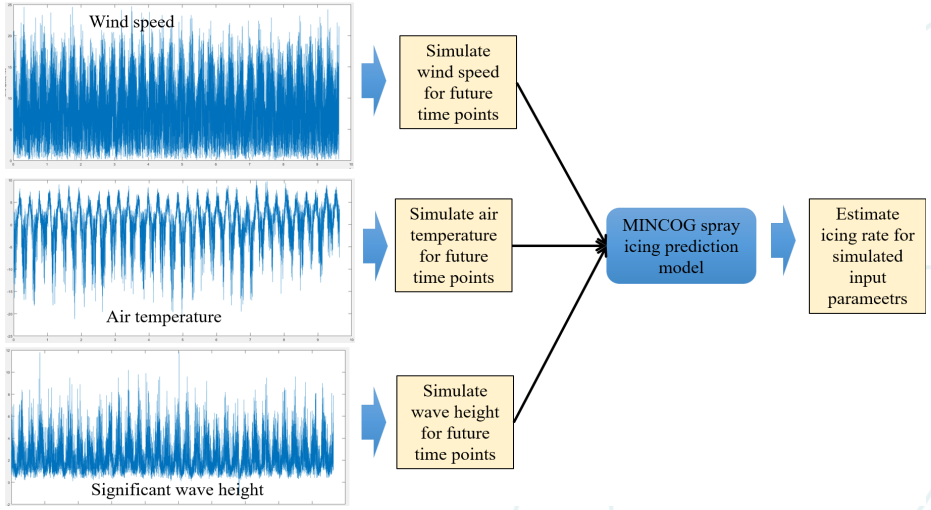


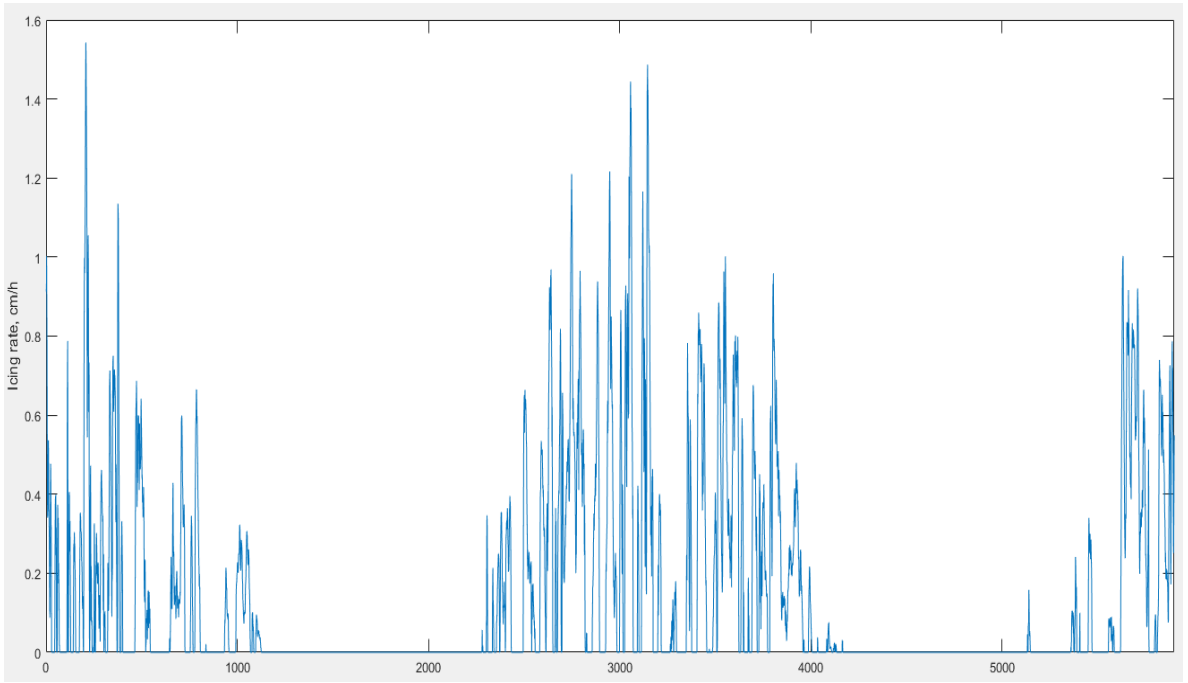


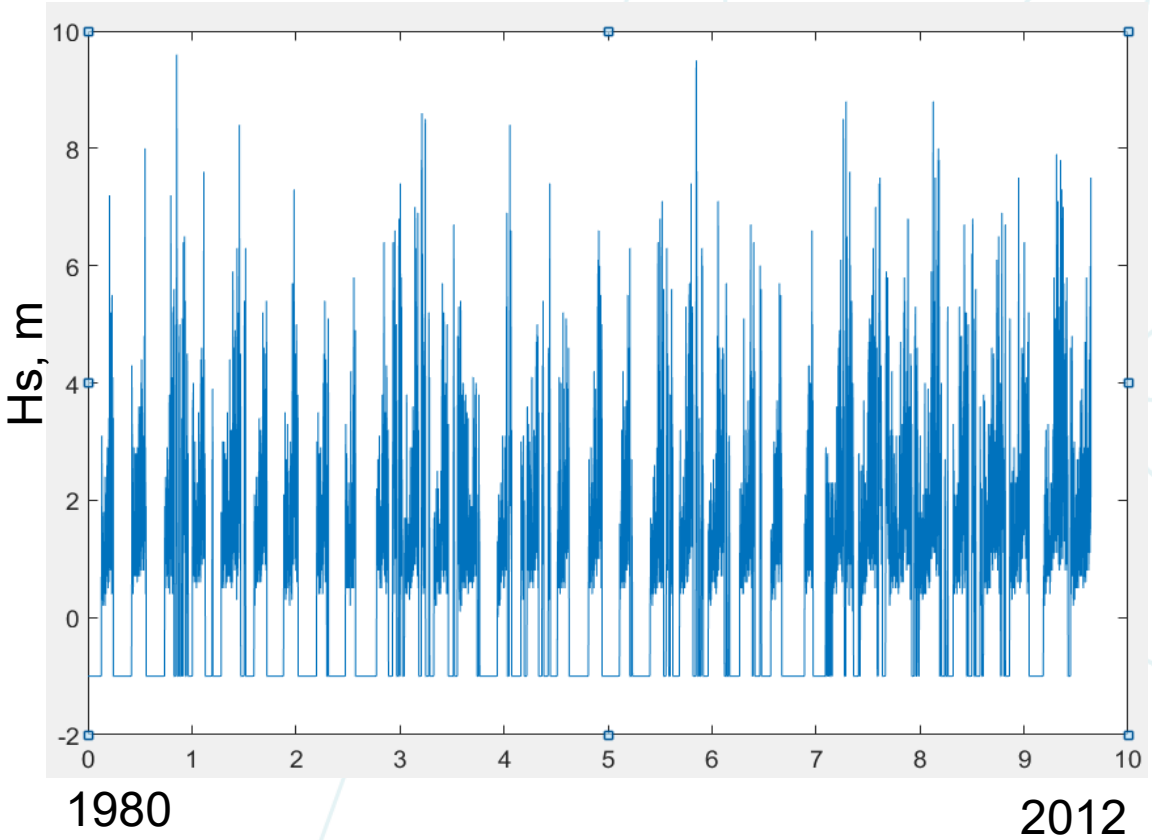


Understanding spray icing

- Time series analysis and ML methods for data analysis







Managing risks of spray icing – Where do we stand?

In order to manage the risk:

- **What data and inputs do we need?**

- **What criteria do we have?,**
  - Cost
  - Safety of facility/fish/operators
  - Regulations
  - Ensuring operational routines
  - ...?

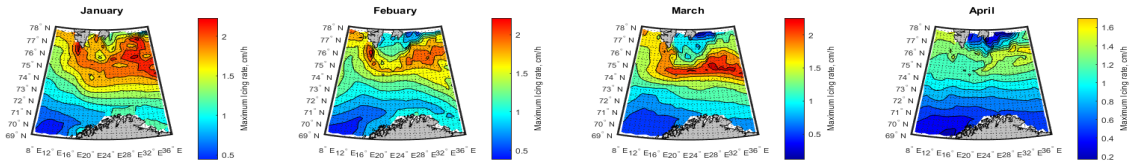
- **What sorts of operational alternatives do we have to choose** (Anti-icing/de-icing techniques, design modification, operational/organisational)?

- **What are the time frames for having such necessary data and information?**

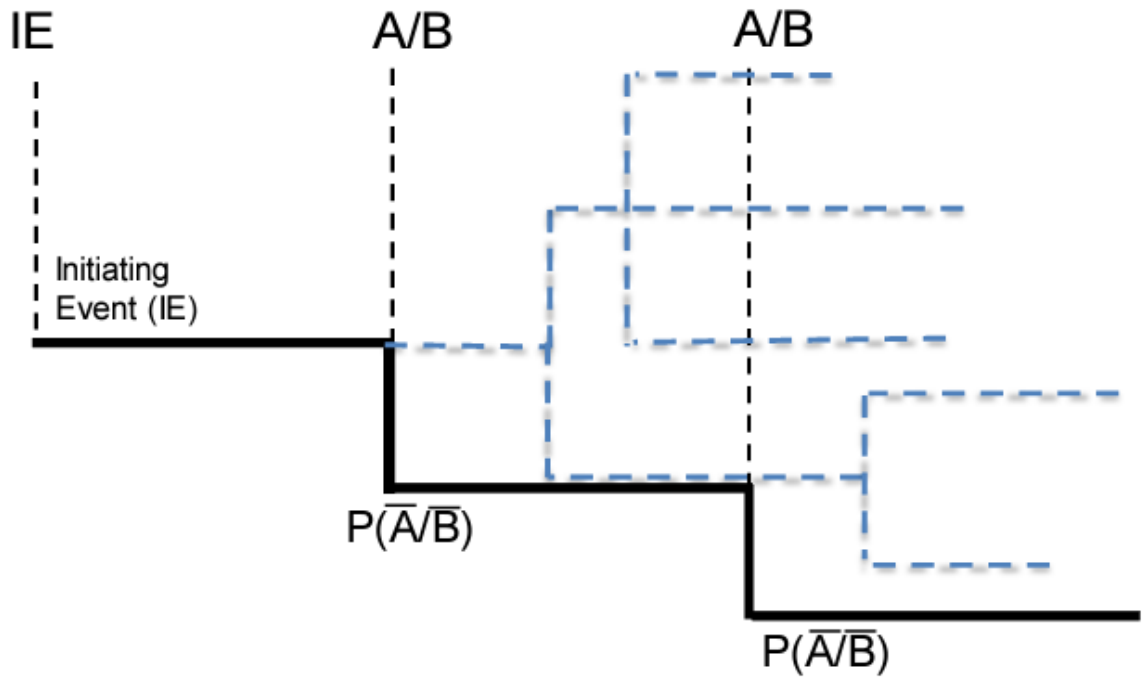
- **How do we perceive risks?**

- **...?**

RISK ASSESSMENT MATRIX				
SEVERITY / PROBABILITY	Catastrophic (1)	Critical (2)	Marginal (3)	Negligible (4)
Frequent (A)	High	High	Serious	Medium
Probable (B)	High	High	Serious	Medium
Occasional (C)	High	Serious	Medium	Low
Remote (D)	Serious	Medium	Medium	Low
Improbable (E)	Medium	Medium	Medium	Low
Eliminated (F)	Eliminated			

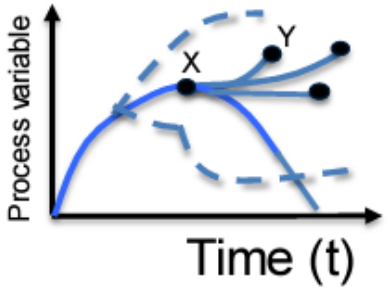


Dynamic Risk Assessment



Scenarios Exploration and Sequential decision-making

Timing (t)
Order (o)
Magnitude (m)



	Component A			Component B			Component Y		
Scenario 1	t_1	m_1	o_1	…	…	…	t_1	m_1	O_1
Scenario 2	t_2	m_2	o_2	…	…	…	t_2	m_2	o_2
…	…	…	…	…	…	…	…	…	…
Scenario *N*	t_N	m_N	o_N	…	…	…	t_N	m_N	o_N

SPRICE – A step forward

RQ1 To what extent can spray icing field observations be utilized for spray icing model refinement and validation?

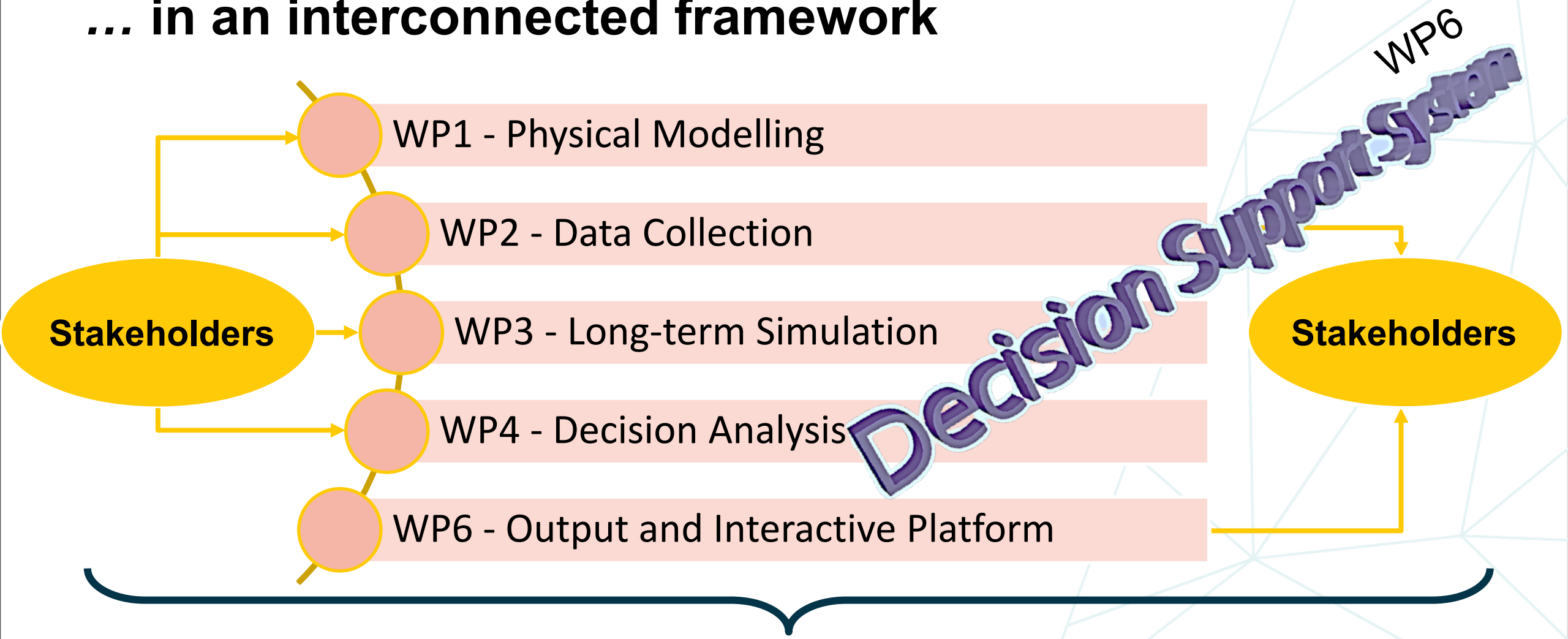
RQ2 To what extent is our refined spray icing model applicable to vessels and fish farms operating in Arctic waters, or in waters with conditions for spray icing?

RQ3 Which statistical frameworks are most suitable for long-term simulation of spray icing rates and frequencies?

RQ4 What thresholds exist in spray-icing-concerned decision-making, do they differ by different stakeholders, and how can they be improved or reduced?

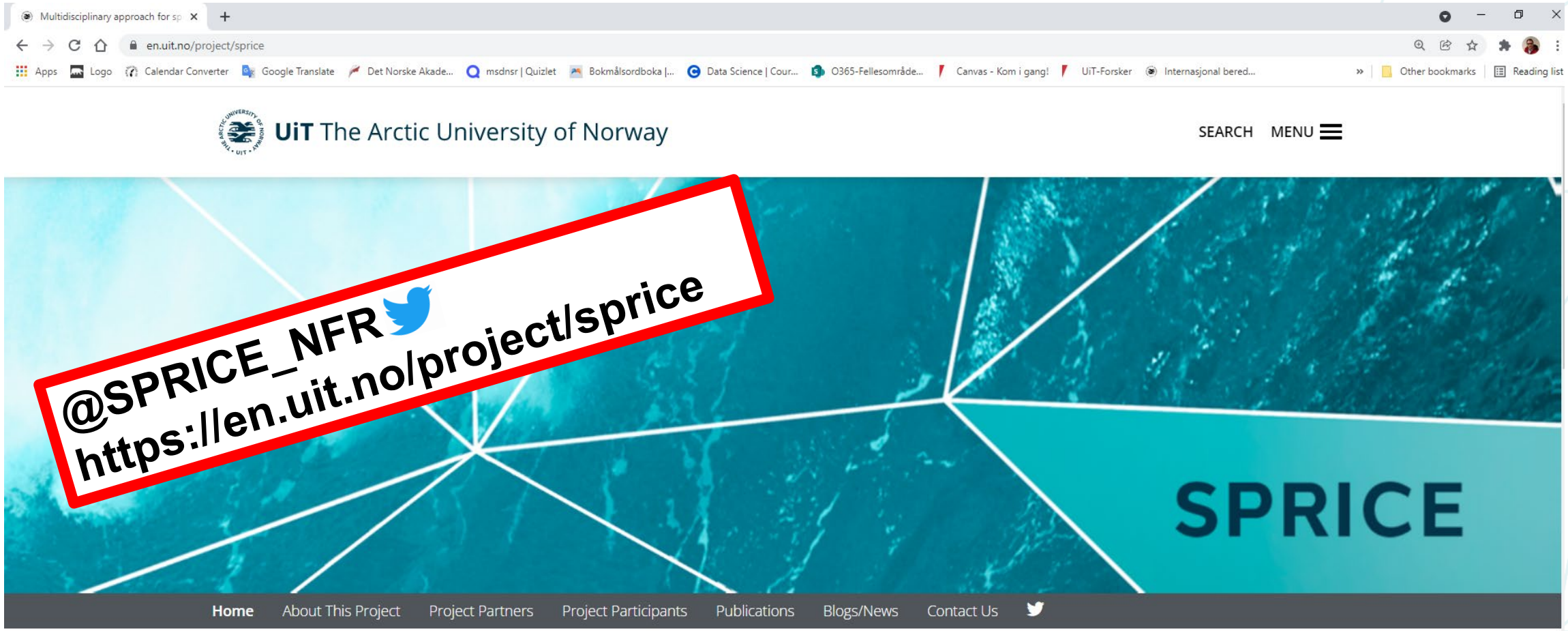
RQ5 What elements are necessary to include in a comprehensive decision support system (different stakeholders, various spray icing scenarios, short- and long-term risk-informed decisions)?

… in an interconnected framework



- **Project Period:** June 2021 – May 2025
- **Total budget:** 18,166,000 NOK

  (UiT: 962 kNOK, Hermes 2,144 kNOK, NCA: 2100, The Research Council of Norway: 12,960 kNOK)



Multidisciplinary approach for spray icing modelling and decision support in the Norwegian maritime sector (SPRICE)

Sea spray icing poses a great deal of risk to marine operations in the Arctic offshore water and in cold waters with favourable conditions for spray icing. By developing models and simulation frameworks for prediction of spray-icing rates and severity and by developing risk-informed decision-making frameworks, this project helps decision-makers in the Norwegian maritime sector be equipped with better tools that support spray icing-related decision-making, risk perception, and operational safety.

Multidisciplinary approach for spray icing modelling and decision support in the Norwegian maritime sector
(**SPRICE**)

The Research Council of Norway



UiT The Arctic University of Norway

HERMES

SINTEF

KYSTVERKET

Norwegian Meteorological Institute

Gratanglaks

Leveraging AIS Data and Field Knowledge for Making Spray Icing Risk-Informed Decisions
(**SPRISK**)



UNIVERSITETET I TROMSØ

Meteorologisk institutt

KYSTVERKET

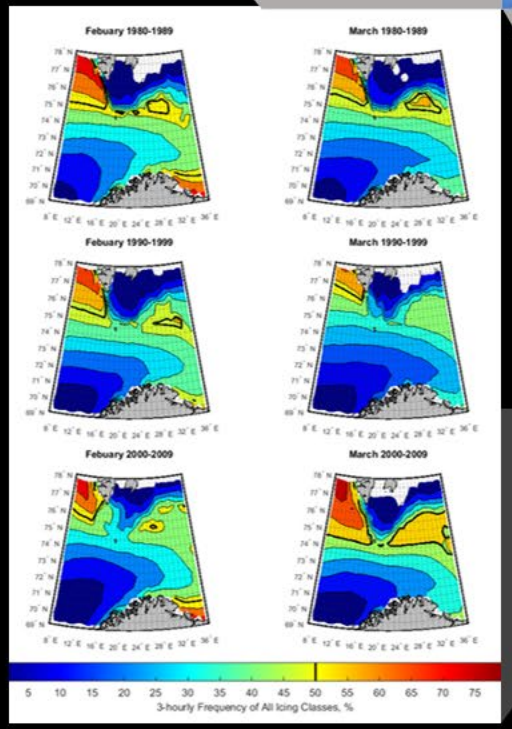
SINTEF

- Mapping the available operational experience
- AIS data mining and knwoledge discovery using advanced ML tools
- Risk-informed decision-making framework







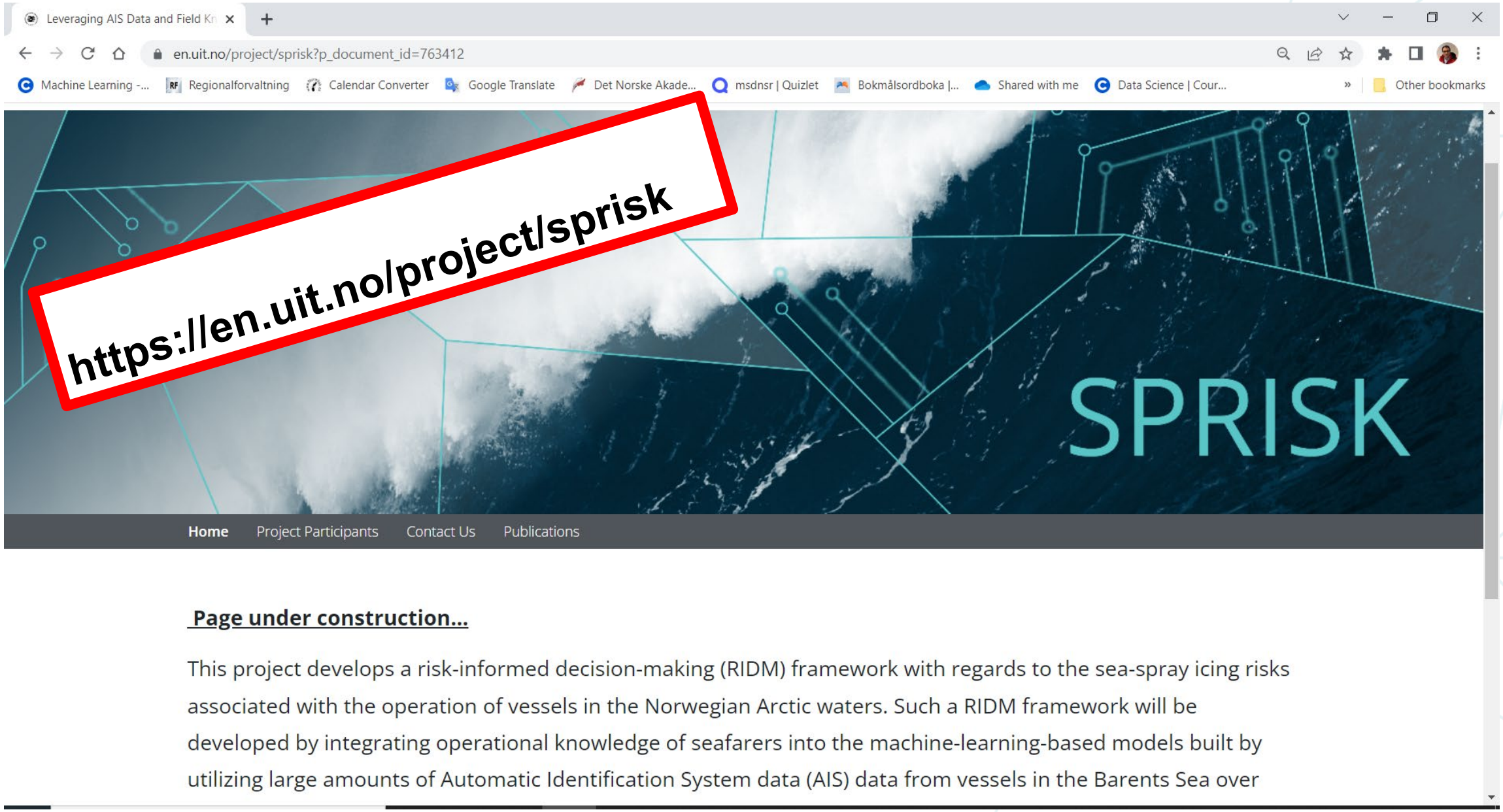




SPRISK - Goal

- **Project goal**

*Proposing **risk-informed decision-making** frameworks developed by leveraging historical **AIS data**, employing **spray icing estimation model**, **meteorological and oceanographic conditions**, and **field knowledge** in fishery industry.*


Leveraging AIS Data and Field Kn
en.uit.no/project/sprisk?p_document_id=763412
Machine Learning -...
Regionalforvaltning
Calendar Converter
Google Translate
Det Norske Akade...
msdnsr | Quizlet
Bokmålsordboka |...
Shared with me
Data Science | Cour...
Other bookmarks
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This project develops a risk-informed decision-making (RIDM) framework with regards to the sea-spray icing risks associated with the operation of vessels in the Norwegian Arctic waters. Such a RIDM framework will be developed by integrating operational knowledge of seafarers into the machine-learning-based models built by utilizing large amounts of Automatic Identification System data (AIS) data from vessels in the Barents Sea over