


Poster # 38


Case studies towards cryosphere digital twin applications





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The Nordic Cryosphere Digital Twin (NOCOS DT)

Aims to **explore and pilot the digital twin technology opportunities and showcase how outputs from key initiatives such as the Destination Earth (DestinE) Climate Change Adaptation Digital Twin (Climate DT)**

could be leveraged for key **sea ice impact sectors in the Nordic and Baltic context.**

In the longer term, deliver a major Arctic and Baltic contribution to the **climate change information system** developed by Climate DT, with cryosphere-related **use cases at the interface between science and policy**, in line with the overarching **Destination Earth approach.**

Partners



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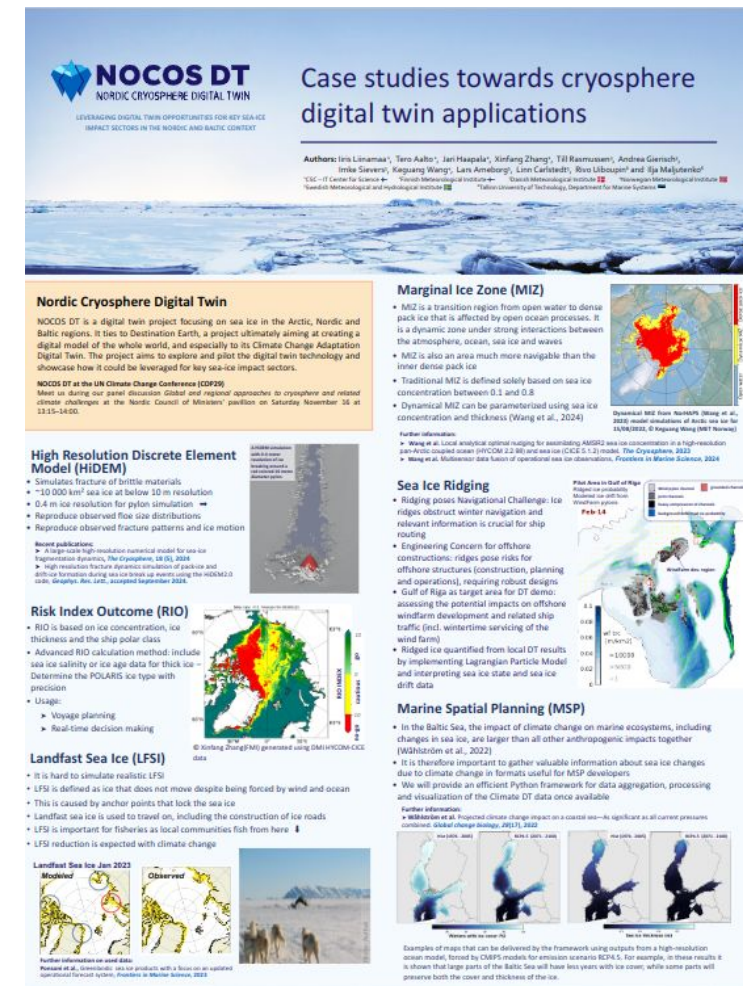


Nordic Council
of Ministers

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Case studies in NOCOS DT

1. Ship navigation risk indicator (led by FMI)
2. Landfast ice (led by DMI)
3. Ridged ice (led by TalTech)
4. Marginal ice zone (led by MetNo)
5. Marine Spatial Planning (led by SMHI)
6. DEM-based sea ice model development (led by CSC)



NOCCOS DT
NORDIC CRYOSPHERE DIGITAL TWIN
LEVERAGING DIGITAL TWIN OPPORTUNITIES FOR KEY SERVICE
IMPACT SECTORS IN THE NORDIC AND BALTIC CONTEXT

Case studies towards cryosphere digital twin applications

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Nordic Cryosphere Digital Twin
NOCCOS DT is a digital twin project focusing on sea ice in the Arctic, Nordic and Baltic regions. It ties to Destination Earth, a project ultimately aiming at creating a digital model of the whole world, and especially to its Climate Change Adaptation Digital Twin. The project aims to explore and pilot the digital twin technology and showcase how it could be leveraged for key sea-ice impact sectors.

NOCCOS DT at the UN Climate Change Conference (COP28)
Meet us during our panel discussion Global and regional approaches to cryosphere and related climate challenges at the Nordic Council of Ministers' pavilion on Saturday November 18 at 13:15-14:00.

High Resolution Discrete Element Model (HIDEM)
• Simulates fracture of brittle materials
• ~10 000 km² sea ice at below 10 m resolution
• 0.4 m ice resolution for pylon simulation
• Reproduce observed floe size distributions
• Reproduce observed fracture patterns and ice motion

Risk Index Outcome (RIO)
• RIO is based on ice concentration, ice thickness and the ship polar class
• Advanced RIO calculation method: include sea ice salinity or ice age data for thick ice
• Determine the POLARIS ice type with precision
• Usage:
 > Voyage planning
 > Real-time decision making

Landfast Sea Ice (LFSI)
• It is hard to simulate realistic LFSI
• LFSI is defined as ice that does not move despite being forced by wind and ocean
• This is caused by anchor points that lock the sea ice
• Landfast sea ice is used to travel on, including the construction of ice roads
• LFSI is important for fisheries as local communities fish from here
• LFSI reduction is expected with climate change

Marginal Ice Zone (MIZ)
• MIZ is a transition region from open water to dense pack ice that is affected by open ocean processes. It is a dynamic zone under strong interactions between the atmosphere, ocean, sea ice and waves
• MIZ is also an area much more navigable than the inner dense pack ice
• Traditional MIZ is defined solely based on sea ice concentration between 0.1 and 0.8
• Dynamical MIZ can be parameterized using sea ice concentration and thickness (Wang et al., 2024)

Sea Ice Ridging
• Ridging poses Navigational Challenge: ice ridges obstruct winter navigation and relevant information is crucial for ship routing
• Engineering Concern for offshore constructions: ridges pose risks for offshore structures (construction, planning and operations), requiring robust designs
• Gulf of Riga as target area for DT demo: assessing the potential impacts on offshore windfarm development and related ship traffic (incl. wintertime servicing of the wind farm)
• Ridged ice quantified from local DT results by implementing Lagrangian Particle Model and interpreting sea ice state and sea ice drift data

Marine Spatial Planning (MSP)
• In the Baltic Sea, the impact of climate change on marine ecosystems, including changes in sea ice, are larger than all other anthropogenic impacts together (Wahlgren et al., 2022)
• It is therefore important to gather valuable information about sea ice changes due to climate change in formats useful for MSP developers
• We will provide an efficient Python framework for data aggregation, processing and visualization of the Climate DT data once available

Landfast Sea Ice Jan 2023
Modified | Observed

Examples of ridges that can be identified by the framework using outputs from a high-resolution ocean model, forced by CMSP models for emission scenario RCP4.5. For example, in these results it is shown that large parts of the Baltic Sea will have less years with ice cover, while some parts will generate both the cover and the brine of the ice.

Presenters:

Ilja Majutenko (TalTech)



Tero Aalto (CSC)



15-16.10.2024

Third Destination Earth User eXchange

