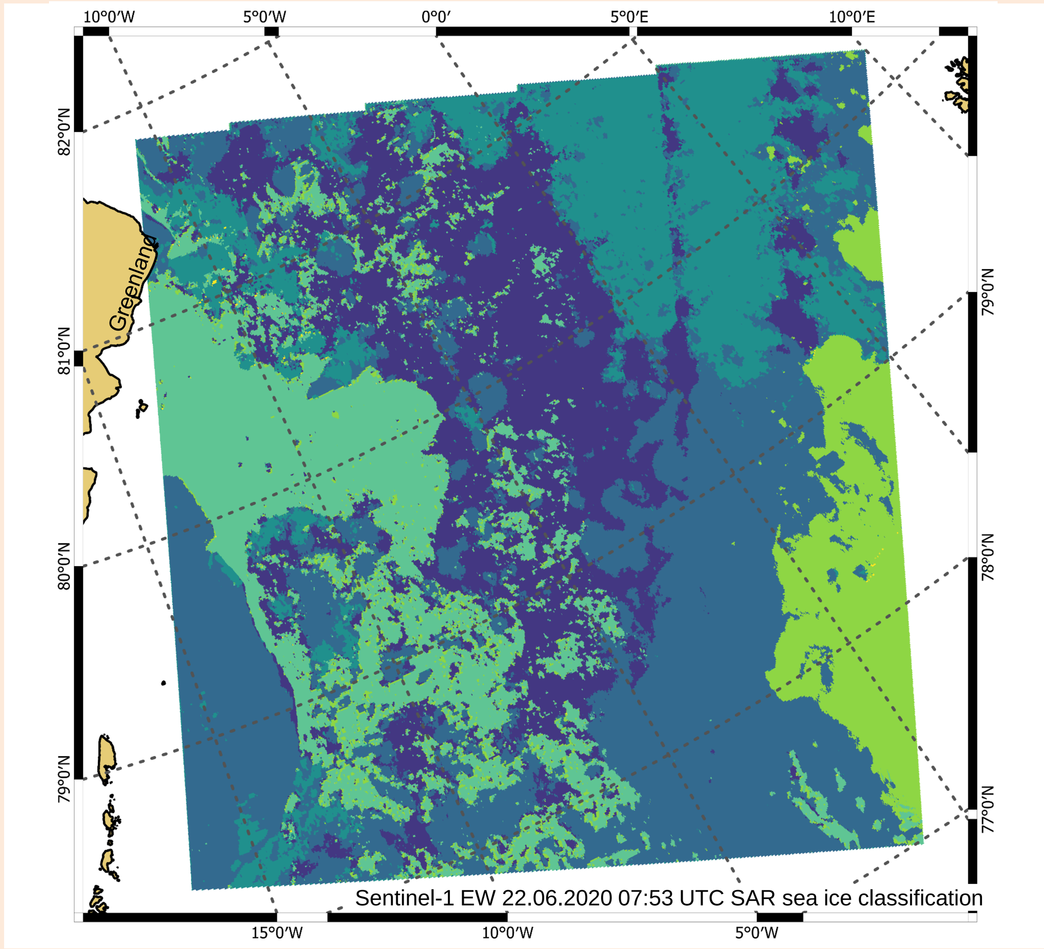
Sea Ice Classification with Sentinel-1 and Sentinel-3 data – first results from the EisKlass2 project

Stefan Wiehle (1), Dmitrii Murashkin (1,7), Anja Frost (1), Suman Singha (1), Egbert Schwarz (2), Tobias Kaminski (2), Detmar Krause (2), Christine König (3), Thomas König (3), Lasse Rabenstein (4), Bernhard Schmitz (4), Thomas Kaminski (5), Michael Voßbeck (5), Frank Kauker (6)

1: German Aerospace Center (DLR), Maritime Safety and Security Lab, Bremen; 2: German Aerospace Center (DLR), Maritime Safety and Security Lab, Neustrelitz, Germany; 3: Dr. Thomas König & Partner, Fernerkundung GbR, Dießen am Ammersee, Germany; 4: Drift+Noise Polar Services GmbH, Bremen, Germany; 5: The Inversion Lab Thomas Kaminski Consulting, Hamburg, Germany; 6: Ocean Atmosphere Systems GmbH, Hamburg, Germany; 7: University of Bremen, Bremen, Germany

Summary

- Precise knowledge of sea ice situation crucial for shipping in polar waters
- Sea ice classification combining data from Sentinel-1 SAR and Sentinel-3 optic/thermal for highest reliability
- Validation with multiple sources
- Development using continuous feedback from ice navigators
- Impact assessment by quantitative network design modelling system
- Development of prototype for operational, cloud-based processing chain
- End-user data access via https://icysea.app



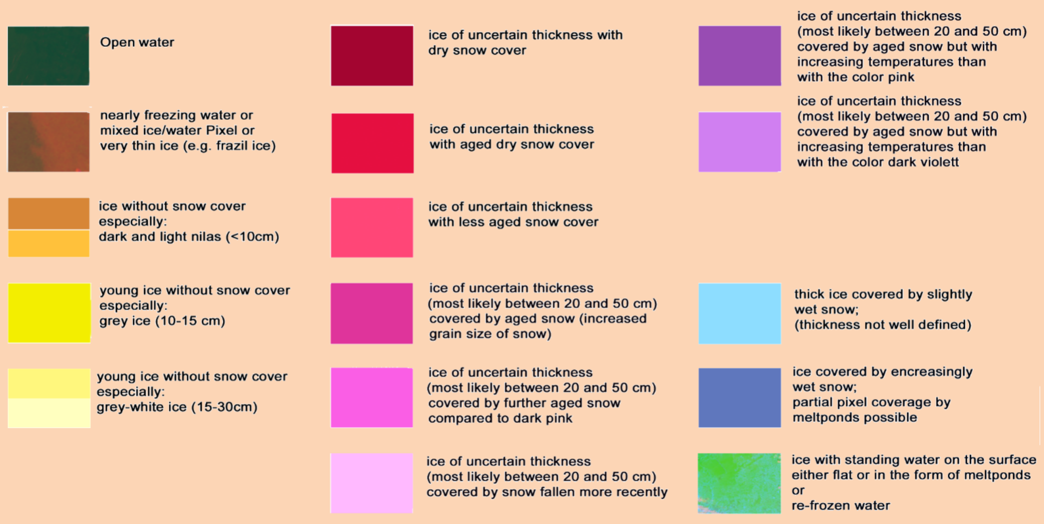
Sentinel-1 SAR sea ice classification

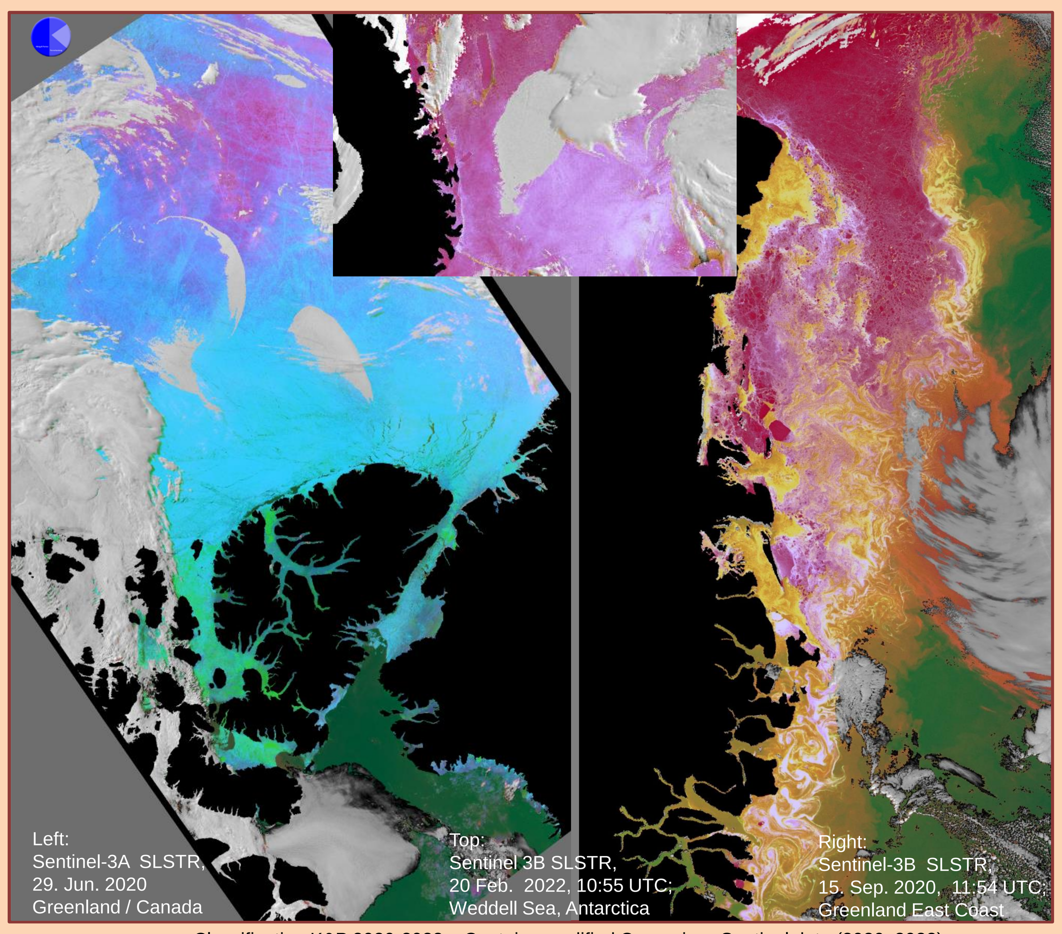
- Based on Convolutional Neural Network (CNN)
- Using Sentinel-1 EW radar images with 410 km swath and both channels HH/HV
- Counteracting tile-edge effect by using 4 classifications with offsets
- Resulting classification resolution: 160 m
- Six classes distinguished by surface roughness

Multi-year ice | Leads (smooth)
First-year ice | Leads (rough)
New ice | Rough ice

Sentinel-3 SLSTR sea ice classification

- Single pixel classification with 500 m resolution and 1400 km swath (same as original product)
- Sensitive for ice thickness up to 50 cm
- Sensitive for age and humidity of snow cover
- Filtering of clouds and cloud shadows
- Continuous classification with 16 main classes:





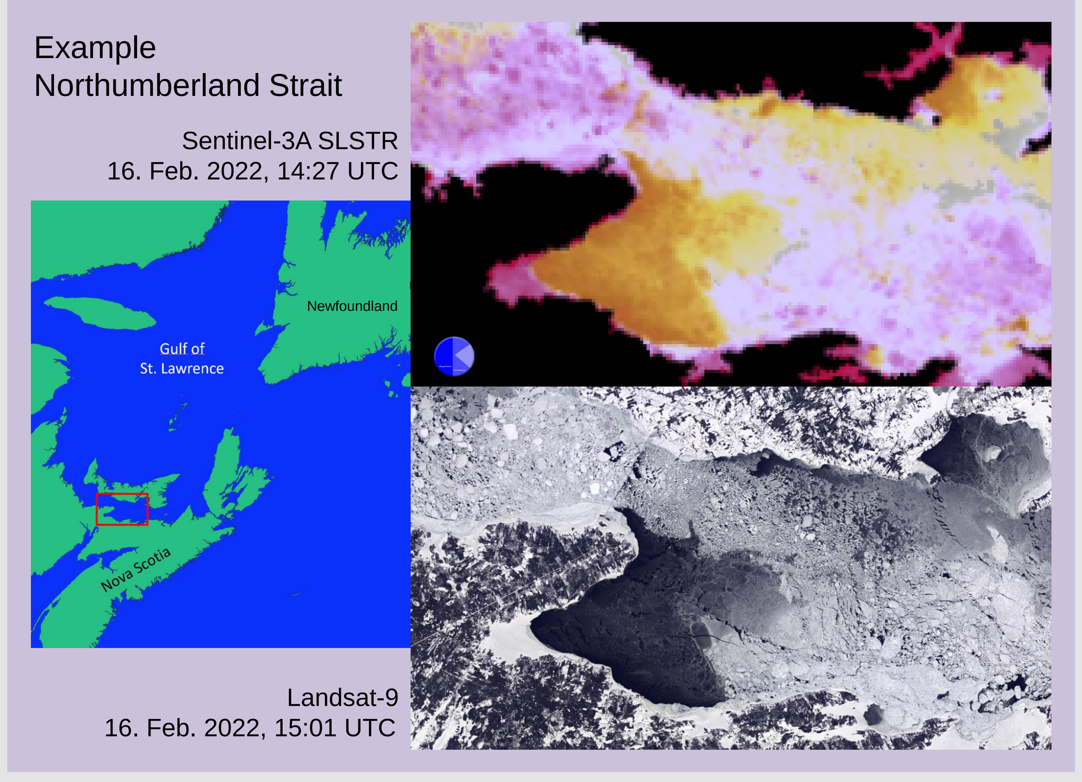
Classification K&P 2020-2022. Contains modified Copernicus Sentinel data (2020, 2022)

Fusion

- Train CNN model using
  - Sentinel-1 calibrated dual-channel
  - Sentinel-3 SLSTR classification
- Only in areas where both data sources are available within a small timeframe
- Goals
  - More reliability of classification
  - More detailed sea ice information
- Increased usability for
  - Vessels at sea
  - Ship owners for route optimization
  - Science, e.g., climate research
  - Sea ice services

Validation

- Challenges for sea ice validation
  - Remote areas
  - Rarely in-situ data
  - Quickly changing sea ice conditions
- Using in-situ data wherever available, e.g.
  - MOSAIC expedition
  - Endurance22 expedition
  - Data from research vessels
- Using official sea ice charts
- Using highres satellite and webcam images

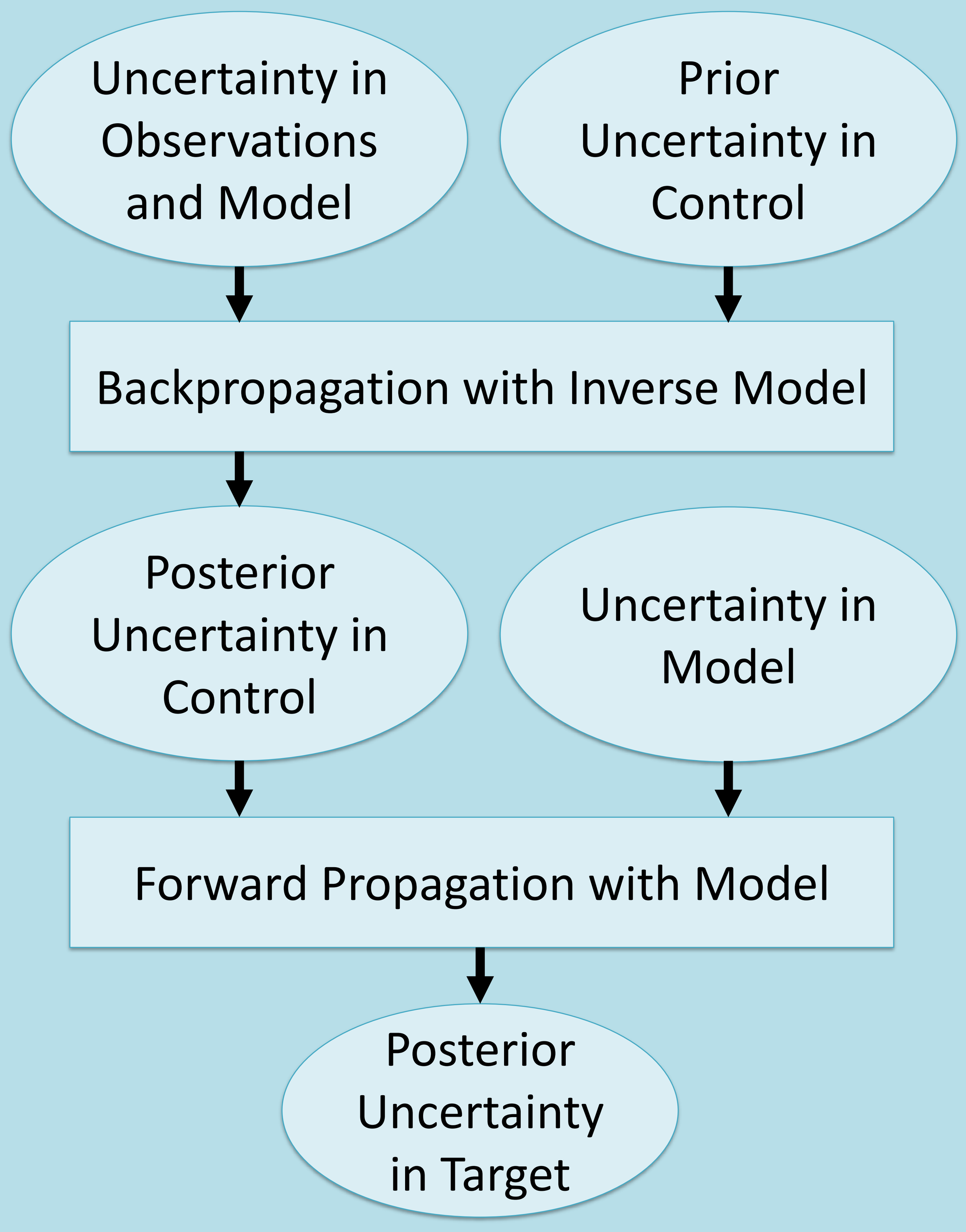


Operationalization and processing chain

- Project goal: enable demonstrational service available to users via icysea.app
- Fully automated data processing chain
- Flexible, cloud-based framework
- Always provide latest available classification: Sentinel-1, Sentinel-3 or Fusion

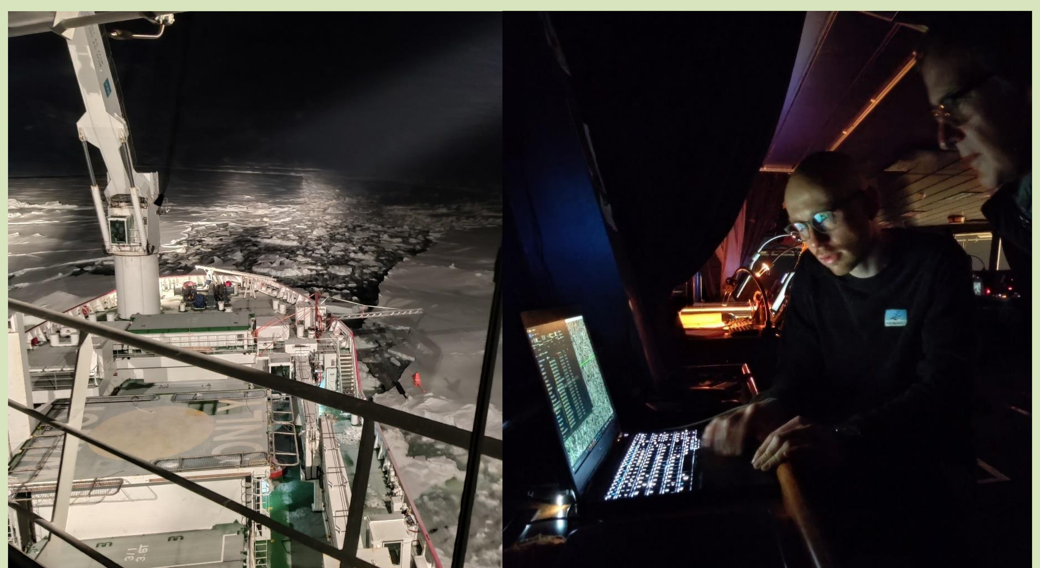
Impact assessment

- Applies the Arctic Mission Benefit Analysis System (ArcMBA) developed in ESA's Arctic+ cluster to assess impact of ice classification data sets on to target quantities relevant for navigation, i.e. regional sea ice and snow conditions (Kaminski et al., 2018)
- Applies quantitative network design approach (Kaminski and Rayner, 2017) of propagating observational uncertainty through modelling chain



User interaction and data access

- Challenges for navigation with satellite sea ice data on board of a vessel
  - Low internet bandwidth
  - Manual data handling
  - Satellite image interpretation
  - Deprecated data and images
  - No link to navigational planning tools
- Developed icysea.app as progressive web app (PWA) to overcome these challenges
- Test users in several polar regions
- Used by navigators on scientific campaigns; recently Endurance22 expedition



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German Aerospace Center (DLR)
Remote Sensing Technology Institute
Maritime Safety and Security Lab
Am Fallturm 9,
28359 Bremen, Germany