

# AI4Arctic Sea Ice (CCN1)



# AI4Arctic & AutoICE Sea Ice Challenge goals

**The AI for the Arctic (AI4Arctic) project uses deep learning, in particular deep convolutional neural networks, for Earth Observation applications within the cryosphere, focusing on sea ice and snow.**

**The project extension “AI4Arctic Sea Ice Challenge” (CCN1) improved sea ice charting for applications in the sea ice community through a “data challenge” tackled by sea ice, EO and AI experts collaboratively. The AutoICE Challenge contributed to advancing the state of the art of sea ice retrieval from SAR data resulting in an increased capacity to derive more robust and accurate automated sea ice maps. The sea ice parameters in focus were sea ice concentration (SIC), stage of development (SOD) and floe size (FLOE).**

# AutoICE on the AI4EO.eu challenge platform

The AI4Arctic project prepared and delivered the following AutoICE challenge elements to the AI4EO platform, for setup of the challenge:

- Challenge information text: overview, rules, prizes, data etc.
- YouTube video introducing the challenge - <https://youtu.be/iuXleLPyKfg>
- Information about sponsored prizes and contact information to the prize sponsors, for the Prize Catalogue.
- A link to the challenge dataset and manual - hosted on ESA PolarTEP and data.dtu.dk

AI4EO Challenges by ESA

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## AutoICE

Challenge closed

Overview Rules Prizes Data Teams Leaderboard Forum

### Challenge Overview

The Norwegian Computing Center, the Danish Meteorological Institute (DMI), the Technical University of Denmark (DTU), Polar View, Nansen Environmental Remote Sensing Center (NERSC) and ESA (European Space Agency), have created an extraordinary sea ice challenge with the aim to bring together AI and

### AI4EO

A bridge between EO and AI

#### Introducing AI4EO

AI4EO is an initiative from the 6-10-0 ESA (European Space Agency) and the 6-10-0 program. It aims to bring the worlds of artificial intelligence (AI) and Earth Observation (EO) closer together to bridge and encourage interaction and collaboration.

**AI4EO Challenge**  
The Norwegian Computing Center, the Danish Meteorological Institute (DMI), the Technical University of Denmark (DTU), Polar View, Nansen Environmental Remote Sensing Center (NERSC) and ESA (European Space Agency), have created an extraordinary sea ice challenge with the aim to bring together AI and EO players to address the challenge of automated sea ice mapping from Sentinel-1 SAR data.

**The Objective**  
The objective of the AutoICE challenge is to advance the state of the art of sea ice parameter retrieval from SAR data resulting in an increased capability to deliver more robust and accurate automated sea ice mapping from Sentinel-1 SAR data.

**The Importance**  
Manual sea charting from multi-sensor satellite data analysis has for many years been the primary method at the National Ice Service for producing sea ice information to marine safety, ice warning, primarily via satellite synthetic aperture radar (SAR) imagery due to the high spatial resolution and the capability to image the surface through clouds and under darkness, but also optical imagery in a clear sky and daylight conditions, thermal infrared and microwave radiometer data from e.g. AMSR-2. Ice analysts monitor the spatial resolution of microwave radiometers as the primary indication of using the data.

The traditional manual sea charting method is time-consuming and limited in spatial and temporal coverage. Hence, it is challenged by an increasing amount of available satellite imagery, along with a growing number of users accessing sea ice data for the benefit of the Arctic sea.

The automation of the time-consuming and labor-intensive sea ice charting process has the potential to provide users with near-real time sea ice products of higher spatial resolution, larger spatial and temporal coverage, and increased consistency.

Continental Neural Network (CNN) has great potential within the automated prediction of sea ice from satellite images. Automating the process of SAR sea ice parameter retrieval from SAR imagery allows for more consistent and accurate sea ice mapping. However, the high-resolution SAR data is not available for the entire Arctic region, and the training dataset made available in this challenge contains Sentinel-1 SAR microwave data and corresponding Microwave Radiometer (AMSR) data from AMSR-2, to enable challenge participants to exploit the advantages of both instruments. Is your method the best to detect and create sea ice charts?

### AI4EO points

#### How it works: The AI4EO Prize catalogue

This catalogue presents the available prizes for the top five teams and their members. The teams in the 2nd, 3rd, 4th, and 5th place will receive "AI4EO credits" that can be used to subsidize their participation in the challenge - it's like redeeming points from a consumer rewards and loyalty programme!

**Restrictions**  
Some prizes come with restrictions. These can be found in small print in the description of those specific prizes.

Order for choosing prizes on a "first come first served" basis is the following: 2nd, 3rd, 4th, and 5th prize. The assigned team leader is responsible for communicating the selected prizes to the organizers.

to be eligible for the 5th prize, at least one participant of the winning team must be a citizen of an ESA Member State, including Canada (not Cooperating States), Slovakia, Latvia, and Lithuania (ESA Associate Member States). Check the full list of ESA members and cooperating states [here](#).

The prize money will be paid in the currency of the contracting authority or of the team in the place it is not eligible, an equivalent of expenses spent by the members of the bank receiving 1000 AI4EO points will be additionally attributed to being used on picking a prize from the catalogue.

AI4EO)

Challenge datasets

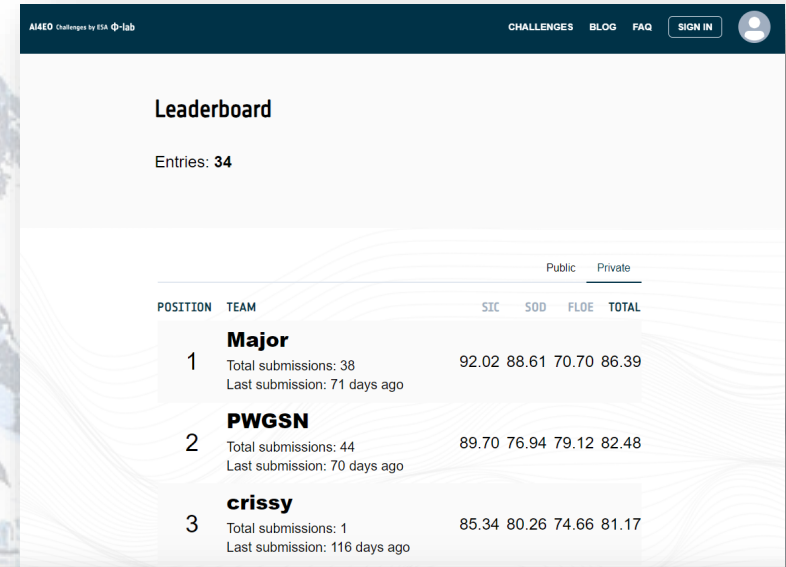



Challenge tools



# AutoICE on the AI4EO.eu challenge platform

- Code components for leaderboard live scoring and metric calculation on validation dataset files
- Jupyter notebook (Starter Pack) for assisting participants with data handling.
- Link and information about the (optional) cloud storage and development environment through Hopsworks and ESA-PolarTEP platform.
- and testing!



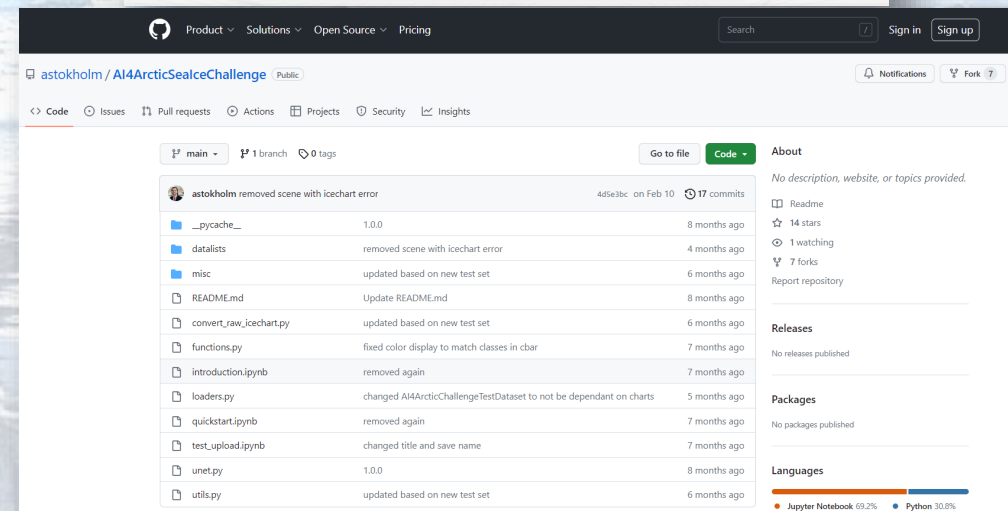
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### Leaderboard

Entries: 34

Public Private

POSITION	TEAM	SIC	SOD	FLOE	TOTAL
1	<b>Major</b> Total submissions: 38 Last submission: 71 days ago	92.02	88.61	70.70	86.39
2	<b>PWGSN</b> Total submissions: 44 Last submission: 70 days ago	89.70	76.94	79.12	82.48
3	<b>crissy</b> Total submissions: 1 Last submission: 116 days ago	85.34	80.26	74.66	81.17



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Code Issues Pull requests Actions Projects Security Insights

main 1 branch 0 tags Go to file Code About

astokholm removed scene with icechart error 4d5ebc on Feb 10 17 commits

__pycache__	1.0.0	8 months ago
datalists	removed scene with icechart error	4 months ago
misc	updated based on new test set	6 months ago
README.md	Update README.md	8 months ago
convert_raw_icechart.py	updated based on new test set	6 months ago
functions.py	fixed color display to match classes in cbar	7 months ago
introduction.ipynb	removed again	7 months ago
loaders.py	changed AI4ArcticChallengeTestDataset to not be dependant on charts	5 months ago
quickstart.ipynb	removed again	7 months ago
test_upload.ipynb	changed title and save name	7 months ago
unet.py	1.0.0	8 months ago
utils.py	updated based on new test set	6 months ago

**Releases**  
No releases published

**Packages**  
No packages published

**Languages**  
Jupyter Notebook 69.2% Python 30.8%

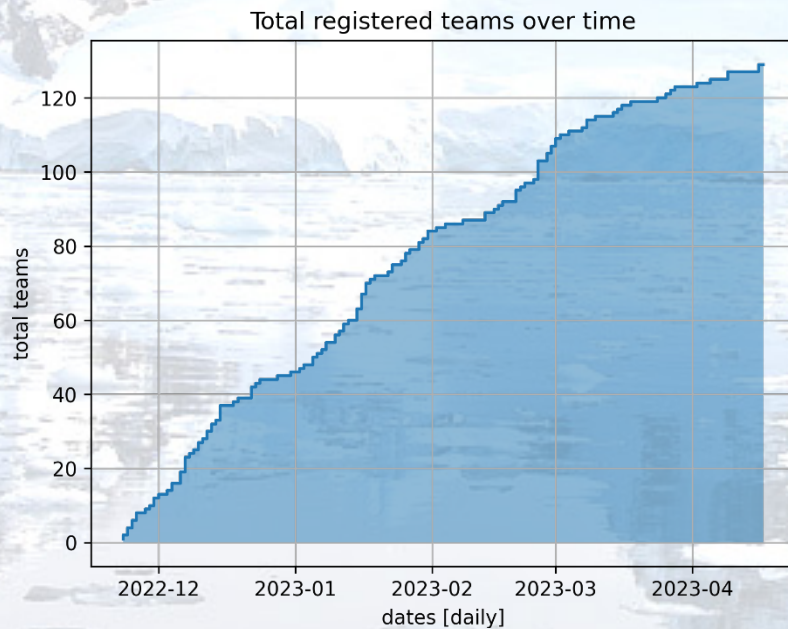
# AutoICE machine Learning Platform



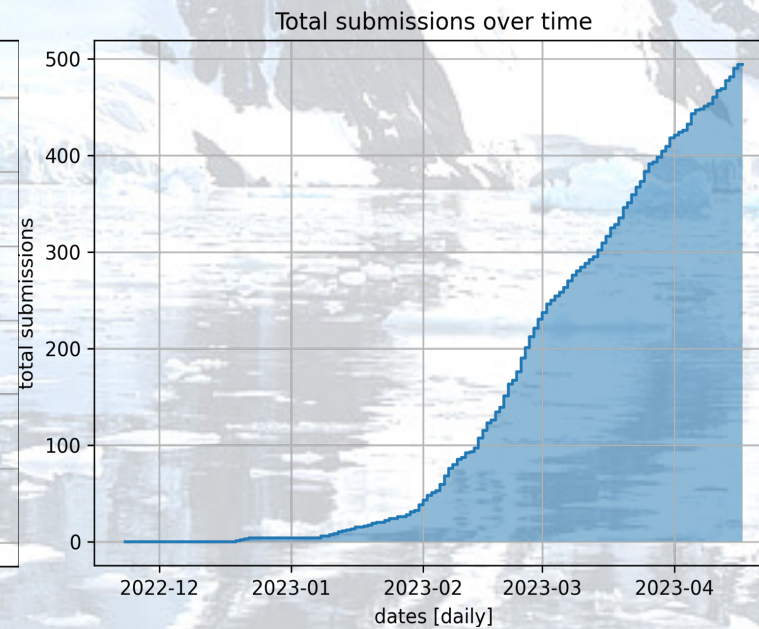
- ML computing resources available to challenge participants on [polartep.polarview.org](http://polartep.polarview.org)
- MLflow
- Direct access to AutoIce Jupyter notebooks and challenge datasets.
- Computing resources:
  - A small CPU (4GB 1CPU), with unlimited time: exploring/manipulating notebooks or downloading results.
  - A larger CPU (8GB 2CPU), soft limited to 200 hours: large data manipulation without need of GPU training.
  - A GPU (16GB 1 GPU), soft limited to 40 hours: for developing ML models.
- Supported by the ESA Network of Resources.

# Participation and platform activity

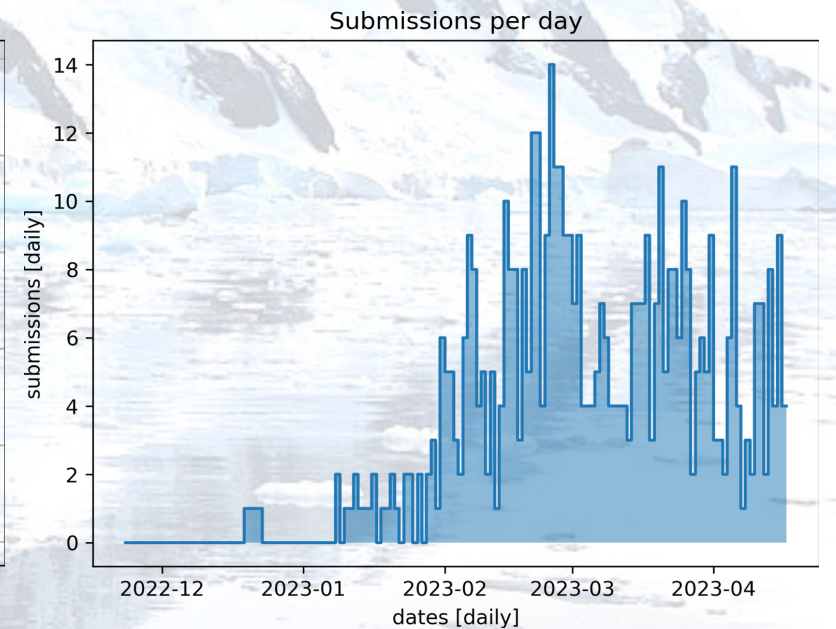
- Launched 23 November 2022 → Winners' Event on 24 May 2023.
- Online AutoICE Webinar on February 14<sup>th</sup>.
- Variety of team affiliations.
- AI4EO forum discussions and problem solving.



Total number of teams at challenge closure: 129  
Total registered users at challenge closure: 179  
(Teams can consist of more registered users).



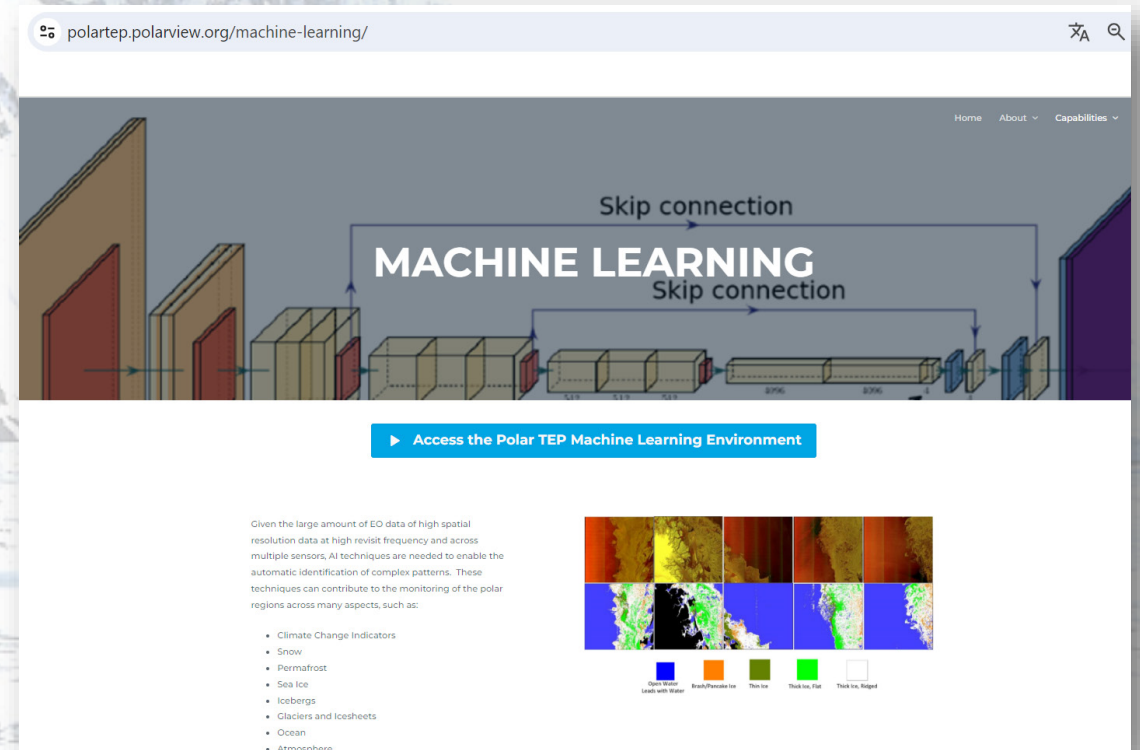
Total number of submissions: 494  
Number of teams that made submissions: 34



Number of submission per day during challenge period.

# Machine Learning Platform Use

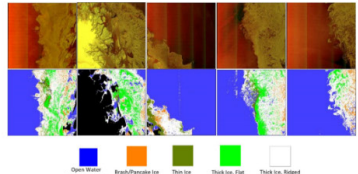
- In total, 42 Polar TEP ML accounts were provided to challenge participants.
- Challenge participants used 3,912 hours of processing time.
- Six of the top ten teams used Polar TEP.



The screenshot shows the web interface for the Polar TEP Machine Learning platform. The browser address bar displays `polartep.polarview.org/machine-learning/`. The main content area features a diagram of a neural network architecture with the text "MACHINE LEARNING" and "Skip connection" overlaid. Below the diagram is a blue button labeled "Access the Polar TEP Machine Learning Environment".

Given the large amount of EO data of high spatial resolution data at high revisit frequency and across multiple sensors, AI techniques are needed to enable the automatic identification of complex patterns. These techniques can contribute to the monitoring of the polar regions across many aspects, such as:

- Climate Change Indicators
- Snow
- Permafrost
- Sea Ice
- Icebergs
- Glaciers and Icesheets
- Ocean
- Atmosphere



The legend below the grid identifies the following categories:

- Open Water / Land with Water (Blue)
- Break/Parcelle Ice (Orange)
- Thin Ice (Green)
- Thick Ice, Flat (Light Green)
- Thick Ice, Ridge (White)

# Challenge closure

- Increasing platform activity up to closure on April 17th
- Last edits to procedures for the private leaderboard scoring.
- After closure, a final check of submission scores (and collab. betw. teams).
- Announcement of top-five winning teams on April 27<sup>th</sup>

1st place	2nd place	3rd place	4th place	5th place
Waterloo University Teams	PWGSN	crissy	sim	jff

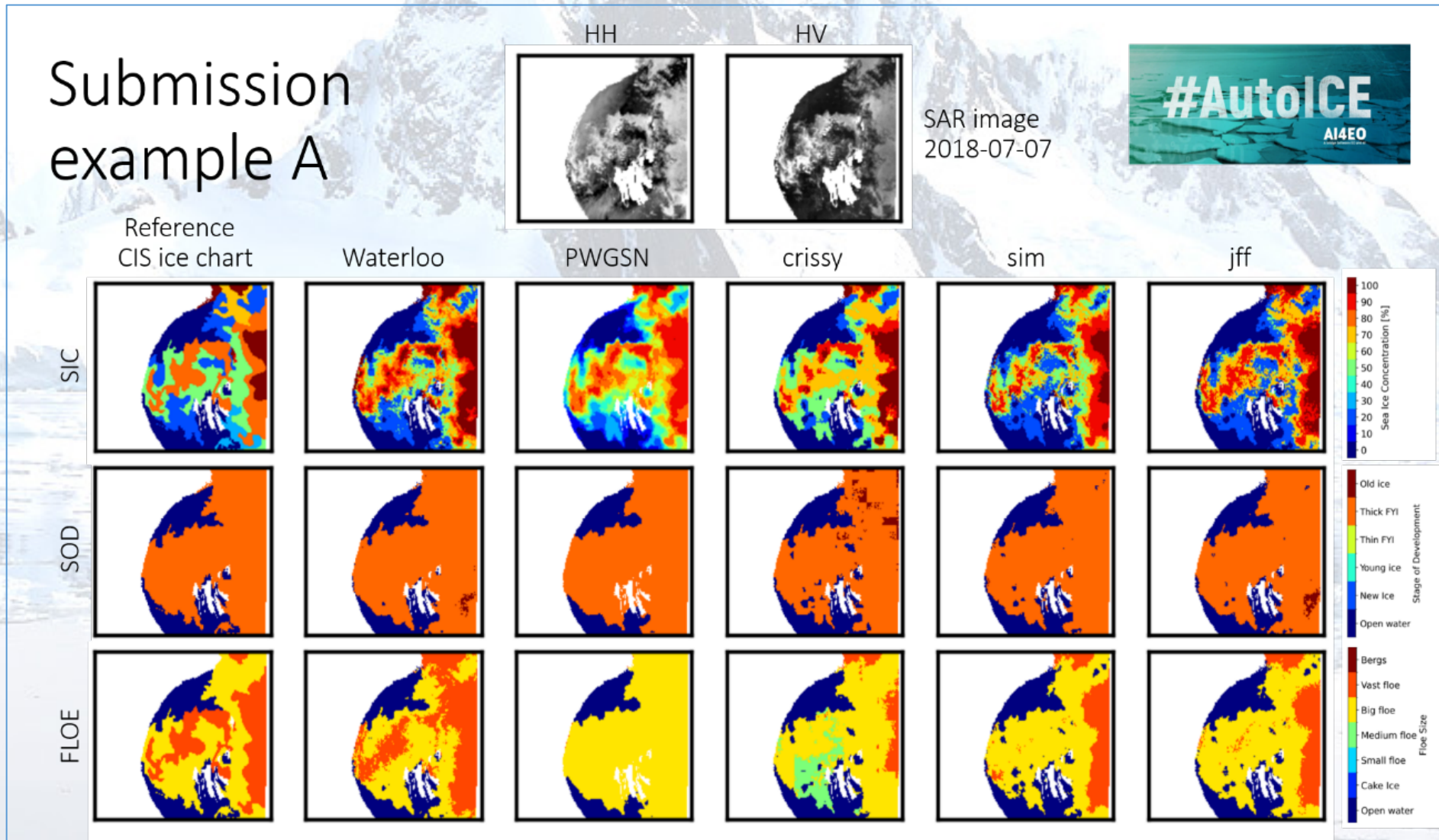
### Leaderboard

Entries: 34

POSITION	TEAM	Public Private			
		SIC	SOD	FLOE	TOTAL
1	<b>Major</b> Total submissions: 38 Last submission: 80 days ago	92.02	88.61	70.70	86.39
2	<b>PWGSN</b> Total submissions: 44 Last submission: 59 days ago	89.70	76.94	79.12	82.48
3	<b>crissy</b> Total submissions: 1 Last submission: 105 days ago	85.34	80.26	74.66	81.17
4	<b>sim</b> Total submissions: 7 Last submission: 59 days ago	87.22	77.52	73.59	80.61
5	<b>jff</b> Total submissions: 66 Last submission: 74 days ago	86.68	77.18	75.10	80.56
6	<b>Rompetchos</b> Total submissions: 39 Last submission: 59 days ago	87.19	77.56	72.27	80.35
7	<b>ICE-ML</b> Total submissions: 20 Last submission: 59 days ago	83.18	80.17	74.08	80.16
8	<b>eciaes</b> Total submissions: 41 Last submission: 60 days ago	87.02	76.57	73.28	80.09
9	<b>Ncub</b> Total submissions: 2 Last submission: 80 days ago	84.18	79.10	72.49	79.81
10	<b>Malthe Esbensen</b> Total submissions: 9 Last submission: 62 days ago	85.31	75.53	72.96	78.93



# Comparative analysis of Winners' submissions



# Winners event

- AutoICE online Winners event on May 24<sup>th</sup> 2023
- Presentations by Winning teams #1, #2 and #4.
- Q&A with the AutoICE expert panel →
- 35-40 Winners event participants
- Good questions and discussions
- Event recording: <https://youtu.be/C7P3vaaS98Y>
- Pay-out of prizes to winners.



**#AutoICE**  
AI4EO  
A bridge between EO and AI

📅 **Wednesday 24 May 2023** | 🕒 **14:00 CEST**

Learn more about the winning solutions of the **AutoICE Challenge** and the thinking behind them, check what the industry experts have to say about the topic and support the winners behind the ideas that will help us make significant strides in understanding and monitoring sea ice.

[Register for #AutoICE event](#)

## The AutoICE expert panel

Martin Rogers, Researcher  
Expertise: Machine learning and hydrosphere, cryosphere  
Affiliation: British Antarctic Survey



Nicolas Longép , Technical Officer  
Expertise: Machine learning, earth observation and sea ice  
Affiliation: ϕ-lab, European Space Agency



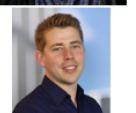
Nick Hughes, Leader of the Norwegian Ice Service,  
Expertise: Sea ice charting  
Affiliation: Norwegian Ice Service, Norwegian Meteorological Institute  
Appointed by the International Ice Charting Working Group (IICWG)



Tom Zagon, Sea ice Scientist  
Expertise: Sea ice charting  
Affiliation: Canadian Ice Service, Environment and Climate Change Canada  
Appointed by the International Ice Charting Working Group (IICWG)



Jan van Rijn, Assistant Professor (Not present)  
Expertise: Automated Machine Learning  
Affiliation: Leiden University



# Publication in a special issue

- 15 journals were considered for publication of a special issue devoted to the AutoIce Challenge wrt impact factor, publication, fee, openness, etc.
- The Cryosphere was selected as the journal and a special issue named "AutoICE: Results of the Sea Ice Classification Challenge" was created.
- List of guest editors of the SI: Anton Korosov, Juha Karvonen, Anthony Paul Doulgeris, Suman Singha, Christian Haas.
- Submission deadline is 1 May 2024. AutoICE organizers may provide a subsidy in cases where the fee is not covered elsewhere.
  - [https://editor.copernicus.org/TC/manuscript\\_registration](https://editor.copernicus.org/TC/manuscript_registration)
- One manuscript was already received from the participating and is under consideration.
- AutoICE organizers will prepare a challenge summary paper, with input from top-performing teams, describing the challenge objective, data, participation, and a comparison of winning results.