



Managing big data in ice charting and forecasting: How will the ice services do this?

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St. John's, NL – October 18, 2018*

Outline

- The ice services and Big Data
- Approaches to dealing with Big Data
- Ice services Big Data project examples
- Next Steps and Summary
- Questions/Discussion

The International Ice Charting Working Group (IICWG)

IICWG Charter Signatories – operational ice services

Argentina: Argentine Naval Hydrographic Office
 Canada: Canadian Ice Service
 Denmark: DMI Greenland Ice Service
 Finland: Finnish Meteorological Institute
 Germany: Federal Maritime and Hydrographic Agency
 Iceland: Iceland Meteorological Office
 Norway: Norwegian Meteorological Institute
 Poland: Polish Institute of Meteorology and Water Management
 Russia: Arctic and Antarctic Research Institute
 Sweden: Swedish Meteorological and Hydrological Institute
 UK: British Antarctic Survey
 USA: US National Ice Center
 USCG International Ice Patrol
 Observers: Australia, Chile, China, Japan, New Zealand



IICWG welcomes participation by private ice services, mariners and offshore operators, Coast Guards, research institutes, et al.

The 19th annual meeting took place September 24-28, 2019 in Helsinki hosted by the Finnish Meteorological Institute (FMI)

IICWG-18 and -19: Talking about Big Data

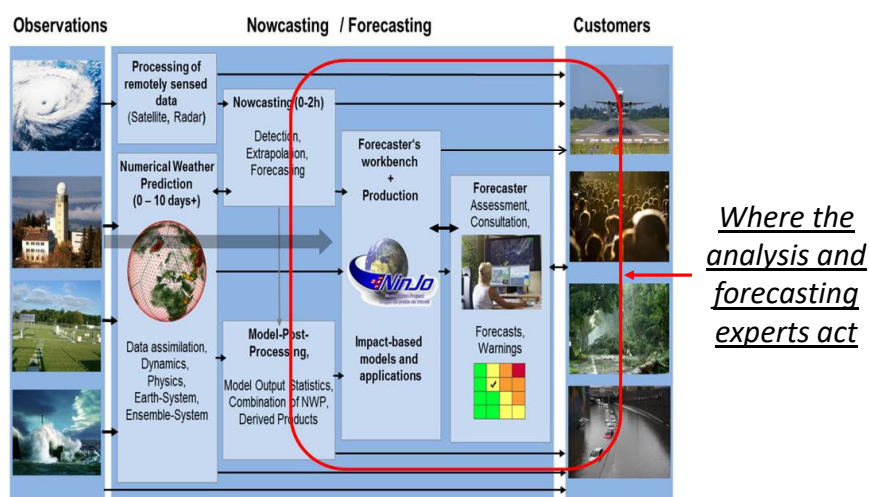
- **IICWG-18** (September 25-29, 2017 in Hobart, Tasmania) theme – *“New technologies, big data, and the future of ice charting and forecasting”*
 - Single plenary session on ***Handling Huge Data Volumes in Operational Ice Services***
- **IICWG-19**: Introductory talk and three (3) Special Sessions
 - Introductory talk: ***“Big Data & Artificial Intelligence”: What Do We Mean?***
 - Session 1: Identifying the Problem – ***“So Much Data, So Little Information? The Ice Navigation Dilemma”***
 - Session 2: Solutions – ***“Big Data, Artificial Intelligence, and the Role of the Ice Analyst”***
 - Session 3: ***“Transitioning to Future Satellite/Sensor Conceptions”***
- Each session was followed by a **panel and/or group discussion**

IICWG-19: Summary of Sessions

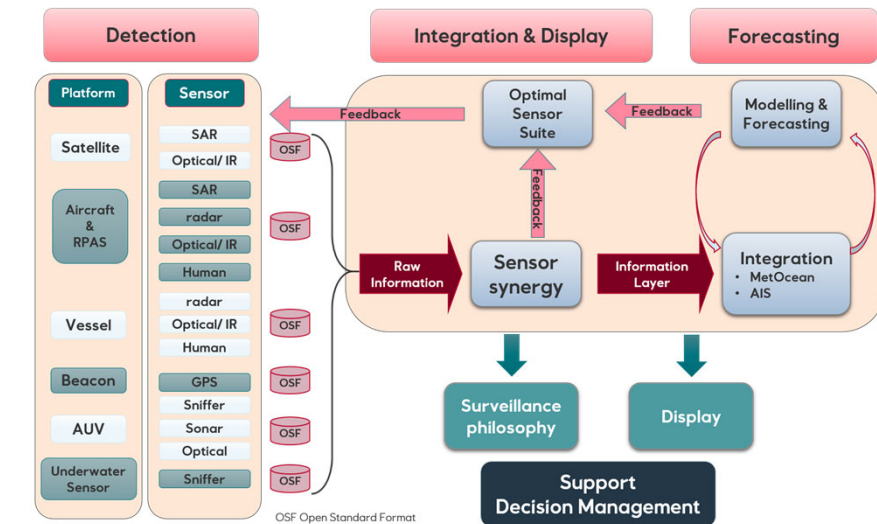
- The ice services are starting to drown in data – The **volume of satellite data** is becoming/has become massive
- Machine Learning (ML) and Artificial Intelligence (AI) – Several ice services are starting to **explore the potential of using ML/AI** to handle data volumes
- Technological advantages of **Cloud computing** – Avoids the need to download, store, and manage data, but **would ice services accept “Black Box Solutions”** for production? → Issues of trust and national security
- The **role of the ice analyst/forecaster will have to evolve** – Expert quality control, greater attention to difficult and tactically important ice situations, and the production of more tailored support
- Need “smart” solutions to discover, access, process, analyse, and visualise data to create the **next generation of ice information products**

Learning from the Weather world: Integration of Data Sources for Services

The Canadian Meteorological Service (MSC) monitoring and forecasting approach



An example ice observation, analysis, and forecasting system



Where will automation take us?

- Repetitive jobs will be in "danger"
- What will survive?
 - Workers engaged in "intellectual capital" with aspects of:
 - Creativity
 - Analysis
 - Writing
 - Science
 - Leadership
 - Judgment



Unattributed from a Ted Talk

Leveraging Strengths: Technology and People

- Technology:
 - Best suited for routine and repetitive tasks
 - Identify/calculate critical info in a complex mass of data
 - Objective analysis/prognosis
 - Product production/dissemination
- People:
 - Best suited for adapting to minute-by-minute dynamics of shift, adapt team resources to address problems
 - Can innovate, addressing deficiencies in data, tools, technology, doing “science on-the-fly”, and develop solutions
 - Interact with clients, discuss scenarios, adapt to their needs
 - Train new staff, provide feedback to researchers, developers, etc.

The ASIP Project



‘Automated Sea Ice Products’



Project lead, training data, implementation, user demonstration

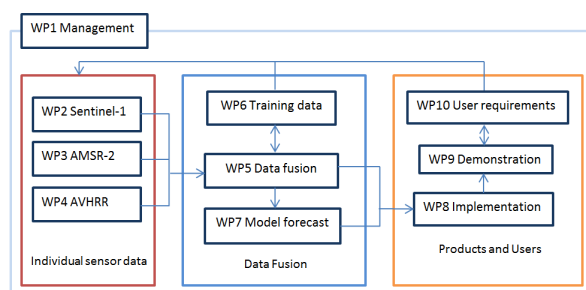


Technical University of Denmark

Sensor data pre-processing and algorithm development



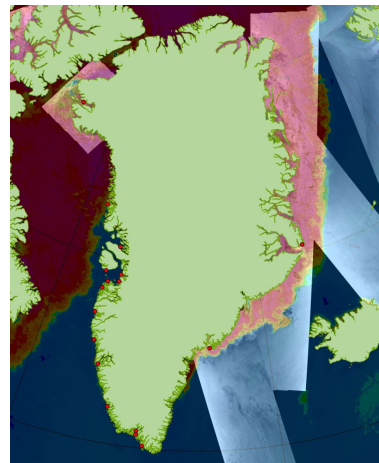
User requirements and market analysis



ML and AI – Opportunities...

Better...

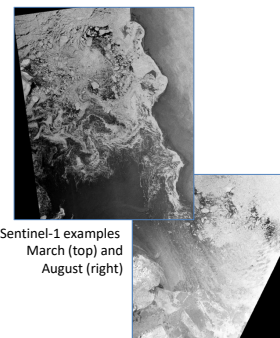
- Timeliness (NRT)
- Frequency, daily revisit
- Geographical coverage, overview
- Resolution, more details, scalable
- Input to ice charting
- Tool for forecasting



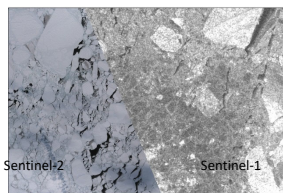
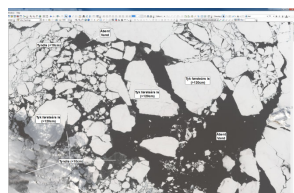
ASIP vers. 0.1 - Merged Sentinel-1 and AMSR2 SIC (DTU)

...and challenges

- Ice charts as training data, new parameters
- Test data, verification
- CNN (Convolutional Neural Network) when missing or changing input data
- Seasonal robustness
- Coastal area and fjords, landfast ice, icebergs



Sentinel-1 examples
March (top) and
August (right)



Sentinel-2

Sentinel-1

High-res training dataset from
Sentinel-2 optical imagery

Future Role of the Ice Analyst?

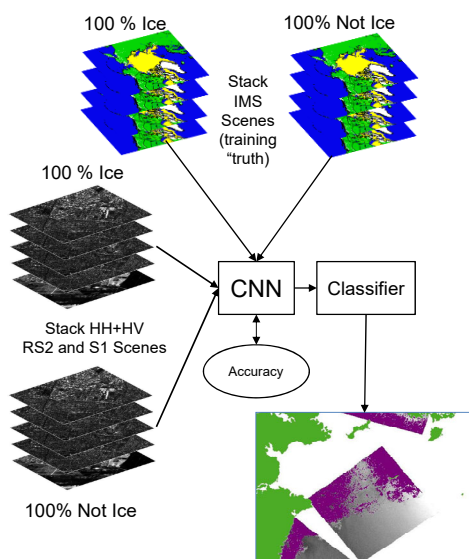


- Focus on coastal areas, fjords
- Added-value ice information
- Anomalies and extreme events
- In-situ ice info network, verification
- Close cooperation with users, advice

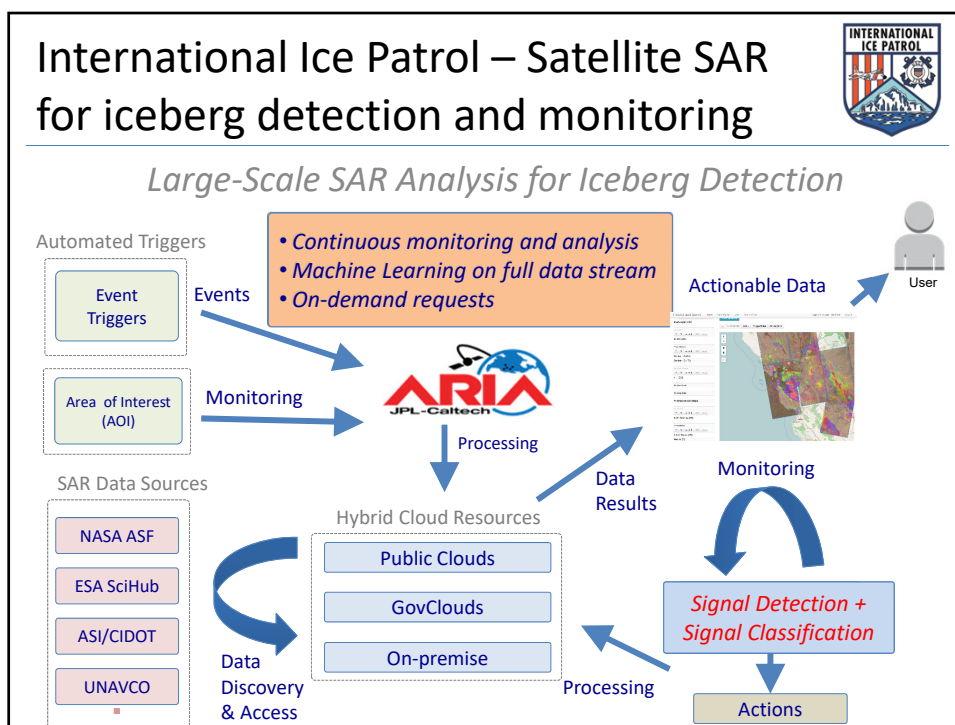


Left: Qaanaaq user meeting
Photo: Hans Jensen, Qaanaaq

US NOAA – Automated Sea Ice Extent



- 2-D Convolutional Neural Network approach → closest algorithm to visual interpretation
 - Classification of entire image rather than a single pixel
 - Develops relational pixel patterns in image
 - Still requires prior knowledge of image class
- AI shows promise for improvement of automated techniques for determining ice characterization.
- At the exploratory phase. Much more time is required to train and optimize the algorithm



Towards new iceberg products

- Benefit from frequent SAR satellite coverage
- Automated data management
- Automated target detection and classification
- Automated filtering of non-ice targets
- Human quality control, potential intervention, user interaction

Iceberg Limit for NV Atlantic

Iceberg population (WMO Nomenclature)

Isolated: >45 km
Few: 10-45 km
Many: <10 km

Now

Future?

Next Steps

- Complete and assess ML/AI projects → potential implementation at national ice services
- Potential for joint production
- User engagement
 - Surveys (NAIS iceberg survey currently ongoing)
 - User meetings
 - Workshops and conferences
 - User driven services supporting decisions at sea, taking advantage of vast amounts of data

Final thought – Any new, Big Data-leveraged ice product must be reliable, relevant, timely, and accessible

Thank you for your attention.

Questions and/or Discussion

