6th Session of the Expert Team on Sea Ice
Iceberg Monitoring, Modeling, and Charting
28 February 2017

Northern Hemisphere

Arctic and Antarctic Research Institute (AARI)

Product: Operational, weekly, daily (2-3Q 2017)

- Region: Northern Sea Route – METAREAs XX & XXI
- Format: graphical (PNG), SIGRID-3 and SafetyNet text (planned from 2-3Q 2017)
- Standalone iceberg or combined ice and iceberg chart
- Icebergs, ice islands and grounded hummocks indicated using WMO symbols with concentration (IA_BCN, “Ice Objects Catalogue”, ver.5.2)

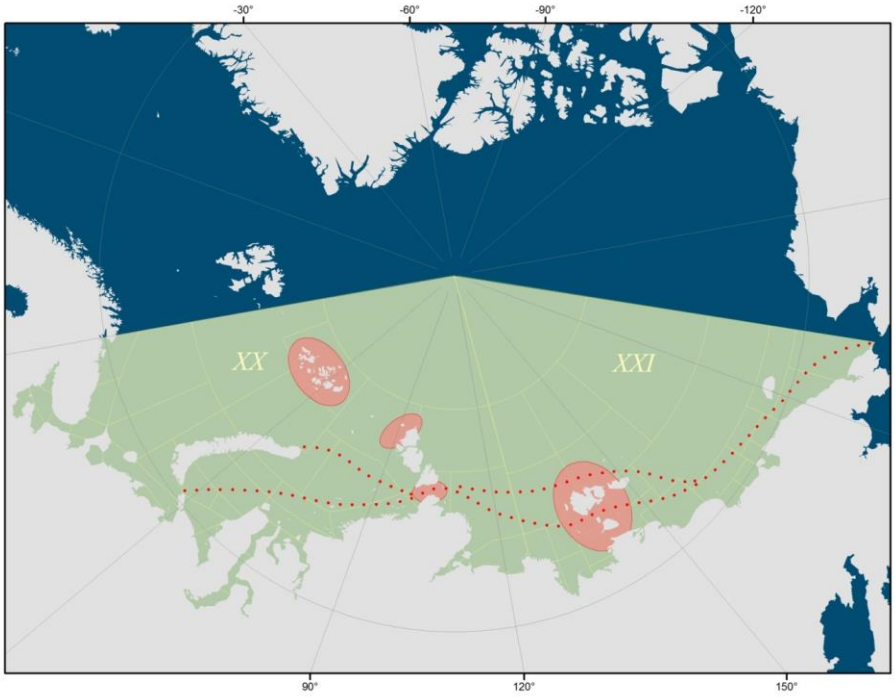
Purpose: Maritime Safety

Monitoring: Daily satellite with navigator reports as available

- Manual detection for routine products
- Semi-automated CFAR detection with validation from ship navigators
- Sentinel-1a,b (EWS & IWS)
- Radarsat-2 (ScanSAR Wide, Quad Fine),
- COSMO SkyMed (ScanSAR, HIMAGE)

Modeling: None

Coverage:



Canadian Ice Service (CIS)

Product (1): Operational, twice daily

- Region: METAREAs XVII &XVIII and Hudson Bay
- Format: SafetyNet text
- Combined sea ice and iceberg bulletins

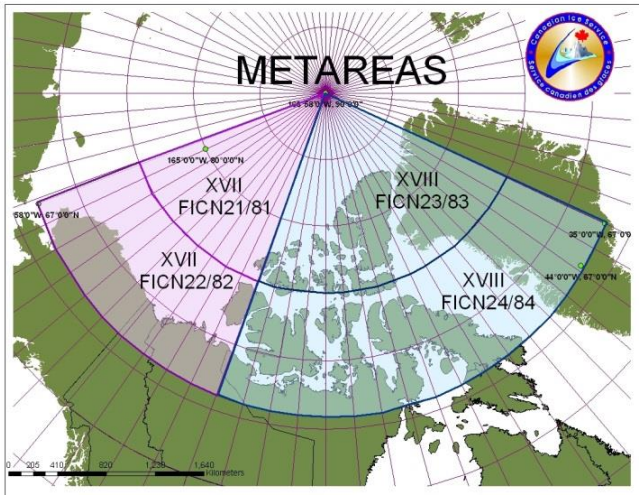
Purpose: Maritime Safety

Monitoring:

- Ship and aircraft opportunistic reports
- Iceberg information is estimated, largely based on climatology

Modeling: None

Coverage:



Product (2): Operational, once daily

- Region: Canadian East Coast
- Format: plain language text (French and English), graphic chart
- Number of icebergs per degree square and limit of all known icebergs

Purpose: Maritime Safety, public

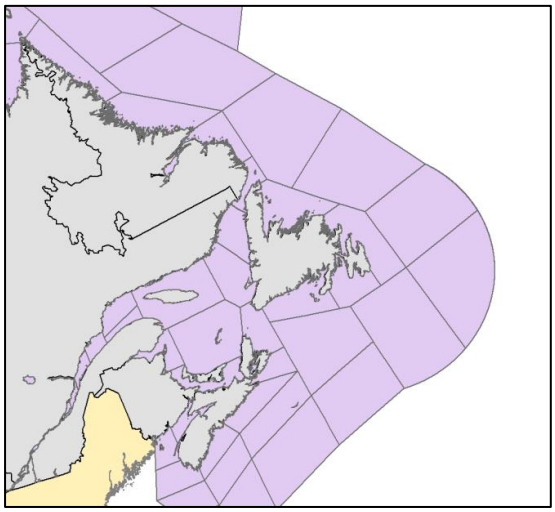
Monitoring:

- Ship and aircraft reports, satellite detection in northern Labrador waters
- Some iceberg information is estimated, based on climatology

Modeling: Iceberg Analysis and Prediction System

CIS (cont'd)

Coverage:



Product (3): Ice island analysis

- Region: Baffin Bay, Labrador Sea
- Format: Annotated JPEG satellite images, KML. Annotation provides image date & time, position, approximate size (area), ice island designator (origin, calving date, & number), and analyst notes
- Distribution: Monthly by e-mail

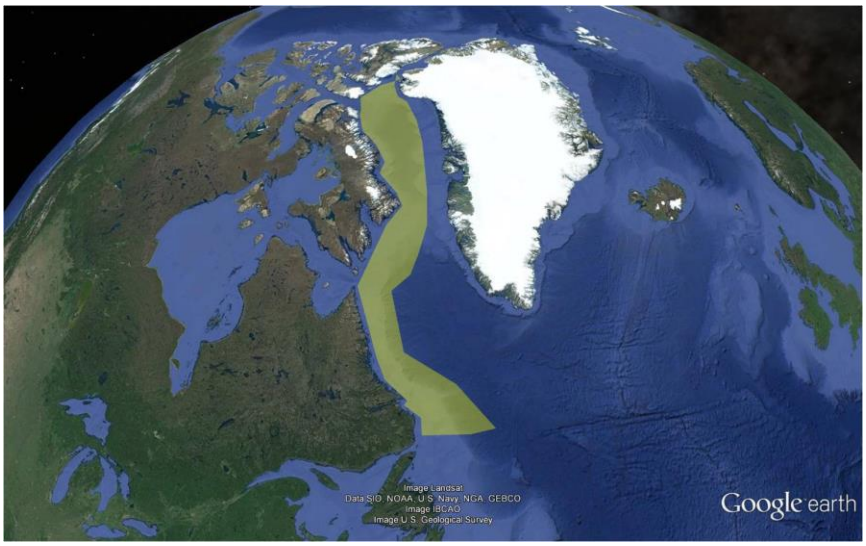
Purpose: Offshore energy companies, researchers and scientists

Monitoring:

- Manual detection and analysis
- RADARSAT-2 (SCW, SCN, DVWF, OSVN)
- Sentinel-1a,b (EWS)
- MODIS

Modeling: None

Coverage:



Danish Meteorological Institute (DMI)

Product (1): Iceberg concentration product

- Region: Greenland Waters (will soon be extended down to 50N)
- Format: Net CDF
- Distribution: Copernicus Marine Environment Monitoring Service

Purpose: Monitoring, climatology

Monitoring: Remote Sensing CFAR automated analysis on Sentinel-1a,b (EWS)

Modeling: None

Product (2): Iceberg reports

- Region: South Greenland inshore shipping lanes
- Format: Plain text, photographs
- Distribution: dmi.dk.e-mail, Facebook, Arctic Web

Purpose: Maritime Safety

Monitoring: Helicopter support for ice navigators

- Remote Sensing - high resolution when available, automated CFAR analysis
- Sentinel-1a,b (EWS)
- Radarsat-2 (SCW)

Modeling: None

Product (3): Approach outlook (commercial)

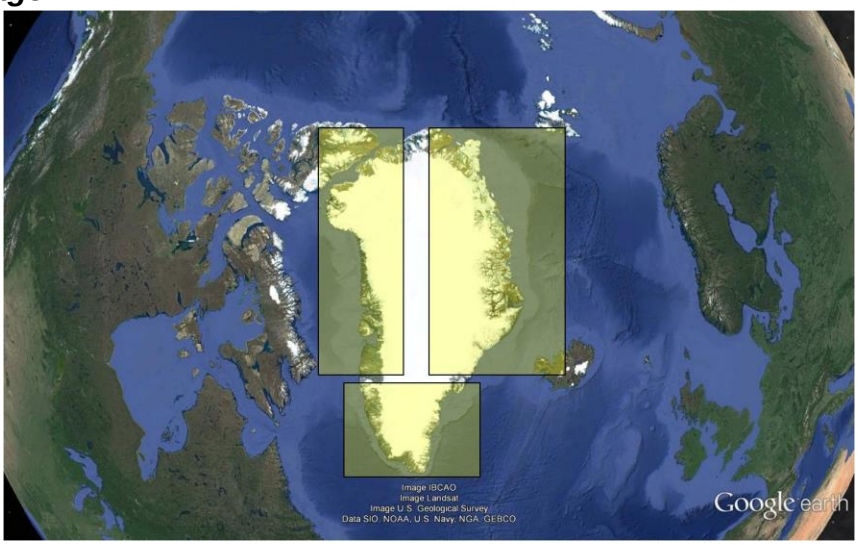
- Region: Ice sensitive or hazardous Greenland straits and/or harbors
- Format: One page summary with illustrated graphics
- Distribution: E-mail to ice pilots or ship captains

Purpose: Maritime Safety (primary users are cruise ships)

Monitoring: Remote Sensing (high resolution better than 10 m)

Modeling: None (but expectations for next 24 hours is provided)

Coverage:



North American Ice Service (NAIS): IIP, CIS, NIC, DMI

Product: Joint Iceberg Limit and Concentration

- Region: North Atlantic Ocean
- Format: Graphical and text
- Distribution: Daily by Internet, HF Radio Facsimile, NAVTEX, Safety-Net. NOTE: IIP and CIS share product development and distribution responsibilities seasonally – IIP: January-August; CIS: September-January

Purpose: Maritime Safety

Monitoring: Mix of aerial reconnaissance and remote sensing

- Aerial Reconnaissance:
  - US Coast Guard HC-130J aircraft (IIP)
  - Government and contracted aircraft (CIS)
  - Helicopter patrols along Greenland coasts (DMI)
- Satellite (manual and automated analyses)
  - Radarsat-2 (SCN, Wide Fine, Extra Fine),
  - Sentinel-1a,b (EWS, IWS)
  - TerraSAR-X (ScanSAR) (when available)
  - CSK (ScanSAR Wide Region (when available)
  - IIP & CIS will begin using C-CORE's automated Iceberg Detection Software (IDS) for 2017 ice season, operationally.
  - DMI provides estimated Iceberg Limit around southern Greenland. IIP and DMI intend to add iceberg counts in the region south of Greenland.

Modeling:

- CIS & IIP perform twice daily runs of IIP and NAIS drift and deterioration models for 00Z and 12Z.
- IIP model is presently used operationally to develop products.
- NAIS model is run concurrently and is being considered for operational use at IIP/CIS

Coverage:

Norwegian Ice Service (NIS)

Product: Occasional iceberg alerts on ice charts and Twitter (@istjenesten) since we had no major iceberg outbreaks until summers of 2015 and 2016.

- Region: Svalbard and Barents Sea
- Format: Graphical and Text
- Distribution: As required, via Internet

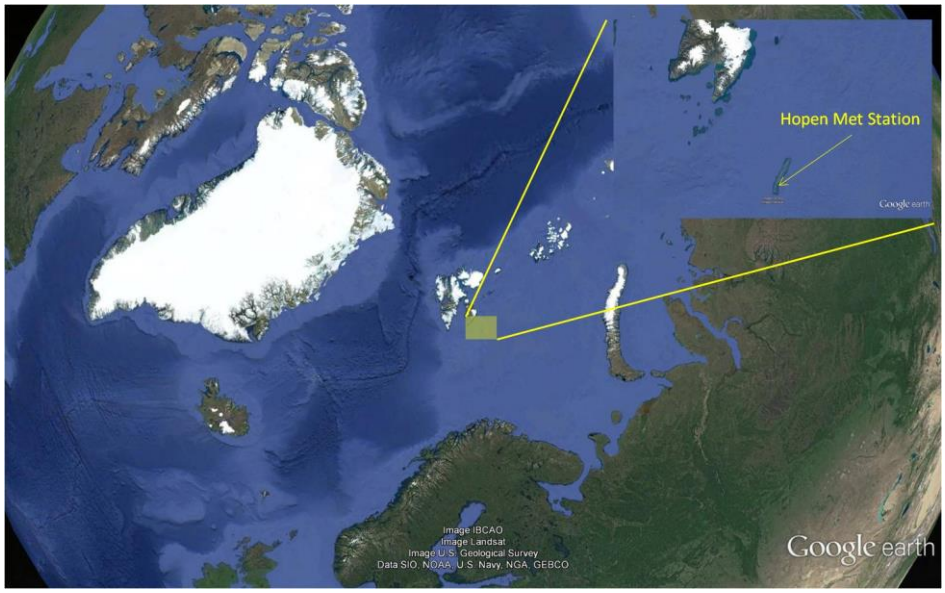
Purpose: Maritime Safety

Monitoring: Mix of ground observations and remote sensing

- Satellite (Automated detection using CFAR, but not run routinely due to lack of ground truth)
  - Sentinel-1a,b (EWS & IWS)
  - Radarsat-2 (SCW, Quad Fine)
  - COSMO SkyMed (ScanSAR, HIMAGE)
  - Further automated detection under development as part of Centre for Integrated Remote Sensing and Forecasting for Arctic Operations (CIRFA, https://cirfa.uit.no/)
- Ground observations (Very occasional)
  - From untrained meteorologists at Hopen and Bear Island weather stations, and untrained scientists on board research vessels.
  - Reports from Icelandic Met Office for Denmark Strait.

Modeling: None. MET Norway research department was running the NRC CHC iceberg drift and deterioration model until early 2013 but changed environmental models breaking the supply of forcing data. So far, no plans to reinstate the service.

Coverage:



Southern Hemisphere

Arctic and Antarctic Research Institute (AARI)

Product – Operational, weekly table of Antarctic icebergs using USNIC coding convention

- Depicts icebergs greater than 10 n.m. (name, position, dimensions, state)
- Region: Southern Ocean
- Format: CSV, ESRI shape

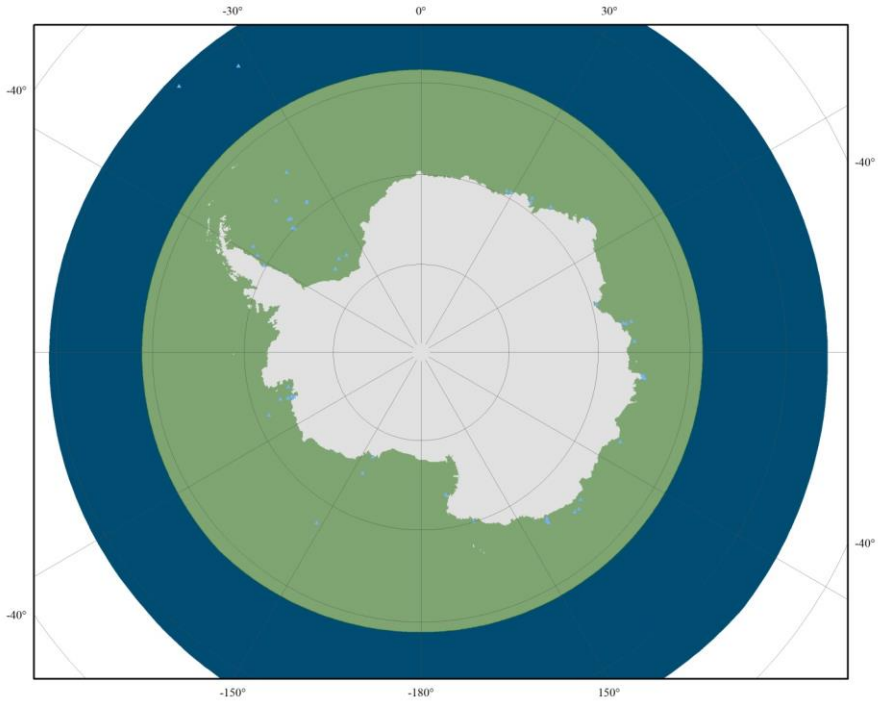
Purpose – pilot project in cooperation with NIC and NMI, Maritime Safety

Monitoring - Daily satellite with manual (visual) iceberg detection

- based on the data from optical sensors of low resolution (
- MODIS – optical sensors during summer period,
- AVHRR – during winter period
- Sentinel-1a,b (EWS & IWS)

Modeling: none

Coverage:



Alfred Wegener Institute (AWI) and University of Tromsø (UiT)

Results from research:

- Region: Weddell Sea, waters around Antarctica
- Format: for detection and tracking, different SAR sytems and imaging modes were used: ASAR wide swath mode (WSM HH), RS-2 quadpol fine, Sentinel EW HH/HV, Radarsat-1 Antarctic Mosaic, ERS-1 SAR
- Distribution: publications in scientific journals (see list below)

Purpose: study the robustness of iceberg detection in sea ice and open water and develop new tracking algorithms, classification of calving sites, statistics of iceberg sizes around Antarctica, simulations of iceberg drift for aiding tracking in SAR images

Monitoring: only in the framework of research projects (following iceberg paths for comparison with model calculations, using GPS buoys deployed on icebergs and Envisat ASAR WSM images)

Modeling: only in the framework of research projects (simple = fast model for calculating iceberg drift requiring only the wind field as input)

Antarctic Climate and Ecosystems Cooperative Research Centre (ACE CRC) and Antarctic Gateway Partnership Sea Ice Service

Results from research:

- Region: Waters around Antarctica, primarily off East Antarctica
- Format: Detection and tracking: images with either moderate or high resolution, such as acquired by SAR systems, vis/ir sensors, and coarser products such as derived from data acquired by scatterometer systems, as well as estimates of free-board height from various satellite altimeter systems. The data sets include location and time together with some combination of linear dimension or area icebergs and free-board height. In addition, an extensive data base has been accumulated from ship-board observations that were made during Antarctic re-supply voyages of location and horizontal dimension of the iceberg as seen from the observer's perspective. For some cases there have also been observations of free-board height using a sextant to measure subtended angle.
- Distribution: publications in scientific journals, and submissions to Antarctic science data centres.

Purpose: To study the tracks and dissolution rates of icebergs. Icebergs can be used as tracers of ocean currents and as analogues for investigation of the melt and decay of Antarctic ice shelves. The dissolution of icebergs contributes fresh water and particulate matter to the surface waters of the ocean affecting salinity and the stability of the near-surface stratigraphy, as well as productivity.
Monitoring: Systematic monitoring is not undertaken as part of the ice service. Monitoring of individual icebergs or clusters may be made on an ad hoc basis where there is a specific requirement for response to an emergency or other

ACE CRC (cont'd)

situation, and may also be included in sea ice assessment reports provided routinely to specific users as part of the sea ice service where relevant to their area of operations.

Modeling: Studies incorporating development of models of dissolution of icebergs and of their drift have been undertaken in the past. Response to a past emergency situation did include model assessment of the ocean circulation pattern in a localized area to inform vessel masters of the causes of observed ice behavior in their vicinity.

Argentine Naval Hydrographic Service

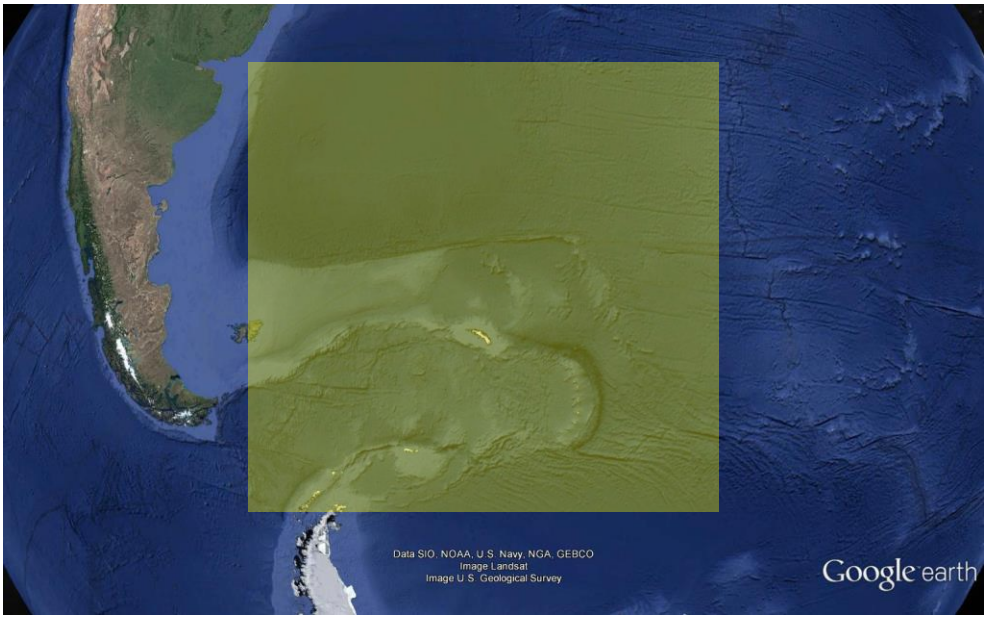
Product: Iceberg charts

- Region: Antarctic Peninsula, Drake Passage, S. Orkney Islands. NAVAREA VI
- Format: JPEG on the web site. Presently testing product for ECDIS format.
- Distribution: Daily in the web site and through the SafetyNet and NAVTEX systems for NAVAREA VI.

Purpose: Safety of Navigation. Public Service.

Monitoring: Remote sensing, aerial recognizance and land based observations.

Modeling: Argentina will begin testing and operational use of NAIS Operational Iceberg Drift and Deterioration Model in November 2016.



U.S. National Ice Center (NIC)

Product: Weekly table of Antarctic Icebergs with designator indicating origin, location and size information.

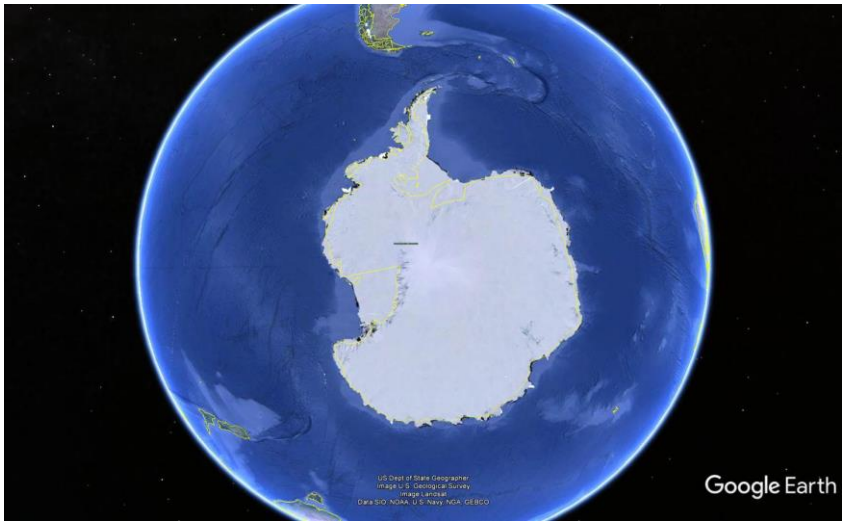
- Region: Southern ocean
- Format: Information provided as CSV or PDF in tabular format. Depicts icebergs greater than 10 nautical miles and those with areas greater than 20 nm^2 with designator indicating origin.
- Distribution: Available on NIC web site

Purpose: Maritime safety, Public interest

Monitoring: Daily satellite imagery manual analysis.

- Sentinel-1a,b (EWS & IWS)
- Radarsat-2 (ScanSAR Wide, Quad Fine)
- MODIS

Modeling: None



Acronyms

AARI	Arctic and Antarctic Research Institute
ACECRC	Antarctic Climate and Ecosystems Cooperative Research Centre
AVHRR	Advanced Very-High-Resolution Radiometer
AWI	Alfred Wegener Institute for Polar and Marine Research
CFAR	Constant False Alarm Rate (type of automated SAR detection algorithm)
CIS	Canadian Ice Service
CSK HIMAGE	COSMO-SkyMed image mode (40 km swath)
CSK ScanSAR Wide	COSMO-SkyMed ScanSAR Wide Region image mode (100 km swath)
CSV	Comma Separated Value data format
DLR	Deutsche Luft-Reederei (German Aerospace Center)
DMI	Danish Meteorological Institute
ECDIS	Electronic Chart Display and Information System
EF	Extra Fine. Radarsat-2 image mode (125 km swath)
EnviSAT ASAR	Envisat Advanced Synthetic Aperture Radar
ESA	European Space Agency
EWS	Extra Wide Swath. Sentinel-1a,b image mode (400 km swath)
IIP	International Ice Patrol
IWS	Interferometric Wide Swath. Sentinel-1a,b image mode (250 km swath)
JPEG	Joint Photographic Experts Group compression format for digital images
KML	Keyhole Markup Language developed for viewing geographic information using Google Earth
METAREA	Geographical area for coordinating broadcast of meteorological information
MODIS	Moderate Resolution Imaging Spectroradiometer
NAIS	North American Ice Service
NAVAREA	Geographical sea area for coordinating the broadcast of navigational safety information
NAVTEX	Navigational TELex is a medium frequency system for transmitting
NetCDF	Network Common Data Format
NIC	National Ice Center
NIS	Norwegian Ice Service
NMI	Norwegian Meteorological Institute
NRC CHC	National Research Council - Canadian Hydraulic Centre
PNG	Portable Networks Graphic (image compression format)
Polar TEP	Polar Thematic Exploitation Platform
SafetyNET	System used for transmission of maritime safety information via
SCN	ScanSAR Narrow. Radarsat-2 image mode (300 km swath)
SCW	ScanSAR Wide. Radarsat-2 image mode (500 km swath)
SIGRID-3	Sea Ice GeoReferenced Information and Data, Version 3
TSX ScanSAR	TerraSAR-X image mode (100 km swath)
UiT	University of Tromsø
WMO	World Meteorological Organization