Detect and monitor ice-risk at sea

Application

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Sea ice and icebergs pose a significant set of challenges in and around icebound regions. The level of shipping and offshore activities in these regions is growing steadily and with it the demand for reliable sea ice information. Particularly with the melting of the Artic sea ice, the region becomes more and more attractive for oil and gas activities.

Sea ice is formed of sea water whereas icebergs are calved from coastal glaciers, thus from fresh water and aren't encountered in the same areas. Sea ice is a major hazard that can damage ships or vessels transporting passengers, oil, natural gas or goods. Remote sensing and satellite technologies give the possibility to study sea ice and measure for instance its thickness, its spatial extent, its motion and ridges. This information is important to know to manage operations in hazardous sea ice conditions.

Use of Satellite Imagery

Satellite imagery provides wide area, synoptic pictures of the ice conditions. Since the scale of ice fields is quite large, mainly moderate resolutions are fine down to around 10m in scale. Multispectral imagery can provide more information on ice-type but in the main, SAR imagery is used due to its all-weather and day/night capability.

The data collected can be more accurate than in-situ measurements due to a higher and faster coverage of a whole area. Constant monitoring is most important to identify the risk and opportunities (for instance in opening shipping lanes).

Uses and users

Information on sea ice can help several sectors and is used in cases such as:

- Serving of offshore platforms: The oil and gas companies need to comply with very strict standards on security and protection of the environment to monitor platforms remotely and minimize risk of damage in ice-covered areas. Earth observation plays an important role assessing the ice conditions throughout the oil and gas lifecycle. Areas of current oil and gas interest include the Barents Sea (Shtockman), east and west Greenland, and the Beaufort and Chukchi Seas.
- Protecting platforms from icebergs: SAR imagery can provide regular updates on icebergs positions. Icebergs have a different distribution than sea ice and challenges oil and gas platforms particularly around Greenland, along the east Canadian coast, in the Barents Sea and, potentially, in the south Atlantic (Falkland Islands).
- Routing ships safely (either for platforms or ports): Information on sea ice can contribute to improve navigation significantly in icebound regions. Ship need up to date information on location of ice edge and ice-free routes. Maps of the ice conditions are produced daily and delivered to ships operators and public authority. Based on these maps, ice motion, concentration, thickness and ridges can be forecasted. Icebreakers also use imagery to clear sea lanes to ensure safe passage of ships. This service can serve populated areas with ice bounded water in winter such as the Baltic, Russia, the North of China or Canada.

Impact

More than 20,000 ships travel through the Baltic to Finnish and Swedish ports on an average winter. According to EARSC analysis, between €24m and €116m per annum of economic value is being generated in Finland and Sweden thanks to the use of satellite radar images to help winter navigation in the region. There are also environmental benefits as marine pollution decreases through fewer accidents and CO2 emissions are reduced as ships save fuel thanks to more efficient routing.

As for the Arctic, according to the US Geological Survey, 30% of the world's gas and 11% of the world's oil deposits are estimated to lie beneath the region. The overall economic and environmental impacts of new shipping ways through the Arctic have not yet been made clear.

Products

Products	Source	Descriptions	Product Standards	Ref. Project

Sea-ice and Icebergs	Polarview ESA GSE	ship and iceberg monitoring sea ice floe edge advisory high resolution ice charts sea-ice thickness charts met-ice ocean regional forecasting medium resolution ice charting (Greenland) global sea-ice monitoring	sea-ice and icebergs	Polarview
Sea Ice mapping		Improve navigation safety and efficiency through the ice (lesser risks of pollution, less fuel consumption, less idle time) Assistance to ice-breaking services Maritime navigation in Icebergs areas		MyOcean SIDARUS MAIRES
Ice coverage monitoring				MyOcean
ice thickness	NERSC	radar altimeter signals of sea ice and validate retrieval of ice thickness from CryoSat-2 data		Prodex Cryosat
ice sheet dynamics	NERSC	variability and changes in ice-sheet elevation; mass balance estimates;		SEALEV
sea ice variability	NERSC	ice variability, trends and uncertainties over the last 3 decades using passive microwave data from satellites		ArticSIV
ice charts				IceMar
Ice Navigation	KSAT Ice Navigation	provides near-real time data on Iceberg locations to enable successful navigation for ships		KSAT Ice Navigation
Sea Ice Mapping		Improves navigation safety and efficiency through the ice (lesser risks of pollution, less fuel consumption, less idle time) Assistance to ice-breaking services Maritime navigation in Icebergs areas		MyOcean SIDARUS MAIRES

Success Stories

Operational risk in ice-prone waters	Winter navigation in the Baltic
? Unknown Attachment	? Unknown Attachment

References

Topic	Description	Key words	Reference
Arctic Sea Ice News	**Article** - Scientific analysis on Sea Ice conditions	Arctic, Sea Ice	NSIDC
CryoSat	**Article** - Earth explorer mission to monitor Ice	Ice, Earth explorer, Mission	ESA
ICEMON	**Project** - Sea Ice monitoring in the polar regions	Sea, Ice, Monitoring, polar	Polar View
DAMOCLES	**Project** - an integrated ice-atmosphere-ocean monitoring and forecasting system designed for observing, understanding and quantifying climate changes in the Arctic. This project ended in 2010 and the website will not be updated.	Ice, Climate Change, Arctic	DAMOCLES
ICESat	**Article** on ICESat (Ice, Cloud,and land Elevation Satellite) is the benchmark Earth Observing System mission for measuring ice sheet mass balance, cloud and aersol heights, as well as land topography and vegetation characteristics	Ice, Earth observation, Land	NASA
Icelights: Your Burning Questions About Ice & Climate	**Article** on Ice and climate change	Ice, Climate change, Earth observation	NSIDC
Ice mission ready for launch	**Article** on ESA's CryoSat-2	Ice, Mission, Earth observasion	NERC
Cryosat-2 data reveals Arctic ocean circulation	**Article** on ESA's CryoSat-2 findings	Ice, CryoSat-2, Earth observation	NERC
Ice Information Services	**IICWG report** on Socio-Economic benifits and Earth Observation requirements	Ice, Earth observation, Climate change	NSIDC
Ice Hazards	**Report** identifies requirements and reviewes the current and projected utility of earth observation space technology as applied to the detection, mapping and management of ice hazards	Ice, Hazards, Earth observation, Mapping	IGOS
The use of Earth Observing Satellites for Hazard Support	**Fina CEOS report** on assessments & scenarios	Ice, Hazard, Earth observation	ESA

CryoLand - GMES Service Snow and Land Ice - Interoperability, Service Integration and User Access	**Research paper** on the CryoLand project (Requires purchasing to view full text)	Ice, snow, spatial data infrastructure, Service architecture	SpringerLink
Digital Image Processing of Earth Observation Sensor Data	**Research paper** describing digital image processing techniques that were developed to precisely correct Landsat multispectral Earth observation data and gives illustrations of the results achieved (Available to subscribers and IEEE members)	Ice, Earth observation	IEEE
Canadian Polar Communication and Weather (PCW) satellite system	**Presentation** on the new capabilities for mapping Arctic snow and ice dynamics from Highly Elliptical Orbit of PCW Satellite system	Ice, Satellite, Polar	Canadian Space Agency
An ice topography observation system (ITOS) on the ODIN platform	**Research paper** gives a brief description of the mission and the defined elements of the mission architecture, i.e. the mission parameters, the payload (laser altimeter) and the spacecraft (Requires purchasing to view full text)	Ice, Spacecraft	ScienceDirect
Arctic ice thickness drops by up to 19 per cent	**News article** on Arctic ice	Ice, Arctic, Earth observation	Telegraph
Atmospheric controls on sea ice motion in the southern Beaufort Sea	**Research paper** based on the comparison of ice and atmospheric relative vorticity fields in the Beaufort Sea region (BSR) for all weeks from 1979 to 2000	Ice, Sea, Earth observation	JGR
New ice thickness map of the Arctic unveiled	**News article** on the first map of sea-ice thickness from ESA's CryoSat mission	Ice, Sea, Satellite	ESA
Millimetre-Wave Aperture Synthesis Radiometry for Snow and Ice Mapping	**Research paper** discusses the design of a thinned-array synthetic aperture interferometric radiometer (SAIR) for dual applications	Ice, Snow, Earth observation, Wave	EPS
Measurements Of Winter Arctic Sea Ice Shows Continuing Ice Loss	**News article** on Arctic sea ice	Ice, Sea, Arctic, Earth observation	SpaceDaily
Norwegian Satellite Earth Observation Database for Marine and Polar Research	**Full infrastructure proposal** for the NORMAP project targeting an important segment of satellite based Earth Observations (EO) in the high latitude and Arctic regions	Ice, Arctic, Earth observations, NORMAP	NERSC