Seventh Framework Programme FP7-SPACE-2010-1
EU-Russia Cooperation in GMES (SICA)

Grant agreement for: Collaborative Project
Project acronym: **MAIRES**
Project title: **Monitoring Arctic Land and Sea Ice using Russian and European Satellites**

Grant agreement no. 263165
Start date of project: 01.06.11
Duration: 36 months
Project coordinator: Nansen Environmental and Remote Sensing Center, Bergen, Norway

D7.2 Material for promotion and education

Due date of deliverable: 31.05.2014

Actual submission date: 01.07.2014

Organization name of lead contractor for this deliverable: NERSC

Project co-funded by the European Commission within the Seventh Framework Programme, Theme 6 SPACE		
Dissemination Level		
PU	Public	x
PP	Restricted to other programme participants (including the Commission)	
RE	Restricted to a group specified by the consortium (including the Commission)	
CO	Confidential, only for members of the consortium (including the Commission)	

ISSUE	DATE	CHANGE RECORDS	AUTHOR
1.0	01/07/2014	Version 1.0	N. Zakhvatkina

MAIRES CONSORTIUM

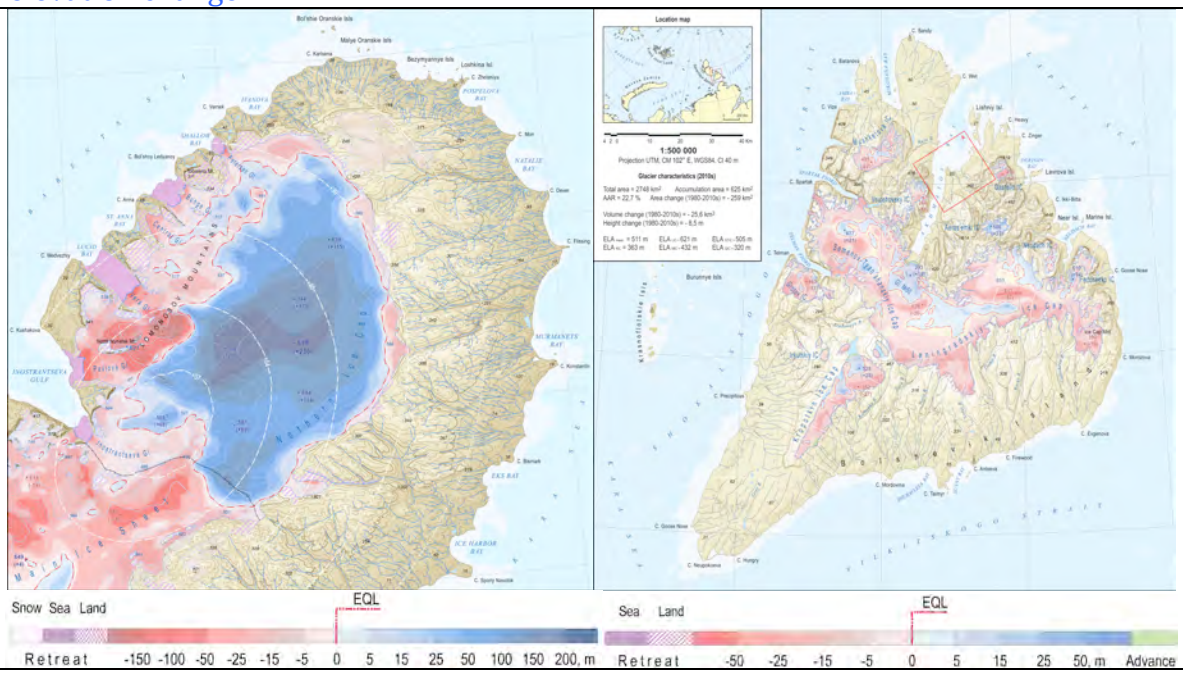
Participant no.	Participant organisation name	Short name	Country
1 (Coordinator)	Nansen Environmental and Remote Sensing Center	NERSC	NO
2	JOANNEUM RESEARCH Forschungsgesellschaft mbH	JR	AU
3	Scientific foundation Nansen International Environmental and Remote Sensing Centre (NIERSC)	NIERSC	RU
4	Moscow State University of Geodesy and Cartography	MIIGAiK	RU

Monitoring Arctic Land and Sea Ice using Russian and European Satellites

Collaborative project under FP7-SPACE 2011-2013
EU-Russia Cooperation in GMES (SICA)

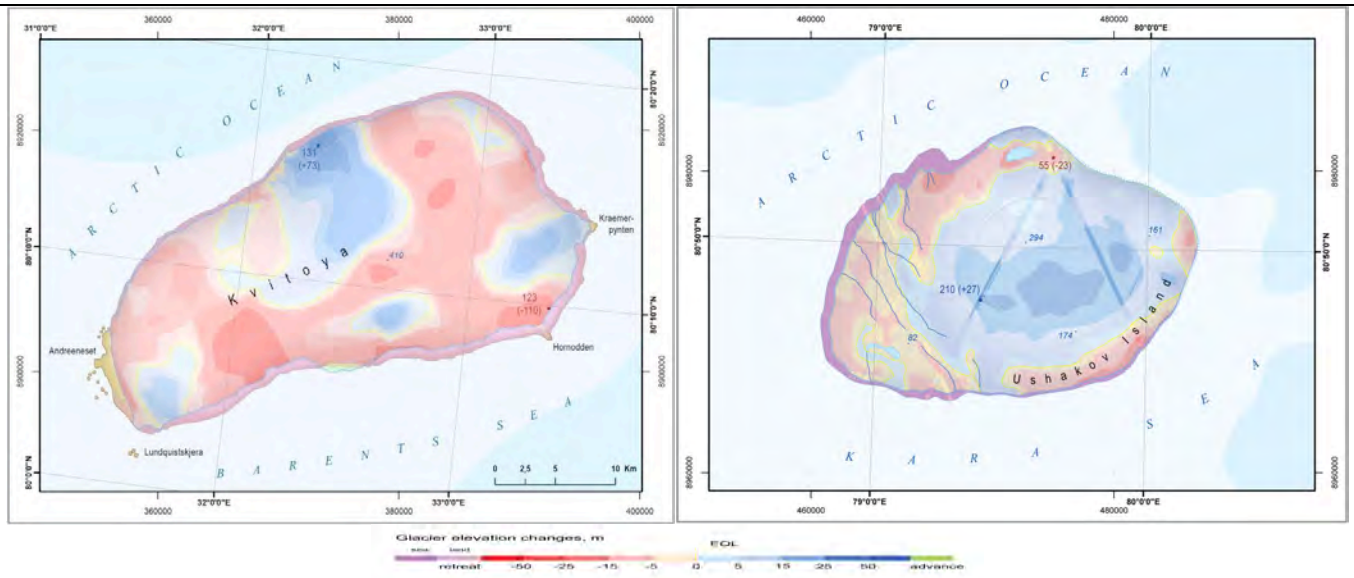
Glacier changes in the Eurasian Arctic

Glacier elevation change



Glacier elevation changes in the Barents-Kara-Laptev region over the past 60 years was performed by means of joint geometric processing of altimetric, interferometric and reference elevation data (Russian topographic and hydrographic maps, ICESat GLA06, Cryosat-2, etc). The results models of glacier changes allowed a precise measurement of glacier changes in linear, areal and volumetric terms. The research revealed the reduction of glacier area and general lowering of the glacier surface on most ice caps. **Left, Novaya Zemlya, Northern Ice Cap (1950 - 2010s):** Total area = 1976 km2, Accumulation area = 1352 km2, ELA mean = 436 m, Height change = + 46 m, Area change = - 204 km2 and Volume change = + 99,8 km3. **Right, Severnaya Zemlya Bol'shevik island(1980 – 2010s):** Total area = 2748 km2, Accumulation area = 625 km2, ELA mean = 511 m, Height change 010s) = - 8,5 m, Area change = - 259 km2, Volume change = -25,6 m.

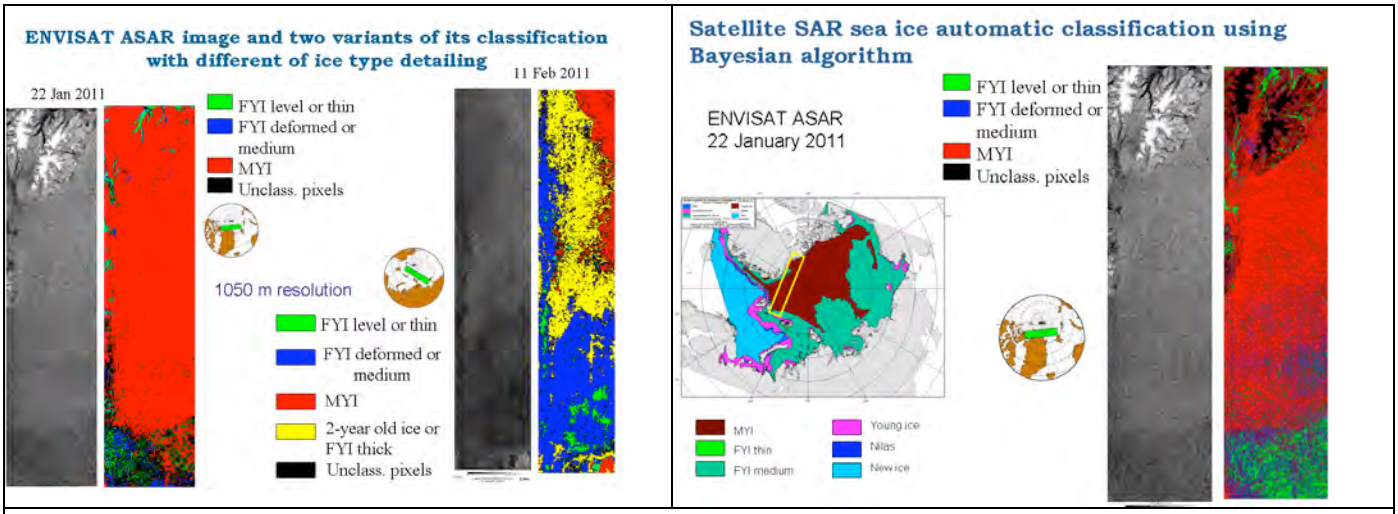
Glacier mass balance



In the course of past 60 years, the insular glaciation in the Barents, Kara and Laptev seas lost nearly 1,005±20 km^3 (-4.5%) of its volume and its total area decreased by 2,030±100 km^2 (-2%). The cumulative mass budget in the study region is negative while individual rates of volume change vary from -3 km^3/a to +0.6 km^3/a and the glacier change pattern commonly remains heterogeneous. **Left, Kvitoya (1987-2011):**ΔH = -15.2 m; ΔS = -52.1 km2; ΔV = -15.8 km3 (Ice) Source data: ERS-2 INSAR (31.03/06.04.2011). **Right, Shmidt Island (1956-2012):** ΔH = 0.4 m; ΔS = -39.4 km2; ΔV = -2.2 km3 (Ice) Source data: TanDEM-X INSAR (27.04.2011)

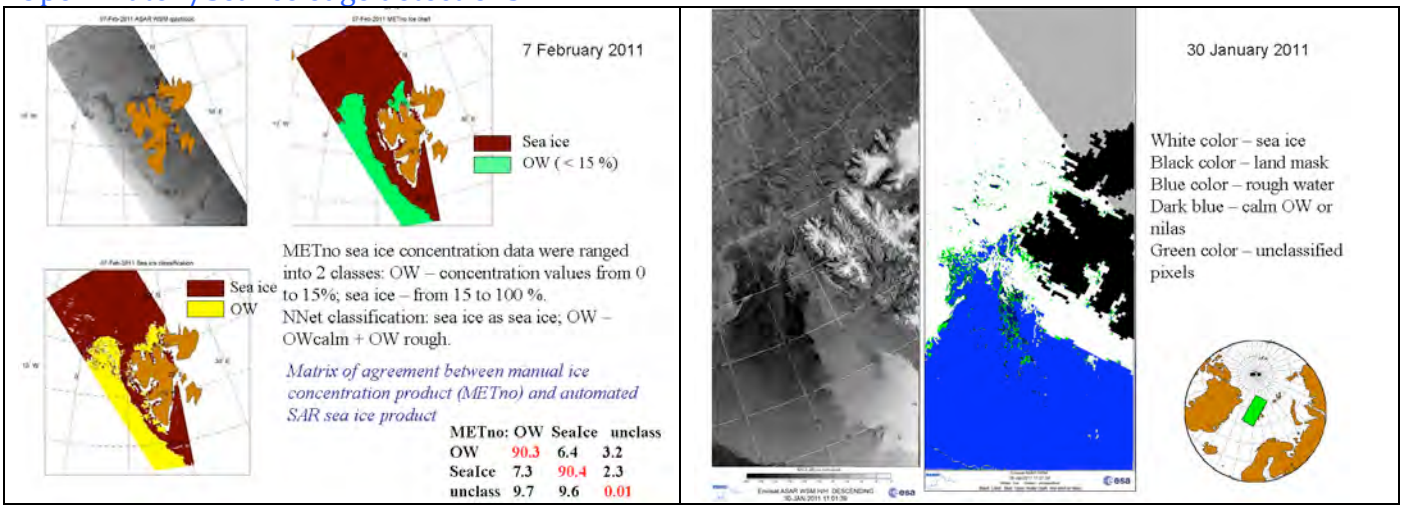
Sea ice products

Sea Ice Classifications



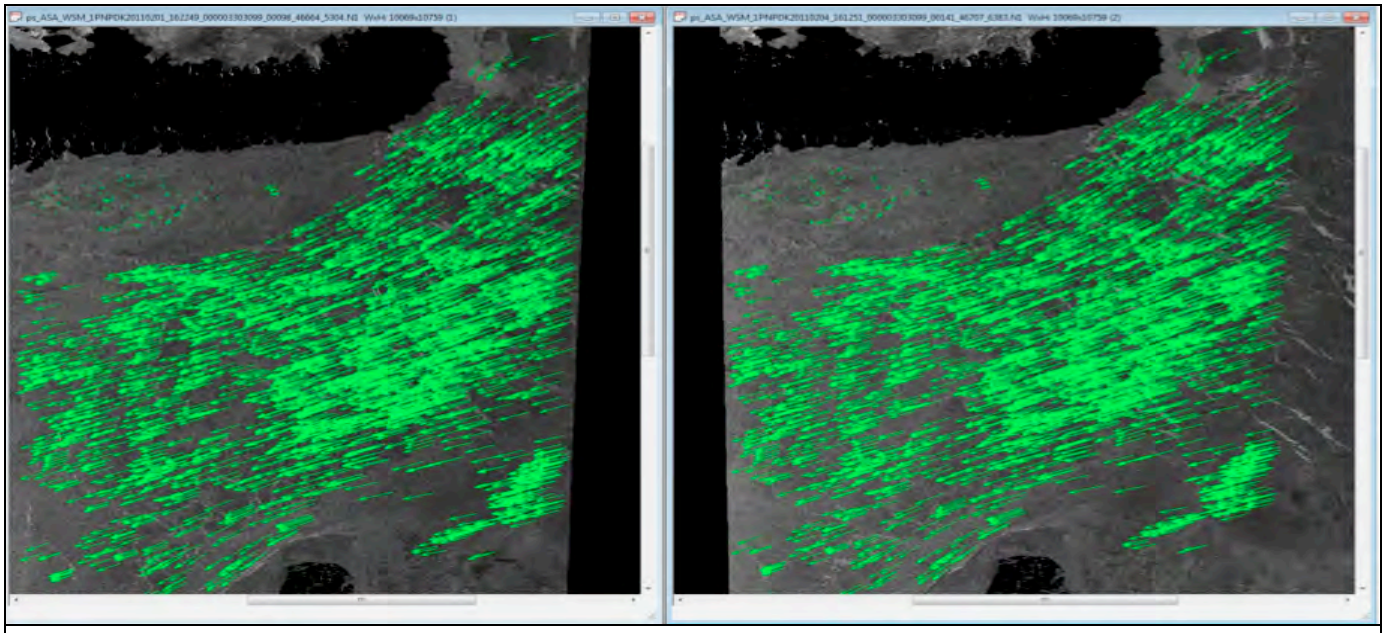
Sea ice occurs in a wide range of types and forms, and affects significantly and directly marine transport and navigation. Economic and social developments are engendering significant increases in international shipping, particularly in areas susceptible to sea ice. SAR image reflects the geometric and electromagnetic properties of the ice surface, because the backscatter from sea ice in C-band is dominated by the surface backscatter. **Left**, Result of Neural Network (NN) automated classification, full ENVISAT ASAR image scene with different sea ice type number (general sea ice types for the Central Arctic on the left figure and more detailed thick sea ice on the right). **Right,** Result of Bayesian automated classification: (left) general ice chart manually developed in AARI for 21 – 23 January 2011; (right) full ENVISAT ASAR image scene: corrected image and the result with 3 sea ice types with 300 meter final resolution.

Open Water /Sea Ice edge detections



The algorithm for sea ice edge\OW detection were developed using NN approach. The Arctic sea ice edge\OW detection product is based on ENVISAT ASAR images together with a coarser ice concentration product from AMSR-E. The SAR data during prepossessing are averaging to a spatial resolution of 525 m x 525 m in pixel. AMSR-E data is interpolated into same grid. **Left**, automated classification of OW\sea ice edge; corrected ASAR scene acquired 7 February 2011, upper (left), collocated subset of a manual ice concentration product of Met.no for the same day; upper (right), classification product. SAR OW\ice edge lower (left) product are compared with a manual ice concentration product of Met.no: main diagonal (red colored) of presented error matrix shows the percentage of agreement between areas of the same classes. **Right**, automated classification of OW\sea ice edge; operational product.

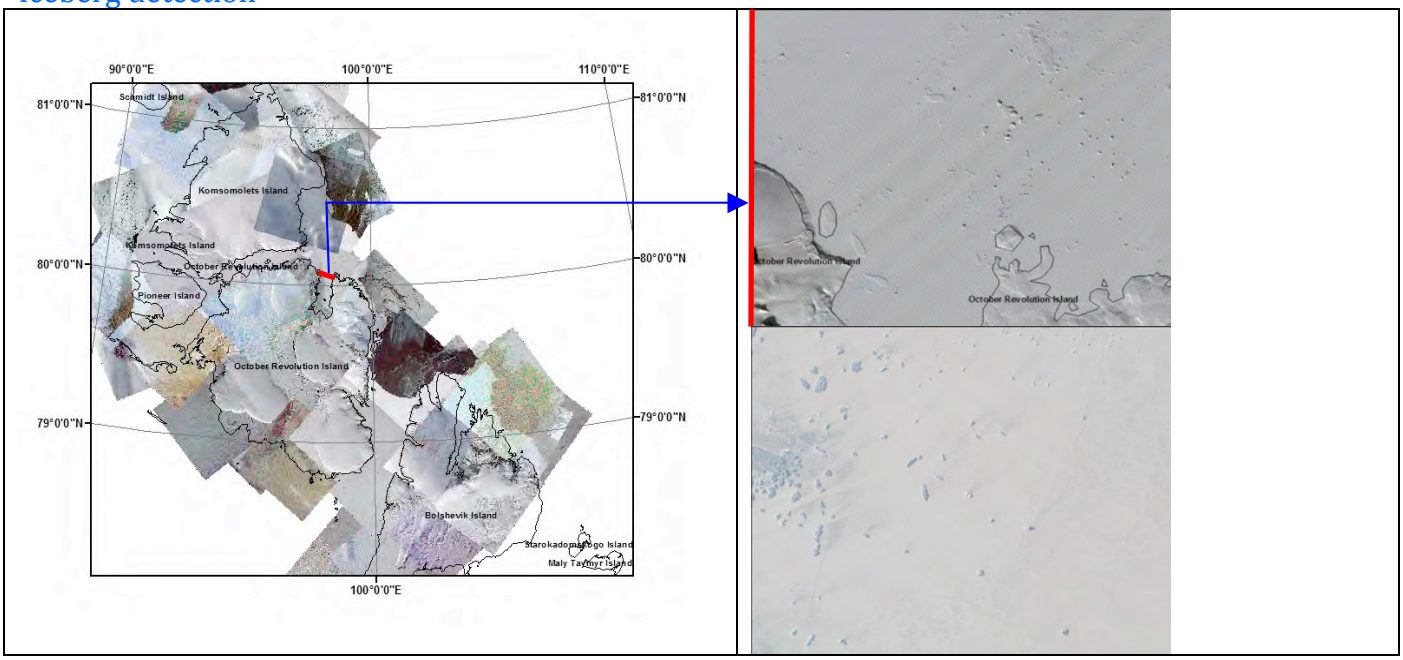
Sea Ice drifts



Sea ice motion can be estimated from a set of two radar images recorded at different points in time. Improved sea ice drift retrieval algorithm has been developed and tested over Kara sea and Northern part of the Barents sea region. It is a novel combination of feature-based techniques. **Left**, ASAR ENVISAT image covering the Kara Sea from 2011/02/01. **Right,** ASAR ENVISAT image covering the Kara Sea from 2011/02/04. Both images are overlaid with drift arrows calculated based on the two images.

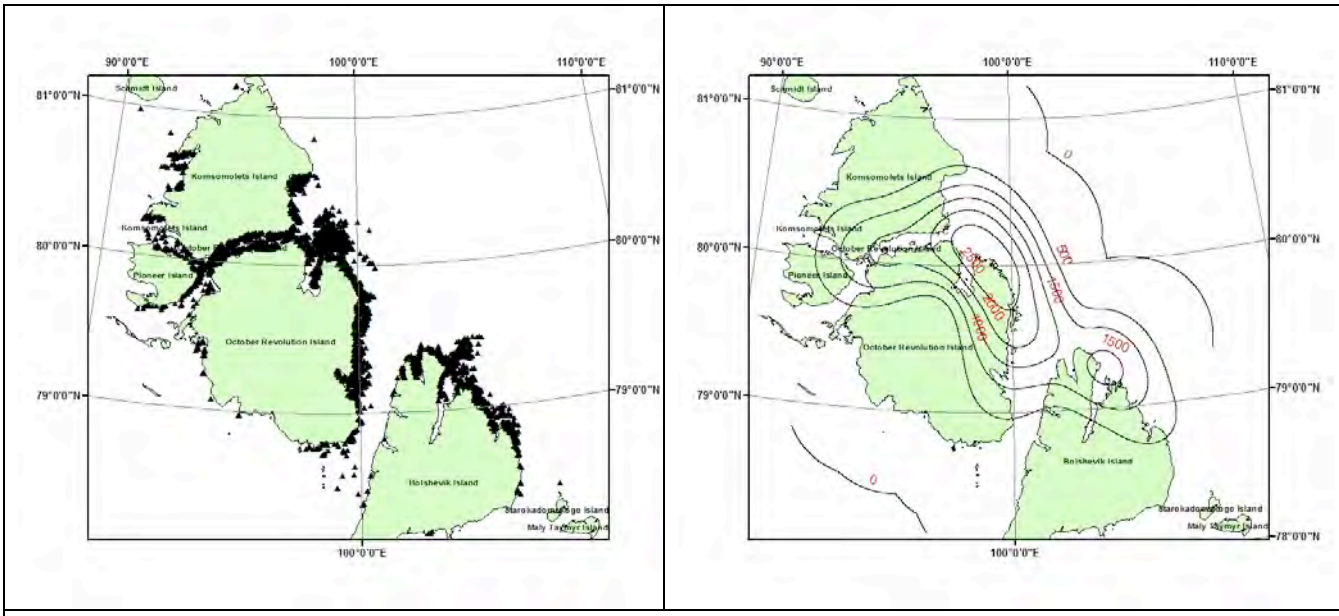
Iceberg detection and monitoring

Iceberg detection



Icebergs drifting in the ocean are one of the most dangerous threats to offshore operations. Icebergs are commonly found off eastern Canada, around Greenland, in the Barents Sea and several places in the Russian Arctic. Icebergs are well detected from high-resolution visible images from Landsat, Aster, "Monitor-E" and other satellites, received in light conditions in absence of clouds. **Left** ASTER images from March and April covering Severnaya Zemlya. **Right** zoomed in part of the ASTER images used in the analysis where iceberg are easy to detect.

Iceberg monitoring



Analysis of iceberg distribution and temporal changes near the boundaries of the outlet glaciers is important parameters for icebergs monitoring. Usually, glaciers with good coverage of high-resolution images are selected. The average number of icebergs per unit area is calculated for these regions. These estimates are compared with the historical maps data and ship observations. The changes in iceberg distribution in the areas under study is assessed and analyzed. Here, **Left**, a map of iceberg distribution for Severnaya Zemlya based on ASTER images from (Mach-April 2012). **Right**, iceberg density map based on the icebergs distribution map, the isoline represent the number of iceberg per 100 X 100 km. These maps are compared with the maps presented in Atlas by Abramov, which are based on air reconnaissance

The overall objective of MAIRES is to develop methodologies for satellite monitoring of Arctic glaciers, sea ice and icebergs. Methodologies to retrieve quantitative information from the ESA and RKA data will be developed, and examples of satellite derived products for each of the three thematic areas will be presented.

Summary

Satellite Earth Observation (EO) data provides unique opportunities to studying Arctic climate processes and in particular changes in the cryosphere. There have never been more polar orbiting satellites in operation, providing EO data for environmental monitoring on global and regional scale. Use of EO data is necessary in several climate-related scientific disciplines, providing methods for environmental monitoring, support to marine operations, resource management and contribution to education. The user requirements for land and sea ice information in the Arctic region are growing as a result of climate change and its impact on the environment and human activities. The expected growth in ship traffic, oil and gas exploration, fisheries and tourism in the coming years will increase the risk of accidents affecting the environment, health, safety and economy of this unique and vulnerable region. The EU has started developing the Arctic policy1 with the environmental protection and sustainable use of resources considered as issues of the highest priority (EU Communication, 2008).

Products

- Glacier changes in the Eurasian Arctic
  - Glacier elevation changes in the Barents-Kara-Laptev region over the past 60 years was performed by means of joint geometric processing of altimetric, interferometric and reference elevation data and the mass balance of these glaciers were estimated.
- Sea ice products
  - Improvement of SAR-based Sea ice classification and sea ice drift methods to map details of the ice cover, sea ice drift and sea ice edge\ open water detection.
- Iceberg detection and monitoring
  - Iceberg maps from high-resolution satellite images were produced and analysis of iceberg distribution was carried out near the boundaries of the outlet glaciers in Franz Josef Land and Severnaya Zemlya. ASTER images were used. The average number of icebergs per unit area has been calculated for these regions. These estimates has been compared with the historical maps, presented in Atlas by Abramov, which are based on air reconnaissance data and ship observations.

Consortium

- Stiftelsen Nansen Senter for Fjernmaling (NERSC) Norway
- Joanneum Research Forschungsgesellschaft MBH (JR) Austria
- Scientific Foundation Nansen International Environmental And Remote Sensing Centre (NIERSC) Russia
- Moscow State University Of Geodesy And Cartography (MIIGAiK) Russia

Further Information:
Project coordinator:
stein.sandven@nersc.no (NERSC)

MARIES website:
http://maries.nersc.no/